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(54) Title: NETWORK MANAGEMENT INFRASTRUCTURE

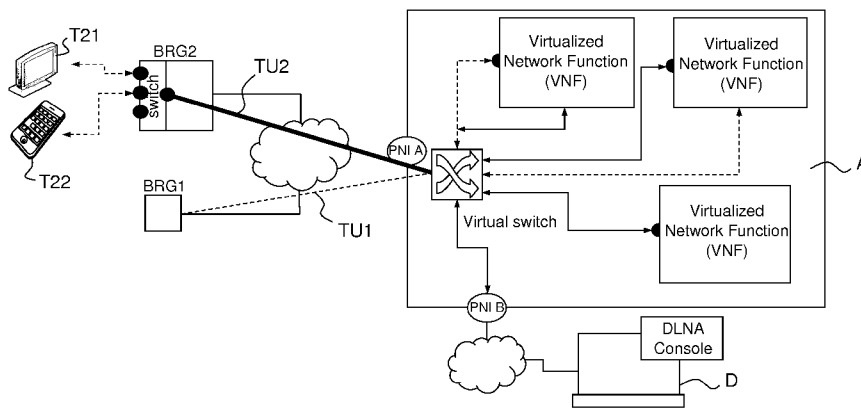


FIG.6

(57) Abstract: Network management infrastructure operable to be connected to at least one remote home network comprising at least one terminal (T21, T22) connected to a gateway (BRG2), wherein said infrastructure comprises a processor configured to connect a physical network interface (PNIB) of the infrastructure to the home network.

NETWORK MANAGEMENT INFRASTRUCTURE

TECHNICAL FIELD

5 The present disclosure generally relates to the field of networks.
More particularly, the disclosure deals with the provision of services to users in the context of the NFV ("Network Functions Virtualization") paradigm.
Thus, the disclosure concerns a network management infrastructure and a method for troubleshooting a home network. It further concerns a computer program implementing
10 the troubleshooting method of the disclosure.

BACKGROUND

The approaches described in this section could be pursued, but are not necessarily approaches that have been previously conceived or pursued. Therefore, unless
15 otherwise indicated herein, the approaches described in this section are not prior art to the claims in this application and are not admitted to be prior art by inclusion in this section.

Figure 1 shows an example of a conventional network architecture wherein NSPs (Network Service Providers) provide users internet access by installing in users
20 premises broadband residential gateways.

In Figure 1, two homes H1, H2 equipped with broadband residential gateways BRG1, BRG 2 are represented. In each home, a LAN (Local Area Network) connecting one or more terminals is deployed. Each broadband residential gateway BRG1, BRG2 is connected to the Internet through an access line L1, L2 and a server SP of the NSP.

25 In this conventional network architecture, a broadband residential gateway gathers a lot of network functions. Thus, it implements generally the following functions : DLNA (Digital Living Network Alliance) Server, DHCP (Dynamic Host Configuration Protocol), DNS (Domain Name System), NAT (Network Address Translation), firewall, UI (User Interface), router, switch, management interface.

30 Within this architecture, the subscription of a new network service by the user is often accompanied by the deployment of a software upgrade in the best case or of a new device in the worst case within the user premises. This results in a long and costly deployment for the NSP.

Furthermore, new and more advanced services require more complex devices to
35 enable them. This also leads to increasing operational expenditure in service maintenance.

NFV is a solution that aims to reduce the deployment cost and the time to market of network services through virtualization, thereby allowing certain network functions to be moved from specialized hardware located on-site, in the home network, to general-purpose hardware possibly located in the network operator virtual infrastructure.

5 Virtual CPE is part of this so called NFV paradigm that is about executing network functions hosted by the residential home gateway onto commoditized hardware hosting a virtual machine infrastructure, e.g. private or public cloud infrastructure, instead of requiring specific on purpose hardware.

10 Figure 2 shows an example of network architecture, within the NFV framework, implementing the virtual CPE concept.

In Figure 2, two homes H1, H2 equipped with broadband residential gateways BRG1, BRG 2 are represented. In each home, a LAN (Local Area Network) connecting one or more terminals is deployed. Each broadband residential gateway BRG1, BRG2 is connected to the Internet through an access line L1, L2 and a server infrastructure S of
15 the service provider. The server infrastructure S comprises a plurality of apparatuses, i.e. physical machines, for instance, as represented in Figure 2, two physical machines A1, A2.

In this network architecture, a broadband residential gateway is basically a simple bridge between the home LAN and the access line. Thus, it implements mainly an
20 Ethernet switch function and a few network functions permitting, if the access line goes down, to cope with DNS and DHCP for supporting the connection of new devices to the home LAN.

In this architecture, most of the network functions are moved within the server infrastructure S which implements the NSP cloud infrastructure. Thus, the server
25 infrastructure S plays here the role of a virtual gateway. In addition to the network functions, this virtual gateway hosts an entity for managing the virtual resources (virtual machines, storage and networking), an entity for managing and controlling, for each customer/subscriber, the VNFs (Virtual Network Functions) that compose the virtual CPE and a user interface for allowing an operator controlling and provisioning the
30 virtual CPEs.

In the following disclosure, the server infrastructure S is also named virtual gateway or network management infrastructure.

Thus, by this virtualization approach, it is possible to reduce the cost and lead time associated with the deployment of layer 3 CPE devices (Figure 1, e.g. a router) by
35 replacing them with less complex and therefore less expensive layer 2 CPE devices

(Figure 2, e.g. a switch) in the user premises, while virtualizing and moving the layer 3 and above functions to the network operator infrastructure cloud (Figure 2).

Figure 3 shows a NSP user interface when adding a new subscriber, for instance in the home H1.

- 5 Once the user is provisioned by the NSP through an admin portal, the broadband residential gateway BRG1 can establish a tunnel with the virtual gateway S which provides indeed an extension of the LAN of the home H1 up to the virtual gateway and the NSP cloud infrastructure.

For the new subscriber, the default network functions that are activated are shown in
10 Figure 3. The customer can connect terminals behind its broadband residential gateway BRG1 as a laptop PC labelled T1 in Figure 2. The terminal IP address is automatically configured through the DHCP protocol by the DHCP server residing in the virtual gateway S that allocates IP addresses according to the range provisioned by the NSP, as shown in Figure 3.

- 15 The user has the possibility to interact with her/his virtual gateway through a dedicated user interface as it was already possible with a legacy broadband residential gateway. The Figure 4 shows an example of such user interface wherein the user can see and change the range of IP addresses allocated to her/his home.

One problem with the architecture described above is related to troubleshooting.
20 Indeed, existing hardware and software tools cannot easily be adapted under the form of a Virtualized Network Function (VNF) for being plugged as part of the virtual CPE of a particular subscriber's home.

SUMMARY

- 25 The present disclosure proposes a solution for improving the situation.

Accordingly, the present disclosure provides a network management infrastructure operable to be connected to at least one remote home network comprising at least one terminal connected to a gateway, wherein said infrastructure comprises a processor configured to connect a physical network interface of the infrastructure to the home
30 network.

According to an embodiment, the physical network interface belongs to one apparatus of the server infrastructure.

Advantageously, the processor is operable to associate the physical network interface of said one apparatus with a switch of the gateway of the home network.

- 35 Thus, any device connected to this physical network interface is automatically connected to the home network.

For instance, the device is a troubleshooting device.

The present disclosure also provides a method for troubleshooting a home network, comprising:

- 5 - attaching a physical network interface of a remote network management infrastructure, comprising at least one apparatus, to the home network;
- connecting a troubleshooting device to the physical network interface.

According to an embodiment, the physical network interface belongs to one apparatus of the server infrastructure.

Advantageously, the method comprises associating the physical network interface of 10 said one apparatus with a switch of a gateway of the home network.

According to an embodiment, the home network is a Local Area Network, LAN.

The method according to the disclosure may be implemented in software on a programmable apparatus. It may be implemented solely in hardware or in software, or in a combination thereof.

15 Since the present disclosure can be implemented in software, the present disclosure can be embodied as computer readable code for provision to a programmable apparatus on any suitable carrier medium. A carrier medium may comprise a storage medium such as a floppy disk, a CD-ROM, a hard disk drive, a magnetic tape device or a solid state memory device and the like.

20 The disclosure thus provides a computer-readable program comprising computer-executable instructions to enable a computer to perform the method of the disclosure. The diagram of figure 7 illustrates an example of the general algorithm for such computer program.

25 **BRIEF DESCRIPTION OF THE DRAWINGS**

The present disclosure is illustrated by way of examples, and not by way of limitation, in the figures of the accompanying drawings, in which like reference numerals refer to similar elements and in which:

- 30 - Figure 1, already described, is a schematic view of a conventional network architecture;
- Figure 2, already described, is a schematic view of a NFV network architecture wherein embodiments of the present disclosure are advantageously implemented;
- Figure 3, already described, shows an example of a NSP user interface when 35 adding a new subscriber;
- Figure 4, already described, shows an example of a subscriber user interface;

- Figure 5 shows an example of a NSP user interface when attaching a troubleshooting port, according to an embodiment of the disclosure;
- Figure 6 is a schematic view illustrating the connection of a remote device to a home network, according to an embodiment of the disclosure; and
- 5 - Figure 7 is a flowchart showing the steps of the troubleshooting method according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

The embodiments of the present disclosure are implemented in a network system
10 having the NFV architecture represented in Figure 2.

According to an embodiment of the disclosure, a physical network interface, or port, of the virtual gateway S is attached to the LAN of the home H2.

Referring to Figure 7, there is shown therein an example of a NSP user interface dedicated to the virtual CPE management. An operator can activate/associate, at step
15 100 (Figure 7), a troubleshooting port with the subscriber's home LAN.

As it appears in Figure 5, there is no DLNA service attached to the LAN of the home H2. It also appears that the IP address scheme is identical to the one of the LAN of the home H1 (Figure 3) allowing overlapping addresses. This is not a problem despite sharing common network functions (like DHCP, NAT) as the latter operate a context
20 and some resources dedicated to the subscriber.

Once the troubleshooting port is associated with the subscriber, then the LAN of the home H2 gets extended up to the devices connected to the troubleshooting port of the virtual gateway S. Thus a device D connected, at step 110, to the troubleshooting port in the virtual gateway S is virtually connected to the LAN of the home H2.

25 For instance, the device D is a troubleshooting console that will be used to facilitate the troubleshooting of the LAN of the home H2. The software of the device D can thus be launched easily and can access and control the subscriber terminals for troubleshooting.

An example of use is a connectivity problem between a TV and a tablet running a
30 DLNA server in the LAN of the home H2. The NSP connects, at step 110, to the LAN of the home H2 a DLNA/UPnP analyzer D, which can act as a renderer, controller or yet a server for troubleshooting. The analyzer D carries out, at step 120, an analysis of the connectivity problem. The analyzer D first attempts to read the subscriber's content from his tablet successfully and then it sends the content to the TV. As it does not work,
35 the console D streams to the TV a transcoded version of the content that gets displayed. The NSP informs then the subscriber that there is no connectivity problem

but that the content format is not supported by his TV and that the DLNA controller he was using on his tablet does not work properly. The way the physical network interface of the virtual gateway S is associated with a particular home network depends on the virtualization implementation.

5 As explained earlier, once provisioned, a broadband residential gateway is connected with the server infrastructure S through a network tunnel, for example a Generic Routing Encapsulation (GRE) or a Virtual Extensible LAN (VxLAN). The tunnel endpoint in the server infrastructure S is a virtual Ethernet switch wherein virtual LANs interconnect the VNFs together with the tunnels and the physical network interfaces.

10 With reference to Figure 6, the broadband residential gateway BRG2 associated with the home H2, interconnects, through its hosted Ethernet switch, home LAN terminals T21, T22 with a virtual switch hosted by an apparatus A of the server infrastructure S through a dedicated tunnel TU2.

Thanks to the administrator user interface, as represented in Figure 5, a physical
15 network interface PNIB of the apparatus A has been virtually connected to the switch of the broadband residential gateway BRG2. Thus, traffic to/from the broadband residential gateway BRG2 is forwarded from/to the physical network interface PNIB through the virtual switch.

In the example represented in Figure 6, three VNFs are attached to the broadband
20 residential gateway BRG2 (continuous lines) whereas two VNFs are also attached to the broadband residential gateway BRG1 (dotted lines) associated with the home H1 through a dedicated tunnel TU1. A VNF can be multi-tenant so as it functions to be shared among several subscribers home networks.

While there has been illustrated and described what are presently considered to be the
25 preferred embodiments of the present disclosure, it will be understood by those skilled in the art that various other modifications may be made, and equivalents may be substituted, without departing from the true scope of the present disclosure. Additionally, many modifications may be made to adapt a particular situation to the teachings of the present disclosure without departing from the central inventive concept
30 described herein. Furthermore, an embodiment of the present disclosure may not include all of the features described above. Therefore, it is intended that the present disclosure is not limited to the particular embodiments disclosed, but that the disclosure includes all embodiments falling within the scope of the appended claims.

Expressions such as "comprise", "include", "incorporate", "contain", "is" and "have" are
35 to be construed in a non-exclusive manner when interpreting the description and its associated claims, namely construed to allow for other items or components which are

not explicitly defined also to be present. Reference to the singular is also to be construed to be a reference to the plural and vice versa.

A person skilled in the art will readily appreciate that various parameters disclosed in the description may be modified and that various embodiments disclosed and/or
5 claimed may be combined without departing from the scope of the disclosure.

CLAIMS

1. Network management infrastructure (S) operable to be connected to at least one remote home network comprising at least one terminal (T21, T22) configured to be connected to a gateway (BRG2), wherein said infrastructure (S) comprises a processor configured to connect a physical network interface (PNIB) of the infrastructure (S) to the home network.
5
2. Network management infrastructure (S) of claim 1, wherein the physical network interface (PNIB) belongs to one apparatus (A) of the server infrastructure (S).
10
3. Network management infrastructure (S) of claim 2, wherein the processor is configured to associate the physical network interface (PNIB) of said one apparatus with a switch of the gateway (BRG2) of the home network.
- 15 4. Method for troubleshooting a home network, comprising:
 - attaching (100) a physical network interface (PNIB) of a remote network management infrastructure (S), comprising at least one apparatus (A), to the home network;
 - connecting (110) a troubleshooting device (D) to the physical network interface
20 (PNIB).
5. Method of claim 4, wherein the physical network interface belongs to one apparatus (A) of the server infrastructure (S).
- 25 6. Method of claim 5, comprising associating the physical network interface (PNIB) of said one apparatus (A) with a switch of a gateway (BRG2) of the home network.
7. Method of any one of claims 4 to 6, wherein the home network is a Local Area Network, LAN.
30
8. A computer-readable program comprising computer-executable instructions to enable a computer to perform the method of any one of claims 4 to 7.

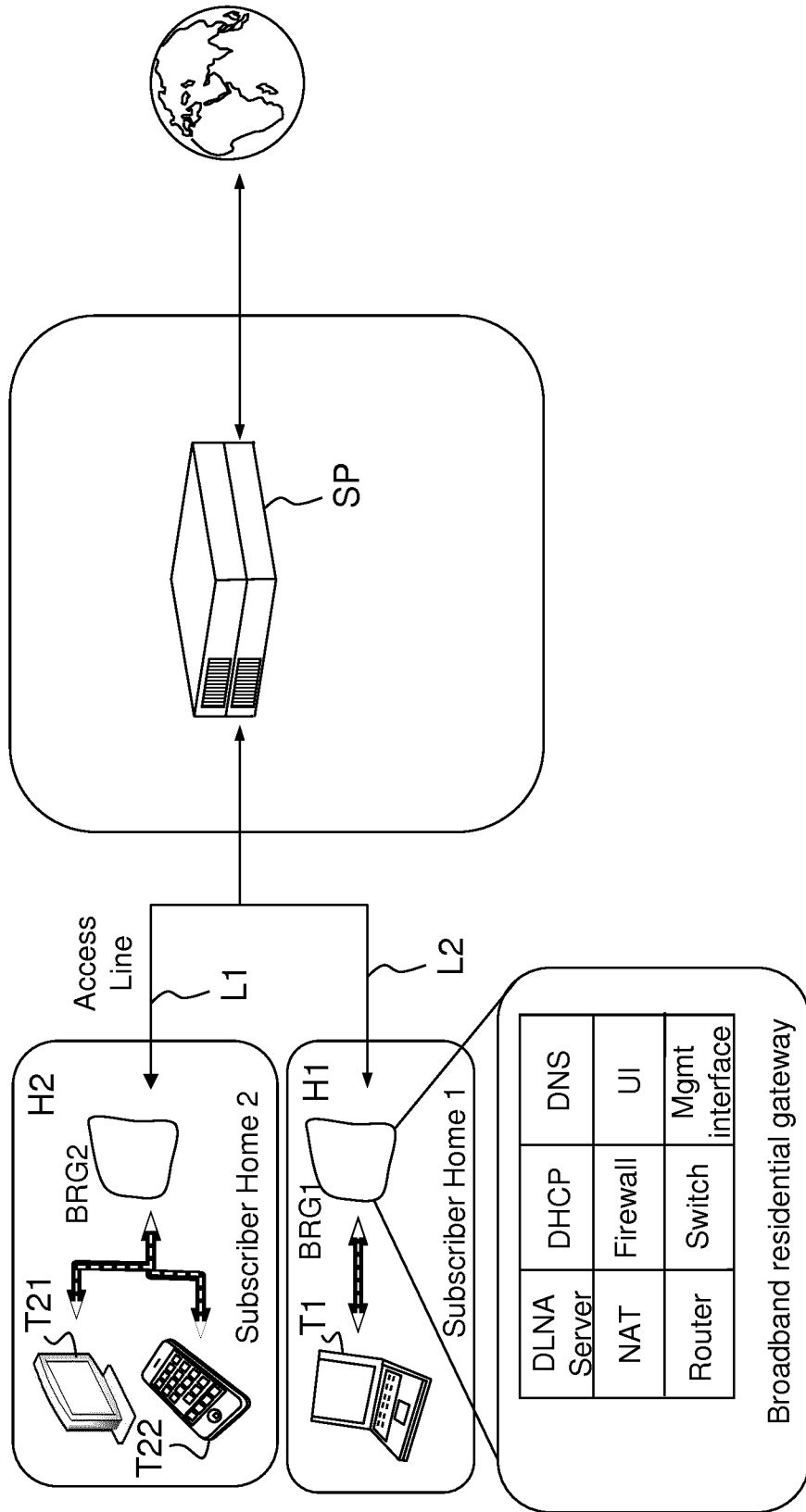


FIG.1

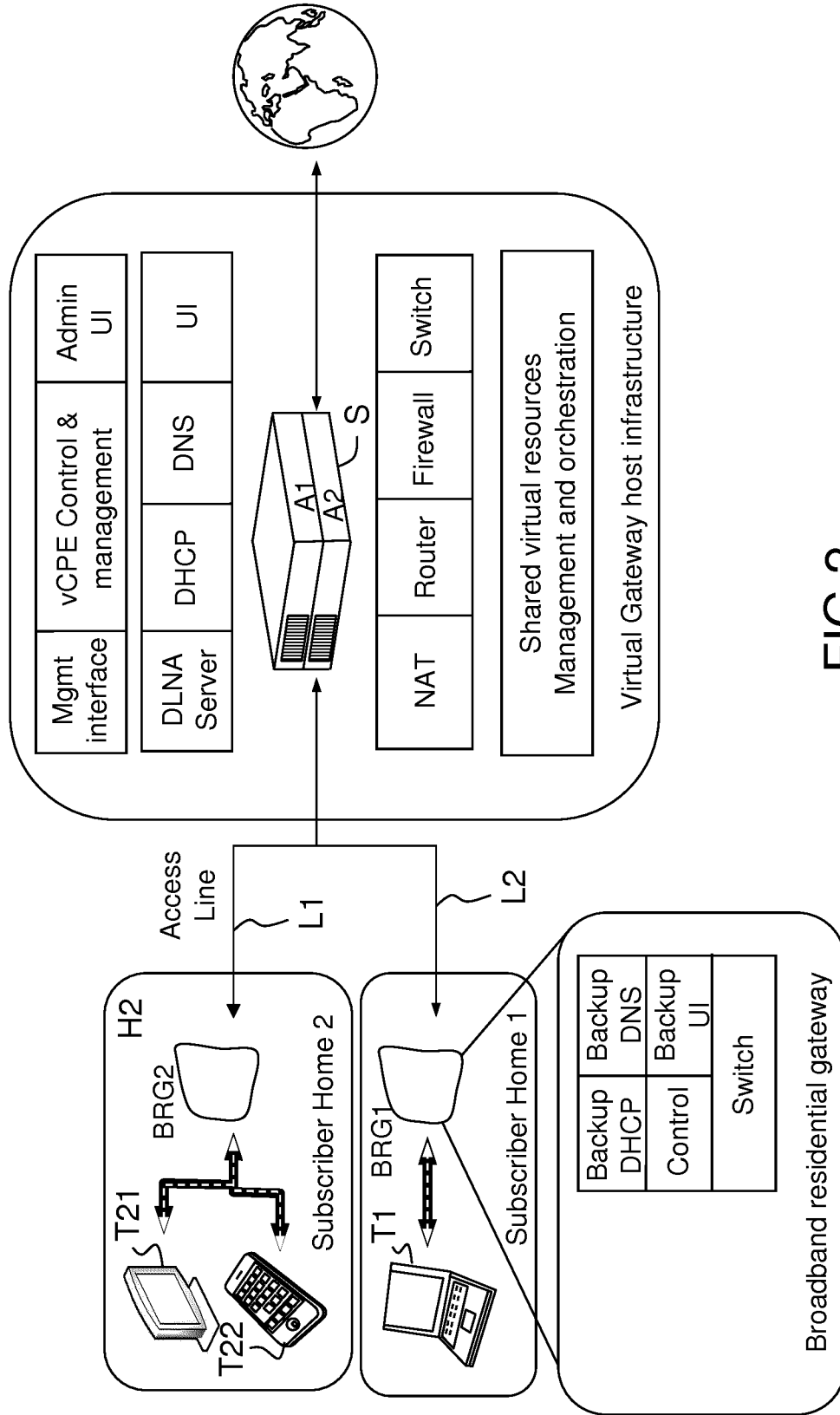


FIG.2

← → localhost :4000/app/server/#/create_customer

↑ R&1 VCPE Customers System

New Customer

MAC address	AA-BB-CC-DD-EE-FF ✓
IP address	192.168.0.101 ✓
DHCP Range Start	192.168.1 50 ✓
DHCP Range End	192.168.1 70 ✓

Create


NFV Name	Endpoint	Status
TEP	192.168.10.101.8000	✓
DHCP	192.168.10.102.8000	✓
DNS	192.168.10.103.8000	✓
NAT	192.168.10.104.8000	✓
DLNA	192.168.10.121.8000	⊗
MnC	10.12.113.104.5000	✓


FIG.3


← myVirtualGateway(192.168.1.254.80)

e

☁


R&1 VCPE


DHCP


Wifi

Customer Detail

DHCP Range Start	192.168.1.50
DHCP Range End	192.168.1.70
DLNA Service	Activated

Ip Address	Mac Address	Host name	End date
192.168.1.66	08:00:27:57:f1:84	client1	21/5/2015 05:30:53

FIG.4

← → localhost :4000/app/server/#/customer/AA-BB-CC-DD-EE-FF

🏠 R&1 VCPE Customers System

Customer Detail

Customer Mac AA-BB-CC-DD-EE-FF

Customer IP 192.168.0.102

DHCP Range Start 192.168.1 50

DHCP Range End 192.168.1 70

DLNA Service

NFV Name	Endpoint	Status
TEP	192.168.10.101.8000	<input checked="" type="checkbox"/>
DHCP	192.168.10.102.8000	<input checked="" type="checkbox"/>
DNS	192.168.10.103.8000	<input checked="" type="checkbox"/>
NAT	192.168.10.104.8000	<input checked="" type="checkbox"/>
DLNA	192.168.10.121.8000	<input checked="" type="checkbox"/>
MnC	10.12.113.104.5000	<input checked="" type="checkbox"/>

TroubleShoot Port (default: localhost/eth3)

Apply Cancel

FIG.5

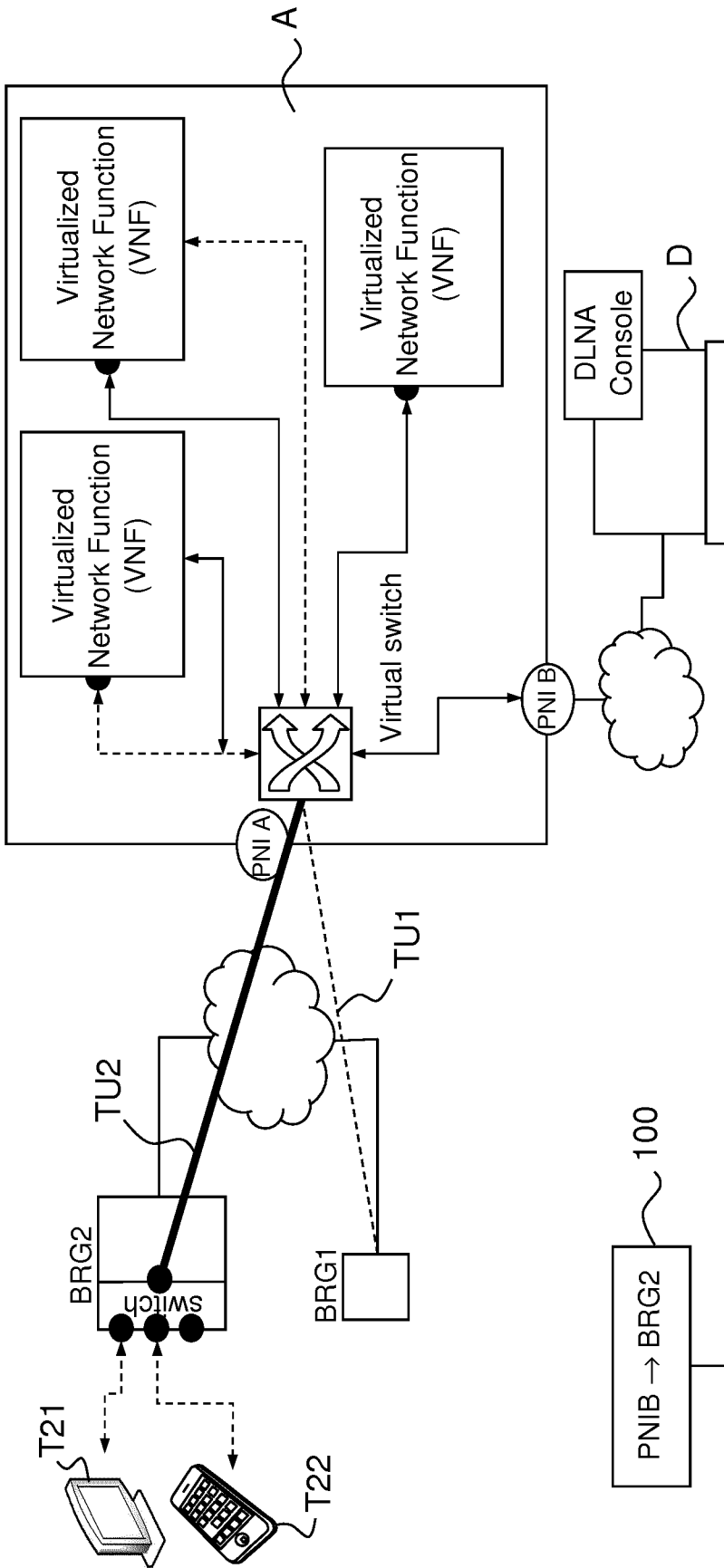


FIG.6

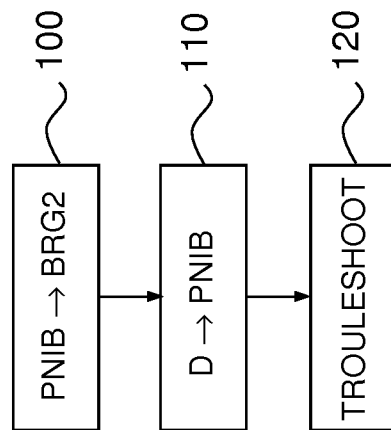


FIG.7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/061931

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L12/28
ADD.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
H04L

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2014/328161 A1 (HADDAD WASSIM [US] ET AL) 6 November 2014 (2014-11-06) abstract paragraph [0002] - paragraph [0003] paragraph [0036] paragraph [0038] paragraph [0041] claim 1	1-8
X	US 2011/122774 A1 (HASSAN OMAR [US] ET AL) 26 May 2011 (2011-05-26) abstract paragraph [0017] paragraph [0053] - paragraph [0054] paragraph [0082] paragraph [0142] paragraph [0151] figure 4	1-8

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

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

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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

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"&" document member of the same patent family

Date of the actual completion of the international search 30 August 2016	Date of mailing of the international search report 20/09/2016
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Cichra, Michael
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INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>US 2013/091279 A1 (HADDAD WASSIM [US] ET AL) 11 April 2013 (2013-04-11) abstract paragraph [0010] paragraph [0029] - paragraph [0030] paragraph [0048] paragraph [0066] figures 1,2</p> <p style="text-align: center;">-----</p>	1-8
A	<p>EP 2 747 386 A1 (TELEFONICA SA [ES]) 25 June 2014 (2014-06-25) abstract paragraph [0010] paragraph [0029] paragraph [0035] - paragraph [0036] claim 1</p> <p style="text-align: center;">-----</p>	1-8

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/061931

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