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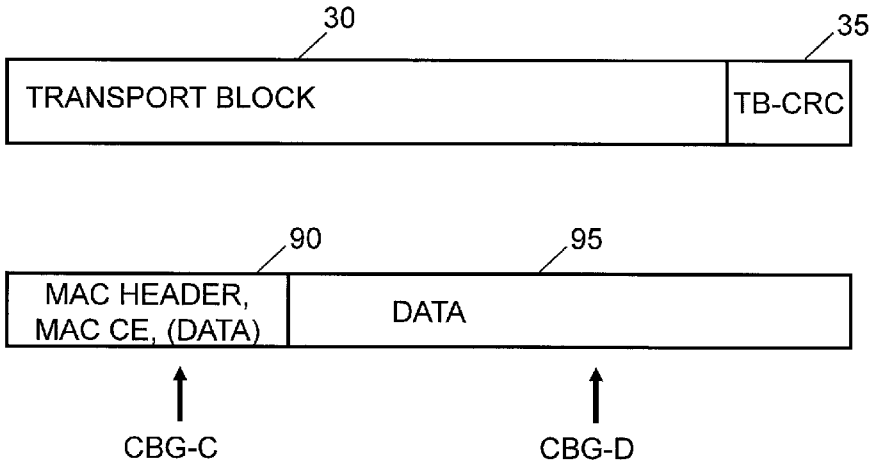

Fig. 4

(57) Abstract: An apparatus for use by a communication network control element or function, the apparatus comprising at least one processing circuitry, and at least one memory for storing instructions to be executed by the processing circuitry, wherein the at least one memory and the instructions are configured to, with the at least one processing circuitty, cause the apparatus at least: to conduct a transmission control processing for transmitting a data block in a communication network between at least two network elements or funcrions, the transmission control processing including defining a transmission format for the data block to be transmitted, wherein the format is based on dividing data to be transmitted into a first type of code block group and a second type of code block group, determining a first modulation and coding scheme to be used for transmission of the first type of code block group and a second modulation and coding scheme being different to the fist modulation and coding scheme and to be used for transmission of the second type of code block group, and allocating resources to be used for transmission of the first type of code block group, to prepare configuration information on the basis of the result of the transmission control processing, and to cause transmission of the configuration information to a network element or function participating in a transmission of the data block.

[Continued on next page]

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TRANSMISSION CONTROL MECHANISM

BACKGROUND

Field

The present invention relates to apparatuses, methods, systems, computer programs, computer program products and computer-readable media usable for controlling transmission of data in a communication network.

Background Art

The following description of background art may include insights, discoveries, understandings or disclosures, or associations, together with disclosures not known to the relevant prior art, to at least some examples of embodiments of the present invention but provided by the invention. Some of such contributions of the invention may be specifically pointed out below, whereas other of such contributions of the invention will be apparent from the related context.

The following meanings for the abbreviations used in this specification apply:

3GPP:	3rd Generation Partner Project
5G:	5th generation
ACK:	acknowledgement
ARQ:	automatic repeat request
BS:	base station
BSR:	buffer status report
CB:	code block
CBG	code block group
CE:	control element
CPU:	central processing unit
CRC:	cyclic redundancy check
DCI:	downlink control information

DL:	downlink
DRB:	data radio bearer
eMBB:	enhanced mobile broadband
ETSI	European Telecommunications Standards Institute
gNB:	5G base station
GPRS:	general packet radio system
HARQ:	hybrid ARQ
ID:	identification
LCID:	logical channel ID
LTE:	Long Term Evolution
LTE-A:	LTE Advanced
MAC:	media access control
MCS:	modulation and coding scheme
mMTC:	massive machine type communication
NACK:	negative acknowledgement
NR:	new radio
PDU:	packet data unit
PHR:	power head room
PRB:	physical resource block
RAN:	radio access network
SDU:	service data unit
TB:	transport block
TBS:	transport block size
UE:	user equipment
UL:	uplink
UMTS:	universal mobile telecommunication system
URLLC:	ultra-reliable and low latency communications

Embodiments of the present invention are related to a mechanism which allows to control transmission of data in a communication network in a more efficient manner, in particular, for example, in cases where large data packets are to be transmitted UL or DL.

SUMMARY

According to an example of an embodiment, there is provided, for example, an apparatus for use by a communication network control element or function, the apparatus comprising at least one processing circuitry, and at least one memory for storing instructions to be executed by the processing circuitry, wherein the at least one memory and the instructions are configured to, with the at least one processing circuitry, cause the apparatus at least: to conduct a transmission control processing for transmitting a data block in a communication network between at least two network elements or functions, the transmission control processing including defining a transmission format for the data block to be transmitted, wherein the format is based on dividing data to be transmitted into a first type of code block group and a second type of code block group, determining a first modulation and coding scheme to be used for transmission of the first type of code block group and a second modulation and coding scheme being different to the fist modulation and coding scheme and to be used for transmission of the second type of code block group, and allocating resources to be used for transmission of the first type of code block group, to prepare configuration information on the basis of the result of the transmission control processing, and to cause transmission of the configuration information to a network element or function participating in a transmission of the data block.

Furthermore, according to an example of an embodiment, there is provided, for example, a method for use by a communication network control element or function, the method comprising conducting a transmission control processing for transmitting a data block in a communication network between at least two network elements or functions, the transmission control processing including defining a transmission format for the data block to be transmitted, wherein the format is based on dividing data to be transmitted into a first type of code block group and a second type of code block group, determining a first modulation and coding scheme to be used for transmission of the first type of code block group and a second modulation and coding scheme being different to the fist modulation and coding scheme and to be used for transmission of the second type of code block group, and allocating resources to be used for transmission of the first type of code block group, preparing configuration information on the basis of the result of the transmission control processing, and causing transmission of the configuration information to a network element or function participating in a transmission of the data block.

According to further refinements, these examples may include one or more of the following features:

- the first type of code block group may comprise one first code block group including header information and control information of the data block to be transmitted and the second type of code block group may comprise at least one second code block group including the remaining data of the data blocks to be transmitted;

- alternatively, the first type of code block group may comprise at least one first code block group including data to be retransmitted from a previously transmitted data block, and the second code block group may comprise at least one second code block group including data of the data block to be newly transmitted;

- the transmission control processing may further include acquiring, when the data block is to be transmitted from the communication network control element or function in a downlink direction, a size of a part of the data block which contains header information and control information for determining the first modulation and coding scheme and allocating the resources to be used, and estimating, when the data block is expected to be transmitted towards the communication network control element or function in an uplink direction, a size occupied by header information and control information by considering communication settings for a sending network element or function;

- the first code block group may be set to include, besides the header information and the control information of the data block to be transmitted, a part of the remaining data;

- the first modulation and coding scheme to be used for transmission of the first type of code block group may have a higher robustness than the second modulation and coding scheme to be used for transmission of the second type of code block group;

- the configuration information may include at least one of an indication of at least one of the first modulation and coding scheme and the second modulation and coding scheme, an indication, in case only one of the first modulation and coding scheme and the second modulation and coding scheme is included, an offset of the other modulation and coding scheme, and an indication of the resources to be used for the transmission of the first type of code block group;

- the configuration information may be transmitted to the network element or function participating in a transmission of the data block by using at least one of a downlink control information signaling and a higher layer signaling, wherein the

configuration information may be transmitted in one set by using one signaling path or in two or more sets by using one or more signaling paths;

- a segmentation indication may be prepared for indicating that a segmentation of the data block into the first type of code block group and the second type of code block group is used in the transmission of the data block, and a transmission of the segmentation indication to the network element or function participating in a transmission of the data block may be caused;

- a transmission of a data block in a downlink direction may be conducted under consideration of the configuration information for segmenting the data block into the first code block group and the at least one second code block group, wherein the size of the first code block group may be determined on the basis of the first modulation and coding scheme and the allocated resources, at least the header information and the control information of the data block may be included in the first code block group, and the remaining data of the data block may be distributed into the at least one second code block group by using a preset code block segmentation scheme, and the first code block group and the at least one second code block group into which the data block is segmented may be transmitted by using the first and second modulation and coding schemes, respectively, at the resources being allocated;

- alternatively, a retransmission of data and a transmission of a new data block in a downlink direction may be conducted under consideration of the configuration information for segmenting the data to be retransmitted and the new data into the first type of code block group and the second type of code block group, wherein the size of the first type code block group may be determined on the basis of the first modulation and coding scheme and the allocated resources, at least the data to be retransmitted may be included in the first type of code block group, and the data of the new data block may be included into the second type of code block group by using a preset code block segmentation scheme, and the first type of code block group and the second type of code block group into which the data to be retransmitted and the new data are segmented may be transmitted by using the first and second modulation and coding schemes, respectively, at the resources being allocated;

- segmentation of the data block may be executed when a total size of the data block to be transmitted is greater than a predetermined threshold, or segmentation of the data block may be executed irrespective of the total size of the data block to be transmitted;

- when receiving a transmission of a data block transmitted in an uplink direction and segmented into the first type of code block group and the second type of code block group, an acknowledgment signal or a negative acknowledgement signal for each of the first type of code block group and the second type of code block group may be transmitted in accordance with a correct or incorrect reception of the data;

- the communication network control element or function may be part of a base station in the communication network to which at least one communication element or function acting as the network element or function participating in a transmission of the data block is connected, wherein the communication element may be a terminal device or user equipment communicating in the communication network.

Furthermore, according to an example of an embodiment, there is provided, for example, an apparatus for use by a communication element or function, the apparatus comprising at least one processing circuitry, and at least one memory for storing instructions to be executed by the processing circuitry, wherein the at least one memory and the instructions are configured to, with the at least one processing circuitry, cause the apparatus at least: to receive and process configuration information defining a transmission procedure of a data block in a communication network between at least two network elements or functions, wherein the transmission procedure of the data block involves using a transmission format for the data block to be transmitted, wherein the format is based on dividing data to be transmitted into a first type of code block group and a second type of code block group, using of a first modulation and coding scheme for transmission of the first type of code block group and a second modulation and coding scheme being different to the first modulation and coding scheme for transmission of the at least one second code block group, and using of resources allocated for transmission of the first type of code block group.

In addition, according to an example of an embodiment, there is provided, for example, a method for use by a communication element or function, the method comprising receiving and processing configuration information defining a transmission procedure of a data block in a communication network between at least two network elements or functions, wherein the transmission procedure of the data block involves using a transmission format for the data block to be transmitted, wherein the format is based on dividing data to be transmitted into a first type of code block group and a second type of code block group, using of a first modulation and coding scheme for transmission of

the first type of code block group and a second modulation and coding scheme for transmission of the second type of code block group, and using of resources allocated for transmission of the first type of code block group.

According to further refinements, these examples may include one or more of the following features:

- the first type of code block group may comprise one first code block group including header information and control information of the data block to be transmitted and the second type of code block group may comprise at least one second code block group including the remaining data of the data blocks to be transmitted;

- alternatively, the first type of code block group may comprise at least one first code block group including data to be retransmitted from a previously transmitted data block, and the second code block group may comprise at least one second code block group including data of the data block to be newly transmitted;

- the first code block group may be set to include, besides the header information and the control information of the data block to be transmitted, a part of the remaining data.

- the first modulation and coding scheme to be used for transmission of the first type of code block group may have a higher robustness than the second modulation and coding scheme to be used for transmission of the second type of code block group;

- the configuration information may include at least one of an indication of at least one of the first modulation and coding scheme and the second modulation and coding scheme, an indication, in case only one of the first modulation and coding scheme and the second modulation and coding scheme is included, an offset of the other modulation and coding scheme, and an indication of the resources to be used for the transmission of the first code block group;

- the configuration information may be received from a communication network control element or function by at least one of a downlink control information signaling and a higher layer signaling, wherein the configuration information may be received in one set by using one signaling path or in two or more sets by using one or more signaling paths;

- a segmentation indication may be received and processed indicating that a segmentation of the data block into the first type of code block group and the second type of code block group is used in the transmission of the data block;

- a transmission of a data block in an uplink direction may be conducted under consideration of the configuration information for segmenting the data block into the first code block group and the at least one second code block group, wherein the size of the first code block group may be determined on the basis of the first modulation and coding scheme and the allocated resources, at least the header information and the control information of the data block may be included in the first code block group, and the remaining data of the data block may be distributed into the at least one second code block group by using a preset code block segmentation scheme, and the first code block group and the at least one second code block group into which the data block is segmented may be transmitted by using the first and second modulation and coding schemes, respectively, at the resources being allocated;

- alternatively, a retransmission of data and a transmission of a new data block in an uplink direction may be conducted under consideration of the configuration information for segmenting the data to be retransmitted and the new data into the first type of code block group and the second type of code block group, wherein the size of the first type of code block group may be determined on the basis of the first modulation and coding scheme and the allocated resources, at least the data to be retransmitted may be included in the first type of code block group, and the data of the new data block may be included into the second type of code block group by using a preset code block segmentation scheme, and the first type of code block group and the second type of code block group into which the data to be retransmitted and the new data are segmented may be transmitted by using the first and second modulation and coding schemes, respectively, at the resources being allocated;

- segmentation of the data block may be executed when a total size of the data block to be transmitted is greater than a predetermined threshold, or segmentation of the data block may be executed irrespective of the total size of the data block to be transmitted;

- when receiving a transmission of a data block transmitted in a downlink direction and segmented into the first type of code block group and the second type of code block group, an acknowledgment signal or a negative acknowledgement signal for each of the first type of code block group and the second type of code block group may be sent in accordance with a correct or incorrect reception of the data;

- the communication element or function may be connected to a communication network control element or function being part of a base station in the communication

network, wherein the communication element may be a terminal device or user equipment communicating in the communication network.

In addition, according to embodiments, there is provided, for example, a computer program product for a computer, including software code portions for performing the steps of the above defined methods, when said product is run on the computer. The computer program product may include a computer-readable medium on which said software code portions are stored. Furthermore, the computer program product may be directly loadable into the internal memory of the computer and/or transmittable via a network by means of at least one of upload, download and push procedures.

BRIEF DESCRIPTION OF THE DRAWINGS

Some embodiments of the present invention are described below, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 shows a diagram illustrating a configuration of a communication network environment where some examples of embodiments are implementable;

Fig. 2 shows a diagram illustrating an example how a data block is segmented for transmission;

Fig. 3 shows a diagram illustrating an example of a structure of a data packet to be transmitted;

Fig. 4 shows a diagram illustrating an example how a data block is segmented for transmission according to some examples of embodiments;

Fig. 5 shows a flow chart of a processing conducted in a communication network control element or function according to some examples of embodiments;

Fig. 6 shows a flow chart of a processing conducted in a communication element according to some examples of embodiments;

Fig. 7 shows a diagram of a network element or function acting as a communication network control element or function according to some examples of embodiments; and

Fig. 8 shows a diagram of a network element or function acting as a communication element according to some examples of embodiments.

DESCRIPTION OF EMBODIMENTS

In the last years, an increasing extension of communication networks, e.g. of wire based communication networks, such as the Integrated Services Digital Network (ISDN), DSL, or wireless communication networks, such as the cdma2000 (code division multiple access) system, cellular 3rd generation (3G) like the Universal Mobile Telecommunications System (UMTS), fourth generation (4G) communication networks or enhanced communication networks based e.g. on LTE or LTE-A, fifth generation (5G) communication networks, cellular 2nd generation (2G) communication networks like the Global System for Mobile communications (GSM), the General Packet Radio System (GPRS), the Enhanced Data Rates for Global Evolution (EDGE), or other wireless communication system, such as the Wireless Local Area Network (WLAN), Bluetooth or Worldwide Interoperability for Microwave Access (WiMAX), took place all over the world. Various organizations, such as the European Telecommunications Standards Institute (ETSI), the 3rd Generation Partnership Project (3GPP), Telecoms & Internet converged Services & Protocols for Advanced Networks (TISPAN), the International Telecommunication Union (ITU), 3rd Generation Partnership Project 2 (3GPP2), Internet Engineering Task Force (IETF), the IEEE (Institute of Electrical and Electronics Engineers), the WiMAX Forum and the like are working on standards or specifications for telecommunication network and access environments.

Generally, for properly establishing and handling a communication connection between two or more end points (e.g. communication stations or elements, such as terminal devices, user equipments (UEs), or other communication network elements, a database, a server, host etc.), one or more network elements such as communication network control elements, for example access network elements like access points, radio base stations, eNBs, gNBs etc., and core network elements or functions, for example control nodes, support nodes, service nodes, gateways etc., may be involved,

which may belong to one communication network system or different communication network systems.

Future communication networks, such as the fifth generation of mobile technology (5G), are developed for fulfilling growing demands on telecommunication systems. Those demands include a growth in connectivity and density/volume of traffic, a multi-layer densification in enabling this, and a broad range of use cases and business models.

Therefore, in new telecommunication systems like 5G, it is necessary to provide, where needed, greater throughput, lower latency, ultra-high reliability, higher connectivity density, and higher mobility range. This is expected to be provided along with the capability to control a highly heterogeneous environment, and capability to, among others, ensure security and trust, identity, and privacy.

Usage scenarios and applications supported in e.g. 5G include, for example, enhanced mobile broadband (eMBB) addressing human-centric use cases for access to multimedia content, services and data, ultra-reliable-low latency communications (URLLC) with strict requirements, especially in terms of latency and reliability, and massive machine type communications (mMTC) for a very large number of connected devices and typically transmitting a relatively low volume of non-delay-sensitive information.

Fig. 1 shows a diagram illustrating a configuration of communication network environment where some examples of embodiments are implementable. It is to be noted that the configuration indicated in Fig. 1 shows only a simplified architecture and hence those parts which are useful for understanding principles underlying some examples of embodiments of the invention. As also known by those skilled in the art there may be several other network elements or devices involved e.g. in a communication which are omitted here for the sake of simplicity. Furthermore, it is to be noted that links indicated in Fig. 1 are intended to show only principle examples of connections between respective network parts. It is possible that also additional or alternative links besides those indicated in Fig. 1 are provided in a corresponding network, and/or that respective network elements or functions communicate with other network elements or functions by using intermediate nodes shown or not shown in Fig.

1. It is to be noted that examples of embodiments are not limited to the number of communication stations, elements, functions, and links as indicated in Fig. 1, i.e. there may be implemented or present less of or more of the corresponding stations, elements, functions, and links than those shown in Fig. 1.

As shown in Fig. 1, a communication element 10, such as a UE, is located within a communication network environment. It is assumed in the scenario according to Fig. 1 that the UE 10 is capable of conducting different types of communication, including also a multi-connectivity communication with a plurality of access points.

Access to a communication network (i.e. core network) 25 is provided by one or more communication network control element or function 20, such as an access point or a base station like BS or gNB providing a wireless interface between the communication element 10 and the network. An access network element like an gNB 20 can be configured to cover a corresponding coverage area, also referred to as cell, in which a communication with the UE 10 is possible.

It is to be noted that more access network elements may be provided in the network, each covering a corresponding coverage area. Furthermore, additional or alternative access network elements can be provided, which use the same or another radio access technology, such as relay nodes, micro cells, wireless local area network nodes and the like, which can be seen in the context of examples of embodiments as corresponding access network elements or functions for the UE 10. Furthermore, even though Fig. 1 shows an example of one UE 10 and one gNB, it is to be noted that examples of embodiments are not limited to these numbers. More elements or functions can be involved in a control procedure according to examples of embodiments. For example, a group of users including a plurality of UEs may be connected to the network.

In a communication network environment as shown in Fig. 1, information or data can be transmitted between the UE 10 and the gNB 20. Sizes of data blocks representing the data to be transmitted can vary, e.g. depending on the type of data. However, also the communication condition may vary, depending e.g. on the number of UEs to be served by a gNB, and the like.

Generally, when transmitting data, error correction procedures including e.g. retransmission are used, such as ARQ and HARQ. In 5G based networks, in particular when data blocks (also referred to as transport blocks (TB)) having a large size (also referred to as transport block size (TBS)) are to be transmitted, such error correction procedures have to be appropriately set.

Fig. 2 describes an example how an incoming data block having a large size can be transmitted. Specifically, Fig. 2 shows an example of a procedure which is applied, for example, in existing LTE networks. That is, a so-called multi-code block transmission is employed, in particular for large incoming packets having a predetermined size or more (e.g. size is greater than 6144 bits).

As shown in Fig. 2, when a TB 30 to which a CRC 35 is attached represent the data packet to be transmitted (in either UL or DL), the TB is segmented to be multiple code blocks (CB) 40-1, 40-2 and 40-3. As shown in Fig. 2, each of CBs 40-1, 40-2 and 40-3 is attached with a code block CRC 45-1, 45-2 and 45-3, respectively. For example, the code block segmentation used in the example shown in Fig. 2 can be based on a segmentation method as specified in 3GPP specification TS 36.212 (e.g. version 14.2.9), wherein a resulting CB size is approximately equal for each CB.

With regard to a transmission error correction procedure in a transmission using the approach described in connection with Fig. 2, it is to be noted that conventionally one bit ACK/NACK feedback per TB is transmitted back to the sender. That is, in a DL transmission, for example, the UE normally sends one-bit HARQ-ACK per TB to the BS and then the BS schedules the TB again for HARQ retransmission. In other words, the whole TB is retransmitted, which includes also an unnecessary transmission of code blocks (CB's) included in the TB which were correctly received.

In order to deal with this situation, in a 5G network, for example, it is considered to use a CBG based transmission and feedback e.g. for transmitting a large transport block. This involves a code block group (CBG) based ACK/NACK feedback. Specifically, each CBG contains one or more CBs, depending for example on a BS configuration. Then, by using e.g. a CBG based HARQ-ACK, partial retransmissions of data is possible.

The benefits of using multi-CBG include faster decoding process at the receiver side, which may be equipped with multiple decoder modules and therefore enable parallel processing. Thus, the decoding latency is decreased. Besides, with separate ACK/NACK feedback for each CBG, UE will only transmit those CBGs that are not successfully decoded previously, leading to higher resource efficiency and lower interference to other UEs.

The present invention deals with the objective problem to improve transmission control for data blocks to be transmitted in a communication network and to set corresponding transmission parameters and feedback for each CBG.

In the following, different exemplifying embodiments will be described using, as an example of a communication network to which the embodiments may be applied, a communication network architecture based on 3GPP standards, such as 5G communication networks, without restricting the embodiments to such architectures, however. It is obvious for a person skilled in the art that the embodiments may also be applied to other kinds of communication networks having suitable means by adjusting parameters and procedures appropriately, e.g. 4G (LTE) networks, WiFi, worldwide interoperability for microwave access (WiMAX), Bluetooth®, personal communications services (PCS), ZigBee®, wideband code division multiple access (WCDMA), systems using ultra-wideband (UWB) technology, mobile ad-hoc networks (MANETs), wired access, etc..

The following examples and embodiments are to be understood only as illustrative examples. Although the specification may refer to "an", "one", or "some" example(s) or embodiment(s) in several locations, this does not necessarily mean that each such reference is related to the same example(s) or embodiment(s), or that the feature only applies to a single example or embodiment. Single features of different embodiments may also be combined to provide other embodiments. Furthermore, terms like "comprising" and "including" should be understood as not limiting the described embodiments to consist of only those features that have been mentioned; such examples and embodiments may also contain features, structures, units, modules etc. that have not been specifically mentioned.

A basic system architecture of a (tele)communication network including a communication system where some examples of embodiments are applicable may include an architecture of one or more communication networks including a wired or wireless access network subsystem and a core network. Such an architecture may include one or more communication network control elements, access network elements, radio access network elements, access service network gateways or base transceiver stations, such as a base station (BS), an access point (AP), a NodeB (NB), an eNB or a gNB, which control a respective coverage area or cell(s) and with which one or more communication stations such as communication elements, user devices or terminal devices, like a UE or a vehicle, or another device having a similar function, such as a modem chipset, a chip, a module etc., which can also be part of a station, an element, a function or an application capable of conducting a communication, such as a UE, an element or function usable in a machine-to-machine communication architecture, or attached as a separate element to such an element, function or application capable of conducting a communication, or the like, are capable to communicate via one or more channels for transmitting several types of data in a plurality of access domains. Furthermore, core network elements such as gateway network elements, mobility management entities, a mobile switching center, servers, databases and the like may be included.

The general functions and interconnections of the described elements, which also depend on the actual network type, are known to those skilled in the art and described in corresponding specifications, so that a detailed description thereof is omitted herein. However, it is to be noted that several additional network elements and signaling links may be employed for a communication to or from an element, function or application, like a communication endpoint, a communication network control element, such as a server, a radio network controller, and other elements of the same or other communication networks besides those described in detail herein below.

A communication network as being considered in examples of embodiments may also be able to communicate with other networks, such as a public switched telephone network or the Internet. The communication network may also be able to support the usage of cloud services for virtual network elements or functions thereof, wherein it is to be noted that the virtual network part of the telecommunication network can also be provided by non-cloud resources, e.g. an internal network or the like. It should be

appreciated that network elements of an access system, of a core network etc., and/or respective functionalities may be implemented by using any node, host, server, access node or entity etc. being suitable for such a usage.

Furthermore, a network element, such as communication elements, like a UE, a terminal device, control elements or functions, such as access network elements, like a base station, an gNB, a radio network controller, other network elements as well as corresponding functions as described herein, and other elements, functions or applications may be implemented by software, e.g. by a computer program product for a computer, and/or by hardware. For executing their respective functions, correspondingly used devices, nodes, functions or network elements may include several means, modules, units, components, etc. (not shown) which are required for control, processing and/or communication/signaling functionality. Such means, modules, units and components may include, for example, one or more processors or processor units including one or more processing portions for executing instructions and/or programs and/or for processing data, storage or memory units or means for storing instructions, programs and/or data, for serving as a work area of the processor or processing portion and the like (e.g. ROM, RAM, EEPROM, and the like), input or interface means for inputting data and instructions by software (e.g. floppy disc, CD-ROM, EEPROM, and the like), a user interface for providing monitor and manipulation possibilities to a user (e.g. a screen, a keyboard and the like), other interface or means for establishing links and/or connections under the control of the processor unit or portion (e.g. wired and wireless interface means, radio interface means including e.g. an antenna unit or the like, means for forming a radio communication part etc.) and the like, wherein respective means forming an interface, such as a radio communication part, can be also located on a remote site (e.g. a radio head or a radio station etc.). It is to be noted that in the present specification processing portions should not be only considered to represent physical portions of one or more processors, but may also be considered as a logical division of the referred processing tasks performed by one or more processors.

It should be appreciated that according to some examples, a so-called "liquid" or flexible network concept may be employed where the operations and functionalities of a network element, a network function, or of another entity of the network, may be performed in different entities or functions, such as in a node, host or server, in a

flexible manner. In other words, a "division of labor" between involved network elements, functions or entities may vary case by case.

Fig. 3 shows a structure of a data block which can be seen as one example of data to be transmitted according to examples of embodiments of the invention. Specifically, Fig. 3 shows a MAC PDU structure.

A MAC PDU (corresponding to a PHY transport block) consists of a MAC header 50, , zero or more MAC control elements (MAC CE) 60, 61, zero or more MAC service data units (MAC SDU) 70, 71, and optionally padding bits 80. MAC CE 60, 61, MAC SDU 70, 71, and optional padding bits 80 represent the payload of the MAC PDU. It is to be noted that both the MAC header 50 and the MAC SDUs 70, 71 can be of variable sizes.

Furthermore, the MAC header 50 consists of one or more MAC PDU sub-headers 52 to 55. For example, each sub-header 52 to 55 corresponds to either a MAC SDU (70, 71), a MAC CE (60, 61) or padding bits (80). The MAC sub-header 52 to 55 indicate e.g. a logical channel ID (LCID) and a length of the corresponding MAC CE or MAC SDU.

On the other hand, the MAC CEs 60, 61 carry control related information, such as a buffer status report, a radio network temporary identifier, such as a C-RNTI, timing advance, power headroom, etc., which are important for data transmission and detection.

In the following, measures for transmission control processing according to some examples of embodiments are described with reference to the configuration of a data block as shown Fig. 3.

As indicated above, the transmission of a data packet like that shown in Fig. 3 is based, according to examples of embodiments, on a multi-CBG transmission. In a first phase, the communication network control element, such as BS or gNB 20, sets a specific format for the segmentation of the data block to be transmitted and configures different MCS levels for the different (types of) CBG

In detail, according to some examples of embodiments, there are two types of CBG defined.

According to one example of embodiments, the first type is referred to as CBG-C and is a CBG in which header and control information of the data block to be transmitted are included. That is, with reference to Fig. 3, the CBG-C is a CBG containing at least data according to the MAC header 50 and the MAC CE 60, 61. According to some examples of embodiments, the CBG-C can also be configured to contain some of the remaining data, that is bits of the MAC SDU 70, 71, for example. According to examples of embodiments, this depends on a general configuration of the communication procedure, for example.

Specifically, according to some examples of embodiments, the CBG-C contains one CB.

The second type is referred to as CBG-D and is a CBG which contains at least one CB containing data bits of the MAC-SDUs 70, 71 and the (optional) padding bits 80.

Furthermore, the communication network control element or function 20 configures corresponding MCS for the two types of CBGs. In detail, for example, a first MCS (referred to as MCS#1) is configured for the CBG-C, and another MCS (referred to as MCS#2) is configured to the CBG-D.

According to examples of embodiments, when the above described CBG-C and CBG-D are defined, the MCS#1 is of a lower level than the MCS level of MCS#2. By means of this, it is possible to allow a more robust transmission of the CBG containing the header and control information, that is the CBG-C containing e.g. the MAC CE.

According to another example of embodiments, for the two types of CBG, a first type of CBG is defined for transporting retransmitted code blocks from a previously transmitted transport block, and a second type of CBG is defined for transporting new transmitted data (i.e. data of a transport block to be transmitted in the current transmission time). In other words, the first type of CBG contains retransmitted CBs from a previously transmitted TB, and the second type of CBG contains the (new) CBs of the current TB.

Specifically, when it is determined by UE 10 or gNB 20 that a retransmission of parts of the previously transmitted data block is required, e.g. due to a transmission error detected on the receiving side, and a corresponding error correction procedure is executed, e.g. HARQ, then the data of the former transmission phase which are to be retransmitted are included in a first type of CBG. On the other hand, the data which have to be transmitted in the current phase (i.e. the data of the TB being to be transmitted regularly) are included in a second type of CBG.

Furthermore, the communication network control element or function 20 configures corresponding MCS for the two types of CBGs. In detail, for example, a first MCS (referred to as MCS#A) is configured for the CBG containing the retransmitted data (or CB(s)), and another MCS (referred to as MCS#B) is configured to the CBG containing the new data (or CB(s)).

According to the present example of embodiments, the MCS#A and MCS#B are different to each other, for example, with regard to a robustness level. Which one of the MCS#A and MCS#B is provided with a higher robustness can depend on a general configuration of the communication procedure, for example.

According to examples of embodiments, the different types of MCS to be used for the transmission of the different types of CBGs can be configured in various ways. For example, each MCS type can be separately defined and configured, wherein also a corresponding indication is transmitted to other network elements participating in the transmission procedure. Another option is that the communication network control element or function (e.g. BS 20) explicitly defines one MCS for one type of CBG and informs the UE for example via a corresponding signaling, e.g. through DCI. The other MCS to be used for the other CBG is not directly indicated; rather, the communication network control element or function 20 indicates an MCS offset, which is signaled, for example, by means of a higher layer signaling. Such a form of indication allows to avoid that additional data bits for the MCS indication of the other CBG are to be included in the DCI, for example.

In a next phase, the communication network control element or function (BS 20) decides on resources to be used for transmitting the different types of CB/CBGs. For

example, the resources allocated for the transmission of CBG is determined in the form of PRBs, OFDM symbols, or another unit configured for the BS 20. The resource being selected are then indicated for at least one of the CBGs, e.g. for the first type of CBG (like the CBG-C according to one of the above described examples of embodiments). Specifically, according to some embodiments of the invention, the BS 20 indicates the resources for transmitting the encoded CBG-C, wherein the indication is either carried in the DCI or is transmitted by a higher layer signaling. For example, a resource unit for CBG-C resource allocation is one PRB, one OFDM symbol, or a BS configured unit. A corresponding setting applies in an equivalent manner, for example, when a CBG for retransmitted CB(s) is defined.

By means of the above described processing, it is possible to define configuration information for a transmission control processing. The information being required for conducting a transmission control including a segmentation of the data block to be transmitted include at least an indication of an MCS to be used for at least one type of the CBG (e.g. CBG-C or CBG-D, or CBG for retransmitted data and CBG for new data), and an indication of resources for transmitting for at least one type of the CBG (e.g. CBG-C or CBG-D, or CBG for retransmitted data and CBG for new data). Then, the segmentation of the data to be transmitted can be conducted as follows: according to some examples of embodiments, through the configured MCS and the configured resources for transmitting e.g. CBG-C, the size of the (only) CB in the CBG-C is determined; the remaining data (bits) of the TB to be transmitted are then segmented to be one or multiple CBs (corresponding to the CBG-D, for example), by following a predetermined code block segmentation scheme, e.g. as defined in TS36.212. In a similar manner, according to some examples of embodiments, through the configured MCS and the configured resources for transmitting e.g. the CBG containing the retransmitted data, the size of the CB(s) in the CBG for the retransmitted data is determined; the new data of the current TB to be transmitted are then segmented to be one or multiple CBs in the CBG for the new data, by following e.g. a predetermined code block segmentation scheme, e.g. as defined in TS36.212.

It is to be noted that according to some examples of embodiments, the format for the data transmission includes one CBG-C and one or more CGB-Ds, wherein always the same MCS (e.g. MCS#2) is set for each of the CBG-D(s).

According to examples of embodiments, there are different options for deciding as to whether or not a segmentation of a data block to be transmitted (and hence to conduct a transmission control processing according to examples of embodiments) is to be executed or not.

For example, one option is to set all network elements or functions participating in the transmission of a data block in such a manner that the data packed is always segmented into the CBG-C and CBG-D, irrespective of e.g. a TBS (i.e. also in case the TBS is within a margin of a maximum supported code block size).

Another option is that the TBS is considered. That is, when the TBS is lower than e.g. a predetermined threshold specifying e.g. a maximum code block size being supported, measures of the transmission control procedure as described for embodiments of the invention, such as segmentation into CBG-C and CBG-D, will not be executed. Otherwise, when the TBS is greater than the threshold, the segmentation is conducted as described above.

Furthermore, it is also possible to consider a segmentation indication. For example, the: BS 10 can prepare a segmentation indication in the form of an information element or the like so as to explicitly or implicitly indicate to an UE that a CBG-C (and hence also CBG-D) exists or has to be generated. This indication can be provided, for example, in the DCI.

It is to be noted that according to examples of embodiments the receiver sends a feedback in form of e.g. a separate ACK/NACK for each type of CBG.

Furthermore, as already indicated, the transmission control processing according to examples of embodiments applies for both UL and DL transmission.

In the following, referring to Fig. 4, an example of a transmission control processing according to examples of embodiments will be described.

Specifically, Fig. 4 shows a diagram illustrating an example how a data block is segmented for transmission according to some examples of embodiments.

As shown in Fig. 4, the data block to be transmitted, i.e. an incoming transport block 30 including CRC 35 is divided into the two types of CBGs 90 and 95, i.e. CBG-C and CBG-D. When assuming the example of Fig. 3 to be valid, the former is used to carry information of MAC header, MCA CE and possibly some of the data bits, and the latter carries data bits and possibly padding bits. Specifically, the one TB is segmented to be two CBs, wherein the CBG-C is the 1st CB containing MAC header and (possibly) some of the data bits, and CBG-D is the 2nd CB containing the rest of data bits.

According to examples of embodiments, the processing for transmitting the data block depends also on the direction of the transmission, i.e. UL or DL. In the DL transmission, the communication network control element like BS 20, as the element or function being responsible for the preparation of the configuration information, generates the DL MAC PDU and knows consequently the exact size of the part containing the MAC header and MAC CE. Based on the known size, the BS 20 is able to configure the MCS and indicate the resources to be used accurately.

On the other hand, for the UL case, BS 20 configures the DRB and L2, including the parameters applied in MAC. Therefore, the BS 20 is able to estimate the presence and the type of MAC CE included in the UL data (which are generated by the UE). For example, whether the PHR MAC CE is included can be determined on the basis of the PHR periodic timer configuration, while size and presence of BSR can be estimated according to the allocated UL grant and the logical control configuration. In other words, the BS 20 is able to estimate, on the basis of the practical situation and e.g. communication settings and parameters being set for the UE 10, the size of a MAC header and the potential MAC CE in a MAC PDU sent in the UL direction. Consequently, a determination of the size of the CBG-C is possible, which allows configuration of the MCS and resources.

It is to be noted that according to examples of embodiments one or both MCS to be used for the CBGs can be set and indicated, wherein the lower level MCS is used for CBG-C and the higher level MCS is used for CBG-D. On the other hand, it is also possible that the BS 20 configures and indicates one MCS, e.g. the MCS for CBG-D, in the scheduling DCI, while the MCS for CBG-C is to be calculated by using an offset being sent in another signaling, so that the MCS value for the CBG-C is determined by

subtracting the value of the MCS indicated in the DCI minus the MCS offset indicated in a higher layer signaling.

As indicated above, according to examples of embodiments, one CBG, e.g. the CBG-C is transmitted in a configured resource. As one example, it can be configured to transmit the CBG-C in the first n PRBs. As another example, it can be configured to transmit the CBG-C in first m OFDM symbols.

Regarding the code block segmentation, according to examples of embodiments, when the incoming bits of a TB are denoted as b_1, b_2, ..., b_{B-1}, then the segmentation is performed as follows. In a first phase, the size of the CBG-C is decided in accordance with the configured MCS and the allocated resources. Assuming the CBG-C size is c, then b_1, b_2, ..., b_c are contained in CBG-C. In a second phase, code block segmentation for the bits b_{c+1}, b_{c+2}, ..., b_{B-1} is executed, e.g. by following the a predefined code block segmentation scheme as defined in in TS36.212.

Fig. 5 shows a flow chart of a processing conducted in a communication network control element or function being part of, for example, a base station in the communication network according to some examples of embodiments. Specifically, the example according to Fig. 5 is related to a procedure conducted by a communication network control element or function, such as the gNB 20 as shown in connection with Fig. 1.

In S100, a transmission control processing for transmitting a data block in the communication network between at least two network elements or functions is conducted. The at least two network elements or function are e.g. the UE 10 and the gNB 20. Specifically, the transmission control processing includes the following. A transmission format for the data block to be transmitted is defined, wherein the format is based on dividing the data to be transmitted into one first type of code block group (such as, for example, CBG-C or CBG for data to be retransmitted) and a second type of code block group (such as, for example, CBG-D or CBG for new data to be transmitted). Furthermore, a first MCS (i.e. MCS#1 or MCS#A) to be used for transmission of the first type of code block group (e.g. CBG-C or CBC for data to be retransmitted) and a second modulation and coding scheme (i.e. MCS#2 or MCS#B) being different to the first modulation and coding scheme and to be used for

transmission of the second type of code block group (e.g. CBG-D or CBG for new data to be transmitted) is determined. Moreover, resources to be used for transmission of (at least) the first type of code block group are allocated.

According to some examples of embodiments, the first type of code block group comprises one first code block group including header information and control information of the data block to be transmitted (i.e. the CBG-C) and the second type of code block group comprises at least one second code block group including the remaining data of the data blocks to be transmitted (i.e. the CBG-D).

It is to be noted that according to some examples of embodiments, the first code block group can then include, besides the header information and the control information of the data block to be transmitted, also a part of the remaining data.

Alternatively, according to some examples of embodiments, the first type of code block group comprises at least one first code block group including data to be retransmitted from a previously transmitted data block, and the second code block group comprises at least one second code block group including data of the data block to be newly transmitted (i.e. the data block of the current transmission phase).

According to some examples of embodiments, the transmission control processing may further include the following. When the data block is to be transmitted from the communication network control element or function in a DL direction, a size of a part of the data block which contains header information and control information can be directly acquired. Hence, the MCS can be determined accurately, wherein also the resources to be used can be accurately allocated. On the other hand, when the data block is expected to be transmitted towards the communication network control element or function in an UL direction, a size occupied by header information and control information can be estimated by considering communication settings (e.g. the UL grant, timer configuration) for a sending network element or function (i.e. UE 10).

According to some examples of embodiments, the first MCS to be used for transmission of the first type of code block group (CBG-C or CBG for data to be retransmitted) has a higher robustness (or lower level) than the second MCS to be used for transmission of the second type of code block group (CBG-D or new data to

be transmitted). It is to be noted that in case of defining a CBG for data to be retransmitted, the MCS (i.e. MCS#A) may also have a lower robustness or the same robustness like that of the CBG for the new data to be transmitted.

In S110, configuration information is prepared on the basis of the result of the transmission control processing. Specifically, according to some examples of embodiments, the configuration information includes at least one of an indication of at least one of the first MCS and the second MCS, an indication, in case only one of the first MCS and the second MCS is included, an offset of the other MCS, and an indication of the resources to be used for the transmission of the first type of code block group.

In S120, the configuration information is transmitted to a network element or function participating in a transmission of the data block (i.e. UE 10). The configuration information is transmitted to the UE 10, for example, by using at least one of a downlink control information (DCI) signaling and a higher layer signaling. That is, the configuration information can be transmitted in one set by using one signaling path (i.e. the complete configuration information is sent in one signaling), or in two or more sets by using one or more signaling paths (for example, DCI signaling is used for informing about the MCS while the MCS offset is transmitted by using the higher layer signaling).

It is to be noted that according to some further examples of embodiments, a segmentation indication is prepared for indicating that a segmentation of the data block into the first type of code block group and the second type of code block group is used in the transmission of the data block. The segmentation indication is then transmitted to the network element or function participating in a transmission of the data block (i.e. UE 10) so as to explicitly or implicitly indicate that a first type of code block group (such as a CBG-C or a CBG for data to be retransmitted) exists and that the data to be transmitted are segmented accordingly.

In S130, when a data block is to be sent in the DL direction, for example, a corresponding transmission is conducted under consideration of the configuration information.

Specifically, in a first type of examples of embodiments, the data block is segmented into the first code block group (CBG-C) and the at least one second code block group (CBG-D), wherein the size of the first code block group is determined on the basis of the first MCS and the allocated resources, for example. The header information and the control information (CE) of the data block are included in the first code block group (and optionally additional data, as indicated above). The remaining data of the data block are distributed into the at least one second code block group (CBG-D) by using, for example, a preset code block segmentation scheme (e.g. the code block segmentation scheme according to the above indicated specification TS 36.212). Then, the first code block group and the at least one second code block group into which the data block is segmented are transmitted by using the first and second modulation and coding schemes, respectively, at the resources being allocated.

On the other hand, in a second type of examples of embodiments (i.e. in a retransmission case), retransmission of data and a transmission of a new data block in a downlink direction are conducted under consideration of the configuration information for segmenting the data to be retransmitted and the new data into the first type of code block group and the second type of code block group. The size of the first type of code block group is determined on the basis of the first modulation and coding scheme (MCS#A) and the allocated resources. Then, at least the data to be retransmitted are included in the first type of code block group. Moreover, the data of the new data block are included into the second type of code block group by using a preset code block segmentation scheme (e.g. the code block segmentation scheme according to the above indicated specification TS 36.212). Then, the first type of code block group and the second type of code block group into which the data to be retransmitted and the new data are segmented are transmitted by using the first and second modulation and coding schemes, respectively, at the resources being allocated.

It is to be noted that segmentation of the data block is executed, for example, when a total size of the data block to be transmitted is greater than a predetermined threshold. Alternatively, segmentation of the data block is conducted always, i.e. irrespective of the total size of the data block to be transmitted. Also receipt of an indication (i.e. the segmentation indication indicated above) is usable as a trigger for using the segmentation procedure defined above.

According to further examples of embodiments, when the specific network element is on the receiving side, i.e. a segmented data packet comprising the first type of code block group (e.g. CBG-C or CBG including data to be retransmitted) and the second type of code block group (i.e. CBG-D or CBG including new data to be transmitted) is received from the UE 10 in UL direction, an acknowledgment signal or a negative acknowledgement signal for each of the first type of code block group and the second type of code block group in accordance with a correct or incorrect reception of the data is sent in return.

Fig. 6 shows a flow chart of a processing conducted in a communication element in the communication network according to some examples of embodiments. Specifically, the example according to Fig. 6 is related to a procedure conducted by a communication element, such as the UE 10 as shown in connection with Fig. 1.

In S200, configuration information defining a transmission procedure of a data block in a communication network between at least two network elements or functions is received and processed. The at least two network elements or function are e.g. the UE 10 and the gNB 20. Specifically, the transmission control processing includes the following. A transmission format for the data block to be transmitted is to be used, wherein the format is based on dividing the data to be transmitted into one first type of code block group (such as, for example, CBG-C or CBG for data to be retransmitted) and a second type of code block group (such as, for example, CBG-D or CBG for new data to be transmitted). Furthermore, a first MCS (i.e. MCS#1 or MCS#A) for transmission of the first type of code block group (e.g. CBG-C or CBC for data to be retransmitted) and a second modulation and coding scheme (i.e. MCS#2 or MCS#B) being different to the first modulation and coding scheme for transmission of the second type of code block group (e.g. CBG-D or CBG for new data to be transmitted) are to be used. Moreover, resources allocated for transmission of (at least) the first type of code block group are to be used.

According to some examples of embodiments, the first type of code block group comprises one first code block group including header information and control information of the data block to be transmitted (i.e. the CBG-C) and the second type of code block group comprises at least one second code block group including the remaining data of the data blocks to be transmitted (i.e. the CBG-D).

It is to be noted that according to some examples of embodiments, the first code block group can then include, besides the header information and the control information of the data block to be transmitted, also a part of the remaining data.

Alternatively, according to some examples of embodiments, the first type of code block group comprises at least one first code block group including data to be retransmitted from a previously transmitted data block, and the second code block group comprises at least one second code block group including data of the data block to be newly transmitted (i.e. the data block of the current transmission phase).

According to some examples of embodiments, the first MCS to be used for transmission of the first type of code block group (CBG-C or CBG for data to be retransmitted) has a higher robustness (or lower level) than the second MCS to be used for transmission of the at least one second code block group (CBG-D or new data to be transmitted). It is to be noted that in case of defining a CBG for data to be retransmitted, the MCS (i.e. MCS#A) may also have a lower robustness or the same robustness like that of the CBG for the new data to be transmitted.

According to some examples of embodiments, the configuration information includes at least one of an indication of at least one of the first MCS and the second MCS, an indication, in case only one of the first MCS and the second MCS is included, an offset of the other MCS, and an indication of the resources to be used for the transmission of the first type of code block group.

Furthermore, according to some examples of embodiments, the configuration information is received from a communication network control element or function (e.g. GNB 20) by at least one of a downlink control information (DCI) signaling and a higher layer signaling. That is, the configuration information can be received in one set via one signaling path (i.e. the complete configuration information is sent in one signaling), or in two or more sets via one or more signaling paths (for example, DCI signaling is used for informing about the MCS while the MCS offset is transmitted by using the higher layer signaling).

It is to be noted that according to some further examples of embodiments, a segmentation indication is received which indicates that a segmentation of the data block into the first type of code block group and the second type of code block group is used in the transmission of the data block. The segmentation indication is transmitted so as to explicitly or implicitly indicate that a first type of code block group (such as a CBG-C or a CBG for data to be retransmitted) exists and that the data to be transmitted are segmented accordingly.

In S210, when a data block is to be sent in the UL direction, for example, a corresponding transmission is conducted under consideration of the configuration information.

Specifically, according to a first type of examples of embodiments, the data block is segmented into the first code block group (CBG-C) and the at least one second code block group (CBG.D), wherein the size of the first code block group is determined on the basis of the first MCS and the allocated resources, for example. The header information and the control information (CE) of the data block are included in the first code block group (and optionally additional data, as indicated above). The remaining data of the data block are distributed into the at least one second code block group (CBG-D) by using, for example, a preset code block segmentation scheme (e.g. the code block segmentation scheme according to the above indicated specification TS 36.212). Then, the first code block group and the at least one second code block group into which the data block is segmented are transmitted by using the first and second modulation and coding schemes, respectively, at the resources being allocated.

On the other hand, in a second type of examples of embodiments (i.e. in a retransmission case), retransmission of data and a transmission of a new data block in an uplink direction are conducted under consideration of the configuration information for segmenting the data to be retransmitted and the new data into the first type of code block group and the second type of code block group. The size of the first type of code block group is determined on the basis of the first modulation and coding scheme (MCS#A) and the allocated resources. Then, at least the data to be retransmitted are included in the first type of code block group. Moreover, the data of the new data block are included into the second type of code block group by using a preset code block segmentation scheme (e.g. the code block segmentation scheme according to the

above indicated specification TS 36.212). Then, the first type of code block group and the second type of code block group into which the data to be retransmitted and the new data are segmented are transmitted by using the first and second modulation and coding schemes, respectively, at the resources being allocated.

It is to be noted that segmentation of the data block is executed, for example, when a total size of the data block to be transmitted is greater than a predetermined threshold. Alternatively, segmentation of the data block is conducted always, i.e. irrespective of the total size of the data block to be transmitted. Also receipt of an indication (i.e. the segmentation indication indicated above) is usable as a trigger for using the segmentation procedure defined above.

According to further examples of embodiments, when the specific network element is on the receiving side, i.e. a segmented data packet comprising the first type of code block group (e.g. CBG-C or CBG including data to be retransmitted) and the second type of code block group (i.e. CBG-D or CBG including new data to be transmitted) is received from the gNB 20 in DL direction, an acknowledgment signal or a negative acknowledgement signal for each of the first type of code block group and the second type of code block group in accordance with a correct or incorrect reception of the data is sent in return.

Fig. 7 shows a diagram of a network element or function acting as a communication network control element or function according to some examples of embodiments, e.g. as the gNB 20, which is configured to implement a procedure for a transmission control processing as described in connection with some of the examples of embodiments. It is to be noted that the network element or function, like the gNB 20 of Fig. 1, may include further elements or functions besides those described herein below. Furthermore, even though reference is made to a network element or function, the element or function may be also another device or function having a similar task, such as a chipset, a chip, a module, an application etc., which can also be part of a network element or attached as a separate element to a network element, or the like. It should be understood that each block and any combination thereof may be implemented by various means or their combinations, such as hardware, software, firmware, one or more processors and/or circuitry.

The network element 20 shown in Fig. 7 may include a processing circuitry, a processing function, a control unit or a processor 201, such as a CPU or the like, which is suitable for executing instructions given by programs or the like related to the control procedure. The processor 201 may include one or more processing portions or functions dedicated to specific processing as described below, or the processing may be run in a single processor or processing function. Portions for executing such specific processing may be also provided as discrete elements or within one or more further processors, processing functions or processing portions, such as in one physical processor like a CPU or in one or more physical or virtual entities, for example. Reference sign 202 denotes input/output (I/O) units or functions (interfaces) connected to the processor or processing function 201. The I/O units 202 may be used for communicating with the communication elements like UE 10, as described in connection with Fig. 1, for example. The I/O units 202 may be a combined unit including communication equipment towards several entities, or may include a distributed structure with a plurality of different interfaces for different entities. Reference sign 204 denotes a memory usable, for example, for storing data and programs to be executed by the processor or processing function 201 and/or as a working storage of the processor or processing function 201. It is to be noted that the memory 204 may be implemented by using one or more memory portions of the same or different type of memory.

The processor or processing function 201 is configured to execute processing related to the above described procedure for transmission control. In particular, the processor or processing circuitry or function 201 includes one or more of the following sub-portions. Sub-portion 2011 is a processing portion which is usable as a portion for conducting a transmission control processing. The portion 2011 may be configured to perform processing according to S100 of Fig. 5. Furthermore, the processor or processing circuitry or function 201 may include a sub-portion 2012 usable as a portion for preparing configuration information. The portion 2012 may be configured to perform a processing according to S110 of Fig. 5. In addition, the processor or processing circuitry or function 201 may include a sub-portion 2013 usable as a portion for transmitting the configuration information. The portion 2013 may be configured to perform a processing according to S120 of Fig. 5. Moreover, the processor or processing circuitry or function 201 may include a sub-portion 2014 usable as a portion

for transmitting a data block. The portion 2014 may be configured to perform a processing according to S130 of Fig. 5.

Fig. 8 shows a diagram of a network element or function acting as a communication element according to some examples of embodiments, e.g. as UE 10, which is configured to implement a procedure for a transmission control processing as described in connection with some of the examples of embodiments. It is to be noted that the network element or function, like the UE 10 of Fig. 1, may include further elements or functions besides those described herein below. Furthermore, even though reference is made to a communication element, the element or function may be also another device or function having a similar task, such as a chipset, a chip, a module, an application etc., which can also be part of a communication network element or attached as a separate element to a communication network element, or the like. It should be understood that each block and any combination thereof may be implemented by various means or their combinations, such as hardware, software, firmware, one or more processors and/or circuitry.

The UE 10 shown in Fig. 8 may include a processing circuitry, a processing function, a control unit or a processor 101, such as a CPU or the like, which is suitable for executing instructions given by programs or the like related to the control procedure. The processor 101 may include one or more processing portions or functions dedicated to specific processing as described below, or the processing may be run in a single processor or processing function. Portions for executing such specific processing may be also provided as discrete elements or within one or more further processors, processing functions or processing portions, such as in one physical processor like a CPU or in one or more physical or virtual entities, for example. Reference sign 102 denotes input/output (I/O) units or functions (interfaces) connected to the processor or processing function 101. The I/O units 102 may be used for communicating with the communication network and/or other entities or functions, as described in connection with Fig. 1, for example. The I/O units 102 may be a combined unit including communication equipment towards several entities, or may include a distributed structure with a plurality of different interfaces for different entities. Reference sign 104 denotes a memory usable, for example, for storing data and programs to be executed by the processor or processing function 101 and/or as a working storage of the processor or processing function 101. It is to be noted that the memory 104 may be

implemented by using one or more memory portions of the same or different type of memory.

The processor or processing function 101 is configured to execute processing related to the above described procedure for transmission control processing. In particular, the processor or processing circuitry or function 101 includes one or more of the following sub-portions. Sub-portion 1011 is a processing portion which is usable as a portion for processing configuration information. The portion 1011 may be configured to perform processing according to S200 of Fig. 6. Moreover, the processor or processing circuitry or function 101 may include a sub-portion 1012 usable as a portion for transmitting a data block. The portion 1012 may be configured to perform a processing according to S210 of Fig. 6.

It is to be noted that examples of embodiments of the invention are applicable to various different network configurations. In other words, the example shown in Fig. 1, which is used as a basis for the above discussed examples, is only illustrative and does not limit the present invention in any way. That is, additional further existing and proposed new functionalities available in a corresponding operating environment may be used in connection with examples of embodiments of the invention based on the principles defined.

With the transmission control processing described above, it is possible that a per-CBG ACK/NAKC feedback is given wherein the proposed two types of CBGs and the different MCS configuration for each CBG allows a more robust transmission and reception of information like BSR, PHR, and UE-ID etc. This enables a more efficient packet scheduling, power control, UL timing adjustment and so on, which in turn leads to a more efficient data transmission performance.

It is to be noted that the examples of embodiments described above can also be combined. That is, for example, the segmentation of a TB into CBG-C and CBG-D can be used in connection with a segmentation into a CBG for data to be retransmitted and a CBG for new data to be transmitted. For example, the CBG-C may contain, besides the heater and CE related data, also the data to be retransmitted. Alternatively, the data to be retransmitted can be included in a CBG-D, for example.

It is to be noted that the measures described in the present specification can be executed on top of common/general measures or communication procedures. Some of the measures described in the present specification can be applied separately, some in various combinations, or all measures can be combined in one procedure.

According to a further example of embodiments, there is provided, for example, an apparatus for use by a communication network control element or function, the apparatus comprising means configured to conduct a transmission control processing for transmitting a data block in a communication network between at least two network elements or functions, the transmission control processing including defining a transmission format for the data block to be transmitted, wherein the format is based on dividing data to be transmitted into a first type of code block group and a second type of code block group, determining a first modulation and coding scheme to be used for transmission of the first type of code block group and a second modulation and coding scheme being different to the fist modulation and coding scheme and to be used for transmission of the second type of code block group, and allocating resources to be used for transmission of the first type of code block group, means configured to prepare configuration information on the basis of the result of the transmission control processing, and means configured to cause transmission of the configuration information to a network element or function participating in a transmission of the data block.

Furthermore, according to some other examples of embodiments, the above defined apparatus may further comprise means for conducting at least one of the processing defined in the above described methods, for example a method according that described in connection with Fig 5.

According to a further example of embodiments, there is provided, for example, an apparatus for use by a communication element or function, the apparatus comprising means configured to receive and process configuration information defining a transmission procedure of a data block in a communication network between at least two network elements or functions, wherein the transmission procedure of the data block involves using a transmission format for the data block to be transmitted, wherein the format is based on dividing data to be transmitted into a first type of code block group and a second type of code block group, using of a first modulation and coding

scheme for transmission of the first type of code block group and a second modulation and coding scheme for transmission of the second type of code block group, and using of resources allocated for transmission of the first type of code block group.

Furthermore, according to some other examples of embodiments, the above defined apparatus may further comprise means for conducting at least one of the processing defined in the above described methods, for example a method according that described in connection with Fig 6.

It should be appreciated that

- an access technology via which traffic is transferred to and from an entity in the communication network may be any suitable present or future technology, such as WLAN (Wireless Local Access Network), WiMAX (Worldwide Interoperability for Microwave Access), LTE, LTE-A, 5G, Bluetooth, Infrared, and the like may be used; additionally, embodiments may also apply wired technologies, e.g. IP based access technologies like cable networks or fixed lines.
- embodiments suitable to be implemented as software code or portions of it and being run using a processor or processing function are software code independent and can be specified using any known or future developed programming language, such as a high-level programming language, such as objective-C, C, C++, C#, Java, Python, Javascript, other scripting languages etc., or a low-level programming language, such as a machine language, or an assembler.
- implementation of embodiments is hardware independent and may be implemented using any known or future developed hardware technology or any hybrids of these, such as a microprocessor or CPU (Central Processing Unit), MOS (Metal Oxide Semiconductor), CMOS (Complementary MOS), BiMOS (Bipolar MOS), BiCMOS (Bipolar CMOS), ECL (Emitter Coupled Logic), and/or TTL (Transistor-Transistor Logic).
- embodiments may be implemented as individual devices, apparatuses, units, means or functions, or in a distributed fashion, for example, one or more processors or processing functions may be used or shared in the processing, or one or more processing sections or processing portions may be used and shared in the processing, wherein one physical processor or more than one physical processor may be used for implementing one or more processing portions dedicated to specific processing as described,

- an apparatus may be implemented by a semiconductor chip, a chipset, or a (hardware) module including such chip or chipset;
- embodiments may also be implemented as any combination of hardware and software, such as ASIC (Application Specific IC (Integrated Circuit)) components, FPGA (Field-programmable Gate Arrays) or CPLD (Complex Programmable Logic Device) components or DSP (Digital Signal Processor) components.
- embodiments may also be implemented as computer program products, including a computer usable medium having a computer readable program code embodied therein, the computer readable program code adapted to execute a process as described in embodiments, wherein the computer usable medium may be a non-transitory medium.

Although the present invention has been described herein before with reference to particular embodiments thereof, the present invention is not limited thereto and various modifications can be made thereto.

WHAT IS CLAIMED IS:

1. An apparatus for use by a communication network control element or function, the apparatus comprising

at least one processing circuitry, and

at least one memory for storing instructions to be executed by the processing circuitry,

wherein the at least one memory and the instructions are configured to, with the at least one processing circuitry, cause the apparatus at least:

to conduct a transmission control processing for transmitting a data block in a communication network between at least two network elements or functions, the transmission control processing including

defining a transmission format for the data block to be transmitted, wherein the format is based on dividing data to be transmitted into a first type of code block group and a second type of code block group,

determining a first modulation and coding scheme to be used for transmission of the first type of code block group and a second modulation and coding scheme being different to the fist modulation and coding scheme and to be used for transmission of the second type of code block group, and

allocating resources to be used for transmission of the first type of code block group,

to prepare configuration information on the basis of the result of the transmission control processing, and

to cause transmission of the configuration information to a network element or function participating in a transmission of the data block.

2. The apparatus according to claim 1, wherein the first type of code block group comprises one first code block group including header information and control information of the data block to be transmitted and the second type of code block group comprises at least one second code block group including the remaining data of the data blocks to be transmitted.

3. The apparatus according to claim 1, wherein the first type of code block group comprises at least one first code block group including data to be retransmitted from a previously transmitted data block, and the second code block group comprises at least one second code block group including data of the data block to be newly transmitted.

4. The apparatus according to claim 2, wherein the transmission control processing further includes

acquiring, when the data block is to be transmitted from the communication network control element or function in a downlink direction, a size of a part of the data block which contains header information and control information for determining the first modulation and coding scheme and allocating the resources to be used, and

estimating, when the data block is expected to be transmitted towards the communication network control element or function in an uplink direction, a size occupied by header information and control information by considering communication settings for a sending network element or function.

5. The apparatus according to claim 2 or 4, wherein the first code block group is set to include, besides the header information and the control information of the data block to be transmitted, a part of the remaining data.

6. The apparatus according to any of claims 1 to 5, wherein the first modulation and coding scheme to be used for transmission of the first type of code block group has a higher robustness than the second modulation and coding scheme to be used for transmission of the second type of code block group.

7. The apparatus according to any of claims 1 to 6, wherein the configuration information includes at least one of

an indication of at least one of the first modulation and coding scheme and the second modulation and coding scheme,

an indication, in case only one of the first modulation and coding scheme and the second modulation and coding scheme is included, an offset of the other modulation and coding scheme, and

an indication of the resources to be used for the transmission of the first type of code block group.

8. The apparatus according to any of claims 1 to 7, wherein the configuration information is transmitted to the network element or function participating in a transmission of the data block by using at least one of a downlink control information signaling and a higher layer signaling, wherein the configuration information is transmitted in one set by using one signaling path or in two or more sets by using one or more signaling paths.

9. The apparatus according to any of claims 1 to 8, wherein the at least one memory and the instructions are further configured to, with the at least one processing circuitry, cause the apparatus at least

to prepare a segmentation indication for indicating that a segmentation of the data block into the first type of code block group and the second type of code block group is used in the transmission of the data block, and

to cause transmission of the segmentation indication to the network element or function participating in a transmission of the data block.

10. The apparatus according to any of claims 2 and 4 to 9, wherein the at least one memory and the instructions are further configured to, with the at least one processing circuitry, cause the apparatus at least

to conduct a transmission of a data block in a downlink direction under consideration of the configuration information for segmenting the data block into the first code block group and the at least one second code block group, wherein

the size of the first code block group is determined on the basis of the first modulation and coding scheme and the allocated resources,

at least the header information and the control information of the data block are included in the first code block group, and

the remaining data of the data block are distributed into the at least one second code block group by using a preset code block segmentation scheme, and

to transmit the first code block group and the at least one second code block group into which the data block is segmented by using the first and second modulation and coding schemes, respectively, at the resources being allocated.

11. The apparatus according to any of claims 3 to 9, wherein the at least one memory and the instructions are further configured to, with the at least one processing circuitry, cause the apparatus at least

to conduct a retransmission of data and a transmission of a new data block in a downlink direction under consideration of the configuration information for segmenting the data to be retransmitted and the new data into the first type of code block group and the second type of code block group, wherein

the size of the first type code block group is determined on the basis of the first modulation and coding scheme and the allocated resources,

at least the data to be retransmitted are included in the first type of code block group, and

the data of the new data block are included into the second type of code block group by using a preset code block segmentation scheme, and

to transmit the first type of code block group and the second type of code block group into which the data to be retransmitted and the new data are segmented by using the first and second modulation and coding schemes, respectively, at the resources being allocated.

12. The apparatus according to claim 10, wherein the at least one memory and the instructions are further configured to, with the at least one processing circuitry, cause the apparatus at least

to execute segmentation of the data block when a total size of the data block to be transmitted is greater than a predetermined threshold, or

to execute segmentation of the data block irrespective of the total size of the data block to be transmitted.

13. The apparatus according to any of claims 1 to 12, wherein the at least one memory and the instructions are further configured to, with the at least one processing circuitry, cause the apparatus at least

to send, when receiving a transmission of a data block transmitted in an uplink direction and segmented into the first type of code block group and the second type of code block group, an acknowledgment signal or a negative acknowledgement signal for each of the first type of code block group and the second type of code block group in accordance with a correct or incorrect reception of the data.

14. The apparatus according to any of claims 1 to 13, wherein

the communication network control element or function is part of a base station in the communication network to which at least one communication element or function acting as the network element or function participating in a transmission of the data block is connected, wherein the communication element is a terminal device or user equipment communicating in the communication network.

15. A method for use by a communication network control element or function, the method comprising

conducting a transmission control processing for transmitting a data block in a communication network between at least two network elements or functions, the transmission control processing including

defining a transmission format for the data block to be transmitted, wherein the format is based on dividing data to be transmitted into a first type of code block group and a second type of code block group,

determining a first modulation and coding scheme to be used for transmission of the first type of code block group and a second modulation and coding scheme being different to the fist modulation and coding scheme and to be used for transmission of the second type of code block group, and

allocating resources to be used for transmission of the first type of code block group,

preparing configuration information on the basis of the result of the transmission control processing, and

causing transmission of the configuration information to a network element or function participating in a transmission of the data block.

16. The method according to claim 15, wherein the first type of code block group comprises one first code block group including header information and control information of the data block to be transmitted and the second type of code block group comprises at least one second code block group including the remaining data of the data blocks to be transmitted.

17. The method according to claim 15, wherein the first type of code block group comprises at least one first code block group including data to be retransmitted from a previously transmitted data block, and the second code block group comprises at least one second code block group including data of the data block to be newly transmitted.

18. The method according to claim 16, wherein the transmission control processing further includes

acquiring, when the data block is to be transmitted from the communication network control element or function in a downlink direction, a size of a part of the data block which contains header information and control information for determining the first modulation and coding scheme and allocating the resources to be used, and

estimating, when the data block is expected to be transmitted towards the communication network control element or function in an uplink direction, a size occupied by header information and control information by considering communication settings for a sending network element or function.

19. The method according to claim 16 or 18, wherein the first code block group is set to include, besides the header information and the control information of the data block to be transmitted, a part of the remaining data.

20. The method according to any of claims 15 to 19, wherein the first modulation and coding scheme to be used for transmission of the first type of code block group has a higher

robustness than the second modulation and coding scheme to be used for transmission of the second type of code block group.

21. The method according to any of claims 15 to 20, wherein the configuration information includes at least one of

an indication of at least one of the first modulation and coding scheme and the second modulation and coding scheme,

an indication, in case only one of the first modulation and coding scheme and the second modulation and coding scheme is included, an offset of the other modulation and coding scheme, and

an indication of the resources to be used for the transmission of the first type of code block group.

22. The method according to any of claims 15 to 21, wherein the configuration information is transmitted to the network element or function participating in a transmission of the data block by using at least one of a downlink control information signaling and a higher layer signaling, wherein the configuration information is transmitted in one set by using one signaling path or in two or more sets by using one or more signaling paths.

23. The method according to any of claims 15 to 22, further comprising

preparing a segmentation indication for indicating that a segmentation of the data block into the first type of code block group and the second type of code block group is used in the transmission of the data block, and

causing transmission of the segmentation indication to the network element or function participating in a transmission of the data block.

24. The method according to any of claims 16 and 18 to 23, further comprising

conducting a transmission of a data block in a downlink direction under consideration of the configuration information for segmenting the data block into the first code block group and the at least one second code block group, wherein

the size of the first code block group is determined on the basis of the first modulation and coding scheme and the allocated resources,

at least the header information and the control information of the data block are included in the first code block group, and

the remaining data of the data block are distributed into the at least one second code block group by using a preset code block segmentation scheme, and

transmitting the first code block group and the at least one second code block group into which the data block is segmented by using the first and second modulation and coding schemes, respectively, at the resources being allocated.

25. The method according to any of claims 17 to 23, further comprising

conducting a retransmission of data and a transmission of a new data block in a downlink direction under consideration of the configuration information for segmenting the data to be retransmitted and the new data into the first type of code block group and the second type of code block group, wherein

the size of the first type code block group is determined on the basis of the first modulation and coding scheme and the allocated resources,

at least the data to be retransmitted are included in the first type of code block group, and

the data of the new data block are included into the second type of code block group by using a preset code block segmentation scheme, and

transmitting the first type of code block group and the second type of code block group into which the data to be retransmitted and the new data are segmented by using the first and second modulation and coding schemes, respectively, at the resources being allocated.

26. The method according to claim 24, further comprising

executing segmentation of the data block when a total size of the data block to be transmitted is greater than a predetermined threshold, or

executing segmentation of the data block irrespective of the total size of the data block to be transmitted.

27. The method according to any of claims 15 to 26, further comprising

sending, when receiving a transmission of a data block transmitted in an uplink direction and segmented into the first type of code block group and the second type of code block group, an acknowledgment signal or a negative acknowledgement signal for each of the first type of code block group and the second type of code block group in accordance with a correct or incorrect reception of the data.

28. The method according to any of claims 15 to 27, wherein

the communication network control element or function is part of a base station in the communication network to which at least one communication element or function acting as the network element or function participating in a transmission of the data block is connected,

wherein the communication element is a terminal device or user equipment communicating in the communication network.

29. An apparatus for use by a communication element or function, the apparatus comprising at least one processing circuitry, and

at least one memory for storing instructions to be executed by the processing circuitry,

wherein the at least one memory and the instructions are configured to, with the at least one processing circuitry, cause the apparatus at least:

to receive and process configuration information defining a transmission procedure of a data block in a communication network between at least two network elements or functions, wherein the transmission procedure of the data block involves

using a transmission format for the data block to be transmitted, wherein the format is based on dividing data to be transmitted into a first type of code block group and a second type of code block group,

using of a first modulation and coding scheme for transmission of the first type of code block group and a second modulation and coding scheme being different to the first modulation and coding scheme for transmission of the at least one second code block group, and

using of resources allocated for transmission of the first type of code block group.

30. The apparatus according to claim 29, wherein the first type of code block group comprises one first code block group including header information and control information of the data block to be transmitted and the second type of code block group comprises at least one second code block group including the remaining data of the data blocks to be transmitted.

31. The apparatus according to claim 29, wherein the first type of code block group comprises at least one first code block group including data to be retransmitted from a previously transmitted data block, and the second code block group comprises at least one second code block group including data of the data block to be newly transmitted.

32. The apparatus according to claim 30, wherein the first code block group is set to include, besides the header information and the control information of the data block to be transmitted, a part of the remaining data.

33. The apparatus according to any of claims 29 to 32, wherein the first modulation and coding scheme to be used for transmission of the first type of code block group has a higher

robustness than the second modulation and coding scheme to be used for transmission of the second type of code block group.

34. The apparatus according to any of claims 29 to 33, wherein the configuration information includes at least one of

an indication of at least one of the first modulation and coding scheme and the second modulation and coding scheme,

an indication, in case only one of the first modulation and coding scheme and the second modulation and coding scheme is included, an offset of the other modulation and coding scheme, and

an indication of the resources to be used for the transmission of the first code block group.

35. The apparatus according to any of claims 29 to 34, wherein the configuration information is received from a communication network control element or function by at least one of a downlink control information signaling and a higher layer signaling, wherein the configuration information is received in one set by using one signaling path or in two or more sets by using one or more signaling paths.

36. The apparatus according to any of claims 29 to 35, wherein the at least one memory and the instructions are further configured to, with the at least one processing circuitry, cause the apparatus at least

to receive and process a segmentation indication indicating that a segmentation of the data block into the first type of code block group and the second type of code block group is used in the transmission of the data block.

37. The apparatus according to any of claims 30 and 32 to 36, wherein the at least one memory and the instructions are further configured to, with the at least one processing circuitry, cause the apparatus at least

to conduct a transmission of a data block in an uplink direction under consideration of the configuration information for segmenting the data block into the first code block group and the at least one second code block group, wherein

the size of the first code block group is determined on the basis of the first modulation and coding scheme and the allocated resources,

at least the header information and the control information of the data block are included in the first code block group, and

the remaining data of the data block are distributed into the at least one second code block group by using a preset code block segmentation scheme, and

to transmit the first code block group and the at least one second code block group into which the data block is segmented by using the first and second modulation and coding schemes, respectively, at the resources being allocated.

38. The apparatus according to any of claims 31 to 36, wherein the at least one memory and the instructions are further configured to, with the at least one processing circuitry, cause the apparatus at least

to conduct a retransmission of data and a transmission of a new data block in an uplink direction under consideration of the configuration information for segmenting the data to be retransmitted and the new data into the first type of code block group and the second type of code block group, wherein

the size of the first type of code block group is determined on the basis of the first modulation and coding scheme and the allocated resources,

at least the data to be retransmitted are included in the first type of code block group, and

the data of the new data block are included into the second type of code block group by using a preset code block segmentation scheme, and

to transmit the first type of code block group and the second type of code block group into which the data to be retransmitted and the new data are segmented by using the first and second modulation and coding schemes, respectively, at the resources being allocated.

39. The apparatus according to claim 37, wherein the at least one memory and the instructions are further configured to, with the at least one processing circuitry, cause the apparatus at least

to execute segmentation of the data block when a total size of the data block to be transmitted is greater than a predetermined threshold, or

to execute segmentation of the data block irrespective of the total size of the data block to be transmitted.

40. The apparatus according to any of claims 29 to 39, wherein the at least one memory and the instructions are further configured to, with the at least one processing circuitry, cause the apparatus at least

to send, when receiving a transmission of a data block transmitted in a downlink direction and segmented into the first type of code block group and the second type of code block group, an acknowledgment signal or a negative acknowledgement signal for each of

the first type of code block group and the second type of code block group in accordance with a correct or incorrect reception of the data.

41. The apparatus according to any of claims 29 to 40, wherein

the communication element or function is connected to a communication network control element or function being part of a base station in the communication network, wherein the communication element is a terminal device or user equipment communicating in the communication network.

42. A method for use by a communication element or function, the method comprising

receiving and processing configuration information defining a transmission procedure of a data block in a communication network between at least two network elements or functions, wherein the transmission procedure of the data block involves

using a transmission format for the data block to be transmitted, wherein the format is based on dividing data to be transmitted into a first type of code block group and a second type of code block group,

using of a first modulation and coding scheme for transmission of the first type of code block group and a second modulation and coding scheme for transmission of the second type of code block group, and

using of resources allocated for transmission of the first type of code block group.

43. The method according to claim 42, wherein the first type of code block group comprises one first code block group including header information and control information of the data block to be transmitted and the second type of code block group comprises at least one second code block group including the remaining data of the data blocks to be transmitted.

44. The method according to claim 42, wherein the first type of code block group comprises at least one first code block group including data to be retransmitted from a previously transmitted data block, and the second code block group comprises at least one second code block group including data of the data block to be newly transmitted.

45. The method according to claim 43, wherein the first code block group is set to include, besides the header information and the control information of the data block to be transmitted, a part of the remaining data.

46. The method according to any of claims 42 to 45, wherein the first modulation and coding scheme to be used for transmission of the first type of code block group has a higher

robustness than the second modulation and coding scheme to be used for transmission of the second type of code block group.

47. The method according to any of claims 42 to 46, wherein the configuration information includes at least one of

an indication of at least one of the first modulation and coding scheme and the second modulation and coding scheme,

an indication, in case only one of the first modulation and coding scheme and the second modulation and coding scheme is included, an offset of the other modulation and coding scheme, and

an indication of the resources to be used for the transmission of the first code block group.

48. The method according to any of claims 42 to 47, wherein the configuration information is received from a communication network control element or function by at least one of a downlink control information signaling and a higher layer signaling, wherein the configuration information is received in one set by using one signaling path or in two or more sets by using one or more signaling paths.

49. The method according to any of claims 42 to 48, further comprising

receiving and processing a segmentation indication indicating that a segmentation of the data block into the first type of code block group and the second type of code block group is used in the transmission of the data block.

50. The method according to any of claims 43 and 45 to 49, further comprising

conducting a transmission of a data block in an uplink direction under consideration of the configuration information for segmenting the data block into the first code block group and the at least one second code block group, wherein

the size of the first code block group is determined on the basis of the first modulation and coding scheme and the allocated resources,

at least the header information and the control information of the data block are included in the first code block group, and

the remaining data of the data block are distributed into the at least one second code block group by using a preset code block segmentation scheme, and

transmitting the first code block group and the at least one second code block group into which the data block is segmented by using the first and second modulation and coding schemes, respectively, at the resources being allocated.

51. The method according to any of claims 44 to 49, further comprising

conducting a retransmission of data and a transmission of a new data block in an uplink direction under consideration of the configuration information for segmenting the data to be retransmitted and the new data into the first type of code block group and the second type of code block group, wherein

the size of the first type of code block group is determined on the basis of the first modulation and coding scheme and the allocated resources,

at least the data to be retransmitted are included in the first type of code block group, and

the data of the new data block are included into the second type of code block group by using a preset code block segmentation scheme, and

transmitting the first type of code block group and the second type of code block group into which the data to be retransmitted and the new data are segmented by using the first and second modulation and coding schemes, respectively, at the resources being allocated.

52. The method according to claim 50, further comprising

executing segmentation of the data block when a total size of the data block to be transmitted is greater than a predetermined threshold, or

executing segmentation of the data block irrespective of the total size of the data block to be transmitted.

53. The method according to any of claims 42 to 52, further comprising

sending, when receiving a transmission of a data block transmitted in a downlink direction and segmented into the first type of code block group and the second type of code block group, an acknowledgment signal or a negative acknowledgement signal for each of the first type of code block group and the second type of code block group in accordance with a correct or incorrect reception of the data.

54. The method according to any of claims 42 to 53, wherein

the communication element or function is connected to a communication network control element or function being part of a base station in the communication network, wherein the communication element is a terminal device or user equipment communicating in the communication network.

55. A computer program product for a computer, including software code portions for performing the steps of any of claims 15 to 28 or any of claims 42 to 54 when said product is run on the computer.

56. The computer program product according to claim 55, wherein

the computer program product includes a computer-readable medium on which said software code portions are stored, and/or

the computer program product is directly loadable into the internal memory of the computer and/or transmittable via a network by means of at least one of upload, download and push procedures.

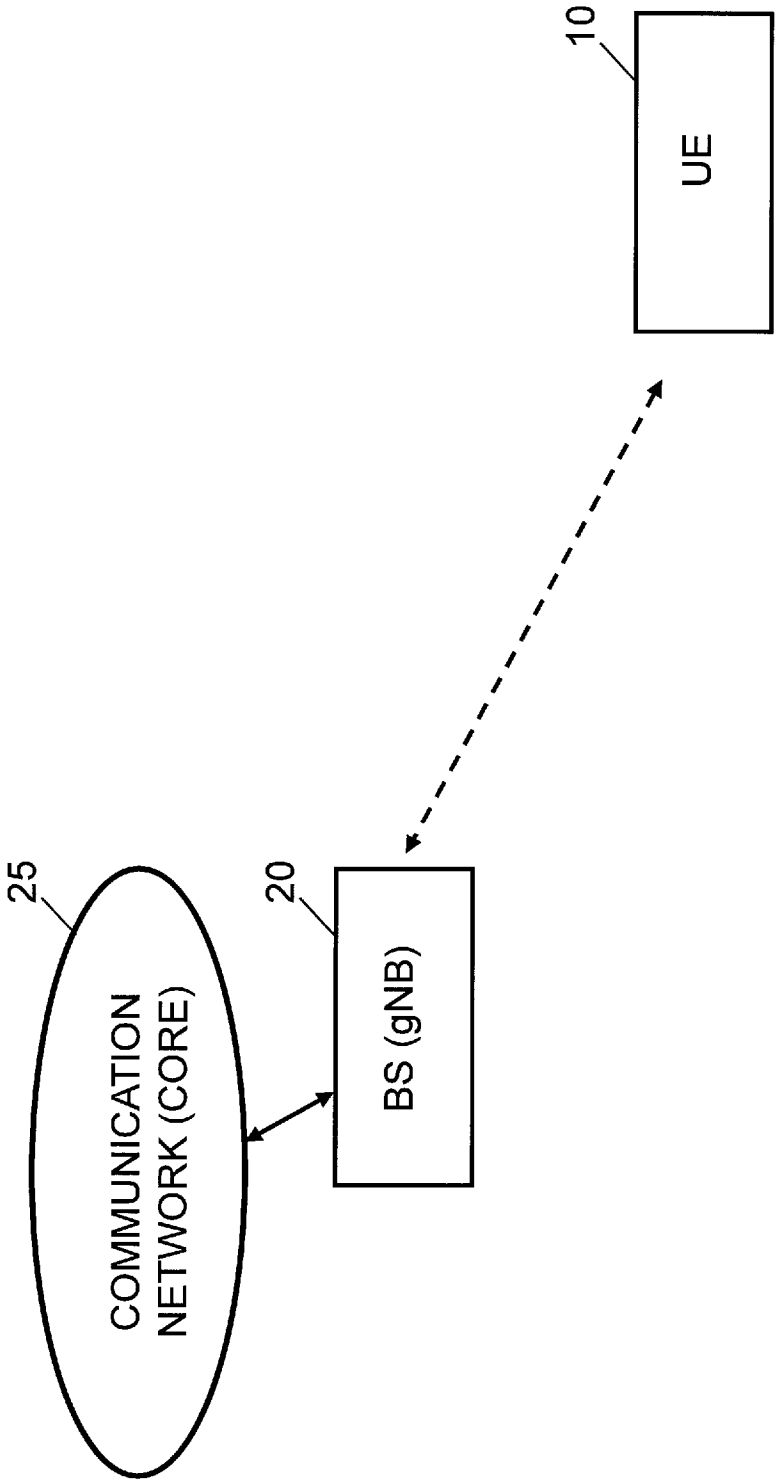

Fig. 1

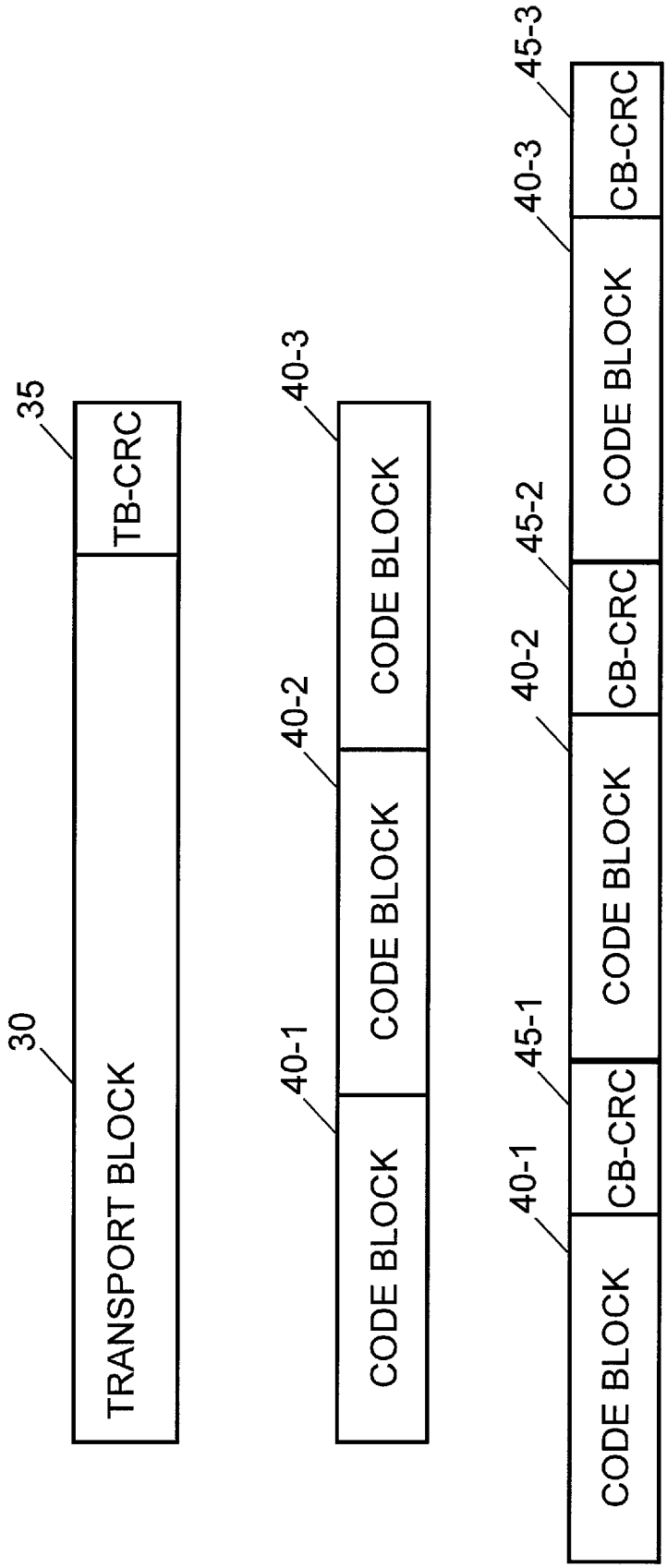
30
TRANSPORT BLOCK
35
TB-CRC
40-1
CODE BLOCK
40-2
CODE BLOCK
40-3
CODE BLOCK
40-1
CODE BLOCK
45-1
CB-CRC
40-2
CODE BLOCK
45-2
CB-CRC
40-3
CODE BLOCK
45-3
CB-CRC

Fig. 2

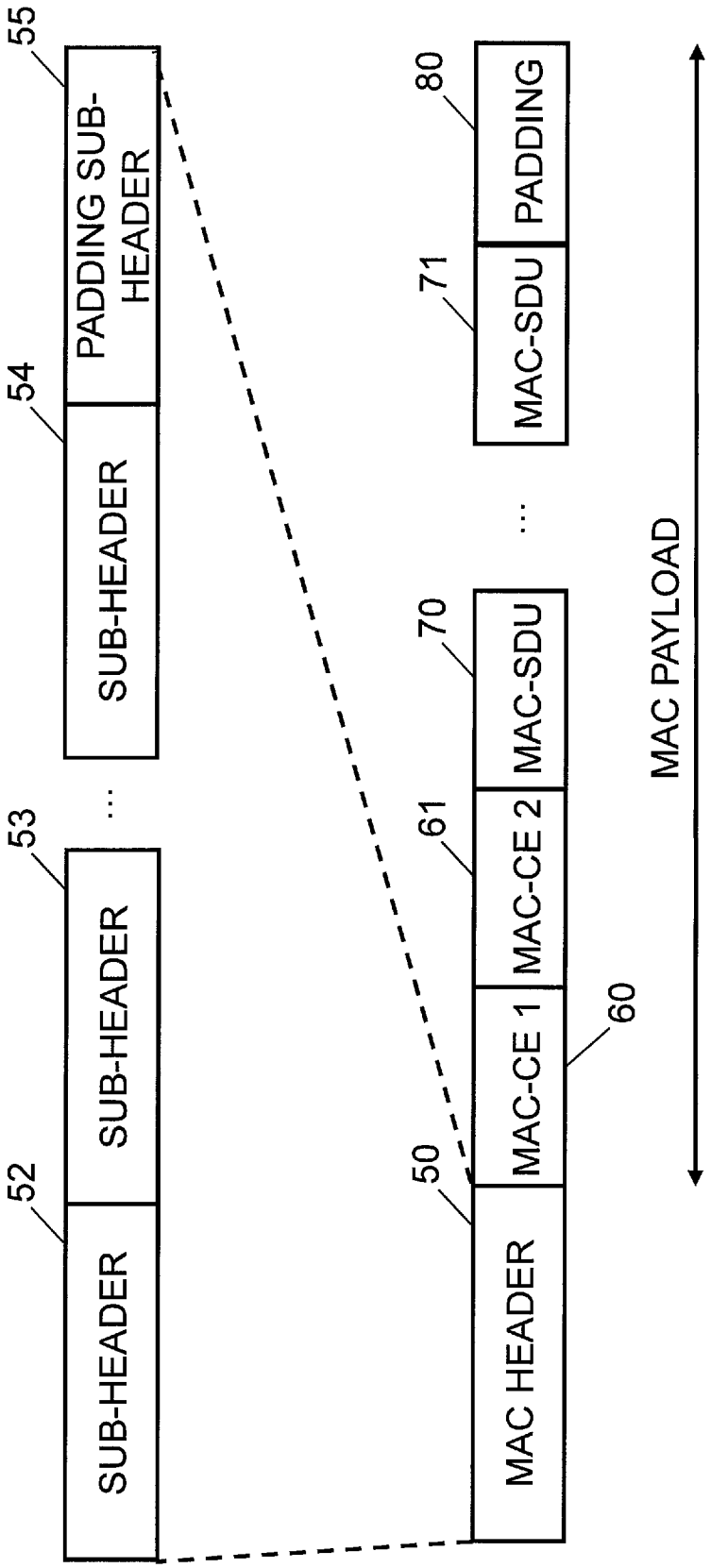
55
PADDING SUB-HEADER
54
SUB-HEADER
...
53
SUB-HEADER
52
SUB-HEADER
80
PADDING
71
MAC-SDU
...
70
MAC-SDU
61
MAC-CE 2
MAC-CE 1
60
MAC HEADER
50
MAC PAYLOAD

Fig. 3

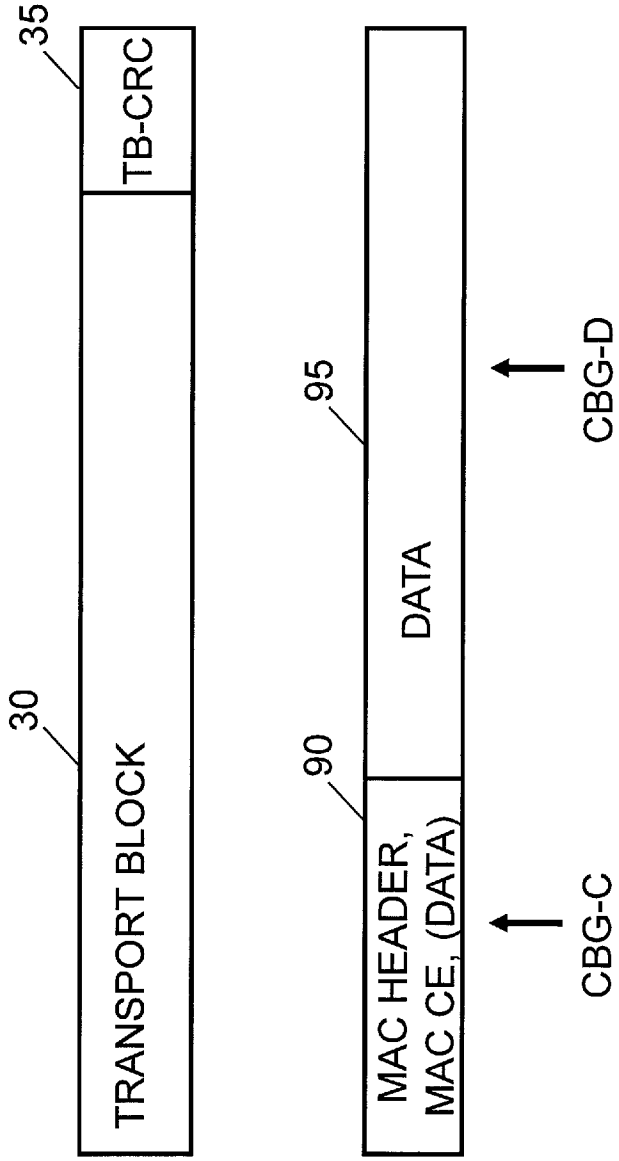
35
TB-CRC
30
TRANSPORT BLOCK
95
DATA
CBG-D
90
MAC HEADER,
MAC CE, (DATA)
CBG-C

Fig. 4

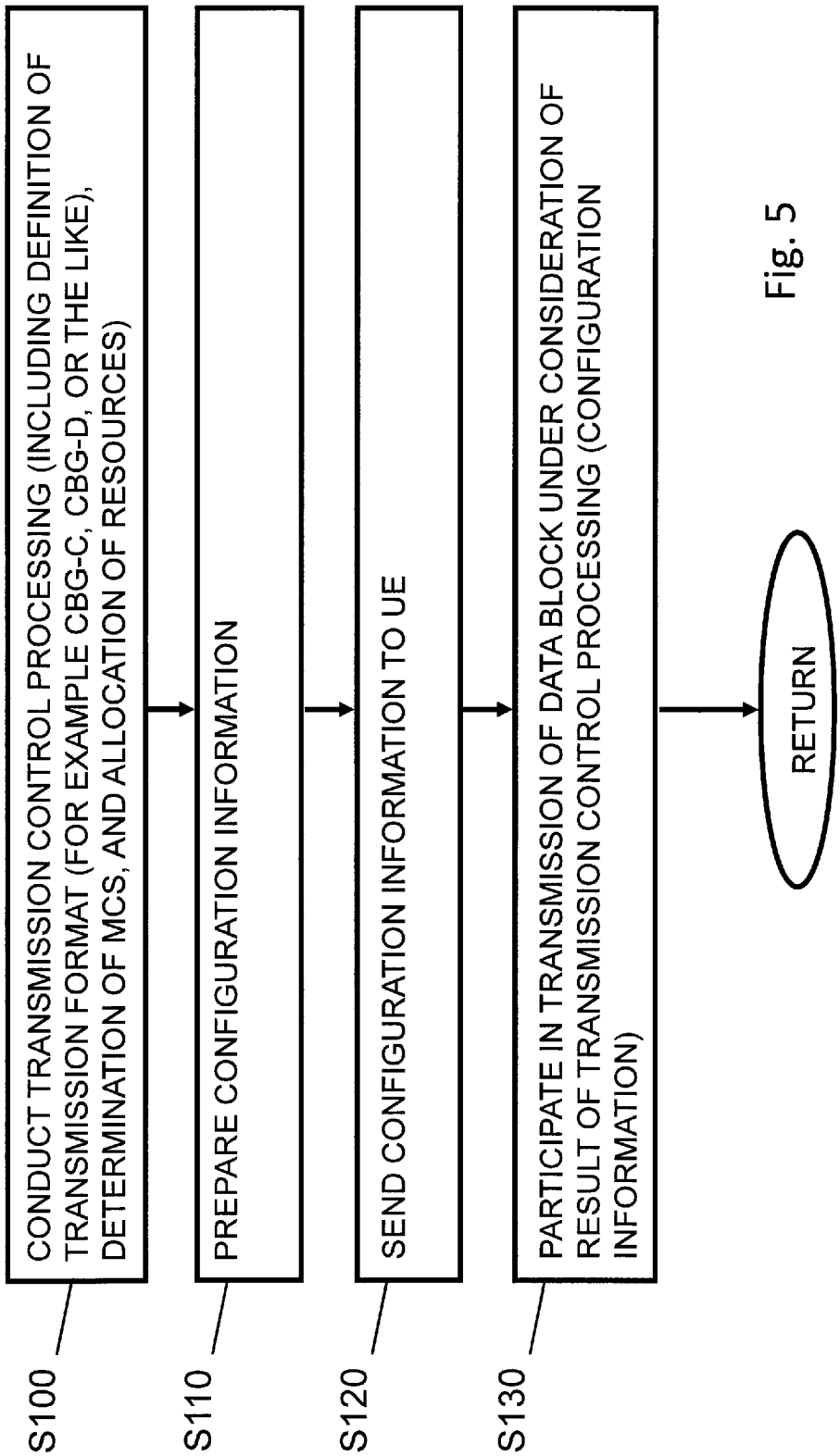
CONDUCT TRANSMISSION CONTROL PROCESSING (INCLUDING DEFINITION OF TRANSMISSION FORMAT (FOR EXAMPLE CBG-C, CBG-D, OR THE LIKE), DETERMINATION OF MCS, AND ALLOCATION OF RESOURCES)
PREPARE CONFIGURATION INFORMATION
SEND CONFIGURATION INFORMATION TO UE
PARTICIPATE IN TRANSMISSION OF DATA BLOCK UNDER CONSIDERATION OF RESULT OF TRANSMISSION CONTROL PROCESSING (CONFIGURATION INFORMATION)
RETURN
S100
S110
S120
S130

Fig. 5

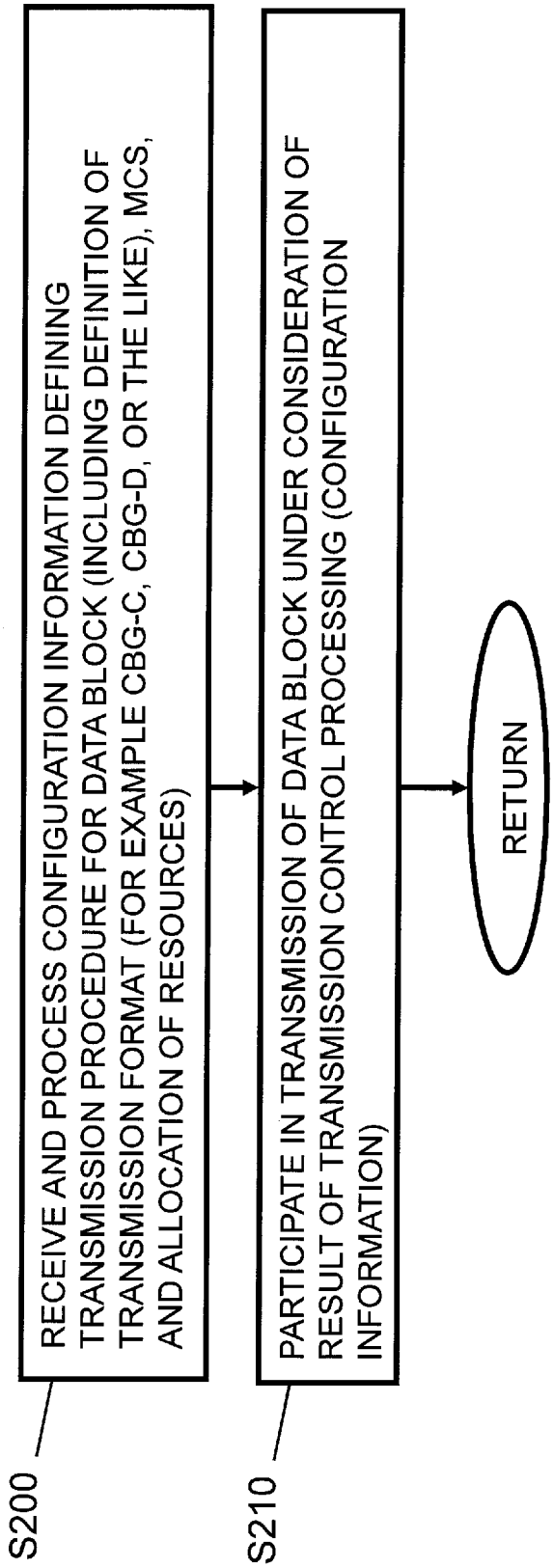
S200
RECEIVE AND PROCESS CONFIGURATION INFORMATION DEFINING TRANSMISSION PROCEDURE FOR DATA BLOCK (INCLUDING DEFINITION OF TRANSMISSION FORMAT (FOR EXAMPLE CBG-C, CBG-D, OR THE LIKE), MCS, AND ALLOCATION OF RESOURCES)
S210
PARTICIPATE IN TRANSMISSION OF DATA BLOCK UNDER CONSIDERATION OF RESULT OF TRANSMISSION CONTROL PROCESSING (CONFIGURATION INFORMATION)
RETURN

Fig. 6

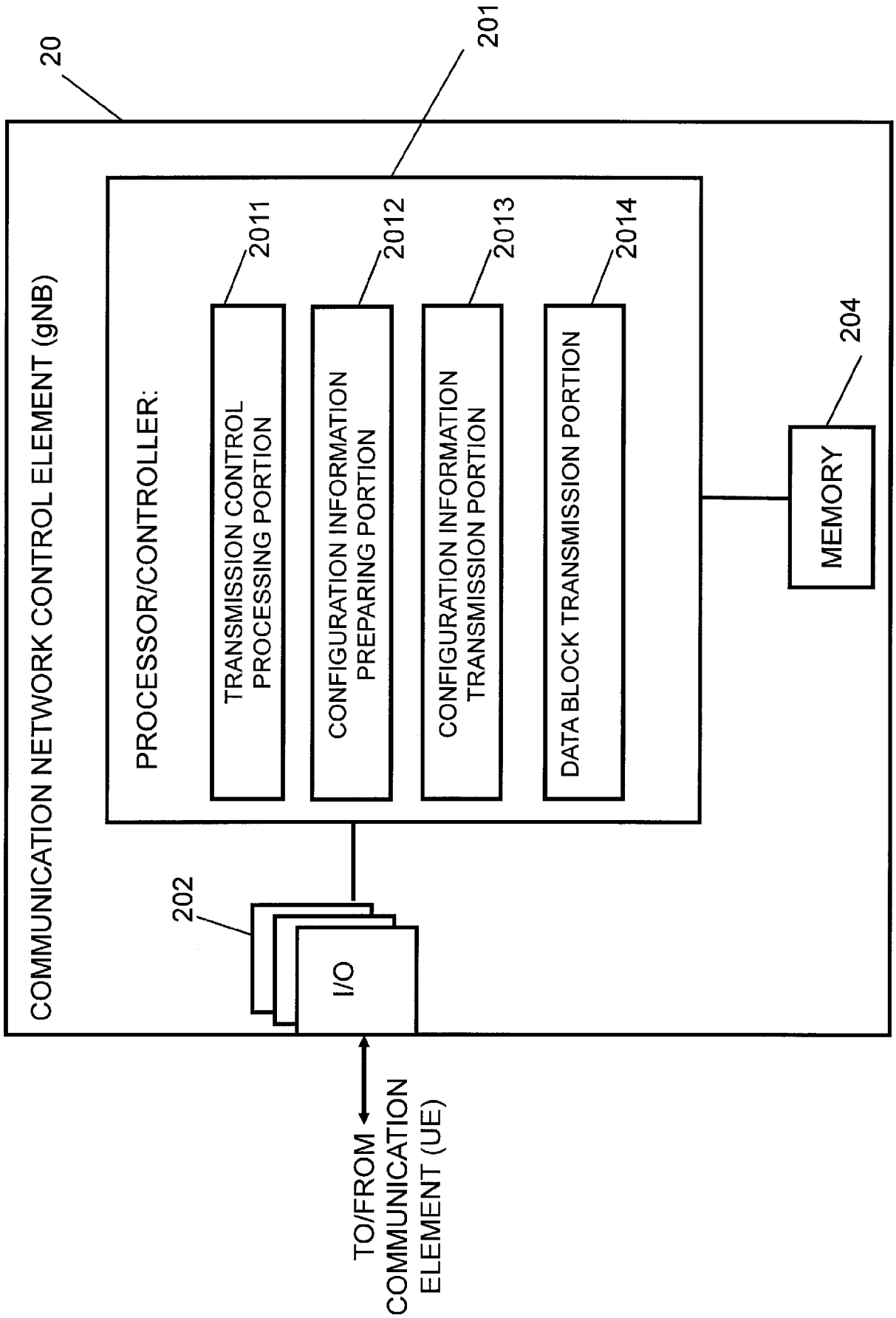
20
201
COMMUNICATION NETWORK CONTROL ELEMENT (gNB)
PROCESSOR/CONTROLLER:
2011
TRANSMISSION CONTROL PROCESSING PORTION
2012
CONFIGURATION INFORMATION PREPARING PORTION
2013
CONFIGURATION INFORMATION TRANSMISSION PORTION
2014
DATA BLOCK TRANSMISSION PORTION
204
MEMORY
202
I/O
TO/FROM COMMUNICATION ELEMENT (UE)

Fig. 7

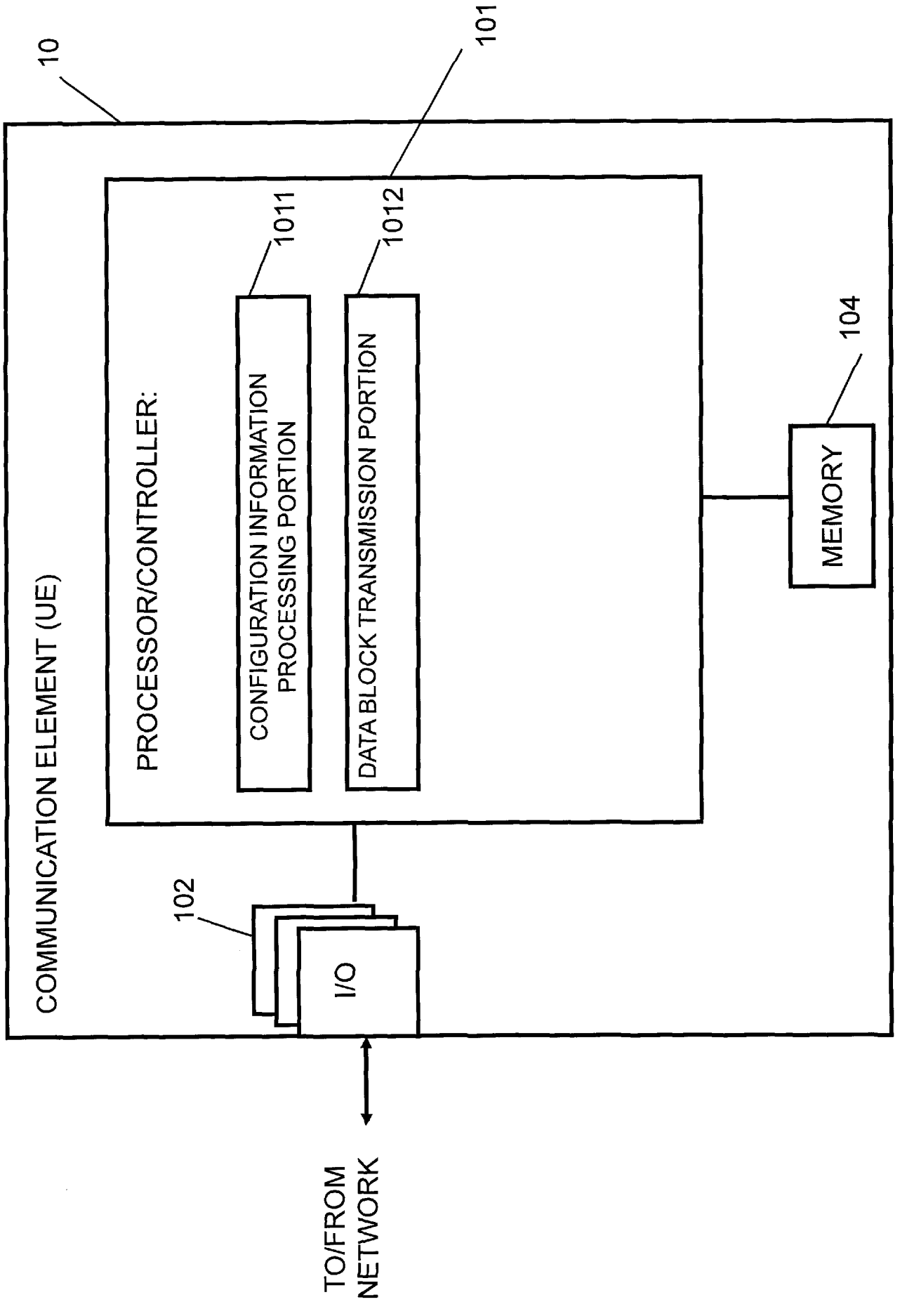
10
101
COMMUNICATION ELEMENT (UE)
PROCESSOR/CONTROLLER:
1011
CONFIGURATION INFORMATION PROCESSING PORTION
1012
DATA BLOCK TRANSMISSION PORTION
104
MEMORY
102
I/O
TO/FROM NETWORK

Fig. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/083947

A. CLASSIFICATION OF SUBJECT MATTER

H04L 27/26(2006.01)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)

H04L; H04W; H04B; H04Q

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)

WPI, EPODOC, CNPAT, 3GPP: MCS, modulation coding scheme, first, second, control, traffic, data, robust, high, low

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 106254085 A (TELEFONAKTIEBOLAGET L M ERICSSON PUBL) 21 December 2016 (2016-12-21) claim 1	1-56
A	WO 2016057431 A1 (MEDIATEK INC.) 14 April 2016 (2016-04-14) the whole document	1-56
A	CN 105142227 A (DATANG MOBILE COMM. EQUIP. CO., LTD.) 09 December 2015 (2015-12-09) the whole document	1-56
A	WO 2016032959 A1 (QUALCOMM INCORPORATED) 03 March 2016 (2016-03-03) the whole document	1-56
A	CN 106550467 A (SHANGHAI HUAWEI TECH. CO., LTD.) 29 March 2017 (2017-03-29) the whole document	1-56
A	US 2016323046 A1 (REDLINE COMMUNICATIONS INC.) 03 November 2016 (2016-11-03) the whole document	1-56

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 January 2018	**31 January 2018**

Name and mailing address of the ISA/CN	Authorized officer
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Facsimile No. **(86-10)62019451**	Telephone No. **(86-10)62413423**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2017/083947

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	106254085	A	21 December 2016	CN	102484774	A	30 May 2012
				JP	2014222932	A	27 November 2014
				US	2012163286	A1	28 June 2012
				EP	2471283	A1	04 July 2012
				US	2016226796	A1	04 August 2016
				JP	2013503529	A	31 January 2013
				JP	2016158299	A	01 September 2016
				WO	2011023254	A1	03 March 2011
				RU	2012111281	A	10 October 2013
WO	2016057431	A1	14 April 2016	EP	3192183	A1	19 July 2017
CN	105142227	A	09 December 2015	WO	2016150308	A1	29 September 2016
WO	2016032959	A1	03 March 2016	JP	2017529773	A	05 October 2017
				AU	2015306825	A1	16 February 2017
				KR	20170051421	A	11 May 2017
				PE	06482017	A1	17 May 2017
				US	2016065327	A1	03 March 2016
				CU	20170020	A7	04 July 2017
				CN	106797275	A	31 May 2017
				EP	3186911	A1	05 July 2017
CN	106550467	A	29 March 2017	None			
US	2016323046	A1	03 November 2016	US	2017026138	A1	26 January 2017
				US	2013329774	A1	12 December 2013
				US	2015349898	A1	03 December 2015