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DEVICES AND METHODS FOR ROUTEING A UNIT OF DATA IN A
NETWORK

FIELD OF THE INVENTION

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The present invention relates generally to devices and methods for routeing a unit of data in a network. More specifically, the present invention has particular - but by no means exclusive - application to
10 routeing packets in a shared network environment for latency driven distributed applications.

BACKGROUND OF THE INVENTION

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There is an emerging class of computer applications that require the use of a network of geographically dispersed servers in order to improve the performance of the applications by reducing network delay. Applications of this nature are sometimes referred to as
20 Latency Driven Distributed (LDD) applications. An example of an LDD application is a massively multi-player real-time game that operates over the Internet. Applications of this nature typically involve the real-time composition of multimedia material from distributed sources around the
25 Internet. Consequently, to preserve the real-time nature of LDD applications it is often necessary to perform processing and distribution of data on servers that are located near users of the LDD applications. For example, performing processing and distribution of multimedia data
30 on a server located in Europe for users located in Australia may introduce a delay that significantly degrades the real-time performance of the LDD applications for Australian users. In this example it would be advantageous to reduce the delay by performing the processing and
35 distribution of the multimedia data from a server located in Australia.

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Whilst it is possible for LDD application providers to purchase and install their own infrastructure to provide themselves with a set of geographically dispersed servers, this option has the disadvantage of being relatively costly. A more cost-effective solution is to lease or hire the necessary computing resources from a party that owns the servers and provide the paths etc. Unfortunately, the disadvantage with this option is that application providers will probably share the physical resources (that is, computing resources) with other application providers, which may lead to a degradation in the perform of LDD applications due to processing delays.

DEFINITIONS

The following provides definitions for various terms used throughout this specification.

- Routeing - used to refer to the action of forwarding a unit of data in a communication network. The term "routeing" as used in this specification is not restricted to a particular technique for forward a unit of data. Consequently, the word "routeing" is broad enough to cover a range of techniques including, for example, level 3 network level packet routeing or level 2 link level switching.

- Path - used to refer one or more links in a communication network that are used to transfer a unit of data between network nodes. Consequently, a path can include a single link that allows adjacent nodes to exchange data, or a series of links that enable the data to be exchanged between non-adjacent nodes via other nodes. Furthermore, the terms "path" and "link" as used throughout this specification are indented to cover physical paths or links, such as a fibre optic cable, or virtual paths or links such as an IP tunnel.

SUMMARY OF THE INVENTION

According to a first aspect of the present
5 invention there is provided a device for routeing a unit of
data in a network, the device comprising a processing means
that is operable to:

determine an identity of a first path in the
network that was used to transfer the unit of data;

10 identify a second path in the network based on
the identity of the first path; and

forward the unit of data over the second path to
thereby route the unit of data in the network.

15 Preferably, the processing means is operable to
identify the second path by:

selecting a routeing record from one or more
first routeing records;

determining whether the routeing record contains
20 a reference to one or more second routeing records;

identifying the second path by examining the
routeing record upon determining that the routeing record
does not contain the reference; and

upon determining that the routeing record
25 contains the reference: selecting another routeing record
from the second routeing records; and identifying the
second path by examining the other routeing record.

Preferably, the processing means is operable such
30 that when selecting the routeing record from the first
routeing records the processing means identifies one of the
first routeing records that comprises information that
corresponds to the identity of the first path to thereby
select the routeing record.

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Preferably, the processing means is operable such
that when selecting the other routeing record from the

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second routeing records the processing means identifies one of the second routeing records that comprises the information that corresponds to the identity of the first path, and additional information that corresponds to application information contained in the unit of data to thereby select the other routeing record.

Preferably, the application information contained in the unit of data comprises an identification of a computing device from which the unit of data originated.

Preferably, the processing means is operable to determine the identity of the first path by examining the unit of data.

Preferably, the processing means is operable such that when forwarding the unit of data over the second path it arranges the unit of data such that it identifies the second path.

Preferably, the first path comprises a tunnel in the network.

Preferably, the second path is one of a plurality of second paths in the network, wherein the second paths comprises another tunnel in the network and a non-tunnel path in the network.

Preferably, the network is based on packet switching.

Preferably, the unit of data is an IP packet.

According to a second aspect of the present invention, there is provided a method of routeing a unit of data in a network, the method comprising the steps of:
determining an identity of a first path in the

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network that was used to transfer the unit of data;
identifying a second path based on the identity
of the first path; and
forwarding the unit of data over the second path
5 to thereby route the unit of data.

Preferably, the step of identifying the second
path comprises the steps of:

selecting a routeing record from one or more
10 first routeing records;
determining whether the routeing record contains
a reference to one or more second routeing records;
identifying the second path by examining the
routeing record upon determining that the routeing record
15 does not contain the reference; and
upon determining that the routeing record
contains the reference: selecting another routeing record
from the second routeing records; and identifying the
second path by examining the other routeing record.

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Preferably, the step of selecting the routeing
record from the first routeing records comprises the step
of identifying one of the first routeing records that
comprises information that corresponds to the identity of
25 the first path to thereby select the routeing record.

Preferably, the step of selecting the other
routeing record from the second routeing records comprises
the step of identifying one of the second routeing records
30 that comprises the information that corresponds to the
identity of the first path, and additional information that
corresponds to application information contained in the
unit of data to thereby select the other routeing record.

35 Preferably, the application information contained
in the unit of data comprises an identification of a
computing device from which the unit of data originated.

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Preferably, the step of determining the identity of the first path comprises the step of examining the unit of data.

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Preferably, the step of forwarding the unit of data over the second path comprises the step of arranging the unit of data such that it identifies the second path.

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Preferably, the first path comprises a tunnel in the network.

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Preferably, the second path is one of a plurality of second paths in the network wherein the second paths comprises another tunnel in the network and a non-tunnel path in the network.

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Preferably, the network is based on packet switching.

Preferably, the unit of data is an IP packet.

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According to a third aspect of the present invention, there is provided a device for routeing a unit of data in a network, the device comprising a processing means operable to:

determine a destination of the unit of data;

assign the unit of data a label based on the destination of the unit of data;

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select a routeing record from one or more routeing records based on the label; and

forward the unit of data over a path identified in the routeing record.

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Preferably, the processing means is operable to select the routeing record by identifying one of the routeing records that comprises information that

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corresponds to the label assigned to the unit of data, and additional information that corresponds to application information contained in the unit of data to thereby select the routeing record.

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Preferably, the application information contained in the unit of data comprises an identification of a computing device from which the unit of data originated.

10

Preferably, the processing means is operable such that when forwarding the unit of data over the path it arranges the unit of data such that it identifies the path.

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Preferably, the path is one of a plurality of paths in the network wherein the paths comprises a tunnel in the network and a non-tunnel path in the network.

Preferably, the network is a packet switched network.

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Preferably, the unit of data comprises an IP packet.

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According to a fourth aspect of the present invention, there is provided a method of routeing a unit of data in a network, the method comprising the steps of:

determining a destination of the unit of data;
assigning the unit of data a label based on the destination of the unit of data;

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selecting a routeing record from one or more routeing records based on the label; and

forwarding the unit of data over a path identified in the routeing record.

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Preferably, the step of selecting the routeing record comprises the step of identifying one of the routeing records that comprises information that

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corresponds to the label assigned to the unit of data, and additional information which corresponds to application information contained in the unit of data to thereby select the routing record.

5

Preferably, the application information contained in the unit of data comprises an identification of a computing device from which the unit of data originated.

10

Preferably, the step of forwarding the unit of data over the path comprises the step of arranging the unit of data such that it identifies the path.

15

Preferably, the path is one of a plurality of paths in the network wherein the paths comprises a tunnel in the network and a non-tunnel path in the network.

Preferably, the network is a packet switched network.

20

Preferably, the unit of data comprises an IP packet.

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According to a fifth aspect of the present invention, there is provided a computer program comprising at least one instruction for causing a computing device to carry out the method according to the second and/or fourth aspect of the present invention.

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According to a sixth aspect of the present invention, there is provided a computer readable medium comprising the computer program according to the fifth aspect of the present invention.

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BRIEF DESCRIPTION OF THE DRAWINGS

Notwithstanding any other embodiments that may

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fall within the scope of the present invention, an embodiment of the present invention will now be described, by way of example only, with reference to the accompanying figures, in which:

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figure 1 provides a schematic diagram of a network according to the embodiment of the present invention;

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figure 2 provides a representation of a device for routeing units of data in the network of figure 1;

figure 3 shows an example of routeing tables maintained by the device of figure 2;

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figure 4 provides an example of a network in accordance with another embodiment of the present invention; and

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figure 5 provides a flow chart of various steps performed by the networks of figures 1 and 4.

figure 6 provides another flow chart of various steps performed by the networks of figures 1 and 4

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AN EMBODIMENT OF THE INVENTION

Figure 1 depicts a shared computer network 101 that can be used to run Latency Driven Distributed (LDD) applications. The network 101 comprises a plurality of
30 geographically dispersed sub-networks 103. For example, the sub-networks 103 may be located in different countries and maintained by different organisations. The sub-networks 103 are sometimes referred to as intranets. Each sub-
35 networks 103 comprises one or more computer servers 105 and a device 107 that is operable to route data packets between the sub-networks 103. Each device 107, which is commonly

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referred to as a gateway, router or switch is in the form of an electronic device dedicated to routeing data packets. To exchange a data packet with each other the computer servers 105 and the device 107 in each sub-network 103 are
5 networked together using, for example, high speed Ethernet. To enable data packets to be routed between the sub-networks 103 the network 101 also comprises a plurality of links 109 that can be established to connect adjacent devices 107 the devices 107 to route (exchange) data
10 amongst each other. The links 109 can be in the form of 'best effort' (no service level agreement) or tunnels or VPN's that provide a required level of service.

Before deploying an LDD application in the
15 network 101 the LDD application provider approaches the operators of a number of the sub-networks 103 to hire some of the capacity of the computer servers 105 and switching resources in the devices 107. Typically, the application provider will only approach those operators who control a
20 sub-network 103 in a geographic location that the application provider wishes to have application processing capacity. The computer servers 105 are such that the operator of the respective sub-networks 103 can configure the hired capacity as virtual servers for exclusively
25 running the application provider's LDD applications. The application provider then establishes the links 109 that interconnect the devices 107 in the sub-networks 103 that the application provider has virtual servers. For instance, if the application provider has virtual servers in sub-
30 networks 103a 103c and 103d the application provider may hire bandwidth assured links 109b and 109d from network providers.

Alternatively, the application provider may
35 choose to hire bandwidth assured links 109b and 109d and establish a best effort link 9h between sub-networks 103a and 103d. The link 109c will be used where delay in

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routeing a packet does not matter. The application provider or network service provider establishes the necessary links 109 so that data packets can be transferred to the appropriate virtual servers for processing by the LDD application running thereon.

As mentioned previously, the network 101 comprises the device 107, which performs routeing of data packets. More specifically, the devices 107 are arranged to perform the task of routeing the data packets for delivery to the appropriate virtual server running the LDD application. With reference to figure 2, each of the devices 107 has a first interface 211 and a second interface 213. The first interface 211 is capable of supporting a number of IP tunnels over a link 109. In the previous example where the application provider has virtual servers in sub-networks 103a and 103c, the IP tunnels would be supported by link 9b. In addition to supporting IP tunnels, the first interface 211 is also capable of supporting non-tunnel best effort IP connections. The second interface 213 is basically connected to the virtual servers that may be operating in the respective sub-networks 103.

Each of the devices 107 also comprises a routeing process (not shown in the figures). Generally speaking, the routeing process is capable of routeing data packets received on the first interface 211 (that is, data packets received via the IP tunnels or non-tunnel IP connection) based on an identity of the IP tunnel over which the first interface 211 received the data packets. As is elaborated on in the following paragraphs, the routeing process in each of the devices 107 determines the identity of the IP tunnel by examining a forwarding label (tunnel identifier) contained in a field of the data packets received on the first interface 211. In the present embodiment of the invention the forwarding label is in the form a destination

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IP address of the packets received on the first interface 211. The IP address could also identify an IP in IP tunnel. It is envisaged that in an alternative embodiment of the present invention the forwarding label could also be
5 another identifier in the packet header or payload. In this regard, the forward label could be the "flow label" identifier in an IPv6 packet. The routeing process is such that it involves selecting one of the IP tunnels or non-tunnel IP connections based on the identify of the IP
10 tunnel over which the data packets were received, and forwarding the received data packets over the selected IP tunnels or non-tunnel IP connection. Alternatively, the routeing process can involve the received data packets being forwarded onto a virtual server via the second
15 interface 213 for processing by the LDD applications running thereon.

To increase the level of granularity in the routeing process's ability to route data packets, the
20 devices 107 can also route data packets based on application information. Thus, the device 107 effectively performs tunnel level switching (as described in the previous paragraph) and application level switching. To determine the application information the routeing process
25 in a device 107 checks an application label that is contained in received data packets. In the case of the present embodiment of the invention the application information is effectively a unique identifier of a device from which the data packet originated.

30

The advantage of having the devices 107 route data packets based on the forwarding labels (the identification of the IP tunnels) and the application labels (application related information) is that the
35 application provider has the ability to control Quality of Service (QoS), implement multicast, deploy efficient session redirection and flow re-routeing as well as packet

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filtering and similar services between the virtual servers without burdening the virtual servers with network level functions.

5 In order to forward the data packets based on the forwarding labels and the applications labels, each of the devices 107 maintains a forwarding label table, an example of which is shown in figure 3. The forwarding label table contains an incoming forwarding label FL_i , an outgoing
10 forwarding label FL_o and a link to an application forwarding table. Whilst not shown in the forwarding table of figure 3, it is envisaged that the forwarding table could also comprises an Application Label Offset and an Application Label Mark. These two components of the
15 forwarding table can effectively be used to locate the application label in received data packets. More specifically, the Application Label Offset represents the number of bytes from the start of a received data packet at which the application label is located. The Application
20 Label Mask is then used to calculate the application label by applying the Application Label Mask to data which is contained at the Application Label Offset.

Each application provider has their own
25 application forwarding table. If the link to the application forwarding table is empty then the routeing process will route data packets based on information contained in the forwarding label table. If on the other hand the link to the application forwarding table is not
30 empty then the routeing process will route data packets based on information contained in the application forwarding table. An example application forwarding table is also shown in figure 3. The application forwarding table contains an incoming forwarding label FL_i , an incoming
35 application label AL_i , an outgoing application label AL_o and an outgoing forwarding label FL_o .

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Data packets forwarded to virtual servers from client devices will initially arrive at one of the devices 107. These received data packet may or may not have a forwarding label. Typically, the data packets would arrive
5 by the normal routeing process in the network 101. In order to forward data packets of this nature each of the devices 107 maintains an ingress mapping table, an example of which is shown in figure 3. The ingress mapping table contains a destination IP address prefix (of one of the computer
10 servers 105 which is supporting the virtual server) in the form of an address and bit mask, a forwarding label FL_o and a link to an application forwarding table. If the destination address of a data packet matches an entry in the ingress mapping table then the routeing process assigns
15 a forwarding label FL_o to the data packet. The routeing process then routes the data packet based on information contained in the application forwarding table which is pointed to by the "App Table" field in the ingress mapping table. If the "App Table" is empty the data packet will be
20 routed directly to the tunnel identified by FL_o .

The devices 107 are arranged such that the application providers can alter the various labels contained in the tables maintained by the devices 107. It
25 is noted that the devices 107 are such that application providers can only alter tables and labels that are associated with them and can not alter tables or use labels associated with other application providers. To enforce this aspect, each of the devices 107 comprises an
30 application program interface (API) called the Network Abstraction Layer, which can be seen in figure 2. The network abstraction layer hides the actual values of the forwarding labels used by the application providers and ensures that application providers can only change label
35 table entries that belong to them. Furthermore, as mentioned earlier each of the devices 107 maintains a separate application label table for each different

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application provider.

The following provides an example of how the network 101 provides a rich immersive communications environment within a massively multi-player game or a distributed virtual environment. For the purposes of this example the LDD application provides an individual three-dimensional audio scene for each player of all other players within earshot. The example describes: (1) labelling of packets with application labels at the client; (2) the use of forwarding labels to create tunnel switched paths; (3) application level control of forwarding using application labels within the network; and (4) application control over quality of service.

It is assumed that application provider A has hired virtual servers at the sites S^1 to S^7 as shown in Figure 4. A small subset of the clients ($C_A...C_H$) of the rich immersive communication service is examined. Figure 4 (a) shows the location of these users in the virtual world and their spatial location with respect to Avatar A. Two areas are defined as the hearing range of an avatar as well as an interactive zone (where interactive communication is likely with other avatars). A low delay is required from other sources within the interactive zone and a higher delay can be tolerated from sources outside the interactive zone. The physical location of the "owners" of the avatars in relation to a subset of the hired servers is shown in Figure 4(b). The best position to calculate the audio scene for the area of the virtual world which contains these users is calculated by the application provider (possibly as a compromise between delay and resource usage) to be in San Francisco in server S^3 . It is assumed that servers S^1 and S^7 shown in Figure 4(c) maintain the formal label tables and ingress mapping tables shown in figure 3.

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For this application a unique avatar ID is assigned to each client. Client C_A is assigned avatar ID A, C_B is assigned avatar ID B etc. This avatar ID is useful for the application to route audio flows to the correct server and to determine the required quality of service to give to each flow. Because of its usefulness, the application provider uses this value for the application label. Thus each client sets the application label of each audio packet to their avatar ID. Other types of flows such as state information may be labelled differently.

In order to send audio packets from the client node C_D through the network 101 to server S^3 they are encapsulated in an IP-in-IP tunnel with the address of server S^7 in the outside IP header and the address of S^3 in the inside header. When the packet arrives at S^7 the encapsulation is removed and the packet is forwarded based on the ingress mapping tables S^7 . In this case, since D is within the interactive zone of A a low delay link is required. The packet is given a forwarding label of a and is then forwarded by application provider A 's forwarding table. The forwarding label will be swapped from a to b and will be forwarded to S^1 . At S^1 the packet will be switched from tunnel b to tunnel c on the way towards S^3 .

Packets arriving at S^7 from C_B will also be switched to S^3 . However, the application decides to send the stream on a higher delay path (since avatar B is just at the edge of avatar A's hearing range). This is enabled by placing an entry for application label B in the application forwarding table in S^7 with an empty forwarding label out field (FL_o). This indicates that forwarding labels will be removed and the packets will be sent on an Internet routed path.

To keep this example simple references to multicast and other switch operations have been left out.

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The two level application/forwarding label switching operation is very powerful. Many operations can be performed within the overlay network based on the application label, flows may be dropped, re-routed, or
5 multicast based upon network conditions or changes in the game requirements (a flow may not require a low delay link at this point in time).

The various steps performed by the network 104
10 are shown in the flow charts 501 and 601 of figures 5 and 6.

Those skilled in the art will appreciate that the invention described herein is susceptible to variations and
15 modifications other than those specifically described. It should be understood that the invention includes all such variations and modifications which fall within the spirit and scope of the invention.

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WE CLAIM:

1. A device for routeing a unit of data in a network, the device comprising a processing means that is operable to:

determine an identity of a first path in the network that was used to transfer the unit of data;

identify a second path in the network based on the identity of the first path; and

forward the unit of data over the second path to thereby route the unit of data in the network.

2. The device as claimed in claim 1, wherein the processing means is operable to identify the second path by:

selecting a routeing record from one or more first routeing records;

determining whether the routeing record contains a reference to one or more second routeing records;

identifying the second path by examining the routeing record if it is determined that the routeing record does not contain the reference; and

upon determining that the routeing record contains the reference: selecting another routeing record from the second routeing records; and identifying the second path by examining the other routeing record.

3. The device as claimed in claim 2, wherein the processing means is operable such that when selecting the routeing record from the first routeing records the processing means identifies one of the first routeing records that comprises information that corresponds to the identity of the first path to thereby select the routeing record.

4. The device as claimed in any one of the preceding claims, wherein the processing means is operable

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such that when selecting the other routeing record from the second routeing records it identifies one of the second routeing records which comprises the information that corresponds to the identity of the first path, and
5 additional information that corresponds to application information contained in the unit of data to thereby selecting the other routeing record.

5. The device as claimed in claim 4, wherein
10 the application information contained in the unit of data comprises an identification of a computing device from which the unit of data originated.

6. The device as claimed in any one of the
15 preceding claims, wherein the processing means is operable to determine the identity of the first path by examining the unit of data.

7. The device as claimed in any one of the
20 preceding claims, wherein the processing means is operable such that when forwarding the unit of data over the second path it arranges the unit of data such that it identifies the second path.

8. The device as claimed in any one of the
25 preceding claims, wherein the first path comprises a tunnel in the network.

9. The device as claimed in any one of the
30 preceding claims, wherein the second path is one of a plurality of second paths in the network, wherein the second paths comprising another tunnel in the network and a non-tunnel path in the network.

10. The device as claimed in any one of the
35 preceding claims, wherein the network is a packet switched network.

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11. The device as claimed in any one of the preceding claims, wherein the unit of data comprises an IP packet.

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12. A method of routeing a unit of data in a network, the method comprising the steps of:

determining an identity of a first path in the network that was used to transfer the unit of data;

10 identifying a second path based on the identity of the first path; and

forwarding the unit of data over the second path to thereby route the unit of data.

15

13. The method as claimed in claim 12, wherein the step of identifying the second path comprises the steps of:

selecting a routeing record from one or more first routeing records;

20

determining whether the routeing record contains a reference to one or more second routeing records;

identifying the second path by examining the routeing record if it is determined that the routeing record does not contain the reference; and

25

upon determining that the routeing record contains the reference: selecting another routeing record from the second routeing records; and identifying the second path by examining the other routeing record.

30

14. The method as claimed in claim 13, wherein the step of selecting the routeing record from the first routeing records comprises the step of identifying one of the first routeing records that comprises information that corresponds to the identity of the first path to thereby
35 select the routeing record.

15. The method as claimed in claim 13 or 14,

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wherein the step of selecting the other routeing record from the second routeing records comprises the step of identifying one of the second routeing records that comprises the information that corresponds to the identity
5 of the first path, and additional information that corresponds to application information contained in the unit of data to thereby select the other routeing record.

16. The method as claimed in claim 15, wherein
10 the application information contained in the unit of data comprises an identification of a computing from which the unit of data originated.

17. The method as claimed in any one of claims
15 12 to 16, wherein the step of determining the identity of the first path comprises the step of examining the unit of data.

18. The method as claimed in any one of claims
20 12 to 17 wherein the step of forwarding the unit of data over the second path comprises the step of arranging the unit of data such that it identifies the second link.

19. The method as claimed in any one of claims
25 12 to 18, wherein the first path comprises a tunnel in the network.

20. The method as claimed in any one of claims
30 12 to 19, wherein the second path is one of a plurality of second paths in the network wherein the second paths comprise another tunnel in the network and a non-tunnel path in the network.

21. The method as claimed in any one of claims
35 12 to 20, wherein the network is based on packet switching.

22. The method as claimed in any one of claims

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12 to 21, wherein the unit of data comprises an IP packet.

23. A device for routeing a unit of data in a network, the device comprising a processing means operable to:

5 determine a destination of the unit of data;
 assign the unit of data a label based on the destination of the unit of data;
 select a routeing record from one or more
10 routeing records based on the label; and
 forward the unit of data over a path identified in the routeing record.

24. The device as claimed in claim 23, wherein
15 the processing means is operable to select the routeing record by identifying one of the routeing records that comprises information that corresponds to the label assigned to the unit of data, and additional information that corresponds to application information contained in
20 the unit of data to thereby select the routeing record.

25. The device as claimed in claim 24, wherein the application information contained in the unit of data comprises an identification of a computing device from
25 which the unit of data originated.

26. The device as claimed in any one of claims 23 to 25, wherein the processing means is operable such that when forwarding the unit of data over the path it
30 arranges the unit of data such that it identifies the path.

27. The device as claimed in any one of claims 23 to 26, wherein the path is one of a plurality of paths in the network, wherein the paths comprises a tunnel in the
35 network and a non-tunnel path in the network.

28. The device as claimed in any one of claims

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23 to 27, wherein the network is a packet switched network.

29. The device as claimed in any of claims 23 to 28, wherein the unit of data comprises an IP packet.

5

30. A method for routeing a unit of data in a network, the method comprising the steps of:

determining a destination of the unit of data;

10 assigning the unit of data a label based on the destination of the unit of data;

selecting a routeing record from one or more routeing records based on the label; and

forwarding the unit of data over a path identified in the routeing record.

15

31. The method as claimed in claim 30, wherein the step of selecting the routeing record comprises the step of identifying one of the routeing records which comprises information that corresponds to the label
20 assigned to the unit of data, and additional information that corresponds to application information contained in the unit of data to thereby select the routeing record.

20

32. The method as claimed in claim 31, wherein the application information contained in the unit of data
25 comprises an identification of a computing device from which the unit of data originated.

25

33. The method as claimed in any one of claims 30 to 32, wherein the step of forwarding the unit of data over the path comprises the step of arranging the unit of data such that it identifies the path.

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34. The method as claimed in any one of claims 30 to 33, wherein the path is one of a plurality of paths in the network, wherein the paths comprising a tunnel in the network and a non-tunnel path in the network.

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35. The method as claimed in any one of claims 30 to 34, wherein the network comprises a packet entitled network.

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36. The method as claimed in any one of claims 30 to 35, wherein the unit of data comprises an IP packet.

10 37. A computer program comprising at least one instruction for causing a computing device to carry out the method as claimed in any one of claims 12 to 22 and 30 to 36.

15 38. A computer readable medium comprising the software as claimed in claim 37.