



An Ethernet PON Using Existing 802.3 MAC Layer

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Version 5**

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Abstract

The EFM group has identified a number of objectives for Ethernet Access Networks, this presentation is intended to present further work in satisfaction of:

Point to multipoint on optical fiber

Vote on point to multipoint fiber (75% required)

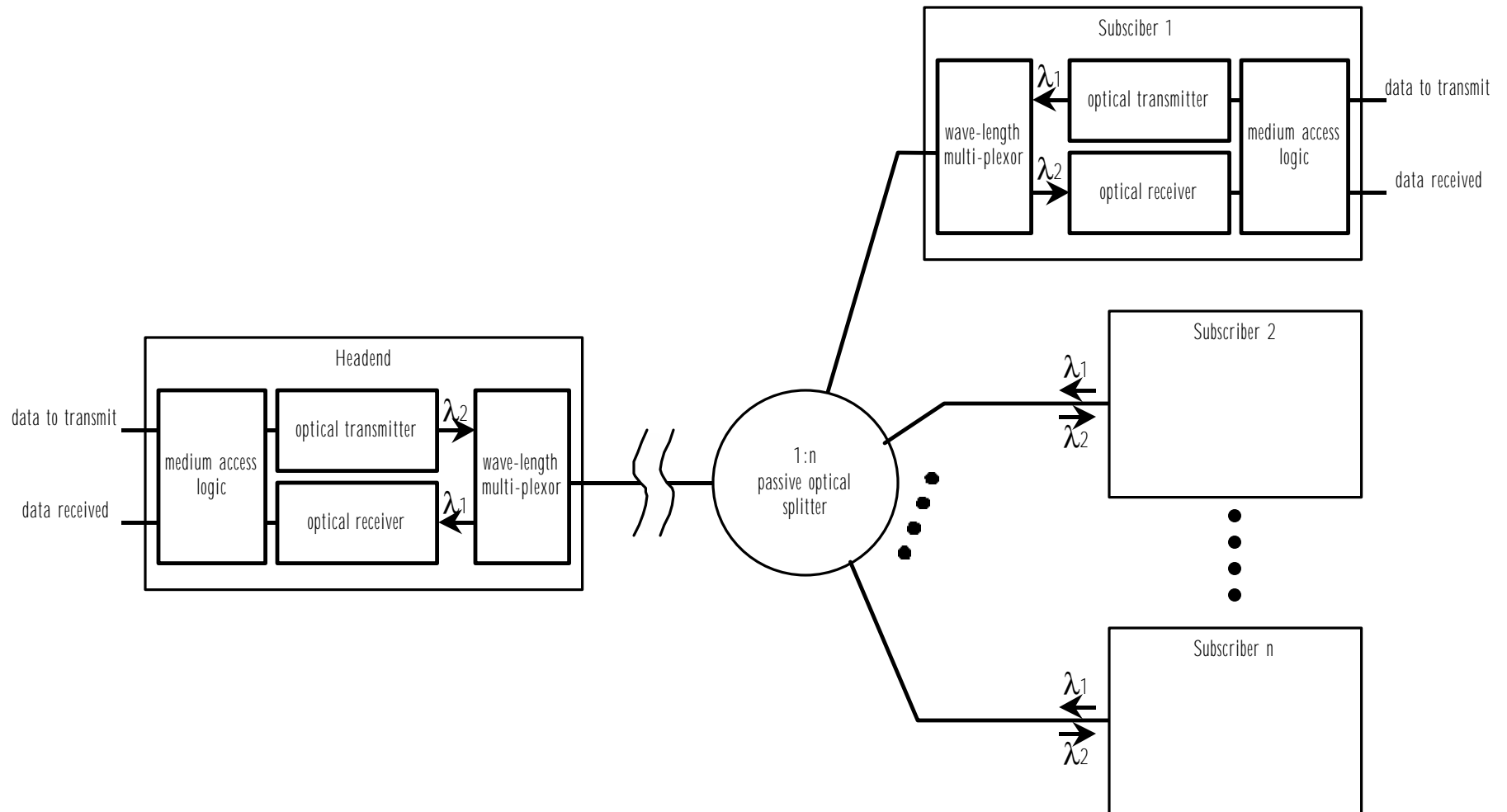
In favor 84, opposed 3, abstain 12 Passed

‘PHY for long distance over PON’

In favor, 59, opposed 3, abstain 19 Passed

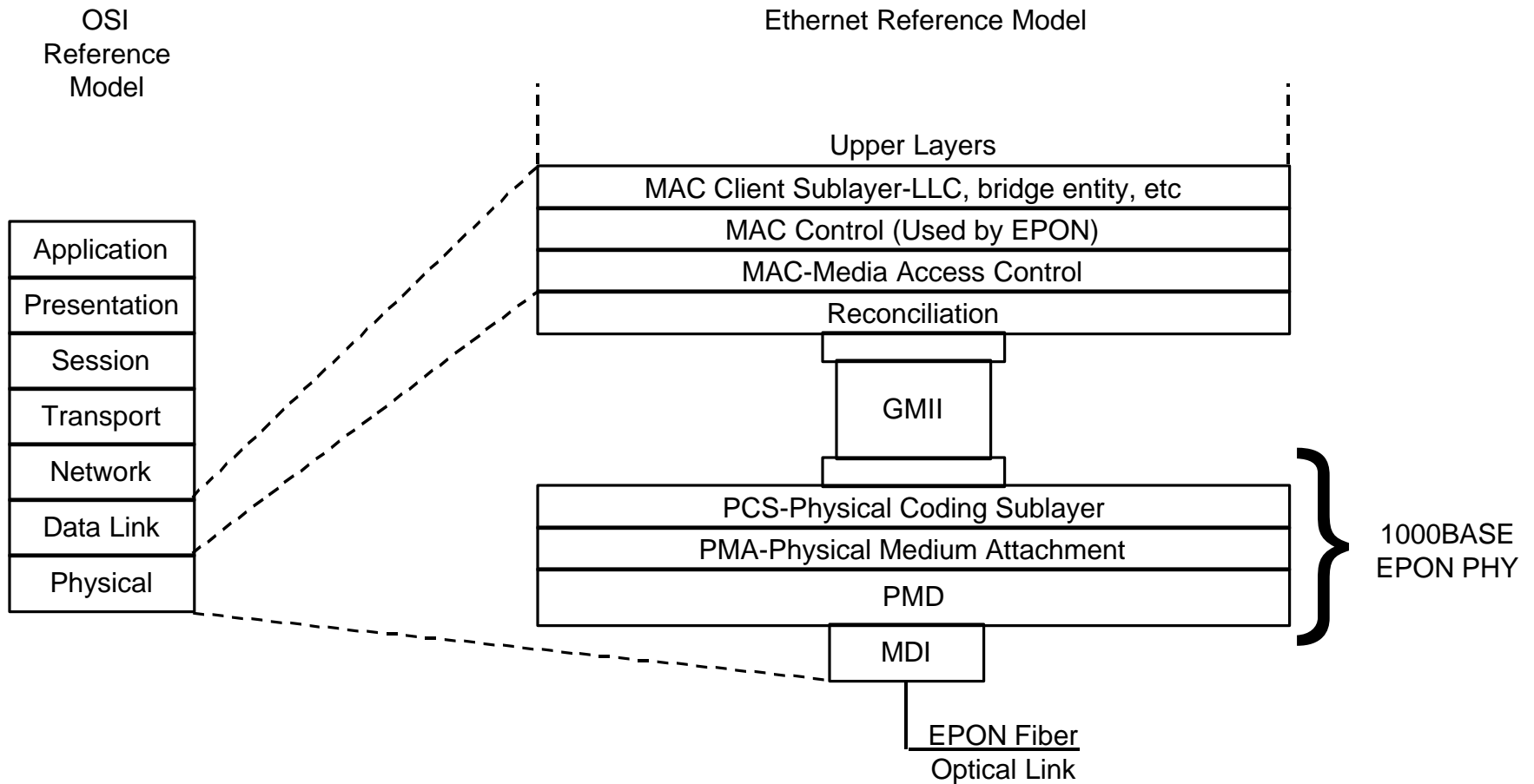
This presentation aims to to define an EFM proposal for Ethernet Passive Optical Networks (EPONs). The contribution demonstrates that the existing 802.3 Standard includes MAC-layer features upon which point-to- multipoint optical Ethernet networks can be built. Performance can be modeled with respect to number of users served per PON headend in terms of efficiency and latency. Further analysis is needed at the optical layer, where we might expect to draw on both 802.3 and FSAN specifications. Existing, commercially-available Ethernet MAC and SERDES silicon may be used to implement this optical point-to-multipoint configuration. Such a system, which requires no change to the existing MAC layer specification, can in principle form the basis of a streamlined standardization process and stay within the 802.3 Standard.

EPON Configuration



GePON Layer Model

(Headend and Subscriber are the same at this level)



Why Ethernet PON

- Single standard MAC for point to point and PON
- All services provided over common IP over Ethernet infrastructure
- Conserves fiber infrastructure
- No outside plant electronics, no power on utility poles
- Upgradeable via WDM and/or 10Gbit/s Ethernet when business case requires and costs allow
- Supports high bandwidths – e.g. multiple HDTV streams
- Provides port multiplication at head end leading to higher density and lower cost
 - Headend costs amortized over larger number of customers
 - Reduced space requirements
 - Smaller fiber distribution frame
- Builds on existing standards, volume and increasing levels of integration

EPON Not a Peer to Peer Network: 802 Criteria #2, Compatibility

- Requirement:
 - IEEE Project 802 defines a family of standards. All standards shall be in conformance with 802.1 Architecture, Management and Interworking
- EPON is not a peer-to-peer network per the “key concept” text (shown on the next slide) taken from the 802 Overview and Architecture
- Explanation:
 - EPON provides shared media headend to subscriber communication. There is no communication between shared media subscribers
- SG needs to note this in its 5 Criteria presentations and ask 802.3 and the Exec for specific approval of this “expansion of” or “exception to” the key concepts

IEEE P802 Overview & Architecture

D29, Clause 1.2

1.2 Key Concepts.

The LANs described herein are distinguished from other types of data networks in that they are optimized for a moderate-sized geographic area, such as a single office building, a warehouse, or a campus. An IEEE 802 LAN is a peer-to-peer communications network that enables stations to communicate directly on a point-to-point, or point-to-multipoint, basis without requiring them to communicate with any intermediate switching nodes...

Peer to Peer Issue: Solution

- EFM is a new application space for 802.3 which presents new problems and new solutions
- In normal operation EPON shared media end nodes should **not** be allowed to communicate without intermediate switching nodes
- EFM SG needs to request permission for exception to key concepts. This means a motion in SG Wed.
- Change Compatibility criterion in PAR & Five Criteria
 - “As a supplement to Std 802.3 the proposed project will remain in conformance with 802 Overview and Architecture.”
 - TO
 - “As a supplement to Std 802.3 the proposed project will remain in conformance with 802 Overview and Architecture **with the exception of allowing EPON shared media end nodes to communicate by means of intermediate switching nodes.**”

Requirements and Observations

- No changes to existing Ethernet MAC
 - Add PON functionality by enhancing MAC control layer and new PHY
- Multiplexing upstream traffic by frames (or multiple frames) reduces the need for tight control of subscriber timing
 - Avoiding frame segmentation significantly reduces complexity
- A modest split ratio already achieves significant economies and provides customers with bandwidth to spare
 - Higher split ratios increase outstation costs because of higher specification electro-optics
 - We believe that the appropriate maximum is at 32 way split with a 10 km reach (equivalent to 16 @ 20 km)
- Reusing existing components reduces time to market and allows PONs to ride volume cost curves
- Preserve capabilities for later enhancements by upgrading head end only
 - Preferably no changes to subscriber access unit

KISS

Keep It Simple,
Preserve the Integrity of Ethernet

EPON Principles: 1

- Downstream and upstream paths are logically and physically separate via WDM on a single fiber
- Service between Headend and Subscriber is achieved using existing standardized functions in Full-Duplex mode (No CSMA/CD)
- Subscribers see traffic only from the head end, not from each other (therefore not true “peer” Ethernet service)
- Subscribers preferably apply a customer specific filter (e.g. MAC address or Multicast) to select local traffic from downstream broadcast multiplex

EPON Principles:2

- Headend permits only one subscriber at a time to transmit onto the upstream medium via TDMA (implemented e.g. via new MAC Control commands and/or in the PHY)
- Headend must guard between transmissions from different subscribers via either:
 - Timing guard bands allowing for maximum differential delay
 - Auto-ranging so differential delay from each station is known
- When changing from one subscriber to the next, headend must permit any transmission which has already started to finish and must allow for differential delays between subscriber transmissions

Review of Pause Facility: 1

(See 802.3 Standard, Clause 31, Annex 31B)

- IEEE 802.3 includes a mechanism to hold off the emission of packets from a node by sending the node a 'Pause Command'
- Pause Command specifies length of time to interrupt transmission in "Pause Quanta" (multiples of 512 nsec for Gigabit Ethernet)
- MAC finishes sending any packet that has already started, but must not start transmitting any new packets after receiving a Pause Command until the pause time expires
- A new Pause Command overwrites the a previous command. The newly specified pause time can be zero, effectively clearing the previous pause

Review of Pause Facility: 2

- Pause packets are minimum fixed-length packets (64 bytes, approx 500 nsec), inserted, in-band, between data packets
- Nodes implementing the pause facility must respond to commands sent to both a well known multicast destination address (multicast pause) and the node's own MAC address (directed pause)
- The well-known multicast address does not pass through 802.1D bridges (ref: 802.1D, Table 7-9)

Advantages and Features

- **Upstream capacity is guaranteed by timing imposed from the headend**
- **Downstream traffic is regulated by headend policy up to the capability of the downstream channel (i.e., provisioning is outside the scope of 802.3 work)**
- **Protocol requires only minor additions to existing standards and silicon and no change to Ethernet MAC**
- **PON systems can ride the technology and price curves of high volume point to point silicon**
- **Fast time to market**

Conclusions

- The 802.3 specification already includes a mechanism which can be adapted for use in a Gigabit Ethernet PON via MAC Control
- Goal: Multiplexing of upstream traffic must achieve acceptable latency and carry native Ethernet frames without segmentation
- Goal: Needs to provide guaranteed upstream bandwidth
- Lower cost in many configurations
- Further work is needed to define the optical layer
- Need to ask for exception/expansion of peer to peer key concept