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(71) Applicant: **NOKIA SOLUTIONS AND NETWORKS OY** [FI/FI]; Karaportti 3, FI-02610 Espoo (FI).

(72) Inventor: **RASANEN, Juha Antero**; Sinirinnantie 21, FI-02660 Espoo (FI).

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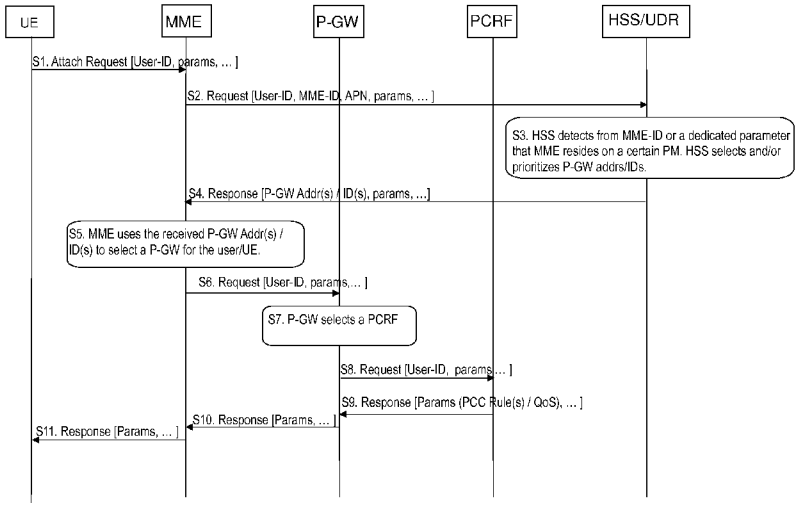
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(54) Title: SELECTION OF VIRTUAL MACHINES OR VIRTUALIZED NETWORK ENTITIES

Fig. 2



(57) Abstract: Apparatuses and methods are provided, by which identities of virtualized network entities which are realized as virtual machines or as entities running on virtual machines in a virtualized network, and identities of physical entities on which the virtualized network entities are carried out, are stored in a memory, and an identity of at least one virtualized network entity is selected based on an identity of the physical entity on which the at least one virtualized network entity is carried out. For example, when a request for selecting a virtualized network entity is received, a virtualized network entity is selected which is carried out on the same physical entity as the requesting entity.

Selection of virtual machines or virtualized network entities

Field of the Invention

The present invention relates to network virtualization, in particular to selection of virtual machines or virtualized network entities in a virtualized network.

Related background Art

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

3GPP	3rd generation partnership project
APN	Access point name
GW	Gateway
HSS	Home subscriber server
ID	Identity, Identifier
IP	Internet protocol
LTE	Long term evolution
MME	Mobile management entity
PCC	Policy and charging control
PCRF	Policy and charging rules function
PE	Physical environment
P-GW	Packet data network gateway
PM	Physical machine
QoS	Quality of service

SDN	Software defined networking
UDR	User data repository
UE	User equipment
VM	Virtual machine

Embodiments of the present invention relate to virtualized networks in connection with mobile networks. For example, ETSI ISG NFV is studying network function virtualization concerning mobile network environment, refer e.g. to “Terms of Reference of the Industry Specification Group on Network Functions Virtualisation (ISG NFV)” (ETSI ISG NFV ToR_v5_4_October_2012) and/or to “Network Functions Virtualization - Introductory White Paper”, October 22-24, 2012 at the “SDN and OpenFlow World Congress”, Darmstadt-Germany”.

Embodiments also relate to performing an attach procedure of a UE, in particular to selecting a P-GW by an HSS, for example. Detailed information can be found in 3GPP TS 23.401, in particular in subclauses 4.3.8 and 5.3.2.1, for example. That is, concerning some network entities in 3GPP environment, a given/certain entity amongst a number of similar entities is selected for a user/UE, when the UE attaches the network or sets up a session (like e.g. an IMS session). Examples of such entities are P-GW/GGSN, PCRF, P-CSCF. Details in case of IMS are also described in 3GPP TS 29.061, especially clause 13a.

Several vendors offer hardware platforms / physical machines (PM) and software environments with virtual machines (VM) to be used for network functions virtualization.

In a fully fledged, virtualized telecommunication environment, like e.g. 3GPP mobile network, there will obviously be a large number of physical machines (PMs), or servers or server farms, at least in big networks. Each PM may support different kinds of VMs, i.e. the same kind of VMs reside in more than one PM (for security, redundancy etc. reasons). Inter VM communication on the hypervisor/OS level can take place within a PM, or (perhaps even) within a server farm, but not between such physical environments (PE).

Hence, considering such large arrangements, it might be advisable to perform the selection of network entities by taking into account such a structure of a virtualized network.

Summary of the Invention

Embodiments of the present invention address this situation and aim to provide a method, apparatus, and computer program product by means of which selection of network entities for the case of a virtualized network having a large structure and running on distributed physical entities is improved.

According to a first aspect of the present invention an apparatus is provided which comprises a processor and at least one memory for storing instructions to be executed by the processor, wherein the at least one memory is configured to store identities of virtualized network entities which are realized as virtual machines or as entities running on virtual machines in a virtualized network, and identities of physical entities on which the virtualized network entities are carried out, and wherein the processor is configured to

select an identity of at least one virtualized network entity based on an identity of the physical entity on which the at least one virtualized network entity is carried out.

According to a second aspect of the present invention an apparatus is provided which comprises a processor and at least one memory for storing instructions to be executed by the processor, wherein the processor is configured to perform a network control function as a virtual machine or as an entity running on a virtual machine on a physical entity, to send a request for selecting a virtualized network entity to a network database entity, to include information regarding the physical entity into the request, and to receive a response from the network database entity including an identity of at least one virtualized network entity selected based on the physical entity.

According to a third aspect of the present invention an apparatus is provided which comprises a processor and at least one memory for storing instructions to be executed by the processor, wherein the processor is configured to perform a network control function as a virtual machine or as an entity running on a virtual machine on a physical entity, to receive a control message including an identity of at least one virtualized network entity selected based on the physical entity, and to request or allocate the at least one virtualized network entity to a user equipment.

According to a fourth aspect of the present invention a method is provided which comprises

storing identities of virtualized network entities which are realized as virtual machines or as entities running on virtual machines in a virtualized network, and identities of physical entities on which the virtualized network entities

are carried out, and

selecting an identity of at least one virtualized network entity based on an identity of the physical entity on which the at least one virtualized network entity is carried out.

According to a fifth aspect of the present invention a method is provided which comprises

performing a network control function as a virtual machine or as an entity running on a virtual machine on a physical entity,

sending a request for selecting a virtualized network entity to a network database entity,

including information regarding the physical entity into the request, and

receiving a response from the network database entity including an identity of at least one virtualized network entity selected based on the physical entity.

According to a sixth aspect of the present invention a method is provided which comprises

performing a network control function as a virtual machine or as an entity running on a virtual machine on a physical entity,

receiving a control message including an identity of at least one virtualized network entity selected based on the physical entity, and

requesting or allocating the at least one virtualized network entity to a user equipment.

Modifications of the above aspects are defined in the dependent claims.

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

Brief Description of the Drawings

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

Fig. 1 shows a simplified block diagram of network entities according to embodiments of the present invention,

Fig. 2 shows a signaling flow according to an embodiment of the present invention, and

Fig. 3 shows a signaling flow according to a modified embodiment of the present invention.

Detailed Description of embodiments

In the following, description will be made to embodiments of the present invention. It is to be understood, however, that the description is given by way of example only, and that the

described embodiments are by no means to be understood as limiting the present invention thereto.

In the following, a general embodiment of the present invention is described by referring to Fig. 1. In particular, Fig. 1 shows several elements involved in the procedure according to embodiments of the present invention. In more detail, Fig. 1 shows an HSS 1, a MME 2 and a P-GW 3.

The HSS 1 is an example for an apparatus or a network element in which identities of network entities such as MME, P-GW, PCRF and the like are stored, and which are to be selected, e.g., when a UE requests to be attached to a network. Another example of such an apparatus is a UDR. The apparatus may also be only a part of the corresponding network element.

The HSS 1 comprises a processor 11 and at least one memory 12 for storing instructions to be executed by the processor. Moreover, the memory stores identities of virtualized network entities which are realized as virtual machines or as entities running on virtual machines in a virtualized network, and identities of physical entities on which the virtualized network entities are carried out. The processor 11 is configured to select an identity of a virtualized network entity based on an identity of the physical entity on which the virtualized network entity is carried out.

That is, the HSS 1 stores identities of the network entities (such as P-GW, PCRF etc.), and identities of the physical entities on which the virtualized network entities are actually carried out or are located. When the HSS 1 has to select a network entity (e.g., a P-GW), it selects based on the identity of the physical entity.

For example, when a request to select a network entity comes from another virtualized network entity (e.g., a MME), the HSS 1 may select a network entity such that both entities are located at the same physical entity.

The memory 12 can be a single memory or a combination of different kinds of memory. E.g., the instructions for carrying out processes on the processor may be stored in a separate dedicated memory, and the network element identities, physical entity identities etc. may be stored in a separate database.

The MME 2 is an example for an apparatus which requests selection of a virtualized network entity from the HSS 1. Similar as the HSS 1, the MME 2 comprises a processor 21 and at least one memory 22 for storing instructions to be executed by the processor. The processor 21 is configured to perform a network control function as a virtual machine or as an entity running on a virtual machine on a physical entity, to send a request for selecting a virtualized network entity to a network database entity (e.g., the HSS 1), to include information regarding the physical entity into the request, and to receive a response from the network database entity including an identity of the virtualized network entity (e.g., the P-GW 3) selected based on the physical entity on which the requesting entity (MME2) resides. The information regarding the physical entity may be e.g. an identity of the virtualized network control element sending the request, and/or a dedicated parameter indicating the physical entity.

The P-GW 3 is an example for a network element which is selected by the HSS 1. The P-GW 3 comprises a processor 31 and at least one memory 32 for storing instructions to be executed by the processor. The processor 31 is configured to perform a network control function as a virtual machine or as

an entity running on a virtual machine on a physical entity, to receive a control message including an identity of at least one virtualized network entity (e.g., P-CSCF or PCRF) selected based on the physical entity, and to request or allocate the at least one virtualized network entity to a user equipment.

That is, for example in case of an attach procedure of the user equipment, a further virtualized network entity which is needed for the user equipment is selected such that it is on the same physical entity as the P-GW 3, and also as the MME 2.

It is to be noted that the HSS 1, the MME 2 and the P-GW 3 may comprise a connection unit (interface unit or interface resources) 13, 23, 33, respectively, by which a connection to the network and/or to other elements may be established.

Hence, according to embodiments, network entities which have to operate together (e.g., MME, P-GW and PCRF for a connection of a user equipment) are selected such that they all are located on the same physical entity, i.e., that they are run on the same PM/PE.

In the following, a more detailed embodiment of the present invention is described.

According to this embodiment, the function of the HSS/UDR is extended. Namely, in present 3GPP specification, the HSS/UDR stores addresses/IDs of P-GWs available for a user/UE. According to the present embodiment, the HSS(/UDR) (e.g., HSS 1 shown in Fig. 1) classifies the P-GWs as per physical machines (PMs) or physical environments (PEs) of a virtual environment. In other words, the HSS is made / configured / orchestrated to know which network entities / VMs reside in a given physical environment (PE) or physical machine (PM) that

is preferably capable to support inter VM communication by-passing the I/O system PM/PE internally.

When a UE attaches the network, the HSS deduces from the MME address / ID, or from a new / dedicated parameter, that the MME resides, as a VM or as an entity in a VM, in a certain PM/PE.

Knowing all other network entities that reside in the same PM/PE, the HSS can now select and/or prioritize (i.e. give higher priority to) such P-GW(s), that reside in the same PM/PE, for the user/UE session. The HSS sends the P-GW addresses / IDs to MME (as per current specifications, but with a list selected by new criteria) and the MME uses the addresses / IDs to select a P-GW (which is now optimally in the same PM/VM with the MME).

Fig. 2 illustrates the operation according to the embodiment including the further developments described above with a simplified signaling scenario.

In S1, the UE sends an attach request to the MME, which includes user-ID and further parameters. In S2, the MME forwards a corresponding request to the HSS/UDR, wherein this request includes user-ID, MME-ID, APN and further parameters.

In S3, the HSS/UDR detects from MME-ID or a dedicated parameter that the MME resides on a certain PM. The HSS selects and/or prioritizes P-GW addresses/Ids. In S4, the HSS/UDR forwards a response to the MME, the response including address(es) or identity/identities of the selected P-GW(s).

In S5, the MME uses the received P-GW address(es) or identity/identities to select a P-GW for the user/UE. In S6,

the MME sends a corresponding request to the selected P-GW. The request includes the user-ID and further parameters.

In S7, the P-GW selects a PCRF for the UE. In S8, the P-GW forwards a corresponding request to the PCRF, which includes the user-ID and further parameters. The PCRF establishes the connection by setting PCC rules and/or QoS or the like for the connection, and sends a corresponding response in S9 to the P-GW. The response is forwarded to the MME in S10, and finally to the UE in S11, so that then the attach procedure is completed.

Hence, according to the embodiment as illustrated in Fig. 2, when a UE attaches to the network, entities on the same physical machine are selected. Hence, disadvantages due to a distributed arrangement of network entities on several physical machines (such as additional signaling on external transmission paths etc. and delays caused thereby) can be avoided.

According to a modification of the embodiment described above, the HSS can send also the address(es) / ID(s) of the PCRF(s) that reside in the same PM/PE. The MME may send the address(es) / ID(s) of the PCRF(s) further to the P-GW in the session request message. This way the P-GW can automatically, and optimally, select a PCRF that resides in the same PM/VM.

As another modification of the embodiment described above, in case the APN requested by the UE is IMS, the HSS can send also the address(es) / ID(s) of the P-CSCF(s) that reside in the same PM/PE. The MME may send the address(es) / ID(s) of the P-CSCF(s) further to the P-GW in the session request message. The P-GW may then use the address(es) / ID(s), as per current 3GPP specifications, to inform the UE about the available P-CSCF(s). This way the P-GW can automatically, and

optimally, make the UE select a P-CSCF that resides in the same PM/VM. (In the current 3GPP specifications the P-CSCF addresses are preconfigured in the P-GW.)

Fig. 3 shows a signaling flow in which also the two modifications described above are realized. Fig. 3 is similar to Fig. 2, so that in the following only the differences are described. That is, messages indicated by the same reference sign are identical to those as shown in Fig. 2, so that they will not be explained again.

In S3A, after having received the request from the MME in S2, the HSS does not only select and/or prioritize the P-GW, but also PCRF addresses/IDs, on the same PM, accordingly. If the APN is IMS, HSS may also select and/or prioritize P-CSCF addresses/IDs, on the same PM, accordingly. Thus, in S4A, also these address(es)/identity(ies) are included in the response to the MME.

In S6A, the request sent from the MME to the P-GW does not only include the user-ID, but also the address(es) and/or identities of the P-CSCF and/or PCRF. In S7A, the P-GW selects a PCRF as per received addresses / IDs. P-GW saves received P-CSCF address(es) / ID(s). The received PCRF and/or P-CSCF addresses / Ids may overwrite possible pre-configured addresses / IDs.

It is to be noted that the embodiments and the present invention in general is not limited to the specific examples given above.

For example, in the embodiments described above PCRF and P-CSCF addresses / IDs are added in the message exchange between HSS and MME, and in the message exchange between MME and P-GW, in order to fully optimize the management and orchestration of 3GPP mobile network resources. However, this

is not necessary, and an example embodiment realizing a minimum solution needs only one new parameter (PM/PE identity) in the HSS.

Thus, according to embodiments of the present invention, virtualized network entities which should work together are selected such that they are running on the same physical entity.

Namely, some environments support optimized communication between VMs residing on the same physical environment / PM by way of supporting inter VM communication through e.g. common memory within the PM or by applying virtual switching, i.e. avoiding looping through input/output facilities and possible PM external transmission paths and/or entities. In other words, VMs residing on the same PM/PE can communicate with each other on the hypervisor/OS level, thus speeding up operations and consuming less (input/output (I/O) and PM external) resources.

This can be exploited by the measures as described in the embodiments. That is, according to embodiments of the present invention, it can be ensured that relevant virtual network entities (VMs) used by a given UE reside in the same physical environment (PE) and/or physical machine (PM). Then, the communication between the entities / VMs would be PM/PE internal, inter VM communication on the hypervisor/OS level, instead of transporting the messages via I/O and external routers.

Moreover, by the measures as defined in the embodiments, it is also advantageous that in a dynamically adjustable virtualized environment, adding and removing of VMs to/from the system, i.e. the orchestration of resources, can work flexibly in an automated way (compared to pre-configurations,

as in current 3GPP specification / environment concerning some network entities, e.g., in connection with PCRF).

Further, in order to be able to use the existing 3GPP application level network element selection mechanisms, and their further developments e.g. for the user group services planned to be specified, it is beneficial, if the HSS is made aware of the physical environment information (as per the present invention) in some form. If the current 3GPP mechanisms (and their further developments) are not (re-)used, it means that virtualization causes changes in the application level in many places of the 3GPP architecture and specifications.

Hence, the benefits of network functions virtualization can be fully exploited.

Hence, according to some aspects of embodiments, apparatuses and methods are provided, by which identities of virtualized network entities which are realized as virtual machines or as entities running on virtual machines in a virtualized network, and identities of physical entities on which the virtualized network entities are carried out, are stored in a memory, and an identity of at least one virtualized network entity is selected based on an identity of the physical entity on which the at least one virtualized network entity is carried out. For example, when a request for selecting a virtualized network entity (e.g., P-GW shown in Fig. 1) is received, a virtualized network entity is selected which is carried out on the same physical entity as the requesting entity (e.g., the MME shown in Fig. 1).

According to a another aspect of embodiments of the present invention an apparatus is provided which comprises

means for storing identities of virtualized network

entities which are realized as virtual machines or as entities running on virtual machines in a virtualized network, and identities of physical entities on which the virtualized network entities are carried out, and

means for selecting an identity of at least one virtualized network entity based on an identity of the physical entity on which the at least one virtualized network entity is carried out.

According to a further aspect of embodiments of the present invention an apparatus is provided which comprises

means for performing a network control function as a virtual machine or as an entity running on a virtual machine on a physical entity,

means for sending a request for selecting a virtualized network entity to a network database entity,

means for including information regarding the physical entity into the request, and

means for receiving a response from the network database entity including an identity of at least one virtualized network entity selected based on the physical entity.

According to a still further aspect of embodiments of the present invention an apparatus is provided which comprises

means for performing a network control function as a virtual machine or as an entity running on a virtual machine on a physical entity,

means for receiving a control message including an identity of at least one virtualized network entity selected

based on the physical entity, and

means for requesting or allocating the at least one virtualized network entity to a user equipment.

It is to be understood that any of the above modifications can be applied singly or in combination to the respective aspects and/or embodiments to which they refer, unless they are explicitly stated as excluding alternatives.

- For the purpose of the present invention as described herein above, it should be noted that
- - an access technology via which signaling is transferred to and from a network element may be any technology by means of which a network element or sensor node can access another network element or node (e.g. via a base station or generally an access node). Any present or future technology, such as WLAN (Wireless Local Access Network), WiMAX (Worldwide Interoperability for Microwave Access), LTE, LTE-A, Bluetooth, Infrared, and the like may be used; although the above technologies are mostly wireless access technologies, e.g. in different radio spectra, access technology in the sense of the present invention implies also wired technologies, e.g. IP based access technologies like cable networks or fixed lines but also circuit switched access technologies; access technologies may be distinguishable in at least two categories or access domains such as packet switched and circuit switched, but the existence of more than two access domains does not impede the invention being applied thereto,
- - usable communication networks, stations and transmission nodes may be or comprise any device, apparatus, unit or means by which a station, entity or other user equipment may connect to and/or utilize services offered by

the access network; such services include, among others, data and/or (audio-) visual communication, data download etc.;

- – a user equipment or communication network element (station) may be any device, apparatus, unit or means by which a system user or subscriber may experience services from an access network, such as a mobile phone or smart phone, a personal digital assistant PDA, or computer, or a device having a corresponding functionality, 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;
- – method steps likely to be implemented as software code portions and being run using a processor at a network element or terminal (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 invention 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 embodiments as described above, eNode-B etc. 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 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.
-

It is noted that the embodiments and 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 be included which fall within the spirit and scope of the appended claims.

CLAIMS

1. An apparatus comprising

a processor and

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

wherein the at least one memory is configured to store identities of virtualized network entities which are realized as virtual machines or as entities running on virtual machines in a virtualized network, and identities of physical entities on which the virtualized network entities are carried out, and

wherein the processor is configured to select an identity of at least one virtualized network entity based on an identity of the physical entity on which the at least one virtualized network entity is carried out.

2. The apparatus according to claim 1, wherein the processor is configured

to receive a request for selecting a virtualized network entity, wherein the request includes an information regarding a physical entity on which a virtualized network control element sending the request is carried out,

to select the at least one virtualized network entity based on the information regarding the physical entity, and

to send a response including the identity of the selected virtualized network entity.

3. The apparatus according to claim 2, wherein the physical entity of the selected at least one virtualized network entity is identical to the physical entity on which the

virtualized network control element is carried out.

4. The apparatus according to claim 2 or 3, wherein the information regarding a physical entity on which the virtualized network control element sending the request is carried out is an identity of the virtualized network control element, and/or a dedicated parameter indicating the physical entity.

5. The apparatus according to any one of the claims 2 to 4, wherein the processor is configured to select at least one further virtualized network entity involved in a network operation based on the received request by referring to the physical entity, and to include an identity of the at least one further virtualized network entity in the response.

6. The apparatus according to any one of the claims 2 to 5, wherein the processor is configured to receive the request during an attach request procedure of a user equipment.

7. The apparatus according to any one of the claims 1 to 5, wherein the identity of an entity is an identifier of the entity or an address of the entity.

8. An apparatus comprising

a processor and

at least one memory for storing instructions to be executed by the processor, wherein the processor is configured

to perform a network control function as a virtual machine or as an entity running on a virtual machine on a physical entity,

to send a request for selecting a virtualized network entity to a network database entity,

to include information regarding the physical entity into the request, and

to receive a response from the network database entity including an identity of at least one virtualized network entity selected based on the physical entity.

9. The apparatus according to claim 8, wherein the processor is configured to forward a control message to the selected virtualized network entity,

wherein the response from the network database entity includes an identity of at least one further virtualized network entity involved in a network operation based on the request which is selected based on the physical entity, and

to forward the identity of the at least one further virtualized network entity into the control message.

10. The apparatus according to claim 8 or 9, wherein the processor is configured to send the request in response to receiving an attach request from a user equipment.

11. The apparatus according to any one of the claims 8 to 10, wherein the identity of an entity is an identifier of the entity or an address of the entity.

12. An apparatus comprising

a processor and

at least one memory for storing instructions to be executed by the processor, wherein the processor is configured

to perform a network control function as a virtual machine or as an entity running on a virtual machine on a physical entity,

to receive a control message including an identity of at least one virtualized network entity selected based on the physical entity, and

to request or allocate the at least one virtualized network entity to a user equipment.

13. The apparatus according to claim 12, wherein the processor is configured to receive the control message during an attach request procedure of the user equipment.

14. The apparatus according to claim 12 or 13, wherein the identity of an entity is an identifier of the entity or an address of the entity.

15. A method comprising

storing identities of virtualized network entities which are realized as virtual machines or as entities running on virtual machines in a virtualized network, and identities of physical entities on which the virtualized network entities are carried out, and

selecting an identity of at least one virtualized network entity based on an identity of the physical entity on which the at least one virtualized network entity is carried out.

16. The method according to claim 15, further comprising

receiving a request for selecting a virtualized network entity, wherein the request includes an information regarding a physical entity on which a virtualized network control element sending the request is carried out,

selecting the at least one virtualized network entity based on the information regarding the physical entity, and

sending a response including the identity of the selected virtualized network entity.

17. The method according to claim 16, wherein the physical entity of the selected at least one virtualized network entity is identical to the physical entity on which the virtualized network control element is carried out.

18. The method according to claim 16 or 17, wherein the information regarding a physical entity on which the virtualized network control element sending the request is carried out is an identity of the virtualized network control element, and/or a dedicated parameter indicating the physical entity.

19. The method according to any one of the claims 15 to 18, further comprising

selecting at least one further virtualized network entity involved in a network operation based on the received request by referring to the physical entity, and

including an identity of the at least one further virtualized network entity in the response.

20. The method according to any one of the claims 15 to 19, further comprising

receiving the request during an attach request procedure of a user equipment.

21. The method according to any one of the claims 15 to 20, wherein the identity of an entity is an identifier of the entity or an address of the entity.

22. A method comprising

performing a network control function as a virtual

machine or as an entity running on a virtual machine on a physical entity,

sending a request for selecting a virtualized network entity to a network database entity,

including information regarding the physical entity into the request, and

receiving a response from the network database entity including an identity of at least one virtualized network entity elected based on the physical entity.

23. The method according to claim 22, further comprising

forwarding a control message to the selected virtualized network entity,

wherein the response from the network database entity includes an identity of at least one further virtualized network entity involved in a network operation based on the request which is selected based on the physical entity, and the method further comprises

forwarding the identity of the at least one further virtualized network entity into the control message.

24. The method according to claim 22 or 23, further comprising

sending the request in response to receiving an attach request from a user equipment.

25. The method according to any one of the claims 22 to 24, wherein the identity of an entity is an identifier of the entity or an address of the entity.

26. A method comprising

performing a network control function as a virtual machine or as an entity running on a virtual machine on a physical entity,

receiving a control message including an identity of at least one virtualized network entity selected based on the physical entity, and

requesting or allocating the at least one virtualized network entity to a user equipment.

27. The method according to claim 26, further comprising

receiving the control message during an attach request procedure of the user equipment.

28. The method according to claim 26 or 27, wherein the identity of an entity is an identifier of the entity or an address of the entity.

29. A computer program product comprising code means for performing a method according to any one of claims 15 to 28 when run on a processing means or module.

30. The computer program product according to claim 29, wherein the computer program product is embodied on a computer-readable medium.

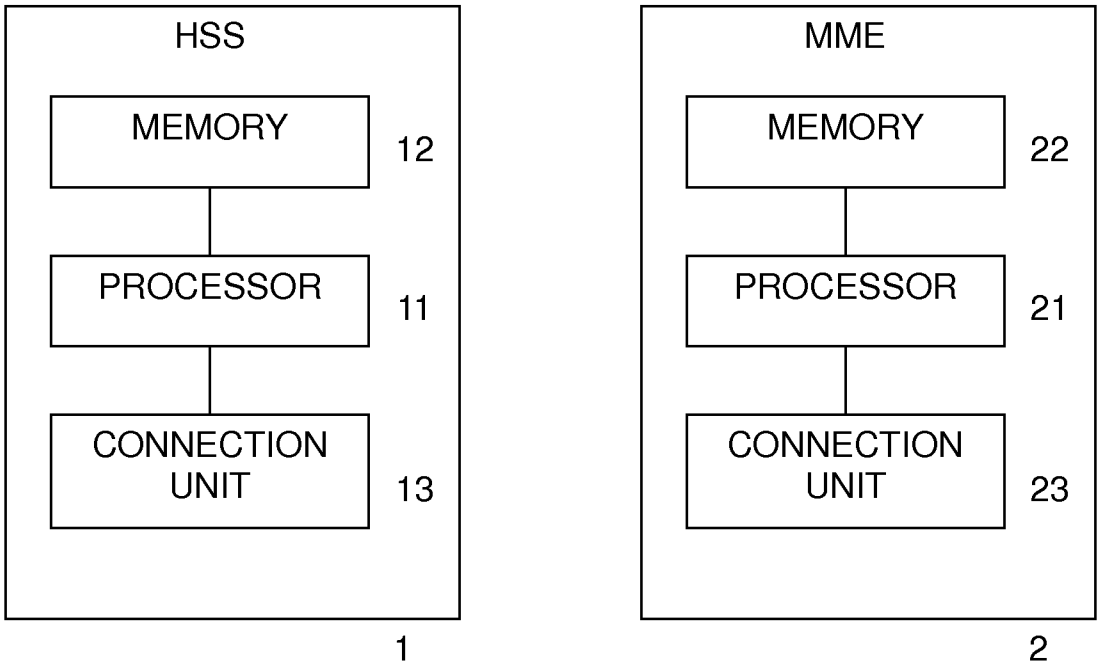

HSS
MEMORY
12
PROCESSOR
11
CONNECTION UNIT
13
1
MME
MEMORY
22
PROCESSOR
21
CONNECTION UNIT
23
2
P-GW
MEMORY
32
PROCESSOR
31
CONNECTION UNIT
33
3

Fig. 1

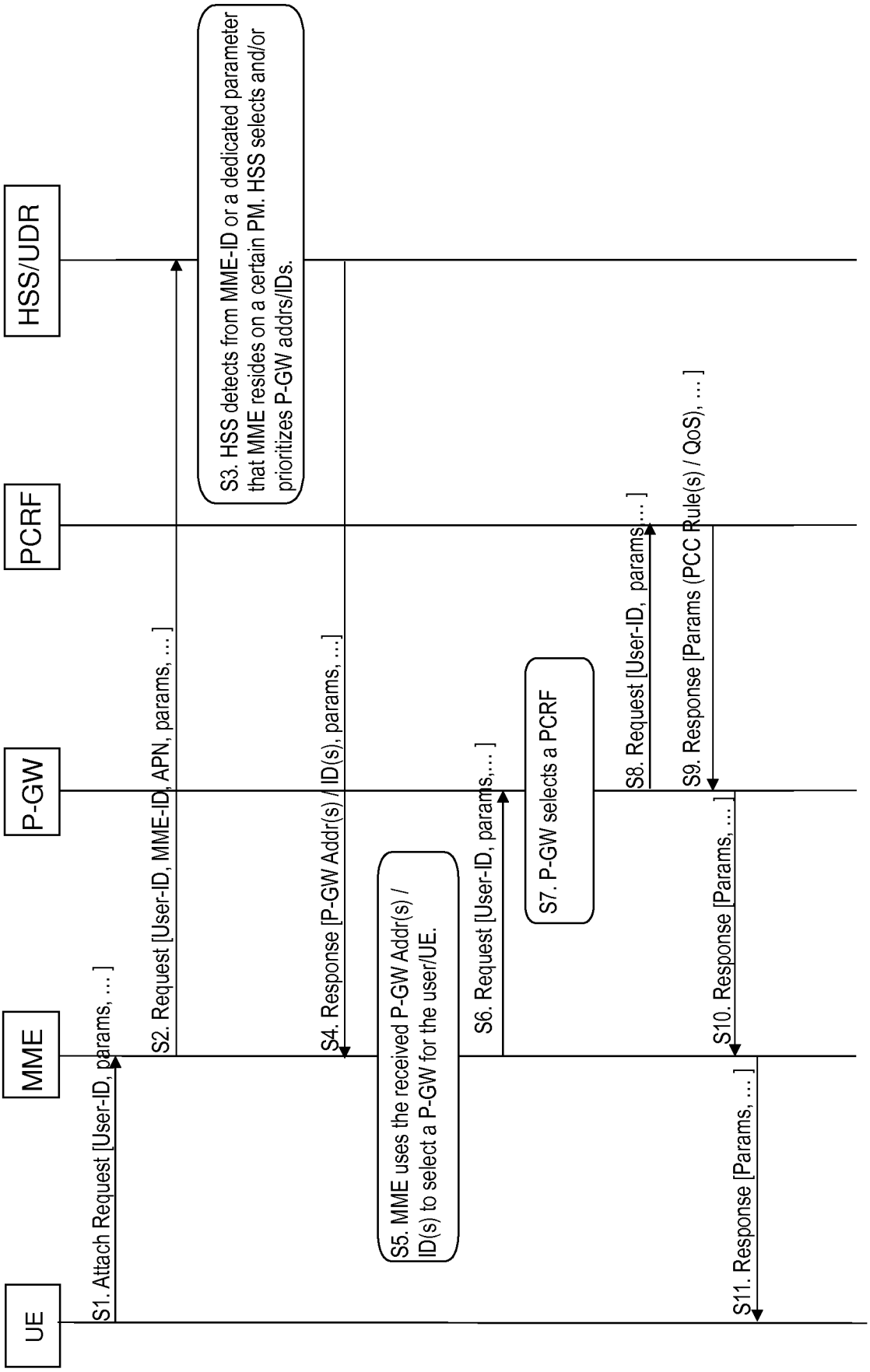

UE
MME
P-GW
PCRF
HSS/UDR
S1. Attach Request [User-ID, params, ...]
S2. Request [User-ID, MME-ID, APN, params, ...]
S3. HSS detects from MME-ID or a dedicated parameter that MME resides on a certain PM. HSS selects and/or prioritizes P-GW addrs/IDs.
S4. Response [P-GW Addr(s) / ID(s), params, ...]
S5. MME uses the received P-GW Addr(s) / ID(s) to select a P-GW for the user/UE.
S6. Request [User-ID, params,...]
S7. P-GW selects a PCRF
S8. Request [User-ID, params,...]
S9. Response [Params (PCC Rule(s) / QoS), ...]
S10. Response [Params, ...]
S11. Response [Params, ...]

Fig. 2

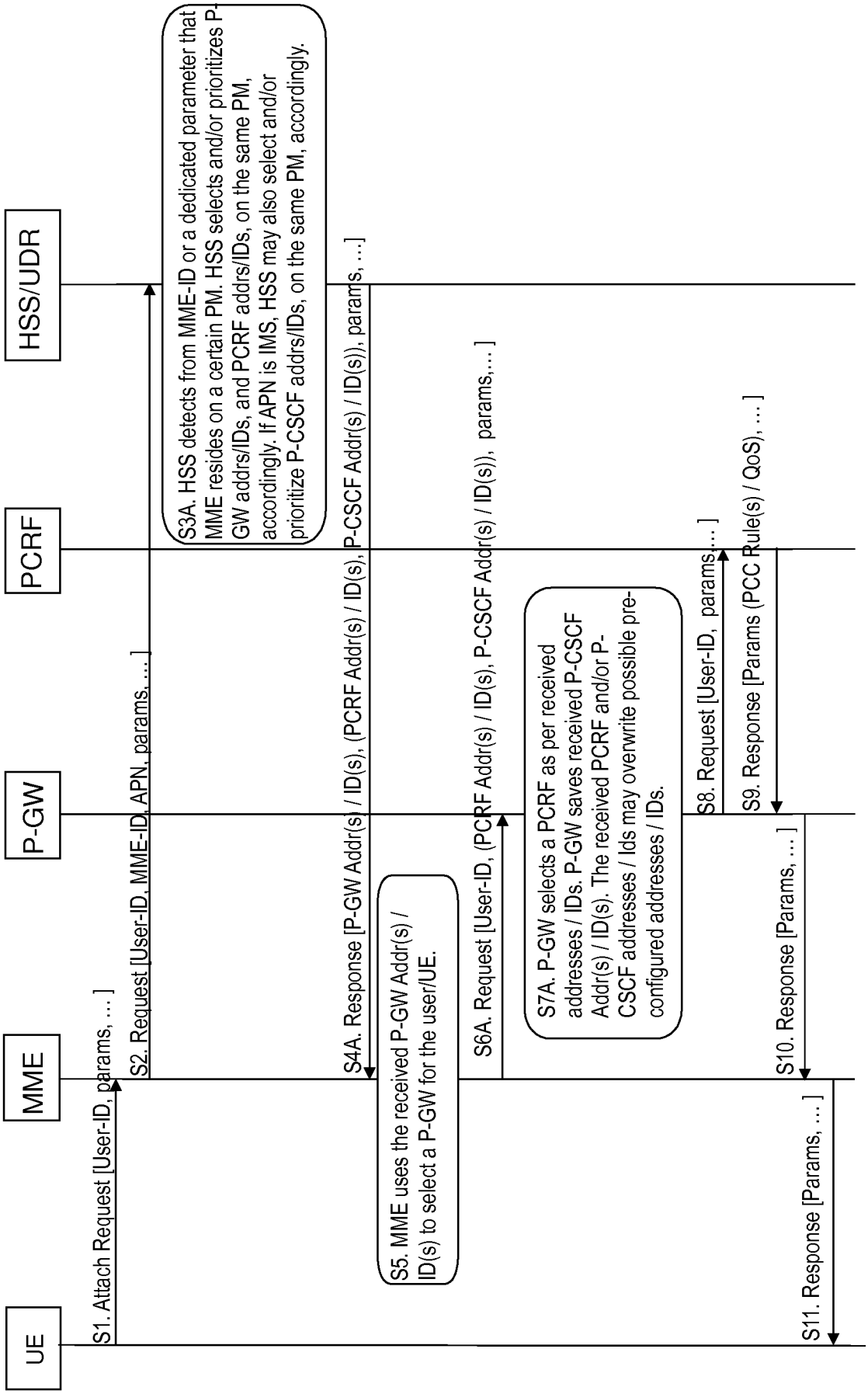

UE
MME
P-GW
PCRF
HSS/UDR
S1. Attach Request [User-ID, params, ...]
S2. Request [User-ID, MME-ID, APN, params, ...]
S3A. HSS detects from MME-ID or a dedicated parameter that MME resides on a certain PM. HSS selects and/or prioritizes P-GW addrs/IDs, and PCRF addrs/IDs, on the same PM, accordingly. If APN is IMS, HSS may also select and/or prioritize P-CSCF addrs/IDs, on the same PM, accordingly.
S4A. Response [P-GW Addr(s) / ID(s), (PCRF Addr(s) / ID(s), P-CSCF Addr(s) / ID(s)), params, ...]
S5. MME uses the received P-GW Addr(s) / ID(s) to select a P-GW for the user/UE.
S6A. Request [User-ID, (PCRF Addr(s) / ID(s), P-CSCF Addr(s) / ID(s)), params,...]
S7A. P-GW selects a PCRF as per received addresses / IDs. P-GW saves received P-CSCF Addr(s) / ID(s). The received PCRF and/or P-CSCF addresses / Ids may overwrite possible pre-configured addresses / IDs.
S8. Request [User-ID, params,...]
S9. Response [Params (PCC Rule(s) / QoS), ...]
S10. Response [Params, ...]
S11. Response [Params, ...]

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/062987

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06F9/50
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)
G06F

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	US 2012/166624 A1 (SUIT) 28 June 2012 (2012-06-28) abstract paragraph [0004] paragraph [0006] paragraphs [0016] - [0017] paragraphs [0037] - [0039] paragraph [0062] claims 1,3	1-30
A	EP 2 549 381 A2 (HON HAI PRECISION INDUSTRY CO., LTD.) 23 January 2013 (2013-01-23) the whole document	1-30
A	US 2009/013325 A1 (KOBAYASHI, NARITA, ITO, OOSHIMA, HARA) 8 January 2009 (2009-01-08) the whole document	1-30

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 March 2014	20/03/2014

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

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2013/062987

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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