(19) DANMARK

(10) DK/EP 3220613 T3

(12) Oversættelse af europæisk patentskrift

Patent- og Varemærkestyrelsen

(51) Int.Cl.: ***H 04 L 29/12 (2006.01)*** ***B 61 L 27/00 (2006.01)*** ***H 04 L 29/08 (2006.01)***
B 61 L 15/00 (2006.01)

(45) Oversættelsen bekendtgjort den: **2020-03-23**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2019-12-18**

(86) Europæisk ansøgning nr.: **17161131.2**

(86) Europæisk indleveringsdag: **2017-03-15**

(87) Den europæiske ansøgnings publiceringsdag: **2017-09-20**

(30) Prioritet: **2016-03-17 DE 102016204419**

(84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**

(73) Patenthaver: **Thales Management & Services Deutschland GmbH, Thalesplatz 1, 71254 Ditzingen, Tyskland**

(72) Opfinder: **SKOWRON, Frank, Petunienweg 28B, 12357 Berlin, Tyskland**
RICHTER, Robert, Wittekindstr. 85, 12105 Berlin, Tyskland
EISEN, Jens, Lenbachstr. 17, 10245 Berlin, Tyskland

(74) Fuldmægtig i Danmark: **Zacco Denmark A/S, Arne Jacobsens Allé 15, 2300 København S, Danmark**

(54) Benævnelse: **Fremgangsmåde til drift af et pakkebaseret kommunikationsnetværk i et jernbanenet**

(56) Fremdragne publikationer:
WO-A1-2009/030659
UIC: "Top Level Domain for ETCS in PS-mode;RT(14)054017_ETCS_Top_Level_Domain ", ETSI DRAFT; RT(14)054017_ETCS_TOP_LEVEL_DOMAIN, EUROPEAN TELECOMMUNICATIONS STANDARDS INSTITUTE (ETSI), 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS ; FRANCE, Bd. RT, 6. Juli 2014 (2014-07-06), Seiten 1-4, XP014206174, [gefunden am 2014-07-06]
Anonymous: "ERTMS/ETCS EuroRadio FIS, version 3.2.0", , 17. Dezember 2015 (2015-12-17), Seiten 1-126, XP055397009, Gefunden im Internet: URL:http://www.era.europa.eu/Document-Regi ster/Documents/SUBSET-037 v320.pdf [gefunden am 2017-08-08]
GABRIELE CECCHETTI ET AL: "An implementation of EURORADIO protocol for ERTMS systems", INTERNATIONAL JOURNAL OF COMPUTER, ELECTRICAL, AUTOMATION, CONTROL AND INFORMATION ENGINEERING, Bd. 7, Nr. 6, 1. Juni 2013 (2013-06-01), Seiten 693-702, XP055397196,

Description

[0001] The invention relates to a method for operating a packet-based communication network in a railway network,
wherein the railway network comprises a plurality of trains, a plurality of radio block centres and an address management unit, which communicate with one another in a packet-based manner via the communication network,
wherein a communication hardware of a respective train comprises a hardware name, and a communication unit of a respective radio block centre comprises a hardware name,
wherein the address management unit stores statically or dynamically a respective physical packet address for different hardware names, and the address management unit responds to inquiries about physical packet addresses for hardware names from the communication network .

[0002] Such a method was disclosed in DE 10 2007 041 959 B4.

[0003] In order to improve cross-border railway traffic in Europe, the European Train Control System (ETCS) was developed, which provides a European standardized system for train protection and train control. Within the framework of the ETCS, in particular as of level 2, data transmissions via mobile radio are provided in the railway network, in particular between trains or their carried along communication hardware on board (the so-called "on-board unit", OBU) and radio block centres (RBC) for the transmission of train control data.

[0004] This communication is currently typically based on connection-oriented data channels ("telephone connections"), in particular via GSM-R. A radio channel is thus permanently occupied by each train, even when only a limited data transmission to or from the train in question is required. A packet-based communication would make it possible to realize a significantly higher throughput of data in an available frequency band, which would alleviate the burden in particular at traffic junctions. With a packet-based communication, however, the physical packet addresses of the communication participants have

to be known to the other communication participants or be ascertainable for the latter.

[0005] The UNISIG work group proposed in UNISIG subset 037, "EuroRadio FIS", Version 3.2.0 (17 December 2015), Section 8.3.2.3 (Addressing) using a domain name service (DNS) if a train wants to contact a radio block centre.

[0006] The use of a packet-oriented data transfer for rail applications was disclosed in DE 10 2007 041 959 B4. Communication partners are mobile participants (vehicles, FZGs) and stationary participants (radio block centre, RBCs). RBCs and FZGs are equipped with memory and functions for the management of dynamic address data of known FZGs and RBCs. Moreover, an address centre (ADZ) acts as a central, stationary entity for the determination of packet addresses. It contains a memory which contains a dynamic allocation of ETCS-IDs of the FZGs and RBCs to physical packet addresses. In order to ascertain a packet address unknown in an FZG, an FZG first checks with RBCs known to it (primary set-up protocol); should this be unsuccessful, the FZG then checks with the ADZ (secondary set-up protocol). In the process, the ETCS-ID of a desired communication partner is transferred to the RBC or the ADZ and its current packet address is then provided. The RBCs exchange packet addresses with one another by means of an RBC up-date protocol. The ADZ is updated by the RBCs by means of an ADZ up-date protocol. The FZGs are updated by the RBCs with an FZG up-date protocol. In the event of new entries in the ETCS or RBC handovers, an FZG - RBC communication is established on the initiative of the FZG; the ETCS-ID of a target RBC can occur, for example, via a balise.

[0007] With this approach, the communication between trains and responsible radio block centres required within the framework of the ETCS can be established; however, this approach is very complex. For trackside services independent of the radio block centres, it is difficult to contact a train because, to do so, the ETCS-ID of the train determined by the train hardware would have to be known.

Object of the invention

[0008] It is thus the object of the invention to simplify the communication in a railway network and in particular to allow the establishment of a communication between trackside services and trains in a simple manner.

Description of the invention

[0009] This object is solved in accordance with the invention by a method according to Claim 1.

[0010] According to the method in accordance with the invention, it is provided that the trains further are assigned a symbolic name for the duration of individual journeys, that the address management unit further respectively stores the physical packet address of the communication hardware of the train dynamically for different symbolic names, and the address management unit also responds to inquiries about physical packet addresses for symbolic names from the communication network.

[0011] According to the invention, the address management unit allocates the physical packet address to a communication hardware unit of a train twice, namely both to the permanent hardware name of the communication hardware and to a further name, namely a changeable symbolic name of the train that contains the communication hardware. It should be borne in mind that this physical packet address of the communication hardware of the train is dynamic and can in principle be re-issued at every log-in into the packet-based communication network.

[0012] The hardware names of the communication hardware of the trains are tied to the communication hardware in a permanent manner and thus in principle do not change from journey to journey (notwithstanding the possibility of changing the allocation in the event of maintenance procedures). By means of the hardware name, the locomotive or the car in which the communication hardware is installed

can be identified. The hardware names typically have a core component (typically a multi-digit number, for instance "001"), from which the queryable (complete) symbolic name is formed in accordance with a defined syntax (for instance "id001.ty02.etcs"). The core component of the hardware name can be used in the ETCS, or in inventory lists, maintenance schedules and the like. The core component of the hardware name most often corresponds to an ETCS-ID. The hardware name of a communication hardware or its core component can be indicated, for example, on the housing of the communication hardware. It should be borne in mind that, within the framework of the invention, if the syntax is known, the hardware name can be transmitted/saved by transmitting/saving the core component.

[0013] The symbolic name of a train, on the other hand, is in principle only valid for a train journey (notwithstanding the possibility that the next journey of the train may coincidentally occur under the same symbolic name). The symbolic name represents a current journey assignment of the train. The symbolic names typically have a core component (most often a multi-digit number, for instance "22557", if applicable also in conjunction with letters such as "RE", "RB", "IR"), from which the queryable (complete) symbolic name is formed in accordance with a defined syntax (for instance "22567.hsl.adif" or "trn22567.ty02.etcs"). The core component of the symbolic name is generally used in train schedules and partly also in signal boxes. The core component of the symbolic name most often corresponds to a train running number (TRN). It should be borne in mind that, within the framework of the invention, if the syntax is known, the symbolic name can be transmitted/saved by transmitting/saving the core component.

[0014] By means of the double allocation of the physical packet address both to the hardware name of the communication hardware and to the symbolic name of the train, the traceability of the train or of its communication hardware is rendered considerably easier. It is in particular easier for a rolling stock management (RSM) to contact the train.

[0015] Trackside services wishing to contact a certain physical railway vehicle independently of its journey assignment can do so via the hardware name. Moreover, radio block centres can also contact a train via the hardware name, for instance in order to grant a movement authority, if desired.

[0016] Trackside services, in particular additional services going beyond the functions of the ETCS or ERTMS, which wish to contact a train because of its current journey assignment, can do so via the symbolic name. Information regarding the hardware name of a communication hardware of a train that is carrying out a certain journey assignment or even regarding the dynamic physical packet address is not necessary for the initiation of a communication in accordance with the invention. A trackside service wishing to contact a train because of its current journey assignment in particular does not have to ascertain the hardware name of the communication hardware unit of the train in advance, for instance via the rail depot which initially deployed the train or via the currently responsible radio block centre. Ascertaining the physical packet address can instead simply occur via a query with the address management unit. If desired, radio block centres can also contact a train via the symbolic name.

[0017] It is provided here according to the method in accordance with the invention that the railway network comprises additional services on the track side, which access the trains via the communication network, that the additional services on the track side direct inquiries about physical packet addresses for symbolic names to the address management unit, and that the additional services on the track side only know the symbolic name, but not the hardware name. Within the framework of the invention, the trackside additional services can access the train by means of the symbolic name of the train, i.e. with no knowledge of the hardware name of the communication hardware of the train. By means of the trackside additional services, information or control commands are transmitted by trackside (stationary) facilities to the travelling train and/or information is transmitted from the travelling train to trackside (stationary) facilities. Typical trackside services comprise SCADA (Supervisory Control and Data Acquisition), passenger services (in particular passenger information

services, for instance regarding connecting trains, speaker announcements, the sale of electronic tickets on-board, internet access for passengers), telemetry and remote maintenance (in particular regarding vehicle condition data, error messages, error rectification), and automatic (driverless) rail traffic. It is only through the use of packet-based communication that in many cases additional services requiring a high data transfer rate (for example higher than 1 Mbit/s, in particular higher than 10 Mbit/s) are rendered possible.

[0018] The railway network is preferably configured and operated in accordance with the UNISIG standard or in accordance with the ETCS. The radio block centres can in particular issue the movement authority for the trains. It should be borne in mind that the communication via the communication network of the railway network can occur both within the missions of the ETCS and outside the missions of the ETCS in order to provide further services.

[0019] The physical packet addresses for the (permanent) hardware names of communication units of radio block centres are allocated for the most part statically; however, a dynamic allocation is also possible. The same holds true for physical packet addresses for (permanent) hardware names/symbolic names of possible trackside services or additional services.

[0020] The address management unit can be allocated to a radio block centre territorially or also be connected in the communication network independently of radio block centres as a separate node.

[0021] The address management unit can organize the double allocation of the hardware name of a communication hardware of a train and the symbolic name of the train to the physical packet address of the communication hardware unit of the train either by allocating, in a three-column table, to the physical packet address (entry in first column) both the hardware name (entry in second column) and the symbolic name (entry in third column) or by allocating, in a two-column table, the physical packet address in two lines (entry in first column in first and

second line) to the hardware name (entry in second column in first line) and to the symbolic name (entry in second column in second line).

Preferred variants of the invention

[0022] In a preferred variant of the method in accordance with the invention, the communication network is an Internet Protocol based intranet. Within the framework of the Internet Protocol, already existing, tested standards or programmed algorithms can be used. By means of an intranet, an external accessing or external manipulation of data can be effectively prevented or at least rendered more difficult. Alternatively, it is also possible to use the public internet; here, however, additional security measures are necessary, for example comprising an encryption of the transmitted data.

[0023] Particularly preferred is a variant which provides that the address management unit is configured as a domain name system (=DNS) server, in particular as an Open Source DNS server, and that the inquiries to the address management unit are done as a DNS lookup. This approach is particularly simple and can be carried out essentially in accordance with known standards and algorithms. The queries relating to physical addresses are executed in the background without a particular retrofitting of the communication hardware of the train or of the communication units of radio block centres or trackside additional services ("transparent name resolution") being necessary.

[0024] A variant is also preferred in which one or more ETCS functions, in particular ATP, is/are operated between the trains and the radio block centres via the communication network. The packet-based communication uses the transmission resources particularly efficiently when ETCS functions, the data flow of which is usually subject to pronounced fluctuations, are realized. Automatic train protection (ATP) can be readily integrated. Further additional services can also be realized via the communication network.

[0025] A variant is particularly preferred in which the additional services on the track side comprise linking to a camera of a train, which monitors a track section located in front of the train, from a control centre on the track side (CCTV - Closed Circuit Television), in particular wherein the driving of a train, which is travelling without a driver, is taken over at times by a train driver in the control centre on the track side, who receives the image data of the camera of the train. By linking to the camera, it is possible to decide from the control centre on the basis of the image data whether or how the train should be moved further. By means of the image information, decisions can be made with close to the same quality as by means of a locomotive operator in the cab of the train. The high data transfer rate connected to the transmission of images with a good resolution can be adequately provided within the framework of the invention. If desired, an acoustic monitoring of the track section lying in front of the train can also occur from the control centre by means of a microphone on the front of the train.

Variants of the communication process

[0026] In a preferred variant, the symbolic name of a train is revealed to the communication hardware of the train at the start of each journey, in particular by the train driver via a driver machine interface. The symbolic name can be constantly kept up to date by this means. Alternatively, symbolic names of the train can also be disclosed in advance for a plurality of journeys; in this case, however, the information must, if necessary, be updated in good time in the event of unexpected changes in the operating schedule. It should be borne in mind that the symbolic name can also be disclosed to the communication hardware unit by entering or inputting a core component of the symbolic name at the communication hardware unit. A typical driver machine interface is, for example, a keyboard or a reader for a data carrier.

[0027] In a preferred variant, it is provided that the communication hardware of the train is assigned a new physical packet address at least in case of a new logging in to the communication network. By means of the re-issue of a physical packet address (and, correspondingly, the release of an old packet address in the

event of a preceding log-out), an unnecessary blocking of physical packet addresses, which are generally limited in number, is avoided. It should be borne in mind that a re-issuing of a physical packet address can occur every time the area of responsibility of a new radio block centre is entered.

[0028] A particularly preferred variant provides that the communication hardware of a train that enters the area of responsibility of a radio block centre builds up a packet-based communication with this radio block centre and communicates its physical packet address, its hardware name and the symbolic name of its train to this radio block centre, that this radio block centre subsequently transmits the hardware name of the communication hardware of the train, its physical packet address and the symbolic name of the train to the address management unit, and that the address management unit subsequently stores the physical packet address with the hardware name of the communication hardware of the train and with the symbolic name of the train. In this approach, the registration of the communication hardware of the train, including the hardware name and symbolic name, is initiated practically automatically by the establishment of the communication with the (responsible) radio block centre, which is already provided for ETCS functions, in particular ATP functions. The status of the address management unit is thus kept extremely current. It should be borne in mind that, during the actual establishment of the packet-based communication, the communication unit of the train typically initially only transmits its physical packet address and its hardware name to the radio block centre, and the symbolic name of the communication unit of the train is only transmitted in the further course of the established packet-based communication to the radio block centre (typically immediately after the establishment of the packet-based communication).

[0029] A preferred embodiment of this variant provides that the train passes a balise upon entry into the area of responsibility of this radio block centre, and that the balise transmits a hardware name or a physical packet address of this radio block centre to the communication hardware of the train, and based on this the communication hardware of the train builds up the packet-based

communication with this radio block centre. The transmission of the information necessary for the establishment of a communication by means of a balise has proven reliable in practice. However, other information transfers are also possible.

[0030] A further, likewise preferred embodiment provides that, when the train leaves the area of responsibility of this radio block centre, this radio block centre reports this to the address management unit, and the address management unit deletes the hardware name of the communication hardware of the train, the physical packet address thereof and the symbolic name of the train from its memory. This approach avoids the further storage of obsolete address information.

[0031] In a preferred variant, it is provided that after logging in to the communications network, the communication hardware of a train transmits its hardware name, its physical packet address and the symbolic name of its train to the address management unit bypassing any radio block centre, and that the address management unit subsequently stores the physical packet address with the hardware name of the communication hardware unit of the train and with the symbolic name of the train. This direct transmission by means of the communication hardware of the train can occur on request (for instance by the locomotive operator) or automatically (for instance at the beginning of a journey or when the train is started) and independently of the entry into the area of responsibility of a radio block centre. The notification of the address management unit independently of the radio block centres is useful in particular when additional services are to be used while the train is not integrated in the ETCS, for example during maintenance work on the train in a maintenance hangar.

[0032] A variant is also advantageous that provides that upon logging out of the communications network, the communication hardware of a train communicates to the address management unit its imminent logging out bypassing any radio block centre, and that the address management unit subsequently deletes the hardware name of the communication hardware of the train, the physical packet address thereof and the symbolic name of the train from its memory. This approach once again avoids the further storage of obsolete address information.

The log-out can occur on request (for instance by the locomotive operator) or automatically (for instance at the end of a journey or when the train is shut down) and independently of the exiting of the area of responsibility of a radio block centre.

[0033] A variant is also preferred in which the communication hardware of the trains, the radio block centres and optionally the additional services on the track side do not locally store any physical packet addresses with the exception of the respective own physical packet addresses and physical packet addresses for their own active communication connections, but direct an inquiry to the address management unit via the communication network to resolve names. The design of the communication hardware, of the radio block centres (or their communication units) and, if applicable, of the trackside additional services is thus simplified. Only the address management unit has to administer address-storage functions to a significant extent and be kept up to date. It should be borne in mind that the address management unit is preferably designed in a redundant manner, in particular with a plurality of (permanent) physical packet addresses for contacting it via the communication network. The physical packet address(es) of the address management unit is (are) stored in a permanent manner with all communication partners in the communication network.

Address management unit in accordance with the invention

[0034] An address management unit for a packet-based communication network of a railway network also falls within the scope of the present invention, wherein the address management unit comprises a memory in which physical packet addresses are respectively stored dynamically or statically for hardware names of the communication hardware of trains and radio block centres, characterized in that, in the memory, physical packet addresses of the communication hardware of the train in question are further respectively stored dynamically for symbolic names of the trains which are only valid for individual journeys of the trains. The address management unit can be used in particular in a method in accordance with the invention as set out above. The address management unit is preferably

configured as a DNS server. With the address management unit in accordance with the invention, trains or their communication hardware can be contacted both via the symbolic name as well as via the hardware name, in particular in a transparent manner.

[0035] Further advantages of the invention ensue from the description and the drawing. Likewise, the features mentioned above and those further elaborated can respectively be implemented in accordance with the invention individually on their own or plurally in any combination. The embodiments illustrated and described are not to be understood as an exhaustive list but rather possess an illustrative character for the depiction of the invention.

Detailed description of the invention and drawing

[0036]The invention will be described in greater detail by means of embodiments.

Fig. 1 schematically shows a communication network, operated in accordance with the invention, with an automated log-in of a train with an address management unit via a balise and a radio block centre;

Fig. 2 schematically shows a communication network, operated in accordance with the invention, with a direct log-in of a train with an address management unit;

Fig. 3 schematically shows name queries and packet-based communication links in a communication network, operated in accordance with the invention;

Fig. 4 schematically shows the use of an image transmission from the camera of a train to a trackside additional service for the temporary remote control of the train within the framework of the invention.

[0037] Fig. 1 schematically shows a packet-based communication network 10 of a railway network, which is operated in accordance with the invention.

[0038] Arranged in a train 1 running on rails is a communication hardware 2, also called the On-Board Unit OBU, with which the train 1 relays and can receive information. The OBU 2 is to establish a packet-based communication link with a responsible radio block centre 4, also called radio block centre RBC, via links of an intranet 3, in particular within the framework of the ETCS (European Train Control System). The links of the intranet 3 typically comprise mobile radio and stationary data transmission paths and are based on the Internet Protocol. Via the OBU 2, train-side additional services (also called on-board service) 7, for instance a passenger information service, can be controlled, if desired. It should be borne in mind that a plurality of trains, radio block centres and additional services are comprised by the communication network 10, which are respectively illustrated with an example in Fig. 1.

[0039] The locomotive operator of the train 1 entered the symbolic name of the train 1 that is valid for the pending journey according to the train schedule into the OBU 2 at the beginning of the journey. When the train 1 passes a balise 5, it enters the area of responsibility of the RBC 4. The balise 5 transmits a message 11 directly (i.e. without the intranet 3) via radio to the OBU 2, which contains the hardware name of the communication unit CU 8 of the responsible RBC 4 here. If it has not already happened, the OBU 2 logs into the intranet 3 at the latest at this point and has a dynamic physical packet address allocated to it (log-in into the communication network 10).

[0040] The OBU 2 then sends an establishment-of-contact message 12 via the intranet 3 to the RBC 4, addressed by means of the hardware name of the communication unit CU 8. The hardware name of the communication unit CU 8 is resolved in the process via a query (DNS lookup) 13 with an address management unit 6, called EDNS+ here (enhanced domain name server +). For this purpose, the address management unit 6 possesses in a memory a (here static)

table 9a containing the physical packet addresses for the hardware names of the communication units of all RBCs of the communication network 10.

[0041] The establishment-of-contact message 12 can then be relayed via the intranet 3 to the RBC 4, cf. the relayed establishment-of-contact message 12'.

[0042] The establishment-of-contact message 12 or 12' contains the current physical packet address allocated to the OBU 2 and the permanent hardware name of the OBU 2.

[0043] Via the data of the establishment-of-contact message 12, 12', the RBC 4 can establish an ETCS communication (or ERTMS communication, Extended Rail Traffic Management System) 14, 14' via the intranet 3 with the train 1 or its OBU 2. This ETCS communication 14, 14' can comprise in particular control commands within the framework of an automatic train protection (ATP). In the further course of the ETCS communication 14, 14' (typically immediately after the establishment of the ETCS communication 14, 14'), a symbolic name of the train 1 is transmitted by the OBU 2 to the RBC 4. This symbolic name corresponds to a train running number, for instance as indicated in the train schedule of the railway network.

[0044] The RBC 4 or its communication unit CU 8 additionally sends a log-in message 15, 15' via the intranet 3 to the address management unit 6. This contains the current physical packet address of the OBU 2, the hardware name of the OBU 2 and the symbolic name of the train 1 on which the OBU 2 is arranged. This information is entered in a dynamic table 9b stored in the EDNS+ 6 so that it is available for a query (DNS lookup) from the intranet 3.

[0045] The trackside (stationary) additional service 6 also belongs to the communication network 10. The trackside (stationary) additional service 6 knows only the symbolic name of the train 1 from the train schedule, but would like to establish a communication link 16, 16' with the train 1 or its OBU 2 via the intranet 3. To this end, it can use the symbolic name when establishing contact,

as the symbolic name can now be resolved via a query (DNS lookup) 17 by means of the entry in the table 9b.

[0046] Conversely, the train 1 or the OBU 2 can also easily establish a communication with the additional service 6, even when only a (generally permanent) symbolic name of the additional service 6 is known in the train 1, as the physical packet addresses of all additional services are contained in a (here preconfigured, static) stored table 9c of the address management unit 6 and are thus available for a DNS lookup.

[0047] When the train 1 exits the area of responsibility of the RBC 4 (which is typically ascertainable from the travel data relating to the train 1 known in the RBC 4), the RBC 4 sends a log-out message 18, 18' via the intranet 3 to the address management unit 6. The latter then deletes the entries regarding the physical packet address, the hardware name of the OBU 2 as well as the symbolic name of the train 1 from the table 9b.

[0048] When the train 1 enters the area of responsibility of a further radio block centre, a communication and log-in/log-out can occur there analogously to the process described above.

[0049] If desired, a log-in of a communication hardware or an OBU 2 of a train 1 with an address management unit or EDNS+ 6 can also occur independently of the communication with a responsible radio block centre or RBC 4, cf. Fig. 2, after the OBU 2 has logged into the communication network 10 and has been allocated a physical packet address. Only the essential differences to Fig. 1 are explained.

[0050] The OBU 2 sends a log-in message 20, 20' via the intranet 3 to the address management unit 6, for example following a manual initiative of a locomotive operator in the train 1. The log-in message 20, 20' contains the current physical packet address allocated to the OBU 2, the hardware name of the OBU 2 and the

symbolic name of the train 1 on which the OBU 2 is installed. The address management unit 6 then effects a corresponding entry in the table 9b.

[0051] It is thus now possible for the trackside additional service 6 to establish a communication link 16, 16' with the train 1 or with the OBU 2 by means of the symbolic name from the train schedule, wherein a query (DNS lookup) 17 is directed to the address management unit 6.

[0052] For example once again on the initiative of the locomotive operator, prompted by an imminent log-out of the OBU 2 from the communication network 10, a log-out message 21, 21' can also be sent by the OBU 2 via the intranet 3 to the address management unit 6, following the reception of which the physical packet address, the hardware name of the OBU 2 and the symbolic name of the train 1 are deleted from the table 9b.

[0053] In Fig. 3, a typical configuration of queries (DNS lookups) and communication links used in a communication network 10 operated in accordance with the invention is presented.

[0054] A communication hardware unit or OBU 2 of a train has a permanently allocated hardware name on the basis of an ETCS-ID with the number "001". This number "001" is the core component of the hardware name here. Moreover, the corresponding train has received a symbolic name on the basis of a train running number (TRN), here "22567", for its current journey. This number "22567" is the core component of the symbolic name. The OBU 2 has also been allocated the Internet Protocol address 172.20.0.1 dynamically following a request for a physical packet address.

[0055] This information regarding the OBU 2 has already been relayed to the address management unit or EDNS+ 6 within the framework of a log-in procedure via the responsible radio block centre or RBC 4a with a log-in message (update message) 15' (cf. also Fig. 1 in this regard). Accordingly, this information is already stored in the address management unit 6 in the dynamic table 9b.

[0056] The address management unit 6 further has, in a (static or dynamic) table 9a, allocations of hardware names of the communication units of the different RBCs 4a, 4b to their physical packet addresses. If desired, a further (static or dynamic) table can be set up in the address management unit 6 for allocations of hardware names of communication units of the trackside additional services 6a, 6b, 6c.

[0057] The OBU 2 is conducting a communication 14 with the RBC 4a responsible for its train. As its hardware name, the RBC 4a has ETCS-ID 002, which is known to the OBU 2 (for instance from a balise). For the establishment of a communication, the OBU 2 sent a corresponding name resolution query 13 to the EDNS+ 6, i.e. a DNS lookup for the (complete) hardware name "id002.ty02.etcs" of the RBC 4a or its communication unit. The corresponding syntax provides here for the placement of an "id" before the core component "002" and a ".ty02.etcs" after the core component. Within the framework of its response to the name resolution query 13, the EDNS+ 6 transmits the corresponding physical packet address "173.25.0.5" to the OBU 2. The communication 14 here comprises, for example, UNISIG Euroradio and UNISIG ETCS messages.

[0058] The OBU 2 also prepares here a communication with the next RBC 4b, which has the ETCS-ID 003. The purpose of this communication can be, for example, an RBC handover (handover of responsibility). The OBU 2 sent a corresponding query 30 regarding the hardware name "id003.ty02.etcs" to the EDNS+ 6.

[0059] The RBC 4a has already initiated a communication 31 with the next RBC 4b, which in turn was associated with a query 32 regarding the hardware name "id003.ty02.etcs".

[0060] In the illustrated variant, a first trackside additional service 6a also wishes to establish a communication 33 with the OBU 2. The ETCS-ID 001 of the OBU 2 here is known to the additional service 6a or its communication unit. The

additional service 6a thus sends a corresponding name resolution query 34 regarding the hardware name "id001.ty02.etcs" to the EDNS+ 6. The communication 33 can be established with the physical packet address 172.20.0.1 determined via the EDNS+ 6. A typical communication 33 relates here to the maintenance condition of the train (for instance the remaining thickness of the brake pads), which is checked independently of a current journey assignment.

[0061] The second trackside additional service 6b likewise wishes to establish a communication 35 with the OBU 2. Only the symbolic name TRN 22567 of the train belonging to the OBU 2 is known to this additional service 6b. The additional service 6b accordingly sends a name resolution query 36 regarding the (complete) symbolic name "trn22567.ty02.etcs" to the EDNS+ 6. The corresponding syntax provides here for the placement of a "trn" before the core component "22567" and a",.ty02.etcs" after the core component. The communication 35 can be established after the reception of the physical packet address 172.20.0.1 from the EDNS+ 6. A typical communication 35 relates here to information for the passengers of the train regarding connecting trains that are available or no longer available at the destination station.

[0062] The third trackside additional service 6c wishes here to set up a communication 37 with the RBC 4b, whose ETCS-ID 003 is known to the additional service 6c. By means of the name resolution query 38 regarding the (complete) hardware name "id003.ty02.etcs", the physical packet address of the RBC 4b or its communication unit can be obtained from the EDNS+ 6. A typical communication 37 here can relate, for example, to an enquiry regarding current line closures in the area of responsibility of the RBC 4b.

[0063] With the EDNS+ 6, name resolution queries of the trains/OBUs, of the RBCs/CUs and of the additional services which respectively know the (permanent) physical packet address of the EDNS+ can be answered.

[0064] Fig. 4 illustrates an application of the invention within the framework of a CCTV (closed circuit television).

[0065] A train 1 is travelling without a driver with an autonomous control unit on a track 40. The train 1 monitors a track section 43 lying in front of it with a camera 41. The image data captured by the camera 41 are transmitted by the communication hardware or OBU 2 of the train 1 via radio 45 in a packet-based manner (for instance by means of LTE) to a communication network 10 and, for example, received at a trackside mobile radio antenna 46 and routed via a fibre optic line 42 to a connected trackside additional service 6. This additional service 6 is housed in a trackside control centre 47 in which a trained locomotive operator 48 views the image data captured by the camera 41 on a computer screen 49 and temporarily operates the train 1 via remote control. The additional service 6 was able to contact the OBU 2 in accordance with the invention via the symbolic name of the train 1. Due to the packet-based data transmission in the communication network 10, the image data can be transmitted in a high resolution.

[0066] In the present case, a fallen tree 44 is blocking the track 40. The locomotive operator 48 in the control centre 47 has thus assumed control of the train. He lets the train wait until the fire brigade (not illustrated) has cleared the track 40. He then sets the train 1 in motion again and finally lets the autonomous control unit take over. In summary, the present invention allows a UNISIG-compatible communication with a train or its OBU via the hardware name (ETCS-ID) as well as, moreover, via an additional symbolic name (TRN) of the corresponding train on which the OBU is installed. The address management unit EDNS+, which can resolve both hardware names and symbolic names of an OBU/of a train, enables a conventional name resolution in the background according to the Internet Protocol. In principle, all communication links (in particular train to additional service within the framework of the ETCS, train to additional service outside of the ETCS, train to RBC, additional service to train via hardware names/OBU-ID (ETCS-ID), additional service to train via symbolic names/TRN) can be established via the DNS address resolution of the EDNS+. Trains that change their IP address, for instance via DHCP, are registered and unregistered at the EDNS+ dynamically; this can occur automatically in the

context of the ETCS, or also via a train-side service outside of the ETCS. The name resolution (DNS) is preferably designed with redundancy.

Patentkrav

1. Fremgangsmåde til drift af et pakkebaseret kommunikationsnetværk (10) i et jernbanenet,
hvor jernbanenettet omfatter en flerhed af tog (1), en flerhed af radiostrækningscentraler (4, 4a-4b) og en adresseforvaltningsenhed (6), der kommunikerer pakkebaseret med hinanden via kommunikationsnetværket (10),
hvor en kommunikationshardware (2) af et pågældende tog (1) har et hardwarenavn, og en kommunikationsenhed (8) af en pågældende radiostrækningscentral (4, 4a-4b) har et hardwarenavn,
hvor adresseforvaltningsenheden (6) til forskellige hardwarenavne statisk eller dynamisk gemmer hver især en fysisk pakkeadresse, og adresseforvaltningsenheden (6) svarer på forespørgsler (13, 30, 32, 34, 38) via fysiske pakkeadresser til hardwarenavne fra kommunikationsnetværket (10), **kendetegnet ved,**
at togene (1) for enkelte kørslers varighed endvidere får tildelt et symbolsk navn, der repræsenterer en aktuel køreopgave af toget (1), og hardwarenavnene på togenes (1) kommunikationshardware (2) ikke ændrer sig fra kørsel til kørsel,
at adresseforvaltningsenheden (6) endvidere til forskellige symbolske navne dynamisk gemmer hver især den fysiske pakkeadresse på togets (1) kommunikationshardware (2), og adresseforvaltningsenheden (6) også svarer på forespørgsler (17; 36) via fysiske pakkeadresser for symbolske navne fra kommunikationsnetværket (10), at jernbanenettet endvidere omfatter ekstratjenester (6, 6a-6c) på strækningssiden, der via kommunikationsnetværket (10) får adgang til togene (1), hvor ekstratjenesterne (6; 6a-6c) på strækningssiden retter forespørgsler om fysiske pakkeadresser for symbolske navne mod adresseforvaltningsenheden (6), og hvor ekstratjenesterne (6, 6a-6c) på strækningssiden kun kender det symbolske navn, men ikke hardwarenavnet (6).

2. Fremgangsmåde ifølge krav 1, **kendetegnet ved, at** kommunikationsnetværket (10) er et internet-protokol-baseret intranet (3).

3. Fremgangsmåde ifølge krav 1 eller 2, **kendetegnet ved, at** adresseforvaltningsenheden (6) er indrettet som en domæne-navn-system(=DNS)-server, især som open source DNS-server, og at forespørgslerne (13; 17; 30, 32, 34, 36, 38) til adresseforvaltningsenheden (6) er udformet som DNS-lookup.

4. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** en eller flere ETCS-funktioner, især ATP, drives mellem togene (1) og radiostrækningscentralerne (4, 4a-4b) via kommunikationsnetværket (10).

5. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** ekstratjenesterne (6; 6a-6c) på strækningssiden omfatter opkobling til et kamera (41) af et tog (1), der overvåger et strækningsafsnit (43) foran toget (1), fra et kontrolcentrum (47) på strækningssiden, især hvor føringen af et førerløst tog (1) periodisk overtages af en trækkøretøjsfører (48) i kontrolcentret (47) på strækningssiden, der modtager billeddataene fra togets (1) kamera (41).

6. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** togets (1) symbolske navn vises i begyndelsen af en respektiv kørsel af togets (1) kommunikationshardware (2), især af trækkøretøjsføreren via et driver-machine-interface.

7. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** togets (1) kommunikationshardware (2) i det mindste ved en ny indlogning i kommunikationsnetværket (10) får tildelt en ny fysisk pakkeadresse.

8. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved,**
at kommunikationshardwaren (2) af et tog (1), der kommer ind i en radiostrækningscentrals (4; 4a-4b) ansvarsområde, opbygger (12, 12') en pakkebaseret kommunikation til denne radiostrækningscentral (4; 4a-4b) og meddeler den fysiske pakkeadresse, hardwarenavnet og det symbolske navn på toget (1) til denne radiostrækningscentral (4; 4a-4b),
at denne radiostrækningscentral (4; 4a-4b) efterfølgende overfører (15, 15') hardwarenavnet på togets (1) kommunikationshardware (2), den fysiske pakkeadresse og togets (1) symbolske navn til adresseforvaltningsenheden (6),

og adresseforvaltningsenheden (6) således gemmer den fysiske pakkeadresse med hardwarenavnet (4; 4a-4b) på togets (1) kommunikationshardware (2) og med togets (1) symbolske navn (TRN).

9. Fremgangsmåde ifølge krav 8, **kendetegnet ved, at** toget (1), når det kommer ind i denne radiostrækningscentrals (4; 4a-4b) ansvarsområde, kører over en balise (5), og at denne balise (5) af togets (1) kommunikationshardware (2) overfører (11) et hardwarenavn eller en fysisk pakkeadresse af denne radiostrækningscentral (4; 4a-4b), og togets (1) kommunikationshardware (2) dermed opbygger (12, 12') den pakkebaserede kommunikation til denne radiostrækningscentral (4; 4a-4b).

10. Fremgangsmåde ifølge et af kravene 8 eller 9, **kendetegnet ved, at** når toget (1) forlader denne radiostrækningscentrals (4; 4a-4b) ansvarsområde, meddeler (18, 18') denne radiostrækningscentral (4; 4a-4b) dette til adresseforvaltningsenheden (6), og adresseforvaltningsenheden (6) sletter hardwarenavnet på togets (1) kommunikationshardware (2), den fysiske pakkeadresse og det symbolske navn på toget (1) fra sin hukommelse.

11. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** et togs (1) kommunikationshardware (2) efter en indlogning i kommunikationsnetværket (10) overfører (20, 20') hardwarenavnet, den fysiske pakkeadresse og det symbolske navn af toget (1) til adresseforvaltningsenheden (6) uden medvirken af en radiostrækningscentral (4; 4a-4b), og adresseforvaltningsenheden (6) således gemmer den fysiske pakkeadresse med hardwarenavnet på togets (1) kommunikationshardware (2) og med togets (1) symbolske navn.

12. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** et togs (1) kommunikationshardware (2) ved udlogning fra kommunikationsnetværket (10) meddeler (21, 21') sin forestående udlogning til adresseforvaltningsenheden (6) uden medvirken af en radiostrækningscentral (4; 4a-4b), og adresseforvaltningsenheden (6) således sletter hardwarenavnet på togets (1) kommunikationshardware (2), den fysiske pakkeadresse og det symbolske

navn på toget (1) fra sin hukommelse.

13. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** togenes (1) kommunikationshardware (2), radiostrækningscentralerne (4; 4a-4b) og evt. ekstratjenesterne (6; 6a-6c) på strækningssiden ikke gemmer nogen fysiske pakkeadresser lokalt, med undtagelse af den i hvert tilfælde egne fysiske pakkeadresse og fysiske pakkeadresser til egne, aktive kommunikationsforbindelser, men til navneopløsning retter en forespørgsel (13; 17; 30, 32, 34, 36, 38) mod adresseforvaltningsenheden (6) via kommunikationsnetværket (10).

14. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** hardwarenavnet omfatter en ETCS-ID.

15. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** det symbolske navn er baseret på et driftstognummer.

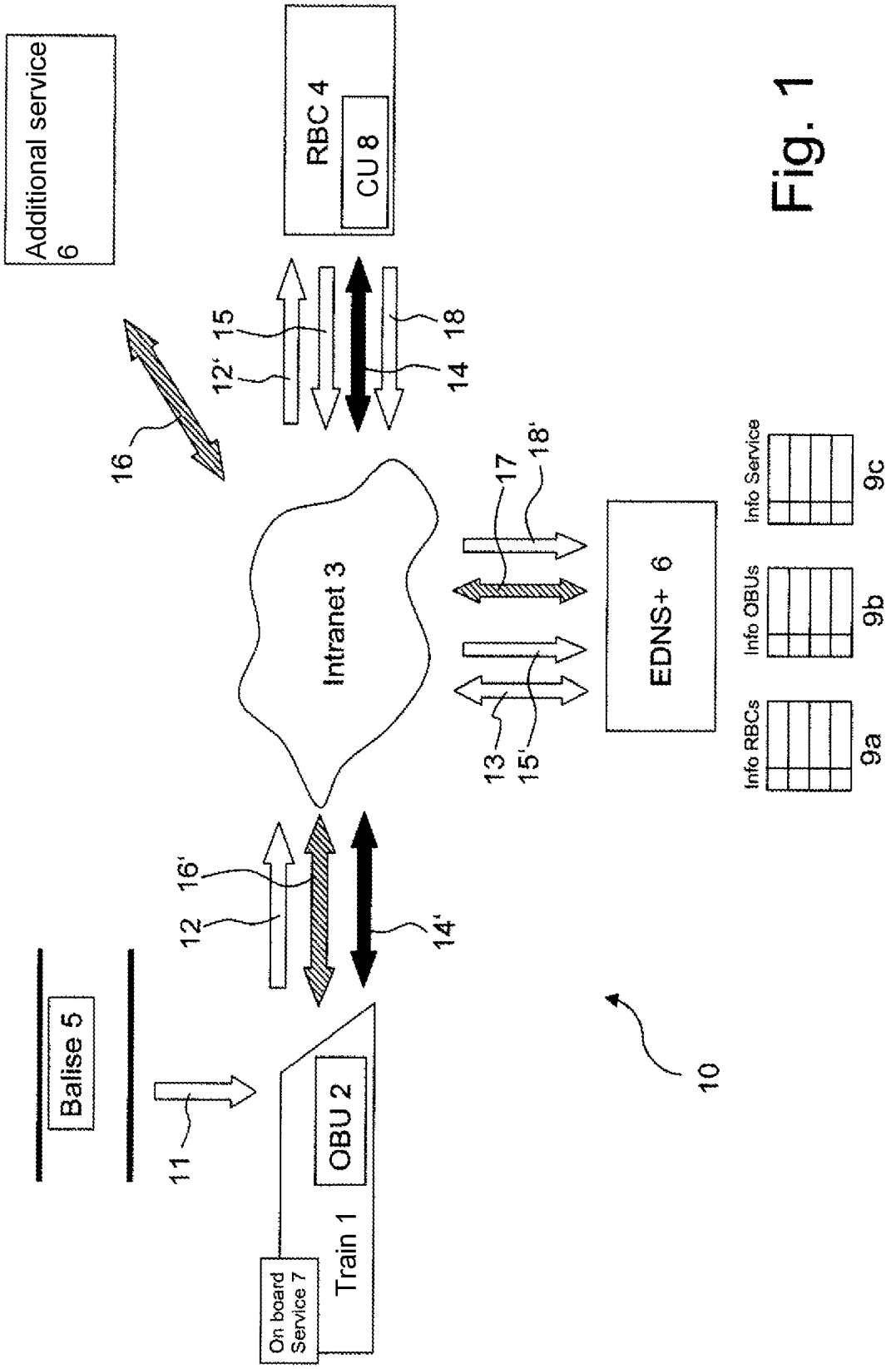
Additional service 6
RBC 4
CU 8
12' 15
18
14
16
Intranet 3
17
18'
EDNS+ 6
Info Service
9c
Info OBUs
9b
Info RBCs
9a
13
15'
16'
12
14'
Balise 5
11
OBU 2
Train 1
On board Service 7
10

Fig. 1

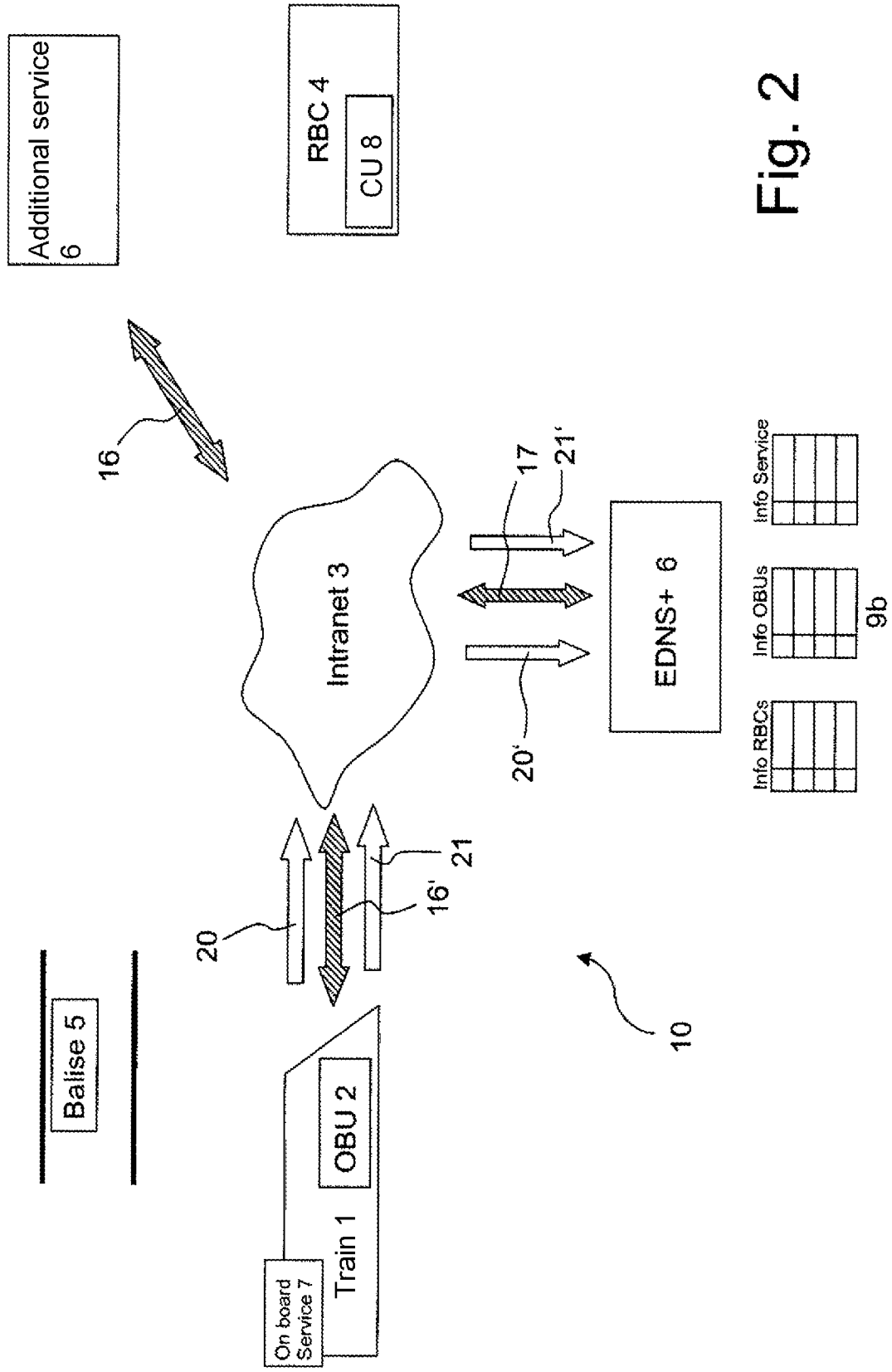
Additional service 6
RBC 4
CU 8
16
Intranet 3
17
21'
EDNS+ 6
Info Service
Info OBUs
9b
Info RBCs
20'
20
16'
21
Balise 5
OBU 2
Train 1
On board Service 7
10

Fig. 2

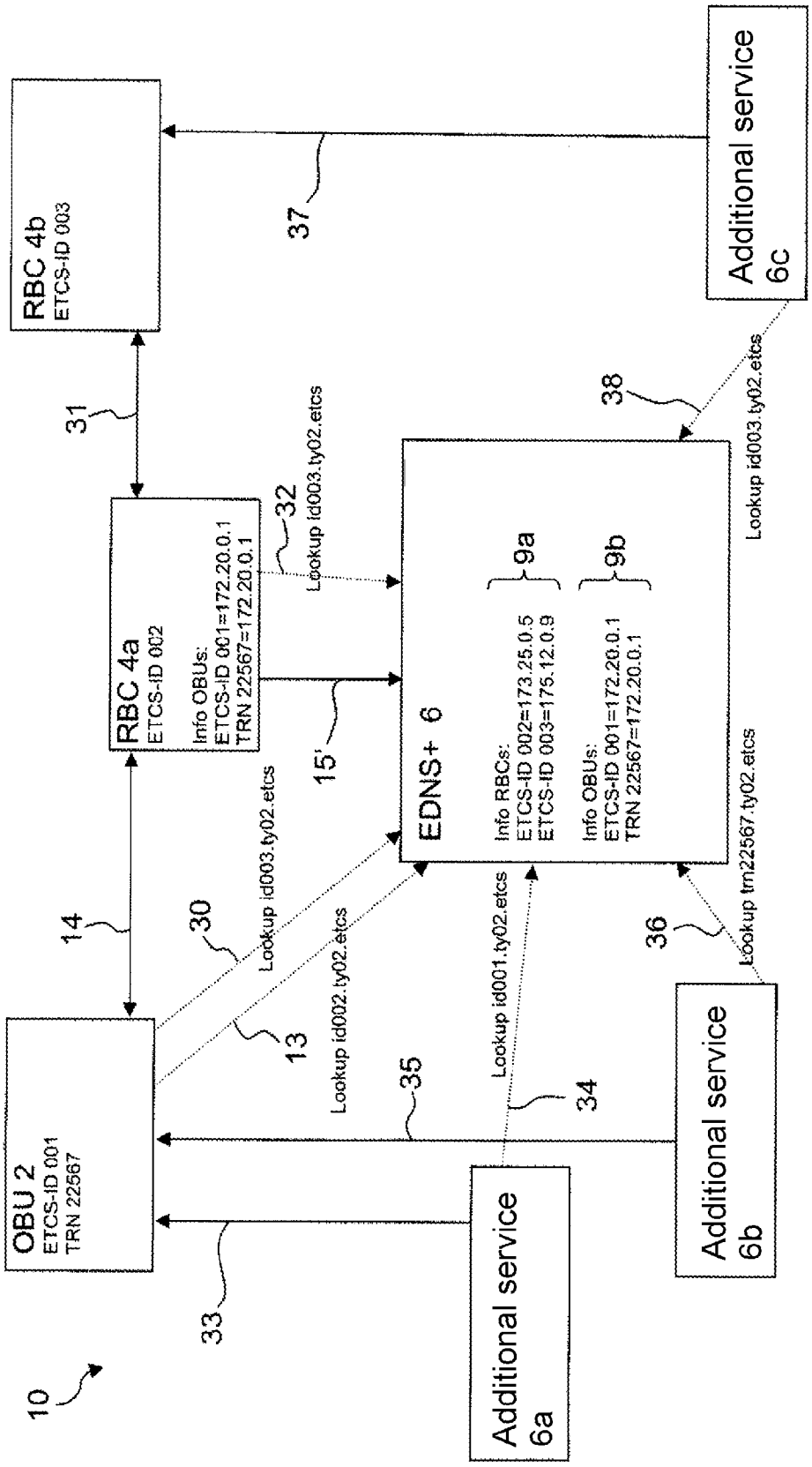
RBC 4b
ETCS-ID 003
Additional service
6c
37
31
38
RBC 4a
ETCS-ID 002
Info OBUs:
ETCS-ID 001=172.20.0.1
TRN 22567=172.20.0.1
32
Lookup id003.ty02.etcs
15'
EDNS+ 6
9a
9b
Info RBCs:
ETCS-ID 002=173.25.0.5
ETCS-ID 003=175.12.0.9
Info OBUs:
ETCS-ID 001=172.20.0.1
TRN 22567=172.20.0.1
Lookup id003.ty02.etcs
14
30
Lookup id003.ty02.etcs
13
Lookup id002.ty02.etcs
Lookup id001.ty02.etcs
36
Lookup trn22567.ty02.etcs
OBU 2
ETCS-ID 001
TRN 22567
35
34
Additional service
6b
33
Additional service
6a
10

Fig. 3

Fig. 4