The Requirements and Evolution to Next Generation Optical Access Network

Wang Feng (sam@huawei.com)
- Optical access status
- Next generation PON technologies
Broadband Optical Access

**Network Architecture**
- Point-to-point: Active Ethernet
- Point-to-multipoint: tree topology
  
  High-bandwidth and low cost per bit
  High reliability and easy maintenance

**Access schemes**
- TDM
  - SCM/OFDM
- WDM
  - OCDMA

**FTTx for Broadband Access**
- Fiber to the office/business
- Fiber to the curb/neighborhood
- Fiber to the home/user

OLT: Optical Line Terminal
ONU: Optical Network Unit
ONT: Optical Network Terminal

Splitter or WDM

10 – 20 km
Standard Bodies and Related Organizations

- **Related organizations**
  - **GPON standard body**
    - ITU-T SG15 Q2: GPON
  - **IEEE 802.3: EPON**

- **Standard bodies and related organizations work together to promote optical access technologies and standards.**
FSAN and ITU-T Working Flow

FSAN Management Committee

FSAN OAN WG

Interoperability Task Group
- Test Plan
- Events

NG Access Task Group
- NGA PHY
- NGA MAC

Supervision Study Topics
- G.984.sup

G-PON additions Study Topics
- G.984.re

White paper

ITU Q2/15

ITU-T SG15/Q2 Studies
- G.984.x Amendments
- Power Savings
- Etc.
- G.987.x

FSAN summarizes the requirements of operator and technical whitepaper as input of ITU_T.
Trends of XPON Market Share

Source: infonetics, 2009

Trends of xPON market share
- Optical access status
- Next generation PON technologies
Three Driving Forces for NG PON

- Higher service requirements
  - Seamless Evolution helps to saving the system investments
  - ODN compatibility and smooth upgrade – helps to saving the construction investment
  - More users, higher density
  - Higher rate, larger bandwidth

- Network structure changes
- Carrier network converges
- New technology achievement
With Evolution, What Stays?

- **In a word, the outside plant**
  - Huge investments have been made in OSP
  - Purported life of this investment is >30 years
  - To ask for its replacement in 10 years would be suicide
- **For the next 15 years, we must use this ODN network**

![Pie chart showing the cost distribution of ODN network components.](chart.png)

Source: Corning

No replacement of OSP deployed for GPON
Four Key Issues for Seamless Migration

**Smooth & Seamless migration from xPON to NG-PON**

- **Now**
  - OLT
  - xPON 1490nm
  - ONT
  - xPON ONT

- **Future**
  - OLT
  - xPON 1490nm
  - NG GPON card

**Unified EMS**
- Physical adaption layer for different PON technologies
- Same OSS integration platform

**Platform Ready**
- Compatible with NG PON
- 40G/slot
- NG PON Compatible chassis
- Integrated passive WDM

**ODN Ready**
- Reusing ODN network with multiple wavelength
- Reuse existed ODN

**ONU Ready**
- Built-in WBF (Wavelength Block Filter)
- xPON ONU integrated NG PON WBF currently
- NG PON ONU with xPON WBF in the future

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Technical Candidates for NG-PON

**Higher speed TDMA-PON**
- High speed Burst mode Transceiver
  - 10Gbps DML (Direct Modulator Laser)
  - 2.5G/10G TIA (Trans-Impedence Amplifier), LA (Limiting Amplifier), BCDR (Burst Clock and Data Recovery)

**WDM-PON**
- Colorless light source for ONU – IL-FPLD, RSOA, Tunable Laser
- High power BLS (Broadband Light Source)
- Athermal AWG (Array Wave Grating)

**Hybrid WDM-TDMA PON**
- Hybrid WDM-TDMA Components
# EPON /10G EPON/10G GPON Comparison

<table>
<thead>
<tr>
<th>Item</th>
<th>EPON</th>
<th>10G EPON</th>
<th>10/2.5G GPON (XG-PON1)</th>
<th>10G/10G GPON (XG-PON2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Line rate</strong></td>
<td>1G DS/1G US</td>
<td>10G DS/1G US</td>
<td>1G DS / 2.5G US</td>
<td>10G DS/10G US</td>
</tr>
<tr>
<td><strong>Upstream Line code</strong></td>
<td>8B10B (75%)</td>
<td>8B10B (75%)</td>
<td>64B66B (97%)</td>
<td>TBD</td>
</tr>
<tr>
<td><strong>Split ratio</strong></td>
<td>1:32</td>
<td>1:16/32</td>
<td>1:16/32</td>
<td>≥1:64</td>
</tr>
<tr>
<td><strong>FEC</strong></td>
<td>RS(255, 239), option</td>
<td>RS(255,223), mandatory</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td><strong>Max. Distance</strong></td>
<td>20km</td>
<td>20km</td>
<td>≥20km</td>
<td>≥20km</td>
</tr>
<tr>
<td><strong>Power budget</strong></td>
<td>PX 10/20</td>
<td>PRX 10/20/30</td>
<td>PR 10/20/30</td>
<td>Class B+, Class C+</td>
</tr>
<tr>
<td><strong>MAC</strong></td>
<td>MPCP</td>
<td>MPCP</td>
<td>MPCP</td>
<td>XGTC</td>
</tr>
<tr>
<td><strong>Service provisioning</strong></td>
<td>Over Ethernet frame</td>
<td>Over Ethernet frame</td>
<td>Over Ethernet frame</td>
<td>Over GEM frame</td>
</tr>
<tr>
<td><strong>Management</strong></td>
<td>MPCP for basic management</td>
<td>MPCP for basic management</td>
<td>MPCP for basic management</td>
<td>OAM+PLOAM+OMCI for comprehensive Management</td>
</tr>
<tr>
<td><strong>Key challenge</strong></td>
<td>1G BMT/R</td>
<td>1G BMT/R</td>
<td>10G BMT/R, 10/1G BMR</td>
<td>2.5G BMT/R</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>Low</td>
<td>Relatively high</td>
<td>High</td>
<td>Relatively low</td>
</tr>
<tr>
<td><strong>Standard body</strong></td>
<td>IEEE 802.3ah</td>
<td>IEEE 802.3av</td>
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<td>ITU-T Q2/SG15, G.987 series</td>
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## 10G EPON/10G GPON WDM-PON Comparison

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<th>10G EPON</th>
<th>WDM PON</th>
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<tr>
<td>Ultra-broadband</td>
<td>D.S. Bandwidth: 10Gbps shared</td>
<td>10Gbps shared</td>
<td>1Gbps/(\lambda) individual</td>
</tr>
<tr>
<td></td>
<td>U.S. Bandwidth: 2.5Gbps shared; 10Gbps shared</td>
<td>1Gbps shared; 10Gbps shared</td>
<td>1Gbps/(\lambda) individual</td>
</tr>
<tr>
<td>Convergence</td>
<td>possible</td>
<td>possible</td>
<td>possible</td>
</tr>
<tr>
<td>Compatibility</td>
<td>BPON Possibility</td>
<td>Yes</td>
<td>Yes but complex</td>
</tr>
<tr>
<td></td>
<td>ODN protection</td>
<td>untouched</td>
<td>untouched</td>
</tr>
<tr>
<td></td>
<td>Service Interruption</td>
<td>No</td>
<td>Yes</td>
</tr>
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<td>EPON</td>
<td>Possibility</td>
<td>Yes but complex</td>
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10G GPON standard is coming in Sep 2010

The 10G GPON white paper has been released in Q4 of 2008. The physical layer specifications of XG-PON1 has been dealt with.

ITU-T speeds up the standardization process for 10G-GPON. G.987.1 and G.987.2 (PHY) recommendations are scheduled to be consented and then published in next SG15 plenary, in Sept., 2009. G.987.3 and .4 recommendations are scheduled to be consented and then published in the plenaries in Sep, 2010.
10G EPON PHY standard is coming in Sept 2009

IEEE 802.3 Ethernet WG

802.3av
10G Ethernet PON

- FEC Framing Ad Hoc
- Link Model Ad Hoc
- Dual Rate PMD Ad Hoc
- Super rating Ad Hoc
- Power Budget Ad Hoc

IEEE 802.3av focuses on solving 10G EPON PHY issues. Its PHY specification is planned to be published in Sept., 2009.

We are here
Huawei’s contributions to OAN

- On June 3rd, 2009, Huawei released the NG PON solution
- Huawei plays actively in the mainstream international standard bodies

As actively involved in ITU-T, FSAN, IEEE and some other standard organizations, Huawei has been assigned many chairmanships and editors positions. Huawei has served as the liaison between IEEE 802.3 and ITU-T.

Huawei leads a very positive position in the next generation PON research and development work. Huawei has contributed a lot in prototypes, in order to accelerate the progress of standard.
Huawei Optical Access Footprint

- **Generation 0:** Research projects a-plenty
- **Generation 1:** STM-PON
  - ITU G.982: 50 Mb/s TDM, based on static time slots
- **Generation 2:** ATM-PON
  - ITU G.984: 155/622 Mb/s TDM, based on ATM cell transmission
- **Generation 3:** EPON and G-PON
  - IEEE 802.3ah: 1Gb/s TDM, based on Ethernet frame transmission
  - ITU G.984: 2.4/1.2 Gb/s TDM, based on GEM fragment transmission
- **Generation 4:** 10G-EPON, XG-PON
- **Generation 5:** !
Huawei: Optical Access Technology Trends


- 1.2G
- 2.5G
- 10G
- Nx2.5G
- Nx10G

Downstream:
- GPON
- XGPON1
- XGPON2
- Future Systems (NGA2)

Acceptable bandwidth asymmetry

Coexistence On same ODN

40/100G TDM PON, DWDM PON, OFDM, Elect./Opt. CDM
Future: Integrated Broadband Access Networks

Anyone, anywhere, anytime, anymedia communications
Thank You

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