

Ethernet WDM Aggregation Networks

Call For Interest

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49 Individuals
31 Entities

Agenda

- Introduction
 - Objectives
 - Problem Statement
- Market & Potential/Applications
 - NA / ASIA / EU / Other
 - Mobile backhaul
 - Business Services
 - CO Consolidation
 - HFC Upgrade
- Technical Examples
 - Candidate technologies
 - Examples
- Why Now?
- Q&A
- Straw Polls

Objectives of this meeting

- To assess the interest in starting a study group to develop a standards project proposal (PAR and 5 Criteria) for Ethernet WDM Aggregation Networks
- We don't need to:
 - Fully explore the problem
 - Debate the strengths and weaknesses of any given solution
 - Select a solution
 - Create the PAR or the 5 critters
 - Create a standard
- Ground Rules
 - Anyone may speak
 - Be respectful and be respected

What is the Problem?

- Very high, sustained bandwidth clients are not served well with existing shared medium technologies. ⁽¹⁾
 - Mobile backhaul
 - High bandwidth customers
 - An appropriate P2P shared media solution is needed
- Certain clients require a higher level of security (i.e., physical layer) than is available on existing shared medium technologies.
 - Requires a pure peer to peer, P2P network.
- Certain clients prefer the robustness of P2P networks over P2MP networks that risk service degradation due to “rogue” ONUs.
- Projections indicate sustained growth of business traffic and very high (18x) growth for Mobile Backhaul traffic in the next 4-5 years.

What isn't needed

- **We don't need to replace EPON**
 - EPON is the leading Residential Fiber Access solution
 - EPON is one of 802.3 most successful interfaces
 - 1G-EPON and 10G-EPON appear to be the optimal solution for residential services for the foreseeable future
 - 1G-EPON and 10G-EPON will continue to serve the residential market for many years to come

What is needed?

- Need a solution that provides the fiber efficiencies of EPON with the dedicated bandwidth and security benefits of P2P
 - A method to aggregate services for a high number of high bandwidth P2P end points over a single fiber (30-40 bi-directional links) to alleviate the excessive cost of installing additional fibers
 - Optimized for 1 Gbps or better “Fat Pipe” per end point with
 - very low delay/delay variation
 - dynamic QoS under customer control
 - Wavelength routed architecture to ensure PHY level security (no PHY sees data other than it's own)
 - Targeted towards the access aggregation and business access markets
 - Low cost appropriate for the access market



Ethernet WDM Aggregation Network Markets and Applications

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Potential Markets

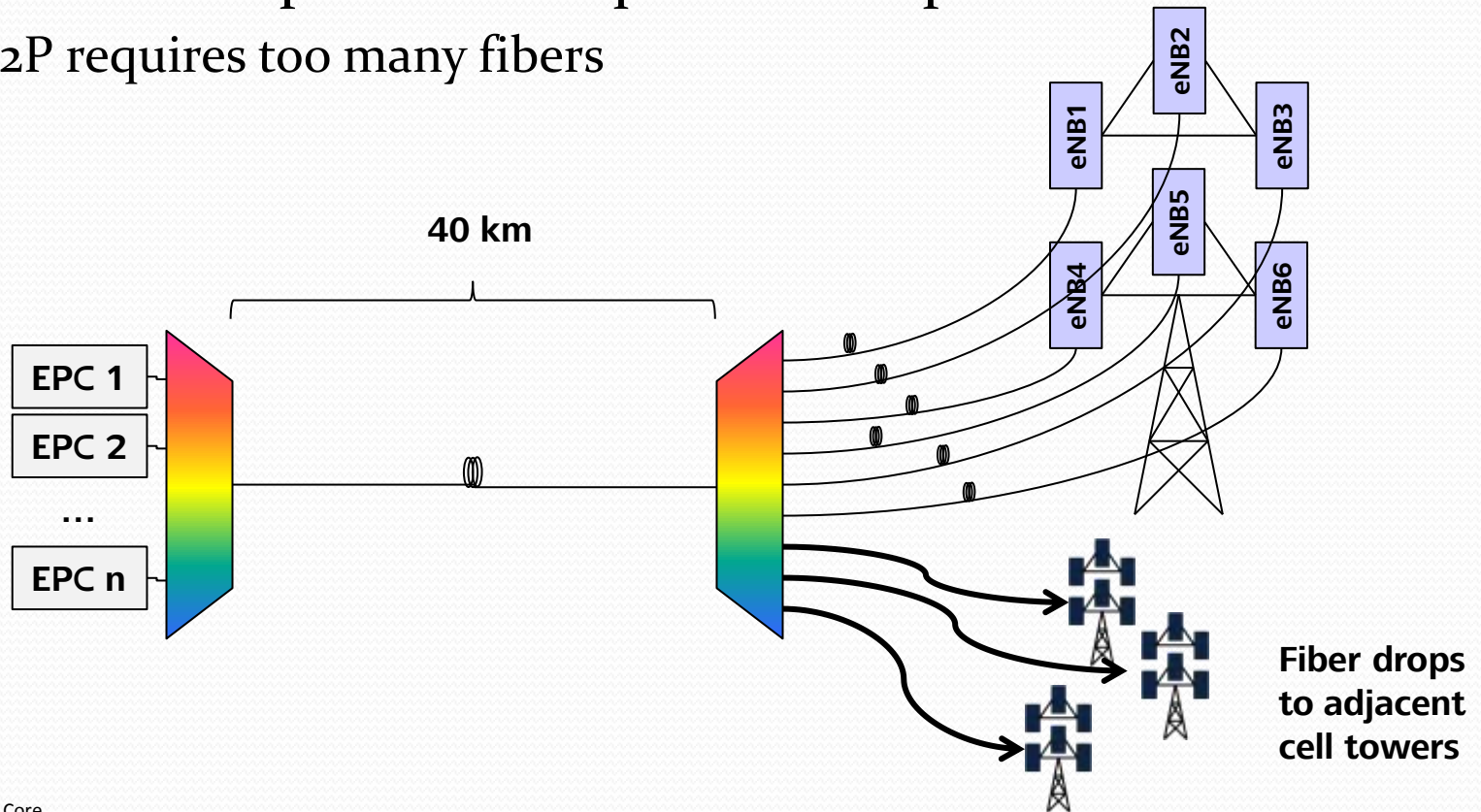
- WDM for Mobile Market⁽²⁾: the CloudRAN allows re-architecting RAN (Radio Access network) to centralize baseband processing in locations distant from the radio frequency transceivers. CloudRAN is expected to be 20 to 30% cheaper than traditional RAN (similar value for power consumption)
 - 2015 prediction for global spending on Cloud RAN vs. standard RAN
 - ASIA : 25%
 - North America : 10%
 - Europe : 15%
 - The Upshot: The requirement for extensive dark fiber runs to remote radio heads (RRHs) limits cloud RAN to a small number of very large cities.
 - Eth-WDM is an opportunity to solve the need for extensive dark fiber infrastructure

Potential Market/Applications

- Mobile backhaul
 - Fiber fed cell sites are projected to increase from 142k to 1.9M by 2015 ⁽³⁾
 - In ~2014 small cell site roll out is expected to begin, large volumes expected ⁽³⁾
 - By 2016 iGR expects unmet demand for mobile data will increase nearly 16 fold ⁽⁴⁾
- Fiber based Ethernet Business services are expected to show a 10% annual growth rate ⁽³⁾
 - North American business fiber connection to exceed 2M by 2015 ⁽⁵⁾
 - Significant investments in EU & ASIA
- Aggregation technology would reduce the need to deploy additional fiber accelerating fiber access.

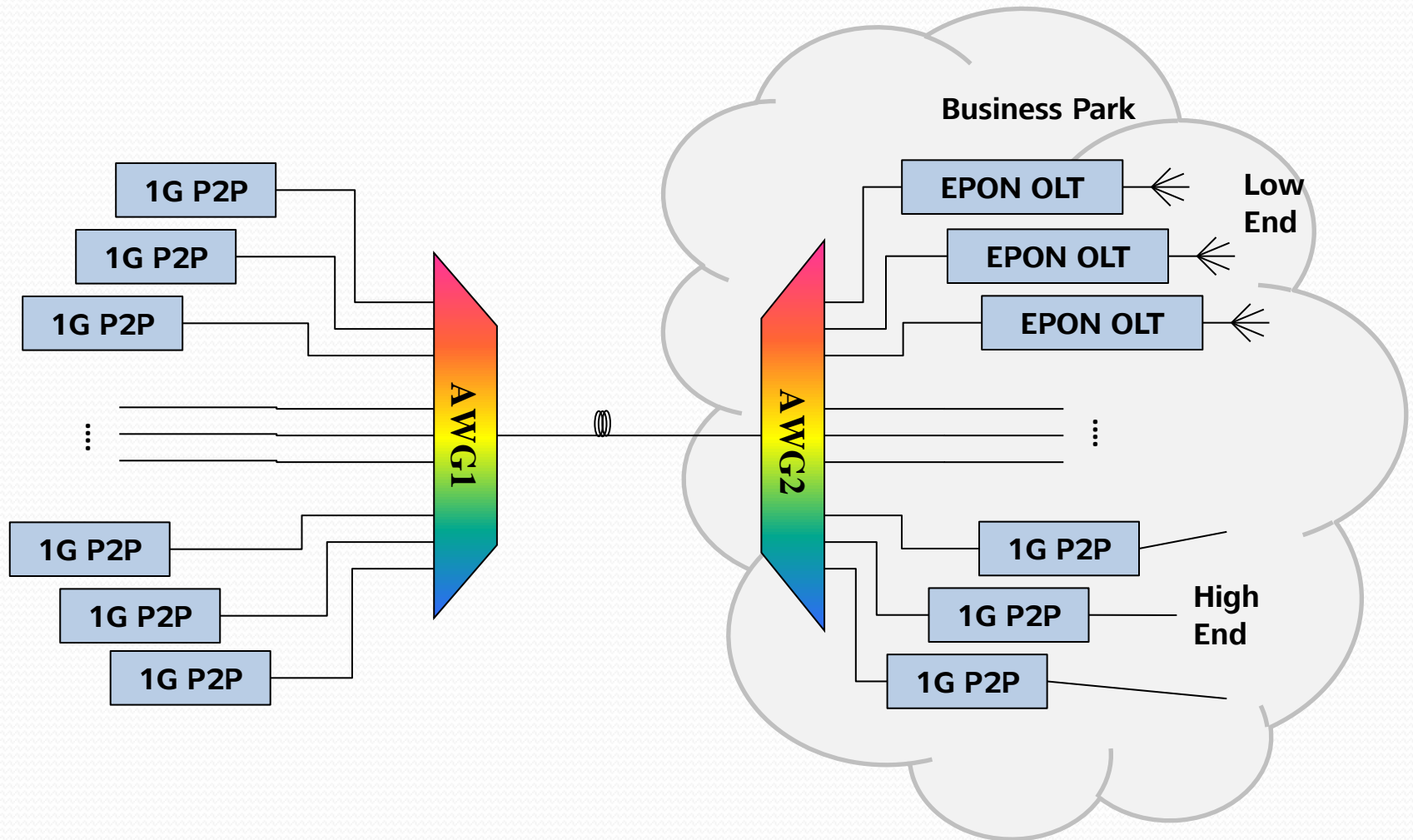
Mobile Backhaul

- LTE or similar protocols requires 1+ Gbps to each antenna
 - P2P requires too many fibers



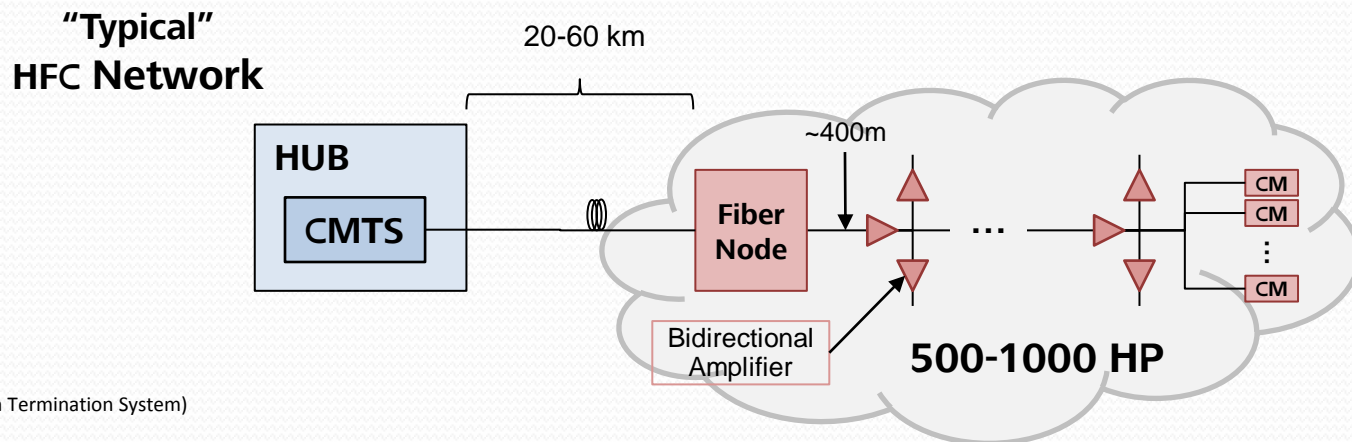
EPC - Evolved Packet Core
eNB - Evolved NodeB

Business services applications



HFC Network Upgrade

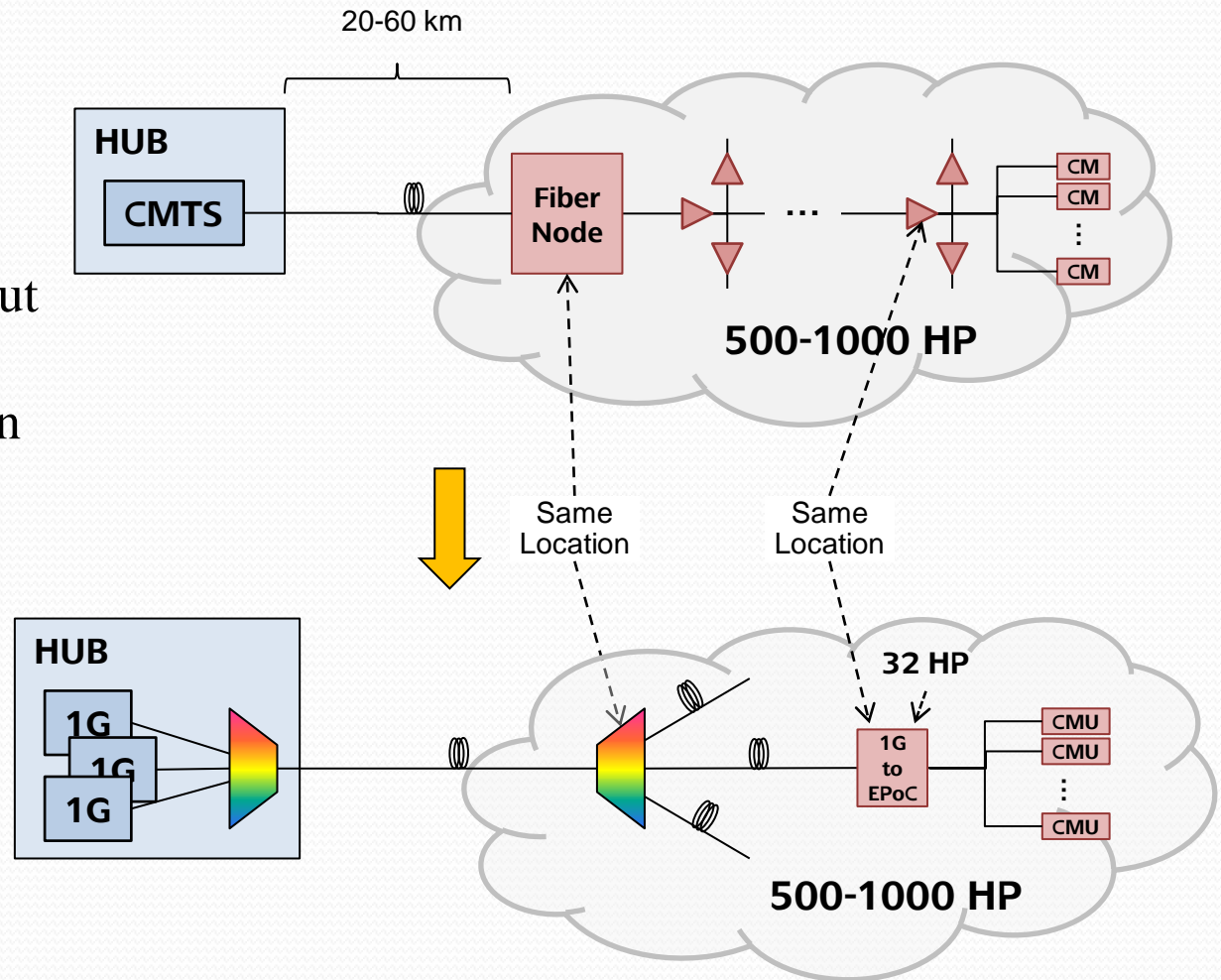
- HFC Networks are often served by only a few fibers
- Typical Fiber Node serves between 500 and 1000 subscribers
 - EPON cannot easily service this large a group
 - Need a method to deliver multiple (20-30) EPONs (or EPoC's)



CMTS – (Cable Modem Termination System)
CM – (Cable Modem)

HFC Network Upgrade

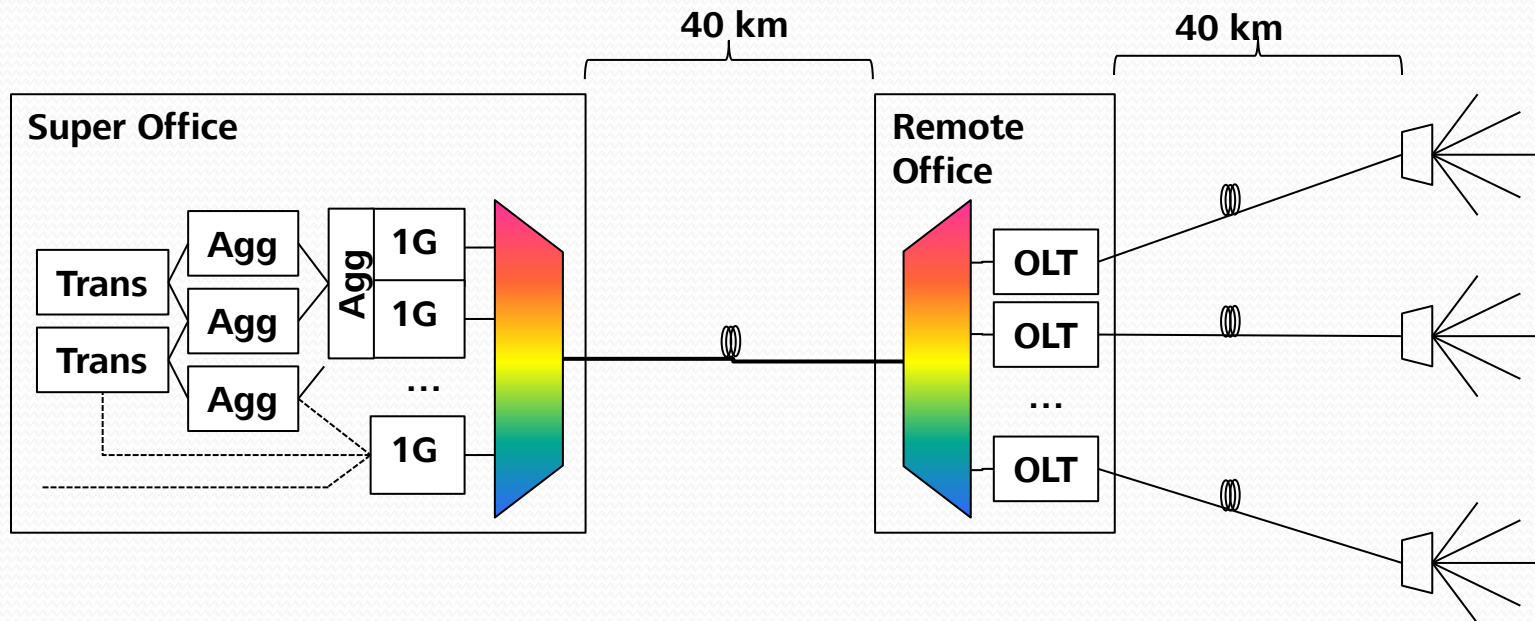
- Cable carriers want to upgrade HFC network, but they are facing fiber shortages in the trunk



EPoC – (EPON over COAX)
CMU – (Coax Network Unit)

CO Consolidation

- EPON OLTs could be consolidated in a “Super Office”
 - Remote office equipment becomes extremely simple
 - Combined reach of > 80 km may be possible when combined with Ext EPON Optics





Ethernet WDM Aggregation Network Technical Examples

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Candidate Technologies exist

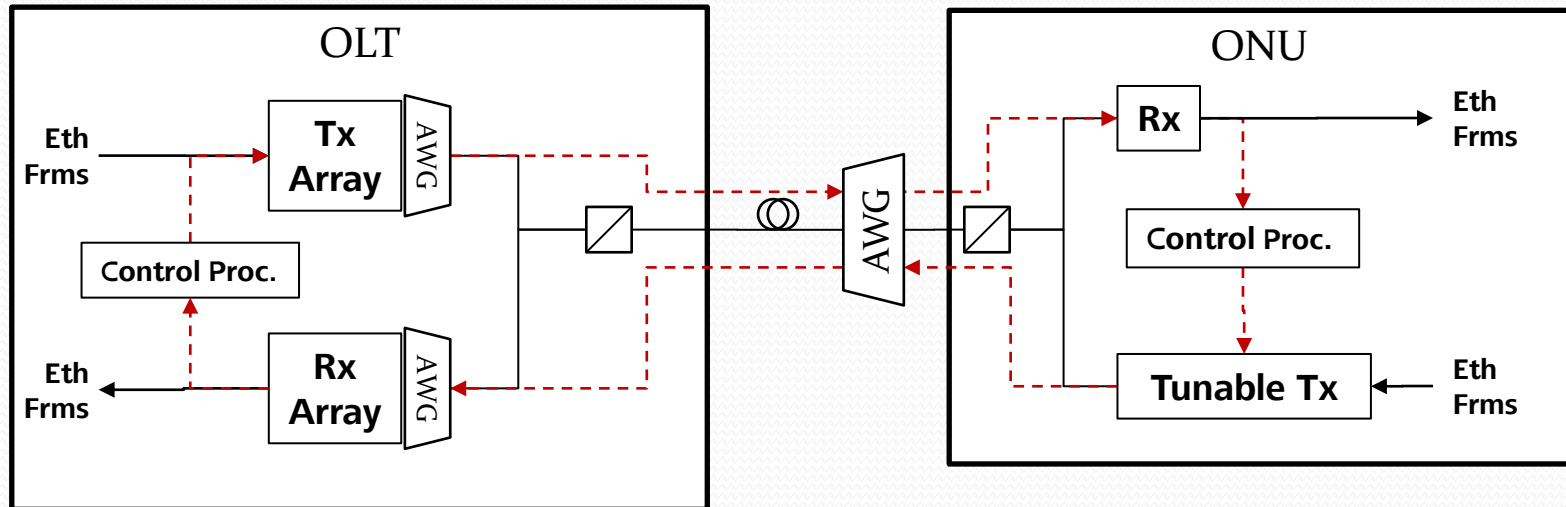
- Fixed wavelength (CWDM / DWDM)
- Tunable lasers
- Seeded WDM from CO
- Self seeded WDM
- Modulation erasure / wavelength reuse
- OFDM
- ...

CWDM – Course WDM

DWDM – Dense WDM

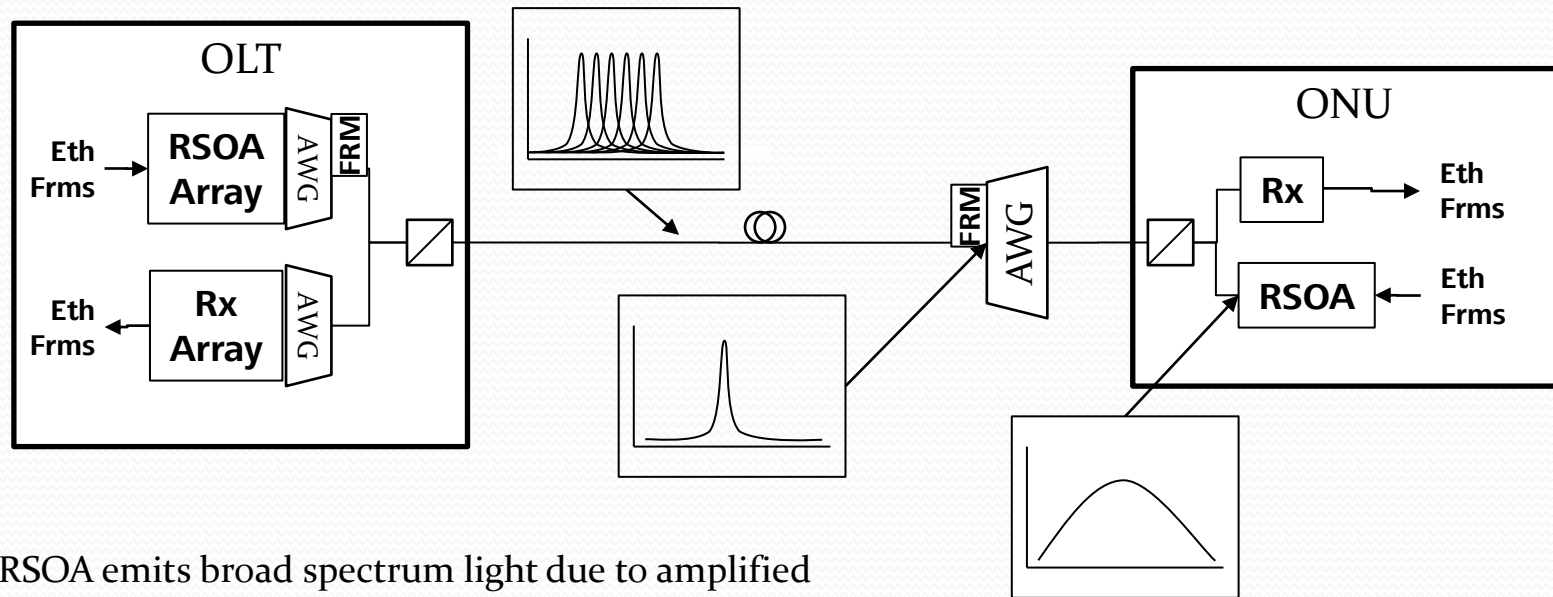
OFDM – Orthogonal Frequency Division Multiplexing

Tunable lasers



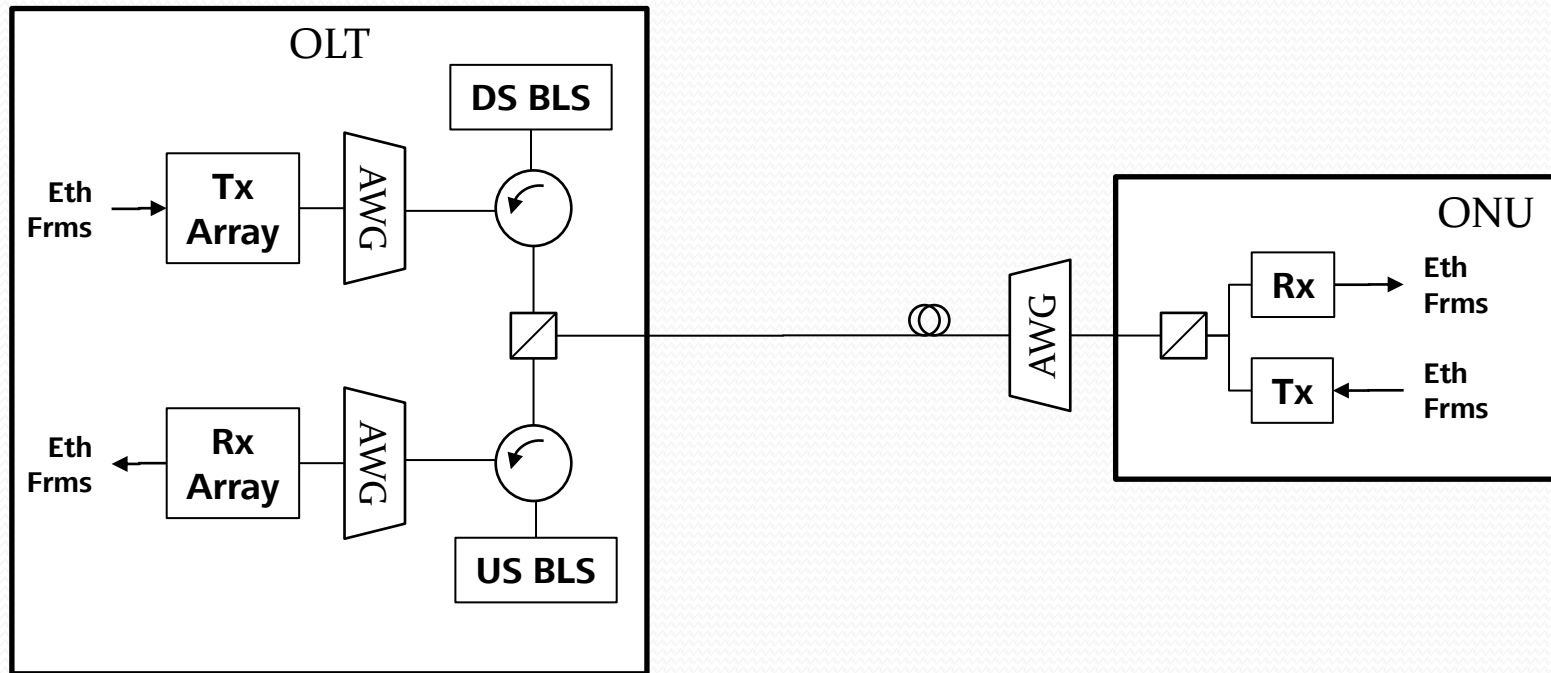
- Could use fixed wavelength laser and photo diode arrays in OLT
- Tunable laser with control function in ONU
- Wavelength tuning mechanism and protocol required to complete control loop
- Transmitters and Receivers could be co-packed into arrays for denser equipment

Self seeded WDM



- RSOA emits broad spectrum light due to amplified spontaneous emission (ASE)
- ASE is filtered by AWG
- Filtered ASE is reflected by Faraday Rotating Mirror (FRM)
- RSOA amplifies and modulates the reflected light creating a stable lasing cavity between the RSOA and the FRM
- Both OLT and ONU can have an identical structure

Seeded WDM from CO



- Laser and photo diode arrays in OLT (could use fixed wavelength laser array)
- Two Broadband Light Sources (BLS) provided seed light to Fabry-Perot laser or RSOA
- AWG filters the BLS into slices
- Fabry-Perot/RSOA laser locks to incoming filtered slice from broadband light source



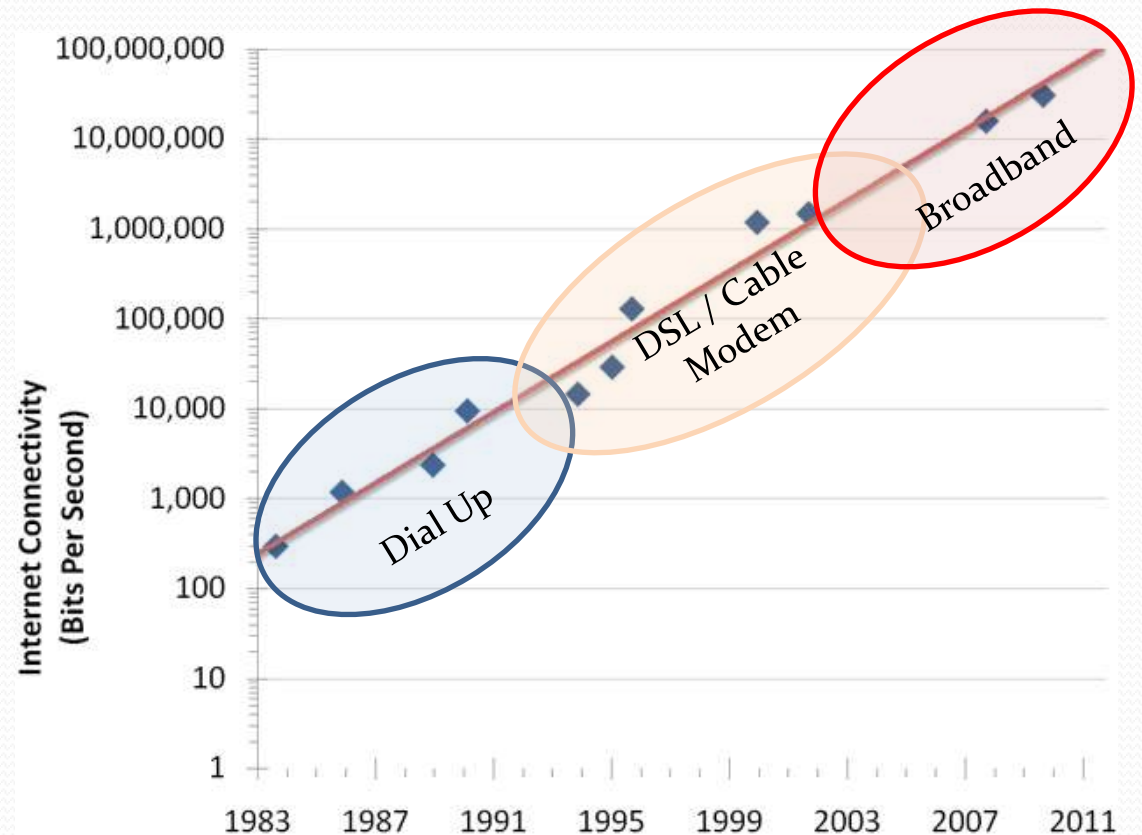
Ethernet WDM Aggregation Network Why Now?

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A Brief History of Data Access Speeds

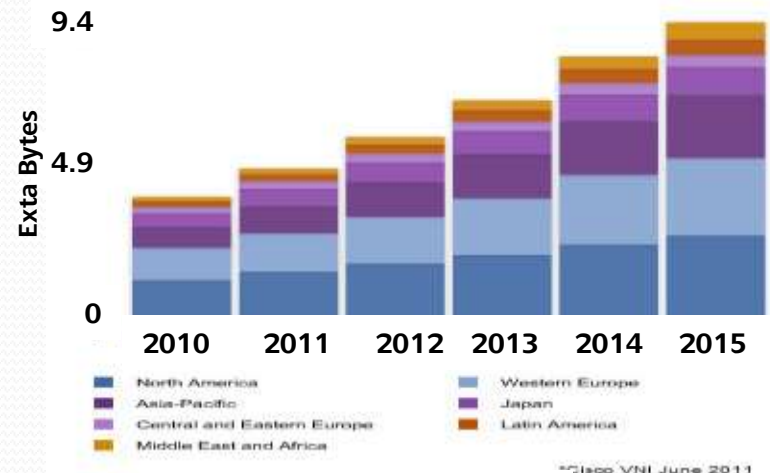
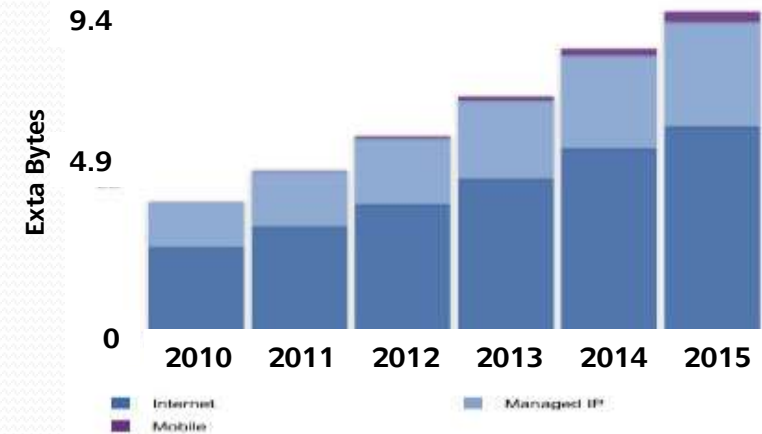
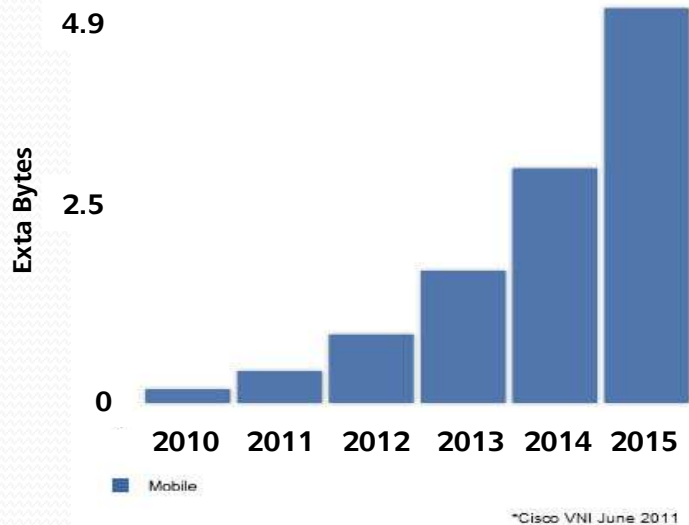
Internet Access speeds are, by and large, following Nielsen's Law
{ network connection speeds for high-end home users increase 50% per year ⁽⁸⁾ }

The unrelenting demand for increased bandwidth continues



Why a New CFI? (1)

- Business IP traffic increases by 2x by 2015 to 9.4 EB
- Consumer Mobile increases by 12.4x by 2015 to 4.9EB
 - this factor was revised to 18x between 2011 & 2016 ⁽¹¹⁾
- Businesses will need high BW Access solutions.



Why a New CFI? (2)

- Traditional P2P Ethernet needs one or two fibers per link
- Creates fiber congestion in the CO
- Need a solution that provides improved fiber utilization efficiency
 - Minimize deployment costs
 - Reduces maintenance errors



Why Now?

- Some business subscribers demand Ethernet services with higher bandwidths than currently available
- Some business subscribers demand physical layer security
- Some service providers have deployed P2P Ethernet, however, more efficient fiber usage is needed along with growing bandwidth demand for future applications
- Some service providers have delayed FTTx deployment due to fiber shortages
- Some wireless carriers have been unable to realize bandwidth capabilities of 3G/4G systems due to fiber shortages between base stations and CO
- A solution is needed soon

Why IEEE 802.3?

- IEEE 802.3 is the natural and rightful home to develop Ethernet Phy's
 - Eth WDM should be a new Ethernet Phy
 - Eth WDM should inherit all Ethernet standard features
- A solution from IEEE 802.3 WG is needed to avoid:
 - proliferation of proprietary solutions
 - development of operator-specific solutions
- IEEE 802.3 WG should promote network convergence
 - Eth WDM promotes network convergence



Ethernet WDM Aggregation Network Questions & Answers

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Ethernet WDM Aggregation Network Summary & Straw Polls

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Straw Polls

Should the 802.3 WG form a study group to develop a PAR and 5 Criteria for Ethernet WDM Aggregation Networks?

Anyone in Room

Yes: _____

No: _____

Abstain: _____

Straw Polls

_____ Number of people in the room

_____ I would participate in an Ethernet WDM Aggregation Network Study Group if formed

_____ My company would support participation in an Ethernet WDM Aggregation Network Study Group if formed



Thank You



Ethernet WDM Aggregation Network Backup and Reference

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Glossary

- ADC – analog to digital converter
- ASE – Amplified Spontaneous Emission
- AWG – Array Waveguide Grating
- BLS – Broadband Light Source
- CM – (Cable Modem)
- CMTS – (Cable Modem Termination System)
- CMU – (Coax Network Unit)
- CWDM – Coarse WDM
- DAC – digital to analog converter
- DSP – digital signal processor
- DWDM – Dense WDM
- eNB - (Evolved NodeB)
- EPC - (Evolved Packet Core)
- EPoC – (EPON over COAX)
- FM/FRM – Faraday Rotating Mirror
- PDV - Packet Delay Variation
- OFDM – Orthogonal Frequency Division Multiplexing
- RAN – Radio Access Network
- RSOA – Reflective Semiconductor Optical Amplifier

References

- 1 OFC 2012, K. Grobe et. al., OM3I.1 “Results from the OASE project”
- 2 Yankee Group 6th Dec. 2011, “2012 Mobility Predictions: A Year of Living Dangerously”
- 3 Heavy Reading 7/11
- 4 Communications Technology Jan 19 2012, “[Even With LTE, Work-Day Data Will Be Crunched](#)”
- 5 Infonetics 7/11
- 6 OECC 2009, Michael J. Wale, “[Technology Options for Future WDM-PON Access Systems](#)”
- 7 OFC2011, M. Presi & E. Ciaramella, OPM4 “Stable self-seeding of R-SOAs for WDM-PONs”
- 8 Huawei internal experiments
- 9 Wikipedia [http://en.wikipedia.org/wiki/Jakob_Nielsen_\(usability_consultant\)](http://en.wikipedia.org/wiki/Jakob_Nielsen_(usability_consultant))
- 10 Nielson Jakob’s Alert Box: <http://www.useit.com/alertbox/980405.html>
- 11 CISCO VNI 2011
- 12 Wireless World 15 Feb 2012 “[Cisco forecasts 18-fold increase in mobile data by 2016](#)”

What should the Study Group Look at when determining the PAR and 5 Criteria?

- Project Objectives:
 - Discuss data rate(s) and link types accommodated
 - Discuss wavelength plan (number & spacing of wavelengths / links)
 - Discuss transmission distance
 - Determine PMD only or include PCS/PMA
 - Discuss the number of power budget classes, target power budget values, with or without FEC, etc.
- Reuse existing MAC
- Minimal changes to MAC Control definitions (attributes / objects necessary to manage new PHYs).