Twisted Pair Cabling for 40G

Key issues for twisted pair cables for next-gen 40G Ethernet

Harshang Pandya
Psiber Data
hpandya@psiber-data.com

www.psiberdata.com

BICSI South East Asia Conference 2011
Agenda

- Next generation Ethernet standards and physical layer options
- Need for twisted pair cables for 40G
- Key issues for 40G twisted pair cabling
- Actions from standardization bodies
- Field test requirements and challenges
- Measured field tester performance data
- Field testing for 40G in smart phone era
## 40Gbit and 100Gbit Ethernet Physical Layer Options

<table>
<thead>
<tr>
<th>Physical layer</th>
<th>40 Gigabit Ethernet</th>
<th>100 Gigabit Ethernet</th>
</tr>
</thead>
<tbody>
<tr>
<td>at least 1 m over a backplane</td>
<td>40GBASE-KR4</td>
<td>802.3bj</td>
</tr>
<tr>
<td>approximately 7 m over copper cable</td>
<td>40GBASE-CR4</td>
<td>100GBASE-CR10</td>
</tr>
<tr>
<td>at least 100 m over OM3 MMF</td>
<td>40GBASE-SR4</td>
<td>100GBASE-SR10</td>
</tr>
<tr>
<td>at least 125 m over OM4 MMF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>at least 10 km over SMF</td>
<td>40GBASE-LR4</td>
<td>100GBASE-LR4</td>
</tr>
<tr>
<td>at least 40 km over SMF</td>
<td></td>
<td>100GBASE-ER4</td>
</tr>
<tr>
<td>serial SMF over 2 km</td>
<td>40GBASE-FR</td>
<td></td>
</tr>
</tbody>
</table>

No twisted pair structured cabling?
Who Want Twisted Pair for 40G and Why

1. Data Center Managers

- Lower the cost of datacom infrastructure
- Flexibility in moves, adds, changes
- Auto-negotiation enables phased upgrade of infrastructure
- Large proportion of the links are short distance, well within the capability of twisted pair cabling for carrying 40G
- Capitalize training and familiarity even as technologies evolve
Who Want Twisted Pair for 40G and Why

2. Network Equipment Vendors

- Provide cost competitive migration to 40G
- Provide backward compatibility
- Enable customers to adopt 40G with incremental CapEx budgets over years
Who Want Twisted Pair for 40G and Why

3. Networking Semiconductor Companies

- Open new market of 40G copper PHY
- Regain momentum after initial 10G copper PHY issues
4. Copper Cable Vendors

- Ensure continuation and growth of their huge and matured operations
- Look for application support for latest cabling types
- Continue technological progress on transmission over twisted pair copper cabling
Who Want Twisted Pair for 40G and Why

5. Test Equipment Vendors

- Protect customers’ investment as 40G ready deployments grow
- Open new market by helping 40G over copper evolution
Recap of Industry Segments Driving Twisted Pair Cabling for 40G

<table>
<thead>
<tr>
<th>Data Center Managers</th>
<th>Network Equipment Vendors</th>
<th>Test Equipment Vendors</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Lower the cost of datacom infrastructure</td>
<td>- Provide cost competitive migration to 40G</td>
<td>- Protect customers investment as 40G ready deployments grow</td>
</tr>
<tr>
<td>- Large proportion of the links are short distance</td>
<td>- Provide backward compatibility</td>
<td>- Open new market by helping 40G over copper evolution</td>
</tr>
<tr>
<td>- Capitalize training and familiarity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semiconductor Companies</th>
<th>Copper Cable Vendors</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Open new market of 40G copper PHY</td>
<td>- Look for application support for latest cabling types</td>
</tr>
<tr>
<td></td>
<td>- Existence and growth of their huge and matured operations</td>
</tr>
</tbody>
</table>
## Key Technical Issues for 40G Over Copper

<table>
<thead>
<tr>
<th>Issue</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data rate stretches Shannon Capacity of available cabling types</td>
<td>- Use higher bandwidth</td>
</tr>
<tr>
<td></td>
<td>- Current discussions at TIA, ISO, and IEEE range from 1600 to 2000 MHz</td>
</tr>
</tbody>
</table>
### Key Technical Issues for 40G Over Copper

<table>
<thead>
<tr>
<th>Issue</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY devices in the network cards become too hot trying to remove impairments in signal</td>
<td>- Smaller geometry semiconductor technologies optimize power utilization</td>
</tr>
<tr>
<td></td>
<td>- Higher category cabling systems have far less impairments. These cables may relieve some work of PHY devices and let them remain cooler</td>
</tr>
</tbody>
</table>
Key Technical Issues for 40G Over Copper

<table>
<thead>
<tr>
<th>Issue</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion Loss at high frequencies degrade signal too much</td>
<td>This may necessitate standards to specify shorter lengths than 100m Not a big issue for data centers because large proportions of copper links already less than 50m</td>
</tr>
</tbody>
</table>
What are the Standards Bodies Doing for Next gen Applications over Twisted Pair

- **TIA** has started *next generation cabling* project

- **ISO** is also engaged in active discussion on next generation cabling and testing requirements

- **IEEE** is expected to start a new project for defining 40GBASE-T
TIA’s Next Generation Cabling Project

• **Capacity task group** – determine technical parameters like overall noise model (NEXT, FEXT, reflection, external noise), and capability of PHY devices to cancel noise, power consumption, bandwidth requirements

• **Application space task group** – determine what applications will be served e.g. 40G Ethernet, what topology e.g. data center server links, what constraints e.g. limited length, limited number of connectors

• **Cable task group, connector task group** – translate the capacity and application requirements into cable and connector requirements
ISO Activities in Next Generation Copper Cabling

- TC 46/WG 9 working on defining tester accuracy specs to at least 1000MHz
- New specification for tester accuracy (proposed level V specs) are being developed
- SC25, committee responsible for ISO/IEC 11801 standard is considering specifying cables to 2000 MHz
• Is going through initial brain-storming, a formal 802.3?? Project can be expected soon

• Interest from potential users, and reporting of feasibility from suppliers are key considerations
Field Testing for Next Gen Cabling Systems

• Key aspect for field testing of next generation structured copper cabling will be increased test frequency range

• New field tester accuracy requirement will need to be defined to cater for high measurement accuracy over very wide bandwidth
Field Testing Bandwidth for 40G Over Copper

Field testing bandwidth will be stretched more than two-folds!!
Tester Bandwidth Challenge

• Till recently, field testers could not achieve such test bandwidths due to technical issues like
  – Limited bandwidth of passive components like baluns
  – Clock jitter
  – Sampling rate limitations
  – Unavailability of precision low cost wideband sources

• But now, at least one field tester is already available with very high bandwidth capability
Actual Measurement Data from New Field Tester - RNEXT

- RNEXT is the amount of near-end cross-talk experienced by test instruments when no cable is connected.
- Tells how good the internal hardware of the tester is regarding cross-talk.

Limit line (red) is extrapolation of existing level IV accuracy spec to higher frequencies.
Directivity is the amount of reflection (return loss) experienced by test instruments when no cable is connected and tester interface is terminated.

Tells how good the internal hardware of the tester is regarding Return Loss.
Field Testing for 40G in Smart Phone Era

Trusted Phone a few years back
Field Testing for 40G in Smart Phone Era

Trusted Phone a few years back

Today...
# Field Testing for 40G in Smart Phone Era

<table>
<thead>
<tr>
<th>Field Cable Testers Before</th>
<th>Field Cable Tester Today</th>
</tr>
</thead>
<tbody>
<tr>
<td>Button based user interface with “insensitive” display</td>
<td>Big Touch-screen based user interface – every action in a few clicks</td>
</tr>
<tr>
<td>Display on only main unit, technician at the remote end in dark</td>
<td>Detailed information and control from remote: “finish the work fast”</td>
</tr>
<tr>
<td>Will become obsolete when 40G arrives; need to buy new</td>
<td>Ready for future testing requirements for 40G; protect today’s investment</td>
</tr>
</tbody>
</table>
Thank You!!