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(54) Title: METHOD AND APPARATUS FOR ENABLING UPLINK SCHEDULING PRIORITIZATION IN A RADIO ACCESS NETWORK (RAN)

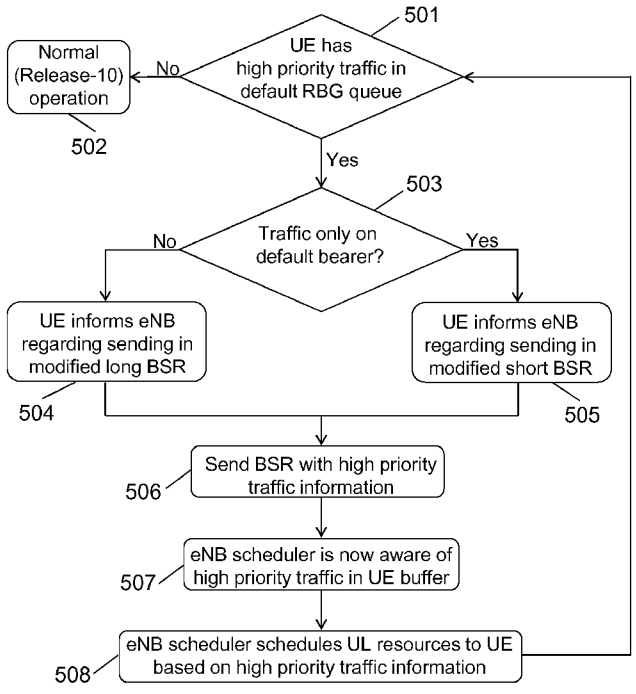

Fig. 5

(57) Abstract: A method of uplink scheduling in a radio access network (RAN), wherein buffer status reports of radio bearers of a mobile terminal are communicated to a base station, wherein said base station performs scheduling of said mobile terminal in the uplink based on information contained in the buffer status reports received from said mobile terminal, is characterized in the steps of, at said mobile terminal, classifying traffic contained in said mobile terminal's uplink default bearer buffer as high priority traffic and including information on said high priority traffic in said mobile terminal's buffer status reports communicated to said base station, and, at said base station, adapting the scheduling of said mobile terminal's uplink default bearer by allocating uplink resources to said mobile terminal based on the information on said high priority traffic contained in the buffer status reports received from said mobile terminal. Furthermore, a corresponding apparatus for use in uplink scheduling in RAN is disclosed.

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METHOD AND APPARATUS FOR ENABLING UPLINK SCHEDULING PRIORITIZATION IN A RADIO ACCESS NETWORK (RAN)

The present invention relates to a method of uplink scheduling in a radio access network (RAN), wherein buffer status reports of radio bearers of a mobile terminal are communicated to a base station, wherein said base station performs scheduling of said mobile terminal in the uplink based on information contained in the buffer status reports received from said mobile terminal.

Furthermore, the present invention relates to an apparatus for use in uplink scheduling in a radio access network (RAN), comprising a base station radio resource scheduler for receiving from a mobile terminal buffer status reports of radio bearers of said mobile terminal and for performing scheduling of said mobile terminal in the uplink based on information contained in the buffer status reports received from said mobile terminal.

Mobile traffic demand is increasing exponentially and LTE-Advanced networks need to continually adapt to cater to these demands. As a result, RAN (Radio Access Network) User Plane congestion is one of the most prominent challenges faced by network operators. Currently, User Plane Congestion (UPCON) management is a topic of interest in 3GPP (see, for instance, 3GPP S2-130402, “Analysis and discussion of UPCON solution elements,” Prague, Feb. 2013). However, most of the solutions currently being proposed are mainly looking at the problem from data traffic requirements in the downlink direction. Congestion handling in the uplink (UL) direction has received limited focus so far.

Congestion in the uplink can occur due to heavy user traffic in the uplink direction, resulting from various reasons such as a significant number of users being engaged in sending of TCP ACKs resulting from downlink traffic, due to allocating uplink resources for downlink in flexible TDD (as described, e.g., in Y. Wang et al., “Performance Evaluation of Flexible TDD Switching in 3GPP LTE System,” IEEE SARNOFF, May 2012), or due to a significant number of users being engaged in using applications which utilize substantial amount of uplink resources such as

video telephony. In today's networks, nearly all over-the-top (OTT) traffic is transported on the so-called default bearer, preventing any kind of traffic differentiation for different applications. This means that the evolved NodeB (eNodeB or eNB), which is the base station in the LTE architecture, does not know how many resources a traffic flow needs in order to fulfil the user's expectations on service quality. Accordingly, in cellular systems such as 3GPP LTE-Advanced systems, there are currently only means available to prioritize uplink traffic for operator-controlled traffic on dedicated bearers (for reference, see 3GPP 36.321, "E-UTRA: Medium Access Control (MAC) protocol specification," Version 11.1.0, January 2013).

Scheduling in the uplink is controlled by the RAN in order to enable flexible and dynamic utilization of radio resources. In order to transmit on the UL-SCH (uplink shared channel), a User Equipment (UE) must have a valid UL grant. This means that the address of resource blocks in the physical layer for the UE to transmit data are signaled to the UE either via the physical downlink control channel (PDCCH),in a Random Access Response, or configured semi-persistently (for voice traffic).

According to current standards, UEs use Scheduling Requests (SR) to request UL-SCH resources for transmission. In this context, UEs use the procedure of Buffer Status Reporting (BSR) to inform the eNB about the amount of data available in UL buffers for transmission. This also ensures that radio resources are not wasted. Buffer status reporting for delay constrained flows or radio bearers are considered in Pradap K.V. et al., "Uplink Buffer Status Reporting for Delay Constrained Flows in 3GPP Long Term Evolution," IEEE WCNC, April 2009. Here, a prioritization of radio bearers is done by grouping radio bearers having same priority into Radio Bearer Group (RBG) or Logical Channel Group (LCG), and BSRs are sent along with LCG IDs so that RAN is aware of high priority traffic in UE buffers of radio bearers that belong to an RBG having assigned a high priority.

Fig. 1 illustrates uplink channel mapping of logical channels into transport channels, as defined in 3GPP 36.321, "E-UTRA: Medium Access Control (MAC) protocol specification," Version 11.1.0, January 2013. Here, it can be observed that various logical channels – CCCH (Common Control Channel), DCCH

(Dedicated Control Channel), and DTCH (Dedicated Traffic Channel) – are mapped into the UL-SCH, hence also necessitating the need for prioritization procedures mentioned above.

Currently, the key concern among operators is the prioritization of traffic on default bearer during RAN congestion. However, the techniques currently defined for UL scheduling prioritization does not take this key consideration into account. Default bearer contains traffic such as TCP ACKs which are considered to be important from network operators' point-of-view, whereas traffic due to OTT services, such as peer-to-peer file transfers, etc. might be considered less important. Hence, techniques are required for prioritization of traffic classified as important in the default bearer (which can be generalized to any RBG/LCG) while scheduling UL resources. Considerations as the ones disclosed in 7,724,656 B2 aim to lower allocation of UL resources to mitigate congestion, but do not take into account the priority of traffic which needs to be transmitted even during congestion.

In view of the above, it is an objective of the present invention to improve and further develop a method of uplink scheduling in a radio access network (RAN) and an apparatus for use therein of the initially described type in such a way that the base station has high control over the network performance, especially during congestion, while at the same time mobile terminals' QoS experiences are improved.

In accordance with the invention, the aforementioned object is accomplished by a method comprising the features of claim 1. According to this claim such a method is characterized in the steps of

at said mobile terminal, classifying traffic contained in said mobile terminal's uplink default bearer buffer as high priority traffic and including information on said high priority traffic in said mobile terminal's buffer status reports communicated to said base station, and

at said base station, adapting the scheduling of said mobile terminal's uplink default bearer by allocating uplink resources to said mobile terminal based on the information on said high priority traffic contained in the buffer status reports received from said mobile terminal.

Furthermore, the above mentioned objective is accomplished by an apparatus comprising the features of claim 9. According to this claim such an apparatus is characterized in that said base station radio resource scheduler is configured to adapt the scheduling of said mobile terminal's uplink default bearer by allocating uplink resources to said mobile terminal based on information on high priority traffic contained said mobile terminal's uplink default bearer buffer, which said mobile terminal included in said mobile terminal's buffer status reports.

According to the invention it has first been recognized that current state-of-the-art cannot mitigate user plane congestion, especially on default bearer. It has further been recognized that the above objective can be solved by sending priority related information to the base station about buffer occupancy of default bearer traffic. In particular, the priority related information may include information on traffic classified by the mobile terminal as high priority traffic, where high priority traffic generally denotes traffic that has to be transported even in case of network congestion. The method according to the present invention, which provides a method for uplink scheduling prioritization of default bearer congestion mitigation, enables adaptation of the scheduling of the uplink default bearer according to the traffic which needs to be transported. Dedicated bearers cannot be used for this purpose, since this would mean an end-to-end EPS (Evolved Packet System) bearer have to be setup, which causes significant overhead.

The present invention enhances UL resource availability to UEs without affecting the base station and eNB scheduler flexibility. It enables base stations to have better control over the network performance, especially during congestion. As a result, by applying method according to embodiments of the present invention better resource prioritization and hence utilization is achieved. As a further advantage, the present invention enables operators to define congestion mitigation techniques at the eNB with limited impact on currently defined standards. Finally, in a network using flexible TDD, based on modified BSR in accordance with embodiments of the invention, eNB can decide the flexible switching point more efficiently, leading to better utilization of physical resources.

According to a preferred embodiment the mobile terminal may perform a binary level classification of traffic contained in its uplink default bearer buffer, for instance, by dividing the traffic contained in the uplink default bearer buffer and to high priority traffic on the one hand and into low priority traffic on the other hand.

Alternatively, it may be provided that the mobile terminal performs a classification of buffer occupancy on a more fine grained level, i.e. by assigning traffic contained the uplink default bearer buffer a number of three or more different priority levels. For instance, the classification may be performed by using service differentiated buffer occupancy criteria together with associated priority IDs. This would bring service differentiation function to the base station or, more specifically, to the base station radio resource scheduler, giving the base station radio resource scheduler more flexibility in scheduling.

According to another preferred embodiment the mobile terminal may classify traffic contained in its uplink default bearer buffer as high priority traffic based on service class identifier (SCI) information obtained from downlink traffic.

According to an embodiment of the invention the mobile terminal may inform the base station of the employed format of the buffer status reports. Generally, the mobile terminal may transmit the modified buffer status reports by either using a modified long BSR format or by using a modified short BSR format, based on the BSR format definitions as specified in 3GPP 36.321, "E-UTRA: Medium Access Control (MAC) protocol specification," Version 11.1.0, January 2013 (see section 6.1.3 "MAC Control Elements", which is incorporated herein by way of reference). For instance, the mobile terminal may send a message (that contains information regarding the employed BSR format) to the base station in RRCReconfiguration (Radio Resource Control). Upon receiving this information, the base station understands which format of BSR to expect from the mobile terminal.

In a specific embodiment it may be provided that a field indicating the size of high priority traffic contained in the mobile terminal's uplink default bearer buffer is added to the buffer status report. By reporting this information, the base station is informed of the amount of UL resources that the mobile terminal really needs on

the default bearer during congestion situation. For instance, this report could be realized by adding another octet to the buffer status reports as currently defined in the above quoted 3GPP document. Hence, as a result, buffer status reports would defined in such a way that high priority UL traffic is sent without significant delays, while de-prioritizing low-priority traffic.

Additionally or alternatively, it may be provided that a field indicating a priority ID of the high priority traffic contained in the mobile terminal's uplink default bearer buffer is added to the buffer status report. This would give additional information to the base station or, more specifically, to the base station radio resource scheduler regarding the type of traffic the mobile terminal has classified as high priority traffic.

It is noted that by adding an additional information element parameter – size and/or priority ID of the high priority traffic contained in the mobile terminal's uplink default bearer buffer – to the BSR as specified according to current standards, the solutions according to the present invention are fully compatible with legacy UEs.

While generally the decision of using either the modified Short or the modified Long BSR format is up to the mobile terminal, it may be provided that it is the base station that decides on the BSR modifications to be used by the mobile terminal, i.e. the base station decides on which fields to add to the (long or short) buffer status report and on how to size/arrange these fields. The base station may transmit a corresponding configuration message to the mobile terminal in order to advise the mobile terminal accordingly.

There are several ways how to design and further develop the teaching of the present invention in an advantageous way. To this end it is to be referred to the patent claims subordinate to patent claim 1 on the one hand and to the following explanation of preferred embodiments of the invention by way of example, illustrated by the drawing on the other hand. In connection with the explanation of the preferred embodiments of the invention by the aid of the drawing, generally preferred embodiments and further developments of the teaching will be explained. In the drawing

Fig. 1 is a schematic view illustrating uplink channel mapping according to 3GPP specifications,

Fig. 2 is a schematic view illustrating the short BSR format according to 3GPP specifications,

Fig. 3 is a schematic view illustrating the long BSR format according to 3GPP specifications,

Fig. 4 is a schematic view illustrating a scenario of BSR reporting and traffic handling according to prior art,

Fig. 5 is a flow diagram illustrating the reporting of modified BSR information in accordance with a first embodiment of the invention,

Fig. 6 is a schematic view illustrating a modified BSR reporting format in accordance with an embodiment of the invention,

Fig. 7 is a schematic view illustrating a modified BSR reporting format in accordance with another embodiment of the invention, and

Fig. 8 is a diagram illustrating uplink scheduling based on traffic prioritization using service class identifiers (SCI) in accordance with an embodiment of the invention,

Figs. 2 and 3 illustrate buffer status reporting (BSR) formats, as specified according to current standards (see 3GPP 36.321, “E-UTRA: Medium Access Control (MAC) protocol specification,” Version 11.1.0, January 2013, subsection 6.1.3 “MAC Control Elements”). In this regard it is important to note that in 3GPP networks buffer status reporting is performed not on single radio bearer basis, but on a per Radio Bearer Group (RBG) basis. Here, each radio bearer is mapped to one of four defined RGBs (#0 - #3) based on its QoS. Each RBG is identified by a

RBG Identifier (RGB ID). Based on these specifications, Fig. 2 illustrates the short BSR format that consists of one RGB ID and one corresponding buffer size field, which identifies the total amount of traffic buffered in the respective RBG. The RBG ID is represented as Logical Channel Group ID (LCG ID). The long BSR format, which is illustrated in Fig. 3 and which is sent if multiple RBG/LCGs have data in the UE buffer, consists of four buffer size fields, each of which corresponding to a respective LCG (LCG IDs 0-3). As will be described hereinafter in connection with embodiments of the present invention, these standardized BSR formats may form the basis for designing modified BSRs that include information on high priority traffic contained in a mobile terminal's uplink default bearer buffer in accordance with the invention.

However, before describing embodiments of the invention in detail, specific aspects of the problems underlying the present invention are illustrated with the help of Fig. 4, which is related to BSR reporting and traffic handling according to prior art. More specifically, Fig. 4 depicts an LTE network architecture comprising a radio access network (RAN) in which a mobile terminal – UE 1 – is connected to a base station – eNodeB 2. As illustrated in Fig. 4, it is assumed that UE 1 is running various applications. The traffic of IP applications, like YouTube Video, TCP ACKs, Web service requests, Facetime Data upload, etc., is scheduled in the UE's 1 default radio bearer queue, while the traffic belonging to non-IP applications, for instance voice or video calls, is scheduled in the buffers of dedicated radio bearers established by UE 1.

As described in connection with Figs. 2 and 3, since multiple RBG/LCGs have data in the buffer, UE 1 employs the long BSR format to report buffer size information (i.e. the amount of data available in the buffers) to eNodeB 2. In Fig. 4, this BSR procedure is indicated by the solid line arrows denoted "Default RBG BSR#0" (indicating the RBG to which UE's 1default bearer belongs to) and "Dedicated RBG BSR#1-3". Based on this information, eNodeB 2 grants the UE 1 uplink resources for transmission via the UL-SCH.

As we can observed from Fig 4, UE 1 buffers are occupied by different types of traffic and, in particular, within the default bearer buffer there could be traffic with

different levels of priority. By applying the currently defined mechanisms as outlined above, this cannot be informed to the eNB 2. This means that in particular during congestion conditions, UE 1 cannot be allocated with proper amount of uplink resources since the eNB 2 scheduler is unaware of the high priority traffic information contained in the default RBG buffer.

Further details shown in Fig. 4 (like the cellular protocol stack or GPRS tunneling protocol (GTP) performed by eNodeB 2) are not of particular importance with respect to the present invention. Apart from this it is assumed that those skilled in the art are sufficiently familiar with these aspects, such that a detailed description thereof can be omitted here.

Turning now to Fig. 5, this figure illustrates a flow diagram for reporting modified BSR information in accordance with a first embodiment of the present invention. In this embodiment the UE 1 informs the eNB 2 about sending modified BSR information for default bearer when there is significant amount of high priority traffic in the default bearer which could not be sent within particular time duration.

In a first step, indicated at 501, UE 1 detects that it has a significant amount of high priority traffic in its default RBG queue. The trigger for initiating the modified BSR reporting according to the invention could be based, e.g., on the relative occupancy of UE's 1 default bearer buffer. For instance, in case more than, e.g., 50% of the default bearer buffer is occupied by high priority traffic for a certain amount of time (e.g. for a few seconds) modified BSR reporting will be initiated. Otherwise, indicated at 502, UE 1 would proceed with normal 3GPP LTE Release-10 operation, as described in connection with Fig. 4.

It is noted that here high priority traffic denotes traffic that has to be sent despite of any congestion situations. In particular, high priority traffic may contain packets with a certain short lifetime or time to expiry, which will be dropped at the Radio Link Control (RLC) layer when not being served within their lifetime or time to expiry, resulting in poor user experience at the UE 1.

If the modified BSR reporting is initiated, at 503, a check is performed whether traffic is available only on the UE's 1 default bearer. Depending on buffer occupancy of various RBGs, UE 1 signals (at 504 and 505, respectively) whether it is sending new BSR format in short or long form. For instance, this information may be sent in a RRCReconfiguration message.

Next, at 506, the UE 1 sends the modified BSR, i.e. BSR with high priority traffic information, to the eNB 2. With this enhancement, eNB 2 scheduler will be aware of the resources UE needs to send the high priority traffic in its buffer, as indicated at 507, and schedules UL resources for the UE accordingly (step 508).

With respect to details of involved signalling messages, the logical channel configurations may be sent in the LogicalChannelConfig information element (IE), as defined in 3GPP 36.331, "E-UTRA: Radio Resource Control (RRC) protocol specification," Ver 11.2.0, January 2013 , subsection 6.3.2, which is incorporated herein by way of reference. From this IE, UE 1 and eNB 2 are aware of which logical channel group or radio bearer group each logical channel belongs to. From extendedBSR-Sizes-r10 parameter in MAC-MainConfig IE, also defined in the above quoted specification, eNB 2 can interpret whether UE 1 is going to send long or short BSR format. From RadioResourceConfigDedicated parameter, the mapping between DRB-ID of default RB and logical channel ID (logicalChannelIdentity) can be mapped. One possible implementation for informing the eNB about sending default RB BSR in a format modified in accordance with the present invention is to add a new parameter called highPriorityTrafficIndicator in RadioResourceConfigDedicated which could be optional or set to '0' by default. When the parameter is set to '1', eNB 2 will be aware of UE 1 sending BSR for default RBG in the modified format.

Turning now to Fig. 6, this figure illustrates a new BSR reporting format modified in accordance with an embodiment of the present invention. In this embodiment, at 601, the eNB 2 informs the UE 1 to send BSR in an RRCConnectionReconfiguration message. Upon receiving this information, UE 1 performs the same BSR selection procedure (comprising steps 602-604) as described in connection with Fig. 5 (corresponding to steps 503-505).

As can be seen in the lower part of Fig. 6, both in case of selecting the modified Short BSR format or selecting the modified Long BSR format, another octet is added to the respective standard format (Octet 2 in case of the Short BSR format and Octet 4 in case of the Long BSR format) in order to indicate the size of high-priority information contained in the UE's 1 uplink default bearer buffer. The buffer size levels indicated by the new field could be chosen to be similar to the currently defined buffer size levels for BSR, as specified in 3GPP 36.321, "E-UTRA: Medium Access Control (MAC) protocol specification," Version 11.1.0, January 2013.

Fig. 7 shows another possible implementation of a BSR reporting format modified in accordance with an embodiment of the present invention. In contrast to the embodiment of Fig. 6, along with the high priority buffer occupancy information, the priority ID of the high priority traffic is informed to the eNB 2. This gives additional information to the eNB 2 regarding the type of traffic UE 1 has classified as high-priority. For this purpose, both in Short and in Long modified BSR format, the added octet (Octet 2 and Octet 4, respectively) are subdivided in two fields, where the first field contains the Priority ID, while the second field contains the size of high priority traffic. Both in the embodiment of Fig. 6 and of Fig. 7, while eNB 2 is informing the configurations, the actual source for the prioritization information could be some external entities as well (for e.g. OMA-DM(Open Mobile Alliance-Device Management).

Fig. 8 is a diagram showing uplink scheduling based on traffic prioritization using service class identifiers (SCI) in accordance with an embodiment of the invention. More specifically, Fig. 8 illustrates the inter-working of BSR reporting modified in accordance with the invention on the one hand with SCI based enhancement in DL traffic on the other end. In detail, at 801, the network state is being analyzed. In case no congestion is detected, at 802, normal 3GPP LTE Release-10 traffic handling procedures are performed. In case of network congestion, at 803, the eNB 2 sends SCI or any other related information, which indicates the traffic priority or QoS-related characteristics, in the default bearer to the UE 1 along with the data packets. In the next steps 804 and 805, UE 1 receives and deciphers the

SCI information and prioritizes the UL traffic at the UE 1 based on the SCI information obtained from downlink traffic. In other words, the UE 1 prioritizes UL traffic in the same way as DL traffic is being prioritized, based on information conveyed from the core network. Also, UE 1 can use the deciphered SCI information to form the priority ID while reporting buffer occupancy in UL so that eNB 2 can have additional information regarding the class of traffic occupying the queue and schedule downlink resource blocks accordingly. In step 806, UE 1 informs eNB 2 about sending buffer status in modified BSR format and, in step 807, UE 1 sends the BSR in modified format. This embodiment shows how well the proposed invention works with other enhancement solutions currently being considered for user plane congestion management.

Many modifications and other embodiments of the invention set forth herein will come to mind the one skilled in the art to which the invention pertains having the benefit of the teachings presented in the foregoing description and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

Claims

1. Method of uplink scheduling in a radio access network (RAN), wherein buffer status reports of radio bearers of a mobile terminal are communicated to a base station, wherein said base station performs scheduling of said mobile terminal in the uplink based on information contained in the buffer status reports received from said mobile terminal,

characterized in the steps of

at said mobile terminal, classifying traffic contained in said mobile terminal's uplink default bearer buffer as high priority traffic and including information on said high priority traffic in said mobile terminal's buffer status reports communicated to said base station, and

at said base station, adapting the scheduling of said mobile terminal's uplink default bearer by allocating uplink resources to said mobile terminal based on the information on said high priority traffic contained in the buffer status reports received from said mobile terminal.

2. Method according to claim 1, wherein said mobile terminal performs a binary level classification of traffic contained in said mobile terminal's uplink default bearer buffer.

3. Method according to claim 1, wherein said mobile terminal performs a classification of traffic contained in said mobile terminal's uplink default bearer buffer by assigning different priority levels.

4. Method according to any of claims 1 to 3, wherein said mobile terminal classifies traffic contained in said mobile terminal's uplink default bearer buffer as high priority traffic based on downlink traffic characteristic obtained from service class identifier or similar information.

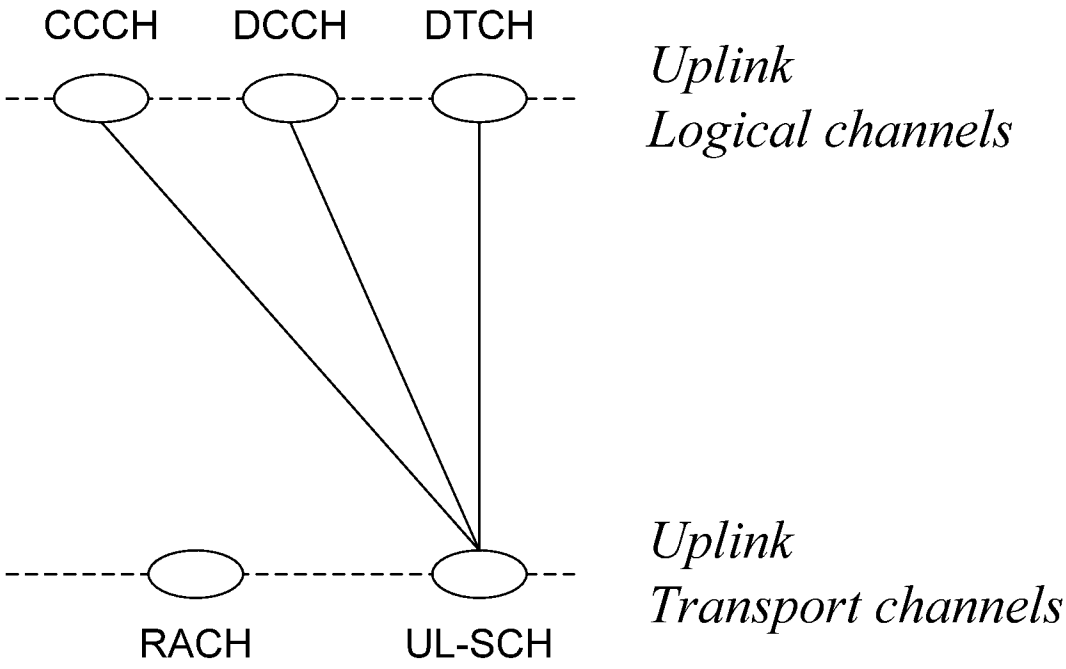
5. Method according to any of claims 1 to 4, wherein said mobile terminal informs the base station of the employed format of the buffer status reports.

6. Method according to any of claims 1 to 5, wherein a field indicating the size of high priority traffic contained in said mobile terminal's uplink default bearer buffer is added to the buffer status report.

7. Method according to any of claims 1 to 6, wherein a field indicating a priority ID of the high priority traffic contained in said mobile terminal's uplink default bearer buffer is added to the buffer status report.

8. Method according to any of claims 1 to 7, wherein said base station transmits a configuration message to said mobile terminal advising said mobile terminal of which fields to add to the buffer status report and of how to arrange the added fields.

9. Apparatus for use in uplink scheduling in a radio access network (RAN), in particular for executing a method according to any of claims 1 to 8, comprising a base station radio resource scheduler for receiving from a mobile terminal buffer status reports of radio bearers of said mobile terminal and for performing scheduling of said mobile terminal in the uplink based on information contained in the buffer status reports received from said mobile terminal,
c h a r a c t e r i z e d i n that said base station radio resource scheduler is configured to adapt the scheduling of said mobile terminal's uplink default bearer by allocating uplink resources to said mobile terminal based on information on high priority traffic contained said mobile terminal's uplink default bearer buffer, which said mobile terminal included in said mobile terminal's buffer status reports.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DCCH
DTCH
Uplink
Logical channels
Uplink
Transport channels
RACH
UL-SCH

Fig. 1

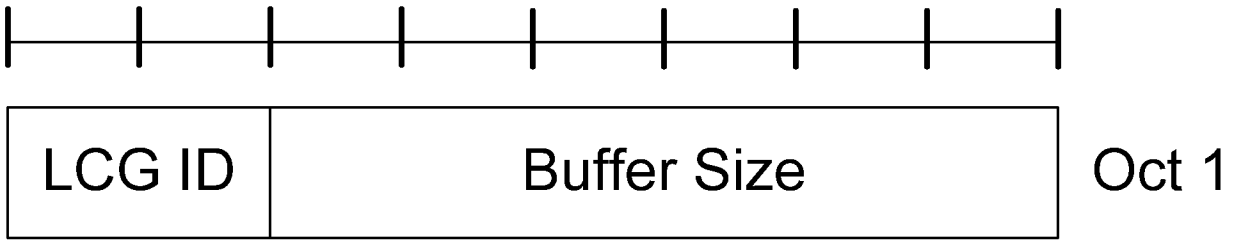
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Fig. 2

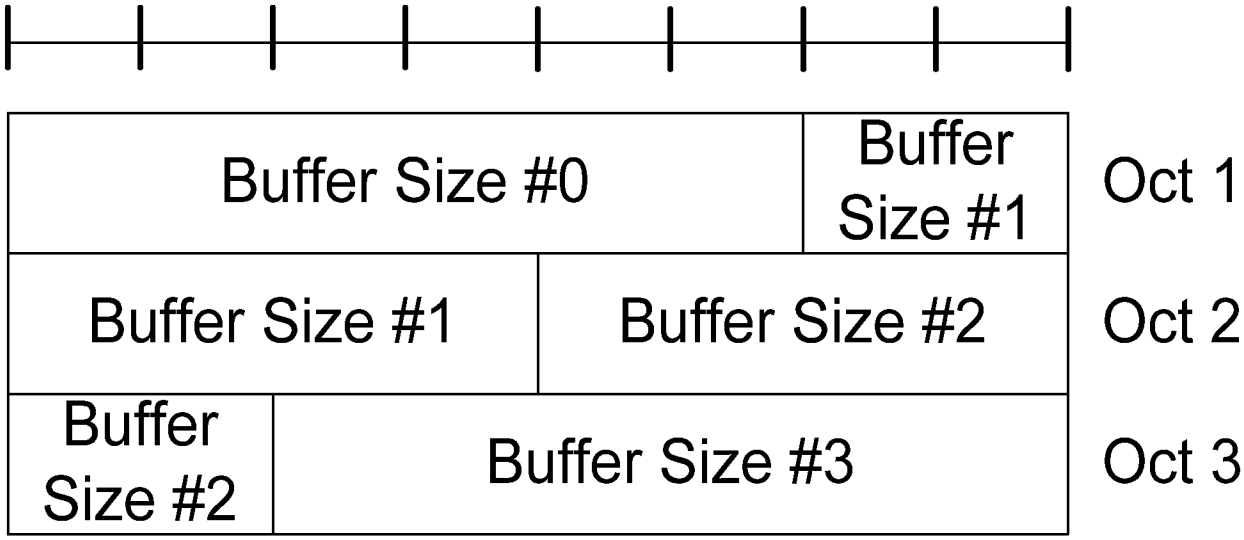
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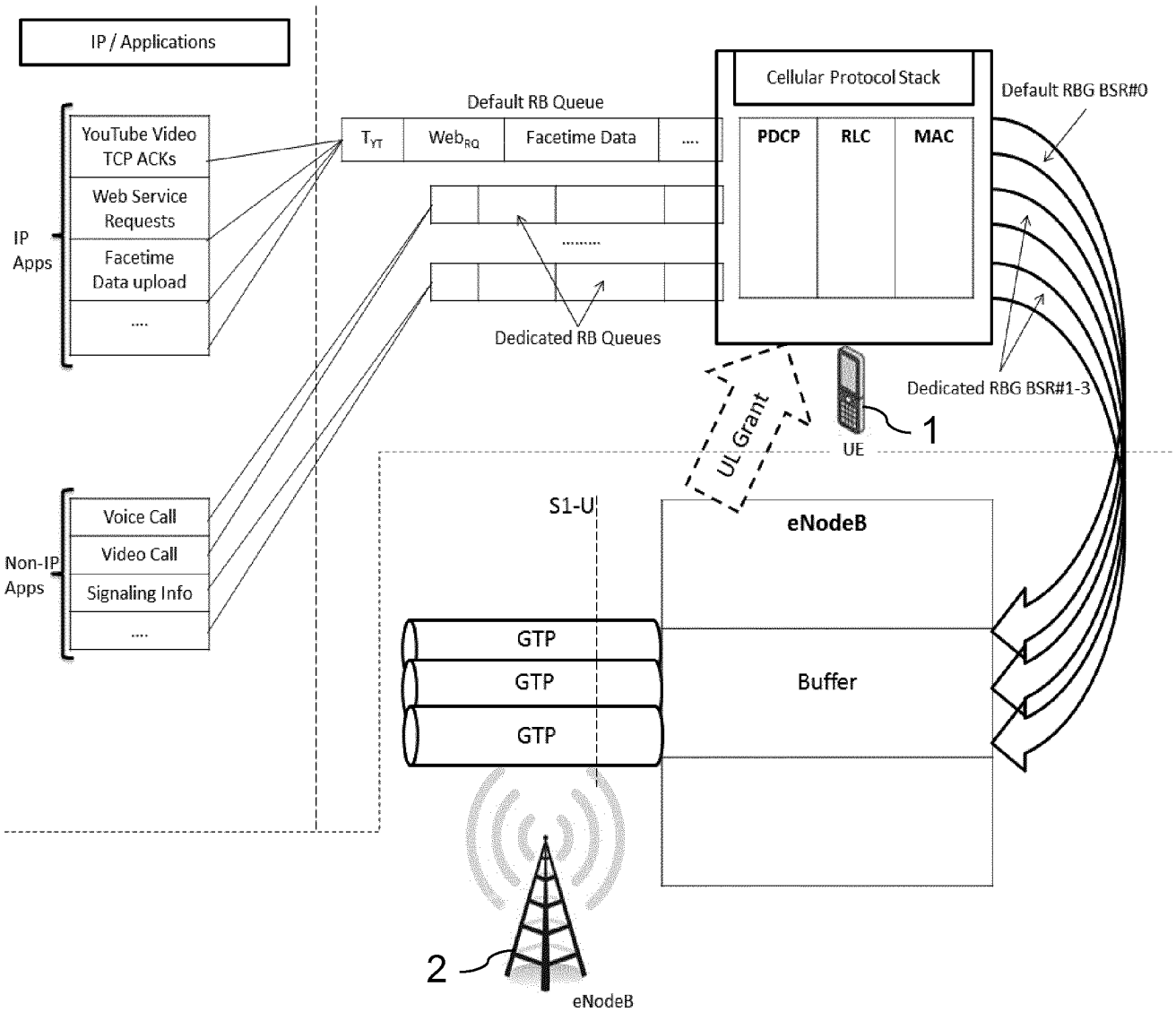
Fig. 3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RLC
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Fig. 4

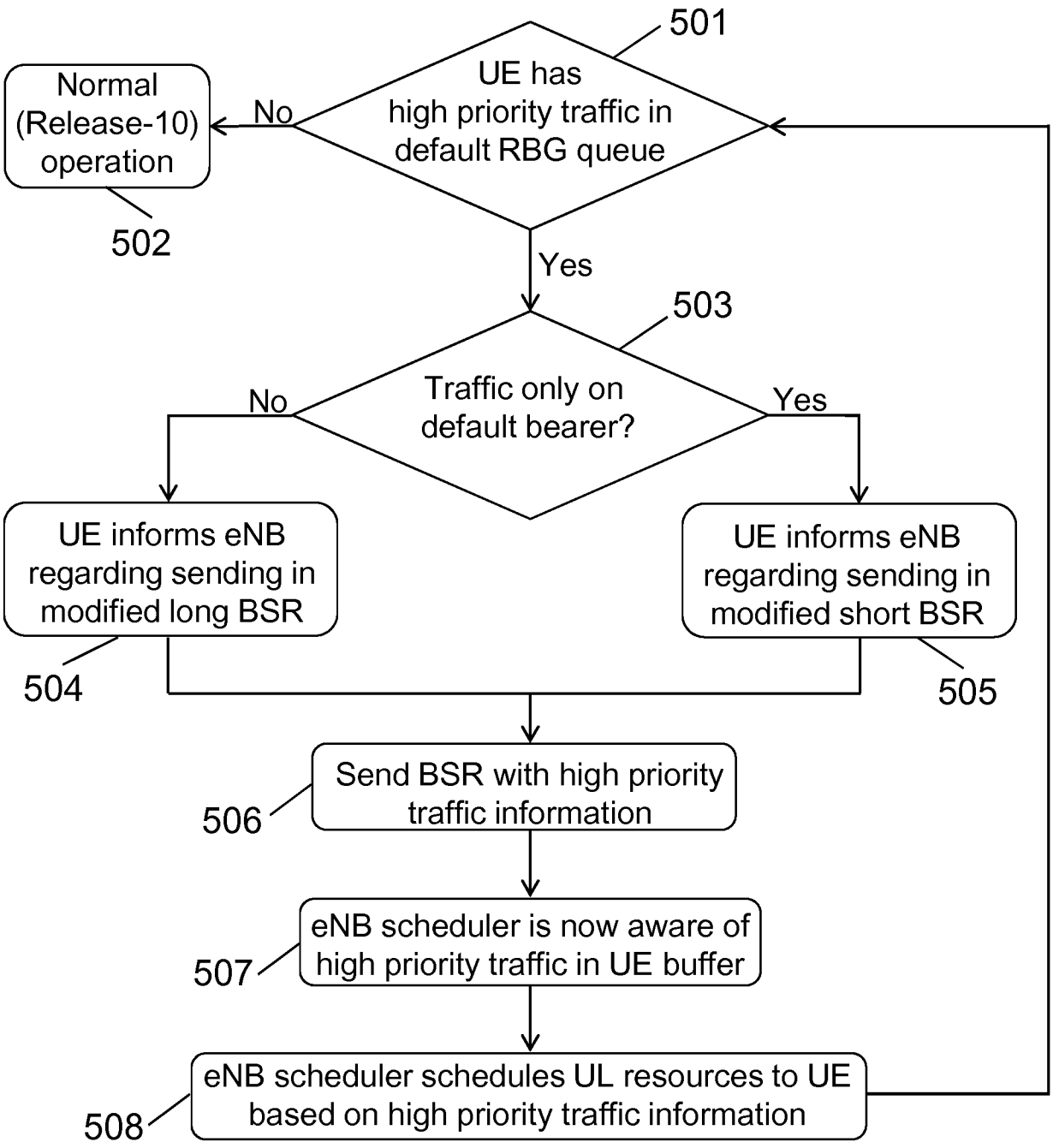
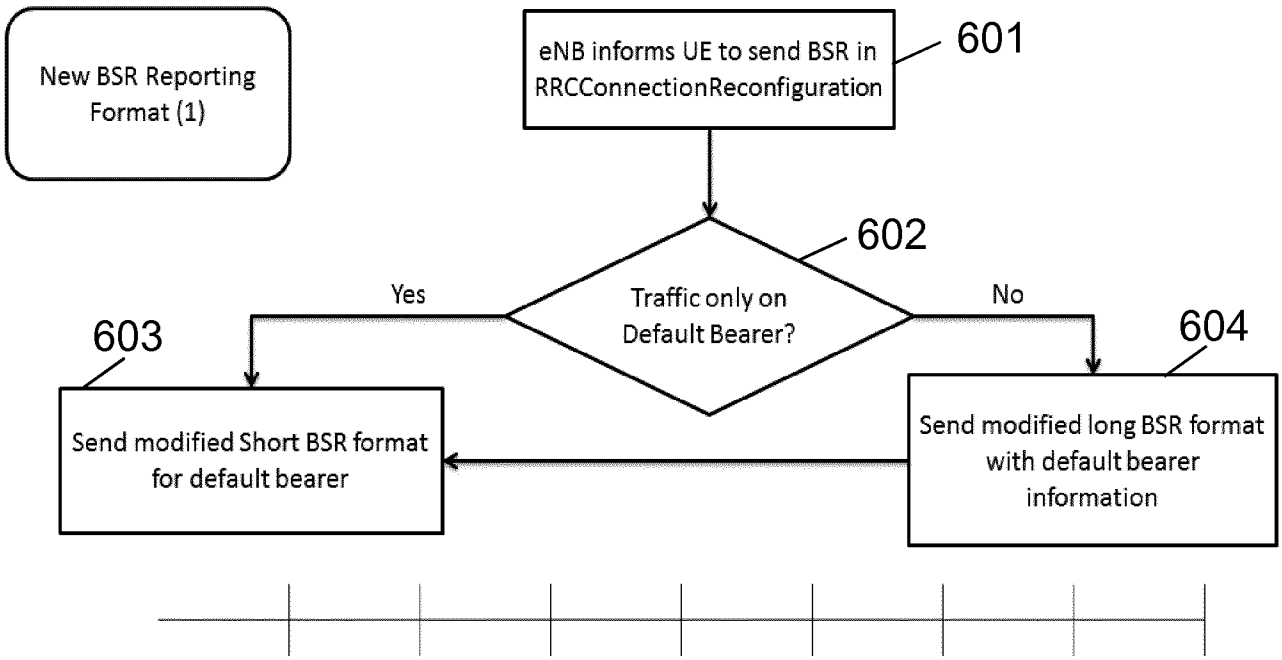

501
UE has high priority traffic in default RBG queue
No
Normal (Release-10) operation
502
Yes
503
Traffic only on default bearer?
No
Yes
UE informs eNB regarding sending in modified long BSR
504
UE informs eNB regarding sending in modified short BSR
505
Send BSR with high priority traffic information
506
eNB scheduler is now aware of high priority traffic in UE buffer
507
eNB scheduler schedules UL resources to UE based on high priority traffic information
508

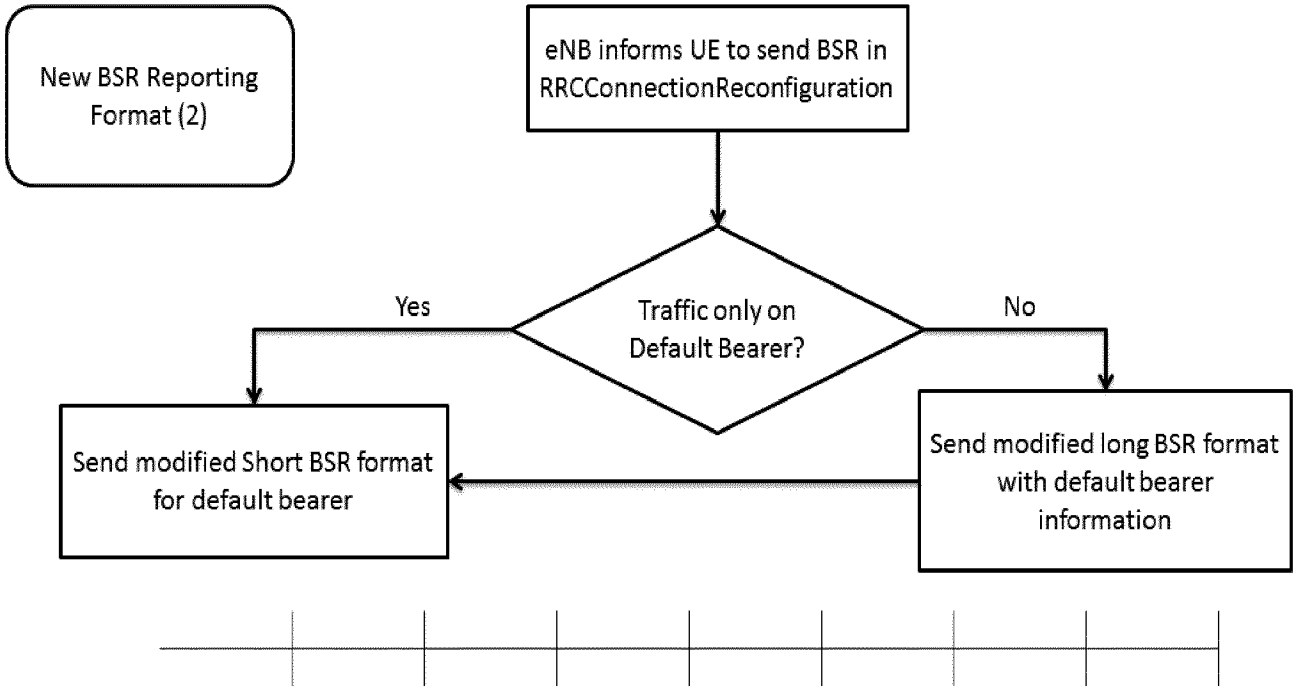
Fig. 5



Octet 1	LCG ID	Buffer Size
Octet 2	Size of High-Priority Traffic + Padding Bits (optional)	

Octet 1	Buffer Size #0		Buffer Size #1
Octet 2	Buffer Size #1	Buffer Size #2	
Octet 3	Buffer Size #2	Buffer Size #3	
Octet 4	Size of High-Priority Traffic + Padding Bits (optional)		

Fig. 6



Octet 1	LCG ID	Buffer Size
Octet 2	Priority ID	Size of High-Priority Traffic

Octet 1	Buffer Size #0	Buffer Size #1
Octet 2	Buffer Size #1	Buffer Size #2
Octet 3	Buffer Size #2	Buffer Size #3
Octet 4	Priority ID	Size of High-Priority Traffic

Fig. 7

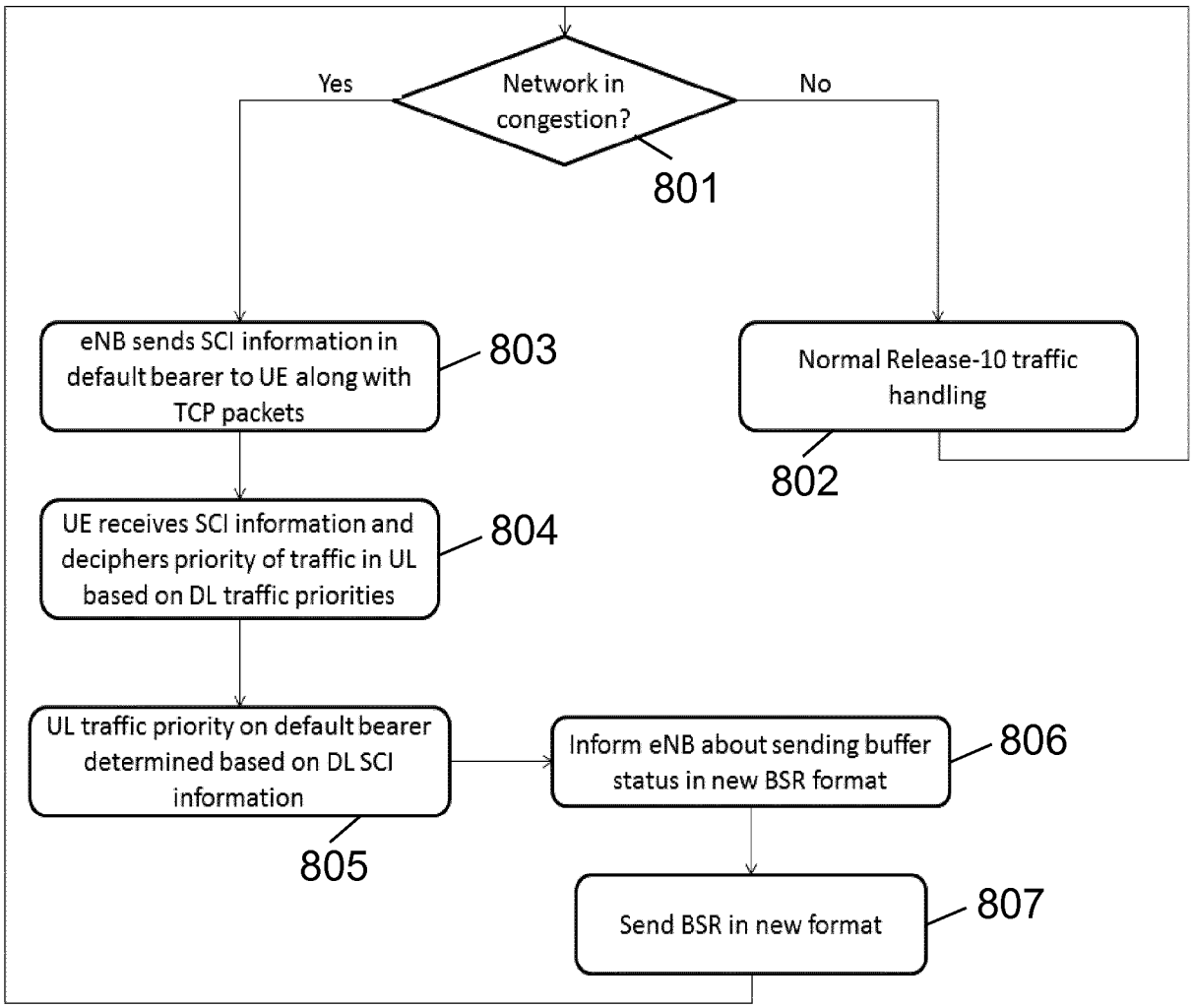

Network in congestion?
801
Yes
No
eNB sends SCI information in default bearer to UE along with TCP packets
803
Normal Release-10 traffic handling
802
UE receives SCI information and deciphers priority of traffic in UL based on DL traffic priorities
804
UL traffic priority on default bearer determined based on DL SCI information
805
Inform eNB about sending buffer status in new BSR format
806
Send BSR in new format
807

Fig. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/056868

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W72/12
ADD.

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)
H04W

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 practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2012/307783 A1 (TORSNER PER JOHAN [FI] ET AL) 6 December 2012 (2012-12-06) paragraphs [0021] - [0030] table 1 -----	1-3,5-9 4
Y	EP 2 557 882 A1 (MIMOON GMBH [DE]) 13 February 2013 (2013-02-13) paragraphs [0007] - [0009], [0011] - [0019], [0026] -----	4

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

☒ 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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
4 July 2014	14/07/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Chimet, Dan

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2014/056868

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