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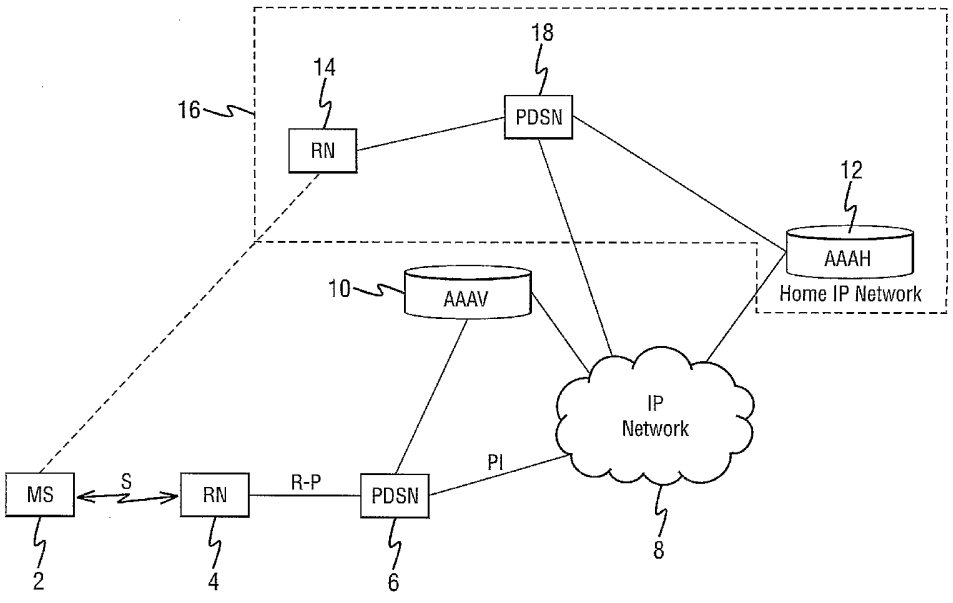
[Continued on next page]

(54) Title: A METHOD OF FACILITATING HANDOFF



(57) Abstract: A method of configuring a router for facilitating handoff. The method comprising the steps of configuring a virtual interface in a current router used by user equipment; and assigning a global address to said interface.

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A METHOD OF FACILITATING HANDOFF

Field of the Invention

The present invention relates to a method of facilitating handoff.

Background of the Invention

A communication system is a facility that enables communication between two or more entities such as user terminal equipment and/or network entities and other nodes associated with a communication system. The communication may comprise, for example, communication of voice, electronic mail (e-mail), text messages, data, multimedia and so on.

The communication may be provided by a fixed line and/or a wireless communication interface. A feature of wireless communication systems is that they provide mobility for the users thereof. An example of communication systems providing wireless communication are public land mobile networks (PLMN). An example of the fixed line system is a public switched telephone network (PSTN).

A communication system typically operates in accordance with a given standard or specification which sets out what the various elements of a system are permitted to do and how that should be achieved. For example, the standard or specification may define if the user, or more precisely user equipment, is provided with a circuit switched server or a packet switched server or both. Communication protocols

and/or parameters which should be used for the connection are also typically defined. For example, the manner in which the communication should be implemented between the user equipment and the elements of the communication networks is typically based on a predefined communication protocol. In other words, a specific set of "rules" on which the communication can be based needs to be defined to enable the user equipment to communicate via the communication system.

So called third generation communication systems are being introduced. These so called third generation systems use code division multiple access techniques. One example of such a third generation communication system is the cdma2000 system.

When a mobile node (MN) moves and changes its point of attachment to the Internet, there is a period of time when it is not able to send packets because of the link switching delay and IP configuration procedures. Reference is made to the document "Fast Handovers for Mobile IP (Internet Protocol)v6 - A Draft IETF (Internet Engineering Task Force) Specification (draft- ietf-mipshop-fast-mipv6-01.txt)". As discussed in this document, fast handoffs for IPv6 enable a mobile node to minimise this handoff latency by moving operations such as router discovery, IP address configuration and signalling the correspondent nodes to update its location out of the critical period when the mobile node is handing off. The proposed procedure discussed in this document for the fast handoff protocol involves setting up temporary forwarding for the traffic meant for the mobile node from the previous router to the new access router. To set up this forwarding, the mobile node needs to know the IPv6 global address of the previous access router

so that it can send a fast binding update message to the previous access router.

In cdma2000 networks, when the mobile node requests a simple IPv6 service, it configures a topologically correct IPv6 address from the IPv6 prefix advertised by the PDSN (Packet Data Serving Node). If the mobile node moves and attaches to a different PDSN there is a period of time when the mobile node is not able to receive packets. The IPv6 address is configured during the IPv6CP:IPv6 Control Protocol. phase of the PPP (Point-to-Point Protocol) set up between the mobile node the PDSN. However, in the CDMA 2000 networks, the PDSN only configures a link local address on the PPP link and does not configure a global address from the prefix advertised on the PPP link. The mobile node only knows the link local address of the PDSN. A link local address is one which is valid only on a link. In other words, a different link can have a different link address. A unicast global address has a global routing prefix which is a (typically hierarchically-structured) value assigned to a site (a cluster of subnets/links), a subnet ID identifying a link within the site and an interface ID. This is discussed in IETF document RFC 3513 (http://www.ietf.org/rfc/rfc3513.txt) Thus a link local address is valid only on a link whereas a global unicast address is globally routable.

Even if the PDSN were to configure a global address from the prefix advertised on the PPP link and inform the mobile node of the global address, it would still not be possible for the mobile node to send a fast binding update to the old PDSN from the new PDSN, if the mobile node hands off to a new PDSN. This is because the PPP link between the mobile node and the old PDSN is terminated when the mobile node

moves to a new link and the PDSN's global address is no longer valid.

It is an aim of embodiments of the present invention to address or at least mitigate the above described problem.

Summary of the Invention

According to a first aspect there is provided a method of configuring a router for facilitating handoff comprising the steps of:

configuring a virtual interface in a current router used by user equipment; and

assigning a global address to said interface.

According to a second aspect, there is provided a system comprising a current router and user equipment, said current router being configured to have a virtual interface and having a global address assigned to said interface, said global address assigned to said interface being used to facilitate handoff of the user equipment from said current router to a new router.

According to a third aspect, there is provided a router configurable to have a virtual interface and having a global address assigned to said interface, said global address assigned to said interface being used to facilitate handoff of user equipment from said router to a new router.

According to a fourth aspect, there is provided user equipment arranged to communicate with a current router, said router being configured to have a virtual interface and having a global address assigned to said interface, said

global address assigned to said interface being used to facilitate handoff of the user equipment from said current router to a new router, said user equipment being arranged to receive information on said global address from said current router.

Brief Description of Drawings

For a better understanding of the present invention as to how the same may be carried into effect, reference will now be made by way of example only to the accompanying drawings in which:

Figure 1 shows a network in which embodiments of the present invention can be implemented;

Figure 2 shows the signalling flow in an embodiment of the present invention;

Figure 3 shows a message for providing a PDSN global address;

Figure 4 shows a method of predictive handoff used in embodiments of the invention; and

Figure 5 shows a method of reactive handoff used in embodiments of the invention.

Detailed Description of Preferred Embodiments of the Present Invention

Reference is made first to Figure 1 which shows a network in which embodiments of the present invention can be incorporated. This network is, by way of example a cdma2000 packet data network. It should be appreciated that embodiments of the present invention may be applied to any other network conforming to any other suitable standard.

Other standards could for example include other third generation standards but are not limited thereto.

User equipment (mobile node) is provided which may be a mobile station. The user equipment can take any suitable format. For example, the user equipment may be a portable computer, mobile telephone, personal data assistant, organiser or the like.

In this embodiment, the user equipment is a mobile station 2 arranged to communicate with a radio network RN4 via a wireless connection 5. The radio network may comprise, for example, base stations and base station control functions.

The radio network 4 is connected to a packet data serving node (PDSN) 6. The PDSN 6 provides the network access gateway functionality and acts effectively as a router. The PDSN is arranged to communicate with an IP network 8 which may for example be the Internet or the like. The PDSN permits communication from the mobile station and to the mobile station to be routed via the IP network 8.

The PDSN 6 is also connected to an authentication, authorisation and accounting server 10. In the example shown in Figure 1, the mobile station is not in its home network. Accordingly, the AAA entity 10 to which the PDSN 6 is connected will be that of the visited network. This entity will be referred to as the AAAV 10. The AAAV 10 is also able to communicate with the IP network 8.

The IP network 8 is connected to the authentication authorisation and accounting server 12 in the user's home IP network. This is the AAAH 12.

A second radio access network 14 is shown. This radio access network 14 is in the user's home network 16. The radio access network 14 is connected to a second PDSN 18. The second PDSN 18 is connected to the IP network 8 and the AAAH 12.

Embodiments of the present invention will now be described where the mobile station moves from the first PDSN 6 to the second PDSN 18. Embodiments of the present invention are described in the context where the mobile station is connected to a PDSN in a visited network and moves to a PDSN in the home network. This is by way of example only. The PDSNs may both be in the visited network, both be in the home network or any other two networks.

Reference is now made to Figure 2 which shows the signalling used in embodiments of the present invention. Shown in Figure 2 is the mobile station 2, the radio access network 4 to which the mobile station is currently connected and the PDSN 6 to which the mobile station is also currently connected. The AAAV 10 is also shown.

In step S1, a network access request procedure is carried out between the mobile station and the radio access network 4 to which the mobile station is currently attached.

In step S2 a link control protocol phase LCP of the PPP is carried out between the mobile station and the PDSN. LCP is one of the phases in PPP setup. LCP is described in IETF specification RFC 1331 http://www.ietf.org/rfc/rfc1331.txt?number=1331. The LCP is used to automatically agree upon the encapsulation format

options, handle varying limits on sizes of packets, authenticate the identity of its peer on the link, determine when a link is functioning properly and when it is not, detect a looped-back link and other common configuration errors, and terminate the link. The Link Control Protocol (LCP) is used to establish the connection through an exchange of Configure packets. This exchange is completed, and the LCP Opened state entered, once a Configure-Ack packet has been both sent and received.

In step S3, the AAAV 10 authenticates mobile station.

In step S4 the PDSN configures a virtual interface which is internal to the PDSN. Between the MS and the PDSN, a real PPP link is set up. The PDSN configures a global unicast address on the virtual interface and advertises this address for Fast Handoffs to the Mobile Station on a PPP link.
An IPv6 global address is assigned to the virtual interface. This is to provide support for fast handoff.

In step S5, the PDSN informs the mobile station of this global IPv6 address by including a new option in the router advertisement it sends in step S5 after the PPP set up.

The message format for the new message is shown in Figure 3. The message format comprises a first field 40 which is an 8 bit field indicating the type of the ICMPv6 option. The next field 42 is an 8 bit field indicating the length of the option in units of 8 octets excluding the type and length of fields. It is set to 2 in one embodiment of the invention.

The third field 44 is the PDSN global address field. This is a 16 byte field which contains the IPv6 address of the PDSN for the purpose of fast handoffs.

This message is valid only in a router advertisement. The PDSN includes this option in the router advertisement only if the mobile nodes subscriber profile says that the mobile station is capable of IPv6 fast handoffs and eligible for the fast handoff service. The mobile station profile is downloaded to the PDSN when the mobile station authenticates itself to the PDSN to obtain network access. This may take place in for example step S3

Reference will now be made to Figures 4 and 5 which show two examples of handoffs which can occur after step S5 or Figure 2 when the MS moves to another PDSN.

Reference is made to Figures 4 and 5 which show handoff. The steps in figure 2 happen when the mobile station attaches to a PDSN. The steps in Figure 4 or 5 happen when the mobile station hands off from one PDSN to another. .

Reference is made to Figure 4 which shows an example of predictive handoff.

In step T1, the mobile station sends a message to the old PDSN to resolve one or more access point identifiers to subnet specific information.

In step T2, the PDSN sends a Proxy Router advertisement. It contains information about the new link, like for eg. the IPv6 prefix information. The MS can configure a new CoA

before moving to the new link based on the information obtained through the proxy router advertisement.

In step T3 the mobile station send a fast binding update FBU message instruction to the global address of the virtual interface of the old PDSN to redirect its traffic towards the new PDSN. The global address of the PDSN that was obtained by the mobile station in step S5 of Figure 2 is used as destination address of the FBU message.

In step T4, the old PDSN sends a handoff initiate message to the new PDSN.

In step T5, the handoff message is acknowledged by the new PDSN.

In step T6, a fast binding acknowledgement is sent by the old PDSN towards the mobile station and the new PDSN.

The mobile station disconnects from the old PDSN.

In step T7, the old PDSN forwards packets to the new PDSN.

The mobile station connects to the new PDSN.

In step T8, a fast neighbour advertisement is sent from the mobile station to announce itself to the new PDSN.

In step T9, the new PDSN starts delivering packets to the mobile station.

Sometimes the FBU message sent in the predictive case can get lost. In this case the MS might have to send a FBU after

attaching to the new PDSN. The destination address on the FBU message would be old PDSN's global unicast address.

Reference is now made to Figure 5 which shows an example of reactive handoff.

Steps R1 and R2 are the same steps T1 and T2 of Figure 4.

The mobile station disconnects from the old PDSN and connects to the new PDSN.

In step R3 a fast neighbour advertisement is sent from the mobile station to announce itself to the new PDSN including a fast binding update. The destination address on the FBU message is set the old PDSN's global unicast address.

In step R4, the new PDSN sends the FBU message in the FNA to the old PDSN.

In step R5, a fast binding acknowledgement is sent from the old PDSN to the new PDSN.

In step R6, packets are forwarded from the old PDSN to the new PDSN.

In step R7, the new PDSN delivers packages to the mobile station.

The PDSN uses the same IPv6 address to support fast handover for all mobile stations that attach to it. The mobile stations send fast binding updates FBU to this address configured on the PDSN.

It should be appreciated that other mechanisms for handoff can be used in embodiments of the present invention.

The mobile station is arranged to process the ICMPv6 option described in Figure 3 and use the PDSN address for sending the fast binding update. It is arranged so that it does not attempt to send a FBU to the other address if the PDSN includes this ICMPv6 option in the router advertisement.

In embodiments of the present invention, it is possible to implement fast handoffs for IPv6 over cdma2000 networks for inter PDSN handovers. Knowing the global address of the PDSN is important to make this happen.

Even if the PPP link between the mobile station and the PDSN is terminated, the mobile station can send fast binding updates to the PDSN global address. The virtual interface is necessary so that this can be supported. The virtual interface is permanent and does not depend on the MS attaching to the PDSN.

Every communication device needs an interface over which it can communicate with another node. A physical interface is something like an Ethernet interface, WLAN interface, cellular radio link, etc. The software inside the communication device however sees something called a logical interface. A logical interface is associated with a physical interface. A virtual interface is also a logical interface, but is not associated with a physical interface. For example, the PPP link between the Mobile Station and PDSN in cdma2000 networks is a logical interface set up over the radio interface between the PDSN and the Mobile station. A

virtual interface on the other hand is not associated with a physical interface on the PDSN. It is internal to the PDSN.

CLAIMS

1. A method of configuring a router for facilitating handoff comprising the steps of:

configuring a virtual interface in a current router used by user equipment; and

assigning a global address to said interface.

2. A method as claimed in claim 1 comprising the step of advertising said global address for handoff of said user equipment from said current router.

3. A method as claimed in claim 1, comprising providing a PPP link between said user equipment and said current router.

4. A method as claimed in claimed in claim 1, comprising the step of sending from the user equipment to a new router the global address.

5. A method as claimed in claim 1, comprising terminating a link between the user equipment and the router and after terminating said link, sending a message from a new router to the router using said global address.

6. A method as claimed in claim 5, wherein said message instructs said router to redirect traffic to said new router.

7. A method as claimed in claim 5, wherein said message is a Fast binding update message.

8. A method as claimed in claim 1, comprising the step of sending a message from the user equipment to said router using the global address instructing the router to route packets to a new router.

9. A method as claimed in claim 8, wherein said message is a Fast binding update message

10. A method as claimed in claim 1, wherein said global address comprises an IPv6 address.

11. A method as claimed in claim 1 comprising the step of sending said global address from said current router to said user equipment.

12. A method as claimed in claim 11, wherein said sending step comprises sending said global address in a router advertisement.

13. A method as claimed in claim 1, comprising the step of terminating the connection with said current router and connecting to a second router.

14. A method as claimed in claim 1 wherein said router comprises a packet data support node.

15. A method as claimed in claim 1, comprising the step of determining if a subscriber profile of the user equipment is eligible for a predetermined handoff service and only if so is said global address sent to said user equipment.

16. A method as claimed in claim 15, wherein said predetermined handoff service is a fast handoff service.

17. A system comprising a current router and user equipment, said current router being configured to have a virtual interface and having a global address assigned to said interface, said global address assigned to said interface being used to facilitate handoff of the user equipment from said current router to a new router.

18. A router configurable to have a virtual interface and having a global address assigned to said interface, said global address assigned to said interface being used to facilitate handoff of user equipment from said router to a new router.

19. User equipment arranged to communicate with a current router, said router being configured to have a virtual interface and having a global address assigned to said interface, said global address assigned to said interface being used to facilitate handoff of the user equipment from said current router to a new router, said user equipment being arranged to receive information on said global address from said current router.

FIG. 1

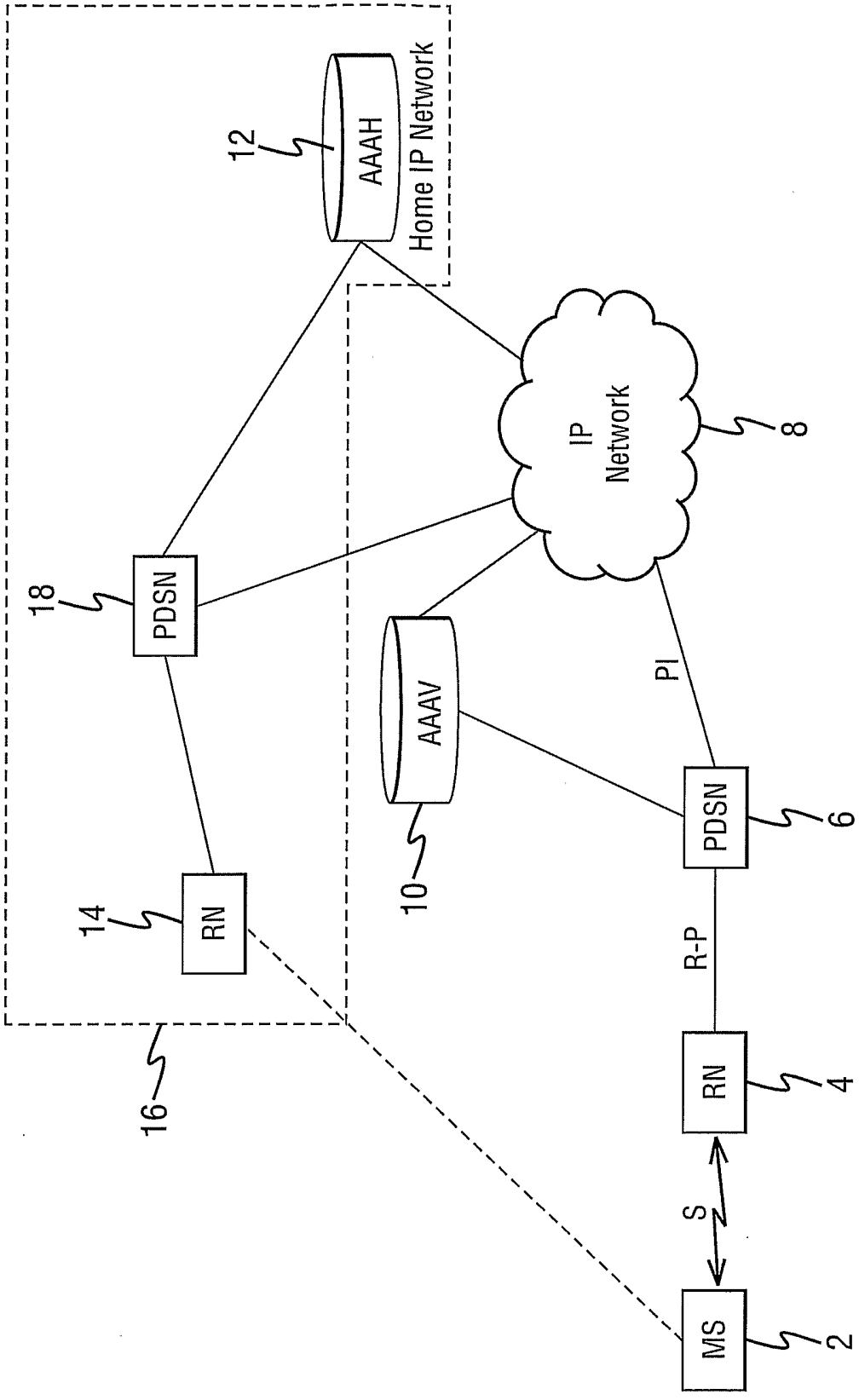

Home IP Network
AAAH
12
IP Network
8
PDSN
18
AAAV
10
PI
PDSN
6
RN
14
R-P
RN
4
S
MS
2
16

FIG. 2

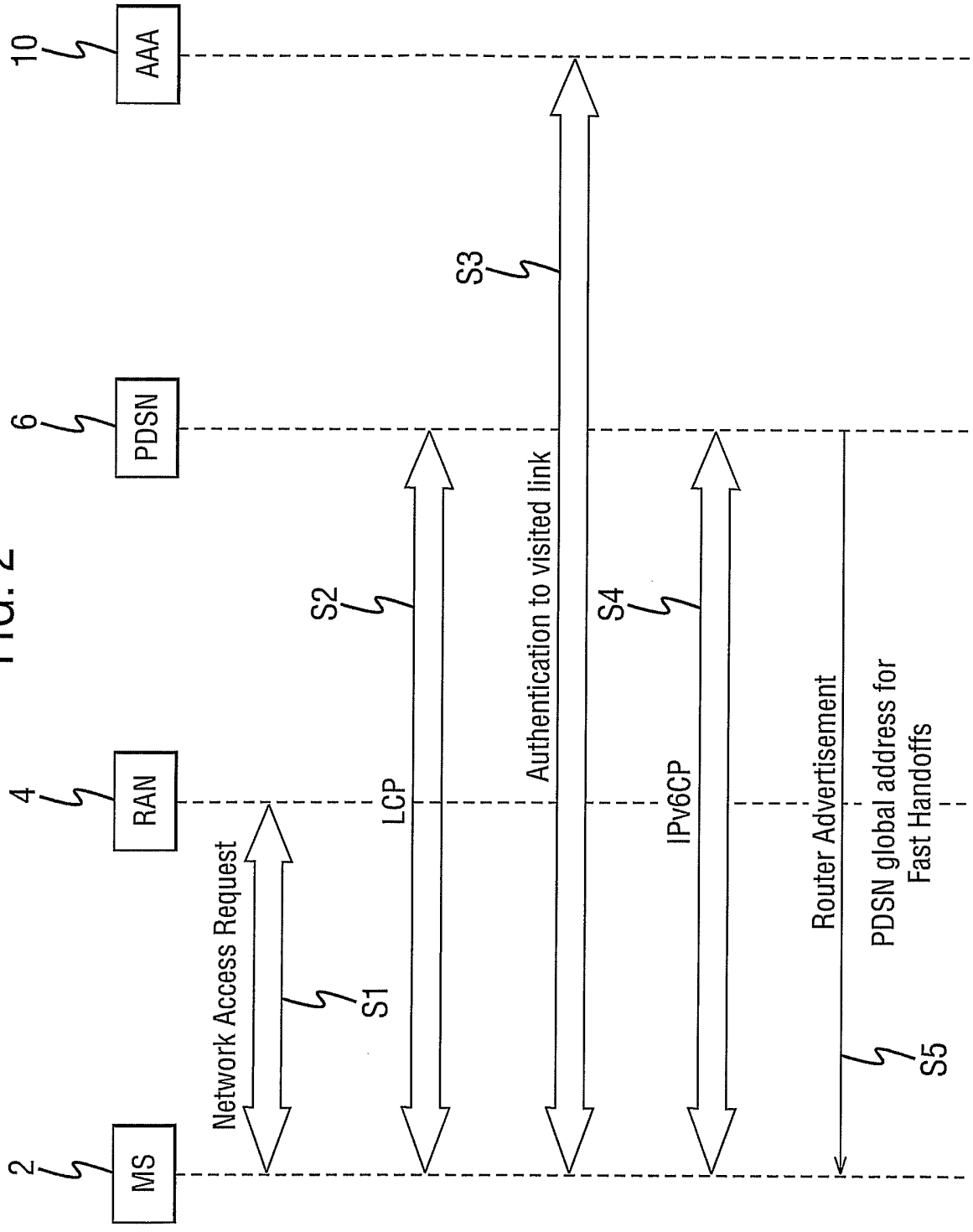

10
AAA
6
PDSN
4
RAN
2
MS
S1
S2
S3
S4
S5
Network Access Request
LCP
Authentication to visited link
IPv6CP
Router Advertisement
PDSN global address for Fast Handoffs

FIG. 3

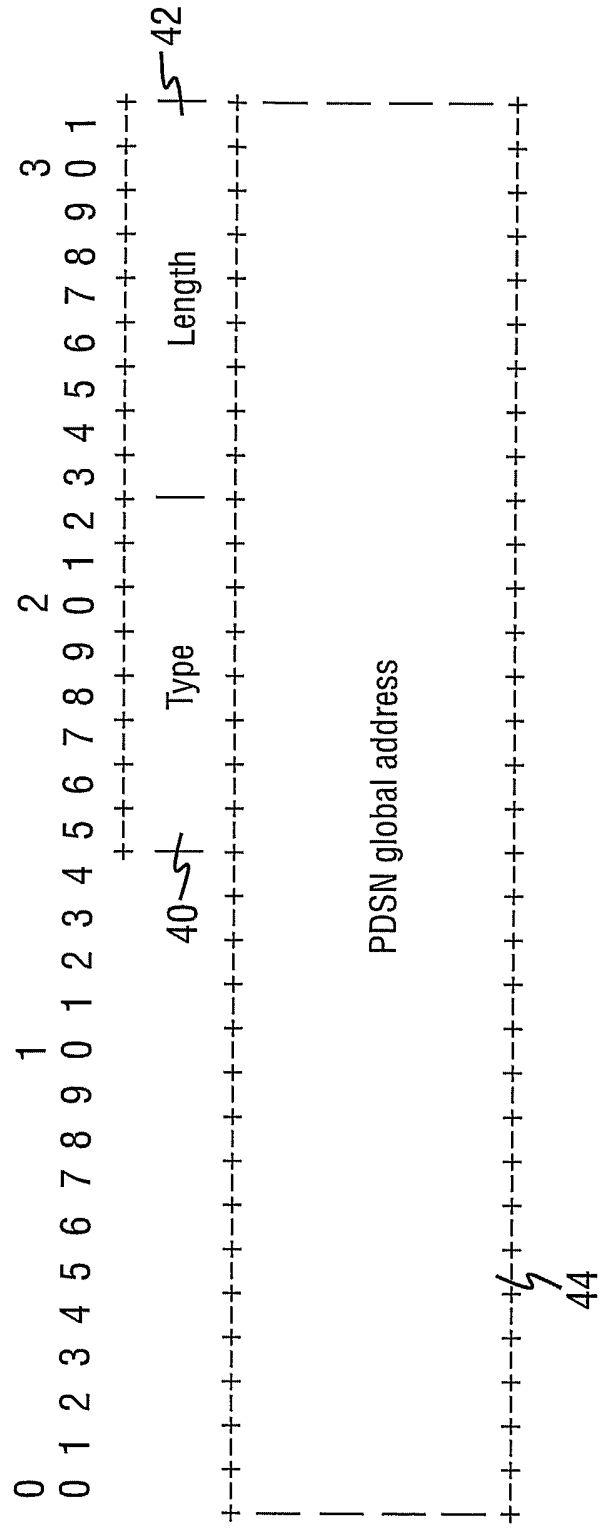

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
Type
Length
PDSN global address
40
42
44

FIG. 4

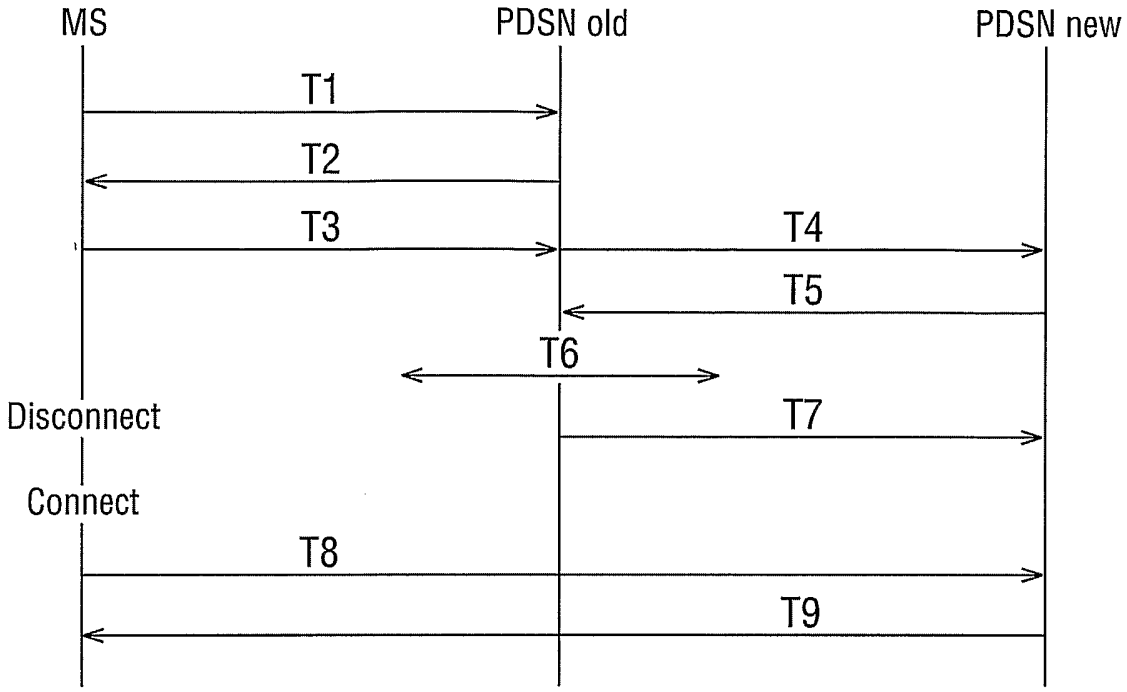
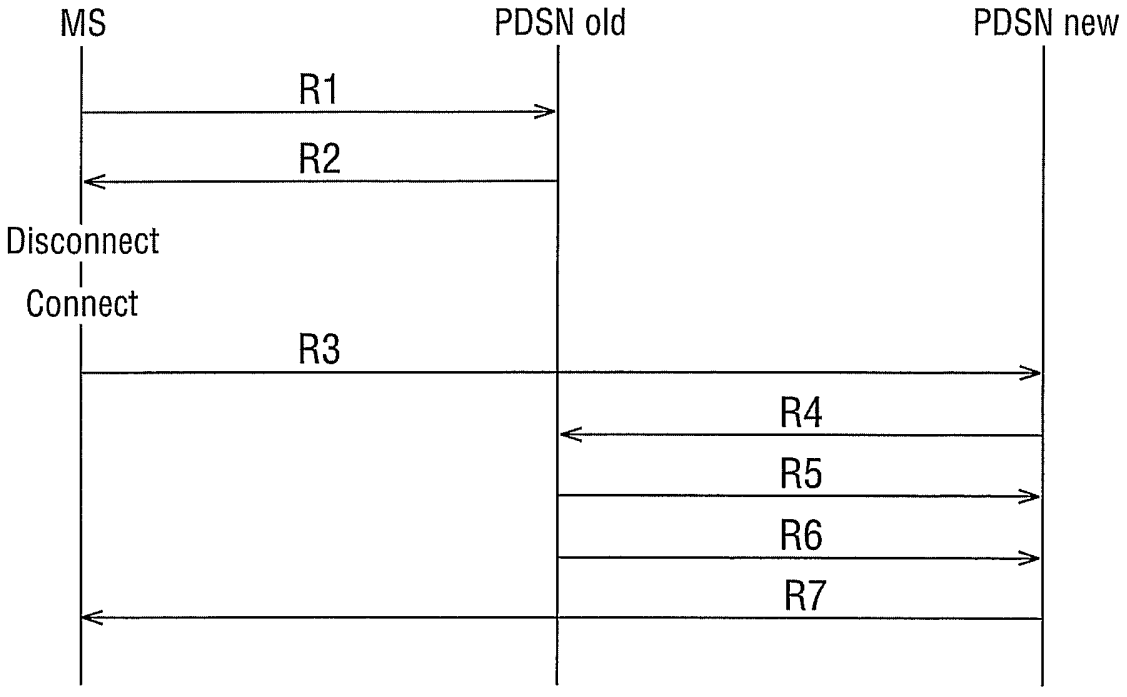

MS
PDSN old
PDSN new
T1
T2
T3
T4
T5
T6
Disconnect
T7
Connect
T8
T9

FIG. 5


MS
PDSN old
PDSN new
R1
R2
Disconnect
Connect
R3
R4
R5
R6
R7

INTERNATIONAL SEARCH REPORT

PCT/IB2005/001505

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04L29/06

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 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 practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JOHNSON D: "Mobility Support in IPv6" IETF STANDARD-WORKING-DRAFT, INTERNET ENGINEERING TASK FORCE, IETF, CH, 30 June 2003 (2003-06-30), XP015002681 ISSN: 0000-0004 abstract * points 7.2, 10.1, 11.5.1 *	1-19
X	CA 2 359 040 A1 (TELEFONAKTIEBOLAGET LM ERICSSON) 28 March 2002 (2002-03-28) abstract page 9, line 1 - page 10, line 21 page 12, line 19 - page 13, line 17 claims 1,2 figures 3a,3b,5a,5b,5c	1-19

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 September 2005	08/09/2005

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, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Goya, J

INTERNATIONAL SEARCH REPORT

PCT/IB2005/001505

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 867 666 A (HARVEY ET AL) 2 February 1999 (1999-02-02) abstract column 1, line 62 - column 2, line 42	1-19
A	US 2003/092444 A1 (SENGODAN SENTHIL ET AL) 15 May 2003 (2003-05-15) abstract claims 1,6	15

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