Standard for Service Interoperability in Ethernet Passive Optical Networks

Project Proposal

Outline

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   - Standardization History
2. Standard for Service Interoperability in Ethernet Passive Optical Networks (SIEPON)
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   - Broad Support and Broad Market Potential
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3. Relevance to the Communications Society
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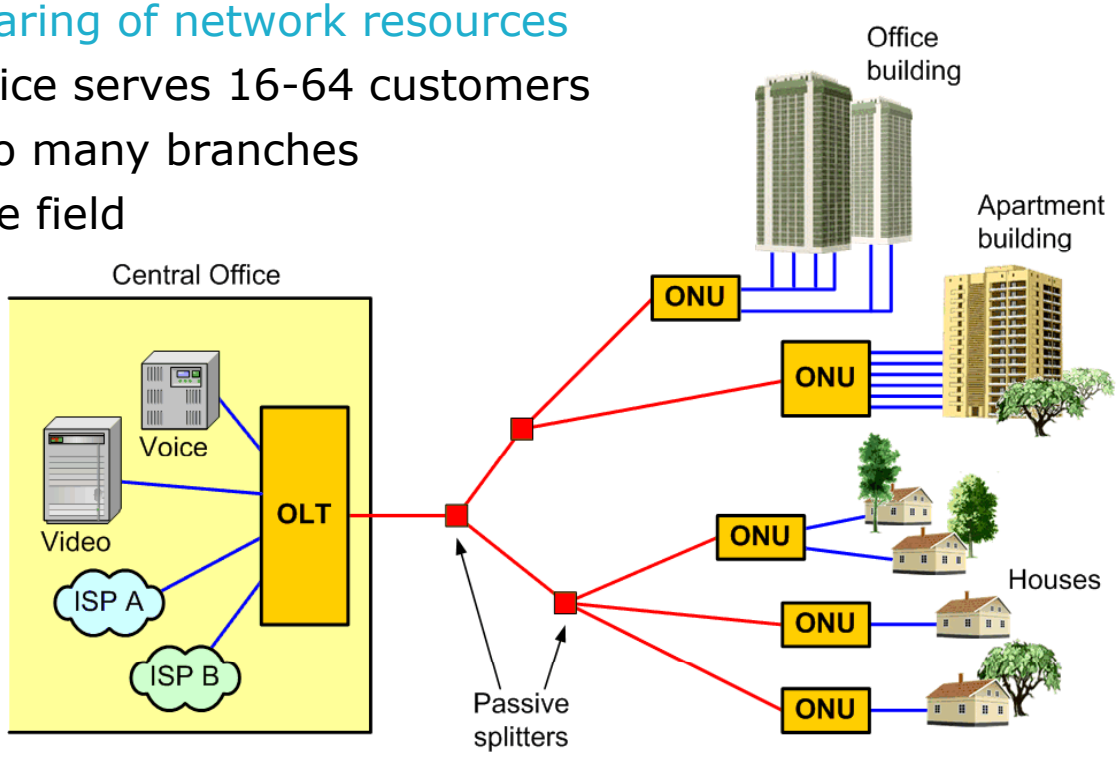
Ethernet Passive Optical Networks

- Technology Overview
- Standardization History
- The Need for an Additional Standard

EPON Architecture

- Ethernet Passive Optical Network (EPON) is a state-of-the-art FTTx access technology
  - Provides high data rates and serves large distances
  - Very cost-efficient due to sharing of network resources
    - One port in the central office serves 16-64 customers
    - One trunk fiber is split into many branches
    - No active electronics in the field



- EPON consists of an **Optical Line Terminal (OLT)** located in the central office and **Optical Network Units (ONUs)** located at users' premises.
  - Downstream is broadcast-and-select
  - Upstream is based on time-shared access to the medium.

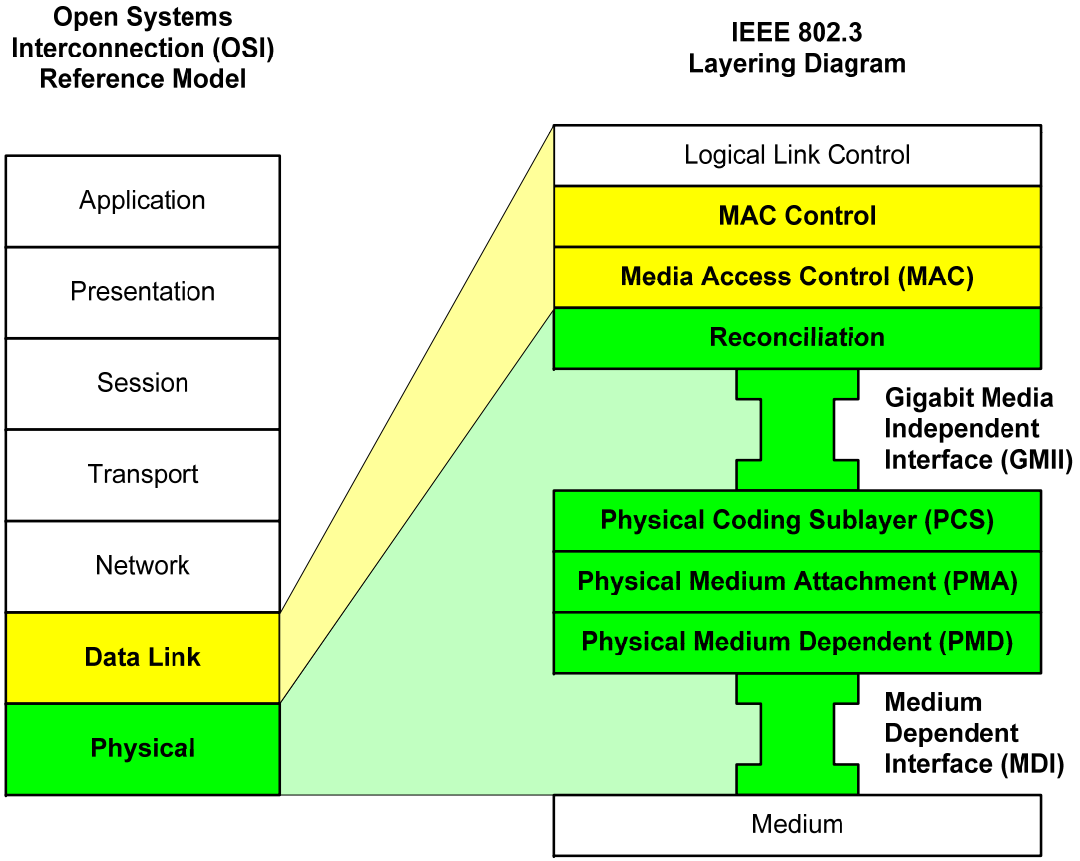
EPON Standardization

- **1G-EPON was standardized as part of the IEEE P802.3ah "Ethernet in the First Mile" project (2000-2004)**
  - 1 Gb/s upstream and downstream data rates
  - Focus on Physical and Data Link layers and Link Management functions
  - Highly successful technology: **30 million subscribers are served by 1G-EPON**

- **10G-EPON was standardized in the IEEE P802.3av project (2006-2009)**
  - 10 Gb/s downstream rate; 10 Gb/s or 1 Gb/s upstream rate
  - Focus on Physical and Data Link layers and Link Management functions

Scope of IEEE 802.3 is on Lower Layers

- **IEEE 802.3 covers only the Physical Layer…**
  - Physical Medium Dependent Sublayer
  - Physical Medium Attachment Sublayer
  - Physical Coding Sublayer
  - Reconciliation Sublayer
- **… and a portion of the Data Link Layer**
  - Media Access Control (MAC)
  - MAC Control
- **IEEE 802.3 focus is on transport, not on the system**

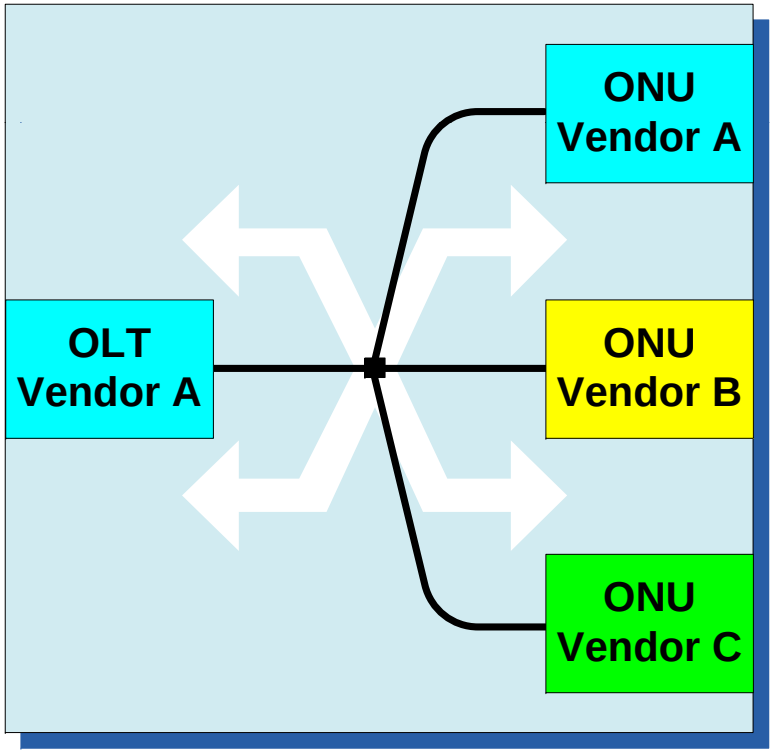


View on Higher-Layer Features

- The IEEE 802 specifications enable various system-level features or functions, but do not provide formal specification for some features, treating them as out-of-scope. Examples include:
  - Exact DBA mechanism
  - Packet-classification rules
  - Software/Firmware download
  - Service and device management
  - System-level power-saving mechanisms
  - Service protection and restoration mechanisms
- These features traditionally are outside of the scope of IEEE 802 networks and treated as implementation choices because…
  - These features typically pertain to inner-working of a single device
  - These features typically do not affect service interfaces or interoperability

EPON System-Level View

- **At the system level, EPON devices (OLT and ONUs) are somewhat distinct from typical L2 devices, such as switches or bridges.**
  - EPON can be viewed as a distributed switch
  - To ensure service interoperability, including QoS enforcement, the OLT and ONUs must fully interoperate at all protocol layers, not just at the PHY and Data Link Layers specified by the IEEE Std. 802.3.
  - Yet the OLT and ONUs are separate devices which may be sourced from different vendors.
  - **A standard covering EPON system-level features is needed**



EPON System-Level Specification

- No system-level specification existed when the 1G-EPON transport standard (IEEE Std. 802.3ah) was completed.
- For initial EPON deployments carriers have created their own system specifications and interoperability testing plans.
- The Chinese operators and vendors have gone further and produced a country-wide EPON system-level standard (standardized in CCSA).

Why Is SIEPON Necessary?

- SIEPON? - Service Interoperability in Ethernet Passive Optical Networks
- The convergence of communications, computing, and entertainment is happening faster than anticipated. Network operators are becoming service providers.
- To successfully provide, manage, and scale services, network operators must ensure that the deployed EPON devices implement necessary features and interoperate in the following areas:
  - Traffic engineering functions
  - Provisioning and QoS support of multiple services (current and future/not yet known)
  - Device and service management

SIEPON: Scope and Purpose

Need for the Project

- More than 30 million subscribers are being served by 1G-EPON now, and it is expected that deployment volumes soon will reach more than 10 million new subscribers annually. There are no open, international, system-level specifications describing how to achieve multi-vendor interoperability.
- A detailed system-level standard, developed in an open fashion by the IEEE, will eliminate the need for service providers and national bodies to create unique interoperability specifications that needlessly fragment the market. This will serve a number of important purposes:
  1. EPON devices will follow a common specification for the world-wide market, resulting in larger volumes and reduced costs;
  2. Operators will not face the challenge of developing system-level specifications and interoperability testing procedures before they can deploy EPON;
  3. EPON vendors will not need to implement multiple options to comply with multiple proprietary/national specifications. Reduced device complexity will further reduce costs;
  4. Competition among EPON equipment and component suppliers will increase, thus driving further innovation and cost reductions.

Scope of the Project

- The proposed standard will describe the system-level requirements needed to ensure service-level, multi-vendor interoperability of Ethernet Passive Optical Network (EPON) equipment. The specifications developed in the course of this project will complement the existing IEEE Std. 802.3 and IEEE Std. 802.1 standards which ensure the interoperability at the Physical layer and Data Link layer. Specifically included in the proposed work are:

  1. EPON system-level interoperability specifications covering equipment functionality, traffic engineering, and service-level QoS/CoS mechanisms.
  2. Management specifications covering: equipment management, service management, and power utilization.

Examples of In-Scope Features

- **Multi-service QoS mechanisms**
  - SLA and service provisioning
  - Dynamic bandwidth allocation
  - Service scheduling at the OLT
  - Service scheduling at the ONU
- **Configuration and control of point-to-multipoint connectivity**
- **System monitoring and diagnostics**
  - Optical link monitoring and diagnostics
  - Device monitoring and diagnostics
  - Fault detection and isolation
- **Service Protection and Restoration**
  - Optical link protection switching function
  - Equipment redundancy and dual homing
  - Configuration recovery function
- **Power utilization modes**
- **Software/firmware updates**
- **Device and service management for all the above features**

SIEPON:
Broad Support and Broad Market Potential

Organizations Endorsing 10G-EPON

Excerpt from joint press release:

Piscataway, NJ, September 11, 2009 - Today, more than 40 companies and organizations that supported or participated in the IEEE P802.3av 10 Gb/s Ethernet Passive Optical Network (10G-EPON) Task Force are celebrating completion of IEEE Std. 802.3av™-2009, also known as Physical Layer Specifications and Management Parameters for 10 Gb/s Passive Optical Networks. <…> The following companies have expressed their support for the approved standard: Alloptic, Anritsu Company, ARRIS, B-DeltaCom, Bright House Networks, Cambridge Industries Group, China Mobile Communications Corporation, China Telecom – STTRI, China Unicom – Beijing, Corecess, Cortina Systems, CyOptics, Dasan Networks, Dongwon, Enablence Technologies, ETRI, FiberHome, Fujitsu, H3C, Hisense Broadband, Hitachi, Huawei Technologies, Kawasaki Microelectronics, KDDI R&D, KT, Ligent Photonics, Mitsubishi Electric, NEC, NTT Corporation, OF Networks, OneChip Photonics, PMC-Sierra, Shanghai Luster Teraband Photonics Co., Sumitomo Electric, Teknovus, Telekom Malaysia R&D, Ubiquoss, Vitesse Semiconductor, and ZTE. The China Communications Standards Association (CCSA), the Ethernet Alliance, the Optical Access (FTTx) Industry Alliance (OAIA) of China, and the Taiwan Optical Communication Industry Alliance also endorse the 10G-EPON standard.

(reviewed and approved by every listed organization)

Evolution from 1G-EPON to 10G-EPON

- **Ethernet PON opened the floodgates for advanced services**
  - Video-on-Demand
  - High-definition IP TV
  - Time-shifted broadcast
  - Online video games
- **Users began to accept, like, and demand more bandwidth-intensive services**
  - File sharing, picture uploading, video conferencing
  - More simultaneous IP TV channels
  - More on-demand, less broadcast ("information pull" instead of "information push")
- **Successful deployments of 1G-EPON created strong demand for even greater bandwidth**
- **In 2005-2006, carriers started looking for a next generation solution**
  - Compatible with the existing outside plant
  - Compatible with the existing NMS and OAM

10G-EPON Will Have Many Applications

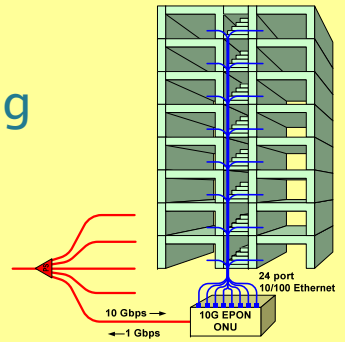
IPTV

- Bandwidth/channel is increasing
  - SDTV = 2 Mb/s per channel
  - HDTV = 10 Mb/s per channel
  - 3DTV = 50-90 Mb/s per channel
- Number of US households using HDTV (HD-IPTV) is increasing
  - 2010: 40% (20%)
  - 2020: 90% (80%)

L. K. Vanston, R. L. Hodges, and J. Savage, "Forecasts for Higher Bandwidth Broadband Services", Technologies Futures, Inc.

MDU Market

- The biggest emerging markets are predominantly MDU
  - China, India, Russia, Brazil, etc.
- **With 24-48 subs per ONU, PON should have 10 Gb/s capacity**

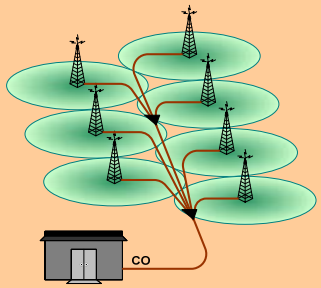


MSO Market

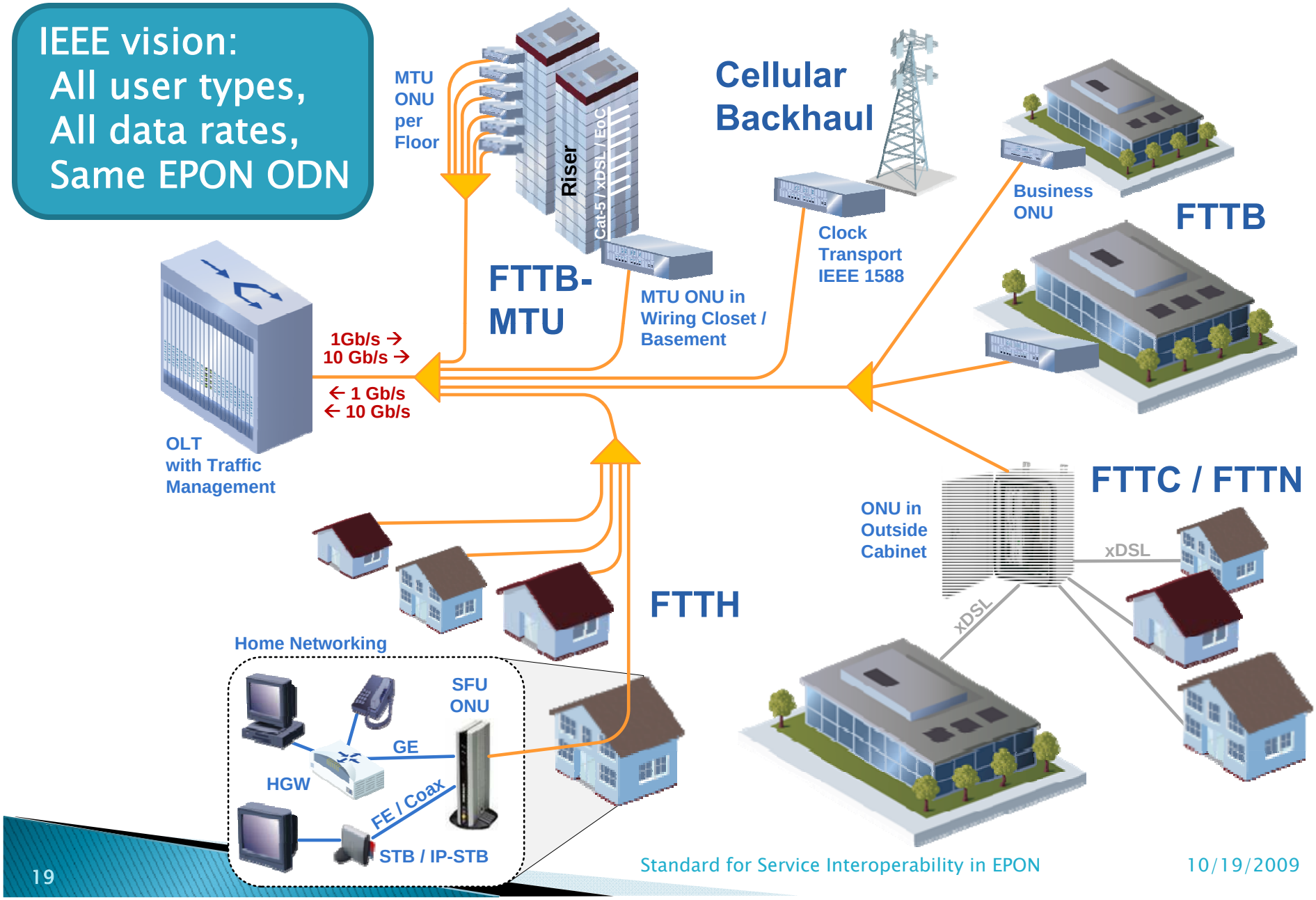
- MSOs are looking for post-DOCSIS 3.0, all-fiber solutions
  - DOCSIS 3.0 can provide a total of 5 Gb/s
  - **The EPON architecture is a perfect match for the MSO networks, but more bandwidth is needed**

Wireless Backhaul

- Desired access point density makes PON the only feasible solution
- 4G Wireless requires up to 1 Gb/s per access point ➔ **PON capacity of 10Gb/s is needed**



EPON is a Unifying Architecture



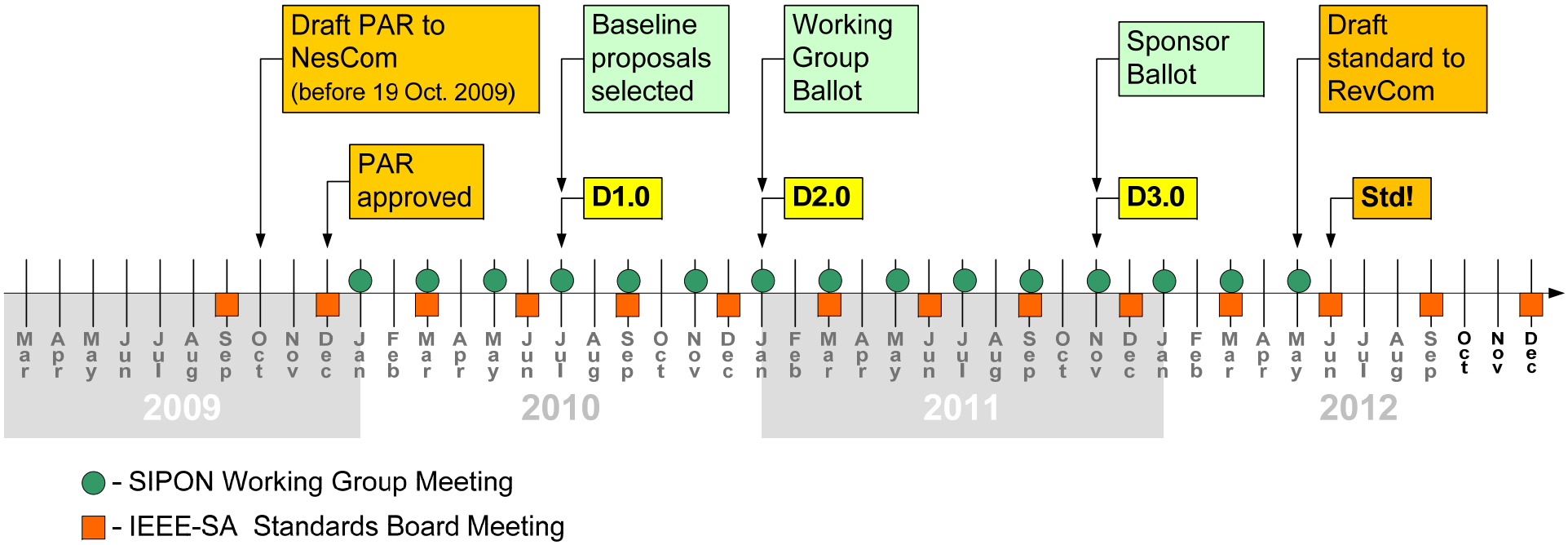
Proposed Timeline and Expected Participation

Organization of WG Activities

- Current plan: Six meetings per year
  - Meetings will be hosted by member entities
  - A significant fraction of meetings will be held in APAC
  - Additional meetings will be scheduled as necessary
  - As needed, task forces will be formed to address specific topics

- Between meetings
  - Work is to be divided among the various task forces
  - Task forces will conduct conference calls as necessary

Tentative Schedule



- Schedule is tentative, subject to confirmation by the Working Group

Expected Participation

- The following entities expect to join the SIEPON project as voting members:

Company	Contact
Bright House Networks	John Dickinson john.dickinson@mybrighthouse.com
Cavera Systems	Venkat Vankayalapati venkatv@caverasys.com
China Telecom	Wang Bo wangbo@chinatelecom.com.cn
FiberHome Telecommunications Technologies Corp.	Duane Remein duane.remein@att.net
Teknovus, Inc.	Glen Kramer glen.kramer@teknovus.com
University of New Hampshire – Interoperability Lab	Jeff Lapak jrlapak@iol.unh.edu
ZTE Corp.	Marek Hajduczenia marek.hajduczenia@zte.com.cn

Relevance to the IEEE Communications Society

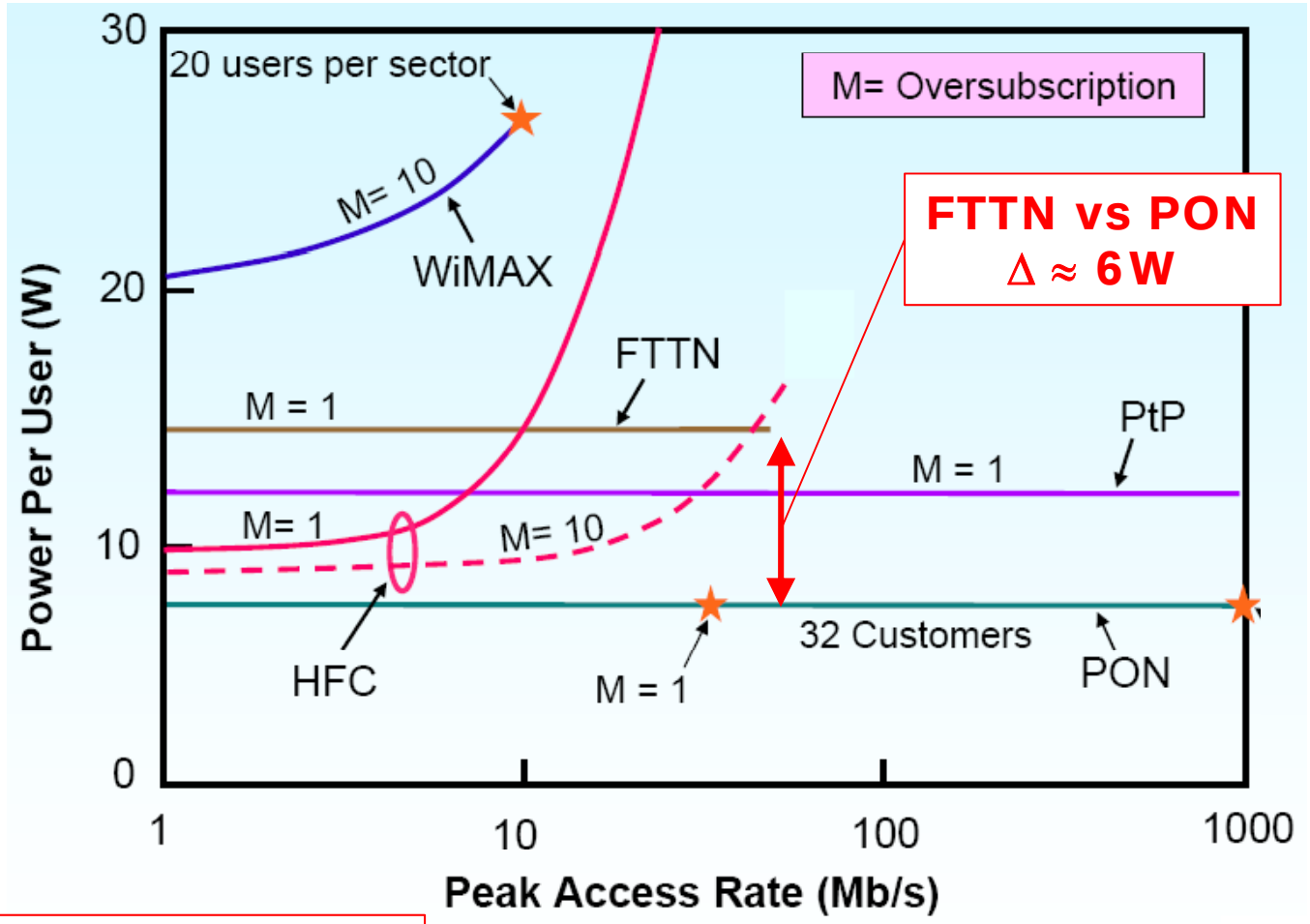
Why ComSoc?

- The convergence of communications, computing, and entertainment is happening faster than anticipated.
- No existing international standard has addressed system-level requirements for EPON
- The system-level functions proposed for standardization match very well with the established scope of the Communications Society. Specifically, the work may be of interest to the following Technical Committees :
  - **Transmission, Access, & Optical Systems**
  - **Optical Networking**
  - **High-Speed Networking**
  - **Network Operations & Management**
  - **Multimedia Communications**

SIEPON is Green

- EPON's potential to reduce CO_2 emissions is huge. This reduction comes from reducing power consumption by the telecom network and by modifying user behavior.
  - Telecommuting reduces or eliminates auto commuting.
  - Telepresence reduces or eliminates business trips
  - Convenient and personalized news feeds allow many users to give up newspaper subscriptions.
  - High-quality video streaming reduces the energy and resources required to manufacture, store, and distribute DVDs.
- The SIEPON standard will enable and facilitate the deployment of services that are known to modify user behavior in the right direction.

SIEPON is Green



For 25M subscribers

6W/sub = 150 MW / network
= 590k tons of coal annually
= 2.2M tons of CO_2 annually

PON FTTH is "greenest"

R. S. Tucker, *A Green Internet,*
http://www.ee.unimelb.edu.au/people/rst/talks/files/Tucker_Green_Plenary.pdf

Relationships with other IEEE-SA projects and other SDOs

Other IEEE-SA Projects

- The project should be developed in the IEEE-SA because it will build upon and incorporate by reference various IEEE 802 specifications as a means to achieve end-to-end Ethernet service continuity.

- The SIEPON project will develop close ties with the 802.3 and 802.1 Working Groups. This project…
  - Will establish liaisons with the 802.3 and 802.1 Working Groups.
  - Will not redefine or modify the PHY and Data Link layers defined by IEEE Std. 802.3 and IEEE Std. 802.1
  - Will not use the 802.3 and 802.1 specifications in ways not intended by respective Working Groups.

Other SDOs

- **The new project will establish a liaison with the ITU-T SG15** to ensure cooperation and alignment among various projects targeting next-generation optical access.

- **The project will establish a liaison with the Broadband Forum** to harmonize the proposed work with relevant BBF projects that treat EPON systems as components in an end-to-end architecture.

- **The project will establish a liaison with the Metro-Ethernet Forum** to align the proposed work with the MEF's work on service definitions.