FTTH Overview

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Verizon & AT&T Update

• Verizon's FiOS (FTTH) $23 billion Project by the end of September, service was available to about 8.5 million homes and businesses in 16 states. Verizon plans to make the service available to 3 million additional premises each year through 2010

• AT&T U-verse (VDSL) Brown Field (FTTH) Green Field $6.5 billion to $7 billion Project by the end of 2007, had 231,000 subscribers, an 83% increase from 126,000 three months earlier.

Source: Business Week Special Report January 28, 2008,
Compliant PON IP Data Only
## Bandwidth Requirements for IPTV

### MPEG2

<table>
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<tr>
<th></th>
<th>2 TVs, no DVR</th>
<th>3 TVs, 1 DVR</th>
<th>2 TVs +1 HDTV With DVR</th>
<th>4 TVs +1 HDTV With DVR</th>
<th>2 TVs + 2 HDTV, 1 DVR</th>
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<tr>
<td>Internet</td>
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<tr>
<td>HD Video</td>
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<td>18.0</td>
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<td>Total Mbps required</td>
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<td>20.0</td>
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### MPEG4

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<td>8.0</td>
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<tr>
<td>HD Video</td>
<td>----</td>
<td>----</td>
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<td>14.0</td>
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<tr>
<td>Total Mbps required</td>
<td>8.0</td>
<td>12.0</td>
<td>15.0</td>
<td>22.0</td>
<td>26.0</td>
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</table>

**Assumptions:**
- 2 Mbps for SD video (MPEG4), 4Mbps for SD video (MPEG2)
- 7 Mbps for HD video (MPEG4), 18Mbps for SD video (MPEG2)
Compliant PON Data / Enhancement RF Video (G983 & G984 Compliant)
FTTH Bandwidth Delivery Options - IP and RF

Video Overlay (RF) 1550 wavelength supports 5.2 - 6 Gbps broadcast & VOD services

In band supports 20-40 Mbps shared bandwidth with internet & voice services

E PON Gigabit Ethernet

B PON with Video Overlay 25 dB Link 32 Users

G PON with Video Overlay 25 dB Link 32 Users

RF Overlay Capacity

870 Mhz Platform, 870 MHz - 55 MHz (below ch 2) = 815 MHz / 6 MHz per Channel Slot = 135 Channes x 38.8 Mbps = 5.2GHz

1 Ghz Platform, 1 GHz - 55 MHz (below ch 2) = 945 MHz / 6 MHz per Channel Slot = 157 Channes x 38.8 Mbps = 6GHz
Benefits & uses of a Video overlay

• **Local Modulation Model**
  - Is used when the modulators for both Analog & QAM are located in a central facility next to the PON OLT Equipment.

• **Distance Transport Model**
  - Is used when the modulation gear is located greater than 20 km from the desired customer service area. The Pre-amps, optical switch & PON-amps are located in the same facility as the OLT equipment.

• **NEBS Certified Equipment.**

  Both the LM & DT Models are a low cost proven solution of transporting video to the customer
  - The video overlay Typically transports <=78 Analog Channels of Video
  - 30 Channels of High Definition Video
  - 300+ Channels of Standard Definition Digital Video
  - No Set top box needed with Analog Tier *(large capital investment savings)*
  - User friendly CATV like video delivery
  - The 1550nm WL is inserted with the 1490/1310nm by using CWDM filter
  - Greatly reduces the back office complexity of a IP Video solution
  - Resolves many in home wiring problems experienced with IP video solutions
FSAN G983 & G984 Video Transport

Video Serving Office

1490 / 1310 nm
Up to 20km

Ont (inside or outside)

Home

POTS
Ethernet
Video

Optical Video TX

Optical Amp

FTTH OLT

1550 nm

Optical Distribution Network

B/GPON ONT

RJ11
Coax
FTTH Growing Rapidly

Homes Passed with FTTH in US

Verizon will fill in fiber drops to all FiOS subs and begin turning off copper. ILECs continue growth.

Qwest begins FTTH builds. MSOs forced to start limited FTTH overbuilds.

Inevitable that AT&T will begin overbuilding with FTTH – will likely “unofficially” cite 1) management change, 2) newly available 2.4 GPON and 3) completion of merger actions.

Verizon will continue to build beyond 18 M HP.

Verizon switching from BPON to GPON.

55% of FTTH subs will be video subs*

Percentage of homes passed with FTTH: 9% 12% 16% 20% 26%
Percentage of homes connected: 2% 3% 4% 6% 10%

FTTH Increasing Percentage of Starts

US Greenfield FTTH Forecast

Key Points
- By 2011, 39% of all new SF housing starts will be built with FTTH*
- By 2011, 69% of all MPC will be built with FTTH*

Percentage of total MPC with FTTH:
- 2007: 22%
- 2011: 69%

Prisma D-PON Catalyst

Pressure from MPC
Compete or abdicate?

Future proofing
Are PONs in the future?

HFC Foundation
- Significant investment in…
  - CMTS base
  - Operations (OSS)
  - Billing (BSS)
  - CSR training
- DOCSIS has very long legs
- Enormous RF video base
- HFC CPEs
- History of incremental upgrade – not complete overbuild

Fiber Future
- Increased competition from and consumer acceptance of FTTH and satellite video
- MPC builder pressure to deploy FTTH as amenity
- Future proof architecture – never touch the plant again
- No upgrade required for transition from DOCSIS 2 to DOCSIS 3 or to add VoIP
- Significantly more upstream bandwidth

Prisma D-PON Solution
MSO PON Considerations

• Future proof OSP
  – Only upgrades on ends, never touch OSP again
  – FSAN OSP 1x32 split 20 km architecture ensures longevity

• Simple Greenfield additions with minimal Hub change
  – Looks and behaves like HFC RF network

• Leverage Existing MSO Back Office
  – Seamless transition with existing HFC OSS / BSS / CMTS

• Bandwidth
  – DOCSIS 3.0 capable today

• Ease of subscriber installation
  – ‘Look’ like coax - Install like coax (minimal splicing)
  – Utilize existing HFC CPEs
Prisma D-PON Solution

- True MSO PON Solution
  - Provides MSOs with a seamless operating transition from HFC networks to FTTH while maintaining existing OSS & BSS systems
  - FSAN PON OSP architecture allows low cost future upgrade path to any industry standard FTTH solution (architecture not proprietary)

- No Back Office Change
  - Leverages DOCSIS control, D-PON can share same CMTS shelf with existing HFC plant

- All the Benefits of HFC – None of the Limitations
  - Downstream supports standard CATV 78 Analog / 75 QAMs
  - D-PON transmitter will reach 20 kms even with a 1x32 home split and full DOCSIS 3.0 upstream loading
  - Does not require deployment of additional field EDFAs
  - Supports DAVIC or DOCSIS, SA or Motorola
Prisma D-PON Components

Headend / Hub

- 7600
- CMTS

Outside Plant

- Transamp Rx
- Splitter Enclosure
- Up to 32 ONT Tx / Rx

Transamp

- 1550 nm broadcast forward optics with combined EMT and EDFA components
- Maximizes rack space in a 2RU chassis
- Cost effective FTTH PON transport

PON

- FSAN 1x32 PON OSP architecture
- Prisma II Rx modified for D-PON solution

D-PON ONT

- Receives at 1550 nm & transmits at 1310 nm on same fiber
- DOCSIS control for collision resistance & ingress suppression
- Advanced return technology enables 20 km reach

Availability Expected Late CY08
• D-PON target market is any Greenfield network build where the Service Provider will be using a DOCSIS control plane

• D-PON solution allows for incremental upgrades on a future proof architecture while leveraging the existing back office infrastructure

D-PON Lives Side-by-Side with Existing HFC Networks Today
Prisma TransAmp

- Small 128 home service groups
- Full 78 analog 75 QAM loading
- 48 CNR to the home
- Cost effective 1550 transport

Cost-Effective 1550nm Transport for PON Architectures
Prisma D-PON System Architecture

Headend / Hub

CMTS D2.0 Blade

Signal Mgr 1

HD module in XD Rx chassis

Tx - TransAmp

WDM

Outside Plant

1x32

DOCSIS ONT

Signal Mgr 2

Signal Mgr 3

Signal Mgr 4

HD module in XD Rx chassis
What do you deploy in a Greenfield build?

PON: 70% take rate, EMTA not included in DPON
Back Office Cost to Deploy Telco PON

1) Tier 2 / 3 Method

- Initial training cost is a one time cost
- OSS / BSS cost are full initial cost and partial annual costs

2) MSO BSS Vendors

- New and separate non-DOCSIS OSS solution (18-24 months and millions)
- New integrations between the BSS and the OSS
  - assuming 2 BSS & 2 OSS vendors, that would be 4 new integrations
  - integrations would cost $1.2 M, plus $15k per deployment location for each integration (anywhere from 20 to 100 depending on MSO)
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3) Universal OSS/BSS

- New network agnostic OSS / BSS platform
- Approximate cost:
  - $5-10 management system based on historical provisioning analysis
  - Software development for this effort = $20/MAC address
  - Ongoing support for these systems = $20/MAC address

20,000 subs at $40 / MAC at 1.5 MAC addresses / sub = $1.2 M

6% of OSP Cost

Tens of Millions

$40 / MAC address
## Theoretical Max Capacity Comparison

### Apples-to-apples comparison of throughput

<table>
<thead>
<tr>
<th>Technology</th>
<th>Standards</th>
<th>Framing</th>
<th># of Subs per Fiber</th>
<th>Downstream</th>
<th>Upstream</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPON*</td>
<td>ITU-T G.984.2</td>
<td>ATM / Ethernet</td>
<td>32 / 64*</td>
<td>2.5 Gbps</td>
<td>78 / 39 Mbps</td>
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<tr>
<td>GEPON</td>
<td>IEEE 802.3ah</td>
<td>Ethernet</td>
<td>32</td>
<td>1.25 Gbps</td>
<td>39 Mbps</td>
</tr>
<tr>
<td>Docsis PON</td>
<td>None</td>
<td>DOCSIS</td>
<td>32</td>
<td>6 Gbps *</td>
<td>6 Gbs – 185 Mbps</td>
</tr>
</tbody>
</table>

- A PON is equal to 1 32-way splitter
- All networks are currently traffic engineered to lower throughput per customer – today most Telco SP cap bandwidth to service level purchased, 5, 15, or 30 Mbps
- Notes
  - * = 1GHz equates to 156, 256 QAMs @ 38Mbps each ~ 6Gbps
  - ** = 1 user on the upstream network receives all of the available bandwidth with Docsis 3.0 channel bonding (64QAM, 27.7Mbps with 4 channels bonded = 110Mbps)
  - *** = all 32 users on the upstream network simultaneously drive data rates down to 3.4 – can increased by adding CMTS blades or by changing to a mid-split

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**D-PON with DOCSIS 3.0 can be Competitive to a Telco PON Solution**
Summary

• SA believes a HFC-based PON is a natural HFC evolution conclusion

• FSAN PON infrastructure appears to offer the most future-proof capability and a low-cost, competitive plant

• An HFC-based PON, coupled with DOCSIS 3.0 and new technology developments offers DOCSIS a long runway

• SAs Access Business Unit is committed to development of products in this space