Data Center Cabling Standards Keeping Pace with Technology Changes
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Updates in TIA-942-A

- We are updating data center cabling standards to keep pace with technology changes
- TIA-942 was recently revised with publication of TIA-942-A
- Recent publication of addendum to TIA-942-A dealing with data center fabrics
- BICSI-002 is undergoing revision with 2014 or 2015 publication
Fit TIA-942 into new TIA cabling standards structure

- In TIA-568-C series, cabling standards were reorganized to permit premises specific standards to be developed without duplication of content.
- TIA-942-A was rewritten to fit into the new structure
Reorganization of TIA standards

- Common Standards
  - ANSI/TIA-568-C.0 (Generic)
  - ANSI/TIA-569-C (Pathways and spaces)
  - ANSI/TIA-606-B (Administration)
  - ANSI/TIA-607-B (Bonding and grounding [earthing])
  - ANSI/TIA-758-B (Outside plant)
  - ANSI/TIA-862-A (Building automation systems)

- Premises Standards
  - ANSI/TIA-568-C.1 (Commercial)
  - ANSI/TIA-570-C (Residential)
  - ANSI/TIA-942-A (Data centers)
  - ANSI/TIA-1005 (Industrial)
  - ANSI/TIA-1179 (Healthcare)
  - ANSI/TIA-4496 (Educational)
  - Not Assigned (Large Buildings)

- Component Standards
  - ANSI/TIA-568-C.2 (Balanced twisted-pair)
  - ANSI/TIA-568-C.3 (Optical fiber)
  - ANSI/TIA-568-C.4 (Broadband coaxial)

Future

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Move content to proper standards

- Reference generic cabling topology, terms, and MICE (mechanical, ingress, climatic, electromagnetic) environmental classifications from **TIA-568-C.0**
- Move bonding & grounding content to **TIA-607-B**
- Move administration & labeling to **TIA-606-B**
- Move racks & cabinets, power and telecom separation, and temperature/humidity requirements to **TIA-569-C**
- Move outside plant pathways to **TIA-758-B**
- **ISO/IEC 11801** series also being reorganized
Reorganization of ISO/IEC standards

- **Common Standards**
  - ISO/IEC 11801-1 Generic cabling requirements
  - ISO/IEC 14763-2 Planning & Installation
  - ISO/IEC 14763-3 Testing of Optical Fiber Cabling

- **Premises Standards**
  - ISO/IEC 11801 (ISO/IEC 11801-2 in next revision) Office premises
  - ISO/IEC 24702 (ISO/IEC 11801-3 in next revision) Industrial Premises
  - ISO/IEC 15018 (ISO/IEC 11801-4 in next revision) Homes
  - ISO/IEC 24764 (ISO/IEC 11801-5 in next revision) Data Centres

- **Technical Reports**
  - ISO/IEC TR 24704 wireless access point cabling
  - ISO/IEC TR 24750 Support of 10GBaseT
  - ISO/IEC 29106 MICE classification
  - ISO/IEC 29125 Remote powering
TIA to match with ISO

- **LC connector** for up to 2 fibers
  (ISO/IEC specifies angled LC for SM at the External Network Interface)
- **MPO connector** for more than two fibers
- Removed 100m channel length limitation for horizontal cabling of fiber
  Now limited by application length restrictions of the type of fiber used
- Match some terminology (ENI, EO)
Higher bandwidths

- Specify higher bandwidth cabling types to support
  - Higher performance systems and applications
  - Higher performance networks (switch fabrics)
  - LAN & SAN convergence
Benefits of LAN/SAN Convergence

- Reduce number of server connections
- Allow use of small servers (blade & 1U) that can’t support large number of adapters
- **Reduce cost and administration** (fewer adapters, fewer switches, less cabling)
- **Simplify support** – Ethernet only (no separate Fibre Channel infrastructure)
- But it requires **high bandwidth** and **low latency** data center LAN
TIA-942-A Higher Bandwidth Copper

- Retained 734/735 coax cable for T-3/E-3
- Removed support for Category 3 and 5e for horizontal cabling, but kept for backbone cabling (WAN, voice, console)
- Category 6 min for horizontal cabling
- Category 6A is recommended
- Category 6A is the minimum in ISO/IEC 24764
10GBase-T

• To support 10GBaseT, Category 6A or better recommended in TIA-942-A and minimum in ISO/IEC 24754
• 10GBase-T will be widely adopted in 2013 and is predicted to be the most widely shipped version of 10G Ethernet in 2014
Factors in adoption of 10Base-T

- Rapidly declining cost
- Improved power efficiency, now <4W, less with short-reach mode (e.g., <2W at 10m)
- Auto-negotiation - backward-compatible with 100M & 1G Ethernet
- Familiar balanced twisted-pair cabling & RJ45 that technicians know how to troubleshoot and terminate
- Flexible configuration and lengths: 2 to 4 connectors, up to 100m
Next Generation Cabling

• IEEE 40GBase-T length target 30 m (~20 cabinets) and will use 2 connector channels (w/auto negotiation to lower speed)

• TIA-568-C.2-1 Category 8 – new balanced TP cable backward compatible w/Category 6A

• ISO/IEC TR 11801-99-1 guidance for cabling in support of 40Gbps transmission specifies
  – 30 m channels for Cat 6A, 7, 7A that can support 40 Gbps
  – 30 m channels using Cat 8.1 (backward compatible w/Cat 6A) or Cat 8.2 components (backward compatible with Cat 7A)
Higher bandwidth optical fiber

- Removed OM1 and OM2 (62.5 µm and non-laser-optimized 50/125 µm multimode fiber)

- **OM3** (50/125 µm laser optimized) is the **minimum** requirement
- **OM4** is **recommended** for more bandwidth and longer lengths
## Ethernet channel lengths over multimode fiber

<table>
<thead>
<tr>
<th>Fiber Type</th>
<th>1G</th>
<th>10G</th>
<th>40G</th>
<th>100G</th>
<th>100G</th>
</tr>
</thead>
<tbody>
<tr>
<td># fibers</td>
<td>2</td>
<td>2</td>
<td>8</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>OM1</td>
<td>275 m</td>
<td>26 m</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>OM2</td>
<td>550 m</td>
<td>82 m</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>OM3</td>
<td>800 m</td>
<td>300 m</td>
<td>100 m</td>
<td>100 m</td>
<td>20 m*</td>
</tr>
<tr>
<td>OM4</td>
<td>1040 m</td>
<td>550 m</td>
<td>150 m</td>
<td>150 m</td>
<td>106 m*</td>
</tr>
</tbody>
</table>

Distances in **red** are specified by manufacturers but not in IEEE standards.

*IEEE 802.3bm Standard for 4-lane 100G target 1Q2015*
40G / 100G over Optical Fiber

- Multimode fiber more cost effective than single-mode for lengths <=150 m
- 40G uses 8 MM fibers and MPO
- 100G uses 20 MM fibers and either two 12 fiber MPOs or one 24 fiber MPO
- 4-lane/8-fiber 100G will cost less and is expected to support at least 20m over OM3, 100m over OM4, and at least 500m over SMF.
Single-mode fiber

• Single-mode needed for:
  – Delivery of circuits from carriers
  – Campus cabling
  – Backbone for large data centers

• Backbone cable lengths >150m will need single mode fiber for 40/100G Ethernet

• 2 SM fibers for current standard (10/40km)

• 4-lane 100G SMF standard in development (500m - 2 km, 2 or 8 fibers – to be determined)

• Next step is 400G Ethernet (in progress)
TIA-942-A Energy Efficiency

• New section on energy efficiency
• Wider range of temperatures and humidity (see TIA-568-C) based on new ASHRAE TC 9.9 guidelines
• Other guidelines for energy efficiency relating to cabling, pathways, and spaces
Energy Efficiency

• 2011/2012 ASHRAE guidelines were adopted (ANSI/TIA-569-C-1)
  – Temperature: 15 – 35 °C (59 – 95 °F)
  – Relative humidity (RH): 20 – 80%

• ESD could be a problem with low humidity (<44% at 18 °C, <25% at 27 °C)

• These are temperatures in the cold-aisles. In hot aisles temperatures could be 55 °C

• Attenuation of balanced pair cables increases at high temperatures (~14% at 55 °C)
Energy Efficiency

• Overhead cabling if under floor space is used for cooling
• Route cables and pathways to minimize interfering with proper airflow
Energy Efficiency

- Avoid exterior windows and sky lights because they create additional heat load

Great building, but not good for a data center
Energy Efficiency

• Cable routing should not compromise efficiency of enclosures - blanking panels, brushes & grommets for cable openings
• Equipment should match airflow design of cabinets (front to back, use baffles for side-to-side cooled equipment)
Energy Efficiency

- Enclosures or enclosure systems:
  - cabinets with isolated supply or return (e.g., chimneys)
  - cabinet cooling system
  - hot or cold aisle containment
Energy Efficiency

• Separate areas for equipment with high power density needs

• Build in phases (modular construction)
Energy Efficiency - Lighting

- Energy efficient lighting such as LED
- 3 Level lighting protocol by zone for data centers depending on human occupancy
  - **Level 1** – no occupants - enough light for cameras
  - **Level 2** – motion to initiate higher level access to provide safe passage & ID by cameras
  - **Level 3** – occupied for work – full lighting 500 lux
Larger and modular data centers

• New TIA-942 space **Intermediate Distribution Area (IDA)** containing the Intermediate Cross-Connect (IC)

• Adopted in ISO/IEC 24764 Addendum 1 as **Intermediate Distributor (ID)**

• Eliminated TIA requirement that centralized optical fiber topologies be limited to one building to accommodate modular data centers using outdoor containers & modules
ISO/IEC JTC 1 SC 39

• New ISO/IEC JTC 1 Subcommittee 39 Sustainability for & by Information Technology

• New projects:
  – Best Practices for Green Data Centers
  – Power Usage Effectiveness (PUE) & Data Center infrastructure Efficiency (DCiE) metrics
  – Secretariat for SC-39

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IDA Example

BASE BUILDING

Entrance Room

Main Distribution Area

Entrance Room

Intermediate Distribution Area

Intermediate Distribution Area

Intermediate Distribution Area

COMPUTER ROOM MODULES EACH WITH THEIR OWN HDA

COMPUTER ROOM MODULES EACH WITH THEIR OWN HDA

OUTDOOR MODULES EACH WITH THEIR OWN HDA

PHASE 1 (INDOOR)

PHASE 2 (INDOOR)

PHASE 3 (OUTDOOR)
Modular data centers

- Outdoor using containers/modules
- Indoor using manufactured modules or by simply building rooms/areas in phases
- Reduce capital expenditures (Capex) and operating expenditures (Opex) by building only what you need when you need it.
- Do not need to pay maintenance and power/cool equipment and rooms that aren’t needed yet.
- Modularity reduces the risk created by uncertainty about the future
Data center switch fabrics

• TIA-942-A addendum 1 (approved for publication Feb 2013) provides guidance regarding cabling for data center switch fabrics
• No standard definition or implementation
• Generally, low-latency switch fabric that is non-blocking, permitting any port to communicate with any other port at the full capacity of the ports
• Cloud computing, virtualization and LAN/SAN convergence are major driving factors
• Backup connections inactive due to spanning tree protocols
• Connections between switches are over-subscribed
• As many as 3 hops between servers
• All switches connected to all other switches in full mesh
• For non-blocking sum of backbone $\geq$ sum of switch bandwidth
• All connections active
• Not suitable for large # of switches
Fat-Tree / Leaf & Spine

- Each access switch connected to every interconnection switch
- Non-blocking if sum backbone bandwidth >= sum server port bandwidth
- All connections active
- More scalable than full-mesh
- Another layer of inter-connection switches can be added for very large data centers
Fat-Tree with Port Extenders

- Same as fat-tree, but with port extenders at top of racks
- May be non-blocking if bandwidth from access switch to port extender $\geq$ sum of bandwidth of server ports
Data center fabrics

• Much **more cabling and higher bandwidth** needed for data center backbones
• Possible need for longer cable runs to connect switches
• **Fabrics can be built using the cabling topology in ANSI/TIA-942-A**
  – May need IDA-to-IDA & HDA-to-HDA cabling
  – Point-to-point cabling in EDAs should be less than or equal 10 m and within a cabinet row
Other convergence

• Structured cabling is being used to support other building systems and should be considered when planning data centers:
  – IP cameras
  – Security systems
  – Building automation/monitoring
  – Possibly even lighting

• See BICSI Electronics Safety & Security Design Reference Manual & TIA-862-A
Summary

• Standards are being updated to support industry changes and new technologies
• Consider future needs to support 10/40/100G to support LAN/SAN convergence, data center fabrics, virtualization
  – Cat 6A or better (e.g. Cat 7/7A) for balanced-pair cable
  – OM4 for multimode fiber (with LC & MPO connectors)
• Consider energy efficiency recommendations
• Build modularly (in phases)
• Consider the impact of data center fabrics
• Consider other systems (e.g. cameras & security) that can use structured cabling
ISO/IEC JTC1 SC25 WG3 Updates

• Automated Infrastructure Management (AIM) addendum to 14763-2 (core & optional AIM functions) and new standard (requirements for device discovery, security management, process mgmt & model for data exchange)

• ISO/IEC 14763-3 Edition 2 testing of optical fibre cabling
  – Improved test methods
  – should testing at 1300 nm be optional? Yes, for now but we may amend future standards to make it optional
ISO/IEC JTC1 SC25 WG3 Updates

• ISO/IEC TR 11801-99-1 - 40Gbps channels – 40Gbps using Cat 6A, 7, 7A, and new Cat 8.1 and Cat 8.2

• New standard in development for equipotential bonding – based on ANSI/TIA-607-B and CENELEC EN 50310

• Twinax cabling (for short IEEE 802.3 connections)

• 3rd Edition of ISO/IEC 11801 & reorganization of related standards (-1 General, -2 Offices, -3 Industrial, -4 Homes, -5 Data Centres)
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