(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
24 December 2003 (24.12.2003)

PCT

(10) International Publication Number
WO 03/107600 A1

(51) International Patent Classification[7]: H04L 12/56, 29/06

(21) International Application Number: PCT/FI03/00389

(22) International Filing Date: 20 May 2003 (20.05.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
20021164 14 June 2002 (14.06.2002) FI

(71) Applicant *(for all designated States except US)*: **NOKIA CORPORATION** [FI/FI]; Keilalahdentie 4, FIN-02150 Espoo (FI).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **MÄENPÄÄ, Sanna** [FI/FI]; Kiiskitie 5 B 13, FIN-02170 Espoo (FI). **VESTERINEN, Seppo** [FI/FI]; Lillukkakuja 8, FIN-90460 Oulunsalo (FI).

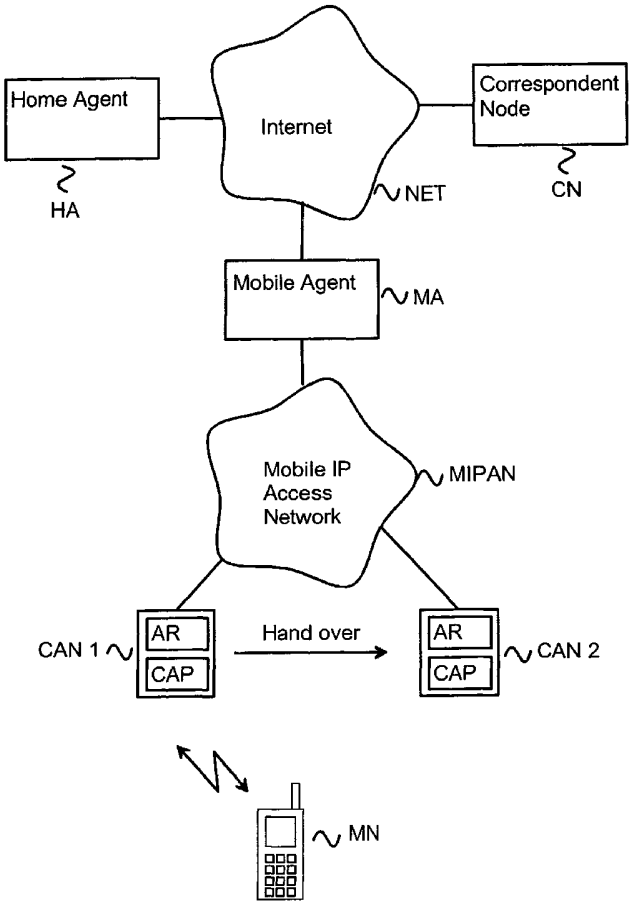
(74) Agent: **PAPULA OY**; P.O. BOX 981, (Fredrikinkatu 61 A), FIN-00101 Helsinki (FI).

(81) Designated States *(national)*: AE, AG, AL, AM, AT (utility model), AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (utility model), DE, DK (utility model), DK, DM, DZ, EC, EE (utility model), EE, ES, FI (utility model), FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK (utility model), SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),

[Continued on next page]

(54) Title: A METHOD AND SYSTEM FOR LOCAL MOBILITY MANAGEMENT



(57) Abstract: The present invention describes a method and system for local mobility management in which the mobility management taking place inside the mobile agent (MA) domain is hidden from the home agent (HA) and correspondent node (CN). In the method the mobile agent (MA) prefix information is broadcast over the air interface. An access router is implemented in the cellular access node (CAN). The cellular access node (CAN) also comprises a cellular access point (CAP). Proxy functionality is arranged to the cellular access point (CAP). Binding entries are created to the mobile agent (MA) so that only basic mobile IPv6 needs to be supported in the mobile node (MN).

WO 03/107600 A1

European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:

— *with international search report*

A METHOD AND SYSTEM FOR LOCAL MOBILITY MANAGEMENT

FIELD OF THE INVENTION

The present invention relates to data communications. Particularly the present invention relates to the optimization of the performance of the Internet Protocol (IP) localized mobility concepts.

BACKGROUND TO THE INVENTION

As the trend goes towards mobile internet, the complete internet protocol must be adopted in the mobile networks. A mobile terminal is assigned a unique IP-address so that data packets can be sent to the right terminal. The internet protocol has been used for a long time in fixed networks. There has not been need for mobility functionality until recently due to the new mobile devices with the possibility for packet switched data communications.

To provide the new functionality required by the mobility, a mobile internet protocol was introduced. The mobile internet protocol allocates two associated addresses for a mobile terminal: home address which enables the mobile terminal to be reachable with the same address regardless of its point of attachment and a care of address which enables to route the packets to the current point of attachment of the mobile terminal. This means that routing devices and transceiver stations of a mobile network must know and control the location of the mobile terminal and be able to efficiently route packets to the right terminal. At the moment, the IPv4 addressing scheme is in use but it will be replaced by the IPv6 in the future.

Within a radio access network (RAN) mobile terminals can move rapidly from one base station to another. A handover may occur when mobile stations move within a mobile network. When a mobile terminal moves from one base station to another, the routing

must be changed. In the handover procedure, packets destined to the mobile terminals are directed to a base station. When the actual handover occurs packets will be directed to a new base station. This change must be fast to allow the data communication service continue at the selected quality of service. The handover can occur between similar network cells, for example from a GSM (Global System for Mobile communications) cell to another GSM cell, or between different type of networks, for example from a GSM network to a UMTS (Universal Mobile Telecommunications System) network.

New routing rules must be carried out within a mobile network for handover procedures. In routed networks, the routing rules are stored in routing tables. To change the routing table a routing table update message must be sent to all routers that the change effects to. The publication WO 0199458 introduces an efficient method for performing a mobile user terminal route update in a telecommunications network based on the internet protocol. The publication WO 0199458 teaches a method for updating the routing procedures. The method works in circuit and packet switched networks. In the method, a second base station sends new routing information to a routing element. The mobile device does not need to initiate the change of the routing tables. A benefit of the publication is that the router learns the new route early enough so that no data is lost in the handover procedure. The publication teaches the basic principles of the proxy localized management concept, in which the IP level local mobility management operations are hidden from the actual mobile device.

The drawbacks of prior-art solutions are that the modifications are needed to the terminal side and the signalling over the air interface. Required changes to already existing terminals are hard to im-

plement. In cases where the changes cannot be implemented by software only, the customer needs to update his/her terminal.

PURPOSE OF THE INVENTION

The present invention teaches a method e.g. for the MIPv6 (Mobile Internet Protocol, version 6) in a manner that localization mobility management extensions are not needed. Furthermore, the purpose of the present invention is to describe how IPv6 handover methods currently under definition in the IETF (Internet Engineering Task Force) can be utilized in these concepts. The same method can be appliedalso with MIPv4 ((Mobile Internet Protocol, version 4) with slight modifications.

SUMMARY OF THE INVENTION

The present invention describes a method and system in which proxy local mobility management functions are utilized e.g. with the MIPv6. The invention neither requires any changes to the mobile nodes using the MIPv6 nor any extension for local mobility management. Furthermore, the present invention describes a method in which IPv6 handover methods can be utilized in the concepts without changes in the standards or definitions set by the IETF.

In the present invention, layer 3 mobile agent information is broadcast over the air interface instead of the access router prefix information. In order to know when a mobile node is away from home, it must get a temporary address which is called as a care of address (CoA). According to the present invention, a mobile node generates a CoA based on the mobile agent's prefix and mobile node's layer 2 address or some other locally unique identifier.

The generated CoA is used when the mobile node sends a binding update message towards the home agent or correspondent node. Thus, the mobile node needs to support only basic MIPv6 and it does not have to be aware of the local mobility management taking place between the mobile agent and cellular access node. The local mobility management utilized in the present invention is based e.g. on mobile IPv6 regional registration protocol (MIPv6RR), hierarchical mobile IPv6 (HMIPv6) or basic mobile IPv6.

The present invention has various benefits. Compared to other local mobility management solutions, the proxy mechanism reduces the MIPv6+ extension signalling over the radio interface, which is important for capacity limited cellular radio interfaces. The present invention takes an advantage of the MIPv6 regional forwarding that avoids an extra 40-byte overhead due to tunnelling. The proxy care of address (PcoA) assigned during initial registration with the mobile agent can be kept unchanged until the MA handover occurs. This reduces signalling over the air interface because the update binding has to be sent to the mobile node only when it moves from a mobile agent to another. The present invention does not require layer 3 signalling at all over the air during handovers because layer 3 mobility activies are hidden from the mobile node, and a proxy function in the cellular access point (CAP) takes care of the required MIPv6 signalling. The route switching happens in the mobile agent so there is no need for routing via an access router. Because the layer 2 is aware of the layer 3 issues, a proper synchronization can be implemented between layer 2 and 3 handovers. Layer 3 context transfer can be triggered optionally from the target CAP at an optimal point of the handover scenario.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 illustrates a prior-art solution in which an access router is used,

Figure 2 illustrates a system in accordance with the invention,

Figure 3 illustrates the signalling of the initial registration with the proxy model,

Figure 4 illustrates binding update packets used in the initial registration,

Figure 5 illustrates the signalling of the network initiated inter mobile agent relocation, and

Figure 6 illustrates binding update packets used in the network initiated inter mobile agent relocation.

DETAILED DESCRIPTION OF THE INVENTION

Figure 2 represents a system in accordance with the present invention. In the system, a mobile node MN is connected to a cellular access node CAN. There are two nodes, CAN 1 and CAN 2, but the amount of nodes can vary. Cellular access nodes CAN are connected to the mobile IP access network MIPAN that is connected to the mobile agent MA. More accurately, the mobile IP access network MIPAN forms the Local Mobility Domain that is under management of the mobile agent MA. The mobile agent MA is connected to the home agent HA and correspondent node CN via the Internet NET. The cellular access node CAN consists of an access router AR and a cellular access point CAP. Proxy functions are implemented in the cellular access point CAP. The system of Figure 2 has the advantages over the prior-art solutions that it does not need any separate routing element. In the present invention, layer 3 MA prefix information is broadcast over the air interface instead of access router AR prefix information. The mobile node MN generates a care of ad-

dress (CoA) based on the mobile agent MA prefix and mobile node layer 2 address. Instead of the layer 2 address some other locally unique identifier may be used. CoA is then used when the mobile node MN sends binding updates towards the home agent HA or correspondent node CN. Thus, the mobile node MN needs to support only basic MIPv6 and it does not has to be aware of the local mobility management taking place between the cellular access node CAN and mobile agent MA.

Figure 3 illustrates the signalling in the MIPv6 initial registration and binding entry creation in the mobile agent MA. The mobile node MN initiates the signalling by sending a binding update (BU) message to the cellular access point CAP, step 30. MIP in Figure 3 refers to mobile ip. The CAP encapsulates the message and changes the source address of the packet to AR@ (access router address). The CAP sends a proxy binding update to the mobile agent MA, step 31. MRR in Figure 3 refers to mobile ip regional registration. The mobile agent MA creates a binding entry including the proxy care of address (PcoA) based on the mobile agent MA prefix and mobile node's layer 2 address associated with AR@. The mobile agent responds to the CAP with a BU acknowledgement message, step 32. The mobile agent MA sends the changed binding information to the home agent HA, step 33. The home agent HA responds with the acknowledgement message, step 34. The mobile agent MA sends an acknowledgement message to the mobile node, step 35. Every time the access router AR changes, the mobile agent's PCoA is associated with the new AR@.

Figure 4 illustrates binding update packet structures. Packet 40 is used in sending the initial packet for binding update. Packet 40 is formed in a mobile node. In the packet 40, the source address is PCoA and the destination is the address of the home

agent. Packet 41 is formed by encapsulating the packet 40. In the encapsulation process AR@ is set to the source address and the mobile agent's address MA@ is set to the destination address. The packet 42 formed by the mobile agent is similar to the packet 40. The content and length of the fields are not fixed but can be chosen according to application needs.

Figure 5 illustrates signalling flow in inter mobile agent relocation. In this example the serving CAP relocation is described according to WCDMA (Wide-band Code Division Multiple Access) soft handover case. A relocation request is sent from the old cellular access point oCAP to the new cellular access point nCAP, step 50. RCTRL in Figure 5 refers to radio access control protocol between cellular access points. The nCAP sends a proxy binding update packet to the new mobile agent nMA via the new access router nAR, step 51. New mobile agent nMA responds with an acknowledgement message, step 52. After receiving the acknowledgement message, the nCAP sends a relocation response to the oCAP, step 53. The oCAP sends relocation information to the nCAP, step 54. Then, the nCAP sends layer 3 context trigger to the new access router nAR, step 55. The new access router nAR and old access router oAR start the layer 3 context transfer, step 56. Universal Terrestrial Radio Network (UTRAN) mobility information is sent to the mobile node MN, step 57 (WCDMA soft handover). RRC in Figure 5 refers to the radio resource control protocol. The mobile node MN responds by sending a confirmation message to the new CAP, step 58. A relocation complete message is sent to old CAP, step 59. The procedure is then continued with binding entry creation, step 510. The binding entry creation signalling is illustrated in Figure 3.

Figure 6 illustrates packets used in mobile IPv6 regional forwarding. The original regional forwarding is specified in the IETF draft "mobile Ipv6

Regional Forwarding", March 2001. The original regional forwarding is slightly modified because the proxy function is located in the cellular access point CAP. The proxy care of address (PcoA) is based on a mobile agent's prefix and mobile node's layer 2 address associated with AR@. AR@ is based on access router prefix and mobile node's layer 2 address. The forwarding of packets from correspondent node to the mobile node is initiated by sending the packet 60. In the packet, the source is the correspondent node's address CNA, the destination field is PCoA and the mobile node's home address is used as a routing header MNHA. The mobile agent modifies the packet 60 by setting AR@ to the destination field. When the mobile agent has an entry in the regional binding cache for the home address in the routing header MNHA, the modified packet 61 is forwarded to the access router AR that forwards it further to the link where the cellular access point CAP is connected. The packet 61 is modified in a cellular access point that comprises binding information between AR@ and PCoA. In the packet 62, the destination field is set to PCoA. The mobile node sends packet 63 to the correspondent node using PCoA as the source address exactly as with the basic mobile IPv6.

In the regional route updates in handovers, the invention applies an already known method for performing a mobile user terminal route update in a telecommunication network operated based on the Internet Protocol. Radio access specific mobility functions are synchronized with the Mobile IPv6 functions in the cellular access points that are involved in the handover. The proxy function in the cellular access point sends the route update message to the mobile agent. The route update message is named in this invention as a proxy binding update. The mobile agent replies to

the cellular access point with an acknowledgement message.

It is obvious to a person skilled in the art that with the advancement of technology, the basic idea of the invention may be implemented in various ways. The invention and its embodiments are thus not limited to the examples described above, instead they may vary within the scope of the claims.

CLAIMS

1. A method for local mobility management in a communications network comprising at least a home agent connected to the Internet, a mobile agent connected to the Internet a mobile IP access network comprising one or more local IP mobility domains, a correspondent node connected to the Internet, one or more cellular access nodes connected to the mobile IP access network; and one or more mobile nodes connected to the cellular access nodes, in which method binding updates are registered when mobile node changes location,

characterized in that:

the mobile node mobility inside the local mobility domain is hidden from the home agent and correspondent node by performing the IP local mobility management with proxy function not visible to the mobile node.

2. The method according to claim 1, characterized in that the network is a packet switched network.

3. The method according to claim 1 or 2, characterized in that the network is an IPv6 network.

4. The method according to claim 1 or 2, characterized in that the network is an IPv4 network.

5. The method according to claim 1, 2, 3 or 4, characterized in that the network is a cellular communications network.

6. The method according to claim 1, 2, 3, 4 or 5, characterized in that the layer 3 mobile agent prefix is broadcast over the air interface.

7. The method according to claim 1, 2, 3, 4, 5 or 6, characterized in that a care of address (CoA) is generated based on the mobile agent's prefix and locally unique identifier.

8. The method according to claim 7, characterized in that the locally unique identifier is the mobile agent's layer 2 address.

9. The method according to claim 1, 2, 3, 4, 5, 6, 7 or 8, characterized in that the proxy function is implemented in a cellular access point.

10. The method according to claim 9, characterized in that the cellular access point encapsulates binding update messages.

11. The method according to claim 1, 2, 3, 4, 5, 6, 7, 8, 9 or 10, characterized in that the mobile agent creates a binding entry including a proxy care of address (PcoA) based on the mobile agent's prefix and mobile node's layer 2 address associated with an access router address.

12. The method according to claim 11, characterized in that the binding is updated whenever the access router changes.

13. A system for local mobility management in a communications network comprising at least:

a home agent (HA) connected to the Internet (NET);

a mobile agent (MA) connected to the Internet (NET);

a mobile IP access network (MIPAN) comprising one or more local IP mobility domains;

a correspondent node (CN) connected to the Internet (NET);

one or more cellular access nodes (CAN) connected to the mobile IP access network (MIPAN); and

one or more mobile nodes (MN) connected to the cellular access nodes (CAN);

characterized in that:

the cellular access node (CAN) further comprises a cellular access point (CAP) comprising a proxy function arranged to perform the IP local mobility management.

14. The system according to claim 13, characterized in that the cellular access point (CAP) is arranged to encapsulate binding update messages sent by the mobile node (MN).

15. The system according to claim 13 or 14, characterized in that the binding entries are arranged to the mobile agent (MA).

16. The system according to claim 13, 14 or 15 characterized in that the network is a packet switched network.

17. The system according to claim 13, 14, 15 or 16, characterized in that the network is an IPv6 network.

18. The system according to claim 13, 14, 15, 16 or 17, characterized in that the network is an IPv4 network.

19. The system according to claim 13, 14, 15, 16, 17 or 18, characterized in that the network is a cellular communications network.

Packet sent by correspondent node

60

Src	Dest	Routing Header	
CNA	PCoA	MNHA	Payload

Packet modified in the Mobile Agent

61

Src	Dest	Routing Header	
CNA	AR@	MNHA	Payload

Packet modified by CAP

62

Src	Dest	Routing Header	
CNA	PCoA	MNHA	Payload

Packet sent to the correspondent node

63

Src	Dest	Home Address Option	
PCoA	CNA	MNHA	Payload

FIG. 6

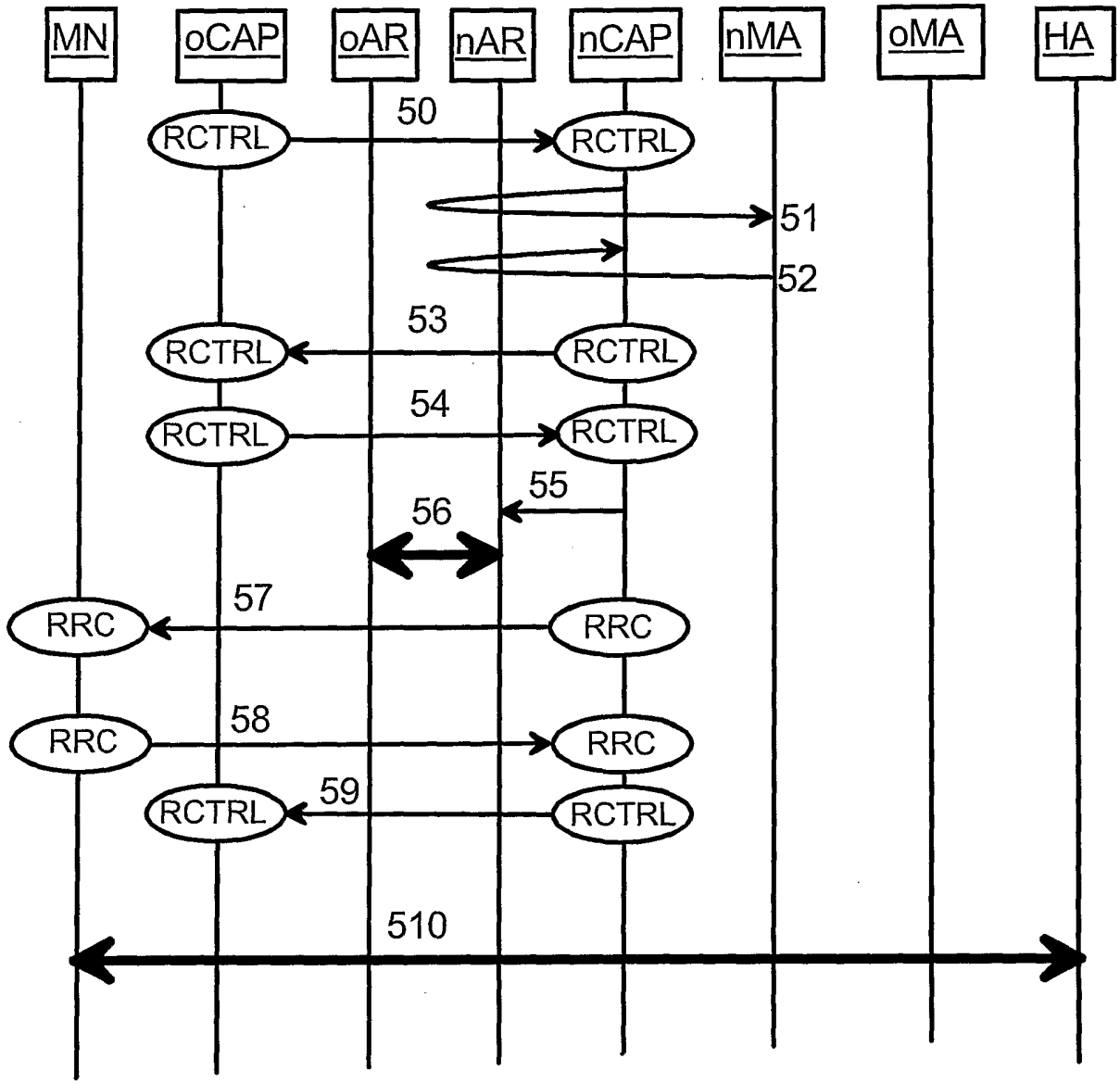

MN
oCAP
oAR
nAR
nCAP
nMA
oMA
HA
50
RCTRL
RCTRL
51
52
53
RCTRL
RCTRL
54
RCTRL
RCTRL
55
56
57
RRC
RRC
58
RRC
RRC
59
RCTRL
RCTRL
510

FIG. 5

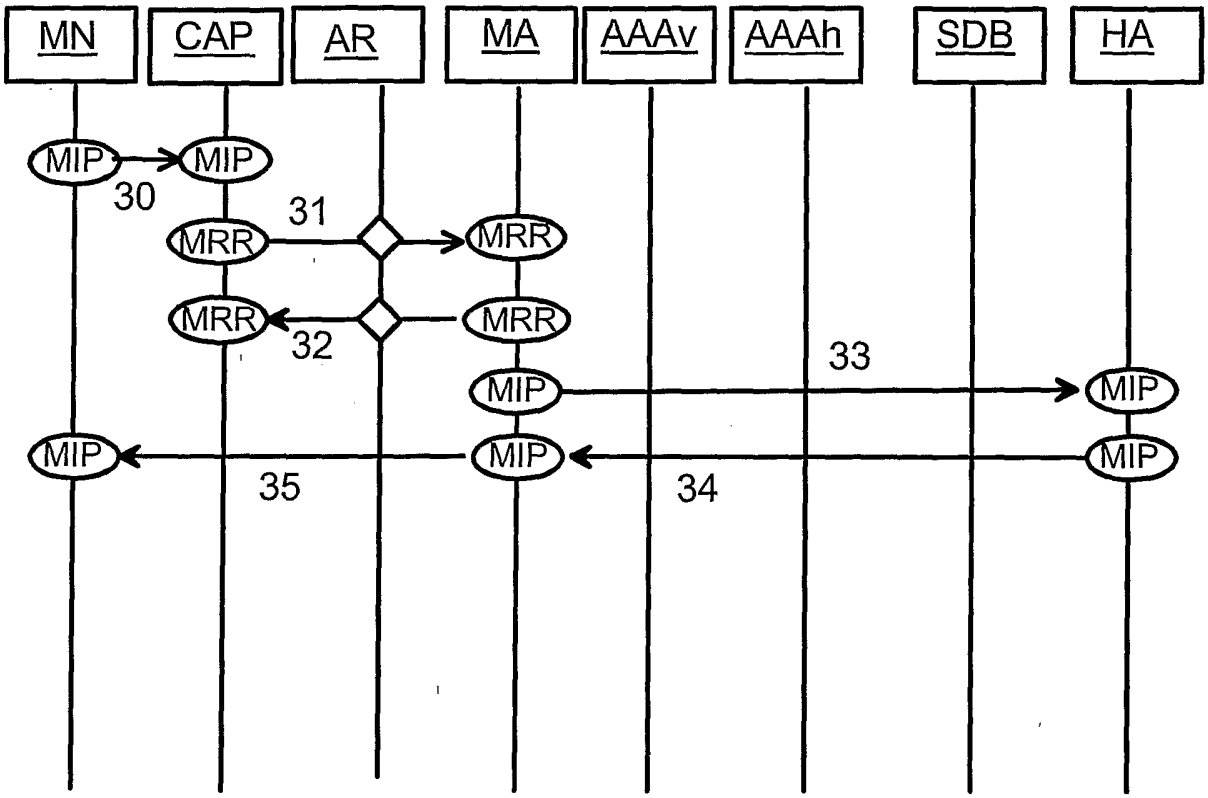

MN
CAP
AR
MA
AAAv
AAAh
SDB
HA
MIP
MIP
30
31
MRR
MRR
MRR
MRR
32
33
MIP
MIP
MIP
MIP
MIP
35
34

FIG. 3

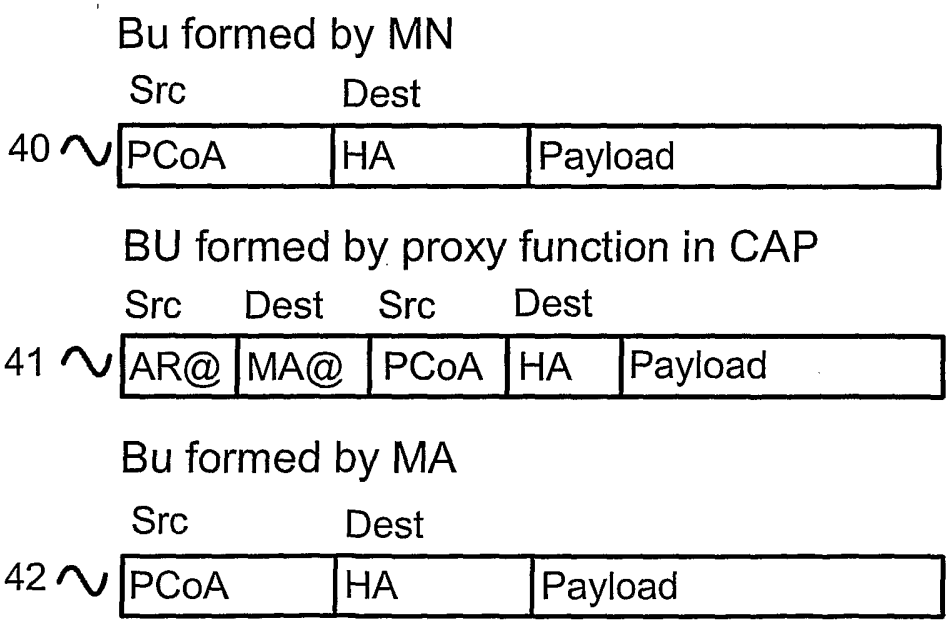

Bu formed by MN
Src
Dest
40
PCoA
HA
Payload
BU formed by proxy function in CAP
Src
Dest
Src
Dest
41
AR@
MA@
PCoA
HA
Payload
Bu formed by MA
Src
Dest
42
PCoA
HA
Payload

FIG. 4.

FIG. 2

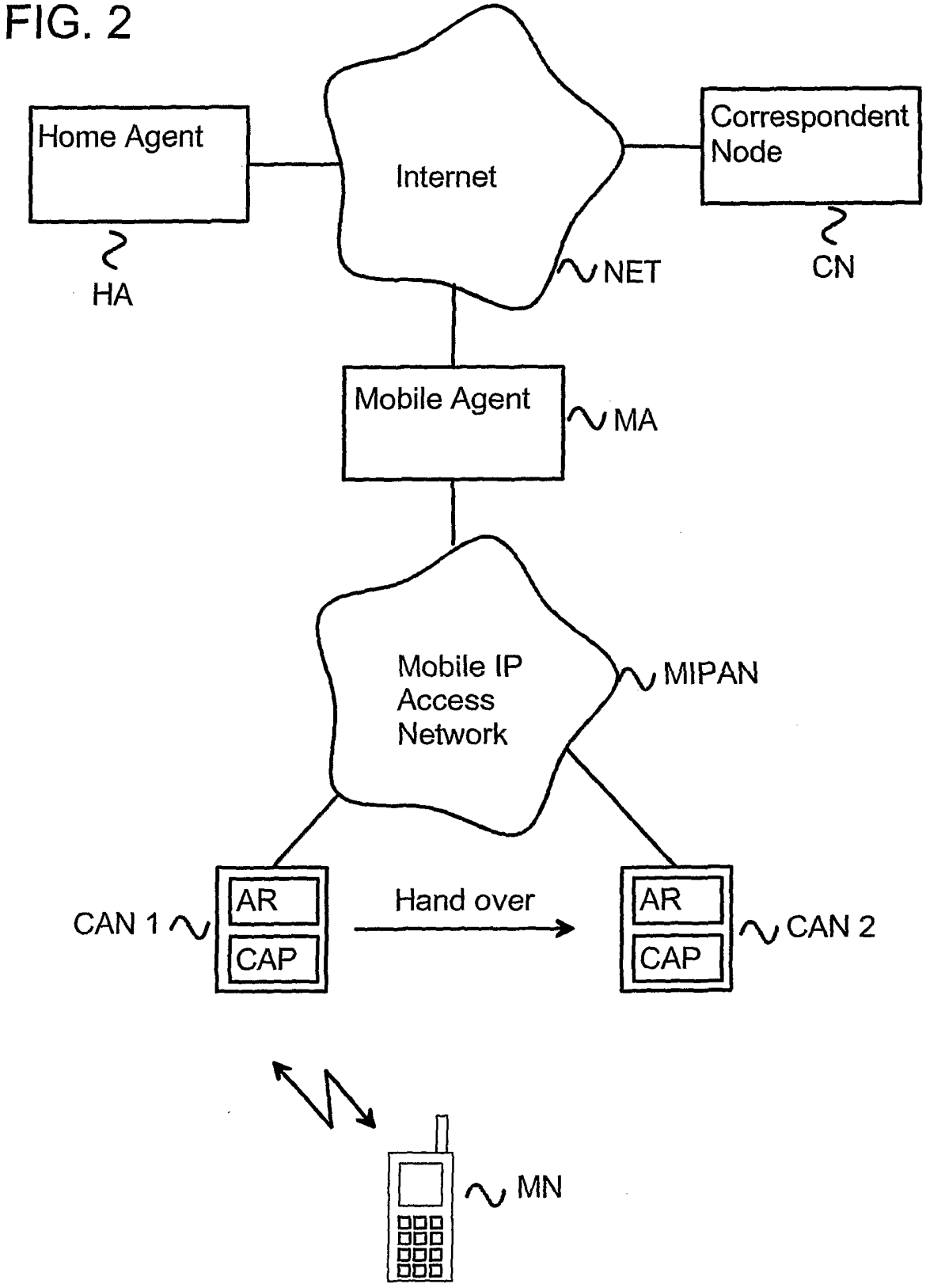
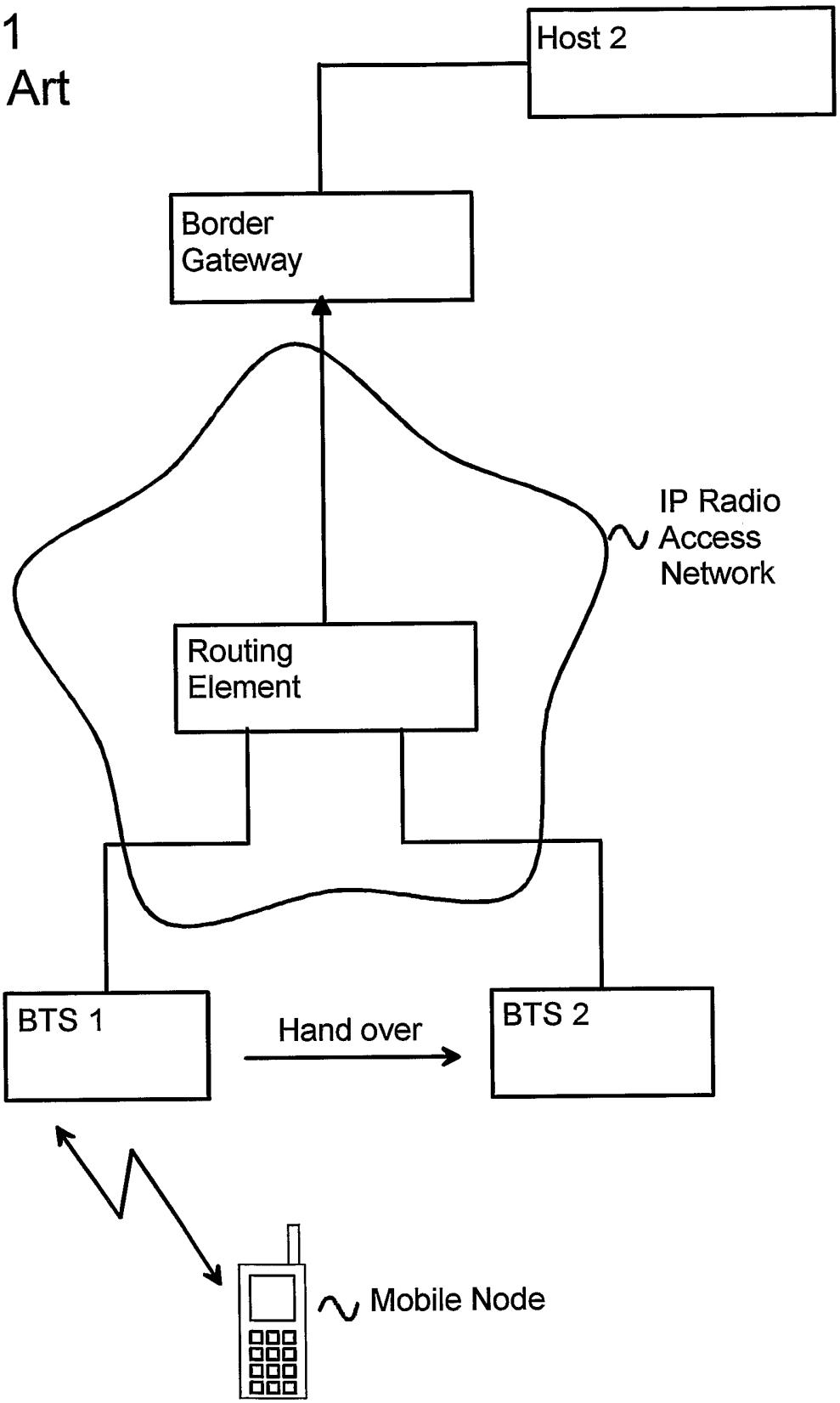

Home Agent
HA
Internet
NET
Correspondent Node
CN
Mobile Agent
MA
Mobile IP Access Network
MIPAN
CAN 1
AR
CAP
Hand over
AR
CAP
CAN 2
MN

FIG. 1
Prior Art



INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 03/00389

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04L 12/56, H04L 29/06
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)

IPC7: H04L, H04Q

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

SE,DK,FI,NO classes as above

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

EPO-INTERNAL, WPI DATA, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1009141 A1 (LUCENT TECHNOLOGIES INC.), 14 June 2000 (14.06.00), column 8, line 38 - column 9, line 4 --	1-19
X	EP 1009134 A2 (LUCENT TECHNOLOGIES INC.), 14 June 2000 (14.06.00), column 8, line 2 - line 26, abstract --	1-19
A	EP 1124396 A2 (FUJITSU LIMITED), 16 August 2001 (16.08.01), column 13, line 48 - column 14, line 19, abstract --	1-19

[X] Further documents are listed in the continuation of Box C. [X] 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
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 August 2003	25 -08- 2003
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Peder Gjervaldsaeter /OGU Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 03/00389

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1128632 A2 (FUJITSU LIMITED), 29 August 2001 (29.08.01), column 4, line 32 - column 6, line 13, abstract --	1-19
A	UM, Tai Won et al. "A study on path re-routing algorithms at the MPLS-based hierarchical mobile IP network" In: PROCEEDINGS OF IEEE REGION 10 INTERNATIONAL CONFERENCE ON ELECTRICAL AND ELECTRONIC TECHNOLOGY, 2001. TENCON. Singapore, 19 - 22 August 2001, Vol. 2, pages 691-697, INSPEC AN: 7154362, see abstract. --	1-19
A	CHEN, Chyi-Nan et al. "Solving location problem of a mobile host by an agent group" In: SEVENTH IEEE INTERNATIONAL SYMPOSIUM ON PERSONAL, INDOOR AND MOBILE RADIO COMMUNICATIONS, 1996. PIMRC'96.Taipei, Taiwan, 15-18 October 1996, Vol. 2, pages 708-712, INSPEC AN: 5658036, XP010209263, see abstract. -- --------	1-19

INTERNATIONAL SEARCH REPORT

Information on patent family members

26/07/03

International application No.
PCT/FI 03/00389

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1009141 A1	14/06/00	JP 2000183974 A	30/06/00
EP 1009134 A2	14/06/00	SE 1009134 T3	
		JP 2000183973 A	30/06/00
		US 6496505 B	17/12/02
		US 2002057657 A	16/05/02
EP 1124396 A2	16/08/01	JP 2001224070 A	17/08/01
		US 2001012777 A	09/08/01
EP 1128632 A2	29/08/01	JP 2001237878 A	31/08/01
		US 2001016492 A	23/08/01