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

Data over Transport – Generic aspects – Transport network control aspects

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

Internet protocol aspects – Operation, administration and maintenance

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Architecture and specification of data communication network

Recommendation ITU-T G.7712/Y.1703

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Recommendation ITU-T G.7712/Y.1703

Architecture and specification of data communication network

Summary

Recommendation ITU-T G.7712/Y.1703 defines the architecture requirements for a data communication network (DCN) which may support distributed management communications related to the telecommunication management network (TMN), distributed control plane communications (e.g., signalling and routing) related to the automatically switched optical network (ASON), distributed control plane communications (e.g., signalling and routing) related to multiprotocol label switching – transport profile (MPLS-TP), 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 – other protocols (other than IP or OSI) are outside the current scope of this Recommendation.

Various applications (e.g., TMN, ASON, 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., network element function (NEF) component and operations system function (OSF) component). ASON and MPLS-TP require communication networks, which are referred to as the signalling communication networks (SCNs) to transport signalling and routing messages between functional control plane components (e.g., connection controller (CC) components and routing controller (RC) components). This Recommendation specifies data communication functions that can be used to support one or more application's communication network.

The data communication functions provided in the 11/2001 version of this Recommendation support connectionless network services. The 03/2003 revision of this Recommendation adds the support of connection-oriented network SCN services by including a specific MPLS-based mechanism.

This 2010 revision of this Recommendation provides the requirements for the MPLS transport profile (MPLS-TP) signalling communication channel (SCC) and management communication channel (MCC) data communication functions. The part of this Recommendation that addresses MPLS for transport networks complies with the transport profile of MPLS architecture as defined by IETF. In the event of a difference between this ITU-T Recommendation and any of the normatively referenced RFCs for MPLS-TP, the RFCs will take precedence.

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

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Keywords

Data communication network, Internet protocol (IP), open system interface (OSI).

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Recommendation ITU-T G.7712/Y.1703

Architecture and specification of data communication network

1 Scope

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 control plane communications (e.g., signalling and routing) related to the automatically switched optical network (ASON), distributed control plane communications (e.g., signalling and routing) related to multiprotocol label switching – transport profile (MPLS-TP), 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 – other protocols (other than IP or OSI) are outside the current scope of this Recommendation.

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 communication channels (ECCs).

Various applications (e.g., TMN, ASON, etc.) require a packet-based communication network to transport information between various components. For example, the TMN requires a communication network, which is referred to as the management communication network (MCN) to transport management messages between TMN components (e.g., network element function (NEF) component and operations support function (OSF) component). ASON and MPLS-TP require communication networks, which are referred to as signalling communication networks (SCNs) to transport signalling and routing messages between functional control plane components (e.g., connection controller (CC) components and routing controller (RC) components). This Recommendation specifies data communication functions that can be used to support one or more application's communication network.

The data communication 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.

This 2010 revision of this Recommendation provides the requirements for the MPLS transport profile (MPLS-TP) signalling communication channel (SCC) and management communication channel (MCC) data communication functions. The part of this Recommendation that addresses MPLS for transport networks complies with the transport profile of MPLS architecture as defined by IETF. In the event of a difference between this ITU-T Recommendation and any of the normatively referenced RFCs for MPLS-TP, the RFCs will take precedence.

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. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

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3 Terms and definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 Terms defined in [ITU-T G.709]:

a) optical channel data unit (ODUk)

b) optical channel transport unit (OTUk)

c) OTM overhead signal (OOS)

d) general management communications overhead (COMMS OH)

3.1.2 Term defined in [ITU-T G.784]:

a) data communications channel (DCC)

3.1.3 Terms defined in [ITU-T G.8080] and [ITU-T G.8081]:

a) automatically switched optical network (ASON)

b) external network-network interface (E-NNI)

c) internal network-network interface (I-NNI)

d) user-network interface (UNI)

e) call controller (CallC)

f) connection controller (CC)

g) connection controller interface (CCI)

h) subnetwork connection controller (SN-CC)

3.1.4 Term defined in [ITU-T G.874]:

a) general communication channel (GCC)

3.1.5 Terms defined in [ITU-T G.7710]:

a) x.management network

b) x.management subnetwork

3.1.6 Term defined in [ITU-T G.872]:

a) optical transport network (OTN)

3.1.7 Terms defined in [ITU-T 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

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i) transformation function

j) workstation function (WSF)

3.1.8 Term defined in [ITU-T M.3013]:

a) message communication function (MCF)

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 automatic encapsulating data communication function (AE-DCF): An AE-DCF automatically encapsulates packets when necessary so that they may be routed by NEs that would otherwise be unable to forward them. An AE-DCF also features a matching de-encapsulation function to restore the packet back to its original form once it has traversed incompatible NEs.

3.2.2 data communication 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 ASON, and other operations communications (e.g., orderwire/voice communications, software downloads, etc.).

3.2.3 embedded communication channel (ECC): An ECC provides a logical operations channel between NEs that can be utilized by multiple applications (e.g., management applications, control plane applications, etc.). 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.

3.2.4 IP routing interworking function: An IP routing interworking function allows IP topology or routes to be passed from one IP routing protocol to a different incompatible IP routing protocol. For example, an IP routing interworking function may form a gateway between an integrated IS-IS routed DCN and an OSPF routed DCN.

3.2.5 management communication channel (MCC): An MCC provides a dedicated logical operations channel between NEs for management communications. The physical channel supporting the MCC is technology specific.

3.2.6 network-layer interworking function: A network-layer interworking function provides interoperability between nodes that support incompatible network-layer protocols. An example of a network-layer interworking function is static GRE tunnels, or an AE-DCF.

3.2.7 non-MPLS-TP server to MPLS-TP adaptation function (SRV/MT_A): The non-MPLS-TP server to MPLS-TP adaptation function is defined as an ITU-T G.805 adaptation function between a non-MPLS server layer network and the MPLS-TP layer network.

3.2.8 signalling communication channel (SCC): An SCC provides a dedicated logical operations channel between NEs for control plane communications. This SCC may not only be used for ASON signalling but may also carry other control plane messages, e.g., routing messages. The physical channel supporting the SCC is technology specific.

4 Abbreviations

This Recommendation uses the following abbreviations:

AD	Adaptation Device
AE-DCF	Automatic Encapsulating Data Communication Function
AI	Adapted Information
ARP	Address Resolution Protocol

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ASON	Automatically Switched Optical Network
ATM	Asynchronous Transfer Mode
CallC	Call Controller
CC	Connection Controller
CCI	Connection Controller Interface
CI	Characteristic Information
CLNP	ConnectionLess Network layer Protocol
CLNS	ConnectionLess Network layer Service
COMMS OH	General Management Communications Overhead
CP	Connection Point
DCC	Data Communication Channel
DCF	Data Communication Function
DCN	Data Communication Network
DF	Don't Fragment
ECC	Embedded Communication Channel
EMF	Equipment Management Function
EoT	Ethernet over Transport
ES	End System
ESH	End System Hello [ISO 9542]
ES-IS	End System-to-Intermediate System
G-ACh	Generic Associated Channel
GAL	Generic Associated Channel Label
GCC	General Communication Channel
GFP-F	Frame-mapped GFP
GNE	Gateway Network Element
GRE	Generic Routing Encapsulation
HDLC	High Level Data Link Control
ICMP	Internet Control Message Protocol
ID	Identifier
IIH	IS-IS Hello
IP	Internet Protocol
IPCP	Internet Protocol Control Protocol
IPI	Initial Protocol Identifier
IPv4	Internet Protocol Version 4
IPv6	Internet Protocol Version 6
IS	Intermediate System
ISDN	Integrated Services Digital Network

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ISH	Intermediate System Hello [ISO 9542]
IS-IS	Intermediate System-to-Intermediate System
IWF	InterWorking Function
LAN	Local Area Network
LAPD	Link-Access Procedure D-Channel
LCN	Local Communication Network
LSP	Label Switched Path
LS-PDU	Link State Protocol Data Unit
LSR	Label Switched Router
MAC	Media Access Control
MCC	Management Communication Channel
MCF	Message Communication Function
MCN	Management Communication Network
MD	Mediation Device
MPLS-TP	Multiprotocol Label Switching – Transport Profile
MTU	Maximum Transmission Unit
NE	Network Element
NEF	Network Element Function
NLPID	Network Layer Protocol Identifier
NNE	Network NE
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	Protocol Data Unit
PHOP	Previous HOP
PID	Protocol Identifier
PPP	Point-to-Point Protocol

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RC	Routing Controller
RSVP-ORE	Resource Reservation Protocol – Overhead Reduction Extensions
SCC	Signalling Communication Channel
SCN	Signalling Communication Network
SDH	Synchronous Digital Hierarchy
SID	System Identifier
SN-CC	SubNetwork Connection Controller
S/OMS	SDH/OTN Management Subnetwork
SP	Segmentation Permitted
SPF	Shortest Path First
SRM	Send Routing Message
SSF	Server Signal Fail
TCP	Transmission Control Protocol
TF	Translation Function
TLV	Type Length Value
TMN	Telecommunication Management Network
TNE	Transport Network Element
TSF	Trail Signal Fail
TT	Trail Termination
UNI	User-to-Network Interface
UPI	User Payload Identifier
WAN	Wide Area Network
WS	Work Station
WSF	Work Station Function

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.

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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, ASON, etc.) require a packet-based communication network to transport information between various components. For example, the TMN requires a communication 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). ASON requires a communication network, which is referred to as the signalling communication network (SCN) to transport control plane messages between ASON components (e.g., CC components, RC components, etc.). This Recommendation specifies data communication functions that can be used to support one or more application's communication 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.

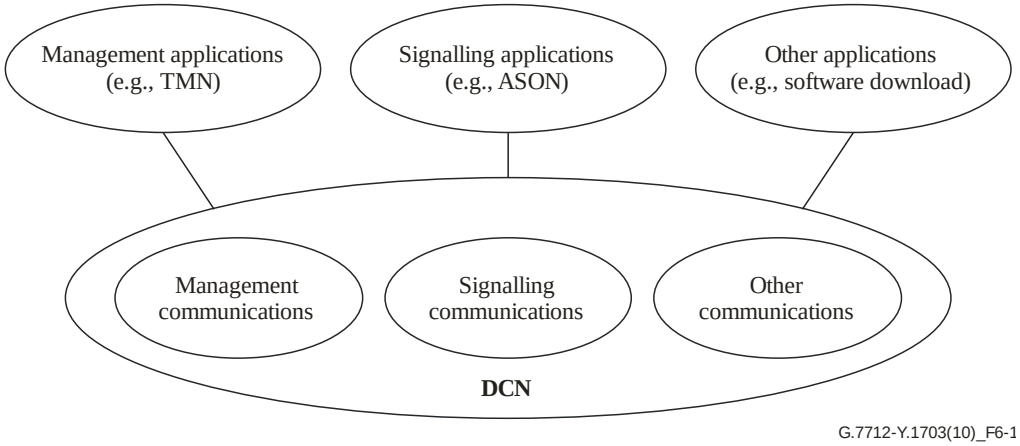

Figure 6-1 – Example applications supported by a DCN

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 control plane communications related to the ASON. 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 M.3010] and [ITU-T M.3013] provide further specifications for the TMN functions. In the case of a DCN supporting distributed signalling communications, the distributed components are ASON components (NEs containing ASON CallC/CC functions). [ITU-T G.8080] provides further specifications for the ASON functions.

A number of telecommunication technologies can support the DCN functions, such as circuit switching, packet switching, LAN, ATM, SDH, OTN, MPLS-TP, and Ethernet over transport. 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

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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, ASON 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 ASON 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, MPLS-TP, Ethernet, 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 communication 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 M.3010]. A DCN supporting distributed control plane communications related to the ASON needs to support the transport of information associated with the ASON interfaces defined in [ITU-T G.8080].

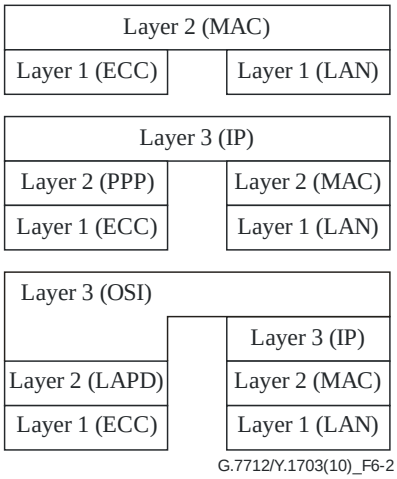

Figure 6-2 – Examples of DCN interworking

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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 M.3010] and [ITU-T M.3013] for detailed specifications regarding these management functional blocks. A data communication function (DCF) is part of each physical element and provides data communication functions.

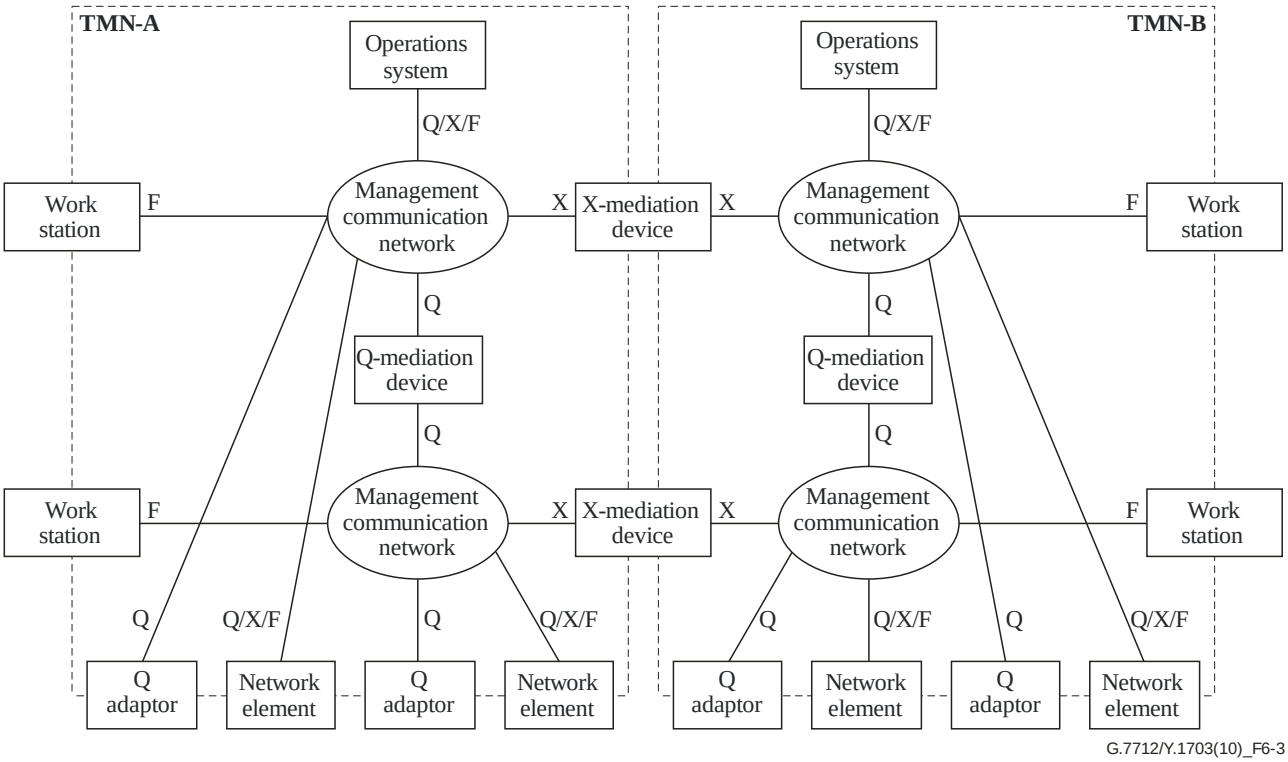

Figure 6-3 – Example relationship of TMN interfaces and MCN

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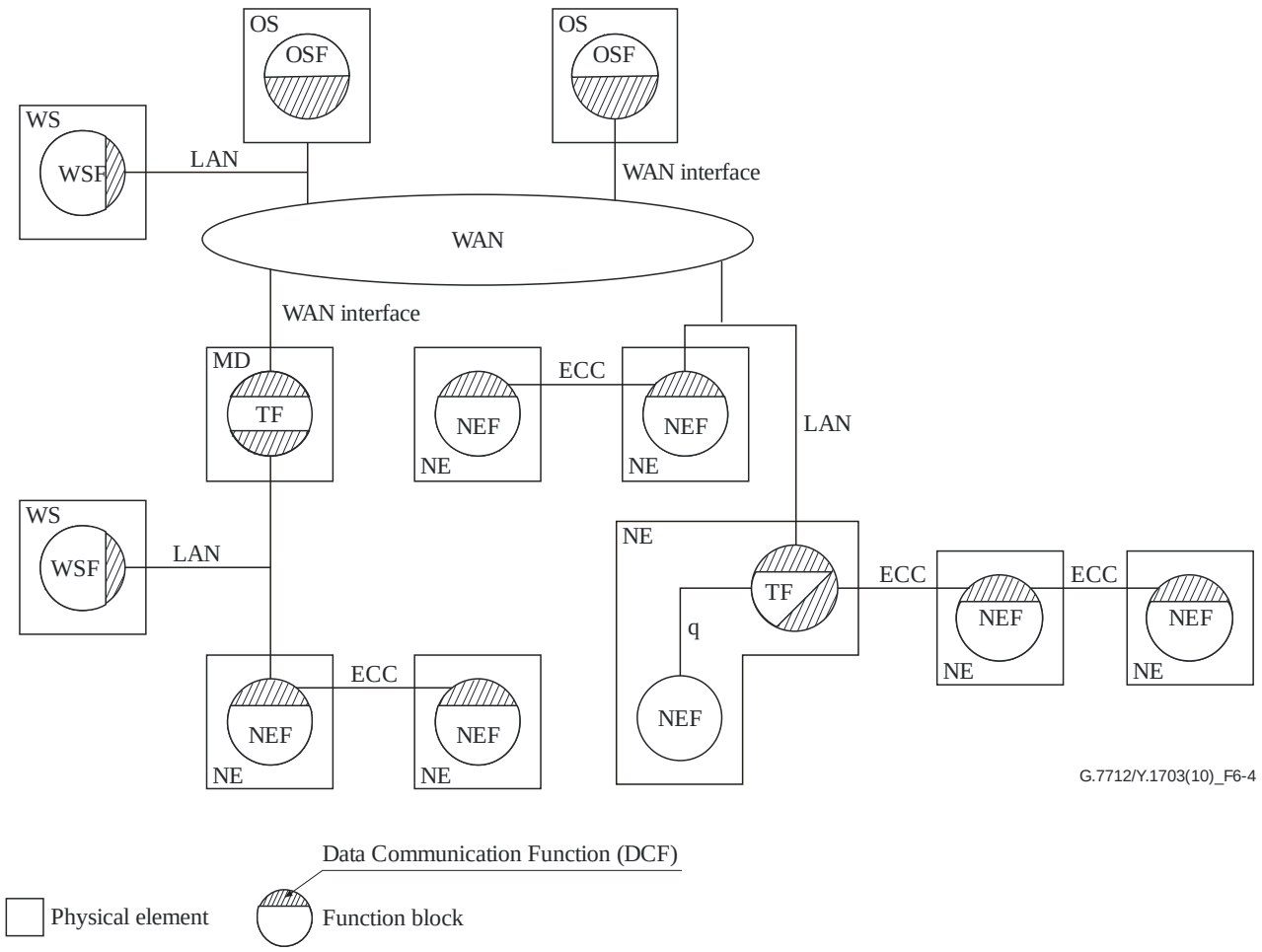

Figure 6-4 – Example of physical implementation of MCN supporting TMN

6.1.1 X management subnetwork architecture

In Figure 6-5, a number of points should be noted concerning the architecture of a X management subnetwork:

– *Multiple NEs at a single site*

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

– *SDH/OTN/MPLS-TP NEs and their communication functions*

The message communication function of an SDH, OTN, or MPLS-TP 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/MPLS-TP inter-site communications*

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

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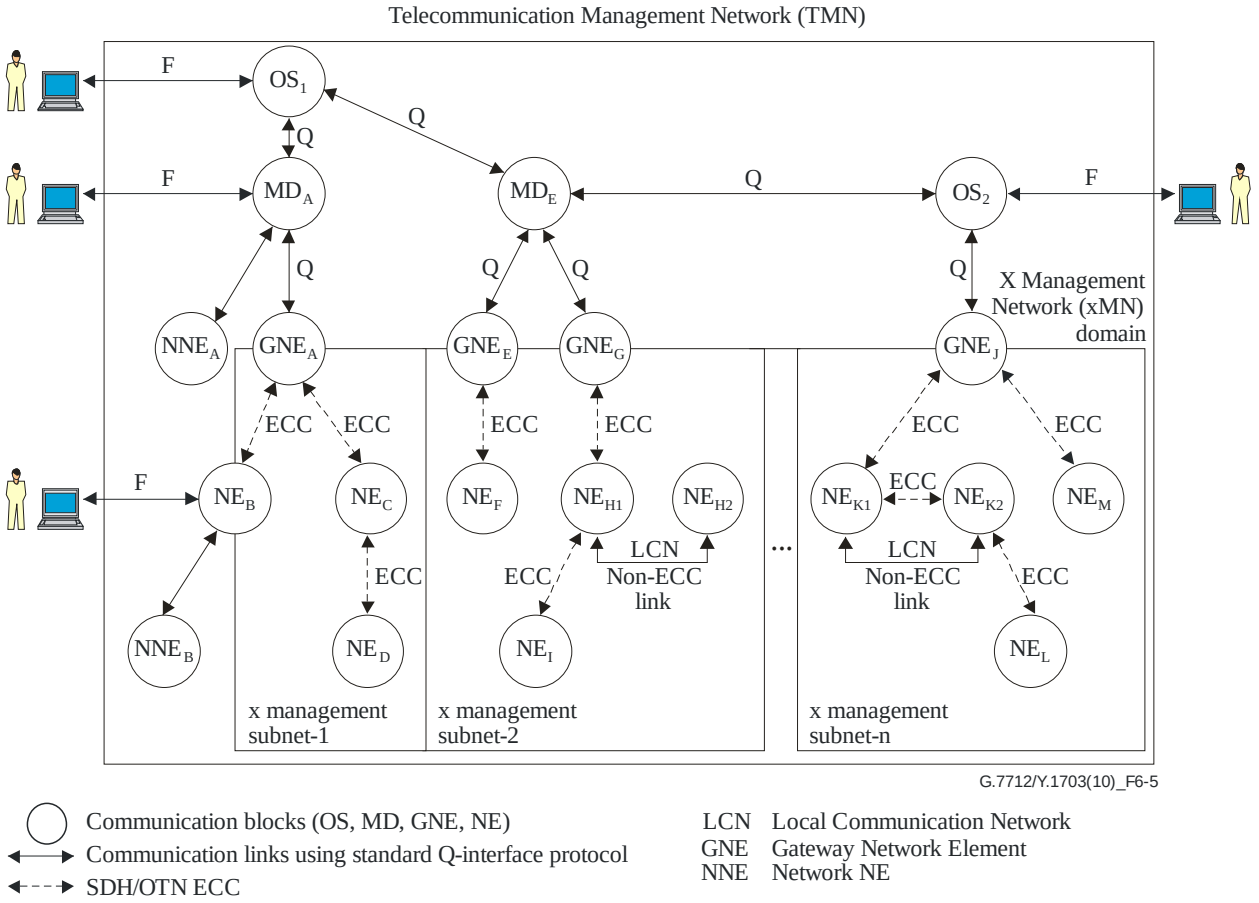
– *SDH/OTN/MPLS-TP intra-site communications*

Within a particular site, SDH/OTN/MPLS-TP NEs may communicate via an intra-site ECC or via a local communication 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 communication network serving SDH, OTN, MPLS-TP, and non-SDH/OTN/MPLS-TP NEs (NNEs).



NOTE – The designation "Q" is used in a generic sense.

Figure 6-5 – 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 (LCN) (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 operations system (OS).

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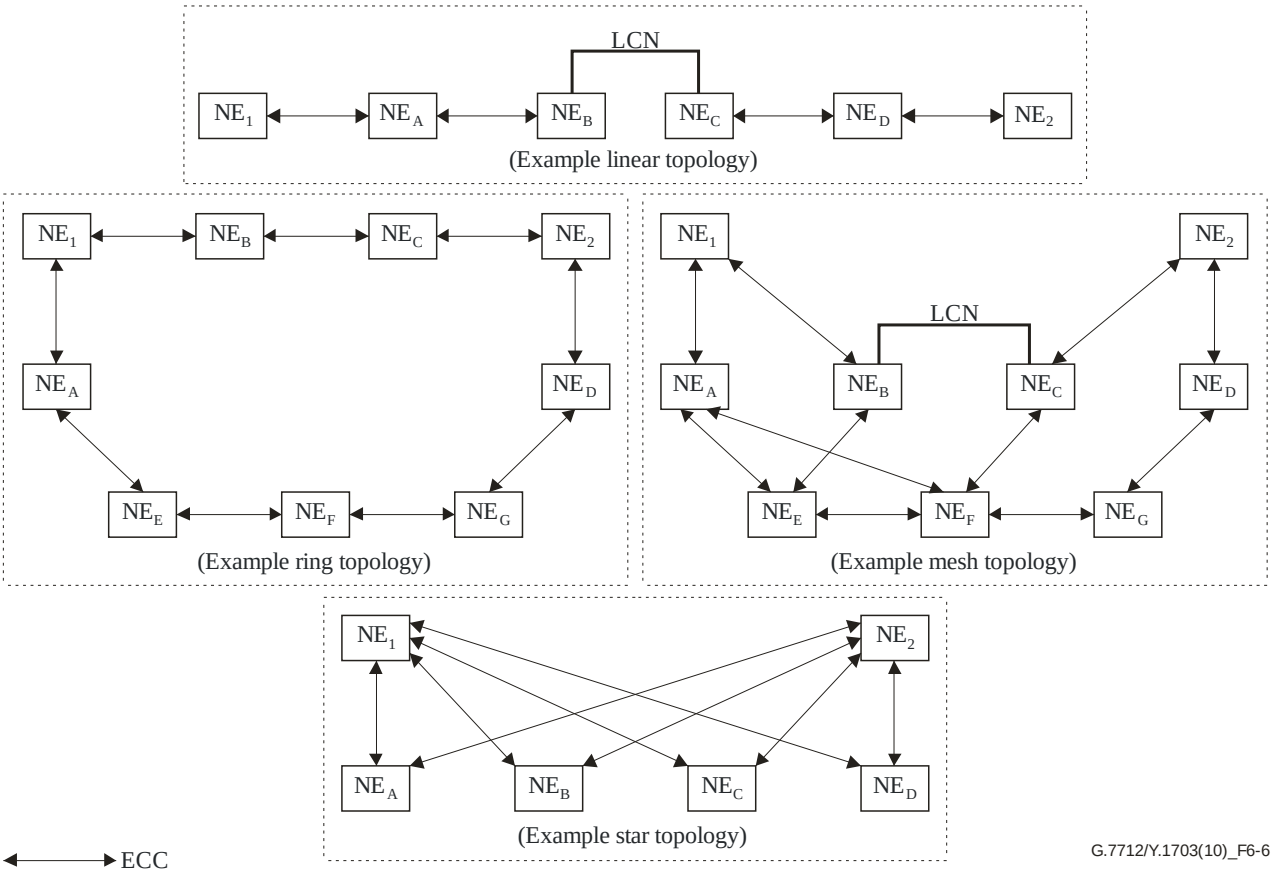

Figure 6-6 – Example topologies

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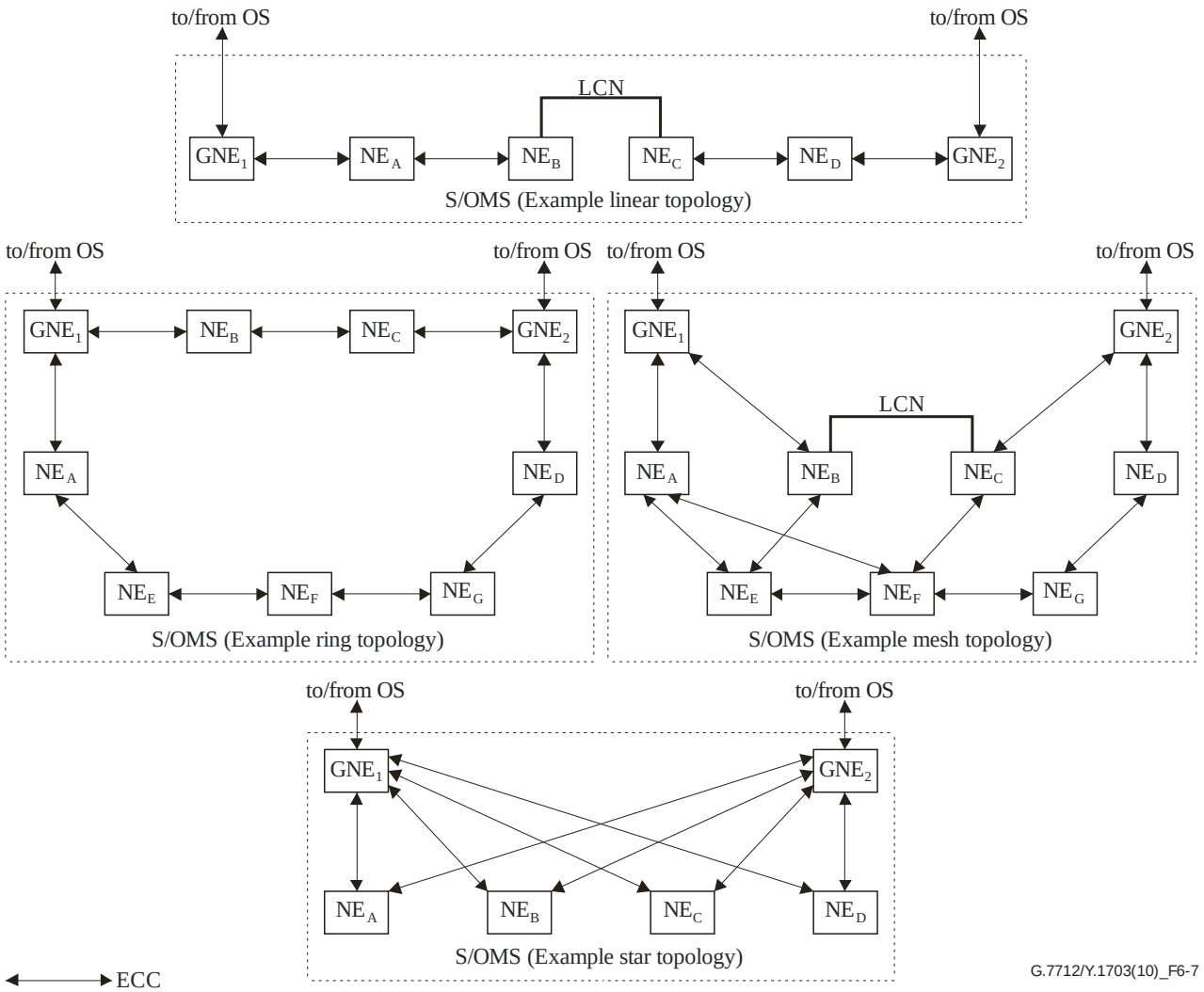

Figure 6-7 – Supporting a management subnetwork on various topologies

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 M.3016.x] for MCN security requirements.

6.1.4 MCN data communication functions

The DCF within the TMN entities shall support the 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 clause 7.1.1)
  - ECC data-link layer termination function (as specified in clause 7.1.2)

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– "Network layer PDU into ECC data-link layer frame" encapsulation function (as specified in clause 7.1.3)
– "MPLS PDU into ECC data-link layer" encapsulation function (as specified in clause 7.1.13), if native MPLS is used in the DCN.

- 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 clause 7.1.4)
  – "Network layer PDU into Ethernet frame" encapsulation function (as specified in clause 7.1.5)
  – "MPLS PDU into Ethernet frame" encapsulation function (as specified in clause 7.1.14), if native MPLS is used in the DCN.

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, operates as an IS/router, the following functions are required to be supported:
  – Network layer PDU forwarding function (as specified in clause 7.1.6)
  – Network layer routing function (as specified in clause 7.1.10).

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

- When the DCF within a TMN entity that supports IP is connected directly to a DCF in a neighbouring 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 clause 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 clause 7.1.8)
  – Network layer PDU tunnelling function (as specified in clause 7.1.9).

The DCF within a TMN entity that supports IP using OSPF routing may be connected directly to a DCF in a neighbouring TMN entity that supports IP using integrated IS-IS.

- When the DCF within a TMN entity that supports IP using OSPF routing is connected directly to a DCF in a neighbouring TMN entity that supports IP using integrated IS-IS, the following function is required to be supported in the DCF supporting OSPF:
  – IP routing interworking function (as specified in clause 7.1.11).

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6.2 Control plane application (ASON and MPLS-TP)

The ASON/MPLS-TP control plane requires a communications network, which is referred to as the signalling communication network (SCN) to transport signalling and routing protocol messages between ASON/MPLS-TP control plane components (e.g., CC components, RC components).

In the following, ASON is used as an example for a control plane application. What is described for the ASON control plane is also applicable to the MPLS-TP control plane.

Figure 6-8 illustrates an example relationship of the SCN and the ASON. 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 SCC 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 G.8080] for detailed specifications regarding these control functional blocks. A data communication function (DCF) is part of each physical element and provides data communication functionality.

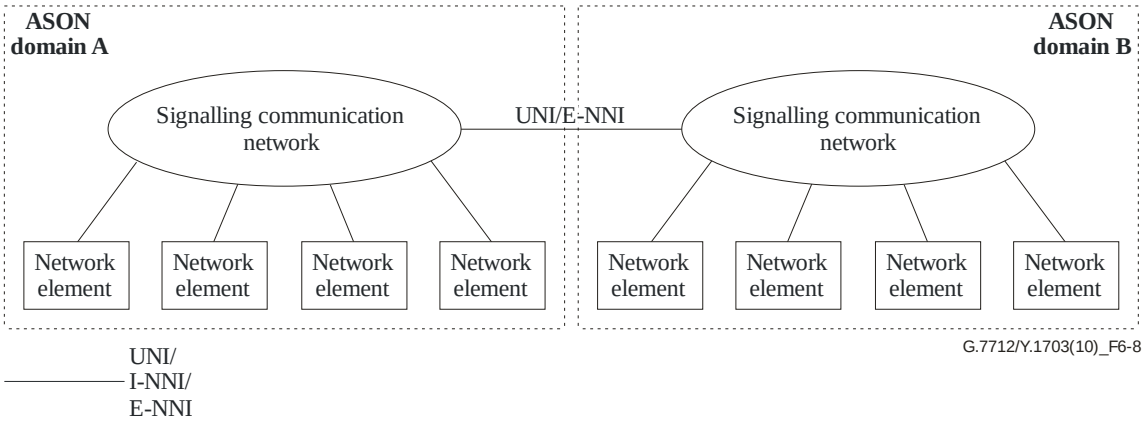

Figure 6-8 – Example relationship of ASON interfaces to SCN

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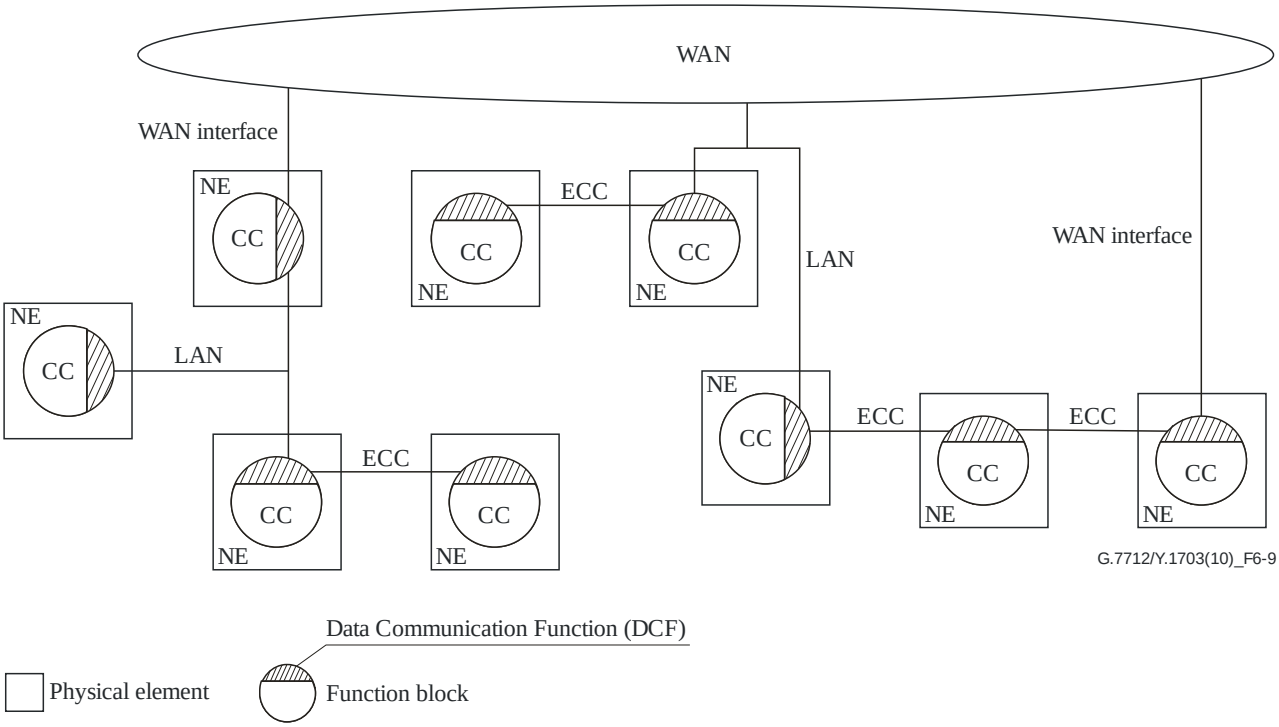

Figure 6-9 – Example of physical implementation of SCN supporting ASON

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 ASON 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 ASON capable NEs). Note that to support alternate diverse paths between communicating ASON NEs under a linear topology, an external WAN link could be provided between the edge ASON NEs.

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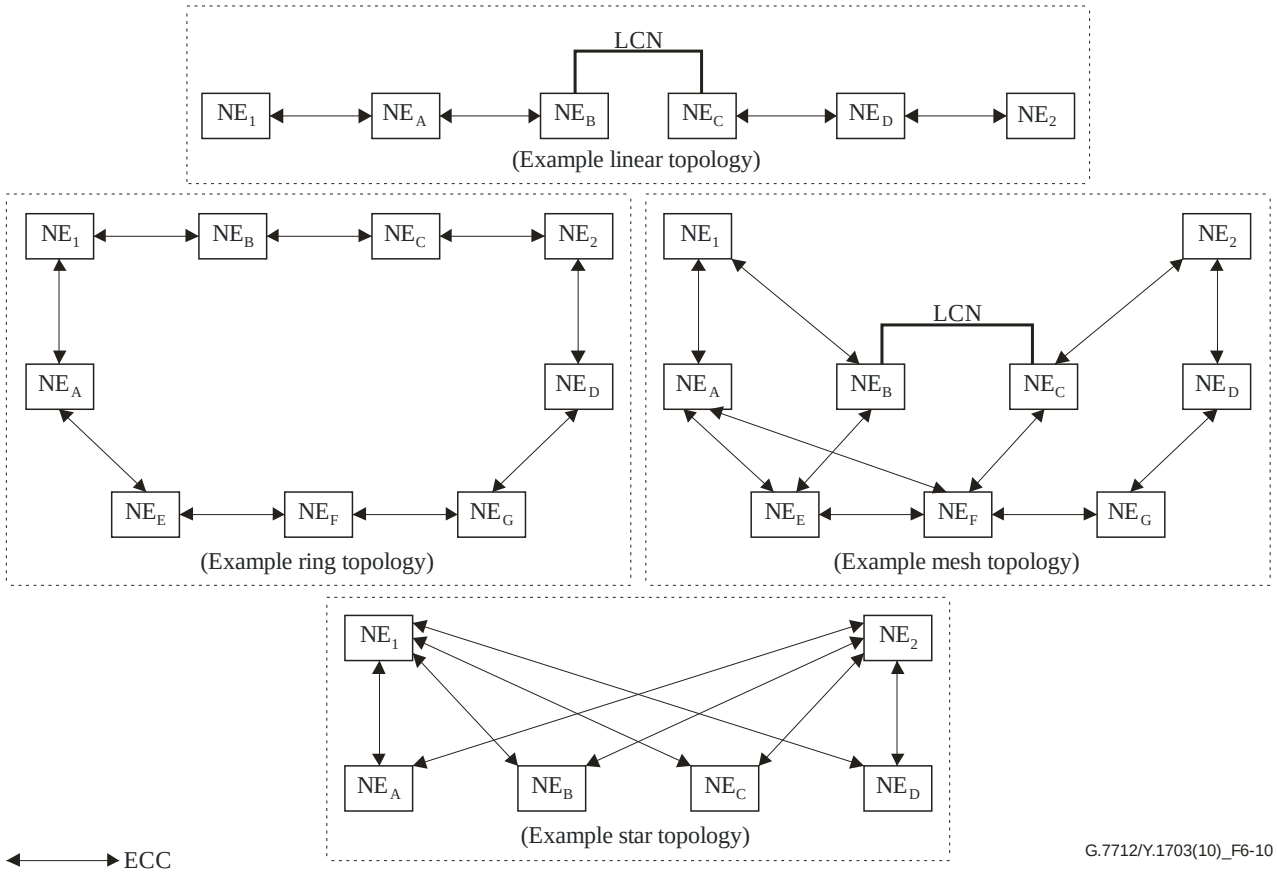

Figure 6-10 – Example topologies

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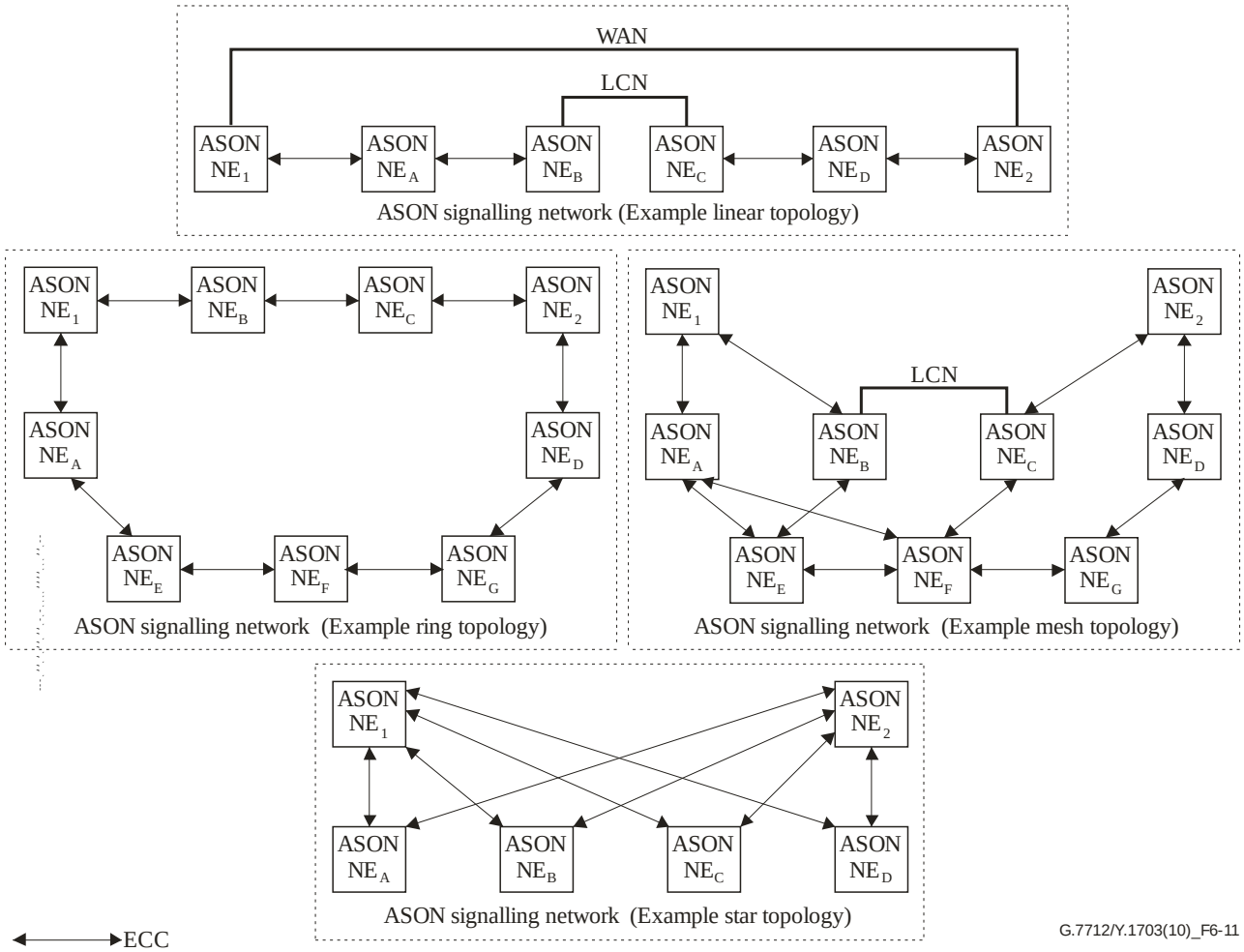

Figure 6-11 – Supporting an ASON signalling network on various topologies

Figure 6-12 illustrates how the ASON 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 ASON NEs. The topology of the intra-administrative domain portion allows signalling to have alternate diverse paths between two communicating ASON 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.

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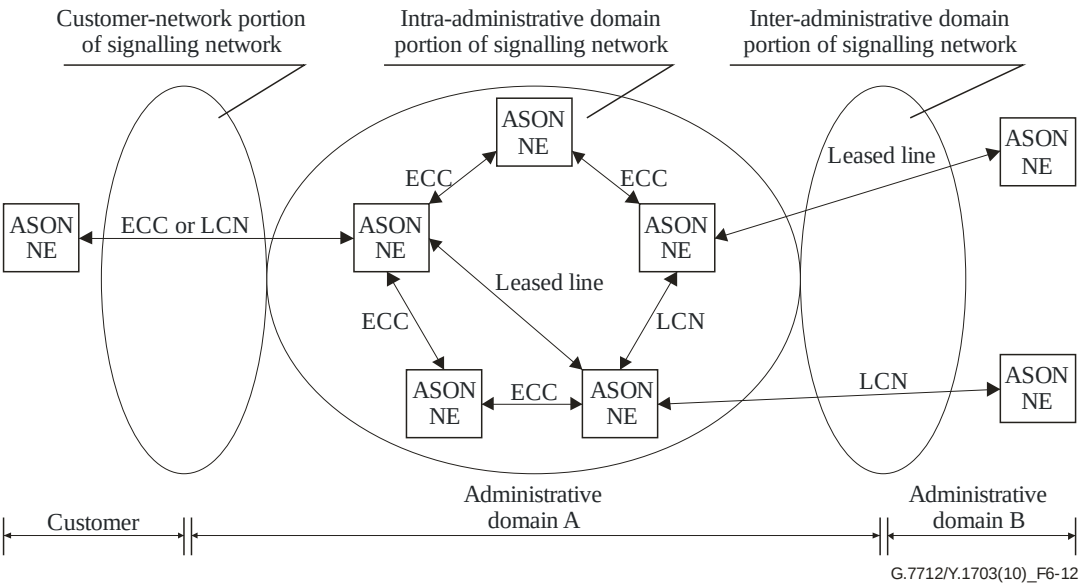

Figure 6-12 – Example SCN

6.2.2 Reliability of SCN

Figure 6-13 illustrates ASON 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.

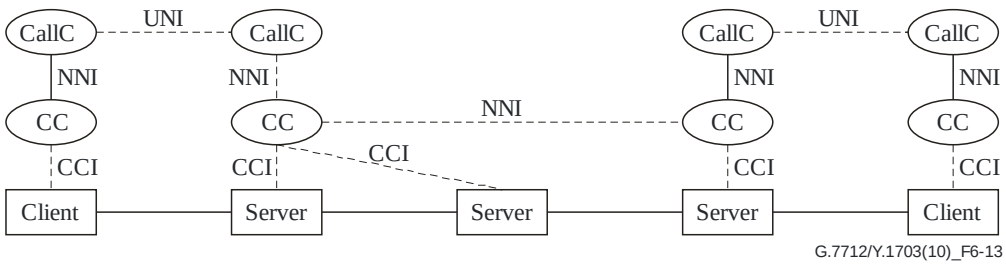

Figure 6-13 – ASON interfaces supported on SCN

In this example, the messages across 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 a configuration is neither required nor 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 ASON messages transported over the SCN, an independent failure to the SCN would affect new connection set-up and connection tear-down requests.

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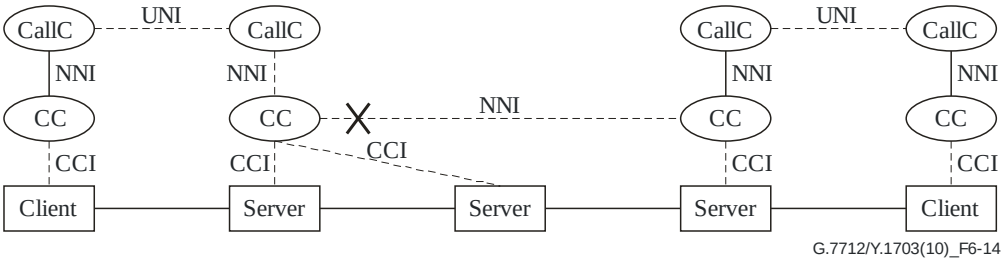

Figure 6-14 – SCN failure impacting signalling interface

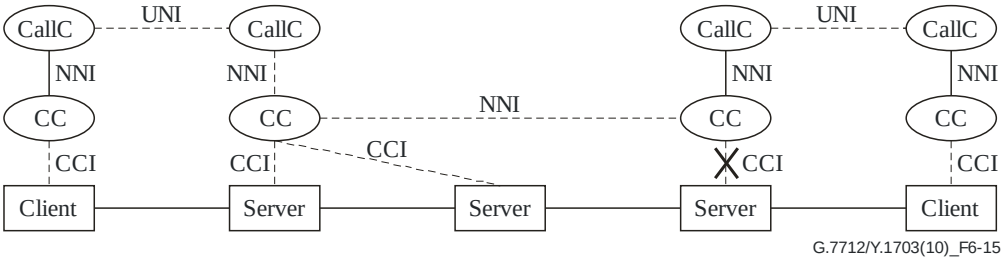

Figure 6-15 – SCN failure impacting CCI interface

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 ASON messages transported over the SCN, such a failure may impact restoration when ASON is used to provide restoration of existing connections. It is, therefore, critical for the SCN to provide resiliency when transporting restoration messages.

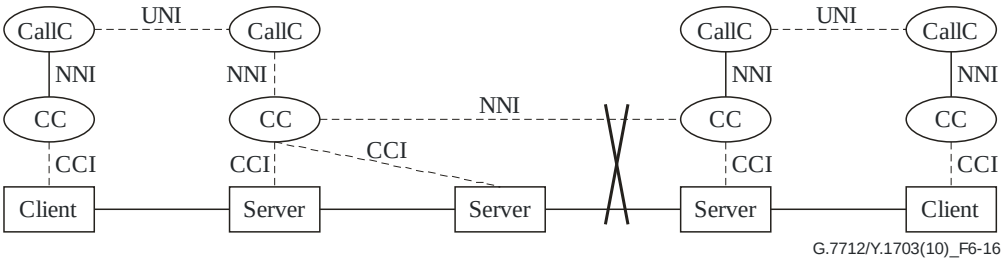

Figure 6-16 – SCN failure impacting both signalling and data interfaces

If the ASON application is only used to provide connection-setup and teardown, a connectionless SCN may be sufficient. However, if the ASON 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).

One way of achieving reliable SCN is through use of Packet 1+1 protection for connection-oriented protocols such as MPLS as described in clause 6.2.4.

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The SCN may provide transport for restoration messages. In such a case, the SCN should be fast enough to allow proper operation of the connections under control by these restoration messages control.

6.2.3 Security of SCN

A SCN supporting ASON messages may provide connectivity between different administrative domains. When a SCN provides connectivity between administrative boundaries, precautions must be taken such that only those 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 are prevented from crossing the interface. The SCN needs to ensure that only a selected set of messages, which are allowed by the administrative parties on either side of the interface, are actually able to pass across the interface.

[b-IETF RFC 5920] describes the security threats relevant in the context of MPLS and GMPLS (also relevant in the context of MPLS-TP) and the defensive techniques to combat those threats.

6.2.4 SCN data communication functions

The DCF within the ASON entities shall support the end system (ES) (in OSI terms) or host (in IP terms) functionality.

- When the DCF within the ASON entities support ECC interfaces, the following functions are required to be supported:
  - ECC access function (as specified in clause 7.1.1)
  - ECC data-link layer termination function (as specified in clause 7.1.2)
  - "Network layer PDU into ECC data-link layer frame" encapsulation function (as specified in clause 7.1.3).
- When the DCF within the ASON entities support Ethernet LAN interfaces, the following functions are required to be supported:
  - Ethernet LAN physical layer termination function (as specified in clause 7.1.4)
  - "Network layer PDU into Ethernet frame" encapsulation function (as specified in clause 7.1.5).

The DCF within the ASON entities may operate as an intermediate system (IS) (in OSI terms), or as a router (in IP terms). The routing protocol used for DCF determines how to forward SCN messages to their destination. The DCF within ASON 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 ASON 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 ASON entities.

- When the DCF within the ASON entities operate as an IS/router, the following functions are required to be supported:
  - Network layer PDU forwarding function (as specified in clause 7.1.6)
  - Network layer routing function (as specified in clause 7.1.10).

The DCF within an ASON entity that supports IP may be connected directly to a DCF in a neighbouring ASON entity that supports only OSI.

- When the DCF within an ASON entity that supports IP is connected directly to a DCF in a neighbouring 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 clause 7.1.7).

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