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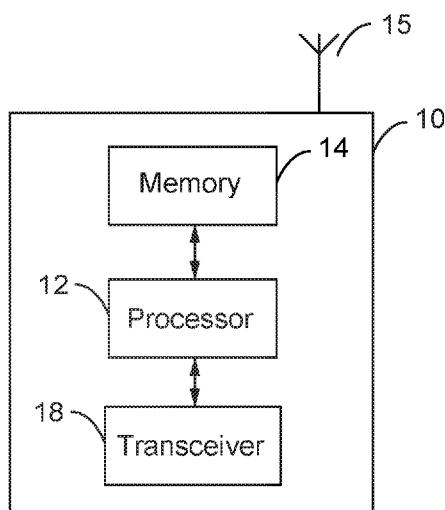


Fig. 8

(57) Abstract: Systems, methods, apparatuses, and computer program products for integrated access and backhaul (IAB) resource allocation for 5G or NR are provided. One method may include configuring integrated access and backhaul distributed unit resource configurations according to criteria based at least in part on a resource configuration of a parent distributed unit. The criteria may include initially using the parent distributed unit resource configuration to start the configuring of the integrated access and backhaul distributed unit resource configuration.

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INTEGRATED ACCESS AND BACKHAUL RESOURCE ALLOCATION**CROSS-REFERENCE TO RELATED APPLICATIONS:**

[0001] This application claims priority from U.S. provisional patent application no. 62/791,333 filed on January 11, 2019. The contents of this earlier filed application are hereby incorporated by reference in their entirety.

FIELD:

[0002] Some example embodiments may generally relate to mobile or wireless telecommunication systems, such as Long Term Evolution (LTE) or fifth generation (5G) radio access technology or new radio (NR) access technology, or other communications systems. For example, certain embodiments may relate to systems and/or methods for integrated access and backhaul (IAB) resource allocation for 5G or NR.

BACKGROUND:

[0003] Examples of mobile or wireless telecommunication systems may include the Universal Mobile Telecommunications System (UMTS) Terrestrial Radio Access Network (UTRAN), Long Term Evolution (LTE) Evolved UTRAN (E-UTRAN), LTE-Advanced (LTE-A), MulteFire, LTE-A Pro, and/or fifth generation (5G) radio access technology or new radio (NR) access technology. Fifth generation (5G) wireless systems refer to the next generation (NG) of radio systems and network architecture. 5G is mostly built on a new radio (NR), but the 5G (or NG) network can also build on E-UTRA radio. It is estimated that NR will provide bitrates on the order of 10-20 Gbit/s or higher, and will support at least enhanced mobile broadband (eMBB) and ultra-reliable low-latency-communication (URLLC) as well as massive machine type communication (mMTC). NR is expected to deliver extreme broadband and ultra-robust, low latency connectivity and massive networking to support the Internet of Things (IoT). With IoT and machine-to-machine (M2M) communication becoming more widespread, there will be a growing need for networks that meet the needs of lower power, low data rate, and long battery life. It is noted that, in 5G, the nodes that can provide radio access functionality to a user equipment (i.e., similar to Node B in UTRAN or eNB

in LTE) may be named gNB when built on NR radio and may be named NG-eNB when built on E-UTRA radio.

SUMMARY:

[0004] One embodiment is directed to a method for inter-integrated access and backhaul (IAB) distributed unit (DU) coordination. The method may include configuring IAB DU resource configurations according to criteria based at least in part on the resource configuration of the parent DU. The criteria may include initially using the parent DU resource configuration to start configuring IAB DU resource configuration.

[0005] Another embodiment is directed to a method for inter-IAB DU/mobile termination (MT) coordination. The method may include configuring IAB MT resource configurations according to criteria based at least in part on the resource configuration of the parent DU. The criteria may include initially using the parent DU resource configuration to start configuring IAB MT resource configuration.

[0006] Another embodiment is directed to an apparatus including at least one processor and at least one memory comprising computer program code. The at least one memory and computer program code may be configured, with the at least one processor, to cause the apparatus at least to configure IAB DU resource configurations according to criteria based at least in part on the resource configuration of the parent DU. The criteria may include initially using the parent DU resource configuration to start configuring IAB DU resource configuration.

[0007] Another embodiment is directed to an apparatus including at least one processor and at least one memory comprising computer program code. The at least one memory and computer program code may be configured, with the at least one processor, to cause the apparatus at least to configure IAB MT resource configurations according to criteria based at least in part on the resource configuration of the parent DU. The criteria may include initially using the parent DU resource configuration to start configuring IAB MT resource configuration.

[0008] Another embodiment is directed to an apparatus that may include circuitry configured to configure IAB DU resource configurations according to criteria based at least in part on the resource configuration of the parent DU. The criteria

may include initially using the parent DU resource configuration to start configuring IAB DU resource configuration.

[0009] Another embodiment is directed to an apparatus that may include circuitry configured to configure IAB MT resource configurations according to criteria based at least in part on the resource configuration of the parent DU. The criteria may include initially using the parent DU resource configuration to start configuring IAB MT resource configuration.

[0010] Another embodiment is directed to an apparatus that may include means for configuring IAB DU resource configurations according to criteria based at least in part on the resource configuration of the parent DU. The criteria may include initially using the parent DU resource configuration to start configuring IAB DU resource configuration.

[0011] Another embodiment is directed to an apparatus that may include means for configuring IAB MT resource configurations according to criteria based at least in part on the resource configuration of the parent DU. The criteria may include initially using the parent DU resource configuration to start configuring IAB MT resource configuration.

[0012] Another embodiment is directed to a computer readable medium comprising program instructions stored thereon for configuring IAB DU resource configurations according to criteria based at least in part on the resource configuration of the parent DU. The criteria may include initially using the parent DU resource configuration to start configuring IAB DU resource configuration.

[0013] Another embodiment is directed to a computer readable medium comprising program instructions stored thereon for configuring IAB MT resource configurations according to criteria based at least in part on the resource configuration of the parent DU. The criteria may include initially using the parent DU resource configuration to start configuring IAB MT resource configuration.

BRIEF DESCRIPTION OF THE DRAWINGS:

[0014] For proper understanding of example embodiments, reference should be made to the accompanying drawings, wherein:

[0015] Fig. 1 illustrates an example of an integrated access and backhaul (IAB) architecture;

[0016] Fig. 2 illustrates an example system diagram including IAB nodes and the connections between the IAB nodes and access UE(s), according to an embodiment;

[0017] Fig. 3 illustrates an example of uncoordinated resource allocation at different DUs in multi-hop scenario;

[0018] Fig. 4 illustrates an example of a scenario where each node receives separate configuration for mobile termination (MT) and distributed unit (DU) parts, according to an embodiment;

[0019] Fig. 5 illustrates one example flow diagram for a DU resource categorization process, according to certain embodiments;

[0020] Fig. 6 illustrates an example flow diagram for a MT resource categorization process, according to certain embodiments;

[0021] Fig. 7 illustrates an example of the coordinated resource allocation at different DUs in a multi-hop scenario, according to certain embodiments; and

[0022] Fig. 8 illustrates an example block diagram of an apparatus, according to one embodiment.

DETAILED DESCRIPTION:

[0023] It will be readily understood that the components of certain example embodiments, as generally described and illustrated in the figures herein, may be arranged and designed in a wide variety of different configurations. Thus, the following detailed description of some example embodiments of systems, methods, apparatuses, and computer program products for integrated access and backhaul (IAB) resource allocation for 5G or NR, is not intended to limit the scope of certain embodiments but is representative of selected example embodiments.

[0024] The features, structures, or characteristics of example embodiments described throughout this specification may be combined in any suitable manner in one or more example embodiments. For example, the usage of the phrases “certain embodiments,” “some embodiments,” or other similar language, throughout this specification refers to the fact that a particular feature, structure, or characteristic

described in connection with an embodiment may be included in at least one embodiment. Thus, appearances of the phrases “in certain embodiments,” “in some embodiments,” “in other embodiments,” or other similar language, throughout this specification do not necessarily all refer to the same group of embodiments, and the described features, structures, or characteristics may be combined in any suitable manner in one or more example embodiments.

[0025] Additionally, if desired, the different functions or steps discussed below may be performed in a different order and/or concurrently with each other. Furthermore, if desired, one or more of the described functions or steps may be optional or may be combined. As such, the following description should be considered as merely illustrative of the principles and teachings of certain example embodiments, and not in limitation thereof.

[0026] Example embodiments relate to integrated access and backhaul (IAB). For example, certain embodiments may relate to resource configuration in the case of IAB architecture Option 1A. However, other example embodiments are not limited to IAB scenario. For example, some embodiments may relate to some D2D or V2X scenarios.

[0027] 5G NR will be able to allow network deployment with minimized manual efforts and automated self-configuration to the extent possible. Especially on higher frequency bands, the coverage may be a challenge and specific capabilities are needed for NR to enable effortless coverage extensions with minimized or no requirements for the network (re-)planning in a fast and cost-effective manner. For these reasons, 3GPP is specifying capabilities enabling wireless backhauling for NR sites that do not have a fixed (wired/fiber) connection to the network. Using a radio connection for backhauling will eliminate the need for cabling of all sites of the radio network (that can be very dense) and therefore dramatically reduce the initial deployment costs.

[0028] Furthermore, the intention is to use the same carrier for both backhaul (BH) and access links sharing the same radio resources and radio transceivers. This is called self-backhauling or, in 3GPP terms, IAB. Frequency bands especially applicable for IAB are those having sufficient capacity, i.e., large enough carrier bandwidths. Those carriers are typically on millimetre wave (mmWave) bands and

are typically time division duplex (TDD) bands. Therefore, the IAB may consider the half-duplex constraint, i.e., no simultaneous transmission and reception to avoid excessive interference between transmitter and receiver. It is noted that certain embodiments are not limited to a self-backhauling scenario; for example, some embodiments may be applied in other scenarios, such as multi-hop out-band-backhauling, where access and backhaul link of the IAB node operate on different frequency bands.

[0029] Yet another requirement for IAB is the support for multi-hop relaying where an IAB node may provide wireless BH link for the next hop IAB node. The serving node providing the BH connection may be called a parent node that can be either a donor node (with a wired network connection) or another IAB node. The served IAB node may be called a child node.

[0030] There may be several different options for IAB architecture. Fig. 1 illustrates one example of a high-level IAB architecture for layer 2 (L2) relaying with a distributed base station (e.g., gNB), according to an embodiment. In the example of Fig. 1, the donor node 101 may host a centralized unit (CU) for all IAB nodes 105, 106. In other words, the donor node 101 may run radio resource control (RRC), higher L2 (PDCP) and control functions for the subtending IAB topology. Distributed units (DUs) may reside at the IAB nodes 105, 106 hosting the lower L2 protocol layers (RLC, MAC) and the physical (PHY) layer. The CU of donor node 101 may have two control interfaces to the IAB nodes 105, 106, namely RRC connection to the IAB-mobile termination (MT) and F1 interface-control (F1-C) to the IAB-DU. Hence, both RRC signalling and F1 interface-application protocol (F1-AP) are available for the IAB configuration and control. It is noted that the RRC message transmission from CU to MT may be first transferred over F1 transparently as a RRC container to the DU. The DU may forward the message, to the MT, over the Uu (NR radio interface) by scheduling it on the PDSCH. The same may also occur in a multi-hop case just that the RRC container is relayed over F1* until the DU of the IAB node serving the MT of the next hop IAB node. With this principle, the RRC connection is logically between Donor CU and the IAB MT. According to this example architecture, the radio resources usage can have central coordination by the donor CU. It is noted that, while the example of

Fig. 1 depicts two IAB nodes, any number of IAB nodes may be included according to other embodiments.

[0031] 3GPP has made certain agreements regarding IAB resource coordination for IAB nodes. From an MT point-of-view, it has been agreed that the following time-domain resources can be indicated for the parent link: downlink time resource, uplink time resource, and/or flexible time resource. From a DU point-of-view, the child link has the following types of time resources: downlink time resource, uplink time resource, flexible time resource, and/or not available time resources (not to be used for communication on the DU child links).

[0032] For each of the downlink, uplink and flexible time-resource types of the DU child link, there are two flavours, hard and soft. For hard, the corresponding time resource is always available for the DU child link. For soft, the availability of the corresponding time resource for the DU child link is explicitly and/or implicitly controlled by the parent node.

[0033] Further, 3GPP has agreed that, in order to support mechanisms for resource allocation for IAB nodes, semi-static configuration will be supported for the configuration of IAB node DU resources. In addition, dynamic indication (L1 signalling) from Parent node to an IAB node indicating the availability of soft resources for an IAB node DU will be supported. With existing 3GPP Release-15 L1 signalling methods as the baseline, while potential enhancements (e.g., new slot formats), rules for DU/MT behaviour in case of conflicts across multiple hops, and processing time constraints at the IAB node may need to be considered.

[0034] Tables 1 and 2 below capture the possible combinations of DU and MT behavior. Table 1 applies in case of time division multiplexing (TDM) operation, where there can be no simultaneous transmission in the DU and the MT, nor any simultaneous reception in the DU and the MT. Table 2 applies in case of space division multiplexing (SDM) operation, where there can be simultaneous transmission in the DU and the MT, alternatively simultaneous reception in the DU and the MT.

[0035] In Tables 1 and 2, “MT: Tx” means that the MT should transmit if scheduled, “DU: Tx” means that the DU may transmit, “MT: Rx” means that the MT should be able to receive (if there is anything to receive), “DU: Rx” means that

the DU may schedule uplink transmissions from child nodes or UEs, “MT: Tx/Rx” means that the MT should transmit if scheduled and should be able to receive but not simultaneously, “DU: Tx/Rx” means that the DU may transmit and may schedule uplink transmission from child nodes and UEs but not simultaneously, “IA” means that the DU resource is explicitly or implicitly indicated as available, “INA” means that the DU resource is explicitly or implicitly indicated as not available, “MT: NULL” means that the MT does not transmit and does not have to be able to receive, and “DU: NULL” means that the DU does not transmit and does not schedule uplink transmission from child nodes and UEs. It is noted that Tables 1 and 2 assume an IAB not capable of full-duplex operation.

DU Configuration	MT configuration		
	DL	UL	F
DL-H	DU: Tx MT: NULL	DU: Tx MT: NULL	DU: Tx MT: NULL
DL-S	When DU resource: IA DU: Tx MT: NULL	When DU resource: IA DU: Tx MT: NULL	When DU resource: IA DU: Tx MT: NULL
	When DU resource: INA DU: NULL MT: Rx	When DU resource: INA DU: NULL MT: Tx	When DU resource: INA DU: NULL MT: Tx/Rx
UL-H	DU: Rx MT: NULL	DU: Rx MT: NULL	DU: Rx MT: NULL
UL-S	When DU resource: IA DU: Rx MT: NULL	When DU resource: IA DU: Rx MT: NULL	When DU resource: IA DU: Rx MT: NULL
	When DU resource: INA	When DU resource: INA	When DU resource: INA

	DU: NULL MT: Rx	DU: NULL MT: Tx	DU: NULL MT: Tx/Rx
F-H	DU: Tx/Rx MT: NULL	DU: Tx/Rx MT: NULL	DU: Tx/Rx MT: NULL
F-S	When DU resource: IA DU: Tx/Rx MT: NULL When DU resource: INA DU: NULL MT: Rx	When DU resource: IA DU: Tx/Rx MT: NULL When DU resource: INA DU: NULL MT: Tx	When DU resource: IA DU: Tx/Rx MT: NULL When DU resource: INA DU: NULL MT: Tx/Rx
NA	DU: NULL MT: Rx	DU: NULL MT: Tx	DU: NULL MT: Tx/Rx

TABLE 1

	DL	UL	F
DL-H	DU: Tx MT: NULL	DU: Tx MT: Tx	DU: Tx MT: Tx
DL-S	When DU resource: IA DU: Tx MT: NULL When DU resource: INA DU: NULL MT: Rx	When DU resource: IA DU: Tx MT: Tx When DU resource: INA DU: NULL MT: Tx	When DU resource: IA DU: Tx MT: Tx When DU resource: INA DU: NULL MT: Tx/Rx
UL-H	DU: Rx MT: Rx	DU: Rx MT: NULL	DU: Rx MT: Rx

UL-S	When DU resource: IA DU: Rx MT: Rx When DU resource: INA DU: NULL MT: Rx	When DU resource: IA DU: Rx MT: NULL When DU resource: INA DU: NULL MT: Tx	When DU resource: IA DU: Rx (only if MT is Rx and the DU knows that ahead of time) MT: Rx When DU resource: INA DU: NULL MT: Tx/Rx
F-H	DU: Tx/Rx MT: Rx (only if DU is Rx and the parent DU is aware in advance)	DU: Tx/Rx MT: Tx (only if DU is Tx and the parent is aware in advance)	DU: Tx/Rx MT: Tx (only if DU is Tx and the parent DU knows that ahead of time), Rx (only if DU is Rx and the parent DU is aware in advance)
F-S	When DU resource: IA DU: Tx/Rx MT: Rx (only if DU is Rx and the parent DU is aware in advance) When DU resource: INA DU: NULL MT: Rx	When DU resource: IA DU: Tx/Rx MT: Tx (only if DU is Tx and the parent DU is aware in advance) When DU resource: INA DU: NULL MT: Tx	When DU resource: IA DU: Tx/Rx MT: Tx (only if DU is Tx and the parent DU knows that ahead of time), Rx (only if DU is Rx and the parent DU is aware in advance) When DU resource: INA DU: NULL MT: Tx/Rx

NA	DU: NULL MT: Rx	DU: NULL MT: Tx	DU: NULL MT: Tx/Rx
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TABLE 2

[0036] Fig. 2 illustrates an example system diagram including IAB nodes 201, 202, 203 and the connections between the IAB nodes 201, 202, 203 and access UE(s) 205. In some embodiments, IAB node 201 may be a donor node. As illustrated in the example of Fig. 2, from the perspective of the middle IAB node 202, there will be parent BH links as well as child BH and access links, all for both UL and DL.

[0037] In a multi-hop IAB network, the parent node 201 can also be an IAB node, and it is assumed that the CU makes separate configurations for DU and MT parts of all IAB nodes. With respect to Fig. 2, it is expected that resource configurations should handle the following cases in the resource allocation: configurations of Intra-IAB DU/MT parts of the IAB node, configurations of Inter-IAB DUs considering multiple hops (e.g., Parent DU, IAB DU, and Child DU), and configurations of Inter-IAB DU/MT considering parent DU and MT. Example: pairs (Parent DU, IAB MT) and (IAB DU, Child MT). In Tables 1 and 2, the cases needed to handle for Intra-IAB resource configurations are listed and may be separately handled considering the cases expected on different DU and MT configurations.

[0038] Therefore, one problem that arises relates to configurations of Inter-IAB DUs considering multiple hops. Considering TDM at IAB nodes, the resource allocation should be orthogonal for the links mentioned in Fig. 2. The concept of soft resources is such that IAB DU can utilize the resources when they are not used by the parent node DU. However, there could be conflicts if DU resource configurations do not follow certain rules. For example, if the parent DU controls the soft resources for the IAB DU, there will be issues at the child DU resources. The child DU may have conflicts on the resources coming from the CU and the use of resources of its parent. Fig. 3 illustrates an example of resource allocation. More specifically, Fig. 3 illustrates an example of uncoordinated resource allocation at different DUs in multi-hop scenario. The child DU has the same hard resources as the parent DU. However, when the parent DU decides to share its hard resources

(or IAB DU decides to use them based on implicit indication), it creates conflicts with the Child DU hard resource allocation.

[0039] Another problem that arises relates to configurations of Inter-IAB DU/MT. When the DU and MT are configured by the CU separately for each IAB node, it should make sure that communication is possible within each link. For example, in order for the IAB node to receive data from the parent node in a soft DL resource, an IAB MT should have either DL or flexible (F) resource. As DU has seven different combinations and MT can have three different combinations, CU should follow certain rules when configuring the resources at different DUs and MTs.

[0040] In summary, there exists a need to ensure that resource configuration is consistent across IAB nodes while providing means for adaptation for traffic needs by enabling dynamic allocation of radio resources to different links. The problem becomes more severe due to the fact that IAB resources are scheduled from multiple physical locations, where downlink IAB node transmissions (i.e., DL Child BH/Access) are scheduled by the IAB-node itself and uplink IAB node transmissions (i.e., UL Parent BH) are scheduled by the parent node/IAB donor (the same holds for IAB reception: UL Child BH/Access and DL Parent BH).

[0041] An embodiment may introduce rules to follow when configuring different IAB nodes to avoid Inter-IAB DU conflicts and Inter-IAB DU/MT conflicts, for example, in the case where IAB nodes operate in TDM. Fig. 4 illustrates an example of the considered scenario where each node receives separate configuration for MT and DU parts. In this example, it is assumed that the following time domain resources are available for DU and MT:

- DU config: DU Hard (DL, UL, Flexible), DU Soft (DL-soft, UL-soft, Flexible-soft), NA; and
- MT config: DL, UL, Flexible.

[0042] It is noted that a flexible time resource, from MT point of view, can be seen as resources assigned for DL Parent BH link or resources assigned for UL Parent BH link or resources not assigned for Parent BH link. A parent IAB node may define the resource usage for flexible resources and may indicate the MT accordingly, e.g., by means of DCI and/or higher layer configuration. The MT may

determine the actual resource usage for flexible time resources based on rules defined in 3GPP specifications (e.g., TS 38.213, Section 11.1) and according to received DCI and/or higher layer configuration. The MT may determine that flexible time resources are assigned for Parent BH link when DCI 2_0 (if configured/detected) indicates that flexible time resources are used as DL or UL (i.e., for Parent BH links), when the MT has received an indication (DCI or higher layer config) to receive PDCCH, PDSCH or CSI-RS (in the DL Parent BH link) during flexible time resources, and/or when the MT has received an indication (DCI or higher layer config) to transmit PUSCH, PUCCH, PRACH or SRS (in the UL Parent BH link) during flexible time resources. Otherwise, the MT may assume that flexible time resources are not assigned for Parent BH link.

[0043] Certain embodiments may consider at least two scenarios for inter-IAB coordination. One scenario relates to the coordination between consecutive DUs (such as DU#0-#1, or DU#1-#2 shown in Fig. 4). A second scenario relates to coordination between DU and MT of one link (such as DU#0-MT#1, or DU#1-#MT2 shown in Fig. 4).

[0044] One embodiment is directed to inter-IAB DU coordination between consecutive DUs (such as DU#0-#1, and DU#1-#2 shown in Fig. 4). In an embodiment, IAB DU is configured to align with the resource allocation of the parent DU(s) according to certain criteria or rules. For example, the rules may include that initially the parent DU resource configuration is used (assumed available) to start configuring (or overwriting) IAB DU resource configuration. When the parent DU resource configuration is Hard, IAB DU resources can be configured as NA or IAB DU resources can be configured as Soft. When the Parent DU resource configuration is NA, IAB DU resource can be configured as Hard or IAB DU resource can be configured as NA. When the Parent DU resource configuration is Soft, IAB DU resource can be NA or IAB DU resource can be Soft. In an embodiment, the rules may further include that the IAB DU node further categorizes their Hard and Soft resources as DL, UL, and F (flexible) based on Inter-IAB DU/MT rules and Intra-IAB DU/MT rules. The next child, e.g. IAB node 2 in Fig. 4, will follow the above steps, and so on for the child nodes.

[0045] Fig. 5 illustrates one example flow diagram for a DU resource categorization process, according to certain embodiments. As illustrated in the example of Fig. 5, at 505, it is determined whether the parent DU resource configuration is hard. If the parent DU resource configuration is hard, then it is determined, at 510, whether soft resources are available for the child node. If it is determined that soft resources are available for the child node, then the resource configuration according to table 550 is applied.

[0046] If it is determined, at 505, that the parent DU resource configuration is not hard, then, at 515, it is determined whether the parent DU resource configuration is soft. If the parent DU resource configuration is soft, then it is determined, at 510, whether soft resources are available for the child node. If it is determined that soft resources are available for the child node, then the resource configuration according to table 550 is applied. If it is determined, at 510, that soft resources are not available for the child node, then the child DU configuration is not available (NA) 520 and the resource configuration according to table 560 is applied.

[0047] If it is determined, at 515, that the parent DU resource configuration is not soft, then it is determined, at 525, whether the parent DU resource configuration is NA. If it is determined that the parent DU resource configuration is NA, then, at 530, it is determined whether hard resources are available for the child node. If it is determined that hard resources are available for the child node, then the resource configuration according to table 570 is applied. If it is determined that hard resources are not available for the child node, then the child DU configuration is not available (NA) 520 and the resource configuration according to table 560 is applied. If it is determined, at 525, that parent DU configuration is not NA, then a resource configuration error may be given (since the parent DU configuration is either hard, soft or NA). In this case, the IAB node may operate according to default configuration, for example according to F for the MT part, and NA for the DU part, respectively.

[0048] Table 3 illustrates an example of valid resource configuration combinations between a (parent, child) DU pair, according to certain embodiments. Option 1a in Table refers to the case with dedicated (=Hard) resources for Parent

DU and NA for IAB DU, option 1b refers to the case with dedicated resources for Parent DU and IAB DU can use the resources when indicated by the parent, option 2a refers to the case with dedicated resources for IAB DU and NA for Parent DU, option 2b refers to the case with NA for both Parent and IAB DUs, option 3a refers to the case where parent DU can use the soft resources when they are indicated as available by its parent and resources are not available for IAB DU, option 3b refers to the case where parent DU and IAB DU can use the soft resources when they are indicated as available by a respective parent. Soft resources should be released from the parent of Parent DU first, and next by the parent of IAB DU to use them by IAB DU. Other combinations are not possible in TDM scenario to avoid the conflicts of the transmissions.

Resource configuration		IAB DU		
		Hard	NA	Soft
Parent DU	Hard		1a	1b
	NA	2a	2b	
	Soft		3a	3b

TABLE 3

[0049] In an embodiment, the availability of the soft resources may be explicitly indicated by the parent or may be implicitly known at the IAB node. According to certain embodiments, an explicit indication may be based on dedicated downlink control information (DCI), or an information element of dedicated DCI, or group-common DCI (such as DCI format 2_0). When an explicit indication (a bit map, start/end symbol/slots, slot format indication etc.) is used by the parent to acquire/release resources, it normally does not have full understanding on the IAB DU configuration and may indicate the release of time resources that are not actually soft resources at the IAB DU. However, the IAB DU is allowed to use the resources only when indicated resources are overlapped with its soft resources. Additionally, in an embodiment, the IAB DU can modify the explicit indication on available resources to indicate less or more resources to the Child DU. In certain embodiments, the procedure discussed above may be fulfilled across multiple hops.

[0050] In another embodiment, soft resources can be made available for DU based on implicit signaling. For example, the MT may determine resource assignment for BH resource, such as flexible resources (similar functionality can be defined for DL and UL resources as well). If flexible MT resource is not assigned for Parent BH link, it is considered as “IA,” i.e., DU resource is implicitly indicated as available. Otherwise, if flexible MT resource is assigned for Parent BH DL or Parent BH link, it is considered as “INA,” i.e., DU resource is implicitly indicated as not available.

[0051] With respect to inter-IAB DU/MT coordination, an embodiment provides coordination between DU and MT of one link (such as DU#0-MT#1, or DU#1-MT2 shown in Fig. 4). According to certain embodiments, IAB MT is configured to align the resource allocation of the parent DU according to certain criteria or rules. In an embodiment, the rules may include that parent DU resource configuration is used (assumed available) to start configuring (or overwriting) IAB MT resource configuration. For example, when the Parent DU resource configuration is Hard, IAB MT configuration on DL, UL, and flexible (F) resources may be aligned to match the Parent DU’s DL, UL, and F resources. When the Parent DU resource configuration is NA, IAB MT configuration may be set to be F. When the Parent DU resource configuration is Soft, IAB MT resource may be DL or F for the Parent DU’s Soft-DL resources, IAB MT resource may be UL or F for the Parent DU’s Soft-UL resources, and IAB MT resource may be F for the Parent DU’s Soft-F resources. According to an embodiment, when IAB MT configuration is not coordinated by CU, the Parent DU can overwrite the IAB MT resource configuration based on the aforementioned combinations.

[0052] Fig. 6 illustrates an example flow diagram for a MT resource categorization process, according to certain embodiments. As illustrated in the example of Fig. 6, at 605, it is determined whether the parent DU resource configuration is hard. If the parent DU resource configuration is hard, then, at 610, the IAB MT configuration follows the parent DU configuration according to table 650. If it is determined that the parent DU resource configuration is not hard, then the process may determine, at 615, if the parent DU resource configuration is NA. If it is determined that the parent DU resource configuration is NA, then at 620 the

IAB MT configuration may be set to flexible according to table 660. If it is determined that the parent DU resource configuration is not NA, then the process may determine, at 625, if the parent DU configuration is soft. If it is determined that the parent DU configuration is soft, then it is determined, at 640, whether to allocate matching DL resources. If it is determined to allocate matching DL resources, then the IAB MT configuration may be set according to table 680. If it is determined not to allocate matching DL resources, then the process may determine, at 630, whether to allocate matching UL resources. If it is determined to allocate matching UL resources, then the IAB MT configuration may be set according to table 670. If it is determined not to allocate matching UL resources, then the IAB MT configuration may be set to flexible at 620 according to table 660.

[0053] Some benefits of the process illustrated in Fig. 6 may include that the DU and MT are always running in the same phase, the MT does not monitor DL or send (periodic) UL signal when DU is “NA”, and MT operation can be based on rules defined in 3GPP NR Release-15. Example embodiments have inbuilt support for solving the configuration errors.

[0054] In an embodiment, it is also possible that IAB MT resources are set to flexible resources when parent DU resources are Soft (regardless whether they are DL, UL, or F). In such a situation, Soft resources of a parent DU always become flexible resources to the IAB MT.

[0055] Table 4 below illustrates an example of valid resource configuration combinations for IAM DU/MT pair, according to certain embodiments.

Inter IAB DU/MT configuration		IAB MT		
		DL	UL	F
Parent DU	DL - Hard	x		
	UL - Hard		x	
	F - Hard			x
	NA			x
	DL- Soft	x		x

	UL - Soft		x	x
	F-Soft			x

TABLE 4

[0056] In one example, DU resource configuration for IAB donor and IAB node(s) may be carried out by higher layer signaling by CU. Another option is to use a separate network element, such as the network element responsible for operation and maintenance (O&M) and the corresponding O&M signaling for the DU resource configuration. According to some embodiments, the parent DU configuration (e.g., the input signal for the logic flow depicted in Fig. 5 and Fig. 6) may be determined based on higher layer signaling/configuration made by the CU. In an embodiment, signaling received from the parent node may also be used to determine the parent DU configuration, for example DCI and/or RRC may override soft/flexible resources configured by CU configuration (which can be referred to as semi-static slot format indication). The signaling configured by parent node or CU may include: RRC configured DL signals (PDCCH, or a PDSCH, or a CSI-RS), RRC configured UL signals (SRS, or PUCCH, or PUSCH, or PRACH), dynamic DCI received from the parent node (resources scheduled as UL/DL by different DCI formats received from the parent node), group-common DCI (such as DCI format 2_0) received from the parent node, and/or other explicit indication received from the parent node via PHY/MAC/RRC.

[0057] Given the Inter-IAB DU coordination provided by example embodiments described herein, the example resource confliction shown in Fig. 3 can be resolved, where an example of the outcome of the resource categorization is illustrated in Fig. 7. More specifically, Fig. 7 illustrates an example of the coordinated resource allocation at different DUs in a multi-hop scenario, according to certain embodiments. As illustrated in the example of Fig. 7, the parent DU may provide an explicit or implicit indication of the availability of soft resources to the IAB DU. The IAB DU is allowed to use the resources when the indicated resources overlap with its soft resources. The IAB DU may then modify the indication on available resources to indicate less or more available soft resources to the child DU.

[0058] Considering an example of three IAB nodes, examples of the possible configuration combinations to be expected across multiple hops are shown in Table

5 below, considering a maximum of three hops. In some embodiments, it may also be possible for CU to consider all these cases together and make the resource allocation for multiple IAB nodes at the same time. It is noted that the three node scenario of Table 5 is just one example, and any number of nodes may be included according to other example embodiments.

Multi-Hop Scenario	Two Hop IAB	Three Hop IAB
	(IAB #1, IAB#2)	(IAB #1, IAB#2, IAB #3)
Combinations	Hard, NA	Hard, NA, Hard
		Hard, NA, NA
	Hard, Soft	Hard, Soft, NA
		Hard, Soft, Soft
	NA, Hard	NA, Hard, NA
		NA, Hard, Soft
	NA, NA	NA, NA, Hard
		NA, NA, NA
	Soft, NA	Soft, NA, Hard
		Soft, NA, NA
	Soft, Soft	Soft, Soft, NA
		Soft, Soft, Soft

TABLE 5

[0059] Fig. 8 illustrates an example of an apparatus 10 according to an embodiment. In an embodiment, apparatus 10 may be a node, host, or server in a communications network or serving such a network. For example, apparatus 10 may be a satellite, base station, a Node B, an evolved Node B (eNB), 5G Node B or access point, next generation Node B (NG-NB or gNB), and/or WLAN access point, associated with a radio access network, such as a LTE network, 5G or NR. In example embodiments, apparatus 10 may be an eNB in LTE or gNB in 5G.

[0060] It should be understood that, in some example embodiments, apparatus 10 may be comprised of an edge cloud server as a distributed computing system where the server and the radio node may be stand-alone apparatuses communicating with each other via a radio path or via a wired connection, or they may be located in a same entity communicating via a wired connection. For instance, in certain example embodiments where apparatus 10 represents a gNB, it may be configured in a central unit (CU) and distributed unit (DU) architecture that divides the gNB functionality. In such an architecture, the CU may be a logical node that includes gNB functions such as transfer of user data, radio resource

control and management including mobility control, radio access network sharing, positioning, etc. The CU may control the operation of DU(s) over a front-haul interface (for example F1 interface as specified by 3GPP). The DU may be a logical node that includes a subset of the gNB functions, depending on the functional split option. Further, in some embodiments, apparatus 10 may include mobile termination (MT) functionality. It should be noted that one of ordinary skill in the art would understand that apparatus 10 may include components or features not shown in Fig. 8.

[0061] As illustrated in the example of Fig. 8, apparatus 10 may include a processor 12 for processing information and executing instructions or operations. Processor 12 may be any type of general or specific purpose processor. In fact, processor 12 may include one or more of general-purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs), field-programmable gate arrays (FPGAs), application-specific integrated circuits (ASICs), and processors based on a multi-core processor architecture, as examples. While a single processor 12 is shown in Fig. 8, multiple processors may be utilized according to other embodiments. For example, it should be understood that, in certain embodiments, apparatus 10 may include two or more processors that may form a multiprocessor system (e.g., in this case processor 12 may represent a multiprocessor) that may support multiprocessing. In certain embodiments, the multiprocessor system may be tightly coupled or loosely coupled (e.g., to form a computer cluster).

[0062] Processor 12 may perform functions associated with the operation of apparatus 10, which may include, for example, precoding of antenna gain/phase parameters, encoding and decoding of individual bits forming a communication message, formatting of information, and overall control of the apparatus 10, including processes related to management of communication resources.

[0063] Apparatus 10 may further include or be coupled to a memory 14 (internal or external), which may be coupled to processor 12, for storing information and instructions that may be executed by processor 12. Memory 14 may be one or more memories and of any type suitable to the local application environment, and may be implemented using any suitable volatile or nonvolatile

data storage technology such as a semiconductor-based memory device, a magnetic memory device and system, an optical memory device and system, fixed memory, and/or removable memory. For example, memory 14 can be comprised of any combination of random access memory (RAM), read only memory (ROM), static storage such as a magnetic or optical disk, hard disk drive (HDD), or any other type of non-transitory machine or computer readable media. The instructions stored in memory 14 may include program instructions or computer program code that, when executed by processor 12, enable the apparatus 10 to perform tasks as described herein.

[0064] In an embodiment, apparatus 10 may further include or be coupled to (internal or external) a drive or port that is configured to accept and read an external computer readable storage medium, such as an optical disc, USB drive, flash drive, or any other storage medium. For example, the external computer readable storage medium may store a computer program or software for execution by processor 12 and/or apparatus 10.

[0065] In some embodiments, apparatus 10 may also include or be coupled to one or more antennas 15 for transmitting and receiving signals and/or data to and from apparatus 10. Apparatus 10 may further include or be coupled to a transceiver 18 configured to transmit and receive information. The transceiver 18 may include, for example, a plurality of radio interfaces that may be coupled to the antenna(s) 15. The radio interfaces may correspond to a plurality of radio access technologies including one or more of GSM, NB-IoT, LTE, 5G, WLAN, Bluetooth, BT-LE, NFC, radio frequency identifier (RFID), ultrawideband (UWB), MulteFire, and the like. The radio interface may include components, such as filters, converters (for example, digital-to-analog converters and the like), mappers, a Fast Fourier Transform (FFT) module, and the like, to generate symbols for a transmission via one or more downlinks and to receive symbols (for example, via an uplink).

[0066] As such, transceiver 18 may be configured to modulate information on to a carrier waveform for transmission by the antenna(s) 15 and demodulate information received via the antenna(s) 15 for further processing by other elements of apparatus 10. In other embodiments, transceiver 18 may be capable of

transmitting and receiving signals or data directly. Additionally or alternatively, in some embodiments, apparatus 10 may include an input and/or output device (I/O device).

[0067] In an embodiment, memory 14 may store software modules that provide functionality when executed by processor 12. The modules may include, for example, an operating system that provides operating system functionality for apparatus 10. The memory may also store one or more functional modules, such as an application or program, to provide additional functionality for apparatus 10. The components of apparatus 10 may be implemented in hardware, or as any suitable combination of hardware and software.

[0068] According to some embodiments, processor 12 and memory 14 may be included in or may form a part of processing circuitry or control circuitry. In addition, in some embodiments, transceiver 18 may be included in or may form a part of transceiving circuitry.

[0069] As used herein, the term “circuitry” may refer to hardware-only circuitry implementations (e.g., analog and/or digital circuitry), combinations of hardware circuits and software, combinations of analog and/or digital hardware circuits with software/firmware, any portions of hardware processor(s) with software (including digital signal processors) that work together to cause an apparatus (e.g., apparatus 10) to perform various functions, and/or hardware circuit(s) and/or processor(s), or portions thereof, that use software for operation but where the software may not be present when it is not needed for operation. As a further example, as used herein, the term “circuitry” may also cover an implementation of merely a hardware circuit or processor (or multiple processors), or portion of a hardware circuit or processor, and its accompanying software and/or firmware. The term circuitry may also cover, for example, a baseband integrated circuit in a server, cellular network node or device, or other computing or network device.

[0070] As introduced above, in certain embodiments, apparatus 10 may be a network node or RAN node, such as a base station, access point, Node B, eNB, gNB, WLAN access point, or the like. According to certain embodiments, apparatus 10 may be controlled by memory 14 and processor 12 to perform the functions associated with any of the embodiments described herein, such as the

flow diagrams illustrated in Figs. 5 or 6. In some embodiments, apparatus 10 may be configured to perform a procedure(s) for inter-IAB resource allocation. According to certain embodiments, apparatus 10 may correspond to or include an IAB node or IAB donor as illustrated in Figs. 1 or 2.

[0071] For instance, in one embodiment, apparatus 10 may be controlled by memory 14 and processor 12 to configure or align IAB DU and/or IAB MT resource configurations according to criteria based at least in part on the resource configuration of the parent DU.

[0072] For example, in a scenario for coordination between consecutive IAB DUs, apparatus 10 may be controlled by memory 14 and processor 12 to align IAB DU resource configurations with the resource allocation of the parent DU(s) according to certain criteria. For instance, the criteria may include that initially apparatus 10 may be controlled to use the parent DU resource configuration to start configuring (or overwriting) IAB DU resource configuration. When the parent DU resource configuration is Hard, apparatus 10 may be controlled to configure IAB DU resources as NA or configure IAB DU resources as Soft. When the Parent DU resource configuration is NA, apparatus 10 may be controlled to configure IAB DU resources as Hard or to configure IAB DU resources as NA. When the Parent DU resource configuration is Soft, apparatus 10 may be controlled to configure IAB DU resources as NA or configure IAB DU resources as Soft. In an embodiment, the criteria may further include that the IAB DU node further categorizes its Hard and Soft resources as DL, UL, and F based on Inter-IAB DU/MT rules and Intra-IAB DU/MT rules.

[0073] In another example, in a scenario for coordination between the DU and MT of one link, apparatus 10 may be controlled by memory 14 and processor 12 to align IAB MT resource configurations with the resource allocation of the parent DU(s) according to certain criteria. For example, the criteria may include that initially apparatus 10 may be controlled to use the parent DU resource configuration to start configuring (or overwriting) IAB MT resource configuration. For example, when the Parent DU resource configuration is Hard, apparatus 10 may be controlled to align IAB MT configuration on DL, UL, and flexible (F) resources to match the Parent DU's DL, UL, and F resources. When the Parent DU

resource configuration is NA, apparatus 10 may be controlled to set IAB MT configuration to be F. When the Parent DU resource configuration is Soft, apparatus 10 may be controlled to set IAB MT resource as DL or F for the Parent DU's Soft-DL resources, to set IAB MT resource as UL or F for the Parent DU's Soft-UL resources, and to set IAB MT resource as F for the Parent DU's Soft-F resources. In an embodiment, when IAB MT configuration is not coordinated by CU, the Parent DU can overwrite the IAB MT resource configuration based on the aforementioned combinations.

[0074] Therefore, certain example embodiments provide several technical improvements, enhancements, and/or advantages. For example, certain embodiments support robust IAB operation for NR, provide inbuilt support for dynamic traffic adaptation also in multi-hop scenario, and allow 3GPP NR Release-15 rules defined for UE operation to be maximally reused for MT part of the IAB node. Accordingly, the use of certain example embodiments results in improved functioning of communications networks and their nodes.

[0075] In some example embodiments, the functionality of any of the methods, processes, signaling diagrams, algorithms or flow charts described herein may be implemented by software and/or computer program code or portions of code stored in memory or other computer readable or tangible media, and executed by a processor.

[0076] In some example embodiments, an apparatus may be included or be associated with at least one software application, module, unit or entity configured as arithmetic operation(s), or as a program or portions of it (including an added or updated software routine), executed by at least one operation processor. Programs, also called program products or computer programs, including software routines, applets and macros, may be stored in any apparatus-readable data storage medium and include program instructions to perform particular tasks.

[0077] A computer program product may comprise one or more computer-executable components which, when the program is run, are configured to carry out some example embodiments. The one or more computer-executable components may be at least one software code or portions of it. Modifications and configurations required for implementing functionality of an example embodiment

may be performed as routine(s), which may be implemented as added or updated software routine(s). Software routine(s) may be downloaded into the apparatus.

[0078] As an example, software or a computer program code or portions of it may be in a source code form, object code form, or in some intermediate form, and it may be stored in some sort of carrier, distribution medium, or computer readable medium, which may be any entity or device capable of carrying the program. Such carriers may include a record medium, computer memory, read-only memory, photoelectrical and/or electrical carrier signal, telecommunications signal, and software distribution package, for example. Depending on the processing power needed, the computer program may be executed in a single electronic digital computer or it may be distributed amongst a number of computers. The computer readable medium or computer readable storage medium may be a non-transitory medium.

[0079] In other example embodiments, the functionality may be performed by hardware or circuitry included in an apparatus (e.g., apparatus 10), for example through the use of an application specific integrated circuit (ASIC), a programmable gate array (PGA), a field programmable gate array (FPGA), or any other combination of hardware and software. In yet another example embodiment, the functionality may be implemented as a signal, a non-tangible means that can be carried by an electromagnetic signal downloaded from the Internet or other network.

[0080] According to an example embodiment, an apparatus, such as a node, device, or a corresponding component, may be configured as circuitry, a computer or a microprocessor, such as single-chip computer element, or as a chipset, including at least a memory for providing storage capacity used for arithmetic operation and an operation processor for executing the arithmetic operation.

[0081] A first embodiment is directed to a method for inter-IAB DU coordination. The method may include configuring IAB DU resource configurations according to criteria based at least in part on the resource configuration of the parent DU. The criteria may include initially using the parent DU resource configuration to start configuring IAB DU resource configuration.

[0082] In a variant, when the parent DU resource configuration is hard, the method may include configuring IAB DU resources as NA or configuring IAB DU resources as soft.

[0083] In a variant, when the parent DU resource configuration is NA, the method may include configuring IAB DU resources as hard or configuring IAB DU resources as NA.

[0084] In a variant, when the parent DU resource configuration is soft, the method may include configuring IAB DU resources as NA or configuring IAB DU resources as soft.

[0085] In another variant, the criteria may further include categorizing the hard and soft resources of the IAB DU as DL, UL, and F based on Inter-IAB DU/MT rules and/or Intra-IAB DU/MT rules.

[0086] A second embodiment is directed to a method for inter-IAB DU/MT coordination. The method may include configuring IAB MT resource configurations according to criteria based at least in part on the resource configuration of the parent DU. The criteria may include initially using the parent DU resource configuration to start configuring IAB MT resource configuration.

[0087] In a variant, when the parent DU resource configuration is hard, the method may include aligning IAB MT configuration on DL, UL, and F resources to match the DL, UL, and F resources of the parent DU.

[0088] In a variant, when the parent DU resource configuration is NA, the method may include configuring the IAB MT configuration to be F.

[0089] In a variant, when the parent DU resource configuration is soft, the method may include configuring IAB MT resource as DL or F for the parent DU's Soft-DL resources, configuring IAB MT resource as UL or F for the parent DU's Soft-UL resources, and configuring IAB MT resource as F for the parent DU's Soft-F resources.

[0090] In another variant, when IAB MT configuration is not coordinated by CU, the method may include overwriting the IAB MT resource configuration based on the aforementioned variants/combinations.

[0091] A third embodiment is directed to an apparatus including at least one processor and at least one memory comprising computer program code. The at

least one memory and computer program code may be configured, with the at least one processor, to cause the apparatus at least to perform the method according to the first embodiment or the second embodiment, or any of their variants.

[0092] A fourth embodiment is directed to an apparatus that may include circuitry configured to perform the method according to the first embodiment or the second embodiment or any of their variants.

[0093] A fifth embodiment is directed to an apparatus that may include means for performing the method according to the first embodiment or the second embodiment or any of their variants.

[0094] A sixth embodiment is directed to a computer readable medium comprising program instructions stored thereon for performing at least the method according to the first embodiment or the second embodiment or any of their variants.

[0095] One having ordinary skill in the art will readily understand that the example embodiments as discussed above may be practiced with steps in a different order, and/or with hardware elements in configurations which are different than those which are disclosed. Therefore, although some embodiments have been described based upon these example preferred embodiments, it would be apparent to those of skill in the art that certain modifications, variations, and alternative constructions would be apparent, while remaining within the spirit and scope of example embodiments.

We Claim:

1. An apparatus, comprising:

at least one processor; and

at least one memory comprising computer program code,

the at least one memory and computer program code configured, with the at least one processor, to cause the apparatus at least to:

configure integrated access and backhaul distributed unit resource configurations according to criteria based at least in part on a resource configuration of a parent distributed unit,

wherein the criteria comprises initially using the parent distributed unit resource configuration to start the configuring of the integrated access and backhaul distributed unit resource configuration.

2. The apparatus according to claim 1, wherein, when the parent distributed unit resource configuration is hard, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus at least to configure the integrated access and backhaul distributed unit resources as not available or to configure the integrated access and backhaul distributed unit resources as soft.

3. The apparatus according to claims 1 or 2, wherein, when the parent distributed unit resource configuration is not available, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus at least to configure the integrated access and backhaul distributed unit resources as hard or to configure the integrated access and backhaul distributed unit resources as not available.

4. The apparatus according to any of claims 1-3, wherein, when the parent distributed unit resource configuration is soft, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus at least to configure the integrated access and backhaul distributed unit

resources as not available or to configure the integrated access and backhaul distributed unit resources as soft.

5. The apparatus according to any of claims 1-4, wherein the criteria further comprises categorizing the hard and soft resources of the integrated access and backhaul distributed unit as at least one of downlink, uplink, or flexible, based on at least one of inter-integrated access and backhaul distributed unit or mobile termination rules or intra-integrated access and backhaul distributed unit or mobile termination rules.

6. The apparatus according to any of claims 1-5, wherein, when configuring the integrated access and backhaul distributed unit resource configurations, the at least one memory and computer program code are configured, with the at least one processor, to cause the apparatus to provide an explicit or implicit indication of the availability of soft resource to the integrated access and backhaul distributed unit.

7. A method, comprising:

configuring integrated access and backhaul distributed unit resource configurations according to criteria based at least in part on a resource configuration of a parent distributed unit,

wherein the criteria comprises initially using the parent distributed unit resource configuration to start the configuring of the integrated access and backhaul distributed unit resource configuration.

8. The method according to claim 7, wherein, when the parent distributed unit resource configuration is hard, the method comprises configuring the integrated access and backhaul distributed unit resources as not available or configuring the integrated access and backhaul distributed unit resources as soft.

9. The method according to claims 7 or 8, wherein, when the parent distributed unit resource configuration is not available, the method comprises configuring the

integrated access and backhaul distributed unit resources as hard or configuring the integrated access and backhaul distributed unit resources as not available.

10. The method according to any of claims 7-9, wherein, when the parent distributed unit resource configuration is soft, the method comprises configuring the integrated access and backhaul distributed unit resources as not available or configuring the integrated access and backhaul distributed unit resources as soft.

11. The method according to any of claims 7-10, wherein the criteria further comprises categorizing the hard and soft resources of the integrated access and backhaul distributed unit as at least one of downlink, uplink, or flexible, based on at least one of inter-integrated access and backhaul distributed unit or mobile termination rules or intra-integrated access and backhaul distributed unit or mobile termination rules.

12. The method according to any of claims 7-11, wherein the configuring the integrated access and backhaul distributed unit resource configurations comprises providing an explicit or implicit indication of the availability of soft resource to the integrated access and backhaul distributed unit.

13. An apparatus, comprising:

at least one processor; and

at least one memory comprising computer program code,

the at least one memory and computer program code configured, with the at least one processor, to cause the apparatus at least to:

configure integrated access and backhaul mobile termination resource configurations according to criteria based at least in part on the resource configuration of a parent distributed unit,

wherein the criteria comprises initially using the parent distributed unit resource configuration to start configuring the integrated access and backhaul mobile termination resource configuration.

14. The apparatus according to claim 13, wherein, when the parent distributed unit resource configuration is hard, the at least one memory and computer program code are configured, with the at least one processor, to cause the apparatus at least to align the integrated access and backhaul mobile termination resource configuration on downlink, uplink, or flexible resources to match the downlink, uplink, or flexible resources of the parent distributed unit.

15. The apparatus according to claims 13 or 14, wherein, when the parent distributed unit resource configuration is not available, the at least one memory and computer program code are configured, with the at least one processor, to cause the apparatus at least to configure the integrated access and backhaul mobile termination configuration to be flexible.

16. The apparatus according to any of claims 13-15, wherein, when the parent distributed unit resource configuration is soft, the at least one memory and computer program code are configured, with the at least one processor, to cause the apparatus at least to:

- configure the integrated access and backhaul mobile termination resource as downlink or flexible for the parent distributed unit's soft downlink resources;

- configure the integrated access and backhaul mobile termination resource as uplink or flexible for the parent distributed unit's soft uplink resources; and

- configure integrated access and backhaul mobile termination resource as flexible for the parent distributed unit's soft flexible resources.

17. The apparatus according to any of claims 13-16, wherein, when configuring the integrated access and backhaul mobile termination resource configurations, the at least one memory and computer program code are configured, with the at least one processor, to cause the apparatus to provide an explicit or implicit indication of the availability of soft resource.

18. A method, comprising:

configuring integrated access and backhaul mobile termination resource configurations according to criteria based at least in part on the resource configuration of a parent distributed unit,

wherein the criteria comprises initially using the parent distributed unit resource configuration to start configuring the integrated access and backhaul mobile termination resource configuration.

19. The method according to claim 18, wherein, when the parent distributed unit resource configuration is hard, the method comprises aligning the integrated access and backhaul mobile termination resource configuration on downlink, uplink, or flexible resources to match the downlink, uplink, or flexible resources of the parent distributed unit.

20. The method according to claims 18 or 19, wherein, when the parent distributed unit resource configuration is not available, the method comprises configuring the integrated access and backhaul mobile termination configuration to be flexible.

21. The method according to any of claims 18-20, wherein, when the parent distributed unit resource configuration is soft, the method comprises:

configure the integrated access and backhaul mobile termination resource as downlink or flexible for the parent distributed unit's soft downlink resources;

configure the integrated access and backhaul mobile termination resource as uplink or flexible for the parent distributed unit's soft uplink resources; and

configure integrated access and backhaul mobile termination resource as flexible for the parent distributed unit's soft flexible resources.

22. The method according to any of claims 18-21, wherein the configuring the integrated access and backhaul mobile termination resource configurations comprises providing an explicit or implicit indication of the availability of soft resource.

23. An apparatus, comprising:

configuring means for configuring integrated access and backhaul distributed unit resource configurations according to criteria based at least in part on a resource configuration of a parent distributed unit,

wherein the criteria comprises initially using the parent distributed unit resource configuration to start the configuring of the integrated access and backhaul distributed unit resource configuration.

24. An apparatus, comprising:

configuring means for configuring integrated access and backhaul mobile termination resource configurations according to criteria based at least in part on the resource configuration of a parent distributed unit,

wherein the criteria comprises initially using the parent distributed unit resource configuration to start configuring the integrated access and backhaul mobile termination resource configuration.

25. A computer readable medium comprising program instructions stored thereon for performing the method according to any of claims 7-12 or 18-22.

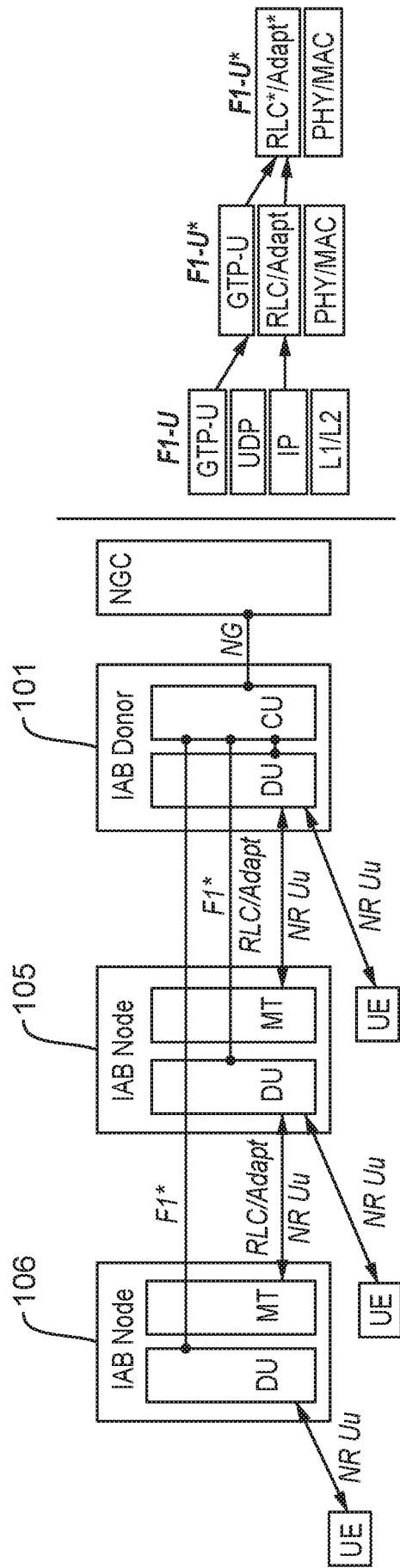


Fig. 1

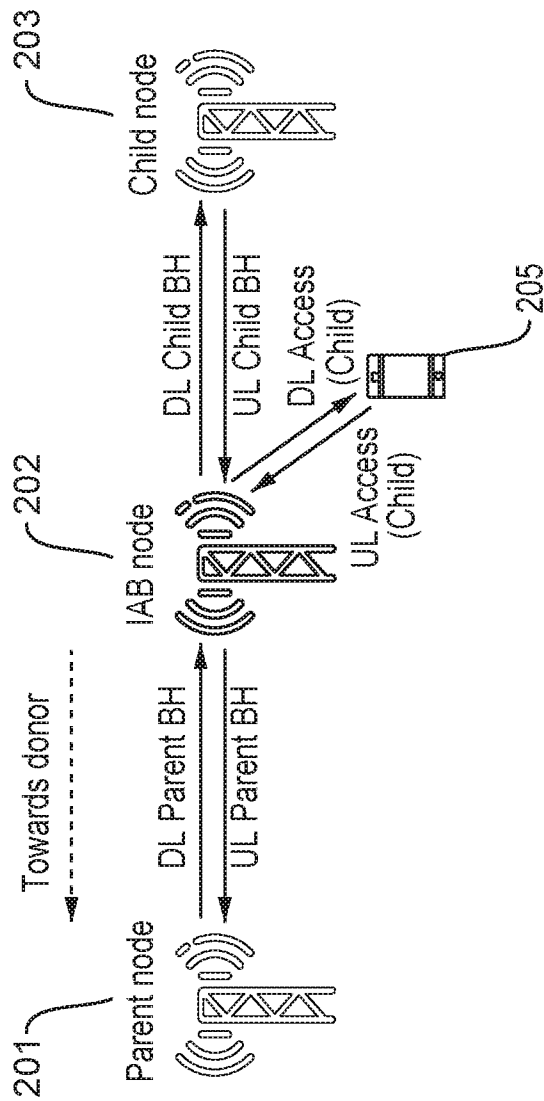


Fig. 2

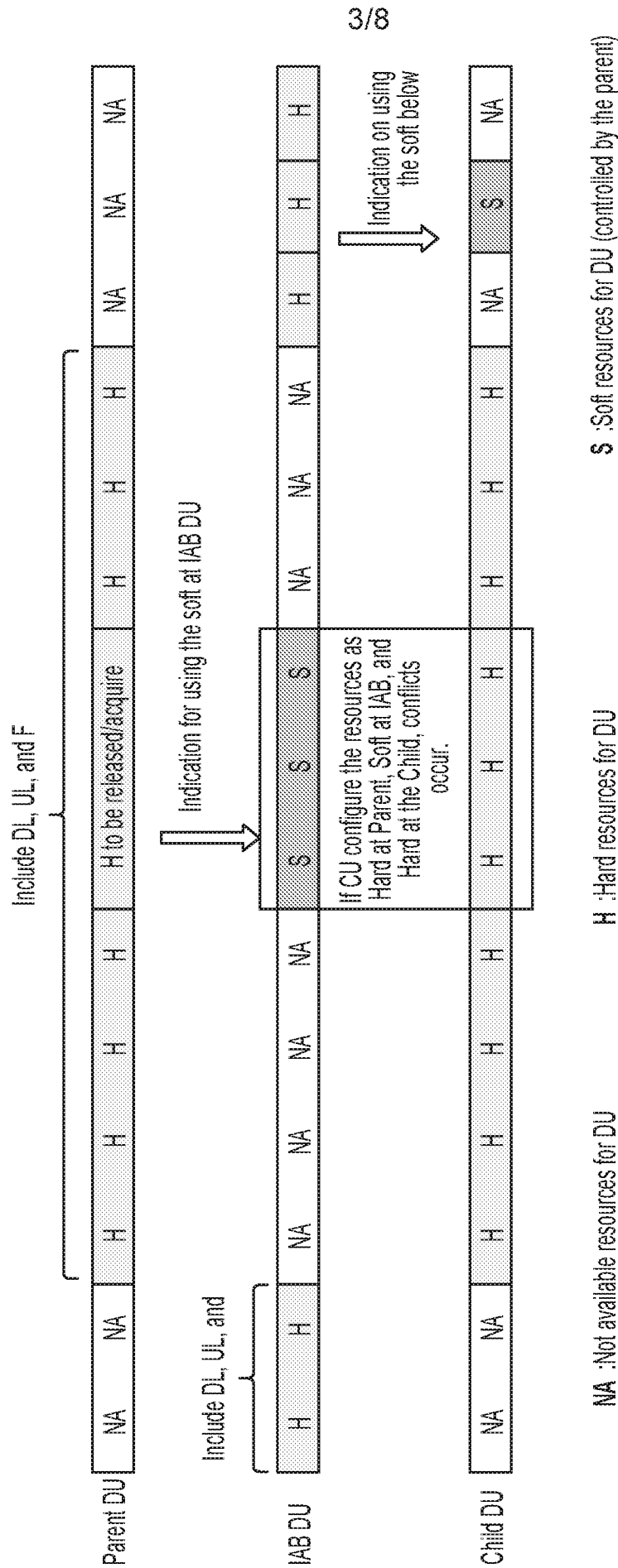


Fig. 3

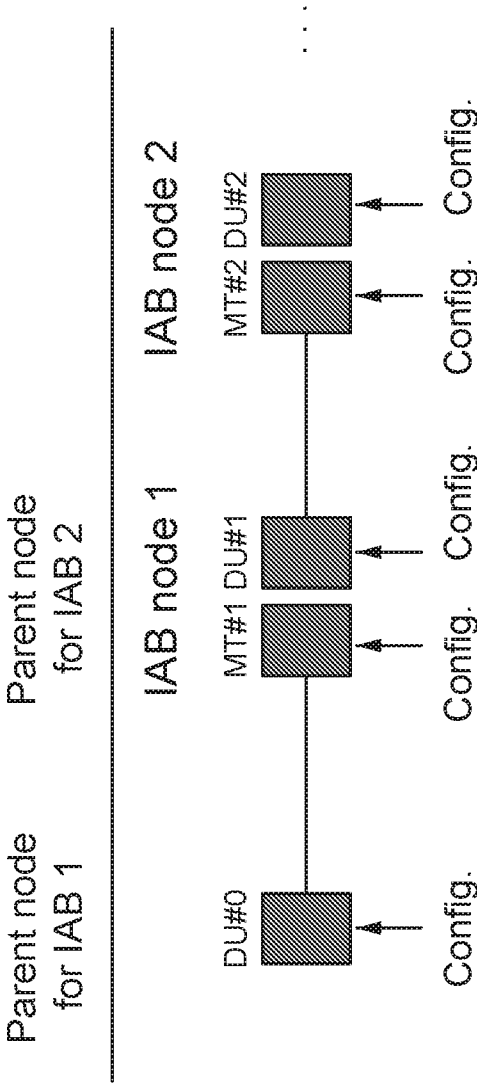


Fig. 4

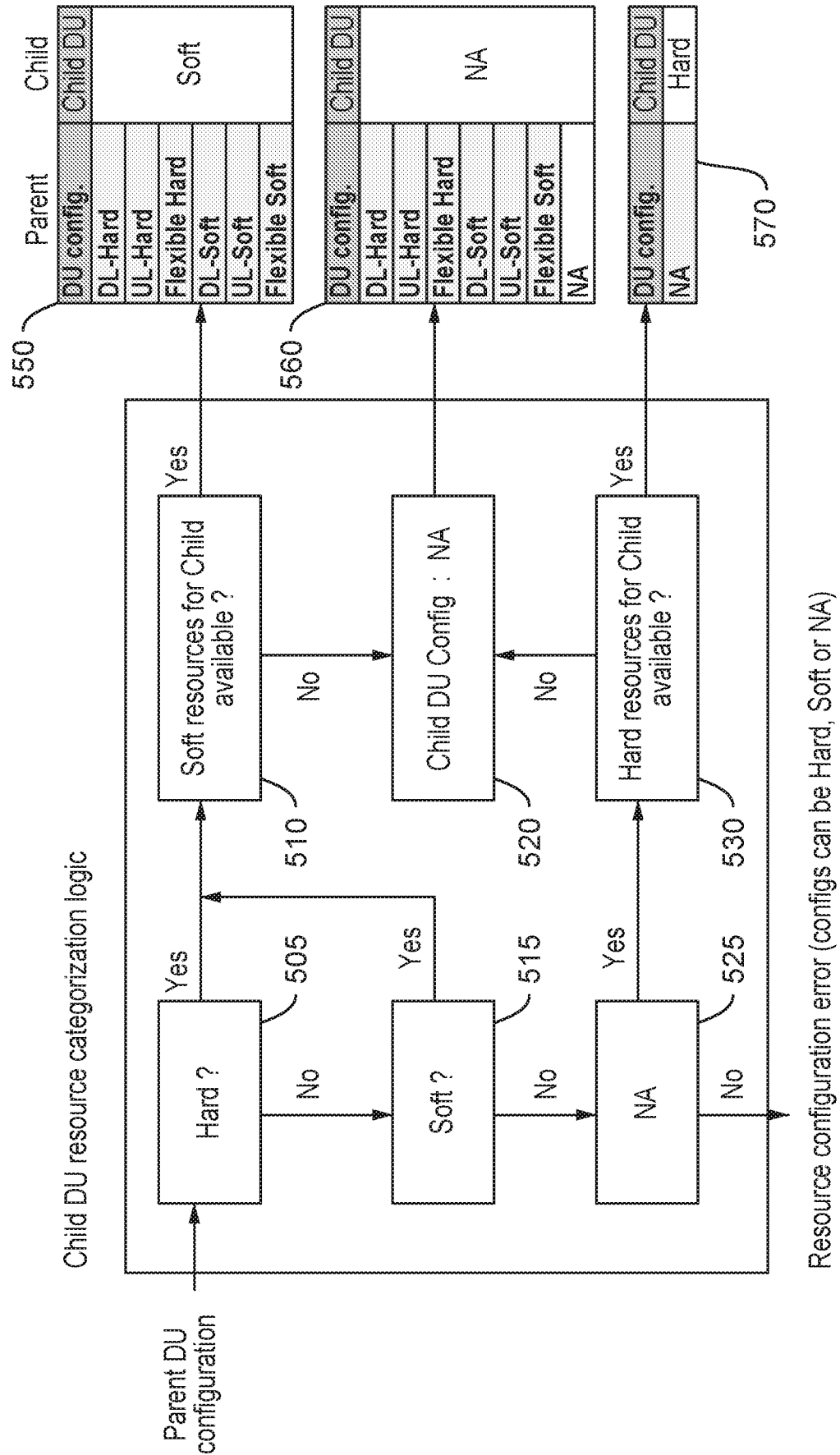


Fig. 5

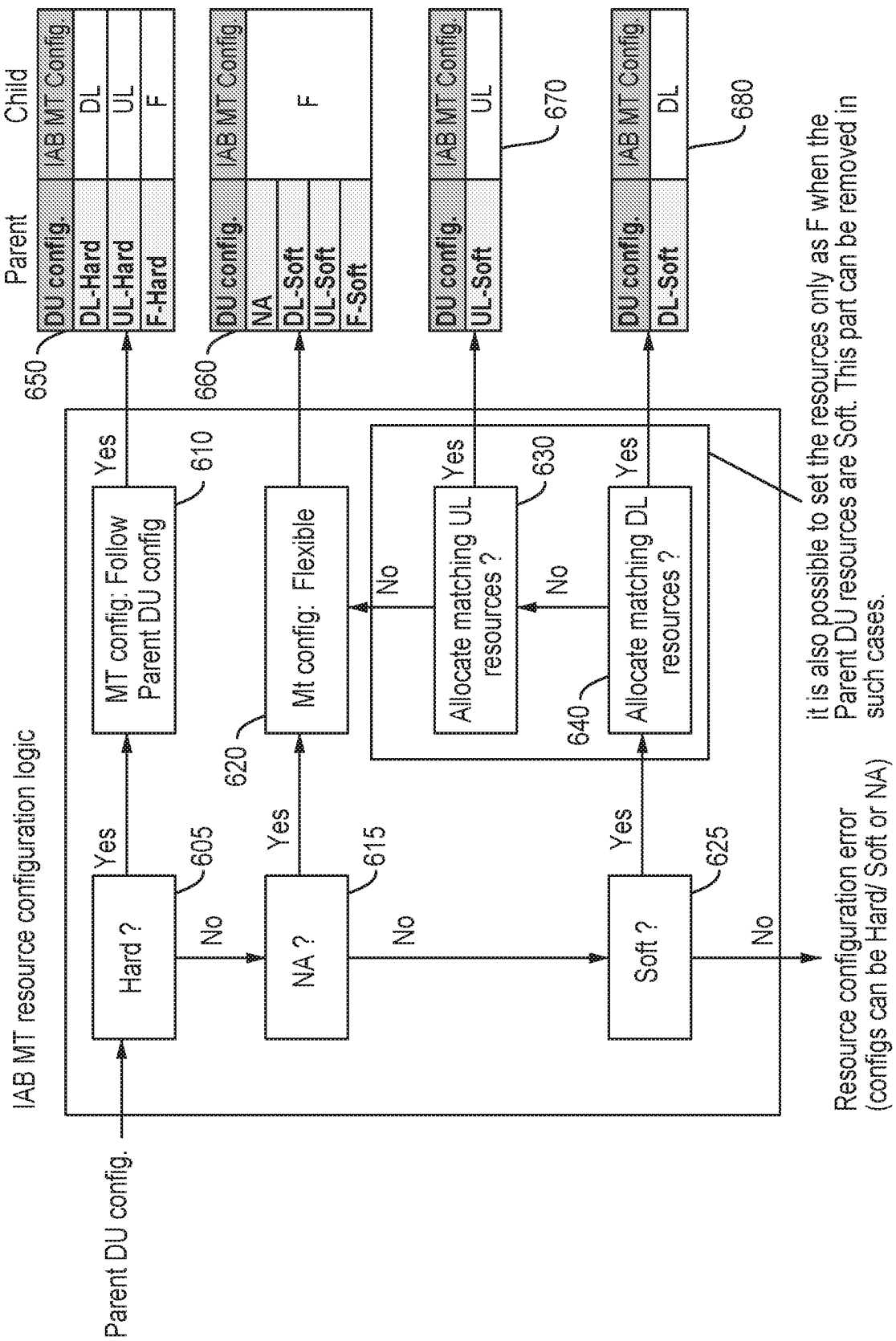


Fig. 6

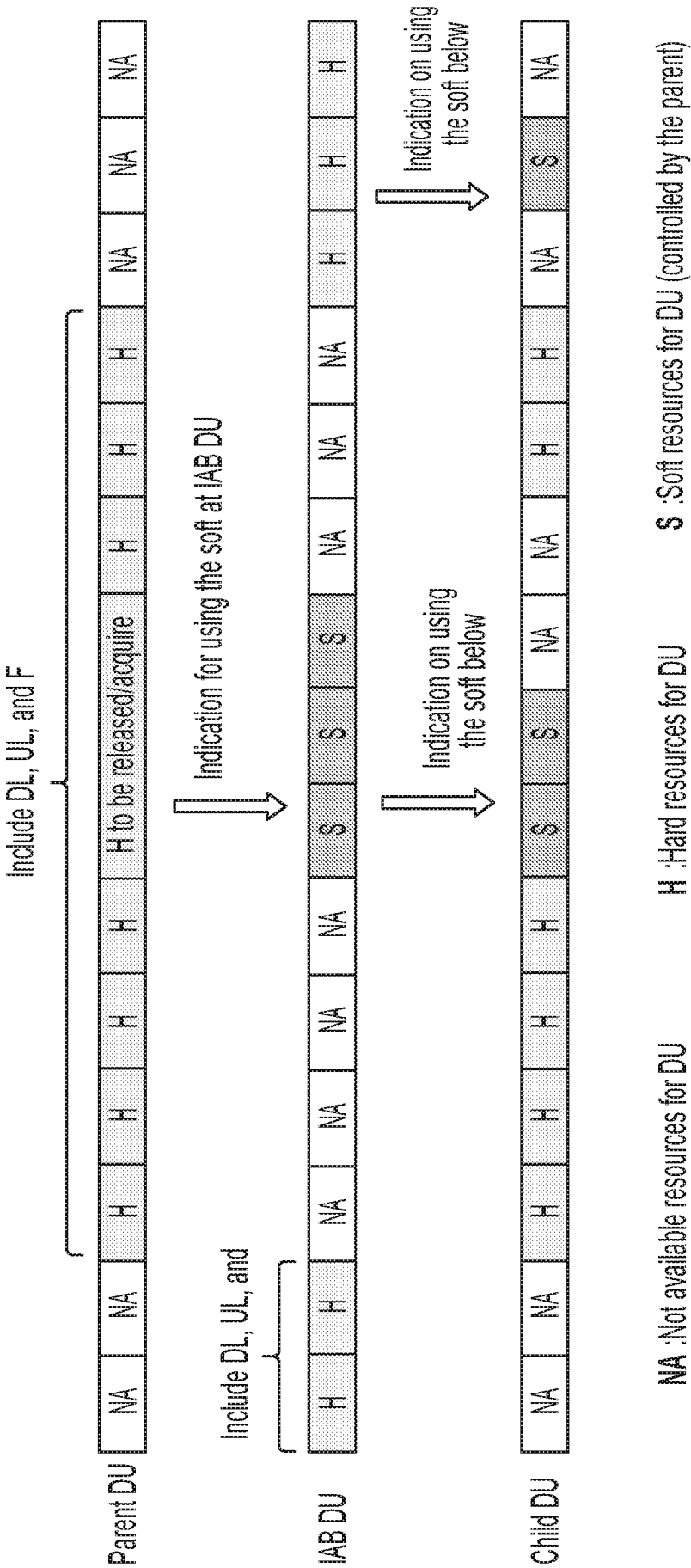


Fig. 7

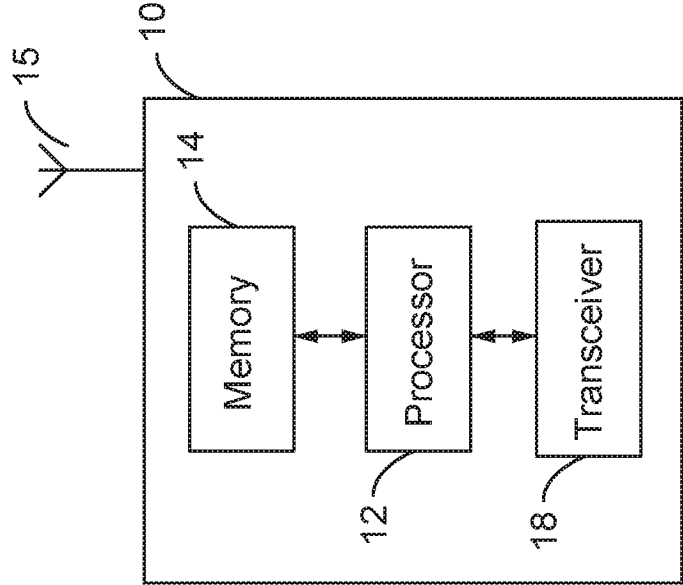


Fig. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2020/050202

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L12/12
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)
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)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2018/270875 A1 (HAMPEL KARL GEORG [US] ET AL) 20 September 2018 (2018-09-20) figures 1, 8B, 9A, 11 page 1, paragraphs 4, 8, 10 page 2, paragraph 23 page 4, paragraph 46 page 7, paragraphs 73, 74 page 8, paragraph 92 -----	1-25
A	US 2004/133314 A1 (EHLERS GREGORY A [US] ET AL) 8 July 2004 (2004-07-08) figures 1A, 4A page 1, paragraph 13 page 3, paragraph 69 page 6, paragraphs 109, 110 ----- -/--	1-25



Further documents are listed in the continuation of Box C.



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Date of the actual completion of the international search

20 March 2020

Date of mailing of the international search report

30/03/2020

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INTERNATIONAL SEARCH REPORT

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	EP 2 184 890 A1 (BROADCOM CORP [US]) 12 May 2010 (2010-05-12) figures 1, 4 page 2, paragraph 5 page 3, paragraph 35 page 4, paragraph 40 -----	1-25
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Information on patent family members

International application No

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