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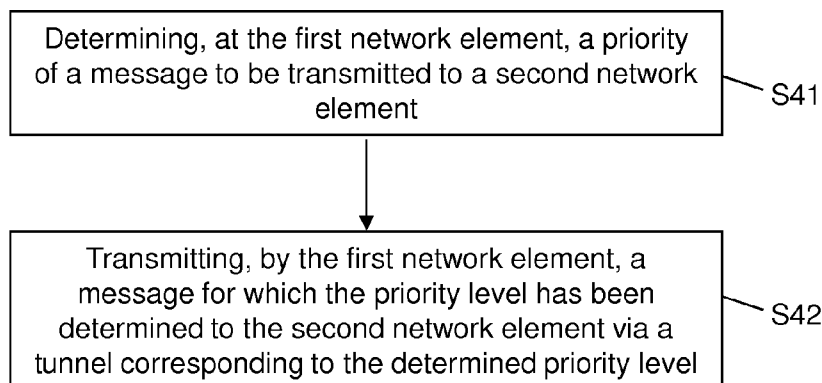
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Fig. 4



(57) Abstract: The present invention provides apparatuses, methods, computer programs, computer program products and computer-readable media regarding distinction of signaling messages carried over the same bearer. Certain aspects of the present invention include determining, at the first network element, a priority level of a message to be transmitted to a second network element, transmitting, by the first network element, a message for which the priority level has been determined, to the second network element via a tunnel corresponding to the determined priority level or to a specific IP address and possibly a specific port number.



DESCRIPTION

METHOD COMPUTER PROGRAM PRODUCT AND APPARATUS FOR
TRAFFIC FLOW DIFFERENTIATIONField of the invention

The present invention relates to apparatuses, methods, systems, computer programs, computer program products and computer-readable media regarding distinction of signaling messages carried over the same bearer.

Background of the invention

EPS is the Evolved Packet System, the successor of GPRS (General Packet Radio System). It provides new radio interface and new packet core network functions for broadband wireless data access. Such EPS core network functions are the Mobility Management Entity (MME), Packet Data Network Gateway (P-GW) and Serving Gateway (S-GW).

Fig. 1 is a diagram illustrating the EPS architecture as defined in 3GPP TS 23.401. Since this architecture is well-known by the skilled person, a detailed description thereof is omitted here and it is referred to 3GPP TS 23.401 for further details.

A common packet domain Core Network is used for all Radio Access Networks (RAN), GERAN (GSM (Global System for Mobile Communication) EDGE (Enhanced Data rates for GSM Evolution) RAN), UTRAN (UMTS (Universal Mobile Telecommunication System) Terrestrial Radio Access Network) and E-UTRAN (Enhanced UTRAN).

The PCC (Policy and Charging Control) architecture, including DPI (Deep Packet Inspection) functionality in TDF (Traffic Detection Function) and PCEF (Policy and Charging Enforcement Function) enhanced with ADC (Application Detection and Control) rules, extends the architecture of an IP-CAN (Internet Protocol Connectivity Access Network), where the PCEF is a functional entity in the gateway node (PGW or GGSN) implementing the IP access to the PDN (Packet Data Network). An example for an Application Function (AF) is the P-CSCF (Proxy Call Session Control Function) that is part of the IP Multimedia

Subsystem (IMS) or any other application proxy and server function within the IMS or other application domains.

Fig. 2 is a diagram illustrating the overall PCC architecture (roaming with home routed access) when SPR (Subscription Profile Repository) is used, as defined in 3GPP TS 23.203. Since the overall PCC architecture is well-known by the skilled person, a detailed description thereof is omitted here and it is referred to 3GPP TS 23.203 for further details.

The following problem was encountered in a specific operator's network: The operator wants to use different paging strategies for VoLTE (Voice over Long Term Evolution) and non-VoLTE signaling messages in case the UE (User Equipment) is idle. As an example: A SIP (Session Initiation Protocol) INVITE message that triggers establishment of a voice call shall trigger a more "aggressive" paging (e.g. paging in a wider area as usual) of the UE than SIP MESSAGE or SIP NOTIFY messages. Thus, the UE is transferred in most cases much faster from idle to connected mode, paging re-transmissions are avoided and voice calls are also established faster. Instead of VoLTE or IMS conversational voice any other IMS service can also be considered for special paging.

However, problem is that between PGW/GGSN and eNodeB/RNC all SIP signaling messages are carried in the same QCI5 (Quality of service Class Identifier = 5) EPC user plane bearer. Each SIP message towards an idle UE arriving at the SGW triggers a Downlink Data Notification (DDN) message to the MME. The problem is that currently SGW and MME cannot distinguish between VoLTE and non-VoLTE related SIP messages.

The following short-term proprietary solution was proposed for the operator in this case: The AF/P-CSCF marks SIP messages with different DSCP (Differentiated Services Code Point) value, e.g. the first TCP-SYN (Transmission Control Protocol Synchronization) followed by a SIP INVITE is marked with a different DSCP value than the TCP-SYN followed by a SIP MESSAGE. SGW recognizes the DSCP value and provides a proper indication to MME within the DDN (Downlink Data Notification). Based on this indication in the DDN, MME can page the UE in different ways. Problem with this solution is that standardizing DSCP values on the link between AF/P-CSCF and PGW/GGSN is not possible as DSCP is already used in routers for packet scheduling. This was the reason why all attempts to use DSCP for traffic differentiation in 3GPP were not successful. As a consequence a standardized solution for the above described operator's problem will most likely not be based on DSCP or the used

DSCP values are implementation and deployment specific, since DSCP marking has some drawbacks (e.g. DSCP values widely used in transport networks).

Summary of the Invention

It is therefore an object of the present invention to overcome the above mentioned problems and to provide apparatuses, methods, systems, computer programs, computer program products and computer-readable media regarding distinction of signaling messages carried over the same bearer.

According to an aspect of the present invention there is provided a method comprising:

- determining, at the first network element, a priority level of a message to be transmitted to a second network element, and

- transmitting, by the first network element, a message for which the priority level has been determined, to the second network element via a tunnel corresponding to the determined priority level.

According to another aspect of the present invention, there is provided an apparatus for use in a network element, comprising:

- at least one processor,

- and

- at least one memory for storing instructions to be executed by the processor, wherein the at least one memory and the instructions are configured to, with the at least one processor, cause the apparatus at least to perform:

- determining, at the first network element, a priority level of a message to be transmitted to a second network element, and

- transmitting, by the first network element, a message for which the priority level has been determined, to the second network element via a tunnel corresponding to the determined priority level.

According to another aspect of the present invention there is provided an apparatus comprising:

- means for determining, at the first network element, a priority level of a message to be transmitted to a second network element, and

means for transmitting, by the first network element, a message for which the priority level has been determined, to the second network element via a tunnel corresponding to the determined priority level.

According to another aspect of the present invention there is provided a computer program product comprising code means adapted to produce steps of any of the methods as described above when loaded into the memory of a computer.

According to a still further aspect of the invention there is provided a computer program product as defined above, wherein the computer program product comprises a computer-readable medium on which the software code portions are stored.

According to a still further aspect of the invention there is provided a computer program product as defined above, wherein the program is directly loadable into an internal memory of the processing device.

Brief Description of the Drawings

These and other objects, features, details and advantages will become more fully apparent from the following detailed description of aspects/embodiments of the present invention which is to be taken in conjunction with the appended drawings, in which:

Fig. 1 is a diagram illustrating the EPS architecture;

Fig. 2 is a diagram illustrating the overall PCC architecture;

Fig. 3 is a diagram illustrating an example of two communication paths between AF/P-CSCF and PGW/GGSN for high- and low-priority messages according to certain aspects of the present invention;

Fig. 4 is a flowchart illustrating an example of a method according to certain aspects of the present invention;

Fig. 5 is block diagram illustrating an example of an apparatus according to certain aspects of the present invention.

Detailed Description

In the following, some example versions of the disclosure and embodiments of the present invention are described with reference to the drawings. For illustrating the present invention, the examples and embodiments will be described in connection with a cellular communication network based on a 3GPP based communication system, for example a GSM, UMTS or LTE/LTE-A (EPS) based system. However, it is to be noted that the present invention is not limited to an application using such type of communication system or communication network, but is also applicable in other types of communication systems or communication networks and the like. It is even applicable in case of fixed access networks.

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

The basic system architecture of a communication network where examples of embodiments of the invention are applicable may comprise a commonly known architecture of one or more communication systems comprising a wired or wireless access network subsystem and a core network. Such an architecture may comprise of one or more communication network control elements, access network elements, radio access network elements, access service network gateways or base transceiver stations, such as a base station (BS), an access point or an eNodeB, which control a respective coverage area or cell and with which one or more communication elements or terminal devices such as a UE or another device having a similar function, such as a modem chipset, a chip, a module etc., which can also be part of a UE or attached as a separate element to a UE, or the like, are capable to communicate via one or more channels for transmitting several types of data. Furthermore, core network elements

such as gateway network elements, policy and charging control network elements, mobility management entities, operation and maintenance elements, and the like may be comprised.

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

The communication network is also able to communicate with other networks, such as a public switched telephone network or the Internet. The communication network may also be able to support the usage of cloud services. It should be appreciated that BSs and/or eNodeBs or their functionalities may be implemented by using any node, host, server or access node etc. entity suitable for such a usage.

Furthermore, the described network elements and communication devices, such as terminal devices or user devices like UEs, communication network control elements of a cell, like a RNC or an eNodeB, access network elements like APs and the like, as well as corresponding functions as described herein may be implemented by software, e.g. by a computer program product for a computer, and/or by hardware. In any case, for executing their respective functions, correspondingly used devices, nodes or network elements may comprise several means, modules, units, components, etc. (not shown) which are required for control, processing and/or communication/signaling functionality. Such means, modules, units and components may comprise, for example, one or more processors or processor units including one or more processing portions for executing instructions and/or programs and/or for processing data, storage or memory units or means for storing instructions, programs and/or data, for serving as a work area of the processor or processing portion and the like (e.g. ROM, RAM, EEPROM, and the like), input or interface means for inputting data and instructions by software (e.g. floppy disc, CD-ROM, EEPROM, and the like), a user interface for providing monitor and manipulation possibilities to a user (e.g. a screen, a keyboard and the like), other interface or means for establishing links and/or connections under the control of the processor unit or portion (e.g. wired and wireless interface means, radio interface means comprising e.g. an antenna unit or the like, means for forming a radio

communication part etc.) and the like, wherein respective means forming an interface, such as a radio communication part, can be also located on a remote site (e.g. a radio head or a radio station etc.). It is to be noted that in the present specification processing portions should not be only considered to represent physical portions of one or more processors, but may also be considered as a logical division of the referred processing tasks performed by one or more processors.

According to certain aspects of the present invention, there are proposed several options to be used on the link between an Application Function (AF) like the P-CSCF and the PGW/GGSN to differentiate between user plane packets and allow e.g. for differentiated paging in the MME. It is noted that for the link between PGW and SGW most probably an extension of GTP-U (GPRS Tunneling Protocol User Plane) and for DDN a new Information Element will be used.

In particular, there are proposed the following options to indicate different priorities for signaling messages between an AF (e.g. P-CSCF) and the PGW/GGSN on the Gi/SGi interface.

Option 1: Usage of tunneling (additional encapsulation of packets or frames)

A first option according to certain aspects of the present invention proposed the usage of tunneling (additional encapsulation of packets or frames).

Between PGW/GGSN and AF/P-CSCF a Layer 2 (L2), a Layer 3 (L3) or a Layer 3 and Layer 4 (L3/L4) tunnel for high-priority signaling can be established. If a more fine-granular separation is required, more tunnels (several tunnels for different priority levels) are also possible.

Possible examples for tunnels are L2 tunnels like Virtual LANs, L3 tunnels like IP-in-IP, GRE (Generic Routing Encapsulation) and L3/L4 tunnels like IP/UDP tunnels. It is noted that other L2, L3, L3/L4 or other tunneling mechanisms are not excluded.

Another option is to use Network Service Header (NSH) (cf. Quinn et al, "Network Service Header", July 12, 2013; <http://tools.ietf.org/html/draft-quinn-nsh-02>). NSH provides the possibility to carry service related metadata in a packet. The packets and the NSH are then encapsulated in an outer header for transport. One example for NSH encapsulation is GRE.

In an implementation according to certain aspects of the present invention, the AF (e.g. P-CSCF) delivers ordinary or “low-priority” signaling messages to PGW/GGSN as of now (e.g. IP/UDP/SIP, where “IP” denotes the Internet Protocol header carrying the UE's IP address), i.e. without any changes to the existing procedures (i.e. no tunneling is applied). However, “high-priority” signaling messages are delivered to PGW/GGSN with additional encapsulation (e.g. L3 encapsulation: IP-1/IP-2/UDP/SIP or IP-1/GRE/IP-2/UDP/SIP, etc., where IP-1 denotes the encapsulating, or outer IP header and IP-2 denotes the inner IP header of the original SIP message) (cf. Fig. 3). An example of L3/L4 encapsulation would be IP-1/UDP-1/IP-2/UDP-2/SIP, etc., where IP-1 and UDP-1 denote the encapsulating, or outer IP/UDP header and IP-2/UDP-2 denote the inner IP/UDP header of the original SIP message.

What is high- and low-priority signaling traffic is determined by the AF/P-CSCF based on operator configuration. In case of L3 or L3/L4 tunnels, PGW/GGSN can discriminate signaling messages by looking into the destination IP address and in case of L3/L4 tunneling, by also checking the port number. For ordinary SIP messages the destination IP address will be UE's IP address (which is advertised by PGW/GGSN to the routers across to Gi/SGi interface), while high-priority SIP messages can use dedicated PGW/GGSN IP addresses as destination address in the outer IP header. With L3/L4 tunneling high-priority SIP messages can use a dedicated port number in the outer Layer 4 header (e.g. in the UDP header). These IP addresses and for L3/L4 tunneling also port numbers are either pre-configured at the AF/P-CSCF or determined via DNS resolution of an appropriate FQDN (Full Qualified Domain Name) that is assigned to the PGW/GGSN.

In case GRE is used as tunneling protocol, high-priority SIP messages can be marked with a special GRE key that is known to both PGW/GGSN and AF/P-CSCF.

Optionally, extension headers in the outer IP header can be used to indicate high-priority SIP messages. The tunnels for high-priority SIP messages can be encrypted (e.g. by using IPsec or SSH).

When PGW/GGSN receives a tunneled packet (i.e. high priority signaling message) from AF/P-CSCF, it must determine the priority of the received SIP signaling message, which is known by the outer, tunnel specific address and port number and potentially GRE key, NSH header or any other information specific to the used tunnel mechanism. PGW/GGSN needs

to strip off the additional, tunnel specific header(s) before forwarding the original SIP message to SGW/SGSN within a GTP-U tunnel (for GTP based S5/S8 or for Gn/Gp interfaces) or within a GRE tunnel (for PMIP (Proxy Mobile Internet Protocol) based S5/S8 interfaces). PGW/GGSN shall send this information in a new or existing GTP-U header to SGW/SGSN; SGW forwards the information to MME in a way that is not defined in this invention. In the uplink direction from PGW/GGSN to AF/P-CSCF no tunneling is required, i.e. PGW/GGSN need not add extra IP or other headers to SIP messages towards AF/P-CSCF.

Option 1 is the most preferred solution, because it works also if SIP messages are encrypted. From option 1, the simplest solution would be if AF/P-CSCF adds another IP header before sending a high priority SIP message. This implies PGW/GGSN must be configured with one or more special IP addresses (in case of L3/L4 tunneling with special IP addresses and special port numbers). Therefore, each of the high priority SIP messages from AF/P-CSCF should use a dedicated destination IP address and possibly also a port number configured in PGW/GGSN and AF/P-CSCF. Operator must ensure each AF/P-CSCF gets such IP addresses and port numbers for all PGW/GGSNs it can send packets to, so that both the ordinary SIP messages and the high priority SIP messages of the same UE end up in the same PGW/GGSN. With this method each priority level is mapped to a certain IP address and port number pair at the PGW/GGSN. When using GRE simplest solution is to use a special GRE key that indicates the actual priority for a high-priority SIP message. In the simplest case only one priority level is used but potentially also different priority levels can be applied with this method.

The above option includes splitting the interface between the PGW/GGSN and the AF/P-CSCF into two paths. This is a bigger functional change than a smart usage of certain fields in different protocol headers. In both cases however AF/P-CSCF must identify high priority SIP messages and handle them differently before sending the messages to PGW/GGSN.

Splitting refers to the option to use a tunneling approach for the messages that have to be treated differently, while "normal" messages do not use this path (i.e. are not tunneled). So, the solution is backward compatible, and is not creating big overhead. It can be used for the IMS/VoLTE use case but also for other IMS services or other applications. Another advantage is also that PGW/GGSN supports usually e.g. GRE and other L2/L3 tunneling techniques and even additional information can be provided in extra tunnel specific headers.

In the following, a more general description of certain embodiments of the present invention is made with respect to Figs. 4 and 5.

Fig. 4 is a flowchart illustrating an example of a method according to example versions of the present invention.

According to example versions of the present invention, the method may be implemented in a gateway, or the like. The method comprises determining, at the first network element, a priority level of a message to be transmitted to a second network element in a step S41, and transmitting, by the first network element, a message for which the priority level has been determined, to the second network element via a tunnel corresponding to the determined priority level in a step S42.

According to further example versions of the present invention, the method further comprises transmitting a message for which no priority level has been determined or the priority has been determined as being at the lowest level directly to the second network element without using a tunnel.

According to further example versions of the present invention, a message with a certain priority level uses a dedicated address or a dedicated address and port number of the second network element as destination address or destination address and port of the message.

According to further example versions of the present invention, the method further comprises establishing a tunnel per priority level between the first network element and a second network element, and transmitting a message with a certain priority level to the second network element via the tunnel corresponding to the certain priority level.

According to further example versions of the present invention, the message with a certain priority level is transmitted according to the generic routing encapsulation protocol and a high priority message is marked with a special generic routing encapsulation key.

According to further example versions of the present invention, the message with a certain priority level is encapsulated in an internet protocol, IP, message and the priority of the message is indicated in an extension header of the IP header.

According to further example versions of the present invention, the message with a certain priority level is transmitted within a layer 2 tunnel.

According to further example versions of the present invention, the first network element is an application function or a proxy call session control function and the second network element is a packet data network gateway.

According to further example versions of the present invention, the priority level of a message is determined based on operator configuration.

According to further example versions of the present invention, each tunnel can be established at the time of configuring the first network element or at any time before a message needs to be sent by the first network element.

According to further example versions of the present invention, the priority levels are predefined at the first network element. The first network element can set priority levels with a certain granularity in either ascending or descending order prior to determining the priority level of a message.

Fig. 5 is a block diagram showing an example of an apparatus according to example versions of the present invention.

In Fig. 5, a block circuit diagram illustrating a configuration of an apparatus 50 is shown, which is configured to implement the above described aspects of the invention. It is to be noted that the apparatus 50 shown in Fig. 5 may comprise several further elements or functions besides those described herein below, which are omitted herein for the sake of simplicity as they are not essential for understanding the invention. Furthermore, the apparatus may be also another device having a similar function, such as a chipset, a chip, a module etc., which can also be part of an apparatus or attached as a separate element to the apparatus, or the like.

The apparatus 50 may comprise a processing function or processor 51, such as a CPU or the like, which executes instructions given by programs or the like. The processor 51 may comprise one or more processing portions dedicated to specific processing as described below, or the processing may be run in a single processor. Portions for executing such specific processing may be also provided as discrete elements or within one or further processors or processing portions, such as in one physical processor like a CPU or in several physical entities, for example. Reference sign 52 denotes transceiver or input/output (I/O) units (interfaces) connected to the processor 51. The I/O units 52 may be used for communicating with one or more other network elements, entities, terminals or the like. The I/O units 52 may be a combined unit comprising communication equipment towards several network elements, or may comprise a distributed structure with a plurality of different interfaces for different network elements. Reference sign 53 denotes a memory usable, for example, for storing data and programs to be executed by the processor 51 and/or as a working storage of the processor 51.

The processor 51 is configured to execute processing related to the above described aspects. In particular, the apparatus 50 may be implemented in or may be part of a first network element, or the like, and may be configured to perform a method as described in connection with Figs 4. Thus, the processor 51 is configured to perform determining, at the first network element, a priority level of a message to be transmitted to a second network element, transmitting, by the first network element, a message for which the priority level has been determined, to the second network element via a tunnel corresponding to the determined priority level.

For further details regarding the functions of the apparatus 5, reference is made to the description of the method according to example versions of the present invention as described in connection with Fig. 4.

Option 2: Usage of IPv6 parameters

A second option according to certain aspects of the present invention proposed the usage of IPv6 parameters.

If IMS uses IPv6 as transport (this is the recommended standard IP version to be used) parameter fields like 'Flow Label', 'Next Header' and 'Traffic Class' can be used to carry information that allows to differentiate between different SIP messages.

The parameter field 'Flow label' was designed for differentiating various services, i.e. for enabling the labeling of packets belonging to particular traffic flows for which the sender requests special handling (cf. IETF RFC2460). Further, this document defines: "Hosts or routers that do not support the functions of the Flow Label field are required to set the field to zero when originating a packet, pass the field on unchanged when forwarding a packet, and ignore the field when receiving a packet".

The 'Next Header' parameter field, which points to the upper layer protocol, is an 8-bit selector. It identifies the type of header immediately following the IPv6 header. It uses the same values as the IPv4 Protocol field (cf. IETF RFC2460). However, changing this to differentiate between various SIP message types may require IETF changes.

Further, the parameter field 'Traffic Class' has the same drawback as DSCP marking for IPv4, as described above.

It is noted that the limitation for this option is that it will not work with IPv4.

Option 3: Usage of UDP/TCP/SCTP headers, if SIP signaling is not encrypted

A third option according to certain aspects of the present invention proposed the usage of UDP/TCP/SCTP headers, if SIP signaling is not encrypted.

Currently, PGW/GGSN and AF/P-CSCF may exchange SIP messages on top of UDP, TCP or SCTP. According to the third option, it is noted that these sub-options may work only if SIP signaling is not encrypted between UE and AF/P-CSCF.

In case of an UDP header (cf. IETF RFC 768), there is no solution. The reason is, the source port is dynamically negotiated between UE and AF/P-CSCF, while the destination port is a well-known one (5060).

In case of a TCP header (cf. IETF RFC 793), source/destination ports cannot be used, like in UDP case. However, URG flag and Urgent pointer could be used for the purpose. This will work if TCP message carries only one TCP-SYN of an INVITE.

Further, options field could also be used for the purpose in two ways:

- Option-Kind (1 octet) indicates the exact SIP message priority;
- Option-Kind (1 octet) indicates that the following Option-Data (variable length) contains the exact SIP message priority. In this case Option-Length (1 octet) should also be used.

The above will work if (a) TCP message carries only one SIP message and (b) if such specific value range is standardized by IETF and 3GPP.

In case of an SCTP header, (cf. IETF RFC 4960), it is noted that SCTP is message-oriented like UDP and ensures reliable, in-sequence transport of messages with congestion control like TCP:

Source/destination ports cannot be used, like in UDP case.

Data chunks could also be used for the purpose in two ways:

- Chunk Value contains a SIP message, which determines the Chunk Length value. In this case Chunk Type (1 octet) can indicate e.g. SIP INVITE with the already standardized value 1 (INIT = initiation).
- A separate Chunk is used for signaling the SIP message priority. In this case a new Chunk Type must be defined by 3GPP and adopted by IETF. Note that Chunk Length must be set to 4, which indicates Chunk Value is not present and Chunk Flags should be set to 0.

As stated above, the most appealing solution from the above options is option 1, because (a) it does not have limitations specific to other options and (b) it works also if SIP messages are encrypted.

In the foregoing exemplary description of the apparatus, only the units/means that are relevant for understanding the principles of the invention have been described using functional blocks. The apparatus may comprise further units/means that are necessary for its respective operation, respectively. However, a description of these units/means is omitted in this specification. The arrangement of the functional blocks of the apparatus is not construed to limit the invention, and the functions may be performed by one block or further split into sub-blocks.

When in the foregoing description it is stated that the apparatus (or some other means) is configured to perform some function, this is to be construed to be equivalent to a description stating that a (i.e. at least one) processor or corresponding circuitry, potentially in cooperation with computer program code stored in the memory of the respective apparatus, is configured to cause the apparatus to perform at least the thus mentioned function. Also, such function is to be construed to be equivalently implementable by specifically configured circuitry or means for performing the respective function (i.e. the expression "unit configured to" is construed to be equivalent to an expression such as "means for").

For the purpose of the present invention as described herein above, it should be noted that

- method steps likely to be implemented as software code portions and being run using a processor at an apparatus (as examples of devices, apparatuses and/or modules thereof, or as examples of entities including apparatuses and/or modules therefore), are software code independent and can be specified using any known or future developed programming language as long as the functionality defined by the method steps is preserved;
- generally, any method step is suitable to be implemented as software or by hardware without changing the idea of the aspects/embodiments and its modification in terms of the functionality implemented;
- method steps and/or devices, units or means likely to be implemented as hardware components at the above-defined apparatuses, or any module(s) thereof, (e.g., devices carrying out the functions of the apparatuses according to the aspects/embodiments as described above) are hardware independent and can be implemented using any known or future developed hardware technology or any hybrids of these, such as MOS (Metal Oxide Semiconductor), CMOS (Complementary MOS), BiMOS (Bipolar MOS), BiCMOS (Bipolar CMOS), ECL (Emitter Coupled Logic), TTL (Transistor-Transistor Logic), etc., using for example ASIC (Application Specific IC (Integrated Circuit)) components, FPGA (Field-programmable Gate Arrays) components, CPLD (Complex Programmable Logic Device) components or DSP (Digital Signal Processor) components;
- devices, units or means (e.g. the above-defined apparatuses, or any one of their respective units/means) can be implemented as individual devices, units or means, but this does not exclude that they are implemented in a distributed fashion throughout the system, as long as the functionality of the device, unit or means is preserved;
- an apparatus may be represented by a semiconductor chip, a chipset, or a (hardware) module comprising such chip or chipset; this, however, does not exclude the possibility that a functionality of an apparatus or module, instead of being hardware implemented, be

implemented as software in a (software) module such as a computer program or a computer program product comprising executable software code portions for execution/being run on a processor;

- a device may be regarded as an apparatus or as an assembly of more than one apparatus, whether functionally in cooperation with each other or functionally independently of each other but in a same device housing, for example.

In general, it is to be noted that respective functional blocks or elements according to above-described aspects can be implemented by any known means, either in hardware and/or software, respectively, if it is only adapted to perform the described functions of the respective parts. The mentioned method steps can be realized in individual functional blocks or by individual devices, or one or more of the method steps can be realized in a single functional block or by a single device.

Generally, any method step is suitable to be implemented as software or by hardware without changing the idea of the present invention. Devices and means can be implemented as individual devices, but this does not exclude that they are implemented in a distributed fashion throughout the system, as long as the functionality of the device is preserved. Such and similar principles are to be considered as known to a skilled person.

Software in the sense of the present description comprises software code as such comprising code means or portions or a computer program or a computer program product for performing the respective functions, as well as software (or a computer program or a computer program product) embodied on a tangible medium such as a computer-readable (storage) medium having stored thereon a respective data structure or code means/portions or embodied in a signal or in a chip, potentially during processing thereof.

It is noted that the aspects/embodiments and general and specific examples described above are provided for illustrative purposes only and are in no way intended that the present invention is restricted thereto. Rather, it is the intention that all variations and modifications which fall within the scope of the appended claims are covered.

Abbreviations:

APN	Access Point Name
AF	Application Function

AS	Application Server
CN	Core Network
GGSN	GPRS Gateway Support Node
P-CSCF	Proxy Call Session Control Function
DL	Downlink
DPI	Deep Packet Inspection
DS/DiffServ	Differentiated Services
DSCP	DiffServ Code Point
eNodeB	Enhanced NodeB
E-UTRAN	Enhanced UTRAN
EPC	Evolved Packet Core
EPS	Evolved Packet System
GGSN	GPRS Gateway Serving Node
GTP	GPRS Tunneling Protocol
GRE	Generic Routing Encapsulation
IE	Information Element
IMS	IP Multimedia Subsystem
LTE	Long Term Evolution
MME	Mobility Management Entity
PCC	Policy and Charging Control
PCEF	Policy and Charging Enforcement Function
PCRF	Policy and Charging Rules Function
P-GW/PGW	Packet Data Network Gateway
PDN	Packet Data Network
PMIP	Proxy Mobile Internet Protocol
RAN	Radio Access Network
RNC	Radio Network Controller
S-GW/SGW	Serving Gateway
SGSN	Serving GPRS Support Node
SSH	Secure Shell
VoLTE	Voice over LTE
UE	User Equipment
UL	Uplink

CLAIMS

1. A method, comprising:

determining, at the first network element, a priority level of a message to be transmitted to a second network element,

transmitting, by the first network element, a message for which the priority level has been determined, to the second network element via a tunnel corresponding to the determined priority level.

2. The method according to claim 1, further comprising:

transmitting a message for which no priority level has been determined or the priority has been determined as being at the lowest level directly to the second network element without using a tunnel.

3. The method according to any one of the preceding claims, wherein

a message with a certain priority level uses a dedicated address or a dedicated address and port number of the second network element as destination address or destination address and port of the message.

4. The method according to any one of the preceding claims, further comprising:

establishing a tunnel per priority level between the first network element and a second network element, and

transmitting a message with a certain priority level to the second network element via the tunnel corresponding to the certain priority level.

5. The method according to any one of the preceding claims, wherein

the message with a certain priority level is transmitted according to the generic routing encapsulation protocol and a high priority message is marked with a special generic routing encapsulation key.

6. The method according to any one of claims 1 to 4, wherein

the message with a certain priority level is encapsulated in an internet protocol, IP, message and the priority of the message is indicated in an extension header of the IP header.

7. The method according to any one of claims 1 to 4, wherein

the message with a certain priority level is transmitted within a layer 2 tunnel.

8. The method according to any one of the preceding claims, wherein
the first network element is an application function or a proxy call session control function
and the second network element is a packet data network gateway or a gateway GPRS support
node.
9. The method according to any one of the preceding claims, wherein
the priority level of a message is determined based on operator configuration.
10. The method according to any one of the preceding claims, wherein
each tunnel can be established at the time of configuring the first network element or at
any time before a message needs to be sent by the first network element.
11. An apparatus for use in a first network element, comprising:
at least one processor,
and
at least one memory for storing instructions to be executed by the processor, wherein
the at least one memory and the instructions are configured to, with the at least one
processor, cause the apparatus at least to perform:
determining, at the first network element, a priority level of a message to be transmitted to
a second network element,
transmitting, by the first network element, a message for which the priority level has been
determined, to the second network element via a tunnel corresponding to the determined priority
level.
12. The apparatus according to claim 11, wherein the at least one memory and the instructions
are further configured to, with the at least one processor, cause the apparatus at least to perform:
transmitting a message for which no priority level has been determined or the priority has
been determined as being at the lowest level directly to the second network element without
using a tunnel.
13. The apparatus according to claim 11 or 12, wherein

a message with a certain priority level uses a dedicated address or a dedicated address and port number of the second network element as destination address or destination address and port of the message.

14. The apparatus according to any one of claims 11 to 13, wherein the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus at least to perform:

establishing a tunnel per priority level between a first network element and a second network element, and

transmitting a message with a certain priority level to the second network element via the tunnel corresponding to the certain priority level.

15. The apparatus according to any one claim 11 to 14, wherein

the message with a certain priority level is transmitted according to the generic routing encapsulation protocol and a high priority message is marked with a special generic routing encapsulation key.

16. The apparatus according to any one of claims 11 to 14, wherein

the message with a certain priority level is encapsulated in an internet protocol, IP, message and the priority of the message is indicated in an extension header of the IP header.

17. The apparatus according to any one of claims 11 to 14, wherein

the message with a certain priority level is transmitted within a layer 2 tunnel.

18. The method according to any one of claims 11 to 17, wherein

the first network element is an application function or a proxy call session control function and the second network element is a packet data network gateway or a gateway GPRS support node.

19. The apparatus according to any one of claims 11 to 18, wherein

the priority level of a message is determined based on operator configuration.

20. The apparatus according to any one of claims 11 to 19, wherein

each tunnel can be established at the time of configuring the first network element or at any time before a message needs to be sent by the first network element.

21. A computer program product including a program for a processing device, comprising software code portions for performing the method of any one of claims 1 to 10 when the program is run on the processing device.

22. The computer program product according to claim 21, wherein the computer program product comprises a computer-readable medium on which the software code portions are stored.

23. The computer program product according to claim 21, wherein the program is directly loadable into an internal memory of the processing device.

24. An apparatus, comprising:

means for determining, at the first network element, a priority level of a message to be transmitted to a second network element,

means for transmitting, by the first network element, a message for which the priority level has been determined, to the second network element via a tunnel corresponding to the determined priority level.

Fig. 1

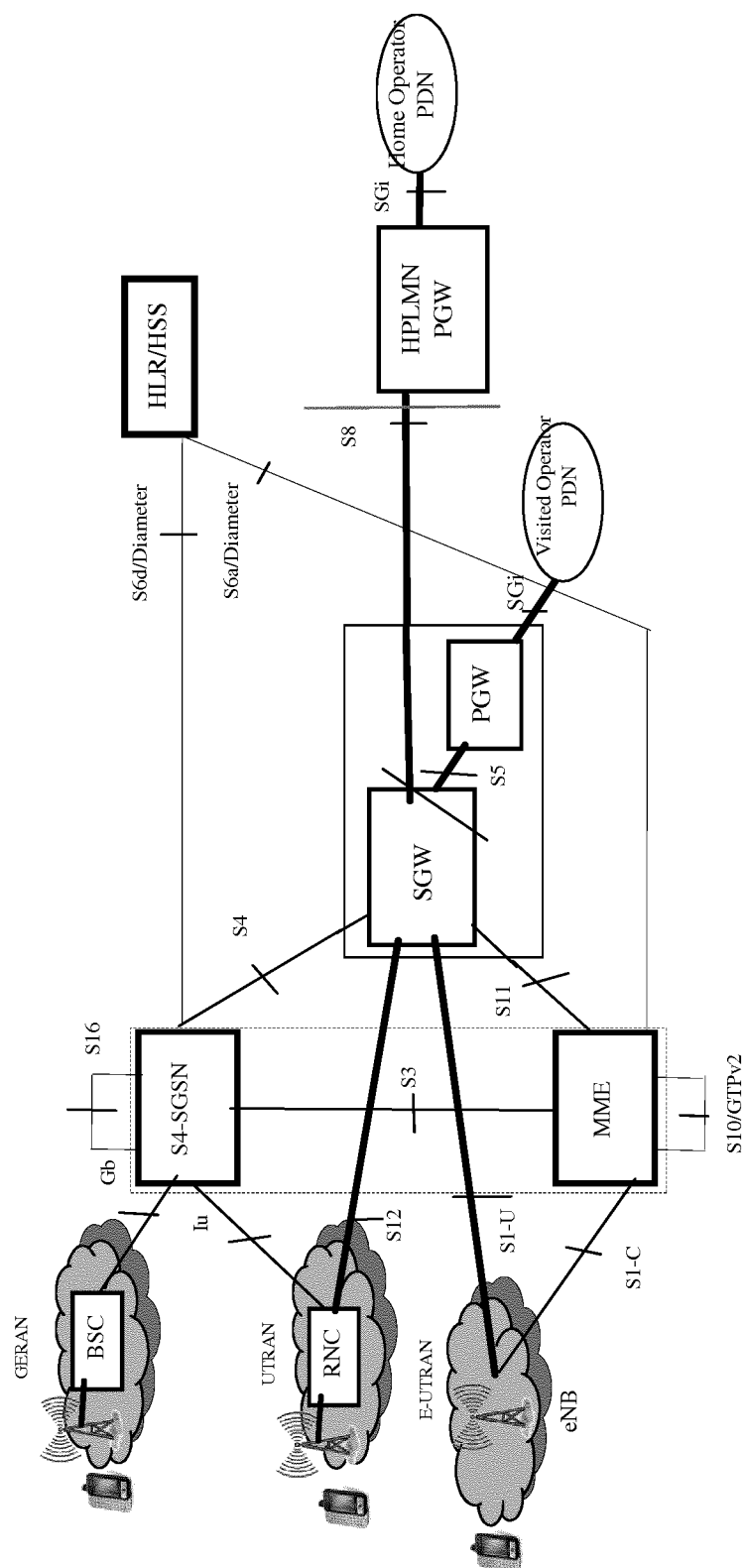


Fig. 2

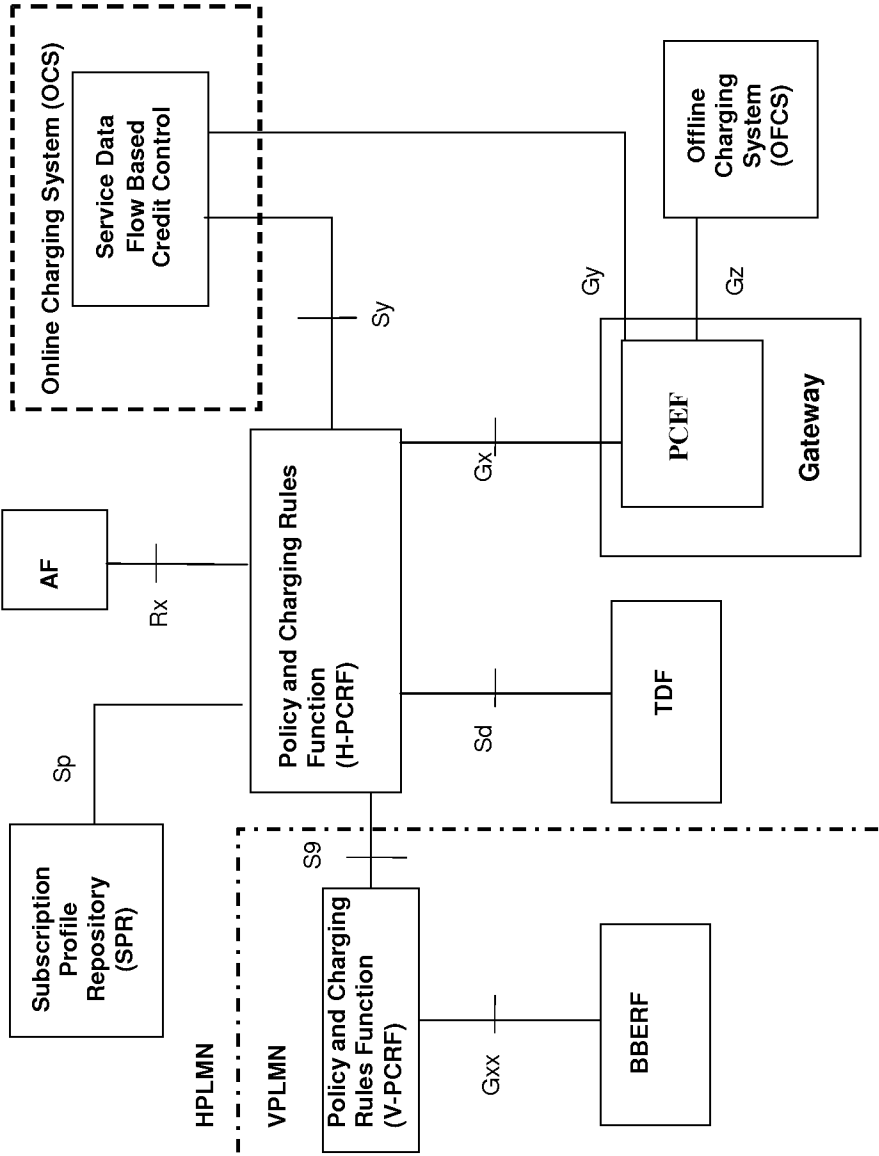


Fig. 3

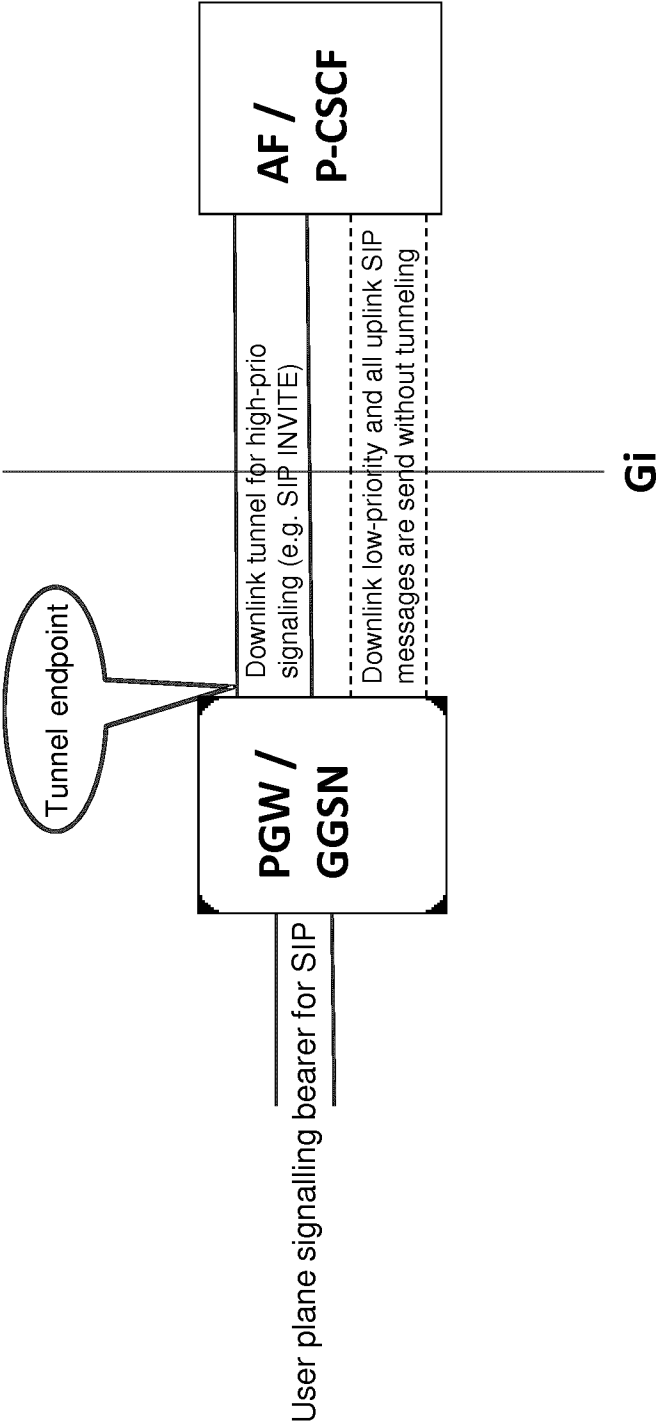


Fig. 4

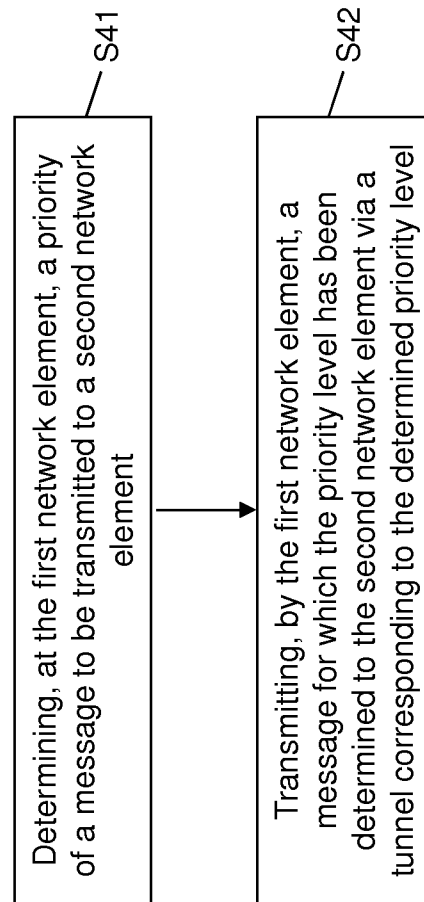
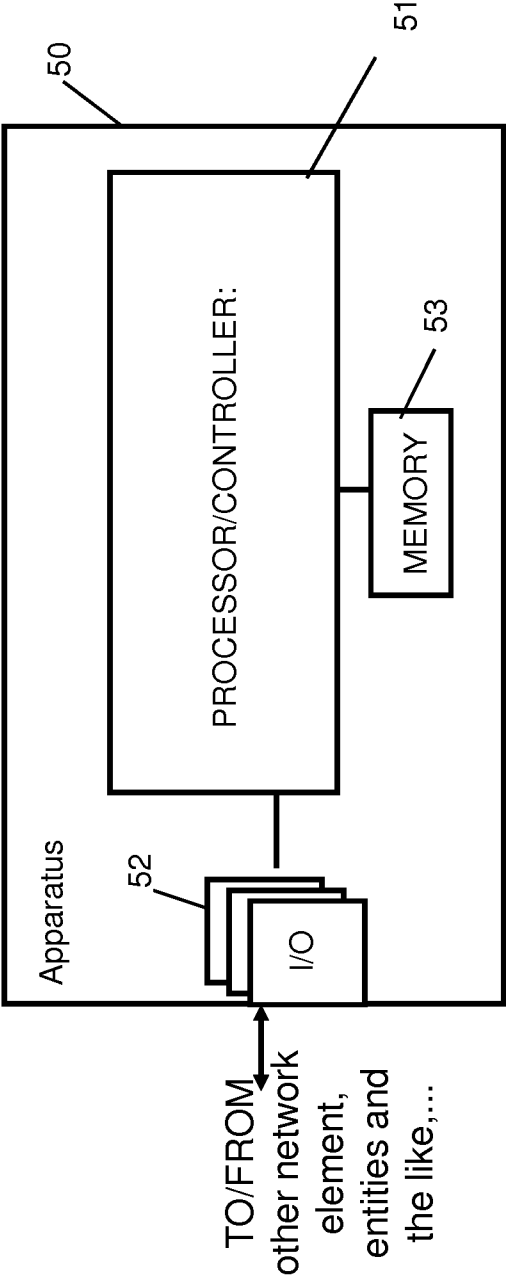


Fig. 5



INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2014/066900

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04W28/16

ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W

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

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

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CHINA TELECOM, NSN: "ADDRESSING EN RELATED TO TUNNELLING BETWEEN PGW/GGSN AND AF", SA WG2 MEETING 103, 19 May 2014 (2014-05-19), - 23 May 2014 (2014-05-23), pages 1-2, XP002737936, Phoenix, Arizona, Usa the whole document -----	1-24
X	US 7 697 422 B1 (ARAD CARMi [IL] ET AL) 13 April 2010 (2010-04-13) column 1, line 20 - column 16, line 59 -----	1-24
X	US 2014/082114 A1 (VADASSERY PRASAD [US] ET AL) 20 March 2014 (2014-03-20) page 1, paragraph 2 - page 3, paragraph 27 -----	1-24



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

30 March 2015

Date of mailing of the international search report

09/04/2015

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2014/066900

Patent document cited in search report	Publication date	Patent family member(s)	Publication date	
US 7697422	B1	13-04-2010	US 7697422 B1	13-04-2010
			US 8077608 B1	13-12-2011

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