5. Medium Access Control (MAC) reference and service model

5.1 Scope

This clause specifies the services provided by the MAC sublayer and the MAC Control sublayer to the client of the MAC (see Figure 5–1). MAC clients may include the Logical Link Control (LLC) sublayer, Bridge Relay Entity, or other users of ISO/IEC LAN International Standard MAC services (see Figure 5–1). The services are described in an abstract way and do not imply any particular implementations any exposed interface.There is not necessarily a one-to-one correspondence between the primitives and the formal procedures and interfaces.

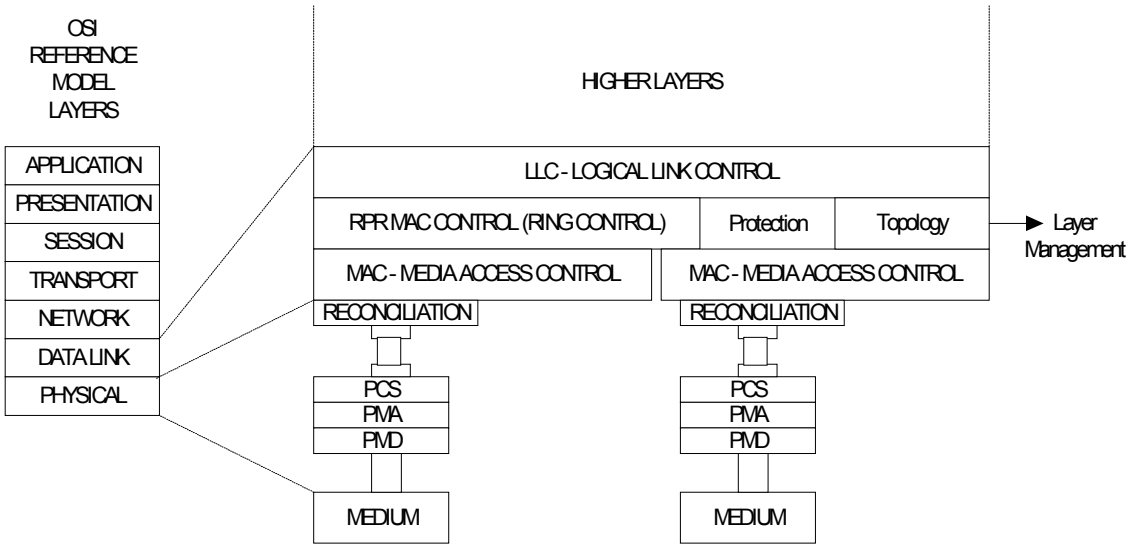

Figure 5–1—Service specification relation to the LAN model

5.2 Overview of MAC Services

The services provided by the MAC sublayer allow:

a) The local LLC sublayer in an end node to exchange data with peer LLC sublayer entities
b) The local LLC sublayer in an end node to exchange resilient packet ring parameters with local MAC entities.
c) The relay entity in a bridge to change data with local MAC entities in the bridge.
d) A non LLC MAC Client sublayer in an end node to exchange data with peer MAC client sub entities

The MAC sublayer is presents 5 service access points for the exchange of MAC client PDUs between MAC client entities. The service access points provide access to 5 logical channels at the MAC layer: reserved channel, high priority channel, medium priority channel, low priority channel and control channel.

5.2.1 Reserved Service

The 802.17 MAC provides a mechanism to reserve ring bandwidth. This bandwidth is invisible to the RPR fariness algorithm and must be wholly managed by the RPR MAC client. Traffic admitted in the other 3 traffic classes will not be able to utilized the bandwidth allocated to the Provisioned class, even when that bandwidth idle.

By definition, if this service is offered in the RPR network, the network operator must set the provisioned bandwidth allocation consistently amongst all stations on the ring and then set allocation the provisioned bandwidth amongst nodes in the network. How this badwidth allocation is performed is the responsibility of the MAC client and beyond the scope of this specification.

The transmit data requests to the provisioned service access point are policed by the RPR MAC to meet the statically provisioned rate for this service. The service access point will also provide an indication to the MAC client of the status of the underlying channel. This information includes whether the service is currently operative (up or down).

The bandwidth allocated to the provisioned service may be set to zero allowing network designers the option of not offering such a service.

5.2.2 High Priority Service

The MAC provides a high priority delivery service. This service is intended to support application which require bounded end-to-end delay and jitter specifications.

The MAC assumes that traffic requesting high priority service will be shaped at ingress to meet provisioned values for CIR, BIR and EIR by the MAC client. The MAC sublayer implements a policing function as part of the high priority service to ensure that provisioned service parameters are not violated.

The high priority service is an engineered service and must be provisioned by the network designer.

The service access point also provides an indication to the MAC client of the status of the underlying channel. This information includes whether the service is currently operative (up or down) and whether there is dynamic backpressure from the media to indicate that traffic cannot currently be accepted.

5.2.3 Medium Priority Service

The Medium priority service is provided to implement a traffic class for applications which are not delay sensitive but which require BW guarantees.

It is similar in implementation to the High Priority service, in that it expects the client to provide a shaped ingress traffic stream that conforms to provisioned CIR and EIR limits. However, traffic is treated differently with respect to the RPR-FA depending on whether it meets its CIR/EIR profile.

Those frames determined to be in-profile will be marked as such with a bit in the RPR header at ingress to the ring. These frames will not be counted as part of the RPR fairness algorithm at ingress to the ring or when transitting through stations on the ring. They are essentially invisible to the fairness algorithm in the same way that high priority packets are.

Those frames determined to be out-of-profile will be marked as such with a bit in the RPR header at ingress to the ring. Out-of profile frames will be counted as part of the RPR fairness algorithm both at ingress to the ring and while transitting stations on the ring.

Regardless of whether the frame is marked in- or out-of-profile, the frames are still sent on the low priority transit channel on the ring.

For in-profile traffic, applications using the medium priority service will not be blocked by ingress rate prolicing from the RPR fairness algorithm (like the high priority service) but will still incur the increased end-to-end delay of the low priority transit channel.

For out-of-profile traffic, applications using the medium priority service receive the same service level as if they had used the low priority service access point.

The service access point also provides an indication to the MAC client of the status of the underlying channel. This information includes whether the service is currently operative (up or down) and whether there is dynamic backpressure from the media to indicate that traffic cannot currently be accepted.

5.2.4 Low Priority Service

The Low Priority service is provided to implement a Best Effort Traffic Class (BETC). It is transmitted on the MAC Low Priority Transit Path and is intended for traffic not sensitive to end-to-end delay or jitter.

The service access point also provides an indication to the MAC client of the status of the underlying channel. This information includes whether the service is currently operative (up or down) and whether there is dynamic backpressure to indicate that traffic cannot currently be accepted.

5.3 MAC Peer-to-Peer Services

Since 802.17 MAC network is a ring based, shared medium network, each MAC provides transit service to frames that are not destined or sourced from the MAC client, hosted by that particu.lar MAC. This traffic passes through the MAC sublayer on one of 3channels: high priority, low priority or control. Note that transit packets in the Reserved class are combined with High Priority in terms of their transit treatment; likewise medium and low-priority classes are combined and treated as Low Priority.

5.3.1 High Priority Transit Channel

The MAC implements a high priority transit channel to support the High Priority traffic services. The high priority transit channel provides a worst-case per-station transit delay of one frame-time in order to bound the maximum delay for the network on the high priority service class.

The high priority transit channel does not support preemption of either the transit or ingress frames; any packet already in transmission continues to the end.

5.3.2 Low Priority Transit Channel

The MAC implements a low priority transit channel to support both medium and low priority service classes. All low priority traffic and medium priority traffic travels through the Low Priority Transit Channel on the ring.

The Low Priority Channels implements a lossless service on the ring.

5.3.3 Control Channel

The MAC implements a control channel through which control messages are passed between MAC entities on the RPR network. Traffic for this channel has the highest priority in terms of scheduling at ingress to the ring and does not participate in nor is policed by the RPR fairness mechanism.

Control traffic on the ring transit path is treated the same as traffic in the High Priority channel for the purposes of transit path scheduling and ring access (i.e. it has priority over all ingress traffic).

The MAC provides no policing of traffic destined for this channel except for inter-station synchronization purposes.

5.4 MAC services to the MAC Client Layer

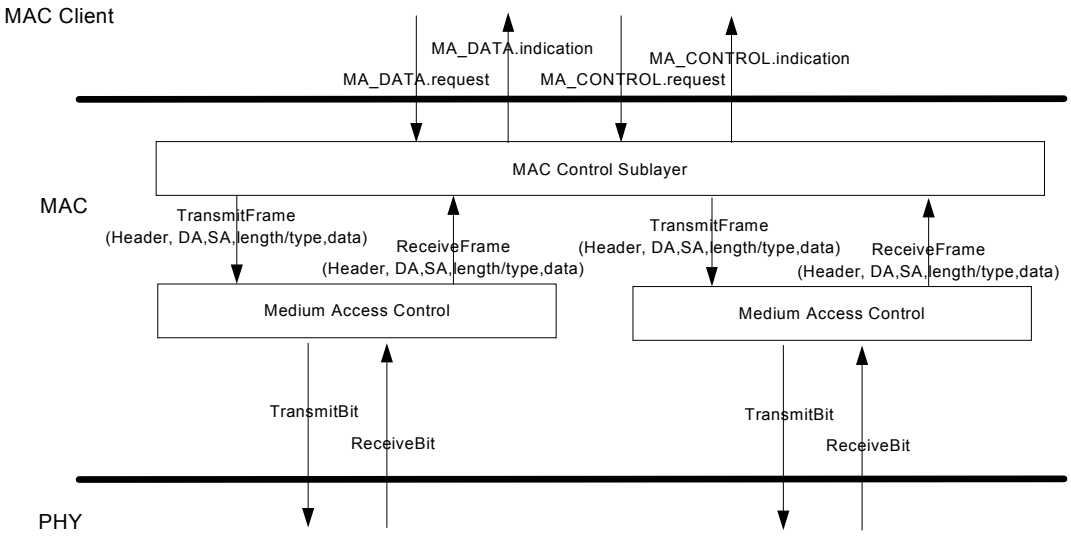

Figure 5–1—MAC Service Model

5.4.1 Overview of the interactions

Four service primitives are defined for the LLC interfaces.

- MA_DATA.request
- MA_DATA.indication.
- MA_CONTROL.request (used by MAC Control sublayer).
- MA_CONTROL.indication (used by MAC Control sublayer).

The formats for the M_DATA.indications and M_DATA.requests are the same as formats for MA_DATA.indication and MA_DATA.requests, except for the addition of an optional parameter for the FCS. This parameter may be used to preserve the FCS when bridging between LANs using like formats.

5.4.2 Basic services and options

The MA_DATA.request, MA_DATA.indication service, MA_CONTROL.request and MA_CONTROL.indication primitives described in this subclause are mandatory.

5.4.3 Detailed service specification

Editors' Notes: *To be removed prior to final publication.*

This section needs to be reviewed to ensure that it contains the sufficient set of service primitives needed to ensure compatibility with 802.2 LLC.

5.4.3.1 MA_DATA.request

5.4.3.1.1 Function

This primitive defines the transfer of data from a MAC client entity to a single peer entity or multiple peer entities in the case of group addresses.

5.4.3.1.2 Semantics of the service primitive

The semantics of the primitives are as follows:

```
MA_DATA.request (header,
         destination_address,
         source_address,
         m_sdu,
         service_class,
         ringlet_id)
```

The header parameter may specify one or the other ring medium, priority, Time To Live (TTL), and unicast or multicast. The destination_address parameter may specify either an individual or a group MAC entity address. It must contain sufficient information to create the DA field that is pre-appended to the frame by the local MAC sub- layer entity and any physical information. The source_address parameter, if present, must specify an individual MAC address. If the source_address parameter is omitted, the local MAC sublayer entity will insert a value associated with that entity. The m_sdu parameter specifies the MAC service data unit to be transmitted by the MAC sublayer entity. There is sufficient information associated with m_sdu for the MAC sublayer entity to determine the length of the data unit. The service_class parameter indicates the quality of service requested by the MAC client. The ringlet_id parameter, if present, allows the MAC client to optionally specify the desired ring on which to transmit the m_sdu. The MAC shall obey this request except when the ringlet status shows that it is down for a protection event.

5.4.3.1.3 When generated

This primitive is generated by the MAC client entity whenever data shall be transferred to a peer entity or entities. This can be in response to a request from higher protocol layers or from data generated internally to the MAC client, such as required by Type 2 LLC service.

5.4.3.1.4 Effect of receipt

The receipt of this primitive will cause the MAC entity to insert all MAC specific fields, including header, DA,SA, and any fields that are unique to the particular media access method, and pass the properly formed frame to the lower protocol layers for transfer to the peer MAC sublayer entity or entities.

5.4.3.1.5 Additional comments

The RPR MAC protocol provides four qualities of service in service_class requested.

5.4.3.2 MA_DATA.indication

5.4.3.2.1 Function

This primitive defines the transfer of data from the MAC sublayer entity (through the MAC Control sub-layer) to the MAC client entity or entities in the case of group addresses.

5.4.3.2.2 Semantics of the service primitive

The semantics of the primitive are as follows:

```
MA_DATA.indication (header,
         destination_address,
         m_sdu,
```

```
          ringlet_id,
          reception_status)
```

The header parameter may specify one or the other ring medium, priority, Time To Live (TTL), and unicast or multicast. The destination_address parameter may be either an individual or a group address as specified by the DA field of the incoming frame. The source_address parameter is an individual address as specified by the SA field of the incoming frame. The m_sdu parameter specifies the MAC service data unit as received by the local MAC entity. The reception_status parameter is used to pass status information to the MAC client entity. The ringlet_id parameter indicates, to MAC clients which optionally use the information, which ringlet the m_sdu was received from.

5.4.3.2.3 When generated

The MA_DATA.indication is passed from the MAC sublayer entity (through the MAC Control sub-layer) to the MAC client entity or entities to indicate the arrival of a frame to the local MAC sublayer entity that is destined for the MAC client. Such frames are reported only if they are validly formed, received without error, and their destination address designates the local MAC entity.Frames destined for the MAC Control sublayer are not passed to the MAC client if the MAC Control sublayer is implemented.

5.4.3.2.4 Effect of receipt

The effect of receipt of this primitive by the MAC client is unspecified.

5.4.3.2.5 Additional comments

If the local MAC sublayer entity is designated by the destination_address parameter of an MA_DATA.request, the indication primitive will also be in oked by the MAC entity to the MAC client entity. This characteristic of the MAC sublayer may be due to unique functionality within the MAC sublayer or characteristics of the lower layers (for example, all frames transmitted to the broadcast address will invoke MA_DATA.indication at all stations in the network including the station that generated the request).

5.4.3.3 MA_CONTROL.request

This primitive defines the transfer of control requests from the MAC client to the MAC Control sublayer.

5.4.3.3.1 Function

This primitive defines the transfer of control commands from a MAC client entity to the local MAC Control sublayer entity.

5.4.3.3.2 Semantics of the service primitive

> ***Editors' Notes:*** *To be removed prior to final publication.*
>
> *This primitive is a placeholder. The working group needs to consider and define the full set of opcodes and operands required by the MAC layer to support control plane functions, and then enumerate them here.*

The semantics of the primitive are as follows:

```
MA_CONTROL.request (header
          destination_address,
          opcode,
          request_operand_list)
```

The destination_address parameter may specify either an individual or a group MAC entity address. It must contain sufficient information to create the DA field that is preappended to the frame by the local MAC sublayer entity. The opcode specifies the control operation requested by the MAC client entity. The request_operand_list is an opcode-specific set of parameters. The valid opcode and their respective meanings are described in Table 1— on page 37.

Table 1—Control Request Opcodes

Opcode	Operand	Meaning
0x00	none	No Request
0x01	none	Request Network Topology
0x02	Service_Class	Request Service Status
0x03	Station_MAC_Address	Request Station Configuration
0x04	Station_MAC_Address	Request Transit Path Congestion Status
0x05	Station_MAC_Address	Request Current Topology Database
0x06	none	Pause Message
0x07-0xFF	TBD	TBD

5.4.3.3.3 When generated

This primitive is generated by a MAC client whenever it wishes to use the services of the MAC Control sublayer entity.

5.4.3.3.4 Effect of receipt

The effect of receipt of this primitive by the MAC Control sublayer is opcode-specific.(See Clause TBD.)

5.4.3.4 MA_CONTROL.indication

Editors' Notes: *To be removed prior to final publication.*

This primitive is a placeholder. The working group needs to consider and define the full set of opcodes and operands required by the MAC layer to support control plane functions, and then enumerate them here.

Editors' Notes: *To be removed prior to final publication.*

The working group needs to consider the proper way to abstract service policing status and link bandwidth for VDQ to the client layer via primitives. Is a separate primitive required?

5.4.3.4.1 Function

This primitive defines the transfer of control status indications from the MAC Control sublayer to the MAC client.

5.4.3.4.2 Semantics of the service primitive

The semantics of the primitive are as follows:

```
MA_CONTROL.indication(header,
          opcode,
          indication_operand_list)
```

The elements of the indication_operand_list are opcode-specific, and specified in Table 2.

Table 2—Control Indication Opcodes

Opcode	Operand	Meaning
0x01	Network Topology Data Structure	Network Topology Change
0x02	Service_Class, Status (ok_to_send, do_not_send)	Service Status Change
0x03	configuration_parameter_list	Request Station Configuration
0x04	normalized_bandwidth_value	Request Transit Path Congestion Status
0x05-0xFF	TBD	TBD

5.4.3.4.3 When generated

The MA_CONTROL.indication is generated by the MAC Control sublayer under conditions specific to each MAC Control operation.

5.4.3.4.4 Effect of receipt

The effect of receipt of this primitive by the MAC client is unspecified.

5.5 Physical layer service access point (PSAP) definition

Editors' Notes: *To be removed prior to final publication.*

The term SAP cannot be used in this context. The OSI and IEEE interpretation of SAP differ. Where OSI considers SAP as an "interface", IEEE treats SAP as a code point. The Term SAP may corrrectly be replaced with "Service Interface".

5.5.1 PSAP

The IEEE 802.17 MAC supports the following Physical Service Access Point (PSAP) primitives:

- PHY_LINK_STATUS.indication
- PHY_DATA.request
- PHY_DATA.indication
- PHY_DATA_VALID.indication

— PHY_READY.indication

5.5.1.1 PHY_LINK_STATUS.indication

This interface provides a means to indicate some the status of the physical link to the MLME. The setting of this MLME MIB attribute can cause the MLME to perform an action and/or request that an action be performed by the MAC.

The semantics of the primitive are as follows:

```
PHY_LINK_STATUS.indication (
          link_status
          )
```

The link_status parameter may have the values of OK, DEGRADE, or FAIL. All physical layers shall support OK and FAIL. Support for generation of DEGRADE is optional.

5.5.1.2 PHY_DATA.request

This interface defines the transfer of an octet of data from the MAC to the RS.

The semantics of the primitive are as follows:

```
PHY_DATA.request (
          output_unit
          )
```

The output_unit parameter contains an octet_of_data, or DATA_COMPLETE.

5.5.1.3 PHY_DATA.indication

This interface defines the transfer of an octet of data from the RS to the MAC.

The semantics of the primitive are as follows:

```
PHY_DATA.indication (
          input_unit
          )
```

The input_unit parameter contains an octet_of_data.

5.5.1.4 PHY_DATA_VALID.indication

This interface indicates whether the parameter of PHY_DATA.indicate contains valid data.

The semantics of the primitive are as follows:

```
PHY_DATA_VALID.indication (
          data_valid_status
          )
```

The data_valid_status parameter may have the values of VALID or NOT_VALID.

5.5.1.5 PHY_READY.indication

This interface indicates whether the PHY is ready to accept a new MAC frame.

The semantics of the primitive are as follows:

```
PHY_READY.indication (
          ready_status
          )
```

The ready_status parameter may have the values of READY or NOT_READY.

5.6 Management layer service access point

Editors' Notes: *To be removed prior to final publication.*

This service interface should be moved to the Layer Management Clause

Editors' Notes: *To be removed prior to final publication.*

The working group should consider whether the definition of a service interface from the MAC to the LME is really necessary. Traditional ways of representing the LME do not specify the ways and means of accessing the LME objects. If one is defined, then implementations wil have to conform to it and conformance testing will be needed. Normally, one defines the standard set of objects maintained in the LME, not how one obtains the information stored within these objects.

5.6.1 MLSAP

The IEEE 802.17 MAC supports the following Management Layer Service Access Point (MLSAP) primitives:

— MLME_GET.request
— MLME_SET.request

5.6.1.1 MLME_GET.request

This primitive requests the value of an attribute of the MLME MIB from the MAC.

The semantics of the primitive are as follows:

```
MLME_GET.request (
          mib_attribute
          )
```

The mib_attribute parameter contains an attribute of the MLME MIB.

5.6.1.2 MLME_SET.request

This primitive requests that an attribute of the MLME MIB, residing within the MAC, be set to a given value.

The semantics of the primitive are as follows:

```
MLME_SET.request (
          mib_attribute,
```

```
        mib_attribute_value
        )
```

The mib_attribute parameter contains an attribute of the MLME MIB. The mib_attribute_value contains the requested value for mib_attribute. If the given mib_attribute is associated with a specific action, then the action shall be performed by the MAC.

5.7 MAC Reference model

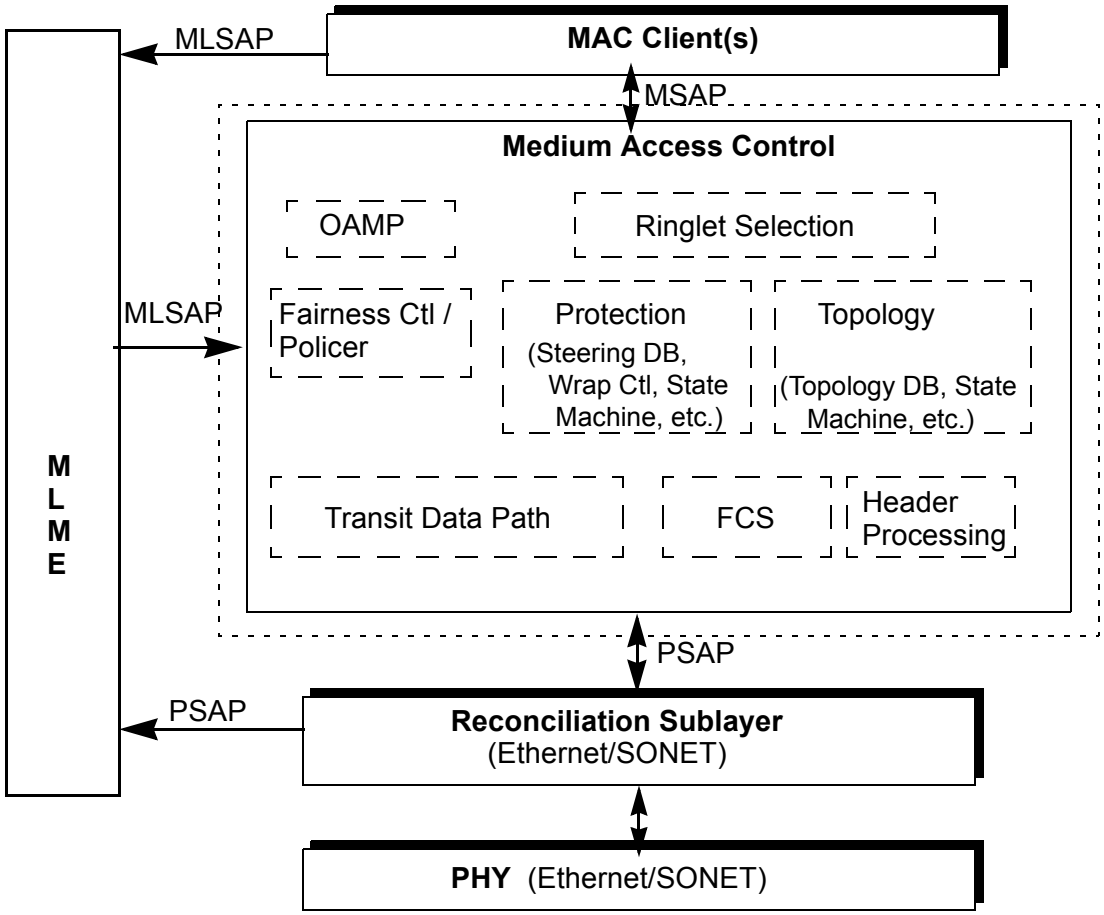

Figure 5–1—MAC reference Model, showing internal MAC functions

Editors' Notes: *To be removed prior to final publication.*

One cannot define a LME service interface to the Client as shown in Figure 5–1— on page 42. This is beyond the scope of 802.17. As well, specification of the PSAP interface to the LME is unnecessary. The working group should consider removal of these interfaces.

Editors' Notes: *To be removed prior to final publication.*

The working group should consider moving Subclause 5.7 to precede Subclause 5.4 to improve readability and logical flow of the draft.

5.7.1 PHY

The 1Gb/s and 10 Gb/s Ethernet Physical Layers and GFP SONET Physical are referenced, Byte Synchronous HDLC is described in relationship to the referenced standard. It is understood that different Physical Layers will provide different services. The differences are reconciled by each PHY specific Reconciliation Sublayer.

5.7.2 Reconciliation Sublayer

The Reconciliation Sublayer is part of the Physical Layer, and provides a uniform, reconciled service interface to the MAC Layer. There is one Reconciliation Sublayer Entity for each Physical Layer interface. In addition to providing a common interface for MAC/PHY data, the Reconciliation Sublayer also presents a common interface for management and control of the PHY that is needed by the MAC.

5.7.3 RPR Medium Access Control

The RPR Medium Access Control Layer provides the access control for the Physical Layer. It also controls the transit path through the MAC. Its functions include Rate Control, Policing, Protection, Topology Discovery, and Link Aggregation. this is the end

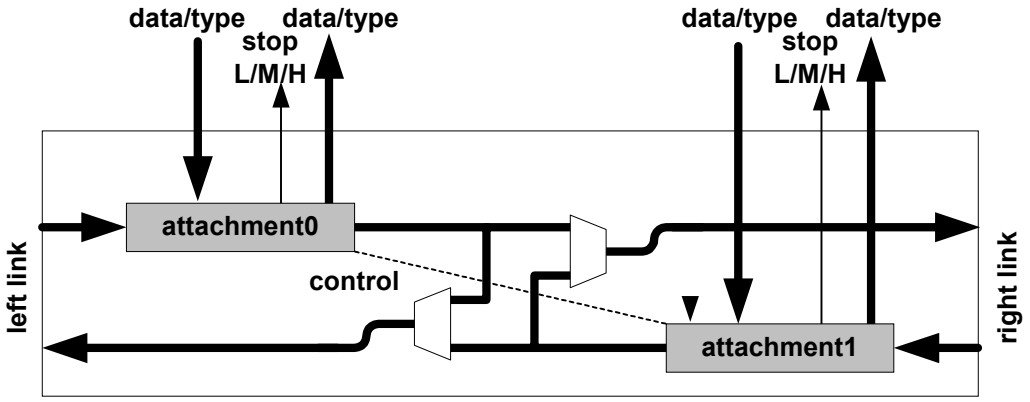

Figure 5–1—MAC client interface

5.7.3.1 Rate Control and Policing

The Rate Control and Policing function of the MAC sublayer controls the rate at which frames are transmitted by the MAC and coordinates this control with the other MAC sublayers on the ring.

An RPR MAC shall police access to each service by the MAC client in order to ensure that medium access and bandwidth provisioning rules are obeyed. If the client chooses to disregard feedback from the MAC on service availability and issue a DATA.request, the MAC shall accept the request but return an indication to the effect that immediate transmission is not possible. The MAC shall not transmit the packet until the packet is allowed to be transmitted.

There is one shaper each for HP, MP, and LP traffic. The shapers are simple token buckets, and if a bucket become empty or negative, the RPR MAC communicates with the MAC client with the CONFIRM primitive using the parameters STOP_HIGH, STOP_MED and STOP_LOW. If the client sends the traffic anyway, the RPR MAC may not schedule the client until the token bucket has a token in it. The detail shaper function is described in 6.2. .

5.7.3.2 Protection

The Protection function of the MAC sublayer directs frames to the appropriate ringlet based on the protection database. It also provides the protection state machine for the local MAC and coordination of this control with the other MAC sublayers on the ring.

5.7.3.3 Topology Awareness

The Topology function of the MAC sublayer manages the topology database. It also provides the topology state machine for the local MAC, and coordination of this control with the other MAC Control sublayers on the ring.

In its canonical form, an 802.17 network consists of dual, counter-rotating ringlets. The MAC can optionally present two views of the network to the MAC client: a flat view of the network, in which the MAC sublayer hides the dual-ring-based topology from the client, or a topology-aware view in which allows the MAC client to make data and control requests for specific ringlets. Topological information is collected via a MAC sublayer entity process known as topology discovery and is made available to the client via a request to the Layer Management Entity, MAC Control Indicate.

5.7.3.4 Ringlet Selection

Ringlet selection is optionally specified by trusted client. Otherwise, it is the responsibilty of MAC to decide the ringlet based on the current ring status for a particular destination address.

5.7.4 MAC Layer Management Entity

The MAC Layer Management Entity is an independent entity that resides outside of the MAC Layer in a separate management plane. The MLME contains the Management Information Base for the MAC Layer, and provides Get and Set operations on the MIB to MLME SAP user-entities. The MLME also provides actions upon the MAC Layer as a result of the invocation of Set.request primitives.