40GBASE-T / Category 8 Update

Ing. Davide Badiali, RCDD
Technical Manager CommScope
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NGBase-T Update

Market Need for NGBASE-T

Lessons learned from 10GBASE-T

Progress To-date
EU Example: AMS-IX Traffic Exceeding 2 Tb/s

High speed interfaces needed to efficiently transport data
• In 2016, the gigabyte equivalent of all movies ever made will cross Global IP networks every 3 minutes.

• Globally, IP traffic will reach 15 Gigabytes per capita in 2016, up from 4 Gigabytes per capita in 2011.

• 50 Billion IP devices on Internet by 2010.
The New World - The Internet World

- Society has become addicted to the Internet
- We “need” to be connected in the office, (wired and wireless), on the move, (wireless), at home, (broadband)
- Facebook - 5 M photos uploaded per hour
- Youtube - 3,000 hrs uploaded per hour

Average Western person today consumes as much data by 9.00 AM each day as a person in the 1700’s did in his lifetime!!
Market Data and Forecast for Server Port Speeds through 2020

Source: IEEE 802.3 NGBASE-T CFI Meeting – July 2012
### Addressing the Need for 40GbE: Current PMDs and their Applications

| Copper | | | |
| --- | --- | --- | |
| **PHY** | **Support** | **Application** |
| 40GBASE-KR4 | 4 Lanes over Backplane ≤ 1 m | Backplane |
| 40GBASE-CR4 | 4 Lanes over Twinax ≤ 7 m | Top of Rack |

| Fibre | | | |
| --- | --- | --- | |
| **PHY** | **Support** | **Application** |
| 40GBASE-SR4 | 4 Lanes @ 850 nm ≤ 100 m with OM3 ≤ 150 m with OM4 | Switch Uplink |
| 40GBASE-LR4 | 4λ CWDM @ ~1310 nm ≤ 10 km with OS1/OS2 | Backbone/Carrier |
| 40GBASE-FR | 40G @ ~1550 nm ≤ 2 km with OS1/OS2 | Backbone/Carrier |
• 40GBASE-CR4 “Direct Attach” reach is limited to adjacent cabinets
• Cost effective solution needed for End-of-Row (EOR) / Middle-of-Row (MOR) topologies
• 40GBASE-T solution proposed for this application
NGBase-T Update

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Progress To-date
Mass Adoption of 10GBASE-T
Why so long?

1st Gen PHYs
90 nm
10 watt power consumption

2nd Gen PHYs
65 nm
6 watt power consumption

3rd Gen PHYs
40 nm
<4 watt power consumption

4th Gen PHYs
28 nm
<2.5 watt power consumption
10GBASE-T and Power

- Power became *the* key design issue while 10GBASE-T was in development.

- Several generations of silicon were developed before the power levels were acceptable.

To simplify development of NGBASE-T, power concerns should be addressed up front.

Evolution of 10GBASE-T Transceiver Power

**Source:** NGBASE-T CFI Sept 2012 (Applied Micro)
• LOM removes the cost barrier to adopt 10G on servers
  – 10G Server LOM started volume shipments in 2012
• Server vendors require LOM to be backward compatible, hence LOMs should support:
  – interoperability with 100M/1G/10G switches
  – support RJ45 cabling infrastructure
Mass Adoption of 10GBASE-T

A number of drivers:

- Costs
- Customer needs
- Key technologies
- Applications
- User scenarios and values

![Graph showing 10GBASE-T and FCoE-capable Shipments]

We are here

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NGBASE-T Transceiver Design Considerations

- Moving through several generations of silicon delayed deployment of 10GBASE-T

- Keeping the NGBASE-T complexity at the same level as 10GBASE-T will speed development

- Mass market need for 40G in the DC forecasted for 2016-17

- Higher bandwidth cabling system can facilitate this:

\[
\text{IL}_{10\text{GBASE-T@100 m & 400 MHz}} \approx \text{IL}_{40\text{GBASE-T@50 m & 1600 MHz}}
\]

- Adding 25% overhead brings frequency to 2 GHz
NGBase-T Update

Market Need for NGBASE-T

Lessons learned from 10GBASE-T

Progress To-date
# 40GbE and 100GbE Options

<table>
<thead>
<tr>
<th>Interfaces</th>
<th>IEEE Standards</th>
<th>Supported Media</th>
<th>Distance Supported</th>
</tr>
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<tbody>
<tr>
<td>40GBASE-KR4</td>
<td>802.3ba</td>
<td>Backplane, 4-Lane</td>
<td>≤ 1 m</td>
</tr>
<tr>
<td>40GBASE-CR4</td>
<td>802.3ba</td>
<td>Twinax, 4-Lane</td>
<td>≤ 7 m</td>
</tr>
<tr>
<td>40GBASE-SR4</td>
<td>802.3ba</td>
<td>Multimode @ 850 nm, 4-Lane</td>
<td>OM3 ≤ 100 m, OM4 ≤ 150 m</td>
</tr>
<tr>
<td>40GBASE-LR4</td>
<td>802.3ba</td>
<td>Singlemode @ 1310 nm, CWDM</td>
<td>OS1/OS2 ≤ 10 km</td>
</tr>
<tr>
<td>40GBASE-FR</td>
<td>802.3bg</td>
<td>Singlemode @ 1550 nm, Serial</td>
<td>OS1/OS2 ≤ 2 km</td>
</tr>
<tr>
<td>100GBASE-CR10</td>
<td>802.3ba</td>
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<tr>
<td>100GBASE-ER4</td>
<td>802.3ba</td>
<td>Singlemode @ 1310 nm, CWDM</td>
<td>OS1/OS2 ≤ 40 km</td>
</tr>
</tbody>
</table>

**Supported Media:**
- **Backplane, 4-Lane**
- **Twinax, 4-Lane**
- **Multimode @ 850 nm, 4-Lane**
- **Singlemode @ 1310 nm, CWDM**
- **Singlemode @ 1550 nm, Serial**
- **Singlemode @ 1310 nm, CWDM**

**Distance Supported:**
- ≤ 1 m
- ≤ 7 m
- OM3 ≤ 100 m, OM4 ≤ 150 m
- OS1/OS2 ≤ 10 km
- OS1/OS2 ≤ 2 km
- OS1/OS2 ≤ 7 m
- OS1/OS2 ≤ 10 km
- OS1/OS2 ≤ 40 km

**CWDM:** Coarse Wavelength Division Multiplexing
Extended Reach 40GbE-SR

- Emerging de-facto standard: Extended Reach 40GbE-SR QSFP+ transceivers now available
  - Avago: 40GBASE-eSR4
  - Cisco: QSFP-40G-CSR4
  - Dell Force10: GP-QSFP-40GE-ESR4
- Supports 40GbE
  - 300 m on OM3
  - 400 m on OM4
- Must be used at both ends of link
# 40GbE and 100GbE Technologies in Development

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<td>OS1/OS2 ≤ 40 km</td>
</tr>
<tr>
<td>100GBASE-SR4</td>
<td>802.3bm</td>
<td>Multimode @ 850 nm, 4-Lane</td>
<td>OM3 ≤ 70 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>OM4 ≤ 100 m</td>
</tr>
<tr>
<td>100GBASE-xxxxx</td>
<td>802.3bm</td>
<td>Singlemode</td>
<td>OS1/OS2 ≤ 500 m</td>
</tr>
<tr>
<td>100GBASE-CR4</td>
<td>802.3bj</td>
<td>Twinax, 4-Lane</td>
<td>≤ 5 m</td>
</tr>
<tr>
<td>100GBASE-KR4</td>
<td>802.3bj</td>
<td>Backplane, 4-Lane</td>
<td>IL ≤ 35 dB @ 12.9 GHz</td>
</tr>
<tr>
<td>100GBASE-KP4</td>
<td>802.3bj</td>
<td>Legacy Backplane, 4-Lane</td>
<td>IL ≤ 33 dB @ 7 GHz</td>
</tr>
</tbody>
</table>

802.3bm: Q1 2015
802.3bj: Q2 2014

CWDM: Coarse Wavelength Division Multiplexing

xxxx: Not defined yet. Depends on choice of technology
<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Addresses bandwidth requirements between releases of faster links</td>
<td>• Non-deterministic performance</td>
</tr>
<tr>
<td></td>
<td>• Fastest flow limited to individual link speed</td>
</tr>
<tr>
<td></td>
<td>• Exponential bandwidth growth implies:</td>
</tr>
<tr>
<td></td>
<td>− Exponential growth in number of links</td>
</tr>
<tr>
<td></td>
<td>− Growth in operational &amp; management issues</td>
</tr>
<tr>
<td></td>
<td>• Doesn’t scale forever</td>
</tr>
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</table>
40GBase-T Link Segment Objective

- Transceiver and LOM technologies require reasonable power consumption
- Committing to develop new LOM technology requires
  - Reasonable power
  - High adoption rate (economy of scale)
    - Compatibility with legacy speeds
  - Low cost
- Support Auto-Negotiation
- Define a link segment based upon copper media specified by ISO/IEC SC25 WG3 and TIA TR42.7 meeting the following characteristics:
  - 4-pair, balanced twisted pair copper cabling
  - Up to 2 connectors
  - Up to at least 30 m
Summary

- Server BASE-T family provides highest volume Ethernet port shipment
- Server virtualization app will drive server bandwidth
- 40GBASE-T is being developed into an IEEE standard (802.3bq)
- 40GBASE-T reduces the need for link aggregation
- 40GBASE-T provides cost effective solution for EOR/MOR data center topologies (ideal for POD design)
40GBASE-T Proposed Timeline

Source: IEEE 802.3 802.3bq 40GBASE-T TF May 2013
CommScope’s Category 8 channel demonstration to IEEE

TIA TR42 Meeting (02/13)
Propose CAT 8 as name

ISO/IEC agreement on Category 8 naming convention

40GBASE-T Task Force (802.3bq) announced.
As a follow up to the joint contribution made to IEEE in November with Belden, CommScope presented an end to end proof of concept Category 8 channel with our components: cable, connectors and cords.

- Focused our commitment on the ubiquitous RJ-45 connector
- Press Release issued 14 February, broadly reported on in trade press

http://www.ieee802.org/3/NGBASE-T/public/jan13/Larsen_01a_0113_NGBT.pdf
CommScope demos technical feasibility of Category 8 copper cabling system

February 14, 2013

CommScope announced that it has successfully demonstrated the technical feasibility of Category 8 cabling system for enterprise networks. The company calls the demonstration “a step along the path towards a viable 40GBASE-T system for datacentre applications.”

40Gbps 'copper cabling' Ethernet one step closer to becoming reality

40Gbps Ethernet breakthrough

Posted by admin on Mar 4, 2013 in Datacentre, Structured cabling

More on the news we Tweeted last week, that CommScope has succeeded in bringing a prototype Category 8 RJ-45 connectors and copper twisted pair cables were used in a proof-of-concept demonstration of the technology to an IEEE study group.

Summary: Prototype Category 8 RJ-45 connectors and copper twisted pair cables were used in a proof-of-concept demonstration of the technology to an IEEE study group.
TIA TR-42.7: Category 8

First Draft Proposal from CommScope
Feb 2012

TIA selected Category 8 nomenclature
Oct 2012

TIA Liaison (Draft Spec) to IEEE
Nov 2012

CommScope Category 8 POC to IEEE
Jan 2013
TIA TR-42.7: Category 8

- Specified to 2 GHz
- Minimum cable design: F/UTP
- Align configuration with IEEE objective: 2-connection, 30 meters channel
- Adopted ISO Class II channel RL spec
  - Improved connector RL required
  - Cable RL unchanged
- New task group formed to study “the concept of ISO Class II limits” for Category 8 cabling
## TIA Category 8: Backward-Compatibility Matrix

<table>
<thead>
<tr>
<th>Category of Modular Plug and Cord Performance</th>
<th>Cat 3</th>
<th>Cat 5e</th>
<th>Cat 6</th>
<th>Cat 6A</th>
<th>Cat 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat 3</td>
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Matrix of backward-compatible mated component performance
ISO/IEC JTC1 SC25 WG3: Category 8.1 and Category 8.2


ISO Liaison to IEEE Nov 2012

ISO selected Category 8.1 and Category 8.2 nomenclatures Mar 2013

Class I: Cat 8.1
Class II: Cat 8.2
ISO/IEC JTC1 SC25 WG3: Category 8.1 and Category 8.2

- Class I: Uses Category 8.1 components
- Class II: Uses Category 8.2 components
- Cat 8.1: Minimum cable design: F/UTP
- Cat 8.2: Minimum cable design: x/FTP
- Specified to 1.6 GHz with 2 GHz under consideration
- Configuration: 2-connection, 30 meters channel

Channel I achieved by using **Category 8.1** components (F/UTP)
- ISO/IEC Category 8.1 components are backwards compatible and interoperable with Category 6A

Channel II achieved using **Category 8.2** components (S/FTP)
- *Implied* that ISO/IEC Category 8.2 components are backwards compatible and interoperable with Category 7A
THE 50M DATA

- The suck out at ~1200MHz means we should avoid putting Nyquist here. Note it violates the 100m IL extrapolated limit line.
- Outer shielding means Alien XT is not a concern.
- Very good PSNEXT and PSFEXT levels (still >20dB down on signal even at 1GHz).
- RL crosses IL at less than 500MHz.
- Implies echo will dominate impairments at receiver.
Matrix of backward-compatible mated component performance
Category 8 and the RJ-45

- RJ-45 Proves itself again
- World’s only ubiquitous connector
- Long the industry favourite for data cabling
- Prevalent in other industries
  - Facilities
  - Consumer electronics
- Where Ethernet goes, so goes the RJ-45
- Alternate design connectors have met with very limited success to date

- Category 8 objective is to use the RJ-45
• IEEE 802.3bz 40GBASE-T link segment objective is 2-connection, 30 meters

• Majority of installed Enterprise cabling links exceed the 40GBASE-T link segment objective

Impact on Enterprise Architecture Design
Summary and Key Points

• The cabling industry has come together and is building a clear path for supporting 40G applications over copper, and that path is Category 8.

• Rapid Progress to-date:
  – Use of industry favourite RJ45 connector
  – Demonstrated working 40GBase-T Channel out to 2 GHz
  – Current draft Category 8 specifications specified to at least 1.6 GHz
    • ISO/IEC TR 11801-99-1 Class I (Category 8.1) and Class II (Category 8.2) specified to 1.6 GHz
    • TIA Category 8 specified to 2 GHz
  • The choice of code to use for 40GBASE-T will determine the ultimate critical frequency for the app and therefore the maximum frequency for the cabling specifications. This decision will be determined by the IEEE 802.3bq task force (primarily the equipment/transceiver vendors)
    – Two connectors channel configuration, at least up to 30 meters
Summary and Key Points

- Future of Category 7/7A is questionable
  - It has not been completely ruled out for 40G
  - Establishment of Category 8 specs in ISO/IEC out to 1600 MHz does raise serious questions about its viability
  - Raises serious question of any value add for CAT7/7A over Cat6A
  - Category 7A is specified to only 1 GHz
  - Current installed base of ‘Category 7A‘ cabling IL doesn’t meet the proposed draft Category 8 IL specifications
  - In addition, majority of the installed base of ‘Category 7A‘ cabling consists of Category 7A cables terminated on Cat 6 or Cat 6A connectors and connecting hardware
  - Also, majority of installed Enterprise cabling links exceed the 40GBASE-T link segment objective
Thank You
Ing. Davide Badiali, RCDD
Technical Manager Italy, Greece & Cyprus

Via Archimede 22/24, 20864 Agrate Brianza (MB) Italy
T: +390396054687
M: +393483013063
E: badiali@commscope.com

www.commscope.com