Technology Advancements and Network Applications for Optical Burst Transport Networks

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Agenda

- Optical Burst technologies
  - Technology viability
  - Potential Benefits
  - Scalability
- Applications
  - Metro to Core aggregation
  - PON-like data services
  - Next-generation intra-data center switching
  - Low latency metro access
  - Content delivery
- Summary and Q&A
Optical Burst Transport Network Viability

- Many implementations of OBS/OPS require fast, flexible optical buffers, and complicated scheduling to guarantee switching performance.
- Huawei has adopted a novel approach to Optical Burst technology called Optical Burst Transport Network or OBTN which minimizes dependencies on complex optical components.

<table>
<thead>
<tr>
<th></th>
<th>WDM + OTN + Switch</th>
<th>OPS / OBS</th>
<th>OBTN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Layers</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Number of Transponders</td>
<td>High</td>
<td>Greatly reduced</td>
<td>Greatly reduced</td>
</tr>
<tr>
<td>Electrical XC / Switch</td>
<td>Large</td>
<td>Greatly reduced</td>
<td>Greatly reduced</td>
</tr>
<tr>
<td>Photonic Components</td>
<td>Low Requirements</td>
<td>Very High Requirements</td>
<td>Medium-High Requirements</td>
</tr>
<tr>
<td>Flexible Optical Buffer</td>
<td>N/A</td>
<td>Large / Many, FDL arrays are feasible but scalability is an issue</td>
<td>None</td>
</tr>
<tr>
<td>Burst Mode Transceiver</td>
<td>N/A</td>
<td>10Gbps is available, scalability to 100G is challenging</td>
<td>Scalable to 100G+</td>
</tr>
<tr>
<td>Fast Optical Burst Selector</td>
<td>N/A</td>
<td>Small scale Fast optical switches are available. Larger scale fast optical switches or fast tunable optical filters on the horizon</td>
<td></td>
</tr>
<tr>
<td>Optical Burst Amplification</td>
<td>N/A</td>
<td>May be challenging for multi-wavelength signals</td>
<td>Simplified design, many options, feasible today</td>
</tr>
<tr>
<td>Near-term Viability</td>
<td>Deployed today</td>
<td>Poor</td>
<td>Good</td>
</tr>
</tbody>
</table>
Layer Convergence

- Current optical networks utilize $\lambda$-granularity switching at L0 (optical layer) and rely on L1 and L2 for aggregation / grooming / switching of sub-$\lambda$ traffic.

- OBTN facilitates sub-$\lambda$ burst switching and reduces costly O/E/O conversion and hidden costs due to layer transitions.
Compatibility with Current WDM/OTN Networks

- OBTN can co-exist or be co-deployed with WDM/OTN networks
  - Supports fixed-wavelength transmitters (FTx) and does not require fast Tunable Tx
  - Works across existing line amplifiers, ROADM, etc.

- OBTN may also share the same networking architecture with OTN to enable all-optical multiplexing and cross connection of ODUs
OBTN Scalability

OBTN technology has been demonstrated at 10Gbps line rates, and exhibits scalability to 100Gbps and beyond.

OBTN technology scales to access and metro distances, but can be applied to LH and ULH technologies in the future.

OFC 2011
**Access and Metro Network Applications**

**Metro-Access**
- Facilitates high-BW access to end-users / businesses
- Long reach (100 km), wide coverage (>1000 users) via WDM+TDMA

**Metro-Aggregation**
- Decreases no. of transponders and network latency
- Simple upgrade to higher line rates

**Metro-Core**
- Supports distributed services, realizes sub-wavelength bypass
- Reduces capacity and power constraints of core routers / electrical switches

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**Star topology**

**Ring topology**

**Mesh topology**

**BRAS/BAS/ MSE/BNG Router**

**MSAN**
Metro Ring Aggregation

- Optical burst ring with multi-granularity flexible bandwidth provisioning and dynamic bandwidth allocation
  - Supports sub-\(\lambda\) and \(\lambda\) granularity services
  - Supports multiple service types
    - Ethernet / IP
    - Video services
    - TDM
  - Compatible with current WDM systems
  - Supports Dynamic Bandwidth Allocation (DBA)

PON-like Access for Business Services

- WDM+TDMA metro-access architecture utilizing relatively mature devices and PON control schemes
- Suitable for PON-like business services
  - Supports >1000 users (e.g. 32 \(\lambda\) x 32 split ratio) with up to 100km reach without O/E/O
  - Improves upstream bandwidth vs. traditional PON architectures
Next-Generation Data Center Intra-networking

- Typical data center network architecture utilizes a tree structure.
- There is a significant amount of traffic between TORs (~80% of traffic, large packet flows).
- Traffic between TORs is switched via EORs → Requires many line cards & switch cards.

By applying OBTN, transmission and (distributed) switching are realized at TORs, and EORs can be saved.

ECH: line card
TC: tributary (server access) card
SC: switch card
XC: OBTN all-optical switch card
**Low Latency Metro Services**

- Amazon: Every 100ms of latency costs 1% in sales
- Google and Bing: Slow page loads can significantly affect usage, especially delays >400-500ms (Velocity 2009 O'Reilly conference)
- Financial (High Frequency Trading): “If a broker’s electronic trading platform is 5 ms behind the competition it could lose them at least 1% of their flow” and “10ms of latency could result in a 10% drop in revenues” (TABB Group 2008)

- OBTN is an all-optical technology which drastically reduces delay associated with Electrical switching and processing
  - Reduces layer transitions and associated delay
  - Scalable to higher bit-rates
Content Delivery / Video Distribution

- Content delivery and Video distribution
  - Transport vs. Cache – OBTN can reduce video transport and distribution cost
  - Video distribution and delivery of master digital file from movie house or sporting events to editing / post-production and content providers
  - Accommodates short term peak demand on CDN networks such as re-watching a previous sporting event game when a team makes it to the Super Bowl or World Cup finals
Key Technology Benefits

- **Reduce transponders; offers dynamic bandwidth utilization**
  - O/E/O not required at intermediate nodes
  - Better bandwidth utilization through DBA

  ![WDM networks](image1)

- **Shift L1/L2 XC functions to L0**
  - Optical-layer enables switching bypass and provides aggregation functions
  - Layer convergence provides power consumption savings

  ![OBTN Current networks](image2)

- **Upgradeable and co-exists with today’s WDM networks**
  - Optical-layer switch independent of modulation format and line rate
  - OBTN ring compatible with WDM/OTN

  ![10G 40G 100G OBTN XC](image3)

- **Viable for near-term development**
  - OBTN does not require optical buffers or memory
  - A pragmatic evolution towards all-optical router / all-optical networking
Summary

- Optical Burst Switching technologies are becoming more viable
  - Novel approaches to implementation can alleviate the dependencies on advanced optical components, such as the Holy Grail of optical networking – the optical buffer
- These technologies have the potential to greatly reduce transport costs via layer convergence and elimination of costly O/E/O and electrical processing at various layers
- There appear to be a variety of applications for this technology
  - Metro aggregation, Intra-data center connectivity, PON-like high bandwidth business services, Video and content distribution
- Huawei believes OBTN is viable in the near-term and as scalability requirements are satisfied, it can scale to higher speed line-rates and to distances beyond the metro area network
Thank You

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