Higher Speeds and Next Generation Needs
4th September 2014
Applications & Cabling technologies

New applications 40GbE & 100GbE
Cat8 – 40GbE over Copper
Standards Overview

Data centre cabling solutions/considerations

Cabling infrastructure and containment equipment are often considered the least, though are one of the most important considerations when planning a Data Centre, they are the very foundation of the investment and the transportation highway of the data.

Can copper systems compete with the latest high speed optical fibre solutions?

How are IT networks expected to evolve?
our company
**Big Data**
Predicted to grow by 800% in the next 5 years

**Interoperability**
Solutions built on open infrastructure architecture

**Energy Efficiency**
Saving a few % can make a difference

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**Cloud**

Virtualisation

Ultra high definition 4K Video

Audio streaming

High bit rate Video

+ others not yet identified

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**Healthcare IT spending increase focused on improved care**

**IBM to invest $1.2bn in 15 data centres to expand push into cloud**

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**Worldwide IT spending to grow 3.2% in 2014**

Post date: Thursday, 03 Apr 2014

With the global economy showing signs of a gradual recovery, worldwide IT spending is on pace to total US$3.8 trillion in 2014, a 3.2% increase from 2013 spending, according to the latest forecast by Research house, Gartner, Inc.

Google, Facebook and Apple lead on green data centers

A new report by Greenpeace shows US tech giants are increasingly buying into renewable energy but European companies are still streets ahead
<table>
<thead>
<tr>
<th>Big Data</th>
<th>Interoperability</th>
<th>Energy Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>Flexibility</td>
<td>Sustainability</td>
</tr>
</tbody>
</table>

- Introduced products with superior performance - 40 & 100G solutions
- Smaller diameter cables - significant space savings and improved airflow
- Shielded cables – providing immunity from electrical interference and proven reliability
- Plug & Play solutions - easier and faster to install
- Manufactured to international standards - interoperability
cabling investment Vs other DC equipment

<table>
<thead>
<tr>
<th>Lifetime</th>
<th>%Cost of Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-9 yrs</td>
<td>5-10%</td>
</tr>
<tr>
<td>3 yrs</td>
<td>40%</td>
</tr>
<tr>
<td>1 yr</td>
<td>50%</td>
</tr>
</tbody>
</table>

CABLE: 
- 3 yrs: 40%

HARDWARE: 
- 3 yrs: 40%
- 1 yr: 50%

SOFTWARE: 
- 7-9 yrs: 5-10%

Total cost: x9
Lowers Whole Life Costs, Faster MACs and Lower MTTRs

(Moves, Adds & Changes)  (Mean Time to Repair)

Total Cost of Ownership

Conventional FO cable  Pre-Term Conventional FO cable  Pre-Term MPO cable

Maintenance Cost

Install cost

Parts cost
planned life of the installation

- 3 year
- 5 year
- 10 year
- 10+ year

building

- small/medium/large data centre
- new ‘green’ field
- refurbished room
- co-location
- corporate
- tier i, ii, iii, iv

transmission technologies

- 1 & 10GbE
- 1, 2, 4, 8, 16g & 10g fc
- 40GbE & 100GbE
- fibre channel over ethernet
- infiniband
- data centre ethernet
- backplane/top rack/end rack/centralised

installation environment

- safety
- pathways and spaces
- pressurised floor
- local cooling
- electromagnetic environment
There are three published standards which cover Structured Cabling for Datacentres,

ANSI/TIA/EIA-942  
EN 50173-5  
ISO/IEC 24764

The European standard deals specifically with the cabling for Datacentre’s whereas the TIA standard covers cabling but also includes Architectural, Mechanical and Electrical aspects. The TIA standard also references the Uptime Institutes’ tier system as a classification method for Datacentre’s.

The published standards recommend that a minimum of **Class EA performance copper cabling** and **OM3/OM4 fibre** is installed in the Datacentre. The high performance level for copper cabling is recommended because it is expected that cabling systems installed today will be required to provide transmission paths for 10GBASE-T technology within their lifetime.

The standards also recommend LC duplex optical fibre connectors and MPO (Multi-fibre Push On) connectors for multiple optical channel solutions. Space saving, high density solutions are recommended to compliment the high performance necessary in the Datacentre.
<table>
<thead>
<tr>
<th>Fibre type</th>
<th>Bandwidth</th>
<th>Cable Specification</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>10GBASE-LX4</td>
<td>160/500</td>
<td>TIA spec</td>
<td>300 m</td>
</tr>
<tr>
<td></td>
<td>200/500</td>
<td>OM1</td>
<td>300 m</td>
</tr>
<tr>
<td></td>
<td>500/500</td>
<td>OM2</td>
<td>300 m</td>
</tr>
<tr>
<td>10GBASE-SR</td>
<td>26 m</td>
<td>OM3</td>
<td>300 m</td>
</tr>
<tr>
<td></td>
<td>33 m</td>
<td>OM4</td>
<td>550 m</td>
</tr>
<tr>
<td></td>
<td>82 m</td>
<td>OS1/2</td>
<td>-</td>
</tr>
<tr>
<td>10GBASE-LW</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10GBASE-EW</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1550 nm serial</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>IEEE 802.3ae Ten Gigabit Ethernet distances</td>
<td>10 kb</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 10GbE on optical fibre vs copper

<table>
<thead>
<tr>
<th>Reach</th>
<th>10GBASE-</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E</td>
</tr>
<tr>
<td><strong>Relative cost</strong></td>
<td>3.2</td>
</tr>
<tr>
<td>OS2 SMF</td>
<td>40km</td>
</tr>
<tr>
<td>OS1 SMF</td>
<td>x</td>
</tr>
<tr>
<td>OM4 MMF</td>
<td>x</td>
</tr>
<tr>
<td>OM3 MMF</td>
<td>x</td>
</tr>
<tr>
<td>OM2 MMF</td>
<td>x</td>
</tr>
<tr>
<td>OM1 MMF</td>
<td>x</td>
</tr>
<tr>
<td>Class EA</td>
<td>x</td>
</tr>
<tr>
<td>Class E</td>
<td>x</td>
</tr>
<tr>
<td>Class D</td>
<td>x</td>
</tr>
<tr>
<td>Cable assembly</td>
<td>x</td>
</tr>
</tbody>
</table>

**Note 1:** limited reach on UTP cabling, full channel length on screened cabling

**Note 2:** 550m on OM4 with 1dB connectivity losses
**Cat 5e**
Technology of choice for smaller LANs where there is no likely need for greater than 1Gb/s.
Ideal commercial choice for short-term networks.

**Cat 6**
No application of its own - better alternative for Gigabit Ethernet:
- Headroom / POE / Reliability / low premium uplift
- Shouldn't be installed in the DC as it has no future proofing past 1Gb/s.

**Cat 6A**
Finally mainstream.
- Cost effective option - In enterprise backbones with links of 100m or less, which means that Cat 6A should be the cabling system of choice for the majority of enterprise.
- Standards compliance - The key data centre standards:
  - European EN 51073-5, ISO/IEC 24764 and American TIA 942A all recommend Cat 6A or Class EA as the minimum standard now for data centres.

**Cat 7**
Like Cat 6, Cat 7 never had an application to call its own.
- Main justification? 'cable-sharing' the ability to use two-pairs for data and the spare two pairs for two single pair applications like analogue voice or fax.
- With the arrival of 1000BASE-T Ethernet needing all four pairs pair-sharing argument has been weakened. Cat 7 can easily run 10Gb/s Ethernet but what is the connector of choice – cat6a? The performance will drop respectively.
- Could quickly become obsolete if not already.

**Cat 7A**
With Cat 6A doing everything that Cat 7 was proposed for, Cat7A effectively offers additional headroom however several considerations:
- 10G? - As of today, the fastest available Ethernet protocol is 10GBASE-T which needs only 500MHz.
- 40G and beyond? - There is only a slim possibility that existing Cat 7A components will actually support 40 Gb/s.
- Connector type? - RJ45 would be the preference. The square connector is thicker than the latest laptops that pretty much rules it out from deployment on mass market user equipment.
Cabling Category vs Mbps
Category 8 : Timeline

ISO Class 8.1 & 8.2

TIA Cat8

2013  2014  2015  2016

IE802.3bq Task Force March 2013

IEEE 802.3bq 40GBASE-T
Category 8

Timescale

- IEC & TIA project completion/standards publication Q1 2016
- Manufacturers delivering in-line with standards publication
- Working toward a product set comprising RJ45 shielded connectivity (plugs & sockets with IDC’s ISO/IEC 8.2 Class I)
  (some manufacturers may choose other connection type ISO/IEC 8.2 Class II)
- Shielded “Zone 8” and patch cord cables (U/FTP or F/UTP)
Category 8

- The key technical challenges faced by each industry sector

- Coding
  - BER
  - Throughput
  - Compatibility
  - Interoperability

- Insertion loss
  - NEXT
  - ACR-F
  - Return Loss
  - 2GHz

- Dynamic range
  - Measurement noise
  - Common mode rejection
  - 2GHz
Switch to server Link Length survey in DCs

- 50m = 90%

Source: IEEE HSSG

<table>
<thead>
<tr>
<th>Link Length</th>
<th>Percentage of all data centre links covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10m</td>
<td>33%</td>
</tr>
<tr>
<td>&lt;30m</td>
<td>80%</td>
</tr>
<tr>
<td>&lt;50m</td>
<td>93%</td>
</tr>
<tr>
<td>&lt;70m</td>
<td>97%</td>
</tr>
</tbody>
</table>
Category 8

- TIA Cat 8 (568C.2-1)
  - = Cat6A to higher frequency 2GHz
  - F/UTP cable
  - RJ45 connectors

- ISO (11801-99-1)
  - Cat8.1 = Cat6A to 1600MHz (2GHz ffs)
  - Cat8.2 = Cat7A to 1600MHz (2GHz ffs)
  - S/FTP cables
  - RJ45 or a.n.other connector
Category 8
Which Connector?

- RJ45 (TIA 568C.2-1 draft to 2GHz) [ISO Class 8.1]
- RJ45 (IEC 60603-7-81 draft to 2GHz) [ISO Class 8.1]
- GG45 (IEC 60603-7-82 draft to 2GHz) [ISO Class 8.2]
- ARJ45 (IEC 61076-3-110 to 3GHz by an amendment) [Class 8.2]
- Tera (IEC 61076-3-104 to 2GHz by an amendment) [Class 8.2]

All currently in draft
40GBASE-T on Copper – Can my existing cabling support 40G?

• Cat 6A? - it’s very unlikely

• Cat 7. Cat 7A? - Slim possibility but it’s more likely to be a revised Cat 7A at 1200MHz or 1600MHz instead of the current 1000MHz

• 2000Mhz? - Our own modelling over 5 years ago, developed together with DeMontfort University, Leicester, using Technology Forecasting Techniques indicates that a 2000MHz cable frequency could actually prove to be needed.
### Which cabling types for 40Gbps or 100Gbps technologies?

<table>
<thead>
<tr>
<th>UTP or Shielded?</th>
<th>U/UTP &amp; square</th>
<th>S/FTP &amp; square</th>
<th>F/UTP &amp; RJ45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited by cable &amp; conn NEXT &amp; FEXT &amp; susceptible to external noise</td>
<td>Limited by cable &amp; conn NEXT &amp; FEXT &amp; Susceptible to external noise</td>
<td>Limited by cable NEXT &amp; FEXT &amp; susceptible to external noise &amp; conn footprint too big</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Limited by conn NEXT &amp; FEXT &amp; susceptible to external noise</td>
<td>Limited by conn NEXT &amp; FEXT</td>
<td>Highest performance cabling but conn footprint too big</td>
<td></td>
</tr>
</tbody>
</table>
40G on UTP or Shielded Copper
-Reality or Myth?

- Achieving 40Gb/s channel capacity can be achieved by increasing operating frequency or increasing the degree of compensation for interference between signals or a combination of both. Increased compensation of interfering signals only makes sense if the parts that can compensated are greater than those that cannot. For twisted pair systems this is ONLY possible with shielded systems due to alien crosstalk (ANEXT/AFEXT) and is the reason and current thinking behind why Shielded Copper is the only solution for 40GBase-T for Cat8 @ 30mts.
IEEE’s vision:
“40GBASE-T is well suited to cover all connections within a row within a DC”

Distance served by 40GBASE-T:
- Within the rack
- Neighbouring racks
- End of row

Distance served by 40GBASE-CR4:
- Within the rack
- Neighbouring racks
Applications

- Use of 10G applications is growing in cabling backbones and in data centre connections
- New higher speeds of 40GbE & 100GbE have emerged

Cabling

- ClassEA performance Cu cabling is required to future proof for 10GBASE-T.
- Multi-lane optical connectivity will be required for multi-mode fibre links
- Copper solutions with Cat8 for 40GBASE-T are coming
• Plan for a comprehensive future proof cabling infrastructure and containment system
  – 40Gb & 100Gb transmission technologies are arriving
• Higher performance cabling offers the silicon designers certain advantages
  – Reduced complexity of electronics
  – Possibility of improved latency
  – Low loss high quality systems will improve network performance & future proof
  – Smaller OD cabling will provide additional benefits
• A 100m link is technically feasible but a 30/50m will be specified by IEEE
  – Shorter reach distances = reduced complexity/power/latency
  – Shorter distances will suffice for the majority of the DC market
  – Network design topology in the Data Centre is likely to change
• Cabling
  – Shielded cabling provides better protection against external interference
  – S/FTP cabling has 25dB better NEXT than F/UTP solutions
  – RJ45 or square connector - ISO/IEC cat8 class I or class II?
  – Optical fibre is 40Gb future proof for TODAY.. Copper is coming
when will High Speed Ethernet (HSE) technology emerge?

Based on IDC Server Forecast and Hays_01_0407 ratios of Ethernet port speed

Source: HSSG

- 10G emerges 2007/8
- 40G emerges 2012/3
- 100G emerges 2017/8

millions server units

100M, 1G, 10G, 40G, 100G
Introduced products with superior performance - 40 & 100G solutions

Smaller diameter cables - significant space savings and improved airflow

Shielded cables – providing immunity from electrical interference and proven reliability

Plan cabling and containment – Routing & ease of MAC’s critical

Plug & Play solutions - easier and faster to install, but ensure Cabling Engineers are of comparable level to DC Engineers

Manufactured to international standards - interoperability
Innovative products & flexible solutions

Proven product reliability and system performance

Responsive and reliable customer service and technical support

Sustainability policy that provides tangible benefits

THANK YOU
THANK YOU
Kevan Sproston