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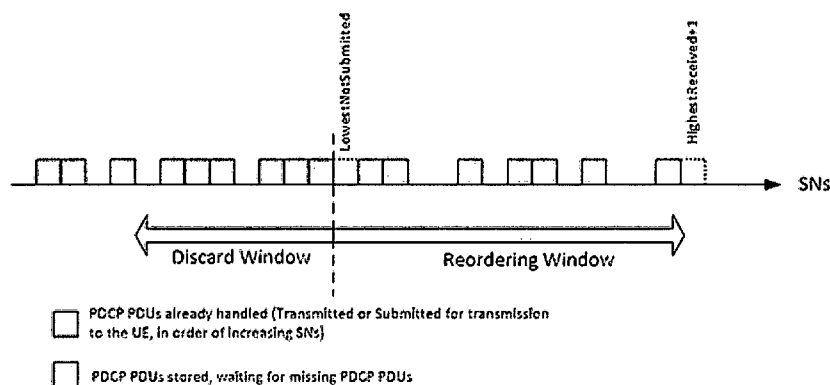


Fig. 7

(57) Abstract: Processes for the management and routing of packets in an IAB cellular communications network. In particular methods and processes for re-ordering of packets to allow carriage of LTE data on an NR backhaul.



Packet Management in a Cellular Communications Network

Technical Field

[1] The following disclosure relates to packet management in a cellular communications network, and in particular to ensuring in-order delivery.

Background

[2] Wireless communication systems, such as the third-generation (3G) of mobile telephone standards and technology are well known. Such 3G standards and technology have been developed by the Third Generation Partnership Project (3GPP). The 3rd generation of wireless communications has generally been developed to support macro-cell mobile phone communications. Communication systems and networks have developed towards a broadband and mobile system.

[3] In cellular wireless communication systems User Equipment (UE) is connected by a wireless link to a Radio Access Network (RAN). The RAN comprises a set of base stations which provide wireless links to the UEs located in cells covered by the base station, and an interface to a Core Network (CN) which provides overall network control. As will be appreciated the RAN and CN each conduct respective functions in relation to the overall network. For convenience the term cellular network will be used to refer to the combined RAN & CN, and it will be understood that the term is used to refer to the respective system for performing the disclosed function.

[4] The 3rd Generation Partnership Project has developed the so-called Long Term Evolution (LTE) system, namely, an Evolved Universal Mobile Telecommunication System Territorial Radio Access Network, (E-UTRAN), for a mobile access network where one or more macro-cells are supported by a base station known as an eNodeB or eNB (evolved NodeB). More recently, LTE is evolving further towards the so-called 5G or NR (new radio) systems where one or more cells are supported by a base station known as a gNB. NR is proposed to utilise an Orthogonal Frequency Division Multiplexed (OFDM) physical transmission format.

[5] In wireless communications networks base stations provide wireless coverage to the UE. This is called access. In addition, traffic is carried between base stations and the CN, or between base stations in a network using relays. This is called backhaul. The backhaul can use wireless resources. One area of development in wireless communications networks is Integrated Access and Backhaul (IAB). In IAB wireless channel resources are shared between wireless access and wireless backhaul. NR creates an opportunity to deploy IAB links for providing access to UEs.

[6] Figure 1 shows an IAB architecture. The system comprises a plurality of wireless or Radio Access Network (RAN) nodes. An IAB donor node interfaces to the core network (CN) and interfaces to IAB nodes 1a and 1b by a respective wireless backhaul link. The nodes may support access and backhaul links. Each of IAB-nodes 1a and 1b serves as a relay node. An IAB-node may support backhaul to another IAB-node as well as access to one or more UEs, see nodes 2a and 2b. A UE may be served directly by an access link to the IAB donor node, see UE_A, or by an access link to one of the IAB-nodes, see the UEs.

[7] A plurality of RAN nodes can be involved in a route between a UE and the CN. In Figure 1, UE_B is connected to the core network CN by a route comprising an access link (UE_B to IAB node 1b) and a backhaul link (IAB node 1b to the IAB donor node). UE_D is connected to the CN by a route comprising an access link (UE_D to IAB node 2a), a backhaul link (IAB node 2a to IAB node 1b) and a backhaul link (IAB node 1b to the IAB donor node).

[8] Each of the IAB nodes may multiplex access and backhaul links in one or more of time, frequency, and space (e.g. beam-based operation).

[9] The IAB donor node may be treated as a single logical node that comprises a set of functions such as gNB-DU, gNB-CU-CP, gNB-CU-UP and potentially other functions. In a deployment, the IAB donor node can be split according to these functions, which can be either be collocated or non-collocated as allowed by the NG-RAN architecture.

[10] There is a need to allow the use of IAB networks to support varied Radio Access Technologies (RATs).

Summary

[11] This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

[12] The invention is set out in the appended claims.

[13] The non-transitory computer readable medium may comprise at least one from a group consisting of: a hard disk, a CD-ROM, an optical storage device, a magnetic storage device, a Read Only Memory, a Programmable Read Only Memory, an Erasable Programmable Read Only Memory, EPROM, an Electrically Erasable Programmable Read Only Memory and a Flash memory.

Brief description of the drawings

[14] Further details, aspects and embodiments of the invention will be described, by way of example only, with reference to the drawings. Elements in the figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale. Like reference numerals have been included in the respective drawings to ease understanding.

[15] Figure 1 shows an example of an IAB network,

[16] Figure 2 shows an example of an architecture 1a of an IAB network,

[17] Figure 3 shows an example of an architecture 1b of an IAB network,

[18] Figure 4 shows examples of IAB user plane protocol stacks for architecture 1a with access and intermediate node requirements,

[19] Figure 5 shows an example of IAB user plane protocol stacks for architecture 1b with access and intermediate node requirements,

[20] Figure 6 shows examples of type of PDUs relayed by IAB nodes,

[21] Figure 7 shows examples of discard or reordering window for a reordering function,

Detailed description of the preferred embodiments

[22] Those skilled in the art will recognise and appreciate that the specifics of the examples described are merely illustrative of some embodiments and that the teachings set forth herein are applicable in a variety of alternative settings.

[23] Figure 1 shows a reference diagram for IAB architectures. There are 2 main architecture groups.

[24] Architecture group 1:

[25] This consists of architectures 1a and 1b, both of which leverage Central Unit (CU)/Distributed Unit (DU) split architecture.

[26] Architecture 1a is shown in Figure 2. Backhauling of F1-U uses an adaptation layer or GTP-U combined with an adaptation layer. Hop-by-hop forwarding across intermediate nodes uses the adaptation layer.

[27] Architecture 1b is shown in Figure 3. Backhauling of F1-U on access node uses GTP-U/UDP/IP. Hop-by-hop forwarding across intermediate node uses the adaptation layer.

[28] Architecture group 2:

[29] This consists of architectures 2a, 2b and 2c.

[30] Architecture 2a, Backhauling of F1-U or NG-U on access node uses GTP-U/UDP/IP. Hop-by-hop forwarding across intermediate node uses PDU-session-layer routing.

[31] Architecture 2b, Backhauling of F1-U or NG-U on access node uses GTP-U/UDP/IP. Hop-by-hop forwarding across intermediate node uses GTP-U/UDP/IP nested tunnelling.

[32] Architecture 2c: Backhauling of F1-U or NG-U on access node uses GTP-U/UDP/IP. Hop-by-hop forwarding across intermediate node uses GTP-U/UDP/IP/PDCP nested tunnelling.

[33] Architecture group 2 yields significant additional overhead.

[34] Figure 4 shows proposed UP protocol stacks for the group 1a architecture, and Figure 5 shows the UP protocol stacks for the group 1b architecture. Figure 6 shows the PDUs which are relayed at the IAB nodes.

[35] The protocol stacks shown in Figures 4 & 5 are defined to allow the carriage of NR protocols through the IAB network, but do not consider the carriage of other Radio Access Technologies (RAT). It has now been recognised that it would be desirable if an IAB network could also be utilised with other RATs, for example LTE.

[36] In order to ensure backhauling of LTE access, i.e. usage of LTE access link at an IAB access node, it would be beneficial to reuse a similar UP architecture as for backhauling of NR access. For this purpose, the CU at the donor would be configured with LTE PDCP, instead of NR PDCP, and exchange LTE UE PDCP PDUs with the UE, over NR backhaul (BH) lower layers.

[37] A particular difficulty arises due to differences between the LTE and NR protocol stacks. The LTE RLC layer ensures in-order-deliver (IOD) of RLC packets to the LTE PDCP layer. The LTE PDCP layer does not therefore provide a re-ordering (except in particular cases such as handover) as it assumes it receives ordered PDCP PDUs from the LTE RLC layer. However, in NR RLC does not ensure IOD and hence may deliver PDCP PDUs to the PDCP layer out of order.

[38] This prevents the protocol stacks of Figures 4 and 5 being utilised to backhaul LTE access because the delivery of LTE PDCP PDUs may be out of order, and this cannot be corrected by the LTE PDCP layer.

[39] For unacknowledged mode (UM) bearers, for which no ARQ is configured, out of order arrival is mainly due to HARQ operation over the backhaul links. For acknowledged mode (AM) bearers, out of order arrival is due to both HARQ and ARQ operation over NR the backhaul links. In addition, for both cases, out of order arrival may be also due to possible topology adaptation (rerouting) within the IAB tree.

[40] If PDCP PDUs are transmitted to the LTE UE without taking this into account, the effect on LTE PDCP reception is that only SDU corresponding to increasing PDCP COUNT would be delivered to upper layers. PDCP PDUs arriving out-of-order (e.g., delayed because of HARQ/ARQ retransmissions) would be discarded by the LTE PDCP receiver.

[41] In a modified IAB network, the CU may be provided with an LTE PDCP layer which exchanges LTE UE PDCP PDUs with the UE, over NR BH links at the lower layers. In order to address the ordering problem discussed above, the LTE UE could be configured with a PDCP reordering function, as introduced for dual connectivity in Rel-12, but this would not provide a solution for legacy LTE UEs for which PDCP layer does not support such reordering function.

[42] For downlink transmission the access node may be configured with a reordering function on a UE/bearer basis. When configured with a reordering function, the IAB node shall perform reordering of the PDCP PDUs prior to sending the PDCP PDUs to the LTE UE. The reordering is performed on a UE/bearer basis such that the LTE UE receives in-order PDCP PDUs at its PDCP layer. The link between the access node and the UE is according to the LTE protocols and hence the RLC layer will preserve the order provided to it by the reordering function of the access node..

[43] The reordering function in the access node may be provided with a reordering delay to define how long the function should wait for missing PDUs. Packet (and hence PDU) loss between the CU and access node can be expected, particularly when UM bearers are utilised as there is no ARQ to correct HARQ failures. For AM bearers, loss may still occur due to congestion at IAB nodes.

[44] The reordering delay should be set to a value which is large enough to cover the maximum expected HARQ (and ARQ in the case of AM) delays over the BH links between the CU and access node. An additional time may be added to allow for topology adaptation of the IAB tree.

[45] In an example the reordering function utilises sequence numbers (SN) associated with the PDCP PDUs (this SN may not be the PDCP sequence number, as discussed below). When configured with a reordering function, the IAB access node submits the PDCP PDUs for transmission to the RLC layer in increasing SN order. If a reordering delay is configured, the IAB access node shall wait for missing PDCP PDU(s) at least for a duration equal to the reordering delay before submission of subsequent PDCP PDU(s) (with higher SN). Having waiting for that time, the IAB access node shall consider the missing PDCP PDU(s) as lost and submission can continue with subsequent in-order PDUs.

[46] It is possible that PDCP PDUs were delayed more than expected. I.e., some late PDCP PDUs may reach the IAB access node whereas more than reordering delay has passed, so that some subsequent PDCP PDUs were already sent to the UE. In such case, the reordering function shall discard them. However, it is not straightforward for the reordering function to identify if a received PDCP PDU is a late one (to be discarded) or a new one (with a large SN gap), to be kept and send to the UE.

[47] One of the following configurations may be utilised for the reordering function to discriminate between each type of packet, we propose to configure either (see Figure 7):

- A maximum reordering window length, wherein the reordering window is defined as [LowestNotSubmitted, Highest Received+1]. PDUs received outside the maximum reordering window are discarded (considered as late).

- A discard window, defined as [LowestNotSubmitted – DiscardWindowLength, LowestNotSubmitted]. PDUs received within the discard window are discarded (considered as late).

[48] As will be appreciated, operations SN operations take into account SN rollover.

[49] In some configurations, for example when only AM bearers are utilised, packet loss might not be expected. A network may want to ensure lossless transmission of packets on AM bearers between the IAB donor node and the IAB Access Node, as it is ensured on the Uu interface between a base station and a UE in LTE. In such cases, if the reordering function detects a gap in the SNs (packet loss) a notification may be sent to the IAB donor node.

[50] Where applicable, for example architectures 1a b) and (c), the PDU reordering may be configured to be performed at intermediate nodes as well as the access node.

[51] In an alternative, the reordering function uses the PDCP SN. In this alternative, although the access node performs a reordering function based on PDCP SN, which is part of the NR PDCP layer but not of the legacy PDCP layer, the access node does not provide a full PDCP layer and the PDCP layer is not terminated at the access node. For example, main PDCP functions such as RoHC and Security functions remain end-to-end between the PDCP entity at the CU and the PDCP entity at the UE. The IAB Access Node will be configured with the PDCP type (LTE or NR) for a given communication, which may be inferred from other configuration information as the DU interface will be configured as an LTE Uu interface. The IAB Access Node will also require the PDCP SN length such that the SN can be extracted for reordering.

[52] Also, where AM bearers are utilised, the reordering function in the IAB access node will require the “first SN” and “initial SN” sent on a new link after a handover. In the case of AM links, to support lossless handover, the PDCP SN sequence continues. In legacy system, the PDCP receiver is in the UE. At handover, the PDCP entity is re-established, which does not reset its internal state variables, meaning that it can then handle the reception of PDCP PDUs from the new link and provide lossless in sequence delivery of PDCP SDUs to upper layers.

[53] However, following a handover of IAB access node, the IAB access node will start receiving PDCP PDUs with non-zero SNs. The IAB access node needs to know whether to wait for the earlier SNs or not. In an example, this may be addressed using out of band signalling. The IAB donor node (or any node responsible for transmitting packets towards the new IAB access node) transmits the value of the first/initial expected SN to the new IAB access node through control plane signalling. In an alternative example, in band signalling may be utilised. The IAB donor node (or any node responsible for transmitting packets towards the new IAB access node) marks the first/initial packet, e.g. with a new field in GTP-U and/or adaptation layer header. It is possible this packet is lost, however by configuring a reordering delay, it will be considered lost as expected after the corresponding time.

[54] A benefit of using PDCP SN for the reordering is the very low overhead, since no additional SN is required. Possible drawbacks are the need to handle the “first/initial packet” in case of handover to a new IAB access node for AM bearers. An additional drawback may be that PDCP Control PDUs without SN would not be reordered. In the context of NR, this was not perceived as an issue (so SN was not added to PDCP Control PDUs).

[55] In an alternative arrangement the reordering of PDCP PDUs may be performed on the basis of a different SN. For example, in architectures 1a (b) and 1a (c) the SN in the GTP extension header and then in adaptation layer may be used, or in architectures 1a (d), 1a (e) and 1b the SN in the GTP extension header may be utilised.

[56] In particular, the NR-U sequence number from the GTP-U container may be used.

[57] This is generally applicable if F1-U option is selected (full F1 header). In this alternative, the NR-U sequence number starts with 0 upon creation of a new GTP tunnel, the reordering function in a new IAB access node always expects SN 0 as the first SN and hence avoids the need for signalling as with the cases utilising PDCP SN.

[58] A drawback of this alternative may be the additional overhead required. The GTP-U extension (NR container) including the NR User Plane Protocol was designed for wired links and is particularly large in terms of overhead.

[59] For the UL direction, the PDCP entity at the CU can be provided with a reordering function (e.g. the DC reordering function) which will reorder received PDUs prior to delivering them.

[60] The architecture 1a (a) provides end to end ARQ, however it cannot be applied easily to LTE UEs due to interactions between MAC and RLC layers. In an alternative configuration for architecture 1a (a) NR RLC may instead be terminated in the IAB access node. The IAB access node would thus relay LTE PDCP PDUs and apply the principles discussed above. In this modified architecture, ARQ would be provided between Access Node and Donor node instead.

[61] In an option, the reordering function may be configured at access IAB node for NR access as well. As it is known, NR link (RLC and below layer) does not ensure in order delivery, contrary to LTE link. Hence, even if reordering is performed by the access IAB node, NR PDCP PDUs would arrive out of order at the UE PDCP receiver. However, the benefit of such configuration is to limit the possible delay between PDUs at the UE PDCP receiver. This delay would be limited to the maximum delay caused by HARQ and/or ARQ on one link, whereas without such reordering configured at the access node, the reordering delay between NR PDCP PDUs at the UE PDCP receiver would scale with the number of links (hops) in the IAB network.

[62] Lowering the possible reordering delay at the UE enable to reduce the buffering (memory) requirements, and can help to reduce the delay to transmit congestion notification.

[63] Although the above description has been given in relation to an LTE wireless link, the methods and systems also apply to NR wireless links wherein the use of reordering in the access node may reduce reordering delay at the UE.

[64] Although not shown in detail any of the devices or apparatus that form part of the network may include at least a processor, a storage unit and a communications interface, wherein the processor unit, storage unit, and communications interface are configured to perform the method of any aspect of the present invention. Further options and choices are described below.

[65] The signal processing functionality of the embodiments of the invention especially the gNB and the UE may be achieved using computing systems or architectures known to those who are skilled in the relevant art. Computing systems such as, a desktop, laptop or notebook computer, hand-held computing device (PDA, cell phone, palmtop, etc.), mainframe, server, client, or any other type of special or general purpose computing device as may be desirable or appropriate for a given application or environment can be used. The computing system can include one or more processors which can be implemented using a general or special-purpose processing engine such as, for example, a microprocessor, microcontroller or other control module.

[66] The computing system can also include a main memory, such as random access memory (RAM) or other dynamic memory, for storing information and instructions to be executed by a processor. Such a main memory also may be used for storing temporary variables or other intermediate information during execution of instructions to be executed by the processor. The computing system may likewise include a read only memory (ROM) or other static storage device for storing static information and instructions for a processor.

[67] The computing system may also include an information storage system which may include, for example, a media drive and a removable storage interface. The media drive may include a drive or other mechanism to support fixed or removable storage media, such as a hard disk drive, a floppy disk drive, a magnetic tape drive, an optical disk drive, a compact disc (CD) or digital video drive (DVD) read or write drive (R or RW), or other removable or fixed media drive. Storage media may include, for example, a hard disk, floppy disk, magnetic tape, optical disk, CD or DVD, or other fixed or removable medium that is read by and written to by media drive. The storage media may include a computer-readable storage medium having particular computer software or data stored therein.

[68] In alternative embodiments, an information storage system may include other similar components for allowing computer programs or other instructions or data to be loaded into the computing system. Such components may include, for example, a removable storage unit and an interface, such as a program cartridge and cartridge interface, a removable memory (for example, a flash memory or other removable memory module) and memory slot, and other removable storage units and interfaces that allow software and data to be transferred from the removable storage unit to computing system.

[69] The computing system can also include a communications interface. Such a communications interface can be used to allow software and data to be transferred between a computing system and external devices. Examples of communications interfaces can include a modem, a network interface (such as an Ethernet or other NIC card), a communications port (such as for example, a universal serial bus (USB) port), a PCMCIA slot and card, etc. Software and data transferred via a communications interface are in the form of signals which can be electronic, electromagnetic, and optical or other signals capable of being received by a communications interface medium.

[70] In this document, the terms 'computer program product', 'computer-readable medium' and the like may be used generally to refer to tangible media such as, for example, a memory, storage device, or storage unit. These and other forms of computer-readable media may store one or more instructions for use by the processor comprising the computer system to cause the processor to perform specified operations. Such instructions, generally referred to as 'computer program code' (which may be grouped in the form of computer programs or other groupings), when executed, enable the computing system to perform functions of embodiments of the present invention. Note that the code may directly cause a processor to perform specified operations, be compiled to do so, and/or be combined with other software, hardware, and/or firmware elements (e.g., libraries for performing standard functions) to do so.

[71] The non-transitory computer readable medium may comprise at least one from a group consisting of: a hard disk, a CD-ROM, an optical storage device, a magnetic storage device, a Read Only Memory, a Programmable Read Only Memory, an Erasable Programmable Read Only Memory, EPROM, an Electrically Erasable Programmable Read Only Memory and a Flash memory. In an embodiment where the elements are implemented using software, the software may be stored in a computer-readable medium and loaded into computing system using, for example, removable storage drive. A control module (in this example, software instructions or executable computer program code), when executed by the processor in the computer system, causes a processor to perform the functions of the invention as described herein.

[72] Furthermore, the inventive concept can be applied to any circuit for performing signal processing functionality within a network element. It is further envisaged that, for example, a semiconductor manufacturer may employ the inventive concept in a design of a stand-alone device, such as a microcontroller of a digital signal processor (DSP), or application-specific integrated circuit (ASIC) and/or any other sub-system element.

[73] It will be appreciated that, for clarity purposes, the above description has described embodiments of the invention with reference to a single processing logic. However, the inventive concept may equally be implemented by way of a plurality of different functional units and processors to provide the signal processing functionality. Thus, references to specific functional units are only to be seen as references to suitable means for providing the described functionality, rather than indicative of a strict logical or physical structure or organisation.

[74] Aspects of the invention may be implemented in any suitable form including hardware, software, firmware or any combination of these. The invention may optionally be implemented, at least partly, as computer software running on one or more data processors and/or digital signal processors or configurable module components such as FPGA devices.

[75] Thus, the elements and components of an embodiment of the invention may be physically, functionally and logically implemented in any suitable way. Indeed, the functionality may be implemented in a single unit, in a plurality of units or as part of other functional units. Although the present invention has been described in connection with some embodiments, it is not intended to be limited to the specific form set forth herein. Rather, the scope of the present invention is limited only by the accompanying claims. Additionally, although a feature may appear to be described in connection with particular embodiments, one skilled in the art would recognise that various features of the described embodiments may be combined in accordance with the invention. In the claims, the term 'comprising' does not exclude the presence of other elements or steps.

[76] Furthermore, although individually listed, a plurality of means, elements or method steps may be implemented by, for example, a single unit or processor. Additionally, although individual features may be included in different claims, these may possibly be advantageously combined, and the inclusion in different claims does not imply that a combination of features is not feasible and/or advantageous. Also, the inclusion of a feature in one category of claims does not imply a limitation to this category, but rather indicates that the feature is equally applicable to other claim categories, as appropriate.

[77] Furthermore, the order of features in the claims does not imply any specific order in which the features must be performed and in particular the order of individual steps in a method claim does not imply that the steps must be performed in this order. Rather, the steps may be performed in any suitable order. In addition, singular references do not exclude a plurality. Thus, references to 'a', 'an', 'first', 'second', etc. do not preclude a plurality.

[78] Although the present invention has been described in connection with some embodiments, it is not intended to be limited to the specific form set forth herein. Rather, the scope of the present invention is limited only by the accompanying claims. Additionally, although a feature may appear to be described in connection with particular embodiments, one skilled in the art would recognise that various features of the described embodiments may be combined in accordance with the invention. In the claims, the term 'comprising' or "including" does not exclude the presence of other elements.

Claims

1. A method of transmission in a cellular communications network, the wireless communications network comprising a plurality of nodes which support integrated wireless access and backhaul between a core network and user equipment (UE), one of the plurality of nodes being an access node with a wireless link to a UE and a second of the plurality of nodes being a donor node with an interface to a core network of the cellular communications network, the method comprising the steps of
at a function of the access node receiving PDCP PDUs which PDCP PDUs are for delivery to the UE via the wireless link;
reordering the PDCP PDUs into the correct delivery order, without terminating the PDCP layer towards to the donor node; and
transmitting the PDCP PDUs to the UE via the wireless link in the correct order.
2. A method of transmission according to claim 1, wherein the wireless link is a link according to the LTE standard.
3. A method of transmission according to claim 1, wherein the wireless link is a link according to the NR standard.
4. A method of transmission according to any of claims 1 to 3, wherein the access node and donor node communicate utilising the NR standard.
5. A method of transmission according to any preceding claim, wherein the reordering function is based on a PDCP SN.
6. A method of transmission according to any preceding claim, further comprising, following handover of the UE to a new IAB node, the step of transmitting a PDCP SN of the first PDCP PDU to be expected by the new IAB node to the new IAB node.
7. A method of transmission according to any of claims 1 to 5, further comprising, following handover of the UE to a new IAB node, marking the first packet sent towards the UE to the new IAB node to identify it as the first packet.
8. A method of transmission according to any preceding claim, wherein the reordering function is based on a GTP SN.
9. A method of transmission according to claim 8, wherein, following handover of the UE to a new IAB node, the first packet sent towards the UE to the new IAB node uses a GTP SN set to 0.
10. A method according to any preceding claim, wherein the function of the access node is on a UE bearer basis.
11. A method according to any of claims 1 to 10 wherein the access node is configured with a reordering delay indicating the maximum delay it shall wait for out-of-order packets, as well as a maximum reordering window or discard window size used to discriminate between late and new packets.

12. A cellular communications network comprising a plurality of nodes which support integrated wireless access and backhaul between a core network and user equipment (UE), wherein
 - one of the plurality of nodes is an access node with a wireless link to a UE;
 - a second of the plurality of nodes is a donor node with an interface to a core network of the cellular communications network, and
 - wherein the access node does not terminate the PDCP layer towards the donor node, and is configured to reorder PDCP PDUs which are for delivery to the UE into the correct delivery order.
13. A cellular communications network according to claim 12, wherein the wireless link is a link according the LTE standard.
14. A cellular communications network according to claim 12, wherein the wireless link is a link according the NR standard
15. A cellular communications network according to any of claims 12 to 14, wherein the access node and donor node communicate utilising the NR standard.
16. A method of transmission according to any of claims 12 to 15, wherein the reordering function is based on a PDCP SN.
17. A method of transmission according to any of claims 12 to 16, further comprising, following handover of the IAB node to a new IAB node, the step of transmitting a PDCP SN of the first PDCP PDU to be expected by the new IAB node to the new IAB node.
18. A method of transmission according to any of claims 12 to 17, wherein the reordering function is based on a GTP SN.

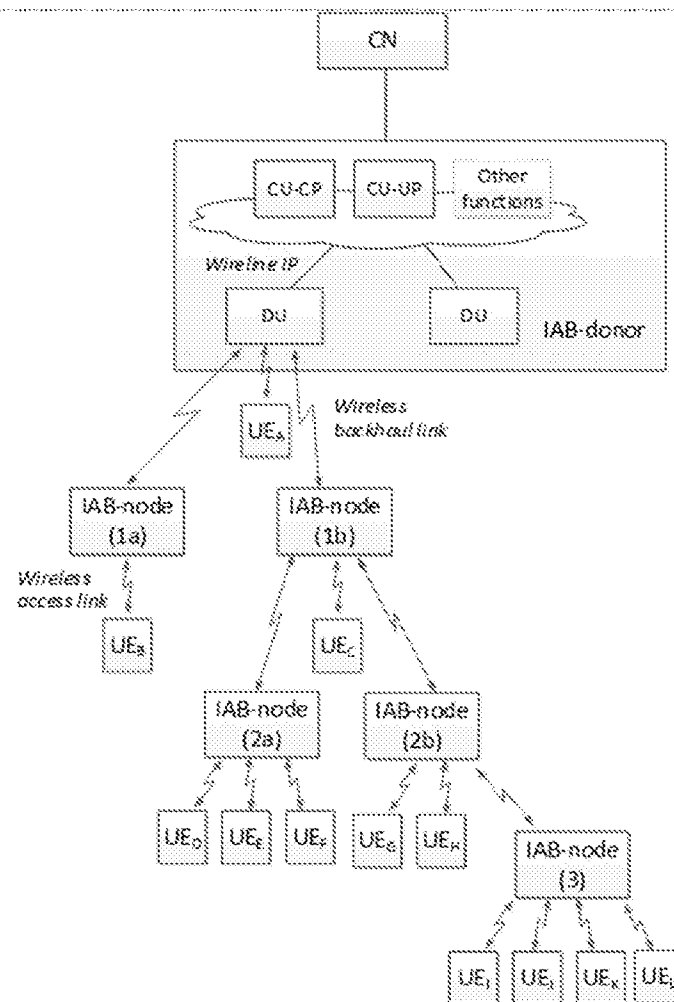


Figure 8.2.4.2-1 IAB network with 3 hops and 12 UEs

Fig. 1

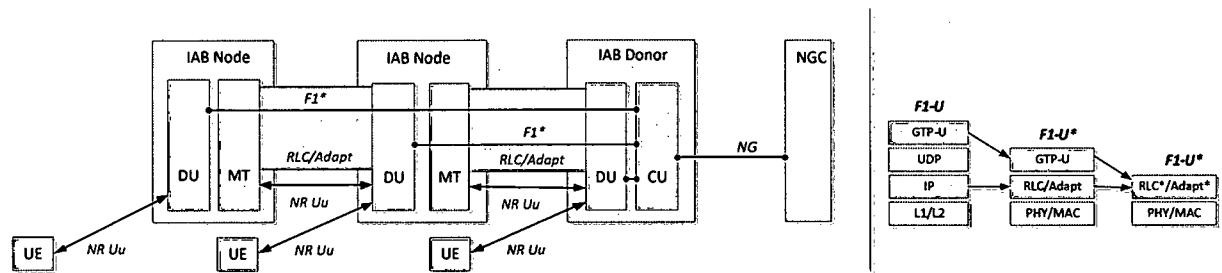


Fig. 2

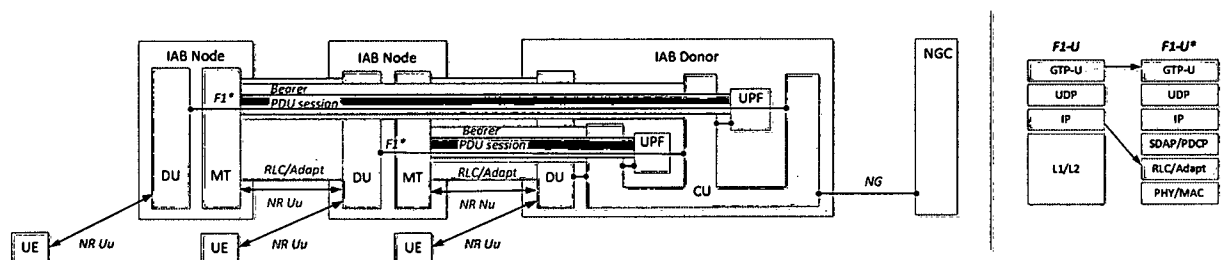


Fig. 3

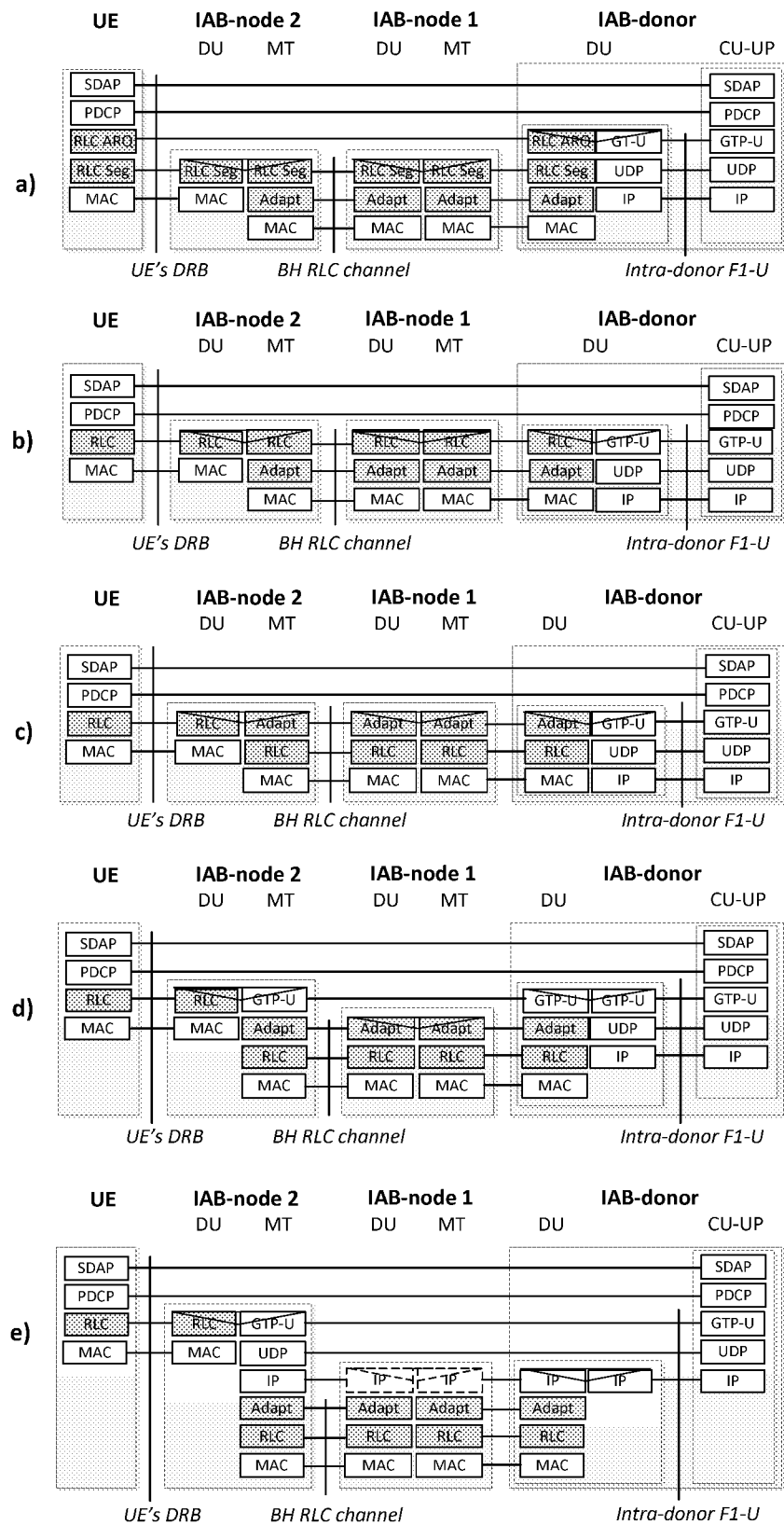


Fig. 4

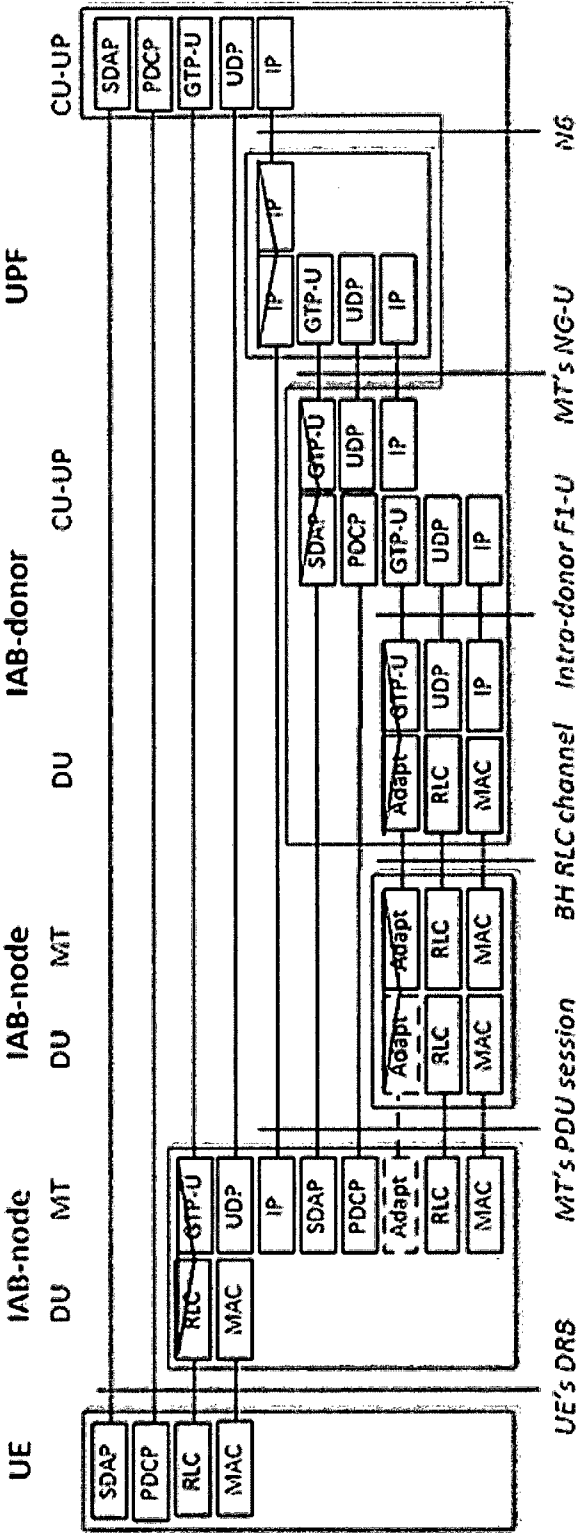


Fig. 5

UP Option	Access Node (node 2 above)	Intermediate Node (node 1 above)
1a a)	UE RLC PDU	UE RLC PDU
1a b)	UE PDCP PDU	UE PDCP PDU
1a c)	UE PDCP PDU	UE PDCP PDU
1a d)	UE PDCP PDU	GTP-U PDU
1a e)	UE PDCP PDU	UDP PDU
2b	UE PDCP PDU	BH PDCP PDU

Fig. 6

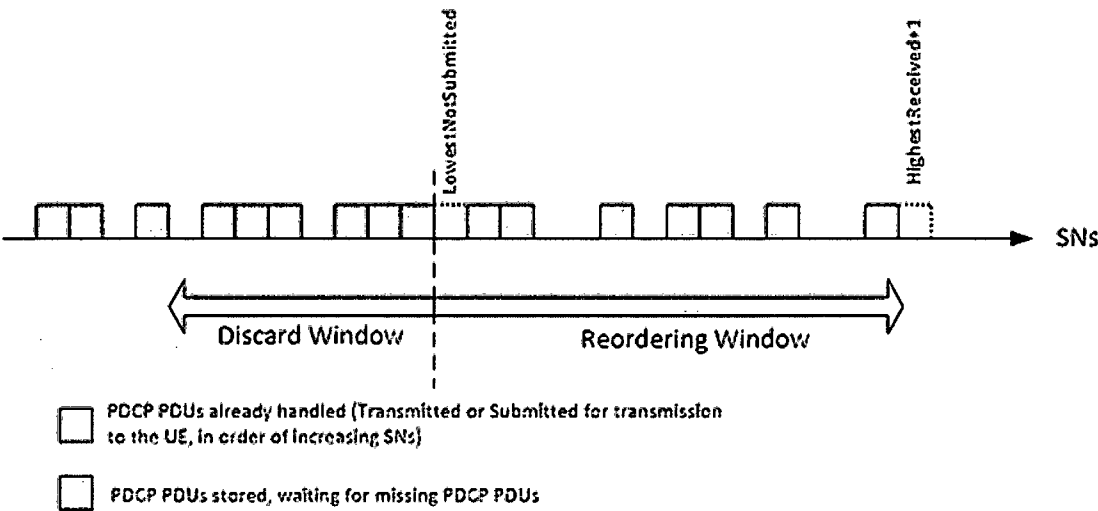


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2019/108310

A. CLASSIFICATION OF SUBJECT MATTER

H04W 88/00(2009.01)i

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; 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 practicable, search terms used)

CNPAT;CNKI;WPI;EPODOC;IEEE;3GPP:access, node, DU, donor, node, reorder+, UE, IAB, window, SN, sequence

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	QUALCOMM INC. "L2 congestion in IAB arch group 1" 3GPP TSG-RAN WG2 Meeting #103.R2-1812055, 24 August 2018 (2018-08-24), sections 2-4	1-18
A	SEQUANS COMMUNICATIONS. "Flow control for PDCP operation" 3GPP TSG-RAN WG2 Meeting #103.R2-1812865, 24 August 2018 (2018-08-24), the whole document	1-18
A	US 2018083688 A1 (SAMSUNG ELECTRONICS CO., LTD.) 22 March 2018 (2018-03-22) the whole document	1-18
A	CN 107852363 A (QUALCOMM INC.) 27 March 2018 (2018-03-27) the whole document	1-18



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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

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"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

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Date of mailing of the international search report

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Telephone No. 86-(10)-53961595

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2019/108310

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
US	2018083688	A1	22 March 2018	EP	3494756	A1	12 June 2019
				KR	20190029741	A	20 March 2019
				WO	2018030798	A1	15 February 2018
				CN	109691155	A	26 April 2019
				IN	201641027192	A	16 February 2018
CN	107852363	A	27 March 2018	US	2017005913	A1	05 January 2017
				WO	2017004255	A1	05 January 2017