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SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE AND INTERNET PROTOCOL ASPECTS

Internet protocol aspects – Operation, administration and maintenance

Generalized automatic discovery techniques

ITU-T Recommendation G.7714/Y.1705

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ITU-T Recommendation G.7714/Y.1705

Generalized automatic discovery techniques

Summary

This Recommendation provides the generic attributes, state diagram and message sets for the automatic discovery process.

Source

ITU-T Recommendation G.7714/Y.1705 was prepared by ITU-T Study Group 15 (2001-2004) and approved under the WTSA Resolution 1 procedure on 29 November 2001.

Keywords

Auto-discovery, Layer Adjacency Discovery, Physical Media Adjacency Discovery, Service Capability Exchange.

FOREWORD

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NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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ITU-T Recommendation G.7714/Y.1705

Generalized automatic discovery techniques

1 Scope

This Recommendation describes the specifications for automatic discovery techniques to aid resource management and routing. Other areas such as connection operations, routing of connections within a switched network, are not part of this specification.

In this Recommendation, two major instances of discovery are addressed:

a) layer adjacency discovery;

b) physical media adjacency discovery.

In addition the results of either discovery processes are also used for establishing logical adjacencies between control entities.

2 References

The following ITU-T Recommendations and other references contain provisions, which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

– ITU-T G.805 (2000), *Generic functional architecture of transport networks.*

– ITU-T G.806 (2000), *Characteristics of transport equipment – Description methodology and generic functionality.*

– ITU-T G.852.2 (1999), *Enterprise viewpoint description of transport network resource model.*

– ITU-T G.853.1 (1999), *Common elements of the information viewpoint for the management of a transport network.*

– ITU-T M.3100 (1995), *Generic network information model.*

3 Terms and definitions

This Recommendation makes uses of the following terms defined in other ITU-T Recommendations.

Access Point (AP)	See ITU-T G.805
Connection Termination Point (CTP)	See ITU-T M.3100
Link	See ITU-T G.852.2 and G.853.1
Link Connection	See ITU-T G.852.2 and G.853.1
Network Connection	See ITU-T G.805
Port	See ITU-T G.805
Subnet Termination Point Pool	See ITU-T G.852.2 and G.853.1
Trail	See ITU-T G.852.2 and G.853.1
Trail Termination Point (TTP)	See ITU-T M.3100

4 Abbreviations

This Recommendation uses the following abbreviations:

AP	Access Point
CELA	Control Entity Logical Adjacency
CTP	Connection Termination Point
Id	Identifier
LAD	Layer Adjacency Discovery
LC	Link Connection
NC	Network Connection
NE	Network Element
PMAD	Physical Media Adjacency Discovery
Rx	Receive
SCE	Service Capability Exchange
SNTP	Subnetwork Termination Point
TTP	Trail Termination Point
Tx	Transmit
UNI	User Network Interface

5 Conventions

SNTP: For the purposes of this Recommendation, the SNTP is used as a port on a subnetwork. SNTP may be used as an alias to a CTP or TTP. It is understood to have an assigned identifier that would be used for the purposes of routing and resource management.

6 Instances of discovery

6.1 Layer adjacency discovery

Layer Adjacency Discovery can be described as a process that is used for deriving an association between two SNTPs that form a link connection in a particular layer network. The association created through layer adjacency discovery is valid so long as the trail supporting the link connection is valid.

6.2 Physical media adjacency discovery

Physical media adjacency discovery can be described as a process that is used for verifying the physical connectivity (connected over fiber or any other physical media) between two ports on physical media adjacent network elements in the network. For example, physical media adjacency discovery can aid in improving inventory of network resources, verifying port characteristics of physically media adjacent network elements, etc.

6.3 Control entity logical adjacency establishment

Control Entity Logical Adjacency Establishment is the process of creating a logical adjacency between two control entities that control SNTPs that are associated through layer adjacency discovery.

7 Layer adjacency discovery

In clause 6, layer adjacency discovery was defined as the association between two SNTPs that form a link connection.

Layer adjacency discovery will be used for:

a) building layer network topology to aid routing decisions;

b) creating logical adjacencies between control entities; and

c) for identifying link connection endpoints for purposes of connection management.

Figure 7-1 shows an example scenario.

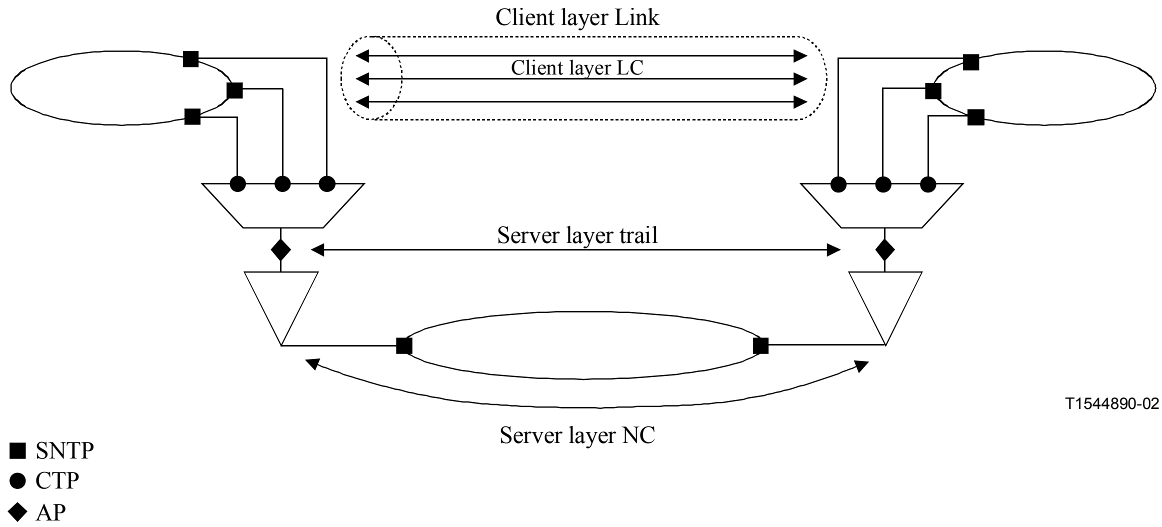

Figure 7-1/G.7714/Y.1705 – Layer adjacency discovery – Example

In this example, we have two APs that are associated over a server layer NC to form a trail at the server layer and this trail supports the association of three SNTPs in the client layer to form a client layer link composed of three LCs. The layer adjacency discovery process in this example associates the two SNTPs in the server layer (alias to the corresponding network TTPs) and the three SNTPs in the client layer (alias to the client layer CTPs). The purpose served by the server layer NC is to ensure the validity of the trail and hence the validity of the supported client layer LCs. Thus, the associations established at the two layers are valid only as long as the supporting server layer NC is valid.

For the discovery process to be effective in establishing the associations, it is necessary to provide suitable identification to the end points of the associations, i.e. SNTP IDs have to be assigned. Based on the application that uses the results of the discovery process, the SNTP IDs may be different, e.g.:

a) **Routing**: This requires knowledge of the layer network topology. The information relevant to the building of the topology are the links and link connection endpoint identifiers.

b) **Connection Management**: This requires knowledge of the CTPs that are associated with the SNTPs and the CTP IDs need to be discovered for this application. The CTP ID could be the same as the routing address or could be different, e.g. timeslot number, tributary number, etc.

Note that although SNTP-SNTP associations are referred to, as link connections, this has to be understood to be "potential link connections" because the SNTP-SNTP association becomes an LC only when CTPs that are bound to SNTP get instantiated.

Note that the SNTP-SNTP associations that exist over an UNI reference point may not be exposed to the user for security of operator proprietary information.

Although in the above example, it is mentioned that two discovery processes are used to identify the topology of the two layer networks, this is not necessary and methods shown in Annex A and Appendix I may be used to reduce the number of discovery tests.

7.1 SNTP control entity logical adjacency establishment

In this phase of discovery, a logical adjacency is established between control entities that control SNTPs that are associated via layer adjacency discovery. The procedures for establishing these adjacencies are beyond the scope of this Recommendation; however, for establishing these logical adjacencies it may be necessary to communicate the control entity identifiers as identification attributes as part of the layer adjacency discovery process. After the logical adjacency is established service capability exchange (described in Annex A) can take place.

8 Physical media adjacency discovery

In clause 6, physical media adjacency discovery is described as the process of verifying physical connectivity between two ports on physical media adjacent network elements. Depending on the physical packaging of the functions within a network element, different types of associations may need to be discovered as part of physical media adjacency discovery. This is illustrated in Figure 8-1.

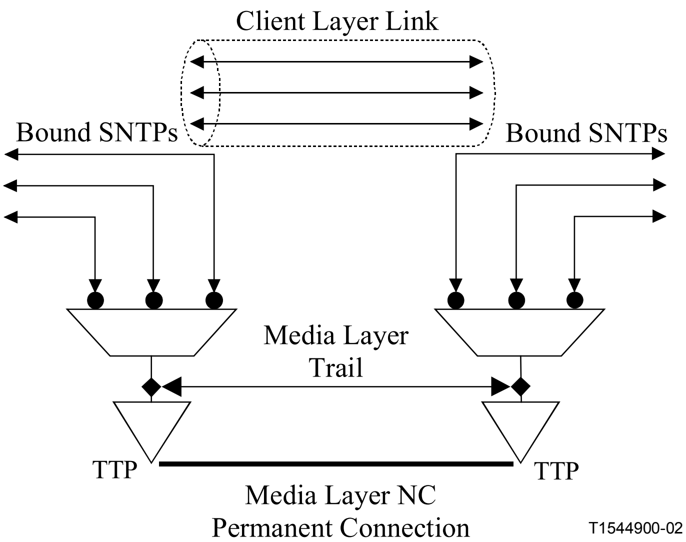

Figure 8-1/G.7714/Y.1705 – Physical media adjacency discovery – Example

In this example, there are two TTPs are associated through a media layer network connection which is a permanent connection (so long as there are no fault conditions on the media layer, e.g. fiber break). A media layer trail is supported over this media layer NC. The client layer link contains three link connections which are the associations between the instantiated CTPs or the bound SNTPs. If the bound SNTPs are contained within the same network element that contains the media layer termination function, then the SNTP to CTP association is internal to the network element and does not require any discovery tests to be performed. This is illustrated in Figure 8-2.

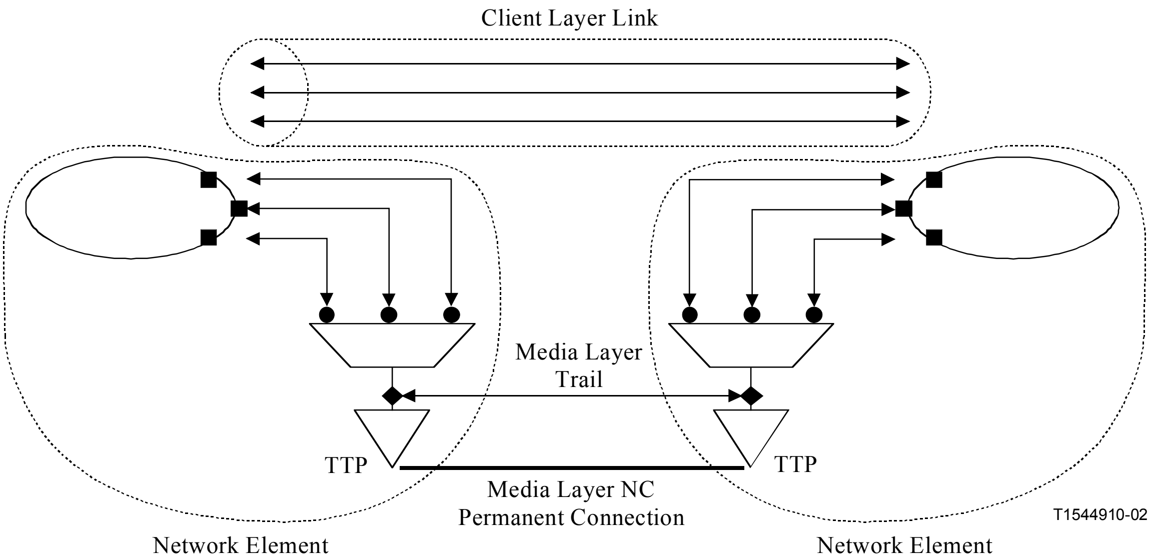

Figure 8-2/G.7714/Y.1705 – Physical media adjacency discovery when SNTPs and associated CTPs are contained within the same network element – Example

8.1 Port control entity logical adjacency establishment

In this phase of discovery, a logical adjacency is established between control entities that control ports that are associated via physical media adjacency discovery. The procedures for establishing these adjacencies are beyond the scope of this Recommendation; however, for establishing these logical adjacencies it may be necessary to communicate the control entity identifiers as identification attributes as part of the physical media adjacency discovery process. After the logical adjacency is established service capability exchange (described in Annex A) can take place.

9 Discovery attributes list

Attribute
LAD Attributes
A-end SNTP Id
B-end SNTP Id
A-end SNTPpool Id
B-end SNTPpool Id
A-end SNTP control entity Id
B-end SNTP control entity Id
PMAD Attributes
A-end Port Id
B-end Port Id
A-end Port control entity Id
B-end Port control entity Id

9.1 LAD Attributes

A-end SNTP Id	Identifier of near end SNTP of the association to be discovered.
B-end SNTP Id	Identifier of far end SNTP of the association to be discovered.
A-end SNTPpool Id	Identifier of near end SNTPpool of the association to be discovered.
B-end SNTPpool Id	Identifier of the far-end SNTPpool of the association to be discovered.
A-end SNTP control entity Id	Identifier of the control entity that controls the A-end SNTP.
B-end SNTP control entity Id	Identifier of the control entity that controls the B-end SNTP.

9.2 PMAD Attributes

A-end Port Id	Port Identifier for the A-end of the media layer association.
B-end Port Id	Port Identifier for the B-end of the media layer association.
A-end Port control entity Id	Identifier of the control entity that controls the A-end port. Note that this Port control entity identifier need not be the same as the SNTP control entity identifier used in the LAD attributes.
B-end Port control entity Id	Identifier of the control entity that controls the B-end port. Note that this Port control entity identifier need not be the same as the SNTP control entity identifier used in the LAD attributes.

10 Discovery message

The LAD and PMAD processes can be effected using a message based scheme which exchanges identity attributes. Note that neither the actual protocol specific attributes nor the protocol mechanisms are discussed here. There is no assumption made on whether the same or different protocols are needed for the different instances of discovery. The actual protocol may operate in either an acknowledged or unacknowledged mode. In the acknowledged mode the discovery message might carry the near end identity attributes and the acknowledgement can carry the far end identity attributes in response to the received near end attributes. Additionally, the service capability information may also be carried as part of the acknowledgement. In the unacknowledged mode either end send their respective identity attributes and service capability exchange is done at a different time. In either mode the messages are expected to be sent at least until the discovery process is completed. Clauses 10.1 and 10.2 show the attributes for an acknowledged discovery process.

10.1 HELLO: Discovery

Attribute
LAD Attributes
A-end SNTP Id
A-end SNTPpool Id
A-end SNTP control entity Id
PMAD Attributes
A-end Port Id
A-end Port control entity Id

10.2 HELLO_ACK: Discovery Response

Attribute
LAD Attributes B-end SNTP Id B-end SNTPpool Id B-end SNTP control entity Id
PMAD Attributes B-end Port Id B-end Port control entity Id

11 Discovery process flow

The overall discovery process flow (shown in Figure 11-1) is a generic process that is applicable to both LAD and PMAD. However, LAD and PMAD occur at different times in the network. The detailed state machines for the LAD and PMAD processes are shown in the subclauses. The state machines for CELA and SCE are not discussed in this Recommendation.

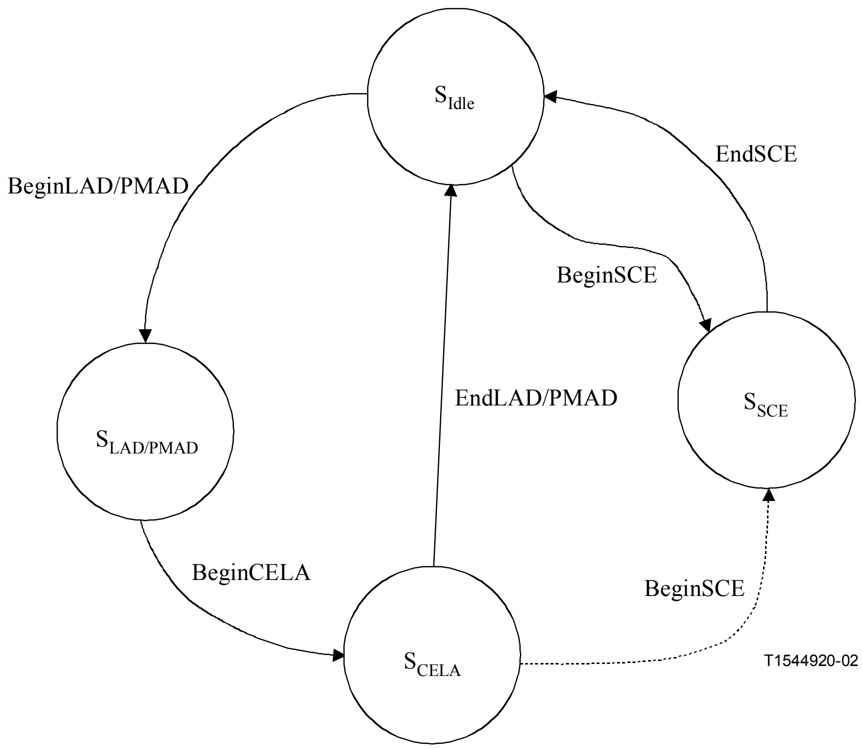

Figure 11-1/G.7714/Y.1705 – Discovery process flow diagram

The process flow diagram shown in Figure 11-1 indicates the states as S_{xx} where xx represents the state description. LAD refers to layer adjacency discovery, PMAD refers to Physical Media Adjacency Discovery, CELA represents the control entity logical adjacency establishment between control entities and SCE refers to service capability exchange. According to the process flow diagram, the establishment of control entity logical adjacencies could potentially trigger a service capability exchange process or this could be triggered at a different time from the Idle state. Note that the transitions shown in dashed lines represent the optional modifications to the overall discovery process flow. These options only modify the times at which a particular process is executed.

The state descriptions for the discovery process flow is shown in Table 11-1.

Table 11-1/G.7714/Y.1705 – Discovery process state description

State	Description
S_{Idle}	Start of the discovery process. This is also a repository for all diagnostic information that could be used for fixing problems discovered during the discovery processes, e.g. reception of wrong trace Id.
$S_{LAD/PMAD}$	Implements the LAD/PMAD process.
S_{CELA}	Implements the process to establish logical adjacency between SNTP or Port control entities.
S_{SCE}	Implements the service capability exchange process.

The description of events is shown in Table 11-2.

Table 11-2/G.7714/Y.1705 – Event descriptions for discovery process flow

Event	Description
BeginLAD/PMAD	Begin the LAD/PMAD Process.
BeginCELA	Begin the logical adjacency establishment process between SNTP or Port control entities.
BeginSCE	Begin the service capability exchange process.
EndLAD/PMAD	State Action Ended for LAD/PMAD.
EndSCE	State Action Ended for SCE.

11.1 LAD/PMAD State Diagram

The LAD/PMAD process state shown in Figure 11-1 is elaborated in a state diagram which is depicted in Figure 11-2. The states descriptions, event descriptions and state transitions are shown in Tables 11-3 to 11-5 respectively.

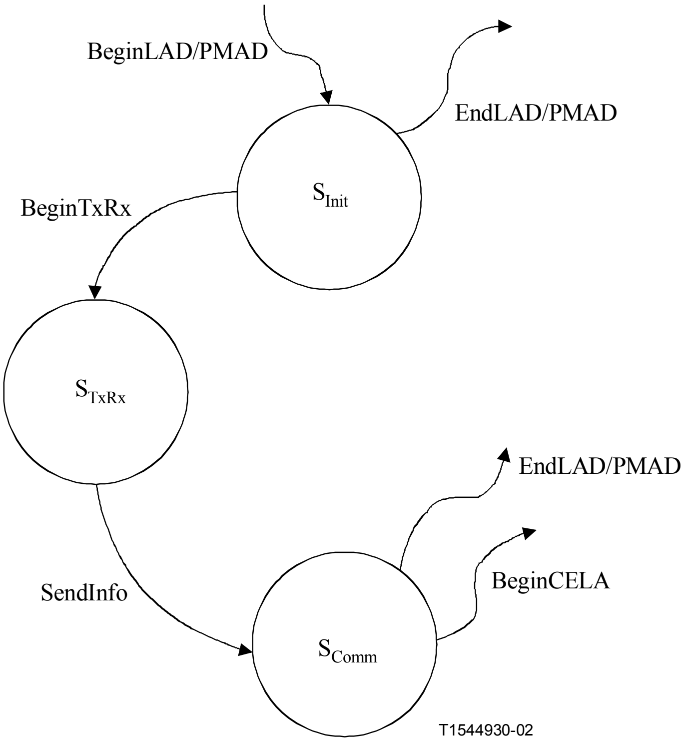

Figure 11-2/G.7714/Y.1705 – LAD/PMAD state diagram

Table 11-3/G.7714/Y.1705 – LAD/PMAD state description

State	Description
S_{Init}	Initialize the LAD/PMAD process – this might entail provisioning of test signals, test signal receivers, SNTP ID and associated control entity information, port Id and associated control entity information in the discovery test.
S_{TxRx}	Start the transmission of test signals or trace IDs and the reception thereof.
S_{Comm}	Communicate the results of the discovery test to the appropriate control entity

Table 11-4/G.7714/Y.1705 – LAD/PMAD event description

Event	Description
BeginTxRx	LAD/PMAD Initialization is successful.
SendInfo	Send the information gathered to the appropriate control entity.

Table 11-5/G.7714/Y.1705 – LAD/PMAD state transitions

State	Action	Event generated	Next state
S_{Init}	LAD/PMAD Initialization Successful	BeginTxRx	S_{TxRx}
S_{Init}	LAD/PMAD Initialization Failed	EndLAD/PMAD	S_{Idle}
S_{TxRx}	LAD/PMAD Transmission or Reception Successful or Failed	SendInfo	S_{Comm}
S_{Comm}	Results of LAD/PMAD successful	BeginCELA	S_{CELA}
S_{Comm}	Results of LAD/PMAD failed	EndLAD/PMAD	S_{Idle}

ANNEX A

Service capability exchange

Service Capability Exchange is a process of exchange of service related information. This process refers to services supported over a trail or link (that is discovered as part of LAD or PMAD). Typical information exchanged includes.

i) The service (link connection) types that are supported over the trail/link.

ii) The ability to support flexible adaptation at either end of the connection.

iii) The ability to support diverse routing.

iv) The Cos/GoS that is supported by different administrative domains.

Service capability exchange is also a way of reducing the amount of in-band events that are required for performing discovery. By discovering trails at a server layer, the link connections (SNTP-SNTP associations) that are supported by the trail can be inferred. This sharing of the inferred associations does not require any in-band event and can be done as part of the service capability exchange process. This is illustrated in Figure A.1.

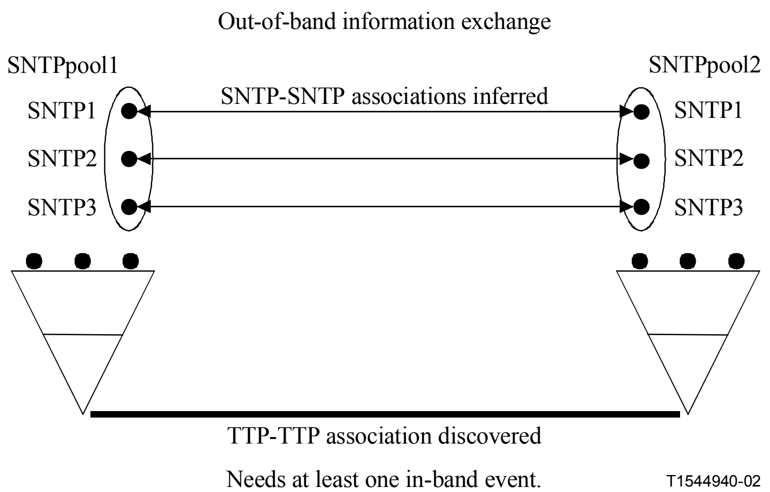

Figure A-1/G.7714/Y.1705 – Service capability exchange – Example

APPENDIX I

Methods for discovery

In clause 6, LAD/PMAD is described to be a layer-specific process. However, this does not necessarily mean that separate discovery processes are required at each layer of connectivity in the network. Two specific methods for discovery are discussed in this appendix.

I.1 Trace Id method

In this method:

TTP-TTP associations are first discovered.

Given the TTP-TTP and the internal SNTP to TTP associations, link connections are inferred.

I.2 Test signal method

In this method:

Associations at the layer at which flexibility exists are discovered. All fixed associations are inferred or provisioned.

Specific test signals are used for creating in-band events that effect associations between two SNTPs directly, i.e. without discovering any server layer trails.

I.3 Relative advantages of the two strategies

Given the above two strategies and associated mechanisms, the following clauses enumerate the relative advantages of either strategy.

I.3.1 Trace Id method

This strategy requires the use of a smaller number of discovery tests to be used as the network topology is sparse in the server layers compared to the client layers.

There is no need for specific test signal generators and receivers.

Minimal special provisioning (e.g. trace information) is needed.

I.3.2 Test signal method

There is no dependency on specific trace Ids. All in-band events are accomplished via specific test signal generators.

Direct discovery of the topology in the layer at which flexibility exists, so there is minimum amount of inference required.

Discovery across "trunked" (or fixed) link connections is possible.

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