



# Stadium Wi-Fi Deployments

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# Reaching New Heights

- Extreme Networks is the #1 provider of stadium-class high density Wi-Fi
- Extreme is the official Wi-Fi analytics provider of the NFL
- Extreme delivers robust connectivity with fewer access points

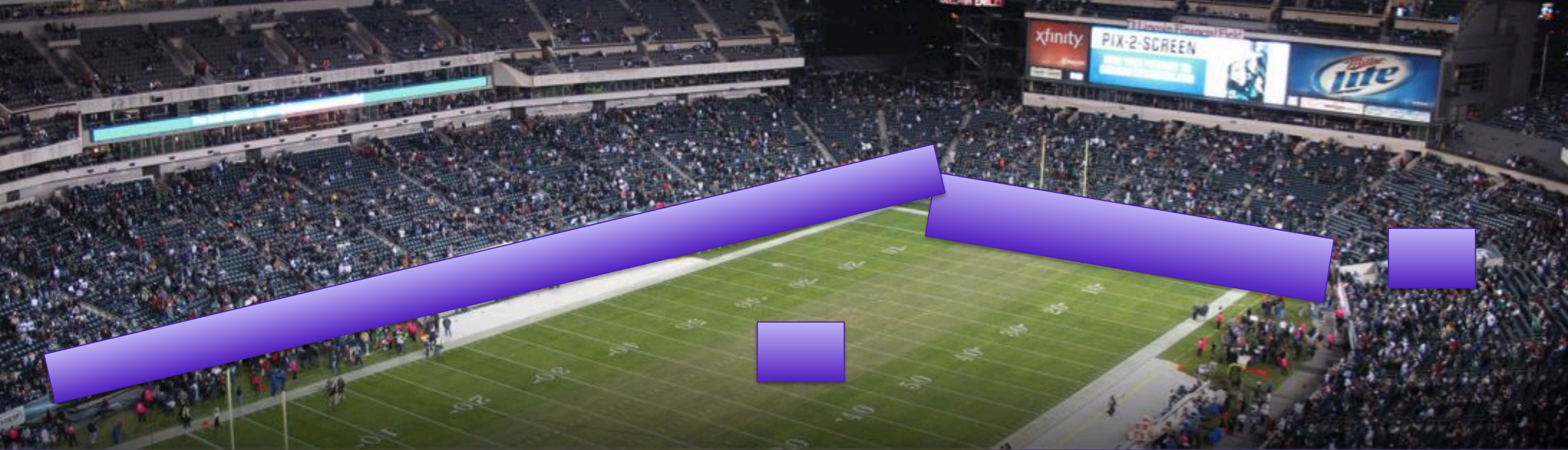




# Experience Driven

- Stadium Wi-Fi is not about technology; its about fan experience
- Wi-Fi enables new experiences for fans – its an incursion
- You can't build when the fan asks for it
- Failure is costly – worse than having no Wi-Fi? bad Wi-Fi!





# Why So Challenging?

- 70,000+ people in the building
- You cannot recreate the scenario in an empty stadium
- No two stadiums are identical
- Same IT expectations – small shops – holistic visibility, reliability, control are crucial





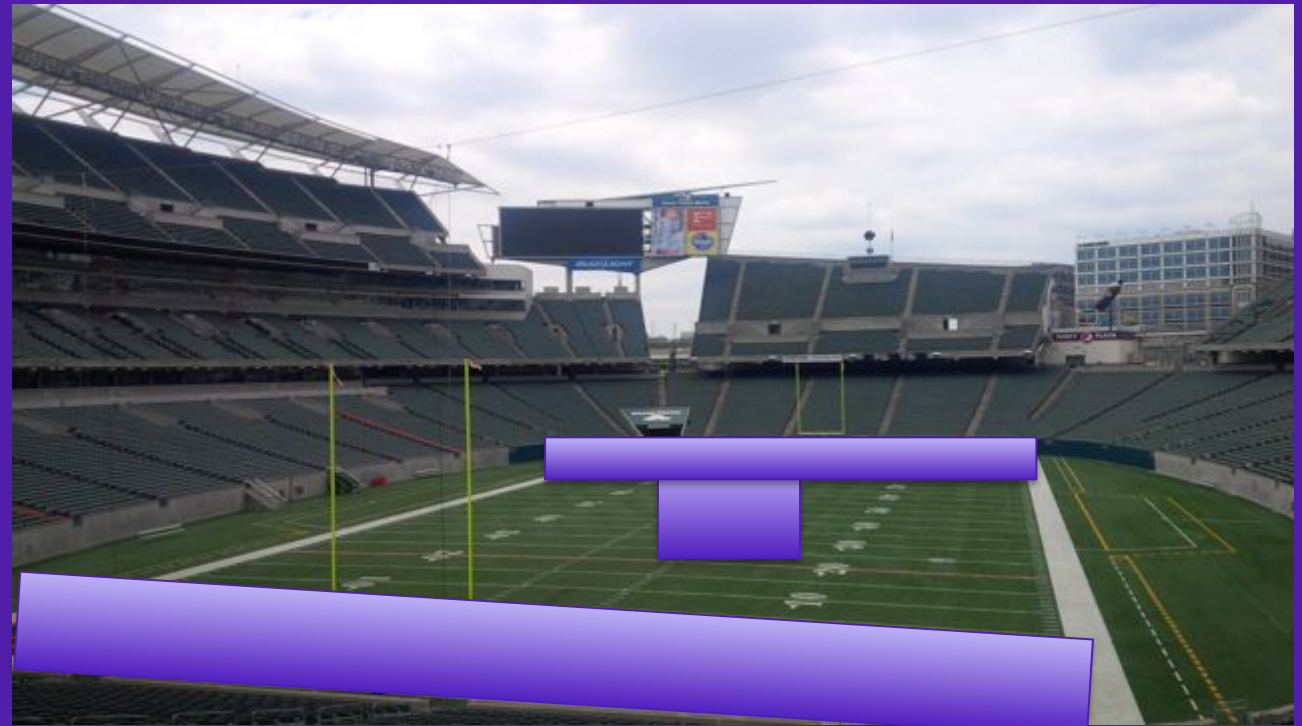
# Solving Scale Is More Than RF

- Wired infrastructure: Access-to-Datacenter
- Context-aware provisioning, analytics, and reporting
- Command and control management system





# Physical Challenges

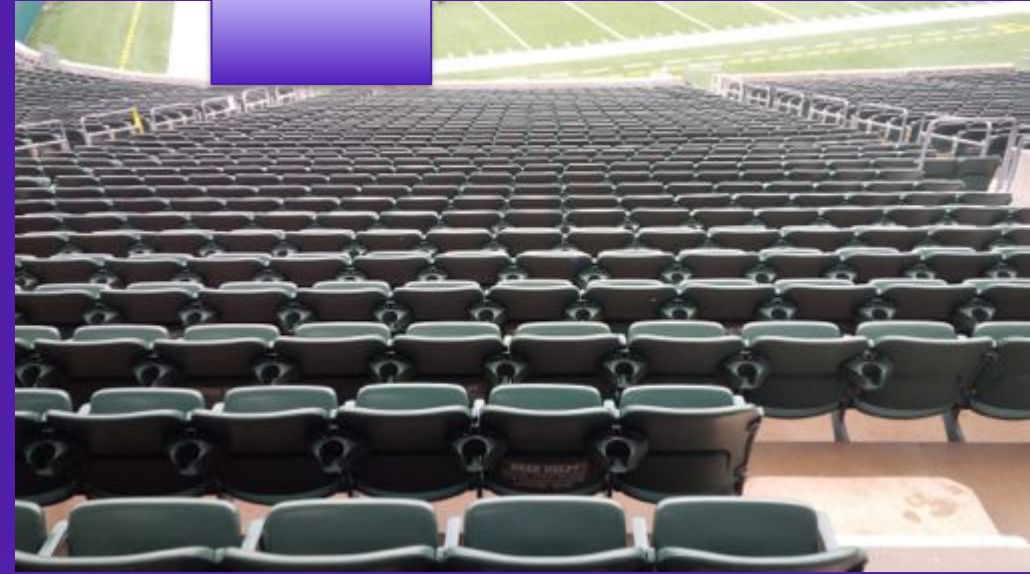


- Sheer size of the project is daunting
- Miles of cabling, IDF/MDF considerations – PoE
- Type of expected weather conditions
- Sight lines and aesthetics
- There are always unknown factors you can't account for

# Wi-Fi Challenges

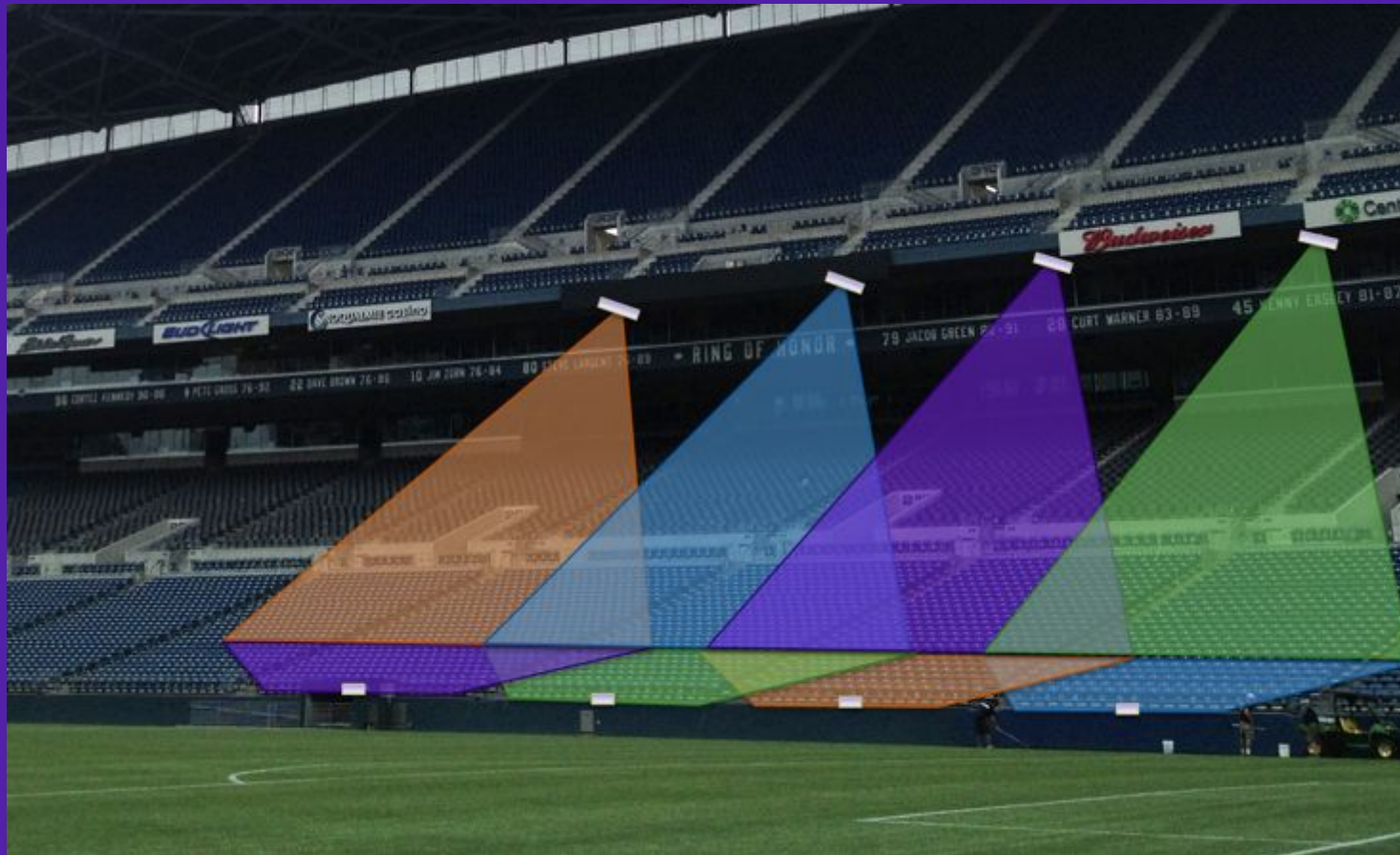
RF signal travels far in free space

- Many devices – elevated noise floor
  - Some running hotspots
  - Mostly 1x1 clients
- Frequency scarcity
  - 2.4Ghz is nice to have, 5Ghz is critical
  - Often using 2x 5Ghz radios in an area
  - We typically see about 60% of devices on the 5Ghz spectrum
  - Seeing about 30% of Androids with 802.11ac support
- Distances of some clients, in long sections



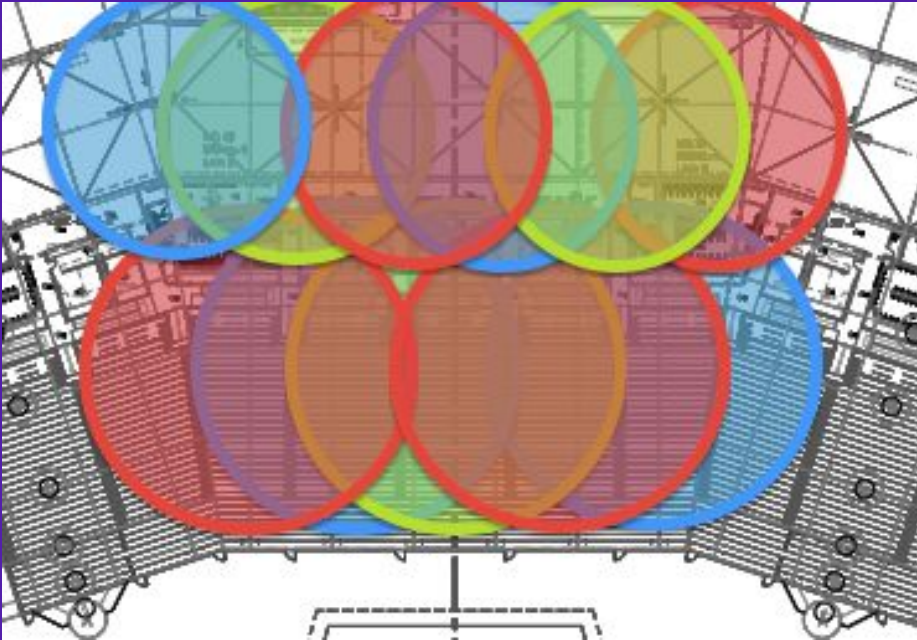
# Primary RF Goal

- Frequency re-use is the single biggest factor affecting capacity
- Noise control affects each channel's capacity (ACI/CCI)

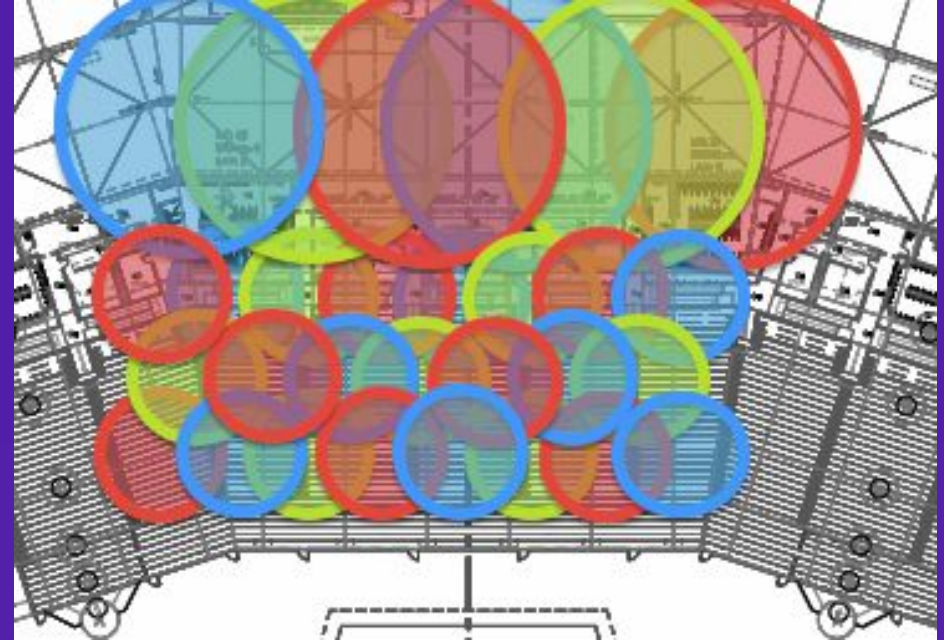




# Design Methodologies



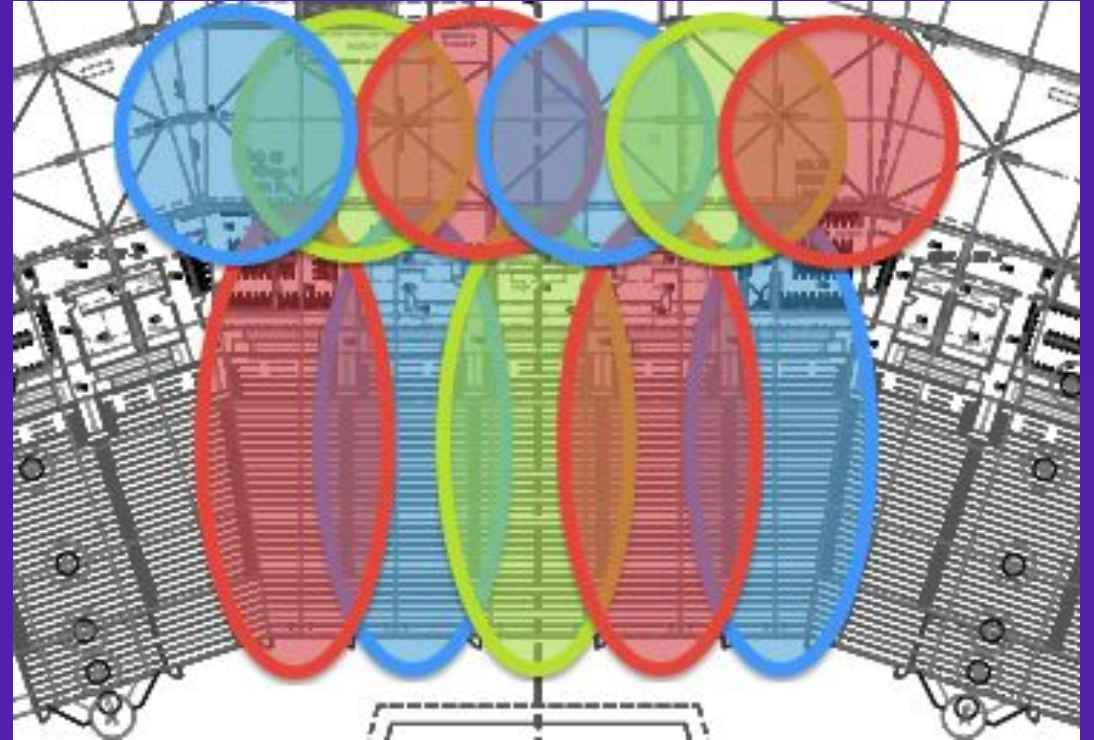
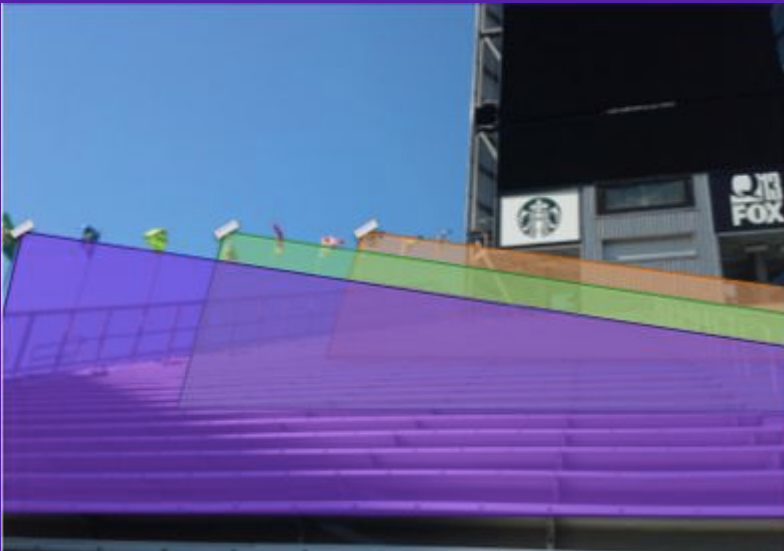
- Traditional overhead design
- Wide high gain directional antenna for seating



- Pico cell design
- Pico cell antenna, often under seat mounting

# Extreme Networks Methodology

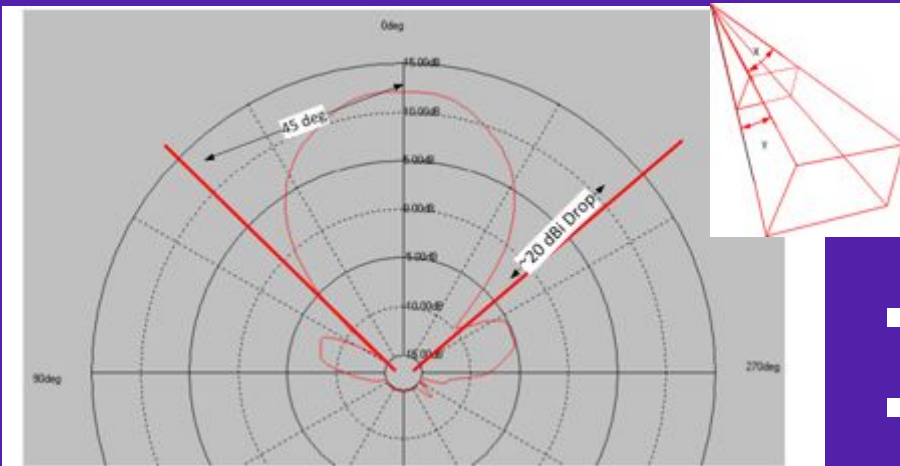
- Extreme utilizes open-air overhead



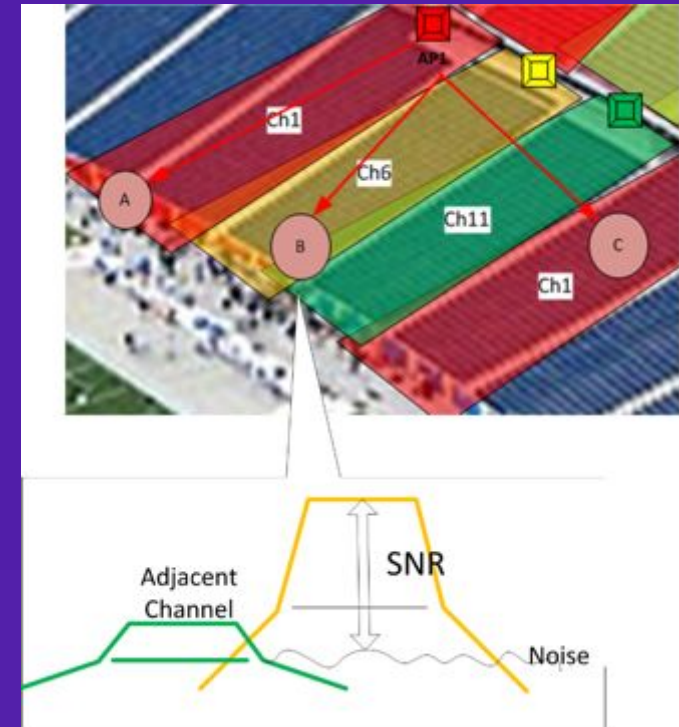
- Side propagation utilized in certain scenarios

# Antenna Directionality

- Directional antenna is the key attribute for overhead RF
- Designed for spatial isolation from other cells
- Lower TX creates symmetric (or balanced) link rates

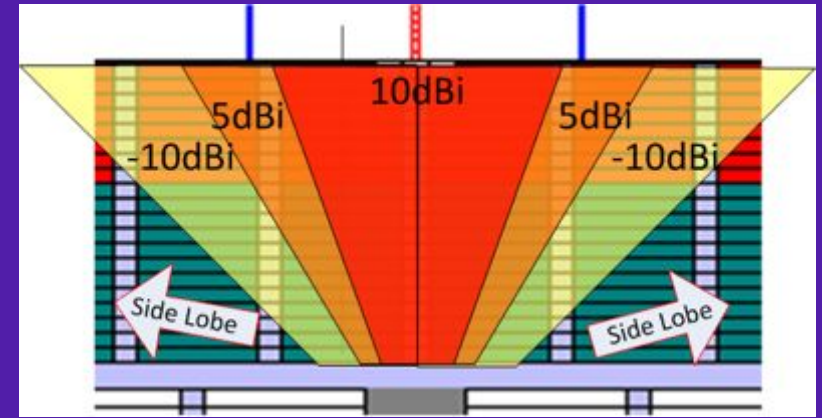


- Main lobe 10dBi gain with beam width of ~30 deg
- Side lobe of -10dBi on 45 deg from the main lobe





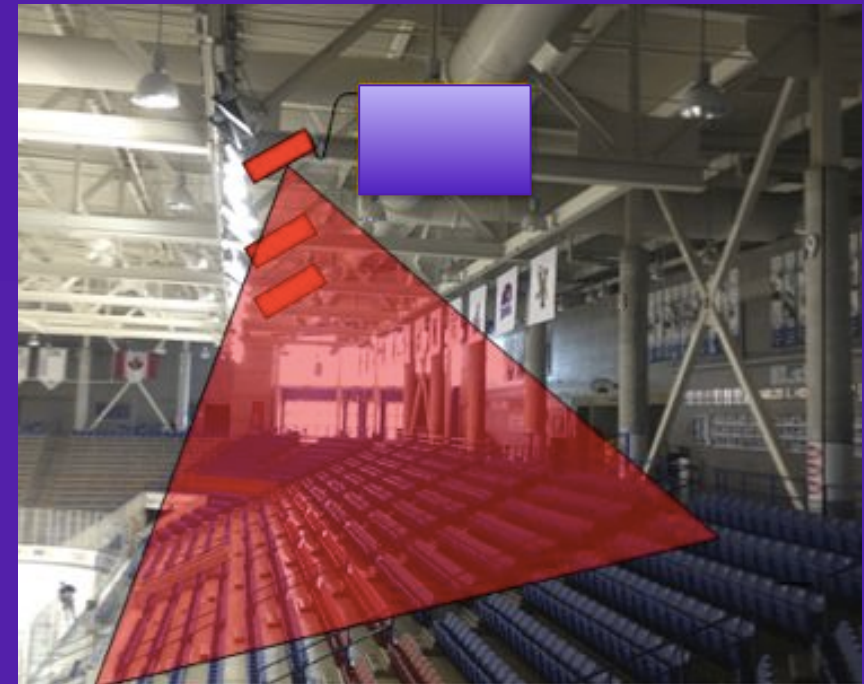
# Cell Dimensioning

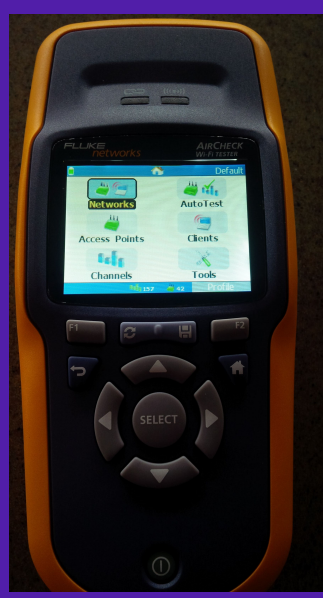


- Targets 100 clients per cell, clients in cell determine mounting locations
- Dimensioning based on association of 50% and concurrent usage of 30% (varies from venue to venue)
- Dimensioning calculations derive by target of 54Mbps per client/min
- -55dBm is targeted signal strength to farthest seats in a given section
  - Noise level increases during the event, typical around -80dB (target 25dB SNR)
- Min basic rate desire at 24Mbps
- Channel width is 20Mhz. on both 2.4Ghz and 5Ghz
- Clients sees neighboring AP signal, with approximate ~20dB less than the signal from the designated AP

# Success = Planning

- Lack of planning, is planning to fail
- Stadium deployments require accuracy
  - Accurate calculations
  - Accurate physical installations
  - Accurate configurations – the right channel on the right AP
- Pre-survey is required to know how many APs, what powers will be required, and the optimal tilt for the intended section



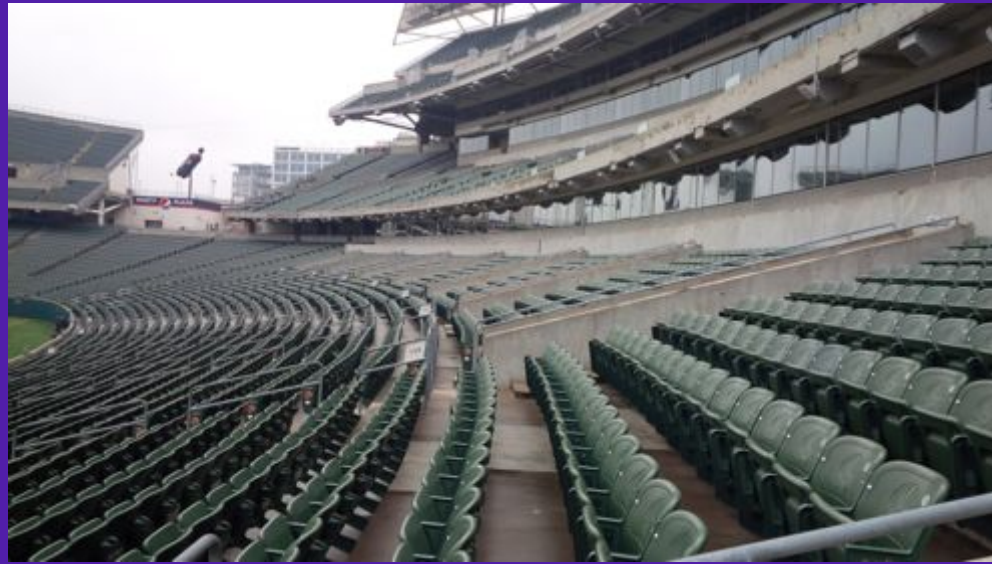


# Our Kit

- Ekahau site survey
- Fluke Meter
- Laser pointers (distance calculations)
- 3x Indoor and outdoor Aps
- 3x Indoor and outdoor Antennas
- Mounting equipment







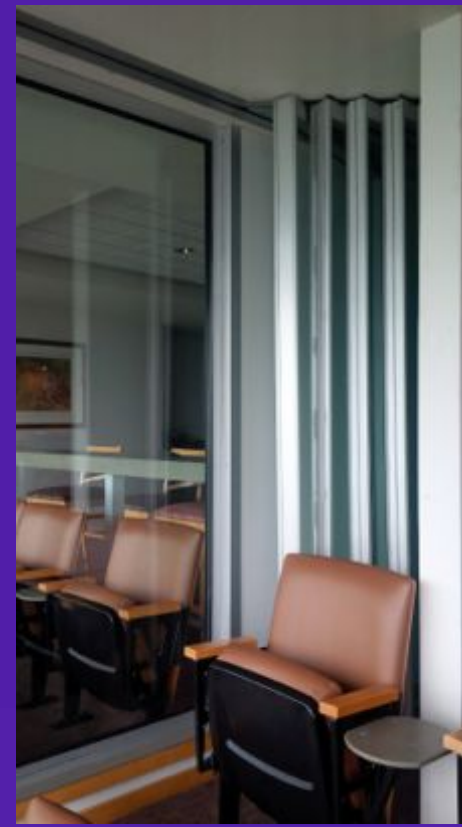
# Lower Bowl

- Typically the biggest/most seats/most difficult
- Calculate the # of seats, length and width
- Utilize the antenna overhang setup
  - Pro tip – Look for existing DAS – good indication of where team will allow install, and where they already believe connectivity is required
- Calculate the desired antenna tilt and play with Tx power
  - Fluke meter is used in 3 places to determine accuracy
- Install 3x adjacent APs to assure channel isolation as intended

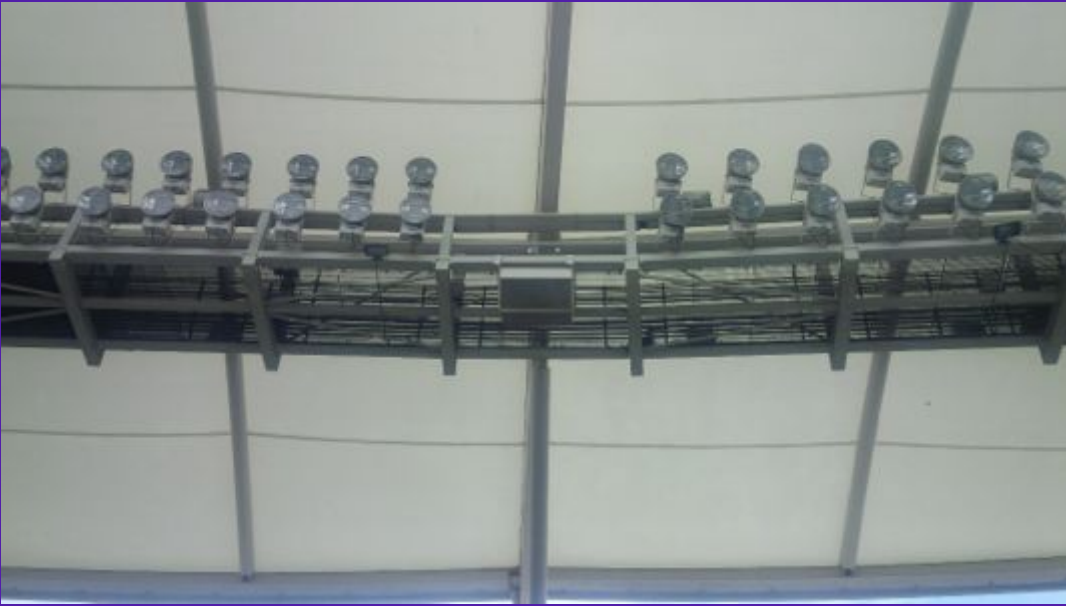


# Suites

- Typically designed similar to classrooms/office space
  - One AP per suite, or every other AP pending size and # of seats
- APs are usually installed closer to the back of the suite, near the hallway, or even out in the hallway
- Many suites have glass that attenuate all the signal, yet many stadium suites have moving glass that opens







# Upper Bowl

- Same approach as lower bowl
- Down-tilt becomes more crucial pending height/distance to the seats
- Catwalks can be scary - be prepared if you're going up!

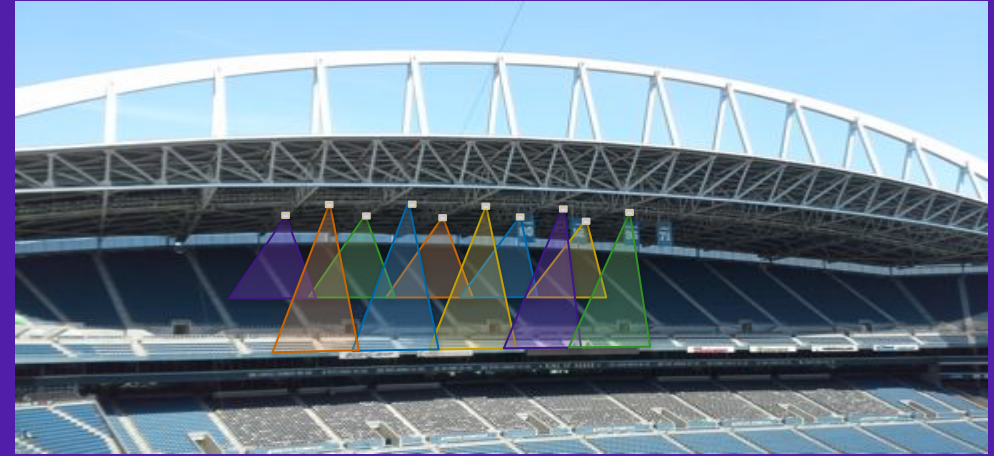


# Installation



- Physical installation is a huge, and costly task – “measure twice, drill once”
- Our job is to recommend where to install – the customer chooses
- Retrofit buildings are challenging – drilling, and cabling not always simple
- Costs can be more than assumed, often with union, sometimes x-rays or core drilling required

# Post-Install



- Channelization only occurs once all of the APs are installed
  - This is a manual task
  - Changing one AP can ripple effect your configuration (reconfiguration)
- Documentation, serial numbers are critical assurance of what's being worked on
- Active site survey, or post install MUST be done once all channels and powers are set

# Results Can Be Inspiring







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