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Architecture and requirements for routing in the automatically switched optical networks

ITU-T Recommendation G.7715/Y.1706

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TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

INTERNATIONAL TELEPHONE CONNECTIONS AND CIRCUITS	G.100–G.199
GENERAL CHARACTERISTICS COMMON TO ALL ANALOGUE CARRIER-TRANSMISSION SYSTEMS	G.200–G.299
INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES	G.300–G.399
GENERAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON RADIO-RELAY OR SATELLITE LINKS AND INTERCONNECTION WITH METALLIC LINES	G.400–G.449
COORDINATION OF RADIOTELEPHONY AND LINE TELEPHONY	G.450–G.499
TESTING EQUIPMENTS	G.500–G.599
TRANSMISSION MEDIA CHARACTERISTICS	G.600–G.699
DIGITAL TERMINAL EQUIPMENTS	G.700–G.799
DIGITAL NETWORKS	G.800–G.899
DIGITAL SECTIONS AND DIGITAL LINE SYSTEM	G.900–G.999
QUALITY OF SERVICE AND PERFORMANCE	G.1000–G.1999
TRANSMISSION MEDIA CHARACTERISTICS	G.6000–G.6999
DIGITAL TERMINAL EQUIPMENTS	G.7000–G.7999
General	G.7000–G.7099
Coding of analogue signals by pulse code modulation	G.7100–G.7199
Coding of analogue signals by methods other than PCM	G.7200–G.7299
Principal characteristics of primary multiplex equipment	G.7300–G.7399
Principal characteristics of second order multiplex equipment	G.7400–G.7499
Principal characteristics of higher order multiplex equipment	G.7500–G.7599
Principal characteristics of transcoder and digital multiplication equipment	G.7600–G.7699
Operations, administration and maintenance features of transmission equipment	**G.7700–G.7799**
Principal characteristics of multiplexing equipment for the synchronous digital hierarchy	G.7800–G.7899
Other terminal equipment	G.7900–G.7999
DIGITAL NETWORKS	G.8000–G.8999

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ITU-T Recommendation G.7715/Y.1706

Architecture and requirements for routing in the automatically switched optical networks

Summary

This Recommendation specifies the requirements and architecture for the routing functions used for the establishment of switched connections (SC) and soft permanent connections (SPC) within the framework of the Automatically Switched Optical Network (ASON). The main areas covered in this Recommendation include the ASON routing architecture, functional components including path selection, routing attributes, abstract messages and state diagrams.

This Recommendation forms a part of the suite of Recommendations covering the full functionality of the automatic switched transport network (ASTN) and the automatic switched optical network (ASON).

Source

ITU-T Recommendation G.7715/Y.1706 was prepared by ITU-T Study Group 15 (2001-2004) and approved under the WTSA Resolution 1 procedure on 13 June 2002.

Keywords

Automatic Switched Optical Network, Automatic Switched Transport Network, Network-Network Interface (NNI), Network Resources, Path Selection, Routing, Routing Area, Routing Attributes, Routing Control Domain, Routing Controller, Routing Messages, Routing State Machine, User Network Interface (UNI).

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CONTENTS

		Page
1	Scope	1
2	References	1
3	Terms and definitions	2
4	Abbreviations	3
5	ASON routing architecture	3
5.1	Fundamental concepts	3
5.2	Routing architecture and functional components	5
5.2.1	Considerations for different protocols	6
5.2.2	Considerations for multiple VPNs	7
5.2.3	Considerations for policy	7
5.3	Routing area hierarchies	7
5.3.1	Routing performer realization in relation to routing Area hierarchies	8
5.3.2	Correspondence between LRM and RCs for hierarchical routing areas	9
6	ASON routing requirements	10
6.1	Architectural requirements	10
6.2	Protocol requirements	11
6.3	Path selection requirements	11
7	Routing attributes	11
7.1	Node attributes	11
7.1.1	Reachability attributes	12
7.1.2	Diversity related attributes	12
7.1.3	Other attribute information	12
7.2	Link attributes	12
7.2.1	Link state	12
7.2.2	Diversity related attributes	13
7.2.3	Other attribute information	13
8	Routing messages	13
8.1	Routing adjacency maintenance	14
8.2	Routing information messages	14
8.3	Routing exception and error handling	15
8.4	State diagrams	15
8.4.1	Information element transmission	15
8.4.2	Information element reception	16
8.4.3	Local information element transmission generation	17

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Page

9 Routing message distribution topology 18
9.1 Congruent topology 18
9.2 Hubbed topology using a routing message server 19
9.3 Directed topology 19

10 Path selection 20
10.1 Inputs to path selection 20
10.1.1 Step-by-step routing 20
10.1.2 Source and hierarchical routing 21
10.2 Output of path selection 21
10.3 Routing paradigms and path selection 22

Appendix I – Information flow between levels of the routing hierarchy 22
I.1 Information dissemination related to resolving end-point addresses 23
I.1.1 Parent to child information flow 23
I.1.2 Child to parent information flow 23
I.2 Information exchange between hierarchical levels for resolving end-point addresses 24

Appendix II – Shared Risk Group 25
II.1 Path diversity 25
II.2 Network resources and risk sharing 25
II.3 Shared Risk Group (SRG) 26
II.4 SRG implications for routing 26

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ITU-T Recommendation G.7715/Y.1706

Architecture and requirements for routing in the automatically switched optical networks

1 Scope

This Recommendation specifies the requirements and architecture for the routing functions used for the establishment of switched connections (SC) and soft permanent connections (SPC) within the framework of the Automatically Switched Optical Network (ASON). The main areas covered in this Recommendation include the ASON routing architecture, functional components including path selection, routing attributes, abstract messages and state diagrams.

This Recommendation forms a part of the suite of Recommendations covering the full functionality of the automatic switched transport network and the automatic switched optical network. It builds upon the high-level functional requirements and architecture as outlined in ITU-T Recs G.807/Y.1302 (ASTN) and G.8080/Y.1304 (ASON) as the baseline framework for the specification.

This Recommendation is aimed at providing a protocol neutral approach to describe routing for the automatic switched optical networks. Routing messages are transported over a data communication network (DCN). One possible implementation is specified in ITU-T Rec. G.7712/Y.1703.

In order to provide routing service, *a priori* knowledge of the network resources is needed. These resources may be manually provisioned or automatically discovered.

ASON routing has many applications, e.g. traffic engineering, diverse routing, etc. However details of these applications are beyond the scope of this Recommendation.

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 Recommendation G.805 (2000), *Generic functional architecture of transport networks*.
- ITU-T Recommendation G.807/Y.1302 (2001), *Requirements for Automatic Switched Transport Networks (ASTN)*.
- ITU-T Recommendation G.851.1 (1996), *Management of the transport network – Application of RM-ODP framework*.
- ITU-T Recommendation G.7712/Y.1703 (2001), *Architecture and specification of Data Communication Network (DCN)*.
- ITU-T Recommendation G.8080/Y.1304 (2001), *Architecture of the Automatically Switched Optical Network (ASON)*.
- ITU-T Recommendation M.3016 (1998), *TMN security overview*.
- ITU-T Recommendation X.800 (1991), *Security architecture for Open Systems Interconnection (OSI) for CCITT applications*.

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3 Terms and definitions

3.1 This Recommendation uses the following terms defined in ITU-T Rec. G.805:

a) Administrative Domain;

b) Link;

c) Link Connection (LC);

d) Partitioning;

e) Subnetwork;

f) Subnetwork Connection (SNC).

3.2 This Recommendation uses the following term defined in ITU-T Rec. G.851.1:

a) Cluster.

3.3 This Recommendation uses the following term defined in ITU-T Rec. G.7712/Y.1703:

a) Data Communication Network (DCN).

3.4 This Recommendation uses the following terms defined in ITU-T Rec. G.8080/Y.1304:

a) Connection Controller;

b) Federation;

c) Link Resource Manager (LRM);

d) Protocol Controller (PC);

e) Routing Area;

f) Routing Controller (RC);

g) Routing Information Database (RDB);

h) Subnetwork Point Pool (SNPP);

i) Subnetwork Point (SNP);

j) Virtual Private Network (VPN).

3.5 This Recommendation defines the following terms:

3.5.1 node: In the context of this Recommendation, the term node is used to signify a subnetwork or a Routing Area.

3.5.2 Routing Adjacency (RAdj): A logical association between two Routing Controllers.

3.5.3 Routing Control Domain (RCD): An abstract entity that hides the details of the RC distribution. See 5.1 for more information.

3.5.4 Routing Performer (RP): A computational viewpoint object (per ITU-T Rec. G.851.1) that is associated with a routing area and provides an abstraction of the routing service for the routing area.

3.5.5 Shared Risk Group (SRG): A group of resources that share a common risk component whose failure can cause the failure of all the resources in the group.

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4 Abbreviations

This Recommendation uses the following abbreviations:

AD	Administrative Domain
ASON	Automatically Switched Optical Network
ASTN	Automatic Switched Transport Network
DCN	Data Communication Network
E-NNI	External Network-Network Interface
IE	Information Element
I-NNI	Internal Network-Network Interface
LRM	Link Resource Manager
RA	Routing Area
RAdj	Routing Adjacency
RC	Routing Controller
RCD	Routing Control Domain
RDB	Routing Information Database
RI	Routing Information
RP	Routing Performer
SNP	Subnetwork Point
SNPP	Subnetwork Point Pool
SRG	Shared Risk Group
UNI	User Network Interface
VPN	Virtual Private Network

5 ASON routing architecture

The ASON routing architecture supports various routing paradigms listed in ITU-T Rec. G.8080/Y.1304, e.g. hierarchical, step-by-step and source-based. The architecture also abstracts away differences in routing information representation, e.g. link-state, distance-vector, etc. The routing architecture applies after the network has been subdivided into routing areas, and the necessary network resources have been accordingly assigned. The process of subdividing the network into routing areas and assigning network resources is beyond the scope of this Recommendation.

5.1 Fundamental concepts

An operator may choose to subdivide its network based upon specific operator policies, which could include such criteria as geography, administration, technology, etc. The network subdivisions may, by operator decision, be treated as routing areas for the purpose of providing a routing service. Routing areas provide for routing information abstraction, thereby enabling scalable routing information representation. The service offered by a routing area (e.g. path selection) is provided by a Routing Performer (a federation of Routing Controllers), and each Routing Performer is responsible for a single routing area. The RP supports path computation functions consistent with one or more of the routing paradigms listed in ITU-T Rec. G.8080/Y.1304 (source, hierarchical and step-by-step) for the particular routing area that it provides service for. The path computation

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functions that may be supported by a RP are based upon the types of information available to it via a Routing Information Database.

Routing areas may be hierarchically contained and a separate Routing Performer is associated with each routing area in the routing hierarchy. It is possible for each level of the hierarchy to employ different Routing Performers that support different routing paradigms. Routing Performers are realized through the instantiation of possibly distributed Routing Controllers. The Routing Controller provides the routing service interface, i.e. the service access point, as defined for the Routing Performer. The Routing Controller is also responsible for coordination and dissemination of routing information. Routing Controller service interfaces provide the routing service across NNI reference points at a given hierarchical level. Different Routing Controller instances may be subject to different policies depending upon the organizations they provide services for. Policy enforcement may be supported via various mechanisms; e.g. by usage of different protocols.

An RC may be implemented as a cluster of distributed entities; such a cluster is called a Routing Control Domain (RCD). An RCD is the abstract entity that hides the details of the distribution internal to the cluster, while providing distribution interfaces with identical characteristics as those of the RC distribution interfaces. The nature of the routing information exchanged between RCDs captures the common semantics of the routing information exchanged between RC distribution interfaces while allowing for different representations within each cluster. The realization of the RCD is implementation specific and outside the scope of this Recommendation.

The relationship between the RA, RP, RC and RCD concepts is illustrated in Figure 1, below.

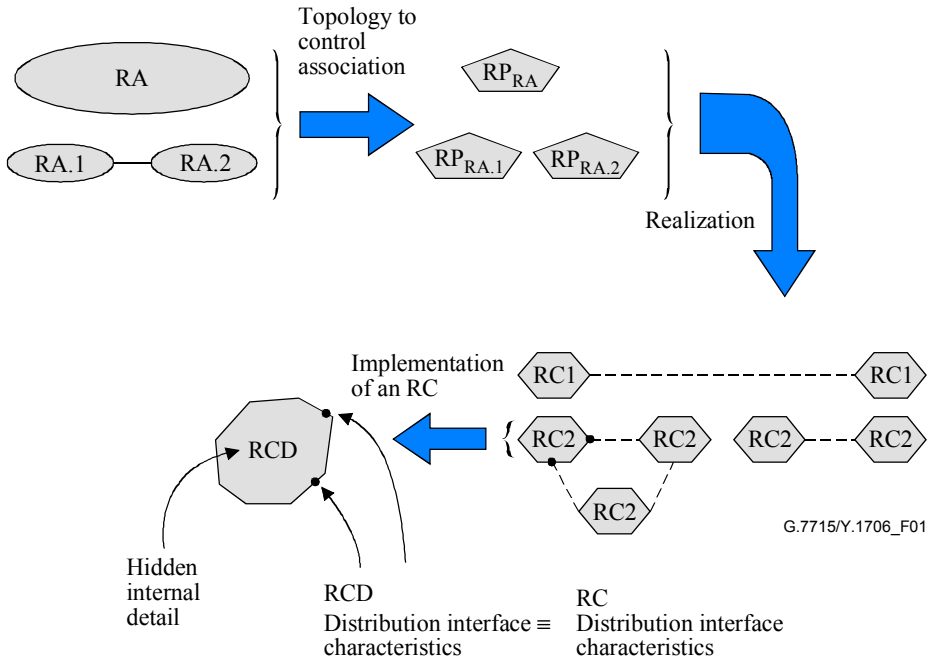

Figure 1/G.7715/Y.1706 – Relationship between RA, RP, RC and RCD

As illustrated above, routing areas contain routing areas that recursively define successive hierarchical routing levels. A separate RP is associated with each routing area. Thus, RP_{RA} is associated with routing area RA, and Routing Performers $RP_{RA.1}$ and $RP_{RA.2}$ are associated with routing areas RA.1 and RA.2, respectively. In turn, the RPs themselves are realized through instantiations of distributed RCs RC1 and RC2, where the RC1s are derived from RP_{RA} and the

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RC2s are derived from Routing Performers $RP_{RA.1}$ and $RP_{RA.2,}$ respectively. It may be seen that the characteristics of the RCD distribution interfaces and the RC distribution interfaces are identical[1].

5.2 Routing architecture and functional components

The routing architecture has protocol independent components (LRM, RC), and protocol specific components (Protocol Controller). The Routing Controller handles abstract information needed for routing. The Protocol Controller handles protocol specific messages according to the reference point over which the information is exchanged (e.g. E-NNI, I-NNI), and passes routing primitives to the Routing Controller. An example of routing functional components is illustrated in Figure 2.

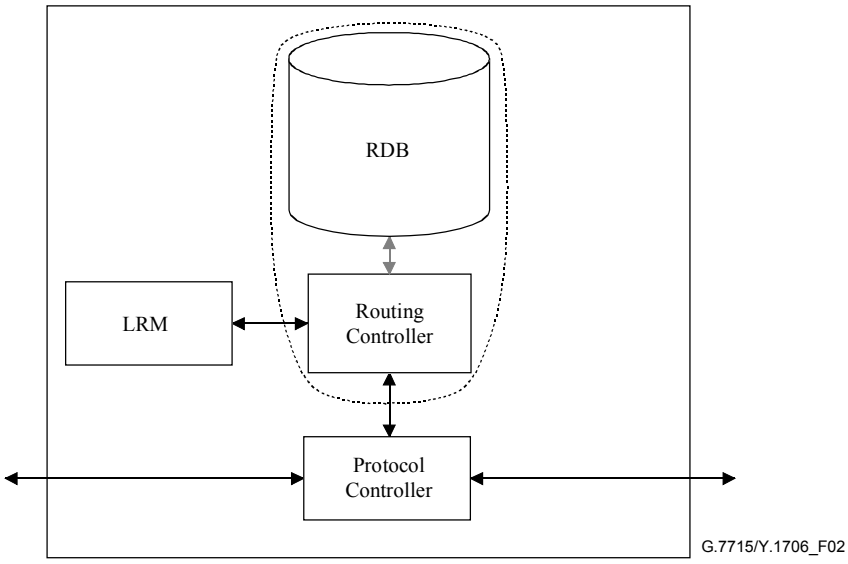

Figure 2/G.7715/Y.1706 – An example of routing functional components

1) Routing Controller – The RC functions include exchanging routing information with peer RCs and replying to a route query (path selection) by operating on the Routing Information Database. The RC is protocol independent.

2) Routing Information Database (RDB) – The RDB is a repository for the local topology, network topology, reachability, and other routing information that is updated as part of the routing information exchange and may additionally contain information that is configured. The RDB may contain routing information for more than one routing area. The Routing Controller has access to a view of the RDB. Figure 2 illustrates this by showing a dotted line around the RC and the RDB. This dotted line signifies the RC (as described in ITU-T Rec. G.8080/Y.1304) as encapsulating a view of the RDB. The RDB is protocol independent.

   NOTE – Since the RDB may contain routing information pertaining to multiple Routing Areas (and hence possibly multiple layer networks), the routing controllers accessing the RDB may share the routing information. This is illustrated in Figure 3 by showing the overlap between the dotted lines.

3) Link Resource Manager – The LRM supplies all the relevant SNPP link information to the Routing Controller. It informs the RC about any state changes of the link resources it controls.

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[1] Depending upon implementation choice, the number of RCD distribution interface instances need not be the same as that for an RC instance.

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