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(54) Title: ENABLING EFFICIENT UTILIZATION OF GRANTED RESOURCES IN A WIRELESS COMMUNICATION SYSTEM

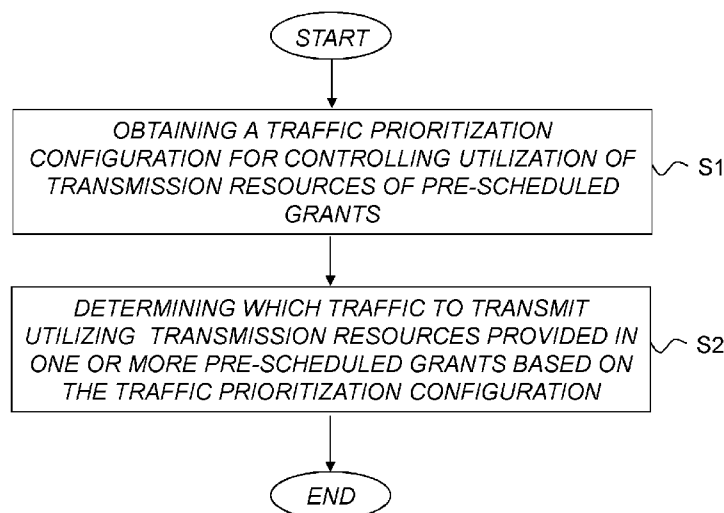


Fig. 2

(57) Abstract: There is provided a method and corresponding arrangement for controlling utilization of transmission resources allocated to a wireless communication device. The method comprises obtaining (S1) a traffic prioritization configuration for controlling utilization of 5 transmission resources of pre-scheduled grants, and determining (S2) which traffic to transmit utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

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ENABLING EFFICIENT UTILIZATION OF GRANTED RESOURCES IN A WIRELESS COMMUNICATION SYSTEM

TECHNICAL FIELD

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The proposed technology generally relates to wireless communications, and more specifically to resource allocation and enabling efficient utilization of granted resources in a wireless communication system.

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BACKGROUND

In wireless communication systems, such as Long term Evolution (LTE), uplink transmissions as well as downlink transmissions are scheduled by the network. For LTE, as an example, this means that when and on which resources the User
15 Equipment (UE) transmits is indicated by the eNB, optionally also including other information such as which modulation and coding scheme the UE shall apply, and so forth.

FIG. 1 is a schematic diagram illustrating an example of a grant-based procedure for
20 enabling uplink transmission in a wireless communication system. Basically, a network node 10 allocates grant(s) to a wireless communication device 20 for enabling uplink transmission utilizing transmission resources provided in the grant(s). The grant(s) may be allocated in response to a Scheduling Request (SR) and/or Buffer Status Report (BSR). Alternatively, the grants may be so-called pre-
25 scheduled grants.

In current LTE the uplink is normally scheduled by dynamic grants meaning that the grants are provided on a per-need basis. The UE indicates via a SR indication to the eNB that it needs to be scheduled in UL. The eNB may then provide a PDCCH
30 transmission to the UE containing an UL grant. The UL grant is usually rather small since the SR is only a one-bit indication and hence the eNB only knows that the UE has data to transmit, but does not know how much data the UE has to transmit.

Hence the eNB may only provide a grant which allows for little data to be transmitted.

Normally, the UE will in the first transmission provide a BSR report to the eNB which indicates in more detail, compared to the SR, how much data the UE has in its UL buffer(s). If the BSR indicates that, even after the first transmission which contained the BSR, the UE has more data in its buffers the eNB can provide further UL transmission grants.

10 A way to reduce scheduling latency in LTE is to lower the time for signaling and grant acquisition by using pre-scheduling, including also Semi-Persistent Scheduling (SPS) strategies. The idea of pre-scheduling is to opportunistically schedule users, without scheduling requests, when network resources are available. With pre-scheduling, a UE can thus receive UL grants without the UE
15 having sent, or the network having received, a prior request such as an SR and/or BSR for an UL grant by the UE. For example, with SPS the network can provide periodic UL grants and/or DL assignments with reduced L1/L2 control signaling compared to dynamic scheduling.

20 However, even with pre-scheduling, system behavior analysis seems to indicate that there is still room for further improvements, especially when it comes to utilizing the transmission resources allocated in prescheduled grants more effectively.

SUMMARY

25

It is an object to provide a method for controlling utilization of transmission resources allocated to a wireless communication device.

It is also an object to provide a method for enabling control of utilization of transmission
30 resources allocated to a wireless communication device.

Another object is to provide an arrangement configured to control utilization of transmission resources allocated to a wireless communication device.

Yet another object is to provide a wireless communication device comprising such an arrangement.

Still another object is to provide an arrangement configured to enable control of
5 utilization of transmission resources allocated to a wireless communication device.

It is also an object to provide a network device comprising such an arrangement.

Another object is to provide corresponding computer programs and computer-program
10 products.

It is also an object to provide an apparatus for controlling utilization of transmission resources allocated to a wireless communication device.

15 Another object is to provide an apparatus for enabling control of utilization of transmission resources allocated to a wireless communication device.

These and other objects are met by embodiments of the proposed technology.

20 According to a first aspect, there is provided a method for controlling utilization of transmission resources allocated to a wireless communication device. The method comprises obtaining a traffic prioritization configuration for controlling utilization of transmission resources of pre-scheduled grants, and determining which traffic to transmit utilizing transmission resources provided in one or more pre-scheduled grants
25 based on the traffic prioritization configuration.

According to a second aspect, there is provided a method for enabling control of utilization of transmission resources allocated to a wireless communication device. The method comprises generating a traffic prioritization configuration for controlling
30 utilization of transmission resources of pre-scheduled grants, and preparing the traffic prioritization configuration for transmission to the wireless communication device to enable the wireless communication device to determine which traffic to transmit

utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

According to a third aspect, there is provided an arrangement configured to control
5 utilization of transmission resources allocated to a wireless communication device. The arrangement is configured to obtain a traffic prioritization configuration for controlling utilization of transmission resources of pre-scheduled grants. The arrangement is also configured to determine which traffic to transmit utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization
10 configuration.

According to a fourth aspect, there is provided a wireless communication device comprising an arrangement of the third aspect.

15 According to a fifth aspect, there is provided an arrangement configured to enable control of utilization of transmission resources allocated to a wireless communication device. The arrangement is configured to generate a traffic prioritization configuration for controlling utilization of transmission resources of pre-scheduled grants. The arrangement is also configured to prepare the traffic prioritization configuration for
20 transmission to the wireless communication device to enable the wireless communication device to determine which traffic to transmit utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

25 According to a sixth aspect, there is provided a network device comprising an arrangement of the fifth aspect.

According to a seventh aspect, there is provided a computer program for controlling, when executed by a processor, utilization of transmission resources allocated to a
30 wireless communication device, wherein the computer program comprises instructions, which when executed by the processor, cause the processor to:

- obtain a traffic prioritization configuration for controlling utilization of transmission resources of pre-scheduled grants, and

- determine which traffic to transmit utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

5 According to an eighth aspect, there is provided a computer program for enabling, when executed by a processor, control of utilization of transmission resources allocated to a wireless communication device, wherein the computer program comprises instructions, which when executed by the processor, cause the processor to:

- generate a traffic prioritization configuration for controlling utilization of transmission resources of pre-scheduled grants; and
- output the traffic prioritization configuration for transmission to the wireless communication device to enable the wireless communication device to determine which traffic to transmit utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

According to a ninth aspect, there is provided a computer-program product comprising a computer-readable medium having stored thereon a computer program of the seventh aspect or eighth aspect.

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According to a tenth aspect, there is provided an apparatus for controlling utilization of transmission resources allocated to a wireless communication device. The apparatus comprises an input module for obtaining a traffic prioritization configuration for controlling utilization of transmission resources of pre-scheduled grants. The apparatus also comprises a determination module for determining which traffic to transmit utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

According to an eleventh aspect, there is provided an apparatus for enabling control of utilization of transmission resources allocated to a wireless communication device. The apparatus comprises a generating module for generating a traffic prioritization configuration for controlling utilization of transmission resources of pre-scheduled grants. The apparatus also comprises an output module for outputting the traffic

prioritization configuration for transmission to the wireless communication device to enable the wireless communication device to determine which traffic to transmit utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

- 5 The proposed technology provides new and efficient ways of enabling efficient utilization of transmission resources allocated in prescheduled grants in a wireless communication system.

Other advantages will be appreciated when reading the detailed description.

10

BRIEF DESCRIPTION OF THE DRAWINGS

The embodiments, together with further objects and advantages thereof, may best be understood by making reference to the following description taken together with
15 the accompanying drawings, in which:

FIG. 1 is a schematic diagram illustrating an example of a grant-based procedure for enabling uplink transmission in a wireless communication system.

- 20 FIG. 2 is a schematic flow diagram illustrating an example of a method for controlling utilization of transmission resources allocated to a wireless communication device according to an embodiment.

FIG. 3 is a schematic flow diagram illustrating an example of a method for enabling
25 control of utilization of transmission resources allocated to a wireless communication device.

FIG. 4 is a schematic flow diagram illustrating a particular example of a method for
method for controlling utilization of transmission resources allocated to a wireless
30 communication device according to an alternative embodiment.

FIG. 5 is a schematic signaling diagram illustrating a particular example of signaling between a network node such as an eNb and a wireless communication device such as a UE.

5 FIG. 6 is a schematic block diagram illustrating an example of an arrangement configured to control utilization of transmission resources allocated to a wireless communication device.

FIG. 7 is a schematic block diagram illustrating an example of a wireless
10 communication device comprising an arrangement of FIG. 6.

FIG. 8 is a schematic block diagram illustrating an example of an arrangement configured to enable control of utilization of transmission resources allocated to a wireless communication device.

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FIG. 9 is a schematic block diagram illustrating an example of a network device comprising an arrangement of FIG. 8.

FIG. 10 is a schematic diagram illustrating an example of a computer implementation
20 according to an embodiment.

FIG. 11 is a schematic block diagram illustrating an example of an apparatus for controlling utilization of transmission resources allocated to a wireless communication device.

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FIG. 12 is a schematic block diagram illustrating an example of an apparatus for enabling control of utilization of transmission resources allocated to a wireless communication device.

30 FIG. 13 is a schematic diagram illustrating an example of a cloud-based network device in connection with a wireless network according to an embodiment.

DETAILED DESCRIPTION

Throughout the drawings, the same reference designations are used for similar or corresponding elements.

5 As used herein, the non-limiting terms “User Equipment”, “UE”, “terminal” and “wireless communication device” may refer to a mobile phone, a cellular phone, a Personal Digital Assistant, PDA, equipped with radio communication capabilities, a smart phone, a laptop or Personal Computer, PC, equipped with an internal or external mobile broadband modem, a tablet PC with radio communication
10 capabilities, a target device, a device to device UE, a machine type UE or UE capable of machine to machine communication, iPad, customer premises equipment, CPE, laptop embedded equipment, LEE, laptop mounted equipment, LME, USB dongle, a portable electronic radio communication device, a sensor device equipped with radio communication capabilities or the like. In particular, the
15 term “UE”, the term “terminal” and the term “wireless communication device” should be interpreted as non-limiting terms comprising any type of wireless device communicating with a radio network node in a cellular or mobile communication system or any device equipped with radio circuitry for wireless communication according to any relevant standard for communication within a cellular or mobile
20 communication system.

As used herein, the term “network device” may generally refer to an electronic device being communicatively connected to other electronic devices in a network context. A network device may for example be seen as any device located in
25 connection with a communication network, including but not limited to devices and network nodes in access networks, core networks and similar network structures. The term network device may include any suitable network node. The term network device may also encompass cloud-based network devices.

30 As used herein, the non-limiting term “network node” may refer to base stations, network control nodes such as network controllers, radio network controllers, base station controllers, and the like. In particular, the term “base station” may encompass different types of radio base stations including standardized base station functions

such as Node Bs, or evolved Node Bs, eNBs, and also macro/micro/pico radio base stations, home base stations, also known as femto base stations, relay nodes, repeaters, radio access points, base transceiver stations, BTSs, and even radio control nodes controlling one or more Remote Radio Units, RRUs, or the like.

5

A careful analysis by the inventor has revealed that there is a need for more efficient ways of utilizing pre-scheduled grants. Sometimes the pre-scheduled grants may be referred to as preconfigured grants.

10 FIG. 2 is a schematic flow diagram illustrating an example of a method for controlling utilization of transmission resources allocated to a wireless communication device according to an embodiment. The method comprises the following steps:

S1: obtaining a traffic prioritization configuration for controlling utilization of
15 transmission resources of pre-scheduled grants, and

S2: determining which traffic to transmit by utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

20 By way of example, the considered traffic may relate to traffic data available in the wireless communication device, and the step of determining which traffic to transmit may comprise deciding which type or types of the available traffic to transmit using transmission resources provided in the pre-scheduled grant(s).

25 In a particular example, the step of determining which traffic to transmit may comprise determining, for traffic available for transmission by the wireless communication device, whether the traffic is prioritized or allowed for transmission utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

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In other words, it thus decided whether traffic is prioritized, or allowed, to use transmission resources provided in pre-scheduled grants based on the traffic prioritization configuration.

After the decision, prioritized traffic may be transmitted utilizing the transmission resources provided in one or more of the pre-scheduled grants.

- 5 The proposed technology provides new and efficient ways of enabling efficient utilization of transmission resources allocated in prescheduled grants in a wireless communication system.

By way of example, the traffic prioritization configuration may comprise information
10 indicating, per pre-scheduled grant and/or per grant configuration, which traffic can be transmitted using the grant.

The traffic prioritization configuration may comprise information indicating whether traffic is prioritized, allowed, unprioritized and/or prohibited to use transmission
15 resources provided in pre-scheduled grants.

As an example, the traffic prioritization configuration may comprise information indicating whether traffic is prioritized or unprioritized to use transmission resources provided in pre-scheduled grants.

20

By way of example, the traffic prioritization configuration may comprise information indicating whether traffic is allowed or prohibited to use transmission resources provided in pre-scheduled grants.

- 25 For example, the traffic prioritization configuration may comprise information indicating which type(s) of traffic that is/are prioritized or allowed for transmission utilizing transmission resources provided in pre-scheduled grants, and/or which type(s) of traffic that is/are not allowed for transmission utilizing transmission resources provided in pre-scheduled grants.

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As an example, if desired, it may be ensured that the wireless communication device only transmits high-priority data and/or delay sensitive data using the preconfigured

grants, while not transmitting low-priority data and/or delay tolerant data using such grants.

In a particular example, the information indicating whether traffic is prioritized, 5 allowed, unprioritized and/or prohibited includes information that indicates per Radio Bearer, RB, per Logical Channel, LC, per Logical Channel Group, LCG and/or per Quality of Service, QoS, Class Indicator, QCI, whether the associated traffic is prioritized, allowed, unprioritized and/or prohibited.

10 By way of example, at least part of the traffic prioritization configuration may be received from a network device such as a network node. Thus, the step of obtaining the traffic prioritization configuration may involve receiving at least part of the traffic prioritization configuration from a network device. As an example, the traffic prioritization configuration may be obtained based on Radio Resource Control, RRC, 15 signaling.

Alternatively, or as a complement, at least part of the traffic prioritization configuration may be preconfigured in the wireless communication device. In the latter case, the step of obtaining the traffic prioritization configuration may involve accessing or reading at 20 least part of the traffic prioritization configuration from a suitable memory location such as a configuration storage in the wireless communication device.

As mentioned, in a particular example, the traffic prioritization configuration may comprise information indicating at least one traffic type being prioritized, or allowed, for 25 transmission utilizing transmission resources provided in pre-scheduled grants. In this case, the step S2 of determining whether the traffic is prioritized for transmission utilizing transmission resources provided in pre-scheduled grants comprises checking whether the traffic type of the traffic available for transmission by the wireless communication device matches the prioritized, or allowed, traffic type(s) of the traffic 30 prioritization configuration. If there is a match, it is concluded that the available traffic is prioritized, or allowed, for transmission using the pre-scheduled grant(s).

There are many variations of implementing the indication of prioritized traffic types. By way of example, the prioritized traffic type(s) may be indicated directly, e.g. by means of traffic type indications and/or Quality of Service (QoS) class indicators (QCI), and/or indirectly, e.g. by using indications of prioritized Radio Bearers (RB), Logical Channels
5 (LC), Logical Channel Groups (LCG). The indications may for example be given per RB, per LC, per LCG and/or per pre-scheduled grant, as will be exemplified later on.

In a particular example, the proposed technology may be regarded as a mechanism to map RBs, LCs, LCGs and/or QCI to pre-scheduled uplink resources.

10

If it has been determined that some traffic is prioritized for transmission utilizing transmission resources provided in one or more pre-scheduled grant, the traffic may be transmitted accordingly.

15 If the pre-scheduled grant(s) includes more transmission resources than required for transmission of the prioritized traffic, it may be possible to allow also unprioritized traffic for transmission using part of the transmission resources of the pre-scheduled grant(s).

As mentioned, the traffic prioritization configuration may comprise information indicating
20 which type(s) of traffic that is/are being prioritized or allowed, for transmission utilizing transmission resources provided in pre-scheduled grants. Alternatively, it is possible to indicate in the traffic prioritization configuration which type(s) of traffic that is/are not allowed for transmission utilizing transmission resources provided in pre-scheduled grants. This is information that can also be used as a basis for determining whether
25 traffic is prioritized, or allowed, to use transmission resources provided in pre-scheduled grants.

Alternatively, or as a complement, the traffic prioritization configuration may include information representing a priority order of traffic types. In this case, the step of
30 determining which traffic to transmit may be based on the priority order of the traffic types. In this way, the priority order may be applied to decide which traffic to transmit utilizing transmission resources allocated in pre-scheduled grant(s).

By way of example, such a priority order may look like this:

	<u>Priority</u>	<u>Traffic type</u>
	1	A
5	2	B
	3	C

The method may for example be performed by the wireless communication device.

FIG. 3 is a schematic flow diagram illustrating an example of a method for enabling
 10 control of utilization of transmission resources allocated to a wireless communication device. The method comprises the following steps:

S11: generating a traffic prioritization configuration for controlling utilization of
 transmission resources of pre-scheduled grants, and

15

S12: preparing the traffic prioritization configuration for transmission to the wireless communication device to enable the wireless communication device to determine which traffic to transmit utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

20

By way of example, the traffic prioritization configuration may enable the wireless communication device to determine whether traffic is prioritized for transmission utilizing transmission resources provided in one or more pre-scheduled grants.

25 As an example, the traffic prioritization configuration may comprise information indicating, per pre-scheduled grant and/or per grant configuration, which traffic can be transmitted using the grant.

For example, the traffic prioritization configuration comprises information indicating
 30 whether traffic is prioritized, allowed, unprioritized and/or prohibited to use transmission resources provided in pre-scheduled grants.

As an example, the traffic prioritization configuration comprises information indicating which type(s) of traffic that is/are prioritized or allowed for transmission utilizing transmission resources provided in pre-scheduled grants, and/or which type(s) of traffic that is/are not allowed for transmission utilizing transmission resources provided in pre-scheduled grants.

In a particular example, the information indicating whether traffic is prioritized, allowed, unprioritized and/or prohibited includes information that indicates per Radio Bearer, RB, per Logical Channel, LC, per Logical Channel Group, LCG and/or per Quality of Service, QoS, Class Indicator, QCI, whether the associated traffic is prioritized, allowed, unprioritized and/or prohibited.

When the traffic prioritization configuration has been generated and prepared for transmission, the traffic prioritization configuration may be transmitted to the wireless communication device. For example, the traffic prioritization configuration may be transmitted to the wireless communication device by Radio Resource Control, RRC, signaling.

As an example, the traffic prioritization configuration may comprise information indicating at least one traffic type being prioritized, or allowed, for transmission utilizing transmission resources provided in pre-scheduled grants.

By way of example, the prioritized traffic type(s) may be indicated directly, e.g. by means of traffic type indications and/or Quality of Service (QoS) class indications, and/or indirectly, e.g. by using indications of prioritized Radio Bearers (RB), Logical Channels (LC), Logical Channel Groups (LCG). The indications may for example be given per RB, per LC, per LCG and/or per pre-scheduled grant, as will be exemplified later on.

The network side may thus indicate which type of bearer/logical channel/logical channel group/QCI can be sent using a pre-scheduled grant.

Alternatively, it is possible to indicate in the traffic prioritization configuration which type(s) of traffic that is/are not allowed for transmission utilizing transmission resources provided in pre-scheduled grants.

- 5 In a particular example, the traffic prioritization configuration may include information representing a priority order of traffic types for allowing a decision on which traffic to transmit utilizing transmission resources provided in pre-scheduled grants, as previously mentioned.
- 10 The method may for example be performed by a network device. By way of example, the network device may be a cloud-based network device or a network node such as a radio access network node.

When the traffic prioritization configuration has been prepared for transmission, it can
15 be transmitted to the wireless device, either by the same network device that generated and prepared the traffic prioritization configuration or by another network device. In the former case, the network node may be a radio access network node such as an eNB. In the latter case, the network device that generated the traffic prioritization configuration may forward the traffic prioritization configuration to another network
20 device that is responsible for transmitting the configuration to the relevant wireless communication device.

In the following, specific non-limiting examples will be presented.

- 25 In current LTE networks the eNB performs UL scheduling for the UE based on information received from the UE. Such information comprises for example Scheduling Requests (SRs) and Buffer Status Reports (BSRs).

The eNB may know which type of traffic the UE available for transmission e.g. based
30 on the BSR as the UE indicates the amount of data available for a Logical Channel Group in the BSR. The eNB can therefore determine how critical it is to provide a grant to the UE based on the type of traffic which is waiting for transmission in the UE.

In case of pre-scheduling the eNB may provide UL resources to a UE prior to arrival of data which may reduce the delay for transmitting the UL data because the UE may use the pre-scheduled UL resources when the data arrives without
5 needing an SR and/or BSR from the UE. As an example, the eNB may foresee that for a certain UE, UL data may arrive in the buffers and hence the eNB preconfigures the UE with grants such that the UE can transmit as soon as the data arrives.

10 A problem with prior art is that low-priority traffic such as delay tolerant traffic may arrive in the UE and being sent using preconfigured grant even though the eNB's intention of the preconfigured grant was to transmit high-priority traffic such as delay sensitive traffic.

15 By way of example, it will be described how it is determined which traffic (which may be indicated by referring to a bearer, logical channel, logical channel group, QCI, and so forth) is prioritized or allowed to be transmitted using a preconfigured grant, and optionally also which traffic is not (unprioritized or prohibited traffic).

20 For brevity the term "prioritized traffic" or alternatively expressed as "allowed traffic", will be used for traffic which is prioritized or allowed to be sent using resources indicated by prescheduled grants. The optional term "unprioritized traffic" will be used for traffic which is not prioritized to be sent using resources indicated by prescheduled grants. The optional term "prohibited traffic" may be used for traffic
25 which is not allowed to be transmitted using resources indicated by prescheduled grants.

Upon transmitting using the pre-scheduled grant(s), the wireless communication device such as a UE would send prioritized, allowed traffic while not sending
30 prohibited traffic. There may be special cases, where unprioritized traffic can be sent using pre-scheduled grants.

Since by applying some embodiments herein, some traffic may be prohibited from using prescheduled grants, therefore the UE may need to acquire a dynamic grant for example by performing a random access procedure or sending a scheduling request.

5

Which traffic is prioritized, allowed, unprioritized and/or prohibited may be determined based on signaling received from the network side (e.g. the eNB), preconfigured rules, or a combination thereof.

- 10 For example, it will be described how a wireless communication device such as UE can determine whether traffic is "prioritized" or "allowed", or "unprioritized" or even "prohibited" from being sent using resources provided in preconfigured uplink grants.

By way of example, this may ensure that the wireless communication device such as
15 a UE only transmits delay sensitive data using the preconfigured grants, while not transmitting delay tolerant data using such grants.

For example, it may be determined which traffic is "prioritized", "allowed", "unprioritized" or "prohibited" based on RRC signaling per bearer, logical channel,
20 logical channel group and/or QoS Class indicator(s).

Further in some embodiments the wireless communication device such as a UE may, in some scenarios, be allowed to send "unprioritized" traffic using preconfigured grant(s) in case there is capacity for both prioritized and unprioritized
25 traffic in such a grant. For example, this will ensure that the UE does not send padding, which could otherwise reduce radio resource efficiency, user experience and potentially UE battery consumption.

An illustrative benefit is that the network side may ensure that a certain wireless
30 device such as a UE only sends certain types of traffic using a preconfigured grant, while not sending other types of traffic (e.g. low priority and/or delay tolerant traffic) using preconfigured grants and hence the amount of resources which needs to be preconfigured for a UE can be reduced.

This is particularly beneficial when the network side configures several UEs to use the same resources for UL transmissions but prohibit the UEs from using those resources for non-delay sensitive data and hence the number of UEs assigned to
5 those resources can be increased and the overall system capacity can be improved.

FIG. 4 is a schematic flow diagram illustrating a particular example of a method for
method for controlling utilization of transmission resources allocated to a wireless
10 communication device according to an alternative embodiment.

In this particular example, step S21 comprises obtaining/accessing a traffic prioritization configuration.

In step S22, traffic X becomes available for transmission.

15

In step S23, it is determined whether traffic X is prioritized for pre-scheduled grant(s).

If Yes, traffic X is sent using pre-scheduled grant(s) in step S24.

20 If No, it is determined in step S25 whether other traffic Y is to be sent using pre-scheduled grant(s).

If no other traffic Y is to be sent (No) using pre-scheduled grant(s), traffic X is not sent using pre-scheduled grant (step S27).

25

If other traffic Y is to be sent (Yes) using pre-scheduled grant(s), it is determined in step S26 whether traffic X can be included (at least partially) in the same grant(s) as traffic Y.

30 If traffic X can be included (at least partially) in the same grant (Yes), traffic X and Y is sent using pre-scheduled grant(s) in step S24.

If traffic X cannot be included (at least partially) in the same grant (No), traffic X is not sent using pre-scheduled grant (S27).

FIG. 5 is a schematic signaling diagram illustrating a particular example of signaling
5 between a network node such as an eNB and a wireless communication device such as a UE.

By way of example, a grant configuration involving normal and/or pre-scheduled grant(s) is sent from the network node to the wireless communication device. In this
10 example, a traffic prioritization configuration or part thereof is also sent from the network node to the wireless communication device, unless the traffic prioritization configuration or part thereof is already preconfigured in the wireless communication device.

15 It should be understood that the order of transmitting the grant configuration and the traffic prioritization configuration can be changed. Alternatively, the grant configuration and the traffic prioritization configuration can be sent in the same control message.

20 In this particular example, the traffic prioritization configuration indicates that traffic X is unprioritized and traffic Y is prioritized.

When traffic X becomes available in the wireless communication device, traffic X is therefore typically sent using normal grant(s), normally allocated in response to a
25 scheduling request.

When traffic Y becomes available in the wireless communication device, traffic Y is sent using pre-scheduled grant(s).

30 If both traffic X and Y are available, and both fit (traffic X at least partially) in the same pre-scheduled grant, traffic X and Y are sent using pre-scheduled grant(s).

For example, the signaling may be provided using Radio Resource Control (RRC). A number of non-limiting examples of how to implement the proposed technology in the specific context of the RRC specification (e.g. see 3GPP TS 36.331 v13.0.0) will be given below.

5

In some of the examples below, the traffic prioritization configuration may be in the form of a RRC configuration. It should however, be understood that the traffic prioritization configuration is not limited thereto, but may be any general type of configuration indicating traffic prioritization information. The traffic prioritization may
10 even be preconfigured, for example as a configuration in a Subscriber Identity Module (SIM) card or the like.

Per-bearer/logical channel/logical channel group indication

Different signaling alternatives for how the eNB can indicate to the UE whether traffic is prioritized, allowed, unprioritized and/or prohibited are provided in the
15 following sections.

It is also possible to provide solutions in which the eNB indicates which traffic is the "allowed traffic" and all traffic which is not indicated as "allowed traffic" will instead be considered "prohibited traffic" by the UE. However, negative logic could also be used where the eNB indicates which traffic cannot use the preconfigured grant (i.e.
20 eNB indicated "prohibited traffic", and traffic which is not indicated as "prohibited" will be considered as "allowed traffic".

Per bearer

The signaling for indicating which traffic is prioritized, allowed, unprioritized and/or prohibited may be a bit-flag indicator for a bearer which indicates whether
25 transmissions from this bearer should be done using a pre-configured grant. An example is shown below. It can be seen that the parameter "usePreScheduling" can be included and set to true to indicate that this bearer is "allowed traffic". If the indication is not present it could be used to indicate that the traffic of the bearer is "prohibited" from using prescheduled resources.

DRB-ToAddMod ::= SEQUENCE {			
eps-BearerIdentity	INTEGER (0..15)	OPTIONAL,	--
Cond DRB-Setup			
drb-Identity	DRB-Identity,		
pdcp-Config	PDCP-Config	OPTIONAL,	--
Cond PDCP			
rlc-Config	RLC-Config	OPTIONAL,	--
Cond SetupM			
logicalChannelIdentity	INTEGER (3..10)	OPTIONAL,	--
Cond DRB-SetupM			
logicalChannelConfig	LogicalChannelConfig	OPTIONAL,	--
Cond SetupM			
...			
[[drb-TypeChange-r12	ENUMERATED {toMCG}	OPTIONAL,	
rlc-Config-v1250	RLC-Config-v1250	OPTIONAL	--
Need ON			
]],			
[[rlc-Config-v13xx	RLC-Config-v13xx	OPTIONAL	--
Need ON			
]],			
[[usePreScheduledGrants-r14	ENUMERATED {true}	OPTIONAL	
]]			
}			

Other possible ways of encoding this indication is possible, e.g. to have a BOOLEAN, or a setup-release structure.

Per logical channel or logical channel group

- 5 Another alternative to implement this embodiment is to indicate per logical channel whether traffic from this logical channel is prioritized, allowed, unprioritized and/or prohibited. An example with a flag for indicating this is provided below. If the flag is present for a logical channel the UE is allowed to transmit traffic from this logical channel on resources provided in preconfigured grants, otherwise not.
- 10 Another alternative for how to implement this is to indicate per logical channel group if the traffic from this logical channel group is prioritized, allowed, unprioritized and/or prohibited.

LogicalChannelConfig ::=	SEQUENCE {
ul-SpecificParameters	SEQUENCE {

priority	INTEGER (1..16),		
prioritisedBitRate	ENUMERATED {		
kBps128,	kBps0, kBps8, kBps16, kBps32, kBps64,		
kBps1024-v1020,	kBps256, infinity, kBps512-v1020,		
spare3, spare2,	kBps2048-v1020, spare5, spare4,		
	spare1},		
bucketSizeDuration	ENUMERATED {		
ms1000, spare2,	ms50, ms100, ms150, ms300, ms500,		
	spare1},		
logicalChannelGroup	INTEGER (0..3)	OPTIONAL	
}	OPTIONAL,		--
Cond UL			
....,			
[[logicalChannelSR-Mask-r9	ENUMERATED {setup}	OPTIONAL	
]],			
[[logicalChannelSR-Prohibit-r12	BOOLEAN	OPTIONAL	
]],			
[[usePreconfiguredGrants-r14	ENUMERATED {true}	OPTIONAL	
]]			
}			

Other possible ways of encoding this indication is possible, e.g. to have a BOOLEAN, or a setup-release structure.

Per QoS class

In LTE networks the concept of QoS is used to allow traffic differentiation etc. For this framework traffic can be assigned to different QoS Classes which are indicated by QoS Class Identifiers (QCIs). Different QCIs are associated with different traffic characteristics and different requirements.

Below is a table showing the standardized QCIs. This table can be found in 3GPP TS 23.203 v13.7.0. For example QCI 1 may for example be used for Conversational Voice and the Packet Delay Budget and Packet Error Loss Rate are set to values which are suitable for such type of traffic. On the other hand QCI 4 can for example be used for Non-Conversational Video and the delay and packet error loss rates are set to suitable values for this type of traffic.

QCI	Resource Type	Priority Level	Packet Delay Budget	Packet Error Loss Rate (NOTE 2)	Example Services
1 (NOTE 3)	GBR	2	100 ms (NOTE 1, NOTE 11)	10^{-2}	Conversational Voice
2 (NOTE 3)		4	150 ms (NOTE 1, NOTE 11)	10^{-3}	Conversational Video (Live Streaming)
3 (NOTE 3)		3	50 ms (NOTE 1, NOTE 11)	10^{-3}	Real Time Gaming
4 (NOTE 3)		5	300 ms (NOTE 1, NOTE 11)	10^{-6}	Non-Conversational Video (Buffered Streaming)
65 (NOTE 3, NOTE 9, NOTE 12)		0.7	75 ms (NOTE 7, NOTE 8)	10^{-2}	Mission Critical user plane Push To Talk voice (e.g., MCPTT)
66 (NOTE 3, NOTE 12)		2	100 ms (NOTE 1, NOTE 10)	10^{-2}	Non-Mission-Critical user plane Push To Talk voice
5 (NOTE 3)	Non-GBR	1	100 ms (NOTE 1, NOTE 10)	10^{-6}	IMS Signalling
6 (NOTE 4)		6	300 ms (NOTE 1, NOTE 10)	10^{-6}	Video (Buffered Streaming) TCP-based (e.g., www, e-mail, chat, ftp, p2p file sharing, progressive video, etc.)
7 (NOTE 3)		7	100 ms (NOTE 1, NOTE 10)	10^{-3}	Voice, Video (Live Streaming) Interactive Gaming
8 (NOTE 5)		8	300 ms (NOTE 1)	10^{-6}	Video (Buffered Streaming) TCP-based (e.g., www, e-mail, chat, ftp, p2p file sharing, progressive video, etc.)
9 (NOTE 6)		9			
69 (NOTE 3, NOTE 9, NOTE 12)		0.5	60 ms (NOTE 7, NOTE 8)	10^{-6}	Mission Critical delay sensitive signalling (e.g., MC-PTT signalling)

70 (NOTE 4, NOTE 12)	5.5	200 ms (NOTE 7, NOTE 10)	10^{-6}	Mission Critical Data (e.g. example services are the same as QCI 6/8/9)
NOTE 1: A delay of 20 ms for the delay between a PCEF and a radio base station should be subtracted from a given PDB to derive the packet delay budget that applies to the radio interface. This delay is the average between the case where the PCEF is located "close" to the radio base station (roughly 10 ms) and the case where the PCEF is located "far" from the radio base station, e.g. in case of roaming with home routed traffic (the one-way packet delay between Europe and the US west coast is roughly 50 ms). The average takes into account that roaming is a less typical scenario. It is expected that subtracting this average delay of 20 ms from a given PDB will lead to desired end-to-end performance in most typical cases. Also, note that the PDB defines an upper bound. Actual packet delays - in particular for GBR traffic - should typically be lower than the PDB specified for a QCI as long as the UE has sufficient radio channel quality. NOTE 2: The rate of non-congestion related packet losses that may occur between a radio base station and a PCEF should be regarded to be negligible. A PELR value specified for a standardized QCI therefore applies completely to the radio interface between a UE and radio base station. NOTE 3: This QCI is typically associated with an operator controlled service, i.e., a service where the SDF aggregate's uplink / downlink packet filters are known at the point in time when the SDF aggregate is authorized. In case of E-UTRAN this is the point in time when a corresponding dedicated EPS bearer is established / modified. NOTE 4: If the network supports Multimedia Priority Services (MPS) then this QCI could be used for the prioritization of non-real-time data (i.e. most typically TCP-based services/applications) of MPS subscribers. NOTE 5: This QCI could be used for a dedicated "premium bearer" (e.g. associated with premium content) for any subscriber / subscriber group. Also in this case, the SDF aggregate's uplink / downlink packet filters are known at the point in time when the SDF aggregate is authorized. Alternatively, this QCI could be used for the default bearer of a UE/PDN for "premium subscribers". NOTE 6: This QCI is typically used for the default bearer of a UE/PDN for non-privileged subscribers. Note that AMBR can be used as a "tool" to provide subscriber differentiation between subscriber groups connected to the same PDN with the same QCI on the default bearer. NOTE 7: For Mission Critical services, it may be assumed that the PCEF is located "close" to the radio base station (roughly 10 ms) and is not normally used in a long distance, home routed roaming situation. Hence delay of 10 ms for the delay between a PCEF and a radio base station should be subtracted from this PDB to derive the packet delay budget that applies to the radio interface. NOTE 8: In both RRC Idle and RRC Connected mode, the PDB requirement for these QCIs can be relaxed (but not to a value greater than 320 ms) for				

the first packet(s) in a downlink data or signalling burst in order to permit reasonable battery saving (DRX) techniques.

NOTE 9: It is expected that QCI-65 and QCI-69 are used together to provide Mission Critical Push to Talk service (e.g., QCI-5 is not used for signalling for the bearer that utilizes QCI-65 as user plane bearer). It is expected that the amount of traffic per UE will be similar or less compared to the IMS signalling.

NOTE 10: In both RRC Idle and RRC Connected mode, the PDB requirement for these QCIs can be relaxed for the first packet(s) in a downlink data or signalling burst in order to permit battery saving (DRX) techniques.

NOTE 11: In RRC Idle mode, the PDB requirement for these QCIs can be relaxed for the first packet(s) in a downlink data or signalling burst in order to permit battery saving (DRX) techniques.

NOTE 12: This QCI value can only be assigned upon request from the network side. The UE and any application running on the UE is not allowed to request this QCI value.

In an example embodiment the eNB will indicate whether traffic associated with a certain QCI is prioritized, allowed, unprioritized and/or prohibited. For example, the eNB may indicate to the UE that e.g. QCI 1 is allowed to use resources provided in
5 prescheduled grants (i.e. it is "allowed traffic"), while other traffic is considered as prohibited traffic.

Indication per pre-scheduling grant

In another embodiment it is indicated per preconfigured grant which traffic can be sent using this grant, e.g. it may be indicated that traffic from a certain bearer, or
10 logical channel, or logical channel group may be sent in resources provided by this grant.

By way of example, without loss of generality, this may be implemented by providing in RRC an indication for a prescheduled grant configuration an indication of a bearer identity, or logical channel identity, or logical channel group identity
15 may be sent using this grant.

In case several bearers or logical channels or logical channel groups should be allowed to use the resources provided by the prescheduled grant the eNB may provide a list of such cells.

```

SPS-ConfigUL ::= CHOICE {
  release          NULL,
  setup            SEQUENCE {
    semiPersistSchedIntervalUL    ENUMERATED {
      sf10, sf20, sf32, sf40, sf64, sf80,
      sf128, sf160, sf320, sf640, spare6,
      spare5, spare4, spare3, spare2,
      spare1},
    implicitReleaseAfter          ENUMERATED {e2, e3, e4, e8},
    p0-Persistent                SEQUENCE {
      p0-NominalPUSCH-Persistent  INTEGER (-126..24),
      p0-UE-PUSCH-Persistent      INTEGER (-8..7)
    } OPTIONAL, -- Need OP
    twoIntervalsConfig           ENUMERATED {true}
  } OPTIONAL, -- Cond TDD
  ...,
  [[ p0-PersistentSubframeSet2-r12 CHOICE {
    release          NULL,
    setup            SEQUENCE {
      p0-NominalPUSCH-PersistentSubframeSet2-r12
        INTEGER (-126..24),
      p0-UE-PUSCH-PersistentSubframeSet2-r12
        INTEGER (-8..7)
    }
  } ]],
  } OPTIONAL --
  Need ON
  ]],
  [[ allowedBearers          SEQUENCE (SIZE (1..maxDRB)) OF
    DRB-Identity
  ]],
  }
}

```

Note that it would be possible to instead of indicating which bearers, logical channels, or logical channel groups or QCI are "allowed" indicate which bearers, logical channels, or logical channel groups or QCI are "prohibited".

Default behavior

In an example embodiment the UE applies a default preconfigured behavior for certain types of bearers, logical channels, logical channel groups or QCI. By way of example, for traffic for which the eNB has not provided (or is not able to due to
5 signaling restrictions) any indication the UE determines whether the traffic is prioritized, allowed, unprioritized and/or prohibited from using prescheduled grants. This allows the eNB to omit indications.

This is beneficial from a signaling overhead point of view as less signaling is sent. This may for example be applied to signaling radio bearers (SRBs). For example,
10 the UE may be preconfigured to always send transmissions including SRBs using a preconfigured grant, even without explicit indication that the UE is allowed to do so. SRBs are in general more important than data radio bearers (DRBs) as these bearers carry control signaling which may be essential to maintain the connection with the network. This basically implies that the traffic prioritization configuration is
15 preconfigured.

Alternatively, the UE applies a default behavior for traffic associated with a certain QoS class, e.g. having a certain QCI. For example the UE may by consider traffic of a first QCI as "allowed", while consider traffic of a second QCI as "prohibited". This may be beneficial as some traffic may always be considered delay sensitive
20 (e.g. Conversational Voice which has QCI 1).

In case the eNB provides an indication for traffic where a default rule is established (e.g. SRBs may be associated with a default rule) the eNB provided indication may take precedence and the UE may apply the indicated behavior rather than the default rule in case an indication has been received. In other words, if for example
25 SRBs are by default considered "allowed" the eNB may override this behavior by indicating to the UE that SRBs are "prohibited".

Methods for handling multiple preconfigured grants

In the above it has been described the scenario where the eNB indicates to the UE whether traffic is prioritized, allowed, unprioritized and/or prohibited. However in some cases the UE may have a set of preconfigured grants. For example, the UE
 5 may be configured with one pre-configuration of grants G1 and another pre-configuration of grants G2, where G1 allows the UE to transmit when the following is true:

$$\begin{aligned}
 & - (10 * \text{SFN} + \text{subframe}) = [(10 * \text{SFN}_{\text{start time}} + \text{subframe}_{\text{start time}}) + N * \\
 10 \quad & \text{semiPersistSchedIntervalUL1} + \text{Subframe_Offset} * (N \text{ modulo } 2)] \text{ modulo } \\
 & 10240.
 \end{aligned}$$

and G2 allows the UE to transmit when the following is true:

$$\begin{aligned}
 & - (10 * \text{SFN} + \text{subframe}) = [(10 * \text{SFN}_{\text{start time}} + \text{subframe}_{\text{start time}}) + N * \\
 15 \quad & \text{semiPersistSchedIntervalUL2} + \text{Subframe_Offset} * (N \text{ modulo } 2)] \text{ modulo } \\
 & 10240.
 \end{aligned}$$

In case the UE is configured with multiple pre-configured grants it would be possible to indicate (rather than just indicating whether traffic can or cannot use pre-configured UL grants) which pre-configured grant a traffic is "allowed" for. For
 20 example, the eNB may configure G1 such that the UE is allowed to transmit every 1 ms which some very delay sensitive traffic is "allowed" for, and also configure G2 such that UE is allowed to transmit every 40 ms which some less delay sensitive traffic is "allowed" for.

An example of how to implement this in RRC is provided below. In this example it is assumed that the UE can have up to 4 prescheduled grant configurations and usePreScheduledGrants is a bit string where each position in the bit string corresponds to a prescheduling configuration. If the bit corresponding to a certain
 5 prescheduled grant configuration is set to 1 (or 0) it may indicate that this bearer is "allowed" to use the resources of that preconfigured grant configuration. In other words, the traffic prioritization configuration may comprise information indicating per grant configuration which traffic can be transmitted using the grant. This would then require the prescheduling configurations are given indices:

10

DRB-ToAddMod ::= SEQUENCE {			
eps-BearerIdentity	INTEGER (0..15)	OPTIONAL,	--
Cond DRB-Setup			
drb-Identity	DRB-Identity,		
pdcp-Config	PDCP-Config	OPTIONAL,	--
Cond PDCP			
rlc-Config	RLC-Config	OPTIONAL,	--
Cond SetupM			
logicalChannelIdentity	INTEGER (3..10)	OPTIONAL,	--
Cond DRB-SetupM			
logicalChannelConfig	LogicalChannelConfig	OPTIONAL,	--
Cond SetupM			
....			
[[drb-TypeChange-r12	ENUMERATED {toMCG}	OPTIONAL,	
rlc-Config-v1250	RLC-Config-v1250	OPTIONAL	--
Need ON			
]],			
[[rlc-Config-v13xx	RLC-Config-v13xx	OPTIONAL	--
Need ON			
]],			
[[usePreScheduledGrants-r14	BIT STRING (SIZE (4))	OPTIONAL	
]]			
}			

This may be beneficial for example in a scenario where the UE has two types of traffic where one type of traffic may be infrequent but very delay sensitive, and the other type of traffic is frequent but delay tolerant. The eNB may therefore configure several UEs to use the resources associated with G1, but only a few (possibly one)
 15 UE is configured to use the resources associated with G2. The eNB may in this scenario not want the UE to use the resources associated with G1 for the delay tolerant traffic (which is mapped to G2).

It should be appreciated that this embodiment can be generalized to apply for any number of pre-configurator grants, but for it has been used as an example that the UE has two preconfigured grants.

Opportunistic inclusion of unprioritized traffic

- 5 In case the UE is performing a transmission using a prescheduled grant and for this grant only certain bearers are prioritized to be transmitted it may be so that those bearers has less data than can be transmitted using the grant. E.g. if the grant allows the UE to transmit 1000 Bytes but for the bearers which are prioritized to be transmitted using this grant only has 800 Bytes available then there is 200
- 10 Bytes which are unused.

In an example embodiment, the UE will send data from other bearers in the above scenario. In other words, data from bearers which are normally not prioritized or allowed to be transmitted on pre-scheduled resources may anyway be sent on a pre-scheduled grant if the UE is transmitting using a prescheduled grant and there

15 is room left in the transmission. In the example above, the UE may send 200 Bytes from a bearer which is normally not prioritized to be sent using prescheduled grants.

Example:

Data available for bearer A: 800 Byte

Data available for bearer B: 500 Byte

Prescheduled grant size: 1000 Byte.

Embodiment 1:

UE transmits 800 Byte from bearer A + 200 Byte padding.

Embodiment 2:

UE transmits 800 Byte from bearer A + 200 Byte from bearer B.

Embodiment 2 ensures that if there is room for additional data in a pre-scheduled transmission and data is available for a bearer which is normally not prioritized to be transmitted in pre-scheduled resources, the UE would refrain from sending
5 padding and hence radio resource efficiency will be improved.

When the UE includes traffic which is not highly prioritized in a pre-scheduled transmission as described above, it is possible to specify that the UE may only do so for certain type(s) of traffic. Which type(s) of traffic which may anyway be opportunistically included in a pre-scheduled grant may be configured by the
10 network. It would also be possible that when non-prioritized traffic can be included in a pre-scheduled grant, the UE applies a priority order to decide which traffic to include. This is beneficial as there may be some non-prioritized traffic which is more important than other non-prioritized traffic.

In general, when considering a priority order of traffic types, the proposed
15 technology allows for higher priority traffic to be included before lower priority traffic.

Although bearers were used as examples above, the general concept can be applied equally well to include traffic of an unprioritized logical channel, logical channel group, QoS Class, and so forth if there are remaining resources in a grant.
20

It will be appreciated that the methods and devices described herein can be combined and re-arranged in a variety of ways.

For example, embodiments may be implemented in hardware, or in software for
25 execution by suitable processing circuitry, or a combination thereof.

The steps, functions, procedures, modules and/or blocks described herein may be implemented in hardware using any conventional technology, such as discrete circuit or integrated circuit technology, including both general-purpose electronic circuitry
30 and application-specific circuitry.

Particular examples include one or more suitably configured digital signal processors and other known electronic circuits, e.g. discrete logic gates interconnected to perform a specialized function, or Application Specific Integrated Circuits, ASICs.

5 Alternatively, at least some of the steps, functions, procedures, modules and/or blocks described herein may be implemented in software such as a computer program for execution by suitable processing circuitry such as one or more processors or processing units.

10 Examples of processing circuitry includes, but is not limited to, one or more microprocessors, one or more Digital Signal Processors, DSPs, one or more Central Processing Units, CPUs, video acceleration hardware, and/or any suitable programmable logic circuitry such as one or more Field Programmable Gate Arrays, FPGAs, or one or more Programmable Logic Controllers, PLCs.

15

It should also be understood that it may be possible to re-use the general processing capabilities of any conventional device or unit in which the proposed technology is implemented. It may also be possible to re-use existing software, e.g. by reprogramming of the existing software or by adding new software components.

20

According to an aspect, there is provided an arrangement configured to control utilization of transmission resources allocated to a wireless communication device. The arrangement is configured to obtain a traffic prioritization configuration for controlling utilization of transmission resources of pre-scheduled grants. The arrangement is also
25 configured to determine which traffic to transmit utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

For example, the arrangement may be configured to determine, for traffic available for
30 transmission by the wireless communication device, whether the traffic is prioritized or allowed for transmission utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

Optionally, the arrangement is configured to transmit the prioritized traffic utilizing the transmission resources provided in one or more of the pre-scheduled grants.

By way of example, the traffic prioritization configuration may comprise information
5 indicating whether traffic is prioritized, allowed, unprioritized and/or prohibited to use transmission resources provided in pre-scheduled grants.

For example, the traffic prioritization configuration may comprise information indicating which type(s) of traffic that is/are prioritized or allowed for transmission utilizing
10 transmission resources provided in pre-scheduled grants, and/or which type(s) of traffic that is/are not allowed for transmission utilizing transmission resources provided in pre-scheduled grants.

In a particular example, the information indicating whether traffic is prioritized,
15 allowed, unprioritized and/or prohibited includes information that indicates per Radio Bearer, RB, per Logical Channel, LC, per Logical Channel Group, LCG and/or per Quality of Service, QoS, Class Indicator, QCI, whether the associated traffic is prioritized, allowed, unprioritized and/or prohibited.

20 By way of example, the arrangement may be configured to receive at least part of the traffic prioritization configuration from a network device such as a network node. Alternatively, or as a complement, as the arrangement is implemented in the wireless communication device, at least part of the traffic prioritization configuration may be preconfigured in the wireless communication device. In the latter case, the
25 arrangement may be configured to access or read at least part of the traffic prioritization configuration from a suitable memory location such as a configuration storage in the wireless communication device.

FIG. 6 is a schematic block diagram illustrating an example of an arrangement
30 configured to control utilization of transmission resources allocated to a wireless communication device. In this particular example, the arrangement 100 comprises a processor 110 and a memory 120, the memory 120 comprising instructions executable by the processor, whereby the processor is operative to control the

utilization of the transmission resources allocated to the wireless communication device.

Optionally, the arrangement 100 may also include a communication circuit 130. The communication circuit 130 may include functions for wired and/or wireless communication with other devices and/or network nodes in the network. In a particular example, the communication circuit may be based on radio circuitry for communication with one or more other nodes, including transmitting and/or receiving information. The communication circuit 130 may be interconnected to the processor 110 and/or memory 120.

FIG. 7 is a schematic block diagram illustrating an example of a wireless communication device comprising an arrangement of FIG. 6. In this example, the wireless communication device 200 comprises an arrangement 100 as illustrated in FIG. 6.

According to yet another aspect, there is provided an arrangement configured to enable control of utilization of transmission resources allocated to a wireless communication device. The arrangement is configured to generate a traffic prioritization configuration for controlling utilization of transmission resources of pre-scheduled grants. The arrangement is also configured to prepare the traffic prioritization configuration for transmission to the wireless communication device to enable the wireless communication device to determine which traffic to transmit utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

By way of example, the traffic prioritization configuration may enable the wireless communication device to determine whether traffic is prioritized for transmission utilizing transmission resources provided in one or more pre-scheduled grants. As an example, the traffic prioritization configuration comprises information indicating whether traffic is prioritized, allowed, unprioritized and/or prohibited to use transmission resources provided in pre-scheduled grants.

For example, the traffic prioritization configuration may comprise information indicating which type(s) of traffic that is/are prioritized or allowed for transmission utilizing transmission resources provided in pre-scheduled grants, and/or which type(s) of traffic that is/are not allowed for transmission utilizing transmission resources provided in pre-
5 scheduled grants.

In a particular example, the information indicating whether traffic is prioritized, allowed, unprioritized and/or prohibited includes information that indicates per Radio Bearer, RB, per Logical Channel, LC, per Logical Channel Group, LCG and/or per
10 Quality of Service, QoS, Class Indicator, QCI, whether the associated traffic is prioritized, allowed, unprioritized and/or prohibited.

FIG. 8 is a schematic block diagram illustrating an example of an arrangement configured to enable control of utilization of transmission resources allocated to a
15 wireless communication device. In this particular example, the arrangement 300 comprises a processor 310 and a memory 320, the memory 320 comprising instructions executable by the processor, whereby the processor 310 is operative to enable control of the utilization of the transmission resources.

20 Optionally, the arrangement 300 may also include a communication circuit 330. The communication circuit 330 may include functions for wired and/or wireless communication with other devices and/or network nodes in the network. In a particular example, the communication circuit may be based on radio circuitry for communication with one or more other nodes, including transmitting and/or receiving
25 information. The communication circuit 330 may be interconnected to the processor 310 and/or memory 320.

For example, the arrangement 300 may be configured to transmit the traffic prioritization configuration to the wireless communication device.

30 FIG. 9 is a schematic block diagram illustrating an example of a network device comprising an arrangement of FIG. 8. In this example, the network device 400 comprises an arrangement 300 as illustrated in FIG. 8.

By way of example, the network device may be a cloud-based network device or a network node such as a radio access network node (e.g. eNB).

FIG. 10 is a schematic diagram illustrating an example of a computer implementation according to an embodiment. In this particular example, at least some of the steps, functions, procedures, modules and/or blocks described herein are implemented in a computer program 525; 535, which is loaded into the memory 520 for execution by processing circuitry including one or more processors 510. The processor(s) 510 and memory 520 are interconnected to each other to enable normal software execution. An optional input/output device may also be interconnected to the processor(s) and/or the memory to enable input and/or output of relevant data such as input parameter(s) and/or resulting output parameter(s).

The term 'processor' should be interpreted in a general sense as any system or device capable of executing program code or computer program instructions to perform a particular processing, determining or computing task.

The processing circuitry including one or more processors is thus configured to perform, when executing the computer program, well-defined processing tasks such as those described herein.

The processing circuitry does not have to be dedicated to only execute the above-described steps, functions, procedure and/or blocks, but may also execute other tasks.

There is provided a computer program 525; 535 for controlling, when executed by a processor, utilization of transmission resources allocated to a wireless communication device.

In a particular embodiment, the computer program 525; 535 comprises instructions, which when executed by at least one processor, cause the processor(s) to:

- obtain a traffic prioritization configuration for controlling utilization of transmission resources of pre-scheduled grants, and

- determine which traffic to transmit by utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

5 According to another aspect, there is also provided a computer program 525; 535 for enabling, when executed by a processor, control of utilization of transmission resources allocated to a wireless communication device.

In a particular embodiment, the computer program 525; 535 comprises instructions,
10 which when executed by at least one processor, cause the processor(s) to:

- generate a traffic prioritization configuration for controlling utilization of transmission resources of pre-scheduled grants; and
- output the traffic prioritization configuration for transmission to the wireless communication device to enable the wireless communication device to
15 determine which traffic to transmit by utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration .

The proposed technology provides a carrier comprising the computer program, wherein the carrier is one of an electronic signal, an optical signal, an electromagnetic signal, a
20 magnetic signal, an electric signal, a radio signal, a microwave signal, or a computer-readable storage medium.

By way of example, the software or computer program 225; 235 may be realized as a computer program product, which is normally carried or stored on a computer-readable
25 medium 220; 230, in particular a non-volatile medium. The computer-readable medium may include one or more removable or non-removable memory devices including, but not limited to a Read-Only Memory, ROM, a Random Access Memory, RAM, a Compact Disc, CD, a Digital Versatile Disc, DVD, a Blu-ray disc, a Universal Serial Bus, USB, memory, a Hard Disk Drive, HDD, storage device, a flash memory, a
30 magnetic tape, or any other conventional memory device. The computer program may thus be loaded into the operating memory of a computer or equivalent processing device for execution by the processing circuitry thereof.

There is thus provided a computer-program product comprising a computer-readable medium having stored thereon a computer program as described herein.

The flow diagram or diagrams presented herein and/or the presented pseudo code
5 may be regarded as a computer flow diagram or diagrams, when performed by one or more processors. A corresponding apparatus may thus be defined as a group of function modules, where each step performed by the processor corresponds to a function module. In this case, the function modules are implemented as a computer program running on the processor.

10

The computer program residing in memory may thus be organized as appropriate function modules configured to perform, when executed by the processor, at least part of the steps and/or tasks described herein.

15 FIG. 11 is a schematic diagram illustrating an example of an apparatus for controlling utilization of transmission resources allocated to a wireless communication device. The apparatus 600 basically comprises modules 610, 620 for performing functions and/or actions described herein. In particular, the apparatus 600 comprises an input module 610 for obtaining a traffic prioritization configuration for controlling utilization of
20 transmission resources of pre-scheduled grants. The apparatus 600 also comprises a determination module 620 for determining which traffic to transmit by utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

25 FIG. 12 is a schematic diagram illustrating an example of an apparatus for enabling control of utilization of transmission resources allocated to a wireless communication device. The apparatus 700 basically comprises modules 710, 720 for performing functions and/or actions described herein. In particular, the apparatus 700 comprises a generating module 710 for generating a traffic prioritization configuration for controlling
30 utilization of transmission resources of pre-scheduled grants. The apparatus 700 also comprises an output module 720 for outputting the traffic prioritization configuration for transmission to the wireless communication device to enable the wireless communication device to determine which traffic to transmit by utilizing transmission

resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

Alternatively it is possibly to realize the modules in FIG. 11 and FIG. 12
5 predominantly by hardware modules, or alternatively by hardware, with suitable interconnections between relevant modules. Particular examples include one or more suitably configured digital signal processors and other known electronic circuits, e.g. discrete logic gates interconnected to perform a specialized function, and/or Application Specific Integrated Circuits, ASICs, as previously mentioned.
10 Other examples of usable hardware include input/output, I/O, circuitry and/or circuitry for receiving and/or sending signals. The extent of software versus hardware is purely implementation selection.

It is becoming increasingly popular to provide computing services (hardware and/or
15 software) in network devices such as network nodes and/or servers where the resources are delivered as a service to remote locations over a network. By way of example, this means that functionality, as described herein, can be distributed or re-located to one or more separate physical nodes or servers. The functionality may be re-located or distributed to one or more jointly acting physical and/or virtual
20 machines that can be positioned in separate physical node(s), i.e. in the so-called cloud. This is sometimes also referred to as cloud computing, which is a model for enabling ubiquitous on-demand network access to a pool of configurable computing resources such as networks, servers, storage, applications and general or customized services.

25

There are different forms of virtualization that can be useful in this context, including one or more of:

- Consolidation of network functionality into virtualized software running on
30 customized or generic hardware. This is sometimes referred to as network function virtualization.

- Co-location of one or more application stacks, including operating system, running on separate hardware onto a single hardware platform. This is sometimes referred to as system virtualization, or platform virtualization.
- 5 • Co-location of hardware and/or software resources with the objective of using some advanced domain level scheduling and coordination technique to gain increased system resource utilization. This is sometimes referred to as resource virtualization, or centralized and coordinated resource pooling.
- 10 Although it may often desirable to centralize functionality in so-called generic data centers, in other scenarios it may in fact be beneficial to distribute functionality over different parts of the network.

FIG. 13 is a schematic diagram illustrating an example of a cloud-based network device 910 in connection with a wireless network 800. The network device 910 is located in a cloud environment 900. Functionality relevant for the wireless network 800, such as a wireless access network and/or core network, may be at least partially implemented for execution in a cloud-based network device 910, with suitable transfer of information such as a traffic prioritization configuration between the cloud-based network device and the relevant network nodes such as an network node 810 and/or one or more wireless communication devices 820 in the wireless network 800.

By way of example, the network device may be implemented in hardware, software or a combination thereof. For example, the network device may be a special-purpose network device or a general purpose network device, or a hybrid thereof.

A special-purpose network device may use custom processing circuits and a proprietary operating system (OS), for execution of software to provide one or more of the features or functions disclosed herein.

A general purpose network device may use common off-the-shelf (COTS) processors and a standard OS, for execution of software configured to provide one or more of the features or functions disclosed herein.

5 By way of example, a special-purpose network device may include hardware comprising processing or computing resource(s), which typically include a set of one or more processors, and physical network interfaces (NIs), which sometimes are called physical ports, as well as non-transitory machine readable storage media having stored thereon software. A physical NI may be seen as hardware in a
10 network device through which a network connection is made, e.g. wirelessly through a wireless network interface controller (WNIC) or through plugging in a cable to a physical port connected to a network interface controller (NIC). During operation, the software may be executed by the hardware to instantiate a set of one or more software instance(s). Each of the software instance(s), and that part of the hardware
15 that executes that software instance, may form a separate virtual network element.

By way of another example, a general purpose network device may for example include hardware comprising a set of one or more processor(s), often COTS processors, and network interface controller(s) (NICs), as well as non-transitory
20 machine readable storage media having stored thereon software. During operation, the processor(s) executes the software to instantiate one or more sets of one or more applications. While one embodiment does not implement virtualization, alternative embodiments may use different forms of virtualization – for example represented by a virtualization layer and software containers. For example, one such
25 alternative embodiment implements operating system-level virtualization, in which case the virtualization layer represents the kernel of an operating system (or a shim executing on a base operating system) that allows for the creation of multiple software containers that may each be used to execute one of a sets of applications. In an example embodiment, each of the software containers (also called
30 virtualization engines, virtual private servers, or jails) is a user space instance (typically a virtual memory space). These user space instances may be separate from each other and separate from the kernel space in which the operating system is executed; the set of applications running in a given user space, unless explicitly

allowed, cannot access the memory of the other processes. Another such alternative embodiment implements full virtualization, in which case: 1) the virtualization layer represents a hypervisor (sometimes referred to as a Virtual Machine Monitor (VMM)) or the hypervisor is executed on top of a host operating system; and 2) the software
5 containers each represent a tightly isolated form of software container called a virtual machine that is executed by the hypervisor and may include a guest operating system.

A hypervisor is the software/hardware that is responsible for creating and managing
10 the various virtualized instances and in some cases the actual physical hardware. The hypervisor manages the underlying resources and presents them as virtualized instances. What the hypervisor virtualizes to appear as a single processor may actually comprise multiple separate processors. From the perspective of the operating system, the virtualized instances appear to be actual hardware
15 components.

A virtual machine is a software implementation of a physical machine that runs programs as if they were executing on a physical, non-virtualized machine; and applications generally do not know they are running on a virtual machine as opposed
20 to running on a “bare metal” host electronic device, though some systems provide para-virtualization which allows an operating system or application to be aware of the presence of virtualization for optimization purposes.

The instantiation of the one or more sets of one or more applications as well as the
25 virtualization layer and software containers if implemented, are collectively referred to as software instance(s). Each set of applications, corresponding software container if implemented, and that part of the hardware that executes them (be it hardware dedicated to that execution and/or time slices of hardware temporally shared by software containers), forms a separate virtual network element(s).

30

The virtual network element(s) may perform similar functionality compared to Virtual Network Element(s) (VNEs). This virtualization of the hardware is sometimes referred to as Network Function Virtualization (NFV)). Thus, NFV may be used to

consolidate many network equipment types onto industry standard high volume server hardware, physical switches, and physical storage, which could be located in data centers, NDs, and Customer Premise Equipment (CPE). However, different embodiments may implement one or more of the software container(s) differently.

5 For example, while embodiments are illustrated with each software container corresponding to a VNE, alternative embodiments may implement this correspondence or mapping between software container-VNE at a finer granularity level; it should be understood that the techniques described herein with reference to a correspondence of software containers to VNEs also apply to embodiments where
10 such a finer level of granularity is used.

According to yet another embodiment, there is provided a hybrid network device, which includes both custom processing circuitry/proprietary OS and COTS processors/standard OS in a network device, e.g. in a card or circuit board within a
15 network device ND. In certain embodiments of such a hybrid network device, a platform Virtual Machine (VM), such as a VM that implements functionality of a special-purpose network device, could provide for para-virtualization to the hardware present in the hybrid network device.

20 The embodiments described above are merely given as examples, and it should be understood that the proposed technology is not limited thereto. It will be understood by those skilled in the art that various modifications, combinations and changes may be made to the embodiments without departing from the present scope as defined by the appended claims. In particular, different part solutions in the different
25 embodiments can be combined in other configurations, where technically possible.

CLAIMS

1. A method for controlling utilization of transmission resources allocated to a wireless communication device (20; 200), wherein the method comprises:
 - 5 - obtaining (S1) a traffic prioritization configuration for controlling utilization of transmission resources of pre-scheduled grants, and
 - determining (S2) which traffic to transmit utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.
- 10 2. The method of claim 1, wherein the traffic relates to traffic data available for transmission by the wireless communication device (20; 200), and the step (S2) of determining which traffic to transmit comprises deciding which type or types of the traffic to transmit using transmission resources provided in the pre-scheduled grant(s).
- 15 3. The method of claim 1 or 2, wherein the step (S2) of determining which traffic to transmit comprises determining, for traffic available for transmission by the wireless communication device (20; 200), whether the traffic is prioritized or allowed for transmission utilizing transmission resources provided in one or more pre-scheduled
- 20 grants based on the traffic prioritization configuration.
4. The method of claim 3, wherein the prioritized traffic is transmitted utilizing the transmission resources provided in one or more of the pre-scheduled grants.
- 25 5. The method of any of the claims 1 to 4, wherein the traffic prioritization configuration comprises information indicating, per pre-scheduled grant and/or per grant configuration, which traffic can be transmitted using the grant.
6. The method of any of the claims 1 to 5, wherein the traffic prioritization
- 30 configuration comprises information indicating whether traffic is prioritized, allowed, unprioritized and/or prohibited to use transmission resources provided in pre-scheduled grants.

7. The method of claim 6, wherein the traffic prioritization configuration comprises information indicating whether traffic is prioritized or unprioritized to use transmission resources provided in pre-scheduled grants.

5 8. The method of claim 6, wherein the traffic prioritization configuration comprises information indicating whether traffic is allowed or prohibited to use transmission resources provided in pre-scheduled grants.

9. The method of any of the claims 6 to 8, wherein the information indicating
10 whether traffic is prioritized, allowed, unprioritized and/or prohibited includes information that indicates per Radio Bearer, RB, per Logical Channel, LC, per Logical Channel Group, LCG and/or per Quality of Service, QoS, Class Indicator, QCI, whether the associated traffic is prioritized, allowed, unprioritized and/or prohibited.

15

10. The method of any of the claims 1 to 9, wherein the step of obtaining the traffic prioritization configuration comprises receiving at least part of the traffic prioritization configuration from a network device.

20 11. The method of claim 10, wherein the traffic prioritization configuration is obtained based on Radio Resource Control, RRC, signaling.

12. The method of any of the claims 1 to 11, wherein at least part of the traffic prioritization configuration is preconfigured in the wireless communication device (20;
25 200), and the step of obtaining the traffic prioritization configuration comprises accessing at least part of the traffic prioritization configuration from a memory location in the wireless communication device (20; 200).

13. The method of any of the claims 1 to 12, wherein unprioritized traffic is also
30 allowed for transmission using part of the transmission resources of the pre-scheduled grant if the pre-scheduled grant includes more transmission resources than required for transmission of prioritized traffic.

14. The method of any of the claims 1 to 13, wherein the method is performed by the wireless communication device (20; 200).

15. A method for enabling control of utilization of transmission resources allocated
5 to a wireless communication device (20; 200), wherein the method comprises:

- generating (S11) a traffic prioritization configuration for controlling utilization of transmission resources of pre-scheduled grants, and
- preparing (S12) the traffic prioritization configuration for transmission to the wireless communication device to enable the wireless communication device to
10 determine which traffic to transmit utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

16. The method of claim 15, wherein the traffic prioritization configuration comprises information indicating, per pre-scheduled grant and/or per grant configuration, which
15 traffic can be transmitted using the grant.

17. The method of claim 15 or 16, wherein the traffic prioritization configuration comprises information indicating whether traffic is prioritized, allowed, unprioritized and/or prohibited to use transmission resources provided in pre-scheduled grants.

20

18. The method of claim 17, wherein the traffic prioritization configuration comprises information indicating which type(s) of traffic that is/are prioritized or allowed for transmission utilizing transmission resources provided in pre-scheduled grants, and/or which type(s) of traffic that is/are not allowed for transmission utilizing
25 transmission resources provided in pre-scheduled grants.

19. The method of claim 17 or 18, wherein the information indicating whether traffic is prioritized, allowed, unprioritized and/or prohibited includes information that indicates per Radio Bearer, RB, per Logical Channel, LC, per Logical Channel
30 Group, LCG and/or per Quality of Service, QoS, Class Indicator, QCI, whether the associated traffic is prioritized, allowed, unprioritized and/or prohibited.

20. The method of any of the claims 15 to 19, wherein the traffic prioritization configuration is transmitted to the wireless communication device (20; 200).

21. The method of claim 20, wherein the traffic prioritization configuration is
5 transmitted to the wireless communication device (20; 200) by Radio Resource Control, RRC, signaling.

22. The method of any of the claims 15 to 21, wherein the method is performed by a network device (10; 400; 810; 910).

10

23. An arrangement (100) configured to control utilization of transmission resources allocated to a wireless communication device (20; 200),

wherein the arrangement (100) is configured to obtain a traffic prioritization configuration for controlling utilization of transmission resources of pre-scheduled
15 grants,

wherein the arrangement (100) is configured to determine which traffic to transmit utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

20 24. The arrangement of claim 23, wherein the arrangement (100) is configured to determine, for traffic available for transmission by the wireless communication device (20; 200), whether the traffic is prioritized or allowed for transmission utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

25

25. The arrangement of claim 24, wherein the arrangement (100) is configured to transmit the prioritized traffic utilizing the transmission resources provided in one or more of the pre-scheduled grants.

30 26. The arrangement of any of the claims 23 to 25, wherein the traffic prioritization configuration comprises information indicating whether traffic is prioritized, allowed, unprioritized and/or prohibited to use transmission resources provided in pre-scheduled grants.

27. The arrangement of claim 26, wherein the traffic prioritization configuration comprises information indicating which type(s) of traffic that is/are prioritized or allowed for transmission utilizing transmission resources provided in pre-scheduled grants, and/or which type(s) of traffic that is/are not allowed for transmission utilizing transmission resources provided in pre-scheduled grants.

28. The arrangement of claim 26 or 27, wherein the information indicating whether traffic is prioritized, allowed, unprioritized and/or prohibited includes information that indicates per Radio Bearer, RB, per Logical Channel, LC, per Logical Channel Group, LCG and/or per Quality of Service, QoS, Class Indicator, QCI, whether the associated traffic is prioritized, allowed, unprioritized and/or prohibited.

29. The arrangement of any of the claims 23 to 28, wherein the arrangement (100) is configured to receive at least part of the traffic prioritization configuration from a network device.

30. The arrangement of any of the claims 23 to 29, wherein the arrangement (100) is implemented in the wireless communication device (20; 200) and at least part of the traffic prioritization configuration is preconfigured in the wireless communication device (20; 200).

31. The arrangement of claim 30, wherein the arrangement (100) is configured to access at least part of the traffic prioritization configuration from a memory location in the wireless communication device (20; 200).

32. The arrangement of any of the claims 23 to 31, wherein the arrangement (100) comprises a processor (110) and a memory (120), the memory (120) comprising instructions executable by the processor (110), whereby the processor (110) is operative to control the utilization of the transmission resources.

33. A wireless communication device (20; 200) comprising the arrangement (100) of any of the claims 23 to 32.

34. An arrangement (300) configured to enable control of utilization of transmission resources allocated to a wireless communication device (20; 200),

wherein the arrangement (300) is configured to generate a traffic prioritization configuration for controlling utilization of transmission resources of pre-scheduled grants,

wherein the arrangement (300) is configured to prepare the traffic prioritization configuration for transmission to the wireless communication device (20; 200) to enable the wireless communication device to determine which traffic to transmit utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

35. The arrangement of claim 34, wherein the traffic prioritization configuration comprises information indicating whether traffic is prioritized, allowed, unprioritized and/or prohibited to use transmission resources provided in pre-scheduled grants.

36. The arrangement of claim 35, wherein the traffic prioritization configuration comprises information indicating which type(s) of traffic that is/are prioritized or allowed for transmission utilizing transmission resources provided in pre-scheduled grants, and/or which type(s) of traffic that is/are not allowed for transmission utilizing transmission resources provided in pre-scheduled grants.

37. The arrangement of claim 35 or 36, wherein the information indicating whether traffic is prioritized, allowed, unprioritized and/or prohibited includes information that indicates per Radio Bearer, RB, per Logical Channel, LC, per Logical Channel Group, LCG and/or per Quality of Service, QoS, Class Indicator, QCI, whether the associated traffic is prioritized, allowed, unprioritized and/or prohibited.

38. The arrangement of any of the claims 34 to 37, wherein the arrangement (300) is configured to transmit the traffic prioritization configuration to the wireless communication device (20; 200).

39. The arrangement of any of the claims 34 to 38, wherein the arrangement (300) comprises a processor (310) and a memory (320), the memory (320) comprising instructions executable by the processor, whereby the processor (310) is operative to enable control of the utilization of the transmission resources.

5

40. A network device (10; 400; 810; 910) comprising the arrangement (300) of any of the claims 34 to 39.

41. The network device of claim 40, wherein the network device (10; 400; 810; 910) is a network node (10; 400; 810) or a cloud-based network device (400; 910).

42. A computer program (525; 535) for controlling, when executed by a processor (510), utilization of transmission resources allocated to a wireless communication device (20; 200), wherein the computer program comprises instructions, which when
15 executed by the processor (510), cause the processor (510) to:

- obtain a traffic prioritization configuration for controlling utilization of transmission resources of pre-scheduled grants, and
- determine which traffic to transmit utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization
20 configuration.

43. A (525; 535) computer program for enabling, when executed by a processor (510), control of utilization of transmission resources allocated to a wireless communication device (20; 200), wherein the computer program comprises
25 instructions, which when executed by the processor (510), cause the processor (510) to:

- generate a traffic prioritization configuration for controlling utilization of transmission resources of pre-scheduled grants; and
- output the traffic prioritization configuration for transmission to the
30 wireless communication device to enable the wireless communication device to determine which traffic to transmit utilizing transmission resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

44. A computer-program product comprising a computer-readable medium (520; 530) having stored thereon a computer program (525; 535) of claim 41 or 42.

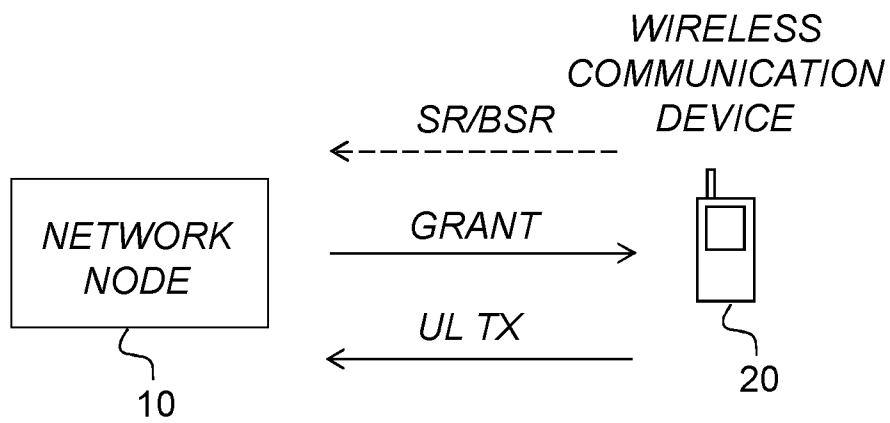
45. An apparatus (600) for controlling utilization of transmission resources allocated
5 to a wireless communication device, wherein the apparatus (600) comprises:

- an input module (610) for obtaining a traffic prioritization configuration for controlling utilization of transmission resources of pre-scheduled grants, and
- a determination module (620) for determining which traffic to transmit utilizing transmission resources provided in one or more pre-scheduled grants based
10 on the traffic prioritization configuration.

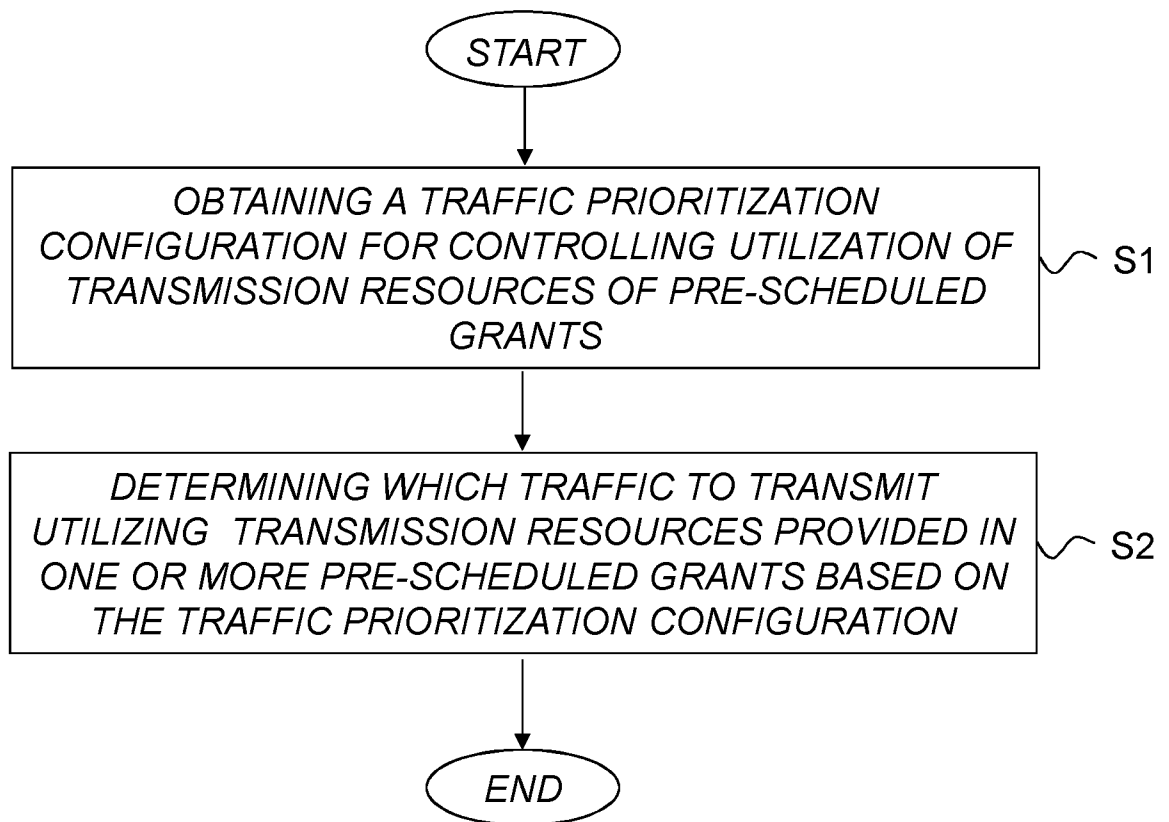
46. An apparatus (700) for enabling control of utilization of transmission resources allocated to a wireless communication device, wherein the apparatus (700) comprises:

- a generating module (710) for generating a traffic prioritization
15 configuration for controlling utilization of transmission resources of pre-scheduled grants,
- an output module (720) for outputting the traffic prioritization configuration for transmission to the wireless communication device to enable the wireless communication device to determine which traffic to transmit utilizing transmission
20 resources provided in one or more pre-scheduled grants based on the traffic prioritization configuration.

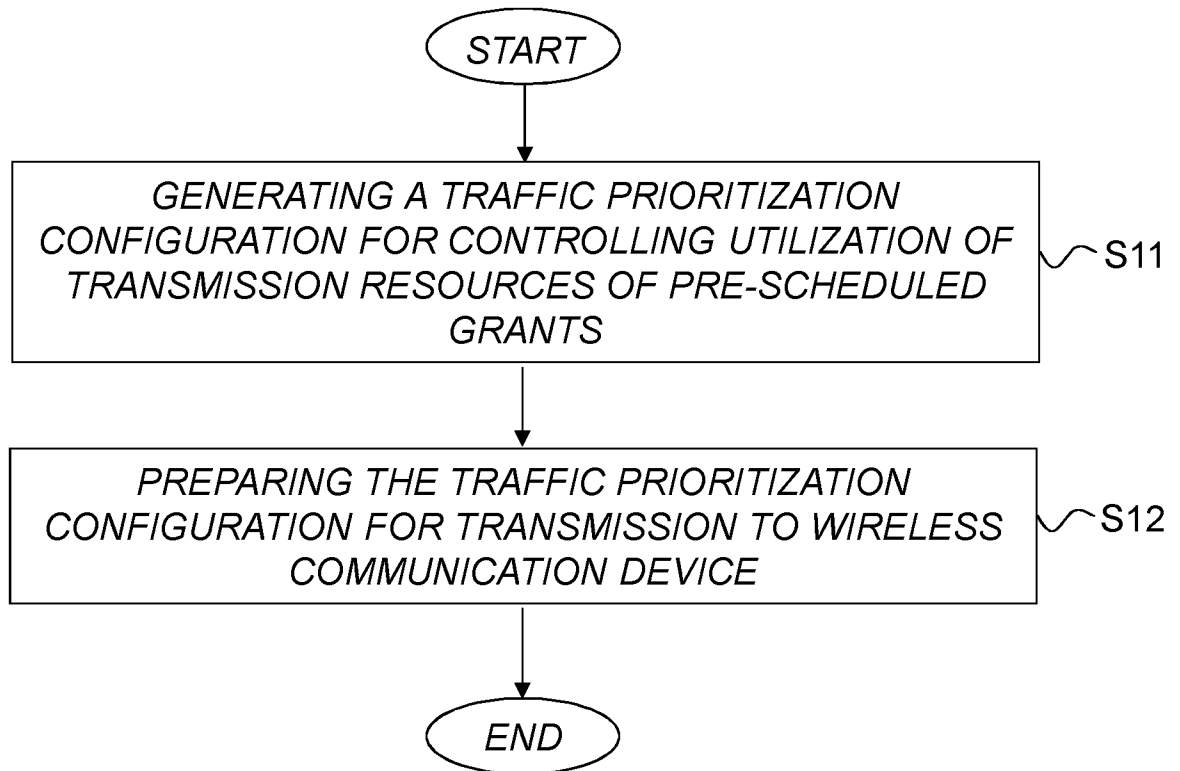
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*Fig. 1*

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*Fig. 2*

3/10

*Fig. 3*

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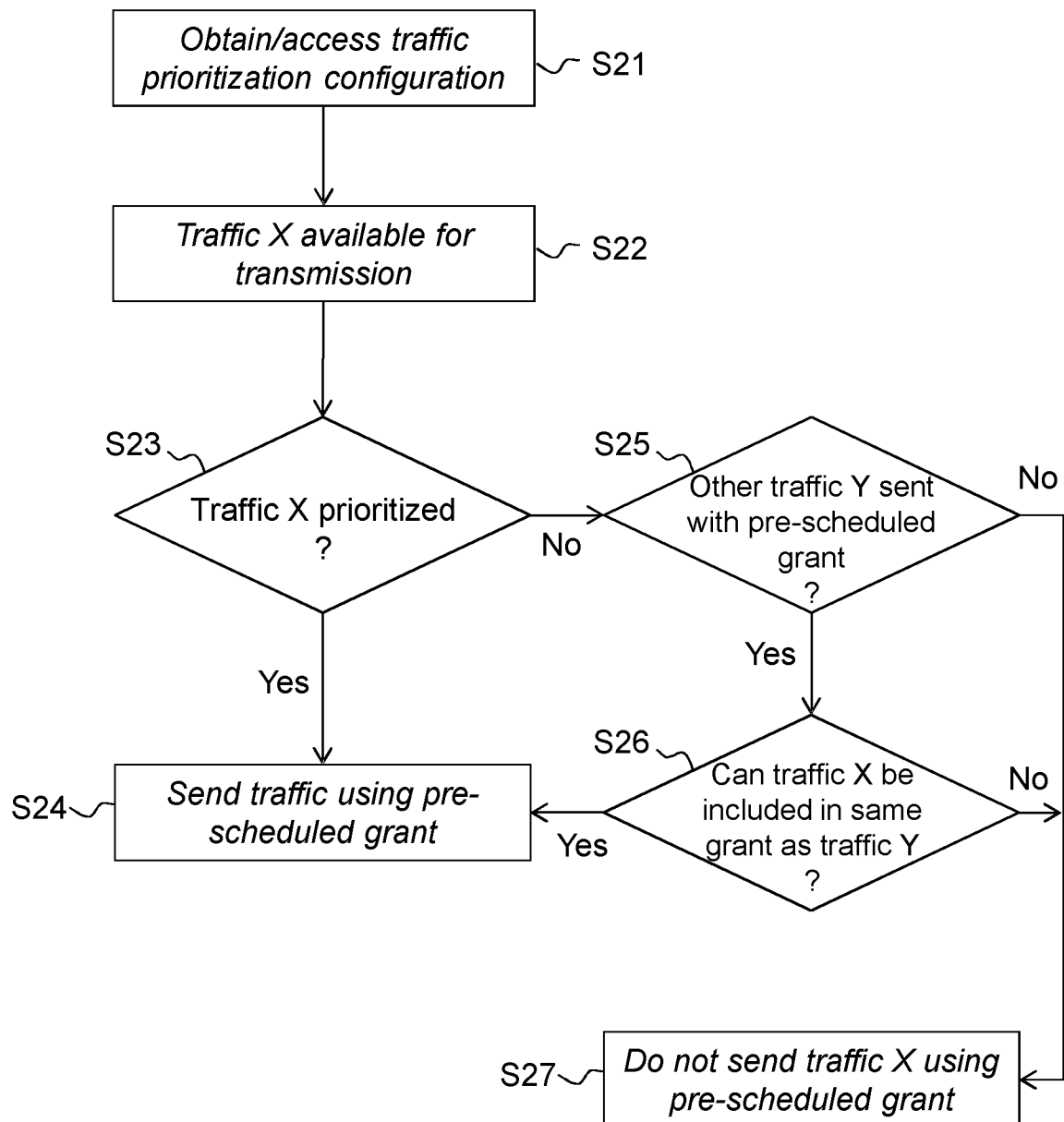


Fig. 4

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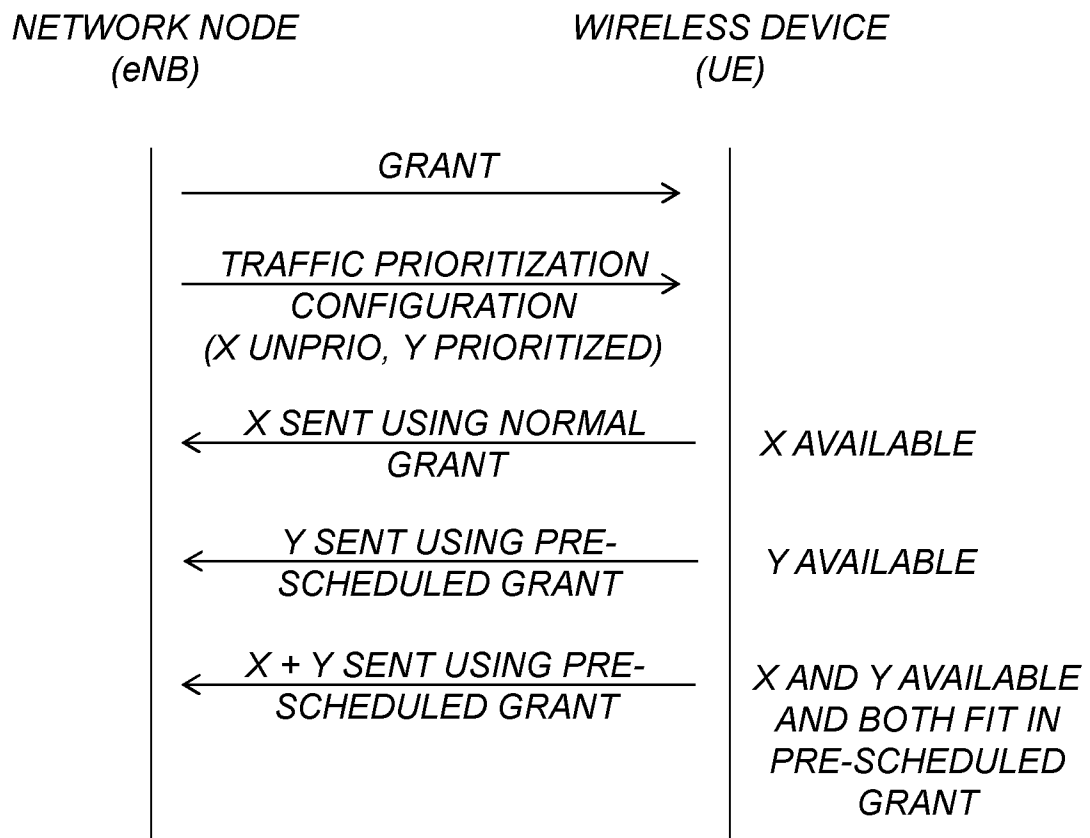


Fig. 5

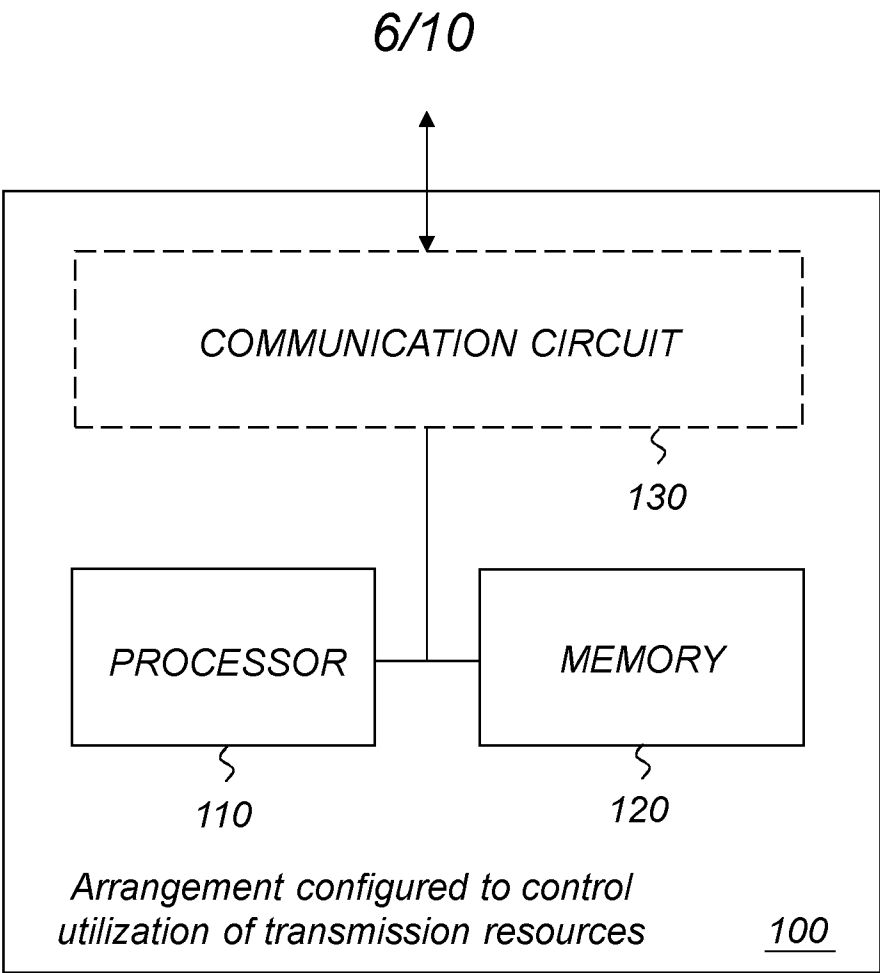


Fig. 6

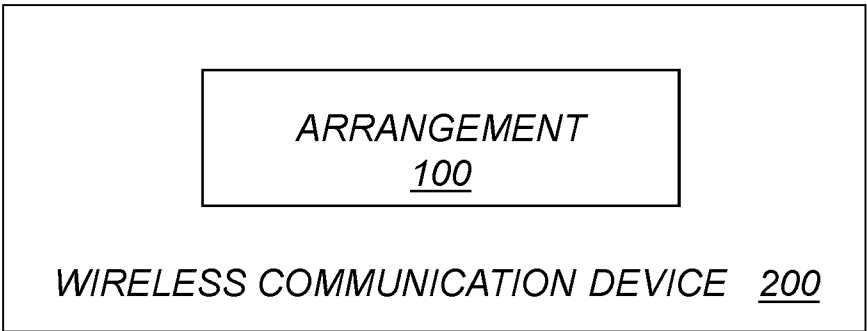


Fig. 7

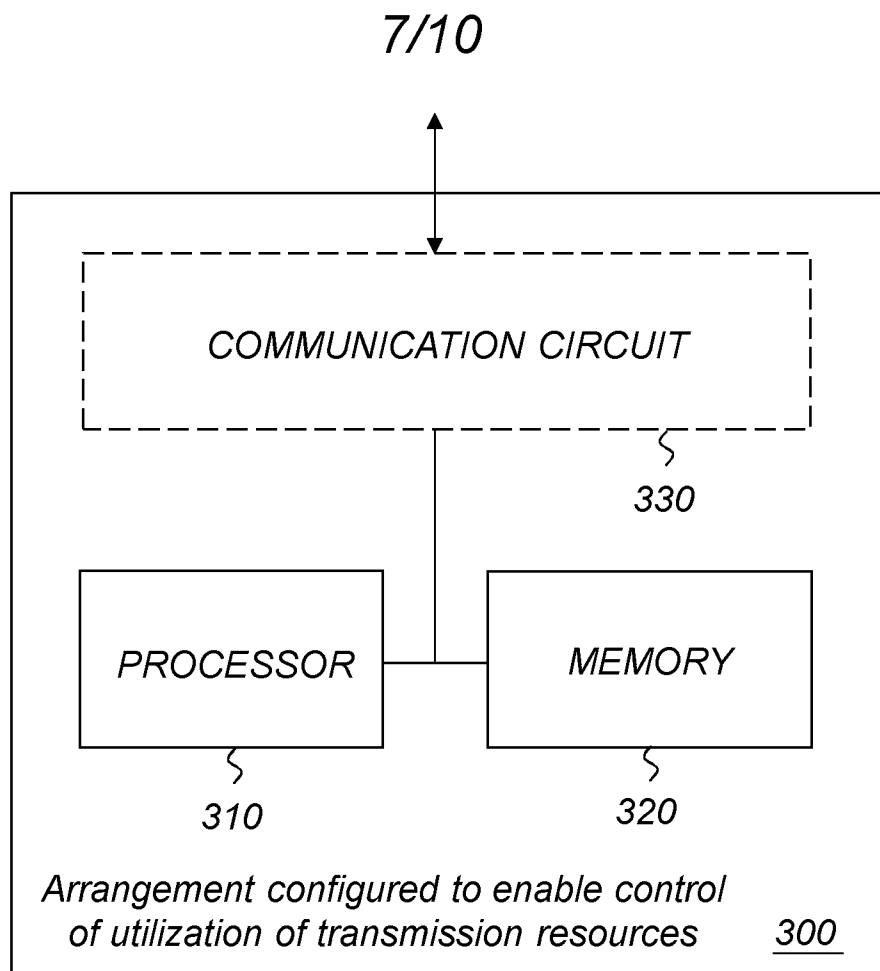


Fig. 8

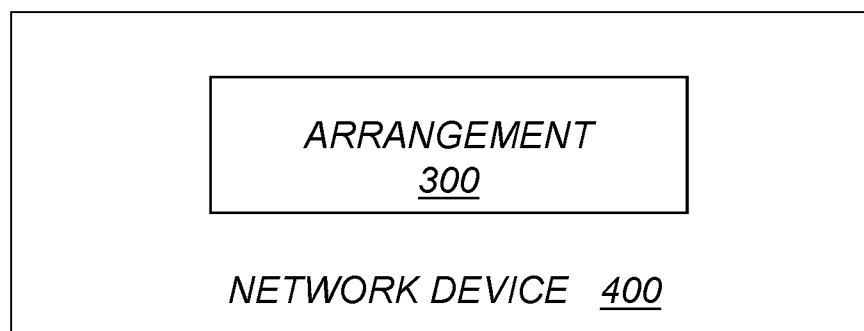


Fig. 9

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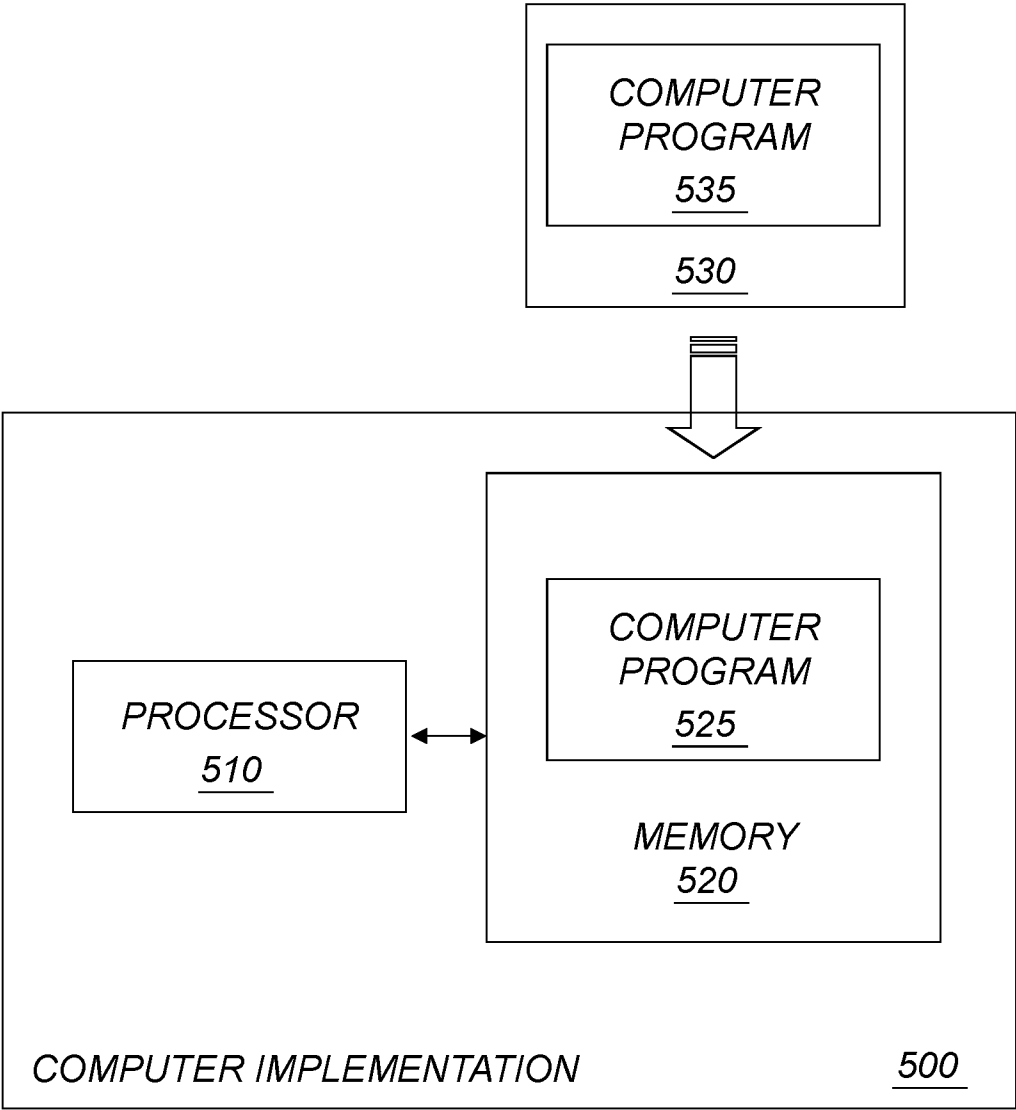
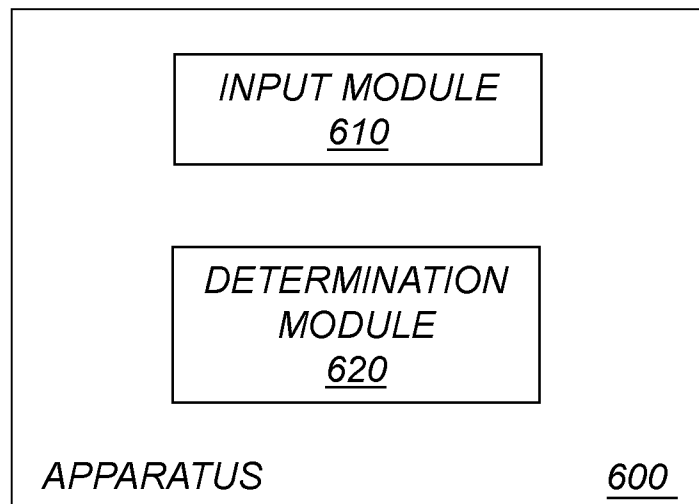
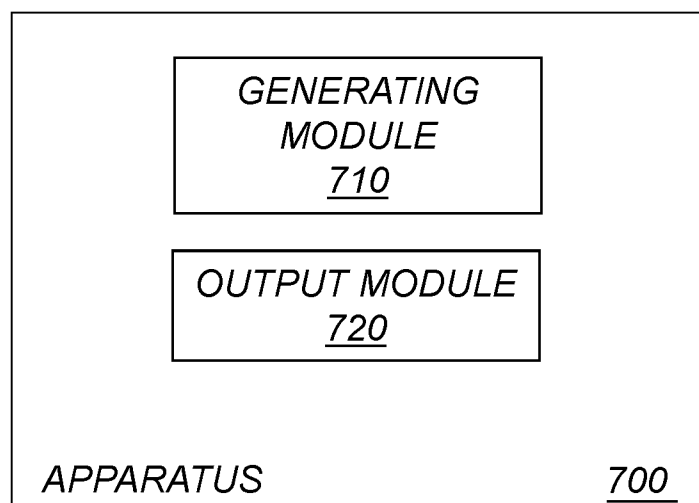


Fig. 10

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*Fig. 11**Fig. 12*

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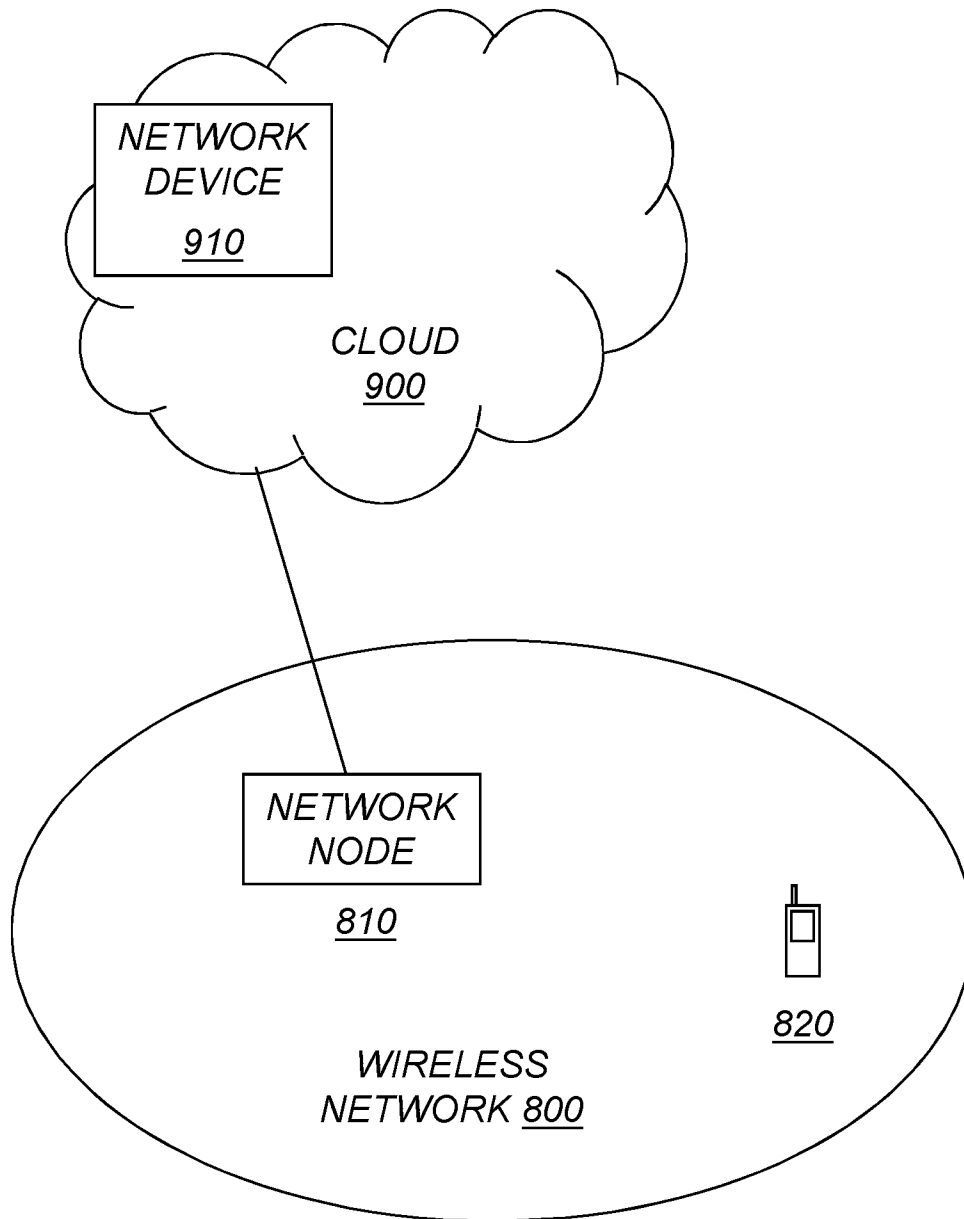


Fig. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2017/050180

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: H04L, H04W

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

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2010051513 A2 (INTERDIGITAL PATENT HOLDINGS ET AL), 6 May 2010 (2010-05-06); abstract; paragraphs [0033], [0083], [0139], [0142], [0144], [0147]-[0148], [0156], [0161]-[0164] --	1-46
X	US 20140078985 A1 (KANAMARLAPUDI SITARAMANJANEYULU ET AL), 20 March 2014 (2014-03-20); abstract; paragraphs [0037]-[0038], [0078]-[0081]; figure 2 -- -----	1-46

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

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search 24-04-2017	Date of mailing of the international search report 24-04-2017
Name and mailing address of the ISA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Authorized officer Magdalena Nohrborg Telephone No. + 46 8 782 28 00

Continuation of: second sheet

International Patent Classification (IPC)

H04W 72/12 (2009.01)

H04L 29/08 (2006.01)

H04W 72/04 (2009.01)

H04W 72/10 (2009.01)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2017/050180

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