ABSTRACT

In a Synchronous Digital Hierarchy (SDH) based communications network comprising

a plurality of Intermediate Systems (IS), the IS being divided between at least one IS-IS

Area and at least one non-IS-IS Area, an IS-IS Area being an area with which a routeing

5   protocol forming part of the Network Layer (Layer 3) of the Open Systems

Interconnection including routeing (OSI), is provided for routeing messages between

areas, including routeing means, whereby where a message is routed from an IS-IS Area

to a destination IS within a non-IS-IS Area and the connection to the destination IS is

broken, and as a result a message is returned from the non-IS-IS Area to the originating

10   IS-IS Area connection to the destination IS is made by a second choice connection.

P/OO/O11
Regulation 3.2

AUSTRALIA

Patents Act 1990

ORIGINAL

COMPLETE SPECIFICATION

STANDARD PATENT

Invention Title: RAP ALTERNATE ROUTEING FOR ISO 10589

The following statement is a full description of this invention, including the best method of performing it known to us:

GH REF: P20319-BF:TJS:RK

RAP ALTERNATE ROUTEING FOR ISO 10589

Synchronous Digital Hierarchy (SDH) equipment is the latest generation of equipment that is used to provide high bandwidth communications capabilities for use between telephone exchanges and in other areas where high quality telecomms is required 5 (broadcast video distribution, etc). Embedded within the traffic 'traffic' carrying capability of the equipment are data communications channels (DCCs). These channels constitute a datacomms network that uses OSI protocols.

Each piece of equipment constitutes a routeing node in the datacomms network formed 10 by the data channels, and can operate any one of a number of different routeing methods. The present invention is concerned with the interworking of two of the possible routeing method.

The two routeing methods that will commonly occur in SDH networks are IS-IS (ISO 15 10589) and quasi-static routeing (where alternate routes may be chosen on link failure). Where this occurs, routeing loops, causing loss of communications can be caused. The present invention detects the formation of a routeing loop and changes the behaviour of the IS-IS node accordingly.

20 The IS-IS routeing protocol is one of a set of 'link state' dynamic routeing protocols. These protocols automatically distribute routeing information round the datacomms network, allowing nodes to learn the required routeing information from the actual network. This provides the ability to automatically reconfigure, allowing routeing round network faults, in case of network link failure.

The IS-IS routeing protocol has two routeing levels, Level-1 and Level-2. See Figure 2 (from ISO 10589) for the use of these levels and the general environment of this protocol and the topologies and systems supported by Intradomain Routeing.

5   The present invention is also applicable to other datacomms scenarios, where a dynamic routeing protocol is interworked with static routeing, or a different dynamic protocol (e.g. OSPF and static routes, etc).

In a first aspect, the present invention provides a Synchronous Digital Hierarchy (SDH)
10   based communications network comprising a plurality of Intermediate Systems (IS), the ISs being divided between at least one IS-IS Area and at least one non-IS-IS Area, an IS-IS Area being an area with which a routeing protocol forming part of the Network Layer (Layer 3) of the Open Systems Interconnection including routeing (OIS), is provided for routeing messages between areas, including routeing means, whereby
15   where a message is routed from an IS-IS Area to a destination IS within a non-IS-IS Area and the connection to the destination IS is broken, and as a result a message is returned from the non-IS-IS Area to the originating IS-IS Area connection to the destination IS is made by a second choice connection.

20   There is further provided a method for use in Synchronous Digital Hierarchy (SDH) based communications network comprising a plurality of Intermediate Systems (IS), the IS being divided between at least one IS-IS Area and at least one non-IS-IS Area, wherein when a message is returned from the non-IS-IS Area to the originating IS-IS Area a second choice connection to the destination IS is made.

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In a second aspect, the present invention provides a method, for use in a Synchronous Digital Hierarchy (SDH) based communications network, which network comprises a

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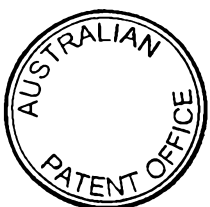
plurality of Data Communications Channels embedded within the communications network and a plurality of Intermediate Systems (IS), the IS being divided between at least one IS IS Area and at least one non-IS-IS Area, an IS-IS Area being an area within which a routing protocol, as specified in ISO10589. forming part of the Network Layer

5   (Layer 3) of the Open Systems Interconnection including routing (OSI), is provided for routing messages between areas and includes routing means, there being a plurality of connections between an IS-IS Area and a non-IS-IS Area, comprising the steps of:

a)   where the connection to a destination IS within a non-IS-IS Area is broken within the non-IS-IS Area returning a message to the IS-IS Area;

10   b)   making a connection to the destination IS via a further one of the plurality of connections between the originating IS-IS Area and the non-IS-IS Area.

Preferably, the returned message is received by the IS-IS Area from the non-IS-IS Area

15   by an Internal RAP Route having been sent to the non-IS-IS Area by an Internal RAP Route, the further one of the plurality of connections is by an External RAP Route.

The invention will now be described by way of example, with reference to the accompanying drawings, in which;

Figure 1 is a routeing diagram illustrating the invention; and

5   Figure 2 illustrates the ISO 10589 Level 1 and Level 2 IS-IS routeing protocols.

References:

[1]   ISO/IEC 10589 : 1992 (E)

       Information technology -

10   Telecommunications and information exchange between systems -

       Intermediate systems to Intermediate system intra-domain routeing information

       exchange for use in conjunction with the protocol for providing the

       connectionless-mode Network Service (ISO 8473).

15   Glossary:

Area - An IS-IS Level routeing subdomain

ES - End System - These systems deliver NPDUs to other systems and receive NPDUs

from other systems, but do not relay NPDUs

External RAP Route A RAP Route derived from a RAP with metric type *External*

20   *Internal RAP Route* A RAP Route derived from a RAP with a metric type *Internal*

IS - Intermediate System (a node where data may be routed on to another IS or to an

End System (ES))

IS-IS - The IS to IS intra-domain routeing protocol as specified in ISO 10589.

NE - Network Element

NPDU - Network Layer Protocol Data Unit

NSAP - Network Service Access Point

OSI - Open Systems Interconnection

RAP - Reachable Address Prefix

5   *RAP Route* Route derived from a RAP (regardless of whether the RAP is configured

locally or on a remote *Router*)

Router An IS running IS-IS

Level 1 Intermediate Systems deliver and receive NPDUs from other systems, and relay

10   NPDUs from other source systems to other designation systems. They route directly to

systems within their own area, and route towards a Level 2 Intermediate system when

the destination system is in a different area.

Level 2 Intermediate Systems act as Level 1 Intermediate systems in addition to acting

15   as a system in the subdomain consisting of Level 2 ISs. Systems in the Level 2

subdomain route towards a destination area, or another routeing domain.

References to the routeing of NPDUs are made with regard to NPDUs destined for

NSAPs residing on NEs in the non-IS-IS subdomain.

20   References to routeing over *RAP Routes* (whether *Internal* or *External*) pertain to

routeing NPDUs, where the Address Prefix associated with the *RAP Route* is a prefix

of the destination NSAP of the NPDU.

Knowledge of reference ISO 10589 is assumed and reference is made to terms defined

in it. The *RAP Alternate Routeing* is an extension to IS-IS and resolves a problem when

interworking with non-IS-IS. Although the present invention was born out of an IS-IS

problem, it may have applications in other dynamic routeing protocols which use and

discriminate between static route entries when interworking with other routeing

5   protocols, whether dynamic, static or quasi-static.

IS-IS is a dynamic, link state based, routeing protocol which can be included as part of

the Network Layer (layer 3) of the OSI Reference Model. For the purpose of this

document, ISs running IS-IS will be termed *Routers*.

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Routers can participate in two levels or routeing:

i)   Level 1 -   For routeing within an *Area*

ii)   Level 2 -   For routeing between *Areas*

15   Level 2 *Routers* provide the ability to enter static routes to NEs (and subdomains of

NEs) which do not support IS-IS. These static routes are termed Reachable Address

Prefixes (RAP) and they can have a metric type of either *Internal* or *External*. A level

2 *Router,* with a configured RAP, propagates the details of the RAP within it's Level

2 link state information. Thus all Level 2 *Routers* gain information about all RAPs

20   configured with the Level 2 subdomain and calculate routes (*RAP Routes*) accordingly.

When routeing decisions are made, *Internal RAP Routes* are selected in preference to

External RAP Routes.

Since the NEs within the non-IS-IS subdomain do not propagate ISO 10589 link state

information, the *Routers* cannot determine the state of routes beyond the boundary of the IS-IS subdomain. This means there is no way to monitor complete end-to-end routes which terminate in, or are routed through, the non-IS-IS subdomain.

5   There are two problems with this situation:

i)   The inability to provide a second (back-up) route for resilience;

ii)   The possibility of forming routeing loops when certain links in the non-IS-IS subdomain break (i.e. a *Router* may route NPDUs into the non-IS-IS subdomain and the non-IS-IS NEs may route the NPDUs back into the IS-IS subdomain).

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RAP Alternate Routeing provides resilience when RAPs are used in a mixed routeing environment (i.e. to provide routes into non-IS-IS subdomains) by enabling automatic control of a second choice static route to non-IS-IS equipment. This makes uses of the two different metric types possible with RAPs (*Internal* and *External*) and will require

15   one of each to be configured within the IS-IS subdomain.

The two problems i) and ii) above can be solved by selecting *External RAP Routes* when an NPDU is received on an *Internal RAP Route* and the originally selected outgoing route is an *Internal RAP Route*. By performing this function, *Internal RAP Routes* can

20   be viewed as **primary** *RAP Routes and External RAP Routes* as **secondary** *RAP Routes*. Provision of this secondary route can provide resilience and can avoid routeing loops if the RAPs are configured correctly. A more detailed explanation is given below.

When a message (NPDU) is received on a circuit *C* associated with an *Internal RAP*

Route and the selected outgoing route is an *Internal RAP Route*, the Routeing Table is searched for another *RAP Route* (i.e. a RAP Route other than the *Internal RAP Route* associated with circuit *C*). The two *Internal RAP Routes* can be different if the IS-IS parameter **maximum Path Splits** is set to 2. *External RAP Routes* are selected in preference to *Internal RAP Routes*. If no other *RAP Route* exists then the original *RAP Route* is selected (an NPDU forwarded on this route will probably loop and timeout in the network). The message is then forwarded on the circuit associated with the selected route.

This mechanism provides alternate routeing on a packed-by-packet basis. It does not change the state of the RAPs and hence does not advertise the fact that an alternate route has been used to the rest of the network. As soon as the non-IS-IS subdomain is repaired (i.e. it does not route NPDUs back into the IS-IS subdomain), the *RAP Alternate Routeing* will cease to be invoked, so the best available route will always be used.

As an example, referring to Figure 1, an NPDU from node 1 and destined for node 7 will be routed to node 2, on to node 3 and on to node 4 (since 3 has an *Internal RAP* to the non-IS-IS Routeing Domain).

It is necessary to make assumptions about the routeing in the non-IS-IS domain It is assumed that node 4 will route the NPDU to node 5 and that node 5 has no choice (because the link between nodes 5 and 7 is broken) and so routes the NPDU back to node 4. Also assume that node 4, now realising that a route to node 7 via node 5 does

not exist, routes the NPDU back to node 3.

The actual mechanism of the routeing within the non-IS-IS domain is not significant, the key to invoking the *RAP Alternate Routeing* is that an NPDU, destined for the non-

5   IS-IS domain, returns to the IS-IS domain on a link, where a RAP to the non-IS-IS domain is configured.

The original IS-IS protocol will force node 3 to route the NPDU back into the non-IS-IS domain via node 4. At this point a probable routeing loop has occurred and the NPDU

10   will expire (due to lifetime decay) within the network.

With *RAP Alternate Routeing* node 3 will detect that it is receiving a NPDU on a link which it should use to route the packet. It will detect that this link is an *Internal RAP Route* for the non-IS-IS domain and will invoke *RAP Alternate Routeing*. Node 3 will

15   then route the NPDU to node 2 (i.e. on the *External RAP Route*).

Node 2 will receive the NPDU on an *Internal RAP Route* and will route the NPDU to 6 (i.e. on the *External RAP Route*).

20   Node 6 will receive the NPDU on an *Internal RAP Route* and will route the NPDU to 7 (i.e. on the *External RAP Route*).

Node 7 is the destination for the NPDU. Thus the routeing loop described above has been avoided and the NPDU has reached it's destination.

It is to be understood that, if any prior art publication is referred to herein, such reference does not constitute an admission that the publication forms a part of the common general knowledge in the art, in Australia or any other country.

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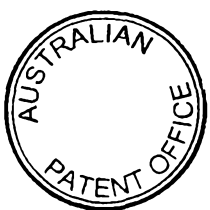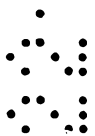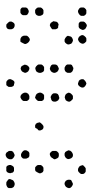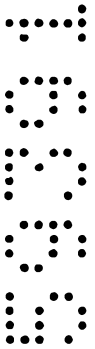
CLAIMS

1.   A Synchronous Digital Hierarchy (SDH) based communications network comprising a plurality of Data Communications Channels embedded within the communications network and a plurality of Intermediate Systems (IS), the Intermediate Systems being divided between at least one IS-IS Area and at least one non-IS-IS Area, an IS-IS Area being an area within which a routing protocol, as specified in ISO10589, forming part of the Network Layer (Layer 3) of the Open Systems Interconnection and wherein routing (OSI), is provided for routing messages between areas and includes routing means, there being a plurality of connections between an IS-IS Area and a non-IS-IS Area, whereby where a message is routed from an IS-IS Area to a destination IS within a non-IS-IS Area and the connection to the destination IS is broken within the non-IS-IS Area, and as a result the message is returned from the non-IS-IS Area to the originating IS-IS Area, then a connection to the destination IS is made by a further one of the plurality of connections between the originating IS-IS Area and the non-IS-IS Area.

2.   An SDH network as claimed in Claim 1, the routing means being arranged so that where the returned message is received by the IS-IS Area from the non-IS Area by an Internal Reachable Address Prefix (RAP) Route having been sent to the non-IS-IS Area by an Internal RAP Route, the further one of the plurality of connections is by an External RAP Route.

3.   An SDH network as claimed in Claim 1, comprising routing means substantially as hereinbefore described with reference to Figures 1 and 2.
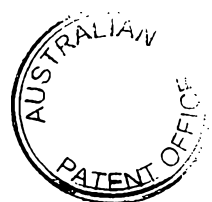
4.   A method, for use in a Synchronous Digital Hierarchy (SDH) based communications network, which network comprises a plurality of Data Communications Channels embedded within the communications network and a plurality of Intermediate Systems (IS), the IS being divided between at least one IS IS Area and at least one non-IS-IS Area, an IS-IS Area being an area within which a routing protocol, as specified in ISO10589. forming part of the Network Layer (Layer 3) of the Open Systems Interconnection including routing (OSI), is provided for routing messages between areas and includes routing means, there being a plurality of connections between an IS-IS Area and a non-IS-IS Area, comprising the steps of:

a)   where the connection to a destination IS within a non-IS-IS Area is broken within the non-IS-IS Area returning a message to the IS-IS Area;

b)   making a connection to the destination IS via a further one of the plurality of connections between the originating IS-IS Area and the non-IS-IS Area.

5.   A method as claimed in Claim 4, wherein where the returned message is received by the IS-IS Area from the non-IS-IS Area by an Internal RAP Route having been sent to the non-IS-IS Area by an Internal RAP Route, the further one of the plurality of connections is by an External RAP Route.

6.   A method as claimed in Claim 4, and substantially as hereinbefore described, with reference to and as illustrated in Figures 1 and 2.
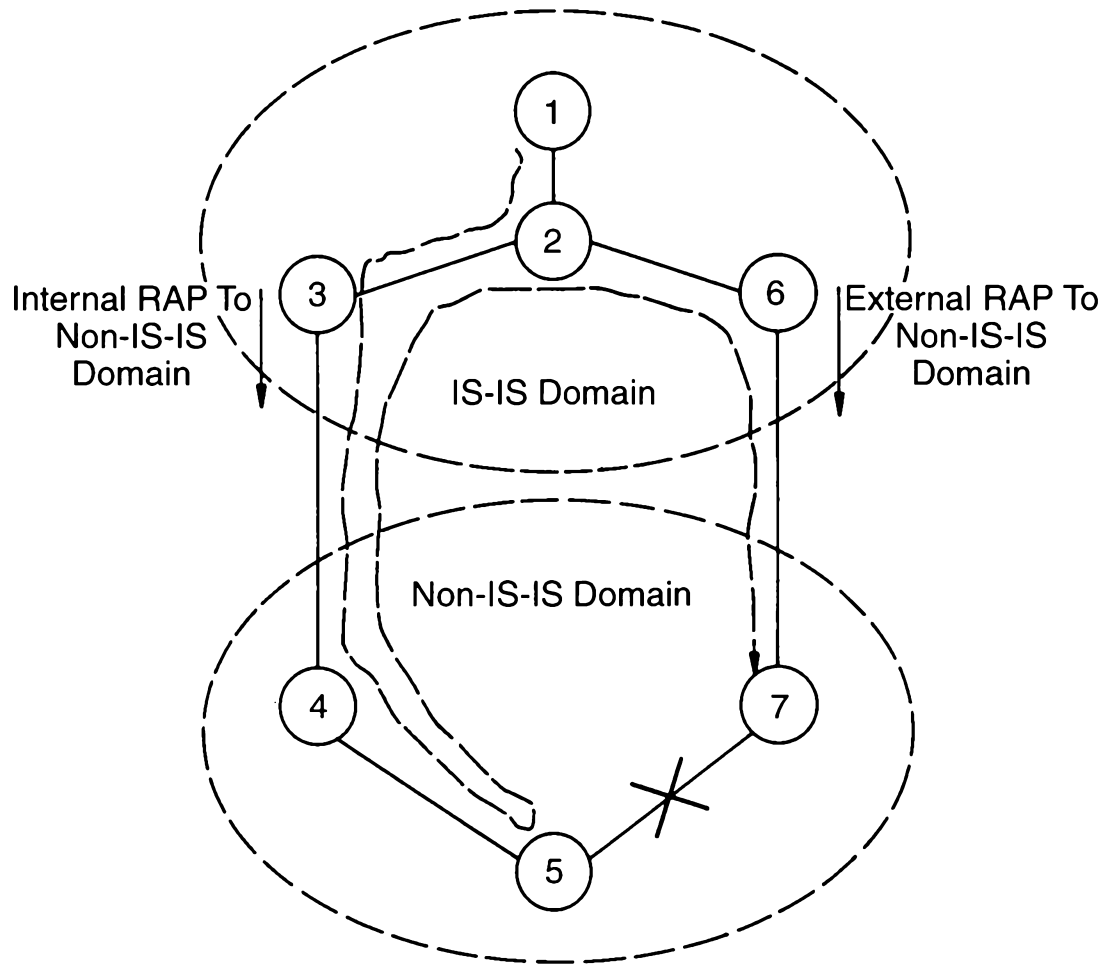
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Fig.1.

Internal RAP To
Non-IS-IS
Domain

IS-IS Domain

External RAP To
Non-IS-IS
Domain

Non-IS-IS Domain

Legend

↷→ NPDU Path

Ⓧ NE Node x

✗ Link Break

◯ Routeing Domain

Fig.2.

ES End System   IS Intermediate System

······· ES-IS Protocol   —— Subnetwork Path

--- Level 1 IS-IS Routeing   ⊂⊃ IS-IS Area

—— Level 2 IS-IS Routeing   ⊂⊃ Routeing Domain Boundary

--- Interdomain Routeing