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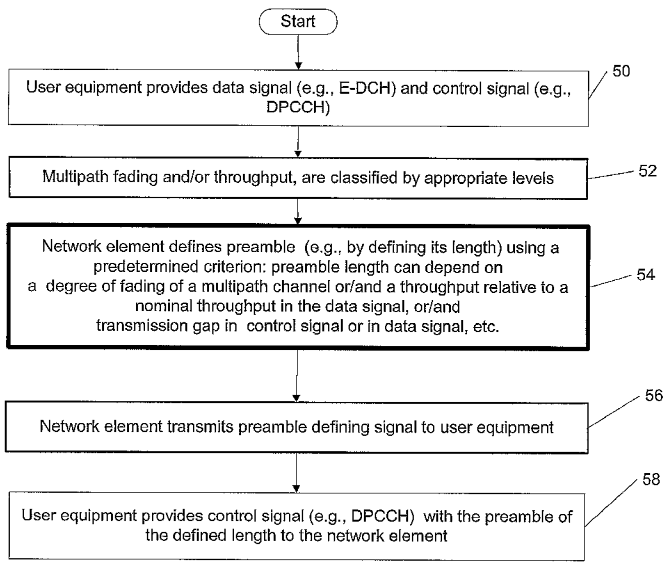
(54) **Title:** ADAPTIVE PREAMBLE LENGTH FOR CONTINUING CONNECTIVITY TRANSMISSION



(57) **Abstract:** The specification and drawings present a new method, system, apparatus and software product for defining an adaptive preamble length of a preamble for a continuous connectivity transmission using a control channel, e.g., a UL (uplink) dedicated physical control channel (DPCCH), for transmitting the preamble. Such a preamble would reduce the accuracy requirement for the initial power setting after a transmission gap and also help the channel estimation and the synchronization of a data channel, e.g., an enhanced dedicated channel (E-DCH). The preamble length can be optimized and defined using a predetermined criterion depending on: a) a degree of fading of a multipath channel which is used for transmitting data on the data channel and/or b) a throughput relative to a nominal throughput in the data channel.

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ADAPTIVE PREAMBLE LENGTH FOR CONTINUOUS CONNECTIVITY TRANSMISSION

Priority and Cross Reference to Related Application

This application claims priority from U.S. Provisional Application Serial No. 60/772,999, filed on February 13, 2006.

Technical Field

This invention generally relates to mobile/wireless communications and more specifically to defining an adaptive preamble length for a continuous connectivity transmission.

Background Art

Packet data users are continuously connected to the network typically with only occasional periods of activity. In a continuously connected mode, the users do not relinquish their data channels during periods of inactivity only to re-establish them when traffic is available: this can create delays that would ruin the user experience. In order to allow for a large number of such users, the UEs can be configured to discontinue their DPCCH (continuous dedicated physical control channel) transmissions (i.e., using gating) when not sending data. Users can, for example, transmit one 2ms TTI (transmission timing interval) of data every 2-5 frames and nothing in between (i.e., no DPCCH during the transmission gaps).

In an uplink (a direction from a user equipment to a network), when no dedicated channels (DCHs) and no corresponding dedicated physical data channels (DPDCHs) are configured, all data is transmitted on an enhanced dedicated channel (E-DCH) which is mapped to an enhanced dedicated physical data channel (E-DPDCH). Control signaling associated with the E-DCH is transmitted on an enhanced dedicated physical control channel (E-DPCCH). The E-DPDCH and E-DPCCH can be discontinuous and are transmitted only when there is data to be transmitted and the transmission has been granted by the network. In the uplink, in addition to the E-DPDCH and E-DPCCH, a continuous dedicated physical control channel (DPCCH) and possibly a continuous or discontinuous dedicated physical control channel (e.g., an uplink high speed dedicated physical control channel, HS-DPCCH) for an HS-DSCH (high speed downlink shared channel) are transmitted.

A packet service session contains one or several packet calls depending on the application as described in ETSI standard, TR 101 112, UMTS 30.03 "Selection procedures for the choice of radio transmission technologies of the UMTS", version 3.2.0. The packet service session can be considered as an NRT (non-real time) radio access bearer duration and the packet call as an active period of packet data transmission. During the packet call several packets may be generated, which means that the packet call constitutes a bursty sequence of packets. The burstiness is a characteristic feature of the packet transmission. A typical behavior of the packet data traffic is illustrated in Figure 1.

The UL DPCCH carries control information generated at layer 1 (physical layer). The layer 1 control information consists of, e.g., known pilot bits to support channel estimation for coherent detection, transmit power control (TPC) for DL DPCH (dedicated physical channel), optional feedback information (FBI) and optional transport format combination indicator (TFCI). Typically, the UL DPCCH is continuously transmitted (even if there is no data to be transmitted for certain time periods), and there is one UL DPCCH for each radio link. The continuous transmission is not a problem with circuit switched services, which are typically sent continuously. However, for bursty packet services, continuous DPCCH transmission causes a significant overhead.

The uplink capacity can be increased by decreasing a control overhead. One possibility for decreasing the control overhead is UL DPCCH gating (or discontinuous transmission), i.e., not transmitting signals on the DPCCH all the time.

Rationale for using gating includes (but is not limited to):

- providing user equipment (UE) power savings and longer battery life;
- providing interference reduction; and
- providing higher capacity.

There is a fast closed loop power control for all uplink signals to combat against the power imbalance between different user signals and fast fading. The Node B, e.g., estimates continuously a signal-to-interference ratio (SIR) of the DPCCH transmitted by the UE and compares an estimate to a target value, and transmits transmit power control (TPC) commands in a downlink to the UE to increase or decrease the transmit power level. With the power control, the signals from different UEs can be received with the required quality in changing conditions.

During the uplink transmission gap the UL power control cannot operate as normally because Node B cannot estimate the received signal quality to determine the proper TPC command (the SIR would be extremely low, and normally generated TPC commands would tell the UE to increase the UL transmit power). Therefore the transmission power to be used after the gap needs to be estimated or predefined. Due to a user movement or a change in propagation conditions (fading) it is likely that in case of a long transmission gap that the power used prior to the transmission gap is not sufficient to ensure a proper communication leading to increased usage of the HARQ (hybrid automatic repeat request) or too excessive thus increasing a UL noise making the UL power control and scheduling of UL capacity (e.g., in case of a high speed uplink packet access, HSUPA) more difficult.

In order to improve radio link performance, a DPCCH preamble with a duration of a few slots can be attached to the transmissions. This has a dual benefit of allowing both power control and channel estimation to adapt to the present link conditions. In terms of HARQ (hybrid automatic repeat request), the preamble can be attached either to the first transmission only, or to the first transmission and to subsequent retransmissions.

Disclosure of the Invention

According to a first aspect of the invention, a method, comprises: providing a data signal on a data channel and a control signal on a control channel in a communication system adapted for continuously connected users; defining a preamble length of a preamble using a predetermined criterion, the preamble length depends on at least one of: a degree of fading of a multipath channel which is used for transmitting the data signal, a throughput relative to a nominal throughput in the data signal, and a transmission gap length in the control signal or in the data signal; and transmitting the control signal comprising the preamble.

According further to the first aspect of the invention, the throughput relative to a nominal throughput may be classified by K levels, wherein K is an integer of at least a value of two.

Further according to the first aspect of the invention, the degree of fading may be classified by N levels, wherein N is an integer of at least a value of two.

Still further according to the first aspect of the invention, the control channel may be an uplink dedicated physical control channel transmitting the power control preamble from a user equipment to a network element. Further, the network element may be a Node B and the network element and the user equipment may be configured for wireless communications. Still further, the user equipment may be a wireless device, a portable device, a mobile communication device or a mobile phone. Yet still further, the defining may be provided by the network element or may be provided by the user equipment.

According further to the first aspect of the invention, the data channel may be an enhanced dedicated channel.

According still further to the first aspect of the invention, before transmitting the preamble, the method may comprise: defining a preamble power time dependence using a further predetermined criterion.

According further still to the first aspect of the invention, the preamble length may further depend on a length of a transmission timing interval of the data signal.

According yet further still to the first aspect of the invention, during the defining, the preamble length may be changed by a pre-selected value using the predetermined criterion depending on a change in the transmission gap length. Still further, the preamble length may be non-zero only if the transmission gap exceeds a pre-defined threshold value.

According to a second aspect of the invention, a user equipment, comprises: an uplink scheduling and signal generating module (or in general, signal generation means), for providing a data signal on a data channel and a control signal on a control channel, wherein a preamble length of a preamble is defined adaptively using a predetermined criterion, and the preamble length depends on at least one of: a degree of fading of a multipath channel which is used for transmitting the data signal, a throughput relative to a nominal throughput in the data signal, and a transmission gap length in the control signal or in the data signal; and a module configured to transmit the control signal comprising the preamble (this module, in general, can be means for receiving and transmitting such as , e.g., a transceiver).

According further to the second aspect of the invention, the throughput relative to a nominal throughput may be classified by K levels, wherein K is an integer of at least a value of two and/or the degree of fading maybe classified by N levels, wherein N is an integer of at least a value of two.

Still further according to the second aspect of the invention, the defining may be provided by the network element, and/or the uplink scheduling and signal generating module may be configured to define the preamble length.

According still further to the second aspect of the invention, the data channel may be an enhanced dedicated channel.

According further still to the second aspect of the invention, the preamble length may further depend on a length of a transmission timing interval of the data signal. Still further, during the defining, the preamble length may be changed by a pre-selected value using the predetermined criterion depending on a change in the transmission gap length. Yet still further, the preamble length may be non-zero only if the transmission gap exceeds a pre-defined threshold value. Further still, the transmission gap length may be variable.

According yet further still to the second aspect of the invention, the preamble may have a dynamic length varied during transmission of the data signal.

Yet still further according to the second aspect of the invention, an integrated circuit may comprise the uplink scheduling and signal generating module and the module configured to transmit.

Still yet further according to the second aspect of the invention, the control channel and the data channel may be combined such that the control signal and the data signal are transmitted on one combined channel.

According to a third aspect of the invention, a communication system, comprises: a user equipment, for providing a data signal on a data channel and a control signal on a control channel in the communication system adapted for continuously connected users, wherein a preamble length of a preamble is defined using a predetermined criterion, the preamble depends on at least one of: a degree of fading of a multipath channel which is used for transmitting the data signal, a throughput relative to a nominal throughput in the data signal, and a transmission gap length in the control signal or in the data signal, and for transmitting the power control preamble on the control channel; and a network element, responsive to the control signal comprising the preamble.

According to a fourth aspect of the invention, a network element, comprises: a receiver, for receiving a data signal on a data channel and a control signal on a control channel from a user equipment; a downlink scheduling and signal generating module, for adaptively defining a preamble length of a preamble, wherein the preamble length depends, using a predetermined criterion, on at least one of: a degree of fading of a multipath channel which is used for transmitting the data signal, a throughput relative to a nominal throughput in the data signal, and a transmission gap length in the control signal or in the data signal; and a transmitter, for transmitting the preamble to the user equipment.

According to a fifth aspect of the invention, a computer program product comprises: a computer readable storage structure embodying computer program code thereon for execution by a computer processor with the computer program code, wherein the computer program code comprises instructions for performing the first aspect of the invention, indicated as being performed by any component or a combination of components of a network element or a user equipment

Brief Description of the Drawings

For a better understanding of the nature and objects of the present invention, reference is made to the following detailed description taken in conjunction with the following drawings, in which:

Figure 1 is a diagram illustrating characteristics of a packet service session, according to related art;

Figure 2a and 2b are graphs showing simulation results of a system throughput as a function of Ec/N_0 for different preamble lengths for: a) strongly fading (e.g., a ITU defined Pedestrian A channel model with 3 km/h UE speed, or PA3) and b) less strongly fading (e.g., a ITU defined Vehicular A channel model with 30 km/h UE speed, or VA30) multipath channel;

Figure 3 is a block diagram to demonstrate defining an adaptive preamble length for a continuous connectivity transmission using, e.g., a dedicated physical control channel (DPCCH) for transmitting the preamble, according to an embodiment of the present invention;

Figure 4 is a block diagram to demonstrate defining an adaptive preamble length in DL, according to an embodiment of the present invention; and

Figure 5 is a flow chart to illustrate defining an adaptive preamble length for a continuous connectivity transmission using, e.g., a dedicated physical control channel (DPCCH) for transmitting the preamble, according to an embodiment of the present invention.

Modes for Carrying Out the Invention

A new method, system, apparatus and software product are presented for defining an adaptive preamble length of a preamble for a continuous connectivity transmission using a control channel, e.g., a UL (uplink) dedicated physical control channel (DPCCH), for transmitting the preamble. Such a preamble would reduce the accuracy requirement for the initial power setting after a transmission gap and also help the channel estimation and the synchronization of a data channel, e.g., an enhanced dedicated channel (E-DCH). According to one embodiment of the present invention, the preamble length can be optimized and defined using a predetermined criterion depending on: a) a degree of fading and/or degree of multipath reflections due to the radio channel which is experienced by the transmitted signal propagating from the transmitter to the receiver, which signal is used for transmitting data on the data channel (or a control signal on the control channel), b) a throughput relative to a nominal throughput in the data channel, and/or c) a transmission gap length (e.g., a period of inactivity which can be variable) in the discontinuous control signal (e.g., transmitted on the DPCCH) or in a discontinuous data signal, e.g., transmitted on an enhanced dedicated channel (E-DCH).

Moreover, according to a further embodiment of the present invention, the preamble length can further depend on a length of a transmission timing interval

(TTI) of the discontinuous data signal. Furthermore, a power in the power control preamble (or preamble) can be changed in time (i.e., a time dependent power in the preamble, e.g., using ramping preamble or power changed in steps) using a further predetermined criterion.

According to embodiments of the present invention, the preamble length can be adaptively changed according to pre-existing knowledge and the prevailing channel conditions, as well as the operating point in use. Advantageously the preamble length determination could be done at a network element (e.g., Node B) and signalled to the UE (user equipment). In case of SHO (soft handover), the UE can combine the preamble length requests from multiple Node-Bs in the active set (i.e., the UE should decide what preamble length to use). If the preamble length determination is done at the RNC (radio network controller), there is no need for combination at the UE (i.e., there is only one setting for the preamble length communicated to the UE) but the signalling landscape can be more complex.

The challenge which can be solved by using various embodiments of the present invention is how to identify the optimal preamble length. On one hand, adding slots to a preamble gives benefit in terms of better power control and channel estimation, but on the other hand transmitting a longer preamble also consumes battery power and adds interference. Therefore, it should be determined, how many slots are "energy well spent" and beyond which adding more length to the preamble would not provide additional benefit.

Figures 2a and 2b show the examples among others of graphs demonstrating single-user simulation results of a throughput as a function of Ec/N_0 (received energy per PN chip of the signal consisting of control and data channels being received to a total received power spectral density at an antenna connector of a Node B) for different preamble lengths for; a) strongly fading (PA3) and b) less strongly fading (VA30) multipath channels. Here PA3 means "Pedestrian A 3km/h" and is defined here as a multipath environment where the tap (multipath component) configuration is (the power relative a first tap, tap delay given in nanoseconds): (0 dB 0ns), (-20 dB 260ns), (-24dB 520ns). VA30 is defined as "Vehicular A 30km/h with the taps (0dB 0ns), (-2.4dB 260ns),(-6.5dB 520ns), (-9.4dB 780ns), (-12.7dB 1040ns). In the vehicular case (in Figure 2b), the last tap has no rake receiver finger allocated to it, i.e., the Node B does not utilize the energy of the last multipath instance of the received signal, in all others (e.g., in the pedestrian case in Figure 2a), the finger is allocated to the exact tap location, i.e., the Node B utilizes the energy of the other multipath instances of the signal fully when combining the multipath instances together as a single received signal. In other words, the settings can be chosen in order to have a significant trade-off between the energy collected from the channel and the complexity of the receiver. For example, in the vehicular case (in Figure 2b), the last tap is much weaker than the others, and it's possible to discard it without significantly degrading the performance. This way, there is no need to allocate a further finger in the rake reciever, thus saving in the complexity.

As can be seen from Figures 2a and 2b, the optimal preamble length can depend on:

- the multipath channel type: strongly fading(PA3)/less strongly fading(VA30), and/or
- the operating point: low/high throughput relative to nominal throughput; the high/low throughput can be defined, e.g., for the E-DCH data channel (E-DPDCH) according to the need of the application in use. Nominal throughput refers to the data rate of a single transmission. The actual throughput is lower due to retransmissions occurring after incorrect deliveries. If all packets get through successfully with the first try then throughput equals to the nominal throughput, if packets require in average 2 transmissions to get successfully delivered then throughput is equal to a half of the nominal throughput.

Also, as it was stated above, the gap length and other factors can affect the optimal preamble length as well.

These variables can be known to the network element (e.g., Node B). Then the network element can choose the optimal preamble length using the predetermined criterion and signal it to the UE. The optimal length can be determined, e.g., by simulations using link-level simulators: it is sufficient to categorize each parameter (e.g., fading, throughput, etc.) to two or a more categories (levels). For example, the multipath channel can be considered strongly fading or weakly fading (or categorized by N levels of fading in general, wherein N is an integer of at least a value of two), according to the number and relative strengths of channel taps in the RAKE receiver.

If the channel is dominated by one tap (i.e., most of the energy of the signal is received via a single signal propagation path), then it is strongly fading whereas many equipotent taps indicate a weakly fading multipath channel.

For example, if the Node B receiver classifies the radio channel through which the radio signal propagates from the UE antenna to the Node B antenna as strongly fading, e.g., because more than 75% of the signal energy is received via a single path, the Node B can configure the UE to use 4 slot preamble length. Alternatively, it can configure the UE to use 2 slot preamble length. With a longer preamble, the power control has more time to adjust the transmitted power level to the correct setting before the data transmission takes place. With a strongly fading channel it is more probable that the power setting is further off from the optimum setting after the transmission gap than with a weakly fading channel.

One simple operation example, which can be implemented by software in the Node-B, can be broken down to the following steps, which are repeated for each Continuous Connectivity UE at configurable intervals:

classify Multipath channel to strongly or weakly fading multipath channel;

choose an optimized preamble length from a pre-computed table considering multipath classification, operating point and a gating profile; and

signal the preamble length to the UE.

Note that the embodiments of the present invention should not be limited to the choices of the input parameters described above when adaptively defining the preamble length but other time-dependent or static parameters can be included as well, thus providing the network's ability to adjust the length of the preamble according to whatever criteria it sees fit, which may just as well be related to the specific receiver type, or implementation used for the external radio channel, or data rate conditions estimated or measured by the receiver.

The key advantage introduced here is savings in the noise rise generated per user, which allows more users to be placed in a cell using Continuous Connectivity. Even a small (in dB) savings per user results in several more users, which can increase the economic importance of the embodiments of the present invention. Moreover, according to an embodiment of the present invention, a network element (e.g., the node B or the RNC) can provide an instruction to the UE, e.g., to set a limit for the preamble length, e.g. from 0 up to 10 slots instead of providing a precise length using the same predetermined criterion described by the embodiments above. Then the final determination of the preamble length can be made by the UE using further considerations. For example, within the limit provided by the network element, the preamble length can be defined, depending on the DPCCH transmission gap length and/or on the E-DCH TTI (transmission timing interval) length: the shorter the transmission gap length the shorter the preamble length, and the longer the TTI length the shorter the preamble length (e.g., for 2ms E-DCH TTI, the same preamble length could be needed and used with a shorter transmission gap than for the 10ms E-DCH TTI).

Furthermore, according to an embodiment of the present invention, the preamble length can be defined, e.g., by a user equipment (UE) using the predetermined criterion with or without feedback from the network (e.g., the power control preamble in 3GPP TS25.214 is defined without the feedback, and the PRACH (physical random access channel) preamble in 3GPP TS25.211 and 3GPP TS25.214 is defined with the feedback). If a preamble is used with the feedback (e.g., a power ramping type of preamble), the maximum preamble length, after which the E-DCH transmission can be started even without the preamble ending feedback from the network element (e.g., a Node B), could be dynamic. A minimum preamble will protect against DL (downlink) TPC (transmit power control) errors, but a minimum preamble length may not need to be dynamic.

According to a further embodiment of the present invention, a preamble power time dependence can be defined using a further predetermined criterion including (but not limiting to): power ramping, using power step size, using higher power control step sizes until a feedback is received from the network element (e.g., the Node B), etc.

According to the predetermined criterion mentioned above, rules for defining the preamble length could be, e.g., to double the preamble length for a doubled transmission gap, to increase the preamble length by a pre-selected value (e.g., a pre-selected number of slots) after the transmission gap is changed by a further pre-selected value (e.g., a further pre-selected number of slots), or to increase the preamble length by a pre-selected value for every gap during a long E-DCH inactivity. The rules for defining the preamble length (including the maximum preamble length defined above) can also have a variety of similar dependences as a function of the TTI lengths.

It is noted that all embodiments of the present invention described above for the control channel, e.g., the UL DPCCH, can be applied to any L1 control channel in the UL (carrying, e.g., pilot and/or power control information) used for, e.g., channel estimation and power control and for downlink control channels as well. It is also noted, that defining the preamble length can be performed by the network element or by the UE as well, according to embodiments of the present invention. It is further noted that in one embodiment, the control channel and the data channel can be combined such that the control signal and the data signal can be transmitted on this combined channel.

Figure 3 shows a block diagram of an example among others, which demonstrates defining an adaptive preamble length for a continuous connectivity transmission using, e.g., a dedicated physical control channel (DPCCH) for transmitting the preamble, according to an embodiment of the present invention.

In the example of Figure 3, a mobile terminal **10** comprises an uplink scheduling and signal generating module **12** and a transmitter/receiver/processing module **14**. It is noted that the module **12** can generally be signal generation means or a structural equivalence (or equivalent structure) thereof. Also, the module **14** can generally be transmitting and/or receiving means, e.g., a transceiver, or a structural equivalence (or equivalent structure) thereof. The user equipment **10** can be a wireless device, a portable device, a mobile communication device, a mobile phone, etc.

In the example of Figure 3, a network element **16** (e.g., a node B or a radio network controller, RNC) comprises a transmitter **18**, a signal scheduling and generating module **20** and a receiver **22**. The module **20** can be used for providing (see signals **34**, **34a** and **36**) a preamble defining signal which the preamble length, or alternatively a power control feedback and/or instruction (e.g., range) for the preamble length (see signals **35**, **35a** and **35b**) to the user equipment **10,** using the predetermined and further predetermined criteria, according to different embodiments of the present invention as described above.

According to an embodiment of the present invention, the module **12, 14** or **20** can be implemented as a software or a hardware module or a combination thereof. Furthermore, the module **12, 14** or **20** can be implemented as a separate module/block or can be combined with any other standard module/block of the user equipment **10** or the network element **16**, respectively, or it can be split into several modules/blocks according to their functionality. The transmitter/receiver/processing module **14** can be implemented in a plurality of ways and typically can include a transmitter, a receiver, a CPU (central processing unit), etc. The transmitter and receiver can be combined, for example, in one module such as transceiver, as known in the art. The module **14** provides an effective communication of the module **12** with the network element **16**. All or selected modules of the user equipment **10** can be implemented using an integrated circuit, and all or selected blocks and/or modules of the network element **16** can be implemented using an integrated circuit as well.

The module **12** can provide a data/ control/preamble signal **30,** according to embodiments of the present invention, which is then forwarded (signals **32a**, **32b**, **32c,** wherein signals **32b** and **32c** are both transmitted on the DPCCH) to the receiver **22** of the network element **16**. Specifically, the module **12** can provide, e.g., a discontinuous data signal (which comprises the E-DCH signal **32a** transmitted on the E-DCH channel) and a discontinuous control signal (which comprises both the DPCCH signal **32c** and the preamble signal **32b** transmitted on the UL DPCCH channel).

If the UE **10** is used for defining the preamble, it can be coordinated and originated by the module **12.** The module **12** can optimize the preamble length, using the predetermined criterion depending on the instructions signal (see signals **35**, **35a** and **35b**) received from the network element **16** and by monitoring the appropriate parameters, e.g., a transmission gap length (which can be variable) in the discontinuous DPCCH signal **32c** or in the discontinuous E-DCH signal **32a**, and/or on a length of a transmission timing interval (TTI) of the E-DCH signal **32a** (also the power dependence in the power control preamble can be optimized using the further predetermined criterion by the module **12**).

It is also shown in Figure 3 that the network element **16** can use the received preamble signal (which can be alternatively defined as a special format of the DPCCH signal) for proving a power control feedback (the preamble feedback signal **35**). Figure 3 further demonstrates that the received E-DCH signal and received DPCCH signal can be used by the module **20** to determine important parameters, such as the degree of fading in the radio channel or the used data rate and probability of successful transmission of a TTI for defining the preamble length by the module **20.**

The example of Figure 3 demonstrates defining the preamble length according to embodiments of the present invention in the UL direction. The same principles can be applied to the DL (downlink) direction, according to an embodiment of the present invention. Figure 4 demonstrates such an arrangement wherein a downlink scheduling and signal generating module **21** of a network element **27** is used to define the preamble for the DL transmission using, e.g., the predetermined and further predetermined criteria, thus providing a preamble signal **23** which is then transmitted (a preamble signal **23a**) downlink by the transmitter **18.** Information (signals **25** and **25a**) needed for determining the degree of fading of the multipath channel or/and a throughput relative to a nominal throughput in the downlink can be signaled to the network element by the UE.

Figure 5 is an example of a flow chart for defining an adaptive preamble length for a continuous connectivity transmission using, e.g., a dedicated physical control channel (DPCCH) for transmitting the preamble, according to an embodiment of the present invention.

The flow chart of Figure 5 only represents one possible scenario among others. The order of steps shown in Figure 5 is not absolutely required, so generally, the various steps can be performed out of order. In a method according to an embodiment of the present invention, in a first step **50**, the user equipment **10** provides the discontinuous data signal (e.g., the E-DCH signal) **32a** and the discontinuous control signal (e.g., the DPCCH signal) **32c** to the network element **16.**

In a next step **52**, critical parameters, such as multipath fading and/or throughput, are classified by appropriate levels.

In a next step **54**, the network element **16** defines the preamble (e.g., by defining its length) using a predetermined criterion: preamble length can depend on the degree of fading of the multipath channel or/and a throughput relative to a nominal throughput in the data signal, or/and transmission gap in the control signal or in the data signal, etc., according to embodiments of the present invention.

In a next step **56**, the network element **16** transmits the preamble defining signal **34** to the user equipment **10**. Finally, in a next step **58**, the user equipment **10** provides the control signal (e.g., on the DPCCH) with the preamble (signal **32b**) of the defined length to the network element **16**.

As explained above, the invention provides both a method and corresponding equipment consisting of various modules providing the functionality for performing the steps of the method. The modules may be implemented as hardware, or may be implemented as software or firmware for execution by a computer processor. In particular, in the case of firmware or software, the invention can be provided as a computer program product including a computer readable storage structure embodying computer program code (i.e., the software or firmware) thereon for execution by the computer processor.

Also, it is noted that various embodiments of the present invention recited herein can be used separately, combined or selectively combined for specific applications.

It is to be understood that the above-described arrangements are only illustrative of the application of the principles of the present invention. Numerous modifications and alternative arrangements may be devised by those skilled in the art without departing from the scope of the present invention, and the appended claims are intended to cover such modifications and arrangements.

What is claimed is:

1. A method, comprising:

providing a data signal on a data channel and a control signal on a control channel in a communication system adapted for continuously connected users;

defining a preamble length of a preamble using a predetermined criterion, said preamble length depends on at least one of:

a degree of fading of a multipath channel which is used for transmitting said data signal,

a throughput relative to a nominal throughput in said data signal, and

a transmission gap length in said control signal or in said data signal; and

transmitting said control signal comprising said preamble.

2. The method of claim 1, wherein said throughput relative to a nominal throughput is classified by K levels, wherein K is an integer of at least a value of two.

3. The method of claim 1, wherein said degree of fading is classified by N levels, wherein N is an integer of at least a value of two.

4. The method of claim 1, wherein said control channel is an uplink dedicated physical control channel transmitting said power control preamble from a user equipment to a network element.

5. The method of claim 4, wherein said network element is a Node B and the network element and the user equipment are configured for wireless communications.

6. The method of claim 4, wherein said user equipment is a wireless device, a portable device, a mobile communication device or a mobile phone.

7. The method of claim 4, wherein said defining is provided by said network element.

8. The method of claim 4, wherein said defining is provided by said user equipment.

9. The method of claim 1, wherein said data channel is an enhanced dedicated channel.

10. The method of claim 1, wherein before said transmitting said preamble, the method comprises:

defining a preamble power time dependence using a further predetermined criterion.

11. The method of claim 1, wherein the preamble length further depends on a length of a transmission timing interval of said data signal.

12. The method of claim 1, wherein during said defining, said preamble length is changed by a pre-selected value using said predetermined criterion depending on a change in said transmission gap length.

13. The method of claim 11, wherein said preamble length is non-zero only if said transmission gap exceeds a pre-defined threshold value.

14. A computer program product comprising: a computer readable storage structure embodying computer program code thereon for execution by a computer processor with said computer program code, wherein said computer program code comprises instructions for performing the method of claim 1, indicated as being performed by any component or a combination of components of a user equipment or a network.

15. A user equipment, comprising:

an uplink scheduling and signal generating module, for providing a data signal on a data channel and a control signal on a control channel, wherein a preamble length of a preamble is defined adaptively using a predetermined criterion, and said preamble length depends on at least one of:

a degree of fading of a multipath channel which is used for transmitting said data signal,

a throughput relative to a nominal throughput in said data signal, and

a transmission gap length in said control signal or in said data signal; and

a module configured to transmit said control signal comprising said preamble.

16. The user equipment of claim 15, wherein said throughput relative to a nominal throughput is classified by K levels, wherein K is an integer of at least a value of two.

17. The user equipment of claim 15, wherein said degree of fading is classified by N levels, wherein N is an integer of at least a value of two.

18. The user equipment of claim 15, wherein said control channel is an uplink dedicated physical control channel transmitting said power control preamble from the user equipment to a network element.

19. The user equipment of claim 15, wherein said defining is provided by said network element.

20. The user equipment of claim 15, wherein said uplink scheduling and signal generating module is configured to define said preamble length.

21. The user equipment of claim 15, wherein said data channel is an enhanced dedicated channel.

22. The user equipment of claim 15, wherein the preamble length further depends on a length of a transmission timing interval of said data signal.

23. The user equipment of claim 22, wherein during said defining said preamble length is changed by a pre-selected value using said predetermined criterion depending on a change in said transmission gap length.

24. The user equipment of claim 22, wherein said preamble length is non-zero only if said transmission gap exceeds a pre-defined threshold value.

25. The user equipment of claim 22, wherein said transmission gap length is variable.

26. The user equipment of claim 15, wherein said preamble has a dynamic length varied during transmission of said data signal.

27. The user equipment of claim 15, wherein an integrated circuit comprises the uplink scheduling and signal generating module and the module configured to transmit.

28. The user equipment of claim 15, wherein said control channel and said data channel are combined such that said control signal and said data signal are transmitted on one combined channel.

29. A communication system, comprising:

a user equipment, for providing a data signal on a data channel and a control signal on a control channel in said communication system adapted for continuously connected users, wherein a preamble length of a preamble is defined using a predetermined criterion, said preamble depends on at least one of:

a degree of fading of a multipath channel which is used for transmitting said data signal,

a throughput relative to a nominal throughput in said data signal, and

a transmission gap length in said control signal or in said data signal,

and for transmitting said power control preamble on said control channel; and

a network element, responsive to said control signal comprising said preamble.

30. The system of claim 29, wherein said throughput relative to a nominal throughput is classified by K levels, wherein K is an integer of at least a value of two.

31. The system of claim 29, wherein the preamble length further depends on a length of a transmission timing interval (TTI) of said data signal.

32. A user equipment, comprising:

signal generation means, for providing a data signal on a data channel and a control signal on a control channel, wherein a preamble length of a preamble is defined adaptively using a predetermined criterion, and said preamble length depends on at least one of:

a degree of fading of a multipath channel which is used for transmitting said data signal,

a throughput relative to a nominal throughput in said data signal, and

a transmission gap length in said control signal or in said data signal; and

means for receiving and transmitting, for transmitting said control signal comprising said preamble.

33. The user equipment of claim 32, wherein the signal generation means is an uplink scheduling and signal generating module.

34. A network element, comprising:

a receiver, for receiving a data signal on a data channel and a control signal on a control channel from a user equipment;

a downlink scheduling and signal generating module, for adaptively defining a preamble length of a preamble, wherein said preamble length depends, using a predetermined criterion, on at least one of:

a degree of fading of a multipath channel which is used for transmitting said data signal,

a throughput relative to a nominal throughput in said data signal, and

a transmission gap length in said control signal or in said data signal; and a transmitter, for transmitting said preamble to the user equipment.

35. The network element of claim 34, wherein the preamble length further depends on a length of a transmission timing interval of said data signal.

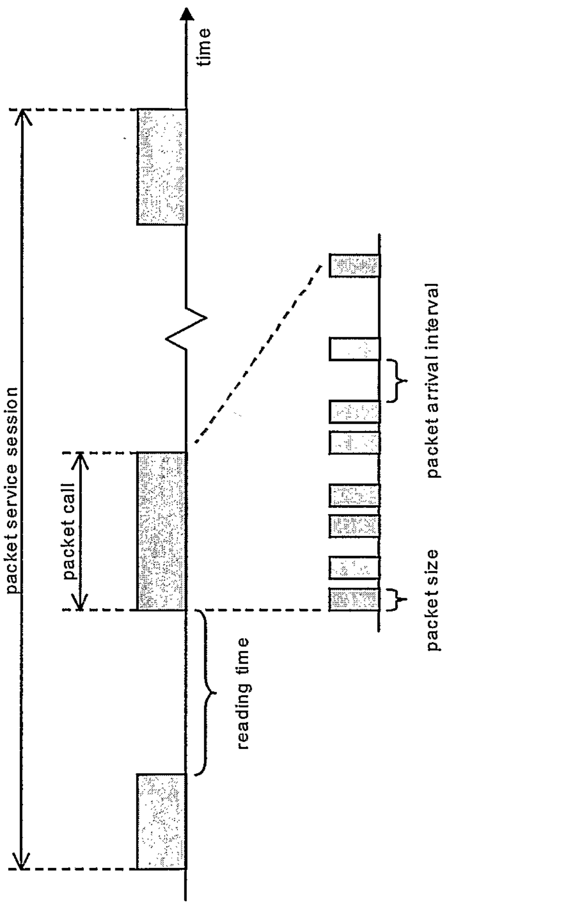
packet service session
packet call
time
reading time
packet size
packet arrival interval

Figure 1

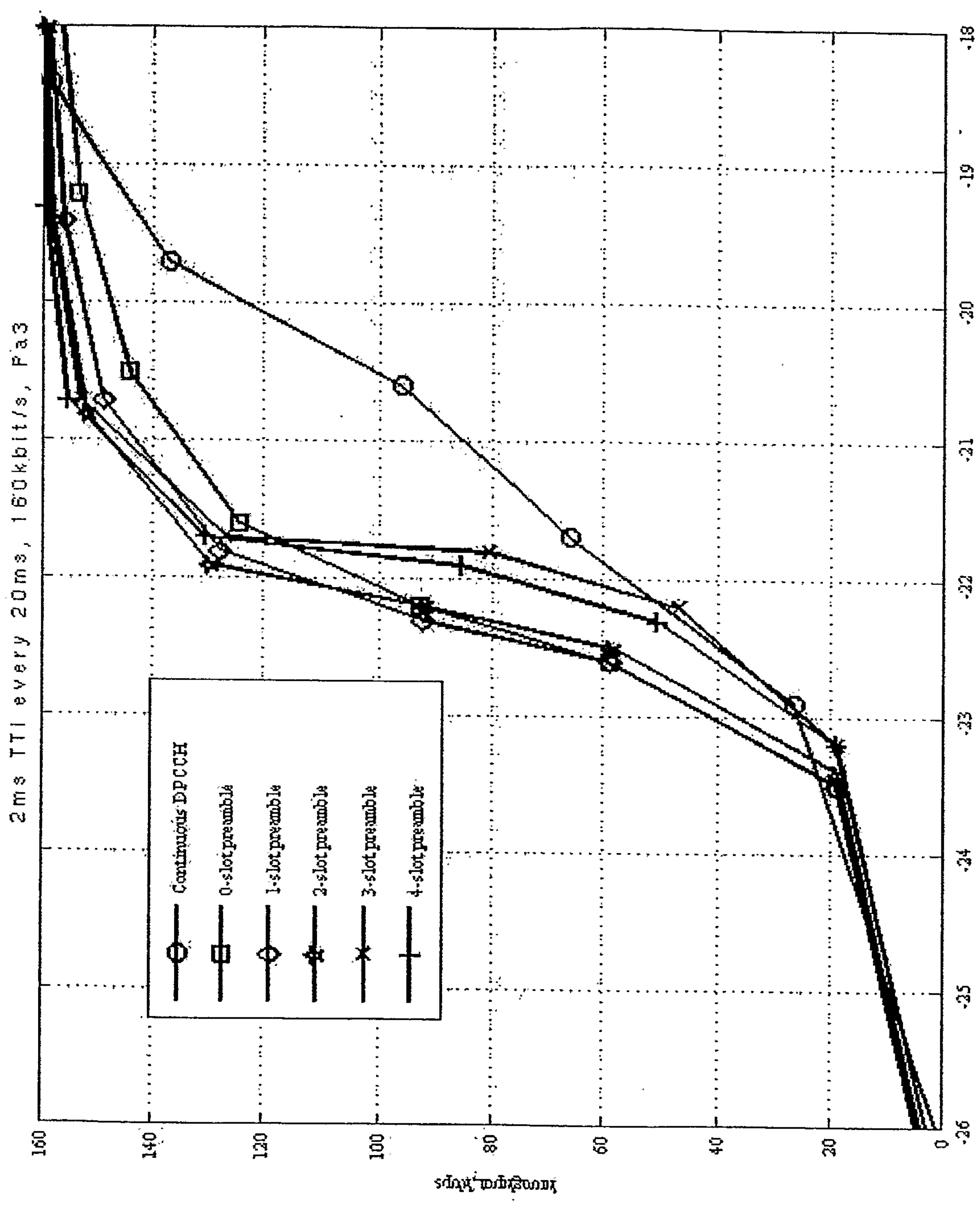
2ms TTI every 20ms, 160kbit/s, Pa3
Continuous DPCCH
0-slot preamble
1-slot preamble
2-slot preamble
3-slot preamble
4-slot preamble
EDCH Ec/No, dB
throughput, kbps
160
140
120
100
80
60
40
20
0
-26
-25
-24
-23
-22
-21
-20
-19
-18

Fig. 2a

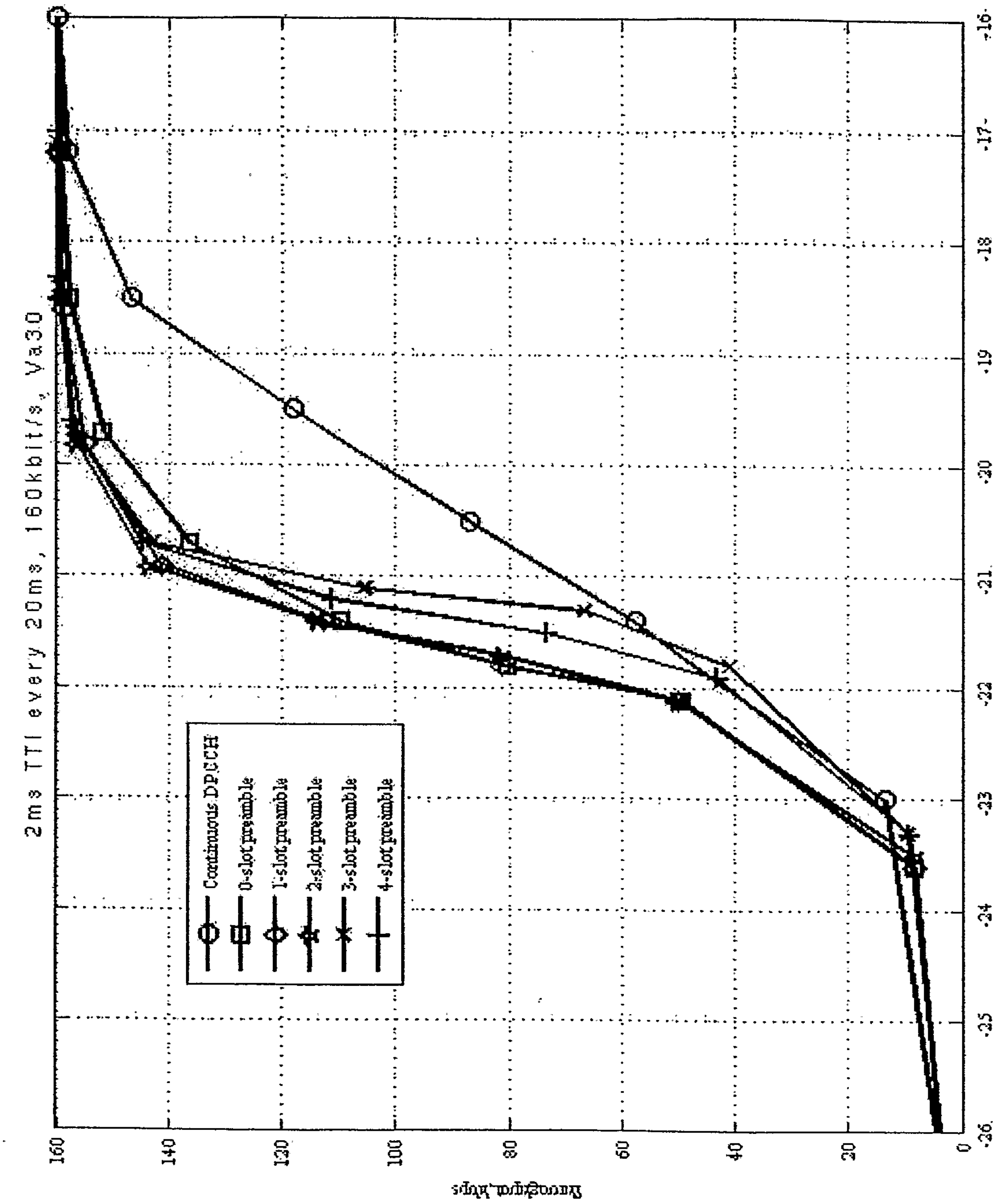
2ms TTI every 20ms, 160kbit/s, Va30
Continuous DPCCH
0-slot preamble
1-slot preamble
2-slot preamble
3-slot preamble
4-slot preamble
EDCH Ec/No, dB
160
140
120
100
80
60
40
20
0
-26
-25
-24
-23
-22
-21
-20
-19
-18
-17
-16

Fig. 2b

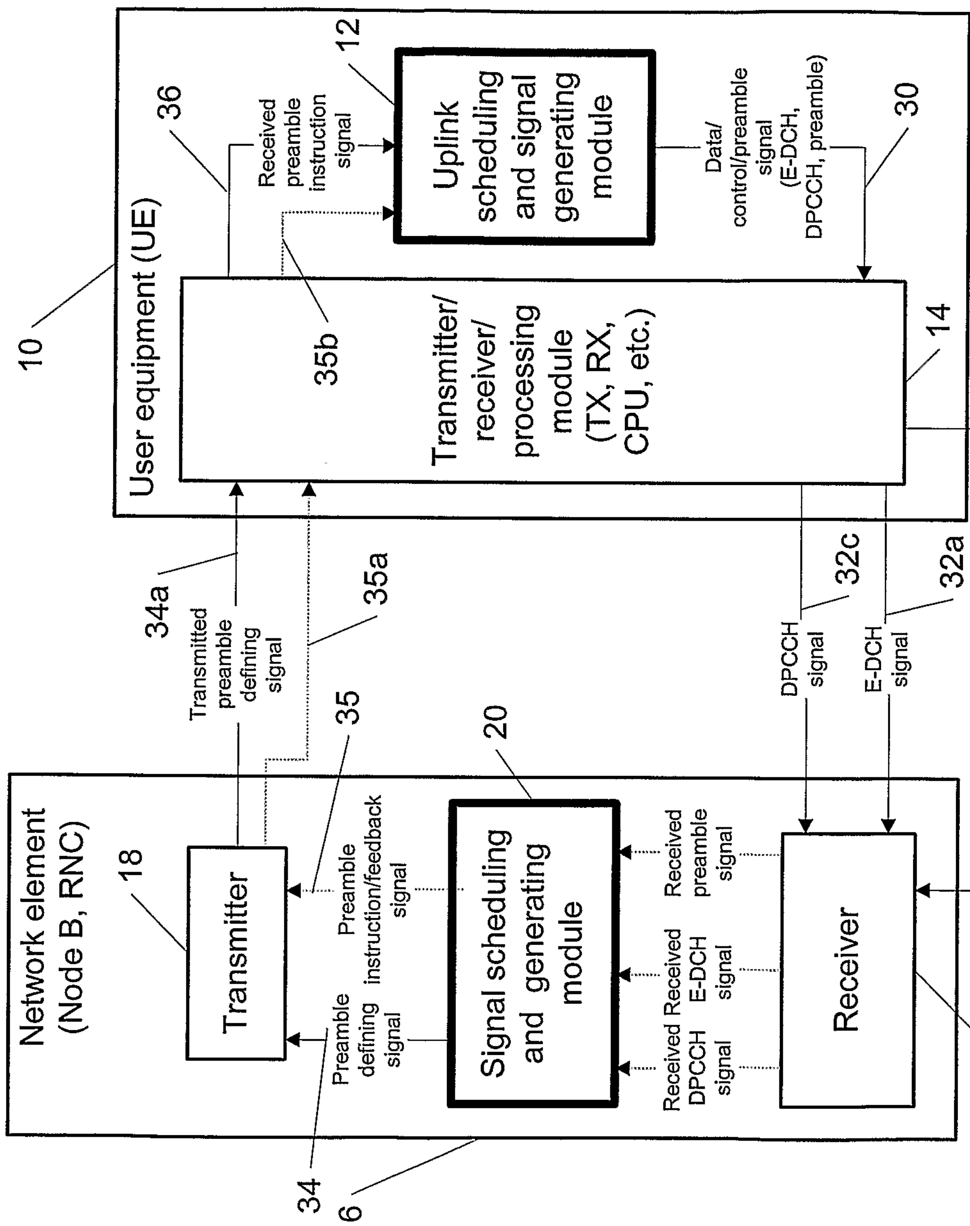
10
User equipment (UE)
12
Uplink scheduling and signal generating module
36
Received preamble instruction signal
35b
Data/ control/preamble signal (E-DCH, DPCCH, preamble)
30
Transmitter/ receiver/ processing module (TX, RX, CPU, etc.)
14
34a
Transmitted preamble defining signal
35a
DPCCH signal
32c
E-DCH signal
32a
Preamble signal
32b
Network element (Node B, RNC)
18
Transmitter
35
Preamble instruction/feedback signal
Preamble defining signal
20
Signal scheduling and generating module
Received DPCCH signal
Received E-DCH signal
Received preamble signal
Receiver
22
34
16

Figure 3

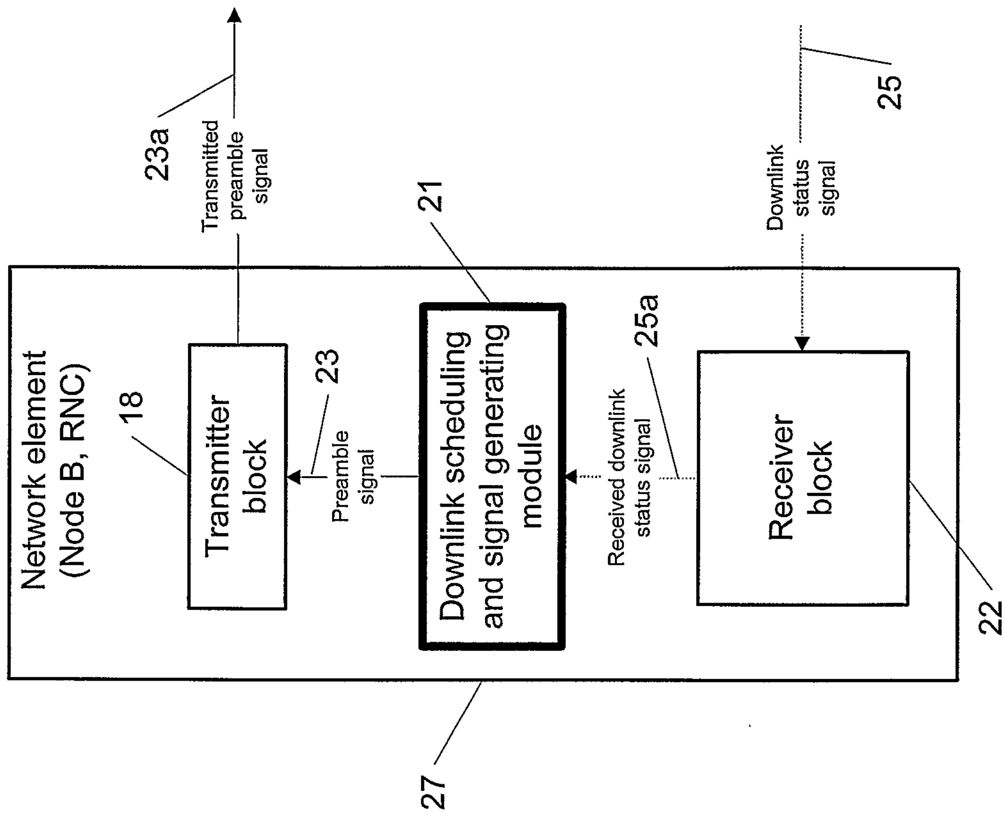
Network element
(Node B, RNC)
18
Transmitter
block
23
Preamble
signal
Transmitted
preamble
signal
23a
21
Downlink scheduling
and signal generating
module
25a
Received downlink
status signal
Receiver
block
22
Downlink
status
signal
25
27

Figure 4

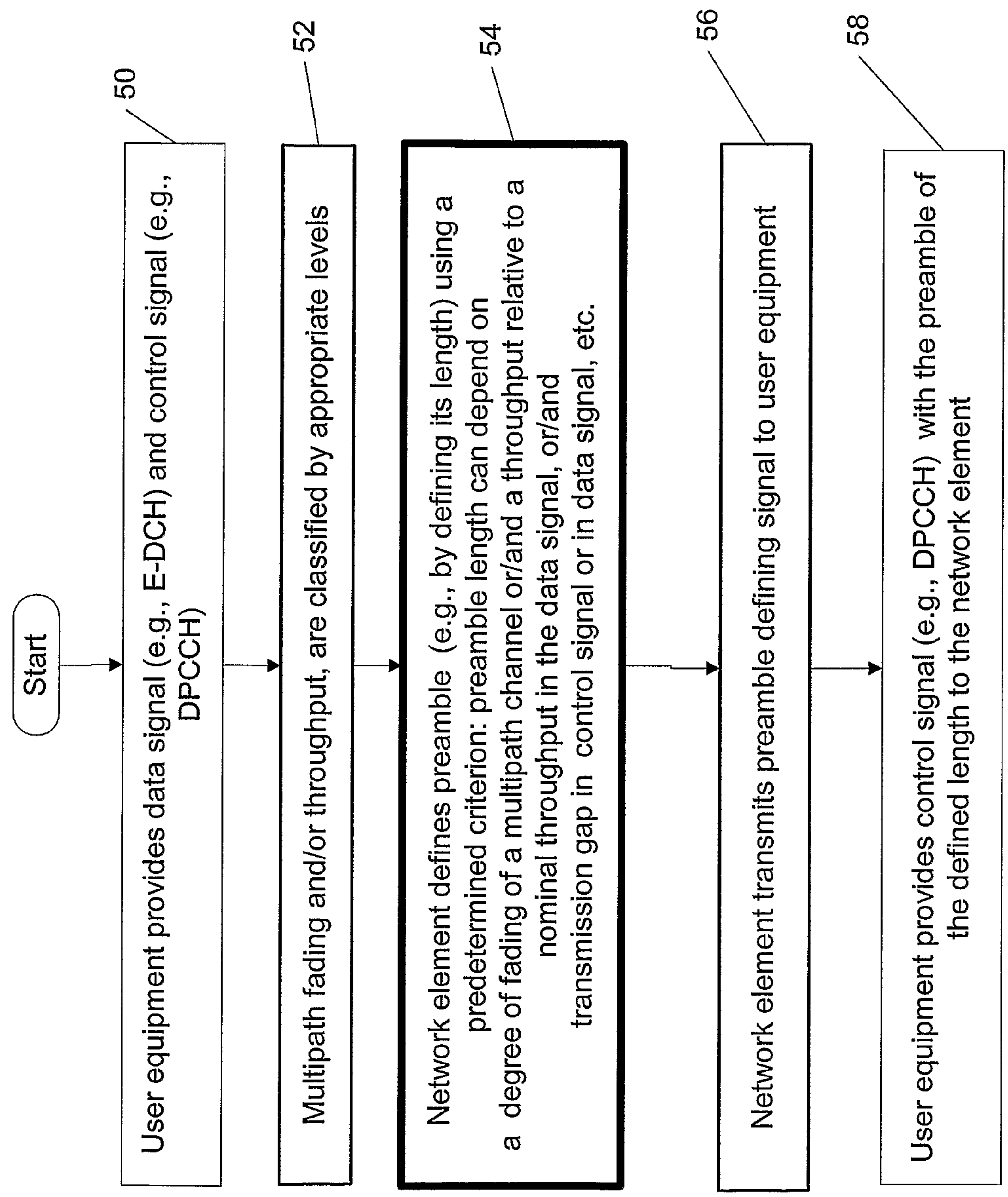
Start
50
User equipment provides data signal (e.g., E-DCH) and control signal (e.g., DPCCH)
52
Multipath fading and/or throughput, are classified by appropriate levels
54
Network element defines preamble (e.g., by defining its length) using a predetermined criterion: preamble length can depend on a degree of fading of a multipath channel or/and a throughput relative to a nominal throughput in the data signal, or/and transmission gap in control signal or in data signal, etc.
56
Network element transmits preamble defining signal to user equipment
58
User equipment provides control signal (e.g., DPCCH) with the preamble of the defined length to the network element

Figure 5