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(54) **Title:** CLIENT DEVICE, NETWORK ACCESS NODE AND METHODS FOR EFFICIENT UPLINK TRANSMISSION

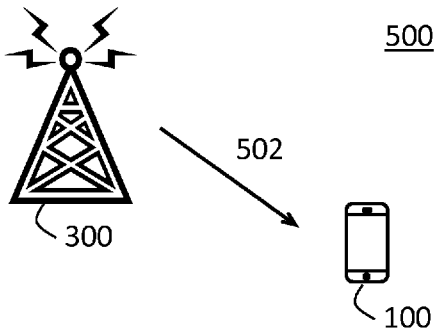


Fig. 5

(57) **Abstract:** The invention relates to efficient uplink transmission from a client device (100) using configured grant transmissions. The client device (100) is configured by a network access node (300) to transmit a total number of repetitions K of a data packet in at least two configured grant periods. The client device (100) transmit a first number of repetitions N of a first data packet in a first configured grant period (P1) to the network access node (300), wherein N<K. The client device (100) further determines how many of the remaining number of repetitions of the first data packet to transmit in a second configured grant period (P2) and transmits the determined number of repetitions of the first data packet in the second configured grant period (P2) to the network access node (300). Furthermore, the invention also relates to the network access node (300), corresponding methods and a computer program.

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CLIENT DEVICE, NETWORK ACCESS NODE AND METHODS FOR EFFICIENT UPLINK TRANSMISSION

Technical Field

The invention relates to a client device and a network access node for efficient uplink transmission using configured grant transmissions. Furthermore, the invention also relates to corresponding methods and a computer program.

Background

3GPP new radio (NR) technology is being designed to support ultra-reliable and low latency communications (URLLC) services. URLLC services have very stringent quality of service (QoS) requirements on user plane latency and reliability. One way to minimize the uplink transmission latency in NR is to configure a client device to use configured grant transmissions. In NR, there are two types of configured grant transmissions:

- Type 1 where an uplink grant is provided by radio resource control (RRC) and stored as a configured uplink grant;
- Type 2 where an uplink grant is provided by physical downlink control channel (PDCCH) and stored or cleared as a configured uplink grant based on L1 signaling activation or deactivation of the configured uplink grant.

Type 1 and type 2 are configured by RRC per serving cell and per bandwidth part. Multiple configurations can be active simultaneously but only one per serving cell. For type 2, activation and deactivation are performed per serving cell. For each serving sell, the medium access control (MAC) entity is configured with either type 1 or type 2.

For type 1 physical uplink shared channel (PUSCH) transmissions with a configured uplink grant, the transmission parameters are provided in RRC information element (IE) ConfiguredGrantConfig. For type 2 PUSCH transmissions with a configured uplink grant, the transmission parameters are provided in the higher layer configuration and uplink grant received on the downlink control information (DCI).

As part of configured grant configuration, the client device is configured by the network access node with a set of time-frequency resources to be used for configured grant transmissions in the uplink. Each configured grant configuration also specifies a configured grant periodicity for the time-frequency resources to be used for the configured grant transmissions. There can be multiple time-frequency resources available within one configured grant period. Each of the time-frequency resource allocation associated with configured grant transmission within one

configured grant period is called a transmission occasion. All the transmission occasions within a configured grant period and across different configured grant periods are identical in terms of the location of the time-frequency resources.

The higher layer configured parameters repK and repK-RV define the number of repetitions K to be applied to the transmitted transport block and the redundancy version (RV) pattern to be applied to the repetitions associated with a configured grant transmission, respectively. The parameter repK can take values from the set {1, 2, 4 ,8}. The n^{th} transmission occasion among the number of repetitions K, n=1, 2, …, K, is associated with the $(mod(n-1,4)+1)^{th}$ value in the configured RV sequence. The initial transmission of a transport block may start at

- the first transmission occasion of the number of repetitions K if the configured RV sequence is {0,2,3,1},
- any of the transmission occasions of the number of repetitions K that are associated with RV=0 if the configured RV sequence is {0,3,0,3},
- any of the transmission occasions of the number of repetitions K if the configured RV sequence is {0,0,0,0}, except the last transmission occasion when K=8.

For any RV sequence, the repetitions shall be terminated after transmitting the number of repetitions K, or at the last transmission occasion among the number of repetitions K within a configured grant period, or when an uplink grant for scheduling the same transport block is received within the configured grant period, whichever is reached first. The client device is not expected to be configured with a time duration for the transmission of the number of repetitions K larger than the time duration for the configured grant period.

For both type 1 and type 2 PUSCH transmissions with a configured grant, when the client device is configured with repK > 1, the client device shall repeat the transport block across the repK consecutive slots and apply the same symbol allocation in each slot. If the client device procedure for determining slot configuration, as defined in subclause 11.1 of TS 38.213, determines symbols of a slot allocated for PUSCH as downlink symbols, the transmission on that slot is omitted for the PUSCH transmission.

The following periodicities are supported for uplink transmission without uplink grant for type 1 and type 2, depending on the configured subcarrier spacing ([symbols):
15kHz: 2, 7, n*14, where n={1, 2, 4, 5, 8, 10, 16, 20, 32, 40, 64, 80, 128, 160, 320, 640}
30kHz: 2, 7, n*14, where n={1, 2, 4, 5, 8, 10, 16, 20, 32, 40, 64, 80, 128, 160, 256, 320, 640, 1280}

60kHz with normal cyclic prefix (CP): 2, 7, n*14, where n={1, 2, 4, 5, 8, 10, 16, 20, 32, 40, 64, 80, 128, 160, 256, 320, 512, 640, 1280, 2560}

60kHz with enhanced cyclic prefix (ECP): 2, 6, n*12, where n={1, 2, 4, 5, 8, 10, 16, 20, 32, 40, 64, 80, 128, 160, 256, 320, 512, 640, 1280, 2560}

120kHz: 2, 7, n*14, where n={1, 2, 4, 5, 8, 10, 16, 20, 32, 40, 64, 80, 128, 160, 256, 320, 512, 640, 1024, 1280, 2560, 5120}

Summary

An objective of embodiments of the invention is to provide a solution which mitigates or solves the drawbacks and problems of conventional solutions.

The above and further objectives are solved by the subject matter of the independent claims. Further advantageous embodiments of the invention can be found in the dependent claims.

According to a first aspect of the invention, the above mentioned and other objectives are achieved with a client device for a wireless communication system, the client device being configured to

receive a first control message from a network access node, wherein the first control message instructs the client device to transmit a total number of repetitions K of a data packet in at least two configured grant periods;

transmit a first number of repetitions N of a first data packet in a first configured grant period to the network access node, wherein $N<K$;

obtain a second number of repetitions M of the first data packet for transmission in a second configured grant period consecutive to the first configured grant period, wherein $0 \leq M \leq K-N$;

initiate transmission of the second number of repetitions M of the first data packet in the second configured grant period to the network access node.

In this disclosure, the total number of repetitions K can correspond to the maximum number of repetitions the client device can apply to a data packet across one or more configured grant periods. Each configured grant period can comprise one or more transmission occasions in which the client device has the opportunity to transmit a data packet. Thus, when a data packet has arrived for transmission, if there is a sufficient number of transmission occasions available to transmit the total number of repetitions K of the data packet across one or more configured grant periods, the client device can transmit the total number of repetitions K of the data packet across the one or more configured grant periods. However, in certain cases, the client device can due to different factors only transmit a number of repetitions of the data packet which is

smaller than the total number of repetitions K. The data packet can be associated with a transport block, e.g. can correspond to a transport block. After transmitting the first number of repetitions N in the first configured grant period, there are a maximum of K-N number of repetitions still remaining/pending from the client device.

That the client device initiates transmission of the second number of repetitions M of the first data packet can in this disclosure be understood to mean that the client device waits for the start of the second configured grant period and starts transmitting the second number of repetitions M of the first data packet in the available transmission occasions of the second configured grant period.

That the second configured grant period is consecutive to the first configured grant period can mean that the second configured grant period comes after the first configured grant period in time, either with or without a time gap between the first and the second configured grant periods.

An advantage of the client device according to the first aspect is that the client device can efficiently utilize the resources for configured grant transmissions and achieve a better trade-off in terms of improving the reliability of the first data packet in the second configured grant period and meeting the latency requirements of the first data packet.

In an implementation form of a client device according to the first aspect, the second configured grant period is adjacent to the first configured grant period.

That the second configured grant period is adjacent to the first configured grant period can mean that there is no time gap between the first and second configured grant periods, i.e. the second configured grant period starts directly after the first configured grant period.

An advantage with this implementation form is that the client device can transmit the second number of repetitions M of the first data packet in the second configured grant period directly after the first configured grant period, thereby achieving a better reliability and latency trade-off of the first data packet.

In an implementation form of a client device according to the first aspect, obtain the second number of repetitions M comprises

determine the second number of repetitions M based on at least one of: obtaining of a second data packet for transmission in the second configured grant period, an overlap in time

between a downlink symbol and at least one uplink configured grant transmission occasion in a configured grant period, and reception of an uplink grant associated with the first data packet from the network access node.

A second data packet for transmission in the second configured grant period can mean that the MAC layer has a received a new data packet for transmission either before or during the first data packet is being transmitted in the first configured grant period. If a second data packet has arrived for transmission, then the client device has data of the first data packet (the remaining number of repetitions K-N) and data of the second data packet to be transmitted in the second configured grant period. Hence, the client device can obtain the second number of repetitions M based on if there is a second data packet to be transmitted in the second configured grant period.

An overlap in time between a downlink symbol and at least one uplink configured grant transmission occasion in a configured grant period can mean that certain resources allocated for configured grant transmissions may belong to downlink symbols in a certain 14 symbol slot. The client device cannot perform uplink transmissions during these transmission occasions. Hence, the client device determines the second number of repetitions M based on if any of the transmission occasions in the second or a third configured grant period overlap with downlink symbols.

During the transmission of the first number of repetitions N, the client device may receive an uplink grant associated with the first data packet. An uplink grant associated with the first data packet can mean that the content of the uplink grant allows the client device to obtain information about the time-frequency resources and the transmission parameters such as the modulation and coding scheme to be used for the transmission of the first data packet. The uplink grant associated with the first data packet is transmitted by the network access node using the DCI. In this case, it is advantageous to retransmit the first data packet using the received uplink grant. Hence, the second number of repetitions M of the first data packet can also depend on whether an uplink grant associated with the first data packet is received from the network access node.

An advantage with this implementation form is that the client device can efficiently determine the second number of repetitions M of the first data packet.

In an implementation form of a client device according to the first aspect, obtain the second number of repetitions M comprises

obtain the second number of repetitions M based on a predefined value.

The predefined value can be defined in a standard specification using a set of rules or received in a second control message from the network access node.

An advantage with this implementation form is that the implementation of the client device can be simplified.

In an implementation form of a client device according to the first aspect, the client device is further configured to

finish the initiated transmission of the second number of repetitions M in the second configured grant period upon obtaining a second data packet for transmission;

start the initial transmission of the second data packet in the second configured grant period after finishing the transmission of the second number of repetitions M.

An advantage with this implementation form is that priority is given to improve the reliability of the first data packet over meeting the latency requirement of the second data packet.

In an implementation form of a client device according to the first aspect, the client device is further configured to

cancel the initiated transmission of the second number of repetitions M in the second configured grant period upon obtaining a second data packet for transmission;

start the initial transmission of the second data packet in the second configured grant period after cancelling the initiated transmission of the second number of repetitions M.

An advantage with this implementation form is that priority is given to meet the latency requirements of the second data packet over improving the reliability of the first data packet.

In an implementation form of a client device according to the first aspect, the client device is further configured to

cancel the initiated transmission of the second number of repetitions M in the second configured grant period upon obtaining an uplink grant associated with the first data packet;

transmit the first data packet according to the uplink grant.

An advantage with this implementation form is that by cancelling the second number of repetitions M in the second configured grant period and transmitting the first data packet according the uplink grant, reliability of the first data packet can be improved.

In an implementation form of a client device according to the first aspect, the client device is further configured to

cancel the initiated transmission of the second number of repetitions M upon expiry of a timer T, wherein the timer T starts with the initiation of the transmission of the first number of repetitions N.

This implementation form also implies that at the start of the initial transmission of the first data packet in the first configured grant period, a timer T is started at the client device. The first number of repetitions N plus the second number of repetitions M should be finished before the expiry of the timer T.

The value of the timer T can be specified in terms of number of transmission occasions or number of configured grant periods associated with the configured grant transmissions. Furthermore, the value of the timer T may be predefined e.g. in a standard specification such as the 3GPP NR specification.

An advantage with this implementation form is that a time limit to finish transmitting the first number of repetitions N plus the second number of repetitions M of the first data packet can be set, thereby meeting the latency requirements of the first data packet.

In an implementation form of a client device according to the first aspect, the client device is further configured to

transmit the first number of repetitions N according to a transmission parameter with a first value;

transmit the second number of repetitions M according to the transmission parameter with a second value.

An advantage with this implementation form is that the client device can facilitate the network access node to determine if the data received in a transmission occasion belongs to the remaining repetitions of the first data packet or the first number of repetitions of the second data packet.

In an implementation form of a client device according to the first aspect, the transmission parameter is at least one of a demodulation reference signal, DMRS, sequence, a scrambling sequence, and a configured scheduling - radio network temporary identifier, CS-RNTI, used for cyclic redundancy check, CRC, scrambling.

An advantage with this implementation form is that the client device does not need additional time-frequency resources to convey if the transmissions belong to the first number of repetitions N or the second number of repetitions M.

According to a second aspect of the invention, the above mentioned and other objectives are achieved with a network access node for a wireless communication system, the network access node being configured to

transmit a first control message to a client device, wherein the first control message instructs the client device to transmit a total number of repetitions K of a data packet in at least two configured grant periods;

receive a first number of repetitions N of a first data packet in a first configured grant period from the client device, wherein $N<K$;

obtain a second number of repetitions M of the first data packet for reception in a second configured grant period consecutive to the first configured grant period, wherein $0<M\leq K-N$;

receive at least one of the second number of repetitions M of the first data packet in the second configured grant period from the client device;

decode the first data packet based on the received first number of repetitions N and the at least one of the second number of repetitions M of the first data packet.

An advantage of the network access node according to the second aspect is that the probability of successfully decoding the first data packet is improved. Thereby, the reliability of the reception of the first data packet is improved.

In an implementation form of a network access node according to the second aspect, the second configured grant period is adjacent to the first configured grant period.

An advantage with this implementation form is that the latency associated with the first data packet can be minimized.

In an implementation form of a network access node according to the second aspect, the network access node is further configured to

transmit a second control message to the client device, wherein the second control message indicates the second number of repetitions M.

An advantage with this implementation form is that the network access node has control over the second number of repetitions M it can receive in the second configured grant period.

In an implementation form of a network access node according to the second aspect, the network access node is further configured to

receive an initial transmission of a second data packet in the second configured grant period after in time receiving the second number M of repetitions of the first data packet in the second configured grant period.

An advantage with this implementation form is that higher priority is given to the second number of repetitions of the first data packet over the initial transmission of the second data packet. Hence, latency requirement of the first data packet can be met.

In an implementation form of a network access node according to the second aspect, the network access node is further configured to

transmit an uplink grant associated with the first data packet upon unsuccessful decoding of the first data packet based on the received first number of repetitions N and at least one of the second number of repetitions M of the first data packet;

receive the first data packet according to the uplink grant.

An advantage with this implementation form is that the client device can retransmit the first data packet based on the uplink grant and the first data packet can be decoded successfully at the network access node.

According to a third aspect of the invention, the above mentioned and other objectives are achieved with a method for a client device, the method comprises

receiving a first control message from a network access node, wherein the first control message instructs the client device to transmit a total number of repetitions K of a data packet in at least two configured grant periods;

transmitting a first number of repetitions N of a first data packet in a first configured grant period to the network access node, wherein $N<K$;

obtaining a second number of repetitions M of the first data packet for transmission in a second configured grant period consecutive to the first configured grant period, wherein $0 \leq M \leq K-N$;

initiating transmission of the second number of repetitions M of the first data packet in the second configured grant period to the network access node.

The method according to the third aspect can be extended into implementation forms corresponding to the implementation forms of the client device according to the first aspect.

Hence, an implementation form of the method comprises the feature(s) of the corresponding implementation form of the client device.

The advantages of the methods according to the third aspect are the same as those for the corresponding implementation forms of the client device according to the first aspect.

According to a fourth aspect of the invention, the above mentioned and other objectives are achieved with a method for a network access node, the method comprises

transmitting a first control message to a client device, wherein the first control message instructs the client device to transmit a total number of repetitions K of a data packet in at least two configured grant periods;

receiving a first number of repetitions N of a first data packet in a first configured grant period from the client device, wherein $N<K$;

obtaining a second number of repetitions M of the first data packet for reception in a second configured grant period consecutive to the first configured grant period, wherein $0<M\leq K-N$;

receiving at least one of the second number of repetitions M of the first data packet in the second configured grant period from the client device;

decoding the first data packet based on the received first number of repetitions N and the at least one of the second number of repetitions M of the first data packet.

The method according to the fourth aspect can be extended into implementation forms corresponding to the implementation forms of the network access node according to the second aspect. Hence, an implementation form of the method comprises the feature(s) of the corresponding implementation form of the network access node.

The advantages of the methods according to the fourth aspect are the same as those for the corresponding implementation forms of the network access node according to the second aspect.

The invention also relates to a computer program, characterized in program code, which when run by at least one processor causes said at least one processor to execute any method according to embodiments of the invention. Further, the invention also relates to a computer program product comprising a computer readable medium and said mentioned computer program, wherein said computer program is included in the computer readable medium, and comprises of one or more from the group: ROM (Read-Only Memory), PROM (Programmable

ROM), EPROM (Erasable PROM), Flash memory, EEPROM (Electrically EPROM) and hard disk drive.

Further applications and advantages of the embodiments of the invention will be apparent from the following detailed description.

Brief Description of the Drawings

The appended drawings are intended to clarify and explain different embodiments of the invention, in which:

- Fig. 1 shows a client device according to an embodiment of the invention;
- Fig. 2 shows a method for a client device according to an embodiment of the invention;
- Fig. 3 shows a network access node according to an embodiment of the invention;
- Fig. 4 shows a method for a network access node according to an embodiment of the invention;
- Fig. 5 shows a wireless communication system according to an embodiment of the invention;
- Fig. 6 shows a method for a client device according to an embodiment of the invention;
- Fig. 7 shows a method for a network access node according to an embodiment of the invention;
- Fig. 8 shows an embodiment where the client device finishes the transmission of a first data packet upon obtaining a second data packet for transmission;
- Fig. 9 shows an embodiment where the client device cancels the transmission of a first data packet upon obtaining a second data packet for transmission;
- Fig. 10 shows a further embodiment where the client device cancels the transmission of a first data packet upon obtaining a second data packet for transmission;
- Fig. 11 shows an embodiment where the client device determines whether to cancel the transmission of a first data packet based on an overlap;
- Fig. 12 shows an embodiment where the client device cancels the transmission of a first data packet upon obtaining an uplink grant associated with the first data packet.

Detailed Description

In an example, the network access node configures the client device using a configured grant configuration to transmit a total number of repetitions K of a data packet in a configuration grant period. The total number of repetitions K corresponds to the maximum number of repetitions the client device can perform of a data packet in one configured grant period. If a data packet arrives at the beginning of a configured grant period and if the available number of transmission occasions in the configured grant period is larger than K, the client device can

perform the total number of repetitions K of the data packet in the configured grant period. However, if the data packet arrives towards the end of a configured grant period, the number of available transmission occasions may be smaller than K and the client device cannot perform the total number of repetitions K of the data packet in the configured grant period. For example, assume that the client device is configured with 6 symbol allocation and the parameter repK = 3 and the periodicity is 5*14 symbols (five 14 symbol slots). Furthermore, within one configured grant period, the client device has three transmission occasions available for configured grant transmissions. In this case, if data arrives during the second 14 symbol slot in a first configured grant period, the client device is only able to perform one configured grant transmission during the last transmission occasion of the first configured grant period, as shown e.g. in Fig. 8 (note that Fig. 8 also illustrates other embodiments of the invention). Hence, the remaining two configured grant transmissions are not performed during the first configured grant period and the reliability of the data may not meet the specified requirements.

Hence, depending on the configured grant configuration and when the data packet arrives, the client device may not have time to transmit the configured total number of repetitions K in one configured grant period. This may lead to decreased reliability.

In a further example, it may therefore be proposed to increase the reliability by allowing the client device to cross the configured grant periodicity boundary and finish any remaining repetitions of a data packet in the next configured grant period. With the proposed solution, the reliability can be increased but it may take additional time to finish transmitting and receiving data associated with a data packet. This may in some cases impact the data transmission of newly arrived data packets.

Consequently, there is a need for a mechanism to support repetitions of configured grant transmissions across periodicity boundary without affecting transmission of newly arrived data packets.

Fig. 1 shows a client device 100 according to an embodiment of the invention. In the embodiment shown in Fig. 1, the client device 100 comprises a processor 102, a transceiver 104 and a memory 106. The processor 102 is coupled to the transceiver 104 and the memory 106 by communication means 108 known in the art. The client device 100 further comprises an antenna or antenna array 110 coupled to the transceiver 104, which means that the client device 100 is configured for wireless communications in a wireless communication system.

That the client device 100 is configured to perform certain actions can in this disclosure be understood to mean that the client device 100 comprises suitable means, such as e.g. the processor 102 and the transceiver 104, configured to perform said actions.

According to embodiments of the invention the client device 100 is configured to receive a first control message 502 from a network access node 300. The first control message 502 instructs the client device 100 to transmit a total number of repetitions K of a data packet in at least two configured grant periods. The client device 100 is further configured to transmit a first number of repetitions N of a first data packet in a first configured grant period to the network access node 300, where $N<K$. The client device 100 is further configured to obtain a second number of repetitions M of the first data packet for transmission in a second configured grant period consecutive to the first configured grant period, where $0\leq M\leq K-N$. Furthermore, the client device 100 is configured to initiate transmission of the second number of repetitions M of the first data packet in the second configured grant period to the network access node 300.

Fig. 2 shows a flow chart of a corresponding method 200 which may be executed in a client device 100, such as the one shown in Fig. 1. The method 200 comprises receiving 202 a first control message 502 from a network access node 300. The first control message 502 instructs the client device 100 to transmit a total number of repetitions K of a data packet in at least two configured grant periods. The method 200 further comprises transmitting 204 a first number of repetitions N of a first data packet in a first configured grant period to the network access node 300, where $N<K$. The method 200 further comprises obtaining 206 a second number of repetitions M of the first data packet for transmission in a second configured grant period consecutive to the first configured grant period, where $0\leq M\leq K-N$. Furthermore, the method 200 comprises initiating 208 transmission of the second number of repetitions M of the first data packet in the second configured grant period to the network access node 300.

Fig. 3 shows a network access node 300 according to an embodiment of the invention. In the embodiment shown in Fig. 3, the network access node 300 comprises a processor 302, a transceiver 304 and a memory 306. The processor 302 is coupled to the transceiver 304 and the memory 306 by communication means 308 known in the art. The network access node 300 may be configured for both wireless and wired communications in wireless and wired communication systems, respectively. The wireless communication capability is provided with an antenna or antenna array 310 coupled to the transceiver 304, while the wired communication capability is provided with a wired communication interface 312 coupled to the transceiver 304.

That the network access node 300 is configured to perform certain actions can in this disclosure be understood to mean that the network access node 300 comprises suitable means, such as e.g. the processor 302 and the transceiver 304, configured to perform said actions.

According to embodiments of the invention the network access node 300 is configured to transmit a first control message 502 to a client device 100. The first control message 502 instructs the client device 100 to transmit a total number of repetitions K of a data packet in at least two configured grant periods. The network access node 300 is further configured to receive a first number of repetitions N of a first data packet in a first configured grant period from the client device 100, where $N<K$. The network access node 300 is further configured to obtain a second number of repetitions M of the first data packet for reception in a second configured grant period consecutive to the first configured grant period, where $0<M\leq K-N$. The network access node 300 is further configured to receive at least one of the second number of repetitions M of the first data packet in the second configured grant period from the client device 100. Furthermore, the network access node 300 is configured to decode the first data packet based on the received first number of repetitions N and the at least one of the second number of repetitions M of the first data packet.

Fig. 4 shows a flow chart of a corresponding method 400 which may be executed in a network access node 300, such as the one shown in Fig. 3. The method 400 comprises transmitting 402 a first control message 502 to a client device 100. The first control message 502 instructs the client device 100 to transmit a total number of repetitions K of a data packet in at least two configured grant periods. The method 400 further comprises receiving 404 a first number of repetitions N of a first data packet in a first configured grant period from the client device 100, where $N<K$. The method 400 further comprises obtaining 406 a second number of repetitions M of the first data packet for reception in a second configured grant period consecutive to the first configured grant period, where $0<M\leq K-N$. The method 400 further comprises receiving 408 at least one of the second number of repetitions M of the first data packet in the second configured grant period from the client device 100. Furthermore, the method 400 comprises decoding 410 the first data packet based on the received first number of repetitions N and the at least one of the second number of repetitions M of the first data packet.

Fig. 5 shows a wireless communication system 500 according to an embodiment of the invention. The wireless communication system 500 comprises a client device 100 and a network access node 300 configured to operate in the wireless communication system 500. For simplicity, the wireless communication system 500 shown in Fig. 5 only comprises one

client device 100 and one network access node 300. However, the wireless communication system 500 may comprise any number of client devices 100 and any number of network access nodes 300 without deviating from the scope of the invention.

In the wireless communication system 500, the network access node 300 instructs/configures the client device 100 to transmit a total number of repetitions K of a data packet in one or more configured grant periods using a first control message 502 according to the invention. Thus, the first control message 502 indicates the total number of repetitions K with which the client device 100 may transmit a data packet. The first control message 502 further indicates that the client device 100 may use more than one configured grant period, i.e. is allowed to cross the boundary of one configured grant period. Hence, if the total number of repetitions K of the data packet cannot be completed in one configured grant period, the client device 100 may finish any remaining/pending repetitions in a consecutive configured grant period. According to embodiments of the invention the client device 100 determines how many of the remaining repetitions of the data packet the client device 100 should perform in the next configured grant period based on a pre-defined value using a set of rules specified in a standard specification or configured by the network access node 300. However, the client device 100 may in embodiments instead determine how many of the remaining repetitions of the data packet the client device 100 should perform in the next configured grant period based on information associated with e.g. obtaining of a second data packet for transmission in the next configured grant period, an overlap in time of the transmission occasions of a configured grant period with downlink symbols, and reception of an uplink grant associated with the first data packet from the network access node 300. Further details related to the transmission of data packets from the client device 100 to the network access node 300 will now be described with reference to Fig. 6.

Fig. 6 shows a flow chart of a method 600 in the client device 100 according to an embodiment of the invention. In step 602, the client device 100 receive a first control message 502 from the network access node 300, the first control message 502 instructs the client device 100 to transmit a total number of repetitions K of a data packet in at least two configured grant periods. The total number of repetitions K may correspond to the maximum number of repetitions the client device 100 can apply to a data packet across one or more configured grant periods.

Upon arrival of a first data packet from higher layers, the client device 100 transmits a first number of repetitions N of the first data packet in a first configured grant period to the network access node 300 in step 604. The first number of repetitions N may correspond to the number of repetitions the client device 100 have time to transmit in the first configured grant period and

may depend on e.g. the time of arrival of the first data packet and the number of transmission occasions in the first configured grant period. The first number of repetitions N is less than the total number of repetitions K, i.e. N<K. In other words, there is at least one repetition of the first data packet remaining, after the transmission of the first number of repetitions N of the first data packet in the first configured grant period, before the client device 100 has transmitted the total number of repetitions K of the first data packet.

In step 606, the client device 100 obtains a second number of repetitions M of the first data packet for transmission in a second configured grant period. The second configured grant period is consecutive to the first configured grant period, i.e. the second configured grant period comes after the first configured grant period in time. In embodiments, the second configured grant period is adjacent to the first configured grant period. However, there may in embodiments instead be one or more configured grant periods between the second configured grant period and the first configured grant period.

The second number of repetitions M obtained in step 606 is equal to or larger than zero and equal to or smaller than the remaining number of repetitions, i.e. $0 \leq M \leq K-N$. In embodiments, the client device 100 obtains the second number of repetitions M by determining the second number of repetitions M based on input information. Hence, the obtaining of the second number of repetitions M in step 606 may in embodiments comprise the client device 100 determining the second number of repetitions M based on at least one of: obtaining of a second data packet for transmission in the second configured grant period, an overlap in time between a downlink symbol and at least one uplink configured grant transmission occasion in a configured grant period, and reception of an uplink grant associated with the first data packet from the network access node 300. For example, the client device 100 may determine the second number of repetitions M to be equal to the remaining number of repetitions K-N if no second packet has been obtained for transmission during the second configured grant period or if a second packet with a lower priority than the first packet has been obtained. The client device 100 may further determine the second number of repetitions M to be equal to zero if an uplink grant associated with the first data packet has been received before determining the second number of repetitions M. Furthermore, the client device 100 may consider more than one of the listed input information when determining the second number of repetitions M. For example, if a second packet has been obtained, the client device 100 may further consider overlap of future transmission occasions with downlink symbols and determine the second number of repetitions M to be smaller if there are overlap of future transmission occasions with downlink symbols that will affect the transmission of the second packet than if no such overlap

exists. Further details related to the transmission of the first data packet and the determination of the second number of repetitions M are described below with reference to Figs. 8-12.

In embodiments, the client device 100 may instead obtain the second number of repetitions M based on a predefined value. The predefined value may be defined in a standard specification using a set of rules or received by the client device 100 in a second control message 504 from the network access node 300. When the predefined value is defined in a standard specification such as e.g. the 3GPP NR specification, the predefined value may be preconfigured in the client device 100. When the predefined value is received 100 in the second control message 504 from the network access node 300, the predefined value may be determined or preconfigured in the network access node 300. Furthermore, the second control message 504 may be a separate control message or may be comprised in the first control message 502.

In step 608, the client device 100 initiate transmission of the second number of repetitions M of the first data packet in the second configured grant period to the network access node 300. The client device 100 starts to transmit the second number of repetitions M of the first data packet one by one, while monitoring in step 610 for events affecting the transmission of the second number of repetitions M of the first data packet in the second configured grant period.

The monitoring in step 610 may comprise the client device 100 monitoring for events such as obtaining of a second data packet for transmission and/or obtaining an uplink grant associated with the first data packet. When the client device 100 in step 610 detects that a second data packet for transmission has been obtained, the client device 100 may determine whether to continue or cancel the transmission of the second number of repetitions M of the first data packet in step 608. In embodiments, the client device 100 may finish the initiated transmission of the second number of repetitions M in the second configured grant period upon obtaining the second data packet for transmission and further in step 612 start the initial transmission of the second data packet in the second configured grant period after finishing the transmission of the second number of repetitions M. In embodiments, the client device 100 may instead cancel the initiated transmission of the second number of repetitions M in the second configured grant period upon obtaining the second data packet for transmission and further in step 612 start the initial transmission of the second data packet in the second configured grant period after cancelling the initiated transmission of the second number of repetitions M. When the client device 100 in step 610 detects that an uplink grant associated with the first data packet has been obtained, the client device 100 may determine to cancel the transmission of the second number of repetitions M of the first data packet in step 608. Hence, the client device 100 may in embodiments cancel the initiated transmission of the second number of repetitions

M in the second configured grant period upon obtaining the uplink grant associated with the first data packet and further in step 612 transmit the first data packet according to the uplink grant. Further details related to the transmission of the first data packet upon obtaining a second data packet for transmission and/or obtaining of an uplink grant associated with the first data packet are described below with reference to Figs. 8-12.

According to embodiments of the invention a total time duration for the transmission of the first data packet in at least two configured grant periods may be limited. Thus, a limited total time is available to finish the transmission of the first number of repetitions N of the first data packet in the first configured grant period and the second number of repetitions M of the first data packet in the second configured grant period. The total time duration may be a predefined time limit and may e.g. be specified in terms of number of transmission occasions or number of configured grant periods associated with the configured grant transmissions. In embodiments, the total time duration for the transmission of the first data packet in at least two configured grant periods may be controlled using a timer, e.g. a predefined timer T. In this case, the value of the timer T may be specified in terms of number of transmission occasions or number of configured grant periods associated with the configured grant transmissions. When the timer T is used to limit the total time duration for the transmission of the first data packet, the client device 100 starts the timer T with the initiation of the transmission of the first number of repetitions N of the first data packet, i.e. at the initial transmission of the first data packet, and cancels the initiated transmission of the second number of repetitions M upon expiry of the timer T.

The client device 100 may in embodiments use a transmission parameter with different values for the first number of repetitions N of a data packet and the second number of repetitions M of the data packet. In this way, the network access node 300 may identify if transmissions received in a configured grant period belongs to delayed repetitions of an old data packet or to repetitions of a new data packet. Hence, the client device 100 may transmit the first number of repetitions N according to a transmission parameter with a first value and transmit the second number of repetitions M according to the transmission parameter with a second value. The transmission parameter may be at least one of a demodulation reference signal (DMRS) sequence, a scrambling sequence, and a configured scheduling - radio network temporary identifier (CS-RNTI) used for cyclic redundancy check (CRC) scrambling. For example, the client device 100 may transmit the first number of repetitions N using a first DMRS sequence and transmit the second number of repetitions M using a second DMRS sequence.

Fig. 7 shows a flow chart of a method 700 in the network access node 300 according to an embodiment of the invention. In step 702, the network access node 300 transmits the first control message 502 to the client device 100. The first control message 502 instructs the client device 100 to transmit a total number of repetitions K of a data packet in at least two configured grant periods. As previously described, the total number of repetitions K may correspond to the maximum number of repetitions the client device 100 can apply to a data packet across one or more configured grant periods.

In step 704, the network access node 300 receives a first number of repetitions N of a first data packet in a first configured grant period from the client device 100. The first number of repetitions N is less than the total number of repetitions K, i.e. $N<K$.

In step 706, the network access node 300 obtains a second number of repetitions M of the first data packet for reception in a second configured grant period consecutive to the first configured grant period, i.e. the second configured grant period comes after the first configured grant period in time. In embodiments, the second configured grant period is adjacent to the first configured grant period. However, there may in embodiments instead be one or more configured grant periods between the second configured grant period and the first configured grant period. The second number of repetitions M obtained in step 706 is larger than zero and equal to or smaller than the remaining number of repetitions, i.e. $0<M\leq K-N$. The network access node 300 may obtain the second number of repetitions M of the first data packet e.g. based on a predefined value. The predefined value may e.g. be defined in a standard specification such as the 3GPP NR specification. In embodiments, the network access node 300 may inform the client device 100 about the obtained second number of repetitions M. The network access node 300 may e.g. transmit a second control message 504 to the client device 100, where the second control message 504 indicates the second number of repetitions M to the client device 100. The second control message 504 may be a separate control message or may be comprised in the first control message 502.

The network access node 300 receives in step 708 at least one of the second number of repetitions M of the first data packet in the second configured grant period from the client device 100. As described with reference to Fig. 6, the transmission of the second number of repetitions M can vary depending on certain aspects of the client device 100. Hence, the network access node 300 may receive one or more of the second number of repetitions M of the first data packet in the second configured grant period.

In step 710, the network access node 300 decodes the first data packet based on the received first number of repetitions N and the at least one of the second number of repetitions M of the first data packet. In some cases, the network access node 300 may not able to decode the first data packet in step 710, i.e. the decoding of the first data packet based on the received first number of repetitions N and the at least one of the second number of repetitions M of the first data packet may be unsuccessful. In such cases, the network access node 300 may determine and transmit an uplink grant associated with the first data packet to the client device 100. Thus, the network access node 300 may in embodiments transmit an uplink grant associated with the first data packet to the client device 100 upon unsuccessful decoding of the first data packet. The network access node 300 may in this case receive the first data packet according to the uplink grant.

When the client device 100 is configured to finish the initiated transmission of the second number of repetitions M before starting the initial transmission of the second data packet, the network access node 300 receives the initial transmission of the second data packet in the second configured grant period P2 after (in time) receiving the second number M of repetitions of the first data packet in the second configured grant period.

The transmission of the first data packet and the second data packet in different embodiments of the invention will now be described with reference to Figs 8-12. In the embodiments shown in Figs 8-12, the client device 100 is configured with 6 symbol allocation and the total number of repetitions K is three. Furthermore, the configured grant period is 5*14 symbols (five 14 symbol slots) and each configured grant period comprises three transmission occasions (TOs).

Fig. 8 shows an embodiment where the client device 100 finishes the transmission of the first data packet DP1 upon obtaining the second data packet DP2 for transmission. The client device 100 obtains both the first data packet DP1 and the second data packet DP2 in the first configured grant period P1. The first data packet DP1 is obtained in time to transmit one repetition of the first data packet DP1 in the last transmission occasion TO in the first configured grant period P1. As the total number of repetitions K is three, the client device 100 hence has two remaining/pending repetitions of the first data packet DP1 after the first configured grant period P1. In the embodiment shown in Fig. 8, the client device 100 does not start the initial transmission of the second data packet DP2 in the first transmission occasion TO of the second configured grant period P2 because of the remaining repetitions of the first data packet DP1. The client device 100 instead determines to delay the initial transmission of the second data packet DP2 until the remaining repetitions of the first data packet DP1 has been transmitted. Thus, the client device 100 transmits the two remaining repetitions of the

first data packet D1 in the two first transmission occasions TOs of the second configured grant period P2 and a first repetition of the second data packet DP2 in the last transmission occasion TO in the second configured grant period P2. The two remaining repetitions of the second data packet DP2 are transmitted in a third configured grant period P3, as shown in Fig. 8.

Figs. 9 and 10 show embodiments where the client device 100 cancels the transmission of the first data packet DP1 upon obtaining the second data packet DP2 for transmission. In the embodiment shown in Fig. 9, the client device 100 obtains both the first data packet DP1 and the second data packet DP2 in the first configured grant period P1. The client device 100 transmits one repetition of the first data packet DP1 in the last transmission occasion TO in the first configured grant period P1. The client device 100 hence has two remaining repetitions of the first data packet DP1 after the first configured grant period P1. However, as the client device 100 has obtained the second data packet DP2, the client device 100 cancels the two remaining repetitions of the first data packet DP1 and instead starts the initial transmission of the second data packet DP2. Hence, the client device 100 transmits the three repetitions of the second data packet DP2 in the transmission occasions TOs in the second configured grant period P2, as shown in Fig. 9.

In the embodiment shown in Fig. 10, the client device 100 obtains the first data packet DP1 in the first configured grant period P1 and the second data packet DP2 in the second configured grant period P2. The client device 100 transmits one repetition of the first data packet DP1 in the last transmission occasion TO in the first configured grant period P1. The client device 100 hence has two remaining repetitions of the first data packet DP1 after the first configured grant period P1. The client device 100 initiates the transmission of the two remaining repetitions of the first data packet DP1 in the second configured grant period P2. After transmission of the first remaining repetition of the first data packet DP1 in the first transmission occasion TO in the second configured grant period P2, the client device 100 obtains the second data packet DP2. Upon obtaining the second data packet DP2, the client device 100 cancels the one remaining repetition of the first data packet DP1 and initiates the transmission of the second data packet DP2. As shown in Fig. 10, the client device 100 hence transmits the three repetitions of the second data packet DP2 in the two last transmission occasions TOs in the second configured grant period P2 and in the first transmission occasion TO in the third configured grant period P3.

In Figs. 9-10, the client device 100 cancels all the remaining repetitions of the first data packet DP1 upon obtaining the second data packet DP2. However, the client device 100 may in embodiments instead determine to transmit one or more of the remaining repetitions of the first

data packet DP1 before starting the transmission of the second data packet DP2 (not shown in Figs.).

In embodiments, the client device 100 may determine whether to cancel one or more remaining repetitions of the first data packet DP1 based on an overlap in time between a downlink symbol and at least one transmission occasion in a configured grant period. Fig. 11 shows such an embodiment. In the embodiment shown in Fig. 11, the client device 100 obtains both the first data packet DP1 and the second data packet DP2 in the first configured grant period P1 and has time to transmit one repetition of the first data packet DP1 in the last transmission occasion TO in the first configured grant period P1. Furthermore, the first two transmission occasions TOs in the third configured grant period P3 are associated with downlink symbols and hence the client device 100 cannot transmit anything in these transmission occasions TOs. Based on the overlap information, the two remaining repetitions of the first data packet DP1, and the obtained second data packet DP2, the client device 100 determines how many of the remaining repetitions of the first data packet DP1 to transmit before initiating the transmission of the second data packet DP2. In the embodiment shown in Fig. 11, the client device 100 determines to use the three transmission occasions TOs in the second configured grant period P2 to transmit one of the two remaining repetitions of the first data packet DP1 and two repetitions of the second data packet DP2.

Fig. 12 shows an embodiment where the client device 100 cancels the transmission of the first data packet DP1 upon obtaining an uplink grant associated with the first data packet DP1. In the embodiment shown in Fig. 12, the client device 100 obtains the uplink grant UG for the first data packet DP1 after transmitting the second repetition of the first data packet DP1 in the first transmission occasion TO in the second configured grant period P2. The client device 100 cancels the remaining repetitions of the first data packet DP1 and instead transmits the first data packet DP1 according to the uplink grant, not shown in Fig. 12.

The client device 100 herein, may be denoted as a user device, a User Equipment (UE), a mobile station, an internet of things (IoT) device, a sensor device, a wireless terminal and/or a mobile terminal, is enabled to communicate wirelessly in a wireless communication system, sometimes also referred to as a cellular radio system. The UEs may further be referred to as mobile telephones, cellular telephones, computer tablets or laptops with wireless capability. The UEs in this context may be, for example, portable, pocket-storable, hand-held, computer-comprised, or vehicle-mounted mobile devices, enabled to communicate voice and/or data, via the radio access network, with another entity, such as another receiver or a server. The UE can be a Station (STA), which is any device that contains an IEEE 802.11-conformant Media

Access Control (MAC) and Physical Layer (PHY) interface to the Wireless Medium (WM). The UE may also be configured for communication in 3GPP related LTE and LTE-Advanced, in WiMAX and its evolution, and in fifth generation wireless technologies, such as New Radio.

The network access node 300 herein may also be denoted as a radio network access node, an access network access node, an access point, or a base station, e.g. a Radio Base Station (RBS), which in some networks may be referred to as transmitter, “gNB”, “gNodeB”, “eNB”, “eNodeB”, “NodeB” or “B node”, depending on the technology and terminology used. The radio network access nodes may be of different classes such as e.g. macro eNodeB, home eNodeB or pico base station, based on transmission power and thereby also cell size. The radio network access node can be a Station (STA), which is any device that contains an IEEE 802.11-conformant Media Access Control (MAC) and Physical Layer (PHY) interface to the Wireless Medium (WM). The radio network access node may also be a base station corresponding to the fifth generation (5G) wireless systems.

Furthermore, any method according to embodiments of the invention may be implemented in a computer program, having code means, which when run by processing means causes the processing means to execute the steps of the method. The computer program is included in a computer readable medium of a computer program product. The computer readable medium may comprise essentially any memory, such as a ROM (Read-Only Memory), a PROM (Programmable Read-Only Memory), an EPROM (Erasable PROM), a Flash memory, an EEPROM (Electrically Erasable PROM), or a hard disk drive.

Moreover, it is realized by the skilled person that embodiments of the client device 100 and the network access node 300 comprises the necessary communication capabilities in the form of e.g., functions, means, units, elements, etc., for performing the solution. Examples of other such means, units, elements and functions are: processors, memory, buffers, control logic, encoders, decoders, rate matchers, de-rate matchers, mapping units, multipliers, decision units, selecting units, switches, interleavers, de-interleavers, modulators, demodulators, inputs, outputs, antennas, amplifiers, receiver units, transmitter units, DSPs, MSDs, TCM encoder, TCM decoder, power supply units, power feeders, communication interfaces, communication protocols, etc. which are suitably arranged together for performing the solution.

Especially, the processor(s) of the client device 100 and the network access node 300 may comprise, e.g., one or more instances of a Central Processing Unit (CPU), a processing unit, a processing circuit, a processor, an Application Specific Integrated Circuit (ASIC), a microprocessor, or other processing logic that may interpret and execute instructions. The

expression “processor” may thus represent a processing circuitry comprising a plurality of processing circuits, such as, e.g., any, some or all of the ones mentioned above. The processing circuitry may further perform data processing functions for inputting, outputting, and processing of data comprising data buffering and device control functions, such as call processing control, user interface control, or the like.

Finally, it should be understood that the invention is not limited to the embodiments described above, but also relates to and incorporates all embodiments within the scope of the appended independent claim.

CLAIMS

1. A client device (100) for a wireless communication system (500), the client device (100) being configured to

receive a first control message (502) from a network access node (300), wherein the first control message (502) instructs the client device (100) to transmit a total number of repetitions K of a data packet in at least two configured grant periods;

transmit a first number of repetitions N of a first data packet in a first configured grant period (P1) to the network access node (300), wherein $N<K$;

obtain a second number of repetitions M of the first data packet for transmission in a second configured grant period (P2) consecutive to the first configured grant period (P1), wherein $0 \leq M \leq K-N$;

initiate transmission of the second number of repetitions M of the first data packet in the second configured grant period (P2) to the network access node (300).

2. The client device (100) according to claim 1, wherein the second configured grant period (P2) is adjacent to the first configured grant period (P1).

3. The client device (100) according to claim 1 or 2, wherein obtain the second number of repetitions M comprises

determine the second number of repetitions M based on at least one of: obtaining of a second data packet for transmission in the second configured grant period (P2), an overlap between a downlink symbol and at least one uplink configured grant transmission occasion in a configured grant period, and reception of an uplink grant associated with the first data packet.

4. The client device (100) according to claim 1 or 2, wherein obtain the second number of repetitions M comprises

obtain the second number of repetitions M based on a predefined value.

5. The client device (100) according to any of claims 1-4, configured to

finish the initiated transmission of the second number of repetitions M in the second configured grant period (P2) upon obtaining a second data packet for transmission;

start the initial transmission of the second data packet in the second configured grant period (P2) after finishing the transmission of the second number of repetitions M.

6. The client device (100) according to any of claims 1-4, configured to

cancel the initiated transmission of the second number of repetitions M in the second configured grant period (P2) upon obtaining a second data packet for transmission;

start the initial transmission of the second data packet in the second configured grant period (P2) after cancelling the initiated transmission of the second number of repetitions M.

7. The client device (100) according to any of the preceding claims, configured to

cancel the initiated transmission of the second number of repetitions M in the second configured grant period (P2) upon obtaining an uplink grant associated with the first data packet;

transmit the first data packet according to the uplink grant.

8. The client device (100) according to any of the preceding claims, configured to

cancel the initiated transmission of the second number of repetitions M upon expiry of a timer T.

9. The client device (100) according to any of the preceding claims, configured to

transmit the first number of repetitions N according to a transmission parameter with a first value;

transmit the second number of repetitions M according to the transmission parameter with a second value.

10. The client device (100) according to claim 9, wherein the transmission parameter is at least one of a demodulation reference signal, DMRS, sequence, a scrambling sequence, and a configured scheduling - radio network temporary identifier, CS-RNTI, used for cyclic redundancy check, CRC, scrambling.

11. A network access node (300) for a wireless communication system (500), the network access node (300) being configured to

transmit a first control message (502) to a client device (100), wherein the first control message (502) instructs the client device (100) to transmit a total number of repetitions K of a data packet in at least two configured grant periods;

receive a first number of repetitions N of a first data packet in a first configured grant period (P1) from the client device (100), wherein $N<K$;

obtain a second number of repetitions M of the first data packet for reception in a second configured grant period (P2) consecutive to the first configured grant period (P1), wherein $0<M\leq K-N$;

receive at least one of the second number of repetitions M of the first data packet in the second configured grant period (P2) from the client device (100);

decode the first data packet based on the received first number of repetitions N and the at least one of the second number of repetitions M of the first data packet.

12. The network access node (300) according to claim 11, wherein the second configured grant period (P2) is adjacent to the first configured grant period (P1).

13. The network access node (300) according to claim 11 or 12, configured to

transmit a second control message (504) to the client device (100), wherein the second control message (504) indicates the second number of repetitions M.

14. The network access node (300) according to any of claims 11-13, configured to

receive an initial transmission of a second data packet in the second configured grant period (P2) after receiving the second number M of repetitions of the first data packet in the second configured grant period (P2).

15. The network access node (300) according to any of claims 11-14, configured to

transmit an uplink grant associated with the first data packet upon unsuccessful decoding of the first data packet;

receive the first data packet according to the uplink grant.

16. A method (200) for a client device (100), the method (200) comprising

receiving (202) a first control message (502) from a network access node (300), wherein the first control message (502) instructs the client device (100) to transmit a total number of repetitions K of a data packet in at least two configured grant periods;

transmitting (204) a first number of repetitions N of a first data packet in a first configured grant period (P1) to the network access node (300), wherein $N<K$;

obtaining (206) a second number of repetitions M of the first data packet for transmission in a second configured grant period (P2) consecutive to the first configured grant period (P1), wherein $0 \leq M \leq K-N$;

initiating (208) transmission of the second number of repetitions M of the first data packet in the second configured grant period (P2) to the network access node (300).

17. A method (400) for a network access node (300), the method (400) comprising

transmitting (402) a first control message (502) to a client device (100), wherein the first control message (502) instructs the client device (100) to transmit a total number of repetitions K of a data packet in at least two configured grant periods;

receiving (404) a first number of repetitions N of a first data packet in a first configured grant period (P1) from the client device (100), wherein $N<K$;

obtaining (406) a second number of repetitions M of the first data packet for reception in a second configured grant period (P2) consecutive to the first configured grant period (P1), wherein $0<M\leq K-N$;

receiving (408) at least one of the second number of repetitions M of the first data packet in the second configured grant period (P2) from the client device (100);

decoding (410) the first data packet based on the received first number of repetitions N and the at least one of the second number of repetitions M of the first data packet.

18. A computer program with a program code for performing a method according to claim 16 or 17 when the computer program runs on a computer.

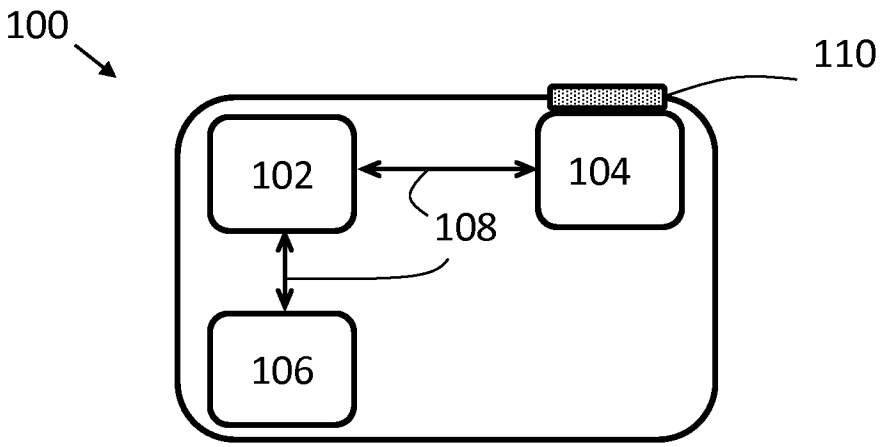


Fig. 1

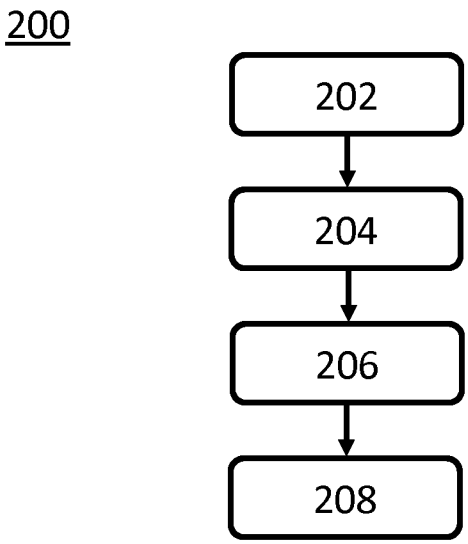


Fig. 2

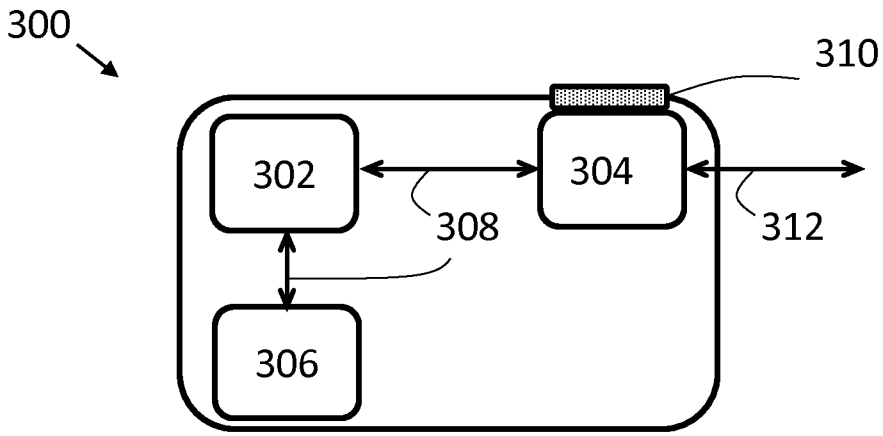


Fig. 3

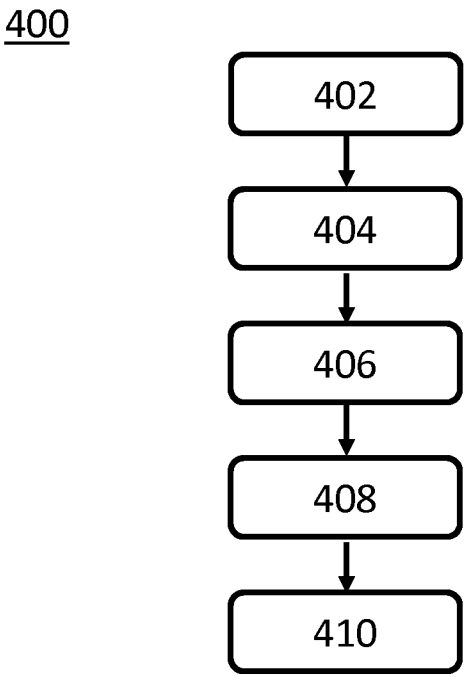


Fig. 4

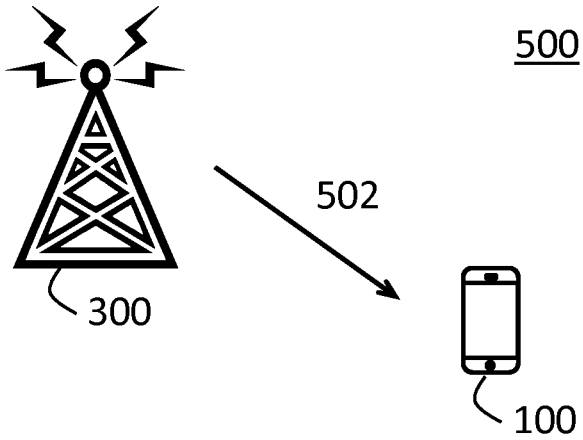


Fig. 5

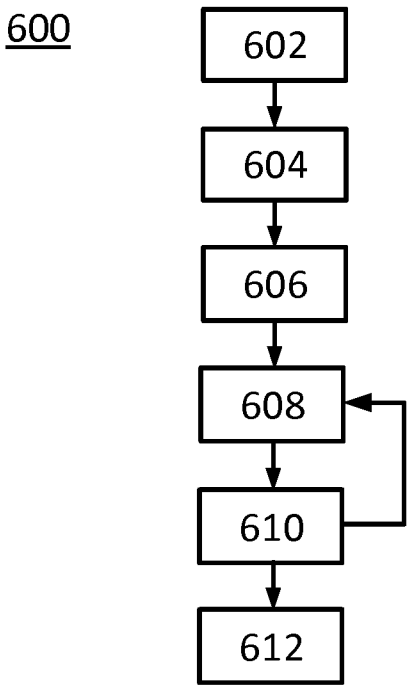


Fig. 6

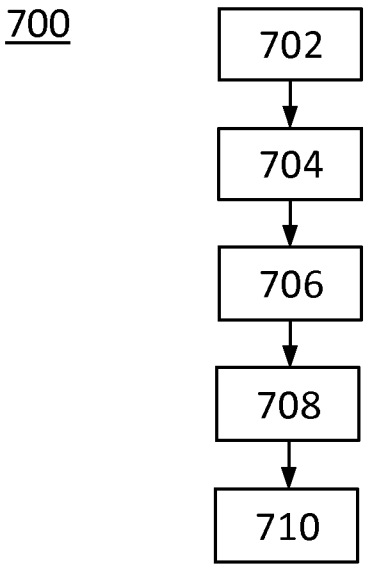


Fig. 7

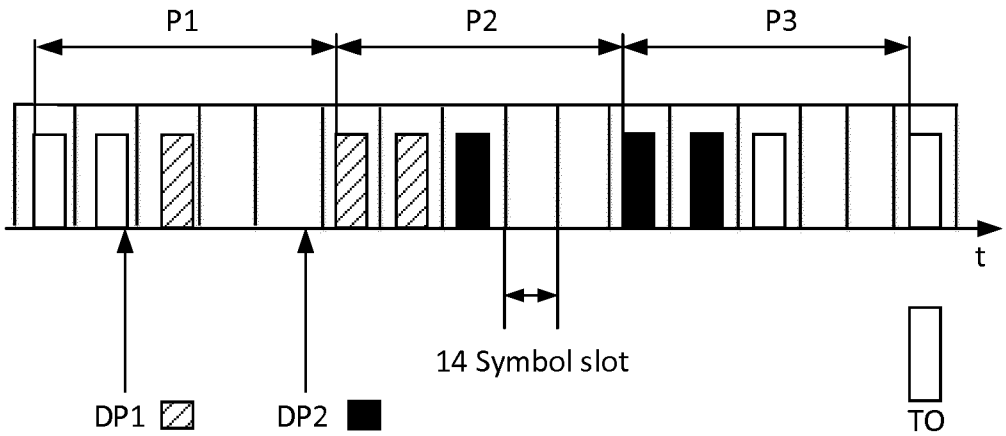


Fig. 8

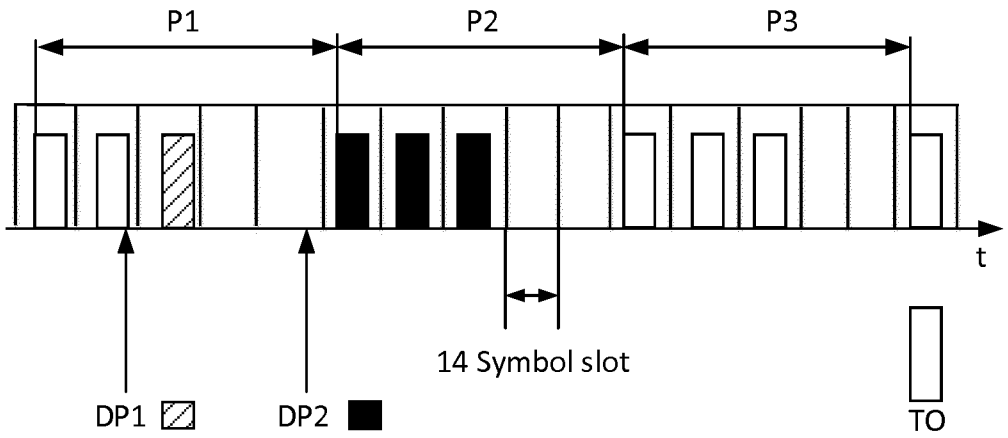

P1
P2
P3
t
14 Symbol slot
DP1
DP2
TO

Fig. 9

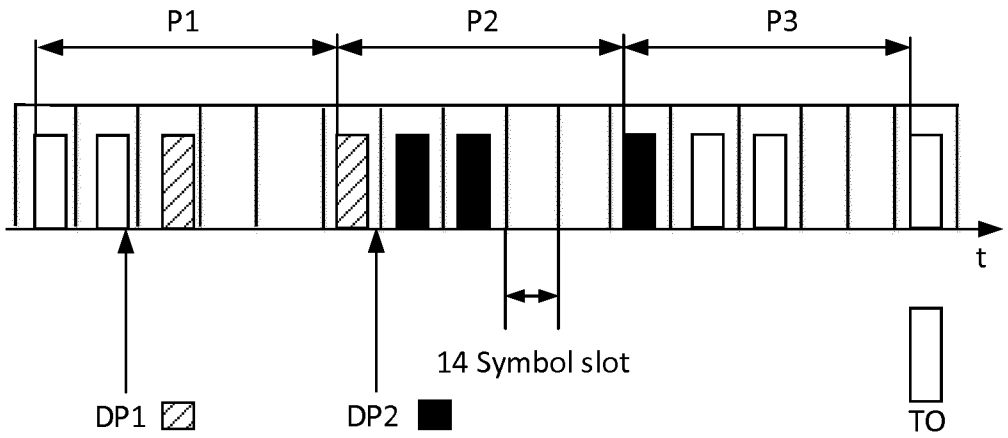

P1
P2
P3
t
14 Symbol slot
DP1
DP2
TO

Fig. 10

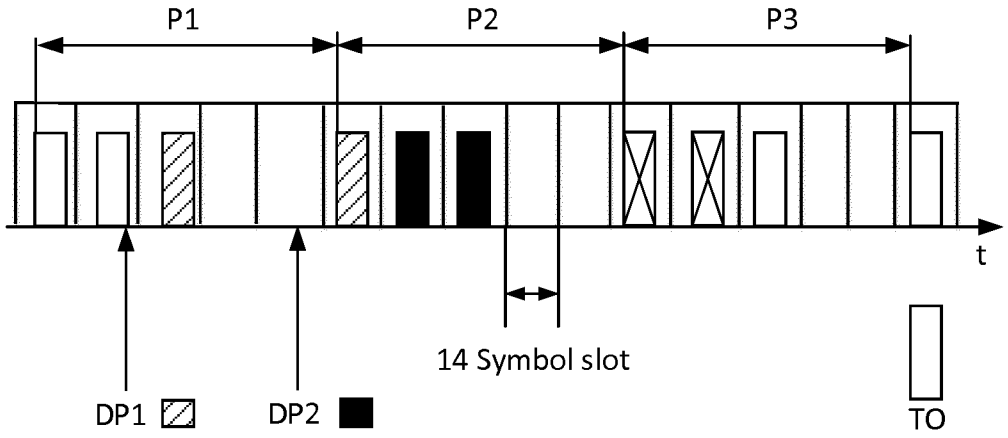

P1
P2
P3
t
14 Symbol slot
DP1
DP2
TO

Fig. 11

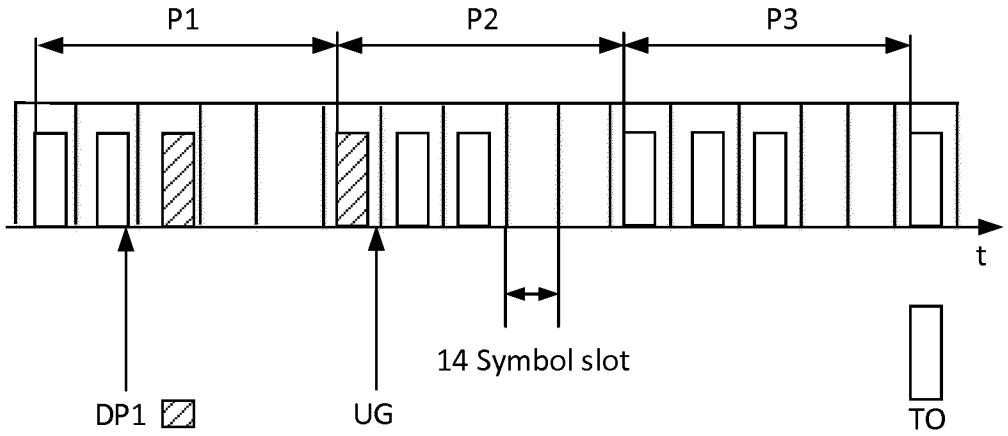

P1
P2
P3
t
14 Symbol slot
DP1
UG
TO

Fig. 12

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/050441

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L1/08 H04L1/18
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04L

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 3 282 619 A1 (CHINA ACADEMY TELECOMMUNICATIONS TECHNOLOGY [CN]) 14 February 2018 (2018-02-14)	1,2,4,5, 11-14, 16-18
A	abstract figures 5A-5E paragraphs [0070] - [0076]	3,6-10, 15

X	WO 2016/092492 A1 (ERICSSON TELEFON AB L M [SE]) 16 June 2016 (2016-06-16)	1,2,5, 11-14, 16-18
A	abstract figure 14 page 23, line 6 - page 26, line 26	3,4, 6-10,15

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

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
20 September 2019	30/09/2019

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

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Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	HUAWEI ET AL: "UL Grant-free transmission", 3GPP DRAFT; R1-1701665, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. RAN WG1, no. Athens, Greece; 20170213 - 20170217 6 February 2017 (2017-02-06), XP051220544, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_88/Docs/ [retrieved on 2017-02-06]	1,2,5, 11-14, 16-18
A	section 3 figures 1,2	3,4, 6-10,15

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A	sections 2 and 3	4,6,8-10

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A	sections 2.2, 2.3 and 3.2	2-4,6,7, 12,15

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2019/050441

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