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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	092546
	Application Number	
Title of Invention	METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
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Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Applicant Information:

Applicant 1

Applicant Authority	◉ Inventor	○ Legal Representative under 35 U.S.C. 117	○ Party of Interest under 35 U.S.C. 118

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Citizenship under 37 CFR 1.41(b)	CN				
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Applicant Authority (•) Inventor ( ) Legal Representative under 35 U.S.C. 117 ( ) Party of Interest under 35 U.S.C. 118

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Citizenship under 37 CFR 1.41(b)	IN				

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All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	23696		
Email Address	us-docketing@qualcomm.com	Add Email	Remove Email

Application Information:

Title of the Invention	METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM		
Attorney Docket Number	092546	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Suggested Class (if any)		Sub Class (if any)	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	14	Suggested Figure for Publication (if any)	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S. C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Enter either Customer Number or complete the Representative Name section below. If both sections are completed the Customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	23696		

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Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	non provisional of	61218769	2009-06-19
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	non provisional of	61294053	2010-01-11
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	non provisional of	61305014	2010-02-16

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).

Remove

Application Number	Country	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
			Yes / No

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Assignee Information:

Providing this information in the application data sheet does not substitute for compliance with any requirement of part 3 of Title 37 of the CFR to have an assignment recorded in the Office.

Assignee 1

If the Assignee is an Organization check here. ☒

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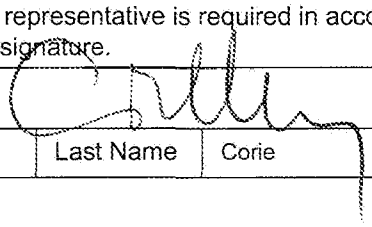
Application Data Sheet 37 CFR 1.76	Attorney Docket Number	092546
	Application Number	
Title of Invention	METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM	

Additional Assignee Data may be generated within this form by selecting the **Add** button.

Signature:

A signature of the applicant or representative is required in accordance with 37 CFR 1.33 and 10.18. Please see 37 CFR 1.4(d) for the form of the signature.

Signature				Date (YYYY-MM-DD)	2010-06-17
First Name	Florin	Last Name	Corie	Registration Number	46244



This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application Serial No. 61/218,769 entitled "TIMING ALIGNMENT IN A MULTICARRIER SYSTEM," which was filed June 19, 2009, U.S. Provisional Patent Application Serial No. 61/294,053 entitled "TIMING ALIGNMENT IN A MULTICARRIER SYSTEM," which was filed January 11, 2010, and U.S. Provisional Patent Application Serial No. 61/305,014 entitled "TIMING ALIGNMENT IN A MULTICARRIER SYSTEM," which was filed February 16, 2009. The aforementioned applications are herein incorporated by reference in their entirety.

BACKGROUND

I. Field

[0002] The following description relates generally to wireless communications, and more particularly to methods and apparatuses that facilitate maintaining timing synchronization for user equipment in a multicarrier Long Term Evolution-Advanced (LTE-A) system.

II. Background

[0003] Wireless communication systems are widely deployed to provide various types of communication content such as voice, data, and so on. These systems may be multiple-access systems capable of supporting communication with multiple users by sharing the available system resources (e.g., bandwidth and transmit power). Examples of such multiple-access systems include code division multiple access (CDMA) systems, time division multiple access (TDMA) systems, frequency division multiple access (FDMA) systems, 3GPP Long Term Evolution (LTE) systems, and orthogonal frequency division multiple access (OFDMA) systems.

[0004] Generally, a wireless multiple-access communication system can simultaneously support communication for multiple wireless terminals. Each terminal communicates with one or more base stations via transmissions on the forward and

reverse links. The forward link (or downlink) refers to the communication link from the base stations to the terminals, and the reverse link (or uplink) refers to the communication link from the terminals to the base stations. This communication link may be established via a single-in-single-out, multiple-in-signal-out or a multiple-in-multiple-out (MIMO) system.

[0005] A MIMO system employs multiple (N_T) transmit antennas and multiple (N_R) receive antennas for data transmission. A MIMO channel formed by the N_T transmit and N_R receive antennas may be decomposed into N_S independent channels, which are also referred to as spatial channels, where $N_S \leq \min\{N_T, N_R\}$. Each of the N_S independent channels corresponds to a dimension. The MIMO system can provide improved performance (e.g., higher throughput and/or greater reliability) if the additional dimensionalities created by the multiple transmit and receive antennas are utilized.

[0006] A MIMO system supports a time division duplex (TDD) and frequency division duplex (FDD) systems. In a TDD system, the forward and reverse link transmissions are on the same frequency region so that the reciprocity principle allows the estimation of the forward link channel from the reverse link channel. This enables the access point to extract transmit beamforming gain on the forward link when multiple antennas are available at the access point.

[0007] With respect to timing synchronization in a single-carrier environment, it is noted that the maintenance of such timing synchronization for user equipment (UE) includes having the UE receive an uplink/downlink offset from the network, which occasionally needs to be updated, indicating how it should align its uplink transmissions in relation to the received downlink timing. In a multicarrier environment, however, the synchronization is more complex. Assuming that all carriers serving a single UE are transmitted from the same cell site, it appears that a common offset should be adequate. However, even co-sited carriers could experience some variation in timing for a number of reasons (e.g., cable delays, distance between the base station site and a remote radio head, etc.), which would make separate timing offsets per carrier beneficial or even necessary.

[0008] The above-described deficiencies of current wireless communication systems are merely intended to provide an overview of some of the problems of

conventional systems, and are not intended to be exhaustive. Other problems with conventional systems and corresponding benefits of the various non-limiting embodiments described herein may become further apparent upon review of the following description.

SUMMARY

[0009] The following presents a simplified summary of one or more embodiments in order to provide a basic understanding of such embodiments. This summary is not an extensive overview of all contemplated embodiments, and is intended to neither identify key or critical elements of all embodiments nor delineate the scope of any or all embodiments. Its sole purpose is to present some concepts of one or more embodiments in a simplified form as a prelude to the more detailed description that is presented later.

[0010] In accordance with one or more embodiments and corresponding disclosure thereof, various aspects are described in connection with maintaining timing synchronization for user equipment in a LTE-A system. In one aspect, methods and computer program products are disclosed that facilitate a timing alignment in a multicarrier system. These embodiments include determining at least one downlink timing associated with at least one downlink carrier, and ascertaining an uplink timing associated with an uplink group of carriers. For these embodiments, the uplink timing is ascertained based on a processing of at least one downlink timing and a timing offset associated with the uplink group of carriers. Each of the uplink group of carriers is then transmitted within a threshold value of the uplink timing.

[0011] In another aspect, an apparatus configured to facilitate a timing alignment in a multicarrier system is disclosed. Within such embodiment, the apparatus includes a processor configured to execute computer executable components stored in memory. The computer executable components include a downlink timing component, an uplink timing component, and a communication component. The downlink timing component is configured to determine at least one downlink timing associated with at least one downlink carrier, whereas the uplink timing component is configured to ascertain an uplink timing associated with an uplink group of carriers. For this embodiment, the uplink timing is ascertained based on at least one downlink timing and a timing offset associated with the uplink group of carriers. The communication

component is then configured to transmit each of the uplink group of carriers within a threshold value of the uplink timing.

[0012] In a further aspect, another apparatus is disclosed. Within such embodiment, the apparatus includes means for determining, means for ascertaining, and means for transmitting. For this embodiment, the means for determining determines at least one downlink timing associated with at least one downlink carrier, whereas the means for ascertaining ascertains an uplink timing associated with an uplink group of carriers. For this embodiment, the uplink timing is ascertained based on at least one downlink timing and a timing offset associated with the uplink group of carriers. The means for transmitting then transmits each of the uplink group of carriers within a threshold value of the uplink timing. In other embodiments, the apparatus further includes a means for performing a random access procedure on at least one random access carrier. For this embodiment, the at least one random access carrier is included in a downlink group of carriers that includes the at least one downlink carrier.

[0013] In another aspect, other methods and computer program products are disclosed for facilitating a timing alignment in a multicarrier system. For these embodiments, various acts are provided, including an act to transmit a downlink communication to a wireless terminal via at least one downlink carrier. These embodiments further include assigning a timing offset to an uplink group of carriers, and providing the timing offset to the wireless terminal via the at least one downlink carrier. An uplink communication is then received via the uplink group of carriers according to the timing offset.

[0014] Another apparatus for facilitating a timing alignment in a multicarrier system is also disclosed. Within such embodiment, the apparatus includes a processor configured to execute computer executable components stored in memory. The computer executable components include a timing offset component, a transmitting component, and a receiving component. The timing offset component is configured to assign a timing offset to an uplink group of carriers, whereas the transmitting component is configured to provide the timing offset to a wireless terminal via at least one downlink carrier. The receiving component is then configured to receive an uplink communication via the uplink group of carriers according to the timing offset.

[0015] In a further aspect, another apparatus is disclosed. Within such embodiment, the apparatus includes means for transmitting, means for assigning, means

for providing, and means for receiving. For this embodiment, the means for transmitting transmits at least one downlink carrier to a wireless terminal. The means for assigning then assigns a timing offset to an uplink group of carriers, whereas the means for providing provides the timing offset to the wireless terminal via the at least one downlink carrier. The means for receiving then receives an uplink communication via the uplink group of carriers according to the timing offset. In another embodiment, the apparatus further includes a means for generating a timing message. For this embodiment, the timing message includes a set of uplink timing instructions which are provided to the wireless terminal.

[0016] To the accomplishment of the foregoing and related ends, the one or more embodiments comprise the features hereinafter fully described and particularly pointed out in the claims. The following description and the annexed drawings set forth in detail certain illustrative aspects of the one or more embodiments. These aspects are indicative, however, of but a few of the various ways in which the principles of various embodiments can be employed and the described embodiments are intended to include all such aspects and their equivalents.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. 1 is an illustration of a wireless communication system in accordance with various aspects set forth herein.

[0018] FIG. 2 is an illustration of an exemplary wireless network environment that can be employed in conjunction with the various systems and methods described herein.

[0019] FIG. 3 is an illustration of an exemplary system where two timing groups are associated with a single eNodeB according to an embodiment.

[0020] FIG. 4 is an illustration of an exemplary ambiguous uplink timing.

[0021] FIG. 5 is an illustration of an exemplary averaging of uplink timings according to an embodiment.

[0022] FIG. 6 illustrates a block diagram of an exemplary wireless terminal that facilitates a timing alignment in a multicarrier system in accordance with an aspect of the subject specification.

[0023] FIG. 7 is an illustration of an exemplary coupling of electrical components that effectuate a timing alignment in a multicarrier system.

[0024] FIG. 8 is a flow chart illustrating an exemplary methodology for facilitating a timing alignment in a multicarrier system in accordance with an aspect of the subject specification.

[0025] FIG. 9 illustrates a block diagram of an exemplary base station that facilitates a timing alignment in a multicarrier system in accordance with an aspect of the subject specification.

[0026] FIG. 10 is an illustration of an exemplary coupling of electrical components that effectuate a timing alignment in a multicarrier system.

[0027] FIG. 11 is flow chart illustrating an exemplary methodology for facilitating a timing alignment in a multicarrier system in accordance with an aspect of the subject specification.

[0028] FIG. 12 is an illustration of an exemplary communication system implemented in accordance with various aspects including multiple cells.

[0029] FIG. 13 is an illustration of an exemplary base station in accordance with various aspects described herein.

[0030] FIG. 14 is an illustration of an exemplary wireless terminal implemented in accordance with various aspects described herein.

DETAILED DESCRIPTION

[0031] Various embodiments are now described with reference to the drawings, wherein like reference numerals are used to refer to like elements throughout. In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of one or more embodiments. It may be evident, however, that such embodiment(s) may be practiced without these specific details. In other instances, well-known structures and devices are shown in block diagram form in order to facilitate describing one or more embodiments.

[0032] The subject specification is directed towards facilitating a timing alignment for user equipment in systems with multiple carriers whose timing may be different. Exemplary embodiments are disclosed in which carriers are grouped into "timing groups" with the similar timing information (within a tolerance), wherein signaling behavior for timing synchronization takes place on a per-group basis rather than a per-carrier basis.

[0033] To this end, it is noted that the techniques described herein can be used for various wireless communication systems such as code division multiple access (CDMA), time division multiple access (TDMA), frequency division multiple access (FDMA), orthogonal frequency division multiple access (OFDMA), single carrier-frequency division multiple access (SC-FDMA), High Speed Packet Access (HSPA), and other systems. The terms "system" and "network" are often used interchangeably. A CDMA system can implement a radio technology such as Universal Terrestrial Radio Access (UTRA), CDMA2000, *etc.* UTRA includes Wideband-CDMA (W-CDMA) and other variants of CDMA. CDMA2000 covers IS-2000, IS-95 and IS-856 standards. A TDMA system can implement a radio technology such as Global System for Mobile Communications (GSM). An OFDMA system can implement a radio technology such as Evolved UTRA (E-UTRA), Ultra Mobile Broadband (UMB), IEEE 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20, Flash-OFDM, *etc.* UTRA and E-UTRA are part of Universal Mobile Telecommunication System (UMTS). 3GPP Long Term Evolution (LTE) is a release of UMTS that uses E-UTRA, which employs OFDMA on the downlink and SC-FDMA on the uplink.

[0034] Single carrier frequency division multiple access (SC-FDMA) utilizes single carrier modulation and frequency domain equalization. SC-FDMA has similar performance and essentially the same overall complexity as those of an OFDMA system. A SC-FDMA signal has lower peak-to-average power ratio (PAPR) because of its inherent single carrier structure. SC-FDMA can be used, for instance, in uplink communications where lower PAPR greatly benefits access terminals in terms of transmit power efficiency. Accordingly, SC-FDMA can be implemented as an uplink multiple access scheme in 3GPP Long Term Evolution (LTE) or Evolved UTRA.

[0035] High speed packet access (HSPA) can include high speed downlink packet access (HSDPA) technology and high speed uplink packet access (HSUPA) or enhanced uplink (EUL) technology and can also include HSPA+ technology. HSDPA, HSUPA and HSPA+ are part of the Third Generation Partnership Project (3GPP) specifications Release 5, Release 6, and Release 7, respectively.

[0036] High speed downlink packet access (HSDPA) optimizes data transmission from the network to the user equipment (UE). As used herein, transmission from the network to the user equipment UE can be referred to as the "downlink" (DL). Transmission methods can allow data rates of several Mbits/s. High

speed downlink packet access (HSDPA) can increase the capacity of mobile radio networks. High speed uplink packet access (HSUPA) can optimize data transmission from the terminal to the network. As used herein, transmissions from the terminal to the network can be referred to as the "uplink" (UL). Uplink data transmission methods can allow data rates of several Mbit/s. HSPA+ provides even further improvements both in the uplink and downlink as specified in Release 7 of the 3GPP specification. High speed packet access (HSPA) methods typically allow for faster interactions between the downlink and the uplink in data services transmitting large volumes of data, for instance Voice over IP (VoIP), videoconferencing and mobile office applications

[0037] Fast data transmission protocols such as hybrid automatic repeat request, (HARQ) can be used on the uplink and downlink. Such protocols, such as hybrid automatic repeat request (HARQ), allow a recipient to automatically request retransmission of a packet that might have been received in error.

[0038] Various embodiments are described herein in connection with an access terminal. An access terminal can also be called a system, subscriber unit, subscriber station, mobile station, mobile, remote station, remote terminal, mobile device, user terminal, terminal, wireless communication device, user agent, user device, or user equipment (UE). An access terminal can be a cellular telephone, a cordless telephone, a Session Initiation Protocol (SIP) phone, a wireless local loop (WLL) station, a personal digital assistant (PDA), a handheld device having wireless connection capability, computing device, or other processing device connected to a wireless modem. Moreover, various embodiments are described herein in connection with a base station. A base station can be utilized for communicating with access terminal(s) and can also be referred to as an access point, Node B, Evolved Node B (eNodeB), access point base station, or some other terminology.

[0039] Referring now to Fig. 1, a wireless communication system 100 is illustrated in accordance with various embodiments presented herein. System 100 comprises a base station 102 that can include multiple antenna groups. For example, one antenna group can include antennas 104 and 106, another group can comprise antennas 108 and 110, and an additional group can include antennas 112 and 114. Two antennas are illustrated for each antenna group; however, more or fewer antennas can be utilized for each group. Base station 102 can additionally include a transmitter chain and a receiver chain, each of which can in turn comprise a plurality of components

associated with signal transmission and reception (*e.g.,* processors, modulators, multiplexers, demodulators, demultiplexers, antennas, *etc.*), as will be appreciated by one skilled in the art.

[0040] Base station 102 can communicate with one or more access terminals such as access terminal 116 and access terminal 122; however, it is to be appreciated that base station 102 can communicate with substantially any number of access terminals similar to access terminals 116 and 122. Access terminals 116 and 122 can be, for example, cellular phones, smart phones, laptops, handheld communication devices, handheld computing devices, satellite radios, global positioning systems, PDAs, and/or any other suitable device for communicating over wireless communication system 100. As depicted, access terminal 116 is in communication with antennas 112 and 114, where antennas 112 and 114 transmit information to access terminal 116 over a forward link 118 and receive information from access terminal 116 over a reverse link 120. Moreover, access terminal 122 is in communication with antennas 104 and 106, where antennas 104 and 106 transmit information to access terminal 122 over a forward link 124 and receive information from access terminal 122 over a reverse link 126. In a frequency division duplex (FDD) system, forward link 118 can utilize a different frequency band than that used by reverse link 120, and forward link 124 can employ a different frequency band than that employed by reverse link 126, for example. Further, in a time division duplex (TDD) system, forward link 118 and reverse link 120 can utilize a common frequency band and forward link 124 and reverse link 126 can utilize a common frequency band.

[0041] Each group of antennas and/or the area in which they are designated to communicate can be referred to as a sector of base station 102. For example, antenna groups can be designed to communicate to access terminals in a sector of the areas covered by base station 102. In communication over forward links 118 and 124, the transmitting antennas of base station 102 can utilize beamforming to improve signal-to-noise ratio of forward links 118 and 124 for access terminals 116 and 122. Also, while base station 102 utilizes beamforming to transmit to access terminals 116 and 122 scattered randomly through an associated coverage, access terminals in neighboring cells can be subject to less interference as compared to a base station transmitting through a single antenna to all its access terminals.

[0042] Fig. 2 shows an example wireless communication system 200. The wireless communication system 200 depicts one base station 210 and one access terminal 250 for sake of brevity. However, it is to be appreciated that system 200 can include more than one base station and/or more than one access terminal, wherein additional base stations and/or access terminals can be substantially similar or different from example base station 210 and access terminal 250 described below. In addition, it is to be appreciated that base station 210 and/or access terminal 250 can employ the systems and/or methods described herein to facilitate wireless communication there between.

[0043] At base station 210, traffic data for a number of data streams is provided from a data source 212 to a transmit (TX) data processor 214. According to an example, each data stream can be transmitted over a respective antenna. TX data processor 214 formats, codes, and interleaves the traffic data stream based on a particular coding scheme selected for that data stream to provide coded data.

[0044] The coded data for each data stream can be multiplexed with pilot data using orthogonal frequency division multiplexing (OFDM) techniques. Additionally or alternatively, the pilot symbols can be frequency division multiplexed (FDM), time division multiplexed (TDM), or code division multiplexed (CDM). The pilot data is typically a known data pattern that is processed in a known manner and can be used at access terminal 250 to estimate channel response. The multiplexed pilot and coded data for each data stream can be modulated (*e.g.,* symbol mapped) based on a particular modulation scheme (*e.g.,* binary phase-shift keying (BPSK), quadrature phase-shift keying (QPSK), M-phase-shift keying (M-PSK), M-quadrature amplitude modulation (M-QAM), *etc.*) selected for that data stream to provide modulation symbols. The data rate, coding, and modulation for each data stream can be determined by instructions performed or provided by processor 230.

[0045] The modulation symbols for the data streams can be provided to a TX MIMO processor 220, which can further process the modulation symbols (*e.g.,* for OFDM). TX MIMO processor 220 then provides N_T modulation symbol streams to N_T transmitters (TMTR) 222a through 222t. In various embodiments, TX MIMO processor 220 applies beamforming weights to the symbols of the data streams and to the antenna from which the symbol is being transmitted.

[0046] Each transmitter 222 receives and processes a respective symbol stream to provide one or more analog signals, and further conditions (*e.g.,* amplifies, filters, and upconverts) the analog signals to provide a modulated signal suitable for transmission over the MIMO channel. Further, N_T modulated signals from transmitters 222a through 222t are transmitted from N_T antennas 224a through 224t, respectively.

[0047] At access terminal 250, the transmitted modulated signals are received by N_R antennas 252a through 252r and the received signal from each antenna 252 is provided to a respective receiver (RCVR) 254a through 254r. Each receiver 254 conditions (*e.g.,* filters, amplifies, and downconverts) a respective signal, digitizes the conditioned signal to provide samples, and further processes the samples to provide a corresponding "received" symbol stream.

[0048] An RX data processor 260 can receive and process the N_R received symbol streams from N_R receivers 254 based on a particular receiver processing technique to provide N_T "detected" symbol streams. RX data processor 260 can demodulate, deinterleave, and decode each detected symbol stream to recover the traffic data for the data stream. The processing by RX data processor 260 is complementary to that performed by TX MIMO processor 220 and TX data processor 214 at base station 210.

[0049] A processor 270 can periodically determine which available technology to utilize as discussed above. Further, processor 270 can formulate a reverse link message comprising a matrix index portion and a rank value portion.

[0050] The reverse link message can comprise various types of information regarding the communication link and/or the received data stream. The reverse link message can be processed by a TX data processor 238, which also receives traffic data for a number of data streams from a data source 236, modulated by a modulator 280, conditioned by transmitters 254a through 254r, and transmitted back to base station 210.

[0051] At base station 210, the modulated signals from access terminal 250 are received by antennas 224, conditioned by receivers 222, demodulated by a demodulator 240, and processed by a RX data processor 242 to extract the reverse link message transmitted by access terminal 250. Further, processor 230 can process the extracted message to determine which precoding matrix to use for determining the beamforming weights.

[0052] Processors 230 and 270 can direct (*e.g.*, control, coordinate, manage, *etc.*) operation at base station 210 and access terminal 250, respectively. Respective processors 230 and 270 can be associated with memory 232 and 272 that store program codes and data. Processors 230 and 270 can also perform computations to derive frequency and impulse response estimates for the uplink and downlink, respectively.

[0053] As a general framework, aspects disclosed herein are directed towards assigning a UE to at least one "timing group", which hereinafter refers to a group of carriers with uplink timings that are the same to within some tolerance. Depending on the tolerance, a timing group might include carriers that share a common controlling site (but may still have fine differences in timing), or only of carriers whose antennae are collocated. For some embodiments, different carriers with synchronized downlinks, but significant differences in uplink timing for a given UE (e.g., from different cell sites in a synchronous network), would thus not normally belong to the same timing group.

[0054] In an aspect, it is contemplated that a UE may be assigned carriers from multiple timing groups. In principle, a UE with enough reception and decoding capabilities could listen to several sets of carriers with independent timing. Such a situation may, for example, arise if a UE were assigned to carriers from different cell sites. However, with the current LTE design (with no soft handover), and the complexities that arise when attempting to design such a system, a multiple-site assignment seems unlikely.

[0055] Even so, if the tolerances defining a timing group are adequate, it is possible that a UE could be assigned carriers from multiple timing groups originating from the same cell site. For instance, in Fig. 3, an exemplary system illustrates how two timing groups may originate from a single eNode B. As illustrated, system 300 includes a remote radio head 320 belonging to main base station site 310, wherein carriers from remote radio head 320 are associated with timing group 322, whereas carriers from main base station site 310 are associated with timing group 312. Accordingly, wireless terminal 330 receives carriers having different timings from a single eNodeB, wherein carriers within a timing difference tolerance are grouped together. In such a case, since wireless terminal 330 could be assigned to carriers in both timing group 312 and timing group 322, it is contemplated that wireless terminal 330 will maintain timing separately for each group. For some embodiments, this might require separate timing advance

procedures for each group, or enhanced signaling allowing timing maintenance to take place for all groups in parallel.

[0056] In an aspect, embodiments directed towards selecting carriers for performing a random access procedure are also contemplated. Indeed, within each timing group, a UE may occasionally perform random access to update its timing (e.g., if timing is maintained through a separate procedure for each timing group). Here, although this update only needs to be performed with one carrier of each timing group, the issue arises of how the UE should decide which carrier this is. In an aspect, the UE is configured to avoid performing unnecessary timing updates (i.e., to select a single carrier from the timing group to use for its timing control).

[0057] In principle, it is noted that performing random access on any carrier in a timing group should work. However, it is desirable to avoid situations in which a large number of UEs concentrate their random access attempts on a particular carrier, to minimize contention on the random access channel. To this end, it is contemplated that the system could adopt either a UE-based or a network-based solution.

[0058] In an exemplary network-based solution, the UE is assigned to carriers in a particular timing group, wherein the network provides the UE with instructions regarding which carrier in that group to use for random access. Within such embodiment, the instructions could be absolute (e.g., "always use this carrier") or subject to relaxation based on conditions at the UE (e.g., "use this carrier preferentially, unless radio conditions on that carrier are worse than indicated by a threshold").

[0059] In an exemplary UE-based approach, each UE selects a single carrier for random access for timing updates autonomously. Here, similar to the exemplary network-based solution, the determination of the carrier could be absolute or subject to modification. In a particular embodiment, carrier selection is based on a function that tends to distribute UEs more or less evenly across the timing group. A hash function may be utilized, for example, in which a UE associated with a timing group of n carriers provides some input to a hash function with n possible values, wherein the function's output is the index of the carrier of the group that the UE will (prefer to) use for random access. Here, it is noted that there are many options for an appropriate hash function including, for example, using a UE identifier as an input, as well as other values such as an eNode B identifier. It is further noted that the inputs could be static or time-varying. If they are static (depending on characteristics of the UE and/or the serving eNode B),

the UE may tend to use the same carrier for random access throughout its assignment to a particular group whereas, if the inputs vary with time (e.g., through the use of an input value derived from a time measurement, a counter, etc.), the UE may tend to "cycle" through the available carriers. For some embodiments, the latter approach may be preferable, since coincidental "spikes" in concentration (e.g., when a particular site is serving a large number of UEs whose identities result in the same output from the hash function) will tend to correct themselves over time.

[0060] Other UE-based distribution mechanisms are also contemplated. For instance, instead of a fixed hash function, the UE could use a pseudorandom function to choose the carrier. In such a case, the determination could be made only at the time of carrier assignment (so that a given UE consistently uses the same carrier for timing) or at each request for a timing update (so that each UE tends to balance its requests across the available carriers).

[0061] Issues pertaining to timing alignment granularity are now discussed. To this end, it is noted that, if all carriers within a timing group are precisely aligned in both downlink and uplink timing, there is no ambiguity about what the "correct" timing alignment for a given UE should be. However, in the case of small differences between carrier transmission timing (e.g., due to cable delays), carriers with the same timing offset may nevertheless have different absolute timings.

[0062] An exemplary timing diagram illustrating such ambiguous uplink timing is provided in Fig. 4. As illustrated, carrier 410 is associated with downlink 412 and uplink 414, whereas carrier 420 is associated with downlink 422 and uplink 424. Here, it is noted that a UE in such environment could receive its timing information from either carrier 410 or carrier 420. In an aspect, the timings of carrier 410 and carrier 420 may differ, but by less than the tolerance that the deployment requires for a timing group. It thus follows that, depending on which carrier the UE received its last update from, a UE connected to carrier 410 and carrier 420 could consider the correct uplink timing to be at either uplink 414 or uplink 424.

[0063] In a particular embodiment, the UE applies the timing offset to the carrier on which it received the timing offset, and assumes that the timing of other carriers in the group is "close enough". With respect to Fig. 4, this would mean that the system considered uplink 414 and uplink 424 to be the same for purposes of uplink timing accuracy.

[0064] As an alternative, however, the UE could apply the timing offset, not to the received downlink timing from the carrier that transmitted the offset, but to the average timing of the carriers in the timing group. In such a case, although the UE received its timing information from a particular carrier, it tracks the (downlink) timing of each carrier in the group separately, so that when a single downlink/uplink offset is received, the UE can apply the offset separately to each carrier and take an average of the results to provide an "adequate" uplink timing for use with all carriers in the group. Such an averaging behavior could be either a specified UE behavior (to allow greater downlink tolerances within a timing group while still keeping the variation in uplink timing acceptable) or left to UE implementation.

[0065] In Fig. 5, an illustration of an exemplary averaging procedure is provided. As illustrated, wireless terminal 510 receives a downlink/uplink offset via either of Carrier A or Carrier B. For this particular example, Carrier A is associated with Downlink_A and Uplink_A, whereas Carrier B is associated with Downlink_B and Uplink_B. The actual uplink timing may then be ascertained by adding the timing offset to the average of Downlink_A and Downlink_B, which is equal to the average of Uplink_A and Uplink_B.

[0066] For some embodiments, in the event that a UE is assigned to several timing groups that are controlled from a common site, the UE may receive timing adjustments for all groups with a single interaction with the base station. Indeed, such a procedure is essentially a signaling optimization since the UE could, in principle, receive the same information by performing a separate timing adjustment for each group. Sending the adjustments as a vector, however, reduces over-the-air activity, and in particular random access procedures, which are expensive in terms of radio resources and UE battery life.

[0067] To implement such a command, the network may need to be aware of the timing groups in which the UE is assigned to at least one carrier. This knowledge could be maintained autonomously in the network, so that upon determining the need to signal a timing advance to a particular UE, the network automatically includes timing advance commands for all appropriate timing groups. Alternatively, the UE could request timing advance values for a particular set of timing groups (e.g., the groups for which the UE's time-alignment timers are within some range of expiring). However, the request for particular groups would represent a new medium access control (MAC) element, which

may need to be transmitted over the air at random access with a potentially significant cost in radio resources. For some embodiments, it may therefore be desirable for the network to maintain knowledge of what timing groups require timing advance commands towards a particular UE.

[0068] In another aspect of this vector approach, the network could opt to send only a single timing advance command per MAC element, but indicate which timing group the value is associated with. Such approach would minimize the specification impact to the concerned MAC control element, since the existing information only needs to be augmented by a group identifier. It is presumed that such an identifier could be sent with a small number of bits (e.g., as an index into the set of timing groups with which the UE was configured). Such a mapping could be established by explicit signaling (in higher layers such as the Radio Resource Control) at the time the UE is configured with particular carriers.

[0069] Referring next to Fig. 6, a block diagram of an exemplary wireless terminal that facilitates a timing alignment in a multicarrier system according to an embodiment is provided. As shown, wireless terminal 600 may include processor component 610, memory component 620, downlink timing component 630, uplink timing component 640, communication component 650, random access component 660, message processing component 670, and averaging component 680.

[0070] In one aspect, processor component 610 is configured to execute computer-readable instructions related to performing any of a plurality of functions. Processor component 610 can be a single processor or a plurality of processors dedicated to analyzing information to be communicated from wireless terminal 600 and/or generating information that can be utilized by memory component 620, downlink timing component 630, uplink timing component 640, communication component 650, random access component 660, message processing component 670, and/or averaging component 680. Additionally or alternatively, processor component 610 may be configured to control one or more components of wireless terminal 600.

[0071] In another aspect, memory component 620 is coupled to processor component 610 and configured to store computer-readable instructions executed by processor component 610. Memory component 620 may also be configured to store any of a plurality of other types of data including generated by any of downlink timing component 630, uplink timing component 640, communication component 650, random

access component 660, message processing component 670, and/or averaging component 680. Memory component 620 can be configured in a number of different configurations, including as random access memory, battery-backed memory, hard disk, magnetic tape, etc. Various features can also be implemented upon memory component 620, such as compression and automatic back up (e.g., use of a Redundant Array of Independent Drives configuration).

[0072] As illustrated, wireless terminal 600 may also include downlink timing component 630 and uplink timing component 640. Within such embodiment, downlink timing component 630 is configured to determine at least one downlink timing associated with at least one downlink carrier, whereas uplink timing component 640 is configured to ascertain an uplink timing associated with an uplink group of carriers based on at least one downlink timing and a timing offset associated with the uplink group of carriers. In an aspect, uplink timing component 640 is configured to determine the uplink timing by utilizing a different timing offset for each of a plurality of uplink group of carriers. Uplink timing component 640 may also be configured to determine the uplink timing by utilizing a different downlink timing for each of a plurality of uplink group of carriers.

[0073] In other aspects, the at least one downlink carrier is included in one of a plurality of downlink groups. Within such embodiment, uplink timing component 640 may be configured to determine the uplink timing by associating the uplink group of carriers with the one of the plurality of downlink groups. In a particular aspect, uplink timing component 640 is configured to determine a plurality of uplink timings respectively associated with a plurality of uplink groups. Here, uplink timing component 640 ascertains the plurality of uplink timings by identifying a subset of downlink groups that include an assigned carrier, wherein the plurality of uplink groups are respectively associated with the subset of downlink groups that include the assigned carrier.

[0074] In yet another aspect, wireless terminal 600 includes communication component 650, which is coupled to processor component 610 and configured to interface wireless terminal 600 with external entities. For instance, communication component 650 may be configured to transmit uplink carriers of a common uplink group according to the uplink timing ascertained by uplink timing component 640. In a

particular embodiment, each of the uplink group of carriers is transmitted within a threshold value of the corresponding uplink timing.

[0075] As illustrated, wireless terminal 600 may also include message processing component 670. Within such embodiment, message processing component 670 is configured to process a received timing message encoded with a set of uplink timing instructions respectively corresponding to an uplink group subset of the uplink group of carriers. In a particular aspect, message processing component 670 is configured to associate the uplink group of carriers with one of a plurality of downlink groups, wherein the timing message is encoded with a set of uplink timing instructions respectively corresponding to a downlink group subset of the plurality of downlink groups. Here, it should be noted that the received timing message may be a timing advance command, and/or may comprise a vector encoded with timing adjustment values associated with the uplink group subset.

[0076] Particular embodiments are also contemplated wherein the uplink group subset includes assigned carriers. For instance, in one embodiment, each uplink group within the uplink group subset includes at least one carrier with an assigned radio resource. In another embodiment, the uplink group of carriers comprises a set of uplink groups in which each uplink group includes at least one carrier with an assigned radio resource, wherein the uplink group subset is a subset of the set of uplink groups.

[0077] For some embodiments, it is contemplated that the uplink group subset is determined by a network entity. For instance, message processing component 670 may be configured to submit a request requesting the network entity to provide the uplink group subset, wherein the uplink group subset is determined by the network entity in response to the request. Indeed, it should be noted that the received timing message itself may include an indication of which of the uplink group of carriers are included in the uplink group subset. For such embodiments, message processing component 670 may be configured to decode the indication according to a mapping of group identities shared with the network. In an aspect, the mapping of group identities is configured in association with an assignment of dedicated radio resources on uplink carriers within at least one uplink group of the uplink group subset.

[0078] Timing messages which include inter-group uplink timings are also contemplated. For instance, message processing component 670 may be configured to decode a timing message received via a timing message carrier included in a messenger

downlink group, wherein the timing message is encoded with at least one inter-group uplink timing. Here, the inter-group uplink timing is an uplink timing corresponding to a target downlink group, wherein the target downlink group is different than the messenger downlink group. For these embodiments, the timing message may include an indication of the target downlink group, message processing component 670 may again be configured to decode the indication according to a mapping of group identities shared with the network. For instance, the mapping of group identities may be configured in association with an assignment of dedicated radio resources on downlink carriers included in the target downlink group.

[0079] In another aspect, rather than using any particular downlink timing, the subject innovation contemplates utilizing a plurality of downlink timings. To this end, wireless terminal 600 may further include averaging component 680, which is configured to compute an average downlink timing from a plurality of downlink timings. Within such embodiment, the plurality of downlink timings respectively correspond to a set of downlink carriers within a particular downlink group that includes the at least one downlink carrier. Here, uplink timing component 640 is then configured to determine the uplink timing by applying the timing offset to the average downlink timing. With respect to the particular downlink group utilized by averaging component 680, it is contemplated that such downlink group may be a particular downlink group that comprises at least one carrier associated with an assigned radio resource. Alternatively, the particular downlink group comprises a set of carriers identified by the network.

[0080] Wireless terminal 600 may also include random access component 660, which is configured to perform a random access procedure. Within such embodiment, random access component 660 is configured to perform the random access procedure on at least one random access carrier included in a downlink group of carriers that includes the at least one downlink carrier received from the network. In a particular aspect, the random access procedure is performed on a single carrier, wherein the single carrier is an assigned carrier provided by a network prior to the performing of the random access procedure. Alternatively, the random access procedure may include receiving the single carrier as part of a dedicated radio resource configuration.

[0081] In another embodiment, a criterion for selecting the appropriate carrier is utilized. For instance, the random access procedure may include receiving a criterion

associated with a usage of the single carrier, wherein the criterion is received with an assignment of the single carrier. Within such embodiment, the criterion may be a minimum signal quality threshold associated with the single carrier. Here, it is also contemplated that random access component 660 may be configured to perform the random access procedure on an alternative carrier in response to the criterion not being met by the single carrier. For such embodiment, random access component 660 may be configured to receive an indication of the alternative carrier from the network. Alternatively, the alternative carrier is independently selected by random access component 660.

[0082] In addition to selecting the alternative carrier, it is also contemplated that the single carrier is independently selected by random access component 660. Within such embodiment, the selecting may comprise applying a determination function across a set of available carriers in the downlink group of carriers. Here, it is contemplated that any of a plurality of determination functions may be utilized including, for example, a pseudorandom function and/or a hash function. For instance, if a hash function is implemented, the random access procedure may include inputting an identifier into the hash function, wherein the identifier can be associated with the wireless terminal and/or a network node (wherein the downlink group of carriers is controlled by the network node). Embodiments are also contemplated in which the procedure includes inputting a time-varying value into the hash function. For such embodiments, the procedure may further include determining the time-varying value via a time measurement taken from within wireless terminal 600. The procedure may also include modifying the time-varying value by an arithmetic operation each time the time-varying value is used.

[0083] In another aspect, random access component 660 is configured to select the random access carrier at a particular time. For instance, the selecting procedure may be performed at a time when radio resources are assigned to wireless terminal 600 on any of the downlink group of carriers. Alternatively, the selecting is performed in response to a triggering of the random access procedure.

[0084] Turning to Fig. 7, illustrated is a system 700 that facilitates a timing alignment in a multicarrier system according to an embodiment. System 700 and/or instructions for implementing system 700 can reside within user equipment (e.g., wireless terminal 600) or a computer-readable storage medium, for instance. As depicted, system 700 includes functional blocks that can represent functions

implemented by a processor, software, or combination thereof (e.g., firmware). System 700 includes a logical grouping 702 of electrical components that can act in conjunction. As illustrated, logical grouping 702 can include an electrical component for determining at least one downlink timing associated with at least one downlink carrier 710. Logical grouping 702 can also include an electrical component for ascertaining an uplink timing associated with an uplink group of carriers based on at least one downlink timing and a timing offset 712. Further, logical grouping 702 can include an electrical component for transmitting each of the uplink group of carriers within a threshold value of the uplink timing 714. Additionally, system 700 can include a memory 720 that retains instructions for executing functions associated with electrical components 710, 712, and 714, wherein any of electrical components 710, 712, and 714 can exist either within or outside memory 720.

[0085] Referring next to Fig. 8, a flow chart illustrating an exemplary method for facilitating a timing alignment in a multicarrier system is provided. As illustrated, process 800 includes a series of acts that may be performed by various components of user equipment (e.g., wireless terminal 600) according to an aspect of the subject specification. Process 800 may be implemented by employing at least one processor to execute computer executable instructions stored on a computer readable storage medium to implement the series of acts. In another embodiment, a computer-readable storage medium comprising code for causing at least one computer to implement the acts of process 800 is contemplated.

[0086] In an aspect, process 800 begins with a downlink communication being received at act 810. Here, the downlink communication is a multicarrier communication, wherein at least one downlink carrier is associated with a downlink group. Process 800 then proceeds to act 820 where a downlink timing of the downlink carrier is determined, followed by act 830 where a timing offset of the downlink carrier's timing group is ascertained.

[0087] Next, at act 840, an uplink group of carriers is associated with the downlink group of carriers. An uplink timing for the uplink group is then ascertained based on the downlink timing and timing offset, at act 850. Process 800 then concludes at act 860 where an uplink communication is transmitted via the uplink group of carriers according to the particular uplink timing of the uplink group. Moreover, for this

particular example, each of the uplink carriers of an uplink group are transmitted within a threshold tolerance of the uplink timing associated with the group.

[0088] Referring next to Fig. 9, a block diagram illustrates an exemplary base station that facilitates a timing alignment in a multicarrier system in accordance with various aspects. As illustrated, base station 900 may include processor component 910, memory component 920, timing offset component 930, transmitting component 940, receiving component 950, generation component 960, and random access component 970.

[0089] Similar to processor component 610 in wireless terminal 600, processor component 910 is configured to execute computer-readable instructions related to performing any of a plurality of functions. Processor component 910 can be a single processor or a plurality of processors dedicated to analyzing information to be communicated from base station 900 and/or generating information that can be utilized by memory component 920, timing offset component 930, transmitting component 940, receiving component 950, generation component 960, and/or random access component 970. Additionally or alternatively, processor component 910 may be configured to control one or more components of base station 900.

[0090] In another aspect, memory component 920 is coupled to processor component 910 and configured to store computer-readable instructions executed by processor component 910. Memory component 920 may also be configured to store any of a plurality of other types of data including data generated by any of timing offset component 930, transmitting component 940, receiving component 950, generation component 960, and/or random access component 970. Here, it should be noted that memory component 1220 is analogous to memory component 620 in wireless terminal 600. Accordingly, it should be appreciated that any of the aforementioned features/configurations of memory component 620 are also applicable to memory component 920.

[0091] As illustrated, base station 900 may also include timing offset component 930. Within such embodiment, timing offset component 930 is configured to assign a timing offset to an uplink group of carriers. For instance, in a particular embodiment, timing offset component 930 is configured to assign a different timing offset to each of a plurality of uplink groups.

[0092] In another aspect, base station 900 includes transmitting component 940 and receiving component 950, which are coupled to processor component 910 and configured to interface base station 900 with external entities. For instance, transmitting component 940 may be configured to provide the timing offset ascertained by timing offset component 930 to a wireless terminal via at least one downlink carrier, whereas receiving component 950 may be configured to receive an uplink communication via the uplink group of carriers according to the timing offset. In a particular embodiment, transmitting component 940 is configured to transmit a downlink group of carriers from antennas located at a common site. In another embodiment, transmitting component 940 is configured to identify a set of carriers respectively corresponding to a plurality of downlink timings to facilitate an averaging of the plurality of downlink timings performed by the wireless terminal.

[0093] As illustrated, base station 900 may also include generation component 960. Within such embodiment, generation component 960 is configured to generate a timing message encoded with a set of uplink timing instructions. For instance, such instructions may include uplink timing instructions respectively corresponding to an uplink group subset of the plurality of uplink groups, wherein transmitting component 940 is configured to transmit the timing message to a wireless terminal. Here, it should be noted that the timing message may be a timing advance command, and/or may comprise a vector encoded with timing adjustment values associated with the uplink group subset.

[0094] Particular embodiments are also contemplated wherein the uplink group subset includes assigned carriers. For instance, in one embodiment, each uplink group within the uplink group subset includes at least one carrier with a radio resource assigned to the wireless terminal. In another embodiment, the plurality of uplink groups comprise a set of uplink groups in which each uplink group within the set of uplink groups includes at least one carrier with a radio resource assigned to the wireless terminal, wherein the uplink group subset is a subset of the set of uplink groups.

[0095] In another aspect, it should be noted that base station 900 may include components to facilitate determining the uplink group subset. Such embodiment may, for example, include receiving a request from the wireless terminal to provide the uplink group subset, wherein the determining is performed in response to the request. Generation component 960 may also be configured to generate timing messages

encoded with an indication of which of the plurality of uplink groups are included in the uplink group subset. In an exemplary embodiment, the indication is encoded according to a mapping of group identities shared with the wireless terminal. For this embodiment, the mapping of group identities may be configured in association with an assignment of dedicated radio resources on uplink carriers within at least one uplink group of the uplink group subset.

[0096] In another aspect, timing messages encoded with inter-group uplink timings are contemplated. For instance, generation component 960 may be configured to generate a timing message encoded with at least one inter-group uplink timing corresponding to a target downlink group. Within such embodiment, transmitting component 940 is configured to transmit the timing message to the wireless terminal via a timing message carrier included in a messenger downlink group, wherein the target downlink group is different than the messenger downlink group. Here, it should be noted that the timing message can be encoded with an indication of the target downlink group. Similar to the intra-group embodiment discussed previously, such indication can be encoded according to a mapping of group identities shared with the wireless terminal. For example, the mapping of group identities can be configured in association with an assignment of dedicated radio resources on downlink carriers included in the target downlink group.

[0097] As illustrated, base station 900 may also include random access component 970. Within such embodiment, random access component 970 is configured to identify a random access carrier to facilitate a random access procedure, wherein the random access carrier is a carrier assigned to the wireless terminal. In an aspect, transmitting component 940 may be configured to transmit the random access carrier as part of a dedicated radio resource configuration. In another aspect, random access component 970 may be configured to ascertain a criterion associated with a usage of the random access carrier, wherein the criterion is provided to the wireless terminal with an assignment of the random access carrier. For example, the criterion can be a minimum signal quality threshold associated with the random access carrier. In yet another aspect, random access component 970 is configured to identify an alternative carrier to facilitate a performing of the random access procedure by the wireless terminal on the alternative carrier in response to the criterion not being met by the random access carrier.

[0098] Referring next to Fig. 10, illustrated is a system 1000 that facilitates a timing alignment in a multicarrier system according to an embodiment. System 1000 and/or instructions for implementing system 1000 can reside within a network entity (e.g., base station 900) or a computer-readable storage medium, for instance, wherein system 1000 includes functional blocks that can represent functions implemented by a processor, software, or combination thereof (*e.g.,* firmware). Moreover, system 1000 includes a logical grouping 1002 of electrical components that can act in conjunction similar to logical grouping 702 in system 700. As illustrated, logical grouping 1002 can include an electrical component for transmitting at least one downlink carrier to a wireless terminal 1010, as well as an electrical component for assigning a timing offset to an uplink group of carriers 1012. Furthermore, logical grouping 1002 can include an electrical component for providing the timing offset to the wireless terminal via the at least one downlink carrier 1014. Logical grouping 1002 can also include an electrical component for receiving an uplink communication via the uplink group of carriers according to the timing offset 1016. Additionally, system 1000 can include a memory 1020 that retains instructions for executing functions associated with electrical components 1010, 1012, 1014, and 1016. While shown as being external to memory 1020, it is to be understood that electrical components 1010, 1012, 1014, and 1016 can exist within memory 1020.

[0099] Referring next to Fig. 11, a flow chart illustrating an exemplary method that facilitates a timing alignment in a multicarrier system is provided. As illustrated, process 1100 includes a series of acts that may be performed by various components of a network entity (e.g., base station 900) according to an aspect of the subject specification. Process 1100 may be implemented by employing at least one processor to execute computer executable instructions stored on a computer readable storage medium to implement the series of acts. In another embodiment, a computer-readable storage medium comprising code which causes at least one computer to implement the acts of process 1100 is contemplated.

[00100] In an aspect, process 1100 begins with a multicarrier communication being established with a user equipment at act 1110. Next, at act 1120, a timing offset is assigned to an uplink group of carriers, wherein a different timing offset may be assigned to each of a plurality of uplink groups. Once the timing offsets have been assigned, process 1100 proceeds to act 1130 where particular downlink carriers are

configured to facilitate a downlink communication with the user equipment. At act 1140, the timing offset is then provided to the user equipment via at least one of the downlink carriers configured at act 1130. Process 1100 then concludes at act 1150 where an uplink communication is received from the user equipment according to the timing offset assigned at act 1120.

EXEMPLARY COMMUNICATION SYSTEM

[00101] Referring next to Fig. 12, an exemplary communication system 1200 implemented in accordance with various aspects is provided including multiple cells: cell I 1202, cell M 1204. Here, it should be noted that neighboring cells 1202, 1204 overlap slightly, as indicated by cell boundary region 1268, thereby creating potential for signal interference between signals transmitted by base stations in neighboring cells. Each cell 1202, 1204 of system 1200 includes three sectors. Cells which have not been subdivided into multiple sectors (N=1), cells with two sectors (N=2) and cells with more than 3 sectors (N>3) are also possible in accordance with various aspects. Cell 1202 includes a first sector, sector I 1210, a second sector, sector II 1212, and a third sector, sector III 1214. Each sector 1210, 1212, and 1214 has two sector boundary regions; each boundary region is shared between two adjacent sectors.

[00102] Sector boundary regions provide potential for signal interference between signals transmitted by base stations in neighboring sectors. Line 1216 represents a sector boundary region between sector I 1210 and sector II 1212; line 1218 represents a sector boundary region between sector II 1212 and sector III 1214; line 1220 represents a sector boundary region between sector III 1214 and sector 1 1210. Similarly, cell M 1204 includes a first sector, sector I 1222, a second sector, sector II 1224, and a third sector, sector III 1226. Line 1228 represents a sector boundary region between sector I 1222 and sector II 1224; line 1230 represents a sector boundary region between sector II 1224 and sector III 1226; line 1232 represents a boundary region between sector III 1226 and sector I 1222. Cell I 1202 includes a base station (BS), base station I 1206, and a plurality of end nodes (ENs) in each sector 1210, 1212, 1214. Sector I 1210 includes EN(1) 1236 and EN(X) 1238 coupled to BS 1206 *via* wireless links 1240, 1242, respectively; sector II 1212 includes EN(1') 1244 and EN(X') 1246 coupled to BS 1206 *via* wireless links 1248, 1250, respectively; sector III 1214 includes EN(1'') 1252 and EN(X'') 1254 coupled to BS 1206 *via* wireless links 1256, 1258,

respectively. Similarly, cell M 1204 includes base station M 1208, and a plurality of end nodes (ENs) in each sector 1222, 1224, and 1226. Sector I 1222 includes EN(1) 1236' and EN(X) 1238' coupled to BS M 1208 *via* wireless links 1240', 1242', respectively; sector II 1224 includes EN(1') 1244' and EN(X') 1246' coupled to BS M 1208 *via* wireless links 1248', 1250', respectively; sector III 1226 includes EN(1'') 1252' and EN(X'') 1254' coupled to BS 1208 *via* wireless links 1256', 1258', respectively.

[00103] System 1200 also includes a network node 1260 which is coupled to BS I 1206 and BS M 1208 *via* network links 1262, 1264, respectively. Network node 1260 is also coupled to other network nodes, *e.g.*, other base stations, AAA server nodes, intermediate nodes, routers, etc. and the Internet *via* network link 1266. Network links 1262, 1264, 1266 may be, *e.g.*, fiber optic cables. Each end node, *e.g.* EN 1 1236 may be a wireless terminal including a transmitter as well as a receiver. The wireless terminals, *e.g.,* EN(1) 1236 may move through system 1200 and may communicate *via* wireless links with the base station in the cell in which the EN is currently located. The wireless terminals, (WTs), *e.g.* EN(1) 1236, may communicate with peer nodes, *e.g.*, other WTs in system 1200 or outside system 1200 *via* a base station, *e.g.* BS 1206, and/or network node 1260. WTs, *e.g.*, EN(1) 1236 may be mobile communications devices such as cell phones, personal data assistants with wireless modems, etc. Respective base stations perform tone subset allocation using a different method for the strip-symbol periods, from the method employed for allocating tones and determining tone hopping in the rest symbol periods, *e.g.*, non strip-symbol periods. The wireless terminals use the tone subset allocation method along with information received from the base station, *e.g.*, base station slope ID, sector ID information, to determine tones that they can employ to receive data and information at specific strip-symbol periods. The tone subset allocation sequence is constructed, in accordance with various aspects to spread inter-sector and inter-cell interference across respective tones. Although the subject system was described primarily within the context of cellular mode, it is to be appreciated that a plurality of modes may be available and employable in accordance with aspects described herein.

EXEMPLARY BASE STATION

[00104] Fig. 13 illustrates an example base station 1300 in accordance with various aspects. Base station 1300 implements tone subset allocation sequences, with different tone subset allocation sequences generated for respective different sector types of the cell. Base station 1300 may be used as any one of base stations 1206, 1208 of the system 1200 of Figure 12. The base station 1300 includes a receiver 1302, a transmitter 1304, a processor 1306, e.g., CPU, an input/output interface 1308 and memory 1310 coupled together by a bus 1309 over which various elements 1302, 1304, 1306, 1308, and 1310 may interchange data and information.

[00105] Sectorized antenna 1303 coupled to receiver 1302 is used for receiving data and other signals, e.g., channel reports, from wireless terminals transmissions from each sector within the base station's cell. Sectorized antenna 1305 coupled to transmitter 1304 is used for transmitting data and other signals, e.g., control signals, pilot signal, beacon signals, etc. to wireless terminals 1400 (see Figure 14) within each sector of the base station's cell. In various aspects, base station 1300 may employ multiple receivers 1302 and multiple transmitters 1304, e.g., an individual receivers 1302 for each sector and an individual transmitter 1304 for each sector. Processor 1306, may be, e.g., a general purpose central processing unit (CPU). Processor 1306 controls operation of base station 1300 under direction of one or more routines 1318 stored in memory 1310 and implements the methods. I/O interface 1308 provides a connection to other network nodes, coupling the BS 1300 to other base stations, access routers, AAA server nodes, etc., other networks, and the Internet. Memory 1310 includes routines 1318 and data/information 1320.

[00106] Data/ information 1320 includes data 1336, tone subset allocation sequence information 1338 including downlink strip-symbol time information 1340 and downlink tone information 1342, and wireless terminal (WT) data/info 1344 including a plurality of sets of WT information: WT 1 info 1346 and WT N info 1360. Each set of WT info, e.g., WT 1 info 1346 includes data 1348, terminal ID 1350, sector ID 1352, uplink channel information 1354, downlink channel information 1356, and mode information 1358.

[00107] Routines 1318 include communications routines 1322 and base station control routines 1324. Base station control routines 1324 includes a scheduler module 1326 and signaling routines 1328 including a tone subset allocation routine 1330 for

strip-symbol periods, other downlink tone allocation hopping routine 1332 for the rest of symbol periods, e.g., non strip-symbol periods, and a beacon routine 1334.

[00108] Data 1336 includes data to be transmitted that will be sent to encoder 1314 of transmitter 1304 for encoding prior to transmission to WTs, and received data from WTs that has been processed through decoder 1312 of receiver 1302 following reception. Downlink strip-symbol time information 1340 includes the frame synchronization structure information, such as the superslot, beaconslot, and ultraslot structure information and information specifying whether a given symbol period is a strip-symbol period, and if so, the index of the strip-symbol period and whether the strip-symbol is a resetting point to truncate the tone subset allocation sequence used by the base station. Downlink tone information 1342 includes information including a carrier frequency assigned to the base station 1300, the number and frequency of tones, and the set of tone subsets to be allocated to the strip-symbol periods, and other cell and sector specific values such as slope, slope index and sector type.

[00109] Data 1348 may include data that WT1 1400 has received from a peer node, data that WT 1 1400 desires to be transmitted to a peer node, and downlink channel quality report feedback information. Terminal ID 1350 is a base station 1300 assigned ID that identifies WT 1 1400. Sector ID 1352 includes information identifying the sector in which WT1 1400 is operating. Sector ID 1352 can be used, for example, to determine the sector type. Uplink channel information 1354 includes information identifying channel segments that have been allocated by scheduler 1326 for WT1 1400 to use, e.g., uplink traffic channel segments for data, dedicated uplink control channels for requests, power control, timing control, etc. Each uplink channel assigned to WT1 1400 includes one or more logical tones, each logical tone following an uplink hopping sequence. Downlink channel information 1356 includes information identifying channel segments that have been allocated by scheduler 1326 to carry data and/or information to WT1 1400, e.g., downlink traffic channel segments for user data. Each downlink channel assigned to WT1 1400 includes one or more logical tones, each following a downlink hopping sequence. Mode information 1358 includes information identifying the state of operation of WT1 1400, e.g. sleep, hold, on.

[00110] Communications routines 1322 control the base station 1300 to perform various communications operations and implement various communications protocols. Base station control routines 1324 are used to control the base station 1300 to perform

basic base station functional tasks, e.g., signal generation and reception, scheduling, and to implement the steps of the method of some aspects including transmitting signals to wireless terminals using the tone subset allocation sequences during the strip-symbol periods.

[00111] Signaling routine 1328 controls the operation of receiver 1302 with its decoder 1312 and transmitter 1304 with its encoder 1314. The signaling routine 1328 is responsible controlling the generation of transmitted data 1336 and control information. Tone subset allocation routine 1330 constructs the tone subset to be used in a strip-symbol period using the method of the aspect and using data/info 1320 including downlink strip-symbol time info 1340 and sector ID 1352. The downlink tone subset allocation sequences will be different for each sector type in a cell and different for adjacent cells. The WTs 1400 receive the signals in the strip-symbol periods in accordance with the downlink tone subset allocation sequences; the base station 1300 uses the same downlink tone subset allocation sequences in order to generate the transmitted signals. Other downlink tone allocation hopping routine 1332 constructs downlink tone hopping sequences, using information including downlink tone information 1342, and downlink channel information 1356, for the symbol periods other than the strip-symbol periods. The downlink data tone hopping sequences are synchronized across the sectors of a cell. Beacon routine 1334 controls the transmission of a beacon signal, e.g., a signal of relatively high power signal concentrated on one or a few tones, which may be used for synchronization purposes, e.g., to synchronize the frame timing structure of the downlink signal and therefore the tone subset allocation sequence with respect to an ultra-slot boundary.

EXEMPLARY WIRELESS TERMINAL

[00112] Fig. 14 illustrates an example wireless terminal (end node) 1400 which can be used as any one of the wireless terminals (end nodes), e.g., EN(1) 1236, of the system 1200 shown in Fig. 12. Wireless terminal 1400 implements the tone subset allocation sequences. The wireless terminal 1400 includes a receiver 1402 including a decoder 1412, a transmitter 1404 including an encoder 1414, a processor 1406, and memory 1408 which are coupled together by a bus 1410 over which the various elements 1402, 1404, 1406, 1408 can interchange data and information. An antenna

1403 used for receiving signals from a base station (and/or a disparate wireless terminal) is coupled to receiver 1402. An antenna 1405 used for transmitting signals, e.g., to a base station (and/or a disparate wireless terminal) is coupled to transmitter 1404.

[00113] The processor 1406, e.g., a CPU controls the operation of the wireless terminal 1400 and implements methods by executing routines 1420 and using data/information 1422 in memory 1408.

[00114] Data/information 1422 includes user data 1434, user information 1436, and tone subset allocation sequence information 1450. User data 1434 may include data, intended for a peer node, which will be routed to encoder 1414 for encoding prior to transmission by transmitter 1404 to a base station, and data received from the base station which has been processed by the decoder 1412 in receiver 1402. User information 1436 includes uplink channel information 1438, downlink channel information 1440, terminal ID information 1442, base station ID information 1444, sector ID information 1446, and mode information 1448. Uplink channel information 1438 includes information identifying uplink channels segments that have been assigned by a base station for wireless terminal 1400 to use when transmitting to the base station. Uplink channels may include uplink traffic channels, dedicated uplink control channels, e.g., request channels, power control channels and timing control channels. Each uplink channel includes one or more logic tones, each logical tone following an uplink tone hopping sequence. The uplink hopping sequences are different between each sector type of a cell and between adjacent cells. Downlink channel information 1440 includes information identifying downlink channel segments that have been assigned by a base station to WT 1400 for use when the base station is transmitting data/information to WT 1400. Downlink channels may include downlink traffic channels and assignment channels, each downlink channel including one or more logical tone, each logical tone following a downlink hopping sequence, which is synchronized between each sector of the cell.

[00115] User info 1436 also includes terminal ID information 1442, which is a base station-assigned identification, base station ID information 1444 which identifies the specific base station that WT has established communications with, and sector ID info 1446 which identifies the specific sector of the cell where WT 1400 is presently located. Base station ID 1444 provides a cell slope value and sector ID info 1446 provides a sector index type; the cell slope value and sector index type may be used to

derive tone hopping sequences. Mode information 1448 also included in user info 1436 identifies whether the WT 1400 is in sleep mode, hold mode, or on mode.

[00116] Tone subset allocation sequence information 1450 includes downlink strip-symbol time information 1452 and downlink tone information 1454. Downlink strip-symbol time information 1452 include the frame synchronization structure information, such as the superslot, beaconslot, and ultraslot structure information and information specifying whether a given symbol period is a strip-symbol period, and if so, the index of the strip-symbol period and whether the strip-symbol is a resetting point to truncate the tone subset allocation sequence used by the base station. Downlink tone info 1454 includes information including a carrier frequency assigned to the base station, the number and frequency of tones, and the set of tone subsets to be allocated to the strip-symbol periods, and other cell and sector specific values such as slope, slope index and sector type.

[00117] Routines 1420 include communications routines 1424 and wireless terminal control routines 1426. Communications routines 1424 control the various communications protocols used by WT 1400. Wireless terminal control routines 1426 controls basic wireless terminal 1400 functionality including the control of the receiver 1402 and transmitter 1404. Wireless terminal control routines 1426 include the signaling routine 1428. The signaling routine 1428 includes a tone subset allocation routine 1430 for the strip-symbol periods and an other downlink tone allocation hopping routine 1432 for the rest of symbol periods, *e.g.*, non strip-symbol periods. Tone subset allocation routine 1430 uses user data/info 1422 including downlink channel information 1440, base station ID info 1444, *e.g.*, slope index and sector type, and downlink tone information 1454 in order to generate the downlink tone subset allocation sequences in accordance with some aspects and process received data transmitted from the base station. Other downlink tone allocation hopping routine 1430 constructs downlink tone hopping sequences, using information including downlink tone information 1454, and downlink channel information 1440, for the symbol periods other than the strip-symbol periods. Tone subset allocation routine 1430, when executed by processor 1406, is used to determine when and on which tones the wireless terminal 1400 is to receive one or more strip-symbol signals from the base station 1300. The uplink tone allocation hopping routine 1430 uses a tone subset allocation function,

along with information received from the base station, to determine the tones in which it should transmit on.

[00118] In one or more exemplary embodiments, the functions described may be implemented in hardware, software, firmware, or any combination thereof. If implemented in software, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. Computer-readable media includes both computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A storage media may be any available media that can be accessed by a computer. By way of example, and not limitation, such computer-readable media can comprise RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium that can be used to carry or store desired program code in the form of instructions or data structures and that can be accessed by a computer. Also, any connection is properly termed a computer-readable medium. For example, if the software is transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, DSL, or wireless technologies such as infrared, radio, and microwave are included in the definition of medium. Disk and disc, as used herein, includes compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk and blu-ray disc where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Combinations of the above should also be included within the scope of computer-readable media.

[00119] When the embodiments are implemented in program code or code segments, it should be appreciated that a code segment can represent a procedure, a function, a subprogram, a program, a routine, a subroutine, a module, a software package, a class, or any combination of instructions, data structures, or program statements. A code segment can be coupled to another code segment or a hardware circuit by passing and/or receiving information, data, arguments, parameters, or memory contents. Information, arguments, parameters, data, *etc.* can be passed, forwarded, or transmitted using any suitable means including memory sharing, message passing, token passing, network transmission, *etc.* Additionally, in some aspects, the steps and/or actions of a method or algorithm can reside as one or any combination or set of codes

and/or instructions on a machine readable medium and/or computer readable medium, which can be incorporated into a computer program product.

[00120] For a software implementation, the techniques described herein can be implemented with modules (*e.g.*, procedures, functions, and so on) that perform the functions described herein. The software codes can be stored in memory units and executed by processors. The memory unit can be implemented within the processor or external to the processor, in which case it can be communicatively coupled to the processor via various means as is known in the art.

[00121] For a hardware implementation, the processing units can be implemented within one or more application specific integrated circuits (ASICs), digital signal processors (DSPs), digital signal processing devices (DSPDs), programmable logic devices (PLDs), field programmable gate arrays (FPGAs), processors, controllers, micro-controllers, microprocessors, other electronic units designed to perform the functions described herein, or a combination thereof.

[00122] What has been described above includes examples of one or more embodiments. It is, of course, not possible to describe every conceivable combination of components or methodologies for purposes of describing the aforementioned embodiments, but one of ordinary skill in the art may recognize that many further combinations and permutations of various embodiments are possible. Accordingly, the described embodiments are intended to embrace all such alterations, modifications and variations that fall within the spirit and scope of the appended claims. Furthermore, to the extent that the term "includes" is used in either the detailed description or the claims, such term is intended to be inclusive in a manner similar to the term "comprising" as "comprising" is interpreted when employed as a transitional word in a claim.

[00123] As used herein, the term to "infer" or "inference" refers generally to the process of reasoning about or inferring states of the system, environment, and/or user from a set of observations as captured *via* events and/or data. Inference can be employed to identify a specific context or action, or can generate a probability distribution over states, for example. The inference can be probabilistic–that is, the computation of a probability distribution over states of interest based on a consideration of data and events. Inference can also refer to techniques employed for composing higher-level events from a set of events and/or data. Such inference results in the

construction of new events or actions from a set of observed events and/or stored event data, whether or not the events are correlated in close temporal proximity, and whether the events and data come from one or several event and data sources.

[00124] Furthermore, as used in this application, the terms "component," "module," "system," and the like are intended to refer to a computer-related entity, either hardware, firmware, a combination of hardware and software, software, or software in execution. For example, a component can be, but is not limited to being, a process running on a processor, a processor, an object, an executable, a thread of execution, a program, and/or a computer. By way of illustration, both an application running on a computing device and the computing device can be a component. One or more components can reside within a process and/or thread of execution and a component can be localized on one computer and/or distributed between two or more computers. In addition, these components can execute from various computer readable media having various data structures stored thereon. The components can communicate by way of local and/or remote processes such as in accordance with a signal having one or more data packets (*e.g.*, data from one component interacting with another component in a local system, distributed system, and/or across a network such as the Internet with other systems by way of the signal).

CLAIMS

What is claimed is:

1. A method that facilitates a timing alignment in a multicarrier system, the method comprising:

determining at least one downlink timing associated with at least one downlink carrier;

ascertaining an uplink timing associated with an uplink group of carriers, wherein the uplink timing is ascertained based on a processing of at least one downlink timing and a timing offset associated with the uplink group of carriers; and

transmitting each of the uplink group of carriers within a threshold value of the uplink timing.

2. The method of claim 1, further comprising performing a random access procedure on at least one random access carrier, wherein the at least one random access carrier is included in a downlink group of carriers that includes the at least one downlink carrier.

3. The method of claim 2, wherein the performing comprises performing the random access procedure on a single carrier.

4. The method of claim 3, wherein the single carrier is an assigned carrier provided by a network prior to the performing of the random access procedure.

5. The method of claim 4, further comprising receiving the single carrier as part of a dedicated radio resource configuration.

6. The method of claim 4, further comprising receiving a criterion associated with a usage of the single carrier, wherein the criterion is received with an assignment of the single carrier.

7. The method of claim 6, wherein the criterion is a minimum signal quality threshold associated with the single carrier.

8. The method of claim 6, wherein the performing comprises performing the random access procedure on an alternative carrier in response to the criterion not being met by the single carrier, and wherein the receiving further comprises receiving an indication of the alternative carrier from the network.

9. The method of claim 6, wherein the performing comprises performing the random access procedure on an alternative carrier in response to the criterion not being met by the single carrier, and wherein the alternative carrier is independently selected by a wireless terminal.

10. The method of claim 3, further comprising selecting the single carrier, wherein the single carrier is independently selected by a wireless terminal.

11. The method of claim 10, wherein the selecting comprises applying a determination function across a set of available carriers in the downlink group of carriers.

12. The method of claim 11, wherein the determination function is a pseudorandom function.

13. The method of claim 11, wherein the determination function is a hash function.

14. The method of claim 13, further comprising inputting an identifier associated with the wireless terminal into the hash function.

15. The method of claim 13, further comprising inputting an identifier associated with a network node into the hash function, wherein the downlink group of carriers is controlled by the network node.

16. The method of claim 13, further comprising inputting a time-varying value into the hash function.

17. The method of claim 16, further comprising determining the time-varying value via a time measurement taken from within the wireless terminal.

18. The method of claim 16, further comprising modifying the time-varying value by an arithmetic operation each time the time-varying value is used.

19. The method of claim 10, wherein the selecting is performed at a time when radio resources are assigned to the wireless terminal on any of the downlink group of carriers.

20. The method of claim 10, wherein the selecting is performed in response to a triggering of the random access procedure.

21. An apparatus configured to facilitate a timing alignment in a multicarrier system, the apparatus comprising:

a processor configured to execute computer executable components stored in memory, the components including:

a downlink timing component configured to determine at least one downlink timing associated with at least one downlink carrier;

an uplink timing component configured to ascertain an uplink timing associated with an uplink group of carriers, wherein the uplink timing is ascertained based on at least one downlink timing and a timing offset associated with the uplink group of carriers; and

a communication component configured to transmit each of the uplink group of carriers within a threshold value of the uplink timing.

22. The apparatus of claim 21, wherein the uplink timing component is configured to determine the uplink timing by utilizing a different timing offset for each of a plurality of uplink group of carriers.

23. The apparatus of claim 21, wherein the uplink timing component is configured to determine the uplink timing by utilizing a different downlink timing for each of a plurality of uplink group of carriers.

24. The apparatus of claim 21, wherein the at least one downlink carrier is included in one of a plurality of downlink groups, and wherein the uplink timing component is configured to determine the uplink timing by associating the uplink group of carriers with the one of the plurality of downlink groups.

25. The apparatus of claim 24, wherein the uplink timing component is configured to determine a plurality of uplink timings respectively associated with a plurality of uplink groups by identifying a subset of downlink groups that include an assigned carrier, and wherein the plurality of uplink groups are respectively associated with the subset of downlink groups that include the assigned carrier.

26. The apparatus of claim 24, further comprising a message processing component configured to process a received timing message encoded with a set of uplink timing instructions respectively corresponding to an uplink group subset of the uplink group of carriers.

27. The apparatus of claim 26, wherein the received timing message is a timing advance command.

28. The apparatus of claim 26, wherein the received timing message comprises a vector encoded with timing adjustment values associated with the uplink group subset.

29. The apparatus of claim 26, wherein each uplink group within the uplink group subset includes at least one carrier with an assigned radio resource.

30. The apparatus of claim 26, wherein the uplink group of carriers comprise a set of uplink groups in which each uplink group within the set of uplink groups includes at least one carrier with an assigned radio resource, and wherein the uplink group subset is a subset of the set of uplink groups.

31. The apparatus of claim 30, wherein the uplink group subset is determined by a network entity.

32. The apparatus of claim 31, wherein the message processing component is configured to submit a request requesting the network entity to provide the uplink group subset, and wherein the uplink group subset is determined by the network entity in response to the request.

33. The apparatus of claim 30, wherein the received timing message includes an indication of which of the uplink group of carriers are included in the uplink group subset.

34. The apparatus of claim 33, wherein the message processing component is configured to decode the indication according to a mapping of group identities shared with a network.

35. The apparatus of claim 34, wherein the mapping of group identities is configured in association with an assignment of dedicated radio resources on uplink carriers within at least one uplink group of the uplink group subset.

36. The apparatus of claim 24, further comprising a message processing component configured to decode a timing message received via a timing message carrier included in a messenger downlink group, wherein the timing message is encoded with at least one inter-group uplink timing corresponding to a target downlink group, and wherein the target downlink group is different than the messenger downlink group.

37. The apparatus of claim 36, wherein the timing message includes an indication of the target downlink group.

38. The apparatus of claim 37, wherein the message processing component configured to decode the indication according to a mapping of group identities shared with a network.

39. The apparatus of claim 38, wherein the mapping of group identities is configured in association with an assignment of dedicated radio resources on downlink carriers included in the target downlink group.

40. The apparatus of claim 21, further comprising an averaging component configured to compute an average downlink timing from a plurality of downlink timings respectively corresponding to a set of downlink carriers within a particular downlink group that includes the at least one downlink carrier, wherein the uplink timing component is configured to determine the uplink timing by applying the timing offset to the average downlink timing.

41. The apparatus of claim 40, wherein the particular downlink group comprises at least one carrier associated with an assigned radio resource.

42. The apparatus of claim 40, wherein the particular downlink group comprises a set of carriers identified by a network.

43. A computer program product that facilitates a timing alignment in a multicarrier system, comprising:

a computer-readable storage medium comprising code for causing at least one computer to:

determine at least one downlink timing associated with at least one downlink carrier;

ascertain an uplink timing associated with an uplink group of carriers, wherein the uplink timing is ascertained based on at least one downlink timing and a timing offset associated with the uplink group of carriers; and

transmit each of the uplink group of carriers within a threshold value of the uplink timing.

44. The computer program product of claim 43, wherein the code causes the at least one computer to associate the uplink group of carriers with one of a plurality of downlink groups, and wherein the code further causes the at least one computer to

receive a timing message encoded with a set of uplink timing instructions respectively corresponding to a downlink group subset of the plurality of downlink groups.

45. The computer program product of claim 43, wherein the code causes the at least one computer to decode a timing message received via a timing message carrier included in a messenger downlink group, and wherein the timing message is encoded with at least one inter-group uplink timing corresponding to a target downlink group different than the messenger downlink group.

46. The computer program product of claim 43, wherein the code causes the at least one computer to compute an average downlink timing from a plurality of downlink timings respectively corresponding to a set of downlink carriers within a particular downlink group that includes the at least one downlink carrier, and wherein the code further causes the at least one computer to determine the uplink timing by applying the timing offset to the average downlink timing.

47. The computer program product of claim 43, wherein the code causes the at least one computer to perform a random access procedure on at least one random access carrier, and wherein the at least one random access carrier is included in a downlink group of carriers that includes the at least one downlink carrier.

48. An apparatus configured to facilitate a timing alignment in a multicarrier system, the apparatus comprising:

means for determining at least one downlink timing associated with at least one downlink carrier;

means for ascertaining an uplink timing associated with an uplink group of carriers, wherein the uplink timing is ascertained based on at least one downlink timing and a timing offset associated with the uplink group of carriers; and

means for transmitting each of the uplink group of carriers within a threshold value of the uplink timing.

49. The apparatus of claim 48, wherein the means for ascertaining is configured to utilize a different timing offset for each of a plurality of uplink group of carriers.

50. The apparatus of claim 48, wherein the means for ascertaining is configured to utilize a different downlink timing for each of a plurality of uplink group of carriers.

51. The apparatus of claim 48, wherein the at least one downlink carrier is included in one of a plurality of downlink groups, and wherein the means for ascertaining is configured to associate the uplink group of carriers with the one of the plurality of downlink groups.

52. The apparatus of claim 48, further comprising means for performing a random access procedure on at least one random access carrier, wherein the at least one random access carrier is included in a downlink group of carriers that includes the at least one downlink carrier.

53. A method that facilitates a timing alignment in a multicarrier system, the method comprising:

transmitting a downlink communication to a wireless terminal via at least one downlink carrier;

assigning a timing offset to an uplink group of carriers;

providing the timing offset to the wireless terminal via the at least one downlink carrier; and

receiving an uplink communication via the uplink group of carriers, wherein the uplink group of carriers are received according to the timing offset.

54. The method of claim 53, wherein the assigning comprises assigning a different timing offset to each of a plurality of uplink groups.

55. The method of claim 54, further comprising generating a timing message encoded with a set of uplink timing instructions respectively corresponding to an uplink group subset of the plurality of uplink groups, wherein the transmitting comprises transmitting the timing message to the wireless terminal.

56. The method of claim 55, wherein the timing message is a timing advance command.

57. The method of claim 55, wherein the timing message comprises a vector encoded with timing adjustment values associated with the uplink group subset.

58. The method of claim 55, wherein each uplink group within the uplink group subset includes at least one carrier with a radio resource assigned to the wireless terminal.

59. The method of claim 55, wherein the plurality of uplink groups comprise a set of uplink groups in which each uplink group within the set of uplink groups includes at least one carrier with a radio resource assigned to the wireless terminal, and wherein the uplink group subset is a subset of the set of uplink groups.

60. The method of claim 59, further comprising determining the uplink group subset.

61. The method of claim 60, further comprising receiving a request from the wireless terminal to provide the uplink group subset, wherein the determining is performed in response to the request.

62. The method of claim 59, wherein the timing message is encoded with an indication of which of the plurality of uplink groups are included in the uplink group subset.

63. The method of claim 62, wherein the indication is encoded according to a mapping of group identities shared with the wireless terminal.

64. The method of claim 63, wherein the mapping of group identities is configured in association with an assignment of dedicated radio resources on uplink carriers within at least one uplink group of the uplink group subset.

65. The method of claim 54, further comprising generating a timing message encoded with at least one inter-group uplink timing corresponding to a target downlink group, wherein the transmitting comprises transmitting the timing message to the wireless terminal via a timing message carrier included in a messenger downlink group, and wherein the target downlink group is different than the messenger downlink group.

66. The method of claim 65, wherein the timing message is encoded with an indication of the target downlink group.

67. The method of claim 66, wherein the indication is encoded according to a mapping of group identities shared with the wireless terminal.

68. The method of claim 67, wherein the mapping of group identities is configured in association with an assignment of dedicated radio resources on downlink carriers included in the target downlink group.

69. An apparatus configured to facilitate a timing alignment in a multicarrier system, the apparatus comprising:

a processor configured to execute computer executable components stored in memory, the components including:

a timing offset component configured to assign a timing offset to an uplink group of carriers;

a transmitting component configured to provide the timing offset to a wireless terminal via at least one downlink carrier; and

a receiving component configured to receive an uplink communication via the uplink group of carriers, wherein the uplink group of carriers are received according to the timing offset.

70. The apparatus of claim 69, wherein the transmitting component is configured to transmit a downlink group of carriers from antennas located at a common site.

71. The apparatus of claim 69, wherein the transmitting component is configured to identify a set of carriers respectively corresponding to a plurality of downlink timings to

facilitate an averaging of the plurality of downlink timings performed by the wireless terminal.

72. The apparatus of claim 69, further comprising a random access component configured to identify a random access carrier to facilitate a random access procedure, wherein the random access carrier is a carrier assigned to the wireless terminal.

73. The apparatus of claim 72, wherein the transmitting component is configured to transmit the random access carrier as part of a dedicated radio resource configuration.

74. The apparatus of claim 72, wherein the random access component is configured to ascertain a criterion associated with a usage of the random access carrier, and wherein the criterion is provided to the wireless terminal with an assignment of the random access carrier.

75. The apparatus of claim 74, wherein the criterion is a minimum signal quality threshold associated with the random access carrier.

76. The apparatus of claim 74, wherein the random access component is configured to identify an alternative carrier to facilitate a performing of the random access procedure by the wireless terminal on the alternative carrier in response to the criterion not being met by the random access carrier.

77. A computer program product that facilitates a timing alignment in a multicarrier system, comprising:

a computer-readable storage medium comprising code for causing at least one computer to:

transmit at least one downlink carrier to a wireless terminal;

assign a timing offset to an uplink group of carriers;

provide the timing offset to the wireless terminal via the at least one downlink carrier; and

receive an uplink communication via the uplink group of carriers, wherein the uplink group of carriers are received according to the timing offset.

78. The computer program product of claim 77, wherein the code causes the at least one computer to transmit a downlink group of carriers from antennas located at a common site.

79. The computer program product of claim 77, wherein the code causes the at least one computer to assign a different timing offset to each of a plurality of uplink groups.

80. The computer program product of claim 79, wherein the code causes the at least one computer to generate a timing message encoded with a set of uplink timing instructions respectively corresponding to an uplink group subset of the plurality of uplink groups, and wherein the code further causes the at least one computer to transmit the timing message to the wireless terminal.

81. The computer program product of claim 77, wherein the code causes the at least one computer to identify a set of carriers respectively corresponding to a plurality of downlink timings to facilitate an averaging of the plurality of downlink timings performed by the wireless terminal.

82. The computer program product of claim 77, wherein the code causes the at least one computer to identify a random access carrier to facilitate a random access procedure, and wherein the random access carrier is a carrier assigned to the wireless terminal.

83. An apparatus configured to facilitate a timing alignment in a multicarrier system, the apparatus comprising:

means for transmitting at least one downlink carrier to a wireless terminal;

means for assigning a timing offset to an uplink group of carriers;

means for providing the timing offset to the wireless terminal via the at least one downlink carrier; and

means for receiving an uplink communication via the uplink group of carriers, wherein the uplink group of carriers are received according to the timing offset.

84. The apparatus of claim 83, wherein the means for transmitting is configured to transmit a downlink group of carriers from antennas located at a common site.

85. The apparatus of claim 83, wherein the means for assigning is configured to assign a different timing offset to each of a plurality of uplink groups.

86. The apparatus of claim 85, further comprising a means for generating a timing message encoded with at least one inter-group uplink timing corresponding to a target downlink group, wherein the means for transmitting is configured to transmit the timing message to the wireless terminal via a timing message carrier included in a messenger downlink group, and wherein the target downlink group is different than the messenger downlink group.

87. The apparatus of claim 83, wherein the means for transmitting is configured to identify a set of carriers respectively corresponding to a plurality of downlink timings to facilitate an averaging of the plurality of downlink timings performed by the wireless terminal.

88. The apparatus of claim 83, wherein the means for transmitting is configured to identify a random access carrier to facilitate a random access procedure, and wherein the random access carrier is a carrier assigned to the wireless terminal.

ABSTRACT

Aspects are disclosed for facilitating a timing alignment in a multicarrier system. In one aspect, at least one downlink timing associated with at least one downlink carrier is determined, and an uplink timing associated with an uplink group of carriers is ascertained based on at least one downlink timing and a timing offset associated with the uplink group of carriers. Each of the uplink group of carriers is then transmitted within a threshold value of the uplink timing. In another aspect, a downlink communication is transmitted to a wireless terminal via at least one downlink carrier. This embodiment further includes assigning a timing offset to an uplink group of carriers, and providing the timing offset to the wireless terminal via the at least one downlink carrier. An uplink communication is then received via the uplink group of carriers according to the timing offset.

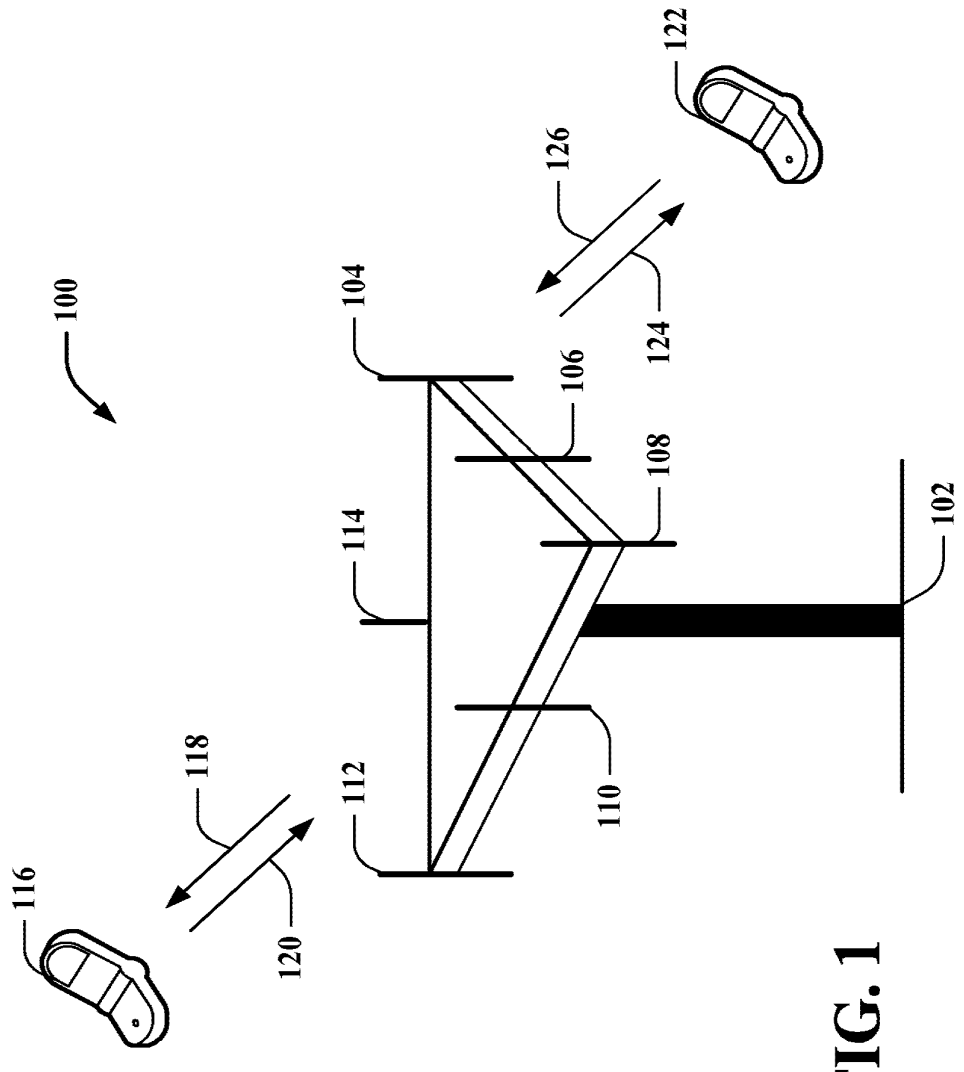


FIG. 1

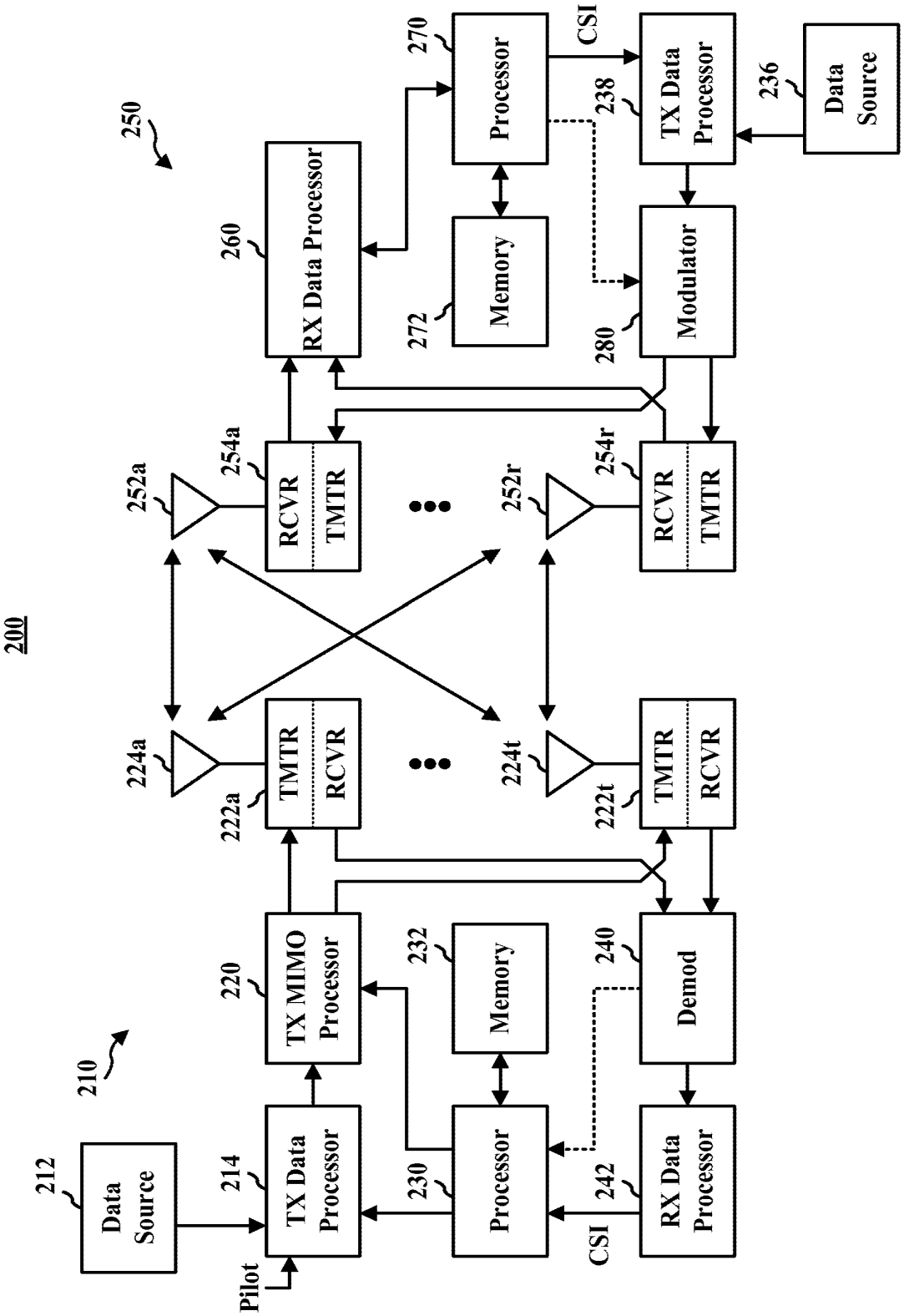

200
210
212
Data Source
214
TX Data Processor
Pilot
220
TX MIMO Processor
222a
TMTR
RCVR
224a
230
Processor
232
Memory
240
Demod
242
RX Data Processor
CSI
250
252a
254a
RCVR
TMTR
252r
254r
RCVR
TMTR
260
RX Data Processor
270
Processor
272
Memory
280
Modulator
238
CSI
TX Data Processor
236
Data Source
222t
TMTR
RCVR
224t

FIG. 2

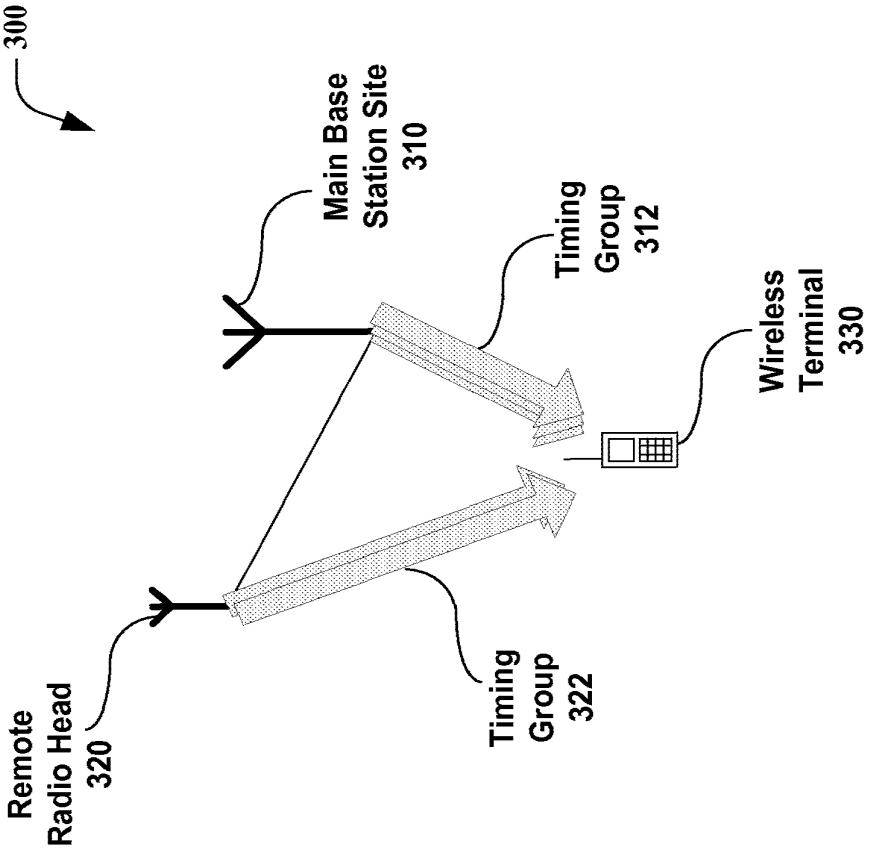

300
Main Base Station Site 310
Timing Group 312
Wireless Terminal 330
Remote Radio Head 320
Timing Group 322

FIG. 3

FIG. 4

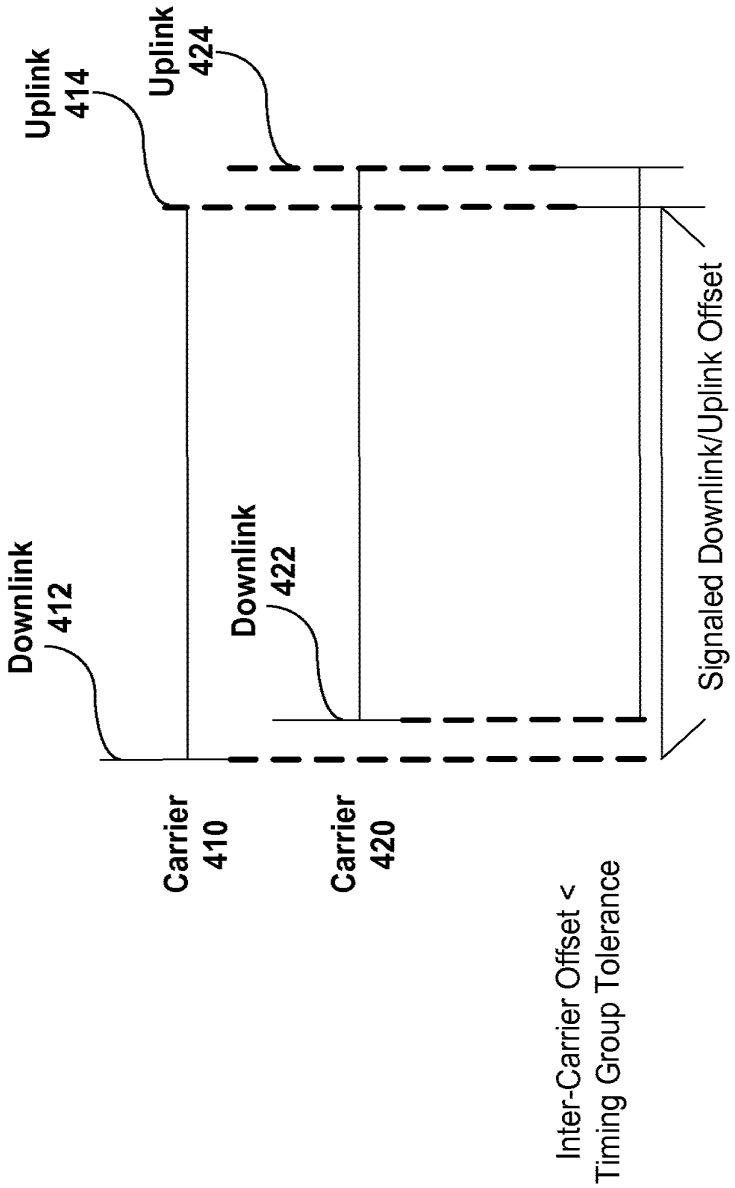

Uplink
414
Uplink
424
Downlink
412
Downlink
422
Signaled Downlink/Uplink Offset
Carrier
410
Carrier
420
Inter-Carrier Offset <
Timing Group Tolerance

FIG. 5

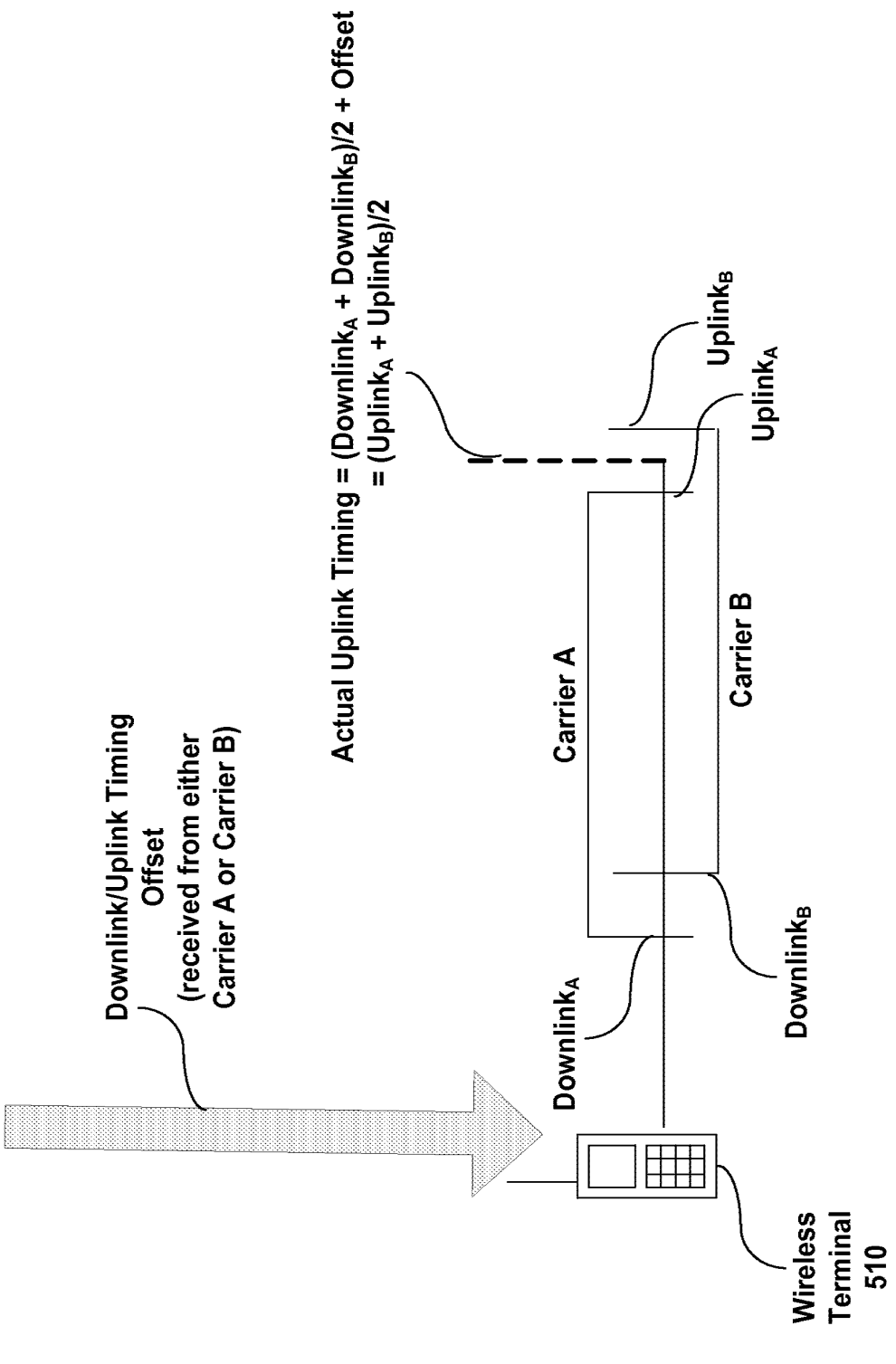
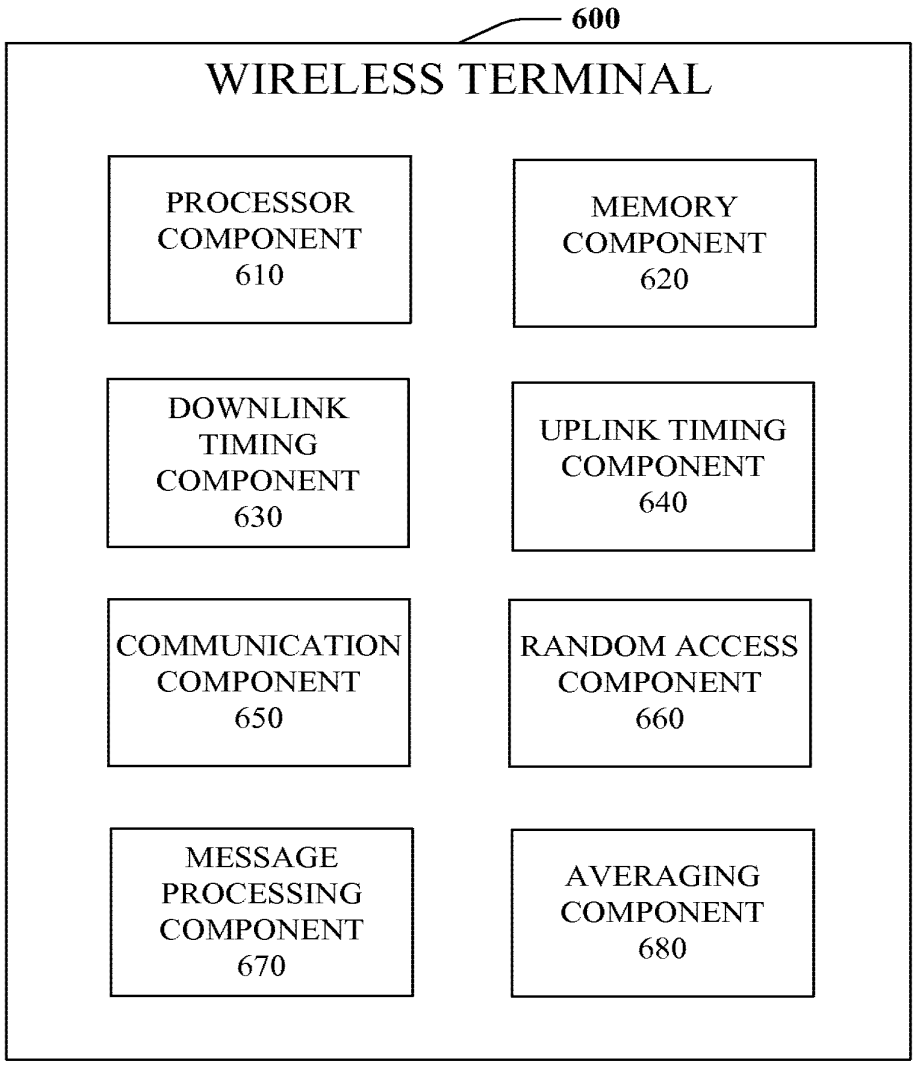

Downlink/Uplink Timing Offset (received from either Carrier A or Carrier B)
Actual Uplink Timing = (Downlink$_A$ + Downlink$_B$)/2 + Offset = (Uplink$_A$ + Uplink$_B$)/2
Carrier A
Carrier B
Downlink$_A$
Downlink$_B$
Uplink$_A$
Uplink$_B$
Wireless Terminal 510

FIG. 6


600
WIRELESS TERMINAL
PROCESSOR COMPONENT 610
MEMORY COMPONENT 620
DOWNLINK TIMING COMPONENT 630
UPLINK TIMING COMPONENT 640
COMMUNICATION COMPONENT 650
RANDOM ACCESS COMPONENT 660
MESSAGE PROCESSING COMPONENT 670
AVERAGING COMPONENT 680

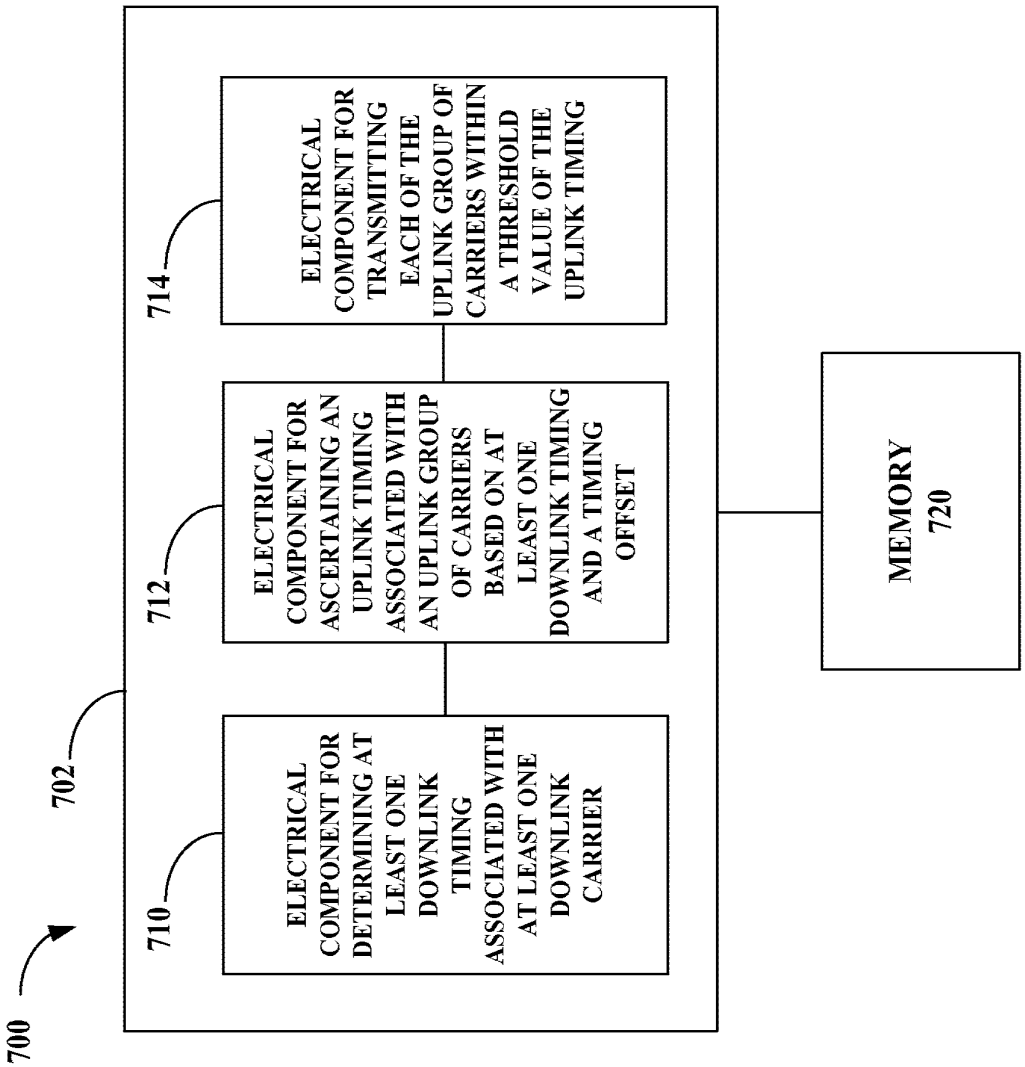

700
702
710
ELECTRICAL COMPONENT FOR DETERMINING AT LEAST ONE DOWNLINK TIMING ASSOCIATED WITH AT LEAST ONE DOWNLINK CARRIER
712
ELECTRICAL COMPONENT FOR ASCERTAINING AN UPLINK TIMING ASSOCIATED WITH AN UPLINK GROUP OF CARRIERS BASED ON AT LEAST ONE DOWNLINK TIMING AND A TIMING OFFSET
714
ELECTRICAL COMPONENT FOR TRANSMITTING EACH OF THE UPLINK GROUP OF CARRIERS WITHIN A THRESHOLD VALUE OF THE UPLINK TIMING
MEMORY 720

FIG. 7

FIG. 8

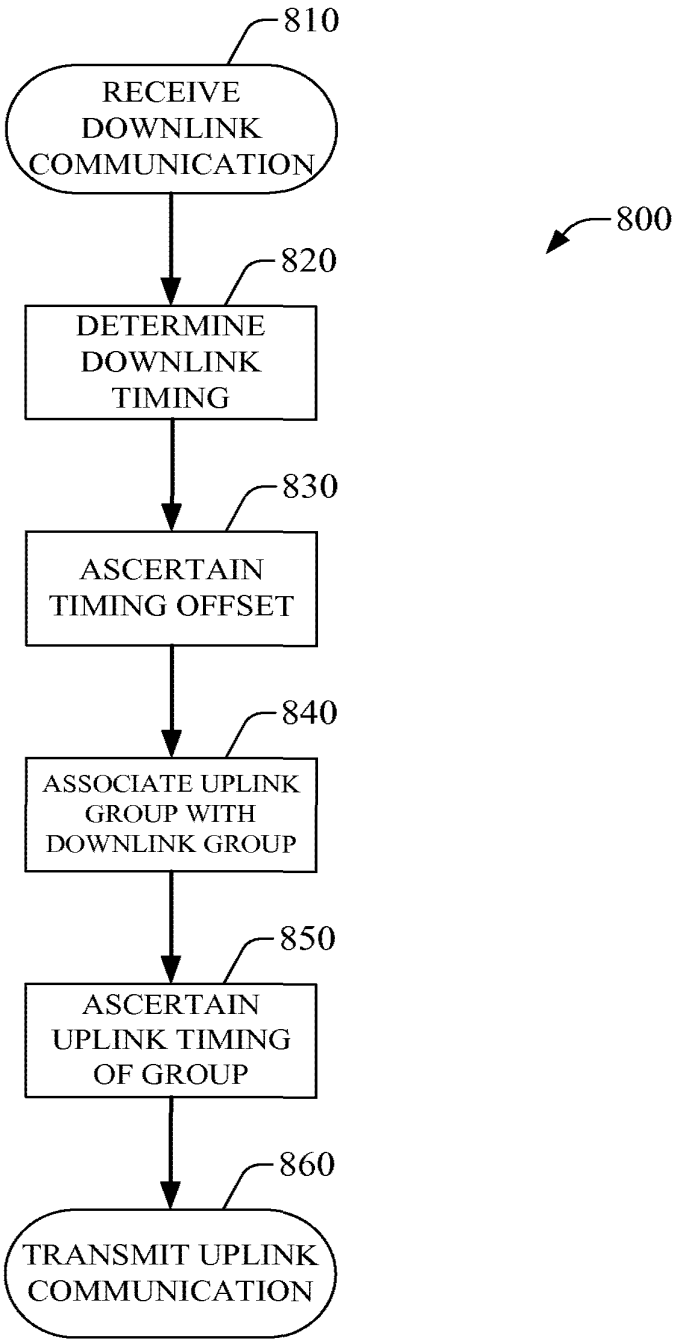
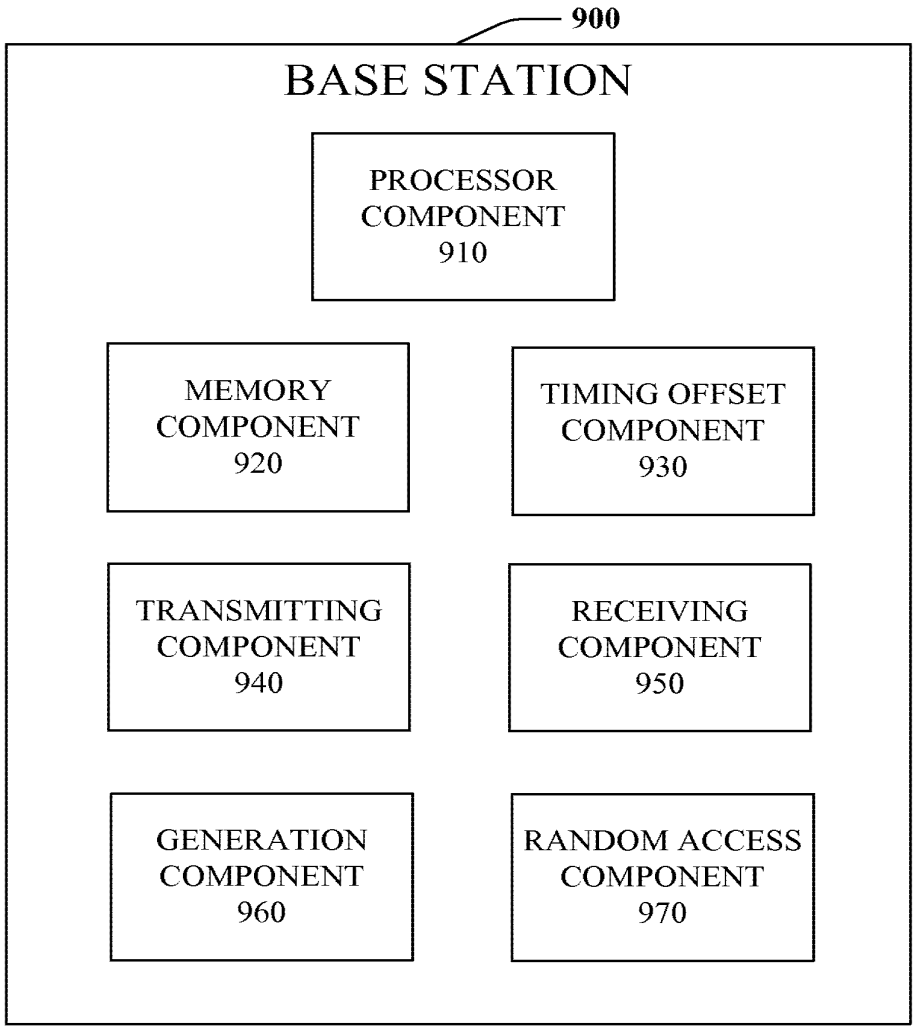

810
RECEIVE DOWNLINK COMMUNICATION
800
820
DETERMINE DOWNLINK TIMING
830
ASCERTAIN TIMING OFFSET
840
ASSOCIATE UPLINK GROUP WITH DOWNLINK GROUP
850
ASCERTAIN UPLINK TIMING OF GROUP
860
TRANSMIT UPLINK COMMUNICATION

FIG. 9


900
BASE STATION
PROCESSOR COMPONENT 910
MEMORY COMPONENT 920
TIMING OFFSET COMPONENT 930
TRANSMITTING COMPONENT 940
RECEIVING COMPONENT 950
GENERATION COMPONENT 960
RANDOM ACCESS COMPONENT 970

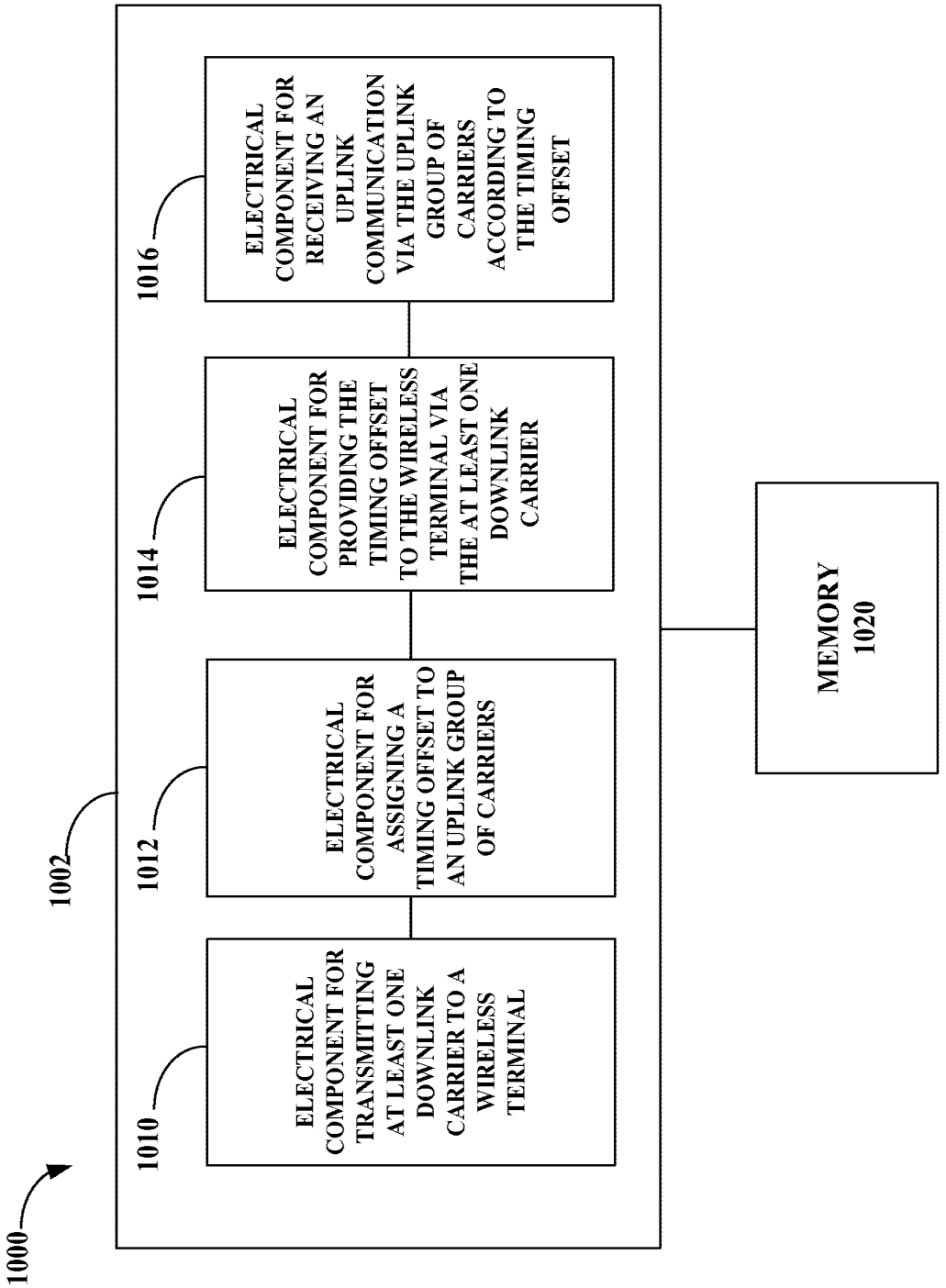

1000
1002
1010
ELECTRICAL COMPONENT FOR TRANSMITTING AT LEAST ONE DOWNLINK CARRIER TO A WIRELESS TERMINAL
1012
ELECTRICAL COMPONENT FOR ASSIGNING A TIMING OFFSET TO AN UPLINK GROUP OF CARRIERS
1014
ELECTRICAL COMPONENT FOR PROVIDING THE TIMING OFFSET TO THE WIRELESS TERMINAL VIA THE AT LEAST ONE DOWNLINK CARRIER
1016
ELECTRICAL COMPONENT FOR RECEIVING AN UPLINK COMMUNICATION VIA THE UPLINK GROUP OF CARRIERS ACCORDING TO THE TIMING OFFSET
MEMORY 1020

FIG. 10

FIG. 11

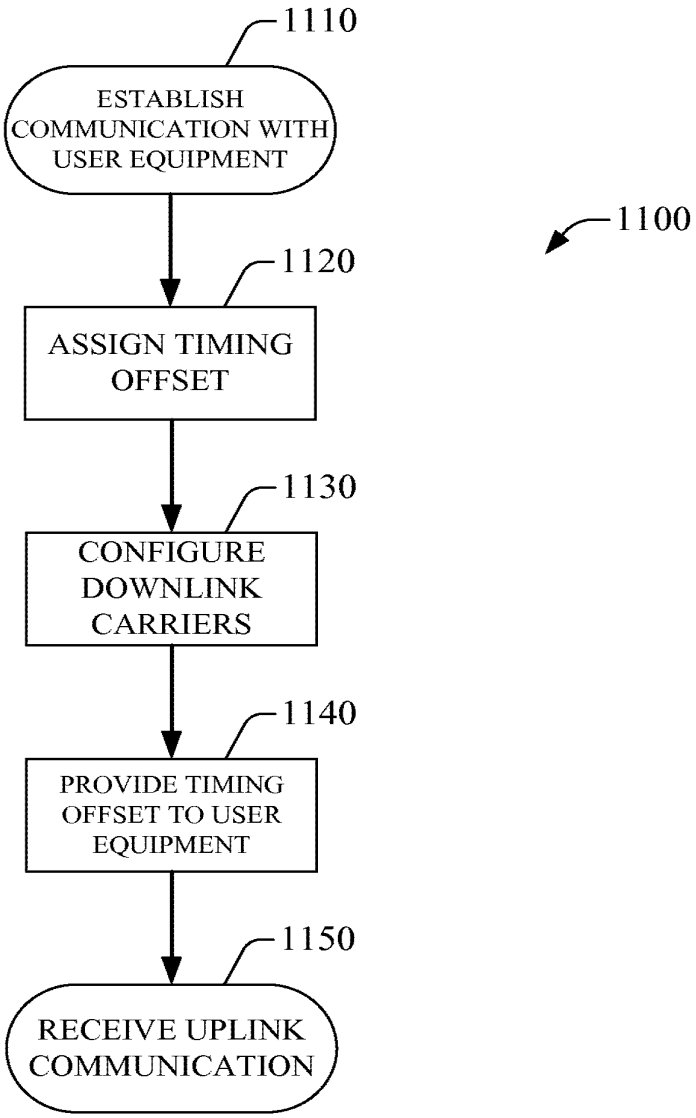

1110
ESTABLISH COMMUNICATION WITH USER EQUIPMENT
1100
1120
ASSIGN TIMING OFFSET
1130
CONFIGURE DOWNLINK CARRIERS
1140
PROVIDE TIMING OFFSET TO USER EQUIPMENT
1150
RECEIVE UPLINK COMMUNICATION

FIG. 12

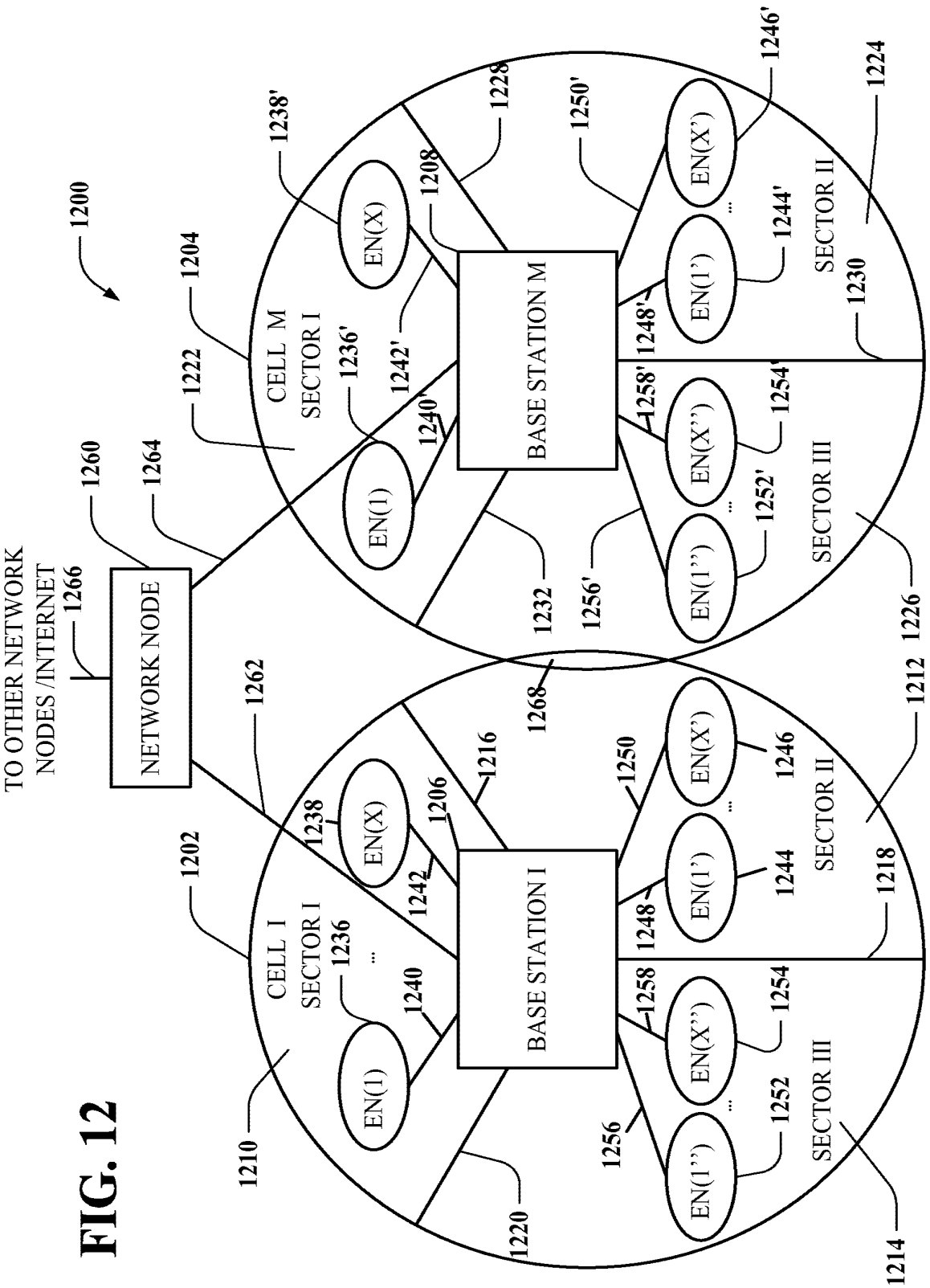

1200
TO OTHER NETWORK NODES /INTERNET
1266
NETWORK NODE
1260
1264
1262
1204
1222
1202
CELL I
SECTOR I
1236
...
EN(1)
1240
1238
EN(X)
1242
1206
1216
BASE STATION I
1248
1258
EN(1')
EN(X')
1244
1246
1250
SECTOR II
1218
1212
EN(1'')
EN(X'')
1252
1254
SECTOR III
1210
1220
1214
1256
1268
1232
1226
1238'
CELL M
SECTOR I
1236'
EN(1)
1240'
EN(X)
1242'
1208
1228
BASE STATION M
1248'
1258'
EN(1')
EN(X')
1244'
1246'
1250'
SECTOR II
1230
1224
EN(1'')
EN(X'')
1252'
1254'
SECTOR III
1256'

FIG. 13

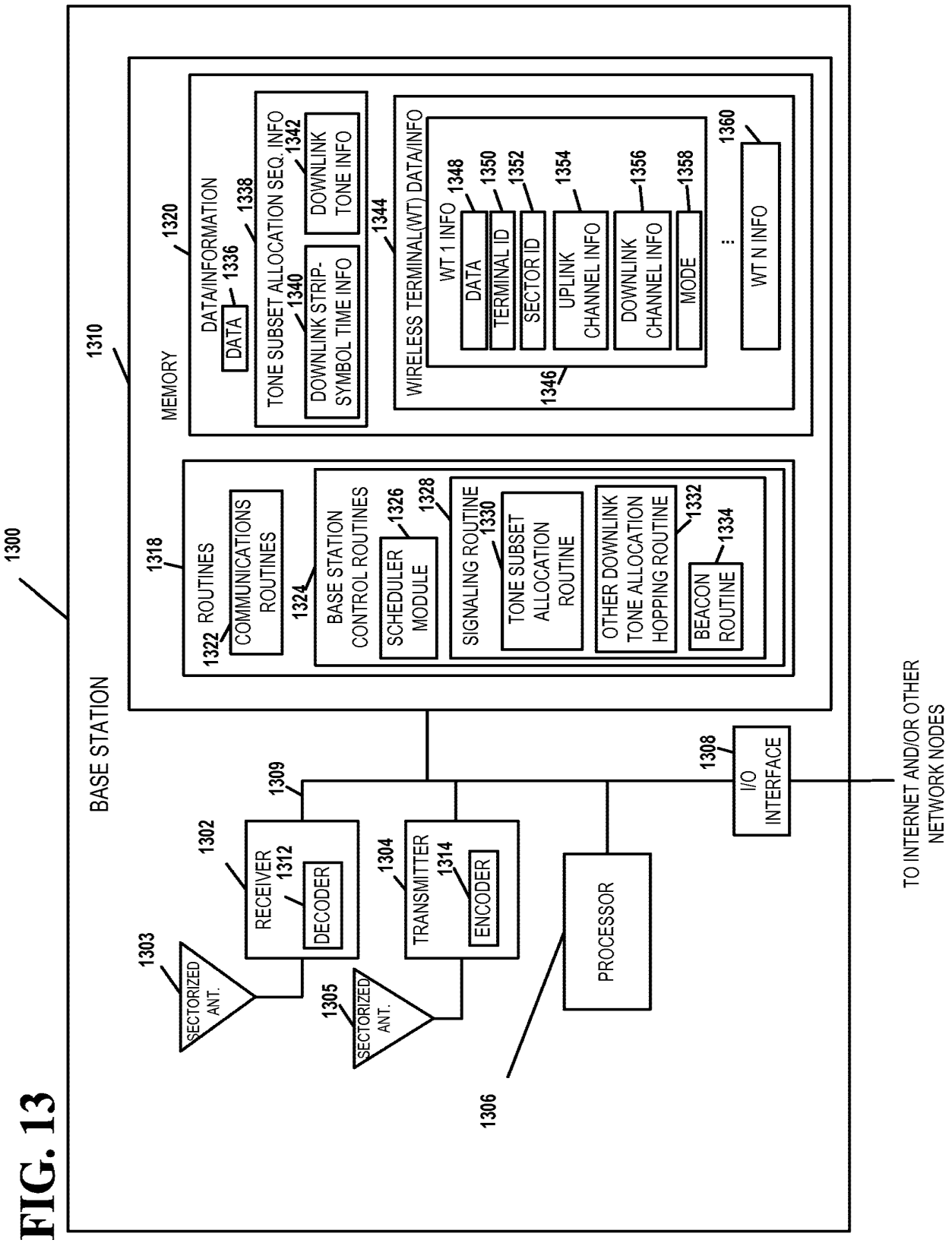
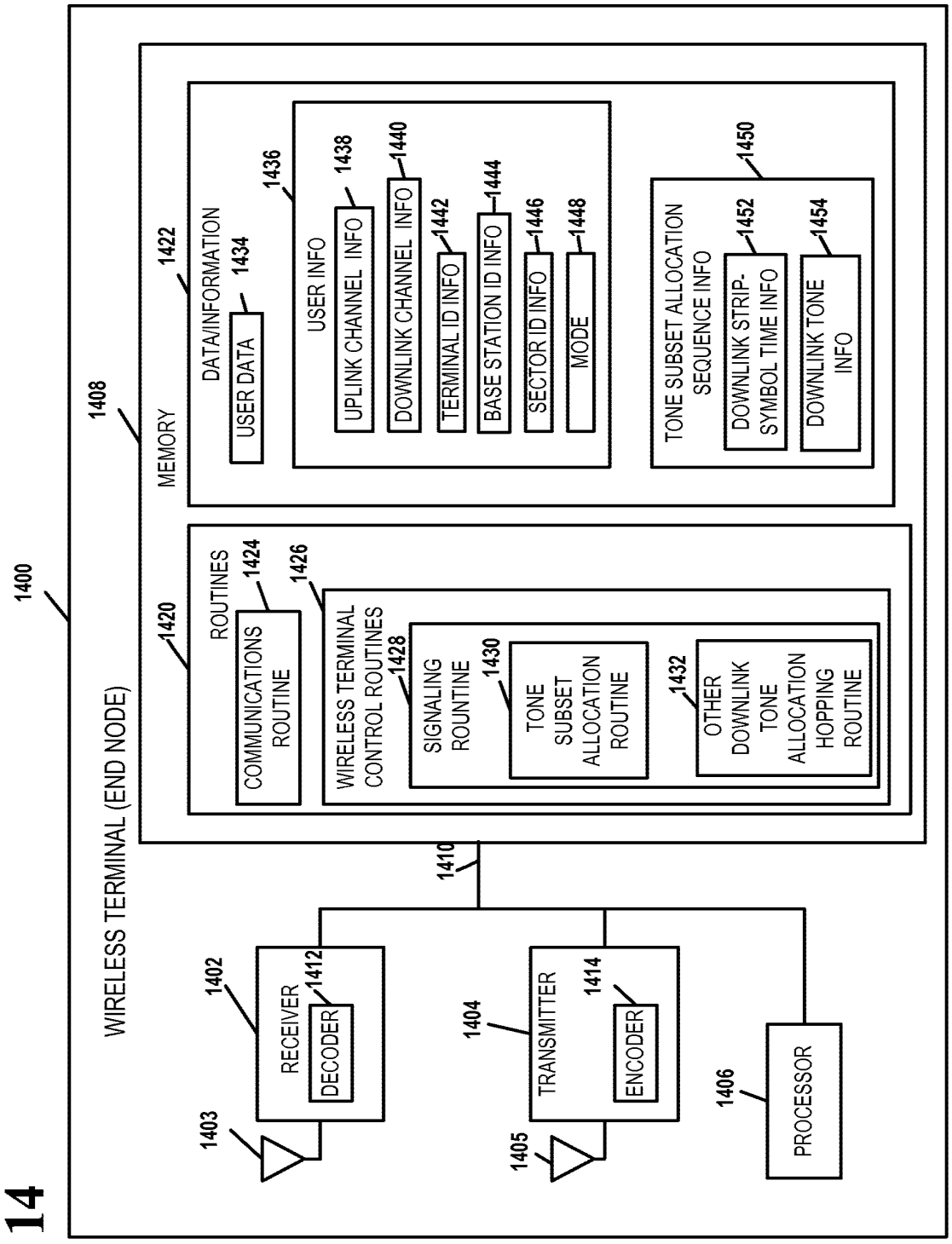

1300
BASE STATION
1310
MEMORY
1320
DATA/INFORMATION
DATA
1336
TONE SUBSET ALLOCATION SEQ. INFO
1338
DOWNLINK STRIP-SYMBOL TIME INFO
1340
DOWNLINK TONE INFO
1342
WIRELESS TERMINAL(WT) DATA/INFO
1344
WT 1 INFO
1348
DATA
1350
TERMINAL ID
1352
SECTOR ID
1354
UPLINK CHANNEL INFO
1356
DOWNLINK CHANNEL INFO
1358
MODE
1346
WT N INFO
1360
1318
ROUTINES
1322
COMMUNICATIONS ROUTINES
1324
BASE STATION CONTROL ROUTINES
1326
SCHEDULER MODULE
1328
SIGNALING ROUTINE
1330
TONE SUBSET ALLOCATION ROUTINE
1332
OTHER DOWNLINK TONE ALLOCATION HOPPING ROUTINE
1334
BEACON ROUTINE
1309
1302
RECEIVER
1312
DECODER
1304
TRANSMITTER
1314
ENCODER
1303
SECTORIZED ANT.
1305
SECTORIZED ANT.
1306
PROCESSOR
1308
I/O INTERFACE
TO INTERNET AND/OR OTHER NETWORK NODES

FIG. 14


1400
WIRELESS TERMINAL (END NODE)
1408
MEMORY
1422
DATA/INFORMATION
1434
USER DATA
1436
USER INFO
1438
UPLINK CHANNEL INFO
1440
DOWNLINK CHANNEL INFO
1442
TERMINAL ID INFO
1444
BASE STATION ID INFO
1446
SECTOR ID INFO
1448
MODE
1450
TONE SUBSET ALLOCATION SEQUENCE INFO
1452
DOWNLINK STRIP-SYMBOL TIME INFO
1454
DOWNLINK TONE INFO
1420
ROUTINES
1424
COMMUNICATIONS ROUTINE
1426
WIRELESS TERMINAL CONTROL ROUTINES
1428
SIGNALING ROUNTINE
1430
TONE SUBSET ALLOCATION ROUTINE
1432
OTHER DOWNLINK TONE ALLOCATION HOPPING ROUTINE
1410
1402
RECEIVER
1412
DECODER
1403
1404
TRANSMITTER
1414
ENCODER
1405
1406
PROCESSOR

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM
First Named Inventor/Applicant Name:	Nathan Edward Tenny
Filer:	Florin C. Corie/Susan Turner
Attorney Docket Number:	092546

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility application filing	1011	1	330	330
Utility Search Fee	1111	1	540	540
Utility Examination Fee	1311	1	220	220
Pages:				
Claims:				
Claims in excess of 20	1202	68	52	3536
Independent claims in excess of 3	1201	5	220	1100
Miscellaneous-Filing:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**5726**

Electronic Acknowledgement Receipt

EFS ID:	7840513
Application Number:	12818064
International Application Number:	
Confirmation Number:	6903
Title of Invention:	METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM
First Named Inventor/Applicant Name:	Nathan Edward Tenny
Customer Number:	23696
Filer:	Florin C. Corie/Susan Turner
Filer Authorized By:	Florin C. Corie
Attorney Docket Number:	092546
Receipt Date:	17-JUN-2010
Filing Date:	
Time Stamp:	19:28:59
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$5726
RAM confirmation Number	5543
Deposit Account	170026
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	092546_20100617_ADSsigned.pdf	4830887 b8fe1f6077081e014d26835977fa7fdd7782c7b7	no	5
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
2		092546_20100617_APP.pdf	312764 20bd6c1e5fe363c26749533f84608c01a052859a	yes	49

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	35
Claims	36	48
Abstract	49	49

Warnings:					
Information:					
3	Drawings-only black and white line drawings	092546_20100617_DWG.pdf	172636 6f276281ce1dccd05e749123bf8513edd44b4640	no	14
Warnings:					
Information:					
4	Fee Worksheet (PTO-875)	fee-info.pdf	38025 224d2f21ab52f8a7829a652ba9a6b0bd70352721	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	5354312	

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

SCORE Placeholder Sheet for IFW Content

Application Number: 12818064 Document Date: 6/17/2010

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

- Drawings – Other than Black and White Line Drawings

Since this was an electronic submission, there is no physical artifact folder, no artifact folder is recorded in PALM, and no paper documents or physical media exist. The TIFF images in the IFW record were created from the original documents that are stored in SCORE.

To access the documents in the SCORE database, refer to instructions developed by SIRA.

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- Examiners may access SCORE content via the eDAN interface.
- Other USPTO employees can bookmark the current SCORE URL (http://es/ScoreAccessWeb/).
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Form Revision Date: February 8, 2006

PTO/SB/06 (12-04)

Date: **06/17/10**

Approved for use through 7/31/2006. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 12/818,064

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)	SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
FOR	NUMBER FILED	NUMBER EXTRA	RATE ($)	FEE ($)		RATE ($)	FEE ($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	**330**
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	**540**
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	**220**
TOTAL CLAIMS (37 CFR 1.16(i))	**88** minus 20 =	**68**	x$26		OR	x$52	**3536**
INDEPENDENT CLAIMS (37 CFR 1.16(h))	**8** minus 3 =	* **5**	x$110			x$220	**1100**
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $270 ($135 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR						
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))			195			390	
			TOTAL			TOTAL	**5726**

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED – PART II

AMENDMENT A		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
						TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

AMENDMENT B		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)	OR	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
						TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/818,064	06/17/2010	Nathan Edward Tenny	092546

CONFIRMATION NO. 6903

23696
QUALCOMM INCORPORATED
5775 MOREHOUSE DR.
SAN DIEGO, CA 92121

FORMALITIES LETTER

OC000000042431196

Date Mailed: 07/08/2010

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The oath or declaration is missing.
  A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.
  Note: If a petition under 37 CFR 1.47 is being filed, an oath or declaration in compliance with 37 CFR 1.63 signed by all available joint inventors, or if no inventor is available by a party with sufficient proprietary interest, is required.

The applicant needs to satisfy supplemental fees problems indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- To avoid abandonment, a surcharge (for late submission of filing fee, search fee, examination fee or oath or declaration) as set forth in 37 CFR 1.16(f) of $**130** for a non-small entity, must be submitted with the missing items identified in this notice.

SUMMARY OF FEES DUE:

Total additional fee(s) required for this application is $**130** for a non-small entity
- $**130** Surcharge.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web.
https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at **1-866-217-9197** or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

/rgreen/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
12/818,064	06/17/2010	2617	5726	092546	88	8

CONFIRMATION NO. 6903

23696
QUALCOMM INCORPORATED
5775 MOREHOUSE DR.
SAN DIEGO, CA 92121

FILING RECEIPT

OC000000042431195

Date Mailed: 07/08/2010

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Nathan Edward Tenny, Poway, CA;
Parag Arun Agashe, San Diego, CA;
Peter Gaal, San Diego, CA;
Tingfang Ji, San Diego, CA;
Ravi Palanki, San Diego, CA;
Rajat Prakash, La Jolla, CA;

Assignment For Published Patent Application

QUALCOMM Incorporation, San Diego, CA

Power of Attorney: None

Domestic Priority data as claimed by applicant

This appln claims benefit of 61/218,769 06/19/2009
and claims benefit of 61/294,053 01/11/2010
and claims benefit of 61/305,014 02/16/2010

Foreign Applications

If Required, Foreign Filing License Granted: 07/06/2010

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 12/818,064**

Projected Publication Date: To Be Determined - pending completion of Missing Parts

Non-Publication Request: No

Early Publication Request: No

Title

METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM

Preliminary Class

370

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where

the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

PTO/SB/80 (11-08)
Approved for use through 11/30/2011. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(b).

I hereby appoint:

☑ Practitioners associated with the Customer Number: 23696

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(b) to:

☑ The address associated with Customer Number: 23696

OR

☐ Firm or Individual Name			
Address			
City		State	Zip
Country			
Telephone		Email	

Assignee Name and Address:

Qualcomm Incorporated
5775 Morehouse Drive
San Diego, CA 92121

A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature		Date	August 28, 2009
Name	Katherine W. Umpleby	Telephone	858-651-7170
Title	Vice President, Chief Patent Counsel		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

ASSIGNMENT

TO WHOM IT MAY CONCERN:

For the sum of One Dollar and other valuable consideration to us in hand paid, receipt of which is hereby acknowledged, be it known that We,

1. Nathan Edward Tenny, a citizen of the United States of America, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of Poway, California, United States of America,

2. Parag Arun Agashe, a citizen of the United States of America, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of San Diego, California, United States of America,

3. Peter Gaal, a citizen of the United States of America, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of San Diego, California, United States of America,

4. Tingfang Ji, a citizen of China, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of San Diego, California, United States of America,

5. Ravi Palanki, a citizen of India, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of San Diego, California,

ASSIGNMENT

United States of America,

6. Rajat Prakash, a citizen of India, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of La Jolla, California, United States of America,

have sold, assigned and transferred and by these presents do sell, assign, transfer and set over unto QUALCOMM Incorporated, a Delaware corporation, having a place of business at 5775 Morehouse Drive, San Diego, California 92121-1714, its successors, legal representatives, or assigns, the entire right, title and interest in and to a certain invention relating to **METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM** by us devised and the application for United States Patent therefore filed in the United States Patent and Trademark Office on **June 17, 2010**, and assigned Serial No. **12/818,064**, including Provisional Application Number **61/218,769**, filed on **June 19, 2009**, and Provisional Application Number **61/294,053**, filed on **January 11, 2010**, and Provisional Application Number **61/305,014**, filed on **February 16, 2010**, and all original and reissue patents granted thereof (in the United States and any foreign country), and all divisionals, continuations and continuations-in-part thereof, including the subject matter of any and all claims which may be obtained in every such patent, and all foreign rights to said invention, and covenant that we have full right to do so, and agree that we will communicate to said corporation or its representatives all facts known to us respecting said invention, whenever requested, and testify in any legal proceedings, sign all lawful papers, make all rightful oaths and generally do everything possible to aid said corporation, its successors, assigns and nominees, to obtain and enforce proper patent protection for said invention in all countries.

ASSIGNMENT

The Commissioner of Patents and Trademarks is requested to issue the Letters Patent which may be granted for said invention or any part thereof unto said corporation in keeping with this Assignment.

Done at San Diego, California this 27th day of June, 2010.

Nathan Edward Tenny

Done at San Diego, California this _____ day of _____, 2010.

Parag Arun Agashe

Done at San Diego, California this _____ day of _____, 2010.

Peter Gaal

Done at San Diego, California this _____ day of _____, 2010.

Tingfang Ji

Done at San Diego, California this _____ day of _____, 2010.

Ravi Palanki

ASSIGNMENT

Done at San Diego, California this _____ day of _____, 2010.

_____

Rajat Prakash

ASSIGNMENT

TO WHOM IT MAY CONCERN:

For the sum of One Dollar and other valuable consideration to us in hand paid, receipt of which is hereby acknowledged, be it known that We,

1. Nathan Edward Tenny, a citizen of the United States of America, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of Poway, California, United States of America,

2. Parag Arun Agashe, a citizen of the United States of America, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of San Diego, California, United States of America,

3. Peter Gaal, a citizen of the United States of America, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of San Diego, California, United States of America,

4. Tingfang Ji, a citizen of China, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of San Diego, California, United States of America,

5. Ravi Palanki, a citizen of India, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of San Diego, California,

ASSIGNMENT

United States of America,

6. Rajat Prakash, a citizen of India, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of La Jolla, California, United States of America,

have sold, assigned and transferred and by these presents do sell, assign, transfer and set over unto QUALCOMM Incorporated, a Delaware corporation, having a place of business at 5775 Morehouse Drive, San Diego, California 92121-1714, its successors, legal representatives, or assigns, the entire right, title and interest in and to a certain invention relating to **METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM** by us devised and the application for United States Patent therefore filed in the United States Patent and Trademark Office on **June 17, 2010**, and assigned Serial No. **12/818,064**, including Provisional Application Number **61/218,769**, filed on **June 19, 2009**, and Provisional Application Number **61/294,053**, filed on **January 11, 2010**, and Provisional Application Number **61/305,014**, filed on **February 16, 2010**, and all original and reissue patents granted thereof (in the United States and any foreign country), and all divisionals, continuations and continuations-in-part thereof, including the subject matter of any and all claims which may be obtained in every such patent, and all foreign rights to said invention, and covenant that we have full right to do so, and agree that we will communicate to said corporation or its representatives all facts known to us respecting said invention, whenever requested, and testify in any legal proceedings, sign all lawful papers, make all rightful oaths and generally do everything possible to aid said corporation, its successors, assigns and nominees, to obtain and enforce proper patent protection for said invention in all countries.

ASSIGNMENT

The Commissioner of Patents and Trademarks is requested to issue the Letters Patent which may be granted for said invention or any part thereof unto said corporation in keeping with this Assignment.

Done at San Diego, California this _____ day of _____, 2010.

_____
Nathan Edward Tenny

Done at San Diego, California this 23 day of June, 2010.

_____
Parag Arun Agashe

Done at San Diego, California this _____ day of _____, 2010.

_____
Peter Gaal

Done at San Diego, California this _____ day of _____, 2010.

_____
Tingfang Ji

Done at San Diego, California this _____ day of _____, 2010.

_____
Ravi Palanki

ASSIGNMENT

Done at San Diego, California this _____ day of _____, 2010.

_____

Rajat Prakash

ASSIGNMENT

TO WHOM IT MAY CONCERN:

For the sum of One Dollar and other valuable consideration to us in hand paid, receipt of which is hereby acknowledged, be it known that We,

1. Nathan Edward Tenny, a citizen of the United States of America, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of Poway, California, United States of America,

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5. Ravi Palanki, a citizen of India, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of San Diego, California,

ASSIGNMENT

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have sold, assigned and transferred and by these presents do sell, assign, transfer and set over unto QUALCOMM Incorporated, a Delaware corporation, having a place of business at 5775 Morehouse Drive, San Diego, California 92121-1714, its successors, legal representatives, or assigns, the entire right, title and interest in and to a certain invention relating to **METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM** by us devised and the application for United States Patent therefore filed in the United States Patent and Trademark Office on **June 17, 2010**, and assigned Serial No. **12/818,064**, including Provisional Application Number **61/218,769**, filed on **June 19, 2009**, and Provisional Application Number **61/294,053**, filed on **January 11, 2010**, and Provisional Application Number **61/305,014**, filed on **February 16, 2010**, and all original and reissue patents granted thereof (in the United States and any foreign country), and all divisionals, continuations and continuations-in-part thereof, including the subject matter of any and all claims which may be obtained in every such patent, and all foreign rights to said invention, and covenant that we have full right to do so, and agree that we will communicate to said corporation or its representatives all facts known to us respecting said invention, whenever requested, and testify in any legal proceedings, sign all lawful papers, make all rightful oaths and generally do everything possible to aid said corporation, its successors, assigns and nominees, to obtain and enforce proper patent protection for said invention in all countries.

ASSIGNMENT

The Commissioner of Patents and Trademarks is requested to issue the Letters Patent which may be granted for said invention or any part thereof unto said corporation in keeping with this Assignment.

Done at San Diego, California this _____ day of _____, 2010.

_____
Nathan Edward Tenny

Done at San Diego, California this _____ day of _____, 2010.

_____
Parag Arun Agashe

Done at San Diego, California this 8th day of July, 2010.

_____
Peter Gaal

Done at San Diego, California this _____ day of _____, 2010.

_____
Tingfang Ji

Done at San Diego, California this _____ day of _____, 2010.

_____
Ravi Palanki

ASSIGNMENT

Done at San Diego, California this _____ day of _____, 2010.

_____
Rajat Prakash

ASSIGNMENT

TO WHOM IT MAY CONCERN:

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have sold, assigned and transferred and by these presents do sell, assign, transfer and set over unto QUALCOMM Incorporated, a Delaware corporation, having a place of business at 5775 Morehouse Drive, San Diego, California 92121-1714, its successors, legal representatives, or assigns, the entire right, title and interest in and to a certain invention relating to **METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM** by us devised and the application for United States Patent therefore filed in the United States Patent and Trademark Office on **June 17, 2010**, and assigned Serial No. **12/818,064**, including Provisional Application Number **61/218,769**, filed on **June 19, 2009**, and Provisional Application Number **61/294,053**, filed on **January 11, 2010**, and Provisional Application Number **61/305,014**, filed on **February 16, 2010**, and all original and reissue patents granted thereof (in the United States and any foreign country), and all divisionals, continuations and continuations-in-part thereof, including the subject matter of any and all claims which may be obtained in every such patent, and all foreign rights to said invention, and covenant that we have full right to do so, and agree that we will communicate to said corporation or its representatives all facts known to us respecting said invention, whenever requested, and testify in any legal proceedings, sign all lawful papers, make all rightful oaths and generally do everything possible to aid said corporation, its successors, assigns and nominees, to obtain and enforce proper patent protection for said invention in all countries.

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Done at San Diego, California this _____ day of _____, 2010.

_____
Nathan Edward Tenny

Done at San Diego, California this _____ day of _____, 2010.

_____
Parag Arun Agashe

Done at San Diego, California this _____ day of _____, 2010.

_____
Peter Gaal

Done at San Diego, California this 11 day of June, 2010.

_____
Tingfang Ji

Done at San Diego, California this _____ day of _____, 2010.

_____
Ravi Palanki

ASSIGNMENT

Done at San Diego, California this _____ day of _____, 2010.

_____

Rajat Prakash

ASSIGNMENT

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4. Tingfang Ji, a citizen of China, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of San Diego, California, United States of America,

5. Ravi Palanki, a citizen of India, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of San Diego, California,

ASSIGNMENT

United States of America,

6. Rajat Prakash, a citizen of India, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of La Jolla, California, United States of America,

have sold, assigned and transferred and by these presents do sell, assign, transfer and set over unto QUALCOMM Incorporated, a Delaware corporation, having a place of business at 5775 Morehouse Drive, San Diego, California 92121-1714, its successors, legal representatives, or assigns, the entire right, title and interest in and to a certain invention relating to **METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM** by us devised and the application for United States Patent therefore filed in the United States Patent and Trademark Office on **June 17, 2010**, and assigned Serial No. **12/818,064**, including Provisional Application Number **61/218,769**, filed on **June 19, 2009**, and Provisional Application Number **61/294,053**, filed on **January 11, 2010**, and Provisional Application Number **61/305,014**, filed on **February 16, 2010**, and all original and reissue patents granted thereof (in the United States and any foreign country), and all divisionals, continuations and continuations-in-part thereof, including the subject matter of any and all claims which may be obtained in every such patent, and all foreign rights to said invention, and covenant that we have full right to do so, and agree that we will communicate to said corporation or its representatives all facts known to us respecting said invention, whenever requested, and testify in any legal proceedings, sign all lawful papers, make all rightful oaths and generally do everything possible to aid said corporation, its successors, assigns and nominees, to obtain and enforce proper patent protection for said invention in all countries.

ASSIGNMENT

The Commissioner of Patents and Trademarks is requested to issue the Letters Patent which may be granted for said invention or any part thereof unto said corporation in keeping with this Assignment.

Done at San Diego, California this _____ day of _____, 2010.

_____
Nathan Edward Tenny

Done at San Diego, California this _____ day of _____, 2010.

_____
Parag Arun Agashe

Done at San Diego, California this _____ day of _____, 2010.

_____
Peter Gaal

Done at San Diego, California this _____ day of _____, 2010.

_____
Tingfang Ji

Done at San Diego, California this 23 day of June, 2010.

_____
Ravi Palanki

ASSIGNMENT

Done at San Diego, California this _____ day of _____, 2010.

_____
Rajat Prakash

ASSIGNMENT

TO WHOM IT MAY CONCERN:

For the sum of One Dollar and other valuable consideration to us in hand paid, receipt of which is hereby acknowledged, be it known that We,

1. Nathan Edward Tenny, a citizen of the United States of America, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of Poway, California, United States of America,

2. Parag Arun Agashe, a citizen of the United States of America, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of San Diego, California, United States of America,

3. Peter Gaal, a citizen of the United States of America, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of San Diego, California, United States of America,

4. Tingfang Ji, a citizen of China, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of San Diego, California, United States of America,

5. Ravi Palanki, a citizen of India, having a mailing address of 5775 Morehouse Drive, San Diego, California, 92121, United States of America; and a resident of San Diego, California,

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Done at San Diego, California this _____ day of _____, 2010.

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Parag Arun Agashe

Done at San Diego, California this _____ day of _____, 2010.

_____
Peter Gaal

Done at San Diego, California this _____ day of _____, 2010.

_____
Tingfang Ji

Done at San Diego, California this _____ day of _____, 2010.

_____
Ravi Palanki

ASSIGNMENT

Done at San Diego, California this 23 day of June, 2010.

Rajat Prakash

Electronic Patent Application Fee Transmittal

Application Number:	12818064
Filing Date:	17-Jun-2010
Title of Invention:	METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM
First Named Inventor/Applicant Name:	Nathan Edward Tenny
Filer:	Florin C. Corie/Denise Miles
Attorney Docket Number:	092546

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Extension - 1 month with $0 paid	1251	1	130	130

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
			Total in USD ($)	**130**

Electronic Acknowledgement Receipt

EFS ID:	8143141
Application Number:	12818064
International Application Number:	
Confirmation Number:	6903
Title of Invention:	METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM
First Named Inventor/Applicant Name:	Nathan Edward Tenny
Customer Number:	23696
Filer:	Florin C. Corie/Denise Miles
Filer Authorized By:	Florin C. Corie
Attorney Docket Number:	092546
Receipt Date:	03-AUG-2010
Filing Date:	17-JUN-2010
Time Stamp:	13:06:49
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$130
RAM confirmation Number	9487
Deposit Account	170026
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Oath or Declaration filed	092546_2010-07-09_DEC_Signed.pdf	3479974 33ea69cfd65719ab16726559b0d76a9ff6a0587d	no	6
Warnings:					
Information:					
2	Assignee showing of ownership per 37 CFR 3.73(b).	092546_373B.pdf	429967 f2e3ac06b138353a5a8cb1e92adf0b644641144b	no	1
Warnings:					
The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					
3	Power of Attorney	GeneralPOA.pdf	365552 d60edd94fb9d54fff8dcb97a9b1aeec393cb2f64	no	1
Warnings:					
Information:					
4	Miscellaneous Incoming Letter	092546_2010-07-09_ASST_Signed.pdf	5926913 241fc3cec95328af7b24565dac3e765d108e9ce4	no	24
Warnings:					
Information:					
5	Fee Worksheet (PTO-875)	fee-info.pdf	30423 64e40021ddbf0547239f4423f87711046903 27ad	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	10232829		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM

As the below named inventor(s), I/we declare that:

This declaration is directed to:

☐ The attached application, or

☒ Application No. 12/818,064 filed on June 17, 2010

☐ As amended on _____ (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

All statements made herein of my/our own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF INVENTOR(S)

Inventor one: Nathan Edward Tenny Date: 6/23/2010

Signature: _____ Citizen of: US

Inventor two: Parag Arun Agashe Date: _____

Signature: _____ Citizen of: US

☒ Additional inventors or a legal representative are being named on Page 1/3 additional form(s) attached hereto.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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Title of Invention	METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM

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☐ The attached application, or

☒ Application No. 12/818,064 filed on June 17, 2010

☐ As amended on _____ (if applicable);

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FULL NAME OF INVENTOR(S)

Inventor one: Nathan Edward Tenny Date: _____

Signature: _____ Citizen of: US

Inventor two: Parag Arun Agashe Date: 06-23-2010

Signature: _____ Citizen of: US

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☒ Application No. 12/818,064 filed on June 17, 2010

☐ As amended on _____ (if applicable);

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FULL NAME OF INVENTOR(S)

Inventor one: Peter Gaal Date: July 8, 2010

Signature: [signature] Citizen of: US

Inventor two: Tingfang Ji Date: _____

Signature: _____ Citizen of: CN

☐ Additional inventors or a legal representative are being named on Page 2/3 additional form(s) attached hereto.

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FULL NAME OF INVENTOR(S)

Inventor one: Peter Gaal Date: _____

Signature: _____ Citizen of: US

Inventor two: Tingfang Ji Date: 6/17/2010

Signature: _____ Citizen of: CN

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☐ As amended on _____ (if applicable);

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FULL NAME OF INVENTOR(S)

Inventor one: Ravi Palanki Date: Jun 22 2010

Signature: [signature] Citizen of: IN

Inventor two: Rajat Prakash Date: _____

Signature: _____ Citizen of: IN

☐ Additional inventors or a legal representative are being named on Page 3/3 additional form(s) attached hereto.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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PTO/SB/01A (01-09)
Approved for use through 06/30/2010. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM

As the below named inventor(s), I/we declare that:

This declaration is directed to:

☐ The attached application, or

☒ Application No. 12/818,064 filed on June 17, 2010

☐ As amended on _____ (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT International filing date of the continuation-in-part application.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

All statements made herein of my/our own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF INVENTOR(S)

Inventor one: Ravi Palanki Date: _____

Signature: _____ Citizen of: IN

Inventor two: Rajat Prakash Date: June 23, 2010

Signature: Rajat Prakash Citizen of: IN

☐ Additional inventors or a legal representative are being named on Page 3/3 additional form(s) attached hereto.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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PTO/SB/96 (07-09)
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STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: QUALCOMM INCORPORATED

Application No./Patent No.: 12/818,064 Filed/Issue Date: June 17, 2010

Titled:
METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM

QUALCOMM INCORPORATED , a corporation
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.

states that it is:

1. [X] the assignee of the entire right, title, and interest in;

2. [ ] an assignee of less than the entire right, title, and interest in
(The extent (by percentage) of its ownership interest is _____ %); or

3. [ ] the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

A. [X] An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy therefore is attached.

OR

B. [ ] A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

2. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

3. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

[ ] Additional documents in the chain of title are listed on a supplemental sheet(s).

[X] As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (*i.e.*, a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

Signature

08/02/2010
Date

Florin Corie
Printed or Typed Name

Patent Counsel
Title

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Acknowledgement Receipt

EFS ID:	8143141
Application Number:	12818064
International Application Number:	
Confirmation Number:	6903
Title of Invention:	METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM
First Named Inventor/Applicant Name:	Nathan Edward Tenny
Customer Number:	23696
Filer:	Florin C. Corie/Denise Miles
Filer Authorized By:	Florin C. Corie
Attorney Docket Number:	092546
Receipt Date:	03-AUG-2010
Filing Date:	17-JUN-2010
Time Stamp:	13:06:49
Application Type:	Utility under 35 USC 111(a)

Adjustment date: 03/15/2011 MTEKLEMI
08/03/2010 INTEFSW 00009487 170026 12818064
01 FC:1251 130.00 CR

03/15/2011 MTEKLEMI 00000009 170026 12818064
01 FC:1051 130.00 DA

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$130
RAM confirmation Number	9487
Deposit Account	170026
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

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UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
12/818,064	06/17/2010	2617	5856	092546	88	8

CONFIRMATION NO. 6903

UPDATED FILING RECEIPT

23696
QUALCOMM INCORPORATED
5775 MOREHOUSE DR.
SAN DIEGO, CA 92121



Date Mailed: 03/21/2011

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Nathan Edward Tenny, Poway, CA;
Parag Arun Agashe, San Diego, CA;
Peter Gaal, San Diego, CA;
Tingfang Ji, San Diego, CA;
Ravi Palanki, San Diego, CA;
Rajat Prakash, La Jolla, CA;

Assignment For Published Patent Application

QUALCOMM Incorporation, San Diego, CA

Power of Attorney: The patent practitioners associated with Customer Number 23696

Domestic Priority data as claimed by applicant

This appln claims benefit of 61/218,769 06/19/2009
and claims benefit of 61/294,053 01/11/2010
and claims benefit of 61/305,014 02/16/2010

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)

If Required, Foreign Filing License Granted: 07/06/2010

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 12/818,064**

Projected Publication Date: 06/30/2011

Non-Publication Request: No

Early Publication Request: No

Title

METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM

Preliminary Class

370

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/818,064	06/17/2010	Nathan Edward Tenny	092546

CONFIRMATION NO. 6903

23696
QUALCOMM INCORPORATED
5775 MOREHOUSE DR.
SAN DIEGO, CA 92121

POA ACCEPTANCE LETTER

OC000000046558316

Date Mailed: 03/21/2011

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 08/03/2010.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/lchau/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 12/818,064

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	330
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	540
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	220
TOTAL CLAIMS (37 CFR 1.16(i))	88 minus 20 =	* 68			OR	x 52 =	3536
INDEPENDENT CLAIMS (37 CFR 1.16(h))	8 minus 3 =	* 5				x 220 =	1100
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $270 ($135 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	5726

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/818,064	06/17/2010	Nathan Edward Tenny	092546

CONFIRMATION NO. 6903

23696
QUALCOMM INCORPORATED
5775 MOREHOUSE DR.
SAN DIEGO, CA 92121

PUBLICATION NOTICE

OC000000048525039

Title:METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM

Publication No.US-2011-0158116-A1
Publication Date:06/30/2011

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet	1	of	3

Complete if Known

Application Number	12/818,064
Filing Date	2010-06-17
First Named Inventor	TENNY; Nathan Edward
Art Unit	2472
Examiner Name	KIZOU; Hassan
Attorney Docket No:	092546

U.S. PATENT DOCUMENTS					
Examiner Initials*	**Cite No.[1]**	**Document Number** Number-Kind Code[2](if known)	**Publication Date MM-DD-YYYY**	**Name of Patentee or Applicant of Cited Document**	**Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear**

FOREIGN PATENT DOCUMENTS						
Examiner Initials*	**Cite No.[1]**	**Foreign Patent Document** Country Code[3]-Number[4]-Kind Code[5](if known)	**Publication Date MM-DD-YYYY**	**Name of Patentee or Applicant of Cited Document**	**Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear**	**T[6]**

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	**Cite No.**	**Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.**	**T2**
	001	E-MAIL RAPPORTEUR (NTT DOCOMO ET AL: "CA , support for multi-TA" 3GPP DRAFT; R2-101567, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol . RAN WG2, no. San Francisco, USA; 20100222, 18 February 2010 (2010-02-18), XP050421923 [retrieved on 2010-02-18] paragraphs [0001] - [02.2].	☐
	002	ERICSSON ET AL: "Multiple Timing Advance , for Carrier Aggregation" 3GPP DRAFT; R2-101196 - MULTIPLE TA FOR CA, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol . RAN WG2, no. San Francisco, USA; 20100222, 16 February 2010 (2010-02-16), XP050421769 [retrieved on 2010-02-16] paragraphs [0001] - [02.2].	☐
	003	ERICSSON: "Reference for Timing Advance" 3GPP DRAFT; R2-103106 REFERENCE FOR TIMNIG ADVANCE, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol . RAN WG2, no. Montreal, Canada; 20100510, 3 May 2010 (2010-05-03), XP050423092 [retrieved on 2010-05-03] paragraphs [0001] - [0003].	☐
	004	International Search Report and Written Opinion -PCT/U S2010/039372, International Search Authority - European Patent Office - 10-04-2010 (092546).	☐

EXAMINER SIGNATURE **DATE CONSIDERED**

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes ofUSPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5]Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by theUSPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet	**2**	**of**	**3**

Complete if Known

Application Number	12/818,064
Filing Date	2010-06-17
First Named Inventor	TENNY; Nathan Edward
Art Unit	2472
Examiner Name	KIZOU; Hassan
Attorney Docket No:	092546

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	**Cite No.**	**Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.**	**T2**
	005	RAN2: "LS on RAN2 status on carrier aggregation design" 3GPP DRAFT; R2-093599, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, no. San Francisco, USA; 20090509, 9 May 2009 (2009-05-09), XP050341057 [retrieved on 2009-05-09] paragraph [0001].	☐

EXAMINER SIGNATURE **DATE CONSIDERED**

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional). 2 See Kinds Codes ofUSPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached.This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by theUSPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet	**3**	**of**	**3**

Complete if Known	
Application Number	12/818,064
Filing Date	2010-06-17
First Named Inventor	TENNY; Nathan Edward
Art Unit	2472
Examiner Name	KIZOU; Hassan
Attorney Docket No:	092546

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/John J. Ketchum/	Date (YYYY-MM-DD)	2011-12-16
Name/Print	John J. Ketchum	Registration Number	61932

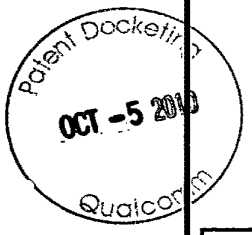
This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SENDFEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

To:
Corie, Florin C.
QUALCOMM INCORPORATED
5775 Morehouse Drive
San Diego, CA 92121-1714
ETATS-UNIS D'AMERIQUE



NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

Applicant's or agent's file reference 092546WO	Date of mailing *(day/month/year)* 4 October 2010 (04-10-2010) **FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/US2010/039372	International filing date *(day/month/year)* 21 June 2010 (21-06-2010)
Applicant QUALCOMM Incorporated	

1. [X] The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the International Search Report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Fascimile No.: (41-22) 338.82.70

   For more detailed instructions, see the notes on the accompanying sheet.

2. [ ] The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. [ ] **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   [ ] the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

   [ ] no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

   The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

   In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

   See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, National Chapters.

Name and mailing address of the International Searching Authority European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040 Fax: (+31-70) 340-3016	Authorized officer EOZENOU, Bernard Tel: +49 (0)89 2399-6022

Form PCT/ISA/220 (July 2009) *(See notes on accompanying sheet)*

NOTES TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the *PCT Applicant's Guide*.

In these Notes, "Article", "Rule", and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions, respectively.

INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report and the written opinion of the International Searching Authority, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims,description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only (see *PCT Applicant's Guide*, Annex B).

The attention of the applicant is drawn to the fact that amendments to the claims under Article 19 are not allowed where the International Searching Authority has declared, under Article 17(2), that no international search report would be established (see *PCT Applicant's Guide*, International Phase, paragraph 296).

What parts of the international application may be amended?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

When? Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

Where not to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

How? Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet or sheets containing a complete set of claims in replacement of all the claims previously filed must be submitted.

Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively in Arabic numerals (Section 205(a)).

The amendments must be made in the language in which the international application is to be published.

What documents must/may accompany the amendments?

Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.

BNSDOCID: <XS_____201006011P4_I_>

NOTES TO FORM PCT/ISA/220 (continued)

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped),whether

(i) *the claim is unchanged;*

(ii) the claim is cancelled;

(iii) the claim is new;

(iv) the claim replaces one or more claims as filed;

(v) the claim is the result of the division of a claim as filed.

The following examples illustrate the manner in which amendments must be explained in the accompanying letter:

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."

2. [Where originally there were 15 claims and after amendment of all claims there are 11]:
"Claims 1 to 15 replaced by amended claims 1 to 11."

3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added." or
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."

4. [Where various kinds of amendments are made]:
"Claims 1-10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

"Statement under article 19(1)" (Rule 46.4)

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

It must be in the language in which the international application is to be published.

It must be brief, not exceeding 500 words if in English or if translated into English.

It should not be confused with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)."

It may not contain any disparaging comments on the international search report or the relevance of citations contained in that report. Reference to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

Consequence if a demand for international preliminary examination has already been filed

If, at the time of filing any amendments and any accompanying statement, under Article 19, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the time of filing the amendments (and any statement) with the International Bureau, also file with the International Preliminary Examining Authority a copy of such amendments (and of any statement) and, where required, a translation of such amendments for the procedure before that Authority (see Rules 55.3(a) and 62.2, first sentence). For further information, see the Notes to the demand form (PCT/IPEA/401).

If a demand for international preliminary examination is made, the written opinion of the International Searching Authority will, except in certain cases where the International Preliminary Examining Authority did not act as International Searching Authority and where it has notified the International Bureau under Rule 66.1*bis*(b), be considered to be a written opinion of the International Preliminary Examining Authority. If a demand is made, the applicant may submit to the International Preliminary Examining Authority a reply to the written opinion together, where appropriate, with amendments before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later (Rule 43*bis*.1(c)).

Consequence with regard to translation of the international application for entry into the national phase

The applicant's attention is drawn to the fact that, upon entry into the national phase, a translation of the claims as amended under Article 19 may have to be furnished to the designated/elected Offices, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/elected Office, see the *PCT Applicant's Guide*, National Chapters.

BNSDOCID: <XS_____201006011P4_I_>

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
092546WO		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US2010/039372	21/06/2010	19/06/2009
Applicant		
QUALCOMM Incorporated		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language,** the international search was carried out on the basis of:
      [X] the international application in the language in which it was filed
      [ ] a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. [ ] This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. [ ] With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. [ ] **Certain claims were found unsearchable** (See Box No. II)

3. [ ] **Unity of invention is lacking** (see Box No III)

4. With regard to the **title,**
   [X] the text is approved as submitted by the applicant
   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**
   [X] the text is approved as submitted by the applicant
   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority

6. With regard to the **drawings,**
   a. the figure of the **drawings** to be published with the abstract is Figure No. 1
      [X] as suggested by the applicant
      [ ] as selected by this Authority, because the applicant failed to suggest a figure
      [ ] as selected by this Authority, because this figure better characterizes the invention
   b. [ ] none of the figures is to be published with the abstract

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2010/039372

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W56/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04W H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	RAN2: "LS on RAN2 status on carrier aggregation design" 3GPP DRAFT; R2-093599, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, no. San Francisco, USA; 20090509, 9 May 2009 (2009-05-09), XP050341057 [retrieved on 2009-05-09] paragraph [0001]	53,54, 69,77, 79,83,85

-/--

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 September 2010	04/10/2010

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Staeger, Rainer

2

Form PCT/ISA/210 (second sheet) (April 2005)

IPR2023-01269 Page 132

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	ERICSSON ET AL: "Multiple Timing Advance for Carrier Aggregation" 3GPP DRAFT; R2-101196 - MULTIPLE TA FOR CA, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG2, no. San Francisco, USA; 20100222, 16 February 2010 (2010-02-16), XP050421769 [retrieved on 2010-02-16]	53,69, 77,83
A,P	paragraphs [0001] - [02.2]	1-4, 21-24, 43-52

X,P	ERICSSON: "Reference for Timing Advance" 3GPP DRAFT; R2-103106 REFERENCE FOR TIMNIG ADVANCE, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG2, no. Montreal, Canada; 20100510, 3 May 2010 (2010-05-03), XP050423092 [retrieved on 2010-05-03]	53,69, 77,83
A,P	paragraphs [0001] - [0003]	1,21,43, 48

X,P	E-MAIL RAPPORTEUR (NTT DOCOMO ET AL: "CA support for multi-TA" 3GPP DRAFT; R2-101567, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG2, no. San Francisco, USA; 20100222, 18 February 2010 (2010-02-18), XP050421923 [retrieved on 2010-02-18]	53,69, 77,83
A,P	paragraphs [0001] - [02.2]	1,21,43, 48

2

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

see form PCT/ISA/220

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2010/039372	21.06.2010	17.06.2010

International Patent Classification (IPC) or both national classification and IPC
INV. H04W56/00

Applicant
QUALCOMM Incorporated

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☒ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☒ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notifed the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA:	Date of completion of this opinion	Authorized Officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Fax: +49 89 2399 - 4465	see form PCT/ISA/210	Staeger, Rainer Telephone No. +49 89 2399-8124

Form PCT/ISA/237 (Cover Sheet) (July 2009)

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing filed or furnished:

   a. (means)

      ☐ on paper

      ☐ in electronic form

   b. (time)

      ☐ in the international application as filed

      ☐ together with the international application in electronic form

      ☐ subsequently to this Authority for the purposes of search

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Box No. II Priority

1. ☒ The validity of the priority claim has not been considered because the International Searching Authority does not have in its possession a copy of the earlier application whose priority has been claimed or, where required, a translation of that earlier application. This opinion has nevertheless been established on the assumption that the relevant date (Rules 43*bis*.1 and 64.1) is the claimed priority date.

2. ☐ This opinion has been established as if no priority had been claimed due to the fact that the priority claim has been found invalid (Rules 43*bis*.1 and 64.1). Thus for the purposes of this opinion, the international filing date indicated above is considered to be the relevant date.

3. Additional observations, if necessary:

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-88
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-52, 55-68, 70-76, 78, 80-82, 84, 86-88
	No:	Claims	53, 54, 69, 77, 79, 83, 85
Industrial applicability (IA)	Yes:	Claims	1-88
	No:	Claims	

2. Citations and explanations

see separate sheet

Box No. VI Certain documents cited

1. Certain published documents (Rules 43*bis*.1 and 70.10)

and / or

2. Non-written disclosures (Rules 43*bis*.1 and 70.9)

see form 210

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

V. Reasoned statement with regard to novelty and inventive step:

Reference is made to the following documents:

D1 RAN2: "LS on RAN2 status on carrier aggregation design" 3GPP DRAFT; R2-093599, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, no. San Francisco, USA; 20090509, 9 May 2009 (2009-05-09) , XP050341057

D2 ERICSSON ET AL: "Multiple Timing Advance for Carrier Aggregation" 3GPP DRAFT; R2-101196 - MULTIPLE TA FOR CA, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG2, no. San Francisco, USA; 20100222, 16 February 2010 (2010-02-16) , XP050421769 [retrieved on 2010-02-16]

D3 ERICSSON: "Reference for Timing Advance" 3GPP DRAFT; R2-103106 REFERENCE FOR TIMNIG ADVANCE, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG2, no. Montreal, Canada; 20100510, 3 May 2010 (2010-05-03) , XP050423092 [retrieved on 2010-05-03]

D4 E-MAIL RAPPORTEUR (NTT DOCOMO ET AL: "CA support for multi-TA" 3GPP DRAFT; R2-101567, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG2, no. San Francisco, USA; 20100222, 18 February 2010 (2010-02-18) , XP050421923 [retrieved on 2010-02-18]

1 With respect to Article 6 PCT the number of independent apparatus claims leads to a lack of conciseness and a lack of clarity of the claims as a whole. Further details see section VIII below. Moreover, the antecedents of the expressions "timing offset" and "within a threshold value" are unclear (details see section VIII). The following positive opinion is given merely under the assumption that the above mentioned deficiencies are clarified.

2 The application relates to method and apparatus that provides maintaining uplink timing synchronization within a multicarrier wireless communication system, especially within a LTE-A system.

3 **Problem:**

Facilitating uplink timing synchronization in such a multicarrier system.

4 Independent claims 1,21,43,48:

Solution:

The following features render the independent claims 1,21,43,48 inventive:

ascertaining an uplink timing associated with an uplink group of carriers, wherein the ascertained uplink timing is based on at least one downlink timing and a timing offset associated with the uplink group of carriers (unclear antecedent); and

transmitting each of the uplink group of carriers within a threshold tolerance of the uplink timing associated with the group.

None of the documents of the available prior art documents gives an indication to such determining and use of an uplink timing for a group or aggregation of carriers in a multicarrier wireless communication system.

5 Independent claims 53, 69, 77, 83:

Claim 53 is formulated in such a general and partly unclear manner (see section VIII) that most of the features of said claim can be read or are implied from D1. In the following references to D1 will be indicated in brackets.

Document D1, in particular headline, section 1. point 9), discloses as in claim 53:

A method that facilitates a timing alignment in a multicarrier system (system with aggregation of carriers), the method comprising:

transmitting a downlink communication to a wireless terminal via at least one downlink carrier (any wireless downlink communication);

assigning a timing offset to an uplink group of carriers (D1, point 9: provide same timing advance for group of different carriers);

providing the timing offset (timing advance) to the wireless terminal via the at least one downlink carrier (usually in uplink timing synchronization the timing advance information is transmitted via downlink carrier); and

receiving an uplink communication via the uplink group of carriers, wherein the uplink group of carriers are received according to the timing offset (since in D1 transmitting of uplink group uses same timing advance it is implied that the receiving of the uplink group of carriers uses the same timing advance).

As shown above the main issue of claim 53 ("same timing advance or same timing offset for group of carriers") seems to be disclosed in D1.

Claim 53 merely differs in that D1 does not provide the features in a detailed manner, but these details are either implied in D1 or obvious for the skilled person in the field of synchronization and cannot be considered inventive.

6 Equivalent objections seem to be possible for correspondent claims 69, 77, 83.

7 For reasons of efficiency a detailed examination of the dependent claims is postponed until the number of independent claims fulfils the requirements of conciseness as mentioned above and in section VIII.

Prima facie at least claims 54, 79, 85 seem to be obvious.

VI Certain cited documents:

Prima facie, Document D2 or D3 or D4 seem to show all features of the independent claims 53, 69,77, 83. These documents will have to be taken into account when entering the national phase. In such a phase it might be necessary to check the priority of the present application.

Prima facie D2, sections 1 to 2.2 (first paragraph) or D3 sections 1-3 or D4, sections 1- 2.2 seem to be readable on claims 53, 69, 77, 83.

VII Certain defects in the international application:

1 To meet the requirements of Rule 5.1(a)(ii) PCT, documents D1-D4 should be identified in the description and the relevant background art disclosed therein should be briefly discussed.

2 When filing an amended apparatus claim, the claim should be filed in the two-part form in accordance with Rule 6.3(b) PCT, with those features known in combination from the prior art being placed in a preamble (Rule 6.3(b)(I) PCT) and with the remaining features being included in a characterising part (Rule 6.3(b)(ii) PCT).

3 If necessary, the description should be adapted to correctly reflect any changes in the scope of the claimed invention.

4 The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

VIII Certain observations:

1 The various definitions of the invention given in independent apparatus claims 21, 48 (TX) and 69, 83 (RX) are such that the claims as a whole are not concise, contrary to Article 6 PCT. The claims should be recast to include only the minimum necessary number of independent claims (one related to TX and one related to RX), with dependent claims as appropriate (Rule 6.4(a)-(c) PCT).

2 Claim 1 and some of the remaining independent claims are not supported by the description as required by Article 6 PCT, as its scope is broader than justified by the description and drawings, because the whole application merely supports "wireless" communication methods and devices.

3 As mentioned already in section V., in claim 1, l. 7 the antecedent of "a timing offset associated with the uplink group of carriers" is unclear. In particular, which link or group of crriers has a time offset to which other link or group of carriers?

For instance, it could be intended timing offsets according to figure 4 and corresponding paragraphs 62-64 or according to [86] or a timing offset associated with a timing advance of the group of carriers.

4 In claim 1, last two lines the expression "transmitting ... within a threshold value of the uplink timing" is misleading and inconsistent. In particular the word "within" leads to a range, but not to a "threshold value". Probably it is intended a formulation according to p. 22, l. 1-2.

5 Equivalent objections as in sections 2-4 have to be raised for claims 21, 43 and 48.

6 Equivalent objections as in section 3 have to be raised for claims 53,69,77,83.

7 In claim 65, l. 2 the expression "target downlink group" seems unclear.

Electronic Acknowledgement Receipt

EFS ID:	11644995
Application Number:	12818064
International Application Number:	
Confirmation Number:	6903
Title of Invention:	METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM
First Named Inventor/Applicant Name:	Nathan Edward Tenny
Customer Number:	23696
Filer:	John J. Ketchum/Marion Comer De Yoe
Filer Authorized By:	John J. Ketchum
Attorney Docket Number:	092546
Receipt Date:	16-DEC-2011
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Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	092546_2011-12-13_IDS_esig.pdf	48509 7e87c998f8a2d3298032523addda16cd96a28f04	no	3

Warnings:	
Information:	

This is not an USPTO supplied IDS fillable form

2	Non Patent Literature	3GPP_DRAFT_R2_101567_E_MAIL_RAPPORTEUR_YEAR_2010.PDF	132458 42b16fca454224ccbe2f215886180cd877617f6d	no	1
Warnings:					
Information:					
3	Non Patent Literature	3GPP_DRAFT_R2_101196_ERICSSON_ET_AL_YEAR_2010.PDF	351359 e6282bbcaa3b64087f5c7540533efd2270ff74be	no	3
Warnings:					
Information:					
4	Non Patent Literature	3GPP_DRAFT_R2_103106_ERICSSON_YEAR_2010.PDF	287070 e1ff3e672507fc3843008b939b408b13fe6bbab7	no	2
Warnings:					
Information:					
5	Non Patent Literature	092546WO_2010_10_04_ISR_WO.PDF	1823591 23f70bc6e6767c95f31d85e7e3ec6e283ccf0335	no	13
Warnings:					
Information:					
6	Non Patent Literature	3GPP_DRAFT_R2_093599_LS_ON_RAN2_YEAR_2009.PDF	291452 1cc41915c8ffbcddcb590cbf4fe97ec9be37c4b3	no	3
Warnings:					
Information:					
		Total Files Size (in bytes):	2934439		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/818,064	06/17/2010	Nathan Edward Tenny	092546	6903

23696 7590 04/15/2013
QUALCOMM INCORPORATED
5775 MOREHOUSE DR.
SAN DIEGO, CA 92121

EXAMINER	
LOUIS, VINNCELAS	
ART UNIT	PAPER NUMBER
2474	

NOTIFICATION DATE	DELIVERY MODE
04/15/2013	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

us-docketing@qualcomm.com

Office Action Summary	Application No. 12/818,064	Applicant(s) TENNY ET AL.	
	Examiner VINNCELAS LOUIS	Art Unit 2474	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *17 June 2010*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

5)☒ Claim(s) *1-88* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-88* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *17 June 2010* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some * c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Interim copies:

a)☐ All b)☐ Some c)☐ None of the: Interim copies of the priority documents have been received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

Specification

1. The lengthy specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

Allowable Subject Matter

2. Claim(s) 40-42 and 46 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claim Rejections - 35 USC § 101

3. 35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

4. Claim 43-47 and 77-82 are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter.

Claims “43 and 77” recite a “computer readable storage medium”, with nothing in the specification specifically limiting this medium from being a transitory medium (i.e. such as a signal medium), which is considered non-

statutory. Further, the USPTO Official Gazette from week #8 of 2010 (Feb 23, 2010), Volume 1351 page 212 specifically explains that the addition of the term "non-transitory" before the computer readable medium will alleviate any issues with 35 USC 101 rejections, since the claims would no longer cover non statutory subject matter.

Regarding claims 44-47 and 78-82, they are rejected for the same reason as set forth in claims 43 and 77 because of their deficiency.

Appropriate correction is required.

Claim Rejections - 35 USC § 112

5. The following is a quotation of 35 U.S.C. 112(b):

(B) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

6. Claims 48-52 and 83-88 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Claims 48 and 83 respectively recite "**means for determining… means for ascertaining… and means for transmitting**" and "**means for transmitting… means for assigning…means for providing… and means for receiving**" which are means (or step) plus function limitations that invokes 35 U.S.C. 112, sixth paragraph. However, the written description fails to clearly link or associate the disclosed structure, material, or acts to the claimed function such that one of ordinary skill in the art would recognize what structure, material, or acts perform the claimed function. Without a specific algorithm for each function, general purpose processors, memories, and software are not considered sufficient disclosure under 35 USC 112, 6th paragraph.

Applicant is required to:

(a) Amend the claim so that the claim limitation will no longer be a means (or step) plus function limitation under 35 U.S.C. 112, sixth paragraph; or

(b) Amend the written description of the specification such that it clearly links or associates the corresponding structure, material, or acts to the claimed function without introducing any new matter (35 U.S.C. 132(a)); or

(c) State on the record where the corresponding structure, material, or acts are set forth in the written description of the specification that perform the claimed

function. For more information, see 37 CFR 1.75(d) and MPEP §§ 608.01(o) and 2181.

Claims 49-52 and 84-88 contains a similar issue as discussed for claims 48 and 83 above, thus, the dependent Claims 49-52 and 84-88 are rejected for the same reasons as set forth above for claims 48 and 83 due its deficiency.

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. Claims 1-11, 19-32, 36-39, 43-45, and 47-52 are rejected under 35 U.S.C. 103(a) as being unpatentable over Damnjavonic et al (US 2006/0280142) and in view of Chun et al (US 2010/0142457).

Regarding claim 1, Damnjavonic'142 discloses a method that facilitates a timing alignment in a multicarrier system, the method comprising:

determining at least one downlink timing associated with at least one downlink carrier (**see para.0034, which discusses determining by acquiring downlink timing of each of the downlink carrier assigned**);

ascertaining an uplink timing associated with an uplink group of carriers (**see para.0031, which discusses base station determine timing advance from the request and sends the timing advance, which corrects timing, to the mobile, para.0035, which discusses ascertaining by applying proper uplink timing advance to each uplink carriers**), wherein the uplink timing(**see para.0035, which discusses uplink timing)** is ascertained based on a processing of at least one downlink timing(**see para.0034, which discusses all downlink DL carriers transmitted by a given base station are typically aligned/synchronized in time, see para.0037, discusses the mobile may indicate it is synchronized to the auxiliary DL carriers, where the indications of synchronization/aligned for all DL are sent in the UL anchor carrier, it is noted aligned/synchronized)** and a timing offset associated with the uplink group of carriers (**see para.0031, 0035, based on by having the mobile applying the advance timing to uplink carriers**); and

transmitting each of the uplink group of carriers (**see para.0028-0029, which discusses the network to transmit assigned uplink carriers)**within

a slot value of the uplink timing(**see para.0029, which discusses within time slot/threshold value for each carrier of the uplink, see para.0043, given transmission interval, see para.0035**).

As discussed above, although Damnjavonic'142 discloses transmit assigned uplink carrier (**see para.0028-0029, see fig.3**), Damnjavonic'142 does not explicitly show the use of "threshold" as required by present claimed invention. However, including "threshold" would have been obvious to one having ordinary skill in the art as evidenced by Chun'457.

In particular, Chun'457 teaches the use of within a threshold (**see para.0039, which discusses the multicarrier LTE system allocates resource block based on predetermined time as threshold value, see para.0054, base station transmits random access response information that includes time advance, allocation information of radio resources for uplink transmission of** Chun'457**).**

In view of the above, having the system of Damnjavonic'142 and then given the well-established teaching of Chun'457, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the system of Damnjavonic'142 as taught by Chun'457, since Chun'457 stated in

para.0026+ that such a modification would improve the scheduling efficiency of a wireless communication using buffer status information of a UE.

Regarding claim 2, Damnjavonic'1426 discloses further comprising performing a random access procedure on at least one random access carrier (**see para.0031, which discusses performing random access channel on at least one carrier, see para.0035, 0043 & see para.0075**), wherein the at least one random access carrier (**see para.0031, which discusses performing random access channel on at least one carrier, see para.0035, 0043 & see para.0075**) is included in a downlink group of **carriers (see fig.3, which shows DL carriers)** that includes the at least one downlink carrier (**see fig.3, DL anchor carrier 1** of Damnjavonic'142).

Regarding claim 3, Damnjavonic'1426 discloses wherein the performing comprises performing the random access procedure on a single carrier (**see para.0031, which discusses performing random access channel on at least one carrier, see para.0035, 0043 & see para.0075, see fig.3, which shows DL anchor carrier** of Damnjavonic'142).

Regarding claim 4, Damnjavonic'1426 discloses wherein the single carrier is an assigned carrier provided by a network prior (**see fig.3, which shows assigned carrier, see para.0028-0029**) to the performing of the random access

procedure (**see para.0031, which discusses performing random access channel on at least one carrier, see para.0035, 0043 & see para.0075, see fig.3, which shows DL carrier** of Damnjavonic'142).

Regarding claim 5, Damnjavonic'1426 discloses further comprising receiving the single carrier as part of a dedicated radio resource configuration (**see fig.3, which shows carrier assignment, see para.0031 & see para.0043, which discusses assigned one or more carrier dedicated radio resource assignment configuration of Damnjavonic'142**).

Regarding claim 6, Damnjavonic'1426 discloses further comprising receiving a criterion associated with a usage of the single carrier (**see para.0050-0051, which discusses the mobile reports DL anchor carrier based on signal level and signal quality as criterion of that carrier to base station**), wherein the criterion is received with an assignment of the single carrier (**see para.0050-0051, signal level and/or signal quality is received with anchor carrier, see para.0056** of Damnjavonic'142).

Regarding claim 7, Damnjavonic'1426 discloses wherein the criterion is a minimum signal quality threshold associated with the single carrier (**see para.0050-0051, which discusses signal level and/or signal quality**

associated some minimum quality threshold, see para.0056 of Damnjavonic'142).

Regarding claim 8, Damnjavonic'1426 discloses wherein the performing comprises performing the random access procedure on an alternative carrier in response to the criterion not being met by the single carrier(**see para.0031, 0035, see para.0051-0052, in response to anchor carrier due signal quality threshold, performing channel qualities on auxiliary channel as alternative**), and wherein the receiving further comprises receiving an indication of the alternative carrier from the network (**see para.0052-0055, the best auxiliary becomes the new alternative carrier**).

Regarding claim 9, Damnjavonic'1426 discloses wherein the performing comprises performing the random access procedure on an alternative carrier in response to the criterion not being met by the single carrier(**see para.0031, 0035, see para.0051-0052, in response to anchor carrier due signal quality threshold, performing channel qualities on auxiliary channel as alternative**), and wherein the alternative carrier is independently selected by a wireless terminal(**see para.0052-0055, which discusses the best independent auxiliary becomes the new alternative carrier selected by the mobile wireless terminal for listening for timing advance**).

Regarding claim 10, Damnjavonic'1426 discloses further comprising selecting the single carrier (**see fig.3**), wherein the single carrier is independently selected by a wireless terminal (**see para.0052-0055, which discusses the best independent auxiliary becomes the new alternative carrier selected by the mobile wireless terminal for listening for timing advance**).

Regarding claim 11, Damnjavonic'1426 discloses wherein the selecting comprises applying a determination function across a set of available carriers in the downlink group of carriers (**see para.0052, which discusses selecting by ranking DL auxiliary carriers based on channel qualities of Damnjavonic'142**).

Regarding claim 19, Damnjavonic'142 discloses wherein the selecting is performed at a time when radio resources are assigned to the wireless terminal on any of the downlink group of carriers (**see fig.3, which shows downlink carries, see para.0031, which discusses base station sends the assigned radio resources**).

Regarding claim 20, Damnjavonic'142 discloses wherein the selecting is performed in response to a triggering of the random access procedure (**see para.0031, which discusses in response to random access procedure**).

Regarding claim 21, Damnjavonic'142 discloses an apparatus configured to facilitate a timing alignment in a multicarrier system, the apparatus comprising:

a processor configured to execute computer executable components stored in memory (**see para.0078-0079, which discuses processor to execute computer executable**), the components including:

a downlink timing component configured to determine at least one downlink timing associated with at least one downlink carrier(**see para.0034, which discusses determining by acquiring downlink timing of each of the downlink carrier assigned**);

an uplink timing component configured to ascertain an uplink timing associated with an uplink group of carriers(**see para.0031, which discusses base station determine timing advance from the request and sends the timing advance, which corrects timing, to the mobile, para.0035, which discusses ascertaining by applying proper uplink timing advance to each uplink carriers**), wherein the uplink timing(**see para.0035, which discusses uplink timing)** is ascertained based on at least one downlink timing(**see para.0034, which discusses all downlink DL carriers transmitted by a given base station are typically aligned/synchronized in time, see para.0037, discusses the**

mobile may indicate it is synchronized to the auxiliary DL carriers, where the indications of synchronization/aligned for all DL are sent in the UL anchor carrier) and a timing offset associated with the uplink group of carriers(**see para.0031, 0035, based on by having the mobile applying the advance timing/offset time to uplink carriers**); and

a communication component configured to transmit each of the uplink group of carriers(**see para.0028-0029, which discusses the network to transmit assigned uplink carriers)** within a slot value of the uplink timing(**see para.0029, which discusses within time slot value for each carrier of the uplink, see para.0043, given transmission interval, see para.0035**).

As discussed above, although Damnjavonic'142 discloses transmit assigned uplink carrier (**see para.0028-0029, see fig.3**), Damnjavonic'142 does not explicitly show the use of "threshold" as required by present claimed invention. However, including "threshold" would have been obvious to one having ordinary skill in the art as evidenced by Chun'457.

In particular, Chun'457 teaches the use of within a threshold **(see para.0039, which discusses the multicarrier LTE system allocates resource block based on predetermined time as threshold value, see para.0054, base station transmits random access response information that includes time advance,**

allocation information of radio resources for uplink transmission of Chun'457**).**

In view of the above, having the system of Damnjavonic'142 and then given the well-established teaching of Chun'457, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the system of Damnjavonic'142 as taught by Chun'457, since Chun'457 stated in para.0026+ that such a modification would improve the scheduling efficiency of a wireless communication using buffer status information of a UE.

Regarding claim 22, Damnjavonic'142 discloses wherein the uplink timing component is configured to determine the uplink timing(**see para.0035, which discusses uplink timing)** by utilizing a different timing offset for each of a plurality of uplink group of carriers (**see para.0035, which discusses by using separate timing advance updates for each UL carrier**).

Regarding claim 23, Damnjavonic'142 discloses wherein the uplink timing component is configured to determine the uplink timing (**see para.0035, which discusses uplink timing)** by utilizing a different downlink timing (**see para.0037, which discusses by using indications of synchronization for each DL carriers**) for each of a plurality of uplink group of carriers (see fig.3, see

para.0035, **separate timing advance updates for each UL carrier, see para.0037).**

Regarding claim 24, Damnjavonic'142 discloses wherein the at least one downlink carrier is included in one of a plurality of downlink groups (**see fig.3, which shows at DL anchor carrier 1 of the DL carrier 2-n**), and wherein the uplink timing component is configured to determine the uplink timing(**see para.0035, which discusses uplink timing)** by associating the uplink group of carriers with the one of the plurality of downlink groups(**see para.0037, which discusses by synchronizing downlink carries with uplink carriers, see fig.3**) .

Regarding claim 25, Damnjavonic'142 discloses wherein the uplink timing component is configured to determine a plurality of uplink timings respectively associated with a plurality of uplink groups(**see para.0035, which discusses by using separate timing advance updates for each UL carrier**)by identifying a subset of downlink groups that include an assigned carrier (**see fig.3, which shows downlink groups 1-N, see para.0043, which discusses the mobile to receive information via assigned DL anchor carrier)** , and

wherein the plurality of uplink groups **(see fig.3, which shows plurality of uplink groups)** are respectively associated with the subset of

downlink groups that include the assigned carrier (**see fig.3, which shows associated with downlink groups includes the assigned anchor carrier**).

Regarding claim 26, Damnjavonic'142 discloses further comprising a message processing component configured to process a received timing message encoded with a set of uplink timing instructions respectively corresponding to an uplink group subset of the uplink group of carriers (**see para.0035, which discusses a message including timing advance updates for each of uplink carrier UL).**

Regarding claim 27, Damnjavonic'142 discloses wherein the received timing message is a timing advance command (**see para.0035, which discusses a message including timing advance updates for each of uplink carrier UL, see para.0031).**

Regarding claim 28, Damnjavonic'142 discloses wherein the received timing message comprises a vector encoded with timing adjustment values associated with the uplink group subset (**see para.0035, which discusses a message including timing advance updates/adjustments value for each of uplink carrier UL, para.0031).**

Regarding claim 29, Damnjavonic'142 discloses wherein each uplink group within the uplink group subset includes at least one carrier with an assigned

radio resource (**see fig.3, which shows each uplink group with at least one carrier assigned radio resource, para.0031**).

Regarding claim 30, Damnjavonic'142 discloses wherein the uplink group of carriers comprise a set of uplink groups in which each uplink group within the set of uplink groups includes at least one carrier with an assigned radio resource (**see fig.3, which shows uplink group includes at least one carrier with assigned radio resource)**, and wherein the uplink group subset is a subset of the set of uplink groups (**see fig.1, which shows UL anchor of UP carrier 2-N, para.0031**).

Regarding claim 31, Damnjavonic'142 discloses wherein the uplink group subset is determined by a network entity (**see fig.3, see para.0028-0029, see para.0031, which discusses base station assigns one or more carriers each of the uplink, see para.0043).**

Regarding claim 32, Damnjavonic'142 discloses wherein the message processing component is configured to submit a request requesting the network entity(**see para.0031, which discusses establishes radio resource RR by sending an RR channel request**) to provide the uplink group subset(**see fig.3, see para.0031, which discusses the base station network assigns one or more carrier for each of the uplink)**, and wherein the uplink group subset is

determined by the network entity in response to the request (**see para.0031, which discusses uplink group subset is determined by the network entity in response to the request).**

Regarding claim 36, Damnjavonic'142 discloses further comprising a message processing component configured to decode a timing message received via a timing message carrier included in a messenger downlink group(**see para.0031, which discusses the mobile to decode timing advance by applying it**), wherein the timing message is encoded with at least one inter-group uplink timing **(see para.0031, see para.0035, with at least one inter-group uplink timing, see fig.7, which shows encoder 710)** corresponding to a target downlink group(**see fig.3, see 0034, see fig.3, which shows downlink group target terminal, see fig.7**), and wherein the target downlink group **(see fig.3, see 0034, see fig.3, which shows downlink group target terminal, see fig.7)** is different than the messenger downlink group(**see para.0031, which discusses the mobile to decode timing advance by applying it**).

Regarding claim 37, Damnjavonic'142 discloses wherein the timing message(**see para.0031, which discusses the mobile to decode timing advance by applying it, see para.0035**) includes an indication of the target downlink

group(**see fig.1, see fig.3, see para.0031, which discusses base station sends timing advance indication of the of target downlink group mobile).**

Regarding claim 38, Damnjavonic'142 discloses wherein the message processing component configured to decode the indication according to a mapping of group identities shared with a network (**see fig.7, which shows decoder to decode indication, see para.0031, 0035, see fig.1, which group mobile identities**).

Regarding claim 39, Damnjavonic'142 discloses wherein the mapping of group identities is configured in association with an assignment of dedicated radio resources on downlink carriers included in the target downlink group (**see fig.3, which shows radio resource on downlink carriers in the target downlink group mobile**).

Regarding claim 43, Damnjavonic'142 discloses a computer program product that facilitates a timing alignment in a multicarrier system, comprising: a computer-readable storage medium comprising code for causing at least one computer to:

determine at least one downlink timing associated with at least one downlink carrier (**see para.0034, which discusses determining by acquiring downlink timing of each of the downlink carrier assigned**);

ascertain an uplink timing associated with an uplink group of carriers (**see para.0031, which discusses base station determine timing advance from the request and sends the timing advance, which corrects timing, to the mobile, para.0035, which discusses ascertaining by applying proper uplink timing advance to each uplink carriers**), wherein the uplink timing(**see para.0035, which discusses uplink timing)** is ascertained based on a processing of at least one downlink timing(**see para.0034, which discusses all downlink DL carriers transmitted by a given base station are typically aligned/synchronized in time, see para.0037, discusses the mobile may indicate it is synchronized to the auxiliary DL carriers, where the indications of synchronization/aligned for all DL are sent in the UL anchor carrier, it is noted aligned/synchronized)** and a timing offset associated with the uplink group of carriers (**see para.0031, 0035, based on by having the mobile applying the advance timing to uplink carriers**); and

transmitt each of the uplink group of carriers (**see para.0028-0029, which discusses the network to transmit assigned uplink carriers)**within a slot value of the uplink timing(**see para.0029, which discusses within time slot/threshold value for each carrier of the uplink, see para.0043, given transmission interval, see para.0035**).

As discussed above, although Damnjavonic'142 discloses transmit assigned uplink carrier (**see para.0028-0029, see fig.3**), Damnjavonic'142 does not explicitly show the use of "threshold" as required by present claimed invention. However, including "threshold" would have been obvious to one having ordinary skill in the art as evidenced by Chun'457.

In particular, Chun'457 teaches the use of within a threshold (**see para.0039, which discusses the multicarrier LTE system allocates resource block based on predetermined time as threshold value, see para.0054, base station transmits random access response information that includes time advance, allocation information of radio resources for uplink transmission of** Chun'457**).**

In view of the above, having the system of Damnjavonic'142 and then given the well-established teaching of Chun'457, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the system of Damnjavonic'142 as taught by Chun'457, since Chun'457 stated in para.0026+ that such a modification would improve the scheduling efficiency of a wireless communication using buffer status information of a UE.

Regarding claim 44, Damnjavonic'142 discloses wherein the code causes the at least one computer to associate the uplink group of carriers with one of a plurality of downlink groups (**see fig.3, which shows uplink carriers and downlink carriers),** and wherein the code further causes the at least one computer to receive a timing message encoded with a set of uplink timing instructions respectively corresponding to a downlink group subset of the plurality of downlink groups (**see para.0035, which discusses common/separate timing advance for all/each UL carrier received on downlink carrier, see fig.3**).

Regarding claim 45, Damnjavonic'142 discloses further comprising a message processing component configured to decode a timing message received via a timing message carrier included in a messenger downlink group(**see para.0031, which discusses the mobile to decode timing advance by applying it**), wherein the timing message is encoded with at least one inter-group uplink timing (**see para.0031, see para.0035, with at least one inter-group uplink timing, see fig.7, which shows encoder 710**) corresponding to a target downlink group(**see fig.3, see 0034, see fig.3, which shows downlink group target terminal, see fig.7**), and wherein the target downlink group (**see fig.3, see 0034, see fig.3, which shows downlink group target terminal, see fig.7**) is different

than the messenger downlink group(**see para.0031, which discusses the mobile to decode timing advance by applying it**).

Regarding claim 47, Damnjavonic'142 discloses wherein the code causes the at least one computer to perform a random access procedure on at least one random access carrier, and wherein the at least one random access carrier is included in a downlink group of carriers that includes the at least one downlink carrier (**see fig.3, which shows downlink carrier, see para.0031, which discusses perform rand access procedure**).

Regarding claim 48, Damnjavonic'142 discloses an apparatus configured to facilitate a timing alignment in a multicarrier system, the apparatus comprising:

means for determining at least one downlink timing associated with at least one downlink carrier (**see para.0034, which discusses determining by acquiring downlink timing of each of the downlink carrier assigned**);

means for ascertaining an uplink timing associated with an uplink group of carriers (**see para.0031, which discusses base station determine timing advance from the request and sends the timing advance, which corrects timing, to the mobile, para.0035, which discusses ascertaining by applying proper uplink timing advance to each uplink carriers**), wherein the uplink

timing(**see para.0035, which discusses uplink timing)** is ascertained based on a processing of at least one downlink timing(**see para.0034, which discusses all downlink DL carriers transmitted by a given base station are typically aligned/synchronized in time, see para.0037, discusses the mobile may indicate it is synchronized to the auxiliary DL carriers, where the indications of synchronization/aligned for all DL are sent in the UL anchor carrier, it is noted aligned/synchronized)** and a timing offset associated with the uplink group of carriers (**see para.0031, 0035, based on by having the mobile applying the advance timing to uplink carriers**); and

means for transmitting each of the uplink group of carriers (**see para.0028-0029, which discusses the network to transmit assigned uplink carriers)**within a slot value of the uplink timing(**see para.0029, which discusses within time slot/threshold value for each carrier of the uplink, see para.0043, given transmission interval, see para.0035**).

As discussed above, although Damnjavonic'142 discloses transmit assigned uplink carrier (**see para.0028-0029, see fig.3**), Damnjavonic'142 does not explicitly show the use of "threshold" as required by present claimed invention. However, including "threshold" would have been obvious to one having ordinary skill in the art as evidenced by Chun'457.

In particular, Chun'457 teaches the use of within a threshold (**see para.0039, which discusses the multicarrier LTE system allocates resource block based on predetermined time as threshold value, see para.0054, base station transmits random access response information that includes time advance, allocation information of radio resources for uplink transmission of** Chun'457**).**

In view of the above, having the system of Damnjavonic'142 and then given the well-established teaching of Chun'457, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the system of Damnjavonic'142 as taught by Chun'457, since Chun'457 stated in para.0026+ that such a modification would improve the scheduling efficiency of a wireless communication using buffer status information of a UE.

Regarding claim 49, Damnjavonic'142 discloses wherein the means for ascertaining is configured to utilize a different timing offset for each of a plurality of uplink group of carriers (**see para.0035, which discusses separate/different timing advance for each of UL carrier**).

Regarding claim 50, Damnjavonic'142 discloses wherein the means for ascertaining is configured to utilize a different downlink timing for each of a

plurality of uplink group of carriers(**see para.0035, which discusses separate/different timing advance for each of UL carrier, see para.0037, which discusses synchronization for all DL, implying different downlink timing**).

Regarding claim 51, Damnjavonic'142 discloses wherein the at least one downlink carrier is included in one of a plurality of downlink groups (**see fig.3, which shows downlink carrier),** and wherein the means for ascertaining is configured to associate the uplink group of carriers with the one of the plurality of downlink groups (**see fig.3, which shows ascertain uplink carriers with downlink carriers).**

Regarding claim 52, Damnjavonic'142 discloses further comprising means for performing a random access procedure on at least one random access carrier, wherein the at least one random access carrier is included in a downlink group of carriers that includes the at least one downlink carrier (**see fig.3, which shows carrier, see para.0031, which discusses performing rand access procedure**).

9. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Damnjavonic et al (US 2006/0280142) in view of Chun et al (US 2010/0142457)

in view of Burgess et al (US 2004/0266445) and further in view of Falco et al (US 6,545,996).

Regarding claim 12, Damnjavonic'142 does not explicitly disclose "pseudorandom function" as required by present claimed invention. However, including "pseudorandom function" would have been obvious to one having ordinary skill in the art as evidenced by Burgess '445.

In particular, Burgess '445 teaches the use of a pseudorandom function (**see fig.1, which shows performing using hashing function algorithm to select one of the available carriers, see para.0023, 0045 of Burgess '445 & see col.2, lines 20-25, which discusses hash algorithm is a function or table that pseudo-randomly assigns an output of Falco'996**).

In view of the above, having the system of Damnjavonic'142 and then given the well-established teaching of Burgess '445, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the system of Damnjavonic'142 as taught by Burgess '445, since Burgess '445 stated in para.0010+ that such a modification would provide a demand for a system of applying hashing a hashing algorithm that supports a uniform distribution of carrier usage based on the services supported by each available carrier

10. Claims 13-14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Damnjavonic et al (US 2006/0280142) in view of Chun et al (US 2010/0142457) and further in view of Burgess et al (US 2004/0266445).

Regarding claim 13, Damnjavonic'142 does not explicitly disclose "a hash function" as required by present claimed invention. However, including "a hash function" would have been obvious to one having ordinary skill in the art as evidenced by Burgess '445.

In particular, Burgess '445 teaches the use of a hash function (**see fig.1, which shows performing using hashing function algorithm to select one of the available carriers, see para.0023, 0045 of Burgess '445**).

In view of the above, having the system of Damnjavonic'142 and then given the well-established teaching of Burgess '445, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the system of Damnjavonic'142 as taught by Burgess '445, since Burgess '445 stated in para.0010+ that such a modification would provide a demand for a system of applying hashing a hashing algorithm that supports a uniform distribution of carrier usage based on the services supported by each available carrier.

Regarding claim 14, Burgess '445 discloses comprising inputting an identifier associated with the wireless terminal into the hash function (**see para.0011 & see para.0026, which discusses hash function inputs wireless unit's identification, identification number).**

11. Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Damnjavonic et al (US 2006/0280142) in view of Chun et al (US 2010/0142457) in view of Burgess et al (US 2004/0266445) and further Bachmann et al (US 7,688,785).

Regarding claim 15, Damnjavonic'142 discloses wherein the downlink group of carriers is controlled by the network node (**see fig.3, which discusses downlink group of carriers is controlled by the base station network node of** Damnjavonic'142).

As discussed above, although Damnjavonic'142 discloses downlink group of carriers is controlled by the base station network node (**see fig.3**), Damnjavonic'142 does not explicitly show the use of "inputting an identifier associated with a network node into the hash function" as required by present claimed invention. However, including "inputting an identifier associated with a network node into the hash function" would have been obvious to one having ordinary skill in the art as evidenced by Bachmann'785.

In particular, Bachmann'785 teaches the use of inputting an identifier associated with a network node into the hash function **(see col.13, lines 36-60, which discusses BSSID as identifier of the access point network node input into hash function of Bachmann'785).**

In view of the above, having the system of Damnjavonic'142 and then given the well-established teaching of Bachmann'785, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the system of Damnjavonic'142 as taught by Bachmann'785, since Bachmann'7856 stated in col.2, lines 53+ that such a modification would provide an improved system to keep the handover duration as short as possible.

12. Claims 16 and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Damnjavonic et al (US 2006/0280142) in view of Chun et al (US 2010/0142457)in view of Burgess et al (US 2004/0266445) and further in view of Li et al (US 2008/0037487).

Regarding claim 16, the combination of Damnjavonic'142 and Burgess '445 disclose further comprising inputting a time-varying value into the hash function (**see fig.1, which shows performing using hashing function**

algorithm to select one of the available carriers, see para.0023, 0045 of Burgess '445).

Regarding claim 16, the combination of Damnjavonic'142 and Burgess '445 does not explicitly disclose "inputting a time-varying value" as required by present claimed invention. However, including "inputting a time-varying value" would have been obvious to one having ordinary skill in the art as evidenced by Li'487.

In particular, Li'487 teaches the use of comprising inputting a time-varying value into the hash function (**see para.0056, inputting time variable value into hash function of** Li'487).

In view of the above, having the system of Burgess '445 and then given the well-established teaching of Li'487, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the system of Burgess '445 as taught by Li'487, since Li'487 stated in para.0008+ that such a modification would provide peer to peer network that operates in a synchronous manner whereby peers may not encounter difficulty associated with identifying and/or communicate with disparate peers within range, power may be efficiently utilized and so forth.

Regarding claim 17, Li'487 disclose comprising determining the time-varying value(**see para.0056, inputting time variable value into hash function**) via a time measurement taken from within the wireless terminal **(see para.0040, see para.0046, see para.0054, the wireless may utilize pseudo random number, whose seed can be an identifier and time counter, to select transmission time. As time counter varies, the transmission time may also vary. See fig.7, which shows terminal with synchronizer 214, see fig.1-6, 8-17**).

Regarding claim 18, Li'487 disclose further comprising modifying the time-varying value by an arithmetic operation each time the time-varying value is used(**see para.0040, see para.0046, see para.0054, the wireless may utilize pseudo random number arithmetic operation, whose seed can be an identifier and time counter, to select transmission time. As time counter varies, the transmission time may also vary. See fig.7, which shows terminal with synchronizer 214, see fig.1-6, 8-17**).

13. Claim 33-35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Damnjavonic et al (US 2006/0280142) in view of Chun et al (US 2010/0142457) and further in view of Anh et al (US 2011/0235620).

Regarding claim 33, Damnjavonic'142 discloses wherein the received timing message **(see para.0031, which discusses timing advance, see para.0035**) and the uplink group of carriers are included in the uplink group subset (**see para.0031, which discusses the base station assigns one or more carriers for each uplink and sends the uplink carriers, timing advance and others to the mobile station see fig.3, see para.0066, see para.0071).**

As discussed above, although Damnjavonic'142 discloses base station sends the uplink carriers, timing advance and others to the mobile station (**see fig.3, see para.0031**), Damnjavonic'142 does not explicitly show the use of "indication of which" as required by present claimed invention. However, including "indication of which" would have been obvious to one having ordinary skill in the art as evidenced by Anh'620.

In particular, Anh'620 teaches the use of the timing message includes indication of which uplink group carriers (**see para.0063, see para.0069, which discuses the user equipment received the reference transmission timing information may be respective to a specific uplink link UL CC group or may be used only for identifying the transmission timing information to the UL CC group, see para.0071, see fig.12 of** Anh'620**).**

In view of the above, having the system of Damnjavonic'142 and then given the well-established teaching of Anh'620, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the system of Damnjavonic'142 as taught by Anh'620, since Anh'620 stated in para.0003 that such a modification would provide an apparatus for efficiently controlling power that is used for transmitting control information.

Regarding claim 34, Anh'620 discloses wherein the message processing component is configured to decode the indication according to a mapping of group identities shared with a network (**see para.0070, which discusses decode by having the user equipment may use the reference transmission timing received so as to identify or verify multiple transmission information indicating mapping UL CC group**, see fig.1) .

Regarding claim 35, Anh'620 discloses wherein the mapping of group identities is configured in association with an assignment of dedicated radio resources on uplink carriers within at least one uplink group of the uplink group subset (**see fig.5, see fig.12, see para.0063-0064, which discusses dedicated bandwidth resources on uplink carriers**).

Claim Rejections - 35 USC § 102

14. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

15. Claims 53-61, 65-70, 72-79, 82-86 and 88 are rejected under 35 U.S.C. 102(b) as being anticipated by Damnjavonic et al (US 2006/0280142).

Regarding claim 53, Damnjavonic'142 discloses method that facilitates a timing alignment in a multicarrier system, the method comprising:

transmitting a downlink communication to a wireless terminal via at least one downlink carrier (**see fig.3, which shows base station transmits downlink communication to a mobile/terminal station via downlink carrier, see para.0033**);

assigning a timing offset (**see para.0031, which discusses the base station determine a timing advance as timing offset**) to an uplink group of carriers (**see para.0035, which discusses for all/each assigned uplink carrier UL, see fig.3**);

providing the timing offset to the wireless terminal (**see para.0031, which discusses the base station sends the timing advance to the mobile terminal statio**n)via the at least one downlink carrier (**see fig.3, see para.0033, which discusses DL anchor carrier may convey assignment of carriers**); and

receiving an uplink communication via the uplink group of carriers (**see fig.3, which shows receiving uplink communication vi a uplink group carriers, see para.0043**), wherein the uplink group of carriers are received (**see fig.3, which shows mobile terminal to received uplink carriers, see para.0028, 0031, mobile terminal to received one or more assigned uplink carriers transmitted by the base station, see para.0043)** according to the timing offset (**see para.0031 & see para.0035, which mobile to apply time advance or updates to all or for each group UL carrier**).

Regarding claim 54, Damnjavonic'142 discloses wherein the assigning comprises assigning a different timing offset to each of a plurality of uplink groups (**see fig.3, see para.0035, which discusses separate/different timing advance for each UL carrier, see para.0043).**

Regarding claim 55, Damnjavonic'142 discloses comprising generating a timing message encoded with a set of uplink timing instructions respectively corresponding to an uplink group subset of the plurality of uplink

groups(**see fig.3, see para.0035, which discusses separate/different timing advance for each UL carrier, see para.0043**), wherein the transmitting comprises transmitting the timing message to the wireless terminal (**see para.0031, which discusses base station transmits timing advance message to the mobile terminal**).

Regarding claim 56, Damnjavonic'142 discloses wherein the timing message is a timing advance command **(see para.0031-0035, which discusses timing advance).**

Regarding claim 57, Damnjavonic'142 discloses wherein the timing message comprises a vector encoded with timing adjustment values associated with the uplink group subset (see fig7, **see fig.3, see para.0035, which discusses separate/different timing advance updates for each UL carrier, see para.0043**),

Regarding claim 58, Damnjavonic'142 discloses wherein each uplink group within the uplink group subset includes at least one carrier with a radio resource assigned to the wireless terminal (**see fig.3, which shows each uplink with at least one carrier with a radio resource assigned, see para.0028, see para.0043**).

Regarding claim 59, Damnjavonic'142 discloses wherein the plurality of uplink groups **(see fig.3**) comprise a set of uplink groups in which each uplink group within the set of uplink groups includes at least one carrier with a radio resource assigned to the wireless terminal(**see fig.3, see para.0043, which discusses subsets of multiple UL with at least one UL carrier),** and wherein the uplink group subset is a subset of the set of uplink groups **(see para.0043, which discusses uplink group subset is subset of the set of uplink groups as shown, see fig.3**)

Regarding claim 60, Damnjavonic'142 discloses further comprising determining the uplink group subset **(see para.0043, which discusses determine a subset group of the multiple UL carriers, see fig.3, see para.0071).**

Regarding claim 61, Damnjavonic'142 discloses further comprising receiving a request from the wireless terminal to provide the uplink group subset(**see para.0031, which discusses the base station to receive a request to assign/provide one or more UL carriers, see para.0043, see fig.3**), wherein the determining is performed in response to the request (**see para.0031, which discusses it is performed in response to the request).**

Regarding claim 65, Damnjavonic'142 discloses further comprising a message processing component configured to decode a timing message received

via a timing message carrier included in a messenger downlink group(**see para.0031, which discusses the mobile to decode timing advance by applying it**), wherein the timing message is encoded with at least one inter-group uplink timing **(see para.0031, see para.0035, with at least one inter-group uplink timing, see fig.7, which shows encoder 710)** corresponding to a target downlink group(**see fig.3, see 0034, see fig.3, which shows downlink group target terminal, see fig.7**), and wherein the target downlink group **(see fig.3, see 0034, see fig.3, which shows downlink group target terminal, see fig.7)** is different than the messenger downlink group(**see para.0031, which discusses the mobile to decode timing advance by applying it**).

Regarding claim 66, Damnjavonic'142 discloses wherein the timing message(**see para.0031, which discusses the mobile to decode timing advance by applying it, see para.0035**) includes an indication of the target downlink group(**see fig.1, see fig.3, see para.0031, which discusses base station sends timing advance indication of the of target downlink group mobile).**

Regarding claim 67, Damnjavonic'142 discloses wherein the message processing component configured to decode the indication according to a mapping of group identities shared with a network (**see fig.7, which shows**

decoder to decode indication, see para.0031, 0035, see fig.1, which group mobile identities).

Regarding claim 68, Damnjavonic'142 discloses wherein the mapping of group identities is configured in association with an assignment of dedicated radio resources on downlink carriers included in the target downlink group (**see fig.3, which shows radio resource on downlink carriers in the target downlink group mobile, see para.0028, see para.0043**).

Regarding claim 69, Damnjavonic'142 discloses an apparatus configured to facilitate a timing alignment in a multicarrier system, the apparatus comprising: a processor configured to execute computer executable components stored in memory, the components including:

a timing offset component configured to assign a timing offset (**see para.0031, which discusses the base station determine a timing advance as timing offset**) to an uplink group of carriers (**see para.0035, which discusses for all/each assigned uplink carrier UL, see fig.3**);

a transmitting component configured to provide the timing offset to the wireless terminal (**see para.0031, which discusses the base station sends the timing advance to the mobile terminal statio**n)via the at least one downlink

carrier (**see fig.3, see para.0033, which discusses DL anchor carrier may convey assignment of carriers**); and

a receiving component configured to receive an uplink communication via the uplink group of carriers (**see fig.3, which shows receiving uplink communication vi a uplink group carriers, see para.0043**), wherein the uplink group of carriers are received (**see fig.3, which shows mobile terminal to received uplink carriers, see para.0028, 0031, mobile terminal to received one or more assigned uplink carriers transmitted by the base station, see para.0043)** according to the timing offset (**see para.0031 & see para.0035, which mobile to apply time advance or updates to all or for each group UL carrier**).

Regarding claim 70, Damnjavonic'142 discloses wherein the transmitting component is configured to transmit a downlink group of carriers from antennas located at a common site (**see fig.1 & see fig.7, which shows antennas for transmitting, see fig.3).**

Regarding claim 72, Damnjavonic'1426 discloses further comprising performing a random access procedure on at least one random access carrier (**see para.0031, which discusses performing random access channel on at least one carrier, see para.0035, 0043 & see para.0075**), wherein the at least one random

access carrier (**see para.0031, which discusses performing random access channel on at least one carrier, see para.0035, 0043 & see para.0075**) is assigned to the wireless terminal **(see fig.3, see para.0031).**

Regarding claim 73, Damnjavonic'1426 discloses further comprising receiving the single carrier as part of a dedicated radio resource configuration (**see fig.3, which shows carrier assignment**, **see para.0031 & see para.0043, which discusses assigned one or more carrier dedicated radio resource assignment configuration of Damnjavonic'142**).

Regarding claim 74, Damnjavonic'1426 discloses further comprising receiving a criterion associated with a usage of the single carrier (**see para.0050-0051, which discusses the mobile reports DL anchor carrier based on signal level and signal quality as criterion of that carrier to base station**), wherein the criterion is received with an assignment of the single carrier (**see para.0050-0051, signal level and/or signal quality is received with anchor carrier, see para.0056** of Damnjavonic'142).

Regarding claim 75, Damnjavonic'1426 discloses wherein the criterion is a minimum signal quality threshold associated with the random access carrier (**see para.0050-0051, which discusses signal level and/or signal quality**

associated some minimum quality threshold, see para.0056 of Damnjavonic'142).

Regarding claim 76, Damnjavonic'1426 discloses wherein the performing comprises performing the random access procedure on an alternative carrier in response to the criterion not being met by the single carrier(**see para.0031, 0035, see para.0051-0052, in response to anchor carrier due signal quality threshold, performing channel qualities on auxiliary channel as alternative**), and wherein the receiving further comprises receiving an indication of the alternative carrier from the network (**see para.0052-0055, the best auxiliary becomes the new alternative carrier**).

Regarding claim 77, Damnjavonic'142 discloses computer program product that facilitates a timing alignment in a multicarrier system, comprising:

a computer-readable storage medium comprising code for causing at least one computer to:

transmitting a downlink communication to a wireless terminal via at least one downlink carrier (**see fig.3, which shows base station transmits downlink communication to a mobile/terminal station via downlink carrier, see para.0033**);

assigning a timing offset (**see para.0031, which discusses the base station determine a timing advance as timing offset**) to an uplink group of carriers (**see para.0035, which discusses for all/each assigned uplink carrier UL, see fig.3**);

providing the timing offset to the wireless terminal (**see para.0031, which discusses the base station sends the timing advance to the mobile terminal statio**n) via the at least one downlink carrier (**see fig.3, see para.0033, which discusses DL anchor carrier may convey assignment of carriers**); and

receiving an uplink communication via the uplink group of carriers (**see fig.3, which shows receiving uplink communication vi a uplink group carriers, see para.0043**), wherein the uplink group of carriers are received (**see fig.3, which shows mobile terminal to received uplink carriers, see para.0028, 0031, mobile terminal to received one or more assigned uplink carriers transmitted by the base station, see para.0043)** according to the timing offset (**see para.0031 & see para.0035, which mobile to apply time advance or updates to all or for each group UL carrier)**.

Regarding claim 78, Damnjavonic'142 discloses wherein the transmitting component is configured to transmit a downlink group of carriers

from antennas located at a common site (**see fig.1 & see fig.7, which shows antennas for transmitting, see fig.3).**

Regarding claim 79, Damnjavonic'142 discloses wherein the code causes the at least one computer to assign a different timing offset for each of a plurality of uplink group of carriers (**see para.0035, which discusses by using separate timing advance updates for each UL carrier**).

Regarding claim 80, Damnjavonic'142 discloses comprising generating a timing message encoded with a set of uplink timing instructions respectively corresponding to an uplink group subset of the plurality of uplink groups(**see fig.3, see para.0035, which discusses separate/different timing advance for each UL carrier, see para.0043)**, wherein the transmitting comprises transmitting the timing message to the wireless terminal (**see para.0031, which discusses base station transmits timing advance message to the mobile terminal**).

Regarding claim 82, Damnjavonic'1426 discloses further comprising performing a random access procedure on at least one random access carrier (**see para.0031, which discusses performing random access channel on at least one carrier, see para.0035, 0043 & see para.0075**), wherein the at least one random access carrier (**see para.0031, which discusses performing random access**

channel on at least one carrier, see para.0035, 0043 & see para.0075) is assigned to the wireless terminal **(see fig.3, see para.0031).**

Regarding claim 83, Damnjavonic'142 discloses apparatus configured to facilitate a timing alignment in a multicarrier system, the apparatus comprising:

means for transmitting a downlink communication to a wireless terminal via at least one downlink carrier (**see fig.3, which shows base station transmits downlink communication to a mobile/terminal station via downlink carrier, see para.0033**);

means for assigning a timing offset (**see para.0031, which discusses the base station determine a timing advance as timing offset**) to an uplink group of carriers (**see para.0035, which discusses for all/each assigned uplink carrier UL, see fig.3**);

means for providing the timing offset to the wireless terminal (**see para.0031, which discusses the base station sends the timing advance to the mobile terminal statio**n) via the at least one downlink carrier (**see fig.3, see para.0033, which discusses DL anchor carrier may convey assignment of carriers**); and

means for receiving an uplink communication via the uplink group of carriers (**see fig.3, which shows receiving uplink communication vi a uplink group carriers, see para.0043**), wherein the uplink group of carriers are received (**see fig.3, which shows mobile terminal to received uplink carriers, see para.0028, 0031, mobile terminal to received one or more assigned uplink carriers transmitted by the base station, see para.0043)** according to the timing offset (**see para.0031 & see para.0035, which mobile to apply time advance or updates to all or for each group UL carrier**).

Regarding claim 84, Damnjavonic'142 discloses wherein the transmitting component is configured to transmit a downlink group of carriers from antennas located at a common site (**see fig.1 & see fig.7, which shows antennas for transmitting, see fig.3).**

Regarding claim 85, Damnjavonic'142 discloses wherein the code causes the at least one computer to assign a different timing offset for each of a plurality of uplink group of carriers (**see para.0035, which discusses by using separate timing advance updates for each UL carrier**).

Regarding claim 86, Damnjavonic'142 discloses further comprising a message processing component configured to decode a timing message received via a timing message carrier included in a messenger downlink group(**see**

para.0031, which discusses the mobile to decode timing advance by applying it), wherein the timing message is encoded with at least one inter-group uplink timing **(see para.0031, see para.0035, with at least one inter-group uplink timing, see fig.7, which shows encoder 710)** corresponding to a target downlink group(**see fig.3, see 0034, see fig.3, which shows downlink group target terminal, see fig.7**), and wherein the target downlink group **(see fig.3, see 0034, see fig.3, which shows downlink group target terminal, see fig.7)** is different than the messenger downlink group(**see para.0031, which discusses the mobile to decode timing advance by applying it**).

Regarding claim 88, Damnjavonic'1426 discloses further comprising performing a random access procedure on at least one random access carrier (**see para.0031, which discusses performing random access channel on at least one carrier, see para.0035, 0043 & see para.0075**), wherein the at least one random access carrier (**see para.0031, which discusses performing random access channel on at least one carrier, see para.0035, 0043 & see para.0075**) is assigned to the wireless terminal **(see fig.3, see para.0031).**

16. Claim 62-64 are rejected under 35 U.S.C. 103(a) as being unpatentable over Damnjavonic et al (US 2006/0280142) in view of Anh et al (US 2011/0235620).

Regarding claim 62, Damnjavonic'142 discloses wherein the received timing message **(see para.0031, which discusses timing advance, see para.0035**) and the uplink group of carriers are included in the uplink group subset (**see para.0031, which discusses the base station assigns one or more carriers for each uplink and sends the uplink carriers, timing advance and others to the mobile station see fig.3, see para.0066, see para.0071).**

As discussed above, although Damnjavonic'142 discloses base station sends the uplink carriers, timing advance and others to the mobile station (**see fig.3, see para.0031**), Damnjavonic'142 does not explicitly show the use of "indication of which" as required by present claimed invention. However, including "indication of which" would have been obvious to one having ordinary skill in the art as evidenced by Anh'620.

In particular, Anh'620 teaches the use of the timing message includes indication of which uplink group carriers (**see para.0063, see para.0069, which discuses the user equipment received the reference transmission timing information may be respective to a specific uplink link UL CC group or may be used only for identifying the transmission timing information to the UL CC group, see para.0071, see fig.12 of** Anh'620**).**

In view of the above, having the system of Damnjavonic'142 and then given the well-established teaching of Anh'620, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the system of Damnjavonic'142 as taught by Anh'620, since Anh'620 stated in para.0003 that such a modification would provide an apparatus for efficiently controlling power that is used for transmitting control information.

Regarding claim 63, Anh'620 discloses wherein the message processing component is configured to decode the indication according to a mapping of group identities shared with a network (**see para.0070, which discusses decode by having the user equipment may use the reference transmission timing received so as to identify or verify multiple transmission information indicating mapping UL CC group**, see fig.1) .

Regarding claim 64, Anh'620 discloses wherein the mapping of group identities is configured in association with an assignment of dedicated radio resources on uplink carriers within at least one uplink group of the uplink group subset (**see fig.5, see fig.12, see para.0063-0064, which discusses dedicated bandwidth resources on uplink carriers**).

17. Claims 71, 81 and 87 are rejected under 35 U.S.C. 103(a) as being unpatentable over Damnjavonic et al (US 2006/0280142) in view of Chuang et al (US 5,363,375).

Regarding claim 71, Damnjavonic'142 discloses wherein the transmitting component is configured to identify a set of carriers respectively corresponding to a plurality of downlink timings (**see fig.3, see para.0035-0043**).

As discussed above, although Damnjavonic'142 discloses separate time advance updates (**para.0035-0043**), Damnjavonic'142 does not explicitly show the use of "facilitate an averaging of the plurality of downlink timings performed" as required by present claimed invention. However, including "facilitate an averaging of the plurality of downlink timings performed" would have been obvious to one having ordinary skill in the art as evidenced by Chuang'375.

In particular, Chuang'375 teaches the use of facilitate an averaging of the plurality of downlink timings performed (**see fig.2B, see col.15, lines 63-col.16, lines 1-67, which discusses facilitate average timing difference from the timing from only those downlinks).**

In view of the above, having the system of Damnjavonic'142 and then given the well-established teaching of Chuang'375, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the

system of Damnjavonic'142 as taught by Chuang'375, since Anh'620 stated in col.6, lines that such a modification would provide an apparatus that utilizes small lightweight and relatively inexpensive portable transceivers while eliminating or at least reduces the drawback associated with existing technology.

Regarding claim 81, Damnjavonic'142 discloses wherein the transmitting component is configured to identify a set of carriers respectively corresponding to a plurality of downlink timings (**see fig.3, see para.0035-0043**).

As discussed above, although Damnjavonic'142 discloses separate time advance updates (**para.0035-0043**), Damnjavonic'142 does not explicitly show the use of "facilitate an averaging of the plurality of downlink timings performed" as required by present claimed invention. However, including "facilitate an averaging of the plurality of downlink timings performed" would have been obvious to one having ordinary skill in the art as evidenced by Chuang'375.

In particular, Chuang'375 teaches the use of facilitate an averaging of the plurality of downlink timings performed (**see fig.2B, see col.15, lines 63-col.16, lines 1-67, which discusses facilitate average timing difference from the timing from only those downlinks).**

In view of the above, having the system of Damnjavonic'142 and then given the well-established teaching of Chuang'375, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the system of Damnjavonic'142 as taught by Chuang'375, since Anh'620 stated in col.6, lines that such a modification would provide an apparatus that utilizes small lightweight and relatively inexpensive portable transceivers while eliminating or at least reduces the drawback associated with existing technology.

Regarding claim 87, Damnjavonic'142 discloses wherein the transmitting component is configured to identify a set of carriers respectively corresponding to a plurality of downlink timings (**see fig.3, see para.0035-0043**).

As discussed above, although Damnjavonic'142 discloses separate time advance updates (**para.0035-0043**), Damnjavonic'142 does not explicitly show the use of "facilitate an averaging of the plurality of downlink timings performed" as required by present claimed invention. However, including "facilitate an averaging of the plurality of downlink timings performed" would have been obvious to one having ordinary skill in the art as evidenced by Chuang'375.

In particular, Chuang'375 teaches the use of facilitate an averaging of the plurality of downlink timings performed (**see fig.2B, see col.15, lines 63-col.16,**

lines 1-67, which discusses facilitate average timing difference from the timing from only those downlinks).

In view of the above, having the system of Damnjavonic'142 and then given the well-established teaching of Chuang'375, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the system of Damnjavonic'142 as taught by Chuang'375, since Anh'620 stated in col.6, lines that such a modification would provide an apparatus that utilizes small lightweight and relatively inexpensive portable transceivers while eliminating or at least reduces the drawback associated with existing technology.

Conclusion

18. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Following prior arts are related to the present claimed invention: Laroai et al (6, 967, 936) teaches uplink symbol clock based on timing offset measurement and downlink timing (see col.7, lines 39-67) and Asokan et al (US 6,633,559) teaches transmitting a first and second timing information (see fig.6-16 with related text).

19. Any inquiry concerning this communication or earlier communications from the examiner should be directed to VINNCELAS LOUIS whose telephone number is (571)270-5138. The examiner can normally be reached on M-F from 7:30-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Thier can be reached on 571-272-2832. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/MICHAEL T THIER/ Supervisory Patent Examiner, Art Unit 2474	/VINNCELAS LOUIS/ Examiner, Art Unit 2474 Monday, April 01, 2013

Notice of References Cited	Application/Control No. 12/818,064	Applicant(s)/Patent Under Reexamination TENNY ET AL.	
	Examiner VINNCELAS LOUIS	Art Unit 2474	Page 1 of 2

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2011/0235620	09-2011	Ahn et al.	370/336
*	B	US-6,967,936	11-2005	Laroia et al.	370/329
*	C	US-2006/0280142	12-2006	Damnjanovic et al.	370/329
*	D	US-2004/0266445	12-2004	Burgess et al.	455/450
*	E	US-2008/0037487	02-2008	Li et al.	370/338
*	F	US-6,545,996	04-2003	Falco et al.	370/347
*	G	US-7,688,785	03-2010	Bachmann et al.	370/331
*	H	US-2010/0142457	06-2010	Chun et al.	370/329
*	I	US-6,363,375	03-2002	Hoshino et al.	1/1
*	J	US-8,400,935	03-2013	Pelletier et al.	370/252
*	K	US-2009/0228598	09-2009	Stamoulis et al.	709/230
*	L	US-2011/0075629	03-2011	Seo et al.	370/330
*	M	US-6,633,559	10-2003	Asokan et al.	370/350

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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
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U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2006/0274712	12-2006	Malladi et al.	370/345
*	B	US-2011/0286411	11-2011	Kim et al.	370/329
*	C	US-2012/0002617	01-2012	Vujcic, Dragan	370/329
	D	US-			
	E	US-			
	F	US-			
	G	US-			
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CONFIRMATION NO. 6903

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
12/818,064	06/17/2010 RULE	370	2474	092546

APPLICANTS

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Ravi Palanki, San Diego, CA;
Rajat Prakash, La Jolla, CA;

**** CONTINUING DATA ***************************

This appln claims benefit of 61/218,769 06/19/2009
and claims benefit of 61/294,053 01/11/2010
and claims benefit of 61/305,014 02/16/2010

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****

07/06/2010

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /VINCELAS LOUIS/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		CA	14	88	8

ADDRESS

QUALCOMM INCORPORATED
5775 MOREHOUSE DR.
SAN DIEGO, CA 92121
UNITED STATES

TITLE

METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM

FILING FEE RECEIVED		
5856	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12818064	TENNY ET AL.
	Examiner	Art Unit
	VINCELAS LOUIS	2474

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	04/01/2013								
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CLAIM		DATE								
Final	Original	04/01/2013								
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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
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	Examiner	Art Unit
	VINCELAS LOUIS	2474

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	04/01/2013								
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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12818064	TENNY ET AL.
	Examiner	Art Unit
	VINCELAS LOUIS	2474

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
370	252, 329-338, 345, 347, 350	4/1/2013	Vinncelas Louis
709	230	4/1/2013	Vinncelas Louis
455	450	4/1/2013	Vinncelas Louis

SEARCH NOTES		
Search Notes	Date	Examiner
East search history including text limited search along with class/subclass as listed above	4/1/2013	Vinncelas Louis
Consulted with Mered Habte	4/1/2013	Vinncelas Louis
East inventors search	4/1/2013	Vinncelas Louis
Consulted with Frank Duong	4/3/2013	Vinncelas Louis
Consulted with Hoon J. Chung	4/1/2013	Vinncelas Louis

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

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(Use as many sheets as necessary)

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Complete if Known

Application Number	12/818,064
Filing Date	2010-06-17
First Named Inventor	TENNY; Nathan Edward
Art Unit	2472
Examiner Name	KIZOU; Hassan
Attorney Docket No:	092546

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Examiner Initials*	Cite No.[1]	Document Number: Number-Kind Code[2](if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

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Examiner Initials*	Cite No.[1]	Foreign Patent Document: Country Code[3]-Number[4]-Kind Code[5](if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T2
	001	E-MAIL RAPPORTEUR (NTT DOCOMO ET AL: "CA , support for multi-TA" 3GPP DRAFT; R2-101567, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol . RAN WG2, no. San Francisco, USA; 20100222, 18 February 2010 (2010-02-18), XP050421923 [retrieved on 2010-02-18] paragraphs [0001] - [02.2].	☐
	002	ERICSSON ET AL: "Multiple Timing Advance , for Carrier Aggregation" 3GPP DRAFT; R2-101196 - MULTIPLE TA FOR CA, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol . RAN WG2, no. San Francisco, USA; 20100222, 16 February 2010 (2010-02-16), XP050421769 [retrieved on 2010-02-16] paragraphs [0001] - [02.2].	☐
	003	ERICSSON: "Reference for Timing Advance" 3GPP DRAFT; R2-103106 REFERENCE FOR TIMNIG ADVANCE, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol . RAN WG2, no. Montreal, Canada; 20100510, 3 May 2010 (2010-05-03), XP050423092 [retrieved on 2010-05-03] paragraphs [0001] - [0003].	☐
	004	International Search Report and Written Opinion -PCT/U S2010/039372, International Search Authority - European Patent Office - 10-04-2010 (092546).	☐

EXAMINER SIGNATURE /Vinncelas Louis/ (04/03/2013) **DATE CONSIDERED** 04/03/2013

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PTO/SB/08a (07-09)
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet	2	of	3

Complete if Known

Application Number	12/818,064
Filing Date	2010-06-17
First Named Inventor	TENNY; Nathan Edward
Art Unit	2472
Examiner Name	KIZOU; Hassan
Attorney Docket No:	092546

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	**Cite No.**	**Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.**	**T2**
	005	RAN2: "LS on RAN2 status on carrier aggregation design" 3GPP DRAFT; R2-093599, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, no. San Francisco, USA; 20090509, 9 May 2009 (2009-05-09), XP050341057 [retrieved on 2009-05-09] paragraph [0001].	☐

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(Use as many sheets as necessary)

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Complete if Known

Application Number	12/818,064
Filing Date	2010-06-17
First Named Inventor	TENNY; Nathan Edward
Art Unit	2472
Examiner Name	KIZOU; Hassan
Attorney Docket No:	092546

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/John J. Ketchum/	Date (YYYY-MM-DD)	2011-12-16
Name/Print	John J. Ketchum	Registration Number	61932

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SENDFEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

/Vinncelas Louis/ (04/03/2013)

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	12411	370/252.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 20:10
L2	39948	370/329-338.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 20:11
L3	2488	370/347.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 20:11
L4	2850	370/350.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 20:11
L5	5184	709/230.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 20:12
L6	5882	455/450.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 20:12
L7	36	(l1 l2 l3 l4 l5 l6) and (uplink$3 revers$3) same (downlink$3 forward$3) with (timing$3) same (carriers$3) same (timing$3 clock$3 time$3) and (timing$3 clock$3 time$3) near3 (advance$3 offset$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 20:14
L8	3	"20060274712"	US-PGPUB;	OR	OFF	2013/04/01

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			20:21
L16	139	((NATHAN) near2 (TENNY)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:48
L17	4	6 AND (uplink$3 revers$3) same (downlink$3 forward$3) with (timing$3) same (carriers$3) same (timing$3 clock$3 time$3) and (timing$3 clock$3 time$3) near3 (advance$3 offset$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:49
L18	232	((PARAG) near2 (AGASHE)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:50
L19	1	((PARAG) near2 (AGASHE)).INV. AND (uplink$3 revers$3) same (downlink$3 forward$3) with (timing$3) same (carriers$3) same (timing$3 clock$3 time$3) and (timing$3 clock$3 time$3) near3 (advance$3 offset$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:51
L20	365	((PETER) near2 (GAAL)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:51
L21	4	((PETER) near2 (GAAL)).INV. AND (uplink$3 revers$3) same (downlink$3 forward$3) with (timing$3) same (carriers$3) same (timing$3 clock$3 time$3) and (timing$3 clock$3 time$3) near3 (advance$3 offset$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:51
L22	218	((TINGFANG) near2 (JI)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:53
L23	1	((TINGFANG) near2 (JI)).INV. AND (uplink$3 revers$3) same (downlink$3 forward$3) with (timing$3) same (carriers$3) same (timing$3 clock$3 time$3) and (timing$3 clock$3 time$3) near3 (advance$3 offset$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:53
L24	242	((RAVI) near2 (PALANKI)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:53
L25	1	((RAVI) near2 (PALANKI)).INV. AND (uplink$3 revers$3) same (downlink$3 forward$3) with (timing$3) same (carriers$3) same (timing$3 clock$3 time$3) and (timing$3 clock$3 time$3) near3 (advance$3 offset$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:53
L26	232	((RAJAT) near2 (PRAKASH)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:54
L27	2	((RAJAT) near2 (PRAKASH)).INV. AND (uplink$3 revers$3) same (downlink$3 forward$3) with (timing$3) same (carriers$3) same (timing$3 clock$3 time$3) and (timing$3 clock$3 time$3) near3 (advance$3 offset$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:54

L28	1	"20110158116"	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 21:07
S1	1965	(timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3) with (downlink$3 forward$3) same (uplink$3 revers$3) same (carrier$3 provider$3 company$3 circuits$3 bearer$3) same (offset$3 adjust$3 compensat$3 recoup$3 counteract$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/19 12:25
S2	517	(transmi$3 send$3 convey$3 communicat$3 transfer$3 broadcast$3) with(carrier$3 provider$3 company$3 circuits$3 bearer$3)same (group$3 cluster$3 aggregat$3 bundl$3 combin$3) same (thrshold$3 border$3 boundary$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/19 12:32
S3	5	S1 and S2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/19 12:33
S4	44275	(transmi$3 send$3 convey$3 communicat$3 transfer$3 broadcast$3) with((carrier$3 provider$3 company$3 circuits$3 bearer$3)same (group$3 cluster$3 aggregat$3 bundl$3 combin$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/19 12:36
S5	129	S1 and S4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/19 12:37
S6	126	S5 not S3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/19 12:37
S7	9	"1466285"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/19 21:54
S8	1	"1466285" and timing$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/19 21:55
S9	1246	(timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)	US-PGPUB; USPAT;	OR	OFF	2013/03/19 22:13

		same (uplink$3 revers$3) with(offset$3 adjust$3 compensat$3 recoup$3 counteract$3) same ((downlink$3 forward$3) same (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) same (carrier$3 provider$3 company$3 circuits$3 bearer$3)	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S10	172	(timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3) near10 (uplink$3 revers$3) near10 (offset$3 adjust$3 compensat$3 recoup$3 counteract$3) near10 ((downlink$3 forward$3) snear10 (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) near10 (carrier$3 provider$3 company$3 circuits$3 bearer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/19 22:14
S11	76	(timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3) near5 (uplink$3 revers$3) near5 (offset$3 adjust$3 compensat$3 recoup$3 counteract$3) near5 ((downlink$3 forward$3) snear5 (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) near5 (carrier$3 provider$3 company$3 circuits$3 bearer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/19 22:15
S12	25	("20070189205" | "20090239545" | "20100067470" | "20100227569" | "20100238872" | "20110158116" | "20110261776" | "20110268032" | "20110299489" | "20120008600" | "20120063425" | "20120076103" | "20120113914" | "20120113941" | "20120113962" | "20120170570" | "20120178482" | "20120218987" | "20120218988" | "20120243498" | "20120250520" | "20120257513" | "20120287865" | "20120300743" | "20120307811").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/03/19 22:24
S13	8	(uplink$3 revers$3) near20 (based$3 depend$3 according$3 rely$4) near10 (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3) near10 (downlink$3 forward$3) near10 (offset$3 adjust$3 compensat$3 recoup$3 counteract$3) near10 (carrier$3 provider$3 company$3 circuits$3 bearer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/20 23:51
S14	424	(uplink$3 revers$3) with (based$3 depend$3 according$3 rely$4) same (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3) same (downlink$3 forward$3) same (offset$3 adjust$3 compensat$3 recoup$3 counteract$3)same (carrier$3 provider$3 company$3 circuits$3 bearer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/20 23:54
S15	1286	((uplink$3 revers$3) same (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) with	US-PGPUB; USPAT; USOCR;	OR	OFF	2013/03/20 23:56

		(downlink$3 forward$3) same (offset$3 adjust$3 compensat$3 recoup$3 counteract$3)same (carrier$3 provider$3 company$3 circuits$3 bearer$3)	FPRS; EPO; JPO; DERWENT; IBM_TDB			
S16	1075	((uplink$3 revers$3) same (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) with ((downlink$3 forward$3) same (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) same (offset$3 adjust$3 compensat$3 recoup$3 counteract$3)same (carrier$3 provider$3 company$3 circuits$3 bearer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/20 23:56
S17	194	((uplink$3 revers$3) near3 (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) with ((downlink$3 forward$3) near3 (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) same (offset$3 adjust$3 compensat$3 recoup$3 counteract$3)same (carrier$3 provider$3 company$3 circuits$3 bearer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/20 23:57
S18	9	((uplink$3 revers$3) near3 (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) with ((downlink$3 forward$3) near3 (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) same (offset$3 adjust$3 compensat$3 recoup$3 counteract$3)same (carrier$3 provider$3 company$3 circuits$3 bearer$3) same threshold$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/20 23:58
S19	66	((uplink$3 revers$3) near3 (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) with ((downlink$3 forward$3) near3 (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) same (offset$3 adjust$3 compensat$3 recoup$3 counteract$3)same (carrier$3 provider$3 company$3 circuits$3 bearer$3) and threshold$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/21 00:00
S20	57	S19 not S18	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/21 00:01
S21	482	(uplink$3 revers$3) with(timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3) same (downlink$3 forward$3) same (offset$3)same (carrier$3 provider$3 company$3 circuits$3 bearer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 00:40
S22	399	(uplink$3 revers$3) with(timing$3 time$3) same (downlink$3 forward$3) same (offset$3)same (carrier$3 provider$3 company$3 circuits$3	US-PGPUB; USPAT; USOCR; FPRS;	OR	OFF	2013/03/24 00:41

		bearer$3)	EPO; JPO; DERWENT; IBM_TDB			
S23	346	((uplink$3 revers$3) same(timing$3 time$3))with (downlink$3 forward$3) same (offset$3)same (carrier$3 provider$3 company$3 circuits$3 bearer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 00:41
S24	207	((uplink$3 revers$3) same(timing$3 time$3))with (downlink$3) same (offset$3)same (carrier$3 provider$3 company$3 circuits$3 bearer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 00:42
S25	189	((uplink$3 revers$3) same(timing$3 time$3))with (downlink$3)same (offset$3)same (carrier$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 00:42
S26	340	((uplink$3 revers$3) same(timing$3 time$3))with (downlink$3)same (offset$3 correction$3 adjust$3)same (carrier$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 01:15
S27	178	S26 and (random$3 same access)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 01:16
S28	64	S27 not S25	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 01:17
S29	143	S26 and (random$3 same access same channel$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 01:18
S30	49	S29 not S25	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 01:19
S31	1141	(uplink$3 revers$3) with(timing$3 same offset$3)	US-PGPUB; USPAT;	OR	OFF	2013/03/24 11:36

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S32	237	(uplink$3 revers$3) with (based$3 depend$3 according$3 relate$3) same (timing$3 same offset$3) same (downlink$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 11:36
S33	84	(uplink$3 revers$3) with (based$3 depend$3 according$3 relate$3) same (timing$3 same offset$3) same (downlink$3) and timing$3 same advance$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 11:38
S34	66	(uplink$3 revers$3) with (based$3 depend$3 according$3 relate$3) same (timing$3 same offset$3) same (downlink$3) and timing$3 near3 advance$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 11:38
S35	29	(uplink$3 revers$3) near10 (add$3 sum$3 calculat$3 accumulat$4 count$3 enumerat$3 total$3) near10 (tim$3 near3 offset$3) near10 (downlink$3 forward$2)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 12:22
S36	2	"6967936".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 12:26
S37	11	("5430760" | "5726981" | "5883888" | "5909436" | "6144656" | "6181947" | "6223040" | "6449290" | "6477151" | "6493539" | "6496490").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/03/24 12:29
S38	48	("5430760" | "5726981" | "5883888" | "5909436" | "6144656" | "6181947" | "6223040" | "6449290" | "6477151" | "6493539" | "6496490").PN. OR ("6967936").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/03/24 12:30
S39	19	("5430760" | "5726981" | "5883888" | "5909436" | "6144656" | "6181947" | "6223040" | "6449290" | "6477151" | "6493539" | "6496490").PN. OR ("6967936").URPN. and (tim$3 near3 offset$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/03/24 12:31
S40	15	("5430760" | "5726981" | "5883888" | "5909436" | "6144656" | "6181947" | "6223040" | "6449290" | "6477151" | "6493539" | "6496490").PN. OR ("6967936").URPN. and (tim$3 near3 offset$3) near10 (uplink$3 forward$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/03/24 12:32

S41	15	("5430760" | "5726981" | "5883888" | "5909436" | "6144656" | "6181947" | "6223040" | "6449290" | "6477151" | "6493539" | "6496490").PN. OR ("6967936").URPN. and (tim$3 near3 offset$3) near10 (uplink$3 reverse$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/03/24 12:33
S42	96	(send$3 transmi$3 communicat$3 transfer$3 convey$3) with (carriers$3) same (uplink$3 revers$3) same (threshold$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 14:18
S43	46	S42 and (random$3 near3 access$3 RACH$2)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 14:23
S44	13	(threshold$3) with (send$3 transmi$3 communicat$3 transfer$3 convey$3) same (carriers$3 providers$3) same (uplink$3 revers$3) and (random$3 near3 access$3 near3 channel$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 14:37
S45	11	(threshold$3 same value$3) with (send$3 transmi$3 communicat$3 transfer$3 convey$3) same (carriers$3 providers$3) same (uplink$3 revers$3) and (random$3 near3 access$3 near3 channel$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 14:38
S46	10	(RACH$3 same random$3 same access$3) with (carrier$3) same (downlink$3 forward$3) same (dedicat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 19:41
S47	1	"12818064".rlan. or ("12".src. and "818064".ap.)	US-PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2013/03/24 19:46
S48	348	(timing$3 interval$3 duration$3 time$3) with (uplink$3 reverse$3) same (threshold$3) same carrier$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 19:49
S49	122	(timing$3 interval$3 duration$3 time$3) with (uplink$3 reverse$3) same (threshold$3) same carriers$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 19:50
S50	53	(timing$3 interval$3 duration$3 time$3) with (uplink$3 reverse$3) same	US-PGPUB; USPAT;	OR	OFF	2013/03/24 19:51

		(threshold$3) same carriers$4 same (transm$3 send$3 communicat$3 transfer$3 convey$3 transport$3 carry$3)	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S51	30	(transm$3 send$3 communicat$3 transfer$3 convey$3 transport$3 carry$3) with ((timing$3 interval$3 duration$3 time$3 TT1) same (threshold$3)) same carriers$4 same (uplink$3 reverse$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 20:33
S52	20	carriers$4 near10 (uplink$3 reverse$3) and (transm$3 send$3 communicat$3 transfer$3 convey$3 transport$3 carry$3) near10 ((timing$3 interval$3 duration$3 time$3 TT1) near3 (threshold$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 20:39
S53	526	carrier$4 with(uplink$3 reverse$3) and (transm$3 send$3 communicat$3 transfer$3 convey$3 transport$3 carry$3) with ((timing$3 interval$3 duration$3 time$3 TT1) same (threshold$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 20:47
S54	172	carriers$4 with(uplink$3 reverse$3) and (transm$3 send$3 communicat$3 transfer$3 convey$3 transport$3 carry$3) with ((timing$3 interval$3 duration$3 time$3 TT1) same (threshold$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 20:47
S55	9	S54 and (random$3 same access$3 same rach$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 20:49
S56	86	(transm$3 send$3 communicat$3 transfer$3 convey$3 transport$3 carry$3) with (threshold$3) same(carriers$4 same (uplink$3 reverse$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 20:52
S57	18	(uplink$3 revers$3) near3 (timing$3) near10 (carriers$3) near10(transm$3 send$3 communicat$3 transfer$3 convey$3 transport$3 carry$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 21:20
S58	135	(downlink$3) near3 timing$3 near10 carrier$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 21:21

S59	7	S57 and S58	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 21:21
S60	164	(downlink$3 forward$3) near3 timing$3 near10 carrier$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 21:27
S61	193	(uplink$3 revers$3) with (timing$3) same (carriers$3) same(transm$3 send$3 communicat$3 transfer$3 convey$3 transport$3 carry$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 21:28
S62	32	S60 and S61	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 21:28
S63	25	S62 not S59	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 21:28
S64	64	(uplink$3 revers$3) same (downlink$3 forward$3) with (timing$3) same (carriers$3) same(transm$3 send$3 communicat$3 transfer$3 convey$3 transport$3 carry$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 21:48
S65	18	(uplink$3 revers$3) same (downlink$3 forward$3) with (timing$3) same (carriers$3) same(transm$3 send$3 communicat$3 transfer$3 convey$3 transport$3 carry$3) same group$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 21:49
S66	46	S64 not S65	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 21:50
S67	518	(timing$3 near advance$3) and timing$2 near offset$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2013/03/24 23:00

			DERWENT; IBM_TDB			
S68	248	(timing$3 near advance$3) and timing$2 near offset$3 and (uplink$3) with downlink$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 23:00
S69	3	"20060280142"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 23:59
S70	16	(random$3 same access$3 same carrier$3) with (usage$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 00:23
S71	3	(random$3 same access$3) with carrier$3 same (usage$3) same (QOS$3 signal$3 same quality$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 00:27
S72	9	(random$3 same access$3) with carrier$3 same (usage$3 threshold$3 utilization$3) same (QOS$3 signal$3 same quality$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 00:31
S73	54	((single$3 alone$3 distinct$3 anchor$2 individual$3 loner$3 "one") same carrier$3) with (usage$3 utilization$3) same (QOS$3 signal$3 same quality$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 00:35
S74	224	((single$3 alone$3 distinct$3 anchor$2 individual$3 loner$3 "one") same carrier$3) with (usage$3 utilization$3) same (downlink$3 forward$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 00:46
S75	63	((single$3 alone$3 distinct$3 anchor$2 individual$3 loner$3 "one") same carrier$3) with (usage$3 utilization$3) same (downlink$3 forward$3) same (reverse$3 uplink$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 00:47
S76	133	(uplink$3 revers$3) near3(timing$3) and (downlink$3 forward$3) near3 timing$3 and timing$3 near3 advance$3 and	US-PGPUB; USPAT; USOCR;	OR	OFF	2013/03/25 07:10

		carriers$3	FPRS; EPO; JPO; DERWENT; IBM_TDB			
S77	191	(uplink$3 revers$3) near3(timing$3) and (downlink$3 forward$3) near3 timing$3 and (time$3 timing$3) near3 offset$3 and carriers$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 07:16
S78	147	(uplink$3 revers$3) near3(timing$3) and (downlink$3 forward$3) near3 timing$3 and (timing$3) near3 offset$3 and carriers$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 07:16
S79	56	(downlink$3 forward$3) near3 timing$3 and ((timing$3 time$3) near3 offset$3) near10 ((uplink$3 revers$3) near3(timing$3))and carriers$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 07:17
S80	31	((uplink$3 revers$3) near3(timing$3)) near10((timing$3 time$3) near3 (offset$3 advance$3)) near10 ((downlink$3 forward$3) near3 timing$3)and carriers$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 07:28
S81	481	(uplink$3 revers$3) with (determin$3 calculat$3 comput$3 add$3 sum$3 total$3 depend$2 according$3 based$2) same((timing$3 time$3) same (offset$3 advance$3)) same (downlink$3 forward$3)and carriers$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 07:34
S82	60	(uplink$3 revers$3) with (determin$3 calculat$3 comput$3 add$3 sum$3 total$3 depend$2 according$3 based$2) same((timing$3 time$3) same (offset$3 advance$3)) same (downlink$3 forward$3)and carriers$3 and (random$3 same access$3 same RACH$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 07:35
S83	36	((uplink$3 revers$3) same (time$3 timing$3)) with ((timing$3 time$3) same (offset$3 advance$3)) same (downlink$3 forward$3)same carrier$3 and (random$3 same access$3 same RACH$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 07:42
S84	6	(downlink$3 forward$3)with carriers$3 same (pseudorandom$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:07

S85	21	(downlink$3 forward$3)with carriers$3 same (pseudorandom$3 pseudo-random$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:07
S86	432	((downlink$3 forward$3)same carrier$3) same (pseudorandom$3 pseudo-random$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:16
S87	14	((downlink$3 forward$3)near10 carrier$3) near10 (pseudorandom$3 pseudo-random$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:17
S88	11	S87 not S85	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:17
S89	220	(downlink$3 forward$3)with (carrier$3)same (select$3 choos$3 pick$3 elect$3 cull$2 opt$2) and (pseudorandom$3 pseudo-random$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:23
S90	23	(downlink$3 forward$3)with (carrier$3)same (select$3 choos$3 pick$3 elect$3 cull$2 opt$2) same (pseudorandom$3 pseudo-random$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:24
S91	16	S90 not (S88 S85)\	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:24
S92	0	(downlink$3 forward$3)with (carrier$3)same (select$3 choos$3 pick$3 elect$3 cull$2 opt$2) and (pseudorandom$3 pseudo-random$3) near10 funtion$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:27
S93	0	(downlink$3 forward$3)same (carrier$3)same (select$3 choos$3 pick$3 elect$3 cull$2 opt$2) and (pseudorandom$3 pseudo-random$3) near10 funtion$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2013/03/25 12:27

			DERWENT; IBM_TDB			
S94	0	(downlink$3 forward$3)with(select$3 choos$3 pick$3 elect$3 cull$2 opt$2) and (pseudorandom$3 pseudo-random$3) near10 funtion$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:27
S95	0	(downlink$3 forward$3 carrier$3)with(select$3 choos$3 pick$3 elect$3 cull$2 opt$2) and (pseudorandom$3 pseudo-random$3) near10 funtion$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:27
S96	661	(downlink$3 forward$3 carrier$3)with(select$3 choos$3 pick$3 elect$3 cull$2 opt$2) and (pseudorandom$3 pseudo-random$3) near10 function$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:28
S97	13	(downlink$3 forward$3)with carrier$3 same (select$3 choos$3 pick$3 elect$3 cull$2 opt$2) and (pseudorandom$3 pseudo-random$3) near10 function$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:28
S98	3	(downlink$3 forward$3)with carrier$3 same (select$3 choos$3 pick$3 elect$3 cull$2 opt$2) same (hash$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:36
S99	680	(downlink$3 forward$3 carrier$3) with (select$3 choos$3 pick$3 elect$3 cull$2 opt$2) same (hash$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:36
S100	35	(carrier$3) with (select$3 choos$3 pick$3 elect$3 cull$2 opt$2) same (hash$3) and (downlink$3 forward$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:37
S101	3773	(pseudorandom$3 pseudo-random$3) with (carrier$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 05:26
S102	367	(pseudorandom$3 pseudo-random$3) same function$3 with (carrier$3)	US-PGPUB; USPAT; USOCR;	OR	OFF	2013/03/27 05:26

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S103	10	(pseudorandom$3 pseudo-random$3) same function$3 with (carrier$3) same downlink$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 05:26
S104	2	(pseudorandom$3 same function$3) with (carrier$3) and downlink$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 05:32
S105	37	(pseudorandom$3 same function$3) same (carrier$3) and (downlink$3 forward$3 near3 (link$2 channel$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 05:33
S106	0	(pseudorandom$3 same function$3) with (carrier$3 bearer$3 provider$3 company$3) same(downlink$3 forward$3 near3 (link$2 channel$3)) same (choos$3 pick$3 select$3 cull$2)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 05:41
S107	2	(pseudorandom$3) with (carrier$3 bearer$3 provider$3 company$3) same(downlink$3 forward$3 near3 (link$2 channel$3)) same (choos$3 pick$3 select$3 cull$2)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 05:41
S108	1	(carrier$3 bearer$3 provider$3 company$3) WITH(downlink$3 forward$3 SAME (link$2 channel$3)) SAME (pseudorandom$2 pseudo-random$3) same (hash$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 05:53
S109	146	(carrier$3 bearer$3 provider$3 company$3) WITH(downlink$3 forward$3 SAME (link$2 channel$3)) SAME (pseudorandom$2 pseudo-random$3) same (timing$3 clock$3 time$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 05:56
S110	14	(carrier$3 bearer$3 provider$3 company$3) WITH(downlink$3 forward$3 SAME (link$2 channel$3)) SAME (pseudorandom$2 pseudo-random$3) same (timing$3 clock$3 time$3)same (choos$3 pick$3 select$3 cull$2)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 05:57
S111	1663	(pseudorandom$2 pseudo-random$3)	US-PGPUB;	OR	OFF	2013/03/27

		with hash$3	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			06:14
S112	16	(pseudorandom$2 pseudo-random$3) with hash$3 and (downlink$3 forward$3 same (link$3 channel$3)) with (carrier$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 06:15
S113	0	(base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) with (hashing$3 hash$3) same (identifer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 07:36
S114	290	(base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) with (hashing$3 hash$3) same (identifer$3 name$3 SSId$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 07:38
S115	46	(base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) with (hashing$3 hash$3) same (identifer$3 SSId$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 07:40
S116	628	(hashing$3 hash$3) with(base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identifer$3 identif$3 SSId$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 07:48
S117	306	(hashing$3 hash$3) with(base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identifer$3 identif$3 SSId$3) same (includ$3 contain$3 compris$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 07:50
S118	45	(hashing$3) with(base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identifer$3 identif$3 SSId$3) same (includ$3 contain$3 compris$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 07:50
S119	45	S118 not S115	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2013/03/27 07:50

			IBM_TDB			
S120	9	(hashing$3) with(base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identifer$3 identif$3 SSId$3) same (includ$3 contain$3 compris$3) same (broadcast$3 transmit$3 send$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 07:53
S121	41	(hashing$3)same (table$3 database$3 queue$3 buffer$3) with((base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identifer$3 identif$3 SSId$3 name$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 07:56
S122	110	(hashing$3 hash$3) with(SSId$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 08:00
S123	1	"12818064".rlan. or ("12".src. and "818064".ap.)	US-PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2013/03/27 09:56
S124	2050	(identifier$3 identif$3 name$3 SSID$3) same (associat$3 correspond$3 match$3 join$2) same (network$3 base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (input$3 enter$3 download$3 comput$3 load$2) same (hashing$3 hash$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 10:04
S125	980	(identifier$3 identif$3 name$3 SSID$3) same (associat$3 correspond$3 match$3 join$2) same (network$3 base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (input$3 enter$3 download$3 comput$3 load$2) same ((hashing$3 hash$3) same (function$3 algorithm$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 10:05
S126	435	(identifier$3 identif$3 name$3 SSID$3) with (associat$3 correspond$3 match$3 join$2) same (network$3 base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (input$3 enter$3 download$3 comput$3 load$2) same ((hashing$3 hash$3) same (function$3 algorithm$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 10:05
S127	24	(identifier$3 identif$3 name$3 SSID$3) near10 (associat$3 correspond$3 match$3 join$2) near10 (network$3 base$3 nea3 station$3 access$3 near3 point$3 EnB$2 EnodeB$3) near10 (input$3 enter$3 download$3 comput$3 load$2) near10 ((hashing$3 hash$3) near5 (function$3 algorithm$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 10:08
S128	90	((hashing$3 hash$3) same (algorithm$3 function$3)) with (timing$3 time$3) same (downlink$3 forward$3 same (link$3 channel$3))	US-PGPUB; USPAT; USOCR; FPRS;	OR	OFF	2013/03/27 10:34

			EPO; JPO; DERWENT; IBM_TDB			
S129	1129	((hashing$3 hash$3) same (algorithm$3 function$3)) with(pseudorandom$3 pseudo-random$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 10:59
S130	3	((hashing$3 hash$3) same (algorithm$3 function$3)) with(pseudorandom$3 pseudo-random$3) same carrier$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 10:59
S131	1689	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3) with (network$3 same node$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:02
S132	725	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3) same (fucntion$3 table$3 database$3) with (network$3 same node$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:02
S133	1904	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3) same (fucntion$3 table$3 database$3) with (network$3 base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identif$3 name$3 SSID$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:04
S134	1339	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3) same (fucntion$3 table$3 database$3) with ((network$3 base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identif$3 name$3 SSID$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:06
S135	356	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3) same (fucntion$3 table$3 database$3) with ((base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identif$3 name$3 SSID$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:07
S136	50	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3) same (fucntion$3 table$3 database$3) with ((base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identif$3 name$3 SSID$3)) SAME (ENTER$3 INPUT$3 download$3 load$2)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:08
S137	38	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3) same (fucntion$3	US-PGPUB; USPAT;	OR	OFF	2013/03/27 11:16

		table$3 database$3) with ((network$3 base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identif$3 name$3 SSID$3)) same wireless$3	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S138	105	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3) same (function$3 table$3 database$3) with ((network$3 base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identif$3 name$3 SSID$3)) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:16
S139	74	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3 lookup$3 look-up$3) with (function$3 table$3 database$3 storag$3 memory$3 queue$3 buffer$3) same (network$3 base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identif$3 name$3 SSID$3) same (time$3 duration$3 timing$3 period$3 interval$3) same wireless$3 same (measur$3 estimat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:26
S140	12836	(function$3 table$3 database$3 storag$3 memory$3 queue$3 buffer$3) with(hashing$3 hash$3 pseudorandom$3 pseudo-random$3 lookup$3 look-up$3) same ((network$3 base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) SAME (identif$3 name$3 SSID$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:37
S141	385	(function$3 table$3 database$3 storag$3 memory$3 queue$3 buffer$3) with(hashing$3 hash$3 pseudorandom$3 pseudo-random$3 lookup$3 look-up$3) same ((time$3 duration$3 timing$3 period$3 interval$3) same (measur$3 estimat$3)) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:38
S142	82	S140 AND S141	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:39
S143	116	(function$3 table$3 database$3 storag$3 memory$3 queue$3 buffer$3) with(hashing$3 hash$3 pseudorandom$3 pseudo-random$3 lookup$3 look-up$3) same ((time$3 duration$3 timing$3 period$3 interval$3) same (measur$3 estimat$3) SAME VARI$4) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 12:07
S144	53	S140 AND S143	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 12:08
S145	4275	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3 lookup$3 look-up$3)	US-PGPUB; USPAT;	OR	OFF	2013/03/28 09:34

		with (function$3 table$3 database$3 storag$3 memory$3 queue$3 buffer$3) same (time$3 same vari$3)	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S146	99	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3 lookup$3 look-up$3) with (function$3 table$3 database$3 storag$3 memory$3 queue$3 buffer$3) same (time$3 same vari$3) SAME (ENTER$3 INPUT$3 download$3 load$2) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 09:36
S147	1	"12818064"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 10:27
S148	266	(uplink$3 revers$3) with (carrier$3) same (transm$3 send$3 communicat$3 transfer$3) same threshold$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 11:40
S149	122	(uplink$3 revers$3) with (carrier$3) same (transm$3 send$3 communicat$3 transfer$3) same threshold$3 same value$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 11:41
S150	46	(uplink$3 revers$3) with (carriers$3) same (transm$3 send$3 communicat$3 transfer$3) same threshold$3 same value$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 11:41
S151	464	(timing$3 interval$3 duration$3 time$3) with(uplink$3 revers$3) same (threshold$3 compar$3) same(carrier$3) same (transm$3 send$3 communicat$3 transfer$3 allocat$3 assign$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 11:53
S152	198	(timing$3 interval$3 duration$3 time$3) with(uplink$3 revers$3) same (threshold$3 compar$3) same(carriers$3) same (transm$3 send$3 communicat$3 transfer$3 allocat$3 assign$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 11:54
S153	173	S152 not S150	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 11:55

S154	11	(timing$3 interval$3 duration$3 time$3) with(uplink$3 revers$3) same (threshold$3 compar$3) same(carriers$3) same (transm$3 send$3 communicat$3 transfer$3 allocat$3 assign$3) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 11:56
S155	48750	(transm$3 send$3 communicat$3 transfer$3 allocat$3 assign$3) same (carriers$3) with((timing$3 interval$3 duration$3 time$3) same (threshold$3 compar$3)) samewith (uplink$3 revers$3) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 12:01
S156	19	(transm$3 send$3 communicat$3 transfer$3 allocat$3 assign$3) same (carriers$3) with((timing$3 interval$3 duration$3 time$3) same (threshold$3 compar$3 predetermin$3 pre-determin$3)) same (uplink$3 revers$3) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 12:02
S157	19	(transm$3 send$3 communicat$3 transfer$3 allocat$3 assign$3) same (carriers$3) with((timing$3 interval$3 duration$3 time$3 interval$3) same (threshold$3 compar$3 predetermin$3 pre-determin$3)) same (uplink$3 revers$3) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 12:19
S158	19	(transm$3 send$3 communicat$3 transfer$3 allocat$3 assign$3) same (carriers$3) with((timing$3 interval$3 duration$3 time$3 interval$3 period$3) same (threshold$3 compar$3 predetermin$3 pre-determin$3)) same (uplink$3 revers$3) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 12:28
S159	19	(transm$3 send$3 communicat$3 transfer$3 allocat$3 assign$3) same (carriers$3) with((timing$3 interval$3 duration$3 time$3 interval$3 period$3 window$3) same (threshold$3 compar$3 predetermin$3 pre-determin$3)) same (uplink$3 revers$3) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 13:02
S160	19	(transm$3 send$3 communicat$3 transfer$3 allocat$3 assign$3) same (carriers$3) with((timing$3 interval$3 duration$3 time$3 interval$3 period$3 window$3 space$3) same (threshold$3 compar$3 predetermin$3 pre-determin$3)) same (uplink$3 revers$3) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 13:03
S161	203	((uplink$3 revers$3) same(carriers$3)) with((timing$3 interval$3 duration$3 time$3 interval$3 period$3 window$3 space$3) same (threshold$3 compar$3 predetermin$3 pre-determin$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 13:04
S162	24	((uplink$3 revers$3) near5(carriers$3)) near20 ((timing$3 interval$3 duration$3 time$3 interval$3 period$3 window$3 space$3) near3 (threshold$3 compar$3	US-PGPUB; USPAT; USOCR; FPRS;	OR	OFF	2013/03/28 13:05

		predetermin$3 pre-determin$3))	EPO; JPO; DERWENT; IBM_TDB			
S163	15	((uplink$3 revers$3) same(carriers$3)) with((timing$3 interval$3 duration$3 time$3 interval$3 period$3 window$3 space$3) same (threshold$3 compar$3 predetermin$3 pre-determin$3)) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 13:07
S164	21	(uplink$3 revers$3) same(carriers$3) with((timing$3 interval$3 duration$3 time$3 interval$3) same (threshold$3 compar$3 predetermin$3 pre-determin$3)) same (wireless$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 13:17
S165	2	S164 not (S163 S162 S159)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 13:18
S166	57	((timing$3 interval$3 duration$3 time$3 interval$3 slot$3) same (threshold$3 compar$3 predetermin$3 pre-determin$3)) with (uplink$3 revers$3) same(carrier$3 provider$3 company$3) with (wireless$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 13:22
S167	59	((timing$3 interval$3 duration$3 time$3 interval$3 slot$3) same (threshold$3 compar$3 predetermin$3 pre-determin$3)) with (uplink$3 revers$3) same(carrier$3 T1$2 media$3 same circuit$3) with (wireless$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 13:27
S168	75	((uplink$3 revers$3) same(timing$3 interval$3 duration$3 time$3 interval$3 slot$3)) with (threshold$3 compar$3 predetermin$3 pre-determin$3) same(carrier$3) same (wireless$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 13:35
S169	71	((uplink$3 revers$3) same(timing$3 interval$3 duration$3 time$3 interval$3 slot$3)) with (threshold$3 compar$3 predetermin$3 pre-determin$3) same(carrier$3) same (wireless$3) same (transm$3 send$3 communicat$3 transfer$3 allocat$3 assign$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 13:39
S170	573	(random same access$3) with (uplink$2 same timing$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 20:13
S171	81	(random same access$3) with (uplink$2 same timing$3)same carrier$3	US-PGPUB; USPAT;	OR	OFF	2013/03/28 20:13

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S172	2544	(downlink$3 forward$3) with (timing$3 duration$3 interval$3 time$3 clock$3 counter$3) same (average$3 mean$3 median$3 middle$3) and (tim$3) near5 (offset$3 advance$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 20:33
S173	173	((downlink$3) same (timing$3 duration$3 interval$3 time$3 clock$3)) with (average$3 mean$3 median$3 middle$3) and (tim$3) near5 (offset$3 advance$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 20:34
S174	173	((downlink$3) same (timing$3 duration$3 interval$3 time$3 clock$3)) with (average$3 mean$3 median$3 middle$3) and (time$3 timing$3) near5 (offset$3 advance$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 20:35
S175	36	((downlink$3) same (timing$3 duration$3 interval$3 time$3 clock$3)) with (average$3 mean$3 median$3 middle$3) same ((time$3 timing$3) same (offset$3 advance$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 20:35
S176	26	((downlink$3) same (timing$3 duration$3 interval$3 time$3 clock$3)) with (average$3 mean$3 median$3 middle$3) same ((time$3 timing$3) same (offset$3 advance$3)) and carrier$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 20:37
S177	32	((downlink$3 forward$3 same (link$3 channel$3)) near5 (timing$3 duration$3 interval$3 time$3 clock$3)) near10 (average$3 mean$3 median$3 middle$3) and ((time$3 timing$3) near3 (offset$3 advance$3)) and carrier$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 20:44
S178	18	((time$3 timing$3) same (offset$3 advance$3)) with (indication$3) same (uplink$3 reverse$3) same carrier$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 22:56
S179	1	("2012/0113914").URPN.	USPAT	OR	OFF	2013/03/28 23:00
S180	238	((timing$3 time$3) same (offset$3 advance$3)) with (message$3 respon$3 reply$3 answer$3 acknowledgment$3 feedback$3 return$3 echo$3) same ((uplink$3 reverse$3) same carrier$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2013/03/29 09:04

			DERWENT; IBM_TDB			
S181	63	((timing$3 time$3) same (offset$3 advance$3)) with (message$3 respon$3 reply$3 answer$3 acknowledgment$3 feedback$3 return$3 echo$3) same ((uplink$3 reverse$3) same carrier$3) and LTE$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 09:07
S182	23	((timing$3 time$3) same (offset$3 advance$3)) with (message$3 respon$3 reply$3 answer$3 acknowledgment$3 feedback$3 return$3 echo$3) same ((uplink$3 reverse$3) same carrier$3) and random$3 near3 access$3 near10 RACH$2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 09:18
S183	77	((timing$3 time$3) same (offset$3 advance$3)) with (number$3 set$2 group$3 total$3 bunch$3 cluster$3 combin$3 category$3) same ((uplink$3 reverse$3) same carrier$3) and random$3 near3 access$3 near10 RACH$2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 09:30
S184	63	S183 not S182	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 09:31
S185	38	(timing$3 time$3) with (number$3 set$2 group$3 total$3 bunch$3 cluster$3 combin$3 category$3) same ((uplink$3 reverse$3) same carrier$3) same (align$3 synchroniz$3) and ((random$3 same access$3) same (RACH$2 procedur$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 09:45
S186	112	(timing$3 time$3) with (number$3 set$2 group$3 total$3 bunch$3 cluster$3 combin$3 category$3) same ((uplink$3 reverse$3) same carrier$3) same (align$3 synchroniz$3 adust$3 coordinat$3) and ((random$3 same access$3) same (RACH$2 procedur$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 09:45
S187	33	S185 not S184	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 09:46
S188	23	(timing$3 time$3) with (number$3 set$2 group$3 total$3 bunch$3 cluster$3 combin$3 category$3) same ((uplink$3 reverse$3) same carrier$3) same (align$3 synchroniz$3 adust$3 coordinat$3) and ((random$3 near3 access$3) near5 (RACH$2 procedur$3)) and (timing$3 time$3) near3 (offset$3 advance$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 09:51
S189	1	S188 not (S187 S185 S184 S182)	US-PGPUB;	OR	OFF	2013/03/29

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			09:52
S191	10	(number$3 set$2 group$3 total$3 bunch$3 cluster$3 combin$3 category$3) near5((uplink$3 reverse$3) near5 carrier$3) near10 (align$3 synchroniz$3 adust$3 coordinat$3) and (timing$3 time$3) near3 (offset$3 advance$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 09:53
S192	1	"13133315"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 10:48
S193	1	"12818064"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 10:48
S194	4427	((uplink$3 reverse$3) with(number$3 set$2 group$3 total$3 bunch$3 cluster$3 combin$3 category$3) same carrier$3)same (timing$3 time$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 12:55
S195	542	S194 and (timing$3 time$3) near3 (offset$3 advance$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 12:56
S196	191	S195 and LTE$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 12:57
S197	254	((uplink$3 reverse$3) with(number$3 set$2 group$3 total$3 bunch$3 cluster$3 combin$3 category$3) same carrier$3)same (SUBSET$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 13:25
S198	56	S197 and (timing$3 time$3) near3 (offset$3 advance$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2013/03/29 13:26

			IBM_TDB			
S199	30	S198 and lte$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 13:26
S200	382	(uplink$3 reverse$3) with (carrier$3)same (SUBSET$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 13:32
S202	76	S200 and (timing$3 time$3) near3 (offset$3 advance$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 13:32
S203	41	S202 and lte$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 13:32
S204	15	S203 not S199	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 13:33
S205	51379	(carrier$3) with (dedicated$3 same resource$3 configuration$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 21:59
S206	2450	(single$3 same carrier$3) with (dedicated$3 same resource$3 configuration$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 21:59
S207	1	(single$3 near3 carrier$3) near10 (dedicated$3 near3 resource$3 near3 configuration$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 22:00
S208	16	(single$3 near3 carrier$3) near10 (dedicated$3 near3 resource$3)	US-PGPUB; USPAT; USOCR; FPRS;	OR	OFF	2013/03/29 22:01

			EPO; JPO; DERWENT; IBM_TDB			
S209	75	(uplink$3 revers$3) with(carrier$3) same (dedicated$3 same radio$3 same resource$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 22:53
S210	7	(uplink$3 revers$3) with(carrier$3) same (dedicated$3 same radio$3 same resource$3)same group$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 22:53
S211	149	(uplink$3 revers$3) with(carrier$3) same (dedicated$3) same (radio$3 same resource$3 RR$2 bandwidth$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 23:06
S212	111	(uplink$3 revers$3) with(carrier$3) same (dedicated$3) same (radio$3 same resource$3 RR$2 bandwidth$3) and LTE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 23:08
S213	6594	(carrier$3) near3 aggregat$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 05:54
S214	461	(carrier$3) near3 aggregat$4 and (timing$3 time$3) near3 (offset$3 advance$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 05:54
S215	355	S214 and (uplink$3 revers$3) with(downlink$3 forward$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 05:55
S216	33	(carrier$3) near3 aggregat$4 and (timing$3 time$3) near3 (offset$3 advance$3) near10 (uplink$3 revers$3) near10(downlink$3 forward$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 05:56
S217	96	S214 and (group$3 subset$3 cluster$3) with (uplink$3 revers$3)	US-PGPUB; USPAT;	OR	OFF	2013/04/01 06:01

		same(downlink$3 forward$3)	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S218	86	S217 not S216	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 06:02
S219	187	(carrier$3) near3 (aggregat$4 gather$3 assembl$3 accumulat$3 amass$3) and (timing$3 time$3) near3 (offset$3 advance$3) and (random$3 near3 access$3) near5 (RACH$3 procedure$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 06:25
S220	176	S219 and (uplink$3 revers$3) with(downlink$3 forward$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 06:26
S221	113	S220 not (S216 S217 S218)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 06:26
S222	383	(carrier$3) near3 (aggregat$4 gather$3 assembl$3 accumulat$3 amass$3) near10 (threshold$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 06:43
S223	15	(carrier$3) near3 (aggregat$4 gather$3 assembl$3 accumulat$3 amass$3) near10 (threshold$3) near10 (transm$3 send$3 transf$3 communicat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 06:44
S224	17	((downlink$3 forward$3) near10(average$3 mean$3 middl$3)) near20 ((time$3 timing$3) near3 (offset$3 advance$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 07:30
S225	15444	(downlink$3 forward$3)same (timing$3 time$3) with(average$3 mean$3 middl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 10:12

S226	782	(downlink$3 forward$3)same (timing$3 time$3) with(average$3 mean$3 middl$3) same carrier$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 10:12
S227	211	(downlink$3 forward$3)same (timing$3 time$3) with(average$3 mean$3 middl$3) same carriers$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 10:12
S228	35	S227 and LTE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 10:13
S229	161	(downlink$3 forward$3)same (timing$3 time$3) with(midpoint$3 median$3 standard$3 medium$3) same carriers$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 10:27
S230	25	S229 and LTE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 10:28
S231	48	(timing$3 time$3) with(midpoint$3 median$3 standard$3 medium$3 average$3 mean$3) same carriers$3 same (downlink$3) and LTE$2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 12:20
S232	2	"5363375".PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 12:28

EAST Search History (Interference)

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appln. No.: 12/818,064	
Applicant: Nathan Edward Tenny	
Filed: June 17, 2010	
Examiner: Louis Vinncelas	
Art Unit: 2474	
Customer No.: 23696	
Confirm. No.: 6903	
Docket No.: 092546	

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT

Sir:

In response to the Office Action dated April 15, 2013, please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper.

Remarks/Arguments begin on page 17 of this paper.

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently amended) A method that facilitates a timing alignment in a multicarrier system, the method comprising:

determining ~~at least one~~ different downlink timings associated with ~~at least one~~ a plurality of downlink carriers;

ascertaining an uplink timing associated with an uplink group of carriers including a first uplink carrier and a second uplink carrier, wherein the uplink timing is ascertained based on a processing of at least one downlink timing of the different downlink timings and a timing offset associated with the uplink group of carriers; and

transmitting ~~each of the uplink group of carriers within a threshold value of~~ on the first uplink carrier at the uplink timing adjusted based on the timing offset, and on the second uplink carrier at the adjusted uplink timing.

2. (original) The method of claim 1, further comprising performing a random access procedure on at least one random access carrier, wherein the at least one random access carrier is included in a downlink group of carriers that includes the at least one downlink carrier.

3. (original) The method of claim 2, wherein the performing comprises performing the random access procedure on a single carrier.

4. (original) The method of claim 3, wherein the single carrier is an assigned carrier provided by a network prior to the performing of the random access procedure.

5. (original) The method of claim 4, further comprising receiving the single carrier as part of a dedicated radio resource configuration.

6. (original) The method of claim 4, further comprising receiving a criterion associated with a usage of the single carrier, wherein the criterion is received with an assignment of the single carrier.

7. (original) The method of claim 6, wherein the criterion is a minimum signal quality threshold associated with the single carrier.

8. (original) The method of claim 6, wherein the performing comprises performing the random access procedure on an alternative carrier in response to the criterion not being met by the single carrier, and wherein the receiving further comprises receiving an indication of the alternative carrier from the network.

9. (original) The method of claim 6, wherein the performing comprises performing the random access procedure on an alternative carrier in response to the criterion not being met by the single carrier, and wherein the alternative carrier is independently selected by a wireless terminal.

10. (original) The method of claim 3, further comprising selecting the single carrier, wherein the single carrier is independently selected by a wireless terminal.

11. (original) The method of claim 10, wherein the selecting comprises applying a determination function across a set of available carriers in the downlink group of carriers.

12. (original) The method of claim 11, wherein the determination function is a pseudorandom function.

13. (original) The method of claim 11, wherein the determination function is a hash function.

14. (original) The method of claim 13, further comprising inputting an identifier associated with the wireless terminal into the hash function.

15. (original) The method of claim 13, further comprising inputting an identifier associated with a network node into the hash function, wherein the downlink group of carriers is controlled by the network node.

16. (original) The method of claim 13, further comprising inputting a time-varying value into the hash function.

17. (original) The method of claim 16, further comprising determining the time-varying value via a time measurement taken from within the wireless terminal.

18. (original) The method of claim 16, further comprising modifying the time-varying value by an arithmetic operation each time the time-varying value is used.

19. (original) The method of claim 10, wherein the selecting is performed at a time when radio resources are assigned to the wireless terminal on any of the downlink group of carriers.

20. (original) The method of claim 10, wherein the selecting is performed in response to a triggering of the random access procedure.

21. (Currently amended) An apparatus configured to facilitate a timing alignment in a multicarrier system, the apparatus comprising:

a processor configured to execute computer executable components stored in memory, the components including:

a downlink timing component configured to determine ~~at least one~~ different downlink timing associated with ~~at least one~~ a plurality of downlink carriers;

an uplink timing component configured to ascertain an uplink timing associated with an uplink group of carriers including a first uplink carrier and a second uplink carrier, wherein the uplink timing is ascertained based on at least one downlink timing of the different downlink timings and a timing offset associated with the uplink group of carriers; and

a communication component configured to transmit ~~each of the uplink group of carriers within a threshold value of~~ on the first uplink carrier at the uplink timing adjusted based on the timing offset, and on the second uplink carrier at the adjusted uplink timing.

22. (original) The apparatus of claim 21, wherein the uplink timing component is configured to determine the uplink timing by utilizing a different timing offset for each of a plurality of uplink group of carriers.

23. (original) The apparatus of claim 21, wherein the uplink timing component is configured to determine the uplink timing by utilizing a different downlink timing for each of a plurality of uplink group of carriers.

24. (original) The apparatus of claim 21, wherein the at least one downlink carrier is included in one of a plurality of downlink groups, and wherein the uplink timing component is configured to determine the uplink timing by associating the uplink group of carriers with the one of the plurality of downlink groups.

25. (original) The apparatus of claim 24, wherein the uplink timing component is configured to determine a plurality of uplink timings respectively associated with a plurality of uplink groups by identifying a subset of downlink groups that include an assigned carrier, and wherein the plurality of uplink groups are respectively associated with the subset of downlink groups that include the assigned carrier.

26. (original) The apparatus of claim 24, further comprising a message processing component configured to process a received timing message encoded with a set of uplink timing instructions respectively corresponding to an uplink group subset of the uplink group of carriers.

27. (original) The apparatus of claim 26, wherein the received timing message is a timing advance command.

28. (original) The apparatus of claim 26, wherein the received timing message comprises a vector encoded with timing adjustment values associated with the uplink group subset.

29. (original) The apparatus of claim 26, wherein each uplink group within the uplink group subset includes at least one carrier with an assigned radio resource.

30. (original) The apparatus of claim 26, wherein the uplink group of carriers comprise a set of uplink groups in which each uplink group within the set of uplink groups includes at least one carrier with an assigned radio resource, and wherein the uplink group subset is a subset of the set of uplink groups.

31. (original) The apparatus of claim 30, wherein the uplink group subset is determined by a network entity.

32. (original) The apparatus of claim 31, wherein the message processing component is configured to submit a request requesting the network entity to provide the uplink group subset, and wherein the uplink group subset is determined by the network entity in response to the request.

33. (original) The apparatus of claim 30, wherein the received timing message includes an indication of which of the uplink group of carriers are included in the uplink group subset.

34. (original) The apparatus of claim 33, wherein the message processing component is configured to decode the indication according to a mapping of group identities shared with a network.

35. (original) The apparatus of claim 34, wherein the mapping of group identities is configured in association with an assignment of dedicated radio resources on uplink carriers within at least one uplink group of the uplink group subset.

36. (original) The apparatus of claim 24, further comprising a message processing component configured to decode a timing message received via a timing message carrier included in a messenger downlink group, wherein the timing message is encoded with at least one inter-group uplink timing corresponding to a target downlink group, and wherein the target downlink group is different than the messenger downlink group.

37. (original) The apparatus of claim 36, wherein the timing message includes an indication of the target downlink group.

38. (original) The apparatus of claim 37, wherein the message processing component configured to decode the indication according to a mapping of group identities shared with a network.

39. (original) The apparatus of claim 38, wherein the mapping of group identities is configured in association with an assignment of dedicated radio resources on downlink carriers included in the target downlink group.

40. (Currently amended) ~~The apparatus of claim 21, further comprising~~ An apparatus configured to facilitate a timing alignment in a multicarrier system, the apparatus comprising:

a processor configured to execute computer executable components stored in memory, the components including:

a downlink timing component configured to determine at least one downlink timing associated with at least one downlink carrier;

an uplink timing component configured to ascertain an uplink timing associated with an uplink group of carriers, wherein the uplink timing is ascertained based on at least one downlink timing and a timing offset associated with the uplink group of carriers;

an averaging component configured to compute an average downlink timing from a plurality of downlink timings respectively corresponding to a set of downlink carriers within a particular downlink group that includes the at least one downlink carrier, wherein the uplink

timing component is configured to determine the uplink timing by applying the timing offset to the average downlink timing;

a communication component configured to transmit each of the uplink group of carriers within a threshold value of the uplink timing.

41. (original) The apparatus of claim 40, wherein the particular downlink group comprises at least one carrier associated with an assigned radio resource.

42. (original) The apparatus of claim 40, wherein the particular downlink group comprises a set of carriers identified by a network.

43. (Currently amended) A computer program product that facilitates a timing alignment in a multicarrier system, comprising:

a non-transitory computer-readable storage medium comprising code for causing at least one computer to:

determine ~~at least one~~ different downlink timings associated with ~~at least one~~ a plurality of downlink carriers;

ascertain an uplink timing associated with an uplink group of carriers including a first uplink carrier and a second uplink carrier, wherein the uplink timing is ascertained based on at least one downlink timing of the different downlink timings and a timing offset associated with the uplink group of carriers; and

transmit ~~each of the uplink group of carriers within a threshold value of~~ the first uplink carrier at the uplink timing adjusted based on the timing offset, and on the second uplink carrier at the adjusted uplink timing.

44. (Currently amended) The computer program product of claim 43, wherein the code causes the at least one computer to associate the uplink group of carriers with one of a plurality of downlink groups, and ~~wherein the code further causes the at least one computer~~ to receive a timing message encoded with a set of uplink timing instructions respectively corresponding to a downlink group subset of the plurality of downlink groups.

45. (original) The computer program product of claim 43, wherein the code causes the at least one computer to decode a timing message received via a timing message carrier included in a messenger downlink group, and wherein the timing message is encoded with at least one inter-group uplink timing corresponding to a target downlink group different than the messenger downlink group.

46. (Currently amended) ~~The computer program product of claim 43, wherein the code causes the at least one computer to~~ A computer program product that facilitates a timing alignment in a multicarrier system, comprising:

a non-transitory computer-readable storage medium comprising code for causing at least one computer to:

determine at least one downlink timing associated with at least one downlink carrier;

ascertain an uplink timing associated with an uplink group of carriers, wherein the uplink timing is ascertained based on at least one downlink timing and a timing offset associated with the uplink group of carriers;

compute an average downlink timing from a plurality of downlink timings respectively corresponding to a set of downlink carriers within a particular downlink group that includes the at least one downlink carrier, and wherein the code further causes the at least one computer to determine the uplink timing by applying the timing offset to the average downlink timing; and

transmit each of the uplink group of carriers within a threshold value of the uplink timing.

47. (original) The computer program product of claim 43, wherein the code causes the at least one computer to perform a random access procedure on at least one random access carrier, and wherein the at least one random access carrier is included in a downlink group of carriers that includes the at least one downlink carrier.

48. (Currently amended) An apparatus configured to facilitate a timing alignment in a multicarrier system, the apparatus comprising:

means for determining ~~at least one~~ different downlink timings associated with ~~at least one~~ a plurality of downlink carriers;

means for ascertaining an uplink timing associated with an uplink group of carriers including a first uplink carrier and a second uplink carrier, wherein the uplink timing is ascertained based on at least one downlink timing of the different downlink timings and a timing offset associated with the uplink group of carriers; and

means for transmitting ~~each of the uplink group of carriers within a threshold value of~~ the first uplink carrier at the uplink timing adjusted based on the timing offset, and on the second uplink carrier at the adjusted uplink timing.

49. (original) The apparatus of claim 48, wherein the means for ascertaining is configured to utilize a different timing offset for each of a plurality of uplink group of carriers.

50. (original) The apparatus of claim 48, wherein the means for ascertaining is configured to utilize a different downlink timing for each of a plurality of uplink group of carriers.

51. (original) The apparatus of claim 48, wherein the at least one downlink carrier is included in one of a plurality of downlink groups, and wherein the means for ascertaining is configured to associate the uplink group of carriers with the one of the plurality of downlink groups.

52. (original) The apparatus of claim 48, further comprising means for performing a random access procedure on at least one random access carrier, wherein the at least one random access carrier is included in a downlink group of carriers that includes the at least one downlink carrier.

53. (Currently amended) A method that facilitates a timing alignment in a multicarrier system, the method comprising:

transmitting [[a]] downlink communications to a wireless terminal via ~~at least one~~ a plurality of downlink carriers with different downlink timings;

assigning a timing offset to an uplink group of carriers including a first uplink carrier and a second uplink carrier;

providing the timing offset to the wireless terminal via one of the ~~at least one~~ plurality of downlink carriers; and

receiving a[[n]] first uplink communication via the first uplink ~~group of~~ carrier[[s]] at an uplink timing adjusted based on the timing offset, and a second uplink communication via the second uplink carrier at the adjusted uplink timing~~, wherein the uplink group of carriers are received according to the timing offset~~.

54. (original) The method of claim 53, wherein the assigning comprises assigning a different timing offset to each of a plurality of uplink groups.

55. (original) The method of claim 54, further comprising generating a timing message encoded with a set of uplink timing instructions respectively corresponding to an uplink group subset of the plurality of uplink groups, wherein the transmitting comprises transmitting the timing message to the wireless terminal.

56. (original) The method of claim 55, wherein the timing message is a timing advance command.

57. (original) The method of claim 55, wherein the timing message comprises a vector encoded with timing adjustment values associated with the uplink group subset.

58. (original) The method of claim 55, wherein each uplink group within the uplink group subset includes at least one carrier with a radio resource assigned to the wireless terminal.

59. (original) The method of claim 55, wherein the plurality of uplink groups comprise a set of uplink groups in which each uplink group within the set of uplink groups includes at least one carrier with a radio resource assigned to the wireless terminal, and wherein the uplink group subset is a subset of the set of uplink groups.

60. (original) The method of claim 59, further comprising determining the uplink group subset.

61. (original) The method of claim 60, further comprising receiving a request from the wireless terminal to provide the uplink group subset, wherein the determining is performed in response to the request.

62. (original) The method of claim 59, wherein the timing message is encoded with an indication of which of the plurality of uplink groups are included in the uplink group subset.

63. (original) The method of claim 62, wherein the indication is encoded according to a mapping of group identities shared with the wireless terminal.

64. (original) The method of claim 63, wherein the mapping of group identities is configured in association with an assignment of dedicated radio resources on uplink carriers within at least one uplink group of the uplink group subset.

65. (original) The method of claim 54, further comprising generating a timing message encoded with at least one inter-group uplink timing corresponding to a target downlink group, wherein the transmitting comprises transmitting the timing message to the wireless terminal via a timing message carrier included in a messenger downlink group, and wherein the target downlink group is different than the messenger downlink group.

66. (original) The method of claim 65, wherein the timing message is encoded with an indication of the target downlink group.

67. (original) The method of claim 66, wherein the indication is encoded according to a mapping of group identities shared with the wireless terminal.

68. (original) The method of claim 67, wherein the mapping of group identities is configured in association with an assignment of dedicated radio resources on downlink carriers included in the target downlink group.

69. (Currently amended) An apparatus configured to facilitate a timing alignment in a multicarrier system, the apparatus comprising:

a processor configured to execute computer executable components stored in memory, the components including:

a timing offset component configured to assign a timing offset to an uplink group of carriers including a first uplink carrier and a second uplink carrier;

a transmitting component configured to provide the timing offset to a wireless terminal via one of a ~~at least one~~ plurality of downlink carriers with different downlink timings; and

a receiving component configured to receive a[[n]] first uplink communication via the first uplink ~~group of~~ carrier[[s]] at an uplink timing adjusted based on the timing offset, and a second uplink communication via the second uplink carrier at the adjusted uplink timing~~, wherein the uplink group of carriers are received according to the timing offset~~.

70. (original) The apparatus of claim 69, wherein the transmitting component is configured to transmit a downlink group of carriers from antennas located at a common site.

71. (original) The apparatus of claim 69, wherein the transmitting component is configured to identify a set of carriers respectively corresponding to a plurality of downlink timings to facilitate an averaging of the plurality of downlink timings performed by the wireless terminal.

72. (original) The apparatus of claim 69, further comprising a random access component configured to identify a random access carrier to facilitate a random access procedure, wherein the random access carrier is a carrier assigned to the wireless terminal.

73. (original) The apparatus of claim 72, wherein the transmitting component is configured to transmit the random access carrier as part of a dedicated radio resource configuration.

74. (original) The apparatus of claim 72, wherein the random access component is configured to ascertain a criterion associated with a usage of the random access carrier, and wherein the criterion is provided to the wireless terminal with an assignment of the random access carrier.

75. (original) The apparatus of claim 74, wherein the criterion is a minimum signal quality threshold associated with the random access carrier.

76. (original) The apparatus of claim 74, wherein the random access component is configured to identify an alternative carrier to facilitate a performing of the random access procedure by the wireless terminal on the alternative carrier in response to the criterion not being met by the random access carrier.

77. (Currently amended) A computer program product that facilitates a timing alignment in a multicarrier system, comprising:

a non-transitory computer-readable storage medium comprising code for causing at least one computer to:

transmit downlink communications ~~at least one~~ via a plurality of downlink carriers to a wireless terminal;

assign a timing offset to an uplink group of carriers including a first uplink carrier and a second uplink carrier;

provide the timing offset to the wireless terminal via one of the ~~at least one~~ plurality of downlink carriers; and

receive a[[n]] first uplink communication via the first uplink ~~group of~~ carrier[[s]] at an uplink timing adjusted based on the timing offset, and a second uplink communication via the second uplink carrier at the adjusted uplink timing~~wherein the uplink group of carriers are received according to the timing offset~~.

78. (original) The computer program product of claim 77, wherein the code causes the at least one computer to transmit a downlink group of carriers from antennas located at a common site.

79. (original) The computer program product of claim 77, wherein the code causes the at least one computer to assign a different timing offset to each of a plurality of uplink groups.

80. (Currently amended) The computer program product of claim 79, wherein the code causes the at least one computer to generate a timing message encoded with a set of uplink timing instructions respectively corresponding to an uplink group subset of the plurality of uplink groups, and ~~wherein the code further causes the at least one computer~~ to transmit the timing message to the wireless terminal.

81. (original) The computer program product of claim 77, wherein the code causes the at least one computer to identify a set of carriers respectively corresponding to a plurality of downlink timings to facilitate an averaging of the plurality of downlink timings performed by the wireless terminal.

82. (original) The computer program product of claim 77, wherein the code causes the at least one computer to identify a random access carrier to facilitate a random access procedure, and wherein the random access carrier is a carrier assigned to the wireless terminal.

83. (Currently amended) An apparatus configured to facilitate a timing alignment in a multicarrier system, the apparatus comprising:

means for transmitting downlink communications via ~~at least one~~ a plurality of downlink carriers with different downlink timings to a wireless terminal;

means for assigning a timing offset to an uplink group of carriers including a first uplink carrier and a second uplink carrier;

means for providing the timing offset to the wireless terminal via one of the ~~at least one~~ plurality of downlink carriers; and

means for receiving a[[n]] first uplink communication via the first uplink ~~group of~~ carrier[[s]] at an uplink timing adjusted based on the timing offset, and a second uplink communication via the second uplink carrier at the adjusted uplink timing~~, wherein the uplink group of carriers are received according to the timing offset~~.

84. (original) The apparatus of claim 83, wherein the means for transmitting is configured to transmit a downlink group of carriers from antennas located at a common site.

85. (original) The apparatus of claim 83, wherein the means for assigning is configured to assign a different timing offset to each of a plurality of uplink groups.

86. (original) The apparatus of claim 85, further comprising a means for generating a timing message encoded with at least one inter-group uplink timing corresponding to a target downlink group, wherein the means for transmitting is configured to transmit the timing message to the wireless terminal via a timing message carrier included in a messenger downlink group, and wherein the target downlink group is different than the messenger downlink group.

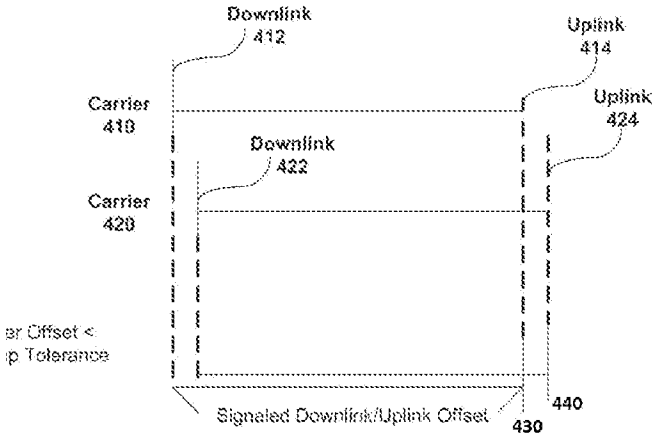
87. (original) The apparatus of claim 83, wherein the means for transmitting is configured to identify a set of carriers respectively corresponding to a plurality of downlink timings to facilitate an averaging of the plurality of downlink timings performed by the wireless terminal.

88. (original) The apparatus of claim 83, wherein the means for transmitting is configured to identify a random access carrier to facilitate a random access procedure, and wherein the random access carrier is a carrier assigned to the wireless terminal.

REMARKS/ARGUMENTS

The above identified patent application has been amended and reconsideration and reexamination are hereby requested.

Claims 1-88 are now pending in the application. Claims 1, 21, 40, 43, 44, 46, 48, 53, 69, 77, 80, and 83 have been amended. For support of the claim amendments, the Applicant points the Examiner to FIGs. 4, 5 and the corresponding specification of the current patent application.



The reference numbers 430, 440 have been added to FIG. 4 above to facilitate the explanation of amendment support. As shown in FIG. 4, an eNB transmits downlink communications 412, 422 to a wireless terminal via a plurality of downlink carriers 410, 420 with different downlink timings (i.e., the downlink 412, 422 are at different times). The wireless terminal determines different downlink timings 412, 422 associated with the plurality of downlink carriers 410, 420. The eNB assigns a timing offset to an uplink group of carriers 410, 420 including a first uplink carrier 410 and a second uplink carrier 420. The eNB provides the timing offset to the wireless terminal via one of the plurality of downlink carriers 410, 420.

The wireless terminal ascertains an uplink timing associated with an uplink group of carriers including a first uplink carrier 410 and a second uplink carrier 420. The uplink timing is ascertained based on a processing of at least one downlink timing of the downlink timings and a timing offset associated with the uplink group of carriers. That is, the wireless terminal applies the timing offset to determine the uplink timing for the first uplink carrier 410. The wireless terminal determines the uplink timing to be at 430 for a first uplink communication 414 on the first uplink carrier 410. The wireless terminal may apply the same uplink timing for the second

uplink carrier 420 (see, for example, paragraph [0063]). See, for another example, FIG. 5, which shows the uplink timing to be at the same time for the $uplink_A$ and $uplink_B$. As such, the wireless terminal may transmit the first and second uplink communication 414, 424 at the same time. Accordingly, the eNB receives a first uplink communication 414 via the first uplink carrier 410 at an uplink timing adjusted based on the timing offset, and a second uplink communication 424 via the second uplink carrier 420 at the same uplink timing.

Accordingly, no new matter has been added, as the claim amendments have support in the application as originally filed.

Claim Rejections - 35 U.S.C. § 112

The Examiner has rejected claims 48-52 and 83-88 under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the Applicant regards as the invention. Specifically, the Examiner asserts that the means limitations in claims 48 and 83 are not linked or associated with structure in the written description. With respect to claim 48, the "means for determining," the "means for ascertaining," and the "means for transmitting" may be the processor 270 of FIG. 2. With respect to claim 53, the "means for transmitting," the "means for assigning," the "means for providing," and the "means for receiving" may be the processor 230 of FIG. 2. At least paragraphs [0062]-[0068] and FIGs. 4, 5 describe an algorithm for each of the means. Beyond what is disclosed throughout the specification and figures, any other structure for the means would be implicit or inherent in the specification, as it would be clear to those skilled in the art what structure corresponds to the means, especially given the description and the algorithms provided in the description (see MPEP 2181, Section II). Accordingly, the Applicant submits that the claims 48-52 and 83-88 are definite and particularly point out and distinctly claim the subject matter which the Applicant regards as the invention.

Claims Rejections

The Examiner has rejected claims 1-11, 19-32, 36-39, 43-45, and 47-52 under 35 U.S.C. § 103(a) as being unpatentable over Damnjanovic et al. (US 2006/0280142) in view of Chun et al. (US 2010/0142457). The Examiner has rejected claim 12 under 35 U.S.C. § 103(a) as being unpatentable over Damnjanovic et al. in view of Chun et al. in view of Burgess et al. (US

2004/0266445) and further in view of Falco et al. (US 6,545,996). The Examiner has rejected claims 13, 14 under 35 U.S.C. § 103(a) as being unpatentable over Damnjanovic et al. in view of Chun et al. and further in view of Burgess et al. The Examiner has rejected claim 15 under 35 U.S.C. § 103(a) as being unpatentable over Damnjanovic et al. in view of Chun et al. in view of Burgess et al. and further in view of Bachmann et al. (US 7,688,785). The Examiner has rejected claims 16-18 under 35 U.S.C. § 103(a) as being unpatentable over Damnjanovic et al. in view of Chun et al. in view of Burgess et al. and further in view of Li et al. (US 2008/0037487). The Examiner has rejected claims 33-35 under 35 U.S.C. § 103(a) as being unpatentable over Damnjanovic et al. in view of Chun et al. and further in view of Anh et al. (US 2011/0235620). The Examiner has rejected claims 53-61, 65-70, 72-80, 82-86 and 88 are rejected under 35 U.S.C. 102(b) as being anticipated by Damnjavonic et al. The Examiner has rejected claims 62-64 under 35 U.S.C. § 103(a) as being unpatentable over Damnjanovic et al. in view of Anh et al. The Examiner has rejected claims 71, 81, and 87 under 35 U.S.C. § 103(a) as being unpatentable over Damnjanovic et al. in view of Chuang et al. (US 5,363,375).

Amended independent claim 1 recites "wherein the uplink timing is ascertained based on a processing of at least one downlink timing of the different downlink timings and a timing offset associated with the uplink group of carriers; and transmitting on the first uplink carrier at the uplink timing adjusted based on the timing offset, and on the second uplink carrier at the adjusted uplink timing." Amended independent claims 21, 43, and 48 recite similar limitations. The Applicant submits that the recitations as claimed in claims 1, 21, 43, and 48 are neither taught nor suggested nor are an obvious result from a combination of the teachings in the references Damnjanovic et al. and Chun et al., alone or in combination. Amended independent claim 53 recites "receiving a first uplink communication via the first uplink carrier at an uplink timing adjusted based on the timing offset, and a second uplink communication via the second uplink carrier at the adjusted uplink timing." Amended independent claims 69, 77, and 83 recite similar limitations. The Applicant submits that Damnjanovic et al. does not teach the recitations of claim 53 or the similar recitations of claims 69, 77, and 83.

Damnjanovic et al., while providing for using a common timing advance for all UL carriers or receiving separate timing advance updates for each UL carrier (paragraph [0035]), and for transmitting on the UL carriers (paragraphs [0029], [0036]), does not disclose the above recitations. In Damnjanovic et al, a common timing advance for all UL carriers may be used

(paragraph [0035], 2nd sentence). One of ordinary skill in the art would understand that application of a common timing advance with different DL timings would result in different UL timings. Alternatively, separate timing advance updates may be received for each UL carrier (paragraph [0035], last sentence). However, Damnjanovic et al. does not teach that the UL timing is determined based on at least one downlink timing of different downlink timings, and therefore does not teach "wherein the uplink timing is ascertained based on a processing of at least one downlink timing of the different downlink timings and a timing offset associated with the uplink group of carriers" of claim 1 or the similar recitations of claims 21, 43, and 48. Furthermore, Damnjanovic et al. does not teach that a timing advance is applied for one UL carrier to determine the UL timing, and the same UL timing is used for other UL carriers (see paragraph [0035] in which a common UL timing advance is applied to all UL carriers or a separate timing advance is applied to each UL carrier). As such, Damnjanovic et al. also does not teach "transmitting on the first uplink carrier at the uplink timing adjusted based on the timing offset, and on the second uplink carrier at the adjusted uplink timing" of claim 1 or the similar recitations of claims 21, 43, and 48. Furthermore, Damnjanovic et al. does not teach "receiving a first uplink communication via the first uplink carrier at an uplink timing adjusted based on the timing offset, and a second uplink communication via the second uplink carrier at the adjusted uplink timing" of claim 53 or the similar recitations of claims 69, 77, and 83. Chun et al. also does not teach "wherein the uplink timing is ascertained based on a processing of at least one downlink timing of the different downlink timings and a timing offset associated with the uplink group of carriers; and transmitting on the first uplink carrier at the uplink timing adjusted based on the timing offset, and on the second uplink carrier at the adjusted uplink timing" of claim 1 or the similar recitations of claims 21, 43, and 48. Furthermore, Chun et al. does not teach "receiving a first uplink communication via the first uplink carrier at an uplink timing adjusted based on the timing offset, and a second uplink communication via the second uplink carrier at the adjusted uplink timing" of claim 53 or the similar recitations of claims 69, 77, and 83.

Accordingly, because the cited references do not teach or suggest all of the claim features, the Applicant submits that the *prima facie* case of obviousness is not established, and therefore claims 1, 21, 43, and 48 are unobvious and patentable over the cited references. Furthermore, the Applicant submits that claims 53, 69, 77, and 83 are not anticipated by

Damnjanovic et al. under 35 U.S.C. § 102. The dependent claims are dependent on their respective base claims and therefore include all of the features of their respective base claims and additional features therein. As such, these claims are also allowable based upon their respective base claims and the additional features therein.

Claim Objections/Allowable Subject Matter

The Examiner has objected to claims 40-42 and 46 as being dependent upon a rejected base claim. The Applicant has amended the claims 40 and 46 into independent form including all of the limitations of the base claim and any intervening claims. Accordingly, claims 40 and 46 are now allowable.

CONCLUSION

In light of the amendments contained herein, the Applicant submits that the application is in condition for allowance, for which early action is requested.

Please charge any fees or overpayments that may be due with this response to Deposit Account No. 17-0026.

Respectfully submitted,

Dated: June 27, 2013

By: /John J. Ketchum/
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(Not for submission under 37 CFR 1.99)

Application Number	12818064
Filing Date	2010-06-17
First Named Inventor	TENNY; Nathan Edward
Art Unit	2474
Examiner Name	VINNCELAS, Louis
Attorney Docket Number	092546

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5363375		1994-11-08	CHUANG; Justin C. et al.	

If you wish to add additional U.S. Patent citation information please click the Add button.

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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	1	1887758	EP	A2	2008-02-13	CISCO TECH INC [US]		☐
	2	1988648	EP	A1	2008-11-05	NOKIA SIEMENS NETWORKS OY [FI]		☐
	3	2009124450	JP	A	2009-06-04	TOYOTA CENTRAL RES & DEV.		☒

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	12818064
	Filing Date	2010-06-17
	First Named Inventor	TENNY; Nathan Edward
	Art Unit	2474
	Examiner Name	VINNCELAS, Louis
	Attorney Docket Number	092546

	4	2009219625	JP	A	2009-10-01	AISIN SEIKI., et al.		☒
	5	2009022840	WO	A2	2009-02-19	LG ELECTRONICS INC [KR], et al.		☐

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	ERICSSON, "Impact of Carrier Aggregation on the L2 protocol architecture for LTE Rel-10", 3GPP TSG-RAN WG2 #66, Tdoc R2-092957, San Francisco, USA, 4th - 8th May 2009, pages 1-8, URL,http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_66/docs/R2-092957.zip.	☐
	2	TAIWAN SEARCH REPORT - TW099120129 - TIPO - 2013-05-27 (092546TW).	☐

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[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(**Not for submission under 37 CFR 1.99)**

Application Number	12818064
Filing Date	2010-06-17
First Named Inventor	TENNY; Nathan Edward
Art Unit	2474
Examiner Name	VINNCELAS, Louis
Attorney Docket Number	092546

CERTIFICATION STATEMENT

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OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

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A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/John J. Ketchum/	Date (YYYY-MM-DD)	2013-06-27
Name/Print	JOHN J. KETCHUM	Registration Number	61932

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(11) EP 1 887 758 A2

(12) EUROPEAN PATENT APPLICATION

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Remarks:
This application was filed on 21-11-2007 as a divisional application to the application mentioned under INID code 62.

(54) 802.11 Using a Compressed Reassociation Exchange to Facilitate Fast Handoff

(57) A method and apparatus for reassociation of a mobile node is described. The mobile node is associated with an access point coupled to a network. A new pairwise transient key is computed based on a pairwise transient key and a rekey request number derived from a previous association. A reassociation request is then sent including a mobile node identification, the rekey request number and an authentication element. A reassociation response is received. The reassociation response includes a response authentication element that comprises proof of possession of a group transient key and the new pairwise transient key. The reassociation response is then confirmed by verifying that the new pairwise transit key received in the reassociation response matches the computed new pairwise transient key.

EP 1 887 758 A2

Printed by Jouve, 75001 PARIS (FR)

Description

CROSS-REFERENCE TO RELATED APPLICATIONS.

[0001] This application claims the benefit of U.S. Provisional Application No. 60/429,714, filed November 26, 2002. This application claims the benefit of U.S. Provisional Application No. 60/439,419, filed January 10, 2003.

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BACKGROUND OF THE INVENTION

[0003] The present invention is generally related to wireless networking, more specifically to methods and systems for authenticating and provisioning wireless devices as the devices roam among access points.

[0004] Most current 802.11 network-level authentication protocols require a substantial amount of time to re-establish a wireless station's connectivity to the network after that station roams from one access point (AP) to another access point. Typically, when a station associates with a first access point, it has to be authenticated through a central authentication server. When the station roams to a new access point, the station loses the session to the network and must again authenticate itself with the authentication server which typically involves a full challenge request and response. A new accounting session is then established. This method introduces a new key hierarchy that commences on the initial authentication and allows for the authentication key to persist across the duration of a session to the network versus an 802.11 link. Further, this new key hierarchy is based on counter mode key generation to allow the precomputation of the 802.11 key obviating the need for unnecessary session teardown and restart.

[0005] This delay in re-establishing connectivity greatly impacts 802.11 service to the point that some upper-level protocols, such as Voice-over-IP (VoIP), actually fail. Furthermore, each roam commonly necessitates interaction with a site's Authentication, Accounting, and Authorization (AAA) servers, resulting in a significant increase in server load, to the point at which some servers fail to provide the necessary rate of authentications requests for the 802.11 stations. More importantly, after the authentication has succeeded, the 802.11 station must then use the key provisioned at authentication to establish a fresh key used to secure the 802.11 link with the access point.

[0006] Thus, the need exists for a fast, secure and reliable method for authenticating and provisioning a station when the station roams from one access point to another that decreases traffic to the authentication server and optimizes the generation of a fresh 802.11 key. In designing a fast secure and reliable method for seamlessly roaming a station between access points, the following underlying assumptions and requirements are desirable:

1) Fast handoff must minimize the message transactions and computations between MN and AP
2) Fast handoff is affected only in intra-subnet mobility, though an infrastructure is built to allow for future support for inter-subnet mobility
3) The handoff must be secure
4) The overall design must leverage existing standards to the extent possible
5) The overall design must not interfere with existing protocols.
6) The handoff mechanism is based on key management and thus is independent of the authentication mechanism. Note however that any key management mechanism must be aware of chosen authentication type as it must know how to properly retrieve and interpret the NSK.
7) The handoff mechanism relies on a centralized service to provide secure key distribution services

[0007] Current authentication protocols such as PEAP or TLS require interaction with the authentication state. PEAP touts the ability to shorten roam time by allowing a MN to bypass a full challenge-response authentication exchange by affecting a resume operation. IEEE 802.11 security task group 'i' e.g. TGi have accommodated for the means of pre-authenticating. These two mechanisms presume a need for re-establishment of the network session key (NSK) before the link between the AP and MN can establish a pairwise transient key (PTK) for protecting 802.11 and 802.1X traffic. However, with a defined key hierarchy, TGi also alludes to the ability of transferring the NSK from one AP to another. This design also uses the notion of retaining the NSK and relies only on the key management mechanisms to affect a fast handoff during a roam. However, to provide freshness and uniqueness of a session key for each access point, CCKM defines an initial authenticated key exchange by which the MN and first associated AP contribute material for

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deriving fresh keys for authenticating key requests, KRK, and a base transient key, BTK for deriving PTKs.

[0008] The following is a list of acronyms and their corresponding definition as used throughout this specification:

AKM - Authenticated Key Management
AP - Access Point
AS - Authentication server
BSSID - Basic Service Set Indetifier
BTK - Base Transient Key
CCKM -Central Key Management
CCM - Campus Context Manager
CCX -Client Enablement
CTK - Context Transfer Key
GTK - Group Transient Key
KRK - Key Request Key
MN - Mobile Node
MN-ID - Mobile Node Identifier
NSK - network session key
PRF - PseudoRandom Function
PMK - Pairwise Master Key
PTK - pairwise transient key
RN - rekey request sequence number
SCM - Subnet Context Manager
SSID - Service Set Identifier
SSN - Simple Security Network
VLAN - Virtual Local Area Network
WLCCP - Wireless Local Context Control Protocol.

[0009] Along with the aforementioned acronyms, defined below is a definition of terms appearing throughout this application:

IEEE - Institute of Electrical and Electronics Engineers, Inc.
IEEE 802.11 - The 802.11 protocol and 802.11 terms are defined in IEEE Std 802.11, 1999 Edition
IEEE 802.11 TGi - a task group in IEEE 802.11 currently focused in addressing 802.11 security.

[0010] 802 address. A canonical IEEE 48 bit "Ethernet"address. 802.11 and Ethernet addresses are 802 addresses.

[0011] 802.11 bridge - An 802.11 bridge is a transparent bridge with an Ethernet bridge port and one or more 802.11 bridge ports. A parent 802.11 bridge has a secondary 802.11 port which links to a primary 802.11 port in a child 802.11 bridge.

[0012] 802.11 station - A MN or AP.

[0013] 802.1X - The IEEE 802.1X protocol and 802.1X terms are defined in []. 802.1X defines a protocol where an 802.1X Supplicant mutually authenticates with an 802.1X Authenticator via an Authentication Server.

[0014] AAA - Authentication Authorization Accounting. A node will request network access by executing a protocol to a (typically) Authentication Server that provides protocols and services for providing authentication, authorization and session accounting.

[0015] AKM - Authenticated Key Management. New selector in both the SSN and TGi negotiated element present in beacons, probe response and reassociation request/response messages. This selector allows for definition of authentication type and key management.

[0016] AP - Access Point. In this document, "AP" is used as a general term to refer to any 802.11-to-Ethernet or 802.11-to-802.11 relay devices.

[0017] Association Message - An 802.11 station sends an Association Request message to initially associate with a parent AP. The parent AP replies with an Association Response message.

[0018] AS - Authentication Server. A node that provides AAA (specifically authentication) service.

[0019] BDPU - an 802.1D Bridge Protocol Data Unit.

[0020] BSS - An 802.11 Basic Service Set. A BSS is the set of 802.11 stations associated with a single 802.11 AP. A logical "BSS port" in an AP is used to access stations in the BSS.

[0021] Base Transient Key (BTK) - the base transient key that is mutually derived between MN and SCM to serve as the key for generating PTKs.

[0022] Campus Network - an aggregate "seamless roaming domain" which implies a geographic locality which may

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include one or more 802.11 Extended Service Sets. A physical campus network may contain multiple "campus networks."

[0023] Central Key Management (CCKM)- the key management scheme of the present invention. It utilizes a central node, an AP, as the key distributor to enable protected communications between a link (e.g. an AP and MN).

[0024] Context Transfer Key (CTK) - A key shared between two nodes to establish protection of its data packets. The CTK may consist of a pair of keys if the protection mechanism requires a unique key for each encryption and packet authentication (e.g. a MIC).

[0025] Correspondent Host (CH) - A mobile or non-mobile node that is actively communicating with a MN.

[0026] Descednant - A node that is in the sub tree of a Topology Tree that is roonated in an ancestor node.

[0027] DRR - Descendant Registration Record. A DRR contains state information for descendant nodes. An MN-DRR is a DRR for a mobile node. An AP-DRR is a DRR for an AP.

[0028] DPR - Descendant Path Record (DPR). A DPR contains path state information for descendant nodes.

[0029] Downlink - The logical radio path from an 802.11 AP radio to a child 802.11 station.

[0030] ESS - An 802.11 Extended Service Set. An ESS includes one or more BSSes and may span one or more subnets. MNs can roam between APs in the ESS. A SWAN Campus Network may include multiple ESSes.

[0031] FA - A Mobile Ipv4 foreign agent.

[0032] Group Transient Key (GTK) - A key owned and managed by an AP. It is used to protect multicast and broadcast traffic.

[0033] HA - A Mobile Ipv4 home agent.

[0034] Hopwise Routing - "Hopwise routing" is used when an inbound or outbound WLCCP message must be forwarded to intermediate APs on the path from the Originator to the Responder.

[0035] IA - Infrastructure Node Authenticator. In standalone mode, the SCM is the IA; in a full SWAN configuration, the CCM is the IA.

[0036] IGMP - Internet Group Management Protocol. IGMP is used to determine IP multicast group membership.

[0037] IGMP Snooping - Switches and APs "snoop" IGMP messages, received on a port, to determine which IP multicast addresses must be transmitted on the port.

[0038] Inbound - An "inbound frame" is forwarded toward the CCM, in the SWAN Topology Tree. An "inbound node" is accessed via the "primary port". (An "inbound node" is not necessarily an "ancestor node".)

[0039] IN - Infrastructure Node. An IN is an AP, SCM, LCM, or CCM.

[0040] IRR - Inbound Registration Record.

[0041] KDC - Key Distribution Center. This is a service provided by the IN Authenticator to distribute CTKs to be consumed by registered infrastructure nodes.

[0042] Key Request Key (KRK) - the portion of the expanded NSK used to authenticate key refresh request/response handshakes

[0043] Layer 2 - The data link layer, as defined in the ISO 7-layer model.

[0044] L-CTK - Lateral Context Transfer Key.

[0045] Link - the logical link between two immediate neighbors in the SWAN Topology tree.

[0046] Link State - Each SWAN node is responsible for monitoring the link to each of its immediate neighbors. The Link State can be "Connected" or "Disconnected".

[0047] MIP - Mobile IPv4 as defined in RFC 2002.

[0048] MN - 802.11 Mobile Node.

[0049] MN-ID - 802.11 Mobile Node identifier represented as the node's MAC address

[0050] Network Session Key (NSK) - the key established by a successful authentication between a node an its authenticator. With the CCM being the authenticator for all infrastructure nodes and the LCM being the authenticator for all MNs. In the case where an SCM is acting in standalone mode, the SCM is the authenticator for all nodes.

[0051] MNR - Mobile Node Record. A Mobile Node Record contains state information for MNs.

[0052] Mobility bindings - The "mobility bindings" for a station are used to determine the current path to the station. APs, context managers, and MIP agents maintain mobility bindings for 802.11 stations.

[0053] MSC - Message Sequence Counter. This is effectively the RC4 IV and replay protector.

[0054] Native VLAN ID - A switch port and/or AP can be configured with a "native VLAN ID". Untagged or priority-tagged frames are implicitly associated with the native VLAN ID.

[0055] Network Access Identifier (NAI) - An NAI is used to identify a user within a network domain. For example, "joe@cisco.com" is a typical NAI.

[0056] NSK - Network Session Key. An NSK is the key established by a successful authentication between a node and its "authenticator". (The CCM is the authenticator for all infrastructure nodes and the LCM is the authenticator for all MNs, in a campus network. In a standalone subnet domain, the SCM is the authenticator for all nodes in the subnet.)

[0057] Originator - The node that "originates" a WLCCP "request" message.

[0058] Outbound - An "outbound frame" is forwarded away from the CCM, in the SWAN Topology Tree. An "outbound node" is a "descendant" node that is relatively further from the CCM in the SWAN Topology Tree.

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[0059] OMNR - Outbound Mobile Node Record

[0060] Pairwise Master Key (PMK) - the key established by a successful authentication. This is the term used in both the TGi and SSN draft specification and is a key used to derive PTKs.

[0061] Pairwise Transient Key (PTK) - the key mutually derived by AP and MN and is a function of BTK and RN

[0062] Path Authentication - Path authentication refers to the process where an AP or child CM mutually authenticates and establishes a path CTK with each of its ancestors. Path-Init and (optionally) intial Registration messages are used for path authentication.

[0063] Port - The logical entity that provides access to a SWAN Topology Tree "link". Multiple logical ports may exist on a single hardware interface.

[0064] PNR - Parent Node Record

[0065] Primary LAN - The wired Ethernet LAN directly attached to the SCM. Each subnet has one Primary Ethernet LAN. The primary LAN may include multiple Ethernet segments and wired transparent bridges/switches.

[0066] Primary Port - The port that is used to attach to the SWAN topology tree. In an SCM, it is the port that is used to access the parent LCM or CCM. In an AP, it is the port that is used to transmit frames toward the primary LAN. An AP primary port can be an Ethernet or 802.11 port. The AP primary port is the "default port" for unicast flooding purposes. [If an AP is co-located with an SCM, then a logical internal link exists between the AP and SCM. A logical AP "internal primary port" provides access to the SCM; however, the Ethernet port is still the "primary port" for frame forwarding purposes.]

[0067] PTK - Pairwise Transient Key. This key is used to protect 802.1X and 802.11 data packets between a MN and AP. PTKs are mutually derived by each node in the link based on a predefined strong pseudorandom function, BSSID, RN and BTK.

[0068] Reassociation Message - An 802.11 station sends an 802.11 Reassociation Request message to associate with a new parent AP after it roams. The parent AP replies with a Reassociation Response message.

[0069] Rekey Request Number (RN) - the counter used to protect PTK key refreshes from replay attacks. The counter is also used as part of the PTK key generator.

[0070] Repeater - A repeater is a "wireless AP" that is attached to a parent AP on an 802.11 primary port.

[0071] RN - Request Number. A sequence value used to rotate PTKs used between an authenticated MN and Root AP.

[0072] Root AP - A "root AP" is directly attached to the primary LAN on its primary Ethernet port.

[0073] Root CM - The CM that is at the root of the active SWAN Topology Tree. The CCM is the root CM in a campus network. The SCM is the root CM in a "stand-alone" subnet control domain.

[0074] Responder - The destination of a WLCCP Request message or the node that originates a WLCCP Reply message.

[0075] SARpM - SCM-Advertisement Reply Message

[0076] SCM - Subnet Context Manager. An SCM provides a central control point for each subnet. The SCM establishes the "primary LAN" for each subnet. From the perspective of a MN, a home SCM is the SCM of the home subnet for the MN and a foreign SCM is an SCM on any other "foreign subnet".

[0077] Seamless roaming. A MN is said to roam "seamlessly" if it roams between APs in different subnets without changing its "home IP address".

[0078] Secondary LAN - Any wired Ethernet LAN that is attached to the Primary Ethernet LAN by a wireless link. A secondary LAN may include multiple Ethernet segments and wired transparent bridges/switches.

[0079] Secondary Port - A secondary port is any active AP or CM port other than the primary port.

[0080] SSID - 802.11 Service Set Identifier. Authentication parameters are defined globally per SSID. An SSID can be locally bound to a "home subnet" or VLAN, in each AP.

[0081] Simple Security Network (SSN) - Microsoft's specification for a framework used to provide 802.11 security. It mandates use of 802.1X EAP authentication, TKIP and Microsoft's 802.1X 4-way handshake for managing unicast keys and 802.1X 2-way handshake for managing broadcast and multicast keys.

[0082] STP - IEEE 802.1D Spanning Tree Protocol. An "STP AP" executes the 802.1D STP and the 802.1D STP is operated on an "STP link". A "non-STP AP" does not execute the 802.1D STP.

[0083] Subnet - An IP subnet. A MN is associated with a single "home subnet" at any given time. Any other subnet is a "foreign subnet", from the perspective of the MN.

[0084] Supplicant - The IEEE 802.1X standard defines the term "supplicant". A supplicant is a node that is mutually authenticating with an "802.1X authenticator" via an authentication server.

[0085] SWAN - Smart Wireless Architecture for Networking, an architecture for radio, network and mobility management within a secure environment.

[0086] SWAN Topology Tree - The logical structure of a SWAN network as determined by the SWAN parent/child relationships. The SWAN CCM is at the root of the topology tree.

[0087] VLAN - A "Virtual LAN", as defined in the IEEE 802.1 Q standard.

[0088] TLV - Type, Length, Value "TLV's" contain optional parameters in WLCCP messages.

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[0089] Uplink - The logical radio path from an 802.11 child station to its parent AP radio.

[0090] URR - Unbound Registration Record.

[0091] VLAN - A "Virtual LAN" as defined in the IEEE 802.1Q standard. VLAN tagged frames are transmitted on a VLAN Trunk link.

[0092] Wireless station - A MN, repeater, WGB, or child 802.11 bridge.

[0093] WGB - A work-group bridge is a non-STP AP with an 802.11 primary port and a secondary Ethernet port that provides access to a non-STP secondary Ethenet LAN segment.

[0094] WLAN-Wireless LAN.

[0095] WLCCP - Wireless LAN Context Control Protocol.

[0096] In addition to the aforementioned acronyms, unless otherwise defined acronyms from the 802.11 specification should be given their usual and customary meaning as defined by the 802.11 specification. The 802.11 specification is hereby incorporated by reference.

BRIEF SUMMARY OF THE INVENTION

[0097] In view of the aforementioned needs, the invention contemplates a design that reduces both message and computational burdens by employing a key hierarchy that decouples authentication session time from key management. Current 802.11 implementations tightly bind authentication and key management and enforce full backend (re)authentications because they are bound to the cipher suite selection. For Wired Equivalent Privacy (WEP), this can result in very frequent (re)authentications due to WEPs rekey requirements. For roaming, current implementations also enforce a full (re)authentication.

[0098] The key hierarchy defines keys established on a successful authentication as network session keys (NSKs), which are independent of the 802.11 cipher suite selection. The NSK is used to generate a key refresh key (KRK) to authenticate key refresh requests and a base transient key (BTK) which serves as the base key from which pairwise transient keys (PTK) are derived.

[0099] Only PTKs are bound to the selected 802.11 cipher suite and thus must be managed based on the cipher suite security policies. The longevity of the NSK is defined by the Authentication Server (AS) as a session timeout which can now be defined as a function of the NSK entropy versus the 802.11 negotiated cipher suite. It is desired is to strongly encourage the use of authentication types that result in generation of dynamic NSK with more good entropy.

[0100] Keys are managed by a centralized node that provides subnet context management (SCM). Preferably, the SCM is the 802.1X authenticator for all MNs and APs enforcing all MN nodes to implicitly register. The registration process ensures that all nodes in the registry have successfully associated, authenticated and have security credentials cached. The mechanisms described in this proposal are defined as Central Key Management (CCKM) and negotiated as a proprietary value in the Authenticated Key Management (AKM) information element as defined in SSN/TGi's drafts.

[0101] While the authentication mechanism remains unchanged, e.g. 802.1X Extensible Authentication Protocol (EAP) authentication, this design introduces a new key management scheme: Central Key Management (CCKM). This new capability is advertised and negotiated using SSN's IE or RSN's IE as described herein *infra*.

[0102] One aspect of the present invention is a method for authenticating a mobile node with a network, the steps comprising associating with an access point, authenticating the mobile node using an extensible authentication protocol by the access point, and establishing a network session key and registering the mobile node into the network infrastructure. The network session key is used to establish a key request key and a base transient key.

[0103] After the initial authentication, the network session key is sent to a Subnet Context Manager. The present invention further contemplates authenticating key refreshes using the network session key. It is further contemplated that pairwise transient keys are derived using the network session key.

[0104] Another aspect of the present invention is a method of re-association by a mobile node, the steps comprising sending a re-association request from a mobile node to an access point, the re-association request comprising a mobile node identification, a rekey request number, and an authentication element, validating the re-association request, the validating step comprising computing a new pairwise transient key, sending a response, the response comprising an authentication element, to the mobile node, the authentication element comprising the new pairwise transit key and an extensible authentication protocol over local area network key; and confirming the response by verifying the new pairwise transit key to a second computed pairwise transit key.

[0105] Typically the response is validated by verifying the new pairwise transient key. The response may also be verified by verifying a timestamp included in the response. The authentication element preferably uses a current pairwise transient key. The validating step is performed by either a subnet context manager (SCM), an authentication server (AS), or the access server (AAA server). Other methods for validating the request include but are not limited to verifying that the timestamp of the re-association request is within a configurable value, verifying the sequence number is greater than a previous value, sending to a query to a subnet context manager to validate the re-association request, wherein the access point (AP) receives a rekey request number and a base transient key from the subnet context manager and

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generates a pairwise transient key (PTK).

[0106] Another aspect of the present invention is a rekey sequence, the steps comprising: computing an authentication element, the authentication element comprising a rekey request number and a new pair transient key, transmitting to a responder a call for a new pair transient key, receiving an response authentication element from the responder; and verifying the response authentication element, the response authentication element comprising the new pair transient key. The rekey sequence may further comprise sending an extensible authentication protocol over local area network key confirm message. Prior to computing the authentication element, the rekey request number is incremented.

[0107] Another aspect of the present invention is a rekey sequence, the steps comprising: receiving a rekey request, the rekey request comprising a rekey request number and an authentication element, computing a new pair transient key; and sending a ready to transmit and receive with the new pair transient key message. The rekey sequence may further comprise receiving an extensible authentication protocol over local area network key confirm message, verifying the rekey request number is greater than a cached rekey request number, verifying all attributes of an extensible authentication protocol over local area network key request, updating a cached rekey request number, or a combination thereof. Furthermore, the authentication element may comprise a new initiator pair transient key and the steps may further comprise comparing the new pair transient key with the new initiator pair transient key.

(SUMMARY OF NEXT REMAINING CLAIMS)

[0108] Still other objects of the present invention will become readily apparent to those skilled in this art from the following description wherein there is shown and described a preferred embodiment of this invention, simply by way of illustration of one of the best modes best suited for to carry out the invention. As it will be realized, the invention is capable of other different embodiments and its several details are capable of modifications in various obvious aspects all without from the invention. Accordingly, the drawing and descriptions will be regarded as illustrative in nature and not as restrictive.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

[0109] The accompanying drawings incorporated in and forming a part of the specification, illustrates several aspects of the present invention, and together with the description serve to explain the principles of the invention. In the drawings:

FIG 1 is a block diagram illustrating a key hierarchy as contemplated by the present invention;
FIG 2 is a table of Subnet Context Manager acquisition of network session keys;
FIG 3 is a table illustrating authenticated key management selector values;
FIG 4 is a table illustrating a Subnet Context Manager's cached credentials;
FIG 5 is a table illustrating the credentials cached by an Access Point;
FIG 6 is a block diagram illustrating the keys used to secure messages between links;
FIG 7 is a flow diagram showing the steps for AP registration to an SCM;
FIG 8 shows an example of a successful mobile node Lightweight Extensible Authentication Protocol Authentication and Registration;
FIG 9 shows an example of a successful mobile node non-Lightweight Extensible Authentication Protocol authentication and registration;
FIG 10 is a flow diagram illustrating the sequence triggered to complete a key establishment after a successful authentication;
FIG 11 is an example key descriptor for a rekey sequence;
FIG 12 is a block diagram showing a rekey sequence;
FIG 13 is an example of the authenticating element included in a re-association request sent by a mobile node;
FIG 14 is an example of the format of the response to the re-association request by the access point;
FIG 15 is a block diagram illustrating the communications that take place between the various network components for a successful mobile node reassocation to a new access point;
FIG 16 is a block diagram showing a method for propagating keys for legacy or SSN mobile nodes;
FIG 17 is a block diagram exemplifying a topology tree for a full implementation of one aspect of the present invention;
FIG 18 is a table illustrating the format of a WLCCP Node ID.
FIG 19 is block diagram showing the internal bridging structure in an access point;
FIG 20 is an example of an Ethernet-encapsulated WLCCP Context Management frame;
FIG 21 is an example of a WLCCP Message Header;
FIG 22 is an example of a TLV format;
FIG 23 is a block diagram showing how hopwise routing is used;
FIG 24 is a block diagram illustrating a handoff from a first access point to a second access point for a mobile node on a campus topology;

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FIG 25 is an example of the message sequences for initial mobile node association;
FIG 26 is an example of the message sequences for a mobile node roaming from a first access point to a second access point;
FIG 27 is a block diagram illustrating a handoff of a repeater access point from a first access point to a second access point;
FIG 28a is an example of the message sequences for initial repeater access point association;
FIG 28b is an example of the message sequences for a repeater access point roaming from a first access point to a second access point;
FIG 29 is an example of a root access point authentication;
FIG 30 is a block diagram illustrating defined CTK's;
FIG 31 is an example block diagram of an AP authenticating and registering to the infrastructure;
FIG 32 is an example block diagram of an alternate sequence used for a path update requiring no registration;
FIG 33 is an example of an Establish (refresh) CTK's between an access point and a subnet context manager;
FIG 34 is a block diagram illustrating an example message sequence for a successful mobile node authentication and registration to full topology;
FIG 35 is a block diagram of a WLAN spanning tree for a single subnet;

DETAILED DESCRIPTION OF INVENTION

[0110] Throughout this description, the preferred embodiment and examples shown should be considered as exemplars, rather than limitations, of the present invention.

[0111] The present invention reduces both message and computational burdens by employing a key hierarchy that decouples authentication session time from key management. Current 802.11 implementations tightly bound authentication and key management and enforce full backend (re)authentications because they are bound to the cipher suite selection. For WEP, this can result in very frequent (re)authentications due to WEPs rekey requirements. For roaming, current implementations also enforce a full (re)authentication.

[0112] The key hierarchy defines keys established on a successful authentication as network session keys (NSKs), which are independent of the 802.11 cipher suite selection. The NSK is used to generate a key refresh key (KRK) to authenticate key refresh requests and a base transient key (BTK) which serves as the base key from which pairwise transient keys (PTK) are derived.

[0113] Only PTKs are bound to the selected 802.11 cipher suite and thus must be managed based on the cipher suite security policies. The longevity of the NSK is defined by the Authentication Server (AS) as a session timeout which can now be defined as a function of the NSK entropy versus the 802.11 negotiated cipher suite. The goal is to strongly encourage the use of authentication types that result in generation of dynamic NSK with more good entropy. The new key hierarchy 100 is depicted in Figure 1. Keys (as defined in Figure 1) are managed by a centralized node that provides subnet context management (SCM). The SCM is the 802.1X authenticator for all MNs and APs enforcing all MN nodes to implicitly register. The registration process ensures that all nodes in the registry have successfully associated, authenticated and have security credentials cached. The mechanisms described in this proposal are defined as Central Key Management (CCKM) and negotiated as a proprietary value in the Authenticated Key Management (AKM) information element as defined in current SSN and TGi's drafts.

[0114] Referring to Figure 1, the top of the hierarchy 100 is the NSK 102. The NSK 102 is implicitly derived as a result of a successful EAP authentication. From the NSK 102 is generated the KRK and BTK as shown in block 104. The KRK and BTK are generated using a PRF with the NSK, BSSID, STA-ID, $Nonce_{STA}$ and $Nonce_{SCM}$ as parameters. The 128 bit KRK 106a and 256 bit BTK 106b are derived from the NSK. From the BTK 106b is generated the PTK_{SN} using a PRF with the BTK, RN and BSSID as parameters. From the PTK are derived the 802.1X Encrypt Key 110 (16 bytes), the 802.1X MIC key 112 (16 bytes), the 802.11 Encrypt Key 114 (16 byes) and the AP MIC Keys 116 (TKIP only). The AP MIC Keys 116 further comprise a Tx Key 118a, 8 bytes, and a Rx Key 118b, also 8 bytes.

[0115] While the authentication mechanism remains unchanged, e.g. 802.1X EAP authentication, the present invention introduces a new key management scheme: CCKM. This new capability is advertised and negotiated using SSN's IE or RSN's IE, described herein *infra*.

[0116] An implementation consideration of the present invention is ensuring autonomy from authentication mechanisms. Like TGi and SSN, the present invention also presumes the presence of a (NSK) key upon successful authentication. For security reasons, this key should in general be dynamically configured and managed. The present invention provisions for short NSK's and provides a means to stretch them to the required 384 bit length. Though heavily discouraged, this design can also allow for the use of pre-shared keys to be defined as the NSKs.

[0117] The CCKM must be aware of the authentication type used to interpret and retrieve the NSK. Figure 2 is a table 200 that describes how the NSK is derived and retrieved by the SCM. Column 202 describes the 802.1X Authentication type. Column 204 describes the NSK computation. Column 206 shows the length of the NSK in bytes, and column 208

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describes how the SCM acquires the NSK.

[0118] Authentication types that do not mutually derive dynamic keys, such as EAP-MD5 rely on having a static key to be configured similar to how legacy systems support *pre-shared key authentication*. These static configurations are traditionally managed at the AP. To allow for backward compatibility, these configurations must persist. Thus, CCKM will request these NSK types from the first associated AP as the session NSK.

[0119] The present invention contemplates a fast handoff system and method (herein referred to as CCKM) that is based on a centralized service, a Subnet Context Manager (SCM) to enable a seamless secure context transfer required to transition a MN from one AP to a new one. To secure such transfers, the SCM relies on each node both APs and MNs to mutually authenticate with the SCM. Upon successful authentication, a shared secret must be established: a network session key (NSK).

[0120] The use of the NSK deviates from IEEE 802.11 TGi's (as well as SSN) use of the key established at authentication. TGi/SSN refers to this key as a PMK which in turn is used as key material to derive both the 802.1X and 802.11 pairwise transient keys (PTKs). While CCKM also derives further key material from the NSK, the derived keys are used to authenticate transient key requests and to derive the PTKs. The key hierarchy is depicted in Figure 1.

[0121] By defining a key rotation scheme, CCKM allows the MN to derive the new PTK before reassociation. The MN may derive the PTK for the new AP once it determines the new BSSID it is roaming to and before the reassociation request is transmitted. Thus, upon a reassociation request, the MN can be ready to protect unicast communications to the new AP but must await the AP's reassociation response as acknowledgement that both parties can now secure unicast communications. The AP's reassociation response also includes delivery of the broadcast keys (GTK) to enable full protected communications.

[0122] For general PTK rekeying, CCKM introduces EAPOL key descriptor enhancements similar to those defined in SSN/TGi to affect a CCKM rekey.

[0123] Using either SSN or TGi's information elements, SSN IE and RSN IE respectively, CCKM capabilities can be negotiated. Currently both specifications allow the negotiation for an *authenticated key management* suite. The suite selector encapsulates both an authentication and a key management mechanism, the assigned values are described in table 300 in Figure 3. Column 302 is the Organization Unique Identifier (OUI), column 304 is the type corresponding to the OUI in column 302, and column 306 is the description for the OUI in column 302.

[0124] Both AP and MN must support CCKM for interoperability. The AP must advertise CCKM capability by using a new value in the Authenticated Key Management Suite Selector as defined in SSN v 0.21 and TGi draft 2.3.

[0125] CCKM capability must be advertised in beacons and negotiated during probe response and association request. Successful negotiation of CCKM enables the centralized key management defined in this specification. Enabling CCKM also implies activation of the SCM.

[0126] The SCM is designed to provide context control for a subnet and affect client context transfers upon a roam. The SCM is a module that can coexist in an AP, be a standalone server, or coexist in an AS. While the SCM is designed to affect full inter-subnet mobility, this design only employs the components required to affect intra-subnet mobility. These elements include:

- a repository holding authenticated node's security credentials including the node's NSK, session timeout and security policy
- an MN's security credentials include an NSK, SSID, VLAN, session timeout, associated BSSID and possibly also authentication mechanism, key management mechanism and cipher suite negotiated at association. The credentials are used to validate the session before a context transfer and PTK can be delivered.
- an AP's security credentials include an NSK, session timeout and list of associated MNs
- a context repository including security credentials for all registered nodes
- services required to manage the context repository for registered MNs and APs
- services to identify and enable the SCM as the Authenticator for all APs and MNs
- SCM provides services to automatically provide the new AP with the MNs security credentials without client interaction
- services to generate and secure delivery of PTKs based on security policy.

[0127] The SCM maintains a cache of all registered MN contexts within a given subnet including the MNs' NSKs (shown in Figure 4). The cached credentials for an AP are slightly different and are described in Figure 5. Referring to Figure 4, column 402 lists the SCAM cache ofMN credentials, comprising the fields State 408, STA Addr 410, Authentication type 412, Key Management Type 414, Session Timeout 416, KRK 418, BTK 420, RN 422, SSID 424, VLAN ID 426, BSSID 428, Cipher 430, NSK Key length 432, NSK 434, Tx Key Length 436 and Tx Key 438. The length in bytes and a description of these fields are provided in columns 404 and 406 respectively. Referring to Figure 5, the AP's cached credentials comprise the state 508, Node-ID 510, NSK 512, Session Timeout 514, CTK 516 and key sequence counter 518 as shown in column 502. The length and description of these fields are provided in columns 504 and 506 respectively.

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[0128] The SCM establishes shared secrets with both the MN and APs. It uses the Key Request Key (KRK) as the shared secret with MNs to authenticate key requests. The Context Transfer Key (CTK) is the shared secret with APs to protect communications between the SCM and AP. The trust relationship is depicted in Figure 6.

[0129] CTKs are distributed by the SCM to the AP for protecting link communications. Note that while it has been suggested that NSKs be used to protect AP to SCM communications, this would enforce a shorter session timeout and full reauthentications to the AS when link keys need updating.

[0130] Figure 6 shows the keys used to protect communication between assigned links. Note that BTKs are not used to protect messages directly, rather, it is used to derive PTKs used to protect communications between AP and MN. As shown in Figure 6, the AS 602 uses NSK0 606 to communicate with the SCM 604. The SCM 604 communicates with AP1 608 and AP2 610 using keys CTK1 612 and CTK2 614 respectively. AP1 608 communicates with MN3 616 and MN4 618 using PTK3 622 and PTK4 624 respectively, while AP2 610 communicates with MN5 with PTK5 628. The SCM 604 may also directly communicate with the mobile nodes, MN3 616, MN4 618 and MN5 620 using KRK6 630, KRK7 632 and KRK8 634 respectively.

[0131] PTKs are derived and refreshed based on a Rekey sequence counter and BTKs as defined or refreshed based on the NSK as decribed herein *infra*.

[0132] By employing Bering's SCM capabilities, the fast handoff design provides a scalable infrastructure that is required to provide inter-subnet roaming in a subsequent release.

[0133] The SCM services coexist in any AP and thus an election mechanism may be defined to allow for the selection of an AP as the SCM provider.

[0134] While there will be no initial support for SCM to SCM (e.g, lateral) communication to enable warm restarts, the election mechanism still enables cold standby. To secure communications with MNs, the AP must first authenticate and register with its SCM. Authentication is required to establish an NSK and registration allows secure communications between the SCM and the AP. The AP's NSK is derived by the AP as a result of a successful 802.1X LEAP authentication with the SCM; the authentication server delivers the NSK to the SCM via the Radius MS-MPPE attribute also as a result of a successful authentication. The AP identifies its SCM by listening to the SCM advertisement messages.

[0135] Upon successful authentication with the SCM, the AP must then register itself with the SCM as a valid AP. Upon pre-registration, the SCM delivers a set of CTKs to the AP that is used to both encrypt and authenticate WLCCP messages between the SCM and the AP.

[0136] A message depiction of how an AP establishes the required NSK and CTKs is shown in Figure 7. The AP must also establish the CTK to ensure that no rogue AP is introduced and compromise either NSK or CTK. The authentication mechanism is similar to that used for bridges, where the configure LEAP username and password are used to authenticate with the AS. Tasks performed by the AP are in column 702, tasks performed by the SCM are listed in column 704, and tasks performed by the AS are in column 706.

[0137] For some embodiments, the SCM is the 802.1X Authenticator for all nodes. Thus, CTK establishment between the AP and SCM must be mutually derived.

[0138] To secure communications, a MN must first authenticate with the network via 802.1X EAP authentication. The result of a successful authentication establishes a NSK that is used to establish the KRK and BTK used to respectively authenticate key refreshes and derive PTKs.

[0139] Like SSN, CCKM also initiates a session with a 4-way handshake to establish the KRK and BTK, for enabling protection of unicast traffic These handshakes are only required after successful authentication. Rekey requests either upon re-association or due to general key management rekeying (like cipher suite countermeasures) only require an authenticated 3-way handshake. Figure 8, depicts a successful MN LEAP Authentication and registration with the SCM.

[0140] A mechanism is needed to pass the NSK from EAP supplicants which are independent of the CCKM module. For instance, for non-LEAP EAP authentication on Windows platforms, the MN's NSK is usually generated in the EAP supplicant and passed to the EAP framework. The EAP framework will then pass the NSK to the CCKM module. Since the current SSN-capable EAP framework treats CCKM as non-SSN compliant, it will just process the 802.1X EAP authentication and send down the NSK after an EAP authentication success. Similarly, non-SSN EAP supplicants will simply process the 802.1X EAP authentication and send down the NSK after an EAP authentication success.

[0141] However, it is likely that the NSK will not be delivered until after the group key delivery EAPOL Key message from the AP is received. Thus, as shown in Figure 8, for non-LEAP EAP authentication, the AP needs to send an additional 802.1X EAPOL key message with a dummy group key right after sending an EAP-Success message to the station.

[0142] It is up to the implementation in the CCKM module to indicate to the AP that it needs to send an additional EAPOL key message. This information could be negotiated during the association request RSNIE. An alternate solution is to always send the dummy EAPOL key message after EAP Success message. The CCKM module can ignore the dummy key if it already has the NSK and establish the real keys post the four-way handshake.

[0143] However, for legacy systems, association exchanges will always trigger a full authentication and 4-way handshake. Receipt of the CCKM rekey elements will be ignored.

[0144] An additional 2-way handshake is used to rekey the multicast/broadcast keys (GTK). The rekey protocol for

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GTK management is the same as specified in TGi and SSN. The 2-message handshake is initiated by the AP to deliver the GTK over and encrypted EAPOL Key message. The current PTK is used to protect these EAPOL Key messages.

[0145] In a CCKM capable system, an AP will always request the SCM for security credentials during a pre-registration request/reply. Associations imply session initiation and thus, upon an association if security credentials are valid in an SCM and CCKM is negotiated then 802.1X authentication can be bypassed. However fresh KRK and BTKs must be established. If no security credentials exist, then the AP must expect full authentication between MN and AS.

[0146] After a successful authentication, the sequence shown in Figure 10 is triggered to complete the key establishment and result in the necessary PTKs used to protect packets between AP and MN.

[0147] Since the AP is also provided with the MN's session timeout, policy for managing (re)authentications is assigned to the AP. Similar to current implementations, APs can trigger (re)authentications before the session timeout expires and can also manage the update of the KRK and BTK refreshment as defined herein.

[0148] Either MN or AP can trigger a PTK rekey. Conditions in which either node may request a rekey include: TKIP failures, particularly in Michael countermeasures; Exhaustion of IV (mainly for WEP) and Countermeasures if the node feels the PTK has been compromised.

[0149] The rekey exchange is a 3-message EAPOL Key handshake. A new key descriptor is defined to allow for a secure rekey exchange, which is shown in Figure 11. The fields are defined as follows:

Key Information 1102: designates whether it is a request (0), response (1) or confirm (3);
Status 1104: is used by the responder and confirmer. A zero value means success; non-zero means the rekey failed and either a full KRK, BTK or deauthentication must be invoked;
EAPOL Replay Counter 1106: is the EAPOL Key message counter also used to protect from message replays;
Reserved field 1108: an extra byte is added to better align the element;
Key-ID 1110: 1 byte field that stored the key identifier (0, 1, 2 or 3) assignment, it must match the currently assigned key ID;
MN-ID 1112: the client's MAC address;
BSSID 1114: the AP's MAC address;
RN 1116: the rekey request number;
MIC 1118: authentication element using the current PTK. The MIC is defined as:

$$MIC_{request} = \text{HMAC-MD5}(\, PTK, \text{Key Info} \,\|\, \text{EAPOL Replay Ctr} \,\|\, \text{Key ID} \,\|\, \text{MN-ID} \,\|\, \text{BSSID} \,\|\, RN\,),$$

$$MIC_{response} = \text{HMAC-MD5}(\, PTK, \text{Key Info} \,\|\, \text{EAPOL Replay Ctr} \,\|\, \text{Key ID} \,\|\, \text{MN-ID} \,\|\, \text{BSSID} \,\|\, RN \,\|\, \text{Status}),$$

$$MIC_{confirm} = \text{HMAC-MD5}(\, PTK, \text{Key Info} \,\|\, \text{EAPOL Replay Ctr} \,\|\, \text{Key ID} \,\|\, \text{MN-ID} \,\|\, \text{BSSID} \,\|\, RN \,\|\, \text{Status}).$$

[0150] The rekey sequence 1200 is shown in Figure 12. The left column 1202 shows tasks performed by the initiator while the right column 1204 shows tasks performed by the responder.

[0151] At block 1206 the State transition calls for a new PTK. The initiator sets RN = RN + 1, the new PTK = PTK_{RN+1}, and the compute $MIC_{request}$. Transmission to responder is halted until a valid response or timeout is reached. Reception with PTK_{RN} must be allowed. Request use of PTK_{RN+1} in Key ID is sent.

[0152] The responder receives the request. If as shown at block 1208 the $MIC_{request}$ new RN is not greater than cached RN, or any attribute in EAPOL Key request is invalid, the responder does not update PTK or send a response with non zero status. However, if as shown at block 1210 the $MIC_{request}$ RN and EAPOL Key attributes are valid, the responder

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will update RN and compute PTK_{RN+1}, flush MN transmit queue, install PTK_{RN+1}, and Respond ready to xmit and rcv with PTK_{RN+1} (once response is sent, rcvd packets from MN using PTK_{RN} will not decrypt properly).

[0153] The initiator then receives the responder's response. As shown in block 1212, if the $MIC_{response}$ or any EAPOL Key attribute is invalid, the rekey is aborted and the initiator will try again. However, if as shown at block 1204 the $MIC_{response}$ and EAPOL Key attributes are valid, then the initiator installs PTK_{RN+1} and is ready to xmit and rcv with PTK_{RN+1}. The initiator then sends an EAPOL Key confirm message.

[0154] The responder then receives the EAPOL confirm message. As shown in block 1216, if the $MIC_{confirm}$ or any attribute in EAPOL Key confirm is invalid, the responder will either trigger another rekey, determine it's a spoof and disassociate or deauthenticate. As shown in block 1218, if EAPOL confirm is valid, the link is now protected using PTK_{RN+1}

[0155] On a successful rekey, the AP must synchronize the SCM's RN value for the MN. It is recommended that the synchronization be made at every rekey. To update the SCM, a WLCCP_CONTEXT message with a WTLV_UPDATE_RN is sent to the SCM.

[0156] The description above assumes that neither request nor responder is capable of using multiple Key IDs to buffer PTKs. However, the protocol of the present invention allows for this function and thus facilitate a smoother transition during a rekey operation. That is, the requestor can install PTK_{RN+1} into a new KeyID and thus enable reception of packets under either PTK_{RN} or PTK_{RN+1}. Similarly, the responder could plumb the key in the alternate specified Key ID and also allow transmission and reception under either key. The final confirmation is to halt transmission and reception under the current (old) PTK_{RN}.

[0157] CCKM uses the SSN and TGi style of rekeying for updating multicast (GTK) keys and is thus not defined in this specification. For details on group/broadcast key updates refer to the latest TGi draft.

[0158] To shorten the re-association handshake, this design minimizes the number of packets exchanged between the client station and the AP to two packets - re-association request and re-association response. Referring to FIG 13, a new proprietary element 1300 is introduced to facilitate the handoff in the re-association messages. The element in the re-association request includes the rekey request number (RN) and an authenticated element. Where:

$$MIC_{MN}\ 1314 = \text{HMAC-MD5}(KRK, \text{MN-ID} \| BSSID \| RSNIE_{MN} \| \text{Timestamp} \| RN),$$

and

Element ID 1302 is a Cisco defined element whose value is 0x9c

Length 1304 should be the length of the CCKM element request (e.g. 24 bytes)

OUI 1306 should be 00:40:96

OUI 1308 Type should be 0

MN-ID (not shown) is the MN's MAC address,

BSSID (not shown) is the AP's MAC address,

Timestamp 1310 is the current TSF timer value,

RN 1312 is the rekey request number,

$RSNIE_{MN}$ (not shown) is the MN's requesting security policy (e.g. AKM and cipher suite negotiation);

CCKM (now shown)must be specified in the AKM selector of $RSNIE_{MN}$

[0159] The re-association response includes a new element authenticating 1400 the request, confirming use of PTK_{RN} and delivering the multicast key as shown in FIG 14. Where:

$$EGTK = RC4(RN \| PTK_{RN}, GTK)$$

$$MIC_{AP}\ 1402 = \text{HMAC-MD5}(PTK_{RN}, \text{MN-ID} \| RSNIE_{AP} \| RN \| KeyID_{unicast} \| KeyID_{multicast} \| \text{Key length} \| EGTK)$$

[0160] Referring now to FIG 15 , there is shown an example of a successful MN reassocation to a new AP. The handoff occurs in the re-associate request/response exchange. The MN 1502 must include CCKM 1528 in the RSNIE 1530 to employ the fast handoff. More importantly, the security policy negotiated by the MN 1502at reassociation must match to the one specified at initial association. The SCM 1506 must validate that the requesting RN 1532 value is greater than the previous one. The timestamp provided in the request must also be within a configurable value of the AP's TSF timer (not shown); the timestamp is included to ensure that this request is fresh. On a response, the AP 1504 must also provide it's TSF timer value in the CCKM response element to assure the MN 1502 that the response is also fresh.

[0161] When the AP 1504 receives a re-association request and CCKM is negotiated, it must query the SCM 1506

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for validation of security credentials and acquire the RN and BTK before it can generate PTK_{RN}. The request is made using a WTLV_SECURE_CONTEXT request to the SCM 1506. If the SCM 1506 cannot validate credentials, then it will not deliver anything and provide a non-zero status indicating failure. On a successful transfer, the SCM 1506 will deliver the RN and BTK in an encrypted and authenticated WTLV_SECURE_CONTEXT reply. The validation of security credentials prevents an insider from fast reassociation with a different SSID.

[0162] On a successful context transfer, the AP 1504 proceeds to generate the PTK as described herein *infa.* It will then use the PTK to encrypt and authenticate the new information element to affirm PTK and securely deliver the multicast key, GTK.

[0163] If CCKM is negotiated but no proprietary element is provided, the AP 1504 can still request for security credentials. If credentials are valid then a full WTLV_INIT_SESSION establishment of fresh KRK and BTK is triggered and upon a successful 4-way exchange, KRK and BTK are mutually derived by SCM 1506 and MN 1502 and RN is reset to 1. If there are no credentials or the request to the SCM fails, the AP may choose to enforce a full (re)authentication.

[0164] By utilizing a sequence of PTK the client station is ready to decrypt unicast packets *before* the client initiates the re-association request. The client confirms its identity in the re-association request by using an incrementing authenticator (request number) and corresponding authentication (MIC). The AP 1504 uses the re-association response to confirm its identity and to piggyback the multicast key information (GTK) to the client STA.

[0165] For each fast re-association attempt, a unique request number (RN) will be used. On each fast re-association attempt, the client will increment the RN. The SCM prevents replay of a fast re-association request by caching the last RN used by the client, and rejecting any request for which the RN is less than or equal to the cached last RN.

[0166] Note that the derivation of the credentials and keying information includes the BSSID to prevent replay attempts across different APs. For example, without the BSSID, a hacker could attempt to reuse a fast-reassociation request for one AP to associate to a second AP. Which attempt will reach the SCM first - the hacker or the true client - depends on the delays through the network.

[0167] In another embodiment, there may be included the ability to forward security credentials to registered APs. For networks with large latency between the AP 1504 and the SCM 1506, the SCM 1506 information can also be cached at the AP 1504. In this case, the AP 1504 could perform all of the calculations that would normally be done at the SCM 1506. The AP 1504 can verify the authentication of a client, without having to query the SCM 1506 to obtain the latest RN, as the last RN used for a particular BSSID is sufficient to prevent replay. The AP 1504 should send an update to the SCM 1506 to ensure that the SCM 1506 has the latest RN information - this is particularly important if the AP should stale the information and request the information from the SCM later.

[0168] The process for the reassociatoin starts at 1510 wherein a MN 1502 advances RN and generates a new PTK_{RN}. As shown at 1512, the MN 1502 sends the Re-Assoc Request to the AP 1512 which includes RN 1532, $RSNIE_{MN}$ 1530 with CCKM 1528 as the negotiated key management value. The AP 1504 then sends a WLCCP(MN, Pre-Reg Req, WTLV_SECURE__CONTEXT, MN-ID, BSSID, RN, VLAN, MIC_{KRK}) to the SCM 1506 as shown by 1514. The SCM 1506 responds with WLCCP(MN Pre-Req Reply, WTLV_SECURE_CONTEXT, MN-ID, BSSID, RN, VLAN, BTK) as shown by 1516. As shown in block 1518, the AP 1504 authenticates and decrypts the BTK for the MN 1502 using it's AP's CTK and derives PTK_{RN}. At 1520, the AP 1504 sends Re-Assoc Resp(RN, $RSNIE_{AP}$ $Nonce_{GTK}$ E(PTK, GTK), MIC(PTK, MN-ID, BSSID, RN, RSNIEAP, $Nonce_{GTK}$, E(PTK,GTK)) which completes the liveness of PTK_{RN} and delivery of the GTK. Then as shown in block 1522 the MN 1502 authenticates and decrypts the GTK for this STA using PTK. Once the AP 1504 has completed the establishment of a secure communication link with the MN 1502, it registers the MN 1502 as being active with the AP 1504. This is accomplished by steps 1524 and 1526. At step 1524 a WLCCP(MN, REg Req) is sent from AP 1504 to SCM 1506 and the reply is sent at step 1526 as WLCCP(MN Reg Reply).

[0169] While this design promotes the use of CCKM, other Authenticated Key Management (AKM) types can be supported. Since CCKM-capable MNs are the only MN types that have their credentials cached at the SCM and thus require registration. However, in order to properly propagate credentials to the AP, all MNs require pre-registration. Whether supporting a legacy or SSN-capable client the credential propagation and pre-registration is the same, as shown in Figure 16.

[0170] A key hierarchy is defined to allow for stretching keys as well as derivation of fresh keys. This section describes the functions used to derive the keys. A comment must be made though, to address the issue of key entropy.

[0171] CCKM ensures key freshness but relies on the provisioning of strong keys; e.g. having good entropy. If implementations like LEAP which are password based are believed to have low entropy then further crypto tools can be used to improve the key's entropy. TGi has already adopted a variation of PKCS#5 as a means of improving key entropy which this design can easily adopt. Note however, that this requires far more computation that some NICs can provide.

KRK and BTK derivation:

[0172] To ensure fresh KRK and BTK keys, the AP and MN engage in a 4-way handshake to provide key material required for deriving KRK and BTK. Each node must provide 16byte nonces that are subsequently used with the NSK

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to derive the required keys. The function is defined as follows:

$$GK = PRF\text{-}384(NSK, \text{“Cisco Key Management Base Key Generator”} \mid BSSID \mid STA\text{-}ID \mid Nonce_{STA} \mid Nonce_{SCM})$$

$$KRK = GK[0:127]$$

$$BTK = GK[128:383]$$

PRF-384 is defined in Section 0.

[0173] Since the same PRF-XXX function is used to generate multiple key types, the string "Cisco's Key Management Base Key Generator" is introduced to this key derivation function to ensure that these keys are uniquely constructed from other key types.

Securing WLCCP messages:

[0174] To protect WLCCP messages from eavesdropping and man-in-the-middle attacks, most WLCCP messages are encrypted using RC4 and authenticated using HMAC-MD5. An AP establishes a CTK with the SCM during pre-registration so that it can commence protection of WLCCP messages.

[0175] The CTK is a 256bit key that is used to protect WLCCP messages as follows:

- The low order 128bits of CTK is used as the RC4 key.
- The high order 128bits of CTK is used as the HMAC-MD5 key

CTK Key Derivation:

[0176] Context transfer keys used between the AP and SCM are generated and distributed by the SCM. Each node in the link must provide an 16 byte nonce to assure a fresh key:

$$CTK = PRF\text{-}256(NSK, \text{“SWAN IN - IA link Context Transfer Key Derivation”} \mid AP\text{-}ID \mid SCM\text{-}ID \mid Nonce_{AP} \mid Nonce_{SCM} \mid KSC)$$

[0177] The CTK is computed by the SCM and delivered to the AP for protecting subsequent WLCCP messages. Delivery of the CTK is done by encrypting and authenticating the key using the NSK.

PTK Key Derivation

[0178] PTKs are a maximum of 512 bytes as they are used to protect both 802.1X and 802.11 communications. Its length is dependent on the 802.11 cipher suite negotiation established at association.

[0179] PTKs are derived by use of a one way hash function: SHA-1 and is based on the BTK, RN and BSSID:

$$PTK = PRF\text{-}Len(BTK, RN \mid BSSID)$$

where Len = 384 for WRAP or CCMP, 512 for TKIP or CKIP

[0180] While the present invention uses PTK liberally, the PTK generated is partitioned into several keys used to protect the following (also shown in Figure 1):

- EAPOL Key encryption between the AP and MN

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- EAPOL Key authentication between the AP and MN
- 802.11 encryption
- For 802.11 TKIP and CKIP: data packet authentication between the AP and MN

[0181] The key assignment for PTK is as follows:

EAPOL-Key MIC Key	= PTK[0 :127]
EAPOL-Key ENC Key	= PTK[128 : 255]
802.11 Encrypt Key	= PTK[256 : 383]
TKIP Michael Authenticator Tx Key	= PTK[384 : 447]
TKIP Michael Authenticator Rx Key	= PTK[448 : 511]

[0182] The definition and pseudocode for generating arbitrary length keys based on given key material is as follows (extracted from TGi draft 2.3):

```
    H-SHA-1(K, A, B, X) = HMAC-SHA-1(K, A|Y|B|X) where Y is a single octet
containing 0x00 (zero)
     PRF-384(K, A, B) = PRF(K, A, B, 384)
     PRF-512(K, A, B) = PRF(K, A, B, 512)
     PRF(K, A, B, Len)
     {
     octet i;
   for (i = 0; i < (Len+159)/160; i++) {
    R = R |H-SHA-1(K, A, B, i)
     }
    L(R, 0, Len)
    }
```

[0183] The key used in SHA-1 is one generated independently by the SCM and need not be shared by any other party.

```
    HMAC-SHA1 Reference code

    #include "stdafx.h"
    #define ULONG unsigned long
    #include <sha.h>

    void hmac_sha1(
    unsigned char *text, int text_len,
    unsigned char *key, int key_len,
    unsigned char *digest)
    {
    A_SHA_CTX context;
    unsigned char k_ipad[65]; /* inner padding - key XORd with ipad */
    unsigned char k_opad[65]; /* outer padding - key XORd with opad */
    int i;

     /* if key is longer than 64 bytes reset it to key=SHA1(key) */
     if (key_len > 64) {
     A_SHA_CTX tctx;

     A_SHAInit(&tctx);
     A_SHAUpdate(&tctx, key, key_len);
     A_SHAFinal(&tctx, key);

     key_len = 20;
     }

    /*
     * the HMAC_SHA1 transform looks like:
     *
     * SHA1(K XOR opad, SHA1(K XOR ipad, text))
```


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```
 *
 * where K is an n byte key
 * ipad is the byte 0x36 repeated 64 times
 * opad is the byte 0x5c repeated 64 times
 * and text is the data being protected
 */

/* start out by storing key in pads */
memset(k_ipad, 0, sizeof k_ipad);
memset(k_opad, 0, sizeof k_opad);
memcpy(k_ipad, key, key_len);
memcpy(k_opad, key, key_len);

 /* XOR key with ipad and opad values */
 for (i = 0; i < 64; i++) {
 k_ipad[i] ^= 0x36;
 k_opad[i] ^= 0x5c;
 }

 /* perform inner SHA 1 */
 A_SHAInit(&context); /* init context for 1st pass */
 A_SHAUpdate(&context, k_ipad, 64); /* start with inner pad */
 A_SHAUpdate(&context, text, text_len); /* then text of datagram */
 A_SHAFinal(&context, digest); /* finish up 1st pass */

/* perform outer SHA1 */
A_SHAInit(&context); /* init context for 2nd pass */
A_SHAUpdate(&context, k_opad, 64); /* start with outer pad */
A_SHAUpdate(&context, digest, 20); /* then results of 1st hash */
A_SHAFinal(&context, digest); /* finish up 2nd pass */
}
```

HMAC-SHA1 Test vectors (extracted from the SSN draft):

```
        The test vectors for HMAC_SHA1 are from rfc2202 and have
been checked against the reference code above. The PRF test vectors have
been checked against two other implementations.

    test_case = 1
    key = 0x0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b
    key_len = 20
    data = "Hi There"
    data_len = 8
    digest = 0xb617318655057264e28bc0b6fb378c8ef146be00
    PRF =
0xbcd4c650b30b9684951829e0d75f9d54b862175ed9f00606e
        17d8da35402ffee75df78c3d31e0f889f012120c0862beb6775
         3e7439ae242edb8373698356cf5a
     test_case = 2
    key = "Jefe"
    key_len = 4
    data = "what do ya want for nothing?"
    data_len = 28
    digest = 0xeffcdf6ae5eb2fa2d27416d5f184df9c259a7c79
    PRF = 0x51f4de5b33f249adf81aeb713a3c20f4fe631446fabdfa58
         244759ae58ef9009a99abf4eac2ca5fa87e692c440eb40023e
         7babb206d61de7b92f41529092b8fc
    test_case = 3
    key = 0xaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
    key_len = 20
    data = 0xdd repeated 50 times
    data_len = 50
```


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```
digest = 0x125d7342b9ac11cd91a39af48aa17b4f63f175d3
PRF = 0xe1ac546ec4cb636f9976487be5c86be17a0252ca5d8d8df12c
      fb0473525249ce9dd8d 177ead710bc9b590547239107aef7b4ab
      d43d87f0a68f1cbd9e2b6f7607
```

[0184] In addition to the aforementioned method, another aspect of the present invention is a Wireless LAN Context Control Protocol (WLCCP) that is used to establish and manage a network topology, referred to herein as the Smart Wireless Architecture for Networking (SWAN), and it is used to securely manage the "operational context" for mobile stations in a SWAN "campus network".

[0185] A WLCCP registration protocol a) automatically creates and deletes links in the SWAN topology, b) securely distributes operational context, and c) (optionally) reliably establishes Layer 2 forwarding paths on wireless links.

[0186] A WLCCP SCM advertisement/election protocol automatically establishes a single SCM as the central control point for each subnet, and enables APs and MNs to select the parent node that provides the "least-cost path" to a backbone LAN.

[0187] WLCCP "Context" messages provide a general-purpose transport for context and management information. WLCCP "Trace" messages facilitate network diagnostic tools.

[0188] WLCCP is a transaction-oriented "request/reply" protocol. All WLCCP request and reply messages have a fixed-length header that contains message-type-dependent fields. Optional Type-Length-Value pairs follow the fixed length header; therefore, WLCCP is extensible.

[0189] Ethernet or UDP/IP encapsulation can be used for WLCCP messages. Ethernet encapsulation is restricted to intra-subnet (e.g. AP-to-AP or AP-to-SCM) WLCCP messages. IP encapsulation must be used for inter-subnet WLCCP messages and may also be used for intra-subnet WLCCP messages.

[0190] As those skilled in the art can readily appreciate, a specific WLCCP implementation may not include all of the components described herein.

[0191] A "distributed" context transfer protocol can be used to directly transfer context from an "old AP" to a "new AP", when a MN roams. The IEEE 802.11f draft protocol, for example, defines a distributed context transfer protocol. There are a number of inherent problems with such a distributed approach. The most notable problems are: 1) Secure context transfer requires a many-to-many trust relationship between APs (or requires some additional hierarchy). 2) A protocol is needed to enable the "new AP" to determine the "old AP" when a MN roams. (The "old AP" 802.11 Reassociation field is not sufficient.) Context is passed around from AP to AP as a station roams; therefore, critical context may be lost (e.g. if the link to an old AP is lost). 4) A distributed protocol is susceptible to an inherent race condition where "handoff messages" for rapidly roaming stations may arrive out-of-order.

[0192] The SWAN network disclosed herein is organized as a hierarchical "Topology Tree". When a station roams from an "old AP" to a "new AP", context is generally transferred via the "nearest common ancestor", in the Topology Tree, of both the old and new APs. WLCCP registration includes the necessary routing logic to automatically find the nearest common ancestor. Cached configuration and context information is stored in the network infrastructure. The common ancestor securely forwards the cached information on the new Topology Tree branch for a station that has roamed. Therefore, context transfer is automatically "localized" and context information is not lost if the link to an old AP is lost. The common ancestor also forwards the "old AP bindings" to the new AP.

[0193] A many-to-many security relationship between 802.11 APs is not needed for secure context transfer in a SWAN network. Instead, a trust hierarchy is established that corresponds to the SWAN Topology Tree. Operational context is generally forwarded on Topology Tree branches; therefore, WLCCP context transfer keys are pre-established between all SWAN nodes on the same topology tree branch. If it necessary to transfer context "laterally" between 2 nodes on different topology tree branches, then the nearest common ancestor of the 2 nodes can function as a trusted third party to quickly establish mutual authentication and a transient context transfer key.

[0194] The hierarchical Topology Tree facilitates central management and control points. For example, network-wide parameters can be centrally configured and distributed. A central WLCCP control point establishes and deletes topology links; therefore, it is possible to maintain a consistent network topology even if hand-off messages for rapidly roaming stations arrive out-of-order.

[0195] A locally or globally administered 48-bit IEEE 802 address is used as an internal WLCCP network Node Address. An IP address is not used as a Node Address because: a) A node may change its IP address. b) WLCCP is used to manage Layer 2 mobility; it should generally be independent of any network layer protocol.

[0196] A WLCCP Node Address is an internal WLCCP node identifier and should NOT be used to identify APs and CMs to users in network management applications. Instead, a Network Access Identifier (NAI) or domain name can be used as a user WLCCP node identifier.

[0197] The design of WLCCP of the present invention considers the following underlying assumptions and requirements:

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1) The target environment is an enterprise "campus network".
2) 802.11 is an Ethernet access technology, which is used to extend wired Ethernet backbone LANs to Mobile Nodes and select "secondary LANs".
3) An 802.11 AP is, effectively, a Layer 2 "Ethernet" bridge.
4) An 802.11 Mobile Node (MN) is, effectively, a mobile "Ethernet" node.
5) WLCCP is generally independent of the underlying radio technology.
6) A MN should be able to roam seamlessly within a single subnet or between subnets within a "campus network" and operate as if attached to an Ethernet switch port; therefore, is necessary to transfer location-specific operational context when a MN roams.
7) The path between a MN and each Correspondent Host (CH) must be reliably re-established when the MN roams. [Simple backward-learning is not sufficient and is susceptible to a "race conditions".]
8) Non-WLCCP Ethernet bridges and switches must support backward-learning, as defined in the 802.1D standard.
9) WLCCP must provide context management services for an integrated Proxy-MIP/VLAN seamless inter-subnet mobility solution. The seamless mobility solution must support both IP and non-IP applications; it must not require client support; and it must not require users to significantly change their existing wired topologies.
10) WLCCP does NOT facilitate (or preclude) seamless roaming between subnets in different geographic locales.
11) A campus network may include a large population of stations that roam frequently; therefore, the overhead for roaming must be minimal.
12) WLCCP must support very fast roaming for QoS applications.
13) WLCCP must support existing WLAN features, include wireless (i.e. repeater) APs, wireless bridges, and mobile APs and bridges.
14) Unicast and multicast frame flooding must be minimized on wireless links.
15) WLCCP must support fast, secure context transfer, without introducing a need for many-to-many security relationships between APs.
16) WLCCP must operate independently of any underlying Spanning Tree Protocol.
17) WLCCP must not significantly increase user configuration requirements; therefore, the underlying topology must be largely self-configuring.
18) WLCCP must not introduce single points of failure. The network must continue to operate, possibly with reduced features, if a SWAN node or link fails.
19) WLCCP must leverage existing standards, as much as possible.
20) WLCCP must not interfere with existing protocols. In particular, WLCCP must not preclude standard Mobile IP clients.
21) Client MNs must NOT be required to directly support WLCCP. Instead, MNs can indirectly support WLCCP via 802.11 elements.
22) WLCCP must provide building blocks for WLAN management and diagnostic tools.
23) The radio coverage of APs on different subnets may overlap.
24) WLCCP secure context transfer and message authentication is independent of the underlying security infrastructure, except that it must be possible to mutually authenticate SWAN nodes and establish secret session keys.
25) WLCCP does NOT provide MN authentication; however, it must facilitate fast re-authentication by securely transferring dynamic MN security credentials.

As used herein, a SWAN network is a "tree topology" rooted at a SWAN CM. WLCCP is used to establish and maintain the Topology Tree. An example Topology Tree for a full WLCCP implementation is shown in figure 17. Figure 17 shows a "campus topology" with two local control domains (LCM) 1706 and 1706 and three subnet control domains (SCM) 1708, 1710 and 1712. The example network includes a Work-group Bridge (WGB-1) 1714 and its attached Ethernet Nodes (EN-1 and EN-2, 1716 and 1718 respectively). Topology branches that exist over 802.11 links are shown as dashed lines 1720a - f.

Possible subnet topology components are specific to the WLCCP implementation. An example subnet topology for an implementation that supports Layer 2 path updates and wireless bridges will be illustrated herein *infra*.

[0198] SWAN CMs and APs are interior nodes (INs) and MNs and secondary Ethernet Nodes (ENs) are leaves in the SWAN Topology Tree. The SWAN CCM 1702 is at the root of the campus Topology Tree. The CCM 1702 is the root CM, in a campus network. An LCM 1704, 1706 is at the root of the sub tree contained in a Local Control Domain. An SCM 1708, 1710, 1712 is at the root of the sub tree contained in each network subnet. A "parent AP" 1722, 1724, 1726 and 1728 is at the root of a sub tree that contains child MNs 1730, 1732 and 1734 and any child Aps 1736 and 1738.

[0199] The format of a WLCCP Node ID is shown in table 1800 of FIG 18. A 64-bit WLCCP Node ID identifies each node in a SWAN network. A Node ID is a concatenated 16-bit WLCCP Node Type 1802 and a 48-bit WLCCP Node Address 1804. The Node Address 1804 for a MN, EN, AP, or SCM is a global 48-bit IEEE 802 address. The Node Address 1804 for an LCM or CCM can be a global or locally-administered 48-bit IEEE 802 address. It is contemplated

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in one embodiment, the CCM can automatically assign "local" 48-bit addresses to itself and other LCMs. A Node Address of 'all zeros' is used to identify the "local WLCCP node" in a WLCCP CM or AP. The Node Type is CCM, LCM, SCM, AP, MN, or EN.

[0200] Each physical AP (e.g. Ethernet and 802.11) communications interface is identified by a 48-bit IEEE 802 port address. An SCM's LAN communications interface is also identified by a 48-bit IEEE 802 port address. An 802 port address can be re-used as the WLCCP Node Address. Each WLCCP CM must have an IP communications interface, which is identified by an IP port address. An IP port address is not used as a CM node address because a CM's IP address may change.

[0201] AP communications interfaces generally operate in "promiscuous mode"; therefore, an AP can receive WLCCP frames destined to its Node Address on any physical interface. In a simple implementation, the AP Node Address can be used to identify an "internal WLCCP interface" in an AP.

[0202] Figure 19 shows the internal bridging structure in an AP. The Ethernet 802 port address is also the WLCCP Node Address. A frame, which is destined to the Node Address and received on either the Ethernet or 802.11 interface, is "bridged" internally to the WLCCP protocol interface; therefore, the Node Address can also be used as the WLCCP "Hop Address" on any AP port. [WLCCP and DDP are shown together because they share the same Ethernet DIX type.]

[0203] Each WLCCP AP and CM should be configured with a permanent "node name" [e.g. Network Access Identifier (NAI) or a DNS domain name]. An LCM must be configured with a node name to request a locally administered Node Address from the CCM.

[0204] A Node ID is NOT a permanent node identifier and should not be used as such. An NAI can be used to represent network nodes to users.

[0205] An Instance Identifier and its Node ID identify each "instance" of an "Attached" AP or CM. In WLCCP, an *Instance Age* is used as the instance identifier, as described below.

[0206] Each WLCCP CM must maintain cross-referenced tables that are used to map a WLCCP Node ID to a node name or IP address, or vice-versa.

[0207] Referring again to FIG. 17, in a campus network, each SWAN AP 1722, 1724, 1726, and 1728 CM 1704, 1706, 1708, 1710, 1712 other than the SWAN CCM 1702, is bound to a single "parent node" and to a single "parent CM". The parent CM for an LCM is the CCM. The parent CM for an SCM is an LCM. [Note that a single device may include multiple logical CMs. The device that contains the CCM always contains a logical LCM.] In figure 17, the parent node and parent CM, for AP 1720 ,are AP 1728 and SCM 1712, respectively.

[0208] The SCM for each subnet is the parent CM for all APs on its subnet and for all MNs that are associated with those APs. Note that a MN is a child of the SCM for the parent AP's "native" subnet even if the MN is bound to a different "home subnet" via VLAN trunking or Proxy MIP tunneling. For example, in figure 17, SCM 1708, AP 1722 and AP 1724 all belong to the same subnet. MN 1730 is a child of AP 1722; therefore, it is a child of SCM 1708. However, MN 1730 may belong to a different subnet if AP-1 is attached on a VLAN trunk link.

[0209] The "parent node" for an LCM or SCM is the parent CM. The parent node for a MN is the 802.11 parent AP. The parent node for a "root AP" is an SCM. The parent node for a non-root AP is the 802.11 parent AP. A node is considered a "child" of its parent. A "neighbor" is a parent or child node.

[0210] A logical "link" exists between a node and each of its neighbors. A "port" is the logical entity that provides access to a link. Each CM and AP has a single primary port and one or more secondary ports. A node attaches to the network on its primary port. Multiple logical ports may exist on top of a single physical communications interface. For example, in figure 17, AP 1728 may use the same physical 802.11 interface to access the link to AP 1736 and AP 1738; however, AP 1728 has a separate logical port for each link.

[0211] A "branch" of the Topology Tree is comprised of a set of nodes and links that provide the shortest path between an "ancestor" node and a "descendant" node. An inbound node is an ancestor and an outbound node is a descendant. All nodes are descendants of the root CM 1702. An outbound path originates from an ancestor node and terminates at a descendant node. An inbound path originates at a descendant node.

[0212] SWAN CMs are NOT in the forwarding path for non-WLCCP messages; therefore, a node's SWAN "path instance" is NOT the same as the node's data forwarding path. A Topology Tree **"link"** exists between each SWAN node and each of its neighbors. A link is established when a "child node" selects a "parent node" and registers with the SWAN infrastructure via its parent node. An SCM-to-AP link is always an Ethernet link. An AP-to-AP link can be an Ethernet or 802.11 link. An AP-to-MN link is (currently) always an 802.11 link. A CM-to-CM link can, conceptually, be any link that supports IP.

[0213] A node is responsible for maintaining the "link state" for each of its neighbors. An active link is in a "connected" state. A link transitions to a "disconnected" state if the underlying physical communications link is lost or if a child roams to a different parent node. A node must be able to detect link state changes in its neighbors; otherwise, links may exist in a "half-connected" state. [AP-to-AP 802.11 link state is transparent to WLCCP implemations where WLCCP is not used for Layer 2 path updates.]

[0214] The CCM's IP address or domain name must be statically configured in each LCM and in each SCM candidate.

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It is contemplated that in one embodiment an LCM or SCM can automatically discover the CCM, via a CCM Advertisement Protocol.

[0215] The list of subnets that are bound to each LCM is configured in the CCM. An SCM sends a request message to the CCM, initially and whenever any parent LCM is lost, to obtain its parent LCM assignment.

[0216] An SCM is automatically elected for each subnet. An AP automatically discovers its parent SCM, via an SCM Advertisement Protocol. A non-root "child AP" is also bound to a "parent AP", as described below. A MN is bound to a parent AP via the 802.11 association protocol.

[0217] A node is either in an "Attached" or "Unattached" state. A node is initially in the Unattached state. A CCM candidate transitions to the Attached state when it becomes the active CCM. A CCM transitions to the Unattached state when it relinquishes the CCM role. A non-CCM node transitions to the Attached state when it initially registers with the SWAN infrastructure. An Attached non-CCM node transitions to the Unattached state if a) it detects that is parent node is unattached, or b) it is unable to communicate with its parent node.

[0218] Each CM must maintain an internal Instance Age that contains the elapsed time, in seconds, since the node last transitioned to the Attached state. The Instance Age is initialized to 0 and is reset to 0 each time the node initially registers with a new parent CM. The Instance Age of an SCM is copied into the *Instance Age* field in SCM-Advertisement Reply messages, so that a child AP can detect a new instance of its parent SCM. A child AP becomes Unattached if it receives an advertisement message with a lower *Instance Age.* In one embodiment, an AP does not need to maintain an Instance Age if WLCCP is not used for Layer 2 path updates.

[0219] A SWAN network generally operates in "campus infrastructure mode" with a single CCM and corresponding Campus Control Domain. An LCM and its corresponding Local Control Domain must operate in "local stand-alone mode" if the LCM cannot communicate with the CCM. An LCM must also operate in stand-alone mode if it is not assigned to a CCM. Likewise, each SCM and corresponding subnet must operate in "subnet stand-alone mode", if the SCM is not assigned to a parent LCM.

[0220] In stand-alone mode, a Local Control Domain or Subnet Control Domain operates much like a SWAN campus network. An LCM operating in local stand-alone mode assumes CCM functions. The LCM or SCM at the root of a stand-alone domain functions as the 802.1X authenticator for both infrastructure nodes and MNs. A Local or Subnet Control Domain must be able to transition smoothly between infrastructure mode and stand-alone mode.

[0221] An LCM is configured with the IP address of the CCM, to operate in infrastructure mode. If an LCM is operating in stand-alone mode because it lost the link to its assigned CCM, then it must periodically attempt to re-establish communications with the CCM.

[0222] An SCM is configured with the IP address or domain name of the CCM, to operate in infrastructure mode. The CCM is responsible for assigning each SCM to an LCM, as described below in the section entitled "W2 - Parent LCM Assignment".

[0223] An AP must operate in a fallback "distributed mode" if it cannot discover an SCM for its subnet. An AP must be able to transition smoothly between infrastructure mode and distributed mode. For example, an AP can use the existing Cisco Datagram Delivery Protocol in distributed mode. Note that a user can force APs to operate in distributed mode by simply not configuring any SCM candidates.

[0224] In general, an LCM or SCM can transition smoothly from infrastructure mode to stand-alone (i.e. when the link to its parent is lost) mode without disconnecting nodes in its sub tree. Nodes in a "new" stand-alone domain can continue to use existing registration information and security credentials, which were previously established in infrastructure mode.

[0225] The sub tree rooted at an LCM or SCM must be rebuilt when the LCM or SCM transitions from stand-alone mode to infrastructure mode. An SCM or LCM establishes a new Instance ID when it transitions from stand-alone to infrastructure mode. An SCM also establishes a new Instance ID if its parent LCM changes. The sub tree rooted at the SCM or LCM is automatically deleted as nodes in the sub tree detect the new SCM or LCM instance.

[0226] WLCCP "Context Management" message types are listed below. A "request" and "reply" subtype is defined for each message type. An optional "confirm" and "ack" subtype is defined for select message types that require additional handshaking.

SCM-Advertisement
CCM-Advertisement
Registration
Preregistration
Deregistration
Detach
Context
Path-Update
Path-Check
Trace

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AAA
Path-Init

[0227] WLCCP message formats are defined in the section entitled "WLCCP Protocol Definitions".

[0228] A "Response-Req" Flag is set ON in a Request message to solicit a Reply message. In general, a reply message is used to acknowledge a request message and to return status and/or context information to the Originator. A request "message identifier" is copied into the corresponding reply message to "match" request/reply pairs. The same message identifier is used in retransmitted request messages, to identify all request/reply messages that belong to a single transaction.

[0229] An optional "Confirm" message can be used to acknowledge a Reply message and return status and/or context information to the Responder. The Response-Req Flag is set ON in a Reply message to solicit a Confirm message.

[0230] An optional "Ack" message can be used to acknowledge a Confirm message and return status and/or context information to the Originator. The Response-Req Flag is set ON in a Confirm message to solicit an Ack message.

[0231] WLCCP messages contained a fixed-length header, followed by optional, variable-length TLVs.

[0232] An SCM sends periodic SCM-Advertisement-Reply messages to advertise network parameters and availability and to facilitate the SCM election protocol, on each AP "native" subnet. APs automatically discover the active SCM for the local subnet by monitoring SCM advertisements. APs receive SCM advertisements on a "primary port" and forward SCM advertisements on "secondary ports" to propagate SCM and subnet information to descendent nodes in the SWAN topology.

[0233] A node can send an SCM-Advertisement-Request message to solicit an SCM-Advertisement-Reply message (e.g. to shorten the discovery period).

[0234] A CCM can, optionally, send periodic CCM-Advertisement-Reply messages to advertise network parameters and availability and to facilitate a CCM election protocol. LCMs and SCMs can automatically discover the active CCM by monitoring CCM advertisements. CCM-Advertisement Request and Reply messages are sent to an IP multicast address.

[0235] A node can send a CCM-Advertisement-Request message to solicit a CCM-Advertisement-Reply message.

[0236] A Registration-Request message is used to request registration for a MN, AP, or CM with the SWAN infrastructure. A SWAN node is always registered with the CCM and each LCM, SCM, and AP on the path to the CCM. A Registration-Request is always forwarded inbound on a single branch in the SWAN topology. There are two Registration Request types: An "initial" Registration Request is generated to establish a new Path Instance. An "update" Registration Request is used to refresh a Path Instance and to update cached dynamic context information.

[0237] A CM returns a Registration-Reply to acknowledge receipt of a registration request, establish a "path instance", and to return context information, including any "old mobility bindings". Registration-Reply messages establish the Layer 2 forwarding path on wireless links. A Registration-Reply is always forwarded outbound on the reverse path of the corresponding request.

[0238] Preregistration Request and Preregistration Reply messages are used to obtain security credentials and establish the authentication state for an 802.11 MN or child AP prior to registration.

[0239] A CM sends a Deregistration-Request message to request deletion an old path instance when a station roams. A Deregistration-Request is always generated by a CM (SCM, LCM, or CCM) and is always forwarded outbound on a single branch in the SWAN topology.

[0240] An AP or CM returns a Deregistration-Reply to acknowledge receipt of a Deregistration Request, delete the respective path instance, and (optionally) to return context and status information. Transient accounting statistics and an activity timestamp are (optionally) returned in the Deregistration Reply.

[0241] An AP or CM sends a Detach-Request message to its parent CM to indicate that a "detached" child station should be "deregistered". A Detach-Request message is forwarded inbound until it reaches either a CM with a "newer" registration record or the CCM.

[0242] A CM can send a Detach-Reply message to acknowledge a Detach-Request.

[0243] A Context-Request message is used to get or set context, configuration, or management information. Context messages provide a general-purpose transport for exchanging information. A Context-Request can be used, for example, to initiate a lateral handoffwhen a station roams from an old LCM to a new LCM. The new LCM or the old LCM may send the Context-Request. A Context-Request that is generated by the old LCM may contain context and configuration information. A Context-Request message can also be used to predictively forward mobility context for a MN to SCMs or APs. [A Context-Request that is used to "get" information contains one or more "request" TLVs.]

[0244] A Context-Reply message is used to acknowledge a Context-Request message. It is also used to return status information (e.g. for a "set" request) or context, configuration, or management information (e.g. for a "get" request) for a corresponding Context-Request message.

[0245] A Path-Update-Request message is used to re-establish the backward-learned path between a wireless station and each correspondent host, when the wireless station roams from an old AP to a new AP within a single subnet. The

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Path-Update-Request is sent from the new AP to the old AP, with the source 802 address of the station that roamed.

[0246] A Path-Update-Reply message is, optionally, used to acknowledge a Path-Update-Request message and it is used to transfer transient context information directly from an "old AP" to a "new AP".

[0247] A Path-Check message is used to implement a Reliable Path Update mechanism (i.e. to recover from lost Path-Update-Request messages).

[0248] A Trace-Request message is used for SWAN path testing, response time analysis, and station tracking.

[0249] A Trace-Reply is used to acknowledge a Trace Request.

[0250] AAA messages are encapsulated 802.1X EAPOL messages typically used for authentication. Alternately, AAA messages could also be typed to designate the beginning (START) or end (SUCCESS) of an AAA message exchange. Finally, AAA messages are also encapsulated Cisco accounting messages typically used by the AP to update the session accounting maintained by the AS. When the MN is employing Cisco's Central Key Management (CCKM), initial key establishment between the MN and MN Authenticator, is triggered by the MN Authenticator initiating a 4-way handshake by sending the MN an EAPOL Key message with a 16byte nonce. To achieve this, a nonce is passed from the MN Authenticator to the AP using an AAA Success message. Details of the key establishment is described in the Fast Handoff Protocol Specification [8]. This is the only EAPOL Key message generated by the SWAN Topology, all others are results of 802.1X EAP Authentication.

[0251] AAA messages are WLCCP encapsulations of 802.1X EAPOL or Cisco session accounting messages and thus do not follow the Request-Reply norm. However, since Authenticators can detect authentication failures, the Status field provided in the outbound messages can provide more information to reflect authentication status.

[0252] Path-Init Request, Reply, Confirm, Ack. Path-Init messages are used for IN path authentication, where an IN mutually authenticates and establishes a path CTK with each of its ancestors. The necessary path authentication 4-way handshake may consist of 1) a Path-Init Request/Reply exchange followed by an initial Registration Request/Reply exchange, or 2) a Path-Init Request/Reply/Confirm/Ack exchange. (The second sequence is used to refresh path CTKs for a registered IN.)

[0253] WLCCP fields are defined in network byte and bit order (i.e. big endian). The bits in each field are numbered from left to right starting with '0' (i.e. the high-order bit is bit '0').

[0254] WLCCP messages can be encapsulated in Ethernet frames or UDP/TCP/IP packets. Ethernet encapsulation can be used for intra-subnet messages sent between two APs or an AP and SCM, which are on the same subnet. IP encapsulation must be used for inter-subnet messages. The WLCCP Ethernet DIX type is 0x872d. The WLCCP UDP/TCP protocol port is decimal 2887. It is a "well-known" protocol port that is registered with the Internet Assigned Number Authority.

[0255] A single WLCCP message format is used for both Ethernet and IP encapsulation. All WLCCP messages share a common header format, which is defined below. The header format is defined so that it is unambiguous with existing Ethernet and IP DDP message formats. The WLCCP message body, which follows the common header, contains SAP-specific message types. This document defines message formats for the WLCCP "Context Management" SAP, which is '0'.

[0256] An example Ethernet-encapsulated WLCCP Context Management frame 2000 is shown in FIG 20. The frame 2000 comprises the destination MAC address 2002, the source MAC address 2004, the DIX Type (0x872D for this example) 2006, WLCCP Common Header 2008, WLCCP Context management header 2010, Type-specific fields 2012, and Optional TLVs 2014.

[0257] In general, Ethernet encapsulation can be used for WLCCP messages that are limited to a single subnet. IP encapsulation is required for all inter-subnet messages. Ethernet encapsulation is used for SCM-Advertisement messages and intra-subnet Registration, Deregistration, Detach, Path-Update, and Path Check messages. UDP/IP encapsulation is used for CCM Advertisement messages and inter-subnet Registration, Deregistration, and Detach messages. Either Ethernet or UDP/IP encapsulation can be used for Trace messages. Ethernet, UDP/IP, or TCP/IP encapsulation can be used for Context messages.

[0258] Sample definitions for the Ethernet-encapsulated WLCCP Context Management frame 2000 are shown below:

```
#define WLCCP_DIX_ETHER_TYPE 0x872d
#define WLCCP_DEF_UDP_PROTO_PORT 2887
#define WLCCP_IP_MCAST_ADDRESS 0xE0000128 /* 224.0.1.40 */
#define WLCCP_MCAST_ADDRESS_IN {0x01, 0x40, 0x96, 0xff, 0xff, 0xC0}
```

[0259] Sample WLCCP Node Type Definitions

```
#define WLCCP_NODE_TYPE_ANY          0

#define WLCCP_NODE_TYPE_AP           1
```


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```
#define WLCCP_NODE_TYPE_SCM             2

#define WLCCP_NODE_TYPE_LCM             4

#define WLCCP_NODE_TYPE_CCM             8

#define WLCCP_NODE_TYPE_ICN             /* 0x10 infrastructure client node */

#define WLCCP_NODE_TYPE_CLIENT          0x40

#define WLCCP_NODE_TYPE_MULTI_MASK      0x8000
```

[0260] Sample WLCCP Port Type Definitions

```
#define WLCCP_PORT_TYPE_ETHER       1

#define WLCCP_PORT_TYPE_INTERNAL    2

#define WLCCP_PORT_TYPE_DOT11       0x80

#define WLCCP_PORT_TYPE_DOT11A      0x81

#define WLCCP_PORT_TYPE_DOT11B      0x82

#define WLCCP_PORT_TYPE_DOT11G      0x83
```

[0261] An "internal port" is a logical port that exists between an AP and SCM that are co-located in the same device.

```
#define WLCCP_PORT_COST_ETHER       10
#define WLCCP_PORT_COST_INTERNAL    10
#define WLCCP_PORT_COST_DOT11       50
#define WLCCP_PORT_COST_DOT11A      30
#define WLCCP_PORT_COST_DOT11B      50
#define WLCCP_PORT_COST_DOT11G      40
```

[0262] 1.1.1 Sample Miscellaneous Constants

```
#define DEF_SCM_ADVERTISE_PERIOD                            FIVE_SECONDS

#define DEF_SCM_LISTEN_TIME DEF_SCM_ADVERTISE_PERIOD        4 *

#define MAX_SCM_ELECT_TIME DEF_SCM_ADVERTISE_PERIOD         6 *

#define MAX_SCM_AGE DEF_SCM_ADVERTISE_PERIOD                8 *
```

[0263] Referring now to FIG 21 there is a table illustrating the fields for a WLCCP Message Header 2100. The columns comprise the Field Name 2102, Offset 2104, Size 2106 and a Description 2108 of each field of the message header 2100.

[0264] The length of the fixed WLCCP header 2100 is 28 bytes. The fields Protocol ID/Version 2110, WLCCP SAP 2112 and Destination Node type 2114 are common to all WLCCP SAPs. The remaining fixed fields are common to all Context Management frames (i.e. all frames defined in this document). If the Relay Flag is set ON, then the header is immediately followed by an 8-byte *Relay Node ID* field.

```
#define WLCCP_PROTO_ID 0xC0
```

[0265] The WLCCP *Protocol ID* 2110, 0xC0, is defined so that WLCCP and DDP messages can share the same DIX Ethernet type and UDP protocol port. The DDP message header is defined in Appendix B.

[0266] The *Destination Node Type* 2114 and *WLCCP SAP* 2112 fields are used to select the internal destination within the device identified by the Ethernet or IP destination address. The sender must set the *Destination Node Type* 2114 to the node type of the immediate receiver, before sending a WLCCP message. The *Destination Node Type 2114* can be '0' if the SAP uniquely identifies the internal destination.

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[0267] The *Hop Count* 2116 field contains the number of WLCCP hops (minus one) between the Originator and Responder. The Originator or Responder must initialize the *Hop Count* to '0'. The *Hop Count* is incremented by each intermediate node on the path to the Originator or Responder. A message is discarded if the *Hop Count* exceeds WLCCP_MAX_HOP_COUNT.

```
#define WLCCP_MAX_HOP_COUNT        25

#define WLCCP_PROTO_VERSION        1

#define WLCCP_CONTEXT_MGMT_SAP     0x00 /* WLCCP (mobility/context control) */

#define WLCCP_SECURITY_SAP         0x01

#define WLCCP_RRM_SAP              0x02 /* radio resource management */

#define WLCCP_QOS_SAP              0x03

#define WLCCP_NM_SAP               0x04 /* network management */

#define WLCCP_MIP_SAP              0x05
```

[0268] WLCCP message *Type* 2118 definitions :

```
#define WLCCP_TYPE_SCM_ADVERTISE   1

#define WLCCP_TYPE_CCM_ADVERTISE   2

#define WLCCP_TYPE_REG             3

#define WLCCP_TYPE_DEREG           4

#define WLCCP_TYPE_DETACH          5

#define WLCCP_TYPE_CONTEXT         6

#define WLCCP_TYPE_PATH_UPDATE     7

#define WLCCP_TYPE_PATH_CHECK      8

#define WLCCP_TYPE_PREREG          9

#define WLCCP_TYPE_TRACE           10

#define WLCCP_TYPE_EAP_AUTHEN      11

#define WLCCP_TYPE_PATH_AUTHEN     12
```

[0269] WLCCP "Reply" message types are equal to the corresponding request type ORed with WLCCP_TYPE_REPLY_MASK.

```
#define WLCCP_TYPE_CONFIRM_MASK 0x80
#define WLCCP_TYPE_REPLY_MASK 0x40
```

[0270] The *Flags* field 2120 is used as follows:

[0271] The *Retry* flag is set ON in retransmitted Request or Confirm messages. The Message ID in a retransmitted message is the same as in the original message. The Retry flag is set ON in a Reply or Ack message if it is set ON in the corresponding request message.

[0272] The *Response-Req Flag* is set ON in a request message to solicit a reply.

[0273] The *TLV* flag is set ON to indicate that optional TLVs follow the fixed fields.

[0274] The *Inbound Flag, Outbound Flag,* and *Hopwise-Routing Flag* determine how a WLCCP message is forwarded

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(as described below).

[0275] If the *Root CM Flag* is set ON in an inbound message, then the message is always forwarded to the CM at the root of the entire Topology Tree - the "root CM". If the *Root CM Flag* is set ON in an outbound message, then the message originated at the root CM.

[0276] If the *Relay Flag* is set ON, then the WLCCP header is immediately followed by a 64-bit *Relay Node ID* field (a 16-bit Node Type followed by a 48-bit Node Address).

[0277] The *MIC* flag is set ON to in a message that must be authenticated and contains a WTLV_MIC TLV.

[0278] The *Responder Node Type* bits contain the Node Type of the WLCCP node that generated the original reply message.

[0279] The *Originator Node ID* 2122, generally, identifies the node that originated a request message. The *Responder Node ID* 2124 generally identifies the target of a request message and the source of the corresponding reply message. In a WLCCP Registration message for a MN, the *Originator Node ID* is the 802 address of the MN. The *Responder Node ID* may be '0' in Registration Request, Advertisement Request, or Detach Request messages. The *Responder Node ID* may be '0' in any IP-encapsulated Request message. The *Responder Node ID* identifies the source of a solicited or unsolicited Advertisement Reply message.

[0280] The *Hop Source Node ID* contains the WLCCP Node ID of the hop source of a request or reply message.

[0281] Optional parameters may follow the fixed fields in any WLCCP message. Optional parameters are in the "TLV" format as shown in FIG 22.

[0282] The TLV *"Type"* 2210 field contains a *Container Flag,* an *Encrypted Flag,* a *Request Flag,* a *Group ID* and a *Type ID.* A "request TLV" has the *Request Flag* set ON in the *Type ID* field.

```
#define WLCCP_TLV_CONTAINER_MASK    0x8000
#define WLCCP_TLV_ENCRYPTED_MASK    0x4000
#define WLCCP_TLV_GROUP_MASK        0x0300
#define WLCCP_TLV_REQUEST_MASK      0x0080
#define WLCCP_TLV_TYPE_MASK         0x007f
```

[0283] TLV *Group IDs* are used to group TLVs hierarchically. A *Group ID* can be used to identify the software module in the target node that must process the respective TLV type.

[0284] The *Request Flag* is set on in a TLV in a WLCCP request message to "request" information from the target WLCCP node. A "request TLV" has the Request Flag set ON.

[0285] The TLV *Container Flag* can be used to group fixed attributes and other optional TLVs into a single "container TLV". The Container Flag should only be set ON in a TLV if any required TLV fields are followed by other optional TLVs. Container TLVs can be nested.

[0286] TLV Group IDs:

```
#define WTLV_WLCCP_GROUP_ID         0x00
#define WTLV_SECURITY_GROUP_ID      0x01
#define WTLV_RRM_GROUP_ID           0x02 /* radio resource management */
#define WTLV_QOS_GROUP_ID           0x03
#define WTLV_NM_GROUP_ID            0x04 /* network management */
#define WTLV_MIP_GROUP_ID           0x05
```

[0287] WLCCP TLV formats are defined in the tables below. The first row in each table contains the TLV name, TLV ID, and TLV description. The description includes a list of message types that may contain the respective TLV. The *Type* and *Length* fields are not included in the field definitions.

WTLV_NULL	0x0000	A NULL TLV can be used to pad a message for even alignment. The length must be at least '4'.
WTLV_CONTAINER	0x0001	The generic "Container" TLV is used to logically group arbitrary TLVs.
WTLV_AP_PORT_INTO	0x0002	The type, mode, and address of an AP port. Msgs: Contained in an AP_PORT_LIST TLV in an AP Registration Request

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(continued)

Field Name	*Offset*	*Size*	*Field Description*
Type	4	1	1 = Ethernet, 2 = Internal, 0x80 = 802.11, 0x81 = 802.11a, 0x82 = 802.11b, 0x83 = 802.11g
Mode	5	1	1 = Parent, 2 = Child, 3 = Parent/Child 0x80 = Primary Port mask
Address	6	6	802 hardware address
NIC ID	12	2	An integer that is used internally to identify the NIC type (e.g. Venus radio).
Version String TLV (optional)	14	N	

WTLV_IPV4_SUBNET_ID		0x0003	IP Subnet Address. Msgs: Contained in an SCM Advertisement Reply to advertise the IP address and subnet of the SCM. Optionally contain in a PMIP_SSID_LIST TLV in a Registration Request to bind a PMIP SSID to a subnet.
Field Name	*Offset*	*Size*	*Field Description*
IPv4 Address	4	4	IPv4 address
Prefix Length	8	1	Number of bits in the subnet mask
Flags	9	1	(reserved - must be 0)

WTLV_SEC_LAN_ADDR_LIST		0x0004	A list of Ethernet addresses of stations on a secondary LAN. Msgs: WLCCP Designated BridgeRegistration Req.
Field Name	*Offset*	*Size*	*Field Description*
Count	4	2	Number of addresses in the list
VLAN ID	6	2	VLAN ID of the secondary LAN. A value of '0' is used to indicate the "native VLAN".
Address List	8	N X 6	A list of Ethernet addresses.

WTLV_MCAST_ADDR_LIST		0x0005	A list of enabled multicast Ethernet addresses. Msgs: Child AP Registration Req. (implementation is optional)
Field Name	*Offset*	*Size*	*Field Description*
Count	4	2	Number of addresses in the list
Address List	6	N X 6	A list of multicast Ethernet addresses.

WTLV_IPV4_MCAST_ADDR_LIST		0x0006	A list of enabled multicast IPv4 addresses. Msgs: AP Registration Req. (implementation is optional)
Field Name	*Offset*	*Size*	*Field Description*
Count	4	2	Number of addresses in the list
Address List	6	N X 4	A list of multicast IPv4 addresses.

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WTLV_AP_PORT_LIST		0x0007	A list of AP_PORT_INFO TLVs (see above). Msgs: AP Registration Requests.
Field Name	*Offset*	*Size*	*Field Description*
Count	4	2	Number of AP ports
Port List	6	N X 16	A list of AP_PORT_INFO TLVs.

WTLV_SSID		0x0008	The SSID of an 802.11 "Requester Node". If the "Broadcast Translation" flag is set ON, then the station used a broadcast SSID. Msgs: Preregistration and Registration Request/Reply
Field Name	*Offset*	*Size*	*Field Description*
Flags	4	1	Bit 0 - AAA Assigned (set ON in a Reply message to assign a MN to the SSID) Bit 1 - Broadcast Translation Bit 2 - IN WLCCP SSID Bits 3-7 - (reserved - must be zero)
Length	5	1	SSID Length (Max. length = 32)
SSID	6	N	802.11 SSID

WTLV_IPV4_ADDRESS		0x0009	The IPv4 address of a "Requester Node" - registered in a Request msg or returned in a Reply msg. Msgs: Preregistration, Registration, Context Request/Reply
Field Name	*Offset*	*Size*	*Field Description*
IP Address	4	4	IPv4 address

WTLV_PARENT_AP_BSSID		0x000A	The BSSID for the BSS of an 802.11 MN or AP "Requester Node". Msgs: Registration Request for an 802.11 station
Field Name	*Offset*	*Size*	*Field Description*
BSSID	4	6	802.11 BSSID of the station's current BSS

WTLV_OLD_AP_BSSID		0x000B	The previous BSSID of an 802.11 MN orAP "Requester Node" from the "Current AP" element in an 802.11 Reassociation Request. Msgs: Preregistration or Registration Request for an 802.11 station.
Field Name	*Offset*	*Size*	*Field Description*
BSSID	4	6	802.11 BSSID of the station's previous BSS

WTLV_PMIP_SSID_LIST	0x000C	A container TLV that contains SSID TLVs and for each SSID TLV, a list of 0 or more MIPV4_AGENT TLVs or a SUBNET_ID TLV. The optional SUBNET_ID is included only if an HA is not known, but the subnet address is known. Msgs: SCM or AP Registration Request.

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(continued)

Field Name	*Offset*	*Size*	*Field Description*
SSID TLV	4	N	SSID TLV which contains a PMIP SSID (repeated for each PMIP SSID)
MIPV4_AGENT TLV	4 + N	6	MIPv4 HA for the default subnet bound to the SSID (repeated for each HA on the subnet).

WTLV_PARENT_CM (request)		0x008E	An SCM uses a request PARENT_CM TLV to request a parent CM (LCM or CCM) from the CCM. If the SCM was previously bound to a parent CM, then the Node ID field must contain the old parent CM's Node ID; otherwise, the Node ID field must be '0'. Msgs: Context Request sent by an SCM to the CCM.
Field Name	*Offset*	*Size*	*Field Description*
Node ID	4	8	Node ID of any old parent CM or '0'.
IPv4 Address	12	4	IPv4 address of any old parent CM or '0'.

WTLV_PARENT_CM		0x000E	The CCM uses a PARENT_CM TLV to assign an SCM to a parent CM (LCM or CCM). Msgs: Context Reply sent by the CCM to an SCM.
Field Name	*Offset*	*Size*	*Field Description*
Node ID	4	8	Node ID of the parent CM. A Node ID of '0' is used to indicate "no parent CM" (i.e. standalone mode).
IPv4 Address	12	4	IPv4 address of the parent CM.

WTLV_DELETED_NODE_LIST		0x000F	A list of Node IDs of deleted nodes. A parent SCM or AP uses the DELETED_NODE_LIST TLV to notify a child AP that it must reregister. Msgs: SCM Advertisement Reply
Field Name	*Offset*	*Size*	*Field Description*
Count	4	2	The number of deleted nodes.
Node Instance	6	12	An 8-byte Node ID followed by a 4-byte Path ID of a deleted node. The Node Instance field is repeated for each deleted node.

WTLV_MIPV4_AGENT		0x0010	The IP address, subnet prefix length, and capabilities of a MIP HA. Msgs: Contained in a PMIP_SSID_LIST TLV in an SCM or AP Registration Request.
Field Name	*Offset*	*Size*	*Field Description*
IPv4 Address	4	4	MIP agent IPv4 address
Prefix Length	8	1	Number of bits in the agent's subnet mask.
Flags	9	1	Bit 0 - Statically Configured Bits 1-7 - (reserved - must be zero)

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(continued)

Field Name	*Offset*	*Size*	*Field Description*
Capability Bits	10	2	The capability bits are the same as the last 16 bits in a MIPv4 Agent Advertisement Extension: Bits 0-8 - R,B,H,F,M,G,H,r,T Bits 9-15 - (reserved - must be zero)
Age	12	2	Elapsed time in seconds since an advertisement was received from the agent.

WTLV_OLD_AP_BINDINGS		0x0011	The Node ID, IPv4 address, and BSSID of the old AP for an 802.11 "Requester Node". Msgs: Preregistration or Registration Reply for an 802.11 station.
Field Name	*Offset*	*Size*	*Field Description*
Node ID	4	8	Node ID of the old AP
IP Address	12	4	IPv4 address of the old AP
BSSID	16	6	802.11 BSSID of the old BSS

WTLV_HOME_SUBNET		0x0412	The IP address, MIP HA, and subnet prefix length of a Proxy MIP MN. Msgs: Registration Request/Reply
Field Name	*Offset*	*Size*	*Field Description*
IPv4 Address	4	4	IPv4 address of the MN
Prefix Length	8	1	Number of bits in the MN's home subnet mask. The field can be '0' if the mask is unknown.
Flags	9	1	Bit 0 - At Home Flag (set ON if the MN is at home) Bits 1-7 - (reserved - must be zero)
HA Address	10	4	IPv4 address of the MN's HA. It is the default HA for the MN's subnet in a Request. It is the assigned HA in a Reply.

WTLV_LOST_LINK		0x0013	The LOST_LINK TLV is used to report a lost infrastructure link. Msgs: A lost secondary link is reported in a Registration Request. A lost SCM primary link is reported to the CCM in a Context Request.
Field Name	*Offset*	*Size*	*Field Description*
Node ID	4	8	Parent Node ID if the Primary flag is set ON; otherwise, the child Node ID
Reason	12	1	Reason code. 0 = General Error, 1 = Retry Error, 2 = Keepalive Timeout, 3 = Administrative Dereg., 4 = Beacon Timeout, 5 = Path Cost
Flags	13	1	Bit 0 - Primary (set ON for a primary link; set OFF for a secondary link) Bits 1-7 - (reserved - must be zero)

WTLV_VERSION_STRING	0x0014	The hardware and software version of an AP or CM "Requester Node". Msgs: Registration Request

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(continued)

Field Name	*Offset*	*Size*	*Field Description*
HW Version Length	4	1	HW version string length in bytes. The length may include 'null' padding bytes.
HW Version	5	M	HW Version String
SW Version Length	5+M	1	SW version string length in bytes. The length may include 'null' padding bytes.
SW Version	6+M	N	SW Version String

WTLV_NAME		0x0015	The Network Access Identifier (NAI) or Domain Name of a MN, AP, or CM "Requester Node". Msgs: Registration Request
Field Name	*Offset*	*Size*	*Field Description*
Name Type	4	1	1 = NAI, 2 = Domain Name
Name Length	5	1	Name length in bytes
Name	6	N	A string that contains the NAI or domain name.

WTLV_SYSTEM_ID		0x0016	System ID values. Msgs: Registration Request
Field Name	*Offset*	*Size*	*Field Description*
Product ID	4	2	An integer that is used internally to identify the product type (e.g. Ivory AP).
Version String TLV (optional)	NA	M	Optional VERSION_STRING TLV - which can contain the HW and/or SW version.
System Name TLV (optional)	NA	N	Optional NAME TLV - which contains the system name.

WTLV_NODE_ID_LIST		0x0018	A list of Node IDs, with an entry for each node on the path to the root CM. Msgs: Path-Init Request/Reply
Field Name	*Offset*	*Size*	*Field Description*
Count	4	2	The number of Node IDs in the list.
Node ID List	6	8 X N	A list of Node IDs

WTLV_MIP4_REG_REQ		0x0019	An SCM sends a MIP_REG_REQ container TLV to trigger a parent AP to send a MIP registration request for the Requester Node. A MIP "deregistration request" is sent if the MN is "at home". Msgs: MN Registration Reply
Field Name	*Offset*	*Size*	*Field Description*
Flags	4	2	Bit 0 - At Home Flag (set ON if the MN is at home) Bits 1-15 - (reserved - must be zero)
Home subnet bindings	6	N	HOME_SUBNET TLV (It may be possible to just use a flag in the HOME_SUBNET TLV)

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WTLV_AUTH_METHOD		0x001A	The authentication method(s) used for the "Requester Node". The *Fast Reauthentication Flag* is set ON if the node used fast reauthentication. Msgs: Preregistration and Registration Request
Field Name	*Offset*	*Size*	*Field Description*
Base Type	4	2	None = 0, Open = 0x0001, Shared Key = 0x0002, LEAP = 0x0004, EAP = 0x0008, MAC Address = 0x0010, Alternate = 0x0020, Client = 0x0040, Unknown = 0x8000
EAP Type	5	1	
Fast Reauthentication	6	1	Bit 0 - Fast Reauthen. Flag Bits 1-7 - Fast Reauthen. Type. CCKM = 1

WTLV_IPV4_HOP_ADDRESS		0x001B	The IPV4_HOP_ADDRESS TLV is used to advertise the IP address of an AP. Msgs: SCM Advertisement Reply generated by an AP.
Field Name	*Offset*	*Size*	*Field Description*
IP Address	4	4	AP IPv4 address

WTLV_EAP_IDENTITY		0x001C	The EAP Identity string of the "Requester Node". Msgs: Preregistration and Registration Request
Field Name	*Offset*	*Size*	*Field Description*
EAP ID Length	4	1	Length of the EAP ID in bytes.
EAP ID	5	N	A string that contains the EAP ID from the node's EAP Identity Response message.

WTLV_MN_1X_AUTHEN		0x001E	The Node ID and IPv4 address of the 802.1X MN authenticator. Msgs: IN Registration Reply and SCM Advertisement Reply. The TLV is included in SCM Advertisement messages to advertise a MN authenticator change.
Field Name	*Offset*	*Size*	*Field Description*
Node ID	4	8	Node ID of the 802.1 X MN Authenticator.
IPv4 Address	12	4	IPv4 address of the 802.1X MN Authenticator.

WTLV_ROOT_CM__INFO		0x001F	The Node ID and IPv4 address of the WLCCP Root CM. Msgs: SCM Advertisement Reply.
Field Name	*Offset*	*Size*	*Field Description*
Node ID	4	8	Node ID of the root CM.
IPv4 Address	12	4	IPv4 address of the root CM.

WTLV_REPLY_STATE	0x0020	Opaque transaction state information. REPLY_STATE TLVs contained in Request messages must be copied, in order, to Reply messages.

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(continued)

Field Name	*Offset*	*Size*	*Field Description*
Node ID	4	8	Node ID of the node that entered the TLV.
State	12	N	Opaque transaction state information.

WTLV_MN_REG		0x0021	A MN_REG TLV contains any information necessary to register a MN. It is contained in a MN_REG_LIST TLV. Any fields that are not described are defined the same as the corresponding field in the Registration header.
Field Name	*Offset*	*Size*	*Field Description*
Requestor Node ID	4	8	WLCCP Node ID of the MN.
Path ID	12	4	Contains the Path ID assigned to the MN in a Reply message.
Registration Flags	16	2	
VLAN ID	18	2	
Status	20	1	
Age	21	1	Seconds since the MN was last active.
Optional TLVs	22	N	Optional TLVs (e.g. IPV4_ADDRESS or SSID) can be included by setting the container flag ON.

[0288] Any parameters that are not contained in the WTLV_MN_REG TLV are taken from the Registration message or the encapsulating WTLV_MN_REG_LIST TLV.

WTLV_MN_REG_LIST		0x0022	A list of MN_REG TLVs and o
Field Name	*Offset*	*Size*	*Field Description*
MN_REG TLVs an other optional TLVs.	4	N	Any TLVs, other that MN_REG TLVs, establish default parameter values for succeeding MN_ REG TLVs.

[0289] The table below shows the fields for an SCM Advertisement Reply Message.

Field Name	Offset	Size (bytes)	Description
WLCCP Header	0	28	Common Context Mgmt SAP Header
Hop Address	28	6	Source 802 Port Address
SCM Flags	34	2	Bit 15 - Active Flag. Set ON in advertisements from the active SCM. Bit 14 - Unscheduled Flag (set ON in unscheduled advertisement messages) Bit 13 - Unattached Flag* (set ON in advertisements from an unattached node) Bit 12 - Layer 2 Update Flag (set ON if WLCCP Layer 2 path updates are enabled. Set OFF by default) Bits 0-11 - (reserved - must be zero)
SCM Election Group	36	1	(reserved for future use - must be zero)
Attach Count	37	1	Attach count of the hop source
SCM Priority	38	1	Bits 1-7 - SCM Priority value from 0 (lowest) to 127 (highest). Bit 0 - Preferred Flag - Set OFF if the SCM is the "preferred SCM".

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(continued)

Field Name	Offset	Size (bytes)	Description
Bridge Priority	39	1	Bits 1-7 - Bridge Priority value from 0 (highest) to 127 (lowest). Bit 0 - Bridge Disable Flag. Set ON to indicate that secondary bridging is disabled. The Bridge Priority is used to negotiate the WLCCP designated bridge on a non-STP secondary Ethernet LAN.
Instance Age	40	4	The "instance age" of the SCM, in seconds
SCM Node ID	44	6	WLCCP Node ID of the SCM
Path Cost	50	2	Sum of port costs on the path to the SCM
Hop Count	52	1	Number of wireless hops on the path to the SCM
Advertisement Period	53	1	The average number of seconds between SCM advertisements.
(Optional TLVs)	54	N	(required TLVs are defined below)
*A parent node sends an SCM Advertisement Request with the *Unattached Flag* set ON to quickly notify child nodes that it has become "unattached". If it is unattached because the active SCM was lost, then it must also set the SCM Node ID to '0'. The *Instance Age* field contains the "age" of the instance of the node that transmits an SCM-Advertisement Reply message, in seconds. (See the section entitled "Topology State Information" for a description of an "Instance Number".)			

[0290] An SCM Advertisement Reply message must include a WTLV_SUBNET_ID TLV, which contains the IP address and subnet mask of the SCM.

[0291] An SCM Advertisement Reply message must include a WTLV_ROOT_CM_INFO TLV which contains the IPv4 address of the root CM (which is also the 802.1X IN Authenticator).

[0292] An SCM Advertisement Reply message sent by an AP can include a WTLV_IPV4_HOP_ADDRESS TLV, which contains the AP's IP address.

#define SCM_ADVERTISE_INTERVAL 5 /* The default SCM advertisement interval is 5 seconds. */
#define SCM_INFINITE_PATH_COST OxFFFF
#define SCM_INFINITE_HOP_COUNT 0xFF

[0293] The below table shows the fields for an SCM-Advertisement Request Message.

Field Name	Offset	Size (bytes)	Description
WLCCP Header	0	28	Common Context Mgmt SAP Header*
Hop Address	28	6	Source 802 Port Address
(optional TLVs)	34	N	

[0294] The below table gives the fields for a Registration Request/Reply Message

Field Name	Offset	Size (bytes)	Description
WLCCP Header	0	28	Common Context Mgmt SAP Header
Relay Node ID	28	8	Relay Node Type and Node Address
802 Hop Address	36	6	802 Source Port Interface Address.
Requester Node ID	42	8	WLCCP Node ID of the node that is "requesting" network registration. It is the 802 address of a MN, in a "proxy" request.
Registration Sub Type Flags	50	1	Bit 7 - Initial Registration Flag Bit 6 - Proxy Registration Flag Bit 5 - List Registration Flag Bits 0-5 (reserved - must be zero)

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(continued)

Field Name	Offset	Size (bytes)	Description
Bridging Flags	51	1	Bit 7 - Secondary Bridge Flag Bit 6 - Unicast Flooding Flag Bit 5 - Multicast Flooding Flag Bit 4 - IP Multicast Flooding Flag Bits 0-3 - (reserved - must be zero)
Registration Flags	52	2	Bit 15 - Authenticated Flag Bit 14 - (reserved - must be zero) Bit 13 - Proxy MIP flag Bit 12 - L2 Path Update (0=disable, 1=enable) Bits 0-11 - (reserved - must be zero)
Delay	54	2	Time since the node was last active, in hundredths of seconds, in a request message.
Path ID	56	4	Path ID establish by a CM. A value of '0' is used to indicate "no Path ID".
Lifetime	62	1	Registration lifetime in minutes. A value of '0' is used to indicate an "infinite" lifetime.
Status	63	1	Registration status in a reply message. 0-126 - good status 127 - (reserved) 128-254 - error status 255 - extended error status (an extended error status is contained in a TLV)
VLAN ID	64	2	Bit 3 - Assigned Flag. Set ON in a Reply if the VLAN ID was assigned by the infrastructure. Bits 4-15 - VLAN ID of the *Requester* node (may be 0).
(Optional TLVs)	66	N	

#define WLCCP_DEF_AP_REG_LIFETIME 10 /* 10 minutes */
#define WLCCP_DEF_CM_REG_LIFETIME 10
#define WLCCP_DEF_MN_REG_LIFETIME 0 /* infinite */

[0295] The *Status* field contains the registration status in a Reply message. Values from 0 to 126 are used to indicate a "good" status. The high-order bit is set ON to indicate an error status. Values from 128 to 254 are used to return an error status. A value of 255 is used to indicate that an extended error status code is contained in a WTLV_STATUS TLV.

[0296] Registration Reply status codes:

0 - General good status
0x80 - General error status
0x81 - Unauthenticated. The Requester node is not authenticated.
0x82 - Path Error. A path error was detected. The error will occur, for example, if a parent or relay node is not registered.
0x83 - Invalid Update. An update Registration Request did not match the current path instance or a path instance did not exist.
0x84 - Out-of-order. The Registration Request was received out-of-order.
0x85 - A MIC error occurred.
0x86 - Admin. Disabled. The Requester node is administratively disabled.
0x87 - Max. Nodes. The registration was rejected because the max. number of registered nodes was exceeded.
0x88 - Memory. A registration error occurred due to a lack of internal resources.

[0297] The *Authenticated Flag* is set ON in a Request for a MN, to indicate that the MN has been authenticated by the parent AP. The flag is used to register authenticated MNs when an AP transitions from distributed to infrastructure mode. It is also set on for a MN where authentication is not required (i.e. open authentication).

[0298] The *Proxy MIP Flag* is set ON in a Registration message for a proxy MIP MN.

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[0299] The *L2 Path Update Flag* is set ON if WLCCP layer 2 path updates are enabled.

[0300] The *VLAN ID* in an initial Registration Request for a MN is set to the default VLAN ID for the MN's SSID. The *VLAN ID* in an initial Reply message for a MN contains an assigned VLAN ID, if the *Assigned VLAN ID Flag* is set ON. The *VLAN ID* in a Request for a child AP is always '0'. The *VLAN ID* in an initial Reply for a child AP is the AP native VLAN ID. (A child AP inherits its native VLAN ID from its parent AP.) The VLAN ID in an update Request or Reply can be '0' or the current VLAN ID for the Requester node.

[0301] A WTLV_IPV4_ADDRESS TLV always contains the IP address of the Requester Node. The IP address is included in a Request to register it with the WLCCP infrastructure. The IP address is included in a Reply for a MN to transfer it to the new parent AP.

[0302] An initial Registration Request for a MN must include a WTLV _AUTH_METHOD TLV that contains the MN authentication type.

[0303] An initial Registration Request for an 802.11 station (MN or child AP) must include a WTLV_SSID TLV, which contains the SSID from the station's 802.11 (Re)Association Request message.

[0304] An initial Registration Request for an 802.11 station (MN or child AP) must include a WTLV_PARENT_AP_BSSID TLV, which contains the BSSID of the stations parent AP.

[0305] An initial Registration Request for an 802.11 station, which has "reassociated", must include a WTLV_OLD_AP_BSSID TLV, which contains the BSSID from the "Old AP" field in the respective 802.11 Reassociation Request message.

[0306] A Registration Request for an AP must include a WTLV_AP_PORT_LIST container TLV, which contains a list of one or more WTLV_AP_PORT_INFO TLVs.

[0307] A Registration Reply for an 802.11 station must include a WTLV_OLD_AP_BINDINGS TLV, if the station was previously associated with an "old AP".

[0308] The table below shows the format of the Preregistration Request/Reply Message.

Field Name	Offset	Size (bytes)	Description
WLCCP Header	0	28	Common Context Mgmt SAP Header
Relay Node ID	28	8	Relay Node Type and Node Address
Requester Node ID	36	8	WLCCP Node ID of the child 802.11 station (MN or child AP).
Preregistration Flags	42	2	Bits 0-15 - (reserved - must be zero)
(reserved)	44	1	(must be zero)
Status	45	1	Preregistration status in a reply message. 0 - good status
VLAN ID	46	2	Bits 0-2 - (reserved - must be zero) Bit 3 - Assigned VLAN Flag Bits 4-15 - VLAN ID of the *Requester* node (may be 0). Default VLAN ID in the Request message. Optional, assigned VLAN ID in the Reply Message.
(Optional TLVs)	48	N	

[0309] The *VLAN ID* in a Preregistration Request for a MN is set to the default VLAN ID for the MN's SSID. The *VLAN ID* in a Reply message for a MN contains an assigned VLAN ID, if the *Assigned VLAN ID Flag* is set ON. The *VLAN ID* in a Request for a child AP is always '0'. The *VLAN ID* in a Reply for a child AP is the AP native VLAN ID. (A child AP inherits its native VLAN ID from its parent AP.)

[0310] A Preregistration Request for an 802.11 station (MN or child AP) must include a WTLV_SSID TLV, which contains the SSID from the station's 802.11 (Re)Association Request message.

[0311] A Preregistration Request for an 802.11 station, which has "reassociated", must include a WTLV_OLD_AP_BSSID TLV, which contains the BSSID from the "Old AP" field in the respective 802.11 Reassociation Request message.

[0312] A Preregistration Reply for an 802.11 station must include a WTLV_OLD_AP_BINDINGS TLV, if the station was previously associated with an "old AP".

[0313] Referring to the table below, there is shown a Deregistration Request/Reply Message.

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Field Name	Offset	Size (bytes)	Description
WLCCP Header	0	28	Common Context Mgmt SAP Header
Relay Node ID	28	8	Relay Node Type and Node Address
Path ID	36	4	Path identifier established by a CM.
Status	40	1	A "reason" code in a request; a "status" value in a reply. The high-order bit of the reason code is set ON in "administrative" Dereg. Requests.
Deregistration Flags	41	1	Bit 7 - L2 Path Update (0=disable, 1=enable) Bits 0-6 - (reserved - must be zero)
Registration Message ID	42	2	Message ID of the last Registration Request received for the node.
Target Node ID	44	8	WLCCP Node ID of the node whose path instance must be "deleted.
Activity Timestamp	52	2	Number of seconds since the target node was last active, in a Reply message.
(Optional TLVs)	54	N	

[0314] The format of the Detach Request/Reply Message is shown below:

Field Name	Offset	Size (bytes)	Description
WLCCP Header	0	28	Common Context Mgmt SAP Header
Relay Node ID	28	8	Relay Node Type and Node Address
Path ID	36	4	Path identifier established by a CM.
Status	40	1	A "reason" code in a request; a "status" value in a reply.
Detach Flags	41	1	Bit 7 - L2 Path Update (0=disable, 1=enable) Bits 0-6 - (reserved - must be zero)
Requester Node ID	42	8	WLCCP Node ID of the node whose path instance must be "deleted.
(optional TLVs)	50	N	

[0315] The format of the Path Check Request/Reply message is shown in the table below:

Field Name	Offset	Size (bytes)	Description
WLCCP Header	0	28	Common Context Mgmt SAP Header
Relay Node ID	28	8	Relay Node Type and Node Address
Path ID	36	4	Path identifier established by a CM.
Status	40	1	A "reason" code in a request; a "status" value in a reply.
Query Flags	41	1	(reserved - must be 0)
Parent Node ID	42	8	Node ID of the parent AP that initiated the "path check".
(optional TLVs)	50	N	

[0316] Path check usage is defined *infra*.

[0317] The Path Update Request/Reply Message is shown below:

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Field Name	Offset	Size (bytes)	Description
WLCCP Header	0	28	Common Context Mgmt SAP Header
Path ID	28	4	Path identifier established by a CM.
Update Flags	32	2	(reserved - must be 0)
Parent Node ID	34	8	Node ID of the new parent AP
(optional TLVs)	42	N	

[0318] It should be noted that Disassociation Notification messages may be used in lieu of Path Update messages, if it is not necessary to transfer context information directly from an old AP to a new AP.

[0319] The format of the Context Request/Reply Message is given in the table below:

Field Name	Offset	Size (bytes)	Description
WLCCP Header	0	28	Common WLCCP Context Mgmt SAP Header
(optional TLVs)	28+N	P	

WLCCP AAA messages are used to encapsulate EAPOL and proprietary, e.g. Cisco, accounting messages, so that messages can be forwarded to/from the WLCCP Security SAP in the WLCCP MN or IN Authenticator. For instance, a repeater AP's or MN's EAPOL message will be WLCCP encapsulated by it's parent AP. Additionally, an AP may update the AS with session accounting reports and must thus send the appropriate Cisco proprietary messages.

The AAA messages need not be encrypted as they are typically either already protected by the original protocol (e.g. EAPOL or Cisco accounting) nor do they need to be authenticated. However, it is good security practice to authenticate (MIC) authentication messages.

Optionally, only the MN's EAPOL messages should include a WTLV_MIC. If a WTLV_MIC TLV is included, the contained MIC authenticates the entire WLCCP message using the link's CTK. For instance, if the message is transmitted by an AP to the SCM, the shared CTK between the AP and SCM shall be used. Each hop in the inbound (or outbound) path must authenticate and recompute the MIC, if it is enabled. Finally, AAA messages must also indicate whether the state machine has entered into a AAA message as well as when it has completed. To provision these states, the AAA message is further typed accordingly.

[0320] The general format for encapsulated EAPOL and proprietary, e.g. Cisco, accounting messages is as follows:

Field Name	Offset	Size (bytes)	Description
WLCCP Header	0	28	Common Context Mgmt SAP Header
Requester Node ID	28	8	WLCCP Node ID of the node that is "requesting" network authentication.
AAA Type	36	1	AAA protocol message type: 0 - Start 1 - Finish 2 - EAPOL 3 - Cisco Accounting
Authentication Type	37	1	If AAA Type = EAPOL authentication, then it could be one of the following types: 0 - EAP only 1 - MAC only 2 - do MAC first, if it fails then do EAP 3 - do MAC and EAP 4 - LEAP only 5 - do MAC first, if it fails then do LEAP 6 - do MAC then do LEAP

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(continued)

Field Name	Offset	Size (bytes)	Description
Key Management Type	38	1	Type of (or no) key management negotiated. Valid values are: 0 - none 1 - CCKM 2 - Legacy 802.1X 3 - SSN/TGi
Status	39	1	Status field
Message	40	N	AAA message

[0321] The WLCCP AAA messages serve several purposes:

1. Distinguish entry and exit of the AAA state
2. Encapsulate Cisco accounting messages sent from an AP to the AS to report accounting information.
3. Encapsulate EAPOL authentication messages. The first WLCCP (request) message must define the Key Management Type to trigger session key action by the MN authenticator. If CCKM is defined, then the MN authenticator will trigger a EAPOL Key message after receipt of a Radius Access Accept with a securely delivered NSK. Otherwise, the MN authenticator will temporarily hold the NSK to forward to the AP (but will remove the MN's entry upon a pre-registration request).
4. Encapsulate EAPOL Key message from the MN authenticator to the MN to initiate CCKM's initial 4-message handshake between the MN Authenticator and MN to establish the KRK and BTK.

If the AAA message is of type *Start*, then the message format is only a request message (no reply is expected). The *Start* message not only initiates the start of the AAA message exchange but it also provides SSID information as well as the AAA authentication or accounting messages to follow. The subsequent AAA messages must match in both AAA Authentication and Key Mangement type defined in the *Start* request. It's format is as follows:

Field Name	Offset	Size (bytes)	Description
WLCCP Header	0	28	Common Context Mgmt SAP Header
Requester Node ID	28	8	WLCCP Node ID of the node that is "requesting" to initiate AAA message exchanges
AAA Type	36	1	0 - for Start
Authentication Type	37	1	If AAA Type = EAPOL authentication, then it could be one of the following types: 0 - EAP only 1 - MAC only 2 - do MAC first, if it fails then do EAP 3 - do MAC and EAP 4 - LEAP only 5 - do MAC first, if it fails then do LEAP 6 - do MAC then do LEAP
Key Management Type	38	1	Type of (or no) key management negotiated. Valid values are: 0 - none 1 - CCKM 2 - Legacy 802.1X 3 - SSN/TGi
Status	39	1	Field value is ignored
TLV	40	N	SSID TLV

[0322] When the AAA authentication or accounting exchange is complete, a AAA *Finish* (reply) message must be issued to terminate the AAA state. The AAA *Finish* is also used to indicate an AAA success (e.g. EAP or accounting

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success). If AAA *Finish* is successful and CCKM is defined as the Key Management, then the *Finish* message also includes a nonce. The AAA *Finish* message format is as follows:

Field Name	Offset	Size (bytes)	Description
WLCCP Header	0	28	Common Context Mgmt SAP Header
Requester Node ID	28	8	WLCCP Node ID of the node that is "requesting" to initiate AAA message exchanges
AAA Type	36	1	1 - for Finish
Authentication Type	37	1	Type must match that defined at AAA *Start*
Key Management Type	38	1	Type must match that defined at AAA *Start*
Status	39	1	0 - success
Nonce length	40	2	Should always be set to 16 bytes
Nonce	42	16	16 byte pseudorandom value

[0323] The below table shows the format of the Path-Init Request/Reply/Confirm/ACK Message:

Field Name	Offset	Size (bytes)	Description
WLCCP Header	0	28	Common Context Mgmt SAP Header
Relay Node	28	8	Node ID of any intermediate relay AP
Requester Node ID	36	8	WLCCP Node ID of the "requesting" node to establish a CTK to share with the IN Authenticator.
Reserved	44	1	Reserved for byte alignment
Status	45	1	Status field
TLV(s)	46	N	Includes either Secure Context or Init Session TLVs to establish CTKs.

[0324] The Requester Node must include a Secure Context TLV within the Init Session TLV to ensure that a CTK is mutually derived between the Requester Node and its IA. In the Secure Context TLV, the Requester Node must provide it's nonce and CTK Sequence counter to allow the IA to derive a CTK and be assured the request is not a reply. In initial releases, the rekeys can be discarded if a replay has been detected; the sequence counter is sufficiently large that rekeys should never be exhausted. However, in the case where the value is about to wrap, the IN must re-authenticate. For further details on establishing CTKs refer to the sections on Secure Context TLVs.

[0325] The following 802.11 elements are used to support the operation of WLCCP.

#define WLCCP_PATH_COST
#define WLCCP_HOP_COUNT
#define IPv4_SUBNET_ID
#define MULTICAST_802_ADDRESS_LIST
#define DOT1D_PATH_COST
#define DOT1D_ROOT_ID /* 802.1D priority and 802 address of the root bridge */

[0326] A WLCCP inter-AP SSID is contained in a standard 802.11 SSID element. The general operation of the architecture will now be disclosed.

[0327] A Request message is always forwarded from the *Originator* to the *Responder.* A Reply message is always forwarded from the *Responder* to the *Originator.* The *Inbound* and *Outbound* flags determine how a message is forwarded. If both the *Inbound* and *Outbound* flags are set OFF, then a message is forwarded via IP routing and/or transparent bridging to the target destination (i.e. to the "Responder" in a Request message).

[0328] The *Inbound Flag* or *Outbound Flag* is set ON in a message to indicate that the message is being forwarded inbound or outbound, respectively, on a branch of the Topology Tree. It is an error if a node receives an "inbound" message from a node that is not a descendant. It is also an error if a node receives an "outbound" message from a node that is not an ancestor.

[0329] The *Hopwise-Routing Flag* is set ON in an inbound or outbound message to force intermediate APs to process

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the message, where an "intermediate AP" is any AP on the topology tree branch between the *Originator* and the *Responder* of the message. A "hopwise-routed" inbound message is forwarded to the hop address of the parent node; an outbound message is forwarded to the "Next Hop" on the path to the target node. A hopwise-routed message is processed by each node on the inbound or outbound path. It is an error if a node receives a hopwise-routed message from a *Hop Source* that is not a neighbor.

[0330] The *Hopwise-Routing Flag* can be used in a registration message, for example, to update Layer 2 path information in each AP on the path to a MN. The *Responder* is always the SCM in a Proxy Registration message generated by an AP. FIG 23 illustrates how hopwise routing is used. If Layer 2 path updating is enabled (as in the W2 implementation), then Registration messages are forwarded with Hopwise-Routing set ON. If Layer 2 path updating is not enabled (as in the W1 implementation) then Registration messages are forwarded with the Hopwise-Routing Flag set OFF.

[0331] If the *Relay Flag* is set ON, in a WLCCP message, then the general WLCCP header is immediately followed by a *Relay Node ID* field. If the *Relay Node ID* field is non-zero, then it contains the Node ID of any intermediate node that "relayed" the respective message. The *Relay Node ID* is initialized to all zeroes by both the Originator and Responder. As shown in FIG 23, AP 2304 is the relay node for a hopwise-routed message sent from AP 2306 to the SCM 2302; therefore, AP 2304 must set the *Relay Flag* ON and enter its Node ID in the *Relay Node ID* field before forwarding the message inbound to the SCM.

[0332] If the *Root CM Flag* is set ON in an inbound request message, then the message is always forwarded inbound to the CM at the root of the entire Topology Tree - the root CM. In a campus network, for example, the message is forwarded to the CCM. For example, an AP can use the *Root CM Flag* to forward a MN's IP address to the CCM. The AP can simply send a request message to its parent SCM that contains the MN's IP address and has the *Root CM Flag* set ON.

[0333] In many cases the original Responder of a request message must forward the message on the path to the final destination. For example, an SCM must forward an inbound Registration Request to its parent LCM if the SCM is not the "nearest common ancestor" or if the Root CM Flag is set ON. Likewise, an LCM must forward an outbound Deregistration Request to the parent SCM of the *Target Node*. An original or intermediate "relay Responder" forwards such a message as follows: a) The *Responder* field is updated with the Node ID of the next-hop CM, b) The relay Responder enters its Node ID in the *Relay Node ID* field, c) The *Originator* and *Message ID* fields are unchanged. The relay Responder does not update the *Responder* field in any corresponding Reply message; therefore, the *Responder* field in the Reply message will contain the Node ID of the "final Responder" when it is received by the Originator.

[0334] The *Originator* of a Request message sets the *Response-Req Flag* ON to solicit a corresponding Reply message. The Originator is always responsible for error recovery if an expected Reply message is not received. An Originator must start a "retry timer" for each outstanding Request message that requires a Reply. A Request message is retransmitted, with the *Retry Flag* set ON and the original *Message ID,* if an expected Reply message is not received before the respective timer expires. A retry timer is not needed in an intermediate "relay Responder", which forwards a Request message on the path to the final Responder.

[0335] An *Originator* or relay node can include a *Reply_State* TLV in a Request message, to reduce the amount of state information that must be kept in memory. A *Reply_State* TLV contains information that is necessary to process (e.g. forward) a Reply message.

[0336] AP message forwarding logic is generally independent of the network infrastructure. The parent SCM is the *Responder* in messages generated by an AP, with one exception. [If Layer 2 path updating is enabled, then the Responder in an initial Registration Request generated by a non-root AP is the parent AP.] In a local or campus infrastructure, the SCM forwards AP messages to the root CM as required. Likewise, SCM message forwarding logic is the same in a standalone local infrastructure or a campus infrastructure. The parent LCM is always the *Responder* in messages generated by the SCM. In a campus network, the LCM forwards SCM messages to the CCM, as required.

[0337] A WLCCP node only accepts "valid" WLCCP messages transmitted on its native VLAN. All other messages are discarded. A message is invalid if it fails a Message Integrity Check or if the message type is unknown.

[0338] The SCM Election and Advertisement Protocol is used to elect a single active SCM for each subnet and to advertise network availability and network parameters. A registered, active SCM sends periodic SCM Advertisement Reply messages, with the "SCM Active" flag set ON, to a WLCCP "all nodes" 802 group address. An AP selects its "primary port" and registers with the active SCM whenever the SCM instance changes.

[0339] The general operational steps for SCM election and advertisement are as follows:

1) One or more "SCM candidates" are configured with a non-zero SCM priority value, on each subnet.
2) As an option, each SCM candidate can authenticate with the root CM to establish a shared WLCCP multicast key. The multicast key is used to optionally authenticate multicast SCM Advertisement messages. [If SCM Advertisement messages are not authenticated, then authentication is deferred until an active SCM is elected.]
3) Each SCM candidate sends a Context Mgmt Request message to the CCM. The CCM assigns the SCM candidate to a parent LCM or directs it to operate in stand-alone mode in the Context Reply message.

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4) In campus infrastructure mode, each SCM candidate initiates Path Authentication with its assigned LCM and the CCM.

5) In each subnet, SCM candidates participate in the SCM election protocol to determine the active SCM for the subnet.

6) In campus infrastructure mode, the elected "active SCM" registers with its assigned LCM and the CCM.

7) Steps 3-5 are repeated if an active SCM becomes unattached.

8) In infrastructure mode, the active SCM begins generating "active" SCM Advertisements (i.e. advertisements with the *Active* flag set ON) only after it has successfully registered with the root CM.

9) Root APs must register with the active SCM and propagate active SCM Advertisements.

10) Other APs must register with the active SCM and propagate active SCM Advertisements. A registered parent AP must send a unicast unscheduled SCM advertisement to a child AP, immediately after the child AP is authenticated.

[0340] The SCM election protocol is described in detail in the section entitled "Active SCM Election".

[0341] SCM Advertisement messages contain an *IPv4_SUBNET_ID* TLV, which uniquely identifies the local subnet, and *"Path Cost"* and *"Hop Count"* fields. The Path Cost is used to convey the path cost to the primary LAN for the respective subnet. The *Hop Count* field is used for backward-compatibility with existing APs and radio firmware and contains the number of wireless hops to the primary LAN. An active SCM sends SCM Advertisement Reply messages with the *Path Cost* and *Hop Count* fields set to '0'.

[0342] SCM advertisement messages must contain a *Root CMIP Address* TLV, which is used to advertise the IP address of the root CM in the SWAN Topology Tree. The SCM is the Root CM if the SCM is operating in stand-alone mode. If the SCM is operating in infrastructure mode, then the IP address of the LCM or CCM that is at the root of the entire Topology Tree. The Root CM is the default 802.1X authenticator for infrastructure nodes.

[0343] SCM advertisment messages contain a *Root CM* field, which contains the Node ID of the Root CM. An AP can determine if the Root CM changes by monitoring the Root CM field in SCM advertisements.

[0344] An AP or SCM candidate can send a multicast SCM-Advertisement Request to solicit an "unscheduled" SCM-Advertisement Reply message. The active SCM must send a unicast unscheduled Reply if it receives a Request on its Ethernet port. An "Attached" AP must send a unicast unscheduled Reply if it receives a Request on a secondary port from a child AP. The unicast MAC destination address in the unscheduled Reply is taken from the *Hop Address* in the corresponding Request and is the same as the MAC source address in the Request.

[0345] An AP must NOT forward an SCM-Advertisement Request. The SCM and each Attached AP must maintain the state information that is necessary to generate an unscheduled SCM-Advertisement Reply (i.e. the information used to generate the last scheduled advertisement message).

[0346] An SCM Candidate or AP can set the *Responder* Node ID to '0' in an SCM-Advertisement Request (i.e. if it does not know the Node ID of the active SCM or parent AP). The actual responder (i.e. the active SCM or a parent AP) must enter its Node ID in the *Responder* field in the Reply message.

[0347] A non-root AP should set the *Responder* Node ID, in an SCM-Advertisement Request, to the Node ID of its parent AP, if it is known.

[0348] "Initial Authentication" is used to fully authenticate a node when it first enters the network. A MN initially authenticates with the MN 802.1X Authenticator; an infrastructure node (AP or CM) initially authenticates with the IN 802.1X Authenticator in the root CM. Initial Authentication messages are encapsulated in 802.1X EAPOL messages on an 802.11 link between a child and parent 802.11 station. Initial Authentication messages are encapsulated in WLCCP AAA messages on all other links.

[0349] An AP or child CM uses "Path Authentication" messages to mutually authenticate and establish a CTK with each of its ancestors. An AP or child CM initiates Path Authentication after it initially authenticates and whenever it path changes.

[0350] "Fast Reauthentication" is used to quickly "reauthenticate an 802.11 station (MN or child AP) when it roams to a new parent AP. A parent AP uses "Preregistration" messages to fetch the necessary security context for Fast Reauthentication when an 802.11 station reassociates. Preregistration messages do NOT update the forwarding path.

[0351] Initial Authentication, Preregistration, Fast Re-authentication, and Path Authentication is discussed in detail in the section entitled "WLCCP Security Support".

[0352] The WLCCP Registration and Handoff Protocol is used to establish, maintain, and delete branches and path instances in the SWAN Topology Tree. Registration (and deregistration) messages are also use to transfer context information when a node roams. Each authenticated child CM, AP, and MN in a SWAN network is registered with the root of the SWAN Topology Tree - the root CM. In general, each CM, AP, and MN in a sub tree is reliably registered with the CM at the root of the sub tree. Example registration and handoff message sequences are shown in following sections.

[0353] The Registration and Handoff Protocol is implemented with three message types - Registration, Deregistration,

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and Detach.

[0354] Each MN, AP, and child CM must successfully authenticate (or reauthenticate) before it is registered with the SWAN infrastructure.

[0355] An inbound "initial" Registration Request is generated to initially register a node with the root CM after it has successfully (re)authenticated. A Registration Request is acknowledged by a Registration Reply that contains a matching *Message ID.* An outbound initial Registration Reply establishes a Path Instance, which is (optionally) identified by a Path ID. An "update Registration Request" is used to refresh the registration state of an Attached station. An update Registration Request is also used to update the context information cached in ancestor nodes.

[0356] "Proxy" Registration Request/Reply messages are used to register WLCCP-unaware MNs. A "registered" parent AP generates a proxy "initial" Registration Request for an associated MN after it successfully authenticates.

[0357] A Registration message contains an *Initial Flag,* which is set ON in an "initial" Registration message and OFF in an "update" Registration message. A Registration message has a *Proxy Flag,* which is set on in a "proxy" Registration message generated "in proxy" by a parent AP for a non-WLCCP MN. An "initial, proxy" Registration message, for example, has both the *Initial Flag* and the *Proxy Flag* set ON.

[0358] In general, a Registration Request for a node, which has roamed, is forwarded inbound until it reaches the "nearest common ancestor CM". The "nearest common ancestor CM" is the CM that is at the root of the smallest sub tree that includes the CM and both the old and new parent nodes. For example, the SCM is the nearest common ancestor when a MN roams within a single subnet. An LCM is the nearest common ancestor when a MN roams between subnets in the same Local Control Domain. The nearest common ancestor CM is referred to as the "common CM".

[0359] The common CM returns a Registration Reply outbound to acknowledge the Registration Request and to establish a new path instance for the *"Requester Node".* The common CM (optionally) "deregisters" any old path instance, when it establishes the new path instance for the node.

[0360] A non-parent CM or AP must forward an "initial" or "proxy" Registration Reply to the "parent" of the *Requester Node,* identified by the *Requester Node ID* field. Therefore, the parent node is the *Originator* of any "initial" or "proxy" Registration Request that it forwards inbound for a child *Requestor Node.*

[0361] The *Root CM Flag* is set ON in a Registration Request to force a "full path update". A Registration Request is always forwarded to the root CM if the *Root CM Flag* is set ON.

[0362] The *Path ID* field in an "initial" Registration Request is always set to '0'. The parent CM (optionally) establishes the path ID, for a path instance, by entering a path ID value into the *Path ID* field of an initial Registration Reply. The *Path ID* field in an "update" Registration Request is set to the path ID for the path instance.

[0363] A Registration Request is always transmitted with the *Response-Req Flag* set ON, to solicit a Reply. A Registration Request message is retransmitted if an expected matching Reply is not received, until a REGISTRATION_RETRY_MAX limit is exceeded. The same Message ID is used for the original Registration Request and all retransmissions.

[0364] In general, received Registration Requests are ordered by time-of-arrival. The Registration *Delay* field is, optionally, used to order received Proxy Registration Requests that are generated by a parent AP for a child node. The *Delay* field contains the elapsed time, in hundredths of seconds, since the respective child node last transmitted an uplink frame. A Registration Record in a CM must contain a timestamp field that contains the "time-of-arrival" of the last Registration Request. The time-of-arrival is calculated by subtracting the *Delay* value from the current time.

[0365] A parent AP or SCM forwards a Registration Reply to a child AP by sending it to the port MAC address contained in the *Hop Source* field in the original Registration Request. A parent CCM or LCM forwards a message to a child CM by sending it to the hop IP address of the child CM.

[0366] If WLCCP is used to establish forwarding paths, then an "old" path instance must be deleted when a node roams. Inbound Deregistration Reply and Detach Request messages are optionally used to delete old path instances. A Deregistration Request is generated by a "common CM" to delete any old path instance when a new path instance is established. Also, an "administrative" Deregistration Request can be generated by the Root CM to administratively disconnect a node.

[0367] A parent AP generates a Detach Request, when a child node is disassociated. If the child node is an AP, then the sub tree rooted at the AP is deleted. Deregistration and Detach logic is described in more detail below.

[0368] Each AP in a subnet, and any MNs associated with the AP, are registered with the active SCM for the subnet. An AP discovers the "active SCM" via the SCM advertisement protocol, as described above. Each MN is registered with the SCM for its parent AP, even if the MN belongs to a different subnet.

[0369] Intra-subnet registration logic is implementation-specific. In the simple W1 implementation, WLCCP registration is used to establish and distribute context information between the SCM and child APs. It is NOT used to establish the Layer 2 forwarding path. The *L2-Path-Update Flag* is set OFF and the *Hopwise-Routing Flag* is set OFF in Registration messages in the W1 implementation. Detach and Deregistration messages are not used in the W 1 implementation.

[0370] If Layer 2 path updating is enabled, then WLCCP registration reliably establishes the wireless forwarding path between the primary LAN and wireless stations, so that it is never necessary to flood unicast frames to 802.11 stations.

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Registration, Deregistration, and Detach messages must be forwarded with Hopwise Routing so that each AP on the path instance can process the message. A Registration Reply, for example, is forwarded outbound, with hopwise routing, by sending it to the MAC or IP destination address of the "next hop" on the path to the target node. A Deregistration Reply or Detach Request is forwarded inbound, with hopwise routing, by sending it to the MAC or IP destination address of the parent node identified in the "Parent Node Record".

[0371] Non-WLCCP bridges and switches transparently forward registration messages.

[0372] Referring to FIG 24 there is shown a block diagram illustrating a mobile node 2412 roaming from a first access point 2408 to a second access point 2410 on a campus network 2400. The network 2400 comprises a CCM 2402 which is an IN 802.1X Authenticator, an LCM 2404 which is a MN 802.1X authenticator, an SCM 2406, a first access point 2408, second access point 2410, and the mobile node 2412.

[0373] The message sequences for registering and deregistering mobile node 2412 are shown in FIGs 25 and 26. FIG 25 shows the message sequences for the mobile node 2412 as it first associates and authenticates with access point 2408, and FIG 26 shows the message sequences as the mobile node 2412 roams to the second access point 2410. The arrows indicate the direction of the message (source -> destination or bi-directional <->) and the vertical bars indicate the network component.

[0374] Referring first to FIG 25, the mobile node 2412 associates with the first access point 2408. The steps comprise sending the assocation request 2502 from the mobile node 2412 to the first access point 2408 and the first access point 2408 sending an association response 2504. The mobile node 2412 then authenticates with LCM 2404 (the MN 802.1X authenticator) and the first access point 2408. The mobile node 2412 performs an initial authentication 2506 with the first access point 2408, an EAP authentication 2508 is then performed between the first access point 2408 and the SCM 2406, and a AAA request 2510 is performed between SCM 2406 and LCM 2404.

[0375] For CCKM mobile nodes, preregistration is required. The preregistration starts by the firs access point 2408 sending an initial proxy registration request 2512 to SCM 2406. SCM 2406 then forwards the initial registration request 2514 to LCM 2404 The CCKM preregistration reply 2418 is sent from LCM 2404 to SCM 2406, then as shown by 2516 from SCM 2406 to the first access point 2408, and the first access point 2408 sends the CCKM keying 2530 to the mobile node 2412. The mobile node 2412 can communicate after initial authentication and keying is complete.

[0376] The first access point then sends an initial proxy registration request 2520 to the SCM 2406, the SCM 2406 then forwards the initial proxy registration request request 2522 to the LCM 2404 with the LCM 2404 as the responder, then LCM 2404 forwards the initial registration request 2532 to the CCM 2402 with the CCM as the responder. The CCM 2402 then sends an initial registration reply 2528 to LCM 2404. LCM 2404 then forwards the initial registration reply as shown by 2526 to the SCM 2406. The SCM 2406 then forwards the initial registration reply to the first access point 2408 as shown by 2524.

[0377] Referring now to FIG 26, there is illustrated the messaging sequence when the mobile node roams from the first access point 2408 to the second access point 2410. Mobile node 2412 reassociates with the second access point 2410 by sending a reassociation request 2552. access point 2410. The second access point 2410 then sends a preregistration request 2554 to SCM 2406 to obtain the dynamic credentials for the mobile node 2410. SCM 2406 then sends a preregistration reply 2558 to the second access point 2410. The second access point 2412 then sends a reassociation response 2556 to the mobile node 2412. The mobile node 2412 then re-authenticates with the second access point 2410 using its dynamic credentials by fast reauthentication 2560. The mobile node can communicate after reauthentication is complete. The second access point 2410 then sends an initial proxy registration request 2562 to SCM 2406 for the mobile node 2412. SCM 2406 then sends a deregistration request 2564 to the first access point 2408. SCM 2406 then sends a initial registration reply 2566 to the second access point 2410. The first access point 2408 sends a deregistration reply 2568 to SCM 2406. The second access point 2410 sends a path update request 2570 to the first access point 2408.

[0378] Referring to FIG 27 there is shown a block diagram illustrating a repeater access point 2712 roaming from a first access point 2708 to a second access point 2710 on a campus network 2700. The network 2700 comprises a CCM 2702 which is an IN 802.1X Authenticator, an LCM 2704, an SCM 2706, a first access point 2708, second access point 2710, and the repeater access point 2712.

[0379] The message sequences for registering and deregistering repeater access point 2712 are shown in FIGs 28a and 28b. FIG 28a shows the message sequences for the repeater access point 2712 as it first associates and authenticates with access point 2708, and FIG 28b shows the message sequences as the repeater access point 2712 roams to the second access point 2710. The arrows indicate the direction of the message (source -> destination) and the vertical bars indicate the network component.

[0380] Referring to FIG 28a, the repeater AP 2712 (AP 2712) associates with the first access point 2708 (AP 2708). This process comprises AP 2712 sending an association request 2802 to AP 2708 and AP 2708 responding with an association response 2804. AP 2712 then authenticates with CCM 2702, the IN 802.1X Authenticator, and AP 2708 via initial authentication 2806 and AAA 2808.

[0381] AP 2712 then sends a Path-Init request to AP 2708 with AP 2708 as the responder. AP 2708 then sends the

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Path-Init Request to SCM 2706 as shown by 2812 with SCM 2706 as the responder. SCM 2706 forwards the Path-Init Request to LCM 2704 as shown by 2814 with LCM 2704 as the ersponder. LCM then forwards the Path-Init request to CCM 2702 as shown by 2816 with CCM as the responder. As shown by 2834, CCM 2702 then sends a Path-Init Reply to the LCM 2704 with AP 2708 as the originator. The LCM 2704 sends th Path-Init reply to SCM 2706 with AP 2708 as the originator as shown by 2822. SCM 2706 sends the Path-Init reply to AP 2708 as shown by 2820. AP 2708 sends the Path-Init reply to AP 2712 as shown by 2818.

[0382] AP 2712 then sends an Initial Registration Request 2826 to AP 2708 with AP 2712 as the Responder. AP 2708 sends the Initial Registration Request to SCM 2706 for AP 2712 with SCM 2706 as the Responder at 2828. At 2830, SCM 2706 forwards the Initial Registration Request to LCM 2704 with LCM 2704 as the Responder. Then at 2832, LCM 2704 forwards the Initial Registration request to CCM 2702 with CCM 2702 as the Responder. At 2840 CCM 2702 sends an Initial Registration Request Reply to LCM 2704. At 2838 LCM 2704 then forwards the Initial Registration Request Reply to SCM 2706. Then at 2836 SCM 2706 forwards the Initial Registration Request Reply to AP2708, which then at 2834 forwards the Initial Registration Request Reply to AP 2712.

[0383] Referring now to FIG 28b there is shown the sequence of messages that occurs when the repeater AP (AP 2712) roams from the first access point 2708 (AP 2708) to a second access point 2710 (AP 2710). The process begins at 2850 when AP 2712 sends a reassocation request to AP 2760 and indicates a "fast reauthentication" capability. At 2852 AP 2710 then sends a Preregistration Request to SCM 2706 to obtain the dynamic credentials for AP 2712. SCM 2706 sends a Preregistration reply to AP 2710 at 2856. AP 2720 then sends a reassociation response to AP 2712 at 2854. At 2858 AP 2712 reauthenticates with AP 2710 using its dynamic credentials.

[0384] AP 2712 then sends a Path-Init Request to AP 2710 at 2860 with AP 2710 as the Responder. At 2862 AP 2710 sends a Path-Init reuest to SCM 2706 for AP 2712 with SCM 2706 as the Responder. SCM 2706 sends a Path-Init Reply to AP 2710 at 2866 with AP 2710 as the Originator. At 2864 AP 2710 sends a Path-Init Reply to AP 2712.

[0385] At 2872 AP 2712 sends an Initial Registration Request to AP 2710 with AP 2710 as the Responder. At 2874 AP 2710 sends an Initial Registration Request to SCM 2706 for AP 2712 with SCM 2706 as the Responder. At 2876 SCM 2706 sends a Deregistration Request to AP 2708. At 2880 SCM 2706 sends an Initial Registration Reply to AP 2710. At 2878 AP 2710 sends an Initial Registration Reply to AP 2712. At 2882 AP 2708 sends a Deregistration reply to SCM 2706. AP 2710 sends a Path-Update Request to AP 2708.

[0386] A single active SCM is elected for each subnet, as described *infra.* By default, APs on a subnet operate in "distributed mode" if no SCM candidates are configured for the subnet

[0387] The active SCM either operates in 1) Stand-alone Mode or 2) SWAN Infrastructure Mode. An SCM operates in Stand-alone mode whenever it cannot communicate with a parent LCM. In Infrastructure Mode, an SCM is registered with a parent LCM and forwards WLCCP messages to its parent CM. SCM operation in infrastructure mode is specified in the section entitled "W2 - SCM Operation".

[0388] The LCM co-located with the CCM is the default backup LCM for all SCMs.

[0389] If an active SCM transitions from Stand-alone mode to Infrastructure mode then any existing sub tree rooted at the SCM must be deleted, to force all nodes in the sub tree to reregister. [An SCM resets its *Instance Age* to '0' to delete its sub tree. Sub Tree Deletion is described in a separate section.]

[0390] The sub tree rooted at an SCM does NOT need to be rebuilt when an SCM transitions from Infrastructure Mode to Stand-alone mode. The SCM must function as the IEEE 802.1X authenticator for its subnet, in stand-alone mode. The general SCM Data Structures and State Variables will now be described.

[0391] SCM_Advertisement_Timer - An SCM-Advertisement Reply messages is generated by an SCM Candidate or active SCM when the timer expires. The period of the timer is DEF_SCM_ADVERTISE_PERIOD seconds (e.g. 5 seconds).

[0392] SCM_Instance_Age - The SCM_Instance_Age is initialized to '0' and is reset to '0' whenever an SCM relinquishes the active SCM status. The active SCM increments the SCM_Instance_Age value each time the SCM_Advertisement_Timer expires.

[0393] Authenticated Node Table - The SCM is the 802.1X IN and MN Authenticator IN if the SCM is operating in standalone mode. In standalone mode, the SCM must maintain an Authenticated Node Table, which is a list of Authenticated Node Entries. Each Authenticated Node Entry contains authentication state information for APs and MNs in the sub tree rooted at the SCM. The authentication state in a node entry is initialized to 'unauthenticated'. The state information contained in the table is defined in the section entitled *"WLCCP Security Support"*.

[0394] Registration Tables - The active SCM must maintain a Registration Table, which contains state information for each AP and MN in its sub tree. An AP Registration Table contains an AP Registration Record for each AP in its subnet. A MN Registration Table contains a MN Registration Record for each MN that is associated with an AP in the subnet. A Registration Record is created or updated when a Registration Request is received for an AP or MN. A Registration Record contains a cross reference to an Authenticated Node Entry. A MN Registration Record contains a cross reference to the AP Registration Record for the MN's parent AP. A Registration Record is aged and discarded if a successful Registration Request is not received for the respective node with the registration *Lifetime.*

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[0395] SCM Candidate Path Authentication. Each SCM candidate in a campus control domain is automatically assigned to a parent LCM by the CCM using Context Request/Reply messages. An SCM candidate must send a Path-Init Request to its assigned parent LCM, after it has successfully authenticated with the root CM, to initiate Path Authentication. The LCM always forwards the Path-Init Request to the CCM, in campus infrastructure mode. The CCM functions as a KDC to mutually authenticate the SCM Candidate and the LCM and establish a shared CTK. An (optional) WLCCP "multicast CTK" is forwarded to the SCM during the Path Authentication process. The SCM candidate (optionally) uses the WLCCP multicast CTK to sign SCM-Advertisement Reply messages. The CTK shared by an SCM Candidate and the LCM is not used, if the SCM Candidate is not elected as the active SCM.

[0396] Active SCM Election.

[0397] An SCM election protocol is used to elect a single active SCM for each subnet, from a set of one or more SCM Candidates. By definition, the Primary LAN is the wired Ethernet LAN attached to the SCM; therefore, SCM election automatically establishes the Primary LAN for each Subnet. The election protocol is facilitated by SCM Advertisement messages.

[0398] Each SCM candidate is configured with a non-zero *SCM priority value* from 1 to 255. A WLCCP node is not an SCM candidate if it is configured with an SCM priority value of '0'. The high-order bit of the SCM priority value is used as a *"Preferred SCM"* flag and is set ON in a "preferred" SCM. The *Preferred SCM* flag is set OFF in a "backup" SCM. Therefore, priority values from 128 to 255 are used for "preferred" SCM candidates. Normally, there should only be one preferred SCM candidate. Priority values from 1 to 127 are used for "backup" SCM candidates. The SCM "priority value" is concatenated with the SCM Node ID for form an SCM "Priority ID". The effective relative SCM priority is discussed in detail below.

[0399] The state transition table below defines the operation of the SCM election protocol.

State	Event	Action	Next State
Initial	SCM priority is non- zero	Start SCM listen timer with an average expiration time of DEF_ SCM_LISTEN_TIME seconds; start periodic SCM advertisement timer; send SCM Advertisement Request	SCM_CAND
SCM_CAND	Receive higher-priority SCM Advertisement	Restart SCM listen timer with an expiration time of MAX_SCM_AGE seconds	SCM_BACKUP
SCM_CAND	Receive SCM Advertisement request or lower-priority SCM Advertisement reply	Send an SCM Advertisement with the *active flag* set OFF	SCM_CAND
SCM_CAND	SCM advertisement timer expires	Send an SCM Advertisement with the *active flag* set OFF	SCM_CAND
SCM_CAND	SCM listen timer expires	Reset SCM Instance Age to 0; send SCM Advertisement with the *active flag* set ON; restart SCM advertisement timer	SCM_ACTIVE
SCM_BACKUP	Receive higher-priority SCM Advertisement	Restart the SCM listen timer with an expiration time of MAX_SCM_AGE seconds	SCM_BACKUP
SCM_BACKUP	SCM listen timer expires	Restart the SCM listen time with an expiration of DEF_SCM_LISTEN_ TIME seconds; restart periodic SCM advertisement timer; send SCM Advertisement with the *active flag* set OFF	SCM_CAND

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(continued)

State	Event	Action	Next State
SCM_ACTIVE	Receive higher-priority SCM Advertisement. (The effective priority of the received Adver. is "higher" if a) the "priority value" is higher, or b) the *active flag* is ON and the Priority ID is higher.)	Start SCM listen timer with an expiration time of MAX_SCM_AGE seconds	SCM_BACKUP
SCM_ACTIVE	Receive an SCM Advertisement request or a lower-priority SCM Advertisement Reply	Send unicast unscheduled SCM Advertisement with the *active flag* set ON	SCM_ACTIVE
SCM_ACTIVE	SCM advertisement timer expires	Send scheduled SCM Advertisement with the *active flag* set ON; restart the SCM advertisement timer	SCM_ACTIVE

[0400] The SCM election/advertisement protocol operates on a single "native" VLAN that is shared by SCM candidates and APs. SCM Advertisement messages that are received on any other VLAN are ignored.

[0401] An "SCM Candidate" is configured with a non-zero SCM "priority value". Each SCM candidate has an "SCM Priority ID" which consists of the concatenated SCM priority value and the SCM Node Address. The rules for the effective relative SCM priority are as follows:

1) An SCM candidate or active SCM has a relatively "higher priority" if it is configured with a higher priority value.
2) A first SCM candidate has a relatively higher priority than a second SCM Candidate if it has an SCM "Priority ID" that is lexicographically higher.
3) A first active SCM has a relatively higher priority than a second active SCM if it has an SCM "Priority ID" that is lexicographically higher.
4) An SCM candidate has a relatively higher priority than an active SCM if it is configured with a higher priority value. If an SCM Candidate is configured with the same or a lower priority value than an active SCM, then it has a relatively lower priority than the active SCM.

[0402] The effective priority is structured so that an SCM Candidate will not replace an active SCM with the same priority value, even if it has a "higher" Node ID. However, the user can explicitly select the active SCM by configuring a higher priority value.

[0403] An SCM candidate initially enters an SCM_CANDIDATE state to listen for SCM advertisements on its Ethernet port. The SCM candidate remains in the SCM_CANDIDATE state for a "listen period" which exceeds 3 SCM advertisement intervals or until it discovers a higher-priority SCM. An SCM candidate enters the SCM_ACTIVE state if it does NOT receive a higher-priority SCM advertisement message within the listen period. In infrastructure mode, the "elected" active SCM must immediately register with its parent LCM and the CCM. The active SCM sets the "SCM Active" flag ON in its SCM Advertisement Reply messages after it has successfully registered or enters "stand-alone mode".

[0404] An SCM candidate or active SCM enters an SCM_BACKUP state if it discovers a higher priority SCM.

[0405] An AP or SCM candidate must send an SCM Advertisement Request message, to the WLCCP "all INs" group address, on each port when the port is first enabled. A node in the SCM_ACTIVE or SCM_CANDIDATE state responds by sending an SCM Advertisement Reply. A node in the SCM_CANDIDATE state sets the "SCM Active" flag OFF in the reply and sets the Path Cost and Hop Count fields to "infinite" values.

[0406] As an option, multiple active SCMs can be elected for a single subnet. An SCM Advertisement Request message contains an *SCM Group Election* field for that purpose. The field contains the number of SCM election groups and the group ID assigned to the respective SCM candidate (i.e. identified by the *SCM Node ID).* The group ID must be less than the number of election groups. An SCM candidate only considers SCM Advertisements from other candidates in the same group, so that an active SCM is elected for each group. Registrations are distributed across multiple active SCMs. The algorithm for determining the active SCM for a node is described in the section entitled "WLCCP Registration Protocol".

[0407] The elected active SCM transmits SCM Advertisement Reply messages, with the *Active Flag* set ON, once per *Advertisement Period.* The fields in SCM_Advertisement Reply messages sent by the active SCM are set as follows:

WLCCP header fields:

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Type - '0x41' (SCM_Advertisement Reply)
Originator - '0'.
Responder - SCM Node ID.
Outbound Flag - '1'.
TLV FLag - '1' (the Request must include an IPV4_SUBNET TLV and an ROOT_CM_INFO TLV).

[0408] SCM_Advertisement Reply fields:

Hop_Address - The SCM Ethernet port address.

[0409] *SCM Flags*:

Active Flag - '1'

SCM Priority - User-configured SCM Priority.
SCM Node ID - SCM Node Type and Ethernet port address
Instance Age - *SCM_Instance_Age* value.
Path Cost - '0'
Hop Count - '0'
Advertisement Period - DEF_SCM_ADVERTISE_PERIOD seconds.
WTLV_IPV4_SUBNET_ID TLV - IPv4 address and prefix length of the SCM
[0410] WTLV_ROOT_CM_INFO TLV - Contains the IPv4 address of the root CM (which is also the 802.1X IN Authenticator).
[0411] SCM Registration.
[0412] An SCM must register with the root CM immediately after it is elected as the "active SCM" for its subnet. [Note that it has already completed Path Authentication.] The elected active SCM sends an "initial" Registration Request its assigned parent LCM. The LCM always forwards the initial Registration Request inbound to the CCM, in campus infrastructure mode. The CCM returns an initial Registration Reply message to the parent LCM, which forwards the Registration Reply message to the SCM. The Reply message contains the Node ID and IP address of the "root CM" in a *Root CM* TLV.
[0413] The SCM must generate periodic "update" Registration Request messages to refresh its registration bindings in the parent LCM and CCM. The update Registration Request messages are always forwarded to the root CM. The root CM returns an update Registration Reply message, to acknowledge the Registration Request. The parent LCM resets the age of the DPR, for the SCM, to '0' when it receives a "matching" Registration Request with a "good" status. A parent LCM must delete the sub tree rooted at the SCM if it does not receive an update Registration Reply message for the SCM with the registration *Lifetime.*
[0414] An SCM must repeat the path authentication and initial registration processes whenever it is assigned to a different parent LCM instance.
[0415] Genearal AP operations will now be discussed.
[0416] A WLCCP AP either operates in 1) "Distributed Mode" or 2) SWAN "Infrastructure Mode".
[0417] The AP operational mode depends on the presence of an SCM and on an AP "Operational Mode" parameter, which can be set to one of the following values:

a) Infrastructure-only
b) Automatic-fallback (default)

[0418] A WLCCP AP always operates in "infrastructure mode" if it discovers a SWAN SCM. An AP operates in "distributed mode" if it cannot register with the active SWAN SCM and "Operational Mode" is set to "Automatic-fallback". The CISCO Datagram Delivery Protocol (DDP) is used as the inter-AP protocol, in distributed mode. It should be noted that a WLCCP Context or Path-Update messages can be used, in distributed mode, to directly transfer context from an "old AP" to a "new AP", when a station roams. The "old AP" MAC address can be obtained from an 802.11 Reassociation message.] Each AP must function as the 802. 1X authenticator, in distributed mode. APs should operate in distributed mode if the network contains non-WLCCP APs.
[0419] An AP can NOT operate in "distributed mode" if "Operational Mode" is set to "Infrastructure-only".
[0420] AP operation in infrastructure mode is generally the same in a standalone subnet infrastructure, a standalone local infrastructure, or a campus infrastructure.
[0421] An AP that is operating in infrastructure mode is considered "Attached" if it is registered with the active SCM; otherwise, it is considered "Unattached". An AP that is operating in "distributed" mode is considered "Attached" if it has

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a good Ethernet link, which is configured in parent or parent/child mode (see below), or if it is associated with a parent AP; otherwise, it is considered "Unattached". An Unattached AP must prohibit 802.11 station associations, to prevent stations from associating with an AP that cannot provide access to the Primary LAN. A management station can use a special "Management SSID" to associate with an Unattached AP, when other station associations are prohibited.

[0422] A child 802.11 bridge or repeater AP cannot operate in infrastructure mode unless it is associated with a parent AP that is operating in infrastructure mode. [A parent AP that is operating in infrastructure mode transmits periodic SCM Advertisement Reply messages to child APs and bridges.]

[0423] Below is a list of general AP state variables.

[0424] *Infrastructure_Mode* - TRUE if there is an active SCM; otherwise, FALSE.

[0425] *AP_Top_Level_State* - Contains the current top-level AP state. Top-level AP states and top-level state transitions are described in the section entitled *"AP Operational Modes"*.

[0426] *Parent_SCM_Record* - contains the following information about the active parent SCM:

SCM_Node_ID - The Node ID of the active SCM copied from the SARpM.
SCM_Age - Incremented once per SCM Advertisement Period. Reset to 0 when an "active" SARpM is received. Infrastructure_Mode is reset to False when the SCM_Age equals MAX_SCM_AGE.
SCM_Instance_Age - The Instance Age of the SCM copied from the SARpM.
SCM_Subnet_Address - IPv4 Address and (optional) Subnet Mask of the SCM copied from a WTLV_IPV4_SUBNET_ID TLV in the SARpM.
SCM_Priority - The priority of the active SCM copied from the *SCM Priority* field in the SARpM.
SCM_Advertisement_Period - The number of seconds between scheduled SCM advertisements copied from the *Advertisement Period* field in the SARpM.
SCM_Path_Cost - The *Path Cost* value from the SARpM, plus the cost assigned to the AP's primary port.
SCM_Hop_Count - The *Hop Count* value from the SARpM, plus '1' for the primary port.

[0427] *SCM_Advertisment_Timer* (optional) - A timer that expires once per "SCM Advertisement Period" when WLCCP is enabled. The duration of the timer is *SCM_Advertisement_Period* seconds (see above).

[0428] *IN_1X_Authenticatar* - Node ID and IPv4 Address of the WLCCP Infrastrucutre 802.1X Authenticator, which is always the SCM in the simple WLCCP implementation.

[0429] An AP must monitor SCM Advertisement Reply messages received on its primary port on the native VLAN to determine if there is an active SCM for the native VLAN. An AP operates in infrastructure mode and executes the WLCCP protocol if there is an active SCM for the AP's native VLAN.

[0430] An AP must update its "Parent SCM Record" each time it receives an SCM Advertisement Reply message. Infrastructure mode is enabled when an AP first receives an SCM Advertisement with the "*Active_Flag*" set ON. An AP must generate SCM Advertisement Reply messages on each of its secondary ports,using one of the following methods: 1) An AP can simply generate SCM Advertisements on each of its secondary ports when it receives an SCM Advertisement on its primary port, or 2) an AP can start a periodic SCM_Advertisement_Timer and generate SCM Advertisements on its secondary ports each time the timer expires. The period of the timer is the non-zero *Advertisement Period* value in advertisements received on the primary port. The first method must be used if the *Advertisement Period* value is zero in advertisements received on the primary port.

[0431] A repeater AP must send a multicast SCM Advertisement Request on its primary port when it first associates with a parent AP, to solicit a unicast unscheduled SCM Advertisement Reply message.

[0432] The AP top-level state transition table below specifies SCM_Advertisement Reply message (SARpM) processing logic. An "active" SARpM has the "Active Flag" set ON.

[0433] The IN 802.1X Authenticator is in the root CM when the AP is in the I,R state; otherwise, the IN 802.1X Authenticator is in the AP. Preregistration and Registration of MNs is only enabled in the I,R state.

[0434] AP top-level states are described below:

D,* - Any state in Distributed mode. "*Infrastructure_Mode*" is False, because the AP has not discovered an active SCM.
D,L - The AP is in a power-up SCM discovery period.
D,A - The AP is actively operating in Distributed mode and is accepting station associations.
D,SC - The AP discovered an SCM Candidate during the power-up SCM discovery period.
I, U - Infrastructure_Mode is True and the AP has not authenticated with the root CM.
I, A - Infrastructure_Mode is True and the AP has successfully authenticated with the root CM.
I, P - The AP has successfully completed Path Authentication.
I, R - The AP has successfully Registered with the root CM; MN (pre)registration is enabled.
I,* - Any state where Infrastructure_Mode is True.

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[0435] Top-level AP State Transition Table

State	Event	Action	Next State
Initial	System reset; good Ethernet link; Auto-fallback is enabled	Start an "SCM Listen timer" with a 10-second expiration time; send SCM Advertisement Request	D,L
D,*	Receive active SARpM	Set Infrastructure_Mode to TRUE; Update the Parent SCM Record and the IN_1X_ Authenticator; Initiate authentication with the SCM	I, U
D,L	Receive inactive SARpM	restart SCM Listen timer with a MAX_SCM_ ELECT_TIME expiration time; Save SCM Candidate Priority ID	D,SC
D,SC	Receive higher-priority inactive SCM Advertisement	restart SCM Listen timer with a MAX_SCM_ ELECT_TIME expiration time; Save SCM Candidate Priority ID	D,SC
D,L	SCM Listen timer expires	Start active operation in distributed mode.	D,A
D,SC	SCM Listen timer expires (i.e. because the active SCM election did not complete)	Start active operation in distributed mode.	D,A
D,A	Receive inactive SARpM	(none)	D, U
I, U	Authentication with the root CM completes successfully.	Initiate Path Authentication.	I,A
I,A	Path Authentication completes successfully	Initiate AP Registration	P
I, P	Registration completes successfully	Enable MN Preregistration and Registration; Register authenticated MNs; transfer the MN 802.1X Authenticator function to the SCM; start the *SCM_Advertisement_Timer*	I,R
I,*	Receive an active SARpM from the active SCM instance.	Reset the SCM_Age to 0; Update the Parent_ SCM_Record	I, *
I, *	Receive inactive SARpM or an "active" SARpM, with a lower *Instance Age,* from the active SCM	Set Infrastructure_Mode to False	D, U
I, *	Receive a higher priority active SARpM from a different priority SCM	Update the SCM state information; Initiate authentication with the new active SCM	I, U
I, *	Receive an inactive SARpM or a lower priority active SARpM from a different SCM (Candidate)	(none)	I, *
I, R	SCM_Advertisement_Timer expires; the SCM_Age is less than MAX_SCM_AGE	Restart the timer with the current Advertisement Period; Increment SCM Age; Generate SARpMs on each secondary port	I, R
I, R	SCM_Advertisement_Timer expires; the SCM_Age is equal to MAX_SCM_AGE	Set Infrastructure_Mode to False	D, U

[0436] SCM Advertisement Reply messages are NOT transparently forwarded by WLCCP APs. Instead, a registered AP generates "secondary" SCM Advertisement Reply messages, on each of its active secondary ports, with the same period as the SCM. [The advertisement period is contained in SCM Advertisement Reply messages.] SCM Advertisement Reply messages are NOT transmitted on the AP primary port or on AP ports that are "blocked" by the underlying STP.

[0437] SCM advertisements, which are transmitted on AP secondary ports, contain updated "path cost" and "hop count" values. Each AP port is assigned a user-configurable "path cost". Default path cost values are defined for each AP port type (e.g. Ethernet, 802.11 a, 802.11b). The updated path cost is calculated by adding the path cost assigned

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to the AP's primary port to the parent AP's path cost (i.e. the path cost in SCM advertisements received on the primary port); the "hop count" is incremented by '1', if the AP's primary port is a wireless port. A subnet address and updated path cost and hop count information is also advertised in 802.11 Beacon and Probe Response messages, sent on AP 802.11 secondary ports, so that unassociated wireless APs and MNs can quickly discover the least-cost path to the primary LAN (i.e. without iteratively associating and authenticating with each potential parent AP).

[0438] An AP may register with a logical SCM that is contained in the same hardware box. In that case, the cost assigned to the "internal primary port" should be consistent with Ethernet port cost (i.e. to prevent stations from migrating to an AP that is co-located in the same box as an SCM).

[0439] A non-SWAN AP may transparently forward SCM Advertisement Reply messages generated by a different SWAN node. A child AP must discard any SCM Advertisement Reply messages that are not generated by its parent. A child AP can use the SCM Advertisement *Hop Source* field to determine if its parent AP generated an SCM Advertisement message. The *Hop Source* address must be the same as the parent AP's Hop Address.

[0440] Root APs are always bound to the active SCM on the native VLAN. A Root AP only receives SCM Advertisement Reply messages on its native VLAN on the primary port. A non-root AP must belong to the same subnet as its parent AP; therefore, a non-root AP is always bound to the same SCM as the parent (or ancestor) root AP.

[0441] SWAN APs are configured with a single "WLCCP SSID". A campus-wide WLCCP SSID is sufficient if a campus network only contains root APs or if non-root APs can dynamically bind to any subnet. Subnet-specific WLCCP SSIDs can be used to bind non-root APs to a specific subnet (i.e. the subnet with root APs with a matching WLCCP SSID). . [A child AP can use DHCP to dynamically bind to a subnet; however, the native VLAN and the set of enabled VLANs in a parent and child AP must match.]

[0442] A child 802.11 port (i.e. in a repeater AP or child 802.11 bridge) uses the WLCCP SSID to associate with a parent AP. A child AP sends Probe Requests that contains the WLCCP SSID and potential parent APs reply with a Probe Response that also contains the WLCCP SSID. A child AP can only attach to a parent AP with a matching WLCCP SSID.

[0443] An AP or child CM must authenticate its path to the root CM, after it has successfully authenticated with the 802.1X IN Authenticator, to mutually authenticate and establish a secret Context Transfer Key (CTK) with each ancestor node on its branch of the SWAN Topology Tree. An AP must also initiate path authentication whenever it detects a new SCM instance. A non-root AP must also initiate path authentication whenever it roams to a new parent AP. [As an option, a non-root AP does not need to fully authenticate when it roams, if fast reauthentication is supported for child APs.] . Path authentication includes a Path-Init Request/Reply exchange and initial Registration Request/Reply exchange. Path Authentication and CTK updates are described in more detail in the section entitled "*Infrastructure Path Authentication*".

[0444] An Unattached AP must send a Path-Init Request to its selected parent node, on its selected primary port, to initiate path authentication. The *Originator* is the Unattached AP; the *Requester* is also the Unattached AP; and the *Responder* is the selected parent node (i.e. parent AP or SCM), in the Path-Init Request and the corresponding Reply.

[0445] Non-security fields in a Path-Init Request, sent by an Unattached AP, are set as described below. (Unspecified fields are set to '0'.) The Hopwise-Routing Flag is set to '1' so that each ancestor AP on the path to the SCM processes the Request and the corresponding Reply. Security TLVs included in Path-Init messages (and initial Registration messages).

[0446] WLCCP header fields:

Type - '12'
Originator - Node ID of the Unattached AP.
Responder - Node ID of the SCM.
Response-Req Flag - '1' to solicit a Reply.
Inbound Flag- '1'.
Hopwise-Routing Flag - '1' if Layer 2 Path Updates are enabled; otherwise '0'..
Root CM Flag - '1'
TLV FLag - '1' (The Request must include an EAP_IDENTITY_TLV.)

[0447] Path-Init fields:

Requester - Node ID of the AP.
Relay Node ID - '0'.
Proxy Flag - '0'.

[0448] The parent node must forward a Path-Init Request from an Unattached AP or CM inbound until it reaches the root CM. The parent node enters its Node ID in the *Originator* field and the Node ID of its parent CM in the *Responder* field, before forwarding the request inbound. An intermediate LCM must update the *Responder* field with the CCM Node

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ID before it forwards the request inbound to the CCM. The CCM returns a Path-Init Reply to the parent node (i.e. the Originator). The parent node updates the *Responder* field with the *Requester Node ID* before forwarding the Reply to the Unattached AP or CM.

[0449] An AP must authenticate with the root CM before it can register with the SWAN infrastructure. An AP discovers the root CM via a WTLV_ROOT_CM TLV contained in SCM advertisement messages. The root CM may be the local SCM, an LCM, or the CCM.

[0450] An Unattached AP scans for a potential parent SCM or AP on each of its ports that are configured in child or parent/child mode. [Note that an Attached AP becomes Unattached if it discovers a new instance of its parent AP or SCM.] An Unattached AP or CM must send an initial Registration Request to its selected parent node, on its selected primary port, to request attachment to the network. The *Originator* is the Unattached AP; the *Requester* is also the Unattached AP; and the *Responder* is the selected parent node (i.e. parent AP or SCM), in the initial Registration Request and the corresponding Reply.

[0451] The fields in an initial Registration Request sent by an Unattached AP are set as described below. (Unspecified fields are set to '0'.)

[0452] WLCCP header fields:

Type - '3'
Originator - Node ID of the Unattached AP.
Responder - Node ID of the selected parent node (parent AP or parent SCM).
Response-Req Flag - '1' to solicit a Reply.
Inbound Flag - '1'.
Hopwise-Routing Flag - '1'.
TLV FLag - '1' (the Request must include a *WTLV_AP_PORT_ADDRESS* TLV for each AP port).

[0453] Registration fields:

Requester - Node ID of the Unattached AP.
Hop Address - 802 address of the Unattached AP's selected Primary Port.
Relay Node ID - '0' in a registration message generated by the Originator or Responder. Otherwise, the Node ID of an intermediate "relay" node that forwarded the message.
Initial Flag - '1'.
VLAN ID - The native VLAN ID of both the Unattached AP and the parent node. The *VLAN ID* value may be '0'. It is an error if the *VLAN ID* value is different than the parent node's native VLAN ID.

[0454] The parent node must forward an initial Registration Request from an Unattached AP inbound until it reaches the root CM. The parent node enters its Node ID in the *Originator* field and the Node ID of its parent CM in the *Responder* field, before forwarding the request inbound. An intermediate LCM must update the *Responder* field with the CCM Node ID before it forwards the request inbound to the CCM. The CCM returns a Registration Reply to the parent node (i.e. the Originator). The parent node updates the *Responder* field with the *Requester Node ID* before forwarding the Reply to the Unattached AP or CM.

[0455] An AP periodically sends an "update" Registration Request message to the SCM to "refresh" its mobility bindings in each node on the path to the SCM. An update Registration Request has the *Initial Flag* set OFF and it contains a valid *Path ID.* An Attached AP or CM can send an "update" Registration Request directly to its parent CM, with itself as both the *Originator* and the *Requester Node* and the parent CM as the *Responder.* The parent CM must update the *Responder* field, with the Node ID of its parent CM, before forwarding the request inbound.

[0456] An AP (re)transmits a Registration Request either until it receives a Registration Reply with a matching message ID, or until the maximum retries are exceeded. An AP is "registered" when it receives a matching Registration Reply with a "good" *RegStatus.* The Registration Reply contains a *Path ID,* set by the SCM, which identifies the "path instance" from the AP to the SCM.

[0457] A Registration Request from an AP must include a WTLV_AP_PORT_LIST TLV, which contains a list of WTLV_AP_PORT_INFO TLVs. Each PORT_INFO TLV includes the port type, port mode (parent, child, or parent/child), and 802 port address of a physical communications interface.

[0458] A Registration Request from an AP must include an *IP Address* TLV to bind its IP address to its Node ID. An AP must generate an update Registration Request immediately whenever its IP address changes.

[0459] A Registration Request from an AP, which is configured with a Proxy MIP SSID, must include a WTLV_PMIP_SSID_LIST TLV, which contains a list of Proxy MIP SSIDs and MIP HA bindings.

[0460] Preregistration messages are used to obtain context information that is required prior to registration. A new parent AP, optionally, sends a Preregistration Request message, to its parent SCM, to obtain dynamic credentials and

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"old AP bindings" for an 802.11 station (MN or child AP) when it "reassociates". [A Preregistration Request is NOT generated when an 802.11 station initially "associates".] The parent AP generates a Preregistration Request when it receives 1) an 802.11 Reassociation Request or 2) an 802.1X EAP Identity Response message from the 802.11 station. The Preregistration Request contains the child station's Node ID and its security "Identifier".

[0461] A Preregistration Request is forwarded inbound to the nearest common ancestor CM of the old AP and new AP (with some restrictions noted below). If the "common CM" has the mobility bindings and security context for the child station, then the old AP bindings and dynamic credentials are returned in a Preregistration Reply message. Otherwise, a Preregistration Reply is returned with a "not found" status and the station must fully authenticate.

[0462] A Preregistration Request for a MN is never forwarded beyond the nearest common LCM, since the LCM is the MN Authenticator. An AP cannot roam across subnet boundaries; therefore, the nearest common ancestor CM for a child AP should always be the local SCM.

[0463] A Preregistration Reply does NOT establish a "bound" Path Instance. An 802.11 Reassociation Response message is, optionally, generated when the parent AP receives the Reply.

[0464] A new parent AP does not need to send a Preregistration Request to obtain an 802.11 station's's dynamic credentials if fast reauthentication with a Network Session Key is not supported or if the station's dynamic credentials are "predictively" forwarded to the new parent AP. In that case, the station's "old AP bindings" are returned in a Registration Reply message. Specific Preregistration handshaking is dependent on the 802.11 (re)authentication method.

[0465] The fields in a Proxy Preregistration Request message, generated by a parent AP for a child 802.11 MN, are set as follows:

[0466] WLCCP header fields:

Type - '9'
Originator - Node ID of the Parent AP.
Responder - Node ID of the SCM.
Response-Req Flag - '1' to solicit a Reply.
Inbound Flag - '1'.
Root CM Flag - '1' for an AP; '0' for a MN.
Hopwise-Routing Flag - '0'.
TLV FLag - '1' (The Request must include an EAP_IDENTITY_TLV and an SSID_TLV).

[0467] Preregistration fields:

Requester - Node ID of the MN.
Relay Node ID - '0'.
Proxy Flag - '1'.

[0468] *EAP_IDENTITY TLV* - The Preregistration Request for a MN or child AP must contain a WTLV_EAP_IDENTITY TLV that contains the node's identifier from an optional 802.11 Reassociation element or from the EAP Identity Response message.

[0469] *SSID_TLV*- The SSID of the MN taken from the MN's (Re)Association Request message.

[0470] A child AP can, optionally, include a Node_ID element in its (Re)Asssociation Request messages, to communicate its WLCCP Node ID to its parent AP. If a parent AP does not know the Node ID of a child AP, when it generates a Preregistration Message for the child AP, it must set the Requester Node Address to '0'. A Preregistration Request should include a WTLV_PORT_ADDRESS_TLV, which contains the MAC port address of the child AP.

[0471] A parent AP generates "proxy" Registration Request messages for associated MNs. The *Originator, Responder,* and *Requester* fields are always set as follows:

Originator - Node ID of the Parent AP.
Responder - Node ID of the SCM.
Requester - 802 address of the MN.

[0472] A parent AP must generate a Proxy Registration Request for a MN after it successfully authenticates or reauthenticates (as described below).

[0473] Proxy MN Registration logic is specific to the implementation and is described in more detail below in the sections entitled "W1 Proxy MN Registration" and "W2 Proxy MN Registration".

[0474] SWAN Authentication and Privacy is achieved by enforcing SWAN infrastructure nodes to mutually authenticate with both the root CM (CCM) as well as the IN nodes it will communicate with. Protection of WLCCP messages is achieved by the CCM generating and distributing CTKs upon successful pre-registration of INs.

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[0475] "Initial authentication" is based on the IEEE 802.1X protocol. Each "secure MN", AP, and CM must initially "mutually authenticate" with an 802.1X authenticator, via an external authentication server (e.g. a RADIUS server). Infrastructure nodes (APs, SCMs, and LCMs) mutually authenticate with an "IN Authenticator". "Secure MNs" mutually authenticate with a "MN Authenticator". While MNs can select from any supported 802.1X EAP authentication types, for initial releases, IN nodes shall authenticate using LEAP.

[0476] In a campus network, the SWAN CCM contains the IN Authenticator and LCMs contain a MN Authenticator. In a stand-alone local domain, both the IN Authenticator and the MN Authenticator are contained in the LCM. In a stand-alone subnet domain, both the IN Authenticator and the MN Authenticator are contained in the SCM.

[0477] All nodes must authenticate into the SWAN topology prior to registration. The node authenticator will cache the credentials upon successful 802.1X EAP authentication. The IN Authenticator will cache:

Field	Length (bytes)	Description
Reserved	1	Used for byte alignment
State	1	Indicates whether this node is Active or not.
Node-ID	8	WLCCP Node Identifier: AP's MAC Address (e.g. BSSID)
NSK	16	The key resulting from a successful LEAP authentication.
Session Timeout	4	Session expiration time provided by the Radius Access Accept
CTK	32	The current context transfer key used to protect communications between the SCM Authenticator and the Node-ID
Key Sequence Counter	4	A sequence counter used to track how many CTK key refreshes have occurred
MIC Sequence Counter	8	A sequence counter used to track how many messages were authenticated

[0478] Similarly, the MN Authenticator will cache:

Field	Length(bytes)	Description
Reserved	1	Used for byte alignment
State	1	Indicates whether this node is Active or not
STA Addr	8	WLCCP Node identifier: MN's MAC address
Authentication Type	1	EAP Type used to authenticate
Key Management Type	1	Type of (or no) key management negotiated. Valid values are: 0 - none (NSK is not forwarded) 1 - CCKM 2 - 802.1X Legacy systems (doing an effective re-authentication) forwards the NSK. 3 - SSN
Session Timeout	4	Session expiration time provided by the Radius Access Accept
KRK	16	Key Request Key used to authenticate MNs request for context transfers
BTK	32	Base Transient Key used to derive PTKs
RN	8	Rekey number used to track how many PTKs have been derived from BTK
SSID	L	MN's associated SSID TLV
EAP-ID	P	EAP Identity TLV
VLAN ID	2	MN's associated VLAN assignment
BSSID	6	Defines the current associated AP
Cipher	2	Negotiated cipher, values are: 0x0000 - none 0x0001 - WEP 0x0002 - TKIP 0x0003 - AES-OCB 0x0004 - AES-CCMP 0x0005 - CKIP 0xff<value> - Vendor specific

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(continued)

Field	Length(bytes)	Description
NSK Length	2	NSK length in bytes
NSK	N	The key resulting from a successful 802.1X EAP authentication. This is the MS-MPPE Rx Key sent by the AS
Tx Key Length	2	Tx Key Length
Tx Key	M	The key resulting from a successful 802.1X EAP authentication. This is the MS-MPPE Tx Key sent by the AS

[0479] The fields in each registration entry are populated at either 802.1X EAP Authentication success or during a pre-registration. A successful authentication will result in the creation of a registration entry with the proper IDs, NSK and session timeout values defined. For MN, the valid BSSID, SSID and VLAN ID will also be defined at authentication based on the EAP identity.

[0480] 802.1X EAP authentication messages are WLCCP encapsulated by the node's parent. An infrastructure node communicates directly via a wired link to the IN Authenticator during authentication. Once the IN parent has received the EAPOL authentication message, it will encapsulate it using a WLCCP_AAA message.

[0481] Since a MN always communicates through the AP to the MN Authenticator the AP must WLCCP encapsulate the EAP messages. Since the AP has authenticated and registered with the MN authenticator, WLCCP_AAA messages can be optionally authenticated. As described in the section entitled "EAP-Authentication Request/Reply Message", WLCCP_AAA messages can have a_MIC TLV appended. The MIC applies to the entire WLCCP message including the header:

MIC = HMAC-MD5(CTK, WLCCP- _AAA message)

[0482] Where CTK = the key shared between the immediate sender and immediate reciever

[0483] WLCCP replies, or outbound messages, allow the opportunity to specify a status. For error conditions the following status values will apply during a WLCCP_AAA:

Status	Value	Description
NO CONTEXT	1	Insufficient credentials were provided: either the NSK or session timeout were missing from the Radius Access Accept message
BAD SSID	2	Invalid SSID is specified
EAP FAILURE	3	EAP Authenticaiton failed

[0484] Each "secure" MN must mutually authenticate with a MN 802.1X Authenticator via an external security server. In infrastructure mode, the MN authenticator is in an LCM. In SCM stand-alone mode, the MN authenticator is in the SCM.

[0485] A MN does not require knowledge of the infrastructure behind the AP. Thus, from the MN's view, MN authentication is done as specified by the 802.11 (SSN and TGi) protocols as well as the use of CCKM. For an MN to be properly managed by the SWAN topology, it must negotiate 802.1X EAP Authentication.

[0486] The MN must employ 802.1X EAP Authentication to reap the benefits of LEAP, SSN or TGi's security advantages as well as SWAN manageability. In the SWAN architecture, the MN Authenticator is detached from the parent AP. When the MN engages in an 802.1X EAP authentication, its EAPOL messages are WLCCP encapsulated by the parent AP, in EAP-Authentication Request messages, and forwarded to the MN Authenticator.

[0487] Depending on the key management negotiated, the MN Authenticator must also properly forward the required keys to the AP in a Pre-registration Request/Reply exchange. The following table describes what the MN Authenticator must forward based on negotiated key management type:

Key Management Type	Description
None	While the Radius may generate an NSK, the MN Authenticator will forward the NSK only on initial association; the operation is effectively a non-cached NSK.

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(continued)

Key Management Type	Description
Cisco-LEAP	The Radius MS-MPPE key is forwarded to the SCM and subsequently to the AP for protection of 802.11 packets
SSN/TGI	The Radius MS-MPPE key is forwarded to the SCM and subsequently to the AP for the 802.1X 4-way handshake to establish PTKs per AP
CCKM	The MN Authenticator engages in a 4-way handshake to establish the rekey authentication key, KRK and base transient key, BTK. Only the BTKs need to be forwarded to the AP to establish PTKs. CCKM requires a Pre-registration Request/Reply following initial Authentication.

[0488] The pairwise transient keys (PTKs) used to protect communications between the MN and AP are generated by the MN and AP in all key management schemes.

[0489] The AS must also accommodate the session timeout setting based on key management approaches. For LEAP, the session timeout remains a function of the 802.11 negotiated cipher suite. However, for either SSN/TGi and CCKM, the session timeout is a function of the mutually derived key of each EAP authentication type.

[0490] After a CCKM MN has successfully authenticated, the MN Authenticator must trigger a key initialization to establish the Key Request Key (KRK) and Base Transient Key (BTK) before the MN and associated AP can establish PTKs.

[0491] To trigger KRK and BTK derivation, the MN Authenticator must generate a 16-byte nonce. An EAPOL Key message of the format described in the current TGi Draft [6] is generated to send the nonce to the MN and thus initiate the 4-way handshake used to establish KRK and BTK. The EAPOL Key message is encapsulated in a WLCCP_AAA message and delivered to the MN. The delivery is through the AP, thus the AP will unencapsulate the WLCCP message and forward the EAPOL Key message to the MN. The handshake proceeds as described in the Fast Handoff using Cisco's Central Key Management Protocol Specification.

[0492] After a CCKM MN has successfully authenticated, the MN Authenticator must trigger a key initialization to establish the Key Request Key (KRK) and Base Transient Key (BTK) before the MN and associated AP can establish PTKs.

[0493] To trigger KRK and BTK derivation, the MN Authenticator must generate a 16-byte nonce. An EAPOL Key message of the format described in the current TGi Draft [6] is generated to send the nonce to the MN and thus initiate the 4-way handshake used to establish KRK and BTK. The EAPOL Key message is encapsulated in a WLCCP_AAA message and delivered to the MN. The delivery is through the AP, thus the AP will unencapsulate the WLCCP message and forward the EAPOL Key message to the MN. The handshake proceeds as described in the Fast Handoff using Cisco's Central Key Management Protocol Specification .

[0494] An infrastructure node must first authenticate with the IN Authenticator using 802.1X EAP Authentication to establish a secret network session key (NSK). For initial releases, LEAP will be the authentication type. Since LEAP is known to be susceptible to dictionary attacks, as well as good security practice, a CTK must also be mutually derived to protect data exchanged between the IN and IN Authenticator.

[0495] An authenticating "supplicant" IN exchanges EAPOL authentication messages with its parent AP or CM. The supplicant's parent AP or CM relays the EAPOL authentication messages between the supplicant and the IN Authenticator in the root CM The EAPOL authentication messages are encapsulated in WLCCP AAA Message Request and Reply messages, with one exception. A child AP must exchange raw EAPOL messages with its parent AP on an 802.11 link.

[0496] The IN Authenticator contains a RADIUS client, which converts EAP_Authentication Request messages to RADIUS request messages, and converts RADIUS response messages to AAA Message Replies. The IN Authenticator determines if the authentication process has failed based on the RADIUS messages received. The IN Authenticator indicates authentication failure by returning a non-zero *Status* value in a WLCCP_AAA Reply.

[0497] A secret "session key", NSK, is established during initial authentication. The NSK is then used by the IN and IA along with exchanged key material to mutually derive the CTK. The CTK protecting TLVs and messages between the IN and IA are the only CTKs that require mutual derivation, all other links' CTKs are derived through a strong pseudorandom function by the IA and delivered to the Ins.

[0498] An SCM or LCM determines that it must initially authenticate with the IN Authenticator in the CCM if it is configured with the IP address of the CCM.

[0499] All infrastructure nodes must also initiate "path authentication", after a successful LEAP authentication, to mutually authenticate and establish a CTK with each of its ancestors.Path authentication is described below in the section entitled "Infrastructure Path Authentication".

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[0500] SCM Advertisement Reply messages contain an ROOT_CM_INFO TLV, which enables APs to automatically discover the Root CM and the IN Authenticator. An AP must initially authenticate with the IN Authenticator identified by the IP address contained in the TLV.

[0501] A Registration Reply message sent to an AP can include a MN_1X_AUTHEN TLV, which identifies the current MN authenticator. The SCM can advertise a new MN Authenticator in a MN_1X_AUTHEN TLV contained in SCM Advertisement Reply messages.

[0502] An IN must periodically repeat the initial authentication process to maintain a "fresh" session key (e.g. NSK); the refreshing of NSKs is determined by the session timeout defined by the authentication server (AS).

[0503] When in standalone mode, the SCM acts as both the MN and IN Authenticator. A path initialization message with only a single Secure Context TLV is required as it only requires the direct CTK with the IN Authenticator (e.g. the SCM). Since this is the only present link the Path Intialization message only requires a 3-way handshake: request, reply and confirm. However, to keep consistant with a full topology infrastructure, in the SCM standalone configuration, the AP shall use a request/reply handshake for Path Initialization and confirm the key establishment through the use of the Authenticator TLV in the Registration request/reply exchange.

[0504] However, in a full SWAN topology, a full 4-message handshake is required to establish both the key delivery and liveness confirmation between the supplicant IN and its ancestors. The request/reply messages are required for key delivery and the confirm/ack are required to prove each link is live. FIG 29 gives an example of a root AP authentication. While the example demonstrates the root AP authentication and CTK establishment, the same steps are required for all other infrastructure nodes, e.g. LCM and SCM.

[0505] After an infrastructure node has initially authenticated, it must mutually authenticate and establish a separate secret a "Context Transfer Key" (CTK) with each of its ancestor nodes including the IA. A Path-Init message is used to establish CTKs between the supplicant IN and its ancestors. Each ancestor node must provide a 16-byte nonce to allow for the distribution of fresh CTKs. The IA serves as a trusted key distribution center, KDC, for that purpose. The CTKs are used to generate MICs and encrypt sensitive context information in messages that are forwarded on branches of the Topology Tree. CTKs are 256-bit values whose lower 128 bits are used to authenticate messages and TLV and whose upper 128 bits are used to encrypt messages and TLVs.

[0506] For the CTK used between the IN and the IA, the supplicant IN must provide a 16-byte nonce in the Path-Init request message so that the IA can derive the CTK. The IA provides its 16-byte nonce in the Path-Init reply message so that the IN can derive the CTK. A final Path-Init confirm message is needed to allow the IN to confirm proper receipt of key material and liveness of the CTK. If a full path authentication is requested by the use of a WTLV_INIT_SESSION TLV, a fourth message is required to establish liveness of the CTK distributed in the Path-Init request/reply exchange.

[0507] An unregistered and unauthenticated IN "supplicant" initiates Path Authentication by sending a Path-Init Request message and embeds a WTLV_INIT_SESSION to its selected parent node. Included in the Init Session TLV is a Secure Context TLV that includes the IN's 16-byte nonce directed to the IA (e.g. the DST-ID is the IA in the Secure Context TLV). The parent node forwards the Path-Init Request inbound to the root CM, which contains the IA. Each node on the path to the root CM, including the parent node, inserts a Secure Context TLV into the request message's Init Session TLV. The IN Authenticator in the root CM determines the supplicant's list of ancestors from the list of WTLV_IN_SECURE_CONTEXT_REQ TLVs when it receives the Path-Init Request.

[0508] The IA will mutually derive the CTK to protect the link between the requesting IN and the IA. Additionally, the IA will generate CTKs for each of the supplicant's ancestors. The IA must first derive the CTK protecting the IN-IA link so that it can generate the Transient Key TLVs to properly deliver the CTKs to the requesting IN. For all of the ancestors, the CTKs are embedded in the corresponding (and now encrypted) Secure Context TLVs. For the Secure Context TLV corresponding to the IN-IA link, the nonce generated by the IA is included in the TLV and a new MIC is computed using the newly established CTK_{IN-IA}. This WTLV_MIC within the Secure Context TLV serves as the liveness authenticator to the requesting IN.

[0509] To better describe the actions required to authenticate a IN to the SWAN topology, a simplified terminology is defined. First, the set of CTK's are explicitly defined in FIG 30.

[0510] The AP path authentication are as follows:

- An NSK is shared between the AP and the CCM
- It is presumed it's ancestors have successfully registered. In the example shown in FIGu 30, CTK1, CTK2 and CTK3 are fresh and valid. This is a requirement as CTK1 is used to deliver and authenticate delivery of CTK5 to the LCM. While CTK2 is used to deliver CTK6 to the SCM but is sent via the LCM. The LCM in turn protects the WTLV_IN_SECURE_CONTEXT_REPLY using CTK3.

[0511] The WTLV_TRANSIENT_KEY's used are described in shorthand as:

$$TKE1 = WTLV\_TRANSIENT\_KEY(CTK4, KSC_{AP-LCM} \| LCM\text{-}ID \| AP\text{-}ID \| CTK5 \| MIC_{CTK4})$$

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TKE2 = WTLV_TRANSIENT_KEY(CTK4, $KSC_{AP\text{-}SCM}$ || SCM-ID || AP-ID || CTK6 || MIC_{CTK4})

[0512] These TKE's are embedded in the encrypted Secure Context TLV's whose shorthand is:

WSC0 = WTLV_IN_SECURE_CONTEXT_REQ(<no encryption/MIC>, IA-ID || AP-ID || $Nonce_{AP}$)
WSC1 = WTLV_IN_SECURE_CONTEXT_REQ(CTK2, SCM-ID || AP-ID || $Nonce_{SCM}$ || MIC_{CTK2})
WSC2 = WTLV_IN_SECURE_CONTEXT_REQ(CTK1, LCM-ID || AP-ID || $Nonce_{LCM}$ || MIC_{CTK1})
WSC3 = WTLV_IN_SECURE_CONTEXT_REPLY(CTK1,
LCM-ID || AP-ID || $Nonce_{LCM}$ || CTK5 || TKE1 || MIC_{CTK1})
WSC4 = WTLV_IN_SECURE_CONTEXT_REPLY(CTK2,
SCM-ID || AP-ID || $NonceS_{CM}$ || CTK6 || TKE2 || MIC_{CTK2})
WSC5 = WTLV_IN_SECURE_CONTEXT_REPLY(<no encryption>, AP-ID || IA-ID || $Nonce_{IA}$ || MIC_{CTK4})

WAUTH1 = WTLV_AUTHENTICATOR(CTK6,
$KSC_{AP\text{-}SCM}$ || SCM-ID || AP-ID || $Nonce_{AP\text{-}SCM}$ || MIC_{CTK6})
WAUTH2 = WTLV_AUTHENTICATOR(CTK5,
$KSC_{AP\text{-}LCM}$ || LCM-ID || AP-ID || $Nonce_{AP\text{-}LCM}$ || MIC_{CTK5})
WAUTH3 = WTLV_AUTHENTICATOR(CTK4,
$KSC_{AP\text{-}CCM}$ || CCM-ID || AP-ID || $Nonce_{AP\text{-}CCM}$ || MIC_{CTK4})
WAUTH4 = WTLV_AUTHENTICATOR(CTK6,
$KSC_{AP\text{-}SCM}$ || SCM-ID || AP-ID || $Nonce_{AP\text{-}SCM}$ +1 || MIC_{CTK6})
WAUTH5 = WTLV_AUTHENTICATOR(CTK5,
$KSC_{AP\text{-}LCM}$ || LCM-ID || AP-ID || $Nonce_{AP\text{-}LCM}$ + 1 || MIC_{CTK5})
WAUTH6 = WTLV_AUTHENTICATOR(CTK4,
$KSC_{AP\text{-}CCM}$ || CCM-ID || AP-ID || $Nonce_{AP\text{-}CCM}$ + 1 || MIC_{CTK4})

[0513] Using the above terminology, the WTLV_INIT_SESSION (WIS) TLV exchanges during path authentication serves as the means to authenticate and establish the path CTKs between a requesting infrastructure node and it's ancestors. An example of an AP authenticating and registering to the infrastructure is depicted in FIG 31.

[0514] An alternate sequence for when paths need to be updated but no registration is required is shown in FIG 32.

[0515] Each CTK delivered to the supplicant is encoded in a *WTLV_TRANSIENT_KEY* TLV. The CTK is directly delivered to the supplicant's ancestor in the WTLV_SECURE_CONTEXT_REPLY TLV. The list of TLVs is then entered into the Path-Init Reply message, which is sent to the supplicant's parent node. The parent node relays the Reply to the supplicant. Each node on the outbound path of the Path-Init Reply decrypts the CTK that it shares with the supplicant when it receives its respective WTLV_SECURE_CONTEXT_REPLY TLV. As shown in FIG 32, once the supplicant receives the Path-Init Reply message, it must send an "initial" Registration Request message to the root CM, via its parent node, as described above. The supplicant must enter a WTLV_AUTHENTICATOR TLV into the request message for each of its ancestor nodes. Each ancestor node "authenticates" the supplicant when it receives its WTLV_AUTHENTICATOR TLV; therefore, the supplicant is fully authenticated before a Registration Reply is generated. Each ancestor node must update and re-encrypt the WTLV_AUTHENTICATOR TLV before forwarding the Registration Request. The supplicant mutually authenticates each of its ancestor nodes when it receives the updated list of WTLV_AUTHENTICATOR TLVs in the Registration Reply.

[0516] CTKs can be similarly refreshed as shown in FIG 33, with the only difference being that no registration is needed and thus, rather than using a Registration message type, it extends the Path-Init message to use subtypes Confirm and ACK.

[0517] The CTKs must be refreshed based on the entropy defined by the cipher suites used to provide privacy and authenticity. [Initial releases will employ RC4 and HMAC-MD5 for respectively encrypting and authenticating all messages or TLVs. However, future releases may support AES.] CTKs must be refreshed when the message sequence counter has been exhausted or at a frequency of no more than a couple times a day (a 6hr. interval will be reasonable). However, if a node is experiencing frequent MIC and or decryption failures it should silently discard these messages. Optionally (e.g. in future releases), with proper heuristics, the IN can decide whether to trigger a CTK refresh or a full (re)authentication.

[0518] CTK refreshes can optionally be refreshed for an entire branch, using WTLV_INIT_SESSION, or a single CTK can be refreshed using a Secure Context request/reply exchange. While the CTK used between the infrastructure node and the IA is also established and refreshed in WTLV_INIT_SESSION or WTLV_SECURE_CONTEXT_REQ and WTLV_SECURE_CONTEXT_REPLY, its key can not be directly delivered by the IA, but rather key material (e.g. nonces) are exchanged to mutually derive a CTK. Thus the semantics of the WTLV_SECURE_CONTEXT_{REQ/REPLY} changes on whether the CTK is being delivered versus derived.

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[0519] To rekey or establish a single CTK, the supplicant IN must request the IA for a fresh key. A 2-phase exchange is required. In the first phase, a WTLV_SECURE_CONTEXT TLV is used to establish the CTK. In the second phase a WTLV_AUTHENTICATOR TLV is used to confirm liveness of the CTK. The first phase is done during a Path-Init Request/ Reply exchange while the second phase is completed during initial registration through the use of WTLV_AUTHENTICATORs. The second phase is required to ensure CTK liveness between the link nodes.

[0520] As shown in FIG 33, an example of how a CTK used to protect the link between the AP and SCM employs the CCM for key delivery and direct path authentication from AP to SCM to confirm liveness of the CTK.

[0521] - Mobile Node Security Context Transfer.

[0522] Dynamic security credentials for a MN are established in the initial MN authentication process, described above. These credentials include: NSK, session timeout, VLAN ID, SSID, KRK, BTK and RN. A MN's cached configuration information and dynamic credentials are automatically transferred to the new parent AP when a MN roams. The cached configuration information and dynamic credentials are also forwarded to any new SCM on the new path so that future roaming is localized (i.e. so that the LCM is not accessed as the MN roams within the subnet). The dynamic credentials are forwarded to the SCM during SCM registration updates..

MN SSID Authorization

[0523] A MN must be authorized to use its SSID. The 802.1X authentication server returns a list of allowed SSIDs for a MN, when the MN authenticates. The list of SSIDs (and any other static configuration information) is cached in each CM on the path to the MN. A MN's SSID is included in its Pre-registration and Registration Requests. The nearest common ancestor CM verifies that a MN is authorized to use its SSID each time that it receives a Pre-registration or Registration Request for the MN.

Fast Roaming and Rekeying

[0524] On a reassociate request, the roaming node affects an authenticated key refresh request to the new AP. The new AP subsequently requests security credentials to the MN Authenticator via a pre-registration request. The MN Authenticator must validate the security credentials provided by the MN (forwarded by the new AP to the MN Authenticator). On a successful pre-registration reply, the MN Authenticator will forward the security credentials to the new AP. On a failed pre-registration reply, the MN Authenticator will only provide a status code to indicate the failure point and allow the AP to decide whether to allow the MN to reestablish credentials by imposing a full authentication or to fully disassociate the MN.

-MN Security Context Forwarding

[0525] In a full topology, the LCM acts as the MN Authenticator. The location of the MN Authenticator in a full topology can present longer latencies and thus it is desirable to forward the MN's security credentials down to the SCM. The forwarding of the credentials is achieved during Registration request/reply. This allows the MN's infrastructure ancestors, mainly the SCM, to cache the MN's security credentials and facilitate roaming.

[0526] The credentials are forwarded by request. That is, during a MN Registration Request, each ancestor (excluding the AP) can insert a WTLV_SECURE_CONTEXT_REQ requesting that the MN credentials be forwarded, a MIC must be included in the Secure Context TLV for the MN Authenticator to validate. On a successful request, the MN Authenticator will then embed a WTLV_MN_SEC_CONTEXT_REPLY TLV that includes all of the cached credentials encrypted in the TLV. Like the request, the Secure Context TLV must be MIC'ed on a reply as well. A full depiction of an MN authentication and registration undea SWAM topology is shown in FIG 34.

[0527] The WLCCP_AAA message is the only explicit message type defined for node authentication. EAPOL messages are protected from man in the middle attacks as they are routed to the node's authenticator by means of a MIC in the WLCCP message encapsulation.

[0528] TLVs can be protected by using a modified RC4 algorithm to provide privacy and HMAC-MD5 to provide message authenticity. For privacy, TLVs are encrypted using the standard RC4 algorithm but discarding the first 256 bytes of the RC4 stream to thwart the FMS attack. For authenticity, a MIC TLV is included in WLCCP. The CTK is thus a 256bit value comprised of two keys, the high order 128 bits is used as the HMAC-MD5 key while the low order 128 bits is used as the RC4 key.

[0529] A Message Integrity Check (MIC) TLV is used to authenticate WLCCP messages. A source node can, optionally, set the *MIC Flag* ON and enter a WTLV_MIC TLV in a WLCCP message to "authenticate" the message to the destination. The TLV contains a MIC that is calculated with the high order 128bits of the Context Transfer Key (CTK) shared by the source and destination. If a Request message is authenticated, then the corresponding Reply message must also be authenticated. Each, source and destination node maintains a message sequence counter, MSC, initialized to 0 when

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a CTK is initialized or refreshed. The MSC serves as a replay counter as well as the RC4 initialization vector. If the current MSC is less than or equal to the previous MSC value, then the message is a replay and must be discarded. The MSC value is concatenated with the low order 128bits of the CTK to generate the RC4 key. In little endian order:

RC4-key = MSC || CTK[0:127] where || is the concatenation function

[0530] To avoid MSC collisions and definition of directional CTKs, the MSC values shall be even on inbound paths and odd on outbound paths. The MSC should also be incremented every time a TLV or message is encrypted or authenticated.

[0531] Messages that are forwarded on branches of the SWAN Topology Tree are authenticated with CTKs that are established during the preregistration/registration process. Messages that are forwarded "laterally" are authenticated with dynamically-established lateral CTKs. Lateral message authentication is discussed in the next section.

[0532] If the *Relay Flag* is set OFF in a message, then the MIC is calculated using the CTK shared by the Originator and the Responder. An intermediate AP may "relay" a message that is forwarded with "Hopwise Routing". If the *Relay Flag* is set ON in a message, then the MIC is calculated using the CTK shared by the immediate sender and receiver. The rules for determining the shared CTK for a hopwise-routed message are as follows:

The immediate sender AP of an inbound message uses the CTK it shares with its parent node.
The immediate sender (AP or SCM) of an outbound message uses the CTK it shares with the next hop child node.
The immediate receiver uses the CTK it shares with the immediate sender. If the Relay Flag is set OFF, then the immediate sender is the Originator in a Request message and the Responder in a Reply message. If a the Relay Flag is set ON, then the immediate sender is the "relay node" identified by the required *Relay Node ID* field.
A CTK is also used to encrypt any TLVs that contain sensitive data (e.g. a session key for a descendant node). The rules for determining the CTK used to encrypt sensitive TLVs are the same as the rule for determining the CTK used for message authentication. Note that each relay AP must decrypt and re-encrypt TLVs in messages that are forwarded with Hopwise-Routing.
TLVs are defined to allow for node authentication, context management, and CTK and PTK management (i.e. path authentication and pre-registration).

[0533] There are five basic operations to establish, cache and manage security credentials; these are defined as TLV Group IDs in the following table:

TLV Type ID	Value	Description
WTLV_INIT_SESSION	0x0101	An IN node must initialize its CTK with the SWAN infrastructure. An MN node must initialize its BTK with the SWAN infrastructure.
WTLV_IN_SECURE_CONTEXT_REQ	0x0102	IN node CTK refresh
WTLV_UPDATE_RN	0x0103	Update of MNs PTK sequencing
WTLV_TRANSIENT_KEY	0x0104	Deliver a CTK
WTLV_AUTHENTICATOR	0x0106	Link authentication must be achieved on registration
WTLV_NSK	0x0107	MN Authenticator must retrieve NSK from associated AP, since key is statically configured
WTLV_MIC	0x0108	Generic MIC that can be embedded in messages or TLVs
WTLV_MN_SEC_CONTEXT	0x0109	TLV used to forward required MN security credentials
WTLV_IN_SECURE_CONTEXT_REPLY	0x010a	TLV used to deliver IN CTKs
WTLV_MN_SECURE_CONTEXT_REQ	0x010b	IN's request for MN's credentials
WTLV_MN_SECURE_CONTEXT_REPLY	0x010c	IA's response for request of MN cache
WTLV_EAP_ID	0x010d	EAP Identity
WTLV_CCKM_ASSOCIATE	0x010e	Contents of 802.11 Association required for CCKM validation
WTLV_CCKM_REASSOCIATE	0x010f	Contents of 802.11 Reassociation CCKM element

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[0534] The fourth type, WTLV_TRANSIENT_KEY is an embedded TLV used to deliver link keys within a WTLV_INIT_SESSION or WTLV_SECURE_CONTEXT_REPLY.

[0535] The Identity string provided within an EAP Identity request/response for MNs are cached at the SCM and used in the Secure Context TLVs to enable proper accounting at the AP. Since EAP Identity can be of arbitrary length a TLV is define as follows:

TLV Type ID	Length	Identity (byte) Length	EAP Identity
WTLV EAP ID	TLV-length	8bytes	Nbytes

- WTLV_MIC

[0536] Another TLV used to secure WLCCP messages or TLVs is the WTLV_MIC. It is defined as:

TLV Type ID	Length	Message Sequence Counter	MIC length (in bytes) value = 8	MIC
WTLV_MIC	TLV-length	8bytes	2bytes	8 bytes

[0537] The WTLV_MIC allows expansion of the MIC for some future use. Initially, the MIC length is preset to 8 bytes to define the MIC to be of length 8 bytes. The message sequence counter is used to define the number of WTLV_MICs generated using the corresponding CTK. This TLV will be appended to any WLCCP message whose Flags value includes the MIC Flag (0x0100). Messages that require a WTLV_MIC must define the fields covered by the HMAC-MD5 function.

[0538] Some WLCCP messages and TLVs that require a WTLV_MIC TLV:

WTLV_MIC is used to authenticate WLCCP_AAA messages for MN authentications only.
WTLV_TRANSIENT_KEYs must include a MIC to authenticate delivery of a CTK or when forwarding MN's keys.
WTLV_MN_SECURE_CONTEXT_REQ, WTLV_IN_SECURE_CONTEXT_REQ, WTLV_IN_SECURE_CONTEXT_REPLY and WTLV_MN_SECURE_CONTEXT_REPLY must be authenticated as they are augmented and propagated hop to hop.
WTLV_INIT_SESSION must be authenticated as they are augmented and propagated from the supplicant node to its authenticator.
WTLV_AUTHENTICATOR must include a MIC to ensure session liveness between a supplicant node and ancestor

- WTLV_INIT_SESSION: Path authentication and Pre-Registration

[0539] Path authentication and Pre-registration are required to establish CTKs and BTKs, respectively. For IN nodes, CTKs must be established between the node and it's ancestors up to the root CM. The WTLV_INIT_SESSION TLV triggers the state for establishing fresh CTKs. On a successful WLTV_INIT_SESSION, sequence counters are initialized to zero and CTKs are established for all links between the requesting IN nodes and the IN Authenticator.

[0540] For MN nodes, only PTKs are required for an MN and its currently associated AP to consume. The key established between the MN and IA must be forwarded to the AP before PTKs can be mutually derived and consumed between MN and AP. However, a BTK must first be established for a CCKM MN. The WTLV_INIT_SESSION triggers the state for establishing fresh CTKs and BTKs. On a successful 802.1X authentication followed by a WTLV_INIT_SESSION, sequence counters are initialized to zero and CTKs are established for all links between the requesting IN nodes and the IN Authenticator. Key sequence counters are only set to zero after a successful authentication, they are incremented every time a key is refreshed.

[0541] For a CCKM MN, a BTK and first PTK are established for securing data packets between the AP and MN; this of course, implies that for SCM standalone mode, the AP must have secured a CTK between itself and the SCM. That is, APs must first authenticate and register into the SWAN topology before it can pre-register or register MNs.

[0542] The WTLV_INIT_SESSION TLV is defined as follows:

Field Name	Length	Description
WTLV_INIT_SESSION	2	TLV Type
TLV Length	2	TLV length
Reserved	1	Reserved for byte alignment

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(continued)

Field Name	Length	Description
Path Length	1	Number of Ancestors between Supplicant and IN Authenticator
Optional TLV(s)	N	Different TLVs must be included depending on the State and direction specified

[0543] Since TLVs can vary in length, each TLV is preceded by an offset to indicate the next TLV length or the offset to the next TLV. An offset of 0 (zero) indicates the end, e.g. no more TLVs.

- WTLV_ INIT_ SESSION for MNs

[0544] When MNs successfully authenticate into the network, the MN Authenticator will cache it's NSK and other relevant security credentials. If CCKM is the negotiated Authenticated Key Management selector, the MN Authenticator must respond with an EAPOL Key to the MN and trigger establishment of the KRK and BTK.

[0545] The response from the MN provides a $Nonce_{MN}$ and the negotiated security elements for which the AP can validate. However, the MN Authenticator must also validate some of these credentials to ensure that no VLAN hopping occurs.

[0546] For an inbound MN pre-registration request, the WTLV_INIT_SESSION includes a Secure Context TLV that includes the AP's identity as the Destination-ID and the negotiated 802.11 security information element (RSNIE) The SSID is also included in the Secure Context request by the MN and checked by the MN Authenticator to ensure that the MN is not hopping VLANs and thus breaching security. The Secure Context's Nonce must be provided by the MN as it serves as the keying material used to derive the KRK and BTK.

[0547] The WTLV_INIT_SESSION generated by the AP (on behalf of the MN) is defined as:

Field Name	Length	Description
WTLV_INIT_SESSION	2	TLV Type
TLV Length	2	TLV length
Reserved	1	0
Path Length	1	Number of Ancestors between Supplicant and IN Authenticator
SECURE_CONTEXT TLV	N	MN_SECURE_CONTEXT is embedded with SID=MN-ID and DID = AP-ID, include RSNIE

[0548] If the MN has negotiated CCKM then it must have also provided a nonce, which is embedded in the WTLV_ MN_SECURE_CONTEXT_REQ. The AP should trigger an error if the MN does not provide a nonce.

[0549] If the MN has negotiated SSN or legacy systems, the AP must obtain only the NSK. However, if the MN has negotiated CCKM then the MN Authenticator must derive and deliver the BTK to the AP and cache the KRK. Thus, on a response, the MN Authenticator must deliver the key (NSK or BTK) to the AP, embedded in the MN_SECURE_ CONTEXT_TLV. Since it is an MN requesting such a key, the MN Authenticator will omit the WTLV_TRANSIENT_KEY normally used to deliver the NSK or BTK to the MN. This step is redundant and unnecessary as the MN has already mutually derived this key as well as it need not be aware what is behind the AP.

1.1.1.1.1.1 WTLV_INIT_SESSION for INs

[0550] Path authentication and initialization of CTKs for IN nodes presumes that the IN's ancestors have successfully registered into the SWAN infrastructure. Path authentication is initiated with a Path-Init request that includes a WTLV_ IMT_SESSION TLV of the form:

Field Name	Length	Description
WTLV_INIT_SESSION	2	TLV Type
TLV Length	2	TLV length
Reserved	1	0

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(continued)

Field Name	Length	Description
Path Length	1	0
Secure Context Request for IN-IA TLV	N	WTLV_IN_SECURE_CONTEXT_REQ SID=IN, DID=IA

[0551] As the WLCCP Path-Init request is forwarded to the IA, the Supplicant's ancestors will in turn request a key to protect the link between it and the requesting IN by embedding their WTLV_SECURE_CONTEXT_REQ:

Field Name	Length	Description
WTLV_INIT_SESSION	2	TLV Type
TLV Length	2	TLV length
Reserved	1	0
Path Length	1	0
Secure Context Request for IN-IA TLV	N	WTLV_IN_SECURE_CONTEXT_REQ SID=IN, DID=IA
Secure Context Request for Ancestor[i] TLV	M	WTLV_IN_SECURE_CONTEXT_REQ SID=IN, DID=Ancestor[i]
...continued list of Secure Context TLVs		

[0552] As the inbound WTLV_INIT_SESSION request augments WTLY_IN_SECLERE_CONTEXT_REQs, the outbound reply will consume these TLVs and respond with WTLV_IN_SECURE_CONTEXT_REPLYs and update them with the CTK and a WTLV_TRANSIENT_KEY to be consumed by the Supplicant node. FIG 33 is an example of how a node initializes the CTKs between itself and it's ancestry path up to the IA.

[0553] The *Path Length* field must incremented by one by each ancestor as the request is forwarded to the IA. The IA must return this value and confirm that there are *Path Length* WTLV_SECURE_CONTEXT_REQ TLVs in the WTLV_INIT_SESSION. If too many or too few are provided then it must discard this request.

[0554] Each ancestor must identify itself and provide it's corresponding WTLV_SECURE_CONTEXT_REQ. The IA in turn will convert each requesting Secure Context TLV into a WTLV_SECURE_CONTEXT_REPLY to deliver the appropriate CTKs. Since keys are delivered within WTLV_SECURE_CONTEXT_REPLYs, the responding Secure Context TLVs must be both encrypted and MIC'ed.

-WTLV_TRANSIENT_KEY: delivering keys

[0555] A key must be distributed securely. To assure this, the key is encrypted using a shared secret between the source and intended receiver. The TLV is encapsulated as follows:

Type	Length	KSC	IN-ID	IN-ID	Key	MIC TLV
WTLV_ TRANSIENT_ KEY	TLV len	Key sequence counter	Source IN ID	Destination IN ID	E_{SUP_DST}	KEY-MIC$_{SUP_DST}$

[0556] The TLV implies the source IN identifier from the overall WLCCP message to avoid too much redundancy. The encryption uses RC4 to encrypt the key only:

$$E_{SUP\_DST} = \text{Encrypted Key RC4}(MSC \| CTK_{Authenticator\_IN\text{-}ID}, CTK_{IN\text{-}ID\_SupplicantID})$$

[0557] The key, $CTK_{IN\text{-}ID\_SupplicantID}$, is encrypted using the key established between the IN Authenticator and the destination IN. The delivered key, $CTK_{IN\text{-}ID\_SupplicantID}$ is used to protect data between the destination IN and the Supplicant. For the supplicant node, since it is the leaf node that is yet to register, the NSK is used to deliver its CTK.

[0558] The key delivery for protecting messages between the AP and MN is the same as that defined above, with the

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difference being that the BTK is the delivered key along with the Rekey sequence number to the AP only:

E_{AP} = Encrypted Key RC4(MSC||$CTK_{Authenticator\ AP}$, BTK_{MN})

[0559] The authentication of the TLV includes fields excluded in the WTLV_TRANSIENT_KEY but embedded in the overall WLCCP message. The MIC for an IN node response is computed as follows:

$KEY\text{-}MIC_{SUP\_DST}$ = HMAC-MD5($CTK_{Authenticator\_IN\text{-}ID}$, KSC, SNonce, $ANonce_i$, Supplicant-ID, Destination-IN_ID, E_{SUP_DST})

The responding MIC for an AP request for a BTK is computed as follows:

$KEY\text{-}MIC_{AP}$ = HMAC-MD5($CTK_{Authenticator\_AP}$, KSC, SNonce, $ANonce_i$, Supplicant-ID, Destination-IN_ID, E_{AP})

[0560] A counter, KSC, for all keys delivered to the Destination IN must be kept and used between the destination IN and the IN Authenticator to prevent replays. Similarly, if the keys are delivered to the AP for protecting AP to MN communications, it must also retain a count for such keys in its KSC.

-Secure Context TLVs

[0561] Secure Context TLVs are used to establish link keys between the Supplicant node and its ancestor. Since requesting Secure Context TLVs do not include keys but other pertinent information to carry the requests, the Secure Context TLVs are split into a *requesting* and a *responding* Secure Context TLV. Further, since MNs define a key management type and are proxied by the AP, the Secure Context TLV for requesting MN security credentials are distinguished from IN secure contexts.

[0562] The requesting MN Secure Context TLV is defined as:

Field Name	Length	Description
WTLV_MN_SECURE_CONTEXT_REQ	2	TLV Type
TLV Length	2	TLV length
Key Sequence Counter (KSC)	4	Number of times this key has been updated
Destination-ID (DID)	8	Ancestor requesting to share key with SID
Supplicant-ID (SID)	8	Requesting (Supplicant) node
Reserved	1	Used for byte alignment
Key Management Type	1	0 - none (NSK is not forwarded) 1 - CCKM 2 - 802.1X Legacy systems (doing an effective re-authentication) forwards the NSK. 3 - SSN (this field is ignored when establishing IN path CTKs)
Nonce	16	Random value
EAP ID	Q	EAP ID TLV
SSID	L	SSID TLV
RSNIE	P	Propagate the $RSNIE_{MN}$ TLV for authentication
Optional (CCKM) TLVs	N	If CCKM is the negotiated Key Management, then Associate or Reassociate TLVs must be provided
MIC	M	WTLV_MIC for this TLV

[0563] Optional TLVs are also provided for when CCKM is the negotiated key management and thus further work is required by the MN authenticator to validate the EAPOL Key message on association or the Reassociation CCKM element.

[0564] The requesting IN Secure Context TLV is defined as:

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Field Name	Length	Description
WTLV_IN_SECURE_CONTEXT_REQ	2	TLV Type
TLV Length	2	TLV length
Key Sequence Counter (KSC)	4	Number of times this key has been updated
Destination-ID (DID)	8	Ancestor requesting to share key with SID
Supplicant-ID (SID)	8	Requesting (Supplicant) node
Nonce	16	Random value
MIC	M	WTLV_MIC for this TLV

[0565] A responding MN Secure Context TLV is defined as follows:

Field Name	Length	Description
WTLV_MN_SECURE_CONTEXT_REPLY	2	TLV Type
TLV Length	2	TLV length
Key Sequence Counter (KSC)	4	Number of times this key has been updated
Destination-ID (DID)	8	Ancestor requesting to share key with SID
Supplicant-ID (SID)	8	Requesting (Supplicant) node
Nonce	16	Random value
Session Timeout	4	Remaining session timeout for MN
EAP ID	Q	EAP ID TLV
Rx Key Length	2	Rx key length
Rx Key	32	Corresponds to one of CTK, BTK or NSK
Optional Tx Key Length	2	Tx key length
Optional Tx Key	M	Provided only after successful authentication when AS returns a Tx Key as a result of a successful authentication
Optional MN Cached Credentials	P	Provided only during MN registration to forward cached credentials from IA to outbound nodes (SCM).
MIC	Q	WTLV-MIC for this TLV

[0566] The responding MN Secure Context TLV will ultimately deliver Key(s) to the Supplicant node. Depending on the Supplicant node (SID) type, optional fields are included. The succeeding subsections further describe the required fields based on the requests.

[0567] When a MN roams, WLCCP pre-registration is used to request security credentials. The parent AP sends a Pre-registration Request message to the SCM to request security credentials. [The request may be forwarded inbound, as required, if the security credentials are not cached in the SCM.] The Pre-registration request includes a WTLV_SECURE_CONTEXT REQ TLV. The parent AP must be authenticated and have an established CTK between itself and the SCM (i.e. via Path Authentication).

[0568] The WTLV_SECURE_CONTEXT_REPLY, contained in a Pre-registration Reply, is used to deliver keys and thus the TLV must be encrypted as follows:

RC4'(MSC||CTK_{IN-IA} , Key Management Type || Nonce || <included fields in TLV>)

[0569] Similarly, during a response the TLV must be authenticated as follows:

MIC = HMAC-MD5(CTK_{IN-IA}, DST-ID || SRC-ID || KSC ||
Nonce || <included fields in TLV>)

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[0570] A responding IN Secure Context TLV is defined as follows:

Field Name	Length	Description
WTLV_IN_SECURE_CONTEXT_REPLY	2	TLV Type
TLV Length	2	TLV length
Key Sequence Counter (KSC)	4	Number of times this key has been updated
Destination-ID (DID)	8	Ancestor requesting to share key with SID
Supplicant-ID (SID)	8	Requesting (Supplicant) node
Nonce	16	Random value
Session Timeout	4	Remaining session timeout for MN
CTK Key Length	2	Rx key length
CTK Key	32	Corresponds to one of CTK, BTK or NSK
Optional Key TLV	N	WTLV_TRANSIENT_KEY delivering the new CTK to the SID. This field must be provided when establishing CTKs between Ins. It is absent when the SID IN is mutually deriving keys with its IA.
MIC	Q	WTLV-MIC for this TLV

-Propogating MN Association information for CCKM

[0571] The WTLV_CCKM_ASSOCIATE element is used to forward the second EAPOL Key message from the MN to the MN Authenticator as it is MIC'ed with the KRK, which only the MN Authenticator holds. The EAPOL Key message must be validated by the MN Authenticator. Thus a TLV is defined to propage the EAPOL Key message for MIC validation as follows:

Field Name	Length	Description
WTLV_CCKM_ASSOCIATE	2	TLV Type
TLV Length	2	TLV length
EAPOL message length	4	Byte length of EAPOL message
EAPOL message	N	EAPOL message as received by the AP and forwarded to the MN Authenticator
MIC-KRK	P	MIC TLV containing the EAPOL MIC using the KRK

- Propogating MN's Reassociation CCKM element.

[0572] The WTLV_CCKM_REASSOCIATE element is used to forward the timestamp and MIC portions of the CCKM information element provided by the MN in the reassociation message. When CCKM is in effect, the MN includes a CCKM element in the Reassociation message of the format:

Element ID	Length	OUI	OUI Type	Timestamp	RN	MIC_{MN}
1byte	1byte	3bytes	1byte	8bytes	4bytes	8bytes

[0573] The AP places the RN value as the KSC field in the MN Secure Context Request TLV. In addition, it propagates this element in the CCKM Reassociate TLV as follows:

Field Name	Length	Description
WTLV_CCKM_REASSOCIATE	2	TLV Type

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(continued)

Field Name	Length	Description
TLV Length	2	TLV length
Element ID	1	Must be 0x9c
Element ID Length	1	Should be 24 (bytes)
OUI	3	Must be 00:40:96
OUI Type	1	Must be 0
Timestamp	8	TSF timer that must be validated by the AP, forwarded for authentication
RN	4	Must be the same as KSC and validated by MN authenticator
MIC	P	MIC TLV containing the HMAC-MD5(KRK, MN-ID ‖BSSID ‖ $RSNIE_{MN}$ ‖ Timestamp ‖ RN)

- IN to IN CTK requests using WTLV_SECURE_CONTEXT

[0574] IN nodes can request subsequent CTKs via a WTLV_SECURE_CONTEXT request. WTLV_SECURE_CONTEXT requests a new CTK for the link specified between the Supplicant and IN. The request format is defined as follows:

Field Name	Length	Description
WTLV_IN_SECURE_CONTEXT_REQ	2	TLV Type
TLV Length	2	TLV length
Key Sequence Counter (KSC)	4	A replay counter used to keep state of the rekeys for the link between SID and DID
Destination-ID (DID)	8	Ancestor with whom IN wants to rekey
Supplicant-ID (SID)	8	Requesting IN
Reserved	1	Used for byte alignment
Key Management Type	1	For IN the value is always set to 0.
Nonce	16	Random value provided by the DID
MIC	M	WTLV_MIC for this TLV

[0575] The IN Authenticator will deliver a CTK for protection of WLCCP messages between the Supplicant and IN-ID. The delivery mechanism to the Supplicant is through the use of WLTV_TRANSIENT_KEY while the key can be delivered in the encrypted WTLV_SECURE_CONTEXT to the Destination (ancestor to the Supplicant) directly.

[0576] The WTLV_SECURE_CONTEXT response must encrypt the Nonce, Key and Key TLV as well as append a WTLV_MIC.

Field Name	Length	Description
WTLV_IN_SECURE_CONTEXT_REPLY	2	TLV Type
TLV Length	2	TLV length
Key Sequence Counter (KSC)	4	Number of times this key has been updated
Destination-ID (DID)	8	Ancestor requesting to share key with SID
Supplicant-ID (SID)	8	Requesting IN
Nonce	16	Random value provided by DID
Session Timeout	4	Remaining session timeout for SID
CTK Length	2	CTK length should be 32

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(continued)

Field Name	Length	Description
CTK	32	CTK shared between SID and DID
Key TLV	N	WTLV_TRANSIENT_KEY delivering the new CTK to the SID.
MIC	Q	WTLV-MIC for this TLV

-IN to IA CTK requests using WTLV_SECURE_CONTEXT.

[0577] Both the IN and IA must mutually derive their link CTK since:

- keys can not readily be delivered in a clear channel
- the NSK provided at authentication may be not meet the freshness requirement
- the key length requirements to protect messages and TLVs may not be satisfied The supplicant IN must include a Nonce in the requesting

WTLV_SECURE_CONTEXT_REQ so that the IA can then derive a CTK and use it to authenticate the reply. The Reply message will include the IA's Nonce and it's WTLV_SECURE_CONTEXT_REPLY MIC and an extra WTLV_MIC that serves as the authenticator to the supplicant IN. The final authentication and liveness proof of this key refresh must be completed with at WTLV_AUTHENTICATOR.

[0578] Both the IN and IA can mutually derive the CTK as follows:

$CTK_{IN\text{-}IA}$ = PRF-256(NSK, "SWAN IN - IA link Context Transfer Key Derivation" ||
IN-ID || IA-ID || KSC || $Nonce_{AP}$ || $Nonce_{SCM}$)

[0579] The defined PRF-256 function is based on HMAC-SHA1 and allows the NSK to be *stretched* to 256 and ensure freshness by having each node contribute fresh key material.

[0580] The extra MIC computed for the IN to validate is defined as:

MIC_{STATE2} = HMAC-MD5($CTK_{IN\text{-}IA}$, DST-ID || SRC-ID ||
KSC || $Nonce_{IN}$ || $Nonce_{AP}$)
Note however that while the reply is not sending the $Nonce_{IN}$ in the clear, it must authenticate the value of the $Nonce_{IN}$. Also, since the key is mutually derived, there is no WTLV_TRANSIENT_KEY delivered, this TLV is replaced by the authenticating MIC as defined above.

- WTLV_SECURE_CONTEXT for initial associations.

[0581] When a CCKM-capable MN first associates and 802.1X authenticates into the *network,* the SCM initiates a 4-way handshake with the MN to establish the KRK and BTK. The messages are forwarded to the MN via the AP, with the AP decapsulating the WLCCP header and forwarding the EAPOL Key messages to the MN. On receipt of the 2nd message from the MN to the SCM, the AP triggers a pre-registration request to request forwarding of the BTK. Details of this exchange depicted in the Fast Handoff Specification[8].

[0582] The pre-registration uses a WTLV_INIT_SESSION that embeds a Secure Context TLV forwarding the following MN information:

Field Name	Length	Description
WTLV_MN_SECURE_CONTEXT_REQ	2	TLV Type
TLV Length	2	TLV length
Key Sequence Counter (KSC)	4	should be set to 1
Destination-ID (DID)	8	AP ID
Supplicant-ID (SID)	8	MN ID
Reserved	1	Used for byte alignment

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(continued)

Field Name	Length	Description
Key Management Type	1	0 - none (NSK is not forwarded) 1 - CCKM 2 - 802. 1X Legacy systems (doing an effective re-authentication) forwards the NSK. 3 - SSN
Nonce	16	$Nonce_{MN}$ required to derive KRK & BTK
SSID	L	SSID TLV
RSNIE	P	Propagate the $RSNIE_{MN}$ TLV for authentication
Optional TLV	M	For CCKM, include WTLV_CCKM_ASSOCIATE
MIC	N	WTLV_MIC for this TLV

[0583] If Key Management Type = 1 (CCKM), the Pre-Registration request includes the above TLV to propagate the $Nonce_{MN}$ contributed by the MN as well as the MIC TLV used to prove liveness to the SCM that the MN has correctly derived the KRK. The pre-registration concludes with a reply with the Secure Context TLV as:

Field Name	Length	Description
WTLV_MN_SECURE_CONTEXT_REPLY	2	TLV Type
TLV Length	2	TLV length
Key Sequence Counter (KSC)	4	Should be 1 (RN value)
Destination-ID (DID)	8	AP-ID
Supplicant-ID (SID)	8	MN-ID
Nonce	16	reaffirm (resend) the 1st msg $Nonce_{SCM}$
Session Timeout	4	Remaining session timeout for MN
Optional Rx Key Length	2	Must be = 32
Optional Rx Key	32	BTK
Optional Tx Key Length	2	Should be= 0
Optional Tx Key	0	No Tx Key is applicable
MIC	N	WTLV-MIC for this TLV

[0584] If Key Management Type = 2 or 3, then the MN Authenticator will remove the MN's credential after it sends a Pre-Registration Reply. That is, the MN Authenticator will not cache nor will it propagate the PMK to any node other than to the immediate AP. The Pre-registration reply terminates by forwarding the PMK to the AP using the following Secure Context TLV:

Field Name	Length	Description
WTLV_MN_SECURE_CONTEXT_REPLY	2	TLV Type
TLV Length	2	TLV length
Key Sequence Counter (KSC)	4	Value is ignored
Destination-ID (DID)	8	AP-ID
Supplicant-ID (SID)	8	MN-ID
Nonce	16	Value is unused (ignored)
Session Timeout	4	Remaining session timeout for MN
Optional Rx Key Length	2	Reflects value based on 802.1X Auth Type

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(continued)

Field Name	Length	Description
Optional Rx Key	32	Key sent in MS-MPPE Rx Key
Optional Tx Key Length	2	Reflects value based on 802.1X Auth Type
Optional Tx Key	0	Key sent in MS-MPPE Tx Key
MIC	N	WTLV-MIC for this TLV

[0585] Note that there is a second Optional Tx Key Length, for authentication types that provide both a Rx and Tx key in the MS-MPPE Radius attribute. All authentication types will provide an Rx key, the Tx key is optional and it's length will be zero when it is not provided by the Authentication Server. Note that in any of the negotiated Key Management types, the VLAN is forwarded to the AP as the VLAN field provided in the Pre-Registration message.

[0586] The WTLV_SECURE_CONTEXT replies are encrypted from the WTLV SECURE_CONTEXT Nonce field through the end (up to but excluding) the WTLV-MIC using the CTK established between the AP and MN Authenticator. Similarly, the same fields are authenticated using HMAC-MD5.

-WTLV_SECURE_CONTEXT for MN reassocations

[0587] When a MN roams, the new parent AP must initiate pre-registration to request the MN's WTLV_SECURE_CONTEXT.. To facilitate the context transfer and minimize transactions between AP and MN, CCKM provides a base key, BTK to generate the link key, PTK. The request format is defined as follows:

Field Name	Length	Description
WTLV_MN_SECURE_CONTEXT_REQ	2	TLV Type
TLV Length	2	TLV length
Key Sequence Counter (KSC)	4	A replay counter used to keep state of the rekeys for the link between SID and DID
Destination-ID (DID)	8	AP ID
Supplicant-ID (SID)	8	MN ID
Reserved	1	Used for byte alignment
Key Management Type	1	0 - none (NSK is not forwarded) 1 - CCKM 2 - 802.1X Legacy systems 3 - SSN
Nonce	16	Random value provided by the DID
SSID	L	SSID TLV
RSNIE	P	Propagate the $RSNIE_{MN}$ for authentication if State = 0
Optional (CCKM) TLV	M	For CCKM, include WTLV_CCKM_REASSOCIATE
MIC	N	SECURE CONTEXT MIC TLV

[0588] The new AP identifies the MN by using its MAC address. The BSSID, RN and MIC_{MN} must be provided by the MN. The RN is encapsulated as the KSC. The MIC is an HMAC-MD5 operation over the entire WTLV_MN_SECURE_CONTEXT_REQ message, beginning with the WLTV_MN_SECURE_CONTEXT_REQ type through and including the MIC_{MN}. The MIC_{MN} must be provided if State=0; this signifies that the MN has negotiated CCKM and it is authenticating itself with the MN Authenticator via the specified MIC_{MN}.

[0589] The SSID serves as a means for the MN Authenticator to validate *security credentials* for the MN and ensure that the MN is not switching to a prohibited VLAN. While the MN Authenticator can effectively *match* the security credentials, it is up to the AP to decide on policy; e.g. the AP must define what state it will transition to upon a failure. The MN Authenticator must also validate the MN's authorization by computing and matching the provided MIC_{MN}. Finally, it must also ensure that the session timeout for the MN has not expired. On a successful response, the MN Authenticator will safely deliver the BTK to the new AP and affect a *switch* from old AP to new AP. That is, the MN's registration entry

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will reflect the new AP's BSSID and the RN will be incremented by one. The response TLV is defined as follows:

Field Name	Length	Description
WTLV_MN_SECURE_CONTEXT_REPLY	2	TLV Type
TLV Length	2	TLV length
Key Sequence Counter (KSC)	4	RN value
Destination-ID (DID)	8	Ancestor with whom IN wants to rekey
Supplicant-ID (SID)	8	Requesting IN
Nonce	16	Random value provided by the DID
Session Timeout	4	Remaining session timeout for MN
Optional Rx Key Length	2	Length of key delivered (in bytes)
Optional Rx Key	Q/32	BTK if Key Management type = 1 (Q=32) NSK or MS-MPPE Rx Key otherwise
Optional Tx Key Length	2	0 if Key management type = 1 Tx Key length otherwise
Optional Tx Key	Key len	MS-MPPE Tx Key otherwise
Optional MN Credential TLV	P	MN's cached credentials
MIC	N	WTLV-MIC for SECURE_CONTEXT

[0590] The WTLV_MN_SECURE_CONTEXT_REPLY response is encrypted from the WTLV_MN_SECURE_CONTEXT_REPLYNonce field through the end (up to but excluding) the WTLV-MIC using the CTK established between the AP and MN Authenticator. Similarly, the same fields are authenticated using HMAC-MD5.

[0591] Since the MN Authenticator provides the MNs session timeout to the active AP, it is up to the AP to enforce a re-authentication prior to the expiration of the session timeout.

[0592] If the MN Authenticator fails in any of the checks required for a secure context transfer, then the response will populate the BTK field with all zeroes and include one of the following status values:

Status	Value	Description
NO CONTEXT	1	MN does not have cached credentials (no registration entry)
REPLAY	2	RN is out of sequence
SSID	3	Invalid SSID
SESSION EXPIRED	5	MN's session has expired
BAD MIC	6	MN's MIC did not match Authenticator's computed MIC

[0593] MN's credentials are forwarded during a MN registration. If the credentials are being forwarded, then no optional key is forwarded, rather a new TLV holding most of the MN's cached credentials are propagated to the MN's ancestry infrastructure nodes, terminating at the SCM. In the standalone mode, the SCM does not forward credentials unless *predictive roaming* is (statically) configured at the time SCM or LCM is initialized. The MNs credentials are forwarded using the WTLV_MN_SEC_CONTEXT.

-WTLV_MN_SEC_CONTEXT.

[0594] This TLV is only used during a MN Registration Reply to forward it's credentials from the MN Authenticator to the MN's ancestors excluding the AP (unless *predictive roaming* has been configured). For example, if the LCM is the MN Authenticator, the LCM will forward the MN credentials to the SCM.

[0595] The TLV is defined as follows:

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Field	Length(by tes)	Description
WTLV_MN_SEC_CONTEXT	2	TLV Type
TLV Length	2	TLV Length
State	1	Indicates whether this node is Active or not
STA Addr	8	WLCCP Node identifier: MN's MAC address
Authentication Type	1	EAP Type used to authenticate
Key Management Type	1	Type of (or no) key management negotiated. Valid values are: 0 - none (NSK is not forwarded) 1 - CCKM 2 - 802.1X Legacy systems 3 - SSN
Session Timeout	4	Session expiration time provided by the Radius Access Accept
KRK	16	Key Request Key used to authenticate MNs request for context transfers
BTK	32	Base Transient Key used to derive PTKs
RN	8	Rekey number used to track how many PTKs have been derived from BTK
SSID	L	MN's associated SSID TLV
VLAN ID	2	MN's associated VLAN assignment
BSSID	6	Defines the current associated AP
Cipher	2	Negotiated cipher, values are: 0x0000 - none 0x0001 - WEP 0x0002 - TKIP 0x0003 - AES-OCB 0x0004 - AES-CCMP 0x0005 - CKIP 0xff<value> - Vendor specific
NSK Length	2	NSK length in bytes (e.g. Rx MS-MPPE key)
NSK	N	The Rx key resulting from a successful 802.1X EAP authentication
Tx Key Length	2	Tx key length (if sent by Radius)
Tx Key	P	The Tx key resulting from a successful 802.1X EAP authentication

[0596] This TLV carries highly sensitive information and thus must be encrypted using the CTK shared between the MN Authenticator and the destined IN. In addition, the Secure Context TLV that embeds the MN Secure Credentials TLV *must* be authenticated, e.g. a TLV MIC must also be used. The MN Secure Credentials TLV is encrypted from the State field through the Cipher field.

-WTLV_UPDATE_RN: updating sequencing for PTKs.

[0597] This TLV is only valid between APs and MN Authenticators as it is used to update the key sequencing between the AP and MN. Since APs are capable of affecting PTK rekeys, the SCM must be appraised of any key refreshes as they occur. A request for update but be sent from the AP to MN Authenticator as follows:

Type	Len	8bytes	6bytes	6bytes	4bytes	8bytes
WTLV_KEY_UPDATE	TLV len	MSC	BSSID	MN MAC Addr	RN	MIC_{AP}

[0598] The WTLV_KEY_UPDATE message is encrypted and authenticated using the CTK established between the AP and MN Authenticator.

[0599] The MN Authenticator must correctly decrypt and authenticate this request for a successful update and re-

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sponse. That is, if the message can not be decrypted, authenticated nor is the RN greater than the current RN, the MN authenticator discards this message and no update is done. However, the response must provide a status to indicate how it failed. The response is defined as follows:

Type	Len	8bytes	6bytes	6bytes	4bytes	8bytes
WTLV_KEY_UPDATE	TLV len	MSC	BSSID	MN MAC Addr	RN	MIC_{AP}

[0600] If the update request fails, it will also include a status value from the following table:

Status	Value	Description
BAD MIC	1	Computed MIC did not match TLV's MIC
REPLAY	2	RN provided is out of sequence and considered a replay
INVALID BSSID	3	The specified MN is not associated to given BSSID
NO MN	4	The specified MN is not registered

-WTLV_NSK

[0601] The MN Authenticator may need to request the NSK of the associated AP upon a successful EAP authentication. For legacy MN nodes that only support static WEP keys and/or 802.1X authentication types (such as EAP-MD5) that do not provide dynamic keys, the MN Authenticator must use the AP statically configured NSK for the negotiated SSID/VLAN. To achieve this, a new WTLV is defined to allow the MN Authenticator request the NSK of the associated AP.

[0602] The Requesting TLV is defined as:

Type	Length	8 bytes		MIC
WTLV_NSK	TLV length	MN-ID		WTLV-MIC

[0603] The Reply TLV is defined as:

Type	Length	8 bytes	NSK	MIC
WTLV_NSK	TLV length	MN-ID	WTLV_TRANSIENT_KEY	WTLV_MIC

[0604] This TLV is only required when pre-shared keys and authentication types such as EAP-MD5 are used and result in using statically configured keys. While this use is highly discouraged due to insecurities, this feature is presented to better support legacy systems and allow for a migration path. The key retrieval would be achieved by using a WLCCP_CONTEXT request/reply exchange between the MN and AP.

-WTLV_AUTHENTICATOR.

[0605] A WTLV_AUTHENTICATOR is required to ensure liveness of a CTK between a link. This is effectively the means by which the Originating IN authenticates with it's ancestor. While any of the link endpoints can request this in a pre-registration request response. It is expected to follow post a Secure Context (or WTLV_INIT_SESSION) request and reply, typically during registration. The TLV is defined as follows:

Field	Length	Description
WTLV_AUTHENTICATOR	2	
TLV Length	2	
DST-ID	8	Destination IN-ID that must prove it is using the same $CTK_{SRC\text{-}DST}$ as the SRC-ID to protect the (SRC-ID, DST-ID) link.
SRC-ID	8	Originating IN-ID requesting liveness proof

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Field	Length	Description
KSC	4	Key sequence counter to serve as a replay protector. This value must match the value used during a Secure Context request/reply exchange
Reserved	1	
Status	1	Ignored on the request message but can be set on a reply. A non-zero value indicates that the link does not share the same CTK or a replay was detected.
Nonce	16	A random challenge used to prove liveness. The originator must provide a 16byte random value
MIC	ML	WTLV_MIC authenticating this TLV

[0606] The Originating MIC is computed as follows:

$$MIC_{request} = HMAC\text{-}MD5(CTK_{SRC\text{-}DST}, SRC\text{-}ID \parallel DST\text{-}ID \parallel KSC \parallel Nonce_{SRC})$$

[0607] The Destination must increment the provided $Nonce_{SRC}$ and compute it's MIC as follows:

$$Nonce_{DST} = Nonce_{SRC} + 1$$
$$MIC_{reply} = HMAC\text{-}MD5(CTK_{SRC\text{-}DST}, SRC\text{-}ID \parallel DST\text{-}ID \parallel KSC \parallel Nonce_{DST})$$

[0608] Both Request and Reply WTLV_AUTHENTICATOR must encrypt the TLV as follows:

$RC4'(MSC \| CTK_{SRC\text{-}DST}, Status \parallel Nonce)$
Replacing the plaintext fields with their encrypted values. (Note, the first 256bytes of the RC4 random stream must first be deleted before XOR'ing with plaintext).

-WTLV_RSNIE.

[0609] The security policy negotiated by the MN must be propagated to the SCM when:
MN successfully negotiated CCKM and is currently associated to an AP
MN roams from current AP to new AP and establishes reassociation to new AP
During the reassociation, the RSNIE is included in the signature element included in the reassociation message. Thus the RSNIE must be propagated to the SCM for validation. As the RSNIE varies in length, it's TLV is defined as follows:

Field Name	Length	Description
WTLV_RSNIE	2	TLV Type
TLV	2	TLV length
RSNIE Element	N	Contents of RSNIE as provided by the MN

-Lateral Message Authentication and Privacy

[0610] A "lateral" Context Request or Context Reply message is forwarded independently of the SWAN Topology Tree. The Originator and Responder may not be on the same Topology Tree branch; therefore, the Originator and Responder may not share a secret CTK. The *Inbound* and *Outbound* flags are set OFF in a lateral Context message.

[0611] A "lateralL-CTK" (L-CTK) shared by the Originator and Responder of a lateral Context message is used to authenticate the message and to encrypt any sensitive TLVs contained in the message. A common ancestor of the Originator and Responder functions as a trusted third party to generate a L-CTKL-CTK. The common ancestor uses the path CTK it shares with the Originator and the path CTK it shares with the Responder to securely deliver the L-CTKL-

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CTK to each node.

[0612] The common ancestor generates a "ticket" and a L-CTK. The L-CTK is encrypted with the path CTK shared by the common ancestor and the Originator. The ticket also contains the L-CTK and is encrypted with the path CTK shared by the common ancestor and the Responder. The L-CTK and ticket are delivered to the context transfer Originator in a WTLV_CTK_TICKET TLV.

[0613] The Originator includes the Node ID of the common ancestor, the ticket and an "authenticator" in a WTLV_AUTHEN_TICKET TLV in the lateral Context Request sent to the Responder. The Originator uses the L-CTK to generate the WTLV_MIC TLV used to authenticate the Context Request. The Responder decrypts the ticket with the path CTK it shares with the common ancestor and extracts the L-CTK. The Responder can then use the L-CTK to authenticate the message and to decrypt any encrypted TLVs. The Responder also uses the CTK to authenticate the Reply message and to encrypt any sensitive TLVs contained in the Reply.

[0614] The root CM is the common ancestor of all SWAN nodes; therefore, the root CM can establish a L-CTK for any two nodes. An Originator node can send a WTLV_TICKET_REQUEST TLV, in a Context Request message, to the root CM to request a L-CTK and ticket for a second Responder node. The root CM returns the ticket and the L-CTK in a WTLV_CTK_TICKET TLV in the Context Reply message.

[0615] If a MN roams from an old AP to a new AP it may be necessary to forward context information laterally from the old AP to the new AP, in a Context Request message. The nearest common ancestor CM can automatically deliver a L-CTK and a "ticket" for the new AP in the Deregistration Request message sent to the old AP. The old AP can use the L-CTK to generate a WTLV_MIC TLV and to encrypt any sensitive context information in the Context Request sent to the new AP, as described above.

[0616] A similar mechanism can be used to transfer context laterally from the "old LCM" to the "new LCM" when a MN roams to a new local control domain.

-A simple WLCCP Implementation (W1)

[0617] This section describes a simple single-subnet WLCCP implementation where the SCM for each subnet operates in SCM standalone mode and WLCCP is NOT used to update Layer 2 forwarding paths. The simple implementation includes the following components:

The SCM is the "root CM" in a standalone single subnet infrastructure.
AP and MN Initial Authentication
SCM Election and Advertisement
AP Path Authentication
Intra-subnet Security Context Transfer for MNs (i.e. MN Preregistration).
MN Fast Reauthentication
Simple AP and MN Registration. (WLCCP Registration does NOT establish Layer 2 forwarding paths.)
WLCCP Message Authentication and Privacy.

[0618] The SCM is the 802.1X Authenticator for both MNs and APs. EAPOL messages are relayed between the SCM and parent APs in WLCCP AAA messages.

[0619] The simple implementation does not support Layer 2 path updates, inter-subnet handoffs, or inter-subnet context transfer. The network topology does not include a CCM or LCMs. The existing Cisco DDP protocol is used to establish and delete layer-2 forwarding paths. DDP is also used for intra-subnet handoffs (i.e. when stations roam within a single subnet).

[0620] The simple implementation uses the following WLCCP message types:

- SCM-Advertisement
- Registration
- Preregistration
- AAA
- Path-Init

[0621] The W1 Network Topology includes an SCM and APs in a single subnet. It also includes any MNs associated with those APs. Layer 2 path updates are not supported; fast-reauthentication of repeater APs is not supported; therefore, multihop AP-to-AP links are generally transparent to the W1 implementation.

[0622] The active SCM operates in subnet standalone mode in the simple WLCCP implementation.

[0623] The data structures and state variables required for the W1 implementation are the same as the General SCM Data Structures and State Variables. The SCM is the IN and MN 802.1X authenticator; therefore, it must maintain an

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Authenticated Node Table.

[0624] Each SCM Candidate, which is configured with a non-zero *SCM Priority* value, must participate in the SCM election protocol, as described in the section entitled "*Active SCM Election*.

[0625] The fields in SCM_Advertisement Reply messages are set as defined in the section entitled *"Active SCM Election"* with the following constraints:

[0626] The WTLV_ROOT_CM_INFO TLV contains the IPv4 address of the SCM.

W1 - IN Authentication.

[0627] Each AP must mutually authenticate with the 802.1X Infrastructure Authenticator, which is the active SCM in the simple WLCCP implementation. The SCM advertises its IP address in the ROOT_CM_INFO TLV in SCM_Advertisement Reply messages. WLCCP IP-encapsulated Context Request and Reply messages are used to transport EAPOL authentication messages between the "Supplicant" AP and the 802.1X Authenticator. The AP/SCM mutual authentication process establishes a Network Session Key (NSK) that is shared by the Supplicant AP and the SCM. An AP must initiate Path Authentication with the SCM after it has successfully authenticated (and whenever it roams). The NSK is used in the Path Authentication process (described below) to establish an AP-SCM Context Transfer Key (CTK).

W1 - SCM Registration Processing

[0628] The active SCM must maintain an Registration Table, which has an entry for each AP in its subnet and each MN associated with those APs. The Registration Table is initialized to 'empty'. The active SCM resets the table to empty whenever it relinquishes the active SCM status. In the simple WLCCP implementation, the Registration Table is only used to manage MN context information. It does NOT contain Layer 2 forwarding information and Path State information.

[0629] The SCM creates or updates a Registration Record for an AP or MN when it receives a valid Registration Request and generates a corresponding Registration Reply for the AP or MN.

W1 - (Pre)Registration Message Authentication

[0630] In the simple WLCCP implementation, Preregistration and Registration Messages are authenticated with an SCM/AP CTK established via AP Path Authentication. The CTK is used to generate and check a Message Integrity Check contained in a WTLV_MIC TLV in all (Pre)Registration messages. The SCM always uses the CTK it shares with the *Originator* to authenticate (Pre)Registration Request messages. The AP always uses the CTK it shares with the SCM (i.e. the *Responder)* to authenticate (Pre)Registration Reply messages. (Pre)Registration messages generated by a non-root AP are not processed or authenticated by intermediate APs, in the simple WLCCP implementation. General WLCCP message authentication is discussed in detail in the section entitled "*WLCCP Message Authentication*".

[0631] When the SCM receives an "invalid" (Pre)Registration Request, which fails message integrity authentication, the SCM returns a Reply message, with a "Bad MIC" status, without further processing the message.

W1 - Received AP Path-Init Request

[0632] An AP must authenticate its path to the SCM, as described below, to establish and update a Context Transfer Key (CTK) that is shared with the SCM. The SCM generates a Path-Init Reply when it receives a Path-Init Request with the Response-Req Flag set ON. The SCM returns a Path-Init Reply with a 'good' status if it has an Authenticated Node Entry, for the *Requestor* AP, that is in the 'authenticated', 'preregistered', or 'registered' state; otherwise, the SCM returns a Path-Init Reply with an 'unauthenticated' status.

[0633] Path authentication, including AP/SCM CTK generation and distribution, is described in detail in the section entitled "*Infrastructure Path Authentication*".

W1 - Received AP Registration Request

[0634] An AP, which has successfully completed path authentication, must register with the SCM, as described below. The SCM generates a Registration Reply for an AP when it receives a Registration Request from the AP with the Response-Req Flag set ON. The SCM returns a Registration Reply with a 'good' status if it has an Authenticated Node Entry, for the *Requestor* AP, that is in the 'preregistered' or 'registered' state; otherwise, the SCM returns a Registration Reply with an 'unauthenticated' status.

[0635] The SCM creates or updates an AP Registration Record for the *Originator,* when it generates a Registration Reply with a 'good' status. The age of the Registration Record is reset to '0' when a good Reply is generated.

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W1 - Received MN Preregistration Request.

[0636] A new parent AP sends a Preregistration Request to the SCM, with the Response-Req Flag set ON, to obtain the dynamic security credentials of a child MN when it reassociates. The SCM generates a Preregistration Reply for a MN when it receives the Preregistration Request. The SCM returns a Reply with a 'good' status if has an Authenticated Node Entry for the MN. The protocol for transferring a MN's security credentials to a new parent AP is discussed in detail in the section entitled "*MN Security Context Transfer*".

W1 - Received MN Registration Request.

[0637] The SCM generates a Registration Reply for a MN when it receives a Registration Request from the MN's parent AP with the Response-Req Flag set ON. The SCM returns a Registration Reply with a 'good' status if 1) it has an Authenticated Node Entry, with a 'successful' status, for the *Requestor* MN and 2) it has a 'bound' Registration Record for the *Originator* AP. The SCM returns a Registration Reply with an 'unauthenticated' status if the MN is not authenticated. The SCM returns a Registration Reply with an 'unregistered parent' status if the parent AP does not have a bound Registration Record.

[0638] The SCM accepts Registration Requests in order of arrival. As an option, the SCM should timestamp a MN Registration Record each time a 'good' Registration Reply is generated for the respective MN. The timestamp is calculated using the current time minus any *Delay* value in the corresponding Registration Request. The SCM should discard a received Registration Request for a MN if there is an existing Registration Record for the MN and the timestamp value in the entry is greater than the current time minus any *Delay* value in the Registration Request.

[0639] In the simple WLCCP implementation, the SCM does NOT generate a Deregistration Request when a MN roams to a different parent AP.

W1 - AP Operation.

[0640] This section defines the AP state variables, timers, and procedures that are necessary for the simple WLCCP implementation. AP procedures are, generally, described in the order of AP "top-level" WLCCP state transitions. Top-level AP WLCCP states and state transitions are described in the section entitled *"AP Operational Modes"*.

[0641] The simple AP implementation requires the following AP procedures:

An AP must process SCM-Advertisement Reply messages to discover the active SCM.
An AP must mutually authenticate with the 802.1X IN Authenticator, and establish an NSK.

[0642] Each AP must authenticate its path to the SCM to establish a CTK.

[0643] APs must register with SCM.

[0644] Registered APs must generate SCM Advertisement Reply messages on secondary ports.

[0645] Registered APs must preregister MNs to obtain MN dynamic credentials.

[0646] Registered APs must register MNs.

[0647] Preregistration and Registration messages are sent with the Hopwise-Routing Flag set OFF; therefore, intermediate APs do not process the messages.

W1 - SCM Advertisement Message Processing

[0648] An AP must monitor SCM Advertisement Reply messages received on its primary port on the native VLAN to determine if there is an active SCM for the native VLAN. An AP executes the simple WLCCP protocol if there is an active SCM for the AP's native VLAN.

[0649] The MN 802.1X Authenticator is in the SCM when the AP is registered with the active SCM; otherwise, the MN 802.1X Authenticator is in the AP. Path cost and hop count information is not used in the W1 implementation. The SCM Advertisement protocol is not used to determine the AP primary port.

W1 - AP Initial Authentication

[0650] An AP must mutually authenticate with the 802.1X IN Authenticator when it first discovers a new instance of an active SCM, as described above in the section entitled "W1 - IN Authentication". The IN Authenticator is always the active SCM, in the simple WLCCP implementation.

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W1 - AP Path Authentication

[0651] An AP must initiate Path Authentication with the SCM, after it has successfully authenticated, to establish a secret Context Transfer Key (CTK) that is shared by the AP and the SCM. [An AP must periodically update its AP-SCM CTK via update Registration Request/Reply messages.]

[0652] AP Path Authentication, in the simple W1 implementation, is as described above in the section entitled "General AP Path Authentication" except that 1) the root CM is always the SCM, and 2) the *Hopwise-Routing Flag* is set OFF. The *Hopwise-Routing* Flag is set OFF because Layer 2 Path Updating is not enabled; therefore, it is not necessary to establish a shared CTK between a child AP and any ancestor APs.

W1 - AP Registration

[0653] An AP must register with the active SCM for its subnet, initially when it discovers a new instance of the SCM and periodically to refresh its registration record in the SCM.

[0654] The fields in an initial Registration Request sent by an Unattached AP are set as described below. (Unspecified fields are set to '0'.)

WLCCP header fields:
Type - '3'
Originator - Node ID of the Unattached AP.
Responder - Node ID of the SCM.
Response-Req Flag - '1' to solicit a Reply.
Inbound Flag - '1'.
Hopwise-Routing Flag - '0'.

[0655] Registration fields:

Requester - Node ID of the Unattached AP.
Hop Address - 802 address of the Unattached AP's selected Primary Port.
Relay Node ID - '0'.
Initial Flag- '1'.

[0656] An AP (re)transmits a Registration Request either until it receives a Registration Reply with a matching message ID, or until the maximum retries are exceeded. An AP is "registered" when it receives a matching Registration Reply with a "good" *RegStatus*.

[0657] An AP periodically sends an "update" Registration Request message to the SCM to "refresh" its registration record. An update Registration Request has the *Initial Flag* set OFF.

[0658] An AP cannot generate Proxy Preregistration and Registration messages for MNs until it has successfully registered with the SCM.

[0659] An AP that is successfully registered with the active SCM (i.e. the "I,R" state above) must periodically generate SCM Advertisement Reply messages on each of its secondary ports.

[0660] An *SCM_Advertisement_Timer* is started initially when the AP has successfully registered with the active SCM. It is restarted each time that it expires, until the AP transitions to an unregistered state (i.e. when the active SCM changes or is lost). The period of the *SCM_Advertisement_Timer* is always set to the *SCM_Advertisement_Period* value (in seconds) in the AP's *Parent_SCM_Record*. The *SCM_Advertisement_Period* is updated each time the AP receives an SCM Advertisement from the active SCM.

[0661] A registered AP does the following when the *SCM_Advertisement_Timer* expires:

If the *SCM_Age* equals MAX_SCM_AGE, then WLCCP is disabled.
Otherwise, if the *SCM_Age* is less than Increment the SCM_Age then
restart the *SCM_Advertisement_Timer*. with the current *Advertisement_Period* value;
increment the SCM_Age value;
generate an "active" SCM_Advertisement Reply message on each secondary port

[0662] A registered AP generates a scheduled SCM_Advertisement Reply message with the field values shown below. Fields that are not specified are set to '0'.

[0663] WLCCP header fields:

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Type - '0x41' (SCM_Advertisement Reply)
Originator - '0'.
Responder - AP Node ID.
Outbound Flag - '1'.
TLV FLag - '1' (the Request must include an IPV4_SUBNET TLV and an IN_1X_ATHEN TLV).

[0664] SCM_Advertisement Reply fields:

Hop_Address - The 802 hop address used to access the AP via the respective output port (which is the AP Node Address if the output port is operating in promiscuous mode).

[0665] *SCM Flags*:

Active Flag - '1'
SCM Priority - copied from the Parent_SCM_Record
SCM Node ID - copied from the Parent_SCM_Record
Instance Age - copied from the Parent_SCM_Record
Path Cost - copied from the Parent_SCM_Record
Hop Count - copied from the Parent_SCM_Record
Advertisement Period - copied from the Parent_SCM_Record
WTLV_IPV4_SUBNET_ID TLV - IPv4 address and prefix length of the AP
WTLV_ROOT_CM_INFO TLV - copied from the *IN_1X_Authenticator* state variable

W1 - Proxy MN Preregistration.

[0666] MN preregistration, in the simple WLCCP implementation, is exactly the same as General Proxy MN Preregistration.

W1 - Proxy MN Registration.

[0667] WLCCP MN registration is enabled in an AP after it has successfully registered with the active SCM (i.e. when it transitions to the I,R state above). A parent AP generates an initial, proxy Registration Request for a MN, after the MN has successfully authenticated or re-authenticated. [A Registration Request may be used to complete authentication handshaking; however, the MN must be fully authenticated before an "authenticated" Registration Reply message is generated by the SCM.]

[0668] In the simple WLCCP implementation, the WLCCP registration process is not used to establish or delete Layer 2 forwarding paths; therefore, the *L2_Path_Update Flag* and the *Hopwise-Routing Flag* are set OFF in Registration messages. The *Originator* is always the parent AP and the *Responder* is always the parent SCM. A Registration Request for a MN must contain the MN's SSID and the default VLAN ID for the MN.

[0669] The SCM acknowledges a Registration Request by returning a Registration Reply to the *Originator.* The *Status* value in the Reply indicates if the Registration Request was accepted.

[0670] If a parent AP does not receive an expected Registration Reply, then it must retransmit the Registration Request, with the *Retry Flag* set ON and the same *Message ID*, until the number of retries equals REGISTRATION_RETRY_LIMIT. The Delay field should be set to the elapsed time since the MN last transmitted an uplink frame, in a retransmitted Registration Request.

[0671] The Registration Reply *Lifetime* field contains a registration lifetime value, in minutes. An AP must generate an update Registration Request, for a MN, before the registration lifetime expires.

[0672] The fields in an initial, proxy Registration Request for a MN are set as described below. Unspecified fields are set to '0'.

[0673] WLCCP header fields:

Type - '3'
Originator - Node ID of the Parent AP.
Responder - Node ID of the SCM.
Response-Req Flag - '1' to solicit a Reply.
Inbound Flag - '1'.
Hopwise-Routing Flag - '1'.
TLV Flag - '1' (the Request must include an SSID_TLV).

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[0674] Registration fields:

Requester - 802 address of the MN.
Hop Address - 802 address of the Parent AP's Primary Port.
Relay Node ID - '0'
Proxy Flag - '1'.
Initial Flag - '1'.
Authenticated Flag - The Authenticated Flag is set to '1' in a Request to indicate that the MN was authenticated by the parent AP.
Proxy MIP Flag - set to '1' if the MN is using an SSID where Proxy MIP is enabled.
Delay - The delay in hundreds of seconds since the MN last sent an uplink frame. The delay is usually '0' if the *Retry* flag is '0'.
VLAN ID - The VLAN ID assigned to the MN. The MN's VLAN ID is usually the default VLAN ID assigned to the MN's SSID. The assigned VLAN ID may be '0' if the MN is assigned to the "native VLAN". The *VLAN ID* field, in the Registration Reply for a MN, can contain a different VLAN ID, to explicitly assign the MN to a VLAN.
SSID_TLV - The Registration Request for a MN must contain a WTLV_SSID TLV that contains the active SSID for the MN, contained in the MN's (Re)Association Request.

[0675] The *Broadcast SSID Flag* must be set ON if the MN associated with a broadcast SSID. A Registration Reply for a MN can include an SSID TLV, with a different SSID, to explicitly assign the MN to a service set.
[0676] *AUTHENTICATION_TYPE TLV* - Contains the 802.11 authentication type (Open, Shared Key, or EAP type) used to authenticate the MN.
[0677] A Registration Request, which is generated for an 802.11 station that "reassociated", must contain the BSSID of the old AP in a WTLV_OLD_AP_BSSID TLV. The BSSID is obtained from the "old AP" field in the 802.11 Reassociation Request transmitted by the station.
[0678] A Registration Reply message for a MN always contains the MN's IP address, if it is known. A parent AP must generate a "Registration Request for a MN when it first detects a new or different IP address for the MN (i.e. by snooping IP/ARP packets transmitted by the MN). The *Root CM Flag* is set ON in the request to cause an update on the full path to the root CM.

- A Full WLCCP Implementation (W2)

[0679] This section describes a complete WLCCP implementation that supports:

- Inter-subnet Context Transfer via LCMs and the CCM.
- Reliable Layer 2 path updates.
- A subnet topology that includes repeater APs, simple wireless bridges (e.g. WGBs), and an arbitrary mix of Ethernet and 802.11 links.

[0680] Path Instances.
[0681] As noted above, a path lies on a branch of the SWAN Topology Tree. The full path to a node in a campus network includes the node, the CCM, and any intermediate nodes and links. A Path Instance is a full or partial path, at a point in time. Each CM establishes path instances for each node within its domain. For example, an SCM establishes an "SCM path instance" for each AP and MN in its subnet domain; the CCM establishes a "CCM path instance" for each CM, AP, and MN in the campus network. A path instance is established when an unattached node selects a parent node and registers with the SWAN infrastructure.
[0682] A CM path instance is identified by a Path ID, which is allocated by the respective CM. A Path ID of '0' is used to indicate "no Path ID". Valid Path IDs start at '1'. A CM increments its Path ID for a node when it receives an "initial" Registration Request message for the node. Registration Reply, "update" Registration Request, Detach, Deregistration, Path Update, and Path Check messages always contain a valid Path ID.
[0683] An SCM path instance exists within the context of an LCM path instance. An LCM path instance exists within the context of a CCM path instance. The combined CCM, LCM, and SCM Path IDs identify the full path instance for a MN in a campus network. In figure 1, for example, the full path instance for MN-2 is identified by Path IDs 15, 10, and 6, which were established by the CCM, LCM, and SCM, respectively.
[0684] An "inbound path" is defined by the structure of the Topology Tree. An "outbound path" to a node is defined by state information maintained in each CM and AP on the path to the node. In this document, the path state information for a single descendant node is contained in a "Descendant Path Record" (DPR) in each CM and AP on the outbound path to the node.

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[0685] No disconnected path fragments can exist in the Topology Tree. A "bound" path instance is established by an "outbound" Registration Reply message. The inbound portion of a path instance must exist before the outbound portion can be established. For example, in infrastructure mode, an SCM cannot establish a path instance for a node unless an LCM path instance for the node already exists. If a MN roams, then the most outbound portion of the "old path" is deleted first (i.e. by an inbound Deregistration Reply or Detach Request message). If the link to a child AP or CM link is lost, then all path instances in the sub tree rooted at the AP or CM are deleted.

- W2 Registration Records.

[0686] Each CM or AP must maintain a Registration Table that contains a Descendant Registration Record (DRR) for each descendant node (MN, AP, or CM) in its sub tree. A Registration Table can, optionally, include Inbound Registration Records (IRR) for nodes that are not in the sub tree of the respective AP or CM. A temporary Unbound Registration Record (URR) is used to store state information for an unregistered node. Registration Records are updated by Registration, Deregistration, and Detach messages. A Registration Record is aged and discarded if it is not refreshed within the registration *Lifetime.* The primary key for a Registration Record is the WLCCP Node ID of the respective node.

[0687] In the W2 implementation, an AP or CM must maintain additional forwarding and path state information for each descendant WLCCP node. In this document, a "Descendant Path Record" (DPR) contains any information that is necessary to send a message to a descendant node, and other path state information. Each DRR points to a DPR. "DRR/DPR" is used to denote a DRR and the corresponding DPR.

[0688] A DPR can be in a "bound" or "unbound" state. A parent AP creates an unbound DPR and generates an "initial" Registration Request, for a child 802.11 MN, when the MN first enters the 802.11 "associated and authenticated" state. The initial Registration Request also creates an unbound DPR in each AP and CM on the path to the CCM. An "unbound" DPR contains the Message ID of the corresponding initial Registration Request.

[0689] A DPR becomes "bound" when an "authenticated" Registration Reply, with a matching Message ID and good status, is received. A "bound" DPR contains a non-zero Path ID, which is set by the parent CM in the Registration Reply. A DPR in an SCM contains an SCM Path ID and an LCM Path ID. The SCM Path ID identifies the outbound path originating at the SCM; the LCM Path ID (i.e. the Path ID established by the LCM) identifies the inbound path to the LCM. A DPR in an LCM contains an LCM Path ID and a CCM Path ID for similar reasons.

[0690] A path is "bound" if each DPR on the path is in a "bound" state. The path to a node may be both bound and unbound. For example, the most outbound fragment of the path to a MN will be unbound (i.e. until recovery is initiated) if an initial Registration Reply message is lost. Unbound DPRs are quickly aged and discarded; therefore it is not necessary to explicitly delete an "unbound path".

[0691] The maximum age of a bound DPR is established during WLCCP registration via a registration *Lifetime* field. Parent APs and CMs age DPRs for child nodes. A DPR is discarded if it is not "refreshed" within the registration lifetime. The DPR for a child MN is refreshed by uplink data or management frames. The DPR for a child AP or CM is refreshed by periodic update Registration Requests. If the DPR for a child AP or CM is deleted, then the AP or CM is deregistered and the entire sub tree rooted at the child AP or CM is also deleted.

[0692] The CCM has a DRR/DPR for each active CM, AP, or MN in the SWAN campus network. A CCM DPR contains the Node ID and IP address of the node's parent LCM. An LCM has a DRR/DPR for each MN, AP, and SCM in its local control domain (i.e. in its assigned subnets). An LCM DPR for an AP or MN contains the Node ID and IP address of the parent SCM. An SCM has a DPR for each AP and MN in its subnet. An SCM DPR the Node ID of the parent AP, if it exists, and the Node ID of the root AP.

[0693] In an AP, a MN DPR contains a pointer to a Port Record. As noted above, an Ethernet port, an 802.11 BSS, and each AP-to-AP link are considered as a logical port. At any give time, each active logical AP port is either operating as a primary port in "child" mode or as a secondary port in "parent" mode. A Port Record contains the "port state" and the information that is necessary to forward a frame on the respective logical port. A Port Record contains the 802 "hop address" for 802.11 ports. A non-root AP forwards a message "inbound" by sending the message on its primary port.

- W2 Subnet Topology

[0694] A SWAN subnet is an Ethernet LAN. In this document, it is assumed that an underlying IEEE 802.1D Spanning Tree Protocol (STP), or other STP, is used to organize wired Ethernet LAN segments, in each AP subnet, into a loop-free spanning tree topology. WLCCP is generally independent of the underlying STP; therefore, WLCCP is compatible with other STPs, such as the Cisco-proprietary PVST+ STP.

[0695] The WLCCP SCM advertisement and registration protocol is used to build a WLCCP spanning tree in each subnet, which may exist on top of any underlying (i.e. 802.1D) spanning tree. The WLCCP spanning tree may extend the underlying 802.1D spanning tree with non-STP links to non-STP wireless "repeater" APs or non-STP 802.11 bridges. An AP (e.g. a root AP, repeater AP, or 802.11 bridge) is an interior node and a MN is a leaf in the WLCCP spanning tree.

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[0696] A single Primary LAN is at the root of the WLCCP spanning tree in each subnet. Each subnet has a single active SCM. By definition, the Primary LAN is the set of, possibly bridged, wired Ethernet segments directly connected to the SCM. Other secondary wireless Ethernet LANs or "Secondary LANs" are connected to the Primary LAN via wireless 802.11 bridge links. [A Primary or Secondary LAN may contain 802.11 bridges that do not participate in WLCCP. Such non-WLCCP 802.11 bridges are transparent to WLCCP.]

[0697] A Subnet Control Domain includes all APs that are in the same subnet as the respective SCM and any client stations that are directly, or indirectly, associated with those APs. For example, it includes any MNs that are associated with those APs, even if a MN is assigned to a different subnet at the network layer via VLAN trunking or MIP tunneling. It also includes any ENs attached to secondary LANs that are bridged to the Primary LAN.

[0698] An example WLAN spanning tree 3500, for a single subnet, is shown in figure 35. the 802.1D STP links and STP APs are denoted as 3502. Wireless links are shown as dashed lines.

[0699] The Primary and Secondary LANs may include multiple Ethernet segments and 802.1D bridges and/or switches. The 802.1D "root bridge" may be contained in either the Primary LAN or a Secondary LAN. A Primary or Secondary Ethernet LAN functions as a logical, transparent link with respect to WLCCP.

[0700] The "primary port" in a WLCCP AP is the port that is used to access the Primary LAN. A "root AP" is connected directly to the primary LAN on its Ethernet primary port. A "secondary port" is any logical or physical AP port other than the primary port. A primary or secondary port may be an Ethernet or 802.11 port. A logical 802.11 port exists for each wireless AP-to-AP link. A logical secondary BSS port provides access to 802.11 stations in the local BSS. AP 3508 has an 802.11 primary port and an Ethernet secondary port.

[0701] Note that the 802.1D root port, in an STP AP, will be the same as the primary port if, and only if, the 802.1D root bridge is contained in the primary LAN.

[0702] A single "WLCCP designated AP" is responsible for bridging frames to a secondary LAN. The WLCCP designated AP for a secondary Ethernet segment may be different than the 802.1D designated bridge for the same Ethernet segment. For example, in figure 35, AP 3508 is the "WLCCP designated AP" for the "secondary LAN". If the 802.1D root bridge is contained in the primary LAN, then AP 3508 is also the 802.1D designated bridge for its Ethernet segment in the secondary LAN. A WLCCP designated AP must register its attached secondary LAN with the SCM to establish forwarding and flooding parameters, for the secondary LAN, on wireless links.

[0703] In an Ethernet LAN, "backward learning" establishes the forwarding path, to wired stations and MNs, in 802.1D bridges or switches. VLAN tagging and backward learning establish the forwarding path in an Ethernet VLAN. Backward learning is unreliable; therefore, unicast frames must be "flooded" by a transparent bridge, switch, or AP if the location of the destination address is unknown.

[0704] Unicast frames are never flooded into an 802.11 BSS because 802.11 stations reliably associate with a parent AP. Unicast flooding is selectively enabled to secondary Ethernet LANs. A WLCCP "registration protocol" is used to reliably establish the forwarding path from the Primary LAN to 802.11 stations and select secondary LANs. Therefore it is never necessary to flood unicast frames "outbound" (i.e. from the Primary LAN) to 802.11 stations and select secondary LANs. Unicast flooding is always enabled on an AP Primary Port. By default, unicast frames are forwarded "inbound" toward the Primary LAN, if the destination is unknown.

[0705] The WLCCP registration protocol is also used to forward multicast group membership information to the Primary LAN. Optionally, multicast frames are only forwarded on those secondary ports that are used to access members of the multicast group identified by the respective multicast destination address. [Multicast communications between 802.11 stations can, optionally, be prohibited to further restrict multicast flooding.]

[0706] A "secondary LAN" is relative to each AP. For example, in figure 35, the wired LAN labeled "secondary LAN" 3510 is only a secondary LAN from the perspective of AP 3512 and AP 3514. In a single AP, the "Primary LAN" can be considered as that portion of the WLAN spanning tree that is accessed via the AP's primary port, for frame forwarding purposes. For example, AP 3516 forwards a frame to the primary LAN by simply relaying the frame to on its primary port (e.g. to the Ethernet LAN labeled "secondary LAN"). The wireless links to the primary LAN are generally transparent to AP 3516.

[0707] The 802.1D STP should be operated on wireless links that are used to bridge wired STP LANs. In figure 35, for example, the 802.1D STP should be operated on the wireless links between APs 3512, 3514 and 3508 if the Secondary LAN contains 802.1D bridges/switches. AP 3518 is connected to an STP AP, AP 3520, on a non-STP link.

[0708] The WLAN spanning tree can include non-STP wireless links to non-STP wireless repeater APs and "work-group bridges" (WGB). Non-STP repeater APs and WGBs attach to the WLAN spanning tree much like 802.11 MNs.

[0709] By default, an AP is attached to the network on a "normal access" primary port. An AP can, optionally, be attached to the network on a VLAN trunk primary port, so that a single 802.11 BSS can include MNs from multiple VLANs.

[0710] A user-configurable "*WLCCP port mode*" variable is set to one of the following values for each AP port:

a) Child mode. Child mode is the default on the AP Ethernet port.
b) Parent mode.

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c) Parent/child mode. Parent/child mode is the default on 802.11 ports.

[0711] An AP port that is configured in "child mode" can only function as the WLCCP primary port. An AP port that is configured in "parent mode" can only function as a WLCCP secondary port. An 802.11 "parent" port generates beacons and accepts station associations. An 802.11 "child" port associates with an 802.11 "parent" port.

[0712] An 802.11 port that is configured in "parent/child" mode can function both as a "parent" port and a "child" port (i.e. as a repeater port). An Ethernet port that is configured in "parent/child" mode can function as a secondary "parent" port in a child 802.11 bridge, or as a primary "child" port in a wired AP or bridge. The parent/child mode is intended to facilitate a self-configuring subnet topology.

[0713] A port (or ports) in an "unattached" AP, which is configured in child mode or parent/child mode, constantly scans for a potential parent AP or SCM. An AP automatically selects a "primary port" and a parent node that provide the "best" (i.e. least-cost) path to the primary LAN. An AP "secondary port" is any port other than the primary port.

[0714] The user can configure a "parent AP list" for a child 802.11 port, to restrict potential parent APs. Note that a user can explicitly configure an AP-to-AP link by configuring a "parent AP list" with a single entry.

[0715] A parent/child port in an attached AP operates as follows: a) It operates in "child" mode if it is the primary port. b) It operates in "parent" mode if it is a secondary port. c) A physical radio port in an attached repeater AP operates in both parent and child mode, where the single port provides both a logical uplink primary port and one or more logical downlink ports.

[0716] A "root AP" always operates its primary Ethernet port in child mode and its secondary radio ports in "parent mode". By default, an AP that does not have an Ethernet link operates as a "repeater" because the default 802.11 port mode is "parent/child".

[0717] A "child 802.11 bridge" always operates its primary radio port in "child" or "parent/child" mode and its secondary Ethernet port in "parent mode". Note that an AP can only function as a child 802.11 bridge if its Ethernet port is explicitly configured in "parent" or "parent/child" mode.

[0718] On power-up, an unattached AP initially "scans" for SCM advertisement information to discover the SCM and to determine the best path to the Primary LAN. The AP then selects a parent node and Primary Port, which provide the best path, and registers with the SCM.

[0719] Path cost information is contained in SCM Advertisement messages and in 802.11 Beacon and Probe Response messages received on AP ports that are configured in child or parent/child mode. An AP only accepts SCM Advertisements with a "matching" subnet ID and only accepts Beacon and Probe Response messages with a matching subnet ID and matching WLCCP SSID.

[0720] An AP immediately determines that it is a "root AP" if it receives SCM Advertisement messages on its Ethernet port with the *Preferred SCM* flag set ON and with a *Hop Count* of zero. The parent SWAN node for a root AP is the local SCM. A root AP immediately selects the Ethernet port as its "primary port" and registers with the SCM. After it successfully registers, it generates SCM advertisements on each of its secondary ports.

[0721] By default, a non-root AP (i.e. an AP that is not directly attached to the primary LAN) selects a primary port and parent AP that provide the "best" path to the primary LAN, where the best path is the least-cost path with acceptable signal quality. A non-root AP registers with the SWAN infrastructure via its selected "parent AP" on its selected primary port.

[0722] An AP may receive SCM Advertisement messages on its Ethernet port with the *Preferred SCM* flag set OFF. In that case, the AP should scan for a higher priority SCM, for a random interval, on each port where "child mode" is enabled. The AP operates as a root AP, if it does not discover a higher priority SCM. An AP may receive an SCM advertisement from a backup SCM because 1) the preferred SCM failed, or 2) the wired network topology is fragmented. For the later case, scanning for a higher-priority SCM is required for topology convergence.

[0723] A SWAN AP can, optionally, execute the 802.1D Spanning Tree Protocol (STP). SWAN operation with STP APs is discussed *infra.*

[0724] A child 802.11 bridge is the WLCCP designated bridge for a secondary Ethernet LAN. A child 802.11 bridge is responsible for attaching the secondary LAN, and attached secondary Ethernet nodes, to the primary LAN. *Unicast Flooding* and *Multicast Flooding* to the secondary LAN is enabled or disabled locally on the designated bridge. Unicast and multicast flooding requirements are propagated inbound to the primary LAN.

[0725] A non-STP child 802.11 bridge is configured with a *Bridge Priority*. The Bridge Priority is used to elect the WLCCP designated bridge, as described below in the section entitled "WLCCP Designated Bridge Election", if more that one child bridge is attached to a secondary LAN.

[0726] A user-configured *Ethernet Address List* can be configured on an AP Ethernet port. The Ethernet Address List contains a list of static 802 addresses, where each address identifies a station that is accessed via the Ethernet port. [The list can be configured via standard 802.1D configuration options that support the creation of "static" database entries.] A child 802.11 bridge attaches addresses in the list and other dynamically-learned addresses to the primary LAN.

[0727] A Work Group Bridge (WGB) is a special case of a child 802.11 bridge with the following configuration settings:

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1) The Ethernet port is configured in "parent" mode.
2) The 802.11 ports are configured in "child" mode.
3) Unicast flooding is disabled on the Ethernet port.
4) A WGB does not execute the STP. [A WGB can provide access to a secondary LAN that is part of a mobile network (e.g. a LAN in a vehicle that is part of a larger mobile network). It is not practical to execute the standard 802.1D STP in a mobile bridge due to the frequent topology changes.]

[0728] A WGB must include a WLCCP_SEC_LAN_ADDR_LIST TLV in its WLCCP Registration Request records. The TLV contains a list of 802 addresses, where each address identifies an Ethernet station on the Ethernet LAN attached to the WGB's secondary Ethernet port.

[0729] The WLCCP Designated Bridge Election Protocol enables two or more redundant WGBs to be attached to a work-group secondary LAN.

[0730] Note that the Ethernet port on a WGB is configured in "parent" mode; therefore, a WGB cannot attach to the SWAN network on its Ethernet port - even if it could provide a lower cost path.

[0731] An "old path" to a node must be deleted if 1) the node roams to a new parent AP or CM, 2) the node is "disabled" by a network administrator, or 3) the node becomes physically disconnected from the network. For the first two cases, a CM generates a "Deregistration Request" to delete the old path. For the third case, the parent node generates a "Detach Request" to delete the old path.

[0732] The WLCCP Registration/Deregistration/Detach protocol is structured to prevent "disconnected path fragments". A Registration Reply with a "good" status code establishes a path instance for a "Requester Node" as it is forwarded outbound from the common CM toward the Requester Node. Path instances are deleted in the reverse direction. A path instance is deleted as a Deregistration Reply or Detach Request message is forwarded inbound.

- Deregistration Requests.

[0733] A CM "deregisters" any old path instance, 1) when a new path instance is established for a node that has roamed, or 2) a network administrator "disables" a node. A CM sends a Deregistration Request message, with the *Response-Req Flag* set ON, outbound on the old path to solicit a Deregistration Reply message. The Deregistration Reply is forwarded inbound (with hopwise routing if L2 Path Updates are enabled) until it reaches the Originator. The old path instance is deleted in each node as the inbound Deregistration Reply is received; therefore, the most outbound portion of the old path instance is deleted first.

[0734] The CM that is the "nearest common ancestor" is responsible for reliably deregistering a node's old path instance, when the node roams. The nearest common ancestor CM is referred to as the "common CM".

[0735] A common CM only deregisters bound path instances for descendant nodes (i.e. path instances where it has a bound DPR). A Deregistration Request and the corresponding Reply contain the Path ID of the old bound path instance. The common CM is always the "*Originator*" in Deregistration Request/Reply messages.

[0736] A CCM deregisters an old path instance, for a node, by sending a Deregistration Request to the "old" LCM, with the old LCM as the *"Responder"*. An LCM deregisters an old path instance by sending a Deregistration Request to the old SCM, with the SCM as the *Responder.* An SCM deregisters the path to a MN or child AP by sending a Deregistration Request to the "old" parent AP, with the old parent AP as the *Responder.*

[0737] The common CM retransmits a Deregistration Request until it receives a Deregistration Reply with a matching Message ID. A common CM must maintain deregistration state information for an "old" path instance, until it receives a matching reply or the maximum deregistration retries are exceeded. Other descendant APs or CMs on the old path do NOT need to maintain deregistration state information.

[0738] A Deregistration Request is always forwarded to the immediate parent of the *Target Node*, if possible. The immediate parent must generate the Deregistration Reply when it receives a Deregistration Request.

[0739] If an intermediate CM receives a Deregistration Request, it must first determine if it has a DPR for the path instance identified by the *Target Node ID* and *Path ID*. If it does NOT have such a DPR, then it must return a Deregistration Reply. Otherwise, it must forward the request outbound toward the immediate parent. Before the request is forwarded, an LCM must first change the *Responder* to the old SCM; an SCM must first change the *Responder* to the old parent AP. An intermediate CM must update the *Path ID* field, to identify the outbound or inbound path instance, before forwarding a Deregistration Request or Reply message to a child or parent CM.

[0740] An intermediate AP must a forward Deregistration Request to the next hop AP on the outbound path to the immediate parent AP (i.e. the *Responder),* if such a next hop AP exists. Otherwise, an intermediate AP must generate a Deregistration Reply, with an error status, if such a next hop AP does not exist. Note that an AP will be on both the old and new path, when a MN roams between child APs in its sub tree.

[0741] It is possible that an "old parent node" may become Unattached before an old path instance is deregistered. In that case, the old parent node (AP or CM) will be deregistered, when the CM cannot successfully delete an old path

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instance, and the entire sub tree rooted at the old parent node will be deleted.

[0742] An AP or CM must delete a "bound DPR" for a node, if it receives a Deregistration Reply, for the node, with a matching Node ID and a matching or "newer" Path ID. An AP also must delete a DPR for a node if it receives a Registration Reply with a "newer" Path ID. The corresponding DRR can be deleted or, optionally, converted to an IRR.

[0743] A DPR contains the Message ID of the last received Registration Request for the respective path instance. If a common CM receives an out-of-order initial Registration Request, it will generate a Deregistration Request that contains the Registration *Message ID.* An AP or CM must delete an "unbound" DPR if it receives a Deregistration Request with a matching *Registration Message ID.* It must NOT delete a "bound" DPR.

[0744] Unbound DPRs (i.e. which do not transition to the bound state) are quickly aged and discarded; therefore, it is not necessary to explicitly delete an unbound path fragment.

[0745] An incorrect, transient path instance, for a rapidly roaming MN, will exist if Registration Request messages for the MN arrive out-of-order at a CM. In that case, the CM will delete the correct path to the MN with a Deregistration Request. The MN's parent AP must disassociate the MN, when it receives the Deregistration Request. Therefore, a correct path instance will quickly be established when the MN reassociates.

- Detach Requests.

[0746] A "parent" node generates a Detach Request to delete the path instance for a "child", when the link to the child becomes "disconnected". A Detach Request is generated for the following reasons: 1) A parent AP generates a Detach Request for a child 802.11 station, when the station is "disassociated"; 2) a parent node (AP or CM) generates a Detach Request for a child node (MN, AP, or CM) if it can no longer communicate with the child node, or 3) a parent node generates a Detach Request for a child node if it discards the DPR for the child node (i.e. because the Registration Lifetime expired before the DPR was refreshed). [In theory, an AP or CM can also generate a Detach Request to disconnect itself from the network.]

[0747] The *Originator* of a Detach Request is the parent node of the disconnected child node. The *Responder* is always the parent CM of the parent node. The *Requester* is the disconnected child node.

[0748] A Detach Request is (re)transmitted until the Originator receives a matching Detach Reply. The Detach Request is used to change the registration state to "unbound" in each AP and CM on the path to the CCM. A Detach Request contains the Path ID for the path instance. If an AP or SCM receives a Detach Request for a MN, it sets the DPR state to "unbound", if the Path ID in the DPR is not "newer" than the Path ID in the Detach Request. The DPR state is immediately set to "unbound" in a parent AP when a station is disassociated.

[0749] The Path ID and Responder field must be updated, as a Detach Request is forwarded inbound, exactly as for an inbound Deregistration Reply.

Sub Tree Deletion

[0750] If an "Attached" AP becomes disconnected from the SWAN Topology Tree, then the AP and each node in the sub tree rooted at the AP must reliably transition to the "Unattached" state.

[0751] There are two general cases:

1) A parent AP or SCM may "disconnect" a child node.
2) An "Attached" child node may independently transition to the "Unattached" state.

[0752] Case 1: A parent AP or CM asynchronously disconnects a child node if a) the DPR for the child node is aged and discarded, b) the parent can no longer communicate with the child, or c) an administrative Deregistration Request is received for the child. If a parent node deletes a child AP, then the child AP and the entire sub tree rooted at the AP must reliably transition to the Unattached state.

[0753] If a DPR is aged and discarded, then it is guaranteed that the child AP has already transitioned to the Unattached state and no further action is required.

[0754] A parent AP can disconnect an 802.11 child, in its BSS, simply by the changing the child's 802.11 state to Disassociated and, optionally, transmitting a Disassociation (or Deauthentication) message to the station. At worst, the child node will discover that it is unassociated when it attempts to send an uplink frame.

[0755] If a parent SCM or AP disconnects a child AP, which is attached on an Ethernet secondary port, then it must advertise the child AP's Node ID and Path ID, in a WTLV_DELETED_NODE_LIST TLV, in SCM Advertisement Reply messages that are transmitted on the Ethernet secondary port. The disconnected AP's Node ID must be advertised for some threshold period or until the AP reregisters. It is guaranteed that the child AP will transition to Unattached state either a) when it misses all SCM Advertisement Reply messages from its parent in some small threshold period, or b) when it discovers its Node ID in a Deleted Node List.

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[0756] Case 2: An "Attached" child node becomes "Unattached" if a) it loses the link to its parent; b) it detects that its parent node has become Unattached; c) it detects a new parent "instance"; or d) its Node ID and current Path ID are in a *Detached Node List* in an advertisement message.

[0757] Each SWAN CM must maintain an internal "Instance Age", as described in the section entitled "Topology State Information". The Instance Age is entered into the *Instance Age* field in Advertisement Reply messages. A node's Instance Age is initialized to '0' and is reset to '0' each time the node transitions to the Unattached state.

[0758] An AP must maintain an internal "Attach Count" variable that is initialized to '0' and incremented each time that the AP initially registers with the SCM. The Attach Count is copied into the *Attach Count* field in SCM Advertisement Reply messages that are transmitted on the AP's secondary ports.

[0759] A child node must save the *Instance Age* of its parent CM. A non-root AP must also save the *Attach Count* of its parent AP. An Attached node transitions to the Unattached state if it receives an Advertisement Reply message, from its parent node, with a lower *Instance Age* (e.g. because the parent node has restarted). A non-root AP also transitions to the Unattached state if it receives an Advertisement Reply with a different Attach Count. Note that an SCM can directly or indirectly delete its entire sub tree by transmitting an SCM Advertisement message with a lower *Instance Age* value.

[0760] A child AP must also maintain a variable that contains the current Attach Count of its parent AP. A child AP must transition to the Unattached state if it receives an Advertisement Reply from its parent AP with a different *Attach Count* (e.g. because the parent AP roamed).

[0761] When an SCM transitions to the Unattached state it must a) transmit a multicast unscheduled SCM Advertisement Reply message with the *Unattached Flag* set ON and an infinite *Path Cost* and *Hop Count*, and 2) delete all DPRs..

[0762] When an Attached AP transitions to the Unattached state it must: a) transmit a multicast unscheduled SCM Advertisement Reply message with the *Unattached Flag* set ON and an "infinite" *Path Cost* and *Hop Count*, on each Ethernet secondary port, b) disassociate all child 802.11 stations, c) delete all DPRs, d) stop Beaconing on 802.11 ports, and e) initiate scanning for a new parent SCM or AP. The AP "disassociates" 802.11 stations by changing the 802.11 state to "Unauthenticated and Unassociated"; it does not need to send an 802.11 Disassociation Request to each child station.

[0763] An AP must remain in the Unattached state for a hold-down period, (i.e. 5 seconds) before it registers with a new parent AP, to ensure that all child 802.11 stations have disassociated and to prevent out-of-order Registration Requests.

W2 - SCM Sub Tree Deletion.

[0764] If an "Attached" SCM becomes unattached from its parent LCM, then it transitions to subnet standalone mode. The sub tree rooted at the SCM is NOT deleted when the SCM transitions from local infrastructure mode to subnet standalone mode; therefore, the SCM must NOT reset its Instance Age.

[0765] The sub tree rooted at an SCM, which is operating in standalone mode, must be deleted when the SCM it transitions to local infrastructure mode. Therefore, a standalone SCM must reset its Instance Age after it initially registers with a new parent LCM.

[0766] If an "Attached" LCM becomes unattached from the CCM, then it transitions to Local Standalone mode. The sub tree rooted at the LCM is NOT deleted when the LCM transitions from campus infrastructure mode to local standalone mode; therefore, the LCM must NOT reset its Instance Age.

[0767] The sub tree rooted at an LCM, which is operating in standalone mode, must be deleted when the LCM it transitions to campus infrastructure mode. Therefore, a standalone LCM must reset its Instance Age after it initially registers with the CCM.

W2 - LCM Path Authentication.

[0768] In campus infrastructure mode, an unattached LCM must send a Path-Init Request to the CCM, after it initially authenticates, to initiate path authentication. Path authentication is described in detail in the section entitled "*Infrastructure Path Authentication*".

W2 - LCM Registration.

[0769] An LCM sends an "initial" Registration Request to the CCM after it has successfully completed Path Authentication. The CCM returns an initial Registration Reply message. The LCM must generate periodic "update" Registration Request messages to refresh its registration bindings in the CCM. The CCM returns an update Registration Reply message, to acknowledge the Registration Request.

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W2 - SCM Operation.

- Parent LCM Assignment.

[0770] An SCM must send a Context Request message, with a "request" WTLV_PARENT_CM TLV, to the CCM at start-up and whenever its link to an assigned LCM is lost. The CCM determines the SCM's parent LCM, from the set of registered LCMs, when it receives the Context Request. [The user must configure LCM/subnet bindings in the CCM. For redundancy, a user can configure primary and fallback LCMs, for each subnet. By default, the LCM co-located with the CCM can function as the fallback for failed LCMs. The CCM assigns an SCM to an active LCM if the SCM's subnet is assigned to the LCM.] The CCM returns a Context Reply with a non-null WTLV_PARENT_CM TLV to explicitly assign the SCM to a parent LCM. Otherwise, the CCM returns a null WTLV_PARENT_CM TLV to direct the SCM to operate in subnet stand-alone mode. A non-null TLV contains the Node ID and IP address of the assigned parent LCM. The SCM must then path-authenticate and register with its assigned parent LCM.

[0771] If an SCM cannot communicate with a parent LCM and it cannot communicate with its assigned CCM then it must operate in stand-alone mode. However, the SCM must periodically attempt to re-establish communications with the CCM.

[0772] The CCM will return a null WTLV_PARENT_CM TLV (i.e. with a Node ID of '0')to direct an SCM to operate in stand-alone mode.

[0773] An SCM must repeat the process to determine its (i.e. new) parent LCM, if it becomes unattached. An attached SCM becomes unattached if a) it loses the link to its parent LCM, b) it cannot successfully register with its parent LCM, c) it detects a new instance of the CCM or its parent LCM, or d) if it receives a valid administrative Deregistration Request. If an attached SCM becomes unattached from its parent LCM, it must send a Context Request to the CCM, which contains a non-null "request" and WTLV_PARENT_CM TLVs. The "request" TLV contains the Node ID and IP address of the "old parent LCM". If the SCM lost its link to the parent LCM, then it must also include a WTLV_LOST_LINK TLV in the Context Request. As before, the CCM includes a null or non-null WTLV_PARENT_CM TLV in the Context Reply to either direct the SCM to operate in stand-alone mode or to assign the SCM to a parent LCM, respectively.

W2 - AP Operation.

W2 - AP State Variables.

[0774] The AP State Variables for the W2 implementation are described in the section entitled "General AP State Variables", with one exception. The AP must maintain a Registration Table with records that include forwarding and path state information, as described in the section entitled "W2 Registration Records".

W2 - AP Path Authentication.

[0775] An AP must initiate Path Authentication, after it has successfully authenticated, to establish a secret Context Transfer Key (CTK) with each of its ancestors. AP Path Authentication, in the W2 implementation, is as described above in the section entitled "General AP Path Authentication".

W2 - AP Registration.

[0776] An Unattached AP scans for a potential parent SCM or AP on each of its ports that are configured in child or parent/child mode. [Note that an Attached AP becomes Unattached if it discovers a new instance of its parent AP or SCM.] An Unattached AP or CM must send an initial Registration Request to its selected parent node, on its selected primary port, to request attachment to the network. The *Originator* is the Unattached AP; the *Requester* is also the Unattached AP; and the *Responder* is the selected parent node (i.e. parent AP or SCM), in the initial Registration Request and the corresponding Reply.

[0777] The fields in an initial Registration Request sent by an Unattached AP are set as described below. (Unspecified fields are set to '0'.)

[0778] WLCCP header fields:

Type - '3'
Originator - Node ID of the Unattached AP.
Responder - Node ID of the selected parent node (parent AP or parent SCM).
Response-Req Flag - '1' to solicit a Reply.
Inbound Flag - '1'.

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Hopwise-Routing Flag - '1'.
TLV Flag- '1' (the Request must include a *WTLV_AP_PORT_LIST* TLV).

[0779] Registration fields:

Requester - Node ID of the Unattached AP.
Hop Address - 802 address of the Unattached AP's selected Primary Port.
Relay Node ID - '0' in a registration message generated by the Originator or Responder. Otherwise, the Node ID of an intermediate "relay" node that forwarded the message.
Initial Flag - '1'.

[0780] *VLAN ID* - The native VLAN ID of both the Unattached AP and the parent node. The *VLAN ID* value may be '0'. It is an error if the *VLAN ID* value is different than the parent node's native VLAN ID.

[0781] The parent node must forward an initial Registration Request from an Unattached AP inbound until it reaches the root CM. The parent node enters its Node ID in the *Originator* field and the Node ID of its parent CM in the *Responder* field, before forwarding the request inbound. An intermediate LCM must update the *Responder* field with the CCM Node ID before it forwards the request inbound to the CCM. The CCM returns a Registration Reply to the parent node (i.e. the Originator). The parent node updates the *Responder* field with the *Requester Node ID* before forwarding the Reply to the Unattached AP or CM.

[0782] An Attached AP or CM can send an "update" Registration Request directly to its parent CM, to refresh its path instance, with itself as both the *Originator* and the *Requester Node* and the parent CM as the *Responder.* The parent CM must update the *Responder* field, with the Node ID of its parent CM, before forwarding the request inbound.

[0783] An AP (re)transmits a Registration Request either until it receives a Registration Reply with a matching message ID, or until the maximum retries are exceeded. An AP is "registered" when it receives a matching Registration Reply with a "good" *RegStatus.* The Registration Reply contains a *Path ID,* set by the SCM, which identifies the "path instance" from the AP to the SCM.

[0784] An AP periodically sends an "update" Registration Request message to the SCM to "refresh" its mobility bindings in each node on the path to the SCM. An update Registration Request has the *Initial Flag* set OFF and it contains a valid *Path ID.*

[0785] A Registration Request from an AP must include a WTLV_AP_PORT_LIST TLV, which contains a list of AP port descriptors. Each port descriptor includes the port type, port mode (parent, child, or parent/child), and 802 port address of a physical communications interface.

[0786] A Registration Request from an AP must include an *IP Address* TLV.

[0787] A Registration Request from an AP, which is configured with a Proxy MIP SSID, must include a WTLV_PMIP_SSID_LIST TLV, which contains a list of Proxy MIP SSIDs and MIP HA bindings.

W2 - Proxy MN Registration

[0788] This section describes MN registration by a parent AP when WLCCP registration is used to establish the Layer 2 forwarding path between the MN and the primary LAN.

[0789] A "proxy WLCCP MN", in a parent AP, provides proxy WLCCP registration services for WLCCP-unaware MNs. Each MN is registered with the SCM for the native VLAN of its parent AP, even if the MN belongs to a different VLAN.

[0790] A parent AP generates an "initial, authenticated" Registration Request message for a MN, after the MN has successfully authenticated or re-authenticated. A Registration Request for a MN must contain the MN's SSID and the default subnet for the MN.

[0791] If a parent AP does not receive an expected Registration Reply, then it must retransmit the Registration Request with the Delay field set to the elapsed time since the MN last transmitted an uplink frame. A parent AP must disassociate a MN if it does not receive an expected Registration Reply after REGISTRATION_RETRY_LIMIT retransmissions.

[0792] The fields in an initial, proxy Registration Request for a MN are set as described below. Unspecified fields are set to '0'.

[0793] WLCCP header fields:

Type - '3'
Originator - Node ID of the Parent AP.
Responder - Node ID of the SCM.
Response-Req Flag - '1' to solicit a Reply.
Inbound Flag - '1'.
Hopwise-Routing Flag - '1'.

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TLV Flag- '1' (the Request must include an SSID_TLV).

[0794] Registration fields:

Requester - 802 address of the MN.
Hop Address - 802 address of the Parent AP's Primary Port.
Relay Node ID - '0' in a registration message generated by the Originator or Responder. Otherwise, the Node ID of an intermediate "relay" node that forwarded the message.
Proxy Flag - '1'.
Initial Flag - '1'.
Authenticated Flag - The Authenticated Flag is set to '1' in a Request to indicate that the MN was authenticated by the parent AP.
Proxy MIP Flag - set to '1' if the MN is using an SSID where Proxy MIP is enabled.
Delay - The delay in hundreds of seconds since the MN last sent an uplink frame. The delay is usually '0' if the *Retry* flag is '0'.

[0795] *VLAN ID* - The VLAN ID assigned to the MN. The MN's VLAN ID is usually the default VLAN ID assigned to the MN's SSID. The assigned VLAN ID may be '0' if the MN is assigned to the "native VLAN". The *VLAN ID* field, in the Registration Reply for a MN, can contain a different VLAN ID, to explicitly assign the MN to a VLAN.

[0796] *SSID_TLV* - The Registration Request for a MN must contain a WTLV_SSID TLV that contains the active SSID for the MN, contained in the MN's (Re)Association Request.

[0797] The *Broadcast SSID Flag* must be set ON if the MN associated with a broadcast SSID. A Registration Reply for a MN can include an SSID TLV, with a different SSID, to explicitly assign the MN to a service set.

[0798] *AUTHENTICATION_TYPE TLV* - Contains the 802.11 authentication type (Open, Shared Key, or EAP type) used to authenticate the MN.

[0799] A Registration Request, which is generated for an 802.11 station that "reassociated", must contain the BSSID of the old AP in a WTLV_OLD_AP_BSSID TLV. The BSSID is obtained from the "old AP" field in the 802.11 Reassociation Request transmitted by the station.

[0800] A Registration Request for a MN is always forwarded to the "nearest common ancestor" CM. An SCM must forward an initial Registration Request, for a MN, to its parent LCM if it receives a Registration Request from the MN's parent AP and one of the following conditions is true:

[0801] The SCM does not have a bound DPR for the MN.

[0802] Any BSSID in the received Registration Request is NOT the address of a port on the "parent AP" in the SCM's DPR for the MN.

[0803] The SCM creates or updates a "bound" DPR for the MN when it receives a matching Registration Reply from its parent LCM with a "good" status. The SCM generates a Registration Reply, when it receives the Registration Reply from its parent CM, to establish the new path instance within its subnet.

[0804] An LCM must forward a received initial Registration Request, for a MN, inbound to the CCM if it does not have a bound DPR for the MN.

[0805] A Registration Reply message for a MN always contains the MN's IP address, if it is known. A parent AP must generate a "Registration Request for a MN when it first detects a new or different IP address for the MN (i.e. by snooping IP/ARP packets transmitted by the MN). The *Root CM Flag* is set ON in the request to cause an update on the full path to the root CM.

[0806] A parent AP generates a Path Update message for a MN after the MN has successfully authenticated. A Path-Update message is always transmitted on the MN's VLAN to update the forwarding tables in bridges and switches. The Path-Update message is sent to the 802 address of the "old Parent AP", if the address is known and the old parent AP is on the same VLAN as the MN; otherwise, the Path-Update is sent to the 802 broadcast address on the MN's VLAN.

[0807] A parent AP must disassociate a child MN if it does not receive an uplink frame from the MN within a MAX_MN_INACTIVITY period. The parent AP must send a WLCCP Detach Request to the SCM when a child station (MN or AP) is disassociated. Detach Request logic is discussed in more detail below.

[0808] Data frames can be forwarded to or from a MN as soon as the MN is authenticated. However, unicast data frames are not forwarded outbound on an AP-to-AP link until a "bound" path instance exists for the destination address. Data frames are not forwarded from a "home subnet" to a Proxy-MIP MN on "foreign subnet" until a MIP tunnel is established.

- 802.11 Bridge Registration.

[0809] A "parent 802.11 bridge" registers like any other AP, as described in the section entitled "*AP Registration*".

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[0810] A "child 802.11 bridge" is the WLCCP designated bridge for a secondary Ethernet LAN. The designated bridge must register itself, as any other AP, and it must also register its attached secondary LAN and Ethernet nodes on the secondary LAN. A WLCCP designated bridge must set the *Secondary LAN Flag* ON in its Registration Request messages.

[0811] *Unicast Flooding* to a secondary LAN is enabled or disabled locally on the designated bridge's secondary Ethernet port. If unicast flooding is enabled, then the WLCCP designated bridge must set a *Unicast Flooding Flag* ON in its WLCCP Registration Request messages, to propagate unicast flooding requirements to the primary LAN. Unicast Flooding is dynamically enabled on a logical AP secondary port, if a Registration Request is received on the port, with the *Unicast Flooding Flag* set ON. In general, an AP must set the *Unicast Flooding Flag* ON in its Registration Request messages, if unicast flooding is statically or dynamically enabled on any of its secondary ports. Therefore, unicast flooding is enabled on any AP secondary port if the sub tree rooted at the port contains a secondary Ethernet LAN with unicast flooding enabled. Dynamically enabled unicast flooding is disabled on a secondary AP port if a Registration Request, with the *Unicast Flooding Flag* set ON, is not received within the maximum AP registration lifetime.

[0812] If unicast flooding is disabled on a secondary LAN, then the WLCCP designated bridge must include a WTLV_SEC_LAN_ADDR_LIST TLV, in its Registration Request records, to attach Ethernet nodes on the secondary LAN to the primary LAN. The TLV contains a list of VLAN-ID/802-address pairs for stations on the secondary LAN. The addresses can be statically configured or dynamically "learned" via backward-learning.

[0813] A user-configured *Ethernet Address List* can be configured on an AP Ethernet port. The Ethernet Address List contains a list of static 802 addresses, where each address identifies a station that is accessed via the Ethernet port. [The list can be configured via standard 802.1D configuration options that support the creation of "static" database entries.] A child 802.11 bridge attaches addresses in the list to the primary LAN, as described above.

- WLCCP Designated Bridge Election.

[0814] This section describes an optional WLCCP Designated Bridge Election protocol that is used to elect a WLCCP designated bridge for a non-STP secondary LAN. The protocol can be used, for example, to facilitate automatic redundancy for non-STP Work-Group Bridges.

[0815] A non-STP child 802.11 bridge is configured with a *Bridge Priority* value from 0 (default) to 7. A *Bridge ID* is the concatenated *Bridge Priority* and WLCCP Node ID of the respective child 802.11 bridge. A Bridge ID has relatively higher bridge priority if it is lexicographically higher. The child bridge with the highest-priority Bridge ID functions as the WLCCP designated bridge for its attached secondary LAN.

[0816] A non-STP child bridge transmits periodic SCM Advertisement Reply messages, which contain its Bridge ID, on its secondary Ethernet port. A child 802.11 bridge must block its secondary Ethernet port if it receives an SCM Advertisement Reply message, with a higher-priority *Bridge ID,* on the port. A child 802.11 bridge becomes the active WLCCP designated bridge for its attached secondary LAN if it does not receive an SCM Advertisement Reply message on its Ethernet port, with a higher-priority Bridge ID, within WLCCP_BRG_ELECT_HOLDDOWN seconds after it begins transmitting SCM advertisements.

- 802 Multicast Address Registration.

[0817] An AP must set the *Multicast Flooding Flag* ON, in its Registration Request messages, if multicast flooding is enabled on any of its secondary ports. Multicast Flooding is dynamically enabled on a logical AP secondary port, if a Registration Request is received on the port, with the Multicast Flooding flag set ON. Therefore, multicast flooding is enabled on a secondary port if it is enabled on any other AP or secondary LAN in the sub tree rooted at the port.

[0818] An AP must include a, possibly empty, WTLV_MCAST_ADDR_LIST TLV in a Registration Request where the *Multicast Flooding Flag* is set OFF. The TLV contains the aggregate list of 802 multicast addresses that are enabled on the AP's secondary ports. The aggregate list of enabled 802 multicast addresses includes any user-configured list of enabled multicast addresses and multicast addresses registered by MNs.

[0819] A multicast address is dynamically enabled on an AP secondary port if it is contained in a WTLV_MCAST_ADDR_LIST TLV in a Registration Request or in a MULTICAST_802_ADDRESS_LIST element in an 802.11 (Re) Association message or 802.11 Action frame. A dynamically enabled multicast address is aged and discarded if it is not re-registered after the maximum AP registration lifetime.

[0820] 802 multicast flooding is enabled on all AP secondary ports, by default. 802 *Multicast Flooding* to a secondary LAN is enabled or disabled locally on the designated bridge's secondary Ethernet port.

- IP Multicast Address Registration.

[0821] "IGMP Snooping" is commonly used to automatically derive which IP multicast addresses are "active" on a port (i.e. which IP multicast addresses should be forwarded on the port). IGMP Snooping can be enabled globally or it

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can be enabled on each AP (i.e. secondary) port. If IGMP Snooping is enabled, then only IP multicast packets with "active" multicast IP addresses are forwarded on the secondary port.

[0822] If IGMP Snooping is disabled on an AP secondary port, then the *IP Multicast Flooding Flag* must be set ON in the AP's Registration Request messages, so that all Multicast IP packets are flooded to the secondary port. IP Multicast Flooding is dynamically enabled on a logical AP secondary port, if a Registration Request is received on the port, with the *IP Multicast Flooding Flag* set ON. Therefore, IP multicast flooding is enabled on a secondary port if it is enabled on any other AP or secondary LAN in the sub tree rooted at the port.

[0823] By default, IGMP Reports are simply forwarded inbound to the primary LAN to propagate IP multicast membership information to each AP on the inbound path. If reliable IP multicast registration is required, an AP can include a WTLV_IP_MCAST_ADDR_LIST TLV in a Registration Request where the *IP Multicast Flooding Flag* is set OFF. The TLV contains the aggregate list of IP multicast addresses that are active on the AP's secondary ports.

[0824] [WLCCP support is not required for IP multicast filtering, if IGMP Reports are simply forwarded inbound to the primary LAN.]

- Reliable Path Update Mechanism.

[0825] This section describes an optional WLCCP "Reliable Path Update" mechanism that is used to recover from lost Path-Update messages.

[0826] A new AP sends a single Path-Update Request message to update the backward-learned forwarding path, for a MN, in intermediate bridges and switches, when the MN associates. The forwarding path for the MN will NOT be updated correctly in intermediate bridges/switches if the Path-Update message is lost.

[0827] The Reliable Path Update mechanism requires that any AP Ethernet Primary Port must exist on a dedicated Ethernet link. For example, two root APs cannot be plugged into the same Ethernet hub. With that restriction, an "old AP" should not receive frames, on its primary port, for a MN that is not in its sub tree.

[0828] The mechanism is implemented as follows:

[0829] APs must maintain MN-IRRs for MNs that are not in its sub tree.

[0830] A MN-IRR is put into a "Path Update Pending" state for some threshold period (e.g. 1 minute) after a child MN is deregistered, if a Path-Update message is not received for the MN. The pending state ends if the threshold period expires, a Path-Update is received, or a Path-Check Reply indicates the MN has left the subnet. (Note that a Path-Update message may be received before a Deregistration message.)

[0831] An old parent AP generates a Path-Check Request message for a MN if a) it has an MN-IRR for the MN that is in the Path Update Pending state and b) it receives a data frame destined to the MN on its Primary Port. The Path-Check Request is sent to the old AP's parent SCM

[0832] The parent SCM generates a Path-Check Reply message when it receives a Path-Check Request. If the SCM has a newer outbound path to the MN, then it sends the Path-Check Reply to the new parent AP; otherwise, it sends a Path-Check Reply to the old parent AP, to indicate that the MN is no longer registered in the subnet.

[0833] The new parent AP sends a Path-Update Request message to the old parent AP, after it determines that the MN is still associated.

- MN Extended Service Sets.

[0834] An 802.11 Service Set ID (SSID) identifies an Extended Service Set (ESS), which can be considered as a "wireless access domain" for an 802.11 station. A campus network may contain multiple overlapping ESSes. An ESS may span multiple subnets. An AP can be configured with multiple SSIDs to provide access to multiple ESSes.

[0835] The following access parameters are configured for each AP SSID:

Authentication criteria (e.g. a required authentication algorithm)
Proxy MIP Flag (enabled or disabled).
VLAN ID (optional).*

[0836] If Proxy MIP is enabled, then an optional "Home Agent Address and Subnet Mask" can be configured for the SSID.*

[0837] * At most one VLAN ID or Home Agent Address can be configured for each AP SSID; however, multiple AP SSIDs can be configured with the same VLAN ID or Home Subnet Address.

[0838] The VLAN and Proxy MIP access parameters for a single ESS can be configured differently in each AP. For example, the SSID "FOO" may be configured with a VLAN ID, in a first AP, and the SSID "FOO" may be configured with a Home Agent Address in a second AP.

[0839] An SSID can be configured with a "virtual Home Agent Address" so that Proxy MIP MNs can be assigned to a

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MIP "virtual home subnet". [In a simple "seamless roaming" installation, all Proxy MIP MNs can be assigned to a single virtual home subnet via a centrally configured Proxy MIP SSID.]

[0840] Authentication parameters should be configured consistently for an SSID throughout an ESS.

[0841] At any given time, each MN is associated with a single ESS. The physical roaming domain for a MN is limited to those APs that are configured with the SSID for the MN. The "Proxy MIP and VLAN Integration" section includes an example ESS roaming scenario.

- WLCCP Support for VLAN Trunking.

[0842] If 802.1Q VLAN Trunking is enabled in an AP, then an AP must assign each node in its sub tree to a VLAN ID. All APs and SCMs in the WLCCP spanning tree for a subnet are on the same "native" VLAN as the SCM. MNs and Ethernet stations (i.e. on a secondary LAN) can be on a different VLAN.

[0843] All APs in a subnet belong to the same "native VLAN", with one exception. A WGB that is operating in "client mode" can belong to a non-native VLAN. All Ethernet stations attached to the WGB belong to the same VLAN as the WGB. [A WGB associates as a client station in "client mode". A WGB cannot attach to its parent AP on an 802.11 VLAN trunk link, in client mode.]

[0844] A parent AP assigns a child MN to a VLAN ID. By default, a MN is assigned to the VLAN implicitly or explicitly configured for the MN's SSID. The parent AP must include the VLAN ID of the MN in Registration Request messages for the MN. A parent AP may re-assign a MN to a different VLAN ID when it receives a Registration Reply message if the Registration Reply message contains a different VLAN ID, or the Registration Reply message contains a WTLV_HOME_SUBNET TLV.

[0845] A Registration Reply message will contain a different VLAN ID, if an AAA server assigns the VLAN ID. The second case is described in the following section.

[0846] An AP must "count" the number of MNs in its sub tree for each enabled VLAN. A VLAN is "active" on an AP secondary VLAN trunk port, if there are 1 or more registered stations, in the sub tree rooted at the port, that belong to the VLAN. An egress multicast VLAN filter, on each secondary VLAN trunk port, is used to discard multicast transmissions for inactive VLANs.

[0847] Proxy MIP is used to provide "proxy" Mobile IP services for IP MNs that do not directly support Mobile IP.

[0848] [Currently, Proxy MIP does not provide seamless inter-subnet mobility for non-IP applications. Proxy MIP can be extended to provide seamless mobility for any Ethernet-based application by adding backward-compatible extensions to standard MIP. Such MIP extensions require minimal WLCCP changes, and do not affect the WLCCP topology.]

- Proxy MIP Registration and Deregistration.

[0849] The SCM for each subnet maintains the Mobile IP Registration State for Proxy MIP MNs. A "foreign SCM" triggers proxy MIP Registration Requests for a MN when it first visits the foreign subnet, and periodically thereafter, to maintain FA/HA mobility bindings for the MN. [The SCM cannot trigger MIP registration until complete home subnet bindings (i.e. HA address and MN IP address) are established for the MN in the SCM.] A "home SCM" triggers a proxy MIP Deregistration Request for a MN when it first roams back to its home subnet from a foreign subnet.

[0850] MIP Registration Request frames must be transmitted to a MIP FA with the source Ethernet address of the respective MN, so that the FA can discover the Ethernet address of the MN. Therefore, a parent AP must transmit Proxy MIP Registration Requests, to avoid incorrect "backward learning" in any intermediate transparent bridges or switches. A parent AP generates a MIP registration request when it receives an indication from the SCM.

[0851] A "Proxy MIP MN" is a MN that requires proxy MIP services. A Proxy MIP MN must be configured with an SSID that has proxy MIP enabled. The SSID of a MN is contained in 802.11 (Re)Association Request messages; therefore the parent AP for a MN can immediately determine if the MN may require proxy MIP services. The parent AP must set the *Proxy MIP Flag* ON, in a Registration Request for a MN, if Proxy MIP is enabled for the MN's SSID. The SCM includes a WTLV_MIP4_REG_REQ TLV in the Registration Reply, to trigger the parent AP to transmit a MIP Registration (or Deregistration) Request.

[0852] An SCM is NOT in the MIP forwarding path for a proxy-MIP MN on a foreign subnet. IP packets for the MN are forwarded between the home subnet and foreign subnet over a MIP tunnel between the MIP HA and FA. The FA forwards IP frames outbound to the unicast 802 address of the MN. The proxy MIP entity, in the parent AP of the MN, forwards IP frames from the MN, inbound, to the unicast 802 address of the FA (i.e. reverse tunneling) or to the unicast 802 address of the default router (i.e. triangular routing).

- SSID/Home-Agent Database.

[0853] The SSID/HA database contains a list of MIP HAs that are accessible for each SSID, which is configured with

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Proxy MIP enabled, on an AP in the SWAN network. Entries in the SSID/HA database are automatically populated by APs, as described below. A MN is not dynamically bound to a home subnet, based on its source IP address, unless it a) is authorised to use its SSID (i.e. via RADIUS) and b) a MIP HA for the home subnet is in the list of accessible HAs for the MN's SSID.

[0854] Each SSID configured on an AP is either implicitly or explicitly bound to a default VLAN or to a MIPv4-HA/Subnet-mask pair. If a Proxy MIP SSID is bound to a default VLAN, then the AP must attempt to automatically discover the HA for that VLAN by monitoring HA advertisements transmitted on the VLAN. An AP must also attempt to discover the subnet mask for the VLAN. An AP can discover the subnet mask for each VLAN by broadcasting an ICMP Subnet Mask Request message on the VLAN or by monitoring subnet information in Cisco CDP messages.

[0855] An AP that is configured with a Proxy MIP SSID must include a WLTV_PMIP_SSID_LIST container TLV in its Registration Request messages. The container TLV contains a list of WTLV_SSID TLVs, where each SSID TLV is followed by 0 or more WTLV_MIPV4_AGENT TLVs. Each MIPV4_AGENT TLV contains the IP address, subnet mask, and capabilities of a HA that is accessible for the respective SSID. The subnet mask field for a HA is set to '0' if it is unknown. The SCM consolidates the list of Proxy MIP SSIDs and HAs from all APs in its domain and forwards the resulting lists of Proxy MIP SSIDs and associated HAs to the CCM. The CCM uses the information to automatically populate the SSID/HA database and the "Home Agent Database" described below.

- Home Agent Database.

[0856] The CCM maintains a Home Agent Database that contains a list ofMIPv4-HA/Subnet-mask pairs. Entries in the list are statically configured and/or automatically populated by APs. The CCM uses the database to determine the MIP HA for a Proxy MIP MN when it receives a Registration Request with the Proxy-MIP Flag set ON and a WTLV_HOME_SUBNET TLV. The HOME_SUBNET TLV contains an IP address, of a Proxy MIP MN, which was discovered by "snooping" the source IP address in packets sent by the MN. The CCM determines the HA for the MN by matching the MN's subnet address to the subnet address of an HA. A "longest matching prefix" search algorithm can be used if some subnet masks are not known. The MN must be authorized to access the HA's home subnet, as described above.

- Proxy-MIP/VLAN Integration.

[0857] An AP that is attached to the network on a primary VLAN trunk port has a Layer 2 "VLAN link" to multiple Proxy MIP "home subnets". If a parent AP has a VLAN link to a Proxy MIP MN's home subnet, then the Proxy MIP MN is assigned to the corresponding VLAN ID; otherwise, the Proxy MIP MN is assigned to the native VLAN, even if the native VLAN is not the home subnet.

[0858] Each AP must maintain a "VLAN Table" with an entry for each VLAN ID that is enabled on the AP. A VLAN is marked as "Proxy-MIP enabled" if 1 or more Proxy MIP SSIDs are bound to the VLAN. Each VLAN Table entry for a Proxy-MIP enabled VLAN must contain the address and subnet mask of one or more MIPv4 HAs.

[0859] The SWAN infrastructure will return any existing home subnet bindings for a Proxy MIP MN in a WTLV_HOME_SUBNET TLV in a Registration Reply message for the MN. The MN is "at home" if the HA address in the Registration Reply matches any HA address in the VLAN Table. In that case, the MN is assigned to the VLAN ID contained in the matching entry. A MIP "Deregistration" message is generated when a proxy-MIP MN first roams into the domain of an SCM, and the MN is bound to its home subnet via VLAN trunking.

- Home Subnet Bindings.

[0860] The "home subnet bindings" for a Proxy MIP MN include the MIP HA address, subnet mask, and IP address for the MN. The HA bindings for a MN can be statically configured or automatically derived, as described above. The CCM maintains the "master copy" of the home subnet bindings for each active Proxy MIP MN. The proxy MIP client entity, in an SCM, must determine the home subnet bindings for a Proxy MIP MN, before it can generate a MIP Registration Request for the MN.

[0861] A Proxy-MIP MN is assigned to a home subnet with the following (lowest to highest) prioritized rules:

1) A MN is assigned to the default VLAN or Home Subnet Address configured for its SSID in the parent AP.
2) If an AP discovers an IP address of a Proxy-MIP MN, then the MN is assigned to the home subnet that corresponds to its IP address.
3) The MN is assigned to a statically configured home subnet and MIP HA(s).

[0862] A proxy MIP MN with existing MIP home subnet bindings is always bound to its current home subnet - even if the MN is associated with an AP that has a matching SSID that is configured with a VLAN ID or Home Agent Address

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for a different subnet (see the section entitled "Proxy MIP and VLAN Integration"). Proxy MIP is used to access the home subnet, if the MN is attached to an AP on a foreign subnet (i.e. an AP that is not attached to the home subnet on a LAN link or a VLAN trunk link).

[0863] A WTLV_HOME_SUBNET TLV is used to establish home subnet bindings for a Proxy MIP MN. The TLV contains the following fields: a) MIPv4 HA, b) Subnet Mask, and c) MN IP Address. The Subnet Mask and MN IP Address fields can be zero if the values are not known. A MN cannot be bound to a home subnet until its IP address is discovered.

[0864] MN home subnet assignment proceeds as follows. (Note that a Registration Request for a MN always contains the MN's SSID in a WTLV_SSID TLV.)

[0865] When a Proxy MIP MN roams to a parent AP, the AP must include a WTLV_HOME_SUBNET TLV in the initial Registration Request message for the MN. The HOME_SUBNET TLV must contain the "default MIP HA" address and the MN's IP address, if it is known. The default MIP HA is the either a) the HA that is configured for the Proxy MIP MN's SSID or b) it is the HA that is bound to the VLAN that is configured for the Proxy MIP MN's SSID. The default MIP HA address is used to dynamically establish the home subnet for a MN that does not have existing home subnet bindings. The initial Registration Request is forwarded to the nearest common ancestor CM - the "common CM".

[0866] The common CM forwards any existing home subnet bindings for the Proxy MIP MN to the MN's parent AP, in a WTLV_HOME_SUBNET TLV in the corresponding Registration Reply message. The outbound Reply message establishes the bindings in each CM and AP on the path to the MN. The existing bindings override the bindings established by the parent AP. Note that the "existing bindings" may have been statically configured or dynamically established (i.e. by an old parent AP).

[0867] The CCM is the "common CM" if the Proxy MIP MN does not have existing home subnet bindings. In that case, the HA IP address in the WTLV_HOME_SUBNET TLV in the Proxy MIP MN's Registration Request is used to determine the MIP HA for the MN. The home subnet bindings are returned in a WTLV_HOME_SUBNET TLV in the Registration Reply generated by the CCM.*

[0868] A parent AP may discover that a MN is using an IP address that does not belong to its current home subnet. In that case, the parent AP must immediately generate an update Registration Request, which contains the IP address in a WTLV_HOME_SUBNET TLV, to dynamically assign the MN to the home subnet that corresponds to its IP address.

[0869] The CCM uses the SSID/HA database to verify that the MN is permitted to access the home subnet that corresponds to its IP address. If the home subnet assignment is authorised, then the home subnet bindings are contained in a WTLV_HOME_SUBNET TLV in the corresponding Registration Reply generated by the CCM.

[0870] * An SCM cannot trigger MIP registration until both the MN's IP address and home agent are known. If the MN's IP address is unknown, then the MN's parent AP must immediately generate another Registration Request when it discovers the MN's IP address. A Proxy MN can be assigned to a local VLAN before its IP address is known.

[0871] Note that a parent AP consistently assigns a Proxy MIP MN to the home subnet contained in a WTLV_IPV4_HOME_SUBNET TLV in a Registration Reply message for the MN. A Proxy MIP MN is "at home" if the HA address in the Registration Reply message matches a HA address in the AP's VLAN Table. In that case, the MN is assigned to the corresponding VLAN ID in the matching table entry. The parent AP generates a MIP Deregistration Request message for a MN if it receives a Registration Reply, with a WTLV_MIP4_REG_REQ TLV, and the MN is "at home".

[0872] Dynamically-assigned home subnet bindings for a MN are aged and discarded if the MN becomes inactive. Therefore, the home subnet for a Proxy-MIP MN may change (i.e. to a more optimal subnet) after some period of inactivity.

[0873] A MN can be bound to a "virtual home subnet" by configuring APs with a Proxy MIP SSID that is bound to the virtual home subnet.

[0874] [The "IPv4 Subnet Selection Option for DHCP", RFC 3011 [6], is used to maintain the IP address for a DHCP MN on a foreign subnet.]

- Proxy MIP Unicast Forwarding.

[0875] By default, "triangular routing" is used to forward packets for a Proxy MIP node on a foreign subnet: Packets transmitted on a home subnet, which are destined to a MN on a foreign subnet, are encapsulated by a HA and tunnelled to the MN. Packets transmitted by a MN on a foreign subnet are sent to the MAC address of an IP gateway on the foreign subnet. The gateway uses normal IP routing to deliver the packets to the target IP address.

[0876] As an option, "MIP Reverse Tunneling" can be enabled per Proxy MIP SSID. If Reverse Tunneling is enabled for a Proxy MIP MN's SSID, then packets transmitted by the MN on a foreign subnet are encapsulated and forwarded inbound to the MN's HA, as specified in RFC 3024.

[0877] [Reverse Tunneling is needed for unicast IP packets for a couple reasons. The DHCP server for a "private subnet" may allocate an unroutable "private IP address" to a proxy MIP MH associated with the subnet. The router for a private subnet typically contains a Network Address Translator (NAT). A NAT enables a station, with a private address, to access other public networks by translating the station's private address to a routable "public address", in IP packets sent and received by the station. Port Address Translation (PNAT) is used to multiplex many private addresses onto a

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single NAT public address. If a proxy MIP MH, with a private home address, roams to a foreign subnet, then packets transmitted by the MH must be forwarded to its home subnet, on a reverse MIP tunnel, to enable any necessary NAT translation. A private IP address may NOT be an unambiguous "home IP address" if multiple private subnets, in the same campus network, share the same IP address space.

[0878] A campus network may contain "secure subnets" that are protected by "firewall" logic. Packets transmitted by a MN on a foreign subnet may not be allowed to pass through a firewall that exists between the foreign subnet and the home subnet.]

-Proxy MIP Multicast Forwarding

[0879] Per RFC 2002, a standard Mobile IP MN, on a foreign subnet, must generate IGMP Membership Report messages to participate in an IP multicast group. The Membership Reports can either be relayed onto the foreign subnet or forwarded to the MN's MIP HA.

[0880] APs use "IGMP Snooping" to derive IP group membership information for a MN. An AP sends an IGMP General Query to a MN, when it associates, to solicit IGMP Reports.

[0881] A parent AP can be configured to process IGMP Membership Reports and IP Multicast packets for a proxy-MIP MN on a foreign subnet, in one of the following ways:

An AP can forward the Membership Reports to the MN's HA via the local FA. The MIP HA is responsible for encapsulating and forwarding multicast packets, transmitted on the MN's home subnet, to the MN on the foreign subnet, as defined in RFC 2002. If the HA tunnels IP multicast packets to the MN, then the proxy MIP entity in a parent AP is responsible for removing the "inner encapsulation header" from a multicast packet forwarded by the HA to a proxy-MIP MN on a foreign subnet. The parent AP can then send the resulting multicast IP packet to the unicast 802 address of the MN. [The parent AP cannot send the multicast IP packet to a multicast 802 address because it will be incorrectly received by MNs in a different broadcast domain.] Multicast packets transmitted by a proxy-MIP MN on a foreign subnet are forwarded to the MN's home subnet, via a MIP "reverse tunnel", as described in RFC 3024.

An AP can relay Membership Reports onto the local "foreign" LAN. Multicast routers are then responsible for forwarding multicast packets to the MN's foreign subnet. The AP must (i.e. selectively) forward the multicast packets to the MN. Multicast packets transmitted by a proxy-MIP MN on a foreign subnet are relayed onto the local, foreign subnet. A multicast router is responsible for forwarding the multicast packets to the home subnet.*

*The second option requires router support for IGMP and multicast routing. It is preferred because it is much more efficient.

- Proxy MIP Broadcast Domains.

[0882] Currently, an 802.11 broadcast domain corresponds to a VLAN. Proxy MIP nodes should be segregated into a broadcast domain that corresponds to a home subnet. 802.11 broadcast domains should be generalized so that a common radio interface is used for both VLAN and Proxy MIP broadcast domains. If Proxy MIP MNs are not receiving broadcast messages, then a single Proxy MIP broadcast domain can be used to group all Proxy MNs on foreign subnets that share the same 802.11 broadcast encryption suite. IP multicast packets must be copied and transmitted into a Proxy MIP broadcast domain, as required. Note that it is not necessary to segregate standard MIP MNs into such broadcast domains.]

- IP Address Registration.

[0883] The IP address of each MN, AP, and CM interface is optionally registered with the CCM as soon as it is discovered. IP/802 address pairs are distributed in Registration Reply messages to each AP and CM on the path to a node. The IP/802 address bindings are used to facilitate automatic ARP filtering (see below).

- Context Records.

[0884] Each WLCCP CM caches context and configuration information for each node in its domain. In this document, a "Context Record" contains context and configuration information that is transferred when a station roams from an old AP to a new AP. A "context manager", in each AP or CM, manages Context Records. A Context Record is transferred as an opaque object in WLCCP Registration and Context messages. [Currently, a Context Record only contains RADIUS configuration information.]

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- Lateral Context Transfer.

[0885] A Context message can be used to forward a MN's dynamic context "laterally" from a node on the "old" branch to a node on the "new" branch (e.g. from an old SCM to a new SCM) when the MN roams. The nearest common ancestor CM automatically facilitates lateral context transfer by forwarding the MN's old and new bindings in Registration Reply and Deregistration Request messages, respectively. For example, an SCM can forward the address of the "old AP" to the "new AP" in a Registration Reply message. The nearest common ancestor CM functions as a trusted third party, for lateral message authentication, as described in the section entitled "WLCCP Message Authentication".

[0886] Context information can be transferred laterally in either a Context Request or Reply message. For example, an old AP can asynchronously forward context information to a new AP in a Request message. As a second example, a new SCM can send a Context Request to an old SCM to "request" context information. The old SCM returns the request context information in the corresponding Context Reply message.

- Dynamic ARP Filtering.

[0887] The IP address of each node in the sub tree rooted at a "root AP" is registered with the SWAN infrastructure. The IP address of a MN is transferred to the new parent AP each time the MN roams. If "ARP Translation" is enabled, then an AP must filter broadcast ARP requests that are transmitted on 802.11 secondary ports. An ARP request is discarded if the target IP address does not belong to a node in its sub tree; otherwise, if the target IP address belongs to a node in the sub tree, the broadcast destination MAC address is translated to the node's unicast MAC address. The resulting unicast frame is then forwarded as any other unicast frame.

- RADIUS Accounting.

[0888] A RADIUS accounting client in an LCM maintains a single RADIUS accounting session for each MN. A parent AP periodically forwards accounting statistics inbound in a WLTV_ACCOUNTING TLV contained in a WLCCP Context Request message. The WLCCP registration protocol is used to transfer the accounting session when a MN roams. Any "residual" accounting statistics are forwarded inbound in Deregistration Reply and Detach Request messages, when a MN roams or becomes disconnected. If a MN roams to a "new" Local Control Domain then either a) a new accounting session must be started at the new LCM, or b) the accounting session must be transferred from the old LCM to the new LCM via lateral context transfer.

MN Support for WLCCP

[0889] MNs do not directly participate in WLCCP. Instead, MNs can support WLCCP 802.11 elements that convey subnet and path cost information. The elements facilitate the following:

A MN can select a parent AP that provides the least-cost path to the primary LAN on the MN's home subnet.

- A MN can quickly determine when it has roamed to a different subnet.
- A standard Mobile IP MN can quickly discover a MIP Foreign Agent.
- A MN can reliably register its IP address.
- A MN can reliably register its enabled multicast addresses.

[0890] 802.11 elements that are used to convey WLCCP information are defined in the section entitled "*WLCCP 802.11 Elements*".

[0891] The foregoing description of a preferred embodiment of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Obvious modifications or variations are possible in light of the above teachings. The embodiment was chosen and described to provide the best illustration of the principles of the invention and its practical application to thereby enable one of the ordinary skill in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the invention as determined by the appended claims when interpreted in accordance to the breadth to which they are fairly, legally and equitably entitled.

[0892] Embodiments of the systems and methods described herein are further set out in the following numbered clauses:

1. A method for establishing a secure association for a mobile node with a network, the steps comprising:

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associating with an access point;
authenticating the mobile node using an extensible authentication protocol by the access point;
establishing a network session key; and
registering the mobile node into the network infrastructure

wherein the network session key is used to establish a key request key and a base transient key;
wherein the base transient key is used as a counter mode key generator to provide fresh Pairwise transient keys;
wherein the key request key is used by the mobile node to prove it has proper authorization for a session
wherein the roaming involves a compressed set of message exchanges to prove possession of a fresh transient key as well as delivery of the group transient key.

2. The method of clause 1 further comprising sending the network session key to a Subnet Context Manager.

3. The method of clause 1 wherein the extensible authentication protocol is 802.1X compliant.

4. The method of clause 1 further comprising authenticating key refreshes using the key request key.

5. The method of clause 4 further comprising deriving a pairwise transient keys using the base transient key.

6. The method of clause 1 further comprising delivering the group transient key in the reassociation request to compress and optimize messages.

7. The method of clause 1 further comprising computing a Key Request Key and a Base Transient Key from the network session key using a pseudo random function.

8. The method of clause 1 further comprising sending a re-association request, the reassociation request comprising a rekey request number and an authenticated element.

9. The method of clause 8 further comprising verifying the rekey request number of the reassociation request is greater than a previous rekey request number.

10. The method of clause 8 wherein the re-association request further comprises replay protection.

11. The method of clause 10 wherein the replay protection comprises a timestamp.

12. The method of clause 10 wherein the replay protection comprises a random challenge.

13. The method of clause 8 wherein the authenticated element authenticates the security policy defined by the mobile node

14. A mobile node, comprising:

means for associating with an access point;
means for authenticating the mobile node using an extensible authentication protocol by the access point;
means for establishing a network session key; and
means for registering the mobile node into the network infrastructure

wherein the network session key is used to establish a key request key and a base transient key;
wherein the base transient key is used as a counter mode key generator to provide fresh Pairwise transient keys;
wherein the key request key is used by the mobile node to prove it has proper authorization for a session
wherein the roaming involves a compressed set of message exchanges to prove possession of a fresh transient key as well as delivery of the group transient key

15. The mobile node of clause 14 further comprising means for sending the network session key to a Subnet Context Manager.

16. The mobile node of clause 14 wherein the extensible authentication protocol is 802.1X compliant.

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17. The mobile node of clause 14 further comprising means for authenticating key refreshes using the key request key.

18. The mobile node of clause 17 further comprising means for deriving a pairwise transient keys using the base transient key.

19. The mobile node of clause 14 further comprising means for delivering the group transient key in the re-association request to compress and optimize messages.

20. The mobile node of clause 14 further comprising means for computing a Key Request Key and a Base Transient Key from the network session key using a pseudo random function.

21. The mobile node of clause 14 further comprising means for sending a reassociation request, the re-association request comprising a rekey request number and an authenticated element.

22. The mobile node of clause 21 further means for comprising verifying the rekey request number of the re-association request is greater than a previous rekey request number.

23. The mobile node of clause 21 wherein the means for re-association request further comprises means for replay protection.

24. The mobile node of clause 23 wherein the means for replay protection comprises means for using a timestamp.

25. The mobile node of clause 23 wherein the means for replay protection comprises means for a random challenge.

26. The mobile node of clause 21 wherein the authenticated element authenticates the security policy defined by the mobile node

27. A computer program product having a computer readable medium having computer program logic recorded thereon for establishing a secure association for a mobile node with a network, comprising
means for associating with an access point;
means for authenticating the computer readable instructions using an extensible authentication protocol by the access point;
means for establishing a network session key; and
means for registering the computer readable instructions into the network infrastructure
wherein the network session key is used to establish a key request key and a base transient key;
wherein the base transient key is used as a counter mode key generator to provide fresh Pairwise transient keys;
wherein the key request key is used by the computer readable instructions to prove it has proper authorization for a session
wherein the roaming involves a compressed set of message exchanges to prove possession of a fresh transient key as well as delivery of the group transient key

28. The computer program product of clause 27 further comprising means for sending the network session key to a Subnet Context Manager.

29. The computer program product of clause 27 wherein the extensible authentication protocol is 802.1X compliant.

30. The computer program product of clause 27 further comprising means for authenticating key refreshes using the key request key.

31. The computer program product of clause 30 further comprising means for deriving a pairwise transient keys using the base transient key.

32. The computer program product of clause 27 further comprising means for delivering the group transient key in the re-association request to compress and optimize messages.

33. The computer program product of clause 27 further comprising means for computing a Key Request Key and a Base Transient Key from the network session key using a pseudo random function.

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34. The computer program product of clause 27 further comprising means for sending a reassociation request, the re-association request comprising a rekey request number and an authenticated element.

35. The computer program product of clause 34 further means for comprising verifying the rekey request number of the re-association request is greater than a previous rekey request number.

36. The computer program product of clause 34 wherein the means for reassociation request further comprises means for replay protection.

37. The computer program product of clause 36 wherein the means for replay protection comprises means for using a timestamp.

38. The computer program product of clause 36 wherein the means for replay protection comprises means for a random challenge.

39. The computer program product of clause 34 wherein the authenticated element authenticates the security policy defined by the computer program product

40. A method of re-association by a mobile node, the steps comprising:

sending a re-association request from a mobile node to an access point, the re-association request comprising a mobile node identification, a rekey request number, and an authentication element;
validating the current security association to the network by use of the key request key; ensuring a fresh transient key is used to secure the 802.11 link by using an incremental
rekey request number;
sending a response, the response comprising an authentication element, to the mobile node, the authentication element comprising delivery of the group transient key, and proof of possession of a Pairwise transient key by using the key to authenticate the element;
using an extensible authentication protocol over local area network key; and
confirming the response by verifying the new pairwise transit key to a second computed pairwise transit key.

41. The method of clause 40 further comprising validating the response by verifying the new pairwise transient key.

42. The method of clause 41, the validating the response step further comprises verifying a timestamp included in the response.

43. The method of clause 40 wherein the authentication element uses a current fresh pairwise transient key.

44. The method of clause 40 wherein the validating step is performed by one of the group consisting of a subnet context manager, and the access server.

45. The method of clause 40 wherein the validation request comprises verifying a timestamp of the re-association request is within a configurable value.

46. The method of clause 40, the validation step further comprises verifying the sequence number is greater than a previous value.

47. The method of clause 40, the validating step comprises sending to a query to a subnet context manager to validate the re-association request.

48. The method of clause 47 further comprising receiving a the mobile node session timeout and a base transient key from the subnet context manager.

49. The method of clause 48 further comprising generating pairwise transient key, the sending step further comprising:

authenticating the rekey number and the base transient key, forming an authenticated reply; and
sending the encrypted reply.

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50. A rekey sequence, the steps comprising:

computing an authentication element, the authentication element comprising a rekey request number and a new pair transient key
transmitting to a responder a call for a new pairwise transient key and alerting the responder that the requestor is ready to receive and transmit using the new Pairwise transient key; receiving an response authentication element from the responder; and
verifying the response authentication element, the response authentication element comprising the new pair transient key and receipt of the group transient key

51. The rekey sequence of clause 50 further comprising sending an extensible authentication protocol over local area network key confirm message.

52. The rekey sequence of clause 52 further comprising incrementing the rekey request number prior to computing the authentication element.

53. An apparatus for initiating and performing a rekey sequence, comprising:

means for computing an authentication element, the authentication element comprising a rekey request number and a new pair transient key
means for transmitting to a responder a call for a new pairwise transient key and alerting the responder that the requestor is ready to receive and transmit using the new Pairwise transient key;
means for receiving an response authentication element from the responder; and
means for verifying the response authentication element, the response authentication element comprising the new pair transient key and receipt of the group transient key

54. The apparatus of clause 53 further comprising means for sending an extensible authentication protocol over local area network key confirm message.

55. The apparatus of clause 54 further comprising means for incrementing the rekey request number prior to computing the authentication element.

56. A computer program product having a computer readable medium having computer program logic recorded thereon for initiating and performing a rekey sequence, comprising:

means for computing an authentication element, the authentication element comprising a rekey request number and a new pair transient key
means for transmitting to a responder a call for a new pairwise transient key and alerting the responder that the requestor is ready to receive and transmit using the new Pairwise transient key;
means for receiving an response authentication element from the responder; and
means for verifying the response authentication element, the response authentication element comprising the new pair transient key and receipt of the group transient key

57. The computer program product of clause 56 further comprising means for sending an extensible authentication protocol over local area network key confirm message.

58. The computer program product of clause 57 further comprising means for incrementing the rekey request number prior to computing the authentication element.

59. A rekey sequence, the steps comprising:

receiving a rekey request, the rekey request comprising a rekey request number and an authentication element that includes delivery of the group transient key;
computing a new pair transient key; and
sending a ready to transmit and receive with the new pair transient key message.

60. The rekey sequence of clause 59 further comprising receiving an extensible authentication protocol over local area network key confirm message.

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61. The rekey sequence of clause 59 further comprising verifying the rekey request number is greater than a cached rekey request number.

62. The rekey sequence of clause 59 further comprising verifying all attributes of an extensible authentication protocol over local area network key request.

63. The rekey sequence of clause 59 further comprising updating a cached rekey request number.

64. The rekey sequence of clause 59 wherein the authentication element comprises a new initiator pair transient key, the steps further comprising comparing the new pair transient key with the new initiator pair transient key.

65. The rekey sequence of clause 59 wherein the authentication element comprises a key wrapped group transient key.

66. An apparatus for responding to a rekey sequence, comprising:

means for receiving a rekey request, rekey request comprising a rekey request number and an authentication element that includes delivery of the group transient key;
means for computing a new pair transient key; and
means for sending a ready to transmit and receive with the new pair transient key message.

67. The apparatus of clause 66 further comprising means for receiving an extensible authentication protocol over local area network key confirm message.

68. The apparatus of clause 66 further comprising means for verifying the rekey request number is greater than a cached rekey request number.

69. The apparatus sequence of clause 66 further comprising means for verifying all attributes of an extensible authentication protocol over local area network key request.

70. The apparatus of clause 66 further comprising means for updating a cached rekey request number.

71. The apparatus of clause 66 wherein the authentication element comprises a new initiator pair transient key, the steps further comprising comparing the new pair transient key with the new initiator pair transient key.

72. The apparatus of clause 66 wherein the authentication element comprises a key wrapped group transient key.

73. A computer program product having a computer readable medium having computer program logic recorded thereon for responding to a rekey sequence, comprising:

means for receiving a rekey request, rekey request comprising a rekey request number and an authentication element that includes delivery of the group transient key;
means for computing a new pair transient key; and
means for sending a ready to transmit and receive with the new pair transient key message.

74. The computer program product of clause 73 further comprising means for receiving an extensible authentication protocol over local area network key confirm message.

75. The computer program product of clause 73 further comprising means for verifying the rekey request number is greater than a cached rekey request number.

76. The computer program product sequence of clause 73 further comprising means for verifying all attributes of an extensible authentication protocol over local area network key request.

77. The computer program product of clause 73 further comprising means for updating a cached rekey request number.

78. The computer program product of clause 73 wherein the authentication element comprises a new initiator pair

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transient key, the steps further comprising comparing the new pair transient key with the new initiator pair transient key.

79. The computer program product of clause 73 wherein the authentication element comprises a key wrapped group transient key.

80. An infrastructure node in a hierarchical wireless network, comprising:

the infrastructure node configured to establish a unique context transfer key for communicating with each ancestor node in the same branch of the hierarchical network as the infrastructure node;

wherein the infrastructure node is directly coupled to not more than one ancestor node.

81. An infrastructure node according to clause 80, further comprising the infrastructure node configured to establish a unique context transfer key for communicating with each descendant node coupled to the infrastructure node;

82. An infrastructure node according to clause 81, further comprising:

the infrastructure node configured to store a path identification indicative of a path instance for a descendent node.

83. An infrastructure node according to clause 82, the path identification further comprising a layer 2 forwarding path.

84. An infrastructure node according to clause 82, wherein the infrastructure node is the top node of a subnet tree, the infrastructure node is further configured to cache context information for a mobile node attached to a descendant node of the subnet tree.

85. An infrastructure node according to clause 84, further comprising:

the infrastructure node responsive to receive a new path identification for a descendent node;
the infrastructure node responsive to receiving the new path identification for the descendent node to send a deregistration request to a former ancestor node of the descendant node; and
the infrastructure node further responsive to update the path identification stored at the infrastructure node with the new path identification.

86. An infrastructure node according to clause 85, further comprising the infrastructure node responsive to send the new path information to the ancestor node coupled to the infrastructure node.

87. An infrastructure node according to clause 84, further comprising the infrastructure node configured to ascertain a time stamp for a path update message for the descendant node and to discard the path update message responsive to the time stamp being older than a timestamp for a currently stored path identification for the descendant node.

88. An infrastructure node according to clause 82, wherein the infrastructure node is the nearest common ancestor context manager for an old parent node and a new parent node, further comprising:

the infrastructure node responsive to receiving a message from a descendant node that the descendant node has roamed from the old parent node to the new parent node to update the path instance for the descendant node to the new parent node;
the infrastructure node further responsive to receiving the message from the descendant node that the descendant node has roamed to send a message to de-register the old parent node from the path instance; and
the infrastructure node further responsive to sending a registration message to the new parent node to register the descendant node with the new parent.

89. An infrastructure node according to clause 81, wherein the infrastructure node is a nearest common ancestor for an old parent node and a new parent node for a roaming descendant node, further comprising:

the infrastructure node configured for receiving a registration message from the new parent node;
the infrastructure node responsive to the registration message to send a deregistration request message and a lateral context transfer key to the old parent node.

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90. An infrastructure node according to clause 81, further comprising the infrastructure node responsive to receiving a deregistration request and a lateral context transfer key from a common ancestor node with a new parent node to forward context information to the new parent node using the lateral context transfer key to encrypt the message.

91. An infrastructure node according to clause 90, wherein the context information comprises a base transient key for the roaming descendant node.

92. An infrastructure node according to clause 81, further comprising the infrastructure node responsive to receiving context information for a roaming descendant node from an old parent node of the roaming descendant to extract a lateral context transfer key using a context transfer key the infrastructure node has established with a common ancestor node to the old parent node.

93. An infrastructure node according to clause 92, further comprising the infrastructure node responsive to extracting the lateral context transfer key to decrypting context information using the lateral context transfer key.

94. An infrastructure node according to clause 93, further comprising the infrastructure node responsive to identify the roaming descendant node by a media access control address, basic service set identifier, rekey number, and message integrity check provided by the roaming descendant node.

95. An infrastructure node according to clause 92, wherein the context information comprises a base transient key for the roaming descendant node.

96. An infrastructure node according to clause 81, further comprising the infrastructure node responsive to discard bindings for a mobile node after the mobile node becomes inactive.

97. An infrastructure node according to clause 81, further comprising:

the infrastructure node configured to authenticate with an infrastructure authenticator; and
the infrastructure node responsive to receive from the infrastructure authenticator the unique context transfer key for communicating with each ancestor node.

98. An infrastructure node according to clause 97, further comprising the infrastructure node responsive to receive from the infrastructure authenticator context transfer keys for each ancestor node to decrypt the context transfer keys using a context transfer key established between the infrastructure node and the infrastructure authenticator.

99. An infrastructure node according to clause 81, further comprising:

the infrastructure node configured to authenticate with an infrastructure authenticator; and
the infrastructure node responsive to receive from the infrastructure authenticator a context transfer key for a descendant node.

100. An infrastructure node according to clause 98, further comprising the infrastructure node responsive to receive from the infrastructure authenticator the context transfer key the descendant node to decrypt the context transfer key using a context transfer key established between the infrastructure node and the infrastructure authenticator.

101. A method for providing secure wireless network communications in a hierarchical wireless network, comprising:

authenticating an infrastructure node with an infrastructure authenticator;
establishing a context transfer key between the infrastructure node and the infrastructure authenticator; and
establishing a context transfer key with an ancestor node on a path from the infrastructure node and the infrastructure authenticator.

102. A method according to clause 101, wherein the infrastructure node is directly coupled to not more than one ancestor node.

103. A method according to clause 101, wherein the infrastructure node is an originator for a context request to a responder node that is not an ancestor node of the infrastructure, further comprising:

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determining a common ancestor node between the originator and the responder;
receiving from the common ancestor node a lateral context transfer key for the responder; generating a message integrity check using the lateral context transfer key; and
sending a context request to the responder, wherein the context request comprises the message integrity check.

104. A method according to clause 103, wherein the context request further comprises a node identifier of the common ancestor node.

105. A method according to clause 103, further comprises:

receiving a ticket from the common ancestor node that contains the lateral context transfer key;

wherein the context request further comprises the ticket.

106. A method according to clause 105, wherein the ticket is encrypted with a context transfer key established between the originator and the common ancestor node.

107. A method according to clause 101, wherein the infrastructure node is a responder for a context request from an originator that is not an ancestor node of the responder, further comprising:

receiving a context request message from the originator node;
extracting a lateral context key from the context request message using a context transfer key the responder established with the common ancestor node; and
authenticating the message with the lateral context request key.

108. A method according to clause 107, further comprising sending a reply to the context request message, the reply authenticated using the context transfer key the responder established with the common ancestor node.

109. A method according to clause 101, wherein the infrastructure node has a plurality of descendant nodes, each node at a different hierarchical level along a path instance, further comprising:

sending a deregistration request for a deregistering descendant node of the plurality of descendent nodes along the path instance;
the deregistering descendant node being responsive to deleting the path instance for the deregistering descendant node;
the deregistering descendant node being further responsive to sending a deregistration reply back to the infrastructure node; and
each node of the plurality of descendant nodes in the path instance between the infrastructure node and the deregistering descendant node responsive to deleting the path instance for the deregistering descendant node.

110. A method for a new access point coupled to a hierarchical wireless local area network to establish a session with a mobile node roaming from an old access point to the new access point, wherein the old access point and the new access point are not on the same branch of the hierarchical network, comprising:

receiving a message from the mobile node indicative of the mobile node roaming to the new access point;
determining a common ancestor node between the new access point and the old access point;
routing a registration request from the new access point to the common ancestor; and
receiving a registration reply from the common ancestor to the new access point.

111. A method according to clause 110, wherein there is at least one other context manager on a path between the new access point and the common ancestor node, the method further comprising establishing bindings with the at least one other context manager on the path between the new access point and the common ancestor node.

112. A method according to clause 110, further comprising:

determining an IP address for the mobile node;
determining whether the IP address belongs to a current subnet of the mobile node; and
sending an update registration request containing the IP address of the mobile node to dynamically assign the

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mobile node to a home subnet corresponding to the IP address of the mobile node.

113. A method according to clause 112, further comprising verifying the mobile node is permitted to access the home subnet corresponding to the IP address of the mobile node.

114. A method according to clause 113, further comprising receiving home subnet bindings from a root node of the hierarchical network responsive to the mobile node being authorized for the home subnet corresponding to the IP address of the mobile node.

115. A method according to clause 111, further comprising routing a deregistration request to the old access point.

116. A method according to clause 111, further comprising:

receiving a context message for the mobile node;
determining a timestamp for the context message;
discarding the message responsive to the timestamp for the context message being earlier than a timestamp for a current context for the mobile node; and
updating the context for the mobile node based on the context message responsive to the timestamp for the context message being later than the timestamp for the current context of the mobile node.

Claims

1. A method for reassociation of a mobile node (2412) associated with an access point (2408) coupled to a network, the method comprising:

computing a new pairwise transient key based on a pairwise transient key and a rekey request number derived from a previous association;
sending a reassociation request (2552), the reassociation request comprises a mobile node identification, the rekey request number and an authentication element;
receiving a reassociation response (2556), the reassociation response comprises a response authentication element that comprises proof of possession of a group transient key and the new pairwise transient key; and
confirming the reassociation response by verifying the new pairwise transit key received in the reassociation response matches the computed new pairwise transient key.

2. The method of claim 1 wherein the re-association request is sent from the mobile node (2412) to a second access point (2410), the method further comprising:

validating the current security association to the network (2554) by use of the key request key;
ensuring a fresh transient key is used to secure the 802.11 link by using an incremental rekey request number;
sending the resassociation response (2556), to the mobile node, the authentication element comprising delivery of the group transient key, wherein the proof of possession is effected by using the new pairwise transient key to authenticate the element; and
using an extensible authentication protocol over local area network key.

3. The method of claim 1 or 2, wherein confirming the reassociation response further comprises verifying a timestamp included in the reassociation response.

4. The method of any preceding claim, wherein the response authentication element comprises the new computed pairwise transient key.

5. The method of any preceding claim, wherein confirming the reassociation response further comprises verifying the rekey request number is greater than a previous value.

6. The method of any preceding claim, further comprising computing the authentication element, based on the rekey request number and the new computed pairwise transient key.

7. The method of any preceding claim, further comprising performing a fast reauthentication (2560) using the new

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pairwise transient key.

8. The method of claim 6, further comprising incrementing the rekey request number prior to computing the authentication element.

9. The method of any preceding claim, wherein the reassociation response further comprises a basic service set identifier.

10. The method of any preceding claim, further comprising generating a cryptographic checksum comprising the authentication element with a key request key derived during a previous initial association.

11. The method of any preceding claim, wherein the reassociation request is sent to an unassociated access point to initiate a roam to the access point.

12. An apparatus comprising a mobile node (2412) associated with an access point (2408) coupled to a network, the apparatus comprising:

means for computing a new pairwise transient key based on a pairwise transient key and a rekey request number derived from a previous association;
means for sending a reassociation request (2552), the reassociation request comprising a mobile node identification, the rekey request number and an authentication element;
means for receiving a reassociation response (2556), the reassociation response comprising a response authentication element that comprises proof of possession of a group transient key and the new pairwise transient key; and
means for confirming the reassociation response by verifying the new pairwise transit key received in the reassociation response matches the computed new pairwise transient key.

13. The apparatus according to claim 12 wherein:

the mobile node (2412) is configured to initiate a roam to a second access point (2410) coupled to the network; and the mobile node is responsive to confirming the reassociation response to begin secure communication with the network through the second access point.

14. The apparatus according to claim 12 or 13, wherein the mobile node further comprising means for validating a timestamp included in the reassociation response.

15. The apparatus according to any of claims 12 to 14, further comprising means for computing the authentication element based on the rekey request number and the new computed pairwise transient key.

16. The apparatus according to any of claims 12 to 15, further comprising means for performing a fast reauthentication (2560) with the second access point using the new pairwise transient key responsive to confirming the reassociation response.

17. The apparatus according to claim 15, further comprising means for incrementing the rekey request number prior to computing the authentication element.

18. The apparatus according to any of claims 12 to 17, further comprising means for incrementing the rekey request number prior to computing the new pairwise transient key.

19. The apparatus according to any of claims 12 to 18, wherein the reassociation request further comprises the basic service set identifier for the second access point.

20. The apparatus according to any of claims 12 to 19, further comprising means for generating a cryptographic checksum comprising the authentication element from a key request key derived during a previous initial authentication.

21. The apparatus according to any of claims 12 to 20, further comprising means for acquiring the groupwise transient key by decrypting the reassociation response using the new pairwise transient key.

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22. A computer program or computer program product comprising instructions for carrying out a method according to any of Claims 1 to 11.

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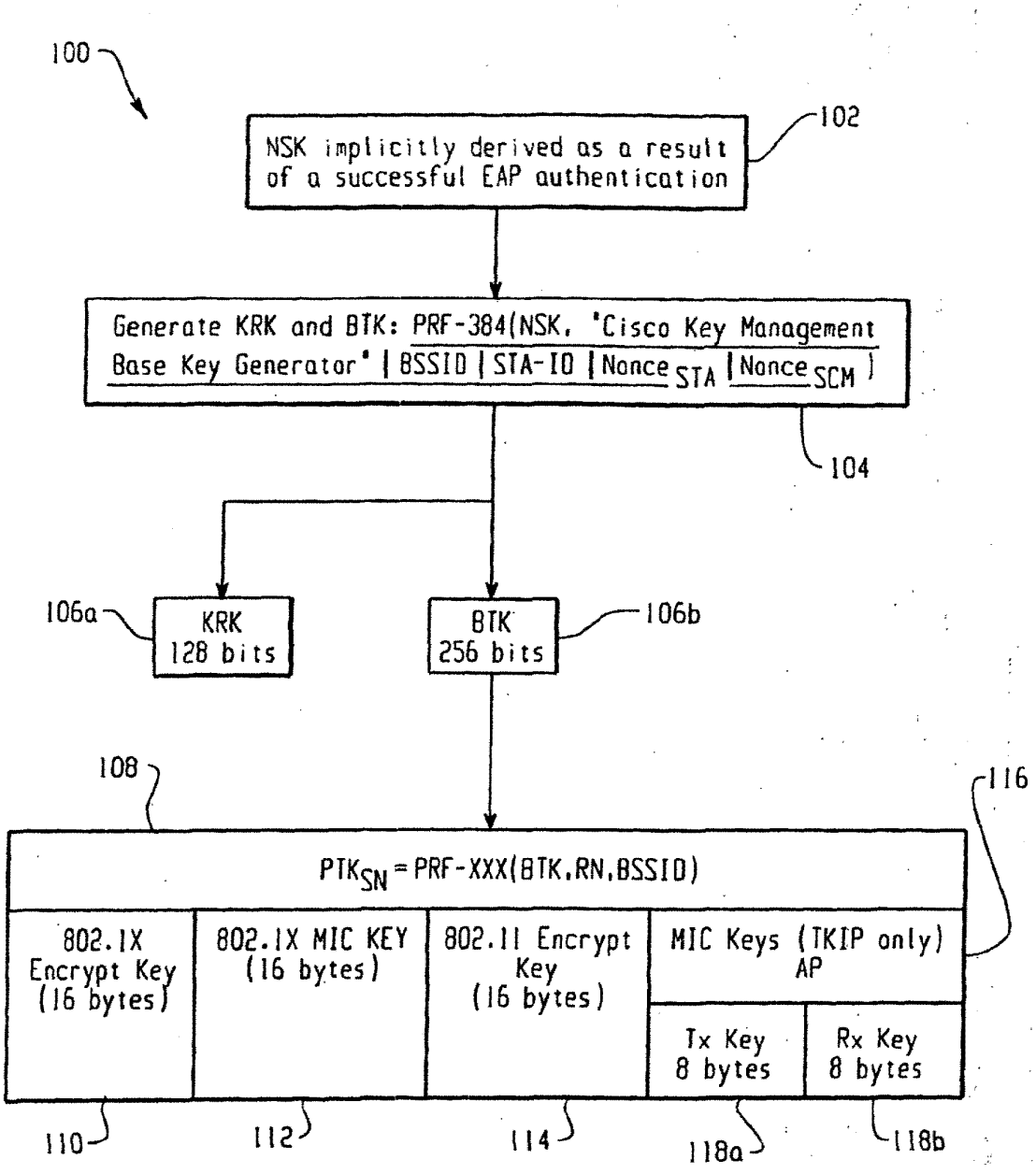


Fig. 1

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202 802.1X Authentication Type	204 NSK computation	206 NSK length (in bytes)	208 SCM Acquisition
LEAP	Mutually derived by MN and AS	16	Radius attribute: MS-MPPE single-key
PEAP	Mutually derived by MN and AS	32	Radius attribute: MS-MPPE Recv-key (ignore Send-key)
EAP-TLS	Mutually derived by MN and AS	32	Radius attribute: MS-MPPE Recv-Key (ignore Send-key)
EAP-MD5	None	5,13 OR 16	Static configuration

Fig. 2

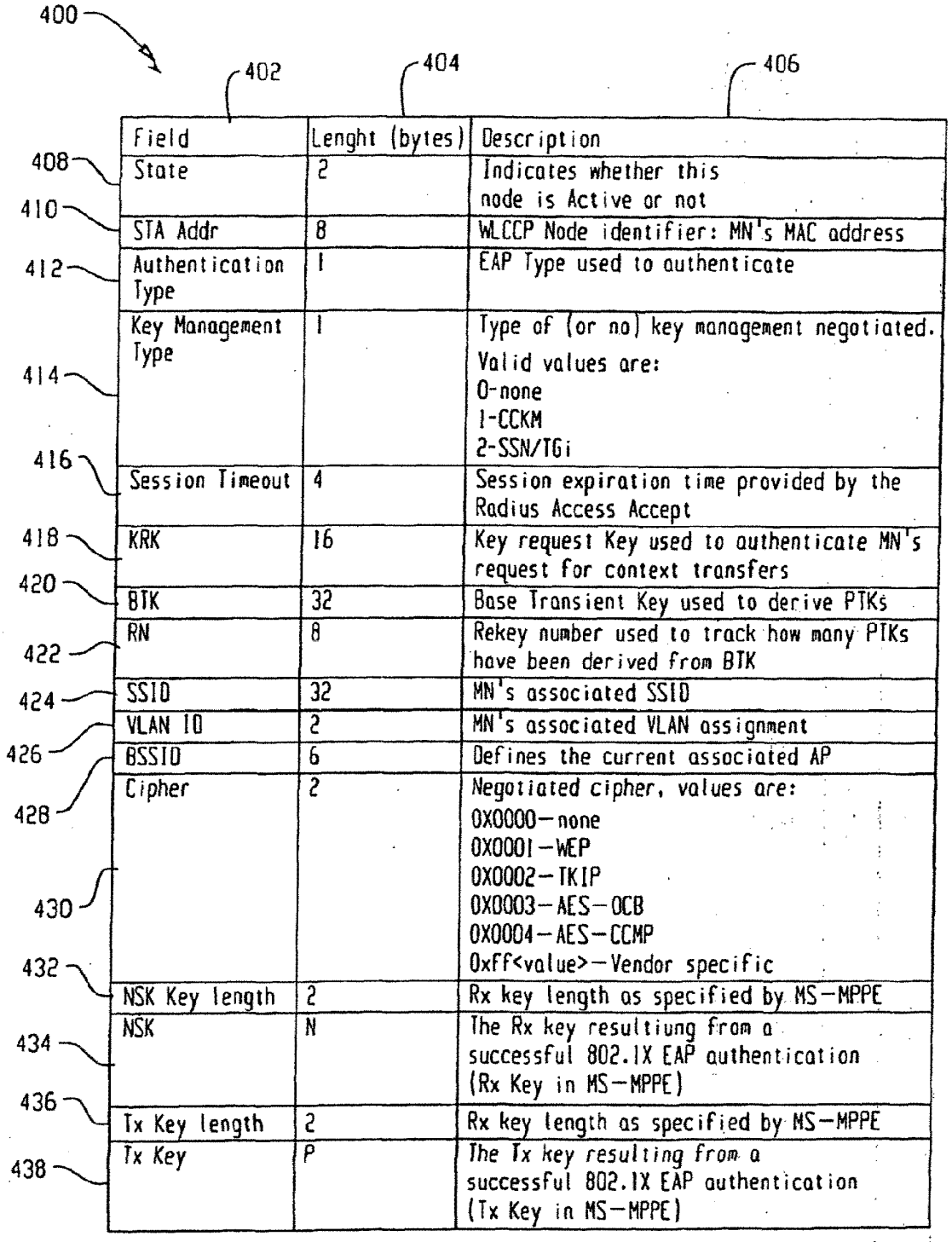


302 OUI	304 Type	306 Meaning
00:50:F2	0	No Authenticated Key Management
00:50:F2	1	Authenticated Key Management using unspecified authentication over 802.1X: default for SSN
00:50:F2	2	Authenticated Key Management using pre-shared Key over 802.1X
00:50:F2	3-255	Reserved
00:40:96	Agreed value	CCKM**
Other	Any	Vendor Specific

Fig. 3

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Field	Lenght (bytes)	Description
State	2	Indicates whether this node is Active or not
STA Addr	8	WLCCP Node identifier: MN's MAC address
Authentication Type	1	EAP Type used to authenticate
Key Management Type	1	Type of (or no) key management negotiated. Valid values are: 0-none 1-CCKM 2-SSN/TGi
Session Timeout	4	Session expiration time provided by the Radius Access Accept
KRK	16	Key request Key used to authenticate MN's request for context transfers
BTK	32	Base Transient Key used to derive PTKs
RN	8	Rekey number used to track how many PTKs have been derived from BTK
SSID	32	MN's associated SSID
VLAN ID	2	MN's associated VLAN assignment
BSSID	6	Defines the current associated AP
Cipher	2	Negotiated cipher, values are: 0X0000—none 0X0001—WEP 0X0002—TKIP 0X0003—AES—OCB 0X0004—AES—CCMP 0xff<value>—Vendor specific
NSK Key length	2	Rx key length as specified by MS—MPPE
NSK	N	The Rx key resultiung from a successful 802.1X EAP authentication (Rx Key in MS—MPPE)
Tx Key length	2	Rx key length as specified by MS—MPPE
Tx Key	P	The Tx key resulting from a successful 802.1X EAP authentication (Tx Key in MS—MPPE)

Fig. 4

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	502 Field	504 Lenght (bytes)	506 Description
508	State	1	Indicates whether this node is Active or not.
510	Node—ID	8	WLCCP Node identifier: AP's MAC Address (e.g.BSSID)
512	NSK	16	The key resulting from a successful LEAP authentication.
514	Session Timeout	4	Session expiration time provided by the Radius Access Accept
516	CTK	32	The current context transfer key used to protect communications between the SCM Authenticator and the Node—ID
518	Key Sequence Counter	4	A sequence counter used to track how many CTK key refreshes have occured

Fig. 5

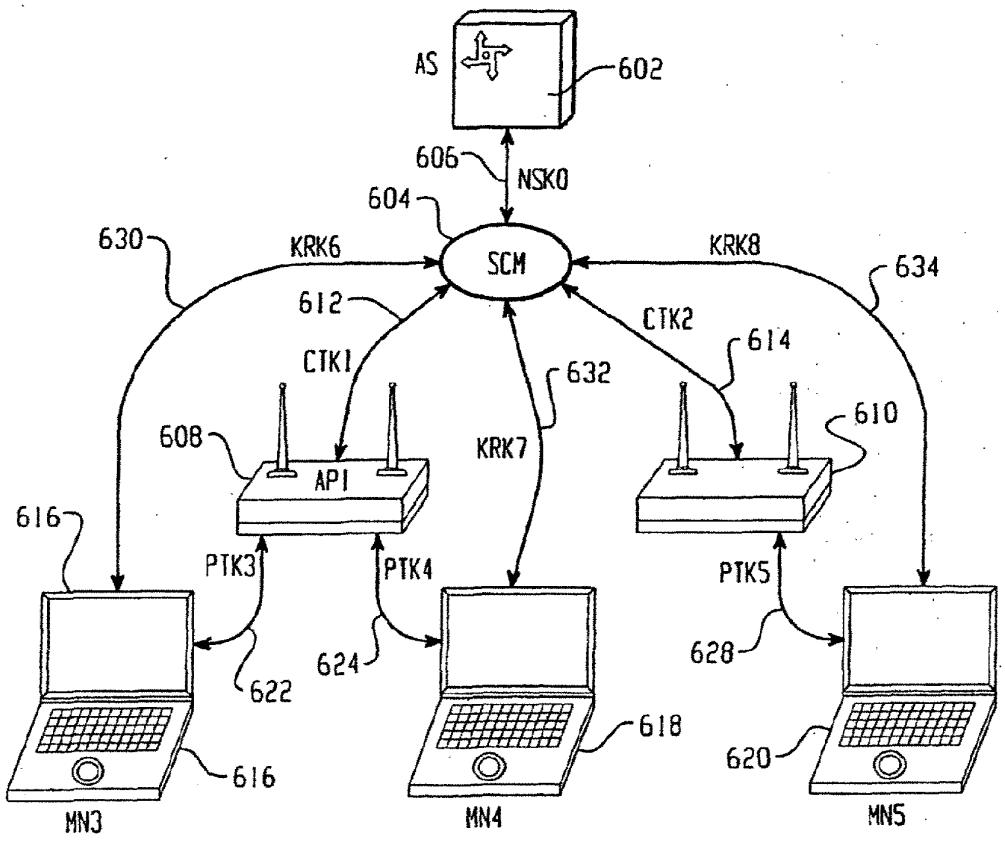
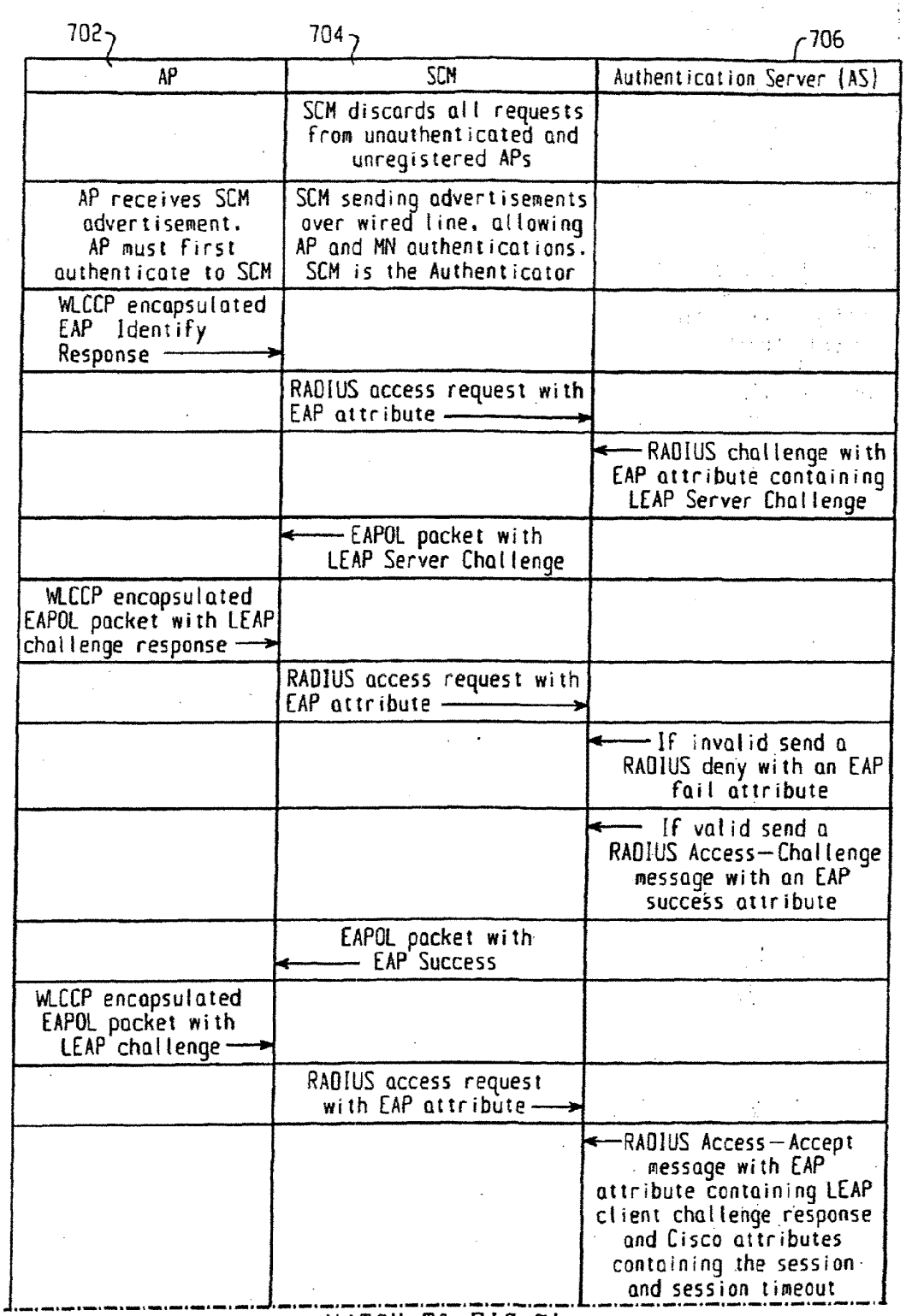


Fig. 6

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MATCH TO FIG. 7b

Fig. 7a

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MATCH TO FIG.7a

	SCM caches NSK and session timeout	
	←EAPOL packet with LEAP client challenge response	
AP installs keys		
WLCCP(Path Init, provide $Nonce_{AP}$) →		
	← If Path Init fails, respond with a non-zero status	
	←If Path Init succeeds, generate $Nonce_{SCM}$ and derive CTK, set KSC = 1 send WLCCP (path Init Reply, $Nonce_{SCM}$, MIC_{CTK})	
Obtain $Nonce_{SCM}$ and derive CTK.		
If MIC_{CTK} fails, confirm with a non-zero status →		
If MIC_{CTK} succeeds, set KSC = 1, send WLCCP (Path Init Confirm, MIC_{CTK})		
AP can now protect communications with SCM *using delivered* CTK, request MN MN context transfers and register MNs		
WLCCP (Registration Request) →		
	←If Registration fails, respond with a non-zero status	
	←If Registration succeeds send WLCCP (Pre-Registration Response, status = 0)	

Fig. 7b

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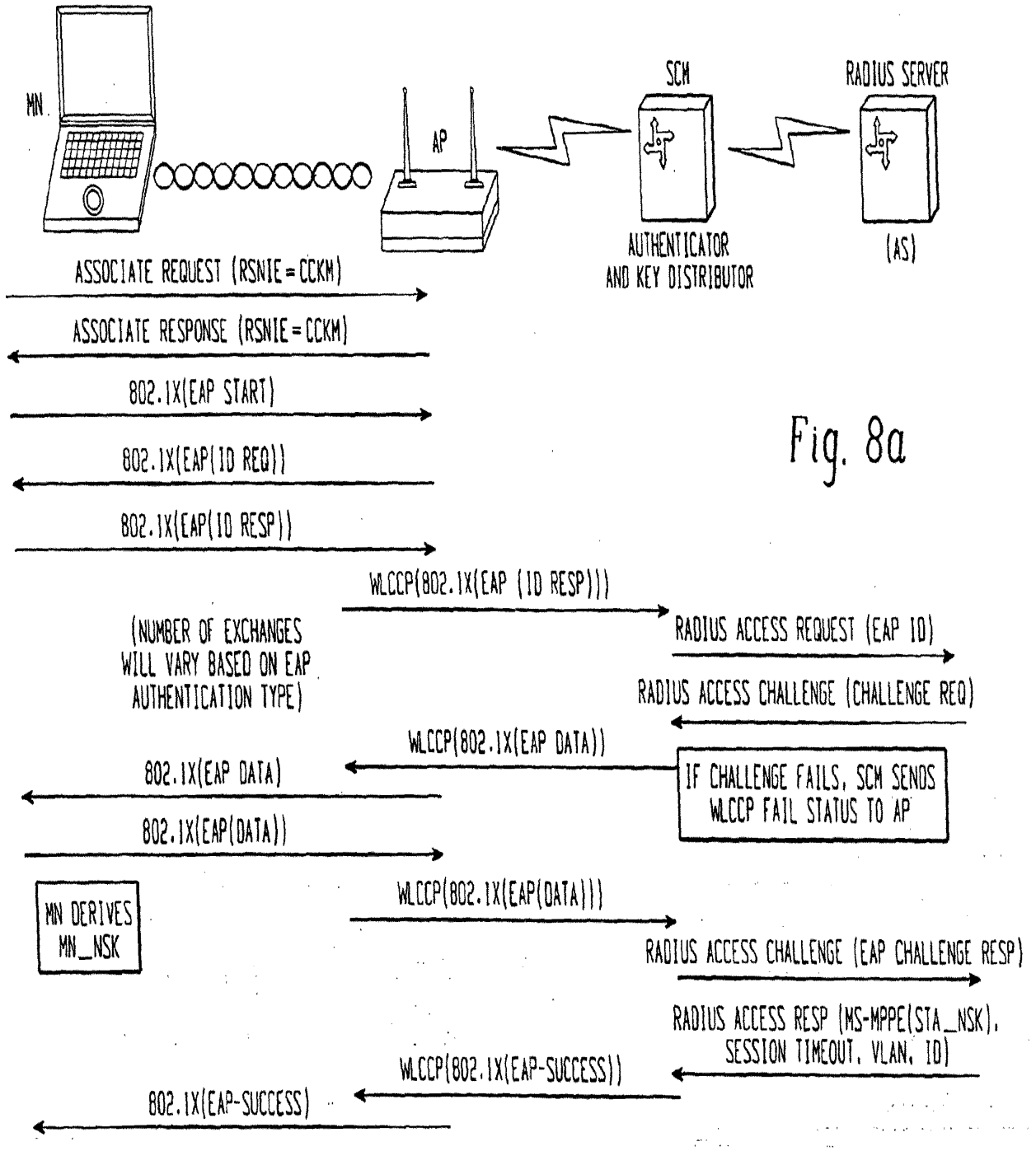


Fig. 8a

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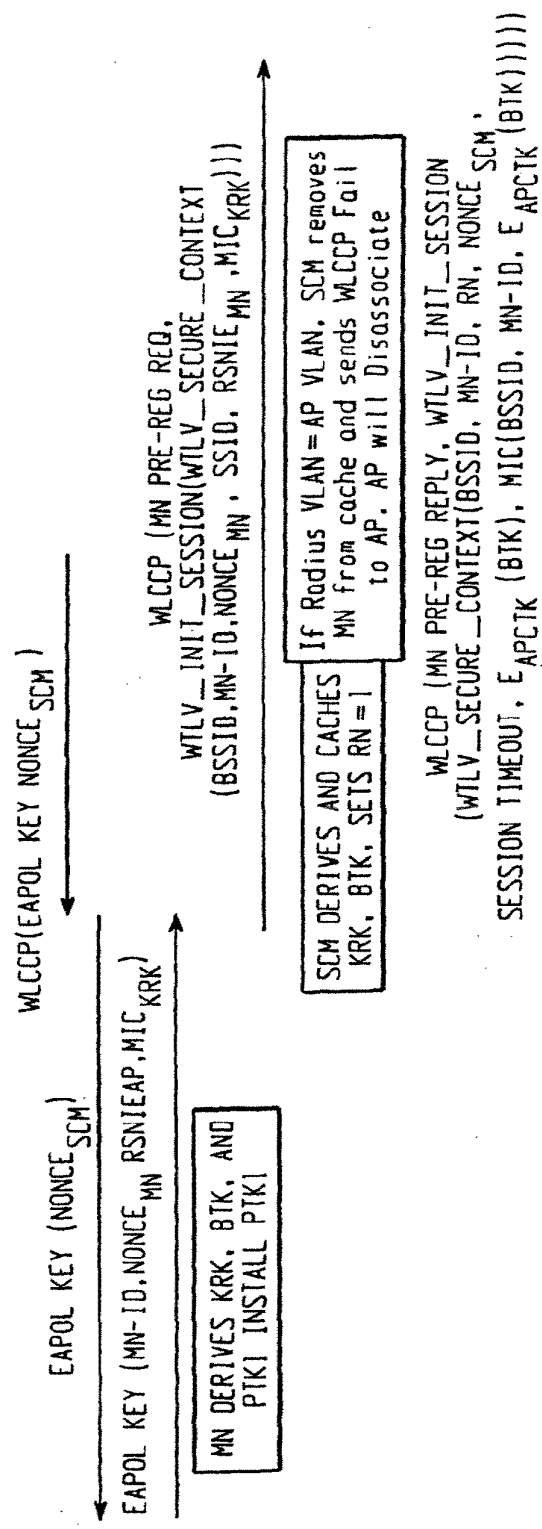


Fig. 86

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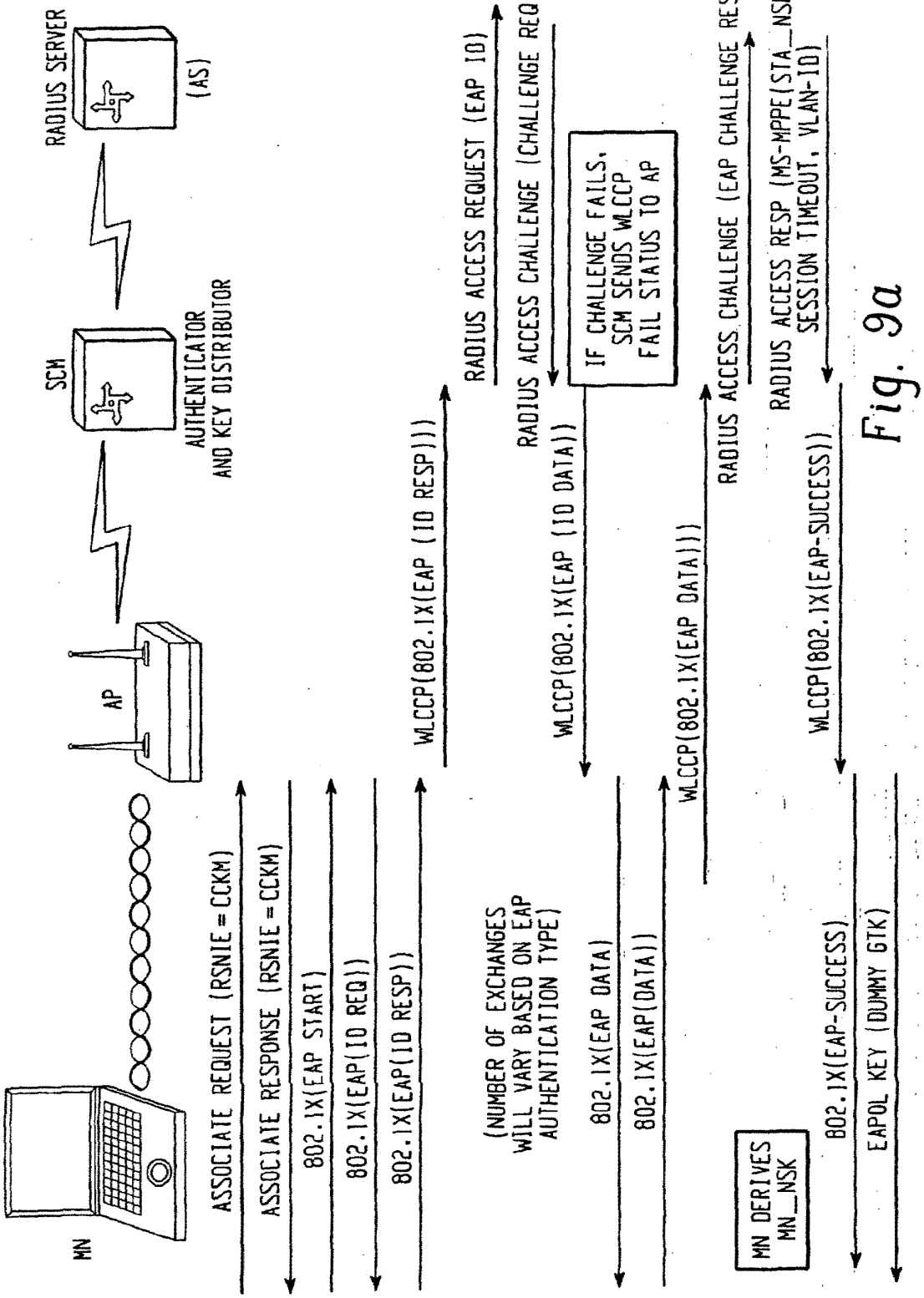


Fig. 9a

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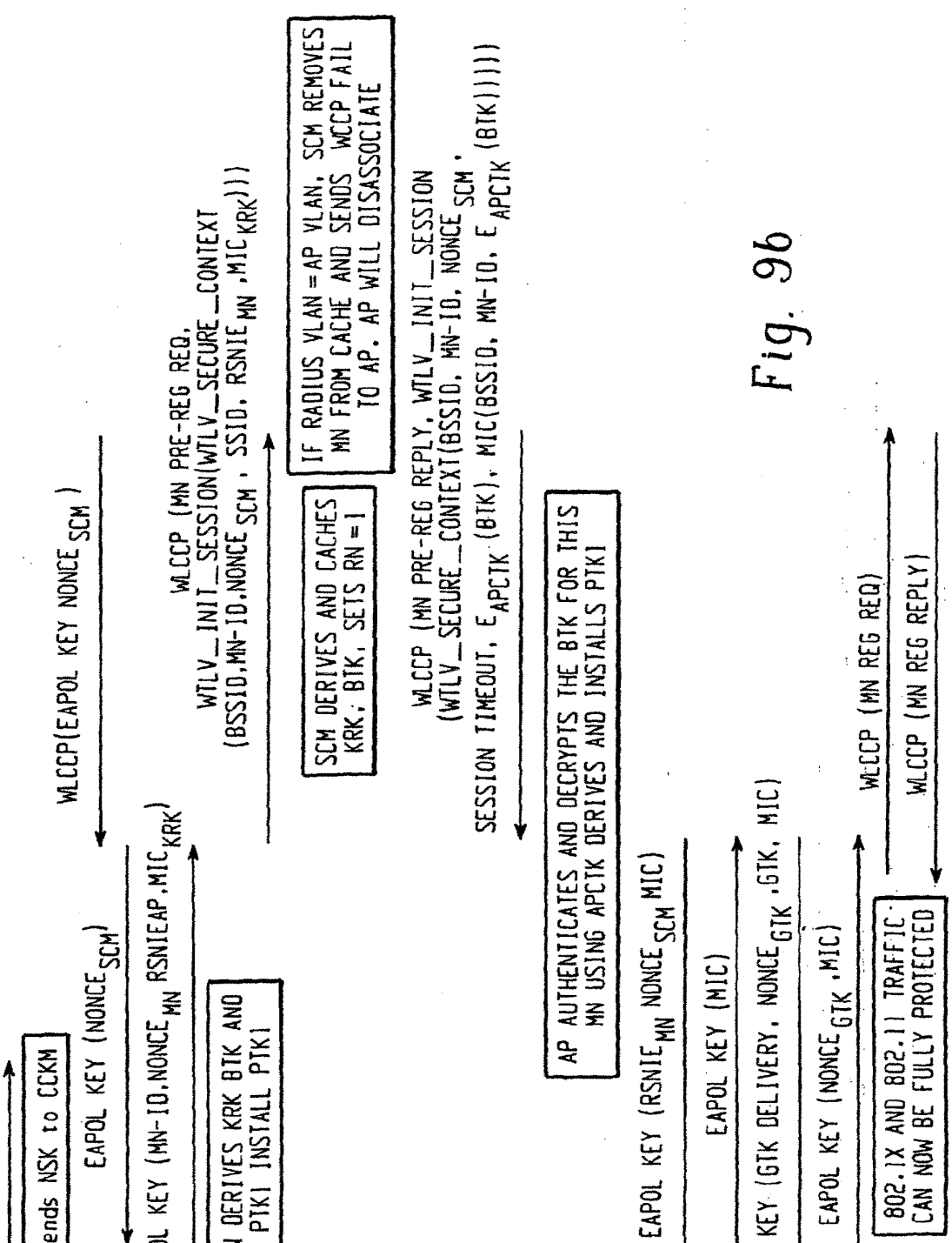


Fig. 96

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MN	AP	SCM
MN Successfully associates and authenticates to the SCM. Both MN an SCM have NSK.		
MN generates $Nonce_{MN}$		MN 802.1X authentication is complete, generate $Nonce_{SCM}$ Initiate KRK, BTK initialization
		← WLCCP_AUTHENTICATE encapsulated EAPOL packet with $Nonce_{SCM}$
	← EAPOL Key with $Nonce_{SCM}$	
Compute KRK and BTK from PRF(NSK, $Nonce_{MN}$, $Nonce_{SCM}$) RN = 1, $PTK_1 = PRF$ (BTK, BSSID ‖ RN) Generate MIC_{MN} (KRK, BSSID, MN-ID, $Nonce_{MN}$, $Nonce_{AP}$, $RSNIE_{AP}$)		
EAPOL Key with $Nonce_{MN}$, → $RSNIE_{AP}$, MIC_{KRK}		
	WLCCP Pre-Reg Req packet → WLTV_SESSION_INIT request with WLTV_SECURE_CONTEX (AP-ID, MN-ID, $NONCE_{MN}$, SSID, MIC_{KRK})	
		← If SSID, VLAN, MIC_{MN} is invalid, do not update registry, do not generate keys. Send appropriate status value

MATCH TO FIG. 10b

Fig. 10a

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MATCH TO FIG.10a

		←If SSID, VLAN, MIC_{MN} is valid, generate KRK, BTK From PRF(NSK, $Nonce_{MN}$, $Nonce_{AP}$), RN=1 Send WLCCP Pre-reg Reply packet with WLTV_SESSION_INIT (WLTV_SECURE_CONTEXT (WTLV_TRANSIENT_KEY (BTK, RN), session timeout))
	←Cache BTK, RN and session timeout for this MN. Compose response EAPOL Key $Nonce_{MN}$, $RSNIE_{MN}$, MIC_{AP}	
MN can receive and transmit protected 802.1X and 802.11 unicast frames to AP	AP can receive and transmit protected 802.1X and 802.11 unicast frames to AP	
MIC_{MN} MIC(PTK, BSSID, MN-ID, $Nonce_{MN}$, $Nonce_{AP}$, $RSNIE_{AP}$) EAPOL Key MIC_{MN} →		
	← EAPOL Key GTK, $Nonce_{GTK}$, MIC_{GTK}	
EAPOL Key $Nonce_{GTK}$, MIC→		
Port is fully open; all packets are protected	Port is fully open; all packets are protected	

Fig. 10b

1102	1104		1106	1108	1110	1112	1114	1116	1118
Descriptor Type	Key Info		EAPOL Replay Ctr	rsvd	Key-ID	MN-ID	BSSID	RN	MIC
1byte	1byte	2bytes	4bytes	1byte	1byte	6bytes	6bytes	4bytes	8bytes

Fig. 11

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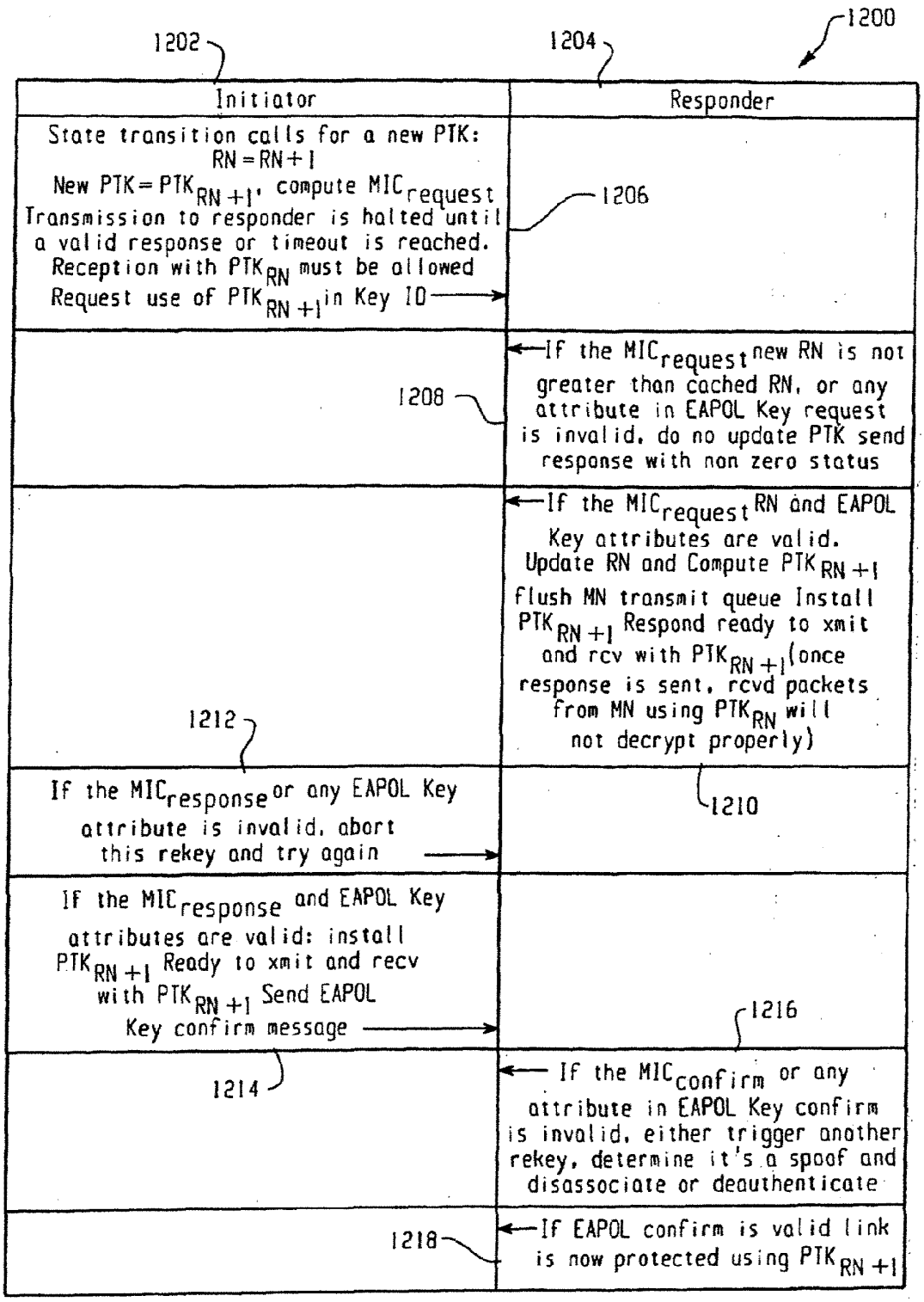


Fig. 12

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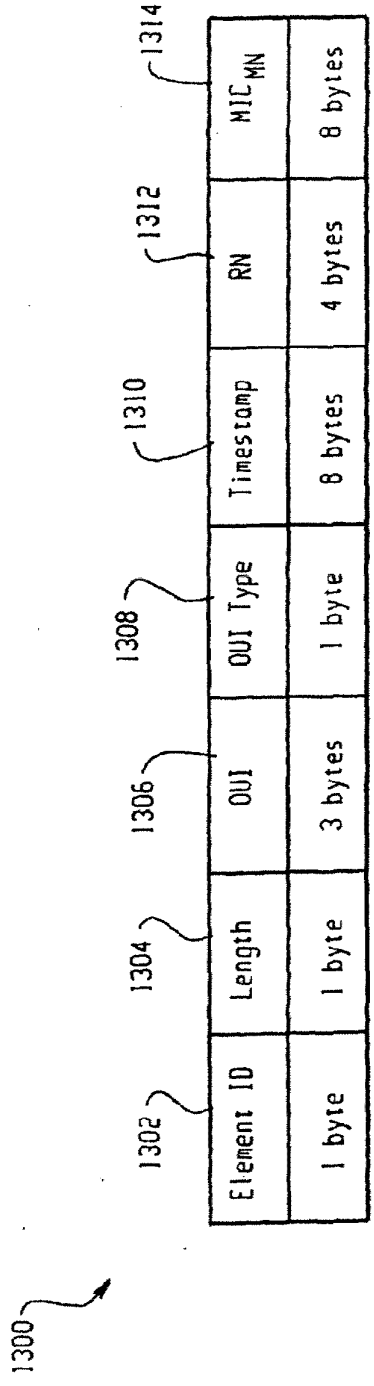


Fig. 13

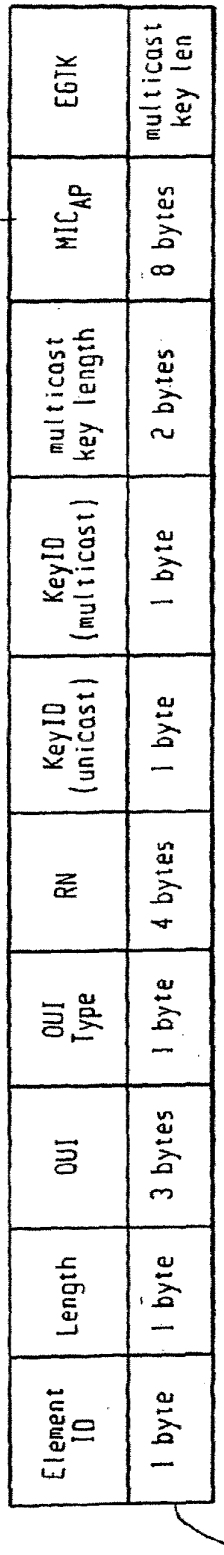


Fig. 14

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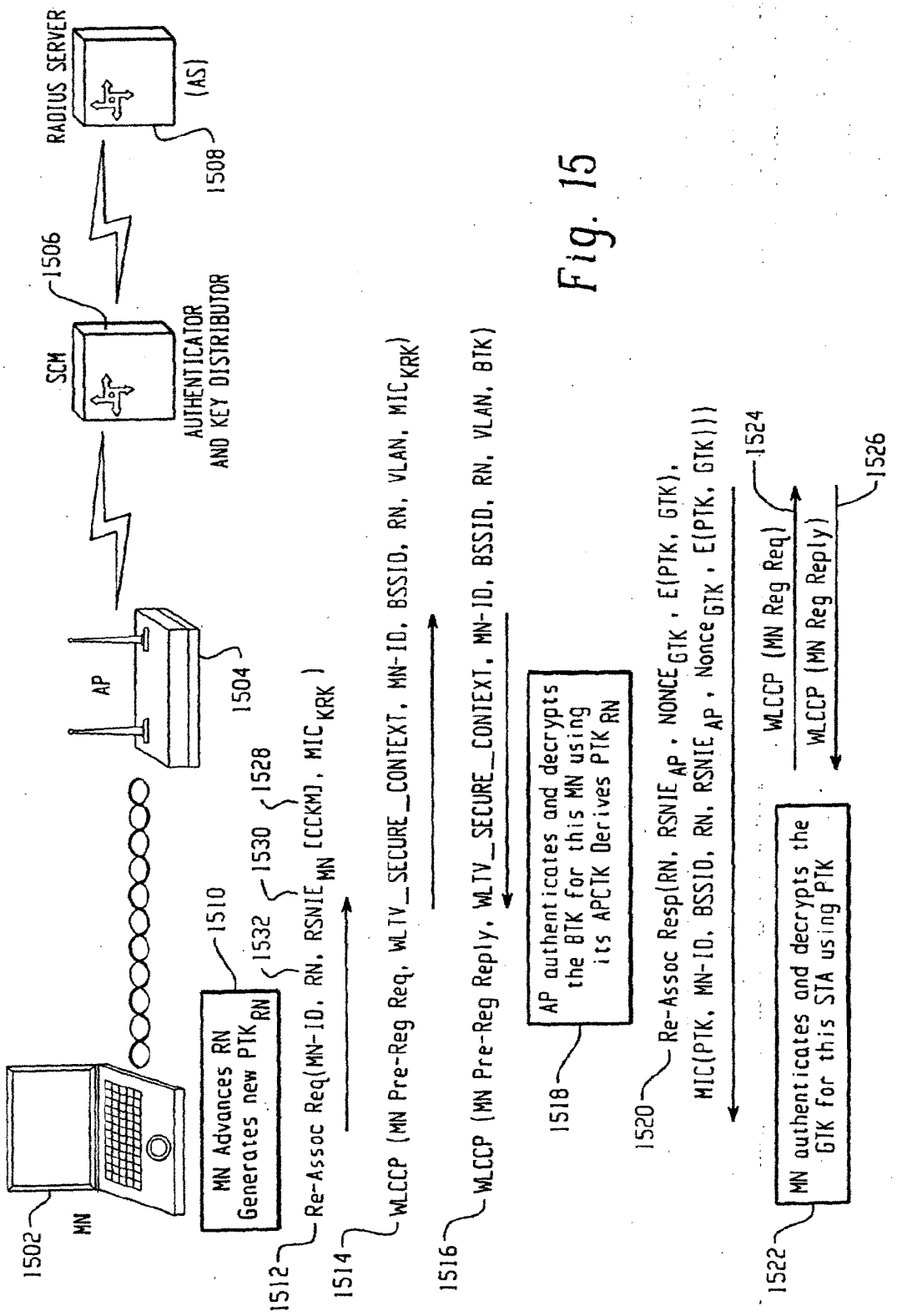


Fig. 15

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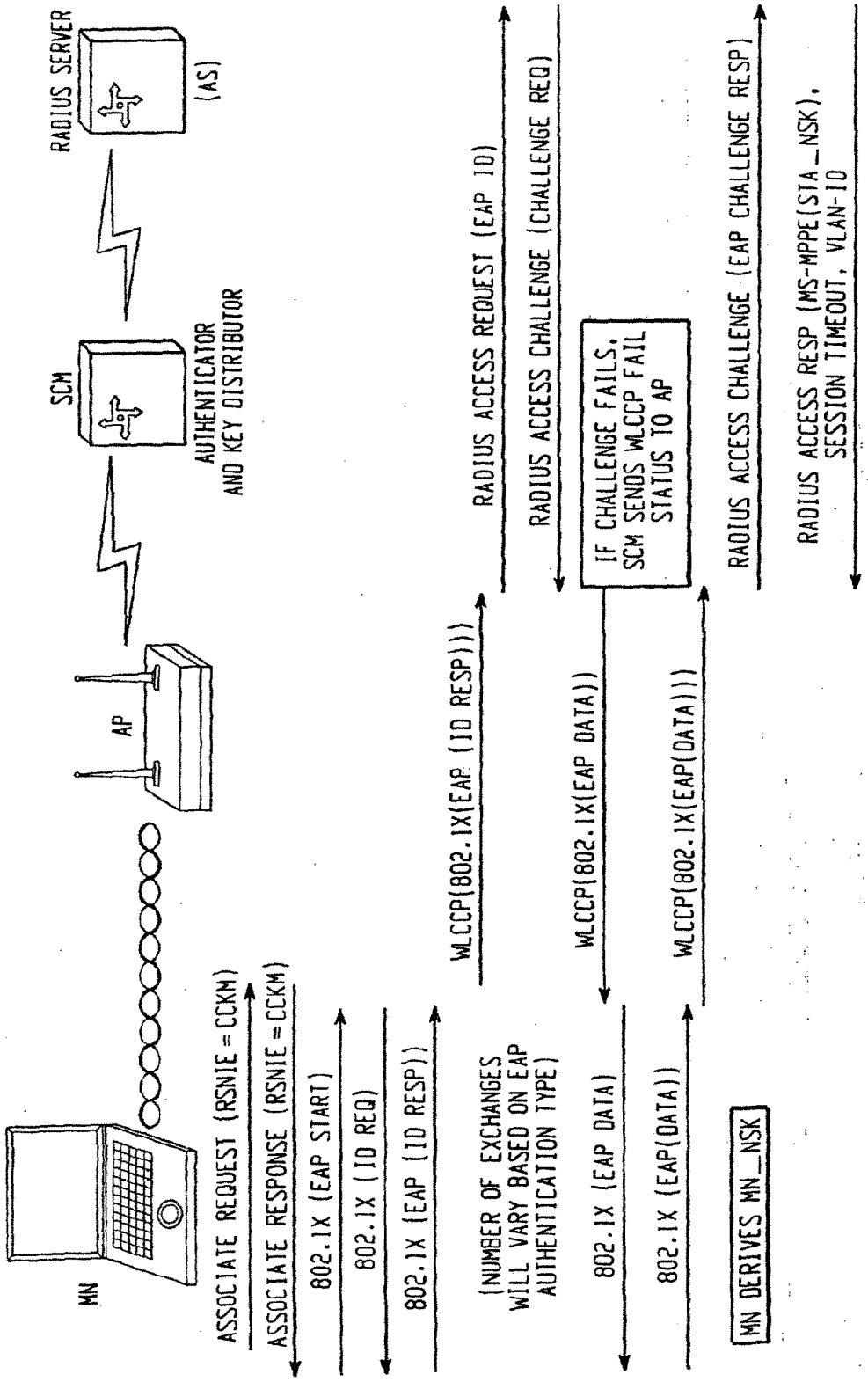


Fig. 16a

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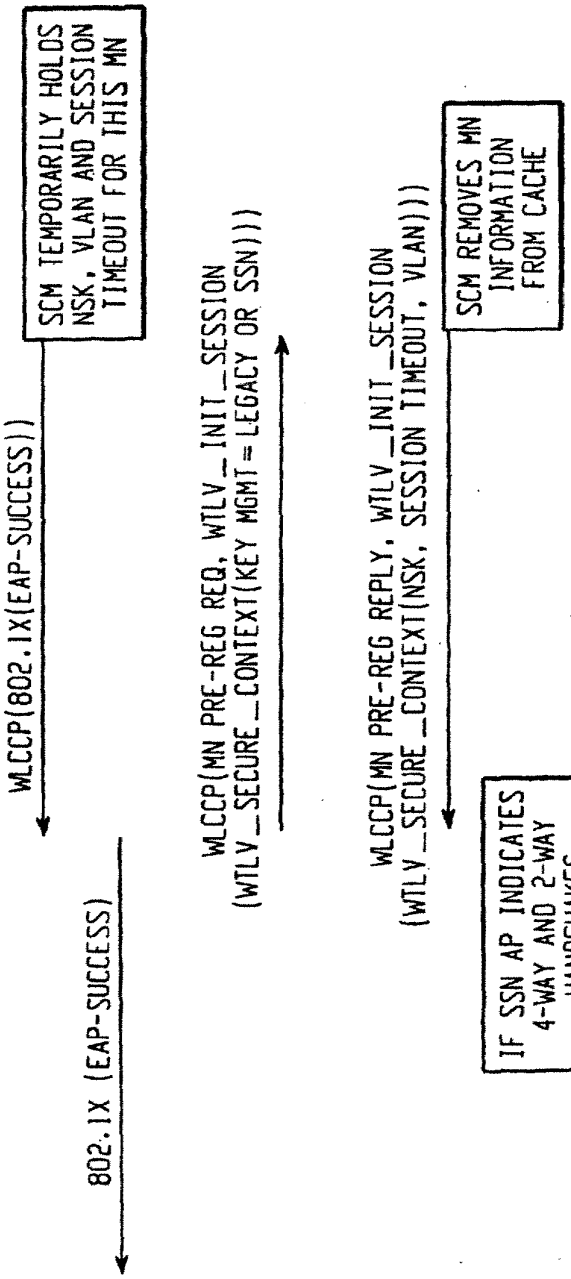


Fig. 16b

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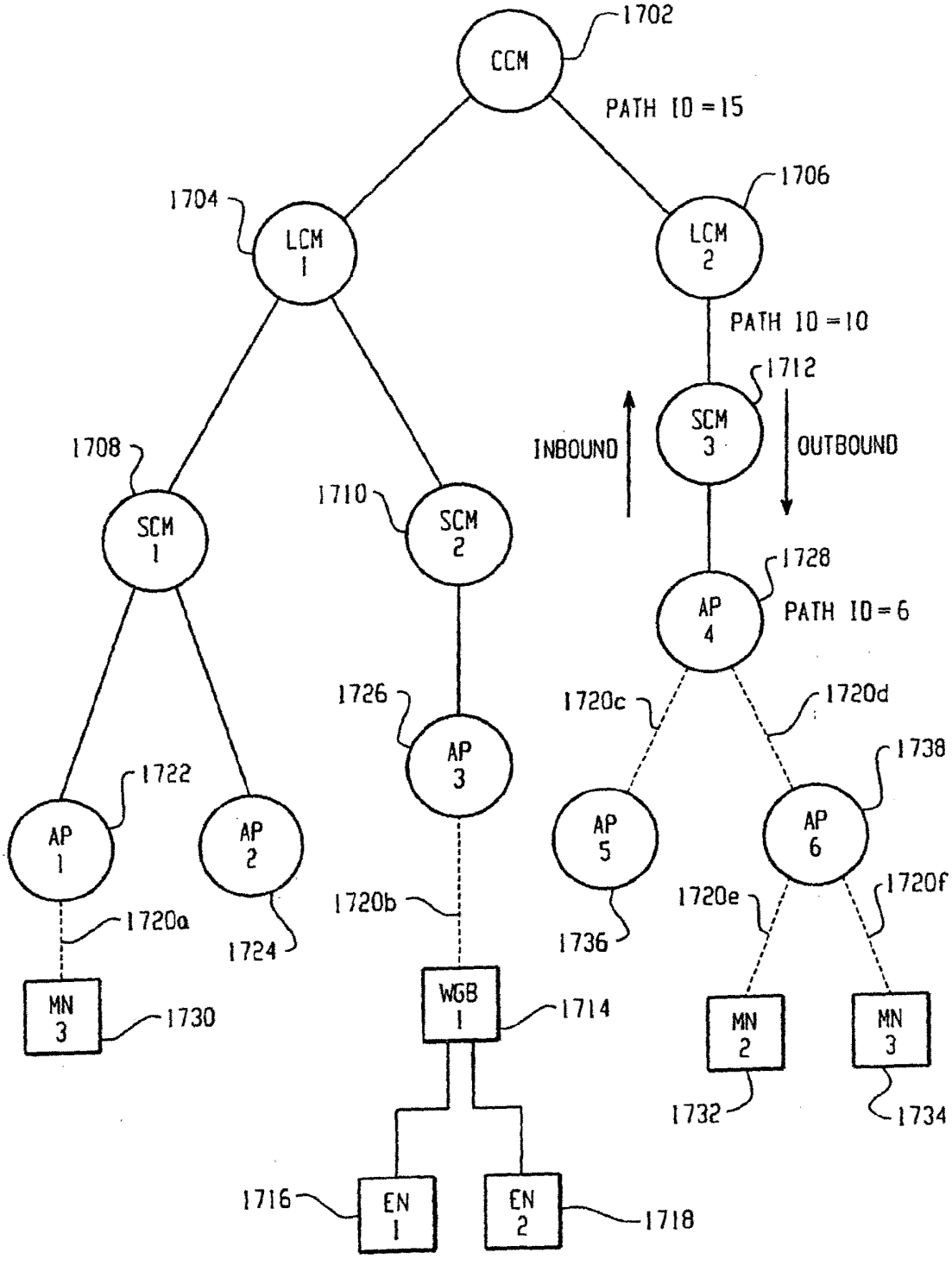


Fig. 17

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1800

Field Name	Offset	Size (bytes)	Description
Node Type 1802	0	2	(none) = 0 AP = 1 SCM = 2 LCM = 4 CCM = 8 ICN = 0X10 /* infrastructure */ Client = 0X40 Multicast Flag — 0X8000
Node Address 1804	2	6	IEEE 48-bit global or locally administered address in canonical (i.e. Ethernet) format.

Fig. 18

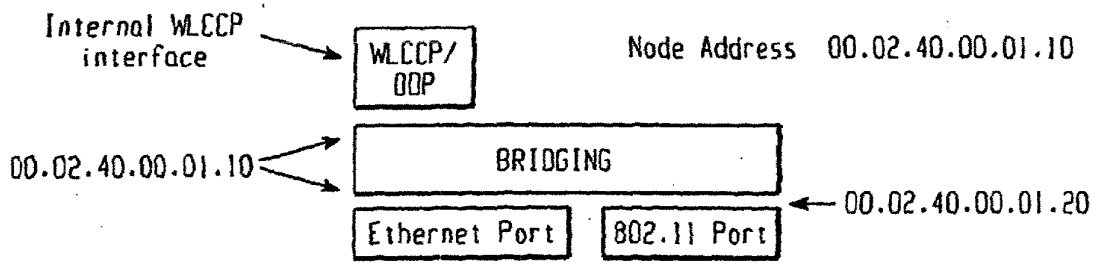


Fig. 19

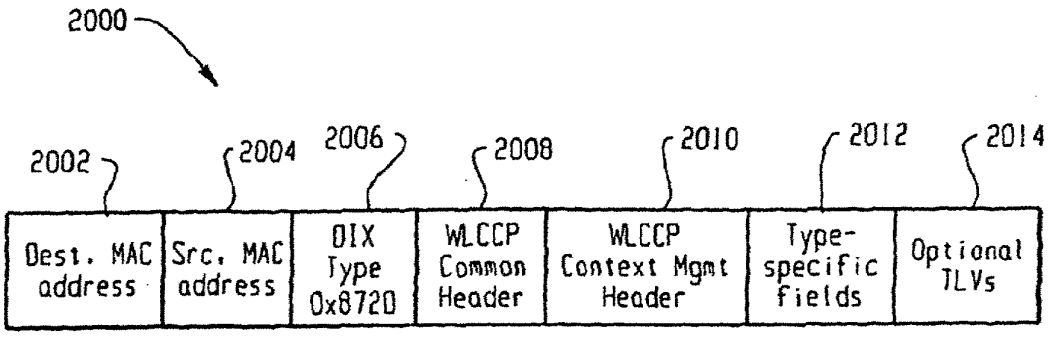
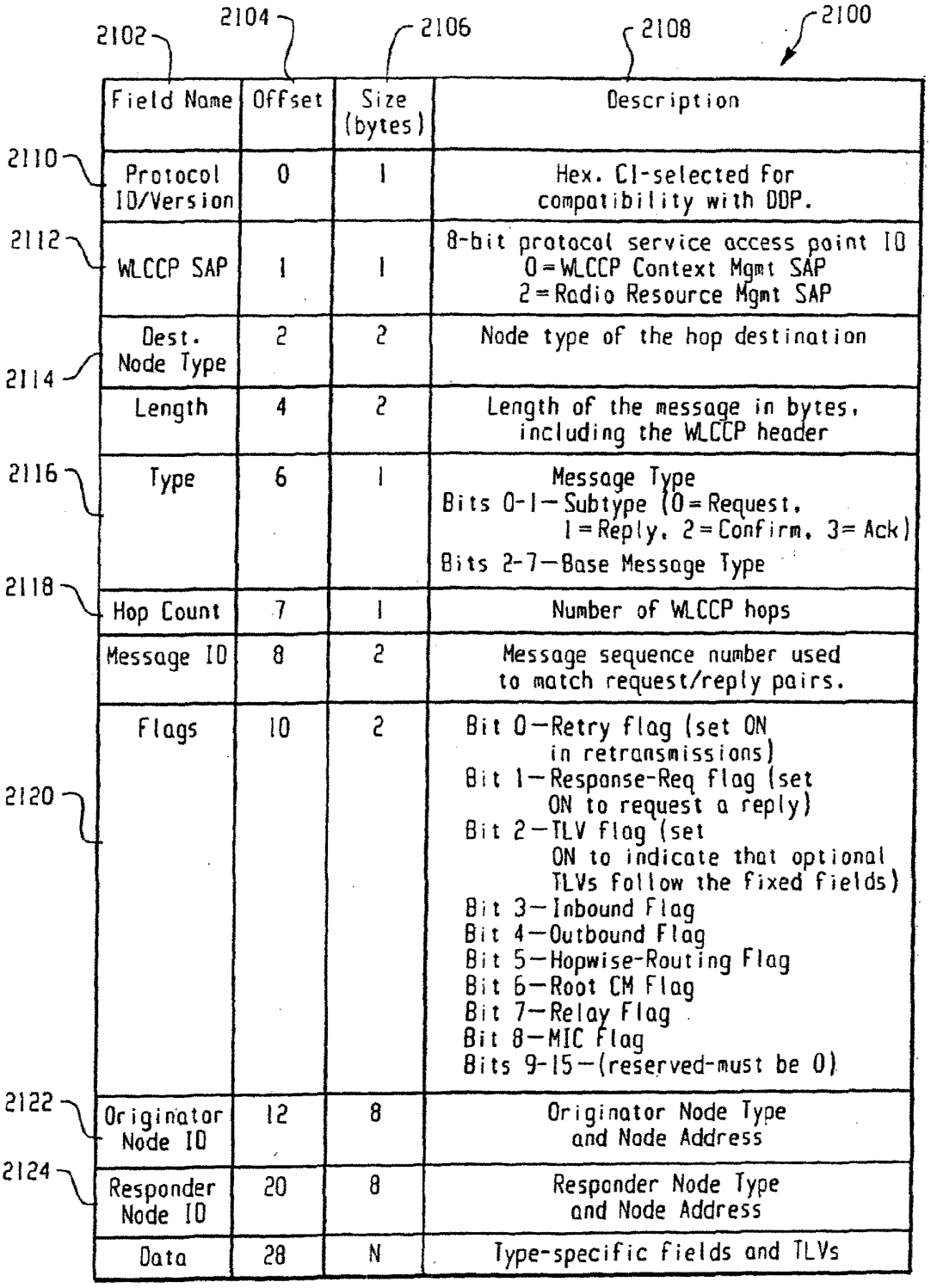


Fig. 20

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2102 Field Name	2104 Offset	2106 Size (bytes)	2108 Description
2110 Protocol ID/Version	0	1	Hex. CI-selected for compatibility with DDP.
2112 WLCCP SAP	1	1	8-bit protocol service access point ID 0 = WLCCP Context Mgmt SAP 2 = Radio Resource Mgmt SAP
2114 Dest. Node Type	2	2	Node type of the hop destination
Length	4	2	Length of the message in bytes, including the WLCCP header
2116 Type	6	1	Message Type Bits 0-1 — Subtype (0 = Request, 1 = Reply, 2 = Confirm, 3 = Ack) Bits 2-7 — Base Message Type
2118 Hop Count	7	1	Number of WLCCP hops
Message ID	8	2	Message sequence number used to match request/reply pairs.
2120 Flags	10	2	Bit 0 — Retry flag (set ON in retransmissions) Bit 1 — Response-Req flag (set ON to request a reply) Bit 2 — TLV flag (set ON to indicate that optional TLVs follow the fixed fields) Bit 3 — Inbound Flag Bit 4 — Outbound Flag Bit 5 — Hopwise-Routing Flag Bit 6 — Root CM Flag Bit 7 — Relay Flag Bit 8 — MIC Flag Bits 9-15 — (reserved-must be 0)
2122 Originator Node ID	12	8	Originator Node Type and Node Address
2124 Responder Node ID	20	8	Responder Node Type and Node Address
Data	28	N	Type-specific fields and TLVs

Fig. 21

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Field Name	Offset	Size (bytes)	Description
Type	0	2	TLV identifier Bit 0—Container Flag Bit 1—Encrypted Flag Bits 2-3—(reserved—must be zero) Bits 4-7—Group ID Bit 8—Request Flag Bits 9-15—Type ID
Length	2	2	Length of the TLV, including the Type and Length fields.
Value	4	N	Type-specific data, if the Request Flag is OFF

2202 2204 2206 2208 2210

Fig. 22

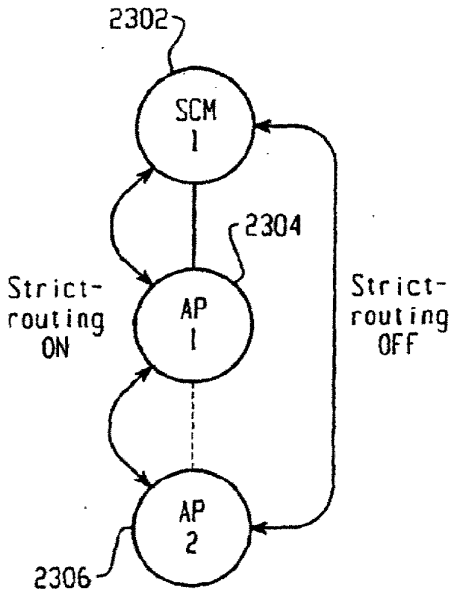


Fig. 23

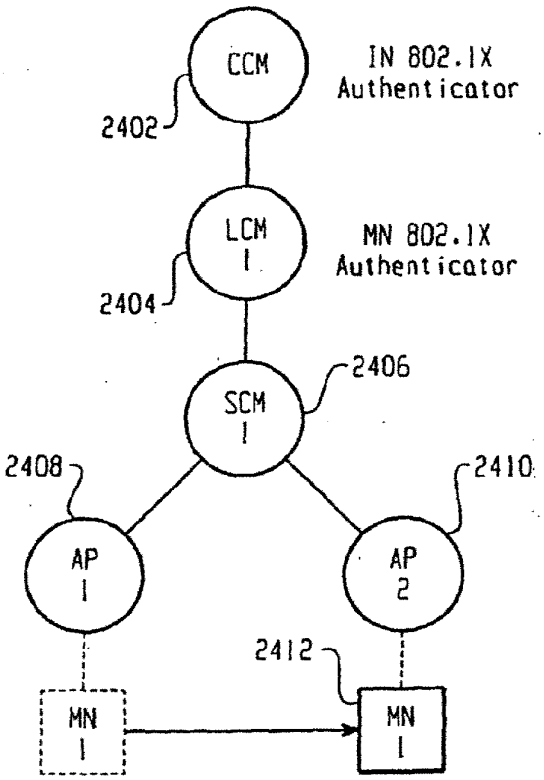


Fig. 24

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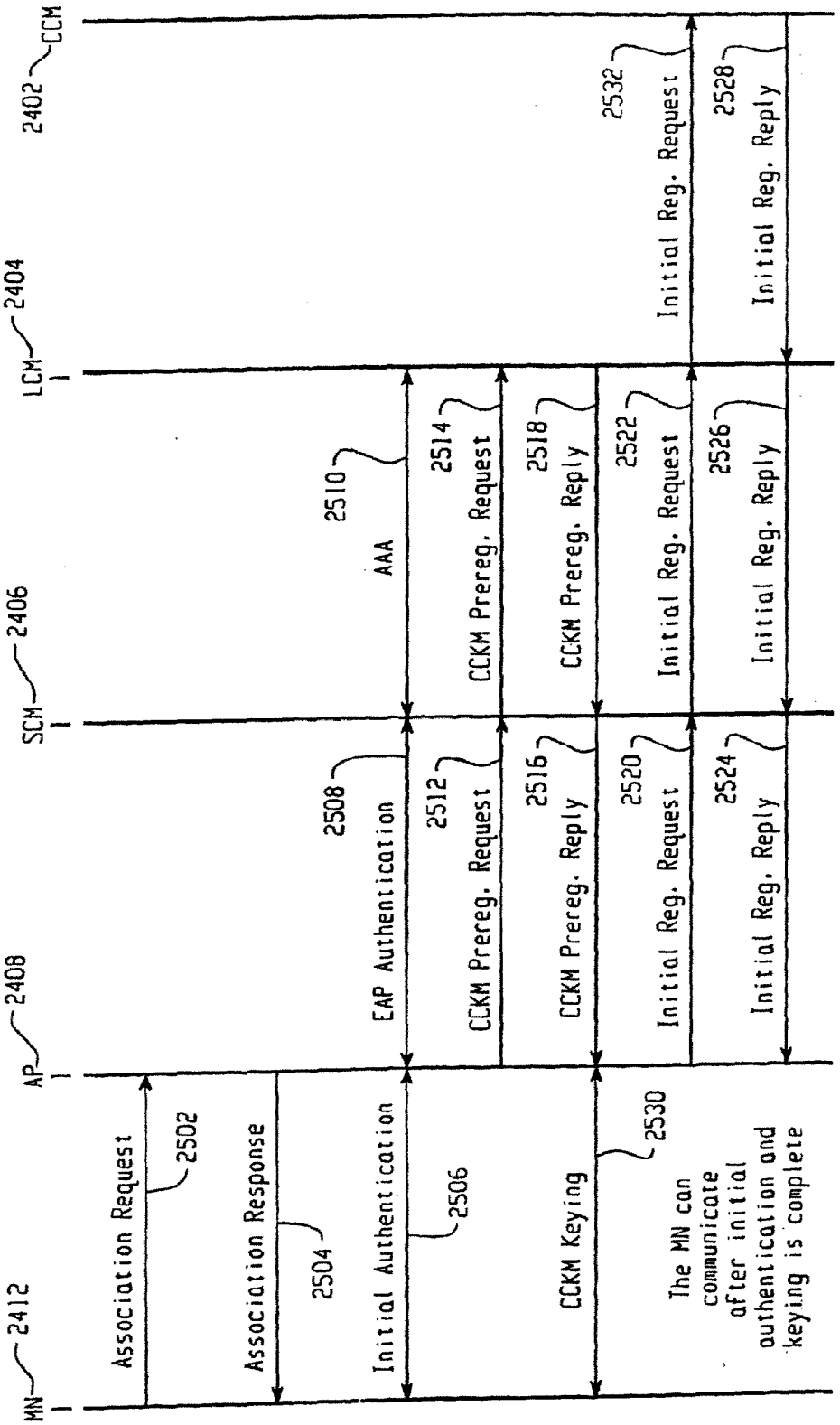


Fig. 25

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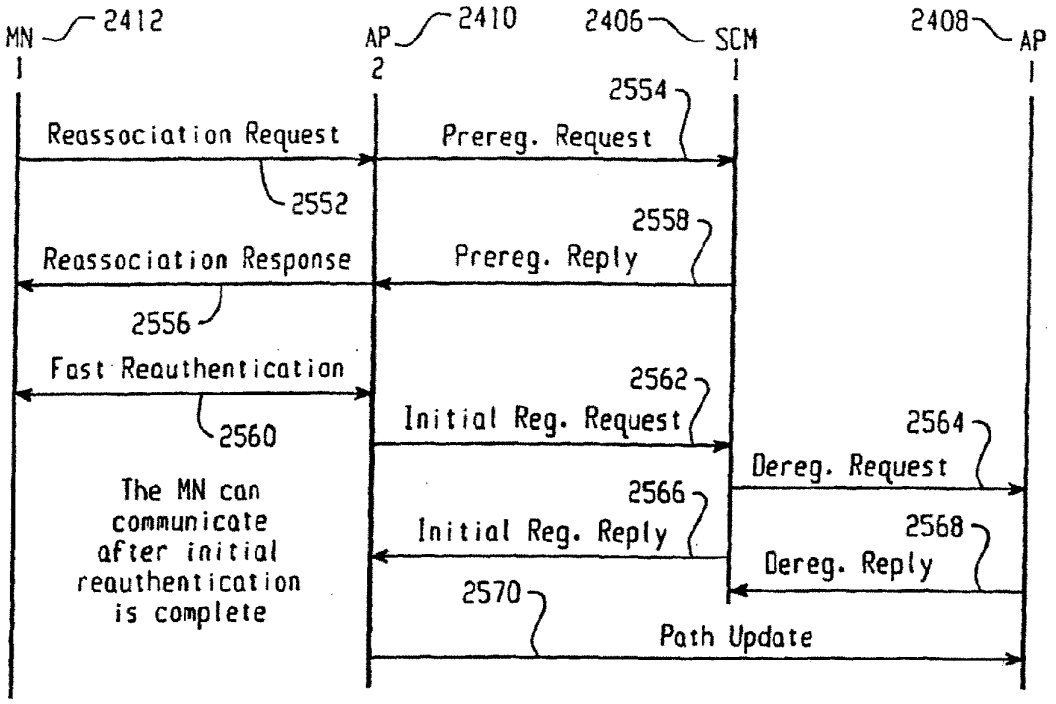


Fig. 26

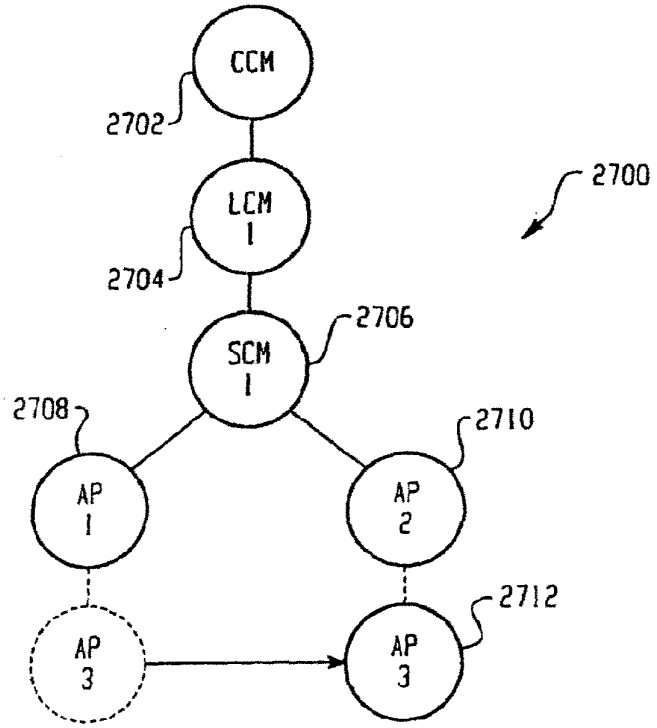


Fig. 27

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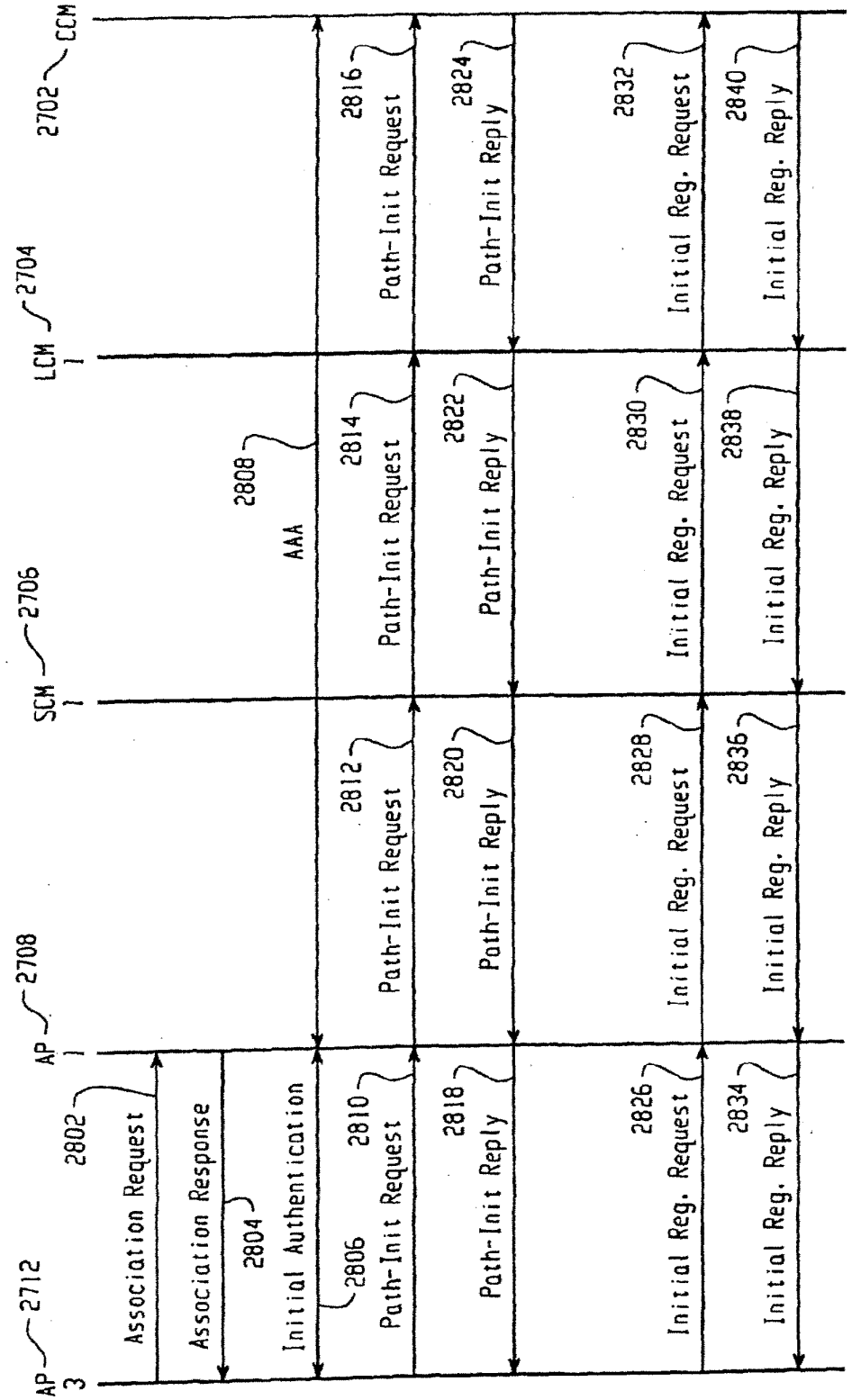


Fig. 28a

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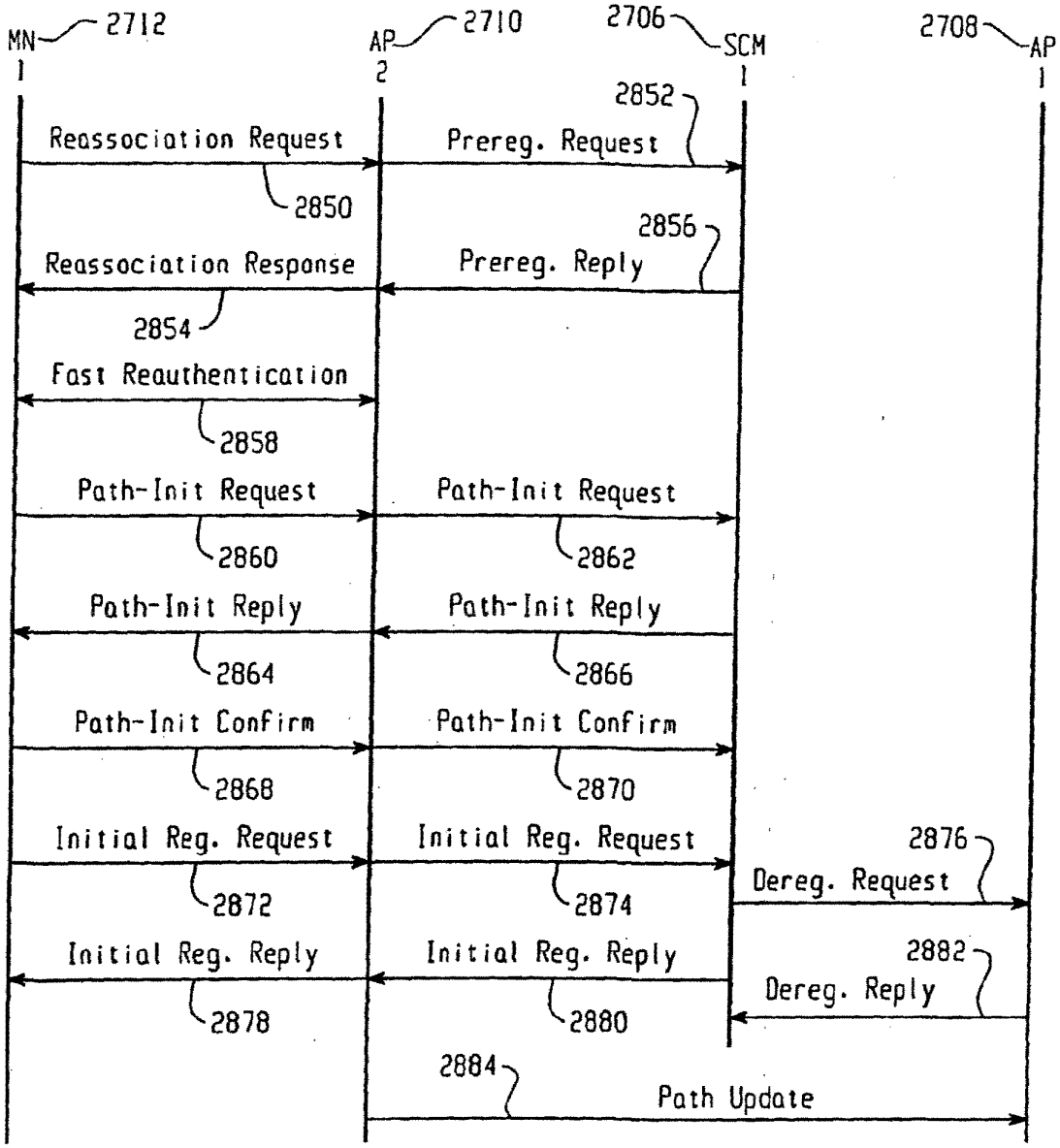


Fig. 28b

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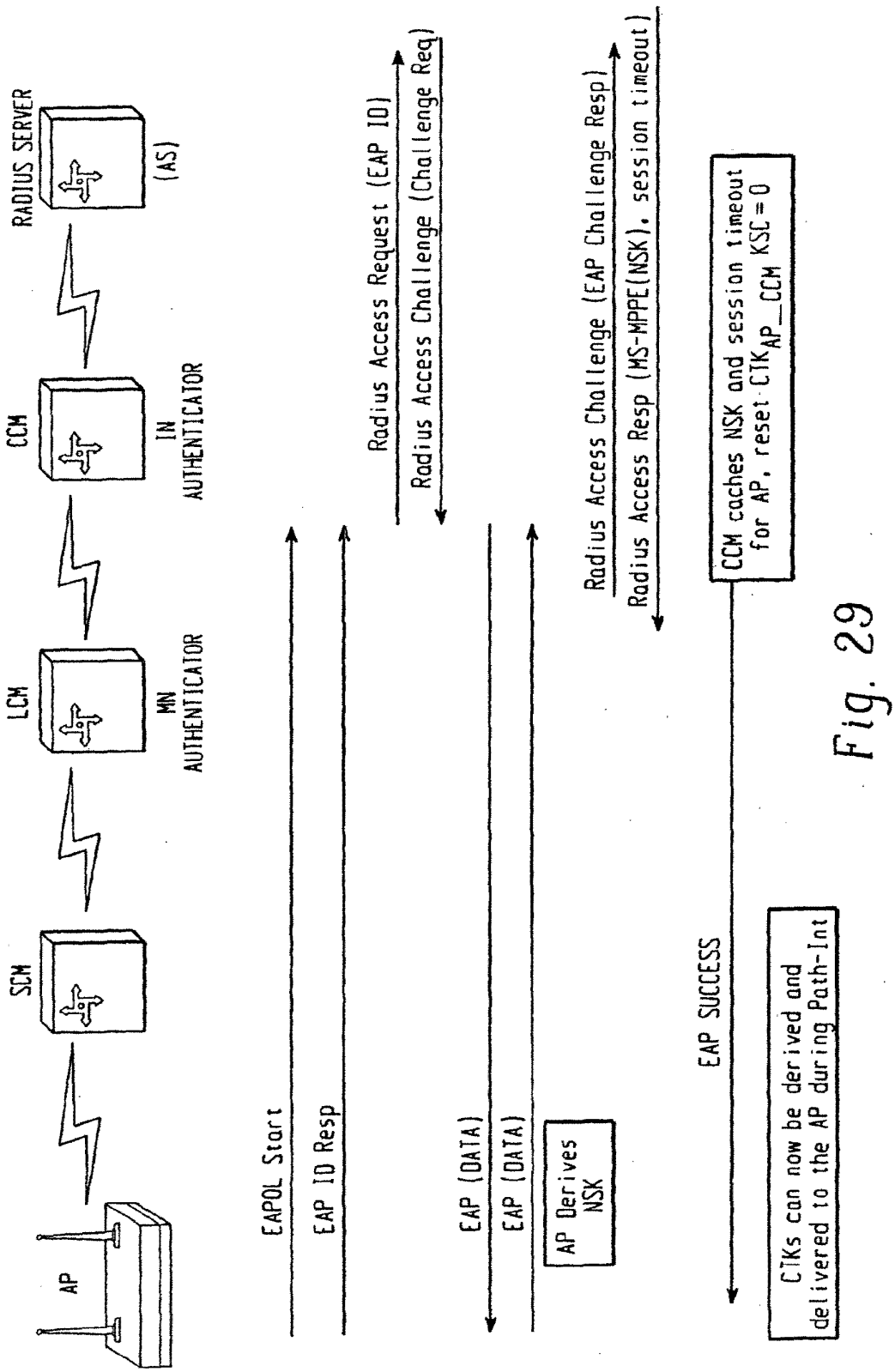


Fig. 29

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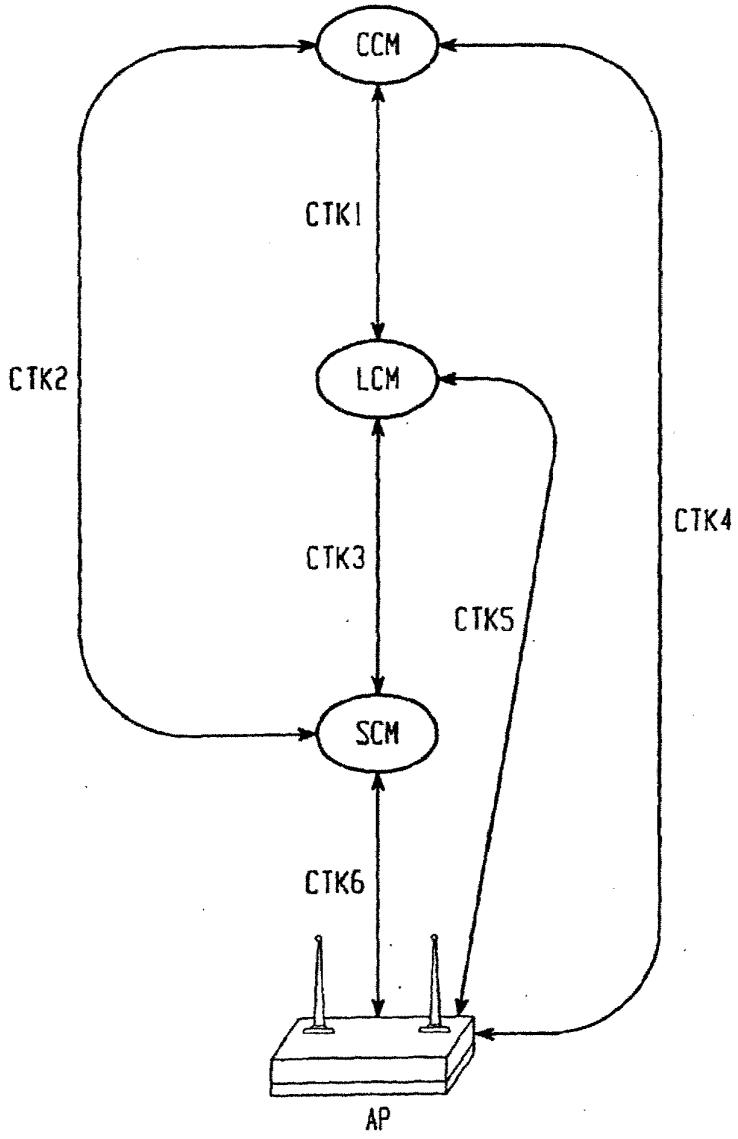


Fig. 30

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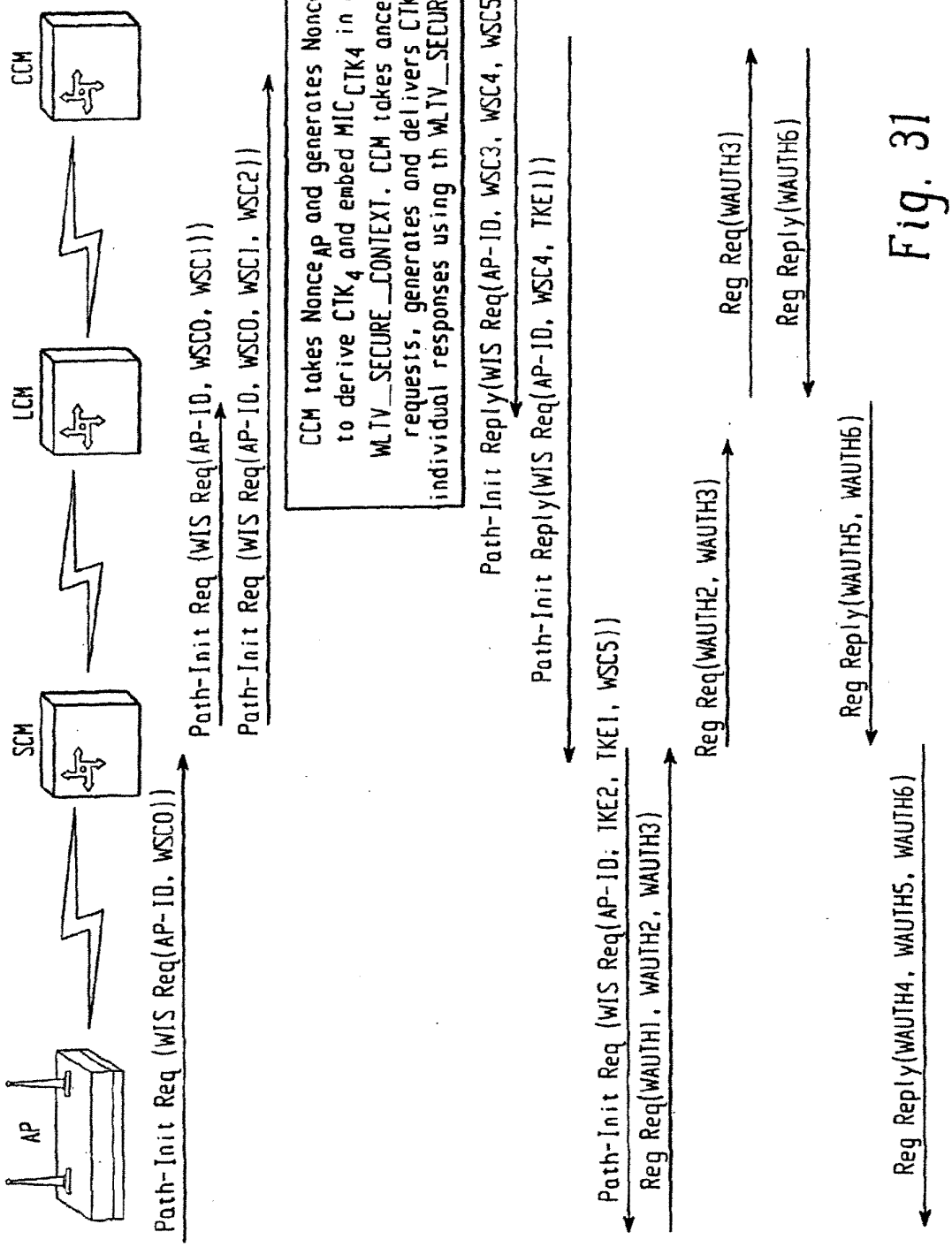


Fig. 31

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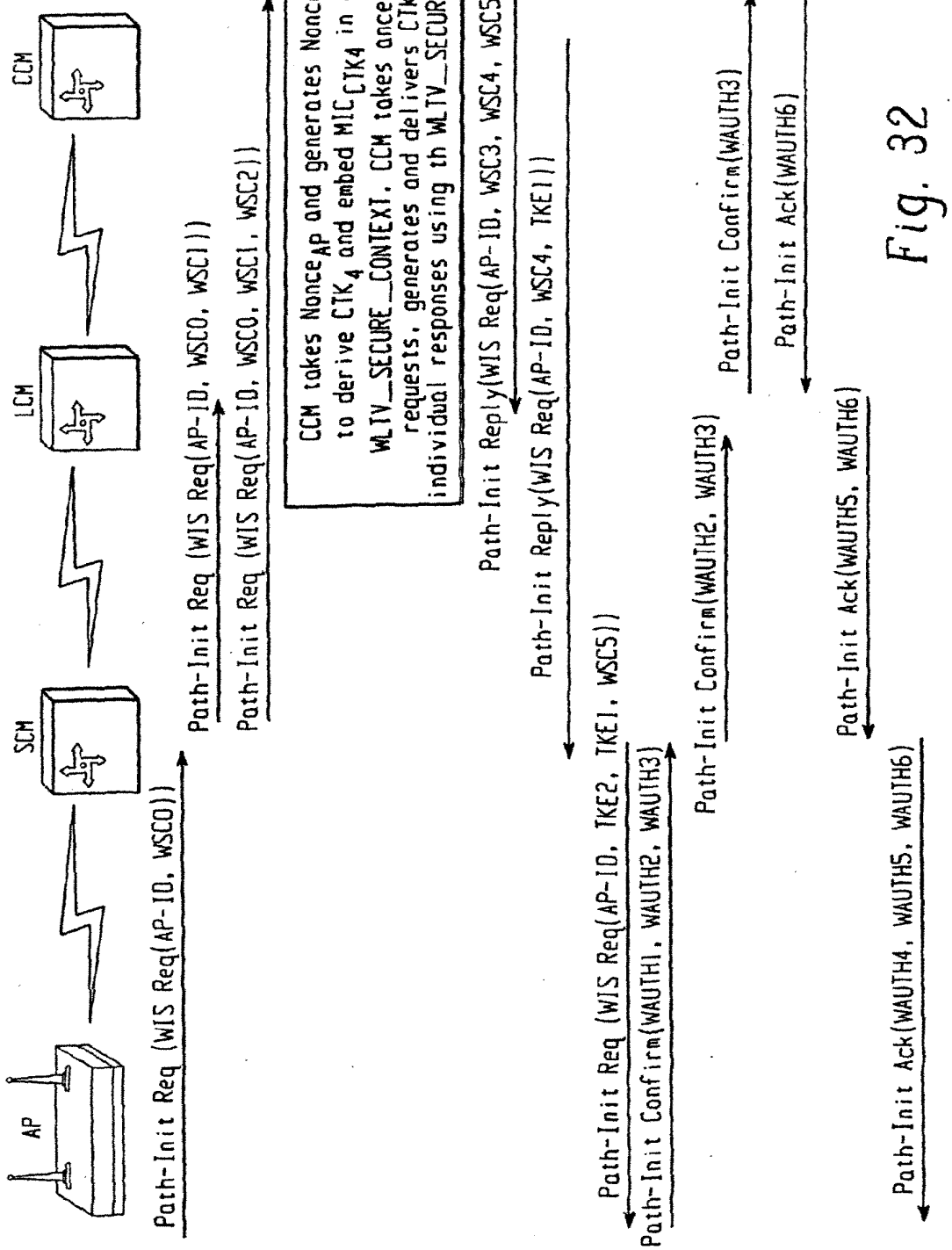


Fig. 32

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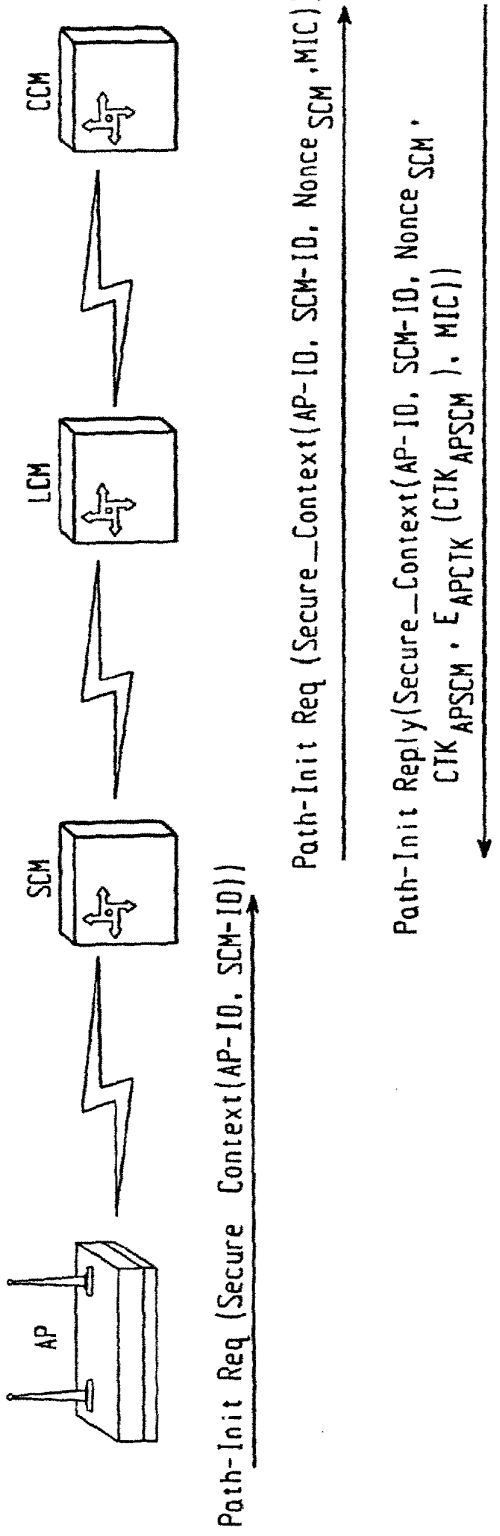


Fig. 33

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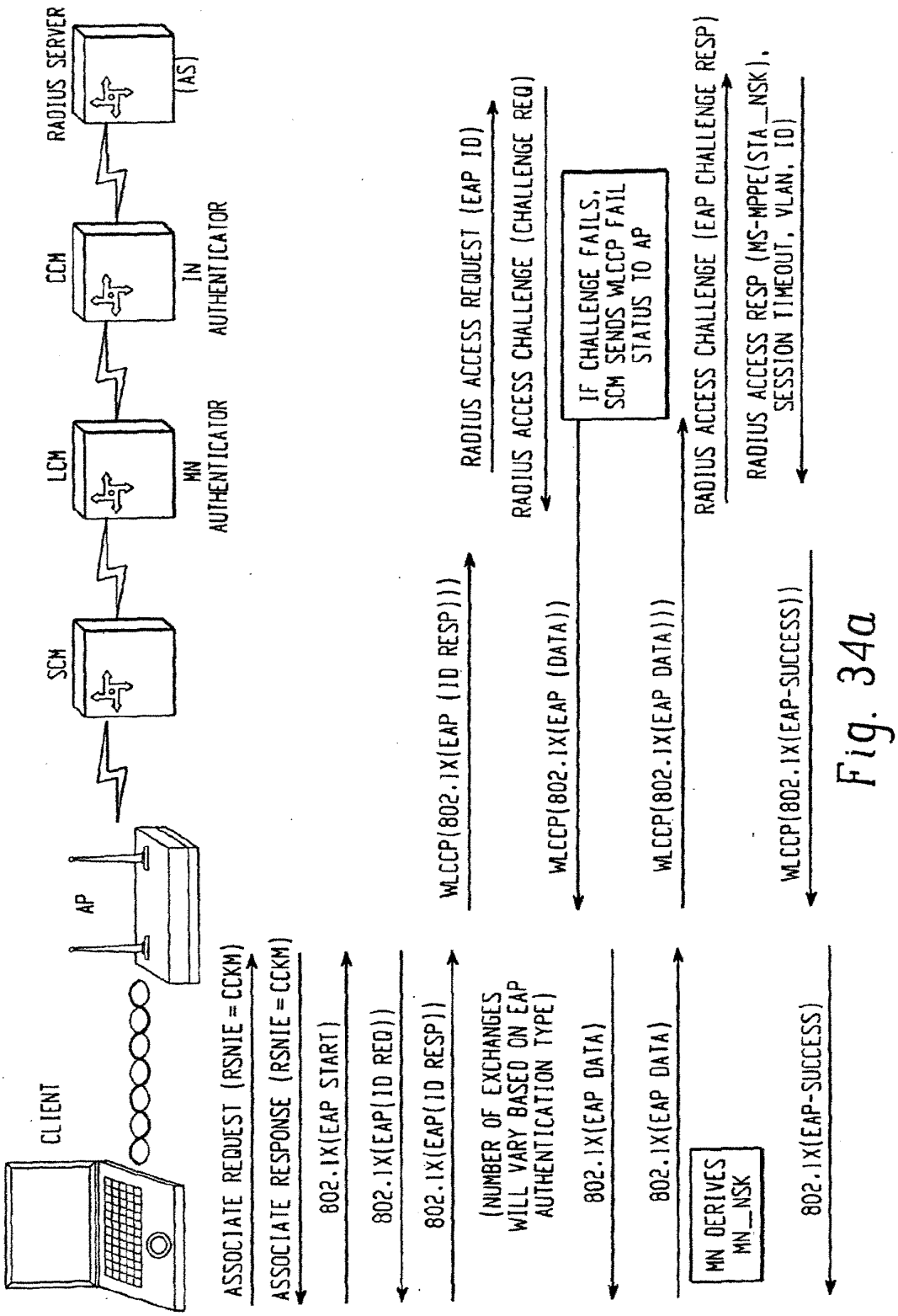


Fig. 34a

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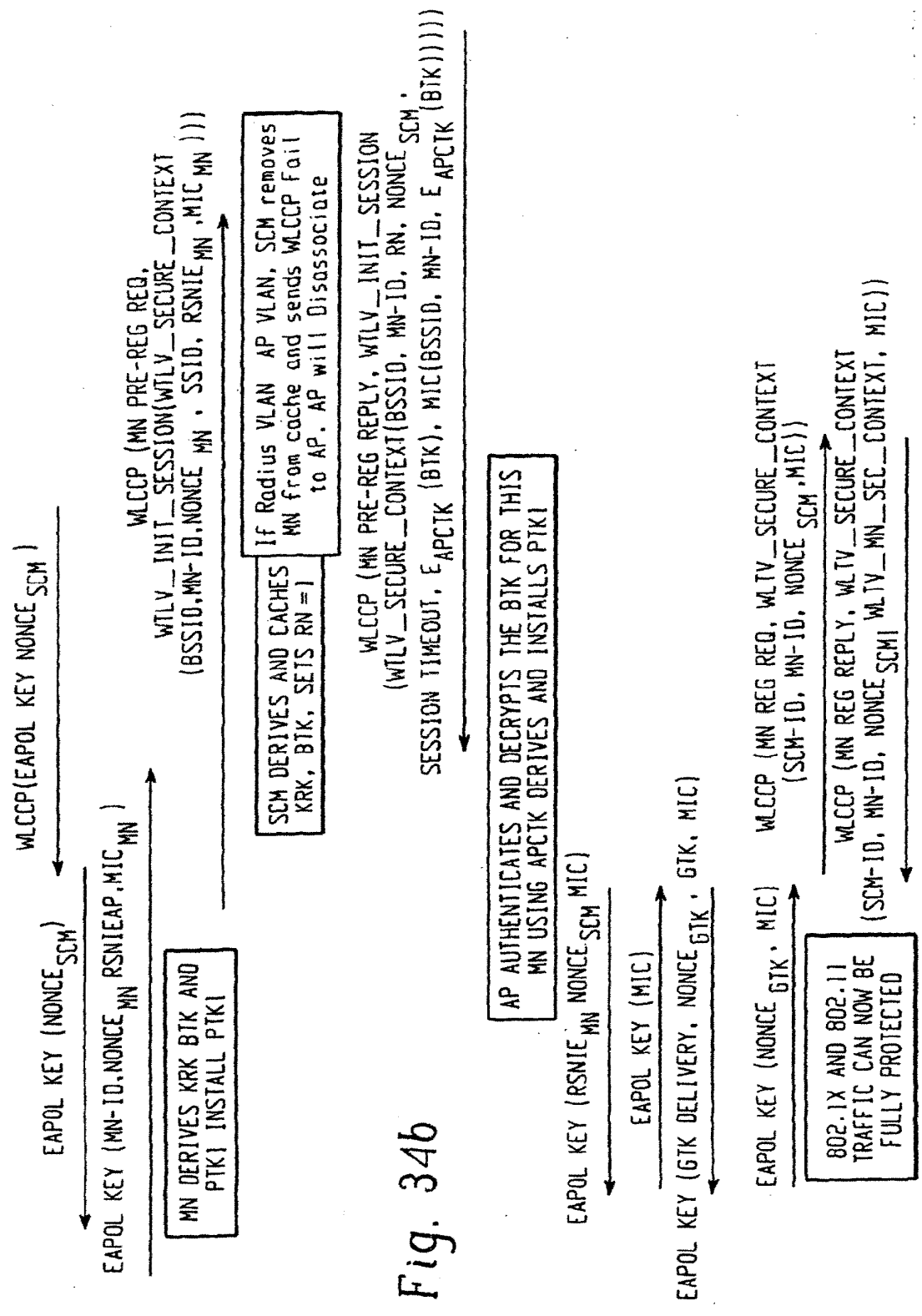


Fig. 34b

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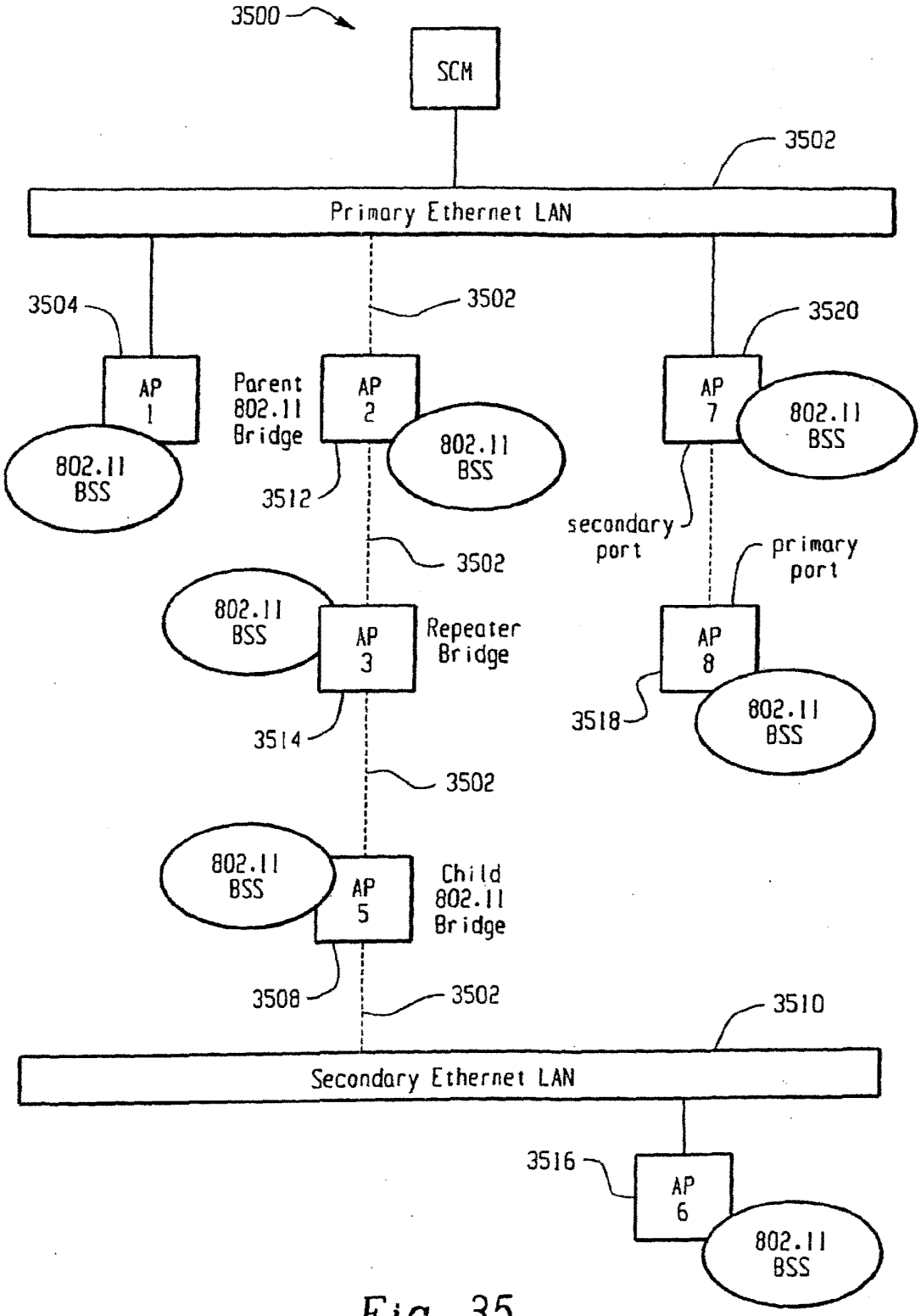


Fig. 35

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 42971402 P **[0001]**
- US 43941903 P **[0001]**

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(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 988 648 A1

(12) EUROPEAN PATENT APPLICATION

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H04B 7/26 *(2006.01)*

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(22) Date of filing: **04.05.2007**

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Designated Extension States:
AL BA HR MK RS

(71) Applicant: **Nokia Siemens Networks Oy**
02610 Espoo (FI)

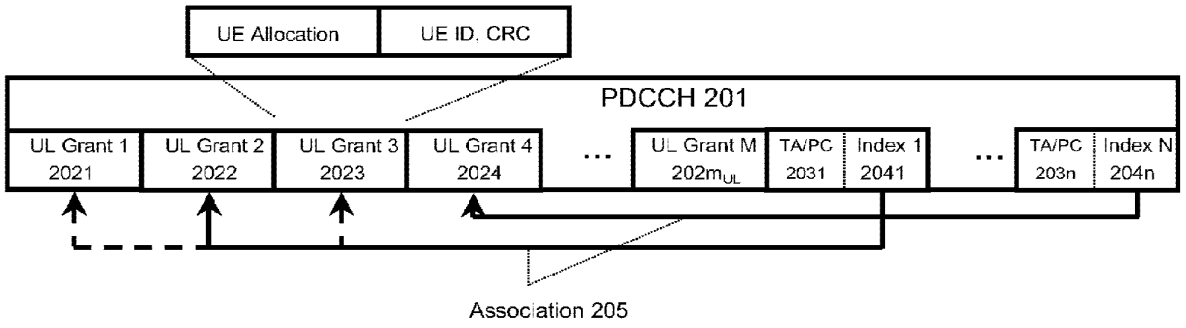
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  81737, München (DE)

(74) Representative: **TBK-Patent**
Bavariaring 4-6
80336 München (DE)

(54) Methods, system, apparatuses and related computer program product for allocation of communication resources

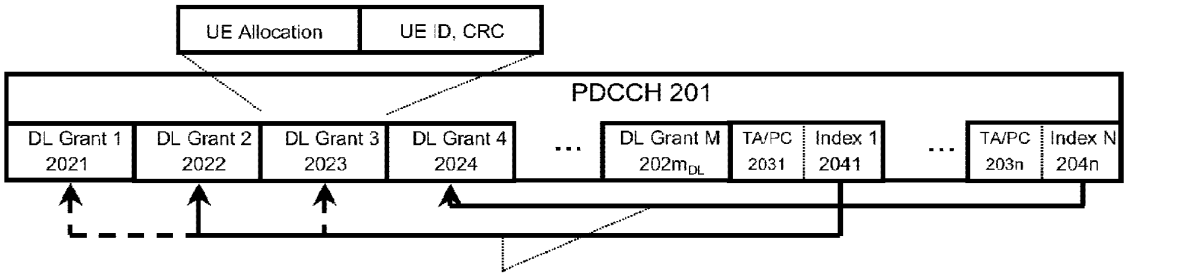
(57) It is disclosed a method comprising associating communication resource update information with communication resource allocation information, the communication resource allocation information and the associated communication resource update information each being a portion of communication resource information, signalling the association of the communication resource update information with the communication resource allocation information, and transmitting the communication resource information. A further method is disclosed, comprising receiving transmitted communication resource information comprising communication resource allocation information, associated communication resource update information, and a signaled association of the communication resource update information with the communication resource allocation information, retrieving the communication resource allocation information and the associated communication resource update information from the communication resource information based on the signaled association, transceiving signals based on the communication resource allocation information using an allocated communication resource, and updating the communication resource based on the communication resource update information.

Fig. 2A



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Fig. 2B



UL/DL Grant: example of CR alloc. info
TA/PC: The PC and/or TA command,
Example of CR update info.
PDCCH: example of CR resource info

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to allocation of communication resources. In particular, the present invention relates to the UTRAN (UMTS Terrestrial Radio Access Network) technology sometimes referred to as LTE (Long Term Evolution).

BACKGROUND

[0002] In 3GPP (3rd Generation Partnership Project), there have been discussions related to the timing control and power control in the UL (Uplink). For example, UL power control adjustments are a-periodic and are included in UL scheduling grants for scheduled data. Furthermore, the view that UL power control adjustments are sent relatively infrequently appears to have wide support in 3GPP. For example, TA (time alignment) updates are sent on a per-need basis, yet at a 2 Hz rate at most. E.g. a L1/L2 (OSI (Open System Interconnection) layer 1/2) control channel is considered as a candidate also for signalling of time alignment updates. Hence, both power control adjustments and time alignment updates can be assumed to be signaled a-periodically and at low rate on average.

[0003] Furthermore, as shown in Fig. 1, the downlink CCHs (control channels) are formed by aggregation of CCEs (control channel elements), and a control channel element is modulated on to a set of resource elements. As shown in Fig. 1, aggregation of the control channel elements is effected in a structured way. A UE (user equipment) monitors a set of candidate control channels, which can be set e.g. by higher layer signalling. The structure defines rules for combining the control channel elements to the Physical Downlink Control Channels (PDCCH). The structure is needed to reduce the number and positions of the potential control channels and hence also the number of blind detections performed by the UE in order to detect the control channels. An example on possible mappings between control channel elements and control channels is also shown in Fig. 1.

[0004] Due to the low signalling rate, the use of higher layer signalling for TA and PC (power control) is a possibility which has been considered in 3GPP. It provides an acknowledged signalling method, and the solution does not cause any overhead when no TA or PC updates are transmitted. However, the overhead per each transmitted TA/PC update is large, e.g. around 100 information bits (DL grant + TA + UE ID (user equipment identification) + CRC (Cyclic Redundancy Code)).

[0005] In order to overcome one or more or the above disadvantages, which is the object of the present invention, the present invention provides the following aspects.

[0006] According to the present invention, in a first aspect, this object is for example achieved by **a method** comprising:

associating communication resource update information with communication resource allocation information, the communication resource allocation information and the associated communication resource update information each being a portion of communication resource information;
signalling the association of the communication resource update information with the communication resource allocation information; and
transmitting the communication resource information.

[0007] According to the present invention, in a second aspect, this object is for example achieved by **a method** comprising:

receiving transmitted communication resource information comprising communication resource allocation information, associated communication resource update information, and a signaled association of the communication resource update information with the communication resource allocation information;
retrieving the communication resource allocation information and the associated communication resource update information from the communication resource information based on the signaled association;
transceiving signals based on the communication resource allocation information using an allocated communication resource; and
updating the communication resource based on the communication resource update information.

[0008] According to further refinements of the invention as defined under the above first and second aspects,

- the communication resource information is received in at least one control channel element;
- the communication resource allocation information comprises at least one of a user equipment allocation, a user equipment identification and a cyclic redundancy code;
- the communication resource update information comprises at least one parameter of the communication resource to be updated and at least one of the following:

  i) at least one information element indicating whether or not the communication resource is to be updated;
  ii) a respective information field for each one of the at least one parameter;
  iii) a common information field for each one of the at least one parameter and one information element, wherein each parameter allocates a different information length in the common information field and the one information element in-

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dicates the information length of the common information field to be read out; and
iv) a common information field consisting of a number of bits, wherein combinations of the at least one parameter are coded by pattern of the number of bits;

- the communication resource update information comprises at least one of a timing alignment update, a power control update, a frequency update, a phase update, an update of phase differences, and an update of directivity of radiation;
- the communication resource information is received in at least one physical downlink control channel;
- the communication resource allocation information is an uplink scheduling grant;
- in the transceiving, the communication resource allocation information is received in at least one communication resource from a set of control channel candidates comprising the uplink scheduling grant;
- the communication resource information is an uplink scheduling grant for at least one resource of the uplink shared data channel;
- the communication resource allocation information is a downlink scheduling grant for at least one resource of the downlink shared data channel;
- in the transceiving, at least a signal is transmitted using a communication resource from at least one set of uplink shared data channel resources comprised in the uplink scheduling grant;
- in the transceiving, the communication resource to receive is at least one of the selected set of downlink shared data channel resources comprised in the downlink scheduling grant;
- the associating and the signalling are performed on a first communication layer of a layered communication model, and the transmitting and the receiving are performed on a second communication layer of the layered communication model different from the first communication layer;
- at least a portion of the communication resource update information comprises sequence number information;
- in the associating, an index indicating the association to the communication resource update information is attached, in the signalling, the index and the communication resource update information are signaled, and in the retrieving, the associated communication resource update information is retrieved based on the index;
- at least a portion of the index comprises sequence number information.

[0009] According to the present invention, in a third aspect, this object is for example achieved by **a method** comprising:

integrating communication resource update information into communication resource allocation information, the communication resource allocation information and the integrated communication resource update information each being a portion of communication resource information; and
transmitting the communication resource information.

[0010] According to the present invention, in a fourth aspect, this object is for example achieved by **a method** comprising:

receiving transmitted communication resource information comprising communication resource allocation information comprising integrated communication resource update information;
transceiving signals based on the communication resource allocation information using an allocated communication resource; and
updating the communication resource based on the integrated communication resource update information.

[0011] According to further refinements of the invention as defined under the above fourth aspect,

- the method according to the fourth aspect further comprises detecting the integrated communication resource update information based on an invalid format of the communication resource information.

[0012] According to the present invention, in a fifth aspect, this object is for example achieved by **an apparatus** comprising:

means for associating communication resource update information with communication resource allocation information, the communication resource allocation information and the associated communication resource update information each being a portion of communication resource information;
means for signalling the association of the communication resource update information with the communication resource allocation information; and
means for transmitting the communication resource information.

[0013] According to the present invention, in a sixth aspect, this object is for example achieved by **an apparatus** comprising:

means for receiving transmitted communication resource information comprising communication resource allocation information and associated communication resource update information, and for receiving a signaled association of the communication resource update information with the communication resource allocation information;

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means for retrieving the communication resource allocation information and the associated communication resource update information from the communication resource information based on the signaled association;
means for transceiving signals based on the communication resource allocation information using an allocated communication resource; and
means for updating the communication resource based on the communication resource update information.

[0014] According to further refinements of the invention as defined under the above fifth and sixth aspects,

- the communication resource information is received in at least one control channel element;
- the communication resource allocation information comprises at least one of a user equipment allocation, a user equipment identification and a cyclic redundancy code;
- the communication resource update information comprises at least one parameter of the communication resource to be updated and at least one of the following:

  i) at least one information element indicating whether or not the communication resource is to be updated;
  ii) a respective information field for each one of the at least one parameter;
  iii) a common information field for each one of the at least one parameter and one information element, wherein each parameter allocates a different information length in the common information field and the one information element indicates the information length of the common information field to be read out; and
  iv) a common information field consisting of a number of bits, wherein combinations of the at least one parameter are coded by pattern of the number of bits;

- the communication resource update information comprises at least one of a timing alignment update, a power control update, a frequency update, a phase update, an update of phase differences, and an update of directivity of radiation;
- the communication resource information is received in at least one physical downlink control channel;
- communication resource allocation information is an uplink scheduling grant;
- the means for transceiving is configured to receive the communication resource allocation information using at least one of a communication resource from a set of control channel candidates comprising the uplink scheduling grant;
- the communication resource information is an uplink scheduling grant for at least one resource of the uplink shared data channel;
- the communication resource allocation information is a downlink scheduling grant for at least one resource of the downlink shared data channel;'
- the means for transceiving is configured to transmit at least a signal in a communication resource from at least one of a set of uplink shared data channel resources comprised in the uplink scheduling grant;
- the communication resource to receive is at least one of the selected set of downlink shared data channel resources comprised in the downlink scheduling grant;
- the means for associating and the means for signalling are configured to operate on a first communication layer of a layered communication model, and the means for transmitting and the means for receiving are configured to operate on a second communication layer of the layered communication model different from the first communication layer;
- at least a portion of the communication resource update information comprises sequence number information;
- the means for associating is configured to attach an index indicating the association to the communication resource update information, the means for signalling is configured to signal the index and the communication resource update information, and the means for retrieving is configured to retrieve the associated communication resource update information based on the index;
- at least a portion of the index comprises sequence number information.

[0015] According to the present invention, in a seventh aspect, this object is for example achieved by **an apparatus** comprising:

means for integrating communication resource update information into communication resource allocation information, the communication resource allocation information and the integrated communication resource update information each being a portion of communication resource information; and
means for transmitting the communication resource information.

[0016] According to the present invention, in an eighth aspect, this object is for example achieved by **an apparatus** comprising:

means for receiving transmitted communication resource information comprising communication resource allocation information comprising integrated communication resource update information;
means for transceiving signals based on the communication resource allocation information using an allocated communication resource; and

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means for updating the communication resource based on the integrated communication resource update information.

[0017] According to further refinements of the invention as defined under the above eighth aspect,

- the apparatus according to the eighth aspect further comprises means for detecting the integrated communication resource update information based on an invalid format of the communication resource information.

[0018] According to further refinements of the invention as defined under the above fifth to eighth aspects,

- the apparatus according to the above fifth to eighth aspects is implemented as a chipset or module.

[0019] According to the present invention, in a ninth aspect, this object is for example achieved by **a system** comprising:

an apparatus according to the above fifth aspect; and at least one apparatus according to the above sixth aspect.

[0020] According to further refinements of the invention as defined under the above ninth aspect,

- the association of the communication resource update information with the communication resource allocation information is a one-to-one association;
- the association of the communication resource update information with the communication resource allocation information is unique for the communication resource allocation information.

[0021] According to the present invention, in a tenth aspect, this object is for example achieved by **a system** comprising:

an apparatus according to the above seventh aspect; and
at least one apparatus according to the above eighth aspect.

[0022] According to the present invention, in an eleventh aspect, this object is for example achieved by **a computer program product** comprising code means for performing methods steps of a method according to the above first to fourth aspects, when run on a computer.

[0023] In this connection, it has to be pointed out that the present invention enables one or more of the following:

- A-periodic and low rate control of timing and power can be coped with by providing a small overhead.
- Moreover, the PC control word and the TA control word appearing at variable rate events for a UE in a non-correlated manner for all the served UEs in the cell can be managed.
- Alternatively, the TA/PC updates may be logically associated also to DL scheduling grants (signalling entities). This is advantageous when UE has scheduled DL transmissions, but does not have any scheduled UL transmissions.
- The UL/DL control channel is dimensioned for transmission of so-called bursty control words in an efficient way.
- Since the signalling resource is shared between transmitted UL/DL scheduling grants, the overhead is in most cases smaller than when TA/PC updates are included to every UL/DL scheduling grant.
- Although TA/PC updates exhibit inherent so-called "burstiness" due to a-periodic updates, TA and PC tolerate relatively high and varying delays. Thus, the update bursts can be smoothened over several sub-frames, by delaying a portion of the TA/PC updates to later sub-frames, providing a more constant signalling load. This can be used to dimension the TA/PC update resources more tightly, thus, reducing the constant overhead further and increasing the efficiency e.g. of TA/PC resource usage.
- The overhead per TA/PC update is relatively small since the updates are associated with the UL/DL scheduling grant. Thus, the overhead due to the UE identification (as with special UL scheduling grants) is avoided.
- The signalling does not change the UL/DL scheduling grant format and, thus, does not impact the decoding complexity of UL/DL scheduling grants.
- The distribution of scheduling commands with control channel candidates or control channel elements remains unlimited by the TA/PC update. Thus, the allocation of UEs to control channel candidates or control channel elements can be done liberally. It is possible to code some other information more efficiently when this freedom of the allocation is available. If several competing optimizations all making use of a particular allocation are possible, then the one that gives the highest advantage may be selected. Explicit indexing such as set out herein below is more efficient than an individual TA/PC command, because the later would need to identify the UE. As there are typically more UEs in a cell or routing area than potential grants in a control channel, also more bits are necessary for an explicit UE identification compared to the indexing described herein below.
- TA/PC updates do not need to be coded individually but can be coded e.g. together with other information, including TA/PC updates for several UEs, or so-called Cat0 information indicating general properties of the scheduling structure, or with the UL/DL scheduling grant, or with a combination thereof.

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[0024] The present invention is directed to provide a signalling scheme for a bursty control of uplink transmission. More particularly, the present invention is directed to the design of UL/DL signalling needed for the signalling of UL power control commands and/or time alignment updates. In an embodiment of the present invention, a signalling design of the Physical Downlink Control Channel (PDCCH) is shown, which induces relatively small signalling overhead, while yet allowing fast scheduling and allocations in a sub-frame resolution both for the DL and UL payload. Alternatively, the TA/PC updates may be logically associated also to DL scheduling grants (signalling entities) e.g. in case the UE has scheduled DL transmissions, but does not have any scheduled UL transmissions.

[0025] More particularly, in the invention, TA and PC updates are transmitted preferably only for a fraction of the UEs having a UL/DL scheduling grant in a given sub-frame/preceding sub-frame. The TA/PC updates may be transmitted separately (e.g. on separate resource elements of PDCCH) from UL scheduling grants but each of TA/PC updates is logically associated to a particular control channel candidate, control channel element, or other such structure used in definition of UL/DL control channel. Hence, a TA/PC update is associated to the UL/DL scheduling grant that uses the corresponding control channel candidate or control channel element. This may associate a TA or PC update to a particular UE ID. As an alternative for implicit association, each of TA/PC updates may include a few bits explicitly indicating an associated control channel candidate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] Embodiments of the present invention are described herein below with reference to the accompanying drawings, in which:

[0027] Fig. 1 shows an example of control channel elements (CCE) and the control channel candidates;

[0028] Fig. 2A shows the signalling principle for the TA and/or PC updates with the UL scheduling grants on the DL control channel according to a first embodiment of the present invention; Fig. 2B shows the signalling principle for the TA and/or PC updates with the DL scheduling grants on the UL control channel according to the first embodiment of the present invention;

[0029] Fig. 3 shows a method for allocating communication resources according to the first embodiment of the present invention;

[0030] Fig. 4 shows one apparatus (e.g. a Base Station) for allocating communication resources according to the first embodiment of the present invention and another apparatus (e.g. a User Equipment) for decoding and interpreting the allocations and control signalling commands of the one apparatus, the another apparatus being configured to apply the allocations and control signalling commands e.g. in the signal transmission.

[0031] Fig. 5 shows a first example of association by means of control channel candidates according to the first embodiment of the present invention;

[0032] Fig. 6 shows a second example of association by means of control channel elements according to the first embodiment of the present invention;

[0033] Fig. 7 shows a method for allocating communication resources according to a second embodiment of the present invention; and

[0034] Fig. 8 shows one apparatus (e.g. a Base Station) for allocating communication resources according to the second embodiment of the present invention and another apparatus (e.g. a User Equipment) for decoding and interpreting the allocations and control signalling commands of the one apparatus, the another apparatus being configured to apply the allocations and control signalling commands e.g. in the signal transmission.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE PRESENT INVENTION

[0035] Embodiments of the present invention are described herein below by way of example with reference to the accompanying drawings.

[0036] There are several embodiments concerning e.g. implementation of the solution according to the present invention. Without being restricted thereto, several embodiments are described herein below, referring to "IMPLICIT AND EXPLICIT ASSOCIATION", "ASSOCIATION VIA CONTROL CHANNEL CANDIDATES/ELEMENTS", "ALTERNATIVE ASSOCIATIONS", "TRANSMISSION OF THE COMMUNICATION RESOURCE UPDATE INFORMATION", "UPDATING COMMUNICATION RESOURCES", and "NON-SCHEDULED UEs".

[0037] It is to be noted that for this description, the terms "TA/PC update(s)/command(s) (e.g. 2031,..., 203n)" and "UL/DL (scheduling) grants (e.g. 2021, ..., $202m_{UL/DL}$)" are examples for the communication resource update information and the communication resource allocation information, respectively, without restricting the latter terms to the special technical or implementation details imposed to the terms "TA/PC update (s)/command(s)" and "UL/DL (scheduling) grants".

[0038] Concerning especially the terms "TA" and/or "PC", there may be other updates than TA and/or PC, e.g. frequency control, phase control, control of phase differences on different sub-carriers or sub-bands, control of directivity of radiation to be used e.g. for beam forming, or control of other similar features. Furthermore, the term "TA/PC" refers to at least one of timing alignment and power control, i.e. TA (i.e. Timing Advance Control) and/or PC (Power Control) may be utilized both jointly and independently:

- Power Control independent of whether or not being used for Timing Advance Control;
- Timing Advance Control independent of whether or not being used for Power Control;

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- jointly to Power Control and Timing Advance Control, regardless of only either one of them being present at a time or of both of them being present at the same time.

[0039] Furthermore, a Power Control (PC) update may be applied to a selected multi-carrier or a single carrier signal waveform so that the previously applied transmission power on a symbol divided by the bandwidth may be updated with a relative increase or decrease of power for the subsequent transmission of symbols divided by the bandwidth. The bandwidth may change between the earlier transmission and the later transmission, which scale the actual transmission power independently of the applied power control divided by the bandwidth. Instead of the relative update mentioned above, as an alternative, also an absolute update inside a defined dynamic range may be provided.

[0040] In addition, a Timing Advance (TA) Update may be applied to a selected multi-carrier or a single carrier waveform so that the previously applied symbol timing in the uplink transmission relative to the downlink reception may be updated by a relative increase or decrease of time delay for the subsequent transmission of symbols. These TA updates may target e.g. at having in-phase symbol reception from multiple UEs at a BS receiver. Such alignment of reception time of symbols provides orthogonality, which reduce uplink interference and increase uplink capacity significantly.

[0041] Further, a Directivity update may be applied to a selected multi-carrier or a single carrier signal waveform so that the previously applied phase difference between multiple transmit antennas on a symbol may be updated to another phase difference between multiple antennas for the forthcoming transmission of symbols. The phase rotation between symbols transmitted from different antennas may be an absolute phase difference or a relative phase difference, updated from the phase difference applied in the earlier transmission.

[FIRST EMBODIMENT]

[0042] IMPLICIT AND EXPLICIT ASSOCIATION

[0043] One possible association principle is illustrated e.g. in Fig. 2A. A physical DL control channel PDCCH 201, as an example of communication resource (CR) information, may comprise from one up to M_{UL} UL scheduling grants 2021, 2022, 2023, 2024,...,202m as examples of CR allocation information. Alternatively, the up to M_{UL} UL scheduling grants may each be conveyed in a separate PDCCH. Each UL scheduling grant may comprise a user equipment identification UE ID, a cyclic redundancy code CRC, and a UE allocation for Physical Resource Blocks (PRBs) on shared data channels. Every PDCCH appears in transmission resources of e.g. one or more control channel candidates or control channel elements as shown in Fig. 1 mapped to the Physical Resource Elements in the transmission frames. The PDCCH 201 may further comprise up to N TA/PC updates 2031, 203n, as examples for CR update information. The TA/PC updates 2031, 203n may be respectively associated with one of the UL scheduling grants 2021,..., $202m_{UL}$ e.g. via indices 2041,...,204n, thus resulting in associations 205.

[0044] As an alternative, another possible association principle is illustrated e.g. in Fig. 2B. The PDCCH 201 may also comprise from one up to M_{DL} DL scheduling grants 2021, 2022, 2023, 2024,...,$202m_{DL}$ as examples of CR allocation information. Alternatively, the up to M_{DL} DL scheduling grants may each be conveyed in a separate PDCCH. It is to be noted that the amount of the number M_{UL} of the UL scheduling grants 2021,..., 202_{UL} and the number M_{DL} of the DL scheduling grants 2021,..., 202_{DL} may be equal or, as an alternative, different numbers. Each scheduling grant may comprise a user equipment identification UE ID, a cyclic redundancy code CRC, and a UE allocation for Physical Resource Blocks (PRBs) on the shared data channels. Every PDCCH appears in transmission resources of e.g. one or more control channel candidates or control channel elements as shown in Fig. 1 mapped to the Physical Resource Elements in the transmission frames. The PDCCH 201 may further comprise up to N TA/PC updates 2031, 203n, as examples for CR update information. The TA/PC updates 2031, 203n may be respectively associated with one of the DL scheduling grants 2021,...,202m e.g. via indices 2041,..., 204n, thus resulting in associations 205. It is to be noted that this alternative is applicable to the case when the UE has scheduled DL transmissions, but does not have any scheduled UL transmissions.

[0045] In case of implicit association 205 between UE ID and TA/PC update, the presence of the indices 2041,...,204n may not required, but the association(s) 205 may be signaled by other means, e.g. on a higher signalling layer or even be associated permanently in a fixed predetermined way, or there may be a default association that my be changed by higher layer signaling, if desired. In that case, the UE may decode the UL scheduling grant after reception. Then, the UE 1) is configured to inspect if a TA/PC update is possibly associated to the UL scheduling grant and 2) to decode the resources corresponding to TA/PC updates if necessary (e.g. when coded with a CRC).

[0046] A further option of implicit association 205 resides in fixedly associating a TA/PC update 2031,...,203n with a subset of the UL/DL scheduling grants 2021,..., $202m_{UL/DL}$ and transmitting the TA/PC update right together with the TA/PC updates of this subset. That means a constant overhead would be attached to the UL/DL scheduling grants in this subset, but not to the other UL/DL scheduling grants. UEs that need to get TA/PC updates can then be scheduled to use one of the UL/DL scheduling grants of this subset, while the remaining UEs could be scheduled to use any of the remaining grants. However, as the subset that does include TA/PC updates is set in advance, no blind decoding attempts from the

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UE are required and therefore, it does not complicate the decoding process of the UE. Therefore, the TA/PC updates do not need to be coded individually but can be coded with the UL/DL scheduling grant.

[0047] Also mixed variants between implicit and explicit associations are possible. For example, some TA/PC updates may be implicitly associated with UL/DL scheduling grants (or CCEs or candidates etc., for the sake of descriptive simplification, the rest of this section refers CCEs) while other ones may be associated explicitly. This is a compromise between full flexibility of explicit association and saving overhead for the indices required for explicit association. A further variant resides in at least some TA/PC updates being explicitly associated not with all possible CCEs, but only with a subset of those. This will reduce the number of bits required for addressing the subset compared to the full set. One variant of the latter that still maintains full flexibility resides in explicitly selecting a set of CCEs and then associating e.g. TA/PC updates with the elements of this set implicitly. The first TA/PC update may be associated with the first element of the set and so on, but other associations are possible as well. To select ns elements for a subset out of a total set of nt elements, there are nt! / (ns! * (nt-ns)!) possibilities, "!" being the factorial operator. This leads to less than the nt ^ ns possibilities to make ns individual associations, each to one of the nt elements, "^" being the exponentiation operator. This allows reducing the signaling amount i.e. the number of bits to signal the association. While the difference is typically not too big for large nt and small ns, for the case where both nt and ns are not too large or of similar size, the difference may well be sufficient to save at least one bit for signaling.

[0048] Another option to transmit the set of TA/PC updates resides in using one of the UL/DL scheduling grants (e.g. a grant for a predetermined dummy UE ID) and using the signaling space provided by the UL/DL scheduling grant for signaling this set of commands. In this way, there is no constant overhead in case no TA/PC updates are to be transmitted. The expense is additional blind detection with this predetermined UE ID. Depending on the detail of the coding, this may actually not be any additional overhead (if e.g. the CRC is bit wise exclusive or combined with the UE ID), or it may be an additional blind decoding attempt. In the latter case, it is possible to limit the set of possible locations even further than the set of grants. For example, in Fig. 5 it may be sufficient to only consider to use the first, 7th or last column, which would allow to aggregate either 1, 2 or 4 CCEs, which may provide in turn sufficient flexibility.

[0049] In case of explicit association 205 between UE ID and TA/PC update 2031,...,203n, the associated control channel candidate or control channel element is explicitly indicated on each of TA/PC update e.g. by means of the indices 2041,...,204n. Each UE having received an UL scheduling grant or a DL scheduling grant needs to decode also the TA/PC updates 2031,...,203n. The additional time consumed for the search and decoding of the TA/PC after a successful decoding of the scheduling grant is not that critical, because e.g. the L2 multiplexing, Transport Block creation and encoding can start immediately after the scheduling grant is available, and PC/TA are needed only beginning at the time instant of transmitting e.g. a first symbol of an UL sub-frame.

[0050] In summary, the association 205 between TA/PC updates 2031,...,203n and control channel candidates or control channel elements can e.g. be set by broadcasting the association(s) 205 via the System Information providing information e.g. about the network configuration within a cell, or by higher layer signalling. Alternatively, the association can be signaled together or as a part of the TA/PC signalling. For example, the index 2041,...,204n is attached with the TA/PC update 2031,...,203n providing information to which control channel candidates or control channel elements the TA/PC update 2031,...,203n refers to. The association 205 may effected between TA/PC updates 2031,...,2031 and UL scheduling grants 2021,...,$202m_{UL}$ or DL scheduling grants 2021,...,$202m_{DL}$, respectively.

[0051] As described herein below in further detail, the association 205 of the UL/DL scheduling grants 2021,..., $202m_{UL/DL}$ with the TA/PC updates 2031,...,203n may be a one-to-one association, or, as an alternative, may be unique for the UL/DL scheduling grants 2021, ..., $202m_{UL/DL}$, as indicated by the dashed arrows pointing, as examples, to the functional blocks of the UL/DL scheduling grants $2021_{UL/DL}$ and $2023_{UL/DL}$.

[0052] Fig. 3 shows the method for allocating CRs according to the present invention. Signalling between elements is indicated in horizontal direction, while time aspects between signalling are reflected in the vertical arrangement of the signalling sequence as well as in the sequence numbers.

[0053] As shown in Fig. 3, a communication network 300 may comprise a user equipment UE 301, a base station BS 302 and an access network 303. The BS 302 may be a portion of an access entity (not shown) providing access for the UE 301 to the access network 303. As shown in Fig. 3, communication or signalling from the UE 301 to the BS 302 is referred to as Uplink (UL), and communication or signalling from the BS 302 to the UE 301 is referred to as Downlink (DL).

[0054] In step S1, e.g. the BS 302 or any other entities in the access network 303, performs associating communication resource (CR) update information (e.g. TA/PC updates 2031,...,203n according to Fig. 2) with CR allocation information (e.g. UL/DL scheduling grants 2021,..., $202m_{UL/DL}$ or UE allocation, respectively). The CR allocation information and the associated CR update information may be a portion of CR information (e.g. the PDCCH 201). Further alternatives for this associating operation are set out in further detail herein below.

[0055] In step S2, the association(s) 205 are signaled from the BS 302 e.g. to the UE 301 e.g. implicitly (see e.g. above-described System Information or higher layer signalling) or explicitly (see e.g. above-described indices

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2041,...,204n).

[0056] In step S3, the CR information (e.g. PDCCH 201) comprising the CR update information and the CR allocation information are transmitted from the BS 302 to the UE 301. This transmitting operation is set out in further detail herein below.

[0057] It is to be noted that the above steps S2 and S3 may be performed in that order or in a reverse order, on the same communication layer or on different communication layers, substantially simultaneously (as shown in Fig. 3) or timely spaced, as long as provision of the CR update information 2031,...,203n, the CR allocation information 2021,..., $202m_{UL/DL}$ and the association(s) 205 to the UE 301 remains ascertained. Alternatively, the CR update information may be logically associated also to the preceding DL scheduling grants.

[0058] In step S4, the UE 301 performs retrieving the CR allocation information 2021,..., $202m_{UL/DL}$ and the associated CR update information 2031,...,203n from the transmitted CR information 201 based on the signaled association(s) 205. This retrieval operation is set out in further detail herein below.

[0059] In step S5, the UE 301 performs transceiving signals using the allocated CR 304 allocated e.g. by the BS 302 or the access network 303.

[0060] In step S6, the UE 301 performs updating the CR based on the communication resource update information (e.g. power-controlling the allocated CR by increasing/decreasing transmitting power according to the PC update received. As an example, increased transmitting power is shown in Fig. 3 by a thick arrow extending from the functional block of step S6).

[0061] Fig. 4 shows apparatuses (i.e. user equipment 301 and base station 302) according to the present invention. The BS 302 of the access network 303 comprises a sender TX 3021, a receiver 3022, a central processing unit (CPU) 3023, a memory 3014 and means for associating 3025. The CPU 3023 may be configured to process various data inputs and to control the functions of TX 3021, the RX 3022, the memory 3024 and means for associating or associator 3025. The memory 3024 serves for storing code means for carrying out e.g. the method according to the invention, when run on the CPU 3023, and e.g. for storing the CR update information 2031,...,203n, the CR allocation information 2021,..., $202m_{UL/DL}$, and optionally the indices 2041,...,204n. The RX 3022 as well as the TX 3021 may optionally be configured to receive (transmit) on different communication layers, as described herein above. It is to be noted that the TX 3021 and the RX 3022 may be provided as separate means (as shown in Fig. 4), but may also be provided as an integral transceiver (not shown). Furthermore, the associating means 3025 may also be, in part or as a whole, comprised in an entity different from the BS 302. As an example of a communication resource (CR), an uplink CR 304 (e.g. an uplink channel for uplink transmission from the UE 301 to the BS 302) is shown in Fig. 4.

[0062] The means for associating 3025 of the BS 302 may be configured to associate communication resource update information 2031,...,203n with communication resource allocation information 2021,..., $202m_{UL/DL}$, the communication resource allocation information 2031,..., 203n and the associated communication resource update information 2031,...,203n each being a portion of communication resource information 201.

[0063] The means for sending 3021 of the BS 302 may be configured to signal the association 205 of the communication resource update information 2031,...,203n with the communication resource allocation information 2021,..., $202m_{UL/DL}$, and also may be configured to transmit the communication resource information 201. As mentioned above, the communication resource update information 2031,...,203n may be signaled/transmitted on the same communication layer (e.g. L1/L2 signalling) as the communication resource allocation information 2021,..., $202m_{UL/DL}$, or alternatively on a higher communication layer.

[0064] As also shown in Fig. 4, the UE 301 comprises a sender TX 3011, a receiver or means for receiving 3012, a central processing unit CPU 3013 and a memory 3014. The CPU 3013 may be configured to process various data inputs and to control the functions of TX 3011, the RX 3012 and the memory 3014. The memory 3014 serves for storing code means for carrying out e.g. the method according to the invention, when run on the CPU 3013. The RX 3012 as well as the TX 3011 may optionally be configured to receive or transmit on different communication layers, as described herein above. It is to be noted that the TX 3011 and the RX 3012 may be provided as separate means (as shown in Fig. 4), but also be provided as an integral transceiver (not shown).

[0065] The means for receiving 3012 of the UE 301 may be configured to receive the transmitted communication resource information 201 comprising communication resource allocation information 2021,..., $202m_{UL/DL}$ and associated communication resource update information 2031,...,203n, and may be configured to receive the signaled association 205 of the communication resource update information 2031,...,203n with the communication resource allocation information 2021,..., $202m_{UL/DL}$. As mentioned above, the communication resource update information 2031,...,203n may be received on the same communication layer (e.g. L1/L2 signalling) as the communication resource allocation information 2021,..., $202m_{UL/DL}$, or alternatively on a different communication layer.

[0066] The CPU 3013 and e.g. the means for receiving 3012 and the memory 3014 of the UE 301 may be configured to retrieve the communication resource allocation information 2021,..., $202m_{UL/DL}$ and the associated communication resource update information 2031,...,203n from the communication resource information 201 based on the signaled association 205.

[0067] Further, the CPU 3013 and e.g. the means for sending 3011, the means for receiving 3012 and the

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memory 3014 of the UE 301 may also be configured to transceive signals using the allocated CR (e.g. an Uplink transmission channel, uplink CR hereinafter) based on the communication resource allocation information 2021,..., $202m_{UL/DL}$.

[0068] Additionally, the CPU 3013 and e.g. the means for sending 3012 and the memory 3014 of the UE 301 may also be configured to update the communication resource 304 (e.g. Uplink CR) based on the communication resource update information 2031,...,203n.

[0069] In addition to the description given above e.g. in the section labeled "IMPLICIT AND EXPLICIT ASSOCIATION", the following description provides embodiments of the present invention with particular regard to the terms "associating" and "association".

[0070] ASSOCIATION VIA CONTROL CHANNEL CANDIDATES

[0071] In Fig. 5, as an example, the association of a TA/PC update 2031,...,203n to a UL/DL scheduling grant 2021,..., $202m_{UL/DL}$ by means of control channel candidates 1 to 10 (1st to 10th columns) is illustrated. The set of candidate control channels monitored by the UE 301 may contain at least one control channel candidate (columns with functional blocks TA/PC 1, TA/PC2 and TA/PC 3 pointing to the same) which is associated with a TA/PC update 2031,...,203n.

[0072] As mentioned herein below, the BS 302 may decide to allocate for UE 301 at least one control channel candidate (Fig. 5: "Used control channel/CCE mapping", 5th to 8th control channel candidates) indicated by the functional blocks of the CCEs being hatched from bottom left to top right. According to Fig. 5, control channel candidates 7 to 9 are associated with a respective TA/PC update 2031,...,203n. When decoding the control channel candidates, particularly the 7th or 8th control channel candidate, the UE 301 may be configured to detect the association 205 of these 7th or 8th control channel candidates, to retrieve the corresponding TA/PC update 2031,...,203n (TA/PC 1 or TA/PC2 according to Fig. 5, TA/PC 3 remains unused in this example), and to update the corresponding UL resource according to the retrieved TA/PC update 2031,...,203n e.g. for the subsequent UL transmission.

[0073] ASSOCIATION VIA CONTROL CHANNEL ELEMENTS

[0074] As shown in Fig. 6, as an alternative to the above "ASSOCIATION VIA CONTROL CHANNEL CANDIDATES", the association 205 of the TA/PC update 2031,...,203n to a UL scheduling grant 2021,..., $202m_{UL/DL}$ may also be effected by means of control channel elements 1 to 6 (1st to 6th lines according to Fig. 5). The set of candidate control channels (CCEs) monitored by the UE 301 may contain at least one control channel element which is associated with a TA/PC update 2031,...,203n.

[0075] As mentioned herein below, the BS 302 may decide to allocate for UE 301 at least one control channel candidate (Fig. 6: "Used control channel/CCE mapping", 5th to 8th control channel candidate) indicated by the functional blocks of the CCEs being hatched from bottom left to top right. According to Fig. 6, control channel elements (CCEs) 1, 3, and 5 are associated with a respective TA/PC update 2031,...,203n. When decoding the control channel candidates, particularly the 5th, 7th or 8th control channel candidates (Fig. 6: "Control channels with associated TA/PC update"), the UE 301 may be configured to detect the association 205 of these 1st, 3rd, or 5th control channel element (CCE), to retrieve the corresponding TA/PC update 2031,...,203n (TA/PC 1, TA/PC2 or TA/PC 3 according to Fig. 5), and to update the corresponding UL resource according to the retrieved TA/PC update 2031,...,203n e.g. for the subsequent UL transmission. It is to be noted that in this example, also control channel candidates 1, 3, 9, and 10 would also be associated, via control channel elements 1, 3, and 5, with at least one TA/PC update 2031,...,203n, but these control channel candidates 1, 3, 9, and 10 are considered to be not allocable by the UE 301 for any reason.

[0076] ALTERNATIVE ASSOCIATIONS

[0077] Alternatively, special associations 205 (e.g. pointers) may be defined that i) point to all the CR allocation information 2021,..., $202m_{UL/DL}$, or ii) point to possibly only a part of all the CR allocation information 2021,...,$202m_{UL/DL}$ e.g. only for the allocations using intra TTI (Transmission Time Interval) hopping, typically the persistently scheduled UEs, or iii) even indicate that e.g. the PC is applicable to a plurality of UEs 301. This may be favorable if e.g. all the UEs 301 e.g. need to be power-controlled (e.g. power up/down) because of a sudden rise/reduction in interference from (or to) neighboring cells. Thus, few indices may be reserved as special associations 205 to indicate which specific (sets of) UEs 301 are addressed. In that case, as shown in Fig. 2, association(s) 205 which is (are) unique for the CR allocation information 2021,..., $202m_{UL/DL}$, but is (are) not a one-to-one association, may be used.

[0078] TRANSMISSION OF THE COMMUNICATION RESOURCE UPDATE INFORMATION

[0079] As described hereinabove, TA/PC updates 2031,...,203n may be transmitted e.g. on a DL control channel element (elements) (CCE/CCEs) that is especially reserved for them. Furthermore, TA/PC updates 2031,...,203n may be encoded separately from the corresponding scheduling grants 2021,..., $202m_{UL/DL}$. With respect to each other, the multiple TA/PC updates 2031,...,203n may be encoded either separately or jointly, possibly with a CRC. In the case of joint coding, the code rate for the TA/PC updates 2031,...,203n may be selected e.g. according to the requirements of the UL/DL scheduling grant 2021,..., $202m_{UL/DL}$ having the lowest code rate from the UL grants 2021,..., $202m_{UL/DL}$ with associated TA/PC update 2031,...,203n, thus, e.g. requiring blind decoding at the UE 301.

[0080] Furthermore, TA/PC updates 2031,...,203n may be mapped directly on DL resource elements (e.g. control channel elements) that are especially reserved

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for them. Again, the TA/PC updates 2031,...,203n may be encoded either jointly or separately, or protected by spreading. The TA/PC updates 2031,...,203n of different users may e.g. be frequency, or time divided or code division multiplexed on the resource elements (except with joint encoding). It is obvious that the control channels for different UEs may apply a reasonable combination of the aforementioned multiplexing schemes in time-, frequency- and code-domains.

[0081] UPDATING COMMUNICATION RESOURCES

[0082] There are multiple possibilities for allocating resources for the TA/PC updates 2031,...,203n and e.g. for multiplexing the TA/PC updates 2031,...,203n to the PDCCH 201. The amount of resources allocated for TA/PC updates 2031,...,203n remains semi-statically constant. In order to maintain a constant allocation of communication resources (CRs) for TA/PC updates 2031,...,203n, the number of TA/PC updates 2031,...,203n e.g. per subframe may vary according the used coding scheme. The resources allocated for TA/PC updates 2031,...,203n may e.g. be set on System Information or by higher layer signalling.

[0083] In addition, there are multiple possibilities for signalling TA/PC updates 2031,...,203n:

- An information element (e.g. one bit) may be added to each TA/PC entry 2031,...,203n indicating whether TA or PC is updated in case that the number of bits for TA and PC updates is equal.
- Each TA/PC update 2031,...,203n may include separate fields for both TA and PC updates, especially if either TA or PC or both may be updated simultaneously. A variant of this is a field, which carries the longer control word (e.g. PC) and a leading bit, which indicates that the shorter control word (e.g. TA) is actually in use. This allows a) the longer control word to be signaled alone, b) the shorter control word to be signaled alone (with unused bits set to 0, and c) both control words to be signaled simultaneously so that the shorter control word is present fully, but the resolution (accuracy) of the longer control word may be reduced to the number of bits remaining unused from the shorter control word.
- E.g. on each sub-frame, a permanent number of TA/PC updates 2031,...,203n may be reserved for TA only, while the remaining TA/PC updates 2031,..., 203n may be used for PC (e.g. with 3 updates/subframe, update #1 is used for TA and updates #2 and #3 are used for PC). In this case, the selection between TA and PC update 2031,...,203n may be performed implicitly by the selection of the CCE or control channel candidate used for the UL scheduling grant 2021,..., $202m_{UL/DL}$.
- Alternatively, more general implementations for the TA/PC updates 2031,...,203n are possible as well: there may be some number of possible TA/PC command combinations e.g. 4 bits allowing 16 different commands. It is not necessary to split bits for TA/PC strictly, but it is also possible to assign some of the 16 commands to specific meanings for TA/PC, e.g. there may be 3 possible values for Power control (e.g. +1db, -1dB and -3dB power change) and 5 values for TA. Then there are 3*5=15 combinations that can be assigned 15 out of the 16 possible commands. The last command may be used for a specific action, e.g. power control step of -5dB but no change in TA. In other words, some of the possible update values correspond to TA updates, some values to PC updates and some to a combination of both TA and PC updates.

[0084] Alternatively, e.g. a PC command 2031,...,203n may need to be repeated. However, the UEs 301 receiving the PC command 2031,...,203n more often, may have to ignore the PC repeated command, based on either a kind of sequence number or timer or both. This is in particular relevant for the case that commands are sent targeting not only a single UE but multiple UEs as described above.

[0085] Alternatively, since UEs 301 may have different DRX (Discontinuous Reception) cycles, a PC command 2031,...,203n may also need to be repeated. However, the UEs 301 receiving the PC command 2031,...,203n more often, may have to ignore the repeated PC command, based on either a kind of sequence number or timer or both. In this case, e.g. sequence number information can be part of the index as well (doubling the number of indices to reserve) or can be part of the "command" 2031,...,203n itself: There is typically no reason that TA control is needed for multiple UEs 301 because it is unlikely that several UEs change their location at the same time (an exception may be UEs traveling in a bus or train on similarly the same transport vehicle or at least at the same speed in the same direction e.g. multiple cars in a row). Therefore, the TA part can be used to convey a sequence number.

[0086] Furthermore, the UE 301 may be configured to apply both such a common and an independent command for an individual PC command 2031,...,203n due to path-loss changes or other reasons. There may be also cases where the UE 301 may be configured to apply multiple individual commands; this could be used to make infrequent larger steps without allocating more bits to every command field. For example, this may be used for TA changes for infrequent round the corner events requiring unusually large TA changes and possibly also power changes.

[SECOND EMBODIMENT]

[0087] In the following, the second embodiment according to the present invention is described with reference to Figs. 7 and 8. It is to be noted that any description of means identical or substantially identical with those of the first embodiment (UE 301, BS 302, Access network

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303, memories 3014 and 3024, sender 3011, receiver 3022, and CPUs 3013 and 3023) is omitted.

[0088] As shown in Figs. 7 and 8, the method and the one apparatus according to the second embodiment comprise:

- in step S1 or means for integrating 3025, integrating of the communication resource update information (2031 to 203n) into the communication resource allocation information (2021 to $202m_{UL/DL}$) is performed, the communication resource allocation information and the associated communication resource update information each being a portion of communication resource information (201); and
- in step S2 or the means for sending 3021 e.g. in conjunction with the CPU 3023 and the memory 3024, transmitting of the communication resource information is performed e.g. on the L1/L2 control channel.

[0089] As also shown in Figs. 7 and 8, the method and the another apparatus according to the second embodiment comprise:

- in step S2 or the means for receiving 3011 e.g. in conjunction with the CPU 3013 and the memory 3014, receiving of the transmitted communication resource information (201) comprising communication resource allocation information (2021 to $202m_{UL/DL}$) comprising integrated resource update information (2031 to 203n) is performed;
- in optional step S21 or optionally e.g. in the CPU 3013 and the memory 3014, detecting of the integrated communication resource update information based e.g. on an invalid format of the communication resource information is performed;
- steps S3 and S4 are substantially identical with steps S5 and S5, respectively, according to the first embodiment of the present invention, with the exception that step s4 or the CPU 3013 e.g. in conjunction with the memory 3014 may optionally be configured to perform updating of the communication resource based on the detected integrated communication resource update information.

[0090] In summary, according to the second embodiment the present invention e.g. the L1/L2 control channel may be used. Although the TA and PC updates are not acknowledged, the robustness of the signalling may be comparable to the one of higher layer signalling. Furthermore, if relative signalling is used, then neither TA nor PC signalling is so critical regarding lost signalling: If the UE does miss a command and consequently does not apply it, a so-called NodeB will realize that the power or timing is still not appropriate and will send another TA/PC command that will cure the loss of the first one.

[0091] One option according to the second embodiment of the present invention for signalling on L1/L2 control channel is to include or integrate TA and/or PC updates into each UL/DL scheduling grant, as described herein below. The overhead per each transmitted TA/PC update is minimal, while this solution creates only a minimum constant overhead when no TA and/or PC updates are transmitted. If, due to the low rate of TA and/or PC updates, the constant non-essential overhead in case of no TA and/or PC updates being transmitted becomes larger, then this solution may be further optimized by the further embodiments described herein above.

[0092] An alternative option according to the second embodiment of the present invention resides in a specific UL/DL scheduling grant e.g. for at least one of TA and/or PC updates. The specific UL/DL scheduling grant containing e.g. TA and/or PC can be identified by an invalid format of the information carried by the L1/L2 control channel. The signalling overhead per each transmitted TA/PC update was estimated to be less than 40 bits, and this solution does not cause any overhead when no TA or PC updates are transmitted.

[0093] Yet another option according to the second embodiment of the present invention is to define a specific L1/L2 signalling e.g. for TA and/or PC updates.

[0094] [Further embodiments]

[0095] For the purpose of the present invention as described herein above, it should be noted that

- an access technology may be any technology by means of which a UE can access a communication network via a BS. Any present or future technologies, such as WiMAX, WLAN, BlueTooth©, Infrared, and the like may be used;
- generally, the present invention is applicable in those BS/UE environments relying e.g. on the Internet Protocol IP. The present invention is, however, not limited thereto, and any other present or future MIP version, or, more generally, a protocol following similar principles as MIPv4/6, is also applicable;
- method steps likely to be implemented as software code portions and being run using a processor at the network element, are software code independent and can be specified using any known or future developed programming language as long as the functionality defined by the method steps is preserved;
- generally, any method step is suitable to be implemented as software or by hardware without changing the idea of the present invention in terms of the functionality implemented;
- method steps and/or devices, units or means likely to be implemented as hardware components at a terminal or network element or module thereof are hardware independent and can be implemented using any known or future developed hardware technology or any hybrids of these, such as MOS (Metal Oxide Semiconductor), CMOS (Complementary MOS), BiMOS (Bipolar MOS), BiCMOS (Bipolar CMOS), ECL (Emitter Coupled Logic), TTL (Transistor-Transistor Logic), etc., using for example

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ASIC (Application Specific IC (Integrated Circuit)) components, FPGA (Field-programmable Gate Arrays) components, CPLD (Complex Programmable Logic Device) components or DSP (Digital Signal Processor) components;

- devices, units or means (e.g. user equipment and base station) can be implemented as individual devices, units or means, but this does not exclude that they are implemented in a distributed fashion throughout the system, as long as the functionality of the device, unit or means is preserved.

[0096] NON-SCHEDULED UEs

[0097] As described above, the invention provides a signalling method for UEs with scheduled UL transmission. Special considerations are needed for UEs without any scheduled UL transmissions. The presented signalling method can be used for TA/PC update signalling specific for UEs with scheduled UL transmission (with a separate TA/PC update signalling for UEs without any scheduled UL transmissions or by forcing scheduled transmissions for UEs requiring TA/PC updating). Alternatively, it is possible to compose an essential part of TA/PC update signalling scheme serving UEs both with and without scheduled UL transmission. Such a solution resides in implicit association of the code sequence index used in the non-scheduled uplink channel to the code sequence index of the TA/PC control channel in the downlink. This applies especially to the code multiplexed downlink TA/PC control channel. This method, however, is equally well applicable to a multiplexing scheme, where frequency- and/or time-multiplexing is applied in addition to the mentioned code multiplexing technique.

[0098] A simple example of this is that there exist semi-statically reserved resources in the downlink frequency domain so that a set of orthogonal spreading factor sequences are available per frequency index. Thus, any PC/TA command that is needed may use its own (UE specific) code index and may be multiplexed with any other UE simultaneously to the same sub-carrier resources, up to the maximum number of UEs equal to the spreading factor. If the PC/TA control resource is not sufficient on these sub-carriers, an additional other set of frequency shifted sub-carriers can be reserved to double the signalling capacity. Again, the same set of code sequence indexes with the same spreading factor are available, as they are uniquely separated from the first set by the frequency indexes of the sub-carrier set. The frequency indexes of the orthogonal sets can further be associated to the scheduled uplink grants based on their CCE index number.

Claims

1. A method, comprising:

   associating communication resource update information with communication resource allocation information, the communication resource allocation information and the associated communication resource update information each being a portion of communication resource information;
   signalling the association of the communication resource update information with the communication resource allocation information; and
   transmitting the communication resource information.

2. A method, comprising:

   receiving transmitted communication resource information comprising communication resource allocation information, associated communication resource update information, and a signaled association of the communication resource update information with the communication resource allocation information;
   retrieving the communication resource allocation information and the associated communication resource update information from the communication resource information based on the signaled association;
   transceiving signals based on the communication resource allocation information using an allocated communication resource; and
   updating the communication resource based on the communication resource update information.

3. The method according to claims 1 or 2, wherein the communication resource information is received in at least one control channel element.

4. The method according to any one of claims 1 to 3, wherein the communication resource allocation information comprises at least one of a user equipment allocation, a user equipment identification and a cyclic redundancy code.

5. The method according to any one of claims 1 to 4, wherein the communication resource update information comprises at least one parameter of the communication resource to be updated and at least one of the following:

   i) at least one information element indicating whether or not the communication resource is to be updated;
   ii) a respective information field for each one of the at least one parameter;
   iii) a common information field for each one of the at least one parameter and one information element, wherein each parameter allocates a different information length in the common infor-

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mation field and the one information element indicates the information length of the common information field to be read out; and
iv) a common information field consisting of a number of bits, wherein combinations of the at least one parameter are coded by pattern of the number of bits.

6. The method according to any one of claims 1 to 5, wherein the communication resource update information comprises at least one of a timing alignment update, a power control update, a frequency update, a phase update, an update of phase differences, and an update of directivity of radiation.

7. The method according to any one of claims 1 to 6, wherein the communication resource information is received in at least one physical downlink control channel.

8. The method according to claim 7, wherein the communication resource allocation information is an uplink scheduling grant.

9. The method according to claim 8, wherein, in the transceiving, the communication resource allocation information is received in at least one communication resource from a set of control channel candidates comprising the uplink scheduling grant.

10. The method according to any one of claims 1 to 6, wherein the communication resource information is an uplink scheduling grant for at least one resource of the uplink shared data channel.

11. The method according to claim 10, wherein the communication resource allocation information is a downlink scheduling grant for at least one resource of the downlink shared data channel.

12. The method according to claim 11, wherein, in the transceiving, at least a signal is transmitted using a communication resource from at least one set of uplink shared data channel resources comprised in the uplink scheduling grant.

13. The method according to claims 9 or 12, wherein, in the transceiving, the communication resource to receive is at least one of the selected set of downlink shared data channel resources comprised in the downlink scheduling grant.

14. The method according to any one of claims 1 to 13, wherein the associating and the signalling are performed on a first communication layer of a layered communication model, and the transmitting and the receiving are performed on a second communication layer of the layered communication model different from the first communication layer.

15. The method according to any one of claims 1 to 14, wherein at least a portion of the communication resource update information comprises sequence number information.

16. The method according to any one of claims 1 to 14, wherein, in the associating, an index indicating the association to the communication resource update information is attached, in the signalling, the index and the communication resource update information are signaled, and in the retrieving, the associated communication resource update information is retrieved based on the index.

17. The method according to claim 16, wherein at least a portion of the index comprises sequence number information.

18. A method, comprising:

integrating communication resource update information into communication resource allocation information, the communication resource allocation information and the integrated communication resource update information each being a portion of communication resource information; and
transmitting the communication resource information.

19. A method, comprising:

receiving transmitted communication resource information comprising communication resource allocation information comprising integrated communication resource update information;
transceiving signals based on the communication resource allocation information using an allocated communication resource; and
updating the communication resource based on the integrated communication resource update information.

20. The method according to claim 19, further comprising
detecting the integrated communication resource update information based on an invalid format of the communication resource information.

21. An apparatus, comprising:

means for associating communication resource update information with communication resource allocation information, the communication resource allocation information and the as-

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sociated communication resource update information each being a portion of communication resource information;
means for signalling the association of the communication resource update information with the communication resource allocation information; and
means for transmitting the communication resource information.

22. An apparatus, comprising:

means for receiving transmitted communication resource information comprising communication resource allocation information and associated communication resource update information, and for receiving a signaled association of the communication resource update information with the communication resource allocation information;
means for retrieving the communication resource allocation information and the associated communication resource update information from the communication resource information based on the signaled association;
means for transceiving signals based on the communication resource allocation information using an allocated communication resource; and
means for updating the communication resource based on the communication resource update information.

23. The apparatus according to claims 21 or 22, wherein the communication resource information is received in at least one control channel element.

24. The apparatus according to any one of claims 21 to 23, wherein the communication resource allocation information comprises at least one of a user equipment allocation, a user equipment identification and a cyclic redundancy code.

25. The apparatus according to any one of claims 21 to 24, wherein the communication resource update information comprises at least one parameter of the communication resource to be updated and at least one of the following:

i) at least one information element indicating whether or not the communication resource is to be updated;
ii) a respective information field for each one of the at least one parameter;
iii) a common information field for each one of the at least one parameter and one information element, wherein each parameter allocates a different information length in the common information field and the one information element indicates the information length of the common information field to be read out; and
iv) a common information field consisting of a number of bits, wherein combinations of the at least one parameter are coded by pattern of the number of bits.

26. The apparatus according to any one of claims 21 to 25, wherein the communication resource update information comprises at least one of a timing alignment update, a power control update, a frequency update, a phase update, an update of phase differences, and an update of directivity of radiation.

27. The apparatus according to any one of claims 21 to 26, wherein the communication resource information is received in at least one physical downlink control channel.

28. The apparatus according to claim 27, wherein the communication resource allocation information is an uplink scheduling grant.

29. The apparatus according to claim 28, wherein the means for transceiving is configured to receive the communication resource allocation information using at least one of a communication resource from a set of control channel candidates comprising the uplink scheduling grant.

30. The apparatus according to any one of claims 21 to 29, wherein the communication resource information is an uplink scheduling grant for at least one resource of the uplink shared data channel.

31. The apparatus according to claim 30, wherein the communication resource allocation information is a downlink scheduling grant for at least one resource of the downlink shared data channel.

32. The apparatus according to claim 31, wherein the means for transceiving is configured to transmit at least a signal in a communication resource from at least one of a set of uplink shared data channel resources comprised in the uplink scheduling grant.

33. The apparatus according to claims 29 or 32, wherein the communication resource to receive is at least one of the selected set of downlink shared data channel resources comprised in the downlink scheduling grant.

34. The apparatus according to any one of claims 21 to 33, wherein the means for associating and the means for signalling are configured to operate on a first communication layer of a layered communication model, and the means for transmitting and the

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means for receiving are configured to operate on a second communication layer of the layered communication model different from the first communication layer.

35. The apparatus according to any one of claims 21 to 34, wherein at least a portion of the communication resource update information comprises sequence number information.

36. The apparatus according to any one of claims 21 to 34, wherein the means for associating is configured to attach an index indicating the association to the communication resource update information, the means for signalling is configured to signal the index and the communication resource update information, and the means for retrieving is configured to retrieve the associated communication resource update information based on the index.

37. The apparatus according to claim 36, wherein at least a portion of the index comprises sequence number information.

38. An apparatus, comprising:

means for integrating communication resource update information into communication resource allocation information, the communication resource allocation information and the integrated communication resource update information each being a portion of communication resource information; and
means for transmitting the communication resource information.

39. An apparatus, comprising:

means for receiving transmitted communication resource information comprising communication resource allocation information comprising integrated communication resource update information;
means for transceiving signals based on the communication resource allocation information using an allocated communication resource; and
means for updating the communication resource based on the integrated communication resource update information.

40. The apparatus according to claim 39, further comprising
means for detecting the integrated communication resource update information based on an invalid format of the communication resource information.

41. The apparatus according to any one of claims 21 to 40, wherein the apparatus is implemented as a chipset or module.

42. A system, comprising:

an apparatus according to claim 21; and
at least one apparatus according to claim 22.

43. The system according to claim 42, wherein the association of the communication resource update information with the communication resource allocation information is a one-to-one association.

44. The system according to claim 42, wherein the association of the communication resource update information with the communication resource allocation information is unique for the communication resource allocation information.

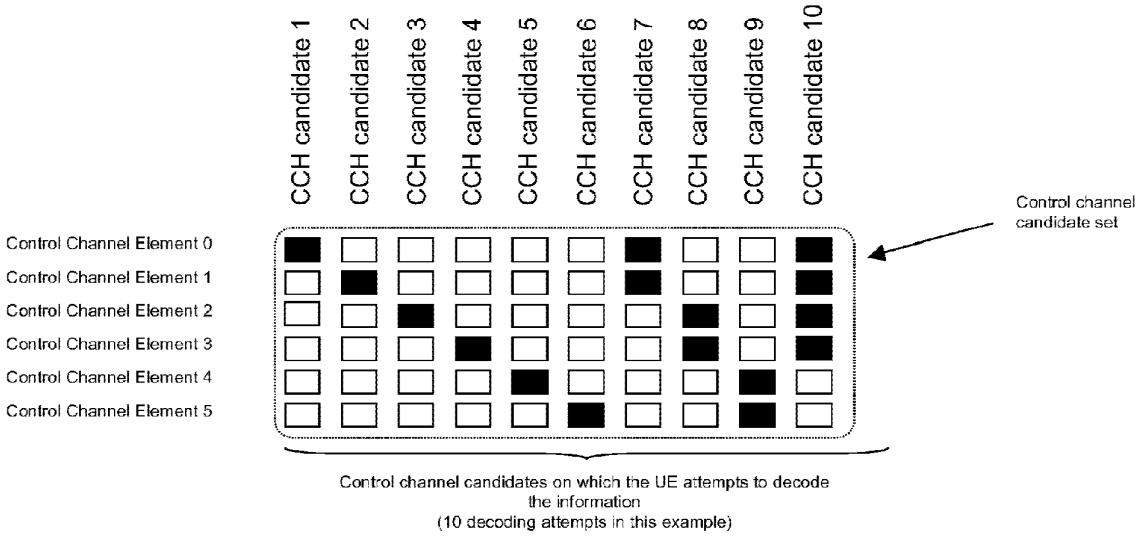
45. A system, comprising:

an apparatus according to claim 38; and
at least one apparatus according to claim 39.

46. A computer program product comprising code means for performing methods steps of a method according to any one of claims 1 to 20, when run on a computer.

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Fig. 1



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Fig. 2A

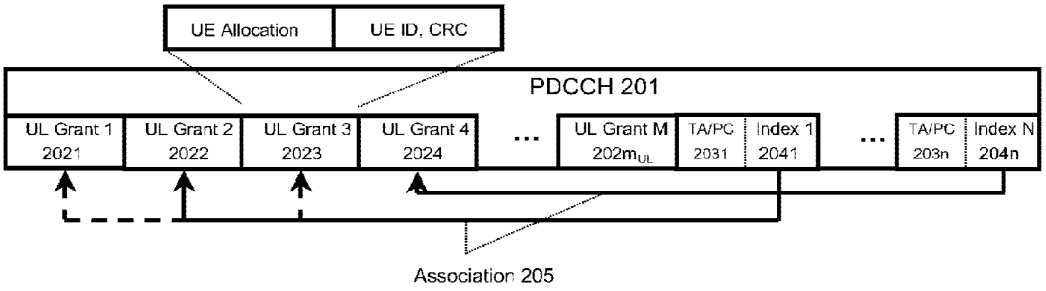
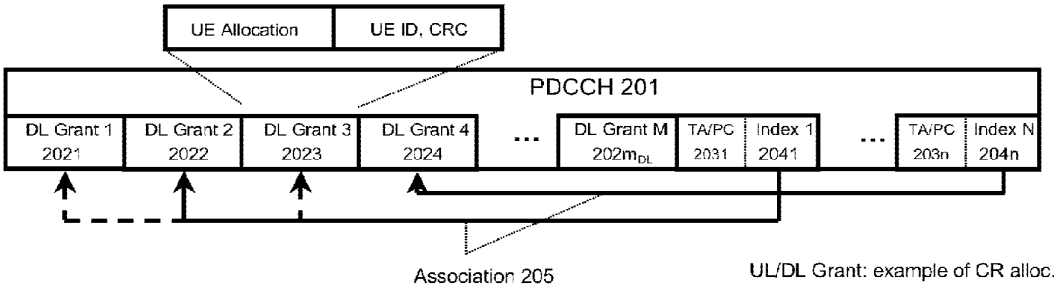


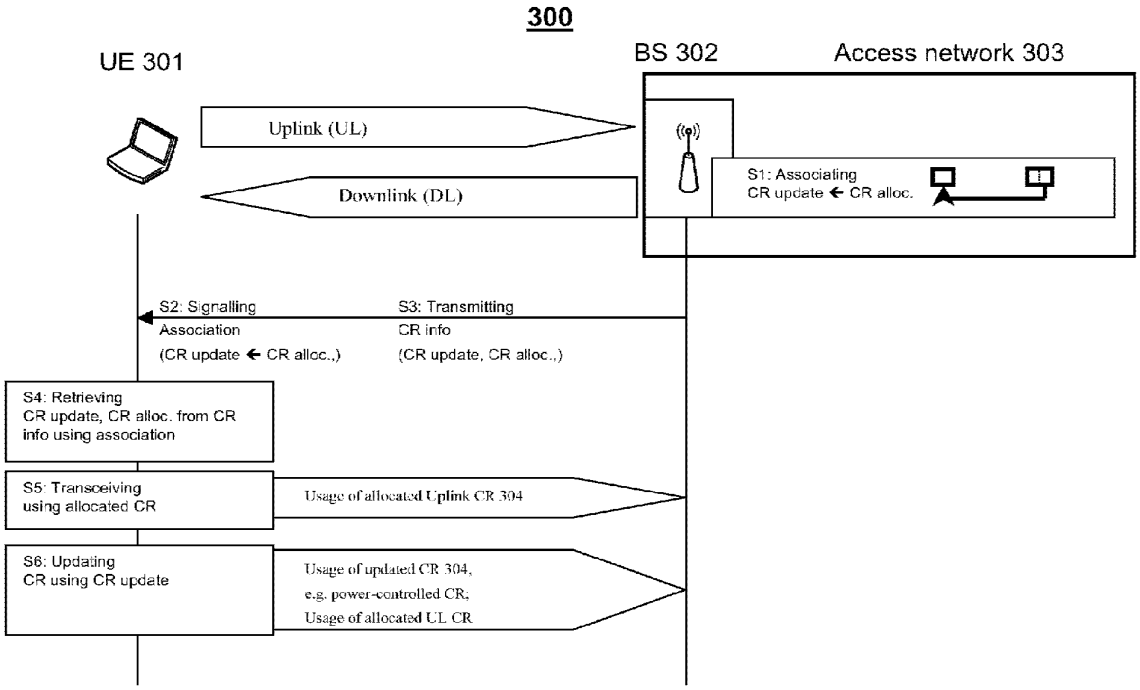
Fig. 2B



UL/DL Grant: example of CR alloc. info
TA/PC: The PC and/or TA command,
Example of CR update info.
PDCCH: example of CR resource info

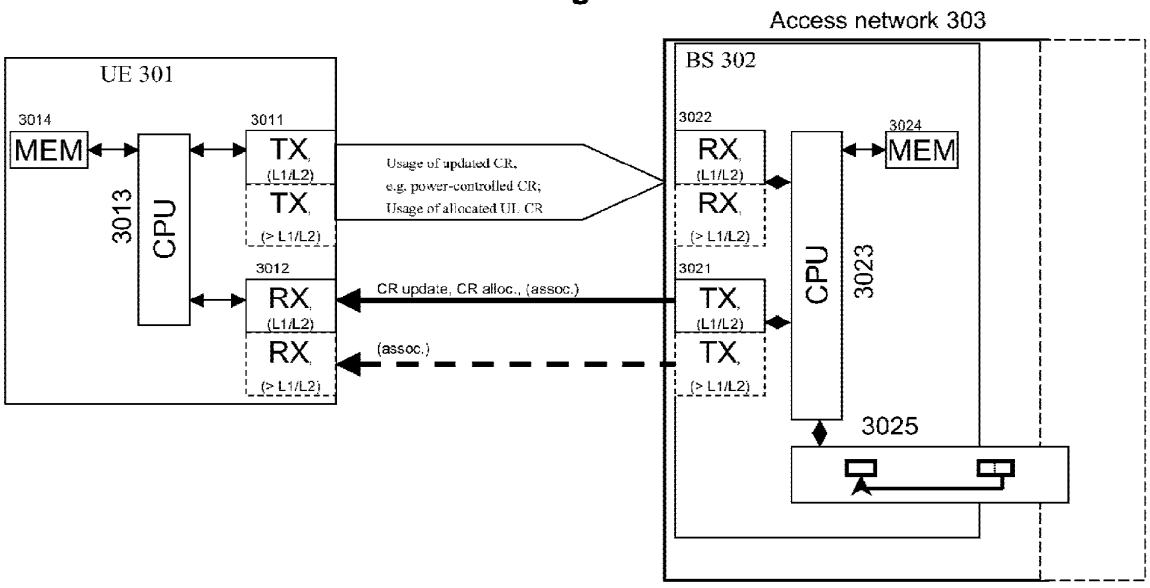
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Fig. 3



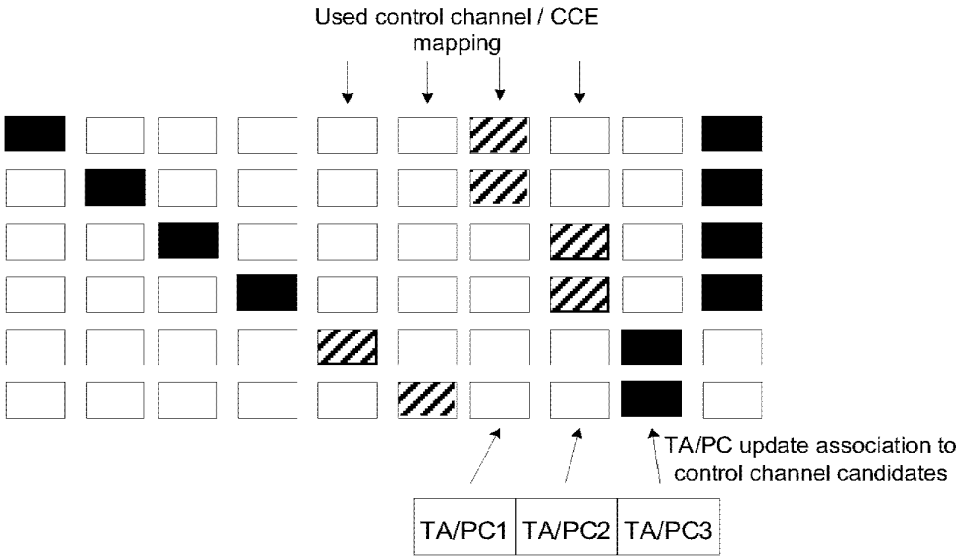
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Fig. 4



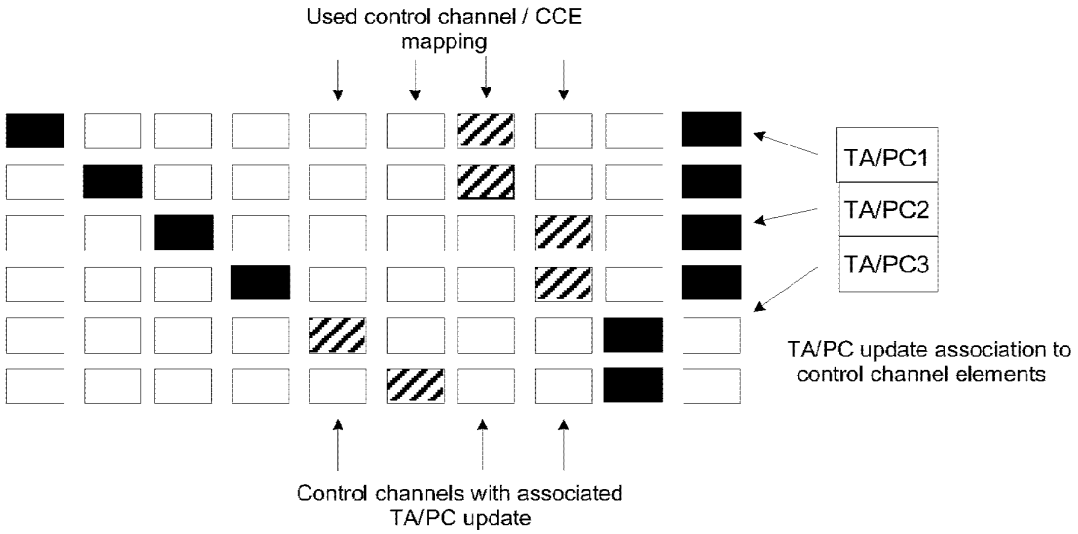
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Fig. 5



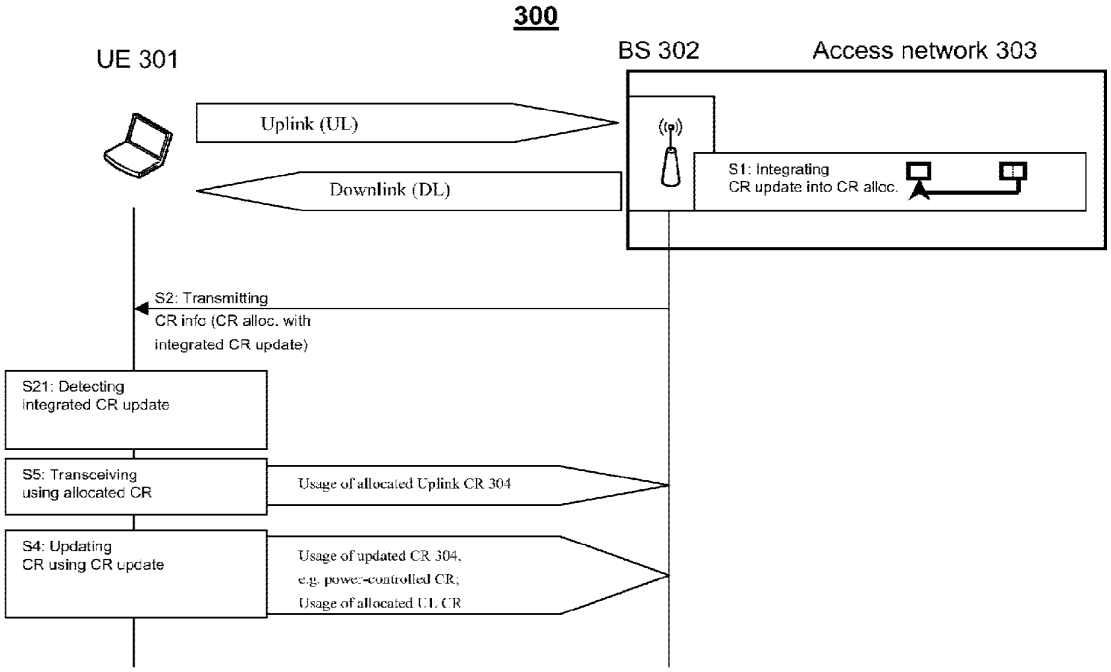
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Fig. 6



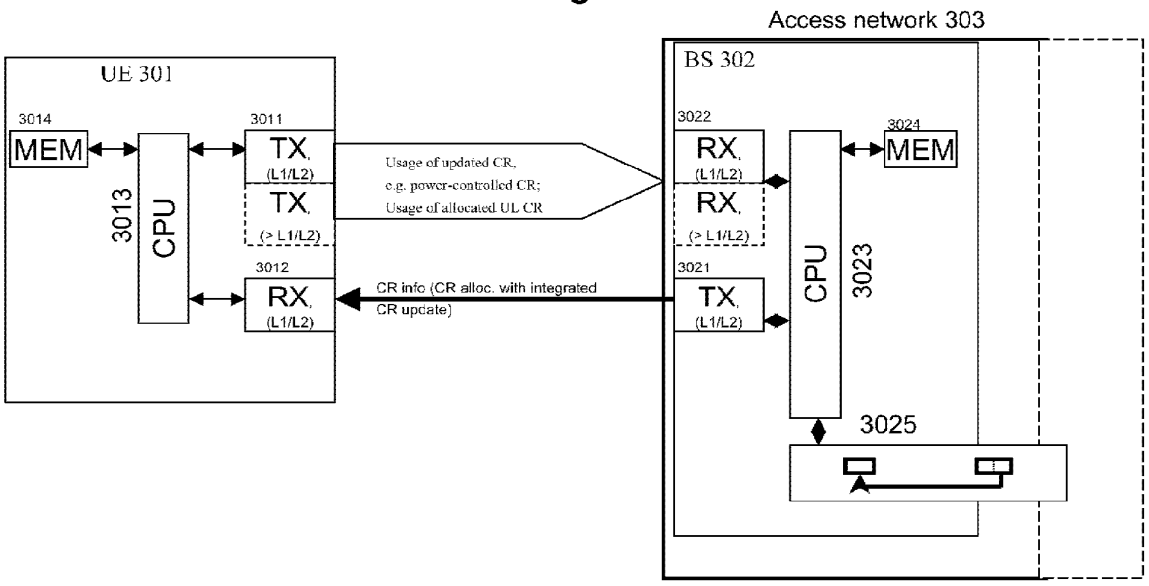
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Fig. 7



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Fig. 8



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European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 10 7547

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	"Universal Mobile Telecommunications System (UMTS); FDD enhanced uplink; Overall description; Stage 2 (3GPP TS 25.309 version 6.4.0 Release 6); ETSI TS 125 309" ETSI STANDARDS, EUROPEAN TELECOMMUNICATIONS STANDARDS INSTITUTE, SOPHIA-ANTIPO, FR, vol. 3-R2, no. V640, September 2005 (2005-09), XP014031929 ISSN: 0000-0001 * paragraph [0009] *	1-46	TECHNICAL FIELDS SEARCHED (IPC) H04B
A	WO 2006/077141 A (ERICSSON TELEFON AB L M [SE]; ENGLUND EVA [SE]; BARK GUNNAR [SE]; DE B) 27 July 2006 (2006-07-27) * abstract * * page 2, line 15 - page 4, line 10 *	1-46	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	25 October 2007	Bittermann, Jörg

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 07 10 7547

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25-10-2007

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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No documents available for this priority number

Espacenet

Bibliographic data: JP2009124450 (A) — 2009-06-04

COMMUNICATION SYNCHRONIZATION METHOD AND COMMUNICATION TERMINAL

Inventor(s): IMAI JUNSHI; SUZUKI NORIYOSHI ± (IMAI JUNSHI, ; SUZUKI NORIYOSHI)

Applicant(s): TOYOTA CENTRAL RES & DEV ± (TOYOTA CENTRAL R&D LABS INC)

Classification: **- international:** ***H04J3/06; H04W56/00; H04W64/00***
- cooperative:

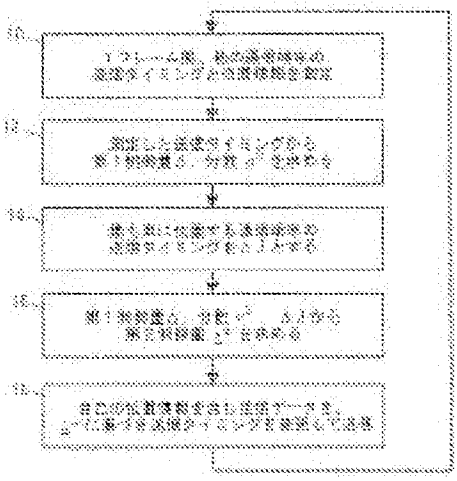
Application number: JP20070296109 20071114

Priority number(s): JP20070296109 20071114

Also published as: JP5018417 (B2)

Abstract of JP2009124450 (A)

PROBLEM TO BE SOLVED: To avoid convergence to local solution in a communication synchronization method of a communication system by a time division multiple access system that does not possess a reference station. SOLUTION: A communication terminal receives transmission data of a plurality of other communication terminals, measures the transmission timing, positional information (a step 10), and calculates a first control amount [Delta] and distribution [sigma] <SP>2</SP>, from the transmission timing (a step 12). A communication terminal of a communication terminal located in the most east is considered as [Delta][lambda] (a step 14); and a second control amount [Delta]<SP>*</SP>is calculated by [Delta]



<SP>*</SP>=[alpha][Delta]+(1-[alpha])
[Delta][lambda] (a step 16). Here, [alpha] is
a function of distribution, which approaches
1 as the distribution [sigma]<SP>2</SP>is
small, and approaches zero as the
distribution [sigma]<SP>2</SP>is large.; Next, the transmission timing is changed by the second control amount [Delta]<SP>*</SP>to transmit the data, positional information of itself is included in the transmission data (a step 18). By the communication synchronization method, areas with large distribution moves to west and the convergence to the local solution is avoided. ; COPYRIGHT: (C)2009,JPO&INPIT

Last updated: 13.03.2013 Worldwide Database 5.8.8.8; 93p

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2009-124450
(P2009-124450A)
(43)公開日　平成21年6月4日(2009.6.4)

(51)Int.Cl.		F I			テーマコード（参考）
H04W 56/00	(2009.01)	H04B	7/26	N	5K028
H04J 3/06	(2006.01)	H04J	3/06		5K067
H04W 64/00	(2009.01)	H04B	7/26	106A	

審査請求 未請求　請求項の数 15　OL　（全 13 頁）

(21)出願番号　特願2007-296109 (P2007-296109)
(22)出願日　平成19年11月14日 (2007.11.14)

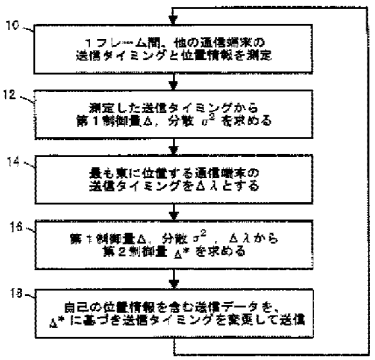
（出願人による申告）平成１９年度、総務省、安全運転を支援する車車間通信の実現に向けた周波数高度利用技術の委託研究、産業技術力強化法第１９条の適用を受ける特許出願

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Ｆターム(参考)　5K028 CC05 NN00
5K067 AA13 CC04 DD20 DD25 EE02 JJ52 JJ56

(54)【発明の名称】通信同期方法および通信端末

(57)【要約】
【課題】基準局を持たない時分割多元接続方式による通信システムの通信同期方法において、局所解に収束することを回避すること。
【解決手段】通信端末は、他の複数の通信端末の送信データを受信し、送信タイミング、位置情報を測定し（ステップ１０）、送信タイミングから第１制御量Δと分散σ^2を求める（ステップ１２）。最も東に位置する通信端末の通信端末をΔλとし（ステップ１４）、第２制御量Δ* をΔ* ＝αΔ＋（１－α）Δλによって求める（ステップ１６）。ここで、αは分散σ^2が小さいほど１に近づき、分散が大きいほど０に近づく分散の関数である。次に、第２制御量Δ* 分送信タイミングを変更してデータを送信し、送信データには自己の位置情報を含ませる（ステップ１８）。この通信同期方法によると、分散の大きい領域が西側へ移動していき、局所解への収束を回避することができる。
【選択図】図２



【特許請求の範囲】
【請求項1】
時分割多元接続方式により通信を行う複数の第１通信端末で構成された通信システムを同期させる通信同期方法において、
前記第１通信端末の送信する送信データには、前記第１通信端末の位置情報が含まれていて、
前記第１通信端末は、
自己の位置情報を取得し、
他の前記第１通信端末の送信データを１フレームの間受信することで、他の前記第１通信端末の送信タイミングおよび位置情報を測定し、
その測定した前記送信タイミングから第１制御量Δを求め、
その測定した前記送信タイミングの分散を求め、
前記分散の値が小さい場合は、第１制御量Δの影響を大きくし、前記分散の値が大きい場合は、自己の位置に対して特定の方向に位置する他の前記第１通信端末の送信タイミングΔλの影響を大きくするように配分して第２制御量Δ* を決定し、
自己の位置情報を含む送信データを送信する際、前記第２制御量Δ* に基づき送信タイミングを変更すること、
を特徴とする通信同期方法。
【請求項2】
前記第２制御量Δ* は、
Δ* ＝αΔ＋（１－α）Δλ、ここでαは分散の関数で、分散が大きくなると０に近づき、小さくなると１に近づく関数、
により決定することを特徴とする請求項１に記載の通信同期方法。
【請求項3】
自己の位置に対して特定の方向に位置する他の前記第１通信端末のうち、最も自己から離れた位置の他の前記第１通信端末の送信タイミングをΔλとすることを特徴とする請求項１または請求項２に記載の通信同期方法。
【請求項4】
前記特定の方向とは、北、南、東、西の４つの方位のうちいずれか特定の一方向であることを特徴とする請求項１ないし請求項３のいずれか１項に記載の通信同期方法。
【請求項5】
前記位置情報は緯度情報であり、自己の位置に対して緯度差が正もしくは負でその絶対値が最も大きい他の前記第１通信端末の送信タイミングをΔλとすることを特徴とする請求項１または請求項２に記載の通信同期方法。
【請求項6】
前記位置情報は経度情報であり、自己の位置に対して経度差が正もしくは負でその絶対値が最も大きい他の前記第１通信端末の送信タイミングをΔλとすることを特徴とする請求項１または請求項２に記載の通信同期方法。
【請求項7】
自己の前記位置情報は、ＧＰＳを利用して取得することを特徴とする請求項１ないし請求項６のいずれか１項に記載の通信同期方法。
【請求項8】
前記通信システムに、まだ通信を開始していない第２通信端末が加入するとき、
前記第２通信端末は、
自己の位置情報を取得し、
前記第１通信端末の送信データを１フレームの間受信することで前記第１通信端末の送信タイミングを測定し、
測定した前記第１通信端末の送信タイミングから第１制御量Δを求め、
自己の位置情報を含む送信データを、前記第１制御量Δに基づき送信タイミングを変更

して送信し、前記通信システムに加入する、
ことを特徴とする請求項１ないし請求項７のいずれか１項に記載の通信同期方法。
【請求項9】
時分割多元接続方式により通信を行う通信端末において、
前記通信端末は、
自己の位置に関する位置情報を取得する位置情報取得手段と、
送信データを送信するデータ送信手段と、
他の前記通信端末の送信データを１フレームの間受信するデータ受信手段と、
前記データ受信手段により受信した他の前記通信端末の送信データの受信タイミングから各前記通信端末の送信タイミングを決定する送信タイミング決定手段と、
前記送信タイミング決定手段により求めた各前記通信端末の送信タイミングと、他の前記通信端末の送信データに含まれた各前記通信端末の第２制御量から、自己の第１制御量Δを決定する第１制御量決定手段と、
前記送信タイミング決定手段により求めた各前記通信端末の送信タイミングの分散を求める分散算出手段と、
前記分散の値が小さい場合は、前記第１制御量Δの影響を大きくし、前記分散の値が大きい場合は、自己の位置に対して特定の方向に位置する他の前記第１通信端末の送信タイミングΔλの影響を大きくするように、第２制御量Δ^*を決定する第２制御量決定手段と、
自己の前記位置情報を含む送信データを生成する送信データ生成手段と、
前記第２制御量決定手段により求めた第２制御量Δ^*に基づき、自己の前記通信端末の送信タイミングを変更する送信タイミング変更手段と、
を有することを特徴とする通信端末。
【請求項10】
前記第２制御量決定手段は、
$\Delta^* = \alpha\Delta + (1-\alpha)\Delta\lambda$、ここで$\alpha$は分散の関数で、分散が大きくなると０に近づき、小さくなると１に近づく関数、
により第２制御量Δ^*を決定することを特徴とする請求項９に記載の通信端末。
【請求項11】
自己の位置に対して特定の方向に位置する他の前記第１通信端末のうち、最も自己から離れた位置の他の前記第１通信端末の送信タイミングをΔλとすることを特徴とする請求項９または請求項１０に記載の通信端末。
【請求項12】
前記特定の方向とは、北、南、東、西の４つの方位のうちいずれか特定の一方向であることを特徴とする請求項９ないし請求項１１のいずれか１項に記載の通信端末。
【請求項13】
前記位置情報は緯度情報であり、自己の位置に対して緯度差が正もしくは負でその絶対値が最も大きい他の前記第１通信端末の送信タイミングをΔλとすることを特徴とする請求項９または請求項１０に記載の通信端末。
【請求項14】
前記位置情報は経度情報であり、自己の位置に対して経度差が正もしくは負でその絶対値が最も大きい他の前記第１通信端末の送信タイミングをΔλとすることを特徴とする請求項９または請求項１０に記載の通信端末。
【請求項15】
前記位置情報取得手段は、ＧＰＳを利用して位置情報を取得することを特徴とする請求項９ないし請求項１４に記載の通信端末。

【発明の詳細な説明】
【技術分野】
【0001】
本発明は、時分割多元接続方式により複数の通信端末が通信を行う通信システムにおいて、通信の同期の基準となる基地局を持たずとも複数の通信端末間の通信を同期させるこ

とができる通信同期方法に関するもので、特に、局所解に収束して通信効率が悪化することを回避できる通信同期方法である。

【背景技術】

【0002】

基地局のような基準となる局を持たずに、複数の通信端末が時分割多元接続方式により通信を行っている場合に、通信端末間において送信タイミングの同期を取る方法として、特許文献１、２の方法が知られている。

【0003】

特許文献１、２に示された通信同期方法は、各通信端末の送信タイミング（自己のスロットタイミングを基準とした、他の通信端末の送信スロットタイミングの基準からのずれ）を測定し、測定した送信タイミングの平均や最多のタイミングに合わせるものである。

【特許文献1】特開平９－４６７６２

【特許文献2】特開２００７－１０４６２１

【発明の開示】

【発明が解決しようとする課題】

【0004】

しかし、本発明者らは、観測した送信タイミングの平均や最多タイミングに合わせる通信同期方法では、通信端末数が多数の場合には局所解に収束してしまうことがあるのを見いだした。局所解に収束すると、送信タイミングの平面分布において、どのタイミングにも同期することができない特異点が生じ、ある範囲についてはタイミングが同期していても、全体としては同期していない状態となる。このような局所解に収束した状態では、特異点付近の通信端末は通信効率が低いままとなる。

【0005】

そこで本発明の目的は、基準局を持たない時分割多元接続方式による通信システムにおいて、局所解に収束することを回避し、全体の通信タイミングが同期に収束する通信同期方法、および、その通信システムに用いる通信端末である。

【課題を解決するための手段】

【0006】

第１の発明は、時分割多元接続方式により通信を行う複数の第１通信端末で構成された通信システムを同期させる通信同期方法において、第１通信端末の送信する送信データには、第１通信端末の位置情報が含まれていて、第１通信端末は、自己の位置情報を取得し、他の第１通信端末の送信データを１フレームの間受信することで、他の第１通信端末の送信タイミングおよび位置情報を測定し、その測定した送信タイミングから第１制御量Δを求め、その測定した送信タイミングの分散を求め、分散の値が小さい場合は、第１制御量Δの影響を大きくし、分散の値が大きい場合は、自己の位置に対して特定の方向に位置する他の第１通信端末の送信タイミングΔλの影響を大きくするように配分して第２制御量Δ^* を決定し、自己の位置情報を含む送信データを送信する際、第２制御量Δ^* に基づき送信タイミングを変更すること、を特徴とする通信同期方法である。

【0007】

他の第１通信端末の送信タイミングとは、自己のスロットタイミングを基準とした、他の第１通信端末の送信タイミングの基準からのずれである。

【0008】

ここで、ある通信端末のスロットタイミングとは、１フレームを複数のスロットに分割した時のスロットの先頭のタイミングである。一般には各通信端末のスロットタイミングは同期していない。ここで同期とは、ある通信端末のスロットタイミングが、そのある通信端末からみた他の各通信端末のスロットタイミングと一致していることを意味し、通信システムが単位時間ごとの制御であれば、１単位時間程度の拡がりをもってスロットタイミングが一致していることを意味する。

【0009】

制御量は、送信タイミングの平均値や中央値を制御量としたり、送信タイミングのうち最も頻度の大きいタイミングを制御量とする、などの方法がある。また、分散を考慮して制御量を求めてもよい。

【0010】

位置情報とは、たとえば緯度、経度の情報であり、緯度情報のみ、もしくは経度情報のみであってもよい。自己の通信端末の位置情報は、ＧＰＳなどを利用して取得する。位置精度は誤差１００ｍ程度以内であればよい。

【0011】

特定の方向とは、あらかじめ通信システムによって設定された一方向である。ただし厳密性は必要なく、その特定の方向に対して、３０度程度以内の範囲を含んでいてもよい。また、この範囲内の第１通信端末であれば、どの通信端末の送信タイミングをΔλとしてもよいが、最も遠い通信端末の送信タイミングをΔλとする方が、同期に至るまでの収束が速く望ましい。

【0012】

第２の発明は、第１の発明において、第２制御量Δ* は、Δ* ＝αΔ＋（１－α）Δλ、ここでαは分散の関数で、分散が大きくなると０に近づき、小さくなると１に近づく関数、により決定することを特徴とする通信同期方法である。

【0013】

第３の発明は、第１の発明または第２の発明において、自己の位置に対して特定の方向に位置する他の第１通信端末のうち、最も自己から離れた位置の他の第１通信端末の送信タイミングをΔλとすることを特徴とする通信同期方である。

【0014】

第４の発明は、第１の発明から第３の発明において、特定の方向とは、北、南、東、西の４つの方位のうちいずれか特定の一方向であることを特徴とする通信同期方法である。

【0015】

第５の発明は、第１の発明または第２の発明において、位置情報は緯度情報であり、自己の位置に対して緯度差が正もしくは負でその絶対値が最も大きい他の第１通信端末の送信タイミングをΔλとすることを特徴とする通信同期方法である。

【0016】

自己の位置に対して緯度差が正でその絶対値が最も大きい、とはつまり、正の経線方向（北側の方向）に最も離れている、ということであり、緯線方向については距離を考慮しないということである。同じく、自己の位置に対して緯度差が負でその絶対値が最も大きい、とはつまり、負の経線方向（南側の方向）に最も離れている、ということである。

【0017】

第６の発明は、第１の発明または第２の発明において、位置情報は経度情報であり、自己の位置に対して経度差が正もしくは負でその絶対値が最も大きい他の第１通信端末の送信タイミングをΔλとすることを特徴とする通信同期方法である。

【0018】

自己の位置に対して経度差が正でその絶対値が最も大きい、とはつまり、正の緯線方向に最も離れている、ということであり、経線方向（南北方向）については距離を考慮しないということである。同じく、自己の位置に対して経度差が負でその絶対値が最も大きい、とはつまり、負の緯線方向に最も離れている、ということである。

【0019】

第７の発明は、第１の発明から第６の発明において、自己の位置情報は、ＧＰＳを利用して取得することを特徴とする通信同期方法である。

【0020】

第８の発明は、第１の発明から第７の発明において、通信システムに、まだ通信を開始していない第２通信端末が加入するとき、第２通信端末は、自己の位置情報を取得し、第１通信端末の送信データを１フレームの間受信することで第１通信端末の送信タイミングを測定し、測定した第１通信端末の送信タイミングから第１制御量Δを求め、自己の位置

情報を含む送信データを、第１制御量Δに基づき送信タイミングを変更して送信し、通信システムに加入することを特徴とする通信同期方法である。

【0021】

第９の発明は、時分割多元接続方式により通信を行う通信端末において、通信端末は、自己の位置に関する位置情報を取得する位置情報取得手段と、送信データを送信するデータ送信手段と、他の通信端末の送信データを１フレームの間受信するデータ受信手段と、データ受信手段により受信した他の通信端末の送信データの受信タイミングから各通信端末の送信タイミングを決定する送信タイミング決定手段と、送信タイミング決定手段により求めた各通信端末の送信タイミングと、他の通信端末の送信データに含まれた各通信端末の第２制御量から、自己の第１制御量Δを決定する第１制御量決定手段と、送信タイミング決定手段により求めた通信端末の送信タイミングの分散を求める分散算出手段と、分散の値が小さい場合は、第１制御量Δの影響を大きくし、分散の値が大きい場合は、自己の位置に対して特定の方向に位置する他の第１通信端末の送信タイミングΔλの影響を大きくするように、第２制御量Δ^*を決定する第２制御量決定手段と、自己の位置情報を含む送信データを生成する送信データ生成手段と、第２制御量決定手段により求めた第２制御量Δ^*に基づき、自己の通信端末の送信タイミングを変更する送信タイミング変更手段と、を有することを特徴とする通信端末である。

【0022】

第１０の発明は、第９の発明において、第２制御量決定手段は、$\Delta^* = \alpha\Delta + (1-\alpha)\Delta\lambda$、ここで$\alpha$は分散の関数で、分散が大きくなると０に近づき、小さくなると１に近づく関数、により第２制御量Δ^*を決定することを特徴とする通信端末である。

【0023】

第１１の発明は、第９の発明または第１０の発明において、自己の位置に対して特定の方向に位置する他の第１通信端末のうち、最も自己から離れた位置の他の第１通信端末の送信タイミングをΔλとすることを特徴とする通信端末である。

【0024】

第１２の発明は、第９の発明から第１１の発明において、特定の方向とは、北、南、東、西の４つの方位のうちいずれか特定の一方向であることを特徴とする通信端末である。

【0025】

第１３の発明は、第９の発明または第１０の発明において、位置情報は緯度情報であり、自己の位置に対して緯度差が正もしくは負でその絶対値が最も大きい他の第１通信端末の送信タイミングをΔλとすることを特徴とする通信端末である。

【0026】

第１４の発明は、第９の発明または第１０の発明において、位置情報は経度情報であり、自己の位置に対して緯度差が正もしくは負でその絶対値が最も大きい他の第１通信端末の送信タイミングをΔλとすることを特徴とする通信端末である。

【0027】

第１５の発明は、第９の発明から第１４の発明において、位置情報取得手段は、ＧＰＳを利用して位置情報を取得することを特徴とする通信端末である。

【発明の効果】

【0028】

本発明による通信同期方法では、分散の値が大きい場合には、特定の方向に位置する通信端末の通信タイミングに配分を大きくして、分散の値が小さい場合には第１制御量の配分を大きくして第２制御量を決定し、その第２制御量に基づき送信タイミングを変更している。これにより、送信タイミングの平面分布において、分散の大きい領域は特定の方向とは逆向きに移動して分散の小さな領域が拡大し、次第に全体の送信タイミングは同期に向かって収束する。その結果、局所解への収束が回避され、通信効率のより良い通信システムを構成することができる。

【0029】

また、第３の発明のように、特定の方向に最も遠い第１通信端末の送信タイミングをΔ

λとすれば、より同期に至るまでの時間が短くなる。特に第４の発明のように、特定の方向を、北、南、東、西の４つの方位のうちいずれかとするほうが、自己の位置から他の第１通信端末までの距離の算出が容易で望ましい。

【0030】

また、第５、６の発明のように、緯度差、もしくは経度差を用いてΔλを決定すると、計算が容易で、かつ、同期までの収束も速いので望ましい。

【0031】

また、第７の発明にように、位置情報の取得にはＧＰＳを利用することができる。

【0032】

また、第８の発明によると、効率的に通信に加入することができる。

【0033】

また、第９～１５の発明による通信端末を用いることで、局所解に収束して特異点付近の通信効率が悪化することを回避し、全体のスロットタイミングを自律的に同期することが可能な通信システムを構成することができる。

【発明を実施するための最良の形態】

【0034】

以下、本発明の具体的な実施例を図を参照にしながら説明するが、本発明はそれらの実施例に限定されるものではない。

【実施例】

【0035】

実施例１は、通信の同期の際に基準となるような基地局を持たずに、複数の通信端末が時分割多元接続方式により通信している場合に、その通信を同期させる方法である。

【0036】

まず、実施例１の通信方式である時分割多元接続方式の概要について説明する。

【0037】

この通信システムでは、単位時間ごとに時間を制御するように設計されている。また、フレーム長およびスロット長は特定の値に固定されて、各スロットにはガード時間が設けられて、その長さは１単位時間より長い時間である。ガード時間は、伝搬遅延や処理遅延などを考慮して設けられた時間である。通信端末は、１スロットをデータ送信に使用し、１フレームを周期としてデータ送信を繰り返す。データ送信に使用するスロット以外のスロットにおいては受信状態にあるものとする。

【0038】

図１（ａ）は、スロット分割の例を示す。送信から次の送信までの時間間隔Ｔ１が１フレーム長、１フレーム長は、一定の時間間隔Ｔで各スロットに分割されていて、Ｔが１スロット長である。図１（ｃ）は、１スロット長Ｔが８単位時間で構成され、１単位時間はτ、ガード時間Ｔ２は２単位時間とした場合の例である。

【0039】

また、以下において他の通信端末の送信タイミングとは、自己の１スロット長を基準とし、他の通信端末の送信データが基準となる１スロット長のどのタイミングで送信されたかを示すものとする。言い換えれば、自己のスロットタイミング（スロットの先頭のタイミング）と他の通信端末の送信スロットタイミングとの差である。

【0040】

自己の送信タイミングが図１（ａ）であり、他の通信端末Ａ、Ｂ、Ｃの送信が図１（ｂ）の状態である場合、通信端末Ａ、Ｂ、Ｃの送信タイミングは、図１におけるＴａ、Ｔｂ、Ｔｃである。図１（ｃ）のように、１単位時間がτであるとき、Ｔａ、Ｔｂ、Ｔｃがτより小さい場合が、通信端末Ａ、Ｂ、Ｃの送信タイミングと自己の送信タイミングが同期している場合である。

【0041】

各通信端末は、自律的に自己の送信タイミングを変更する動作を繰り返し行い、送信タイミングの同期を図っている。各通信端末の動作は、通信への加入手順と加入後の同期手

順に分けられる。

【0042】

この同期手順では、通信端末の位置情報を利用している。そこで、同期手順と平行して、通信端末は位置情報を１フレームごとに取得し、更新している。位置情報の取得は、ＧＰＳを利用する。この位置情報の精度は、誤差１００ｍ程度で十分である。

【0043】

図２のフローチャートは、その同期手順を示している。以下、図２のフローチャートに基づき、実施例１の通信同期方法における同期手順について説明する。

【0044】

通信端末は、自己のデータを送信後、次のデータ送信までの１フレームの間、他の受信しうるすべての通信端末の送信データを受信する。そして、自己のスロットタイミングと、そのデータ受信のタイミングとの差から、他の通信端末の送信タイミングΔを測定する。また、通信端末からの送信データに含まれた、通信端末の位置情報を測定する（ステップ１０）。

【0045】

次に、送信タイミングから、第１制御量Δと送信タイミングの分散σ^2を求める（ステップ１２）。第１制御量Δの求め方としては、送信タイミングの平均値（相加平均、相乗平均、調和平均など）や中央値を第１制御量としたり、送信タイミングのうち最も頻度の大きいタイミングを第１制御量とする、などの方法がある。

【0046】

ステップ１２の動作は、実際に１フレームの間測定したあとで実行する必要はなく、データを受信して送信タイミングを測定する毎に、逐次第１制御量Δと分散σ^2を修正し、その時点での第１制御量Δと分散σ^2を求めるようにしてもよい。

【0047】

次に、自己の位置に対して最も東に位置する通信端末の送信タイミングとしてΔλを決定する（ステップ１４）。Δλは、受信した送信データに含まれていた位置情報と、自己の位置情報とから各通信端末の距離、方向を計算し、東の方向に位置する通信端末のうち、自己の位置からの距離が最も遠い通信端末の送信タイミングとする。東の方向、とは、厳密な東に限らず、厳密な東の方向に対して３０度程度の範囲内であれば良い。このステップ１４の処理は、ステップ１２の処理と並行して行ってもよい。

【0048】

次に、第１制御量Δ、分散σ^2、Δλから第２制御量Δ^*を求める（ステップ１６）。第２制御量Δ^*は、$\Delta^* = \alpha\Delta + (1-\alpha)\Delta\lambda$によって求める。ここで$\alpha$は分散$\sigma^2$の関数であり、分散$\sigma^2$が小さいほど１に近づき、分散が大きいほど０に近づく関数である。このような関数αの例としては、$\alpha = 1\ (0 \leqq \sigma^2 \leqq \sigma^2_0)$、$0\ (\sigma^2_0 \leqq \sigma^2)$（$\sigma^2_0$はある特定の値）や、$\alpha = 1 - \sigma^2 / \sigma^2_{max}$（$\sigma^2_{max}$は、分散$\sigma^2$の最大値）などである。

【0049】

次に、第２制御量Δ^*に基づいて、送信タイミングを変更してデータを送信する。このとき、送信データに、自己の位置情報を含ませる（ステップ１８）。その後ステップ１０に戻る。

【0050】

以上が実施例１の通信同期手順である。

【0051】

次に、まだ通信を開始していない通信端末が新規に通信に加入する方法を、図３に示すフローチャートをもとに説明する。

【0052】

まず、通信端末は、自己の位置情報をＧＰＳを利用して取得する（ステップ２０）。

【0053】

次に、ある時点から１フレームの間、他の受信しうるすべての通信端末の送信データを

受信する。そして、自己のスロットタイミングと、そのデータ受信のタイミングとの差から、他の通信端末の送信タイミングを測定する（ステップ２２）。ある時点とは、たとえば、通信端末の電源が入った直後などである。

【0054】

次に、他の通信端末が送信データの送信に使用していない空きスロット（送信データの送信間隔が１スロット長Ｔよりも長い区間）を特定する（ステップ２４）。

【0055】

次に、ステップにおいて測定した送信タイミングを用いて、自己の第１制御量Δを求める（ステップ２６）。

【0056】

次に、第１制御量Δに基づき、送信タイミングを変更して空きスロットに送信データを送信、つまり通信に加入する。このとき、送信データに、自己の位置情報を含ませる（ステップ２８）。その後、図２のステップ１０に移行する。

【0057】

なお、ステップ２０の処理は、ステップ２２の処理前までに行われている必要はなく、ステップ２８の処理前までに行われていればよい。

【0058】

以上が実施例１の通信加入手順である。

【0059】

この通信同期方法によると、分散σ^2が大きい場合には、第２制御量におけるΔλの配分が大きいため、東の方向に位置する通信端末の送信タイミングに揃うように移動する。また、分散σ^2が小さい場合には、第２制御量における第１制御量Δの配分が大きいため、送信タイミングが第１制御量、つまり、他の通信端末の送信タイミングの平均値や最多のタイミングの方へ送信タイミングが移動する。そのため、送信タイミングの平面分布において、分散σ^2が大きい領域が東とは反対側である西側へ移動して分散σ^2の小さな領域が拡大し、全体の送信タイミングは第１制御量に合わせる方向に収束する。その結果、局所解への収束が回避され、通信全体が同期する最適解へと収束させることができる。

【0060】

実施例１では東の方向に位置する通信端末のうち、自己の位置からの距離が最も遠い通信端末の送信タイミングをΔλとしている。しかし東の方向である必要はなく、ある特定の方向であればどの方向でもかまわない。ただし、東、西、南、北の４方位のいずれかである方が計算が容易で望ましい。また、自己の位置からの距離が最も遠い通信端末としているが、上記特定の方向に位置する通信端末であれば、どの通信端末でもよい。ただし、最も遠い通信端末、とした方が、分散σ^2が大きい領域の移動が速くなり、同期の収束が早くなって望ましい。

【実施例】

【0061】

図４は、実施例２の通信同期方法における同期手順を示したフローチャートである。これは実施例１のステップ１４を、ステップ１１４に置き換えたものであり、ステップ１４におけるΔλの決定方法が異なるものである。以下、ステップ１１４におけるΔλの決定方法について説明する。

【0062】

ステップ１１４におけるΔλの決定方法は、自己の位置との緯度差が正でその絶対値が最も大きい他の通信端末の送信タイミングをΔλとするものである。つまり、自己の位置に対して正の経線方向（北側の方向）に最も離れている通信端末の通信タイミングをΔλとするということである。これは、経線方向の距離は考慮するが、緯線方向の距離は考慮せずにΔλを決定ということでもある。緯度情報のみからΔλを決定するので、実施例１のように距離と方向を算出してΔλを決定する場合よりも計算量が少なくてすむ。

【0063】

この実施例２の同期手順によると、送信タイミングの平面分布において、分散σ^2が大

きい領域が正の経線方向へ移動して分散σ^2の小さな領域が拡大し、全体の送信タイミングは第１制御量に合わせる方向に収束する。その結果、実施例１と同様に、局所解への収束が回避され、通信全体が同期する最適解へと収束させることができる。

【0064】

なお、実施例２では緯度情報のみから$\Delta\lambda$を決定しているので、ステップ１８において送信データに含ませる位置情報も、緯度情報のみであってよい。また、実施例２では、自己の位置との緯度差が正でその絶対値が最も大きい他の通信端末の送信タイミングを$\Delta\lambda$としているが、緯度差が負でその絶対値が最も大きい他の通信端末の送信タイミングを$\Delta\lambda$としてもよい。また、実施例２では、緯度情報を利用しているが、経度情報を利用し、経度差から$\Delta\lambda$を決定するようにしてもよい。

【実施例】

【0065】

実施例３は、実施例１、２の通信同期方法に用いる通信端末である。通信端末の構成について、図５を参照に説明する。

【0066】

図５は、通信端末の構成を示すブロック図である。通信端末は、受信タイミング観測部１００、復調部１０１、演算部１０２、送信タイミング制御部１０３、変調部１０４、送信データ生成部１０５、ＧＰＳ装置１０６により構成されている。受信タイミング観測部１００が、本発明のデータ受信手段と送信タイミング決定手段に相当し、演算部１０２が、本発明の第１制御量決定手段、分散算出手段、第２制御量決定手段に相当し、送信データ生成部１０５が本発明の送信データ生成手段に相当し、送信タイミング制御部１０３が、本発明のデータ送信手段、送信タイミング制御手段に相当し、ＧＰＳ装置１０６が、本発明の位置情報取得手段に相当している。

【0067】

次に、通信端末の動作について説明する。通信端末は、他の通信端末からの信号を受信タイミング観測部１００において受信し、自己の送信タイミングとの差から他の通信端末の送信タイミングを測定する。測定した送信タイミングののデータは演算部１０２へ入力される。また、受信した信号は復調部１０１において復調され、位置情報を含む受信データ（他の通信端末からの送信データ）が演算部１０２へ入力される。以上はステップ１０、２２の処理に対応している。

【0068】

また、通信端末がまだ通信に加入していない場合は、送信タイミング制御部１０３において空きスロットを検出する（ステップ２４の処理に対応）。

【0069】

次に、演算部１０２において、他の通信端末の送信タイミングから第１制御量Δ、分散σ^2を算出する（ステップ１２、２６の処理に対応）。また、他の通信端末の位置情報と、ＧＰＳ装置１０６から取得した自己の位置情報から、他の通信端末の方向、距離を算出し、$\Delta\lambda$を決定する（ステップ１４、１１４の処理に対応）。そして、第１制御量Δ、分散σ^2、$\Delta\lambda$から第２制御量Δ^*を算出する（ステップ１６の処理に対応）。算出した第２制御量Δ^*は、送信タイミング制御部１０３に入力される。通信に加入する場合は、第１制御量Δが送信タイミング制御部１０３に入力される。

【0070】

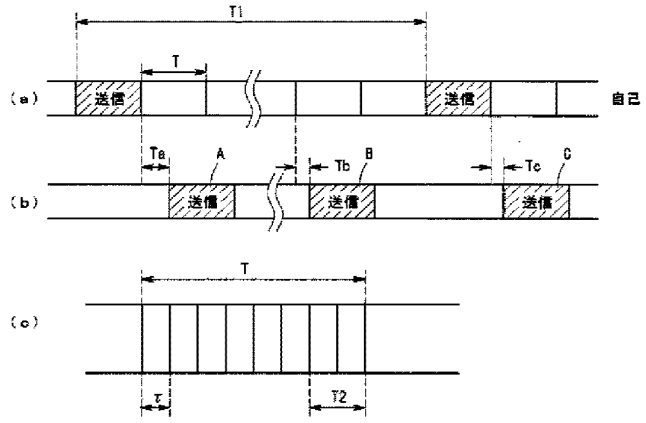
ＧＰＳ装置１０６からの自己の位置情報は、送信データ生成部１０５に入力され、自己の位置情報を含む送信データが生成される。生成された送信データは、変調部１０４に入力されて、変調部１０４において搬送波を送信データにより変調して送信信号が出力される。その後、送信タイミング制御部１０３において、第２制御量Δ^*（通信に加入する場合は第１制御量Δ）に基づき送信タイミングが変更されて送信信号が送信される。以上はステップ１８、２８に対応する。

【0071】

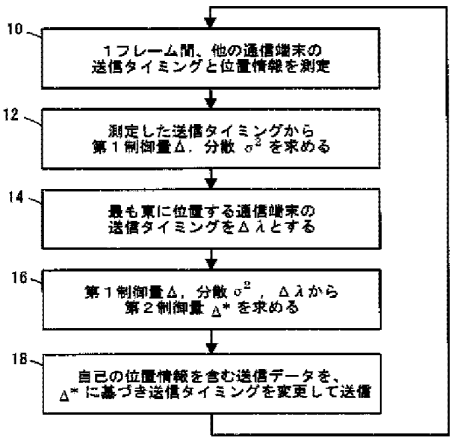
以上の動作により、実施例３の通信端末は、実施例１、２の通信同期方法を実現する。

【0072】
実施例では位置情報の取得にＧＰＳを利用しているが、他の方法によって通信端末の位置情報を取得するようにしてもよい。
【産業上の利用可能性】
【0073】
本発明の通信同期方法は、車車間通信などに用いることができる
【図面の簡単な説明】
【0074】
【図1】スロット分割の例を示す図。
【図2】実施例１の通信同期方法における同期手順を示すフローチャート。
【図3】通信への加入手順を示すフローチャート。
【図4】実施例２の通信同期方法における同期手順を示すフローチャート。
【図5】通信端末の構成を示すブロック図。
【符号の説明】
【0075】
Ｔ：１スロット長
Ｔ１：１フレーム長
Ｔ２：ガード時間
τ：１単位時間
１００：受信タイミング観測部
１０１：復調部
１０２：演算部
１０３：送信タイミング制御部
１０４：変調部
１０５：送信データ生成部
１０６：ＧＰＳ装置

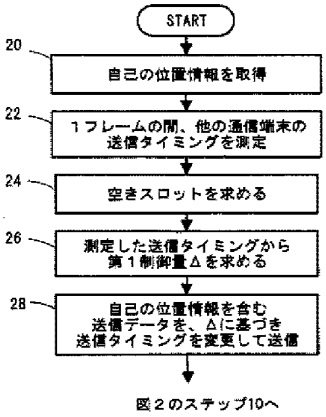
【図1】


T1
T
(a)
送信
送信
自己
Ta
A
Tb
B
Tc
C
(b)
送信
送信
送信
T
(c)
τ
T2

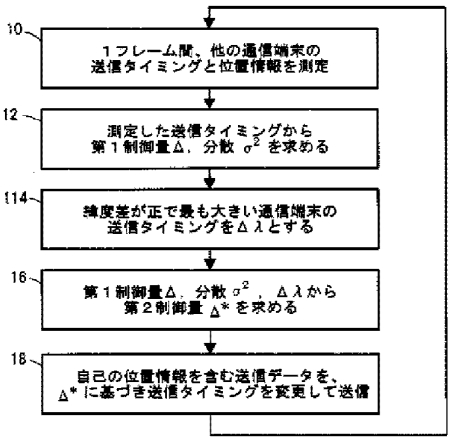
【図2】


10
１フレーム間、他の通信端末の
送信タイミングと位置情報を測定
12
測定した送信タイミングから
第１制御量Δ，分散 σ² を求める
14
最も東に位置する通信端末の
送信タイミングをΔλとする
16
第１制御量Δ，分散 σ²，Δλから
第２制御量 Δ* を求める
18
自己の位置情報を含む送信データを、
Δ* に基づき送信タイミングを変更して送信

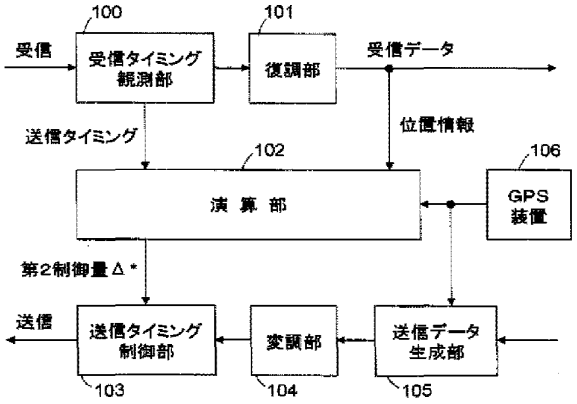
【図3】


START
20
自己の位置情報を取得
22
１フレームの間、他の通信端末の
送信タイミングを測定
24
空きスロットを求める
26
測定した送信タイミングから
第１制御量Δを求める
28
自己の位置情報を含む
送信データを、Δに基づき
送信タイミングを変更して送信
図２のステップ10へ

【図4】


10
１フレーム間、他の通信端末の
送信タイミングと位置情報を測定
12
測定した送信タイミングから
第１制御量Δ，分散 σ² を求める
114
緯度差が正で最も大きい通信端末の
送信タイミングをΔλとする
16
第１制御量Δ，分散 σ²，Δλから
第２制御量 Δ* を求める
18
自己の位置情報を含む送信データを、
Δ* に基づき送信タイミングを変更して送信

【図5】


100
101
受信
受信タイミング観測部
復調部
受信データ
送信タイミング
位置情報
102
106
演 算 部
GPS装置
第2制御量Δ*
送信
送信タイミング制御部
変調部
送信データ生成部
103
104
105

No documents available for this priority number

Espacenet

Bibliographic data: JP2009219625 (A) — 2009-10-01

PERSONAL VEHICLE

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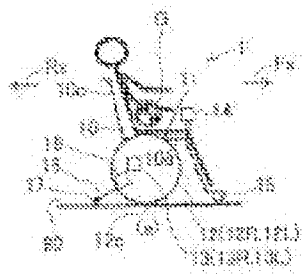
Application number: JP20080066602 20080314

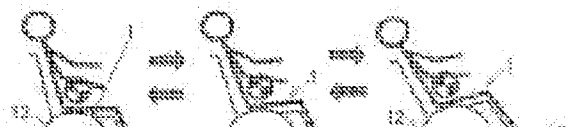
Priority number(s): JP20080066602 20080314

Also published as: JP5109099 (B2)

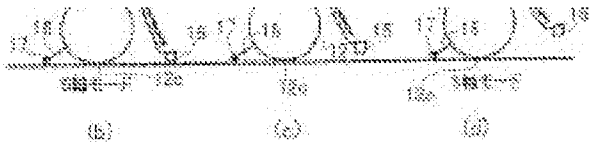
Abstract of JP2009219625 (A)

PROBLEM TO BE SOLVED: To provide a personal vehicle, such as a wheelchair, having traveling stability and the ability to travel over bumps by a simple mechanism. ; SOLUTION: The personal vehicle 1 includes a vehicle body 11 having a seat portion 10, driving wheels 12, driving sources 13 rotatively driving the driving wheels 12, an operating portion 14 controlling the driving of the driving sources 13, front wheels 15, a rear wheel supporting member 16 attached to the vehicle body 11 so as to extend rearward of the driving wheels 12, rear wheels 17 attached to the rear wheel supporting





member 16 so as to make contact with a road surface 90, and an actuator 18 making the rear wheel supporting member 16 make contact with and rise from the road surface 90. ; COPYRIGHT: (C)2010,JPO&INPIT



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審査請求 未請求　請求項の数 15　ＯＬ　（全 33 頁）

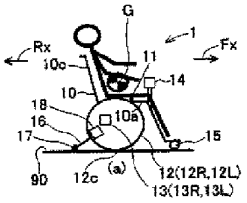
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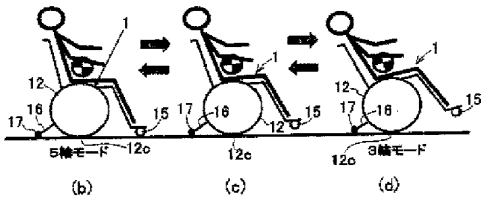
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最終頁に続く

(54)【発明の名称】パーソナルビークル

(57)【要約】
【課題】簡便な機構で走行安定性および段差踏破性を備える車いす等のパーソナルビークルを提供する。
【解決手段】パーソナルビークル１は、着座部１０をもつ車体１１と、駆動輪１２と、駆動輪１２を回転駆動させる駆動源１３と、駆動源１３の駆動を制御する操作部１４と、前輪１５と、駆動輪１２の後方に向けて延びるように車体１１に取り付けられた後輪サポート部材１６と、路面９０に接地可能に後輪サポート部材１６に取り付けられた後輪１７と、後輪サポート部材１６を路面９０に対して接地および浮上させるアクチュエータ１８とを備えている。
【選択図】図１





【特許請求の範囲】
【請求項1】
使用者が着座する着座部をもつ車体と、
前記車体にこれの左右に取り付けられた駆動輪と、
前記車体に取り付けられ駆動輪を回転駆動させる駆動源と、
前記駆動源の駆動を制御する操作部と、
前記駆動輪の前方に位置して前記車体に取り付けられた前輪と、
前記車体に取り付けられた後輪サポート部材と、
路面に接地可能に前記後輪サポート部材に取り付けられ、路面に接地するとき前記駆動輪の接地点よりも後側に位置する後輪と、
前記後輪サポート部材を作動させて前記後輪を前記路面に対して接地および浮上させるアクチュエータと、を具備することを特徴とするパーソナルビークル。
【請求項2】
使用者が着座する着座部をもつ車体と、
前記車体にこれの左右に取り付けられた駆動輪と、
前記車体に取り付けられ前記駆動輪を回転駆動させる駆動源と、
前記駆動源の駆動を制御する操作部と、
前記駆動輪の前方に位置して前記車体に取り付けられた前輪と、
前記車体に取り付けられた後輪サポート部材と、
路面に接地可能に前記後輪サポート部材に取り付けられ、路面に接地するとき前記駆動輪の接地点よりも後側に位置する後輪と、
前記後輪サポート部材を作動させて前記後輪を前記路面に対して接地および浮上させるアクチュエータと、
少なくとも前記駆動輪および前記前輪で走行する第１モードと、前記前輪を浮かせた状態で前記駆動輪および前記後輪を前記路面に接地しつつ走行する第２モードとを切り替え可能な制御装置と、を具備することを特徴とするパーソナルビークル。
【請求項3】
請求項１または２において、前記前輪は前記車体の左右に設けられており、前記後輪は単数であり、前記第１モードは、左右の前記駆動輪、左右の前記前輪および前記後輪で走行するモードであり、前記第２モードは、左右の前記前輪を浮上させつつ左右の前記駆動輪および前記後輪で走行するモードであることを特徴とするパーソナルビークル。
【請求項4】
請求項２および３のうちの一項において、前記パーソナルビークルの走行速度を検知する走行速度検知手段、および／または、前記パーソナルビークルの移動方向の走行速度の速度目標値を設定する目標走行速度設定手段が設けられており、
前記操作部が前記第２モードに切り替えられること、前進方向の走行速度が設定速度以上であること、前記操作部による前進方向の速度目標値が一定値以上であることのうちの少なくとも一つの条件が満足されるとき、
前記制御装置は、前記第１モードから前記第２モードに切り替える制御を行うことを特徴とするパーソナルビークル。
【請求項5】
請求項２～４のうちの一項において、前記第１モードでは、前記使用者の体重を含む前記パーソナルビークルの重心位置が前記駆動輪の接地点よりも前方に位置するように走行しており、
前記制御装置は、前記第１モードから前記第２モードに切り替えるにあたり、前記使用者の体重を含む前記パーソナルビークルの重心位置が前記駆動輪の接地点よりも後方に位置するような駆動トルクを前記駆動輪に与える制御を行うことを特徴とするパーソナルビークル。
【請求項6】

請求項５において、前記駆動輪に与える駆動トルクをＴとし、前記使用者の体重を含む前記パーソナルビークルの重心位置のピッチ方向の傾斜角度をθ１とするとき、
前記制御装置は、前記第１モードから前記第２モードに切り替えるとき、前記車体のピッチ方向傾斜角度θ１が増加すると、前記駆動輪に与える駆動トルクＴを増加させる制御を行うことを特徴とするパーソナルビークル。
【請求項7】
請求項５または６において、前記駆動輪が走行する前記路面における路面傾斜角度をαとするとき、
前記制御装置は、前記第１モードから前記第２モードに切り替えるとき、路面傾斜角度αが増加すると、前記駆動輪に与える駆動トルクＴを増加させる制御を行うことを特徴とするパーソナルビークル。
【請求項8】
請求項１～７のうちの一項において、前記路面に対する前記後輪の接地および／または浮上を検知する後輪状態検知手段を備えていることを特徴とするパーソナルビークル。
【請求項9】
請求項２～８のうちの一項において、前記制御装置は、前記操作部による入力信号のうち所定のカットオフ周波数よりも高い高周波成分をカットするローパスフィルタ手段を備えていることを特徴とするパーソナルビークル。
【請求項10】
請求項２～８のうちの一項において、前記制御装置は、前記第２モードで走行しているときにおいて、前記後輪サポート部材の前記後輪が前記路面から浮上するとき、前記駆動輪の回転速度を減速または停止させる操作と、前記後輪サポート部材を作動させて前記後輪を前記路面に向けて下降させる操作とのうちの少なくとも一つを行うことを特徴とするパーソナルビークル。
【請求項11】
請求項２～８のうちの一項において、前記制御装置は、前記駆動輪の移動方向に凸状の段差があるとき、前記駆動輪を回転させつつ、前記後輪が前記路面を押す方向に、前記後輪サポート部材を前記路面に向けて下降させることにより、前記駆動輪の段差乗り越えを前記後輪でアシストさせる制御を行うことを特徴とするパーソナルビークル。
【請求項12】
請求項１～１１のうちの一項において、前記駆動輪のスリップを検知する検知手段が設けられていることを特徴とするパーソナルビークル。
【請求項13】
請求項２～１２のうちの一項において、前記制御装置は、前記駆動輪のスリップが検知されるとき、前記後輪を上昇させる方向に前記後輪サポート部材を作動させることにより前記駆動輪の接地性を高めて前記駆動輪のスリップを解除する制御を行うことを特徴とするパーソナルビークル。
【請求項14】
請求項２～１３のうちの一項において、前記制御装置は、前記駆動輪が凸状の段差の上面に移行していることが検知されるとき、前記後輪サポート部材を作動させて前記後輪を下降させることにより、前記後輪を接地させて前記第１モードで走行する制御を行うことを特徴とするパーソナルビークル。
【請求項15】
請求項２～１４のうちの一項において、前記制御装置は、前記第１モードで段差の上面を走行した後、前記段差の上面を降りて前記路面に移行するとき、前記駆動輪がスリップすると、前記後輪サポート部材により前記後輪を上昇させることにより前記駆動輪の接地性を高める制御を行うことを特徴とするパーソナルビークル。

【発明の詳細な説明】
【技術分野】
【0001】
本発明は電動式の車いす等のパーソナルビークルに利用できる。

【背景技術】
【0002】
代表的なパーソナルビークルとして、電動式の車いすを例にとって説明する。電動ユニットを搭載した電動車いすは、手動車いすの構造を基本的には踏襲しており、乗り降りの邪魔にならないように前方のキャスター駆動輪（前輪）が小さい。そのため、踏破できる段差の高さは低く（通常２～３ｃｍ程度）であり、例えば、車道から歩道に上がる際の低い段差を踏破する際でも、不都合が生じることがある。
【0003】
そのため、これまでに電動式の車いすに対して、段差を踏破する能力を付加するべく、さまざまな提案がされている。提案を大きく分類すると、（１）前方キャスター駆動輪の形状を工夫（大きさや溝など）する技術、（２）車体を持ち上げるための特別な機構やアクチュエータを付加する方法（特許文献１、特許文献２、特許文献３）、（３）人間の体重移動等で前方キャスター駆動輪を持ち上げる方法（特許文献４、特許文献５、特許文献６）、（４）座面の前後スライド機構により重心位置を変えることで前方キャスター駆動輪を持ち上げる方法（特許文献７）などがある。
【特許文献1】実用新案登録第3077814号
【特許文献2】特開2001-212181号公報
【特許文献3】特開2006-280616号公報
【特許文献4】特開2001-314450号公報
【特許文献5】特開2004-202264号公報
【特許文献6】実用新案登録第3028282号
【特許文献7】特開2001-37816号公報
【発明の開示】
【発明が解決しようとする課題】
【0004】
上記した技術によれば、簡便な機構で、走行安定性、段差に対する良好な踏破性を図るためには、必ずしも充分ではない。このため産業界では、簡便な機構で路面における走行安定性、段差に対する良好な踏破性を備えるパーソナルビークルが要望されている。
【0005】
本発明は上記した実情に鑑みてなされたものであり、簡便な機構で路面における走行安定性、段差に対する良好な踏破性を備えるパーソナルビークルを提供することを課題とする。
【課題を解決するための手段】
【0006】
第１発明に係るパーソナルビークル（以下、ビークルともいう）は、使用者が着座する着座部をもつ車体と、車体にこれの左右に取り付けられた駆動輪と、車体に取り付けられ駆動輪を回転駆動させる駆動源と、駆動源の駆動を制御する操作部と、駆動輪の前方に位置して車体に取り付けられた前輪と、車体に取り付けられた後輪サポート部材と、路面に接地可能に後輪サポート部材に取り付けられ、路面に接地するとき駆動輪の接地点よりも後側に位置する後輪と、後輪サポート部材を作動させて後輪を路面に対して接地および浮上させるアクチュエータと、を具備することを特徴とする。
【0007】
後輪サポート部材は、走行条件が悪いときであっても、ビークルが後方に過剰に傾斜することを防止するための部材であり、後輪を取り付けるものである。後輪は後輪サポート部材に路面に接地可能に取り付けられている。後輪が路面に接地するとき、後輪は、駆動輪の接地点よりも後側に位置しており、車体の安定を図る。
【0008】
アクチュエータが一方向に作動すると、後輪が路面に対して接地する度合が高くなる方向に後輪が移動する。これにより駆動輪、前輪および後輪で走行するモードで走行可能となる。これに対してアクチュエータが他方向に作動すると、後輪が路面から浮上する方向

に移動する。このようにアクチュエータの作動により、駆動輪の後方に設けられた後輪の接地（路面に対する接地度増加）および浮上を切り替えることができる。後輪が路面に接地していれば、前輪を路面から浮上させたとしても、ビークルは駆動輪および後輪で安定的に走行できる。従って、駆動輪および後輪が接地している状態で、前輪を路面から浮上させれば、ビークルは前輪持ち上げモードで走行することができる。この場合、駆動輪の他に後輪が路面に接地しているため、車体の姿勢を安定的に保つことができる。

【0009】

また、ビークルが段差を乗り越えるとき、後輪サポート部材を作動させ、後輪サポート部材に取り付けられている後輪の接地度（路面に対する接地度）が増加する方向に後輪を移動させれば、駆動輪が段差に乗り上げるとき、後輪によるアシスト力を発揮させることができる。これにより段差が高いときであっても、ビークルは段差を容易に乗り越えることができる。

【0010】

第２発明に係るパーソナルビークルは、使用者が着座する着座部をもつ車体と、車体に左右に取り付けられた駆動輪と、車体に取り付けられ駆動輪を回転駆動させる駆動源と、駆動源の駆動を制御する操作部と、駆動輪の前方に位置して車体に取り付けられた前輪と、車体に取り付けられた後輪サポート部材と、路面に接地可能に後輪サポート部材に取り付けられ、路面に接地するとき駆動輪の接地点よりも後側に位置する後輪と、後輪サポート部材を作動させて後輪を路面に対して接地および浮上させるアクチュエータと、少なくとも駆動輪および前輪で走行する第１モードと、前輪を浮かせた状態で駆動輪および後輪を接地しつつ走行する第２モードとを切り替え可能な制御装置とを具備することを特徴とする。

【0011】

制御装置によりアクチュエータが一方向に作動すると、後輪が路面に対して接地する度合が高くなる方向に移動する。これにより駆動輪、前輪および後輪でビークルが走行するモードで走行可能となる。これに対して制御装置によりアクチュエータが他方向に作動すると、後輪が路面から浮上する方向に移動することができる。このようにアクチュエータの作動により、駆動輪の後方に設けられた後輪の接地（路面に対する接地度増加）および浮上を切り替えることができる。

【0012】

ここで、駆動輪の他に後輪が路面に接地していれば、前輪を路面から浮上させたとしても、ビークルは駆動輪および後輪で安定的に走行できる。従って、駆動輪および後輪が接地している状態で、前輪を路面から浮上させれば、ビークルは前輪持ち上げモードで走行することができる。駆動輪の他に後輪が接地しているため、第２モード（前輪浮上モード）の車体姿勢を安定的に保つことができる。

【0013】

また、ビークルが段差を乗り越えるとき、制御装置により後輪サポート部材を作動させ、後輪サポート部材に取り付けられている後輪の接地度が増加する方向に後輪を移動させれば、駆動輪が段差に乗り上げるとき、後輪によるアシスト力を発揮させることができる。これにより段差が高いときであっても、ビークルは段差を容易に乗り越えることができる。

【発明の効果】

【0014】

本発明によれば、簡便な機構で路面における走行安定性、段差に対する良好な踏破性を備えるパーソナルビークルを提供することができる。

【0015】

本発明によれば、電動式の車いす等に代表されるパーソナルビークルを構成する車体に、後輪サポート部材、後輪サポート部材を作動させるアクチュエータを付加することにより、段差乗り越え等を容易に実現することができる。このように本発明によれば、電動式の車いす等のパーソナルビークルの駆動機構に加える工夫を低減できるため、従来の走行

感を大きく損なうことが抑えられる。

【発明を実施するための最良の形態】

【0016】

パーソナルビークルは、使用者が着座する着座部をもつ車体と、車体に左右に取り付けられた駆動輪と、駆動輪を回転駆動させる駆動源と、駆動源の駆動を制御する操作部と、駆動輪の前方に位置して車体に取り付けられた前輪と、駆動輪の接地点よりも先端部が後側に延びるように車体に取り付けられた後輪サポート部材と、後輪サポート部材に取り付けられた後輪と、後輪サポート部材を路面に対して昇降させることにより、後輪を接地および浮上させるアクチュエータとを備えている。駆動源はモータが例示される。駆動輪は、車体に左右に取り付けられており、一般的には駆動輪の径は前輪および後輪の径よりも大きいことが好ましいが、場合によっては、前輪および後輪の径は同じ程度でも良い。駆動源は、駆動輪を回転駆動させるものであり、モータが例示される。操作部は、駆動源の駆動を操作者（一般的には、着座部に着座している者、介護者）が制御するものである。操作部は車体に取り付けられていても良いし、車体から分離されている方式でも良いし、ワイヤレス方式でも良い。前輪は、駆動輪の前方に位置して車体に取り付けられているものである。後輪サポート部材は後輪を車体に取り付けるものである。後輪サポート部材はバー形状、プレート形状等が例示されるが、その形状は特に限定されるものではない。後輪は、後輪サポート部材に取り付けられている。後輪が路面に接地するとき、後輪の接地点が駆動輪の接地点よりも後側に位置する。アクチュエータは、後輪サポート部材を路面に対して昇降させることにより、後輪を接地および浮上させるものであり、モータ、空気圧シリンダ装置、油圧シリンダ装置、電磁機器が例示される。アクチュエータとしては直動タイプでも、回動タイプでも良い。

【0017】

本発明の一形態によれば、前輪は車体の左右に設けられており、後輪は単数であり、第１モードは、左右の駆動輪、左右の前輪および後輪で走行する５輪モード（全輪モード）であり、第２モード（前輪浮上モード）は、左右の前輪を浮上させつつ左右の駆動輪および後輪で走行する３輪モードである。但し、前輪を車幅方向の中央に単数設け、後輪を車幅方向の両側に複数設けても良い。

【0018】

５輪モード等に代表される第１モードは、主として、安定走行、旋回性能の向上、坂道での安定発進、坂道での安定走行を意図することができる。駆動輪、前輪および後輪がそれぞれ車体の左右にあれば、第１モードは６輪モードとなる。要するに、第１モードは、前輪が路面に接地しており、第２モード（前輪が路面に対して浮上している前輪浮上モード）よりも、路面に接地する輪が多いモードである。上記した第２モードつまり前輪浮上モード（例えば３輪モード）は、主として、第１モードでは走行できない段差、溝の踏破、第１モードで発生する振動の低減、乗車姿勢のリクライニング効果を図り、乗り心地を改善させることを意図することができる。パーソナルビークルは、路面に対する後輪の接地および浮上を検知する後輪状態検知手段を備えていることが好ましい。後輪状態検知手段は、マイクロスイッチ、リミットスイッチ、圧力センサ、光センサ、静電気センサ等が例示される。

【0019】

ビークルの走行速度を検知する走行速度検知段、および／または、ビークルの移動（前進および後退を含む）方向の走行速度の速度目標値を設定する目標走行速度設定手段が設けられていることが好ましい。走行速度検知手段としては、駆動輪の回転を検知するセンサ、駆動輪を回転させるモータの回転を検知するセンサが例示される。センサはエンコーダが例示される。目標走行速度設定手段は、使用者または介助者等がビークルの移動方向の走行速度の速度目標値を設定するものであり、ジョイスティク、ボタンスイッチ等が例示される。使用者の体重を含むビークルの重心位置のピッチ方向の傾斜角度（ピッチ軸に対する傾斜角度）を$\theta 1$とするとき、傾斜角度$\theta 1$を検知するセンサが設けられていることが好ましい。このセンサは加速度計およびレートジャイロが例示されるが、これに限定

されるものではない。また、ビークルが走行する路面傾斜角度をαとするとき、路面傾斜角度αを検知するセンサが設けられていることが好ましい。このセンサは加速度計およびレートジャイロが例示されるが、これに限定されるものではない。

【0020】

本発明に係るパーソナルビークルによれば、以下の例示される制御形態が実行されることが好ましい。

【0021】

＊操作部が第２モード（前輪浮上モード）に切り替えられていること、前進方向の走行速度が設定速度以上であること、移動方向の操作部による速度目標値が一定値以上であることのうちの、少なくとも一つの条件が満足されるとき、制御装置は、後輪サポート部材を作動させて後輪を路面から浮上させる方向に相対的に移動させ（後輪が路面に接地したままのときもある）、第１モードから第２モード（前輪浮上モード）に切り替える制御を行うことが好ましい。走行速度が設定速度以上あれば、駆動トルクにより前輪を浮上させて第２モードに切り替え易い。

【0022】

＊第１モードから第２モード（前輪浮上モード）に切り替えるにあたり、制御装置は、後輪サポート部材を作動させて後輪を路面から持ち上げるように位置させると共に、使用者の体重を含むパーソナルビークルの重心位置が駆動輪の接地点よりも後方に位置するような駆動トルクを駆動輪に与える制御を行うことが好ましい。これにより第１モードから前輪を浮上させて第２モードに容易に切り替えることができる。後輪が接地しているため、車体の後方への過剰傾倒は抑えられる。

【0023】

＊第１モードから第２モードに切り替えるとき、制御装置は、使用者の体重を含むパーソナルビークルの重心位置のピッチ方向傾斜角度θ１が増加すると、左右の駆動輪に与える合計の駆動トルクＴを増加させる制御を行うことが好ましい。これにより前輪を上昇させる方向に移動させて第１モードから第２モードに容易に切り替えることができる。この場合、ピッチ方向傾斜角度θ１に応じた駆動トルクＴを駆動輪に継続して与えれば、第２モード（前輪浮上モード）走行を維持することができる。

【0024】

＊第１モードから第２モードに切り替えるとき、制御装置は、路面傾斜角度αが増加すると、左右の駆動輪に与える合計の駆動トルクＴを増加させる制御を行うことが好ましい。これにより第１モードから第２モードに容易に切り替えることができる。

【0025】

＊第１モードから第２モードに切り替えるとき、制御装置は、路面傾斜角度αが増加すると、左右の駆動輪に与える合計の駆動トルクＴを増加させる制御を行うことが好ましい。これにより第１モードから第２モードに容易に切り替えることができる。この場合、路面傾斜角度αに応じた駆動トルクＴを駆動輪に与えれば、第２モード（前輪浮上モード）走行を維持することができる。

【0026】

＊また、第１モードから第２モードに切り替えるとき、制御装置は、使用者の体重を含むパーソナルビークルの重心位置のピッチ方向傾斜角度θ１および／または路面傾斜角度αが増加すると、左右の駆動輪に与える合計の駆動トルクＴを増加させる制御を行うことが好ましい。これにより第１モードから第２モードに容易に切り替えることができる。この場合、ピッチ方向傾斜角度θ１および／または路面傾斜角度αに応じた駆動トルクＴを駆動輪に与えれば、第２モード（前輪浮上モード）走行を維持することができる。

【0027】

＊操作部が急激に操作されるとき等には、パーソナルビークルが急停止したり、急後退したりするおそれがある。この場合、パーソナルビークルの姿勢が損なわれるおそれがある。この点について好ましい形態によれば、制御装置は、操作部による入力信号（例えば操作部からの速度指令値）のうち、所定のカットオフ周波数よりも高い高周波成分をカッ

トするフィルタ部を備えている。この結果、操作部による入力信号（例えば操作部からの速度指令値）のうち、所定のカットオフ周波数よりも高い高周波成分（操作部が急激に操作されるときに相当）は、カットされる。従って、操作部が急激に操作されたとしても、パーソナルビークルが急停止したり、急後退したりするおそれが低減又は回避される。この場合、第１モードでも良いし、第２モード（前輪浮上モード）でも良い。また、上記カットオフ周波数については、操作部による入力信号が前進指令時、後退指令時に合わせて、独立して設定しても良い。

【0028】

＊カットオフ周波数ｆは、路面傾斜角度α、および／または、ピッチ方向への傾斜角度θ１に応じて求められることが好ましい。ここで、カットオフ周波数ｆについては、路面傾斜角度αに応じて設定することができる。例えば、カットオフ周波数ｆについては、路面傾斜角度αが大きくなればカットオフ周波数ｆを増加させる形態と、路面傾斜角度αが大きくなればカットオフ周波数ｆを減少させる形態とに分けることが好ましい。前者の形態は、例えば、３輪状態において前方への過剰傾倒を抑える場合である。後者の形態は、例えば、３輪状態または５輪状態において後方への転倒を抑える場合である。

【0029】

＊第２モード（前輪浮上モード）で走行しているときにおいて、後輪サポート部材に取り付けられている後輪が路面から浮上するとき、パーソナルビークルの姿勢の安定性が損なわれるおそれがある。この点について好ましい形態によれば、制御装置は、第２モード（前輪浮上モード）で走行しているときにおいて、後輪サポート部材の後輪が路面から浮上するとき、駆動輪の回転速度を減速または停止させる操作と、後輪サポート部材を下降させて後輪を路面に向けて下降させる操作とのうちの少なくとも一つを行う制御を行うことが好ましい。

【0030】

＊駆動輪の移動方向（前進方向）に凸状の段差があるとき、駆動輪が段差を乗り越えられないおそれがある。この点について好ましい形態によれば、制御装置は、駆動輪の前進方向に凸状の段差があるとき、駆動輪を回転させつつ、後輪が路面を押す方向に後輪サポート部材を路面に向けて下降させることにより、駆動輪の段差乗り越えを後輪でアシストさせる制御を行うことが好ましい。この場合、段差が高いときであっても、後輪によるアシストにより駆動輪が段差を乗り越えることができる。

【0031】

＊駆動輪のスリップを検知する検知手段が設けられていることが好ましい。検知手段はスリップセンサとしても良いし、ソフトウェア的に検知しても良い。

【0032】

＊前輪が凸状の段差を走行するとき等において、駆動輪のスリップが検知されるときがある。この場合、駆動輪がスリップしているため、パーソナルビークルは走行できないおそれがある。この点について好ましい形態によれば、制御装置は、前輪が凸状の段差を走行するときにおいて、駆動輪のスリップが検知されるとき、後輪を上昇させる方向に後輪サポート部材を作動させることにより、後輪を路面から離間させる方向に移動させると共に駆動輪の接地性を高めて駆動輪のスリップを解除する制御を行うことができる。

【0033】

*前進方向の走行速度が設定速度以上であること、前進方向の操作部による速度目標値が一定値以上であることのうちの少なくとも一つの条件が満足されるとき、制御装置は、後輪サポート部材を作動させて後輪を路面から持ち上げる方向に移動させ、第１モードから第２モード（前輪浮上モード）に切り替える制御を行うことができる。この場合、路面傾斜角度α、および／または、ピッチ方向への傾斜角度θ１に応じて駆動トルクを駆動輪に与えることが好ましい。

【0034】

＊制御装置は、駆動輪が凸状の段差の上面に移行していることが検知されるとき、後輪サポート部材を作動させて後輪を下降させることにより、後輪を接地させ、第１モードに

設定することが好ましい。このように後輪が接地しているため、パーソナルビークルは段差の上面を第１モードで安定的に走行できる。なお、駆動輪が段差の上面に移行していることは、車体が水平であることとして推定できるため、使用者を載せた状態の車体の重心位置のピッチ方向傾斜角度θ１に基づいて検知可能である。

【0035】

＊制御装置は、第１モードで段差の上面を走行し上面を降りて路面に移行するとき、駆動輪がスリップすると、後輪サポート部材により後輪を上昇させて駆動輪の接地性を高める制御を行うことが好ましい。この場合、駆動輪のスリップが生じれば、駆動輪のトルクでビークルは前進できない。そこで、駆動輪のスリップが生じれば、後輪サポート部材により後輪を上昇（浮上）させると、駆動輪は段差の下面または路面に効果的に接地できるため、駆動輪のトルクでビークルは前進できる。

【0036】

以下、本発明を具体化した実施形態１について説明する。

【0037】

（実施形態１）

本実施形態のパーソナルビークル１は電動式の車いすに相当する。前方（矢印Ｆｘ方向）は、ビークル１に正規に着座している使用者の顔面が向いている方向を示し、ビークル１が進行する方向を示す。後方（矢印Ｒｘ方向）は、ビークル１に正規に着座している使用者の顔面が背向している方向を示し、ビークル１が後退する方向を示す。

【0038】

図１（ａ）に示すように、ビークル１は、使用者が着座する着座部１０をもつ車体１１と、車体１１に左右に取り付けられた回転可能な左右の駆動輪１２（１２Ｒ，１２Ｌ）と、駆動輪１２を回転駆動させる駆動源としての駆動輪モータ１３（１３Ｒ，１３Ｌ）と、駆動輪モータ１３（１３Ｒ，１３Ｌ）の駆動を制御する操作部１４と、駆動輪１２の前方に位置して車体１１に取り付けられた回転可能な左右の前輪１５と、駆動輪１２の後方に向けて延びるように車体１１に取り付けられた後輪サポート部材としての後輪サポートバー１６と、後輪サポートバー１６の先端部に取り付けられた回転可能な後輪１７と、後輪サポートバー１６を路面９０に対して接地および浮上させるアクチュエータ１８とを備えている。

【0039】

駆動輪１２は右の駆動輪１２Ｒ，左の駆動輪１２Ｌを備えている。駆動輪モータ１３は右の駆動輪１２Ｒを回転駆動させる右の駆動輪モータ１３Ｒ，左の駆動輪１２Ｌを回転駆動させる左の駆動輪モータ１３Ｌを備えている。 ここで、右の駆動輪１２Ｒ，左の駆動輪１２Ｌを区別する必要があるときには、駆動輪１２Ｒ，駆動輪１２Ｌと称する。右の駆動輪１２Ｒ，左の駆動輪１２Ｌをまとめるときには、駆動輪１２と称することがある。着座部１０は、使用者の腰部を支える座部１０ａと、使用者の背中を支える背もたれ部１０ｃとを備える。

【0040】

操作部１４は、着座部１０に着座している使用者が操作できるように、着座部１０付近に設けられている。駆動輪１２は、ビークル１の前後方向において重心位置Ｇの直下またはその付近に配置されている。前輪１５は駆動輪１２の径よりも小さく且つ後輪１７の径よりも大きな径をもち、キャスター駆動輪である。前輪１５は左右に設けられているが、場合によっては車幅方向の中央に設けた単数でも良い。後輪１７は駆動輪１２および前輪１５の径よりも小さな径をもち、キャスター駆動輪、または、車体１１の左右方向にも移動可能なオムニホィールが例示されるが、これに限定されない。なお、後輪１７は車幅方向の中央に配置されているが、車幅方向の左右に設けても良く、後輪１７の数は特に限定されない。

【0041】

図１（ｂ）はビークル１が５輪モードで走行している状態を示す。図１（ｄ）はビークル１が３輪モードで走行している状態を示す。図１（ｂ）→図１（ｃ）→図１（ｄ）は、

５輪モードから３輪モードに切り替える形態を示す。図１（ｄ）→図１（ｃ）→図１（ｂ）は、３輪モードから５輪モードに切り替える形態とを示す。駆動輪１２の接地点１２ｃは、駆動輪１２が路面９０に接触している部位を示す。

【0042】

ビークル１は、通常時には、図１（ｂ）に示すように、第１モードである５輪モード（Ａモードともいう）で走行し、走行安定性を得る。５輪モードは、駆動輪１２、前輪１５および後輪１７を路面９０に接地させることを目的として走行するモードである。５輪モードは、主として、安定走行、旋回性能の向上、坂道での安定発進、坂道での安定走行を意図することができる。

【0043】

第２モード（前輪浮上モード）である３輪モード（Ｂモードともいう）は、図１（ｄ）に示すように、前輪１５を路面９０から充分に浮かせた状態で、駆動輪１２および後輪１７を路面９０に接地させることを目的として走行するモードである。３輪モードは、主として、５輪モードでは走行できない段差、溝の踏破、５輪モードで発生する振動の低減、乗車姿勢のリクライニング効果を図り、乗り心地を改善させることを意図することができる。また５輪モードによれば、重心位置Ｇは駆動輪１２の接地点１２ｃ付近または接地点１２ｃよりも前方に位置する。３輪モードによれば、重心位置Ｇは駆動輪１２の接地点１２ｃよりも後方に位置する。ここで、重心位置Ｇは、使用者の体重を含むビークル１の全体（左右の駆動輪１２を除く）の重心位置を意味する。このように２つの走行モードを１台のビークル１で実現することができる。

【0044】

図２は、制御系のブロック図を示す。図２に示すように、制御装置２は５輪モードと３輪モードとを切り替える制御を行う。図２に示すように、制御装置２は、デジタルＩＯ２０と、インターフェース機能をもつＡＤ変換器２１と、カウンタ２２と、単数または複数のＣＰＵ２３と、インターフェース機能をもつＤＡ変換器２４とを備える。デジタルＩＯ２０およびＡＤ変換器２１は、操作部１４およびセンサ系からの信号が入力される。カウンタ２２は、左の駆動輪エンコーダ５５Ｌおよび右の駆動輪エンコーダ５５Ｒからの信号が入力される。左の駆動輪エンコーダ５５Ｌは、左の駆動輪１２Ｌに対する角速度センサ、回転数センサ、ビークル１の速度センサ（走行速度検知手段）として機能することができる。右の駆動輪エンコーダ５５Ｒは、右の駆動輪１２Ｒに対する角速度センサ、回転数センサ、ビークル１の速度センサ（走行速度検知手段）として機能することができる。

【0045】

駆動輪駆動系は、右の駆動輪モータ１３Ｒ（第１駆動源）と、ＣＰＵ２３からの指令に基づき右の駆動輪モータ１３Ｒを駆動するための右の駆動輪モータドライバ１３１と、左の駆動輪モータ１３Ｌ（第２駆動源）と、ＣＰＵ２３からの指令に基づき左の駆動輪モータ１３Ｌを駆動するための左の駆動輪モータドライバ１３２とを備えている。右の駆動輪モータドライバ１３１により右の駆動輪モータ１３Ｒが制御され、右の駆動輪１２Ｒが制御される。左の駆動輪モータドライバ１３２により左の駆動輪モータ１３Ｌが制御され、左の駆動輪１２Ｌが制御される。

【0046】

操作部１４は、着座部１０に着座している着座者が操作し易いように、車体１１のうち着座部１０付近に保持されていることが好ましいが、車体１１から分離するリモコン方式でも良い。操作部１４は、５輪モードと３輪モードとを使用者等が切り替えるためのモード切替ボタン１４１（モード切替スイッチ）と、ビークル１の速度を使用者が指令する速度指令操作部１４２（例えばジョイスティック、目標走行速度設定手段）とを備えている。なお、速度指令操作部１４２を前方に傾けると、前進指令が出力され、後方に傾けると、後退指令が出力され、そして、傾き角度に応じて速度目標が増加する方式が採用されている。但し、この方式に限定されるものではない。

【0047】

センサ系は、後輪サポートバー１６に取り付けられている後輪１７が路面９０に接地お

よび浮上したことを検知するための接地スイッチ５０（後輪接地および／または浮上検知手段，後輪状態検知手段）と、車体１１に設けられたレートジャイロ５２と、車体１１に設けられた加速度計５３と、右の駆動輪１２Ｒの回転速度および／または回転角度を検知するために車体１１に設けられた右の駆動輪エンコーダ５５Ｒと、左の駆動輪１２Ｌの回転速度および／または回転角度を検知するために車体１１に設けられた左の駆動輪エンコーダ５５Ｌと、後輪サポートバー１６の位置および／または傾斜角度を検知することにより後輪サポートバー１６の位置を検知するために車体１１に設けられた位置センサ５７とを備えている。接地スイッチ５０は、後輪サポートバー１６または車体１１に設けられている。各センサ、各エンコーダの信号は、それぞれデジタルＩＯ２０、ＡＤ変換器２１、カウンタ２２を介して、制御装置２に入力される。

【0048】

加速度計５３は、ビークル１の車体１１の前進後退方向における加速度を検知することができる。加速度計５３の出力値は、ビークル１がピッチ方向に傾斜しているとき、重力加速度の影響で、ビークル１の重心位置Ｇのピッチ方向の傾斜角度$\theta 1$に応じた加速度を検知することができる。このため加速度計５３は、前記した重心位置Ｇのピッチ方向の傾斜角度$\theta 1$を検知することができる。レートジャイロ５２は、重心位置Ｇのピッチ方向の角速度を検知することができる。

【0049】

このような加速度計５３およびレートジャイロ５２は、水平線に対する路面傾斜角度α、および／または、車体１１のピッチ方向の傾斜角度$\theta 1$を求めるセンサとして機能することができる。ピッチ方向とは、ビークル１の前進方向（矢印Ｆｘ，Ｒｘ方向）において、駆動輪１２の径方向の軸中心１２ｅに対する傾斜角度を意味する。なお、駆動輪１２の径方向の軸中心１２ｅは、ピッチ方向の運動の中心であるピッチ軸に相当する。

【0050】

図２に示すように、後輪サポートバー１６を駆動させるバー駆動系は、後輪サポートバー１６を作動させるために車体１１に設けられたアクチュエータ１８と、制御装置２からの指令に基づきアクチュエータ１８を駆動させる後輪サポートバードライバ１９とを備えている。制御装置２からの指令は、右の駆動輪モータドライバ１３１、左の駆動輪モータドライバ１３２、後輪サポートバードライバ１９に入力され、これらを制御する。

【0051】

以下、本実施形態に係る制御装置２が実行する各制御項目について説明する。＊は実行される制御項目を示す。

【0052】

＊５輪モードの走行から３輪モードの走行へ切替える制御（制御Ａ）

５輪モードでは、ビークル１は、駆動輪１２、前輪１５および後輪１７の合計５輪を路面９０に接地しつつ走行しており、走行安定性が高い。これに対して、３輪モードでは、ビークル１は、前輪１５を路面９０から浮かせた状態で、駆動輪１２および後輪１７を路面９０に接地しつつ走行する。３輪モードでは、前輪１５が路面９０から浮上しているため、走行中のビークル１の前方に段差が存在していたとしても、ビークル１は段差を乗り越え易い。

【0053】

次に示す（ｉ）（ｉｉ）の双方の条件が満足される場合において、操作者（一般的には着座している使用者）等によりモード切替ボタン１４１を一定時間連続的にまたは断続的に操作されると、制御装置２は、モードを５輪モードから３輪モードへ自動的に切替える。モード切替ボタン１４１の一定時間の操作を条件としたのは、モード切替ボタン１４１の押し間違い、速度指令操作部１４２（例えばジョイスティック）の誤操作などによる意図に反して予期しない３輪モードへの移行が生じないようにするためである。ビークル１の前進走行速度が速ければ、使用者の体重を含めたビークル１の全体（左右の駆動輪１２を除く）の重心位置Ｇが駆動輪１２の接地点１２ｃよりも後方に移動し易くなり、前輪１５が路面９０から浮上し易くなり、５輪モードから３輪モードとなり易い。

（ｉ）前進走行速度Ｖが設定速度以上であること
（ｉｉ）速度指令操作部１４２（例えばジョイスティック）による前進速度の目標値Ｖtargetが一定値以上であること
逆に、３輪モードから５輪モードへは、モード切替スイッチとして機能するモード切替ボタン１４１が一定時間、連続的または断続的に操作された場合には、制御装置２は、ビークル１の移動速度に依存することなく、３輪モードから、走行安定性が高い５輪モードへ直ちに移行させる。この場合、実際の前進走行速度、前進速度の目標値に依存しない。
【0054】
ところで、５輪モードで走行しているとき、５輪モードから３輪モードへ移行させるためには、使用者の体重を含めたビークル１の全体（左右の駆動輪１２を除く）の重心位置Ｇが駆動輪１２の接地点１２ｃよりも後方に来るような駆動トルクを与えることが好ましい。同時に、車体１２の後方への傾倒を確保すべく、後輪１７を路面９０に接地させつつ、後輪サポートバー１６を上方（矢印Ｕ方向，浮上させる方向）に持ち上げる指令をアクチュエータ１８に出力する。その結果、ビークル１全体が前方に進みながら後方に傾倒し（一般的には、後輪１７を路面９０に接地させつつ）、３輪モードに移行する。
【0055】
このように５輪モードから３輪モードに移行する場合、左右の駆動輪１２で発生する駆動トルクＴは、次の式（１）で計算されるトルク以上とする。
【0056】
【数1】

$$T \geq \frac{\{(M_1+M_2)R^2+J_2\}M_1Lg\sin\theta_1+M_1RL\cos(\theta_1+\alpha)(M_1+M_2)Rg\sin\alpha}{M_1RL\cos(\theta_1+\alpha)+(M_1+M_2)R^2+J_2} \quad (1)$$

図３は、式（１）で用いられるパラメータを示す。図３および式（１）において、Ｇは、使用者の体重を含むビークル１（駆動輪を除く）の重心位置を示す。図３に示すように、Ｐ１は、駆動輪１２の軸中心１２ｅ（ピッチ運動の中心であるピッチ軸）を通る鉛直線を示す。θ１は、使用者の体重を含むビークル１の重心位置Ｇが駆動輪１２の軸中心１２ｅ（ピッチ軸に相当）に対してピッチ方向（前方）へ傾斜している傾斜角度（駆動輪１２の軸中心１２ｅを通る鉛直線Ｐ１に対するピッチ方向傾斜角度）を示す。
【0057】
図３において、Ｐ２は、ビークル１の重心位置Ｇと駆動輪１２の軸中心１２ｅとを通る仮想線を示す。Ｍ１は、使用者（人間）の体重を含むビークル１（駆動輪を除く）の質量を示す。Ｊ１は、使用者（人間）の体重を含むビークル１（駆動輪を除く）の重心位置Ｇ回りの慣性モーメントを示す。Ｍ２は、左右の駆動輪１２の質量の合計を示す。Ｊ２は、重心位置Ｇ回りの駆動輪１２の慣性モーメントを示す。Ｌは、重心位置Ｇと駆動輪１２の軸中心１２ｅとの距離（仮想線Ｐ２と平行な距離）を示す。Ｒは、駆動輪１２の半径を示す。Ｔは左右の駆動輪１２Ｒ，１２Ｌの合計の駆動トルクを示す。ｇは重力加速度を示す。αは、水平線に対する実際の路面傾斜角度を示す。αは、段差９５の踏破時における段差９５の傾斜も含む。なお、路面傾斜角度αが正値で大きくなることは、路面９０が登り坂となることを意味する。
【0058】
ピッチ方向傾斜角度θ１は、車体１１に設けられた加速度計５３の出力値およびレートジャイロ５２の出力値から求められる。具体的には、ピッチ方向傾斜角度θ１はθHLと同じものであり、θHLの場合と同様に、制御装置２は、レートジャイロ５２の出力値である角速度θｇ（ドット）を時間積分した積分値（レートジャイロ５２で求めたθHLに相当）を求め、その積分値をハイパスフィルタ（カットオフ周波数ｆｃ）によりフィルタリングにより低周波域のノイズを除去した値θHL2を求める。制御装置２はθHL1およびθHL2を加算し、θHL（θHL＝θHL1＋θHL2）＝θ１を求める。
【0059】
ここで、ビークル１の重心位置Ｇとは、使用者が着座部１０に着座しているとき、使用

者の体重を含めたビークル１の全体（但し、左右の駆動輪１２を除く）の重心をいう。使用者が着座部１０に着座しているとき、ビークル１の全体の重心位置Ｇは、前後方向において、左右の駆動輪１２の接地点１２ｃ近傍にある。ここで、θ１，αはそれぞれ大きな角度ではない。このため、便宜上、ｓｉｎθ１≒θ１、ｃｏｓ（θ１＋α）≒（１－（θ１＋α））≒１と取り扱うことができるため、次の式（２）のように線形近似を行うことが可能である。

【0060】

【数2】

$$T \geq \frac{\left[\{(M_1+M_2)R^2+J_2\}\theta_1+(M_1+M_2)R^2\alpha\right]M_1Lg}{M_1RL+(M_1+M_2)R^2+J_2} \qquad (2)$$

制御装置２が５輪モードから３輪モードへモードを移行させるにあたり、式（２）において、Ｍ１，Ｍ２，Ｒ，Ｊ１、Ｊ２、Ｌ，ｇはほぼ固定値であると推定できる。このため、式（２）によれば、ビークル１の全体の重心位置Ｇの傾斜角度θ１および路面傾斜角度αが増加するにつれて、左右の駆動輪１２に発生する駆動トルクＴを増加させる必要がある。このように駆動トルクＴを増加させれば、使用者の体重を含めたビークル１の全体（左右の駆動輪１２を除く）の重心位置Ｇが駆動輪１２の接地点１２ｃよりも前方（鉛直線Ｐ１よりも前方）から、後方（鉛直線Ｐ１よりも後方）に移動することができ、ビークル１を走行させつつ、前輪１５を路面９０から浮上させることができる。

【0061】

なお、駆動輪１２，前輪１５および後輪１７が路面９０に接地しているときには、路面傾斜角度αは、後述の角度θHL（＝θ１）と、水平面上にビークル１が存在するときのθ１（重心位置Ｇと駆動輪１２の軸中心１２ｅとを結ぶ線と鉛直線Ｐ１との成す角度）で定義される角度θ1Sとに基づいて、α≒θ1S－θHLで算出される。ここで、傾斜角度θHLは、ビークル１のピッチ軸（具体的には、駆動輪１２の軸中心１２ｅ）回りに取り付けられたレートジャイロ５２の出力値と、前後進方向の加速度計５３の出力値とから、後述の図６に示す手法により演算で求めて算出する。従って、レートジャイロ５２および加速度計５３は、路面傾斜角度αを検知する路面傾斜角度センサ、および／または、ビークル１の重心位置Ｇのピッチ方向へのピッチ方向傾斜角度θ１を検知するピッチ方向傾斜角度検知センサとして機能することができる。

【0062】

ここで、上記した式（２）を考慮し、実用的には、下記の式(３)ようなトルクを左右の駆動輪１２Ｒ，１２Ｌで発生させれば、５輪モードから３輪モードへの確実なモード移行を実現することができる。従って５輪モードから３輪モードに切り替えるに当たり、制御装置２は駆動トルクＴを演算またはマップから求める。駆動トルクＴは、５輪モードから３輪モードに切り替えるための駆動トルクである。駆動トルクＴ以上のトルクが駆動輪１２Ｒ，１２Ｌに与えられると、ビークル１は５輪モードから３輪モードに切り替えられる。

【0063】

【数3】

$$T = T_c + K_p(\theta_1 - \theta_t) + \frac{\left[\{(M_1+M_2)R^2+J_2\}\theta_1 + (M_1+M_2)R^2\alpha\right]M_1Lg}{M_1RL+(M_1+M_2)R^2+J_2} \quad (3)$$

$$T \geq \frac{\{(M_1+M_2)R^2+J_2\}M_1Lg\theta_1}{M_1RL+(M_1+M_2)R^2+J_2} \quad (2X)$$

$$T = T_c + K_p(\theta_1 - \theta_t) + K_b\theta_1 \quad (3X)$$

$$K_b = \frac{\{(M_1+M_2)R^2+J_2\}M_1Lg}{M_1RL+(M_1+M_2)R^2+J_2}$$

上記した式(３)において、Ｔｃは、摩擦等の補償トルクを示す。Ｋｐは、ピッチ方向傾斜角度θ１に関するフィードバックゲインを示す。θｔは、ビークル１の重心位置Ｇのピッチ方向の目標角度を示し、ビークル１に応じて予め設定されている固定値である。

【0064】

ここで上記した式(３)において、Ｍ１，Ｍ２，Ｊ１，Ｊ２，Ｌ，Ｒは固定値またはほぼ固定値と推定できる。このため上記した式(３)によれば、左右の駆動輪１２に与えられる駆動トルクＴは、路面傾斜角度αおよびピッチ方向傾斜角度θ１に基づいて求められる。従って、駆動トルクＴは、ピッチ方向傾斜角度θ１が大きくなるほど増加し、路面傾斜角度αが増加するほど増加する。従って、５輪モードから３輪モードへ切り替えるにあたり、制御装置２は、ピッチ方向傾斜角度θ１および路面傾斜角度αを求め、式(３)に基づいて駆動トルクＴを設定し、制御装置２は、駆動輪１２に与えられる駆動トルクがＴとなるようフィードバック制御する。これにより３輪モードで安定的に走行できる。

【0065】

上記した式（１）～式(３)によれば、ピッチ方向傾斜角度θ１が増加するにつれて、路面傾斜角度αが増加して路面９０が登り勾配が急になるにつれて、左右の駆動輪１２に発生する駆動トルクＴを増加させる必要がある。ここで、式（１）～式(３)における駆動トルクＴは、左右の駆動輪１２の総和である。よってビークル１が５輪モードから３輪モードに切り替わるとき、左の駆動輪１２の駆動トルクはＴ／２であり、右の駆動輪１２の駆動トルクはＴ／２である。

【0066】

上記した式（１Ｘ）は路面傾斜角度αが０のとき、上記した式（１）に相当する。上記した式（２Ｘ）は路面傾斜角度αが０のとき、上記した式（２）に相当する。上記した式（３Ｘ）は路面傾斜角度αが０のとき、上記した式（３）に相当する。このように式（３Ｘ）によれば、路面傾斜角度αが０のときには、ピッチ方向傾斜角度θ１が増加するにつれて、制御装置２は、左右の駆動輪１２に発生する駆動トルクＴを増加させる必要がある。なお、式(３Ｘ)において、前述同様に、Ｔｃは、摩擦等の補償トルクを示す。Ｋｐは、ピッチ方向傾斜角度θ１に関するフィードバックゲインを示す。θｔは、ビークル１の重心位置Ｇのピッチ方向の目標角度を示し、ビークル１に応じて予め設定されている固定値である。

【0067】

＊ところで、万が一、ビークル１が５輪モードで走行しているとき、５輪モードから予期せぬ３輪モードへの移行が発生したりすることがある。また、５輪モードから３輪モードへの移行中に危険な状態に陥ったりする場合には、操作部１４（ジョイスティック等）による人間の意図的な動作（反対方向への目標速度指令など）により、その場で、制御装置２は、左右の駆動輪１２の駆動を止める指令を出力すると共に、後輪サポートバー１６を下げて後輪１７の接地性を高める指令を出力することにより、モードを５輪モードに戻す。これによりビークル１は３輪モードから５輪モードに安定的に戻ることができる。なお、５輪モードから３輪モードに切り替えるにあたり、上記した（ｉ）および（ｉｉ）の条件を満足させることにしているが、場合によっては、（ｉ）および（ｉｉ）のうちのいずれか一方のみとしても良い。

【0068】

＊３輪モードにおける走行から５輪モードに切り替える制御（制御Ｂ）

３輪モードにおいてビークル１が走行しているとき、着座部１０に着座している使用者の重心移動など、または、予想外の要因により、後輪１７が浮上するおそれがある。この場合には、路面９０に対する後輪１７の接地および浮上を検知する接地スイッチ５０から後輪浮上信号が制御装置２に出力される。そこで制御装置２は、後輪サポートバー１６を下降させる指令をアクチュエータ１８に出力する。これにより制御装置２は後輪１７を路面９０に接地させ、安定走行を図り得る５輪モードに切り替える。この場合、操作部１４のモード切替ボタン１４１が３輪モードを選択している場合には、制御装置２は３輪モードに移行させる制御を行う。この場合においても、３輪モードに移行させるためには、前記した（ｉ）（ｉｉ）の条件を満足させることが好ましい。

【0069】

＊３輪モード及び５輪モードのそれぞれにおける安定走行のためのトルク制御

３輪モード及び５輪モードにおいてビークル１を安定走行させるためには、右の駆動輪１２Ｒの駆動トルクがT_Rに維持されるように、且つ、左の駆動輪１２Ｌの駆動トルクがT_Lに維持されるように、駆動輪１２Ｒ，１２Ｌについてそれぞれ独立にフィードバック制御を行う。これにより左右の駆動輪１２Ｒ，１２Ｌに対して独立に回転数の制御を行う。ここで、式（４）に示されるT_Rは、安定走行のための右の駆動輪１２Ｒの駆動トルクを示す。式（５）に示されるT_Lは、安定走行のための左の駆動輪１２Ｌの駆動トルクを示す。

【0070】

【数4】

$$T_R = K_{VR}(\dot{\theta}_R - \dot{\theta}_{R\_ref}) + K_{PR}(\theta_R - \int \dot{\theta}_{R\_ref}\,dt) \qquad (4)$$

【0071】

【数5】

$$T_L = K_{VL}(\dot{\theta}_L - \dot{\theta}_{L\_ref}) + K_{PL}(\theta_L - \int \dot{\theta}_{L\_ref}\,dt) \qquad (5)$$

T_R，T_L：右駆動輪および左駆動輪の駆動トルク

K_{VR}，K_{VL}：右駆動輪および左駆動輪の角速度フィードバックゲイン

K_{PR}，K_{PL}：右駆動輪および左駆動輪の角度フィードバックゲイン

θ_R，θ_L：右駆動輪および左駆動輪の回転角度

$\dot{\theta}_{R\_ref}$，$\dot{\theta}_{L\_ref}$：右駆動輪および左駆動輪の角速度目標値

ここで、式（４）（５）において、θRは右の駆動輪１２Ｒの回転角度を示す。θＬは左の駆動輪１２Ｌの回転角度を示す。回転角度θR，θＬの微分は角速度θ（ドット）R，θ（ドット）Ｌとなる。θ（ドット）R_refは、右の駆動輪１２Ｒの角速度の目標値を示し、操作部１４の速度指令操作部１４２（ジョイスティック等）を介して使用者により随時変更される。また、θ（ドット）L_refは、左の駆動輪１２Ｌの角速度の目標値を示し、操作部１４の速度指令操作部１４２（ジョイスティック等）を介して使用者により随時変更される。式（４）（５）において、θR等に付されているドットは時間による微分値を意味する。なお、θRは、右の駆動輪エンコーダ５５Ｒにより求められる。θLは、左の駆動輪エンコーダ５５Ｌにより求められる。θＲ（ドット）とθＬ（ドット）は計算機上での時間による差分により求められる。なお、θＲ（ドット）とθＬ（ドット）は、エンコーダではなくタコジェネレータ等の角速度センサにより求めても良い。

【0072】

上記した式（４）によれば、右の駆動輪１２Ｒの駆動トルクT_Rは、右の駆動輪１２Ｒについて、角速度θR（ドット）と角速度目標値θR（ドット）_refとの差に基づいて、または、回転角度θRと角速度目標値の積分値（時間積分）との差に基づいて求められる。また、上記した式（５）によれば、左の駆動輪１２Ｌの駆動トルクT_Lは、左の駆動輪１２について、角速度θL（ドット）と角速度目標値θ（ドット）L_refとの差に基づいて、または、回転角度θLと角速度目標値の積分値（時間積分）との差に基づいて求められる。なお、時間積分の基準となる時間は、予め任意に設定された単位時間、速度指令操作部１４２（ジョイスティック等）の操作時間に基づく。

【0073】

なお、上記した式（４）（５）において、右の駆動輪１２Ｒの角速度フィードバックゲインK_{VR}、左の駆動輪１２Ｌの角速度フィードバックゲインK_{VL}、右の駆動輪１２Ｒの角度フィードバックゲインK_{PR}、左の駆動輪１２Ｌの角度フィードバックゲインK_{PL}はそれぞれ、実験的に適宜求められ、任意値とする。上記したように式（４）（５）によれば、右の駆動輪１２Ｒの駆動トルクT_Rは、右の駆動輪１２の回転角度θRに基づいて求められる。左の駆動輪１２Ｌの駆動トルクT_Lは、左の駆動輪１２の回転角度θLに基づいて求められる。

【0074】

＊ところで、ビークル１が３輪モードで走行しているとき、図１の右図のように、使用者の重心位置Ｇが駆動輪１２の接地点１２ｃに近い位置にある。このため、ビークル１の急停止や急後退などのときには、あるいは、使用者の重心移動などにより、車体１２が前方に傾いたり、後輪サポートバー１６に取り付けられている後輪１７が浮上したりするお

それがある。さらに、ビークル１が５輪モードで走行しているときにおいても、後輪サポートバー１６が短く、かつ、登り傾斜面で急発進する場合などには、ビークル１の姿勢安定性が損なわれ、ビークル１が後方へ過剰傾倒するおそれがある。

【0075】

上記した事情を考慮すると、ビークル１が３輪モードで走行しているとき等、通常の操作部１４（例えばジョイスティック）の急激な操作による急停止や急後退を防止することが好ましい。このため制御装置２は、操作部１４の速度指令操作部１４２（例えばジョイスティック）の操作による入力信号（速度指令値）に対して、ソフトウェア上で、ローパスフィルタ（フィルタ部）をかける。これにより、カットオフ周波数ｆよりも低い周波数域の入力信号のみを入力させ、操作部１４の速度指令操作部１４２の急激な操作によりビークル１が急停止したり、急後退したり、ビークル１の姿勢が過剰に傾倒することを抑制する。

【0076】

換言すると、制御装置２は、操作部１４の速度指令操作部１４２による入力信号（速度指令信号）のうち所定のカットオフ周波数ｆよりも高い高周波成分をカットし、操作部１４の速度指令操作部１４２による入力信号のうち所定のカットオフ周波数ｆよりも低い低周波成分を選択する。つまり、制御装置２は、速度指令操作部１４２の入力信号（速度指令信号，右の駆動輪１２Ｒに対する角速度目標値θＲ（ドット）＿ref，左の駆動輪１２Ｌに対する角速度目標値θＬ（ドット）＿ref）をローパスフィルタによりフィルタリングする。これにより右の駆動輪１２Ｒの速度目標値（角速度目標値θＲ（ドット）＿ref＿LP）と、左の駆動輪１２Ｌの速度目標値（角速度目標値θＬ（ドット）＿ref＿LP）とを決定する。このように操作部１４による入力信号（速度指令信号）のうち所定のカットオフ周波数ｆよりも高い高周波成分をカットしている。このため、操作部１４の速度指令操作部１４２が急激に操作されるときであっても、例えば３輪モードにおいてビークル１を安定走行させることができる。

【0077】

図４は、右の駆動輪１２Ｒおよび左の駆動輪１２Ｌの角速度目標値をローパスフィルタによりフィルタリングすることを示す。図４によれば、右の駆動輪１２Ｒの角速度目標値θＲ（ドット）＿refは、ローパスフィルタでフィルタリングされ、角速度目標値θＲ＿ref＿LPとなる。また、左の駆動輪１２Ｌの角速度目標値θＬ（ドット）＿refは、ローパスフィルタでフィルタリングされ、角速度目標値θＬ（ドット）＿ref＿LPとなる。

【0078】

＊カットオフ周波数ｆの調整制御

上記した場合、ローパスフィルタによるフィルタリングのカットオフ周波数ｆについては、制御装置２は、水平線に対する路面傾斜角度α（$\alpha \fallingdotseq \theta 1S - \theta HL$）を求め、路面傾斜角度$\alpha$（$\alpha \fallingdotseq \theta 1S - \theta HL$）の大きさに応じて、下記のようにフィルタリングのカットオフ周波数ｆを決定することが好ましい。ここで、ビークル１が３輪モードで前進しているとき、操作部１４の速度指令操作部１４２（例えばジョイスティック）の操作により後退速度が速くなるように急激に入力操作されると、ビークル１が慣性力により前方に過剰傾倒し、３輪モードが維持できないおそれがある（第１の場合）。また、ビークル１が３輪及び５輪モードにて移動（前進および後退を含む）しているとき、操作部１４により前進速度が速くなるように急激に入力操作されると、バー１６の長さが短いとき等には、慣性力によりビークル１が後方に過剰に傾倒するおそれがある（第２の場合）。

【0079】

（ｉ）第１の場合には、操作部１４の速度指令操作部１４２等の急激な操作入力を排除することが好ましい。そこで制御装置２は、式（６）に基づいて、制御装置２は演算またはマップなどによりローパスフィルタのカットオフ周波数ｆを決定する。ここで、式（６）において、ｆ(＝1／２πＴ)は、駆動目標値に対するローパスフィルタのカットオフ周波数を示す。ｆｒは、平地上での上記基準カットオフ周波数を示す。ｋｒ（＞0）は、路面傾斜角度αに応じた補正係数を示す。式（６）によれば、カットオフ周波数ｆは路面傾

斜角度αに応じて変化する。具体的には、路面傾斜角度αが大きくなり、路面９０が急勾配の登り坂となれば、平地上での上記基準カットオフ周波数に比較して、カットオフ周波数ｆを高くする。これにより３輪モードで走行しているとき、操作部１４の速度指令操作部１４２が急激に操作されるときであっても、ビークル１の走行加速度が抑制され、ビークル１の前方への過剰傾倒を阻止することができる。なお路面傾斜角度αが正値で大きくなることは、登り坂となることを意味する。

【0080】

【数6】

$$f = k_r\alpha + f_r \qquad (6)$$

f(=1/2πT)：後方への駆動目標値に対するローパスフィルタのカットオフ周波数
f_r：平地上での上記基準カットオフ周波数
k_r(>0)：路面斜度に応じた補正係数

（ｉｉ）第２の場合には、式（７）に基づいて、制御装置２は演算またはマップなどによりカットオフ周波数ｆを決定する。

【0081】

【数7】

$$f = -k_f\alpha + f_f \qquad (7)$$

f(=1/2πT)：前方への駆動目標値に対するローパスフィルタのカットオフ周波数
f_f：平地上での上記基準カットオフ周波数
k_f(>0)：路面斜度に応じた補正係数

ここで、式（７）において、ｆ(＝1／２πＴ)は、前方への駆動目標値に対するローパスフィルタのカットオフ周波数を示す。ｆｒは、平地上での上記基準カットオフ周波数を示す。ｋｆ（＞0）は、路面傾斜角度αに応じた補正係数を示す。式（７）によれば、カットオフ周波数ｆは路面傾斜角度α（≒θHL）に応じて変化する。具体的には、路面傾斜角度αが大きくなり、路面９０が勾配が大きな登り坂であれば、平地上での上記基準カットオフ周波数に比較して、カットオフ周波数ｆを低くする。これにより３輪状態および５輪状態で走行しているとき、ビークル１の走行加速度が抑制され、後方への過剰傾倒を阻止することができる。

【0082】

＊３輪モード走行において後輪サポートバー１６を下降させることにより、５輪モードへ移行させる制御（制御Ｃ）

前述のようなビークル１の急停止や急後退を抑制する制御を施したとしても、それを上回る過大な急停止や急後退、人間の姿勢変化による過大な重心位置Ｇ変化など、あるいは、それ以外の予想外の事情が発生するおそれがある。この場合、３輪モード走行中において後輪サポートバー１６の後輪１７が路面９０よりも浮上する場合が想定される。この場合、後輪１７の接地および／または浮上を検知する接地スイッチ５０（後輪状態検知手段）が後輪サポートバー１６に搭載されているため、接地スイッチ５０の信号の読込により、路面９０に対する後輪サポートバー１６の浮上（路面９０に対する後輪１７の浮上）が検知される。

【0083】

そこで、制御装置２は、駆動輪１２をその場で静止または減速させる指令を出力すると共に、後輪サポートバー１６を５輪モードの位置まで下降させる指令を出力することで、

即座に５輪モードに移行する。５輪モードは走行の安定性に優れている。このため過大な急停止や急後退、人間の姿勢変化による過大な重心位置Ｇ変化、あるいは、予想外の事情が発生したとしても、ビークル１の走行は安定である。なお、後輪１７ばかりではなく、右の駆動輪１２Ｒ、左の駆動輪１２Ｌ、前輪１５、後輪１７の全てが路面に対して接地および／または浮上していることを検知するセンサを設けることができる。

【0084】

（実施形態２）

実施形態２は実施形態１と基本的に同様の構成および同様の作用効果を有するため、実施形態１で説明した図面を準用する。本実施形態によれば、実施形態１に加えて、駆動輪１２が段差９５を乗り越えるときにおける制御を実施する。５輪モードにおける駆動輪１２および前輪１５の双方の接地は、走行安定性に有利であるものの、前輪１５が段差９５に衝突し乗り越えられにくいという問題を抱えている。前輪１５の径を大きくすれば、段差９５を乗り越え易いが、前輪１５の径の増加には限界がある。

【0085】

図５（ａ）～図５（ｆ）は、３輪モードを活用することによりビークル１の駆動輪１２が段差９５を昇って乗り越えるシーケンスを示す。ビークル１が３輪モードで走行しているとき、図５（ａ）に示すように、駆動輪１２および後輪１７が路面９０に接地しているものの、前輪１５が路面９０から浮上している。このためビークル１が前進すると、段差９５の上面９６に容易に駆動輪１２を上げることができる（図５（ａ）～図５（ｃ））。その後、駆動輪１２の発生トルクのみの力で乗り越えられる程度の低い段差９５に対しては、操作部１４の速度指令操作部１４２（例えばジョイスティック等）による前進指令操作に基づいて、駆動輪１２の通常の発生トルクのみで段差９５の上面９６を乗り越えることができる。

【0086】

これに対して、段差９５の上面９６の高さ等の程度によっては、図５の（ｂ）に示す状態において、駆動輪１２の駆動トルクのみで乗り越えられない場合がある。この場合、駆動輪１２の駆動トルクが不足し、駆動輪１２がスリップする。このような段差９５に対しては、制御装置２は制御Ｄを実施する。即ち、制御装置２は操作部１４の速度指令操作部１４２の速度指令値と、駆動輪１２Ｒ，１２Ｌの実際の回転速度とを読み込む。そして過大な速度指令値と駆動輪回転速度との関係から、即ち、過大な速度指令値に比較して駆動輪回転速度が遅いとき、ビークル１がそのままでは乗り越え不可能な段差９５と判断する。そこで、制御装置２は、後輪サポートバー１６を矢印Ｄ方向（図５（ｂ）参照）に下降させる指令をアクチュエータ１８に出力する。これにより後輪サポートバー１６に取り付けられている後輪１７が路面９０を矢印Ｆ１方向（図５の（ｂ）参照）に押圧する。これにより反力により、後輪１７は、ビークル１を押し上げるアシスト力を発生させる。アシスト力の結果、段差９５の上面９６の高さが高いときであっても、ビークル１は段差９５を乗り越えることが容易となる（図５（ｃ）参照）。

【0087】

＊駆動輪１２のスリップ検知

ビークル１には、図２に示すように、加速度計５３（ビークル１の前進および後退方向における加速度を検知する）と、レートジャイロ５２（ビークル１のピッチ方向の角速度を検知する）が搭載されている。ａｃｃは、加速度計５３から求めたビークル１の加速度の出力値を示す。θａｃｃは、駆動輪回転角度センサ（つまりロータリエンコーダ５５，５５Ｌの出力値を計算機で時間に関する差分により求めたものであり、前進後退方向におけるビークル１の加速度を示す。

【0088】

そして図６に示すように、制御装置２は、加速度計５３から求めたビークル１の加速度の出力ａｃｃに基づいて、重力加速度ｇを考慮し、sin^{-1}（ａｃｃ／ｇ）の値（加速度計５３で求めたθHLに相当）を求める。更にその値をローパスフィルタ（カットオフ周波数ｆｃ）によるフィルタリングにより高周波域のノイズを除去した値θHL1を求める。

また、制御装置２は、レートジャイロ５２の出力値である角速度θｇ（ドット）を時間積分した積分値（レートジャイロ５２で求めたθHLに相当）を求め、その積分値をハイパスフィルタ（カットオフ周波数ｆｃ）によりフィルタリングにより低周波域のノイズを除去した値θHL2を求める。制御装置２はθHL1およびθHL2を加算し、θHL（θHL＝θHL1＋θHL2）を求める。

【0089】

上記したように加速度計５３の出力値に基づくθHL1については、ローパスフィルタによりフィルタリングしている。これに対して、レートジャイロ５２の出力値に基づくθHL2については、ハイパスフィルタによりフィルタリングしている。これは、高周波域で精度が充分ではない加速度計５３と、低周波域で精度が充分ではないレートジャイロ５２の時間に関する積分値とのそれぞれのセンサ特性を考慮しているためである。これにより低い周波数域～高い周波数域においてθHLの検知精度を高めることができる。なお、ローパスフィルタのカットオフ周波数ｆｃはハイパスフィルタのカットオフ周波数と同値である。

【0090】

ここで、駆動輪１２，前輪１５および後輪１７が路面９０に実質的に接地しているときには、加速度計５３およびレートジャイロ５２で求められた角度θHLは、実際の路面傾斜角度αに相当する（α≒θHL）。このように２種類のセンサ、即ち、加速度計５３の出力値とレートジャイロ５２の出力値との双方を利用することにより、ビークル１が走行している実際の路面傾斜角度α（α≒θHL）を、角度θHLとして求めることができる。

【0091】

ここで、ビークル１がピッチ方向に傾いている場合には、加速度計５３は、重力加速度の影響で、ビークル１のピッチ方向傾斜角度θ１に応じた加速度を検知することができるため、結果として、加速度計５３によりビークル１のピッチ方向傾斜角度θ１が求められる。下記の式（８）に基づいて駆動輪１２のスリップ値が求められる。

【0092】

【数8】

$$\text{スリップ値} = a_{cc} + g\sin\theta_{HL} - \theta_{acc} \rangle a_{cc\_s} \qquad (8)$$

a_{cc}：加速度計からの加速度出力

θ_{acc}：駆動輪回転角度センサの差分から求めた加速度

a_{cc_s}：スリップ検知のための閾値

そして、スリップ値がスリップ検知のための閾値ａｃｃ＿ｓを超えた場合には、制御装置２は、駆動輪１２がスリップしていると判定することができる。ここで、式（８）によれば、加速度計５３からの加速度出力ａｃｃ［㎜／sec^2］と車体ピッチ方向の重力加速度成分（gsinθHL）の和と駆動輪回転角加速度から求めた車体前後方向加速度θａｃｃとの差が大きいほど、また、θHL（つまりｓｉｎθHL）が大きいほど、スリップ値が高くなり、駆動輪１２がスリップしていると判定される。即ち、駆動輪１２のスリップの有無は、加速度計５３からの加速度出力，θHL，θａｃｃのうちの少なくとも一つの値に基づいて検知される。

【0093】

＊駆動輪がスリップしているとき、アシスト力に基づく段差９５の乗り越えリトライの制御（制御Ｅ）

上記の手法でビークル１が段差９５を乗り越え中において、図５（ｃ）に示す状態において、上記したスリップ判定アルゴリズム（式（８）参照）に基づいて駆動輪１２のスリ

ップが検知される場合には、駆動輪１２の駆動トルクが不足し、ビークル１は段差９５を乗り越え不能であると、制御装置２は判定する。

【0094】

そこで制御装置２は、後輪サポートバー１６を矢印U方向（図５（ｃ）参照）４）に上昇させる指令をアクチュエータ１８に出力する。これにより図５の（ｂ）に示す左右の駆動輪１２が重力により下降して路面９０に確実に接地するため、駆動輪１２のスリップが解除される。その後、制御装置２は、再度、後輪サポートバー１６を矢印D方向に下降させる指令をアクチュエータ１８に出力する。これにより駆動輪１２を回転させつつ、再度、後輪サポートバー１６に取り付けられている後輪１７が路面９０を押圧する。このため、反力に基づいて、後輪サポートバー１６および後輪１７によるアシスト力（駆動輪１２が段差９５を乗り越えるアシスト力）が発生する。このように駆動輪１２を回転させつつ、後輪１７がアシスト力を発生させるため、駆動輪１２は段差９５の上面９６に乗り上げることができる（図５（ｄ）参照）。

【0095】

＊段差９５の昇り終了後における後輪サポートバー１６の基準位置復帰の制御（制御Ｆ）

図５の（ｄ）に示す状態では、駆動輪１２は段差９５の上面９６に移行しているので、駆動輪１２が段差９５の上面９６に持ち上がっている。この場合、加速度計５３およびレートジャイロ５２により求められるビークル１のピッチ方向傾斜角度θ１に基づいて、制御装置２は、ビークル１が段差９５の上面９６への移行を終了したこと（即ち、駆動輪１２が段差９５の上面９６に存在すること）を検知することができる。

【0096】

ここで、ピッチ方向傾斜角度θ１が所定角以内（例えば０度）であれば、ビークル１はほぼ水平と推定でき、制御装置２は、ビークル１が段差９５の上面９６に存在しており、上面９６への移行を終了したことを、制御装置２は検知することができる。すると、制御装置２は、図５の（ｆ）に示すように、後輪サポートバー１６を矢印D方向に下降させて、後輪サポートバー１６の基準位置（５輪モードにおける後輪サポートバー１６の使用位置）に復帰させる指令をアクチュエータ１８に出力し、後輪１７を段差９５の上面９６に接地させる。これによりビークル１は５輪モードに戻り、段差９５の上面９６を５輪モードで安定的に走行する（図５の（ｆ）参照）。

【0097】

＊５輪モード走行時において段差９５を降りる時の駆動輪１２のスリップ検知、及び、後輪サポートバー１６によるスリップ解除の制御（制御Ｇ）

図７は、ビークル１が５輪モードで段差９５の上面９６を走行し、更に段差９５の上面９６を降りて路面９０に移行する場合のシーケンスを示す。この場合、図７の（ｄ）に示す状態によれば、後輪１７が段差９５の上面９６に接地すると共に前輪１５が路面９０に接地するため、駆動輪１２が路面９０および段差９５の上面９６の双方に非接触となり、駆動輪１２がスリップし、駆動輪１２の駆動力が路面９０に伝わらない状態になる場合が生じるおそれがある。この場合、ビークル１の走行に支障をきたすおそれがある。そこで制御装置２は、前述したような駆動輪１２のスリップ検知アルゴリズム（式（８）参照）に基づいて、駆動輪１２のスリップを検知する。そして、制御装置２は、駆動輪１２のスリップが生じなくなるまで、後輪１７および後輪サポートバー１６を矢印U方向（図７（ｄ）参照）に上昇させる指令をアクチュエータ１８に出力する。これにより駆動輪１２の接地性が向上する。そして、駆動輪１２のスリップが生じなくなれば、駆動輪１２のトルクでビークル１は前進可能となる。このため制御装置２は、駆動輪１２のスリップが解除されたことを検知したら、後輪サポートバー１６を矢印D方向に下降させる指令をアクチュエータ１８に出力し、後輪サポートバー１６の後輪１７を下降させ、後輪１７を５輪モードの基準位置まで戻す。このようにビークル１が段差９５を降りるときに駆動輪１２のスリップが発生するときであっても、後輪サポートバー１６および後輪１７を上昇させれば、ビークル１の駆動輪１２は良好に段差９５の上面９６から路面９０に接地できる。な

お、段差９５の上面９６を降りたビークル１は５輪モードで路面９０を走行できる。
【0098】
＊斜面走行時、段差９５の乗り越え時等におけるビークル１の後方への過剰傾倒を防止する制御
斜面走行時、段差９５の乗り越え時等において、駆動輪１２の駆動トルクが大き過ぎると、ビークル１が後方へ過剰に傾倒することがある。これに対処することが好ましい。この場合、前述したように、レートジャイロ５２の出力値、加速度計５３の出力値の合成によって路面傾斜角度α（≒θBL）が制御装置２により求められる。路面傾斜角度α（段差９５の踏破時における段差９５の傾斜も含む）を考慮に入れ、斜面走行時や段差９５の踏破時等におけるビークル１の後方への転倒を阻止することが好ましい。ここで、駆動輪１２のトルクが大き過ぎると、ビークル１が後方に過剰に傾倒するおそれがある。そこで制御装置２は、ビークル１が５輪モードにおいて走行中しているとき、駆動輪１２のトルクが過剰になることを抑えるトルク抑制制御を行う。この場合、駆動輪１２の最大トルクＴlimit（駆動輪１２Ｒ，１２Ｌに与えられる総和トルク）については、ビークル１の機構から式（９）に基づいて決定する。制御装置２は、５輪モードで走行しているとき、駆動トルクを駆動輪１２に与えるにあたり、最大トルクＴlimitを越えないように駆動トルクをフィードバック制御している。
【0099】
【数9】

$$T_{\_limit} = \frac{M_1 g L_b R \cos\alpha}{L_a} \qquad (9)$$

ここで、図８に示すように、Ｐ３は、重心位置Ｇを通るような路面９０に対する路面垂直線を示す。Ｌｂは、路面垂直線Ｐ３と後輪１７の接地点との最短の距離を示す。Ｌａは、後輪１７の接地点と駆動輪１２の中心１２ｃとの距離を示す。Ｒは駆動輪１２の中心１２ｃからの半径を示す。上記した式（９）において、Ｒ，Ｌｂ，Ｌａ，Ｍ１，Ｊ１は固定値またはほぼ固定値とみなし得る。このため、上記した式（９）によれば、路面傾斜角度αが小さくてｃｏｓαの値（路面９０がほぼ水平のとき、ｃｏｓα≒１）が大きいと、最大トルクＴlimitは大きくなる。また、路面傾斜角度αが大きく、ｃｏｓαの値が小さくなると、最大トルクＴlimitは小さくなる。また、距離Ｌｂが増加すると、最大トルクＴlimitは大きくなる。更に距離Ｌａが増加すると、最大トルクＴlimitは小さくなる。但しＬｂが増加すると、Ｌａも増加する。上記したように駆動輪１２に与えられる駆動トルクが最大トルクＴlimitを越えないように、制御装置２はモータ１３Ｒ，１３Ｌをフィードバック制御している。このため斜面走行時、段差９５の乗り越え時などにおいても、ビークル１の姿勢が安定し、後方へ過剰に傾くことが防止される。
【0100】
（実施形態３）
図９～図１１は実施形態３を示す。本実施形態は電動式の車いす１Ｂに適用している。本実施形態は実施形態１と同様の構成および作用効果を有する。実施形態１に共通する部位には共通の符号を付する。図９に示すように、ビークルとしての車いす１Ｂは、使用者が着座する着座部１０をもつ車体１１と、車体１１に左右に取り付けられた回転可能な左右の駆動輪１２と、駆動輪１２を回転駆動させる駆動源としての駆動輪モータ１３と、駆動輪モータ１３の駆動を制御する操作部１４と、駆動輪１２の前方に位置して車体１１に取り付けられた回転可能な左右の前輪１５と、車体１１に取り付けられた後輪サポート部材としての後輪サポートバー１６と、後輪サポートバー１６の先端部１６ｅに保持部１９を介して取り付けられた回転可能な後輪１７と、後輪サポートバー１６を路面９０に対して昇降させることにより、後輪１７を路面９０に対して接地および浮上させるアクチュエータ１８とを備えている。図９に示すように、車体１１は、着座部１０に着座している使

用者の脚を支えるフットレスト１１１と、着座部１０に着座している使用者の腕を支えるアームレスト１１２と、介助者が車いす１Ｂの後側から操作する操作レバー１１３とを備えている。着座部１０は、使用者の腰部を支える座部１０ａと、使用者の背中を支える背もたれ部１０ｃとを備える。

【0101】

図９に示すように、後輪サポートバー１６の先端部１６ｅは、駆動輪１２の接地点１２ｃよりもが後方に向けて延びると共に、駆動輪１２の最外周面１２ｐよりも後方に位置している。後輪サポートバー１６の基端部１６ｆは、車体１１のうち着座部１０よりも下方の取付フレーム１１ｘにおいて、枢支部１１ｋ（枢支軸）により上下方向に揺動可能に取り付けられている。従って、後輪サポートバー１６および後輪１７は、枢支部１１ｋを回動中心として上下方向（矢印Ｕ方向，矢印Ｄ方向）に揺動できる。従って、前記した後輪１７によるアシスト力は、枢支部１１ｋを中心として与えられる。

【0102】

後輪サポートバー１６の基端部１６ｆは、駆動輪１２の軸中心１２ｅよりも後方に取り付けられているが、これに限定されるものではない。駆動輪１２は右の駆動輪１２Ｒ，左の駆動輪１２Ｌを備えている。

【0103】

図９に示すように、アクチュエータ１８は、アクチュエータ本体１８０と、アクチュエータ本体１８０に設けられ後輪１７を路面９０に対して接地させる方向および浮上させる方向に移動させる移動体１８２とを備えている。アクチュエータ本体１８０の一端部１８０ａは、車体１１の取付部１１５に昇降可能に枢支部１１６（枢支軸）により上下方向に沿って揺動可能に枢支されて取り付けられている。移動体１８２はアクチュエータ本体１８０の他端部１８０ｃから路面９０に向けて伸縮可能に突出しており、後輪サポートバー１６の長さ方向の中間部に枢支部１８５（枢支軸）を介して揺動可能に枢支されている。後輪１７が路面９０に接地しているとき、後輪１７の接地点１７ｃは、駆動輪１２の接地点１２ｃよりも後方に位置すると共に、駆動輪１２の最後端１２ｒよりも後方に位置する。

【0104】

アクチュエータ１８は電動式であり、図示しないものの、雌螺子部と、雌螺子部に螺進退可能に螺合する雄螺子部とを備える螺子構造を有する。雌螺子部および雄螺子部により、アクチュエータ本体１８０に対して移動体１８２を矢印Ｄ方向（路面への接地方向）に直動前進させたり、矢印Ｕ方向（路面からの浮上方向）に直動後退させたりできる。

【0105】

図１０に示すように、後輪サポートバー１６は、車体１１の幅方向（前進後退方向と直交する方向，Ｋ１方向）の中央域に位置するように、単数設けられている。後輪サポートバー１６に接続されているアクチュエータ１８は、後輪サポートバー１６と同様に、車体の幅方向（Ｋ１方向）の中央域に位置するように、単数設けられている。

【0106】

図９から理解できるように、移動体１８２がアクチュエータ本体１８０から路面９０に向けて矢印Ｄ方向（路面への接地方向，下方）に前進すると、後輪サポートバー１６の先端部１６ｅを路面９０に接近させ、後輪１７を路面９０に接地させる方向に移動（下降）させることができる。これに対して、移動体１８２がアクチュエータ本体１８０に接近する方向に、つまり、矢印Ｕ方向（路面からの浮上方向、上方）に移動して路面９０から離間すると、後輪サポートバー１６の先端部１６ｅを路面９０から離間させる方向に相対的に持ち上げ、後輪１７を路面９０から浮上（上昇）させることができる。但し、後輪サポートバー１６の先端部１６ｅを路面９０から離間させる方向に相対的に持ち上げたとしても、ビークル１が後方に傾倒するときには、後輪１７が路面９０に接地したままのときもある。

【0107】

図１１（ａ）（ｂ）は後輪１７付近を示す。図１１（ａ）（ｂ）に示すように、後輪サ

ポートバー１６の先端部１６ｅには、後輪１７を保持するための保持部１９の腕部１９ｘが枢支軸１９ｗにより上下方向に揺動可能に設けられている。保持部１９は、上下方向に沿っている軸芯Ｐ５の回りで軸受１７ａにより左右方向（矢印Ｋ３方向）に回転可能に設けられ後輪ホルダ１７ｂと、後輪ホルダ１７ｂの下部に回転可能に設けられ後輪１７用の横軸形の車軸１７ｃと、接地時における衝撃を緩衝するためのバネ１７ｅとを備えている。路面９０に対する後輪１７の接地および／または浮上を検知するリミットスイッチで形成された接触スイッチ５０が設けられている。接触スイッチ５０は後輪サポートバー１６の先端部１６ｅに設けられている。後輪１７が接地すると、保持部１９に設けられている腕部１９ｘが接触スイッチ５０を操作させる。但しこれに限らず、後輪サポートバー１６の傾斜角度により後輪１７の接地および／または浮上を検知することにしても良い。

【0108】

（実施形態４）

図１２は実施形態４を示す。本実施形態は電動式の車いす１Ｃに適用している。本実施形態は実施形態１と同様の構成および作用効果を有する。実施形態１に共通する部位には共通の符号を付する。図１２に示すように、車いす１Ｃは、車体１１に取り付けられた後輪サポート部材としての後輪サポートバー１６と、後輪サポートバー１６の先端部１６ｅに保持部１９を介して取り付けられた回転可能な後輪１７と、後輪サポートバー１６を路面９０に対して昇降させることにより、後輪１７を路面９０に対して接地および浮上させるアクチュエータとしての捻りコイルバネ１８８とを備えている。捻りコイルバネ１８８は、後輪サポートバー１６の基端部１６ｆを介して後輪１７を路面９０に向けて下方（矢印Ｄ方向，接地方向）に付勢する付勢部材として機能しており、後輪１７の路面９０に対する接地性を高めている。前輪１５が路面９０よりも浮上して３輪モードになるときには、重心位置Ｇが駆動輪１２の接地点１２ｃよりも後方となるため、車体１１が後方に傾斜する。この場合、後輪サポートバー１６は、車体１１のフレーム１１ｘに取り付けられたストッパ部１１ｓに当たる。故に、後輪サポートバー１６がそれ以上、矢印Ｕ方向に上昇することは抑えられる。このように捻りコイルバネ１８８は、後輪サポートバー１６を路面９０に向けて作動させて後輪１７を路面９０に対して接地させたり、捻りコイルバネ１８８のバネ力に抗して矢印Ｕ方向（路面９０から離間させる方向）に浮上させたりする機能を備えている。なお、捻りコイルバネ１８８に限らず、コイルバネ、板バネ、皿バネなどの付勢部材でも良い。

【0109】

（フローチャート）

＊図１３は、ビークル１が走行しているとき、５輪モードから３輪モードに切り替える制御Ａのフローチャートを例示する。フローチャートは一例であり、これに限定されるものではない。まず、制御装置２は各種センサおよびスイッチ（モード切替ボタン１４１および速度指令操作部１４２、エンコーダ５５Ｒ，５５Ｌを含む）の出力を読み込む（ステップＳ１０２）。モード切替ボタン１４１が５輪モードから３輪モードに切り替えられたか否か判定する（ステップＳ１０４）。３輪モードに切り替えられていれば（ステップＳ１０４のＹＥＳ）、モード切替ボタン１４１の操作時間Ｔが一定時間Ｔｃ以上操作されていること（ステップＳ１０６のＹＥＳ）、ビークル１の前進走行速度Ｖが設定速度Ｖｃ以上であること（ステップＳ１０８のＹＥＳ）、速度指令操作部１４２（例えばジョイスティック）による前進速度の目標値Ｖtargetが一定値Ｖｔｃ以上であること（ステップＳ１１０のＹＥＳ）の条件が満足されたら、駆動輪１２の駆動トルクＴを演算で求め、モータドライバ１３１および１３２に出力すると共に、バー１６を後輪１７と共に持ち上げる動作を実施する（ステップＳ１１２）。これにより３輪モードに切り替わる。なお、モード切替ボタン１４１の操作時間Ｔが一定時間Ｔｃ以上操作されているとしても（ステップＳ１０６のＹＥＳ）、前進走行速度Ｖが設定速度Ｖｃ以上でないこと（ステップＳ１０８のＮＯ）、速度指令操作部１４２（例えばジョイスティック）による前進速度の目標値Ｖtargetが一定値Ｖｔｃ以上でないこと（ステップＳ１１０のＮＯ）の条件が満足されたら、モードは５輪モードから３輪モードに切り替わらない。

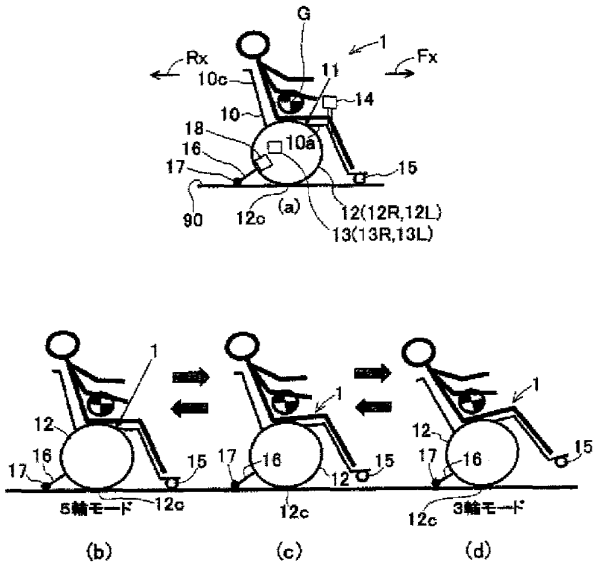
【0110】
＊図１４は３輪モードから５輪モードに切り替える制御Ｂのフローチャートを例示する。フローチャートは一例であり、これに限定されるものではない。まず、制御装置２は各種センサおよびスイッチ（モード切替ボタン１４１、接地スイッチ５０、エンコーダ５５Ｒ，５５Ｌ等を含む）の出力を読み込む（ステップＳ２０２）。モード切替ボタン１４１が５輪モードに切り替えられているか否か判定する（ステップＳ２０４）。５輪モードに切り替えられていれば（ステップＳ２０４のＹＥＳ）、後輪１７が路面９０から浮上しているか否か判定する（ステップＳ２０６）。後輪１７が路面９０から浮上していれば（ステップＳ２０６のＹＥＳ）、バー１６を下降させて後輪１７を路面９０に接地させ、５輪モードに切り替え、走行安定性を図る（ステップＳ２０８）。
【0111】
＊図１５は制御Ｃのフローチャートを例示する。フローチャートは一例であり、これに限定されるものではない。まず、制御装置２は各種センサおよびスイッチ（モード切替ボタン１４１、接地スイッチ５０等を含む）の出力を読み込む（ステップＳ３０２）。ビークル１の走行が３輪モードであり、後輪１７が路面９０から浮上しているか否か判定する（ステップＳ３０４）。後輪１７が路面９０から浮上していれば（ステップＳ３０４のＹＥＳ）、ビークル１の姿勢の安定性が損なわれるので、駆動輪１２を静止または減速させる指令をモータ１３Ｒ，１３Ｌに出力すると共に、バー１６を下降させて後輪１７を路面９０に接地させる（ステップＳ３０６）。
【0112】
＊図１６は上記した段差乗り越え時に実行される制御Ｄのフローチャートを示す。フローチャートは一例であり、これに限定されるものではない。まず制御装置２は、各種センサおよびスイッチの出力値（速度指令操作部１４２の速度指令値、エンコーダ５５Ｒ，５５Ｌの駆動輪回転速度）を読み込む（ステップＳ４０２）。そして過大な速度指令値と駆動輪回転速度との関係から、乗り越え不可能な段差９５か否か判断する（ステップＳ４０４）。乗り越え不可能な段差９５であれば（ステップＳ４０４のＹＥＳ）、制御装置２は、段差乗り越えをアシストすべく、後輪サポートバー１６を下降させる後輪アシスト力を発生させる（ステップＳ４０６）。
【0113】
＊図１７は上記した段差乗り越え時に実行される制御Ｅのフローチャートを例示する。フローチャートは一例であり、これに限定されるものではない。まず、制御装置２は各種センサおよびスイッチ（モード切替ボタン１４１、接地スイッチ５０、レートジャイロ５２，加速度計５３を含む）の出力を読み込む（ステップＳ５０２）。ビークル１の走行が３輪モードであり、段差乗り越え動作中か否か判定する（ステップＳ５０４）。段差乗り越え動作中であれば（ステップＳ５０４のＹＥＳ）、駆動輪１２のスリップが発生しているか否か判定する（ステップＳ５０６）。駆動輪１２のスリップが発生していれば（ステップＳ５０６のＹＥＳ）、バー１６を所定時間上昇させて後輪１７を浮上させる（ステップＳ５０８）。これにより駆動輪１２の接地性を高める。その後、段差乗り越えをアシストすべく、バー１６を下降させて後輪１７を下降させて後輪アシスト力を発揮させる（ステップＳ５１０）。
【0114】
＊図１８は上記した段差乗り越え時に実行されるこの制御Ｆのフローチャートを例示する。フローチャートは一例であり、これに限定されるものではない。まず、制御装置２は各種センサおよびスイッチ（モード切替ボタン１４１、接地スイッチ５０、レートジャイロ５２，加速度計５３を含む）の出力を読み込む（ステップＳ６０２）。ビークル１が段差９５の上面９６に移行したか否か判定する（ステップＳ６０４）。ビークル１が段差９５の上面９６に移行して水平となっていれば（ステップＳ６０４のＹＥＳ）、バー１６を下降させて基準位置まで戻す（ステップＳ６０６）。これにより５輪モードに戻る。これにより段差９５の上面９６を５輪モードで走行できる。ここで、後輪サポートバー１６の基準位置とは、５輪モードにおける後輪サポートバー１６の使用位置を意味する。

【0115】
＊図１９は制御Ｇのフローチャートを例示する。フローチャートは一例であり、これに限定されるものではない。まず、制御装置２は各種センサおよびスイッチ（モード切替ボタン１４１、接地スイッチ５０、レートジャイロ５２，加速度計５３を含む）の出力を読み込む（ステップＳ７０２）。ビークル１が段差９５を降りているときか否か判定する（ステップＳ７０４）。ビークル１が段差９５を降りているときであれば（ステップＳ７０４のＹＥＳ）、上記したスリップ判定アルゴリズムにより駆動輪１２のスリップの有無を検知する（ステップＳ７０６）。駆動輪１２のスリップが検知されれば（ステップＳ７０６のＹＥＳ）、バー１６および後輪１７を所定時間上昇させることにより駆動輪１２を下降させて駆動輪１２の接地性を高める（ステップＳ７０８）。そして駆動輪１２のスリップ解除が検知されれば（ステップＳ７１０のＹＥＳ）、バー１６および後輪１７を下降させる（ステップＳ７１２）。
【0116】
（その他）
上記した実施形態１によれば、操作部が第２モードに切り替えられこと、前進方向の走行速度が設定速度以上であること、前進方向の前記操作部による速度目標値が一定値以上であることのうちの条件が満足されるとき、制御装置は、第１モードから第２モードに切り替える制御を行うことにしているが、これに限らず、操作部が第２モードに切り替えられると、制御装置は、第１モードから第２モードに切り替える制御を行うことにしても良い。パーソナルビークルは、高齢者、障害者等が搭乗する車いすに限定されるものではなく、博覧会、舞台、遊園地等の会場において、単数または複数の健常者（二名等）が搭乗できる簡易的なビークルにも適用できる。本発明は上記した実施例のみに限定されるものではなく、要旨を逸脱しない範囲内で適宜変更して実施できる。
【0117】
上記した思想から次の技術的思想も把握できる。
【0118】
（付記項１）使用者が着座する着座部をもつ車体と、前記車体にこれの左右に取り付けられた駆動輪と、前記車体に取り付けられ前記駆動輪を回転駆動させる駆動源と、前記駆動源の駆動を制御する操作部と、前記駆動輪の前方に位置して前記車体に取り付けられた前輪と、前記車体に取り付けられた後輪サポート部材と、前記後輪サポート部材に取り付けられ、路面に接地可能であり路面に接地するとき前記駆動輪の接地点よりも後側に位置する後輪と、少なくとも前記駆動輪および前記前輪で走行する第１モードと、前記前輪を浮かせた状態で前記駆動輪および前記後輪を前記路面に接地しつつ走行する第２モードとを切り替え可能な制御装置と、を具備していることを特徴とするパーソナルビークル。この場合、第１モード走行および第２モード走行を切り替えることができる。なお、後輪サポート部材を作動させて後輪を前記路面に対して接地および浮上させるアクチュエータを設けても良いし、設けなくても良い。
【0119】
（付記項２）付記項１において、前記前輪は前記車体の左右に設けられており、前記後輪は単数であり、前記第１モードは、左右の前記駆動輪、左右の前記前輪および前記後輪で走行する５輪モードであり、前記第２モードは、左右の前記前輪を浮上させつつ左右の前記駆動輪および前記後輪で走行する３輪モードであることを特徴とするパーソナルビークル。
【0120】
（付記項３）付記項１または２において、前記第１モードでは、前記使用者の体重を含む前記ビークルの重心位置が前記駆動輪の接地点よりも前方に位置するように走行しており、前記制御装置は、前記第１モードから前記第２モード（前輪浮上モード）に切り替えるにあたり、前記使用者の体重を含む前記ビークルの重心位置が前記駆動輪の接地点よりも後方に位置するような駆動トルクを前記駆動輪に発生させる制御を行うことを特徴とするパーソナルビークル。これにより第１モード走行（前輪接地モード）から第２モード走

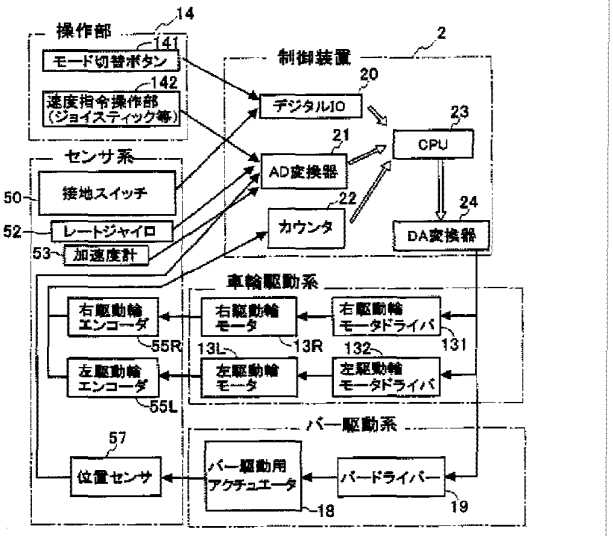
行（前輪浮上モード）に切り替えることができる。
【0121】
（付記項４）付記項３において、前記第１モードから前記第２モードに切り替えるとき、前記駆動輪に与える駆動トルクをＴとし、前記使用者の体重を含む前記パーソナルビークルの重心位置のピッチ方向の傾斜角度を$\theta 1$とするとき、前記制御装置は、前記車体のピッチ方向傾斜角度$\theta 1$に基づいて、前記駆動輪に発生させる駆動トルクＴを制御することを特徴とするパーソナルビークル。この場合、車体のピッチ方向傾斜角度$\theta 1$を検知し、ピッチ方向傾斜角度$\theta 1$に応じた駆動トルクＴを駆動輪に与えれば、第２モード（前輪浮上モード）走行を維持することができる。また、ピッチ方向傾斜角度$\theta 1$が減少するときには、駆動輪に発生させる駆動トルクＴを減少させれば、第２モード（前輪浮上モード）で安定的に走行できる。同様にピッチ方向傾斜角度$\theta 1$が増加するきには、駆動輪に発生させる駆動トルクＴを増加させれば、第２モード（前輪浮上モード）で安定的に走行できる。
【0122】
（付記項５）付記項３において、前記第１モードから前記第２モードに切り替えるとき前記駆動輪に与える駆動トルクをＴとし、前記駆動輪が走行する前記路面における路面傾斜角度をαとし、前記使用者の体重を含む前記パーソナルビークルの重心位置のピッチ方向の傾斜角度を$\theta 1$とするとき、前記制御装置は、前記車体のピッチ方向傾斜角度$\theta 1$および／または路面傾斜角度αが増加すると、前記駆動輪に発生させる駆動トルクＴを増加させる制御を行うことを特徴とするパーソナルビークル。この場合、第１モード（前輪接地モード）から第２モード（前輪浮上モード）に切り替えることができる。
【0123】
（付記項６）付記項１～５のうちの一項において、前記パーソナルビークルの走行速度を検知する走行速度検知手段、および／または、前記パーソナルビークルの前進方向の走行速度の速度目標値を設定する目標走行速度設定手段が設けられており、前記操作部が前記第２モードに切り替えられること、前進方向の走行速度が設定速度以上であること、前記操作部による前進方向の速度目標値が一定値以上であることのうちの少なくとも一つの条件が満足されるとき、前記制御装置は、前記第１モードから前記第２モードに切り替える制御を行うことを特徴とするパーソナルビークル。この場合、第１モード（前輪接地モード）から第２モード（前輪浮上モード）に切り替えることができる。
【0124】
（付記項７）付記項１～６のうちの一項において、前記路面に対する前記後輪の接地および浮上を検知する後輪状態検知手段を備えていることを特徴とするパーソナルビークル。この場合、後輪の接地および浮上を検知することができる。従って、第１モード走行の安定走行の確保、段差乗り越え等に貢献できる。
【産業上の利用可能性】
【0125】
本発明は、電動式の車いす等に代表されるパーソナルビークルに利用することができる。
【図面の簡単な説明】
【0126】
【図1】（ａ）は５輪モードで走行している状態を模式的に示す側面図であり、（ｂ）～（ｄ）は５輪モードおよび３輪モードを切り替える形態を模式的に示す側面図である。
【図2】制御系を模式的に示す図である。
【図3】５輪モードで走行しているときにおけるパラメータを示す図である。
【図4】両輪の角速度目標値のローパスフィルタリングを示す図である。
【図5】段差昇りシーケンスを模式的に示す側面図である。
【図6】加速度計の出力値のローパスフィルタリングした値と、レートジャイロの積分値のハイパスフィルタリングした値との融合を示す図である。
【図7】段差降りシーケンスを模式的に示す側面図である。

【図8】５輪モードで走行しているときにおけるパラメータを示す図である。
【図9】車いすを示す側面図である。
【図10】車いすを示す背面図である。
【図11】（ａ）は後輪付近を示す背面図であり、（ｂ）は後輪付近を示す側面図である。
【図12】車いすを示す側面図である。
【図13】ビークルが走行しているとき、５輪モードから３輪モードに切り替える制御Ａを示すフローチャートである。
【図14】３輪モードから５輪モードに切り替える制御Ｂを示すフローチャートである。
【図15】制御Ｃを示すフローチャートである。
【図16】制御Ｄを示すフローチャートである。
【図17】制御Ｅを示すフローチャートである。
【図18】制御Ｆを示すフローチャートである。
【図19】制御Ｇを示すフローチャートである。
【符号の説明】
【0127】
１はビークル、１０は着座部、１１は車体、１２は駆動輪、１２Ｒは右の駆動輪、１２Ｌは左の駆動輪、１３は駆動輪モータ（駆動源）、１４は操作部、１５は前輪、１６は後輪サポートバー（後輪サポート部材）、１７は後輪、１８はアクチュエータ、２は制御装置、２３はＣＰＵ、１３Ｒは右の駆動輪モータ（第１駆動源）、１３Ｌは左の駆動輪モータ（第２駆動源）、１４は操作部、１４１はモード切替ボタン１４１（モード切替スイッチ）、１４２は速度指令操作部、５０は接地スイッチ（後輪状態検知手段）、５２はレートジャイロ、５３は加速度計、５５Ｒは右の駆動輪エンコーダ（走行速度検知手段）、５５Ｌは左の駆動輪エンコーダ（走行速度検知手段）、５７は位置センサ、１４２は速度指令操作部（目標走行速度設定手段）を示す。

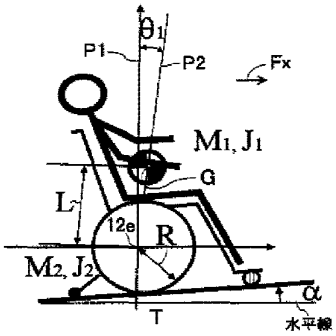
【図1】



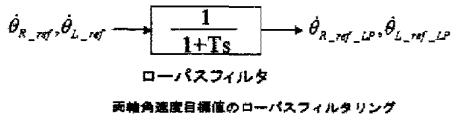
【図2】



【図3】

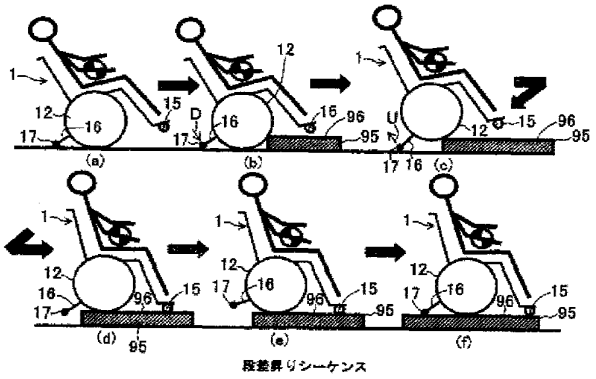


【図4】



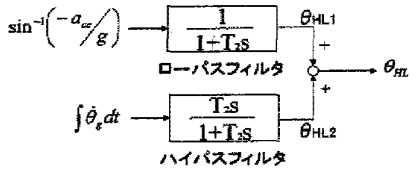
両輪角速度目標値のローパスフィルタリング

【図5】



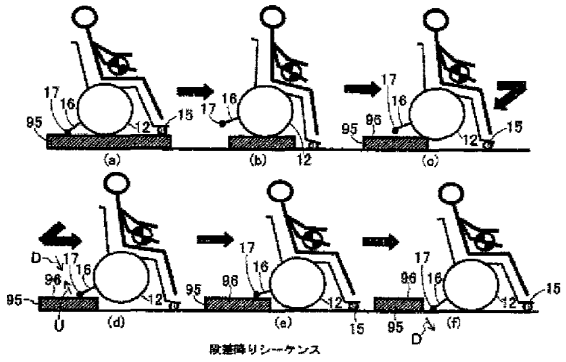
段差昇りシーケンス

【図6】

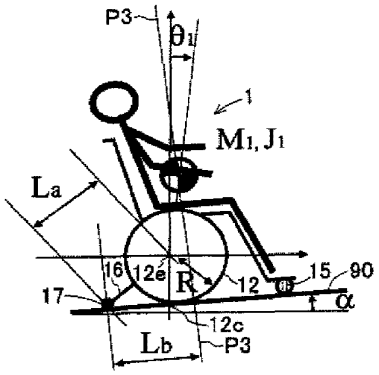


加速度計のローパスフィルタリングとレートジャイロ積分のハイパスフィルタリングの融合

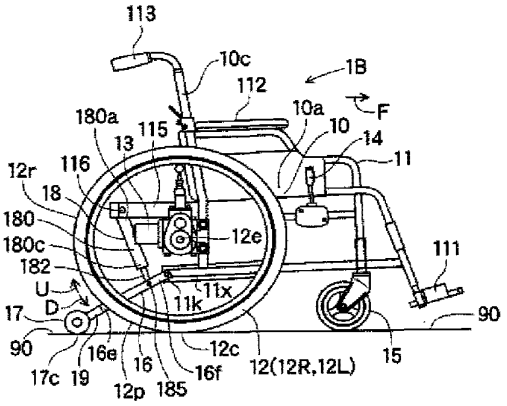
【図7】



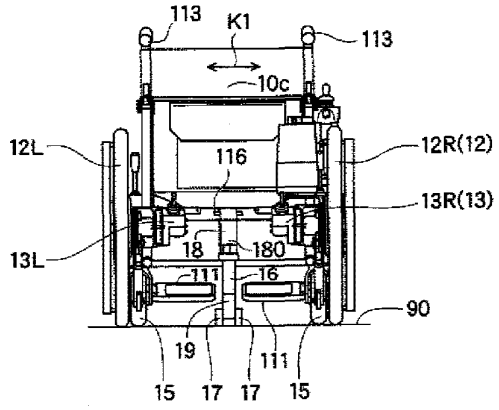
【図8】



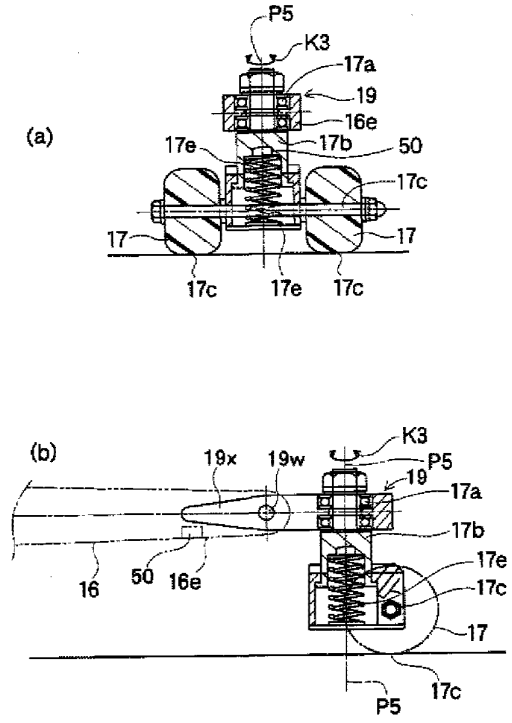
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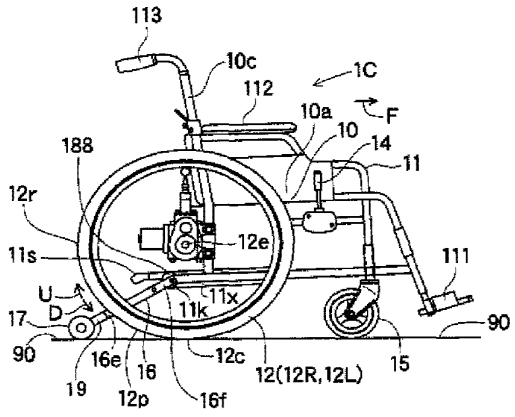
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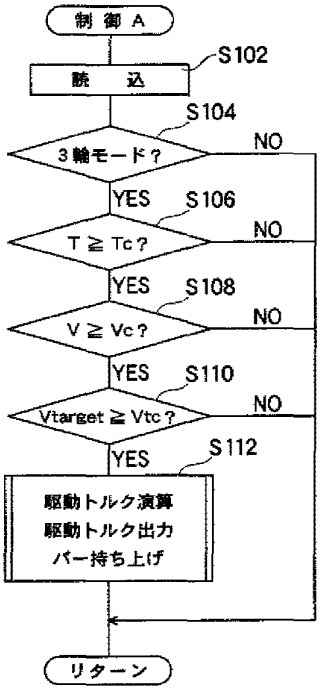
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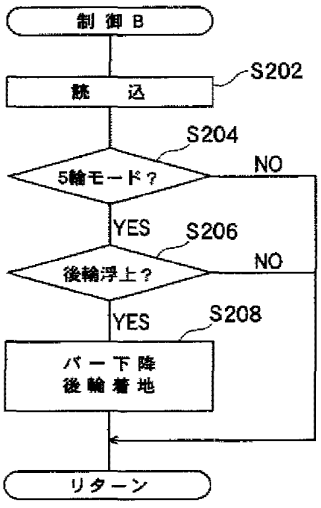
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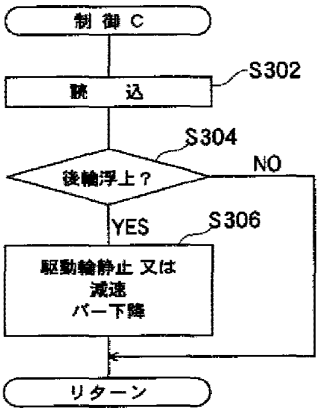
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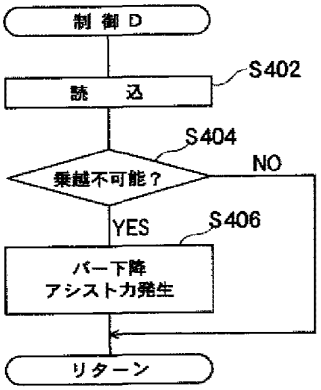
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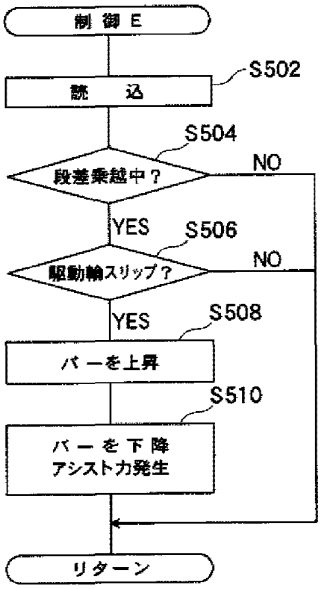
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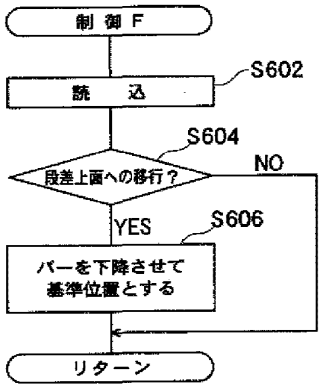
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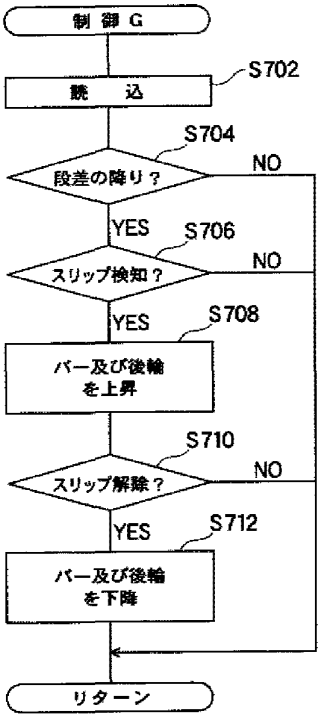
【図17】



【図18】



【図19】



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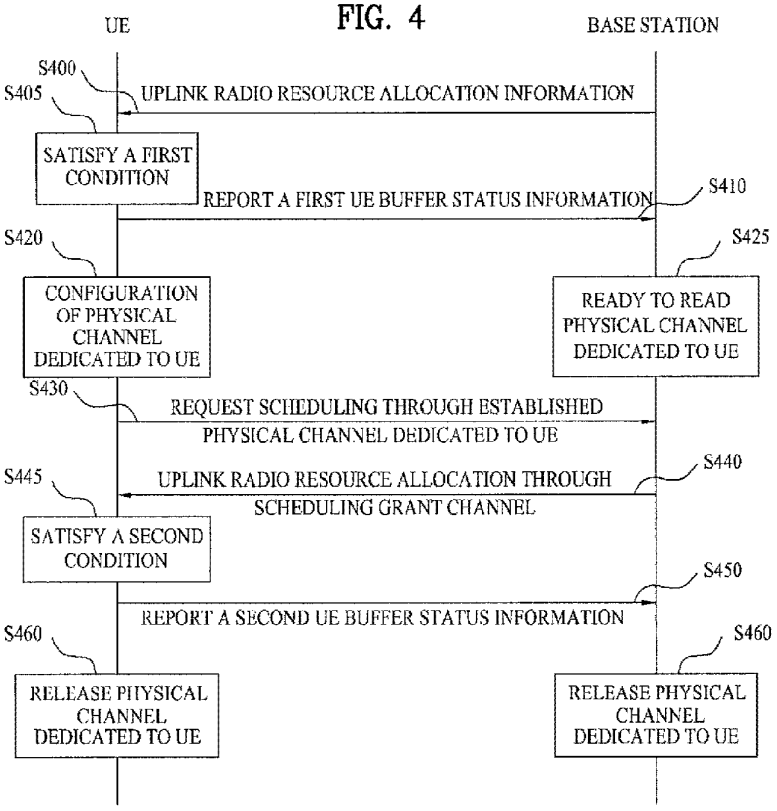
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(54) Title: METHODS OF SETTING UP CHANNEL IN WIRELESS COMMUNICATION SYSTEM

FIG. 4



(57) Abstract: A method of establishing a channel in a wireless communication system is disclosed. The method of establishing a dedicated channel of a user equipment in a wireless communication system includes, receiving channel configuration information which is required for establishing the dedicated channel from a network, transmitting a first status report to the network if at least one first condition is satisfied, and establishing the dedicated channel using the channel configuration information after transmitting the first status report. As a result, the wireless communication system can increase its scheduling efficiency using buffer status information of the UE.

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METHODS OF SETTING UP CHANNEL IN WIRELESS COMMUNICATION SYSTEM

Technical Field

The present invention relates to a method for establishing a channel in a wireless communication system, and more particularly to a method for establishing a channel dedicated for a user equipment (UE) in a wireless communication system.

Background Art

FIG. 1 is a structural diagram illustrating a network structure of an Evolved Universal Mobile Telecommunications System (E-UMTS) which is called a fourth-generation mobile communication system. The E-UMTS system is developed from a conventional UMTS system, and conducts intensive research into a basic standardization process in the current 3GPP. The E-UMTS system may also be called a Long Term Evolution (LTE) system.

The E-UMTS network is classified into an Evolved UTRAN (E-UTRAN) and an Evolved Packet Core (EPC). The E-UMTS includes a user equipment (UE), an eNode-B and an Access Gateway (AG) which is located at the end of a network and connected to an external network. The AG may

be called as a Mobility Management Entity (MME) / User Plane Entity (UPE). The AG may be divided into a first AG part for taking charge of user traffic and a second AG part for taking charge of control traffic. In this case, a new interface may be located between the first AG part for processing the user traffic and the second AG part for processing the control traffic, such that the first AG part may communicate with the second AG part. A single eNode-B may include at least one cell. An interface for transmitting either the user traffic or the control traffic may be used between the eNode-Bs. The EPC may include an AG and a node for user registration of UEs. An interface for distinguishing the E-UTRAN from the EPC may also be used. The eNode-Bs and the AG may be connected via an S1 interface. In this case, the several nodes are interconnected (i.e., Many to Many Connection). The eNode-Bs may be connected to each other via an X2 interface, and have a meshed network structure with the X2 interface.

Radio protocol layers between the user equipment (UE) and the network are classified into a first layer (L1), a second layer (L2), and a third layer (L3) based on an Open System Interconnection (OSI) reference model well known to a communication system. A physical layer,

the first layer (L1), provides an information transfer service using a physical channel. A radio resource control (RRC) layer located in a third layer controls radio resources between the UE and the network. For this operation, the RRC message is exchanged between the UE and the network. The RRC layer is located at the eNode-B in the E-UTRAN.

FIG. 2 is a structural diagram illustrating a radio protocol layer structure between the UE and the E-UTRAN (Evolved - UMTS Terrestrial Radio Access Network) on the basis of the 3GPP radio access network standard specification of the third-generation mobile communication standardization organization. The radio protocol layer structure of FIG. 2 horizontally includes a physical layer, a data link layer, and a network layer. The radio protocol layer structure of FIG. 2 vertically includes a user plane for transmitting data and a control plane for transmitting a control signal (i.e., signaling information). The radio protocol layers of FIG. 2 are classified into a first layer (L1), a second layer (L2), and a third layer (L3) based on an Open System Interconnection (OSI) reference model well known to a communication system.

The control plane and the user plane in the radio protocol layer structure of FIG. 2 will hereinafter be described. The first layer (L1) is a physical layer. The physical layer provides an upper layer with an information transfer service through a physical channel. The physical layer is connected to a medium access control (MAC) layer located at a higher level through a transport channel. Data is transferred between the MAC layer and the physical layer via the transport channel. Data is transferred between different physical layers through a physical channel. Between different physical layers, namely, between physical layers of a transmission side and a reception side, data is transferred via the physical channel.

The medium access control (MAC) layer of the second layer provides services to a radio link control (RLC) layer located at a higher level through a logical channel. The RLC layer supports the transmission of data with reliability. It should be noted that the RLC layer illustrated in FIG. 2 is depicted because if the RLC functions are implemented in and performed by the MAC layer, the RLC layer itself is not required. The PDCP layer of the second layer (L2) performs a header compression function for reducing the IP packet header

size including relatively large- and unnecessary- control information, such that it can effectively transmit IP packet (such as IPv4 or IPv6) within a narrow-bandwidth RF interval. The PDCP layer of the E-UTRAN may be located at the AG.

A Radio Resource Control (RRC) layer located at the lowest portion of the third layer is only defined in the control plane. The RRC layer is associated with configuration, re-configuration, and release of a radio bearer (RB), such that it controls logical channels, transport channels, and physical channels. In this case, the radio bearer (RB) signifies a service provided by the second layer for data communication between the UE and the E-UTRAN.

The unit of data transferred to each layer of the radio protocol layer structure is called different names. This data unit is called a service data unit (SDU). A basic unit for allowing a protocol layer to transfer data to another protocol layer is called a protocol data unit (PDU). Data which is transferred between layers of a radio access protocol structure or between radio access protocol structures signifies a predetermined data block such as the above-mentioned SDU or PDU.

FIG. 3 is a flow chart illustrating a procedure for an RRC connection in the E-UMTS system. In order to establish a call connection between the UE and the E-UTRAN system, the UE must establish a RRC connection with the E-UTRAN system, and must also establish a signaling connection with a Core Network (CN). In order to disclose detailed operations of the above RRC connection and the above signaling connection, a RRC state of the UE and the RRC connection procedure will hereinafter be described in detail. The RRC state indicates whether the RRC layer of the UE is logically connected to the RRC layer of the E-UTRAN. If it is determined that the RRC layer of the UE is logically connected to the RRC layer of the E-UTRAN, this state is called a RRC connected state. If the RRC layer of the UE is not logically connected to the RRC layer of the E-UTRAN, this state is called a RRC idle state. A UE in the RRC connected state has a RRC connection with the E-UTRAN, such that the E-UTRAN can recognize the presence of the corresponding UE in a cell. As a result, the UE can be effectively controlled. Otherwise, a UE in the RRC idle state cannot be recognized by the E-UTRAN, but is controlled by a core network (CN) in a tracking area larger than the cell. In other words, only the presence or absence of the above UE

in the RRC idle state is recognized in the unit of a large region. If the UE in the RRC idle state desires to receive a mobile communication service such as a voice or data service, the UE must transit to the RRC connection state. Associated detailed description will hereinafter be described in detail.

If a user initially powers on his or her UE, the UE searches for an appropriate cell, and stays in a RRC idle state in the searched cell. The UE staying in the RRC idle state establishes a RRC connection with the RRC layer of the E-UTRAN through a RRC connection procedure when the UE needs to establish the RRC connection, such that the UE transits to the RRC connection state. The UE in the RRC idle state must establish the RRC connection with the E-URTAN due to a variety of reasons. For example, if uplink data transmission is needed due to a user's phone call attempt, or if a paging message is received from the E-UTRAN such that a response message for the paging message must be transmitted, the UE in the RRC idle state needs to connect the RRC connection with the E-URTAN. By means of the RRC connection and the signaling connection, the UE exchanges UE-dedicated control information with the E-UTRAN or CN.

As shown in FIG. 3, according to a first process for the RRC connection establishment, the UE transmits a RRC connection request message to a base station (BS) at step S310. The base station is located at the last end of the E-UTRAN, and wirelessly transmits/receives data to/from the UE. For the convenience of description, the base station to be disclosed in the following description is indicative of the E-UTRAN.

In order to response the RRC connection request message, the base station transmits the RRC connection setup message to the UE at step S320.

The UE transmits the RRC connection setup complete message to the base station at step S330. If the above-mentioned process has been successfully completed, the RRC connection is established between the UE and the base station.

After the RRC connection has been established, the UE initiates a process for establishing the signaling connection by transmitting an initial direct transfer (IDT) message at step S340.

In the meantime, the base station may establish a UE-dedicated physical channel for only one UE. The UE can transmit Layer1/Layer2 (L1/L2) control information to the base station using the above UE-dedicated physical

channel. There is a variety of L1/L2 control information, for example, control information to request a scheduling message from the UE to the base station, reference information for the base station to measure a quality of an uplink channel of the UE, downlink channel quality information which the UE reports to the base station, feedback information (e.g., ACK/NACK information) of a Hybrid Automatic Repeat Request (HARQ) scheme, or buffer status information of the UE.

Specifically, the buffer status information of the UE will hereinafter be described in detail. The UE can transmit the buffer status information of the UE as for the L2 control information of the MAC layer to the base station. For this purpose, the buffer status information of the UE may be included in a MAC control element of the MAC PDU which is a data block of the MAC layer of the UE. In this case, the buffer status information of the UE may include information indicating an amount of data stored in the buffer of the UE. The MAC control element including the above buffer status information of the UE forms the MAC PDU along with a MAC header and without the MAC SDU corresponding to payload. So, the MAC control element may be transmitted to the base station, and may

be carried on the MAC PDU according to a piggyback scheme and be then transmitted.

According to a representative method for enabling the base station to establish a UE-dedicated physical channel for only one UE, the base station may transmit allocation information of uplink radio resources, which will be allocated at intervals of a predetermined time, to the UE. The above allocation information of uplink radio resources will hereinafter be referred to as periodic radio resource allocation information. The UE can establish the UE-dedicated physical channel using this periodic radio resource allocation information.

In order to establish the UE-dedicated physical channel, a control message for establishing a UE-dedicated physical channel must be transmitted and received between the UE and the base station, such that system overhead occurs and an unexpected delay also occurs in the process for establishing the UE-dedicated physical channel.

Disclosure of the Invention

Technical Problem

Accordingly, the present invention is directed to a method for establishing a channel in a wireless

communication system that substantially obviates one or more problems due to limitations and disadvantages of the related art.

An object of the present invention is to provide a channel configuration method for use in a wireless communication system.

Another object of the present invention is to provide a method for managing uplink radio resources using buffer status information of a UE.

Technical Solution

To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, a method of establishing a dedicated channel of a user equipment in a wireless communication system comprising: receiving channel configuration information which is required for establishing the dedicated channel from a network; transmitting a first status report to the network if at least one first condition is satisfied; and establishing the dedicated channel using the channel configuration information after transmitting the first status report.

In another aspect of the present invention, there is provided a method for controlling configuration of a

dedicated channel of a user equipment (UE) in a network of a wireless communication system comprising: transmitting channel configuration information which is required for establishing the dedicated channel to a user equipment (UE); receiving a first status report indicating that at least one first condition is satisfied from the user equipment (UE); and receiving a message transmitted via the established dedicated channel, which is established using the channel configuration information.

The method further comprises: receiving a second status report from the user equipment (UE) if at least one second condition is satisfied; and releasing the dedicated channel after receiving the second status report.

Advantageous Effects

The present invention can improve the scheduling efficiency of a wireless communication system using buffer status information of a UE.

Description of Drawings

The accompanying drawings, which are included to provide a further understanding of the invention, illustrate embodiments of the invention and together with the description serve to explain the principle of the

invention.

In the drawings:

FIG. 1 is a structural diagram illustrating a network structure of an Evolved Universal Mobile Telecommunication System (E-UMTS) which is called a fourth-generation mobile communication system;

FIG. 2 is a structural diagram illustrating a radio protocol layer structure between the UE and the E-UTRAN (Evolved - UMTS Terrestrial Radio Access Network) on the basis of the 3GPP radio access network specification of the third-generation mobile communication standardization organization;

FIG. 3 is a flow chart illustrating an RRC connection procedure in an E-UMTS system;

FIG. 4 is a flow chart illustrating a process for establishing/releasing a channel according to one embodiment of the present invention; and

FIG. 5 is a flow chart illustrating a method for establishing/releasing a physical channel according to another embodiment of the present invention.

Best Mode

Reference will now be made in detail to the preferred embodiments of the present invention, examples of

which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

The following embodiments will disclose a variety of application examples of the present invention, which is applied to the IEEE 802.16e system and the IEEE 802.16m system which serve as the standard specification of not only a single-carrier multiple access system but also a multi-carrier multiple access system (e.g., an OFDM mobile communication system) considering the mobile station (MS) mobility [See IEEE Std 802.16e-2005 and http://www.ieee802.org/16/published.html]. Also, the present invention can also be applied to another mobile communication system such as an Evolved Universal Mobile Telecommunications System (E-UMTS) (also called a Long Term Evolution (LTE)). The present invention may be applied to a variety of communication systems including a single-antenna or multi-antenna system.

Generally, a communication system has been widely used to provide a variety of communication services (e.g., VoIP or packet data). The above-mentioned communication system has been used for a downlink or an uplink. The downlink signifies a communication from an eNode-B to a user equipment (UE). The uplink signifies a communication

from the UE to the eNode-B. The eNode-B signifies a fixed node communicating with the UE, and includes a network other than the UE in a communication system including not only a physical layer but also an upper layer. The network or the eNode-B is symmetrical to the user equipment (UE), and it should be noted that the network has the same meaning as the eNode-B. The user equipment (UE) may be fixed or have mobility.

FIG. 4 is a flow chart illustrating a process for establishing/releasing a channel according to one embodiment of the present invention. In more detail, FIG. 4 shows a method for allowing the UE to establish a dedicated channel of the UE such that the UE can generate a scheduling request using the dedicated channel.

Referring to FIG. 4, the base station transmits uplink radio resource allocation information to the UE at step S400. This uplink radio resource allocation information may be periodically transmitted as necessary.

The UE can periodically report its own buffer status (hereinafter referred to as UE buffer status) to the base station using the above uplink radio resource allocation information. The base station can determine whether uplink resources are allocated to the UE using the UE buffer status information, and/or can determine an

amount of allocating resources such that it is able to recognize how much resources should be allocated to the UE. A multi-carrier wireless communication system such as an LTE system allocates resource blocks based on predetermined time- and frequency- units for an uplink of a specific UE, such that the base station is able to use the UE buffer status information transmitted from the UE such that the base station can decide the necessity of allocating uplink resources to the specific UE. In this case, in order to enable the UE to transmit its own buffer status information according to the conventional art, the dedicated physical channel of the UE for transmitting the UE buffer status information must be established. For this operation, it should be noted that the method for transmitting and receiving the RRC message of FIG. 3 is needed, as previously stated above.

In order to allow the UE to report the UE buffer status to the base station, the UE pre-negotiates with the base station about a specific condition of the UE buffer status. Only when this specific condition is satisfied, it is able to report the UE buffer status to the base station. There are two specific conditions of the UE buffer status pre-negotiated with the base station, i.e., a first condition associated with the configuration

of the dedicated physical channel, and a second condition associated with the release of the dedicated physical channel of the UE.

In an example of the first condition, if the UE-buffer size (i.e. the amount of data stored in UE buffer) is 0 or is less than a specific threshold value, or if voice data in a voice communication such as a VoIP is temporarily stopped (e.g., transition from talk spurt to silence period), the first condition can be satisfied.

In an example of the second condition, if the UE-buffer size (i.e. the amount of data stored in UE buffer) is not equal to 0 or is greater than a specific threshold value, or if voice data temporarily stopped in a voice communication such as a VoIP is retransmitted (e.g., transition from silence period to talk spurt), the second condition can be satisfied. The above-mentioned threshold value may be transmitted from the base station to the UE through the RRC or MAC message.

FIG. 4 shows an embodiment in which the UE transmits UE buffer status information to the base station only when the buffer status of the UE satisfies a specific condition. Referring to FIG. 4, if the UE buffer status satisfies the first condition at step S405, the UE transmits the UE buffer status information to the base

station at step S410, in order to report the satisfaction of the first condition to the base station. This operation may be called a first UE buffer status report.

The UE is able to use the HARQ retransmission scheme during the first UE buffer status report. In other words, the UE can transmit the first UE buffer status report until receiving acknowledgement information from the base station in association with the first UE buffer status report.

If the UE receives a positive acknowledgement message indicating the reception of the first UE buffer status report from the base station, the UE establishes the dedicated physical channel of the UE using uplink resource allocation information received from the base station at the above step S400, at step S420. Likewise, the base station having received the first UE buffer status report gets ready to receive the dedicated physical channel at step S425.

The UE can request the scheduling from the base station through the dedicated physical channel at step S430. In this case, the dedicated physical channel may be called a physical scheduling request channel. The base station can periodically allocate uplink radio resources for this physical scheduling request channel. In other

words, in case of using the scheme of reporting the UE buffer status by deciding whether a predetermined condition is satisfied, the base station implicitly pre-allocates uplink resources of the dedicated physical channel of the UE at intervals of a predetermined time, such that the UE can transmit the dedicated physical channel (i.e., the physical scheduling request channel). Also, the UE implicitly allocates the UE-dedicated physical channel. The term "implicit allocation" is as follows. If the UE needs to allocate uplink resources for uplink transmission on the condition that the base station pre-allocates uplink resources although the UE does not actually request allocation of uplink resources, the UE conducts uplink transmission using pre-allocated uplink resources without using the process of exchanging signals with the base station to allocate additional uplink resources.

Thereafter, if the UE buffer status satisfies the first condition, the UE requests the scheduling from the base station via the dedicated physical channel (i.e., a physical scheduling request channel).

If the base station receives the dedicated physical channel (i.e., the physical scheduling request channel),

the base station can allocate uplink resources to the UE through a scheduling grant channel at step S440.

Then, if the UE satifies the second condition at step S445, it transmits UE buffer status information to the base station such that the base station can recognize the satisfaction of the second condition at step S450. For the convenience of description, this operation is called a second UE buffer status report.

In the same manner as in the first UE status report, if the UE receives a positive acknowledgement message indicating the reception of the second UE buffer status report from the base station, it releases the established dedicated physical channel at step S460. For this operation, if the base station receives the second UE buffer status report, it stops receiving the dedicated physical channel.

For another method for allowing the UE to report the UE buffer status to the base station, the UE buffer status information is included in the MAC PDU when the UE transmits an uplink shared channel, such that the UE buffer status information can be transmitted. This MAC PDU may be a control PDU. The above-mentioned uplink shared channel may be an UL-SCH for transmitting user traffic or control information.

FIG. 5 is a flow chart illustrating a method for establishing/releasing a physical channel according to another embodiment of the present invention. In more detail, FIG. 5 shows a scheduling method using a random access channel (RACH) according to the inventive UE status report method.

Generally, the uplink channel of the UE, through which the UE transmits control information or user traffic information to the base station, may be a RACH for transmitting control information at the beginning of a call setup or a UL-SCH for transmitting user traffic data or control information after the call setup has been established. The RACH is mainly used to transmit control information at the beginning of the call setup. But, after the call setup has been established, the RACH may also be used to transmit control information to the base station. FIG. 5 shows a method for requesting the scheduling via the RACH, differently from the embodiment of FIG. 4 in which the UE has used the physical scheduling request channel as the dedicated physical channel so as to request the scheduling to the base station.

Generally, the UE acquires available RACH signature information or RACH occasion information from system

information received from the base station. Thereafter, if the UE has data to be transmitted in uplink in its own buffer, it selects the RACH signature and the RACH occasion and transmits a random access preamble for requesting allocation of uplink resources to the base station. Thereafter, the base station transmits random access response information to the UE. This random access response information includes a UE identifier (also called a user identity), a time advance (TA), allocation information of radio resources for uplink transmission, etc.

The UE can transmit user traffic or the like to the base station using the above-mentioned radio resource allocation information for uplink transmission. Based on the above-mentioned operations, the embodiment of FIG. 5 will hereinafter be described in detail.

Referring to FIG. 5, the base station transmits uplink radio-resource allocation information to the UE at step S500. This uplink radio-resource allocation information can be periodically transmitted to the UE. The uplink radio-resource allocation information may include allocation information of a dedicated RACH signature, or may include information of a time slot capable of using this dedicated RACH signature. In this

case, it should be noted that the above-mentioned uplink radio-resource allocation information includes radio-resource allocation information for reporting the UE's buffer status.

As described above, the base station can determine whether uplink resources are allocated to the UE using the UE buffer status information, and/or can determine the amount of allocated resources. In accordance with the embodiment of FIG. 5, in order to report the UE buffer status to the base station, the UE pre-negotiates with the base station about a specific condition of a UE buffer status, and reports the UE buffer status to the base station only when this specific condition is satified. There are two kinds of the specific condition of the UE buffer status pre-negotiated with the base station, i.e., a first condition associated with the configuration of the dedicated physical channel and a second condition associated with the release of the dedicated physical channel.

In an example of the first condition, if the UE-buffer size (i.e. the amount of data stored in UE buffer) is 0 or is less than a specific threshold value, or if voice data in a voice communication such as a VoIP is

temporarily stppoed (e.g., transition from talk spurt to silence period), the first condition can be satisfied.

In an example of the second condition, if the UE-buffer size (i.e. the amount of data stored in UE buffer) is not equal to 0 or is greater than a specific threshold value, or if voice data temporarily stopped in a voice communication such as a VoIP is retransmitted (e.g., transition from silence period to talk spurt), the second condition can be satisfied. The above-mentioned threshold value may be transmitted from the base station to the UE through the RRC or MAC message.

The embodiment of FIG. 5 uses the RACH based on the dedicated preamble of the UE without using the dedicated physical channel (i.e., the physical scheduling request channel), such that the UE requests the scheduling to the base station, differently from the embodiment of FIG. 4.

If data to be transmitted in uplink by the UE exists or the buffer of the UE has data to be transmitted, the UE transmits a dedicated RACH signature (i.e., RACH preamble) to the base station at a timeslot recognized at step S500, at step S510. If the base station receives the above dedicated RACH signature at the above timeslot, it determines that the UE has transmitted the scheduling request.

Thereafter, the base station transmits UE identification information such as a C-RNTI (Cell Radio Network Temporary Identity) for uplink resource allocation to the UE through the L1/L2 control channel (e.g., RACH response message) at step S520, such that the UE is able to use the above uplink resources. If the UE receives the above UE identification information from the base station, it can transmit the UE buffer status information to the base station using the allocated uplink resources. The UE determines its own buffer status information. If a specific condition is satisfied, the UE transmits a specific message to the base station. Associated detailed description will hereinafter be described in detail.

If the UE buffer status satisfies the first condition, the UE transmits the UE buffer status information to the base station using the allocated uplink resources of the above step S520, at step S530. This operation is called a first UE buffer status report. The UE can transmit the first UE buffer status report using the HARQ retransmission scheme. If the UE receives a positive acknowledgement message indicating the reception of the first UE buffer status report from the base station, the UE implicitly establishes uplink

resources for transmitting the dedicated RACH signature. This implicit establishment is as follows. According to the implicit establishment, if data to be transmitted in uplink exists or data is stored in the UE buffer, uplink resources acquired at the above step S500 are continuously used as the uplink resources of the UE.

If the UE buffer status satisfies the second condition, it transmits the UE buffer status information to the base station using the allocated uplink resources of the above step S520 at step S540. This operation is called a second UE buffer status report. The UE can transmit the second UE buffer status report using the HARQ retransmission scheme. Upon receiving a positive acknowledgement message indicating the reception of the second UE buffer status report from the base station, the UE implicitly releases uplink resources for transmitting the dedicated RACH signature. Also, the base station implicitly releases uplink resources for the dedicated RACH signature.

This implicit release means that uplink resources allocated for data transmission to the uplink are released. Thereafter, the UE is unable to transmit the RACH signature in order to request the scheduling to the base station. In order to request the above scheduling,

the UE may transmit the MAC PDU including the scheduling request information to the base station.

For the convenience of description and better understanding of the present invention, the above-mentioned embodiments have mainly disclosed a communication execution process between the transmission end and the reception end, but it should be noted that the transmission end may be a user equipment (UE) or a base station of the network, and the reception end may be an eNode-B or UE of the network. The terms disclosed in the present invention may be replaced with other terms having the same meanings. For example, the user equipment (UE) may be replaced with a mobile station (MS), a mobile subscriber station (MSS), a communication terminal, a user terminal as necessary. The term "base station" may also be replaced with a fixed station, Node-B (NB), an eNode-B, or eNB as necessary.

If required, individual constituent components or characteristics may be combined with other components or characteristics. Also, some constituent components and/or characteristics may be combined to implement the embodiments of the present invention. The order of operations to be disclosed in the embodiments of the present invention may be changed to another. Some components or characteristics of any embodiment may also be

included in other embodiments, or may be replaced with those of the other embodiments as necessary. It is obvious to those skilled in the art that claims having no explicit citation relationships are combined with each other to implement the embodiments, or new claims obtained by the amendment after the patent application may also be contained in the present invention without departing from the scope and spirit of the present invention.

The above-mentioned embodiments of the present invention can be implemented by hardware, firmware, software, or a combination of them. In the case of implementing the present invention by hardware, one embodiment of the present invention can be implemented with ASICs (application specific integrated circuit), DSPs (digital signal processors), DSPDs (digital signal processing devices), PLDs (programmable logic devices), FPGAs (field programmable gate arrays), a processor, a controller, a microcontroller, and a microprocessor.

If operations or functions of the present invention are implemented by firmware or software, the present invention can be implemented in the form of a variety of formats, for example, modules, procedures, and functions, etc. The software codes may be stored in a memory unit so that it can be driven by a process. The memory unit is

located inside or outside of the processor, so that it can communicate with the aforementioned processor via a variety of well-known parts.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

Industrial Applicability

As apparent from the above description, the present invention can be applied to a wireless mobile communication system. More specifically, the present invention can be applied to a multi-carrier wireless mobile communication system.

What is claimed is:

1. A method of establishing a dedicated channel of a user equipment (UE) in a wireless communication system comprising:

receiving channel configuration information which is required for establishing the dedicated channel from a network;

transmitting a first status report to the network if at least one first condition is satisfied; and

establishing the dedicated channel using the channel configuration information after transmitting the first status report.

2. The method according to claim 1, further comprising:

transmitting a second status report to the network if at least one second condition is satisfied; and

releasing the dedicated channel after transmitting the second status report.

3. The method according to claim 1, wherein the dedicated channel is periodically allocated.

4. The method according to claim 2, wherein the at least one first condition and the at least one second condition are received from the network.

5. The method according to claim 1, further comprising:

performing a scheduling request via the dedicated channel; and

receiving scheduling allocation information from the network.

6. The method according to claim 2, wherein the at least one first condition is satisfied when an amount of data stored in a buffer of the user equipment (UE) is less than a first threshold value.

7. The method according to claim 2, wherein the at least one second condition is satisfied when an amount of data stored in a buffer of the user equipment (UE) is greater than a second threshold value.

8. The method according to claims 6 and 7, wherein the first status report and the second status report include buffer status information of the user equipment

(UE).

9. The method according to claim 1, wherein the at least one first condition is satisfied when a talk or communication period is shifted to a silence period in a voice communication.

10. The method according to claim 9, wherein the at least one second condition is satisfied when the silence period is shifted to the talk or communication period in the voice communication.

11. The method according to any one of claims 9 and 10, wherein the first status report and the second status report include information associated with a mode shift.

12. The method according to any one of claims 9 and 10, wherein the first status report and the second status report are transmitted to the network according to a hybrid automatic repeat request (HARQ) scheme.

13. A method of controlling configuration of a dedicated channel of a user equipment (UE) in a network of a wireless communication system comprising:

transmitting channel configuration information which is required for establishing the dedicated channel to a user equipment (UE);

receiving a first status report indicating that at least one first condition is satisfied from the user equipment (UE); and

receiving a message transmitted via the established dedicated channel, which is established using the channel configuration information.

14. The method according to claim 13, further comprising:

receiving a second status report from the user equipment (UE) if at least one second condition is satisfied; and

releasing the dedicated channel after receiving the second status report.

15. The method according to claim 13, wherein the dedicated channel is periodically allocated.

16. The method according to claim 13, further comprising:

receiving a scheduling request via the dedicated

channel from the user equipment (UE); and

transmitting scheduling allocation information to the user equipment (UE).

17. The method according to claim 14, wherein the at least one first condition is satisfied when an amount of data stored in a buffer of the user equipment (UE) is less than a first threshold value.

18. The method according to claim 14, wherein the at least one second condition is satisfied when an amount of data stored in a buffer of the user equipment (UE) is greater than a second threshold value.

19. The method according to any one of claims 17 and 18, wherein the first status report and the second status report include buffer status information of the user equipment (UE).

20. The method according to claim 13, wherein the at least one first condition is satisfied when a talk or communication period is shifted to a silence period in a voice communication.

21. The method according to claim 20, wherein the at least one second condition is satisfied when the silence period is shifted to the talk or communication period in the voice communication.

22. The method according to any one of claims 20 and 21, wherein the first status report and the second status report include information associated with a mode shift.

23. The method according to any one of claims 20 and 21, wherein the first status report and the second status report are transmitted to the network according to a hybrid automatic repeat request (HARQ) scheme.

FIG. 1

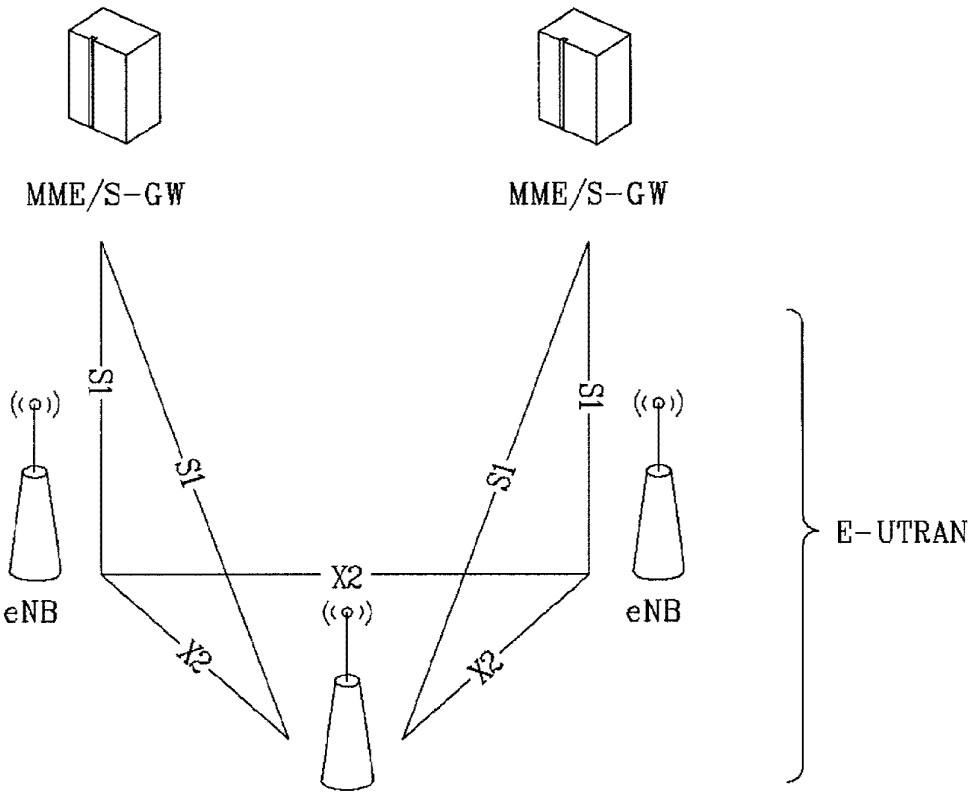


FIG. 2

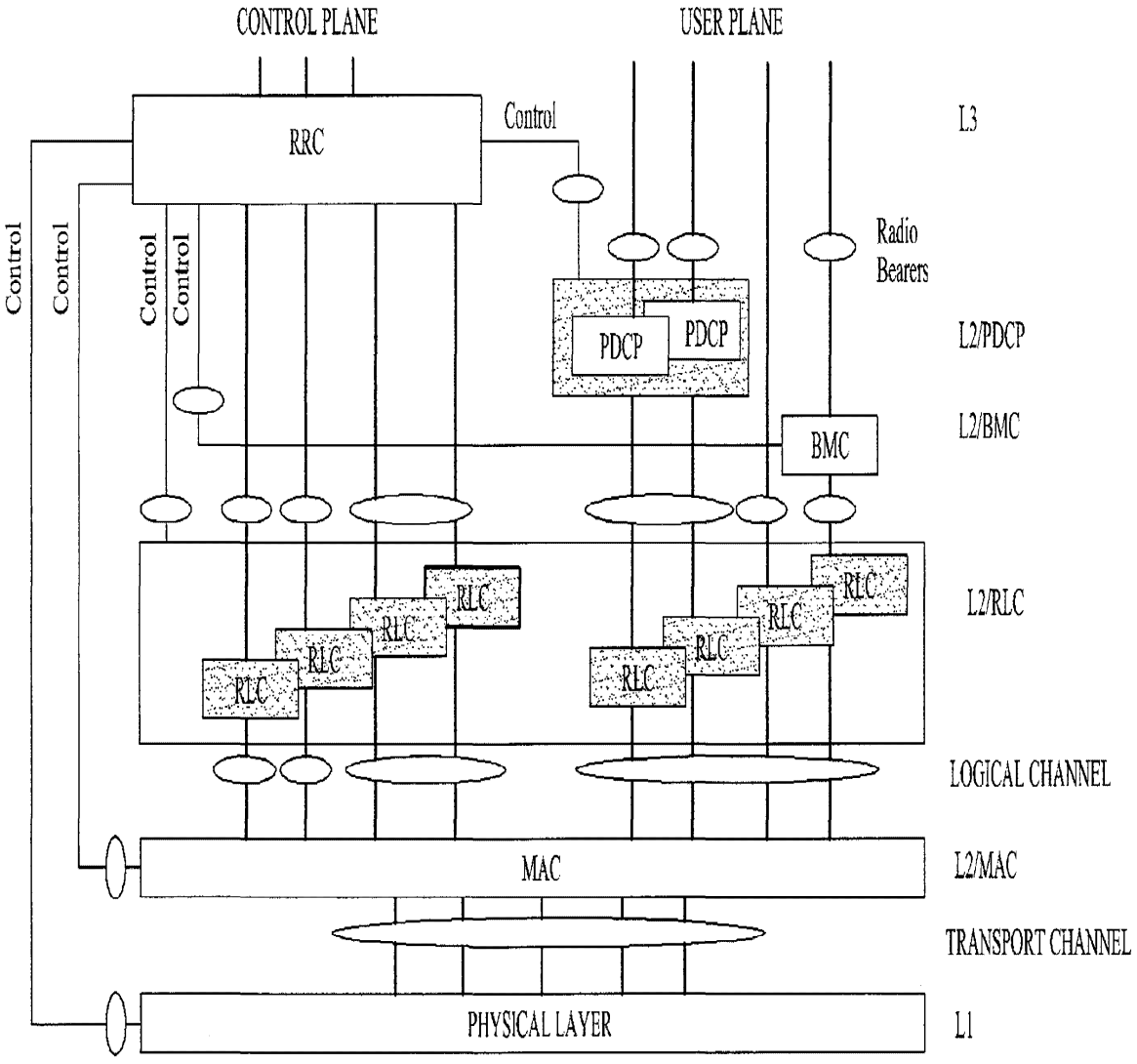

CONTROL PLANE
USER PLANE
RRC
Control
L3
Radio Bearers
Control
Control
Control
Control
PDCP
PDCP
L2/PDCP
BMC
L2/BMC
RLC
RLC
RLC
RLC
RLC
RLC
RLC
RLC
L2/RLC
LOGICAL CHANNEL
MAC
L2/MAC
TRANSPORT CHANNEL
PHYSICAL LAYER
L1

FIG. 3

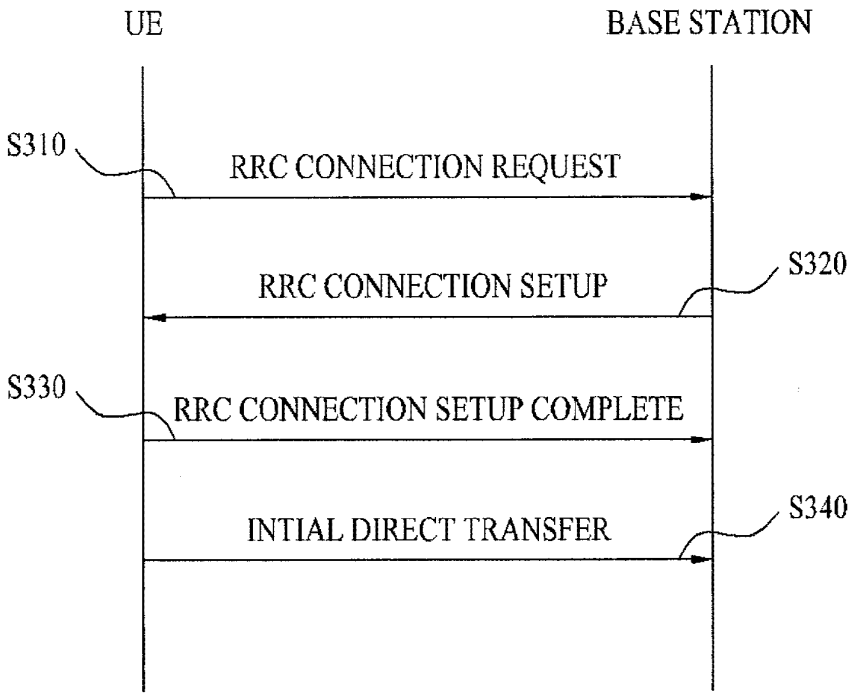

UE
BASE STATION
S310
RRC CONNECTION REQUEST
RRC CONNECTION SETUP
S320
S330
RRC CONNECTION SETUP COMPLETE
INTIAL DIRECT TRANSFER
S340

FIG. 4

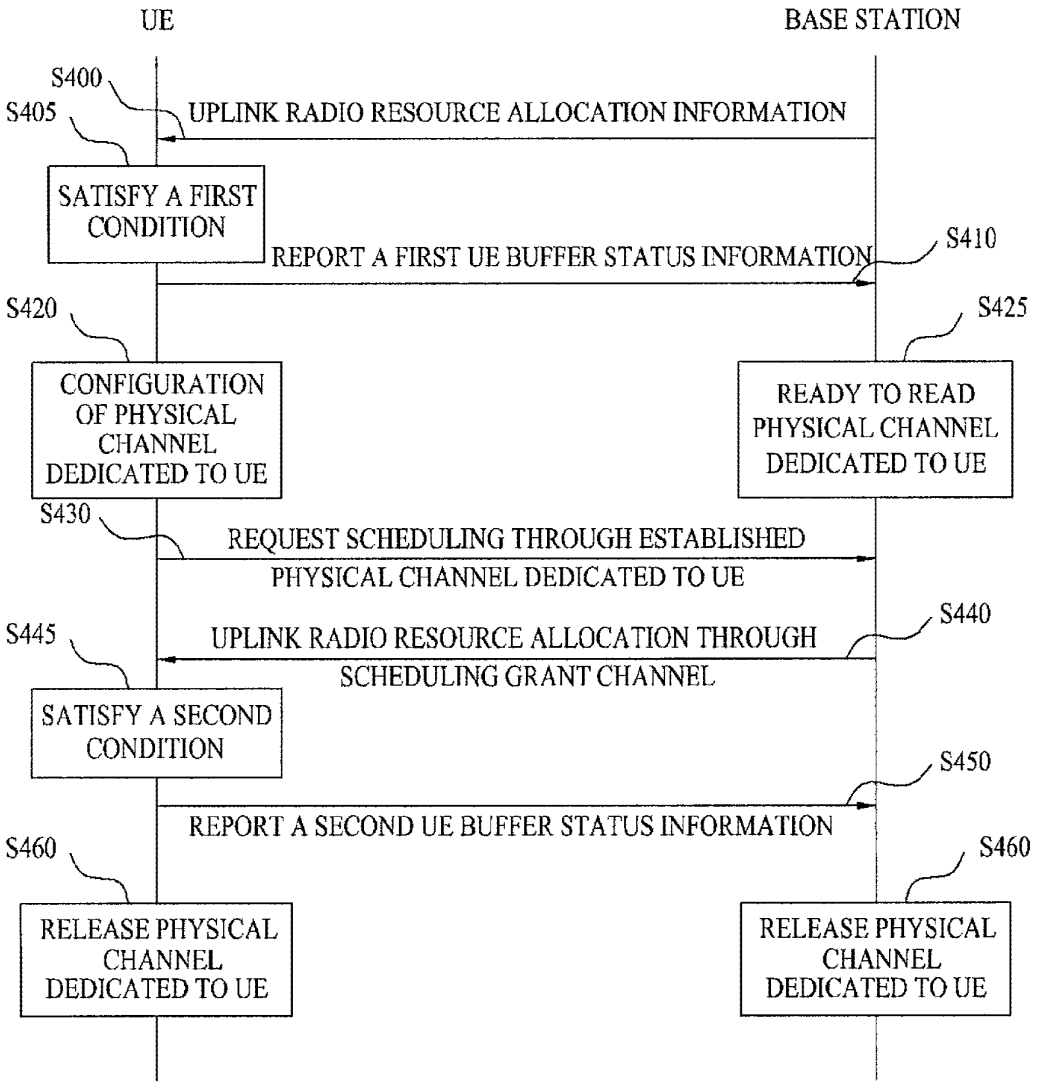
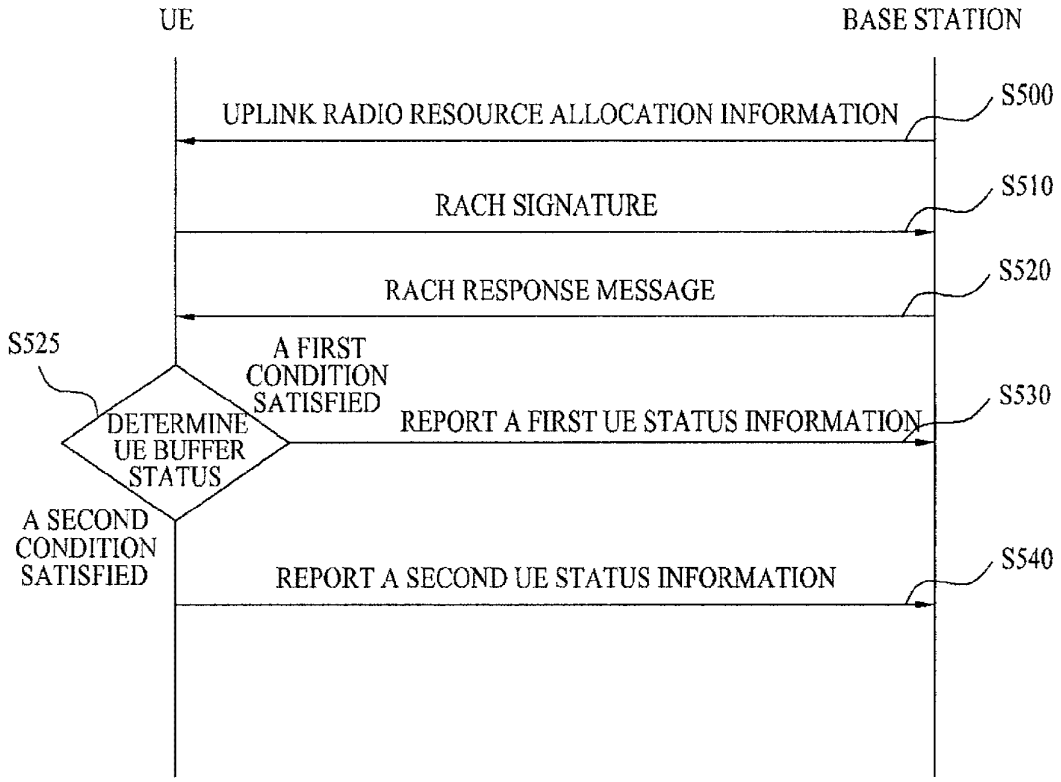

UE
BASE STATION
S400
S405
UPLINK RADIO RESOURCE ALLOCATION INFORMATION
SATISFY A FIRST CONDITION
REPORT A FIRST UE BUFFER STATUS INFORMATION
S410
S420
S425
CONFIGURATION OF PHYSICAL CHANNEL DEDICATED TO UE
READY TO READ PHYSICAL CHANNEL DEDICATED TO UE
S430
REQUEST SCHEDULING THROUGH ESTABLISHED PHYSICAL CHANNEL DEDICATED TO UE
S440
S445
UPLINK RADIO RESOURCE ALLOCATION THROUGH SCHEDULING GRANT CHANNEL
SATISFY A SECOND CONDITION
S450
REPORT A SECOND UE BUFFER STATUS INFORMATION
S460
S460
RELEASE PHYSICAL CHANNEL DEDICATED TO UE
RELEASE PHYSICAL CHANNEL DEDICATED TO UE

FIG. 5


UE
BASE STATION
UPLINK RADIO RESOURCE ALLOCATION INFORMATION
S500
RACH SIGNATURE
S510
RACH RESPONSE MESSAGE
S520
S525
A FIRST CONDITION SATISFIED
DETERMINE UE BUFFER STATUS
REPORT A FIRST UE STATUS INFORMATION
S530
A SECOND CONDITION SATISFIED
REPORT A SECOND UE STATUS INFORMATION
S540

Electronic Patent Application Fee Transmittal

Application Number:	12818064
Filing Date:	17-Jun-2010
Title of Invention:	METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM
First Named Inventor/Applicant Name:	Nathan Edward Tenny
Filer:	John J. Ketchum/Marion Comer De Yoe
Attorney Docket Number:	092546

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt

EFS ID:	16178341
Application Number:	12818064
International Application Number:	
Confirmation Number:	6903
Title of Invention:	METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM
First Named Inventor/Applicant Name:	Nathan Edward Tenny
Customer Number:	23696
Filer:	John J. Ketchum/Marion Comer De Yoe
Filer Authorized By:	John J. Ketchum
Attorney Docket Number:	092546
Receipt Date:	27-JUN-2013
Filing Date:	17-JUN-2010
Time Stamp:	17:40:56
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	5706
Deposit Account	170026
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1		092546_2013-06-27_AMD_esig.pdf	169906 cae05b97debf1719d4312dd00affc227bbd347bc	yes	21

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Amendment/Req. Reconsideration-After Non-Final Reject	1	1
Claims	2	16
Applicant Arguments/Remarks Made in an Amendment	17	21

Warnings:

Information:

2	Information Disclosure Statement (IDS) Form (SB08)	092546_IDS_esig.pdf	67648 2e45696beb2a8602a6ebad6de737c2ee2c1da4cd	no	4

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3	Foreign Reference	EP1887758A2.PDF	8307801 e37b3bc5ddb3cd34c5ef956d7bb6862f43428fc1	no	140

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Information:

4	Foreign Reference	EP1988648A1.PDF	1451531 028ebe62ca2469af71965728d64a584f7bf95ca4	no	27

Warnings:

Information:

5	Foreign Reference	JP2009124450A.PDF	1060763 12a92518862fc4647d0299d760a142d212f157dd	no	16

Warnings:

Information:

6	Foreign Reference	JP2009219625A.PDF	1970134 14e3d6e7fde38d177f4b1870a05e8d09e852dd32	no	35

Warnings:

Information:

7	Foreign Reference	WO2009022840A2.PDF	1300975 4ea816e570eb905477b9c521231271bcfaed5973	no	42

Warnings:

Information:

8	Non Patent Literature	3GPP_IMPACT_OF_CARRIER_AGGREGATION_R2_092957_DATED_MAY_2009.PDF	2520607 944e18fc6cab3e53488b834984a65c078aeea070	no	8
Warnings:					
Information:					
9	Non Patent Literature	092546TW_2013_05_27_TSR.PDF	379582 53c86840177c4a2a92dd219298228d21ca873418	no	2
Warnings:					
Information:					
10	Fee Worksheet (SB06)	fee-info.pdf	30468 6bb4cd2fd6d4e8d96ea83dd2111ba7edfcad547c	no	2
Warnings:					
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			Total Files Size (in bytes):	17259415	

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 12/818,064	Filing Date 06/17/2010	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☒ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	**330**
☒ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	**540**
☒ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	**220**
TOTAL CLAIMS (37 CFR 1.16(i))	88 minus 20 =	* 68	x $52 =	**3536**
INDEPENDENT CLAIMS (37 CFR 1.16(h))	8 minus 3 =	* 5	x $220 =	**1100**
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	**5726**

APPLICATION AS AMENDED – PART II

AMENDMENT **06/27/2013**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 88	Minus	** 88	= 0	x $80 =	0
Independent (37 CFR 1.16(h))	* 10	Minus	***8	= 2	x $420 =	840
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	**840**

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/DIANE JOHNSON/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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23696 7590 09/30/2013

QUALCOMM INCORPORATED
5775 MOREHOUSE DR.
SAN DIEGO, CA 92121

EXAMINER
LOUIS, VINNCELAS

ART UNIT	PAPER NUMBER
2474	

DATE MAILED: 09/30/2013

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/818,064	06/17/2010	Nathan Edward Tenny	092546	6903

TITLE OF INVENTION: METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1780	$300	$0	$2080	12/30/2013

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

23696 7590 09/30/2013
QUALCOMM INCORPORATED
5775 MOREHOUSE DR.
SAN DIEGO, CA 92121

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/818,064	06/17/2010	Nathan Edward Tenny	092546	6903

TITLE OF INVENTION: METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1780	$300	$0	$2080	12/30/2013

EXAMINER	ART UNIT	CLASS-SUBCLASS
LOUIS, VINNCELAS	2474	370-252000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29	NOTE: Absent a valid certification of Micro Entity Status (see form PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
❑ Applicant asserting small entity status. See 37 CFR 1.27	NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
❑ Applicant changing to regular undiscounted fee status.	NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/818,064	06/17/2010	Nathan Edward Tenny	092546	6903

23696 7590 09/30/2013

QUALCOMM INCORPORATED
5775 MOREHOUSE DR.
SAN DIEGO, CA 92121

EXAMINER	
LOUIS, VINNCELAS	
ART UNIT	PAPER NUMBER
2474	

DATE MAILED: 09/30/2013

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)

(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 607 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 607 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Examiner-Initiated Interview Summary	Application No.	Applicant(s)	
	12/818,064	TENNY ET AL.	
	Examiner	Art Unit	
	VINNCELAS LOUIS	2474	

All participants (applicant, applicant's representative, PTO personnel):

(1) *VINNCELAS LOUIS*.

(2) *John J Ketchum, Reg. No. 61,932* .

(3)*Jonas Hodges, Reg. No: 58, 898*.

(4)_____.

Date of Interview: *19 September 2013*.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☒ No.
If Yes, brief description: _____.

Issues Discussed ☐101 ☒112 ☐102 ☐103 ☒Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: *1-88*.

Identification of prior art discussed: *US 2006/0280142*.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

The applicant(s) and examiner discused the difference between prior art(s) and claimed invention. In order to advance prosecution, the applicant amended the claims to differentiate them from prior art(s).We also discussed 112 6th paragraph, where section of MPEP and paragrahs were shown as evidence that specification has enough support for each of the means+for function. Such amendment is clearly reflected in the examiner's amendment.

Applicant recordation instructions: It is not necessary for applicant to provide a separate record of the substance of interview.

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/VINNCELAS LOUIS/ Examiner, Art Unit 2474	/MICHAEL T THIER/ Supervisory Patent Examiner, Art Unit 2474

Notice of Allowability	Application No. 12/818,064	Applicant(s) TENNY ET AL.	
	Examiner VINNCELAS LOUIS	Art Unit 2474	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *06/27/2013*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *1-88 (claims are renumbered 1-88)*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov .
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☒ Interview Summary (PTO-413), Paper No./Mail Date *20130920* .
5. ☒ Examiner's Amendment/Comment
6. ☒ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/VINNCELAS LOUIS/ Examiner, Art Unit 2474	/MICHAEL T THIER/ Supervisory Patent Examiner, Art Unit 2474

DETAILED ACTION

EXAMINER'S AMENDMENT

1. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with John J Ketchum, Reg. No. 61,932 on Thursday, September 19, 2013.

The application has been amended as follows:

1. (Currently amended) A method that facilitates a timing alignment in a multicarrier system, the method comprising:

determining different downlink timings associated with a plurality of downlink carriers;

ascertaining an uplink timing associated with an uplink group of carriers including a first uplink carrier and a second uplink carrier, wherein the uplink timing is ascertained based on a processing of at least one downlink timing of the different downlink timings and a timing offset associated with the uplink group of

carriers and the at least one downlink timing of the different downlink timings; and

transmitting on the first uplink carrier at the uplink timing adjusted based on the timing offset associated with the at least one downlink timing of the different downlink timings, and on the second uplink carrier at the adjusted uplink timing.

2. (Currently amended) The method of claim 1, further comprising performing a random access procedure on at least one random access carrier, wherein the at least one random access carrier is included in a downlink group of carriers that includes [[the]] at least one downlink carrier of the plurality of downlink carriers.

21. (Currently amended) An apparatus configured to facilitate a timing alignment in a multicarrier system, the apparatus comprising:

a processor configured to execute computer executable components stored in memory, the components including:

a downlink timing component configured to determine different downlink timing associated with a plurality of downlink carriers;

an uplink timing component configured to ascertain an uplink timing associated with an uplink group of carriers including a first uplink carrier and a

second uplink carrier, wherein the uplink timing is ascertained based on at least one downlink timing of the different downlink timings and a timing offset associated with the uplink group of carriers and the at least one downlink timing of the different downlink timings; and

a communication component configured to transmit on the first uplink carrier at the uplink timing adjusted based on the timing offset associated with the at least one downlink timing of the different downlink timings, and on the second uplink carrier at the adjusted uplink timing.

24. (Currently amended) The apparatus of claim 21, wherein [[the]] at least one downlink carrier of the plurality of downlink carriers is included in one of a plurality of downlink groups, and wherein the uplink timing component is configured to determine the uplink timing by associating the uplink group of carriers with the one of the plurality of downlink groups.

43. (Currently amended) A computer program product that facilitates a timing alignment in a multicarrier system, comprising:

a non-transitory computer-readable storage medium comprising code for causing at least one computer to:

determine different downlink timings associated with a plurality of downlink carriers;

ascertain an uplink timing associated with an uplink group of carriers including a first uplink carrier and a second uplink carrier, wherein the uplink timing is ascertained based on at least one downlink timing of the different downlink timings and a timing offset associated with the uplink group of carriers and the at least one downlink timing of the different downlink timings; and

transmit the first uplink carrier at the uplink timing adjusted based on the timing offset associated with the at least one downlink timing of the different downlink timings, and on the second uplink carrier at the adjusted uplink timing.

47. (Currently amended) The computer program product of claim 43, wherein the code causes the at least one computer to perform a random access procedure on at least one random access carrier, and wherein the at least one random access carrier is included in a downlink group of carriers that includes [[the]] at least one downlink carrier of the plurality of downlink carriers.

48. (Currently amended) An apparatus configured to facilitate a timing alignment in a multicarrier system, the apparatus comprising:

means for determining different downlink timings associated with a plurality of downlink carriers;

means for ascertaining an uplink timing associated with an uplink group of carriers including a first uplink carrier and a second uplink carrier, wherein the uplink timing is ascertained based on at least one downlink timing of the different downlink timings and a timing offset associated with the uplink group of carriers and the at least one downlink timing of the different downlink timings; and

means for transmitting the first uplink carrier at the uplink timing adjusted based on the timing offset associated with the at least one downlink timing of the different downlink timings, and on the second uplink carrier at the adjusted uplink timing.

51. (Currently amended) The apparatus of claim 48, wherein [[the]] at least one downlink carrier of the plurality of downlink carriers is included in one of a plurality of downlink groups, and wherein the means for ascertaining is configured to associate the uplink group of carriers with the one of the plurality of downlink groups.

52. (Currently amended) The apparatus of claim 48, further comprising means for performing a random access procedure on at least one random access carrier, wherein the at least one random access carrier is included in a downlink group of carriers that includes [[the]] at least one downlink carrier of the plurality of downlink carriers.

53. (Currently amended) A method that facilitates a timing alignment in a multicarrier system, the method comprising:

transmitting downlink communications to a wireless terminal via a plurality of downlink carriers with different downlink timings;

assigning a timing offset to an uplink group of carriers including a first uplink carrier and a second uplink carrier, the timing offset being associated with at least one downlink timing of the different downlink timings;

providing the timing offset to the wireless terminal via one of the plurality of downlink carriers; and

receiving a first uplink communication via the first uplink carrier at an uplink timing adjusted based on the timing offset associated with the at least one

downlink timing of the different downlink timings, and a second uplink communication via the second uplink carrier at the adjusted uplink timing.

69. (Currently amended) An apparatus configured to facilitate a timing alignment in a multicarrier system, the apparatus comprising:

a processor configured to execute computer executable components stored in memory, the components including:

a timing offset component configured to assign a timing offset to an uplink group of carriers including a first uplink carrier and a second uplink carrier;

a transmitting component configured to provide the timing offset to a wireless terminal via one of a plurality of downlink carriers with different downlink timings, the timing offset being associated with at least one downlink timing of the different downlink timings; and

a receiving component configured to receive a first uplink communication via the first uplink carrier at an uplink timing adjusted based on the timing offset associated with the at least one downlink timing of the different downlink timings, and a second uplink communication via the second uplink carrier at the adjusted uplink timing.

77. (Currently amended) A computer program product that facilitates a timing alignment in a multicarrier system, comprising:

a non-transitory computer-readable storage medium comprising code for causing at least one computer to:

transmit downlink communications via a plurality of downlink carriers with different downlink timings to a wireless terminal;

assign a timing offset to an uplink group of carriers including a first uplink carrier and a second uplink carrier, the timing offset being associated with at least one downlink timing of the different downlink timings;

provide the timing offset to the wireless terminal via one of the plurality of downlink carriers; and

receive a first uplink communication via the first uplink carrier at an uplink timing adjusted based on the timing offset associated with the at least one downlink timing of the different downlink timings, and a second uplink communication via the second uplink carrier at the adjusted uplink timing.

83. (Currently amended) An apparatus configured to facilitate a timing alignment in a multicarrier system, the apparatus comprising:

means for transmitting downlink communications via a plurality of downlink

carriers with different downlink timings to a wireless terminal;

means for assigning a timing offset to an uplink group of carriers including a first uplink carrier and a second uplink carrier, the timing offset being associated with at least one downlink timing of the different downlink timings;

means for providing the timing offset to the wireless terminal via one of the plurality of downlink carriers; and

means for receiving a first uplink communication via the first uplink carrier at an uplink timing adjusted based on the timing offset associated with the at least one downlink timing of the different downlink timings, and a second uplink communication via the second uplink carrier at the adjusted uplink timing.

Allowable Subject Matter

2. Claims 1-88 are allowed.

3. The following is a statement of reasons for the indication of allowable subject matter:

Applicants remarks from 06/27/2013 were fully considered and are persuasive. An updated search has been performed and no prior art has been found that reads on the claims as amended. Therefore, none of the cited prior art whether taken alone or in any reasonable combination, reads on the amended claims.

With respect to 112 6th, the specification shows **means for determining** (see fig.4, which shows different downlink timing 412, 422 see para.0064**)…** and **means for ascertaining**(see claims 49-50, which further elaborate how ascertaining is done**)… in claim 48; Means for performing**(see para.0058, the UE may perform random access to update its timing**)…. in claim 52; means for assigning**(see claim 85 that further elaborate on assigning instruction algorithm**)… in claim 83.** See also MPEP Section 2181, part II, section B computer implemented means plus function limitations, states: "If the specification explicitly discloses an algorithm, the sufficiency of the disclosure of the algorithm must be determined in light of the level of ordinary skill in the art. *Aristocrat*, 521 F.3d at 1337; *AllVoice Computing PLC v. Nuance Commc'ns, Inc.*, 504 F.3d 1236, 1245 (Fed. Cir. 2007); Intel Corp., 319 F.3d at 1366-67 (knowledge of a person of ordinary skill in the art can be used to make clear how to implement a disclosed algorithm). The examiner should determine whether one skilled in the art would know how to program the computer to perform the necessary steps described in the specification (i.e., the invention is enabled), and that the inventor was in possession of the invention (i.e., the invention meets the written description requirement). Thus, the specification must sufficiently disclose an algorithm to transform a general purpose microprocessor to a special purpose computer so that a person of

ordinary skill in the art can implement the disclosed algorithm to achieve the claimed function. *Aristocrat*, 521 F.3d at 1338". Based on the above, the specification provides enough instruction/algorithm related to the above means that one ordinary skill in the art could use to program a computer/UE/others. Thus, 112 6th recitations are supported and the 112 2nd rejections are removed.

The prior art of record fails to teach "**wherein the uplink timing is ascertained based on a processing of at least one downlink timing of the different downlink timings and a timing offset associated with the uplink group of carriers and the at least one downlink timing of the different downlink timings; and transmitting on the first uplink carrier at the uplink timing adjusted based on the timing offset associated with the at least one downlink timing of the different downlink timings, and on the second uplink carrier at the adjusted uplink timing**", as substantially described in independent claim(s) **1, 21, 43, 48, 53, 69, 77 and 83**. These limitations, in combination with the remaining limitations of claim(s) **1, 2, 3, 4, 8, 12 and 13**, are not taught nor suggested by the prior art of record.

The prior art of record fails to teach "the uplink timing is ascertained based on at least one downlink timing and a timing offset associated with the uplink group of carriers; an averaging component configured to compute an average

downlink timing from a plurality of downlink timings respectively corresponding to a set of downlink carriers within a particular downlink group that includes the at least one downlink carrier, wherein the uplink timing component is configured to determine the uplink timing by applying the timing offset to the average downlink timing", as substantially described in independent claim(s) **40 and 46**. These limitations, in combination with the remaining limitations of claim(s) **40 and 46**, are not taught nor suggested by the prior art of record.

Conclusion

4. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Following prior arts are related to the present claimed invention

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to VINNCELAS LOUIS whose telephone number is (571)270-5138. The examiner can normally be reached on M-F from 7:30-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Thier can be reached on 571-272-2832. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/MICHAEL T THIER/ Supervisory Patent Examiner, Art Unit 2474	/VINNCELAS LOUIS/ Examiner, Art Unit 2474

Examiner-Initiated Interview Summary	Application No.	Applicant(s)	
	12/818,064	TENNY ET AL.	
	Examiner	Art Unit	
	VINNCELAS LOUIS	2474	

All participants (applicant, applicant's representative, PTO personnel):

(1) *VINNCELAS LOUIS*.

(2) *John J Ketchum, Reg. No. 61,932* .

(3)*Jonas Hodges, Reg. No: 58, 898*.

(4)_____.

Date of Interview: *19 September 2013*.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☒ No.
If Yes, brief description: _____.

Issues Discussed ☐101 ☒112 ☐102 ☐103 ☒Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: *1-88*.

Identification of prior art discussed: *US 2006/0280142*.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

The applicant(s) and examiner discused the difference between prior art(s) and claimed invention. In order to advance prosecution, the applicant amended the claims to differentiate them from prior art(s).We also discussed 112 6th paragraph, where section of MPEP and paragrahs were shown as evidence that specification has enough support for each of the means+for function. Such amendment is clearly reflected in the examiner's amendment.

Applicant recordation instructions: It is not necessary for applicant to provide a separate record of the substance of interview.

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/VINNCELAS LOUIS/ Examiner, Art Unit 2474	/MICHAEL T THIER/ Supervisory Patent Examiner, Art Unit 2474

Notice of References Cited	Application/Control No. 12/818,064	Applicant(s)/Patent Under Reexamination TENNY ET AL.	
	Examiner VINNCELAS LOUIS	Art Unit 2474	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-6,321,083	11-2001	Vaara et al.	455/446
*	B	US-6,839,333	01-2005	.ANG.kerberg, Dag E:son	370/330
*	C	US-2012/0120821	05-2012	Kazmi et al.	370/252
*	D	US-2009/0318175	12-2009	SANDBERG, David	455/502
*	E	US-2011/0319116	12-2011	Iwamura et al.	455/517
*	F	US-7,254,118	08-2007	Terasawa et al.	370/328
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

EAST Search History Interference

EAST Search History

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	1	(downlink$3 same timing$3 and downlink$3 same carrier$3 and uplink$3 same group$3 same carrier$3 and ascertain$5 and timing$3 same offset$3 and different$3 near3 downlink$3 near3 timing$3 and uplink$3 same timing$3).clm.	US-PGPUB; USPAT; UPAD	OR	OFF	2013/09/21 15:36
L12	13602	370/252.ccls.	US-PGPUB; USPAT; UPAD	OR	OFF	2013/09/21 16:25
L13	2152	370/336.ccls.	US-PGPUB; USPAT; UPAD	OR	OFF	2013/09/21 16:26
L14	3029	370/350.ccls.	US-PGPUB; USPAT; UPAD	OR	OFF	2013/09/21 16:26
L15	3860	370/503.ccls.	US-PGPUB; USPAT; UPAD	OR	OFF	2013/09/21 16:26
L16	1	1 and (12 13 14 15)	US-PGPUB; USPAT; UPAD	OR	OFF	2013/09/21 16:27

9/ 21/ 2013 4:27:47 PM
C:\ Users\ vlouis\ Documents\ EAST\ Workspaces\ 12818064.wsp

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L2	8	different$3 near downlink$3 near timing$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/09/21 15:36
L3	77	different$3 near3 downlink$3 near3 timing$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/09/21 15:41
L4	3	(different$3 near3 downlink$3 near3 timing$3) near10 (adjust$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/09/21 15:41
L5	14	((different$3 separat$3 first$3 near5 second$3 distinct$3) near3 (downlink$3 near3 timing$3)) near10 (adjust$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/09/21 15:43
L6	89	(different$3 separat$3 first$3 near5 second$3 distinct$3) near3 (downlink$3 near3 (timing$3 clock$3 time$3)) and (uplink reverse$3) near5 (timing$3 clock$3 time$3) near5 (adjust$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/09/21 15:54
L7	28	(different$3 separat$3 first$3 near5 second$3 distinct$3) near3 (downlink$3 near3 (timing$3 clock$3 time$3)) and (uplink reverse$3) near5 (timing$3 clock$3 time$3) near5 (adjust$4) near10 (offset$3 advance$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/09/21 15:55
L8	24	7 not 5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/09/21 15:55
L9	28	(different$3 separat$3 first$3 near5	US-PGPUB;	OR	OFF	2013/09/21

		second$3 distinct$3) near3 (downlink$3 near3 (timing$3 clock$3 time$3)) and (uplink reverse$3) near5 (timing$3 clock$3 time$3) near5 (adjust$4 change$3 alter$3 modif$3) near10 (offset$3 advance$3)	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			16:07
L10	0	9 not 7	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/09/21 16:08
L11	6	("20070149206" | "20070293157" | "20080002660" | "20080084849" | "20100029291" | "7315536").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/09/21 16:09
S1	1965	(timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3) with (downlink$3 forward$3) same (uplink$3 revers$3) same (carrier$3 provider$3 company$3 circuits$3 bearer$3) same (offset$3 adjust$3 compensat$3 recoup$3 counteract$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/19 12:25
S2	517	(transmi$3 send$3 convey$3 communicat$3 transfer$3 broadcast$3) with(carrier$3 provider$3 company$3 circuits$3 bearer$3)same (group$3 cluster$3 aggregat$3 bundl$3 combin$3) same (thrshold$3 border$3 boundary$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/19 12:32
S3	5	S1 and S2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/19 12:33
S4	44275	(transmi$3 send$3 convey$3 communicat$3 transfer$3 broadcast$3) with((carrier$3 provider$3 company$3 circuits$3 bearer$3)same (group$3 cluster$3 aggregat$3 bundl$3 combin$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/19 12:36
S5	129	S1 and S4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/19 12:37
S6	126	S5 not S3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/19 12:37
S7	9	"1466285"	US-PGPUB; USPAT; USOCR;	OR	OFF	2013/03/19 21:54

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S8	1	"1466285" and timing$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/19 21:55
S9	1246	(timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3) same (uplink$3 revers$3) with(offset$3 adjust$3 compensat$3 recoup$3 counteract$3) same ((downlink$3 forward$3) same (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) same (carrier$3 provider$3 company$3 circuits$3 bearer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/19 22:13
S10	172	(timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3) near10 (uplink$3 revers$3) near10 (offset$3 adjust$3 compensat$3 recoup$3 counteract$3) near10 ((downlink$3 forward$3) snear10 (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) near10 (carrier$3 provider$3 company$3 circuits$3 bearer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/19 22:14
S11	76	(timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3) near5 (uplink$3 revers$3) near5 (offset$3 adjust$3 compensat$3 recoup$3 counteract$3) near5 ((downlink$3 forward$3) snear5 (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) near5 (carrier$3 provider$3 company$3 circuits$3 bearer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/19 22:15
S12	25	("20070189205" | "20090239545" | "20100067470" | "20100227569" | "20100238872" | "20110158116" | "20110261776" | "20110268032" | "20110299489" | "20120008600" | "20120063425" | "20120076103" | "20120113914" | "20120113941" | "20120113962" | "20120170570" | "20120178482" | "20120218987" | "20120218988" | "20120243498" | "20120250520" | "20120257513" | "20120287865" | "20120300743" | "20120307811").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/03/19 22:24
S13	8	(uplink$3 revers$3) near20 (based$3 depend$3 according$3 rely$4) near10 (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3) near10 (downlink$3 forward$3) near10 (offset$3 adjust$3 compensat$3 recoup$3 counteract$3) near10 (carrier$3 provider$3 company$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/20 23:51

		circuits$3 bearer$3)				
S14	424	(uplink$3 revers$3) with (based$3 depend$3 according$3 rely$4) same (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3) same (downlink$3 forward$3) same (offset$3 adjust$3 compensat$3 recoup$3 counteract$3)same (carrier$3 provider$3 company$3 circuits$3 bearer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/20 23:54
S15	1286	((uplink$3 revers$3) same (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) with (downlink$3 forward$3) same (offset$3 adjust$3 compensat$3 recoup$3 counteract$3)same (carrier$3 provider$3 company$3 circuits$3 bearer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/20 23:56
S16	1075	((uplink$3 revers$3) same (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) with ((downlink$3 forward$3) same (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) same (offset$3 adjust$3 compensat$3 recoup$3 counteract$3)same (carrier$3 provider$3 company$3 circuits$3 bearer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/20 23:56
S17	194	((uplink$3 revers$3) near3 (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) with ((downlink$3 forward$3) near3 (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) same (offset$3 adjust$3 compensat$3 recoup$3 counteract$3)same (carrier$3 provider$3 company$3 circuits$3 bearer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/20 23:57
S18	9	((uplink$3 revers$3) near3 (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) with ((downlink$3 forward$3) near3 (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) same (offset$3 adjust$3 compensat$3 recoup$3 counteract$3)same (carrier$3 provider$3 company$3 circuits$3 bearer$3) same threshold$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/20 23:58
S19	66	((uplink$3 revers$3) near3 (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) with ((downlink$3 forward$3) near3 (timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3)) same (offset$3 adjust$3 compensat$3 recoup$3 counteract$3)same (carrier$3 provider$3 company$3 circuits$3 bearer$3) and threshold$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/21 00:00
S20	57	S19 not S18	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2013/03/21 00:01

			DERWENT; IBM_TDB			
S21	482	(uplink$3 revers$3) with(timing$3 time$3 period$3 duration$3 epoch$2 interval$3 span$2 cycle$3) same (downlink$3 forward$3) same (offset$3)same (carrier$3 provider$3 company$3 circuits$3 bearer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 00:40
S22	399	(uplink$3 revers$3) with(timing$3 time$3) same (downlink$3 forward$3) same (offset$3)same (carrier$3 provider$3 company$3 circuits$3 bearer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 00:41
S23	346	((uplink$3 revers$3) same(timing$3 time$3))with (downlink$3 forward$3) same (offset$3)same (carrier$3 provider$3 company$3 circuits$3 bearer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 00:41
S24	207	((uplink$3 revers$3) same(timing$3 time$3))with (downlink$3) same (offset$3)same (carrier$3 provider$3 company$3 circuits$3 bearer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 00:42
S25	189	((uplink$3 revers$3) same(timing$3 time$3))with (downlink$3)same (offset$3)same (carrier$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 00:42
S26	340	((uplink$3 revers$3) same(timing$3 time$3))with (downlink$3)same (offset$3 correction$3 adjust$3)same (carrier$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 01:15
S27	178	S26 and (random$3 same access)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 01:16
S28	64	S27 not S25	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 01:17
S29	143	S26 and (random$3 same access same channel$3)	US-PGPUB; USPAT; USOCR;	OR	OFF	2013/03/24 01:18

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S30	49	S29 not S25	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 01:19
S31	1141	(uplink$3 revers$3) with(timing$3 same offset$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 11:36
S32	237	(uplink$3 revers$3) with (based$3 depend$3 according$3 relate$3) same (timing$3 same offset$3) same (downlink$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 11:36
S33	84	(uplink$3 revers$3) with (based$3 depend$3 according$3 relate$3) same (timing$3 same offset$3) same (downlink$3) and timing$3 same advance$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 11:38
S34	66	(uplink$3 revers$3) with (based$3 depend$3 according$3 relate$3) same (timing$3 same offset$3) same (downlink$3) and timing$3 near3 advance$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 11:38
S35	29	(uplink$3 revers$3) near10 (add$3 sum$3 calculat$3 accumulat$4 count$3 enumerat$3 total$3) near10 (tim$3 near3 offset$3) near10 (downlink$3 forward$2)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 12:22
S36	2	"6967936".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 12:26
S37	11	("5430760" | "5726981" | "5883888" | "5909436" | "6144656" | "6181947" | "6223040" | "6449290" | "6477151" | "6493539" | "6496490").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/03/24 12:29
S38	48	("5430760" | "5726981" | "5883888" | "5909436" | "6144656" | "6181947" | "6223040" | "6449290" | "6477151" | "6493539" | "6496490").PN. OR	US-PGPUB; USPAT; USOCR	OR	OFF	2013/03/24 12:30

		("6967936").URPN.				
S39	19	("5430760" | "5726981" | "5883888" | "5909436" | "6144656" | "6181947" | "6223040" | "6449290" | "6477151" | "6493539" | "6496490").PN. OR ("6967936").URPN. and (tim$3 near3 offset$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/03/24 12:31
S40	15	("5430760" | "5726981" | "5883888" | "5909436" | "6144656" | "6181947" | "6223040" | "6449290" | "6477151" | "6493539" | "6496490").PN. OR ("6967936").URPN. and (tim$3 near3 offset$3) near10 (uplink$3 forward$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/03/24 12:32
S41	15	("5430760" | "5726981" | "5883888" | "5909436" | "6144656" | "6181947" | "6223040" | "6449290" | "6477151" | "6493539" | "6496490").PN. OR ("6967936").URPN. and (tim$3 near3 offset$3) near10 (uplink$3 reverse$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/03/24 12:33
S42	96	(send$3 transmi$3 communicat$3 transfer$3 convey$3) with (carriers$3) same (uplink$3 revers$3) same (threshold$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 14:18
S43	46	S42 and (random$3 near3 access$3 RACH$2)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 14:23
S44	13	(threshold$3) with (send$3 transmi$3 communicat$3 transfer$3 convey$3) same (carriers$3 providers$3) same (uplink$3 revers$3) and (random$3 near3 access$3 near3 channel$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 14:37
S45	11	(threshold$3 same value$3) with (send$3 transmi$3 communicat$3 transfer$3 convey$3) same (carriers$3 providers$3) same (uplink$3 revers$3) and (random$3 near3 access$3 near3 channel$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 14:38
S46	10	(RACH$3 same random$3 same access$3) with (carrier$3) same (downlink$3 forward$3) same (dedicat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 19:41
S47	1	"12818064".rlan. or ("12".src. and "818064".ap.)	US-PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2013/03/24 19:46
S48	348	(timing$3 interval$3 duration$3 time$3) with (uplink$3 reverse$3) same	US-PGPUB; USPAT;	OR	OFF	2013/03/24 19:49

		(threshold$3) same carrier$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S49	122	(timing$3 interval$3 duration$3 time$3) with (uplink$3 reverse$3) same (threshold$3) same carriers$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 19:50
S50	53	(timing$3 interval$3 duration$3 time$3) with (uplink$3 reverse$3) same (threshold$3) same carriers$4 same (transm$3 send$3 communicat$3 transfer$3 convey$3 transport$3 carry$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 19:51
S51	30	(transm$3 send$3 communicat$3 transfer$3 convey$3 transport$3 carry$3) with ((timing$3 interval$3 duration$3 time$3 TT1) same (threshold$3)) same carriers$4 same (uplink$3 reverse$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 20:33
S52	20	carriers$4 near10 (uplink$3 reverse$3) and (transm$3 send$3 communicat$3 transfer$3 convey$3 transport$3 carry$3) near10 ((timing$3 interval$3 duration$3 time$3 TT1) near3 (threshold$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 20:39
S53	526	carrier$4 with(uplink$3 reverse$3) and (transm$3 send$3 communicat$3 transfer$3 convey$3 transport$3 carry$3) with ((timing$3 interval$3 duration$3 time$3 TT1) same (threshold$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 20:47
S54	172	carriers$4 with(uplink$3 reverse$3) and (transm$3 send$3 communicat$3 transfer$3 convey$3 transport$3 carry$3) with ((timing$3 interval$3 duration$3 time$3 TT1) same (threshold$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 20:47
S55	9	S54 and (random$3 same access$3 same rach$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 20:49
S56	86	(transm$3 send$3 communicat$3 transfer$3 convey$3 transport$3 carry$3) with (threshold$3) same(carriers$4 same (uplink$3 reverse$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 20:52

S57	18	(uplink$3 revers$3) near3 (timing$3) near10 (carriers$3) near10(transm$3 send$3 communicat$3 transfer$3 convey$3 transport$3 carry$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 21:20
S58	135	(downlink$3) near3 timing$3 near10 carrier$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 21:21
S59	7	S57 and S58	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 21:21
S60	164	(downlink$3 forward$3) near3 timing$3 near10 carrier$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 21:27
S61	193	(uplink$3 revers$3) with (timing$3) same (carriers$3) same(transm$3 send$3 communicat$3 transfer$3 convey$3 transport$3 carry$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 21:28
S62	32	S60 and S61	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 21:28
S63	25	S62 not S59	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 21:28
S64	64	(uplink$3 revers$3) same (downlink$3 forward$3) with (timing$3) same (carriers$3) same(transm$3 send$3 communicat$3 transfer$3 convey$3 transport$3 carry$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 21:48
S65	18	(uplink$3 revers$3) same (downlink$3 forward$3) with (timing$3) same (carriers$3) same(transm$3 send$3 communicat$3 transfer$3 convey$3 transport$3 carry$3) same group$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2013/03/24 21:49

			DERWENT; IBM_TDB			
S66	46	S64 not S65	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 21:50
S67	518	(timing$3 near advance$3) and timing$2 near offset$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 23:00
S68	248	(timing$3 near advance$3) and timing$2 near offset$3 and (uplink$3) with downlink$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 23:00
S69	3	"20060280142"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/24 23:59
S70	16	(random$3 same access$3 same carrier$3) with (usage$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 00:23
S71	3	(random$3 same access$3) with carrier$3 same (usage$3) same (QOS$3 signal$3 same quality$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 00:27
S72	9	(random$3 same access$3) with carrier$3 same (usage$3 threshold$3 utilization$3) same (QOS$3 signal$3 same quality$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 00:31
S73	54	((single$3 alone$3 distinct$3 anchor$2 individual$3 loner$3 "one") same carrier$3) with (usage$3 utilization$3) same (QOS$3 signal$3 same quality$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 00:35
S74	224	((single$3 alone$3 distinct$3 anchor$2 individual$3 loner$3 "one") same carrier$3) with (usage$3 utilization$3)	US-PGPUB; USPAT; USOCR;	OR	OFF	2013/03/25 00:46

		same (downlink$3 forward$3)	FPRS; EPO; JPO; DERWENT; IBM_TDB			
S75	63	((single$3 alone$3 distinct$3 anchor$2 individual$3 loner$3 "one") same carrier$3) with (usage$3 utilization$3) same (downlink$3 forward$3) same (reverse$3 uplink$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 00:47
S76	133	(uplink$3 revers$3) near3(timing$3) and (downlink$3 forward$3) near3 timing$3 and timing$3 near3 advance$3 and carriers$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 07:10
S77	191	(uplink$3 revers$3) near3(timing$3) and (downlink$3 forward$3) near3 timing$3 and (time$3 timing$3) near3 offset$3 and carriers$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 07:16
S78	147	(uplink$3 revers$3) near3(timing$3) and (downlink$3 forward$3) near3 timing$3 and (timing$3) near3 offset$3 and carriers$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 07:16
S79	56	(downlink$3 forward$3) near3 timing$3 and ((timing$3 time$3) near3 offset$3) near10 ((uplink$3 revers$3) near3(timing$3))and carriers$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 07:17
S80	31	((uplink$3 revers$3) near3(timing$3)) near10((timing$3 time$3) near3 (offset$3 advance$3)) near10 ((downlink$3 forward$3) near3 timing$3)and carriers$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 07:28
S81	481	(uplink$3 revers$3) with (determin$3 calculat$3 comput$3 add$3 sum$3 total$3 depend$2 according$3 based$2) same((timing$3 time$3) same (offset$3 advance$3)) same (downlink$3 forward$3)and carriers$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 07:34
S82	60	(uplink$3 revers$3) with (determin$3 calculat$3 comput$3 add$3 sum$3 total$3 depend$2 according$3 based$2) same((timing$3 time$3) same (offset$3 advance$3)) same (downlink$3 forward$3)and carriers$3 and (random$3 same access$3 same RACH$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 07:35

S83	36	((uplink$3 revers$3) same (time$3 timing$3)) with ((timing$3 time$3) same (offset$3 advance$3)) same (downlink$3 forward$3)same carrier$3 and (random$3 same access$3 same RACH$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 07:42
S84	6	(downlink$3 forward$3)with carriers$3 same (pseudorandom$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:07
S85	21	(downlink$3 forward$3)with carriers$3 same (pseudorandom$3 pseudo-random$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:07
S86	432	((downlink$3 forward$3)same carrier$3) same (pseudorandom$3 pseudo-random$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:16
S87	14	((downlink$3 forward$3)near10 carrier$3) near10 (pseudorandom$3 pseudo-random$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:17
S88	11	S87 not S85	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:17
S89	220	(downlink$3 forward$3)with (carrier$3)same (select$3 choos$3 pick$3 elect$3 cull$2 opt$2) and (pseudorandom$3 pseudo-random$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:23
S90	23	(downlink$3 forward$3)with (carrier$3)same (select$3 choos$3 pick$3 elect$3 cull$2 opt$2) same (pseudorandom$3 pseudo-random$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:24
S91	16	S90 not (S88 S85)\	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2013/03/25 12:24

			DERWENT; IBM_TDB			
S92	0	(downlink$3 forward$3)with (carrier$3)same (select$3 choos$3 pick$3 elect$3 cull$2 opt$2) and (pseudorandom$3 pseudo-random$3) near10 funtion$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:27
S93	0	(downlink$3 forward$3)same (carrier$3)same (select$3 choos$3 pick$3 elect$3 cull$2 opt$2) and (pseudorandom$3 pseudo-random$3) near10 funtion$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:27
S94	0	(downlink$3 forward$3)with(select$3 choos$3 pick$3 elect$3 cull$2 opt$2) and (pseudorandom$3 pseudo-random$3) near10 funtion$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:27
S95	0	(downlink$3 forward$3 carrier$3)with(select$3 choos$3 pick$3 elect$3 cull$2 opt$2) and (pseudorandom$3 pseudo-random$3) near10 funtion$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:27
S96	661	(downlink$3 forward$3 carrier$3)with(select$3 choos$3 pick$3 elect$3 cull$2 opt$2) and (pseudorandom$3 pseudo-random$3) near10 function$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:28
S97	13	(downlink$3 forward$3)with carrier$3 same (select$3 choos$3 pick$3 elect$3 cull$2 opt$2) and (pseudorandom$3 pseudo-random$3) near10 function$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:28
S98	3	(downlink$3 forward$3)with carrier$3 same (select$3 choos$3 pick$3 elect$3 cull$2 opt$2) same (hash$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:36
S99	680	(downlink$3 forward$3 carrier$3) with (select$3 choos$3 pick$3 elect$3 cull$2 opt$2) same (hash$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/25 12:36
S100	35	(carrier$3) with (select$3 choos$3 pick$3 elect$3 cull$2 opt$2) same (hash$3) and (downlink$3 forward$3)	US-PGPUB; USPAT; USOCR;	OR	OFF	2013/03/25 12:37

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S101	3773	(pseudorandom$3 pseudo-random$3) with (carrier$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 05:26
S102	367	(pseudorandom$3 pseudo-random$3) same function$3 with (carrier$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 05:26
S103	10	(pseudorandom$3 pseudo-random$3) same function$3 with (carrier$3) same downlink$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 05:26
S104	2	(pseudorandom$3 same function$3) with (carrier$3) and downlink$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 05:32
S105	37	(pseudorandom$3 same function$3) same (carrier$3) and (downlink$3 forward$3 near3 (link$2 channel$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 05:33
S106	0	(pseudorandom$3 same function$3) with (carrier$3 bearer$3 provider$3 company$3) same(downlink$3 forward$3 near3 (link$2 channel$3)) same (choos$3 pick$3 select$3 cull$2)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 05:41
S107	2	(pseudorandom$3) with (carrier$3 bearer$3 provider$3 company$3) same(downlink$3 forward$3 near3 (link$2 channel$3)) same (choos$3 pick$3 select$3 cull$2)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 05:41
S108	1	(carrier$3 bearer$3 provider$3 company$3) WITH(downlink$3 forward$3 SAME (link$2 channel$3)) SAME (pseudorandom$2 pseudo-random$3) same (hash$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 05:53
S109	146	(carrier$3 bearer$3 provider$3	US-PGPUB;	OR	OFF	2013/03/27

		company$3) WITH(downlink$3 forward$3 SAME (link$2 channel$3)) SAME (pseudorandom$2 pseudo-random$3) same (timing$3 clock$3 time$3)	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			05:56
S110	14	(carrier$3 bearer$3 provider$3 company$3) WITH(downlink$3 forward$3 SAME (link$2 channel$3)) SAME (pseudorandom$2 pseudo-random$3) same (timing$3 clock$3 time$3)same (choos$3 pick$3 select$3 cull$2)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 05:57
S111	1663	(pseudorandom$2 pseudo-random$3) with hash$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 06:14
S112	16	(pseudorandom$2 pseudo-random$3) with hash$3 and (downlink$3 forward$3 same (link$3 channel$3)) with (carrier$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 06:15
S113	0	(base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) with (hashing$3 hash$3) same (identifer$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 07:36
S114	290	(base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) with (hashing$3 hash$3) same (identifer$3 name$3 SSId$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 07:38
S115	46	(base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) with (hashing$3 hash$3) same (identifer$3 SSId$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 07:40
S116	628	(hashing$3 hash$3) with(base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identifer$3 identif$3 SSId$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 07:48
S117	306	(hashing$3 hash$3) with(base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identifer$3 identif$3 SSId$3) same (includ$3 contain$3 compris$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2013/03/27 07:50

			IBM_TDB			
S118	45	(hashing$3) with(base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identifer$3 identif$3 SSId$3) same (includ$3 contain$3 compris$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 07:50
S119	45	S118 not S115	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 07:50
S120	9	(hashing$3) with(base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identifer$3 identif$3 SSId$3) same (includ$3 contain$3 compris$3) same (broadcast$3 transmit$3 send$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 07:53
S121	41	(hashing$3)same (table$3 database$3 queue$3 buffer$3) with((base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identifer$3 identif$3 SSId$3 name$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 07:56
S122	110	(hashing$3 hash$3) with(SSId$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 08:00
S123	1	"12818064".rlan. or ("12".src. and "818064".ap.)	US-PGPUB; USPAT; USOCR; DERWENT	OR	OFF	2013/03/27 09:56
S124	2050	(identifier$3 identif$3 name$3 SSID$3) same (associat$3 correspond$3 match$3 join$2) same (network$3 base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (input$3 enter$3 download$3 comput$3 load$2) same (hashing$3 hash$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 10:04
S125	980	(identifier$3 identif$3 name$3 SSID$3) same (associat$3 correspond$3 match$3 join$2) same (network$3 base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (input$3 enter$3 download$3 comput$3 load$2) same ((hashing$3 hash$3) same (function$3 algorithm$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 10:05
S126	435	(identifier$3 identif$3 name$3 SSID$3) with (associat$3 correspond$3 match$3 join$2) same (network$3 base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (input$3 enter$3 download$3 comput$3 load$2) same	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2013/03/27 10:05

		((hashing$3 hash$3) same (function$3 algorithm$3))	IBM_TDB			
S127	24	(identifier$3 identif$3 name$3 SSID$3) near10 (associat$3 correspond$3 match$3 join$2) near10 (network$3 base$3 nea3 station$3 access$3 near3 point$3 EnB$2 EnodeB$3) near10 (input$3 enter$3 download$3 comput$3 load$2) near10 ((hashing$3 hash$3) near5 (function$3 algorithm$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 10:08
S128	90	((hashing$3 hash$3) same (algorithm$3 function$3)) with (timing$3 time$3) same (downlink$3 forward$3 same (link$3 channel$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 10:34
S129	1129	((hashing$3 hash$3) same (algorithm$3 function$3)) with(pseudorandom$3 pseudo-random$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 10:59
S130	3	((hashing$3 hash$3) same (algorithm$3 function$3)) with(pseudorandom$3 pseudo-random$3) same carrier$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 10:59
S131	1689	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3) with (network$3 same node$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:02
S132	725	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3) same (fucntion$3 table$3 database$3) with (network$3 same node$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:02
S133	1904	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3) same (fucntion$3 table$3 database$3) with (network$3 base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identif$3 name$3 SSID$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:04
S134	1339	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3) same (fucntion$3 table$3 database$3) with ((network$3 base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identif$3 name$3 SSID$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:06
S135	356	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3) same (fucntion$3	US-PGPUB; USPAT;	OR	OFF	2013/03/27 11:07

		table$3 database$3) with ((base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identif$3 name$3 SSID$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S136	50	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3) same (fucntion$3 table$3 database$3) with ((base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identif$3 name$3 SSID$3)) SAME (ENTER$3 INPUT$3 download$3 load$2)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:08
S137	38	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3) same (fucntion$3 table$3 database$3) with ((network$3 base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identif$3 name$3 SSID$3)) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:16
S138	105	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3) same (function$3 table$3 database$3) with ((network$3 base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identif$3 name$3 SSID$3)) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:16
S139	74	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3 lookup$3 look-up$3) with (function$3 table$3 database$3 storag$3 memory$3 queue$3 buffer$3) same (network$3 base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) same (identif$3 name$3 SSID$3) same (time$3 duration$3 timing$3 period$3 interval$3) same wireless$3 same (measur$3 estimat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:26
S140	12836	(function$3 table$3 database$3 storag$3 memory$3 queue$3 buffer$3) with(hashing$3 hash$3 pseudorandom$3 pseudo-random$3 lookup$3 look-up$3) same ((network$3 base$3 same station$3 access$3 same point$3 EnB$2 EnodeB$3) SAME (identif$3 name$3 SSID$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:37
S141	385	(function$3 table$3 database$3 storag$3 memory$3 queue$3 buffer$3) with(hashing$3 hash$3 pseudorandom$3 pseudo-random$3 lookup$3 look-up$3) same ((time$3 duration$3 timing$3 period$3 interval$3) same (measur$3 estimat$3)) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:38
S142	82	S140 AND S141	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 11:39
S143	116	(function$3 table$3 database$3 storag$3 memory$3 queue$3 buffer$3) with(hashing$3 hash$3 pseudorandom$3	US-PGPUB; USPAT; USOCR;	OR	OFF	2013/03/27 12:07

		pseudo-random$3 lookup$3 look-up$3) same ((time$3 duration$3 timing$3 period$3 interval$3) same (measur$3 estimat$3) SAME VARI$4) same wireless$3	FPRS; EPO; JPO; DERWENT; IBM_TDB			
S144	53	S140 AND S143	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/27 12:08
S145	4275	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3 lookup$3 look-up$3) with (function$3 table$3 database$3 storag$3 memory$3 queue$3 buffer$3) same (time$3 same vari$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 09:34
S146	99	(hashing$3 hash$3 pseudorandom$3 pseudo-random$3 lookup$3 look-up$3) with (function$3 table$3 database$3 storag$3 memory$3 queue$3 buffer$3) same (time$3 same vari$3) SAME (ENTER$3 INPUT$3 download$3 load$2) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 09:36
S147	1	"12818064"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 10:27
S148	266	(uplink$3 revers$3) with (carrier$3) same (transm$3 send$3 communicat$3 transfer$3) same threshold$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 11:40
S149	122	(uplink$3 revers$3) with (carrier$3) same (transm$3 send$3 communicat$3 transfer$3) same threshold$3 same value$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 11:41
S150	46	(uplink$3 revers$3) with (carriers$3) same (transm$3 send$3 communicat$3 transfer$3) same threshold$3 same value$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 11:41
S151	464	(timing$3 interval$3 duration$3 time$3) with(uplink$3 revers$3) same (threshold$3 compar$3) same(carrier$3) same (transm$3 send$3 communicat$3 transfer$3 allocat$3 assign$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 11:53

S152	198	(timing$3 interval$3 duration$3 time$3) with(uplink$3 revers$3) same (threshold$3 compar$3) same(carriers$3) same (transm$3 send$3 communicat$3 transfer$3 allocat$3 assign$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 11:54
S153	173	S152 not S150	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 11:55
S154	11	(timing$3 interval$3 duration$3 time$3) with(uplink$3 revers$3) same (threshold$3 compar$3) same(carriers$3) same (transm$3 send$3 communicat$3 transfer$3 allocat$3 assign$3) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 11:56
S155	48750	(transm$3 send$3 communicat$3 transfer$3 allocat$3 assign$3) same (carriers$3) with((timing$3 interval$3 duration$3 time$3) same (threshold$3 compar$3)) samewith (uplink$3 revers$3) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 12:01
S156	19	(transm$3 send$3 communicat$3 transfer$3 allocat$3 assign$3) same (carriers$3) with((timing$3 interval$3 duration$3 time$3) same (threshold$3 compar$3 predetermin$3 pre-determin$3)) same (uplink$3 revers$3) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 12:02
S157	19	(transm$3 send$3 communicat$3 transfer$3 allocat$3 assign$3) same (carriers$3) with((timing$3 interval$3 duration$3 time$3 interval$3) same (threshold$3 compar$3 predetermin$3 pre-determin$3)) same (uplink$3 revers$3) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 12:19
S158	19	(transm$3 send$3 communicat$3 transfer$3 allocat$3 assign$3) same (carriers$3) with((timing$3 interval$3 duration$3 time$3 interval$3 period$3) same (threshold$3 compar$3 predetermin$3 pre-determin$3)) same (uplink$3 revers$3) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 12:28
S159	19	(transm$3 send$3 communicat$3 transfer$3 allocat$3 assign$3) same (carriers$3) with((timing$3 interval$3 duration$3 time$3 interval$3 period$3 window$3) same (threshold$3 compar$3 predetermin$3 pre-determin$3)) same (uplink$3 revers$3) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 13:02
S160	19	(transm$3 send$3 communicat$3 transfer$3 allocat$3 assign$3) same (carriers$3) with((timing$3 interval$3 duration$3 time$3 interval$3 period$3 window$3 space$3) same (threshold$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2013/03/28 13:03

		compar$3 predetermin$3 pre-determin$3)) same (uplink$3 revers$3) same wireless$3	DERWENT; IBM_TDB			
S161	203	((uplink$3 revers$3) same(carriers$3)) with((timing$3 interval$3 duration$3 time$3 interval$3 period$3 window$3 space$3) same (threshold$3 compar$3 predetermin$3 pre-determin$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 13:04
S162	24	((uplink$3 revers$3) near5(carriers$3)) near20 ((timing$3 interval$3 duration$3 time$3 interval$3 period$3 window$3 space$3) near3 (threshold$3 compar$3 predetermin$3 pre-determin$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 13:05
S163	15	((uplink$3 revers$3) same(carriers$3)) with((timing$3 interval$3 duration$3 time$3 interval$3 period$3 window$3 space$3) same (threshold$3 compar$3 predetermin$3 pre-determin$3)) same wireless$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 13:07
S164	21	(uplink$3 revers$3) same(carriers$3) with((timing$3 interval$3 duration$3 time$3 interval$3) same (threshold$3 compar$3 predetermin$3 pre-determin$3)) same (wireless$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 13:17
S165	2	S164 not (S163 S162 S159)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 13:18
S166	57	((timing$3 interval$3 duration$3 time$3 interval$3 slot$3) same (threshold$3 compar$3 predetermin$3 pre-determin$3)) with (uplink$3 revers$3) same(carrier$3 provider$3 company$3) with (wireless$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 13:22
S167	59	((timing$3 interval$3 duration$3 time$3 interval$3 slot$3) same (threshold$3 compar$3 predetermin$3 pre-determin$3)) with (uplink$3 revers$3) same(carrier$3 T1$2 media$3 same circuit$3) with (wireless$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 13:27
S168	75	((uplink$3 revers$3) same(timing$3 interval$3 duration$3 time$3 interval$3 slot$3)) with (threshold$3 compar$3 predetermin$3 pre-determin$3) same(carrier$3) same (wireless$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 13:35
S169	71	((uplink$3 revers$3) same(timing$3 interval$3 duration$3 time$3 interval$3	US-PGPUB; USPAT;	OR	OFF	2013/03/28 13:39

		slot$3)) with (threshold$3 compar$3 predetermin$3 pre-determin$3) same(carrier$3) same (wireless$3) same (transm$3 send$3 communicat$3 transfer$3 allocat$3 assign$3)	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S170	573	(random same access$3) with (uplink$2 same timing$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 20:13
S171	81	(random same access$3) with (uplink$2 same timing$3)same carrier$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 20:13
S172	2544	(downlink$3 forward$3) with (timing$3 duration$3 interval$3 time$3 clock$3 counter$3) same (average$3 mean$3 median$3 middle$3) and (tim$3) near5 (offset$3 advance$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 20:33
S173	173	((downlink$3) same (timing$3 duration$3 interval$3 time$3 clock$3)) with (average$3 mean$3 median$3 middle$3) and (tim$3) near5 (offset$3 advance$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 20:34
S174	173	((downlink$3) same (timing$3 duration$3 interval$3 time$3 clock$3)) with (average$3 mean$3 median$3 middle$3) and (time$3 timing$3) near5 (offset$3 advance$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 20:35
S175	36	((downlink$3) same (timing$3 duration$3 interval$3 time$3 clock$3)) with (average$3 mean$3 median$3 middle$3) same ((time$3 timing$3) same (offset$3 advance$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 20:35
S176	26	((downlink$3) same (timing$3 duration$3 interval$3 time$3 clock$3)) with (average$3 mean$3 median$3 middle$3) same ((time$3 timing$3) same (offset$3 advance$3)) and carrier$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 20:37
S177	32	((downlink$3 forward$3 same (link$3 channel$3)) near5 (timing$3 duration$3 interval$3 time$3 clock$3)) near10 (average$3 mean$3 median$3 middle$3) and ((time$3 timing$3) near3 (offset$3 advance$3)) and carrier$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 20:44

S178	18	((time$3 timing$3) same (offset$3 advance$3)) with (indication$3) same (uplink$3 reverse$3) same carrier$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/28 22:56
S179	1	("2012/0113914").URPN.	USPAT	OR	OFF	2013/03/28 23:00
S180	238	((timing$3 time$3) same (offset$3 advance$3)) with (message$3 respon$3 reply$3 answer$3 acknowledgment$3 feedback$3 return$3 echo$3) same ((uplink$3 reverse$3) same carrier$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 09:04
S181	63	((timing$3 time$3) same (offset$3 advance$3)) with (message$3 respon$3 reply$3 answer$3 acknowledgment$3 feedback$3 return$3 echo$3) same ((uplink$3 reverse$3) same carrier$3) and LTE$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 09:07
S182	23	((timing$3 time$3) same (offset$3 advance$3)) with (message$3 respon$3 reply$3 answer$3 acknowledgment$3 feedback$3 return$3 echo$3) same ((uplink$3 reverse$3) same carrier$3) and random$3 near3 access$3 near10 RACH$2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 09:18
S183	77	((timing$3 time$3) same (offset$3 advance$3)) with (number$3 set$2 group$3 total$3 bunch$3 cluster$3 combin$3 category$3) same ((uplink$3 reverse$3) same carrier$3) and random$3 near3 access$3 near10 RACH$2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 09:30
S184	63	S183 not S182	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 09:31
S185	38	(timing$3 time$3) with (number$3 set$2 group$3 total$3 bunch$3 cluster$3 combin$3 category$3) same ((uplink$3 reverse$3) same carrier$3) same (align$3 synchroniz$3) and ((random$3 same access$3) same (RACH$2 procedur$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 09:45
S186	112	(timing$3 time$3) with (number$3 set$2 group$3 total$3 bunch$3 cluster$3 combin$3 category$3) same ((uplink$3 reverse$3) same carrier$3) same (align$3 synchroniz$3 adust$3 coordinat$3) and ((random$3 same access$3) same (RACH$2 procedur$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 09:45
S187	33	S185 not S184	US-PGPUB; USPAT; USOCR;	OR	OFF	2013/03/29 09:46

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S188	23	(timing$3 time$3) with (number$3 set$2 group$3 total$3 bunch$3 cluster$3 combin$3 category$3) same ((uplink$3 reverse$3) same carrier$3) same (align$3 synchroniz$3 adust$3 coordinat$3) and ((random$3 near3 access$3) near5 (RACH$2 procedur$3)) and (timing$3 time$3) near3 (offset$3 advance$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 09:51
S189	1	S188 not (S187 S185 S184 S182)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 09:52
S191	10	(number$3 set$2 group$3 total$3 bunch$3 cluster$3 combin$3 category$3) near5((uplink$3 reverse$3) near5 carrier$3) near10 (align$3 synchroniz$3 adust$3 coordinat$3) and (timing$3 time$3) near3 (offset$3 advance$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 09:53
S192	1	"13133315"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 10:48
S193	1	"12818064"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 10:48
S194	4427	((uplink$3 reverse$3) with(number$3 set$2 group$3 total$3 bunch$3 cluster$3 combin$3 category$3) same carrier$3)same (timing$3 time$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 12:55
S195	542	S194 and (timing$3 time$3) near3 (offset$3 advance$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 12:56
S196	191	S195 and LTE$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2013/03/29 12:57

			IBM_TDB			
S197	254	((uplink$3 reverse$3) with(number$3 set$2 group$3 total$3 bunch$3 cluster$3 combin$3 category$3) same carrier$3)same (SUBSET$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 13:25
S198	56	S197 and (timing$3 time$3) near3 (offset$3 advance$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 13:26
S199	30	S198 and lte$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 13:26
S200	382	(uplink$3 reverse$3) with (carrier$3)same (SUBSET$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 13:32
S202	76	S200 and (timing$3 time$3) near3 (offset$3 advance$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 13:32
S203	41	S202 and lte$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 13:32
S204	15	S203 not S199	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 13:33
S205	51379	(carrier$3) with (dedicated$3 same resource$3 configuration$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 21:59
S206	2450	(single$3 same carrier$3) with (dedicated$3 same resource$3 configuration$3)	US-PGPUB; USPAT; USOCR; FPRS;	OR	OFF	2013/03/29 21:59

			EPO; JPO; DERWENT; IBM_TDB			
S207	1	(single$3 near3 carrier$3) near10 (dedicated$3 near3 resource$3 near3 configuration$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 22:00
S208	16	(single$3 near3 carrier$3) near10 (dedicated$3 near3 resource$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 22:01
S209	75	(uplink$3 revers$3) with(carrier$3) same (dedicated$3 same radio$3 same resource$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 22:53
S210	7	(uplink$3 revers$3) with(carrier$3) same (dedicated$3 same radio$3 same resource$3)same group$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 22:53
S211	149	(uplink$3 revers$3) with(carrier$3) same (dedicated$3) same (radio$3 same resource$3 RR$2 bandwidth$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 23:06
S212	111	(uplink$3 revers$3) with(carrier$3) same (dedicated$3) same (radio$3 same resource$3 RR$2 bandwidth$3) and LTE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/03/29 23:08
S213	6594	(carrier$3) near3 aggregat$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 05:54
S214	461	(carrier$3) near3 aggregat$4 and (timing$3 time$3) near3 (offset$3 advance$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 05:54
S215	355	S214 and (uplink$3 revers$3) with(downlink$3 forward$3)	US-PGPUB; USPAT;	OR	OFF	2013/04/01 05:55

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S216	33	(carrier$3) near3 aggregat$4 and (timing$3 time$3) near3 (offset$3 advance$3) near10 (uplink$3 revers$3) near10(downlink$3 forward$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 05:56
S217	96	S214 and (group$3 subset$3 cluster$3) with (uplink$3 revers$3) same(downlink$3 forward$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 06:01
S218	86	S217 not S216	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 06:02
S219	187	(carrier$3) near3 (aggregat$4 gather$3 assembl$3 accumulat$3 amass$3) and (timing$3 time$3) near3 (offset$3 advance$3) and (random$3 near3 access$3) near5 (RACH$3 procedure$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 06:25
S220	176	S219 and (uplink$3 revers$3) with(downlink$3 forward$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 06:26
S221	113	S220 not (S216 S217 S218)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 06:26
S222	383	(carrier$3) near3 (aggregat$4 gather$3 assembl$3 accumulat$3 amass$3) near10 (threshold$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 06:43
S223	15	(carrier$3) near3 (aggregat$4 gather$3 assembl$3 accumulat$3 amass$3) near10 (threshold$3) near10 (transm$3 send$3 transf$3 communicat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 06:44

S224	17	((downlink$3 forward$3) near10(average$3 mean$3 middl$3)) near20 ((time$3 timing$3) near3 (offset$3 advance$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 07:30
S225	15444	(downlink$3 forward$3)same (timing$3 time$3) with(average$3 mean$3 middl$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 10:12
S226	782	(downlink$3 forward$3)same (timing$3 time$3) with(average$3 mean$3 middl$3) same carrier$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 10:12
S227	211	(downlink$3 forward$3)same (timing$3 time$3) with(average$3 mean$3 middl$3) same carriers$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 10:12
S228	35	S227 and LTE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 10:13
S229	161	(downlink$3 forward$3)same (timing$3 time$3) with(midpoint$3 median$3 standard$3 medium$3) same carriers$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 10:27
S230	25	S229 and LTE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 10:28
S231	48	(timing$3 time$3) with(midpoint$3 median$3 standard$3 medium$3 average$3 mean$3) same carriers$3 same (downlink$3) and LTE$2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 12:20
S232	2	"5363375".PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2013/04/01 12:28

			DERWENT; IBM_TDB			
S233	12411	370/252.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 20:10
S234	39948	370/329-338.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 20:11
S235	2488	370/347.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 20:11
S236	2850	370/350.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 20:11
S237	5184	709/230.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 20:12
S238	5882	455/450.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 20:12
S239	36	(S233 S234 S235 S236 S237 S238) and (uplink$3 revers$3) same (downlink$3 forward$3) with (timing$3) same (carriers$3) same (timing$3 clock$3 time$3) and (timing$3 clock$3 time$3) near3 (advance$3 offset$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 20:14
S240	3	"20060274712"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/04/01 20:21
S241	139	((NATHAN) near2 (TENNY)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:48

S242	4	S238 AND (uplink$3 revers$3) same (downlink$3 forward$3) with (timing$3) same (carriers$3) same (timing$3 clock$3 time$3) and (timing$3 clock$3 time$3) near3 (advance$3 offset$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:49
S243	232	((PARAG) near2 (AGASHE)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:50
S244	1	((PARAG) near2 (AGASHE)).INV. AND (uplink$3 revers$3) same (downlink$3 forward$3) with (timing$3) same (carriers$3) same (timing$3 clock$3 time$3) and (timing$3 clock$3 time$3) near3 (advance$3 offset$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:51
S245	365	((PETER) near2 (GAAL)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:51
S246	4	((PETER) near2 (GAAL)).INV. AND (uplink$3 revers$3) same (downlink$3 forward$3) with (timing$3) same (carriers$3) same (timing$3 clock$3 time$3) and (timing$3 clock$3 time$3) near3 (advance$3 offset$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:51
S247	218	((TINGFANG) near2 (JI)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:53
S248	1	((TINGFANG) near2 (JI)).INV. AND (uplink$3 revers$3) same (downlink$3 forward$3) with (timing$3) same (carriers$3) same (timing$3 clock$3 time$3) and (timing$3 clock$3 time$3) near3 (advance$3 offset$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:53
S249	242	((RAVI) near2 (PALANKI)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:53
S250	1	((RAVI) near2 (PALANKI)).INV. AND (uplink$3 revers$3) same (downlink$3 forward$3) with (timing$3) same (carriers$3) same (timing$3 clock$3 time$3) and (timing$3 clock$3 time$3) near3 (advance$3 offset$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:53
S251	232	((RAJAT) near2 (PRAKASH)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:54
S252	2	((RAJAT) near2 (PRAKASH)).INV. AND (uplink$3 revers$3) same (downlink$3 forward$3) with (timing$3) same (carriers$3) same (timing$3 clock$3 time$3) and (timing$3 clock$3 time$3) near3 (advance$3 offset$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 20:54
S253	1	"20110158116"	US-PGPUB; USPAT; USOCR	OR	OFF	2013/04/01 21:07
S254	277	(uplink$3 revers$3) same (downlink$3 forward$3) with (carriers$3) same (timing$3 clock$3 time$3) and (timing$3 clock$3 time$3) near3 (advance$3 offset$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/09/21 10:18
S255	41	(uplink$3 revers$3) same (downlink$3	US-PGPUB;	OR	OFF	2013/09/21

		forward$3) with (carriers$3) same (timing$3 clock$3 time$3) and (timing$3 clock$3 time$3) near3 (advance$3 offset$3) near10 (adjust$3)	USPAT; USOCR			10:19
S256	1	((plurality$3 different$3 distinct$3 separat$3 discrete$3) same(uplink$3 revers$3) same(timing$3 clock$3 time$3))with (adjust$3) same (downlink$3 forward$3) with (adjust$3 modif$3 alter$3 chang$3 balance$3) same (carriers$3) same (advance$3 offset$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/09/21 10:30
S257	1	((timings$3 clocks$3 times$3) same (advance$3 offset$3))with (downlink$3 forward$3) with (adjust$3 modif$3 alter$3 chang$3 balance$3) same (carriers$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/09/21 11:03
S258	98	((timings$3 clocks$3 times$3) same (advance$3 offset$3))with (downlink$3 forward$3) with (adjust$3 modif$3 alter$3 chang$3 balance$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/09/21 11:03
S259	546	((timings$3 clocks$3 times$3) near10(downlink$3 forward$3)) near10 (advance$3 offset$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/09/21 11:04
S260	16	((timings$3 clocks$3 times$3) near10(downlink$3 forward$3)) near10 (advance$3 offset$3) near10 (adjust$3 modif$3 alter$3 chang$3 balance$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2013/09/21 11:05

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	1	(downlink$3 same timing$3 and downlink$3 same carrier$3 and uplink$3 same group$3 same carrier$3 and ascertain$5 and timing$3 same offset$3 and different$3 near3 downlink$3 near3 timing$3 and uplink$3 same timing$3).clm.	US-PGPUB; USPAT; UPAD	OR	OFF	2013/09/21 15:36
L12	13602	370/252.ccls.	US-PGPUB; USPAT; UPAD	OR	OFF	2013/09/21 16:25
L13	2152	370/336.ccls.	US-PGPUB; USPAT; UPAD	OR	OFF	2013/09/21 16:26
L14	3029	370/350.ccls.	US-PGPUB; USPAT; UPAD	OR	OFF	2013/09/21 16:26
L15	3860	370/503.ccls.	US-PGPUB; USPAT; UPAD	OR	OFF	2013/09/21 16:26
L16	1	1 and (12 13 14 15)	US-PGPUB; USPAT; UPAD	OR	OFF	2013/09/21 16:27

S261	2	(downlink$3 same timing$3 and downlink$3 same carrier$3 and group$3 same carrier$3 and ascertain$5 and timing$3 same offset$3 and different$3 same downlink$3 same timing$3).clm.	US-PGPUB; USPAT; UPAD	OR	OFF	2013/09/21 11:57
S262	0	("2012/0120821").URPN.	USPAT	OR	OFF	2013/09/21 12:01
S263	2	(downlink$3 same timing$3 and downlink$3 same carrier$3 and group$3 same carrier$3 and ascertain$5 and timing$3 same offset$3 and different$3 same downlink$3 same timing$3 and uplink$3 same timing$3).clm.	US-PGPUB; USPAT; UPAD	OR	OFF	2013/09/21 12:02
S264	2	(downlink$3 same timing$3 and downlink$3 same carrier$3 and uplink$3 same group$3 same carrier$3 and ascertain$5 and timing$3 same offset$3 and different$3 same downlink$3 same timing$3 and uplink$3 same timing$3).clm.	US-PGPUB; USPAT; UPAD	OR	OFF	2013/09/21 12:19
S265	1	(downlink$3 same timing$3 and downlink$3 same carrier$3 and uplink$3 same group$3 same carrier$3 and ascertain$5 and timing$3 same offset$3 and different$3 near3 downlink$3 near3 timing$3 and uplink$3 same timing$3).clm.	US-PGPUB; USPAT; UPAD	OR	OFF	2013/09/21 12:38

9/ 21/ 2013 4:28:16 PM
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PTO/SB/08a (07-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	12818064
Filing Date	2010-06-17
First Named Inventor	TENNY; Nathan Edward
Art Unit	2474
Examiner Name	VINNCELAS, Louis
Attorney Docket Number	092546

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5363375		1994-11-08	CHUANG; Justin C. et al.	

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U.S.PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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	1	1887758	EP	A2	2008-02-13	CISCO TECH INC [US]		☐
	2	1988648	EP	A1	2008-11-05	NOKIA SIEMENS NETWORKS OY [FI]		☐
	3	2009124450	JP	A	2009-06-04	TOYOTA CENTRAL RES & DEV.		☒

/Vinncelas Louis/ (09/21/2013)

EFS Web 2.1.17

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /V.L./

Receipt date: 06/27/2013	Application Number	12818064 12818064 - GAU: 2474
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Filing Date	2010-06-17
	First Named Inventor	TENNY; Nathan Edward
	Art Unit	2474
	Examiner Name	VINNCELAS, Louis
	Attorney Docket Number	092546

	4	2009219625	JP	A	2009-10-01	AISIN SEIKI., et al.		☒
	5	2009022840	WO	A2	2009-02-19	LG ELECTRONICS INC [KR], et al.		☐

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NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	ERICSSON, "Impact of Carrier Aggregation on the L2 protocol architecture for LTE Rel-10", 3GPP TSG-RAN WG2 #66, Tdoc R2-092957, San Francisco, USA, 4th - 8th May 2009, pages 1-8, URL,http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_66/docs/R2-092957.zip.	☐
	2	TAIWAN SEARCH REPORT - TW099120129 - TIPO - 2013-05-27 (092546TW).	☐

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EXAMINER SIGNATURE

Examiner Signature	/Vinncelas Louis/ (09/21/2013)	Date Considered	09/21/2013

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /V.L./

Receipt date: 06/27/2013	Application Number	12818064 12818064 - GAU: 2474
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)	Filing Date	2010-06-17
	First Named Inventor	TENNY; Nathan Edward
	Art Unit	2474
	Examiner Name	VINNCELAS, Louis
	Attorney Docket Number	092546

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☒ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/John J. Ketchum/	Date (YYYY-MM-DD)	2013-06-27
Name/Print	JOHN J. KETCHUM	Registration Number	61932

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

/Vinncelas Louis/ (09/21/2013)

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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/Vinncelas Louis/ (09/21/2013)

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /V.L./

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12818064	TENNY ET AL.
	Examiner	Art Unit
	VINCELAS LOUIS	2474

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	09/21/2013								
1	1	=								
2	2	=								
3	3	=								
4	4	=								
5	5	=								
6	6	=								
7	7	=								
8	8	=								
9	9	=								
10	10	=								
11	11	=								
12	12	=								
13	13	=								
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16	16	=								
17	17	=								
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20	20	=								
21	21	=								
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25	25	=								
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27	27	=								
28	28	=								
29	29	=								
30	30	=								
31	31	=								
32	32	=								
33	33	=								
34	34	=								
35	35	=								
36	36	=								

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12818064	TENNY ET AL.
	Examiner	Art Unit
	VINCELAS LOUIS	2474

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	09/21/2013								
37	37	=								
38	38	=								
39	39	=								
40	40	=								
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42	42	=								
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62	62	=								
63	63	=								
64	64	=								
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66	66	=								
67	67	=								
68	68	=								
69	69	=								
70	70	=								
71	71	=								
72	72	=								

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12818064	TENNY ET AL.
	Examiner	Art Unit
	VINCELAS LOUIS	2474

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	09/21/2013								
73	73	=								
74	74	=								
75	75	=								
76	76	=								
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78	78	=								
79	79	=								
80	80	=								
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82	82	=								
83	83	=								
84	84	=								
85	85	=								
86	86	=								
87	87	=								
88	88	=								

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12818064	TENNY ET AL.
	Examiner	**Art Unit**
	VINCELAS LOUIS	2474

CPC						
Symbol					**Type**	**Version**
			/			
			/			
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			/			

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
			/					
			/					

/VINCELAS LOUIS/ Examiner.Art Unit 2474	09/21/2013	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	88	
/MICHAEL THIER/ Supervisory Patent Examiner.Art Unit 2474	09/23/2013	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	4

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12818064	TENNY ET AL.
	Examiner	**Art Unit**
	VINCELAS LOUIS	2474

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
370	252	H	0	4	W	56 / 00 (2009.01.01)						

CROSS REFERENCE(S)					
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
370	336	350	503		

/VINCELAS LOUIS/ Examiner.Art Unit 2474	09/21/2013	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	88	
/MICHAEL THIER/ Supervisory Patent Examiner.Art Unit 2474	09/23/2013	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	4

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12818064	TENNY ET AL.
	Examiner	**Art Unit**
	VINCELAS LOUIS	2474

☒ **Claims renumbered in the same order as presented by applicant** ☐ **CPA** ☐ **T.D.** ☐ **R.1.47**

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	17	17	33	33	49	49	65	65	81	81				
2	2	18	18	34	34	50	50	66	66	82	82				
3	3	19	19	35	35	51	51	67	67	83	83				
4	4	20	20	36	36	52	52	68	68	84	84				
5	5	21	21	37	37	53	53	69	69	85	85				
6	6	22	22	38	38	54	54	70	70	86	86				
7	7	23	23	39	39	55	55	71	71	87	87				
8	8	24	24	40	40	56	56	72	72	88	88				
9	9	25	25	41	41	57	57	73	73						
10	10	26	26	42	42	58	58	74	74						
11	11	27	27	43	43	59	59	75	75						
12	12	28	28	44	44	60	60	76	76						
13	13	29	29	45	45	61	61	77	77						
14	14	30	30	46	46	62	62	78	78						
15	15	31	31	47	47	63	63	79	79						
16	16	32	32	48	48	64	64	80	80						

/VINCELAS LOUIS/ Examiner.Art Unit 2474 (Assistant Examiner)	09/21/2013 (Date)	**Total Claims Allowed:** 88	
/MICHAEL THIER/ Supervisory Patent Examiner.Art Unit 2474 (Primary Examiner)	09/23/2013 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 4

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12818064	TENNY ET AL.
	Examiner	Art Unit
	VINCELAS LOUIS	2474

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
370	252, 329-338, 345, 347, 350, 503	4/1/2013 (updated 9/21/2013)	Vinncelas Louis
709	230	4/1/2013 (updated 9/21/2013)	Vinncelas Louis
455	450	4/1/2013 (updated 9/21/2013)	Vinncelas Louis

SEARCH NOTES		
Search Notes	Date	Examiner
East search history including text limited search along with class/subclass as listed above	9/21/2013	Vinncelas Louis
Consulted with Mered Habte	4/1/2013	Vinncelas Louis
East inventors search	4/1/2013	Vinncelas Louis
Consulted with Frank Duong	4/3/2013 (updated 9/9/2013)	Vinncelas Louis
Consulted with Hoon J. Chung	4/1/2013	Vinncelas Louis

INTERFERENCE SEARCH	

US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
	East interference search history	9/21/2013	Vinncelas Louis
370	252, 336, 350, 503	9/21/2013	Vinncelas Louis

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

23696 7590 09/30/2013
QUALCOMM INCORPORATED
5775 MOREHOUSE DR.
SAN DIEGO, CA 92121

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Via EFS

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

Leeanne Lawlor	(Depositor's name)
/Leeanne Lawlor/	(Signature)
December 12, 2013	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/818,064	06/17/2010	Nathan Edward Tenny	092546	6903

TITLE OF INVENTION: METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1780	$300	$0	$2080	12/30/2013

EXAMINER	ART UNIT	CLASS-SUBCLASS
LOUIS, VINNCELAS	2474	370-252000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Nerrie M. Zohn
2
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: QUALCOMM Incorporated

(B) RESIDENCE: (CITY and STATE OR COUNTRY): San Diego, California

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ☒ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
- ☒ Issue Fee
- ☒ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number 170026 (enclose an extra copy of this form).

IPR2023-01269 Page 596

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29	NOTE: Absent a valid certification of Micro Entity Status (see form PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
❑ Applicant asserting small entity status. See 37 CFR 1.27	NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
❑ Applicant changing to regular undiscounted fee status.	NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature /Nerrie M Zohn/ Date December 11, 2013

Typed or printed name Nerrie M. Zohn Registration No. 55761

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Electronic Patent Application Fee Transmittal

Application Number:	12818064
Filing Date:	17-Jun-2010
Title of Invention:	METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM
First Named Inventor/Applicant Name:	Nathan Edward Tenny
Filer:	Nerrie Meir Zohn/Leeanne Lawlor
Attorney Docket Number:	092546

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl Issue Fee	1501	1	1780	1780
Publ. Fee- Early, Voluntary, or Normal	1504	1	300	300

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**2080**

Electronic Acknowledgement Receipt

EFS ID:	17639918
Application Number:	12818064
International Application Number:	
Confirmation Number:	6903
Title of Invention:	METHOD AND APPARATUS THAT FACILITATES A TIMING ALIGNMENT IN A MULTICARRIER SYSTEM
First Named Inventor/Applicant Name:	Nathan Edward Tenny
Customer Number:	23696
Filer:	Nerrie Meir Zohn/Leeanne Lawlor
Filer Authorized By:	Nerrie Meir Zohn
Attorney Docket Number:	092546
Receipt Date:	12-DEC-2013
Filing Date:	17-JUN-2010
Time Stamp:	13:24:52
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$2080
RAM confirmation Number	602
Deposit Account	170026
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	092546_issue-fee_signed.pdf	110900 0c7bd8a24106f12cb7a44cabe467198e260b8c6a	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	32148 9cd9a8051448b041786b2af9227d1d45928737c5	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	143048		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/818,064	01/21/2014	8634313	092546	6903

23696 7590 12/31/2013

QUALCOMM INCORPORATED
5775 MOREHOUSE DR.
SAN DIEGO, CA 92121

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 825 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Nathan Edward Tenny, Poway, CA;
Parag Arun Agashe, San Diego, CA;
Peter Gaal, San Diego, CA;
Tingfang Ji, San Diego, CA;
Ravi Palanki, San Diego, CA;
Rajat Prakash, La Jolla, CA;

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