802 Bridging in 802.17 Networks
Proposal to IEEE 802.17

Edited by
Robert Castellano

Annex B 802 Bridging in 802.17 Networks

B.1 Bridging overview

All types of IEEE 802 Local Area Networks (or LANs) can be interconnected using MAC bridges. Each individual LAN consists of devices attached to the LAN having the same MAC type. The bridged LAN created allows for the inter-connection of stations attached to separate LANs as if they were attached to a single LAN, although they are in fact attached to separate LANs. A transparent MAC bridge operates below the MAC service boundary, and is transparent to protocols operating above this boundary, in the logical link control (LLC) sublayer or network layer (ISO/IEC 7498-1: 1994 1). The presence of one or more MAC bridges can lead to differences in the quality of service (QOS) provided by the MAC sublayer; it is only because of such differences that MAC bridge operation may not be fully transparent.

A bridged LAN can provide for

1) The interconnection of stations attached to LANs of different MAC types;
2) An effective increase in the physical extent, the number of permissible attachments, or the total performance of a LAN;
3) Partitioning of the physical LAN for administrative or maintenance reasons.

The MAC bridge standard IEEE Std 802.1D-1990 (subsequently republished as ISO/IEC 15802-3:1998 [IEEE Std 802.1D, 1998 Edition]) specifies an architecture and protocol for the interconnection of IEEE 802 LANs below the MAC service boundary. Within this context, the RPR network defines a ring topology forming a broadcast media where specific access control mechanisms are employed by the MAC in order to achieve frame delivery and spatial reuse on the ring media. The RPR MAC entity shall provide optional functions within the MAC which optimize bridging of 802 traffic across the ring medium in order to maintain spatial reuse of unicast traffic, as illustrated in bridging reference model of Figure B.1.

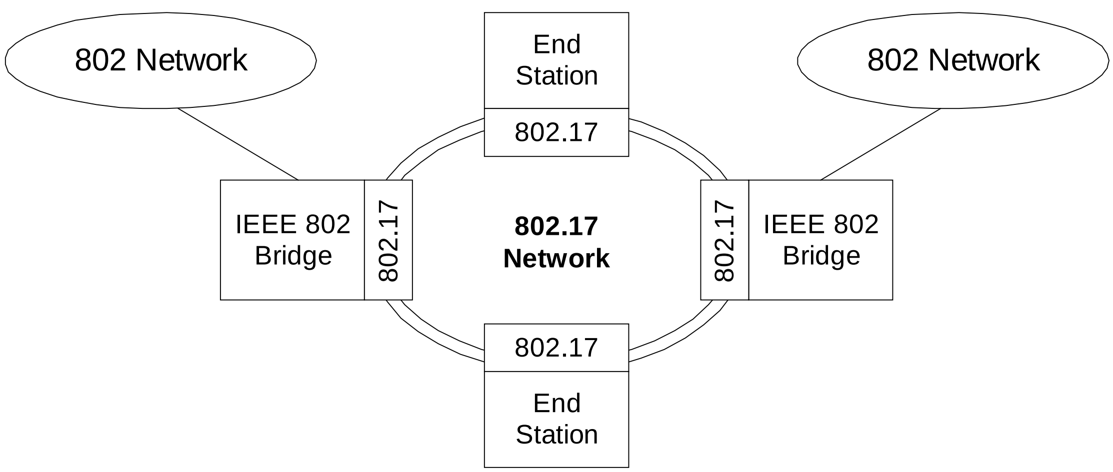


Figure B.1—Bridging Reference Model for an 802.17 network

In order to support transparent bridging of 802 traffic and maintain the spatial reuse property of the ring, the RPR MAC service interface performs the following functions : simple mapping of 802 traffic to the RPR frame format, transport of 802 traffic across the RPR physical medium and delivery of 802 traffic to either the MAC relay or intended 802.17 client at the RPR MAC service interface. The mapping function performed by the RPR MAC service interface shall conform to the interface between a MAC entity and MAC relay, and preserve the filtering services and other requirements for bridged LANs as specified in ISO/IEC 10038 [IEEE Std 802.1D, 1998 Edition], and ISO/IEC [IEEE Std 802.1q, 1998 Edition]. These services include:

1) Maintaining the bridge architecture;
2) Maintaining the nature of filtering services in bridged LANs;
3) Maintaining the extensions specified by IEEE P802.1Q to allow MAC bridges to support the definition and management of virtual LANS (VLANs);
4) Maintaining the provision of filtering services that support the dynamic definition and establishment of groups in a LAN environment, and the filtering of frames by Bridges such that frames addressed to a given group are forwarded only on those LAN segments that are required in order to reach the members of that group;
5) Supporting the registration protocol that is required in order to provide dynamic multicast filtering services;
6) Supporting management services and operations that are required in order to support administration of dynamic multicast filtering services;
7) Maintaining the provision of expedited traffic capabilities, to support the transmission of time-critical information in a LAN environment;
8) Maintaining the concept of traffic classes and the effect on the operation of the forwarding process of supporting multiple traffic classes in bridges;
9) Maintaining the spanning tree algorithm and protocol;
10) Maintaining the generic attribute registration protocol (GARP);
11) Maintaining the GARP multicast registration protocol (GMRP);

B.2 Architectural model of a bridge

The RPR MAC conforms to the architectural model of a bridge as defined by IEEE 802.1D. The component LANs are interconnected by means of MAC bridges; each port of a MAC bridge connects to a single LAN. Figure B.2 illustrates the architecture of such a bridge.

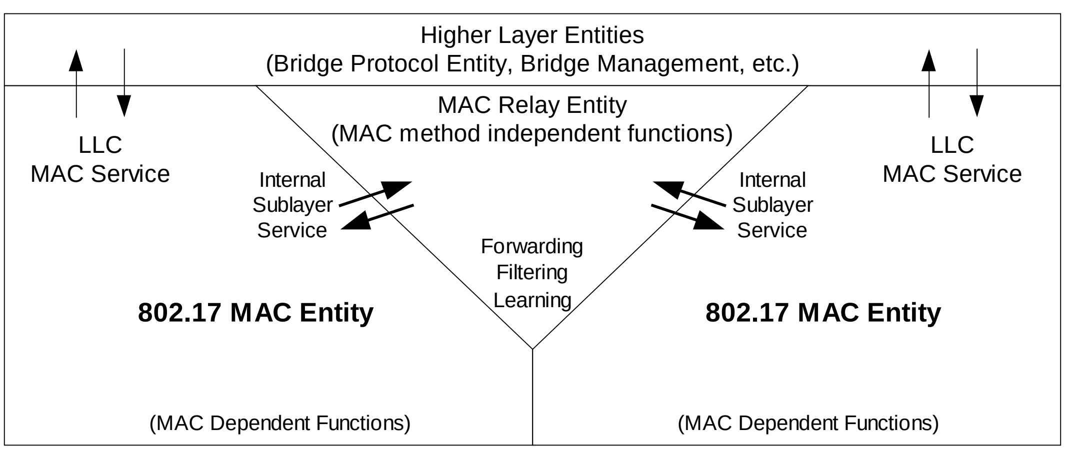


Figure B.2—Bridge architecture model

A bridge consists of:

1) A MAC relay entity that interconnects the bridge's ports;
2) At least two ports;
3) Higher layer entities, including at least a bridge protocol entity.

B.2.1 MAC relay entity

The MAC relay entity handles the MAC method independent functions of relaying frames between bridge ports, filtering frames, and learning filtering information. It uses the internal sublayer service provided by the separate MAC entities for each port. Frames are relayed between ports attached to different LANs.

B.2.2 Ports

Each bridge port transmits and receives frames to and from the LAN to which it is attached. An individual MAC entity permanently associated with the port provides the internal sublayer service used for frame transmission and reception. The MAC entity handles all the MAC method dependent functions (MAC protocol and procedures) as specified in the relevant standard for that IEEE 802 LAN MAC technology.

B.2.3 Higher layer entities

The bridge protocol entity handles calculation and configuration of bridged LAN topology.

The bridge protocol entity and other higher layer protocol users, such as bridge management (7.1.3) and GARP application entities including GARP participants (Clause 12), make use of logical link control procedures. These procedures are provided separately for each port, and use the MAC service provided by the individual MAC Entities.

B.3 RPR MAC bridging reference model

The MAC reference model is illustrated in Figure B.3. The RPR MAC consists of a MAC entity which provides the media access control functions to the pair of ringlets (ringlet0/ringlet1) comprising the RPR ring. The transit function within the RPR MAC entity processes frames which are intended for other RPR stations on the ring. The transit function takes frames from the receive side of the ringlet and presents them to the transmit side of the ringlet. Traffic received from either ringlet_0 or ringlet_1, intended for this RPR station, is passed up to the 802.17 MAC client and 802.17 internal sublayer service which in turn passes ingress traffic to the 802 MAC relay entity. The 802 MAC relay performs forwarding, filtering, learning functions between this RPR interface and other 802 type interfaces within the bridge. Traffic from the 802 MAC Relay destined to the ring is presented to the RPR internal sublayer service and 802.17 MAC client which in turn determines whether to transmit the traffic on either ringlet_0, ringlet_1, or in some cases both. The 802.17 MAC client performs the mapping between client MAC addresses and 802.17 station Ids, ringlet selection, frame replication, and ringlet queueing on the egress path to the MAC. The MAC client also performs client MAC address and station ID updates to the station ID mapping table for traffic on the ingress path.

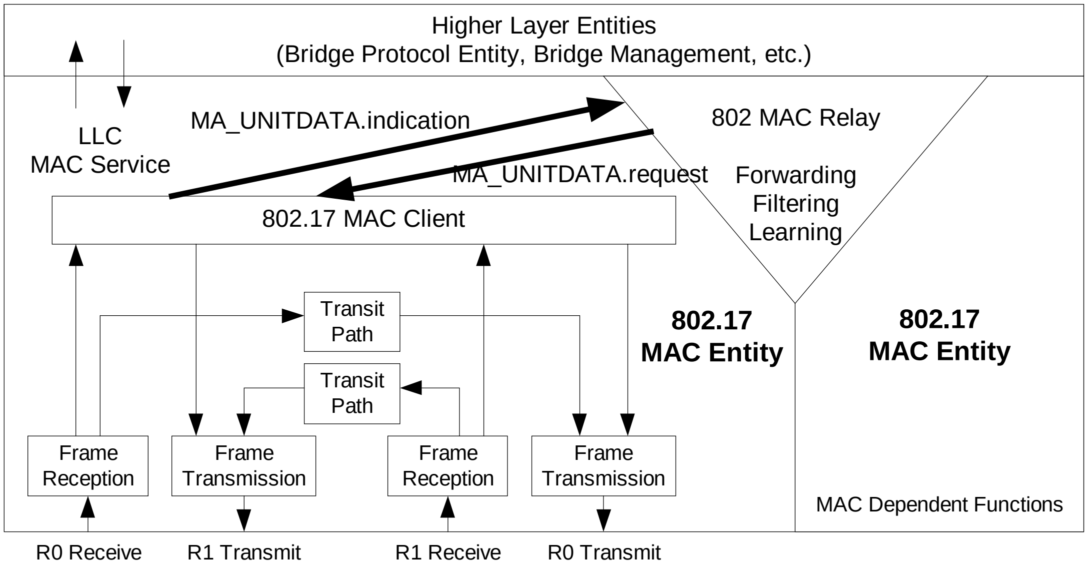


Figure B.3—RPR MAC reference model

The RPR MAC entity appears as a single interface to the 802 MAC relay. This means the RPR ring media and the collection of stations which attach to the ring appears to the 802 MAC relay as a single loop free broadcast media. The RPR MAC ensures that a frame is delivered to the intended RPR station (in the case of a known unicast) or is delivered to all stations (in the cast of a multicast, broadcast or unknown frame). The RPR MAC also ensures that only a single copy of a frame is delivered to the 802.17 internal sublayer service within each station. RPR MAC procedures ensure that duplicate copies of a frame are not transferred to the 802.17 internal sublayer service (ISS). This includes scenarios where the ring is in a normal operating configuration, or frames are being wrapped or steered during a ring failure. Since the RPR ring behaves as a loop free broadcast media, spanning tree protocol is not required on the 802.17 ring when the ring attaches to a loop free network. Spanning tree protocol is required over an RPR ring when multiple 802 networks attached to multiple 802.17 stations forming loops through the 802.17 network. The RPR MAC entity provides LLC services to support the bridge protocol entity and other higher layer protocol users.

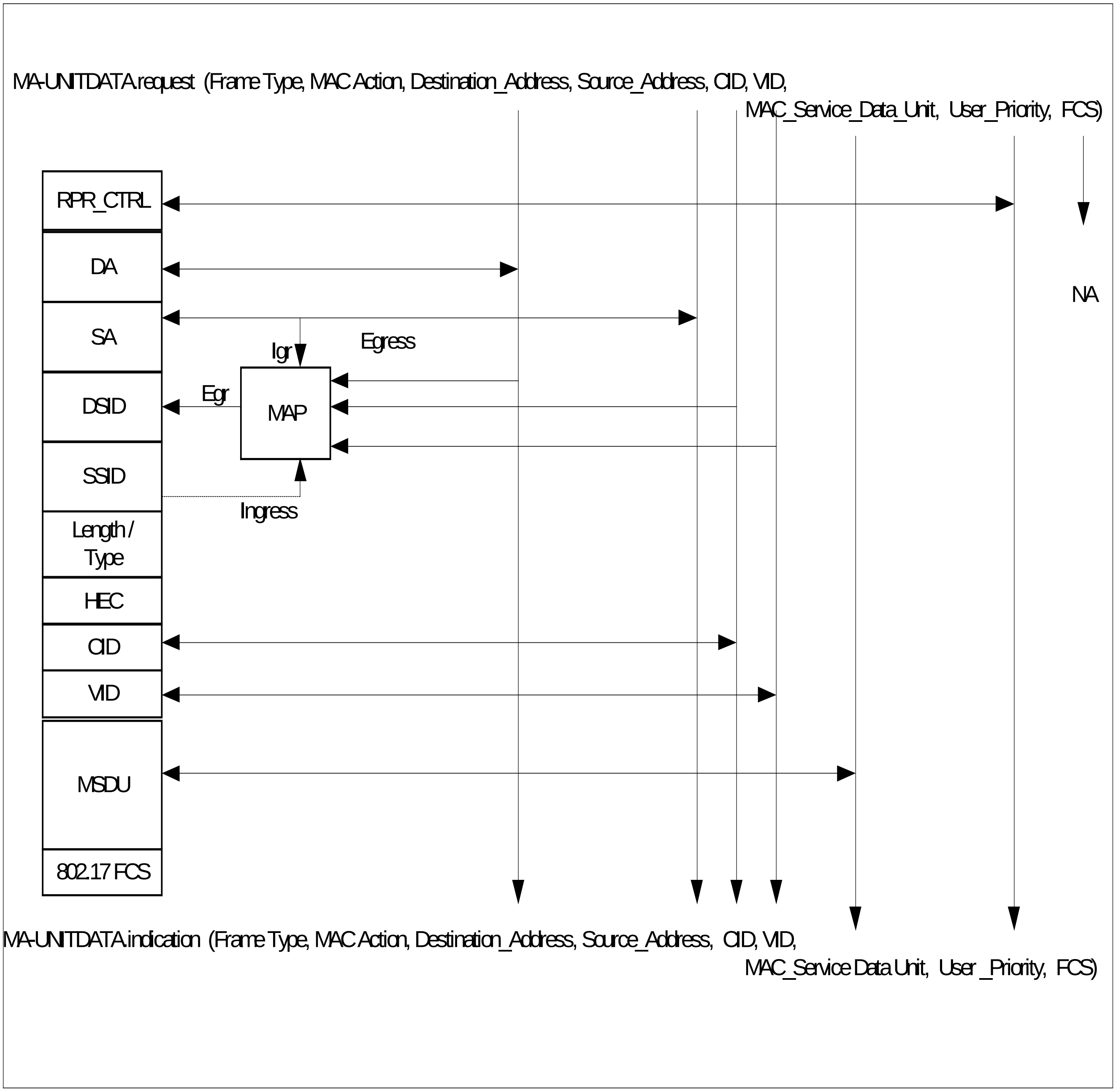
The RPR MAC entity appends RPR source/destination station identifier's (DSID, SSID) to the RPR frame for the purpose of performing destination and source stripping of frames from the ring. Destination stripping allows a frame to be stripped from the ring when arriving at the intended destination without having to traverse the entire ring. Subsequent spans following the span where the packet was stripped, can be reused by other stations for transmitting new traffic onto the ring thereby providing spatial reuse of the ring. Source stripping ensures that a frame which traverses the entire ring is not read a second time by stations, thus maintaining a loop free behavior. RPR destination station ID is appended to the RPR frame via a mapping function as part of the 802.17 MAC Entity support in either the MAC client or ISS. This mapping function maps the 802 *destinationMacAddress* to the RPR *destination_station_ID* in the RPR frame header. The RPR MAC client also appends the RPR *source_station_ID* in the RPR frame header with the transmitter's source station identifier.

B.4 Model of operation

The model of operation is simply a basis for describing the functionality of the MAC bridge. It is in no way intended to constrain real implementations of a MAC bridge; these may adopt any internal model of operation compatible with the externally visible behavior that this standard specifies. Conformance of equipment to this standard is purely in respect of observable protocol.

B.4.2 802.17 Support of the Internal Sublayer Service

The following figure illustrates the mapping of the MA-UNITDATA.request / MA-UNITDATA.indication primitives to the 802.17 frame format.



On receipt of an M_UNITDATA.request primitive, the local MAC Entity performs Transmit Data Encapsulation, assembling a frame using the parameters supplied as specified below IEEE Std 802.17, ?.?.?). On receipt of a MAC frame by Receive Media Access Management, the MAC frame is passed to Receive Data Decapsulation, which validates the FCS and disassembles the frame, as specified below, into the parameters that are supplied with an M_UNITDATA.indication primitive (IEEE Std 802.17, ?.?.?).

The **frame_type** parameter takes only the value user_data_frame and is not explicitly encoded in MAC frames.
The **mac_action** parameter takes only the value request_with_no_response and is not explicitly encoded in MAC frames.
The **destination_address** parameter is encoded in the destination address field of the MAC frame (IEEE Std 802.17, ?.?.?).
The **source_address** parameter is encoded in the source address field of the MAC frame (IEEE Std Std 802.17, ?.?.?).
The number of octets in the mac_service_data_unit parameter is encoded in the length field of the MAC frame (IEEE Std 802.17 ?.?.?), and the octets of data are encoded in the data field (IEEE Std 802.17 ?.?.?).

The **user_priority** parameter provided in a data request primitive is encoded in corresponding priority bits of the RPR control header of the transmitted frame. The user_priority parameter provided in a data indication primitive takes the value of the corresponding priority bits of the RPR control header of the received frame.

The **HEC** of the MAC frame is computed as a function of the destination address, source address, DSID, SSID, length/type, and RPR header control fields of the transmitted frame.

The **CID** parameter is an optional parameter indicating a customer separation identifier and is encoded in the CID field of the MAC frame. The CID parameter is indicated by the length/type field of the MAC frame.

The **VID** parameter is an optional parameter indicating a 802.1Q VLAN identifier and is encoded in the VID field of the MAC frame. The VID parameter is indicated by the length/type field of the MAC frame.

The 802.17_frame_check_sequence of the MAC frame is re-computed as a function of the MAC_Service_Data_Unit IEEE Std 802.17, ?.?.?.

The **frame_check_sequence** parameter in the MA_UNITDATA.request is defined as an unspecified value, signaling the underlying 802.17 MAC to regenerate the frame FCS. The FCS in the MA_UNITDATA.indication is set to either valid or invalid based on whether the FCS of the receive frame is valid/invalid.

NOTE 1—IEEE Std 802.3, 1998 Edition, describes the use of either a Length or an Ethernet protocol type in its frame format; however, the text of this subclause has yet to be revised to describe the use of Ethernet protocol types.

B.4.3 Frame transmission

The individual MAC entity associated with each bridge port transmits frames submitted to it by the MAC relay entity.

Relayed frames for transmission by the forwarding process are submitted to the 802.17 ISS. The M_UNITDATA.request primitive associated with such frames conveys the values of the client MAC source and destination address fields received in the corresponding M_UNITDATA.indication primitive.

LLC protocol data units (PDUs) are submitted by the LLC as a user of the MAC service provided by the bridge port. Frames transmitted to convey such PDUs carry the individual client MAC address of the port in the source address field. All LLC PDUs are submitted to the 802.17 MAC client. The 802.17 MAC client in turn performs the same client MAC destination address to RPR *destination_station_ID* and *destination_address* mapping as described for frames submitted to the 802.17 MAC client from the MAC relay entity.

Each frame is transmitted subject to the following procedure associated with the RPR MAC technology. The values of the frame_type and mac_action parameters of the corresponding M_UNIT-DATA. request primitive shall be user_data_frame and request_with_no_response, respectively (6.5).

The client MAC destination address is used by the RPR ISS mapping function to determine the RPR *destination_station_ID* (DSID) and *destination_address* used in the RPR frame header of the transmitted frame.

1) If the client MAC destination (CID / VID) address is found in the station ID mapping table, the associated RPR *destination_station_ID* and *ringletID* are extracted from the table. The RPR *destination_station_ID* is included in the RPR frame header along with the client *MAC destination address*, and the packet is transmitted on the ringlet based on the associated *ringletID*. The setting of the *destination_station_ID* is used to provide for destination stripping of the unicast frame. If the associated station ID from the table is the null station ID (0xFF), the frame is flooded on the ring.
2) If the client MAC destination (CID / VID) address is not found in the mapping table, the *destination_station_ID* is set to the broadcast value, and is included in the frame header along with the client MAC_destination address. The resulting frame may either be transmitted in either one or both directions around the ring along with the appropriate setting of the TTL (see note below).
3) All broadcast and multicast type frames the *destination_station_ID* is set to the broadcast value, and is included in the frame header along with the client MAC_destination address. The resulting frame may either be transmitted in either one or both directions with the appropriate setting of TTL to reach all stations on the ring (see note below).
4) The RPR *source_station_ID* (SSID) in the transmitted frame, should be set to the transmitting station's source station ID. This parameter is used to invoke source stripping at the receiver, and to allow the receiver to learn the association of source station ID with client MAC source address in received frames for unicast response frames to the client. If the *source_station_ID* is unknown by the transmitting station, it is set to the *null_station_ID* 0xFFH.

NOTE —

(**Note regarding method for ring broadcasts)** — All stations on the ring (bridges and end station clients) must implement the same flooding method for broadcast, multicast or unknown traffic. Broadcasts are normally expected to be transmitted in both directions on the ring, minimizing propagation delay time and maximize the potential for spatial reuse. Care must be taken to set the frame TTL to the proper value to ensure that each station on the ring receives only one copy of the frame. The TTL values for the corresponding ringlet0/ringlet1 broadcasts are computed using the topology discovery algorithm.

Broadcasts may be implemented by unidirectional transmission of traffic on the ring. Unidirectional broadcasts requires a wrapping form of protection to ensure that packets are received by all stations on the ring.

B.4.4 Frame reception

The individual MAC entity associated with each bridge port examines all frames received on the RPR ringlet to which it is attached. The RPR *destination_station_ID* in the RPR frame header is checked to determine if it matches the RPR station address or contains the RPR broadcast address.

1) If the RPR *destination_Station_ID* matches the receiving RPR station address or the client *destination_address* matches the receiving RPR station's MAC address, the frame is stripped from the ring and copied up to the RPR ISS.
2) If the RPR *destination_Station_ID* matches the RPR broadcast address, the frame is copied to the RPR ISS provided the TTL does not = 0 or the RPR *source_station_ID* does not match the receiving RPR station address.
3) If the RPR *destination_Station_ID* does not match the receiving RPR station address or is not the RPR broadcast address, and (the TTL does not equal zero, and the RPR *source_station_ID* does not match the receiving RPR station address) the frame is passed–through to the transmit side of the ringlet (not-stripped). Otherwise, the frame is stripped from the ring.

All error-free received frames are passed to the RPR ISS give rise to M_UNITDATA indication primitives which shall be handled as follows:

NOTE — A frame that is in error, as defined by the relevant MAC specification, is discarded by the MAC entity without giving rise to any M_UNITDATA indication; see 6.4.

The receiving station's receive procedure updates its mapping table with the client MAC source address, its associated CID/VID (if available), and the RPR *source_station_ID* address from the RPR frame header. This entry replaces any previous entry in the table having the same MAC source address/CID/VID value. This ensures the mapping table is updated with the most recent station ID associated with the MAC address. If the SSID field is set to the null station ID, the entry is still updated in the mapping table. The RPR ISS provides the M_UNITDATA indication primitive, frame_type and mac_action parameter values of user_data_frame and request_with_no_response respectively to the learning and forwarding processes in the MAC relay entity.

Frames with other values of frame_type and mac_action parameters (e.g., request_with_response and response frames), shall not be submitted to the forwarding process. They may be submitted to the learning process.

Frames with a frame_type of user_data_frame and addressed to the bridge port as an end station shall be submitted to LLC. Such frames carry either the individual MAC address of the port or a group address associated with the port (7.12) in the destination address field. Frames submitted to LLC can also be submitted to the learning and forwarding processes, as specified above.

Frames addressed to a bridge port as an end station, and relayed to that bridge port from other bridge ports in the same bridge by the forwarding process, shall also be submitted to LLC.

No other frames shall be submitted to LLC.

B.4.5 Aging of Station Ids from mapping table

Stations may temporarily not be reachable due to end station moves, or changes in the network topology. Entries in the station ID mapping table must have an aging timer. When the timer expires, entries are removed allowing frames with aged entries to be retransmitted to all stations on the ring. This allows traffic to reach stations which may be in new portions of the network, which were not reachable due to outdated mapping table entries.

Bridge stations that are participating in Spanning Tree Protocol [IEEE Std 802.1D, 1998 Edition] shall also use the time out information signaled in Configuration BPDUs and the Forwarding Delay value to affect aging of mapping table entries.

B.5 Simple 802.17 Bridging Clients

Simple 802.17 bridging clients are clients which do not implement a station ID mapping table in the egress path. These devices instead flood every frame onto the ring submitted to the 802.17 MAC by the ISS. The resulting frame that is placed on the medium is received by all other stations on the ring. Simple bridging clients still participate in the station ID assignment algorithm, and encoding the station ID that is assigned to them in the SSID field of the 802.17 frame. This allows the simple bridges to perform destination stripping of frames received from other bridges on the ring. Frames received from the ring by a simple bridge having the DSID field set to the bridge's station ID are stripped from the ring.

B.5.2 Frame Transmission

The individual MAC entity associated with each bridge port transmits frames submitted to it by the MAC relay entity.

Relayed frames for transmission by the forwarding process are submitted to the 802.17 ISS. The M_UNITDATA.request primitive associated with such frames conveys the values of the client MAC source and destination address fields received in the corresponding M_UNITDATA.indication primitive.

LLC protocol data units (PDUs) are submitted by the LLC as a user of the MAC service provided by the bridge port. Frames transmitted to convey such PDUs carry the individual client MAC address of the port in the source address field. All LLC PDUs are submitted to the 802.17 MAC client. The 802.17 MAC client in turn performs the same client MAC destination address to RPR *destination_station_ID* and *destination_address* mapping as described for frames submitted to the 802.17 MAC client from the MAC relay entity.

Each frame is transmitted subject to the following procedure associated with the RPR MAC technology. The values of the frame_type and mac_action parameters of the corresponding M_UNIT-DATA. request primitive shall be user_data_frame and request_with_no_response, respectively (6.5).

1) All unicast frames, the *destination_station_ID* is set to the broadcast value, and is included in the frame header along with the client MAC_destination address. The resulting frame may either be transmitted in either one or both directions around the ring along with the appropriate setting of the TTL (see note below).
2) All broadcast and multicast type frames the *destination_station_ID* is set to the broadcast value, and is included in the frame header along with the client MAC_destination address. The resulting frame may either be transmitted in either one or both directions with the appropriate setting of TTL to reach all stations on the ring (see note below).
3) The RPR *source_station_ID* (SSID) in the transmitted frame, should be set to the transmitting station's source station ID. This parameter is used to invoke source stripping at the receiver, and to allow the receiver to learn the association of source station ID with client MAC source address in received frames for unicast response frames to the client. If the *source_station_ID* is unknown by the transmitting station, it is set to the *null_station_ID* 0xFFH.

B.5.3 Frame Reception

The individual MAC entity associated with each bridge port examines all frames received on the RPR ringlet to which it is attached. The RPR *destination_station_ID* in the RPR frame header is checked to determine if it matches the RPR station address or contains the RPR broadcast address.

1) If the RPR *destination_Station_ID* matches the receiving RPR station address or the client *destination_address* matches the receiving RPR station's MAC address, the frame is stripped from the ring and copied up to the RPR ISS.
2) If the RPR *destination_Station_ID* matches the RPR broadcast address, the frame is copied to the RPR ISS provided the TTL does not = 0 or the RPR *source_station_ID* does not match the receiving RPR station address.
3) If the RPR *destination_Station_ID* does not match the receiving RPR station address or is not the RPR broadcast address, and (the TTL does not equal zero, and the RPR *source_station_ID* does not match the receiving RPR station address) the frame is passed–through to the transmit side of the ringlet (not-stripped). Otherwise, the frame is stripped from the ring.

All error-free received frames are passed to the RPR ISS give rise to M_UNITDATA indication primitives which shall be handled as follows:

NOTE — A frame that is in error, as defined by the relevant MAC specification, is discarded by the MAC entity without giving rise to any M_UNITDATA indication; see 6.4.

The RPR ISS provides the M_UNITDATA indication primitive, frame_type and mac_action parameter values of user_data_frame and request_with_no_response respectively to the learning and forwarding processes in the MAC relay entity.

Frames with other values of frame_type and mac_action parameters (e.g., request_with_response and response frames), shall not be submitted to the forwarding process. They may be submitted to the learning process.

Frames with a frame_type of user_data_frame and addressed to the bridge port as an end station shall be submitted to LLC. Such frames carry either the individual MAC address of the port or a group address associated with the port (7.12) in the destination address field. Frames submitted to LLC can also be submitted to the learning and forwarding processes, as specified above.

Frames addressed to a bridge port as an end station, and relayed to that bridge port from other bridge ports in the same bridge by the forwarding process, shall also be submitted to LLC.

No other frames shall be submitted to LLC.

B.6 802.17 End Station Clients

802.17 End Station Clients may or may not implement a station ID mapping table in the egress path. If the station implements a station ID mapping table, it uses the procedures outlined in sections B.4.3, B.4.4, B.4.5 for frame transmission, frame reception, and aging of mapping table entries respectively. The station shall also strip frames from the ring when either its MAC address exactly matches the MAC destination address or if its station ID matches the DSID field in the 802.17 frame.

If the client does not implement a station ID mapping table, the client shall transmit data by performing ringlet selection based on the MAC destination address or by flooding. Clients implementing a flooding procedure shall either transmit the frame on one or both ringlets based on the flooding method being implemented on the ring. 802.17 end station clients are uniquely addressed by their MAC address. An end station client shall strip packets from the ring when its MAC address exactly matches the MAC destination address or if its station ID matches the DSID field in the 802.17 frame. End station clients still participate in the station ID assignment algorithm and encoding the station ID that is assigned to them in the SSID field of the transmitted frame. This allows bridges on the ring that implement the mapping table, are able to learn end station MAC addresses and their associated ringlet. This allows bridges to perform ringlet selection for unicast traffic destined for the end station.

Even in cases where the end station client does not implement the station ID mapping table, the end station can still achieve spatial reuse when sending traffic to other end stations on the ring. For example, unicast traffic destined to another end station on the ring would be stripped by the intended end station based on the destination MAC address.