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[Continued on next page]

(54) **Title**: METHOD FOR COMMUNICATING IN A NETWORK, A SECONDARY STATION AND A SYSTEM THEREFOR

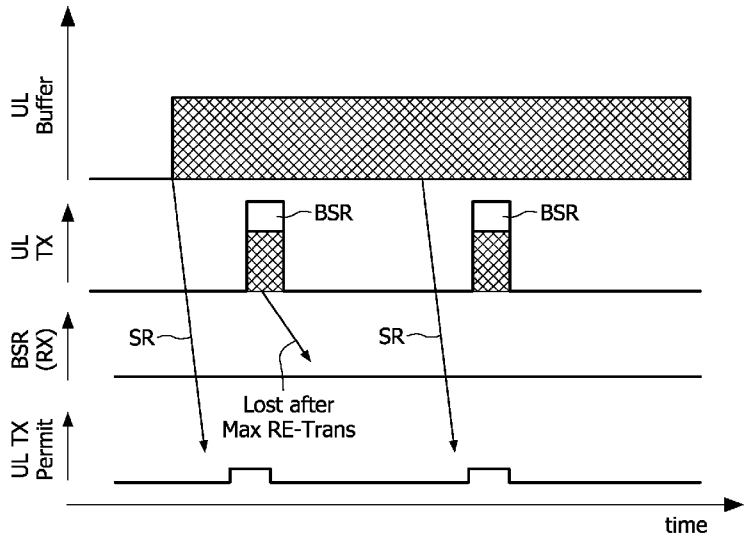

FIG. 3

(57) **Abstract**: The present invention relates to a method for communicating in a network comprising at least one primary station communicating with at least one secondary station, comprising (a) the secondary station sending to the primary station a buffer status report representative of the amount of data in a buffer of the secondary station, (b) in absence of acknowledgement from the primary station, the secondary station retransmitting the buffer status report and, (c) if a maximum number of retransmissions has been reached, the secondary station sending a further buffer status report to the primary station.

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METHOD FOR COMMUNICATING IN A NETWORK, A SECONDARY STATION AND A SYSTEM THEREFOR

FIELD OF THE INVENTION

The present invention relates to a method for communicating in a network comprising a primary station and at least one secondary station, and to such a secondary station. More specifically, this invention relates to a method for communicating in a mobile telecommunication network, like a GSM (Global System for Mobile communications) or a UMTS (Universal Mobile Telecommunications System) network.

This invention is, for example, relevant for UMTS and UMTS Long Term Evolution, but as well to hubs which route calls from multiple terminals to base stations.

BACKGROUND OF THE INVENTION

In a mobile telecommunication network like a UMTS system, a primary station, for instance a Node B (or Base Station or eNB) communicates with at least one secondary station, for instance a User Equipment (or Mobile Station), by means of a plurality of channels. In order to transmit data to the primary station, a secondary station needs to request a resource to the primary station, which is then allocated. This request of allocation can be made by several ways depending on the considered channel.

In an example, in order to request a resource, it is required to indicate the amount of data to be transmitted, i.e. the data in the buffer of the secondary station. To this end, the secondary station transmits to the primary station a buffer status report indicative of the amount of data in the secondary station buffer. Thus, the primary station allocates a resource corresponding to both the capability of the network and the amount of data to be transmitted. This permits to adjust the allocation of resource.

However, in the current version of the specification, when a secondary station transmits this buffer status report, and receives no positive acknowledgement, it performs retransmission till reception of a positive acknowledgement or till the number of retransmissions reaches a maximum number. In the latter case, the secondary station has not been heard by the primary station and will not receive a resource grant for a long period. This leads to a significant delay, the secondary station no longer having any means to indicate its buffer status to the primary station.

SUMMARY OF THE INVENTION

It is an object of the invention to propose a method enabling to alleviate this above problem.

It is another object of the invention to propose a secondary station which is able to keep the contact with the primary station.

To this end, in accordance with a first aspect of the invention, a method is proposed for communicating in a network comprising at least one primary station communicating with at least one secondary station, comprising

(a) the secondary station sending to the primary station a buffer status report representative of the amount of data in a buffer of the secondary station,

(b) in absence of acknowledgement from the primary station, the secondary station retransmitting the buffer status report and,

(c) if a maximum number of retransmissions has been reached, the secondary station sending a further buffer status report to the primary station.

In accordance with a second aspect of the invention, a secondary station is proposed comprising means for communicating in a network comprising at least one primary station communicating with the secondary station, the secondary station comprising transmission means for transmitting to the primary station a buffer status report representative of the amount of data in a buffer of the secondary station, retransmission means for, in absence of acknowledgement from the primary station, retransmitting the buffer status report and, wherein the transmission means are arranged for, if a maximum number of retransmissions has been reached, sending a further buffer status report to the primary station.

In accordance with a third aspect of the invention, a system of communication is proposed comprising at least one primary station communicating with at least one secondary station, the secondary station comprising transmission means for transmitting to the primary station a buffer status report representative of the amount of data in a buffer of the secondary station, retransmission means for, in absence of acknowledgement from the primary station, retransmitting the buffer status report and, wherein the transmission means are arranged for, if a maximum number of retransmissions has been reached, sending a further buffer status report to the primary station.

As a consequence, if a secondary station arrives in the state where it has reached for instance the maximum number of retransmissions, it can again request a resource by sending another buffer status report. This second buffer status report may be of the same kind as the first status report, and even identical to the first report.

These and other aspects of the invention will be apparent from and will be elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described in more detail, by way of example, with reference to the accompanying drawings, wherein:

- Fig. 1 is a block diagram of a system in which is implemented the invention.
- Fig. 2 is a time chart illustrating the exchange of messages in accordance with a conventional technique.
- Fig. 3 is a time chart illustrated the exchange of messages in accordance with a method in accordance with an embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a system of communication 300 as depicted on Figure 1, comprising a primary station 100, like a base station, and at least one secondary station 200 like a mobile station.

The radio system 300 may comprise a plurality of the primary stations 100 and/or a plurality of secondary stations 200. The primary station 100 comprises a transmitter means 110 and a receiving means 120. An output of the transmitter means 110 and an input of the receiving means 120 are coupled to an antenna 130 by a coupling means 140, which may be for example a circulator or a changeover switch. Coupled to the transmitter means 110 and receiving means 120 is a control means 150, which may be for example a processor. The secondary station 200 comprises a transmitter means 210 and a receiving means 220. An output of the transmitter means 210 and an input of the receiving means 220 are coupled to an antenna 230 by a coupling means 240, which may be for example a circulator or a changeover switch. Coupled to the transmitter means 210 and receiving means 220 is a control means 250, which may be for example a processor. Transmission from the primary radio station 100 to the secondary station 200 takes place on a downlink channel 160 and transmission from the secondary radio station 200 to the first radio station 100 takes place on an uplink channel 260.

From time to time, the secondary station 200 transmits on the uplink channel 260 an indication of the status of its buffer containing data to be transmitted. This Buffer Status Report can be of different types. A short Buffer Status Report (BSR) comprises the identity of a single group of logical channels, together with a 6-bit indicator of the amount of data

corresponding to that group of logical channels currently residing in the secondary station's buffer awaiting transmission. A long BSR comprises 4 concatenated short BSRs, each corresponding to a different group of logical channels.

Many communication systems operate using a centralised scheduler which is responsible for allocating transmission resources to different nodes. A typical example is the uplink of the UMTS LTE, where the uplink transmissions from different secondary stations (or UEs) are scheduled in time and frequency by the primary station (or eNB); the eNB transmits a "scheduling grant" message to a UE, indicating a particular time-frequency resource for the UE's transmission typically around 3ms after the transmission of the grant message. The grant message also typically specifies the data rate and/or power to be used for the UE's transmission.

In order for the eNB to issue appropriate grants, it needs to have sufficient information about the amount, type of data and the urgency of it awaiting transmission in the buffer of each UE. This information can be used to inform the scheduler in the eNB of either the satisfaction level of individual UEs or UEs whose service might be close to being dropped.

In LTE, a number of different types of buffer status report (BSR) messages are therefore defined, which may be transmitted from a UE to the eNB when certain triggers occur. The state of the art in this respect is defined by the current version of 3GPP TS36.321 (as of June 2008) §5.4.5, incorporated by reference.

A short BSR comprises the identity of a single group of logical channels, together with a 6-bit indicator of the amount of data corresponding to that group of logical channels currently residing in the UE's buffer awaiting transmission. A long BSR comprises 4 concatenated short BSRs, each corresponding to a different group of logical channels.

This is currently defined in 36.321 (as of June 2008) §6.1.3.1 incorporated by reference.

As detailed in this specification, there are two main types of Buffer Status Reports (BSR) with different characteristics.

- Regular BSR which is triggered only if Uplink data arrives in the UE transmission buffer and the data belongs to a logical channel with higher priority than those for which data already existed in the UE transmission buffer.
- Periodic BSR which is triggered when the PERIODIC BSR TIMER expires.

If the UE has no Uplink resources allocated for new transmission for this TTI and if a Regular BSR has been triggered since the last transmission of a BSR a Scheduling Request (SR) shall be triggered.

A BSR being "triggered" is not necessarily the same as transmitting a BSR. For example, in the case above, the following sequence of steps can be identified:

a) Data of higher priority arrives in UE buffer

b) BSR is triggered

c) No UL resources are allocated for this TTI, so a SR is triggered

d) SR is transmitted

e) UL grant should then be received

f) Finally the BSR is actually transmitted.

The BSR mechanism has been designed so that only regular BSRs can trigger the sending of an SR if there are no UL resources available for the sending of the regular BSR. When a periodic BSR is triggered and there is no UL resource allocated then the UE cannot send SR, as it is assumed that the network knows that the UE has data available and is deliberately not allocating any UL resources for the UE to use.

If the triggering of a periodic BSR were allowed to trigger an SR in the case of no UL resource being available for the sending of the BSR then the system may become overloaded with UEs sending SR, particularly if the UE has no PUCCH resources available, when an SR would require the sending of a RACH access.

Also, an SR is considered pending and is repeated until UL-SCH resources are granted (i.e. for the sending of a BSR).

A problem with the BSR procedure defined above is that there is a possibility that the information that the network knows about the state of the buffers in the UE can be different to the actual state of the UE buffers. This can occur as detailed below:

BSRs are transported as MAC control elements that are subject to HARQ protocol. This means that an individual BSR may be delayed as the initial transmission may be not be received correctly by the eNB and one or more re-transmissions may be required. If the Maximum number of transmissions of a regular BSR is reached without the BSR being successfully received by the eNB then there is no way for the UE to recover from this as there is no trigger defined for the UE to send an SR or repeat again the failed BSR.

This is what is illustrated on Figure 2, where the BSR sent by the secondary station is lost since it has reached the maximum number of retransmissions.

The problem is that if that first BSR is lost then there is no way to generate a subsequent SR to obtain uplink resources (because unless data of even higher priority arrives in the buffer, the data currently in the buffer does not trigger another regular BSR and hence an SR) and a deadlock situation would arise.

One possible solution involves configuring periodic BSRs. If a periodic BSR is configured and the initial BSR is lost then this "lost" BSR will be sent in the first configured UL resource for the periodic BSR. The disadvantage of this is that it requires periodic BSRs to be configured with a sufficiently short interval that the deadlock time is small, and this would increase the control signalling overhead as when data is present in the UL buffer, BSRs will be sent more often. Moreover, if the network does not allocate a grant for the configured periodic BSR, the periodic BSRs cannot be sent and the UE is also not allowed to generate an SR in such a case.

A solution could also be proposed allowing the periodic BSR to generate an SR but only for a configurable amount of time. Thus the following condition: if a Periodic BSR has been triggered since the last transmission of a BSR and the UE has data available for transmission, and the time since the transmission of the last BSR exceeds the BSR STALL AVOIDANCE timer then a Scheduling Request shall be triggered. This would solve the problem but only if periodic BSRs are configured.

In cases described above the secondary station uplink data buffer is out of synchronization with the network view of the buffer.

In accordance with a first aspect of the invention, a mechanism is proposed for a UE to send a buffer status report (BSR) when the transmission of a first buffer status report is not positively acknowledged by the network after a predetermined number of attempts.

This will be known by the secondary station for instance, as the maximum number of HARQ transmissions for the BSR has occurred without the MAC packet containing the BSR being positively acknowledged by the network.

According to one embodiment of the invention, if the secondary station receives a UL grant after the previous BSR has not been positively acknowledged, this UL grant is used to re-send the original BSR or an updated version of it.

According to a variant of this embodiment of the invention, if a previous BSR has not been positively acknowledged then a Scheduling request will be made to request UL resource in order to send the BSR and data. In some embodiments the sending of the SR is conditional on no UL grant being received within a certain time window after e.g. the last transmission of

the previous not-positively acknowledged BSR, or the time at which ACK was expected but not received.

In other words, the invention could be described by stating that a regular BSR is also triggered if a previous regular BSR is not positively acknowledged. Because of the way the triggers for SR are defined, this would also have the effect of triggering an SR if there was no UL grant in which to send the triggered BSR.

On Figure 3, it is illustrated that if a BSR is lost, the whole process can be reinitiated, with the sending of an SR. In accordance with a variant of this embodiment, if some resource is allocated to the secondary station, it is possible to skip the first step (sending of an SR) and use directly this granted resource to send a BSR along with data.

This invention may be implemented in mobile communication systems where communication devices utilize centralized scheduling, such as UMTS and LTE.

Moreover, this invention could as well be implemented for hubs which route calls from multiple terminals to base stations. Such devices would appear like a secondary station from the point of view of the network.

In the present specification and claims the word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. Further, the word "comprising" does not exclude the presence of other elements or steps than those listed.

The inclusion of reference signs in parentheses in the claims is intended to aid understanding and is not intended to be limiting.

From reading the present disclosure, other modifications will be apparent to persons skilled in the art. Such modifications may involve other features which are already known in the art of radio communication and the art of transmitter power control and which may be used instead of or in addition to features already described herein.

CLAIMS

1. A method for communicating in a network comprising at least one primary station communicating with at least one secondary station, comprising

(a) the secondary station sending to the primary station a buffer status report representative of the amount of data in a buffer of the secondary station,

(b) in absence of acknowledgement from the primary station, the secondary station retransmitting the buffer status report and,

(c) if a maximum number of retransmissions has been reached, the secondary station sending a further buffer status report to the primary station.

2. The method of claim 1, wherein the further buffer status report of step (c) is a scheduling request indicative that there is data to be transmitted in the secondary station buffer.

3. The method of claim 2, wherein the scheduling request is sent if no resource grant indicative of an allocated resource is received within a time window after step (c).

4. The method of claim 3, wherein the time window starts from the instant an acknowledgement from the primary station was expected.

5. The method of claim 1, wherein if the secondary station receives from the primary station a resource grant indicative of an allocated resource after step (b), the further buffer status report of step (c) is transmitted in the allocated resource.

6. The method of claim 5, wherein the further buffer status report is of the same type of the buffer status report of step (a).

7. The method of claim 6, wherein the further buffer status report is an update of the buffer status report of step (a).

8. The method of claim 6, wherein the further buffer status report is identical to the buffer status report of step (a).

9. A secondary station comprising means for communicating in a network comprising at least one primary station communicating with the secondary station, the secondary station comprising transmission means for transmitting to the primary station a buffer status report representative of the amount of data in a buffer of the secondary station, retransmission means for, in absence of acknowledgement from the primary station, retransmitting the buffer status report and, wherein the transmission means are arranged for, if a maximum number of retransmissions has been reached, sending a further buffer status report to the primary station.

10. A system of communication comprising at least one primary station communicating with at least one secondary station, the secondary station comprising transmission means for transmitting to the primary station a buffer status report representative of the amount of data in a buffer of the secondary station, retransmission means for, in absence of acknowledgement from the primary station, retransmitting the buffer status report and, wherein the transmission means are arranged for, if a maximum number of retransmissions has been reached, sending a further buffer status report to the primary station.

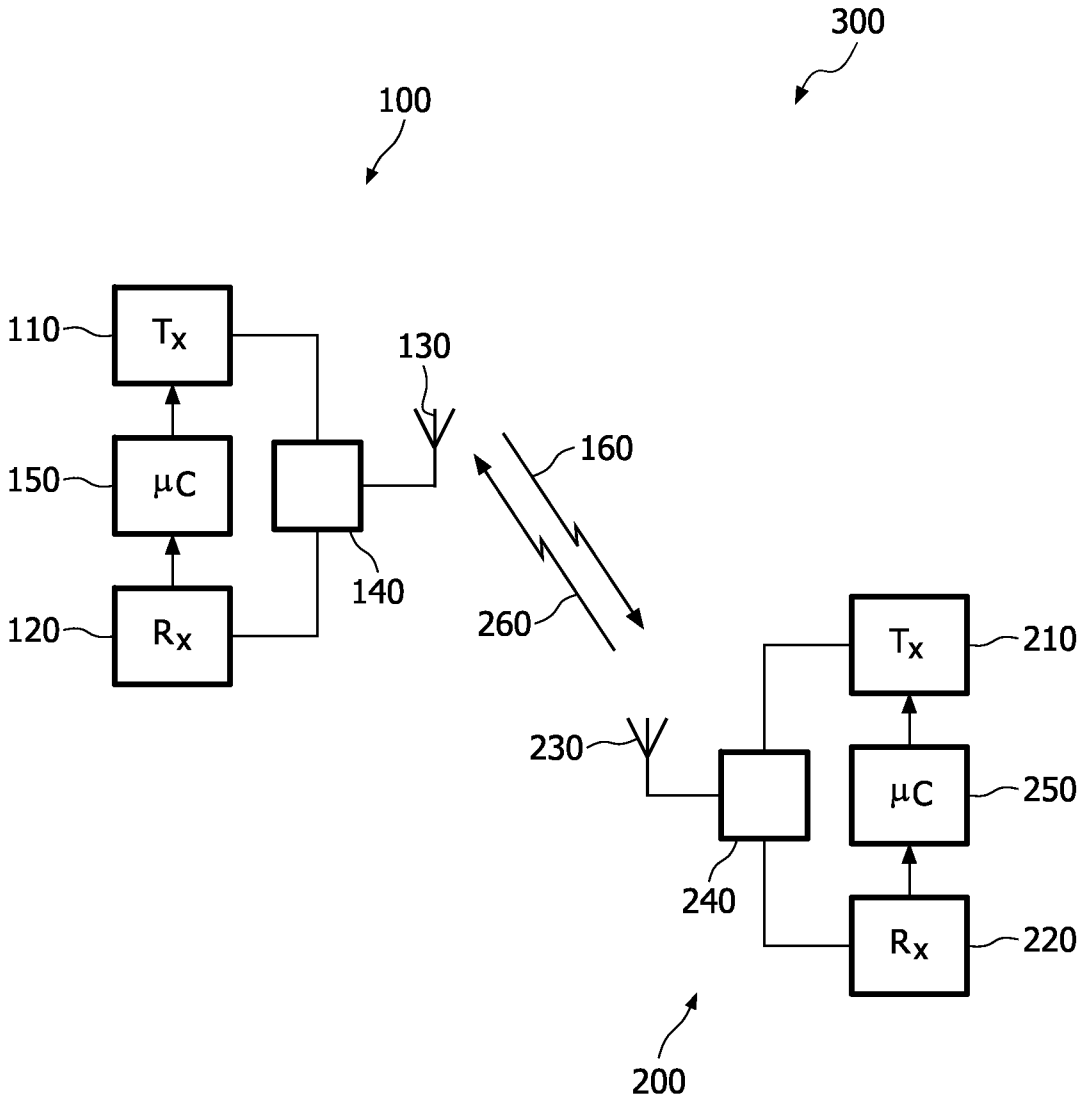
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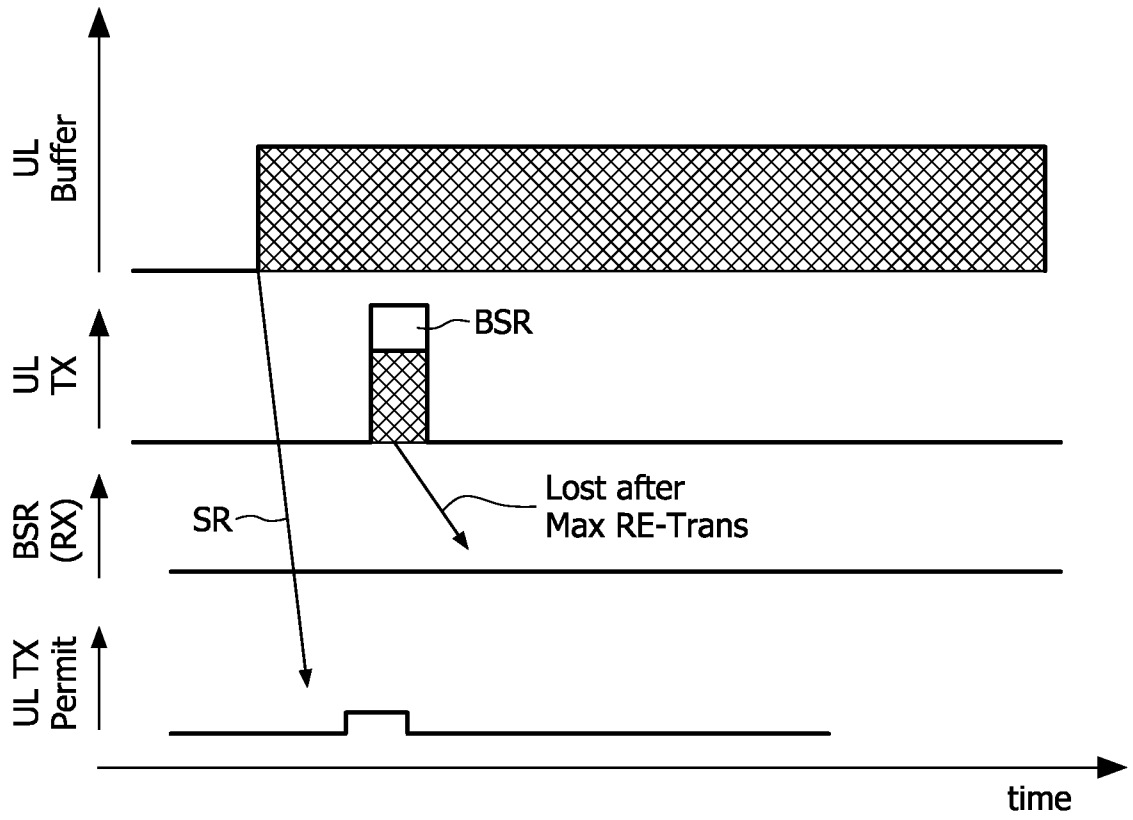
FIG. 1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BSR
BSR (RX)
SR
Lost after Max RE-Trans
UL TX Permit
time

FIG. 2

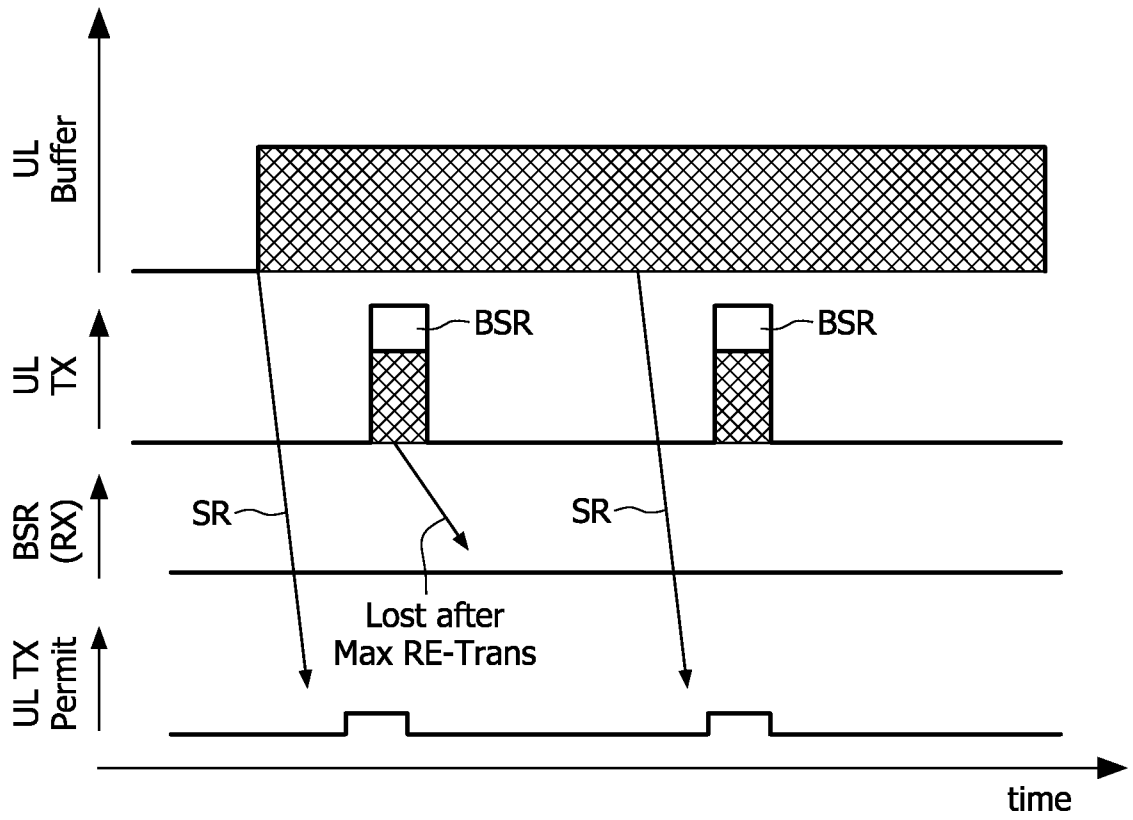
UL Buffer
UL TX
BSR
BSR
BSR (RX)
SR
SR
Lost after Max RE-Trans
UL TX Permit
time

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/053470

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L1/18

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)
H04L

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Ericsson: "Robustness of Buffer Status Reporting" 24 June 2008 (2008-06-24), XP002551799 Retrieved from the Internet: URL:http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_62bis/Docs/R2-083149.zip> [retrieved on 2009-10-20] cited in the application paragraph [0001] --- -/--	1-10

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 October 2009	12/11/2009

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/053470

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	Philips, NXP Semiconductors: "Improving the Robustness of Buffer Status Reporting" 11 August 2008 (2008-08-11), XP002551800 Retrieved from the Internet: URL:http://3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_63/Docs/R2-084090.zip> [retrieved on 2009-10-20] paragraphs [0001], [0002] ---	1-10
A	3GPP: "Evolved Universal Terrestrial Radio Access (E-UTRA) Medium Access Control (MAC) protocol specification" 4 June 2008 (2008-06-04), XP002551801 Retrieved from the Internet: URL:http://www.arib.or.jp/IMT-2000/V700Sep08/5_Appendix/Rel8/36/36321-820.pdf> [retrieved on 2009-10-20] paragraphs [5.4.5], [6.1.3.1] ---	1-10
A	WO 2007/148881 A2 (LG ELECTRONICS INC [KR]; PARK SUNG JUN [KR]; LEE YOUNG DAE [KR]; CHUN) 27 December 2007 (2007-12-27) pages 3,13-15 figure 7 ---	1-10

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2009/053470

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2007148881 A2	27-12-2007	EP 2030359 A2	04-03-2009
		US 2009150739 A1	11-06-2009