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Title: Multiple Services Ring based on RPR

Summary

This draft Recommendation specifies Multiple Services Ring (MSR) Based on RPR. MSR uses local addresses and the multicast address in support of tributary services and uses IEEE802.17 frame format that allows X.msr-rpr to define payload within an Ether-type. Fairness A0 provisioned traffic (and subsequently no fairness) is all that is required to support X.msr-rpr. X.msr-rpr is only used in configurations where tributary service is managed such that over provisioning does not occur. Architecturally, single-ring, the link, broadcast and pseudo-mesh topologies are supported also. The applications used to X.msr-rpr are defined to support tributary transparent transport with various existing data networks and services (e. g. Ethernet, FR and G.702 etc), tributary based bandwidth management with symmetry and asymmetry (e.g. bandwidth limitation and tributary bundling), tributary based 1+1, 1:1 and 1:N protection within 50 ms, tributary based multicast, tributary based security application (e.g. line-speed filtering), tributary based performance monitoring in the 15-minute and 24-hour. X.msr-rpr is provisioning and pre-plan solution.

Editor's notes: The revised marks are shown in the underline part to reflect some change from Rev. 3 to Rev.4

The comments, contributions and reports for this draft Recommendation are given in the table below:

Table of Editor's Note

a)	COM17-D9, Multiple services ring, proposed from China two weeks before 27 February – 8 March 2002 SG17 meeting
b)	TD2053, Multiple services ring, accepted by 27 February – 8 March 2002 SG17 meeting as draft Recommendation X.msr
c)	TD2062Rev.1, meeting report for Q.7/17, at 27 February – 8 March 2002 SG17 meeting
d)	COM15-D.342 in SG15, comments on X.msr from Canada: Nortel Networks at 29 April – 10 May 2002 SG15 meeting
e)	COM15-D.397 in SG15, Concern about ITU-T SG17 work on Multiple Service Rings from USA at 29 April – 10 May 2002 SG15 meeting
f)	TD013r1 in SG15, Comments on draft new Recommendation X.msr on Multiple Service Rings from 29 April – 10 May 2002 SG15 meeting
g)	TD2053 and its working document (informal TD2053Rev.1), discussed at the joint interim Rapporteur meeting of Q.9/15 and Q.7/17 (including IEEE802.17) in Oslo in 23-24 July 2002.
h)	COM17-D49, the meeting report at the joint interim Rapporteur meeting of Q.9/15 and Q.7/17 (including IEEE802.17) in Oslo in 23-24 July 2002

i)	COM17-21, “Link Encapsulation Protocol (LEP) used to Multiple Services Ring (MSR), made by China from August 10 2000, for 20-29 November 2002 SG17 meeting
j)	TD2094, Comments on draft new Recommendation X.msr on Multiple Service Rings, from ITU-T Study Group 15 (29 April – 10 May, 2002)
k)	TD2096, Comments on draft new Recommendation X.msr on Multiple Service Rings [1], from Q.9/15 correspondence group (October 2002), for 20-29 November 2002 SG17 meeting
l)	COM17-D59, Draft new Recommendation X.msr: “Link Encapsulation Protocol (LEP) used to Multiple Services Ring (MSR)” from China, for 20-29 November 2002 SG17 meeting
m)	COM17-D63, Concerns with draft Rec. X.msr from Canada, for 20-29 November 2000 SG17 meeting
n)	COM17-D81, Overlap of work between SG 15, SG 17 and IEEE 802.17 on X,msr from USA, for 20-29 November 2002 SG17 meeting
o)	TD2113, Response to liaison statements on "Draft Recommendation on Multiple Services Ring (MSR)" from ITU-T Study Group 13 (Geneva, 29 October – 8 November 2002)
p)	TD2112, Comments on ITU-T SG17 documents: COM 17-21-E, COM 17-D59 ---Draft New Recommendation X.msr. “Link Encapsulation Protocol (LEP) used to Multiple Services Ring (MSR)” from IEEE802.17, for 20-29 November 2002 SG17 meeting
q)	COM17-D80, Multiple services ring based on RPR lite, from China, for 20-29 November 2002 SG17 meeting
r)	TD21xx, the meeting report for Q.7/17 at 20-29 November 2002 SG17 meeting

CONTENTS

Introduction

The expansion of business and personal use of data network services are driving the need to deploy data services infrastructure facilities with connection oriented and pre-plan method. The dynamic bandwidth allocation and differentiated services over an aggregate pipe, tributary based bandwidth management, security function, protection, multicast, performance monitoring and their applications in the different topologies are the basic requirements of carrier class. Therefore, the development of multiple services ring based on RPR in this Recommendation needs to provide the following capabilities:

(1) The protocol encapsulation and transport of Ethernet, Frame Relay, G.702 PDH circuit -- Synchronous and asynchronous circuit transport, Video signal, voice-band signal, Digital channel supported by 64 kbit/s-based ISDN etc over a two-fibre ring, ~~a single fibre ring,~~ a link-type and broadcast topology of fibres.

(2) Service (or tributary) based protection of 1+1, 1:1, and 1:N models within 50 ms.

(3) Service (or tributary) based multicast and station-based multicast and broadcast.

(4) Bandwidth limitation of service (or tributary) based with symmetry and asymmetry.

(5) Tributary merging with symmetry and asymmetry.

(6) Line-speed filtering of tributary based.

(7) Tributary based performance monitoring in 15-minute and 24-hour.

(8) Mirroring of tributary.

(9) Frame based transparent PPPoE and PPPoA transport from access to backbone along a MSR ring or other topologies, in order to simplify accounting mechanism (e.g. Radius), reduce maintenance work, and improve latency variation (compared to Layer 2 and Layer 3 switch) in Access network application.

This Recommendation provides a packet-based transport model to multiple services and multiple topologies for continuation and extension of ITU-T Recommendation X.85/Y.1321 and X.86/Y.1323. Continued compatibility with all existing requirements and standards from ITU-T and other organizations is required.

Draft new Recommendation X.MSR-RPR

Multiple Services Ring Based on RPR

1 Scope

This Recommendation X.msr-rpr specifies Multiple Services Ring based on RPR in the way of pre-plan based on RPR. MSR uses local addresses and the broadcast address in support of tributary services and uses IEEE 802.17 frame format that allows X.msr-rpr to define payload within an Ethertype. Fairness A0 provisioned traffic (and subsequently no fairness) is all that is required to support X.msr-rpr. X.msr-rpr is only used in configurations where tributary service is managed such that over provisioning does not occur. Architecturally, single-ring, the link, broadcast and pseudo-mesh topologies are supported also. The service tributary interfaces of RPR node are defined to support Ethernet, FR and various TDM Circuit Emulations. X.msr-rpr supports tributary based 1+1, 1:1 and 1:N protection within 50 ms, and tributary based multicast, tributary bandwidth limitation with symmetry and asymmetry, tributary Merging, tributary Line-Speed Filtering of packet, tributary Mirroring, tributary performance monitoring in the 15-minute and 24-hour and is also defined to support forwarding of X.msr-rpr data link frame (also being a tributary) similar to functionality found in a more complex routing data system. X.msr-rpr provides a packet-based transport model to multiple services and multiple topologies.

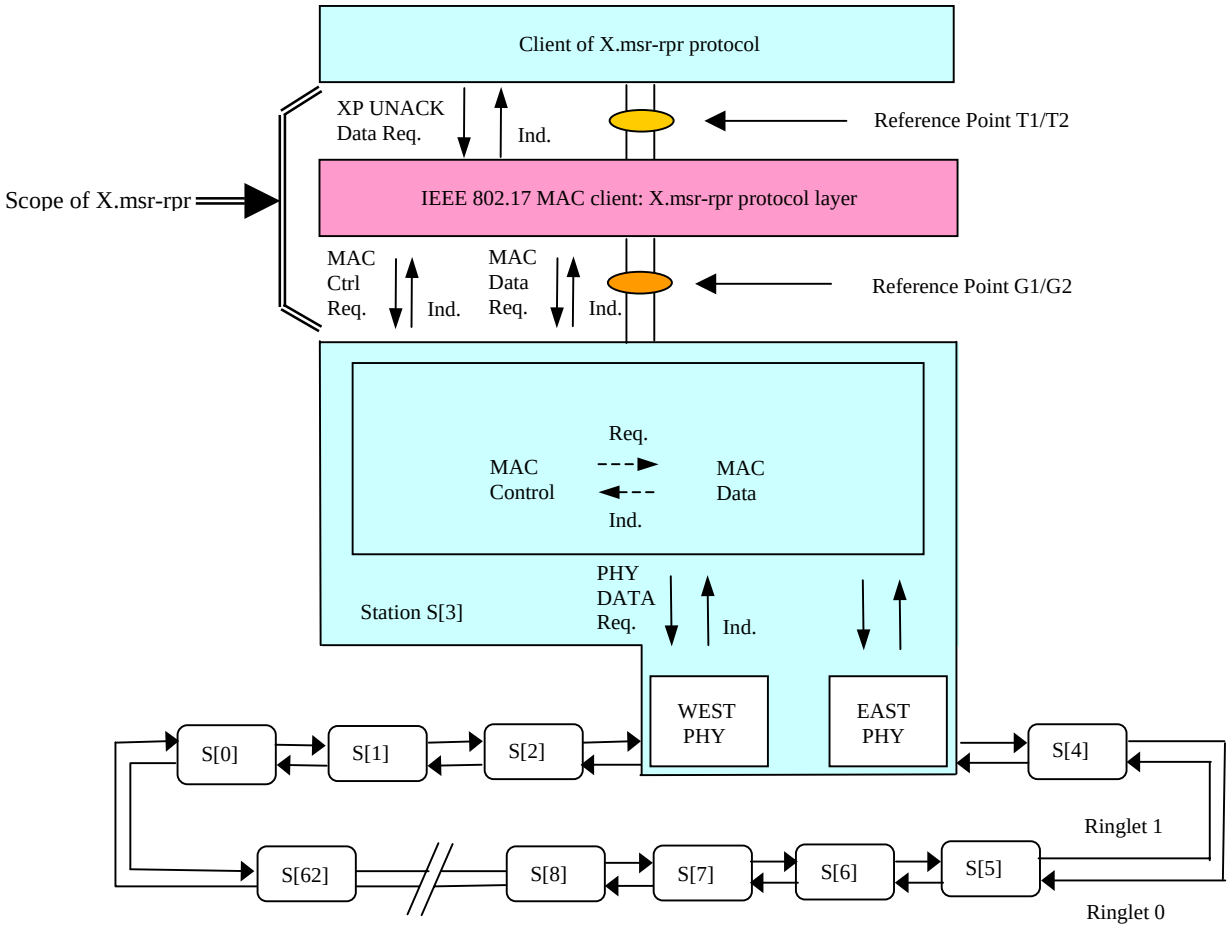


FIGURE 1/X.MSR-RPR

The Scope of X.msr-rpr based on RPR as a MAC client

This Recommendation X.msr-rpr is based on RPR as a MAC client and is used in configurations and pre-plan where topology and protection is provisioned. IEEE 802.17 will only use the provisioned topologies and protections. The data frame, control frame and network management frame in the Recommendation is all required to map to the payload of RPR data frame. Some control frames RPR defined are also used in X.msr-rpr, just like topology discovery. All of these frames specified in the Recommendation has no relations to and is independent on the control frames (just like frames of topology discovery, fairness, protection) of RPR MAC layer. No change is made for all Ethernet-based protocols (including IEEE 802.3 Ethernet), all PDH standards, Frame Relay standards, G.702/ISDN standards and ETSI DVB specifications. X.msr-rpr is located at a dual-directional symmetric counter-rotating rings based on RPR.

NOTE 1 - It is intended that X.msr-rpr can be extended, in future amendments, to support additional new types of data service.

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 currently valid ITU-T Recommendations is regularly published.

2.1 ITU-T Recommendations

[1] ITU-T Recommendation X.85/Y.1321, *IP over SDH using LAPS.*

[2] ITU-T Recommendation X.86/Y.1323, *Ethernet over LAPS.*

[3] ITU-T Recommendation X.211 (1995) | ISO/IEC 10022 (1996), *Information technology - Open Systems Interconnection - Physical service definition*.

[4] ITU-T Recommendation X.212 (1995) | ISO/IEC 8886 (1996), *Information technology - Open Systems Interconnection - Data link service definition.*

[5] ITU-T Recommendation X.200 (1994) | ISO/IEC 7498-1 (1994), Information technology - *Open System Interconnection - Basic reference model: The basic model.*

[6] ITU-T Recommendation I.363.1 (1996), B-ISDN ATM Adaptation Layer specification: Type 1 AAL

[7] ITU-T Recommendation G.805 (2000), Generic functional architecture of transport networks

2.2 IEEE Specifications

[8] IEEE 802.3 *CSMA/CD Access Method and Physical Layer Specifications, 2002 Edition*.

[9] IEEE Draft P802.17/D1.1, Resilient Packet Ring Access Method & Physical Layer Specifications - *Media Access Control (MAC) Parameters, Physical Layer Interface, and Management Parameters, October, 2002 Edition*.

3 Definitions

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

3.1 Aggregate Pipe: a physical connection of two adjacent nodes. Aggregate pipe is a channel of RPR based on a span of RPR.

3.2 Control Signalling Frame: a frame used to tributary connection establishment, topology discovery, Layer 2 protection switching of manual switch or forced switch etc in a node.

3.3 CT_Request Frame: a frame used to send a configuration table request from Node A to Node B along a RPR ring.

3.4 CT_Response Frame: a frame used to send a configuration table response from Node B to Node A along a RPR ring.

3.5 Configuration Table (CT): a mapping table reflecting the actual value of TT and TN in a node and TCCR between nodes on the RPR ring during engineering operation or project installation phase.

3.6 Configuration Table Inquiry (CTI): a function to get CT from a node. CT_Request frame with a CTI parameter reflecting changing part of TCCR of a node on RPR ring is sent to other

nodes (called one of them as Node B) by unicast/multicast/broadcast mode from a node (called Node A, e.g. Central station in the most case) by network management interface during normal engineering operation or project installation phase. All nodes received CT_Request frame with a CTI parameter will give a point-to-point response by CT_Response frame with a CTI parameter reflecting actual configuration table of the local node on RPR ring to Node A.

3.7 Configuration Updating Table (CUT): a mapping table reflecting the available value modification of TT and TN in a node and TCCR between nodes on the RPR ring during engineering operation or project installation phase. The incorrect ICT will lead to fault of Tributary on RPR ring. CT_Request frame with an CUT parameter reflecting changed part of TCCR of all node on RPR ring is sent to other nodes by broadcast mode from a node (e.g. Central station in the most case) by network management interface during normal engineering operation or project installation phase. All nodes received CT_Request frame will build corresponding mapping relations of TCCR in the local node and give a point-to-point response by CT_Response frame to that node sending CT_Request frame. After getting CT-Response frame, that node sourcing CT_Request frame issues a CT_Confirm frame to that remote node sending CT_Response frame.

3.8 Frame Sequence Number (FSN): A modulo used to performance monitoring based on Tributary service. This 8-bit field is used to identify Frame Sequence Number (FSN) of Ethernet or TCE data frames in numbered modulo N_fsn=64 (default value, N_fsn is programmable and can be configured to 256 if application needs) from 0 to 63. The field is used to performance monitoring function for packet lost or duplicated of TCE based tributary. The FSN field will be set to zero if the signalling control frames or network management frames are used.

3.9 Initial Configuration Table (ICT): a mapping table reflecting the initial and available value of TT and TN in a node and TCCR between nodes on the RPR ring during engineering installation or project installation phase. The ICT must be pre-installed before RPR engineering operation or project installation phase. The incorrect ICT will lead to fault of Tributary services on RPR ring. CT_Request frame with an ICT parameter reflecting initial TCCR of all nodes on RPR ring is sent to other nodes by broadcast mode from a node (e.g. Central station in the most case) by network management interface during initial engineering operation or project installation phase. All nodes received CT_Request frame will build corresponding mapping relations of TCCR in the local node and give a point-to-point response by CT_Response frame to that node sending CT_Request frame. After getting CT-Response frame, that node sourcing CT_Request frame issues a CT_Confirm frame to that remote node sending CT_Response frame.

3.10 Multiple Services Ring (MSR): a bi-directional symmetric counter-rotating fibre rings based on RPR and located at RPR MAC client (refer to Figure 1), each node could add and drop one or more independent tributaries.

3.11 Multiple Services Ring over RPR: a special case of RPR, which uses only class A0 traffic (and subsequently no fairness), provisioned topology and protection, IEEE 802.17 frame format, tributary service based operation.

3.12 Resilient Packet Ring (RPR): a high-speed network technology optimised for frame transmission over a redundant ring topology.

3.13 RPR Rx Framer: a RPR MAC framer in Rx side, it terminates a frame of IEEE 802.17 through a station via the ringlet.

3.14 RPR Tx Framer: a RPR MAC framer in Tx side, it passes a frame of IEEE 802.17 through a station via the ringlet.

3.15 XP Data Node: a RPR Node that has an eastward Rx, an eastward Tx, a westward Rx and a westward Tx Aggregate Pipe connections along RPR ring, and one or more adding and dropping independent tributaries. It also has functions of receiving, transmitting and forwarding of network

management frame, control signalling and data frame in a Node. The different connection configuration is applied for the different topologies.

3.16 X.msr-rpr Protocol (XP): a data link protocol between RPR MAC framer and Tributary framer, used to communication between different nodes over a RPR. The XP does operate by sending/receiving both data frame and the associated network management/signalling frames to/from a RPR MAC of a node.

3.17 XP Rx Processor: a set of functions used to XP processing in Rx direction. It includes Rx entity after RPR MAC, discrimination of multicast/broadcast, TT/TN value and other associated XP protocol processing.

3.18 XP Tx Processor: a set of functions used to XP processing in Tx direction. It includes Tx entity outgoing to RPR MAC, Tx schedule unit, functions of determination of NA, TTL, TT, TN, FCS, multicast/broadcast. The other associated XP protocol processing is also included.

3.19 N_ct: a count of retransmission used to Configuration Table Operation. All nodes on a ring will wait to be assigned ICT during engineering installation phase. After issuing CT_Request frame, Node A will automatically send CT_Request frame again after retransmit Timer_ct (it is programmable) if Node A does not receive corresponding CT_Response frame. It is believed that Node B is not reachable after N times of retransmission (N_ct is programmable also). N_ct is also used by CUT operation.

3.20 Network Management Frame: a frame used to performance and fault monitoring, node configuration management etc along a RPR ring or other different topologies.

3.21 Node Address (NA): an address that identifies a particular station on a network. NA is a local address (Global address is TBD) and has local meaning only along the RPR ring or other different topologies. IEEE assigns value of 24 bits, manufacturer assigns remaining 22 – local indicates a locally administered address. It is the responsibility of the administrator to insure uniqueness.

3.22 Reference Point G1: a reference point between RPR MAC Rx Framer and Tributary Multicast/Broadcast Unit. It stands for processing sink of RPR MAC framer in RPR MAC client side.

3.23 Reference Point G2: a reference point between RPR MAC Tx Framer and TX Schedule. It stands for processing source of RPR MAC framer in RPR MAC client side.

3.24 Reference Point T1: a reference point between Tributary Rx Framer and XP processor. It stands for processing sink of XP before Tributary Rx framer of TCE or Ethernet etc.

3.25 Reference Point T2: a reference point between Tributary Tx Framer and XP processor. It stands for processing source of XP after Tributary Tx framer of TCE or Ethernet etc.

3.26 Source Tributary (ST): a Tributary used as multicast/broadcast source in a membership group within a node.

3.27 Timer_ct: a Timer of retransmission used to Configuration Table Operation. All nodes on a ring will wait to be assigned ICT during engineering installation or project installation phase. After issuing CT_Request frame, Node A will automatically send CT_Request frame again after retransmission Timer_ct (it is programmable) if Node A does not receive corresponding CT_Response frame. It is believed that Node B is not reachable after N_ct times of retransmission (N_ct is programmable also). N_ct is also used by CUT operation.

3.28 Transit: a passing of a frame through a station via the ringlet.

3.29 **Tributary**: an independent adding/dropping tributary (or service) channel to/from a data nodes, just like a series “Private Line or Private Circuit for Renting from Carrier”. Tributary can be multi-service with a constant bandwidth of symmetry and asymmetry. The different tributary can be assigned to different priority.

3.30 **Tributary Adaptation Function Unit**: an adaptation function from/to various independent tributary type signals to/from reference point T1/T2. It has Tributary Adaptation Source Function and Tributary Adaptation Sink Function. A Sink corresponds to reference point T1, a source to reference point T2. This adaptation function can include the signal and rate transform, synchronous function between two sides of peer.

3.31 **Tributary Cross-connection Relationship (TCCR)**: a table reflecting Tributary cross-connection relationship of all nodes on a ring or other topologies. It is global table of RPR or other topologies, that is, source and sink connection relationship of all available tributaries.

3.32 **Tributary Membership Copy**: a duplicate function implementation from Source Tributary (ST) to every Tributary in the corresponding membership group within a node.

3.33 **Tributary Multicast/Broadcast**: a discriminator of distinguishing unicast or Multicast/Broadcast packets while a packet is coming up from a RPR Rx Framer via the ringlet, so as to provide TBM function. The TBM Function Unit built in a Node is defined to support one or more independent hierarch of multicast possibly involved the same or different TT at the same time. TBM Function Unit implements a duplication function within a node (station) from a Tributary getting a payload of a frame from the related topologies to other multiple Tributary with the same TT value and with being set to have a relation of membership group. A group of TN with the same TT value within a Node can be set to become a membership group of multicast/broadcast. It is required that a designated Tributary in the membership group should receive data frames at the reference point G1 from the related topologies. This Recommendation defines this designated Tributary as a Source Tributary (ST). Once getting data frames, the ST duplicates those frames to every Tributary in the corresponding membership group within a node. The ST should be set and designated to a given value of TT and TN by network management entity during the project installation phase or on-line operation phase. The one or more STs can be designated or changed dynamically within a node according to the customer requirements.

3.34 **Tributary Rx Framer**: an abstract of physical framer of Tributary at Rx side, it stands for a framer of TCE or Ethernet framer.

3.35 **Tributary Tx Framer**: an abstract of physical framer of Tributary at Tx side, it stands for a framer of TCE or Ethernet framer.

3.36 **Tributary Number (TN)**: a number of same types of Tributary Port on a node. This number is 7 if the 7th ISDN is provided in a node.

3.37 **Tributary Type (TT)**: a type of an independent adding/dropping tributary channel to/from the RPR data nodes. This type can be TCE service.

3.38 **Tx Schedule**: a control function for transmitted frame in a node according to the priority level of (a) forwarded frames from upstream node, (b) multicast/broadcast frames and (c) transmitted frame from the local station. If there are several frames to be sent in a node at the same time, the schedule unit will check priority of frame and decide which frame will go first to the downstream along the ringlet.

3.39 **XP Rx Processor**: a set of logical functions (of RPR MAC client) used to XP processing in Rx direction. It includes Rx entity after RPR MAC, discrimination of multicast/broadcast based on Tributary, TT/CS/NM value, TN value, FSN value and other associated XP protocol processing.

3.40 XP Tx Processor: a set of logical functions (of RPR MAC client) used to XP processing in Tx direction. It includes Tx entity outgoing to RPR MAC, Tx schedule unit, functions of determination of NA, TTL, TT, TN and FSN, multicast/broadcast from the view of RPR MAC layer. The other associated XP protocol processing is also included.

4 Abbreviations

4.1 Abbreviations specified in IEEE 802.17

This Recommendation makes use of the following abbreviations specified in IEEE 802.17:

(1) DA Destination Address
(2) FCS Frame Check Sequence
(3) FE Fairness Eligible
(4) HEC Header Error Check
(5) IEEE Institute of Electrical and Electronics Engineers
(6) LAN Local Area Network
(7) MAC Medium Access Control
(8) MAN Metropolitan Area Network
(9) MIB Management Information Base
(10) MTU Maximum Transfer Unit
(11) PDU Protocol Data Unit
(12) PHY Physical Layer
(13) POS Packet Over SONET
(14) PT Protocol Type
(15) RI Ringlet Identifier
(16) SA Source Address
(17) SDU Service Data Unit
(18) SNMP Simple Network Management Protocol
(19) SPI System Packet Interface
(20) TTL Time-To-Live
(21) WAN Wide Area Network
(22) WTR Wait To Restore

4.2 Abbreviations specified in ITU-T I.321

This Recommendation makes use of the following abbreviations specified in ITU-T Recommendation:

a) ATM Asynchronous Transfer Mode

4.3 Abbreviations specified in ETSI

This Recommendation makes use of the following abbreviations specified in ETSI Recommendation EN 300 429:

a) DVB Digital Video Broadcast

4.4 Abbreviations specified in this Recommendation

1)	AP	Access Point
2)	CP	Connection Point
3)	CS	Control Signalling
4)	CT	Configuration Table
5)	CTI	Configuration Table Inquiry
6)	CUT	Configuration Updating Table
7)	ETBP	Ethernet Tributary Based Protection
8)	ICT	Initial Configuration Table
9)	LMXP	Layer Management of X.msr-rpr Protocol
10)	LSFFU	Line-Speed Filtering Function Unit
11)	MAC	Media Access Control
12)	MDL	MAC Data Link Layer
13)	MDLLC	MDL Link Connection
14)	MDLLF	MDL Link Flow
15)	MDLNC	MDL Network Connection
16)	MDLNF	MDL Network Flow
17)	MDLSC	MDL Subnetwork Connection
18)	MDLSF	MDL Subnetwork Flow
19)	MDCT	MDL Trail Multipoint Connection Point
20)	MPCP	Multipoint Connection Point
21)	MSR	Multiple Services Ring
22)	MSR-RPR	Multiple Services Ring over RPR
23)	NA	Node Address of Resilient Packet Ring
24)	NM	Network Management
25)	PFI	Payload FCS Indication
26)	PT	Payload Type
27)	OAM	Operation, Administration and Maintenance
28)	RPR	Resilient Packet Ring
29)	Rx	Receive data
30)	ST	Source T8ibutary
31)	TBM	Tributary Based Multicast
32)	TBP	Tributary Based Protection
33)	TCCR	Tributary Cross-Connection Relationship
34)	TCE	TDM Circuit Emulation
35)	TCP	Termination Connection Point
36)	TFP	Termination Flow Point
37)	TDM	Time Division Multiplex
38)	TMG	Tributary Merging Group

39) TTBP TCE Tributary Based Protection
40) TN Tributary Number
41) TT Tributary Type
42) Tx Transmission data
43) XP X.msr-rpr Protocol
44) XPLC XP Link Connection
45) XPNC XP Network Connection
46) XP-PDU XP – Protocol Data Unit
47) XP-SAP XP – Service Access Point
48) XPSC XP Subnetwork Connection
49) XP-SDU XP – Service Data Unit
50) XPT XP Trail

5 Network Framework of Multiple Services Ring Based on RPR

5.1 Elements of Ring over RPR MAC

MSR based on RPR employs a dual-ring structure consisting of a pair of unidirectional count-rotating ringlets, more than one nodes of each with RPR MAC, RPR MAC Client and at least one Tributary. “MSR-RPR” uses local node addresses and the multicast address in support of tributary services and uses RPR frame format that allows X.msr-rpr to define payload within an Ethertype. Fairness A0 provisioned traffic (and subsequently no fairness) is all that is required to support X.msr-rpr. X.msr-rpr is used in configurations where tributary service is managed such that over provisioning does not occur. Architecturally, single-ring, the link, broadcast and pseudo-mesh topologies are supported also. Each node could add and drop one or more independent tributary (e.g. DVB port) and control signalling frames and network management frames. X.msr-rpr supports multicast and broadcast of these Tributary service and forwarding data packet.

5.2 Frame Types on a Ring and Multiple Service in Tributary

Each node has ability of adding and dropping one or more independent Tributary services defined in Table 1.

TABLE 1/X.msr-rpr – Types of multi-service in Tributary

Tributary types	**Capabilities**		
TCEs	Full duplex point-to-point	Multicast	Broadcast
Ethernet	Full duplex point-to-point	Multicast	Broadcast

Note 1: The bandwidth of aggregate pipe depends on deployment service requirements, the aggregate Tributary bandwidth be half the aggregate pipe bandwidth to provide protection bandwidth availability where needed. Where services requirements allow the aggregate of Tributary bandwidth can exceed the aggregate bandwidth.

Note 2: Multicast is half duplex point-to-multipoint of node based, Broadcast is half duplex point of node based to all other points on a ring.

Transmitted and received frames on a ring have (1) frames of multi-service station by station, (2) control signalling frame and (3) network management frame specified in Table 2, to show full capabilities of point-to-point, multicast and broadcast along a ring.

TABLE 2/X.msr-rpr – Frame types

Frame types	**Capabilities**		
Frames of multi-service station by station	Point-to-point	Multicast	Broadcast
Control Signalling Frame	Point-to-point	Multicast	Broadcast
Network Management Frame	Point-to-point	Multicast	Broadcast

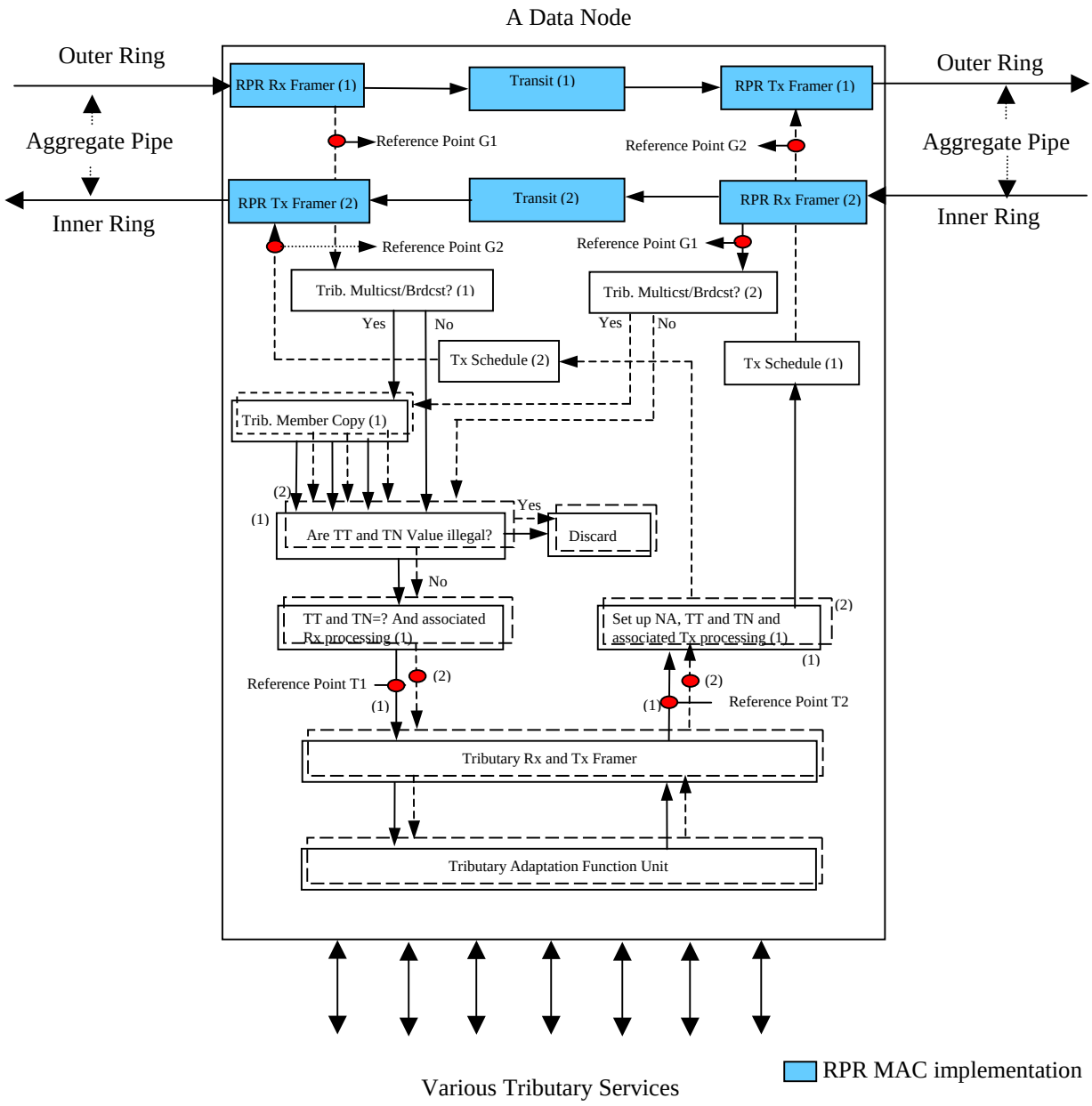


FIGURE 2/X.MSR-RPR

Tx and Rx Diagram of a Data Node

5.3 Components of a Data Node in MAC Client

A RPR data node is the system equipment that has an eastward Rx, eastward Tx, westward Rx and westward Tx Aggregate Pipe connections, and one or more adding and dropping independent Tributaries over RPR MAC. X.msr-rpr node also has functions of receiving, transmitting and forwarding of network management frame, control signalling and data frame in a Node. The corresponding change should be made as the different connection configuration is applied for the different topologies. The basic components of a node are as follows.

5.3.1 Aggregate Pipe: a physical connection of two adjacent RPR nodes.

5.3.2 Tributary: an independent adding/dropping tributary channel to/from the RPR data nodes, just like a series “Private Line or Private Circuit for Renting from Carrier”. Tributary can be a G.702 ports. The different tributary can be assigned to different priority.

5.3.3 Inner Ring: an inner single ring of RPR.

5.3.4 Outer Ring: an outer single ring of RPR.

5.3.5 MAC Client: The layer entity of XP that invokes the MAC service interface.

5.3.6 Transit: a passing of a frame through a station via the ringlet.

5.3.7 Schedule Unit: a control function for transmitted frame in a node according to the priority level of forwarded frames from upstream station, multicast/broadcast frames and transmitted frame from the local station. If there are several frames to be sent in a node at the same time, the schedule unit will decide which frame will go first to the downstream along the ring.

5.3.8 RPR Rx Framer: a RPR MAC framer in Rx side, it terminates a frame of IEEE 802.17 through a station via the ringlet.

5.3.9 RPR Tx Framer: a RPR MAC framer in Tx side, it terminates a frame of IEEE 802.17 through a station via the ringlet.

5.3.10 Tributary Rx Framer: an abstract of physical framer of Tributary at Rx side, it stands for a framer of TCE, Frame Relay or Ethernet framer.

5.3.11 Tributary Tx Framer: an abstract of physical framer of Tributary at Tx side, it stands for a framer of TCE, Frame Relay or Ethernet framer.

3.3.12 XP Rx Processor: a set of logical functions (of RPR MAC client) used to XP processing in Rx direction. It includes Rx entity after RPR MAC, discrimination of multicast/broadcast based on tributary, TT/CS/NM value, TN value, FSN value and other associated XP protocol processing.

3.3.13 XP Tx Processor: a set of logical functions (of RPR MAC client) used to XP processing in Tx direction. It includes Tx entity outgoing to RPR MAC, Tx schedule unit, functions of determination of NA, TTL, TT/CS/NM, TN and FSN, multicast/broadcast from the view of RPR MAC layer. The other associated XP protocol processing is also included.

3.3.14 Addressing (48 bit OUI): The IEEE 48 bit OUI is generally used as MAC addresses. It contains: Individual/Group bit – identifies uni-cast and multi/broadcast frames, Universal/Local bit - indicates that the address was assigned by IEEE and the manufacturer and should be unique, IEEE assigns value of 24 bits, manufacturer assigns remaining 22 – local indicates a locally administered address. It is the responsibility of the administrator to insure uniqueness. MSR-RPR will use local addresses (Universal address is TBD) and the broadcast address in support of tributary services.

5.4 Reference Point in MAC Client of a Data Node

The four different Reference Points are defined in a node.

5.4.1 Reference Point G1: a reference point between RPR MAC Rx Framer and Tributary Multicast/Broadcast Unit. It stands for processing sink of RPR MAC framer in RPR MAC client side.

5.4.2 Reference Point G2: a reference point between RPR MAC Tx Framer and TX Schedule. It stands for processing source of RPR MAC framer in RPR MAC client side.

5.4.3 Reference Point T1: a reference point between Tributary Rx Framer and XP processor. It stands for processing sink of XP before Tributary Rx framer of TCE or Ethernet etc.

5.4.4 Reference Point T2: a reference point between Tributary Tx Framer and XP processor. It stands for processing source of XP after Tributary Tx framer of TCE or Ethernet etc.

5.5 Transport functional architecture of MSR networks

5.5.1 General

The functional architecture of MSR transport networks is described using the generic rules defined in Recommendation G.805. The specific aspects regarding the characteristic information, client/server associations, the topology, the connection supervision and multipoint capabilities of MSR transport networks are provided in this Recommendation.

In an MSR network two levels of multiplexing are used. A node-level multiplexing is used to aggregate multiple packet flows in a single network element. A unique tag (*tributary number*) is used to distinguish between client flows/connections. A ring level MAC layer is used to multiplex aggregates from multiple nodes on a shared ring.

MSR is defined in a modular way; hence a variety of MAC protocols can serve the XP layer. RPR (802.17) could be one realization of the MAC layer. In that case the Destination MAC address field is used to perform the multiplexing function.

5.5.2 MSR Layer Networks

Two layer networks are defined in the MSR transport network architecture:

- XP Layer Network.
- MAC/Data-Link Layer (MDL) Network. The MDL layer could be either connection-oriented or connectionless.

The XP layer network is a path layer network. The MDL layer network is a section layer network.

An MSR packet consists of payload, XP header and MDL header.

5.5.2.1 XP layer network

The XP layer network provides the transport of adapted information through an XP trail between XP access points. The adapted information is a non-continuous flow client frames (the minimum and maximum frame size is protocol dependent). The XP layer network characteristic information is a non-continuous flow of adapted information extended with XP header (see 5.5.2.1.2), and CS or NM packets. The XP layer network contains the following transport processing functions and transport entities:

- XP trail.
- XP trail termination source (XPT source): generates CS or NM packets.
- XP trail termination sink (XPT sink): terminates CS or NM packets.
- XP network connection (XPNC).
- XP link connection (XPLC).
- XP subnetwork connection (XPSC).

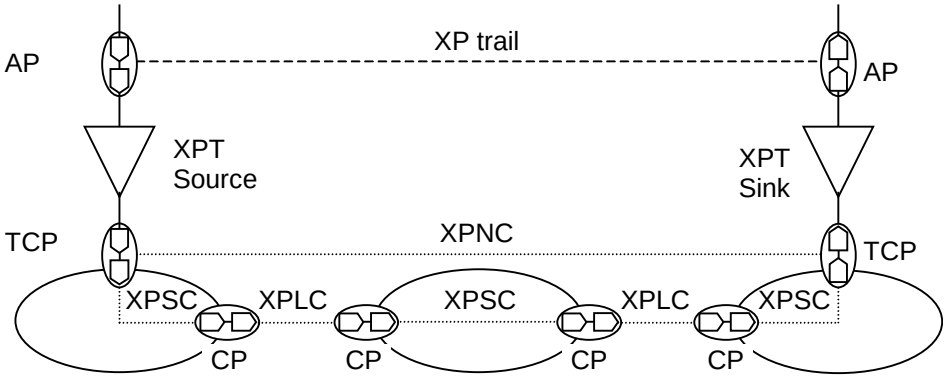


FIGURE 3/X.msr-rpr

XP layer network example

5.5.2.1.1 XP trail termination

The XP trail termination source accepts adapted information at its input, add the *tributary traffic*, inserts CS or NM packets and presents the characteristic information of the XP layer network at its output. The XP trail termination source can be used without binding its input to an adaptation function, e.g. for testing purposes.

The XP trail termination sink accepts the characteristic information of the XP layer network at its input, terminates the *tributary traffic*, extracts the CS or NM packets and presents the adapted information at its output.

The XP trail termination (XPT) consists of a co-located XP trail termination source and sink pair.

5.5.2.1.2 XP header format

Please refer to section 7.

5.5.2.2 MDL layer network

The MDL layer network provides the transport of adapted information through an MDL trail between access points. The adapted information is a non-continuous flow of XP layer network characteristic information plus the *tributary number*. The MDL layer network characteristic information is a non-continuous flow of adapted information and OAM information. The MDL layer network contains the following transport processing functions and transport entities (see Figure 3):

- MDL trail.
- MDL trail termination source (MDLT source): generates CS or NM packets.
- MDL trail termination sink (MDLT sink): terminates CS or NM packets.
- MDL network connection / flow (MDLNC / MDLNF).
- MDL link connection / flow (MDLLC / MDLLF).
- MDL subnetwork connection / flow (MDLSC / MDLSF).

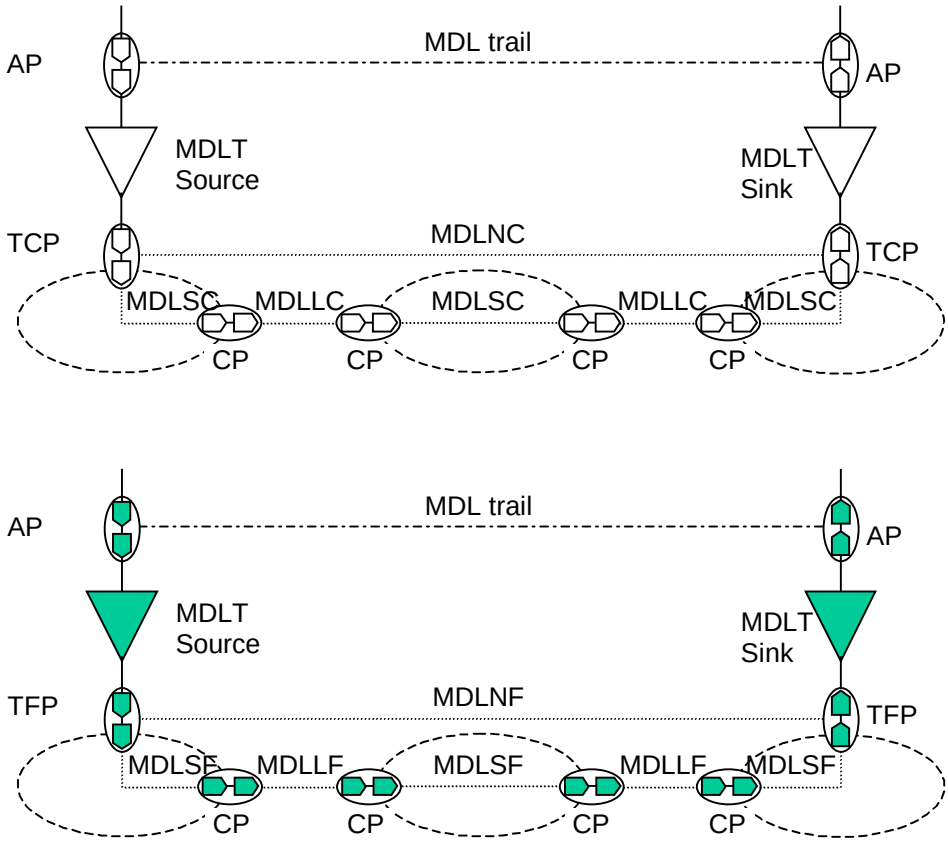


FIGURE 4/X.msr-rpr

MDL layer network example
Connection-oriented (upper) / connectionless (bottom)

5.5.2.2.1 MDL trail termination

The MDL trail termination source accepts adapted information at its input, inserts CS or NM packets and presents the characteristic information of the MDL layer network at its output. The MDL trail termination source can be used without binding its input to an adaptation function, e.g. for testing purposes.

The MDL trail termination sink accepts the characteristic information of the MDL layer network at its input, removes the CS or NM packets and presents the adapted information at its output.

The MDL trail termination (MDLT) consists of a co-located MDL trail termination source and sink pair.

5.5.3 Client/server associations

A key feature of the MSR transport assembly provides the information transfer capability required to support various types of services of different bit rates by various server layers.

In terms of client/server associations, the MSR transport assembly offers a XP trail and uses a trail in a server layer network. This is illustrated in Figure 5.

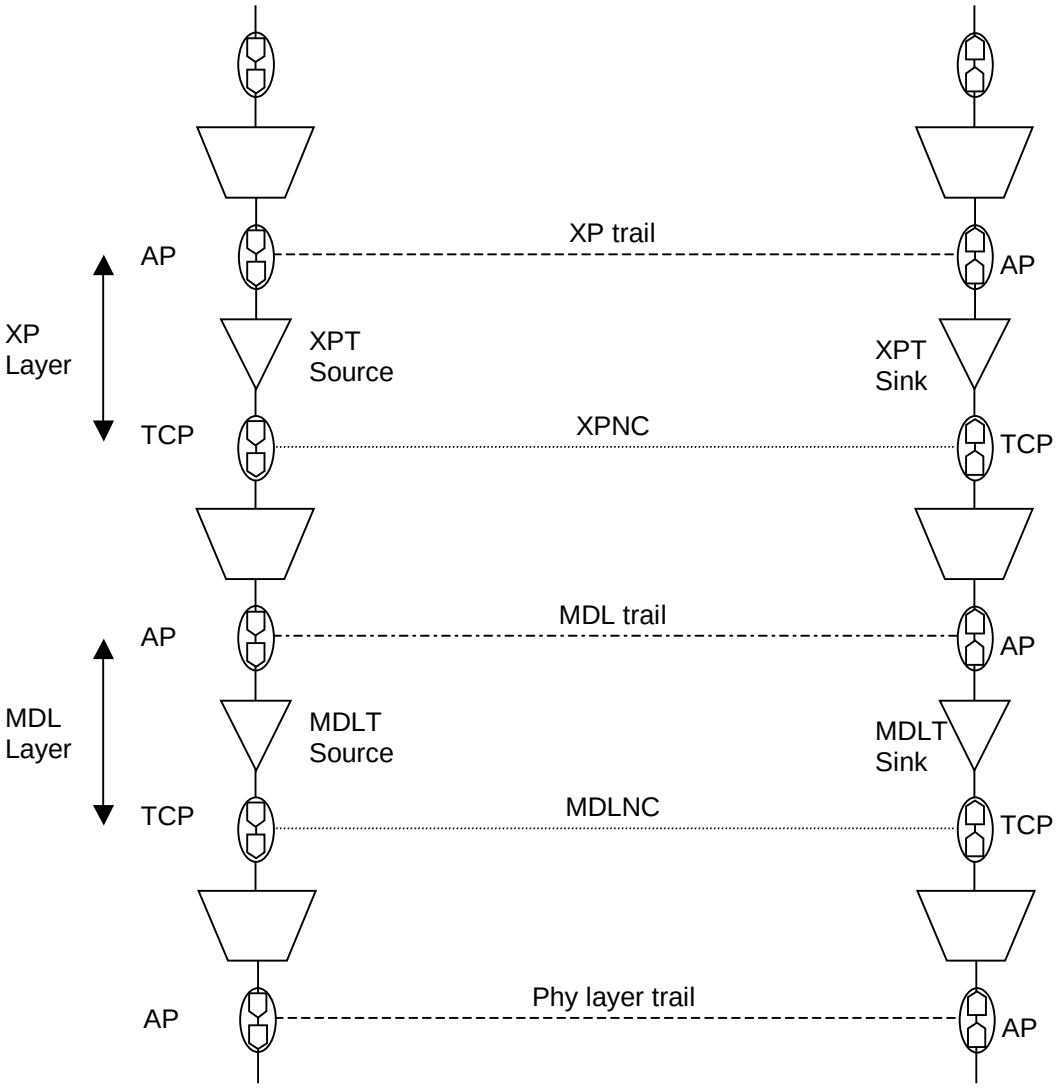


FIGURE 5/X.msr-rpr
Client/Server association in an MSR transport ring

5.5.3.1 XP/Client adaptation

The XP/Client adaptation is considered to consist of two types of processes: client-specific processes and server-specific processes.

Client-specific processes includes

- Detection of client defects. Two generic types of defects are
  - Loss of Client Signal
  - Loss of Client Synchronization

Service-specific XP/Client adaptation source performs the following functions between its input and its output:

- Adding XP header.
- TBD

Service-specific XP/Client adaptation sink performs the following functions between its input and its output:

- Remove XP header.
- TBD

The bi-directional XP/Client adaptation function is performed by a co-located pair of source and sink XP/Client adaptation functions.

5.5.3.2 MDL/XP adaptation

The MDL/XP adaptation source performs the following functions between its input and its output:

- Packet multiplexing,
- Adding MDL header.

The MDL/XP adaptation sink performs the following functions between its input and its output:

- Packet demultiplexing according to *tributary number* value,
- MDL header extraction.

The MDL/XP adaptation consists of a co-located MDL/XP adaptation source and sink pair.

5.5.3.3 MDL/Physical layer adaptation

Beyond the scope of this Recomendataion.

5.5.4 Topology

MSR supports unicast, half-duplex multicast and broadcast connections.

In half-duplex multicast service, traffic from single source port is multicasted to several sink ports.

5.5.4.1 Multipoint connection point (MPCP)

The MPCP is a reference point that binds CP o a set of CPs.

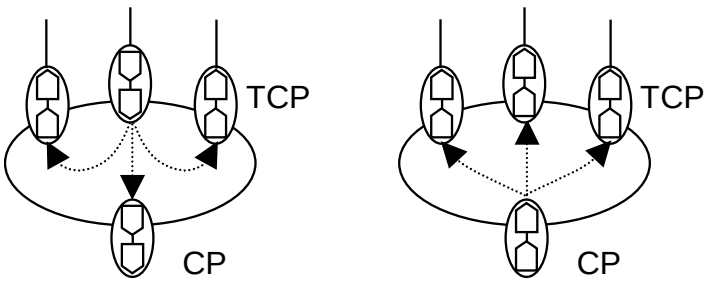


FIGURE 6/X.msr-rpr
XP layer multipoint connection points examples

TBD

5.5.4.2 Point-to-multipoint connections

A point-to-multipoint MDL Network Connection/Flow multicasts customer traffic from single node to a group of nodes. A point-to-multipoint XP Network Connection multicasts customer traffic within a single node, from an MDL/XP adaptation sink to multiple XP/Server adaptation sinks.

TBD

5.5.5 Connection supervision

TBD

5.5.6 Protection

TBD

5.6 Operation of Network Management Frames in MAC client

5.6.1 Initial Configuration Table (ICT) Operation

ICT is a mapping table reflecting the initial and available value of TT and TN in a node and TCCR between nodes along a ringlet during engineering installation. The ICT must be pre-installed before RPR engineering operation. The incorrect ICT will lead to fault of Tributary services on a ring. CT_Request frame with an ICT parameter reflecting initial TCCR of all nodes on a ring is sent to other nodes by broadcast/multicast mode from a node (called Node A, e.g. Central station in the most case) by network management interface during initial engineering operation period. All nodes (called Node B) received CT_Request frame will build corresponding mapping relations of TCCR in the local node and give a point-to-point response by CT_Response frame to Node A.

All nodes on a ring will wait to be assigned ICT during engineering installation period. After issuing CT_Request frame, Node A will automatically send CT_Request frame again after retransmit timer (it is programmable, named for Timer_ct) if Node A does not receive corresponding CT_Response frame. It is believed that Node B is not reachable after N_ct times of retransmission (N_ct is programmable also).

If Node A has received a message of CT_Response frame with a Null parameter from Node B either before CT retransmit expired or before N_ct times of retransmission, it is believed that ICT operation for Node B is successful.

5.6.2 Configuration Updating Table (CUT) Operation

CUT is a mapping table reflecting the available value modification of TT and TN in a node and TCCR between nodes on the RPR ring during an on-line operation. The incorrect CUT will lead to fault of Tributary on RPR ring. CT_Request frame with a CUT parameter reflecting changed part of TCCR of all nodes on RPR ring is sent to other nodes (called one of them Node B) by broadcast/multicast mode from a node (called Node A, e.g. Central station in the most case) by network management interface during normal engineering operation period. All nodes received CT_Request frame will build corresponding mapping relations of TCCR in the local node and give a point-to-point response by CT_Response frame to Node A.

After issuing CT_Request frame, Node A will automatically send CT_Request frame again after retransmit timer (it is programmable, named for Timer_ct) if Node A does not receive corresponding CT_Response frame. It is believed that Node B is not reachable after N_ct times of retransmission (N_ct is programmable also).

If Node A has received a message of CT_Response frame with a Null parameter from Node B either before retransmitted CT expired or before N_ct times of retransmission, it is believed that CUT operation for Node B is successful.

5.6.3 Configuration Table Inquiry (CTI) Operation

CT_Request frame with a Null parameter is sent to other nodes (called one of them Node B) by unicast/multicast/broadcast mode from a node (called Node A, e.g. Central station in the most case) by network management interface during normal engineering operation period. All nodes received CT_Request frame with a Null parameter will send a point-to-point response by CT_Response frame with a CTI parameter reflecting actual configuration table of the local node on a ring to Node A.

5.7 Fault Management in MAC Client

If a fault occurs, Fault_Report frame with a fault parameter defined in 7.10.1 is sent to designated node (connected to network management interface). The network management entity can pass Fault_Request Frame with a fault parameter defined in 7.10.1 from designated node to a targeted node. The targeted node issues Fault_Response Frame with a fault parameter defined in 7.10.1 to designated node as a responding.

5.8 Performance Management in MAC Client

Once 15 minutes or 24 hours expired, each node in a ring will issue Performance_Report frame with a performance parameter defined in 7.10.1 to designated node (connected to network management interface). The network management entity can pass Performance_Request Frame with a performance parameter defined in 7.10.1 from designated node to a targeted node if needed anytime. The targeted node responds by Performance_Response Frame with a performance parameter defined in 7.10.1 to designated node.

6 The Protocol Framework of MSR Based on RPR

6.1 The protocol framework of RPR based Aggregate Pipe

The protocol framework of XP is shown as Figure 7. This Recommendation treats XP as an upper layer protocol of 802.17 MAC of point-to-point full-duplex mode. The use of control signals is not required. The self-synchronous scrambling/descrambling function is not applied in XP layer during insertion/extraction into/from the MAC payload of RPR. Communication service facilities between XP and RPR MAC layer are accomplished by means of primitives (MA_DATA request and MA_DATA indication, MA_Control request and MA_Control indication shown in Figure 8) with parameters of Ring Control Field, Destination Address (It is local), Source Address (It is local), Protocol Type filed, topology status, TT/CS/NM, TN value, FSN and payload or parameters of XP layer, as shown in section 7. Specification of Primitives specifies the interaction between XP and MAC layer to invoke and provide a service, and presents the elements of primitives.

XP located at RPR MAC client is the data link protocol also, which provides point-to-point transferring over RPR MAC frame. The establishment and disconnection of tributary service are accomplished by the associated control signalling (just like Soft Permanent Virtual Circuit) or network management frames. Communications between data link and the associated upper protocols are accomplished by means of primitives according to the principle of ITU-T Recommendation X.212.

The service facility of XP provided to its upper protocols via SAP (Service Access Point) is the XP-UNACK- DATA request primitive with "User data" (data frame in Tributary and frame of CS/NM) and "Priority" parameter set in a node, and the XP -UNACK-DATA indication primitive with "User data" (data frame in Tributary and frame of CS/NM) and "Priority" parameter from received frame.

"User data" is the outgoing/incoming upper layer packet. The default maximum frame size of XP shall be aligned to the size that RPR does after taking into account the overhead of XP frame. Supporting the maximum frame size of Ipv6 jumbo payload needs to align with IEEE 802.17. The octet stuffing procedure will not be used in this case.

An invalid frame is a frame which:

a) Has fewer than eight octets (includes PT, PFI, 4-bit reserved field, TT/CS/NM, TN, 4-bit reserved field, FSN fields, HEC field) within the RPR MAC payload; or

b) Contains a TT or TN that is mismatched or not supported by the receiver.

Invalid frame shall be discarded without notification to the sender. But for the lost or duplicated frames of a tributary, the results of performance monitoring should be reported to layer management entity of RPR MAC client and be operated according to 7.10.1.

The connection management entity is used to monitor the XP link status of receiving the peer link frame. It is local matter only and has not any associated frame to be used between the two sides.

--After initialization (the defaults of T200 and N200 are set to 10 milliseconds and 3 respectively), the XP entity enters the normal way of transmitter and receiver.

--If the timer T200 expires before any frames (including MAC data and control frames) are received at the reference point G1, or status report from RPR MAC layer by MA_Control Indication or MA_Data Indication occurs with one or more opcodes, the XP entity shall restart timer T200 and decrement the retransmission counter N200.

--If timer T200 expires and retransmission counter N200 has been decremented to zero before any frame is received at the reference point G1, or status report from RPR MAC layer by MA_Control Indication or MA_Data Indication occurs with one or more opcodes, the XP entity shall (a) indicate this to the local connection management entity by means of the LMXP-ERROR indication primitive, (b) indicate a notification to the local ETBP/TTBP Function Unit within the node by means of the EVENT_Report primitive with the TT and TN parameters, and (c) restart timer T200 and recover the value of N200.

--The value of T200 and N200 shall be configurable. The minimum unit configured of T200 and N200 is 5 milliseconds and 1 respectively.

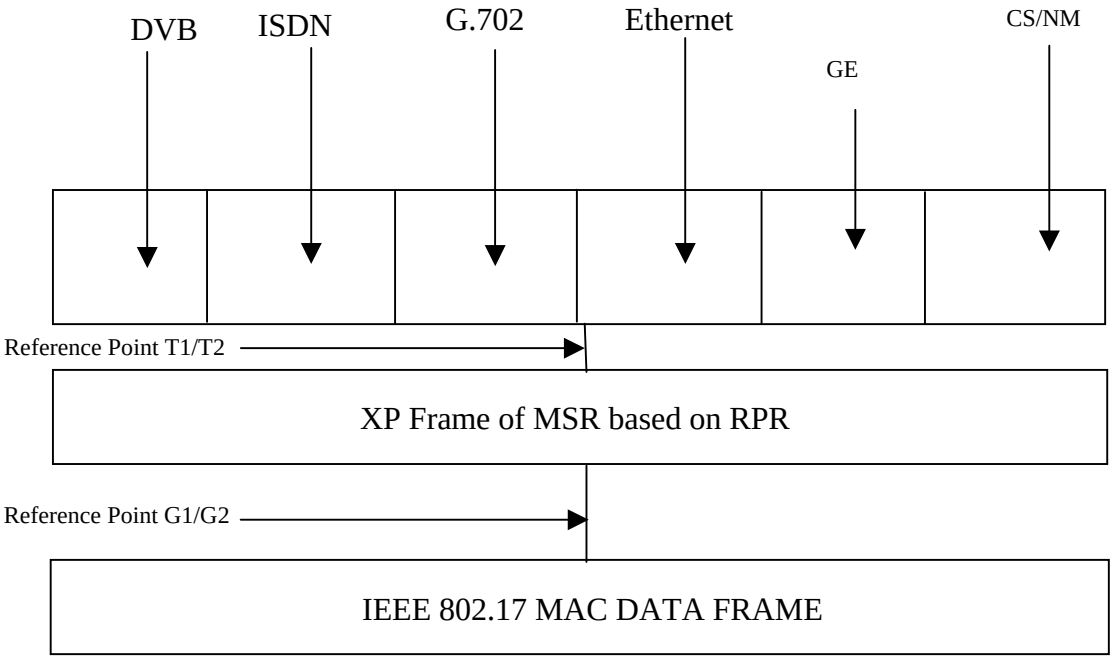


Figure 7/X.msr-rpr

Generic Protocol Stack of MSR Based on RPR

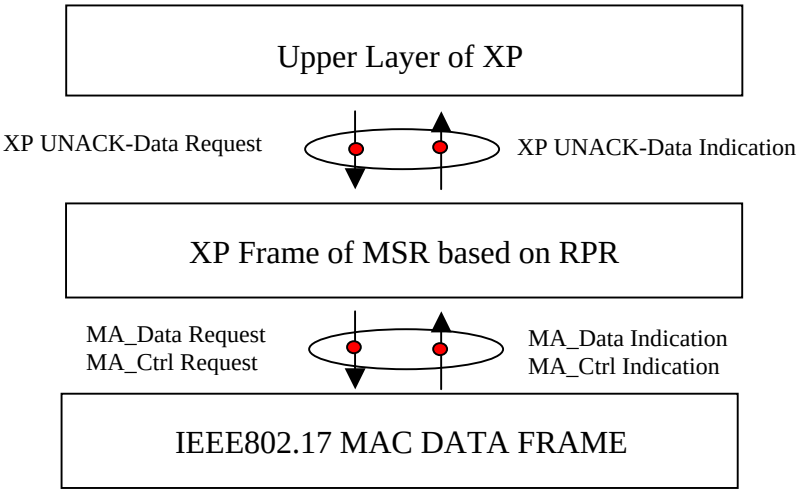


Figure 8/X.msr-rpr

Relationship between XP and RPR MAC, Upper Layer and XP

6.2 RPR MAC services to the client layer

Four service primitives are defined for the client interfaces.

— MA_DATA request {
destinationAddress,
sourceAddress [optional],
mSDU,
serviceClass,
ringletID [optional],
macProtection [optional],
markFE [optional] }

— MA_DATA indication {
destinationAddress,
sourceAddress [optional],
mSDU,
receptionStatus,
ringletID,
serviceClass,
fairnessEligible }

— MA_CONTROL request {
opcode,
request_operand_list }

— MA_CONTROL indication {
opcode,
indication_operand_list }

Their function, semantics of the service primitive, when generated and effect of receipt are shown in section 5.3 of IEEE802.17 specification.

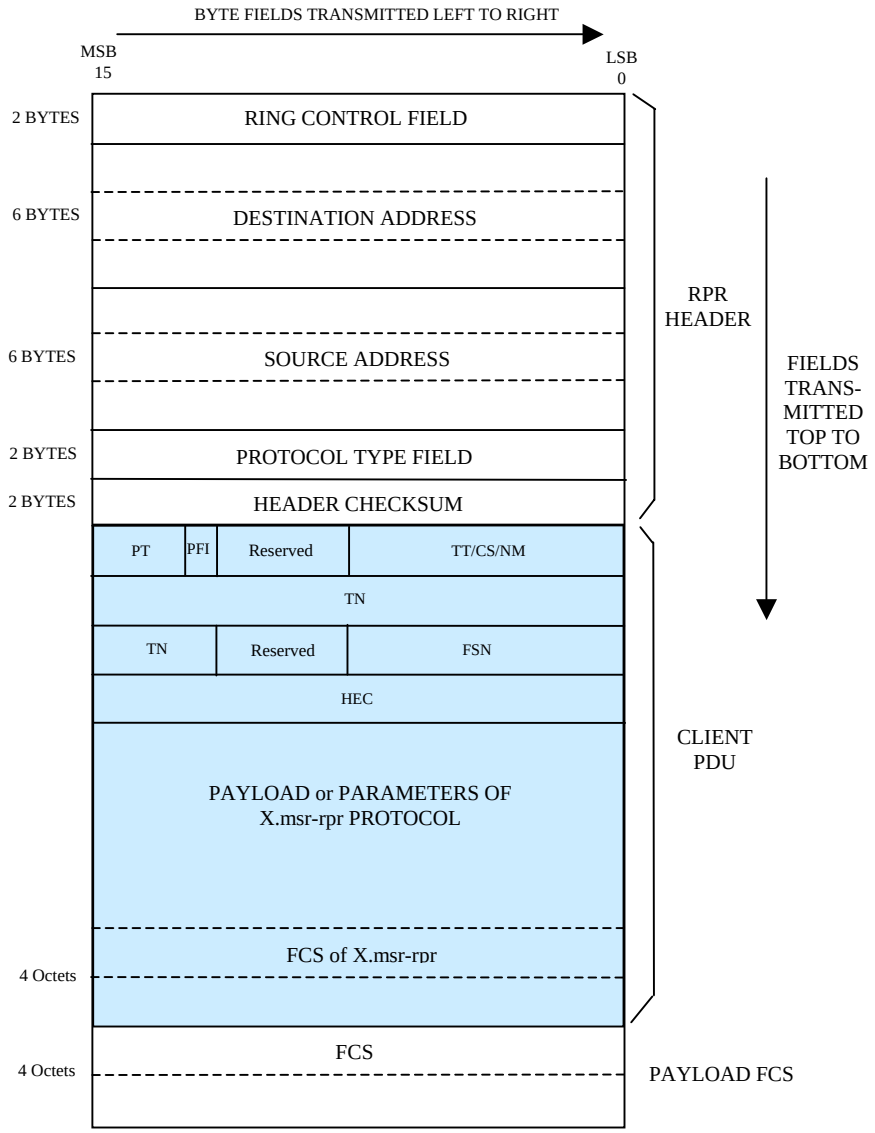
6.3 Tributary Adaptation Function Unit

Tributary Adaptation Function Unit is an adaptation function from/to various independent tributary type signals to/from reference point T1/T2. It has Tributary Adaptation Source Function and Sink Function. The Sink corresponds to reference point T1, The Source to reference point T2. This adaptation function includes the signal and rate transform, synchronous function between Tributary Rx/Tx Framer and tributary service interface.

7 Generic Frame Format

Each XP frame uses a fixed sized header. The generic frame format is shown in Figure 9. All binary fields in the following descriptions are transmitted in Most Significant Bit (MSB) to Least Significant Bit (LSB) order, from top to bottom. The definitions of Ring Control Field, Destination Address, Source Address, Protocol Type Field, Header Checksum and FCS Field have been

specified in IEEE 802.17 RPR. This section will focus on the FT, PFI, 4-bit reserved field, TT/CS/NM, TN, 4-bit reserved field, FSN field. For the specific application of this Recommendation, FE (Fairness Eligible) field is set to ”0”, PT (Payload Type) field is set to “3”, Protocol type field is a fixed value and it will be assigned by IEEE.



FE field =”0” and FT field = “3”in Ring Control Header, Protocol type field is a fixed value to be assigned by IEEE.

Figure 9/X.msr-rpr

Generic Frame Format of X.msr-rpr

7.1 Destination Address for use of this Recommendation

This 48-bit field is different from the global an address that identifies a particular station on a network. NA is a local address (Universal address is TBD) and has local meaning only along the RPR ringlet or other different topologies. IEEE assigns value of 24 bits, manufacturer assigns remaining 22 – local indicates a locally administered address. It is the responsibility of the administrator to insure uniqueness.

7.2 Payload Type (PT) Field

This 3-bit field stands for a type of XP frame, 0: User Data of X.msr-rpr, 1: User Control, 2: Control Signalling (CS), 3: Network Management (NM), 4-7: reserved.

7.3 Payload FCS Indicator (PFI) Field

This 1-bit field is used to indicate if the payload FCS of 4 octets presents, 0: not present, 1: present.

7.4 Reserved Field

This 4-bit field is reserved for future use.

7.5 TT/CS/NM Field

This 8-bit field is used for codes of TT (Tributary Type, or User Data of X.msr-rpr), CS or NM. Which type is presented will be dependent on PT field indication.

7.5.1 Tributary Type (TT) Field

When PT= binary “000”, this 8-bit field stands for a type of an independent adding/dropping tributary channel to/from the RPR (or other topologies) data nodes. Tributary channel can be Ethernet or various TCEs. Its codes are as follows (see Table 3).

TABLE 3/X.msr-rpr – TT Codes

Tributary types	Code
Reserved	00000000-00001000
G.702 PDH circuit -- Synchronous circuit transport	00001001
G.702 PDH circuit -- Asynchronous circuit 1.544Mbit/s	00001010
G.702 PDH circuit -- Asynchronous circuit 2.048Mbit/s	00001011
G.702 PDH circuit -- Asynchronous circuit 6.312Mbit/s	00001100
G.702 PDH circuit -- Asynchronous circuit 8.448Mbit/s	00001101
G.702 PDH circuit -- Asynchronous circuit 34.368Mbit/s	00001110
G.702 PDH circuit -- Asynchronous circuit 44.736Mbit/s	00001111
G.702 PDH circuit -- Synchronous circuit 1.544Mbit/s	00010000

G.702 PDH circuit -- Synchronous circuit 2.048Mbit/s	00010001
G.702 PDH circuit -- Synchronous circuit 6.312Mbit/s	00010010
G.702 PDH circuit -- Synchronous circuit 8.448Mbit/s	00010011
G.702 PDH circuit -- Synchronous circuit 34.368Mbit/s	00010100
G.702 PDH circuit -- Synchronous circuit 44.736Mbit/s	00010101
Reserved for other PDH or DSL specification	00010110-00010111
Video signal -- Distributive television services	00011000
Video signal -- Conversational services of bit rates higher than primary rates	00011001
Video signal -- Conversational services of p×64 kbit/s signals	00011010
Reserved for other Video signals	00011011-00011111
Voiceband signal -- 64 kbit/s A-law coded Recommendation G.711 signals	00100000
Voiceband signal -- 64 kbit/s μ-law coded Recommendation G.711 signals	00100001
Reserved for other Voiceband signals	00100010-100111
Digital channel supported by 64 kbit/s-based ISDN -- Transport of 64 kbit/s channel	00101000
Digital channel supported by 64 kbit/s-based ISDN -- Transport of 384, 1536 or 1920 kbit/s channel	00101001
Reserved for other TCEs	00101010-00101000
Ethernet (10/100Mb/s, specified in IEEE802.3)	00110100
GE (specified in IEEE802.3)	00110101
Reserved	00110110-11111111
Note: The operation of user data between MAC and client will be implemented by invoking MA_Data Request and return of MA_Data Indication defined in section 5.3 of P802.17 D1.1.	

7.5.2 CS Field

When PT= binary “010”, this 8-bit field is used to identify the types of control signalling shown in Table 4. The TN and FSN fields are not used and set to all-zeros value.

TABLE 4/X.msr-rpr – Type of Control Signalling

CS Frame Types	Code
Reserved	00000000-00000110

SYNCHRONIZATION Request (Note 1)	00000101
SYNCHRONIZATION Indication (Note 1)	00000110
Topology Discovery Request (implemented by RPR MAC, via MA_Control Request) (Note2)	00000111
Topology Discovery Indication (implemented by RPR MAC, via MA_Control Indication) (Note2)	00001000
Reserved	00001001-11111111
Note 1: Operation of Control frame between MAC and client will be implemented via MA_Data Request and Indication defined in section 5.3 of P802.17 D1.1. Note 2: Operation of Control frame between MAC and client will be implemented via MA_Control Request and Indication defined in section 5.3 of P802.17 D1.1. Note 3: the codes of Tributary based protection, multicast, bandwidth policing, security and rate duplication is also shown in section 10, 11 and 12.	

7.5.3 NM Field

When PT= binary “011”, this 8-bit field is used to identify the types of network management frame shown in Table 5. The FSN and TN fields are not used and set to binary all-zeros value.

TABLE 5/X.msr-rpr – Type of Network Management Frame

NM Frame Types	Code
Reserved	00000000-00000110
CT_Request Frame	00000111
CT_Response Frame	00001000
Fault_Report Frame	00001001
Fault_Inquiry_Request Frame	00001010
Fault_Inquiry_Response Frame	00001011
Performance_Report Frame	00001100
Performance _Inquiry_Request frame	00001101
Performance _Inquiry_Response frame	00001110
LMXP_ERROR_Indication Request frame	00001111
Reserved	00010000-11111111

7.6 Tributary Number (TN) Field

This 20-bit field is a number of same type of Tributary Ports within a data node.

7.7 Reserved Field

This 4-bit field is reserved for future use.

7.8 Frame Sequence Number (FSN) Field

This 8-bit field is used to identify Frame Sequence Number (FSN) of Ethernet or TCE data frames or in numbered modulo N_fsn=64 (default value, N_fsn is programmable and can be configured to 256 if application needs) from 0 to 63. The field is used to performance monitoring function for packet lost or duplicated of TCE based tributary. The related operation is given in section 9.3. The FSN field will be set to all-zero value if the signalling control frames or network management frames are presented.

7.8.1 Processing in the transmit side

The XP provides a sequence count value and a XP indication associated with each frame in the transmit side. The count value applied to FSN field and starts with 0, it is incremented sequentially to 63 and numbered modulo is 64. When the data link frames carrying Tributary payloads traverse a RPR or other topologies, they may arrive destination station disorderly, or lost or duplicated one or more frames. Due to this reason, it is required that frames must be delivered in order.

7.8.2 Processing in the receive side

The Data Link entity in the receive side must detect the lost or duplicated frames, and track the following status of dynamic data stream:

- Frame sequence number and count;
- Frame loss (if occur);
- Frame duplication (if occur).

There are two ways to solve the real-time processing problem, (1) try to reorder and sort into the correct order, or (2) drop those disordering frames, when disordering case occurred. In implementation, these two methods should be all supported. If method (1) does not meet reliability transport and performance requirement still, the method (2) will be applied. Due to the limitation of native speed and acceptable delay of data link processing, this Recommendation does not support correction method for bit errors and frame losses. If the event of any lost or duplicated frame occurred, data link entity will report to the layer management entity by LMXP-ERROR Indication (see section 9).

7.9 HEC field

The header CRC is a 16-bit checksum. Its generator polynomial is: CRC-16 = $x^{16} + x^{12} + x^5 + 1$. The checksum is computed over the PT, PFI, 4-bit reserved field, TT/CS/NM field, TN, another 4-bit reserved field and FSN field within the scope of XP, with the bits of the frame presented to the CRC generator in the same order as is described in IEEE 802.17. The initial value for the HEC CRC calculation is an all-zeros value. Single-bit error correction by the receiver is optional.

7.10 Payload of XP

When Tributary or Ethernet Packet is applied, payload field is used to encapsulate upper layer protocol data or TDM data listed in Table 3. Payload is octet-oriented and its size is variable. The default maximum frame size shall be aligned to the size that RPR does for both IPv4-based and IPv6-based applications (the support of jumbo payload needs to align with IEEE 802.17

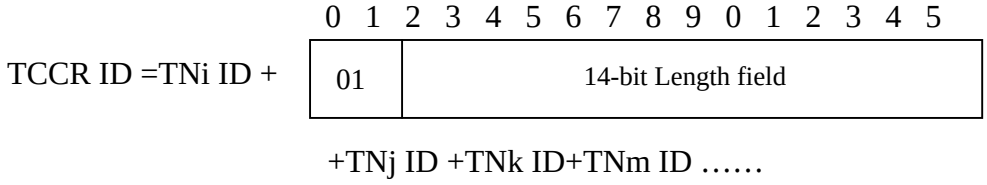
specification). Except for Tributary, control signalling frame and network management are described below.

7.10.1 Control Signalling and Network Management Part

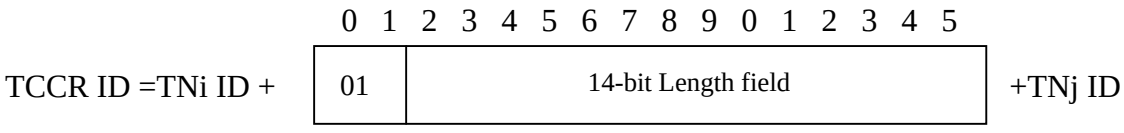
The XP does work by sending both data frame into a unidirectional ringlet and the associated network management/control frames into a counter-rotating ringlet. Generic format of CS/NM Frames is the same as that of Figure 9, just payload field is replaced by the related parameters shown in Figure 9. The difference of the parameter field indicates various control signalling and network management frames below. The first octet of parameters field is used to identify how many parameters are used via CS or NM frames. Each parameter following 1st octet consists of type (or tag), length and value of the parameter. If the total octet number of parameters field is not based on 4-octet, it is optional that the octets padding (Binary 00000000) may be used.

7.10.1.1 CT_Request Frame

The code value of CT-Request Frame is binary “00000111”. CT-Request Frame can be applied to point-to-point operation of Tributary based and node based, and also used to node based multicast/broadcast operation. For the Tributary based multicast/broadcast operation, please refer to as section 13 of this Recommendation. The major portion of CT is TCCR ID. A TCCR ID consists of TNi ID (This is an identifier of Tributary p within node x), 2-bit U/M/B field, 14-bit length field (This filed is used to represent the total number of Tributary TNj ID following length field) and one or more TNj ID (This is an identifier of Tributary q within node y). ID is a value of identifier, TNi, TNj, TNk and TNm are the ith Tributary Number of same TT of Node n, the jth Tributary Number of same TT of Node o, the kth Tributary Number of same TT of Node p and the mth Tributary Number of same TT of Node q. The values of n, o, p, q are 0 through 31, and stands for numbering of node. The values of i, j, k, l are 0 through 2^{20}-1, and stands for tributary number with the same TT value.



Node based multicast/broadcast Mode



Unicast Mode

Figure 10/X.msr-rpr

Expressions of TN ID and TCCR ID

Note: TNi ID=NAx(x=1,2,3…32)+TT+TNp (p=0,1,2,3,…2^{20}-1), to identify the pth Tributary with the fixed TT and TN value within ith node. For the case of Multicast/Broadcast Mode, a tributary based outgoing packet within a source node can be multicast or broadcast to a designated or source tributary (ST) of other sink nodes along a RPR ring or other topologies. Each sink node should have only a source tributary to receive this packet from ringlet at a time. If a membership group of multicast or broadcast has been established within a sink node, the said ST will duplicate this packet to other tributaries with the same membership relation.

What the ICT, CUT and Null parameters indicate is three different operations: ICT, CUT and CTI. Its type and field are described below in Table 6.

Table 6/X.msr-rpr –Parameter Type of CT_Request Frame

Parameter type	Parameter Field
ICT	Binary “00000001 00100000 +” octet number of parameter”+”value of TCCR ID shown in Figure 10”
CUT	Binary “00000001 00100001 +” octet number of parameter”+”value of TCCR ID shown in Figure 10”
Null	Binary “00000001 00100011 00000001 00000000”
Note: these functions between RPR MAC and client are operated via MA_Data Request and Indication primitives.	

7.10.1.2 CT_Response Frame

Null parameter in CT_Response Frame is used by ICT and CUT operation. CTI parameter is followed by CTI operation.

Table 7/X.msr-rpr –Parameter Type of CT_Request Frame

Parameter type	Parameter Field
CTI	Binary “00000001 00100100 +” octet number of parameter”+”value of TCCR ID shown in Figure 10”
Null	Binary “00000001 00100011 00000001 00000000”
Note: these functions between RPR MAC and client are operated via MA_Data Request and Indication primitives.	

The corresponding operation can be got in 5.6 and parameter is shown in Table 7.

7.10.1.3 Fault_Report Frame

Table 8/X.msr-rpr –Parameter Type of Fault_Report Frame

Parameter type	Parameter Field
PSF	Binary “00000001 00000011 00000001 00000000”
PSD	Binary “00000001 00000010 00000001 00000000”
Note: These functions between RPR MAC and client are operated via MA_Control Request and Indication primitives.	

The corresponding operation can be got in 5.7 and parameter is shown in Table 8.

7.10.1.4 Parameter of Fault_Inquiry_Request Frame

Table 9/X.msr-rpr –Parameter Type of Fault_Inquiry_Request Frame

Parameter type	Parameter Field
Null	Binary “00000001 00100011 00000001 00000000”
Note: this function between RPR MAC and client is operated via MA_Control Request and Indication primitives.	

The corresponding operation can be got in 5.7 and parameter is shown in Table 9.

7.10.1.5 Parameter of Fault_Inquiry_Response Frame

Table 10/X.msr-rpr –Parameter Type of Fault_Inquiry_Request Frame

Parameter type	Parameter Field
PSF	Binary “00000001 00000011 00000001 00000000”
PSD	Binary “00000001 00000010 00000001 00000000”
Note: this function between RPR MAC and client is operated via MA_Control Request and Indication primitives.	

The corresponding operation can be got in 5.7 and parameter is shown in Table 10.

7.10.1.6 Parameter of Performance_Report Frame

Table 11/X.msr-rpr –Parameter Type of Performance_Report Frame

Parameter type	Parameter Field
A set of TNi in a node (designated)	Binary “00000001 01000000 +” octet number of parameter ”+”value of TNi shown in Figure 10”
TNFCS_15m (Total Number of FCS error in 15 minutes, 4octets, 4octets length)	Binary “00000001 01000001 00000100 ”value of TNFCS-15m shown in Figure 10”
TNPL_15m (Total Number of Frame Loss in 15 minutes, 4octets length)	Binary “00000001 01000001 00000100 ”value of TNPL-15m shown in Figure 10”

TNFCS_24h (Total Number of FCS error in 24 hours, 5octets length)	Binary “00000001 01000001 00000101 ”value of TNFCS-24h shown in Figure 10”
TNPL_24h (Total Number of Frame Loss in 24 hours, 5octets length)	Binary “00000001 01000001 00000101 ”value of TNPL-24h shown in Figure 10”
Note 1: TNFCS and TNPL represents two different registers reflected values of “Total Number of FCS error” and “Total Number of Frame Loss” respectively. Note 2: this function between RPR MAC and client is operated via MA_Data Request and Indication primitives.	

The corresponding operation can be got in 5.8 and parameter is shown in Table 11.

7.10.1.7 Parameter of Performance_Inquiry_Request Frame

Table 12/X.msr-rpr –Parameter Type of Performance _Inquiry_Request Frame

Parameter type	Parameter Field
A set of TNi in a node (designated)	Binary “00000001 01000000 +”octet number of parameter ”+”value of TNi shown in Figure 10”
Note 1: this function between RPR MAC and client is operated via MA_Data Request and Indication primitives.	

The corresponding operation can be got in 5.8 and parameter is shown in Table 12.

7.10.1.8 Parameter of Performance_Inquiry_Response Frame

Table 13/X.msr-rpr –Parameter Type of Performance _Inquiry_Response Frame

Parameter type	Parameter Field
A set of TNi in a node (designated)	Binary “00000001 01000000 +” octet number of parameter”+”value of TNi shown in Figure 10”
TNFCS_15m (Total Number of FCS in 15 minutes, 4octets length)	Binary “00000001 01000001 00000100 ”value of TNFCS-15m shown in Figure 10”
TNPL_15m (Total Number of Frame Loss in 15 minutes, 4octets length)	Binary “00000001 01000001 00000100 ”value of TNPL-15m shown in Figure 10”
TNFCS_24h (Total Number of FCS in 24 hours, 5octets length)	Binary “00000001 01000001 00000101 ”value of TNFCS-24h shown in Figure 10”
TNPL_24h (Total Number of Frame Loss in 24 hours, 5octets length)	Binary “00000001 01000001 00000101 ”value of TNPL-24h shown in Figure 10”

Note 1: TNFCS and TNPL represents two different registers reflected values of "Total Number of FCS error" and "Total Number of Frame Loss" respectively.

Note 2: this function between RPR MAC and client is operated via MA_Data Request and Indication primitives.

The corresponding operation can be got in 5.8 and the parameters are shown in Table 13.

7.11 XP Payload FCS

The Frame Check Sequence (FCS) is a 32-bit cyclic redundancy check (CRC) as used in IEEE 802.3 CSMA/CD. The generator polynomial is:

$CRC\text{-}32 = x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^8 + x^7 + x^5 + x^4 + x^2 + x^1 + 1$

The FCS CRC is calculated starting from the byte following the HEC field to the end of frame, with the bits of the frame presented to the CRC generator in the same order as is described IEEE 802.17. The initial value for the FCS CRC calculation is an all-ones value. If Ethernet is contained in the payload, or CS/NM parameters are contained in the payload, PFI is set to zero and XP payload FCS will not be used.

8 Tributary Loopback

Once loopback function is set, a node provides local or remote data channel shortcut from Tx interface to Rx interface in Tributary.

9 TDM Circuit Emulation (TCE) over RPR

9.1 Introduction

This section provides a protocol model along RPR for TDM based bit-stream or octet-steam over RPR. Each station can have one or more TCEs as Tributary. TCE is operated end-to-end and is originated from the source station and terminated at the sink station. TCE can be operated in the way of half-duplex point-to-point, full-duplex point-to-point or half-duplex point-to-multipoint.

9.2 Protocol framework of TDM Circuit Emulation (TCE)

The protocol framework of TCE is involved in the underlying RPR MAC aggregate pipe shown in Figure 11. The functions of encapsulation, real-time transport of order, detection of disorder and duplication, sorting, error report, primitives and related parameters, and timing synchronous processing etc are performed within the XP.

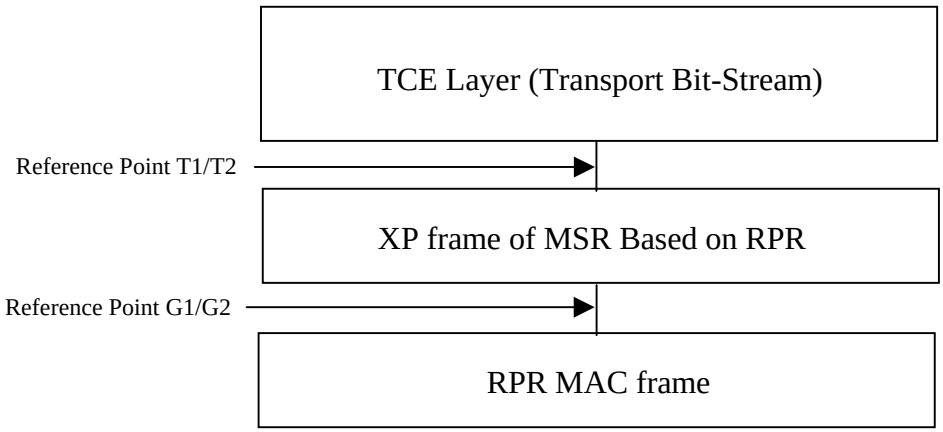


Figure 11/X.msr-rpr

TDM service channel over RPR MAC frame using XP

9.3 Services provided by RPR Data link

9.3.1 Definitions

The layer services provided by RPR Data link to TCE layer are:

- Transfer of service data units with a constant source bit rate from TCE layer and the delivery of them with the same bit rate in RPR data link layer; and/or
- Transfer of timing information between source and destination; and/or
- Transfer of structure information between source and destination; and/or
- Indication of lost, duplicated or errored information that is not recovered by RPR data link if needed.

9.3.2 Primitives between XP and the XP user

9.3.2.1 General

At the Service Access Point (SAP) of XP layer, the following primitives is used between the XP and the TCE layer:

- From a TCE layer to the XP,
  XP-UNACK-DATA Request;
- From the XP to the TCE layer,
  XP -UNACK-DATA Indication.
- From the XP to the management entity;
  LMXP-ERROR Indication.

A XP -UNACK-DATA request primitive at the local XP -SAP will result in a XP -UNACK-DATA indication primitive at its peer XP -SAP.

9.3.2.2 Definition of XP Primitives

9.3.2.2.1 XP -UNACK-DATA request (not be used to signalling frame)

XP -UNACK-DATA request (USERDATA [Necessary],
STRUCTURE [optional])

The XP -UNACK-DATA request primitive requests the transfer of the XP -SDU, i.e. contents of the USERDATA parameter, from the local XP entity to its peer entity. The length of the XP -SDU and the time interval between two consecutive primitives is constant. These two constants are a function of the XP service provided to the TCE layer.

9.3.2.2.2 XP-UNACK-DATA indication (Does not have signalling frame)

XP-UNACK-DATA indication (USERDATA [Necessary],

STRUCTURE [optional],

ERROR [optional])

A XP user is notified by the XP that the XP-SDU, i.e. contents of the USERDATA parameter, from its peer is available. The length of the XP-SDU and the time interval between two consecutive primitives should be constant. These two constants are a function of the XP service provided to the TCE layer.

9.3.2.2.3 LMXP-ERROR indication

LMXP-ERROR indication (T_error [Necessary],

REG_lost [optional],

REG_duplicated [optional])

REG_lost and REG_duplicated parameters are used to identify how many sequence frames are lost and duplicated by FSN detection from the transmit side to receive side in the specific period (T_error). Once sequence lost or duplicated is occurred, LMXP-ERROR indication will be applied.

9.3.2.4 Definition of Primitive Parameters

9.3.2.4.1 USERDATA parameter

The USERDATA parameter carries the XP-SDU to be sent or delivered. The size of each block to be delivered depends on the specific XP layer service used. For the same type of TCE payload, i.e. ITU-T G.702 PDH circuit, the payload length of XP-PDU is constant and default is set to ~~64~~512bytes. For the supported TCE payloads, the payload length of XP-PDUs is defined as following.

TABLE 14/X.msr-rpr – Selection of Default Payload Length of XP-PDU

Types of TCE payload	Default Payload Length of XP-PDU (bytes)
G.702 PDH circuit – Synchronous circuit transport	~~64~~512
G.702 PDH circuit -- Asynchronous circuit transport	~~64~~512
Video signal -- Distributive television services	188
Video signal -- Conversational services of bit rates higher than primary rates	188
Video signal -- Conversational services of p×64 kbit/s signals	188
Voiceband signal -- 64 kbit/s A-law or μ-law coded Recommendation G.711 signals	~~64~~512
Digital channel supported by 64 kbit/s-based ISDN -- Transport of 64 kbit/s channel	~~64~~512
Digital channel supported by 64 kbit/s-based ISDN -- Transport of 384, 1536 or 1920 kbit/s channel	~~64~~512

9.3.2.4.2 STRUCTURED parameter (option of XP-UNACK-DATA Primitive)

The STRUCTURED parameter can be used when the data stream of TCE layer to be transferred to the peer XP entity is organized into groups of bits. The length of the structured block is fixed for each instance of the XP service. The length is an integer multiple of 32 bits. An example of the use of this parameter is to support circuit mode bearer services of the 64 kbit/s-based ISDN. The two values of the STRUCTURED parameter are:

BOUND and

DATA-STREAM.

The value BOUND is used when the USERDATA is the first part of a structured block which can be composed of consecutive USERDATA. In other cases, the structure parameter is set to DATA-STREAM. The use of the STRUCTURED parameter depends on the type of XP service provided. The use of this parameter is agreed prior to or at the connection establishment by network management between the TCE layer and the Data Link layer. In most application, the function of "STRUCTURE parameter" has been covered by the transform and adaptation function of Tributary at the Tributary interface within a node since XP uses pre-plan and connection oriented policy, and TCCR is made (e.g. ISDN 64kb/s Tributary source in a node to ISDN 64kb/s Tributary sink, E1 (2048 kbit/s) Tributary source in a node to E1 (2048 kbit/s) Tributary sink) by network management entity or control signalling before Tributary service is operated on-line.

9.3.2.4.3 ERROR parameter (option of XP-UNACK-DATA Primitive)

The ERROR parameter is involved to identify that the USERDATA is errored or non-errored. The ERROR parameter has two values:

NO and

YES.

The "YES" value does imply that the USERDATA covers a dummy value within this frame. The "NO" value implies that the no error is found from transmit to receive side. The use of the ERROR parameter and the choice of dummy value depend on the type of XP service provided. The use of this parameter is agreed prior to or at the connection establishment of TCCR between the TCE layer and the XP layer.

9.3.2.4.4 T_error, REG_lost and REG_duplicated parameters

The connection management entity is used to monitor the error status of receiving the peer link frame at peer-to-peer level. It is local matter only and has not any associated frame to be used between the two sides.

REG_lost and REG_duplicated parameters are attached to LMXP-ERROR Indication primitive to identify how many sequence frames are lost and/or duplicated from the transmit side to receive side in the specific period (T_error). Their accumulation values are stored and transformed to the two specific registers in the receive side. The parameter T_error in the unit of second is an initial value (15 minutes and 24 hours are two default values) and configurable by the network management entity according to the rate of specific service over XP. Each Tributary has the corresponding REG_lost and REG_duplicated, and is separated operated from other Tributary. At the beginning of RPR Data Node start-up, the REG_lost and REG_duplicated of each Tributary are clear and set to zero.

--If the timer T_error expires before no lost or duplicated frames are received, the link entity shall restart timer T_error. The XP entity shall not indicate this to the local connection management entity.

--Once the timer T_error expires if any lost or duplicated frame is received, the XP entity shall indicate this to the local connection management entity by means of the LMXP-ERROR indication primitive, and restart timer T_error.

9.4 Supported Functions of XP for TCE case

The following functions can be performed in the XP in order to meet requirements of TDM (Time Division Multiplex) timing, structure, jitter and wander:

a) source clock frequency recovery at the receiver;

b) recovery of the source data structure at the receiver;

c) blocking and deblocking of XP user information;

d) control of frame latency variation;

e) processing of lost or duplicated frames;

NOTE – For some XP users, the end-to-end QOS monitoring may be needed to provide. This function can be achieved by calculating a CRC, reporting lost or duplicated frames in the default period (e.g. 15 minutes and 24 hours) for the XP-PDU, A corresponding periodic count of CRC computation, values of REG_lost and REG_duplicated are sent to network management entity.

9.4.1 TCE processing mode

9.4.1.1 Processing mode of G.702 PDH

For this sub-section, it is necessary to identify TCE data structure and the clock operation mode at the XP service boundary, i.e. framing or non-framing, types of clock (synchronous or asynchronous) where needed to make comparison to a network clock. Asynchronous and synchronous TCE transport provides transport of signals from TCE sources whose clocks are non-frequency-locked and frequency-locked to a network clock respectively. The judgement of synchronous or asynchronous will depend on the service provided by the specific network, i.e. PDH, SDH, or ISDN. Care should be taken to select the shortest transport path, control priority of delivery and transient, and reduce transport latency and latency variation along RPR during the project installation phase.

1) Asynchronous G.702 circuit

- Circuit rate at XP service boundary: 1.544, 2.048, 6.312, 8.448, 44.736 and 34.368 Mbit/s as specified in Recommendation G.702.
- Payload size to be encapsulated: see Table 14
- Source clock frequency recovery: Asynchronous frequency
- Error status indication at the receiver: count report of lost or duplicated frames by LMXP-ERROR Indication primitive.

2) Synchronous G.702 circuit

- Circuit rate at XP service boundary: 1.544, 2.048, 6.312, 8.448, 44.736 and 34.368 Mbit/s as specified in Recommendation G.702.
- Payload size to be encapsulated: see Table 14
- Source clock frequency recovery: Synchronous timing
- Error status indication at the receiver: count report of lost or duplicated frames by LMXP-ERROR Indication primitive.

9.4.1.2 Processing mode of Video signal transport

This sub-section presents the processing mode of Video signal transport. Care should be taken to select the shortest transport path, control priority of delivery and transient, and reduce transport latency and latency variation along RPR during the project installation phase.

1) Mode of Conversational services of p×64 kbit/s signals

This sub-section gives the processing mode of interactive video signals of the p × 64 videotelephony and videoconference applications as specified in Recommendation H.320.

a) Circuit rate at XP service boundary: 384, 1536 or 1920 kbit/s in the 64 kbit/s-based ISDN by using H0, H11, H12, respectively.

b) Payload size to be encapsulated: see Table 14

c) Source clock frequency recovery: Synchronous timing

d) Error status indication at the receiver: count report of lost or duplicated frames by LMXP-ERROR Indication primitive.

2) Mode of Distributive television services

This sub-section illustrates transport of distributive television signals encoded by using MPEG2 with a constant bit rate specified in Recommendation J.82.

a) Circuit rate at XP service boundary: Depending on MPEG2 parameters

b) Payload size to be encapsulated: see Table 14

c) Source clock frequency recovery: Asynchronous frequency

d) Error status indication at the receiver: count report of lost or duplicated frames by LMXP-ERROR Indication primitive.

3) Mode of Conversational services of bit rates higher than primary rates

This sub-section illustrates transport of interactive video signals for, i.e. video-telephony and conference application specified in Recommendation H.310.

a) Circuit rate at XP service boundary: Depending on H.310 parameters

b) Payload size to be encapsulated: see Table 14

c) Source clock frequency recovery: Synchronous/Asynchronous per Recommendation H.310

d) Error status indication at the receiver: count report of lost or duplicated frames by LMXP-ERROR Indication primitive. Recommendation H.310 should be taken into account.

9.4.1.3 Processing mode of digital channel supported by 64 kbit/s-based ISDN

This sub-section presents the processing mode of digital channel supported by 64 kbit/s-based ISDN. Care should be taken to select the shortest transport path, control priority of delivery and transient, and reduce transport latency and latency variation along RPR during the project installation phase.

1) Mode of 64 kbit/s channel

a) Circuit rate at XP service boundary: 64 kbit/s

b) Payload size to be encapsulated: see Table 14

c) Source clock frequency recovery: Synchronous timing

d) Error status indication at the receiver: count report of lost or duplicated frames by LMXP-ERROR Indication primitive.

2) Mode of 384, 1536 or 1920 kbit/s channel

a) Circuit rate at XP service boundary: 384, 1536 or 1920 kbit/s

b) Payload size to be encapsulated: see Table 14

c) Source clock frequency recovery: Synchronous timing

d) Error status indication at the receiver: count report of lost or duplicated frames by LMXP-ERROR Indication primitive.

9.4.1.4 Processing mode of Voice-band signal

This sub-section presents the processing mode of 64 kbit/s A-law or μ-law coded Recommendation G.711 signals. Care should be taken to select the shortest transport path, control priority of delivery and transient, and reduce transport latency and latency variation along RPR during the project installation phase.

a) Circuit rate at XP service boundary: 64 kbit/s

b) Payload size to be encapsulated: see Table 14

c) Source clock frequency recovery: Synchronous timing

d) Error status indication at the receiver: count report of lost or duplicated frames by LMXP-ERROR Indication primitive.

9.4.2 TCE Function of RPR Data Link

9.4.2.1 TCE Functions for circuit

The following sections provide both asynchronous and synchronous TCE transport function along RPR or other topologies. Asynchronous and synchronous TCE supports transport of signals from constant bit rate sources whose clocks are non-frequency-locked and frequency- locked respectively to a network clock. Asynchronous examples are Recommendation G.702 signals at 1.544, 2.048, 6.312, 8.448, 32.064, 44.736 and 34.368 Mbit/s, Synchronous examples are at 64, 384, 1536 and 1920 kbit/s as specified in Recommendation I.231.

1) Consideration of XP user information

The length of the XP-SDU is 64 octets. A XP-SDU constitutes one XP PDU payload.

For those XP users that require a peer-to-peer presetting of structured data, i.e. 8 kHz structured data for circuit mode bearer services of the 64 kbit/s-based ISDN.

2) Processing strategy of frame delay variation

A buffer mechanism is used to support this function. In the event of buffer underflow, it can be necessary for the XP to maintain bit count integrity by inserting the appropriate number of dummy bits. In the event of buffer overflow, it may be necessary for the XP to maintain bit count integrity by dropping the appropriate number of bits.

When Recommendation G.702 1.544-Mbit/s and 2.048-Mbit/s signals are being transported, the inserted dummy bits shall be all "1"s.

3) Processing strategy of lost and duplicated frames

A destination XP can determine whether the frames have been lost by tracking the Frame Sequence Number (FSN) or sequence count values of the received XP PDUs. Detected duplicated frames are discarded. The XP procedure to be used for sequence count processing is described in 7.8 and 9.5.1.

In order to maintain the bit count integrity of the XP user information, it may be necessary to compensate for lost frames detected by buffer underflow and sequence count processing by inserting the appropriate number of dummy payloads. The content of this dummy payload depends on the XP service being provided. For example, this dummy payload is all "1"s for Recommendation G.702 1.544 Mbit/s and 2.048-Mbit/s signals.

4) Guaranty of jitter and wander

This function is required for delivery of XP-SDUs to a XP user at a constant bit rate. Recovered source clock should meet the requirement of jitter and wander performance of the related Recommendation defined. For example, the jitter and wander performance for Recommendation G.702 signals is specified in Recommendations G.823 and G.824, for which the XP procedure to be used.

9.4.2.2 TCE Functions of video signal

The following sections present processing of video signals for interactive and distributive services:

1) Consideration of XP user information

The length of the XP-SDU is 188 octets. A XP-SDU constitutes one XP PDU payload.

For those XP users that require a peer-to-peer presetting of structured data. Depending on the type of XP service provided (i.e. the interface to the XP user), the ERROR parameter will be passed to the XP user to facilitate further picture processing.

2) Processing strategy of frame delay variation

A buffer mechanism is used to support this function. The size of this buffer is dependent upon specifications video signal. In the event of buffer underflow, it may be necessary for the XP to maintain bit count integrity by inserting the appropriate number of dummy bits. In the event of buffer overflow, it may be necessary for the XP to maintain bit count integrity by dropping the appropriate number of bits.

3) Processing of lost and duplicated frames

A destination XP can determine whether the frame has been lost by tracking the Frame Sequence Number (FSN) or sequence count values of the received XP PDUs. Detected duplicated frames are discarded. The XP procedure to be used for sequence count processing is described in 7.8 and 9.5.1.

In order to maintain the bit count integrity of the XP user information, it may be necessary to compensate for lost frames detected by buffer underflow and sequence count processing by inserting the appropriate number of dummy payloads. The content of this dummy payload depends on the XP service being provided.

Information in lost frames may be recovered by the mechanism described in 9.5.1.

4) Guaranty of jitter and wander

This function is required for delivery of XP-SDUs to a XP user at a constant bit rate.

Some XP users may require source clock frequency recovery, i.e. recovery in the receive side of camera clock frequency that is not locked to the network clock. The XP procedures available for that purpose are given in 7.8 and 9.5.1.

9.4.2.3 TCE Functions of voice-band signal

The following sections support processing of a single voice-band signal, i.e. one 64 kbit/s A-law or μ-law coded Recommendation G.711 signal.

1) Consideration of XP user information

The length of the XP-SDU is 64 octets. A XP-SDU constitutes one XP PDU payload.

2) Processing of frame delay variation

A buffer mechanism is used to support this function. The size of this buffer depends on specifications provided in voice-band signal.

3) Processing strategy of lost and duplicated frames

For voice-band signals, there is a need still to detect duplicated and lost frames.

The receiving XP entity must detect/compensate for lost frame events to maintain bit count integrity and must also minimize the delay, i.e. to alleviate echo performance problems, in conveying the individual voice-band signal octets from the XP-PDU payload to the XP user. The receiving XP entity may take actions based on the received Sequence Number values, but such actions must not increase the conveyance delay across the XP receiving entity to alleviate echo performance problems.

The XP receiving entity must accommodate a sudden increase or decrease in the nominal frame transfer delay. (A protection switching event in the RPR may result in a change of transfer delay.)

4) Guaranty of jitter and wander

The XP provides synchronous circuit transport for the voice-band signal.

NOTE 1 – Example receiver techniques using a timing-based mechanism or a buffer-fill-based mechanism, possibly supplemented by a Sequence Number processing algorithm that does not introduce additional delay.

NOTE 2 – For transporting signals of speech and 3.1 kHz audio bearer services as specified in 64 kbit/s ISDN, the need for A/μ-law conversion is identified. The conversion between A-law and μ-law coded PCM octets are as specified in Recommendation G.711. This conversion function is outside the scope of this Recommendation.

9.4.2.4 TCE Functions of high quality audio signal

The case is the same as the above. The TCE functions of high quality audio signals in XP include the following capabilities in principle.

a) Consideration of XP user information;

b) Processing strategy of frame delay variation;

c) Processing of lost and duplicated frames;

d) Guaranty of jitter and wander;

9.5 XP protocol involved to support TCE

The following sub-sections describe XP procedures to be provided for implementing XP functions involved to support TCE.

9.5.1 Processing strategy of Frame Sequence Number (FSN)

9.5.1.1 Processing in the transmit side

The XP provides a sequence count value and a XP indication associated with each XP-PDU payload in the transmit side. The count value applied to FSN field starts with 0, is incremented sequentially to 63 and is numbered modulo 64 when TT field is set to support TCE function. When the data link frames carrying TCE payloads traverse a RPR or other topologies, then may arrive

destination station disorderly. Due to this reason, it is required that frames must be delivered in order. Ensuring in-order delivery is also effective approach to out-of-order detection.

9.5.1.2 Processing in the receive side

The XP receives and derives the following information associated with each XP-PDU payload in receive side:

- sequence number;
- count;
- check error of the frame sequence number and count.

The implementation of sequence count values and number will be specified on a service specific basis (e.g. REG_lost and REG_duplicated). The XP entity in the receive side identifies lost or duplicated XP-PDU payloads.

XP entity tracks the following status of dynamic data stream:

- XP-PDU payload sequence number and count;
- XP-PDU payload loss (if occur);
- XP-PDU payload duplication (if occur).

There are two ways to solve the real-time processing problem, (1) try to reorder and sort into the correct order or (2) drop those disordering frames, when disordering case occurred. In implementation, These two methods should be all supported. If method (1) does not meet reliability transport and performance requirement still, the method (2) will be applied. Due to the limitation of native speed and acceptable delay of data link payloads listed in Table 14, this Recommendation does not support correction method for bit errors and frame losses.

9.5.2 Recovery method of timing and structured information

To support TCE services available in Table14, the requirements of timing and structured information should be based on the native characteristics of the these services, and it is necessary for these TCEs to recover these signal characteristics as closely specified in the related standard as possible in the receive side, including the signal jitter, bit-rate, timing characteristics and structured information transfer (if it has) as it was sent. In most application, STRUCTURE information could be provided by the transform and adaptation function of Tributary at the Tributary interface within a node since XP uses pre-plan and connection oriented policy, and TCCR is made (e.g. ISDN 64 k/bits Tributary source in a node to ISDN 64 k/bits Tributary sink, E1 Tributary source in a node to E1 Tributary sink) by network management entity or control signalling before Tributary service is operated on-line.

For the timing issue of MSR, the three methods are: (a) timing (synchronous) signalling broadcasted periodically from that designated station with an external synchronous source along the RPR ring or other topologies; (b) timing (synchronous) information received from an external facility for referencing to all stations; (c) timing (synchronous) information received from an external facility for referencing to a said central station, other stations along a ring will get timing information from the line side and reference to the central station. If the method (a) is applied, the primitives are defined as follows.

SYNCHRONIZATION Request (Local NA, T_sync)

The signalling frame of SYNCHRONIZATION Request primitive will have the highest priority among all other signalling frame defined in this Recommendation and be operated in a way of broadcast. The broadcasted period is Timer T_sync. Its default value is 8000 frames per second. This value is programmable and can be changed by network management entity.

SYNCHRONIZATION Confirm(Non parameter)

After getting the signalling frame of SYNCHRONIZATION Request, each station along a ring will align the phase relations of its oscillator facility (including frequency-locked) and send SYNCHRONIZATION Confirm signalling frame with lower priority to the source station initiated the signalling frame of SYNCHRONIZATION Request. The codes of these two signalling frames are listed in the Table 4.

Since the service types and connection relations of TCEs from source to destination, including Node address, TT and TN, are pre-plan before service Tributary is operated, the initial timing (except for phase relations and actual bit-stream) and structured information should be pre-set by configuration function of network management entity before those TCE services are available. The phase relations and actual bit-stream of TCE signals are designed to perform the extraction of output transmission bit timing information from the received frame stream, and requires a phase-locking mechanism.

9.6 Management function involved to support TCE

The following functions is required to be provided to the network management entity:

9.6.1 TCE property (including structured information of data stream) mismatch between the source and destination

The related operation is described detailed and refer to section 5.6.

10 Tributary Based Protection (TBP)

The Tributary of this section is a logical service channel defined in section 3, such as Ethernet, TCEs with a fixed value of Tributary Type (TT) and Tributary Number (TN) in the frame format. The application scope of Tributary based protection involved in this section is located at full-duplex point-to-point application only. The tributary protection operation of half-duplex point-to-point, multicast and broadcast will not be the scope of this section. A Node of RPR can provide support of multiple ETBP and Multiple TTBP at the same time.

10.1 Ethernet Tributary Based Protection (ETBP)

When needed to support the ETBP Function, ETBP Function Unit embedded in the corresponding Tributary as an attachment in XP entity will be activated by the configuration function of network management entity (this configuration function is performed either in the projection installation phase or MSR on-line operation phase) and the corresponding Tributary is set to a Working Tributary.

For Operation of 1+1 ETBP, it is needed to designate a mate Standby Tributary with the same service property, source and destination. The payloads of the mate Working Tributary and Standby Tributary will carry the same traffic.

For 1:1 ETBP, it is also needed to designate a mate Standby Tributary with the same service property, source and destination. The payloads of the Standby Tributary can carry the other additional traffic (Once ETBP occurred for this Working Tributary, the additional traffic will be destroyed).

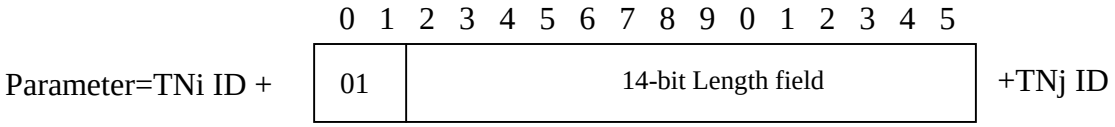
For 1:N ETBP, there are multiple Working Tributaries (e.g. number is N), it is also needed to designate a mate Standby Tributary with the same service property, source and destination. The payloads of the Standby Tributary can carry the other additional traffic (Once ETBP in one of N Working Tributary occurred, this additional traffic will be destroyed).

The CS operational codes of ETBP are listed in the Table 15.

TABLE 15/X.msr-rpr – Codes of ETBP frame

CS Frame Types	Code
1+1 ETBP_Request Frame	00100001
1+1_ETBP_Response Frame	00100010
1:1 ETBP_Request Frame	00100011
1:1_ETBP_Response Frame	00100100
1:N ETBP_Request Frame	00100101
1:N_ETBP_Response Frame	00100110
Note 1: 1+1 and 1:1 ETBP _Request Frame is a multicast frame and should be issued to four ends of two targeted Tributaries (including the working and standby tributaries) at the same time. 1:N ETBP _Request Frame is a multicast frame and should be issued to multiple ends of targeted Tributaries (including the N working tributaries and a standby tributary) at the same time. Note 2: Operation of Control frame for tributary between MAC and client will be implemented via MA_Data Request and Indication primitives defined in section 5.3 of P802.17 D1.1.	

The parameters of 1+1 ETBP_Request Frame and 1:1 ETBP_Request Frame have the same format as that of the unicast mode of TCCR ID. This parameter consists of TNi ID (This is an identifier of Tributary p within node x), 2-bit U/M/B field, 14-bit length field (This filed is used to reflect the total number of Tributary TNj ID following length field, its value should be binary 000000 00000001) and a TNj ID (This is an identifier of Tributary q within node y).



Full duplex point-to-point Mode

Note: TNi ID=NAx(x=1,2,3…32)+TT+TNp (p=0,1,2,3,…2^{20}-1), to identify the pth Tributary with the fixed TT and TN value within xth node. TNi ID and TNj ID stand for standby and working tributary respectively.

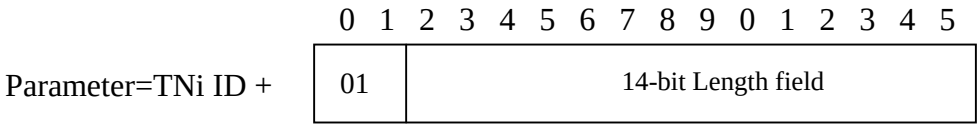
Figure 12/X.msr-rpr

Expressions of 1+1 and 1:1 tributary protection parameters

The parameters of 1+1 ETBP_Response Frame and 1:1 ETBP_Response Frame are the same as that of 1+1 ETBP_Request Frame and 1:1 ETBP_Request Frame respectively.

The parameters of 1:N ETBP_Request Frame have the same format as that of the multicast/broadcast mode of TCCR ID. This parameter also consists of TNi ID (This is an identifier of Tributary p within node x), 2-bit U/M/B field, 14-bit length field (This filed is used to reflect the

total number of Tributary TNj ID following length field, its value should be binary 000000 00000001) and a TNj ID (This is an identifier of Tributary q within node y).



+TNj ID +TNk ID + TNm ID +……

Full duplex point-to-point Mode

Note: TNi ID=NAx(x=1,2,3…32)+TT+TNp (p=0,1,2,3,…2^{20}-1), to identify the pth Tributary with the fixed TT and TN value within xth node. TNi ID is used to present standby tributary, and TNi ID, TNk ID and TNm ID etc represent working tributary, the total number is N.

Figure 13/X.msr-rpr

Expressions of 1:N tributary protection parameter

The parameters of 1+1 ETBP_Response Frame, 1:1 ETBP_Response Frame and 1:N ETBP_Response Frame are specified in the Table 16.

TABLE 16/X.msr-rpr – Parameters of ETBP _Response Frame

CS Frame Types	Code
ETBP successful	Binary “00000001 00010001 00000001 00000000”
ETBP unsuccessful	Binary “00000001 00010010 00000001 00000000”
Note 1: Operation of Control frame for tributary between MAC and client will be implemented via MA_Data Request and Indication primitives defined in section 5.3 of P802.17 D1.1.	

The ETBP Function Unit is used to monitor the link status of receiving the peer link frames at the reference point T1/T2. It is local matter only and has not any associated frame to be used between the two sides.

--After initialization (the defaults of T_etbp and N_etbp are set to 10 mill-seconds and 4 respectively), the link entity enters the normal way of transmitter and receiver.
--If the timer T_etbp expires before any MAC frame is received or status report from RPR MAC layer by MA_CONTROL Indication or MA_DATA Indication occurs with one or more opcodes (receptionStatus, serviceClass, topochange, protchange), the link entity shall restart timer T_etbp and decrement the retransmission counter N_etbp.
-- If the timer T_etbp expires and retransmission counter N_etbp has been decremented to zero before any MAC frame from the aggregate is received or status report from RPR MAC layer by MA_CONTROL Indication or MA_DATA Indication occurs with one or more opcodes (

receptionStatus, serviceClass, topochange, protchange), the link entity of the aggregate shall inform the all local Tributary entities (within a node), which are set to have the other protection Tributary, of error report by sending a Error-Hello message from entity of the aggregate to those entities of Tributary within that node. After getting Error-Hello, the local Tributary entity will perform an action of ETBP (1+1, 1:1 or 1:N) to the corresponding Standby Tributary within the same node,

change previous transmission channel of aggregate to the counter-rotating ringlet of pre-setting. After the entity of Tributary enters into the normal transmission operation, the local aggregate entity will restart timer T_etbp and recover the value of N_etbp. Every Standby Tributary has its T_etbp and N_etbp of itself.

--For the case of 1:1 and 1:N, after the ETBP Function Unit receives Error-Hello message, the link entity in the transmit side will perform an action of ETBP (1:1 or 1:N) to the corresponding Standby Tributary.

--The value of T_etbp and N_etbp shall be configurable. The minimum unit configured of T_etbp and N_etbp is 1 milliseconds and 1 respectively.

Once ETBP Function Unit detects that the failure span is recovered and enters normal status from the TTBP (that is, stop Error-Hello Message), ETBP Function Unit will wait T_etbp_wtr (The default to 10 minutes, its value is also programmable and should be much greater than T_ttbp), and then switch to the Working Tributary. After switching to the Working Tributary, ETBP Function Unit issues an ETBP_RECOVERY_EVENT_Report with parameters of TT and TN to network management entity.

10.2 TCE Tributary Based Protection (TTBP)

When needed to support the TTBP function, TTBP Function Unit embedded in the corresponding Tributary in XP entity will be activated by the configuration of network management (this configuration is performed either in the projection installation phase or RPR on-line operation phase) and the corresponding Tributary is set to a Working Tributary.

For Operation of 1+1 TTBP, it is needed to designate a mate Standby Tributary with the same service property, source and sink. The payloads of the mate Working Tributary and Standby Tributary carrying the same traffic are required.

For 1:1 TTBP, it is also needed to designate a mate Standby Tributary with the same service property, source and sink. The payloads of the Standby Tributary can run the other additional traffic (Once TTBP occurred for this Working Tributary, the additional traffic will be dropped out).

For 1:N TTBP, there are N Working Tributaries; it is also needed to designate a mate Standby Tributary with the same service property, source and sink. The payloads of the Standby Tributary can run the other additional traffic (Once TTBP in one of N Working Tributary occurred, this additional traffic will be dropped out).

The CS operational codes of TTBP are listed in the Table 17.

TABLE 17/X.msr-rpr – Codes of TTBP frame

CS Frame Types	Code
1+1 TTBP_Request Frame	00100111
1+1_TTBP_Response Frame	00101000
1:1 TTBP_Request Frame	00101001
1:1_TTBP_Response Frame	00101010
1:N TTBP_Request Frame	00101011
1:N_TTBP_Response Frame	00101100

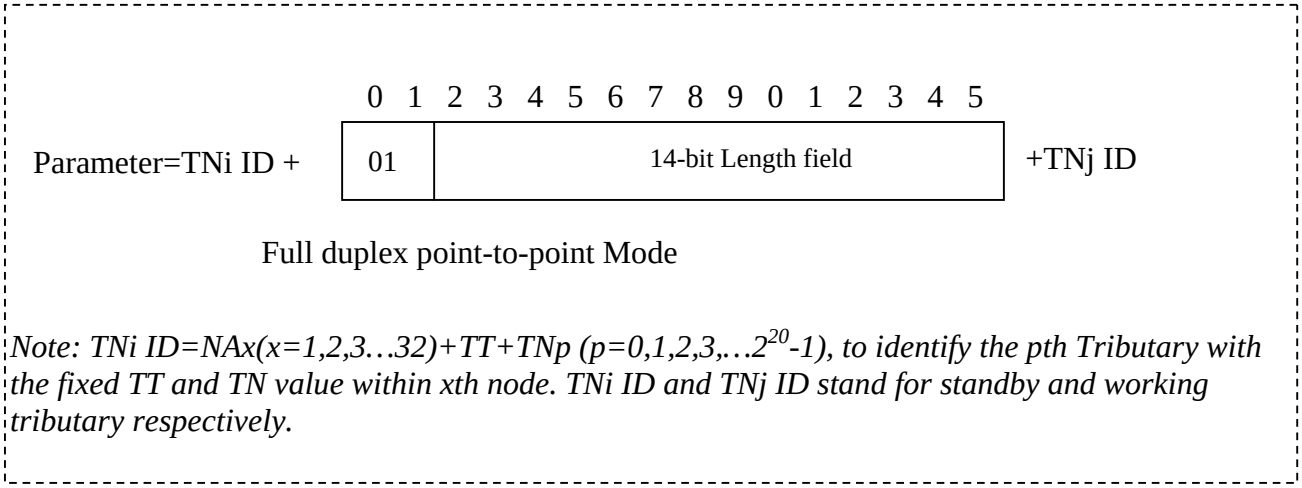
TTBP_RECOVERY_EVENT_Report	00101101
Node 1: Operation of Control frame for tributary between MAC and client will be implemented via MA_Data Request and Indication primitives defined in section 5.3 of P802.17 D1.1. Note 2: 1+1 and 1:1 TTBP _Request Frame is a multicast frame and should be issued to four ends of two targeted Tributaries (including the working and standby tributaries) at the same time. 1:N TTBP _Request Frame is a multicast frame and should be issued to multiple ends of targeted Tributaries (including the N working tributaries and a standby tributary) at the same time.	

The parameters of the 1+1, 1:1 and 1:N TTBP Response frame in this sub-section are specified in Table 18.

TABLE 18/X.msr-rpr – Parameters of Bandwidth Limitation _Response Frame

CS Frame Types	Code
TTBP successful	Binary “00000001 00010011 00000001 00000000”
TTBP unsuccessful	Binary “00000001 00010100 00000001 00000000”
Note 1: Operation of Control frame for tributary between MAC and client will be implemented via MA_Data Request and Indication primitives defined in section 5.3 of P802.17 D1.1.	

The parameters of 1+1 TTBP_Request Frame and 1:1 TTBP_Request Frame have the same format as that of the unicast mode of TCCR ID. This parameter consists of TNi ID (This is an identifier of Tributary p within node x), 2-bit U/M/B field, 14-bit length field (This filed is used to reflect the total number of Tributary TNj ID following length field, its value should be binary 000000 00000001) and a TNj ID (This is an identifier of Tributary q within node y).



Note: TNi ID=NAx(x=1,2,3…32)+TT+TNp (p=0,1,2,3,…2^{20}-1), to identify the pth Tributary with the fixed TT and TN value within xth node. TNi ID and TNj ID stand for standby and working tributary respectively.

Figure 14/X.msr-rpr

Expressions of 1+1 and 1:1 tributary protection parameters

The parameters of 1+1 TTBP_Response Frame and 1:1 TTBP_Response Frame are the same as that of Request primitives above.

The parameters of 1:N TTBP_Request Frame have the same format as that of the multicast/broadcast mode of TCCR ID. This parameter also consists of TNi ID (This is an identifier of Tributary p within node x), 2-bit U/M/B field, 14-bit length field (This filed is used to reflect the total number of Tributary TNj ID following length field, its value should be binary 000000 00000001) and a TNj ID (This is an identifier of Tributary q within node y). Please refer to as Figure 15.

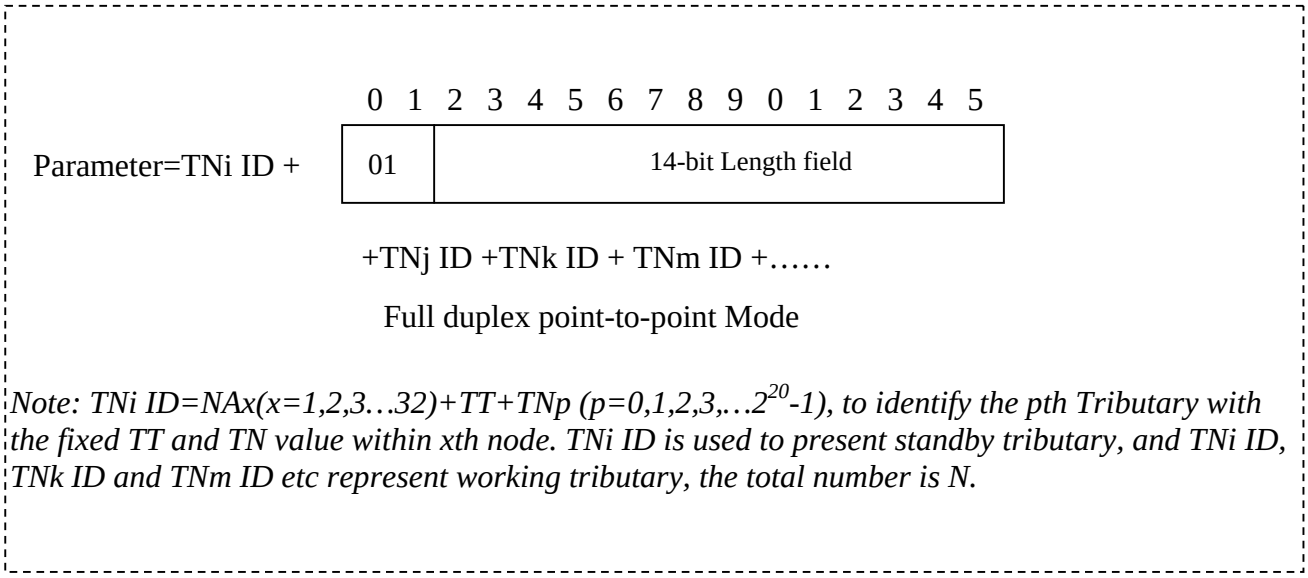


Figure 15/X.msr-rpr

Expressions of 1:N tributary protection parameter

The TTBP Function Unit is used to monitor the link status of Tributary by monitoring the peer link frames of an aggregate. Normally, the entity in the receive side of aggregate does always receive or transit the MAC frame from the upstream node. No link-error occurs and no Error-Hello is also sent to the local Tributary entity within a node. It is local matter only and has not any associated frame to be used between the two sides.

--After initialization (the defaults of T_ttbp and N_ttbp are set to 10 mill-seconds and 3 respectively), the link entity enters the normal way of transmitter and receiver.
--If the timer T_ttbp expires before any MAC frame from the aggregate is received or status report from RPR MAC layer by MA_CONTROL Indication or MA_DATA Indication occurs with one or more opcodes (receptionStatus, serviceClass, topochange, protchange), the link entity of aggregate shall restart timer T_ttbp and decrement the retransmission counter N_ttbp.
--If the timer T_ttbp expires and retransmission counter N_ttbp has been decremented to zero before any MAC frame from the aggregate is received or status report from RPR MAC layer by MA_CONTROL Indication or MA_DATA Indication occurs with one or more opcodes (

receptionStatus, serviceClass, topochange, protchange), the link entity of the aggregate shall inform the all local Tributary entities (within a node), which are set to have the other protection Tributary, of error report by sending a Error-Hello message from entity of the aggregate to those entities of

Tributary within that node. After getting Error-Hello, the local Tributary entity will perform an action of TTBP (1+1, 1:1 or 1:N) to the corresponding Standby Tributary within the same node, change previous transmission channel of aggregate to the counter-rotating ringlet of pre-setting. After the entity of Tributary enters into the normal transmission operation, the local aggregate entity will restart timer T_ttbp and recover the value of N_ttbp. Every Standby Tributary has its T_ttbp and N_ttbp of itself.

--The value of T_ttbp and N_ttbp shall be configurable. The minimum unit configured of T_ttbp and N_ttbp is 1 milliseconds and 1 respectively.

Once TTBP Function Unit detects that the failure span is recovered and enters normal status from the TTBP, TTBP Function Unit will wait T_ttbp_wtr (The default to 10 minutes, its value is also programmable and should be much greater than T_ttbp), and then switch to the Working Tributary. After switching to the Working Tributary, TTBP Function Unit issues a TTBP_RECOVERY_EVENT_Report with parameters of TT and TN to network management entity.

11 Tributary Based Multicast (TBM)

The Tributary of this section is a logical service channel defined in section 3, such as TCE with a fixed value of Tributary Type (TT) and Tributary Number (TN) in the RPR frame. The application scope of Tributary Based Multicast (TBM) is located at the operation of half-duplex point-to-multi-point only. The full-duplex point-to-point will not be recommended to the scope of this section.

The TBM Function Unit built in a Node is defined to support one or more independent hierarch of multicast possibly involved the same or different TT at the same time. TBM Function Unit implements a duplication function within a node (station) from a Tributary getting a payload of a frame from the related topologies to other multiple Tributary with the same TT value and with being set to have a relation of membership group. A group of TN with the same TT value within a Node can be set to become a membership group of multicast/broadcast. It is required that a designated Tributary in the membership group should receive data frames at the reference point G1 from the related topologies. This Recommendation defines this designated Tributary as a Source Tributary (ST). Once getting data frames either from RPR MAC frame or from tributary side, the ST duplicates those frames to every Tributary in the corresponding membership group within a node. The ST should be set and designated to a given value of TT and TN by network management entity during the project installation phase or on-line operation phase. The one or more STs can be designated or changed dynamically within a node according to the customer requirements.

The CS operational codes of TBM are listed in the Table 19.

TABLE 19/X.msr-rpr – Codes of TBM frame

CS Frame Types	Code
TBM_Request Frame	00101101
TBM_Response Frame	00101110
Note 1: Operation of Control frame for tributary between MAC and client will be implemented via MA_Data Request and Indication primitives defined in section 5.3 of P802.17 D1.1.	

If a TBP is applied to operation of TBM, it is recommended that a ST be designated to a Working Tributary, and the ST can also be operated to become the working Tributary of 1+1 and 1:1 application described in section 10.1 and 10.2.

The parameters of TBM_Request and TBM_Response frame in this sub-section are specified in Table 20 if the multicast/broadcast field is changed from "01" to "10" or "11".

TABLE 20/X.msr-rpr – Parameters of TBM _Response Frame

CS Frame Types	Code
TBM successful	Binary "00000001 00010101 00000001 00000000"
TBM unsuccessful	Binary "00000001 00010110 00000001 00000000"
Note 1: Operation of Control frame for tributary between MAC and client will be implemented via MA_Data Request and Indication primitives defined in section 5.3 of P802.17 D1.1.	

12 Bandwidth Policing, Merging, Line-Speed Filtering, Stacking and Mirroring of Tributary

12.1 Tributary Based policing -- Bandwidth Limitation with symmetry and asymmetry

TCE rate at XP service boundary should be operated and be fully compliant with the IEEE 802.3, G.702, ISDN and other related standards in the normal case. But in some application of service level agreement, the policy of operation and maintenance needs a limitation for rate to perform the bandwidth-based accounting. The RPR entity provides a Bandwidth Limitation Function Unit. When this Function Unit is activated to a Tributary, this Tributary provides configuration incremental level with minimum unit granularity (64 k/bits for TCE) from 0 to the standard value. The corresponding standard values of bandwidth are specified in the related standard and must not be passed over. Once bandwidth is set up for a Tributary during project installation or on-line operation phase, this programmable threshold limit applies to this Tributary and its corresponding port. The setting of bandwidth threshold and monitoring of actual traffic flow are performed by configuration function and management entity.

The CS operational codes of Bandwidth Limitation are listed in the Table 21.

TABLE 21/X.msr-rpr – Codes of Bandwidth Limitation frame

CS Frame Types	Code
Bandwidth Limitation _Request Frame	00101111
Bandwidth Limitation _Response Frame	00110000
Note 1: Operation of Control frame for tributary between MAC and client will be implemented via MA_Data Request and Indication primitives defined in section 5.3 of P802.17 D1.1. Note 2: Bandwidth Limitation _Request Frame is a multicast frame and should be issued to two ends of targeted Tributary at the same time.	

The parameter of Bandwidth Limitation _Request Frame includes the following elements:

- Targeted (Tributary) Port A: TNi = NAx + TT + TNp

- Targeted (Tributary) Port B: TNj = NAy + TT + TNq
- Bandwidth required to be provided from Port A to Port B: a designated integer value (an octet) between 0 and Standard Bandwidth, e.g. binary code:01000100 represents 68*64 k/bits Bandwidth.
- Bandwidth required to be provided from B to A: a designated integer value (an octet) between 0 and Standard Bandwidth, e.g. binary code:00100000 represents 32*64 k/bits Bandwidth (This is an example of asymmetrical bandwidth availability), binary code:00000000 represents no Bandwidth available, it is needed that customers use the operation of half duplex point-to-point from port A to port B.
- Standard Bandwidth: the related standard (binary code of G.702 E1: 00100000) for TCE
- Minimum Granularity: 64 k/bits (binary code:00000001) for TCE

Bandwidth from port A to port B and from port B to port A is independent each other. The separated bandwidth can be symmetrical or asymmetrical. All of these elements will be mapped to CS frame in the above order. Bandwidth Limitation _Response Frame uses two parameters: Bandwidth Limitation successful or Bandwidth Limitation unsuccessful shown in the Table 22.

TABLE 22/X.msr-rpr – Parameters of Bandwidth Limitation _Response Frame

CS Frame Types	Code
Bandwidth Limitation successful	Binary “00000001 00010111 00000001 00000000”
Bandwidth Limitation unsuccessful	Binary “00000001 00011000 00000001 00000000”
Note 1: Operation of Control frame for tributary between MAC and client will be implemented via MA_Data Request and Indication primitives defined in section 5.3 of P802.17 D1.1.	

Bandwidth Limitation of Tributary Based can be used to operations of half duplex point-to-point, full duplex point-to-point, multicast and broadcast.

12.2 Tributary Merging with symmetry and asymmetry

The RPR entity provides a Merging Function Unit by which up to sixteen Tributaries of the same TT can be merged together to form a Tributary Merging Group (TMG). Up to eight TMGs can be established in a RPR or other topology node. The TMG is similar to one logical link and is very useful when the higher bandwidth of application is required. The member Tributary of a TMG must be of the same TT and configured in full-duplex mode. The benefits of forming a TMG are link redundancy, aggregate throughput, incremental bandwidth and load balancing on the TMGs. Once a TMG is formed, a TMG of TCE must be identified using only a TN value (It is usual the first member Tributary) in the corresponding frames of data, signalling and network management. For the upper layer application over a TMG, a logical channel can only be seen externally.

The CS operational codes of Tributary Merging are listed in the Table 23.

TABLE 23/X.msr-rpr – Codes of Tributary Merging frame

CS Frame Types	Code

Tributary Merging _Request Frame	00110001
Tributary Merging _Response Frame	00110010
Note 1: Operation of Control frame for tributary between MAC and client will be implemented via MA_Data Request and Indication primitives defined in section 5.3 of P802.17 D1.1.	

The parameter of Tributary Merging_Request Frame includes the following elements:

- First Targeted Tributary: TNi = NAx + TT + TNp
- Second Targeted Tributary: TNj = NAy + TT + TNq
- Third Targeted Tributary: TNk = NAz + TT + TNr
- Fourth Targeted Tributary: ……..

Tributary Merging from A to B and from B to A is independent each other. The Tributary Merging of two half-duplex channels can be symmetrical or asymmetrical. All of these elements will be mapped to CS control frame in the above order. Tributary Merging _Response Frame uses two parameters: Tributary_Merging_successful or Tributary_Merging_unsuccessful shown in the Table 24.

TABLE 24/X.msr-rpr – Parameters of Tributary Merging _Response Frame

CS Frame Types	Code
Tributary_Merging_successful	Binary “00000001 00011001 00000001 00000000”
Tributary_Merging_unsuccessful	Binary “00000001 00011010 00000001 00000000”
Note 1: Operation of Control frame for tributary between MAC and client will be implemented via MA_Data Request and Indication primitives defined in section 5.3 of P802.17 D1.1.	

Tributary Merging can be used to operations of half duplex point-to-point and full duplex point-to-point.

12.3 Tributary Based Security -- Line-Speed Filtering

The RPR entity provides a Line-Speed Filtering Function Unit (LSFFU) of Tributary based to Content-Aware frame classification, which enables a node processing application to filter and classify frames based on certain protocol fields of upper layer in the payload of frame. Filters can be set on the defined fields from Layer 2 to Layer 4 within a frame. LSFFU of a node can filter individual ingress or egress ports of Tributary. Filtering algorithm uses two constructs, (a) the filter mask, which defines which fields to filter, and (b) the rules table, which defines the filtering options. Up to 48 filters are available, each containing a 64-byte wide shuttered filter mask value to apply on any protocol field at any offset within the first 96 bytes of the incoming frame. The rule table is up to 256 entries deep for TCE Tributary.

Once the classification results and filter match or partial match have been gotten, the following policies can be taken, or in their combination:

• Modification of the IP Type Of Service (TOS precedence) field
• Delivery of a copy of the related frames to the domain of management

• Discarding the related frames
• Transferring the related frames to other egress port of a Tributary
• Transmission of a copy of the related frames to the "mirrored to" Tributary
• Modification of protocol field

The LSFFU provides the ability to track and profile up to 1024 data flows. The traffic on these data flows can be monitored or regulated via internal meters and has the ability to assign two independent policies to the profile status of a data flow and execute these actions at line rate.

The CS operational codes of Line-Speed Filtering are listed in the Table 25.

TABLE 25/X.msr-rpr – Codes of Line-Speed Filtering frame

CS Frame Types	Code
Line-Speed Filtering _Request Frame	00110011
Line-Speed Filtering _Response Frame	00110100
Note 1: Operation of Control frame for tributary between MAC and client will be implemented via MA_Data Request and Indication primitives defined in section 5.3 of P802.17 D1.1.	

The parameter of Line-Speed Filtering _Request Frame includes the following elements:

- Targeted Tributary: TNi = NAx + TT + TNp
- Modification of the IP Type Of Service (TOS precedence) field, binary code:10000001 , the detailed operation is under study. Otherwise, binary code:00000000 will be used.
- Delivery of a copy of the related frames to the domain of management, binary code: 10000010 represents that action of “Delivery of a copy of the related frames to the domain of management” will be taken. Otherwise, binary code:00000000 will be used.
- Discarding the related frames, binary code: 10000011 represents that action of “Discarding the related frames” will be taken. Otherwise, binary code:00000000 will be used.
- Transferring the related frames to other egress port of a Tributary, binary code: 10000100 represents that action of “Transferring the related frames to other egress port of a Tributary (This Tributary is presented as TNj = NAx + TT + TNq)” will be taken. So the octet “10000100” plus “TNj” will be used for this function. Otherwise, binary code:00000000 will be used.
- Modification of protocol field, binary code: 10000101, the detailed operation is under study. Otherwise, binary code:00000000 will be used.

Line-Speed Filtering from A to B and from B to A is independent each other. The Line-Speed Filtering of two half-duplex channels can be selected to use or not use. All of these elements will be mapped to CS frame in the above order. Line-Speed Filtering _Response Frame uses two parameters: Line-Speed Filtering successful or Line-Speed Filtering unsuccessful shown in the Table 26.

TABLE 26/X.msr-rpr – Parameters of Line-Speed Filtering _Response Frame

CS Frame Types	Code
Line-Speed_Filtering_successful	Binary “00000001 00011011 00000001 00000000”

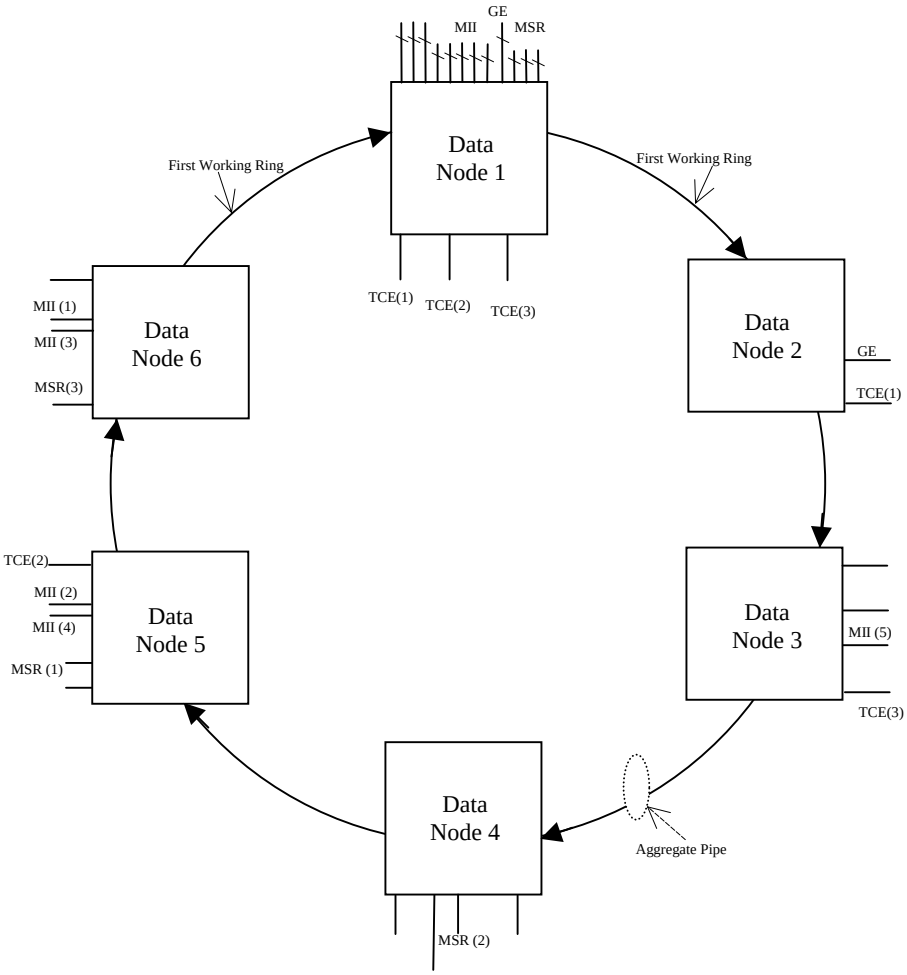
Line-Speed_Filtering_unsuccessful	Binary “00000001 00011100 00000001 00000000”
Note 1: Operation of Control frame for tributary between MAC and client will be implemented via MA_Data Request and Indication primitives defined in section 5.3 of P802.17 D1.1.	

Tributary Merging can be used to operations of half duplex point-to-point and full duplex point-to-point.

13 Topology Application of ~~Single Fibre Ring,~~ Link-type, Broadcast Network and Pseudo-mesh

~~13.1 Support of a single fibre ring~~

~~X.msr-rpr is defined for a default application on a dual-ringlet structure. In some case of access, due to the limitation of fibre resource in which two fibres are available to a ring, it is recommended that a single fibre ring shown in the Figure 16 be applied. If the topology is involved in Figure 16, steering and wrapping, fairness, data node insertion and deletion should not be used. Instead, these functions will be switched off via configuration function of the network management. The data and control packet will share the same channel and RI (Ringlet Identifier) field is always set to “0”.~~



~~**Figure 16/X.msr-rpr**~~

~~**The Single Fibre Ring of RPR**~~

13.~~2~~1 Support of a Link-type with Adding and Dropping Tributary Services

In some application, it is needed to build a link-type topology shown in the Figure ~~17~~ 16 in which the connection between Node 2 and Node 4 (it is suppositional) is one or more Tributaries. This Tributary may be a Tributary of other RPR. If the topology is involved in Figure ~~17~~16, steering and wrapping, data node insertion and deletion, fairness should not be used. Instead, these functions will be switched off via configuration function of the network management. The data and control packet will share the same channel and RI (Ringlet Identifier) field is always set to "0".

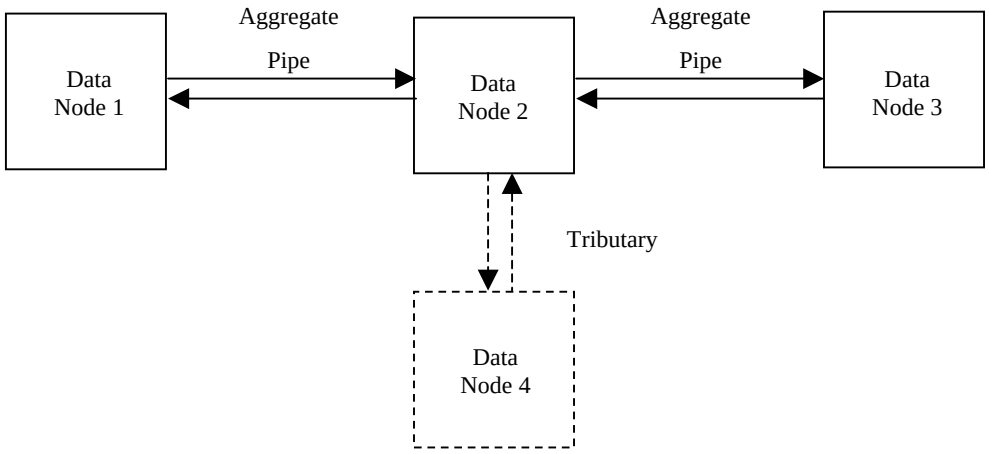


FIGURE ~~17~~16/X.MSR-RPR

A RPR Topology, Link-type with Adding and Dropping Tributary Services

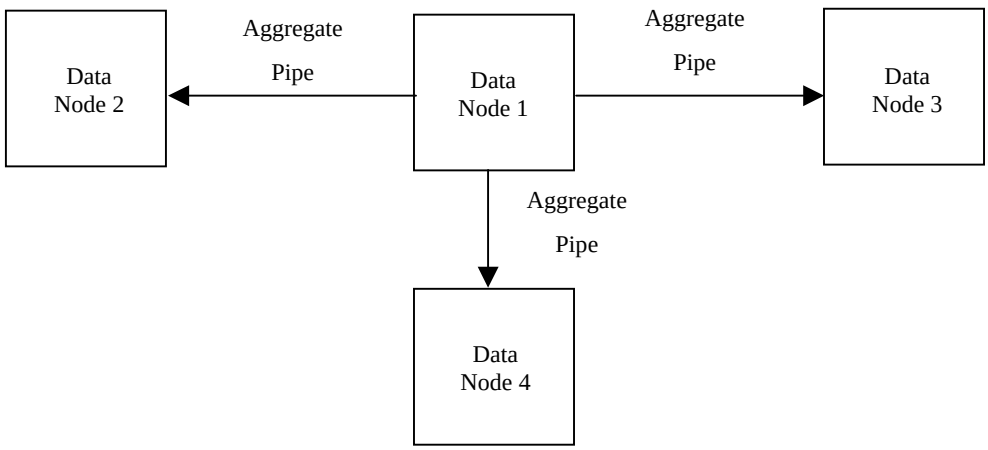


FIGURE ~~18~~17/X.MSR-RPR

A RPR Topology, Broadcast Connection to DVB Application

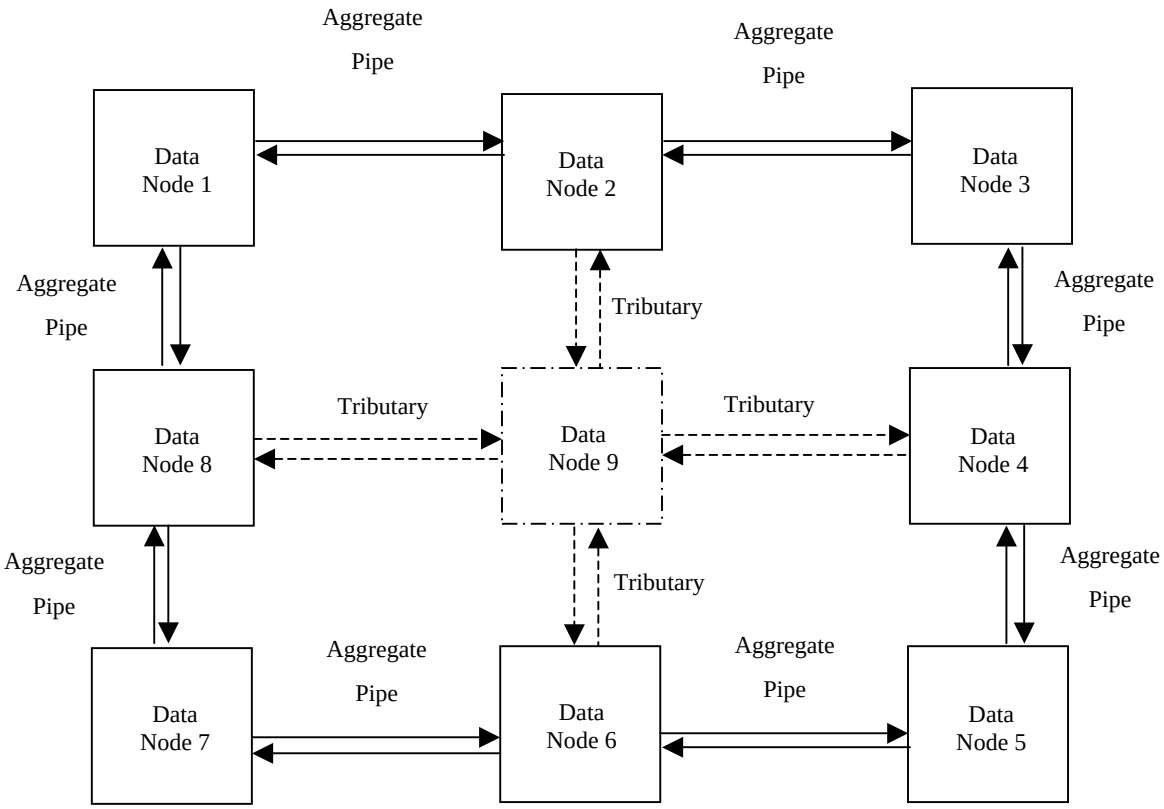


FIGURE ~~19~~18/X.MSR-RPR

A RPR Topology, Pseudo-mesh Connection

13.~~3~~2 Support of a Broadcast Connection to DVB Application

In DVB application for example, it is needed to build a broadcast network topology shown in the Figure ~~18~~ 17 in which the connections from Node 1 to Node2/3/4 are aggregate pipes of single direction. If the topology is involved in Figure ~~18~~17, the L2PS of aggregate pipe based, steering and wrapping, data node insertion and deletion, Tributary based Protection and in-band network management should not be used. Instead, these functions will be switched off via configuration function of the network management. The data and control packet will share the same channel and RI (Ringlet Identifier) field is always set to “0”.

13.~~4~~3 Support of a Pseudo-mesh Topology

Pseudo-mesh Topology presented in Figure ~~19~~ 18 is a particular example of a ring. Eight Nodes via aggregate pipe are attached together to form a ring. The Tributaries of Node 2, 4, 6 and 8 are

connected to the Node 9 (it is suppositional). In this application, all function and specifications defined in this Recommendation can be used effectively.

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