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PI 20083164 19 August 2008 (19.08.2008) MY(71) Applicant (for all designated States except US): **MIMOS BERHAD** [MY/MY]; Technology Park Malaysia, 57000 Kuala Lumpur, Malaysia (MY).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **MOHD EZANI , Muhammad Fahee** [MY/MY]; MIMOS BERHAD, Technology Park Malaysia, 57000 Kuala Lumpur (MY). **HASEEB , Shariq** [IN/MY]; MIMOS BERHAD, Technology Park Malaysia, 57000 Kuala Lumpur (MY). **ABDULLAH, Mohd Ariff** [MY/MY]; MIMOS BERHAD, Technology Park Malaysia, 57000 Kuala Lumpur (MY).(74) Agent: **DAMODHARAN, Ramakrishna**; KASS INTERNATIONAL SDN. BHD., Suite 8 - 7 - 2, Menara

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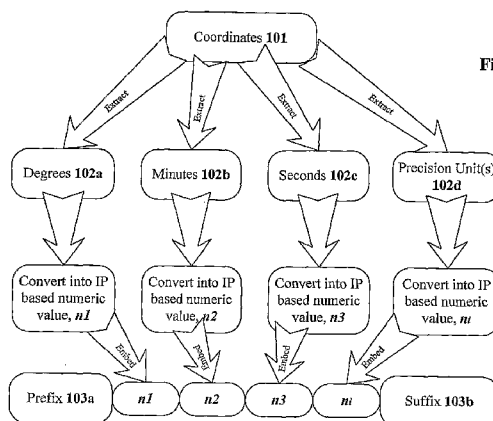


Figure 1

(57) Abstract: A method and a system for implementing a location based Internet Protocol (IP) addressing scheme for improving mobile IP hand-off process are disclosed. In one embodiment herein, location co-ordinates (101) of a mobile device on the globe are obtained. Each location co-ordinate (101) may have a degree unit (102a), a minute unit (102b), a second unit (102c) and at least one precision unit (102d). The co-ordinates (101) are converted into an IP-based numeric value, 'N' and then embedded inside an IP address to create a location based IP address for improving mobile IP hand-off process.

**METHOD AND SYSTEM TO IMPLEMENT LOCATION-BASED INTERNET
PROTOCOL (IP) ADDRESSING SCHEME FOR IMPROVING MOBILE IP HAND-OFF
PROCESS**

5 FIELD OF INVENTION

The embodiments herein relate generally to wireless communication, and more particularly to, handoff control in a wireless communication network.

10 BACKGROUND OF INVENTION

In the field of wireless data communication, Internet Protocol (IP) is the most popular and is greatly used world wide. IP version 6 (IPv6) is a network layer that is designated as the successor of IPv4, the current version of the IP, for packet-switched inter-
15 networks.

One of the primary reasons for introducing IPv6 is due to the decreasing number of IPv4 allocation of addresses. The IPv6 mainly allows a much larger address space and greater flexibility in assigning addresses. With IPv6, the number of addresses that it
20 offers goes far beyond that of IPv4. In fact, it is claimed that IPv6 offers up to roughly 667 quadrillion addresses per square millimeter. The extended address length eliminates the need to use network address translation to avoid address exhaustion, and also simplifies aspects of address assignment and renumbering when changing providers.

25

Although this is more than enough to allocate the whole world with IPv6 addresses, there lacks a mechanism to allocate these addresses in an optimized manner.

A portion of a prior art cellular telephone network and the problem with the conventional Mobile IPv6 implementation is depicted in Figure 2 and Figure 3. As shown in Figure 2, when the Mobile Node (Alice) changes the point of network attachment from one wireless coverage to another, it has to follow steps 1 to 7 for performing a successful handoff. Steps 2 to 6 are responsible for majority of the delays (as shown in Figure 3) observed by the applications that depend on Mobile IPv6. During steps 2 to 6, the Mobile Node is unable to communicate with its corresponding (destination) node and hence results in an interruption. Depending on the Mobile IPv6 implementation, this interruption period usually lasts between 2 to 10 seconds.

Japanese publication number JP2005204286A2 entitled "IP Address Deciding Method Based on Position Information and its Receiving Packet Determining Method, Apparatus and Program" discloses one such approach for deciding IP addresses having a large address display like an IPv6. However, Japanese publication number JP2005204286A2 does not suggest for handoff control carried out with minimum delay and faster speed.

20

In view of the above it was felt necessary to come up with a novel method to implement an IP addressing scheme to facilitate mobile IP hand-off process.

SUMMARY OF INVENTION

Accordingly, it is a principal object of the present invention to have location information embedded as part of the network prefix of the IP address in order to reduce control
5 message relays in IP, and in turn to reduce unnecessary delays.

The present invention therefore provides a location based IP addressing scheme for improving mobile IP hand-off process. For instance, a location-based IPv6 addressing scheme may be implemented for improving mobile IPv6 hand-off process.

10

In one embodiment herein, location co-ordinates of a mobile device on the globe are obtained by a receiving component. The co-ordinates may have a degree unit, a minute unit, a second unit and at least one precision unit. A converting unit may be provided for converting the co-ordinates into an IP-based numeric value, 'N'. The
15 numeric value 'N' may then be embedded inside an IP address to create a location based IP address for improving mobile IP hand-off process.

In one embodiment herein, the degree unit may be converted to its respective IP-based numeric value, 'n1', the minute unit may be converted into its respective IP-based numeric value, 'n2', and the second unit may be converted into its respective
20 IP-based numeric value, 'n3'. The precision unit may also be converted to its respective IP-based numeric value, 'ni'; wherein 'i' is for subsequent integers.

As per the embodiments of the present invention, a prefix may be added to the IP
25 address for identifying the said address as a location-based IP address. Also, a suffix may be added to the IP address for making each mobile device unique.

In one embodiment herein, the location co-ordinates may be obtained from a plurality of areas of the globe including North-East, North-West, South-West, and South-East, wherein each area may be uniquely numbered.

- 5 As per an embodiment herein, the location co-ordinates may be obtained from a Global Positioning Satellite (GPS) system/device.

Other objects, features and advantages of the invention will be apparent from the drawings, and from the detailed description that follows below.

BRIEF DESCRIPTION OF DRAWINGS

Reference will be made to embodiments of the invention, examples of which may be illustrated in the accompanying figures. These figures are intended to be illustrative,
5 not limiting. Although the invention is generally described in the context of these embodiments, it should be understood that it is not intended to limit the scope of the invention to these particular embodiments.

Figure 1 illustrates the steps involved in the location based IP addressing scheme as
10 per an embodiment herein.

Figures 1a to 1d illustrate the steps involved in creating GPS-IPv6 addresses as per an embodiment herein.

15 Figures 1e to 1g illustrate the steps involved in deriving the GPS location of a node from a given GPS-IPv6 address as per an embodiment herein.

Figure 2 is a schematic diagram illustrating conventional handing-off process in execution of mobile IPv6.

20

Figure 3 shows a message flow diagram illustrating conventional method of handoff control in a wireless communication network.

Figure 4 illustrates system implementation of location-based IP addressing scheme as
25 per an embodiment herein.

Figure 5 illustrates improved handing-off process through GPS-IPv6 addressing schemes as per an embodiment herein.

Figure 6 shows a message flow diagram illustrating improved handing-off process
5 through GPS-IPv6 addressing schemes as per an embodiment herein.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention provides a novel system and method to implement location-based IP addressing scheme to facilitate mobile IP hand-off process. Information on
5 location of a mobile device is embedded as part of the network prefix of the IP address in order to reduce control message relays in IP, and in turn to reduce unnecessary delays.

In the following description, for purpose of explanation, specific details are set forth in
10 order to provide an understanding of the invention. It will be apparent, however, to one skilled in the art that the invention may be practiced without these details. One skilled in the art will recognize that embodiments of the present invention, some of which are described below, may be incorporated into a number of different systems. The best mode of the invention described in the specification illustrates the exemplary
15 embodiment of the invention. It is understood that one skilled in art may modify or change the modules used in the best mode of invention.

Reference in the specification to "one embodiment" or "an embodiment" means that a particular feature, characteristic, or function described in connection with the
20 embodiment is included in at least one embodiment of the invention. The appearances of the phrase "in one embodiment" in various places in the specification are not necessarily all referring to the same embodiment.

Figure 1 illustrates the steps involved in the location based IP addressing scheme as
25 per an embodiment herein. The location co-ordinates 101 of a mobile device on the globe may be obtained by a receiving component. The co-ordinates 101 may have a

degree unit 102a, a minute unit 102b, a second unit 102c and at least one precision unit 102d. A converting unit may be provided for converting the co-ordinates 101 into an IP-based numeric value, 'N'.

- 5 In one embodiment herein, the degree unit may be converted to its respective IP-based numeric value, ' $n1$ ', the minute unit may be converted into its respective IP-based numeric value, ' $n2$ ', and the second unit may be converted into its respective IP-based numeric value, ' $n3$ '. The precision unit may also be converted to its respective IP-based numeric value, ' ni '; wherein 'i' is for subsequent integers. Thus, 'N'
- 10 comprises $n1$, $n2$, $n3$ and ni .

The numeric value 'N' may then be embedded inside an IP address comprising a prefix 103a and a suffix 103b to create a location based IP address for improving mobile IP hand-off process. The prefix 103a of the IP address identifies the said

15 address as a location-based IP address, whereas the suffix 103b makes each mobile device a unique device.

Adding a suffix helps to avoid circumstances in which the mobile devices tend to obtain same addresses when aligned vertically at the same location (for example;

20 located in one building but at different floors). In case of IPv6, the suffix would normally be the MAC address of the network interface. In the IP addressing schemes of the embodiments herein, the suffixes may comprise but is not limited to using a MAC address.

- 25 In one embodiment, location of a mobile device on the globe is obtained through a GPS device. The GPS location comprises a degree unit, a minute unit and a second

unit. The GPS location is then mapped to an N-digit hexadecimal value and is embedded inside an IPv6 address to create a GPS based IPv6 address for improving mobile IPv6 hand-off process.

- 5 Figures 1a to 1d illustrate the steps involved for creating GPS-IPv6 addresses in the method for implementing GPS (Global Position Satellite) based IPv6 addressing scheme for improving mobile IPv6 hand-off process as per an embodiment herein.

The steps involved in constructing the address include:

10

1. Obtaining GPS location having a degree unit, a minute unit and a second unit of the mobile device. For example, the device may obtain its GPS location as follows: *6° 4' 12" N, 100° 13' 12" E*.

- 15 2. The GPS location is then mapped to an N-digit (preferably 12 digits) hexadecimal value according to the algorithm mentioned in steps 'a to c' below:

- (a) Determine which part of the globe the mobile device is located at. In one embodiment herein, the globe may be divided into four parts including North-East, North-West, South-West, and South-East. Then map the given degree unit to its respective N/3-digit hexadecimal value. In order to do this, each part may be uniquely numbered from 0 to 64799 (or 0 to FD1F in hexadecimal). Since there are 180 degree units of latitude and 360 degree units of longitude, the total square degree units sums up to 64800 (180 x 360). This explains the number allocations from 0 to 64799.
- 20 Numbers allocated on the 4 areas of the globe (North-East, North-West, South-West, and South-East) follow the allocation rules below:
- 25

- i. North-East part of the globe : 0 to 16199 (Hex: 0 to 3F47)
- ii. North-West part of the globe : 16200 to 32399 (Hex: 3F48 to 7e8F)
- iii. South-West part of the globe : 32400 to 48599 (Hex: 7F90 to BDD7)
- iv. South-East part of the globe : 48600 to 64799 (Hex: BDD8 to FD1F)

5

The numbers above may be assigned via the following formula (where x depicts the latitude degree unit and y depicts the longitude degree unit):

- i. North-East: $x + 180y$
- ii. North-West: $x + 180y + 16200$
- 10 iii. South-West: $x + 180y + 32400$
- iv. South-East: $x + 180y + 48600$

Given the above example of the coordinate $6^{\circ} 4' 12'' N, 100^{\circ} 13' 12'' E$, the unit which is in degrees is extracted to apply the formula:

15 $x = 6$
 $y = 100$

Since it is the North-Eastern part of the globe, the resulting 4 hexadecimal value, v , is calculated as follows:

20 $v = x + 180y$
 $v = 6 + (180 \times 100)$
 $v = 18006$ which, in hexadecimal is "4656".

(b) The next step involves mapping the minute unit to its respective N/3 digit hexadecimal value. From the $6^{\circ} 4' 12'' N, 100^{\circ} 13' 12'' E$ example, the $4' N$ and $13' E$ is

converted to 04 and 0D hexadecimal value respectively. Thus making a N/3 = 12/3 = 4-digit hexadecimal value "040D".

- (c) The last step proceeds by mapping the second unit to its respective N/3 digit hexadecimal value. From the $6^{\circ} 4' 12'' N$, $100^{\circ} 13' 12'' E$ example, the $12'' N$ and $12'' E$ is converted to 0C and 0C hexadecimal value respectively. Thus making a N/3 = 12/3 = 4-digit hexadecimal value "0C0C".

Thus, the N=12 digit hexadecimal values for the GPS location of $6^{\circ} 4' 12'' N$, $100^{\circ} 13' 12'' E$ are 4656 040D 0C0C.

3. The 12 digit hexadecimal value is then embedded inside an IPv6 address format as shown below.

Network Prefix (e.g. 2407 : 4000)	GPS identifiable address (e.g. 4646 : 040D)	MAC Address with GPS identifiable address embedded. (e.g. 0018 : DE0C : 0C3E : 05D7)
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**Note: A normal standard of IPv6 addressing inserts FFFE in the middle of the MAC address.*

4. Process is completed and GPS-IPv6 address is created.

The algorithm above in steps 1 to 4 is shown in flowchart format from Figures 1a to 1d. Derivation of the GPS location of a node from a given GPS-IPv6 address is shown in the flowcharts of Figures 1e to 1g.

As explained in Figure 1, the numeric value n_i may be allocated in order to support precision in the global coordinates acquired. For the location co-ordinates given in the example $6^{\circ} 4' 12'' N, 100^{\circ} 13' 12'' E$ above, the precision unit enhances precision in the coordinates such as the following: $6^{\circ} 4' 12'' 45''' N, 100^{\circ} 13' 12'' 39''' E$. Therefore,
5 the numeric value $n_i = 39'''$ is the precision or the fine unit.

Figure 4 illustrates system implementation of location-based IP addressing scheme as per an embodiment herein. The system comprises a receiving component 401 for obtaining location co-ordinates of a mobile device on the globe, and a converting
10 component 402 for converting the co-ordinates into an IP-based numeric value, 'N'. The co-ordinates include a degree unit, a minute unit, a second unit and at least one precision unit. As explained earlier, the numeric value 'N' is embedded inside an IP address to create a location based IP address for improving mobile IP hand-off process.

15

Figure 5 illustrates improved handing-off process through GPS-IPv6 addressing schemes as per an embodiment herein. As shown in Figure 5, when the Mobile Node (Alice) changes the point of network attachment from one wireless coverage to another, it has to follow steps 1 to 6 for performing a successful handoff. Unlike the
20 prior art method shown in Figure 2, one step of requesting for a new address by Alice is eliminated in Figure 5. Thus, Mobile IPv6 is improved in the hand-off process as per the embodiments of the present invention. Step 3 generates new GPS based IPv6 address and this increases the speed of the hand-off process.

25 A message flow diagram for the process described in Figure 5 is shown in Figure 6 for illustrating improved handing-off process through GPS-IPv6 addressing schemes.

The scope of this invention will appeal to telecommunication and digital broadcasting companies who are keen to deploy and offer real-time mobile services globally. Such services shall use the GPS technology but with the IPv6 addressing schemes implemented. Future equipment vendors may consider this invention as part of their
5 device's addressing schemes.

The foregoing description of the invention has been described for purposes of clarity and understanding. It is not intended to limit the invention to the precise form disclosed. Various modifications may be possible within the scope and equivalence of
10 the appended claims.

CLAIMS

1. A method for implementing a location based Internet Protocol (IP) addressing scheme for improving mobile IP hand-off process, the method comprising the steps of:
- 5 (a) obtaining location co-ordinates (101) of a mobile device on the globe, the co-ordinates (101) having a degree unit (102a), a minute unit (102b), a second unit (102c) and at least one precision unit (102d);
- (b) converting the co-ordinates (101) into an IP-based numeric value, 'N'; and
- (c) embedding the numeric value inside an IP address to create a location based IP
- 10 address for improving mobile IP hand-off process.
2. The method as in claim 1, wherein converting the co-ordinates (101) to said numeric value 'N' comprises the steps of:
- (a) converting the degree unit (102a) to its respective IP-based numeric value, 'n1';
- 15 (b) converting the minute unit (102b) to its respective IP-based numeric value, 'n2';
- (c) converting the second unit (102c) to its respective IP-based numeric value, 'n3';
- and
- (d) converting the precision unit (102d) to its respective IP-based numeric value, 'ni';
- wherein 'i' is for subsequent integers.
- 20
3. The method as in claim 1, wherein embedding the numeric value 'N' inside the IP address to create a location based IP address comprises the steps of:
- (a) adding a prefix (103a) to the IP address for identifying the said address as a location-based IP address; and
- 25 (b) adding a suffix (103b) to the IP address for making each mobile device unique.

4. The method as in claim 1, wherein the location co-ordinates (101) are obtained from a plurality of areas of the globe including North-East, North-West, South-West, and South-East.
- 5 5. The method as in claim 4, wherein each area is uniquely numbered.
6. The method as in claim 1, wherein the precision unit (102d) is optional.
7. The method as in claim 1, wherein the location-based IP addressing scheme is a
10 location-based IPv6 addressing scheme for improving mobile IPv6 hand-off process
8. A system for implementing a location based IP addressing scheme for improving mobile IP hand-off process, the system comprising:
- (a) a receiving component (401) for obtaining location co-ordinates (101) of a mobile
15 device on the globe, the co-ordinates having a degree unit (102a), a minute unit (102b), a second unit (102c) and at least one precision unit (102d); and
- (b) a converting component (402) for converting the co-ordinates into an IP-based numeric value, 'N';
- \wherein, the numeric value 'N' is embedded inside an IP address to create a location
20 based IP address for improving mobile IP hand-off process.
9. The system as in claim 8, wherein the converting component:
- (a) converts the degree unit (102a) to its respective IP-based numeric value, 'n1';
- (b) converts the minute unit (102b) to its respective IP-based numeric value, 'n2';
- 25 (c) converts the second unit (102c) to its respective IP-based numeric value, 'n3'; and

(d) converts the precision unit (102d) to its respective IP-based numeric value, 'ni'; wherein 'i' is for subsequent integers.

10. The system as in claim 8, wherein a prefix (103a) is added to the IP address for
5 identifying the said address as a location-based IP address.

11. The system as in claim 8, wherein a suffix (103b) is added to the IP address for making each mobile device unique.

10 12. The system as in claim 8, wherein the location co-ordinates (101) are obtained from a plurality of areas of the globe including North-East, North-West, South-West, and South-East.

13. The system as in claim 12, wherein each area is uniquely numbered.
15

14. The system as in claim 8, wherein the precision unit (102d) is optional.

15. The system as in claim 8, wherein the location co-ordinates (101) are obtained from a Global Positioning Satellite (GPS) system.

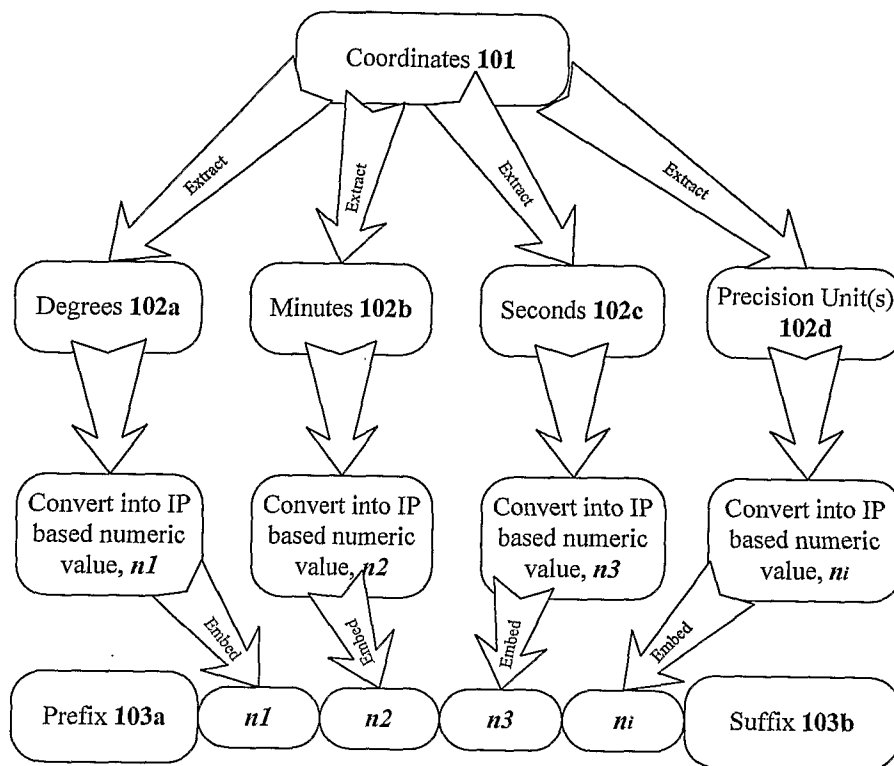


Figure 1

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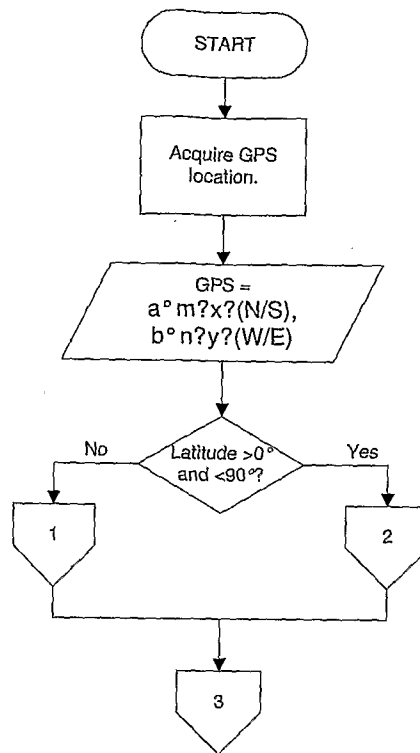


Figure 1a

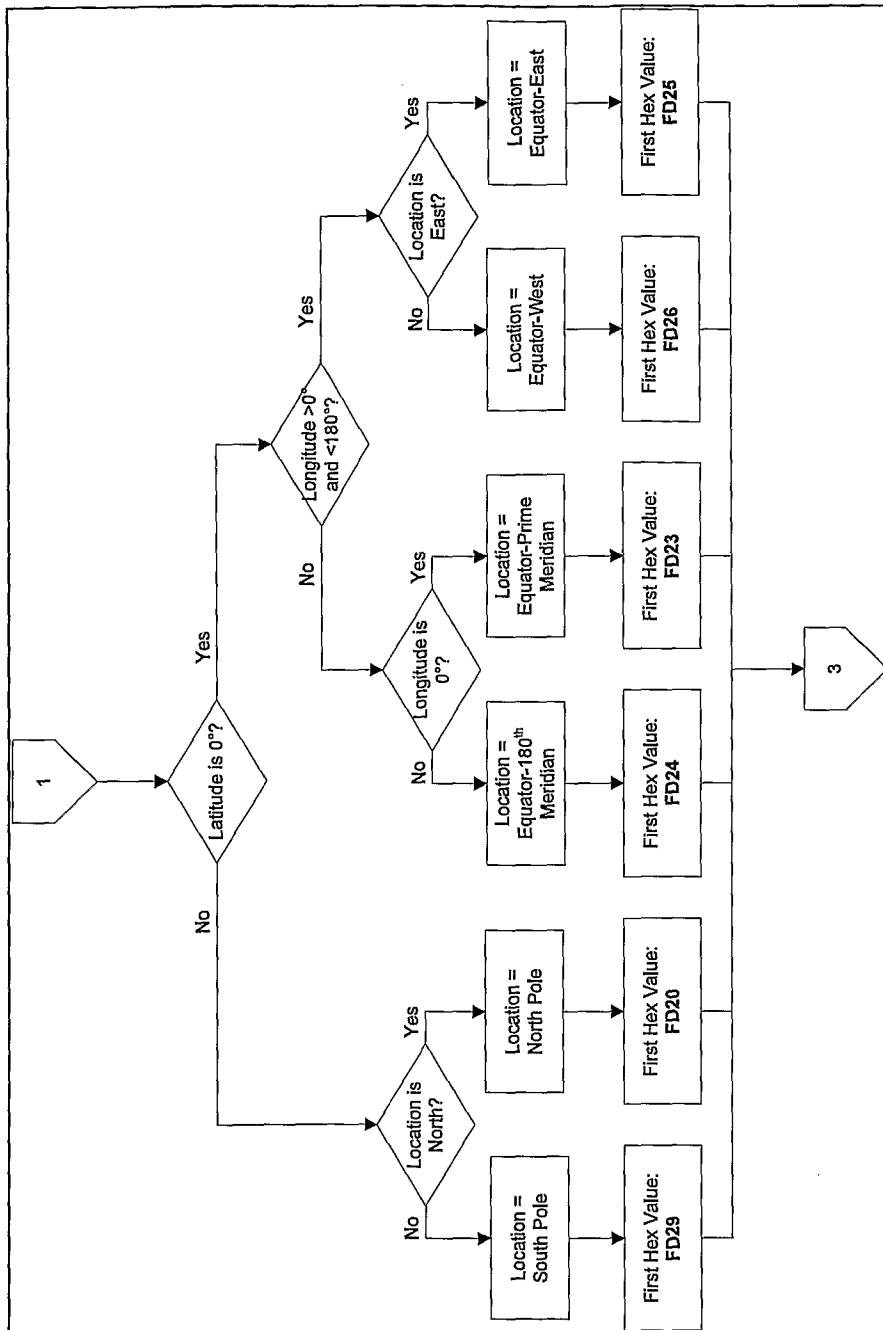


Figure 1b

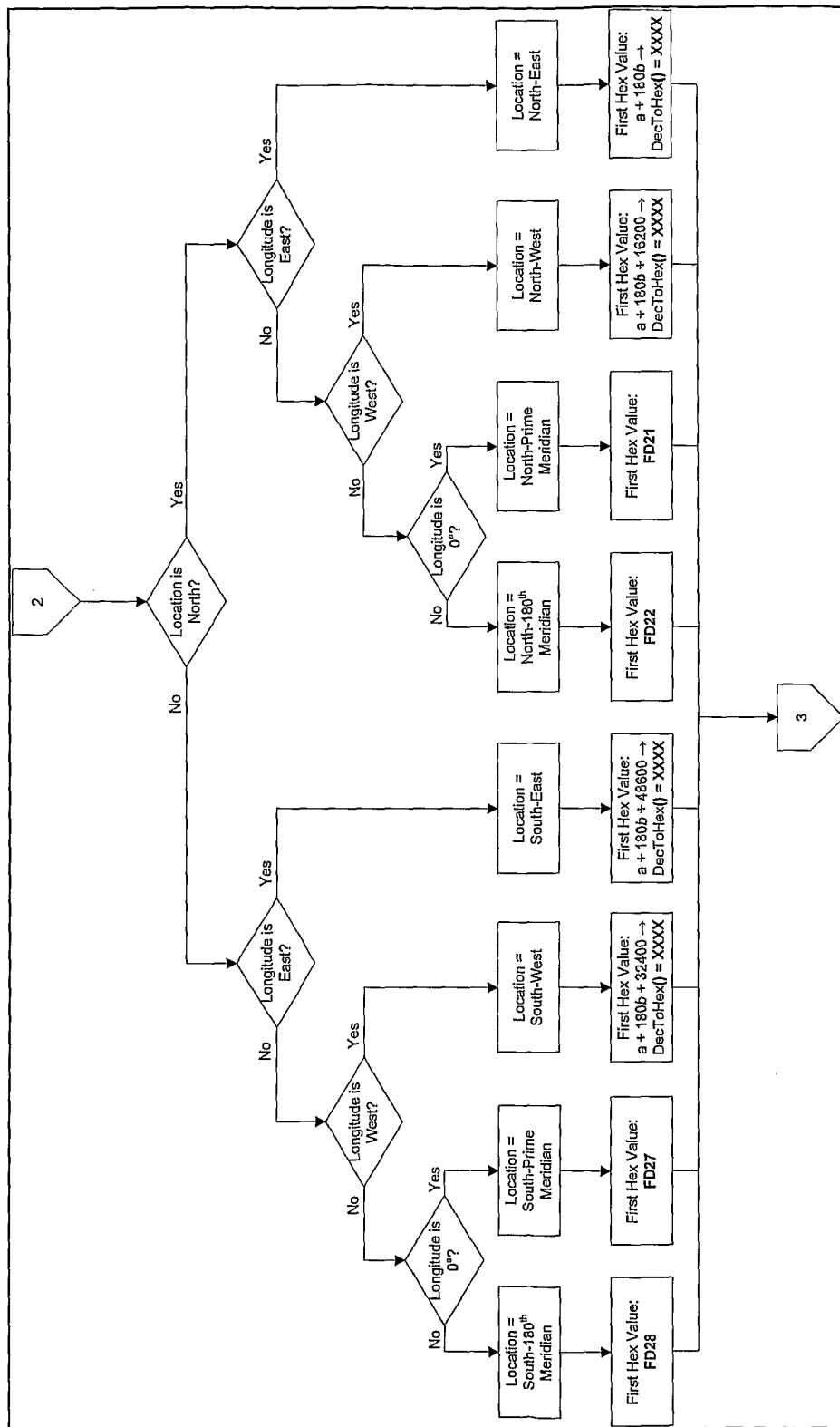


Figure 1c

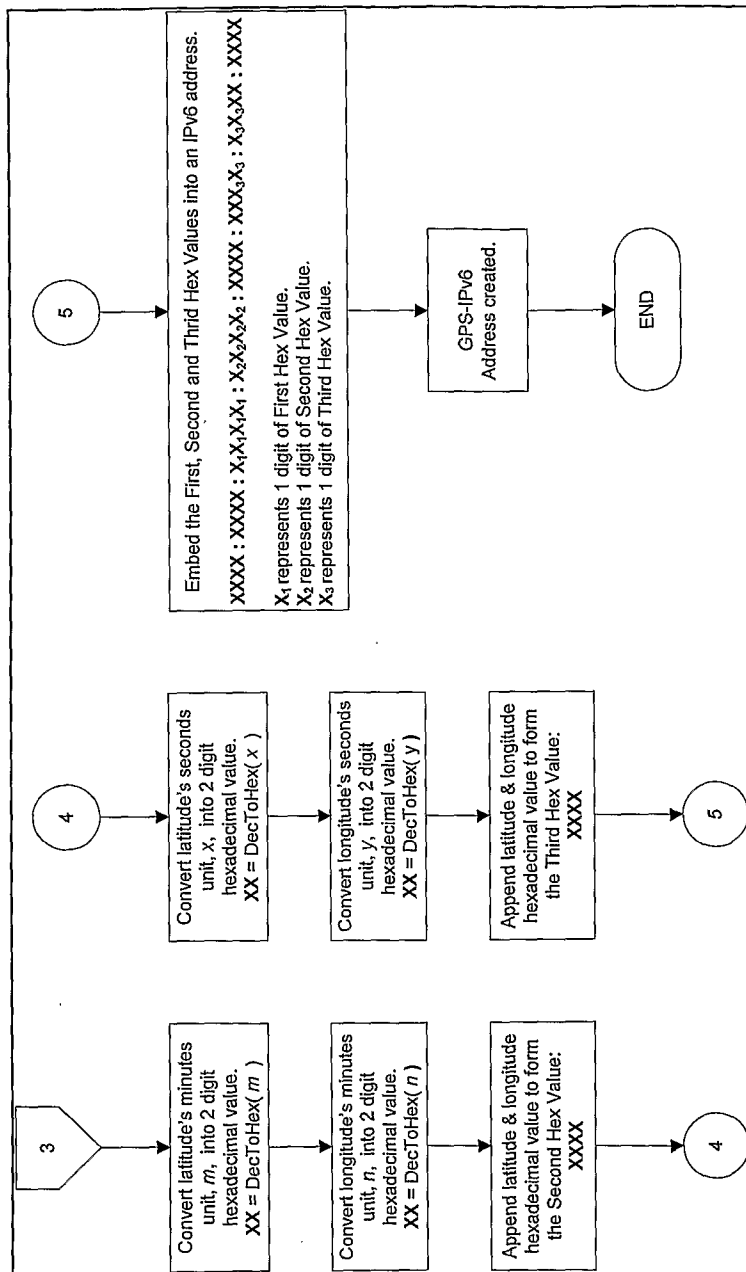


Figure 1d

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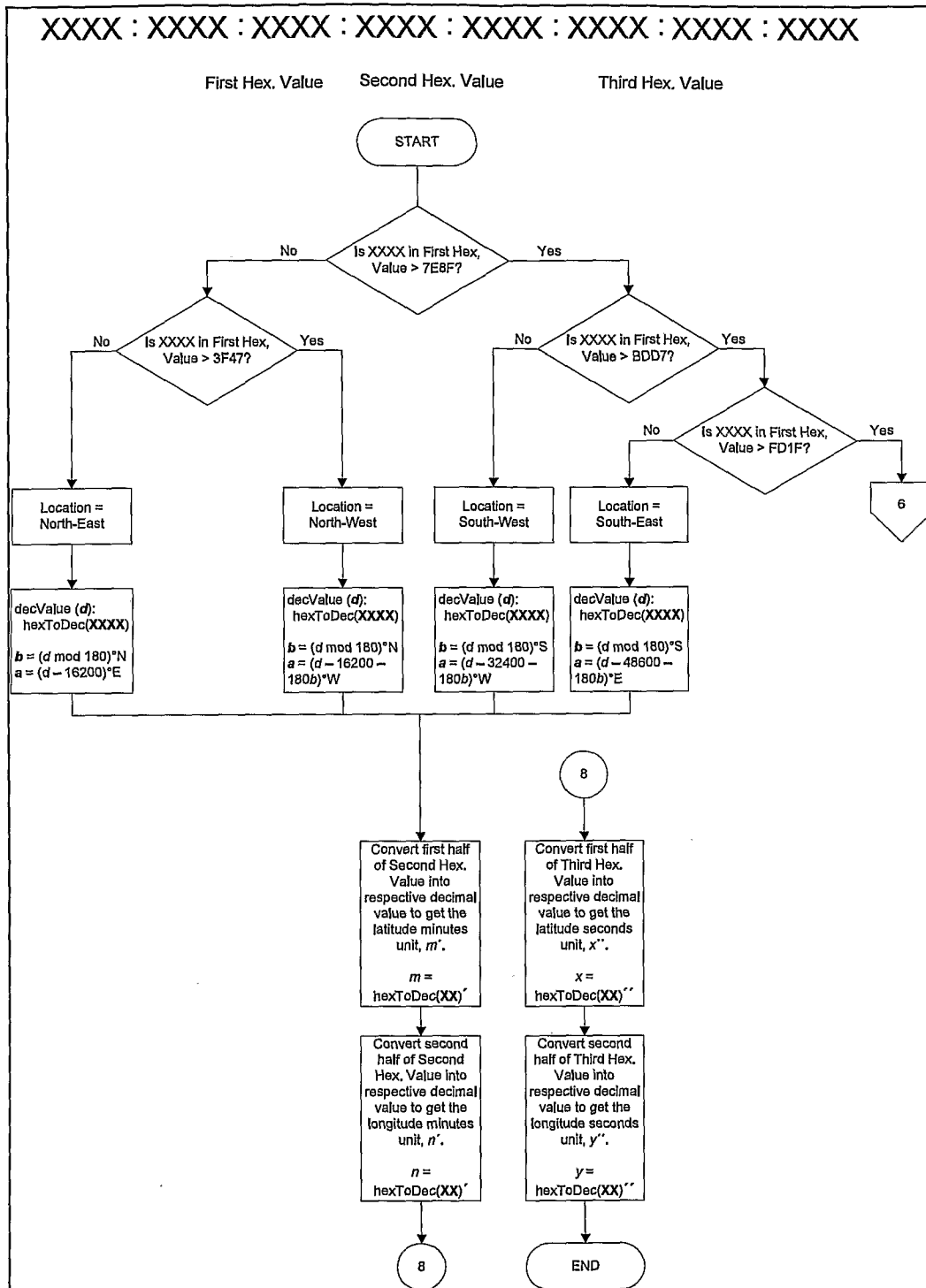


Figure 1e

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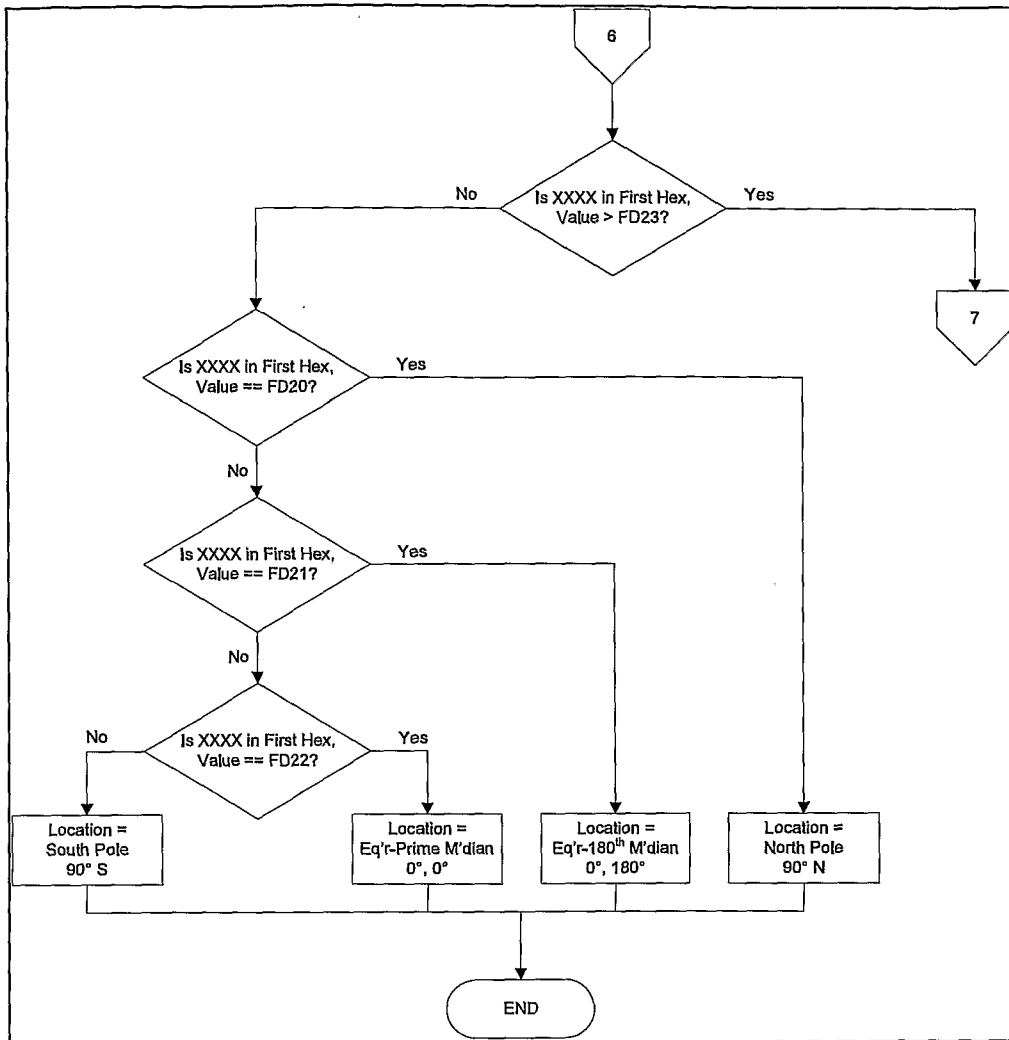


Figure 1f

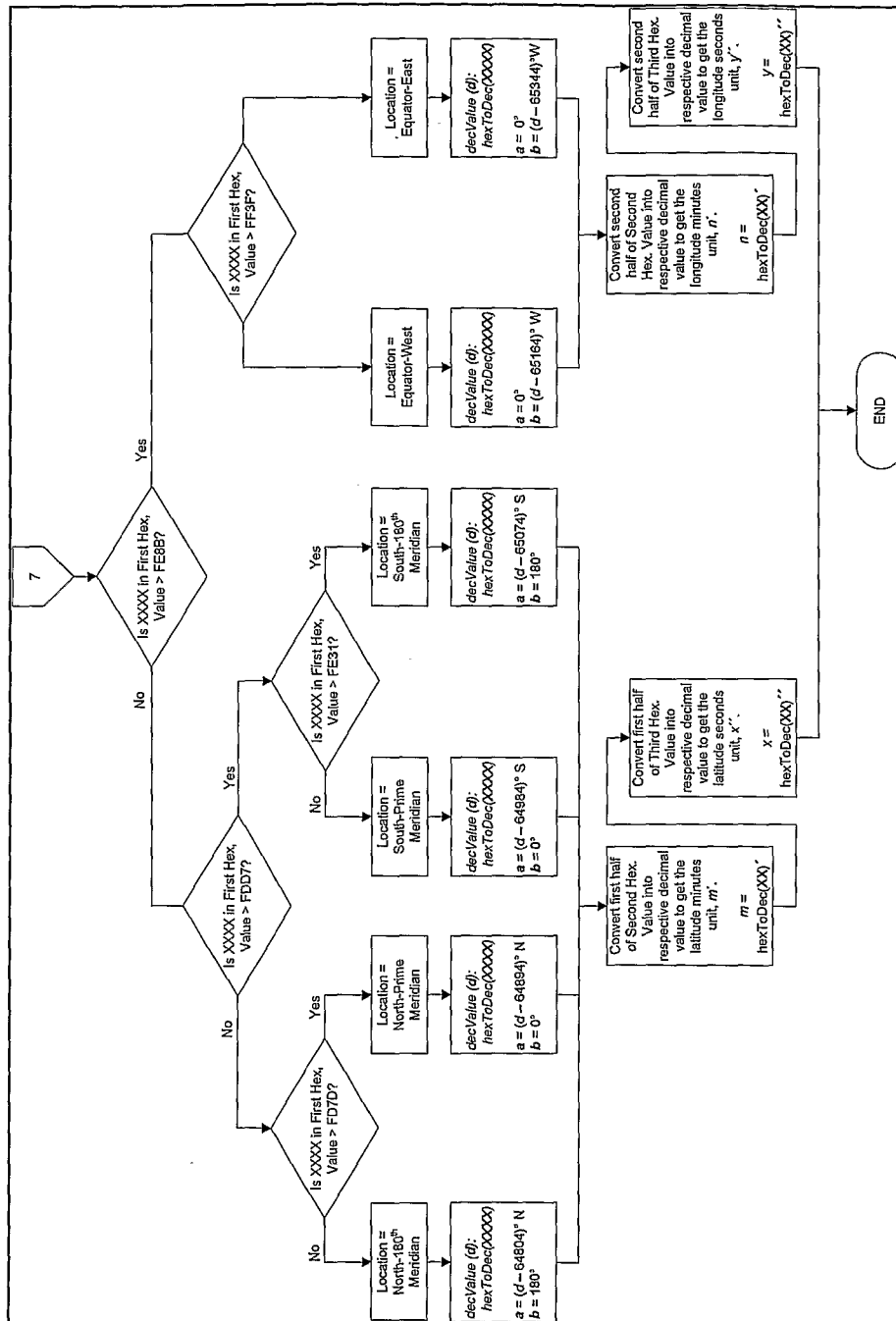


Figure 1g

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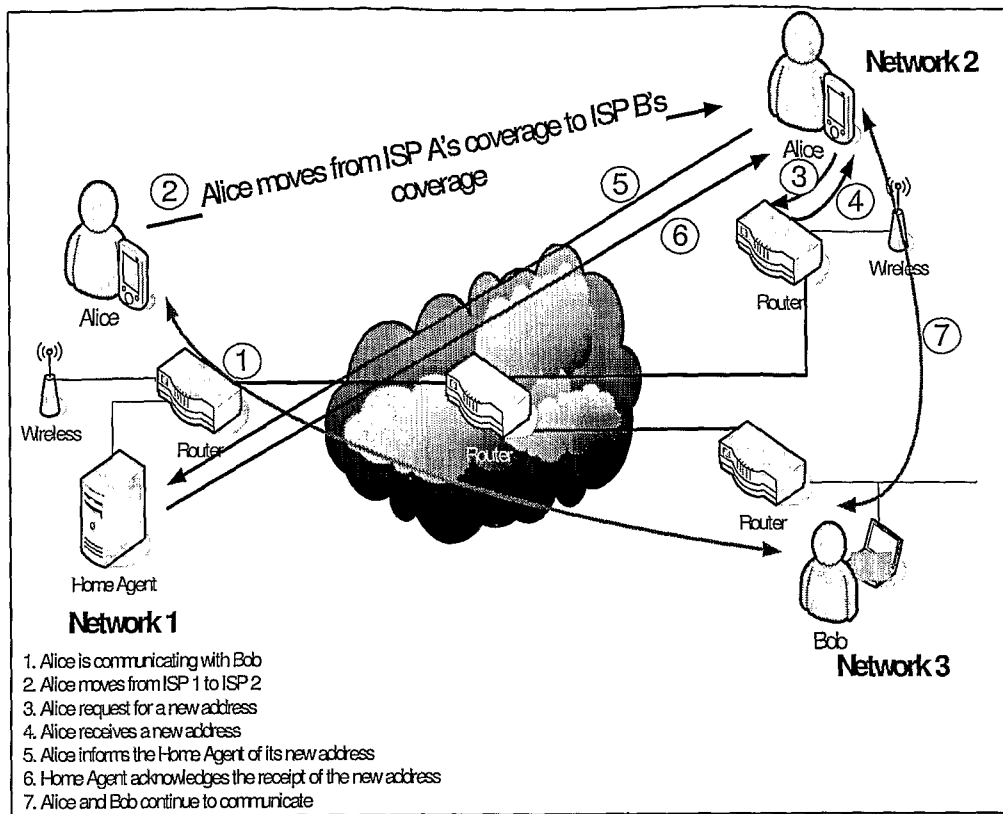


Figure 2

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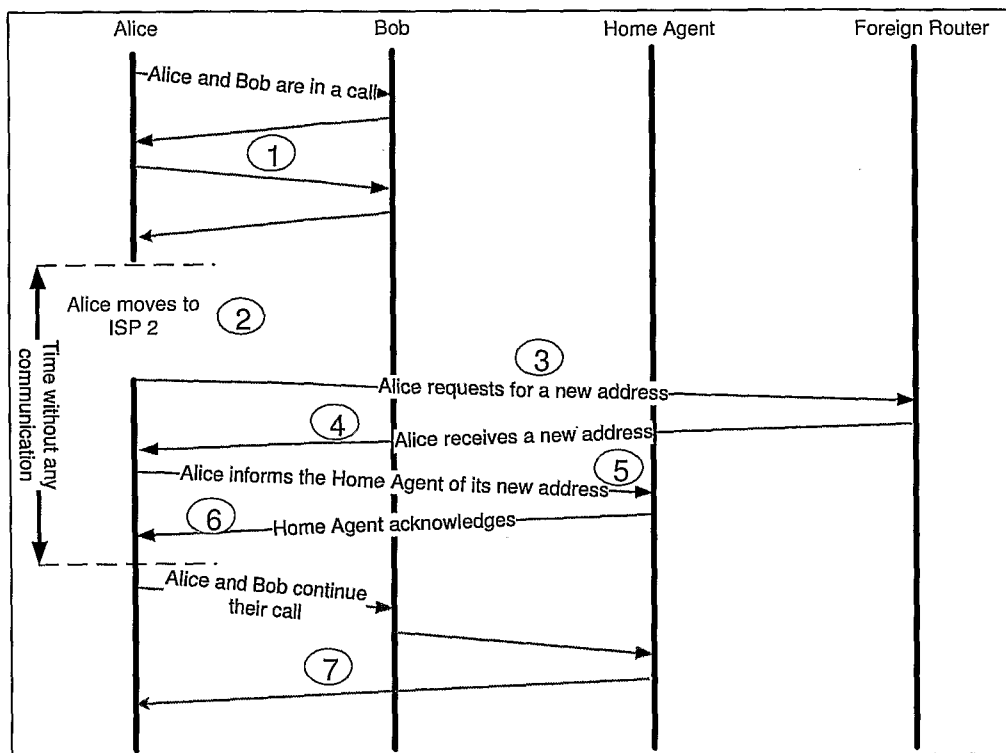
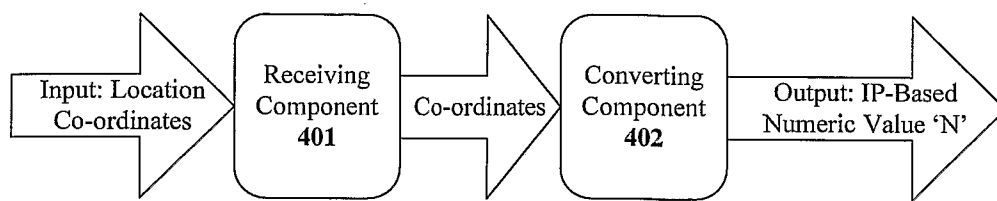


Figure 3

**Figure 4**

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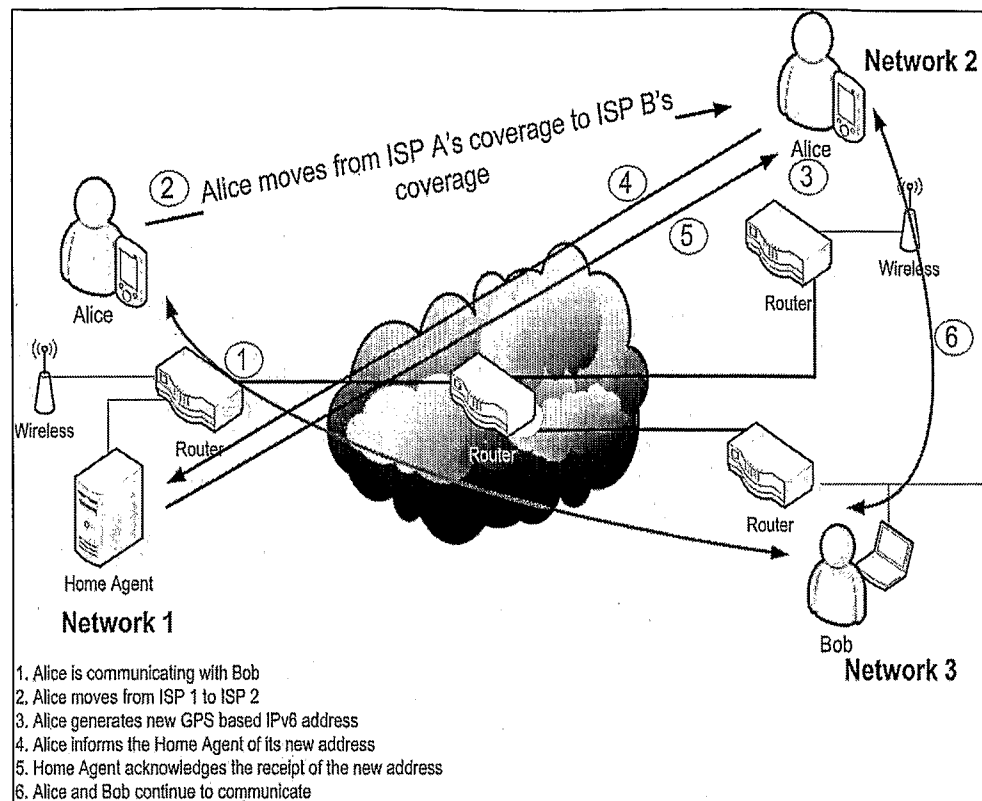


Figure 5

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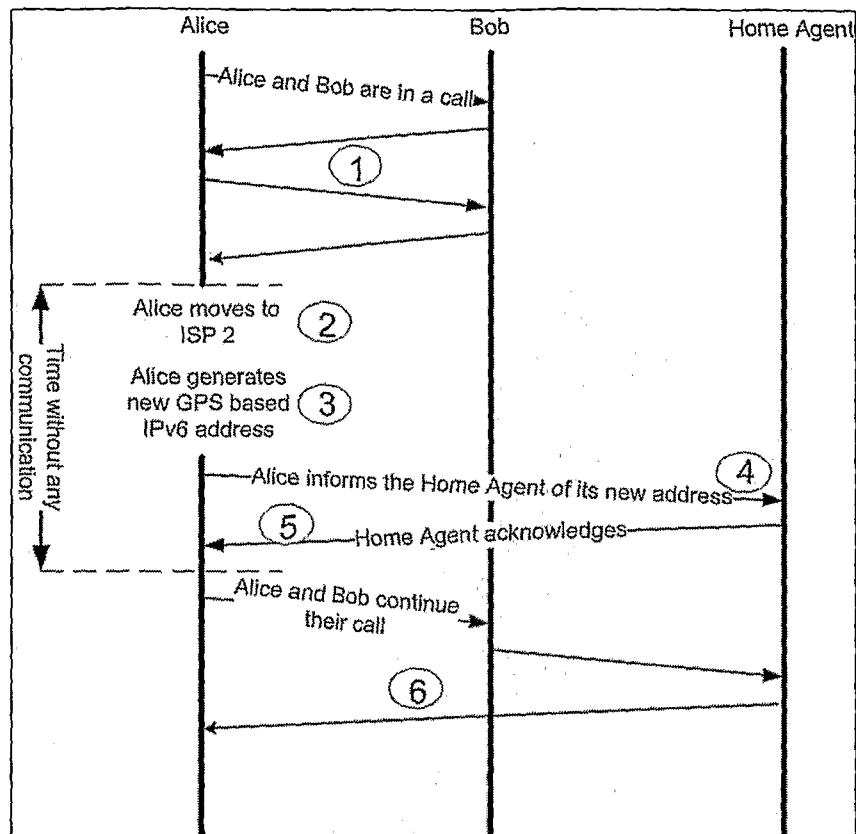


Figure 6