Joint ITU-T/IEEE Workshop on Next Generation Optical Access Systems

Drivers for 10Gbps PON

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Overview

- North American Cable Overview
- PON Architectural Benefits
- PON in Cable Today
- 10Gbps Requirements for PON
- 10Gbps/1Gbps and Beyond
- Summary

Services and Technologies in
North American
Multiple System Operators (MSO)

NORTH AMERICAN CABLE OVERVIEW

Overview

- MSO Network Overview
- Current Services
- Services being Deployed
- Technology Developments
- New Projects

The MSO Network

- Market Size
- Whole Network Overview
- Fiber Plant
- Transport Network Highlights
- Access Network Highlights

US MSO Market 3Q07

	Broadband Subscribers	Total Subs	Business Subscribers
	Internet	Video/Internet/Voice	All
Comcast	12,888,000	24,141,000	400,000
TWC	7,412,000	13,391,000	270,000
Cox	3,650,000	5,424,000	200,000
Charter	2,639,200	5,376,800	
Cablevision	2,222,000	3,139,000	130,000
BHN	1,200,000	2,327,100	45,000
Rogers	1,300,000	2,300,000 *1	
Shaw	1,422,000		
TOTAL	32,733,200	56,098,900	1,045,000

*1 Rogers has 6.9M wireless cellular subscribers not included in this number
All numbers rounded to the nearest thousand or ten-thousand in some cases.

The Whole MSO Network
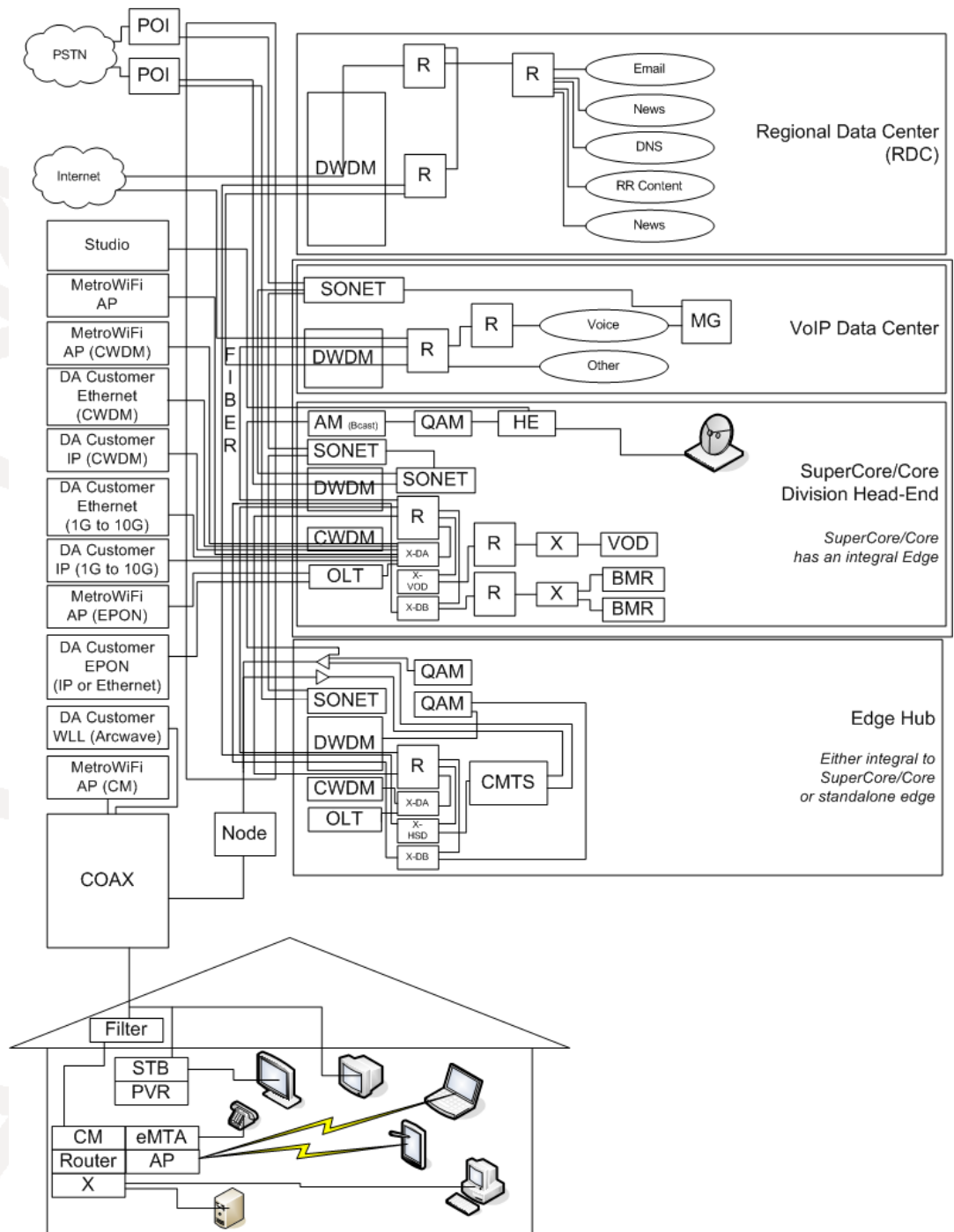
Fiber Plant

- All G.652 Transport
- Hybrid Fiber-Coax Access Network for Residential

  Deep Fiber To The Node (FTTN)

  Typical 500HP / 2 strands (minimum)
- All G.652 FTTP Commercial Access

  Large Commercial

  Cell Backhaul

  Carrier Interconnects

Transport Network

- **Transport Services**
  - Video: MPEG2/IP/Ethernet/DWDM Transport
    - Multicast: Broadcast and Switched Digital
    - Unicast: Video on Demand
  - Residential Broadband Data and VoIP Transport
  - MEF Ethernet Transport for Commercial Services

- **Transport Technology**
  - DWDM has become the new PHY
  - VPLS/MPLS/IP/Ethernet/DWDM for Ethernet Services
  - IP/MPLS/Ethernet/DWDM for IP Services

Access Network

- ## Access Services

  Residential video and both wired and wireless Internet, Voice, and Data

  Business Service voice, video, & both wire-line and wireless data

  Wholesale Ethernet Transport Local Loop Origination/Termination

- ## Access Technology

  Video: SCTE

  Residential and Business voice and data: DOCSIS

  Business data: CWDM and EPON

Current Services

- Video
- High Speed Data (HSD) – Internet Access
- Voice
- Wireless (MVNO-like or integrated, such as Rogers)
- WiFi
- Commercial Services
  - Voice
  - Data
  - Video

Current Services: Video

- **Video**
  - Analog Broadcast / Re-broadcast
  - Standard Definition Digital Video MPEG2 3.76Mbps
  - High Definition Television (HDTV)
  - DVR (SD and HDTV) SUPPORTS DCAS
  - Video On Demand

Current Services: Data

- High Speed Data (Internet access)
  DOCSIS 1.1

  Residential
  - 3Mbps to 20Mbps Downstream
  - 256kbps to 5Mbps Upstream
  - Optional Home Network as a product or service (depending on the MSO)

  Commercial
  - 256kbps to 20Mbps Downstream
  - 256kbps to 10Mbps Upstream
  - Fixed IP Address Optional

Current Services: Voice

- Voice

  DOCSIS 1.1 based with Packet Cable 1.5 (DQoS Lite)

  Typical shared with DOCSIS data among all but one North American MSO

  Unlimited Voice in North America or at least in-country for US$30 to US$40 per month.

  Most services (CallerID, Forwarding, etc.) included

Current Services: Dedicated

- **Dedicated Commercial**

  Service Types
  - Ethernet
  - IP VPN
  - Private IP
  - Public IP / Internet Access

  Technologies
  - DOCSIS 1.1 L2VPN
  - EPON
  - CWDM
  - DWDM
  - Base-band Ethernet

Current Services: Wireless

- **Cellular Wireless**
  - Some MSOs have MVNO-like deals
  - Some MSOs operate their own 3G networks (Rogers)
  - Some MSOs are designing and building 4G wireless networks for AWS Spectrum (2GHz range) TDD (Spectrum Co: Comcast, TWC, Bright House, Cox)
  - Some MSOs are designing and building 4G wireless networks for 700MHz Spectrum (Cox)
  - Clearwire/Sprint/Comcast/TWC/BrightHouse (+partners like Google)

Current Services: Wireless

- WiFi

  Typically free with residential broadband account

  Daily roaming services offered in some cities and some locations

  Includes outdoor and indoor WiFi and roaming

  Will support Fixed Mobile Convergence in the future

New Services Being Deployed Now

- Start Over
- Switched Digital Broadcast
   IGMPv3
- Quad-Play Billing
- Shared wire-line/wireless voice mail
- Caller ID on Set Top Box
- Interactive TV (iAds and iTV)

Technology in Development/Trial

- Addressable Set-Top Boxes (Addressable Ads)
- DOCSIS 3.0
- RFOG/DPON (DOCSIS OVER EPON)
- Multi-Room DVR
- Cell phone video (mobiTV)
- Cable media devices
- True-2-way
- Fixed Mobile Convergence (pico-cells and SIP/IMS/WiFi)
- MPEG4 and H.264 (Advanced CODECs)
- Packet Cable Multi-Media (PCMM)

New Projects

- Converged Transport (MPLS/VPLS)

- IPv6

- Ad-Insertion (CANOE)

- Metro Ethernet Forum (MEF) and DOCSIS BsOD integration

PON ARCHITECTURAL BENEFITS

PON Benefits for MSOs

- Works well with existing HFC architecture
  - Compatible with FTTN
  - Broadcast tree architecture
  - Drop and continue compatible as well as LCP compatible for new build
  - Forward video and return capable/transparent
  - 100% G.652
- Passive outside plant
- Fast ROI for commercial services
- Ethernet native for fastest growing portion of the business: commercial services.

PON system use by MSOs

PON IN CABLE TODAY

PON in Cable: History

- Early adopters of APON systems included:
    - Time Warner Cable
    - Charter
    - Cox

- Existing APON systems still operational at these and other MSOs

EPON Deployments

- MSO EPON deployments join a globally installed base of over 12M ports benefiting from:
  - Proven technology
  - Supplied by dozens of vendors
  - Benefits from economies of scale in manufacturing, support, and services in every technology, component, and system
- Announced Greenfield FTTH Builds
  - Armstrong Cable
- Commercial Services
  - Bright House Networks
  - Cable One
  - Other major MSOs that wish to remain anonymous

Current PON Applications

- ## Commercial Services

  - Cell backhaul
  - Metro Ethernet Forum (MEF) Services
  - WiFi backhaul
  - IP (over Ethernet) Services
  - Voice over IP over Ethernet Services

- ## Residential Services

  - Triple Play Services
    - Video (SCTE 55-1/55-2) (aka 1550nm overlay)
    - IP over Ethernet Data (IEEE 802.3ah)
    - Voice over IP over Ethernet

Why 1GBPS is not enough

10GBPS REQUIREMENTS FOR PON

The 10x Effect

- Service providers must always have a transport 10X their service offering to effectively multiplex customers and share the cost/risk/return of infrastructure build

- Demand exists for 1Gbps Ethernet today

- Therefore 10Gbps transport is required

- If it isn't available on PON, it will be built with P2P broadband (like CWDM/DWDM) or P2P base-band on BiD or individual strands

High Split Ratios

- Residential FTTH

  Use with high split ratios (64 to 128 minimum)

- Multiple Dwelling Unit

  High Split Ratios or High Bandwidth per ONU

	64 Splits		128 Splits	
	CDR*1	Oversubscribed	CDR	Oversubscribed
1Gbps	15.6Mbps	-	7.8Mbps	-
2.5Gbps	23.4Mbps	-	19.5Mbps	-
10Gbps	156Mbps	-	78Mbps	100Mbs "burstable" *2

*1 Committed Data Rate with a full PON

*2 Target architecture

Growth of Current Applications

- Residential and commercial Internet consumption growth
- Cellular 3G and 4G
  - Broadcast applications like MediaFLO, DVB, or IP multicast based broadcast are an excellent fit for PON distribution architecture
  - 4G with high frequencies like AWS will bring much higher tower density 4x or 8x the number of existing towers. Each served by PON!
  - Continued expansion of WiFi
- Flash Video Applications
  - You Tube (as much as 7x increase in average bandwidth consumption in residential for this ONE application)
  - Embedded in many sites
- Streaming Video Applications
- Gaming Applications
- Growth of over the top applications. Recent announcements by:
- Unattended applications

Future Applications

- Video On Demand via IPTV

- Multicast Broadcast IPTV (3 + years out)

- Consumer Broadcasting

  (AT&T is already using this for community broadcasting)

- Un-anticipated applications

  Wouldn't it be great if I had such a list! Of course then they wouldn't be un-anticipated!

- Cellular 3G and 4G

  4G with high frequencies like AWS will bring much higher tower density 4x or 8x the number of existing towers. Each served by PON!

  WiFi/WiMax convergence with WRAN

  New applications in mobile Ethernet for automotive market including those similar to WRAN – could bring massive tower growth.

Sequencing technology and products for emerging demands

10GBP/1GBPS AND BEYOND

Sequencing 10/1 to 10/10

	Downstream	Upstream	Timeline	Applications
10/1	10Gbps	1Gbps	NOW	1Gbps burstable commercial
10/10	10Gbps	10Gbps	2010/2011	Multiple 1Gbps CDR mixed with smaller CDRs and bustables

10G/NG Should Consider

- Accommodate 1610nm RF video return (can be used for other RF overlays). Right now only 1550nm (SCTE 55-1/55-2) is there. Look to SCTE Interface Practices Sub-Committee (IPS) 904-910 called RFoverGlass (RFoG)

- Accommodation of WDM P2P overlays on some portion of the PON. In other words P2P/P2MP WDM

- Recognize OAM work of Metro Ethernet Forum (MEF) as an industry wide recognized OAM

- Coordinated for consistency with both:

  ITU-T Recommendation Y.1731 (SG13/15?)

  IEEE P802.1ag

Summary

- MSOs represent a significant share of the residential broadband and a growing share of commercial services access businesses.

- MSOs benefit now, and will increasingly in the future benefit from PON technology for a variety of applications

- MSOs use PON Technology

    History shows MSOs are technology agnostic, but ...

    Must have:

    - A single clear standard to make investments. Examples of the delays caused by dual-technology solutions:
        - Betamax / VHS
        - HD-DVD / Blue-ray
        - 100Base-T / 100VG-ANYLAN
    - Must be an industry standard from a recognized standards body
    - In short there should be no "technology risk" only vendor and service (business) risks.
    - Should be a widely deployed, proven technology that can benefit from economies of scale

- Multi-year product development, engineering, and deployment cycle. Need a definite technology direction.

- MSO's years of experience with HFC tree (and drop and continue) architecture and video can reduce the risk of future interoperability challenges.

- Analog overlay applications are required in transition for years to come

Contact

Thank you for your interest.

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