

EPON System Requirements

Tony Anderson
Vincent Bemmell
Charles Cook
John George
Ajay Gummalla
Onn Haran
Ryan Hirth
Glen Kramer

Glen Koziuk
JC Kuo
John Limb
Ariel Maislos
John Pickens
Carlos Ribeiro
Dolors Sala

Presentation Objectives

- **This presentation addresses the requirements specific to PON topology only**
 - It assumes that the requirements common to all EFM topologies are discussed separately.
 - However, common EFM requirements are considered if they impose additional requirements for the PON topology. But only the derived PON-specific requirements shall be captured here.
 - These requirements provide a context for the P2MP system. Some of these requirements may need to be addressed outside 802.3ah.

Outline

- **Presentation Objectives**
- **General requirements**
- **Network Requirements**
- **Traffic Requirements**
- **Forwarding requirements**
- **Protocol Requirements: Upstream and downstream**
- **Security Considerations**
- **Performance Measures**
- **Summary**

General Requirements

1. Must support integrated transmission of voice, video and data traffic from higher layer protocols and applications (Example: RTP, VoIP)

2. Plug-and-play installation of ONUs

1. OLT should be able to deny registration

2. The addition/removal of a new ONU must not cause perceptible disruptions of service for the ONUs already connected to the network.

3. Operator should be able to control the amount of bandwidth allocated for each service type per ONU.

- This also applies to best effort

Operators may prefer to waste bandwidth instead of using all uncontractual bandwidth for best effort. This imposes the customer to change the SLA to pay for more bandwidth when needed.

Network Requirements

- 1. Must support a line rate of 1 Gbps on the upstream and downstream**
- 2. Must support a minimum distance of 10 Km**
 1. 20Km distance is the desired distance by ILECs
- 3. Must support a minimum split ratio of 16**
 1. 64 way split is desired by ILECs
 2. 128 way split is desired by MSOs
- 4. PON must operate in full-duplex mode (with ONUs transmitting in time-shared mode)**

Traffic Requirements

- 1. Must support broadcast and multicast traffic according to the forwarding rules**
 - An example of an application is digital broadcast video
- 2. Must support jitter-sensitive periodic traffic**
 - An application example is voice traffic
- 3. Must support delay-sensitive bursty traffic**
- 4. Must support jitter-sensitive bursty traffic**
- 5. Must support best-effort traffic**

Forwarding Requirements

- **PON PHY layer does not optically provide the forwarding capabilities assumed by the 802 MAC layer**
 - Asymmetrical topology: P2MP downstream, P2P upstream
 - PHY support for ONU-to-OLT forwarding but no PHY support for ONU-to-ONU forwarding

Reference: 802.0 Overview and Architecture

Reference: 802 Media Access Control (MAC) Service Definition
- **A model is required for the asymmetrical PON topology**

Segment Models for PON

- **Point-to-point segment model**

- “n” virtual point to point links OLT-to-ONU(n)
- ONU sees only its virtual point to point flow with virtual OLT sub-port
- OLT sees “n” point to point traffic flows with ONUs
- Multicast/Broadcast traffic must be flooded
- Extensions possible to support broadcast/multicast/unknown

- **Shared segment model**

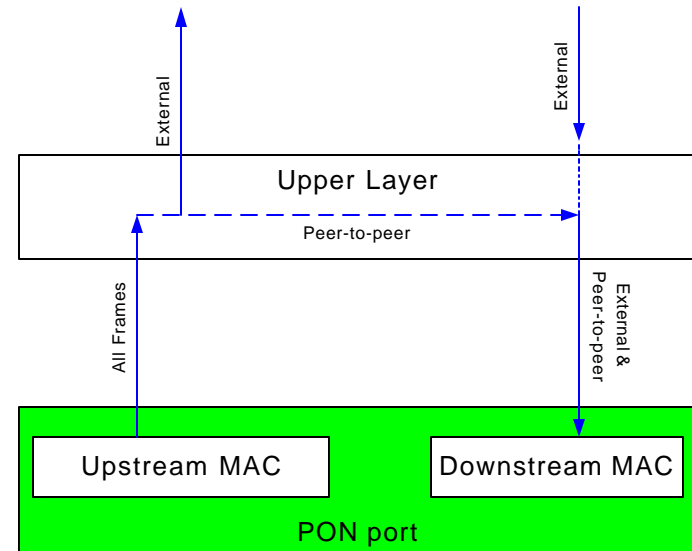
- All frames seen by all ONUs (subject to VLAN constraints)
- Broadcast transmission does not require duplicated transmission
- Peer-to-peer communication within segment is default communication

- **Discussion**

- As in all other MAC types communication across segments is done by higher layer services (i.e., MAC bridge, L3 router) sending a separate copy to each segment
- Both segment models require convergence layer (or MAC layer) augmentation to support 802 MAC layer architecture requirements (if mandated).

P2MP Arch - Unaugmented

- **ONU-to-ONU forwarding not supported at MAC layer**
- **Peer-to-Peer communication mechanism unspecified**
 - Can be done at layer 3
- **Standard upper layer services require P2MP specific augmentation to support broadcast**



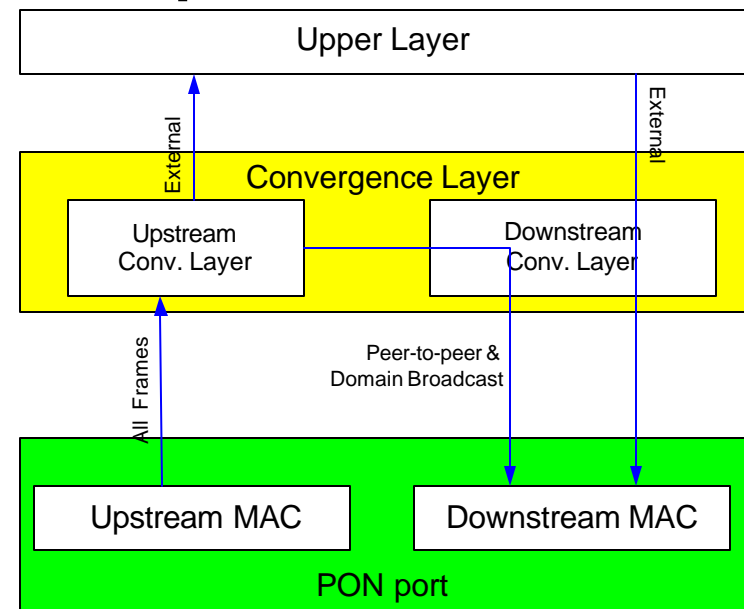
P2MP Arch - Augmented

- **Convergence layer**

- Both virtual point to point and shared segment model
- Implements MAC layer peer-to-peer communication
- Peer-to-peer traffic must be combined with external traffic

- **Specifics of convergence layer depends on solution:**

- Shared: Should send downstream
 - Peer-to-peer traffic
 - Domain broadcast traffic
- Virtual P2P: multicast, broadcast, unknown treated specially



Summary of Forwarding Requirements

- **A PON should operate as a collection of logical point-to-point segments**
 - No augmentation of 802.3
 - But does not allow ONU-to-ONU communication and broadcast service at layer 2
- **A PON segment should operate as a shared segment**
 - Needs convergence layer
- **No consensus on what approach to take yet**

General Protocol Requirements

- 1. OLT shall be able to take advantage of statistical multiplexing across ONUs**
- 2. Must be scalable in distance, rate and number of ONUs within ranges applicable to subscriber access networks**
 - 1. Scalable to rates greater than 1Gbps**
- 3. Frames must not be fragmented across transmission opportunities**

Upstream Protocol Requirements

1. Must support management of time sharing control with no collision in normal operation

2. Shall not preclude flexible bandwidth assignment among ONUs.

3. ONU shall be able to communicate local conditions to OLT

These local conditions may indicate bandwidth requirements, buffer state or other information. This information can be used by the OLT to adjust bandwidth assignments, downstream flow control or other algorithms.

4. OLT must be able to do flow control of a particular ONU on the upstream

5. Shall support ranging and continuous ranging of ONU round trip time

Downstream Protocol Requirements

- 1. Must support flexible bandwidth distribution**

Security Requirements

- 1. Very important topic but no in depth discussion yet**

- 2. A non-exhaustive list of issues for consideration**
 1. Link encryption
 2. Add mechanisms to prevent impersonation of OLT and ONUs
 3. Add mechanisms to prevent unauthorized snooping of frames
 4. Add techniques to avoid or minimize
 1. Denial of service attacks
 2. Theft of service
 3. Other

Performance Measures

- 1. System efficiency for unicast, broadcast and multicast transmissions:** Defined as the amount of user data (in bytes) transmitted divided by the channel capacity (in bytes) during a period in steady state conditions.
- 2. Frame delay:** Defined as the difference between the generation time and the transmitted time (e.g. last bit of the frame is in the wire)
- 3. Frame delay variation:** Defined as the TBD percentile of the frame delay
- 4. Ranging loop time for initial and fine tune ranging:** Defined as the difference between the time the ranging is initiated and the time it is completed.
- 5. Fine-tune ranging frequency:** defined as the minimum frequency the fine-ranging should be performed to keep timing accuracy within the guard-band specification.
- 6. Feed-back loop time:** Defined as the difference between the time the feed-back loop is initiated and the time it is completed.
- 7. Time to recover from a system failure:** Defined as the time from when the system restarts until the time the last ONU is registered.

Summary

- **This presentation addresses the system requirements of the P2MP topology.**
 - It is a framework to discuss requirements for P2MP focusing on, but not limited to, 802.3ah functional and (higher layer) interface requirements
 - Team effort to reach consensus on the functionality needed for 802.3ah P2MP
 - The specific 802.3ah P2MP requirements may be a subset of these requirements
- **Status**
 - Full consensus on the presented general, network and protocol requirements and performance measures
 - Large consensus on interface requirements (I.e., traffic requirements)
 - Some important issues still under debate:
 - Forwarding rules have been extensively debated but consensus has not been reached yet
 - Other 802 compatibility topics not discussed yet
 - Security not discussed
- **Work will continue**
 - Everyone is invited to participate