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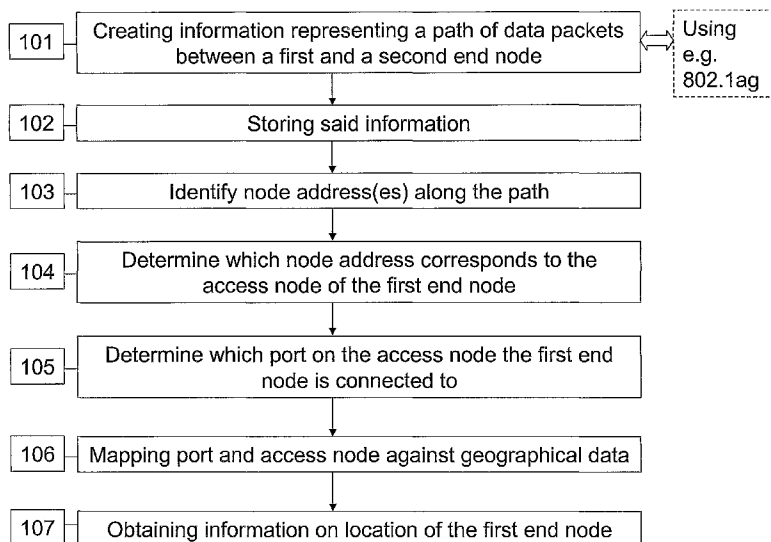
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(54) Title: METHOD AND NODE FOR LOCATING A NETWORK USER



(57) Abstract: The invention relates to a method and a network node (7) for geographically locating an end node (1) in a packet data communication network. The method comprises the steps of creating (101) and storing (102) information representing a path of data packets between a first and a second end node (1, 9) in the network, whereby at least one node address along said path is identified (103) using said information. Thereafter, it is determined (104) which node address that corresponds to the access node (2) for the first end node (1), whereby the access node has several access ports and whereby it is determined (105) which port (P) on said access node (2) the first end node (1) is connected to. Finally, the determined node address and the determined port are mapped (106) against geographical data in a data bank (8), whereby information regarding the location of the first end node (1) is obtained (107).

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METHOD AND NODE FOR LOCATING A NETWORK USER

## FIELD OF THE INVENTION

5 The invention relates to a method and a network node for geographically locating an end node in a packet data communication network.

A problem with IP-based applications, such as Voice over IP (VoIP), is that it may be hard to locate an IP-client geographically. For traditional landline  
10 telephony this is a legal requirement in most countries, and possibly it will become a requirement for VoIP as well, but up to now no liable way of locating an IP-client geographically exists.

## BACKGROUND OF THE INVENTION

15

In conventional network environments, such as the Internet, a plurality of devices are connected through communication media. Such networks permit communicating devices (or users of devices) to easily exchange and share information among the various devices. Each device that forms an interface to  
20 a user may be referred to as an end node, in contrast to intermediate nodes, e.g. switches and routers that act as intermediary nodes, forwarding data from one point to another.

Networks may be configured and graphically depleted in a wide variety of  
25 common topologies. In other words, the particular configurations of network communication links (also referred to as paths) and nodes between a particular pair of nodes wishing to exchange information may be widely varied. Any particular connection between two computers attached to a network may be direct or may pass through a large number of intermediate nodes in the  
30 network. In addition, there may be a plurality of alternative paths through the network connecting any two network nodes. Data networks are therefore complex and vary in their configurations and topologies.

Certain network communication media and protocols are referred to as packet  
35 oriented. A protocol or communication medium may be said to be packet

oriented in that information to be exchanged over the network is broken into discrete sized packets of information. A block of information to be transferred over the network is decomposed into one or more packets for purposes of transmission over the network. At the receiving end of the network  
5 transmission, the packets are re-assembled into the original block of data.

In general, each packet includes embedded control and addressing information that identifies both the source node which originated the transmission of the packet and the destination node to which the packet is  
10 transmitted. Identification of source and destination nodes is by means of an address associated with each node. An address is an identifier which is unique within the particular network to identify each node associated with the network. Such addresses may be unique to only a particular network environment (i.e., a network used to interconnect a single, self-contained  
15 network environment) or may be generated and assigned to nodes so as to be globally unique in co-operation with networking standards organizations.

In conventional network computing environments, a number of nodes are used in addition to interconnected networks to efficiently transfer data over the  
20 network. Routers and switches are network nodes that segregate information flows over various segments of a computer network. A segment, as used herein, is any subset of the data network including nodes and their respective interconnecting communication links. A single computer network communication link has a maximum data transfer bandwidth parameter  
25 defining the maximum rate of information exchange over that network. Where all nodes on a computer network share a common network medium, the maximum bandwidth of the computer network may be rapidly reached. The overall performance of the networked computing environment may thereby be reduced because information exchange requests may have to await completion  
30 of earlier information exchange requests presently utilizing the communication link.

A switch node is a node that filters out packets on the network destined for nodes outside a defined subset (segment) and forwards information directed  
35 between nodes on different segments of a network. The filtering and

forwarding of such information is based on configuration information within the switch that describes the data packets to be filtered and forwarded in terms of source and/or destination address information (once address locations are “learned” by the switch(es)).

5

Network switch nodes and protocols associated therewith are also used to manage redundant paths between network nodes. Where there is only a single path connecting two network nodes, that single path, including all intermediate nodes between the source and destination nodes, represent a single point of failure in network communications between that source and destination node. Therefore, a plurality of redundant paths may be utilized. Multiple paths between two nodes enhances reliability of network communication between the nodes by allowing for a redundant (backup) network path to be used between two nodes when a primary path fails. On the other hand, redundancy costs, and normally operators choose to use network with “single-point-of-failure”, i.e. without backups.

As mentioned in the “field of the invention” a problem in IP-based applications, such as Voice over IP (VoIP), is that it may be hard to locate an IP-client geographically. Different ways of addressing this problem have been proposed. However, no liable way of locating an IP-client geographically exists. No proposed method is independent of the type of access network the user is connected to. So far only methods that are applicable in specific segments of a network have been proposed.

25

One proposed way of finding an end node is to use a “traceroute program”. Tracerouting has been elaborated in order to locate failures in the network by tracing the travelled path for a data packet in a network. Today, tracerouting is the most common way of tracing the route between two IP-nodes. Traceroute shows all intermediate IP-routers/hops between these IP-nodes and may give a basic network location of the IP-nodes, it may however not provide exact locations of end nodes.

In specifying a logical level for path tracing, the Open Systems Interconnection (“OSI”) network reference model is useful. The OSI reference model divides the

35

tasks of moving information between the network devices into groups of manageable tasks. Each group of tasks is assigned to one of seven named and numbered logical layers of the OSI reference model.

- 5 Layer 3 (the Network layer) encompass routing and related functions that enable media to move across a network from a source node to a destination node. For example, Layer 3 may manage the routing of an IP packet from one Local Area Network ("LAN") to another. Layer 2 (the Data Link layer) defines network and protocol characteristics, including physical addressing, network  
10 topology, sequencing of frames, and flow control.

Today, traceroute may only be performed at layer 3 such that only layer 3 nodes, e.g. routers or similar, show up on the tracing, whereas layer 2 nodes, e.g. switches or similar, are excluded from the tracing. This is a problem in  
15 large broadband networks, since most of the access networks contain layer 2 nodes, which followingly will not show up on the traceroute. Therefore, the location of a user/end node can only be traced up to the closest layer 3 node.

However, methods of tracing a path at layer 2 are being proposed and a new  
20 Ethernet standard (802.1ag) that is forecasted to be implemented in 2007 is currently being established. The standard is addressed to allow discovery and verification of the path, through bridges and LANs, and with the new 802.1ag standard it will be possible to trace layer 2 nodes. The standard specifies protocols, procedures, and managed objects to support transport fault  
25 management.

The 802.1ag standard will provide capabilities for detecting, verifying and isolating connectivity failures in all kinds of networks. It is however not aimed at locating users or end nodes.  
30

Therefore, there still exists a need for a method of locating end nodes in a network.

## SUMMARY OF THE INVENTION

Thus, the object of the present invention is to provide a method and a network node for geographically locating an end node in a packet data communication  
5 network.

The object of the invention is achieved by the method of claim 1, a directly loadable computer program product according to claim 5, a stored computer program product according to claim 6, and a network node according to claim  
10 7.

According to a first aspect of the invention a method of geographically locating an end node in a packet data communication network is provided. The method comprises the steps of creating and storing information representing a path of  
15 data packets between a first and a second end node in the network, whereby at least one node address along said path is identified using said information. Thereafter, a node address among the at least one node address that corresponds to the access node for the first end node is determined, whereby the access node has several access ports and whereby it is determined which  
20 port on the determined access node the first end node is connected to. Finally, the determined node address and the determined port are mapped against geographical data in a data bank, whereby information regarding the location of the first end node is obtained.

25 According to a second aspect, the invention relates to a computer program product directly loadable into a processing means in a packet data communication network, comprising the software code means for performing the steps relating to the method.

30 According to a third aspect, the invention relates to a computer program product stored on a computer usable medium, comprising readable program for causing a processing means in a packet data communication network, to control the execution of the steps relating to the method.

According to a fourth aspect, the invention relates to a network node adapted for geographically locating an end node in a packet data communication network is provided. The node comprises means for creating information representing a path of data packets between a first and a second end node in the network, and a database for storing said information. It also comprises 5 means for identifying at least one node address along said path using said information, and means for determining one node address among the at least one node address that corresponds to the access node for the first end node, as well as means for determining which port on the determined access node 10 the first end node is connected to. Further, the network node comprises means for mapping the determined node address and the determined port against geographical data in a data bank, means for obtaining, from said mapping, information concerning the location of the first end node, and means for displaying said information.

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Thus, the invention makes it possible to geographically locate an end node in a packet data communication network.

An advantage of the invention is that it is independent of the type of access 20 node the user is attached to. Whether the user is connected to the network via a telephone line, a cable TV router or fibre optics there will always exist a port that is unique to a specific end node location, and that port will always be traceable from the network.

25 The invention allows for an operator or any other authorized person to find out the physical location of an end user at any given moment. This is for instance useful when a subscriber makes a VoIP call to an alarm centre, e.g. 112 or 911, but gets disconnected or for some other reason is unable to state his location. With the method according to the invention the person can be 30 instantly located and offered help.

Another advantage of the invention is that it provides the possibility trace hackers or other offenders performing illegal activities in a network.



identified it is necessary to determine (step 104) which of these node addresses that represents the access node 2 for the first end node 1. The access node 2 for the first end node 1 is the node in the network that is closest to the first end node 1. Once the access node 2 has been identified it is time to  
5 determine (step 105) which port P on the access node 2 that the first end node 1 is connected to.

The determined access node 2 and port P is then mapped (step 106) against geographical data in a data bank 8, and from this mapping information  
10 regarding the geographical location of the first end node is obtained (step 107).

According to a preferred embodiment of the invention the creating and storing of the path information is done in steps, see figure 2. The first step involves finding the penultimate Layer 3 hop, i.e. the last hop before the layer 2  
15 segment. For this a traceroute program may be used. A traceroute is handled by a network node 7, which sends a packet of data to the destination end node 1. The packet includes a time limit value "time to live" that is selected so that it is exceeded by the first router 6 that receives the packet. The router 6 returns a Time Exceeded message, which allows for the network node 7 to  
20 store the address of the router 6 in a database 10. The traceroute program then increases the time and resends the packet so that it will reach the next router 5 on the path to the destination node 1. The procedure is repeated until the last router 5, which is a gateway to the layer 2 domain, has been reached.

25 Conventional traceroute is as mentioned above not possible at Layer 2. Therefore the only thing visible in a conventional traceroute beyond the gateway router 5 has been the IP-address of the end node 1. In an IP-network the IP-addresses are mobile and not fixed. They are supplied to a user in a random manner once he has been granted access to the network. The IP-  
30 address may or may not be the same as the IP-address supplied to the user during his previous session. Hence, IP-addresses are generally not tied to a specific geographical location and therefore it is not possible to locate the user geographically using only the IP-address. The only useful layer 3 information available to the network node 7 performing the traceroute is which gateway  
35 router 5 the end node is connected to. The gateway router 5 may however be

shared with several thousands of other users, and therefore only provides a basic idea of in which area the end node is located.

Traceroute enhanced with the 802.1ag standard will however be capable of tracing the path even in the layer 2 domain. Hence, the remaining path may also be traced, step by step, starting with the switch 4 closest to the gateway router 5 end stepping via all intermediate switches 3 to the switch 2 that constitutes the access node for the end node 1. It will also be possible to trace which port P on the access node 2 the end node 1 is connected to.

10

Generally, the last part of the connection, e.g. a copper line, TV-cable optical fibre or any other type of fixed connection, runs from a access node 2, 2a, 2b, 2c in e.g. a basement of a residential building to a socket in a specific apartment. The switch and/or the socket may or may not be the same as the ones that are used for e.g. land line telephony or cable TV. In any case each port on the last switch corresponds to a socket at a specific location, such as an office, a house or an apartment. If the end node has a wireless connection to its access node it will be possible to locate the access node, which will reveal in what area or cell the end node is located. Other known methods will then have to be used to locate the wireless end node more closely.

20

Thus, a preferable way of arranging the data bank 8 is to store whereto each port on every access node leads, e.g. access nodes 2, 2a, 2b, 2c so that each port corresponds to a specific location, such as an office, a house or an apartment.

25

A general idea of the invention is to gather information of where to each of these port leads and set up a data bank based on this information. Once the data bank 8 is implemented geographical mapping of on-line users will be possible at all times. Mapping may also be possible for a certain time after the user has gone off-line as information created by the traceroute representing the path of data packets between two end nodes may be stored in the database 10 for as long as the operator decides.

30

According to another preferred embodiment of the invention the geographical information is implemented in an already existing data bank. For instance, operators have data banks with information regarding their subscribers. Normally, such data banks include information about the subscribers' home  
5 addresses and may therefore be updated to also include information regarding which port on which access node the subscribers' fixed connections are connected to, and whereto these connections lead.

For the method to work it is not mandatory to trace all intermediate nodes. To  
10 locate the user's end node geographically it is sufficient to know which access node 1 and which access port the end node is connected to. Normally, this is explored stepwise, as described above, but other ways may be used. When the tracing is done stepwise it is implicitly known which router and/or switch that is closest to the user, as these are the last to be traced. When other methods  
15 are used it is necessary to deduce which one is closest to the user.

According to a preferred embodiment of the invention the locations of all intermediary nodes, e.g. nodes 3-6, are also stored in the data bank 8. This will make it possible to plot a traceroute directly on a map. The storing of  
20 locations of intermediary nodes in the data bank 8 is also useful for tracing users that are connected to the network from locations inside a network, e.g. directly to a switch or a router, i.e. using an intermediary node as access node. Today it presents a weakness in networks that somebody with access to switches and routers, e.g. somebody that works for an operator, may get  
25 connected to the network without risking to be traced, since it presents an opportunity for inside or outside hackers to perform illegal activities on a network with a minimum risk of getting caught. Today, there is no way of tracing which switch an offender is connected to, or if the offender is connected to a router there is no way of knowing if he is connected directly to  
30 the router or via a number of switches. Either way, the traceroute would show up the same. Once the network node 7 according to the invention is implemented in a network it will be possible to trace the geographic location of such offenders by performing the method according to the present invention.

In order for the method according to the invention to work a network node 7 and an ancillary data bank 8 are implemented in the network. The network node may be implemented in an existing node, but may also be a new node. Further, the network node 7 may be implemented anywhere in the network.

- 5 The network node 7 also comprises means for performing the steps relating to the method according to the invention. The data bank 8 may or may not be an integrated part of the network node 7.

- 10 The method of the present invention may preferably be implemented by a computer program product. Thus the present invention also relates to a computer program product directly loadable into a processing means in a data network, comprising the software code means for performing the steps of said method.

- 15 The present invention also relates to a computer program product stored on a computer usable medium, comprising readable program for causing a processing means in a data network, to control the execution of the steps of said method.

- 20 In the drawings and specification, there have been disclosed typical preferred embodiments of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being set forth in the following claims.

Claims

1. A method of geographically locating an end node (1) in a packet data communication network comprising the steps of:
  - 5 - creating (101) and storing (102) information representing a path of data packets between a first end node (1) and a second end node (9) both having an access node (2, 2c) in the network,
    - identifying (103) at least one node address along said path using said information,
  - 10 the method being **characterized** in that it also comprises the steps of:
    - determining (104) a node address among the at least one node address that corresponds to the access node (2) for the first end node (1), the determined access node (2) having several access ports,
    - determining (105) which port (P) among the several access ports on the  
15 determined access node (2) the first end node (1) is connected to,
      - mapping (106) the determined node address and the determined port (P) to geographical data in a data bank (8), and
      - obtaining (107), from said mapping, geographical information regarding the location of the first end node (1).
- 20 2. Method according to claim 1, wherein the step of creating and storing information representing a path of data packets between a first and a second end node in the network comprises both layer 2 and layer 3 information.
- 25 3. Method according claims 1 or 2, wherein the information regarding the location of the first end (1) node comprises information regarding in what apartment, office, house or the like a socket that the first end node (1) is connected to is located.
- 30 4. Method according to any of the preceding claims, wherein the information regarding the location of the first end node (1) further comprises information regarding which subscriber, if any, that corresponds to the location of the first end node (1).

5. A computer program product directly loadable into a processing means in a packet data communication network, comprising the software code means for performing the steps of the method according to any of the claims 1-4.
- 5 6. A computer program product stored on a computer usable medium, comprising readable program for causing a processing means in a packet data communication network, to control the execution of the steps of the method according to any of the claims 1-4.
- 10 7. A network node (7) adapted for geographically locating an end node (1) in a packet data communication network, the network node (7) comprising:
- means for creating information representing a path of data packets between a first end node (1) and a second end node (9) both having an access node (2, 2c) in the network,
  - 15 - a database (10) for storing said information,
  - means for identifying at least one node address along said path using said information,
- the network node (7) being **characterized** in that it further comprises:
- means for determining a node address among the at least one node
  - 20 address that corresponds to the access node (2) for the first end node (1), the determined access node (2) having several access ports,
  - means for determining one port (P) among the several access ports on the determined access node (2) the first end node (1) is connected to,
  - means for mapping the determined node address and the determined
  - 25 port (P) against geographical data in a data bank (8),
  - means for obtaining, from said mapping, geographical information concerning the location of the first end node (1), and
  - means for displaying the geographical information.
- 30 8. Network node (7) according to claim 7, wherein the means for creating information representing a path of data packets between a first and a second end node (1, 9) is adapted to create both layer 2 and layer 3 information, and wherein the database (10) is adapted to store this information.
- 35 9. Network node (7) according claims 7 or 8, wherein the data bank (8)

contains information regarding in what apartment, office, house or the like a socket for the first end node (1) is located.

10. Network node (7) according to any of the claims 7 to 9, wherein the data  
5 bank (8) further contains information regarding which subscriber, if any, that corresponds to the location of the first end node (1).

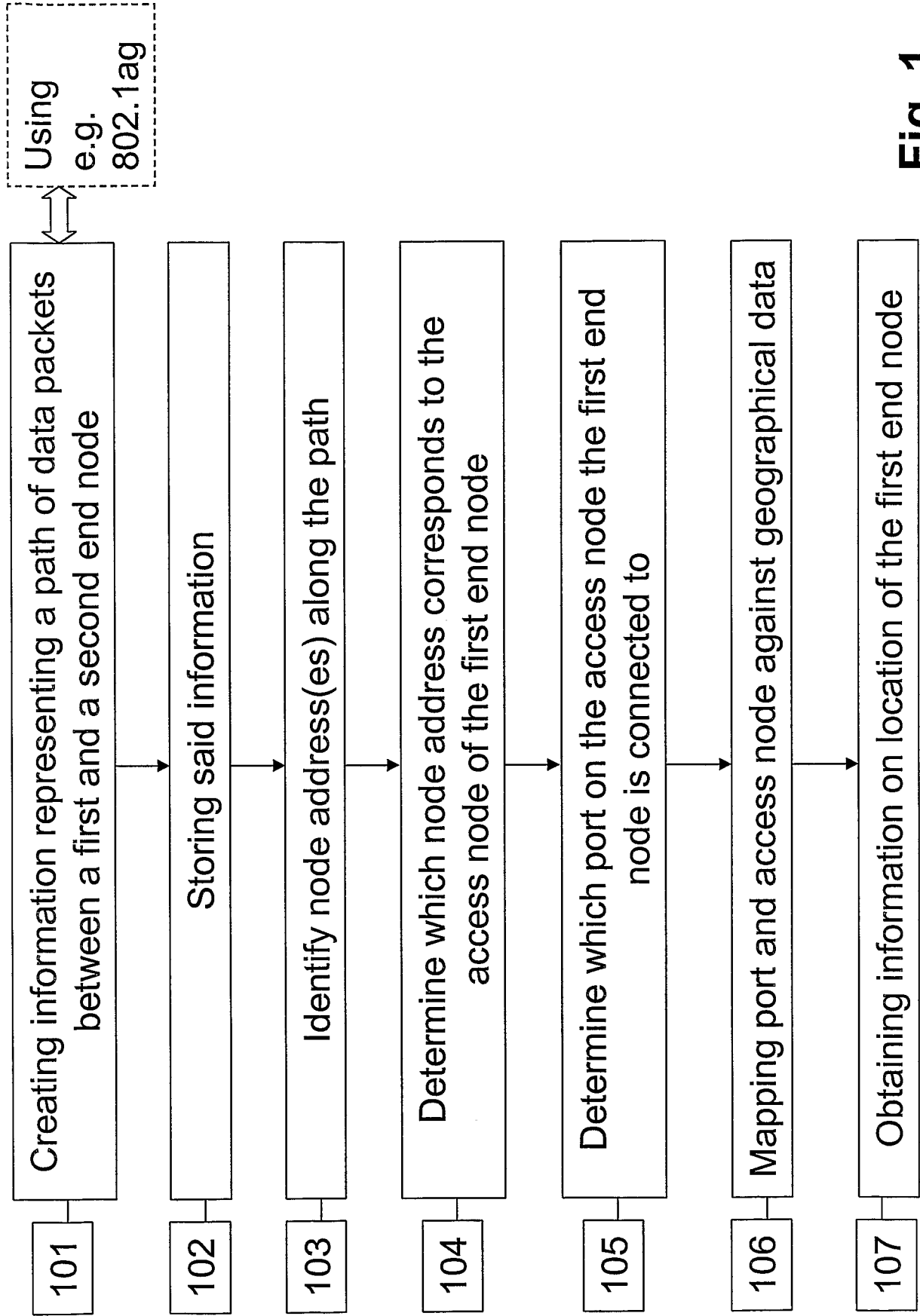


Fig. 1

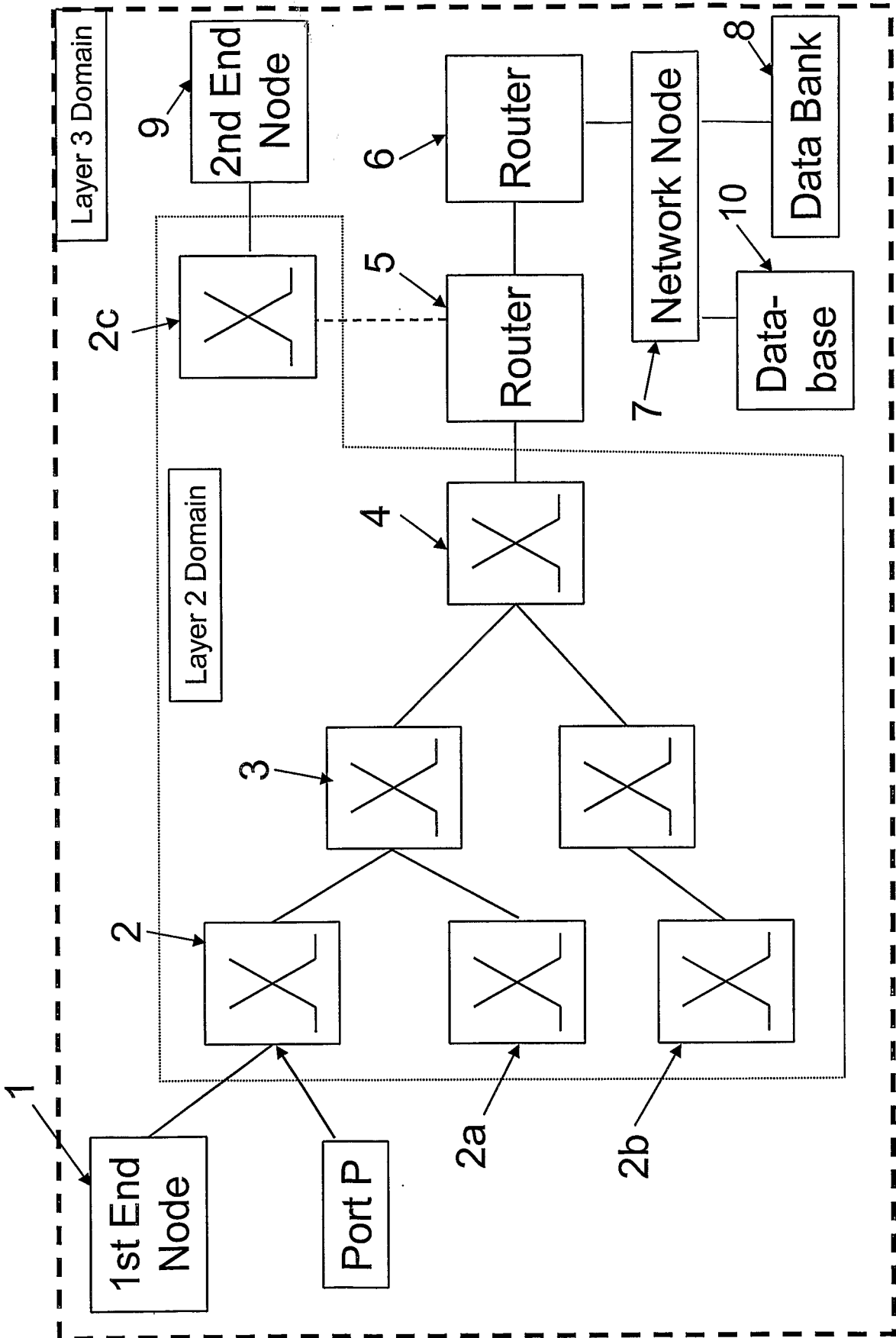


Fig. 2

# INTERNATIONAL SEARCH REPORT

International application No.

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## A. CLASSIFICATION OF SUBJECT MATTER

**IPC: see extra sheet**  
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: H04L, G06F**

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, PAJ**

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 0158111 A1 (NOKIA NETWORKS OY), 9 August 2001 (09.08.2001), claim 1, abstract --	1-10
A	WO 0133808 A2 (NOMADIX, INC.), 10 May 2001 (10.05.2001), see whole document --	1-10
A	US 20030097438 A1 (M.J. BEARDEN ET AL), 22 May 2003 (22.05.2003), abstract, paragraph (0007) - (0012), (0055) -- -----	1-10

Further documents are listed in the continuation of Box C.  See patent family annex.

* Special categories of cited documents:	"I" 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
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"P" document published prior to the international filing date but later than the priority date claimed	

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Cited literature, if any, will be enclosed in paper form.

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2005/001151

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