100GET – OCTET

Higher Speed Ethernet

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February 18th, 2009,
Dr. Ralf-Peter Braun
100GET – OCTET – Higher Speed Ethernet

Overview.

- Introduction
  - 100 Gbit/s Networking
- Standardization
  - IEEE 802.3, ITU-T, OIF
- 100GET – OCTET
  - Test Environment
- Conclusion
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Introduction – Higher Speed Networks.

<table>
<thead>
<tr>
<th>Scalable and cost efficient networks required.</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Network areas ⇒ LAN, Access, Metro, and Backbone</td>
</tr>
<tr>
<td>- Network technology ⇒ Carrier grade Ethernet</td>
</tr>
<tr>
<td>- Network control ⇒ Multi domain &amp; multi layer networks</td>
</tr>
<tr>
<td>- Ethernet services ⇒ Multiple play services for the mass market, Ethernet VPN Services for business customers</td>
</tr>
<tr>
<td>- Traffic increase ⇒ Moore’s Law still holds for Computer capacity, Increasing network capacity (x 10 in 5 years)</td>
</tr>
<tr>
<td>- Reduce CAPEX ⇒ Suitable technology &amp; better network utilization</td>
</tr>
<tr>
<td>- Reduce OPEX ⇒ Less components and simpler networking</td>
</tr>
<tr>
<td>- Increase Revenue ⇒ Suitable service portfolio</td>
</tr>
<tr>
<td>- 5 years target ⇒ Increase network capacity by a factor of 10, Decrease costs by 1/3rd</td>
</tr>
</tbody>
</table>
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Introduction – 100 Gbit/s Ethernet.

100 Gbit/s Ethernet Approach.

- **Architecture** ⇒ Reduce the number of nodes, interfaces, links, and sub layers
- **Transport** ⇒ Resilient, reliable, and available network
- **Utilization** ⇒ Increased spectral efficiency and DWDM technology
- **Inter-domain** ⇒ Seamless, less complex, Ethernet interfaces
- **Inter-layer** ⇒ Layer interworking and advanced functionalities
- **Management** ⇒ Control plane functionalities

![100 Gbit/s Ethernet Diagram](based on OTN)
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**Introduction – 100 Gbit/s network architecture.**

<table>
<thead>
<tr>
<th>Less number of network nodes, devices, interfaces, and links.</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Enable cost efficient scalable networks by simplified network architecture</td>
</tr>
<tr>
<td>- Reduce # of network nodes using</td>
</tr>
<tr>
<td>- Higher capacity nodes and links</td>
</tr>
<tr>
<td>- Reduce # of network devices using</td>
</tr>
<tr>
<td>- Higher capacity switches/routers</td>
</tr>
<tr>
<td>- Reduce # of network interfaces and links</td>
</tr>
<tr>
<td>- Using higher speed interfaces and links</td>
</tr>
<tr>
<td>- Enable carrier grade multi-Tbit/s transmission</td>
</tr>
<tr>
<td>- CFP (100 Gbit/s Form Factor) pluggable needed</td>
</tr>
<tr>
<td>- Enable energy efficient operation</td>
</tr>
</tbody>
</table>

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Introduction – 100 Gbit/s Ethernet Interfaces.

Parallel and serial 100 Gbit/s approaches – Utilization and scalability.

- 100 Gbit/s multi-Tbit/s approaches
  - Multi-lane interfaces
    - 10 x 10 Gbit/s lanes
    - 4 x 25 Gbit/s lanes
  - Serial interface
    - 1 x 100 Gbit/s lane
  - Better network utilization
    - Higher spectral efficiency e.g. 100 Gbit/s via 50 GHz ⇒ 2 Bit/s/Hz
  - Higher traffic aggregation
  - Cost efficient network operation

![Graph showing capacity in Tbit/s vs. number of DWDM Channels](image)
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Progress in 100GE Standardization – IEEE802.3.

Higher Speed Standardization – IEEE802.3ba Ethernet Interfaces.

- IEEE 802.3ba Task Force: 40 Gbit/s and 100 Gbit/s Ethernet Interfaces
- Current status: IEEE802.3ba/Working Draft 1.2
- IEEE802.3ba standard – expected in Q2/2010
  - Important network operator objectives
    - Provide appropriate support for OTN
    - Provide Physical Layer specification which
      - Support 40 Gbit/s operation over at least 10 km on SMF
      - Support 100 Gbit/s operation over at least 10 km and 40 km on SMF
  - Important data center and Intra-POP objectives
    - Provide Physical Layer specification which
      - Support 40/100 Gbit/s operation over at least 100m on OM3 MMF
      - Support 40/100 Gbit/s operation over at least 10m over a copper cable assembly
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Progress in 40/100GE Standardization – IEEE802.3.

Higher Speed Standardization – IEEE802.3ba Ethernet Interfaces – Multi-lane approach.

<table>
<thead>
<tr>
<th>Port Type</th>
<th>Coding</th>
<th>Medium</th>
<th># of Lanes or Wavelength</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>40GBASE–KR4</td>
<td>64B/66B</td>
<td>Backplane</td>
<td>4</td>
<td>1m</td>
</tr>
<tr>
<td>40GBASE–CR4</td>
<td>64B/66B</td>
<td>Copper Cable Assembly</td>
<td>4</td>
<td>10m</td>
</tr>
<tr>
<td>40GBASE–SR4</td>
<td>64B/66B</td>
<td>MMF</td>
<td>4</td>
<td>100m</td>
</tr>
<tr>
<td>40GBASE–LR4</td>
<td>64B/66B</td>
<td>SMF</td>
<td>4</td>
<td>10km</td>
</tr>
<tr>
<td>100GBASE–CR10</td>
<td>64B/66B</td>
<td>Copper Cable Assembly</td>
<td>10</td>
<td>10m</td>
</tr>
<tr>
<td>100GBASE–SR10</td>
<td>64B/66B</td>
<td>MMF</td>
<td>10</td>
<td>100m</td>
</tr>
<tr>
<td>100GBASE–LR4</td>
<td>64B/66B</td>
<td>SMF</td>
<td>4</td>
<td>10km</td>
</tr>
<tr>
<td>100GBASE–ER4</td>
<td>64B/66B</td>
<td>SMF</td>
<td>4</td>
<td>40km</td>
</tr>
</tbody>
</table>

C: Copper Coding
K: Backplane
R: 64B/66B Coding
S: Short reach
L: Long reach
E: Extended reach

IEEE 802.3ba Task Force
40 Gbit/s & 100 Gbit/s Ethernet Interfaces
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Progress in 100GE Standardization – ITU-T G.709.

Higher Speed Standardization – ITU-T G.709 OTN (Optical Transport Network).

- ITU-T G.709 Ethernet over OTN long haul carrier grade WDM transmission
- ITU-T G.709 Ethernet client mapping in lower order ODUs
- 40 Gbit/s and 100 Gbit/s multi-lane approaches
- ITU-T G.709 and IEEE802.3ba coordination
- OTN and Ethernet layer interworking needed
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Advanced Technology – Layer 1-2 Interlayer Interworking for Link Failure.

- External Local Fault should be inserted at the downstream Ethernet interface in the OTN fault event, to alarm OTN clients (routers/switches)
- Reactively triggers a protection/restoration event in the OTN client node in case of a link failure, supporting a fast carrier grade protection switching
- Reduced fault localization processes result in faster recovery times and more cost efficient networking
- This interworking requires joint work in the ITU-T & IEEE802.1
Higher Speed Standardization – OIF Implementation Agreement – 40/100 Gbit/s Interfaces.

- OIF 2008.125.04: 100G Long Distance DWDM Transmission
- Implementation Agreement – expected at Q1/2010
  - Reasonable approach to establish a “100G Ecosystem”
  - Suitable propagation performance for long-distance DWDM networks
  - DP-QPSK-CD Dual Polarization – Quadrature Phase Shift Keying – Coherent Detection
  - Baseline Forward Error Correction (FEC) algorithm

\[
\begin{array}{|c|c|c|}
\hline
\text{OIF: 100 Gbit/s DWDM IA:} & \Rightarrow & \text{Implementation Agreement} \\
\text{IEEE802.3: 40/100 Gbit/s Interfaces:} & \Rightarrow & \text{Cu, MMF, SMF Specifications} \\
\text{OTN G.709 OUT-3: 40 Gbit/s Interfaces already available} & \text{2008} & \text{2009} & \text{2010} & \text{2011} \\
\hline
\end{array}
\]
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100GET – OCTET – Project.

**Brief description**

100GET: 100 Gbit/s Carrier-Grade Ethernet Transport Technologies

- **Motivation:** Next generation networks with 100Gbit/s Carrier Grade Ethernet for the traffic scalability & improved economics
- **Goals:** Bundle the 100 Gbit/s Carrier Grade Ethernet activities
  - Pro-active evaluation of higher speed Ethernet
- **Benefit:** Tracking of German and EU GbE industry development
  - Enable early 100 Gbit/s carrier grade Ethernet adoption
  - Coordinated standardization activities

**Key deliverables**

- Test-bed for advanced NGN higher speed Ethernet solutions
- Requirements for 100 Gbit/s functionalities (Layer 1, 2, 3)
- Joint collaboration with cluster partners (ADVA, ALU, Ericsson, NSN)
- Assessment of new NGN higher speed transport equipment
- Consolidated standardization activities aligned with partners

**Key facts**

- 100GET BMBF & European Celtic Framework
- Duration: 36 months
- Begin: October 1st, 2007
- Involved: Deutsche Telekom AG, EICT GmbH
- Funding: BMBF (50%)
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100GET – OCTET – Test Environment.

Test environment for advanced NGN Higher Speed Ethernet Technologies

- Differentiation via domains, technology, modulation formats, test objectives
- Test objectives
  - Layer 1 transmission (e.g. WDM robust & co-existing formats, impairments, etc.)
  - Layer 2 technology (e.g. PBB-TE, MPLS-TP, synchronization, etc.)
  - Layer 2 carrier service performance (e.g. OAM, bandwidth profiles, CoS/QoS, etc.)
  - Layer 1-3 network control (e.g. layer interworking, path computation elements, etc.)

<table>
<thead>
<tr>
<th>Services, Data Transport, Management and Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Services</td>
</tr>
<tr>
<td>Layer 3 VPN Services</td>
</tr>
<tr>
<td>Layer 2 VPN Services</td>
</tr>
<tr>
<td>Layer 1 VPN Services</td>
</tr>
<tr>
<td>Access Aggregation</td>
</tr>
<tr>
<td>Metro Regional</td>
</tr>
<tr>
<td>Core Backbone</td>
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</tbody>
</table>

Layer 1
Transmission

Layer 2
Carrier
Services & Technology

Layer 1-3
Network Control
Scalable 100Gbit/s Transmission via existing DTAG Network Infrastructure towards Tbit/s Transmission.

- Vestigial sideband filtering of 107Gbit/s ASK
- 100 GHz DWDM spacing
- Spectral efficiency: 1 Bit/s/Hz

- Phase Modulation Format
- 50 GHz DWDM spacing
- Spectral efficiency: 2 Bit/s/Hz

- Layer 1 – 3 test environment available
- 10 km and 40 km Links via existing fiber infrastructure
- DWDM channels and layer 2/3 switch/router devices
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Conclusion.

Higher Speed Ethernet and Advanced Functionality for scalable & cost efficient next generation networks.

- 100Gbit/s for scalable and cost efficient next generation networks required
  - Reduction of number network components
  - Advanced functionalities

- 100 Gbit/s standards expected in 2010
  - IEEE802.3 100GbE Interfaces & OIF 100G long distances DWDM transmission
  - Ethernet over OTN – Ethernet layer interworking via OAM signaling required

- 100GET serial transmission tests via existing DTAG infrastructure demonstrated
  - Alcatel-Lucent: 8 x 100 Gbit/s serial DWDM via 100GHz channel spacing
  - Ericsson: 1 x 100 Gbit/s serial DWDM via 50 GHz channel spacing
Thank you!

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