Transforming the Network:
Coming Migration from 10G to 40G to 100G

Mike Connaughton, RCDD, CDCD – Berk-Tek
Two Technology Driven, Best-in-class Manufacturers Delivering the Best Performing Fiber & Copper Systems

Passionate focus on system performance

Flexibility, reliability, scalability
Value-driven solutions

Best-in-class support
Exceeding customer expectations

Leading the industry into the future

Cabling expertise 50+ Years
Connectivity expertise 27+ Years

Berk-Tek & Leviton Confidential
AGENDA

• Market Drivers
• Impact on Data Centers
• Transceiver Choices
• Cabling Solutions
• Questions
AGENDA

• Market Drivers
  • Impact on Data Centers
  • Transceiver Choices
  • Cabling Solutions
  • Questions
In 2018...

• The Internet of Things (IoT) is coming,

what follows, are a few examples of what I mean.

Figures quoted from Cisco VNI Report (6/2014) and Mobile VNI (2/2014)
In 2018...

• we will have 21 Billion IP Devices and connections.

Up from 12 billion in 2013.
In 2018...

• there will be only 7.6 billion of us.

That’s about **three (3) devices** for every person on earth.
In 2018...

• nearly a million minutes of video content will cross IP networks,
In 2018...

• nearly a million minutes of video content will cross IP networks, every second.
In 2018...

• global IP traffic will be 132 Exabytes per month.

All words ever spoken would consume ≈5 Exabytes*.

*Roy Williams, Data Power of 10; Cisco VNI (6/14)
### Exabyte?

<table>
<thead>
<tr>
<th>Name</th>
<th>Numerical</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Kilobyte</td>
<td>1000</td>
<td>Thousand Bytes</td>
</tr>
<tr>
<td>Megabyte</td>
<td>1000²</td>
<td>Million Bytes</td>
</tr>
<tr>
<td>Gigabyte</td>
<td>1000³</td>
<td>Billion Bytes</td>
</tr>
<tr>
<td>Terabyte</td>
<td>1000⁴</td>
<td>Trillion Bytes</td>
</tr>
<tr>
<td>Petabyte</td>
<td>1000⁵</td>
<td>Quadrillion Bytes</td>
</tr>
<tr>
<td>Exabyte</td>
<td>1000⁶</td>
<td>Quintillion Bytes</td>
</tr>
<tr>
<td>Zettabyte</td>
<td>1000⁷</td>
<td>Sextillion Bytes</td>
</tr>
<tr>
<td>Yottabyte</td>
<td>1000⁸</td>
<td>Septillion Bytes</td>
</tr>
</tbody>
</table>
In 2018...

• “only” 18% of global IP traffic will be business related, ≈24 exabytes per month.
In 2018...

- the world will be different,....

are you ready?
AGENDA

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Flatter Network Architectures

- Trends driving change in architectures:
  - Server Virtualization
  - Cloud Computing
  - Latency Concerns
  - Software Defined Networks
  - Mobile devices apps
- Most leading equipment manufacturers have responded with new equipment & new network architectures
- Network designs moving from the traditional 3-tier to:
  - 2-tier: Fat Tree or Leaf Spine
  - 1-tier: Collapsed Spine
- Moving back to using End of Row (EoR) topology in addition to Top of Rack (ToR)
TIA-942-A-1: Traditional Data Center Architecture

**Figure 1: Example of traditional three-tier data center switch architecture**

This content, from the draft ANSI/TIA-942-A-1 Standard, Telecommunications Infrastructure Standard for Data Centers, is reproduced under written permission from Telecommunications Industry Association.
**Fat-Tree (Leaf/Spine) Architecture – Per TIA**

- Reduces Costs, complexity and power
- Reduces Latency
- Very scalable

**ANSI/TIA-942-A-1: Fat Tree (or Leaf Spine)**

- Interconnection Switches (Spine switches) Typically in MDAs, but may be in IDAs
- Access Switches (Leaf switches) in HDAs for End/Middle of Row or EDAs for Top of Rack

**Servers in EDAs** (server cabinets)

**LEGEND:**

- Active Switch-to-Switch Connections
- Server Connections
- Switch
- Servers
- Repeated Components
10G is becoming the dominant port speed

40G is becoming adopted but 25G could soon overtake it

Think about not just the 10G applications but where you might go in the future with 25, 50 and 100G
High Density Switches supporting 10GBASE-T

- **Arista 7300 Series**
  - 4, 8 & 16-slot Chassis
  - 8RU, 13RU, 21RU

- **New Line cards**
  - 32 x 40G or 128 x 10G
  - 48 x 10G/4 x 40G
  - 48 x 10GBASE-T/4x40G

- **High Density**
  - 2,048 x 10GbE ports
  - 512 x 40GbE ports
  - 768 x 10GBASE-T ports

- **Low Power**
  - 10GBASE-T under 5W
Servers with 10GBASE-T I/O options

- Servers
- Dell PowerEdge™
- Cisco UCS Rack Servers
- HP ProLiant™
- IBM System X

Network Adapters
- Broadcom BCM957810A 1008G
- Intel® Ethernet Converged Network Adapter X540-T2
- Oracle® Sun Dual Dual Port 10GBASE-T networking card
- Solarflare™ SFN5161T Dual-Port 10GBASE-T Performant Server Adapter
Cabling for End of Row (EoR) Architecture

- 8 server cabinets (6 shown) w/48 ports per cabinet
- 1 Arista 7308 EoR Switch = 384 copper ports

40G Fiber Uplinks

384 CAT 6A Cables

Cabinets 7 & 8
Cabling for Middle of Row (MoR) Architecture

- 32 server cabinets w/ 48 copper ports per cabinet
- 2 Arista 7316 MoR switches = 1,536 copper ports

40G Fiber Uplinks

1,536 CAT 6A Cables distributed to 32 cabinets
Why is 10GBase-T in EoR is a Good Option Now

- 10GBase-T offers deployment flexibility
  - Increased distance and cabling topology
  - Allows for interoperability

- 10GBase-T offers compatibility
  - Backwards compatibility from 100Mb to 10Gb and up to the soon to be new 40GBASE-T standard (as well as 25G)

- 10GBase-T offers energy savings
  - Higher switch port utilization
  - Enables Energy Efficient Ethernet (EEE) deployment
  - Decreasing overall power consumption

- 10GBase-T offers Lower Installed Cost
  - Lower cost patch cords
Mfrs are Recommending ToR or EoR Designs
Cabling for Top-of-Rack (ToR) Architecture

- 4 Arista 7308 switches supporting 256 cabinets with ToR switches
- 1,024 x 40G-SR4 Channels (12,288 fibers) all in one fiber patching frame
AGENDA

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Optical Transceiver Form Factors

- **SFP+**
  - Supports 1G, 10GbE
  - Max Density per 1U: 48

- **QSFP+, QSFP28**
  - Supports 40G, 100G
  - Max Density per 1U: 36

- **CFP, CFP2**
  - Supports 100G
  - Max Density per 1U: 6

- **CPAK (Cisco Only)**
  - Supports 40G, 100G
  - Max Density per 1U: 12
## 40G Optics Choices

<table>
<thead>
<tr>
<th>Transceiver</th>
<th>Form Factor</th>
<th>Fiber Type</th>
<th>Distance</th>
<th># of fibers</th>
<th>Connector</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>40G-SR4</td>
<td>QSFP+</td>
<td>OM3/OM4</td>
<td>100m/150m</td>
<td>8</td>
<td>12F MTP</td>
<td>1.5 W</td>
</tr>
<tr>
<td>40G-eSR4</td>
<td>QSFP+</td>
<td>OM3/OM4</td>
<td>300m/400m</td>
<td>8</td>
<td>12F MTP</td>
<td>1.5 W</td>
</tr>
<tr>
<td>40G-LRL4</td>
<td>QSFP+</td>
<td>OS2</td>
<td>1 km/2km</td>
<td>2</td>
<td>LC</td>
<td>3.5 W</td>
</tr>
<tr>
<td>40G-LR4</td>
<td>QSFP+</td>
<td>OS2</td>
<td>10 km</td>
<td>2</td>
<td>LC</td>
<td>3.5 W</td>
</tr>
<tr>
<td>40G-PLRL4/4x10-IR (Arista/Juniper)</td>
<td>QSFP+</td>
<td>OS2</td>
<td>1 km</td>
<td>8</td>
<td>12F MTP</td>
<td>3.5 W</td>
</tr>
<tr>
<td>40G-PLR4</td>
<td>QSFP+</td>
<td>OS2</td>
<td>10 km</td>
<td>8</td>
<td>12F MTP</td>
<td>3.5 W</td>
</tr>
<tr>
<td>40G-SR-BD (Cisco)</td>
<td>QSFP+</td>
<td>OM3/OM4</td>
<td>100/150m</td>
<td>2</td>
<td>LC</td>
<td>3.5 W</td>
</tr>
<tr>
<td>40G-LX4 (Juniper)</td>
<td>QSFP+</td>
<td>OM3/OM4</td>
<td>100/150m</td>
<td>2</td>
<td>LC</td>
<td>3.5 W</td>
</tr>
<tr>
<td>40G-UNIV (Arista)</td>
<td>QSFP+</td>
<td>OM3/OM4</td>
<td>150/150m/500m</td>
<td>2</td>
<td>LC</td>
<td>3.5 W</td>
</tr>
</tbody>
</table>
## 100G Optics Choices

<table>
<thead>
<tr>
<th>Transceiver</th>
<th>Form Factor</th>
<th>Fiber Type</th>
<th>Distance</th>
<th># of fibers</th>
<th>Connector</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>100G-SR10 MXP (Arista)</td>
<td>Embedded</td>
<td>OM3, OM4</td>
<td>100m, 150m</td>
<td>24</td>
<td>24F MTP</td>
<td>12W*</td>
</tr>
<tr>
<td>100G-SR10</td>
<td>CFP2</td>
<td>OM3, OM4</td>
<td>100m, 150m</td>
<td>20</td>
<td>24F MTP</td>
<td>12W</td>
</tr>
<tr>
<td>100G-SR4</td>
<td>QSFP28</td>
<td>OM3, OM4</td>
<td>70m, 100m</td>
<td>8</td>
<td>12F MTP</td>
<td>3.5W</td>
</tr>
<tr>
<td>100G-LR4 NEW</td>
<td>QSFP28</td>
<td>OS2</td>
<td>10km</td>
<td>2</td>
<td>LC</td>
<td>6W</td>
</tr>
<tr>
<td>100G-LR4</td>
<td>CFP2, CPAK</td>
<td>OS2</td>
<td>10km</td>
<td>2</td>
<td>LC, SC</td>
<td>12W, 6.75W</td>
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<tr>
<td>10x10-LR NEW (Cisco)</td>
<td>CPAK</td>
<td>OS2</td>
<td>1km</td>
<td>20</td>
<td>24F MTP</td>
<td>4.5W</td>
</tr>
</tbody>
</table>
Power: The ‘Cascade’ Effect

1 Watt saved at the electronic component level results in cumulative savings of about 2.84 Watts in total consumption.

Source: DVL
AGENDA

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• Transceiver Choices

• Cabling Solutions

• Questions
High Density Cabling solutions
6A Cable is getting smaller

- Innovative noise cancelling XTP technology
  - Best in class alien crosstalk performance
- Supports both short and long channels
  - Maximizes system design flexibility
- Reduced cable size – 0.275” (6.99mm)
  - Increases density and manageability
- Improves pathway space and fill ratios
- Improves operational cooling
  - Less cable bulk in congested cabinet space
- No alien crosstalk testing required
  - Reduces installation labor costs
# Copper Cable Density Comparison

<table>
<thead>
<tr>
<th>8 Cabinet Row</th>
<th># of cables</th>
<th>4 X 12 Cable Trays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Cat 6A UTP</td>
<td>384</td>
<td>2</td>
</tr>
<tr>
<td>Reduced Diameter 6A</td>
<td>384</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>32 Cabinet Pod</th>
<th># of cables</th>
<th>4 X 12 Cable Trays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Cat 6A UTP</td>
<td>768</td>
<td>3</td>
</tr>
<tr>
<td>Reduced Diameter 6A</td>
<td>768</td>
<td>2</td>
</tr>
</tbody>
</table>
Fiber Cable OD Comparison

### 48 Fiber
- **Best in Class Cable** (0.231"")
- **Industry Typical Cable** (0.370"")
- **Stacked Ribbon Cable** (0.520"")

### 96 Fiber
- **Best in Class Cable** (0.316"")
- **Improved Cable** (0.470"")

40% to 60% improvements are possible
Advantages in the Cable Tray

<p>| Capacity of a 4&quot; by 12&quot; Tray |
|-------------------------------|------------------|------------------|</p>
<table>
<thead>
<tr>
<th>Cable Type</th>
<th># of cables</th>
<th>Fiber Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDP24</td>
<td>943</td>
<td>22632</td>
</tr>
<tr>
<td>CCS 24</td>
<td>339</td>
<td>8136</td>
</tr>
<tr>
<td>LTP24</td>
<td>223</td>
<td>5352</td>
</tr>
<tr>
<td>MDP96</td>
<td>306</td>
<td>29376</td>
</tr>
<tr>
<td>CCS96</td>
<td>138</td>
<td>13248</td>
</tr>
<tr>
<td>LTP96</td>
<td>107</td>
<td>10272</td>
</tr>
</tbody>
</table>

Smallest cable provides the greatest cable density:

- Takes the least amount of tray space
- Can provide a 4x increase in capacity
- Enables minimal impact to strained infrastructure

![Graph showing cable density comparison]

- **Best in Class**
- **Improved**
- **Typical**
Advantages in Vertical Managers

- Best in Class
- Improved
- Typical

### Capacity of a 5" Vertical Manager

<table>
<thead>
<tr>
<th>Cable Type</th>
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<th>Fiber Count</th>
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<tbody>
<tr>
<td>MDP24</td>
<td>235</td>
<td>5640</td>
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<tr>
<td>CCS 24</td>
<td>84</td>
<td>2016</td>
</tr>
<tr>
<td>LTP24</td>
<td>55</td>
<td>1320</td>
</tr>
<tr>
<td>MDP96</td>
<td>76</td>
<td>7296</td>
</tr>
<tr>
<td>CCS96</td>
<td>34</td>
<td>3264</td>
</tr>
<tr>
<td>LTP96</td>
<td>26</td>
<td>2496</td>
</tr>
</tbody>
</table>

Bar chart showing the capacity comparison with 4X improvement for MDP24.
Where are the constraints?

**“Arista” Density**  \(4 \times 7508E = 9216\) fibers

<table>
<thead>
<tr>
<th>24-strand</th>
<th>Cables required</th>
<th>4 x 8 tray capacity</th>
<th>4 x 12 tray capacity</th>
<th>Cable Port capacity</th>
<th>Vertical Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best</td>
<td>384</td>
<td>628</td>
<td>754</td>
<td>322</td>
<td>235</td>
</tr>
<tr>
<td>Improved</td>
<td>384</td>
<td>187</td>
<td>271</td>
<td>216</td>
<td>84</td>
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<td>96</td>
<td>198</td>
<td>306</td>
<td>104</td>
<td>76</td>
</tr>
<tr>
<td>Improved</td>
<td>96</td>
<td>92</td>
<td>138</td>
<td>48</td>
<td>34</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>144-strand</th>
<th>Cables required</th>
<th>4 x 8 tray capacity</th>
<th>4 x 12 tray capacity</th>
<th>Cable Port capacity</th>
<th>Vertical Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best</td>
<td>64</td>
<td>157</td>
<td>188</td>
<td>80</td>
<td>58</td>
</tr>
<tr>
<td>Improved</td>
<td>64</td>
<td>84</td>
<td>101</td>
<td>44</td>
<td>31</td>
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</tbody>
</table>
Where are the constraints?

“Arista” Density (4 x 7508E = 9216 fibers)

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<td>84</td>
<td>101</td>
<td>44</td>
<td>31</td>
</tr>
</tbody>
</table>
Grow as you go!

- We are not suggesting that 10,000 fibers need to be installed on Day 1

- But smaller cables allow the existing infrastructure investment to be efficiently utilized as more switch capacity is added.
  - Existing basket tray will still be useable
  - Minimize cabinet penetrations to optimize airflow isolation
Extended Reach Solutions

- For 10G-SR... 600 meters vs. standard OM4 of 550 meters

- For 40G-SR4 or 100G-SR10... 300 meters vs. standard OM4 of 150 meters!
  - With Max of 1.0 dB connector IL

- Highest bandwidth fiber available!
New Violet OM4+ Fiber Solution

- End-to-end color differentiation for latest fiber technology
  - Differentiate OM3/OM4 and OM4+ cabling in existing installations
  - Better manage MACs and tech refreshes
- First leading U.S. Fiber Solution manufacturer to offer
- Industry leading density using MDP cabling and the HDX connectivity
- OM4+ Violet System Components
  - Violet Cable in MDP Trunks, Harnesses & Cords
  - Cable stocked at both BT & Leviton
  - E2XHD, HDX and Opt-X Cassettes with Violet LC’s
  - Adapter Plate with Violet LC’s
Maximize Density in Existing Rackspace

- The highest density fiber optic patching enclosure available, engineered for easy network manageability.
- Maximize space usage and solve challenges associated with typical high-density systems.
- Up to 100% more density than Opt-X enclosures.
- Cable routing and management features.
- Highlighted port identification features.

<table>
<thead>
<tr>
<th>RU Size</th>
<th>Max LC</th>
<th>Max SC</th>
<th>Max MTP (12f / 24f)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>144</td>
<td>72</td>
<td>864/1,728</td>
</tr>
<tr>
<td>2</td>
<td>288</td>
<td>144</td>
<td>1,728/3,456</td>
</tr>
<tr>
<td>4</td>
<td>576</td>
<td>288</td>
<td>3,456/6,912</td>
</tr>
</tbody>
</table>
High Density Fiber in the MDA

- Complete patching system for high-density fiber in the Main Distribution Area (MDA)

- 3,168 (LC) or 15,552 (MTP) fibers in a 2x2’ tile

- Customers can save over $100K per year by minimizing floor space

- Ideal for large web-scale, Enterprise and Co-lo data centers
Migration Strategies for 40/100G
Migration Plan for 40/100G Networks

10G
Leviton components for a 10G channel include 24-fiber MTP-LC modules and LC duplex patch cords.

40G
Migration from 10G to a 40G system replaces LC with MTP components, such as 2 x12-fiber to 3x3-fiber MTP modules and 8-fiber MTP array cords.

100G
Moving from 40G to 100G replaces MTP modules with MTP adapter plates and uses 24-fiber MTP array cords.

COLOR-CODED BOOTS ON MTP
Red: 24 Fiber
Aqua: 13 Fiber
Gray: 8 Fiber
24F MTP backbone

- Provides Duplex (2-fiber) connections at equipment
- Will support 1G/10GbE in SFP+ form factors OR
- Will also support 40G using Wave Division Multiplexing Technology (WDM) like the Cisco BiDi in QSFP+ form factors
40G-SR4 or 100G-SR4 Channel

- Same 24F MTP Backbone stays in place
- Swap out MTP-LC cassettes for MTP-MTP conversion cassettes
- Provides Parallel (8-fiber) connections at equipment
- Will support 40GBASE-SR4/eSR4 in QSPF+ form factor
- Will support 100GBASE-SR4 in QSFP+ form factor
100G-SR10 or MXP Channel

- Same 24F MTP Backbone stays in place
- Swap out MTP-LC/MTP-MTP cassettes with MTP pass-thru cassettes
- Provides Parallel (20 or 24-fiber) connections at equipment
- Will support 100GBASE-SR10 in CFP2/CPAK form factors OR
- Will support an Arista MXP 120G embedded optics port
The Internet of Things will continue to drive bandwidth demand

The Data Center needs to enable faster access to more information

Design decisions need to be made regarding the most economical way to provide connectivity

Product decisions impact maintenance and energy costs

Cabling volume in all layers is increasing, high density options are critical

It is important to design your network today to allow for easy migration to 40 & 100G
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Contact Information

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Email: mike.connaughton@nexans.com