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BREAKOUT SESSION:
ARUBA NETWORKS OUTDOOR

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ARUBA OUTDOOR TECHNOLOGY & CONCEPTS
What is Mesh Networking?

A multi-path, multi-hop wireless LAN/WAN infrastructure

- Self-forming for rapid deployment
- Self-healing for reliability
- Overcomes line-of-sight issues
Single Radio Backhaul

- Single backhaul radios share the air
- Omni antennas retransmit from node to node
- 50% bandwidth loss on every hop
Multi-Radio Backhaul Increases Capacity

**Multichannel Radio Backhaul**

- Directional antennas increase range between mesh routers
- Point-to-multipoint and mesh configurations
- Automated channel configuration
- Policy-based mesh configuration

**Sustained throughput over multiple hops**

<table>
<thead>
<tr>
<th>Radio</th>
<th>Throughput</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio 1</td>
<td>149</td>
</tr>
<tr>
<td>Radio 1</td>
<td>153</td>
</tr>
<tr>
<td>Radio 1</td>
<td>157</td>
</tr>
<tr>
<td>Radio 1</td>
<td>165</td>
</tr>
</tbody>
</table>
Test Results – Single vs. Multichannel

• Performance difference is easy to replicate in the lab or in open air environment
• Translates directly into reduced mesh portals
AirMesh Unique Technology Advantages

High Performance Mesh Networking

1. Intelligent Layer-3 routing of traffic
2. 802.11 multi-radio, multi-frequency system
3. Traffic management and video optimizations
4. Session persistence for high-speed roaming
ARUBA AIRMESH PRODUCT FAMILY
Aruba Outdoor Family

**AP175**
- Dual Radio, 802.11n
- Thin AP
- Requires Aruba Controller

**MSR4000**
- Quad Radio, 802.11n
- Software configurable for 2.4, 5, or 4.9GHz

**MST200**
- Single Radio, 802.11n
- 5GHz
- Integrated MIMO antenna

**MSR2000**
- Dual Radio, 802.11n
- Software configurable for 2.4, 5, or 4.9GHz

**MSR1200**
- Dual-Radio, 802.11n
- 2.4 or 5GHz

**Outdoor Extension**

**Mesh**

+ Pricing in USD EMEA list

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Aruba Mesh Architecture

Mesh Core

MSR2000
MSR4000
MSR4000
MSR4000
MSR2000
MSR1200
MST200
MST200
LAN/WAN
GATEWAY
Aruba 3D Outdoor RF Planner

Simplify Outdoor Mesh Network Design

- Visualize outdoor 802.11n mesh network coverage
- Generate outdoor RF coverage estimates
- Rapid, accurate outdoor mesh network design
- Web-based application works with Google Earth
Elevation Profile View now Available for Mesh Links

Color of 3D models throughput for the coverage area
MIMO Antenna Family

- **Dual Band Antennas (2x2)**
  - ANT-2x2-D805: 120° Sector, 5 dBi, ±45 pol
  - ANT-2x2-D607: 60° Sector, 7 dBi, ±45 pol
  - AP-ANT-90: Downtilt omni, 3 dBi, ±45 pol

- **Single Band Antennas (2x2)**
  - ANT-2x2-5614: 5 GHz, 60° Sector, 14 dBi, ±45 pol
  - ANT-2x2-5010: 5 GHz, Omni, 10 dBi, H/V pol
  - ANT-2x2-5005: 5 GHz, Omni, 5 dBi, H/V pol
  - ANT-2x2-2714: 2.4 GHz, 70° Sector, 14 dBi, H/V pol
  - ANT-2x2-2005: 2.4 GHz, Omni, 5 dBi, H/V pol

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**NOTE**

Aruba MIMO antennas contain special multiple-polarization arrays that have been designed to maximize decorrelation of MIMO spatial streams, and minimize intra-array coupling between antenna elements. **Aruba does not warranty the performance of outdoor networks using non-Aruba antennas.** The use of third-party antennas is at the customer’s own risk.
PLANNING THE BACKHAUL LAYER
Planning the Backhaul Layer

**Discovery**
- Identify Portal Candidates

**Topologies**
- Choose RF backhaul topology
- Choose capacity injection topology

**Capacity Plan**
- Identify usable channel count
- Choose HT40 or HT20
- Compute ingress load
- Compute egress load
- Model end-to-end flows

**RF Design**
- Finalize portal locations
- Add relay nodes if needed
- Choose antennas and bearings

**Model**
- Create 3D Coverage Model
- Create bill of materials

*Iterate until all requirements are met*
Outdoor Application Topologies - 1

Single hop access

Multi-hop access

Remote bridging / Residential coverage
Outdoor Application Topologies - 2

Vehicular Mobile Cell

ArubaOS Tunnel over AirMesh
RF Topologies - 1

**Point-to-Point**

**Linear Mesh**

**Point-to-Multipoint**
RF Topologies - 2

Multichannel Mesh with Dual Uplink

Intra-band & Inter-band Routing
End-fed vs. Center-fed Injection Topology

End-Fed

Center-Fed

Multi-channel

Single channel

Ch. 149
1 hop

Ch. 157
2 hops

Ch. 153
3 hops

Ch. 161

Ch. 149
1 hop

Ch. 149
2 hops

Ch. 149
3 hops

Multi-channel

Ch. 153
2 hops

Ch. 161
1 hop

Ch. 149
1 hop

Ch. 157
1 hop

Ch. 153
2 hops

Ch. 161

Ch. 149
2 hops

Ch. 149
1 hop

Ch. 149
1 hop

Ch. 149
2 hops

Ch. 149

Hybrid Injection Topology

End-fed and center-fed topologies can be combined
Planning the Access Layer
Planning the Access Layer

Discovery
- Define coverage footprint
- Identify siting constraints
- Identify QoS / SLA zones
- Specify key design parameters

Capacity Plan
- Identify offered load by device
- Assign minimum throughputs
- Choose over-subscription ratio
- Identify usable channel count

Cell Size
- Match client to AP power
- Choose minimum data rates
- Estimate path losses

RF Design
- Identify valid mounting assets
- Choose antennas and bearings
- Choose best mounting sites

Model
- Create 3D Coverage Model
- Create bill of materials

Iterate until all requirements are met
Coverage Strategies

- A coverage strategy is a method of delivering access-layer signal into a wireless service area
- For outdoor, there are two major methods
Decreasing Coverage with Height

\[
\frac{40 \text{ m}}{\sin(30^\circ)} = 80 \text{ m}
\]

\[
\frac{25 \text{ m}}{\sin(30^\circ)} = 50 \text{ m}
\]

\[
\frac{10 \text{ m}}{\sin(30^\circ)} = 20 \text{ m}
\]
Sparse Side Coverage
Dense Side Coverage
Dense Overhead Coverage
Understanding Antenna Patterns

- The Basic Antenna is the isotropic radiator
- This is an ideal concept and not a real antenna
- The isotropic radiator has Gain=1 (0 dBi) and radiates in all directions equally (a sphere)
Understanding Antennas

• Real antennas always distort the ideal isotropic pattern
• Antennas do not create or destroy power, but rather “focus” energy into a tighter region of 3D space
• This focusing effect is called “Gain”
• The higher the gain, the more tightly focused the coverage pattern of the antenn is in a particular direction
• This creates regions in space of
  – Higher power density (Gain >0 dBi) (i.e. “Gain”)
  – But also regions of lower power density (Gain<0 dBi) (i.e. “Loss”)
Beam-width and Patterns

- **Half-power or 3 dB beam-width in degrees**
  - Measure of how an antenna directs the energy it radiates

- **Represented as a polar plot for horizontal (azimuth) and vertical (elevation)**
Reading Antenna Pattern Plots

Azimuth

Elevation

Sector Antenna
Antennas – The Elevation Challenge

Mobile Client (Lifter @ 15m height)

AP on Pole @ 45m height

Fixed Clients (View from Crane @ 65m height)

Personnel (Laptops @ 2m height)

Example: GROUND to 65m High Client Coverage is desired!
The Elevation View shows the vertical pattern of the same antennas when mounted at a 40 ft ceiling height. From this view it is clear that the high gain antennas will interfere with other APs on the same channel, but coverage does not reach the clients on the floor. The downtilt omni has coverage that reaches the floor and does not overlap at the AP height.
Vertical Coverage: High Gain Omni

High Gain Omnidirectional (8 dBi, 2.4 GHz)

Direction of Maximum Gain at 0°, Gain=8 dBi

8dBi - 10dB = -2 dBi @ -20°

Highest gain is directed At next AP instead of clients!

8dBi – 20dB = -12 dBi @ 80°

Weakest signal is directed to clients!
Vertical Coverage: Downtilt Omni

- **Downtilt Omnidirectional**
  - +3 dBi gain at -45°
  - "downtilt" angle

- **Direction of maximum gain**
  - At -45° to ceiling
  - Max gain = +3 dBi

- **Gain Calculations**
  - 3 dBi - 5 dBi = -2 dB at -80°
  - 3 dBi - 3 dBi = 0 dB at -20°

Max gain is directed to clients!
Summary: Antenna Basics

• Higher Gain is always at the expense of coverage, usually vertical coverage.

• Always think about the direction of gain relative to the client locations. Clients should be within the -3 dB Area (horizontal and vertical) whenever possible.

• For successful outdoor (or large indoor) planning, vertical coverage is usually a critical design requirement. Pay attention to the vertical pattern plots and the elevation of the clients relative to the proposed mounting heights.

• For overhead installation, outdoor down tilt antenna (AP-ANT-90) helps considerably with very high mounting conditions (6m up to 50m) in some of the most challenging environments such as container facilities.
CASE STUDY – MUNICIPAL VIDEO SURVEILLANCE MESH
1KMx1KM Network – Mesh Model

Predicted TCP Mesh Link Speeds
- **35/71Mbps**
- **29/58Mbps**

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1KMx1KM Network – Coverage Model

Predicted Cell Edges @ -75dBm
*(does not show building attenuation)*
1KMx1KM Network – L3 & RF Topology
Macro Network – 5GHz & 2.4GHz

5 GHz

-65dBm

-75dBm

-85dBm

2.4 GHz

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Node 1C – With Axis PTZ Camera
Node 1C

2.4 GHz

-65dBm

-75dBm

-85dBm

5 GHz

-65dBm

-75dBm

-85dBm

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Node 1D – With Avigilon Fixed Camera
Node 1D

5 GHz
-65dBm
-75dBm
-85dBm

2.4 GHz

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Node 2A
Node 2A – RSSI

- 5 GHz
  - -65dBm
  - -75dBm
  - -85dBm

- 2.4 GHz
  - -65dBm
  - -75dBm
  - -85dBm
Roaming Demonstration
Resources:

  – Outdoor MIMO Wireless Networks
  – Outdoor Point-to-Point Deployments