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Skaar Ulbrich Macari, P.A.
601 Carlson Parkway
Suite 1050
Minneapolis, MN 55305

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 4 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):

ASUSTek Computer Inc., Taipei City, TAIWAN;
Chun-Wei Huang, Taipei City, TAIWAN;
Ko-Chiang Lin, Taipei City, TAIWAN;

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Skaar Ulbrich Macari, P.A.
601 Carlson Parkway
Suite 1050
Minneapolis, MN 55305

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HOANG, THAI D	

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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):

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Response to Rule 312 Communication	Application No. 16/241,368	Applicant(s)
	Examiner	Art Unit

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

1. ☒ The amendment filed on *02/11/21* under 37 CFR 1.312 has been considered, and has been:

a) ☒ entered.

b) ☐ entered as directed to matters of form not affecting the scope of the invention.

c) ☐ disapproved because the amendment was filed after the payment of the issue fee.
Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.

d) ☐ disapproved. See explanation below.

e) ☐ entered in part. See explanation below.

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METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the benefit of U.S. Provisional Patent Application Serial No. 62/619,041 filed on January 18, 2018, the entire disclosure of which is incorporated herein in its entirety by reference.

FIELD

[0002] This disclosure generally relates to wireless communication networks, and more particularly, to a method and apparatus for providing control resource set configuration in a wireless communication system.

BACKGROUND

[0003] With the rapid rise in demand for communication of large amounts of data to and from mobile communication devices, traditional mobile voice communication networks are evolving into networks that communicate with Internet Protocol (IP) data packets. Such IP data packet communication can provide users of mobile communication devices with voice over IP, multimedia, multicast and on-demand communication services.

[0004] An exemplary network structure is an Evolved Universal Terrestrial Radio Access Network (E-UTRAN). The E-UTRAN system can provide high data throughput in order to realize the above-noted voice over IP and multimedia services. A new radio technology for the next generation (e.g., 5G) is currently being discussed by the 3GPP standards organization. Accordingly, changes to the current body of 3GPP standard are currently being submitted and considered to evolve and finalize the 3GPP standard.

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SUMMARY

[0005] Methods and apparatuses for providing control resource set configuration in a wireless communication system are disclosed herein. In one method, a network node transmits a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map. The network node is not allowed to transmit the signal such that an interval between two bit positions in the set in the bit map is smaller than a second duration.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. 1 shows a diagram of a wireless communication system according to one exemplary embodiment.

[0007] FIG. 2 is a block diagram of a transmitter system (also known as access network) and a receiver system (also known as user equipment or UE) according to one exemplary embodiment.

[0008] FIG. 3 is a functional block diagram of a communication system according to one exemplary embodiment.

[0009] FIG. 4 is a functional block diagram of the program code of FIG. 3 according to one exemplary embodiment.

[0010] FIG. 5 is a reproduction of Table 7.3.2.1-1 taken from 3GPP 3GPP R1-1721341.

[0011] FIG. 6 is a reproduction of Table 10.1-1 from 3GPP R1-1721343.

[0012] FIG. 7 is a flow diagram for one exemplary embodiment from the perspective of a network node.

[0013] FIG. 8 is a flow diagram for one exemplary embodiment from the perspective of a network node.

DETAILED DESCRIPTION

[0014] The exemplary wireless communication systems and devices described below employ a wireless communication system, supporting a broadcast service. Wireless communication systems are widely deployed to provide various types of communication such as

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voice, data, and so on. These systems may be based on code division multiple access (CDMA), time division multiple access (TDMA), orthogonal frequency division multiple access (OFDMA), 3GPP LTE (Long Term Evolution) wireless access, 3GPP LTE-A or LTE-Advanced (Long Term Evolution Advanced), 3GPP2 UMB (Ultra Mobile Broadband), WiMax, or some other modulation techniques.

[0015] In particular, the exemplary wireless communication systems devices described below may be designed to support one or more standards such as the standard offered by a consortium named "3rd Generation Partnership Project" referred to herein as 3GPP, including: Final Chairman's Note of 3GPP TSG RAN WG1 Meeting #89; Final Report of 3GPP TSG RAN WG1 #AH_NR2 v1.0.0; Final Chairman's Note of 3GPP TSG RAN WG1 Meeting #AH_NR3; Final Chairman's Note of 3GPP TSG RAN WG1 Meeting #90bis; Final Chairman's Note of 3GPP TSG RAN WG1 Meeting #91; R1-1721341, "NR; Physical channels and modulation (Release 15)"; R1-1721343, "NR; Physical layer procedures for control (Release 15)"; and TS 38.331, "NR; Radio Resource Control (RRC); Protocol specification (Release 15)". The standards and documents listed above are hereby expressly incorporated by reference in their entirety.

[0016] FIG. 1 shows a multiple access wireless communication system according to one embodiment of the invention. An access network 100 (AN) includes multiple antenna groups, one including 104 and 106, another including 108 and 110, and an additional including 112 and 114. In FIG. 1, only two antennas are shown for each antenna group, however, more or fewer antennas may be utilized for each antenna group. Access terminal 116 (AT) is in communication with antennas 112 and 114, where antennas 112 and 114 transmit information to access terminal 116 over forward link 120 and receive information from access terminal 116 over reverse link 118. Access terminal (AT) 122 is in communication with antennas 106 and 108, where antennas 106 and 108 transmit information to access terminal (AT) 122 over forward link 126 and receive information from access terminal (AT) 122 over reverse link 124. In a FDD system, communication links 118, 120, 124 and 126 may use different frequency for communication. For example, forward link 120 may use a different frequency then that used by reverse link 118.

[0017] Each group of antennas and/or the area in which they are designed to communicate is often referred to as a sector of the access network. In the embodiment, antenna

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groups each are designed to communicate to access terminals in a sector of the areas covered by access network 100.

[0018] In communication over forward links 120 and 126, the transmitting antennas of access network 100 may utilize beamforming in order to improve the signal-to-noise ratio of forward links for the different access terminals 116 and 122. Also, an access network using beamforming to transmit to access terminals scattered randomly through its coverage causes less interference to access terminals in neighboring cells than an access network transmitting through a single antenna to all its access terminals.

[0019] An access network (AN) may be a fixed station or base station used for communicating with the terminals and may also be referred to as an access point, a Node B, a base station, an enhanced base station, an evolved Node B (eNB), or some other terminology. An access terminal (AT) may also be called user equipment (UE), a wireless communication device, terminal, access terminal or some other terminology.

[0020] FIG. 2 is a simplified block diagram of an embodiment of a transmitter system 210 (also known as the access network) and a receiver system 250 (also known as access terminal (AT) or user equipment (UE) in a MIMO system 200. At the transmitter system 210, traffic data for a number of data streams is provided from a data source 212 to a transmit (TX) data processor 214.

[0021] In one embodiment, each data stream is transmitted over a respective transmit antenna. TX data processor 214 formats, codes, and interleaves the traffic data for each data stream based on a particular coding scheme selected for that data stream to provide coded data.

[0022] The coded data for each data stream may be multiplexed with pilot data using OFDM techniques. The pilot data is typically a known data pattern that is processed in a known manner and may be used at the receiver system to estimate the channel response. The multiplexed pilot and coded data for each data stream is then modulated (i.e., symbol mapped) based on a particular modulation scheme (e.g., BPSK, QPSK, M-PSK, or M-QAM) selected for that data stream to provide modulation symbols. The data rate, coding, and modulation for each data stream may be determined by instructions performed by processor 230.

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[0023] The modulation symbols for all data streams are then provided to a TX MIMO processor 220, which may 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 certain 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.

[0024] 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. N_T modulated signals from transmitters 222a through 222t are then transmitted from N_T antennas 224a through 224t, respectively.

[0025] At receiver system 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 received signal, digitizes the conditioned signal to provide samples, and further processes the samples to provide a corresponding "received" symbol stream.

[0026] An RX data processor 260 then receives and processes 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. The RX data processor 260 then demodulates, deinterleaves, and decodes 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 transmitter system 210.

[0027] A processor 270 periodically determines which pre-coding matrix to use (discussed below). Processor 270 formulates a reverse link message comprising a matrix index portion and a rank value portion.

[0028] The reverse link message may comprise various types of information regarding the communication link and/or the received data stream. The reverse link message is then processed by a TX data processor 238, which also receives traffic data for a number of data

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streams from a data source 236, modulated by a modulator 280, conditioned by transmitters 254a through 254r, and transmitted back to transmitter system 210.

[0029] At transmitter system 210, the modulated signals from receiver system 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 reserve link message transmitted by the receiver system 250. Processor 230 then determines which pre-coding matrix to use for determining the beamforming weights then processes the extracted message.

[0030] Turning to FIG. 3, this figure shows an alternative simplified functional block diagram of a communication device according to one embodiment of the invention. As shown in FIG. 3, the communication device 300 in a wireless communication system can be utilized for realizing the UEs (or ATs) 116 and 122 in FIG. 1 or the base station (or AN) 100 in FIG. 1, and the wireless communications system is preferably the LTE system. The communication device 300 may include an input device 302, an output device 304, a control circuit 306, a central processing unit (CPU) 308, a memory 310, a program code 312, and a transceiver 314. The control circuit 306 executes the program code 312 in the memory 310 through the CPU 308, thereby controlling an operation of the communications device 300. The communications device 300 can receive signals input by a user through the input device 302, such as a keyboard or keypad, and can output images and sounds through the output device 304, such as a monitor or speakers. The transceiver 314 is used to receive and transmit wireless signals, delivering received signals to the control circuit 306, and outputting signals generated by the control circuit 306 wirelessly. The communication device 300 in a wireless communication system can also be utilized for realizing the AN 100 in FIG. 1.

[0031] FIG. 4 is a simplified block diagram of the program code 312 shown in FIG. 3 in accordance with one embodiment of the invention. In this embodiment, the program code 312 includes an application layer 400, a Layer 3 portion 402, and a Layer 2 portion 404, and is coupled to a Layer 1 portion 406. The Layer 3 portion 402 generally performs radio resource control. The Layer 2 portion 404 generally performs link control. The Layer 1 portion 406 generally performs physical connections.

[0032] In the Final Chairman's Note of 3GPP TSG RAN WG1 Meeting #90bis, the following agreements and working assumptions were reached:

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Agreements:

- One set of the following parameters determines a set of search spaces
  - A set of aggregation levels
  - The number of PDCCH candidates for each aggregation level
  - PDCCH monitoring occasion for the set of search spaces

Agreements:

- At least for cases other than initial access, to identify a set of search spaces, following parameters are configured by UE-specific RRC signaling:
  - The number of PDCCH candidates for each aggregation level of {1, 2, 4, 8, [16]}
    - One value from {0, 1, 2, 3, 4, 5, 6, 8}
  - PDCCH monitoring occasion for the set of search spaces
    - One value of from {1-slot, 2-slot, [5-slot], [10-slot], [20-slot]} (at least 5 values)
    - One or more value(s) from 1st symbol, 2nd symbol, …, 14th symbol within a monitored slot
  - Each set of search spaces associates with a CORESET configuration by RRC signaling

Update after email approval:

Agreements:

- For PDCCH monitoring occasion of 1-slot, 2-slot, [5-slot], [10-slot], and [20-slot],
  - Slot-level offset value for PDCCH monitoring occasion is also supported.
    - For N-slot monitoring occasion, the offset is one from [0, N-1].
  - Note: symbol-level bit map of monitoring occasion within a slot agreed at RAN1#90bis is still available.

[0033] In 3GPP R1-1721341, some configurations of the PDCCH structure are quoted below:

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7.3.2 Physical downlink control channel (PDCCH)

7.3.2.1 Control-channel element (CCE)

A physical downlink control channel consists of one or more control-channel elements (CCEs) as indicated in Table 7.3.2.1-1.

FIG. 5 (a reproduction of Table 7.3.2.1-1 taken from 3GPP R1-1721341).

7.3.2.2 Control-resource set (CORESET)

A control-resource set consists of $N_{\mathrm{RB}}^{\mathrm{CORESET}}$ resource blocks in the frequency domain, given by the higher-layer parameter *CORESET-freq-dom*, and $N_{\mathrm{symb}}^{\mathrm{CORESET}} \in \{1,2,3\}$ symbols in the time domain, given by the higher-layer parameter *CORESET-time-dur*, where $N_{\mathrm{symb}}^{\mathrm{CORESET}} = 3$ is supported only if higher-layer parameter *DL-DMRS-typeA-pos* equals 3.

A control-channel element consists of 6 resource-element groups (REGs) where a resource-element group equals one resource block during one OFDM symbol. Resource-element groups within a control-resource set are numbered in increasing order in a time-first manner, starting with 0 for the first OFDM symbol and the lowest-numbered resource block in the control resource set.

A UE can be configured with multiple control-resource sets. Each control-resource set is associated with one CCE-to-REG mapping only.

The CCE-to-REG mapping for a control-resource set can be interleaved or non-interleaved, configured by the higher-layer parameter *CORESET-CCE-REG-mapping-type*, and is described by REG bundles:

- REG bundle i is defined as REGs $\{iL, iL+1, \ldots, iL+L-1\}$ where L is the REG bundle size, $i = 0,1,\ldots,N_{\mathrm{REG}}^{\mathrm{CORESET}}/L-1$, and $N_{\mathrm{REG}}^{\mathrm{CORESET}} = N_{\mathrm{RB}}^{\mathrm{CORESET}} N_{\mathrm{symb}}^{\mathrm{CORESET}}$ is the number of REGs in the CORESET

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- CCE j consists of REG bundles $\{f(6j/L), f(6j/L+1),..., f(6j/L+6/L-1)\}$ where $f(\cdot)$ is an interleaver

For non-interleaved CCE-to-REG mapping, $L=6$ and $f(j)=j$

For interleaved CCE-to-REG mapping, $L\in\{2,6\}$ for $N_{\text{symb}}^{\text{CORESET}}=1$ and $L\in\{N_{\text{symb}}^{\text{CORSET}},6\}$ for $N_{\text{symb}}^{\text{CORESET}}\in\{2,3\}$ where L is configured by the higher-layer parameter *CORESET-REG-bundle-size*. The interleaver is defined by

$$\begin{aligned} f(j) &= (rC+c+n_{\text{shift}})\bmod\left(N_{\text{REG}}^{\text{CORESET}}/L\right)\\ j &= cR+r\\ r &= 0,1,...,R-1\\ c &= 0,1,...,C-1\\ C &= \left\lceil N_{\text{REG}}^{\text{CORESET}}/(LR)\right\rceil \end{aligned}$$

where $R\in\{2,3,6\}$ is given by the higher-layer parameter *CORESET-interleaver-size* and where

- n_{shift} is a function of $N_{\text{ID}}^{\text{cell}}$ for a PDCCH transmitted in a CORESET configured by the PBCH or RMSI
- $n_{\text{shift}}\in\{0,1,...,274\}$ is a function of the higher-layer parameter *CORESET-shift-index*.

The UE may assume

- the same precoding in the frequency domain being used within a REG bundle if the higher-layer parameter *CORESET-precoder-granularity* equals *CORESET-REG-bundle-size*
- the same precoding in the frequency domain being used across the all resource-element groups within the set of contiguous resource blocks in the CORESET if the higher-layer parameter *CORESET-precoder-granularity* equals the size of the CORESET in the frequency domain

For a CORESET configured by PBCH, $L=6$.

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7.3.2.3 Scrambling

The UE shall assume the block of bits $b(0),...,b(M_{\text{bit}}-1)$, where M_{bit} is the number of bits transmitted on the physical channel, is scrambled prior to modulation, resulting in a block of scrambled bits $\tilde{b}(0),...,\tilde{b}(M_{\text{bit}}-1)$ according to

$$\tilde{b}(i) = \left(b(i) + c(i)\right) \bmod 2$$

where the scrambling sequence $c(i)$ is given by clause 5.2.1.

7.3.2.4 PDCCH modulation

The UE shall assume the block of bits $\tilde{b}(0),...,\tilde{b}(M_{\text{bit}}-1)$ to be QPSK modulated as described in clause 5.1.3, resulting in a block of complex-valued modulation symbols $d(0),...,d(M_{\text{symb}}-1)$.

7.3.2.5 Mapping to physical resources

The UE shall assume the block of complex-valued symbols $d(0),...,d(M_{\text{symb}}-1)$ to be scaled by a factor β_{PDCCH} and mapped to resource elements $(k,l)_{p,\mu}$ in increasing order of first k, then l, in the resource-element groups used for the monitored PDCCH.

7.4.1.3 Demodulation reference signals for PDCCH

7.4.1.3.1 Sequence generation

The UE shall assume the reference-signal sequence $r(m)$ is defined by

$$r(m) = \frac{1}{\sqrt{2}}\left(1-2\cdot c(2m)\right) + j\frac{1}{\sqrt{2}}\left(1-2\cdot c(2m+1)\right).$$

where the pseudo-random sequence $c(i)$ is defined in clause 5.2.1.

7.4.1.3.2 Mapping to physical resources

The UE shall assume the sequence $r(m)$ is mapped to physical resource elements according to

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$$a_{k,l}^{(p,\mu)} = \beta_{\text{DMRS}} \cdot r(3n + k')$$
$$k = N_{\text{sc}}^{\text{RB}} \left\lfloor n / N_{\text{symb}}^{\text{CORESET}} \right\rfloor + 4k' + 1$$
$$k' = 0,1,2$$
$$l = n \bmod N_{\text{symb}}^{\text{CORESET}}$$
$$n = 0,1,...$$

where the following conditions are fulfilled

- they are within the resource element groups constituting the PDCCH the UE attempts to decode if the higher-layer parameter *CORESET-precoder-granularity* equals *CORESET-REG-bundle-size*,
- all resource-element groups within the set of contiguous resource blocks in the CORESET where the UE attempts to decode the PDCCH if the higher-layer parameter *CORESET-precoder-granularity* equals the size of the CORESET in the frequency domain.

The reference point for k is

- subcarrier 0 of the lowest-numbered common resource block in the CORESET if the CORESET is configured by the PBCH or RMSI,
- subcarrier 0 in common resource block 0 otherwise

The reference point for l is the first OFDM symbol fo the CORESET.

A UE not attempting to detect a PDCCH in a CORESET shall not make any assumptions on the presence or absence of DM-RS in the CORESET.

In absence of CSI-RS or TRS configuration, and unless otherwise configured, the UE may assume PDCCH DM-RS and SS/PBCH block to be quasi co-located with respect to Doppler shift, Doppler spread, average delay, delay spread, and spatial Rx.

[0034] A CORESET can be configured with an association between the DMRS antenna port of receiving the CORESET and one or more than one reference signal(s). In 3GPP R1-1721343, the following quotation specifies the UE procedure for receiving control information.

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10 UE procedure for receiving control information

If the UE is configured with a SCG, the UE shall apply the procedures described in this clause for both MCG and SCG

- When the procedures are applied for MCG, the terms 'secondary cell', 'secondary cells' , 'serving cell', 'serving cells' in this clause refer to secondary cell, secondary cells, serving cell, serving cells belonging to the MCG respectively.
- When the procedures are applied for SCG, the terms 'secondary cell', 'secondary cells', 'serving cell', 'serving cells' in this clause refer to secondary cell, secondary cells (not including PSCell), serving cell, serving cells belonging to the SCG respectively. The term 'primary cell' in this clause refers to the PSCell of the SCG.

A UE shall monitor a set of PDCCH candidates in one or more control resource sets on the active DL BWP on each activated serving cell according to corresponding search spaces where monitoring implies decoding each PDCCH candidate according to the monitored DCI formats.

A UE can be configured by higher layer parameter *SSB-periodicity-serving-cell* a periodicity of half frames for transmission of SS/PBCH blocks in a serving cell. If the UE has received *SSB-transmitted-SIB1* and has not received *SSB-transmitted* and if REs for a PDCCH reception overlap with REs corresponding to SS/PBCH block indexes indicated by *SSB-transmitted-SIB1*, the UE receives the PDCCH by excluding REs corresponding to SS/PBCH block indexes indicated by *SSB-transmitted-SIB1*. If a UE has received *SSB-transmitted* and if REs for a PDCCH reception overlap with REs corresponding to SS/PBCH block indexes indicated by *SSB-transmitted*, the UE receives the PDCCH by excluding REs corresponding to SS/PBCH block indexes indicated by *SSB-transmitted*.

If a carrier aggregation capability for a UE, as included in *UE-NR-Capability*, is larger than X, the UE includes in *UE-NR-Capability* an indication for a maximum number of PDCCH candidates the UE can monitor per slot when the UE is configured for carrier aggregation operation over more than X cells. When the UE is configured for carrier aggregation operation over more than X cells, the UE is not expected to be configured with a number of PDCCH candidates to monitor per slot that is larger than the maximum number.

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10.1 UE procedure for determining physical downlink control channel assignment

A set of PDCCH candidates for a UE to monitor is defined in terms of PDCCH search spaces. A search space can be a common search space or a UE-specific search space. A UE shall monitor PDCCH candidates in non-DRX slots in one or more of the following search spaces

- a Type0-PDCCH common search space for a DCI format with CRC scrambled by a SI-RNTI on a primary cell;
- a Type0A-PDCCH common search space for a DCI format with CRC scrambled by a SI-RNTI on a primary cell;
- a Type1-PDCCH common search space for a DCI format with CRC scrambled by a RA-RNTI, or a TC-RNTI, or a C-RNTI on a primary cell;
- a Type2-PDCCH common search space for a DCI format with CRC scrambled by a P-RNTI on a primary cell;
- a Type3-PDCCH common search space for a DCI format with CRC scrambled by INT-RNTI, or SFI-RNTI, or TPC-PUSCH-RNTI, or TPC-PUCCH-RNTI, or TPC-SRS-RNTI, or C-RNTI, or CS-RNTI(s); and
- a UE-specific search space for a DCI format with CRC scrambled by C-RNTI or CS-RNTI(s).

A UE is provided a configuration for a control resource set for Type0-PDCCH common search space by higher layer parameter *RMSI-PDCCH-Config* and a subcarrier spacing by higher layer parameter *RMSI-scs* for PDCCH reception. The UE determines the control resource set and the monitoring occasions for Type0-PDCCH common search space as described in Subclause ~~**Error! Reference source not found.**~~ 14. The Type0-PDCCH common search space is defined by the CCE aggregation levels and the number of candidates per CCE aggregation level given in Table 10.1-1.

The UE may assume that the DM-RS antenna port associated with PDCCH reception in the Type0-PDCCH common search space and the Type2-PDCCH common search space, and for corresponding PDSCH receptions, and the DM-RS antenna port associated with SS/PBCH

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reception are quasi co-located with respect to delay spread, Doppler spread, Doppler shift, average delay, and spatial Rx parameters. The value for the DM-RS scrambling sequence initialization is the cell ID.

For Type0A-PDCCH common search space or for Type-2 PDCCH common search space, the control resource set is same as the control resource set for Type0-PDCCH common search space. A UE is provided a configuration for Type0A-PDCCH common search space by higher layer parameter *osi-SearchSpace*. A UE is provided a configuration for Type2-PDCCH common search space by higher layer parameter *paging-SearchSpace*.

A subcarrier spacing and a CP length for PDCCH reception with Type0A-PDCCH common search space, or Type1-PDCCH common search space, or Type-2 PDCCH common search space are same as for PDCCH reception with Type0-PDCCH common search space.

A UE may assume that the DM-RS antenna port associated with PDCCH reception in the Type0A-PDCCH common search space and the DM-RS antenna port associated with SS/PBCH reception are quasi co-located with respect to delay spread, Doppler spread, Doppler shift, average delay, and spatial Rx parameters.

A UE may assume that the DM-RS antenna port associated with PDCCH reception and associated PDSCH reception in the Type1-PDCCH common search space are quasi co-located with the DM-RS antenna port of the SS/PBCH reception associated with a corresponding PRACH transmission.

If a value for the DM-RS scrambling sequence initialization for Type0A-PDCCH common search space, or Type1-PDCCH common search space, or Type-2 PDCCH common search space is not provided by higher layer parameter *PDCCH-DMRS-Scrambling-ID* in *SystemInformationBlockType1*, the value is the cell ID.

If a UE is configured for downlink bandwidth part (BWP) operation, as described in Subclause ~~**Error! Reference source not found.**~~ 12, the above configurations for the common search spaces apply for the initial active DL BWP. The UE can be additionally configured a control resource set for Type0-PDCCH common search space, Type0A-PDCCH common search space, Type1-PDCCH common search space, or Type2-PDCCH common search space for each configured DL

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BWP on the primary cell, other than the initial active DL BWP, as described in Subclause ~~**Error! Reference source not found.**~~ 12.

FIG. 6 (a reproduction of Table 10.1-1 from 3GPP R1-1721343 showing CCE aggregation levels and number of candidates per CCE aggregation level for PDCCH scheduling *SystemInformationBlockType1* in Type0-PDCCH common search space)

For a serving cell, higher layer signalling provides a UE with P control resource sets. For control resource set p, $0 \le p < P$ where a UE-specific search space, a Type2-PDCCH common search space, or a Type3-PDCCH common search space is mapped, the higher layer signalling provides:

- a control resource set index by higher layer parameter *CORESET-ID*;
- a DM-RS scrambling sequence initialization value by higher layer parameter *PDCCH-DMRS-Scrambling-ID*;
- a number of consecutive symbols provided by higher layer parameter *CORESET-time-duration*;
- a set of resource blocks provided by higher layer parameter *CORESET-freq-dom*;
- a CCE-to-REG mapping provided by higher layer parameter *CORESET-CCE-to-REG-mapping-type*;
- a REG bundle size, in case of interleaved CCE-to-REG mapping, provided by higher layer parameter *CORESET-REG-bundle-size*;
- a cyclic shift for the REG bundle interleaver [4, 38.211] by higher layer parameter *CORESET-shift-index*;
- an antenna port quasi co-location, from a set of antenna port quasi co-locations provided by higher layer parameter *TCI-StatesPDCCH*, indicating quasi co-location information of the DM-RS antenna port for PDCCH reception;

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- an indication for a presence or absence of a transmission configuration indication (TCI) field for DCI format 1_0 or DCI format 1_1 transmitted by a PDCCH in control resource set p, by higher layer parameter *TCI-PresentInDCI*.

For each control resource set in a DL BWP of a serving cell, a respective higher layer parameter *CORESET-freq-dom* provides a bitmap. The bits of the bitmap have a one-to-one mapping with non-overlapping groups of 6 PRBs, in ascending order of the PRB index in the DL BWP bandwidth of $N_{\mathrm{RB}}^{\mathrm{BWP}}$ PRBs where the first PRB of the first group of 6 PRBs has index $6 \cdot \left\lceil N_{\mathrm{RB}}^{\mathrm{BWP}} / 6 \right\rceil$.

If the UE has not received an indication for an antenna port quasi co-location from the set of antenna port quasi co-locations provided by *TCI-StatesPDCCH*, the UE assumes that the DM-RS antenna port associated with PDCCH reception in the UE-specific search space is quasi co-located with the DM-RS antenna port associated with PBCH reception with respect to delay spread, Doppler spread, Doppler shift, average delay, and spatial Rx parameters.

For each serving cell that a UE is configured to monitor PDCCH in a search space other than Type0-PDCCH common search space, the UE is configured the following:

- a number of search space sets by higher layer parameter *search-space-config*;
- for each search space set in a control resource set p
    - an indication that the search space set is a common search space set or a UE-specific search space set by higher layer parameter *Common-search-space-flag*;
    - a number of PDCCH candidates $M_p^{(L)}$ per CCE aggregation level L by higher layer parameters *Aggregation-level-1*, *Aggregation-level-2*, *Aggregation-level-4*, *Aggregation-level-8*, and *Aggregation-level-16*, for CCE aggregation level 1, CCE aggregation level 2, CCE aggregation level 4, CCE aggregation level 8, and CCE aggregation level 16, respectively;
    - a PDCCH monitoring periodicity of k_p slots by higher layer parameter *Monitoring-periodicity-PDCCH-slot*;

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- a PDCCH monitoring offset of o_p slots, where $0 \le o_p < k_p$, by higher layer parameter *Monitoring-offset-PDCCH-slot*;
- a PDCCH monitoring pattern within a slot, indicating first symbol(s) of the control resource set within a slot for PDCCH monitoring, by higher layer parameter *Monitoring-symbols-PDCCH-within-slot*.

A UE determines a PDCCH monitoring occasion from the PDCCH monitoring periodicity, the PDCCH monitoring offset, and the PDCCH monitoring pattern within a slot.

A PDCCH UE-specific search space $S_{k_p}^{(L)}$ at CCE aggregation level $L \in \{1, 2, 4, 8, 16\}$ is defined by a set of PDCCH candidates for CCE aggregation level L.

If a UE is configured with higher layer parameter *CrossCarrierSchedulingConfig* for a serving cell the carrier indicator field value corresponds to the value indicated by *CrossCarrierSchedulingConfig*.

For a serving cell on which a UE monitors PDCCH candidates in a UE-specific search space, if the UE is not configured with a carrier indicator field, the UE shall monitor the PDCCH candidates without carrier indicator field. For a serving cell on which a UE monitors PDCCH candidates in a UE-specific search space, if a UE is configured with a carrier indicator field, the UE shall monitor the PDCCH candidates with carrier indicator field.

A UE is not expected to monitor PDCCH candidates on a secondary cell if the UE is configured to monitor PDCCH candidates with carrier indicator field corresponding to that secondary cell in another serving cell. For the serving cell on which the UE monitors PDCCH candidates, the UE shall monitor PDCCH candidates at least for the same serving cell.

For a control resource set p, the CCEs corresponding to PDCCH candidate $m_{n_{CI}}$ of the search space for a serving cell corresponding to carrier indicator field value n_{CI} are given by

$$L \cdot \left\{ \left(Y_{p,k_p} + \left\lfloor \frac{m_{n_{CI}} \cdot N_{\mathrm{CCE},p}}{L \cdot M_{p,\max}^{(L)}} \right\rfloor + n_{CI} \right) \bmod \left\lfloor N_{\mathrm{CCE},p} / L \right\rfloor \right\} + i$$

where

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for any common search space, $Y_{p,k_p} = 0$;

for a UE-specific search space, $Y_{p,k_p} = (A_p \cdot Y_{p,k_p-1}) \bmod D$, $Y_{p,-1} = n_{\text{RNTI}} \neq 0$, $A_0 = 39827$, $A_1 = 39829$, and $D = 65537$;

$i = 0, \cdots, L-1$;

n_{CI} is the carrier indicator field value if the UE is configured with a carrier indicator field for the serving cell on which PDCCH is monitored; otherwise, including for any common search space, $n_{CI} = 0$;

$N_{\text{CCE},p}$ is the number of CCEs, numbered from 0 to $N_{\text{CCE},p} - 1$, in control resource set p;

$m_{n_{CI}} = 0, \ldots, M_{p,n_{CI}}^{(L)} - 1$, where $M_{p,n_{CI}}^{(L)}$ is the number of PDCCH candidates the UE is configured to monitor for aggregation level L for a serving cell corresponding to n_{CI};

for any common search space, $M_{p,\max}^{(L)} = M_{p,0}^{(L)}$;

for a UE-specific search space, $M_{p,\max}^{(L)}$ is the maximum of $M_{p,n_{CI}}^{(L)}$ for all corresponding DCI formats over all configured n_{CI} values for a CCE aggregation level L in control resource set p;

the RNTI value used for n_{RNTI} is defined in [5, TS 38.212] and in [6, TS 38.214].

A UE configured to monitor PDCCH candidates in a serving cell with a DCI format size with carrier indicator field and CRC scrambled by C-RNTI, where the PDCCH candidates may have one or more possible values of carrier indicator field for the DCI format size, shall assume that an PDCCH candidate with the DCI format size may be transmitted in the serving cell in any PDCCH UE specific search space corresponding to any of the possible values of carrier indicator field for the DCI format size.

[0035] In 3GPP TS 38.331, *PDCCH-Config* IE in the RRC standard is quoted as follows:

PDCCH-Config

The *PDCCH-Config* IE is used to configure UE specific PDCCH parameters such as control resource sets (CORESET), search spaces and additional parameters for acquiring the PDCCH.

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***PDCCH-Config* information element**

```
-- ASN1START

-- TAG-PDCCH-CONFIG-START


-- Downlink control channel related parameters

PDCCH-Config ::=                SEQUENCE {

-- List of Control Resource Sets (CORESETs) to be used by the
UE

controlResourceSetToAddModList        SEQUENCE(SIZE
(1..maxNrofControlResourceSets)) OF ControlResourceSet
   OPTIONAL,

controlResourceSetToReleaseList       SEQUENCE(SIZE
(1..maxNrofControlResourceSets)) OF ControlResourceId
   OPTIONAL


searchSpacesToAddModList           SEQUENCE(SIZE
(1..maxNrofSearchSpaces) OF SearchSpace

OPTIONAL,

searchSpacesToReleaseList          SEQUENCE(SIZE
(1..maxNrofSearchSpaces) OF SearchSpaceId               OPTIONAL


```


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```
• -- FFS: Is this timing information applicable to the entire
PDCCH or could it be different per CORESET?

• -- FFS: Is there a default timing (to be used at least until
first reconfiguration). Are the fields optionally present?

• timing                    SEQUENCE {

•    dl-assignment-to-DL-data        TYPE_FFS!,

•    ul-assignment-to-UL-data        TYPE_FFS!,

•    dl-data-to-UL-ACK            TYPE_FFS!

• }


• OPTIONAL,

•

• }

•

• -- A time/frequency control resource set (CORESET) in which to
search for downlink control information (see 38.213, section
x.x.x.x)FFS_Ref

• ControlResourceSet ::=            SEQUENCE {

• controlResourceSetId            ControlResourceSetId,

•

• -- Frequency domain resources for the CORESET. The network
ensures that the CORESET is within the BWP configured for a UE.
(see 38.213, REF)
```


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- frequencyDomainResources TYPE_FFS!,
- -- Starting OFDM symbol for the CORESET (see 38.213, REF)
- startSymbol INTEGER (0..maxCoReSetStartSymbol),
- -- Contiguouse time duration of the CORESET in number of symbols see 38.213, section x.x.x.x)FFS_Ref
- duration INTEGER (1..maxCoReSetDuration),
- -- Resource Element Groups (REGs) can be bundled to create REG bundles. This parameter defines the size of such bundles.
- -- (see 38.211, section 7.3.2.2)
- reg-BundleSize ENUMERATED {n2, n3, n6},
- -- Mapping of Control Channel Elements (CCE) to Resource Element Groups (REG). (see 38.211, 38.213, FFS_REF)
- cce-reg-MappingType ENUMERATED { interleaved, nonInterleaved },
- -- Precoder granularity in frequency domain (see 38.213, section FFS_REF)
- precoderGranularity TYPE_FFS!,
- -- Corresponds to L1 parameter 'CORESET-interleaver-rows' (see 38.211, 38.213, section FFS_Section)
- interleaverRows ENUMERATED {n2, n3, n6}
- OPTIONAL,

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```
•
• -- Corresponds to L1 parameter 'CORESET-shift-index' (see
38.211, 38.213, section FFS_Section)
• shiftIndex                    FFS_Value

• OPTIONAL,
•
• -- Reference to a configured TCI State providing QCL
configuration/indication for PDCCH.
• -- Corresponds to L1 parameter 'TCI-StateRefId' (see 38.211,
38.213, section FFS_Section)
• tci-
StateRefId                FFS_Value

• OPTIONAL,
•
• -- PDCCH DMRS scrambling initalization. Corresponds to L1
parameter 'PDCCH-DMRS-Scrambling-ID' (see 38.214, section 5.1)
• -- When the field is absent the UE applies the value TBD/FFS
• pdcch-DMRS-
ScramblingID            FFS_Value

• OPTIONAL
• }
```


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```
•
• -- ID of a Control Resource Set.
• ControlResourceSetId ::=          INTEGER
(0..maxNrofControlResourceSets-1)
•
• -- A search space defines how/where to search for PDCCH
candidates. A search space is associated with one Control
Resource Set
• SearchSpace ::=               SEQUENCE {
• searchSpaceId                 SearchSpaceId,
•
• -- The CORESET applicable for this SearchSpace.
• -- FFS: Value 0 identifies the common CORESET configured in
MIB?
• -- FFS: Values 1..maxNrofControlResourceSets-1 identify
CORESETs configured by dedicated signalling?
• controlResourceSetId            ControlResourceSetId,
•
• -- Slots for PDCCH Monitoring configured as periodicity and
offset. Corresponds to L1 parameters 'Montoring-periodicity-
PDCCH-slot' and
• -- 'Montoring-offset-PDCCH-slot' (see 38.213, section 10)
• -- sl15, sl10, sl20 FFS
```


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```
• monitoringSlotPeriodicityAndOffset    CHOICE {
•    sl1                                NULL,
•    sl2                                INTEGER (0..1),
•    sl5                               INTEGER (0..4),
•    sl10                              INTEGER (0..9),
•    sl20                              INTEGER (0..19)
• }

• OPTIONAL,
•
• -- Symbols for PDCCH monitoring in the slots configured for
PDCCH monitoring (see monitoringSlotPeriodicityAndOffset).
• -- The most significant (left) bit represents the first OFDM
in a slot. The least significant (right) bit represents the last
symbol.
• -- Corresponds to L1 parameter 'Montoring-symbols-PDCCH-
within-slot' (see 38.213, section 10)
• monitoringSymbolsWithinSlot             BIT STRING (SIZE
(14))
• OPTIONAL,
•
• -- Number of candidates per aggregation level. Corresponds to
L1 parameter 'Aggregation-level-1' to 'Aggregation-level-8'
```


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```
-- (see 38.213, section 10)
nrofCandidates                    SEQUENCE {
    aggregationLevel1                 ENUMERATED {n0, n1, n2, n3,
n4, n5, n6, n8},
    aggregationLevel2                 ENUMERATED {n0, n1, n2, n3,
n4, n5, n6, n8},
    aggregationLevel4                 ENUMERATED {n0, n1, n2, n3,
n4, n5, n6, n8},
    aggregationLevel8                 ENUMERATED {n0, n1, n2, n3,
n4, n5, n6, n8}
}
```

[0036] The following terminology and assumption may be used hereafter in the detailed description:

- BS: a network central unit or a network node in NR which is used to control one or multiple TRPs which are associated with one or multiple cells. Communication between BS and TRP(s) is via fronthaul. BS may be referred to as central unit (CU), eNB, gNB, or NodeB.
- TRP: a transmission and reception point provides network coverage and directly communicates with UEs. TRP may be referred to as distributed unit (DU) or network node.
- Cell: a cell is composed of one or multiple associated TRPs, i.e. coverage of the cell is composed of coverage of all associated TRP(s). One cell is controlled by one BS. Cell may be referred to as TRP group (TRPG).
- NR-PDCCH: A channel carries downlink control signal which is used to control communication between a UE and a network side. A network transmits NR-PDCCH on

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configured control resource set (CORESET) to the UE.

- Slot: a scheduling unit in NR. Slot duration is 14 OFDM symbols.
- Mini-slot: a scheduling unit with duration less than 14 OFDM symbols.

[0037] In the current NR standard as disclosed in 3GPP R1-1721343 and TS 38.331, a CORESET can be configured by indicating time duration and a bit map. The bit map may indicate at least a starting OFDM symbol for monitoring the CORESET in a slot. Each bit in the bit map corresponds to an OFDM symbol in a slot. If a bit position in the bit map has a value of one, it represents a starting OFDM symbol for monitoring the CORESET. The CORESET may be monitored from at least a starting OFDM symbol(s) indicated by the bit map and occupying following OFDM symbol(s) until the configured time duration is reached. For example, if the time duration of a CORESET is configured as 2 and the bit map indicates 10000000000000, the UE may monitor the CORESET (receive at least a PDCCH) on OFDM symbol #0 and #1 in a slot.

[0038] However, if a bit map indicates a starting OFDM symbol belonging to the following OFDM symbol(s) of previous starting OFDM symbol indicated by the bit map (e.g., time duration of a CORESET is 2 and the bit map is 1100000000000000), a UE may be confused about the configuration. If this situation does not specify nor is captured in the standard, how a UE treat this situation needs further consideration. In addition, if the bit map indicates a starting OFDM symbol on the last few OFDM symbols of a slot, this may create a problem where the CORESET may be configured across a slot boundary. For example, if time duration of a CORESET is 2 and the bit map is 00000000000001, how a UE handle this configuration also needs further consideration. Potential solutions are described below.

[0039] According to one solution, a restriction on the configuration of a CORESET is established. The UE does not expect to receive a CORESET configuration with an overlap OFDM symbols indicated by a bit map indication and the CORESET duration and/or with a CORESET monitoring pattern across a slot boundary.

[0040] According to another solution, the UE is configured to or could deal with one of the above-possible scenarios. For example, a UE is configured with a CORESET. Alternatively, the UE receives a signal indicating configuration of a CORESET. The configuration of the

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CORESET includes at least time duration of the CORESET and a bit map. The bit map comprises 14 bits. A set of the bit position(s) in the bit map have value one. The set of bit position(s) indicates the starting OFDM symbol(s) in a slot for monitoring the CORESET. The interval (or distance) between each bit position (indicating value one) in the set (or bitmap) is larger than or equal to a number. The interval (or distance) between two bit positions indicating the value one in the bit map is larger than or equal to a number. The interval (or distance) between two neighboring bit positions indicating value one in the set is larger than or equal to a number. Two neighboring bit positions indicating the value one could be the two closest bit positions indicating value 1. An interval or distance between two bit positions could be a number of bits between the two bit positions. The two bit positions could be neglected when calculating the interval or distance. For example, an interval or distance between two bit positions indicating value 1 for a bitmap "10001000000000" is 3. Alternatively, an interval or distance between two bit positions could be difference of the two bit positions.

[0041] In one embodiment, the number is the time duration of the CORESET. Alternatively, the number is the time duration of the CORESET minus one. In another alternative, the number is the maximum time duration of the CORESET minus one. For example, if time duration of a CORESET is configured as 2, a bit map of a CORESET has a restriction that interval between two bit positions indicating value one is larger than or equal to 2 minus 1 (e.g., the bit map is 10100000000000). The UE does not expect to receive a configuration of a bit map such that the interval (or distance) between the two bit positions indicating value one in the bit map is smaller than the number (e.g., the bit map is 11000000000000). The UE could ignore a configuration of the bit map such that the interval (or distance) between two bit positions indicating value one in the bit map is smaller than the number (e.g., the bit map is 11000000000000 when the number is 1). The UE could ignore part of the bit map such that the interval (or distance) between the bit positions indicating value one in the part of the bit map is smaller than the number (e.g., if the bit map is 11000000100000, the UE ignores the first two 1 and applies the last 1 when the number is 1). The UE does not apply a configuration of the bit map such that the interval (or distance) between two bit positions indicating value one in the bit map is smaller than the number (e.g., the bit map is 11000000000000 when the number is 1).

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[0042] In one embodiment, a base station does not configure the UE with a bit map such that the interval (or distance) between two bit positions indicating value one in the bit map is smaller than the number (e.g., the bit map is 11000000000000 when the number is 1). The most significant bit in the bit map represents the first OFDM symbol in a slot. The least significant bit in the bit map represents the last OFDM symbol in a slot. The signal could be *PDCCH-Config.* The bitmap could be monitoringSymbolsWithinSlot. The time duration could be CORESET-time-duration. The UE may monitor the CORESET on the OFDM symbol(s) in a slot based on the signal. The UE may monitor the CORESET on OFDM symbol(s) starting from each bit position in the set in a slot.

[0043] Alternatively, the bit map can indicate at least a monitoring occasion for the CORESET by indicating a starting OFDM symbol with the following contiguous OFDM symbol(s) until the time duration of the CORESET is reached. The UE may interpret the bit map based on the time duration of the CORESET. For example, when a UE is configured with a time duration 2 and a bit map "11011000000000", the UE monitors the CORESET the following symbols in a slot: {1st symbol,2nd symbol} and {4th symbol, 5th symbol}.

[0044] Within a slot, different monitoring occasions for the CORESET indicated by the bit map can be separated by at least one bit position indicating the value 0. If the bit map indicates a number of contiguous bit position(s) with the value 1, which the number is smaller than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 indicating a monitoring occasion for the CORESET with time duration as the number. For example, when a UE is configured with time duration 3 and a bit map "11000101011100", the UE monitors CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {6th symbol}, {8th symbol}, and {10th symbol, 11th symbol, 12th symbol}. In this example, the UE may interpret the number of contiguous bit position(s) indicating value 1 in the bit map which is smaller than the time duration 3 as a CORESET monitoring occasion with the time duration same as the contiguous number of the value 1.

[0045] If a bit map indicates a number of contiguous bit position(s) with the value 1, wherein the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as contiguous monitoring occasions for the CORESET with the time duration or smaller than the time duration. More specifically, if the

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number of contiguous bit position(s) indicating the value 1 is multiple of the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as contiguous monitoring occasion(s) for the CORESET with the time duration. If the number of contiguous bit position(s) indicating the value 1 is not a multiple of the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as that earlier contiguous bit(s) indicates contiguous monitoring occasion(s) for the CORESET with the time duration and the last orphan bit(s) indicates a monitoring occasion for CORESET with time duration smaller than the time duration of the CORESET which depends on number of last orphan bit(s). Alternatively, the last orphan bit(s) in the number of contiguous bit(s) with the value 1 can be ignored by the UE. For example, when a UE is configured with a time duration 2 and a bit map "11110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {3rd symbol, 4th symbol}. In another example, when a UE is configured with time duration 2 and a bit map "1110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {3rd symbol}. In a similar example, when a UE is configured with a time duration 2 and a bit map "1110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}. In this example, the UE ignores {3rd symbol} indicated by the bit map.

[0046] Alternatively, if bit map indicates a number of contiguous bit position(s) with value 1, which the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as at least a monitoring occasion for the CORESET in which the time duration of the CORESET is the number of the contiguous bit position(s) with value 1. For example, when a UE is configured with the time duration 2 and a bit map "11100110000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol, 3rd symbol }, {5th symbol, 6th symbol}.

[0047] Alternatively, if a bit map indicates a number of contiguous bit position(s) with value 1 wherein the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as at least a monitoring occasion for the CORESET in which the time duration of the CORESET is the maximum time duration of a CORESET. For example, when a UE is configured with time duration 2 and a bit map "11110000000000", the UE monitors the CORESET for the following symbols in a slot:

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{1st symbol, 2nd symbol, 3rd symbol }, {4th symbol} when the maximum time duration of the CORESET is 3.

[0048] Alternatively, the signal indicates at least a bit map. The UE may receive the PDCCH on the OFDM symbol(s) in a slot based on the bit map. The bit map indicates at least a bit position and/or at least on a contiguous bit position(s) as value one. The UE may monitor a CORESET on the OFDM symbol(s) in a slot based on the bit map. The UE may view the contiguous bit position(s) as a CORESET. The UE may not expect to have the bit map indicating the number of the contiguous bit position(s) with value one exceeds maximum time duration for a CORESET.

[0049] Alternatively, if the UE receives the bit map indicating the number of the contiguous bit position(s) with value one exceeds maximum time duration for a CORESET, the UE may ignore part of the indication of the bit map. Alternatively, the UE may ignore the whole indication of the bit map. For example, when a UE is configured with a bit map "11010111000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {4th symbol}, {6th symbol, 7th symbol, 8th symbol} when the maximum time duration of the CORESET is 3. In a similar example, when a UE is configured with a bit map "11100001100000", the UE may ignore the first three 1's because it will exceed the maximum time duration if the maximum time duration of CORESET is 2. In the above example, the UE may monitor the CORESET in the following symbols in a slot: {8th symbol, 9th symbol}.

[0050] The time duration of a CORESET can be determined based on the bit map and each contiguous bit position(s) with the value one in the bit map. The signal does not indicate the time duration for a CORESET. The signal indicates a different configuration for different time duration CORESET(s). The configuration may comprise at least the Control Channel Element(CCE)- Resource Element Group(REG) mapping type, aggregation level, search space configuration, and frequency resource assignment. The configuration could be *PDCCH-config*.

[0051] In one embodiment, a UE is configured with a CORESET. Alternatively, the UE receives a signal indicating the configuration of a CORESET. The configuration of the CORESET comprises at least time duration of the CORESET and a bit map. The bit map comprises 14 bits. The first bit position and the second bit position in the bit map indicate the value one. The interval (or distance) between the first bit position and the second bit position is

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smaller than a number. The interval (or distance) between two bit positions indicating the value one in the bitmap is larger than or equal to a number. The interval (or distance) between two neighboring bit positions indicating the value one in the set is smaller than a number. The two neighboring bit positions indicating the value one could be the two closest bit positions indicating the value 1. An interval or distance between two bit positions is the number of bits between the two bit positions. The two bit positions could be neglected when calculating the interval or distance. For example, an interval or distance between two bit positions indicating the value 1 for a bitmap "10001000000000" is 3. More specifically, the number is the time duration of the CORESET. Alternatively, the number is time duration of the CORESET minus one. Alternatively, the number is the maximum time duration of the CORESET minus one. Alternatively, the number is the maximum time duration of the CORESET minus one. For example, if time duration of a CORESET is configured as 2, a bit map of a CORESET may be 11000000000000. The first bit position is closer to the most significant bit in the bit map than the second bit position. The most significant bit in the bit map represents the first OFDM symbol in a slot. The least significant bit in the bit map represents the last OFDM symbol in a slot. The signal could be a *PDCCH-Config*. The bitmap could be monitoringSymbolsWithinSlot. The time duration could be a CORESET-time-duration.

[0052] The UE may monitor the CORESET on OFDM symbol(s) in a slot based on the bit map. The UE may monitor the CORESET on OFDM symbol(s) in a slot starting from the bit position(s) in the bit map indicating a value. The value could be one. The UE may monitor the CORESET on OFDM symbol(s) in a slot starting from the bit position(s) in the bit map indicating the value. Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in a slot starting from the bit position(s) in the bit map indicating the value excluding both or one of two bit position(s) wherein the interval (or distance) between the two bit positions is smaller than the number.

[0053] Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value excluding the first bit position and the second bit position. Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value excluding the first bit position. Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value excluding the second bit position.

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For example, when a UE is configured with time duration 2 and a bit map "11000101000000", the UE monitors the CORESET for the following symbols in a slot: {6th symbol,7th symbol} and {8th symbol, 9th symbol}. In this example, the bit locations with too short interval/distance are excluded. In another example, when a UE is configured with time duration 2 and a bit map "11000101000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol}. In this example, one (the latter one) of the two bit locations with too short interval/distance are excluded. A similar example could be that when a UE is configured with time duration 2 and a bit map "11000101000000", the UE monitors the CORESET for the following symbols in a slot: {2nd symbol, 3rd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol}., e.g. ,excluding the earlier one.

[0054] Alternatively, the OFDM symbols for different CORESET could overlap. The OFDM symbol between two CORESETs could overlap if the interval (or distance) between the starting position of the two CORESETs is shorter than the number. In one example, when a UE is configured with a time duration of 2 and a bit map "11000101000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {2nd symbol, 3rd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol}.

[0055] Alternatively, the CORESET time duration of CORESETs associated with a bitmap within a slot could be different. The CORESET time duration could be different from the configured value if the interval (or distance) between starting symbol of two CORESETs is shorter than the number. In one example, when a UE is configured with a time duration of 2 and a bit map "11000101000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol}, {2nd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol}. It can be observed that the CORESETs corresponding to the first two bits in the bitmap have 1 symbol time duration even if the configured value is 2, e.g., due to short interval or distance. In a similar example, when a UE is configured with a time duration of 2 and a bit map "11100101000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol}, {2nd symbol }, {3rd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol} or {1st symbol, 2nd symbol }, {3rd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol} or alternatively {1st symbol}, {2nd symbol, 3rd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol}. It can be observed later two alternatives allow one CORESET corresponding to the first three bits in

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the bit map to have a CORESET time duration with a configured value, i.e., 2 and one CORESET have time duration which is different from the configured value, e.g., 1. For bit locations corresponding to short interval or distance, time duration can be used as a maximum time duration or an upper bound of time duration. For bit locations corresponding to a short interval or distance, a value of 1 could mean a corresponding symbol containing the CORESET and the corresponding symbol is not the first symbol or starting symbol of the CORESET.

[0056] Different alternatives or different examples can be applied in different slot. For example, the UE may monitor the CORESET on OFDM symbol(s) in an even slot (i.e., a slot with even slot number) starting from the bit position(s) in the bit map indicating the value excluding the first bit position, and the UE may monitor the CORESET on OFDM symbol(s) in an odd slot starting from the bit position(s) in the bit map indicating the value excluding the second bit position or vice versa. Different alternatives or examples can be applied to a configuration or an indication. The configuration or indication can be transmitted by a base station to a UE.

[0057] In one embodiment, the UE may ignore the configuration of the CORESET. The UE may transmit a Negative Acknowledgement (NACK) as a feedback of the signal.

[0058] In one alternative, the UE may monitor the CORESET on OFDM symbol(s) in an even slot based on the bit map excluding the second bit position. Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in an odd slot based on the bit map excluding the second bit position. Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in an even slot based on the bit map excluding the first bit position. Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in an odd slot based on the bit map excluding the first bit position.

[0059] The signal may include a pattern for indicating the bit map. The pattern indicates a slot level bit map. If the bit position of the slot level bit map corresponding to a slot indicates the value of one, the UE monitors the CORESET in the slot based on the bit map excluding the second bit position. If the bit position of the slot level bit map corresponding to a slot indicates the value of one, the UE monitors the CORESET in the slot based on the bit map excluding the first bit position. Alternatively, if bit position of the slot level bit map corresponding to a slot indicates the value of zero, the UE monitors the CORESET in the slot based on the bit map

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excluding the first bit position. Alternatively, if bit position of the slot level bit map corresponding to a slot indicates the value of zero, the UE monitors the CORESET in the slot based on the bit map excluding the second bit position.

[0060] The UE can be configured with two CORESETs (e.g., two CORESET IDs) associated with a search space or a bitmap. The time durations of the two CORESETs can be different. For example, one time duration is longer and the other time duration is shorter. For a first CORESET starting symbol, the UE determines one CORESET configuration from the two CORESET configurations according to a distance or interval between the first CORESET starting symbol and a second CORESET starting symbol. The second CORESET starting symbol could be a next CORESET starting symbol in a bitmap after the first CORESET starting symbol.

[0061] In another alternative, the UE determines a CORESET configuration with longer time duration if the distance or the interval between the first CORESET starting symbol and the second CORESET starting symbol is longer than a number. Alternative, the UE determines a CORESET configuration with shorter time duration if the distance or the interval between the first CORESET starting symbol and the second CORESET starting symbol is shorter than a number. The number could be the longer time duration minus 1. Alternatively, the number could be the longer time duration.

[0062] The bitmap is associated with the first CORESET configuration and the second CORESET configuration. For example, when a UE is configured with a first CORESET with time duration 2, a second CORESET with time duration 1 and a bit map "11100101000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol}, {2nd symbol }, {3rd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol}. For the CORESET in {1st symbol}, {2nd symbol }, {3rd symbol}, the configuration of the second COREST is applied. For the CORESET in {6th symbol,7th symbol} and {8th symbol, 9th symbol}, the configuration of the second CORESET is applied.

[0063] The UE can be configured with two CORESET time durations for a given CORESET, search space, or bitmap. In one example, one CORESET time duration is longer and the other is shorter.

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[0064] For a first CORESET starting symbol, the UE determines one CORESET time duration from the two configured CORESET time durations according to a distance or interval between the first CORESET starting symbol and a second CORESET starting symbol. Alternatively, the second CORESET starting symbol could be a next CORESET starting symbol in a bitmap after the first CORESET starting symbol. In one method, the UE determines a longer CORESET time duration if the distance or the interval between the first CORESET starting symbol and the second CORESET starting symbol is longer than a number. Alternatively, the UE determines a shorter CORESET time duration if the distance or the interval between the first CORESET starting symbol and the second CORESET starting symbol is shorter than a number.

[0065] The number could be the longer time duration. Alternatively, the number could be the longer time duration minus 1. The bitmap is associated with a CORESET whose configured time duration is the first CORESET time duration and the second CORESET time duration. For example, when a UE is configured with a first CORESET with time duration 1 and 2, and a bit map "11100101000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol}, {2nd symbol }, {3rd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol}. For the CORESET in {1st symbol}, {2nd symbol }, {3rd symbol}, the CORESET time duration of 1 is applied. For the CORESET in {6th symbol,7th symbol} and {8th symbol, 9th symbol}, the CORESET time duration 2 is applied.

[0066] The UE can be configured with a default CORESET, which is different from the CORESET indicated by the signal. The time duration of the default CORESET may be shorter than or equal to the duration indicated by the signal. More specifically, the time duration of the default CORESET can be one or two. The time duration of the default CORESET is the interval between the first bit position and the second bit position. The UE may monitor the CORESET on the OFDM symbol(s) in a slot based on the bit map excluding the first bit position and/or the second bit position. The UE may monitor the default CORESET on OFDM symbol(s) in the slot based on the first bit position and/or the second bit position.

[0067] Alternatively, the bit map can indicate at least a monitoring occasion for the CORESET by indicating a starting OFDM symbol following contiguous OFDM symbol(s) until the time duration of the CORESET is reached. The UE may interpret the bit map based on the

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time duration of the CORESET. For example, when a UE is configured with time duration 2 and a bit map "11011000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol,2nd symbol} and {4th symbol, 5th symbol}. Different monitoring occasions for the CORESET indicated by the bit map can be separated by at least one bit position indicating the value 0. If the bit map indicates a number of contiguous bit position(s) with the value 1, which is a number is smaller than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 indicating a monitoring occasion for the CORESET with the time duration as the number. For example, when a UE is configured with time duration 3 and a bit map "11000101011100", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {6th symbol}, {8th symbol}, and {10th symbol, 11th symbol, 12th symbol}. In this example, the UE may interpret the number of contiguous bit position(s) indicating the value 1 in the bit map which is smaller than the time duration 3 as a CORESET monitoring occasion with the time duration as the contiguous number of value 1.

[0068] If bit map indicates a number of contiguous bit position(s) with the value 1, which is the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with value 1 as contiguous monitoring occasions for the CORESET with the time duration or smaller than the time duration. More specifically, if the number of contiguous bit position(s) indicating the value 1 is multiple of the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as contiguous monitoring occasion(s) for the CORESET for the time duration.

[0069] If the number of contiguous bit position(s) indicating the value 1 is not a multiple of the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as those earlier contiguous bit(s) indicating contiguous monitoring occasion(s) for the CORESET for the time duration and the last orphan bit(s) indicating a monitoring occasion for the CORESET for the time duration smaller than the time duration of the CORESET which depends on number of last orphan bit(s).

[0070] Alternatively, the last orphan bit(s) in the number of contiguous bit(s) with the value one can be ignored by the UE. For example, when a UE is configured with a time duration 2 and a bit map "11110000000000", the UE monitors the CORESET for the following symbols

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in a slot: {1st symbol, 2nd symbol}, {3rd symbol, 4th symbol}. In another example, when a UE is configured with time duration 2 and a bit map "1110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {3rd symbol}. In a similar example, when a UE is configured with a time duration 2 and a bit map "1110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}. In this example, the UE ignores the {3rd symbol} indicated by the bit map.

[0071] In one embodiment, a UE is configured with a CORESET. Alternatively, the UE receives a signal indicating configuration of a CORESET. The configuration of the CORESET includes at least the time duration of the CORESET and a bit map. The bit map includes 14 bits. A set of bit position(s) in the bit map have a value of one. The set of bit position(s) indicates the starting OFDM symbol(s) in a slot for monitoring the CORESET. The interval (or distance) between each bit position (indicating the value of one) in the set (or bitmap) and the least significant bit in the bit map is larger than or equal to a number. The interval (or distance) between the last bit position (indicating the value one) in the set (or bitmap) and the least significant bit in the bit map is larger than or equal to a number. An interval or distance between two bit positions is the number of bits between the two bit positions. The two bit positions could be neglected when calculating the interval or distance. For example, an interval or distance between two bit position indicating the value 1 for a bitmap "10001000000000" is 3. Alternatively, an interval or distance between two bit positions could be the difference of the two bit positions.

[0072] In one embodiment, the number is a time duration of the CORESET. Alternatively, the number is time duration of the CORESET minus one. Alternatively, the number is the maximum time duration of the CORESET minus one. Alternatively, the number is the maximum time duration of the CORESET minus one. For example, if time duration of a CORESET is configured as 2, a bit map of a CORESET has a restriction that the interval between each bit position in the set and the least significant bit in the bit map is larger than or equal to 2 minus 1 (e.g., the bit map is 00000000000010).

[0073] In another example, the UE does not expect to receive a configuration of a bit map such that the interval (or distance) between each bit position indicating 1 in the bit map and the least significant bit in the bit map (or between the last bit indicating 1 in the bitmap and the

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least significant bit in the bit map) is smaller than the number (e.g., the bit map is 00000000000001).

[0074] The UE could ignore a configuration of a bit map such that the interval (or distance) between each bit position indicating 1 in the bit map and the least significant bit in the bit map (or between the last bit indicating 1 in the bitmap and the least significant bit in the bit map) is smaller than the number (e.g., the bit map is 00000000000001). The UE could ignore a part of a bit map such that the interval (or distance) between the bit position indicating 1 in the part of the bit map and the least significant bit in the bit map (or between the last bit indicating 1 in the bitmap and the least significant bit in the bit map) is smaller than the number (e.g., the bit map is 10000000000001 in which the UE applies the first 1 and ignore the last 1).

[0075] In another example, the UE does not apply a configuration of a bit map such that the interval (or distance) between each bit position indicating 1 in the bit map and the least significant bit in the bit map (or between the last bit indicating 1 in the bitmap and the least significant bit in the bit map) is smaller than the number (e.g., the bit map is 00000000000001).

[0076] A base station does not configure a UE with a bit map such that the interval (or distance) between each bit position indicating 1 in the bit map and the least significant bit in the bit map (or between the last bit indicating 1 in the bitmap and the least significant bit in the bit map) is smaller than the number (e.g., the bit map is 00000000000001). The most significant bit in the bit map represents the first OFDM symbol in a slot. The least significant bit in the bit map represents the last OFDM symbol in a slot. The signal could be *PDCCH-Config*. The bitmap could be monitoringSymbolsWithinSlot. The time duration could be a CORESET-time-duration. The UE may monitor the CORESET on OFDM symbol(s) in a slot based on the signal. The UE may monitor the CORESET on OFDM symbol(s) starting from each bit position in the set in a slot.

[0077] If the bit map indicates a number of contiguous bit position(s) with the value 1, which the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as contiguous monitoring occasions for the CORESET with the time duration or smaller than the time duration. More specifically, if the number of contiguous bit position(s) indicating value 1 is a multiple of the time duration of the

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CORESET, the UE may interpret the number of contiguous bit position(s) with value 1 as contiguous monitoring occasion(s) for the CORESET for the time duration.

[0078] If the number of contiguous bit position(s) indicating value 1 is not a multiple of the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as those earlier contiguous bit(s) indicating contiguous monitoring occasion(s) for the CORESET with the time duration, and the last orphan bit(s) indicating a monitoring occasion for the CORESET with the time duration smaller than the time duration of the CORESET which depends on number of last orphan bit(s).

[0079] Alternatively, the last orphan bit(s) in the number of contiguous bit(s) with the value one can be ignored by the UE. For example, when a UE is configured with a time duration 2 and a bit map "11110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {3rd symbol, 4th symbol}. In another example, when a UE is configured with a time duration 2 and a bit map "11100000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {3rd symbol}. In a similar example, when a UE is configured with a time duration 2 and a bit map "11100000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}. In this example, the UE ignores {3rd symbol} indicated by the bit map.

[0080] Alternatively, if a bit map indicates a number of contiguous bit position(s) with the value 1, which is the number larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as at least a monitoring occasion for CORESET which the time duration of the CORESET is the number of contiguous bit position(s) with the value 1. For example, when a UE is configured with time duration 2 and a bit map "11100110000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol, 3rd symbol }, {5th symbol, 6th symbol}. Alternatively, if a bit map indicates a number of contiguous bit position(s) with the value 1, in which the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as at least a monitoring occasion for CORESET in which the time duration of the CORESET is the maximum time duration of a CORESET. For example, when a UE is configured with time duration 2 and a bit map "11110000000000", the UE monitors

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CORESET in the following symbols in a slot: {1st symbol, 2nd symbol, 3rd symbol }, {4th symbol} when maximum time duration of CORESET is 3.

[0081] Alternatively, the signal indicates at least a bit map. The UE may receive a PDCCH on the OFDM symbol(s) in a slot based on the bit map. The bit map indicates at least a bit position and/or at least on a contiguous bit position(s) as value one. The UE may monitor a CORESET on the OFDM symbol(s) in a slot based on the bit map. The UE may view the contiguous bit position(s) as a CORESET. The UE may not expect to have the bit map indicating the number of the contiguous bit position(s) with the value one exceeding a maximum time duration for a CORESET. Alternatively, if the UE receives the bit map indicating the number of the contiguous bit position(s) with the value one exceeding a maximum time duration for a CORESET, the UE may ignore part of the indication of the bit map. Alternatively, the UE may ignore the whole indication of the bit map. For example, when a UE is configured with a bit map "11010111000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {4th symbol}, {6th symbol, 7th symbol, 8th symbol} when the maximum time duration of CORESET is 3. In a similar example, when a UE is configured with a bit map "11100001100000", the UE may ignore the first three 1's because it will exceed the maximum time duration if the maximum time duration of the CORESET is 2. In the above example, the UE may monitor the CORESET for the following symbols in a slot: {8th symbol, 9th symbol}. The time duration of a CORESET can be determined based on the bit map and each contiguous bit position(s) with the value one in the bit map. The signal does not indicate the time duration for a CORESET. The signal indicates different configurations for the different time duration CORESET(s). The configuration may include at least CCE-REG mapping, aggregation level, search space configuration, and frequency resource assignment.

[0082] In another embodiment, a UE is configured with a CORESET. Alternatively, the UE receives a signal indicating a configuration of a CORESET. The configuration of the CORESET includes at least a time duration of the CORESET and a bit map. The bit map includes 14 bits. A set of bit position(s) in the bit map have a value of one. The set of bit position(s) indicates the starting OFDM symbol(s) in a slot for monitoring the CORESET. The interval (or distance) between a bit position in the set and the least significant bit in the bit map is smaller than a number. The interval (or distance) between the last bit position indicating a value of 1 in the bit map and the least significant bit in the bit map is smaller than a number. An

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interval or distance between two bit positions is a number of bits between the two bit positions. The two bit positions could be neglected when calculating the interval or distance. For example, an interval or distance between two bit positions indicating the value 1 for a bitmap "10001000000000" is 3.

[0083] More specifically, the number is a time duration of the CORESET. Alternatively, the number is a time duration of the CORESET minus one. Alternatively, the number is a maximum time duration of the CORESET minus one. Alternatively, the number is a maximum time duration of the CORESET minus one. For example, if the time duration of a CORESET is configured as 2, a bit map of a CORESET may be 00000000000001. The most significant bit in the bit map represents the first OFDM symbol in a slot. The least significant bit in the bit map represents the last OFDM symbol in a slot. The signal could be a *PDCCH-Config*. The bitmap could be monitoringSymbolsWithinSlot.

[0084] The time duration could be a CORESET-time-duration. The UE may monitor the CORESET on the OFDM symbol(s) in a slot based on the signal. The UE may monitor the CORESET on the OFDM symbol(s) starting from each bit position in the set in a slot. The UE may monitor the CORESET on the OFDM symbol(s) in a slot based on the bit map excluding the bit position. The UE may not expect to monitor the CORESET on OFDM symbol(s) in a slot starting from the bit position. The UE may be configured with a default CORESET, which is different from the CORESET indicated by the signal. The time duration of the default CORESET may be shorter than or equal to the duration indicated by the signal. The time duration of the default CORESET may be one or two. The time duration of the default CORESET is the interval between the bit position and the least significant bit in the bit map. The UE may monitor the CORESET on the OFDM symbol(s) in a slot based on the bit map excluding the bit position. The UE may monitor the default CORESET on tge OFDM symbol(s) in the slot based on the bit position.

[0085] The UE can be configured with two CORESETs (e.g., two CORESET IDs) associated with a search space or a bitmap. The time durations of the two CORESETs can be different. For example, a first duration is longer and a second duration is shorter. For a first CORESET starting symbol, the UE determines one CORESET configuration from the two CORESET configurations according to a distance or interval between the first CORESET

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starting symbol and the last symbol in a slot. The UE determines a CORESET configuration for the longer time duration if the distance or the interval between the first CORESET starting symbol and the last symbol in a slot is longer than a number. The UE determines a CORESET configuration for the shorter time duration if the distance or the interval between the first CORESET starting symbol and the last symbol in a slot is shorter than a number. The number could be the longer time duration minus 1. The number could be the longer time duration.

[0086] In one embodiment, the bitmap is associated with the first CORESET configuration and the second CORESET configuration. For example, when a UE is configured with a first CORESET with a time duration of 2, a second CORESET with a time duration of 1 and a bit map "00000101000001", the UE monitors the CORESET for the following symbols in a slot: {6^{th} symbol,7th symbol}, {8^{th} symbol, 9th symbol} and {14^{th} symbol}. For the CORESET in {14^{th} symbol}, the configuration of the second COREST is applied. For the CORESET in {6^{th} symbol,7th symbol} and {8^{th} symbol, 9th symbol}, the configuration of the second CORESET is applied.

[0087] The UE can be configured with two CORESET time durations for a given CORESET, a search space, or a bitmap. For example, one CORESET time duration is longer and the other time duration is shorter. For a first CORESET starting symbol, the UE determines one CORESET time duration from the two configured CORESET time durations according to a distance or interval between the first CORESET starting symbol and the last symbol in a slot. The UE determines the longer CORESET time duration if the distance or the interval between the first CORESET starting symbol and the last symbol in a slot is longer than a number. The UE determines the shorter CORESET time duration if the distance or the interval between the first CORESET starting symbol and the last symbol in a slot is shorter than a number. The number could be the longer time duration minus 1. Alternatively, the number could be the longer time duration. The bitmap is associated with a CORESET whose configured time duration is the first CORESET time duration and the second CORESET time duration. For example, when a UE is configured with a first CORESET with a time duration of 1 and 2 and a bit map "00000101000001", the UE monitors the CORESET for the following symbols in a slot: {6^{th} symbol,7th symbol}, {8^{th} symbol, 9th symbol} and {14^{th} symbol}. For the CORESET in {14^{th} symbol}, the CORESET time duration of 1 is applied. For the CORESET in {6^{th} symbol,7th symbol} and {8^{th} symbol, 9th symbol}, the CORESET time duration of 2 is applied.

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Alternatively, the OFDM symbols for a CORESET could span different slots. A CORESET could span a first slot and a second slot if the interval or distance between the last bit position indicating 1 in the first slot and the last symbol in the first slot is shorter than the number. The second slot is the next slot of the first slot. For example, when a UE is configured with a time duration 2 and a bit map "10000101000001", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {6th symbol,7th symbol}, {8th symbol, 9th symbol} and {14th symbol, 1st symbol of the next slot}. Alternatively, the CORESET time duration of CORESETs associated with a bitmap within a slot could be different. Alternatively, the CORESET time duration could be different from the configured value if the interval or distance between the last bit position indicating 1 in the first slot and the last symbol in the first slot is shorter than the number. For example, when a UE is configured with a time duration 2 and a bit map "10000101000001", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {6th symbol,7th symbol}, {8th symbol, 9th symbol} and {14th symbol}. It can be observed that the CORESETs corresponding to the last bit in the bitmap have 1 symbol time duration even if the configured value is 2 due to the short interval or distance to the last symbol of a slot.

[0088] Alternatively, if a bit map indicates a number of contiguous bit position(s) with value 1, in which the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as at least a monitoring occasion for the CORESET, in which the time duration of the CORESET is the number of contiguous bit position(s) with value 1. For example, when a UE is configured with a time duration 2 and a bit map "11100110000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol, 3rd symbol }, {5th symbol, 6th symbol}. Alternatively, if bit map indicates a number of contiguous bit position(s) with value 1, in which the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as at least a monitoring occasion for the CORESET, in which the time duration of the CORESET is the maximum time duration of a CORESET. For example, when a UE is configured with a time duration 2 and a bit map "11110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol, 3rd symbol}, {4th symbol} when the maximum time duration of the CORESET is 3.

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[0089] Alternatively, the signal indicates at least a bit map. The UE may receive a PDCCH on the OFDM symbol(s) in a slot based on the bit map. The bit map indicate at least a bit position and/or at least one contiguous bit position(s) as value one. The UE may monitor a CORESET on the OFDM symbol(s) in a slot based on the bit map. The UE may view the contiguous bit position(s) as a CORESET. The UE may not expect to have the bit map indicating number of the contiguous bit position(s) with value one exceeding a maximum time duration for a CORESET. Alternatively, if the UE receives the bit map indicating the number of the contiguous bit position(s) with value one exceeding a maximum time duration for a CORESET, the UE may ignore a part of the indication of the bit map. Alternatively, the UE may ignore the whole indication of the bit map. For example, when a UE is configured with a bit map "11010111000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {4th symbol}, {6th symbol, 7th symbol, 8th symbol} when the maximum time duration of CORESET is 3. In a similar example, when a UE is configured with a bit map "11100001100000", the UE may ignore the first three 1's because it will exceed the maximum time duration if the maximum time duration of CORESET is 2. In the above example, the UE may monitor the CORESET for the following symbols in a slot: {8th symbol, 9th symbol}. The time duration of a CORESET can be determined based on the bit map and each contiguous bit position(s) with value one in the bit map. The signal does not indicate a time duration for a CORESET. The signal indicates the different configurations for different time duration CORESET(s). The configuration may include at least a CCE-REG mapping, aggregation level, search space configuration, or frequency resource assignment.

[0090] According to one method, the UE receives a signal indicating at least a duration and a bit map, wherein a set of bit position(s) in the bit map indicates a value, and wherein an interval between each bit position in the set is larger than or equal to a number.

[0091] According to another method, the network transmits a signal indicating at least a duration and a bit map, wherein a set of bit position(s) in the bit map indicates a value, wherein interval between each bit position in the set is larger than or equal to a number.

[0092] In one or more of the above-disclosed methods, the value is one.

[0093] In one or more of the above-disclosed methods, the number is the duration.

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[0094] In one or more of the above-disclosed methods, the number is the duration minus one.

[0095] In one or more of the above-disclosed methods, the number is maximum duration, wherein the maximum duration is maximum time duration of a control resource set (CORESET).

[0096] In one or more of the above-disclosed methods, the number is maximum duration minus one, wherein the maximum duration is maximum time duration of a CORESET.

[0097] In one or more of the above-disclosed methods, the duration is a time duration of a CORESET.

[0098] In one or more of the above-disclosed methods, the bit map comprises 14 bits.

[0099] In one or more of the above-disclosed methods, the set of bit position(s) in the bit map indicates monitoring starting OFDM symbol(s) of a CORESET in a slot.

[00100] In one or more of the above-disclosed methods, the most significant bit in the bit map represents the first OFDM symbol in a slot.

[00101] In one or more of the above-disclosed methods, the least significant bit in the bit map represents the last OFDM symbol in a slot.

[00102] In one or more of the above-disclosed methods, the signal indicates configuration of a CORESET.

[00103] In one or more of the above-disclosed methods, the signal is a *PDCCH-config* IE which is used to configure UE-specific PDCCH parameters.

[00104] In one or more of the above-disclosed methods, the UE monitors a CORESET based on the signal.

[00105] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot based on the bit map.

[00106] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot starting from each bit position in the set.

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[00107] According to one method, the UE receives a signal indicating at least a duration and a bit map, wherein interval between a pair of bit position(s) indicating a value in the bit map is smaller than the duration.

[00108] According to one method, the network transmits a signal indicating at least a duration and a bit map, wherein interval between a pair of bit position(s) indicating a value in the bit map is smaller than the duration.

[00109] In one or more of the above-disclosed methods, the pair of bit position(s) comprises a first bit position and a second bit position.

[00110] In one or more of the above-disclosed methods, the first bit position is closer to the most significant bit in the bit map than the second bit position.

[00111] In one or more of the above-disclosed methods, the value is one.

[00112] In one or more of the above-disclosed methods, the duration is a time duration of a CORESET.

[00113] In one or more of the above-disclosed methods, the bit map comprises 14 bits.

[00114] In one or more of the above-disclosed methods, the most significant bit in the bit map represents the first OFDM symbol in a slot.

[00115] In one or more of the above-disclosed methods, the least significant bit in the bit map represents the last OFDM symbol in a slot.

[00116] In one or more of the above-disclosed methods, the signal indicates configuration of a CORESET.

[00117] In one or more of the above-disclosed methods, the signal is a *PDCCH-config* IE which is used to configure UE-specific PDCCH parameters.

[00118] In one or more of the above-disclosed methods, the UE monitors a CORESET based on the signal.

[00119] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot based on the bit map.

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[00120] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value.

[00121] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value excluding the pair of bit position.

[00122] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value excluding the first bit position of the pair.

[00123] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value excluding the second bit position of the pair.

[00124] In one or more of the above-disclosed methods, the UE ignores the signal.

[00125] In one or more of the above-disclosed methods, the UE transmits a Negative Acknowledgement (NACK) as a feedback of the signal.

[00126] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in an even slot based on the bit map excluding the second bit position of the pair.

[00127] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in an odd slot based on the bit map excluding the second bit position of the pair.

[00128] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in an even slot based on the bit map excluding the first bit position of the pair.

[00129] In one or more of the above-disclosed methods, the signal comprises a pattern for indicating the bit map.

[00130] In one or more of the above-disclosed methods, the pattern indicates a slot level bit map.

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[00131] In one or more of the above-disclosed methods, if bit position of the slot level bit map indicates one, the UE monitors a CORESET in a slot based on the bit map excluding the second bit position of the pair.

[00132] In one or more of the above-disclosed methods, if bit position of the slot level bit map indicates one, the UE monitors a CORESET in a slot based on the bit map excluding the first bit position of the pair.

[00133] In one or more of the above-disclosed methods, the UE monitors a CORESET in a slot based on the bit map and slot format of the slot.

[00134] In one or more of the above-disclosed methods, if the slot format of the slot indicates a set of OFDM symbol(s) as flexible or uplink which the set comprises part of OFDM symbols which start from the first bit position with the duration, the UE monitors a CORESET based on the bit map excluding the first bit position of the pair.

[00135] In one or more of the above-disclosed methods, if the slot format of the slot indicates a set of OFDM symbol(s) as flexible or uplink which the set comprises part of OFDM symbols which start from the second bit position with the duration, the UE monitors a CORESET based on the bit map excluding the second bit position of the pair.

[00136] In one or more of the above-disclosed methods, the UE is configured with a default CORESET, which is different from a CORESET indicated by the signal.

[00137] In one or more of the above-disclosed methods, the time duration of the default CORESET is shorter than the duration.

[00138] In one or more of the above-disclosed methods, the time duration of the default CORESET is one or two.

[00139] In one or more of the above-disclosed methods, the time duration of the default CORESET is the interval between the first bit position and the second bit position of the pair.

[00140] In one or more of the above-disclosed methods, the UE monitors the CORESET on OFDM symbol(s) in a slot based on the bit map excluding the pair of bit position(s) and monitors the default CORESET on OFDM symbol(s) in the slot based on the pair of bit position(s).

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[00141] According to another method, the UE receives a signal indicating at least a duration and a bit map, wherein a set of bit position indicates a value in the bit map, and wherein an interval between every bit position in the set and the least significant bit in the bit map is larger than or equal to a number.

[00142] According to another method, the network transmits a signal indicating at least a duration and a bit map, wherein a set of bit position indicates a value in the bit map, and wherein an interval between a bit position in the set and the least significant bit in the bit map is larger than or equal to a number.

[00143] In one or more of the above-disclosed methods, the value is one.

[00144] In one or more of the above-disclosed methods, the number is the duration.

[00145] In one or more of the above-disclosed methods, the number is the duration minus one.

[00146] In one or more of the above-disclosed methods, the number is a maximum duration, wherein the maximum duration is maximum time duration of a CORESET.

[00147] In one or more of the above-disclosed methods, the number is a maximum duration minus one, wherein the maximum duration is a maximum time duration of a CORESET.

[00148] In one or more of the above-disclosed methods, the duration is a time duration of a CORESET.

[00149] In one or more of the above-disclosed methods, the bit map comprises 14 bits.

[00150] In one or more of the above-disclosed methods, the set of bit position(s) in the bit map indicates monitoring starting OFDM symbol(s) of a CORESET in a slot.

[00151] In one or more of the above-disclosed methods, the most significant bit in the bit map represents the first OFDM symbol in a slot.

[00152] In one or more of the above-disclosed methods, the least significant bit in the bit map represents the last OFDM symbol in a slot.

[00153] In one or more of the above-disclosed methods, the signal indicates a configuration of a CORESET.

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[00154] In one or more of the above-disclosed methods, the signal is a PDCCH-config IE which is used to configure UE-specific PDCCH parameters.

[00155] In one or more of the above-disclosed methods, the UE monitors a CORESET based on the signal.

[00156] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot based on the bit map.

[00157] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot starting from each bit position in the set.

[00158] According to another method, the UE receives a signal indicating at least a duration and a bit map, wherein a set of bit position(s) indicates a value in the bit map, and wherein an interval between a bit position in the set and the least significant bit in the bit map is smaller than the duration.

[00159] In one or more of the above-disclosed methods, the value is one.

[00160] In one or more of the above-disclosed methods, the duration is a time duration of a CORESET.

[00161] In one or more of the above-disclosed methods, the bit map comprises 14 bits.

[00162] In one or more of the above-disclosed methods, the most significant bit in the bit map represents the first OFDM symbol in a slot.

[00163] In one or more of the above-disclosed methods, the least significant bit in the bit map represents the last OFDM symbol in a slot.

[00164] In one or more of the above-disclosed methods, the signal indicates a configuration of a CORESET.

[00165] In one or more of the above-disclosed methods, the signal is a PDCCH-config IE which is used to configure UE-specific PDCCH parameters.

[00166] In one or more of the above-disclosed methods, the UE monitors a CORESET based on the signal.

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[00167] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot based on the bit map.

[00168] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot based on the bit map excluding the bit position.

[00169] In one or more of the above-disclosed methods, the UE does not monitor a CORESET on OFDM symbol(s) in a slot starting from the bit position.

[00170] In one or more of the above-disclosed methods, the UE is configured with a default CORESET, which is different from a CORESET indicated by the signal.

[00171] In one or more of the above-disclosed methods, the time duration of the default CORESET is shorter than the duration indicated by the signal.

[00172] In one or more of the above-disclosed methods, the time duration of the default CORESET is one or two.

[00173] In one or more of the above-disclosed methods, the time duration of the default CORESET is the interval between the bit position and the least significant bit in the bit map.

[00174] In one or more of the above-disclosed methods, the UE monitors the CORESET on OFDM symbol(s) in a slot based on the bit map excluding the bit position and monitors the default CORESET on OFDM symbol(s) in the slot based on the bit position.

[00175] According to another method, the UE receives a signal indicating at least a bit map, wherein the bit map indicates at least one bit position or at least one contiguous bit position(s) with a value.

[00176] In one or more of the above-disclosed methods, the signal indicates a duration.

[00177] In one or more of the above-disclosed methods, the value is one.

[00178] In one or more of the above-disclosed methods, the duration is a time duration of a CORESET.

[00179] In one or more of the above-disclosed methods, the bit map comprises 14 bits.

[00180] In one or more of the above-disclosed methods, the most significant bit in the bit map represents the first OFDM symbol in a slot.

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[00181] In one or more of the above-disclosed methods, the least significant bit in the bit map represents the last OFDM symbol in a slot.

[00182] In one or more of the above-disclosed methods, the signal indicates a configuration of a CORESET.

[00183] In one or more of the above-disclosed methods, the signal is a PDCCH-config IE which is used to configure UE-specific PDCCH parameters.

[00184] In one or more of the above-disclosed methods, the UE monitors the CORESET on OFDM symbol(s) in a slot based on the bit map.

[00185] In one or more of the above-disclosed methods, the UE monitors the CORESET on OFDM symbol(s) in a slot based on the bit map and the duration.

[00186] In one or more of the above-disclosed methods, the number of the contiguous bit position(s) with the value indicates a time duration of a CORESET.

[00187] In one or more of the above-disclosed methods, if the number of the contiguous bit position(s) with the value is equal to the duration, the UE monitors the CORESET with the duration.

[00188] In one or more of the above-disclosed methods, if number of the contiguous bit position(s) with the value is smaller than the duration, the UE monitors the CORESET with the number of the contiguous bit position(s).

[00189] In one or more of the above-disclosed methods, if number of the contiguous bit position(s) with the value is larger than the duration and the number is multiple of the duration, the UE interprets the contiguous bit position(s) with the value as contiguous occasions for monitoring the CORESET with the duration.

[00190] In one or more of the above-disclosed methods, if number of the contiguous bit position(s) with the value is larger than the duration and the number is not multiple of the duration, the UE interprets the contiguous bit position(s) with the value as at least one occasion for monitoring the CORESET with the duration and a occasion for monitoring the CORESET with time duration equal to number of orphan bit of the contiguous bit position(s).

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[00191] As those skilled in the art will appreciate, the various disclosed embodiments may be combined to form new embodiments and/or methods.

[00192] FIG. 7 is a flow chart 700 according to one exemplary embodiment from the perspective of a network node. In step 705, the network node transmits a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map. In step 710, the network node is not allowed to transmit the signal such that an interval between two bit positions in the set in the bit map is smaller than a second duration.

[00193] In one embodiment, the second duration is the first duration.

[00194] In one embodiment, the second duration is the first duration minus one.

[00195] In one embodiment, the network is not allowed to transmit the signal indicating that the first duration is 2 and the bit map is 11000000000000.

[00196] In one embodiment, the interval between two bit positions in the set in the bit map shall be larger than or equal to the second duration.

[00197] In one embodiment, the network node is not allowed to transmit the signal such that interval between a bit position in the set in the bit map and the least significant bit position in the bit map is smaller than the second duration.

[00198] In one embodiment, the interval between a bit position in the set in the bit map and the least significant bit position in the bit map shall be larger than or equal to the second duration.

[00199] In one embodiment, the network node transmits a Physical Downlink Control Channel (PDCCH) candidate on monitoring occasion(s) of the CORESET.

[00200] In one embodiment, the slot duration comprises 14 OFDM symbols.

[00201] In one embodiment, the bit map comprises 14 bits.

[00202] In one embodiment, the signal indicates the configuration of the CORESET.

[00203] In one embodiment, the signal is PDCCH-config information element.

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[00204] In one embodiment, the interval is the difference between two bit positions.

[00205] In one embodiment, the interval is the number of bits between two bit positions.

[00206] FIG. 8 is a flow chart 800 according to one exemplary embodiment from the perspective of a network node. In step 805, the network node transmits a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map. In step 810, the network node is not allowed to transmit the signal such that interval between a bit position in the set in the bit map and the least significant bit position in the bit map is smaller than a second duration.

[00207] In one embodiment, the second duration is the first duration.

[00208] In one embodiment, the second duration is the first duration minus one.

[00209] In one embodiment, the network is not allowed to transmit the signal indicating that the first duration is 2 and the bit map is 00000000000001.

[00210] In one embodiment, the interval between a bit position in the set in the bit map and the least significant bit position in the bit map shall be larger than or equal to the second duration.

[00211] In one embodiment, the network node is not allowed to transmit the signal such that interval between two bit positions in the set in the bit map is smaller than the second duration.

[00212] In one embodiment, the network node transmits a Physical Downlink Control Channel (PDCCH) candidate on monitoring occasion(s) of the CORESET.

[00213] In one embodiment, the slot duration comprises 14 OFDM symbols.

[00214] In one embodiment, the bit map comprises 14 bits.

[00215] In one embodiment, the signal indicates the configuration of the CORESET.

[00216] In one embodiment, the signal is PDCCH-config information element.

[00217] In one embodiment, the interval is the difference between two bit positions.

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[00218] In one embodiment, the interval is the number of bits between two bit positions.

[00219] Referring back to FIGS. 3 and 4, in one embodiment, the device 300 includes a program code 312 stored in memory 310. The CPU 308 could execute program code 312 (i) to transmit a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map, and (ii) is not allowed to transmit the signal such that an interval between two bit positions in the set in the bit map is smaller than a second duration.

[00220] In another aspect, the CPU 308 could execute program code 312 to (i) transmits a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map, and (ii) and is not allowed to transmit the signal such that interval between a bit position in the set in the bit map and the least significant bit position in the bit map is smaller than a second duration.

[00221] Furthermore, the CPU 308 can execute the program code 312 to perform all of the above-described actions and steps or others methods described herein.

[00222] The above-disclosed methods provide a restriction of a configuration of a CORESET so that UEs can avoid handling ambiguous configurations. Additionally, the various above-disclosed methods can help UEs handle ambiguous configurations.

[00223] Various aspects of the disclosure have been described above. It should be apparent that the teachings herein may be embodied in a wide variety of forms and that any specific structure, function, or both being disclosed herein is merely representative. Based on the teachings herein one skilled in the art should appreciate that an aspect disclosed herein may be implemented independently of any other aspects and that two or more of these aspects may be combined in various ways. For example, an apparatus may be implemented or a method may be practiced using any number of the aspects set forth herein. In addition, such an apparatus may be implemented or such a method may be practiced using other structure, functionality, or structure and functionality in addition to or other than one or more of the aspects set forth herein. As an example of some of the above concepts, in some aspects concurrent channels may be established

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based on pulse repetition frequencies. In some aspects concurrent channels may be established based on pulse position or offsets. In some aspects concurrent channels may be established based on time hopping sequences.

[00224] Those of skill in the art would understand that information and signals may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the above description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[00225] Those of skill would further appreciate that the various illustrative logical blocks, modules, processors, means, circuits, and algorithm steps described in connection with the aspects disclosed herein may be implemented as electronic hardware (e.g., a digital implementation, an analog implementation, or a combination of the two, which may be designed using source coding or some other technique), various forms of program or design code incorporating instructions (which may be referred to herein, for convenience, as "software" or a "software module"), or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present disclosure.

[00226] In addition, the various illustrative logical blocks, modules, and circuits described in connection with the aspects disclosed herein may be implemented within or performed by an integrated circuit ("IC"), an access terminal, or an access point. The IC may comprise a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, electrical components, optical components, mechanical components, or any combination thereof designed to perform the functions described herein, and may execute codes or instructions that reside within the IC, outside of the IC, or both. A general purpose processor may be a microprocessor, but in the

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alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[00227] It is understood that any specific order or hierarchy of steps in any disclosed process is an example of a sample approach. Based upon design preferences, it is understood that the specific order or hierarchy of steps in the processes may be rearranged while remaining within the scope of the present disclosure. The accompanying method claims present elements of the various steps in a sample order, and are not meant to be limited to the specific order or hierarchy presented.

[00228] The steps of a method or algorithm described in connection with the aspects disclosed herein may be embodied directly in hardware, in a software module executed by a processor, or in a combination of the two. A software module (e.g., including executable instructions and related data) and other data may reside in a data memory such as RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, a hard disk, a removable disk, a CD-ROM, or any other form of computer-readable storage medium known in the art. A sample storage medium may be coupled to a machine such as, for example, a computer/processor (which may be referred to herein, for convenience, as a "processor") such the processor can read information (e.g., code) from and write information to the storage medium. A sample storage medium may be integral to the processor. The processor and the storage medium may reside in an ASIC. The ASIC may reside in user equipment. In the alternative, the processor and the storage medium may reside as discrete components in user equipment. Moreover, in some aspects any suitable computer-program product may comprise a computer-readable medium comprising codes relating to one or more of the aspects of the disclosure. In some aspects a computer program product may comprise packaging materials.

[00229] While the invention has been described in connection with various aspects, it will be understood that the invention is capable of further modifications. This application is intended to cover any variations, uses or adaptation of the invention following, in general, the principles of the invention, and including such departures from the present disclosure as come within the known and customary practice within the art to which the invention pertains.

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METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the benefit of U.S. Provisional Patent Application Serial No. 62/619,041 filed on January 18, 2018, the entire disclosure of which is incorporated herein in its entirety by reference.

FIELD

[0002] This disclosure generally relates to wireless communication networks, and more particularly, to a method and apparatus for providing control resource set configuration in a wireless communication system.

BACKGROUND

[0003] With the rapid rise in demand for communication of large amounts of data to and from mobile communication devices, traditional mobile voice communication networks are evolving into networks that communicate with Internet Protocol (IP) data packets. Such IP data packet communication can provide users of mobile communication devices with voice over IP, multimedia, multicast and on-demand communication services.

[0004] An exemplary network structure is an Evolved Universal Terrestrial Radio Access Network (E-UTRAN). The E-UTRAN system can provide high data throughput in order to realize the above-noted voice over IP and multimedia services. A new radio technology for the next generation (e.g., 5G) is currently being discussed by the 3GPP standards organization. Accordingly, changes to the current body of 3GPP standard are currently being submitted and considered to evolve and finalize the 3GPP standard.

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SUMMARY

[0005] Methods and apparatuses for providing control resource set configuration in a wireless communication system are disclosed herein. In one method, a network node transmits a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map. The network node is not allowed to transmit the signal such that an interval between two bit positions in the set in the bit map is smaller than a second duration.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. 1 shows a diagram of a wireless communication system according to one exemplary embodiment.

[0007] FIG. 2 is a block diagram of a transmitter system (also known as access network) and a receiver system (also known as user equipment or UE) according to one exemplary embodiment.

[0008] FIG. 3 is a functional block diagram of a communication system according to one exemplary embodiment.

[0009] FIG. 4 is a functional block diagram of the program code of FIG. 3 according to one exemplary embodiment.

[0010] FIG. 5 is a reproduction of Table 7.3.2.1-1 taken from 3GPP 3GPP R1-1721341.

[0011] FIG. 6 is a reproduction of Table 10.1-1 from 3GPP R1-1721343.

[0012] FIG. 7 is a flow diagram for one exemplary embodiment from the perspective of a network node.

[0013] FIG. 8 is a flow diagram for one exemplary embodiment from the perspective of a network node.

DETAILED DESCRIPTION

[0014] The exemplary wireless communication systems and devices described below employ a wireless communication system, supporting a broadcast service. Wireless communication systems are widely deployed to provide various types of communication such as

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voice, data, and so on. These systems may be based on code division multiple access (CDMA), time division multiple access (TDMA), orthogonal frequency division multiple access (OFDMA), 3GPP LTE (Long Term Evolution) wireless access, 3GPP LTE-A or LTE-Advanced (Long Term Evolution Advanced), 3GPP2 UMB (Ultra Mobile Broadband), WiMax, or some other modulation techniques.

[0015] In particular, the exemplary wireless communication systems devices described below may be designed to support one or more standards such as the standard offered by a consortium named "3rd Generation Partnership Project" referred to herein as 3GPP, including: Final Chairman's Note of 3GPP TSG RAN WG1 Meeting #89; Final Report of 3GPP TSG RAN WG1 #AH_NR2 v1.0.0; Final Chairman's Note of 3GPP TSG RAN WG1 Meeting #AH_NR3; Final Chairman's Note of 3GPP TSG RAN WG1 Meeting #90bis; Final Chairman's Note of 3GPP TSG RAN WG1 Meeting #91; R1-1721341, "NR; Physical channels and modulation (Release 15)"; R1-1721343, "NR; Physical layer procedures for control (Release 15)"; and TS 38.331, "NR; Radio Resource Control (RRC); Protocol specification (Release 15)". The standards and documents listed above are hereby expressly incorporated by reference in their entirety.

[0016] FIG. 1 shows a multiple access wireless communication system according to one embodiment of the invention. An access network 100 (AN) includes multiple antenna groups, one including 104 and 106, another including 108 and 110, and an additional including 112 and 114. In FIG. 1, only two antennas are shown for each antenna group, however, more or fewer antennas may be utilized for each antenna group. Access terminal 116 (AT) is in communication with antennas 112 and 114, where antennas 112 and 114 transmit information to access terminal 116 over forward link 120 and receive information from access terminal 116 over reverse link 118. Access terminal (AT) 122 is in communication with antennas 106 and 108, where antennas 106 and 108 transmit information to access terminal (AT) 122 over forward link 126 and receive information from access terminal (AT) 122 over reverse link 124. In a FDD system, communication links 118, 120, 124 and 126 may use different frequency for communication. For example, forward link 120 may use a different frequency then that used by reverse link 118.

[0017] Each group of antennas and/or the area in which they are designed to communicate is often referred to as a sector of the access network. In the embodiment, antenna

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groups each are designed to communicate to access terminals in a sector of the areas covered by access network 100.

[0018] In communication over forward links 120 and 126, the transmitting antennas of access network 100 may utilize beamforming in order to improve the signal-to-noise ratio of forward links for the different access terminals 116 and 122. Also, an access network using beamforming to transmit to access terminals scattered randomly through its coverage causes less interference to access terminals in neighboring cells than an access network transmitting through a single antenna to all its access terminals.

[0019] An access network (AN) may be a fixed station or base station used for communicating with the terminals and may also be referred to as an access point, a Node B, a base station, an enhanced base station, an evolved Node B (eNB), or some other terminology. An access terminal (AT) may also be called user equipment (UE), a wireless communication device, terminal, access terminal or some other terminology.

[0020] FIG. 2 is a simplified block diagram of an embodiment of a transmitter system 210 (also known as the access network) and a receiver system 250 (also known as access terminal (AT) or user equipment (UE) in a MIMO system 200. At the transmitter system 210, traffic data for a number of data streams is provided from a data source 212 to a transmit (TX) data processor 214.

[0021] In one embodiment, each data stream is transmitted over a respective transmit antenna. TX data processor 214 formats, codes, and interleaves the traffic data for each data stream based on a particular coding scheme selected for that data stream to provide coded data.

[0022] The coded data for each data stream may be multiplexed with pilot data using OFDM techniques. The pilot data is typically a known data pattern that is processed in a known manner and may be used at the receiver system to estimate the channel response. The multiplexed pilot and coded data for each data stream is then modulated (i.e., symbol mapped) based on a particular modulation scheme (e.g., BPSK, QPSK, M-PSK, or M-QAM) selected for that data stream to provide modulation symbols. The data rate, coding, and modulation for each data stream may be determined by instructions performed by processor 230.

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[0023] The modulation symbols for all data streams are then provided to a TX MIMO processor 220, which may 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 certain 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.

[0024] 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. N_T modulated signals from transmitters 222a through 222t are then transmitted from N_T antennas 224a through 224t, respectively.

[0025] At receiver system 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 received signal, digitizes the conditioned signal to provide samples, and further processes the samples to provide a corresponding "received" symbol stream.

[0026] An RX data processor 260 then receives and processes 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. The RX data processor 260 then demodulates, deinterleaves, and decodes 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 transmitter system 210.

[0027] A processor 270 periodically determines which pre-coding matrix to use (discussed below). Processor 270 formulates a reverse link message comprising a matrix index portion and a rank value portion.

[0028] The reverse link message may comprise various types of information regarding the communication link and/or the received data stream. The reverse link message is then processed by a TX data processor 238, which also receives traffic data for a number of data

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streams from a data source 236, modulated by a modulator 280, conditioned by transmitters 254a through 254r, and transmitted back to transmitter system 210.

[0029] At transmitter system 210, the modulated signals from receiver system 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 reserve link message transmitted by the receiver system 250. Processor 230 then determines which pre-coding matrix to use for determining the beamforming weights then processes the extracted message.

[0030] Turning to FIG. 3, this figure shows an alternative simplified functional block diagram of a communication device according to one embodiment of the invention. As shown in FIG. 3, the communication device 300 in a wireless communication system can be utilized for realizing the UEs (or ATs) 116 and 122 in FIG. 1 or the base station (or AN) 100 in FIG. 1, and the wireless communications system is preferably the LTE system. The communication device 300 may include an input device 302, an output device 304, a control circuit 306, a central processing unit (CPU) 308, a memory 310, a program code 312, and a transceiver 314. The control circuit 306 executes the program code 312 in the memory 310 through the CPU 308, thereby controlling an operation of the communications device 300. The communications device 300 can receive signals input by a user through the input device 302, such as a keyboard or keypad, and can output images and sounds through the output device 304, such as a monitor or speakers. The transceiver 314 is used to receive and transmit wireless signals, delivering received signals to the control circuit 306, and outputting signals generated by the control circuit 306 wirelessly. The communication device 300 in a wireless communication system can also be utilized for realizing the AN 100 in FIG. 1.

[0031] FIG. 4 is a simplified block diagram of the program code 312 shown in FIG. 3 in accordance with one embodiment of the invention. In this embodiment, the program code 312 includes an application layer 400, a Layer 3 portion 402, and a Layer 2 portion 404, and is coupled to a Layer 1 portion 406. The Layer 3 portion 402 generally performs radio resource control. The Layer 2 portion 404 generally performs link control. The Layer 1 portion 406 generally performs physical connections.

[0032] In the Final Chairman's Note of 3GPP TSG RAN WG1 Meeting #90bis, the following agreements and working assumptions were reached:

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Agreements:

- One set of the following parameters determines a set of search spaces
    - A set of aggregation levels
    - The number of PDCCH candidates for each aggregation level
    - PDCCH monitoring occasion for the set of search spaces

Agreements:

- At least for cases other than initial access, to identify a set of search spaces, following parameters are configured by UE-specific RRC signaling:
    - The number of PDCCH candidates for each aggregation level of {1, 2, 4, 8, [16]}
        - One value from {0, 1, 2, 3, 4, 5, 6, 8}
    - PDCCH monitoring occasion for the set of search spaces
        - One value of from {1-slot, 2-slot, [5-slot], [10-slot], [20-slot]} (at least 5 values)
        - One or more value(s) from 1st symbol, 2nd symbol, …, 14th symbol within a monitored slot
    - Each set of search spaces associates with a CORESET configuration by RRC signaling

Update after email approval:

Agreements:

- For PDCCH monitoring occasion of 1-slot, 2-slot, [5-slot], [10-slot], and [20-slot],
    - Slot-level offset value for PDCCH monitoring occasion is also supported.
        - For N-slot monitoring occasion, the offset is one from [0, N-1].
    - Note: symbol-level bit map of monitoring occasion within a slot agreed at RAN1#90bis is still available.

[0033] In 3GPP R1-1721341, some configurations of the PDCCH structure are quoted below:

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7.3.2 Physical downlink control channel (PDCCH)

7.3.2.1 Control-channel element (CCE)

A physical downlink control channel consists of one or more control-channel elements (CCEs) as indicated in Table 7.3.2.1-1.

FIG. 5 (a reproduction of Table 7.3.2.1-1 taken from 3GPP R1-1721341).

7.3.2.2 Control-resource set (CORESET)

A control-resource set consists of $N_{\text{RB}}^{\text{CORESET}}$ resource blocks in the frequency domain, given by the higher-layer parameter *CORESET-freq-dom*, and $N_{\text{symb}}^{\text{CORESET}} \in \{1,2,3\}$ symbols in the time domain, given by the higher-layer parameter *CORESET-time-dur*, where $N_{\text{symb}}^{\text{CORESET}} = 3$ is supported only if higher-layer parameter *DL-DMRS-typeA-pos* equals 3.

A control-channel element consists of 6 resource-element groups (REGs) where a resource-element group equals one resource block during one OFDM symbol. Resource-element groups within a control-resource set are numbered in increasing order in a time-first manner, starting with 0 for the first OFDM symbol and the lowest-numbered resource block in the control resource set.

A UE can be configured with multiple control-resource sets. Each control-resource set is associated with one CCE-to-REG mapping only.

The CCE-to-REG mapping for a control-resource set can be interleaved or non-interleaved, configured by the higher-layer parameter *CORESET-CCE-REG-mapping-type*, and is described by REG bundles:

- REG bundle i is defined as REGs $\{iL, iL+1, \ldots, iL+L-1\}$ where L is the REG bundle size, $i = 0,1,\ldots,N_{\text{REG}}^{\text{CORESET}}/L-1$, and $N_{\text{REG}}^{\text{CORESET}} = N_{\text{RB}}^{\text{CORESET}} N_{\text{symb}}^{\text{CORESET}}$ is the number of REGs in the CORESET

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- CCE j consists of REG bundles $\{f(6j/L), f(6j/L+1),..., f(6j/L+6/L-1)\}$ where $f(\cdot)$ is an interleaver

For non-interleaved CCE-to-REG mapping, $L=6$ and $f(j)=j$

For interleaved CCE-to-REG mapping, $L\in\{2,6\}$ for $N_{\text{symb}}^{\text{CORESET}}=1$ and $L\in\{N_{\text{symb}}^{\text{CORSET}},6\}$ for $N_{\text{symb}}^{\text{CORESET}}\in\{2,3\}$ where L is configured by the higher-layer parameter *CORESET-REG-bundle-size*. The interleaver is defined by

$$\begin{aligned} f(j) &= (rC+c+n_{\text{shift}})\bmod\left(N_{\text{REG}}^{\text{CORESET}}/L\right)\\ j &= cR+r\\ r &= 0,1,...,R-1\\ c &= 0,1,...,C-1\\ C &= \left\lceil N_{\text{REG}}^{\text{CORESET}}/(LR)\right\rceil \end{aligned}$$

where $R\in\{2,3,6\}$ is given by the higher-layer parameter *CORESET-interleaver-size* and where

- n_{shift} is a function of $N_{\text{ID}}^{\text{cell}}$ for a PDCCH transmitted in a CORESET configured by the PBCH or RMSI
- $n_{\text{shift}}\in\{0,1,...,274\}$ is a function of the higher-layer parameter *CORESET-shift-index*.

The UE may assume

- the same precoding in the frequency domain being used within a REG bundle if the higher-layer parameter *CORESET-precoder-granularity* equals *CORESET-REG-bundle-size*
- the same precoding in the frequency domain being used across the all resource-element groups within the set of contiguous resource blocks in the CORESET if the higher-layer parameter *CORESET-precoder-granularity* equals the size of the CORESET in the frequency domain

For a CORESET configured by PBCH, $L=6$.

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7.3.2.3 Scrambling

The UE shall assume the block of bits $b(0),...,b(M_{\text{bit}}-1)$, where M_{bit} is the number of bits transmitted on the physical channel, is scrambled prior to modulation, resulting in a block of scrambled bits $\tilde{b}(0),...,\tilde{b}(M_{\text{bit}}-1)$ according to

$$\tilde{b}(i) = \left(b(i) + c(i)\right) \bmod 2$$

where the scrambling sequence $c(i)$ is given by clause 5.2.1.

7.3.2.4 PDCCH modulation

The UE shall assume the block of bits $\tilde{b}(0),...,\tilde{b}(M_{\text{bit}}-1)$ to be QPSK modulated as described in clause 5.1.3, resulting in a block of complex-valued modulation symbols $d(0),...,d(M_{\text{symb}}-1)$.

7.3.2.5 Mapping to physical resources

The UE shall assume the block of complex-valued symbols $d(0),...,d(M_{\text{symb}}-1)$ to be scaled by a factor β_{PDCCH} and mapped to resource elements $(k,l)_{p,\mu}$ in increasing order of first k, then l, in the resource-element groups used for the monitored PDCCH.

7.4.1.3 Demodulation reference signals for PDCCH

7.4.1.3.1 Sequence generation

The UE shall assume the reference-signal sequence $r(m)$ is defined by

$$r(m) = \frac{1}{\sqrt{2}}\left(1-2\cdot c(2m)\right) + j\frac{1}{\sqrt{2}}\left(1-2\cdot c(2m+1)\right).$$

where the pseudo-random sequence $c(i)$ is defined in clause 5.2.1.

7.4.1.3.2 Mapping to physical resources

The UE shall assume the sequence $r(m)$ is mapped to physical resource elements according to

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$$a_{k,l}^{(p,\mu)} = \beta_{\text{DMRS}} \cdot r(3n + k')$$
$$k = N_{\text{sc}}^{\text{RB}} \left\lfloor n / N_{\text{symb}}^{\text{CORESET}} \right\rfloor + 4k' + 1$$
$$k' = 0,1,2$$
$$l = n \bmod N_{\text{symb}}^{\text{CORESET}}$$
$$n = 0,1,...$$

where the following conditions are fulfilled

- they are within the resource element groups constituting the PDCCH the UE attempts to decode if the higher-layer parameter *CORESET-precoder-granularity* equals *CORESET-REG-bundle-size*,
- all resource-element groups within the set of contiguous resource blocks in the CORESET where the UE attempts to decode the PDCCH if the higher-layer parameter *CORESET-precoder-granularity* equals the size of the CORESET in the frequency domain.

The reference point for k is

- subcarrier 0 of the lowest-numbered common resource block in the CORESET if the CORESET is configured by the PBCH or RMSI,
- subcarrier 0 in common resource block 0 otherwise

The reference point for l is the first OFDM symbol fo the CORESET.

A UE not attempting to detect a PDCCH in a CORESET shall not make any assumptions on the presence or absence of DM-RS in the CORESET.

In absence of CSI-RS or TRS configuration, and unless otherwise configured, the UE may assume PDCCH DM-RS and SS/PBCH block to be quasi co-located with respect to Doppler shift, Doppler spread, average delay, delay spread, and spatial Rx.

[0034] A CORESET can be configured with an association between the DMRS antenna port of receiving the CORESET and one or more than one reference signal(s). In 3GPP R1-1721343, the following quotation specifies the UE procedure for receiving control information.

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10 UE procedure for receiving control information

If the UE is configured with a SCG, the UE shall apply the procedures described in this clause for both MCG and SCG

- When the procedures are applied for MCG, the terms 'secondary cell', 'secondary cells' , 'serving cell', 'serving cells' in this clause refer to secondary cell, secondary cells, serving cell, serving cells belonging to the MCG respectively.
- When the procedures are applied for SCG, the terms 'secondary cell', 'secondary cells', 'serving cell', 'serving cells' in this clause refer to secondary cell, secondary cells (not including PSCell), serving cell, serving cells belonging to the SCG respectively. The term 'primary cell' in this clause refers to the PSCell of the SCG.

A UE shall monitor a set of PDCCH candidates in one or more control resource sets on the active DL BWP on each activated serving cell according to corresponding search spaces where monitoring implies decoding each PDCCH candidate according to the monitored DCI formats.

A UE can be configured by higher layer parameter *SSB-periodicity-serving-cell* a periodicity of half frames for transmission of SS/PBCH blocks in a serving cell. If the UE has received *SSB-transmitted-SIB1* and has not received *SSB-transmitted* and if REs for a PDCCH reception overlap with REs corresponding to SS/PBCH block indexes indicated by *SSB-transmitted-SIB1*, the UE receives the PDCCH by excluding REs corresponding to SS/PBCH block indexes indicated by *SSB-transmitted-SIB1*. If a UE has received *SSB-transmitted* and if REs for a PDCCH reception overlap with REs corresponding to SS/PBCH block indexes indicated by *SSB-transmitted*, the UE receives the PDCCH by excluding REs corresponding to SS/PBCH block indexes indicated by *SSB-transmitted*.

If a carrier aggregation capability for a UE, as included in *UE-NR-Capability*, is larger than X, the UE includes in *UE-NR-Capability* an indication for a maximum number of PDCCH candidates the UE can monitor per slot when the UE is configured for carrier aggregation operation over more than X cells. When the UE is configured for carrier aggregation operation over more than X cells, the UE is not expected to be configured with a number of PDCCH candidates to monitor per slot that is larger than the maximum number.

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10.1 UE procedure for determining physical downlink control channel assignment

A set of PDCCH candidates for a UE to monitor is defined in terms of PDCCH search spaces. A search space can be a common search space or a UE-specific search space. A UE shall monitor PDCCH candidates in non-DRX slots in one or more of the following search spaces

- a Type0-PDCCH common search space for a DCI format with CRC scrambled by a SI-RNTI on a primary cell;
- a Type0A-PDCCH common search space for a DCI format with CRC scrambled by a SI-RNTI on a primary cell;
- a Type1-PDCCH common search space for a DCI format with CRC scrambled by a RA-RNTI, or a TC-RNTI, or a C-RNTI on a primary cell;
- a Type2-PDCCH common search space for a DCI format with CRC scrambled by a P-RNTI on a primary cell;
- a Type3-PDCCH common search space for a DCI format with CRC scrambled by INT-RNTI, or SFI-RNTI, or TPC-PUSCH-RNTI, or TPC-PUCCH-RNTI, or TPC-SRS-RNTI, or C-RNTI, or CS-RNTI(s); and
- a UE-specific search space for a DCI format with CRC scrambled by C-RNTI or CS-RNTI(s).

A UE is provided a configuration for a control resource set for Type0-PDCCH common search space by higher layer parameter *RMSI-PDCCH-Config* and a subcarrier spacing by higher layer parameter *RMSI-scs* for PDCCH reception. The UE determines the control resource set and the monitoring occasions for Type0-PDCCH common search space as described in Subclause 14. The Type0-PDCCH common search space is defined by the CCE aggregation levels and the number of candidates per CCE aggregation level given in Table 10.1-1.

The UE may assume that the DM-RS antenna port associated with PDCCH reception in the Type0-PDCCH common search space and the Type2-PDCCH common search space, and for corresponding PDSCH receptions, and the DM-RS antenna port associated with SS/PBCH reception are quasi co-located with respect to delay spread, Doppler spread, Doppler shift,

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average delay, and spatial Rx parameters. The value for the DM-RS scrambling sequence initialization is the cell ID.

For Type0A-PDCCH common search space or for Type-2 PDCCH common search space, the control resource set is same as the control resource set for Type0-PDCCH common search space. A UE is provided a configuration for Type0A-PDCCH common search space by higher layer parameter *osi-SearchSpace*. A UE is provided a configuration for Type2-PDCCH common search space by higher layer parameter *paging-SearchSpace*.

A subcarrier spacing and a CP length for PDCCH reception with Type0A-PDCCH common search space, or Type1-PDCCH common search space, or Type-2 PDCCH common search space are same as for PDCCH reception with Type0-PDCCH common search space.

A UE may assume that the DM-RS antenna port associated with PDCCH reception in the Type0A-PDCCH common search space and the DM-RS antenna port associated with SS/PBCH reception are quasi co-located with respect to delay spread, Doppler spread, Doppler shift, average delay, and spatial Rx parameters.

A UE may assume that the DM-RS antenna port associated with PDCCH reception and associated PDSCH reception in the Type1-PDCCH common search space are quasi co-located with the DM-RS antenna port of the SS/PBCH reception associated with a corresponding PRACH transmission.

If a value for the DM-RS scrambling sequence initialization for Type0A-PDCCH common search space, or Type1-PDCCH common search space, or Type-2 PDCCH common search space is not provided by higher layer parameter *PDCCH-DMRS-Scrambling-ID* in *SystemInformationBlockType1*, the value is the cell ID.

If a UE is configured for downlink bandwidth part (BWP) operation, as described in Subclause 12, the above configurations for the common search spaces apply for the initial active DL BWP. The UE can be additionally configured a control resource set for Type0-PDCCH common search space, Type0A-PDCCH common search space, Type1-PDCCH common search space, or Type2-PDCCH common search space for each configured DL BWP on the primary cell, other than the initial active DL BWP, as described in Subclause 12.

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FIG. 6 (a reproduction of Table 10.1-1 from 3GPP R1-1721343 showing CCE aggregation levels and number of candidates per CCE aggregation level for PDCCH scheduling *SystemInformationBlockType1* in Type0-PDCCH common search space)

For a serving cell, higher layer signalling provides a UE with P control resource sets. For control resource set p, $0 \le p < P$ where a UE-specific search space, a Type2-PDCCH common search space, or a Type3-PDCCH common search space is mapped, the higher layer signalling provides:

- a control resource set index by higher layer parameter *CORESET-ID*;
- a DM-RS scrambling sequence initialization value by higher layer parameter *PDCCH-DMRS-Scrambling-ID*;
- a number of consecutive symbols provided by higher layer parameter *CORESET-time-duration*;
- a set of resource blocks provided by higher layer parameter *CORESET-freq-dom*;
- a CCE-to-REG mapping provided by higher layer parameter *CORESET-CCE-to-REG-mapping-type*;
- a REG bundle size, in case of interleaved CCE-to-REG mapping, provided by higher layer parameter *CORESET-REG-bundle-size*;
- a cyclic shift for the REG bundle interleaver [4, 38.211] by higher layer parameter *CORESET-shift-index*;
- an antenna port quasi co-location, from a set of antenna port quasi co-locations provided by higher layer parameter *TCI-StatesPDCCH*, indicating quasi co-location information of the DM-RS antenna port for PDCCH reception;
- an indication for a presence or absence of a transmission configuration indication (TCI) field for DCI format 1_0 or DCI format 1_1 transmitted by a PDCCH in control resource set p, by higher layer parameter *TCI-PresentInDCI*.

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For each control resource set in a DL BWP of a serving cell, a respective higher layer parameter *CORESET-freq-dom* provides a bitmap. The bits of the bitmap have a one-to-one mapping with non-overlapping groups of 6 PRBs, in ascending order of the PRB index in the DL BWP bandwidth of $N_{\mathrm{RB}}^{\mathrm{BWP}}$ PRBs where the first PRB of the first group of 6 PRBs has index $6 \cdot \lceil N_{\mathrm{RB}}^{\mathrm{BWP}} / 6 \rceil$.

If the UE has not received an indication for an antenna port quasi co-location from the set of antenna port quasi co-locations provided by *TCI-StatesPDCCH*, the UE assumes that the DM-RS antenna port associated with PDCCH reception in the UE-specific search space is quasi co-located with the DM-RS antenna port associated with PBCH reception with respect to delay spread, Doppler spread, Doppler shift, average delay, and spatial Rx parameters.

For each serving cell that a UE is configured to monitor PDCCH in a search space other than Type0-PDCCH common search space, the UE is configured the following:

- a number of search space sets by higher layer parameter *search-space-config*;
- for each search space set in a control resource set p
    - an indication that the search space set is a common search space set or a UE-specific search space set by higher layer parameter *Common-search-space-flag*;
    - a number of PDCCH candidates $M_p^{(L)}$ per CCE aggregation level L by higher layer parameters *Aggregation-level-1*, *Aggregation-level-2*, *Aggregation-level-4*, *Aggregation-level-8*, and *Aggregation-level-16*, for CCE aggregation level 1, CCE aggregation level 2, CCE aggregation level 4, CCE aggregation level 8, and CCE aggregation level 16, respectively;
    - a PDCCH monitoring periodicity of k_p slots by higher layer parameter *Monitoring-periodicity-PDCCH-slot*;
    - a PDCCH monitoring offset of o_p slots, where $0 \le o_p < k_p$, by higher layer parameter *Monitoring-offset-PDCCH-slot*;

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- a PDCCH monitoring pattern within a slot, indicating first symbol(s) of the control resource set within a slot for PDCCH monitoring, by higher layer parameter *Monitoring-symbols-PDCCH-within-slot*.

A UE determines a PDCCH monitoring occasion from the PDCCH monitoring periodicity, the PDCCH monitoring offset, and the PDCCH monitoring pattern within a slot.

A PDCCH UE-specific search space $S_{k_p}^{(L)}$ at CCE aggregation level $L \in \{1, 2, 4, 8, 16\}$ is defined by a set of PDCCH candidates for CCE aggregation level L.

If a UE is configured with higher layer parameter *CrossCarrierSchedulingConfig* for a serving cell the carrier indicator field value corresponds to the value indicated by *CrossCarrierSchedulingConfig*.

For a serving cell on which a UE monitors PDCCH candidates in a UE-specific search space, if the UE is not configured with a carrier indicator field, the UE shall monitor the PDCCH candidates without carrier indicator field. For a serving cell on which a UE monitors PDCCH candidates in a UE-specific search space, if a UE is configured with a carrier indicator field, the UE shall monitor the PDCCH candidates with carrier indicator field.

A UE is not expected to monitor PDCCH candidates on a secondary cell if the UE is configured to monitor PDCCH candidates with carrier indicator field corresponding to that secondary cell in another serving cell. For the serving cell on which the UE monitors PDCCH candidates, the UE shall monitor PDCCH candidates at least for the same serving cell.

For a control resource set p, the CCEs corresponding to PDCCH candidate $m_{n_{CI}}$ of the search space for a serving cell corresponding to carrier indicator field value n_{CI} are given by

$$L \cdot \left\{ \left(Y_{p,k_p} + \left\lfloor \frac{m_{n_{CI}} \cdot N_{\mathrm{CCE},p}}{L \cdot M_{p,\max}^{(L)}} \right\rfloor + n_{CI} \right) \bmod \left\lfloor N_{\mathrm{CCE},p} / L \right\rfloor \right\} + i$$

where

for any common search space, $Y_{p,k_p} = 0$;

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for a UE-specific search space, $Y_{p,k_p} = (A_p \cdot Y_{p,k_{p-1}}) \bmod D$, $Y_{p,-1} = n_{\text{RNTI}} \neq 0$, $A_0 = 39827$, $A_1 = 39829$, and $D = 65537$;

$i = 0, \cdots, L-1$;

n_{CI} is the carrier indicator field value if the UE is configured with a carrier indicator field for the serving cell on which PDCCH is monitored; otherwise, including for any common search space, $n_{CI} = 0$;

$N_{\text{CCE},p}$ is the number of CCEs, numbered from 0 to $N_{\text{CCE},p} - 1$, in control resource set p;

$m_{n_{CI}} = 0, ..., M^{(L)}_{p,n_{CI}} - 1$, where $M^{(L)}_{p,n_{CI}}$ is the number of PDCCH candidates the UE is configured to monitor for aggregation level L for a serving cell corresponding to n_{CI};

for any common search space, $M^{(L)}_{p,\max} = M^{(L)}_{p,0}$;

for a UE-specific search space, $M^{(L)}_{p,\max}$ is the maximum of $M^{(L)}_{p,n_{CI}}$ for all corresponding DCI formats over all configured n_{CI} values for a CCE aggregation level L in control resource set p;

the RNTI value used for n_{RNTI} is defined in [5, TS 38.212] and in [6, TS 38.214].

A UE configured to monitor PDCCH candidates in a serving cell with a DCI format size with carrier indicator field and CRC scrambled by C-RNTI, where the PDCCH candidates may have one or more possible values of carrier indicator field for the DCI format size, shall assume that an PDCCH candidate with the DCI format size may be transmitted in the serving cell in any PDCCH UE specific search space corresponding to any of the possible values of carrier indicator field for the DCI format size.

[0035] In 3GPP TS 38.331, *PDCCH-Config* IE in the RRC standard is quoted as follows:

PDCCH-Config

The *PDCCH-Config* IE is used to configure UE specific PDCCH parameters such as control resource sets (CORESET), search spaces and additional parameters for acquiring the PDCCH.

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***PDCCH-Config* information element**

```
-- ASN1START

-- TAG-PDCCH-CONFIG-START

-- Downlink control channel related parameters

PDCCH-Config ::=                SEQUENCE {

-- List of Control Resource Sets (CORESETs) to be used by the
UE

controlResourceSetToAddModList        SEQUENCE(SIZE
(1..maxNrofControlResourceSets)) OF ControlResourceSet
   OPTIONAL,

controlResourceSetToReleaseList       SEQUENCE(SIZE
(1..maxNrofControlResourceSets)) OF ControlResourceId
   OPTIONAL


searchSpacesToAddModList           SEQUENCE(SIZE
(1..maxNrofSearchSpaces) OF SearchSpace

OPTIONAL,

searchSpacesToReleaseList          SEQUENCE(SIZE
(1..maxNrofSearchSpaces) OF SearchSpaceId              OPTIONAL


```


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- -- FFS: Is this timing information applicable to the entire PDCCH or could it be different per CORESET?
- -- FFS: Is there a default timing (to be used at least until first reconfiguration). Are the fields optionally present?
- timing SEQUENCE {
- dl-assignment-to-DL-data TYPE_FFS!,
- ul-assignment-to-UL-data TYPE_FFS!,
- dl-data-to-UL-ACK TYPE_FFS!
- }

- OPTIONAL,
-
- }
-
- -- A time/frequency control resource set (CORESET) in which to search for downlink control information (see 38.213, section x.x.x.x)FFS_Ref
- ControlResourceSet ::= SEQUENCE {
- controlResourceSetId ControlResourceSetId,
-
- -- Frequency domain resources for the CORESET. The network ensures that the CORESET is within the BWP configured for a UE. (see 38.213, REF)

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- frequencyDomainResources TYPE_FFS!,
- -- Starting OFDM symbol for the CORESET (see 38.213, REF)
- startSymbol INTEGER (0..maxCoReSetStartSymbol),
- -- Contiguouse time duration of the CORESET in number of symbols see 38.213, section x.x.x.x)FFS_Ref
- duration INTEGER (1..maxCoReSetDuration),
- -- Resource Element Groups (REGs) can be bundled to create REG bundles. This parameter defines the size of such bundles.
- -- (see 38.211, section 7.3.2.2)
- reg-BundleSize ENUMERATED {n2, n3, n6},
- -- Mapping of Control Channel Elements (CCE) to Resource Element Groups (REG). (see 38.211, 38.213, FFS_REF)
- cce-reg-MappingType ENUMERATED { interleaved, nonInterleaved },
- -- Precoder granularity in frequency domain (see 38.213, section FFS_REF)
- precoderGranularity TYPE_FFS!,
- -- Corresponds to L1 parameter 'CORESET-interleaver-rows' (see 38.211, 38.213, section FFS_Section)
- interleaverRows ENUMERATED {n2, n3, n6}
- OPTIONAL,

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```
•
• -- Corresponds to L1 parameter 'CORESET-shift-index' (see
38.211, 38.213, section FFS_Section)
• shiftIndex                    FFS_Value
• OPTIONAL,
•
• -- Reference to a configured TCI State providing QCL
configuration/indication for PDCCH.
• -- Corresponds to L1 parameter 'TCI-StateRefId' (see 38.211,
38.213, section FFS_Section)
• tci-
StateRefId                FFS_Value
• OPTIONAL,
•
• -- PDCCH DMRS scrambling initalization. Corresponds to L1
parameter 'PDCCH-DMRS-Scrambling-ID' (see 38.214, section 5.1)
• -- When the field is absent the UE applies the value TBD/FFS
• pdcch-DMRS-
ScramblingID            FFS_Value
• OPTIONAL
• }
```


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```
•
• -- ID of a Control Resource Set.
• ControlResourceSetId ::=          INTEGER
(0..maxNrofControlResourceSets-1)
•
• -- A search space defines how/where to search for PDCCH
candidates. A search space is associated with one Control
Resource Set
• SearchSpace ::=              SEQUENCE {
• searchSpaceId                SearchSpaceId,
•
• -- The CORESET applicable for this SearchSpace.
• -- FFS: Value 0 identifies the common CORESET configured in
MIB?
• -- FFS: Values 1..maxNrofControlResourceSets-1 identify
CORESETs configured by dedicated signalling?
• controlResourceSetId            ControlResourceSetId,
•
• -- Slots for PDCCH Monitoring configured as periodicity and
offset. Corresponds to L1 parameters 'Montoring-periodicity-
PDCCH-slot' and
• -- 'Montoring-offset-PDCCH-slot' (see 38.213, section 10)
• -- sl15, sl10, sl20 FFS
```


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- monitoringSlotPperiodicityAndOffset CHOICE {
- sl1 NULL,
- sl2 INTEGER (0..1),
- sl5 INTEGER (0..4),
- sl10 INTEGER (0..9),
- sl20 INTEGER (0..19)
- }

- OPTIONAL,
-
- -- Symbols for PDCCH monitoring in the slots configured for PDCCH monitoring (see monitoringSlotPeriodicityAndOffset).
- -- The most significant (left) bit represents the first OFDM in a slot. The least significant (right) bit represents the last symbol.
- -- Corresponds to L1 parameter 'Montoring-symbols-PDCCH-within-slot' (see 38.213, section 10)
- monitoringSymbolsWithinSlot BIT STRING (SIZE (14))
- OPTIONAL,
-
- -- Number of candidates per aggregation level. Corresponds to L1 parameter 'Aggregation-level-1' to 'Aggregation-level-8'

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```
• -- (see 38.213, section 10)
• nrofCandidates                    SEQUENCE {
•    aggregationLevel1                 ENUMERATED {n0, n1, n2, n3,
n4, n5, n6, n8},
•    aggregationLevel2                 ENUMERATED {n0, n1, n2, n3,
n4, n5, n6, n8},
•    aggregationLevel4                 ENUMERATED {n0, n1, n2, n3,
n4, n5, n6, n8},
•    aggregationLevel8                 ENUMERATED {n0, n1, n2, n3,
n4, n5, n6, n8}
• }
•
•
```

[0036] The following terminology and assumption may be used hereafter in the detailed description:

- BS: a network central unit or a network node in NR which is used to control one or multiple TRPs which are associated with one or multiple cells. Communication between BS and TRP(s) is via fronthaul. BS may be referred to as central unit (CU), eNB, gNB, or NodeB.
- TRP: a transmission and reception point provides network coverage and directly communicates with UEs. TRP may be referred to as distributed unit (DU) or network node.
- Cell: a cell is composed of one or multiple associated TRPs, i.e. coverage of the cell is composed of coverage of all associated TRP(s). One cell is controlled by one BS. Cell may be referred to as TRP group (TRPG).
- NR-PDCCH: A channel carries downlink control signal which is used to control communication between a UE and a network side. A network transmits NR-PDCCH on

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configured control resource set (CORESET) to the UE.

- Slot: a scheduling unit in NR. Slot duration is 14 OFDM symbols.
- Mini-slot: a scheduling unit with duration less than 14 OFDM symbols.

[0037] In the current NR standard as disclosed in 3GPP R1-1721343 and TS 38.331, a CORESET can be configured by indicating time duration and a bit map. The bit map may indicate at least a starting OFDM symbol for monitoring the CORESET in a slot. Each bit in the bit map corresponds to an OFDM symbol in a slot. If a bit position in the bit map has a value of one, it represents a starting OFDM symbol for monitoring the CORESET. The CORESET may be monitored from at least a starting OFDM symbol(s) indicated by the bit map and occupying following OFDM symbol(s) until the configured time duration is reached. For example, if the time duration of a CORESET is configured as 2 and the bit map indicates 10000000000000, the UE may monitor the CORESET (receive at least a PDCCH) on OFDM symbol #0 and #1 in a slot.

[0038] However, if a bit map indicates a starting OFDM symbol belonging to the following OFDM symbol(s) of previous starting OFDM symbol indicated by the bit map (e.g., time duration of a CORESET is 2 and the bit map is 1100000000000000), a UE may be confused about the configuration. If this situation does not specify nor is captured in the standard, how a UE treat this situation needs further consideration. In addition, if the bit map indicates a starting OFDM symbol on the last few OFDM symbols of a slot, this may create a problem where the CORESET may be configured across a slot boundary. For example, if time duration of a CORESET is 2 and the bit map is 00000000000001, how a UE handle this configuration also needs further consideration. Potential solutions are described below.

[0039] According to one solution, a restriction on the configuration of a CORESET is established. The UE does not expect to receive a CORESET configuration with an overlap OFDM symbols indicated by a bit map indication and the CORESET duration and/or with a CORESET monitoring pattern across a slot boundary.

[0040] According to another solution, the UE is configured to or could deal with one of the above-possible scenarios. For example, a UE is configured with a CORESET. Alternatively, the UE receives a signal indicating configuration of a CORESET. The configuration of the

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CORESET includes at least time duration of the CORESET and a bit map. The bit map comprises 14 bits. A set of the bit position(s) in the bit map have value one. The set of bit position(s) indicates the starting OFDM symbol(s) in a slot for monitoring the CORESET. The interval (or distance) between each bit position (indicating value one) in the set (or bitmap) is larger than or equal to a number. The interval (or distance) between two bit positions indicating the value one in the bit map is larger than or equal to a number. The interval (or distance) between two neighboring bit positions indicating value one in the set is larger than or equal to a number. Two neighboring bit positions indicating the value one could be the two closest bit positions indicating value 1. An interval or distance between two bit positions could be a number of bits between the two bit positions. The two bit positions could be neglected when calculating the interval or distance. For example, an interval or distance between two bit positions indicating value 1 for a bitmap "10001000000000" is 3. Alternatively, an interval or distance between two bit positions could be difference of the two bit positions.

[0041] In one embodiment, the number is the time duration of the CORESET. Alternatively, the number is the time duration of the CORESET minus one. In another alternative, the number is the maximum time duration of the CORESET minus one. For example, if time duration of a CORESET is configured as 2, a bit map of a CORESET has a restriction that interval between two bit positions indicating value one is larger than or equal to 2 minus 1 (e.g., the bit map is 10100000000000). The UE does not expect to receive a configuration of a bit map such that the interval (or distance) between the two bit positions indicating value one in the bit map is smaller than the number (e.g., the bit map is 11000000000000). The UE could ignore a configuration of the bit map such that the interval (or distance) between two bit positions indicating value one in the bit map is smaller than the number (e.g., the bit map is 11000000000000 when the number is 1). The UE could ignore part of the bit map such that the interval (or distance) between the bit positions indicating value one in the part of the bit map is smaller than the number (e.g., if the bit map is 11000000100000, the UE ignores the first two 1 and applies the last 1 when the number is 1). The UE does not apply a configuration of the bit map such that the interval (or distance) between two bit positions indicating value one in the bit map is smaller than the number (e.g., the bit map is 11000000000000 when the number is 1).

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[0042] In one embodiment, a base station does not configure the UE with a bit map such that the interval (or distance) between two bit positions indicating value one in the bit map is smaller than the number (e.g., the bit map is 11000000000000 when the number is 1). The most significant bit in the bit map represents the first OFDM symbol in a slot. The least significant bit in the bit map represents the last OFDM symbol in a slot. The signal could be *PDCCH-Config.* The bitmap could be monitoringSymbolsWithinSlot. The time duration could be CORESET-time-duration. The UE may monitor the CORESET on the OFDM symbol(s) in a slot based on the signal. The UE may monitor the CORESET on OFDM symbol(s) starting from each bit position in the set in a slot.

[0043] Alternatively, the bit map can indicate at least a monitoring occasion for the CORESET by indicating a starting OFDM symbol with the following contiguous OFDM symbol(s) until the time duration of the CORESET is reached. The UE may interpret the bit map based on the time duration of the CORESET. For example, when a UE is configured with a time duration 2 and a bit map "11011000000000", the UE monitors the CORESET the following symbols in a slot: {1st symbol,2nd symbol} and {4th symbol, 5th symbol}.

[0044] Within a slot, different monitoring occasions for the CORESET indicated by the bit map can be separated by at least one bit position indicating the value 0. If the bit map indicates a number of contiguous bit position(s) with the value 1, which the number is smaller than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 indicating a monitoring occasion for the CORESET with time duration as the number. For example, when a UE is configured with time duration 3 and a bit map "11000101011100", the UE monitors CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {6th symbol}, {8th symbol}, and {10th symbol, 11th symbol, 12th symbol}. In this example, the UE may interpret the number of contiguous bit position(s) indicating value 1 in the bit map which is smaller than the time duration 3 as a CORESET monitoring occasion with the time duration same as the contiguous number of the value 1.

[0045] If a bit map indicates a number of contiguous bit position(s) with the value 1, wherein the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as contiguous monitoring occasions for the CORESET with the time duration or smaller than the time duration. More specifically, if the

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number of contiguous bit position(s) indicating the value 1 is multiple of the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as contiguous monitoring occasion(s) for the CORESET with the time duration. If the number of contiguous bit position(s) indicating the value 1 is not a multiple of the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as that earlier contiguous bit(s) indicates contiguous monitoring occasion(s) for the CORESET with the time duration and the last orphan bit(s) indicates a monitoring occasion for CORESET with time duration smaller than the time duration of the CORESET which depends on number of last orphan bit(s). Alternatively, the last orphan bit(s) in the number of contiguous bit(s) with the value 1 can be ignored by the UE. For example, when a UE is configured with a time duration 2 and a bit map "11110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {3rd symbol, 4th symbol}. In another example, when a UE is configured with time duration 2 and a bit map "1110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {3rd symbol}. In a similar example, when a UE is configured with a time duration 2 and a bit map "1110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}. In this example, the UE ignores {3rd symbol} indicated by the bit map.

[0046] Alternatively, if bit map indicates a number of contiguous bit position(s) with value 1, which the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as at least a monitoring occasion for the CORESET in which the time duration of the CORESET is the number of the contiguous bit position(s) with value 1. For example, when a UE is configured with the time duration 2 and a bit map "11100110000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol, 3rd symbol }, {5th symbol, 6th symbol}.

[0047] Alternatively, if a bit map indicates a number of contiguous bit position(s) with value 1 wherein the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as at least a monitoring occasion for the CORESET in which the time duration of the CORESET is the maximum time duration of a CORESET. For example, when a UE is configured with time duration 2 and a bit map "11110000000000", the UE monitors the CORESET for the following symbols in a slot:

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{1st symbol, 2nd symbol, 3rd symbol }, {4th symbol} when the maximum time duration of the CORESET is 3.

[0048] Alternatively, the signal indicates at least a bit map. The UE may receive the PDCCH on the OFDM symbol(s) in a slot based on the bit map. The bit map indicates at least a bit position and/or at least on a contiguous bit position(s) as value one. The UE may monitor a CORESET on the OFDM symbol(s) in a slot based on the bit map. The UE may view the contiguous bit position(s) as a CORESET. The UE may not expect to have the bit map indicating the number of the contiguous bit position(s) with value one exceeds maximum time duration for a CORESET.

[0049] Alternatively, if the UE receives the bit map indicating the number of the contiguous bit position(s) with value one exceeds maximum time duration for a CORESET, the UE may ignore part of the indication of the bit map. Alternatively, the UE may ignore the whole indication of the bit map. For example, when a UE is configured with a bit map "11010111000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {4th symbol}, {6th symbol, 7th symbol, 8th symbol} when the maximum time duration of the CORESET is 3. In a similar example, when a UE is configured with a bit map "11100001100000", the UE may ignore the first three 1's because it will exceed the maximum time duration if the maximum time duration of CORESET is 2. In the above example, the UE may monitor the CORESET in the following symbols in a slot: {8th symbol, 9th symbol}.

[0050] The time duration of a CORESET can be determined based on the bit map and each contiguous bit position(s) with the value one in the bit map. The signal does not indicate the time duration for a CORESET. The signal indicates a different configuration for different time duration CORESET(s). The configuration may comprise at least the Control Channel Element(CCE)- Resource Element Group(REG) mapping type, aggregation level, search space configuration, and frequency resource assignment. The configuration could be *PDCCH-config*.

[0051] In one embodiment, a UE is configured with a CORESET. Alternatively, the UE receives a signal indicating the configuration of a CORESET. The configuration of the CORESET comprises at least time duration of the CORESET and a bit map. The bit map comprises 14 bits. The first bit position and the second bit position in the bit map indicate the value one. The interval (or distance) between the first bit position and the second bit position is

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smaller than a number. The interval (or distance) between two bit positions indicating the value one in the bitmap is larger than or equal to a number. The interval (or distance) between two neighboring bit positions indicating the value one in the set is smaller than a number. The two neighboring bit positions indicating the value one could be the two closest bit positions indicating the value 1. An interval or distance between two bit positions is the number of bits between the two bit positions. The two bit positions could be neglected when calculating the interval or distance. For example, an interval or distance between two bit positions indicating the value 1 for a bitmap "10001000000000" is 3. More specifically, the number is the time duration of the CORESET. Alternatively, the number is time duration of the CORESET minus one. Alternatively, the number is the maximum time duration of the CORESET minus one. Alternatively, the number is the maximum time duration of the CORESET minus one. For example, if time duration of a CORESET is configured as 2, a bit map of a CORESET may be 11000000000000. The first bit position is closer to the most significant bit in the bit map than the second bit position. The most significant bit in the bit map represents the first OFDM symbol in a slot. The least significant bit in the bit map represents the last OFDM symbol in a slot. The signal could be a *PDCCH-Config*. The bitmap could be monitoringSymbolsWithinSlot. The time duration could be a CORESET-time-duration.

[0052] The UE may monitor the CORESET on OFDM symbol(s) in a slot based on the bit map. The UE may monitor the CORESET on OFDM symbol(s) in a slot starting from the bit position(s) in the bit map indicating a value. The value could be one. The UE may monitor the CORESET on OFDM symbol(s) in a slot starting from the bit position(s) in the bit map indicating the value. Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in a slot starting from the bit position(s) in the bit map indicating the value excluding both or one of two bit position(s) wherein the interval (or distance) between the two bit positions is smaller than the number.

[0053] Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value excluding the first bit position and the second bit position. Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value excluding the first bit position. Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value excluding the second bit position.

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For example, when a UE is configured with time duration 2 and a bit map "11000101000000", the UE monitors the CORESET for the following symbols in a slot: {6th symbol,7th symbol} and {8th symbol, 9th symbol}. In this example, the bit locations with too short interval/distance are excluded. In another example, when a UE is configured with time duration 2 and a bit map "11000101000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol}. In this example, one (the latter one) of the two bit locations with too short interval/distance are excluded. A similar example could be that when a UE is configured with time duration 2 and a bit map "11000101000000", the UE monitors the CORESET for the following symbols in a slot: {2nd symbol, 3rd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol}., e.g. ,excluding the earlier one.

[0054] Alternatively, the OFDM symbols for different CORESET could overlap. The OFDM symbol between two CORESETs could overlap if the interval (or distance) between the starting position of the two CORESETs is shorter than the number. In one example, when a UE is configured with a time duration of 2 and a bit map "11000101000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {2nd symbol, 3rd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol}.

[0055] Alternatively, the CORESET time duration of CORESETs associated with a bitmap within a slot could be different. The CORESET time duration could be different from the configured value if the interval (or distance) between starting symbol of two CORESETs is shorter than the number. In one example, when a UE is configured with a time duration of 2 and a bit map "11000101000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol}, {2nd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol}. It can be observed that the CORESETs corresponding to the first two bits in the bitmap have 1 symbol time duration even if the configured value is 2, e.g., due to short interval or distance. In a similar example, when a UE is configured with a time duration of 2 and a bit map "11100101000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol}, {2nd symbol }, {3rd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol} or {1st symbol, 2nd symbol }, {3rd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol} or alternatively {1st symbol}, {2nd symbol, 3rd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol}. It can be observed later two alternatives allow one CORESET corresponding to the first three bits in

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the bit map to have a CORESET time duration with a configured value, i.e., 2 and one CORESET have time duration which is different from the configured value, e.g., 1. For bit locations corresponding to short interval or distance, time duration can be used as a maximum time duration or an upper bound of time duration. For bit locations corresponding to a short interval or distance, a value of 1 could mean a corresponding symbol containing the CORESET and the corresponding symbol is not the first symbol or starting symbol of the CORESET.

[0056] Different alternatives or different examples can be applied in different slot. For example, the UE may monitor the CORESET on OFDM symbol(s) in an even slot (i.e., a slot with even slot number) starting from the bit position(s) in the bit map indicating the value excluding the first bit position, and the UE may monitor the CORESET on OFDM symbol(s) in an odd slot starting from the bit position(s) in the bit map indicating the value excluding the second bit position or vice versa. Different alternatives or examples can be applied to a configuration or an indication. The configuration or indication can be transmitted by a base station to a UE.

[0057] In one embodiment, the UE may ignore the configuration of the CORESET. The UE may transmit a Negative Acknowledgement (NACK) as a feedback of the signal.

[0058] In one alternative, the UE may monitor the CORESET on OFDM symbol(s) in an even slot based on the bit map excluding the second bit position. Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in an odd slot based on the bit map excluding the second bit position. Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in an even slot based on the bit map excluding the first bit position. Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in an odd slot based on the bit map excluding the first bit position.

[0059] The signal may include a pattern for indicating the bit map. The pattern indicates a slot level bit map. If the bit position of the slot level bit map corresponding to a slot indicates the value of one, the UE monitors the CORESET in the slot based on the bit map excluding the second bit position. If the bit position of the slot level bit map corresponding to a slot indicates the value of one, the UE monitors the CORESET in the slot based on the bit map excluding the first bit position. Alternatively, if bit position of the slot level bit map corresponding to a slot indicates the value of zero, the UE monitors the CORESET in the slot based on the bit map

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excluding the first bit position. Alternatively, if bit position of the slot level bit map corresponding to a slot indicates the value of zero, the UE monitors the CORESET in the slot based on the bit map excluding the second bit position.

[0060] The UE can be configured with two CORESETs (e.g., two CORESET IDs) associated with a search space or a bitmap. The time durations of the two CORESETs can be different. For example, one time duration is longer and the other time duration is shorter. For a first CORESET starting symbol, the UE determines one CORESET configuration from the two CORESET configurations according to a distance or interval between the first CORESET starting symbol and a second CORESET starting symbol. The second CORESET starting symbol could be a next CORESET starting symbol in a bitmap after the first CORESET starting symbol.

[0061] In another alternative, the UE determines a CORESET configuration with longer time duration if the distance or the interval between the first CORESET starting symbol and the second CORESET starting symbol is longer than a number. Alternative, the UE determines a CORESET configuration with shorter time duration if the distance or the interval between the first CORESET starting symbol and the second CORESET starting symbol is shorter than a number. The number could be the longer time duration minus 1. Alternatively, the number could be the longer time duration.

[0062] The bitmap is associated with the first CORESET configuration and the second CORESET configuration. For example, when a UE is configured with a first CORESET with time duration 2, a second CORESET with time duration 1 and a bit map "11100101000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol}, {2nd symbol }, {3rd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol}. For the CORESET in {1st symbol}, {2nd symbol }, {3rd symbol}, the configuration of the second COREST is applied. For the CORESET in {6th symbol,7th symbol} and {8th symbol, 9th symbol}, the configuration of the second CORESET is applied.

[0063] The UE can be configured with two CORESET time durations for a given CORESET, search space, or bitmap. In one example, one CORESET time duration is longer and the other is shorter.

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[0064] For a first CORESET starting symbol, the UE determines one CORESET time duration from the two configured CORESET time durations according to a distance or interval between the first CORESET starting symbol and a second CORESET starting symbol. Alternatively, the second CORESET starting symbol could be a next CORESET starting symbol in a bitmap after the first CORESET starting symbol. In one method, the UE determines a longer CORESET time duration if the distance or the interval between the first CORESET starting symbol and the second CORESET starting symbol is longer than a number. Alternatively, the UE determines a shorter CORESET time duration if the distance or the interval between the first CORESET starting symbol and the second CORESET starting symbol is shorter than a number.

[0065] The number could be the longer time duration. Alternatively, the number could be the longer time duration minus 1. The bitmap is associated with a CORESET whose configured time duration is the first CORESET time duration and the second CORESET time duration. For example, when a UE is configured with a first CORESET with time duration 1 and 2, and a bit map "11100101000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol}, {2nd symbol }, {3rd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol}. For the CORESET in {1st symbol}, {2nd symbol }, {3rd symbol}, the CORESET time duration of 1 is applied. For the CORESET in {6th symbol,7th symbol} and {8th symbol, 9th symbol}, the CORESET time duration 2 is applied.

[0066] The UE can be configured with a default CORESET, which is different from the CORESET indicated by the signal. The time duration of the default CORESET may be shorter than or equal to the duration indicated by the signal. More specifically, the time duration of the default CORESET can be one or two. The time duration of the default CORESET is the interval between the first bit position and the second bit position. The UE may monitor the CORESET on the OFDM symbol(s) in a slot based on the bit map excluding the first bit position and/or the second bit position. The UE may monitor the default CORESET on OFDM symbol(s) in the slot based on the first bit position and/or the second bit position.

[0067] Alternatively, the bit map can indicate at least a monitoring occasion for the CORESET by indicating a starting OFDM symbol following contiguous OFDM symbol(s) until the time duration of the CORESET is reached. The UE may interpret the bit map based on the

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time duration of the CORESET. For example, when a UE is configured with time duration 2 and a bit map "11011000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol,2nd symbol} and {4th symbol, 5th symbol}. Different monitoring occasions for the CORESET indicated by the bit map can be separated by at least one bit position indicating the value 0. If the bit map indicates a number of contiguous bit position(s) with the value 1, which is a number is smaller than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 indicating a monitoring occasion for the CORESET with the time duration as the number. For example, when a UE is configured with time duration 3 and a bit map "11000101011100", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {6th symbol}, {8th symbol}, and {10th symbol, 11th symbol, 12th symbol}. In this example, the UE may interpret the number of contiguous bit position(s) indicating the value 1 in the bit map which is smaller than the time duration 3 as a CORESET monitoring occasion with the time duration as the contiguous number of value 1.

[0068] If bit map indicates a number of contiguous bit position(s) with the value 1, which is the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with value 1 as contiguous monitoring occasions for the CORESET with the time duration or smaller than the time duration. More specifically, if the number of contiguous bit position(s) indicating the value 1 is multiple of the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as contiguous monitoring occasion(s) for the CORESET for the time duration.

[0069] If the number of contiguous bit position(s) indicating the value 1 is not a multiple of the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as those earlier contiguous bit(s) indicating contiguous monitoring occasion(s) for the CORESET for the time duration and the last orphan bit(s) indicating a monitoring occasion for the CORESET for the time duration smaller than the time duration of the CORESET which depends on number of last orphan bit(s).

[0070] Alternatively, the last orphan bit(s) in the number of contiguous bit(s) with the value one can be ignored by the UE. For example, when a UE is configured with a time duration 2 and a bit map "11110000000000", the UE monitors the CORESET for the following symbols

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in a slot: {1st symbol, 2nd symbol}, {3rd symbol, 4th symbol}. In another example, when a UE is configured with time duration 2 and a bit map "1110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {3rd symbol}. In a similar example, when a UE is configured with a time duration 2 and a bit map "1110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}. In this example, the UE ignores the {3rd symbol} indicated by the bit map.

[0071] In one embodiment, a UE is configured with a CORESET. Alternatively, the UE receives a signal indicating configuration of a CORESET. The configuration of the CORESET includes at least the time duration of the CORESET and a bit map. The bit map includes 14 bits. A set of bit position(s) in the bit map have a value of one. The set of bit position(s) indicates the starting OFDM symbol(s) in a slot for monitoring the CORESET. The interval (or distance) between each bit position (indicating the value of one) in the set (or bitmap) and the least significant bit in the bit map is larger than or equal to a number. The interval (or distance) between the last bit position (indicating the value one) in the set (or bitmap) and the least significant bit in the bit map is larger than or equal to a number. An interval or distance between two bit positions is the number of bits between the two bit positions. The two bit positions could be neglected when calculating the interval or distance. For example, an interval or distance between two bit position indicating the value 1 for a bitmap "10001000000000" is 3. Alternatively, an interval or distance between two bit positions could be the difference of the two bit positions.

[0072] In one embodiment, the number is a time duration of the CORESET. Alternatively, the number is time duration of the CORESET minus one. Alternatively, the number is the maximum time duration of the CORESET minus one. Alternatively, the number is the maximum time duration of the CORESET minus one. For example, if time duration of a CORESET is configured as 2, a bit map of a CORESET has a restriction that the interval between each bit position in the set and the least significant bit in the bit map is larger than or equal to 2 minus 1 (e.g., the bit map is 00000000000010).

[0073] In another example, the UE does not expect to receive a configuration of a bit map such that the interval (or distance) between each bit position indicating 1 in the bit map and the least significant bit in the bit map (or between the last bit indicating 1 in the bitmap and the

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least significant bit in the bit map) is smaller than the number (e.g., the bit map is 00000000000001).

[0074] The UE could ignore a configuration of a bit map such that the interval (or distance) between each bit position indicating 1 in the bit map and the least significant bit in the bit map (or between the last bit indicating 1 in the bitmap and the least significant bit in the bit map) is smaller than the number (e.g., the bit map is 00000000000001). The UE could ignore a part of a bit map such that the interval (or distance) between the bit position indicating 1 in the part of the bit map and the least significant bit in the bit map (or between the last bit indicating 1 in the bitmap and the least significant bit in the bit map) is smaller than the number (e.g., the bit map is 10000000000001 in which the UE applies the first 1 and ignore the last 1).

[0075] In another example, the UE does not apply a configuration of a bit map such that the interval (or distance) between each bit position indicating 1 in the bit map and the least significant bit in the bit map (or between the last bit indicating 1 in the bitmap and the least significant bit in the bit map) is smaller than the number (e.g., the bit map is 00000000000001).

[0076] A base station does not configure a UE with a bit map such that the interval (or distance) between each bit position indicating 1 in the bit map and the least significant bit in the bit map (or between the last bit indicating 1 in the bitmap and the least significant bit in the bit map) is smaller than the number (e.g., the bit map is 00000000000001). The most significant bit in the bit map represents the first OFDM symbol in a slot. The least significant bit in the bit map represents the last OFDM symbol in a slot. The signal could be *PDCCH-Config*. The bitmap could be monitoringSymbolsWithinSlot. The time duration could be a CORESET-time-duration. The UE may monitor the CORESET on OFDM symbol(s) in a slot based on the signal. The UE may monitor the CORESET on OFDM symbol(s) starting from each bit position in the set in a slot.

[0077] If the bit map indicates a number of contiguous bit position(s) with the value 1, which the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as contiguous monitoring occasions for the CORESET with the time duration or smaller than the time duration. More specifically, if the number of contiguous bit position(s) indicating value 1 is a multiple of the time duration of the

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CORESET, the UE may interpret the number of contiguous bit position(s) with value 1 as contiguous monitoring occasion(s) for the CORESET for the time duration.

[0078] If the number of contiguous bit position(s) indicating value 1 is not a multiple of the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as those earlier contiguous bit(s) indicating contiguous monitoring occasion(s) for the CORESET with the time duration, and the last orphan bit(s) indicating a monitoring occasion for the CORESET with the time duration smaller than the time duration of the CORESET which depends on number of last orphan bit(s).

[0079] Alternatively, the last orphan bit(s) in the number of contiguous bit(s) with the value one can be ignored by the UE. For example, when a UE is configured with a time duration 2 and a bit map "11110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {3rd symbol, 4th symbol}. In another example, when a UE is configured with a time duration 2 and a bit map "11100000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {3rd symbol}. In a similar example, when a UE is configured with a time duration 2 and a bit map "11100000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}. In this example, the UE ignores {3rd symbol} indicated by the bit map.

[0080] Alternatively, if a bit map indicates a number of contiguous bit position(s) with the value 1, which is the number larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as at least a monitoring occasion for CORESET which the time duration of the CORESET is the number of contiguous bit position(s) with the value 1. For example, when a UE is configured with time duration 2 and a bit map "11100110000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol, 3rd symbol }, {5th symbol, 6th symbol}. Alternatively, if a bit map indicates a number of contiguous bit position(s) with the value 1, in which the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as at least a monitoring occasion for CORESET in which the time duration of the CORESET is the maximum time duration of a CORESET. For example, when a UE is configured with time duration 2 and a bit map "11110000000000", the UE monitors

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CORESET in the following symbols in a slot: {1st symbol, 2nd symbol, 3rd symbol }, {4th symbol} when maximum time duration of CORESET is 3.

[0081] Alternatively, the signal indicates at least a bit map. The UE may receive a PDCCH on the OFDM symbol(s) in a slot based on the bit map. The bit map indicates at least a bit position and/or at least on a contiguous bit position(s) as value one. The UE may monitor a CORESET on the OFDM symbol(s) in a slot based on the bit map. The UE may view the contiguous bit position(s) as a CORESET. The UE may not expect to have the bit map indicating the number of the contiguous bit position(s) with the value one exceeding a maximum time duration for a CORESET. Alternatively, if the UE receives the bit map indicating the number of the contiguous bit position(s) with the value one exceeding a maximum time duration for a CORESET, the UE may ignore part of the indication of the bit map. Alternatively, the UE may ignore the whole indication of the bit map. For example, when a UE is configured with a bit map "11010111000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {4th symbol}, {6th symbol, 7th symbol, 8th symbol} when the maximum time duration of CORESET is 3. In a similar example, when a UE is configured with a bit map "11100001100000", the UE may ignore the first three 1's because it will exceed the maximum time duration if the maximum time duration of the CORESET is 2. In the above example, the UE may monitor the CORESET for the following symbols in a slot: {8th symbol, 9th symbol}. The time duration of a CORESET can be determined based on the bit map and each contiguous bit position(s) with the value one in the bit map. The signal does not indicate the time duration for a CORESET. The signal indicates different configurations for the different time duration CORESET(s). The configuration may include at least CCE-REG mapping, aggregation level, search space configuration, and frequency resource assignment.

[0082] In another embodiment, a UE is configured with a CORESET. Alternatively, the UE receives a signal indicating a configuration of a CORESET. The configuration of the CORESET includes at least a time duration of the CORESET and a bit map. The bit map includes 14 bits. A set of bit position(s) in the bit map have a value of one. The set of bit position(s) indicates the starting OFDM symbol(s) in a slot for monitoring the CORESET. The interval (or distance) between a bit position in the set and the least significant bit in the bit map is smaller than a number. The interval (or distance) between the last bit position indicating a value of 1 in the bit map and the least significant bit in the bit map is smaller than a number. An

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interval or distance between two bit positions is a number of bits between the two bit positions. The two bit positions could be neglected when calculating the interval or distance. For example, an interval or distance between two bit positions indicating the value 1 for a bitmap "10001000000000" is 3.

[0083] More specifically, the number is a time duration of the CORESET. Alternatively, the number is a time duration of the CORESET minus one. Alternatively, the number is a maximum time duration of the CORESET minus one. Alternatively, the number is a maximum time duration of the CORESET minus one. For example, if the time duration of a CORESET is configured as 2, a bit map of a CORESET may be 00000000000001. The most significant bit in the bit map represents the first OFDM symbol in a slot. The least significant bit in the bit map represents the last OFDM symbol in a slot. The signal could be a *PDCCH-Config*. The bitmap could be monitoringSymbolsWithinSlot.

[0084] The time duration could be a CORESET-time-duration. The UE may monitor the CORESET on the OFDM symbol(s) in a slot based on the signal. The UE may monitor the CORESET on the OFDM symbol(s) starting from each bit position in the set in a slot. The UE may monitor the CORESET on the OFDM symbol(s) in a slot based on the bit map excluding the bit position. The UE may not expect to monitor the CORESET on OFDM symbol(s) in a slot starting from the bit position. The UE may be configured with a default CORESET, which is different from the CORESET indicated by the signal. The time duration of the default CORESET may be shorter than or equal to the duration indicated by the signal. The time duration of the default CORESET may be one or two. The time duration of the default CORESET is the interval between the bit position and the least significant bit in the bit map. The UE may monitor the CORESET on the OFDM symbol(s) in a slot based on the bit map excluding the bit position. The UE may monitor the default CORESET on tge OFDM symbol(s) in the slot based on the bit position.

[0085] The UE can be configured with two CORESETs (e.g., two CORESET IDs) associated with a search space or a bitmap. The time durations of the two CORESETs can be different. For example, a first duration is longer and a second duration is shorter. For a first CORESET starting symbol, the UE determines one CORESET configuration from the two CORESET configurations according to a distance or interval between the first CORESET

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starting symbol and the last symbol in a slot. The UE determines a CORESET configuration for the longer time duration if the distance or the interval between the first CORESET starting symbol and the last symbol in a slot is longer than a number. The UE determines a CORESET configuration for the shorter time duration if the distance or the interval between the first CORESET starting symbol and the last symbol in a slot is shorter than a number. The number could be the longer time duration minus 1. The number could be the longer time duration.

[0086] In one embodiment, the bitmap is associated with the first CORESET configuration and the second CORESET configuration. For example, when a UE is configured with a first CORESET with a time duration of 2, a second CORESET with a time duration of 1 and a bit map "00000101000001", the UE monitors the CORESET for the following symbols in a slot: {6^{th} symbol,7th symbol}, {8^{th} symbol, 9th symbol} and {14^{th} symbol}. For the CORESET in {14^{th} symbol}, the configuration of the second COREST is applied. For the CORESET in {6^{th} symbol,7th symbol} and {8^{th} symbol, 9th symbol}, the configuration of the second CORESET is applied.

[0087] The UE can be configured with two CORESET time durations for a given CORESET, a search space, or a bitmap. For example, one CORESET time duration is longer and the other time duration is shorter. For a first CORESET starting symbol, the UE determines one CORESET time duration from the two configured CORESET time durations according to a distance or interval between the first CORESET starting symbol and the last symbol in a slot. The UE determines the longer CORESET time duration if the distance or the interval between the first CORESET starting symbol and the last symbol in a slot is longer than a number. The UE determines the shorter CORESET time duration if the distance or the interval between the first CORESET starting symbol and the last symbol in a slot is shorter than a number. The number could be the longer time duration minus 1. Alternatively, the number could be the longer time duration. The bitmap is associated with a CORESET whose configured time duration is the first CORESET time duration and the second CORESET time duration. For example, when a UE is configured with a first CORESET with a time duration of 1 and 2 and a bit map "00000101000001", the UE monitors the CORESET for the following symbols in a slot: {6^{th} symbol,7th symbol}, {8^{th} symbol, 9th symbol} and {14^{th} symbol}. For the CORESET in {14^{th} symbol}, the CORESET time duration of 1 is applied. For the CORESET in {6^{th} symbol,7th symbol} and {8^{th} symbol, 9th symbol}, the CORESET time duration of 2 is applied.

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Alternatively, the OFDM symbols for a CORESET could span different slots. A CORESET could span a first slot and a second slot if the interval or distance between the last bit position indicating 1 in the first slot and the last symbol in the first slot is shorter than the number. The second slot is the next slot of the first slot. For example, when a UE is configured with a time duration 2 and a bit map "10000101000001", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {6th symbol,7th symbol}, {8th symbol, 9th symbol} and {14th symbol, 1st symbol of the next slot}. Alternatively, the CORESET time duration of CORESETs associated with a bitmap within a slot could be different. Alternatively, the CORESET time duration could be different from the configured value if the interval or distance between the last bit position indicating 1 in the first slot and the last symbol in the first slot is shorter than the number. For example, when a UE is configured with a time duration 2 and a bit map "10000101000001", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {6th symbol,7th symbol}, {8th symbol, 9th symbol} and {14th symbol}. It can be observed that the CORESETs corresponding to the last bit in the bitmap have 1 symbol time duration even if the configured value is 2 due to the short interval or distance to the last symbol of a slot.

[0088] Alternatively, if a bit map indicates a number of contiguous bit position(s) with value 1, in which the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as at least a monitoring occasion for the CORESET, in which the time duration of the CORESET is the number of contiguous bit position(s) with value 1. For example, when a UE is configured with a time duration 2 and a bit map "11100110000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol, 3rd symbol }, {5th symbol, 6th symbol}. Alternatively, if bit map indicates a number of contiguous bit position(s) with value 1, in which the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as at least a monitoring occasion for the CORESET, in which the time duration of the CORESET is the maximum time duration of a CORESET. For example, when a UE is configured with a time duration 2 and a bit map "11110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol, 3rd symbol}, {4th symbol} when the maximum time duration of the CORESET is 3.

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[0089] Alternatively, the signal indicates at least a bit map. The UE may receive a PDCCH on the OFDM symbol(s) in a slot based on the bit map. The bit map indicate at least a bit position and/or at least one contiguous bit position(s) as value one. The UE may monitor a CORESET on the OFDM symbol(s) in a slot based on the bit map. The UE may view the contiguous bit position(s) as a CORESET. The UE may not expect to have the bit map indicating number of the contiguous bit position(s) with value one exceeding a maximum time duration for a CORESET. Alternatively, if the UE receives the bit map indicating the number of the contiguous bit position(s) with value one exceeding a maximum time duration for a CORESET, the UE may ignore a part of the indication of the bit map. Alternatively, the UE may ignore the whole indication of the bit map. For example, when a UE is configured with a bit map "11010111000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {4th symbol}, {6th symbol, 7th symbol, 8th symbol} when the maximum time duration of CORESET is 3. In a similar example, when a UE is configured with a bit map "11100001100000", the UE may ignore the first three 1's because it will exceed the maximum time duration if the maximum time duration of CORESET is 2. In the above example, the UE may monitor the CORESET for the following symbols in a slot: {8th symbol, 9th symbol}. The time duration of a CORESET can be determined based on the bit map and each contiguous bit position(s) with value one in the bit map. The signal does not indicate a time duration for a CORESET. The signal indicates the different configurations for different time duration CORESET(s). The configuration may include at least a CCE-REG mapping, aggregation level, search space configuration, or frequency resource assignment.

[0090] According to one method, the UE receives a signal indicating at least a duration and a bit map, wherein a set of bit position(s) in the bit map indicates a value, and wherein an interval between each bit position in the set is larger than or equal to a number.

[0091] According to another method, the network transmits a signal indicating at least a duration and a bit map, wherein a set of bit position(s) in the bit map indicates a value, wherein interval between each bit position in the set is larger than or equal to a number.

[0092] In one or more of the above-disclosed methods, the value is one.

[0093] In one or more of the above-disclosed methods, the number is the duration.

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[0094] In one or more of the above-disclosed methods, the number is the duration minus one.

[0095] In one or more of the above-disclosed methods, the number is maximum duration, wherein the maximum duration is maximum time duration of a control resource set (CORESET).

[0096] In one or more of the above-disclosed methods, the number is maximum duration minus one, wherein the maximum duration is maximum time duration of a CORESET.

[0097] In one or more of the above-disclosed methods, the duration is a time duration of a CORESET.

[0098] In one or more of the above-disclosed methods, the bit map comprises 14 bits.

[0099] In one or more of the above-disclosed methods, the set of bit position(s) in the bit map indicates monitoring starting OFDM symbol(s) of a CORESET in a slot.

[00100] In one or more of the above-disclosed methods, the most significant bit in the bit map represents the first OFDM symbol in a slot.

[00101] In one or more of the above-disclosed methods, the least significant bit in the bit map represents the last OFDM symbol in a slot.

[00102] In one or more of the above-disclosed methods, the signal indicates configuration of a CORESET.

[00103] In one or more of the above-disclosed methods, the signal is a *PDCCH-config* IE which is used to configure UE-specific PDCCH parameters.

[00104] In one or more of the above-disclosed methods, the UE monitors a CORESET based on the signal.

[00105] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot based on the bit map.

[00106] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot starting from each bit position in the set.

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[00107] According to one method, the UE receives a signal indicating at least a duration and a bit map, wherein interval between a pair of bit position(s) indicating a value in the bit map is smaller than the duration.

[00108] According to one method, the network transmits a signal indicating at least a duration and a bit map, wherein interval between a pair of bit position(s) indicating a value in the bit map is smaller than the duration.

[00109] In one or more of the above-disclosed methods, the pair of bit position(s) comprises a first bit position and a second bit position.

[00110] In one or more of the above-disclosed methods, the first bit position is closer to the most significant bit in the bit map than the second bit position.

[00111] In one or more of the above-disclosed methods, the value is one.

[00112] In one or more of the above-disclosed methods, the duration is a time duration of a CORESET.

[00113] In one or more of the above-disclosed methods, the bit map comprises 14 bits.

[00114] In one or more of the above-disclosed methods, the most significant bit in the bit map represents the first OFDM symbol in a slot.

[00115] In one or more of the above-disclosed methods, the least significant bit in the bit map represents the last OFDM symbol in a slot.

[00116] In one or more of the above-disclosed methods, the signal indicates configuration of a CORESET.

[00117] In one or more of the above-disclosed methods, the signal is a *PDCCH-config* IE which is used to configure UE-specific PDCCH parameters.

[00118] In one or more of the above-disclosed methods, the UE monitors a CORESET based on the signal.

[00119] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot based on the bit map.

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[00120] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value.

[00121] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value excluding the pair of bit position.

[00122] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value excluding the first bit position of the pair.

[00123] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value excluding the second bit position of the pair.

[00124] In one or more of the above-disclosed methods, the UE ignores the signal.

[00125] In one or more of the above-disclosed methods, the UE transmits a Negative Acknowledgement (NACK) as a feedback of the signal.

[00126] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in an even slot based on the bit map excluding the second bit position of the pair.

[00127] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in an odd slot based on the bit map excluding the second bit position of the pair.

[00128] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in an even slot based on the bit map excluding the first bit position of the pair.

[00129] In one or more of the above-disclosed methods, the signal comprises a pattern for indicating the bit map.

[00130] In one or more of the above-disclosed methods, the pattern indicates a slot level bit map.

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[00131] In one or more of the above-disclosed methods, if bit position of the slot level bit map indicates one, the UE monitors a CORESET in a slot based on the bit map excluding the second bit position of the pair.

[00132] In one or more of the above-disclosed methods, if bit position of the slot level bit map indicates one, the UE monitors a CORESET in a slot based on the bit map excluding the first bit position of the pair.

[00133] In one or more of the above-disclosed methods, the UE monitors a CORESET in a slot based on the bit map and slot format of the slot.

[00134] In one or more of the above-disclosed methods, if the slot format of the slot indicates a set of OFDM symbol(s) as flexible or uplink which the set comprises part of OFDM symbols which start from the first bit position with the duration, the UE monitors a CORESET based on the bit map excluding the first bit position of the pair.

[00135] In one or more of the above-disclosed methods, if the slot format of the slot indicates a set of OFDM symbol(s) as flexible or uplink which the set comprises part of OFDM symbols which start from the second bit position with the duration, the UE monitors a CORESET based on the bit map excluding the second bit position of the pair.

[00136] In one or more of the above-disclosed methods, the UE is configured with a default CORESET, which is different from a CORESET indicated by the signal.

[00137] In one or more of the above-disclosed methods, the time duration of the default CORESET is shorter than the duration.

[00138] In one or more of the above-disclosed methods, the time duration of the default CORESET is one or two.

[00139] In one or more of the above-disclosed methods, the time duration of the default CORESET is the interval between the first bit position and the second bit position of the pair.

[00140] In one or more of the above-disclosed methods, the UE monitors the CORESET on OFDM symbol(s) in a slot based on the bit map excluding the pair of bit position(s) and monitors the default CORESET on OFDM symbol(s) in the slot based on the pair of bit position(s).

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[00141] According to another method, the UE receives a signal indicating at least a duration and a bit map, wherein a set of bit position indicates a value in the bit map, and wherein an interval between every bit position in the set and the least significant bit in the bit map is larger than or equal to a number.

[00142] According to another method, the network transmits a signal indicating at least a duration and a bit map, wherein a set of bit position indicates a value in the bit map, and wherein an interval between a bit position in the set and the least significant bit in the bit map is larger than or equal to a number.

[00143] In one or more of the above-disclosed methods, the value is one.

[00144] In one or more of the above-disclosed methods, the number is the duration.

[00145] In one or more of the above-disclosed methods, the number is the duration minus one.

[00146] In one or more of the above-disclosed methods, the number is a maximum duration, wherein the maximum duration is maximum time duration of a CORESET.

[00147] In one or more of the above-disclosed methods, the number is a maximum duration minus one, wherein the maximum duration is a maximum time duration of a CORESET.

[00148] In one or more of the above-disclosed methods, the duration is a time duration of a CORESET.

[00149] In one or more of the above-disclosed methods, the bit map comprises 14 bits.

[00150] In one or more of the above-disclosed methods, the set of bit position(s) in the bit map indicates monitoring starting OFDM symbol(s) of a CORESET in a slot.

[00151] In one or more of the above-disclosed methods, the most significant bit in the bit map represents the first OFDM symbol in a slot.

[00152] In one or more of the above-disclosed methods, the least significant bit in the bit map represents the last OFDM symbol in a slot.

[00153] In one or more of the above-disclosed methods, the signal indicates a configuration of a CORESET.

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[00154] In one or more of the above-disclosed methods, the signal is a PDCCH-config IE which is used to configure UE-specific PDCCH parameters.

[00155] In one or more of the above-disclosed methods, the UE monitors a CORESET based on the signal.

[00156] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot based on the bit map.

[00157] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot starting from each bit position in the set.

[00158] According to another method, the UE receives a signal indicating at least a duration and a bit map, wherein a set of bit position(s) indicates a value in the bit map, and wherein an interval between a bit position in the set and the least significant bit in the bit map is smaller than the duration.

[00159] In one or more of the above-disclosed methods, the value is one.

[00160] In one or more of the above-disclosed methods, the duration is a time duration of a CORESET.

[00161] In one or more of the above-disclosed methods, the bit map comprises 14 bits.

[00162] In one or more of the above-disclosed methods, the most significant bit in the bit map represents the first OFDM symbol in a slot.

[00163] In one or more of the above-disclosed methods, the least significant bit in the bit map represents the last OFDM symbol in a slot.

[00164] In one or more of the above-disclosed methods, the signal indicates a configuration of a CORESET.

[00165] In one or more of the above-disclosed methods, the signal is a PDCCH-config IE which is used to configure UE-specific PDCCH parameters.

[00166] In one or more of the above-disclosed methods, the UE monitors a CORESET based on the signal.

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[00167] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot based on the bit map.

[00168] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot based on the bit map excluding the bit position.

[00169] In one or more of the above-disclosed methods, the UE does not monitor a CORESET on OFDM symbol(s) in a slot starting from the bit position.

[00170] In one or more of the above-disclosed methods, the UE is configured with a default CORESET, which is different from a CORESET indicated by the signal.

[00171] In one or more of the above-disclosed methods, the time duration of the default CORESET is shorter than the duration indicated by the signal.

[00172] In one or more of the above-disclosed methods, the time duration of the default CORESET is one or two.

[00173] In one or more of the above-disclosed methods, the time duration of the default CORESET is the interval between the bit position and the least significant bit in the bit map.

[00174] In one or more of the above-disclosed methods, the UE monitors the CORESET on OFDM symbol(s) in a slot based on the bit map excluding the bit position and monitors the default CORESET on OFDM symbol(s) in the slot based on the bit position.

[00175] According to another method, the UE receives a signal indicating at least a bit map, wherein the bit map indicates at least one bit position or at least one contiguous bit position(s) with a value.

[00176] In one or more of the above-disclosed methods, the signal indicates a duration.

[00177] In one or more of the above-disclosed methods, the value is one.

[00178] In one or more of the above-disclosed methods, the duration is a time duration of a CORESET.

[00179] In one or more of the above-disclosed methods, the bit map comprises 14 bits.

[00180] In one or more of the above-disclosed methods, the most significant bit in the bit map represents the first OFDM symbol in a slot.

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[00181] In one or more of the above-disclosed methods, the least significant bit in the bit map represents the last OFDM symbol in a slot.

[00182] In one or more of the above-disclosed methods, the signal indicates a configuration of a CORESET.

[00183] In one or more of the above-disclosed methods, the signal is a PDCCH-config IE which is used to configure UE-specific PDCCH parameters.

[00184] In one or more of the above-disclosed methods, the UE monitors the CORESET on OFDM symbol(s) in a slot based on the bit map.

[00185] In one or more of the above-disclosed methods, the UE monitors the CORESET on OFDM symbol(s) in a slot based on the bit map and the duration.

[00186] In one or more of the above-disclosed methods, the number of the contiguous bit position(s) with the value indicates a time duration of a CORESET.

[00187] In one or more of the above-disclosed methods, if the number of the contiguous bit position(s) with the value is equal to the duration, the UE monitors the CORESET with the duration.

[00188] In one or more of the above-disclosed methods, if number of the contiguous bit position(s) with the value is smaller than the duration, the UE monitors the CORESET with the number of the contiguous bit position(s).

[00189] In one or more of the above-disclosed methods, if number of the contiguous bit position(s) with the value is larger than the duration and the number is multiple of the duration, the UE interprets the contiguous bit position(s) with the value as contiguous occasions for monitoring the CORESET with the duration.

[00190] In one or more of the above-disclosed methods, if number of the contiguous bit position(s) with the value is larger than the duration and the number is not multiple of the duration, the UE interprets the contiguous bit position(s) with the value as at least one occasion for monitoring the CORESET with the duration and a occasion for monitoring the CORESET with time duration equal to number of orphan bit of the contiguous bit position(s).

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[00191] As those skilled in the art will appreciate, the various disclosed embodiments may be combined to form new embodiments and/or methods.

[00192] FIG. 7 is a flow chart 700 according to one exemplary embodiment from the perspective of a network node. In step 705, the network node transmits a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map. In step 710, the network node is not allowed to transmit the signal such that an interval between two bit positions in the set in the bit map is smaller than a second duration.

[00193] In one embodiment, the second duration is the first duration.

[00194] In one embodiment, the second duration is the first duration minus one.

[00195] In one embodiment, the network is not allowed to transmit the signal indicating that the first duration is 2 and the bit map is 11000000000000.

[00196] In one embodiment, the interval between two bit positions in the set in the bit map shall be larger than or equal to the second duration.

[00197] In one embodiment, the network node is not allowed to transmit the signal such that interval between a bit position in the set in the bit map and the least significant bit position in the bit map is smaller than the second duration.

[00198] In one embodiment, the interval between a bit position in the set in the bit map and the least significant bit position in the bit map shall be larger than or equal to the second duration.

[00199] In one embodiment, the network node transmits a Physical Downlink Control Channel (PDCCH) candidate on monitoring occasion(s) of the CORESET.

[00200] In one embodiment, the slot duration comprises 14 OFDM symbols.

[00201] In one embodiment, the bit map comprises 14 bits.

[00202] In one embodiment, the signal indicates the configuration of the CORESET.

[00203] In one embodiment, the signal is PDCCH-config information element.

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[00204] In one embodiment, the interval is the difference between two bit positions.

[00205] In one embodiment, the interval is the number of bits between two bit positions.

[00206] FIG. 8 is a flow chart 800 according to one exemplary embodiment from the perspective of a network node. In step 805, the network node transmits a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map. In step 810, the network node is not allowed to transmit the signal such that interval between a bit position in the set in the bit map and the least significant bit position in the bit map is smaller than a second duration.

[00207] In one embodiment, the second duration is the first duration.

[00208] In one embodiment, the second duration is the first duration minus one.

[00209] In one embodiment, the network is not allowed to transmit the signal indicating that the first duration is 2 and the bit map is 00000000000001.

[00210] In one embodiment, the interval between a bit position in the set in the bit map and the least significant bit position in the bit map shall be larger than or equal to the second duration.

[00211] In one embodiment, the network node is not allowed to transmit the signal such that interval between two bit positions in the set in the bit map is smaller than the second duration.

[00212] In one embodiment, the network node transmits a Physical Downlink Control Channel (PDCCH) candidate on monitoring occasion(s) of the CORESET.

[00213] In one embodiment, the slot duration comprises 14 OFDM symbols.

[00214] In one embodiment, the bit map comprises 14 bits.

[00215] In one embodiment, the signal indicates the configuration of the CORESET.

[00216] In one embodiment, the signal is PDCCH-config information element.

[00217] In one embodiment, the interval is the difference between two bit positions.

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[00218] In one embodiment, the interval is the number of bits between two bit positions.

[00219] Referring back to FIGS. 3 and 4, in one embodiment, the device 300 includes a program code 312 stored in memory 310. The CPU 308 could execute program code 312 (i) to transmit a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map, and (ii) is not allowed to transmit the signal such that an interval between two bit positions in the set in the bit map is smaller than a second duration.

[00220] In another aspect, the CPU 308 could execute program code 312 to (i) transmits a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map, and (ii) and is not allowed to transmit the signal such that interval between a bit position in the set in the bit map and the least significant bit position in the bit map is smaller than a second duration.

[00221] Furthermore, the CPU 308 can execute the program code 312 to perform all of the above-described actions and steps or others methods described herein.

[00222] The above-disclosed methods provide a restriction of a configuration of a CORESET so that UEs can avoid handling ambiguous configurations. Additionally, the various above-disclosed methods can help UEs handle ambiguous configurations.

[00223] Various aspects of the disclosure have been described above. It should be apparent that the teachings herein may be embodied in a wide variety of forms and that any specific structure, function, or both being disclosed herein is merely representative. Based on the teachings herein one skilled in the art should appreciate that an aspect disclosed herein may be implemented independently of any other aspects and that two or more of these aspects may be combined in various ways. For example, an apparatus may be implemented or a method may be practiced using any number of the aspects set forth herein. In addition, such an apparatus may be implemented or such a method may be practiced using other structure, functionality, or structure and functionality in addition to or other than one or more of the aspects set forth herein. As an example of some of the above concepts, in some aspects concurrent channels may be established

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based on pulse repetition frequencies. In some aspects concurrent channels may be established based on pulse position or offsets. In some aspects concurrent channels may be established based on time hopping sequences.

[00224] Those of skill in the art would understand that information and signals may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the above description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[00225] Those of skill would further appreciate that the various illustrative logical blocks, modules, processors, means, circuits, and algorithm steps described in connection with the aspects disclosed herein may be implemented as electronic hardware (e.g., a digital implementation, an analog implementation, or a combination of the two, which may be designed using source coding or some other technique), various forms of program or design code incorporating instructions (which may be referred to herein, for convenience, as "software" or a "software module"), or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present disclosure.

[00226] In addition, the various illustrative logical blocks, modules, and circuits described in connection with the aspects disclosed herein may be implemented within or performed by an integrated circuit ("IC"), an access terminal, or an access point. The IC may comprise a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, electrical components, optical components, mechanical components, or any combination thereof designed to perform the functions described herein, and may execute codes or instructions that reside within the IC, outside of the IC, or both. A general purpose processor may be a microprocessor, but in the

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alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[00227] It is understood that any specific order or hierarchy of steps in any disclosed process is an example of a sample approach. Based upon design preferences, it is understood that the specific order or hierarchy of steps in the processes may be rearranged while remaining within the scope of the present disclosure. The accompanying method claims present elements of the various steps in a sample order, and are not meant to be limited to the specific order or hierarchy presented.

[00228] The steps of a method or algorithm described in connection with the aspects disclosed herein may be embodied directly in hardware, in a software module executed by a processor, or in a combination of the two. A software module (e.g., including executable instructions and related data) and other data may reside in a data memory such as RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, a hard disk, a removable disk, a CD-ROM, or any other form of computer-readable storage medium known in the art. A sample storage medium may be coupled to a machine such as, for example, a computer/processor (which may be referred to herein, for convenience, as a "processor") such the processor can read information (e.g., code) from and write information to the storage medium. A sample storage medium may be integral to the processor. The processor and the storage medium may reside in an ASIC. The ASIC may reside in user equipment. In the alternative, the processor and the storage medium may reside as discrete components in user equipment. Moreover, in some aspects any suitable computer-program product may comprise a computer-readable medium comprising codes relating to one or more of the aspects of the disclosure. In some aspects a computer program product may comprise packaging materials.

[00229] While the invention has been described in connection with various aspects, it will be understood that the invention is capable of further modifications. This application is intended to cover any variations, uses or adaptation of the invention following, in general, the principles of the invention, and including such departures from the present disclosure as come within the known and customary practice within the art to which the invention pertains.

Petitioners' Exhibit 1010, p. 117
AT&T et al v. Asustek Computer
IPR2024-00992

Electronic Acknowledgement Receipt

EFS ID:	41900776
Application Number:	16241368
International Application Number:	
Confirmation Number:	6576
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Chun-Wei Huang
Customer Number:	87197
Filer:	Scott Ulbrich/Christy Ulbrich
Filer Authorized By:	Scott Ulbrich
Attorney Docket Number:	5261.22US01
Receipt Date:	11-FEB-2021
Filing Date:	07-JAN-2019
Time Stamp:	13:37:29
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	Miscellaneous Incoming Letter	Response_Notice_to_Correct.pdf	139917 911cf7fb4a0162147c009544f94dbd594aeae79d	no	5

Warnings:

Information:					
2	Specification	MARKED_UP_SUBSTITUTE_SPECIFICATION_5261_22US01.pdf	305731 39151e310980a0c4021651790eb1f830647d2dc3	no	57
Warnings:					
Information:					
3	Specification	SUBSTITUTE_SPECIFICATION_NO_MARKUPS_5261_22US01.pdf	305513 9a6c435e9b01843a91d1c9943442ec4fe92717eb	no	57
Warnings:					
Information:					
		Total Files Size (in bytes):	751161		

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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Attorney Docket No.: 5261.22US01
Chun-Wei HUANG	Confirmation No.: 6576
Application No.: 16/241,368	Examiner: HOANG, Thai D.
Filed: 7-JAN-2019	Group Art Unit: 2463

For: METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRLESS COMMUNICATION SYSTEM

RESPONSE TO NOTICE TO FILE CORRECTED APPLICATION PAPERS

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

This is in response to a Notice to File Corrected Application Papers, mailed January 6, 2021, of the above-identified Application. Enclosed is a copy of said Notice. Pursuant to 37 C.F.R. 1.121(b)(3), please replace the current specification with the substitute specification presently submitted herewith.

Both marked-up and clean versions of the substitute specification are submitted herewith to comply with said Notice.

The substitute specification adds the missing text on pages 13, 14 and 15. No new matter is introduced in the substitute specification because the missing text can be found in the priority application no. 62/619,041, which was incorporated by reference in the present application.

No fee was indicated due on the Notice. However, the Office is authorized to charge any additional fee due, or to credit any overpayment to Deposit Account No 50-4970 to ensure entry of this paper.

Petitioners' Exhibit 1010, p. 120
AT&T et al v. Asustek Computer
IPR2024-00992

Respectfully submitted,

/Scott G. Ulbrich/
Scott G. Ulbrich (Reg. No. 48005)

Customer No. 87197
SKAAR ULBRICH MACARI, P.A.
601 Carlson Parkway, Suite 1050
Minnetonka, MN 55305
Tel.: 612-216-1700
Fax: 612-234-4465
pto@sumiplaw.com

Petitioners' Exhibit 1010, p. 121
AT&T et al v. Asustek Computer
IPR2024-00992

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.
16/241,368	01/07/2019	Chun-Wei Huang	5261.22US01	6576

87197 7590 01/06/2021

Skaar Ulbrich Macari, P.A.
601 Carlson Parkway
Suite 1050
Minneapolis, MN 55305

EXAMINER	
HOANG, THAI D	

ART UNIT	PAPER NUMBER
2463	

NOTIFICATION DATE	DELIVERY MODE
01/06/2021	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):

pto@sumiplaw.com

Petitioners' Exhibit 1010, p. 122
AT&T et al v. Asustek Computer
IPR2024-00992

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Application No. : 16241368
Applicant : Huang
Filing Date : 01/07/2019
Date Mailed : 01/06/2021

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Notice of Allowance Mailed

This application has been accorded an Allowance Date and is being prepared for issuance. The application, however, is incomplete for the reasons below.

Applicant is given two (2) months from the mail date of this Notice within which to respond. This time period for reply is extendable under 37 CFR 1.136(a) for only TWO additional MONTHS.

The informalities requiring correction are indicated in the attachment(s). If the informality pertains to the abstract, specification (including claims) or drawings, the informality must be corrected with an amendment in compliance with 37 CFR 1.121 (or, if the application is a reissue application, 37 CFR 1.173). Such an amendment may be filed after payment of the issue fee if limited to correction of informalities noted herein. See Waiver of 37 CFR 1.312 for Documents Required by the Office of Patent Publication, 1280 Off. Gaz. Patent Office 918 (March 23, 2004). In addition, if the informality is not corrected until after payment of the issue fee, for purposes of 35 U.S.C. 154(b)(1)(iv), "all outstanding requirements" will be considered to have been satisfied when the informality has been corrected. A failure to respond within the above-identified time period will result in the application being ABANDONED.

See attachment(s).

A copy of this notice MUST be returned with the reply. Please address response to "Mail Stop Issue Fee, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450".

/Daxa Patel/
Publication Branch
Office of Data Management
(571) 272-4200

Application No. 16241368

IDENTIFICATION OF APPLICATION DEFICIENCIES IN APPLICATION FILED ON OR AFTER SEPTEMBER 16, 2012

☐ Applicant must provide legible text for the following item(s).

- ☐ Specification filed , page(s) .
- ☐ Claims filed , claim(s) .
- ☐ Other: .

☒ Applicant must provide missing information on the following page(s) of the specification by amending the specification to add the missing text. No new matter may be added.
Page/line no(s). 13, 14 and 15

☐ The specification refers to one or more applications by attorney docket number and does not show the U.S. application number(s). Applicant must supply the U.S. application number in place of each attorney docket number.
Page/line no(s).

☐ Applicant must provide an Abstract of the Disclosure.

☐ The Application Data Sheet (ADS dated) does not supply the inventor's city and/or does not supply the inventor's U.S. state and/or does not supply the inventor's country. Applicant must submit a signed, in accordance with 37 CFR 1.76(e) and 1.33(b), application data sheet that corrects this deficiency. To be in compliance with 37 CFR 1.76, the corrected application data sheet must identify the information being changed by using underlining for additions and strikethroughs or brackets for deletions.

☐ Other:

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.
16/241,368	01/07/2019	Chun-Wei Huang	5261.22US01	6576

87197 7590 01/06/2021

Skaar Ulbrich Macari, P.A.
601 Carlson Parkway
Suite 1050
Minneapolis, MN 55305

EXAMINER	
HOANG, THAI D	

ART UNIT	PAPER NUMBER
2463	

NOTIFICATION DATE	DELIVERY MODE
01/06/2021	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):

pto@sumiplaw.com

Petitioners' Exhibit 1010, p. 125
AT&T et al v. Asustek Computer
IPR2024-00992

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Application No. : 16241368
Applicant : Huang
Filing Date : 01/07/2019
Date Mailed : 01/06/2021

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Notice of Allowance Mailed

This application has been accorded an Allowance Date and is being prepared for issuance. The application, however, is incomplete for the reasons below.

Applicant is given two (2) months from the mail date of this Notice within which to respond. This time period for reply is extendable under 37 CFR 1.136(a) for only TWO additional MONTHS.

The informalities requiring correction are indicated in the attachment(s). If the informality pertains to the abstract, specification (including claims) or drawings, the informality must be corrected with an amendment in compliance with 37 CFR 1.121 (or, if the application is a reissue application, 37 CFR 1.173). Such an amendment may be filed after payment of the issue fee if limited to correction of informalities noted herein. See Waiver of 37 CFR 1.312 for Documents Required by the Office of Patent Publication, 1280 Off. Gaz. Patent Office 918 (March 23, 2004). In addition, if the informality is not corrected until after payment of the issue fee, for purposes of 35 U.S.C. 154(b)(1)(iv), "all outstanding requirements" will be considered to have been satisfied when the informality has been corrected. A failure to respond within the above-identified time period will result in the application being ABANDONED.

See attachment(s).

A copy of this notice MUST be returned with the reply. Please address response to "Mail Stop Issue Fee, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450".

/Daxa Patel/
Publication Branch
Office of Data Management
(571) 272-4200

Application No. 16241368

IDENTIFICATION OF APPLICATION DEFICIENCIES IN APPLICATION FILED ON OR AFTER SEPTEMBER 16, 2012

☐ Applicant must provide legible text for the following item(s).

- ☐ Specification filed , page(s) .
- ☐ Claims filed , claim(s) .
- ☐ Other: .

☒ Applicant must provide missing information on the following page(s) of the specification by amending the specification to add the missing text. No new matter may be added.
Page/line no(s). 13, 14 and 15

☐ The specification refers to one or more applications by attorney docket number and does not show the U.S. application number(s). Applicant must supply the U.S. application number in place of each attorney docket number.
Page/line no(s).

☐ Applicant must provide an Abstract of the Disclosure.

☐ The Application Data Sheet (ADS dated) does not supply the inventor's city and/or does not supply the inventor's U.S. state and/or does not supply the inventor's country. Applicant must submit a signed, in accordance with 37 CFR 1.76(e) and 1.33(b), application data sheet that corrects this deficiency. To be in compliance with 37 CFR 1.76, the corrected application data sheet must identify the information being changed by using underlining for additions and strikethroughs or brackets for deletions.

☐ Other:

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.
16/241,368	01/07/2019	Chun-Wei Huang	5261.22US01	6576

87197 7590 12/24/2020

Skaar Ulbrich Macari, P.A.
601 Carlson Parkway
Suite 1050
Minneapolis, MN 55305

EXAMINER	
HOANG, THAI D	

ART UNIT	PAPER NUMBER
2463	

NOTIFICATION DATE	DELIVERY MODE
12/24/2020	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):

pto@sumiplaw.com

Petitioners' Exhibit 1010, p. 128
AT&T et al v. Asustek Computer
IPR2024-00992

Response to Rule 312 Communication	Application No.	Applicant(s)	
	16/241,368	Huang et al.	
	Examiner	Art Unit	AIA (FITF) Status
	THAI D HOANG	2463	Yes

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

1. ☑ The amendment filed on 17 December 2020 under 37 CFR 1.312 has been considered, and has been:

a) ☐ entered.

b) ☑ entered as directed to matters of form not affecting the scope of the invention.

c) ☐ disapproved because the amendment was filed after the payment of the issue fee.

Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.

d) ☐ disapproved. See explanation below.

e) ☐ entered in part. See explanation below.

/THAI D HOANG/
Primary Examiner, Art Unit 2463

Petitioners' Exhibit 1010, p. 129
AT&T et al v. Asustek Computer
IPR2024-00992

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Attorney Docket No.: 5261.22US01
Chun-Wei HUANG	Confirmation No.: 6576
Application No.: 16/241,368	Examiner: HOANG, Thai D.
Filed: 07-JAN-2019	Group Art Unit: 2463

For: METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM

AMENDMENT AFTER NOTICE OF ALLOWANCE (RULE 312)

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Approved.
T.H.
12/19/2020

INTRODUCTORY COMMENTS

This paper is submitted in response to the Notice of Allowance mailed on November 18, 2020. This Response consists of the following sections:

A. AMENDMENT TO THE CLAIMS

B. REMARKS

Petitioners' Exhibit 1010, p. 130
AT&T et al v. Asustek Computer
IPR2024-00992

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (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)

106622 7590 11/18/2020
Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

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 transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/241,368	01/07/2019	Chun-Wei Huang	1426-283.101	6576

TITLE OF INVENTION: METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	02/18/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
HOANG, THAI D	2463	370-329000

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 03-09 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 Skaar Ulbrich Macari, P.A.
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 must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: ASUSTek Computer Inc.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Taipei City, Taiwan

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☒ Issue Fee ☒ Publication Fee (if required) ☐ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

☒ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 50-4970

5. **Change in Entity Status** (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
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.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Scott G. Ulbrich/ Date December 17, 2020

Typed or printed name Scott G. Ulbrich Registration No. 48005

Petitioners' Exhibit 1010, p. 131
AT&T et al v. Asustek Computer
IPR2024-00992

Electronic Patent Application Fee Transmittal

Application Number:	16241368
Filing Date:	07-Jan-2019
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Chun-Wei Huang
Filer:	Scott Ulbrich/Christy Ulbrich
Attorney Docket Number:	5261.22US01

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

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:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
PUBL. FEE- EARLY, VOLUNTARY, OR NORMAL	1504	1	0	0
UTILITY APPL ISSUE FEE	1501	1	1200	1200
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1200**

Electronic Acknowledgement Receipt

EFS ID:	41423817
Application Number:	16241368
International Application Number:	
Confirmation Number:	6576
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Chun-Wei Huang
Customer Number:	87197
Filer:	Scott Ulbrich/Christy Ulbrich
Filer Authorized By:	Scott Ulbrich
Attorney Docket Number:	5261.22US01
Receipt Date:	17-DEC-2020
Filing Date:	07-JAN-2019
Time Stamp:	18:56:44
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1200
RAM confirmation Number	E2020BGI57146925
Deposit Account	
Authorized User	

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

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)	Issue_Fee_PartB_5261_22US01.pdf	2366404 bbfb1e0b0f85f4bc006e1c3ce39351338ae0b5bd	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	32284 34e1e27e96623eb3cf4c597ec88b731c74335308	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	2398688		

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.

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Attorney Docket No.: 5261.22US01
Chun-Wei HUANG	Confirmation No.: 6576
Application No.: 16/241,368	Examiner: HOANG, Thai D.
Filed: 07-JAN-2019	Group Art Unit: 2463

For: METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM

AMENDMENT AFTER NOTICE OF ALLOWANCE (RULE 312)

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INTRODUCTORY COMMENTS

This paper is submitted in response to the Notice of Allowance mailed on November 18, 2020. This Response consists of the following sections:

A. AMENDMENT TO THE CLAIMS

B. REMARKS

Petitioners' Exhibit 1010, p. 136
AT&T et al v. Asustek Computer
IPR2024-00992

A. AMENDMENT TO THE CLAIMS

1. (Previously Presented) A method of a network node, the method comprising:

transmitting a signal indicating at least a first duration and a bit map,

wherein the first duration is time duration of a control resource set (CORESET), and

wherein the bit map includes a set of bit positions, where each bit position has a value of one or zero and each bit position with the value of one indicates a starting Orthogonal Frequency Division Multiplexing (OFDM) symbol of a monitoring occasion of the CORESET within a slot; and

not allowing to transmit the signal such that an interval between any two bit positions with the value of one in the set of bit positions in the bit map is smaller than the first duration.

2. (Canceled)

3. (Canceled)

4. (Original) The method of claim 1, wherein the network node is not allowed to transmit the signal indicating that the first duration is 2 and the bit map is 11000000000000.

5. (Previously Presented) The method of claim 1, wherein the interval between two bit positions in the set in the bit map shall be larger than or equal to the first duration.

6. (Previously Presented) The method of claim 1, wherein the network node is not allowed to transmit the signal such that interval between any bit position in the set in the bit map and the least significant bit position in the bit map is smaller than the first duration minus one.

7. (Previously Presented) The method of claim 1, wherein the interval between a bit position in the set in the bit map and the least significant bit position in the bit map shall be larger than or equal to the first duration.

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8. (Original) The method of claim 1, wherein the network node transmits a Physical Downlink Control Channel (PDCCH) candidate on monitoring occasion(s) of the CORESET.

9. (Original) The method of claim 1, wherein the signal indicates the configuration of the CORESET.

10. (Original) The method of claim 1, wherein the signal is PDCCH-config information element.

11. (Original) The method of claim 1, wherein the interval is the difference between two bit positions.

12. (Original) The method of claim 1, wherein the interval is number of bits between two bit positions.

13. (Currently Amended) A method of a network node, the method comprising:

transmitting a signal indicating at least a first duration and a bit map,

wherein the first duration is time duration of a control resource set (CORESET), and

wherein the bit map includes a set of bit positions, where each bit position has a value of one or zero and each bit position with the value of one indicates a starting Orthogonal Frequency Division Multiplexing (OFDM) symbol of a ~~monitoring occasion~~ monitoring occasion of the CORESET within a slot; and

not allowing to transmit the signal such that interval between any bit position with the value of one in the set of bit positions in the bit map and the least significant bit position in the bit map is smaller than the first duration minus one.

14. (Canceled)

15. (Canceled)

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16. (Original) The method of claim 13, wherein the network node is not allowed to transmit the signal indicating that the first duration is 2 and the bit map is 00000000000001.

17. (Previously Presented) The method of claim 13, wherein the interval between a bit position in the set in the bit map and the least significant bit position in the bit map shall be larger than or equal to the first duration minus one.

18. (Previously Presented) The method of claim 13, wherein the network node is not allowed to transmit the signal such that interval between any two bit positions in the set in the bit map is smaller than the first duration.

19. (Original) The method of claim 13, wherein the network node transmits a Physical Downlink Control Channel (PDCCH) candidate on monitoring occasion(s) of the CORESET.

20. (Original) The method of claim 13, wherein the signal indicates the configuration of the CORESET.

21. (Original) The method of claim 13, wherein the signal is PDCCH-config information element.

22. (Original) The method of claim 13, wherein the interval is the difference between two bit positions.

23. (Original) The method of claim 13, wherein the interval is number of bits between two bit positions.

24. (Previously Presented) A network node, comprising:

a control circuit;

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a processor installed in the control circuit; and

a memory installed in the control circuit and coupled to the processor;

wherein the processor is configured to execute a program code stored in the memory to:

transmit a signal indicating at least a first duration and a bit map,

wherein the first duration is time duration of a control resource set (CORESET), and

wherein the bit map includes a set of bit positions, where each bit position has a value of one or zero and each bit position with the value of one indicates a starting Orthogonal Frequency Division Multiplexing (OFDM) symbol of a monitoring occasion of the CORESET within a slot; and

not allowing to transmit the signal such that an interval between any two bit positions with the value of one in the set of bit positions in the bit map is smaller than the first duration.

25. (Previously Presented) The method of claim 1, wherein the CORESET is monitored on a number of consecutive OFDM symbol provided by the first duration from the starting OFDM symbol.

26. (Previously Presented) The method of claim 13, wherein the CORESET is monitored on a number of consecutive OFDM symbol provided by the first duration from the starting OFDM symbol.

27. (Previously Presented) The network node of claim 24, wherein the CORESET is monitored on a number of consecutive OFDM symbol provided by the first duration from the starting OFDM symbol.

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B. REMARKS

Claims 1, 4-13 and 16-27 were pending and indicated as allowed in the November 18, 2020 Notice of Allowance. Claim 13 is amended in this paper. No claims are cancelled or added.

Applicant respectfully requests that claim 13 be amended as requested herein. Applicant presently amends claim 13 to correct a grammar issue. Specifically, the previously hyphenated "monitoring-occasion" is now indicated as two words "monitoring occasion". No new matter is introduced.

The Examiner is invited to telephone the undersigned with any questions.

Respectfully submitted,

/Scott G. Ulbrich/
Scott G. Ulbrich (Reg. No. 48005)

Customer No. 87197
SKAAR ULBRICH MACARI, P.A.
601 Carlson Parkway, Suite 1050
Minnetonka, MN 55305
Tel: 612-216-1700
Fax: 612-234-4465
pto@sumiplaw.com

Please grant any extension of time necessary for entry; charge any additional fee due to Deposit Account No 50-4970.

Petitioners' Exhibit 1010, p. 141
AT&T et al v. Asustek Computer
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Electronic Acknowledgement Receipt

EFS ID:	41423719
Application Number:	16241368
International Application Number:	
Confirmation Number:	6576
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Chun-Wei Huang
Customer Number:	87197
Filer:	Scott Ulbrich/Christy Ulbrich
Filer Authorized By:	Scott Ulbrich
Attorney Docket Number:	5261.22US01
Receipt Date:	17-DEC-2020
Filing Date:	07-JAN-2019
Time Stamp:	18:48:28
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		312_Amendment.pdf	64874 4c484d7468519c6dfca342fcf045def500065e19	yes	6

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment after Notice of Allowance (Rule 312)	1	1
	Claims	2	5
	Applicant Arguments/Remarks Made in an Amendment	6	6
Warnings:			
Information:			
	Total Files Size (in bytes):	64874	

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

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www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/241,368	01/07/2019	Chun-Wei Huang	1426-283.101

CONFIRMATION NO. 6576

POA ACCEPTANCE LETTER

87197
Skaar Ulbrich Macari, P.A.
601 Carlson Parkway
Suite 1050
Minneapolis, MN 55305

OC000000121600076

Date Mailed: 11/30/2020

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 11/24/2020.

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.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/ltaba/

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/241,368	01/07/2019	Chun-Wei Huang	1426-283.101

CONFIRMATION NO. 6576

POWER OF ATTORNEY NOTICE

106622
Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

OC000000121600035

Date Mailed: 11/30/2020

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 11/24/2020.

- The Power of Attorney to you in this application has been revoked by the applicant. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/ltaba/

Petitioners' Exhibit 1010, p. 145
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PTO/AIA/80 (07-17)
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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(c).

I hereby appoint:

[X] Practitioners associated with Customer Number: 87197

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(c).

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

[X] The address associated with Customer Number: 87197

OR

[ ]

Firm or individual name		
Address		
City	State	Zip
Country		
Telephone	Email	

Assignee name and address: ASUSTeK COMPUTER INC.
No. 15, Lite Road, Peitou Dist.
Taipei City, TAIWAN 112

A copy of this form, together with a statement under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(c) may be completed by one of the practitioners appointed in this form, 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 Ming-Hsiu HSU	Date 2019.7.5
Name Ming-Hsiu HSU	Telephone
Title Director	

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 update (and by the USPTO to process) the file of a patent or reexamination proceeding. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 18 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.

PTO/AIA/96 (08-12)
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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: ASUSTek Computer Inc.

Application No./Patent No.: 16/241,368 Filed/Issue Date: 07-JAN-2019

Titled: METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM

ASUSTek Computer Inc., a corporation

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

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☑ 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 047920, Frame 0337, or for which a copy thereof is attached.

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.

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.

PTO/AIA/96 (08-12)
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STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____

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4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

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5. 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.

6. 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).

☑ As required by 37 CFR 3.73(c)(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.

/Scott G. Ulbrich/	November 24, 2020
Signature	Date
Scott G. Ulbrich	48005
Printed or Typed Name	Title or Registration Number

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.

Electronic Acknowledgement Receipt

EFS ID:	41217323
Application Number:	16241368
International Application Number:	
Confirmation Number:	6576
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Chun-Wei Huang
Customer Number:	106622
Filer:	Scott Ulbrich/Lindsey Bullington
Filer Authorized By:	Scott Ulbrich
Attorney Docket Number:	1426-283.101
Receipt Date:	24-NOV-2020
Filing Date:	07-JAN-2019
Time Stamp:	16:33:26
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	Power of Attorney	POA.pdf	72931 1ea7bc5cff74fa80a481ce13b2f9f311fd8369de	no	1

Warnings:

Information:					
2	Assignee showing of ownership per 37 CFR 3.73	373c.pdf	118654 b73e0b1efcc29c111c60b3fbec377042f57fd709	no	3
Warnings:					
Information:					
		Total Files Size (in bytes):	191585		

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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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United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
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Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

106622 7590 11/18/2020

Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

EXAMINER
HOANG, THAI D

ART UNIT	PAPER NUMBER
2463	

DATE MAILED: 11/18/2020

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/241,368	01/07/2019	Chun-Wei Huang	1426-283.101	6576

TITLE OF INVENTION: METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	02/18/2021

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: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

Petitioners' Exhibit 1010, p. 152
AT&T et al v. Asustek Computer
IPR2024-00992

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (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)

106622 7590 11/18/2020
Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

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 transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/241,368	01/07/2019	Chun-Wei Huang	1426-283.101	6576

TITLE OF INVENTION: METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	02/18/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
HOANG, THAI D	2463	370-329000

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 03-09 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 must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). 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. Fees submitted: ❑ Issue Fee ❑ Publication Fee (if required) ❑ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
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.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

Petitioners' Exhibit 1010, p. 153
AT&T et al v. Asustek Computer
IPR2024-00992

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.
16/241,368	01/07/2019	Chun-Wei Huang	1426-283.101	6576

106622 7590 11/18/2020

Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

EXAMINER	
HOANG, THAI D	
ART UNIT	PAPER NUMBER
2463	

DATE MAILED: 11/18/2020

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

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.

Petitioners' Exhibit 1010, p. 154
AT&T et al v. Asustek Computer
IPR2024-00992

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B 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 30 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.

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, local or foreign enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 16/241,368	Applicant(s) Huang et al.	
	Examiner THAI D HOANG	Art Unit 2463	AIA (FITF) Status Yes

-- 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 10/28/2020.
   ☐ 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 See Continuation Sheet . 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. _____.
5. ☐ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/THAI D HOANG/
Primary Examiner, Art Unit 2463

Petitioners' Exhibit 1010, p. 156
AT&T et al v. Asustek Computer
IPR2024-00992

Continuation of 3. The allowed claim(s) is/are: 1,4-12,25,13,16-23,26,24 and 27, which have been renumbered to 1-23 respectively

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Allowable Subject Matter

Claims 1, 4-12, 25, 13, 16-23, 26, 24 and 27 are allowed and renumbered to 1-23 respectively.

The following is an examiner's statement of reasons for allowance:

In the article "CORESET configuration and search space design" published by Huawei does not disclose the limitation *not allowing to transmit the signal such that an interval between any two bit positions with the value of one in the set of bit positions in the bit map is smaller than the first duration* as recited in claims 1, 13 and 24, and argued in the Remarks.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. See attached PTO-892.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to THAI D HOANG whose telephone number is (571)272-3184. The examiner can normally be reached on 10:30 am-18:30pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Rinehart can be reached on (571) 272-3632. 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 https://ppair-my.uspto.gov/pair/PrivatePair. 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.

/THAI D HOANG/
Primary Examiner, Art Unit 2463

Notice of References Cited	Application/Control No. 16/241,368	Applicant(s)/Patent Under Reexamination Huang et al.	
	Examiner THAI D HOANG	Art Unit 2463	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20200259896-A1	08-2020	Sachs; Joachim	H04W4/30	1/1
*	B	US-20200229092-A1	07-2020	WU; Min	H04W76/28	1/1
*	C	US-20200120624-A1	04-2020	Lin; Zhipeng	H04W56/00	1/1
*	D	US-20200015176-A1	01-2020	LI; Yingyang	H04L5/0082	1/1
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC 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.

Petitioners' Exhibit 1010, p. 160
AT&T et al v. Asustek Computer
IPR2024-00992

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/241,368	Huang et al.
	Examiner	**Art Unit**
	THAI D HOANG	2463

CPC						
Symbol					**Type**	**Version**
H04L	/	1	/	1614	F	2013-01-01
H04W	/	72	/	042	I	2013-01-01
H04W	/	72	/	0446	I	2013-01-01
H04L	/	5	/	0053	I	2013-01-01
H04L	/	5	/	0094	I	2013-01-01
H04L	/	5	/	0007	A	2013-01-01

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	23	
/THAI D HOANG/ Primary Examiner, Art Unit 2463	11 November 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	7

U.S. Patent and Trademark Office

Part of Paper No.: 20201111

Petitioners' Exhibit 1010, p. 161
AT&T et al v. Asustek Computer
IPR2024-00992

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/241,368	Huang et al.
	Examiner	**Art Unit**
	THAI D HOANG	2463

INTERNATIONAL CLASSIFICATION					
CLAIMED					
H04W	/	4	/	00	
NON-CLAIMED					
	/		/		

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**
370	329

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 23	
/THAI D HOANG/ Primary Examiner, Art Unit 2463 (Primary Examiner)	11 November 2020 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 7

Petitioners' Exhibit 1010, p. 162
AT&T et al v. Asustek Computer
IPR2024-00992

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/241,368	Huang et al.
	Examiner	**Art Unit**
	THAI D HOANG	2463

☑ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	8	10	16	19										
	2	9	11	17	20										
	3	10	12	18	21										
2	4	12	13	19	22										
3	5		14	20	23										
4	6		15	22	24										
5	7	13	16	11	25										
6	8	14	17	21	26										
7	9	15	18	23	27										

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	23	
/THAI D HOANG/ Primary Examiner, Art Unit 2463	11 November 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	7

U.S. Patent and Trademark Office

Part of Paper No.: 20201111

Petitioners' Exhibit 1010, p. 163
AT&T et al v. Asustek Computer
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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/241,368	Huang et al.
	Examiner	Art Unit
	THAI D HOANG	2463

CPC - Searched*		
Symbol	Date	Examiner
(H04L1/1614 H04L5/0053,0094 H04W72/042,0446).CPC.	07/06/2020	TH
updated	11/10/2020	TH

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner
370	328-329, 335-345, 348	07/06/2020	th

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
EAST: TEXT SEARCH ALL DATABASE. SEE SEARCH HISTORY ATTACHED.	04/13/2020	TH
NPL: IEEE, GOOGLE, STIC, ITU, IETF,	04/13/2020	TH
EAST: UPDATED TEXT SEARCH ALL DATABASE. CPC SEARCH, US CLASS SEARCH, INVENTOR SEARCH. SEE SEARCH HISTORY ATTACHED.	07/06/2020	TH
NPL: UPDATED IEEE, GOOGLE, STIC, ITU, IETF,	07/06/2020	TH
EAST: UPDATED TEXT SEARCH ALL DATABASE. CPC SEARCH, US CLASS SEARCH, INVENTOR SEARCH. SEE SEARCH HISTORY ATTACHED.	11/10/2020	TH
NPL: UPDATED IEEE, GOOGLE, STIC, ITU, IETF.	11/10/2020	TH

/THAI D HOANG/ Primary Examiner, Art Unit 2463	

Petitioners' Exhibit 1010, p. 164
AT&T et al v. Asustek Computer
IPR2024-00992

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/241,368	Huang et al.
	Examiner	Art Unit
	THAI D HOANG	2463

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	EAST: TEXT SEARCH. SEE SEARCH HISTORY.	11/10/2020	TH

/THAI D HOANG/ Primary Examiner, Art Unit 2463	

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AT&T et al v. Asustek Computer
IPR2024-00992

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/241,368	Huang et al.
	Examiner	Art Unit
	THAI D HOANG	2463

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☑ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	04/13/2020	07/06/2020	11/11/2020						
1	1	✓	✓	=						
	2	✓	-	=						
	3	✓	-	=						
2	4	✓	✓	=						
3	5	✓	✓	=						
4	6	✓	✓	=						
5	7	✓	✓	=						
6	8	✓	✓	=						
7	9	✓	✓	=						
8	10	✓	✓	=						
9	11	✓	✓	=						
10	12	✓	✓	=						
12	13	✓	✓	=						
	14	✓	-	=						
	15	✓	-	=						
13	16	✓	✓	=						
14	17	✓	✓	=						
15	18	✓	✓	=						
16	19	✓	✓	=						
17	20	✓	✓	=						
18	21	✓	✓	=						
19	22	✓	✓	=						
20	23	✓	✓	=						
22	24	✓	✓	=						
11	25			=						
21	26			=						
23	27			=						

Petitioners' Exhibit 1010, p. 166
AT&T et al v. Asustek Computer
IPR2024-00992

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S23	36	(tim$3 during duration interval) with ((control adj resource) CORESET) with bit with (smaller larger less shorter longer more)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/11/10 15:04
L4	32	L3 and (tim$3 during duration) with ((control adj resource) CORESET) with bit$1 with (smaller larger less shorter longer more)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/11/10 18:51
L3	170,139	(H04L1/1614 H04L5/0053,0094 H04W72/042,0446).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/11/10 18:51
L2	36	(tim$3 during duration interval) with ((control adj resource) CORESET) with bit$1 with (smaller larger less shorter longer more)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/11/10 18:51
L6	3	L5 and (tim$3 during duration) with ((control adj resource) CORESET) with bit$1 with (smaller larger less shorter longer more)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/11/10 18:52
L5	76,435	(370/328-329,335-345,348).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/11/10 18:52
L9	0	L8 and ((tim$3 during duration) and ((control adj resource) CORESET) and (bit adj map$4)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/11/10 19:35

L8	60	L7 and (asustek.as.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/11/10 19:35
L7	398	(huang near chun-wei).in. (lin near ko-chiang).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/11/10 19:35
L10	10	((tim$3 near3 (during duration interval)) and ((control adj resource) CORESET) and ((bit$1 byte$1) near4 one) and (smaller larger less shorter longer more)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/11/10 19:37

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L12	2	((tim$3 near3 (during duration interval)) and ((control adj resource) CORESET) and ((bit$1 byte$1) near4 one) and (smaller larger shorter longer)).clm.	US-PGPUB; USPAT	OR	ON	2020/11/10 19:38

11/10/2020 7:39:53 PM
C:\Users\thoang2\Documents\EAST\Workspaces\16241368.wsp

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16241368
Filing Date	2019-01-07
First Named Inventor	Chun-Wei Huang
Art Unit	2463
Examiner Name	Thai D. Hoang
Attorney Docket Number	1426-283.101

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					

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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
	1					

If you wish to add additional U.S. Published Application citation information please click the Add button.

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

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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]

Petitioners' Exhibit 1010, p. 169
AT&T et al v. Asustek Computer
IPR2024-00992

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /T.D.H/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16241368
	Filing Date	2019-01-07
	First Named Inventor	Chun-Wei Huang
	Art Unit	2463
	Examiner Name	Thai D. Hoang
	Attorney Docket Number	1426-283.101

	1	Office Action from Intellectual Property Office India in corresponding IN Application No. 201914000620, dated July 29, 2020.	☐
	2	OPPO, "Text proposal for search space", 3GPP TSG RAN WG1 Meeting AH 1801, Vancouver, Canada, January 22nd-26th, 2018, R1-1800495.	☐
	3	InterDigital Inc., "On Remaining Details of Minimum System Information Delivery", 3GPP TSG RAN WG1, Meeting 91, Reno, USA, 27th-1st, November 2017. R1-1720623.	☐
	4	Office Action from TIPO in corresponding TW Application No. 108100603, dated August 3, 2020.	☐
	5	Huawei, HiSilicon, "CORESET configuration and search space design", 3GPP TSG RAN WG1 Meeting #91, Reno, USA, November 27th-December 1st 2017, R1-1719387.	☐
	6	ZTE, "NR-PDCCH CORESET Configuration", 3GPP TSG RAN WG1 Meeting #90, Prague, Czechia 21-25th August 2017. R1-1712441.	☐
	7	3GPP TS 38.213 V15.0.0; Technical Specification Group Radio Access Network; NR; Physical layer procedures for control (Release 15) 2018-01-03 Table 13-1, Chapter 13.	☐
	8	Huawei HiSilicon, "CORESET configuration and search space design", 3GPP TSG RAN WG1 Meeting #90bis, Prague, Czech Republic, 9-13 October 2017. R1-1717062.	☐

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature	/THAI D HOANG/	Date Considered	11/11/2020

*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.

Petitioners' Exhibit 1010, p. 170
AT&T et al v. Asustek Computer
IPR2024-00992

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /T.D.H/

PTO/SB/08a (03-15)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Application Number	16241368
Filing Date	2019-01-07
First Named Inventor	Chun-Wei Huang
Art Unit	2463
Examiner Name	Thai D. Hoang
Attorney Docket Number	1426-283.101

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
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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
	1					

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FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

If you wish to add additional Foreign Patent Document citation information please click the Add button

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]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16241368
	Filing Date	2019-01-07
	First Named Inventor	Chun-Wei Huang
	Art Unit	2463
	Examiner Name	Thai D. Hoang
	Attorney Docket Number	1426-283.101

	1	Office Action from Intellectual Property Office India in corresponding IN Application No. 201914000620, dated July 29, 2020.	☐
	2	OPPO, "Text proposal for search space", 3GPP TSG RAN WG1 Meeting AH 1801, Vancouver, Canada, January 22nd-26th, 2018, R1-1800495.	☐
	3	InterDigital Inc., "On Remaining Details of Minimum System Information Delivery", 3GPP TSG RAN WG1, Meeting 91, Reno, USA, 27th-1st, November 2017. R1-1720623.	☐
	4	Office Action from TIPO in corresponding TW Application No. 108100603, dated August 3, 2020.	☐
	5	Huawei, HiSilicon, "CORESET configuration and search space design", 3GPP TSG RAN WG1 Meeting #91, Reno, USA, November 27th-December 1st 2017, R1-1719387.	☐
	6	ZTE, "NR-PDCCH CORESET Configuration", 3GPP TSG RAN WG1 Meeting #90, Prague, Czechia 21-25th August 2017. R1-1712441.	☐
	7	3GPP TS 38.213 V15.0.0; Technical Specification Group Radio Access Network; NR; Physical layer procedures for control (Release 15) 2018-01-03 Table 13-1, Chapter 13.	☐
	8	Huawei HiSilicon, "CORESET configuration and search space design", 3GPP TSG RAN WG1 Meeting #90bis, Prague, Czech Republic, 9-13 October 2017. R1-1717062.	☐

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*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.

Petitioners' Exhibit 1010, p. 172
AT&T et al v. Asustek Computer
IPR2024-00992

Electronic Acknowledgement Receipt

EFS ID:	40974563
Application Number:	16241368
International Application Number:	
Confirmation Number:	6576
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Chun-Wei Huang
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-283.101
Receipt Date:	28-OCT-2020
Filing Date:	07-JAN-2019
Time Stamp:	16:39:08
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)	1426-283-101--IDSasFiled10282020.pdf	55325 7dca630e54d3d5b3f65360759bdd442fbc7fcbe2	no	2

Warnings:

Information:					
This is not an USPTO supplied IDS fillable form					
2	Non Patent Literature	NPL--INOfficeAction.pdf	153367 6cc2751b1466b175f82f2a5bb6d9028ba7149241	no	6
Warnings:					
Information:					
3	Non Patent Literature	R1-1800495.pdf	266080 a88d8314fc327a740a7b56cd263a292fbbcc2807	no	4
Warnings:					
Information:					
4	Non Patent Literature	R1-1720623.pdf	67835 375e89ee283c0e5d822d60665fe78360d71759e6	no	4
Warnings:					
Information:					
5	Non Patent Literature	NPL--TWOfficeAction.pdf	574601 dc591c4bc05d436efe4bf7196f4cd45531c82d1c	no	6
Warnings:					
Information:					
6	Non Patent Literature	R1-1719387.pdf	511288 592e2d089f7b1a7a1cb2038695051ffb62c825b0	no	14
Warnings:					
Information:					
7	Non Patent Literature	R1-1712441.pdf	81890 a184ecef73331f5f1300277640f0fe449c6eb907	no	6
Warnings:					
Information:					
8	Non Patent Literature	NPL-3GPP38213.pdf	603769 aaf5ffa8c2aad94e6119961d36f029dd789c1f05	no	56
Warnings:					
Information:					

9	Non Patent Literature	R1-1717062.pdf	532249 c28c27601d9e68648df7af1f058c2ebe3494c40c	no	14

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Information:	
Total Files Size (in bytes):	2846404

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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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Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	16/241,368	Filing Date	2019-01-07	Docket Number (if applicable)	1426-283.101	Art Unit	2463
First Named Inventor	Chun-Wei Huang			Examiner Name	Thai D. Hoang		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

- ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
- ☐ Other _____

☒ Enclosed

- ☒ Amendment/Reply
- ☐ Information Disclosure Statement (IDS)
- ☐ Affidavit(s)/ Declaration(s)
- ☐ Other _____

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____
(Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

☐ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No _____

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

☐ Applicant Signature

PTO/SB/30EFS (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
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 contains a valid OMB control number.

Signature of Registered U.S. Patent Practitioner			
Signature	/Sang N. Dang/	Date (YYYY-MM-DD)	2020-10-28
Name	Sang N. Dang	Registration Number	51186

This collection of information is required by 37 CFR 1.114. 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.

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

Electronic Patent Application Fee Transmittal

Application Number:	16241368
Filing Date:	07-Jan-2019
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Chun-Wei Huang
Filer:	Sang N. Dang/Sandy Kim
Attorney Docket Number:	1426-283.101

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

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($)
Extension - 1 month with $0 paid	1251	1	220	220
Miscellaneous:				
RCE- 1ST REQUEST	1801	1	1360	1360
		Total in USD ($)		**1580**

Electronic Acknowledgement Receipt

EFS ID:	40971986
Application Number:	16241368
International Application Number:	
Confirmation Number:	6576
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Chun-Wei Huang
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-283.101
Receipt Date:	28-OCT-2020
Filing Date:	07-JAN-2019
Time Stamp:	14:53:22
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1580
RAM confirmation Number	E20200RE53361120
Deposit Account	
Authorized User	

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

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		1426-283-101-RFOAwRCEasFiled10282020.pdf	236866 0145b8cf2f2c12b7ea67b2cdec73ddb1816f3107	yes	13

Multipart Description/PDF files in .zip description

Document Description	Start	End
Miscellaneous Incoming Letter	13	13
Applicant Arguments/Remarks Made in an Amendment	10	12
Claims	6	9
Amendment Submitted/Entered with Filing of CPA/RCE	5	5
Transmittal Letter	3	4
Request for Continued Examination (RCE)	1	2

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	32762 99d6159fbba5c0bc908dab8d51b235ace19a349d	no	2

Warnings:

Information:

Total Files Size (in bytes):	269628

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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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Chun-Wei Huang and Ko-Chiang Lin	
Title:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM	
Serial No.:	16/241,368	Filed: January 7, 2019
Examiner:	Thai D. Hoang	Group Art Unit: 2463
Attorney Docket No.:	1426-283.101 (1070028-US)	

CERTIFICATE OF EFS-WEB TRANSMISSION
UNDER 37 CFR § 1.8

I hereby certify that the enclosed 2 Page Request for Continued Examination; 2 Page Amendment Transmittal & Petition for Extension of Time; and 8 Page Amendment are being transmitted to the United States Patent and Trademark Office via EFS-Web October 28, 2020.

Date: October 28, 2020 /Sandy Kim/
Sandy Kim

Mailing Address:

BLUE CAPITAL LAW FIRM, P.C. (Customer No.: 106622)
650 Town Center Drive, Suite 1530
Costa Mesa, California 92626
Tel: 714-839-3800
Fax: 714-795-2995

REMARKS

Claims 1, 4-13 and 16-24 are pending in the application. In the Office Action, claims 1, 4-13, and 16-24 stand rejected under 35 U.S.C. § 112, second paragraph as being indefinite. *See* Office Action, Page 2. Although Applicants disagree with the rejection, Applicants amended claims 1, 13, and 24 to further clarify the claimed invention.

FIG. 7 illustrates one exemplary embodiment of the present invention. Furthermore, Paragraphs [0037] - [0039] of the present application provide additional details. In particular, Paragraphs [0037] – [0039] of the present application state:

> [0037] In the current NR standard as disclosed in 3GPP R1-1721343 and TS 38.331, a CORESET can be configured by indicating time duration and a bit map. The bit map may indicate at least a starting OFDM symbol for monitoring the CORESET in a slot. Each bit in the bit map corresponds to an OFDM symbol in a slot. If a bit position in the bit map has a value of one, it represents a starting OFDM symbol for monitoring the CORESET. The CORESET may be monitored from at least a starting OFDM symbol(s) indicated by the bit map and occupying following OFDM symbol(s) until the configured time duration is reached. For example, if the time duration of a CORESET is configured as 2 and the bit map indicates 10000000000000, the UE may monitor the CORESET (receive at least a PDCCH) on OFDM symbol #0 and #1 in a slot.
>
> [0038] However, if a bit map indicates a starting OFDM symbol belonging to the following OFDM symbol(s) of previous starting OFDM symbol indicated by the bit map (e.g., time duration of a CORESET is 2 and the bit map is 1100000000000000), a UE may be confused about the configuration. If this situation does not specify nor is captured in the standard, how a UE treat this situation needs further consideration. In addition, if the bit map indicates a starting OFDM symbol on the last few OFDM symbols of a slot, this may create a problem where the CORESET may be configured across a slot boundary. For example, if time duration of a CORESET is 2 and the bit map is 00000000000001, how a UE handle this configuration also needs further consideration. Potential solutions are described below.
>
> [0039] According to one solution, a restriction on the configuration of a CORESET is established. The UE does not expect to receive a CORESET configuration with an overlap OFDM symbols indicated by a bit map indication and the CORESET duration and/or with a CORESET monitoring pattern across a slot boundary.

According to Paragraphs [0037] - [0039] of the present application, a CORESET can be

Petitioners' Exhibit 1010, p. 184
AT&T et al v. Asustek Computer
IPR2024-00992

configured by indicating time duration and a bit map. If a bit position in the bit map has a value of one, the bit position represents a starting OFDM symbol for monitoring the CORESET. The CORESET may be monitored from at least a starting OFDM symbol(s) indicated by the bit map and occupying following OFDM symbol(s) until the configured time duration is reached. For example, if the time duration of a CORESET is configured as 2 and the bit map indicates 10000000000000, the UE may monitor the CORESET (receive at least a PDCCH) on OFDM symbol #0 and #1 in a slot. However, if a bit map indicates a starting OFDM symbol belonging to the following OFDM symbol(s) of previous starting OFDM symbol indicated by the bit map (e.g., time duration of a CORESET is 2 and the bit map is **11**00000000000000), a UE may be confused about the configuration.

In addition, if the bit map indicates a starting OFDM symbol on the last few OFDM symbols of a slot, this may create a problem where the CORESET may be configured across a slot boundary. For example, if time duration of a CORESET is 2 and the bit map is 00000000000001, how a UE handle this configuration also needs further consideration.

One solution is to restrict the interval (or distance) between two bit positions indicating the value one in the bit map is larger than or equal to a particular number (namely, an interval between any two bit positions in the set in the bit map is smaller than a second duration). For example, an interval or distance between two bit positions indicating value 1 for a bitmap "**1**000**1**000000000" is 3. As such, the problem of UE confusion or cross slot boundary configuration is avoided.

Consistent with the specification, claims 1 and 24 recite "transmitting [or transmit] a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET), and wherein the bit map includes a set of bit positions, where each bit position has a value of one or zero and each bit position with the value of one indicates a starting Orthogonal Frequency Division Multiplexing (OFDM) symbol of a monitoring occasion of the CORESET within a slot" and "not allowing [or not allow] to transmit the signal such that an interval between any two bit positions with the value of one in the set of bit positions in the bit map is smaller than the first duration."

Similarly, claim 13 recites "transmitting a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET), and wherein the bit map includes a set of bit positions, where each bit position has a value of one or zero and each bit position with the value of one indicates a starting Orthogonal Frequency Division

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Multiplexing (OFDM) symbol of a monitoring-occasion of the CORESET within a slot" and "not allowing to transmit the signal such that interval between any bit position with a value of one in the set of bit positions in the bit map and the least significant bit position in the bit map is smaller than the first duration minus one."

Applicants respectfully submit that claims 1, 13, and 14 describe the "first duration" and the "bit map" structure sufficiently to accomplish the solution of restricting the interval (or distance) between two bit positions indicating the value one in the bit map is larger than or equal to a particular number, which is discussed above.

In addition, claims 25-27 have been added based on at least Paragraphs [0037] – [0039] to further clarify the claimed "first duration". No new matter has been added.

For the reasons stated above, Applicants respectfully submit that claims 1, 4-13, 16-24, and 25-27 are in condition for allowance.

In view of the foregoing it is respectfully submitted that the pending claims are in condition for allowance. Reconsideration of the rejections is requested. Allowance of the claims is solicited. The Examiner is invited to contact Applicants' undersigned counsel by telephone at (714) 839-3800 to expedite the prosecution of this case should there be any unresolved matters remaining.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made.

Respectfully submitted,
Sang N. Dang
BLUE CAPITAL LAW FIRM, P.C.

Dated: October 28, 2020

/Sang N. Dang/
Reg. No. 51,186
Tel.: (714) 839-3800

Petitioners' Exhibit 1010, p. 186
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IPR2024-00992

IN THE CLAIMS:

1. (Currently Amended) A method of a network node, the method comprising:

transmitting a signal indicating at least a first duration and a bit map,

wherein the first duration is time duration of a control resource set (CORESET), and

wherein the bit map includes a set of bit positions, where each bit position has a value of one or zero and each bit position with [[a]] the value of one indicates a [[first]] starting Orthogonal Frequency Division Multiplexing (OFDM) symbol of a monitoring occasion of the CORESET within a slot; and

not allowing to transmit the signal such that an interval between any two bit positions with the value of one in the set of bit positions in the bit map is smaller than ~~a second duration, wherein the second duration is~~ the first duration.

2. (Canceled)

3. (Canceled)

4. (Original) The method of claim 1, wherein the network node is not allowed to transmit the signal indicating that the first duration is 2 and the bit map is 11000000000000.

5. (Currently Amended) The method of claim 1, wherein the interval between two bit positions in the set in the bit map shall be larger than or equal to the ~~second~~ first duration.

6. (Currently Amended) The method of claim 1, wherein the network node is not allowed to transmit the signal such that interval between any bit position in the set in the bit map and the least significant bit position in the bit map is smaller than the ~~second~~ first duration minus one.

7. (Currently Amended) The method of claim 1, wherein the interval between a bit position in the set in the bit map and the least significant bit position in the bit map shall be larger than or equal to the ~~second~~ first duration.

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8. (Original) The method of claim 1, wherein the network node transmits a Physical Downlink Control Channel (PDCCH) candidate on monitoring occasion(s) of the CORESET.

9. (Original) The method of claim 1, wherein the signal indicates the configuration of the CORESET.

10. (Original) The method of claim 1, wherein the signal is PDCCH-config information element.

11. (Original) The method of claim 1, wherein the interval is the difference between two bit positions.

12. (Original) The method of claim 1, wherein the interval is number of bits between two bit positions.

13. (Currently Amended) A method of a network node, the method comprising:

transmitting a signal indicating at least a first duration and a bit map,

wherein the first duration is time duration of a control resource set (CORESET), and

wherein the bit map includes a set of bit positions, where each bit position has a value of one or zero and each bit position with [[a]] the value of one indicates a [[first]] starting Orthogonal Frequency Division Multiplexing (OFDM) symbol of a monitoring-occasion of the CORESET within a slot; and

not allowing to transmit the signal such that interval between any bit position with the value of one in the set of bit positions in the bit map and the least significant bit position in the bit map is smaller than ~~a second duration, wherein the second duration is~~ the first duration minus one.

14. (Canceled)

15. (Canceled)

16. (Original) The method of claim 13, wherein the network node is not allowed to transmit the signal indicating that the first duration is 2 and the bit map is 00000000000001.

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17. (Currently Amended) The method of claim 13, wherein the interval between a bit position in the set in the bit map and the least significant bit position in the bit map shall be larger than or equal to the ~~second~~ first duration minus one.

18. (Previously Presented) The method of claim 13, wherein the network node is not allowed to transmit the signal such that interval between any two bit positions in the set in the bit map is smaller than the first duration.

19. (Original) The method of claim 13, wherein the network node transmits a Physical Downlink Control Channel (PDCCH) candidate on monitoring occasion(s) of the CORESET.

20. The method of claim 13, wherein the signal indicates the configuration of the CORESET.

21. (Original) The method of claim 13, wherein the signal is PDCCH-config information element.

22. (Original) The method of claim 13, wherein the interval is the difference between two bit positions.

23. (Original) The method of claim 13, wherein the interval is number of bits between two bit positions.

24. (Currently Amended) A network node, comprising:

a control circuit;

a processor installed in the control circuit; and

a memory installed in the control circuit and coupled to the processor;

wherein the processor is configured to execute a program code stored in the memory to:

transmit a signal indicating at least a first duration and a bit map,

wherein the first duration is time duration of a control resource set (CORESET), and

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wherein the bit map includes a set of bit positions, where each bit position has a value of one or zero and each bit position with [[a]] the value of one indicates a [[first]] starting Orthogonal Frequency Division Multiplexing (OFDM) symbol of a monitoring occasion of the CORESET within a slot; and

not allowing to transmit the signal such that an interval between any two bit positions with the value of one in the set of bit positions in the bit map is smaller than ~~a second duration, wherein the second duration is~~ the first duration.

25. (New) The method of claim 1, wherein the CORESET is monitored on a number of consecutive OFDM symbol provided by the first duration from the starting OFDM symbol.

26. (New) The method of claim 13, wherein the CORESET is monitored on a number of consecutive OFDM symbol provided by the first duration from the starting OFDM symbol.

27. (New) The network node of claim 24, wherein the CORESET is monitored on a number of consecutive OFDM symbol provided by the first duration from the starting OFDM symbol.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	16/241,368
Confirmation No.	:	6576
Applicant	:	Chun-Wei Huang and Ko-Chiang Lin
Filed	:	January 7, 2019
Title	:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM
TC/A.U.	:	2463
Examiner	:	Thai D. Hoang
Docket No.	:	1426-283.101 (1070028-US)
Customer No.	:	106622

Amendment to Final Office Action

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the final Office Action mailed on July 9, 2020, having a three-month period and a one-month extension for filing a response to **November 9, 2020**, Applicants respectfully submit the following amendments and remarks along with a RCE:

Claims begin on page 2.

Remarks begin on page 6.

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IPR2024-00992

Amendment Transmittal & Petition for Extension of Time under 37 CFR 1.136(a)

Docket Number
1426-283.101

Address To
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Title of Invention

METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM

First Named Inventor	Chun-Wei Huang
Application No.	16/241,368
Filing Date	January 7, 2019
Examiner	Thai D. Hoang
Art Unit	2463

Transmitted herewith is an amendment in the above-identified application.

This is also a petition under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above identified application.

The requested extension and fee are as shown below (check time period desired).

Fee Calculation

Extension of Time Fee

☒ One month (37 CFR 1.17(a)(1)) ☐ Two months (37 CFR 1.17(a)(2)) ☐ Three months (37 CFR 1.17(a)(3))
☐ Four months (37 CFR 1.17(a)(4)) ☐ Five months (37 CFR 1.17(a)(5))

Claims as Amended

For	#Filed	#Previously Paid For	#Extra	Rate	Fee
Total Claims	23	- 24 =		x 80 =	
Total Indep. Claims	3	- 3 =		x 420 =	
Multiple Dependent Claims (check if applicable) ☐					
Extension Fee (from above)					
☐ Applicant claims small entity status. See 37 CFR 1.27.				TOTAL	$220

Method of Payment

☐ Deposit Account ☒ Credit Card ☐ Check ☐ Money Order ☐ Other: _____

Deposit Account Number	

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☐ Charge the fee(s) set forth above
☐ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17
☐ Charge fee(s) indicated above, **except for the filing fee**
☐ Credit any overpayments
☐ If an additional extension of time is required, please consider this a petition therefor and charge any additional fees which may be required to the Deposit Account above.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on form PTO-2038.

Amount Grand Total $220

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IPR2024-00992

Amendment Transmittal & Petition for Extension of Time under 37 CFR 1.136(a)	Docket Number
	1426-283.101

Correspondence Address			
Customer Number	106622		
-OR-			
Name			
Address			
City		State	
Country		Postal Code	
Phone Number			
E-mail Address			

Certificate of Mailing by Express Mail

I hereby certify that this Amendment and Petition for Extension of Time, accompanying documents, and fee are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on the date indicated below:

(Date of Mailing)

(Typed or Printed Name of Person Mailing Correspondence)

(Signature of Person Mailing Correspondence)

("Express Mail" Mailing Label Number)

Certificate of Mailing by First Class Mail

I hereby certify that this Amendment and Petition for Extension of Time, accompanying documents, and fee are being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on the date indicated below:

(Date of Mailing) *(Name of Person Mailing Correspondence)*

(Signature of Person Mailing Correspondence)

Certificate of Transmission

I hereby certify that this Amendment and Petition for Extension of Time, accompanying documents, and fee authorization are being facsimile transmitted to the United States Patent and Trademark Office on the date indicated below:

(Date of Transmission) *(Name of Person Transmitting Correspondence)*

(Signature of Person Transmitting Correspondence)

Signature Instructions

Select the name of the person who will electronically sign the Amendment and Petition for Extension of Time from the drop-down box below.

If a practitioner is not present in the drop-down list, you must close this form and select 'Add Practitioner...' in the Form Manager's Utility menu.

Verify that the signatory information is correct and press the 'eSign' button to electronically sign the submission. If you prefer to sign the form manually, simply do not click the 'eSign' button; just print and manually sign.

Signatory Drop-Down Box: Sang N. Dang

Name	Sang N. Dang		Registration Number	51,186
Signatory Capacity	Attorney for Applicant(s)	E-mail Address	sdang@bluecapitallaw.com	
eSign	/Sang N. Dang/		Date Signed	10-28-2020

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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.
16/241,368	01/07/2019	Chun-Wei Huang	1426-283.101	6576

106622 7590 10/19/2020

Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

EXAMINER	
HOANG, THAI D	

ART UNIT	PAPER NUMBER
2463	

NOTIFICATION DATE	DELIVERY MODE
10/19/2020	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):

docketing@bluecapitallaw.com

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IPR2024-00992

Applicant-Initiated Interview Summary	**Application No.** 16/241,368	**Applicant(s)** Huang et al.	
	Examiner THAI D HOANG	**Art Unit** 2463	**AIA (FITF) Status** Yes

All participants (applicant, applicants representative, PTO personnel):

(1) THAI D. HOANG - Primary Patent Examiner. (3) _____.

(2) SANG DANG - Applicants' Representative. (4) _____.

Date of Interview: 13 October 2020.

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.

Identification of prior art discussed: No.

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 limitation "wherein the bit map includes a set of bit positions, each bit position in the set of bit positions is with a value of one, and wherein each bit position in the set of bit positions indicates a first symbol of a monitoring occasion of the CORESET within a slot" recited in the proposed Amendment does not overcome 35 USC, 112(b) rejections. It may have 35 USC, 112(a) rejection because it recites a different scope that was disclosed in figure 7, step 705, and fig.8, step 805. Applicants' Representative would discuss with the client to solve the issue..

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the 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

/THAI D HOANG/ Primary Examiner, Art Unit 2463	

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IPR2024-00992

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) 1.133 Interviews
Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiners responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicants correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:
1) A brief description of the nature of any exhibit shown or any demonstration conducted,-
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
(The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicants record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiners version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, Interview Record OK on the paper recording the substance of the interview along with the date and the examiners initials.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	16/241,368
Confirmation No.	:	6576
Applicant	:	Chun-Wei Huang and Ko-Chiang Lin
Filed	:	January 7, 2019
Title	:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM
TC/A.U.	:	2463
Examiner	:	Thai D. Hoang
Docket No.	:	1426-283.101 (1070028-US)
Customer No.	:	106622

Amendment to Final Office Action

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the final Office Action mailed on July 9, 2020, having a three-month period and a one-month extension for filing a response to **November 9, 2020**, Applicants respectfully submit the following amendments and remarks along with a RCE:

Claims begin on page 2.

Remarks begin on page 6.

Petitioners' Exhibit 1010, p. 197
AT&T et al v. Asustek Computer
IPR2024-00992

IN THE CLAIMS:

1. (Currently Amended) A method of a network node, the method comprising:

transmitting a signal indicating at least a first duration and a bit map,

wherein the first duration is time duration of a control resource set (CORESET), and

wherein the bit map includes a set of bit positions, ~~where~~ each bit position in the set of bit positions is with a value of one, and wherein each bit position in the set of bit positions indicates a first symbol of a monitoring occasion of the CORESET within a slot; and

not allowing to transmit the signal such that an interval between any two bit positions in the set of bit positions in the bit map is smaller than a second duration, wherein the second duration is the first duration.

2. (Canceled)

3. (Canceled)

4. (Original) The method of claim 1, wherein the network node is not allowed to transmit the signal indicating that the first duration is 2 and the bit map is 11000000000000.

5. (Original) The method of claim 1, wherein the interval between two bit positions in the set in the bit map shall be larger than or equal to the second duration.

6. (Previously Presented) The method of claim 1, wherein the network node is not allowed to transmit the signal such that interval between any bit position in the set in the bit map and the least significant bit position in the bit map is smaller than the second duration minus one.

7. (Original) The method of claim 1, wherein the interval between a bit position in the set in the bit map and the least significant bit position in the bit map shall be larger than or equal to the second duration.

8. (Original) The method of claim 1, wherein the network node transmits a Physical Downlink Control Channel (PDCCH) candidate on monitoring occasion(s) of the CORESET.

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9. (Original) The method of claim 1, wherein the signal indicates the configuration of the CORESET.

10. (Original) The method of claim 1, wherein the signal is PDCCH-config information element.

11. (Original) The method of claim 1, wherein the interval is the difference between two bit positions.

12. (Original) The method of claim 1, wherein the interval is number of bits between two bit positions.

13. (Currently Amended) A method of a network node, the method comprising:

transmitting a signal indicating at least a first duration and a bit map,

wherein the first duration is time duration of a control resource set (CORESET), and

wherein the bit map includes a set of bit positions, ~~where~~ each bit position in the set of bit positions is with a value of one, and wherein each bit position in the set of bit positions indicates a first symbol of a monitoring-occasion of the CORESET within a slot; and

not allowing to transmit the signal such that interval between any bit position in the set of bit positions in the bit map and the least significant bit position in the bit map is smaller than a second duration, wherein the second duration is the first duration minus one.

14. (Canceled)

15. (Canceled)

16. (Original) The method of claim 13, wherein the network node is not allowed to transmit the signal indicating that the first duration is 2 and the bit map is 00000000000001.

17. (Original) The method of claim 13, wherein the interval between a bit position in the set in the bit map and the least significant bit position in the bit map shall be larger than or

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AT&T et al v. Asustek Computer
IPR2024-00992

equal to the second duration.

18. (Previously Presented) The method of claim 13, wherein the network node is not allowed to transmit the signal such that interval between any two bit positions in the set in the bit map is smaller than the first duration.

19. (Original) The method of claim 13, wherein the network node transmits a Physical Downlink Control Channel (PDCCH) candidate on monitoring occasion(s) of the CORESET.

20. The method of claim 13, wherein the signal indicates the configuration of the CORESET.

21. (Original) The method of claim 13, wherein the signal is PDCCH-config information element.

22. (Original) The method of claim 13, wherein the interval is the difference between two bit positions.

23. (Original) The method of claim 13, wherein the interval is number of bits between two bit positions.

24. (Currently Amended) A network node, comprising:

a control circuit;

a processor installed in the control circuit; and

a memory installed in the control circuit and coupled to the processor;

wherein the processor is configured to execute a program code stored in the memory to:

transmit a signal indicating at least a first duration and a bit map,

wherein the first duration is time duration of a control resource set (CORESET), and

wherein the bit map includes a set of bit positions, ~~where~~ each bit position in the set of bit positions is with a value of one, and wherein each bit position in the set of bit positions indicates a first symbol of a monitoring-occasion of the CORESET within a slot; and

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not allow the network to transmit the signal such that an interval between two bit positions in the set of bit positions in the bit map is smaller than a second duration, wherein the second duration is the first duration.

DRAFT

Petitioners' Exhibit 1010, p. 201
AT&T et al v. Asustek Computer
IPR2024-00992

REMARKS

Claims 1, 4-13 and 16-24 are pending in the application. In the Office Action, claims 1, 4-13, and 16-24 stand rejected under 35 U.S.C. § 112, second paragraph as being indefinite. *See* Office Action, Page 2. Although Applicants disagree with the rejection, Applicants amended claims 1, 13, and 24 to further clarify the claimed invention.

Paragraphs [0037] and [0038] of the present application state:

> [0037] In the current NR standard as disclosed in 3GPP R1-1721343 and TS 38.331, a CORESET can be configured by indicating time duration and a bit map. The bit map may indicate at least a starting OFDM symbol for monitoring the CORESET in a slot. Each bit in the bit map corresponds to an OFDM symbol in a slot. If a bit position in the bit map has a value of one, it represents a starting OFDM symbol for monitoring the CORESET. The CORESET may be monitored from at least a starting OFDM symbol(s) indicated by the bit map and occupying following OFDM symbol(s) until the configured time duration is reached. For example, if the time duration of a CORESET is configured as 2 and the bit map indicates 10000000000000, the UE may monitor the CORESET (receive at least a PDCCH) on OFDM symbol #0 and #1 in a slot.
>
> [0038] However, if a bit map indicates a starting OFDM symbol belonging to the following OFDM symbol(s) of previous starting OFDM symbol indicated by the bit map (e.g., time duration of a CORESET is 2 and the bit map is 1100000000000000), a UE may be confused about the configuration. If this situation does not specify nor is captured in the standard, how a UE treat this situation needs further consideration. In addition, if the bit map indicates a starting OFDM symbol on the last few OFDM symbols of a slot, this may create a problem where the CORESET may be configured across a slot boundary. For example, if time duration of a CORESET is 2 and the bit map is 00000000000001, how a UE handle this configuration also needs further consideration. Potential solutions are described below.

According to Paragraphs [0037] and [0038] of the present application, a CORESET can be configured by indicating time duration and a bit map. If a bit position in the bit map has a value of one, the bit position represents a starting OFDM symbol for monitoring the CORESET. The CORESET may be monitored from at least a starting OFDM symbol(s) indicated by the bit map and occupying following OFDM symbol(s) until the configured time duration is reached. For example, if the time duration of a CORESET is configured as 2 and the bit map indicates 10000000000000, the UE may monitor the CORESET (receive at least a PDCCH) on OFDM

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symbol #0 and #1 in a slot. However, if a bit map indicates a starting OFDM symbol belonging to the following OFDM symbol(s) of previous starting OFDM symbol indicated by the bit map (e.g., time duration of a CORESET is 2 and the bit map is **11**00000000000000), a UE may be confused about the configuration.

In addition, if the bit map indicates a starting OFDM symbol on the last few OFDM symbols of a slot, this may create a problem where the CORESET may be configured across a slot boundary. For example, if time duration of a CORESET is 2 and the bit map is 00000000000001, how a UE handle this configuration also needs further consideration.

One solution is to restrict the interval (or distance) between two bit positions indicating the value one in the bit map is larger than or equal to a particular number (namely, an interval between any two bit positions in the set in the bit map is smaller than a second duration). For example, an interval or distance between two bit positions indicating value 1 for a bitmap "**1**0001000000000" is 3. As such, the problem of UE confusion or cross slot boundary configuration is avoided.

Consistent with the specification, claims 1 and 24 recite "transmitting [or transmit] a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET), and wherein the bit map includes a set of bit positions, each bit position in the set of bit positions is with a value of one, and wherein each bit position in the set of bit positions indicates a first symbol of a monitoring occasion of the CORESET within a slot" and "not allowing [or allow] to transmit the signal such that an interval between any two bit positions in the set of bit positions in the bit map is smaller than a second duration, wherein the second duration is the first duration."

Similarly, claim 13 recites "transmitting a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET), and wherein the bit map includes a set of bit positions, each bit position in the set of bit positions is with a value of one, and wherein each bit position in the set of bit positions indicates a first symbol of a monitoring-occasion of the CORESET within a slot" and "not allowing to transmit the signal such that interval between any bit position in the set of bit positions in the bit map and the least significant bit position in the bit map is smaller than a second duration, wherein the second duration is the first duration minus one."

Applicants respectfully submit that claims 1, 13, and 14 describe the "first duration" and

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the "bit map" structure sufficiently to accomplish the solution of restricting the interval (or distance) between two bit positions indicating the value one in the bit map is larger than or equal to a particular number, which is discussed above.

For the reasons stated above, Applicants respectfully submit that claims 1, 4-13, and 16-24 are in condition for allowance.

In view of the foregoing it is respectfully submitted that the pending claims are in condition for allowance. Reconsideration of the rejections is requested. Allowance of the claims is solicited. The Examiner is invited to contact Applicants' undersigned counsel by telephone at (714) 839-3800 to expedite the prosecution of this case should there be any unresolved matters remaining.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made.

Respectfully submitted,
Sang N. Dang
BLUE CAPITAL LAW FIRM, P.C.

Dated: _____

Reg. No. 51,186
Tel.: (714) 839-3800

DRAFT

Petitioners' Exhibit 1010, p. 204
AT&T et al v. Asustek Computer
IPR2024-00992

Doc Code: ECOMM.AUTH/ECOMM.WTDW
Doc Description: Internet Communications Authorized/Internet Communications Authorization Withdrawn

PTO/SB/439 (11-15)

AUTHORIZATION FOR INTERNET COMMUNICATIONS IN A PATENT APPLICATION OR REQUEST TO WITHDRAW AUTHORIZATION FOR INTERNET COMMUNICATIONS		
	Application No.	16/241,368
	Filing Date	January 17, 2019
	First Named Inventor	Chun-Wei Huang
	Art Unit	2463
	Examiner Name	Thai D. Hoang
	Practitioner Docket No.	1426-283.101

To: Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

I. To authorize permission for Internet Communications.

☑ Recognizing that Internet communications are not secure, I hereby authorize the USPTO to communicate with the undersigned and practitioners in accordance with 37 CFR 1.33 and 37 CFR 1.34 concerning any subject matter of this application via video conferencing, instant messaging, or electronic mail. I understand that a copy of these communications will be made of record in the application file. (MPEP 502.03)

II. To withdraw authorization for Internet Communications.

☐ The authorization given on _____, to the USPTO to communicate with the undersigned and any practitioner in accordance with 37 CFR 1.33 and 37 CFR 1.34 concerning any subject matter of this application via Internet communications such as video conferencing, instant messaging, or electronic mail is hereby withdrawn. I understand that the withdrawal is effective when approved rather than when received.

I am the

☐ applicant.

☑ attorney or agent of record. Registration number 51,186.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/Sang N. Dang/ — Signature

September 29, 2020 — Date

Sang N. Dang — Typed or printed name

714-418-5811 — Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Juristic entities must be represented by a patent practitioner (see 37 CFR 1.31, which is applicable to any paper filed on or after September 16, 2012, that is presented on behalf of a juristic entity, regardless of application filing date). Submit multiple forms if more than one signature is required, see below*.

☑ * Total of 1 forms are submitted.

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.

Electronic Acknowledgement Receipt

EFS ID:	40707554
Application Number:	16241368
International Application Number:	
Confirmation Number:	6576
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Chun-Wei Huang
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-283.101
Receipt Date:	29-SEP-2020
Filing Date:	07-JAN-2019
Time Stamp:	16:46:54
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	Miscellaneous Incoming Letter	1426-283-101--AuthforInterview09292020.pdf	89000 2f10322a8439143c5c3f3ae2e81ce062a9affe0f	no	2

Warnings:

Information:	
Total Files Size (in bytes):	89000

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

USPTO Automated Interview Request (AIR)

Sep 29 2020

This paper requesting to schedule and/or conduct an interview is appropriate because:

I am concurrently submitting an authorization to communicate via the internet. See form SB/0439.

Name(s):
Sang Dang

S-signature:
/Sang Dang/

Registration Number:
51186

U.S. Application Number:
16241368

Confirmation Number:
6576

E-mail Address:
sdang@bluecapitallaw.com

Phone Number:
+1 714-418-5811

Proposed Time of Interview:
10-5-2020 3:00 PM ET

Alternative Proposed Time(s) of Interview:
10-6-2020 3:00 PM ET

Alternative Proposed Time(s) of Interview:
10-7-2020 3:00 PM ET

Prefered Interview Type:
Telephonic

I am the applicant or applicant's representative for this application.

Topic for Discussion:
Discussion of rejection under 35 U.S.C. 112

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AT&T et al v. Asustek Computer
IPR2024-00992

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.
16/241,368	01/07/2019	Chun-Wei Huang	1426-283.101	6576

106622 7590 07/09/2020

Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

EXAMINER	
HOANG, THAI D	

ART UNIT	PAPER NUMBER
2463	

NOTIFICATION DATE	DELIVERY MODE
07/09/2020	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):

docketing@bluecapitallaw.com

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AT&T et al v. Asustek Computer
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Office Action Summary	Application No. 16/241,368	Applicant(s) Huang et al.	
	Examiner THAI D HOANG	Art Unit 2463	AIA (FITF) Status Yes

-- 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 MONTHS 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 6/30/2020.

☐ 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) 1,4-13 and 16-24 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) 1,4-13 and 16-24 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 _____ 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.

Attachment(s)

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

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

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

4) ☐ Other: _____.

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DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Claim Rejections - 35 USC § 112

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.

Claims 1, 4-13, and 16-24 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.

The limitation recited in claim 1 *"wherein the first duration is time duration of a control resource set (CORESET) and the bit map includes a set of bit positions where each bit position with a value of one indicates a first symbol of a monitoring occasion of the CORESET within a slot,"* is unclear. It is confusing what is meant by *wherein the first duration is time duration of a control resource set (CORESET) and the bit map includes a set of bit positions where each bit position with a value of one indicates a first symbol of a monitoring occasion of the CORESET within a slot.*

Claims 13 and 24 are rejected for the same reason because they recite the same limitation.

All claims depend on rejected claims 1.13 and 24 are rejected.

Response to Arguments

Applicant's arguments with respect to claims 1, 13 and 24 have been considered but are moot because the arguments do not apply to any of the references being used in the current rejection.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to THAI D HOANG whose telephone number is (571)272-3184. The examiner can normally be reached on 10:30 am-18:30pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Rinehart can be reached on (571) 272-3632. 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 https://ppair-my.uspto.gov/pair/PrivatePair. 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.

/THAI D HOANG/
Primary Examiner, Art Unit 2463

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/241,368	Huang et al.
	Examiner	Art Unit
	THAI D HOANG	2463

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	04/13/2020	07/06/2020							
	1	✓	✓							
	2	✓	-							
	3	✓	-							
	4	✓	✓							
	5	✓	✓							
	6	✓	✓							
	7	✓	✓							
	8	✓	✓							
	9	✓	✓							
	10	✓	✓							
	11	✓	✓							
	12	✓	✓							
	13	✓	✓							
	14	✓	-							
	15	✓	-							
	16	✓	✓							
	17	✓	✓							
	18	✓	✓							
	19	✓	✓							
	20	✓	✓							
	21	✓	✓							
	22	✓	✓							
	23	✓	✓							
	24	✓	✓							

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AT&T et al v. Asustek Computer
IPR2024-00992

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/241,368	Huang et al.
	Examiner	Art Unit
	THAI D HOANG	2463

CPC - Searched*		
Symbol	Date	Examiner
(H04L1/1614 H04L5/0053,0094 H04W72/042,0446).CPC.	07/06/2020	TH

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner
370	328-329, 335-345, 348	07/06/2020	th

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
EAST: TEXT SEARCH ALL DATABASE. SEE SEARCH HISTORY ATTACHED.	04/13/2020	TH
NPL: IEEE, GOOGLE, STIC, ITU, IETF,	04/13/2020	TH
EAST: UPDATED TEXT SEARCH ALL DATABASE. CPC SEARCH, US CLASS SEARCH, INVENTOR SEARCH. SEE SEARCH HISTORY ATTACHED.	07/06/2020	TH
NPL: UPDATED IEEE, GOOGLE, STIC, ITU, IETF,	07/06/2020	TH

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

/THAI D HOANG/ Primary Examiner, Art Unit 2463	

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AT&T et al v. Asustek Computer
IPR2024-00992

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
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 contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16241368
Filing Date	2019-01-07
First Named Inventor	Chun-Wei Huang
Art Unit	2463
Examiner Name	Thai D. Hoang
Attorney Docket Number	1426-283.101

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					

If you wish to add additional U.S. Patent citation information please click the Add button.

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
	1					

If you wish to add additional U.S. Published Application citation information please click the Add button.

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

If you wish to add additional Foreign Patent Document citation information please click the Add button

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]

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AT&T et al v. Asustek Computer
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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /T.D.H/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16241368
Filing Date	2019-01-07
First Named Inventor	Chun-Wei Huang
Art Unit	2463
Examiner Name	Thai D. Hoang
Attorney Docket Number	1426-283.101

	1	AT & T, Rate matching aspects of LTE-NR coexistence and further details on resource sets, 3GPP TSG RAN WG1 #90b R1-1718406, October 9, 2017.	☐
	2	OPPO, Text proposal for search space, 3GPP TSG RAN WG1 adhoc_NR_AH_1801 R1-1800495, January 12, 2018.	☐
	3	Office Action from Korean Intellectual Property Office in corresponding KR Application No. 10-2019-0001805, dated May 1, 2020	☒

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature	/THAI D HOANG/	Date Considered	07/06/2020

*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.

Petitioners' Exhibit 1010, p. 218
AT&T et al v. Asustek Computer
IPR2024-00992

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /T.D.H/

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	160,542	(H04L1/1614 H04L5/0053,0094 H04W72/042,0446).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/07/06 03:48
L2	76,430	(370/328-329,335-345,348).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/07/06 03:49
L3	6	1 AND (tim$3 during duration) with ((control adj resource) CORESET) with (bit adj map$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/07/06 03:49
L4	1	2 AND (tim$3 during duration interval) with ((control adj resource) CORESET) with (bit adj map$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/07/06 03:49
L5	0	2 and (tim$3 during duration interval) same ((control adj resource) CORESET) same (bit adj map$4) same ((least adj significant adj bit) LSB) same (smaller less shorter)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/07/06 03:49
L6	1	1 and (tim$3 during duration interval) same ((control adj resource) CORESET) same (bit adj map$4) same ((least adj significant adj bit) LSB) same (smaller less shorter)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/07/06 03:49
L7	6	1 and (tim$3 during duration) with ((control adj resource) CORESET) with (bit adj map$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/07/06 03:50

L8	1	2 and (tim$3 during duration) with ((control adj resource) CORESET) with (bit adj map$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/07/06 03:50
L9	370	(huang near chun-wei).in. (lin near ko-chiang).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/07/06 03:51
L10	52	9 and (asustek.as.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/07/06 03:51
L11	0	10 and ((tim$3 during duration) and ((control adj resource) CORESET) and (bit adj map$4)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/07/06 03:52

EAST Search History (Interference)

<This search history is empty>

7/6/2020 3:53:30 AM
C:\Users\thoang2\Documents\EAST\Workspaces\16241368.wsp

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	16/241,368
Confirmation No.	:	6576
Applicant	:	Chun-Wei Huang and Ko-Chiang Lin
Filed	:	January 7, 2019
Title	:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM
TC/A.U.	:	2463
Examiner	:	Thai D. Hoang
Docket No.	:	1426-283.101 (1070028-US)
Customer No.	:	106622

Amendment to Office Action

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the non-final Office Action mailed on April 16, 2020, having a three-month period for filing a response to **July 16, 2020**, please amend the above-identified application as follows:

Claims begin on page 2.

Remarks begin on page 6.

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IPR2024-00992

IN THE CLAIMS:

1. (Currently Amended) A method of a network node, the method comprising:

transmitting a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map ~~indicates~~ includes a set of bit positions where each bit position with a value of one indicates a first ~~symbol(s)~~ symbol of a monitoring ~~occasion(s)~~ occasion of the CORESET within a slot~~, and wherein a set of bit position indicates value one in the bit map~~; and

not allowing to transmit the signal such that an interval between any two bit positions in the set in the bit map is smaller than a second duration, wherein the second duration is the first duration.

2. (Canceled)

3. (Canceled)

4. (Original) The method of claim 1, wherein the network node is not allowed to transmit the signal indicating that the first duration is 2 and the bit map is 11000000000000.

5. (Original) The method of claim 1, wherein the interval between two bit positions in the set in the bit map shall be larger than or equal to the second duration.

6. (Currently Amended) The method of claim 1, wherein the network node is not allowed to transmit the signal such that interval between [[a]]any bit position in the set in the bit map and the least significant bit position in the bit map is smaller than the second duration minus one.

7. (Original) The method of claim 1, wherein the interval between a bit position in the set in the bit map and the least significant bit position in the bit map shall be larger than or equal to the second duration.

8. (Original) The method of claim 1, wherein the network node transmits a Physical

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Downlink Control Channel (PDCCH) candidate on monitoring occasion(s) of the CORESET.

9. (Original) The method of claim 1, wherein the signal indicates the configuration of the CORESET.

10. (Original) The method of claim 1, wherein the signal is PDCCH-config information element.

11. (Original) The method of claim 1, wherein the interval is the difference between two bit positions.

12. (Original) The method of claim 1, wherein the interval is number of bits between two bit positions.

13. (Original) A method of a network node, the method comprising:

transmitting a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map ~~indicates~~ includes a set of bit positions where each bit position with a value of one indicates a first ~~symbol(s)~~ symbol of a monitoring ~~occasion(s)~~ occasion of the CORESET within a slot~~, and wherein a set of bit position indicates value one in the bit map~~; and

not allowing to transmit the signal such that interval between [[a]]any bit position in the set in the bit map and the least significant bit position in the bit map is smaller than a second duration, wherein the second duration is the first duration minus one.

14. (Canceled)

15. (Canceled)

16. (Original) The method of claim 13, wherein the network node is not allowed to transmit the signal indicating that the first duration is 2 and the bit map is 00000000000001.

17. (Original) The method of claim 13, wherein the interval between a bit position in

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the set in the bit map and the least significant bit position in the bit map shall be larger than or equal to the second duration.

18. (Currently Amended) The method of claim 13, wherein the network node is not allowed to transmit the signal such that interval between any two bit positions in the set in the bit map is smaller than the ~~second~~ first duration.

19. (Original) The method of claim 13, wherein the network node transmits a Physical Downlink Control Channel (PDCCH) candidate on monitoring occasion(s) of the CORESET.

20. The method of claim 13, wherein the signal indicates the configuration of the CORESET.

21. (Original) The method of claim 13, wherein the signal is PDCCH-config information element.

22. (Original) The method of claim 13, wherein the interval is the difference between two bit positions.

23. (Original) The method of claim 13, wherein the interval is number of bits between two bit positions.

24. (Currently Amended) A network node, comprising:

a control circuit;

a processor installed in the control circuit; and

a memory installed in the control circuit and coupled to the processor;

wherein the processor is configured to execute a program code stored in the memory to:

transmit a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map ~~indicates~~ includes a set of bit positions where each bit position with a value of one indicates a first ~~symbol(s)~~ symbol of a monitoring ~~occasion(s)~~ occasion of the CORESET within a slot~~, and wherein a set of bit position indicates value one in the bit map~~; and

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not allow the network to transmit the signal such that an interval between two bit positions in the set in the bit map is smaller than [[the]] a second duration, wherein the second duration is the first duration.

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REMARKS

Claims 1-24 are pending in the application. In the Office Action, claims 1-2, 5-14, and 17-24 stand rejected under 35 U.S.C. § 102 as being anticipated by Huawei (3GPP R1-171062, "CORSET configuration and search space designed", Huawei, HiSilicon, dated 9-13 October 2017). *See* Office Action, Page 2. Furthermore, claims 3-4 and 15-16 stand rejected under 35 U.S.C. § 103 based on Huawei. *See* Office Action, Page 5.

Claims 2, 3, 14, and 15 have been canceled. Claims 1, 6, 13, 18, and 24 have been amended. No new matter has been added. Applicants respectfully request reconsideration of the claims as amended.

According to Paragraphs [0037]-[0038] of the present application, a CORESET can be configured by indicating time duration and a bit map. If a bit position in the bit map has a value of one, the bit position represents a starting OFDM symbol for monitoring the CORESET. The CORESET may be monitored from at least a starting OFDM symbol(s) indicated by the bit map and occupying following OFDM symbol(s) until the configured time duration is reached. For example, if the time duration of a CORESET is configured as 2 and the bit map indicates 10000000000000, the UE may monitor the CORESET (receive at least a PDCCH) on OFDM symbol #0 and #1 in a slot. However, if a bit map indicates a starting OFDM symbol belonging to the following OFDM symbol(s) of previous starting OFDM symbol indicated by the bit map (e.g.,time duration of a CORESET is 2 and the bit map is **11**00000000000000), a UE may be confused about the configuration.

In addition, if the bit map indicates a starting OFDM symbol on the last few OFDM symbols of a slot, this may create a problem where the CORESET may be configured across a slot boundary. For example, if time duration of a CORESET is 2 and the bit map is 00000000000001, how a UE handle this configuration also needs further consideration.

One solution is to restrict the interval (or distance) between two bit positions indicating the value one in the bit map is larger than or equal to a particular number (namely, an interval between any two bit positions in the set in the bit map is smaller than a second duration). For example, an interval or distance between two bit positions indicating value 1 for a bitmap "**1**000**1**000000000" is 3. As such, the problem of UE confusion or cross slot boundary configuration is avoided.

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Consistent with the specification, claims 1 and 24 recite "transmitting [or transmit] a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map includes a set of bit positions where each bit position with a value of one indicates a first symbol of a monitoring occasion of the CORESET within a slot" and "not allowing [or not allow the network] to transmit the signal such that an interval between any two bit positions in the set in the bit map is smaller than a second duration, wherein the second duration is the first duration." Similarly, claim 13 recites "transmitting a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map includes a set of bit positions where each bit position with a value of one indicates a first-symbol of a monitoring occasion of the CORESET within a slot" and "not allowing to transmit the signal such that interval between any bit position in the set in the bit map and the least significant bit position in the bit map is smaller than a second duration, wherein the second duration is the first duration minus one." Applicants respectfully submit that Huawei fails to disclose the noted limitations.

According to Section 2.2.1 and Table 1 of Huawei, Huawei discloses a bit field in NR-PBCH with 5 bits for indicating CORESET configuration. As shown in Table 1 of Huawei, each value of the 5-bit bit field indicates the frequency resources of CORESET and **only** one monitoring occasion of CORESET. For example, for a value of "00000", CORESET occupies the 1st and 2nd OFDM symbols in the same slot. In contrast, the bit-map recited in claim 1, 13, and 24 could indicate starting or first symbol(s) via when a bit position in the bit-map is set to a value of one.

In other words, the meaning of value one in the bit map recited in the claims is different and distinguishable from the disclosure of Huawei. The bit-map of Huawei is used (with different values) to indicate a different monitoring occasion of CORESET while each bit position of the recited bit-map that has a value of one indicates a starting or first symbol.

Furthermore, Appendix A of Huawei **only** teaches frequency resources of CORESET may be contiguous or non-contiguous. However, Appendix A is unrelated to and is not associated with the 5-bit bit field discussed in Section 2.2.1 and Table 1 of Huawei. Even if it is possible to somehow combine Section 2.2.1 (and Table 1) and Apendix A of Huawei, the combination only discloses how to configure CORESET by using various values of the bit-map (shown in Table 1) and the CORESET **in frequency** could be non-contiguous with each part is equal to one or more than the size of REG-bundle. However, claims 1, 13, and 24 recite that the first duration is a **time**

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duration of CORESET rather than in the frequency domain as disclosed in Huawei.

For the reasons stated above, Applicants respectfully submit that claims 1, 4-13, and 16-24 are patentable over Huawei.

In view of the foregoing it is respectfully submitted that the pending claims are in condition for allowance. Reconsideration of the rejections is requested. Allowance of the claims at an early date is solicited. The Examiner is invited to contact Applicants' undersigned counsel by telephone at (714) 839-3800 to expedite the prosecution of this case should there be any unresolved matters remaining.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made.

Respectfully submitted,
Sang N. Dang
BLUE CAPITAL LAW FIRM, P.C.

Dated: June 30, 2020

/Sang N. Dang/
Reg. No. 51,186
Tel.: (714) 839-3800

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AT&T et al v. Asustek Computer
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Chun-Wei Huang and Ko-Chiang Lin	
Title:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM	
Serial No.:	16/241,368	Filed: January 7, 2019
Examiner:	Thai D. Hoang	Group Art Unit: 2463
Attorney Docket No.:	1426-283.101 (1070028-US)	

CERTIFICATE OF EFS-WEB TRANSMISSION UNDER 37 CFR § 1.8

I hereby certify that the enclosed 2 Page Amendment Transmittal Sheet; and 8 Page Amendment are being transmitted to the United States Patent and Trademark Office via EFS-Web June 30, 2020.

Date: June 30, 2020 /Sandy Kim/
Sandy Kim

Mailing Address:

BLUE CAPITAL LAW FIRM, P.C. (Customer No.: 106622)
650 Town Center Drive, Suite 1530
Costa Mesa, California 92626
Tel: 714-839-3800
Fax: 714-795-2995

Electronic Acknowledgement Receipt

EFS ID:	39873485
Application Number:	16241368
International Application Number:	
Confirmation Number:	6576
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Chun-Wei Huang
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-283.101
Receipt Date:	30-JUN-2020
Filing Date:	07-JAN-2019
Time Stamp:	15:40:16
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		1426-283-101--ROAof04162020asFiled06302020.pdf	151526 47b07be20310d37556dfe6ab574e2b78ec3dbd33	yes	11

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Transmittal Letter	1	2
	Amendment/Req. Reconsideration-After Non-Final Reject	3	3
	Claims	4	7
	Applicant Arguments/Remarks Made in an Amendment	8	10
	Miscellaneous Incoming Letter	11	11
Warnings:			
Information:			
	Total Files Size (in bytes):	151526	

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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.

Amendment Transmittal Letter

Docket Number
1426-283.101

Address To
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Title of Invention

METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM

First Named Inventor	Chun-Wei Huang
Application No.	16/241,368
Filing Date	January 7, 2019
Examiner	Thai D. Hoang
Art Unit	2463

Transmitted herewith is an amendment in the above-identified application.

The fee has been calculated and is transmitted as shown below.

☐ **Applicant claims Small Entity Status.** See 37 CFR 1.27.

Fee Calculation

Claims as Amended

For	#Filed	#Previously Paid For	#Extra	Rate	Fee
Total Claims	20	- 24 =		x ☐ =	
Total Indep. Claims	3	- 3 =		x =	
Multiple Dependent Claims (check if applicable) ☐					
				TOTAL	0

Method of Payment

☐ Deposit Account ☐ Credit Card ☐ Check ☐ Money Order ☐ Other: _____

Deposit Account Number

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☐ Charge the fee(s) set forth above
☐ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17
☐ Charge fee(s) indicated above, **except for the filing fee**
☐ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on form PTO-2038.

Amount Grand Total 0

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AT&T et al v. Asustek Computer
IPR2024-00992

Amendment Transmittal Letter

Docket Number
1426-283.101

Correspondence Address

Customer Number	106622		
-OR-			
Name			
Address			
City		State	
Country		Postal Code	
Phone Number			
E-mail Address			

Certificate of Mailing by Express Mail

I hereby certify that this Amendment, accompanying documents, and fee (if appropriate) are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on the date indicated below:

(Date of Mailing)

(Typed or Printed Name of Person Mailing Correspondence)

(Signature of Person Mailing Correspondence)

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(Date of Mailing) *(Name of Person Mailing Correspondence)*

(Signature of Person Mailing Correspondence)

Certificate of Transmission

I hereby certify that this Amendment, accompanying documents, and fee (if appropriate) authorization are being facsimile transmitted to the United States Patent and Trademark Office on the date indicated below:

(Date of Transmission) *(Name of Person Transmitting Correspondence)*

(Signature of Person Transmitting Correspondence)

Signature Instructions

Select the name of the person who will electronically sign the Amendment from the drop-down box below.

If a practitioner is not present in the drop-down list, you must close this form and select 'Add Practitioner...' in the Form Manager's Utility menu.

Verify that the signatory information is correct and press the 'eSign' button to electronically sign the submission. If you prefer to sign the form manually, simply do not click the 'eSign' button; just print and manually sign.

Signatory Drop-Down Box Sang N. Dang

Name	Sang N. Dang			Registration Number	51,186
Signatory Capacity	Attorney for Applicant(s)		E-mail Address	sdang@bluecapitallaw.com	
eSign	/Sang N. Dang/			Date Signed	06-30-2020

Petitioners' Exhibit 1010, p. 233
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IPR2024-00992

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16241368
Filing Date	2019-01-07
First Named Inventor	Chun-Wei Huang
Art Unit	2463
Examiner Name	Thai D. Hoang
Attorney Docket Number	1426-283.101

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					

If you wish to add additional U.S. Patent citation information please click the Add button.

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
	1					

If you wish to add additional U.S. Published Application citation information please click the Add button.

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

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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]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16241368
	Filing Date	2019-01-07
	First Named Inventor	Chun-Wei Huang
	Art Unit	2463
	Examiner Name	Thai D. Hoang
	Attorney Docket Number	1426-283.101

	1	AT & T, Rate matching aspects of LTE-NR coexistence and further details on resource sets, 3GPP TSG RAN WG1 #90b R1-1718406, October 9, 2017.	☐
	2	OPPO, Text proposal for search space, 3GPP TSG RAN WG1 adhoc_NR_AH_1801 R1-1800495, January 12, 2018.	☐
	3	Office Action from Korean Intellectual Property Office in corresponding KR Application No. 10-2019-0001805, dated May 1, 2020	☒

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*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.

Petitioners' Exhibit 1010, p. 235
AT&T et al v. Asustek Computer
IPR2024-00992

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Chun-Wei Huang and Ko-Chiang Lin	
Title:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM	
Serial No.:	16/241,368	Filed: January 7, 2019
Examiner:	Thai D. Hoang	Group Art Unit: 2463
Attorney Docket No.:	1426-283.101 (1070028-US)	

CERTIFICATE OF EFS-WEB TRANSMISSION
UNDER 37 CFR § 1.8

I hereby certify that the enclosed 3 Page Information Disclosure Statement Transmittal; 2 Page Information Disclosure Statement with 3 references are being transmitted to the United States Patent and Trademark Office via EFS-Web May 22, 2020.

Date: May 22, 2020 /Sandy Kim/
Sandy Kim

Mailing Address:

BLUE CAPITAL LAW FIRM, P.C. (Customer No.: 106622)
650 Town Center Drive, Suite 1530
Costa Mesa, California 92626
Tel: 714-839-3800
Fax: 714-795-2995

Electronic Acknowledgement Receipt

EFS ID:	39519855
Application Number:	16241368
International Application Number:	
Confirmation Number:	6576
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Chun-Wei Huang
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-283.101
Receipt Date:	22-MAY-2020
Filing Date:	07-JAN-2019
Time Stamp:	14:34:43
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		1426-283-101--IDSasFiled05222020.pdf	152863 4fa42ef097d455c015cbd993d900735137fa0494	yes	6

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Transmittal Letter	1	3
	Information Disclosure Statement (IDS) Form (SB08)	4	5
	Miscellaneous Incoming Letter	6	6

Warnings:					
Information:					
2	Non Patent Literature	R1-1718406.pdf	1161555 b943ca00f2170b5685d3c78300b1077ea407de61	no	6
Warnings:					
Information:					
3	Non Patent Literature	R1-1800495.pdf	266078 5d85cbd38419166b0bec0c466e7792eda497d563	no	4
Warnings:					
Information:					
4	Non Patent Literature	NPL--KROfficeAction.pdf	1827036 87bb964a2d066a32184fc0bafcd387f4fd159dd1	no	6
Warnings:					
Information:					
5	Non Patent Literature	NPL--KROfficeActionEnglish.pdf	56010 a202c94b66f9bf99a1e2cf4f3aef796c01463fdc	no	6
Warnings:					
Information:					
		Total Files Size (in bytes):	3463542		

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.

Information Disclosure Statement Transmittal

Docket Number
1426-283.101

Address To
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

In Re Application Of:

Chun-Wei Huang

Application No.	16/241,368
Filing Date	January 7, 2019
Examiner	Thai D. Hoang
Art Unit	2463

Title of Invention

METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM

BASIS FOR FILING (Select 1, 2 or 3 below.)

37 CFR 1.97(b)

1) ☐ The Information Disclosure Statement submitted herewith is being filed within three months of the filing of a national application other than a continued prosecution application under 37 CFR 1.53 (d); within three months of the date of entry of the national stage as set forth in 37 CFR 1.491 in an international application; before the mailing of a first Office Action on the merits, or before the mailing of a first Office Action after the filing of a request for continued examination under 37 CFR 1.114.

37 CFR 1.97(c)

2) ☒ The Information Disclosure Statement submitted herewith is being filed after the period specified in 37 CFR 1.97(b), but before the mailing date of a Final Action under 37 CFR 1.113, a Notice of Allowance under 37 CFR 1.311, or an Action that otherwise closes prosecution in the application, and is accompanied by one of:

a) ☒ the statement specified in 37 CFR 1.97(e);

OR

b) ☐ the fee set forth in 37 CFR 1.17(p).

37 CFR 1.97(d)

3) ☐ The Information Disclosure Statement submitted herewith is being filed after the period specified in 37 CFR 1.97(c), and on or before payment of the issue fee, and is accompanied by the Statement as specified in 37 CFR 1.97(e) and the fee set forth in 37 CFR 1.17(p).

Petitioners' Exhibit 1010, p. 240
AT&T et al v. Asustek Computer
IPR2024-00992

Information Disclosure Statement Transmittal

Docket Number
1426-283.101

STATEMENT UNDER 37 CFR 1.97(e) ACCOMPANYING INFORMATION DISCLOSURE STATEMENT

The Information Disclosure Statement submitted herewith is submitted under one of the following conditions, which satisfies the requirement under 37 CFR 1.97(e). (Select 4 or 5 below if applicable.)

4) ☒ 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; or

5) ☐ 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.

Remarks (Enter Remarks Below or Attach Document Containing Remarks)

Fee set forth in 37 CFR 1.17(p):

☒ No additional fee is required.

☐ A check in the amount of _____ is attached.

☐ The Director is hereby authorized to charge and credit Deposit Account No. _____ as described below.

- ☐ Charge the amount of _____
- ☐ Credit any overpayment.
- ☐ Charge any additional fee required.

☐ Payment by credit card. Form PTO-2038 is attached.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

Petitioners' Exhibit 1010, p. 241
AT&T et al v. Asustek Computer
IPR2024-00992

Information Disclosure Statement Transmittal

Docket Number
1426-283.101

Correspondence Address

Customer Number	106622		
-OR-			
Name			
Address			
City		State	
Country		Postal Code	
Phone Number			
E-mail Address			

Certificate of Mailing by Express Mail

I hereby certify that this Transmittal Letter, accompanying documents and fee (if appropriate) are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on the date indicated below:

(Date of Mailing)

(Typed or Printed Name of Person Mailing Correspondence)

(Signature of Person Mailing Correspondence)

("Express Mail" Mailing Label Number)

Certificate of Mailing by First Class Mail

I hereby certify that this Transmittal Letter, accompanying documents and fee (if appropriate) are being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on the date indicated below:

(Date of Mailing) *(Name of Person Mailing Correspondence)*

(Signature of Person Mailing Correspondence)

Certificate of Transmission

I hereby certify that this Transmittal Letter, accompanying documents and fee authorization (if appropriate) is being facsimile transmitted to the United States Patent and Trademark Office on the date indicated below:

(Date of Transmission) *(Name of Person Transmitting Correspondence)*

(Signature of Person Transmitting Correspondence)

Signature Instructions

Select the name of the person who will electronically sign the Trasmittal Letter from the drop-down box below.

If a practitioner is not present in the drop-down list, you must close this form and select 'Add Practitioner...' in the Form Manager's Utility menu.

Verify that the signatory information is correct and press the 'eSign' button to electronically sign the submission. If you prefer to sign the form manually, simply do not click the 'eSign' button; just print and manually sign.

Signatory Drop-Down Box Sang N. Dang

Name	Sang N. Dang	Registration Number	51,186
Signatory Capacity	Attorney for Applicant(s)	E-mail Address	sdang@bluecapitallaw.com
eSign	/Sang N. Dang/	Date Signed	05-22-2020

Petitioners' Exhibit 1010, p. 242
AT&T et al v. Asustek Computer
IPR2024-00992

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/241,368	01/07/2019	Chun-Wei Huang	1426-283.101	6576

106622 7590 04/16/2020

Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

EXAMINER	
HOANG, THAI D	

ART UNIT	PAPER NUMBER
2463	

NOTIFICATION DATE	DELIVERY MODE
04/16/2020	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):

docketing@bluecapitallaw.com

Petitioners' Exhibit 1010, p. 243
AT&T et al v. Asustek Computer
IPR2024-00992

Office Action Summary	Application No. 16/241,368	Applicant(s) Huang et al.	
	Examiner THAI D HOANG	Art Unit 2463	AIA (FITF) Status Yes

-- 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 MONTHS 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 1/7/2019.

☐ 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) 1-24 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) 1-24 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 1/7/2019 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.

Attachment(s)

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

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

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

4) ☐ Other: _____.

Petitioners' Exhibit 1010, p. 244
AT&T et al v. Asustek Computer
IPR2024-00992

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Claim Rejections - 35 USC § 102

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

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 –
>
> (a)(1) the claimed invention was patented, described in a printed publication, or in public use, on sale or otherwise available to the public before the effective filing date of the claimed invention.

Claims 1-2, 5-14 and 17-24 are rejected under 35 U.S.C. 102(a)(1) as being anticipated by Huawei, in the article “CORESET configuration and search space design”, published on October 9, 2017, hereinafter referred to as Huawei.

Regarding claims 1, 13 and 24, Huawei discloses a method comprising: transmitting a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a

set of bit position indicates value one in the bit map (section 2.1.1); and not allowing to transmit the signal such that an interval between two bit positions in the set in the bit map is smaller than a second duration (see Appendix A, Huawei discloses each contiguous part of a CORESET is equal to or more than the size of REG-bundle in frequency).

Regarding claims 2 and 14, Huawei discloses wherein the second duration is the first duration (see Appendix A, Huawei discloses each contiguous part of a CORESET is equal to or more than the size of REG-bundle in frequency).

Regarding claims 5 and 17, Huawei discloses wherein the interval between two bit positions in the set in the bit map shall be larger than or equal to the second duration (see Appendix A, Huawei discloses each contiguous part of a CORESET is equal to or more than the size of REG-bundle in frequency).

Regarding claims 6 and 18, Huawei discloses wherein the network node is not allowed to transmit the signal such that interval between a bit position in the set in the bit map and the least significant bit position in the bit map is smaller than the second duration (see Appendix A, Huawei discloses each contiguous part of a CORESET is equal to or more than the size of REG-bundle in frequency; Therefore, it is inherently not allowed to transmit the signal such that interval between a bit position in the set in the bit map and the least significant bit position in the bit map is smaller than the second duration).

Regarding claims 7 and 17, Huawei discloses wherein the interval between a bit position in the set in the bit map and the least significant bit position in the bit map shall

be larger than or equal to the second duration (see Appendix A, Huawei discloses each contiguous part of a CORESET is equal to or more than the size of REG-bundle in frequency; Therefore, the interval between a bit position in the set in the bit map and the least significant bit position in the bit map shall be larger than or equal to the second duration).

Regarding claims 8 and 19, Huawei discloses wherein the network node transmits a Physical Downlink Control Channel (PDCCH) candidate on monitoring occasion(s) of the CORESET (see sections 2.1.1, 2.1.2, 2.2 and appendix).

Regarding claims 9 and 20, Huawei discloses wherein the signal indicates the configuration of the CORESET (see sections 2.1.1).

Regarding claims 10 and 21, Huawei discloses wherein the signal is PDCCH-config information element (see sections 2.1.1, 2.1.2, 2.2 and appendix A).

Regarding claims 11 and 22, Huawei discloses wherein the interval is the difference between two bit positions (see sections 2.1.1).

Regarding claims 12 and 23, Huawei discloses wherein the interval is number of bits between two bit positions (see sections 2.1.1, 2.1.2, and 2.2).

Claim Rejections - 35 USC § 103

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of

rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

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

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 3-4, and 15-16 are rejected under 35 U.S.C. 103 as being unpatentable over Huawei as shown above.

Reading claims 3 and 15, Huawei does not explicitly disclose the second duration is the first duration minus one. However, Huawei discloses each contiguous part of a CORESET is equal to or more than the size of REG-bundle in frequency (Appendix A). Therefore, the second duration is the first duration minus one was held to be an obvious matter of design choice.

Reading claim 4, Huawei does not explicitly disclose wherein the network node is not allowed to transmit the signal indicating that the first duration is 2 and the bit map is 11000000000000. It would have been obvious matter of design choice to select the first duration and the bit map for the system.

Regarding claim 16, Huawei does not teach wherein the network node is not allowed to transmit the signal indicating that the first duration is 2 and the bit map is 00000000000001. It would have been obvious matter of design choice to select the first duration and the bit map for the system.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. See attached PTO-892.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to THAI D HOANG whose telephone number is (571)272-3184. The examiner can normally be reached on 10:30 am-18:30pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Rinehart can be reached on (571) 272-3632. 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 https://ppair-my.uspto.gov/pair/PrivatePair. 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.

/THAI D HOANG/
Primary Examiner, Art Unit 2463

Notice of References Cited	Application/Control No. 16/241,368	Applicant(s)/Patent Under Reexamination Huang et al.	
	Examiner THAI D HOANG	Art Unit 2463	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20190159226-A1	05-2019	LY; Hung Dinh	H04L5/0053	1/1
*	B	US-20190149275-A1	05-2019	He; Hong	H04W76/11	370/329
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	Huawei; "CORESET Configuration and search space design"; 3GPP TSG RAN WG1 Meeting #90bis, Prague, Czech Republic, 9-13 October, 2017 (Year: 2017)
	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.

Petitioners' Exhibit 1010, p. 251
AT&T et al v. Asustek Computer
IPR2024-00992

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/241,368	Huang et al.
	Examiner	Art Unit
	THAI D HOANG	2463

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	04/13/2020								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
	9	✓								
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	20	✓								
	21	✓								
	22	✓								
	23	✓								
	24	✓								

Petitioners' Exhibit 1010, p. 252
AT&T et al v. Asustek Computer
IPR2024-00992

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/241,368	Huang et al.
	Examiner	Art Unit
	THAI D HOANG	2463

CPC - Searched*		
Symbol	Date	Examiner

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
EAST: TEXT SEARCH ALL DATABASE. SEE SEARCH HISTORY ATTACHED.	04/13/2020	TH
NPL: IEEE, GOOGLE, STIC, ITU, IETF,	04/13/2020	TH

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

/THAI D HOANG/ Primary Examiner, Art Unit 2463	

Petitioners' Exhibit 1010, p. 253
AT&T et al v. Asustek Computer
IPR2024-00992

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
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 contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16241368
Filing Date	2019-01-07
First Named Inventor	Chun-Wei Huang
Art Unit	2464 2463
Examiner Name	Ricky Q[illegible]Ngo THAI HOANG
Attorney Docket Number	1426-283.101

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					

If you wish to add additional U.S. Patent citation information please click the Add button.

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
	1					

If you wish to add additional U.S. Published Application citation information please click the Add button.

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

If you wish to add additional Foreign Patent Document citation information please click the Add button

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]

Petitioners' Exhibit 1010, p. 254
AT&T et al v. Asustek Computer
IPR2024-00992

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /T.D.H/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16241368
Filing Date	2019-01-07
First Named Inventor	Chun-Wei Huang
Art Unit	2464
Examiner Name	Ricky Quoc Ngo
Attorney Docket Number	1426-283.101

	1	PP0: "Text proposal for search space", 3GPP DRAFT; R1-1800495, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ;FRANCE vol. RAN WG1, no. Vancouver, Canada; 20180122 - 20180126 12 January 2018.	☐
	2	INTERDIGITAL INC: "On Remaining Details of Minimum System Information Delivery", 3GPP DRAFT; R1-1720623, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ;FRANCE vol. RAN WG1, no. Reno, USA; 20171127 - 20171101 18 November 2017 (2017-11-18).	☐
	3	European Search Report from EP Patent Office in corresponding EP Application No. 19150466.1, dated June 24, 2019.	☐

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EXAMINER SIGNATURE

Examiner Signature	/THAI D HOANG/	Date Considered	04/13/2020

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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.

Petitioners' Exhibit 1010, p. 255
AT&T et al v. Asustek Computer
IPR2024-00992

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /T.D.H/

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S7	1	(tim$3 during duration interval) same ((control adj resource) CORESET) same (bit adj map$4) same ((least adj significant adj bit) LSB) same (smaller less shorter)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/04/13 01:21
S8	4	"16170572"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/04/13 03:56
S9	7	(tim$3 during duration interval) with ((control adj resource) CORESET) with (bit adj map$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/04/13 03:56
S10	7	(tim$3 during duration) with ((control adj resource) CORESET) with (bit adj map$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/04/13 04:01
S11	1	(tim$3 during duration interval) same ((control adj resource) CORESET) same (bit adj map$4) and ((least adj significant adj bit) LSB) same (smaller less shorter)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; IBM_TDB	OR	ON	2020/04/13 04:02

EAST Search History (Interference)

<This search history is empty>

4/13/2020 7:46:41 AM
C:\Users\thoang2\Documents\EAST\Workspaces\16241368.wsp

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16241368
Filing Date	2019-01-07
First Named Inventor	Chun-Wei Huang
Art Unit	2463
Examiner Name	THAI HOANG
Attorney Docket Number	1426-283.101

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					

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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
	1					

If you wish to add additional U.S. Published Application citation information please click the Add button.

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

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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]

Petitioners' Exhibit 1010, p. 257
AT&T et al v. Asustek Computer
IPR2024-00992

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /T.D.H/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16241368
	Filing Date	2019-01-07
	First Named Inventor	Chun-Wei Huang
	Art Unit	2415
	Examiner Name	Jeffrey M. Rutkowski
	Attorney Docket Number	1426-283.101

	1	3GPP TSG RAN WG1 Meeting #91 R1-1719387 Reno, USA, November 27th – December 1st 2017, Section 2.1.2.1、2.1.2.3、2.2.1、2.2.2、Appendix A	☐
	2	3GPP TSG RAN WG1 Meeting #90 R1-1712441 Prague, Czechia, 21st – 25th August 2017, Section1、2.1	☐
	3	3GPP TS 38.213 V15.0.0; Technical Specification Group Radio Access Network; NR; Physical layer procedures for control (Release 15) 2018-01-03 Table13-1, Chapter13	☐
	4	Office Action from Taiwan Patent Office in corresponding TW Application No. 108100603, dated November 11, 2019.	☐

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature	/THAI D HOANG/	Date Considered	04/13/2020

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Petitioners' Exhibit 1010, p. 258
AT&T et al v. Asustek Computer
IPR2024-00992

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /T.D.H/

Bibliographic Data

Application No: 16/241,368

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /THAI D HOANG/ Examiner's Signature | Initials

Title: METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
01/07/2019	370	2463	1426-283.101
RULE			

APPLICANTS

ASUSTek Computer Inc., Taipei City, TAIWAN

INVENTORS

Chun-Wei Huang Taipei City, TAIWAN

Ko-Chiang Lin Taipei City, TAIWAN

CONTINUING DATA

This application has PRO of 62619041 01/18/2018

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

01/31/2019

STATE OR COUNTRY

TAIWAN

ADDRESS

Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626
UNITED STATES

FILING FEE RECEIVED

$2,120

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	2019-01-07
First Named Inventor	Huang, Chun-Wei
Art Unit	2463
Examiner Name	THAI HOANG
Attorney Docket Number	1426-283.101

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	9462582		2014-10-16	Sujuan Feng	

If you wish to add additional U.S. Patent citation information please click the Add button.

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
	1	20180123759		2018-05-03	ZHANG MENG	
	2	20180049203		2018-02-15	XUE PENG	

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FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

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NON-PATENT LITERATURE DOCUMENTS

Petitioners' Exhibit 1010, p. 260
AT&T et al v. Asustek Computer
IPR2024-00992

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	2019-01-07
First Named Inventor	Huang, Chun-Wei
Art Unit	
Examiner Name	
Attorney Docket Number	1426-283.101

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		☐

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EXAMINER SIGNATURE

Examiner Signature	/THAI D HOANG/	Date Considered	04/13/2020

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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.

Petitioners' Exhibit 1010, p. 261
AT&T et al v. Asustek Computer
IPR2024-00992

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /T.D.H/

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Application Number	16241368
Filing Date	2019-01-07
First Named Inventor	Chun-Wei Huang
Art Unit	2463
Examiner Name	Thai D. Hoang
Attorney Docket Number	1426-283.101

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					

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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
	1	20140112283		2014-04-24	Ki Tae Kim et al.	

If you wish to add additional U.S. Published Application citation information please click the Add button.

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2015180066	JP		2015-08-10	Alexander Golitschek Edler Von Elbwart 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]

Petitioners' Exhibit 1010, p. 262
AT&T et al v. Asustek Computer
IPR2024-00992

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Filing Date	2019-01-07
	First Named Inventor	Chun-Wei Huang
	Art Unit	2463
	Examiner Name	Thai D. Hoang
	Attorney Docket Number	1426-283.101

	1	AT & T, Rate matching aspects of LTE-NR coexistence and further details on resource sets, 3GPP TSG RAN WG1 #90b R1-1718406, October 9, 2017.	☐
	2	OPPO, Text proposal for search space, 3GPP TSG RAN WG1 adhoc_NR_AH_1801 R1-1800495, January 12, 2018.	☐
	3	Office Action from Japan Patent Office in corresponding JP Application No. 2019-000500, dated January 14, 2020	☒

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EXAMINER SIGNATURE

Examiner Signature	/THAI D HOANG/	Date Considered	04/13/2020

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IPR2024-00992

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16241368
Filing Date	2019-01-07
First Named Inventor	Chun-Wei Huang
Art Unit	2464 2463
Examiner Name	Ricky Q[illegible]Ngo THAI HOANG
Attorney Docket Number	1426-283.101

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
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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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AT&T et al v. Asustek Computer
IPR2024-00992

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16241368
	Filing Date	2019-01-07
	First Named Inventor	Chun-Wei Huang
	Art Unit	~~2464~~ 2463
	Examiner Name	~~Ricky Quoc Ngo~~ THAI HOANG
	Attorney Docket Number	1426-283.101

	1	PP0: "Text proposal for search space", 3GPP DRAFT; R1-1800495, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ;FRANCE vol. RAN WG1, no. Vancouver, Canada; 20180122 - 20180126 12 January 2018.	☐
	2	INTERDIGITAL INC: "On Remaining Details of Minimum System Information Delivery", 3GPP DRAFT; R1-1720623, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ;FRANCE vol. RAN WG1, no. Reno, USA; 20171127 - 20171101 18 November 2017 (2017-11-18).	☐
	3	European Search Report from EP Patent Office in corresponding EP Application No. 19150466.1, dated June 24, 2019.	☐

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EXAMINER SIGNATURE

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AT&T et al v. Asustek Computer
IPR2024-00992

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PTO/SB/08a (03-15)
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First Named Inventor	Chun-Wei Huang
Art Unit	2463
Examiner Name	Thai D. Hoang
Attorney Docket Number	1426-283.101

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
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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
	1	20140112283		2014-04-24	Ki Tae Kim et al.	

If you wish to add additional U.S. Published Application citation information please click the Add button.

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	1	2015180066	JP		2015-08-10	Alexander Golitschek Edler Von Elbwart et al.		☐

If you wish to add additional Foreign Patent Document citation information please click the Add button

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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]

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	Filing Date	2019-01-07
	First Named Inventor	Chun-Wei Huang
	Art Unit	2463
	Examiner Name	Thai D. Hoang
	Attorney Docket Number	1426-283.101

	1	AT & T, Rate matching aspects of LTE-NR coexistence and further details on resource sets, 3GPP TSG RAN WG1 #90b R1-1718406, October 9, 2017.	☐
	2	OPPO, Text proposal for search space, 3GPP TSG RAN WG1 adhoc_NR_AH_1801 R1-1800495, January 12, 2018.	☐
	3	Office Action from Japan Patent Office in corresponding JP Application No. 2019-000500, dated January 14, 2020	☒

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Examiner Signature		Date Considered	

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Petitioners' Exhibit 1010, p. 267
AT&T et al v. Asustek Computer
IPR2024-00992

(19) JAPANESE PATENT OFFICE

PATENT ABSTRACTS OF JAPAN

(11) Publication number: 2015-180066 A

(43) Date of publication of application: 08.10.2015

(51) Int. Cl. H04W 72/04 (2009.01)
H04J 11/00 (2006.01)
H04W 16/26 (2009.01)

(21) Application number: 2015082698

(22) Date of filing: 14.04.2015

(30) Priority: 01.10.2010 EP 2010 10012822

(71) Applicant: PANASONIC INTELLECTUAL PROPERTY CORP OF AMERICA

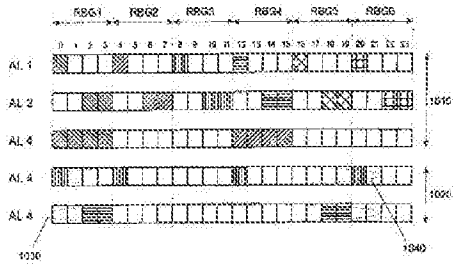
(72) Inventor: ALEXANDER GOLITSCHEK EDLER VON ELBWART
FENG SUJUAN
CHRISTIAN WENGERTER
SUZUKI HIDETOSHI

(54) **TRANSMISSION METHOD AND DEVICE**

(57) Abstract:

PROBLEM TO BE SOLVED: To provide transmission method and device that signals up-link permission control information and downlink permission control information.

SOLUTION: Downlink control information is mapped in one of plural PDCCH (Physical Downlink Control Channel) candidates contained in a search space. Each PDCCH candidate is a resource for mapping the downlink control information, and contains one control channel element (CCE) or consolidated plural CCEs. A first aggregation level value in a local arrangement in which two or more CCEs contained in one PDCCH candidate are arranged to be adjacent to each other on the frequency axis is smaller than a second aggregation level value in a dispersed arrangement in which two or more CCEs contained in one PDCCH candidate are dispersively arranged on the frequency axis. A signal containing the downlink control information mapped in the search space is transmitted.



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(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2015-180066
(P2015-180066A)
(43)公開日　平成27年10月8日(2015.10.8)

(51)Int.Cl.		F I			テーマコード（参考）
H04W 72/04	***(2009.01)***	H04W	72/04	136	5K067
H04J 11/00	***(2006.01)***	H04J	11/00	Z	
H04W 16/26	***(2009.01)***	H04W	72/04	133	
		H04W	16/26		

審査請求 有　請求項の数 14　ＯＬ　（全 33 頁）

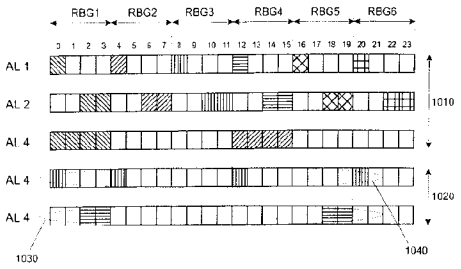
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(71)出願人　514136668
パナソニック　インテレクチュアル　プロパティ　コーポレーション　オブ　アメリカ
Ｐａｎａｓｏｎｉｃ　Ｉｎｔｅｌｌｅｃｔｕａｌ　Ｐｒｏｐｅｒｔｙ　Ｃｏｒｐｏｒａｔｉｏｎ　ｏｆ　Ａｍｅｒｉｃａ
アメリカ合衆国　９０５０３　カリフォルニア州，トーランス，スイート　２００，マリナー　アベニュー　２０００
(74)代理人　100105050
弁理士　鷲田　公一

最終頁に続く

(54)【発明の名称】送信方法および送信装置

(57)【要約】　（修正有）
【課題】アップリンク許可制御情報およびダウンリンク許可制御情報をシグナリングする。
【解決手段】サーチスペースに含まれる複数のＰＤＣＣＨ（物理ダウニリンク制御チャネル）候補のうちの一つに下り制御情報をマッピングする。各ＰＤＣＣＨ候補は、下り制御情報をマッピングするためのリソースであり、かつ、１つの制御チャネル要素（ＣＣＥ）又は集約された複数のＣＣＥを含む。一つのＰＤＣＣＨ候補に含まれる二つ以上のＣＣＥが周波数軸上で隣接して配置される局所配置における第１のアグリゲーションレベル値は、一つのＰＤＣＣＨ候補に含まれる二つ以上のＣＣＥが周波数軸上で分散して配置される分散配置における第２のアグリゲーションレベル値よりも小さく、サーチスペースにマッピングされた下り制御情報を含む信号を送信する。
【選択図】図１０



【特許請求の範囲】
【請求項１】
サーチスペースに含まれる複数のＰＤＣＣＨ候補のうちの一つに下り制御情報をマッピングし、各ＰＤＣＣＨ候補は下り制御情報をマッピングするためのリソースであり、かつ、１つの制御チャネル要素（ＣＣＥ）又は集約された複数のＣＣＥを含み、一つのＰＤＣＣＨ候補に含まれる二つ以上のＣＣＥが周波数軸上で隣接して配置される局所配置における第１のアグリゲーションレベル値は、前記一つのＰＤＣＣＨ候補に含まれる二つ以上のＣＣＥが周波数軸上で分散して配置される分散配置における第２のアグリゲーションレベル値よりも小さく、
前記サーチスペースにマッピングされた前記下り制御情報を含む信号を送信する、
送信方法。
【請求項２】
前記分散配置のＰＤＣＣＨ候補を構成する複数のＣＣＥの各々は、前記局所配置のＰＤＣＣＨ候補を構成するＣＣＥのいずれとも重複しない、
請求項１に記載の送信方法。
【請求項３】
前記サーチスペースは、前記局所配置されるＰＤＣＣＨ候補のみを含む、又は、前記分散配置されるＰＤＣＣＨ候補を含む、
請求項１または２に記載の送信方法。
【請求項４】
一つのサーチスペースが、前記局所配置されるＰＤＣＣＨ候補と前記分散配置されるＰＤＣＣＨ候補とを含む、
請求項１または２に記載の送信方法。
【請求項５】
前記下り制御情報は、アップリンク許可及びダウンリンク割当情報を含む、
請求項１から４のいずれか一項に記載の送信方法。
【請求項６】
前記サーチスペースは、ダウンリンクサブフレームのデータ領域に設定される、
請求項１から５のいずれか一項に記載の送信方法。
【請求項７】
前記第１のアグリゲーションレベル値は１又は２であり、前記第２のアグリゲーションレベル値は４又は８である、
請求項１から６のいずれか一項に記載の送信方法。
【請求項８】
サーチスペースに含まれる複数のＰＤＣＣＨ候補のうちの一つに下り制御情報をマッピングし、各ＰＤＣＣＨ候補は下り制御情報をマッピングするためのリソースであり、かつ、１つの制御チャネル要素（ＣＣＥ）又は集約された複数のＣＣＥを含み、一つのＰＤＣＣＨ候補に含まれる二つ以上のＣＣＥが周波数軸上で隣接して配置される局所配置における第１のアグリゲーションレベル値は、前記一つのＰＤＣＣＨ候補に含まれる二つ以上のＣＣＥが周波数軸上で分散して配置される分散配置における第２のアグリゲーションレベル値よりも小さい、受信部と、
前記サーチスペースにマッピングされた前記下り制御情報を含む信号を送信する送信部と、
を具備する送信装置。
【請求項９】
前記分散配置のＰＤＣＣＨ候補を構成する複数のＣＣＥの各々は、前記局所配置のＰＤＣＣＨ候補を構成するＣＣＥのいずれとも重複しない、
請求項８に記載の送信装置。
【請求項１０】
前記サーチスペースは、前記局所配置されるＰＤＣＣＨ候補のみを含む、又は、前記分

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散配置されるＰＤＣＣＨ候補を含む、
請求項８または９に記載の送信装置。
【請求項１１】
一つのサーチスペースが、前記局所配置されるＰＤＣＣＨ候補と前記分散配置されるＰＤＣＣＨ候補とを含む、
請求項８または９に記載の送信装置。
【請求項１２】
前記下り制御情報は、アップリンク許可及びダウンリンク割当情報を含む、
請求項８から１１のいずれか一項に記載の送信装置。
【請求項１３】
前記サーチスペースは、ダウンリンクサブフレームのデータ領域に設定される、
請求項８から１２のいずれか一項に記載の送信装置。
【請求項１４】
前記第１のアグリゲーションレベル値は１又は２であり、前記第２のアグリゲーションレベル値は４又は８である、
請求項８から１３のいずれか一項に記載の送信装置。

【発明の詳細な説明】
【技術分野】
【０００１】
本発明は、ＯＦＤＭベースの移動通信システム中でアップリンクおよびダウンリンク許可をシグナリングすることに関する。特に、本発明は、探索空間を構成するための方法および装置、ならびに、アップリンク許可制御情報およびダウンリンク許可制御情報をシグナリングするための探索空間チャネル構造に関する。
【背景技術】
【０００２】
第３世代（３Ｇ）移動システム、例えば、第３世代パートナーシップ・プロジェクト（３ＧＰＰ）内で標準化されたユニバーサル移動通信システム（ＵＭＴＳ）などは、広帯域符号分割多元接続（ＷＣＤＭＡ（登録商標））無線アクセス技術に基づいていた。今日、３Ｇシステムは、世界中で大規模に展開されつつある。この技術を、高速ダウンリンク・パケット・アクセス（ＨＳＤＰＡ）と、高速アップリンク・パケット・アクセス（ＨＳＵＰＡ）とも呼ばれる拡張アップリンクとを導入することによって強化した後、ＵＭＴＳ標準の進化における次の主要なステップは、ダウンリンクのための直交周波数分割多重化（ＯＦＤＭ）と、アップリンクのためのシングル・キャリア周波数分割多重化アクセス（ＳＣ－ＦＤＭＡ）とを組み合わせることになった。このシステムは、将来の技術進化に対処するように意図されたため、ロング・ターム・エボリューション（ＬＴＥ）と名付けられた。
【０００３】
ＬＴＥシステムは、低レイテンシかつ低コストで完全なＩＰベースの機能を提供する、効率的なパケットベースの無線アクセスおよび無線アクセス・ネットワークを表す。詳細なシステム要件は、非特許文献１（http://www.3gpp.org/から入手可能であり、参照により本明細書に組み込まれる）に提供されている。ダウンリンクは、データ変調方式ＱＰＳＫ、１６ＱＡＭ、および６４ＱＡＭをサポートすることになり、アップリンクは、ＢＰＳＫ、ＱＰＳＫ、８ＰＳＫ、および１６ＱＡＭをサポートすることになる。
【０００４】
ＬＴＥのネットワーク・アクセスは、１．２５～２０ＭＨｚの間の複数の定義されたチャネル帯域幅を使用して、極めてフレキシブルになり、これは、ＵＭＴＳ地上無線アクセス（ＵＴＲＡ）の固定５ＭＨｚチャネルとは対照的である。スペクトル効率はＵＴＲＡと比較して４倍まで増加し、アーキテクチャおよびシグナリングの改善により、ラウンドトリップ・レイテンシが低減する。多入力多出力（ＭＩＭＯ）アンテナ技術が、１セル当た

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りのユーザを、３ＧＰＰの元々のＷＣＤＭＡ（登録商標）無線アクセス技術の１０倍にすることができるはずである。できるだけ多くの周波数帯域割振り構成に適合するために、対（ｐａｉｒｅｄ）（周波数分割複信ＦＤＤ）と不対（ｕｎｐａｉｒｅｄ）（時分割複信ＴＤＤ）との両方の帯域動作がサポートされる。ＬＴＥは、隣接チャネル中においても以前の３ＧＰＰ無線技術と共存することができ、３ＧＰＰの全ての先行無線アクセス技術との間で呼をハンドオーバすることができる。

【０００５】

図１に、ＬＴＥリリース８におけるコンポーネント・キャリアの構造を示す。３ＧＰＰＬＴＥリリース８のダウンリンク・コンポーネント・キャリアは、いわゆるサブフレーム１００中で時間周波数ドメインにおいて細分され、各サブフレームは、期間T_{slot}に対応する２つのダウンリンク・スロット１１０と１２０とに分割される。第１のダウンリンク・スロットは、第１のＯＦＤＭシンボル（複数可）内に制御チャネル領域を含む。各サブフレームは、時間ドメインにおける所与の数のＯＦＤＭシンボルからなり、各ＯＦＤＭシンボルは、コンポーネント・キャリアの帯域幅全体に及ぶ。

【０００６】

図２は、ＬＴＥリソースをさらに詳細に示す例である。特に、スケジューラによって割り当てることのできるリソースの最小単位は、物理リソース・ブロック（ＰＲＢ）とも呼ばれるリソース・ブロックである。ＰＲＢ２１０は、時間ドメインにおける

【０００７】

【数１】

$$N_{symb}^{DL}$$

個の連続するＯＦＤＭシンボル、および、周波数ドメインにおける

【０００８】

【数２】

$$N_{sc}^{RB}$$

個の連続するサブキャリアとして定義される。実際には、ダウンリンク・リソースは、リソース・ブロック対で割り当てられる。リソース・ブロック対は、２つのリソース・ブロックからなる。リソース・ブロック対は、周波数ドメインにおける

【０００９】

【数３】

$$N_{sc}^{RB}$$

個の連続するサブキャリアと、時間ドメインにおけるサブフレームの

【００１０】

【数４】

$$2 \cdot N_{symb}^{DL}$$

個の変調シンボル全体とに及ぶ。

【００１１】

【数５】

$$N_{\mathrm{symb}}^{\mathrm{DL}}$$

は、６と７のいずれかとすることができ、その結果、合計１２または１４個のＯＦＤＭシンボルとなる。したがって、物理リソース・ブロック２１０は、時間ドメインにおける１スロットと周波数ドメインにおける１８０ｋＨｚとに対応する、

【００１２】

【数６】

$$N_{\mathrm{symb}}^{\mathrm{DL}} \times N_{\mathrm{sc}}^{\mathrm{RB}}$$

個のリソース要素２２０からなる（ダウンリンク・リソース・グリッドに関するこれ以上の詳細は、例えば、参照により本明細書に組み込まれる、http://www.3gpp.org.で入手可能な、非特許文献２に見ることができる）。

【００１３】

ダウンリンクにおける物理リソース・ブロックの数

【００１４】

【数７】

$$N_{\mathrm{RB}}^{\mathrm{DL}}$$

は、セル中で構成されるダウンリンク送信帯域幅に依存し、ＬＴＥでは現在、６～１１０個のＰＲＢの区間として定義されている。

【００１５】

データは、仮想リソース・ブロックの対を用いて物理リソース・ブロック上にマッピングされる。仮想リソース・ブロックの対が、物理リソース・ブロックの対にマッピングされる。ＬＴＥダウンリンクにおける物理リソース・ブロック上への仮想リソース・ブロックのマッピングに従って、以下の２つのタイプの仮想リソース・ブロックが定義される。

【００１６】

局所化された仮想リソース・ブロック（ＬＶＲＢ）

分散された仮想リソース・ブロック（ＤＶＲＢ）

局所化されたＶＲＢを使用する局所化送信モードでは、ｅＮＢは、どのリソース・ブロックが何個使用されるかについて完全に制御することができ、この制御を使用して、通常、スペクトル効率が大きくなるようなリソース・ブロックを選ぶべきである。ほとんどの移動通信システムでは、その結果、隣接する物理リソース・ブロック、または隣接する物理リソース・ブロックの複数のクラスタが単一のユーザ機器へ送信するためのものになる。というのは、無線チャネルは周波数ドメインにおいてコヒーレントであり、このことは、１つの物理リソース・ブロックが大きいスペクトル効率を提供するならば、隣接する物理リソース・ブロックも同様に大きいスペクトル効率を提供する可能性が非常に高いことを含意するからである。分散されたＶＲＢを使用する分散送信モードでは、十分に大きいスペクトル効率を提供する少なくともいくつかの物理リソース・ブロックをヒットするために、同じＵＥへのデータを搬送する物理リソース・ブロックが周波数帯域全体に分散され、それにより周波数ダイバーシティを得る。

【００１７】

３ＧＰＰ　ＬＴＥリリース８では、アップリンクおよびダウンリンクにおいて、１つのコンポーネント・キャリアしかない。ダウンリンク制御シグナリングは基本的に、以下の

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３つの物理チャネルによって搬送される。

【００１８】

サブフレーム中の制御シグナリングに使用されるＯＦＤＭシンボルの数（すなわち制御チャネル領域のサイズ）を示すための、物理制御フォーマット・インジケータ・チャネル（ＰＣＦＩＣＨ）

アップリンク・データ送信に関連するダウンリンクＡＣＫ／ＮＡＣＫを搬送するための、物理ハイブリッドＡＲＱインジケータ・チャネル（ＰＨＩＣＨ）

ダウンリンク・スケジューリング割当ておよびアップリンク・スケジューリング割当てを搬送するための、物理ダウンリンク制御チャネル（ＰＤＣＣＨ）

ＰＣＦＩＣＨは、既知の事前定義済み変調符号化方式を使用して、ダウンリンク・サブフレームの制御シグナリング領域内の既知の位置から送られる。ユーザ機器は、サブフレーム中の制御シグナリング領域のサイズに関する情報、例えばＯＦＤＭシンボルの数を得るために、ＰＣＦＩＣＨを復号する。ユーザ機器（ＵＥ）がＰＣＦＩＣＨを復号することができない場合、または誤ったＰＣＦＩＣＨ値を得た場合、ＵＥは、制御シグナリング領域に含まれるＬ１／Ｌ２制御シグナリング（ＰＤＣＣＨ）を正しく復号できないことになり、その結果、制御シグナリング領域に含まれる全てのリソース割当てを失うことがある。

【００１９】

ＰＤＣＣＨは、制御情報、例えば、ダウンリンクまたはアップリンク・データ送信用のリソースを割り振るためのスケジューリング許可を、搬送する。物理制御チャネルは、１つまたは複数の連続する制御チャネル要素（ＣＣＥ）の集約上で送信される。各ＣＣＥは、いわゆるリソース要素グループ（ＲＥＧ）にグループ化されたリソース要素のセットに対応する。制御チャネル要素は通常、９つのリソース要素グループに対応する。ＰＤＣＣＨ上のスケジューリング許可は、制御チャネル要素（ＣＣＥ）に基づいて定義される。リソース要素グループは、リソース要素への制御チャネルのマッピングを定義するのに使用される。各ＲＥＧは、同じＯＦＤＭシンボル内の基準信号を除いた、４つの連続するリソース要素からなる。ＲＥＧは、１つのサブフレーム内の最初の１～４つのＯＦＤＭシンボル中に存在する。ユーザ機器へのＰＤＣＣＨは、サブフレーム内のＰＣＦＩＣＨに従って、最初の１つ、２つ、または３つのＯＦＤＭシンボル上で送信される。

【００２０】

３ＧＰＰ　ＬＴＥリリース８（および後のリリース）において物理リソース上へのデータのマッピングで使用される別の論理的単位は、リソース・ブロック・グループ（ＲＢＧ）である。リソース・ブロック・グループは、連続（周波数において）する物理リソース・ブロックのセットである。ＲＢＧの概念は、受信ノード（例えばＵＥ）に割り振られたリソースの位置を示すために特定のＲＢＧにアドレスすることを可能にし、このような指示のためのオーバヘッドを最小限に抑え、それにより送信の制御オーバヘッド対データの比率を低減する。ＲＢＧのサイズは現在、システム帯域幅、特に

【００２１】

【数８】

$$N_{\mathrm{RB}}^{\mathrm{DL}}$$

に応じて、１、２、３、または４に指定されている。ＬＴＥリリース８におけるＰＤＣＣＨのＲＢＧマッピングに関するこれ以上の詳細は、http://www.3gpp.org/で自由に入手可能であり参照により本明細書に組み込まれる、非特許文献３に見ることができる。

【００２２】

物理ダウンリンク共有チャネル（ＰＤＳＣＨ）を使用して、ユーザ・データが移送される。ＰＤＳＣＨは、１つのサブフレーム内の、ＰＤＣＣＨの後の残りのＯＦＤＭシンボルにマッピングされる。１つのＵＥに割り振られるＰＤＳＣＨリソースは、各サブフレーム

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ごとのリソース・ブロック単位である。

【００２３】

図３に、サブフレーム内でのＰＤＣＣＨおよびＰＤＳＣＨの例示的なマッピングを示す。最初の２つのＯＦＤＭシンボルは、制御チャネル領域（ＰＤＣＣＨ領域）を形成し、Ｌ１／Ｌ２制御シグナリングに使用される。残りの１２個のＯＦＤＭシンボルは、データ・チャネル領域（ＰＤＳＣＨ領域）を形成し、データに使用される。全てのサブフレームのリソース・ブロック対の内で、セル特有の基準信号、いわゆる共通基準信号（ＣＲＳ）が、１つまたは複数のアンテナ・ポート０～３上で送信される。図３の例では、ＣＲＳは、２つのアンテナ・ポートから送信される（Ｒ０およびＲ１）。

【００２４】

さらに、サブフレームは、ＵＥ特有の基準信号、いわゆる、ＰＤＳＣＨを復調するためにユーザ機器によって使用される復調基準信号（ＤＭ－ＲＳ）も含む。ＤＭ－ＲＳは、特定のユーザ機器にＰＤＳＣＨが割り振られるリソース・ブロック内でのみ送信される。ＤＭ－ＲＳを用いた多入力多出力（ＭＩＭＯ）をサポートするために、４つのＤＭ－ＲＳレイヤが定義されるが、このことは、多くても４レイヤのＭＩＭＯがサポートされることを意味する。図３のこの例では、ＤＭ－ＲＳレイヤ１、２、３、および４が、ＭＩＭＯレイヤ１、２、３、および４に対応する。

【００２５】

ＬＴＥの重要な特徴の１つは、同期した単一周波数ネットワークを介して複数のセルからマルチキャストまたはブロードキャスト・データを送信できることであり、これは、マルチメディア・ブロードキャスト単一周波数ネットワーク（ＭＢＳＦＮ、ｍｕｌｔｉｍｅｄｉａ ｂｒｏａｄｃａｓｔ ｓｉｎｇｌｅ ｆｒｅｑｕｅｎｃｙ ｎｅｔｗｏｒｋ）動作として知られている。ＭＢＳＦＮ動作では、ＵＥは、複数のセルからの同期した信号を受信して結合する。これを容易にするために、ＵＥは、ＭＢＳＦＮ基準信号に基づいて別個のチャネル推定を実施する必要がある。ＭＢＳＦＮ基準信号と通常の基準信号を同じサブフレーム中で混合しないようにするために、ＭＢＳＦＮサブフレームとして知られているいくつかのサブフレームが、ＭＢＳＦＮ送信のために予約される。図４に、ＭＢＳＦＮサブフレームの構造を示す。ＯＦＤＭシンボルの最初の２つまでが、非ＭＢＳＦＮ送信のために予約され、残りのＯＦＤＭシンボルが、ＭＢＳＦＮ送信に使用される。最初の２つまでのＯＦＤＭシンボル中で、アップリンク・リソース割当て用のＰＤＣＣＨ、およびＰＨＩＣＨを送信することができ、セル特有の基準信号は、非ＭＢＳＦＮ送信サブフレームと同じである。１つのセル中の特定のパターンのＭＢＳＦＮサブフレームは、そのセルのシステム情報中でブロードキャストされる。ＭＢＳＦＮを受信することができないＵＥは、最初の２つまでのＯＦＤＭシンボルを復号して、残りのＯＦＤＭシンボルは無視することになる。ＭＢＳＦＮサブフレーム構成は、１０ミリ秒と４０ミリ秒の両方の周期性をサポートする。しかし、番号０、４、５、および９のサブフレームは、ＭＢＳＦＮサブフレームとして構成することはできない。図４は、ＭＢＳＦＮサブフレームのフォーマットを示す。

【００２６】

Ｌ１／Ｌ２制御シグナリング上で送られるＰＤＣＣＨ情報は、共有制御情報と個別制御情報とに分けることができる。ＩＭＴアドバンストに関する周波数スペクトルが、２００８年１１月に世界無線通信会議（ＷＲＣ－０７）で決定された。しかし、実際の利用可能な周波数帯域幅は、地域または国ごとに異なる場合がある。３ＧＰＰによって標準化されたＬＴＥの拡張は、ＬＴＥアドバンスト（ＬＴＥ－Ａ）と呼ばれ、リリース１０の主題として承認されている。ＬＴＥ－Ａリリース１０はキャリア・アグリゲーションを採用するが、このキャリア・アグリゲーションによれば、より広い送信帯域幅、例えば１００ＭＨｚまでの送信帯域幅をサポートするために、ＬＴＥリリース８で定義された２つ以上のコンポーネント・キャリアが集約される。一般に、単一のコンポーネント・キャリアは帯域幅２０ＭＨｚを超えないと仮定される。端末は、その能力に応じて、１つまたは複数のコンポーネント・キャリア上で同時に受信および／または送信することができる。

【００２７】
ＬＴＥ－Ａの別の重要な特徴は、３ＧＰＰ　ＬＴＥ－ＡのＵＴＲＡＮアーキテクチャに中継ノードを導入することによって、中継機能を提供することである。ＬＴＥ－Ａでは、中継は、高データ・レートのカバレッジ、グループ・モビリティ、一時的ネットワーク展開、セル・エッジ・スループットを改善するための、かつ／または新しいエリアでカバレッジを提供するためのツールと見なされる。
【００２８】
中継ノードは、ドナー・セルを介して無線アクセス・ネットワークにワイヤレス接続される。中継戦略に応じて、中継ノードは、ドナー・セルの一部であることもあり、または別法として、それ自体のセルを制御することもある。中継ノードがドナー・セルの一部である場合、中継ノードは、それ自体のセル識別を有さないが、それでもなお中継ＩＤを有することがある。中継ノードがそれ自体のセルを制御する場合、中継ノードは１つまたは複数のセルを制御し、中継によって制御される各セル中で、一意の物理レイヤ・セル識別が提供される。少なくとも、「タイプ１」中継ノードが、３ＧＰＰ　ＬＴＥ－Ａの一部となる。「タイプ１」中継ノードは、以下を特徴とする中継ノードである。
【００２９】
中継ノードは、ユーザ機器にとってはそれぞれがドナー・セルとは異なる別個のセルに見えるようなセルを制御する。
【００３０】
これらのセルは、ＬＴＥリリース８において定義されるようなそれ自体の物理セルＩＤを有するべきであり、中継ノードは、それ自体の同期チャネルや基準シンボルなどを送信するものとする。
【００３１】
単一セル動作に関して、ＵＥは、スケジューリング情報およびＨＡＲＱフィードバックを中継ノードから直接受け取り、その被制御情報（肯定応答、チャネル品質指示、スケジューリング要求）を中継ノードに送るべきである。
【００３２】
中継ノードは、３ＧＰＰ　ＬＴＥ準拠のユーザ機器にとっては、後方互換性をサポートするために、３ＧＰＰ　ＬＴＥ準拠のｅＮｏｄｅＢに見えるべきである。
【００３３】
中継ノードは、３ＧＰＰ　ＬＴＥ－Ａ準拠のユーザ機器にとっては、さらに性能向上を可能にするために、３ＧＰＰ　ＬＴＥ　ｅＮｏｄｅＢとは異なるように見えるべきである。
【００３４】
図５に、中継ノードを使用する例示的な３ＧＰＰ　ＬＴＥ－Ａネットワーク構造を示す。ドナーｅＮｏｄｅＢ（ｄ－ｅＮＢ）５１０は、ユーザ機器ＵＥ１　５１５および中継ノード（ＲＮ）５２０に直接サービスし、ＲＮ５２０はさらに、ＵＥ２　５２５にサービスする。ドナーｅＮｏｄｅＢ５１０と中継ノード５２０との間のリンクは、通常、中継バックホール・アップリンク／ダウンリンクと呼ばれる。中継ノード５２０と、中継ノードに帰属するユーザ機器５２５（ｒ－ＵＥとしても示される）との間のリンクは、（中継）アクセス・リンクと呼ばれる。
【００３５】
ドナーｅＮｏｄｅＢは、Ｌ１／Ｌ２制御およびデータを、マイクロユーザ機器ＵＥ１　５１５に、また中継ノード５２０にも送信し、中継ノード５２０はさらに、このＬ１／Ｌ２制御およびデータを中継ユーザ機器ＵＥ２　５２５に送信する。中継ノードは、送信動作と受信動作とを同時に実施することのできない、いわゆる時間多重化モードで動作することができる。特に、ｅＮｏｄｅＢ５１０から中継ノード５２０へのリンクが中継ノード５２０からＵＥ２　５２５へのリンクと同じ周波数スペクトルで動作する場合、中継の送信機がそれ自体の受信機に対する干渉を引き起こすため、ｅＮｏｄｅＢから中継ノードへの送信と中継ノードからＵＥへの送信を同じ周波数リソース上で同時に行うことは、送出

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信号と入来信号との十分な分離がもたらされない限り、不可能であることがある。したがって、中継ノード５２０がドナーｅＮｏｄｅＢ５１０に送信するとき、中継ノード５２０は、中継ノードに帰属するＵＥ５２５から同時に受信することはできない。同様に、中継ノード５２０がドナーｅＮｏｄｅＢからデータを受信するとき、中継ノード５２０は、中継ノードに帰属するＵＥ５２５にデータを送信することはできない。したがって、中継バックホール・リンクと中継アクセス・リンクとの間に、サブフレーム区分化がある。

【００３６】

中継ノードのサポートに関して、３ＧＰＰでは現在、以下のように合意されている。

【００３７】

ｅＮｏｄｅＢから中継へのダウンリンク・バックホール送信がその間に構成される、中継バックホール・ダウンリンク・サブフレームは、半静的に割り当てられる。

【００３８】

中継からｅＮｏｄｅＢへのアップリンク・バックホール送信がその間に構成される、中継バックホール・アップリンク・サブフレームは、半静的に割り当てられるか、または、中継バックホール・ダウンリンク・サブフレームからＨＡＲＱタイミングによって暗黙的に導出される。

【００３９】

中継バックホール・ダウンリンク・サブフレーム中では、中継ノードは、ドナーｅＮｏｄｅＢに送信することになり、したがって、ｒ－ＵＥは、中継ノードからのどんなデータの受信も予想しないことになっている。中継ノードに帰属することを意識していないＵＥ（中継ノードが標準的なｅＮｏｄｅＢに見える、リリース８のＵＥなど）に対する後方互換性をサポートするために、中継ノードは、バックホール・ダウンリンク・サブフレームをＭＢＳＦＮサブフレームとして構成する。

【００４０】

以下では、例示のために、図５に示すネットワーク構成を仮定する。ドナーｅＮｏｄｅＢは、Ｌ１／Ｌ２制御およびデータを、マクロユーザ機器（ＵＥ１）５１５に、また中継（中継ノード）５２０にも送信し、中継ノード５２０は、Ｌ１／Ｌ２制御およびデータを中継ユーザ機器（ＵＥ２）５２５に送信する。さらに、中継ノードが時分割複信モードで動作する、すなわち送信動作と受信動作とが同時に実施されないと仮定すると、図６に示すような、非網羅的な経時的エンティティ挙動に到る。中継ノードが「送信」モードにあるときは常に、ＵＥ２は、Ｌ１／Ｌ２制御チャネルおよび物理ダウンリンク共有チャネル（ＰＤＳＣＨ）を受信する必要があり、中継ノードが「受信」モードにあるとき、すなわちＮｏｄｅＢからＬ１／Ｌ２制御チャネルおよびＰＤＳＣＨを受信しているときは、中継ノードはＵＥ２に送信することができず、したがってＵＥ２は、このようなサブフレーム中では中継ノードからどんな情報も受信することができない。ＵＥ２が中継ノードに帰属することをＵＥ２が意識していない場合（例えばリリース８のＵＥ）、中継ノード５２０は、通常の（ｅ－）ＮｏｄｅＢとして挙動しなければならない。当業者には理解されるであろうが、中継ノードのない通信システム中では、どんなユーザ機器も常に、あらゆるサブフレーム中に少なくともＬ１／Ｌ２制御信号があると仮定することができる。したがって、中継ノードの下で動作するこのようなユーザ機器をサポートするために、中継ノードは、全てのサブフレーム中で、このような予想される挙動を装うべきである。

【００４１】

図３および４に示したように、各ダウンリンク・サブフレームは、制御チャネル領域とデータ領域との、２つの部分からなる。図７に、中継バックホール送信が行われる状況で中継アクセス・リンク上のＭＢＳＦＮフレームを構成する例を示す。各サブフレームは、制御データ部分７１０、７２０、およびデータ部分７３０、７４０を含む。ＭＢＳＦＮサブフレーム中の第１のＯＦＤＭシンボル７２０は、中継ノード５２０によって、制御シンボルをｒ－ＵＥ５２５に送信するために使用される。サブフレームの残りの部分で、中継ノードは、ドナーｅＮｏｄｅＢ５１０からデータ７４０を受信することができる。したがって、同じサブフレーム中では、中継ノード５２０からｒ－ＵＥ５２５へのどんな送信も

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あり得ない。ｒ－ＵＥは、最初の２つまでのＯＦＤＭ制御シンボルを受信し、サブフレームの残りの部分は無視する。非ＭＢＳＦＮサブフレームは、中継ノード５２０からｒ－ＵＥ５２５に送信され、制御シンボル７１０ならびにデータシンボル７３０がｒ－ＵＥ５２５によって処理される。ＭＢＳＦＮサブフレームは、１０ミリ秒または４０ミリ秒ごとに構成されてよい。したがって、中継バックホール・ダウンリンク・サブフレームもまた、１０ミリ秒と４０ミリ秒の両方の構成をサポートする。ＭＢＳＦＮサブフレーム構成と同様、中継バックホール・ダウンリンク・サブフレームは、＃０、＃４、＃５、および＃９のサブフレームにおいては構成することができない。

【００４２】

ＭＢＳＦＮサブフレームは中継ノードでダウンリンク・バックホールのダウンリンク・サブフレームとして構成されるので、中継ノードは、ドナーｅＮｏｄｅＢからＰＤＣＣＨを受信することはできない。したがって、新しい物理制御チャネル（Ｒ－ＰＤＣＣＨ）を使用して、ダウンリンクおよびアップリンク・バックホール・データ用に半静的に割り当てられたサブフレーム内で、動的にまたは「セミパーシステントに」リソースが割り当てられる。ダウンリンク・バックホール・データは、新しい物理データ・チャネル（Ｒ－ＰＤＳＣＨ）上で送信され、アップリンク・バックホール・データは、新しい物理データ・チャネル（Ｒ－ＰＵＳＣＨ）上で送信される。中継ノードへのＲ－ＰＤＣＣＨ（複数可）は、サブフレームのＰＤＳＣＨ領域内のＲ－ＰＤＣＣＨ領域にマッピングされる。中継ノードは、サブフレームのこの領域内でＲ－ＰＤＣＣＨを受信することを予想する。時間ドメインでは、Ｒ－ＰＤＣＣＨ領域は、構成されたダウンリンク・バックホール・サブフレームに及ぶ。周波数ドメインでは、Ｒ－ＰＤＣＣＨ領域は、より高いレイヤのシグナリングによって中継ノードのために事前構成された、いくつかのリソース・ブロック上に存在する。サブフレーム内のＲ－ＰＤＣＣＨ領域の設計および使用に関して、標準化において以下の特性がこれまでに合意されている。

【００４３】

Ｒ－ＰＤＣＣＨには、送信のためのＰＲＢが半静的に割り当てられる。さらに、これらの半静的に割り当てられたＰＲＢ内でＲ－ＰＤＣＣＨ送信に現在使用されることになるリソースのセットは、サブフレーム間で動的に変動することがある。

【００４４】

動的に構成されるリソースは、バックホール・リンクに利用可能なＯＦＤＭシンボルの完全なセットをカバーしてもよく、またはこれらのサブセットに制約されてもよい。

【００４５】

半静的に割り当てられたＰＲＢ内の、Ｒ－ＰＤＣＣＨに使用されないリソースを使用して、Ｒ－ＰＤＳＣＨまたはＰＤＳＣＨを搬送することができる。

【００４６】

ＭＢＳＦＮサブフレームの場合、中継ノードは、制御信号をｒ－ＵＥに送信する。次いで、同じサブフレーム内でドナーｅＮｏｄｅＢによって送信されたデータを中継ノードが受信できるように、送信モードから受信モードに切り替えることが必要になる可能性がある。このギャップに加えて、ドナーｅＮｏｄｅＢと中継ノードとの間の信号の伝搬遅延を考慮に入れなければならない。したがって、Ｒ－ＰＤＣＣＨはまず、中継ノードが受信するのがサブフレーム内で十分に遅いＯＦＤＭシンボルから、送信される。

【００４７】

物理リソース上へのＲ－ＰＤＣＣＨのマッピングは、周波数分散方式と周波数局所化方式のいずれかで実施することができる。

【００４８】

限られた数のＰＲＢ内でＲ－ＰＤＣＣＨをインタリーブすることで、ダイバーシティ利得を達成することができると同時に、浪費されるＰＲＢの数を制限することができる。

【００４９】

非ＭＢＳＦＮサブフレーム中では、ＥＮｏｄｅＢによってＤＭ－ＲＳが構成されるときは、リリース１０のＤＭ－ＲＳが使用される。そうでない場合は、リリース８のＣＲＳが

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使用される。ＭＢＳＦＮサブフレーム中では、リリース１０のＤＭ－ＲＳが使用される。
【００５０】
Ｒ－ＰＤＣＣＨは、バックホール・リンクに対するダウンリンク許可またはアップリンク許可を割り当てるのに使用することができる。ダウンリンク許可探索空間およびアップリンク許可探索空間の境界は、サブフレームのスロット境界である。特に、ダウンリンク許可は、サブフレームの第１のスロット中でのみ送信され、アップリンク許可は、第２のスロット中でのみ送信される。
【００５１】
ＤＭ－ＲＳを用いて復調するときは、インタリーブは適用されない。ＣＲＳを用いて復調するときは、ＲＥＧレベルのインタリーブと、インタリーブなしの両方がサポートされる。
【００５２】
以上の合意に基づき、Ｒ－ＰＤＣＣＨ探索空間の構成については、以下のように、基本的に３つの異なるオプションがある。
【００５３】
周波数において局所化された非インタリーブドＲ－ＰＤＣＣＨ
周波数において分散された非インタリーブドＲ－ＰＤＣＣＨ
ＲＥＧレベルのインタリーブドＲ－ＰＤＣＣＨ
ＲＥＧレベルのインタリーブドＲ－ＰＤＣＣＨの場合は、リリース８のＰＤＣＣＨ探索空間方式が、Ｒ－ＰＤＣＣＨのための半静的に構成されるＰＲＢ内で再使用されることになる（いわゆるＲ－ＰＤＣＣＨ仮想帯域幅）。非インタリーブドＲ－ＰＤＣＣＨの場合は、帯域幅全体にわたり異なる集約レベルについてＰＤＣＣＨ候補の位置をランダム化するリリース８のＰＤＣＣＨ探索空間の概念を理論的には適用することができるが、この概念は、ｅＮｏｄｅＢによって自由に割り当てることのできる位置に候補が存在できるという利益を促進することにはならない。これにより、制御チャネルの完全な周波数選択的スケジューリング利益を利用することが不可能になる。
【先行技術文献】
【非特許文献】
【００５４】
【非特許文献１】3GPP TR 25.913、「Requirements for evolved UTRA (E-UTRA) and evolved UTRAN (E-UTRAN)」、v8.0.0、2009年1月
【非特許文献２】3GPP TS 36.21.1、「Evolved universal terrestrial radio access (E-UTRA); physical channels and modulations (Release 8)」、バージョン8.9.0、2009年12月、セクション6.2
【非特許文献３】3GPP TS 36.213「Evolved Universal terrestrial Radio Access (E-UTRA); Physical layer procedures」、v8.8.0、2009年9月、セクション7.1.6.1
【非特許文献４】3GPP TS 36.213「Evolved Universal terrestrial Radio Access (E-UTRA); Physical layer procedures」、v8.8.0、2009年9月、セクション9.1.1
【非特許文献５】3GPP TS 36.213、「Evolved Universal terrestrial Radio Access (E-UTRA); Physical layer procedures」、v8.8.0、2009年9月、セクション9.1
【発明の概要】
【発明が解決しようとする課題】
【００５５】
上記に鑑みて、本発明の目的は、共有チャネルに対するアップリンクおよびダウンリンク許可（または割当て）を含み得る制御情報を、受信側に、または特に中継ノードにシグナリングすることができる探索空間を構成するための、効率的な方式を提供することである。
【００５６】
これは、独立請求項の特徴によって達成される。
【００５７】

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本発明の有利な実施形態は、従属請求項に従う。

【００５８】

本発明の特定の手法は、より低い集約レベルの局所化された候補と、より高い集約レベルの少なくとも１つの分散された候補とを含む、探索空間構成を提供することである。

【課題を解決するための手段】

【００５９】

本発明の主たる一態様は、サーチスペースに含まれる複数のＰＤＣＣＨ候補のうちの一つに下り制御情報をマッピングし、各ＰＤＣＣＨ候補は下り制御情報をマッピングするためのリソースであり、かつ、１つの制御チャネル要素（ＣＣＥ）又は集約された複数のＣＣＥを含み、一つのＰＤＣＣＨ候補に含まれる二つ以上のＣＣＥが周波数軸上で隣接して配置される局所配置における第１のアグリゲーションレベル値は、前記一つのＰＤＣＣＨ候補に含まれる二つ以上のＣＣＥが周波数軸上で分散して配置される分散配置における第２のアグリゲーションレベル値よりも小さく、前記サーチスペースにマッピングされた前記下り制御情報を含む信号を送信する、送信方法である。

本発明の一態様によれば、マルチキャリア通信システムにおけるサブフレーム内で制御データを受信する方法が提供される。この方法は、受信ノードにおいて実施される以下のステップ、すなわち、物理リソース・ブロックに論理的に分割され複数の制御チャネル要素を含むサブフレームを送信ノードから受信するステップと、サブフレームの事前定義済み探索空間内で制御情報のブラインド検出を実施するステップとを含む。前記探索空間は、ブラインド検出を実施するための候補に論理的に細分され、各候補は１つまたは複数の集約制御チャネル要素を含み、第１の数の集約制御チャネル要素を有する少なくとも１つの候補は、周波数において隣接して配置された制御チャネル要素からなり、第１の数よりも大きい第２の数の集約制御チャネル要素を有する少なくとも１つの候補は、周波数において少なくとも部分的に分散された制御チャネル要素からなる。

【００６０】

本発明の別の態様によれば、マルチキャリア通信システムのサブフレーム内で少なくとも１つの受信ノードへの制御情報を送信する方法が提供される。この方法は、送信ノードにおいて実施される以下のステップ、すなわち、サブフレーム中の事前定義済み探索空間上に、受信ノードへの制御情報をマッピングするステップであって、受信ノードがブラインド検出を実施しようとするリソースを探索空間が含み、前記探索空間がブラインド検出のための候補に論理的に細分され、各候補が１つまたは複数の集約制御チャネル要素を含み、第１の数の集約制御チャネル要素を有する少なくとも１つの候補が、周波数において隣接して配置された制御チャネル要素からなり、第１の数よりも大きい第２の数の集約制御チャネル要素を有する少なくとも１つの候補が、周波数において少なくとも部分的に分散された制御チャネル要素からなる、ステップと、サブフレームを少なくとも１つの受信ノードに送信するステップとを含む。

【００６１】

本発明の別の態様によれば、マルチキャリア通信システムのサブフレーム内で制御情報を受信するための受信装置が提供される。この装置は、複数の制御チャネル要素を含むサブフレームを送信ノードから受信するための受信ユニットと、サブフレームの事前定義済み探索空間内で制御情報のブラインド検出を実施するための検出ユニットとを備え、前記探索空間は、ブラインド検出が実施されることになる候補に論理的に細分され、各候補は１つまたは複数の集約制御チャネル要素を含み、第１の数の集約制御チャネル要素を有する少なくとも１つの候補は、周波数において隣接して配置された制御チャネル要素からなり、第１の数よりも大きい第２の数の集約制御チャネル要素を有する少なくとも１つの候補は、周波数において少なくとも部分的に分散された制御チャネル要素からなる。

【００６２】

本発明の別の態様によれば、マルチキャリア通信システムのサブフレーム内で少なくとも１つの受信ノードへの制御情報を送信するための送信装置が提供される。この装置は、受信ノードがブラインド検出を実施することになるリソースを含む、サブフレーム中の事

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前定義済み探索空間上に、受信ノードへの制御情報をマッピングするためのマッピング・ユニットであって、前記探索空間がブラインド検出のための候補に論理的に細分され、各候補が１つまたは複数の集約制御チャネル要素を含み、第１の数の集約制御チャネル要素を有する少なくとも１つの候補が、周波数において隣接して配置された制御チャネル要素からなり、第１の数よりも大きい第２の数の集約制御チャネル要素を有する少なくとも１つの候補が、周波数において少なくとも部分的に分散された制御チャネル要素からなる、マッピング・ユニットと、サブフレームを少なくとも１つの受信ノードに送信するための送信ユニットとを備える。

【００６３】

したがって、局所化された候補が構成される場合でも、より高い集約レベルの候補については、フェーディング・ディップ（ｆａｄｉｎｇ　ｄｉｐ）に対する頑強性および回復力が増大する。言い換えれば、本発明は、周波数ドメインにおいて、より高い集約レベルの候補のうちの少なくとも１つを、少なくとも部分的に分散させることを提案する。ここで、用語「分散させる」とは、周波数において連続的に隣接する物理リソース・ブロック上に全てがマッピングされるわけではない制御チャネル要素上に、候補をマッピングすることを指す。したがって、候補の制御チャネル要素の少なくとも２つの部分を、少なくとも１つの他の物理リソース・ブロックが分離する。

【００６４】

第１の数の集約制御チャネル要素が１つまたは２つであり、第２の数の集約制御チャネル要素が４つまたは８つであることが有利である。好ましくは、第２の数の集約制御チャネル要素を有する１つの候補が、単一制御チャネル要素にわたって分散され、かつ／または、８つの集約制御チャネル要素を有する候補が、２制御チャネル要素のサイズの各部分にわたって分散され、部分は一般に、２つ以上の連続的に隣接する物理リソース・ブロックに類似する。これらの特定の数は、集約レベル１、２、４、および８を現在サポートするＬＴＥ／ＬＴＥ－Ａシステムに関して、特に有利である。これらの数を選択すれば、集約レベル２の局所化が可能になり、集約レベル４および／または８の少なくとも１つの候補が分散され、これにより、これらの分散された候補の検出頑強性が増大する。しかし、本発明はこれらの数に限定されない。展開されるシステムに応じて、３、５、６などの集約レベルをサポートすることもできる。一般に、候補が分散されることになる集約レベルの選択は、候補が定義される周波数帯域と、予想されるフェーディング特性とを考慮して実施することができる。

【００６５】

本発明の一実施形態によれば、制御チャネル要素は、３ＧＰＰ　ＬＴＥ／ＬＴＥ－Ａにおいて定義される制御チャネル要素（ＣＣＥ）に対応する。本発明の別の実施形態によれば、制御チャネル要素は、３ＧＰＰ　ＬＴＥ／ＬＴＥ－Ａの物理リソース・ブロックに対応する。しかし、本発明はこれに限定されず、本発明の制御チャネル要素は、時間／周波数ドメインにおいて定義される任意のリソースとすることができる。

【００６６】

第２の数の集約制御チャネル要素を有する少なくとも１つの候補が、周波数において隣接する物理リソース・ブロック上にマッピングされ（すなわち局所化方式で）、第２の数の集約制御チャネル要素を有する少なくとも１つの他の候補が、周波数において分散された物理リソース・ブロック上にマッピングされることが有利である。フェーディングならびに／または雑音および干渉特性が周波数ドメインにおいて一様であり、したがって隣接する物理リソース・ブロックのチャネル特性がよく似ている確率が非常に高い場合は、局所化方式が採用されるのが有利である。ほとんどの態様では、最も重要なチャネル特性は、信号フェーディングおよび伝搬、雑音、干渉、ならびに／または周波数シフトによる、振幅および位相の変化を含む。したがって、チャネル特性がよくわかっていれば、最良のチャネル・リソース（複数可）を選択的に使用することによって、局所化方式を用いてチャネル容量を非常に効率的に利用することができる。反対に、このような知識がなければ、または知識が不正確であれば、チャネル状態のよい少なくともいくつかのリソースをヒ

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ットするのを試みるために（すなわちいくぶんランダムなやり方で）、分散されたチャネル・リソースを使用するのが有益である。

【００６７】

好ましくは、第２の数の集約制御チャネル要素を有する候補を周波数において分散させることは、第３の数の制御チャネル要素を有する部分上に前記候補をマッピングすることによって実施され、これらの部分はさらに、分散方式で周波数にマッピングされる。すなわち、少なくとも１つの物理リソース・ブロックによって相互から分離される。第３の数は、第２の数よりも小さい。特に、候補の制御チャネル要素は、周波数における、第２の数よりも小さい集約レベルの候補の位置に対応する部分に分散されてよい。例えば、集約レベル４または８の候補が複数の部分に分散されてよく、部分は、２つの隣接する物理リソース・ブロックにマッピングされる制御チャネル要素からなり、少なくとも１つのこのような部分は、それ自体で、集約レベル２の候補を構成することになり、または、このような各部分が、集約レベル２の候補を構成することにすらなる。しかし、これらの部分の分散は、より低いレベルの候補の位置にわたって実施する必要はない。周波数における任意の制御チャネル要素位置をとることができる。同じ位置を使用することは、候補をできるだけ少ない物理リソース・ブロック中にパックして、それにより、共有データ・チャネル送信に使用できない物理リソース・ブロックの量を最小限に抑える利益を有する。異なる位置を使用することは、異なる集約レベルの異なる候補の送信を、相互に影響を及ぼさずに可能にする利益を有する。すなわち、より低い集約レベルの候補の送信がより高い集約レベルの候補の送信をブロックせず、またその逆でもある。これらの部分を周波数ドメインにおいて相互からできる限り遠くに、かつ／または他の候補からできる限り遠くに分散させて、より高いダイバーシティを達成することが有利である。

【００６８】

別法として、候補は、周波数において少なくとも１つの物理リソース・ブロックによって相互から分離された物理リソース・ブロックにマッピングされる複数の単一制御チャネル要素に分散されてもよい。

【００６９】

第１の受信ノードに対する、第２の数の集約制御チャネル要素を有する分散された候補の位置は、第２の受信ノードに対する、第２の数の集約制御チャネル要素を有する分散された候補の位置とは異なることが有利である。これにより、受信ノード個別のシグナリングのためのリソースをブロックすることなく効率的なマッピングが可能になる。

【００７０】

本発明の一実施形態によれば、隣接周波数上で局所化されたより大きい数の集約制御チャネル要素を有する候補は、周波数において、より小さい数の集約制御チャネル要素を有する候補と重複せずに位置する。このような構成は、ブロッキングのない効率的なリソース利用を可能にするので、特に有利である。このことは、例えば、レベル１の候補の割当てがレベル２の候補の割当てをブロックするのではなく、両方の候補を同じまたは異なる受信ノードに割り当てることができることを意味する。

【００７１】

特に、本発明の一実施形態によれば、制御チャネル要素は物理リソース・ブロック上にマッピングされ、第４の数の物理リソース・ブロックはリソース・ブロック・グループを形成し、候補は、リソース・ブロック・グループの物理リソース・ブロックに含まれる制御チャネル要素にマッピングされる。より小さい数の制御チャネル要素を有する候補は、局所化され、リソース・ブロック・グループの最初の物理リソース・ブロックから始まるように、隣接（周波数において）する物理リソース・ブロック上にマッピングされる。より大きい数の集約制御チャネル要素を有する候補は、局所化され、リソース・ブロック・グループの最後の物理リソース・ブロックで終わるように、隣接する物理リソース・ブロック上にマッピングされる。リソース・ブロック・グループのサイズを超える数の集約制御チャネル要素を有する候補の場合、候補は、第１のリソース・ブロック・グループを完全に満たし、隣接する第２のリソース・ブロック・グループを少なくとも部分的に満たす

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。このようなマッピングは、異なる集約レベルの候補の重複を回避する可能性が高く、したがってリソース利用の点で効率的である。第４の数は、例えば２、３、または４とすることができる。しかし、一般に、任意の他の数もサポートすることができる。第４の数が１に等しいことは、物理リソース・ブロックが単独でリソース・ブロック・グループに対応することを意味する。

【００７２】

別法として、異なる集約レベルを有する候補の重複を回避するために、隣接する物理リソース・ブロック上で局所化されてマッピングされるより大きい数の集約制御チャネル要素を有する候補は、周波数において、より小さい数の集約制御チャネル要素を有する候補の位置に対してシフトした物理リソース・ブロック中に位置し、より小さい集約の候補はそれぞれ、隣接する物理リソース・ブロック上に局所化されてマッピングされる。特に、シフトは、候補が重複しないように十分であり、例えば、より小さい数の集約制御チャネル要素のサイズであってよい。このことは、より高いレベルの候補が、より低いレベルの候補の次の物理リソース・ブロック中で開始することを意味する。

【００７３】

好ましくは、受信ノードは中継ノードであり、送信ノードは、３ＧＰＰ　ＬＴＥ（－Ａ）ベースのシステムにおけるドナーｅＮｏｄｅＢであり、物理ダウンリンク制御チャネルは、時間ドメインにおける物理リソース・ブロック・インタリーブのない、Ｒ－ＰＤＣＣＨである。しかし、別法としてまたは追加で、通常の移動端末が、局所化された制御情報の送信からの利益を得るために、受信ノードとしての働きをしてもよい。

【００７４】

本発明の別の実施形態によれば、種々の受信ノードのより高いレベルの候補が、重複しない位置に分散される。第１の数の集約物理リソース・ブロックを有する局所化された候補の位置は、第１の受信ノードと第２の受信ノードとで同一であってよい。

【００７５】

本発明の別の態様によれば、コンピュータ可読プログラム・コードが組み入れられたコンピュータ可読媒体を含むコンピュータ・プログラム製品が提供される。プログラム・コードは、本発明を実施するように適合される。

【００７６】

本発明の上記および他の目的および特徴は、添付の図面と共に提供する後続の記述および好ましい実施形態から、より明らかになるであろう。

【図面の簡単な説明】

【００７７】

【図１】３ＧＰＰ　ＬＴＥリリース８で定義される、ダウンリンク・コンポーネント・キャリア上のサブフレームの一般構造を示す概略図である。

【図２】３ＧＰＰ　ＬＴＥリリース８で定義される、サブフレームの２つのダウンリンク・スロットのうちの１つの例示的なダウンリンク・コンポーネント・キャリアを示す概略図である。

【図３】３ＧＰＰ　ＬＴＥリリース８および３ＧＰＰ　ＬＴＥ－ａリリース１０で定義される、非ＭＢＳＦＮサブフレームとその物理リソース・ブロック対との構造を示す概略図である。

【図４】３ＧＰＰ　ＬＴＥリリース８および３ＧＰＰ　ＬＴＥ－Ａリリース１０で定義される、ＭＢＳＦＮサブフレームとその物理リソース・ブロック対との構造を示す概略図である。

【図５】ドナーｅＮｏｄｅＢ、中継ノード、および２つのユーザ機器を含む例示的なネットワーク構成の概略図である。

【図６】送信モードおよび受信モードにおける動作に関する、図３のドナーｅＮｏｄｅＢ、中継ノード、および２つのユーザ機器の例示的な挙動を示す概略図である。

【図７】３ＧＰＰ　ＬＴＥ－Ａリリース１０で使用される中継バックホール・ダウンリンク・サブフレーム構成の構造の例を示す概略図である。

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【図８】様々な集約レベルの候補を含むアップリンクおよびダウンリンク許可のための局所化探索空間の例を示す概略図である。
【図９】様々な集約レベルの候補を含むアップリンクおよびダウンリンク許可のための分散探索空間、ならびに分散マッピングの場合の仮想リソース・ブロックと物理リソース・ブロックとの間の関係の例を示す概略図である。
【図１０】本発明の一実施形態による、サイズ４のリソース・ブロック・グループで集約レベル１、２、および４の候補をマッピングする例を示す概略図である。
【図１１】候補がそれぞれのＲＢＧの終わりと整合された、種々のＲＧＢサイズの探索空間の例を示す概略図である。
【図１２】可能な場合にいくつかの候補がＲＢＧの始まりに対してシフトされた、種々のＲＧＢサイズの探索空間の例を示す概略図である。
【図１３】候補がそれぞれのグループの始まりおよび終わりに整合された、種々のＲＧＢサイズの探索空間の例を示す概略図である。
【図１４】本発明の一実施形態による方法の動作を示すフローチャートである。
【図１５】２つの中継ノードとドナーｅＮｏｄｅＢとを含むネットワークを示す概略図である。
【発明を実施するための形態】
【００７８】
以下の段落では、本発明の様々な実施形態について述べる。単に例示の目的で、実施形態のほとんどは、上記の背景技術セクションで論じた３ＧＰＰ　ＬＴＥ（リリース８）およびＬＴＥ－Ａ（リリース１０）移動通信システムに従うＯＦＤＭダウンリンク無線アクセス方式との関係で概説する。本発明は、例えば前述の３ＧＰＰ　ＬＴＥ（リリース８）およびＬＴＥ－Ａ（リリース１０）移動通信システムなどの移動通信システムとの関連で使用されるのが有利な場合があるが、本発明はこの特定の例示的な通信ネットワーク中での使用に限定されないことに留意されたい。本明細書に述べる本発明の態様はとりわけ、３ＧＰＰ　ＬＴＥ－Ａ（リリース１０）通信システム中で中継ノードやＵＥなどの受信側への割当ておよび許可を主に搬送するアップリンクおよびダウンリンク制御情報（Ｒ－ＰＤＣＣＨ）のための探索空間を定義すること、ならびに、Ｒ－ＰＤＣＣＨデータがダウンリンク探索空間（特に個々のリソース・ブロックおよびそれらのリソース・ブロック・グループ）にマッピングされる点で効果的なリソース利用を提供することのために、使用することができる。上記の背景技術セクションで提供した説明は、本明細書に述べる、主として３ＧＰＰ　ＬＴＥ（リリース８）およびＬＴＥ－Ａ（リリース１０）特有の例示的な実施形態をよりよく理解することを意図したものであり、移動通信ネットワークにおけるプロセスおよび機能に関して述べる具体的な実装形態に本発明を限定するものとして理解すべきではない。具体的には、静止したｅＮｏｄｅＢと静止した中継ノードとの間など、通信ネットワークの２つの非移動ノード間の通信に適用することができる。
【００７９】
一般に、本発明は、より低い集約レベルの局所化された候補と、より高い集約レベルの少なくとも１つの分散された候補とを含む探索空間構成を提供する。
【００８０】
特に、通信システムのサブフレーム内で少なくとも１つの受信ノードへの制御情報を搬送するためのチャネル構造は、次のとおりである。サブフレーム内の探索空間は、複数の制御チャネル要素によって形成される。探索空間は、少なくとも１つの受信ノードによるブラインド復号のための候補に論理的に細分される。各候補は、１つまたは複数の集約制御チャネル要素を含み、少なくとも１つの候補は、第１の数の集約制御チャネル要素を有し、これらの制御チャネル要素は、周波数ドメインにおいて相互に隣接してまたは非常に近接して送信される。別の少なくとも１つの候補は、第１の数よりも大きい第２の数の集約制御チャネルを有し、周波数において少なくとも部分的に分散された制御チャネル要素からなり、分散のレベルは、好ましくは、周波数ドメインにおけるおよそ２よりも多い送信単位である。送信単位は、例えば、ＰＲＢまたは制御チャネル要素である。ここで、分

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散レベルは、２つの候補部分の間の距離を意味する。

【００８１】

このような探索空間は、チャネルの品質が急変動することがあり信号が突然のフェーディング・ディップを被ることがある通信システムで、またはチャネルが周波数ドメインにおいて選択的だがチャネルに関する知識が不正確である場合に、特に有利である。これは、複数のキャリアを使用する移動および／または静的ノードを含むワイヤレス・システムに、特に当てはまる。この一例は、３ＧＰＰ　ＬＴＥベースのシステムであり、本発明はこのようなシステム中で容易に採用することができる。しかし、本発明はこのような種類のシステムに限定されず、複数のキャリアを含む任意の通信システム中で本発明を使用して、ブラインド復号すべき任意の情報のための探索空間を構成することができる。ブラインド復号すべき情報は、典型的には、ノードがさらに他の共有または個別制御リソースにアクセスするのを可能にする、制御情報である。

【００８２】

これらの点から見て、受信ノードは、このようなマルチキャリア通信システム中で制御情報を受信できる任意のノードとすることができる。例えば、受信ノードは、移動または固定である場合のあるユーザ端末とすることができる。このようなユーザ端末は、必ずしもそうとは限らないが、他の端末のための中継ノードとしての働きをすることができる。別法として、受信ノードは、別個の中継ノードとすることができる。このような中継ノードは、固定である場合もあり（例えば基地局のカバレッジを増大させるために）、または移動である場合もある。しかし、受信ノードはまた、基地局や他のネットワーク・ノードなど、他の任意のノードとすることができる。同様に、送信ノードは、任意のネットワーク・ノード、例えば基地局もしくは中継ノード、またはユーザ端末とすることができる。ＬＴＥのコンテキストでは、本発明の有利な一実施形態において、送信ノードはｅＮｏｄｅＢ、特にドナーｅＮｏｄｅＢであり、受信端末は中継ノードである。この実施形態は、Ｒ－ＰＤＣＣＨのための探索空間が今のところまだ標準化されていないので、特に有利である。しかし、本発明の別の実施形態では、送信ノードは中継ノードとすることができ、受信ノードはユーザ機器とすることができ、またはこの逆とすることができる。また、送信ノードと受信ノードの両方が、中継ノードまたはユーザ端末であってもよい。

【００８３】

制御情報に関しては、これは、受信ノードに向けた任意の制御情報とすることができる。特に、制御情報は、受信端末によるデータ送信または受信のための、個別または共有のさらなるリソースの位置を示すことができる。特に、制御情報は、ダウンリンクまたはアップリンク許可を含んでよい。別法として、制御情報は、電力制御のためのコマンド、または、チャネル・サウンディング信号の発信や通信チャネルもしくはサービスの非アクティブ化など、何らかの受信側アクションをトリガするためのコマンドを含んでよい。

【００８４】

一般に、探索空間は、ブラインド復号のための候補からなる。候補とは、このコンテキストでは、物理システム・リソースのサブセットである。制御情報を送信するための基本的なリソース要素は、制御チャネル要素である。各候補は、１つの制御チャネル要素、またはより多くの集約制御チャネル要素を含んでよい。制御チャネル要素は、特定の周波数範囲（マルチキャリア・システムの１つまたは複数のキャリア）に対応してよく、事前定義済みの継続時間を有してよい。ここで、制御チャネル要素は、制御情報の送信のためにアドレス可能な、最も小さい物理リソース部分を表す。ＬＴＥのコンテキストでは、制御チャネル要素は、例えばＣＣＥまたは物理リソース・ブロックとすることができ、図３の共通基準シンボル（ＣＲＳ）または復調基準シンボル（ＤＭ－ＲＳ）を搬送するリソース要素によって例示的に示されるような、基準シンボルなどの必須信号によって占められるリソース要素は例外である可能性がある。制御チャネル要素はさらに、図４に示すように、スロット内のＯＦＤＭシンボルのサブセットのみを含んでもよく、この場合、第１のスロットの第２の部分のみが、制御チャネル要素の搬送に使用可能である。

【００８５】

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本発明による探索空間は、局所化された候補と分散された候補との両方を含むように構成される。局所化された候補は、その制御チャネル要素が周波数ドメインにおいて相互に隣接して連続的に位置する候補である。分散された候補は、局所化されない。すなわち、これらの候補の制御チャネル要素は、周波数ドメインにおいて、同じ候補に属さない少なくとも１つの制御チャネル要素によって相互から分離されて位置する。候補の制御チャネル要素は、隣接しない単一制御チャネル要素（周波数において少なくとも１つの物理リソース・ブロックによって相互から分離された）にわたって分散されてよい。候補はまた、部分的に分散されてもよく、これは候補が、複数の隣接する制御チャネル要素の各部分に細分され、これらの部分はさらに周波数において分散されることを意味する。これらの部分は、そうである必要はないが同じサイズとすることができる。

【００８６】

移動通信システムが地球規模で展開されることは、可能な最も広いカバレッジを提供し高モビリティの端末をサポートするという要件をもたらした。これを容易にするために、中継ノードの概念が標準化された。アクセス・リンク（端末との間のリンク）と中継（バックホール）リンク（ｅＮｏｄｅＢなどのネットワーク・ノードとの間のリンク）とに共通の周波数帯域で動作する中継ノードは、コスト削減を含めた利点をもたらし、より容易に展開することができる。しかし前述のように、このような中継ノードは通常、時分割モードで動作し、これは、このような中継ノードが、中継アクセス・リンク上とバックホール・リンク上で同時にデータを交換することはできないことを意味する。したがって、中継ノードのリソースは、ネットワーク・ノードとの間、および端末との間で、データ送信および／または受信のために共有されなければならない。

【００８７】

本発明の例示的な一実施形態によれば、リソース割当てを搬送するチャネル、特に、バックホール・リンク上のおよびバックホール・リンクへのリソース割当てのシグナリングを搬送するチャネルのための、探索空間が提供される。探索空間は、時間および周波数リソースに関して定義された物理リソースを含み、これらの物理リソースは、アップリンクおよび／またはダウンリンク許可を搬送し、通常は中継ノードによってネットワーク・ノードから受信される。このような探索空間の構成は、再構成可能であることが有利であり、このことは、探索空間の位置を設定して、この位置をネットワーク・ノードから中継ノードにシグナリングすることができることを意味する。システムを効率的に維持するために、このようなシグナリングは、好ましくは、できるだけ低い帯域幅を必要とすべきである。

【００８８】

３ＧＰＰ　ＬＴＥでは、リソースは、物理リソース・ブロック（ＰＲＢ）で割り振ることができる。いくつかの制御チャネルの場合は、より一層小さいリソース部分を割り振ることができる。例えば、サブフレーム内のＰＤＣＣＨ制御チャネル領域は、制御チャネル要素（ＣＣＥ）のセットからなる。ＰＤＣＣＨは、１、２、４、または８個のＣＣＥを集約することができる。同様に、Ｒ－ＰＤＣＣＨは、集約レベル１、２、４、および８をおそらくサポートするであろう。集約は、ＣＣＥにわたるかまたは物理リソース・ブロックにわたる場合がある。以下では、物理リソース・ブロックの集約について例を述べる。しかし、これらの例は全て、物理リソースの単位としてのＣＣＥの集約にも適用可能である。

【００８９】

各中継ノードは、あらゆる非ＤＲＸサブフレーム中で、制御情報を求めて任意の集約レベルのＲ－ＰＤＣＣＨ候補のセットを監視する。監視とは、監視される全てのフォーマットに従ってセット中の各Ｒ－ＰＤＣＣＨを復号しようと試みること、すなわちブラインド復号を意味する。ブラインド復号は、http://www.3gpp.org/で自由に入手可能であり参照により本明細書に組み込まれる、非特許文献４に、ＰＤＣＣＨを受信するＵＥについて記述されている。ＵＥ特有のＰＤＣＣＨに関する現在の仕様によれば、探索空間は、集約レベル１および２の候補を６つ、ならびに集約レベル４および８の候補を２つ含むことがで

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きる。候補の数はまた、端末が実施しなければならないブラインド復号の回数も指定する。

【００９０】

図８に、同様の構成を仮定して、Ｒ－ＰＤＣＣＨの局所化探索空間構成の例を示す。

【００９１】

したがって、Ｒ－ＰＤＣＣＨ集約レベルＬのＲ－ＰＤＣＣＨ探索空間は、仮想リソース・ブロック（ＶＲＢ）インデックスのセット$\{n_{L,1}, n_{L,2}, \cdots, n_{L,M(L)}\}$およびＲ－ＰＤＣＣＨリソース割振りタイプ（分散または局所化ＶＲＢマッピング）によって構成される。構成は、例えばＲＲＣシグナリングによってシグナリングすることができる。ダウンリンク許可とアップリンク許可をそれぞれ搬送する第１と第２の両方のスロットに、同じ構成を適用可能である。このような局所化された探索空間の場合、ＶＲＢのインデックスは、ＰＲＢのインデックスと等しい。したがって、Ｌ個の連続するＰＲＢが、有効なＲ－ＰＤＣＣＨ候補を構成する。各集約レベルの各候補の開始位置が、ドナーｅＮｏｄｅＢから中継ノードにシグナリングされる。ＰＤＣＣＨ構成（例えば、http://www.3gpp.org/で入手可能であり参照により本明細書に組み込まれる、非特許文献５を参照されたい）と同様、図８では、集約レベル１および２については６つの候補、集約レベル４については２つの候補を仮定している。また、各集約レベルの候補のインデックスが、異なるハッチングで示されている。

【００９２】

図９に、ＶＲＢからＰＲＢへのマッピングがリリース８のＤＶＲＢマッピングの規則に従うと仮定して、Ｒ－ＰＤＣＣＨの分散探索空間構成の例を示す。ここでは、各集約レベル（ＡＬ）ごとに、上段はＶＲＢを示し、下段は対応するＰＲＢを示す。

【００９３】

図８に示す局所化探索空間中では、隣接するＰＲＢが集約される。しかし、このような局所化は、ＰＲＢがフェーディング・ディップにある場合、または、特により高い集約レベルに対して干渉がかなり増大する場合、または、送信ノードにおいてチャネルの知識が不正確である場合には、有害である。これは、集約レベル４や８などの高い集約レベルが各集約レベルにつき２つの候補しか有さないからである。これらの候補は、全ての候補が悪いチャネル条件に面している確率がより高いので、悪いチャネル条件の影響をより受ける。したがって、中継ノードがドナーｅＮｏｄｅＢへの接続を失う可能性すらあり、一方でその結果、中継ノードに帰属する端末が、ネットワークへのその接続を失う可能性がある。局所化探索空間のみの場合は種々の集約レベルの全ての候補が局所化方式でマッピングされるので、集約レベル４や８など、特により高い集約レベルについては、フェーディング・ディップまたは不正確なチャネル知識に対する頑強性が低減する。

【００９４】

さらに、図８でわかるように、集約レベル１、２、および４の候補の開始位置は重複する。このことは、集約レベル１のＲ－ＰＤＣＣＨにＰＲＢ＃０が使用される場合、別の中継ノードのための集約レベル２のＲ－ＰＤＣＣＨにはＰＲＢ＃０および＃１を使用することができないことを意味する。一般に、復調にＣＲＳを使用する非インタリーブドＲ－ＰＤＣＣＨの場合は、Ｒ－ＰＤＣＣＨによって占められるリソース・ブロック・グループ（ＲＢＧ）の数を削減するために、１つのＲＢＧ内でＲ－ＰＤＣＣＨを割り振る方がよい。しかし、種々の集約レベルの候補が重複するせいで、ＣＲＳ非インタリーブドＲ－ＰＤＣＣＨの場合に、Ｒ－ＰＤＣＣＨによって占められるＲＢＧの数を削減するために複数のＲ－ＰＤＣＣＨを１つのＲＢＧ中で効率的に割り振ることができない。

【００９５】

フェーディングまたは不正確なチャネル知識に対するより高い頑強性をもたらすために、本発明によれば、構成される局所化探索空間の場合に、より大きい（最も大きい）集約サイズのブラインド復号候補の少なくとも一部が、より低いレベルの集約サイズの候補にわたって分散される。より低いレベルの集約サイズは、レベル１および／または２であることが好ましい。分散は、レベル１および／または２について実施することができる。他

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のサイズの候補が使用可能にされるいくつかのシステムでは、分散は、３または４または５など、任意の集約レベルの候補にわたって実施することができる。

【００９６】

図１０では、最後の３つの列に、集約レベル４（ＡＬ４として示す）の候補のマッピングの例を示す。したがって、集約レベル４の最初の２つの候補は、周波数ドメインにおいて局所化され、リソース・ブロック・グループ＃１およびリソース・ブロック・グループ＃４にマッピングされる。第３の候補１０４０は、集約レベル１の候補にわたって分散される。この場合、第３の候補は、リソース・ブロック・グループ＃１、＃２、＃４、および＃６それぞれの、第１の物理リソース・ブロック中に分散される。第４の候補１０３０は、集約レベル２の候補にわたって分散される。特に、第４の候補は、２つの物理リソース・ブロックの各部分に分かれて、リソース・ブロック・グループ＃１およびリソース・ブロック・グループ＃５の終わりに位置する。このように、図１０の探索空間は、集約レベル４の第３および第４の候補によって形成される、探索空間の分散部分１０２０を含む。探索空間はさらに、集約レベル４の第１および第２の候補と、集約レベル２の６つの候補と、集約レベル１の別の６つの候補とによって形成される、局所化部分１０１０を含む。

【００９７】

図１０における第３および第４の候補を分散させる方式は、例に過ぎないことに留意されたい。レベル４の第３の候補は、別法として、他のレベル１の候補にわたって、例えばＲＢＧ＃３またはＲＢＧ＃３の第１の物理リソース・ブロックにわたって分散されてもよい。

【００９８】

別法として、分散は必ずしも、より低い集約レベルの候補にわたって実施しなければならないわけではない。一般に、レベル４の第３の候補は、ＲＢＧの任意の物理リソース・ブロック（制御チャネル要素）にわたって、さらにはＲＢＧ定義にかかわらず、分散させることができる。より高いレベルの候補を分散させることは、周波数選択性フェーディングに対するより高い頑強性をもたらす。したがって、より高いレベルの候補を、相互からできる限り離れた物理リソース・ブロックに分散させることが、特に有利である。

【００９９】

同様に、図１０におけるレベル４の第４の候補の２ＰＲＢの大きさの部分は、６つのＲＢＧのうちの任意のＲＢＧに分散させることができる。特に、これらの部分は、ＲＢＧ＃１とＲＢＧ＃６、またはＲＧＢ＃２とＲＧＢ＃６、またはいずれか他のＲＢＧ＃の組合せに配置することができる。しかし、これらの部分が相互から離れているほど、これらの部分の少なくとも一方がフェーディングにない確率が高い。また、同じ集約レベルの、かつ同じ受信ノードに対する、異なる候補を、できる限り異なる周波数上にマッピングすることも有利である。レベル４の第４の候補はまた、レベル２の候補位置にわたってマッピングする必要はない。第４の候補の各部分を、それぞれのグループの第２および第３の物理リソース・ブロックにマッピングすることによっても、同様の効果を達成することができる。これらの部分はまた、最初の２つの物理リソース・ブロックにマッピングしてもよい。

【０１００】

このように、図１０は、より低い集約レベル候補（レベル１、レベル２候補）が局所化され、より高い集約レベル候補（レベル４）が局所化および分散された、探索空間の例を示す。しかし、本発明はこれに限定されず、別法として、より高い集約レベルの全ての候補が分散されてもよい。別法として、単一の局所化されたレベル４候補と３つの分散されたレベル４候補、またはこの逆を利用してもよい。

【０１０１】

探索空間の特定の構成は、予想または仮定されるチャネル特性など、特定の展開シナリオに関して設計されるべきであることが有利であり、チャネル特性はさらに、受信側からのチャネル状態フィードバックに依存する可能性がある。チャネル特性は、送信／受信ノ

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ードが移動か静的か、それらの距離および位置などに依存するであろう。チャネル特性はさらに、使用される周波数帯域にも依存するであろう。当業者には理解されるであろうが、異なる展開シナリオおよびシステムでは、他の特定の構成がより適することがある。

【０１０２】

本発明は、制御情報のブラインド復号のための探索空間の構成を提供する。本発明の一実施形態によれば、このような探索空間は、通信システムの仕様において固定的に定義される。本発明の別の実施形態によれば、探索空間は、静的に構成可能であり、通信システムのブロードキャスト制御チャネル（複数可）に関するシステム情報内で受信することができる。本発明のさらに別の実施形態によれば、探索空間構成は、３ＧＰＰ　ＬＴＥにおける無線リソース制御（ＲＲＣ）プロトコル・シグナリングなど、より高いレイヤのシグナリングによって半静的に設定することができる。別法として、探索空間は、サブフレームについて動的に構成することができる。

【０１０３】

より高い集約レベルのいくつかの候補の分散とは別に、図１０はまた、本発明の別の有利な実施形態による、より低い集約レベルの候補の局所化マッピングも示している。したがって、異なる集約レベルの候補の重複が回避される。図１０では、これは、集約レベル１（ＡＬ１として示す）および２（ＡＬ２として示す）に例示されている。特に、集約レベル１の例示的な６つの候補は、各リソース・ブロック・グループの最初の物理リソース・ブロック中、すなわち物理リソース・ブロック０、４、８、１２、１６、および２０中に配置される。集約レベル２の例示的な６つの候補もまた、各リソース・ブロック・グループ中に配置される。しかし、集約レベル１の候補との重複を回避するために、集約レベル２の候補は、各リソース・ブロック・グループの最後の２つの物理リソース・ブロック上にマッピングされる。このように集約レベル１および集約レベル２の候補をリソース・ブロック・グループ上にマッピングすることで、探索空間をより効率的かつよりフレキシブルに定義することが可能になる。図８に関して述べた例とは対照的に、図１０の集約レベル２と集約レベル１の候補は、同じリソース・ブロック・グループにマッピングされていてもなお、異なる受信ノード（例えば中継ノード）に割り振ることができる。

【０１０４】

図１０の例全体は、局所化と分散の両方がなされた探索空間を例示する。特に、集約レベル１および２の候補は局所化され、集約レベル４の候補は分散および局所化される。図１０は、集約レベル４の候補を分散させる可能性を例示するに過ぎないことに留意されたい。他の組合せも可能であり、例えば、集約レベル４の全ての候補が、単一物理リソース・ブロックに、または複数のリソース・ブロックの各部分に分散されてもよい。別法として、集約レベル４の候補が２つしかなく、このうちの一方のみが、例えば集約レベル２の候補にわたって分散されることもあり得る。

【０１０５】

図１０では、異なる集約レベルの候補が、できるだけ少ない重複で、同じリソース・ブロック・グループ上にマッピングされる。３ＧＰＰ　ＬＴＥバックホール・リンクのコンテキストでは、集約レベル１と２のＲ－ＰＤＣＣＨ候補は、１つのリソース・ブロック・グループ内の異なる物理リソース・ブロック上にマッピングされる。この例では、リソース・ブロック・グループのサイズは、４つの物理リソース・ブロックに等しい。１つのリソース・ブロック・グループ内で、集約レベル１のＲ－ＰＤＣＣＨを、集約レベル２のＲ－ＰＤＣＣＨと多重化することができる。これは、複数の中継ノードが同じ探索空間を共有し、これらの中継ノードに対してＣＲＳ非インタリーブドＲ－ＰＤＣＣＨが構成されるときに、特に有用である。

【０１０６】

本発明のこの実施形態による探索空間は、いくつかの利益をもたらす。この概念によれば、より高い集約レベルの候補が分散され、より低い集約レベルの候補が局所化されるといった、局所化集約と分散集約との間の動的な切替えが可能である。このことは、チャネルが急に劣化した場合に接続を失うのを回避する助けとなり、受信側が初期帰属手続きに

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フォールバックするのを防止する（例えば、異なる物理リソース・ブロックを占めるように探索空間を再構成することができることにより、または、図８に示すような分散モード方法に変更することができることにより）。これは、バックホール・リンクの効率の向上、および、中継ノードに帰属する端末に対するよりよいサービスにつながる。さらに、集約レベル４および８の候補の頑強性が増大する。このことは、より高い集約レベルの候補の数がより少ない方式では、特に重要である。というのは、そのような場合は、このような候補がフェーディング・ディップにある確率がいくぶん高いからである。加えて、異なる集約レベルの候補間の重複を回避することにより、局所化されたより小さい集約サイズのブラインド復号候補間のブロッキングが防止され、物理リソース上への制御チャネルのより効率的なマッピングがもたらされる。前述の探索空間構成はまた、異なる集約レベルの候補を同じリソース・ブロック・グループ上にコンパクトにマッピングするので、探索空間およびＲ－ＰＤＣＣＨ割振りによって占められるリソース・ブロック・グループの数を最小限に抑える特性も維持する。

【０１０７】

図１１、１２、１３に、候補と、集約によってこれらの候補を構成する制御チャネル要素と、物理リソース・ブロックおよびＲＢＧサイズに関するこれらの候補の位置とを説明するための例を示す。全般的に、第１列は集約レベル１の候補を示し、その下の列は集約レベル２の候補を示し、その下の列は集約レベル４の候補を示し、その後に続く２つの列は集約レベル８の候補を示す。交互の白と灰色の背景によって、異なるＲＢＧを示す。

【０１０８】

図１１に、種々のサイズのリソース・ブロック・グループの場合に本発明を実施する他の例を示す。特に、図１１の部分（ａ）は、リソース・ブロック・グループのサイズが２物理リソース・ブロックに等しく、集約レベル１、２、４、および８の候補がそれらの物理リソース・ブロックにマッピングされる例を示す。集約レベル１の候補（例えば第１の候補１１０１など）は、各グループ中の最初の各物理リソース・ブロック上にマッピングされる。集約レベル１の候補は６つある。集約レベル２の６つの候補もまた、各リソース・ブロック・グループにマッピングされ、それにより、これらの候補は実際、集約レベル１の候補と重複する。しかし、６つのリソース・ブロック・グループしか必要としないコンパクトなマッピングを達成することができる。ＬＴＥのコンテキストでは、サイズ２のＲＢＧの場合の構成可能なＰＲＢ数は、１１～２６個の間のＰＲＢである。サイズ３のＲＢＧの場合は、２７～６３個のＰＲＢがある。サイズ４のＲＢＧの場合は、６４～１１０個のＰＲＢがある。可能な構成に関するこれ以上の詳細は、すでに上述した、非特許文献３に見ることができる。

【０１０９】

集約レベル４の２つの候補は、最初の４つのリソース・ブロック・グループ上にマッピングされ、各候補は２つのリソース・ブロック・グループをカバーする。最後に、集約レベル８の２つの候補は、次のようにマッピングされる。すなわち、第１の候補は局所化方式でマッピングされ、第２の候補は分散方式でマッピングされる。特に、集約レベル８の第１の候補は、最初の４つのリソース・ブロック・グループをカバーする。集約レベル８の第２の候補は、４物理リソース・ブロックの各部分にわたって分散される。この例では、第１の部分は、最初の２つのリソース・ブロック・グループをカバーし、第２の部分は、最後のリソース・ブロック・グループ５および６をカバーする。図１１、１２、および１３では、中に候補番号が書かれた破線の楕円として、候補を示す。楕円のサイズは、局所化された候補については、候補の集約レベルに対応する。分散された候補については、楕円は候補の各部分を示し、これらの部分は水平の線で接続される。例えば、図１１（ａ）は、下段の集約レベル８の第２の候補が２つの部分（それぞれ４制御チャネル要素のサイズ）を集約し、これらの部分が共に４ＰＲＢ離れて分散されるのを示す。

【０１１０】

図１１の部分（ｂ）には、リソース・ブロック・グループのサイズが３物理レイヤ・ブロックである例を示す。特に、集約レベル１の候補は、６つの各リソース・ブロック・グ

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ループの最初の物理リソース・ブロック上にマッピングされる。集約レベル２の候補は、各リソース・ブロック・グループの最後の２つの物理リソース・ブロックにマッピングされる。わかるように、このようなマッピングにより、集約レベル１の候補は、集約レベル２の候補と重複しない。集約レベル４の２つの候補は、リソース・ブロック・グループ自体よりも大きく、したがって、隣接する２つのリソース・グループにまたがってマッピングされる。特に、集約レベル４の第１の候補１１０２は、第１のリソース・ブロック・グループの最後の物理リソース・ブロック上と、第２のリソース・ブロック・グループの全ての物理リソース・ブロック上とにマッピングされる。集約レベル４の第２の候補も同様に、次の利用可能なリソース・ブロック・グループ＃３および＃４上にマッピングされる。集約レベル８の第１の候補も局所化され、レベル４の候補のマッピングと同様に、すなわち、第１の可能なリソース・ブロック・グループ＃３の終わりに整合させることによって、マッピングされる。レベル８候補はサイズ３のＲＢＧを３つ必要とするので、ＲＢＧ＃３が第１の可能なリソース・ブロック・グループであり、ＲＢＧ＃３の最後のＰＲＢへの整合が実施される。この場合、集約レベル８の第１の候補は、リソース・ブロック・グループ１、２、および３上にマッピングされ、リソース・ブロック・グループ３の最後と整合される。集約レベル８の第２の候補は、分散される。分散は、集約レベル２の候補にわたって実施される。特に、レベル８の候補の分散された２ＰＲＢの長さの各部分の位置は、集約レベル２の第１、第２、第５、および第６の候補の各位置上にマッピングされる。

【０１１１】

図１１の部分（ｃ）は、探索空間がサイズ４のリソース・ブロック・グループ上にマッピングされる例である。図１１の部分（ａ）および（ｂ）に関して述べた前の例と同様、集約レベル１の候補は、各リソース・ブロック・グループ中の最初の物理リソース・ブロックにマッピングされる。集約レベル２の候補（第１の候補１１０３など）は、各リソース・ブロック・グループの最後の２つの物理リソース・ブロックにマッピングされる。これらはＲＢＧの最後のＰＲＢで終わる。集約レベル４の２つの候補は、局所化され、第１の利用可能なリソース・ブロック・グループ、すなわちそれぞれリソース・ブロック・グループ＃１およびリソース・ブロック・グループ＃２上にマッピングされる。集約レベル８の１つの候補は、局所化され、第１の利用可能なリソース・ブロック・グループ上にマッピングされてグループの最後に整合される。したがって、この候補は、リソース・ブロック・グループ＃１および＃２をカバーする。集約レベル８の第２の候補は、集約レベル２の候補にわたって分散される。第２の候補の、分散された２ＰＲＢの大きさの各部分は、リソース・ブロック・グループ＃１、＃２、＃５、および＃６の最後の２つの物理リソース・ブロック上に位置する。

【０１１２】

このように、図１１は、集約レベル１の候補が各リソース・ブロック・グループの最初の物理リソース・ブロック中に位置する実施形態を示す。集約レベル１よりも高い集約レベルの候補は、リソース・ブロック・グループの終わりと整合される。物理リソース・ブロック・グループが、局所化される候補のサイズよりも小さい場合（例えば、集約レベル４の候補について図１１の部分（ａ）および（ｂ）を参照されたい）、候補は、複数のリソース・ブロック・グループをカバーすることになる。このような場合、候補は、カバーされる隣接グループのうちの最後グループの終わりに整合される。集約レベル８の１つの候補は、分散される。分散される候補の各部分もまた、リソース・ブロック・グループの終わりに整合される。すなわち、これらの部分は、レベル２の候補にわたって分散される。

【０１１３】

図１０との関連ですでに上に強調したように、図１１は、例示的な探索空間を提供するに過ぎない。この例では、集約レベル１の６つの候補、集約レベル２の６つの候補、集約レベル４および８についてはそれぞれ２つの候補を採用する。これは、例えばＬＴＥで使用される、典型的な構成である。しかし、本発明はこれに限定されない。集約レベルごと

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の候補の数は、システムの要件に従って選択することができる。さらに、候補に割り振られる基本リソースは、制御チャネル要素であってもよく、制御チャネル要素は、物理リソース・ブロックよりも小さいものとすることができる。この場合、制御チャネル要素の集約が実施される。本発明は、制御チャネル要素にも等しく適用することができる。さらに、基本リソース（物理リソース・ブロックまたは制御チャネル要素）は、必ずしも、物理リソース・ブロックのグループ、または対応する制御チャネル要素のグループにグループ化されなければならないわけではない。本発明の特定の手法、すなわち、より低い集約レベルの集中化された候補とより高いレベルの分散された候補とを含む制御空間は、こうしたどんなリソース・グループ化にも関係なく適用可能である。同様に、異なるレベルの候補間の重複を低減するための構成は、基礎をなすどんなリソース・ブロック・グループ化もなしに適用することができる。

【０１１４】

図１２に、ＲＢＧサイズ２（ａ）、３（ｂ）、および４（ｃ）について、本発明の代替の一実施形態を示す。したがって、集約レベル１の候補（ＲＢＧサイズ２が採用されるときの第１の候補１２０１など）は、図１１に関して述べた例と同様にマッピングされる。すなわち、これらの候補は、各リソース・ブロック・グループの最初の物理リソース・ブロック上にマッピングされる。集約レベル２の候補は、可能なら、集約レベル１の候補がマッピングされた物理リソース・ブロックに続く物理リソース・ブロックから始まるようにマッピングされる（ＲＢＧサイズ４の場合、レベル２の第１の候補１２０３を参照されたい）。これはまた、ＲＢＧの始まりから１ＰＲＢのシフトに対応する。この例では、集約レベル４の候補も、前の例と同様に、すなわち、それらの終わりをそれぞれのリソース・ブロック・グループの終わりに整合させることによって、マッピングされる（レベル４の第１の候補１２０２を参照されたい）。図１２では、１ＰＲＢのシフトが例示されている。しかし、本発明はこれに限定されず、より高い集約レベルの候補は、リソース・ブロック・グループの始まりから、または別の集約レベルの候補に対して、２つ以上の物理リソース・ブロック分シフトされてもよい。

【０１１５】

このような探索空間は、サイズ２および３のＲＢＧについては、図１１の例に関して述べた探索空間と違わない。しかし、サイズ４のリソース・ブロック・グループ中の集約レベル２の候補については、違いを見ることができる（図の部分（ｃ））。シフトは、ＲＢＧの始まりに対して定義することができる。別法として、シフトは、他の集約レベルの候補に対して、例えば最も近いより低い集約レベルに対して、定義することができる。

【０１１６】

別の実施形態は、図１３に示すような本発明による探索空間に関係するものである。したがって、集約レベル４の２つの候補が、異なるように整合される。レベル４の第１の候補１３０２は、ＲＢＧの第１のＰＲＢと整合され、第２の候補１３０３は、ＲＢＧの最後の利用可能なＰＲＢと整合される。この構成により、ブロックされるレベル１およびレベル２の候補の数のバランスをとることができる。特に、図１３は、前の例と同様、集約レベル１の候補（レベル１の第１の候補１３０１を参照されたい）が、各リソース・ブロック・グループの最初の物理リソース・ブロックにマッピングされ、集約レベル２の候補（レベル２の第１の候補１３０４を参照されたい）が、各リソース・ブロック・グループの最後の２つのリソース・ブロックにマッピングされるのを示す。同じより高い集約レベルの、異なる候補を、異なるように整合させることができる。リソース・ブロック・グループの始まりと終わりへの整合とは別に、ＲＢＧの始まりと終わりに対して定義されたシフトを適用することもできる。別法として、他の集約レベルの候補に対するシフトを適用することもできる。シフトは、同じ集約レベルの候補ごとに異なってよい。

【０１１７】

図１１、１２、および１３に関して述べた例では、より高い集約レベルの１つの候補が局所化され、同じレベルの１つの候補が分散される場合を示した。例示した、局所化および分散される集約レベルは、レベル８であった。しかし、本発明はこれに限定されない。

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複数の中継ノード（受信ノード）が同じ探索空間リソースを共有するのをよりよくサポートするために、より高い集約レベルについて、複数の分散される候補をサポートすることができる。さらに、集約レベル４の任意の候補が分散されてもよい。図１１、１２、および１３では、レベル１の候補が、常にＲＢＧ中の最初の制御チャネル要素／リソース・ブロック上にマッピングされるのを示した。しかし、レベル１の候補はまた、ＲＢＧ中の最後の制御チャネル要素／リソース・ブロックにマッピングされてもよい。そのような場合、レベル２の候補は、ＲＢＧ中の最初のＰＲＢで開始してよい。

【０１１８】

複数の中継ノードのサポートに関して、本発明の別の実施形態によれば、１つの受信ノードの、より高い集約レベルの分散された候補の位置は、別の受信ノードの、同じレベルの分散された候補の位置とは異なる（特に、直交する）。これは、例えば受信ノードＩＤに応じて実施することができる。

【０１１９】

例えば、３ＧＰＰ　ＬＴＥリリース８（および後のリリース）によれば、ＵＥは、通常動作中に、いわゆるＣ－ＲＮＴＩによって識別される。Ｃ－ＲＮＴＩは基本的に、１６ビットで表される値である。したがって、本発明における中継ノードＩＤ、または一般に受信側ＩＤを、同様のまたは同じ識別子によって識別できると仮定することができる。単純な一例では、このような識別子のビットの１つまたは複数は、より高い集約レベルの候補（複数可）の位置がシフトされるかどうか、および／または、物理リソース・ブロックでどれくらいシフトされるかを、決定する。例えば、中継ノードＩＤの最下位ビットは、このような候補（複数可）が１物理リソース・ブロック分シフトされる（ビット＝１）か、シフトされない（ビット＝０）かに使用される。

【０１２０】

最も高い集約レベルは、このようにして分散されることが好ましい。より小さい数の集約物理リソース・ブロックを有する局所化された候補の位置は、第１の受信ノードと第２の受信ノードとで同一であることが有利である。例えば、複数の受信ノードに対して、集約レベル１および２の候補は、同じ位置上にマッピングされてよく、集約レベル４および／または８の候補は、直交に分散される（すなわちこれらの候補の位置は異なる）。

【０１２１】

より高い集約レベルによってより低い集約レベルがブロックされること、およびその逆を低減するために、本発明の別の実施形態によれば、より高い集約レベルの候補は、制御チャネル要素からなり、少なくとも第１の制御チャネル要素の位置は、第１のより低い集約レベルの候補の制御チャネル要素の位置と同一であり、少なくとも第２の制御チャネル要素の位置は、第２のより低い集約レベルの候補の制御チャネル要素の位置と同一である。第１のより低い集約レベルのサイズは、第２のより低い集約レベルのサイズとは異なり、これらのサイズは両方とも、より高い集約レベルの集約レベル・サイズよりも小さい。例えば、より高い集約レベルの候補はＡＬ８の候補であり、この候補の第１の制御チャネル要素は、集約レベル１の候補の位置にマッピングされ、この候補の第２の制御チャネル要素の位置は、集約レベル２の候補の制御チャネル要素のいずれかの位置にマッピングされる。さらに他の例では、より高い集約レベルの候補はＡＬ８の候補であり、この候補の第１の制御チャネル要素は、集約レベル１の１つの候補の位置にマッピングされ、この候補の第２および第３の制御チャネル要素の位置は、集約レベル２の１つの候補の位置にマッピングされる。

【０１２２】

集約レベルのブロッキングを低減するために、別の実施形態によれば、分散集約の制御チャネル要素は、ＲＢＧ中のＰＲＢにマッピングされ、少なくとも１つのＰＲＢは、より低いレベルの集約候補に属するどんな制御チャネル要素にも使用されない。例えば、図１３（ｃ）によれば、サイズ４の各ＲＢＧ内の第２のＰＲＢは、集約レベル１および２のための制御チャネル要素によって使用されることはないことがわかる。したがって、このような４つのＰＲＢを使用して、集約レベル４および／または８の分散された候補を形成す

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ることができる。このようなＰＲＢを使用してまた、集約レベル８の分散された候補を形成することもできる。このようにして、より低い集約レベル（複数可）の候補によってすでに部分的に占められているＲＢＧ内で残っているＰＲＢを、より高い集約レベル（複数可）の候補にさらに利用することができる。

【０１２３】

前述のマッピング規則に従うときに配慮され得る１つの問題は、リソース・ブロックで表されるシステム帯域幅が、定義されたＲＢＧサイズの整数倍でない場合に、システム帯域幅の一方の端で半端なＲＢＧが存在する場合があることである。あるいは、小さいＲＢＧサイズの場合には特に、ＲＢＧサイズが集約レベルよりも小さいことが起こり得る。したがって、Ｒ－ＰＤＣＣＨ候補をＲＢＧ上にマッピングするとき、これらのことを考慮に入れるべきである。例えば、図１１（ｂ）では、レベル４の第１の候補を、第１のＲＢＧの第３のＰＲＢ上で終わるようにマッピングすることができない。というのは、そうした場合、候補の第１の制御チャネル要素は使用可能ＰＲＢにマッピングすることができないからである。最も単純な解決法は、半端なＲＢＧがブラインド復号のための候補または制御チャネル要素を搬送できることを不可にすることである。別の解決法は、前述の規則により候補の始まりまたは終わりが利用可能ＰＲＢの外にあることになる場合に、全ての制御チャネル要素をＰＲＢ上にマッピングできるようにそれぞれの候補がシフトされることである。したがって、例えば図１１（ｂ）では、規則に対する例外は、レベル４の第１の候補が第３のＰＲＢで開始して第６のＰＲＢで終了するのではなく、その代わりに第１のＰＲＢで開始して第４のＰＲＢで終了するものとすることができる。

【０１２４】

本発明の有利な一実施形態によれば、受信ノードは中継ノードであり、送信ノードはｅＮｏｄｅＢであり、制御情報は、前述のように構成されたＲ－ＰＤＣＣＨ探索空間を介して通信されるアップリンク／ダウンリンク許可である。図１４に、このような受信ノードおよび送信ノードによって実施されるステップを示す。

【０１２５】

図１４で、実線は本発明の一実施形態を表すが、この実施形態では、送信ノードが、受信ノードによって復号されることになる制御情報を、探索空間上にマッピングする（１４３０）。ここで、探索空間は、上記の例のいずれかに従って構成される。特に、サブフレームがリソース単位に細分され、探索空間を定義する候補のセットから制御情報がブラインド復号される。候補は、制御チャネル要素または物理リソース・ブロックなど、複数のリソース単位を集約することができる。周波数ドメインにおける探索空間は、局所化された候補と分散された候補とを含む。特に、周波数において、より低い集約レベルの候補は局所化され、より高い集約レベルの候補は分散される。送信側は、特定の受信ノードに対する候補上に制御情報をマッピングし、これを相応に送信する（１４４０）。受信ノードは、構成された探索空間の候補をブラインド復号し（１４８０）、復号した候補から制御情報を得る（１４８０）。制御情報はさらに、その目的に従って処理される。

【０１２６】

前述のように、探索空間は一般に、固定的、静的、半静的、または動的に構成することができる。図１４中の破線は本発明の一実施形態を示すが、この実施形態によれば、送信ノードはまず、探索空間構成（すなわち、特定の受信ノードによって監視されることになる、制御情報および／または候補を搬送する制御チャネルのマッピングに利用可能なリソース）を選択する（１４１０）。次いで、選択された構成は、受信ノードにシグナリングされる（１４２０）。受信ノードは、探索空間構成の指示を受信し（１４５０）、監視（ブラインド復号）すべき探索空間を相応に設定する（１４６０）。一般に、受信ノードが送信ノードの代わりに探索空間を構成することもできる。

【０１２７】

特に、上に論じたＬＴＥ実施形態に鑑みれば、送信ノードはドナーｅＮｏｄｅＢ５１０とすることができ、受信ノードは中継ノード５２０である。監視するために特定の中継ノードに割り当てられる候補の点から見た探索空間構成は、動的に実施することができる。

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Ｒ－ＰＤＣＣＨを搬送するのに利用可能なリソースの点から見た探索空間構成は、半静的に（例えばＲＲＣによって）構成されるかまたは固定的とすることができる。

【０１２８】

図１５に、同じドナーｅＮｏｄｅＢによってサービスされる２つの中継ノードを含む例示的なネットワークを示す。本発明は、探索空間がリソースを種々の中継ノードに効率的に割り当てることができるので、より多くの中継ノードがある場合に特に有利である。

【０１２９】

しかし、本発明、および探索空間を構成する上記の実施形態は、ユーザ機器など、他のノードにも等しく適用可能である。

【０１３０】

要約すると、本発明は、マルチキャリア通信システムにおけるブラインド復号のために探索空間内で制御情報を提供することに関する。特に、制御情報は、通信システムのサブフレーム内で搬送され、サブフレームは、複数の制御チャネル要素を含む。制御チャネル要素を、ブラインド復号のための候補に集約することができる。候補中の制御チャネル要素の数は、集約レベルと呼ばれる。本発明によれば、より低い集約レベルの候補は局所化され、これは１つの候補の制御チャネル要素が、周波数ドメインにおいて相互に隣接して位置することを意味する。より高い集約レベル（複数可）のいくつかの候補は、周波数において分散される。

【０１３１】

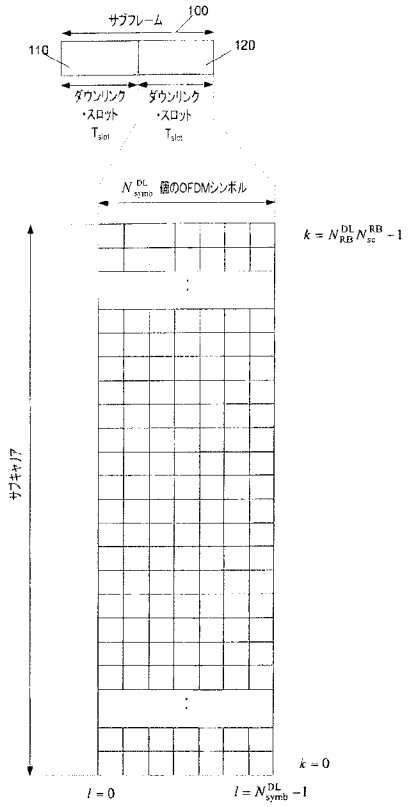
さらに、本発明の様々な実施形態はまた、プロセッサによって実行されるソフトウェア・モジュールを用いて、またはハードウェア中で直接に、実現することができる。ソフトウェア・モジュールとハードウェア実装の組合せもまた可能である。ソフトウェア・モジュールは、任意の種類のコンピュータ可読記憶媒体、例えばＲＡＭ、ＥＰＲＯＭ、ＥＥＰＲＯＭ、フラッシュ・メモリ、レジスタ、ハード・ディスク、ＣＤ－ＲＯＭ、ＤＶＤなどに記憶することができる。

【０１３２】

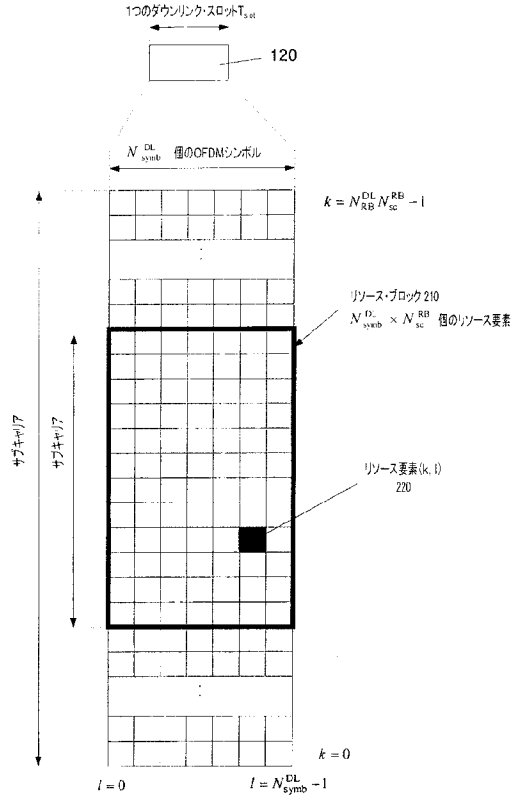
実施形態のほとんどは、通信システムの３ＧＰＰベースのアーキテクチャとの関係で概説した。また、以上のセクションで使用した用語は主に、３ＧＰＰ用語に関係する。しかし、３ＧＰＰベースのアーキテクチャに関する用語および様々な実施形態の記述は、本発明の原理および発想をそのようなシステムのみに限定するものとはしない。また、上記の背景技術セクションで提供した詳細な説明は、本明細書に述べる、主として３ＧＰＰ特有の例示的な実施形態をよりよく理解することを意図したものであり、移動通信ネットワークにおけるプロセスおよび機能に関して述べる具体的な実装形態に本発明を限定するものとして理解すべきではない。しかし、本明細書で提案する概念およびサブフレーム構造は、背景技術セクションで述べたアーキテクチャにおいて容易に適用することができる。さらに、本発明の概念はまた、３ＧＰＰによって現在論じられているＬＴＥ－Ａ　ＲＡＮにおいても容易に使用することができる。

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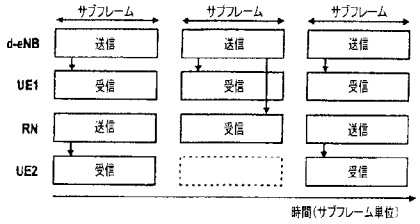
【図１】



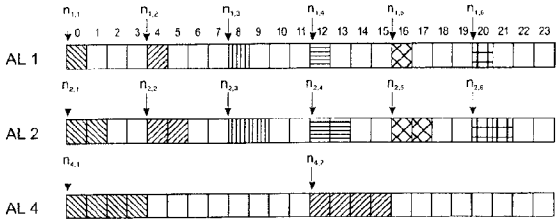
【図２】



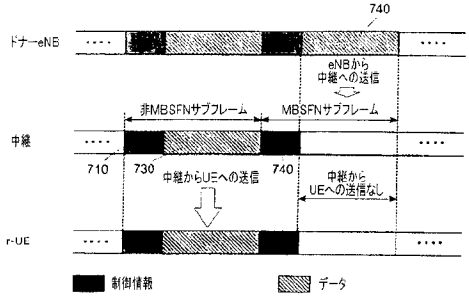
【図６】



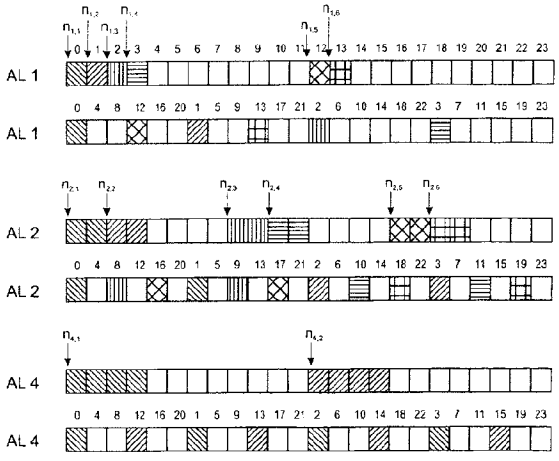
【図８】



【図７】

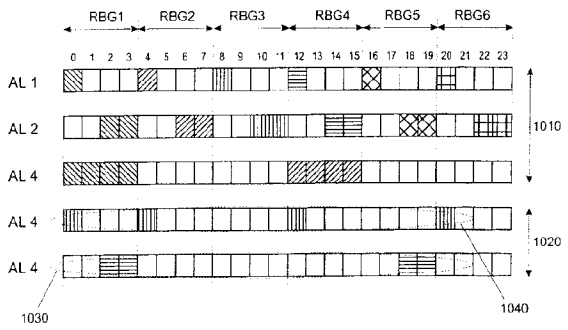


【図９】

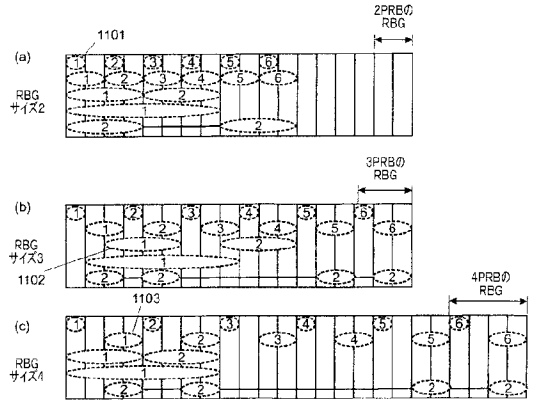


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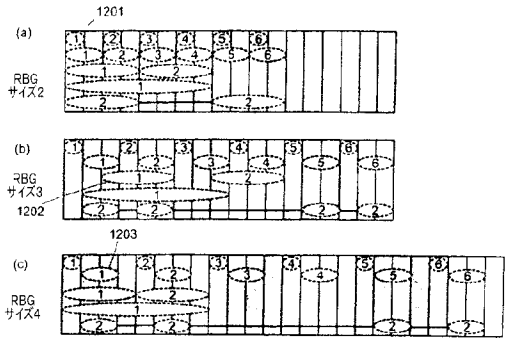
【図１０】



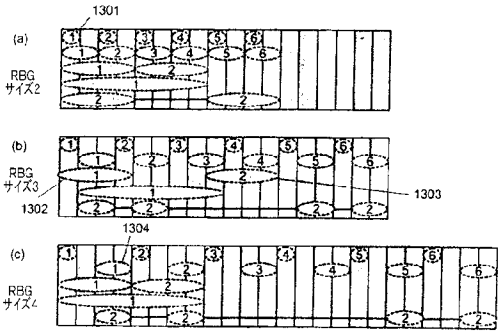
【図１１】



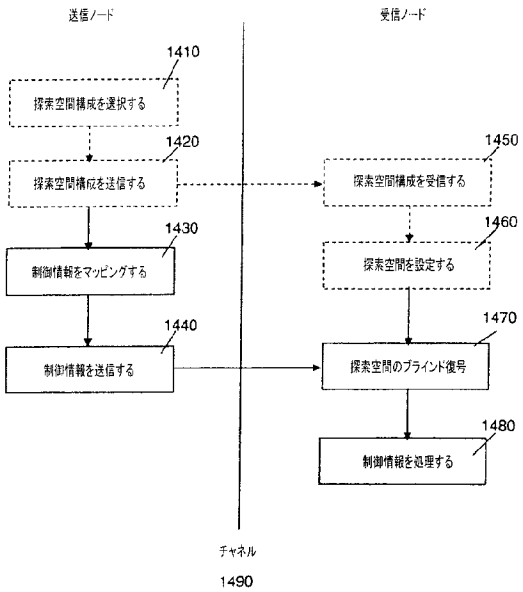
【図１２】



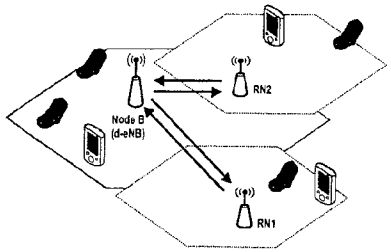
【図１３】



【図１４】

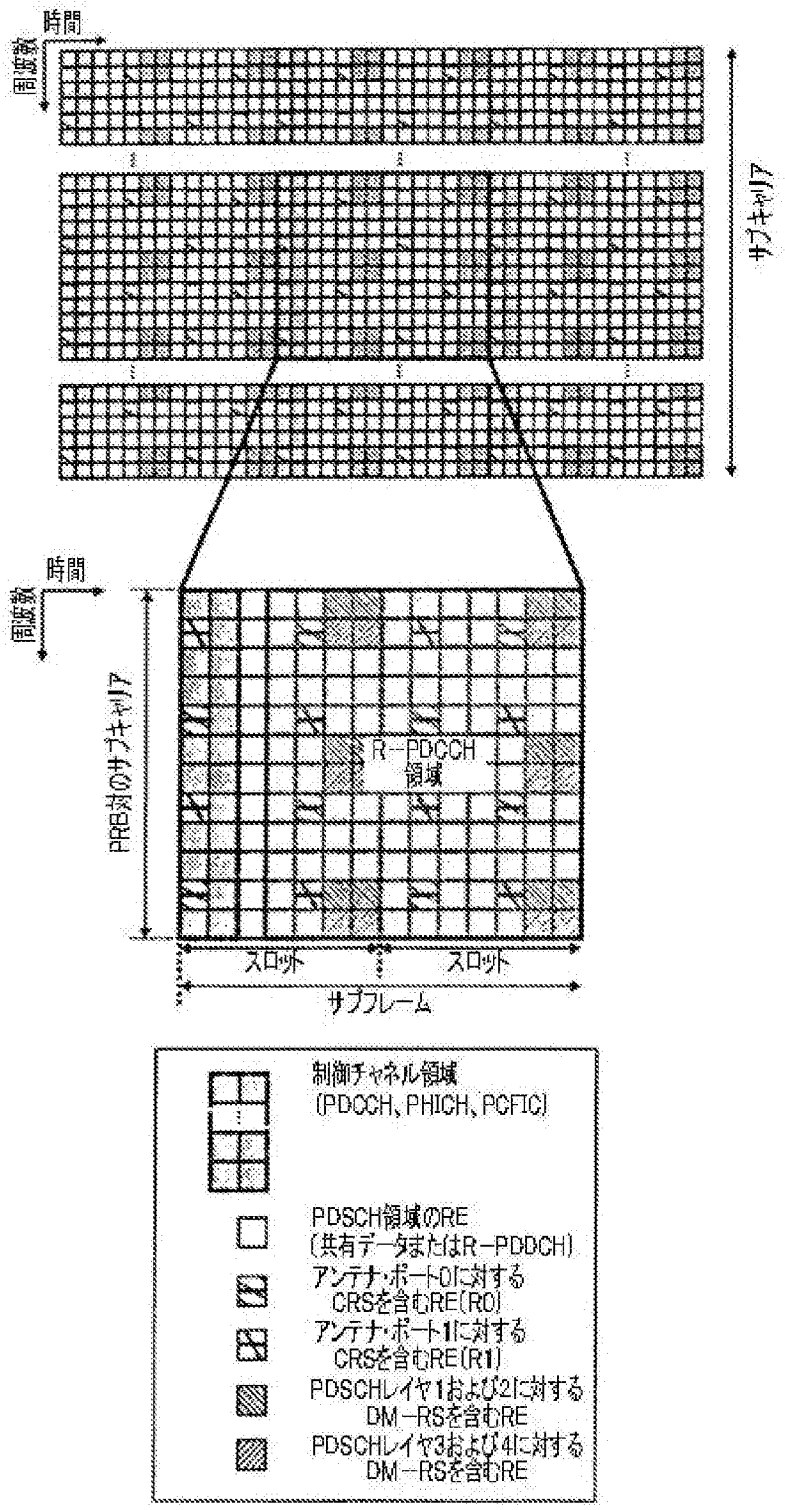


【図１５】

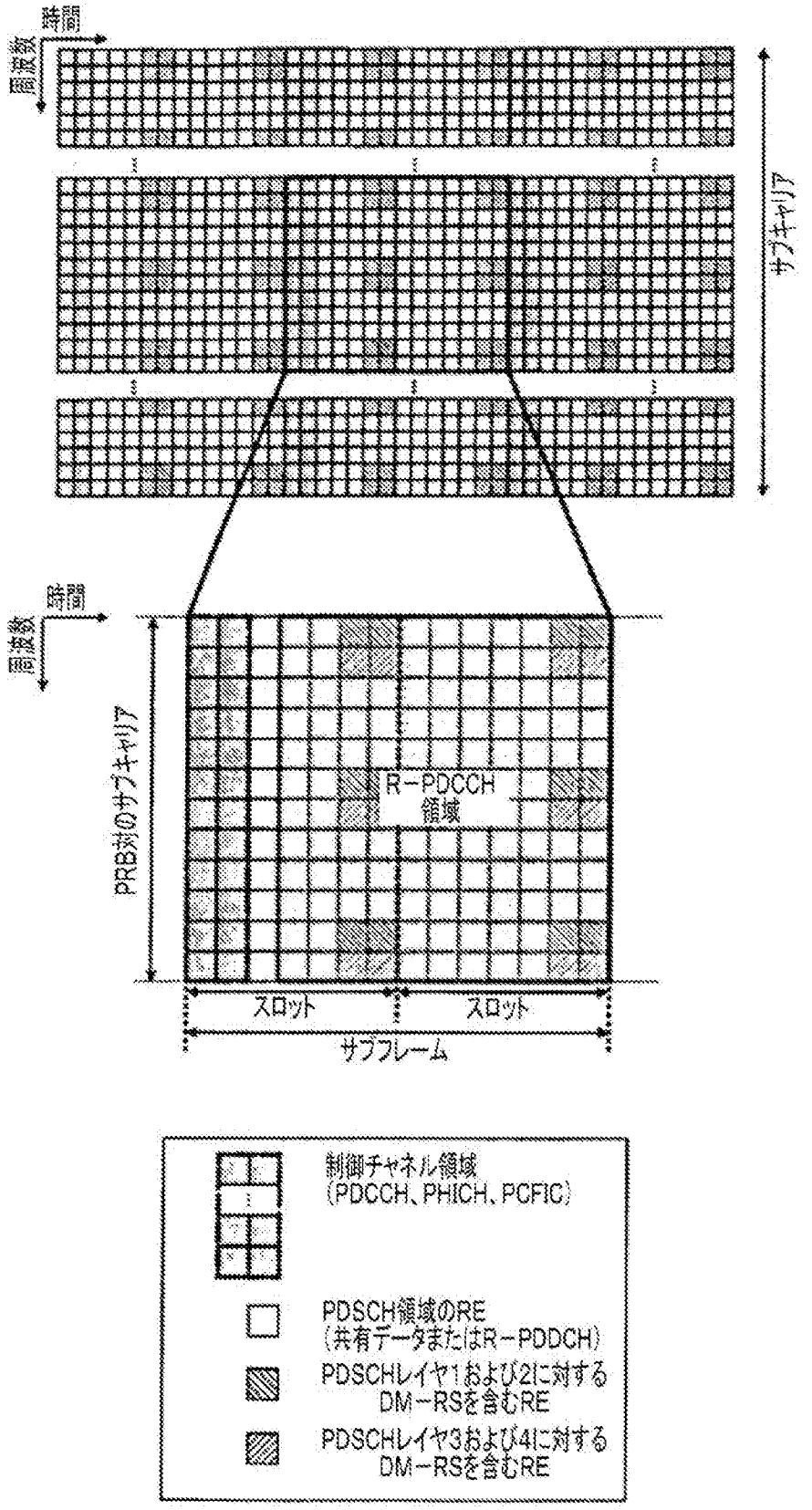


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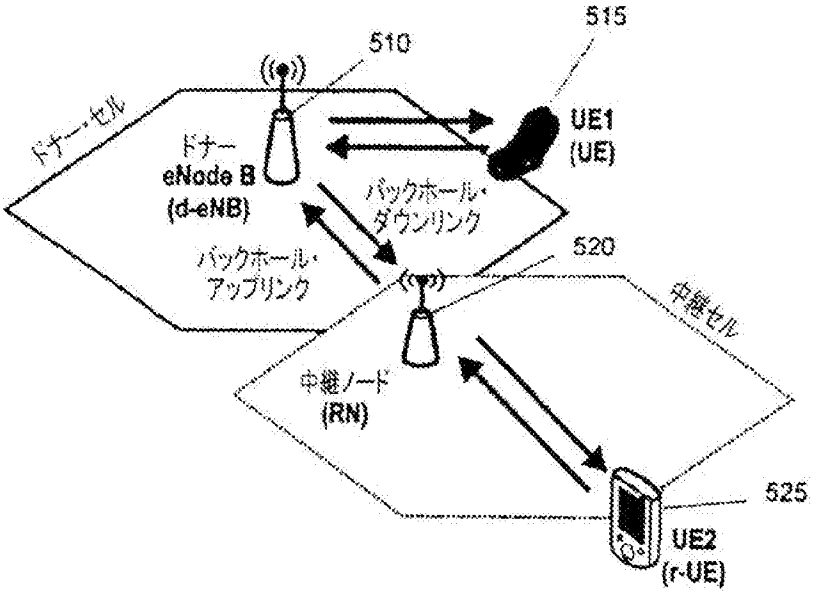
【図３】


時間
周波数
サブキャリア
時間
周波数
PRB対のサブキャリア
R-PDCCH
領域
スロット
スロット
サブフレーム
制御チャネル領域
(PDCCH、PHICH、PCFIC)
PDSCH領域のRE
(共有データまたはR-PDDCH)
アンテナ・ポート0に対する
CRSを含むRE(R0)
アンテナ・ポート1に対する
CRSを含むRE(R1)
PDSCHレイヤ1および2に対する
DM-RSを含むRE
PDSCHレイヤ3および4に対する
DM-RSを含むRE

【図４】


時間
周波数
サブキャリア
時間
周波数
PRB対のサブキャリア
R-PDCCH
領域
スロット
スロット
サブフレーム
制御チャネル領域
(PDCCH、PHICH、PCFIC)
PDSCH領域のRE
(共有データまたはR-PDDCH)
PDSCHレイヤ1および2に対する
DM-RSを含むRE
PDSCHレイヤ3および4に対する
DM-RSを含むRE

【図５】


515
510
ドナーセル
ドナー
eNode B
(d-eNB)
UE1
(UE)
バックホール・
ダウンリンク
バックホール・
アップリンク
520
中継セル
中継ノード
(RN)
525
UE2
(r-UE)

フロントページの続き

(72)発明者　ゴリチェク　エドラー　フォン　エルプバルト　アレクサンダー
ドイツ国　６３２２５　ランゲン　モンツァストラッセ　４ｃ　パナソニックＲ＆Ｄセンター　ジャーマニー　ゲーエムベーハー内
(72)発明者　フェン　スジャン
ドイツ国　６３２２５　ランゲン　モンツァストラッセ　４ｃ　パナソニックＲ＆Ｄセンター　ジャーマニー　ゲーエムベーハー内
(72)発明者　ヴェンゲルター　クリスティアン
ドイツ国　６３２２５　ランゲン　モンツァストラッセ　４ｃ　パナソニックＲ＆Ｄセンター　ジャーマニー　ゲーエムベーハー内
(72)発明者　鈴木　秀俊
大阪府門真市大字門真１００６番地　パナソニック株式会社内

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Customer Number:	106622
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Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-283.101
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Information:					
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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

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PTO/SB/08a (03-15)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16241368
Filing Date	2019-01-07
First Named Inventor	Chun-Wei Huang
Art Unit	2415
Examiner Name	Jeffrey M. Rutkowski
Attorney Docket Number	1426-283.101

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					

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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
	1					

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FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

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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]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16241368
	Filing Date	2019-01-07
	First Named Inventor	Chun-Wei Huang
	Art Unit	2415
	Examiner Name	Jeffrey M. Rutkowski
	Attorney Docket Number	1426-283.101

	1	3GPP TSG RAN WG1 Meeting #91 R1-1719387 Reno, USA, November 27th – December 1st 2017, Section 2.1.2.1、2.1.2.3、2.2.1、2.2.2、Appendix A	☐
	2	3GPP TSG RAN WG1 Meeting #90 R1-1712441 Prague, Czechia, 21st – 25th August 2017, Section1、2.1	☐
	3	3GPP TS 38.213 V15.0.0; Technical Specification Group Radio Access Network; NR; Physical layer procedures for control (Release 15) 2018-01-03 Table13-1，Chapter13	☐
	4	Office Action from Taiwan Patent Office in corresponding TW Application No. 108100603, dated November 11, 2019.	☐

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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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.

Petitioners' Exhibit 1010, p. 306
AT&T et al v. Asustek Computer
IPR2024-00992

Electronic Acknowledgement Receipt

EFS ID:	37742415
Application Number:	16241368
International Application Number:	
Confirmation Number:	6576
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Chun-Wei Huang
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-283.101
Receipt Date:	13-NOV-2019
Filing Date:	07-JAN-2019
Time Stamp:	16:05:36
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)	1426-283-101--IDSasFiled11132019.pdf	56202 23d24fde6025d60cb621749b07dfd5ed5322ecd4	no	2

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2	Non Patent Literature	R1-1719387.pdf	511288 592e2d089f7b1a7a1cb2038695051ffb62c825b0	no	14
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Information:					
3	Non Patent Literature	R1-1712441.pdf	81890 a184ecef73331f5f1300277640f0fe449c6eb907	no	6
Warnings:					
Information:					
4	Non Patent Literature	NPL-3GPP38213.pdf	603769 aaf5ffa8c2aad94e6119961d36f029dd789c1f05	no	56
Warnings:					
Information:					
5	Non Patent Literature	NPL--TWOfficeAction.pdf	631825 5d6249ab6f8d3d7b26d6c93f53b4930aca782cac	no	15
Warnings:					
Information:					
		Total Files Size (in bytes):	1884974		

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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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United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/241,368	01/07/2019	Chun-Wei Huang	1426-283.101

CONFIRMATION NO. 6576

106622
Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

PUBLICATION NOTICE

OC00000109742418

Title:METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM

Publication No.US-2019-0222357-A1
Publication Date:07/18/2019

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 Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, 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 https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

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Petitioners' Exhibit 1010, p. 309
AT&T et al v. Asustek Computer
IPR2024-00992

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
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 contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16241368
Filing Date	2019-01-07
First Named Inventor	Chun-Wei Huang
Art Unit	2464
Examiner Name	Ricky Quoc Ngo
Attorney Docket Number	1426-283.101

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
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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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FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

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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]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16241368
	Filing Date	2019-01-07
	First Named Inventor	Chun-Wei Huang
	Art Unit	2464
	Examiner Name	Ricky Quoc Ngo
	Attorney Docket Number	1426-283.101

	1	PP0: "Text proposal for search space", 3GPP DRAFT; R1-1800495, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ;FRANCE vol. RAN WG1, no. Vancouver, Canada; 20180122 - 20180126 12 January 2018.	☐
	2	INTERDIGITAL INC: "On Remaining Details of Minimum System Information Delivery", 3GPP DRAFT; R1-1720623, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ;FRANCE vol. RAN WG1, no. Reno, USA; 20171127 - 20171101 18 November 2017 (2017-11-18).	☐
	3	European Search Report from EP Patent Office in corresponding EP Application No. 19150466.1, dated June 24, 2019.	☐

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Examiner Signature		Date Considered	

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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.

Electronic Acknowledgement Receipt

EFS ID:	36453811
Application Number:	16241368
International Application Number:	
Confirmation Number:	6576
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Chun-Wei Huang
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-283.101
Receipt Date:	28-JUN-2019
Filing Date:	07-JAN-2019
Time Stamp:	19:33:23
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)	1426-283-101--IDSasFiled06282019.pdf	56262 2c1ace8618dd39b5192c3486e158320cabed6e5b	no	2

Warnings:

Information:					
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2	Non Patent Literature	NPL-R1-1800495.pdf	763801 dfbde0a7f3cea5c4848347026db3012f2cb9dc29	no	4
Warnings:					
Information:					
3	Non Patent Literature	NPLL-R1-1720623.pdf	1008885 bf79cf2d5b26f7c1e900fa9e213b116035d82315	no	4
Warnings:					
Information:					
4	Non Patent Literature	NPL-EPSearchReport.pdf	1994185 a566ba3667adc2129a0fc454abf4279b40cfa4b5	no	8
Warnings:					
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		Total Files Size (in bytes):	3823133		

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 16/241,368

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	300
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	660
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	760
TOTAL CLAIMS (37 CFR 1.16(i))	24 minus 20 =	* 4			OR	x 100 =	400
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*				x 460 =	0.00
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).						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	2120

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	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
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	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/241,368	01/07/2019	2827	2120	1426-283.101	24	3

CONFIRMATION NO. 6576

106622
Blue Capital Law Firm, P.C.
650 Town Center Drive, Suite 1530
Costa Mesa, CA 92626

FILING RECEIPT

OC000000105514119

Date Mailed: 02/01/2019

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**

Inventor(s)

Chun-Wei Huang, Taipei City, TAIWAN;
Ko-Chiang Lin, Taipei City, TAIWAN;

Applicant(s)

ASUSTek Computer Inc., Taipei City, TAIWAN;

Power of Attorney: The patent practitioners associated with Customer Number 106622

Domestic Priority data as claimed by applicant

This appln claims benefit of 62/619,041 01/18/2018

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 01/31/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/241,368**

Petitioners' Exhibit 1010, p. 315
AT&T et al v. Asustek Computer
IPR2024-00992

Projected Publication Date: 07/18/2019

Non-Publication Request: No

Early Publication Request: No

Title

METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM

Preliminary Class

365

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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.

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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 (1-866-999-4258).

Petitioners' Exhibit 1010, p. 316
AT&T et al v. Asustek Computer
IPR2024-00992

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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).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

Petitioners' Exhibit 1010, p. 317
AT&T et al v. Asustek Computer
IPR2024-00992

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82A (07-13)
Approved for use through 01/31/2018. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	Not Yet Assigned
Filing Date	January 7, 2019
First Named Inventor	Chun-Wei Huang
Title	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM
Art Unit	Not Yet Assigned
Examiner Name	Not Yet Assigned
Attorney Docket Number	1426-283.101

SIGNATURE of Applicant or Patent Practitioner

Signature	/Sang N. Dang/	Date (Optional)	January 7, 2019
Name	Sang N. Dang	Registration Number	51,186
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ *Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.131, 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.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82B (07-13)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 106622

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☑ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	MING-HSIU HSU	Date (Optional)	Aug. 26, 2015
Name	MING-HSIU HSU		
Title	Director of ASUSTek Computer Inc.		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ Total of forms are submitted.

This collection of information is required by 37 CFR 1.131, 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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Chun-Wei Huang and Ko-Chiang Lin	
Title:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM	
Serial No.:	TBD	Filed: Herewith
Examiner:	TBD	Group Art Unit: TBD
Attorney Docket No.:	1426-283.101 (1070028-US)	

CERTIFICATE OF EFS-WEB TRANSMISSION
UNDER 37 CFR § 1.8

I hereby certify that the enclosed 1 Page Utility Transmittal Sheet; 1 Page Fee Transmittal; 8 Page Application Data Sheet Web-ADS; 64 Page Specification; 7 Page Drawings; 2 Page executed Declaration; 2 Page Information Disclosure Statement by Applicant; and 2 Page Power of Attorney are being transmitted to the United States Patent and Trademark Office via EFS-Web January 7, 2019.

Date: January 7, 2019 /Sandy Kim/
Sandy Kim

Mailing Address:

BLUE CAPITAL LAW FIRM, P.C. (Customer No.: 106622)
650 Town Center Drive, Suite 1530
Costa Mesa, California 92626
Tel: 714-839-3800
Fax: 714-795-2995

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Chun-Wei Huang
Filer:	Sang N. Dang/Sandy Kim
Attorney Docket Number:	1426-283.101

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	300	300
UTILITY SEARCH FEE	1111	1	660	660
UTILITY EXAMINATION FEE	1311	1	760	760
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	1202	4	100	400
Miscellaneous-Filing:				
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**2120**

Electronic Acknowledgement Receipt

EFS ID:	34779273
Application Number:	16241368
International Application Number:	
Confirmation Number:	6576
Title of Invention:	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM
First Named Inventor/Applicant Name:	Chun-Wei Huang
Customer Number:	106622
Filer:	Sang N. Dang/Sandy Kim
Filer Authorized By:	Sang N. Dang
Attorney Docket Number:	1426-283.101
Receipt Date:	07-JAN-2019
Filing Date:	
Time Stamp:	15:55:35
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$2120
RAM confirmation Number	010819INTEFSW15560100
Deposit Account	
Authorized User	

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

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	WebADS.pdf	126199 21dfa6b990920d72a1ec8a4b8ba35fcff064e7ce	no	8
Warnings:					
Information:					
2		1426-283-101--PackageAsFiled.pdf	1535416 8207a7c8b9193d3fa10238cc66923715ed33fa6e	yes	80

Multipart Description/PDF files in .zip description

Document Description	Start	End
Transmittal of New Application	1	1
Fee Worksheet (SB06)	2	2
Specification	3	61
Claims	62	65
Abstract	66	66
Drawings-only black and white line drawings	67	73
Oath or Declaration filed	74	75
Information Disclosure Statement (IDS) Form (SB08)	76	77
Power of Attorney	78	79
Miscellaneous Incoming Letter	80	80

Warnings:

Information:

3	Fee Worksheet (SB06)	fee-info.pdf	36543 7cb79ecab6bf01990131dc0a1bbee5b145c1e05f	no	2

Warnings:	
Information:	
Total Files Size (in bytes):	1698158

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.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1426-283.101
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION 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.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

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.)

Inventor Information:

Inventor 1

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Chun-Wei		Huang	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Taipei City	Country of Residence i	TW

Mailing Address of Inventor:

Address 1	No. 15, Lite Rd., Peitou District		
Address 2			
City	Taipei City 112	State/Province	OT
Postal Code		Country i	TW

Inventor 2

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Ko-Chiang		Lin	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Taipei City	Country of Residence i	TW

Mailing Address of Inventor:

Address 1	No. 15, Lite Rd., Peitou District		
Address 2			
City	Taipei City 112	State/Province	OT
Postal Code		Country i	TW

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

Petitioners' Exhibit 1010, p. 326
AT&T et al v. Asustek Computer
IPR2024-00992

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1426-283.101
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM	

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	106622		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM		
Attorney Docket Number	1426-283.101	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	7	**Suggested Figure for Publication (if any)**	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

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).
Either enter 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.

Petitioners' Exhibit 1010, p. 327
AT&T et al v. Asustek Computer
IPR2024-00992

PTO/AIA/14 (08-15)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1426-283.101
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM	

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	106622		

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix	
					Remove
Registration Number					
Prefix	**Given Name**	Middle Name	**Family Name**	Suffix	
					Remove
Registration Number					

Additional Representative Information blocks may be generated within this form by selecting the **Add** button.

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim 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.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Claims benefit of provisional	62/619041	2018-01-18

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 priority to a foreign application. 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. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Number	Country	Filing Date (YYYY-MM-DD)	Access Code (if applicable)

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

Petitioners' Exhibit 1010, p. 328
AT&T et al v. Asustek Computer
IPR2024-00992

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1426-283.101
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM	

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. 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 contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1426-283.101
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

Petitioners' Exhibit 1010, p. 330
AT&T et al v. Asustek Computer
IPR2024-00992

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. 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 contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1426-283.101
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM	

Applicant Information:

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

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

◉ Assignee	○ Legal Representative under 35 U.S.C. 117	○ Joint Inventor
○ Person to whom the inventor is obligated to assign.	○ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:	

If the Applicant is an Organization check here. ☒

Organization Name	ASUSTek Computer Inc.

Mailing Address Information For Applicant:

Address 1	No. 15, Lite Rd., Peitou District		
Address 2			
City	Taipei City 112	**State/Province**	OT
Country[i]	TW	Postal Code	
Phone Number		Fax Number	
Email Address			

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

PTO/AIA/14 (08-15)
Approved for use through 04/30/2017. 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 contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1426-283.101
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM	

Assignee Information including Non-Applicant Assignee Information:

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

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1426-283.101
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	2019-01-07
First Named Inventor	Huang, Chun-Wei
Art Unit	
Examiner Name	
Attorney Docket Number	1426-283.101

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	9462582		2014-10-16	Sujuan Feng	

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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
	1	20180123759		2018-05-03	ZHANG MENG	
	2	20180049203		2018-02-15	XUE PENG	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2019-01-07
	First Named Inventor	Huang, Chun-Wei
	Art Unit	
	Examiner Name	
	Attorney Docket Number	1426-283.101

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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.

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METHOD AND APPARATUS FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the benefit of U.S. Provisional Patent Application Serial No. 62/619,041 filed on January 18, 2018, the entire disclosure of which is incorporated herein in its entirety by reference.

FIELD

[0002] This disclosure generally relates to wireless communication networks, and more particularly, to a method and apparatus for providing control resource set configuration in a wireless communication system.

BACKGROUND

[0003] With the rapid rise in demand for communication of large amounts of data to and from mobile communication devices, traditional mobile voice communication networks are evolving into networks that communicate with Internet Protocol (IP) data packets. Such IP data packet communication can provide users of mobile communication devices with voice over IP, multimedia, multicast and on-demand communication services.

[0004] An exemplary network structure is an Evolved Universal Terrestrial Radio Access Network (E-UTRAN). The E-UTRAN system can provide high data throughput in order to realize the above-noted voice over IP and multimedia services. A new radio technology for the next generation (e.g., 5G) is currently being discussed by the 3GPP standards organization. Accordingly, changes to the current body of 3GPP standard are currently being submitted and considered to evolve and finalize the 3GPP standard.

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SUMMARY

[0005] Methods and apparatuses for providing control resource set configuration in a wireless communication system are disclosed herein. In one method, a network node transmits a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map. The network node is not allowed to transmit the signal such that an interval between two bit positions in the set in the bit map is smaller than a second duration.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. 1 shows a diagram of a wireless communication system according to one exemplary embodiment.

[0007] FIG. 2 is a block diagram of a transmitter system (also known as access network) and a receiver system (also known as user equipment or UE) according to one exemplary embodiment.

[0008] FIG. 3 is a functional block diagram of a communication system according to one exemplary embodiment.

[0009] FIG. 4 is a functional block diagram of the program code of FIG. 3 according to one exemplary embodiment.

[0010] FIG. 5 is a reproduction of Table 7.3.2.1-1 taken from 3GPP 3GPP R1-1721341.

[0011] FIG. 6 is a reproduction of Table 10.1-1 from 3GPP R1-1721343.

[0012] FIG. 7 is a flow diagram for one exemplary embodiment from the perspective of a network node.

[0013] FIG. 8 is a flow diagram for one exemplary embodiment from the perspective of a network node.

DETAILED DESCRIPTION

[0014] The exemplary wireless communication systems and devices described below employ a wireless communication system, supporting a broadcast service. Wireless

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communication systems are widely deployed to provide various types of communication such as voice, data, and so on. These systems may be based on code division multiple access (CDMA), time division multiple access (TDMA), orthogonal frequency division multiple access (OFDMA), 3GPP LTE (Long Term Evolution) wireless access, 3GPP LTE-A or LTE-Advanced (Long Term Evolution Advanced), 3GPP2 UMB (Ultra Mobile Broadband), WiMax, or some other modulation techniques.

[0015] In particular, the exemplary wireless communication systems devices described below may be designed to support one or more standards such as the standard offered by a consortium named "3rd Generation Partnership Project" referred to herein as 3GPP, including: Final Chairman's Note of 3GPP TSG RAN WG1 Meeting #89; Final Report of 3GPP TSG RAN WG1 #AH_NR2 v1.0.0; Final Chairman's Note of 3GPP TSG RAN WG1 Meeting #AH_NR3; Final Chairman's Note of 3GPP TSG RAN WG1 Meeting #90bis; Final Chairman's Note of 3GPP TSG RAN WG1 Meeting #91; R1-1721341, "NR; Physical channels and modulation (Release 15)"; R1-1721343, "NR; Physical layer procedures for control (Release 15)"; and TS 38.331, "NR; Radio Resource Control (RRC); Protocol specification (Release 15)". The standards and documents listed above are hereby expressly incorporated by reference in their entirety.

[0016] FIG. 1 shows a multiple access wireless communication system according to one embodiment of the invention. An access network 100 (AN) includes multiple antenna groups, one including 104 and 106, another including 108 and 110, and an additional including 112 and 114. In FIG. 1, only two antennas are shown for each antenna group, however, more or fewer antennas may be utilized for each antenna group. Access terminal 116 (AT) is in communication with antennas 112 and 114, where antennas 112 and 114 transmit information to access terminal 116 over forward link 120 and receive information from access terminal 116 over reverse link 118. Access terminal (AT) 122 is in communication with antennas 106 and 108, where antennas 106 and 108 transmit information to access terminal (AT) 122 over forward link 126 and receive information from access terminal (AT) 122 over reverse link 124. In a FDD system, communication links 118, 120, 124 and 126 may use different frequency for communication. For example, forward link 120 may use a different frequency then that used by reverse link 118.

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[0017] Each group of antennas and/or the area in which they are designed to communicate is often referred to as a sector of the access network. In the embodiment, antenna groups each are designed to communicate to access terminals in a sector of the areas covered by access network 100.

[0018] In communication over forward links 120 and 126, the transmitting antennas of access network 100 may utilize beamforming in order to improve the signal-to-noise ratio of forward links for the different access terminals 116 and 122. Also, an access network using beamforming to transmit to access terminals scattered randomly through its coverage causes less interference to access terminals in neighboring cells than an access network transmitting through a single antenna to all its access terminals.

[0019] An access network (AN) may be a fixed station or base station used for communicating with the terminals and may also be referred to as an access point, a Node B, a base station, an enhanced base station, an evolved Node B (eNB), or some other terminology. An access terminal (AT) may also be called user equipment (UE), a wireless communication device, terminal, access terminal or some other terminology.

[0020] FIG. 2 is a simplified block diagram of an embodiment of a transmitter system 210 (also known as the access network) and a receiver system 250 (also known as access terminal (AT) or user equipment (UE) in a MIMO system 200. At the transmitter system 210, traffic data for a number of data streams is provided from a data source 212 to a transmit (TX) data processor 214.

[0021] In one embodiment, each data stream is transmitted over a respective transmit antenna. TX data processor 214 formats, codes, and interleaves the traffic data for each data stream based on a particular coding scheme selected for that data stream to provide coded data.

[0022] The coded data for each data stream may be multiplexed with pilot data using OFDM techniques. The pilot data is typically a known data pattern that is processed in a known manner and may be used at the receiver system to estimate the channel response. The multiplexed pilot and coded data for each data stream is then modulated (i.e., symbol mapped) based on a particular modulation scheme (e.g., BPSK, QPSK, M-PSK, or M-QAM) selected for

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that data stream to provide modulation symbols. The data rate, coding, and modulation for each data stream may be determined by instructions performed by processor 230.

[0023] The modulation symbols for all data streams are then provided to a TX MIMO processor 220, which may 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 certain 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.

[0024] 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. N_T modulated signals from transmitters 222a through 222t are then transmitted from N_T antennas 224a through 224t, respectively.

[0025] At receiver system 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 received signal, digitizes the conditioned signal to provide samples, and further processes the samples to provide a corresponding "received" symbol stream.

[0026] An RX data processor 260 then receives and processes 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. The RX data processor 260 then demodulates, deinterleaves, and decodes 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 transmitter system 210.

[0027] A processor 270 periodically determines which pre-coding matrix to use (discussed below). Processor 270 formulates a reverse link message comprising a matrix index portion and a rank value portion.

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[0028] The reverse link message may comprise various types of information regarding the communication link and/or the received data stream. The reverse link message is then 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 transmitter system 210.

[0029] At transmitter system 210, the modulated signals from receiver system 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 reserve link message transmitted by the receiver system 250. Processor 230 then determines which pre-coding matrix to use for determining the beamforming weights then processes the extracted message.

[0030] Turning to FIG. 3, this figure shows an alternative simplified functional block diagram of a communication device according to one embodiment of the invention. As shown in FIG. 3, the communication device 300 in a wireless communication system can be utilized for realizing the UEs (or ATs) 116 and 122 in FIG. 1 or the base station (or AN) 100 in FIG. 1, and the wireless communications system is preferably the LTE system. The communication device 300 may include an input device 302, an output device 304, a control circuit 306, a central processing unit (CPU) 308, a memory 310, a program code 312, and a transceiver 314. The control circuit 306 executes the program code 312 in the memory 310 through the CPU 308, thereby controlling an operation of the communications device 300. The communications device 300 can receive signals input by a user through the input device 302, such as a keyboard or keypad, and can output images and sounds through the output device 304, such as a monitor or speakers. The transceiver 314 is used to receive and transmit wireless signals, delivering received signals to the control circuit 306, and outputting signals generated by the control circuit 306 wirelessly. The communication device 300 in a wireless communication system can also be utilized for realizing the AN 100 in FIG. 1.

[0031] FIG. 4 is a simplified block diagram of the program code 312 shown in FIG. 3 in accordance with one embodiment of the invention. In this embodiment, the program code 312 includes an application layer 400, a Layer 3 portion 402, and a Layer 2 portion 404, and is coupled to a Layer 1 portion 406. The Layer 3 portion 402 generally performs radio resource

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control. The Layer 2 portion 404 generally performs link control. The Layer 1 portion 406 generally performs physical connections.

[0032] In the Final Chairman's Note of 3GPP TSG RAN WG1 Meeting #90bis, the following agreements and working assumptions were reached:

Agreements:

- One set of the following parameters determines a set of search spaces
  - A set of aggregation levels
  - The number of PDCCH candidates for each aggregation level
  - PDCCH monitoring occasion for the set of search spaces

Agreements:

- At least for cases other than initial access, to identify a set of search spaces, following parameters are configured by UE-specific RRC signaling:
  - The number of PDCCH candidates for each aggregation level of {1, 2, 4, 8, [16]}
    - One value from {0, 1, 2, 3, 4, 5, 6, 8}
  - PDCCH monitoring occasion for the set of search spaces
    - One value of from {1-slot, 2-slot, [5-slot], [10-slot], [20-slot]} (at least 5 values)
    - One or more value(s) from 1st symbol, 2nd symbol, …, 14th symbol within a monitored slot
  - Each set of search spaces associates with a CORESET configuration by RRC signaling

Update after email approval:

Agreements:

- For PDCCH monitoring occasion of 1-slot, 2-slot, [5-slot], [10-slot], and [20-slot],
  - Slot-level offset value for PDCCH monitoring occasion is also supported.
    - For N-slot monitoring occasion, the offset is one from [0, N-1].
  - Note: symbol-level bit map of monitoring occasion within a slot agreed at RAN1#90bis is still available.

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[0033] In 3GPP R1-1721341, some configurations of the PDCCH structure are quoted below:

7.3.2 Physical downlink control channel (PDCCH)

7.3.2.1 Control-channel element (CCE)

A physical downlink control channel consists of one or more control-channel elements (CCEs) as indicated in Table 7.3.2.1-1.

FIG. 5 (a reproduction of Table 7.3.2.1-1 taken from 3GPP R1-1721341).

7.3.2.2 Control-resource set (CORESET)

A control-resource set consists of $N_{RB}^{CORESET}$ resource blocks in the frequency domain, given by the higher-layer parameter *CORESET-freq-dom*, and $N_{symb}^{CORESET} \in \{1,2,3\}$ symbols in the time domain, given by the higher-layer parameter *CORESET-time-dur*, where $N_{symb}^{CORESET} = 3$ is supported only if higher-layer parameter *DL-DMRS-typeA-pos* equals 3.

A control-channel element consists of 6 resource-element groups (REGs) where a resource-element group equals one resource block during one OFDM symbol. Resource-element groups within a control-resource set are numbered in increasing order in a time-first manner, starting with 0 for the first OFDM symbol and the lowest-numbered resource block in the control resource set.

A UE can be configured with multiple control-resource sets. Each control-resource set is associated with one CCE-to-REG mapping only.

The CCE-to-REG mapping for a control-resource set can be interleaved or non-interleaved, configured by the higher-layer parameter *CORESET-CCE-REG-mapping-type*, and is described by REG bundles:

- REG bundle i is defined as REGs $\{iL, iL+1, ..., iL+L-1\}$ where L is the REG bundle size, $i = 0,1,..., N_{REG}^{CORESET}/L-1$, and $N_{REG}^{CORESET} = N_{RB}^{CORESET} N_{symb}^{CORESET}$ is the number of REGs in the CORESET

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- CCE j consists of REG bundles $\{f(6j/L), f(6j/L+1),..., f(6j/L+6/L-1)\}$ where $f(\cdot)$ is an interleaver

For non-interleaved CCE-to-REG mapping, $L=6$ and $f(j)=j$

For interleaved CCE-to-REG mapping, $L\in\{2,6\}$ for $N_{\text{symb}}^{\text{CORESET}}=1$ and $L\in\{N_{\text{symb}}^{\text{CORSET}},6\}$ for $N_{\text{symb}}^{\text{CORESET}}\in\{2,3\}$ where L is configured by the higher-layer parameter *CORESET-REG-bundle-size*. The interleaver is defined by

$$\begin{aligned} f(j) &= (rC+c+n_{\text{shift}}) \bmod \left(N_{\text{REG}}^{\text{CORESET}}/L\right) \\ j &= cR+r \\ r &= 0,1,..., R-1 \\ c &= 0,1,..., C-1 \\ C &= \left\lceil N_{\text{REG}}^{\text{CORESET}}/(LR)\right\rceil \end{aligned}$$

where $R\in\{2,3,6\}$ is given by the higher-layer parameter *CORESET-interleaver-size* and where

- n_{shift} is a function of $N_{\text{ID}}^{\text{cell}}$ for a PDCCH transmitted in a CORESET configured by the PBCH or RMSI
- $n_{\text{shift}}\in\{0,1,...,274\}$ is a function of the higher-layer parameter *CORESET-shift-index*.

The UE may assume

- the same precoding in the frequency domain being used within a REG bundle if the higher-layer parameter *CORESET-precoder-granularity* equals *CORESET-REG-bundle-size*
- the same precoding in the frequency domain being used across the all resource-element groups within the set of contiguous resource blocks in the CORESET if the higher-layer parameter *CORESET-precoder-granularity* equals the size of the CORESET in the frequency domain

For a CORESET configured by PBCH, $L=6$.

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7.3.2.3 Scrambling

The UE shall assume the block of bits $b(0),...,b(M_{\text{bit}}-1)$, where M_{bit} is the number of bits transmitted on the physical channel, is scrambled prior to modulation, resulting in a block of scrambled bits $\tilde{b}(0),...,\tilde{b}(M_{\text{bit}}-1)$ according to

$$\tilde{b}(i) = \left(b(i) + c(i)\right) \bmod 2$$

where the scrambling sequence $c(i)$ is given by clause 5.2.1.

7.3.2.4 PDCCH modulation

The UE shall assume the block of bits $\tilde{b}(0),...,\tilde{b}(M_{\text{bit}}-1)$ to be QPSK modulated as described in clause 5.1.3, resulting in a block of complex-valued modulation symbols $d(0),...,d(M_{\text{symb}}-1)$.

7.3.2.5 Mapping to physical resources

The UE shall assume the block of complex-valued symbols $d(0),...,d(M_{\text{symb}}-1)$ to be scaled by a factor β_{PDCCH} and mapped to resource elements $(k,l)_{p,\mu}$ in increasing order of first k, then l, in the resource-element groups used for the monitored PDCCH.

7.4.1.3 Demodulation reference signals for PDCCH

7.4.1.3.1 Sequence generation

The UE shall assume the reference-signal sequence $r(m)$ is defined by

$$r(m) = \frac{1}{\sqrt{2}}\left(1-2\cdot c(2m)\right) + j\frac{1}{\sqrt{2}}\left(1-2\cdot c(2m+1)\right).$$

where the pseudo-random sequence $c(i)$ is defined in clause 5.2.1.

7.4.1.3.2 Mapping to physical resources

The UE shall assume the sequence $r(m)$ is mapped to physical resource elements according to

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$$a_{k,l}^{(p,\mu)} = \beta_{\text{DMRS}} \cdot r(3n + k')$$
$$k = N_{\text{sc}}^{\text{RB}} \left\lfloor n / N_{\text{symb}}^{\text{CORESET}} \right\rfloor + 4k' + 1$$
$$k' = 0,1,2$$
$$l = n \bmod N_{\text{symb}}^{\text{CORESET}}$$
$$n = 0,1,...$$

where the following conditions are fulfilled

- they are within the resource element groups constituting the PDCCH the UE attempts to decode if the higher-layer parameter *CORESET-precoder-granularity* equals *CORESET-REG-bundle-size*,
- all resource-element groups within the set of contiguous resource blocks in the CORESET where the UE attempts to decode the PDCCH if the higher-layer parameter *CORESET-precoder-granularity* equals the size of the CORESET in the frequency domain.

The reference point for k is

- subcarrier 0 of the lowest-numbered common resource block in the CORESET if the CORESET is configured by the PBCH or RMSI,
- subcarrier 0 in common resource block 0 otherwise

The reference point for l is the first OFDM symbol fo the CORESET.

A UE not attempting to detect a PDCCH in a CORESET shall not make any assumptions on the presence or absence of DM-RS in the CORESET.

In absence of CSI-RS or TRS configuration, and unless otherwise configured, the UE may assume PDCCH DM-RS and SS/PBCH block to be quasi co-located with respect to Doppler shift, Doppler spread, average delay, delay spread, and spatial Rx.

[0034] A CORESET can be configured with an association between the DMRS antenna port of receiving the CORESET and one or more than one reference signal(s). In 3GPP R1-1721343, the following quotation specifies the UE procedure for receiving control information.

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10 UE procedure for receiving control information

If the UE is configured with a SCG, the UE shall apply the procedures described in this clause for both MCG and SCG

- When the procedures are applied for MCG, the terms 'secondary cell', 'secondary cells' , 'serving cell', 'serving cells' in this clause refer to secondary cell, secondary cells, serving cell, serving cells belonging to the MCG respectively.
- When the procedures are applied for SCG, the terms 'secondary cell', 'secondary cells', 'serving cell', 'serving cells' in this clause refer to secondary cell, secondary cells (not including PSCell), serving cell, serving cells belonging to the SCG respectively. The term 'primary cell' in this clause refers to the PSCell of the SCG.

A UE shall monitor a set of PDCCH candidates in one or more control resource sets on the active DL BWP on each activated serving cell according to corresponding search spaces where monitoring implies decoding each PDCCH candidate according to the monitored DCI formats.

A UE can be configured by higher layer parameter *SSB-periodicity-serving-cell* a periodicity of half frames for transmission of SS/PBCH blocks in a serving cell. If the UE has received *SSB-transmitted-SIB1* and has not received *SSB-transmitted* and if REs for a PDCCH reception overlap with REs corresponding to SS/PBCH block indexes indicated by *SSB-transmitted-SIB1*, the UE receives the PDCCH by excluding REs corresponding to SS/PBCH block indexes indicated by *SSB-transmitted-SIB1*. If a UE has received *SSB-transmitted* and if REs for a PDCCH reception overlap with REs corresponding to SS/PBCH block indexes indicated by *SSB-transmitted*, the UE receives the PDCCH by excluding REs corresponding to SS/PBCH block indexes indicated by *SSB-transmitted*.

If a carrier aggregation capability for a UE, as included in *UE-NR-Capability*, is larger than X, the UE includes in *UE-NR-Capability* an indication for a maximum number of PDCCH candidates the UE can monitor per slot when the UE is configured for carrier aggregation operation over more than X cells. When the UE is configured for carrier aggregation operation

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over more than X cells, the UE is not expected to be configured with a number of PDCCH candidates to monitor per slot that is larger than the maximum number.

10.1 UE procedure for determining physical downlink control channel assignment

A set of PDCCH candidates for a UE to monitor is defined in terms of PDCCH search spaces. A search space can be a common search space or a UE-specific search space. A UE shall monitor PDCCH candidates in non-DRX slots in one or more of the following search spaces

- a Type0-PDCCH common search space for a DCI format with CRC scrambled by a SI-RNTI on a primary cell;
- a Type0A-PDCCH common search space for a DCI format with CRC scrambled by a SI-RNTI on a primary cell;
- a Type1-PDCCH common search space for a DCI format with CRC scrambled by a RA-RNTI, or a TC-RNTI, or a C-RNTI on a primary cell;
- a Type2-PDCCH common search space for a DCI format with CRC scrambled by a P-RNTI on a primary cell;
- a Type3-PDCCH common search space for a DCI format with CRC scrambled by INT-RNTI, or SFI-RNTI, or TPC-PUSCH-RNTI, or TPC-PUCCH-RNTI, or TPC-SRS-RNTI, or C-RNTI, or CS-RNTI(s); and
- a UE-specific search space for a DCI format with CRC scrambled by C-RNTI or CS-RNTI(s).

A UE is provided a configuration for a control resource set for Type0-PDCCH common search space by higher layer parameter *RMSI-PDCCH-Config* and a subcarrier spacing by higher layer parameter *RMSI-scs* for PDCCH reception. The UE determines the control resource set and the monitoring occasions for Type0-PDCCH common search space as described in Subclause **Error! Reference source not found.**. The Type0-PDCCH common search space is defined by the CCE aggregation levels and the number of candidates per CCE aggregation level given in Table 10.1-1.

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The UE may assume that the DM-RS antenna port associated with PDCCH reception in the Type0-PDCCH common search space and the Type2-PDCCH common search space, and for corresponding PDSCH receptions, and the DM-RS antenna port associated with SS/PBCH reception are quasi co-located with respect to delay spread, Doppler spread, Doppler shift, average delay, and spatial Rx parameters. The value for the DM-RS scrambling sequence initialization is the cell ID.

For Type0A-PDCCH common search space or for Type-2 PDCCH common search space, the control resource set is same as the control resource set for Type0-PDCCH common search space. A UE is provided a configuration for Type0A-PDCCH common search space by higher layer parameter *osi-SearchSpace*. A UE is provided a configuration for Type2-PDCCH common search space by higher layer parameter *paging-SearchSpace*.

A subcarrier spacing and a CP length for PDCCH reception with Type0A-PDCCH common search space, or Type1-PDCCH common search space, or Type-2 PDCCH common search space are same as for PDCCH reception with Type0-PDCCH common search space.

A UE may assume that the DM-RS antenna port associated with PDCCH reception in the Type0A-PDCCH common search space and the DM-RS antenna port associated with SS/PBCH reception are quasi co-located with respect to delay spread, Doppler spread, Doppler shift, average delay, and spatial Rx parameters.

A UE may assume that the DM-RS antenna port associated with PDCCH reception and associated PDSCH reception in the Type1-PDCCH common search space are quasi co-located with the DM-RS antenna port of the SS/PBCH reception associated with a corresponding PRACH transmission.

If a value for the DM-RS scrambling sequence initialization for Type0A-PDCCH common search space, or Type1-PDCCH common search space, or Type-2 PDCCH common search space is not provided by higher layer parameter *PDCCH-DMRS-Scrambling-ID* in *SystemInformationBlockType1*, the value is the cell ID.

If a UE is configured for downlink bandwidth part (BWP) operation, as described in Subclause **Error! Reference source not found.**, the above configurations for the common search spaces

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apply for the initial active DL BWP. The UE can be additionally configured a control resource set for Type0-PDCCH common search space, Type0A-PDCCH common search space, Type1-PDCCH common search space, or Type2-PDCCH common search space for each configured DL BWP on the primary cell, other than the initial active DL BWP, as described in Subclause **Error! Reference source not found.**.

FIG. 6 (a reproduction of Table 10.1-1 from 3GPP R1-1721343 showing CCE aggregation levels and number of candidates per CCE aggregation level for PDCCH scheduling *SystemInformationBlockType1* in Type0-PDCCH common search space)

For a serving cell, higher layer signalling provides a UE with P control resource sets. For control resource set p, $0 \le p < P$ where a UE-specific search space, a Type2-PDCCH common search space, or a Type3-PDCCH common search space is mapped, the higher layer signalling provides:

- a control resource set index by higher layer parameter *CORESET-ID*;
- a DM-RS scrambling sequence initialization value by higher layer parameter *PDCCH-DMRS-Scrambling-ID*;
- a number of consecutive symbols provided by higher layer parameter *CORESET-time-duration*;
- a set of resource blocks provided by higher layer parameter *CORESET-freq-dom*;
- a CCE-to-REG mapping provided by higher layer parameter *CORESET-CCE-to-REG-mapping-type*;
- a REG bundle size, in case of interleaved CCE-to-REG mapping, provided by higher layer parameter *CORESET-REG-bundle-size*;
- a cyclic shift for the REG bundle interleaver [4, 38.211] by higher layer parameter *CORESET-shift-index*;

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- an antenna port quasi co-location, from a set of antenna port quasi co-locations provided by higher layer parameter *TCI-StatesPDCCH*, indicating quasi co-location information of the DM-RS antenna port for PDCCH reception;

- an indication for a presence or absence of a transmission configuration indication (TCI) field for DCI format 1_0 or DCI format 1_1 transmitted by a PDCCH in control resource set p, by higher layer parameter *TCI-PresentInDCI*.

For each control resource set in a DL BWP of a serving cell, a respective higher layer parameter *CORESET-freq-dom* provides a bitmap. The bits of the bitmap have a one-to-one mapping with non-overlapping groups of 6 PRBs, in ascending order of the PRB index in the DL BWP bandwidth of $N_{\mathrm{RB}}^{\mathrm{BWP}}$ PRBs where the first PRB of the first group of 6 PRBs has index $6 \cdot \lceil N_{\mathrm{RB}}^{\mathrm{BWP}} / 6 \rceil$.

If the UE has not received an indication for an antenna port quasi co-location from the set of antenna port quasi co-locations provided by *TCI-StatesPDCCH*, the UE assumes that the DM-RS antenna port associated with PDCCH reception in the UE-specific search space is quasi co-located with the DM-RS antenna port associated with PBCH reception with respect to delay spread, Doppler spread, Doppler shift, average delay, and spatial Rx parameters.

For each serving cell that a UE is configured to monitor PDCCH in a search space other than Type0-PDCCH common search space, the UE is configured the following:

- a number of search space sets by higher layer parameter *search-space-config*;

- for each search space set in a control resource set p

    - an indication that the search space set is a common search space set or a UE-specific search space set by higher layer parameter *Common-search-space-flag*;

    - a number of PDCCH candidates $M_p^{(L)}$ per CCE aggregation level L by higher layer parameters *Aggregation-level-1*, *Aggregation-level-2*, *Aggregation-level-4*, *Aggregation-level-8*, and *Aggregation-level-16*, for CCE aggregation level 1, CCE aggregation level 2, CCE aggregation level 4, CCE aggregation level 8, and CCE aggregation level 16, respectively;

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- a PDCCH monitoring periodicity of k_p slots by higher layer parameter *Monitoring-periodicity-PDCCH-slot*;
- a PDCCH monitoring offset of o_p slots, where $0 \le o_p < k_p$, by higher layer parameter *Monitoring-offset-PDCCH-slot*;
- a PDCCH monitoring pattern within a slot, indicating first symbol(s) of the control resource set within a slot for PDCCH monitoring, by higher layer parameter *Monitoring-symbols-PDCCH-within-slot*.

A UE determines a PDCCH monitoring occasion from the PDCCH monitoring periodicity, the PDCCH monitoring offset, and the PDCCH monitoring pattern within a slot.

A PDCCH UE-specific search space $S_{k_p}^{(L)}$ at CCE aggregation level $L \in \{1, 2, 4, 8, 16\}$ is defined by a set of PDCCH candidates for CCE aggregation level L.

If a UE is configured with higher layer parameter *CrossCarrierSchedulingConfig* for a serving cell the carrier indicator field value corresponds to the value indicated by *CrossCarrierSchedulingConfig*.

For a serving cell on which a UE monitors PDCCH candidates in a UE-specific search space, if the UE is not configured with a carrier indicator field, the UE shall monitor the PDCCH candidates without carrier indicator field. For a serving cell on which a UE monitors PDCCH candidates in a UE-specific search space, if a UE is configured with a carrier indicator field, the UE shall monitor the PDCCH candidates with carrier indicator field.

A UE is not expected to monitor PDCCH candidates on a secondary cell if the UE is configured to monitor PDCCH candidates with carrier indicator field corresponding to that secondary cell in another serving cell. For the serving cell on which the UE monitors PDCCH candidates, the UE shall monitor PDCCH candidates at least for the same serving cell.

For a control resource set p, the CCEs corresponding to PDCCH candidate $m_{n_{CI}}$ of the search space for a serving cell corresponding to carrier indicator field value n_{CI} are given by

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$$L \cdot \left\{ \left(Y_{p,k_p} + \left\lfloor \frac{m_{n_{CI}} \cdot N_{\mathrm{CCE},p}}{L \cdot M_{p,\max}^{(L)}} \right\rfloor + n_{CI} \right) \bmod \left\lfloor N_{\mathrm{CCE},p} / L \right\rfloor \right\} + i$$

where

for any common search space, $Y_{p,k_p} = 0$;

for a UE-specific search space, $Y_{p,k_p} = \left(A_p \cdot Y_{p,k_p-1}\right) \bmod D$, $Y_{p,-1} = n_{\mathrm{RNTI}} \neq 0$, $A_0 = 39827$, $A_1 = 39829$, and $D = 65537$;

$i = 0, \cdots, L-1$;

n_{CI} is the carrier indicator field value if the UE is configured with a carrier indicator field for the serving cell on which PDCCH is monitored; otherwise, including for any common search space, $n_{CI} = 0$;

$N_{\mathrm{CCE},p}$ is the number of CCEs, numbered from 0 to $N_{\mathrm{CCE},p} - 1$, in control resource set p;

$m_{n_{CI}} = 0, \ldots, M_{p,n_{CI}}^{(L)} - 1$, where $M_{p,n_{CI}}^{(L)}$ is the number of PDCCH candidates the UE is configured to monitor for aggregation level L for a serving cell corresponding to n_{CI};

for any common search space, $M_{p,\max}^{(L)} = M_{p,0}^{(L)}$;

for a UE-specific search space, $M_{p,\max}^{(L)}$ is the maximum of $M_{p,n_{CI}}^{(L)}$ for all corresponding DCI formats over all configured n_{CI} values for a CCE aggregation level L in control resource set p;

the RNTI value used for n_{RNTI} is defined in [5, TS 38.212] and in [6, TS 38.214].

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A UE configured to monitor PDCCH candidates in a serving cell with a DCI format size with carrier indicator field and CRC scrambled by C-RNTI, where the PDCCH candidates may have one or more possible values of carrier indicator field for the DCI format size, shall assume that an PDCCH candidate with the DCI format size may be transmitted in the serving cell in any PDCCH UE specific search space corresponding to any of the possible values of carrier indicator field for the DCI format size.

[0035] In 3GPP TS 38.331, *PDCCH-Config* IE in the RRC standard is quoted as follows:

PDCCH-Config

The *PDCCH-Config* IE is used to configure UE specific PDCCH parameters such as control resource sets (CORESET), search spaces and additional parameters for acquiring the PDCCH.

PDCCH-Config information element

```
-- ASN1START

-- TAG-PDCCH-CONFIG-START

-- Downlink control channel related parameters

PDCCH-Config ::=                SEQUENCE {

-- List of Control Resource Sets (CORESETs) to be used by the
UE

controlResourceSetToAddModList        SEQUENCE(SIZE
(1..maxNrofControlResourceSets)) OF ControlResourceSet
   OPTIONAL,

controlResourceSetToReleaseList       SEQUENCE(SIZE
(1..maxNrofControlResourceSets)) OF ControlResourceId
   OPTIONAL
```


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```
•
• searchSpacesToAddModList           SEQUENCE(SIZE
(1..maxNrofSearchSpaces) OF SearchSpace
• OPTIONAL,
• searchSpacesToReleaseList          SEQUENCE(SIZE
(1..maxNrofSearchSpaces) OF SearchSpaceId               OPTIONAL
•
•
• -- FFS: Is this timing information applicable to the entire
PDCCH or could it be different per CORESET?
• -- FFS: Is there a default timing (to be used at least until
first reconfiguration). Are the fields optionally present?
• timing                     SEQUENCE {
•    dl-assignment-to-DL-data        TYPE_FFS!,
•    ul-assignment-to-UL-data        TYPE_FFS!,
•    dl-data-to-UL-ACK            TYPE_FFS!
• }
• OPTIONAL,
•
• }
•
```


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- -- A time/frequency control resource set (CORESET) in which to search for downlink control information (see 38.213, section x.x.x.x)FFS_Ref
- ControlResourceSet ::= SEQUENCE {
- controlResourceSetId ControlResourceSetId,
-
- -- Frequency domain resources for the CORESET. The network ensures that the CORESET is within the BWP configured for a UE. (see 38.213, REF)
- frequencyDomainResources TYPE_FFS!,
- -- Starting OFDM symbol for the CORESET (see 38.213, REF)
- startSymbol INTEGER (0..maxCoReSetStartSymbol),
- -- Contiguouse time duration of the CORESET in number of symbols see 38.213, section x.x.x.x)FFS_Ref
- duration INTEGER (1..maxCoReSetDuration),
- -- Resource Element Groups (REGs) can be bundled to create REG bundles. This parameter defines the size of such bundles.
- -- (see 38.211, section 7.3.2.2)
- reg-BundleSize ENUMERATED {n2, n3, n6},
- -- Mapping of Control Channel Elements (CCE) to Resource Element Groups (REG). (see 38.211, 38.213, FFS_REF)

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- cce-reg-MappingType ENUMERATED { interleaved, nonInterleaved },
- -- Precoder granularity in frequency domain (see 38.213, section FFS_REF)
- precoderGranularity TYPE_FFS!,
- -- Corresponds to L1 parameter 'CORESET-interleaver-rows' (see 38.211, 38.213, section FFS_Section)
- interleaverRows ENUMERATED {n2, n3, n6}
- OPTIONAL,
-
- -- Corresponds to L1 parameter 'CORESET-shift-index' (see 38.211, 38.213, section FFS_Section)
- shiftIndex FFS_Value
- OPTIONAL,
-
- -- Reference to a configured TCI State providing QCL configuration/indication for PDCCH.
- -- Corresponds to L1 parameter 'TCI-StateRefId' (see 38.211, 38.213, section FFS_Section)
- tci-StateRefId FFS_Value
- OPTIONAL,
-

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```
• -- PDCCH DMRS scrambling initalization. Corresponds to L1
parameter 'PDCCH-DMRS-Scrambling-ID' (see 38.214, section 5.1)
• -- When the field is absent the UE applies the value TBD/FFS
• pdcch-DMRS-ScramblingID            FFS_Value
• OPTIONAL
• }
•
• -- ID of a Control Resource Set.
• ControlResourceSetId ::=           INTEGER
(0..maxNrofControlResourceSets-1)
•
• -- A search space defines how/where to search for PDCCH
candidates. A search space is associated with one Control
Resource Set
• SearchSpace ::=                    SEQUENCE {
• searchSpaceId                      SearchSpaceId,
•
• -- The CORESET applicable for this SearchSpace.
• -- FFS: Value 0 identifies the common CORESET configured in
MIB?
• -- FFS: Values 1..maxNrofControlResourceSets-1 identify
CORESETs configured by dedicated signalling?
```


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```
controlResourceSetId            ControlResourceSetId,

-- Slots for PDCCH Monitoring configured as periodicity and offset. Corresponds to L1 parameters 'Montoring-periodicity-PDCCH-slot' and
-- 'Montoring-offset-PDCCH-slot' (see 38.213, section 10)
-- sl15, sl10, sl20 FFS
monitoringSlotPeriodicityAndOffset   CHOICE {
   sl1                              NULL,
   sl2                              INTEGER (0..1),
   sl5                          INTEGER (0..4),
   sl10                         INTEGER (0..9),
   sl20                         INTEGER (0..19)
}
OPTIONAL,

-- Symbols for PDCCH monitoring in the slots configured for PDCCH monitoring (see monitoringSlotPeriodicityAndOffset).
-- The most significant (left) bit represents the first OFDM in a slot. The least significant (right) bit represents the last symbol.
```


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```
• -- Corresponds to L1 parameter 'Montoring-symbols-PDCCH-
within-slot' (see 38.213, section 10)

• monitoringSymbolsWithinSlot            BIT STRING (SIZE (14))

• OPTIONAL,

•

• -- Number of candidates per aggregation level. Corresponds to
L1 parameter 'Aggregation-level-1' to 'Aggregation-level-8'

• -- (see 38.213, section 10)

• nrofCandidates                  SEQUENCE {

•    aggregationLevel1               ENUMERATED {n0, n1, n2, n3,
n4, n5, n6, n8},

•    aggregationLevel2               ENUMERATED {n0, n1, n2, n3,
n4, n5, n6, n8},

•    aggregationLevel4               ENUMERATED {n0, n1, n2, n3,
n4, n5, n6, n8},

•    aggregationLevel8               ENUMERATED {n0, n1, n2, n3,
n4, n5, n6, n8}

• }

•

•
```

[0036] The following terminology and assumption may be used hereafter in the detailed description:

- BS: a network central unit or a network node in NR which is used to control one or multiple

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TRPs which are associated with one or multiple cells. Communication between BS and TRP(s) is via fronthaul. BS may be referred to as central unit (CU), eNB, gNB, or NodeB.

- TRP: a transmission and reception point provides network coverage and directly communicates with UEs. TRP may be referred to as distributed unit (DU) or network node.
- Cell: a cell is composed of one or multiple associated TRPs, i.e. coverage of the cell is composed of coverage of all associated TRP(s). One cell is controlled by one BS. Cell may be referred to as TRP group (TRPG).
- NR-PDCCH: A channel carries downlink control signal which is used to control communication between a UE and a network side. A network transmits NR-PDCCH on configured control resource set (CORESET) to the UE.
- Slot: a scheduling unit in NR. Slot duration is 14 OFDM symbols.
- Mini-slot: a scheduling unit with duration less than 14 OFDM symbols.

[0037] In the current NR standard as disclosed in 3GPP R1-1721343 and TS 38.331, a CORESET can be configured by indicating time duration and a bit map. The bit map may indicate at least a starting OFDM symbol for monitoring the CORESET in a slot. Each bit in the bit map corresponds to an OFDM symbol in a slot. If a bit position in the bit map has a value of one, it represents a starting OFDM symbol for monitoring the CORESET. The CORESET may be monitored from at least a starting OFDM symbol(s) indicated by the bit map and occupying following OFDM symbol(s) until the configured time duration is reached. For example, if the time duration of a CORESET is configured as 2 and the bit map indicates 10000000000000, the UE may monitor the CORESET (receive at least a PDCCH) on OFDM symbol #0 and #1 in a slot.

[0038] However, if a bit map indicates a starting OFDM symbol belonging to the following OFDM symbol(s) of previous starting OFDM symbol indicated by the bit map (e.g., time duration of a CORESET is 2 and the bit map is 1100000000000000), a UE may be confused about the configuration. If this situation does not specify nor is captured in the standard, how a UE treat this situation needs further consideration. In addition, if the bit map indicates a starting OFDM symbol on the last few OFDM symbols of a slot, this may create a problem where the

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CORESET may be configured across a slot boundary. For example, if time duration of a CORESET is 2 and the bit map is 00000000000001, how a UE handle this configuration also needs further consideration. Potential solutions are described below.

[0039] According to one solution, a restriction on the configuration of a CORESET is established. The UE does not expect to receive a CORESET configuration with an overlap OFDM symbols indicated by a bit map indication and the CORESET duration and/or with a CORESET monitoring pattern across a slot boundary.

[0040] According to another solution, the UE is configured to or could deal with one of the above-possible scenarios. For example, a UE is configured with a CORESET. Alternatively, the UE receives a signal indicating configuration of a CORESET. The configuration of the CORESET includes at least time duration of the CORESET and a bit map. The bit map comprises 14 bits. A set of the bit position(s) in the bit map have value one. The set of bit position(s) indicates the starting OFDM symbol(s) in a slot for monitoring the CORESET. The interval (or distance) between each bit position (indicating value one) in the set (or bitmap) is larger than or equal to a number. The interval (or distance) between two bit positions indicating the value one in the bit map is larger than or equal to a number. The interval (or distance) between two neighboring bit positions indicating value one in the set is larger than or equal to a number. Two neighboring bit positions indicating the value one could be the two closest bit positions indicating value 1. An interval or distance between two bit positions could be a number of bits between the two bit positions. The two bit positions could be neglected when calculating the interval or distance. For example, an interval or distance between two bit positions indicating value 1 for a bitmap "10001000000000" is 3. Alternatively, an interval or distance between two bit positions could be difference of the two bit positions.

[0041] In one embodiment, the number is the time duration of the CORESET. Alternatively, the number is the time duration of the CORESET minus one. In another alternative, the number is the maximum time duration of the CORESET minus one. For example, if time duration of a CORESET is configured as 2, a bit map of a CORESET has a restriction that interval between two bit positions indicating value one is larger than or equal to 2 minus 1 (e.g., the bit map is 10100000000000). The UE does not expect to receive a

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configuration of a bit map such that the interval (or distance) between the two bit positions indicating value one in the bit map is smaller than the number (e.g., the bit map is 11000000000000). The UE could ignore a configuration of the bit map such that the interval (or distance) between two bit positions indicating value one in the bit map is smaller than the number (e.g., the bit map is 11000000000000 when the number is 1). The UE could ignore part of the bit map such that the interval (or distance) between the bit positions indicating value one in the part of the bit map is smaller than the number (e.g., if the bit map is 11000000100000, the UE ignores the first two 1 and applies the last 1 when the number is 1). The UE does not apply a configuration of the bit map such that the interval (or distance) between two bit positions indicating value one in the bit map is smaller than the number (e.g., the bit map is 11000000000000 when the number is 1).

[0042] In one embodiment, a base station does not configure the UE with a bit map such that the interval (or distance) between two bit positions indicating value one in the bit map is smaller than the number (e.g., the bit map is 11000000000000 when the number is 1). The most significant bit in the bit map represents the first OFDM symbol in a slot. The least significant bit in the bit map represents the last OFDM symbol in a slot. The signal could be *PDCCH-Config.* The bitmap could be monitoringSymbolsWithinSlot. The time duration could be CORESET-time-duration. The UE may monitor the CORESET on the OFDM symbol(s) in a slot based on the signal. The UE may monitor the CORESET on OFDM symbol(s) starting from each bit position in the set in a slot.

[0043] Alternatively, the bit map can indicate at least a monitoring occasion for the CORESET by indicating a starting OFDM symbol with the following contiguous OFDM symbol(s) until the time duration of the CORESET is reached. The UE may interpret the bit map based on the time duration of the CORESET. For example, when a UE is configured with a time duration 2 and a bit map "11011000000000", the UE monitors the CORESET the following symbols in a slot: {1^{st} symbol,2nd symbol} and {4^{th} symbol, 5th symbol}.

[0044] Within a slot, different monitoring occasions for the CORESET indicated by the bit map can be separated by at least one bit position indicating the value 0. If the bit map indicates a number of contiguous bit position(s) with the value 1, which the number is smaller

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than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 indicating a monitoring occasion for the CORESET with time duration as the number. For example, when a UE is configured with time duration 3 and a bit map "11000101011100", the UE monitors CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {6th symbol}, {8th symbol}, and {10th symbol, 11th symbol, 12th symbol}. In this example, the UE may interpret the number of contiguous bit position(s) indicating value 1 in the bit map which is smaller than the time duration 3 as a CORESET monitoring occasion with the time duration same as the contiguous number of the value 1.

[0045] If a bit map indicates a number of contiguous bit position(s) with the value 1, wherein the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as contiguous monitoring occasions for the CORESET with the time duration or smaller than the time duration. More specifically, if the number of contiguous bit position(s) indicating the value 1 is multiple of the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as contiguous monitoring occasion(s) for the CORESET with the time duration. If the number of contiguous bit position(s) indicating the value 1 is not a multiple of the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as that earlier contiguous bit(s) indicates contiguous monitoring occasion(s) for the CORESET with the time duration and the last orphan bit(s) indicates a monitoring occasion for CORESET with time duration smaller than the time duration of the CORESET which depends on number of last orphan bit(s). Alternatively, the last orphan bit(s) in the number of contiguous bit(s) with the value 1 can be ignored by the UE. For example, when a UE is configured with a time duration 2 and a bit map "11110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {3rd symbol, 4th symbol}. In another example, when a UE is configured with time duration 2 and a bit map "1110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {3rd symbol}. In a similar example, when a UE is configured with a time duration 2 and a bit map "1110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}. In this example, the UE ignores {3rd symbol} indicated by the bit map.

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[0046] Alternatively, if bit map indicates a number of contiguous bit position(s) with value 1, which the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as at least a monitoring occasion for the CORESET in which the time duration of the CORESET is the number of the contiguous bit position(s) with value 1. For example, when a UE is configured with the time duration 2 and a bit map "11100110000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol, 3rd symbol }, {5th symbol, 6th symbol}.

[0047] Alternatively, if a bit map indicates a number of contiguous bit position(s) with value 1 wherein the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as at least a monitoring occasion for the CORESET in which the time duration of the CORESET is the maximum time duration of a CORESET. For example, when a UE is configured with time duration 2 and a bit map "11110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol, 3rd symbol }, {4th symbol} when the maximum time duration of the CORESET is 3.

[0048] Alternatively, the signal indicates at least a bit map. The UE may receive the PDCCH on the OFDM symbol(s) in a slot based on the bit map. The bit map indicates at least a bit position and/or at least on a contiguous bit position(s) as value one. The UE may monitor a CORESET on the OFDM symbol(s) in a slot based on the bit map. The UE may view the contiguous bit position(s) as a CORESET. The UE may not expect to have the bit map indicating the number of the contiguous bit position(s) with value one exceeds maximum time duration for a CORESET.

[0049] Alternatively, if the UE receives the bit map indicating the number of the contiguous bit position(s) with value one exceeds maximum time duration for a CORESET, the UE may ignore part of the indication of the bit map. Alternatively, the UE may ignore the whole indication of the bit map. For example, when a UE is configured with a bit map "11010111000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {4th symbol}, {6th symbol, 7th symbol, 8th symbol} when the maximum time duration of the CORESET is 3. In a similar example, when a UE is configured with a bit map

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"11100001100000", the UE may ignore the first three 1's because it will exceed the maximum time duration if the maximum time duration of CORESET is 2. In the above example, the UE may monitor the CORESET in the following symbols in a slot: {8^{th} symbol, 9th symbol}.

[0050] The time duration of a CORESET can be determined based on the bit map and each contiguous bit position(s) with the value one in the bit map. The signal does not indicate the time duration for a CORESET. The signal indicates a different configuration for different time duration CORESET(s). The configuration may comprise at least the Control Channel Element(CCE)- Resource Element Group(REG) mapping type, aggregation level, search space configuration, and frequency resource assignment. The configuration could be *PDCCH-config*.

[0051] In one embodiment, a UE is configured with a CORESET. Alternatively, the UE receives a signal indicating the configuration of a CORESET. The configuration of the CORESET comprises at least time duration of the CORESET and a bit map. The bit map comprises 14 bits. The first bit position and the second bit position in the bit map indicate the value one. The interval (or distance) between the first bit position and the second bit position is smaller than a number. The interval (or distance) between two bit positions indicating the value one in the bitmap is larger than or equal to a number. The interval (or distance) between two neighboring bit positions indicating the value one in the set is smaller than a number. The two neighboring bit positions indicating the value one could be the two closest bit positions indicating the value 1. An interval or distance between two bit positions is the number of bits between the two bit positions. The two bit positions could be neglected when calculating the interval or distance. For example, an interval or distance between two bit positions indicating the value 1 for a bitmap "10001000000000" is 3. More specifically, the number is the time duration of the CORESET. Alternatively, the number is time duration of the CORESET minus one. Alternatively, the number is the maximum time duration of the CORESET minus one. Alternatively, the number is the maximum time duration of the CORESET minus one. For example, if time duration of a CORESET is configured as 2, a bit map of a CORESET may be 11000000000000. The first bit position is closer to the most significant bit in the bit map than the second bit position. The most significant bit in the bit map represents the first OFDM symbol in a slot. The least significant bit in the bit map represents the last OFDM symbol in a

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slot. The signal could be a *PDCCH-Config*. The bitmap could be monitoringSymbolsWithinSlot. The time duration could be a CORESET-time-duration.

[0052] The UE may monitor the CORESET on OFDM symbol(s) in a slot based on the bit map. The UE may monitor the CORESET on OFDM symbol(s) in a slot starting from the bit position(s) in the bit map indicating a value. The value could be one. The UE may monitor the CORESET on OFDM symbol(s) in a slot starting from the bit position(s) in the bit map indicating the value. Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in a slot starting from the bit position(s) in the bit map indicating the value excluding both or one of two bit position(s) wherein the interval (or distance) between the two bit positions is smaller than the number.

[0053] Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value excluding the first bit position and the second bit position. Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value excluding the first bit position. Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value excluding the second bit position. For example, when a UE is configured with time duration 2 and a bit map "11000101000000", the UE monitors the CORESET for the following symbols in a slot: {6^{th} symbol,7th symbol} and {8^{th} symbol, 9th symbol}. In this example, the bit locations with too short interval/distance are excluded. In another example, when a UE is configured with time duration 2 and a bit map "11000101000000", the UE monitors the CORESET for the following symbols in a slot: {1^{st} symbol, 2nd symbol}, {6^{th} symbol,7th symbol} and {8^{th} symbol, 9th symbol}. In this example, one (the latter one) of the two bit locations with too short interval/distance are excluded. A similar example could be that when a UE is configured with time duration 2 and a bit map "11000101000000", the UE monitors the CORESET for the following symbols in a slot: {2^{nd} symbol, 3rd symbol}, {6^{th} symbol,7th symbol} and {8^{th} symbol, 9th symbol}., e.g. ,excluding the earlier one.

[0054] Alternatively, the OFDM symbols for different CORESET could overlap. The OFDM symbol between two CORESETs could overlap if the interval (or distance) between the

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starting position of the two CORESETs is shorter than the number. In one example, when a UE is configured with a time duration of 2 and a bit map "11000101000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {2nd symbol, 3rd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol}.

[0055] Alternatively, the CORESET time duration of CORESETs associated with a bitmap within a slot could be different. The CORESET time duration could be different from the configured value if the interval (or distance) between starting symbol of two CORESETs is shorter than the number. In one example, when a UE is configured with a time duration of 2 and a bit map "11000101000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol}, {2nd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol}. It can be observed that the CORESETs corresponding to the first two bits in the bitmap have 1 symbol time duration even if the configured value is 2, e.g., due to short interval or distance. In a similar example, when a UE is configured with a time duration of 2 and a bit map "11100101000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol}, {2nd symbol }, {3rd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol} or {1st symbol, 2nd symbol }, {3rd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol} or alternatively {1st symbol}, {2nd symbol, 3rd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol}. It can be observed later two alternatives allow one CORESET corresponding to the first three bits in the bit map to have a CORESET time duration with a configured value, i.e., 2 and one CORESET have time duration which is different from the configured value, e.g., 1. For bit locations corresponding to short interval or distance, time duration can be used as a maximum time duration or an upper bound of time duration. For bit locations corresponding to a short interval or distance, a value of 1 could mean a corresponding symbol containing the CORESET and the corresponding symbol is not the first symbol or starting symbol of the CORESET.

[0056] Different alternatives or different examples can be applied in different slot. For example, the UE may monitor the CORESET on OFDM symbol(s) in an even slot (i.e., a slot with even slot number) starting from the bit position(s) in the bit map indicating the value excluding the first bit position, and the UE may monitor the CORESET on OFDM symbol(s) in an odd slot starting from the bit position(s) in the bit map indicating the value excluding the second bit position or vice versa. Different alternatives or examples can be applied to a

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configuration or an indication. The configuration or indication can be transmitted by a base station to a UE.

[0057] In one embodiment, the UE may ignore the configuration of the CORESET. The UE may transmit a Negative Acknowledgement (NACK) as a feedback of the signal.

[0058] In one alternative, the UE may monitor the CORESET on OFDM symbol(s) in an even slot based on the bit map excluding the second bit position. Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in an odd slot based on the bit map excluding the second bit position. Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in an even slot based on the bit map excluding the first bit position. Alternatively, the UE may monitor the CORESET on OFDM symbol(s) in an odd slot based on the bit map excluding the first bit position.

[0059] The signal may include a pattern for indicating the bit map. The pattern indicates a slot level bit map. If the bit position of the slot level bit map corresponding to a slot indicates the value of one, the UE monitors the CORESET in the slot based on the bit map excluding the second bit position. If the bit position of the slot level bit map corresponding to a slot indicates the value of one, the UE monitors the CORESET in the slot based on the bit map excluding the first bit position. Alternatively, if bit position of the slot level bit map corresponding to a slot indicates the value of zero, the UE monitors the CORESET in the slot based on the bit map excluding the first bit position. Alternatively, if bit position of the slot level bit map corresponding to a slot indicates the value of zero, the UE monitors the CORESET in the slot based on the bit map excluding the second bit position.

[0060] The UE can be configured with two CORESETs (e.g., two CORESET IDs) associated with a search space or a bitmap. The time durations of the two CORESETs can be different. For example, one time duration is longer and the other time duration is shorter. For a first CORESET starting symbol, the UE determines one CORESET configuration from the two CORESET configurations according to a distance or interval between the first CORESET starting symbol and a second CORESET starting symbol. The second CORESET starting symbol could be a next CORESET starting symbol in a bitmap after the first CORESET starting symbol.

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[0061] In another alternative, the UE determines a CORESET configuration with longer time duration if the distance or the interval between the first CORESET starting symbol and the second CORESET starting symbol is longer than a number. Alternative, the UE determines a CORESET configuration with shorter time duration if the distance or the interval between the first CORESET starting symbol and the second CORESET starting symbol is shorter than a number. The number could be the longer time duration minus 1. Alternatively, the number could be the longer time duration.

[0062] The bitmap is associated with the first CORESET configuration and the second CORESET configuration. For example, when a UE is configured with a first CORESET with time duration 2, a second CORESET with time duration 1 and a bit map "11100101000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol}, {2nd symbol }, {3rd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol}. For the CORESET in {1st symbol}, {2nd symbol }, {3rd symbol}, the configuration of the second COREST is applied. For the CORESET in {6th symbol,7th symbol} and {8th symbol, 9th symbol}, the configuration of the second CORESET is applied.

[0063] The UE can be configured with two CORESET time durations for a given CORESET, search space, or bitmap. In one example, one CORESET time duration is longer and the other is shorter.

[0064] For a first CORESET starting symbol, the UE determines one CORESET time duration from the two configured CORESET time durations according to a distance or interval between the first CORESET starting symbol and a second CORESET starting symbol. Alternatively, the second CORESET starting symbol could be a next CORESET starting symbol in a bitmap after the first CORESET starting symbol. In one method, the UE determines a longer CORESET time duration if the distance or the interval between the first CORESET starting symbol and the second CORESET starting symbol is longer than a number. Alternatively, the UE determines a shorter CORESET time duration if the distance or the interval between the first CORESET starting symbol and the second CORESET starting symbol is shorter than a number.

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[0065] The number could be the longer time duration. Alternatively, the number could be the longer time duration minus 1. The bitmap is associated with a CORESET whose configured time duration is the first CORESET time duration and the second CORESET time duration. For example, when a UE is configured with a first CORESET with time duration 1 and 2, and a bit map "11100101000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol}, {2nd symbol }, {3rd symbol}, {6th symbol,7th symbol} and {8th symbol, 9th symbol}. For the CORESET in {1st symbol}, {2nd symbol }, {3rd symbol}, the CORESET time duration of 1 is applied. For the CORESET in {6th symbol,7th symbol} and {8th symbol, 9th symbol}, the CORESET time duration 2 is applied.

[0066] The UE can be configured with a default CORESET, which is different from the CORESET indicated by the signal. The time duration of the default CORESET may be shorter than or equal to the duration indicated by the signal. More specifically, the time duration of the default CORESET can be one or two. The time duration of the default CORESET is the interval between the first bit position and the second bit position. The UE may monitor the CORESET on the OFDM symbol(s) in a slot based on the bit map excluding the first bit position and/or the second bit position. The UE may monitor the default CORESET on OFDM symbol(s) in the slot based on the first bit position and/or the second bit position.

[0067] Alternatively, the bit map can indicate at least a monitoring occasion for the CORESET by indicating a starting OFDM symbol following contiguous OFDM symbol(s) until the time duration of the CORESET is reached. The UE may interpret the bit map based on the time duration of the CORESET. For example, when a UE is configured with time duration 2 and a bit map "11011000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol,2nd symbol} and {4th symbol, 5th symbol}. Different monitoring occasions for the CORESET indicated by the bit map can be separated by at least one bit position indicating the value 0. If the bit map indicates a number of contiguous bit position(s) with the value 1, which is a number is smaller than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 indicating a monitoring occasion for the CORESET with the time duration as the number. For example, when a UE is configured with time duration 3 and a bit map "11000101011100", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {6th symbol}, {8th symbol}, and {10th

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symbol, 11th symbol, 12th symbol}. In this example, the UE may interpret the number of contiguous bit position(s) indicating the value 1 in the bit map which is smaller than the time duration 3 as a CORESET monitoring occasion with the time duration as the contiguous number of value 1.

[0068] If bit map indicates a number of contiguous bit position(s) with the value 1, which is the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with value 1 as contiguous monitoring occasions for the CORESET with the time duration or smaller than the time duration. More specifically, if the number of contiguous bit position(s) indicating the value 1 is multiple of the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as contiguous monitoring occasion(s) for the CORESET for the time duration.

[0069] If the number of contiguous bit position(s) indicating the value 1 is not a multiple of the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as those earlier contiguous bit(s) indicating contiguous monitoring occasion(s) for the CORESET for the time duration and the last orphan bit(s) indicating a monitoring occasion for the CORESET for the time duration smaller than the time duration of the CORESET which depends on number of last orphan bit(s).

[0070] Alternatively, the last orphan bit(s) in the number of contiguous bit(s) with the value one can be ignored by the UE. For example, when a UE is configured with a time duration 2 and a bit map "11110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {3rd symbol, 4th symbol}. In another example, when a UE is configured with time duration 2 and a bit map "1110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {3rd symbol}. In a similar example, when a UE is configured with a time duration 2 and a bit map "1110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}. In this example, the UE ignores the {3rd symbol} indicated by the bit map.

[0071] In one embodiment, a UE is configured with a CORESET. Alternatively, the UE receives a signal indicating configuration of a CORESET. The configuration of the CORESET includes at least the time duration of the CORESET and a bit map. The bit map includes 14 bits.

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A set of bit position(s) in the bit map have a value of one. The set of bit position(s) indicates the starting OFDM symbol(s) in a slot for monitoring the CORESET. The interval (or distance) between each bit position (indicating the value of one) in the set (or bitmap) and the least significant bit in the bit map is larger than or equal to a number. The interval (or distance) between the last bit position (indicating the value one) in the set (or bitmap) and the least significant bit in the bit map is larger than or equal to a number. An interval or distance between two bit positions is the number of bits between the two bit positions. The two bit positions could be neglected when calculating the interval or distance. For example, an interval or distance between two bit position indicating the value 1 for a bitmap "10001000000000" is 3. Alternatively, an interval or distance between two bit positions could be the difference of the two bit positions.

[0072] In one embodiment, the number is a time duration of the CORESET. Alternatively, the number is time duration of the CORESET minus one. Alternatively, the number is the maximum time duration of the CORESET minus one. Alternatively, the number is the maximum time duration of the CORESET minus one. For example, if time duration of a CORESET is configured as 2, a bit map of a CORESET has a restriction that the interval between each bit position in the set and the least significant bit in the bit map is larger than or equal to 2 minus 1 (e.g., the bit map is 00000000000010).

[0073] In another example, the UE does not expect to receive a configuration of a bit map such that the interval (or distance) between each bit position indicating 1 in the bit map and the least significant bit in the bit map (or between the last bit indicating 1 in the bitmap and the least significant bit in the bit map) is smaller than the number (e.g., the bit map is 00000000000001).

[0074] The UE could ignore a configuration of a bit map such that the interval (or distance) between each bit position indicating 1 in the bit map and the least significant bit in the bit map (or between the last bit indicating 1 in the bitmap and the least significant bit in the bit map) is smaller than the number (e.g., the bit map is 00000000000001). The UE could ignore a part of a bit map such that the interval (or distance) between the bit position indicating 1 in the part of the bit map and the least significant bit in the bit map (or between the last bit indicating 1

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in the bitmap and the least significant bit in the bit map) is smaller than the number (e.g., the bit map is 10000000000001 in which the UE applies the first 1 and ignore the last 1).

[0075] In another example, the UE does not apply a configuration of a bit map such that the interval (or distance) between each bit position indicating 1 in the bit map and the least significant bit in the bit map (or between the last bit indicating 1 in the bitmap and the least significant bit in the bit map) is smaller than the number (e.g., the bit map is 00000000000001).

[0076] A base station does not configure a UE with a bit map such that the interval (or distance) between each bit position indicating 1 in the bit map and the least significant bit in the bit map (or between the last bit indicating 1 in the bitmap and the least significant bit in the bit map) is smaller than the number (e.g., the bit map is 00000000000001). The most significant bit in the bit map represents the first OFDM symbol in a slot. The least significant bit in the bit map represents the last OFDM symbol in a slot. The signal could be *PDCCH-Config*. The bitmap could be monitoringSymbolsWithinSlot. The time duration could be a CORESET-time-duration. The UE may monitor the CORESET on OFDM symbol(s) in a slot based on the signal. The UE may monitor the CORESET on OFDM symbol(s) starting from each bit position in the set in a slot.

[0077] If the bit map indicates a number of contiguous bit position(s) with the value 1, which the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as contiguous monitoring occasions for the CORESET with the time duration or smaller than the time duration. More specifically, if the number of contiguous bit position(s) indicating value 1 is a multiple of the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with value 1 as contiguous monitoring occasion(s) for the CORESET for the time duration.

[0078] If the number of contiguous bit position(s) indicating value 1 is not a multiple of the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as those earlier contiguous bit(s) indicating contiguous monitoring occasion(s) for the CORESET with the time duration, and the last orphan bit(s) indicating a monitoring occasion for the CORESET with the time duration smaller than the time duration of the CORESET which depends on number of last orphan bit(s).

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[0079] Alternatively, the last orphan bit(s) in the number of contiguous bit(s) with the value one can be ignored by the UE. For example, when a UE is configured with a time duration 2 and a bit map "11110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {3rd symbol, 4th symbol}. In another example, when a UE is configured with a time duration 2 and a bit map "1110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {3rd symbol}. In a similar example, when a UE is configured with a time duration 2 and a bit map "1110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}. In this example, the UE ignores {3rd symbol} indicated by the bit map.

[0080] Alternatively, if a bit map indicates a number of contiguous bit position(s) with the value 1, which is the number larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as at least a monitoring occasion for CORESET which the time duration of the CORESET is the number of contiguous bit position(s) with the value 1. For example, when a UE is configured with time duration 2 and a bit map "11100110000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol, 3rd symbol }, {5th symbol, 6th symbol}. Alternatively, if a bit map indicates a number of contiguous bit position(s) with the value 1, in which the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as at least a monitoring occasion for CORESET in which the time duration of the CORESET is the maximum time duration of a CORESET. For example, when a UE is configured with time duration 2 and a bit map "11110000000000", the UE monitors CORESET in the following symbols in a slot: {1st symbol, 2nd symbol, 3rd symbol }, {4th symbol} when maximum time duration of CORESET is 3.

[0081] Alternatively, the signal indicates at least a bit map. The UE may receive a PDCCH on the OFDM symbol(s) in a slot based on the bit map. The bit map indicates at least a bit position and/or at least on a contiguous bit position(s) as value one. The UE may monitor a CORESET on the OFDM symbol(s) in a slot based on the bit map. The UE may view the contiguous bit position(s) as a CORESET. The UE may not expect to have the bit map indicating the number of the contiguous bit position(s) with the value one exceeding a maximum time duration for a CORESET. Alternatively, if the UE receives the bit map indicating the

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number of the contiguous bit position(s) with the value one exceeding a maximum time duration for a CORESET, the UE may ignore part of the indication of the bit map. Alternatively, the UE may ignore the whole indication of the bit map. For example, when a UE is configured with a bit map "11010111000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {4th symbol}, {6th symbol, 7th symbol, 8th symbol} when the maximum time duration of CORESET is 3. In a similar example, when a UE is configured with a bit map "11100001100000", the UE may ignore the first three 1's because it will exceed the maximum time duration if the maximum time duration of the CORESET is 2. In the above example, the UE may monitor the CORESET for the following symbols in a slot: {8th symbol, 9th symbol}. The time duration of a CORESET can be determined based on the bit map and each contiguous bit position(s) with the value one in the bit map. The signal does not indicate the time duration for a CORESET. The signal indicates different configurations for the different time duration CORESET(s). The configuration may include at least CCE-REG mapping, aggregation level, search space configuration, and frequency resource assignment.

[0082] In another embodiment, a UE is configured with a CORESET. Alternatively, the UE receives a signal indicating a configuration of a CORESET. The configuration of the CORESET includes at least a time duration of the CORESET and a bit map. The bit map includes 14 bits. A set of bit position(s) in the bit map have a value of one. The set of bit position(s) indicates the starting OFDM symbol(s) in a slot for monitoring the CORESET. The interval (or distance) between a bit position in the set and the least significant bit in the bit map is smaller than a number. The interval (or distance) between the last bit position indicating a value of 1 in the bit map and the least significant bit in the bit map is smaller than a number. An interval or distance between two bit positions is a number of bits between the two bit positions. The two bit positions could be neglected when calculating the interval or distance. For example, an interval or distance between two bit positions indicating the value 1 for a bitmap "10001000000000" is 3.

[0083] More specifically, the number is a time duration of the CORESET. Alternatively, the number is a time duration of the CORESET minus one. Alternatively, the number is a maximum time duration of the CORESET minus one. Alternatively, the number is a maximum time duration of the CORESET minus one. For example, if the time duration of a CORESET is

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configured as 2, a bit map of a CORESET may be 00000000000001. The most significant bit in the bit map represents the first OFDM symbol in a slot. The least significant bit in the bit map represents the last OFDM symbol in a slot. The signal could be a *PDCCH-Config*. The bitmap could be monitoringSymbolsWithinSlot.

[0084] The time duration could be a CORESET-time-duration. The UE may monitor the CORESET on the OFDM symbol(s) in a slot based on the signal. The UE may monitor the CORESET on the OFDM symbol(s) starting from each bit position in the set in a slot. The UE may monitor the CORESET on the OFDM symbol(s) in a slot based on the bit map excluding the bit position. The UE may not expect to monitor the CORESET on OFDM symbol(s) in a slot starting from the bit position. The UE may be configured with a default CORESET, which is different from the CORESET indicated by the signal. The time duration of the default CORESET may be shorter than or equal to the duration indicated by the signal. The time duration of the default CORESET may be one or two. The time duration of the default CORESET is the interval between the bit position and the least significant bit in the bit map. The UE may monitor the CORESET on the OFDM symbol(s) in a slot based on the bit map excluding the bit position. The UE may monitor the default CORESET on tge OFDM symbol(s) in the slot based on the bit position.

[0085] The UE can be configured with two CORESETs (e.g., two CORESET IDs) associated with a search space or a bitmap. The time durations of the two CORESETs can be different. For example, a first duration is longer and a second duration is shorter. For a first CORESET starting symbol, the UE determines one CORESET configuration from the two CORESET configurations according to a distance or interval between the first CORESET starting symbol and the last symbol in a slot. The UE determines a CORESET configuration for the longer time duration if the distance or the interval between the first CORESET starting symbol and the last symbol in a slot is longer than a number. The UE determines a CORESET configuration for the shorter time duration if the distance or the interval between the first CORESET starting symbol and the last symbol in a slot is shorter than a number. The number could be the longer time duration minus 1. The number could be the longer time duration.

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[0086] In one embodiment, the bitmap is associated with the first CORESET configuration and the second CORESET configuration. For example, when a UE is configured with a first CORESET with a time duration of 2, a second CORESET with a time duration of 1 and a bit map "00000101000001", the UE monitors the CORESET for the following symbols in a slot: {6^{th} symbol,7th symbol}, {8^{th} symbol, 9th symbol} and {14^{th} symbol}. For the CORESET in {14^{th} symbol}, the configuration of the second COREST is applied. For the CORESET in {6^{th} symbol,7th symbol} and {8^{th} symbol, 9th symbol}, the configuration of the second CORESET is applied.

[0087] The UE can be configured with two CORESET time durations for a given CORESET, a search space, or a bitmap. For example, one CORESET time duration is longer and the other time duration is shorter. For a first CORESET starting symbol, the UE determines one CORESET time duration from the two configured CORESET time durations according to a distance or interval between the first CORESET starting symbol and the last symbol in a slot. The UE determines the longer CORESET time duration if the distance or the interval between the first CORESET starting symbol and the last symbol in a slot is longer than a number. The UE determines the shorter CORESET time duration if the distance or the interval between the first CORESET starting symbol and the last symbol in a slot is shorter than a number. The number could be the longer time duration minus 1. Alternatively, the number could be the longer time duration. The bitmap is associated with a CORESET whose configured time duration is the first CORESET time duration and the second CORESET time duration. For example, when a UE is configured with a first CORESET with a time duration of 1 and 2 and a bit map "00000101000001", the UE monitors the CORESET for the following symbols in a slot: {6^{th} symbol,7th symbol}, {8^{th} symbol, 9th symbol} and {14^{th} symbol}. For the CORESET in {14^{th} symbol}, the CORESET time duration of 1 is applied. For the CORESET in {6^{th} symbol,7th symbol} and {8^{th} symbol, 9th symbol}, the CORESET time duration of 2 is applied. Alternatively, the OFDM symbols for a CORESET could span different slots. A CORESET could span a first slot and a second slot if the interval or distance between the last bit position indicating 1 in the first slot and the last symbol in the first slot is shorter than the number. The second slot is the next slot of the first slot. For example, when a UE is configured with a time duration 2 and a bit map "10000101000001", the UE monitors the CORESET for the following

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symbols in a slot: {1st symbol, 2nd symbol}, {6th symbol,7th symbol}, {8th symbol, 9th symbol} and {14th symbol, 1st symbol of the next slot}. Alternatively, the CORESET time duration of CORESETs associated with a bitmap within a slot could be different. Alternatively, the CORESET time duration could be different from the configured value if the interval or distance between the last bit position indicating 1 in the first slot and the last symbol in the first slot is shorter than the number. For example, when a UE is configured with a time duration 2 and a bit map "10000101000001", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {6th symbol,7th symbol}, {8th symbol, 9th symbol} and {14th symbol}. It can be observed that the CORESETs corresponding to the last bit in the bitmap have 1 symbol time duration even if the configured value is 2 due to the short interval or distance to the last symbol of a slot.

[0088] Alternatively, if a bit map indicates a number of contiguous bit position(s) with value 1, in which the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as at least a monitoring occasion for the CORESET, in which the time duration of the CORESET is the number of contiguous bit position(s) with value 1. For example, when a UE is configured with a time duration 2 and a bit map "11100110000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol, 3rd symbol }, {5th symbol, 6th symbol}. Alternatively, if bit map indicates a number of contiguous bit position(s) with value 1, in which the number is larger than the time duration of the CORESET, the UE may interpret the number of contiguous bit position(s) with the value 1 as at least a monitoring occasion for the CORESET, in which the time duration of the CORESET is the maximum time duration of a CORESET. For example, when a UE is configured with a time duration 2 and a bit map "11110000000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol, 3rd symbol}, {4th symbol} when the maximum time duration of the CORESET is 3.

[0089] Alternatively, the signal indicates at least a bit map. The UE may receive a PDCCH on the OFDM symbol(s) in a slot based on the bit map. The bit map indicate at least a bit position and/or at least one contiguous bit position(s) as value one. The UE may monitor a CORESET on the OFDM symbol(s) in a slot based on the bit map. The UE may view the contiguous bit position(s) as a CORESET. The UE may not expect to have the bit map

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indicating number of the contiguous bit position(s) with value one exceeding a maximum time duration for a CORESET. Alternatively, if the UE receives the bit map indicating the number of the contiguous bit position(s) with value one exceeding a maximum time duration for a CORESET, the UE may ignore a part of the indication of the bit map. Alternatively, the UE may ignore the whole indication of the bit map. For example, when a UE is configured with a bit map "11010111000000", the UE monitors the CORESET for the following symbols in a slot: {1st symbol, 2nd symbol}, {4th symbol}, {6th symbol, 7th symbol, 8th symbol} when the maximum time duration of CORESET is 3. In a similar example, when a UE is configured with a bit map "11100001100000", the UE may ignore the first three 1's because it will exceed the maximum time duration if the maximum time duration of CORESET is 2. In the above example, the UE may monitor the CORESET for the following symbols in a slot: {8th symbol, 9th symbol}. The time duration of a CORESET can be determined based on the bit map and each contiguous bit position(s) with value one in the bit map. The signal does not indicate a time duration for a CORESET. The signal indicates the different configurations for different time duration CORESET(s). The configuration may include at least a CCE-REG mapping, aggregation level, search space configuration, or frequency resource assignment.

[0090] According to one method, the UE receives a signal indicating at least a duration and a bit map, wherein a set of bit position(s) in the bit map indicates a value, and wherein an interval between each bit position in the set is larger than or equal to a number.

[0091] According to another method, the network transmits a signal indicating at least a duration and a bit map, wherein a set of bit position(s) in the bit map indicates a value, wherein interval between each bit position in the set is larger than or equal to a number.

[0092] In one or more of the above-disclosed methods, the value is one.

[0093] In one or more of the above-disclosed methods, the number is the duration.

[0094] In one or more of the above-disclosed methods, the number is the duration minus one.

[0095] In one or more of the above-disclosed methods, the number is maximum duration, wherein the maximum duration is maximum time duration of a control resource set (CORESET).

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[0096] In one or more of the above-disclosed methods, the number is maximum duration minus one, wherein the maximum duration is maximum time duration of a CORESET.

[0097] In one or more of the above-disclosed methods, the duration is a time duration of a CORESET.

[0098] In one or more of the above-disclosed methods, the bit map comprises 14 bits.

[0099] In one or more of the above-disclosed methods, the set of bit position(s) in the bit map indicates monitoring starting OFDM symbol(s) of a CORESET in a slot.

[00100] In one or more of the above-disclosed methods, the most significant bit in the bit map represents the first OFDM symbol in a slot.

[00101] In one or more of the above-disclosed methods, the least significant bit in the bit map represents the last OFDM symbol in a slot.

[00102] In one or more of the above-disclosed methods, the signal indicates configuration of a CORESET.

[00103] In one or more of the above-disclosed methods, the signal is a *PDCCH-config* IE which is used to configure UE-specific PDCCH parameters.

[00104] In one or more of the above-disclosed methods, the UE monitors a CORESET based on the signal.

[00105] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot based on the bit map.

[00106] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot starting from each bit position in the set.

[00107] According to one method, the UE receives a signal indicating at least a duration and a bit map, wherein interval between a pair of bit position(s) indicating a value in the bit map is smaller than the duration.

[00108] According to one method, the network transmits a signal indicating at least a duration and a bit map, wherein interval between a pair of bit position(s) indicating a value in the bit map is smaller than the duration.

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[00109] In one or more of the above-disclosed methods, the pair of bit position(s) comprises a first bit position and a second bit position.

[00110] In one or more of the above-disclosed methods, the first bit position is closer to the most significant bit in the bit map than the second bit position.

[00111] In one or more of the above-disclosed methods, the value is one.

[00112] In one or more of the above-disclosed methods, the duration is a time duration of a CORESET.

[00113] In one or more of the above-disclosed methods, the bit map comprises 14 bits.

[00114] In one or more of the above-disclosed methods, the most significant bit in the bit map represents the first OFDM symbol in a slot.

[00115] In one or more of the above-disclosed methods, the least significant bit in the bit map represents the last OFDM symbol in a slot.

[00116] In one or more of the above-disclosed methods, the signal indicates configuration of a CORESET.

[00117] In one or more of the above-disclosed methods, the signal is a *PDCCH-config* IE which is used to configure UE-specific PDCCH parameters.

[00118] In one or more of the above-disclosed methods, the UE monitors a CORESET based on the signal.

[00119] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot based on the bit map.

[00120] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value.

[00121] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value excluding the pair of bit position.

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[00122] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value excluding the first bit position of the pair.

[00123] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot starting from bit position(s) in the bit map indicating the value excluding the second bit position of the pair.

[00124] In one or more of the above-disclosed methods, the UE ignores the signal.

[00125] In one or more of the above-disclosed methods, the UE transmits a Negative Acknowledgement (NACK) as a feedback of the signal.

[00126] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in an even slot based on the bit map excluding the second bit position of the pair.

[00127] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in an odd slot based on the bit map excluding the second bit position of the pair.

[00128] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in an even slot based on the bit map excluding the first bit position of the pair.

[00129] In one or more of the above-disclosed methods, the signal comprises a pattern for indicating the bit map.

[00130] In one or more of the above-disclosed methods, the pattern indicates a slot level bit map.

[00131] In one or more of the above-disclosed methods, if bit position of the slot level bit map indicates one, the UE monitors a CORESET in a slot based on the bit map excluding the second bit position of the pair.

[00132] In one or more of the above-disclosed methods, if bit position of the slot level bit map indicates one, the UE monitors a CORESET in a slot based on the bit map excluding the first bit position of the pair.

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[00133] In one or more of the above-disclosed methods, the UE monitors a CORESET in a slot based on the bit map and slot format of the slot.

[00134] In one or more of the above-disclosed methods, if the slot format of the slot indicates a set of OFDM symbol(s) as flexible or uplink which the set comprises part of OFDM symbols which start from the first bit position with the duration, the UE monitors a CORESET based on the bit map excluding the first bit position of the pair.

[00135] In one or more of the above-disclosed methods, if the slot format of the slot indicates a set of OFDM symbol(s) as flexible or uplink which the set comprises part of OFDM symbols which start from the second bit position with the duration, the UE monitors a CORESET based on the bit map excluding the second bit position of the pair.

[00136] In one or more of the above-disclosed methods, the UE is configured with a default CORESET, which is different from a CORESET indicated by the signal.

[00137] In one or more of the above-disclosed methods, the time duration of the default CORESET is shorter than the duration.

[00138] In one or more of the above-disclosed methods, the time duration of the default CORESET is one or two.

[00139] In one or more of the above-disclosed methods, the time duration of the default CORESET is the interval between the first bit position and the second bit position of the pair.

[00140] In one or more of the above-disclosed methods, the UE monitors the CORESET on OFDM symbol(s) in a slot based on the bit map excluding the pair of bit position(s) and monitors the default CORESET on OFDM symbol(s) in the slot based on the pair of bit position(s).

[00141] According to another method, the UE receives a signal indicating at least a duration and a bit map, wherein a set of bit position indicates a value in the bit map, and wherein an interval between every bit position in the set and the least significant bit in the bit map is larger than or equal to a number.

[00142] According to another method, the network transmits a signal indicating at least a duration and a bit map, wherein a set of bit position indicates a value in the bit map, and wherein

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an interval between a bit position in the set and the least significant bit in the bit map is larger than or equal to a number.

[00143] In one or more of the above-disclosed methods, the value is one.

[00144] In one or more of the above-disclosed methods, the number is the duration.

[00145] In one or more of the above-disclosed methods, the number is the duration minus one.

[00146] In one or more of the above-disclosed methods, the number is a maximum duration, wherein the maximum duration is maximum time duration of a CORESET.

[00147] In one or more of the above-disclosed methods, the number is a maximum duration minus one, wherein the maximum duration is a maximum time duration of a CORESET.

[00148] In one or more of the above-disclosed methods, the duration is a time duration of a CORESET.

[00149] In one or more of the above-disclosed methods, the bit map comprises 14 bits.

[00150] In one or more of the above-disclosed methods, the set of bit position(s) in the bit map indicates monitoring starting OFDM symbol(s) of a CORESET in a slot.

[00151] In one or more of the above-disclosed methods, the most significant bit in the bit map represents the first OFDM symbol in a slot.

[00152] In one or more of the above-disclosed methods, the least significant bit in the bit map represents the last OFDM symbol in a slot.

[00153] In one or more of the above-disclosed methods, the signal indicates a configuration of a CORESET.

[00154] In one or more of the above-disclosed methods, the signal is a PDCCH-config IE which is used to configure UE-specific PDCCH parameters.

[00155] In one or more of the above-disclosed methods, the UE monitors a CORESET based on the signal.

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[00156] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot based on the bit map.

[00157] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot starting from each bit position in the set.

[00158] According to another method, the UE receives a signal indicating at least a duration and a bit map, wherein a set of bit position(s) indicates a value in the bit map, and wherein an interval between a bit position in the set and the least significant bit in the bit map is smaller than the duration.

[00159] In one or more of the above-disclosed methods, the value is one.

[00160] In one or more of the above-disclosed methods, the duration is a time duration of a CORESET.

[00161] In one or more of the above-disclosed methods, the bit map comprises 14 bits.

[00162] In one or more of the above-disclosed methods, the most significant bit in the bit map represents the first OFDM symbol in a slot.

[00163] In one or more of the above-disclosed methods, the least significant bit in the bit map represents the last OFDM symbol in a slot.

[00164] In one or more of the above-disclosed methods, the signal indicates a configuration of a CORESET.

[00165] In one or more of the above-disclosed methods, the signal is a PDCCH-config IE which is used to configure UE-specific PDCCH parameters.

[00166] In one or more of the above-disclosed methods, the UE monitors a CORESET based on the signal.

[00167] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot based on the bit map.

[00168] In one or more of the above-disclosed methods, the UE monitors a CORESET on OFDM symbol(s) in a slot based on the bit map excluding the bit position.

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[00169] In one or more of the above-disclosed methods, the UE does not monitor a CORESET on OFDM symbol(s) in a slot starting from the bit position.

[00170] In one or more of the above-disclosed methods, the UE is configured with a default CORESET, which is different from a CORESET indicated by the signal.

[00171] In one or more of the above-disclosed methods, the time duration of the default CORESET is shorter than the duration indicated by the signal.

[00172] In one or more of the above-disclosed methods, the time duration of the default CORESET is one or two.

[00173] In one or more of the above-disclosed methods, the time duration of the default CORESET is the interval between the bit position and the least significant bit in the bit map.

[00174] In one or more of the above-disclosed methods, the UE monitors the CORESET on OFDM symbol(s) in a slot based on the bit map excluding the bit position and monitors the default CORESET on OFDM symbol(s) in the slot based on the bit position.

[00175] According to another method, the UE receives a signal indicating at least a bit map, wherein the bit map indicates at least one bit position or at least one contiguous bit position(s) with a value.

[00176] In one or more of the above-disclosed methods, the signal indicates a duration.

[00177] In one or more of the above-disclosed methods, the value is one.

[00178] In one or more of the above-disclosed methods, the duration is a time duration of a CORESET.

[00179] In one or more of the above-disclosed methods, the bit map comprises 14 bits.

[00180] In one or more of the above-disclosed methods, the most significant bit in the bit map represents the first OFDM symbol in a slot.

[00181] In one or more of the above-disclosed methods, the least significant bit in the bit map represents the last OFDM symbol in a slot.

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[00182] In one or more of the above-disclosed methods, the signal indicates a configuration of a CORESET.

[00183] In one or more of the above-disclosed methods, the signal is a PDCCH-config IE which is used to configure UE-specific PDCCH parameters.

[00184] In one or more of the above-disclosed methods, the UE monitors the CORESET on OFDM symbol(s) in a slot based on the bit map.

[00185] In one or more of the above-disclosed methods, the UE monitors the CORESET on OFDM symbol(s) in a slot based on the bit map and the duration.

[00186] In one or more of the above-disclosed methods, the number of the contiguous bit position(s) with the value indicates a time duration of a CORESET.

[00187] In one or more of the above-disclosed methods, if the number of the contiguous bit position(s) with the value is equal to the duration, the UE monitors the CORESET with the duration.

[00188] In one or more of the above-disclosed methods, if number of the contiguous bit position(s) with the value is smaller than the duration, the UE monitors the CORESET with the number of the contiguous bit position(s).

[00189] In one or more of the above-disclosed methods, if number of the contiguous bit position(s) with the value is larger than the duration and the number is multiple of the duration, the UE interprets the contiguous bit position(s) with the value as contiguous occasions for monitoring the CORESET with the duration.

[00190] In one or more of the above-disclosed methods, if number of the contiguous bit position(s) with the value is larger than the duration and the number is not multiple of the duration, the UE interprets the contiguous bit position(s) with the value as at least one occasion for monitoring the CORESET with the duration and a occasion for monitoring the CORESET with time duration equal to number of orphan bit of the contiguous bit position(s).

[00191] As those skilled in the art will appreciate, the various disclosed embodiments may be combined to form new embodiments and/or methods.

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[00192] FIG. 7 is a flow chart 700 according to one exemplary embodiment from the perspective of a network node. In step 705, the network node transmits a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map. In step 710, the network node is not allowed to transmit the signal such that an interval between two bit positions in the set in the bit map is smaller than a second duration.

[00193] In one embodiment, the second duration is the first duration.

[00194] In one embodiment, the second duration is the first duration minus one.

[00195] In one embodiment, the network is not allowed to transmit the signal indicating that the first duration is 2 and the bit map is 11000000000000.

[00196] In one embodiment, the interval between two bit positions in the set in the bit map shall be larger than or equal to the second duration.

[00197] In one embodiment, the network node is not allowed to transmit the signal such that interval between a bit position in the set in the bit map and the least significant bit position in the bit map is smaller than the second duration.

[00198] In one embodiment, the interval between a bit position in the set in the bit map and the least significant bit position in the bit map shall be larger than or equal to the second duration.

[00199] In one embodiment, the network node transmits a Physical Downlink Control Channel (PDCCH) candidate on monitoring occasion(s) of the CORESET.

[00200] In one embodiment, the slot duration comprises 14 OFDM symbols.

[00201] In one embodiment, the bit map comprises 14 bits.

[00202] In one embodiment, the signal indicates the configuration of the CORESET.

[00203] In one embodiment, the signal is PDCCH-config information element.

[00204] In one embodiment, the interval is the difference between two bit positions.

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[00205] In one embodiment, the interval is the number of bits between two bit positions.

[00206] FIG. 8 is a flow chart 800 according to one exemplary embodiment from the perspective of a network node. In step 805, the network node transmits a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map. In step 810, the network node is not allowed to transmit the signal such that interval between a bit position in the set in the bit map and the least significant bit position in the bit map is smaller than a second duration.

[00207] In one embodiment, the second duration is the first duration.

[00208] In one embodiment, the second duration is the first duration minus one.

[00209] In one embodiment, the network is not allowed to transmit the signal indicating that the first duration is 2 and the bit map is 00000000000001.

[00210] In one embodiment, the interval between a bit position in the set in the bit map and the least significant bit position in the bit map shall be larger than or equal to the second duration.

[00211] In one embodiment, the network node is not allowed to transmit the signal such that interval between two bit positions in the set in the bit map is smaller than the second duration.

[00212] In one embodiment, the network node transmits a Physical Downlink Control Channel (PDCCH) candidate on monitoring occasion(s) of the CORESET.

[00213] In one embodiment, the slot duration comprises 14 OFDM symbols.

[00214] In one embodiment, the bit map comprises 14 bits.

[00215] In one embodiment, the signal indicates the configuration of the CORESET.

[00216] In one embodiment, the signal is PDCCH-config information element.

[00217] In one embodiment, the interval is the difference between two bit positions.

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[00218] In one embodiment, the interval is the number of bits between two bit positions.

[00219] Referring back to FIGS. 3 and 4, in one embodiment, the device 300 includes a program code 312 stored in memory 310. The CPU 308 could execute program code 312 (i) to transmit a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map, and (ii) is not allowed to transmit the signal such that an interval between two bit positions in the set in the bit map is smaller than a second duration.

[00220] In another aspect, the CPU 308 could execute program code 312 to (i) transmits a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map, and (ii) and is not allowed to transmit the signal such that interval between a bit position in the set in the bit map and the least significant bit position in the bit map is smaller than a second duration.

[00221] Furthermore, the CPU 308 can execute the program code 312 to perform all of the above-described actions and steps or others methods described herein.

[00222] The above-disclosed methods provide a restriction of a configuration of a CORESET so that UEs can avoid handling ambiguous configurations. Additionally, the various above-disclosed methods can help UEs handle ambiguous configurations.

[00223] Various aspects of the disclosure have been described above. It should be apparent that the teachings herein may be embodied in a wide variety of forms and that any specific structure, function, or both being disclosed herein is merely representative. Based on the teachings herein one skilled in the art should appreciate that an aspect disclosed herein may be implemented independently of any other aspects and that two or more of these aspects may be combined in various ways. For example, an apparatus may be implemented or a method may be practiced using any number of the aspects set forth herein. In addition, such an apparatus may be implemented or such a method may be practiced using other structure, functionality, or structure and functionality in addition to or other than one or more of the aspects set forth herein. As an

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example of some of the above concepts, in some aspects concurrent channels may be established based on pulse repetition frequencies. In some aspects concurrent channels may be established based on pulse position or offsets. In some aspects concurrent channels may be established based on time hopping sequences.

[00224] Those of skill in the art would understand that information and signals may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the above description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[00225] Those of skill would further appreciate that the various illustrative logical blocks, modules, processors, means, circuits, and algorithm steps described in connection with the aspects disclosed herein may be implemented as electronic hardware (e.g., a digital implementation, an analog implementation, or a combination of the two, which may be designed using source coding or some other technique), various forms of program or design code incorporating instructions (which may be referred to herein, for convenience, as "software" or a "software module"), or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present disclosure.

[00226] In addition, the various illustrative logical blocks, modules, and circuits described in connection with the aspects disclosed herein may be implemented within or performed by an integrated circuit ("IC"), an access terminal, or an access point. The IC may comprise a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, electrical components, optical components, mechanical components, or any combination thereof designed to perform the

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functions described herein, and may execute codes or instructions that reside within the IC, outside of the IC, or both. A general purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[00227] It is understood that any specific order or hierarchy of steps in any disclosed process is an example of a sample approach. Based upon design preferences, it is understood that the specific order or hierarchy of steps in the processes may be rearranged while remaining within the scope of the present disclosure. The accompanying method claims present elements of the various steps in a sample order, and are not meant to be limited to the specific order or hierarchy presented.

[00228] The steps of a method or algorithm described in connection with the aspects disclosed herein may be embodied directly in hardware, in a software module executed by a processor, or in a combination of the two. A software module (e.g., including executable instructions and related data) and other data may reside in a data memory such as RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, a hard disk, a removable disk, a CD-ROM, or any other form of computer-readable storage medium known in the art. A sample storage medium may be coupled to a machine such as, for example, a computer/processor (which may be referred to herein, for convenience, as a "processor") such the processor can read information (e.g., code) from and write information to the storage medium. A sample storage medium may be integral to the processor. The processor and the storage medium may reside in an ASIC. The ASIC may reside in user equipment. In the alternative, the processor and the storage medium may reside as discrete components in user equipment. Moreover, in some aspects any suitable computer-program product may comprise a computer-readable medium comprising codes relating to one or more of the aspects of the disclosure. In some aspects a computer program product may comprise packaging materials.

[00229] While the invention has been described in connection with various aspects, it will be understood that the invention is capable of further modifications. This application is intended

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to cover any variations, uses or adaptation of the invention following, in general, the principles of the invention, and including such departures from the present disclosure as come within the known and customary practice within the art to which the invention pertains.

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CLAIMS

1. A method of a network node, the method comprising:

transmitting a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map; and

not allowing to transmit the signal such that an interval between two bit positions in the set in the bit map is smaller than a second duration.

2. The method of claim 1, wherein the second duration is the first duration.

3. The method of claim 1, wherein the second duration is the first duration minus one.

4. The method of claim 1, wherein the network node is not allowed to transmit the signal indicating that the first duration is 2 and the bit map is 11000000000000.

5. The method of claim 1, wherein the interval between two bit positions in the set in the bit map shall be larger than or equal to the second duration.

6. The method of claim 1, wherein the network node is not allowed to transmit the signal such that interval between a bit position in the set in the bit map and the least significant bit position in the bit map is smaller than the second duration.

7. The method of claim 1, wherein the interval between a bit position in the set in the bit map and the least significant bit position in the bit map shall be larger than or equal to the second duration.

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8. The method of claim 1, wherein the network node transmits a Physical Downlink Control Channel (PDCCH) candidate on monitoring occasion(s) of the CORESET.

9. The method of claim 1, wherein the signal indicates the configuration of the CORESET.

10. The method of claim 1, wherein the signal is PDCCH-config information element.

11. The method of claim 1, wherein the interval is the difference between two bit positions.

12. The method of claim 1, wherein the interval is number of bits between two bit positions.

13. A method of a network node, the method comprising:

transmitting a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map; and

not allowing to transmit the signal such that interval between a bit position in the set in the bit map and the least significant bit position in the bit map is smaller than a second duration.

14. The method of claim 13, wherein the second duration is the first duration.

15. The method of claim 13, wherein the second duration is the first duration minus one.

16. The method of claim 13, wherein the network node is not allowed to transmit the signal indicating that the first duration is 2 and the bit map is 00000000000001.

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17. The method of claim 13, wherein the interval between a bit position in the set in the bit map and the least significant bit position in the bit map shall be larger than or equal to the second duration.

18. The method of claim 13, wherein the network node is not allowed to transmit the signal such that interval between two bit positions in the set in the bit map is smaller than the second duration.

19. The method of claim 13, wherein the network node transmits a Physical Downlink Control Channel (PDCCH) candidate on monitoring occasion(s) of the CORESET.

20. The method of claim 13, wherein the signal indicates the configuration of the CORESET.

21. The method of claim 13, wherein the signal is PDCCH-config information element.

22. The method of claim 13, wherein the interval is the difference between two bit positions.

23. The method of claim 13, wherein the interval is number of bits between two bit positions.

24. A network node, comprising:

a control circuit;

a processor installed in the control circuit; and

a memory installed in the control circuit and coupled to the processor;

wherein the processor is configured to execute a program code stored in the memory to:

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transmit a signal indicating at least a duration and a bit map, wherein the duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map; and

not allow the network to transmit the signal such that an interval between two bit positions in the set in the bit map is smaller than the duration.

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ABSTRACT

Methods and apparatuses for providing control resource set configuration in a wireless communication system are disclosed herein. In one method, a network node transmits a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map. The network node is not allowed to transmit the signal such that an interval between two bit positions in the set in the bit map is smaller than a second duration.

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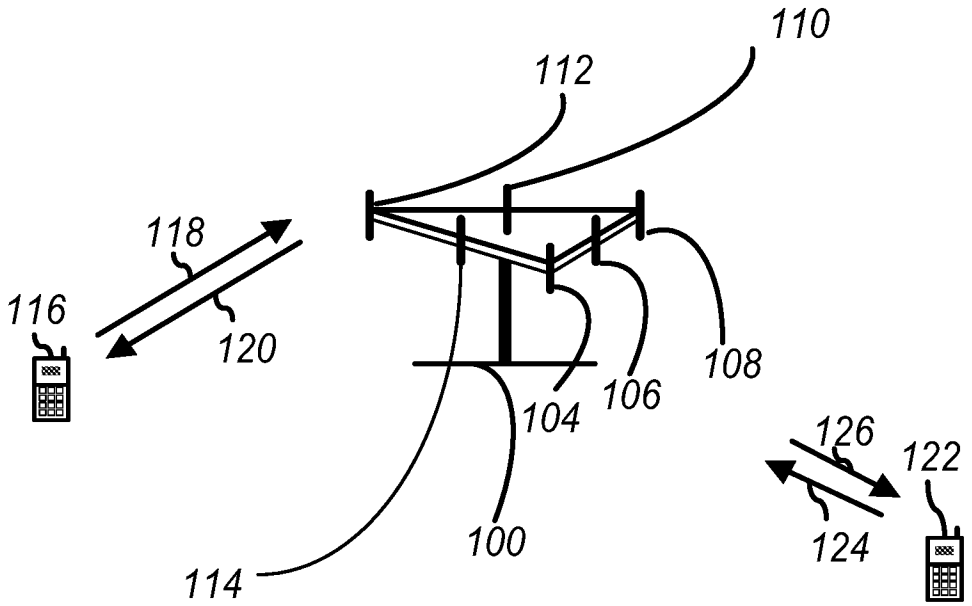


FIG. 1

Petitioners' Exhibit 1010, p. 400
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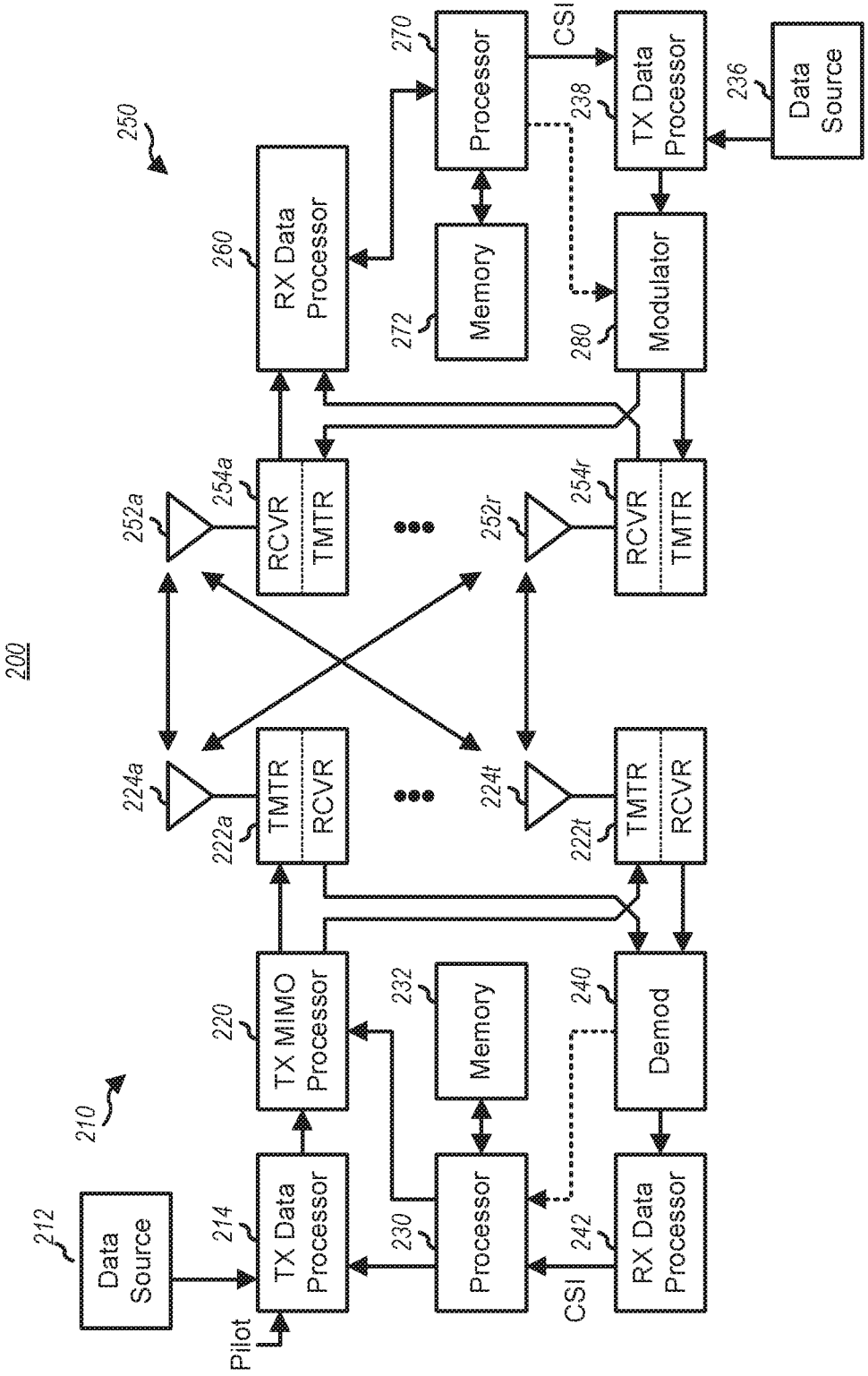

200
210
212
Data Source
214
TX Data Processor
Pilot
220
TX MIMO Processor
222a
TMTR
RCVR
224a
224t
222t
230
Processor
232
Memory
240
Demod
242
RX Data Processor
CSI
250
252a
254a
RCVR
TMTR
252r
254r
260
RX Data Processor
270
Processor
272
Memory
280
Modulator
238
CSI
TX Data Processor
236
Data Source

FIG. 2

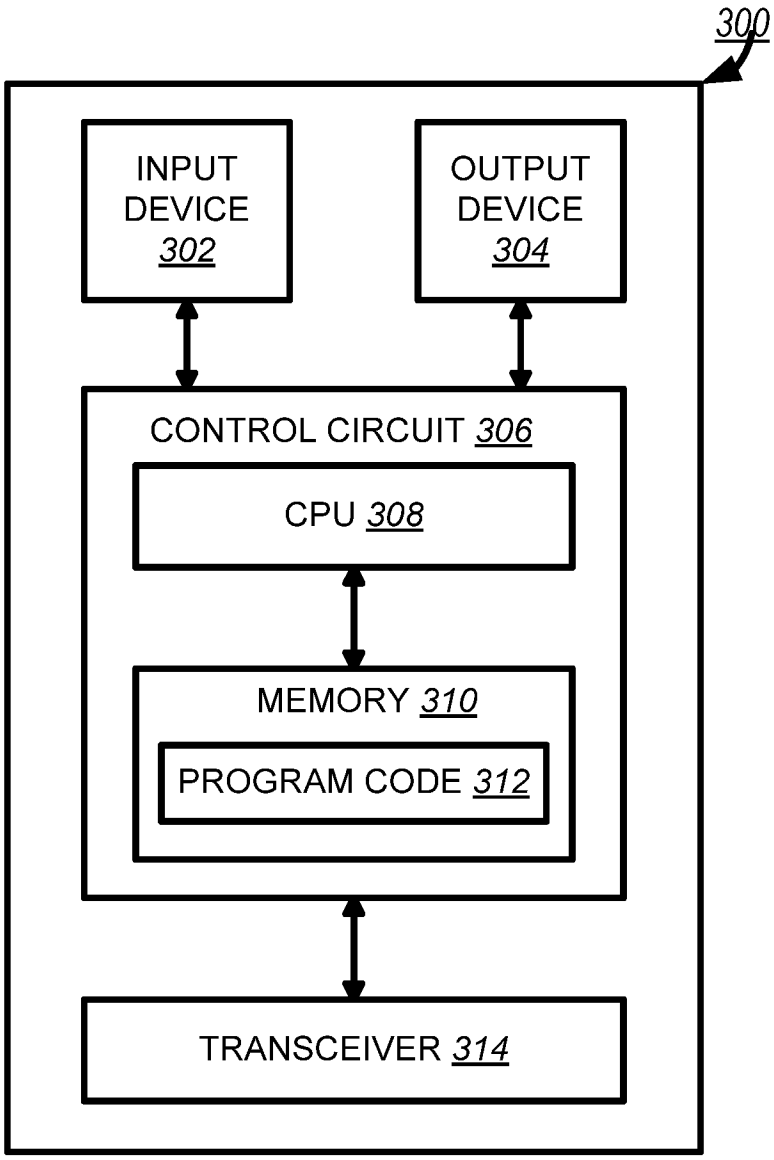

300
INPUT DEVICE 302
OUTPUT DEVICE 304
CONTROL CIRCUIT 306
CPU 308
MEMORY 310
PROGRAM CODE 312
TRANSCEIVER 314

FIG. 3

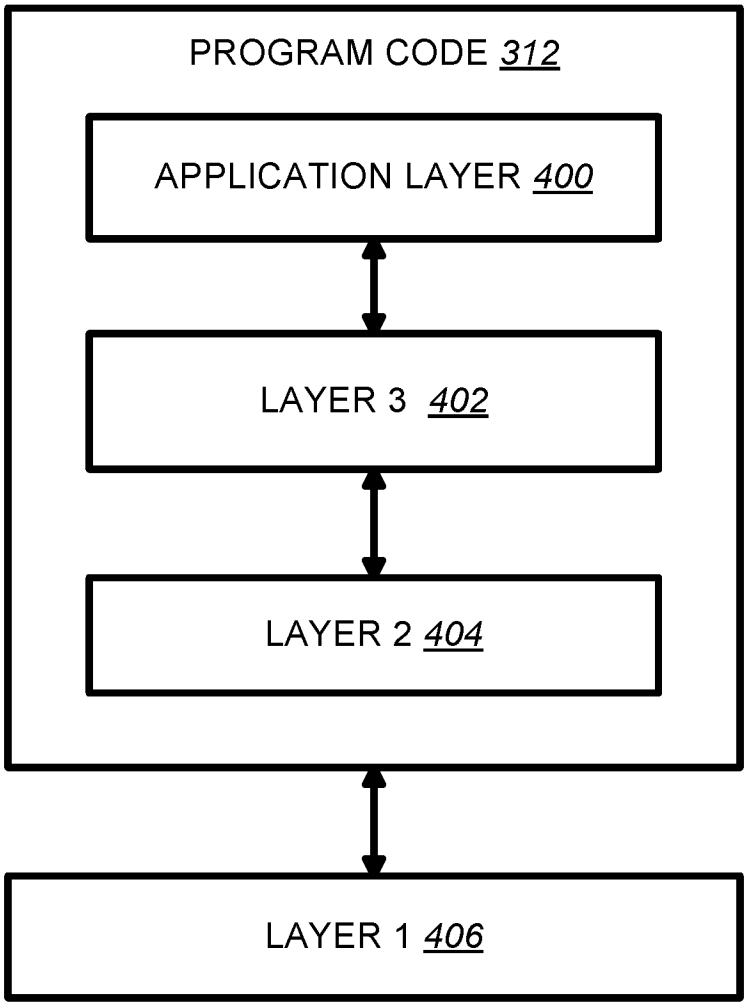

PROGRAM CODE 312
APPLICATION LAYER 400
LAYER 3 402
LAYER 2 404
LAYER 1 406

FIG. 4

Table 7.3.2.1-1: Supported PDCCH aggregation levels.

• Aggregation level	• Number of CCEs
• 1	• 1
• 2	• 2
• 4	• 4
• 8	• 8
• 16	• 16

FIG. 5 (PRIOR ART)

• CCE Aggregation Level	• Number of Candidates
★ 4	★ 4
★ 8	★ 2
★ 16	★ X

FIG. 6 (PRIOR ART)

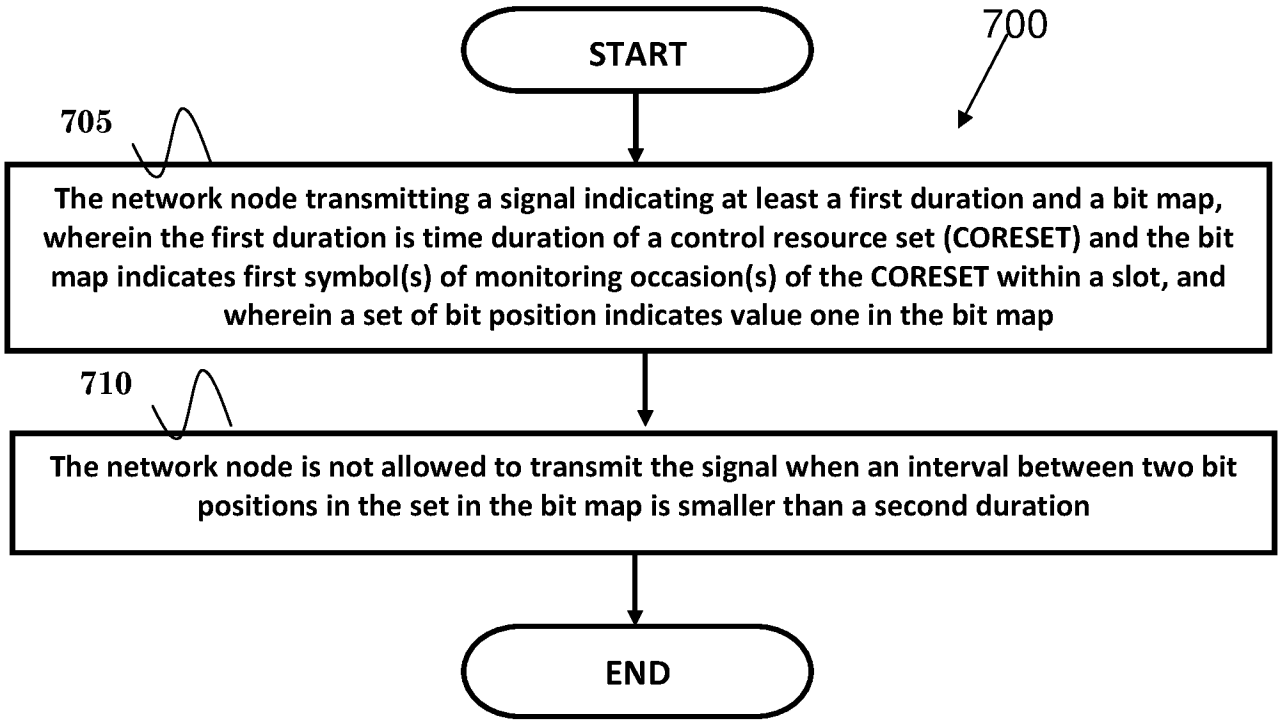

START
700
705
The network node transmitting a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map
710
The network node is not allowed to transmit the signal when an interval between two bit positions in the set in the bit map is smaller than a second duration
END

FIG. 7

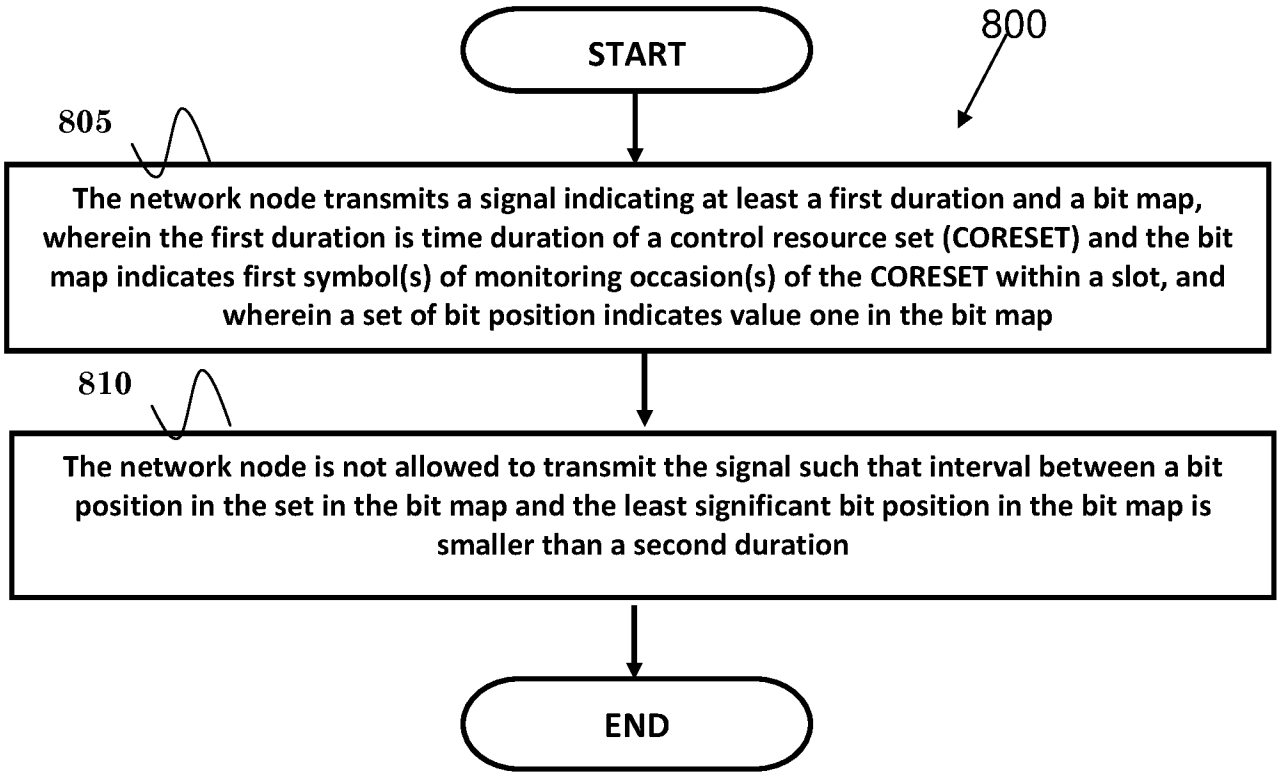

START
800
805
The network node transmits a signal indicating at least a first duration and a bit map, wherein the first duration is time duration of a control resource set (CORESET) and the bit map indicates first symbol(s) of monitoring occasion(s) of the CORESET within a slot, and wherein a set of bit position indicates value one in the bit map
810
The network node is not allowed to transmit the signal such that interval between a bit position in the set in the bit map and the least significant bit position in the bit map is smaller than a second duration
END

FIG. 8

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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 FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
- [ ] United States application or PCT international application number _____

  filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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.

LEGAL NAME OF INVENTOR

Inventor: Huang, Chun-Wei Date (Optional): Dec. 6. 2018

Signature: Huang, Chun-Wei

Note: An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/SB/AIA01 form for each additional inventor.

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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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 FOR PROVIDING CONTROL RESOURCE SET CONFIGURATION IN A WIRELESS COMMUNICATION SYSTEM

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
- [ ] United States application or PCT international application number _____ filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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LEGAL NAME OF INVENTOR

Inventor: Lin, Ko-chiang Date (Optional): 2018.12.6.

Signature: Lin, Ko-Chiang

Note: An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/SB/AIA01 form for each additional inventor.

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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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	1426-283.101
First Named Inventor	Chun-Wei Huang
Title	Method and Apparatus for Providing Control Resource Set Configuration ..
Priority Mail Express® Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**

1. [✓] **Fee Transmittal Form** (PTO/SB/17 or equivalent)
2. [ ] **Applicant asserts small entity status.** See 37 CFR 1.27
3. [ ] **Applicant certifies micro entity status.** See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
4. [✓] **Specification** [*Total Pages* 64] Both the claims and abstract must start on a new page. *(See MPEP § 608.01(a) for information on the preferred arrangement)*
5. [✓] **Drawing(s)** (35 U.S.C. 113) [*Total Sheets* 7]
6. **Inventor's Oath or Declaration** [*Total Pages* 2] *(including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e))*
   a. [✓] Newly executed (original or copy)
   b. [ ] A copy from a prior application (37 CFR 1.63(d))
7. [✓] **Application Data Sheet** ** See note below.* See 37 CFR 1.76 (PTO/AIA/14 or equivalent)
8. **CD-ROM or CD-R** in duplicate, large table, or Computer Program (*Appendix*)
   [ ] Landscape Table on CD
9. **Nucleotide and/or Amino Acid Sequence Submission** (*if applicable, items a. – c. are required*)
   a. [ ] Computer Readable Form (CRF)
   b. [ ] Specification Sequence Listing on:
      i. [ ] CD-ROM or CD-R (2 copies); or
      ii. [ ] Paper
   c. [ ] Statements verifying identity of above copies

ACCOMPANYING APPLICATION PAPERS

10. [ ] **Assignment Papers** (cover sheet & document(s))
    Name of Assignee _____
11. [ ] **37 CFR 3.73(c) Statement** (*when there is an assignee*) [✓] **Power of Attorney**
12. [ ] **English Translation Document** (*if applicable*)
13. [✓] **Information Disclosure Statement** (PTO/SB/08 or PTO-1449)
    [ ] Copies of citations attached
14. [ ] **Preliminary Amendment**
15. [ ] **Return Receipt Postcard** (*MPEP § 503*) (*Should be specifically itemized*)
16. [ ] **Certified Copy of Priority Document(s)** (*if foreign priority is claimed*)
17. [ ] **Nonpublication Request** Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.
18. [ ] **Other:** _____

Note:* (1) Benefit claims under 37 CFR 1.78 and foreign priority claims under 1.55 **must be included in an Application Data Sheet (ADS).
(2) For applications filed under 35 U.S.C. 111, the application must contain an ADS specifying the applicant if the applicant is an assignee, person to whom the inventor is under an obligation to assign, or person who otherwise shows sufficient proprietary interest in the matter. See 37 CFR 1.46(b).

19. CORRESPONDENCE ADDRESS

[✓] The address associated with Customer Number: 106622 **OR** [ ] Correspondence address below

Name					
Address					
City		State		Zip Code	
Country		Telephone		Email	

Signature	/Sang N. Dang/	Date	January 7, 2019
Name (Print/Type)	Sang N. Dang	Registration No. (Attorney/Agent)	51,186

This collection of information is required by 37 CFR 1.53(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.**

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FEE TRANSMITTAL

Complete if known	
Application Number	Not Yet Assigned
Filing Date	January 7, 2019
First Named Inventor	Chun-Wei Huang
Examiner Name	Not Yet Assigned
Art Unit	Not Yet Assigned
Practitioner Docket No.	1426-283.101

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29. Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

TOTAL AMOUNT OF PAYMENT ($) 2,120.00

METHOD OF PAYMENT (check all that apply)

☐ Check ☒ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): _____

☐ Deposit Account Deposit Account Number: _____ Deposit Account Name: _____

For the above-identified deposit account, the Director is hereby authorized to (check all that apply):

☐ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☐ Charge any additional fee(s) or underpayment of fee(s) under 37 CFR 1.16 and 1.17 ☐ Credit any overpayment of fee(s)

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES (U = undiscounted fee; S = small entity fee; M = micro entity fee)

	FILING FEES			SEARCH FEES			EXAMINATION FEES			
Application Type	U ($)	S ($)	M ($)	U ($)	S ($)	M ($)	U ($)	S ($)	M ($)	Fees Paid ($)
Utility	300	150*	75	660	330	165	760	380	190	1720
Design	200	100	50	160	80	40	600	300	150	
Plant	200	100	50	420	210	105	620	310	155	
Reissue	300	150	75	660	330	165	2,200	1,100	550	
Provisional	280	140	70	0	0	0	0	0	0	

* The $150 small entity status filing fee for a utility application is further reduced to $75 for a small entity status applicant who files the application via EFS-Web.

2. EXCESS CLAIM FEES

Fee Description	Undiscounted Fee ($)	Small Entity Fee ($)	Micro Entity Fee ($)
Each claim over 20 (including Reissues)	100	50	25
Each independent claim over 3 (including Reissues)	460	230	115
Multiple dependent claims	820	410	205

Total Claims		Extra Claims		Fee ($)		Fee Paid ($)
24	-20 or HP =	4	x	400	=	400

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims		Extra Claims		Fee ($)		Fee Paid ($)
3	-3 or HP =		x		=	

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims	
Fee ($)	Fee Paid ($)

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $400 ($200 for small entity) ($100 for micro entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets		Extra Sheets		Number of each additional 50 or fraction thereof		Fee ($)		Fee Paid ($)
71	- 100 =		/ 50 =		(round up to a whole number) x		=	

4. OTHER FEE(S) Fees Paid ($)

Non-English specification, $130 fee (no small or micro entity discount) _____

Non-electronic filing fee under 37 CFR 1.16(t) for a utility application, $400 fee ($200 small or micro entity) _____

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