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**GENERAL ASPECTS OF DIGITAL
TRANSMISSION SYSTEMS**

**SYNCHRONOUS DIGITAL HIERARCHY (SDH)
MANAGEMENT OF THE SUBNETWORK
CONNECTION PROTECTION FOR
THE NETWORK ELEMENT VIEW**

ITU-T Recommendation G.774.04

(Previously "CCITT Recommendation")

FOREWORD

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NOTE

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

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CONTENTS

		<i>Page</i>
1	Scope	1
	1.1 Structure of this Recommendation.....	2
2	References	2
3	Definitions.....	3
4	Abbreviations	3
5	Subnetwork connection protection management model.....	3
	5.1 Overview	3
	5.2 SDH subnetwork connection protection requirements	4
6	Managed object class definitions	5
	6.1 Connection protection group	5
	6.2 Connection protection.....	5
	6.3 Multipoint connection protection.....	7
	6.4 Subnetwork connection protection fabric	8
7	Packages.....	9
	7.1 Hold off time package	9
8	Attributes.....	9
	8.1 Hold off time.....	9
	8.2 Protection criteria.....	9
	8.3 Switch status	9
9	Actions	10
	9.1 Protected connect action	10
	9.2 Protect unprotect connection action.....	12
10	Parameters	13
	10.1 Switch status	13
11	Name bindings	14
	11.1 Connection protection.....	14
	11.2 Connection protection group	14
	11.3 Cross connection.....	14
	11.4 Multipoint connection protection.....	15
	11.5 Multipoint cross connection.....	15
12	Subordination rules	15
13	Pointer constraints.....	15
14	Supporting ASN.1 productions	15
	Annex A – Inheritance and naming diagrams	18
	Annex B – Examples of subnetwork connection protection	20
	B.1 Legends.....	20
	B.2 Subnetwork connection protection examples	21
	B.3 Bidirectional subnetwork connection protection in rings	27
	B.4 Interconnection of protected rings by a cross-connected.....	28
	B.5 Interconnections of subnetwork with ADMs (SNCP/SNCP) in SNCP interworking	30
	B.6 Logical connections in SNCP interworking rings	31
	B.7 Logical connections in MS SHARED RINGS interworking	33
	B.8 Logical connections in SNCP Ring and MS SHARED RING interworking	35

	<i>Page</i>
Annex C – State transition diagrams	37
C.1 State diagrams.....	37
C.2 Allowable values of switchStatus for a protected (mp) connection protection	37
C.3 Allowable values of switchStatus for a protecting (mp) connection protection	38
C.4 State diagram for a protected connection protection (non-revertive)	38
C.5 State diagram for a protecting connection protection (non-revertive)	41
C.6 State diagram for a protected connection protection (revertive).....	44
C.7 State diagram for a protecting connection protection (revertive)	47

SUMMARY

This Recommendation provides an information model for the management of subnetwork connection protection of Synchronous Digital Hierarchy (SDH) subnetwork. This model describes the managed object classes and their properties for the subnetwork connection protection function, as defined in Recommendation G.803 [13] and as related to SDH network elements. These objects are useful to describe information exchanged across interfaces defined in M.3010 [4] Telecommunications Management Network (TMN) architecture for the management of the subnetwork connection protection function.

KEYWORDS

Action, ASN.1, Attribute, GDMO, Information Model, Managed Object Class, Notification, Protection, Subnetwork Connection, Synchronous Digital Hierarchy.

**SYNCHRONOUS DIGITAL HIERARCHY (SDH) MANAGEMENT
OF THE SUBNETWORK CONNECTION PROTECTION
FOR THE NETWORK ELEMENT VIEW**

(Geneva, 1995)

The ITU-T,

considering

- (a) that Recommendations G.707, G.708, and G.709 form a coherent set of specifications for the Synchronous Digital Hierarchy (SDH) and the Network Node Interface (NNI);
- (b) that Recommendations G.781, G.782, G.783, and G.784 form a coherent set of specifications for SDH multiplex equipment functions and management;
- (c) that Recommendation G.958 specifies the characteristics of digital line systems based on SDH for use on optical fibre cables;
- (d) that Recommendation M.3010 defines the principles for a Telecommunications Management Network (TMN);
- (e) that Recommendation G.773 defines the protocol suites for Q-interfaces;
- (f) that Recommendation M.3100 defines a Generic Network Information Model for the exchange of management information;
- (g) that Recommendation G.803 defines the SDH Transport Network Functional Architecture;
- (h) that Recommendation G.774 defines an SDH Management Information Model for the Network Element View;
- (i) that Recommendation G.774.03 defines Management of the SDH Multiplex Section Protection for the Network Element View,

recommends

that the management of SDH subnetwork connection protection be carried out by using the information model defined in accordance with the details contained within this Recommendation.

1 Scope

This Recommendation addresses the management of the automatic protection switching within network element at the high and low order path layers. It covers the subnetwork connection protection as described in G.803 [13] and G.841 [16].

This Recommendation provides an information model, as related to the subnetwork connection protection function for the Synchronous Digital Hierarchy (SDH). It identifies the Telecommunications Management Network (TMN) object classes required for the management of the subnetwork connection protection function for SDH network elements. These objects are relevant to information exchanged across standardized interfaces defined in Recommendation M.3010 TMN architecture [4].

This Recommendation applies to SDH network elements which perform the subnetwork connection protection function and those systems in the TMN that manage SDH network elements.

1.1 Structure of this Recommendation

Subclause 5.1 provides an overview of the SDH subnetwork connection protection information model. Clauses 6-14 describe the information model using the notation mechanisms defined in Recommendation X.722, Guidelines for the Definition of Managed Objects [8]. Clause 14 contains the syntax definitions of the information carried in the protocol using Abstract Syntax Notation One (ASN.1) defined in Recommendation X.208 [9]. Naming and Inheritance are illustrated in Annex A. The state transition diagrams are provided in Annex C. Diagrams illustrating the subnetwork connection protection are provided in Annex B. Clauses 5-14 are normative; all other text is informative.

2 References

The following 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: all 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.

- [1] ITU-T Recommendation G.707 (1993), *Synchronous digital hierarchy bit rates*.
- [2] ITU-T Recommendation G.708 (1993), *Network node interface for the synchronous digital hierarchy*.
- [3] ITU-T Recommendation G.709 (1993), *synchronous multiplexing structure*.
- [4] CCITT Recommendation M.3010 (1992), *Principles for a telecommunication management network*.
- [5] CCITT Recommendation M.3100 (1992), *Generic network information model*.
- [6] ITU-T Recommendation G.783 (1994), *Characteristics of Synchronous Digital Hierarchy (SDH) equipment functional blocks*.
- [7] ITU-T Recommendation G.784 (1994), *Synchronous Digital Hierarchy (SDH) management*.
- [8] CCITT Recommendation X.722 (1992), *Information Technology – Open Systems Interconnection – Structure of management information: Guidelines for the definition of managed objects*.
- [9] CCITT Recommendation X.208 (1988), *Specification of Abstract Syntax Notation One (ASN.1)*.
- [10] CCITT Recommendation X.720 (1992), *Information Technology – Open systems Interconnection – Structure of management information: Management information model*.
- [11] CCITT Recommendation G.774 (1992), *Synchronous Digital Hierarchy (SDH) management information model for the network element view*.
- [12] ITU-T Recommendation G.774.01 (1994), *Synchronous Digital Hierarchy SDH performance monitoring for the network element view*.
- [13] ITU-T Recommendation G.803 (1993), *Architectures of transport networks based on The Synchronous Digital Hierarchy (SDH)*.
- [14] CCITT Recommendation X.721 (1992), *Information technology – Open Systems Interconnection – Structure of management information: Definition of management information*.
- [15] ITU-T Recommendation G.774.03 (1994), *SDH management of multiplex – section protection for the network element view*.
- [16] ITU-T Recommendation G.841 (1995) *Types and characteristics of SDH network protection architectures*.

3 Definitions

None.

4 Abbreviations

For the purposes of this Recommendation, the following abbreviations are used:

APDU	Application Protocol Data Unit
APS	Automatic Protection Switching
BSHR	Bidirectional Self Healing Ring
CMIP	Common Management Information Protocol
CMIS	Common Management Information Service
CTP	Connection Termination Point
ISO	International Organization for Standardization
ITU-T	International Telecommunication Union – Telecommunication Standardization
LOS	Loss of Signal
MS	Multiplex Section
MSP	Multiplex Section Protection
NE	Network Element
OS	Operation System
OSI	Open Systems Interconnection
Pkg	Packages
RDN	Relative Distinguished Name
RRP	Reliable Resource Pointer
SD	Signal Degrade
SDH	Synchronous Digital Hierarchy
SF	Signal Fail
SNCP	Subnetwork Connection Protection
STM-N	Synchronous Transport Module N
TMN	Telecommunications Managements Network
TP	Termination Point
TTP	Trail Termination Point
URP	Unreliable Resource Pointer
WTR	Wait-to-Restore

5 Subnetwork connection protection management model

5.1 Overview

The model is based on those generic classes and modelling principles outlined in Recommendation M.3100 and on those common classes from Recommendation G.774.03.

It provides a similar way to control and operate the subnetwork connection protection function as the other protection functions. The model defines three subclasses of the generic protection model:

- connectionProtectionGroup which represents the association of unreliable resources for the purpose of automatic protection switching and which is the focal point for all management operation related to the protection function.
- connectionProtection which represents the protected or the protecting unit and which represents the assignment of an unreliable resource to one reliable resource. The connectionProtection is contained by a connectionProtectionGroup.
- mpConnectionProtection used to model protected broadcast. Each leg of the protected broadcast is represented by individual crossConnection contained by the mpConnectionProtection.

It defines also a subclass of the fabric: sncpFabric derived from the M.3100 fabric. The sncpFabric is used to handle by means of the protectedConnect and protectUnprotect action, in addition to the connect and disconnect actions of the fabric, the following capabilities:

- Configure protected cross connections using the connection protections and multipoint connection protections.
- Change from unprotected to protected connection without traffic cut.
- Change from protected to unprotected connection without traffic cut.

5.2 SDH subnetwork connection protection requirements

The management of the subnetwork connection protection function shall provide the following management capabilities:

- The ability to manage a 1 + 1 single ended subnetwork connection protection for unidirectional and/or bidirectional subnetwork connection.
- The ability to manage the protection of broadcast where all legs are protected altogether and they do not act independently.
- The ability to manage the protection of broadcast where a part of the legs are protected altogether and the other part of the legs are not protected.
- Support of inter-connection of rings using add and drop multiplexer where no interaction between rings exists and where subnetwork connection protection exists in each ring.
- Support of inter-connection of rings using add and drop multiplexer where no interaction between rings exists and where a subnetwork connection protection exists in one ring and a Multiplex Section Shared Protection Ring exists in the other ring.
- Support of inter-connection of rings using add and drop multiplexer where no interaction between rings exists and where a Multiplex Section Shared Protection Ring exists in both rings.
- Support of inter-connection of rings/subnetwork using cross-connects where subnetwork connection protection exists in each ring/subnetwork.
- The ability to configure the protection before activating it.
- The ability to configure the protection without any traffic flow and to resume the traffic afterwards.
- The ability to change the unreliable (alternate routes) resource while the protection is configured.
- The ability to pass from an existing non-protected connection to a protected connection without traffic cut.
- The ability to pass from a protected connection to an unprotected connection without any traffic cut on the transmit direction.
- The ability to pass from a protected leg of a protected broadcast to an unprotected leg without any traffic cut on the transmit direction.
- The ability to pass from an unprotected leg of a broadcast to a protected leg without any traffic cut.

- The ability when passing from a protected connection to an unprotected connection to select which of the two connections will carry the traffic afterwards.
- The ability to initiate and terminate forced and manual switch.
- The ability to lock out the protected and the protecting connection.
- The ability to suspend and resume the traffic on the protected and the protecting connections.
- The ability to configure the switching criteria.
- The ability to control a switch hold off time and a wait to restore time.
- The ability to configure the protection in a single management operation at each end of the subnetwork connection.
- The ability to add or remove a leg to/from a protected broadcast.
- The network element should not store any historical information about connection configuration before it has been configured in the protection state.

NOTE – Throughout this Recommendation the terms protecting and protected are used, it is considered that these terms are respectively equivalent to terms used in [16] protection and working which are no longer used in that Recommendation.

6 Managed object class definitions

The following object class can be used to model an automatic 1 + 1 single-ended protection system for subnetwork connection protection.

6.1 Connection protection group

connectionProtectionGroup MANAGED OBJECT CLASS

DERIVED FROM "Recommendation G.774.03 : 1994": protectionGroup;

CHARACTERIZED BY

connectionProtectionGroupPkg PACKAGE

BEHAVIOUR connectionProtectionGroupBehaviour;

ATTRIBUTES

protectionCriteria GET-REPLACE ADD-REMOVE;

NOTIFICATIONS

"Recommendation G.774.03 : 1994": protectionSwitchReporting switchStatusParameter;;;

CONDITIONAL PACKAGES

holdOffTimePackage PRESENT IF "an instance supports it";

REGISTERED AS { g774.04MObjectClass 1 };

connectionProtectionGroupBehaviour BEHAVIOUR

DEFINED AS "This object class is used to model an automatic protection system for subnetwork connection protection. The protectionGroupType attribute indicates that the protection scheme used is 1 + 1 (plus). This object class is a focal point for management operations and notifications related to management of the protection system. Actual signal flow across the subnetwork connection protection is reflected by the connectivity pointers of the TPs involved in the subnetwork connection protection. At instantiation time of an instance of this class the protectionCriteria attribute is initialized by local initial value.";

6.2 Connection protection

connectionProtection MANAGED OBJECT CLASS

DERIVED FROM "Recommendation G.774.03 : 1994": protectionUnit;

CHARACTERIZED BY

connectionProtectionPkg PACKAGE

BEHAVIOUR connectionProtectionBehaviour;

ATTRIBUTES

switchStatus GET,

"Recommendation X.721 : 1992": administrativeState GET-REPLACE,

"Recommendation X.721 : 1992": operationalState GET,

"Recommendation M.3100 : 1992": signalType GET,

"Recommendation M.3100 : 1992": directionality GET;

NOTIFICATIONS

"Recommendation X.721 : 1992": stateChange,

"Recommendation X.721 : 1992": objectDeletion,

"Recommendation X.721 : 1992": objectCreation;;;

REGISTERED AS { g774.04MObjectClass 2 };

connectionProtectionBehaviour BEHAVIOUR

DEFINED AS "This object class is used to represent the assignment between an unreliable resource (TP) and a reliable resource (TP) for the purpose of subnetwork connection protection. This object class has properties of a cross-connection since it represents a flexible assignment of termination points in the context of subnetwork protection, according to Recommendation G.803. The directionality attribute represents the type of traffic which flows through the connection protection (CP). It can be either:

- Bidirectional – The traffic flow is passing between the unreliable and the reliable resource in both directions.
- Unidirectional – The traffic flow is unidirectional and passing from the unreliable to the reliable resource.

The Unreliable Resource Pointer (URP) points to one termination point which represents one of the alternatives for the protection system. The URP points to a TP according to the directionality of the CP, i.e.:

- the URP of a Bidirectional CP must point to a Bidirectional TP or GTP;
- the URP of an Unidirectional CP must point to a Sink TP or GTP, or to a Bidirectional TP or GTP.

The Unreliable Resource Pointer points to Null when the corresponding (unreliable) TP has been temporarily disconnected from the connection protection.

The crossConnectionObjectPointer of the corresponding TP points to the connectionProtection.

The Reliable Resource Pointer points either:

- to Null in the case of a Protecting Connection Protection; or
- to a Termination Point (CTP or TTP) or GTP instance that represents one end of the subnetwork connection in the case of a protected Connection Protection.

This termination point shall have the same signal type than the CTP or GTP representing the unreliable resource used for protection.

The crossConnectionObjectPointer of the corresponding TP points to the connectionProtection.

The attribute Signal Type describes the signal that is cross-connected. The termination points or GTPs that are cross-connected must have signal types that are compatible.

If the objects listed in the Unreliable Resource Pointer and Reliable Resource Pointer attributes are GTPs, the nth element of the Unreliable Resource GTP is related to the nth element of the Reliable Resource GTP (for every n).

Administrative state

- *Unlocked* – The Connection Protection object is administratively unlocked. Traffic is allowed to pass through the Connection Protection.
- *Locked* – No traffic is allowed to pass through the Connection Protection. The traffic flow is suspended between the termination points representing the reliable and the unreliable resources. The connectivity pointers in the corresponding unreliable resources and reliable resources are updated to reflect the suspension of traffic flow.

Setting the administrative state to locked does not prevent the protection function from attempting to operate.

Operational state

The operational state reflects only the connection capability of the connection protection:

- *Enabled* – The Connection Protection is performing its normal cross-connection function.
- *Disabled* – The Connection Protection is incapable of performing its normal cross-connection function.

The operational state of Disabled is considered as a signal failure on the corresponding connection and as such it must be taken into account in the protection mechanism.

The switchStatus indicates the status of the switching requests.";

6.3 Multipoint connection protection

mpConnectionProtection MANAGED OBJECT CLASS

DERIVED FROM "Recommendation G.774.03 : 1994": protectionUnit;

CHARACTERIZED BY

mpConnectionProtectionPkg PACKAGE

BEHAVIOUR mpConnectionProtectionBehaviour;

ATTRIBUTES

switchStatus GET,

"Recommendation X.721 : 1992": administrativeState GET-REPLACE,

"Recommendation X.721 : 1992": operationalState GET,

"Recommendation X.721 : 1992": availabilityStatus GET,

"Recommendation M.3100 : 1992": signalType GET;

NOTIFICATIONS

"Recommendation X.721 : 1992": stateChange,

"Recommendation X.721 : 1992": objectDeletion,

"Recommendation X.721 : 1992": objectCreation;;;

REGISTERED AS { g774.04MObjectClass 3 };

mpConnectionProtectionBehaviour BEHAVIOUR

DEFINED AS "This object class is used to represent the assignment between an unreliable resource, which is the termination point or GTP object listed in the Unreliable Resource Pointer attribute, and a set of reliable resources for the purpose of protection of point-to-multipoint connection. The reliable resources are the termination point or GTP objects listed in the To Termination attributes of the crossConnectionmanaged objects contained by protected mp Connection Protection.

This object class has properties of a multipoint cross-connection since its represents a flexible assignment of termination points in the context of subnetwork protection according to Recommendation G.803.

The Unreliable Resource Pointer (URP) points to one termination point or GTP which represents one of the two alternatives for the protection system.

The URP must point to a Sink CTP or GTP, or to a Bidirectional TP or GTP.

The Unreliable Resource Pointer points to Null when the corresponding (unreliable) TP has been temporarily disconnected from the multipoint connection protection.

The crossConnectionObjectPointer of the corresponding TP points to the mpConnectionProtection.

The Reliable Resource Pointer has always the value NULL. The reliable resources are represented by all the termination point or GTP objects pointed to by the To Termination attribute of the crossConnection managed objects contained by the protected mpConnectionProtection.

The attribute Signal Type describes the signal that is cross-connected. The termination points or GTPs that are cross-connected must have signal types that are compatible.

Administrative state

- *Unlocked* – The Multipoint Connection Protection object is administratively unlocked. It allows traffic to pass through each contained cross-connection depending on its administrative state.
- *Locked* – No traffic is allowed to pass through the Cross-Connection between the cross-connected termination points. The effect of this value overrides the effect of the administrative state of each contained cross-connection.

Setting the administrative state to locked does not prevent the protection function from attempting to operate.

Operational state

The operational state of a Multipoint Connection Protection object reflects the overall health of the cross-connection including all the Cross-Connection objects contained in the Multipoint Connection Protection.

- *Enabled* – The Cross-Connection is performing its normal function. Note that some (but not all) of the cross-connection objects contained in the protected Multipoint Connection Protection may be disabled.
- *Disabled* – The Cross-Connection is incapable of performing its normal cross-connection function. All the cross-connection objects contained in the protected Multipoint Connection Protection are disabled.

The operational state of Disabled is considered as a signal failure on the corresponding connection and as such it must be taken into account in the protection mechanism.

Availability status

The supported values for this attribute are:

- *Degraded* – The Multipoint Connection Protection is degraded in some respect. For instance, if one or more (but not all) Cross-Connection objects contained in the protected Multipoint Connection Protection are disabled, the Multipoint Connection Protection will be considered as degraded. The Multipoint Connection Protection remains available for service (i.e. its operational state is enabled) while it is degraded. No automatic protection switch occurs.
- *Empty SET*.

The switchStatus indicates the status of the switching requests.";

6.4 Subnetwork connection protection fabric

sncpFabric MANAGED OBJECT CLASS

DERIVED FROM "Recommendation M3100 : 1992": fabric;

CHARACTERIZED BY

sncpFabricPackage PACKAGE

BEHAVIOUR sncpFabricBehaviour;

ACTIONS

protectUnprotect,

protectedConnect;;;

REGISTERED AS { g774.04MObjectClass 4 };

sncpFabricBehaviour BEHAVIOUR

DEFINED AS "The subnetwork connection protection fabric object represents the function of managing the establishment and release of protected cross-connections.";

7 Packages

7.1 Hold off time package

holdOffTimePackage PACKAGE
ATTRIBUTES
 holdOffTime GET-REPLACE;
REGISTERED AS { g774.04Package 1 };

8 Attributes

8.1 Hold off time

holdOffTime ATTRIBUTE
WITH ATTRIBUTE SYNTAX SDHSNCPASN1.HoldOffTime;
MATCHES FOR EQUALITY;
BEHAVIOUR **holdOffTimeBehaviour**;
REGISTERED AS { g774.04Attribute 1 };

holdOffTimeBehaviour BEHAVIOUR

DEFINED AS "This attribute specifies the amount of 100 ms periods which represents the time to wait before performing a protection switch after a defect has occurred on either the protecting or protected protection unit. The minimum value is zero (no hold off time) and the maximum value is 100 (representing 10 seconds). The hold off time is defined in [16].";

8.2 Protection criteria

protectionCriteria ATTRIBUTE
WITH ATTRIBUTE SYNTAX SDHSNCPASN1.ProtectionCriteria;
MATCHES FOR EQUALITY;
BEHAVIOUR **protectionCriteriaBehaviour**;
REGISTERED AS { g774.04Attribute 2 };

protectionCriteriaBehaviour BEHAVIOUR

DEFINED AS "This attribute specifies the list of configurable criteria that are to be used for automatic switch decision supplementing those criteria which are defined as mandatory and fixed within the SNCP function as stated in [16].";

8.3 Switch status

switchStatus ATTRIBUTE
WITH ATTRIBUTE SYNTAX SDHSNCPASN1.ProtectionStatus;
MATCHES FOR EQUALITY;
BEHAVIOUR **switchStatusBehaviour**;
REGISTERED AS { g774.04Attribute 3 };

switchStatusBehaviour BEHAVIOUR

DEFINED AS "The following is a list of all the possible status values of the switchStatus attribute for protected connection protection or protected mpConnectionProtection:

- *No request* – There is no outstanding request. An active switch hold off time is considered a no request.
- *Do Not Revert* – The protected connection protection has been switched to the protecting connection protection and the request to do so has been subsequently cleared. This status is only applicable to 1 + 1 non-revertive systems.
- *Wait-to-Restore* – The protected connection protection has recovered from an auto switch condition and the WTR timer is activated.
- *Manual switch to the protecting connection protection completed* – The protected connection protection has been switched to the protecting connection protection by a manual switch request.

- *Auto switch to the protecting connection completed* – The protected connection protection has been switched to the protecting connection protection due to an auto switch condition.
- *Auto switch pending* – An auto switch request cannot be completed due to the unavailability of the protecting connection protection.
- *Forced switch to the protecting connection protection completed* – The protected connection protection has been forced to switch to the protecting connection protection.
- *Forced switch to the protecting connection protection completed – auto switch pending* – An auto switch request cannot be completed due to a completed forced switch (to protecting connection protection).
- *Lockout of protected connection protection* – The protected connection protection is prevented from switching to protection.
- *Lockout of protected connection protection – auto switch pending* – An auto switch request cannot be completed due to the lockout of the protected connection protection.

The following is a list of all the possible status values of the switchStatus attribute for protecting connection protection or protecting mpConnectionProtection:

- *No request* – There is no outstanding request. An active switch hold off time is considered a no request.
- *Do Not Revert* – The protected connection protection has been switched to the protecting connection protection and the request to do so has been cleared. This status is only applicable to 1 + 1 non-revertive systems.
- *Manual switch to the protecting connection protection completed* – The protected connection protection has been switched to the protecting connection protection by a manual switch request.
- *Auto switch to the protecting connection protection completed* – A protected connection protection has been switched to the protecting connection protection due to an auto switch condition.
- *Signal fail* – A signal fail condition exists on the protecting connection protection (no traffic is being carried on the protecting connection protection).
- *Forced switch to the protecting connection completed* – The protected connection protection has been forced to switch to the protecting connection protection.
- *Lockout of protection* – The protecting connection protection is prevented from providing protection.
- *Lockout of protection – auto switch condition on protecting connection protection* – A lockout of protection is in place, and an auto switch condition exists on the protecting connection protection.";

9 Actions

9.1 Protected connect action

protectedConnect ACTION

BEHAVIOUR protectedConnectBehaviour;

MODE CONFIRMED;

WITH INFORMATION SYNTAX SDHSNCPASN1.ProtectedConnectInformation;

WITH REPLY SYNTAX SDHSNCPASN1.ProtectedConnectResult;

REGISTERED AS { g774.04Action 1 };

protectedConnectBehaviour BEHAVIOUR

DEFINED AS "This action offers the capability, in a single action, to:

- 1) Establish a protected connection between termination points/GTPs (connect Choice of the syntax). The connection to be established is part of a subnetwork connection protection. The Termination Points/GTP involved in this protected connection must not be already connected for the concerned direction. In this case this connection establishment is done according to the following rules:
 - The protecting TP is used to describe the unreliable TP(s) of the protecting connection. This must be done according to the description of the protection Connection Type.
 - The protection Connection Type is used to describe the type of connection to be established, i.e. unidirectional or bidirectional. The protection Connection Type describes the connection between the unreliable TPs and the reliable TPs for the protected connection.
 - If the protection Connection Type is bidirectional, a connectionProtectionGroup is created. The To TP part of the syntax represents the reliable resource.
 - If the protection Connection Type is unidirectional, it can concern either:
 - A unidirectional point-to-point subnetwork connection protection. In this case a connectionProtectionGroup is created.
 - A unidirectional point-to-multipoint subnetwork connection protection where all legs are protected altogether. In this case a connectionProtectionGroup is created, containing:
 - a) the mpConnectionProtection of the working channel, connecting the unreliable TP. The reliable TPs are connected by crossConnection objects contained by the mpConnectionProtection.
 - b) the mpConnectionProtection of the protecting channel. This mpConnectionProtection does not contain crossConnection object.

The administrative state of the created connections objects is specified as an optional parameter of this action. If this parameter is omitted, the administrative state will be set to 'unlocked'.

- 2) Add TPs/GTPs as destinations of a point-to-multipoint connection. (addLeg Choice of the syntax).
 - The legs may be added as part of the protected legs (corresponding to the sub choice "protected" Legs" of the syntax). In that case each crossConnection object corresponding to each individual leg is created, these crossConnections are contained by the protected mpConnectionProtection contained by the connectionProtectionGroup.
 - The legs may be added as non-protected legs (corresponding to the sub-choice "unprotected" Legs" of the syntax). In that case each crossConnection object corresponding to each individual leg is created, these crossConnections are contained by the mpCrossConnection representing the unprotected broadcast. If no unprotected mpCrossConnection exists then an mpCrossConnection is created, containing all the specified unprotected legs (if only one unprotected leg exists, then a point-to-point unidirectional cross-connection is created). If this action concerns an existing unidirectional point-to-point cross-connection then a point-to-multipoint cross-connection is created which contains the crossConnections representing legs.

The administrative state of the created cross-connection or connection protection objects will be the same as that of the containing multipoint cross-connection or multipoint connection protection object unless otherwise specified in the action parameters.

- 3) Connect a TP as the unreliable resource of an existing protected connection (protected or protecting connectionProtection or mpConnectionProtection contained in a connectionProtectionGroup). (addUnreliable Choice of the syntax)

If the specified TP is not already connected for the corresponding direction (notConnected sub-choice of the syntax), it will be connected by the specified connectionProtection or mpConnectionProtection.

If the specified TP is already connected for the corresponding direction (connected sub-choice of the syntax) by a unidirectional connection (point-to-point or multipoint), the TP will point to the connectionProtection or mpConnectionProtection in addition to the existing connection(s).";

9.2 Protect unprotect connection action

protectUnprotect ACTION

BEHAVIOUR protectUnprotectBehaviour;

MODE CONFIRMED;

WITH INFORMATION SYNTAX SDHSNCPASN1.ProtectUnprotectInformation;

WITH REPLY SYNTAX SDHSNCPASN1.ProtectedConnectResult;

REGISTERED AS { g774.04Action 2 };

protectUnprotectBehaviour BEHAVIOUR

DEFINED AS "This action offers the capability, in a single action, to:

- 1) Protect an existing unprotected connection (protect Choice of the syntax). The description for protecting an existing connection uses the same syntax as the establishment of a new protected connection, and follows the same rules, except that all the TPs or GTP specified in the protectionConnectionType part must be explicitly specified by their object instances (i.e. no tpPool, no GTP expressed by a sequence of TPs). The connectivity specified by the protectionConnectionType part of the syntax must reflect the same connectivity (signal flow expressed by the connectivity pointers) as the existing one, i.e.:
 - For a unidirectional point-to-point, the TP specified as the From and the To must be already cross-connected the same way as described and they should not be already protected for the concerned direction.
 - For a bidirectional point-to-point, the TPs specified as the from and the To must be already cross-connected the same way as described, i.e.: a bidirectional cross-connection connecting the From TP and the To TP (reliable TP) must already exist.
 - For a point-to-multipoint, the TP specified as the From and all the TPs specified as the To must be already cross-connected the same way and none of them should be already part of a protection scheme for the concerned direction. Only those legs which are specified as part of the protectedConnect Information will be involved in the protection scheme. A connectionProtectionGroup, two mpConnectionProtection's and each crossConnection representing each leg are created as the result of this action. If all legs are involved in the protection scheme then the existing mpCross-Connection is deleted. The administrative state of the new created connection objects will be the same as that of the existing one they are to replace, unless otherwise specified in the action parameters. The result, if OK is given by the connected Choice of the syntax.
- 2) Unprotect an existing protected connection (unprotect Choice of the syntax). The description for unprotecting an existing connection uses the same syntax as the establishment of a new unprotected connection, i.e. the ConnectionType and ConnectionTypeBi, and follows the same rules, except that all the described connections must already exist, and all the TPs or GTP specified in this action must be explicitly specified by their object instances. The connectivity specified by the syntax must reflect the same connectivity as the existing one for either the working or the protect part of the ConnectionProtectionGroup, i.e.:
 - For a unidirectional point-to-point connection protection, the TP specified as the From and the To must be respectively the unreliable TP and the reliable TP of the (protected or protecting) connectionProtection.

- For a bidirectional point-to-point, the TPs specified as the From and the To must be respectively the unreliable TP of either the protected or protecting connectionProtection and the reliable TP of the protected connectionProtection. When the choice “single” of the syntax is used, a bidirectional cross-connection is created (uniform route) connecting the specified Unreliable TP and the Reliable TP. When the choice “multiple” of the syntax is used, two unidirectional cross-connections are created (diverse route), one connecting the specified Unreliable TP to the Reliable TP, and the other connecting the Reliable TP to the specified Unreliable TP.
- For a point-to-multipoint, the TP specified as the From and all the TPs specified as the To must be respectively the unreliable TP of the protected mp Connection Protection and the To TPs of the cross-connects contained in the mp connection protection. If TPs are specified which do not pertain to the protection scheme, the requests fail with the logical problem “mismatching TP Instances”. Only those TPs which are explicitly specified as part of the protectedUnprotectInformation will be unprotected, and if no mpCrossConnection was already existing then one is created which holds each crossConnection corresponding to each unprotected leg. If no other TP remains in the protected scheme, then the connectionProtectionGroup is deleted and consequently all its contained objects. The administrative state of the new created connection objects will be the same as that of the existing one they are to replace, unless otherwise specified in the action parameters.”;

10 Parameters

10.1 Switch status

switchStatusParameter PARAMETER

CONTEXT EVENT-INFO;

WITH SYNTAX SDHSNCPASN1.ProtectionStatusParameter;

BEHAVIOUR switchStatusParameterBeh;

REGISTERED AS { g774.04Parameter 1 };

switchStatusParameterBeh BEHAVIOUR

DEFINED AS "This parameter is included in the additional info parameters of the protection switching reporting notification. This notification is sent by the protection group according to the following rules. There are several cases:

- The switch from protected to protecting or protecting to protected has been done without preempting an existing switch. In this case, the old and new values of the Switch status attribute of the protecting channel shall be reported in the notification by means of the oldSwitchStatus and newSwitchStatus parameters respectively.
- A switch is performed by preempting an exiting one. In this case, the old and new values of the Switch status attribute of the protecting channel shall be reported in the notification by means of the oldSwitchStatus and newSwitchStatus parameters respectively.
- An auto switch condition exists on a channel but the auto switch cannot be served due to the unavailability of the channel that otherwise protects it. In this case the oldSwitchStatus and newSwitchStatus parameters refer to the switch status attribute value of the channel on which the auto switch condition arises. The exception is when the channel is already forced or locked out, in which case no notification is sent.
- A working channel (protected unit) has been locked out or released from lockout without modifying any existing switch. In this case the oldSwitchStatus and newSwitchStatus parameters refer to the switch status attribute value of the working channel which has been locked out.
- A protection channel (protecting unit) has been locked out or released from lockout without modifying the existing switch. In this case, the oldSwitchStatus and newSwitchStatus parameters refer to the switch status attribute value of the protection channel which has been locked out.

The protectionSwitchReporting is not sent when the automatic switch condition is toggling between SF and WTR condition. While in the lockout of forced switch state no notification is sent except for ending of release failure.";

11 Name bindings

11.1 Connection protection

connectionProtection-connectionProtectionGroup NAME BINDING

SUBORDINATE OBJECT CLASS connectionProtection AND SUBCLASSES;

NAMED BY SUPERIOR OBJECT CLASS connectionProtectionGroup AND SUBCLASSES;

WITH ATTRIBUTE protectionUnitId;

BEHAVIOUR connectionProtection-connectionProtectionGroupBeh

BEHAVIOUR

DEFINED AS "The connection protection is contained by a connection protection Group managed object instance. There must be two and only two CP (Connection Protection) in the CPG (Connection Protection Group), with the same signal type and the same directionality. This is used to represent a point-to-point unidirectional or bidirectional connection protection. One of these CPs must be the protected one (protecting attribute with the value 'FALSE'), and the other must be the protecting one (protecting attribute with the value 'TRUE').";

REGISTERED AS { g774.04NameBinding 1 };

11.2 Connection protection group

connectionProtectionGroup-sncpFabric NAME BINDING

SUBORDINATE OBJECT CLASS connectionProtectionGroup AND SUBCLASSES;

NAMED BY SUPERIOR OBJECT CLASS sncpFabric AND SUBCLASSES;

WITH ATTRIBUTE protectionGroupId;

BEHAVIOUR connectionProtectionGroup-sncpFabricBeh

BEHAVIOUR

DEFINED AS "A Connection Protection Group is created as the result of the establishment of a protected connection (point-to-point or point-to-multipoint) or of the protection of an existing non-protected connection. When disconnecting a TP involved in a protected connection:

- If the TP is the reliable resource of a point-to-point connection protection, or the last reliable resource (last leg) of a multipoint connection protection, this leads to the disconnection of the protection, resulting in the deletion of the connection protection group and all contained objects.
- If the TP is the unreliable resource of a connection protection or multipoint connection protection, the corresponding Unreliable Resource Pointer is set to NULL. Such a disconnection shall be considered as a signal failure. A new unreliable resource (TP) may be connected using the capability to add a new unreliable resource of the protected connect action. When both unreliable TPs are disconnected, this leads to the disconnection of the protection, resulting in the deletion of the connection protection group and all contained objects.";

REGISTERED AS { g774.04NameBinding 2 };

11.3 Cross connection

crossConnection-mpConnectionProtection NAME BINDING

SUBORDINATE OBJECT CLASS "Recommendation M3100 : 1992":

crossConnection AND SUBCLASSES;

NAMED BY SUPERIOR OBJECT CLASS mpConnectionProtection AND SUBCLASSES;

WITH ATTRIBUTE crossConnectionId;

DELETE ONLY-IF-NO-CONTAINED-OBJECTS;

REGISTERED AS { g774.04NameBinding 3 };

crossConnection-sncpFabric NAME BINDING
 SUBORDINATE OBJECT CLASS "Recommendation M3100 : 1992"
 crossConnection AND SUBCLASSES;
 NAMED BY SUPERIOR OBJECT CLASS sncpFabric AND SUBCLASSES;
 WITH ATTRIBUTE crossConnectionId;
 DELETE ONLY-IF-NO-CONTAINED-OBJECTS;
 REGISTERED AS { g774.04NameBinding 5 };

11.4 Multipoint connection protection

mpConnectionProtection-connectionProtectionGroup NAME BINDING
 SUBORDINATE OBJECT CLASS mpConnectionProtection AND SUBCLASSES;
 NAMED BY SUPERIOR OBJECT CLASS connectionProtectionGroup AND SUBCLASSES;
 WITH ATTRIBUTE protectionUnitId;
 BEHAVIOUR mpConnectionProtection-connectionProtectionGroupBeh
 BEHAVIOUR
 DEFINED AS "MultiPoint Connection Protection are created as the result of the establishment of a protected multipoint connection or of the protection of an existing non-protected multipoint connection. The multipoint connection protections are contained directly by the connection protection Group managed object instance. There must be two and only two mpConnectionProtections in the connectionProtectionGroup, with the same signal type. This is used to represent the point-to-multipoint unidirectional connection protection. One of these mpConnectionProtection must be the protected one (protecting attribute with the value FALSE), and the other must be the protecting one (protecting attribute with the value TRUE).
 Only the protected mpConnectionProtection can contain cross-connections representing the reliable resources. The configuration may be done prior to any existing cross-connection or on an existing multipoint cross-connection.";;
 REGISTERED AS { g774.04NameBinding 4 };

11.5 Multipoint cross connection

mpCrossConnection-sncpFabric NAME BINDING
 SUBORDINATE OBJECT CLASS "Recommendation M3100 : 1992":
 mpCrossConnection AND SUBCLASSES;
 NAMED BY SUPERIOR OBJECT CLASS sncpFabric AND SUBCLASSES;
 WITH ATTRIBUTE mpCrossConnectionId;
 REGISTERED AS { g774.04NameBinding 6 };

12 Subordination rules

None.

13 Pointer constraints

None.

14 Supporting ASN.1 productions

```
SDHSNCPASN1 { itu(0) recommendation(0) g(7) g774(774) hyphen(127) sncp(04)
informationModel(0) asn1Module(2) sdhsncp (0) }

DEFINITIONS IMPLICIT TAGS ::=

BEGIN
-- EXPORTS everything --

IMPORTS

ObjectInstance
FROM CMIP-1 { joint-iso-ccitt ms(9) cmip(1) modules(0) protocol(3) }

AdministrativeState, OperationalState
FROM Attribute-ASN1Module { joint-iso-ccitt ms(9) smi(3) part2(2) asn1Module(2) 1 }
```

AddLeg, Connected, ConnectionType, ConnectionTypeBi, Directionality, ExplicitPtoMP, ExplicitPtoP, ExplicitTP, Failed, PointToMultipoint, PointToPoint, PtoMPools, PtoTPPool
FROM ASN1DefinedTypesModule { ccitt recommendation m(13) gnm(3100)
informationModel(0) asn1Modules(2) asn1DefinedTypesModule(0) }

Boolean, Integer, ProtectionStatus, ProtectionStatusParameter
FROM SDHProtASN1 { itu(0) recommendation(0) g(7) g774(774) hyphen(127) prot(03)
informationModel(0) asn1Module(2) sdhprot(0) };

sdhSNCP OBJECT IDENTIFIER ::= { itu(0) recommendation(0) g(7) g774(774) hyphen(127)
snpcp(04) informationModel(0) }

g774.04MObjectClass OBJECT IDENTIFIER ::= { sdhSNCP managedObjectClass(3) }

g774.04Attribute OBJECT IDENTIFIER ::= { sdhSNCP attribute(7) }

g774.04Action OBJECT IDENTIFIER ::= { sdhSNCP action(9) }

g774.04NameBinding OBJECT IDENTIFIER ::= { sdhSNCP nameBinding(6) }

g774.04Parameter OBJECT IDENTIFIER ::= { sdhSNCP parameter(5) }

g774.04Package OBJECT IDENTIFIER ::= { sdhSNCP package(4) }

g774.04StandardSpecificExtension OBJECT IDENTIFIER ::= { sdhSNCP standardSpecificExtension(0) }

-- The following value assignments are for the Protection Criteria in the context of SDH.

-- These values shall always be assigned by this Recommendation in the context of SDH.

snpcpProtectionCriteria OBJECT IDENTIFIER ::= { g774.04StandardSpecificExtension 0 }

snpcpPathTraceMismatchCriteria OBJECT IDENTIFIER ::= { snpcpProtectionCriteria 1 }

snpcpExcessiveErrorCriteria OBJECT IDENTIFIER ::= { snpcpProtectionCriteria 2 }

ConnectUnreliableTP ::= CHOICE {
 notConnected [0] UnreliableTp,
 connected [1] UnreliableTp
}

HoldOffTime ::= INTEGER

PointToPointProtection ::= SEQUENCE {
 protectedPointToPoint PointToPoint,
 protectingPointToPoint ProtectingConnection
}

-- The object Instance of the xCon of PointToPoint represents the object instance of the created
-- connectionProtection

PointToMultipointProtection ::= SEQUENCE {
 protectedPointToMultipoint PointToMultipoint,
 protectingPointToMultipoint ProtectingConnection
}

-- The object Instance of the xConnections and mpXCon of PointToMultipoint represents the
-- object

-- instances of the created crossConnections and mpConnectionProtection

-- The protectingPointToMultipoint represents the object instance of the unreliable TP and

-- the object instance of the created mpConnectionProtection of the protecting connection

ProtectedAddLeg ::= CHOICE {
 protected [0] AddLeg,
 unProtected [1] AddLeg
}

-- The object Instance of the mpXCon of AddLeg represents the object instance of the
-- mpConnectionProtection to which new legs are added

ProtectedConnectInformation ::= SEQUENCE OF SEQUENCE {
 CHOICE {
 connect [0] ProtectedConnection,
 addleg [1] ProtectedAddLeg,
 addUnreliable [2] ConnectUnreliableTP
 },
 administrativeState AdministrativeState OPTIONAL
}

```

ProtectedConnection ::= SEQUENCE {
    protectionConnectionType    ProtectionConnectionType,
    protectingTP                 ExplicitTP,
    revertive                    Boolean,
    waitToRestore                [0] Integer OPTIONAL,
    holdOffTime                  [1] HoldOffTime OPTIONAL
}

```

```

ProtectionConnectionType ::= CHOICE {
    unidirectional [0] ConnectionType,
    bidirectional [1] ConnectionTypeBi
}

```

```

ProtectedConnectionResult ::= SEQUENCE {
    CHOICE {
        pointToPoint [0] PointToPointProtection,
        pointToMultipoint [1] PointToMultipointProtection
    },
    connectionPG ObjectInstance
}

```

```

ProtectedConnectResult ::= SEQUENCE OF CHOICE {
    failed [0] Failed,
    protected [1] ProtectedConnectionResult,
    unprotected [2] Unprotected
}

```

-- the n-th element in the "SEQUENCE OF" is related to the n-th element in the "SEQUENCE OF"
-- of the "ProtectedConnectInformation" type.

```

ProtectingConnection ::= SEQUENCE {
    unreliableTp ObjectInstance,
    conProt ObjectInstance
}

```

ProtectionCriteria ::= SET OF Criterion

Criterion ::= OBJECT IDENTIFIER

```

ProtectUnprotectInformation ::= SEQUENCE OF SEQUENCE {
    CHOICE {
        protect [3] ProtectedConnection,
        unprotect [4] UnprotectConnection
    },
    administrativeState AdministrativeState OPTIONAL
}

```

```

Unprotected ::= CHOICE {
    uniform [0] Connected,
    divers [1] UnprotectedMultiple
}

```

```

UnprotectedMultiple ::= SEQUENCE {
    sending PointToPoint,
    receiving pointToPoint
}

```

```

UnprotectConnection ::= CHOICE {
    uniPtoP [0] ExplicitPtoP,
    pToMp [1] ExplicitPtoMP,
    bidirectional [2] UnprotectBi
}

```

```

UnprotectBi ::= CHOICE {
    uniformRoute [0] ExplicitPtoP,
    diverseRoute [1] UnprotectMultiple
}

```

```

UnprotectMultiple ::= SEQUENCE {
    firstXCon      ExplicitPtoP,
    secondXCon     ExplicitPtoP
}

UnreliableTp ::= SEQUENCE {
    unreliableTp   ExplicitTP,
    connectionProtection ObjectInstance
}
END

```

Annex A

Inheritance and naming diagrams

(This annex forms an integral part of this Recommendation)

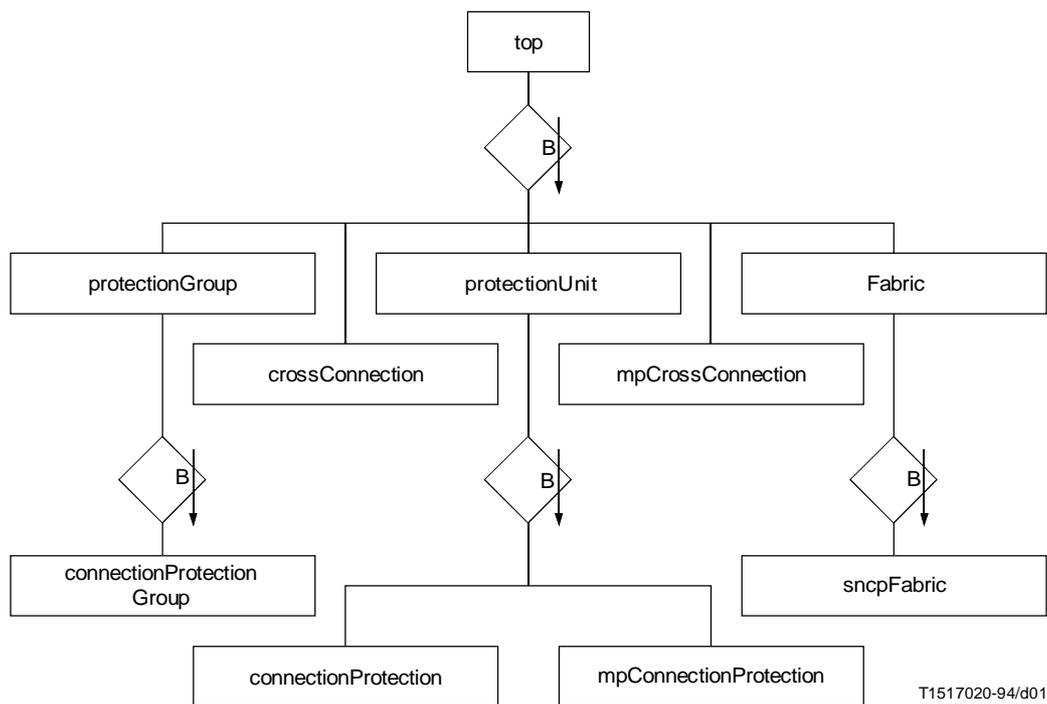
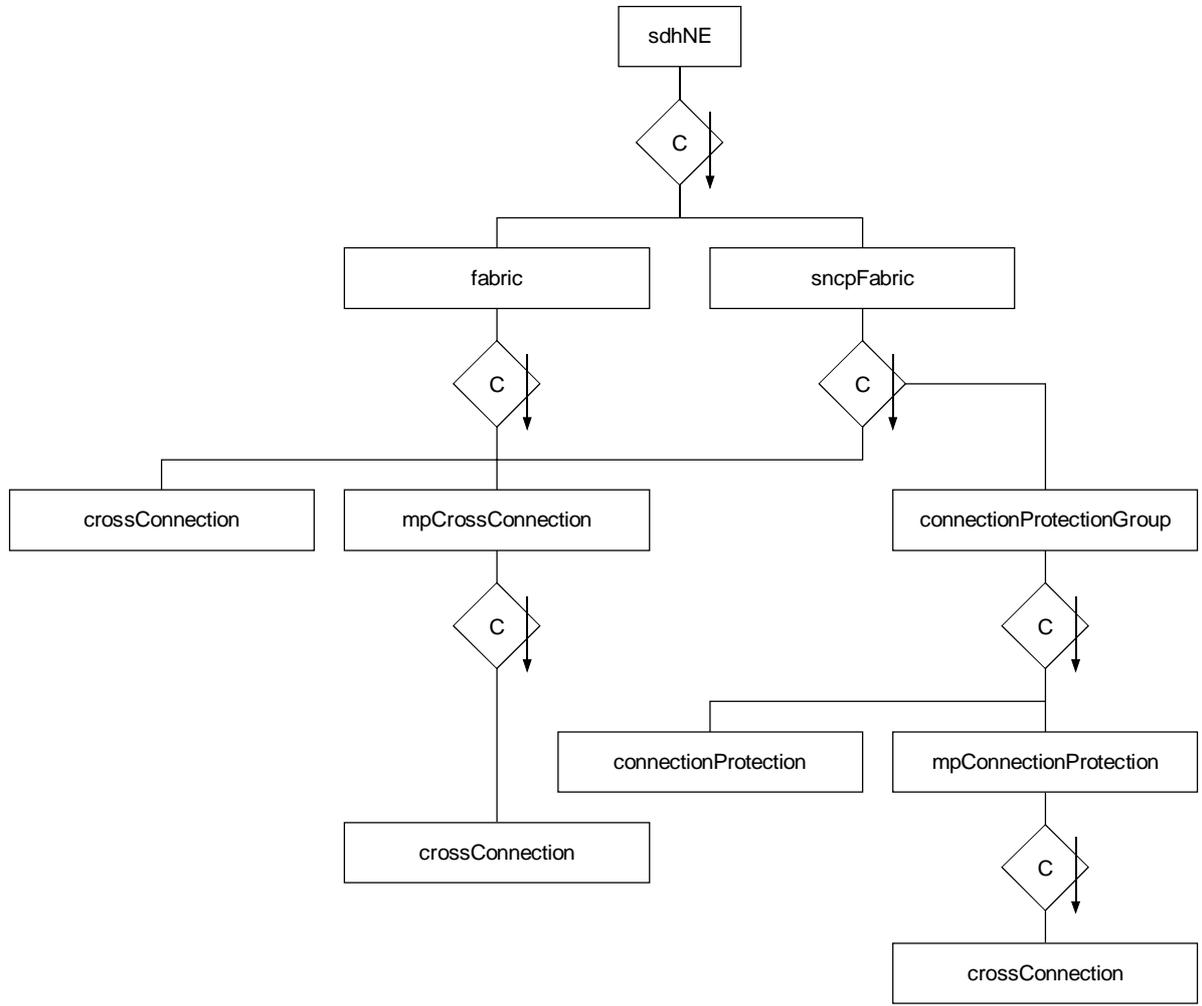


FIGURE A.1/G.774.04

Inheritance subtree of subnetwork connection protection



T1517030-94/d02

FIGURE A.2/G.774.04
Containment tree of the subnetwork connection protection

Annex B

Examples of subnetwork connection protection

(This annex forms an integral part of this Recommendation)

B.1 Legends

In the following figures, the following legends and symbols will be used as described in Figure B.1.

Legend	
U-Pd: Unidirectional Protected	U-Pg: Unidirectional Protecting
B-Pd: Bidirectional Protected	B-Pg: Bidirectional Protecting
	Naming
	Downstream connectivity pointer
	RRP Reliable Resource Pointer
	COP Cross Connection Object Ptr
	DCOP Downstream Cross Connection Object Ptr
	UCOP Upstream Cross Connection Object Ptr
	Upstream connectivity pointer
	URP Unreliable Resource Pointer
	To TP
	From TP

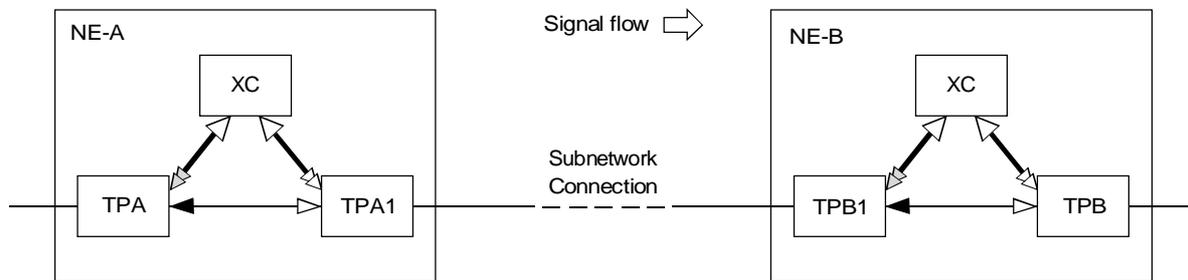
T1517040-94/d03

FIGURE B.1/G.774.04

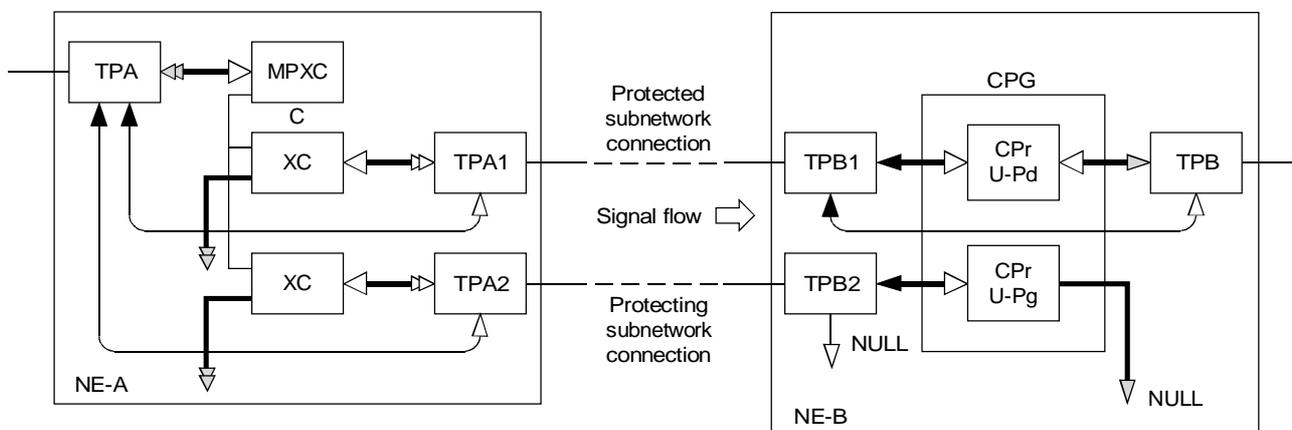
Legend

B.2 Subnetwork connection protection examples

See Figures B.2 to B.7.



a) Non-protected unidirectional subnetwork connection between NE-A and NE-B

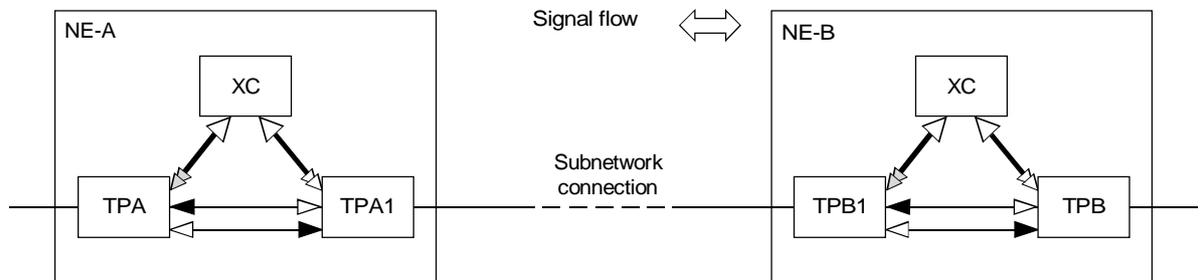


T1517050-94/d04

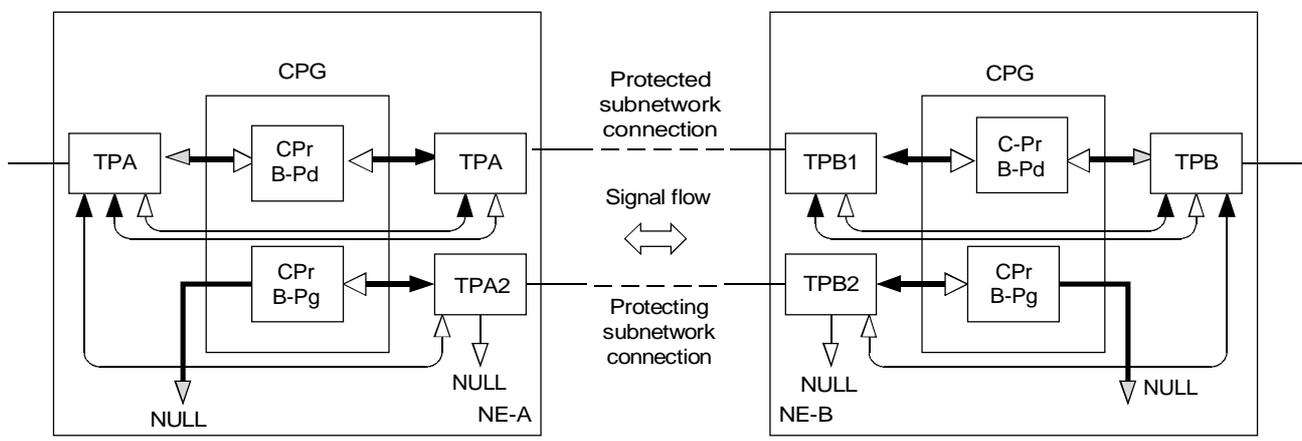
b) Protected unidirectional subnetwork connection between NE-A and NE-B

FIGURE B.2/G.774.04

Indirectional cross-connection and connection protection modeled at the transmit end as a normal broadcast and at the receiving end by connection protection group



a) Non-protected bidirectional subnetwork connection between NE-A and NE-B

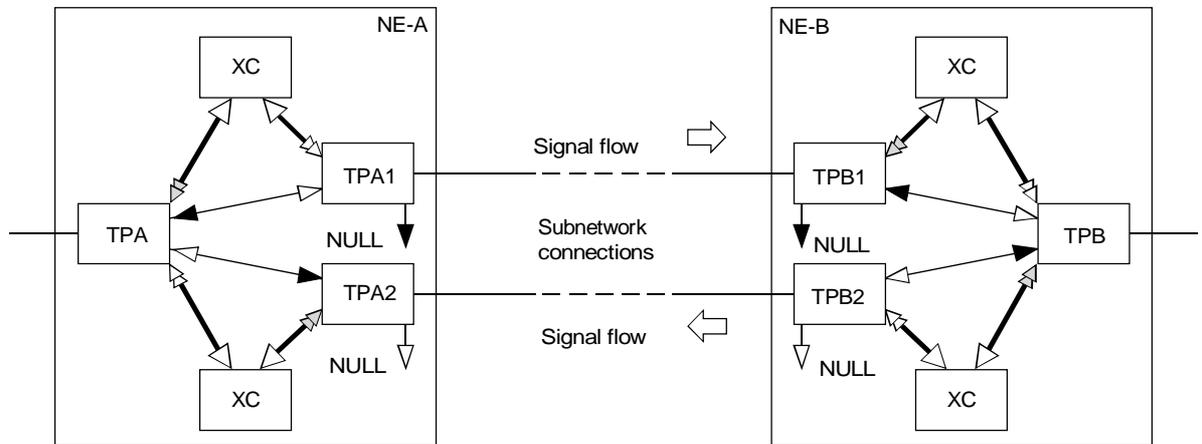


T1517060-94/d05

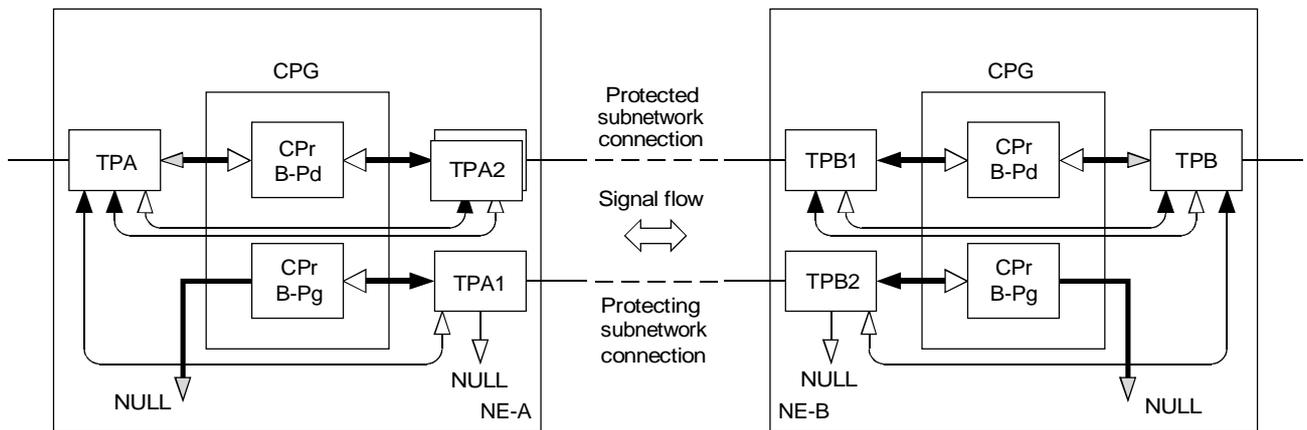
b) Protected bidirectional subnetwork connection between NE-A and NE-B

FIGURE B.3/G.774.04

Bidirectional cross-connection and connection protection (uniform route)



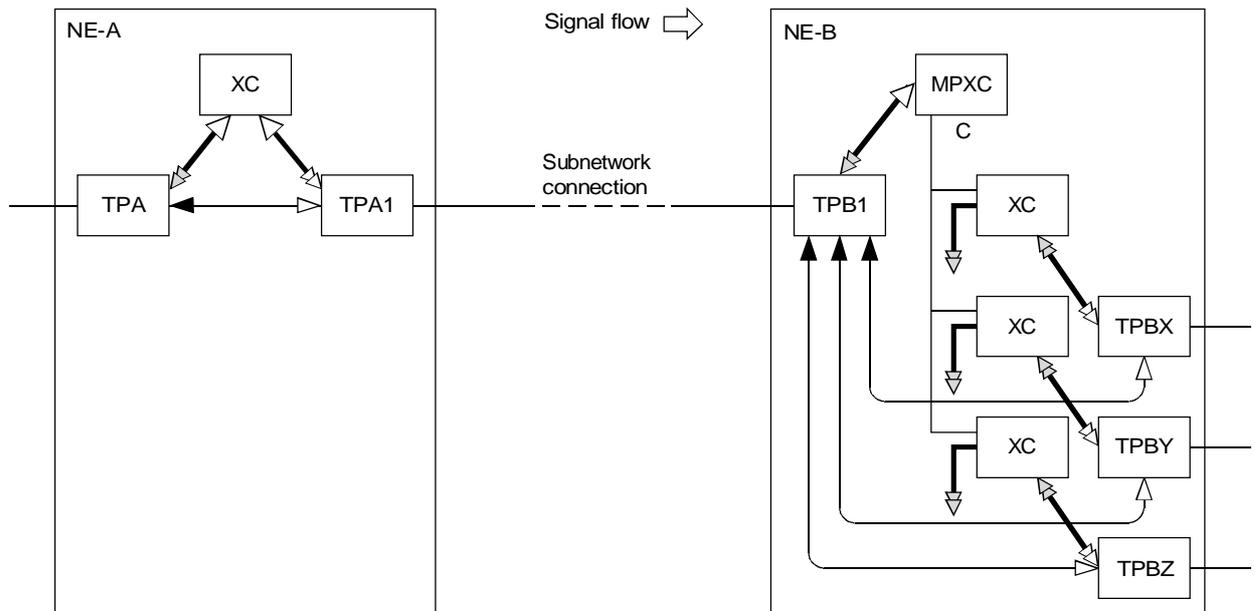
a) Non-protected bidirectional subnetwork connection diverse route between NE-A and NE-B



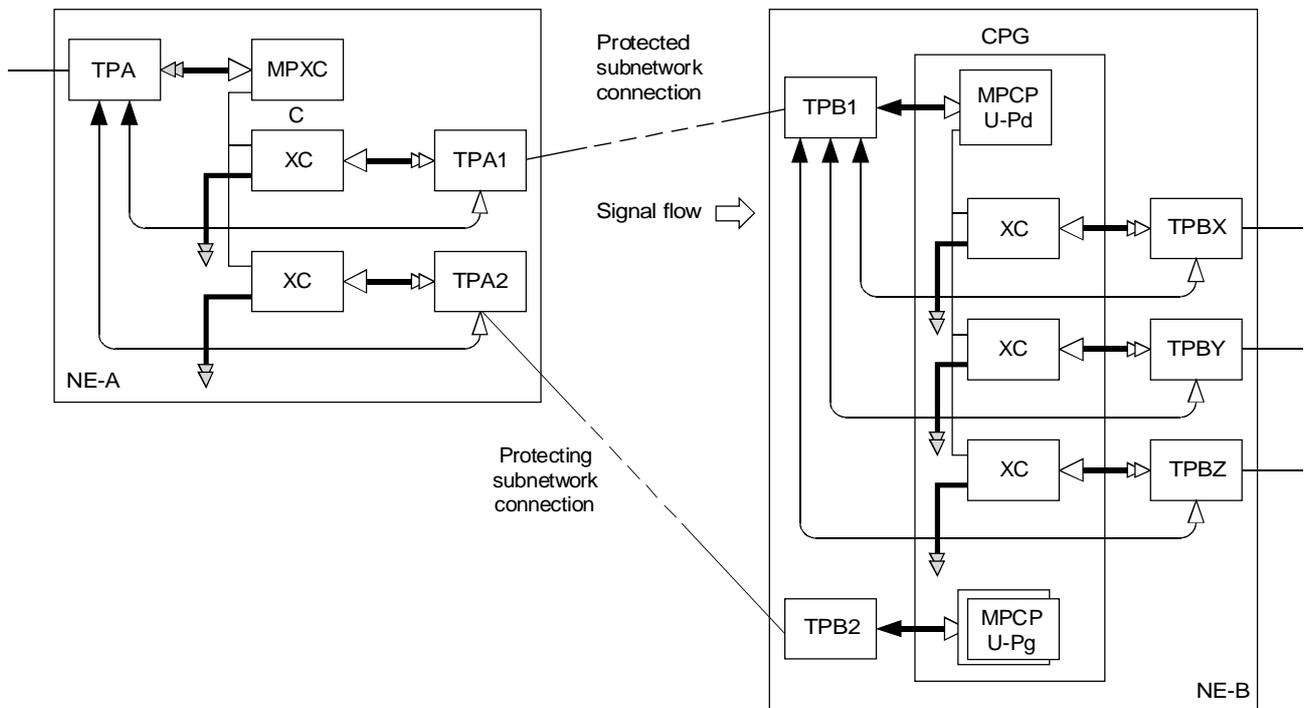
T1517070-94/d06

b) Protected bidirectional subnetwork connection between NE-A and NE-B

FIGURE B.4/G.774.04
Cross-connection and connection protection (diverse route)



a) Non-protected unidirectional subnetwork connection between NE-A and NE-B with broadcast in NE-B

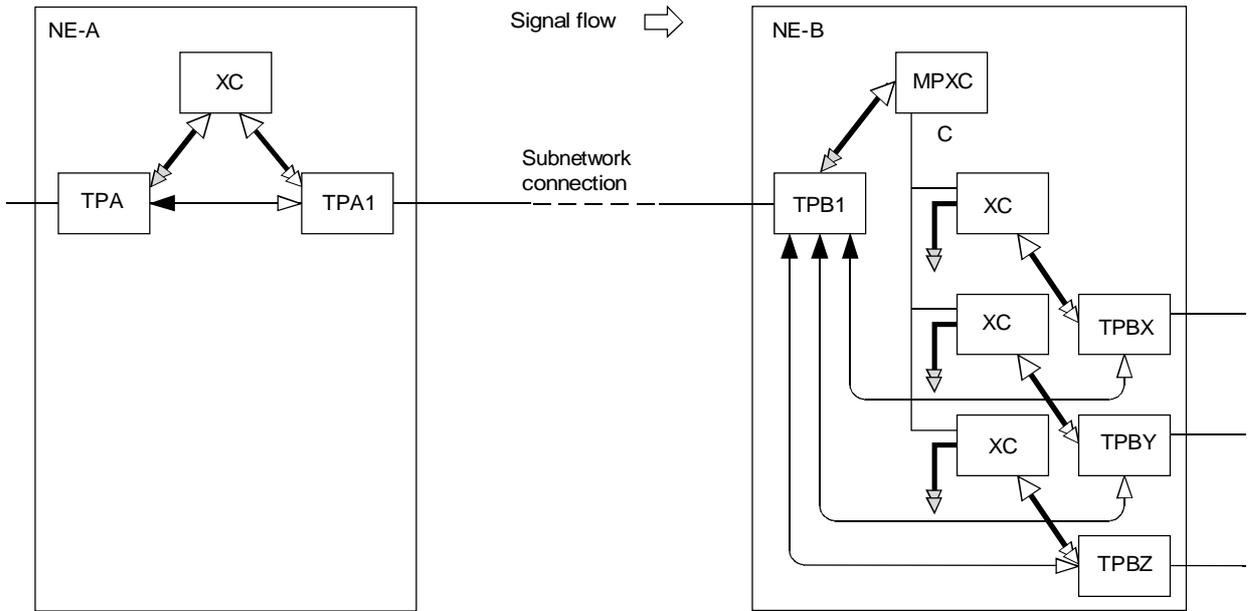


T1517080-94/d07

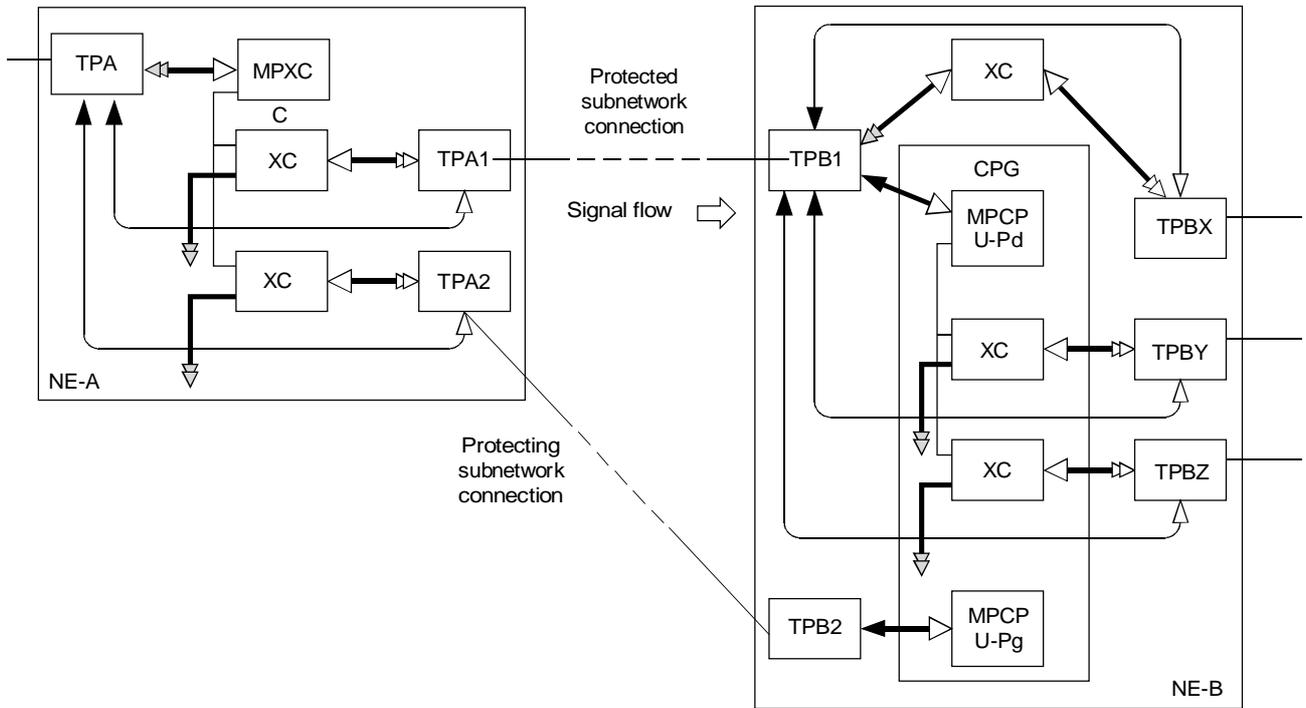
b) Protected unidirectional subnetwork connection between NE-A and NE-B with broadcast in NE-B

FIGURE B.5/G.774.04

Unidirectional upstream point-to-multipoint cross-connection and connection protection
[All the legs (TPBX, TPBY and TPBZ) are protected as a whole]



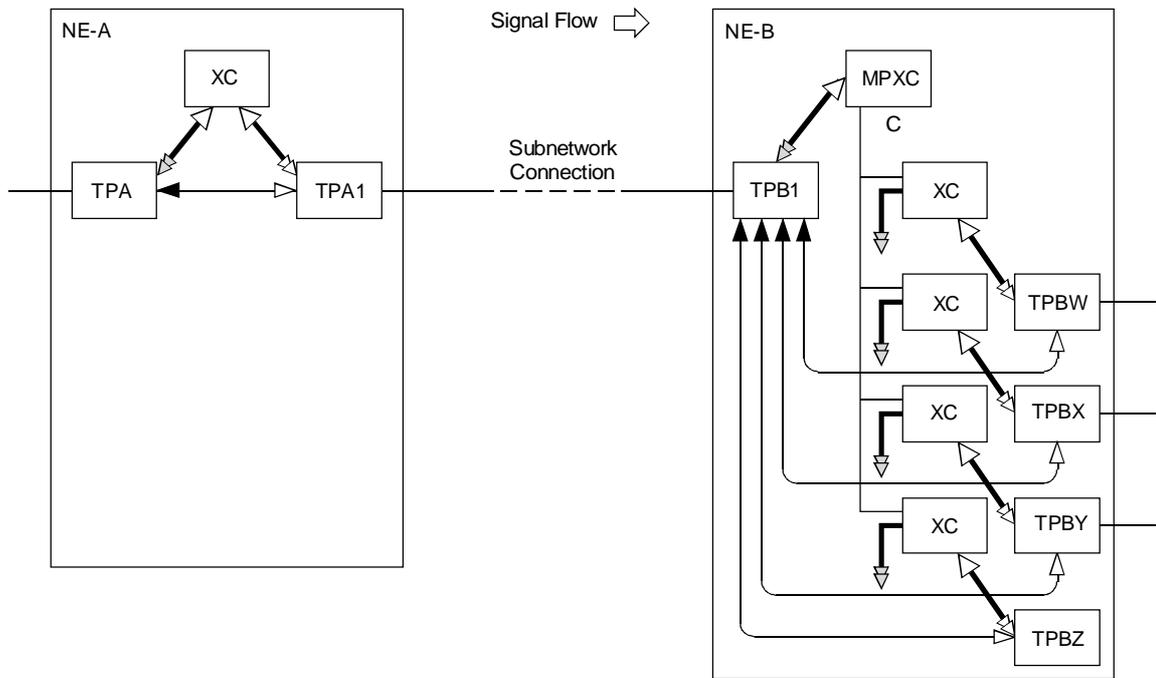
a) Non-protected unidirectional subnetwork connection between NE-A and NE-B with broadcast in NE-B



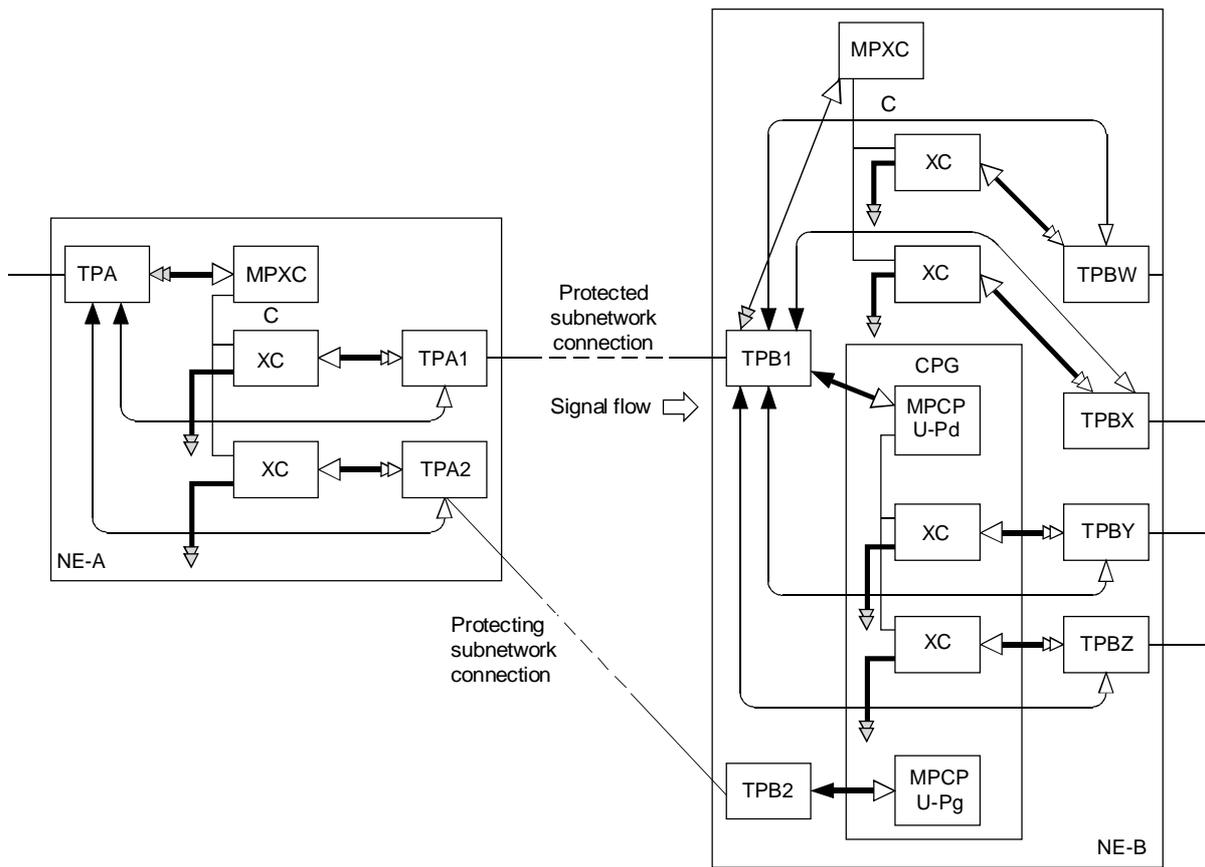
T1517090-94/d08

b) Protected unidirectional subnetwork connection between NE-A and NE-B with broadcast in NE-B

FIGURE B.6/G.774.04
Unidirectional upstream point-to-multipoint cross-connection and connection protection
(Only the legs TPBY and TPBZ are protected)



a) Non-protected unidirectional subnetwork connection between NE-A and NE-B with broadcast in NE-B



b) Protected unidirectional subnetwork connection between NE-A and NE-B with broadcast in NE-B

FIGURE B.7/G.774.04

**Unidirectional upstream point-to-multipoint cross-connection and connection protection
(Only the legs TPBY and TPBZ are protected)**

B.3 Bidirectional subnetwork connection protection in rings

See Figure B.8.

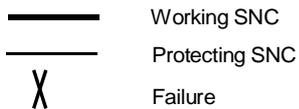
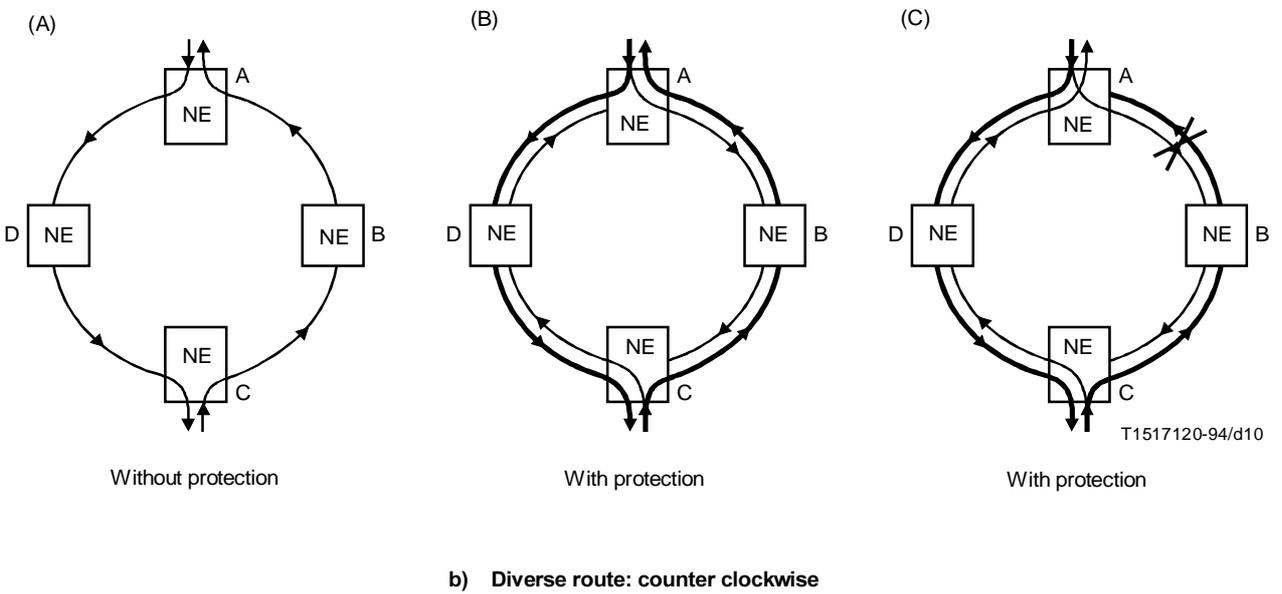
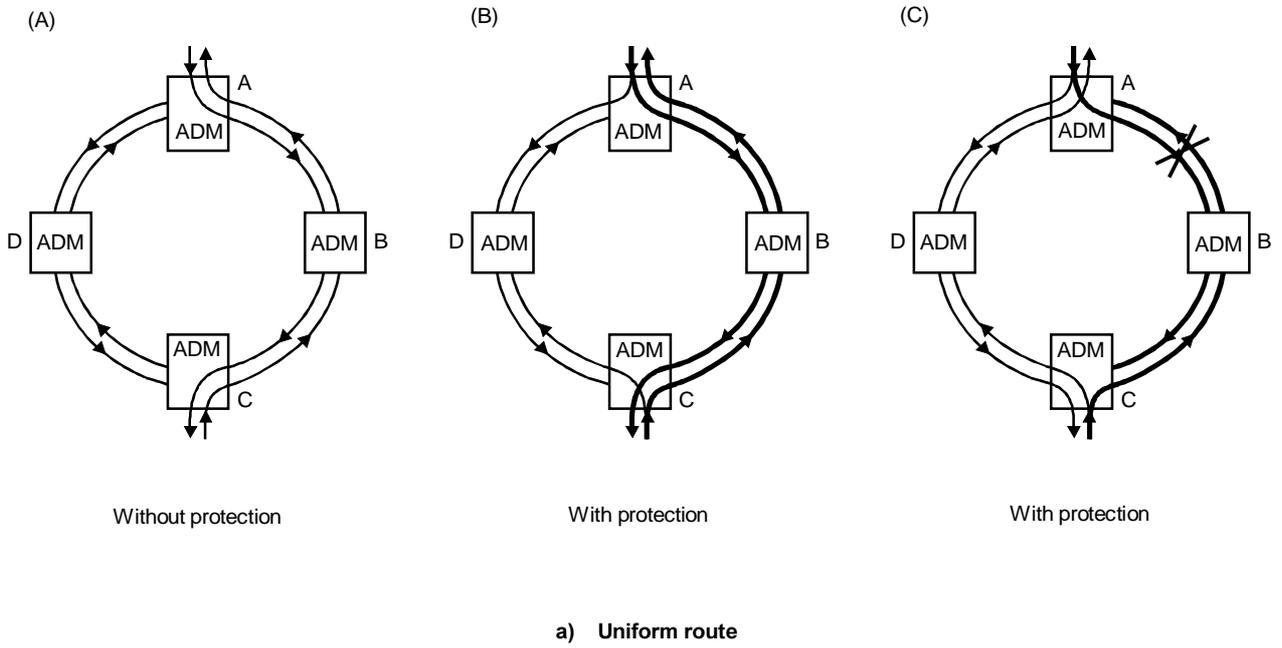


FIGURE B.8/G.774.04
 Bidirectional subnetwork connection protection

B.4 Interconnection of protected rings by a cross-connect

See Figures B.9 and B.10.

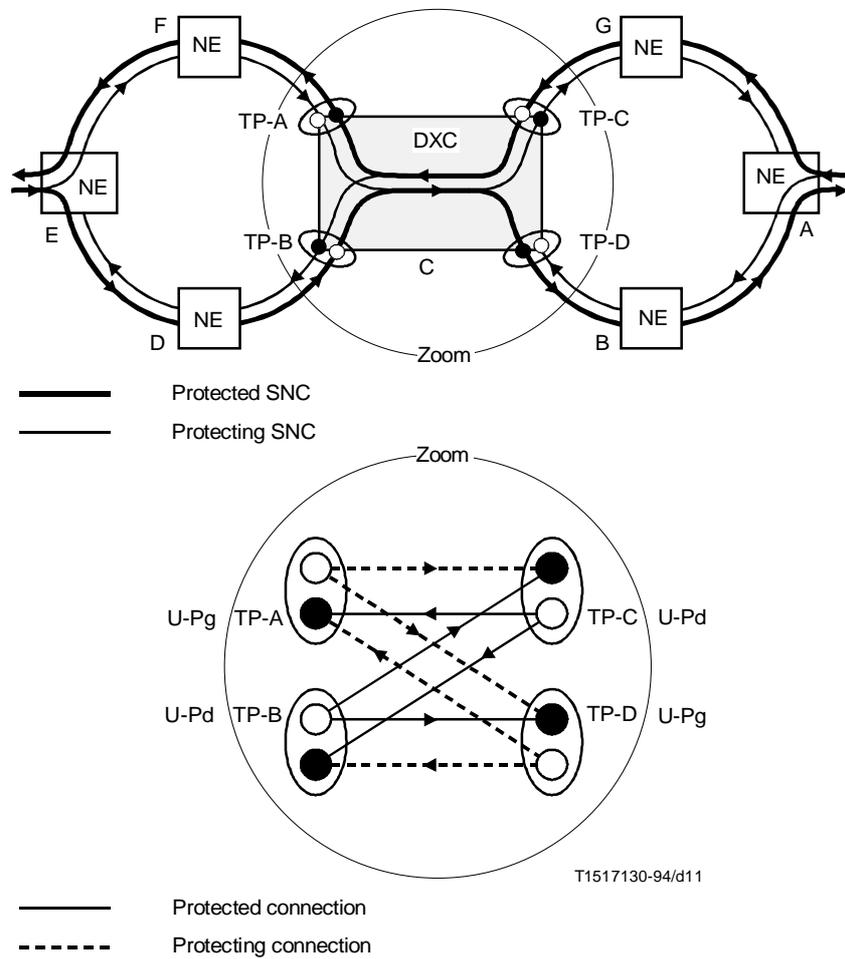


FIGURE B.9/G.774.04
Interconnection of protected rings by a cross-connect

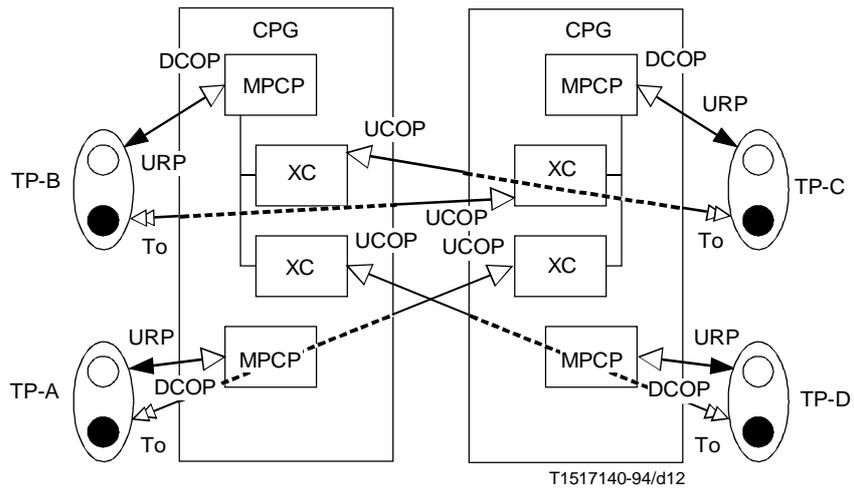


FIGURE B.10/G.774.04
**Interconnection of protected rings by a cross-connect:
 managed objects view**

B.5 Interconnections of subnetwork with ADMs (SNCP/SNCP) in SNCP interworking

See Figure B.11.

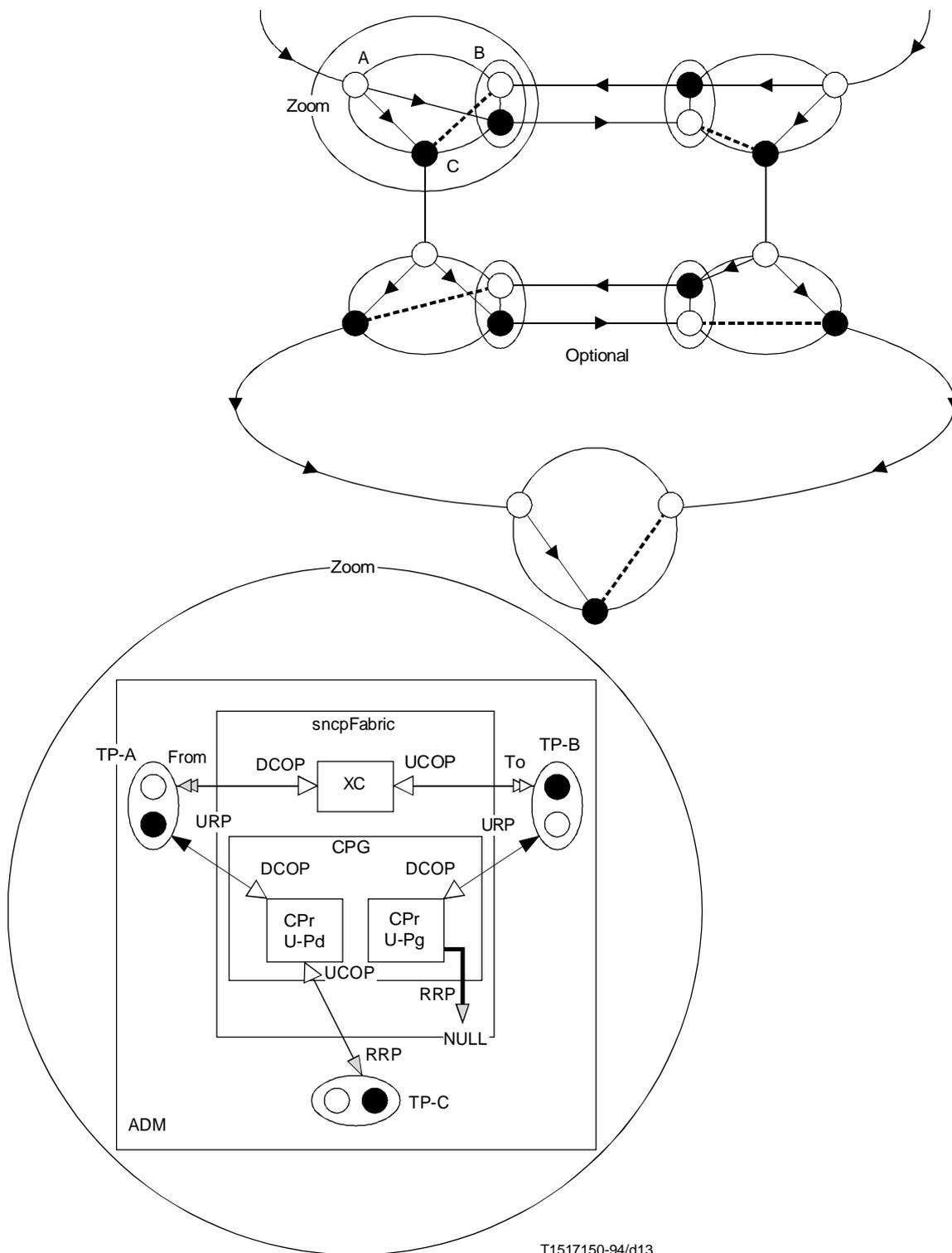


FIGURE B.11/G.774.04

Interconnections of subnetwork with ADMs (SNCP/SNCP) in SNCP interworking

B.6 Logical connections in SNCP interworking rings

See Figures B.12 and B.13.

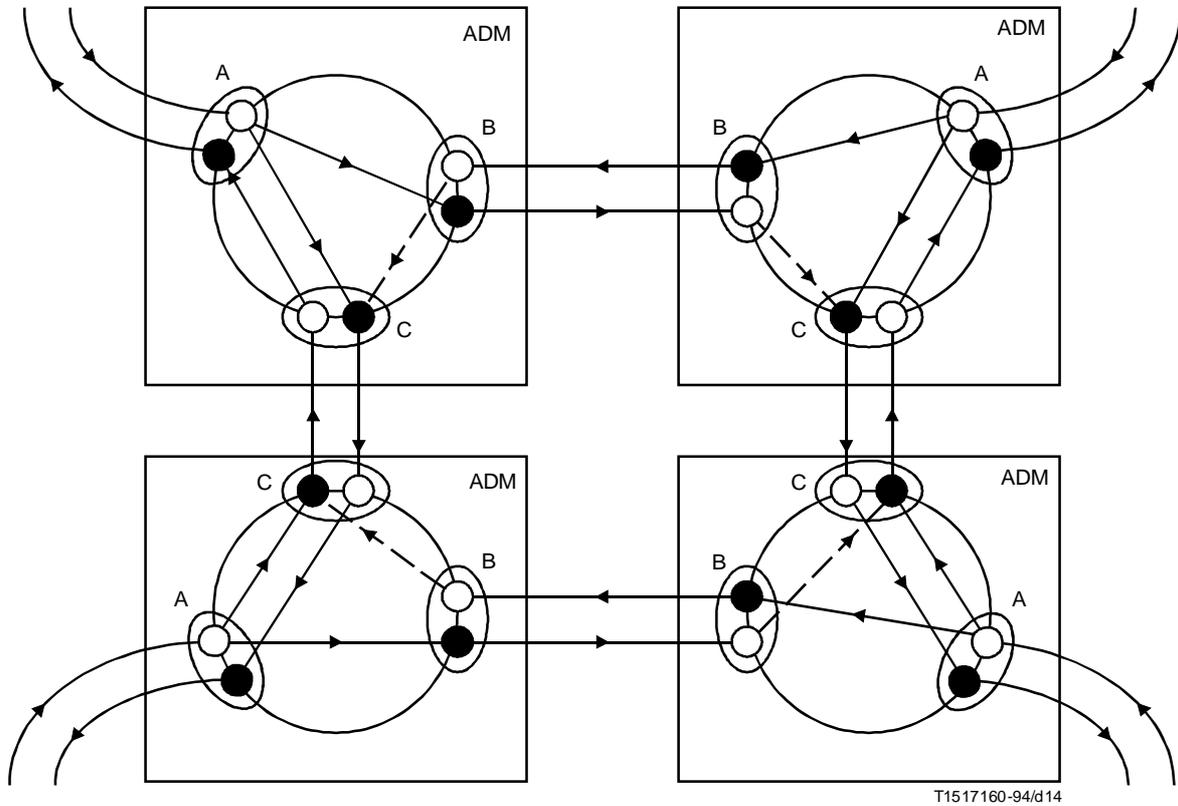


FIGURE B.12/G.774.04

Logical connections in SNCP interworking rings connectivity view

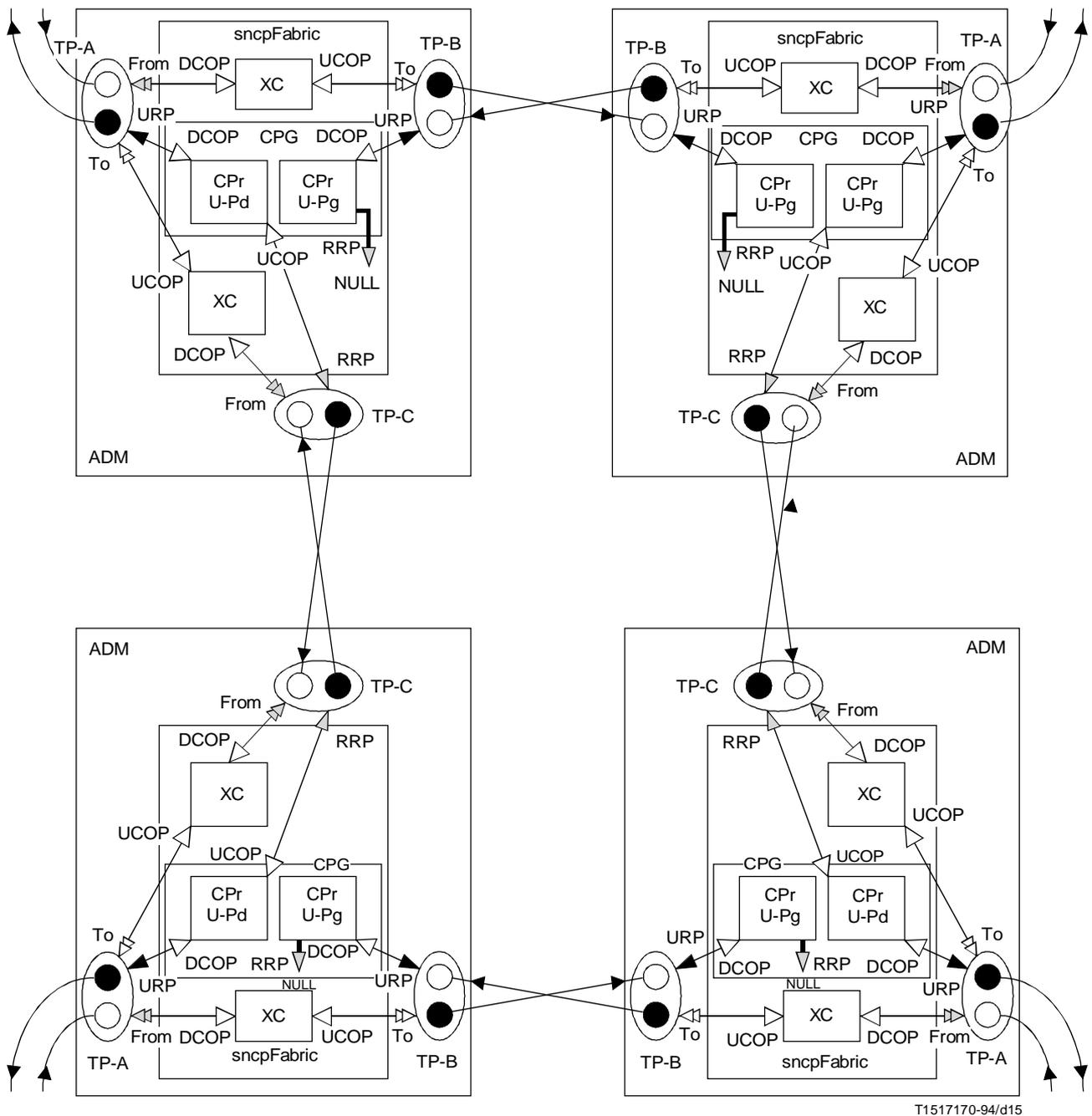


FIGURE B.13/G.774.04
 Logical connections in SNCP interworking rings: management view

B.7 Logical connections in MS SHARED RINGS interworking

See Figures B.14 and B.15.

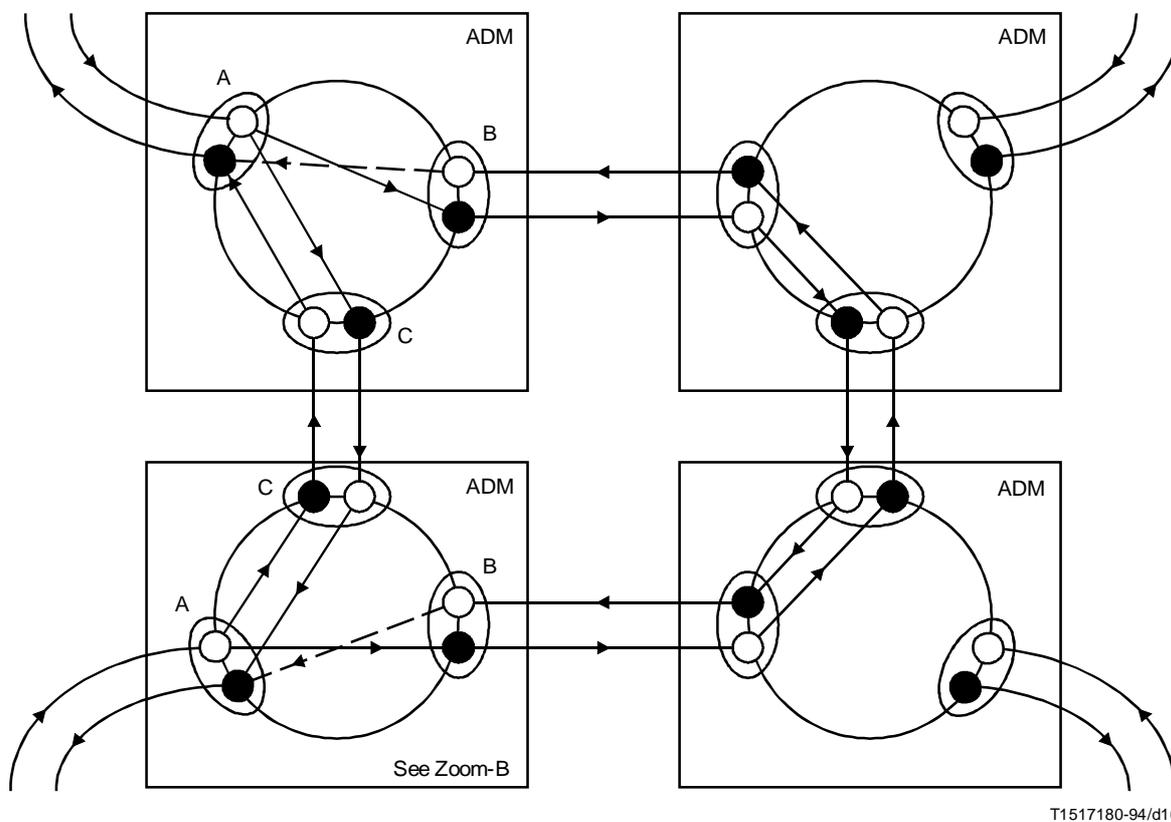
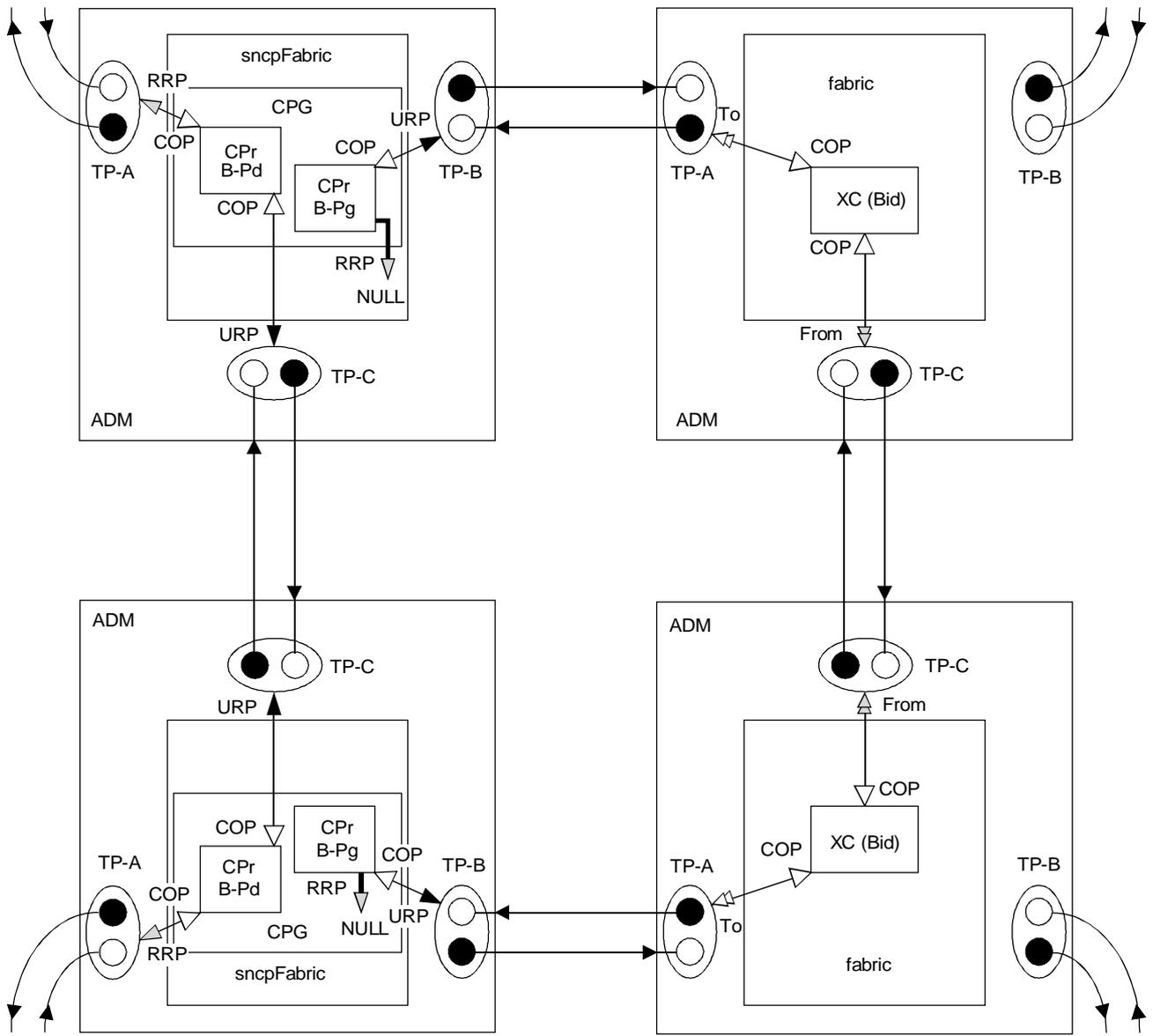


FIGURE B.14/G.774.04

Logical connections in MS SHARED RINGS interworking: connectivity view

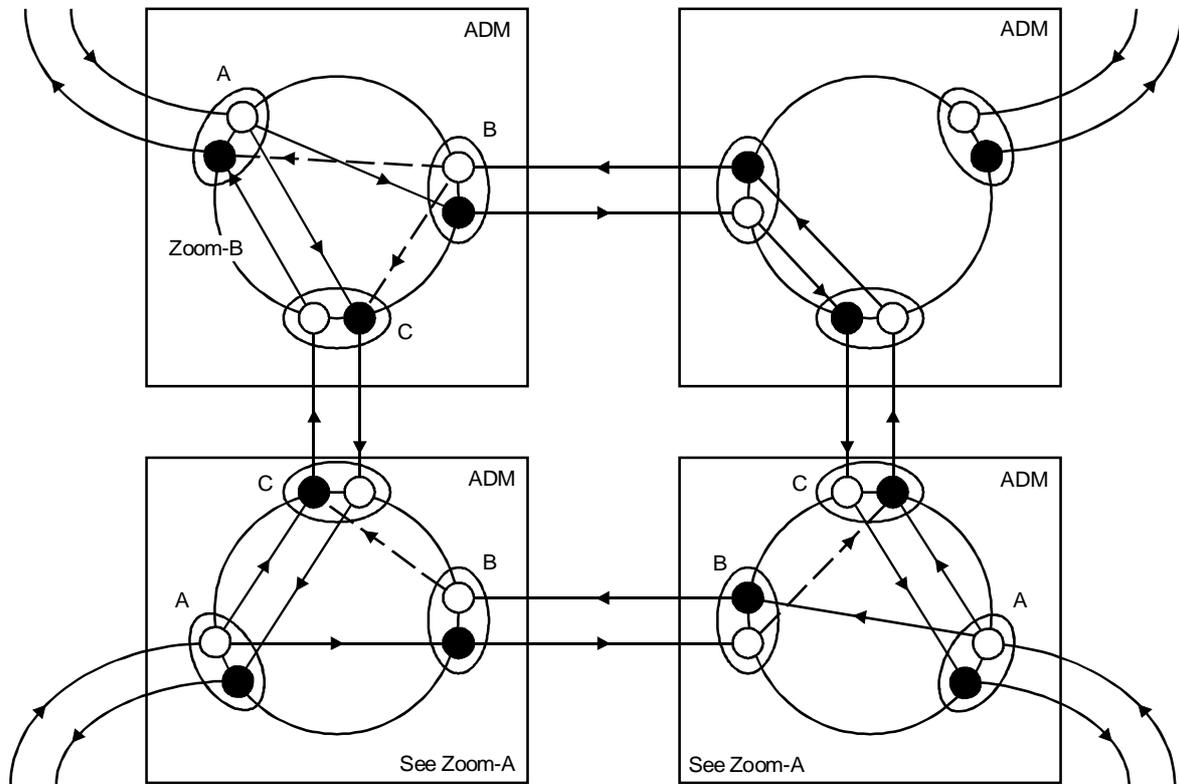


T1517190-94/d17

FIGURE B.15/G.774.04
Logical connections in MS SHARED RINGS interworking: management view

B.8 Logical connections in SNCP Ring and MS SHARED RING interworking

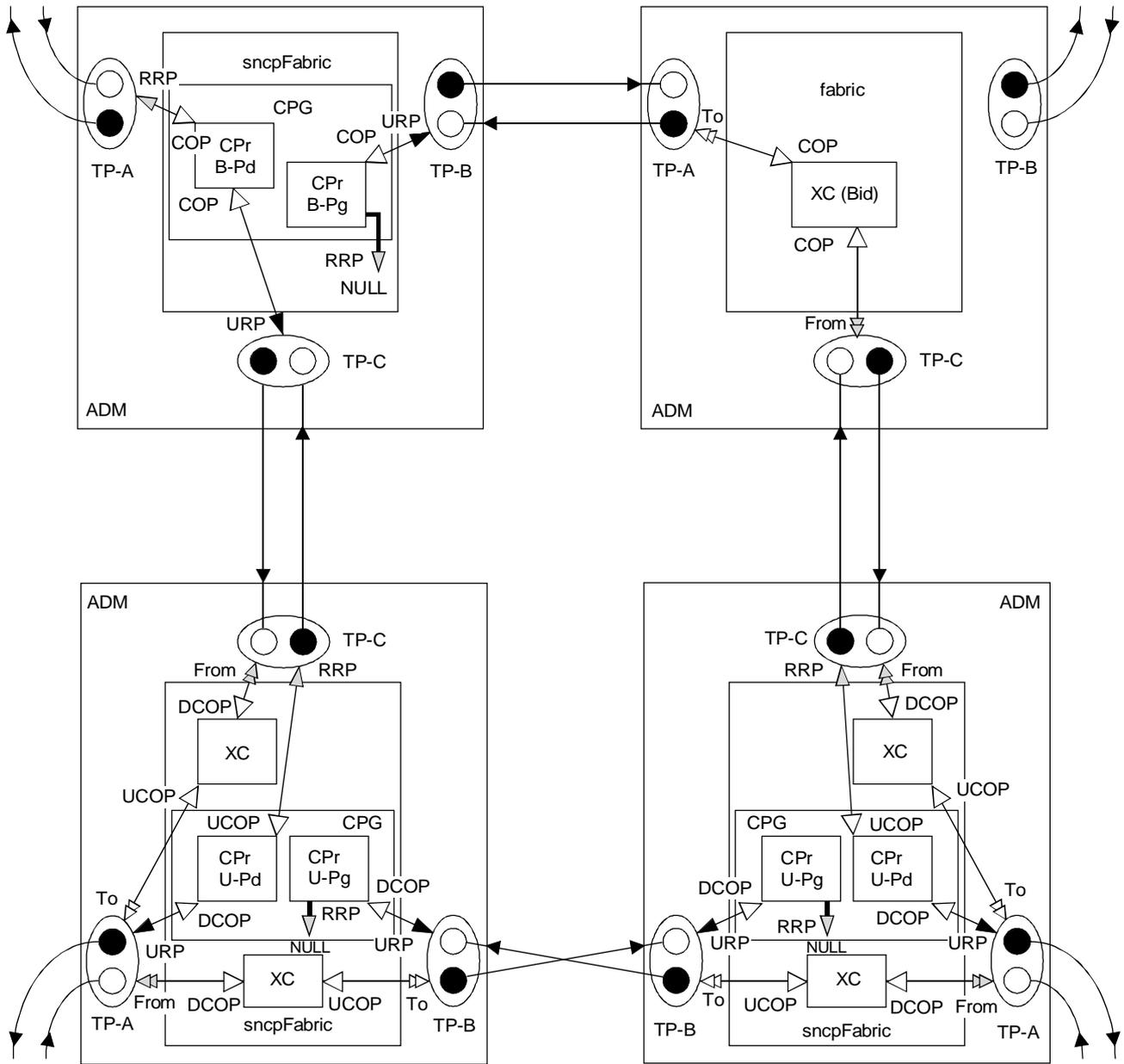
See Figures B.16 and B.17.



T1517200-94/d18

FIGURE B.16/G.774.04

**Logical connections in SNCP Ring and MS SHARED RING interworking:
connectivity view**



T1517210-94/d19

FIGURE B.17/G.774.04
**Logical connections in SNCP Ring and MS SHARED RING interworking:
 management view**

Annex C

State transition diagrams

(This annex forms an integral part of this Recommendation)

C.1 State diagrams

C.2 Allowable values of switchStatus for a protected (mp) connection protection

State	Protection status	Description of the state
STA01	noRequest	No request is currently active on the protected connection protection. The traffic is passed through on the protected connection protection.
STA02	AutoSwitchSFPending	An automatic switch Signal Failure condition is active but could not be protected due to the unavailability of the protecting connection protection.
STA03	AutoSwitchSFComplete	An automatic switch has been successfully completed to the protecting connection protection due to a Signal Failure condition on the protected connection protection.
STA04	ForcedSwitchComplete	A forced switch has been completed successfully to the protecting connection protection.
STA05	ForcedSwitchComplete- AutoSwitchSFPending	A forced switch to the protecting connection protection has been completed successfully. Additionally, an automatic switch Signal Failed condition is active on the protected connection protection.
STA06	LockoutComplete	The protected connection protection has been locked out.
The following are additional values for 1 + 1 non-revertive systems		
STA07	DoNotRevert	The protected connection protection has been switched to the protecting connection protection and the request to do so has been released. The switch to the protecting connection protection is maintained.
The following are additional values for 1 + 1 revertive systems		
STA08	manualSwitchToProtectingComplete	The protected connection protection has completed a manual switch to the protecting connection protection.
STA09	AutoSwitchCompleteWaitToRestore	An automatic switch has been successfully completed to the protecting connection protection. The switch condition has cleared on the protected connection protection, and the wait to restore timer is started for switching back (revertive systems only).

C.3 Allowable values of switchStatus for a protecting (mp) connection protection

State	Protection status	Description of the state
STA01	noRequest	No request is present on the protecting connection protection.
STA02	AutoSwitchSFToProtectingComplete	The protected connection protection has completed an automatic switch (SF) to the protecting connection protection.
STA03	ForcedSwitchToProtectingComplete	The protected connection protection has completed a Forced Switch to the protecting connection protection.
STA04	ForcedSwitchToProtecting-CompleteSFPresentOn-Protecting	The protected connection protection has completed a Forced Switch to the protecting connection protection. Additionally the protecting connection protection has an SF condition present (1 + 1 unidirectional systems only).
STA05	LockoutComplete	The protecting connection protection has been locked out.
STA06	AutomaticSwitchSFToProtectedPending	A Signal Failure condition is active on the protecting connection protection.
The following are additional values for 1 + 1 non-revertive systems		
STA07	DoNotRevert	The protected connection protection has been switched to the protecting connection protection and the request to do so has been released. The switch to the protecting connection protection is maintained.
The following are additional values for 1 + 1 revertive systems		
STA08	manualSwitchToProtectingComplete	The protected connection protection has completed a manual switch to the protecting connection protection.
STA09	AutoSwitchCompleteWaitToRestore	An automatic switch has been successfully completed to the protecting connection protection. The switch condition has cleared on the protected connection protection, and the wait to restore timer is started for switching back (Only for Revertive Systems).

C.4 State diagram for a protected connection protection (non-revertive)

Condition

- c1: The request on the protected connection protection has a higher priority than the existing one on the protecting connection protection. (Refer to the protection switch decision table.)
- c2: There is an auto switch condition present on the protected connection protection.
- c3: The request has been completed.
- c4: There is an auto switch condition present on the protecting connection protection.

Process

- p1: Request switch to protecting connection protection.
- p2: Release the current switch.
- p3: Notify switch report. (The protection switch report is sent by the protection group however the condition under which such notification is sent is specified in the connection protection state diagram using such process.)

States

STA01	noRequest
STA02	AutoSwitchSFPending
STA03	AutoSwitchSFComplete
STA04	ForcedSwitchComplete
STA05	ForcedSwitchCompleteAutoSwitchSFPending
STA06	LockoutComplete
STA07	DoNotRevert

Event

Req. Lock.	A lockout request has been issued on the protected connection protection.
Rel. Lock.	A release request of lockout has been issued on the protecting connection protection.
Req. Force	A Forced Switch request has been issued to switch from the protected connection protection to the protecting connection protection.
Rel. Force	A release request of Forced Switch has been issued on the protected connection protection.
Req. Man.	A Manual Switch request has been issued to switch from the protected connection protection to the protecting connection protection.
Rel. Man.	A Release Manual Switch request has been issued. As Manual Switch is not memorized, this will result as a failed request.
A-S Cond.	An automatic switch condition has occurred on the protected connection protection.
A-S Clr	The automatic switch condition on the protecting connection protection has disappeared.
P-ing Avail.	One or more requests (including Lockout request) have disappeared on the protecting connection protection, so that the protecting connection protection becomes available for use in the protection scheme (i.e. the highest priority request that could remain on the protecting connection protection has lower priority than existing ones on the protected connection protection).
P-ing Unav.	One or more requests (including Lockout request) have appeared on the protecting connection protection, so that the protecting connection protection becomes unavailable for use in the protection scheme (i.e. the highest priority request on the protecting connection protection has higher priority than existing ones on the protected connection protection).
Man. P-ing	A Manual Switch request has been issued to switch from the protecting connection protection to the protected connection protection.
Set Rev.	The connection protection group mode has been changed from non-revertive mode to revertive mode.

State diagram for a protected connection protection in a 1 + 1 non-revertive system

Event	STA01 No Req.	STA02 A-S Pend.	STA03 A-S Comp.	STA04 F-S Comp.	STA05 F-S Comp A-S Pend.	STA06 LockComp (Note 1)	STA07 Do not revert
Req. Lock.	p3:STA06	p3:STA06	p2,p3: STA06	p2,p3: STA06	p2,p3: STA06	STA06	p2,p3: STA06
Rel. Lock.	STA01 (Note 2)	STA02 (Note 2)	STA03 (Note 2)	STA04 (Note 2)	STA05 (Note 2)	c1&c2&c3 p1,p3:STA03	STA07 (Note 2)
						(^c1V^c3)& c2:p3:STA02	
						^c2:p3:STA01	
Req. Force	c1&c3:p1, p3:STA04	c1&c3:p1, p3:STA05	p3:STA05	STA04	STA05	STA06 (Note 2)	p3:STA04
	^c1V^c3: STA01 (Note 2)	^c1V^c3: STA02 (Note 2)					
Rel. Force	STA01 (Note 2)	STA02 (Note 2)	STA03 (Note 2)	p3:STA07	c1&c3:p3: STA03	STA06 (Note 2)	STA07 (Note 2)
					^c1V^c3:p2, p3: STA02		
Req. Man.	c1&c3:p1, p3:STA07	STA02 (Note 2)	STA03 (Note 2)	STA04 (Note 2)	STA05 (Note 2)	STA06 (Note 2)	STA07
	^c1V^c3: STA01 ⁽²⁾						
Rel. Man.	STA01 (Note 2)	STA02 (Note 2)	STA03 (Note 2)	STA04 (Note 2)	STA05 (Note 2)	STA06 (Note 2)	STA07 (Note 2)
A-S Cond.	c1&c3:p1, p3:STA03	c1&c3:p1, p3:STA03	STA03	STA05	STA05	STA06	p3:STA03
	^c1V^c3: p3:STA02	^c1V^c3: STA02					
A-S Clr	-	^c2:p3: STA01	^c2 & ^c4: p3:STA07	-	^c2:STA04	STA06	-
			^c2 & c4:p2, p3:STA01				c2:STA05
		c2:STA02	c2&^c1:p2, p3:STA02				
			c2&c1: STA03				
P-ing Unav.	STA01	STA02	p2,p3: STA02	p2,p3: STA01	p2,p3: STA02	STA06	p2,p3: STA01
P-ing Avail.	STA01	c3:p1,p3: STA03	-	-	-	STA06	-
		^c3:STA02					
Man. P-ing	STA01	-	-	-	-	-	p2,p3: STA01
Set Rev.	STA01 (Note 3)	STA02 (Note 3)	STA03 (Note 3)	STA04 (Note 3)	STA05 (Note 3)	STA06 (Note 3)	p2,p3: STA01 (Note 3)

NOTES

- 1 An automatic switch condition may be pending.
- 2 It results as a failed request.
- 3 The state table to be considered after having changed the state is the state table of the revertive system.

C.5 State diagram for a protecting connection protection (non-revertive)

Condition

- c1: The request on the protected connection protection has a higher priority than the existing one on the protecting connection protection. (Refer to the protection switch decision table.)
- c2: There is an auto switch condition present on the protected connection protection.
- c3: The request has been completed.
- c4: There is an auto switch condition present on the protecting connection protection.

Process

- p1: Request switch to protecting connection protection.
- p2: Release switch.
- p3: Notify switch report. (The protection switch report is sent by the protection group; however, the condition under which such notification is sent is specified in the connection protection state diagram using such process.)

Event

Req. Lock.	A lockout request has been issued on the protecting connection protection.
Rel. Lock.	A release request of lockout has been issued on the protecting connection protection.
Req. Force	A Forced Switch request has been issued to switch from the protected connection protection to the protecting connection protection.
Rel. Force	A release request of Forced Switch has been issued on the protected connection protection.
Req. Man.	A Manual Switch request has been issued to switch from the protected connection protection to the protecting connection protection.
Rel. Man.	A Release Manual Switch request has been issued. As Manual Switch is not memorized, this will result as a failed request.
A-S Cond.	An automatic switch condition has occurred on the protecting connection protection.
A-S Clr	The automatic switch condition on the protecting connection protection has disappeared.
P-ted Lock	The protected connection protection has been locked out.
P-ted Avail.	One or more A-S requests have disappeared on the protected connection protection, so that the protected connection protection becomes available for use in the protection scheme (i.e. the highest priority request that could remain on the protected connection protection has lower priority than existing ones on the protecting connection protection).
P-ted Unav.	One or more A-S requests have appeared on the protected connection protection, so that the protected connection protection becomes unavailable for use in the protection scheme (i.e. the highest priority request on the protected connection protection has higher priorities than existing ones on the protected connection protection).
Set Rev.	The connection protection group mode has been changed from non-revertive to revertive mode.
Req. Man. To P-ted	A Manual Switch request has been issued to switch from the protecting connection protection to the protected connection protection.

States

STA01	noRequest
STA02	AutoSwitchSFToProtectingComplete
STA03	ForcedSwitchToProtectingComplete
STA04	ForcedSwitchToProtectingCompleteSFPresentOnProtecting
STA05	LockoutComplete
STA06	AutomaticSwitchSFToProtectedPending
STA07	DoNotRevert

State diagram for a protected connection protection in a 1 + 1 non-revertive system

Event	STA01 No Req.	STA02 A-S Comp.	STA03 F-S Comp.	STA04 F-S Comp. A-S Pend.	STA05 LockComp (Note 1)	STA06 A-S Pend.	STA07 Do Not Revert
Req. Lock.	p3:STA05	p2,p3: STA05	p2,p3: STA05	p2,p3: STA05	STA05	p3: STA05	p2,p3: STA05
Rel. Lock.	STA01 (Note 2)	STA02 (Note 2)	STA03 (Note 2)	STA04 (Note 2)	\wedge c4:STA01 c4: STA06	STA06 (Note 2)	STA07 (Note 2)
Req. Force	p1,p3: STA03	p3:STA03	STA03	STA04	STA05 (Note 2)	p1,p3: STA04	p3:STA03
Rel. Force	STA01 (Note 2)	STA02 (Note 2)	\wedge c2:p3: STA07 c2:p3: STA02	\wedge c1:p3: STA02 \wedge c1:p2,p3: STA06	STA05 (Note 2)	STA06 (Note 2)	STA07 (Note 2)
Req. Man.	p1,p3: STA07	STA02 (Note 2)	STA03 (Note 2)	STA04 (Note 2)	STA05 (Note 2)	STA06 (Note 2)	STA07
Rel. Man.	STA01 (Note 2)	STA02 (Note 2)	STA03 (Note 2)	STA04 (Note 2)	STA05 (Note 2)	STA06 (Note 2)	STA07 (Note 2)
A-S Cond.	STA06	c1:STA02 \wedge c1:p2,p3: STA06	STA04	STA04	STA05	STA06	p2,p3: STA06
A-S Clr	–	STA02	–	c4:STA04 \wedge c4:STA03	STA05	c1:p1,p3: STA02 \wedge c1 \wedge c4:p3: STA01 \wedge c1 \wedge c4: STA06	–
P-ted Lock	STA01	\wedge c4:p2,p3: STA01 c4:p2,p3: STA06	p2,p3: STA01	p2,p3: STA06	STA05	STA06	p2,p3: STA01
P-ted Unav.	c3:p1,p3: STA02 \wedge c3:STA01	STA02	STA03	STA04	STA05	c1 \wedge c3:p1, p3:STA02 \wedge c1 \vee \wedge c3: STA06	p3:STA02
P-ted Avail.	STA01	\wedge c4:p3 STA07 c4:p2,p3: STA06	STA03	STA04	STA05	STA06	STA07
Req. Man. To P-ted	STA01	STA02 (Note 2)	STA03 (Note 2)	STA04 (Note 2)	STA05 (Note 2)	STA06 (Note 2)	p2,p3: STA01
Set Rev.	STA01 (Note 3)	STA02 (Note 3)	STA03 (Note 3)	STA04 (Note 3)	STA05 (Note 3)	STA06 (Note 3)	p2,p3: STA01 (Note 3)

NOTES

- 1 An automatic switch condition may be pending.
- 2 It results as a failed request.
- 3 The state table to be considered after having changed the state is the state table of the revertive system.

C.6 State diagram for a protected connection protection (revertive)

Condition

- c1: The request on the protected connection protection has a higher priority than the existing one on the protecting connection protection. (Refer to the protection switch decision table.)
- c2: There is an auto switch condition present on the protected connection protection.
- c3: The request has been completed.
- c4: There is an auto switch condition present on the protecting connection protection.

Process

- p1: Request switch to protecting connection protection.
- p2: Release the current switch.
- p3: Notify switch report. (The protection switch report is sent by the protection group; however, the condition under which such notification is sent is specified in the connection protection state diagram using such process.)
- p4: Start wait to restore timer.
- p5: Stop wait to restore timer.

States

STA01	noRequest
STA02	AutoSwitchSFPending
STA03	AutoSwitchSFComplete
STA04	ForcedSwitchComplete
STA05	ForcedSwitchCompleteAutoSwitchSFPending
STA06	LockoutComplete
STA08	manualSwitchToProtectingComplete
STA09	AutoSwitchCompleteWaitToRestore

Event

Req. Lock.	A lockout request has been issued on the protected connection protection.
Rel. Lock.	A release request of lockout has been issued on the protected connection protection.
Req. Force	A Forced Switch request has been issued to switch from the protected connection protection to the protecting connection protection.
Rel. Force	A release request of Forced Switch has been issued on the protected connection protection.
Req. Man.	A Manual Switch request has been issued to switch from the protected connection protection to the protecting connection protection.
Rel. Man.	A Release of Manual Switch request has been issued.
A-S Cond.	An automatic switch condition has occurred on the protected connection protection.
A-S Clr	The automatic switch condition has disappeared.
P-ing Avail.	One or more requests (including Lockout request) have disappeared on the protecting connection protection, so that the protecting connection protection becomes available for use in the protection scheme (i.e. the highest priority request that could remain on the protecting connection protection has lower priority than existing ones on the protected connection protection).
P-ing Unav.	One or more requests (including Lockout request) have appeared on the protecting connection protection, so that the protecting connection protection becomes unavailable for use in the protection scheme (i.e. the highest priority request on the protecting connection protection has higher priority than existing ones on the protected connection protection).
WTR	The Wait-to-Restore Time has elapsed.
Set Non-Rev.	The connection protection group mode has been changed from revertive to non-revertive mode.

State diagram for a protected connection protection in a 1 + 1 revertive system								
Event	STA01 No Req.	STA02 A-S Pend.	STA03 A-S Comp.	STA04 F-S Comp.	STA05 F-S Comp A-S Pend.	STA06 LockComp (Note 1)	STA08 M-S Comp.	STA09 A-S Comp WTR
Req. Lock.	p3:STA06	p3:STA06	p2,p3: STA06	p2,p3: STA06	p2,p3: STA06	STA06	p2,p3: STA06	p2,p3,p5: STA06
Rel. Lock.	STA01 (Note 2)	STA02 (Note 2)	STA03 (Note 2)	STA04 (Note 2)	STA05 (Note 2)	c1&c2&c3 p1,p3: STA03	STA08 (Note 2)	STA09 (Note 2)
						(^c1V^c3)& c2:p3: STA02		
						^c2:p3: STA01		
Req. Force	c1&c3:p1, p3:STA04	c1&c3:p1, p3:STA05	p3:STA05	STA04	STA05	STA06 (Note 2)	p3:STA04	p3,p5: STA04
	^c1V^c3: STA01 (Note 2)	^c1V^c3: STA02 (Note 2)						
Rel. Force	STA01 (Note 2)	STA02 (Note 2)	STA03 (Note 2)	p2,p3: STA01	c1:p3: STA03	STA06 (Note 2)	STA08 (Note 2)	STA09 (Note 2)
					^c1:p2,p3: STA02			
Req. Man.	c1&c3:p1, p3:STA08	STA02 (Note 2)	STA03 (Note 2)	STA04 (Note 2)	STA05 (Note 2)	STA06 (Note 2)	STA08	p3,p5: STA08
	^c1V^c3: STA01 (Note 2)							
Rel. Man.	STA01 (Note 2)	STA02 (Note 2)	STA03 (Note 2)	STA04 (Note 2)	STA05 (Note 2)	STA06 (Note 2)	p2,p3: STA01	STA09 (Note 2)
A-S Cond.	c1&c3:p1, p3:STA03	c1&c3:p1, p3:STA03	STA03	STA05	STA05	STA06	p3:STA03	p3,p5: STA03
	^c1V^c3: p3:STA02	^c1V^c3: STA02						
A-S Clr	-	^c2:p3: STA01	^c2 & ^c4: p3,p4: STA09	-	^c2:STA04	STA06	-	-
			^c2 & c4:p2, p3:STA01					
			c2:STA02					
c2&c1: STA03								
P-ing Unav.	STA01	STA02	p2,p3: STA02	p2,p3: STA01	p2,p3: STA02	STA06	p2,p3: STA01	p2,p3,p5: STA01
P-ing Avail.	STA01	c3:p1,p3: STA03	-	-	-	STA06	-	-
		^c3:STA02						
WTR	-	-	-	-	-	-	-	p2,p3: STA01
Set Non-Rev.	STA01 (Note 3)	STA02 (Note 3)	STA03 (Note 3)	STA04 (Note 3)	STA05 (Note 3)	STA06 (Note 3)	p3:STA07 (Notes 3, 4)	p3,p5: STA07 (Notes 3, 4)

NOTES

- 1 An automatic switch condition may be pending.
- 2 It results as a failed request.
- 3 The state table to be considered after changing the state is the state table of the non-revertive system.
- 4 This state pertains to the state diagram for a protected connection protection in a 1 + 1 non-revertive system.

C.7 State diagram for a protecting connection protection (revertive)

Condition

- c1: The request on the protected connection protection has a higher priority than the existing one on the protecting connection protection. (Refer to the protection switch decision table.)
- c2: There is an auto switch condition present on the protected connection protection.
- c3: The request has been completed.
- c4: There is an auto switch condition present on the protecting connection protection.

Process

- p1: Request switch to protecting connection protection.
- p2: Release switch.
- p3: Notify switch report. (The protection switch report is sent by the protection group; however, the condition under which such notification is sent is specified in the connection protection state diagram using such process.)
- p4: Start wait to restore timer.
- p5: Stop wait to restore timer.

Event

Req. Lock.	A lockout request has been issued on the protecting connection protection.
Rel. Lock.	A release request of lockout has been issued on the protecting connection protection.
Req. Force	A Forced Switch request has been issued to switch from the protected connection protection to the protecting connection protection.
Rel. Force	A release request of Forced Switch has been issued on the protected connection protection.
Req. Man.	A Manual Switch request has been issued to switch from the protected connection protection to the protecting connection protection.
Rel. Man.	A Release of Manual Switch request has been issued.
A-S Cond.	An automatic switch condition has occurred on the protecting connection protection.
A-S Clr	The automatic switch condition on the protecting connection protection has disappeared.
P-ted Lock	The protected connection protection has been locked out.
P-ted Avail.	One or more A-S requests have disappeared on the protected connection protection, so that the protected connection protection becomes available for use in the protection scheme (i.e. the highest priority request that could remain on the protected connection protection has lower priority than existing ones on the protecting connection protection).
P-ted Unav.	One or more A-S requests have appeared on the protected connection protection, so that the protected connection protection becomes unavailable for use in the protection scheme (i.e. the highest priority request on the protected connection protection has higher priorities than existing ones on the protected connection protection).
WTR	The Wait-to-Restore Time has elapsed.
Set Non-Rev.	The connection protection group mode has been changed from revertive to non-revertive mode.

States

STA01	noRequest
STA02	AutoSwitchSFToProtectingComplete
STA03	ForcedSwitchToProtectingComplete
STA04	ForcedSwitchToProtectingCompleteSFPresentOnProtecting
STA05	LockoutComplete
STA06	AutomaticSwitchSFPending
STA08	manualSwitchToProtectingComplete
STA09	AutoSwitchCompleteWaitToRestore

State diagram for a protecting connection protection in a 1 + 1 revertive system

Event	STA01 No Req.	STA02 A-S Comp.	STA03 F-S Comp.	STA04 F-S Comp. A-S Pend.	STA05 F-S Comp Comp (Note 1)	STA06 A-S Pend.	STA08 M-S Comp.	STA09 A-S Comp WTR
Req. Lock.	p3:STA05	p2,p3: STA05	p2,p3: STA05	p2,p3: STA05	STA05	p3: STA05	p2,p3: STA06	p2,p3,p5: STA06
Rel. Lock	STA01 (Note 2)	STA02 (Note 2)	STA03 (Note 2)	STA04 (Note 2)	[^] c4:STA01 c4: STA06	STA06 (Note 2)	STA08 (Note 2)	STA09 (Note 2)
Req. Force	p1,p3: STA03	p3:STA03	STA03	STA04	STA05 (Note 2)	p1,p3: STA04	p3: STA03	p3,p5: STA03
Rel. Force	STA01 (Note 2)	STA02 (Note 2)	p2,p3: STA01	p2,p3: STA06	STA05 (Note 2)	STA06 (Note 2)	STA08 (Note 2)	STA09 (Note 2)
Req. Man.	p1,p3: STA08	STA02 (Note 2)	STA03 (Note 2)	STA04 (Note 2)	STA05 (Note 2)	STA06 (Note 2)	STA08	p3,p5: STA08
Rel. Man.	STA01 (Note 2)	STA02 (Note 2)	STA03 (Note 2)	STA04 (Note 2)	STA05 (Note 2)	STA06 (Note 2)	p2,p3: STA01	STA09 (Note 2)
A-S Cond.	STA06	c1:STA02 [^] c1:p2,p3: STA06	STA04	STA04	STA05	STA06	p2,p3: STA06	p2,p3,p5: STA06
A-S Clr	–	STA02	–	c4:STA04 [^] c4:STA03	STA05	c1:p1,p3: STA02 [^] c1 [^] c4: p3:STA01 [^] c1 [^] c4: STA06	–	–
P-ted Lock	STA01	[^] c4: p2,p3: STA01 c4:p2,p3: STA06	p2,p3: STA01	p2,p3: STA06	STA05	STA06	p2,p3: STA01	p2,p3,p5: STA01
P-ted Unav.	c3:p1,p3: STA02 [^] c3: STA01	STA02	STA03	STA04	STA05	c1 [^] c3:p1, p3:STA02 [^] c1 ^V [^] c3: STA06	p3: STA02	p3,p5: STA02
P-ted Avail.	STA01	[^] c4:p2,p3: STA06 c4:p2,p3, p4:STA09	STA03	STA04	STA05	STA06	STA08	–
WTR	–	–	–	–	–	–	–	p2,p3: STA01
Set Non-Rev.	STA01 (Note 3)	STA02 (Note 3)	STA03 (Note 3)	STA04 (Note 3)	STA05 (Note 3)	STA06 (Note 3)	p3:STA07 (Notes 3, 4)	p3,p5: STA07 (Notes 3, 4)

NOTES

- 1 An automatic switch condition may be pending.
- 2 It results as a failed request.
- 3 The state table to be considered after having changed the state is the state table of the revertive system.
- 4 This state pertains to the state diagram for a protected connection protection in a 1 + 1 non-revertive system.