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

Digital transmission systems – Digital networks – SDH
network characteristics

Interworking of SDH network protection architectures

ITU-T Recommendation G.842

(Previously CCITT Recommendation)

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ITU-T RECOMMENDATION G.842

INTERWORKING OF SDH NETWORK PROTECTION ARCHITECTURES

Summary

This Recommendation provides specifications for the interworking of network protection architectures. Specifically covered are single and dual node interconnection between MS-shared protection rings and SNCP rings of like or unlike types.

Source

ITU-T Recommendation G.842 was prepared by ITU-T Study Group 15 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 8th of April 1997.

FOREWORD

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The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1.

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

NOTE

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

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Recommendation G.842

INTERWORKING OF SDH NETWORK PROTECTION ARCHITECTURES

(Geneva, 1997)

1 Scope

This Recommendation describes mechanisms for interworking between network protection architectures. The network protection architectures are described in Recommendation G.841. Interworking is described for single and dual node interconnection for exchanging traffic between rings. Each ring may be configured for MS-shared protection or for SNCP protection.

2 References

The following ITU-T Recommendations, and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; 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.

- ITU-T Recommendation G.803 (1997), *Architecture of transport networks based on the Synchronous Digital Hierarchy (SDH)*.
- ITU-T Recommendation G.841 (1995), *Types and characteristics of SDH network protection architectures*.
- ITU-T Recommendation G.783 (1997), *Characteristics of Synchronous Digital Hierarchy (SDH) equipment functional blocks*.

3 Terms and definitions

NOTE – These definitions need to be reviewed with respect to the emerging Recommendation on SDH vocabulary.

This Recommendation defines the following terms.

- 3.1 drop-and-continue:** A function within a ring node where traffic is both extracted from the working channels on the ring (drop), and transmitted onwards on the ring (continue).
- 3.2 dual hubbed:** Dual hubbed traffic can be routed to either or both of two central offices (or similar sites). Dual hubbed traffic is survivable under a failure of one of the two hubs.
- 3.3 dual node interconnection:** An architecture between two rings where two nodes in each ring are interconnected.
- 3.4 hold-off time:** The time that a protection switch controller waits after detecting a failure before initiating the switch.
- 3.5 path selector:** Within an SNCP architecture, the node function that selects a tributary which is extracted from the working channels arriving from one side of the node or from the other side of the node, according to path level criteria.
- 3.6 primary node:** Within an MS-shared protection ring interworking architecture, the node which provides the service selection and drop-and-continue functions for a tributary. Different tributaries may have different designated primary nodes.

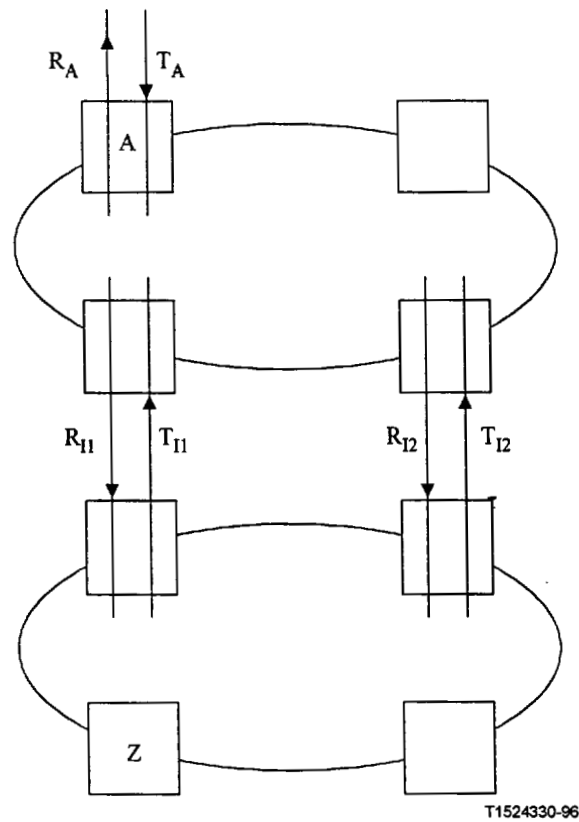


Documents

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- 3.7 propagation of switching:** One protection switch leading to another. Propagation of switching is often, though not always, undesirable from a maintenance point of view.
- 3.8 ring interconnection:** An architecture between two rings where one or more nodes in each ring are interconnected.
- 3.9 ring interworking:** A network topology whereby two rings are interconnected at two nodes on each ring, and the topology operates such that a failure at either of these two nodes will not cause loss of any working traffic. This is illustrated in Figure 1.
- 3.10 secondary circuit:** Within an MS-shared protection ring interworking architecture, this is the alternate routing that traffic travelling from one ring to another follows. This alternate additional routing is used when the service circuit is interrupted.
- 3.11 secondary node:** Within an MS-shared protection ring interworking architecture, the node which provides the alternate interworking route for a tributary.
- 3.12 service circuit:** Within an MS-shared protection ring interworking architecture, this is the preferred original routing that traffic travelling from one ring to another normally follows.
- 3.13 service selector:** Within an MS-shared protection ring architecture, the node function used for ring interworking. It selects traffic from either the channels arriving from one side of the node, or from traffic entering the ring, according to some criteria.
- 3.14 single node interconnection:** An architecture between two rings where one node in each ring is interconnected.
- 3.15 termination node:** The node (other than a primary or secondary node) where a tributary enters or exits the ring.



Failure free state (from perspective of top ring)

$$\begin{aligned} R_{I1} &= R_{I2} = T_A \\ R_A &= T_{I1} \text{ or } T_{I2} \\ T_{I1} &= T_{I2} \end{aligned}$$

Figure 1/G.842 – Generalized ring interworking

4 Abbreviations

This Recommendation uses the following abbreviations:

ADM	Add/Drop Multiplexer
AIS	Alarm Indication Signal
AU	Administrative Unit
HO	Higher Order
HP	Higher order Path
HPC	Higher order Path Connection
HPOM	Higher order Path Overhead Monitor
LO	Lower Order
LOF	Loss of Frame
LOP	Loss of Pointer
LOS	Loss of Signal
LPC	Lower order Path Connection
LPOM	Lower order Path Overhead Monitor

MS	Multiplex Section
SDH	Synchronous Digital Hierarchy
SNC	SubNetwork Connection
SNCP	SubNetwork Connection Protection
SNC/I	SubNetwork Connection Protection with Inherent Monitoring
SNC/N	SubNetwork Connection Protection with Non-Intrusive Monitoring
STM(-N)	Synchronous Transport Module (-N)
TIM	Trace Identifier Mismatch
UNEQ	Unequipped
VC	Virtual Container

5 Interworking criteria/objectives

Interworking SDH protection architectures are meant to provide an even greater degree of protection within a network. Some considerations for interworking criteria are as follows:

- end-to-end availability requirements;
- robustness against various failure events;
- implementation complexity and costs.

The following is a list of interworking objectives:

- 1) Ring interworking shall be accommodated in such a way that if two rings are connected at more than one node each, a failure at one of these node shall not cause loss of any service.
- 2) It should be possible to avoid propagation of switching between interworking rings.
- 3) The ring shall be able to drop traffic at multiple nodes, i.e. working traffic can be dropped at two, or more, nodes on a ring without compromising the ability to restore traffic that is dual hubbed (or any other traffic).
- 4) Ring interconnection may occur among multiple rings. Interconnection boundaries should be the same for all similar instances of interworking between two ring types.

5.1 Criteria for ring interworking with an MS-shared protection ring

The following objectives apply to the particular case of ring interworking with an MS-shared protection ring:

- MS-shared protection ring nodes should support the capability to interconnect with another architecture at two nodes. In particular, MS-shared protection ring nodes should support the capability to interconnect with another ring at two nodes, regardless of the type of protection switching employed by the other ring (e.g. SNCP or MS-shared protection rings).
- For a tributary being protected against ring interconnection failures, the interconnection architecture should be capable of protecting against the failure of one interconnecting node, two interconnecting nodes (each on different rings, but on the same interconnect), or the connection between the two interconnecting nodes.
- The two interconnecting nodes should not need to be adjacent.
- The ring interconnect architecture should support STM-1 electrical or STM-N optical interconnection (where STM-N signals may contain concatenated payloads).
- The ring interconnection architecture should not require inter-ring signalling. Providing protection for the interconnecting line is not considered inter-ring signalling.

- Protection for ring interconnection failures should be based on detecting path defects.
- To avoid propagation of failures when possible, a hold-off time should be allowed.
- Ring interworking using protection bandwidth between ring interworking nodes will be accommodated. The details of ring interworking using protection bandwidth are for further study.

6 Interworking architectures

This clause describes the interworking between multiple instances of protection architectures within the same network layer intersecting at one or more network nodes (e.g. two or more SNC rings exchanging traffic within a single office).

6.1 Single node interconnection

Single node interconnection is an architecture between two rings where one node in each ring is interconnected.

This architecture (shown in Figure 2) has a single point of failure at the point where the rings are interconnected. Interconnection protection can be provided by multiplex section protection of the interconnecting span, but no protection is available due to failure of either interconnecting node.

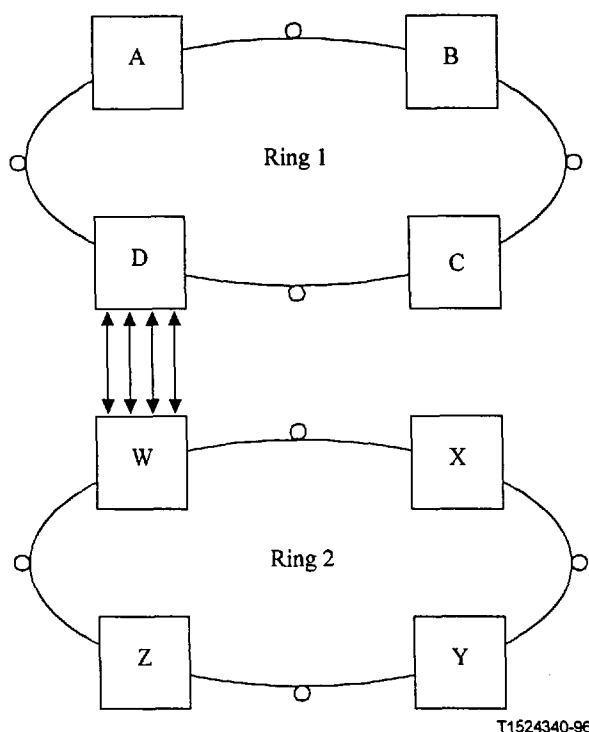


Figure 2/G.842 – Example of single node interconnection

6.2 Dual node interconnection

6.2.1 Generalized architecture

Dual node interconnection is an architecture between two rings where two nodes in each ring are interconnected. This is illustrated in Figure 3. The two interconnections between the two rings can be arranged to provide protection of the traffic crossing from one ring to the other. A special form of

dual node interconnection is given the term ring interworking. Ring interworking is a network topology whereby two rings are interconnected at two nodes on each ring, and the topology operates such that a failure at either of these two nodes will not cause loss of any working traffic. This is illustrated in Figure 1. In this figure, there is a tributary that enters and exits the top ring from Node A, and also enters and exits the bottom ring from Node Z. Using the following notation:

- T_A = the transmit signal at Node A;
- R_A = the receive signal at Node A;
- T_{I1} = the transmit signal at one of the interconnection nodes;
- R_{I1} = the receive signal at one of the interconnection nodes;
- T_{I2} = the transmit signal at the other interconnection node;
- R_{I2} = the receive signal at the other interconnection node.

In ring interworking, the interfaces between the two set of interconnecting nodes is such that:

- $R_{I1} = R_{I2} = T_A$;
- $T_{I1} = T_{I2}$; and
- $R_A = T_{I1}$ or T_{I2} .

In other words, the signal transmitted from Node A towards Node Z is present at both interconnection interfaces. Similarly, the signal transmitted from Node Z back to Node A is also present at both interconnection interfaces. Eventually only one copy of the duplicated signals at the interconnection interfaces is chosen at either Node A or Node Z. Specific examples of ring interworking architectures are described below.

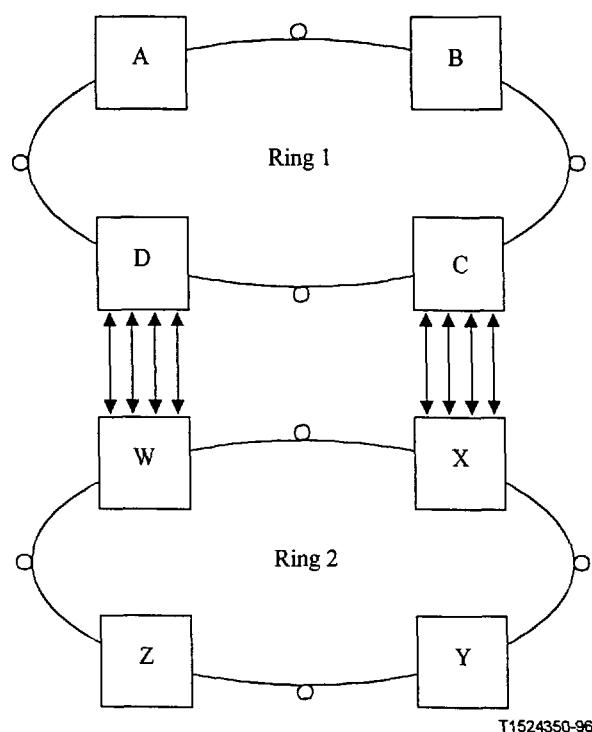


Figure 3/G.842 – Example of dual node interconnection

6.2.2 Ring interworking with an MS-shared protection ring

6.2.2.1 Architecture

Figure 4 shows the nominal failure free state of a simple MS-shared protection ring and illustrates a particular tributary handed-off at two ring interconnection nodes and to be terminated at the node A. The two ring interconnection nodes are referred to as the primary node and the secondary node. These interconnection nodes need not be adjacent. Starting from the top in Figure 4, a bidirectional tributary from the (uppermost) termination node A is assigned counter-clockwise towards the bottom on the ring. Although there is symmetry in the hand-off to the other ring, the primary node would normally be the one "closest" to the terminating node without respect to ring orientation. Primary and secondary nodes are defined on a per tributary basis. The MS-shared protection ring nodes can interface with any architecture at the interconnection nodes so long as the interface requirements illustrated in Figure 4 are met.

This architecture includes recovery from the following failure scenarios:

- 1) Within the MS-shared protection ring, any failure outside of the termination, primary, or secondary nodes are handled in standard fashion. The MS-shared protection ring is assumed to behave as described in Recommendation G.841. The nature of the failure – whether an electronics failure, a cable cut, or even a node failure – has no impact on the configuration of the termination, primary, or secondary nodes. A cable cut failure is illustrated in Figure 5.
- 2) A failure of the primary node in the MS-shared protection ring results in a secondary connection of the tributary. Normally such a tributary would be squelched, but for this architecture this particular tributary remains unsquelched. All other (undesired) crossed traffic is squelched. Failure of the primary node is illustrated in Figure 6. The ring interworking behavior for this case remains the same even if a disaster is large enough (e.g. central office lost) to cause a failure of both the primary node on one ring and its interconnected node on the other ring.
- 3) For a failure of the secondary node, the tributary at the terminating node (see Node A in Figure 7) is unaffected, since it receives its tributary from the primary node. Because of the ring signalling, the primary node knows that the secondary node has failed. The primary node chooses its tributary from the traffic entering it from the other ring. The secondary node has a failed tributary R_s sent to the second ring. The failure of this signal may unavoidably lead to a switch in the second ring depending on its ring type.
- 4) For a failure of either of the signals coming in from the other ring (i.e. T_{11} or T_{12}), the primary node in the MS-shared protection ring chooses the signal that is not failed. Figure 8 illustrates a failure of the hand-off to the secondary node. Here the primary node remains switched to its own good hand-off. Figure 9 illustrates a failure of the hand-off to the primary node. In this case, the primary node switches to choose a good tributary from the secondary node.
- 5) This architecture also protects against a single failure in each of the two rings (i.e. the MS-shared protection ring and the other ring), provided that these failures are not terminating node failures, or these failures do not combine to affect both interconnections between the rings.