

Method and system for noise level communication for high speed uplink packet access.

5 Field of the Invention

The field of the invention is mobile communications and, more particularly, improving link adaptation when using de-centralized scheduling.

Background of the Invention

10 Referring to FIG. 1, the Universal Mobile Telecommunications System (UMTS) packet network architecture includes the major architectural elements of user equipment (UE), UMTS Terrestrial Radio Access Network (UTRAN), and core network (CN). The UE is interfaced to the UTRAN over a radio (Uu) interface, while the UTRAN interfaces to the core network over a (wired) Iu
15 interface.

FIG. 2 shows some further details of the architecture, particularly the UTRAN. The UTRAN includes multiple Radio Network Subsystems (RNSs), each of which contains at least one Radio Network Controller (RNC). Each RNC may be connected to multiple NodeBs which are the UMTS counterparts to GSM base
20 stations. Each NodeB may be in radio contact with multiple UEs via the radio interface (Uu) shown in Fig. 1. A given UE may be in radio contact with multiple NodeBs even if one or more of the NodeBs are connected to different RNCs. For instance a UE1 in Fig. 2 may be in radio contact with NodeB 2 of RNS 1 and NodeB 3 of RNS 2 where NodeB 2 and NodeB 3 are neighboring NodeBs. The
25 RNCs of different RNSs may be connected by an Iur interface which allows mobile UEs to stay in contact with both RNCs while traversing from a cell belonging to a NodeB of one RNC to a cell belonging to a NodeB of another RNC. One of the RNCs will act as the "serving" or "controlling" RNC (SRNC or CRNC) while the other will act as a "drift" RNC (DRNC). A chain of such drift RNCs can even be
30 established to extend from a given SRNC. The multiple NodeBs will typically be neighboring NodeBs in the sense that each will be in control of neighboring cells.

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The mobile UEs are able to traverse the neighboring cells without having to re-establish a connection with a new NodeB because either the NodeBs are connected to a same RNC or, if they are connected to different RNCs, the RNCs are connected to each other. During such movements of a UE, it is sometimes required that radio
5 links be added and abandoned so that the UE can always maintain at least one radio link to the UTRAN. This is called soft-handover (SHO).

The invention relates to the 3GPP (Third Generation Partnership Project) specification of the Universal Mobile Telecommunications System (UMTS) Terrestrial Radio Access (UTRA) and more specifically to the Wideband Code
10 Division Multiple Access (WCDMA) High Speed Uplink Packet Access (HSUPA) which is an enhanced uplink feature used in the Frequency Division Duplex (FDD) mode. This feature is being specified in the 3GPP and targeted to 3GPP release 6.

In the current architecture, the packet scheduler is located in the RNC and therefore is limited in its ability to adapt to the instantaneous traffic, because of
15 bandwidth constraints on the Radio Resource Control (RRC) layer signalling interface between the RNC and the UE. Hence, to accommodate the variability, the packet scheduler must be conservative in allocating uplink power to take into account the influence from inactive users in the following scheduling period - a solution which turns out to be spectrally inefficient for high allocated data-rates and
20 long release timer values.

With the introduction of HSUPA some of the the packet scheduler functionality is moved from the RNC to the NodeB. Due to the decentralization, the possibility arises to more quickly react to overload situations, enabling much more aggressive scheduling, e.g., by faster modifications of the bit rates, which will give
25 a higher cell capacity. HSUPA and the fast NodeB controlled scheduling are also supported in soft handover.

According to Section 7.1 of the Technical Report 3GPP TR 25.896 v6.0.0 (2004-03) entitled "*Feasibility Study for Enhanced Uplink for UTRA FDD (Release 6)*," the term "NodeB scheduling" denotes the possibility for the NodeB to control,
30 within the limits set by the RNC, the set of Transport Format Combinations (TFCs) from which the UE may choose a suitable TFC. In the context of HSUPA, the

transport format combinations (E-TFCs) of the transport channel subject to the Node B scheduling (E-DCH) are controlled by the Node B which can grant the UE with the maximum amount of uplink resources the given UE is allowed to use. An E-TFC (E-DCH Transport Format Combination) is the combination of currently valid
5 Transport Format for the E-DCH with the applicable maximum number of H-ARQ retransmissions and applied transmission power offset. (see 3G TS 25.309 for related definitions and in-depth explanations). In Release 5, the uplink scheduling and rate control resides in the RNC. According further to the TR 25.896 study report, by providing the NodeB with this capability, tighter control of the uplink
10 interference is possible which, in turn, may result in increased capacity and improved coverage. The TR 25.896 report discusses two fundamental approaches to scheduling: (1) rate scheduling, where all uplink transmissions occur in parallel but at a low enough rate such that the desired noise rise at the NodeB is not exceeded, and (2) time scheduling, where theoretically only a subset of the UEs that have
15 traffic to send are allowed to transmit at a given time, again such that the desired total noise rise at the NodeB is not exceeded. The HSUPA feature specified is expected to enable both scheduling approaches.

The present invention is related to these HSUPA enhancements of the uplink DCH (hereafter referred to as EDCH) for packet data traffic in release 6 of 3GPP as
20 specified in the above mentioned 3GPP TR 25.896, "*Feasibility Study for Enhanced Uplink for UTRA FDD*" as well as in the 3GPP specification TS 25.309, "*FDD Enhanced Uplink - Overall description - Stage 2, Version 6.1.0 (2004-12)*". As suggested above, HSUPA enhancements are currently approached by distributing some of the packet scheduler functionality to the NodeBs. This permits faster
25 scheduling of bursty non real-time traffic than possible using the layer 3 in the Radio Network Controller (RNC). The idea is that with faster link adaptation it is possible to more efficiently share the uplink power resource between packet data users: when packets have been transmitted from one user the scheduled resource can be made available immediately to another user. This avoids the peaked variability of
30 noise rise, when high data rates are being allocated to users running bursty high data-rate applications.

As a consequence of much of the packet scheduler functionality having been transferred to the NodeB for EDCH, the NodeB scheduler takes care of allocating uplink resources. But it is desirable for the RNC to be able to set a certain target noise rise to the NodeB. The NodeB then takes care of scheduling such that the total noise rise level, caused by DCH and EDCH, stays below or on the target level. The target noise rise level is set relative to the thermal plus background noise (P_{rx_noise}). P_{rx_noise} is therefore a reference to be used in NodeB scheduling. P_{rx_noise} can either be measured in the NodeB directly or set by the RNC via NodeB Application Part (NBAP) signalling. Background information about measurement values can be found in 3GPP TS 25.433, Version 6.4.0 (2004-12), "*UTRAN Iub Interface NBAP Signalling*," Section 9.2.1.12. Various relevant definitions can be found in 3GPP TS 25.215, Version 5.4.0 (2003-06), "*Physical Layer – Measurements (FDD)*."

Summary of the Invention

Depending on the overall scheduling strategy it may be better to either measure P_{rx_noise} directly in the NodeB or let the RNC fix that value. The problem is then how to design a communication flow for HSUPA, which allows the NodeB to measure, and set the thermal plus background noise level (P_{rx_noise}), and at the same time which also allows the RNC to overwrite the very same value that is used in NodeB scheduling.

In accordance with a first aspect of the present invention, there is provided a method, characterized by: making a measurement in a first network element of noise on a radio interface between user equipment and said first network element, sending a measurement report signal having a magnitude indicative of said measurement of said noise from said first network element to a second network element, and using said measurement of said noise in scheduling decisions made by said first network element.

In accordance with a second aspect of the present invention, there is provided a network element, characterized by: means for making a measurement of noise on a radio interface between user equipment and said network element, means

for sending a measurement report signal having a magnitude indicative of said measurement of said noise from said network element to a radio network controller, and means for using said measurement of said noise in scheduling decisions made by said network element unless said network element receives a noise value sent by said radio network controller to said network element, in which case said network element uses said received value in said scheduling decisions made by said network element, instead of using said measurement of said noise.

In accordance with a third aspect of the present invention, there is provided a system, characterized by: (a) a first network element, comprising: means for making a measurement of noise on a radio interface between user equipment and said first network element, means for sending a measurement report signal having a magnitude indicative of said measurement of said noise, and means for using said measurement of said noise in scheduling decisions unless a set noise value signal is received having a magnitude indicative of a set noise value, in which case said set noise value is used in said scheduling decisions instead of said measurement of said noise; and (b) a second network element, comprising means for providing said set noise value signal indicative of said set noise value to said first network element.

In accordance with a fourth aspect of the present invention, there is provided a controller, characterized by: a receiver, responsive to a measurement report, for providing a measurement value signal having a magnitude indicative of a noise measurement made by a network element for use in scheduling over a radio interface between said network element and user equipment; a device for providing a noise signal having a magnitude indicative of a set noise value; and a transmitter, responsive to said set noise signal, for transmitting same to said network element for use in said scheduling according to the magnitude of said set noise value signal instead of said measurement value.

In accordance with a fifth aspect of the present invention, there is provided a user equipment, characterized by: an antenna, responsive to a scheduling signal from a network element indicative of a transmission characteristic commanded over a radio link established between said user equipment and said network element, for providing a received scheduling signal; and a signal processor, responsive to said

received scheduling signal, for providing an information signal to said antenna for transmission over said radio link to said network element according to said transmission characteristic wherein said scheduling signal is commanded by said network element and wherein said network element is responsive to either a noise measurement made by said network element or to a noise value set and signalled by
5 said radio network controller to said network element.

In accordance with a sixth aspect of the present invention, there is provided a communication method for High Speed Uplink Packet Access (HSUPA) for a Universal Mobile Telecommunications System (UMTS) for permitting a NodeB to
10 measure and set a thermal plus background noise level (P_{rx_noise}) value, and at the same time for permitting a Radio Network Controller (RNC), according to its own centralized strategy, to overwrite said thermal plus background noise level (P_{rx_noise}) value with a value set by said RNC that is then used in said NodeB for decentralized scheduling.

15 In accordance with a seventh aspect of the present invention, there is provided a computer program product with executable code stored on a computer readable medium characterized by executing the steps of: measuring at a Node B a value of received total wide band power, signalling the value of received total wide band power in a common measurement value information element, from the Node B
20 to a radio network controller, and using the value of received total wide band power by a Node B scheduler to make scheduling decisions, unless the Node B receives a noise value from the radio network controller in response to the signalling, in which case the Node B uses said noise value in said scheduling decisions.

In accordance with an eighth aspect of the present invention, there is
25 provided a chip hardware characterized by executing the steps of: measuring or estimating at a Node B a value of received total wide band power, signalling the value of received total wide band power in a common measurement value information element, from the Node B to a radio network controller, and using the value of received total wide band power by a Node B scheduler to make scheduling
30 decisions, unless the Node B receives a noise value from the radio network

controller in response to the signalling, in which case the Node B uses said noise value in said scheduling decisions.

A communication flow may be proposed, in example embodiments which allows NodeB scheduling to either use the P_{rx_noise} measured in the NodeB or the
5 P_{rx_noise} signaled by RNC. RNC signalling P_{rx_noise} to the NodeB causes the NodeB measured quantity to be overwritten in NodeB scheduling.

It is known that the NodeB can measure the thermal plus background noise. It is also known that the RNC can set the value, but the mechanism that the NodeB measures *and* the RNC can overwrite the measured value by another value is new in
10 general and for HSUPA in particular.

Embodiments of the present invention seek to provide flexibility, in that the network can be set up such that the

thermal plus background noise level used as a reference in NodeB scheduling can either be measured in the NodeB, or signalled by RNC. In the multi vendor scenario: an RNC is given means to ensure that a known reference is always used in NodeB scheduling regardless of the measurement capability of the NodeB(s).

5 Although the present specification discloses the invention in the context of an improvement to an HSUPA situation, it should be realized that the core concept is applicable to other situations in wireless interfaces and not limited to HSUPA and not limited to the uplink direction.

 A person of ordinary skill in the art will understand that the method
10 summarized above can also be summarized as follows, for example. At a Node B, a value of received total wide band power is measured. Then the Node B signals the value of received total wide band power in a common measurement value information element, from the Node B to a radio network controller. A Node B scheduler then uses the value of received total wide band power to make scheduling
15 decisions, unless the Node B receives a noise value from the radio network controller in response to the signalling, in which case the Node B uses that noise value in said scheduling decisions. A person of ordinary skill in the art will also understand that the various measurements described in the present application may include estimations.

20 Brief Description of the Drawings

 FIG. 1 shows the packet network architecture for the Universal Mobile Telecommunications System (UMTS).

 FIG. 2 shows some further details of the overall architecture of the UMTS.

25 FIG. 3 is a simplified flow chart showing steps for carrying out the present invention in a NodeB.

 FIG. 4 is a simplified flow chart showing steps for carrying out the present invention in a Radio Network Controller (RNC).

 Fig. 5 illustrates a system according to the present invention.

Detailed Description of the Invention

An embodiment of the present invention is shown in Fig. 3. According to that figure, the invention proposes the following for execution in the NodeB. After determining in a step 302 that a measurement has been initiated, the NodeB
5 measures the thermal plus background noise as shown in a step 304. The NodeB can do so on command of the RNC or based on some internal criterion.

As determined in a step 306, the NodeB may send this value to the RNC when requested or on a periodic basis. If it is determined to send the measurement, such is done in a step 308, as shown. This measurement can, for example, be a
10 received total wide band power (RTWP), signalled via a common measurement value (CMV) information element.

The RNC can decide to provide the NodeB with a value for the thermal plus background noise level to be used as a reference for NodeB scheduling instead of the measured value. The NodeB can check if such a value has been sent as shown in
15 a step 310.

Upon reception of a signalling message carrying the new value from RNC, the NodeB overwrites the measured value by the new one in NodeB scheduling as shown in a step 312.

The thermal plus background noise level used as reference for NodeB
20 scheduling is either the measured value or the one signalled by RNC, as shown in a step 314.

Fig. 4 is a simplified flowchart illustrating steps carried out in a Radio Network Controller (RNC), according to the present invention. A determination is made in a step 402 if a measured P_{rx_noise} value has been received from a NodeB. If
25 so, a step 404 is executed to determine whether the NodeB should use the measured value or a value supplied to the NodeB by the RNC. After the determination, a decision is made in a step 406 whether to send a different value P_{rx_noise} value or not. The decision in step 406 is also made if there was no measured value received

from the NodeB. If a P_{rx_noise} is to be sent, such is done in a step 408, as shown. Whether or not a P_{rx_noise} is sent, a return is made in a step 410.

Fig. 5 shows a system, according to the present invention. A scheduler 500 is located in a NodeB 502 to control, within the limits set by an RNC 504, the set of Transport Format Combinations (TFCs) from which a UE 506 may choose a suitable TFC. The NodeB makes measurements of the the radio interface (Uu) thermal plus background noise (P_{rx_noise}) via an antenna 510, a receiver 512, and a device 514 for measuring P_{rx_noise} . According to the present invention, the measured value of P_{rx_noise} is stored in a memory and may be sent as a signal on a line 518 via a transmitter to a receiver 522 of the RNC 504 where it is provided to a device 524 for determining whether to send a P_{rx_noise} value different from the measured value. Depending on the strategy employed by the RNC 504, a signal on a line 526 may be provided to a transmitter 528 which provides a P_{rx_noise} value set by the RNC to a receiver 530 of the NodeB 502. The NodeB may include a device 532 for using the P_{rx_noise} value received from the RNC to overwrite the measured value stored in the memory 516. The scheduler 500 will thus use the measured value stored by the device 514 or the P_{rx_noise} value supplied by the RNC, depending on the strategy employed by the RNC.

Although the invention has been shown and described with respect to a best mode embodiment thereof, it will be evident to those of skill in the art that various other devices and methods can be provided to carry out the objectives of the present invention while still falling within the coverage of the appended claims. It is to be understood that all of the present figures, and the accompanying narrative discussions of best mode embodiments, do not purport to be completely rigorous treatments of the invention under consideration. A person skilled in the art will understand that the steps and signals of the present application represent general cause-and-effect relationships that do not exclude intermediate interactions of various types, and will further understand that the various steps and structures described in this application can be implemented by a variety of different sequences and configurations, using various different combinations of hardware and software which need not be further detailed herein.

WHAT IS CLAIMED IS:

- 5 1. Method, characterized by:
making a measurement in a first network element of noise on a radio
interface between user equipment and said first network element,
sending a measurement report signal having a magnitude indicative of said
measurement of said noise from said first network element to a second network
10 element, and
using said measurement of said noise in scheduling decisions made by said
first network element.
2. The method of claim 1,
15 wherein the first network element is located at a Node B, and the second
network element is located at a radio network controller,
wherein the measurement of noise is used to obtain a value of received total
wide band power,
wherein said report signal uses a common measurement value information
20 element, and
wherein the value of received total wide band power is used by a Node B
scheduler to make scheduling decisions, unless the Node B receives a noise value
from the radio network controller in response to the sending step, in which case the
Node B uses said noise value in said scheduling decisions.
- 25 3. The method of claim 1, wherein said measurement report is used for
scheduling, admission control, resource allocation, or congestion control decisions
made by said second network element.
- 30 4. The method of claim 1, wherein said measurement of said noise is used in
scheduling decisions made by said first network element unless said first network

element receives a noise value sent by said second network element to said first network element, in which case said first network element uses said received value in said scheduling decisions made by said first network element instead of said measurement of said noise.

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5. The method of claim 1, wherein said making, sending, and using are for execution by a NodeB of a radio access network.

6. Network element, characterized by:

10 means for making a measurement of noise on a radio interface between user equipment and said network element,

means for sending a measurement report signal having a magnitude indicative of said measurement of said noise from said network element to a radio network controller, and

15 means for using said measurement of said noise in scheduling decisions made by said network element unless said network element receives a noise value sent by said radio network controller to said network element, in which case said network element uses said received value in said scheduling decisions made by said network element, instead of using said measurement of said noise.

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7. The network element of claim 6,
wherein the network element is located at a Node B,
wherein the measurement of noise is used to obtain a value of received total wide band power,

25 wherein said report signal uses a common measurement value information element, and

wherein the value of received total wide band power is used by a Node B scheduler to make scheduling decisions, unless the Node B receives a noise value from the radio network controller in response to the sending step, in which case the
30 Node B uses said noise value in said scheduling decisions.

8. The network element of claim 6, wherein said making, sending, and using are for execution by a NodeB of a radio access network.

5 9. System, characterized by:

(a) a first network element, comprising:

means for making a measurement of noise on a radio interface between user equipment and said first network element,

10 means for sending a measurement report signal having a magnitude indicative of said measurement of said noise, and

means for using said measurement of said noise in scheduling decisions unless a set noise value signal is received having a magnitude indicative of a set noise value, in which case said set noise value is used in said scheduling decisions instead of said measurement of said noise; and

15 (b) a second network element, comprising means for providing said set noise value signal indicative of said set noise value to said first network element.

10. Controller, characterized by:

20 a receiver, responsive to a measurement report, for providing a measurement value signal having a magnitude indicative of a noise measurement made by a network element for use in scheduling over a radio interface between said network element and user equipment;

a device for providing a noise signal having a magnitude indicative of a set noise value; and

25 a transmitter, responsive to said set noise signal, for transmitting same to said network element for use in said scheduling according to the magnitude of said set noise value signal instead of said measurement value.

11. User equipment, characterized by:

30 an antenna, responsive to a scheduling signal from a network element indicative of a transmission characteristic commanded over a radio link established

between said user equipment and said network element, for providing a received scheduling signal; and

a signal processor, responsive to said received scheduling signal, for providing an information signal to said antenna for transmission over said radio link to said network element according to said transmission characteristic wherein said scheduling signal is commanded by said network element and wherein said network element is responsive to either a noise measurement made by said network element or to a noise value set and signalled by said radio network controller to said network element.

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12. Computer program product with executable code stored on a computer readable medium for executing the steps of claim 2.

13. A communication method for High Speed Uplink Packet Access (HSUPA) for a Universal Mobile Telecommunications System (UMTS) for permitting a NodeB to measure and set a thermal plus background noise level (P_{rx_noise}) value, and at the same time for permitting a Radio Network Controller (RNC), according to its own centralized strategy, to overwrite said thermal plus background noise level (P_{rx_noise}) value with a value set by said RNC that is then used in said NodeB for decentralized scheduling.

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14. The network element of claim 7, wherein said measurement report is used for scheduling, admission control or congestion control decisions made by said second network element.

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15. Computer program product with executable code stored on a computer readable medium characterized by executing the steps of:

measuring at a Node B a value of received total wide band power,

signalling the value of received total wide band power in a common

30 measurement value information element, from the Node B to a radio network controller, and

using the value of received total wide band power by a Node B scheduler to make scheduling decisions, unless the Node B receives a noise value from the radio network controller in response to the signalling, in which case the Node B uses said noise value in said scheduling decisions.

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16. Chip hardware characterized by executing the steps of:

measuring or estimating at a Node B a value of received total wide band power,

signalling the value of received total wide band power in a common
10 measurement value information element, from the Node B to a radio network controller, and

using the value of received total wide band power by a Node B scheduler to make scheduling decisions, unless the Node B receives a noise value from the radio network controller in response to the signalling, in which case the Node B uses said
15 noise value in said scheduling decisions.