From the Grid to the Gridiron:

Gaining Network Stability in Stadiums and Other Large Venues

Anne Berlin
Chatsworth Products
Power Business Development, Industrial

Chip Foley
TruAccess Networks
Chief Business Officer

Jessica Koch
Corning Optical Communications
Business Development Director, Sports and Entertainment

Julie LeClair, RCDD
Henderson Engineers
Director of Network Design

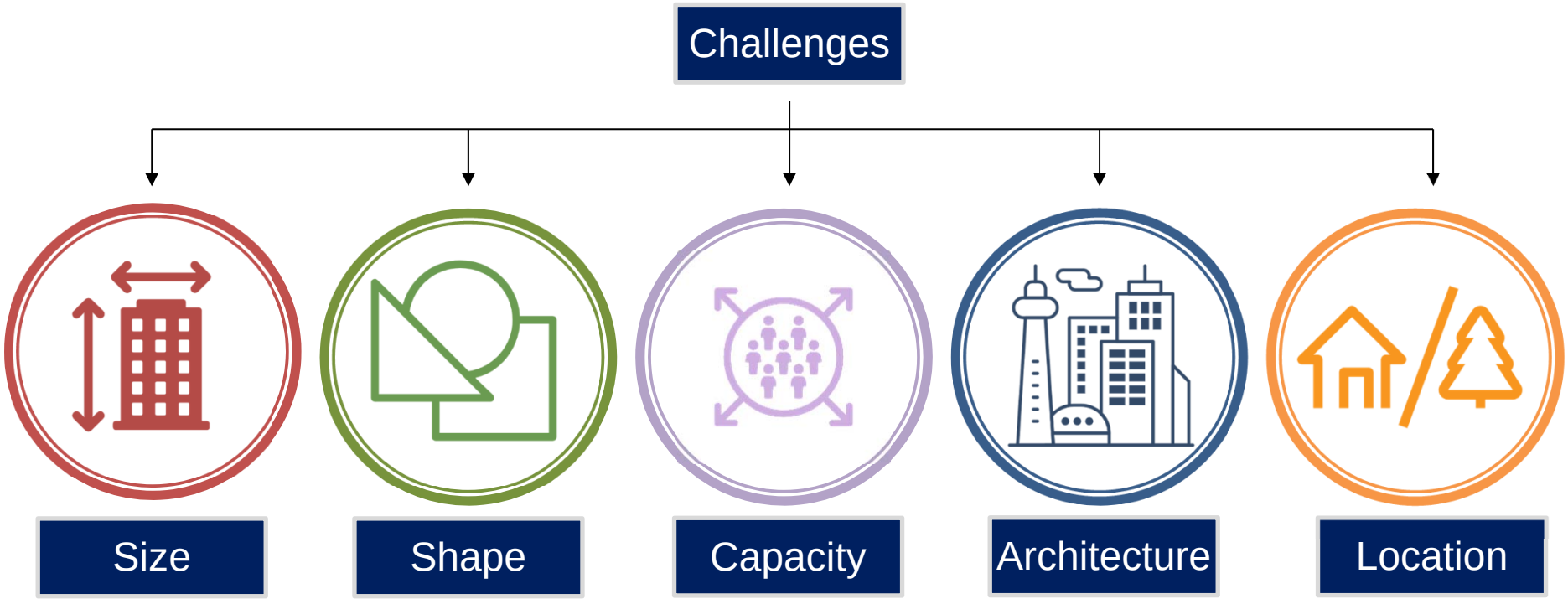
Sam Rodriguez
Chatsworth Products
Sr. Product Manager, Industrial Solutions

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

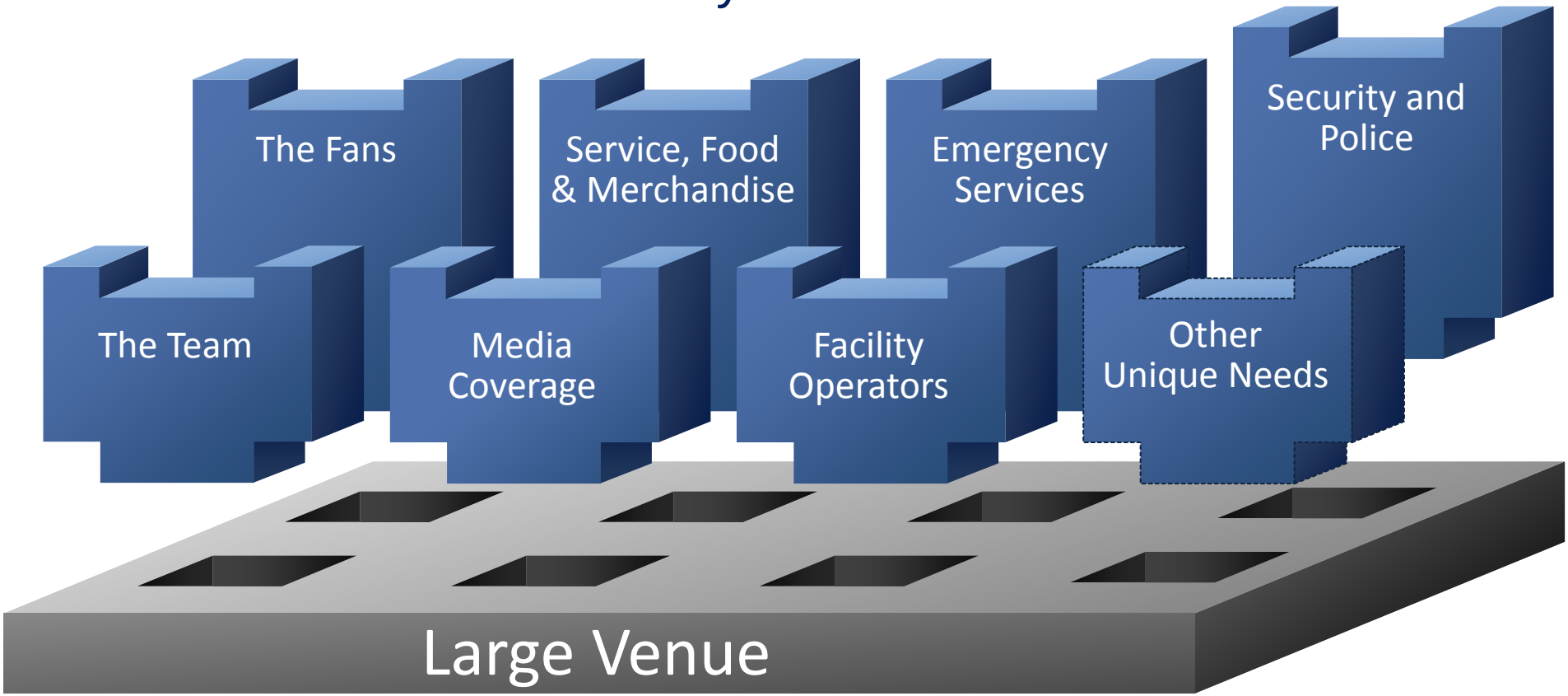
Every Site Has Unique Challenges



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

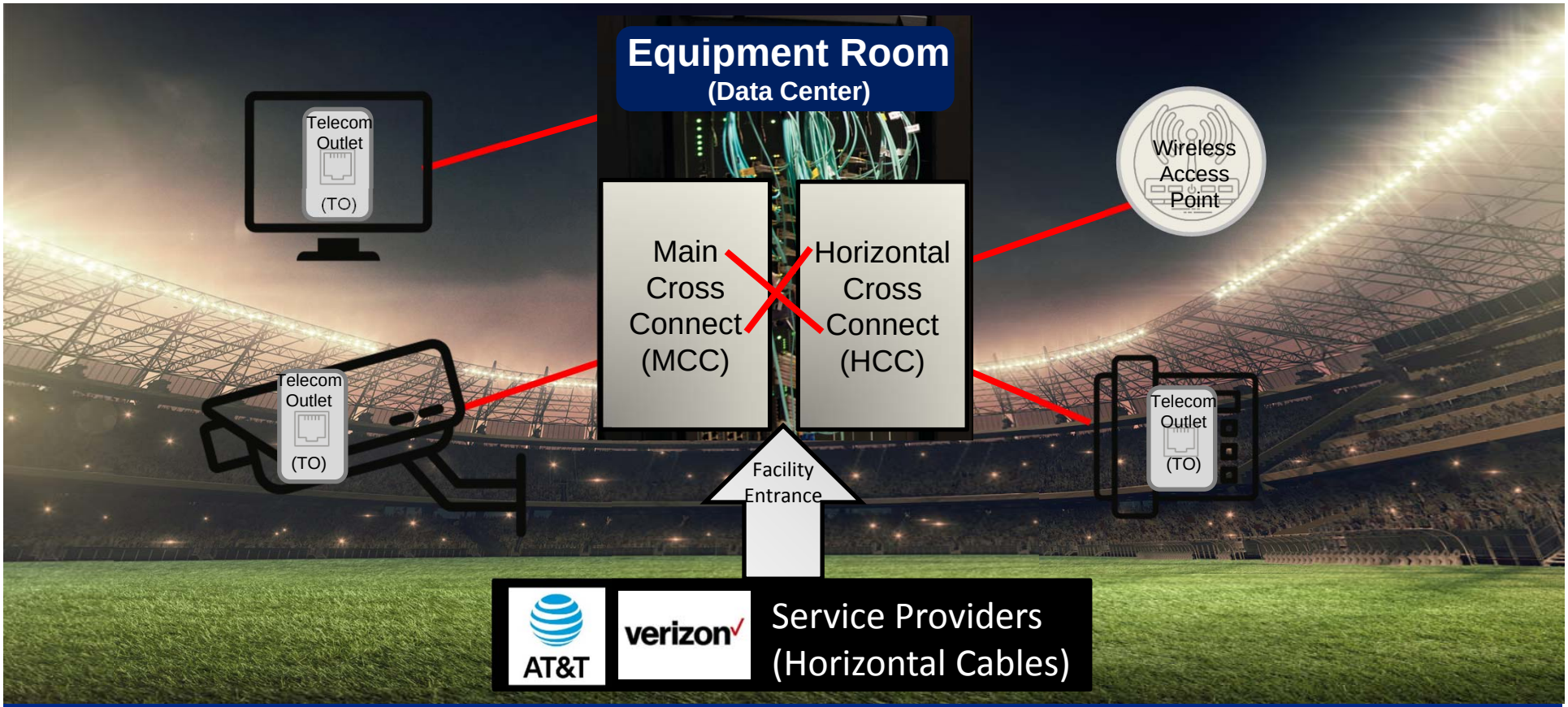


Topology

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



Cable Management

More Power = More Heat

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

*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

	Number of 4-Pair Cables in a Bundle																				
	1			2–7			8–19			20–37			38–61			62–91			92–192		
AWG	Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating		
	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C
26	1	1	1	1	1	1	0.7	0.8	1	0.5	0.6	0.7	0.4	0.5	0.6	0.4	0.5	0.6	NA	NA	NA
24	2	2	2	1	1.4	1.6	0.8	1	1.1	0.6	0.7	0.9	0.5	0.6	0.7	0.4	0.5	0.6	0.3	0.4	0.5
23	2.5	2.5	2.5	1.2	1.5	1.7	0.8	1.1	1.2	0.6	0.8	0.9	0.5	0.7	0.8	0.5	0.7	0.8	0.4	0.5	0.6
22	3	3	3	1.4	1.8	2.1	1	1.2	1.4	0.7	0.9	1.1	0.6	0.8	0.9	0.6	0.8	0.9	0.5	0.6	0.7

Cat 5e

Cat 6, 6A

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 wide-spread use are typically 22–26 AWG.

70 –614 NATIONAL ELECTRICAL CODE 2017 Edition

Source: [NFPA 70, 2017 National Electrical Code](https://www.nfpa.org/NEC/About-the-NEC/Free-online-access-to-the-NEC-and-other-electrical-standards). Used with permission.
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

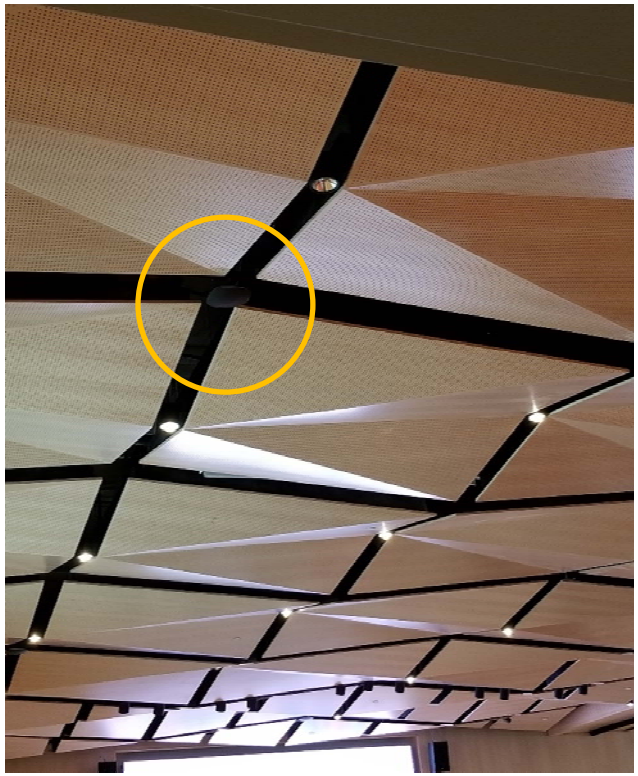
Open or high ceilings

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!!

Access Points Mounting

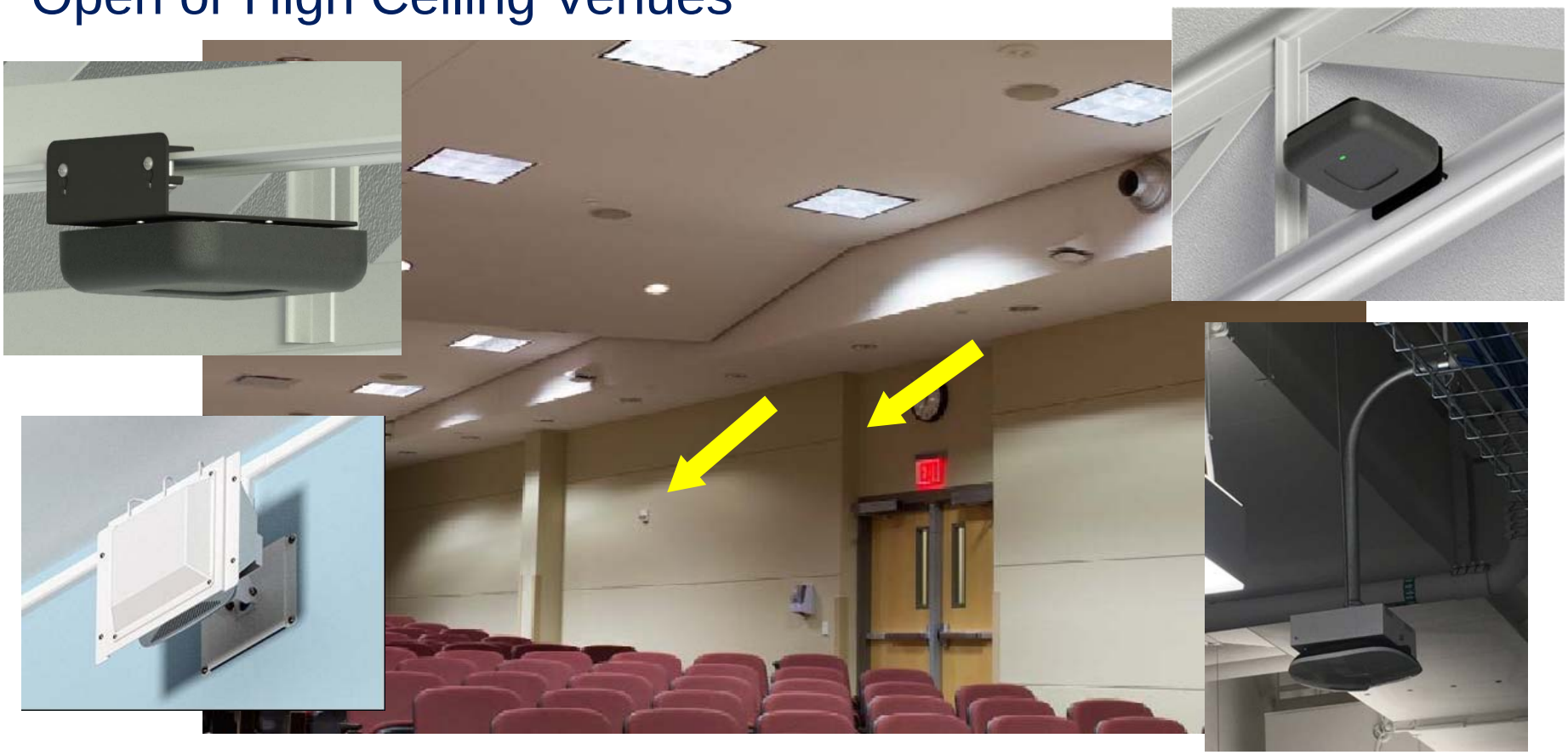
Mounting the access points with integrated antennas in the preferred horizontal orientation will permit full performance of the AP. This is always recommended by the manufacturer.

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

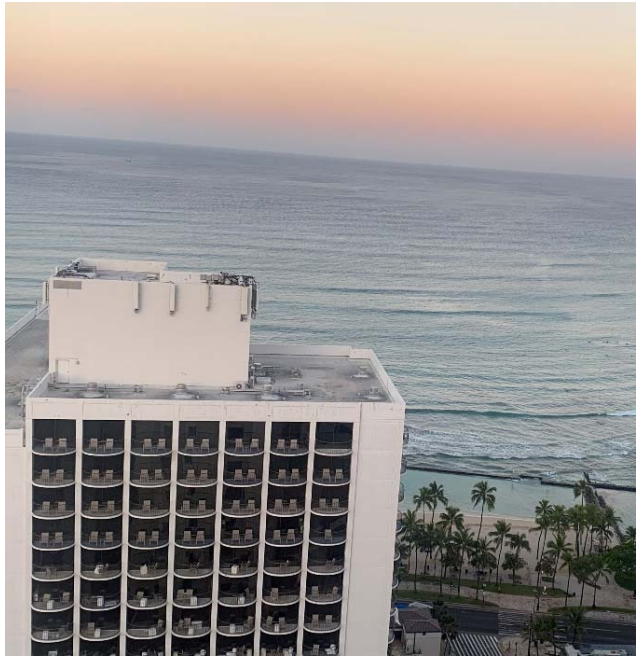
Open or High Ceiling Venues



NEMA 4: Outdoor Protection

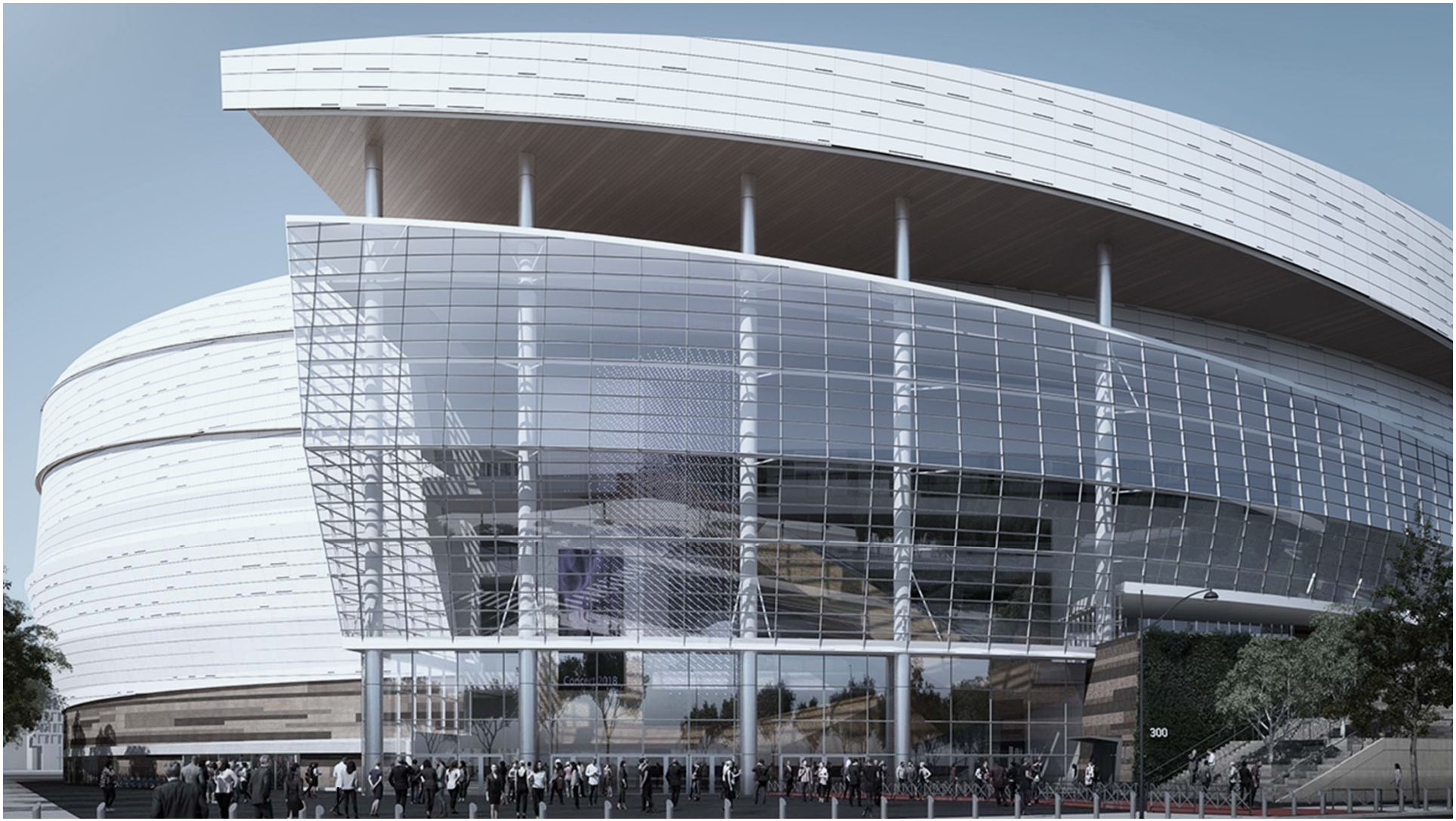
When extending the Wi-Fi infrastructure from indoors to outdoors, physically secure and protect the AP and components from weather, impact and vandalism.

Outdoor Protection Enclosures



Under Seating and Balconies - NEMA 4

Case Study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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!