From the Grid to the Gridiron:
Gaining Network Stability in Stadiums and Other Large Venues
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2020 BICSI WINTER  
Conference & Exhibition
Large Venues: Not Your Ordinary Project
Planning Considerations

- Coverage area (sq meters/miles)
- Number of devices on network
- Number of networks
- Overall costs (CAPEX and OPEX)
  - Who’s paying the bill?
  - Revenue opportunities?
- Bandwidth
- Temporary bandwidth
- Security
Every Site Has Unique Challenges

- Size
- Shape
- Capacity
- Architecture
- Location
Need For Robust and Reliable Wi-Fi

• High-density public venues

• New connections joining the Wi-Fi network

• How the world engages with Wi-Fi networks, demand for advanced Wi-Fi technologies

• “High-resolution video streaming, Wi-Fi calling, smart home monitoring, hotspot access, automation of citywide services, residential AR/VR applications and seamless roaming” [Source: Wi-Fi Alliance]

• IP-enabled intelligent buildings confirm how Wi-Fi will continue to be the connectivity of the future.
Multi-Layered Networks

The Fans
Service, Food & Merchandise
Emergency Services
Security and Police
The Team
Media Coverage
Facility Operators
Other Unique Needs

Large Venue
Topology
Topology of the Network

- **Goal:** To maintain a star-wired network topology
  - Distance makes it difficult to maintain
  - Intermediate points must be utilized
- **All wireless access points must be wired!**
- **Wireless access point zones**
  - Normal coverage areas
  - Heavily used spots
  - Revenue opportunities
Star-Wired Network

Service Providers
(Horizontal Cables)
Cable Management
More Power = More Heat

<table>
<thead>
<tr>
<th>Amendment</th>
<th>Year</th>
<th>PD Type</th>
<th>PSE Input Power</th>
<th>PD Input Power</th>
<th>Maximum Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE802.3af</td>
<td>2003</td>
<td>Type 1</td>
<td>15.4 Watts</td>
<td>12.95 Watts</td>
<td>350 mA</td>
</tr>
<tr>
<td>IEEE802.3at</td>
<td>2009</td>
<td>Type 2</td>
<td>30 Watts</td>
<td>25.50 Watts</td>
<td>600 mA</td>
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<tr>
<td>IEEE802.3bt</td>
<td>2018</td>
<td>Type 3</td>
<td>60 Watts</td>
<td>51 Watts*</td>
<td>600 mA/pair</td>
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<tr>
<td></td>
<td></td>
<td>Type 4</td>
<td>90 Watts</td>
<td>71 Watts*</td>
<td>960 mA/pair</td>
</tr>
</tbody>
</table>

*Note: IEEE802.3bt includes Extended Power capability allowing PD Input Power to increase when channel length is less than 100 m.
### 2017 NEC Limits Cable Bundle Sizes

Table 725.144 Ampacities of Each Conductor in Amperes in 4-Pair Class 2 or Class 3 Data Cables Based on Copper Conductors at an Ambient Temperature of 30°C (86°F) with All Conductors in All Cables Carrying Current, 60°C (140°F), 75°C (167°F), and 90°C (194°F) Rated Cables

<table>
<thead>
<tr>
<th>AWG</th>
<th>Temperature Rating (°C)</th>
<th>Number of 4-Pair Cables in a Bundle</th>
<th>1</th>
<th>2-7</th>
<th>8-19</th>
<th>20-37</th>
<th>38-61</th>
<th>62-91</th>
<th>92-192</th>
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<tbody>
<tr>
<td></td>
<td>60</td>
<td>75</td>
<td>90</td>
<td></td>
<td>60</td>
<td>75</td>
<td>90</td>
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<td>26</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.7</td>
<td>0.8</td>
<td>1</td>
<td>0.5</td>
<td>0.6</td>
<td>0.7</td>
</tr>
<tr>
<td>24</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1.4</td>
<td>1.6</td>
<td>1.6</td>
<td>0.8</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>23</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>1.2</td>
<td>1.5</td>
<td>1.7</td>
<td>0.8</td>
<td>1.1</td>
<td>1.2</td>
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<tr>
<td>22</td>
<td>3</td>
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<td>1.4</td>
<td>1.8</td>
<td>2.1</td>
<td>1</td>
<td>1.2</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Note 1: For bundle sizes over 192 cables, or for conductor sizes smaller than 26 AWG, ampacities shall be permitted to be determined by qualified personnel under engineering supervision.

Note 2: Where only half of the conductors in each cable are carrying current, the values in the table shall be permitted to be increased by a factor of 1.4.

Informational Note: The conductor sizes in data cables in widespread use are typically 22-26 AWG.

https://www.nfpa.org/NEC/About-the-NEC/Free-online-access-to-the-NEC-and-other-electrical-standards
WAP and Enclosure Considerations
Access Point Considerations

- Aesthetics in architecturally sensitive areas
- Mounting in horizontal orientation
- Mounting for quick and easy serviceability
- Open or high ceilings
- Outdoor protection WAP: NEMA 4
- Outdoor protection: Enclosures
- Under seating and balconies
Architecturally Sensitive Areas

Conceal or blend the Wi-Fi access points into the environment

Anywhere!!
Mounting the access points with integrated antennas in the preferred horizontal orientation will permit full performance of the AP. This is always recommended by the manufacturer.
Serviceability Method: Quick and Easy

- Interchangeable doors for quick, easy upgrades

- Rapid access to the AP and the cabling components can help reduce time and cost.

- Choose a method of installation that offers a quick migration path to future AP upgrades
Open or High Ceiling Venues
NEMA 4: Outdoor Protection

When extending the Wi-Fi infrastructure from indoors to outdoors, physically secure and protect the AP and components from weather, impact and vandalism.
Outdoor Protection Enclosures
Under Seating and Balconies - NEMA 4
Chase Center
San Francisco

Challenge:
- Major carrier planning connectivity in a major sports and events arena with a maximum capacity of more than 18,000
- Large sector requirements
- With new technologies/frequencies on horizon, what network will be ready for the future when building infrastructure today?

Solution:
- The Corning® Optical Network Evolution (ONE™) Solution – fiber to the antenna | edge
- Design approach
  - 70 sectors total | 46 in the bowl
  - High and mid-band: Under seating
  - Low-band: Overhead
- 1:1 RAU (low power remote) to antenna
  - Eased optimization and tuning
  - 3.5 and 5 GHz ready
- MRU (mid-power) serving back of house and mechanical areas
- Day 1 millimeter wave – Ericsson NR (28 GHz mmwave)
- 2 carriers headend on site | 2 offsite
- Future planning
  - Fiber
  - Digital electricity
Let’s Discuss
Questions?
Thank You!