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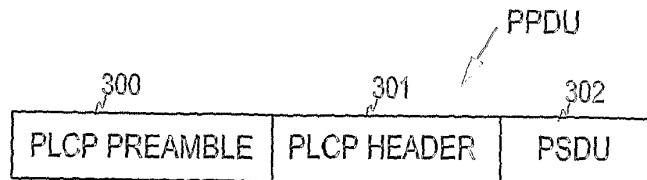
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(54) Title: REDUCTION OF POWER CONSUMPTION IN WIRELESS TERMINALS



the transmission rate of physical layer data units comprising a preamble, a header, and a payload portion so that the header is transmitted at a transmission rate higher than what is standardized for the header. The transmission rate of the header is preferably increased to the highest transmission rate standardized for the payload portion. In further embodiments of the invention further modifications of the MAC functionality are introduced, the embodiments further decreasing the packet transaction times.

(57) Abstract: The invention relates to a method for decreasing power consumption in a wireless terminal intended for a short-range wireless communication system. In the method the standard MAC functionality of a wireless terminal is modified so that packet transaction times become shorter thus reducing the power consumption and giving the terminal more time for the power save mode. This is accomplished by increasing

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REDUCTION OF POWER CONSUMPTION IN WIRELESS TERMINALS

Field of the Invention

The invention relates generally to wireless terminals intended for short-range,
5 beacon-based communication systems. More particularly, the present invention concerns a mechanism for decreasing power consumption in wireless terminals engaged in short-range, beacon-based communication.

Background of the Invention

10 The current development towards truly mobile computing and networking has brought on the evolvment of various access technologies that also provide the users with access to the Internet when they are outside their own home network. At present, wireless Internet access is typically based on either short-range wireless systems or mobile networks, or both.

15 Short-range wireless systems have a typical range of one hundred meters or less. They often combine with systems wired to the Internet to provide communication over long distances. The category of short-range wireless systems includes wireless personal area networks (PANs) and wireless local area networks (WLANs). They have the common feature of operating in
20 unlicensed portions of the radio spectrum, usually either in the 2.4 GHz Industrial, Scientific, and Medical (ISM) band or in the 5 GHz unlicensed band.

Wireless personal area networks use low cost, low power wireless devices that have a typical range of about ten meters. The best-known example of wireless personal area network technology is Bluetooth, which uses the 2.4 GHz ISM
25 band. It provides a peak air link speed of one Mbps, and power consumption low enough for use in personal, portable electronics such as PDAs and mobile phones. Wireless local area networks generally operate at higher peak speeds of 10 to 100 Mbps and have a longer range, which requires greater power consumption.

30 Wireless LAN systems are typically extensions of a wired network, providing mobile users with wireless access to the wired network. Examples of wireless local area network technology include the IEEE 802.11a, which is designed for the 5 GHz unlicensed band, and uses orthogonal frequency division

multiplexing (OFDM) to deliver up to 54 Mbps data rates; the 802.11b, which is designed for the 2.4 GHz ISM band and uses direct sequence spread spectrum (DSSS) to deliver up to 11 Mbps data rates; and the HIPERLAN Standard, which is designed to operate in the 5 GHz unlicensed band.

- 5 In wireless LAN technology, two basic network topologies are available for network configuration: an ad-hoc network and an infrastructure network. An ad-hoc network is formed by two or more independent mobile terminals without the services of a base station, i.e. in an ad-hoc network the terminals communicate on a peer-to-peer basis. An ad-hoc network is normally formed
- 10 for temporary purposes. The infrastructure network, in turn, comprises one or more wireless base stations, called access points, which form part of the wired infrastructure. In a typical network of this type, all traffic goes through the access points, regardless of whether the traffic is between two terminals or a terminal and the wired network, i.e. the mobile terminals do not communicate
- 15 on a peer-to-peer basis. The mobile terminals are provided with wireless LAN cards, whereby they can access the wired network or set up an ad-hoc network.

So far, WLAN (wireless LAN) technology has been used mainly in laptop computers, which are typically AC powered, but which may also be used in

20 battery mode that provides a fairly high battery capacity. To prolong the life of the batteries, the WLAN standards define a specific power save mode into which the terminals may enter in order to decrease their power consumption. In this mode the WLAN-specific power consumption is very low, but the terminals have to wake up (i.e. enter the active state) periodically to receive

25 regular beacon transmissions broadcast in the network. The beacon transmissions indicate, for example, whether there are incoming packets buffered for a terminal. If so, the terminal retrieves the packets, goes back to sleep, and wakes up again to listen to the next beacon transmission.

The current WLAN power management has been designed assuming that the

30 terminal devices are laptop type computers featuring a relatively high battery capacity. Along with the generalization of various other types of personal communication devices, such as intelligent phones, having a smaller size and thus also a lower battery capacity than laptop computers, power consumption has, however, become a critical issue when new properties are designed for

wireless systems and terminals. This development work is complicated by the fact that the capabilities of legacy terminals must be taken into account, which often translates to some sort of compromise. Emerging ad-hoc mode applications in which power consumption may be rather high further aggravate the problem. Examples of such applications are games played in small groups or business meetings in which large files may be shared (wirelessly) by the terminals.

The present invention seeks to accomplish a solution by means of which the above drawbacks can be alleviated or eliminated.

10

Summary of the Invention

The present invention seeks to devise a new mechanism for decreasing the power consumption in wireless terminals operating in short-range, beacon-based communication systems. The invention also seeks to bring about a MAC (Media Access Control) layer functionality which is optimized in terms of power consumption and which is particularly suitable for close proximity communication in ad-hoc networks where beacon frames are broadcast.

In the present invention, a wireless terminal is provided with a modified MAC layer functionality as compared to a standard WLAN terminal. The starting point of the invention is thus a standard WLAN functionality. This functionality is modified by shortening the transmission intervals of the terminal. The transmission of the physical layer frame is accelerated, contrary to the standard WLAN operation, so that the frame header is transmitted at the same high bit rate as the payload portion of the frame. This modification translates to shorter packet transaction intervals and to lower power consumption, while also allowing the terminals more time for the power save mode.

Thus one embodiment of the invention is the provision of a method for decreasing power consumption in a wireless terminal intended for a short-range communication system according to predefined system specifications, in which system beacon frames are broadcast at beacon intervals. The method includes the step of configuring the terminal to assemble data to be transmitted into data units including a preamble, a header and a payload portion, where the data units have a format according to the predefined system

specifications and where said system specifications include at least one dedicated transmission rate for the preamble, at least one dedicated transmission rate for the header, and at least one dedicated transmission rate for the payload portion. The method also includes configuring the terminal to
5 transmit the header at a first transmission rate higher than the at least one dedicated transmission rate for the header, thereby to reduce power consumption in the terminal, where said beacon frames are transmitted in the payload portions of said data units.

In another embodiment, the invention provides a wireless terminal for a
10 wireless communication system. The wireless terminal includes MAC layer functionalities and physical layer (PHY) functionalities, the MAC layer being configured to pass data to the physical layer, and the physical layer being configured to form data units comprising a preamble, a header and a payload portion, where the data units have a format according to predefined system
15 specifications, which include at least one dedicated transmission rate for the preamble, at least one dedicated transmission rate for the header, and at least one dedicated transmission rate for the payload portion. The terminal also includes a first operation mode in which the terminal is configured to transmit the header at a first transmission rate higher than the at least one dedicated
20 transmission rate for the header, thereby to reduce power consumption in the terminal, wherein said beacon frames are transmitted in the payload portions of said data units.

In further embodiments of the invention additional modifications are introduced into the MAC layer, the embodiments further shortening the transmission
25 intervals and reducing the power consumption of the terminal.

Other features and advantages of the invention will become apparent through reference to the following detailed description and accompanying drawings.

Brief Description of the Drawings

30 In the following, the invention and many of its embodiments are described more closely with reference to the examples shown in FIG. 1 to 9 in the appended drawings, wherein:

FIG. 1 illustrates a typical communication system according to the invention;

- FIG. 2 illustrates the MAC entity utilized in the present invention;
- FIG. 3 illustrates a transmission frame according to IEEE 802.11b standard;
- FIG. 4 illustrates a dual MAC terminal according to the invention;
- FIG. 5 is a flow diagram illustrating an embodiment of a terminal transmitting beacon frames;
- FIG. 6 is a flow diagram illustrating an embodiment of the operation of a terminal listening to the beacon transmissions;
- FIG. 7 illustrated a further modification according to the invention;
- FIG. 8 is a block diagram illustrating the basic elements of the terminal; and
- FIG. 9 illustrates a terminal intended for ad-hoc mode only.

Detailed Description of the Invention

The terminal of the invention is preferably based on the IEEE 802.11 standards for wireless local area networking. Furthermore, the terminals of the invention are preferably such that they can operate both in the infrastructure mode and in the ad-hoc mode, although it is also possible that they are only ad-hoc capable devices, as discussed below.

FIG. 1 illustrates a typical WLAN communication system. The system includes one or more WLAN networks 100, each connected by means of a gateway 101 (a router) to another network, such as the Internet, which contains service providers 102. Each WLAN network comprises one or more access points 103, each communicating wirelessly with the terminals within the coverage area, i.e. the cell, of the access point and thus forming a bridge between the terminals and the wired network.

In an infrastructure network an access point and at least one terminal is said to form a Basic Serving Set (BSS). A series of BSSs then forms an Extended Service Set (ESS). These BSSs are connected to each other by a Distribution System (DS), which can be a wired network, such as an Ethernet LAN, within which TCP/IP packets are transmitted, or a wireless network, or a combination of these two. However, the basic type of an IEEE 802.11 LAN is an Independent BSS (IBSS), which consists of two or more terminals. The terminals of an IBSS form an ad-hoc network 110. As the invention does not

relate to the architecture of the WLAN system, it is not discussed in more detail here.

The terminals may be portable computers, PDA equipment, intelligent phones or other such mobile terminals **120**. In the same way as an ordinary GSM telephone, the terminals can be made up of two parts: the actual subscriber device, e.g. a portable computer (with software), and a SIM (Subscriber Identity Module), whereby from the viewpoint of the network the subscriber device becomes a functioning terminal only when the SIM has been inserted into it. The SIM may be the subscriber identity module for use in the GSM (Global System of Mobile communications) network or in the UMTS (Universal Mobile Telecommunication System), for example. In the latter case it is termed the USIM (Universal Services Identity Module). However, the terminals may equally well be traditional WLAN terminals in which no SIM is used.

The system further typically contains an authentication server **130** of the WLAN network. The authentication server is connected to the above-mentioned gateway through a secured connection, which is typically a TCP/IP connection established through an operator network or through the Internet. As discussed below, in an infrastructure network the access points broadcast beacon messages **30**, while in an ad-hoc network the terminals share this responsibility.

As is known, the IEEE standard 802.11 defines the physical layer options and the MAC (Media Access Control) layer protocol for the wireless LAN. In the present invention, the MAC layer is modified to reduce the power consumption of the device and to obtain a solution that is particularly suitable for close proximity communication in ad-hoc mode.

FIG. 2 illustrates the protocol architecture of the IEEE 802.11 standard. As shown in the figure, the actual MAC protocol operates in the lower sub-layer of the second layer of the OSI layer model, which is the Data Link Layer (DLL). The MAC management layer supports the association and roaming functionalities and it further controls the power saving functions, the authentication and encryption mechanisms, and synchronization of the terminals, for example. The MAC management layer further maintains a MAC layer management database, i.e. the MIB (Management Information Base) of the MAC layer. The MAC layer cooperates with the physical management layer to maintain the database. Examples of the MAC layer attributes that can

be utilized in the present invention are RSSI (Received Signal Strength Indicator), which indicates the level of the received signal, and NF (Noise Floor), which indicates the interference level on the link.

The physical layer is divided into two sub-layers, which are the PLCP (Physical Layer Convergence Protocol) sub-layer and the PMD (Physical Medium Dependent) sub-layer. The purpose of the PLCP is to provide minimum dependence on the PMD in order to simplify the interface between the physical layer and the MAC layer. The PLCP sub-layer takes a frame that a terminal wishes to transmit and forms a PLCP Protocol Data Unit (PPDU), the format of which is illustrated in FIG. 3. The PPDU comprises three successive parts: a PLCP preamble 300, a PLCP header 301, and a PLCP Service Data Unit (PSDU) 302. The PSDU contains at least the header of the MAC frame. The IEEE 802.11b standard defines two different preambles and headers for the PPDU: a long preamble and header and a short preamble and header. According to the standard, the long preamble and header comprise 144 and 48 bits, respectively. As they are transmitted at 1 Mbit/s, the total processing time of the preamble and header is 196 μ s. The short preamble and header comprise 72 and 48 bits, respectively. The preamble is transmitted at 1 Mbit/s and the header at 2 Mbit/s. Consequently, the total processing time of the preamble and header is 96 μ s. In both PPDU formats, the actual payload, i.e. the PSDU, is transmitted at 1, 2, 5.5 or 11 Mbit/s.

In the present invention, both the long and short format may be used, although the short PPDU format is preferable, as it has a better performance in terms of overhead and data throughput as compared to the long format. In one embodiment of the invention, the standard functionality described above is modified so that only the highest available data rate, i.e. 11 Mbit/s in this case, is used for the header and the payload portion. In other words, unlike in standard IEEE 802.11b WLAN, the PLCP headers are also transmitted in the high bit rate mode. As the preamble serves to synchronize the receiver, it is transmitted at the standardized rate.

In the invention the range is thus compromised (the coverage is better at a lower rate) in favor of power consumption. This can be done as the modified MAC functionality of the invention is mainly intended for close proximity communication. The modified MAC layer transmits the PLCP headers at an accelerated rate, which preferably corresponds to the highest rate available for the PSDUs. By accelerating the transmission of the header contrary to the

WLAN specifications, the processing time of the data packets can be made shorter than in the standard MAC layer. The shorter transmission intervals (i.e. shorter packet transaction intervals) obtained in this way translate to lower battery consumption, while also allowing the terminal more time for the sleep mode. The modification also simplifies the implementation of the MAC functionality, since a link quality analysis is no longer needed for controlling the transmission rate.

In one embodiment of the invention the WLAN terminal is provided with a dual MAC layer as illustrated in FIG. 4. The first MAC layer 40 provides standard WLAN operation, while the second MAC layer 41 is the modified MAC layer of the invention. The modified MAC layer is in this context termed the Proximity MAC (PMAC). The standard MAC layer is used for accessing standard WLAN networks through access points and other standard WLAN devices, while the PMAC layer 41 is used in ad-hoc networking, i.e. in close proximity communication on a terminal-to-terminal basis. The entity controlling the operation of the (P)MAC and physical layers is in this context termed the WLAN engine. The term thus refers to an entity that includes WLAN-specific control information and controls the said two sub-layers. The two MAC layers preferably use the same RF resources. Consequently, both MAC layers cannot be operated at the same time since in that case one layer would cause interference to the other. As discussed below, the user may select the operation mode by enabling/disabling one of the MAC layers at each time through the user interface.

It is to be noted here that in this context the PMAC refers to the layer comprising the modifications of the invention. Therefore, the interface between the PMAC, which also includes MAC management functions, and the physical layer does not necessarily correspond to the interface between the standard MAC layer and the physical layer, as the modification may relate to the physical layer also. As shown above, the basic modification is such that the transmission rate is raised, although the physical layer frame structure remains in standard format.

In some embodiments of the invention the above PMAC layer is further modified with respect to beacon broadcasts. As is known, in WLAN networks beacon frames are periodically broadcast to enable the terminals to establish and maintain communications in an orderly fashion. In the infrastructure networks, each access point sends beacon frames at regular intervals. In an

ad-hoc network, where no access points exist, one of the wireless terminals assumes the responsibility of sending the beacon frame. Having received a beacon frame, each terminal waits for the beacon interval and then broadcasts a beacon frame if any other terminal does not do so after a random time delay
5 calculated by the terminal. The purpose of the random time delay is to circulate the broadcast responsibility among the terminals of the ad-hoc network. In one embodiment of the modified MAC layer of the invention, the broadcasting of the beacon is changed so that the terminal that instantiates the network (other terminals will join) continues as the beacon broadcaster and
10 maintains the beacon interval in the network. In other words, the responsibility of beacon broadcasting will not circulate, but the initiator of the ad-hoc network remains as a centralized beacon broadcaster. By prohibiting the circulation of the broadcasting turns during the normal operation of the ad-hoc network, all the terminals, except the one broadcasting the beacon, may save their battery.
15 The modification may also allow a decrease in the beacon transmission power, since the point of beacon transmission does not any more circulate at the boundaries of the network, but moves only if the relevant terminal moves.

In this embodiment the power consumption of the initiating node is thus sacrificed to save the batteries of the other terminals. However, the initiating
20 node may also reduce its power consumption, as compared to the use of fixed beacon intervals, by using an adaptive beacon interval the length of which depends on the load detected by the terminal transmitting the beacon.

The use of an adaptive beacon interval is illustrated in FIG. 5, which illustrates the control of the beacon interval during normal operation. The terminal
25 transmitting the beacon frequently defines the current load (step 50), compares the defined load to the previously defined load (step 51), and changes the length of the beacon interval if the load has changed enough. If the load has decreased enough, the beacon interval is decreased (step 54) and if the load has increased enough, the beacon interval is increased (step
30 55). The load can be measured as the channel utilization level, for example.

In another embodiment of the invention, the centralized beacon broadcasting is combined with the traditional distributed mode to form a "semi-centralized" mode, in which the broadcasting terminal is changed after every N ($N > 1$) beacon frames. This mode converts to the centralized mode when N becomes
35 infinite.

If an adaptive beacon interval is utilized in connection with centralized or "semi-centralized" modes, the beacon interval may be decreased and increased by adding beacon transmission moments between fixed beacon transmission moments and by removing beacon transmission moments from
5 between fixed transmission moments, respectively. The transmission moments are added and removed so that all the transmission moments are evenly distributed in the time domain. A beacon transmission method like this is disclosed in a co-pending U.S. Patent Application Serial No. 10/400 233, filed on March 25, 2003. However, the method disclosed in said U.S. Patent
10 Application is intended for access points.

In case the terminal transmitting the beacon frames disappears from the ad-hoc network, rules are defined in the PMAC layer for transferring the responsibility to another terminal.

FIG. 6 illustrates one embodiment for the beacon monitoring operation of a
15 terminal other than the current beacon broadcaster. In this embodiment each of said other terminals monitors the beacon transmission moments (step 60) and if a beacon is not received at the end of the beacon interval, the terminal starts a random time delay (step 62). During this delay the terminal monitors the traffic in the network in order to detect, whether another terminal with a
20 shorter time delay starts to send the beacon or whether there is data traffic on the channel (step 63). When the random delay period elapses, the terminal starts to transmit the beacon signal provided that no other terminal starts the transmission earlier during the delay period, and provided that no traffic is received from the channel. The monitoring of the traffic is a precautionary
25 measure to prevent an event in which the terminal starts to send a beacon when moving temporarily so far from the beacon transmitting terminal that it cannot receive the beacon (although it can hear the traffic of the network).

The transfer of the beacon transmission responsibility may also be based on a priority list, which is stored in each terminal. The terminal transmitting the
30 beacon may compile and maintain the list, and transmit it to the other terminals in the beacon frame. If the terminal that has the highest priority in the list detects that the beacon has disappeared from the network, it starts to transmit the beacon, after which the other terminals join the network. The list may include the MAC addresses of the terminals, for example.

35 In a still further embodiment of the invention, an additional modification is

made to further decrease the transmission intervals of the terminal. This is performed by increasing the proportion of payload data in the data to be transmitted. This is accomplished by utilizing layer 2 (data link layer) frames, i.e. Ethernet frames, without IP and TCP/UDP headers. In other words, application data is written directly to layer 2 frame, i.e. omitting the layers between the application layer and layer 2. This is illustrated in FIG. 7 showing a layer 2 frame. The frame is constructed by encapsulating an application level data unit including user data and an application header into an Ethernet frame by adding an Ethernet header and trailer to the application level data unit. The use of this embodiment thus means that the Ethernet frame does not carry network and transport layer headers (i.e. IP and TCP headers), whereby the proportion of payload data in the transmitted frame is increased. In this embodiment, the addressing is based on terminal-specific MAC addresses. The MAC addresses can be used, since no routing (i.e. IP addresses) is needed in the ad-hoc network, where the terminals communicate on a peer-to-peer basis. By decreasing the amount of overhead the throughput times can be made shorter, whereby power consumption is reduced and the terminals have more time for the sleep mode. The gain achieved by this modification depends greatly on the application used. The gain is greatest in applications that use a lot of short packets. Examples of such applications are network games, which send a lot of control packets of only 60 to 150 bytes. In this case the decrease in overhead, which is achieved by omitting the IP and TCP/UDP protocols, is significant, about half of the packet size. The transmission/reception times are thereby significantly shorter, which reduces the power consumption and gives the terminal more time for the power save mode.

The drawback related to the above modification is that an application modified in the above manner is compatible only with terminals modified similarly, i.e. not necessarily with conventional terminals.

In a still further embodiment of the invention, dynamic power control is utilized to further reduce power consumption in the terminals. Each terminal may measure the power received from the terminal it is communicating with, and adjust its own transmission power according to the power measured. This may be implemented, for example, by dividing the power range into successive sub-ranges, and adjusting the transmission power according to the sub-range to which the RSSI measured on the link concerned belongs. In this way, the

transmission power can be decreased when the measured RSSI value increases and increased when the measured RSSI value decreases. Since the PMAC is typically used in an environment where the terminals are close to each other, the transmission power will be very low. As some terminals may
5 also access through an access point located in the neighborhood, the above-mentioned NF attribute may be used for evaluating the interference level and the signal-to-noise ratio on the channel. Based on the detected interference level, the transmission power may be increased, or the terminals may switch to another channel having a lower interference level.

10 FIG. 8 illustrates the basic elements of the terminal. The mobile terminal 800 comprises a transceiver 801 provided with at least one antenna 802, a control unit 803, user interface means 804 for creating a user interface through which the user can operate the terminal, and memory means 805, which may include one or more smart cards 806, such as a SIM card. However, as discussed
15 above, a SIM card is not included in a traditional WLAN terminal. The control information needed by the PMAC is stored in the memory of the terminal and the control unit performs the basic functions described above, i.e. the modified MAC functions, as well as the standard MAC functions if the terminal is a dual MAC terminal. With the user interface means the user may select, for
20 example, the operation mode. In view of user-friendliness, it is also preferable that the user interface means allow the user to address each terminal with an address/identifier that is easier to remember and use than the above-mentioned MAC address. Such an address may be the first name of the user of the terminal, for example. The name is thus linked to the corresponding
25 MAC address in the user interface means and it hides the MAC address from the user.

As described above, the terminal preferably includes a dual MAC layer functionality in such a manner that one MAC layer provides standard WLAN functions and the other MAC layer provides the modified functions of the
30 invention. This kind of terminal is typically a multimode mobile terminal capable of accessing network services through a mobile communication network or through a WLAN network. In the ad-hoc mode, the terminal may utilize the PMAC functionality of the invention. However, the terminal may be provided with the modified MAC functionality only, if it is intended for ad-hoc mode only.
35 Examples of such devices could be various game terminals, payment terminals communicating with vending machines, or electronic notepads that

may exchange files with other terminals. This kind of terminal is illustrated in FIG. 9.

Although the invention was described above with reference to the examples shown in the appended drawings, it is obvious that the invention is not limited
5 to these, but may be modified by those skilled in the art without departing from the scope and spirit of the invention. For example, the terminals may use known mechanisms to detect access points in the neighborhood and may use known mechanisms for joining to and leaving from the ad-hoc network.

Claims:

1. A method for decreasing power consumption in a wireless terminal intended for a short-range communication system according to predefined system specifications, in which system beacon frames are broadcast at beacon intervals, the method comprising the steps of:
 - configuring the terminal to assemble data to be transmitted into data units including a preamble, a header and a payload portion, the data units having a format according to the predefined system specifications, wherein said system specifications include at least one dedicated transmission rate for the preamble, at least one dedicated transmission rate for the header, and at least one dedicated transmission rate for the payload portion; and
 - configuring the terminal to transmit the header at a first transmission rate higher than the at least one dedicated transmission rate for the header, thereby to reduce power consumption in the terminal, wherein said beacon frames are transmitted in the payload portions of said data units.
2. A method according to claim 1, wherein said first transmission rate corresponds to one of the at least one dedicated transmission rate for the payload portion.
3. A method according to claim 2, wherein the one of the at least one dedicated transmission rate for the payload portion is the highest dedicated transmission rate for the payload portion.
4. A method according to claim 1, further comprising a step of configuring the terminal to start broadcasting said beacon frames upon instantiation of an ad-hoc network by the terminal, and to maintain said broadcasting in a centralized manner.
5. A method according to claim 1, further comprising a step of configuring the terminal to start broadcasting said beacon frames at a predetermined moment of time and to maintain said broadcasting for a predetermined interval.
6. A method according to claim 4, further comprising a step of configuring the terminal to measure its load, and to control said beacon interval in response to the load measured.
7. A method according to claim 4, further comprising a step of

configuring the terminal to transfer data in packets failing to include network and transport layer headers, the packets being carried in the payload portions.

8. A method according to claim 4, further comprising a step of configuring the terminal to monitor a signal level received from another
5 terminal and to control the power at which said data units are transmitted to said another terminal, the power being controlled dependent on the signal level monitored.

9. A method according to claim 1, wherein said predefined system specifications are according to IEEE 802.11b standard.

10 10. A method according to claim 1, wherein the step of configuring the terminal to transmit the header at a first transmission rate higher than the at least one dedicated transmission rate for the header relates to an ad-hoc mode of the terminal.

11. A wireless terminal for a wireless communication system where
15 beacon frames are broadcast, the wireless terminal comprising:

Media Access Control (MAC) layer functionalities and physical layer (PHY) functionalities, the Media Access Control layer being configured to pass data to the physical layer, and the physical layer being configured to form data units comprising a preamble, a header and a payload portion, the data units
20 having a format according to predefined system specifications, which include at least one dedicated transmission rate for the preamble, at least one dedicated transmission rate for the header, and at least one dedicated transmission rate for the payload portion; and

a first operation mode in which the terminal is configured to transmit
25 the header at a first transmission rate higher than the at least one dedicated transmission rate for the header, thereby to reduce power consumption in the terminal, wherein said beacon frames are transmitted in the payload portions of said data units.

12. A wireless terminal according to claim 11, wherein the first
30 transmission rate corresponds to one of said at least one dedicated transmission rate for the payload portion.

13. A wireless terminal according to claim 12, wherein the one of said at least one dedicated transmission rate for the payload portion is the highest dedicated transmission rate for the payload portion.

35 14. A wireless terminal according to claim 11, further comprising

another operation mode in which the terminal is configured to transmit the header at the least one dedicated transmission rate for the header.

5 **15.** A wireless terminal according to claim **11**, wherein the terminal is configured, in the first operation mode, (1) to start broadcasting of beacons frames at beacon intervals upon instantiation of an ad-hoc network by the terminal, and (2) to maintain the broadcasting after said instantiation.

10 **16.** A wireless terminal according to claim **11**, wherein the terminal is configured, in the first operation mode, (1) to start broadcasting of beacons frames at beacon intervals at a predetermined moment of time, and (2) to maintain the broadcasting for a predetermined interval.

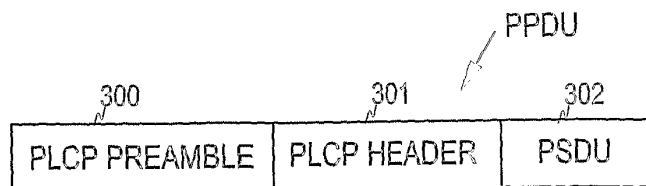
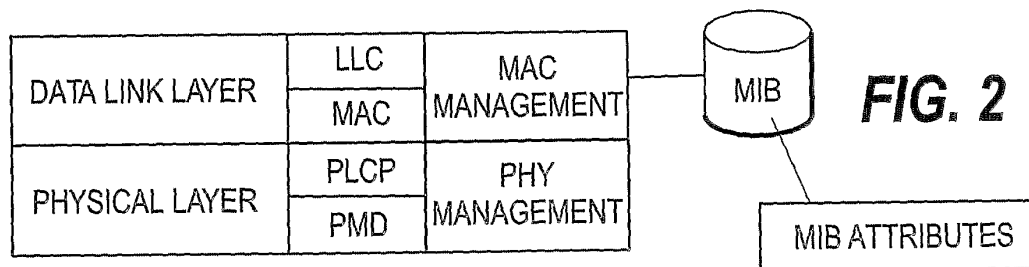
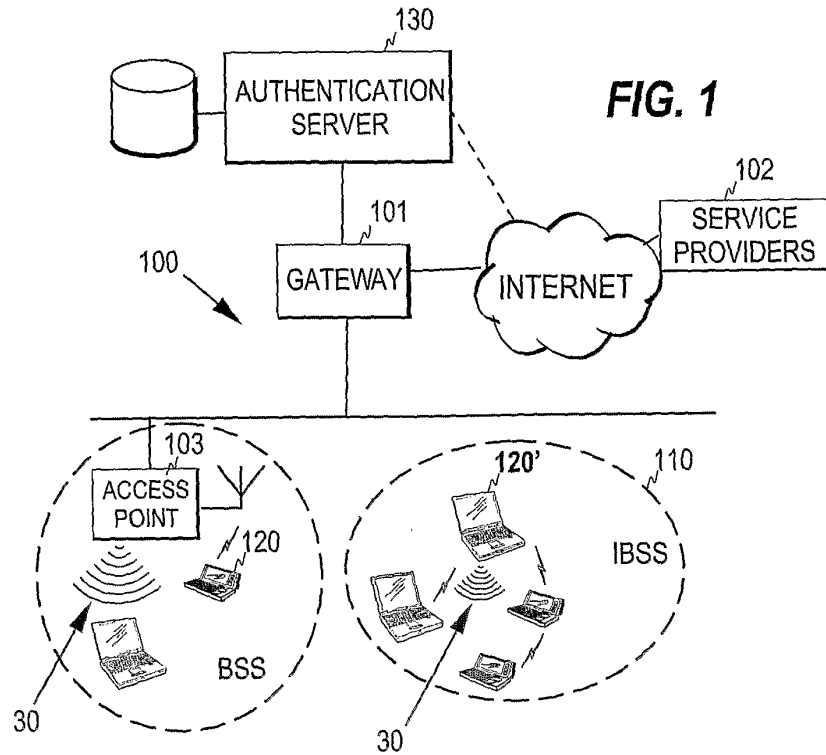
17. A wireless terminal according to claim **16**, wherein the terminal is configured, in the first operation mode, to measure its load, and to control said intervals in response to the load measured.

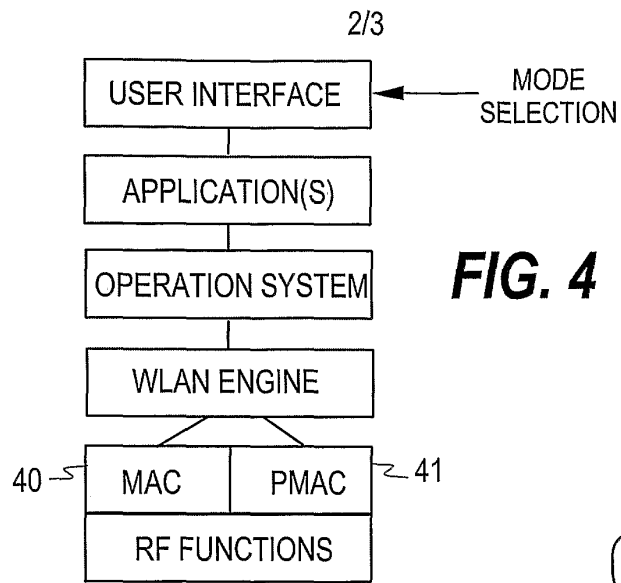
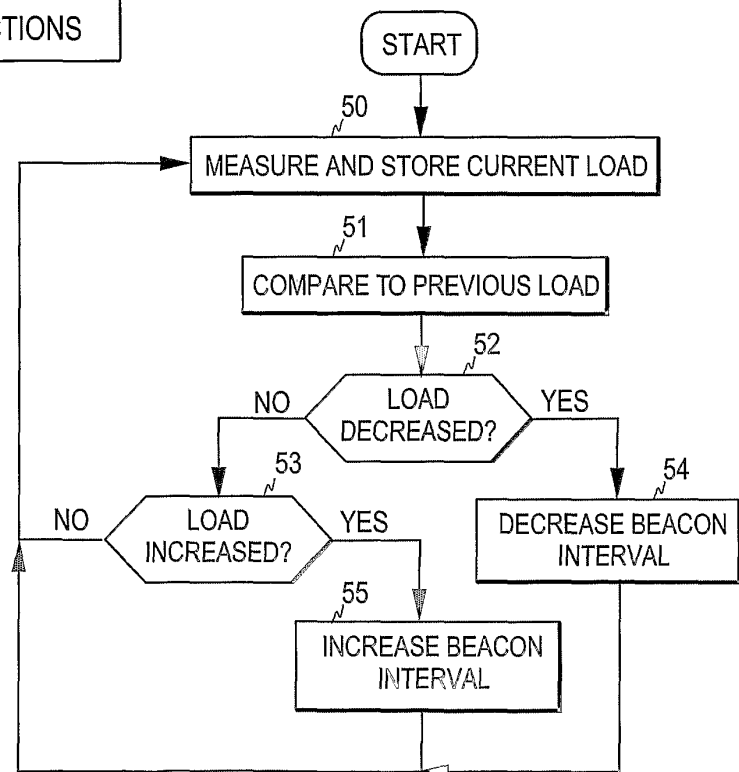
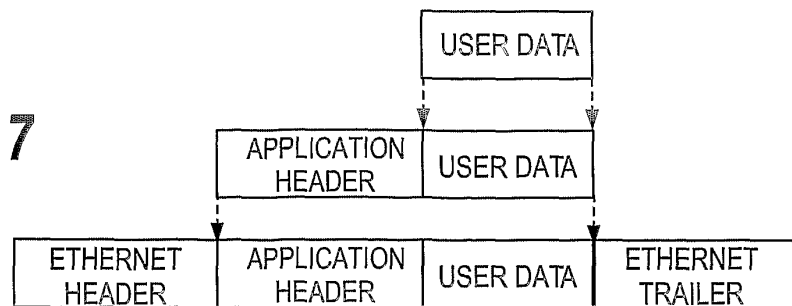
15 **18.** A wireless terminal according to claim **11**, wherein the terminal is configured, in the first operation mode, to transfer data in packets failing to include network and transport layer headers, the packets being carried in the payload portions.

20 **19.** A wireless terminal according to claim **15**, wherein the terminal comprises a first and a second MAC layer entity, the first MAC layer entity being enabled in the first operation mode and the second MAC layer entity being enabled in said another operation mode.

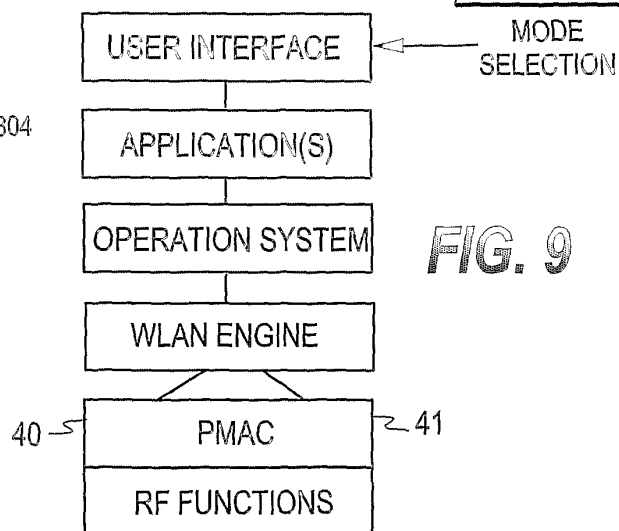
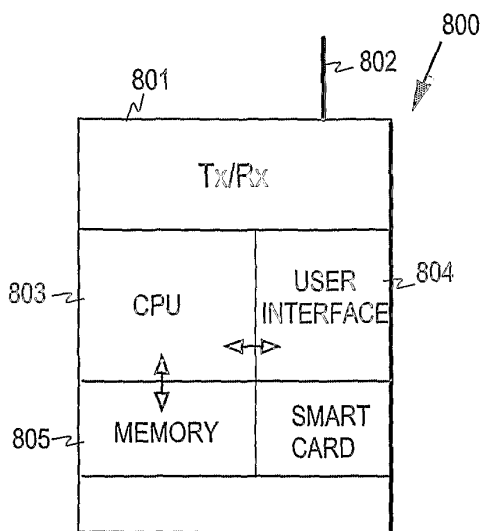
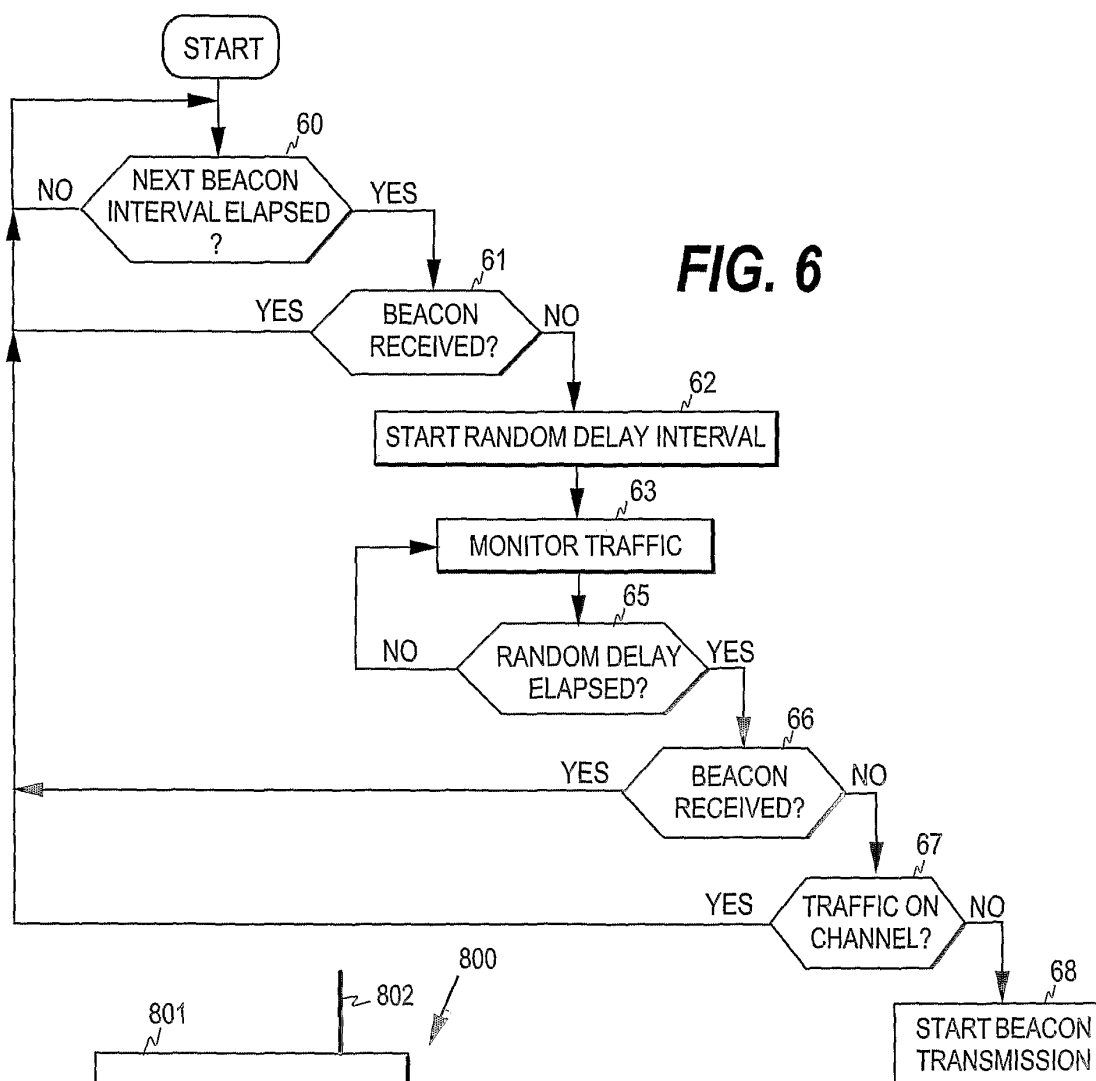
25 **20.** A wireless terminal according to claim **11**, wherein said at least one transmission rate for the preamble and for the header includes the rate of 1 Mbit/s and 2 Mbit/s, respectively, and wherein the first transmission rate is 11 Mbit/s.

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**FIG. 5****FIG. 7**

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 2003/000559

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04L 12/28, H04Q 7/32, G06F 1/32

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04L, H04Q, G06F

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

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EBERT, J-P et al: Measurement and Simulation of the Energy Consumption of an WLAN Interface. TKN Telecommunication Networks Group [online] Berlin, June 2002. Retrieved on 2004-01-26 from the Internet: http://www.tkn.tu-berlin.de/publications/papers/networking2002_withcover.pdf See sections 7,8,10 and abstract --	1-20
A	EP 1033832 A2 (LUCENT TECHNOLOGIES INC), 6 Sept 2000 (06.09.2000), page 1, column 1, line 1 - column 2, line 34, claim 1, abstract --	1-20

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 2003/000559

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 0247321 A2 (TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)), 13 June 2002 (13.06.2002), page 1, line 1 - page 6, line 10, abstract -- -----	1-20

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INTERNATIONAL SEARCH REPORT

Information on patent family members

24/12/2003

International application No.

PCT/FI 2003/000559

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				GB	9304638 D	00/00/0000
				JP	3145242 B	12/03/2001
				JP	7058688 A	03/03/1995
				US	6192230 B	20/02/2001

WO	0247321	A2	13/06/2002	AU	2962902 A	18/06/2002
				EP	1342339 A	10/09/2003
				US	2002132603 A	19/09/2002
