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**SERIES X: DATA NETWORKS, OPEN SYSTEM
COMMUNICATIONS AND SECURITY**

Public data networks – Transmission, signalling and
switching

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

Internet protocol aspects – Transport

Multiple services ring based on RPR

ITU-T Recommendation X.87/Y.1324



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Multiple services ring based on RPR

Summary

This Recommendation specifies Multiple Services Ring (MSR) based on Resilient Packet Ring (RPR) and a way of multi-service provision over RPR. MSR is defined to work at the client of RPR MAC layer and uses Fairness Algorithm (FA) of RPR MAC to support services of Class A, Class B and Class C. MSR is used in configurations where a tributary service is managed from provisioning. Architecturally, the link and broadcast topologies are also supported. The features of tributary (Service, just like Ethernet, Frame Relay and G.702, etc.) based 1+1, 1:1 and 1:N standby within 50 ms, tributary (Service) based BW management with symmetry and asymmetry, tributary based multicast and Frame Sequence Number for Performance Monitoring of tributary are highlighted in this Recommendation.

Source

ITU-T Recommendation X.87/Y.1324 was approved on 29 October 2003 by ITU-T Study Group 17 (2001-2004) under the ITU-T Recommendation A.8 procedure.

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FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

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Introduction

The expansion of business and metro use of data network services are driving the need to deploy data services infrastructure facilities with pre-plan method in the way of tributary or service. The dynamic bandwidth allocation and differentiated services over an aggregate pipe, tributary based bandwidth management, security function, standby, 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, voiceband signal, Digital channel supported by 64 kbit/s-based ISDN, etc. over a two-fibre ring, a link-type and broadcast topology of fibres.
- 2) Service (or tributary) based standby 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 minutes and 24 hours.
- 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 Recs 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.

Multiple services ring based on RPR

1 Scope

This Recommendation specifies Multiple Services Ring (MSR) based on Resilient Packet Ring (RPR) and a way of multi-service provision over RPR. MSR is defined to work at the client of RPR MAC layer and uses Fairness Algorithm (FA) of RPR MAC to support services of Class A, Class B and Class C. MSR is used in configurations where a tributary service is managed such that over provisioning does not occur. Architecturally, the link and broadcast topologies are also supported. The features of tributary (Service, just like Ethernet, Frame Relay and G.702, etc.) based 1+1, 1:1 and 1:N standby within 50 ms, tributary (Service) based Bandwidth management with symmetry and asymmetry, tributary based multicast and Frame Sequence Number for Performance Monitoring of tributary are highlighted in this Recommendation. MSR provides a packet-based transport model to multiple services and multiple topologies.

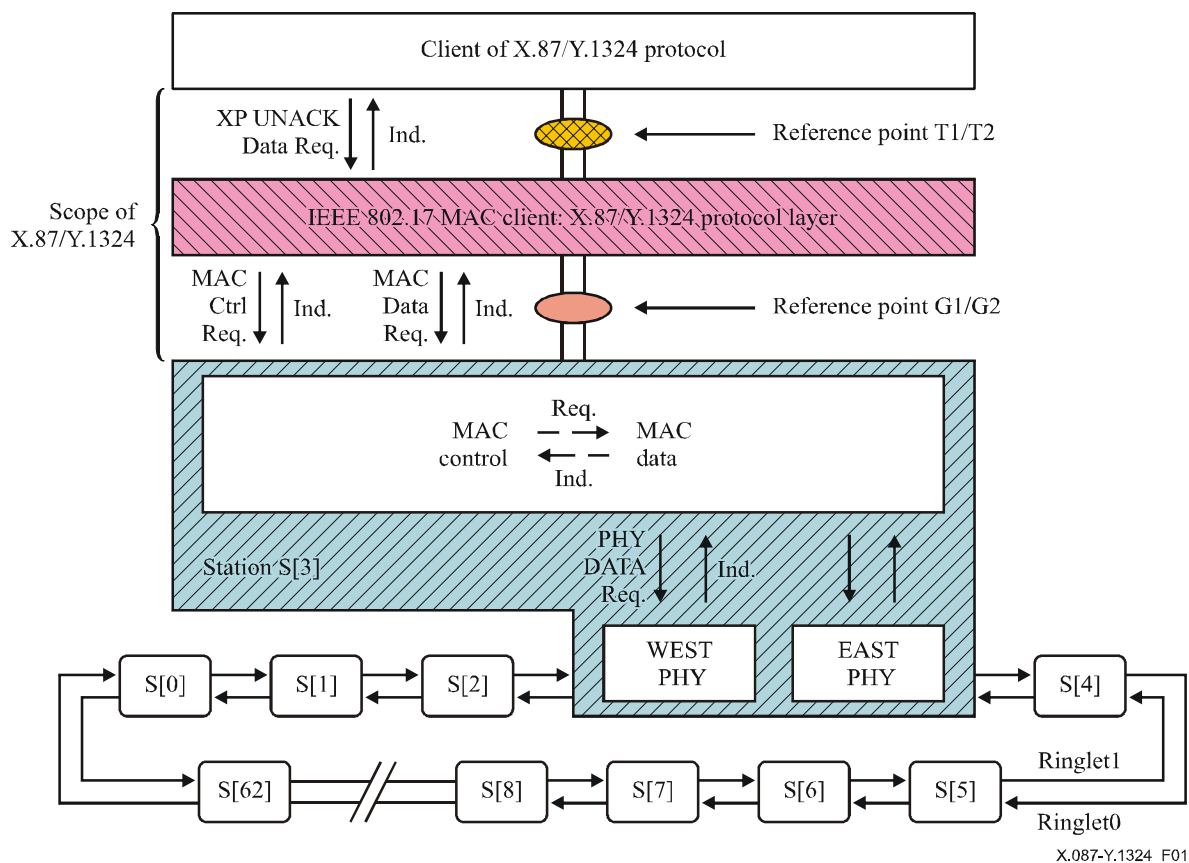


Figure 1/X.87/Y.1324 – Scope of X.87/Y.1324 based on RPR as a MAC client

This Recommendation is based on RPR as a MAC client and is used in configurations where topology and standby is provisioned. What this Recommendation emphasizes is tributary, but not a payload of tributary; standby (1+1, 1:1 and 1:N) and multicast of tributary, but not multicast of MAC; MSR priority, but not MAC priority. The data frame, control frame and network management frame in this Recommendation are all required to map to the payload of RPR data frame. Some control frames RPR defined are also used in X.87/Y.1324, just like topology discovery, protection and FA in RPR. All of these frames specified in this Recommendation have no relations to and are independent of 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. This Recommendation is located at a dual-directional symmetric counter-rotating rings based on RPR.

NOTE – It is intended that this Recommendation 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; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

2.1 ITU-T Recommendations

- [1] ITU-T Recommendation X.85/Y.1321 (2001), *IP over SDH using LAPS*.
- [2] ITU-T Recommendation X.86/Y.1323 (2001), *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 Systems 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 Standard 1802.3-2001, *IEEE Conformance Test Methodology for IEEE Standards for Local and Metropolitan Area Networks – CSMA/CD Access Method and Physical Layer Specifications*.

2.3 Informative Reference

- [9] IEEE Standard P802.17/D3.0 (Draft), *Resilient Packet Ring Access Method & Physical Layer Specifications – Media Access Control (MAC) Parameters, Physical Layer Interface, and Management Parameters*.

3 Definitions

This Recommendation defines the following terms:

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

3.2 control signalling frame: A frame used to tributary multicast or standby, 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 MSR ring.

3.4 CT_Response frame: A frame used to send a configuration table response from Node B to Node A along a MSR 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 MSR 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 changed (or updating) part of TCCR of a node on MSR ring is sent to other nodes (one of them called 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 having received CT_Request frame with a CTI 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 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 MSR ring during engineering operation or project installation phase. The incorrect CUT will lead to fault of Tributary on MSR ring. CT_Request frame with a CUT parameter reflecting changed (or updating) part of TCCR of all nodes on MSR 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 having received CT_Request frame will build corresponding mapping relations of TCCR in the local node and send 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 (or Ethernet) 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 operation 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 having received CT_Request frame will build corresponding mapping relations of TCCR in the local node and send 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): Bidirectional symmetric counter-rotating fibre rings, each node could add and drop one or more independent tributaries.

3.11 multiple services ring over RPR: Bidirectional 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 or services of Class A, Class B and Class C, provisioned topology and standby, RPR [9] frame format, tributary service based operation.

3.12 Resilient Packet Ring (RPR): It is defined by RPR [9], a high-speed network technology optimized 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 RPR [9] through a station via the ringlet.

3.14 RPR Tx framer: A RPR MAC framer in Tx side, it sources or passes a frame of RPR [9] through a station via the ringlet.

3.15 XP data node: A MSR node that has an eastward Rx, an eastward Tx, a westward Rx and a westward Tx Aggregate Pipe connections along MSR 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. A dual-ring structure with a pair of unidirectional counter-rotating ringlets is default and major application form.

3.16 X.87/Y.1324 Protocol (XP): A data link protocol between reference point G1/G2 and reference point T1/T2, used to communicate between different MSR nodes. The XP does operate by sending/receiving both data frame and the associated network management/signalling frames to/from an aggregate pipe of a node.

3.17 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 retransmission of 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 also programmable). N_{ct} is also used by ICT operation.

3.18 Network management frame: A frame used to performance and fault monitoring, node configuration management, etc. along a MSR ring or other different topologies.

3.19 Node Address (NA): An address that identifies a particular station on a network. NA is a OUI MAC address along the RPR ring or other different topologies. IEEE RAC assigns a value of 24 bits, manufacturer assigns the remaining 22 – local indicates a locally administered address. It is the responsibility of the administrator to ensure uniqueness.

3.20 reference point G1: A reference point between RPR MAC and its client. It stands for processing sink of RPR MAC framer in RPR MAC client side.

3.21 reference point G2: A reference point between RPR MAC and its client. It stands for processing source of RPR MAC framer in RPR MAC client side.

3.22 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.

3.23 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.

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

3.25 Timer_{ct} A Timer of retransmission used to Configuration Table Operation. A node after first power-on or during the phase needed to change configuration table on a ring will wait to be assigned ICT during configuration modification or project installation phase. After issuing CT_Request frame, Node A will automatically send CT_Request frame again after retransmission of 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 also programmable). N_{ct} is also used by CUT operation.

3.26 transit: A passing of a frame through a station via the ringlet.

3.27 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 tributaries can be assigned to different priorities.

3.28 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.

3.29 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 a dual-ring structure or other topologies, that is, source and sink connection relationship of all available tributaries.

3.30 tributary membership copy: A duplicate function implementation from Source Tributary (ST) to every Tributary in the corresponding membership group within a node.

3.31 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 hierarchies of multicast which could involve 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 Tributaries with the same TT value set to having 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 (A designated Tributary in the membership group is only allowed to get packets from ST, and is not permitted to receive all other packets). 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.

3.32 tributary Rx framer: An abstract of physical framer of Tributary at Rx side, it stands for a framer of TCE or Ethernet framer.

3.33 tributary Tx framer: An abstract of physical framer of Tributary at Tx side, it stands for a framer of TCE or Ethernet framer.

3.34 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.

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

3.36 Tx schedule: A control function for transmitted frames in a node according to the priority level of:

- a) forwarded frames from upstream node;
- b) multicast/broadcast frames; and
- c) transmitted frames 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.

3.37 XP Rx processor: A set of logical functions used to XP processing in Rx direction. It includes Rx entity from RPR MAC between reference point G1/G2 and T1/T2, discrimination of multicast/broadcast based on Tributary, TT/CS/NM value, TN value, FSN value and other associated XP protocol processing.

3.38 XP Tx processor: A set of logical 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 and FSN, multicast/broadcast from the view of RPR MAC layer. The other associated XP protocol processing is also included.

3.39 1+1 standby (tributary based, unidirectional): A 1+1 standby architecture has one normal traffic signal (packet), one working tributary, one standby tributary and a logical bridge. At the source side, the normal traffic signal (packet) is logically bridged to both the working and standby tributary. At the sink side, the normal traffic signal (packet) is selected from the better of the two tributaries. Due to the logical bridging, the 1+1 architecture does not allow an extra unprotected traffic signal (packet) to be provided.

3.40 1:N standby (tributary based, unidirectional): A 1:N standby architecture has N normal traffic signals (packet), N working tributaries and 1 standby tributary which may have an extra traffic signal (packet) in case of no defect condition (or a fault indication) or external commands for the N working tributaries. The signals (packet) on the working tributaries are the normal traffic signals (packet). The signal (packet) on the standby tributary may be either one of the normal traffic signals (packet), an extra traffic signal (packet), or the null signal (packet) (e.g., an all-ONEs signal, a test signal (packet), one of the normal traffic signals (packet)). At the source side, one of these signals (packet) is connected to the standby tributary. At the sink side, the signals (packet) from the working tributaries are selected as the normal signals (packet). When a defect condition or a fault indication is detected on a working tributary or under the influence of certain external commands, the transported signal (packet) is bridged to the standby tributary. At the sink side, the signal from this standby tributary is then selected.

3.41 automatic standby switching (tributary based) within 50 ms: Autonomous switching of a signal (packet) from a failed working tributary to a standby tributary when a defect condition or a fault indication is detected on a working tributary or under the influence of certain external commands and subsequent restoration using control signals carried by the corresponding control signalling packet.

4 Abbreviations

4.1 Abbreviations specified in RPR [9]

This Recommendation makes use of the following abbreviations specified in RPR [9]:

DA	Destination Address
FCS	Frame Check Sequence
HEC	Header Error Check
IEEE	Institute of Electrical and Electronics Engineers
LAN	Local Area Network
MAC	Medium Access Control
MAN	Metropolitan Area Network
MIB	Management Information Base
MTU	Maximum Transfer Unit
PDU	Protocol Data Unit

PHY	Physical Layer
POS	Packet Over SONET
RI	Ringlet Identifier
SA	Source Address
SDU	Service Data Unit
SNMP	Simple Network Management Protocol
SPI	System Packet Interface
TTL	Time-To-Live
WAN	Wide Area Network
WTR	Wait To Restore

4.2 Abbreviations specified in ITU-T Rec. I.321

This Recommendation makes use of the following abbreviation specified in ITU-T Rec. I.321:

ATM	Asynchronous Transfer Mode
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4.3 Abbreviations specified in ETSI

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

DVB	Digital Video Broadcast
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4.4 Abbreviations specified in this Recommendation

This Recommendation uses the following abbreviations:

AP	Access Point
CP	Connection Point
CS	Control Signalling
CT	Configuration Table
CTI	Configuration Table Inquiry
CUT	Configuration Updating Table
ETBS	Ethernet Tributary Based Standby
FE	Fairness Eligible
ICT	Initial Configuration Table
LMXP	Layer Management of X.87/Y.1324 Protocol
LSFFU	Line-Speed Filtering Function Unit
MAC	Media Access Control
MDCT	MDL Trail Multipoint Connection Point
MDL	MAC Data Link Layer
MDLLC	MDL Link Connection
MDLLF	MDL Link Flow
MDLNC	MDL Network Connection
MDLNF	MDL Network Flow

MDLSC	MDL Subnetwork Connection
MDLSF	MDL Subnetwork Flow
MPCP	Multipoint Connection Point
MSR	Multiple Services Ring
MSR-RPR	Multiple Services Ring over RPR
NA	Node Address of Resilient Packet Ring
NM	Network Management
NRV	Node Reachability Verification
OAM	Operation, Administration and Maintenance
OUI	Organizationally Unique Identifier
PFI	Payload FCS Indicator
PLAS	Pure Local Address Structure (32-bit)
PT	Payload Type
RPR	Resilient Packet Ring
Rx	Receive data
ST	Source Tributary
TBM	Tributary Based Multicast
TBS	Tributary Based Standby
TCCR	Tributary Cross-Connection Relationship
TCE	TDM Circuit Emulation
TCP	Termination Connection Point
TDM	Time Division Multiplex
TFP	Termination Flow Point
TMG	Tributary Merging Group
TN	Tributary Number
TRL	Tributary Loopback
TT	Tributary Type
TTBS	TCE Tributary Based Standby
Tx	Transmission data
U/M/B	Unicast/Multicast/Broadcast
XP	X.87/Y.1324 Protocol entity as a RPR MAC client
XPLC	XP Link Connection
XPNC	XP Network Connection
XP-PDU	XP – Protocol Data Unit
XP-SAP	XP – Service Access Point
XPSC	XP Subnetwork Connection
XP-SDU	XP – Service Data Unit

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 counter-rotating ringlets, more than one node of each with RPR MAC, RPR MAC Client and at least one Tributary. "MSR-RPR" uses OUI MAC addresses and the multicast address in support of tributary services and uses RPR frame format that allows X.87/Y.1324 to define payload within an Ethertype. MSR uses Fairness Algorithm (FA) to support services of Class A, Class B and Class C. X.87/Y.1324 is used in configurations where tributary service is managed by provisioning. Architecturally, the link, broadcast topologies are also supported. Each node could add and drop one or more independent tributaries (e.g., DVB port) and control signalling frames and network management frames. X.87/Y.1324 supports multicast and broadcast of these Tributary services and forwarding data packets.

RPR is defined in [9] and supersedes any descriptive text in X.87/Y.1324. As a result, any descriptive text on RPR functionality in this Recommendation should be considered informative.

5.2 Frame types on a ring and multiple services in tributary

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

Table 1/X.87/Y.1324 – Types of multi-service in Tributary

Tributary types	Capabilities		
TCEs	Full duplex point-to-point	Multicast of node based	Broadcast of node based
Ethernet	Full duplex point-to-point	Multicast of node based	Broadcast of node based
NOTE 1 – The bandwidth of aggregate pipe depends on deployment service requirements, the aggregate Tributary bandwidth be half of the aggregate pipe bandwidth to provide standby 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.87/Y.1324 – 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

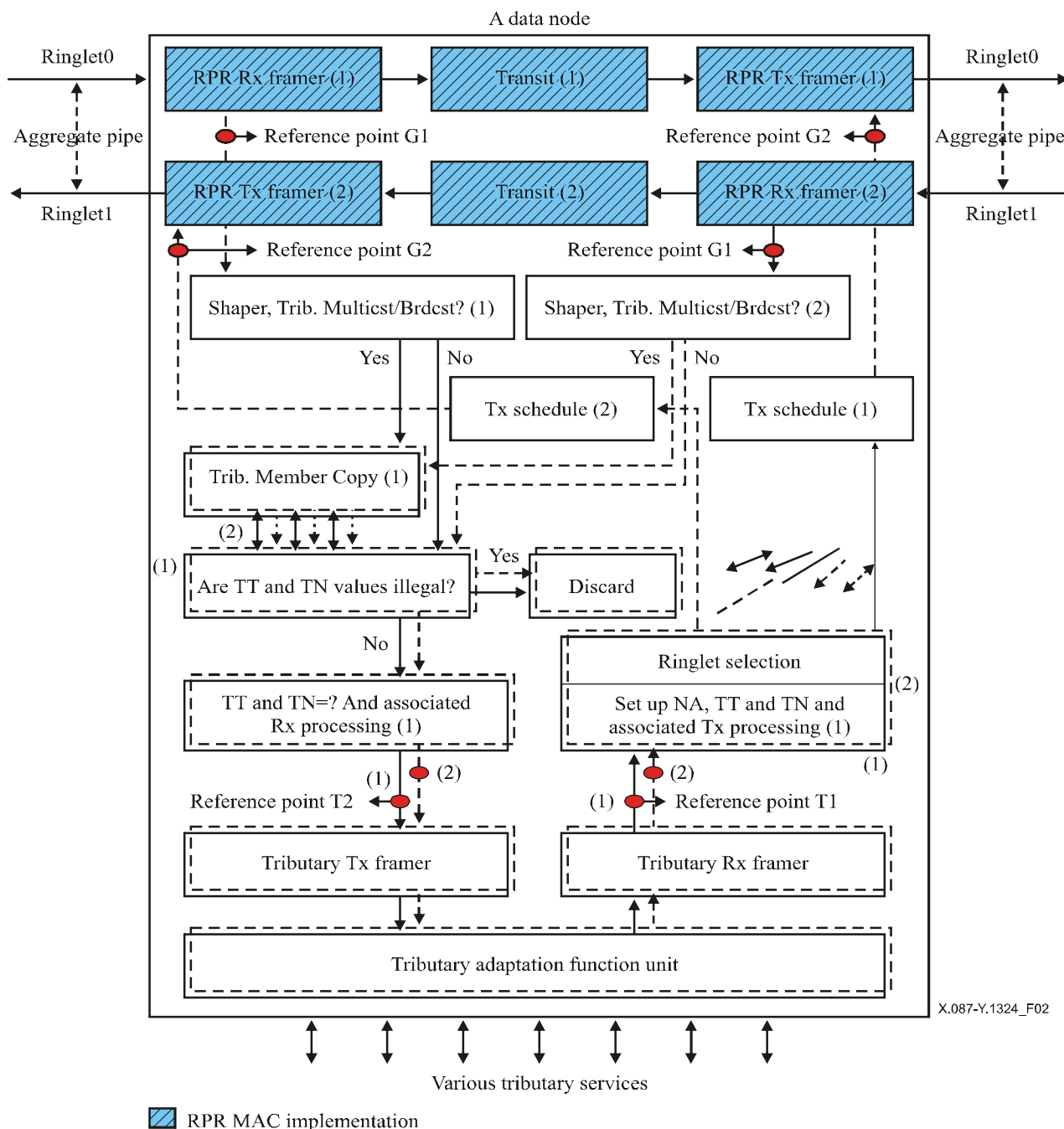


Figure 2/X.87/Y.1324 – Tx and Rx diagram of a data node

5.3 Components of a data node in MAC client

A MSR 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.87/Y.1324 node also has functions of receiving, transmitting and forwarding of network management frame, control signalling and data frame within a node. The corresponding change should be made as the different connection configuration is applied for the different topologies. The basic components and elements of a node are as follows.

5.3.1 Aggregate Pipe: A physical connection of two adjacent MSR nodes.

5.3.2 Tributary: An independent adding/dropping tributary channel to/from the MSR data nodes, just like a series "Private Line or Private Circuit for Renting from Carrier". Tributary can be a G.702 port. The different tributaries can be assigned different priorities.

- 5.3.3 Ringlet1:** An inner single ring of RPR.
- 5.3.4 Ringlet0:** 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 frames within a node according to the priority level of forwarded frames from upstream station, multicast/broadcast frames and transmitted frames from the local station. If there are several frames to be sent within a node at the same time, the schedule unit will decide which frame will be delivered 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 RPR [9] through a station via the ringlet.
- 5.3.9 RPR Tx framer:** A RPR MAC framer in Tx side, it sources or passes a frame of RPR [9] 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.
- 5.3.12 XP Rx processor:** A set of logical functions (of RPR MAC client) used to XP processing in Rx direction. It includes Rx entity to get packets from RPR MAC, discrimination of multicast/broadcast based on tributary, TT/CS/NM value, TN value, FSN value and other associated XP protocol processing.
- 5.3.13 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, TN and FSN, multicast/broadcast from the view of RPR MAC layer. The other associated XP protocol processing is also included.
- 5.3.14 Addressing (48-bit OUI):** The IEEE 48-bit OUI is generally used as MAC addresses. It contains: Individual/Group bit – identifies unicast and multicast/broadcast frames, Universal/Local bit – indicates that the address was assigned by IEEE RAC and the manufacturer and should be unique, IEEE RAC assigns a value of 24 bits, manufacturer assigns the remaining 22 – local indicates a locally administered address. It is the responsibility of the administrator to ensure uniqueness. X.87/Y.1324 will use universal address 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 and its client. 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 and its client. 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 ITU-T Rec. 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 a 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 could be one realization of the MAC layer. In that case the Destination MAC address field is used, plus TT/CS/NM and TN 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 packet based path layer network. The MDL layer network is a section layer network.

A 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 a 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, and CS or NM packets. The XP layer network contains the following transport processing functions and transport entities (see Figure 3a):

- 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).

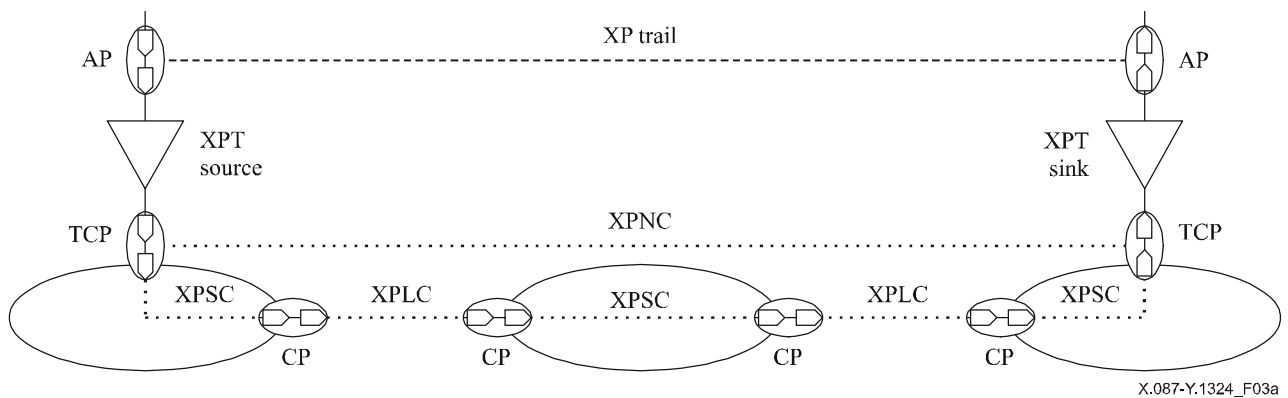


Figure 3a/X.87/Y.1324 – XP layer network example

5.5.2.1.1 XP trail termination

The XP trail termination source sends adapted information at its output, adds the *tributary traffic*, inserts CS or NM packets and generates 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 input.

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 clause 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 3b):

- 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).