INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.7712/Y.1703

(11/2001)

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

Digital terminal equipments – Operations, administration and maintenance features of transmission equipment

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE AND INTERNET PROTOCOL ASPECTS

Internet protocol aspects – Operation, administration and maintenance

---

Architecture and specification of data communication network

ITU-T Recommendation G.7712/Y.1703

ITU-T G-SERIES RECOMMENDATIONS

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

For further details, please refer to the list of ITU-T Recommendations.

ITU-T Recommendation G.7712/Y.1703

Architecture and specification of data communication network

Summary

This Recommendation defines the architecture requirements for a Data Communication Network (DCN) which may support distributed management communications related to the Telecommunication Management Network (TMN), distributed signalling communications related to the Automatic Switched Transport Network (ASTN), and other distributed communications (e.g. Orderwire or Voice Communications, Software Download). The DCN architecture considers networks that are IP-only, OSI-only, and mixed (i.e. support both IP and OSI). The interworking between parts of the DCN supporting IP-only, parts supporting OSI-only, and parts supporting both IP and OSI are also specified.

Various applications (e.g. TMN, ASTN, etc.) require a packet-based communications network to transport information between various components. For example, the TMN requires a communications network, which is referred to as the Management Communication Network (MCN) to transport management messages between TMN components (e.g. NEF component and OSF component). ASTN requires a communications network, which is referred to as the Signalling Communication Network (SCN) to transport signalling messages between ASTN components (e.g. CC components). This Recommendation specifies data communication functions that can be used to support one or more application communication networks.

The data communications functions provided in this Recommendation support connectionless network services. Additional functions may be added in future versions of this Recommendation to support connection-oriented network services.

Source

ITU-T Recommendation G.7712/Y.1703 was prepared by ITU-T Study Group 15 (2001-2004) and approved under the WTSA Resolution 1 procedure on 29 November 2001.

This Recommendation forms part of a suite of Recommendations covering transport networks.

Keywords

Data Communication Network, Internet Protocol (IP), Open System Interface (OSI).

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

		Page
1	Scope	1
2	References	1
3	Terms and definitions	3
4	Abbreviations	4
5	Conventions	6
6	DCN Characteristics	7
6.1	TMN application	9
6.1.1	X Management Subnetwork Architecture	11
6.1.2	Reliability of MCN	14
6.1.3	Security of MCN	15
6.1.4	MCN data communications functions	15
6.2	ASTN Application	16
6.2.1	Topology of SCN	17
6.2.2	Reliability of SCN	20
6.2.3	Security of SCN	22
6.2.4	SCN Data Communication Functions	23
6.3	Other Applications Requiring Communication Networks	24
6.4	Separation of Various Applications	24
7	DCN Functional Architecture and Requirements	25
7.1	Specification of Data Communication Functions	26
7.1.1	ECC Access Function	26
7.1.2	ECC Data-Link Layer Termination Function	26
7.1.3	[Network Layer PDU into ECC Data-Link Frame] Encapsulation Function	28
7.1.4	Ethernet LAN Physical Termination Function	30
7.1.5	[Network Layer PDU into Ethernet Frame] Encapsulation Function	30
7.1.6	Network Layer PDU Forwarding function	30
7.1.7	Network Layer PDU Interworking Function	30
7.1.8	Network Layer PDU Encapsulation Function	30
7.1.9	Network Layer PDU Tunnelling Function	31
7.1.10	Network Layer Routing Function	31
7.1.11	IP Routing Interworking Function	33
7.1.12	[Applications to Network Layer] Mapping Function	33
7.2	Provisioning Requirements	33
7.3	Security Requirements	33

Page

Annex A – Requirements for Three-way Handshaking 33

Appendix I – Constraints of the interworking functions in DCN... 35

Appendix II – Bibliography... 37

ITU-T Recommendation G.7712/Y.1703

Architecture and specification of data communication network

1 Scope

This Recommendation defines the architecture requirements for a Data Communications Network (DCN) which may support distributed management communications related to the Telecommunications Management Network (TMN), distributed signalling communications related to the Automatic Switched Transport Network (ASTN), and other distributed communications (e.g. Orderwire or Voice Communications, Software Download). The DCN architecture considers networks that are IP-only, OSI-only, and mixed (i.e. support both IP and OSI). The interworking between parts of the DCN supporting IP-only, parts supporting OSI-only, and parts supporting both IP and OSI are also specified.

The DCN provides Layer 1 (physical), Layer 2 (data-link) and Layer 3 (network) functionality and consists of routing/switching functionality interconnected via links. These links can be implemented over various interfaces, including Wide Area Network (WAN) interfaces, Local Area Network (LAN) interfaces, and Embedded Control Channels (ECCs).

Various applications (e.g. TMN, ASTN, etc.) require a packet-based communications network to transport information between various components. For example, the TMN requires a communications network, which is referred to as the Management Communication Network (MCN) to transport management messages between TMN components (e.g. NEF component and OSF component). ASTN requires a communications network, which is referred to as the Signalling Communication Network (SCN) to transport signalling messages between ASTN components (e.g. CC components). This Recommendation specifies data communication functions that can be used to support one or more application communication networks.

The data communications functions provided in this Recommendation support connectionless network services. Additional functions may be added in future versions of this Recommendation to support connection-oriented network services.

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.707/Y.1322 (2000), *Network node interface for the synchronous digital hierarchy* (SDH).

– ITU-T Recommendation G.709/Y.1331 (2001), *Interfaces for the Optical Transport Network (OTN)*.

– ITU-T Recommendation G.783 (2000), *Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks*.

– ITU-T Recommendation G.784 (1999), *Synchronous digital hierarchy (SDH) management*.

– ITU-T Recommendation G.798 (2002), *Characteristics of optical transport network hierarchy equipment functional blocks*.

– ITU-T Recommendation G.807/Y.1302 (2001), *Requirements for automatic switched transport networks (ASTN)*.

– ITU-T Recommendation G.872 (2001), *Architecture of optical transport networks*.

– ITU-T Recommendation G.874 (2001), *Management aspects of the optical transport network element*.

– ITU-T Recommendation G.7710/Y.1701 (2001), *Common equipment management function requirements*.

– ITU-T Recommendation G.8080/Y.1304 (2001), *Architecture for the automatically switched optical network (ASON)*.

– ITU-T Recommendation M.3010 (2000), *Principles for a telecommunications management network*.

– ITU-T Recommendation M.3013 (2000), *Considerations for a telecommunications management network*.

– ITU-T Recommendation M.3016 (1998), *TMN security overview*.

– ITU-T Recommendation Q.811 (1997), *Lower layer protocol profiles for the Q3 and X interfaces*.

– ITU-T Recommendation X.263 (1998) | ISO/IEC TR 9577:1999, *Information technology – Protocol identification in the Network Layer*.

– IETF RFC 0791 (1981), *Internet Protocol DARPA Internet Program Protocol Specification*.

– IETF RFC 792 (1981), *Internet Control Message Protocol*.

– IETF RFC 894 (1984), *A Standard for the Transmission of IP Datagrams over Ethernet Networks*.

– IETF RFC 826 (1982), *An Ethernet Address Resolution Protocol*.

– IETF RFC 1195 (1990), *Use of OSI IS-IS for Routing in TCP/IP and Dual Environments*.

– IETF RFC 1122 (1989), *Requirements for Internet Hosts – Communication Layers*.

– IETF RFC 1172 (1999), *The Point-to-Point Protocol (PPP) Initial Configuration Options*.

– IETF RFC 1332 (1992), *The PPP Internet Protocol Control Protocol (IPCP)*.

– IETF RFC 1377 (1992), *The PPP OSI Network Layer Control Protocol (OSINLCP)*.

– IETF RFC 1661 (1994), *The Point-to-Point Protocol (PPP)*.

– IETF RFC 1662 (1994), *PPP in HDLC-like Framing*.

– IETF RFC 1812 (1995), *Requirements for IP Version 4 Routers*.

– IETF RFC 2328 (1998), *OSPF Version 2*.

– IETF RFC 2460 (1998), *Internet Protocol, Version 6 (IPv6) Specification*.

– IETF RFC 2463 (1998), *Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6 (IPv6) Specification*.

– IETF RFC 2472 (1998), *IP Version 6 over PPP*.

– IETF RFC 2740 (1999), *OSPF for IPv6*.

– IETF RFC 2784 (2000), *Generic Routing Encapsulation (GRE)*.

– ISO/IEC 10589:1992, *Information technology – Telecommunications and information exchange between systems – Intermediate system to Intermediate system intra-domain routing information exchange protocol for use in conjunction with the protocol for providing the connectionless-mode Network Service (ISO 8473)*.

3 Terms and definitions

3.1 This Recommendation uses terms defined in ITU-T Rec. G.709/Y.1331:

a) Optical Channel Data Unit (ODUk)

b) Optical Channel Transport Unit (OTUk)

c) Optical Overhead Signal (OOS)

3.2 This Recommendation uses terms defined in ITU-T Rec. G.784:

a) Data Communications Channel (DCC)

3.3 This Recommendation uses terms defined in ITU-T Rec. G.807/Y.1302:

a) Automatic Switched Transport Network (ASTN)

b) Network-to-Network Interface (NNI)

c) User-to-Network Interface (UNI)

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

a) Call Controller (CallC)

b) Connection Controller (CC)

c) Connection Controller Interface (CCI)

d) Subnetwork Controller (SNCr)

3.5 This Recommendation uses terms defined in ITU-T Rec. G.874:

a) General Communications Channel (GCC)

b) General Management Communications Overhead (COMMS OH)

3.6 This Recommendation uses terms defined in ITU-T Rec. G.7710/Y.1701:

a) X Management Network

b) X Management Subnetwork

3.7 This Recommendation uses terms defined in ITU-T Rec. G.872:

a) Optical transport network (OTN)

3.8 This Recommendation uses terms defined in ITU-T Rec. M.3010:

a) Adaptation Device (AD)

b) Data Communications Function (DCF)

c) Mediation Device (MD)

d) Network Element (NE)

e) Network Element Function (NEF)

f) Operations System (OS)

g) Operations System Function (OSF)

h) Q-interface

i) Translation Function

j) Workstation Function (WSF)

3.9 This Recommendation uses terms defined in ITU-T Rec. M.3013:

a) Message Communications Function (MCF)

3.10 This Recommendation defines the following terms:

3.10.1 Data Communications Network (DCN): The DCN is a network that supports Layer 1 (physical), Layer 2 (data-link), and Layer 3 (network) functionality. A DCN can be designed to support transport of distributed management communications related to the TMN, distributed signalling communications related to the ASTN, and other operations communications (e.g. orderwire/voice communications, software downloads, etc.).

3.10.2 Embedded Control Channel (ECC): An ECC provides a logical operations channel between NEs. The physical channel supporting the ECC is technology specific. Examples of physical channels supporting the ECC are; a DCC channel within SDH, GCC channel within OTN OTUk/ODUk, or the COMMS OH channel within the OTN OOS.

4 Abbreviations

This Recommendation uses the following abbreviations:

AD	Adaptation Device
ARP	Address Resolution Protocol
ASON	Automatic Switched Optical Network
ASTN	Automatic Switched Transport Network
ATM	Asynchronous Transfer Mode
CallC	Call Controller
CC	Connection Controller
CCI	Connection Controller Interface
CLNP	ConnectionLess Network Layer Protocol
CLNS	ConnectionLess Network Layer Service
COMMS OH	General Management Communications Overhead
DCC	Data Communications Channel
DCF	Data Communications Function
DCN	Data Communication Network
DF	Don't Fragment
ECC	Embedded Control Channel
EMF	Equipment Management Function
E-NNI	External NNI
ES	End System
ES IS	End System to Intermediate System
GCC	General Communications Channel
GNE	Gateway Network Element
GRE	Generic Routing Encapsulation
HDLC	High Level Data Link Control

ICMP	Internet Control Message Protocol
ID	Identifier
IIH	ISIS Hello
I-NNI	Internal NNI
IntISIS	Integrated Intermediate System-to-Intermediate System
IP	Internetwork Protocol
IPCP	Internet Protocol Control Protocol
IPv4	Internetwork Protocol Version 4
IPv6	Internetwork Protocol Version 6
IS	Intermediate System
ISDN	Integrated Services Digital Network
ISIS	Intermediate System-to-Intermediate System
IWF	InterWorking Function
LAN	Local Area Network
LAPD	Link Access Procedure D-Channel
LCN	Local Communication Network
LSP	Link State Packet
MAC	Media Access Control
MCF	Message Communications Function
MCN	Management Communication Network
MD	Mediation Device
MTU	Maximum Transmission Unit
NE	Network Element
NEF	Network Element Function
NNI	Network-to-Network Interface
NSAP	Network Service Access Point
ODUk	Optical Channel Data Unit
OOS	OTM Overhead Signal
OS	Operations System
OSC	Optical Supervisory Channel
OSF	Operations System Function
OSI	Open System Interface
OSINLCP	OSI Network Layer Control Protocol
OSPF	Open Shortest Path First
OTM	Optical Transport Module
OTN	Optical Transport Network
OTUk	Optical Channel Transport Unit

PDU	Packet Data Unit
PPP	Point-to-Point Protocol
RFC	Request For Comment
SCN	Signalling Communication Network
SDH	Synchronous Digital Hierarchy
SNCr	SubNetwork Controller
SP	Segmentation Permitted
TCP	Transmission Control Protocol
TF	Translation Function
TLV	Type Length Value
TMN	Telecommunication Management Network
TNE	Transport Network Element
UNI	User Network Interface
WAN	Wide Area Network
WS	Work Station
WSF	Work Station Function
xMS	X Management Subnetwork

5 Conventions

The following conventions are used throughout this Recommendation:

Mixed DCN: A mixed DCN supports multiple network layer protocols (e.g. OSI and IPv4). It is possible in a mixed DCN, that the path between two communicating entities (e.g. an OS and a managed NE) will traverse some parts that only support one network layer protocol (e.g. OSI) and other parts that only support another network layer protocol (e.g. IPv4). To provide communication between such entities, one network layer protocol should be encapsulated into the other network layer protocol at the boundary of those parts supporting different network layer protocols.

OSI-only DCN: An OSI-only DCN supports only CLNP as the network layer protocol. Therefore the end-to-end path between two communicating entities (e.g. an OS and a managed NE) will support CLNP and encapsulation of one network layer protocol into another network layer protocol is not required to support such communications.

IPv4-only DCN: An IPv4-only DCN supports only IPv4 as the network layer protocol. Therefore the end-to-end path between two communicating entities (e.g. an OS and a managed NE) will support IPv4 and encapsulation of one network layer protocol into another network layer protocol is not required to support such communications.

IPv6-only DCN: An IPv6-only DCN supports only IPv6 as the network layer protocol. Therefore the end-to-end path between two communicating entities (e.g. an OS and a managed NE) will support IPv6 and encapsulation of one network layer protocol into another network layer protocol is not required to support such communications.

6 DCN Characteristics

Various applications (e.g. TMN, ASTN, etc.) require a packet based communications network to transport information between various components. For example, the TMN requires a communications network, which is referred to as the Management Communication Network (MCN) to transport management messages between TMN components (e.g. NEF component and OSF component). ASTN requires a communications network, which is referred to as the signalling Communication Network (SCN) to transport signalling messages between ASTN components (e.g. CC components). This Recommendation specifies data communication functions that can be used to support one or more application's communications network.

Figure 6-1 illustrates example applications that can be supported via the DCN. Each application can be supported on separate DCNs or on the same DCN depending on the network design.

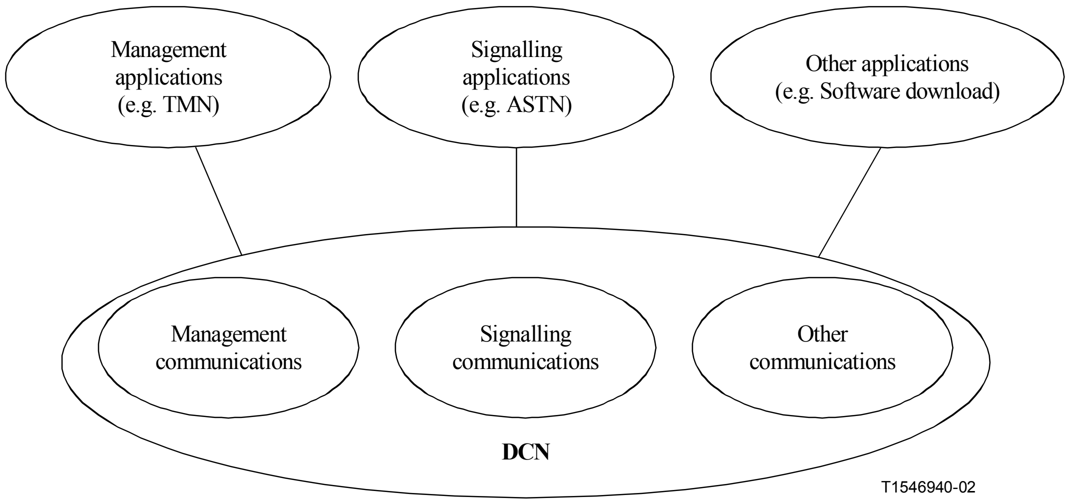


Figure 6-1/G.7712/Y.1703 – Example applications supported by a DCN

The conceptual DCN is a collection of resources to support the transfer of information among distributed components. As discussed above, examples of distributed communication that can be supported by the DCN are distributed management communications related to the TMN and distributed signalling communications related to the ASTN. In the case of a DCN supporting distributed management communications, the distributed components are TMN components (NEs, ADs, OSs, MDs, and WSs containing TMN functions such as OSF, TF, NEF, WSF). ITU-T Recs M.3010 and M.3013 provide further specifications for the TMN functions. In the case of a DCN supporting distributed signalling communications, the distributed components are ASTN components (NEs containing ASTN SNCr functions). ITU-T Recs G.807/Y.1302 and G.8080/Q.1304 provide further specifications for the ASTN functions.

A number of telecommunications technologies can support the DCN functions such as, circuit switching, packet switching, LAN, ATM, SDH, and the OTN. Important aspects of the DCN are the quality of service, information transfer rate, and diversity of routing to support specific operational requirements of the distributed communications supported across the DCN (e.g. distributed management communications, distributed signalling communications).

The goal of an interface specification is to ensure meaningful interchange of data between interconnected devices through a DCN to perform a given function (e.g. TMN function, ASTN function). An interface is designed to ensure independence of the type of device or of the supplier. This requires compatible communication protocols and compatible data representations for the messages, including compatible generic message definitions for TMN management functions and ASTN control functions.

The DCN is responsible for providing compatible communication at the network layer (Layer 3), data-link layer (Layer 2), and physical layer (Layer 1).

Consideration of interfaces should be given to compatibility with the most efficient data transport facilities available to each individual network element (e.g. leased circuits, circuit-switched connections, packet-switched connections, Signalling System No. 7, Embedded Communication Channels of the SDH, OTN, and ISDN access network D- and B-channels).

This Recommendation specifies the lower three layers for data communication and, therefore, any interworking between protocols within the lower three layers. Such interworking is provided by the Data Communications Function (DCF). Examples of such interworking are illustrated in Figure 6-2. Note that such interworking does not terminate the Layer 3 protocols. One example is interworking between different physical layers via a common Layer 2 protocol (e.g. bridging MAC frames from a LAN interface to an ECC). Another example is interworking between different data-link layer protocols via a common layer 3 protocol (e.g. routing IP packets from a LAN interface to an ECC). The third example illustrated in Figure 6-2, shows interworking between different network layer protocols via a Layer 3 tunnelling function (in this example OSI is encapsulated/tunnelled over IP, however, IP over OSI encapsulation/tunnelling is also possible).

The type of information transported between the distributed components depends on the type of interfaces supported between the components. A DCN supporting distributed management communications related to the TMN needs to support the transport of information associated with the TMN interfaces defined in ITU-T Rec. M.3010. A DCN supporting distributed signalling communications related to the ASTN needs to support the transport of information associated with the ASTN interfaces defined in ITU-T Rec. G.807/Y.1302.

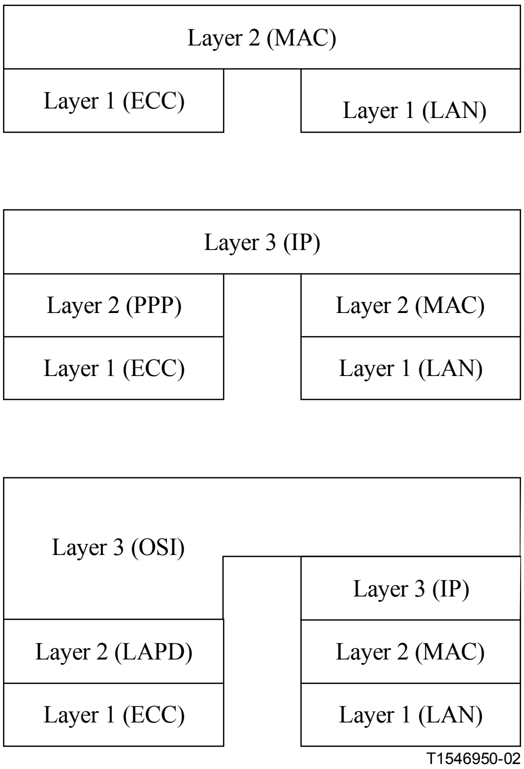


Figure 6-2/G.7712/Y.1703 – Examples of DCN interworking

6.1 TMN application

The TMN requires a communications network, which is referred to as the Management Communication Network (MCN) to transport management messages between TMN components (e.g. NEF component and OSF component). Figure 6-3 illustrates an example relationship of the MCN and the TMN. The interfaces between the various elements (e.g. OS, WS, NE) and the MCN, as illustrated in Figure 6-3, are logical and can be supported over a single physical MCN interface or multiple MCN interfaces.

Figure 6-4 illustrates an example of a physical implementation of a MCN supporting distributed management communications. Depending on the choice of implementation of the MCN, the physical elements may support any combination of ECC interfaces, LAN interfaces, and WAN interfaces. Figure 6-4 also illustrates the types of management plane functional blocks that can be supported in various physical elements. Refer to ITU-T Recs M.3010 and M.3013 for detailed specifications regarding these management functional blocks. A Data Communications Function (DCF) is part of each physical element and provides data communication functions.

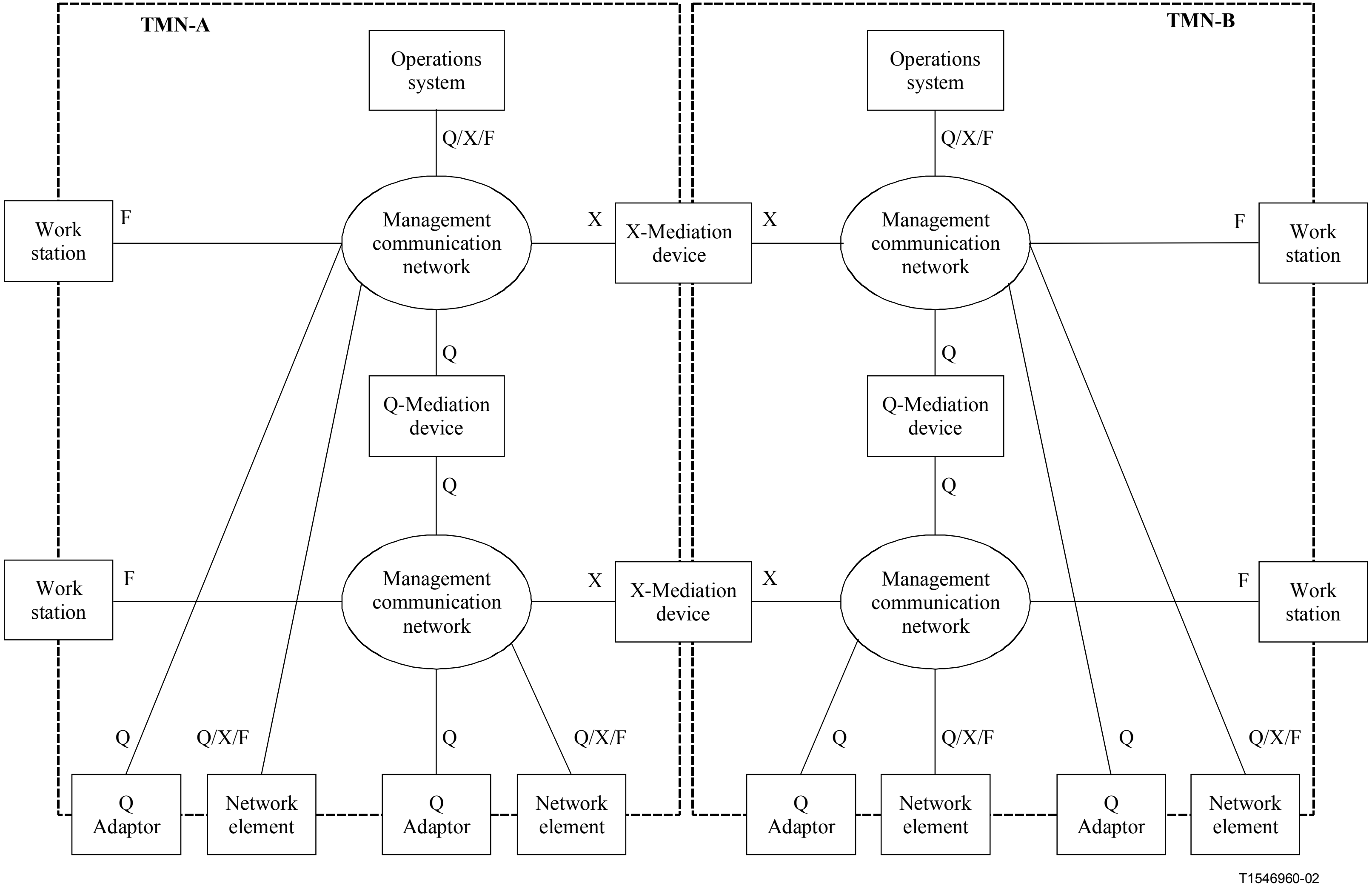


Figure 6-3/G.7712/Y.1703 – Example relationship of TMN interfaces and MCN

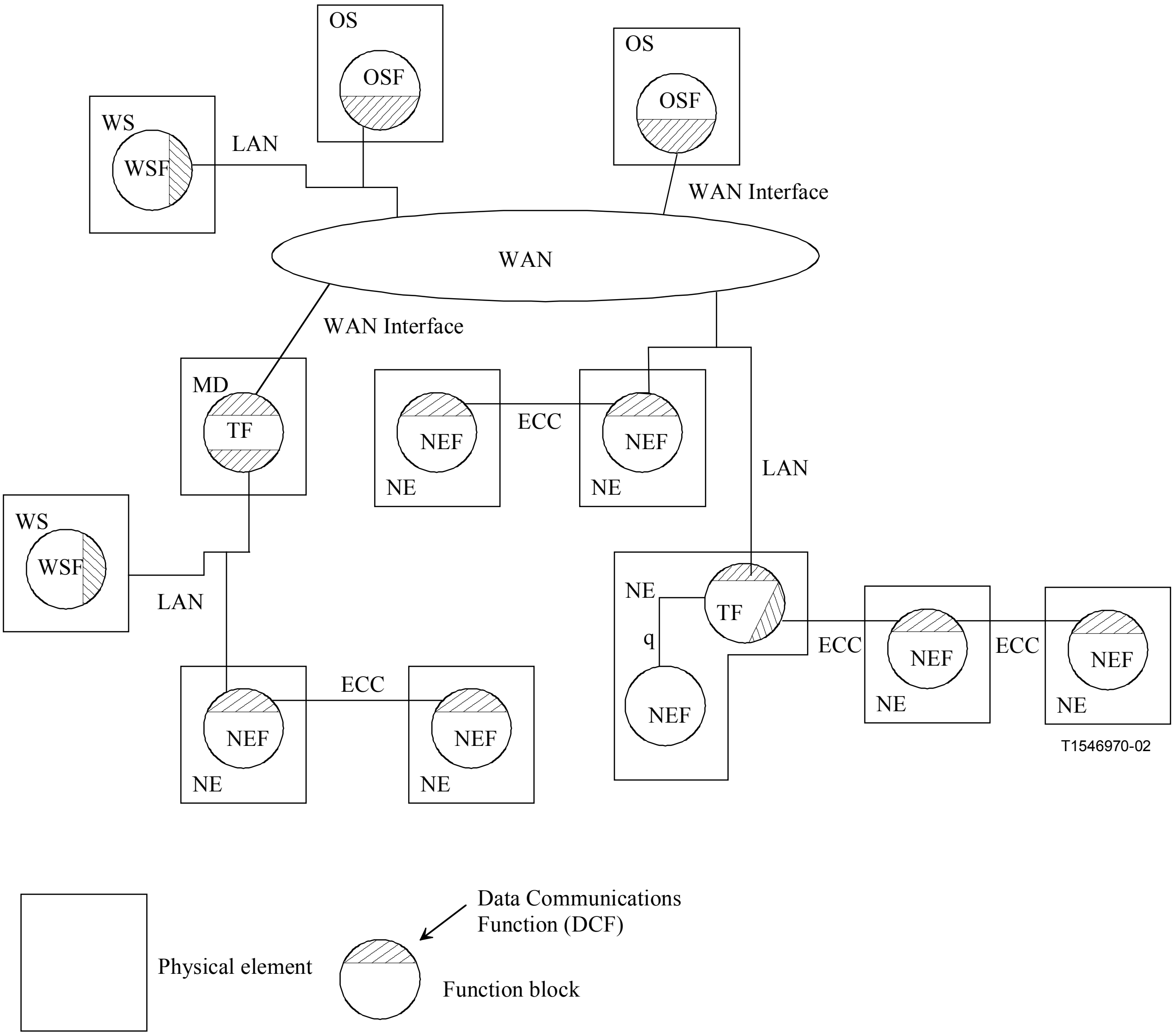


Figure 6-4/G.7712/Y.1703 – Example of physical implementation of MCN supporting TMN

6.1.1 X Management Subnetwork Architecture

In Figure 6-5, a number of points should be noted concerning the architecture of an X Management Subnetwork (xMS):

– Multiple NEs at a single site:

Multiple addressable SDH or OTN NEs may appear at a given site. For example, in Figure 6-5, NE_E and NE_G may be collocated at a single equipment site.

– SDH/OTN NEs and their communication functions:

The message communications function of an SDH or OTN NE terminates (in the sense of the lower protocol layers), routes or otherwise processes messages on the ECC, or connected via an external interface.

i) All NEs are required to terminate the ECC. This means that each NE must be able to perform the functions of an OSI end system or IP host.

ii) NEs may also be required to route ECC messages between ports according to routing control information held in the NE. This means that an NE may also be required to perform the functions of an OSI intermediate system or IP router.

– SDH/OTN inter-site communications:

The inter-site or inter-office communications link between SDH/OTN NEs may be formed from the SDH/OTN ECCs.

– SDH/OTN intra-site communications:

Within a particular site, SDH/OTN NEs may communicate via an intra-site ECC or via a Local Communications Network (LCN). Figure 6-5 illustrates both instances of this interface.

NOTE – A standardized LCN for communicating between collocated network elements has been proposed as an alternative to the use of an ECC. The LCN would potentially be used as a general site communications network serving SDH, OTN, and non-SDH/OTN NEs (NNEs).

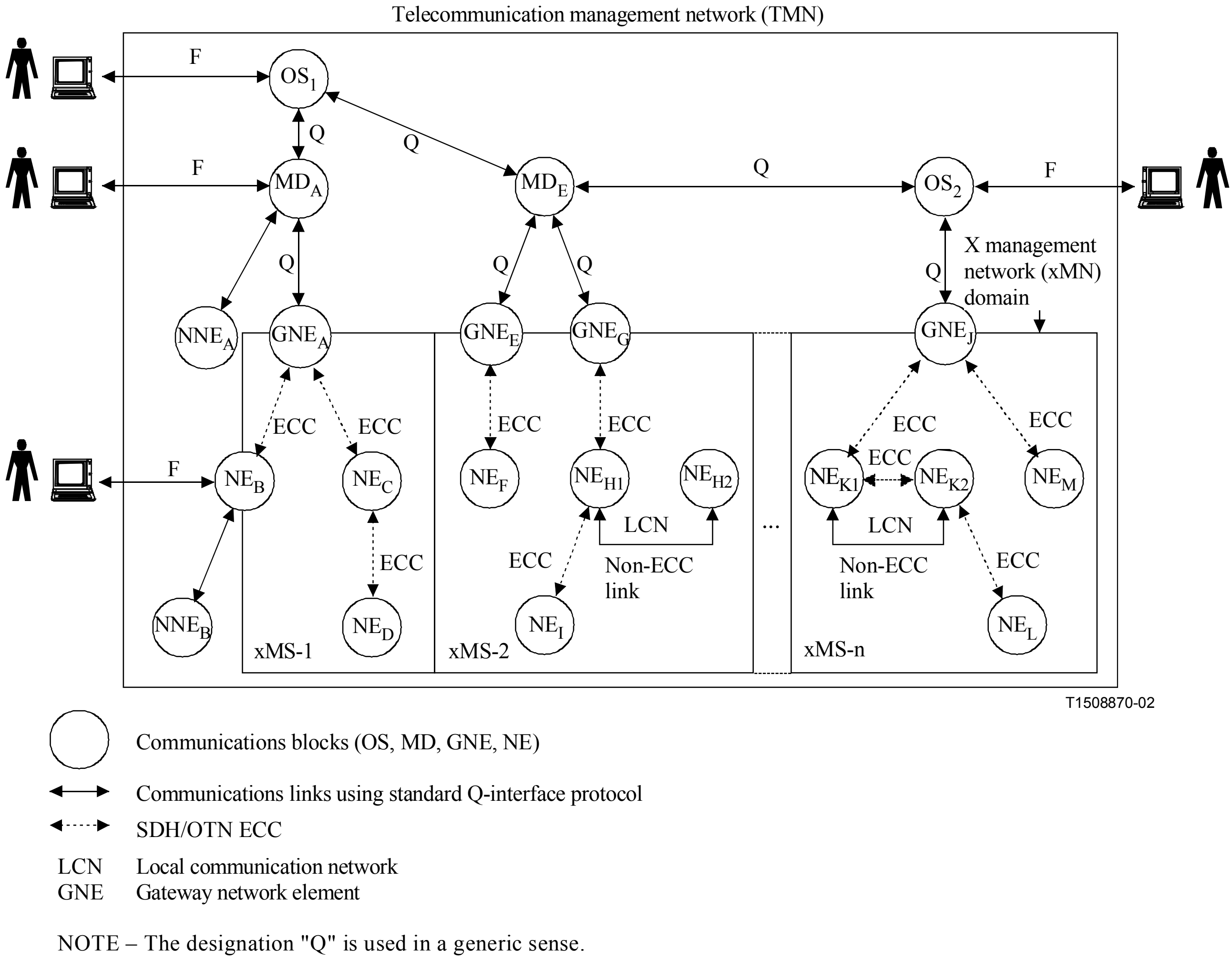


Figure 6-5/G.7712/Y.1703 – TMN, management network and management subnetwork model

6.1.1.1 Topology for management subnetwork

Figure 6-6 illustrates example MCN topologies such as linear, ring, mesh, and star utilizing ECCs and/or Local Communication Networks (LCNs) (e.g. Ethernet LAN) as the physical links interconnecting the Network Elements. Figure 6-7 illustrates how a Management Subnetwork could be supported on each topology. Common to each topology are the dual Gateways (GNE_1 and GNE_2) which allow reliable access to the NEs within the Management Subnetwork. Another common aspect to each of the example topologies is that each topology allows multiple diverse paths between any NE within the Management Subnetwork and the Operation System (OS).

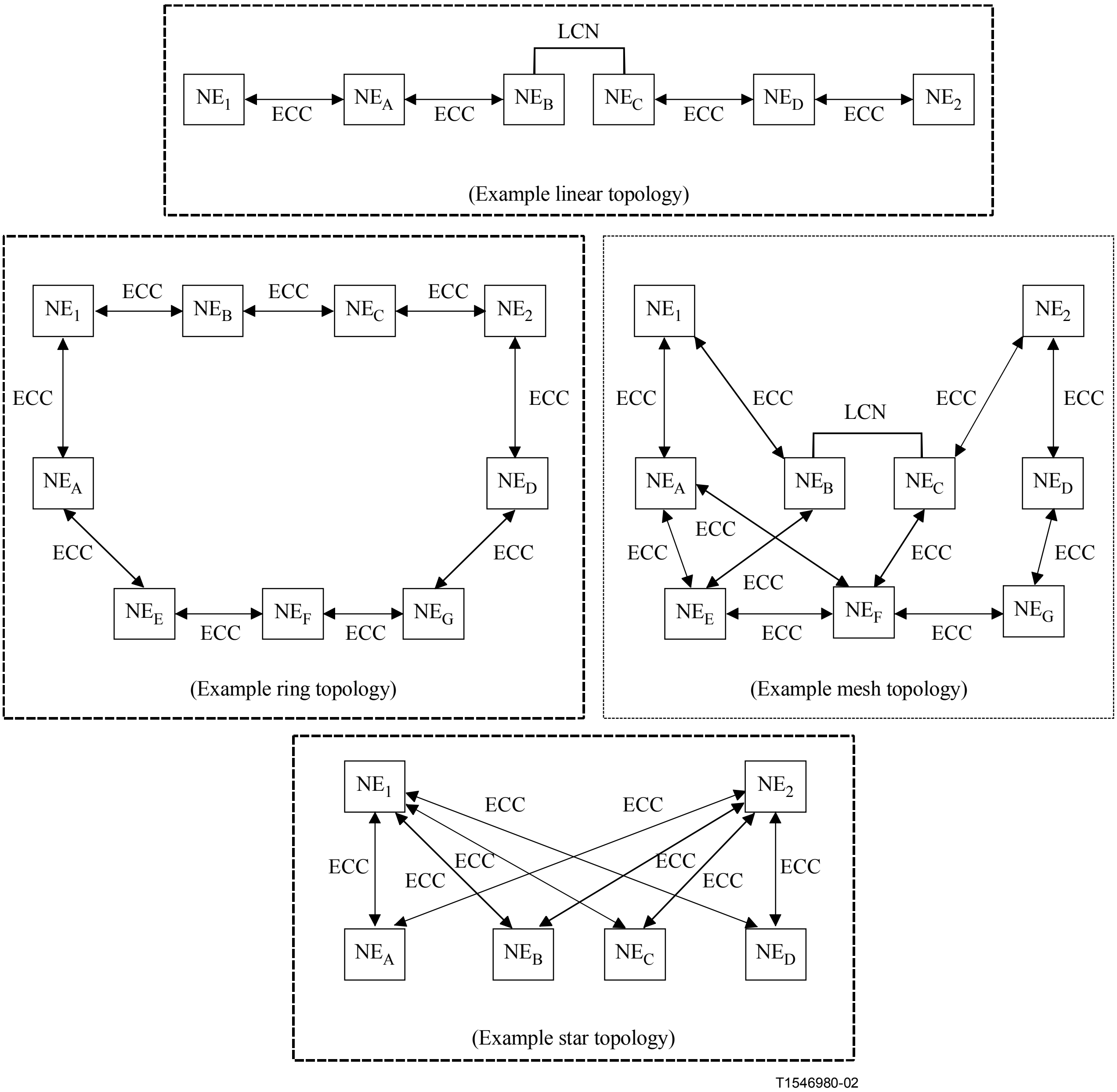


Figure 6-6/G.7712/Y.1703 – Example topologies

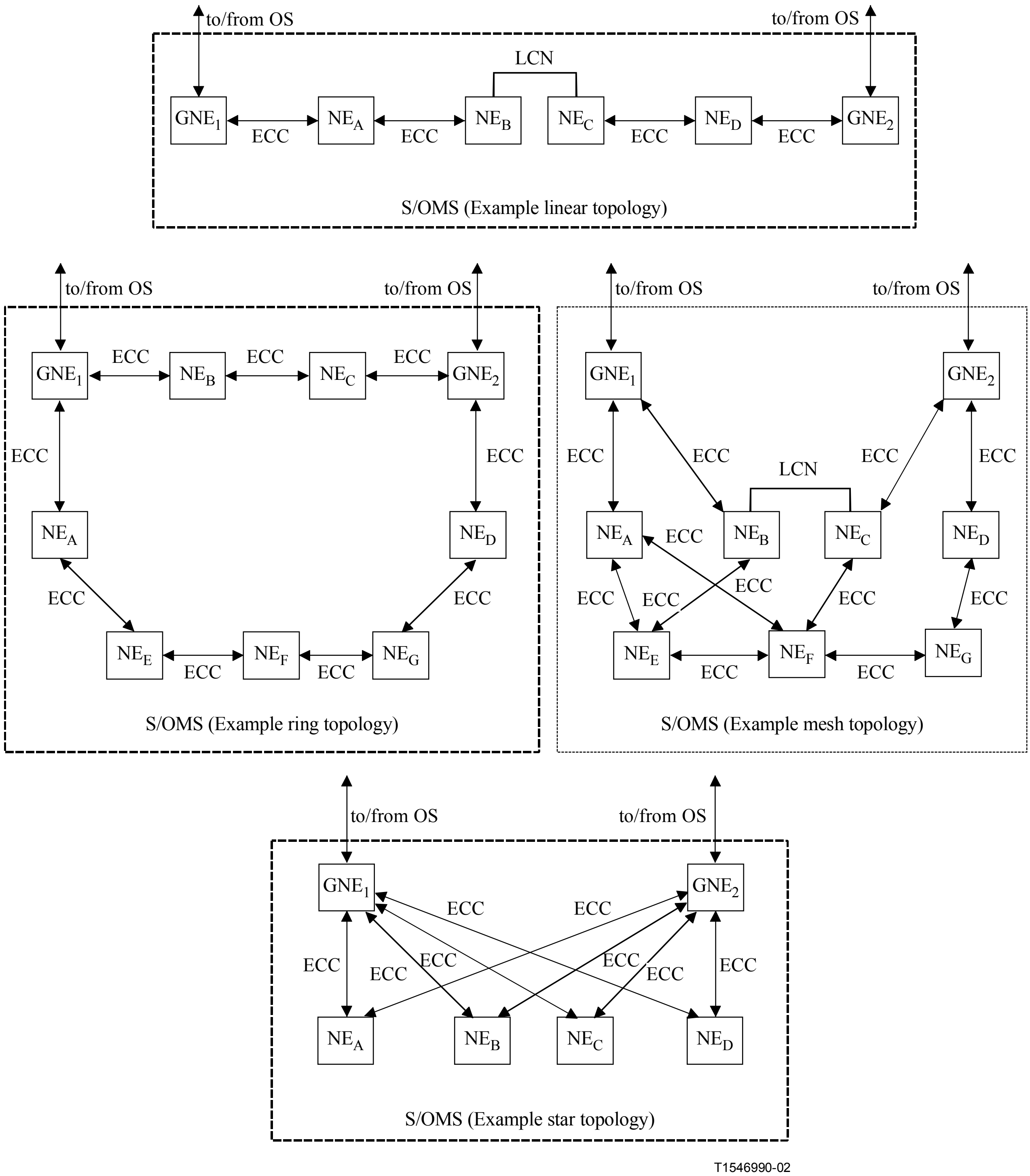


Figure 6-7/G.7712/Y.1703 – Supporting a management subnetwork on various topologies

6.1.2 Reliability of MCN

A MCN should be designed to prevent a single fault from making the transfer of critical management messages impossible.

A MCN should be designed to ensure that congestion in the MCN does not cause the blocking or excessive delay of network management messages that are intended to correct a failure or fault.

OSs and NEs that provide an emergency function may require alternate or duplicate access channels to the MCN for redundancy.

6.1.3 Security of MCN

See ITU-T Rec. M.3016 for MCN security requirements.

6.1.4 MCN data communications functions

The DCF within the TMN entities shall support End System (ES) (in OSI terms) or Host (in IP terms) functionality.

– When the DCF within the TMN entities support ECC interfaces, the following functions are required to be supported:
  - ECC Access Function (as specified in 7.1.1)
  - ECC Data-Link Termination Function (as specified in 7.1.2)
  - [Network Layer PDU into ECC Data-Link Layer] Encapsulation Function (as specified in 7.1.3)

– When the DCF within the TMN entities support Ethernet LAN interfaces, the following functions are required to be supported:
  - Ethernet LAN physical layer termination function (as specified in 7.1.4)
  - [Network Layer PDU into Ethernet Frame] Encapsulation Function (as specified in 7.1.5)

The DCF within the TMN entities may operate as an Intermediate System (IS) (in OSI terms) or as a Router (in IP terms). The DCF within TMN entities that operate as IS/Routers must be capable of routing within their Level 1 area and therefore must provide the functionality of a Level 1 IS/Router. Additionally, the DCF within a TMN entity may be provisioned as a Level 2 IS/Router, which provides the capability of routing from one area to another. The functionality of a Level 2 IS/Router is not needed in the DCF of all TMN entities. An example of a DCF supporting Level 2 IS/Router functionality might be the DCF within a gateway NE.

– When the DCF within the TMN entities operate as an IS/Router, the following functions are required to be supported:
  - Network Layer PDU Forwarding Function (as specified in 7.1.6)
  - Network Layer Routing Function (as specified in 7.1.10)

The DCF within a TMN entity that supports IP may be connected directly to a DCF in a neighboring TMN entity that supports only OSI.

– When the DCF within a TMN entity that supports IP is connected directly to a DCF in a neighboring TMN entity that supports only OSI, the following function is required to be supported in the DCF supporting IP:
  - Network Layer PDU Interworking Function (as specified in 7.1.7)

The DCF within a TMN entity may have to forward a Network Layer PDU across a network that does not support the same Network Layer type.

– When the DCF within a TMN entity must forward a Network Layer PDU across a network that does not support the same Network Layer type, the following functions are required to be supported:
  - Network Layer PDU Encapsulation Function (as specified in 7.1.8)
  - Network Layer PDU Tunnelling Function (as specified in 7.1.9)

The DCF within a TMN entity that supports IP using OSPF routing may be connected directly to a DCF in a neighboring TMN entity that supports IP using IntISIS.

– When the DCF within a TMN entity that supports IP using OSPF routing is connected directly to a DCF in a neighboring TMN entity that supports IP using IntISIS, the following function is required to be supported in the DCF supporting OSPF:

  - IP Routing Interworking Function (as specified in 7.1.11)

6.2 ASTN Application

ASTN requires a communications network, which is referred to as the Signalling Communications Network (SCN) to transport signalling messages between ASTN components (e.g. CC components).

Figure 6-8 illustrates an example relationship of the SCN and the ASTN. The interfaces between the various elements and the SCN as illustrated in Figure 6-8 are logical and can be supported over a single physical SCN interface or multiple SCN interfaces.

Figure 6-9 illustrates an example of a physical implementation of a SCN supporting distributed signalling communications. Depending on the choice of implementation of the SCN, the physical elements may support any combination of ECC interfaces, LAN interfaces, and WAN interfaces. Figure 6-9 also illustrates the types of control plane functional blocks that can be supported in various physical elements. Refer to ITU-T Recs G.807/Y.1302 and G.8080/Y.1304 for detailed specifications regarding these control functional blocks. A Data Communications Function (DCF) is part of each physical element and provides data communication functionality.

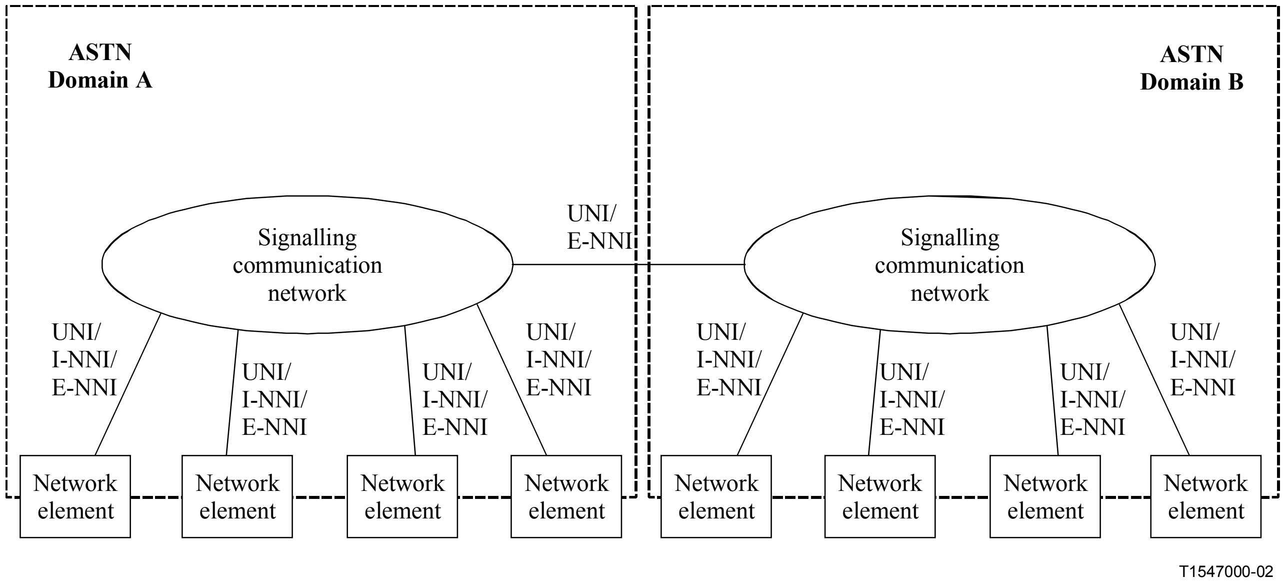


Figure 6-8/G.7712/Y.1703 – Example relationship of ASTN interfaces to SCN

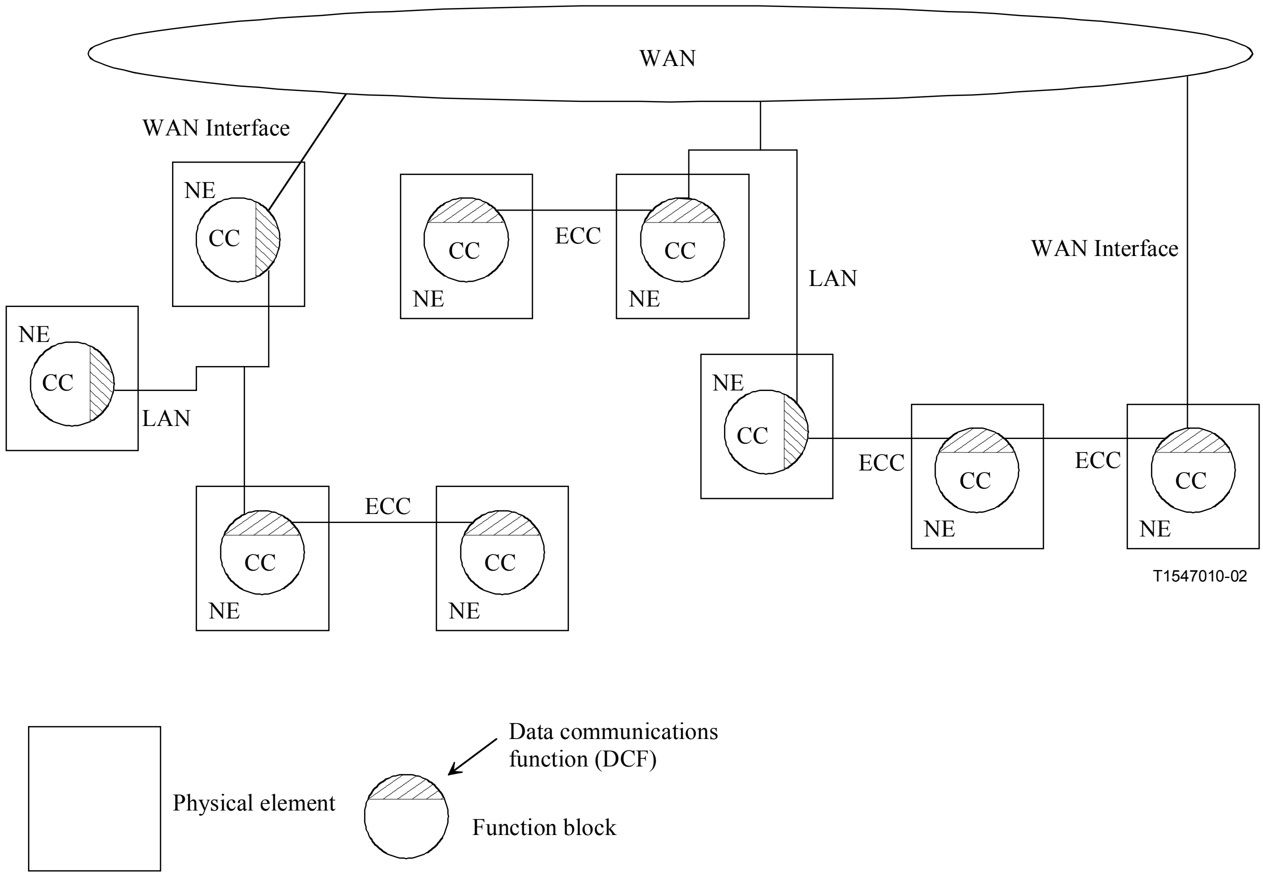


Figure 6-9/G.7712/Y.1703 – Example of physical implementation of SCN supporting ASTN

6.2.1 Topology of SCN

Figure 6-10 illustrates example topologies such as linear, ring, mesh, and star utilizing ECCs and/or Local Communication Networks (LCNs) (e.g. Ethernet LAN) as the physical links interconnecting the Network Elements. Figure 6-11 illustrates how an ASTN Signalling Network could be supported on each topology. Common to each topology is that alternate diverse paths exist between the communicating entities (i.e. the ASTN capable NEs). Note that to support alternate diverse paths between communicating ASTN NEs under a linear topology, an external WAN link could be provided between the edge ASTN NEs.

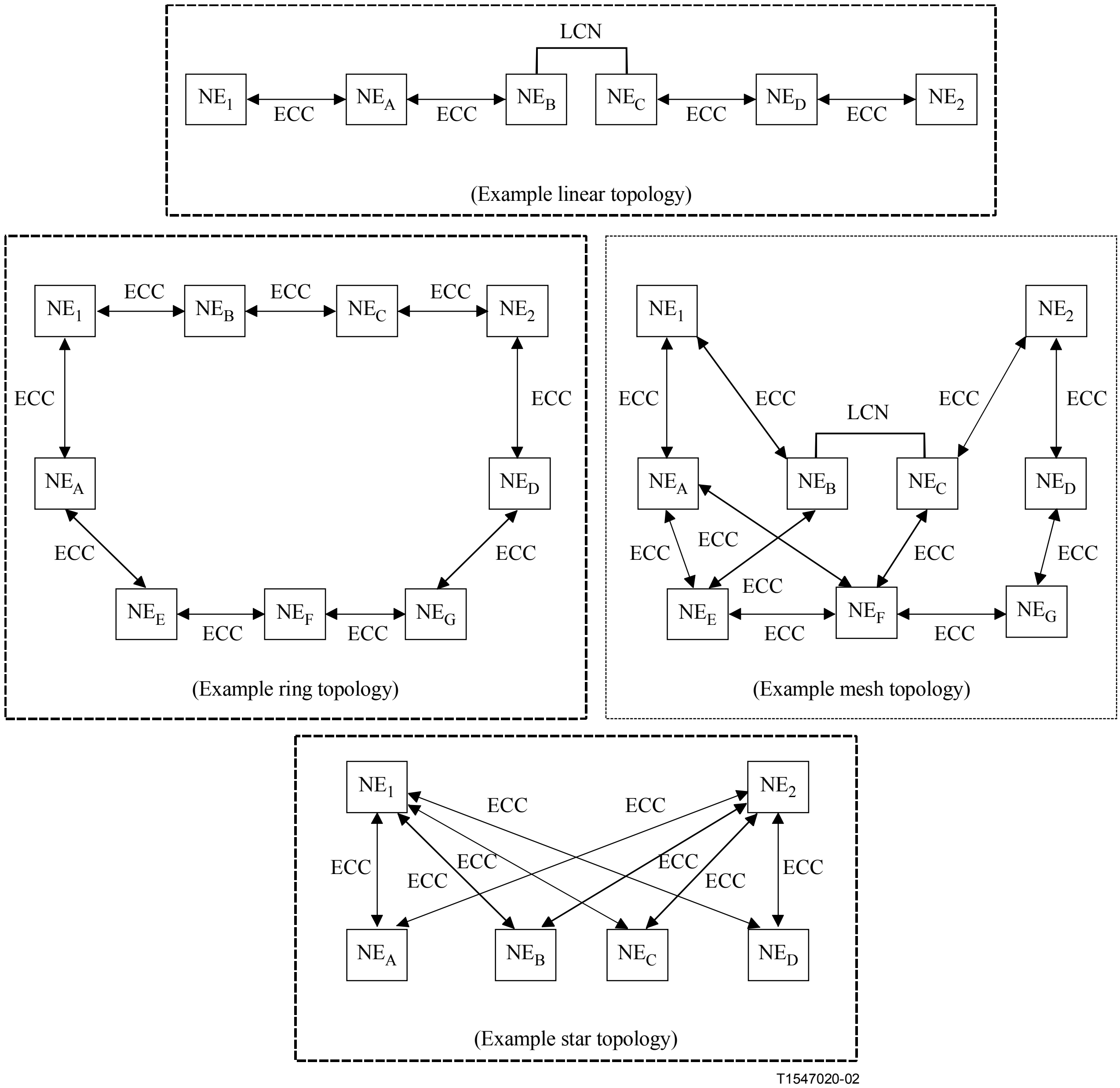


Figure 6-10/G.7712/Y.1703 – Example topologies

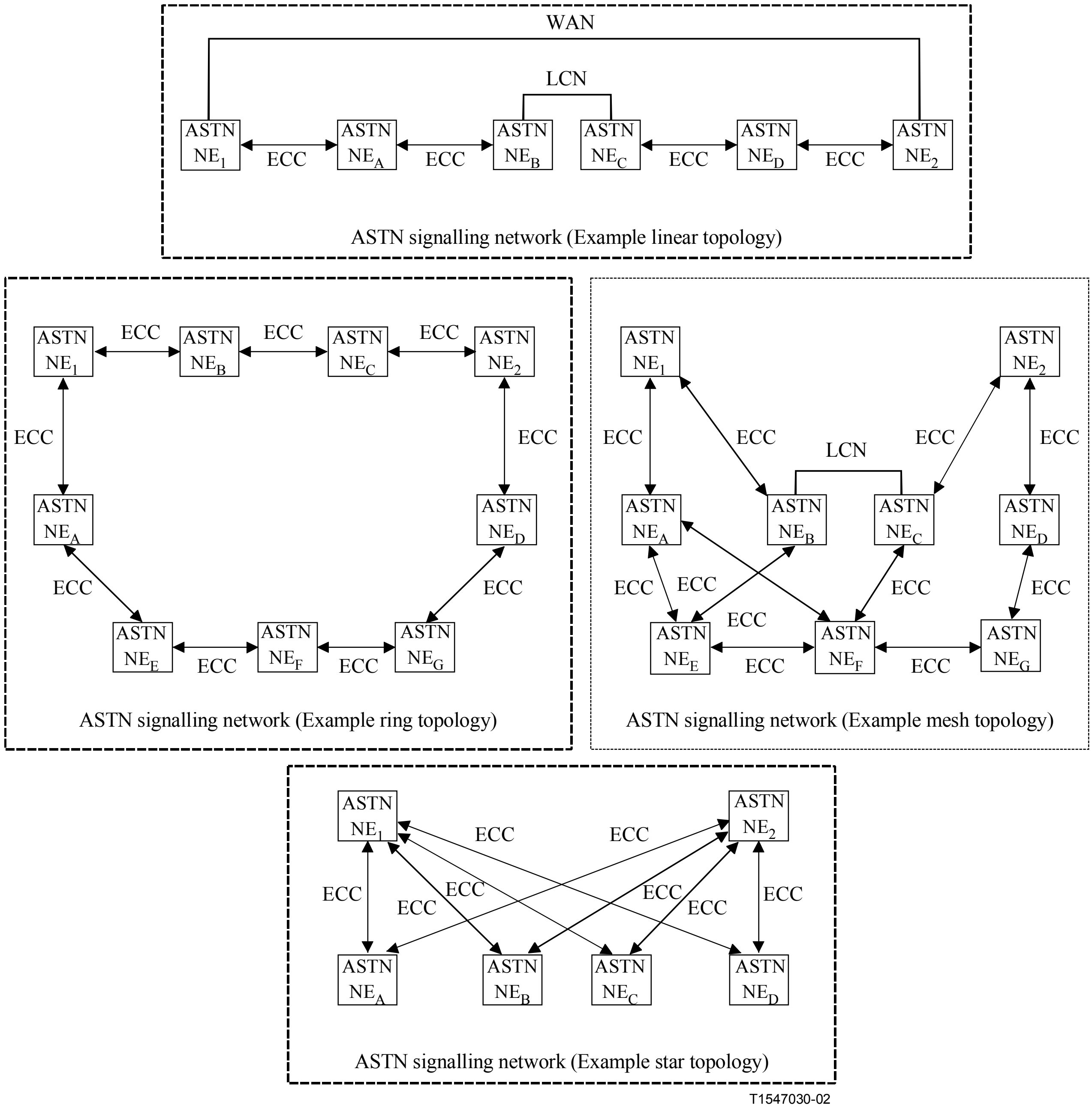


Figure 6-11/G.7712/Y.1703 – Supporting an ASTN signalling network on various topologies

Figure 6-12 illustrates how the ASTN Signalling Network could consist of three different portions; the customer-network portion, the intra-administrative domain portion, and the inter-administrative domain portion. This example shows a mesh topology utilizing ECCs, Local Communication Networks (e.g. Ethernet LAN), and Leased Lines (e.g. DS1/E1, VC-3/4) as the physical links interconnecting the ASTN NEs. The topology of the intra-administrative domain portion allows I-NNI signalling to have alternate diverse paths between two communicating ASTN NEs. The topology of the inter-administrative domain portion depends on agreements between Administrative Domains A and B. This example illustrates dual access points between the Administrative Domains. The topology of the Customer-Network portion depends on agreements between the customer and service provider. This example illustrates a single access point between the customer and the network.

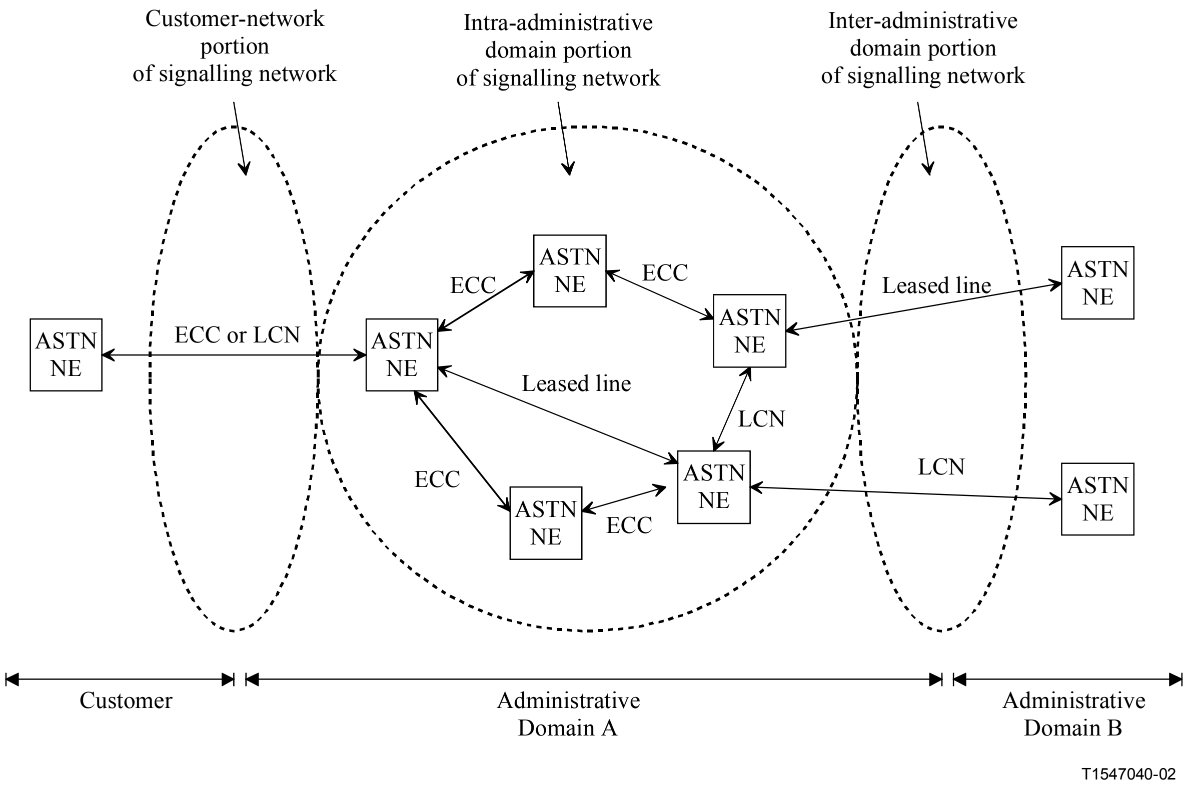


Figure 6-12/G.7712/Y.1703 – Example SCN

6.2.2 Reliability of SCN

Figure 6-13 illustrates ASTN control messages being transported over a SCN. It illustrates the following logical interfaces:

UNI User-to-Network Interface.

NNI Network-to-Network Interface.

CCI Connection Controller Interface.

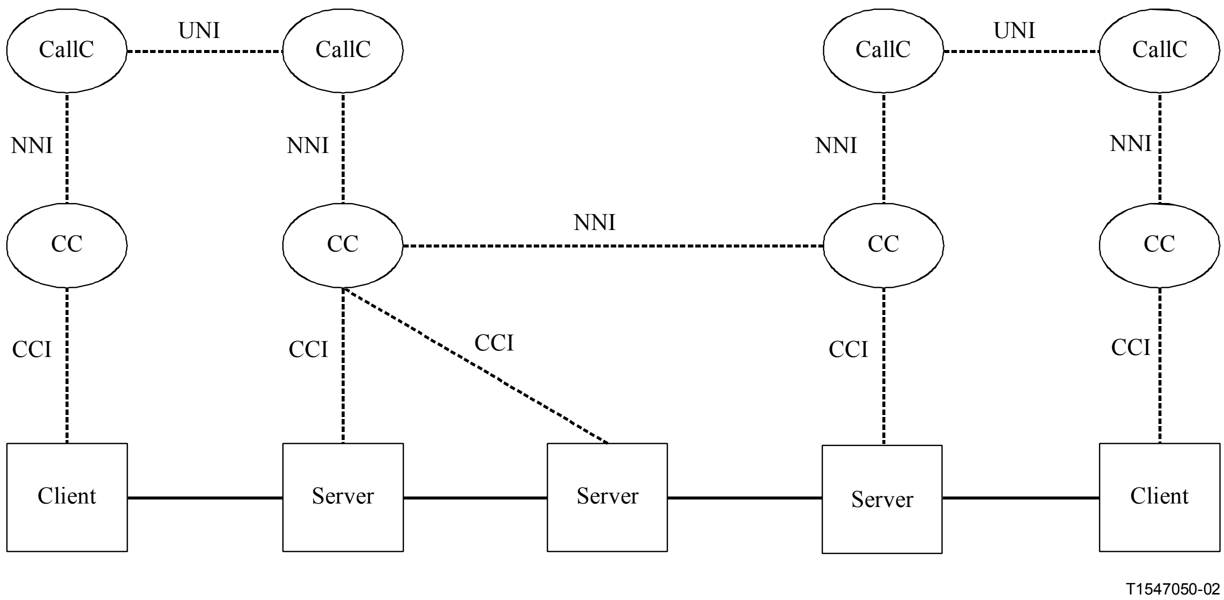


Figure 6-13/G.7712/Y.1703 – ASTN interfaces supported on SCN

In this example, the UNI, NNI, and CCI logical interfaces are carried via the SCN network. The SCN may consist of various subnetworks where logical links in some subnetworks may share common physical routes with the transport network but such is not required or excluded.

It is possible for the SCN to experience an independent failure from the transport network. Such a scenario is illustrated in Figures 6-14 and 6-15. In this example, which focuses on ASTN messages transported over the SCN, an independent failure to the SCN would affect new connection setup and connection teardown requests.

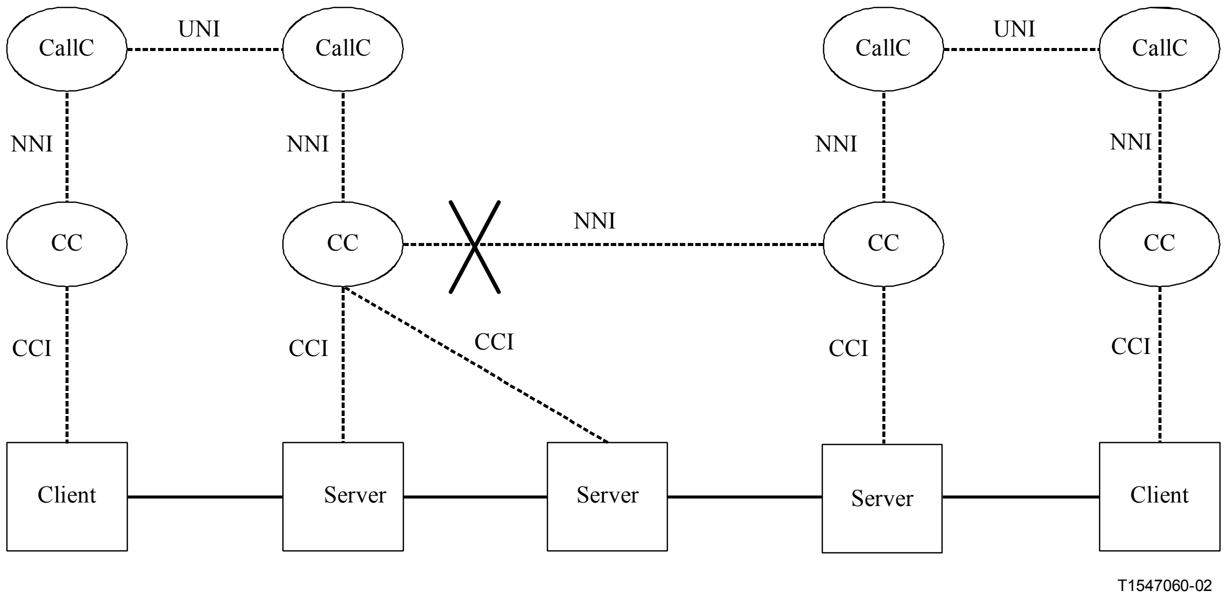


Figure 6-14/G.7712/Y.1703 – SCN failure impacting signalling interface

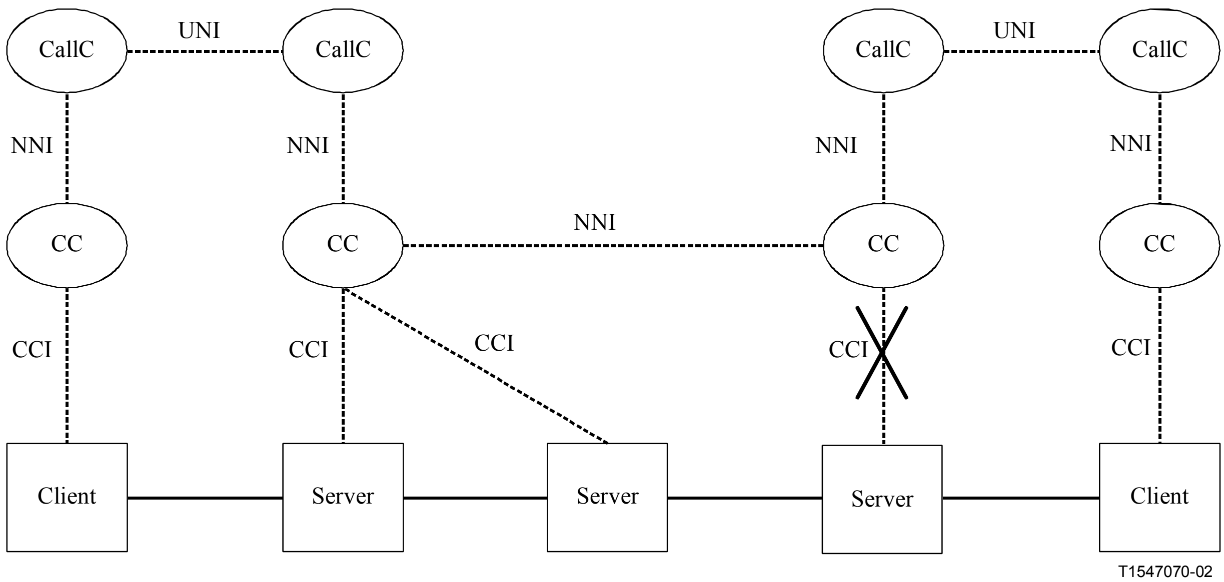


Figure 6-15/G.7712/Y.1703 – SCN failure impacting CCI interface

As indicated in Figure 6-15, it is also possible for some logical links within the SCN to share common physical routes with the transport network. In this case, it is possible for the SCN to experience a failure that is not independent from the transport network (i.e. failure interrupts both SCN traffic as well as transport traffic), as shown in Figure 6-16. In this example, which focuses on ASTN messages transported over the SCN, such a failure may impact restoration when ASTN is used to provide restoration of existing connections. It is therefore critical for the SCN to provide resiliency when transporting restoration messages.

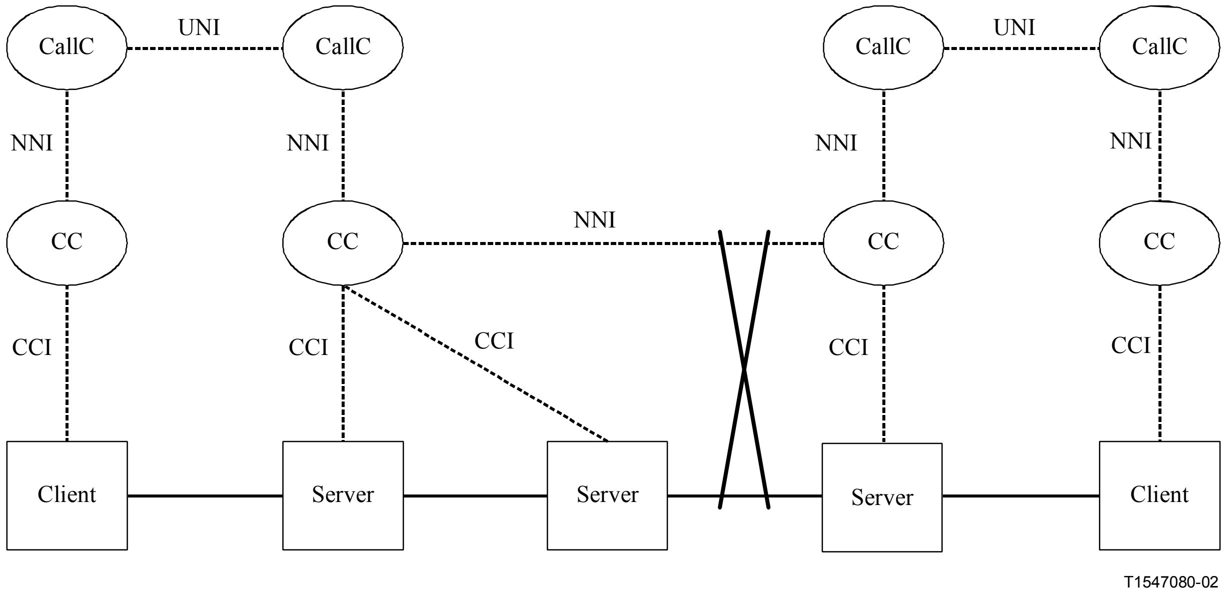


Figure 6-16/G.7712/Y.1703 – SCN failure impacting both signalling and data interfaces

If the ASTN application is only used to provide connection setup and teardown, a connectionless SCN may be sufficient. However, if the ASTN application is also used to provide restoration, a connection-oriented SCN may be required. A connection-oriented SCN would require specification of additional functions to support connection-oriented network services.

The SCN reliability requirements are as follows:

The SCN shall support various levels of restoration depending on the reliability requirements of the communicating components for which it provides transport (i.e. restoration can be supported between those communicating components requiring highly reliable communications without requiring restoration to be supported among all communicating components).

The SCN may provide transport for restoration messages. In such a case, the SCN shall provide restoration speeds which allow proper operation of the connections for which the restoration messages control.

6.2.3 Security of SCN

A SCN supporting ASTN messages may provide connectivity between different administrative domains to support the transport of UNI or E-NNI messages (i.e. messages which cross administrative boundaries). I-NNI messages are only allowed within a single administrative domain. When a SCN provides connectivity between administrative boundaries there must be precautions taken such that only those messages (e.g. E-NNI messages) that are allowed to pass between the two administrative domains are able to cross the interface while other messages which are not allowed to pass between administrative domains (e.g. I-NNI messages) are prevented from crossing the interface. Figure 6-17 illustrates an example where a SCN supporting the transport of ASTN messages is interconnected to multiple administrative domains. The SCN needs to ensure that only a select set of messages, which are allowed by the administrative parties on either side of the interface, are actually able to pass across the interface.

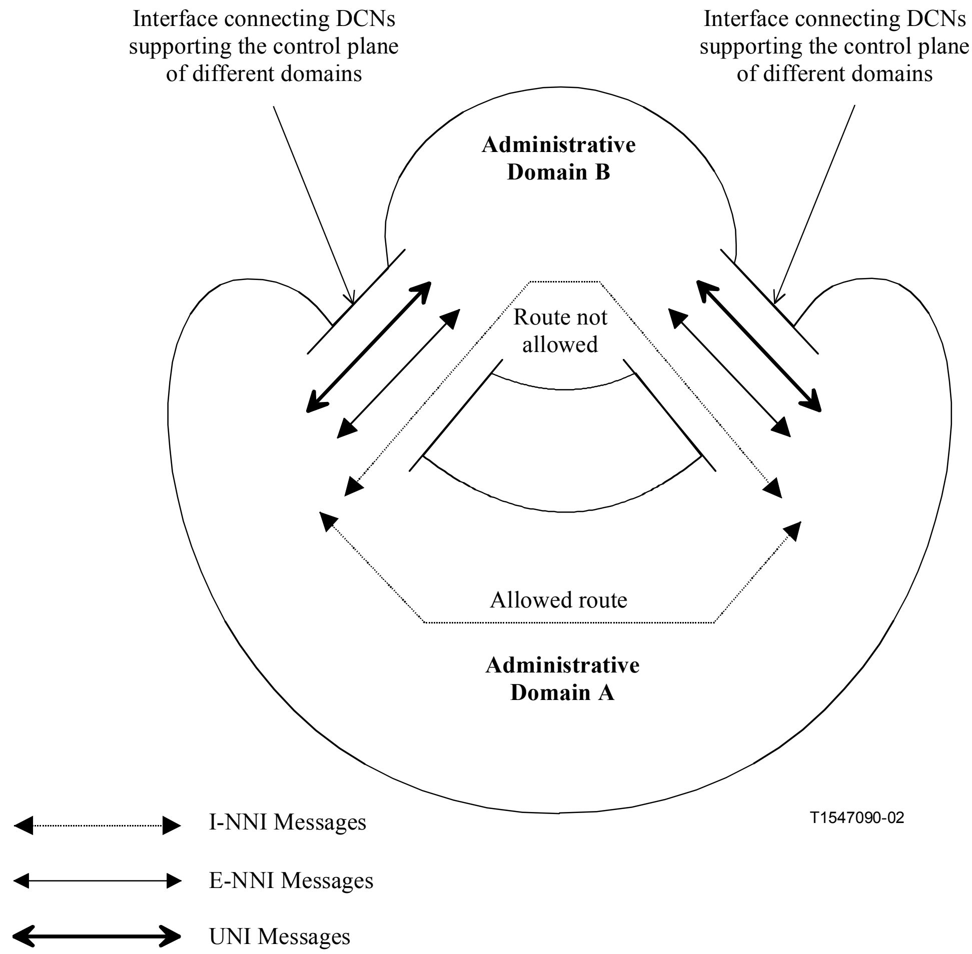


Figure 6-17/G.7712/Y.1703 – Security aspects of SCN

6.2.4 SCN Data Communication Functions

The DCF within the ASTN entities shall support End System (ES) (in OSI terms) or Host (in IP terms) functionality.

– When the DCF within the ASTN entities support ECC interfaces, the following functions are required to be supported:
  - ECC Access Function (as specified in 7.1.1)
  - ECC Data-Link Termination Function (as specified in 7.1.2)
  - [Network Layer PDU into ECC Data-Link Layer] Encapsulation Function (as specified in 7.1.3)

– When the DCF within the ASTN entities support Ethernet LAN interfaces, the following functions are required to be supported:
  - Ethernet LAN Physical Layer Termination Function (as specified in 7.1.4)
  - [Network Layer PDU into Ethernet Frame] Encapsulation Function (as specified in 7.1.5)

The DCF within the ASTN entities may operate as an Intermediate System (IS) (in OSI terms) or as a Router (in IP terms). The DCF within ASTN entities that operate as IS/Routers must be capable of routing within their Level 1 area and therefore must provide the functionality of a Level 1 IS/Router. Additionally, the DCF within an ASTN entity may be provisioned as a Level 2 IS/Router, which provides the capability of routing from one area to another. The functionality of a Level 2 IS/Router is not needed in the DCF of all ASTN entities.

– When the DCF within the ASTN entities operate as an IS/Router, the following functions are required to be supported:
  - Network Layer PDU Forwarding Function (as specified in 7.1.6)
  - Network Layer Routing Function (as specified in 7.1.10)

The DCF within a ASTN entity that supports IP may be connected directly to a DCF in a neighboring ASTN entity that supports only OSI.

– When the DCF within an ASTN entity that supports IP is connected directly to a DCF in a neighboring TMN entity that supports only OSI, the following function is required to be supported in the DCF supporting IP:
  - Network Layer PDU Interworking Function (as specified in 7.1.7)

The DCF within a ASTN entity may have to forward a Network Layer PDU across a network that does not support the same Network Layer type.

– When the DCF within a ASTN entity must forward a Network Layer PDU across a network that does not support the same Network Layer type, the following functions are required to be supported:
  - Network Layer PDU Encapsulation Function (as specified in 7.1.8)
  - Network Layer PDU Tunnelling Function (as specified in 7.1.9)

The DCF within a ASTN entity that supports IP using OSPF routing may be connected directly to a DCF in a neighboring ASTN entity that supports IP using IntISIS.

– When the DCF within an ASTN entity that supports IP using OSPF routing is connected directly to a DCF in a neighboring ASTN entity that supports IP using IntISIS, the following function is required to be supported in the DCF supporting OSPF:
  - IP Routing Interworking Function (as specified in 7.1.11)

6.3 Other Applications Requiring Communication Networks

Besides TMN and ASTN applications, other applications such as voice communications (e.g. orderwire), software downloads and operator specific communications require a communications network to provide transport of information between components.

6.4 Separation of Various Applications

Depending on the network design, network size, link capacity, security requirements and performance requirements, various levels of separation between the multiple applications (e.g. TMN, ASTN) are possible. The level of separation that is provided is a choice that is made among operators and vendors when designing the network. The following are examples of various levels of separation.

Option A: The DCN can be designed such that the MCN, SCN, and other applications (e.g. operator specific communications) are supported on the same Layer 3 network (e.g. share the same IP network).

Option B: The DCN can be designed such that the MCN, SCN, and other applications (e.g. operator specific communications) are supported on separate Layer 3 networks, however, they may share some of the same physical links.

Option C: The DCN can be designed such that the MCN, SCN, and other applications (e.g. operator specific communications) are supported on separate physical networks (i.e. separate Layer 3 networks that do not share any of the same physical links).

7 DCN Functional Architecture and Requirements

The DCN architecture requirements in this clause apply to IP-only Domains, OSI-only Domains, and mixed IP + OSI domains. The DCN architecture requirements are technology independent. Technology-specific Recommendations such as ITU-T Rec. G.784 for SDH and ITU-T Rec. G.874 for OTN, will specify which requirements are applicable for that particular technology.

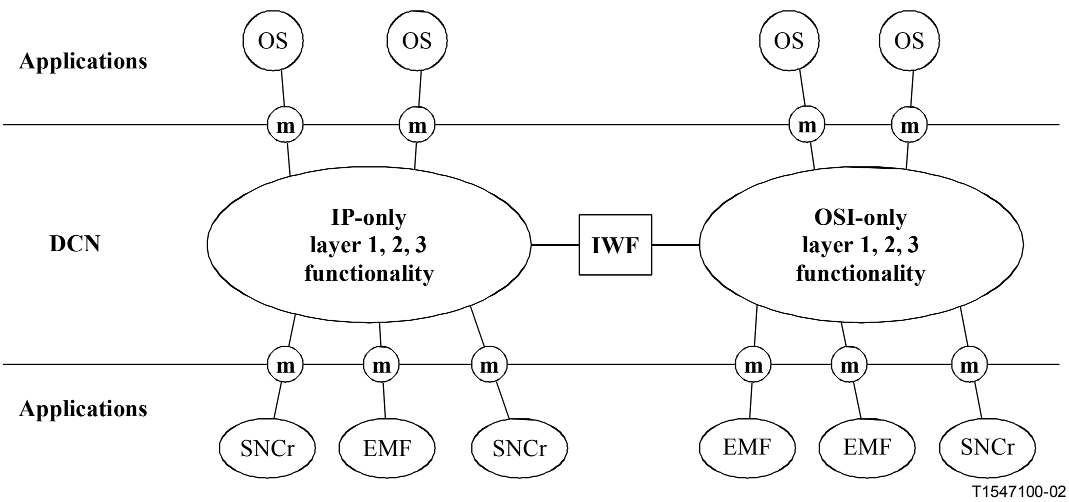
The DCN is aware of Layer 1, Layer 2, and Layer 3 protocols and is transparent to upper-layer protocols used by the applications for which it transports.

A DCN may be designed such that only IP is supported. A DCN supporting only IP may consist of various subnetworks using different physical and data link layer protocols, however, all subnetworks will support IP as the network layer protocol.

However, since embedded DCN networks support OSI, some DCNs may consist of parts that support IP-only, parts that support OSI-only, and parts that support both IP and OSI.

Those parts of the DCN supporting IP (i.e. either those parts supporting only IP or those parts supporting IP and OSI) may consist of DCFs that support IP-only (i.e. a single stack IP-only DCFs) and/or DCFs supporting IP and OSI (e.g. a dual-stack DCF which is capable of routing both IP and OSI packets). Those parts of the DCN supporting only OSI, would consist of DCFs that support OSI-only (i.e. a single stack OSI-only DCF).

Figure 7-1 illustrates the functional architecture of the DCN. As discussed above, the DCN may be composed of parts that only support IP, parts that only support OSI, and parts that support both IP and OSI. An Interworking Function (IWF) between those parts of the DCN supporting IP only, OSI only, and IP and OSI, and mapping functions which map applications to the IP layer are also specified. To provide such transport, the DCN supports Layer 1 (physical), Layer 2 (data-link), and Layer 3 (network) functionality. The architecture requirements for those parts of the DCN supporting IP only, OSI only as well as the requirements for interworking between those parts of the DCN supporting IP only, OSI only, and IP and OSI) are specified. The cloud in Figure 7-1, representing the IP only part of the DCN, is an abstract view of the DCN and therefore may also apply to a single IP NE interconnected to OSI NEs via an IWF.



EMF Equipment management function
IWF Interworking function
m Mapping between application and DCN
OS Operations system
SNCr Subnetwork connection controller

Figure 7-1/G.7712/Y.1703 – Functional architecture of DCN

7.1 Specification of Data Communication Functions

This clause provides specifications for various data communication functions related to ECC interfaces, Ethernet LAN interfaces, and network layer capabilities.

7.1.1 ECC Access Function

An ECC Access Function provides access to the ECC bit stream. This function is defined in technology specific equipment Recommendations (e.g. ITU-T Recs G.783 and G.798). The bit rates and definitions of the various ECCs (e.g. DCC, GCC, and COMMS OH in OSC) is provided in the technology specific Recommendations (e.g. ITU-T Recs G.784 and G.874).

7.1.2 ECC Data-Link Layer Termination Function

An ECC Data-Link Layer Termination Function provides the common data-link layer processing regardless of the network layer PDU encapsulated within the Data-Link Layer Frame. The mapping of the Data-Link Layer Frame into the ECC is also provided by this function. This function is specified in the technology specific Recommendations. However, the specification for the SDH ECC Data-Link Layer Termination Function is provided below.

7.1.2.1 SDH ECC Data-Link Layer Termination Function

7.1.2.1.1 Mapping the SDH Data-Link Layer Frame into the ECC

The HDLC framed signal is a serial bit stream containing stuffed frames surrounded by one or more flag sequences. The HDLC framed signal format is defined in ITU-T Rec. Q.921 for LAPD, and IETF RFC 1662 for PPP in HDLC framing. A HDLC frame consists of N octets as presented in Figure 7-2. The HDLC frame is transmitted right to left and top to bottom. A 0 bit is inserted after all sequences of five consecutive 1 bits within the HDLC frame content (octets 2 to N-1) ensuring that a flag or abort sequence is not simulated within a frame.

The mapping of the HDLC framed signal into the DCC channel is bit-synchronous (rather than octet-synchronous) since the stuffed HDLC frame does not necessarily contain an integer number of octets as a consequence of the 0 insertion process. Therefore, there is no direct mapping of a stuffed HDLC frame into bytes within a DCC channel. The HDLC signal generator derives its timing from the ServerLayer/DCC_A function (i.e. the DCC_CI_CK signal) for SDH. The following ServerLayer/DCC_A functions are defined in ITU-T Rec. G.783; MSn/DCC_A function, MS256/DCC_A function, and RSn/DCC_A function.

The HDLC frame signal is a serial bit stream and will be inserted into the DCC channel such that the bits will be transmitted on the STM-N in the same order that they were received from the HDLC frame signal generator.

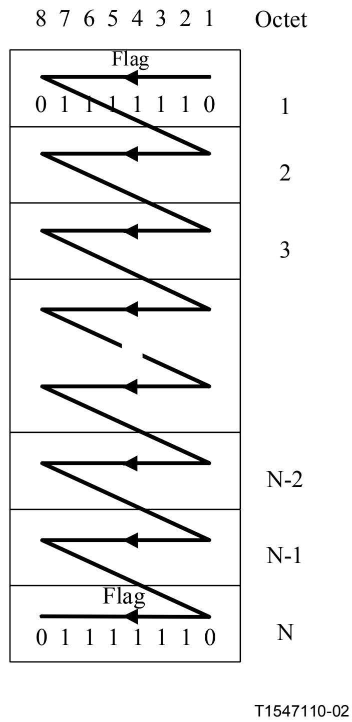


Figure 7-2/G.7712/Y.1703 – HDLC frame format

7.1.2.1.2 SDH ECC Data-Link Layer Protocol Specification

The three types of interfaces identified are; IP-only interfaces, OSI-only interfaces, and Dual interfaces (Dual interfaces are interfaces that can carry both IP and OSI packets). When carrying only IP over the DCC, PPPinHDLC framing shall be used as the data-link layer protocol. Since Dual Interfaces can carry both IP and OSI, it is possible for a Dual Interface to be connected to either an IP-only interface, an OSI-only interface, or another Dual interface. OSI-only interfaces exist in networks today, and the data-link protocol used on such interfaces is LAPD as defined in ITU-T Rec. G.784. To allow Dual Interfaces to connect to either an IP-only interface or an OSI-only interface, the data-link layer protocol supported on a Dual Interface must be configurable to support either PPPinHDLC or LAPD. An exception is allowed for embedded SDH NEs supporting LAPD in hardware that is upgraded to support Dual Interfaces. To limit the amount of hardware upgrades, it is allowed for upgraded SDH NEs to support only LAPD.

7.1.2.1.2.1 IP-only Interface

IP-only interfaces are illustrated in Figure 7-3.

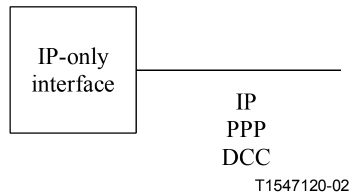


Figure 7-3/G.7712/Y.1703 – IP-only interface

IP-only interfaces shall use PPP as per IETF RFC 1661.

7.1.2.1.2.2 OSI-only Interface

OSI-only interfaces are illustrated in Figure 7-4.

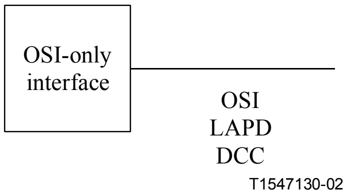


Figure 7-4/G.7712/Y.1703 – OSI-only interface

OSI-only interfaces shall use LAPD as per ITU-T Rec. G.784.

7.1.2.1.2.3 Dual Interface (IP + OSI)

Dual Interfaces (Dual Interfaces are interfaces that can carry OSI and IP packets) can be connected to IP-only interfaces, OSI-only interfaces, or other Dual Interfaces. To allow Dual Interfaces to be connected to other IP-only interfaces or other OSI-only interfaces, the data-link protocol on the Dual Interface must be configurable to switch between PPP in HDLC framing (as per IETF RFC 1662) and LAPD (as per ITU-T Rec. G.784) as illustrated in Figure 7-5. Note that embedded SDH NEs supporting LAPD in hardware that are upgraded to support IP, are not required to support PPP in HDLC framing on its Dual Interfaces. Therefore, its Dual Interfaces are only required to support LAPD.

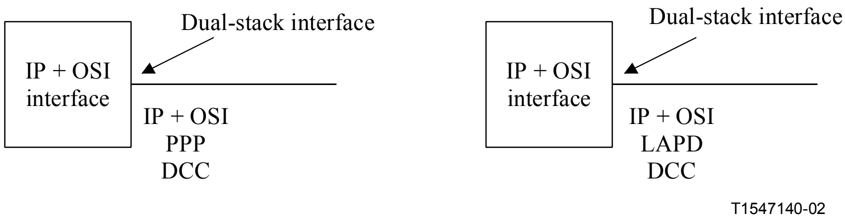


Figure 7-5/G.7712/Y.1703 – Dual interface

Dual interfaces supporting PPP shall use PPP as per IETF RFC 1661.

Dual interfaces supporting LAPD shall use LAPD as per ITU-T Rec. G.784.

7.1.3 [Network Layer PDU into ECC Data-Link Frame] Encapsulation Function

A [Network Layer PDU into ECC Data-Link Frame] Encapsulation Function encapsulates and unencapsulates the Network Layer PDU into the Data-Link Frame. This function also processes the protocol identifier. This function is defined in the technology specific Recommendations. However, the specification for the [Network Layer PDU into SDH ECC Data-Link Frame] Encapsulation Function is provided below.

7.1.3.1 [Network Layer PDU into SDH ECC Data-Link Frame] Encapsulation Function

The specification of the [Network Layer PDU into SDH ECC Data-Link Frame] Encapsulation Function for IP-only interfaces, OSI-only interfaces, and Dual Interfaces is provided below.

7.1.3.1.1 IP-only interface

IP-only interfaces must use only IP/PPPinHDLCframing/DCC as per IETF RFC 1662.

An IP-only interface is defined as follows:

The Transmit End:

– Shall put IPv4 packets directly into PPP Information Field as per IETF RFC 1661 with the IPv4 protocol value as per IETF RFC 1332 into the PPP Protocol Field.

– Shall put IPv6 packets directly into PPP Information Field as per IETF RFC 1661 with the IPv6 protocol value as per IETF RFC 2472 into the PPP Protocol Field.

The Receive End:

– An IPv4 packet is identified if the PPP Protocol Field has the IPv4 protocol value as per IETF RFC 1332.

– An IPv6 packet is identified if the PPP Protocol Field has the IPv6 protocol value as per IETF RFC 2472.

7.1.3.1.2 OSI-only Interface

OSI-only interfaces must use only OSI/LAPD/DCC as per ITU-T Rec. G.784.

An OSI-only interface is defined as follows:

The Transmit End:

– Shall put OSI packets directly into LAPD payload as per ITU-T Rec. G.784

The Receive End:

– Shall inspect the protocol identifier located in the first octet of the LAPD payload. The value of this identifier is consistent with the values assigned in ITU-T Rec. X.263 | ISO/IEC TR 9577. If the PDU received is for a protocol not supported by the receiver, then the PDU shall be discarded.

7.1.3.1.3 Dual (IP + OSI) Interface

A Dual Interface supporting PPP as the data-link protocol is defined as follows:

The Transmit End:

– Shall put OSI packets directly into PPP Information Field as per IETF RFC 1661 with the OSI protocol value as per IETF RFC 1377 into the PPP Protocol Field.

– Shall put IPv4 packets directly into PPP Information Field as per IETF RFC 1661 with the IPv4 protocol value as per IETF RFC 1332 into the PPP Protocol Field.

– Shall put IPv6 packets directly into PPP Information Field as per IETF RFC 1661 with the IPv6 protocol value as per IETF RFC 2472 into the PPP Protocol Field.

The Receive End:

– An OSI packet is identified if the PPP Protocol Field has the OSI protocol value as per IETF RFC 1377.

– An IPv4 packet is identified if the PPP Protocol Field has the IPv4 protocol value as per IETF RFC 1332.

– An IPv6 packet is identified if the PPP Protocol Field has the IPv6 protocol value as per IETF RFC 2472.

A Dual Interface supporting LAPD as the data-link protocol is defined as follows:

The Transmit End:

– Shall put OSI packets directly into LAPD payload as per ITU-T Rec. G.784.

– Shall put IP packets directly into LAPD payload, with a one octet protocol identifier prepended. This identifier will be consistent with the ITU-T Rec. X.263 | ISO/IEC TR 9577 assigned values for IPv4 and IPv6.

The Receive End:

– Shall inspect the protocol identifier located in the first octet of the LAPD payload. The value of this identifier is consistent with the values assigned in ITU-T Rec. X.263 | ISO/IEC TR 9577. If the PDU received is for a protocol not supported by the receiver, then the PDU shall be discarded.

7.1.4 Ethernet LAN Physical Termination Function

An Ethernet LAN Physical Termination Function terminates the physical Ethernet interface.

One or more of the following rates shall be supported: 1 Mbit/s, 10 Mbit/s, 100 Mbit/s.

Access to terminated ECC channels is allowed by Network Elements supporting Ethernet LAN interfaces. Not all network elements supporting ECC channels need to support Ethernet LAN ports, as long as there is an ECC path from a Network Element terminating the ECC channel and another Network Element providing Ethernet LAN ports.

7.1.5 [Network Layer PDU into Ethernet Frame] Encapsulation Function

This function encapsulates and unencapsulates a Network Layer PDU into an 802.3 or Ethernet (version 2) frame.

– It shall encapsulate Network Layer PDUs into 802.3 or Ethernet (version 2) frames according to the following rules:
  - It shall encapsulate and unencapsulate CLNP, ISIS, and ESIS PDUs into 802.3 frames as per ITU-T Rec. Q.811.
  - It shall encapsulate and unencapsulate IP packets into Ethernet (version 2) frames as per IETF RFC 894.
  - IP addresses shall be mapped to Ethernet MAC addresses utilizing the Address Resolution Protocol in IETF RFC 826.

It shall determine the received frame type (802.3 or athernet version 2) as per 2.3.3 IETF RFC 1122.

7.1.6 Network Layer PDU Forwarding function

The Network Layer PDU Forwarding Function forwards network layer packets.

If this function forwards CLNP packets, it shall forward CLNP packets as per Rec. ITU-T Q.811.

If this function forwards IPv4 packets, it shall forward IPv4 packets as per IETF RFC 791.

If this function forwards IPv6 packets, it shall forward IPv6 packets as per IETF RFC 2460.

The preferred addressing format is IPv6. The IP routing protocol should be able to deal with IPv6 and IPv4 addressing.

7.1.7 Network Layer PDU Interworking Function

The Network Layer PDU Interworking Function ensures neighboring DCF functions running different network layer protocols can communicate. The DCF supporting IP is required to support OSI to allow communication to the neighboring DCF supporting only OSI.

7.1.8 Network Layer PDU Encapsulation Function

The Network Layer PDU Encapsulation Function encapsulates and unencapsulates one network layer PDU into another network layer PDU.

CLNP packets shall be encapsulated over IP using Generic Routing Encapsulation (GRE), as specified in IETF RFC 2784, as payload in an IP packet using an IP protocol number of 47 (decimal) and with the DF (Don't Fragment) bit not set. As per IETF RFC 2784, the GRE shall contain an Ethertype to indicate what network layer protocol is being encapsulated. The industry standard for OSI Ethertype, which is 00FE (hex) shall be used.

IP packets shall be encapsulated over CLNS using GRE, as specified in IETF RFC 2784, as the data payload of a CLNP Data Type PDU as specified in ISO/IEC 8473-1, using an NSAP selector value of 47 (decimal) and with the SP (segmentation permitted) flag set.

IP packets shall be encapsulated over IP using GRE, as specified in IETF RFC 2784, as payload in an IP packet using an IP protocol number of 47 (decimal) and with the DF (Don't Fragment) bit not set.

7.1.9 Network Layer PDU Tunnelling Function

The Network Layer PDU Tunnelling Function provides a static tunnel between two DCFs supporting the same network layer PDU.

For a tunnel with a configured MTU size, any IP packet that cannot be forwarded over the tunnel because it is larger than the MTU size, and has its DF bit set, should be discarded, and an ICMP unreachable error message (in particular the "fragmentation needed and DF set" code) should be sent back to the originator of the packet.

7.1.10 Network Layer Routing Function

The Network Layer Routing Function routes network layer packets.

A DCF supporting OSI routing shall support ISIS as per ISO/IEC 10589.

A DCF supporting IP routing shall support Integrated ISIS (see 7.1.10.1 for Integrated ISIS requirements) and may also support OSPF as well as other IP routing protocols.

7.1.10.1 Integrated ISIS Requirements

A DCF supporting Integrated ISIS shall support IETF RFC 1195.

A DCF supporting Integrated ISIS shall support Three-Way Handshaking (see Annex A for Three-Way Handshaking requirements).

A DCF supporting Integrated ISIS shall not consider itself a neighbor of another node on the same subnetwork unless the two nodes have at least one network layer protocol in common. This information is present in the protocol supported TLV of ISIS IIH PDUs as specified in IETF RFC 1195.

The lack of a protocol supported TLV in an ISIS IIH PDU indicates that the DCF only supports OSI.

7.1.10.1.1 ISIS Domain-wide IP Prefix Distribution

DCFs supporting Level-1, Level-2 integrated ISIS shall support the advertising of configured IP destination prefixes learned via Level-2 into Level-1 LSPs, as well as IP destination prefixes learned via Level-1 into Level-2 LSPs. The default behaviour, when no IP destination prefixes have been configured, shall be to not propagate any Level-2 prefixes into Level-1 LSPs, while all Level-1 learned prefixes shall be propagated into Level-2 LSPs.

7.1.10.1.1.1 Configuration Prefixes

The operator shall provision two tables that control the propagation of prefixes. One table shall control propagation from Level-1 to Level-2, while the other controls propagation from Level-2 to Level-1.

7.1.10.1.1.2 Tagging of Propagated Prefixes

Since propagating prefixes from Level-2 into Level-1, and subsequently from Level-1 back into Level-2 can introduce routing loops, a tag is necessary to identify the source of the prefix. This tag, called the up/down bit, is stored in the previously unused high-order bit (bit 8) of the Default Metric field in IP Reachability TLVs and IP External Reachability TLVs. Existing implementations of IETF ISIS that support IETF RFC 1195 will not be impacted by the redefinition of this bit as IETF RFC 1195 requires it to be set to zero when originating LSPs, and ignored upon receipt. Further information is available in IETF RFC 2966.

IP Reachability TLVs and IP External Reachability TLVs shall be processed in the same manor. The type of TLV received will be the same type used when the prefix is propagated from the Level-2 to a Level-1 area, as well as from a Level-1 area to the Level-2.

This is different to IETF RFC 1195 which limited IP External Reachability TLVs to appearing only in IETF Level-2 LSPs.

7.1.10.1.1.2.1 Transmission of LSPs with IP Reachability TLVs and IP External Reachability TLVs

As with normal IETF RFC 1195, the value of the up/down bit shall be zero for all IP TLVs in Level-2 LSPs. The value of the up/down bit shall be zero for Level-1 LSPs originated within a Level-1 area.

The up/down bit shall be set to one in an IP TLVs in Level-1 LSP when a Level-1, Level-2 integrated ISIS NEs is propagating a configured prefix from Level-2 to Level-1.

7.1.10.1.1.2.2 Reception of LSPs with IP Reachability TLVs and IP External Reachability TLVs

A DCF supporting Integrated ISIS shall ignore the value of the up/down bit when developing routes for use within a Level-1 area or for the Level-2.

A DCF supporting Level-1, Level-2 Integrated ISIS that receives an LSP with an IP TLV for a prefix that matches an entry in the Level-1 to Level-2 Propagation table shall advertise the appropriate prefix from Level-1 to Level-2.

A DCF supporting Level-1, Level-2 Integrated ISIS that receives an LSP with an IP TLV with the up/down bit set to one, shall never use the prefix for propagation of information from Level-1 to Level-2.

7.1.10.1.1.2.3 Use the up/down bit in Level-2 LSPs

The use of up/down bit in Level-2 LSPs is for further study.

7.1.10.1.1.3 Route Preference

Given that prefixes can now be propagated from Level-2 to Level-1, the Route Preferences specified in IETF RFC 1195 must be updated to take into account this new source. The resulting Route Preference order is as follows:

1) L1 intra-area routes with internal metric.
   L1 external routes with internal metric.
2) L2 intra-area routes with internal metric.
   L2 external routes with internal metric.
   Inter-area routes propagated from L1 into the L2 with internal metric.
   Inter-area external routes propagated from L1 into the L2 with internal metric.
3) Inter-area routes propagated from L2 into an L1 area with internal metric.
   External routes propagated from L2 into an L1 area with internal metric.

4) L1 external routes with external metric.

5) L2 external routes with external metric.
Inter-area external routes propagated from L1 into the L2 with external metric.

6) Inter-area external routes propagated from L2 into an L1 area with external metric.

7.1.11 IP Routing Interworking Function

A DCF supporting the IP Routing Interworking Function shall support route filtering mechanisms as per 7.5 and 7.6 of IETF RFC 1812 so that networks with two routing protocols can be connected via more than one exchange point.

7.1.12 [Applications to Network Layer] Mapping Function

OSI applications running over (a part of) the DCN that only supports IP may be mapped into IP as specified in the 2.1.6/Q.811 dealing with the IETF RFC 1006/TCP/IP protocol profile. Such a mapping is a Layer 4 solution and is therefore outside the scope of this Recommendation. Another option for carrying OSI applications across (a part of) the DCN that only supports IP is to provide OSI over IP Layer 3 encapsulation as specified in 7.1.8.

The mapping of IP applications over (a part of) the DCN supporting IP shall be in accordance with IP suite specifications.

7.2 Provisioning Requirements

Every NE must support the creation of an interface that does not have any physical manifestation. This interface must be provisionable with an IP address.

The LSP size shall be configurable.

This allows the MTU size within the domain to be set.

Area ID provisioning per interface, including ECC channels and LAN, is required for OSPF.

7.3 Security Requirements

Care must be taken to avoid unwanted interactions (addresses, etc.) between a public IP network and a DCN supporting IP.

Annex A

Requirements for Three-way Handshaking

A new ISIS Option type, "Point-to-Point Adjacency State", must be supported by a DCF that routes IP using integrated ISIS as defined below:

Type = 240
Length = 5 to 17 octets
Value:
  Adjacency State (one octet):
    0 = Up
    1 = Initializing
    2 = Down
  Extended Local Circuit ID (four octets)
  Neighbor System ID if known (zero to eight octets)
  Neighbor Extended Local Circuit ID (four octets, if Neighbor System ID is present)

Any DCF that routes IP using Integrated ISIS shall include this option in its Point-to-Point IIH packets.

A DCF that only routes OSI may or may not understand this option and if not will ignore it, and will not include it in its own IIH packets.

All DCFs that support IP, and OSI-only DCFs that are able to process this option, shall follow the procedures below.

Elements of Procedure

The new handshake procedure is added to the ISIS point-to-point IIH state machine after the PDU acceptance tests have been performed.

The existing procedures are only executed if the neighbor is in the proper state for the adjacency to come up.

Although the extended circuit ID is only used in the context of the three-way handshake, it is worth noting that it effectively protects against the unlikely event where a link is moved to another interface on a system that has the same local circuit ID, as the received PDUs will be ignored (via the checks defined below) and the existing adjacency will fail.

The IS shall include the Point-to-Point Adjacency State option in the transmitted Point-to-Point IIH PDU. The current state of the adjacency with its neighbor on the link (as defined in 8.2.4.1 of ISO/IEC 10589) shall be reported in the Adjacency State field. If no adjacency exists, the state shall be reported as Down.

The Extended Local Circuit ID field shall contain a value assigned by this IS when the circuit is created. This value shall be unique among all the circuits of this Intermediate System. The value is not necessarily related to that carried in the Local Circuit ID field of the IIH PDU.

If the system ID and Extended Local Circuit ID of the neighboring system are known (in state Initializing or Up), the neighbor's system ID shall be reported in the Neighbor System ID field, and the neighbor's Extended Local Circuit ID shall be reported in the Neighbor Extended Local Circuit ID field.

A received Point-to-Point IIH PDU may or may not contain the Point-to-Point Adjacency State option. If it does not, the link is assumed to be functional in both directions, and the procedures described in 8.2.4.2 of ISO/IEC 10589 are followed.

If the option is present, the Neighbor System ID and Neighbor Extended Local Circuit ID fields, if present, shall be examined.

If they are present, and the system ID contained therein does not match the local system's ID, or the extended circuit ID does not match the local system's extended circuit ID, the PDU shall be discarded and no further action is taken.

If the Neighbor System ID and Neighbor Extended Local Circuit ID fields match those of the local system, or are not present, the procedures described in 8.2.4.2 of ISO/IEC 10589 are followed with following changes:

a) In 8.2.4.2 a) and b) of ISO/IEC 10589, the action "Up" from state tables 5, 6, 7 and 8 may create new adjacency but the state of the adjacency will be Down.

b) If the action taken from section 8.2.4.2 a) or b) of ISO/IEC 10589 is "Up" or "Accept", the IS shall perform the action indicated by the new state table below, based on the current adjacency state and the received state value from the option. (Note that the procedure works properly if neither field is ever included. This provides backward compatibility to earlier versions of three way handshaking.)

```
                              Received State
                        Down          Initializing         Up
                   ------------------------------------------------
      Down         |  Initialize           Up              Down
                   |
Adj   Initializing |  Initialize           Up              Up
State              |
      Up           |  Initialize           Accept          Accept
```

If the new action is "Down", an adjacencyStateChange(Down) event is generated with the reason "Neighbor restarted" and the adjacency shall be deleted.

If the new action is "Initialize", the adjacency state shall be set to "Initializing".

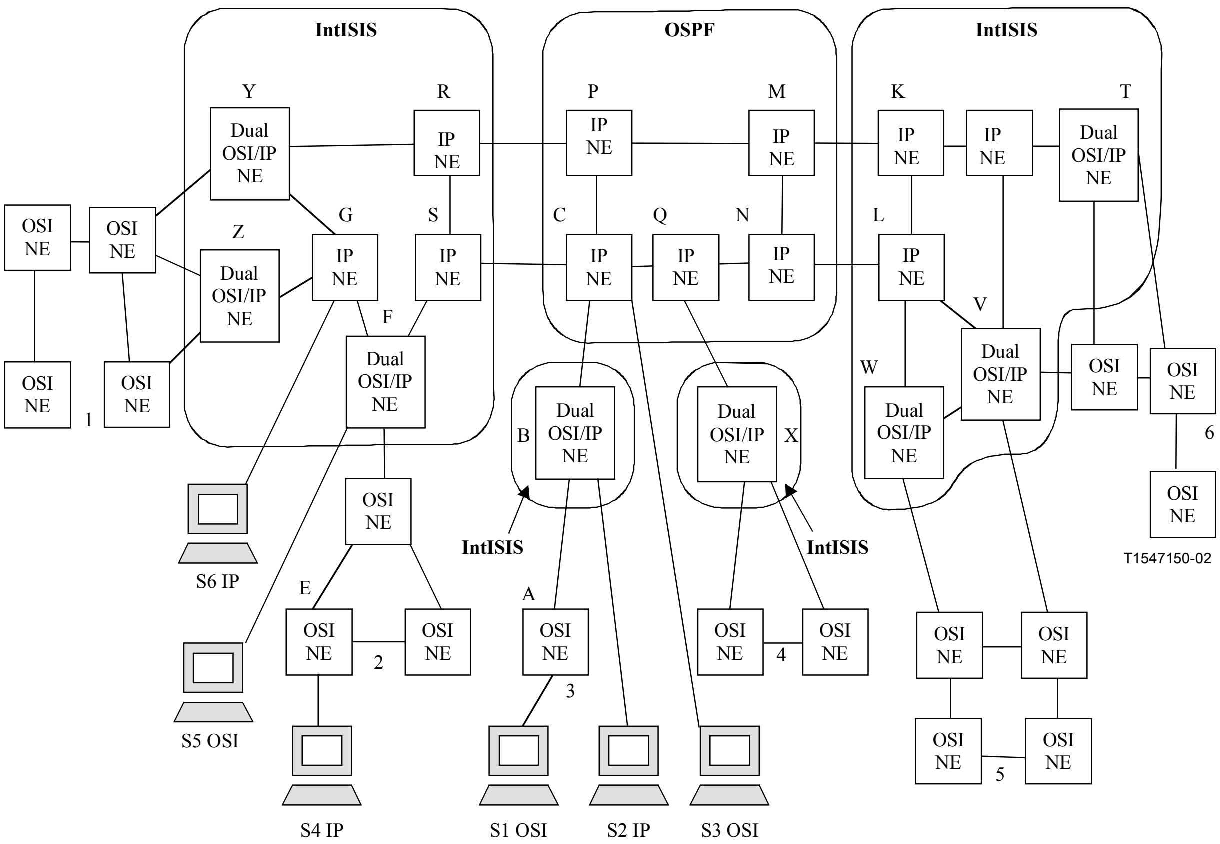
If the new action is "Up", an adjacencyStateChange(Up) event is generated.

c) Skip section 8.2.4.2 c) and d) of ISO/IEC 10589.

d) If the new action is "Initialize", "Up" or "Accept", follow 8.2.4.2 e) of ISO/IEC 10589.

Appendix I

Constraints of the interworking functions in DCN



IntISIS Integrated ISIS

Figure I.1/G.7712/Y.1703 – Interworking scenarios

General Assumptions:

DCN covers the IWF for Layers 2-3 of the IP-OSI stacks. Interworking mechanisms that apply to other layers are beyond the scope of this Recommendation (i.e. mediation).

– See 7.1.7 for a definition of interworking.

Tunnels are based on RFCs.

The IP-only NE's support IP routing and may contain redistribution between Integrated ISIS and OSPF.

Common to all scenarios:

Dynamic routing is accomplished through the use of route redistribution of IP address information between OSPF and ISIS NE's. Route redistribution is preformed on the OSPF nodes between the pairs; (R,P), (S,C), (M,K), (N,L).

Scenario 1: OSI-based management system connected to node A

There must be at least one tunnel configured from B to one or more of Y or Z.

There must be a tunnel configured from B to X.

There must be a tunnel configured from B to F.

There must be at least one tunnel configured from B to one or more of W, V or T.

The above tunnels will probably have ISIS running across them (inside the tunnel), however inter-domain routing techniques is also a possibility. Under some conditions some tunnels could become congested as a result of routing choices.

An OSI-based management system now has CLNS connectivity to any OSI-only or dual stack NE in the network, but does not have connectivity with IP-only NEs. Although an OSI-based manager will be able to send CLNS packets to a dual stack NE, it will not be able to manage it unless it is OSI manageable.

Scenario 2: IP-based management systems connected to node B

In this particular network, IP traffic can be forwarded from B to all IP NEs without requiring tunnels. OSPF NEs P, C, M, and N must support redistribution of IP routes into Integrated ISIS. Filters will have to be configured on OSPF nodes P, C, M, and N in order to stop routing loops from forming.

An IP-based management system now has IP connectivity to any IP-only or dual stack NE in the network, but does not have connectivity with OSI-only NEs. Although an IP-based manager will be able to send IP packets to a dual stack NE, it will not be able to manage it unless it is IP manageable.

Scenario 3: OSI-based management systems connected to node C

NE C cannot provide OSI connectivity, and so CLNS packets cannot be forwarded, therefore an OSI-based management system cannot function at this location.

Scenario 4: IP-based management systems connected to node E

NE E cannot provide IP connectivity, and so IP packets cannot be forwarded, therefore an IP-based management system cannot function at this location.

Scenario 5: OSI-based management systems connected to node F

CLNS traffic can pass through NE F to OSI network 2 without requiring tunnels as NE F can forward CLNS packets natively.

There must be a tunnel configured from F to B.

There must be at least one tunnel configured from F to one or more of Z or Y.

There must be a tunnel configured from F to X.

There must be at least one tunnel configured from F to one or more of W, V or T.

The above tunnels will probably have ISIS running across them (inside the tunnel), however interdomain routing techniques are also a possibility. Under some conditions, some tunnels could become congested as a result of routing choices.

An OSI-based management system now has CLNS connectivity to any OSI-only or dual stack NE in the network, but does not have connectivity with IP-only NEs. Although an OSI-based manager will be able to sent CLNS packets to a dual stack NE, it will not be able to manage it unless it is OSI manageable.

Scenario 6: IP-based management systems connected to node G

In this particular network, IP traffic can be forwarded from G to all IP NEs without requiring tunnels. OSPF NEs P, C, M, and N must support redistribution of IP routes into integrated ISIS. Filters will have to be configured on each OSPF nodes P, C, M, and N in order to stop routing loops from forming.

An IP-based management system now has IP connectivity to any IP-only or dual stack NE in the network, but does not have connectivity with OSI-only NEs. Although an IP-based manager will be able to send IP packets to a dual stack NE, it will not be able to manage it unless it is IP manageable.

Appendix II

Bibliography

– IETF RFC 1006 (1997), *ISO Transport Service on top of the TCP Version: 3*.

– IETF RFC 2966 (2000), *Domain-Wide Prefix Distribution with Two-Level IS-IS*.

ITU-T Y-SERIES RECOMMENDATIONS

GLOBAL INFORMATION INFRASTRUCTURE AND INTERNET PROTOCOL ASPECTS

GLOBAL INFORMATION INFRASTRUCTURE	
General	Y.100–Y.199
Services, applications and middleware	Y.200–Y.299
Network aspects	Y.300–Y.399
Interfaces and protocols	Y.400–Y.499
Numbering, addressing and naming	Y.500–Y.599
Operation, administration and maintenance	Y.600–Y.699
Security	Y.700–Y.799
Performances	Y.800–Y.899
INTERNET PROTOCOL ASPECTS	
General	Y.1000–Y.1099
Services and applications	Y.1100–Y.1199
Architecture, access, network capabilities and resource management	Y.1200–Y.1299
Transport	Y.1300–Y.1399
Interworking	Y.1400–Y.1499
Quality of service and network performance	Y.1500–Y.1599
Signalling	Y.1600–Y.1699
Operation, administration and maintenance	**Y.1700–Y.1799**
Charging	Y.1800–Y.1899

For further details, please refer to the list of ITU-T Recommendations.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series B	Means of expression: definitions, symbols, classification
Series C	General telecommunication statistics
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	**Transmission systems and media, digital systems and networks**
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	TMN and network maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks and open system communications
Series Y	**Global information infrastructure and Internet protocol aspects**
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2002