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# GENERAL ASPECTS OF DIGITAL TRANSMISSION SYSTEMS

# SYNCHRONOUS DIGITAL HIERARCHY (SDH) MANAGEMENT OF MULTIPLEX-SECTION PROTECTION FOR THE NETWORK ELEMENT VIEW

## ITU-T Recommendation G.774.03

(Previously "CCITT Recommendation")

# FOREWORD

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ITU-T Recommendation G.774.03 was prepared by ITU-T Study Group 15 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 1st of November 1994.

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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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# SUMMARY

This Recommendation provides an information model for the Synchronous Digital Hierarchy (SDH). This model describes the managed object classes and their properties for the protection switching function, as defined in ITU-T Recommendation G.803 and as related to SDH transmission resources. These objects are useful to describe information exchanged across interfaces defined in ITU-T Recommendation M.3010 Telecommunications Management Network (TMN) architecture for the management of the protection function.

**Keywords**

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

**Recommendation G.774.03**

# SYNCHRONOUS DIGITAL HIERARCHY (SDH) MANAGEMENT OF MULTIPLEX-SECTION PROTECTION FOR THE NETWORK ELEMENT VIEW

*(Geneva, 1994)*

The ITU,

*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.774 defines an SDH Management information Model for the Network Element view;

(h)    that Recommendation G.774.01 defines an SDH Management information Model for the Network Element view for performance Monitoring,

*recommends*

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

# 1      Scope

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

This Recommendation applies to SDH network elements which perform the Multiplex Section protection function and those systems in the TMN that manage SDH network elements. Functional capabilities of SDH multiplex equipment, particularly the Multiplex Section protection switching function, are given in Recommendation G.783. Performance monitoring requirements for Multiplex Section protection (for the management of SDH equipment with this capability) are provided in Recommendation G.784, however, the information model which supports these can be found in Recommendation G.774.01.

## 1.1      Structure of this Recommendation

Subclause 5.1 provides an overview of the SDH protection information model in this Recommendation. Clauses 3 to 15 describe the information model using the notation mechanisms defined in X.722 Guidelines for the Definition of Managed Objects. Clause 15 contains the syntax definitions of the information carried in the protocol using Abstract Syntax Notation One (ASN.1) defined in Recommendation X.208. Naming and Inheritance are diagrammatically shown

in informative Annex A. Diagrams illustrating the application of the SDH protection model are provided in informative Annex B.

A text version of clauses 5 to 15 is available in diskette from the ITU.

## 2 References

- ITU-T Recommendation G.707 (1993), *Synchronous digital hierarchy bit rates*.
- ITU-T Recommendation G.708 (1993), *Network-node interface for the synchronous digital hierarchy*.
- ITU-T Recommendation G.709 (1993), *Synchronous multiplexing structure*.
- CCITT Recommendation M.3010 (1992), *Principles for a telecommunications management network*.
- CCITT Recommendation M.3100 (1992), *Generic network information model*.
- ITU-T Recommendation G.783 (1994), *Characteristics of Synchronous Digital Hierarchy (SDH) equipment functional blocks*.
- ITU-T Recommendation G.784 (1994), *Synchronous Digital Hierarchy (SDH) management*.
- CCITT Recommendation X.722 (1992), *Information technology – OSI – Structure of management information: Guidelines for the definition of managed objects*.
- CCITT Recommendation X.208 (1988), *Specification of Abstract Syntax Notation One (ASN.1)*.
- CCITT Recommendation X.720 (1992), *Information technology – OSI – Structure of management information: Management information model*.
- CCITT Recommendation G.774 (1992), *SDH Management information model for the network element view*.
- ITU-T Recommendation G.774.01 (1994), *SDH Performance monitoring for the network element view*.
- ITU-T Recommendation G.803 (1993), *Architectures of transport networks based on the Synchronous Digital Hierarchy (SDH)*.
- CCITT Recommendation X.721 (1992), *Definition of management information*.

## 3 Definitions

None.

## 4 Abbreviations

For the purposes of this Recommendation, the following abbreviations apply:

| | |
|---|---|
| APDU | Application Protocol Data Unit |
| APS | Automatic Protection Switching |
| CMIP | Common Management Information Protocol |
| CMIS | Common Management Information Service |
| CTP | Connection Termination Point |
| ISO | International Organization for Standardization |
| ITU | International Telecommunications Union |
| LOS | Loss of Signal |
| MS | Multiplex Section |
| MSP | Multiplex Section Protection |
| NE | Network Element |
| OS | Operation System |
| OSI | Open System Interconnection |

| Pkg | Packages |
|-----|----------|
| RDN | Relative Distinguished Name |
| SD | Signal Degrade |
| SDH | Synchronous Digital Hierarchy |
| SF | Signal Fail |
| STM-N | Synchronous Transport Module N |
| TMN | Telecommunication Management Network |
| TP | Termination Point |
| TSS | Telecommunication Standardization Sector |
| TTP | Trail Termination Point |
| WTR | Wait-to-Restore |

# 5 Multiplex-Section Protection Management Model

## 5.1 Overview

The SDH information model for the Multiplex Section protection switching function is based on the requirements to provide the protection function for transmission in SDH networks. Resources which must be protected have been modelled and are described in Recommendation G.774. They are based on the Generic Network Information Model of Recommendation M.3100. The Generic Network Information Model includes a Termination Point fragment which serves as a structure for specialization for specific technologies such as the SDH.

The information exchanged at a management interface is modelled using design principles outlined in Recommendation X.720 Management Information Model. Resources are modelled as objects, and the management view of a resource is a managed object. Objects with similar attributes may be grouped into object classes. An object is characterized by its object class and object instance, and may possess multiple attribute types and associated values. The terms managed object class and managed object instance apply specifically to objects that are being managed. This Recommendation specifies the properties of the resource visible for management.

An object class may be a subclass of another class. A subclass inherits attribute types, packages and behaviours of its super class, in addition to possessing its own specific attributes and properties. The SDH specific object classes are all derived from super classes in the Generic Network Information Model Recommendation M.3100.

Object classes and attribute types are defined only for the purpose of communicating network management messages between systems, and need not be related to the structure of data within those systems. The object classes defined in this issue of the SDH information model can apply to multiple management functional areas (e.g. fault management and configuration management).

There are several different viewpoints of management information that may be defined for management purposes. The network element viewpoint is concerned with the information that is required to manage a network element. This refers to information required to manage the protection function and the physical aspects of the network element. This Recommendation addresses only the network element viewpoint.

## 5.2 SDH Multiplex Section Protection Requirements

The SDH specific objects specified in this Recommendation shall be used to manage the specific transport resources of SDH network elements, as related to the Multiplex Section protection function. Implementations shall conform to both the management information defined in clauses 3 to 15 and the requirements identified in 5.2.

This Recommendation addresses the management of the automatic protection switching within the network element at the Multiplex Section. The management for Multiplex Section protection is based on the protection function described in Recommendation G.803.

### 5.2.1 Generic SDH Transmission Protection Functional Requirements

The application specific management models for SDH systems are based on a generic protection model for transmission which satisfies the following common protection requirements:

1) Manage a group of protected resources together with their protecting resources as one protection group, where all members of the protection group in a network element may be configured for:

   a) m:n or 1 + 1 type protection;

   b) revertive or non-revertive type switching;

   c) a specific wait-to-restore time (in the case of revertive systems).

2) Indicate the ability of the group of protection units as a whole to provide the protection switching function properly and to send a notification when a change in this operational state occurs.

3) Indicate the status of each individual protection unit such as automatic switch completed.

4) Send a notification, identifying the protection unit and protection group, when a protection switch event occurs. Specific notification requirements are application specific.

5) Send a notification when protection resources are added or removed on the NE.

6) For each protected or protecting resource, the ability to perform the following management operations:

   a) invoke a manual protection request;

   b) invoke a forced protection switch;

   c) lockout a protection or working channel;

   d) determine the operational state of the protection group;

   e) indicate a resource as protecting or protected (although most but not all 1 + 1 systems are symmetrical with respect to their protection switching or management functionality). The equipment in the NE determines this operation and provides this indication;

   f) ability to set the switch priority for protected resources in 1:n systems.

The generic information model for SDH protection management is provided by the **protectionGroup** and **protectionUnit** objects.

### 5.2.2 SDH Multiplex Section Specific Functional Requirements

The management information model for linear system Multiplex Section protection provided in this Recommendation is based on the generic model and approach to protection, which satisfies the requirements described in 5.2.1. Additionally, the following SDH MS specific requirements exist:

1) Ability to configure the protection switch mode for all protection resources within a protection group as uni or bidirectional.

2) Ability to send a notification of the protection status of each protected or protecting resource. The protection status value shall indicate the current switch request active or pending (in the case of automatic switch requests only) on any given protection unit (resource).

3) Manage extra traffic as follows:

   a) ability to explicitly suspend and resume extra traffic in a protection unit;

   b) prevent extra traffic from being preempted by other switch requests;

   c) allow Extra Traffic to be preempted by higher priority requests and allow Extra Traffic to be automatically re-established when the higher priority request is removed;

   d) ability to change between modes b) and c).

4) Send the following protection switch related notifications:

   a)  when a protected resource, having been switched to a protecting resource, is preempted by a higher priority request from the same or another protected resource (applicable in 1:n systems);

   b)  when a protected resource (unit) is switched onto a protecting resource;

   c)  when any switch is released;

   d)  when an auto-switch condition exists but cannot be served due to a higher priority request already being served.

5) Ability to detect a mismatch between near and far-end protection group type configured values (1 + 1 or 1:n).

6) Ability to invoke an exercise on a protected channel.

7) Allow only one protecting resource.

8) Store the most recent protection switch or exercise result, and provide a notification – against the associated group of protection resources as a whole – when a failure to perform the protection function is detected.

   With respect to Recommendation G.774 termination points which represent the protected (working channels) resources, the following requirements exist:

9) Provide a relationship between the termination points which represent the protected (working channels) and the termination point which represents the protecting (protection channel), and the termination point which reflects the reliable resource.

10) In performing a protection switch, update the connectivity pointers of the affected termination points to indicate the new traffic flow.

   The objects relevant to SDH MS Protection Switching are the following sub-classes:

   **sdhMSProtectionGroup** and **sdhMSProtectionUnit**. Additionally, sub-classes of the termination point model are required. These are **protectedTTPSink**, **protectedTTPSource**, **protectedTTPBidirectional**, **unprotectedCTPSink**, **unprotectedCTPSource**, and **unprotectedCTPBidirectional**.

   With respect to the creation/deletion of the protection management objects:

11) It is the responsibility of the NE to create and delete the objects related to protection management according to the make up and mode of the NE.

# 6       Managed Object Class Definitions

To allow SDH equipment to be represented in a consistent manner across the interface, the conditional package **crossConnectionObjectPointerPackage** in Recommendation M.3100 is made mandatory in this Recommendation. The following conditional packages inherited from Recommendation M.3100 shall not be used when the SDH object classes defined in this Recommendation are instantiated: **ttpInstancePackage**, **ctpInstancePackage**, **networkLevelPackage**, **characteristicInformationPackage**, **channelNumberPackage**.

## 6.1      ApsReportRecord

apsReportRecord MANAGED OBJECT CLASS
      DERIVED FROM    "Recommendation X.721 | ISO/IEC 10165-2 : 1992": eventLogRecord;
      CHARACTERIZED BY
          apsReportRecordPkg PACKAGE
      BEHAVIOUR apsReportRecordBeh;
      ATTRIBUTES
          reportedProtectionUnit GET;;;
REGISTERED AS { g774-03ObjectClass 1 };

**apsReportRecordBeh BEHAVIOUR**

**DEFINED AS**

"An instance of the **apsReportRecord** object is created when a **protectionSwitchReporting** Notification is generated. The **protectionStatusParameter** must be included in the management extension.
**";**


## 6.2    Protected Trail Termination Point

**protectedTTPBidirectional MANAGED OBJECT CLASS**
      **DERIVED FROM    "Recommendation M.3100 : 1992": trailTerminationPointBidirectional;**
          **protectedTTPSource,**
          **protectedTTPSink;**
      **CHARACTERIZED BY**
          **protectedTTPBidirectionalPkg PACKAGE**
      **BEHAVIOUR protectedTTPBidirectionalBeh;;;**
**REGISTERED AS { g774-03MObjectClass 2 };**

**protectedTTPBidirectionalBeh BEHAVIOUR**

**DEFINED AS**

"The **protectedTTPBidirectional** object class is a class of objects that represents the bidirectional protected resources in a protection system. If the SDH bidirectional multiplex section protection switching function is present, this object class shall be supported.
**";**

**protectedTTPSink MANAGED OBJECT CLASS**
      **DERIVED FROM    "Recommendation M.3100 : 1992": trailTerminationPointSink;**
      **CHARACTERIZED BY**
          **"Recommendation M.3100 : 1992": crossConnectionPointerPackage,**
          **protectedTTPSinkPkg PACKAGE**
      **BEHAVIOUR protectedTTPSinkBeh;**
      **ATTRIBUTES**
          **protectedTTPId        GET;;;**
**REGISTERED AS { g774-03MObjectClass 3 };**

**protectedTTPSinkBeh BEHAVIOUR**

**DEFINED AS**

"The **protectedTTPSink** object class is a class of objects that represents the protected resources in a protection system. An instance of this object class is pointed to by the **reliableResourcePointer** attribute in an instance of the **protectionUnit** object class. The **crossConnectionObjectPointer** attribute in an instance of this object class points to its associated **protectionUnit** instance which has the **reliableResourcePointer** attribute pointing back to the instance of this object class. The **upstreamConnectivityPointer** in an instance of this object class points to either null or its associated unprotected CTP object instance; it indicates the actual signal flow, and when a signal is switched to another unit, the value of the **upstreamConnectivityPointer** is updated. If the **attributeValueChangeNotification** package is present, then a change in the value of the **supportedByObjectList** shall cause an **attributeValueChange** notification.
**";**

**protectedTTPSource MANAGED OBJECT CLASS**
      **DERIVED FROM    "Recommendation M.3100 : 1992": trailTerminationPointSource;**
      **CHARACTERIZED BY**
          **"Recommendation M.3100 : 1992": crossConnectionPointerPackage,**
          **protectedTTPSourcePkg PACKAGE**
      **BEHAVIOUR protectedTTPSourceBeh;**
      **ATTRIBUTES**
          **protectedTTPId        GET;;;**
**REGISTERED AS { g774-03MObjectClass 4 };**

**protectedTTPSourceBeh BEHAVIOUR**
**DEFINED AS**

"The **protectedTTPSource** object class is a class of objects that represents the protected resources in a protection system. An instance of this object class is pointed to by the **reliableResourcePointer** attribute in an instance of the **protectionUnit** object class. The **crossConnectionObjectPointer** attribute in an instance of this object class points to its associated **protectionUnit** object instance which has the **reliableResourcePointer** attribute pointing back to the instance of this object class. The **downstreamConnectivityPointer** in an instance of this object class points to either null or its associated unprotected CTP object instance(s); it indicates the actual signal flow, and when a signal is switched to another unit, the pointer is updated. If the **attributeValueChangeNotification** package is present, then a change in the value of the **supportedByObjectList** shall cause an **attributeValueChange** notification.
";


## 6.3     Protection Group

protectionGroup MANAGED OBJECT CLASS
        DERIVED FROM     "Recommendation X.721 | ISO/IEC 10165-2 : 1992": top;
        CHARACTERIZED BY
            protectionGroupPkg PACKAGE
        BEHAVIOUR protectionGroupBeh;
        ATTRIBUTES
            "Recommendation X.721 | ISO/IEC 10165-2 : 1992": operationalState       GET,
            "Recommendation X.721 | ISO/IEC 10165-2 : 1992": availabilityStatus  GET,
            protectionGroupId GET,
            protectionGroupType   GET-REPLACE,
            revertive      REPLACE-WITH-DEFAULT
            DEFAULT VALUE SDHProtASN1.booleanTrueDefault     GET-REPLACE,
            "Recommendation M.3100 : 1992": supportedByObjectList       GET,
            waitToRestoreTime GET-REPLACE;
        ACTIONS
            invokeProtection,
            releaseProtection;
        NOTIFICATIONS
            protectionSwitchReporting,
            "Recommendation X.721 | ISO/IEC 10165-2 : 1992": stateChange;;;
        CONDITIONAL PACKAGES
            "Recommendation M.3100 : 1992": createDeleteNotificationsPackage
                PRESENT IF   "an instance supports it",
            "Recommendation M.3100 : 1992": attributeValueChangeNotificationPackage
                PRESENT IF   "an instance supports it";
REGISTERED AS { g774-03MObjectClass 5 };

**protectionGroupBeh BEHAVIOUR**
**DEFINED AS**

"A **protectionGroup** object instance contains zero or more **protectionUnit** objects for defining a protection switching relationship where one or more standby (i.e. backup) entities provide protection for one or more working (i.e. regular or preferred) entities.

The **invokeProtection** action can be used to request a lockout, a forced switch, or a manual switch (i.e. normal switch) on one or more **protectionUnit** instances contained in the **protectionGroup** object. The **releaseProtection** action can be used to release a lockout, a forced switch, or a manual switch (i.e. normal switch) on one or more **protectionUnit** instances contained in the **protectionGroup** object.

The **protectionSwitchReporting** notification is emitted from the **protectionGroup** object to report any protection switch events, such as protection switching (forced switch, manual switch, or automatic switch), protection release (release of forced switch, manual switch, or automatic switch), lockout or release of lockout.

If the **attributeValueChangeNotification** package is present, then changes to the **protectionGroupType** attribute, the revertive attribute or the **waitToRestoreTime** attribute shall cause an **attributeValueChange** notification to be emitted.

The **protectionGroupType** attribute shall have the value 'colon' when more than one **protectionUnit** is protected. Changing the value of this attribute between 'plus' and 'colon' is allowed when only one protected **protectionUnit** and one protecting **protectionUnit** are contained by the **protectionGroup**. The change from 'plus' to 'colon' is only allowed if the underlying resources support M:N protection.
";

## 6.4     Protection Unit

**protectionUnit MANAGED OBJECT CLASS**
        **DERIVED FROM     "Recommendation X.721 | ISO/IEC 10165-2 : 1992": top;**
        **CHARACTERIZED BY**
            **protectionUnitPkg PACKAGE**
        **BEHAVIOUR protectionUnitBeh;**
        **ATTRIBUTES**
            **protectionUnitId          GET,**
            **protecting                GET,**
            **reliableResourcePointer      GET,**
            **unreliableResourcePointer    GET;;;**
        **CONDITIONAL PACKAGES**
            **priorityPkg PRESENT IF   "an instance supports it",**
            **"Recommendation M.3100 : 1992": attributeValueChangeNotificationPackage**
                **PRESENT IF       "an instance supports it";**
**REGISTERED AS { g774-03MObjectClass 6 };**

**protectionUnitBeh BEHAVIOUR**
**DEFINED AS**

"A **protectionUnit** object represents a protected (i.e. working, regular, or preferred) unit or a protecting (i.e. backup or standby) unit. For a protecting **protectionUnit**, the attribute protecting shall have the value TRUE. For a protected **protectionUnit**, the attribute protecting shall have the value FALSE. The value of the **unreliableResourcePointer** attribute points to an unreliable resource (e.g. equipment hardware or termination point) that is associated with the **protectionUnit** instance. The value of the **reliableResourcePointer** attribute points to a reliable resource (e.g. termination point) that is associated with the **protectionUnit** instance.

If the **attributeValueChangeNotificationPackage** is present, then changes to the **unreliableResourcePointer** attribute, the priority attribute or the **reliableResourcePointer** attribute shall cause an **attributeValueChange** notification to be emitted.
";

## 6.5     SDH Multiplex Section Protection Group

**sdhMSProtectionGroup MANAGED OBJECT CLASS**
        **DERIVED FROM    protectionGroup;**
        **CHARACTERIZED BY**
            **sdhMSProtectionGroupPkg PACKAGE**
        **BEHAVIOUR sdhMSProtectionGroupBeh;**
        **ATTRIBUTES**
            **protectionSwitchMode     GET-REPLACE;**
        **NOTIFICATIONS**
            **protectionSwitchReporting protectionStatusParameter;;;**
        **CONDITIONAL PACKAGES**
            **protectionMismatchStatusPkg PRESENT IF "the APS protocol is used",**
            **protectionSwitchExercisePkg PRESENT IF "an instance supports it";**
**REGISTERED AS { g774-03MObjectClass 7 };**

**sdhMSProtectionGroupBeh BEHAVIOUR**
**DEFINED AS**

"This object class is used specifically for representing a SDH multiplex section protection group in a protection system. Only one protecting protection unit is allowed.

The **protectionMismatchStatus** indicates a mismatch between the provisioned **protectionGroupType** of this protection group and the provisioned **protectionGroupType** of the far-end. It also indicates mismatch of unidirectional versus bidirectional switch provisioning between the two protection groups.
";

## 6.6 SDH Multiplex Section Protection Unit

**sdhMSProtectionUnit MANAGED OBJECT CLASS**
        **DERIVED FROM**    protectionUnit;
        **CHARACTERIZED BY**
            **sdhMSProtectionUnitPkg PACKAGE**
        **BEHAVIOUR sdhMSProtectionUnitBeh;**
        **ATTRIBUTES**
            **channelNumber**     **GET,**
            **protectionStatus**       **GET,**
            **reliableResourcePointer PERMITTED VALUES**
**SDHProtASN1.SDHMSResourcePointer,**
            **unreliableResourcePointer  PERMITTED VALUES**
**SDHProtASN1.SDHMSResourcePointer;;;**
        **CONDITIONAL PACKAGES**
            **sdhPriorityPkg PRESENT IF "this is a 1:n system",**
            **lastAttemptResultPkg PRESENT IF "the APS protocol is used",**
            **extraTrafficControlPkg PRESENT IF "extra traffic may be suspended and resumed";**
**REGISTERED AS { g774-03MObjectClass 8 };**

**sdhMSProtectionUnitBeh BEHAVIOUR**
**DEFINED AS**

"This object class is specific to SDH multiplex section protection systems. Instances of this object class are used to represent a relationship between a **protectedTTP** and an **unprotectedCTP**. If this is a protecting protection unit, the **reliableResourcePointer** points to the **protectedTTP** for extra traffic or NULL if there is no extra traffic.

The **channelNumber** attribute value represents the number of the channel used by the SDH MSP protocol, if any. If the **sdhMSProtectionUnit** is protecting, then the **channelNumber** attribute shall have the value 0. If the **sdhMSProtectionUnit** is protected, the **channelNumber** attribute shall have a value between 1 and 14.

For Lockout of protecting unit, protected channels 1 to 14 are incapable of being carried on protection.
";

## 6.7 Unprotected Connection Termination Point

**unprotectedCTPBidirectional MANAGED OBJECT CLASS**
        **DERIVED FROM**    **"Recommendation M.3100 : 1992": connectionTerminationPointBidirectional;**
            **unprotectedCTPSource,**
            **unprotectedCTPSink;**
        **CHARACTERIZED BY**
            **unprotectedCTPBidirectionalPkg PACKAGE**
        **BEHAVIOUR unprotectedCTPBidirectionalBeh;;;**
**REGISTERED AS { g774-03MObjectClass 9 };**

**unprotectedCTPBidirectionalBeh BEHAVIOUR**
**DEFINED AS**

"The **unprotectedCTPBidirectional** object class is a class of objects that represents the unprotected resources in a protection system.
";

**unprotectedCTPSink MANAGED OBJECT CLASS**
        **DERIVED FROM**    **"Recommendation M.3100 : 1992": connectionTerminationPointSink;**
        **CHARACTERIZED BY**
            **"Recommendation M.3100 : 1992": crossConnectionPointerPackage,**
            **unprotectedCTPSinkPkg PACKAGE**
        **BEHAVIOUR unprotectedCTPSinkBeh;**
        **ATTRIBUTES**
            **unprotectedCTPId   GET;;;**
**REGISTERED AS { g774-03MObjectClass 10 };**

**unprotectedCTPSinkBeh BEHAVIOUR**
**DEFINED AS**

"The **unprotectedCTPSink** object class is a class of objects that represents the unprotected resources in a protection system. An instance of this object class is pointed to by the **unreliableResourcePointer** attribute in an instance of the **protectionUnit** object class (or its subclasses). The **crossConnectionObjectPointer** attribute in an instance of this object class points to its associated **protectionUnit** object instance which has the **unreliableResourcePointer** attribute pointing back to the instance of this object class.
";

**unprotectedCTPSource MANAGED OBJECT CLASS**
      **DERIVED FROM**   **"Recommendation M.3100 : 1992": connectionTerminationPointSource;**
      **CHARACTERIZED BY**
         **"Recommendation M.3100 : 1992": crossConnectionPointerPackage,**
         **unprotectedCTPSourcePkg PACKAGE**
      **BEHAVIOUR unprotectedCTPSourceBeh;**
      **ATTRIBUTES**
         **unprotectedCTPId**   **GET;;;**
**REGISTERED AS { g774-03MObjectClass 11 };**

**unprotectedCTPSourceBeh BEHAVIOUR**
**DEFINED AS**

"The **unprotectedCTPSource** object class is a class of objects that represents the unprotected resources in a protection system. An instance of this object class is pointed to by the **unreliableResourcePointer** attribute in an instance of the **protectionUnit** object class (or its subclasses). The **crossConnectionObjectPointer** attribute in an instance of this object class points to its associated **protectionUnit** object instance which has the **reliableResourcePointer** attribute pointing back to the instance of this object class.
";


# 7      Packages

## 7.1      Extra Traffic Control

**extraTrafficControlPkg PACKAGE**
      **BEHAVIOUR extraTrafficControlPkgBeh;**
      **ATTRIBUTES**
         **"Recommendation X.721 | ISO/IEC 10165-2 : 1992": administrativeState**   **GET-REPLACE;**
**REGISTERED AS { g774-03Package 1 };**

**extraTrafficControlPkgBeh BEHAVIOUR**
**DEFINED AS**

"Attribute **administrativeState** is used to suspend or resume extra traffic on the protecting channel. When in the Locked state, no extra traffic is carried on the protecting channel, however, this does not prevent protected channel traffic from being switched to the protecting channel. When unlocked, extra traffic is resumed on the protecting channel as long as there is no request from a protected channel of higher priority than on the protecting channel.
";

## 7.2      Last Attempt Result

**lastAttemptResultPkg PACKAGE**
      **ATTRIBUTES**
         **lastAttemptResult**   **GET;**
**REGISTERED AS { g774-03Package 2 };**

## 7.3      Protection Switch Exercise

**protectionSwitchExercisePkg PACKAGE**
      **ACTIONS**
         **invokeExercise;**
**REGISTERED AS { g774-03Package 3 };**

## 7.4 Protection Mismatch Status

**protectionMismatchStatusPkg PACKAGE**
      **ATTRIBUTES**
          **protectionMismatchStatus GET;**
**REGISTERED AS { g774-03Package 4 };**

## 7.5 Priority

**priorityPkg PACKAGE**
      **ATTRIBUTES**
          **priority GET-REPLACE;**
**REGISTERED AS { g774-03Package 5 };**

## 7.6 Sdh Priority

**sdhPriorityPkg PACKAGE**
      **ATTRIBUTES**
          **sdhPriority PERMITTED VALUES SDHProtASN1.SDHMSPriority GET-REPLACE;**
**REGISTERED AS { g774-03Package 6 };**

# 8 Attributes

## 8.1 Channel Number

**channelNumber ATTRIBUTE**
      **WITH ATTRIBUTE SYNTAX SDHProtASN1.Integer;**
      **MATCHES FOR EQUALITY, ORDERING;**
      **BEHAVIOUR channelNumberBeh;**
**REGISTERED AS { g774-03Attribute 1 };**

**channelNumberBeh BEHAVIOUR**
**DEFINED AS**

"This attribute indicates the channel number associated with a **protectionUnit**.
";

## 8.2 Last Attempt Result

**lastAttemptResult ATTRIBUTE**
      **WITH ATTRIBUTE SYNTAX SDHProtASN1.LastAttemptResult;**
      **MATCHES FOR EQUALITY;**
      **BEHAVIOUR lastAttemptResultBeh;**
**REGISTERED AS { g774-03Attribute 2 };**

**lastAttemptResultBeh BEHAVIOUR**
**DEFINED AS**

"The value of the last exercise result or the result of a protection group/unit diagnostic or switch attempt which performs at least the same functionality as an exercise, is available from his attribute. If a failure ocurs, the **availabilityStatus** of the **protectionGroup** object will be set to degraded. The successful completion of a protection group/unit diagnostic or switch attempt which performs at least the same functionality as an exercise causes the **availabilityStatus** attribute to be set to NULL (i.e available), and the **lastAttemptResult** value is set to success.
";

## 8.3 Priority

**priority ATTRIBUTE**
      **WITH ATTRIBUTE SYNTAX SDHProtASN1.Integer;**
      **MATCHES FOR EQUALITY, ORDERING;**
      **BEHAVIOUR priorityBeh;**
**REGISTERED AS { g774-03Attribute 3 };**

**priorityBeh BEHAVIOUR**
**DEFINED AS**

"This attribute specifies the priority of the service (e.g. traffic) carried on the resource associated with the protected **protectionUnit** instance. Valid values for this attribute are integers, where the value 1 indicates the highest priority, and a larger value indicates a lower priority.

For a protecting **protectionUnit**, the value of this attribute indicates the priority of choice of the protecting **protectionUnit** relative to other available protecting **protectionUnit(s)** within the same **protectionGroup**. The lower the value, the more preferred the **protectionUnit** is relative to other **protectionUnits**.
";

## 8.4     Protected Trail Termination Point Identifier

**protectedTTPId ATTRIBUTE**
           **WITH ATTRIBUTE SYNTAX      SDHProtASN1.NameType;**
           **MATCHES FOR         EQUALITY, ORDERING, SUBSTRINGS;**
           **BEHAVIOUR protectedTTPIdBeh;**
**REGISTERED AS { g774-03Attribute 4 };**

**protectedTTPIdBeh BEHAVIOUR**
**DEFINED AS**

"This attribute is used as an RDN for naming instances of the **protectedTTP** object classes. If the string choice of the syntax is used, then matching on substrings is permitted. If the number choice for the syntax is used, then matching on ordering is permitted.
";

## 8.5     Reported Protection Unit

**reportedProtectionUnit ATTRIBUTE**
           **WITH ATTRIBUTE SYNTAX      SDHProtASN1.RelativeDistinguishedName;**
           **MATCHES FOR         EQUALITY;**
**REGISTERED AS { g774-03Attribute 5 };**

## 8.6     Protection Group Identifier

**protectionGroupId ATTRIBUTE**
           **WITH ATTRIBUTE SYNTAX      SDHProtASN1.NameType;**
           **MATCHES FOR         EQUALITY, ORDERING, SUBSTRINGS;**
           **BEHAVIOUR protectionGroupIdBeh;**
**REGISTERED AS { g774-03Attribute 6 };**

**protectionGroupIdBeh BEHAVIOUR**
**DEFINED AS**

"The **protectionGroupId** attribute is an attribute type whose distinguished value can be used as an RDN when naming an instance of the **protectionGroup** object class. If the string choice of the syntax is used, then matching on substrings is permitted. If the number choice for the syntax is used, then matching on ordering is permitted.
";

## 8.7     Protection Group Type

**protectionGroupType ATTRIBUTE**
           **WITH ATTRIBUTE SYNTAX      SDHProtASN1.ProtectionGroupType;**
           **MATCHES FOR         EQUALITY;**
           **BEHAVIOUR protectionGroupTypeBeh;**
**REGISTERED AS { g774-03Attribute 7 };**

**protectionGroupTypeBeh BEHAVIOUR**
**DEFINED AS**

"This attribute specifies whether the protection scheme used is 1 + 1 (plus) or M:N (colon). M:N includes the cases where M = 1 and/or N = 1.
";

## 8.8    Protection Mismatch Status

**protectionMismatchStatus ATTRIBUTE**
       **WITH ATTRIBUTE SYNTAX    SDHProtASN1.ProtectionMismatchStatus;**
       **MATCHES FOR      EQUALITY;**
       **BEHAVIOUR protectionMismatchStatusBeh;**
**REGISTERED AS { g774-03Attribute 8 };**

**protectionMismatchStatusBeh BEHAVIOUR**
**DEFINED AS**

"This attribute indicates a mismatch between the local and far-end provisioned values for the **protectionGroupType** attribute and has a separate indication for a mismatch between the local and far-end provisioned values for the **protectionSwitchMode** attribute.
";

## 8.9    Protection Status

**protectionStatus ATTRIBUTE**
       **WITH ATTRIBUTE SYNTAX    SDHProtASN1.ProtectionStatus;**
       **MATCHES FOR      EQUALITY, SET-COMPARISON,**
                             **SET-INTERSECTION;**
       **BEHAVIOUR protectionStatusBeh;**
**REGISTERED AS { g774-03Attribute 9 };**

**protectionStatusBeh BEHAVIOUR**
**DEFINED AS**

"This attribute is used to indicate the status of the protection switch in a **protectionUnit** instance. This attribute is set-valued because some requests are allowed to be pending. The following rule shall be followed: Only one of the values lockout, **forcedSwitch**, or **manualSwitch** can be present at the same time, either local or remote. It is also possible to have two or more pending automatic switch requests. The **protectionStatus** attribute of a protection Unit which provides protection is used to hold the protection request which is actually performed on that **protectionUnit**.

Locally invoked management operations (e.g. manual, forced, lockout switch completions) can be overridden at the near end or the far end, but may only be released at the near end.

Single-ended systems keep the status of local and far-end switch requests as separate entities in the **protectionStatus** attribute.

The remainder of this behaviour provides the allowable **protectionStatus** attribute values for protected and protecting units for both revertive and non-revertive systems.

The following allowable **protectionStatus** values are associated with each protected unit:

–    **No Request** – No switch request is present on the unit.

–    **Manual Switch to Protecting Complete** – The unit has completed a Manual Switch.

–    **Release failed** – A switch has been released or preempted and a timeout occurs while waiting for a release of associated bridges, or the near-end switch.

–    **Automatic Switch (SF) Pending** – The unit has a Signal Fail condition present and the protecting unit is unavailable.

–    **Automatic Switch (SD) Pending** – The unit has a Signal Degrade condition present and the protecting unit is unavailable.

–    **Automatic Switch (SF) Complete** – The unit has completed an Automatic Switch to the protecting unit due to a Signal Fail condition.

–    **Automatic Switch (SD) Complete** – The unit has completed an Automatic Switch to the protecting unit due to a Signal Degrade condition.

–    **Automatic Switch (SF) Present, Operate failed** – An automatic switch (SF) request is in progress and a time-out occurs while waiting for completion.

- **Automatic Switch (SD) Present, Operate failed** – An automatic switch (SD) request is in progress and a time-out occurs while waiting for completion.

- **Force Switch Complete, Automatic Switch (SF) Pending** – The unit has completed a Force Switch. Additionally, the unit has an automatic switch (SF) pending.

- **Force Switch Complete, Automatic Switch (SD) Pending** – The unit has completed a Force Switch. Additionally, the unit has an automatic switch (SD) pending.

- **Automatic Switch Complete, Wait-to-Restore** – The unit has completed an Automatic Switch to the protecting unit.

- **Force Switch Complete** – The unit has completed a Force Switch to the protecting unit.

- **Protected Unit Lockout Completed** – The unit has been locked out from the protecting unit.

- **Protected Unit Lockout complete, Operate Failed** – The unit has been locked out from the protecting unit, and, the previously completed switch could not be released within the expected time-out. When the switch is released, the operate failed status is removed.

Additionally, the non-revertive protected protection unit has the following status values:

- **Do Not Revert** – The protected unit has been switched to the protecting unit and the request to do so has been released. The switch to the protecting unit is maintained.

- **Manual Switch to Protected Unit Complete** – The unit has completed a Manual Switch from the protecting unit to the protected unit.

- **Force Switch to Protected Unit Complete** – The unit has completed a Force Switch from the protecting unit to the protected unit.

- **Automatic Switch (SF) to Protected Unit Complete** – The protecting unit has a Signal Fail condition present and traffic is now being carried on the protected unit.

- **Automatic Switch (SD) to Protected Unit Complete** – The protecting unit has a Signal Degrade condition present and traffic is now being carried on the protected unit.

- **Automatic Switch (SD) to Protected Unit Complete, Signal Degrade Present** – The protecting unit has a Signal Degrade condition present and traffic is now being carried on the protected unit. Additionally, the protected unit has a Signal Degrade condition present.

- **Automatic Switch (SF) to Protected Unit Complete, Signal Degrade Present** – The protecting unit has a Signal Fail condition present and traffic is now being carried on the protected unit. Additionally, the protected unit has a Signal Degrade condition present.

- **Force Switch from Protecting Unit Complete, Automatic Switch (SF) Pending** – The unit has completed a Force Switch from the protecting unit to the protected unit. Additionally, the protected unit has an automatic switch (SF) condition present.

- **Force Switch from Protecting Unit Complete, Automatic Switch (SD) Pending** – The unit has completed a Force Switch from the protecting unit to the protected unit. Additionally, the protected unit has an automatic switch (SD) condition present.

The following allowable **protectionStatus** values are associated with each protecting unit:

–   **No Request** – No request is present on the protecting unit.

–   **Manual Switch to Protecting Unit Complete** – The protected unit has completed a Manual Switch.

–   **Automatic Switch Complete (SF) to Protecting Unit** – The protected unit has completed an automatic switch (SF) to the protecting unit.

–   **Automatic Switch Complete (SD) to Protecting Unit** – The protected unit has completed an automatic switch (SD) to the protecting unit.

–   **Automatic Switch Complete (SD) to Protecting Unit, Protecting Unit Signal Degraded** – The protected unit has completed an automatic switch to the protecting unit. Additionally, the protecting unit has a Signal Degrade condition present. This applies to 1:n systems only.

–   **Automatic Switch Complete (SF) to Protecting Unit, Protecting Unit Signal Degraded** – The protected unit has completed an automatic switch to the protecting unit. Additionally, the protecting unit has a Signal Degrade condition present. This applies to 1:n systems only.

–   **Protecting Unit SD Present** – The protecting unit has a Signal Degrade condition present. This state may also be a result of invalid or toggling APS byte values. This applies to 1:n systems only.

–   **Protecting Unit SF Present** – The protecting unit has a Signal Fail condition present. This state may also be a result of invalid or toggling APS byte values. This applies to 1:n systems only.

–   **Force Switch Complete to Protecting Unit** – The unit has completed a Force Switch of a protected unit to the protecting unit.

–   **Force Switch Complete to Protecting Unit, SD Present on Protecting Unit** – The unit has completed a Force Switch of a protected unit to the protecting unit. Additionally, there is a Signal Degrade present on the protecting unit.

–   **Force Switch Complete to Protecting , SF Present on Protecting Unit** – The unit has completed a Force Switch of a protected unit to the protecting unit. Additionally, there is a Signal Fail (1 + 1 unidirectional systems only) present on the protecting unit.

–   **Protecting Unit Locked Out** – The protecting unit has been locked out.

–   **Protecting Unit Locked Out, Release Failed** – A release of a lockout is in progress and a timeout occurs waiting for the lockout condition to clear.

Additionally, the non-revertive protecting unit has the following values:

–   **Do Not Revert** – The protected unit has been switched to the protecting unit and the request to do so has been released. The switch to the protecting unit is maintained.

–   **Manual Switch to Protected Unit Complete** – The unit has completed a Manual Switch from the protecting unit to the protected unit.

–   **Force Switch to Protected Unit Complete** – The protecting unit has completed a forced switch to the protected unit.

–   **Force Switch to Protected Unit Complete, Protecting Unit Signal Degraded** – The protecting unit has completed a forced switch to the protected unit. Additionally, there is a Signal Degrade condition on the protecting unit.

- **Force Switch to Protected Unit Complete, Protecting Unit Signal Failed** – The protecting unit shows a forced switch to the protected unit. Additionally, there is a Signal Fail condition on the protecting unit.

- **Automatic Switch (SF) to Protected Unit Complete** – The protecting unit has a Signal Fail condition present and traffic is now being carried on the protected unit.

- **Automatic Switch (SD) to Protected Unit Complete** – The protecting unit has a Signal Degrade condition present and traffic is now being carried on the protected unit.

- **Automatic Switch Complete (SD) to Protecting, Automatic Switch (SD) to Protected Unit Pending** – The protected unit has completed an automatic switch to the protecting unit. Additionally, the protecting unit has a Signal Degrade condition present.

- **Automatic Switch Complete (SF) to Protecting, Automatic Switch (SD) to Protected Unit Pending** – The protected unit has completed an automatic switch to the protecting unit. Additionally, the protecting unit has a Signal Degrade condition present.

APS timeout detected by the exerciser, or, during an attempt to invoke a manual or forced switch will not be indicated as APS failure (operate or release fail) in the **protectionStatus** attribute. Instead, the **actionReply** for the invoked action will report this. Additionally, attribute **lastAttemptResult** will provide a record of the failure, until a successful exercise or protection switch causes this attribute to be cleared.
";

## 8.10    Protection Switch Mode

**protectionSwitchMode ATTRIBUTE**
> **WITH ATTRIBUTE SYNTAX**          **SDHProtASN1.ProtectionSwitchMode;**
> **MATCHES FOR**          **EQUALITY;**
> **BEHAVIOUR protectionSwitchModeBeh;**
**REGISTERED AS { g774-03Attribute 10 };**

**protectionSwitchModeBeh BEHAVIOUR**
**DEFINED AS**

"This attribute specifies whether protection switching is done on a unidirectional or bidirectional basis.
";

## 8.11    Protection Unit Identifier

**protectionUnitId ATTRIBUTE**
> **WITH ATTRIBUTE SYNTAX**          **SDHProtASN1.NameType;**
> **MATCHES FOR**          **EQUALITY, ORDERING, SUBSTRINGS;**
> **BEHAVIOUR protectionUnitIdBeh;**
**REGISTERED AS { g774-03Attribute 11 };**

**protectionUnitIdBeh BEHAVIOUR**
**DEFINED AS**

"The **protectionUnitId** attribute is an attribute type whose distinguished value can be used as an RDN when naming an instance of the **protectionUnit** object class. If the string choice of the syntax is used, then matching on substrings is permitted. If the number choice for the syntax is used, then matching on ordering is permitted.
";

## 8.12    Protecting

**protecting ATTRIBUTE**
> **WITH ATTRIBUTE SYNTAX**          **SDHProtASN1.Boolean;**
> **MATCHES FOR**          **EQUALITY;**
> **BEHAVIOUR protectingBeh;**
**REGISTERED AS { g774-03Attribute 12 };**

**protectingBeh BEHAVIOUR**
**DEFINED AS**

"This attribute specifies the type of the **protectionUnit**. A value of TRUE indicates that the **protectionUnit** is a protecting (i.e. backup or standby) unit. A value of FALSE indicates that the **protectionUnit** is a protected (i.e. a regular, working, or preferred) unit.
";

## 8.13 Reliable Resource Pointer

**reliableResourcePointer ATTRIBUTE**
   **WITH ATTRIBUTE SYNTAX**    **SDHProtASN1.ResourcePointer;**
   **MATCHES FOR**    **EQUALITY;**
   **BEHAVIOUR reliableResourcePointerBeh;**
**REGISTERED AS { g774-03Attribute 13 };**

**reliableResourcePointerBeh BEHAVIOUR**
**DEFINED AS**

"The value of the **reliableResourcePointer** attribute points to the reliable resource(s) (e.g. termination point) that is/are associated with the **protectionUnit** instance.
";

## 8.14 Revertive

**revertive ATTRIBUTE**
   **WITH ATTRIBUTE SYNTAX**    **SDHProtASN1.Boolean;**
   **MATCHES FOR**    **EQUALITY;**
   **BEHAVIOUR revertiveBeh;**
**REGISTERED AS { g774-03Attribute 14 };**

**revertiveBeh BEHAVIOUR**
**DEFINED AS**

"This attribute indicates whether the protection scheme is revertive or not. If the value of this attribute is TRUE, the traffic is returned to the protected **protectionUnit** instance that initiated the switch after the fault clears and the **waitToRestoreTime** interval (if any) has expired. If the value of this attribute is FALSE, then after the fault has cleared, traffic does not revert to the **protectionUnit** that initiated the switch.
";

## 8.15 Sdh Priority

**sdhPriority ATTRIBUTE**
   **WITH ATTRIBUTE SYNTAX**    **SDHProtASN1.Integer;**
   **MATCHES FOR**    **EQUALITY;**
   **BEHAVIOUR sdhPriorityBeh;**
**REGISTERED AS { g774-03Attribute 15 };**

**sdhPriorityBeh BEHAVIOUR**
**DEFINED AS**

"SDH priority may be High or Low for protected protection units. This is intended for prioritizing SD and SF conditions on 1:n systems.
";

## 8.16 Unprotected Connection Termination Point Identifier

**unprotectedCTPId ATTRIBUTE**
   **WITH ATTRIBUTE SYNTAX**    **SDHProtASN1.NameType;**
   **MATCHES FOR**    **EQUALITY, ORDERING, SUBSTRINGS;**
   **BEHAVIOUR unprotectedCTPIdBeh;**
**REGISTERED AS { g774-03Attribute 16 };**

**unprotectedCTPIdBeh BEHAVIOUR**
**DEFINED AS**

"This attribute is used as an RDN for naming instances of the **unprotectedCTP** object classes. If the string choice of the syntax is used, then matching on substrings is permitted. If the number choice for the syntax is used, then matching on ordering is permitted.
**";**

## 8.17    Unreliable Resource Pointer

**unreliableResourcePointer ATTRIBUTE**
      **WITH ATTRIBUTE SYNTAX**      **SDHProtASN1.ResourcePointer;**
      **MATCHES FOR**      **EQUALITY;**
      **BEHAVIOUR unreliableResourcePointerBeh;**
**REGISTERED AS { g774-03Attribute 17 };**

**unreliableResourcePointerBeh BEHAVIOUR**
**DEFINED AS**

"The value of the **unreliableResourcePointer** attribute points to the unreliable resource(s) (e.g. equipment hardware or termination point) that is/are associated with the **protectionUnit** instance.
**";**

## 8.18    Wait to Restore Time

**waitToRestoreTime ATTRIBUTE**
      **WITH ATTRIBUTE SYNTAX**      **SDHProtASN1.Integer;**
      **MATCHES FOR**      **EQUALITY, ORDERING;**
      **BEHAVIOUR waitToRestoreTimeBeh;**
**REGISTERED AS { g774-03Attribute 18 };**

**waitToRestoreTimeBeh BEHAVIOUR**
**DEFINED AS**

"This attribute specifies the amount of time, in seconds, to wait after a fault clears before restoring traffic to the protected **protectionUnit** that initiated the switching.
**";**

# 9        Actions

## 9.1    Invoke Exercise

**invokeExercise ACTION**
      **BEHAVIOUR invokeExerciseBeh;**
      **MODE CONFIRMED;**
      **WITH INFORMATION SYNTAX  SDHProtASN1.InvokeExerciseArg;**
      **WITH REPLY SYNTAX  SDHProtASN1.InvokeExerciseReply;**
**REGISTERED AS { g774-03Action 1 };**

**invokeExerciseBeh BEHAVIOUR**
**DEFINED AS**

"The **invokeExercise** action can be used to request a protection exercise routine to be performed on one or more **protectionUnit** instances contained in the **protectionGroup** object.

The action argument contains indications of the protected and protecting units to which the request applies. If a protecting unit is identified in the **protectedUnits** field, or if a protected unit is identified in the **protectingUnits** field, the action fails.

The **protectionEntity** field may be absent, indicating that the request applies to all contained protection units.

While an exercise is in progress, the value of the **protectionStatus** attribute shall continue to indicate **No Request**. When an exercise routine has completed for any **protectionUnit** instances, the **lastAttemptResult** attribute is updated to reflect pass or fail for each exercised protection unit.
**";**

## 9.2 Invoke Protection

NOTE – The definition of Lockout, Forced Switch, and Manual Switch is provided in Recommendation G.783.

**invokeProtection ACTION**
      **BEHAVIOUR invokeProtectionBeh;**
      **MODE CONFIRMED;**
      **PARAMETERS invokeProtectionError;**
      **WITH INFORMATION SYNTAX SDHProtASN1.InvokeProtectionArg;**
**REGISTERED AS { g774-03Action 2 };**

**invokeProtectionBeh BEHAVIOUR**
**DEFINED AS**

"The **invokeProtection** action can be used to request a lockout, a forced switch, or a manual (i.e. normal switch) on one or more **protectionUnit** instances contained in the **protectionGroup** object.

The action argument contains a request (Forced Switch, Manual Switch, or Lockout) and indications of the protected and protecting units to which the request applies. If a protecting unit is identified in the **protectedUnits** field, or if a protected unit is identified in the **protectingUnits** field, the action fails.

If the request is Forced Switch or Manual Switch, the **protectedUnits** field shall identify one or more protection units. If only one unit is identified in the **protectedUnits** field, and there is only one protecting unit in the protection group, the **protectingUnits** field may be omitted. If the **protectingUnits** field is present, it shall identify the same number of units as the **protectedUnits** field.

If the request is Lockout, the **protectionEntity** field may be absent, indicating that the request applies to all contained protection units. If the **protectionEntity** field is present, any number of protection units may be identified in the **protectedUnits** and/or **protectingUnits** field, and either field may be absent.

For a Lockout request, the specified protected units and/or protecting units are locked out.

For requests which cannot be completed, either because the request is the protecting unit is serving a request of higher priority (in the error parameter of the CMIP APDU, reason: preempted), or failure occurs (failure), or timeout occurs (timeout), the reply shall indicate why the request could not be completed, and the request shall not be made pending. The CMIP error APDU contains the failure reasons.
";

## 9.3 Release Protection

**releaseProtection ACTION**
      **BEHAVIOUR releaseProtectionBeh;**
      **MODE CONFIRMED;**
      **PARAMETERS releaseProtectionError;**
      **WITH INFORMATION SYNTAX SDHProtASN1.ReleaseProtectionArg;**
**REGISTERED AS { g774-03Action 3 };**

**releaseProtectionBeh BEHAVIOUR**
**DEFINED AS**

"The **releaseProtection** action can be used to release a lockout, a forced switch, or a manual (i.e. normal switch) on one or more **protectionUnit** instances contained in the **protectionGroup** object.

The action argument contains a request (Forced Switch, Manual Switch, or Lockout) and indications of the protected and protecting units to which the request applies. If a protecting unit is identified in the **protectedUnits** field, or if a protected unit is identified in the **protectingUnits** field, the action fails.

If the request is Forced Switch or Manual Switch, the **protectedUnits** field shall identify one or more protection units, and the **protectingUnits** field shall be omitted. For each identified protected unit, if it is not switched to a protecting unit, the action fails.

If the request is Lockout, the **protectionEntity** field may be absent, indicating that the request applies to all contained protection units. If the **protectionEntity** field is present, any number of protection units may be identified in the **protectedUnits** and/or **protectingUnits** field, and either field may be absent.

For a Lockout request, the specified protected units and/or protecting units are no longer locked out. That is, the protected units are now under protection and the protecting units are now capable of providing protection. For release requests which cannot be completed, the reply shall indicate why the request could not be completed.
";

# 10 Notifications

## 10.1 Protection Switch Reporting

**protectionSwitchReporting NOTIFICATION**
        **BEHAVIOUR protectionSwitchReportingBeh;**
        **WITH INFORMATION SYNTAX  SDHProtASN1.ProtectionSwitchReportingInfo;**
          **AND ATTRIBUTE IDS**
          **protectionUnit      reportedProtectionUnit,**
          **additionalInfo     "Rec. X.721 | ISO/IEC 10165-2 : 1992": additionalInformation;**
**REGISTERED AS { g774-03Notification 1 };**

**protectionSwitchReportingBeh BEHAVIOUR**
**DEFINED AS**

"The **protectionSwitchReporting** notification is emitted from the **protectionGroup** object to report any protection switch events. The choice of **protectingUnit** is utilized for the **protectionUnit** argument of the notification in all cases except for when reporting 'lockout of working' or 'release of lockout of working'.
";

# 11 Parameters

## 11.1 Invoke Protection Error

**invokeProtectionError  PARAMETER**
        **CONTEXT SPECIFIC-ERROR;**
        **WITH SYNTAX     SDHProtASN1.InvokeProtectionError;**
        **BEHAVIOUR invokeProtectionErrorBeh;**
**REGISTERED AS { g774-03Parameter 1 };**

**invokeProtectionErrorBeh BEHAVIOUR**
**DEFINED AS**

"This parameter is included in the error parameter of the CMIP APDU when the invoke protection action fails. The preempted choice means that a higher priority switch request exists on the protecting protection unit. The failure choice indicates that the request has not been performed due to an abnormal condition on the protection system. The timeout choice indicates that the protection switch has not been performed in the required time frame.
";

## 11.2 Release Protection Error

**releaseProtectionError  PARAMETER**
        **CONTEXT SPECIFIC-ERROR;**
        **WITH SYNTAX     SDHProtASN1.ReleaseProtectionError;**
        **BEHAVIOUR releaseProtectionErrorBeh;**
**REGISTERED AS { g774-03Parameter 2 };**

**releaseProtectionErrorBeh BEHAVIOUR**
**DEFINED AS**

"This parameter is included in the error parameter of the CMIP APDU when the release protection action fails. The failure choice indicates that the request has not been performed due to an abnormal condition on the protection system. The timeout choice indicates that the protection switch has not been performed in the required time frame.
";

## 11.3 Protection Status Parameter

**protectionStatusParameter PARAMETER**
      **CONTEXT EVENT-INFO;**
      **WITH SYNTAX**     **SDHProtASN1.ProtectionStatusParameter;**
      **BEHAVIOUR protectionStatusParameterBeh;**
**REGISTERED AS { g774-03Parameter 3 };**

**protectionStatusParameterBeh 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 Protection Status attribute of the protecting channel shall be reported in the notification by means of the **oldProtectionStatus** and **newProtectionStatus** parameters respectively.

–   A switch is perfomed by preemting an existing one. In this case the old and new values of the Protection Status attribute of the protecting channel shall be reported in the notification by means of the **oldProtectionStatus** and **newProtectionStatus** parameters respectively.

–   An auto-switch condition exists on a channel but the auto-switch cannot be served due to the unavailibility of the channel that otherwise protects it. In this case the **oldProtectionStatus** and **newProtectionStatus** parameters refer to the protection status attribute value of the channel on which the autoswitch 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 **oldProtectionStatus** and **newProtectionStatus** parameters refer to the protection status attribute value of the working channel which has been locked out.

–   A protection channel (protecting unit) has been locked out or release from lockout without modifying the existing switch. In this case the **oldProtectionStatus** and **newProtectionStatus** parameters refer to the protection 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 SD, SF and WTR condition. While in the lockout of forced switch state no notification is sent except for ending of release failure.
";

## 12 Name Bindings

## 12.1 Protected Trail Termination Point

**protectedTTPBidirectional-sdhNE NAME BINDING**
      **SUBORDINATE OBJECT CLASS**                     **protectedTTPBidirectional;**
      **NAMED BY SUPERIOR OBJECT CLASS**      **"Recommendation G.774 : 1992": sdhNE;**
      **WITH ATTRIBUTE**                               **protectedTTPId;**
      **BEHAVIOUR protectedTTPBidirectional-sdhNEBeh;**
**REGISTERED AS { g774-03NameBinding 1 };**

**protectedTTPBidirectional-sdhNEBeh BEHAVIOUR**
**DEFINED AS**

"The subordinate managed objects are instantiated when the multiplex section protection switching function is present. Instances of this object class may also be instantiated when other types of protection switching functions, such as path protection, are present.
**";**

**protectedTTPSink-sdhNE NAME BINDING**
       SUBORDINATE OBJECT CLASS                 protectedTTPSink;
       NAMED BY SUPERIOR OBJECT CLASS      "Recommendation G.774 : 1992": sdhNE;
       WITH ATTRIBUTE                           protectedTTPId;
       BEHAVIOUR protectedTTPSink-sdhNEBeh;
**REGISTERED AS { g774-03NameBinding 2 };**

**protectedTTPSink-sdhNEBeh BEHAVIOUR**
**DEFINED AS**

"The subordinate managed objects are instantiated when the multiplex section protection switching function is present. Instances of this object may also be instantiated when other types of protection switching functions, such as path protection, are present.
**";**

**protectedTTPSource-sdhNE NAME BINDING**
       SUBORDINATE OBJECT CLASS                 protectedTTPSource;
       NAMED BY SUPERIOR OBJECT CLASS      "Recommendation G.774 : 1992": sdhNE;
       WITH ATTRIBUTE                           protectedTTPId;
       BEHAVIOUR protectedTTPSource-sdhNEBeh;
**REGISTERED AS { g774-03NameBinding 3 };**

**protectedTTPSource-sdhNEBeh BEHAVIOUR**
**DEFINED AS**

"The subordinate managed objects are instantiated when the multiplex section protection switching function is present. Instances of this object class may also be instantiated when other types of protection switching functions, such as path protection, are present.
**";**

## 12.2    Protection Group

**protectionGroup-managedElement NAME BINDING**
       SUBORDINATE OBJECT CLASS                 protectionGroup AND SUBCLASSES;
       NAMED BY SUPERIOR OBJECT CLASS      "Recommendation M.3100: 1992": managedElement AND
               SUBCLASSES;
       WITH ATTRIBUTE                           protectionGroupId;
**REGISTERED AS { g774-03NameBinding 4 };**

## 12.3    Aug

**augBidirectional-protectedTTPBidirectional NAME BINDING**
       SUBORDINATE OBJECT CLASS                 "Recommendation G.774 : 1992": augBidirectional;
       NAMED BY SUPERIOR OBJECT CLASS      protectedTTPBidirectional;
       WITH ATTRIBUTE                           "Recommendation G.774 : 1992": augId;
       BEHAVIOUR augBidirectional-protectedTTPBidirectionalBeh;
**REGISTERED AS { g774-03NameBinding 5 };**

**augBidirectional-protectedTTPBidirectionalBeh BEHAVIOUR**
**DEFINED AS**

"The subordinate managed objects are instantiated when the multiplex section protection switching function is present.
**";**

**augSink-protectedTTPSink NAME BINDING**
       SUBORDINATE OBJECT CLASS                 "Recommendation G.774 : 1992": augSink;
       NAMED BY SUPERIOR OBJECT CLASS      protectedTTPSink;
       WITH ATTRIBUTE                           "Recommendation G.774 : 1992": augId;
       BEHAVIOUR augSink-protectedTTPSinkBeh;
**REGISTERED AS { g774-03NameBinding 6 };**

**augSink-protectedTTPSinkBeh BEHAVIOUR**
**DEFINED AS**

"The subordinate managed objects are instantiated when the multiplex section protection switching function is present.
";

**augSource-protectedTTPSource NAME BINDING**
       SUBORDINATE OBJECT CLASS                 "Recommendation G.774 : 1992": augSource;
       NAMED BY SUPERIOR OBJECT CLASS      protectedTTPSource;
       WITH ATTRIBUTE                        "Recommendation G.774 : 1992": augId;
       BEHAVIOUR augSource-protectedTTPSourceBeh;
**REGISTERED AS { g774-03NameBinding 7 };**

**augSource-protectedTTPSourceBeh  BEHAVIOUR**
**DEFINED AS**

"The subordinate managed objects are instantiated when the multiplex section protection switching function is present.
";

## 12.4    Protection Unit

**protectionUnit-protectionGroup NAME BINDING**
       SUBORDINATE OBJECT CLASS                 protectionUnit AND SUBCLASSES;
       NAMED BY SUPERIOR OBJECT CLASS      protectionGroup AND SUBCLASSES;
       WITH ATTRIBUTE                        protectionUnitId;
**REGISTERED AS { g774-03NameBinding 8 };**

## 12.5    Unprotected Connection Termination Point

**unprotectedCTPBidirectional-msTTPBidirectional NAME BINDING**
       SUBORDINATE OBJECT CLASS                 unprotectedCTPBidirectional;
       NAMED BY SUPERIOR OBJECT CLASS      "Recommendation G.774 : 1992": msTTPBidirectional;
       WITH ATTRIBUTE                        unprotectedCTPId;
       BEHAVIOUR unprotectedCTPBidirectional-msTTPBidirectionalBeh;
**REGISTERED AS { g774-03NameBinding 9 };**

**unprotectedCTPBidirectional-msTTPBidirectionalBeh BEHAVIOUR**
**DEFINED AS**

"The subordinate managed objects are instantiated when the multiplex section protection switching function is present.
";

**unprotectedCTPSink-msTTPSink NAME BINDING**
       SUBORDINATE OBJECT CLASS                 unprotectedCTPSink;
       NAMED BY SUPERIOR OBJECT CLASS      "Recommendation G.774 : 1992": msTTPSink;
       WITH ATTRIBUTE                        unprotectedCTPId;
       BEHAVIOUR unprotectedCTPSink-msTTPSinkBeh;
**REGISTERED AS { g774-03NameBinding 10 };**

**unprotectedCTPSink-msTTPSinkBeh BEHAVIOUR**
**DEFINED AS**

"The subordinate managed objects are instantiated when the multiplex section protection switching function is present.
";

**unprotectedCTPSource-msTTPSource NAME BINDING**
       SUBORDINATE OBJECT CLASS                 unprotectedCTPSource;
       NAMED BY SUPERIOR OBJECT CLASS      "Recommendation G.774 : 1992": msTTPSource;
       WITH ATTRIBUTE                        unprotectedCTPId;
       BEHAVIOUR unprotectedCTPSource-msTTPSourceBeh;
**REGISTERED AS { g774-03NameBinding 11 };**

**unprotectedCTPSource-msTTPSourceBeh BEHAVIOUR**
**DEFINED AS**

"The subordinate managed objects are instantiated when the multiplex section protection switching function is present.
";

# 13 Subordination Rules

None.

# 14 Pointer Constraints

None.

# 15 Supporting ASN.1 Productions

**SDHProtASN1 { itu(0) recommendation(0) g(7) g774(774) hyphen(127) prot(03) informationModel(0) asn1Module(2) sdhmsp(0) }**

**DEFINITIONS IMPLICIT TAGS ::=**

**BEGIN**
*-- EXPORTS everything --*

**IMPORTS**
**NameType**
**FROM**
**ASN1DefinedTypesModule { itu(0) recommendation m gnm(3100) informationModel(0) asn1Modules(2) asn1DefinedTypesModule(0) }**

**RelativeDistinguishedName**
**FROM**
**InformationFramework { joint-iso-itu ds(5) modules(1) informationFramework(1) }**

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

**AdditionalInformation,**
**ManagementExtension**
**FROM**
**Attribute-ASN1Module { joint-iso-itu ms(9) smi(3) part2(2) asn1Module(2) 1 };**

**sdhProt OBJECT IDENTIFIER ::= { itu(0) recommendation(0) g(7) g774(774) hyphen(127) prot(03) informationModel(0) }**

**g774-03ObjectClass OBJECT IDENTIFIER ::= { sdhProt managedObjectClass(3) }**

**g774-03Attribute OBJECT IDENTIFIER ::= { sdhProt attribute(7) }**

**g774-03NameBinding OBJECT IDENTIFIER ::= { sdhProt nameBinding(6) }**

**g774-03Action OBJECT IDENTIFIER ::= { sdhProt action(9) }**

**g774-03Notification OBJECT IDENTIFIER ::= { sdhProt notification(10) }**

**g774-03Parameter OBJECT IDENTIFIER ::= { sdhProt parameter(5) }**

**g774-03Package OBJECT IDENTIFIER ::= { sdhProt package(4) }**
*-- default value definitions --*

**booleanTrueDefault Boolean ::= TRUE**
*-- supporting productions --*

**Boolean ::= BOOLEAN**

**Integer ::= INTEGER**

**InvokeExerciseArg ::= SEQUENCE {**
        **protectionEntity ProtectionEntity OPTIONAL,** *-- if absent, all PUs --*
        **otherInfo SET OF ManagementExtension OPTIONAL }**

**InvokeExerciseReply ::= SET OF SEQUENCE {**
        **protectionUnit RelativeDistinguishedName,**
        **result     LastAttemptResult }**

```
LastAttemptResult ::= CHOICE {
        success        [0]   NULL, -- default value --
        denied         [1]   NULL,
        fail           [2]   RxTxAPS }

RxTxAPS ::= SEQUENCE {
        rxAPSvalue     [0]   INTEGER,
        txAPSvalue     [1]   INTEGER } -- APS byte 1 in low order byte, byte 2 in high order byte --

InvokeProtectionArg ::= SEQUENCE {
        switchType SwitchType,
        protectionEntity ProtectionEntity OPTIONAL, -- if absent, all PUs --
        otherInfo SET OF ManagementExtension OPTIONAL }

ProtectionDirection ::= ENUMERATED {
        transmit       (0),
        receive        (1),
        bidirectional  (2) }

ProtectionEntity ::= SEQUENCE {
        protectedUnits    [0]   SEQUENCE OF RelativeDistinguishedName OPTIONAL,
        protectingUnits   [1]   SEQUENCE OF RelativeDistinguishedName OPTIONAL
}
```
-- In case of a 1 + 1 non revertive MSP system for a manual switch from the protecting protection unit to the protected one, the protectingUnits field shall be used and shall indicate the protection unit which has the channel number 0. If both fields are present they should be compatible sequences. --

```
ProtectionGroupType ::= ENUMERATED {
        plus   (0), -- 1 + 1 (1 plus 1) or hot-standby
        colon  (1) -- M:N (M for N) --
}

ProtectionMismatchStatus ::= SEQUENCE {
        uniBi        [0]     BOOLEAN,
        plusColon    [1]     BOOLEAN }

ProtectionStatus ::= SET OF CHOICE {
        noRequest          [0]  NULL,
        doNotRevert        [1]  NULL,
        manualSwitch       [2]  SEQUENCE {
            requestSource         [0]  RequestSource OPTIONAL,
            switchStatus          [1]  SwitchStatus,
            relatedChannel        [2]  FromAndToProtectionUnit },
        autoSwitch         [3]  SEQUENCE {
            requestSource         [0]  RequestSource OPTIONAL,
            switchStatus          [1]  SwitchStatus,
            relatedChannel        [2]  FromAndToProtectionUnit,
            autoSwitchReason      [3]  AutoSwitchReason },
        forcedSwitch       [4]  SEQUENCE {
            requestSource         [0]  RequestSource OPTIONAL,
            switchStatus          [1]  SwitchStatus,
            relatedChannel        [2]  FromAndToProtectionUnit },
        lockout            [5]  SEQUENCE {
            requestSource         [0]  RequestSource OPTIONAL,
            switchStatus          [1]  SwitchStatus },
        releaseFailed      [6]  NULL,
        protectionFailCond [7]  CHOICE {
            aPSInvalid            [0]  BOOLEAN,
            channelMismatch       [1]  BOOLEAN }            -- invalid or toggling APS byte value
                                                           -- received or channel mismatch --

AutoSwitchReason ::= CHOICE {
        waitToRestore   [0]  NULL,
        signalDegrade   [1]  NULL,
        signalFail      [2]  NULL }

ProtectionSwitchMode ::= ENUMERATED {
        bidirectional      (0),
        unidirectional     (1) }
```

```
ProtectionSwitchReportingInfo ::= SEQUENCE {
        protectionUnit        ProtectionUnit,
        additionalInfo        AdditionalInformation }

ProtectionUnit ::= CHOICE {
        protectingUnit    [0]  RelativeDistinguishedName,
        protectedUnit     [1]  RelativeDistinguishedName }

ProtectionStatusParameter ::= SEQUENCE {
        oldProtectionStatus ProtectionStatus,
        newProtectionStatus ProtectionStatus,
        psDirection ProtectionDirection DEFAULT bidirectional }

ReleaseProtectionArg ::= SEQUENCE {
        switchType SwitchType,
        protectionEntity ProtectionEntity,
        otherInfo SET OF ManagementExtension OPTIONAL }

RequestSource ::= ENUMERATED {
        local          (0),
        remote         (1) }

ResourcePointer ::= CHOICE {
        null           NULL,
        objectInstances            SEQUENCE OF ObjectInstance }

SDHMSPriority ::= Integer(1 .. 2)
-- 1 = high priority, 2 = low priority --

SDHMSResourcePointer ::= ResourcePointer(WITH COMPONENTS {
            ...,
            objectInstances(SIZE(1))
        } )

SwitchStatus ::= ENUMERATED {
        pending        (0),
        completed      (1),
        operateFailed  (2) }

SwitchType ::= ENUMERATED {
        manual         (0),
        forced         (1),
        lockout        (2) }

FromAndToProtectionUnit ::= CHOICE {
        fromProtectionUnitNumber   [0]  RelativeDistinguishedName,
        toProtectionUnitNumber     [1]  RelativeDistinguishedName }
```
-- *The fromProtectionUnitNumber is used for protecting protection unit in order to hold the name of the protected protection unit which has been protected by that protecting protection unit. The toProtectionUnitNumber is used for protected protection unit in order to hold the number of the protecting protection unit to which it has been switched to. In case of a MSP 1 + 1 system these parameters are not mandatory.* --

```
InvokeProtectionError ::= ENUMERATED {
        preempted      (0),
        failure        (1),
        timeout        (2) }

ReleaseProtectionError ::= ENUMERATED {
        failure        (0),
        timeout        (1) }
END
```
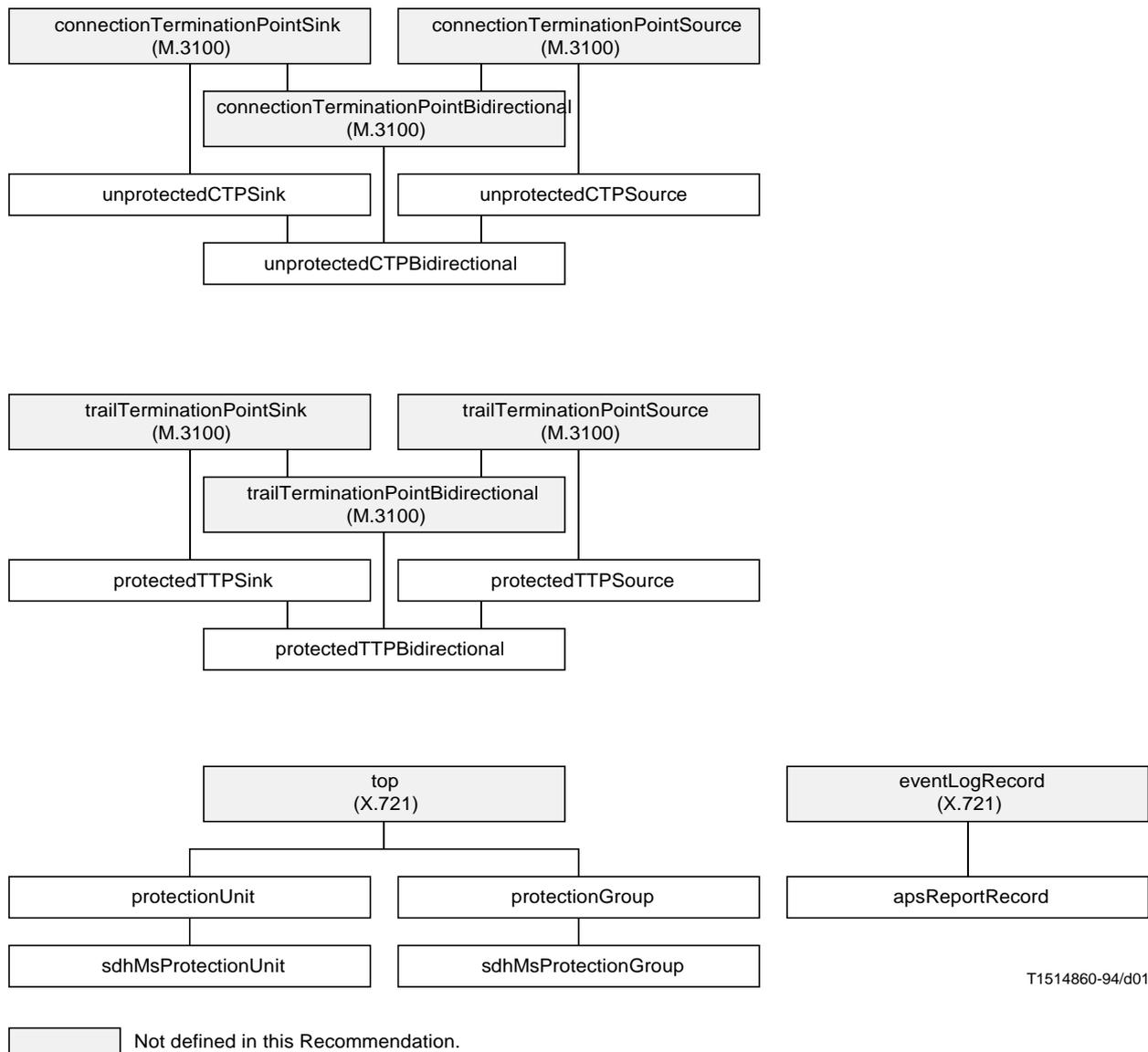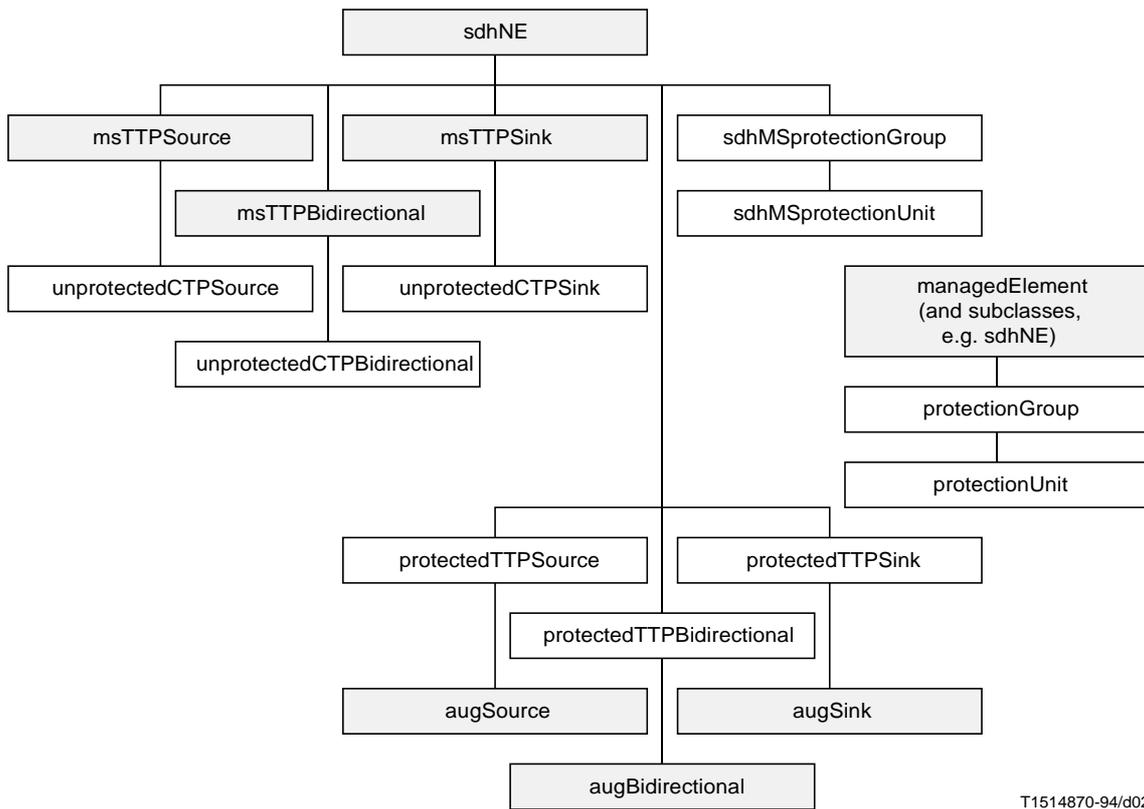
# Annex A

## Naming and Inheritance Diagrams

**(informative)**
(This annex does not form an integral part of this Recommendation)

See Figures A.1 and A.2.



FIGURE A.1/G.774.03

**SDH MS Protection Inheritance Diagram**

FIGURE A.2/G.774.03

**SDH MS Protection Naming Diagram**

# Annex B

## Examples of MS Protection

**(informative)**
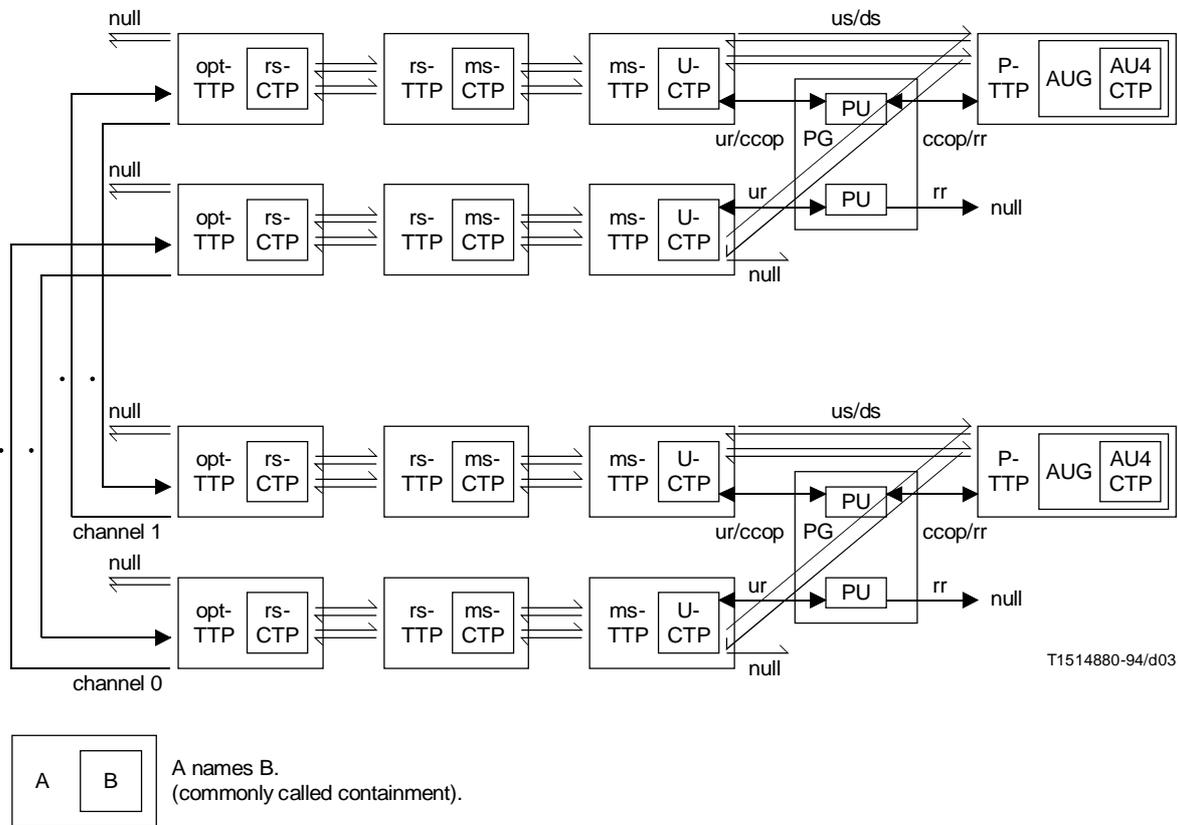(This annex does not form an integral part of this Recommendation)

See Figures B.1 to B.6.



A names B.
(commonly called containment).

us     Upstream pointer (TP)
ds     Downstream pointer (TP)
ur     Unreliable resource pointer (PU)
rr     Reliable resource pointer (PU)
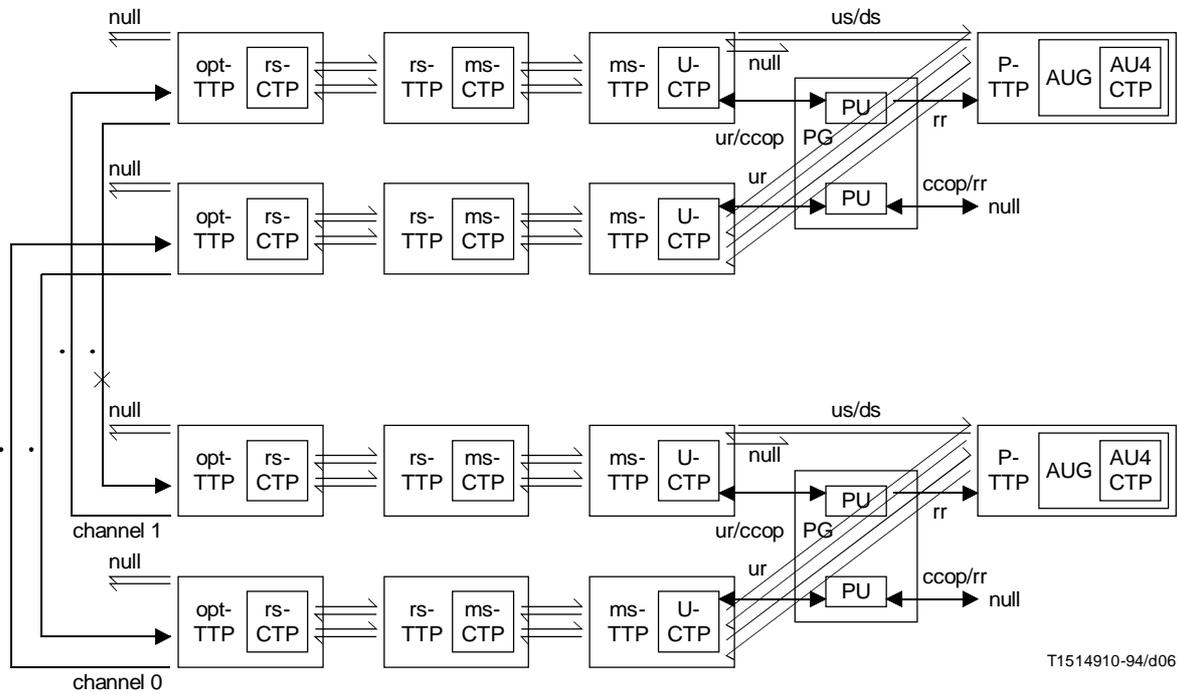ccop   Cross-connect object pointer (TP)

FIGURE B.1/G.774.03

**Example of 1 + 1 Linear MS protection, normal case,
traffic on channel 1**
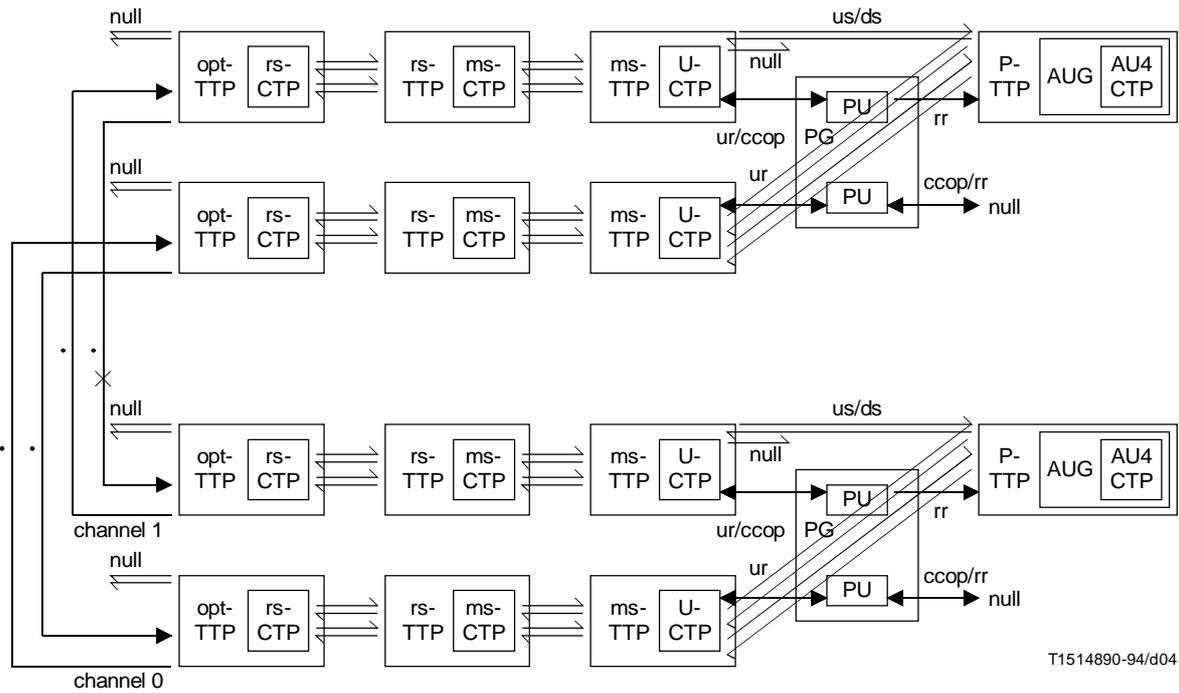
FIGURE  B.2/G.774.03

**Example of 1 + 1 Linear MS protection, failure of channel 1,
traffic switched onto channel 0**
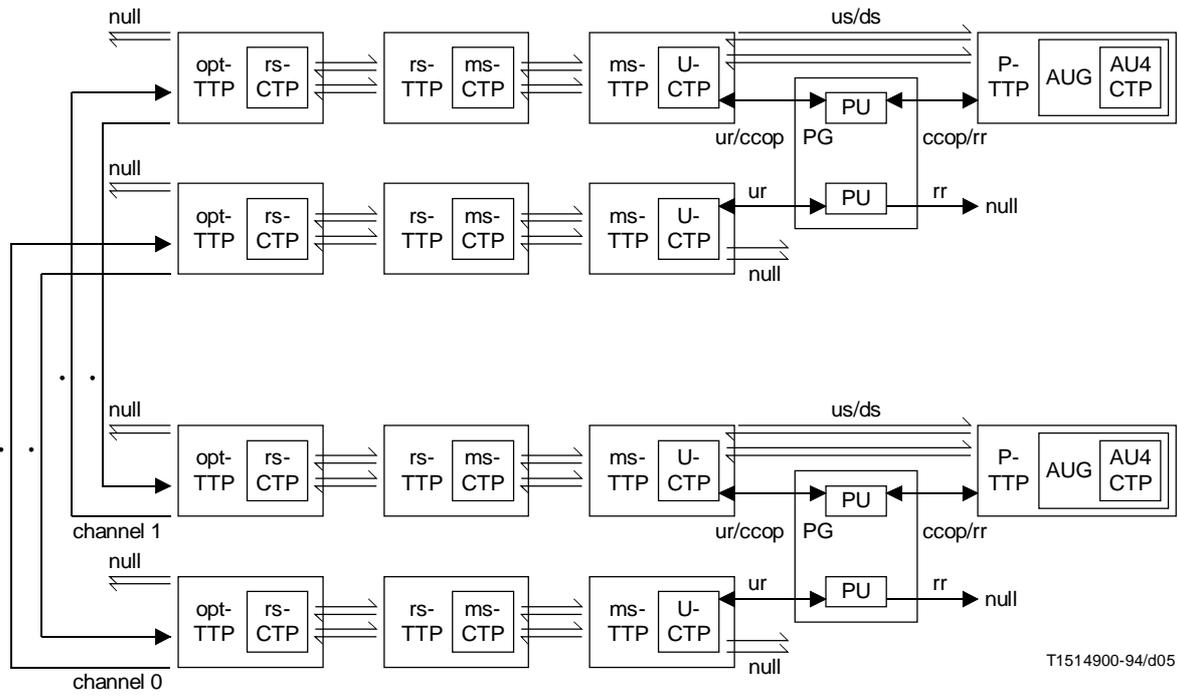
FIGURE B.3/G.774.03

**Example of 1:1 Linear MS protection, normal case, no extra traffic**



FIGURE B.4/G.774.03

**Example of 1:1 Linear MS protection, failure of working channel (channel 1),
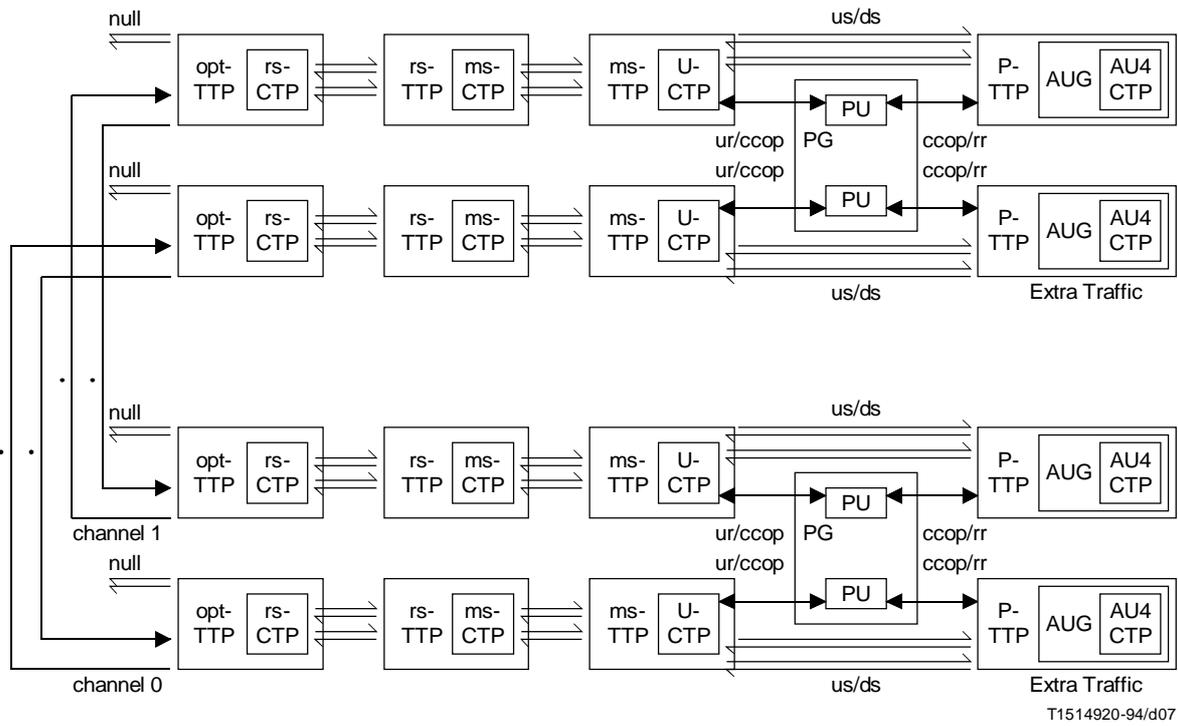traffic switched onto protecting channel**

FIGURE B.5/G.774.03

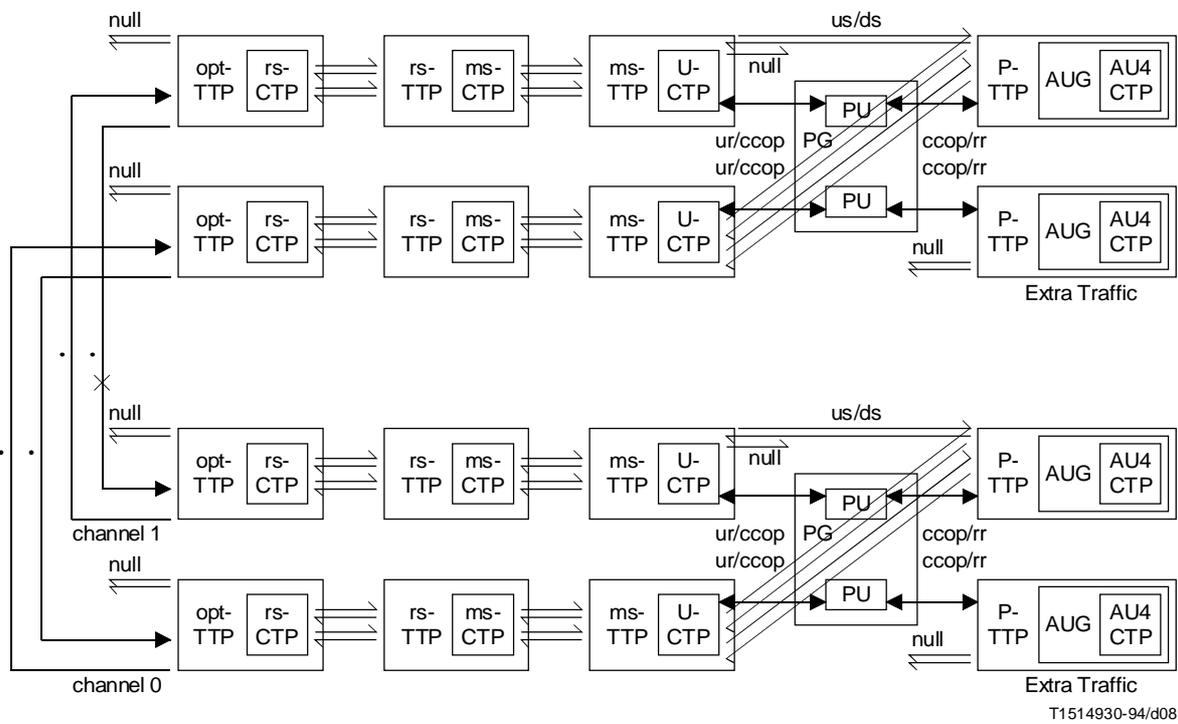**Example of 1.1 Linear MS protection with extra traffic, normal case**



FIGURE B.6/G.774.03

**Example of 1:1 Linear MS protection with extra traffic, failure of working
channel (channel 1), traffic switched onto protecting channel**