2017 is the Year of NG-PON2: Are You Ready

Teresa McGaughey – Sr Director, Marketing - Calix
By 2020…In just 3 years!

- 79% of Internet traffic is video
- 50% of TVs are 4K
- 75% of mobile traffic is video
- 4x mobile traffic growth

- 70% growth in “how to” searches year over year
- 2nd largest search engine

Cisco VNI 2016
Search Engine Land May 13, 2015
Services driving bandwidth demand

- Business and mobile services
- MDU solutions
- Single Family Residential
- Bandwidth
Solving the Bandwidth Problem

- XGS-PON and NG-PON2 approved
  - Both expected to be in deployment in 2017
  - XGS-PON provides 10G / 10G services
  - NG-PON2 provides 4 wavelengths x10G / 10G services

But it's not just about bandwidth!
How can you…

- Reduce cost of operating your network
- Converge mobile, business and residential networks
- Simplify new subscriber and services turn-up
- Scale to easily add new subscribers and technologies
- Add Intelligence to the access network to improve ROI

What else do you need to change?
How many networks are you operating?

- Business Network
- Mobile Network
- Residential Network
Wavelength Multiplexer (passive)

Co-Existence Element (passive)

ONU

Common ODN Multiple Service Types

Splitter
What happened to the maintenance window?
Wavelength Multiplexer (passive)

Co-Existence Element (passive)

Eliminate the maintenance window

ONU
Wavelength Multiplexer (passive)

Co-Existence Element (passive)

Splitter

Future Proof with Channel Bonding

ONU
More Applications to come using NG-PON2 P2P

- Wavelength services such as Fiber Channel
- Mobile Backhaul
- Mobile Fronthaul (CPRI and C-RAN w/ CPRI)
New Optical Elements for Next Gen PON

Wavelength Multiplexer (WM) is a DWDM multiplexer that combines 4 NG-PON2 wavelengths into the Coexistence Element.

Wavelength Multiplexer (passive, 2dB)

Coexistence Element (passive element)

Splitter

Optical Line Terminal (OLT)

NG-PON2

λ 1

λ 2

λ 3

λ 4

GPON

1596.34nm, 1532.68nm

1597.19nm, 1533.47nm

1598.04nm, 1534.25nm

1598.89nm, 1535.04nm

1290-1330nm, 1480-1500nm

RF Video

1550-1560nm

All wavelengths combined to Single fiber

1596.34nm, 1532.68nm

1597.19nm, 1533.47nm

1598.04nm, 1534.25nm

1598.89nm, 1535.04nm

1290-1330nm, 1480-1500nm

RF Video

1550-1560nm

All wavelengths combined to Single fiber
G.989.2 Defined ODN Classes

- ODN Class E1 & E2 require external amplification to operate
- ODN Class N2 will likely require external amplification to operate
- ODN Class N1 has been the focus
  - Removes a single source of failure point in the service

<table>
<thead>
<tr>
<th>ODN Class</th>
<th>Max Attenuation (dB)</th>
<th>Min Attenuation (dB)</th>
<th>Differential ODN Loss (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1</td>
<td>29</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>N2</td>
<td>31</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>E1</td>
<td>33</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>E2</td>
<td>35</td>
<td>20</td>
<td>15</td>
</tr>
</tbody>
</table>
Network Design – Optical Budgets (N1 optics)

Optical Line Terminal (OLT)

- NG-PON2
  - λ 1
  - λ 2
  - λ 3
  - λ 4

Wavelength Multiplexer (passive)

Coexistence Element (passive element, <2dB)

Splitter

29dB Optical Budget

S/R-CG Point

R/S-CG Point

Share your thoughts about this session!
ONT Transceiver Specifications

- Type A ONT Optics are the preferable choice
  - Do not require amplification, removing single point of failure

<table>
<thead>
<tr>
<th>ONT Option</th>
<th>Transmit power range</th>
<th>Receive Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A – 10/10</td>
<td>4dMb to 9dBm</td>
<td>-7dBm to -28dBm</td>
</tr>
<tr>
<td>Type A – 10/2.5</td>
<td>4dMb to 9dBm</td>
<td>-7dBm to -28dBm</td>
</tr>
<tr>
<td>Type B – 10/10</td>
<td>2dBm to 7dBm</td>
<td>-7dBm to -28dBm</td>
</tr>
<tr>
<td>Type B – 10/2.5</td>
<td>2dBm to 5dBm</td>
<td>-7dBm to -28dBm</td>
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</table>
Wavelength Mobility – Channel Tuning Times

- NG-PON2 defines 3 classes for channel tuning times

<table>
<thead>
<tr>
<th>Class</th>
<th>Time Range</th>
<th>Tier</th>
</tr>
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<tbody>
<tr>
<td>Class 1</td>
<td>&lt;10us</td>
<td>Not used</td>
</tr>
<tr>
<td>Class 2</td>
<td>10 us to 25 ms</td>
<td>Enterprise Business</td>
</tr>
<tr>
<td>Class 3</td>
<td>25 ms to 1 s</td>
<td>Residential / Small Business</td>
</tr>
</tbody>
</table>

- Class 2 enables the combination of wavelength switching and OLT service restoration to be within 50ms
Deployment Options – Separate OLTs by Service

- All Ports on the line card utilize a common channel
- Consistency across all OLTs (easier for maintenance and sparing)

10G / 2.5G Residential service
10G / 2.5G Residential service (load balancing & redundancy)
Future
Future
### Deployment Options – Mixed Services OLT

- All ports on a line card utilize the same channel
- Consistency across all OLTs (easier for maintenance and sparing)

#### Channel #1

<table>
<thead>
<tr>
<th>Port</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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<tbody>
<tr>
<td>ODN1</td>
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<td>6</td>
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10G / 2.5G Residential service
10G / 2.5G Residential service (load balancing & redundancy)
10G / 10G Business Service
10G / 10G Business Service (load balancing & redundancy)
Deployment Options - Alternative

Load balancing & redundancy

Load balancing & redundancy
NG-PON2 – Technology for the next generation

Highly Reliable

Converged Services Network

Bandwidth for the Future
NG-PON2 in the News

Verizon and Calix complete first NG-PON2 interoperability trial
Jan 2017

AXOS Strikes Again … Ushers in NG-PON2 Era
New Zealand
Feb 2017

Verizon and Calix future proof NG-PON2 with Channel Bonding
May 2017

AXOS Takes Manhattan Pilot and Calix bring NG-PON2 to the Big Apple
June 2017
Calix AXOS Systems for NG-PON2 / XGS-PON

In the Data Center
In the CO or Cabinet
Strand, Pole Or Vault