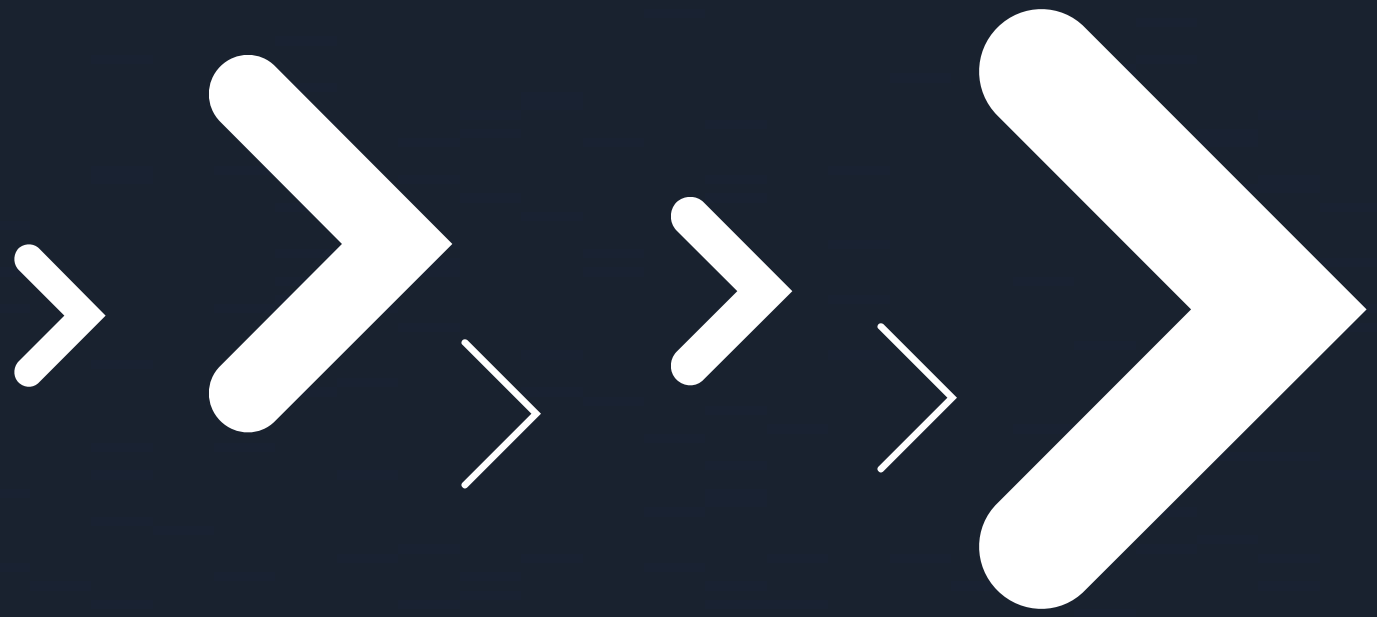
802.11n in the Outdoor Environment - Introducing the AP 7181



Customer Overview Presentation

Mesh Networks Product Group

MOTOROLA WIRELESS BROADBAND

Agenda

Mesh Market Update

The Emergence of the 802.11n Standard

Benefits of 802.11n in Outdoor Environments

Motorola's Outdoor 11n Product – AP 7181

Summary of Product Advantages

Headlines in City Broadband Deployments

- Cities are deploying multi-use mesh networks – supporting many services and agencies with the same infrastructure.
- The focus is on fast Return On Investment (ROI) in the current economic climate.
- The deployment of high quality video surveillance is on the rise, resulting in rising costs for leased lines and fiber.
- City applications increasingly require mobility – public safety officers need connections that work while in motion.
- Cities want to know how 802.11n technology will affect deployment and capacity.

From MuniWireless:

- *94 cities or regions have mesh networks*
- *68 more have 'hotzone' areas established*
- *54 more have networks for public safety or municipal use only*

Typical Municipal Services

- Field based reporting & database access
- Mobile office
- Meter reading
- Video surveillance
- Traffic management
- Residential / tourism internet access
- Remote building management
- GIS mapping downloads
- eCitations / eTicketing
- Tele-medicine / remote biometrics
- Asset / fleet management
- Incident scene / event management
- Automatic license plate reading
- Smart parking
- Leased line replacement
- Red light cameras
- Municipal Rail/Security/Control

The more services your wireless network can support, the more savings you generate for your city.

Meshed Wide Area Network (MWAN)
802.11n Target Markets

Public Safety

Police, EMS and fire

Transportation

Video to/from buses/trains

Video Surveillance

Wireless backhaul for cities and campuses

Public Access

Cities, parks, apartment buildings

Education

Outdoor campus coverage

Industrial Markets

Supports video, handhelds

Mesh Market Needs

Bandwidth Intensive and Real Time Applications

Video – High bandwidth and low latency

Wireless Refresh and Expansion

Over the next 3-4 years all new laptops will support 11n

Reliability and Lower Cost of Ownership

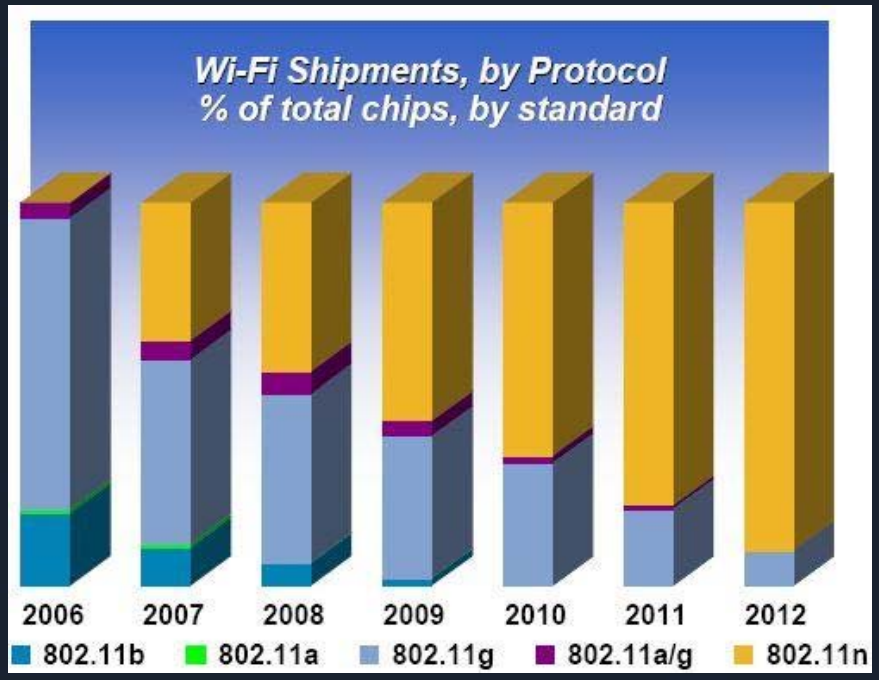
Greater Range + High capacity

= lower cost and highly reliable networks

11n promises 7x more video,
8x the users and 9x the speed!

802.11n Emerging Standard

- Wi-Fi Alliance has certified over 450 802.11n draft 2.0 products
- Final 802.11n standard scheduled for January 2010
  - Intel has shipped over 30 million 11n clients
- Cross industry adoption:
  - Public Safety, Education, Healthcare, Manufacturing, Professional Services



Source: In Stat

Technology Improvements in 802.11n

MIMO	40 MHZ Channels	Packet Aggregation	Backwards Compatibility

- MIMO (Multi-In, Multi-Out) Antenna technology uses advanced signal processing and multiple antennas to increase range and reduce dead spots

- 40MHz Channel Bonding combines two 20 MHz channels to double the data rate

- High-bandwidth data applications are more efficient when multiple data packets are sent in a single transmission, called packet aggregation (video, CAD files, system backup)

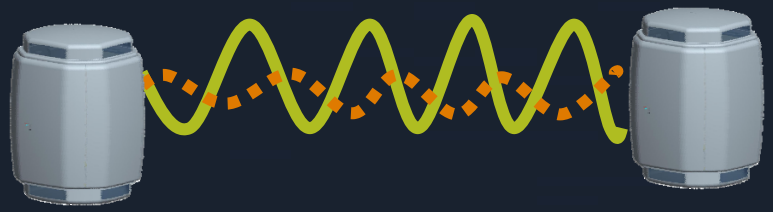
- 11n operates in both 2.4 and 5 GHz channels and is backwards compatible with 802.11a/b/g devices

Technology Improvements

MIMO (Multiple Input, Multiple Output)

Maximum Ratio Combining (MRC)

- Performed by receiver – you hear better
- Combines multiple received signals
- Increases receive sensitivity
- Works with MIMO and non –MIMO clients



Data is split and sent on multiple data streams

Spatial Multiplexing

Multiple independent data streams

- Requires MIMO AP and MIMO client
- In a 20 MHz channel:
  - Single Stream – Max 65 Mbps
  - Dual Stream – Max 130 Mbps

Introducing the AP 7181

Dual Radio 802.11n Access Point

Supports a/b/g/n (draft 2.0)
2.4 GHz 3x3
5.4-5.8 GHz 2x2
20 MHz and 40 MHz channels
802.11 DFS v1.5.1 (1.6.1 ready)

ADEPT MIMO Antenna System

Dual polarization for every radio
Software electronic down tilt

Video Optimization

Robust IP67 with NEMA 4x Enclosure

POE 802.11af Power Out

One Point Wireless Manager/MeshPlanner

Seamless Indoor/Outdoor Networks with the AP 7131

Shipping Q4 2009

AP 7181 Selling Points

Remember…

50 300 Zero!

AP 7181 offers better range, reducing the number of nodes needed by 50%!

AP 7181 provides more system capacity with a 300 Mbps true 11n mesh layer!

AP 7181 has zero external antenna sticks!

Deploy Only Half the Network

The best way to increase ROI is to lower system deployment and operating costs. AP 7181 technology reduces nodes required by 50%.

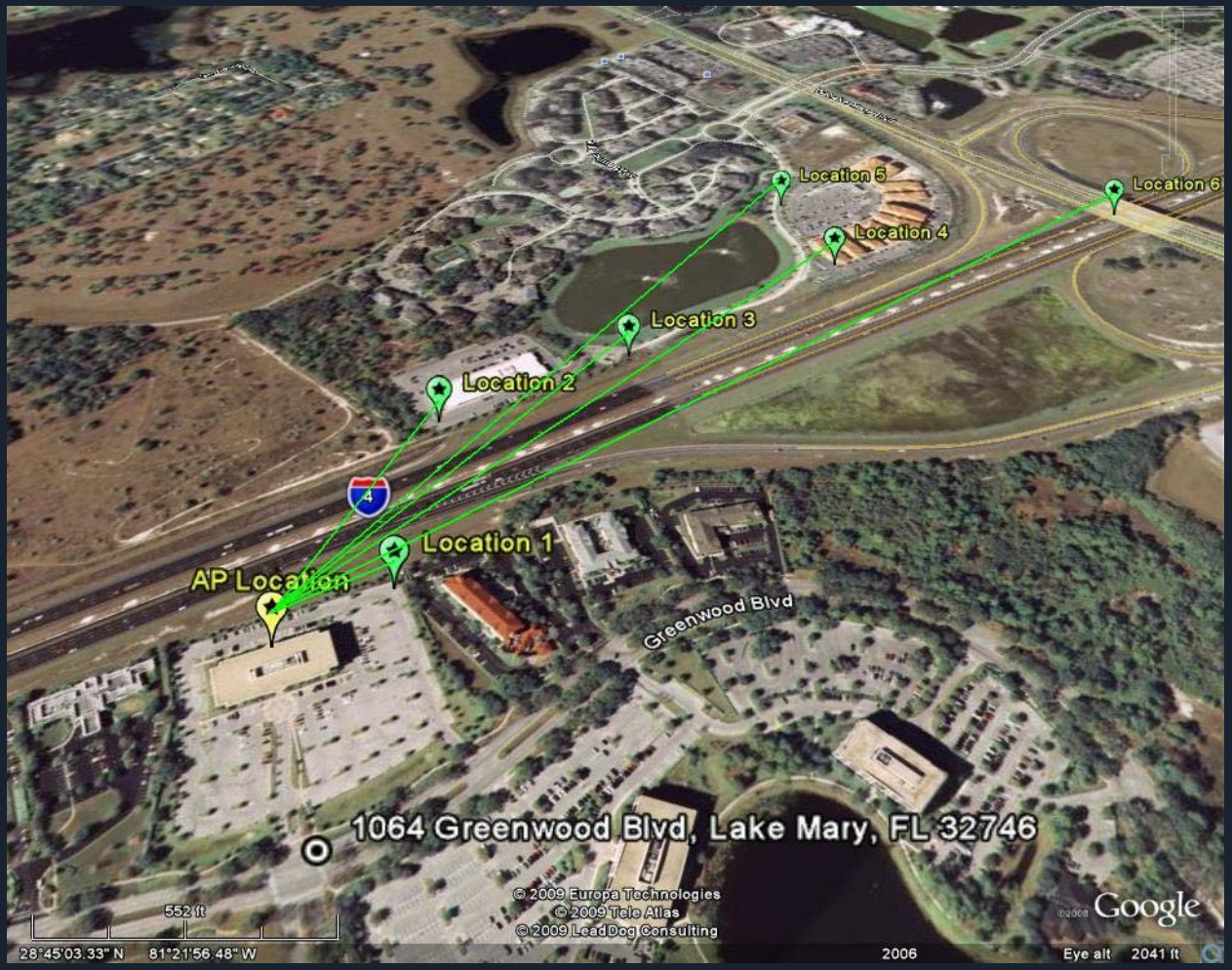
Benefits:

- Lower equipment costs – purchase half the access points
- Lower deployment costs – install and optimize half the number of nodes
- Lower operating costs – pay for half the sites and half the power

How does the AP 7181 accomplish this?

- Best in class receiver/antenna technology – dual polarization diversity
- Maximum transmit power with two simultaneous data streams
- Advanced rate control algorithms to optimize outdoor connections

Outdoor Tests of Client Connections



Location 1 = 0.07 mi
11g: 1.5 Mb (fade)
AP 7181: 19 Mb

Location 2 = 0.16 mi
11g: 11 Mb
AP 7181: 18 Mb

Location 3 = 0.25 mi
11g: 3 Mb
AP 7181: 14 Mb

Location 4 = 0.41 mi
11g: 3 Mb
AP 7181: 10 Mb

Location 5 = 0.51 mi
11g: 8 Mb
AP 7181: 14 Mb

Location 6 = 0.63 mi
11g: <0.5 Mb
AP 7181: 10 Mb

Access points were tested using a common Netgear client, restricted to 11g rates. 10 Mbps client connection at over six tenths of a mile from the access point!

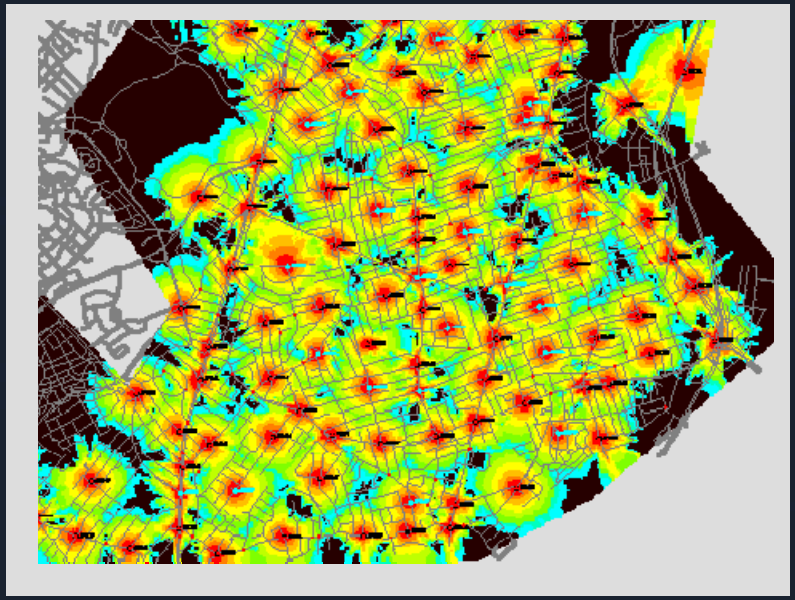
The Affect on Coverage Planning

Design completed for nine square miles of urban city

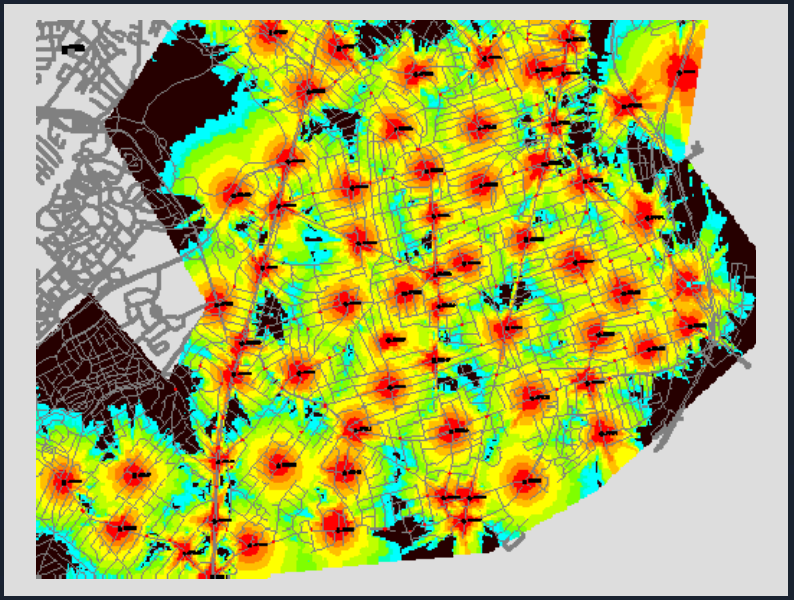
- Portable coverage assumed (iPhone) – *worst case*
- 95% in-street reliability

The difference increases if high powered clients are used!

Today's Technology



AP 7181



2x area of highest data speed as well!

300 Mbps TRUE 11n Mesh Layer

High speed client access requires high speed mesh connections to support. AP 7181 is capable of 300 Mbps – our competitors: only 150 Mbps.

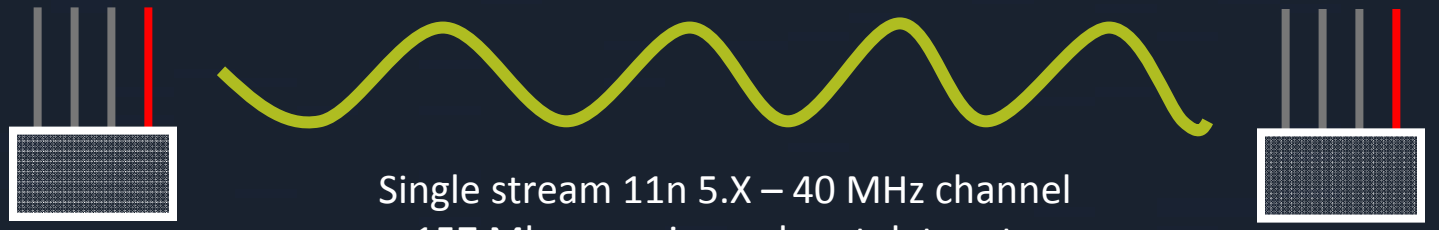
Benefits:

- AP 7181 supports more clients and applications with a single backhaul connection
- Support more fixed and mobile video connections – major ROI drivers
- Avoid "outgrowing" the network – deploy long term capacity

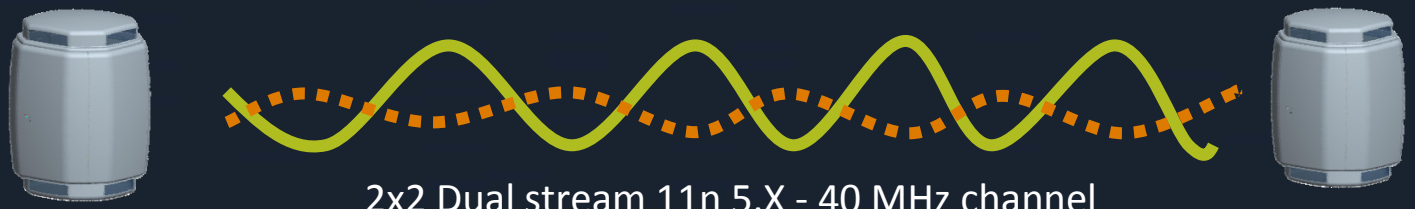
How does the AP 7181 accomplish this?

- True 11n MESH 2x2 implemented for the 5.X radios
- Horizontal and vertical polarized antennas give true diversity
- Full power radios allow nodes to separate and still keep strong links
- Outdoor optimized rate control maintains maximum data rates

True Multi-Stream 802.11n Meshing (5.X radio)



Single stream 11n 5.X – 40 MHz channel
157 Mbps maximum burst data rate
Vertical polarization only



2x2 Dual stream 11n 5.X - 40 MHz channel
300 Mbps maximum burst data rate
Vertical and horizontal polarization gives true diversity

INTERNAL TESTING RESULTS:	*39 Mbps*	*62 Mbps*
Stick range (vert. pol.):	0.14 miles (mcs4)	0.05miles (mcs7)
ADEPT (dual pol.):	0.6 miles (mcs10)	0.24miles (mcs12)

AP 7181 nodes can be placed 4-5 times further apart and maintain the same throughput!

Integrated Antennas – Zero External Sticks

802.11n technology relies on multiple antennas for each radio. The AP 7181 ADEPT antenna integrates 16 antennas without a single stick.

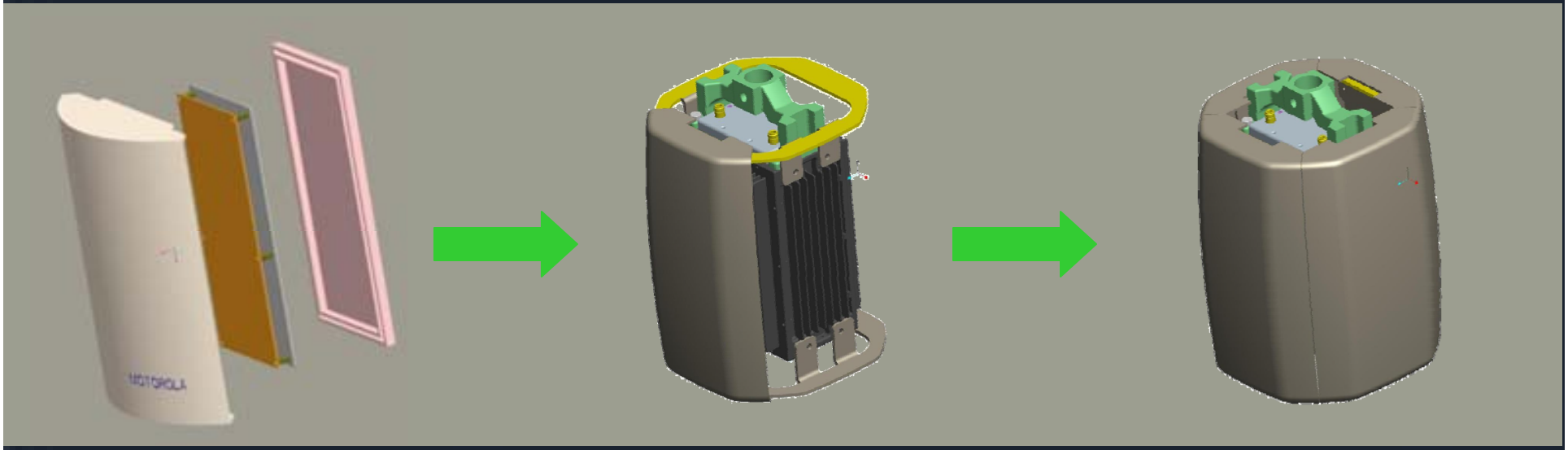
Benefits:

- Integrated vertical and horizontal polarization for every band
- Software-controlled electronic down tilt without antenna replacement or bucket truck
- No coverage gaps from multi-antenna “shadowing” or “notching”
- More compact and aesthetic – gives more choices for mounting locations

How does the AP 7181 accomplish this?

- Each 90-degree panel integrates 2.4 and 5.X patch antennas
- Each antenna is 12 dB gain, with both horizontal and vertical drivers
- By phasing the patches, 15 degrees of electronic down tilt can be activated

AP 7181 Mechanical Design

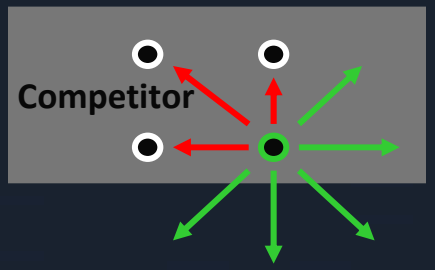


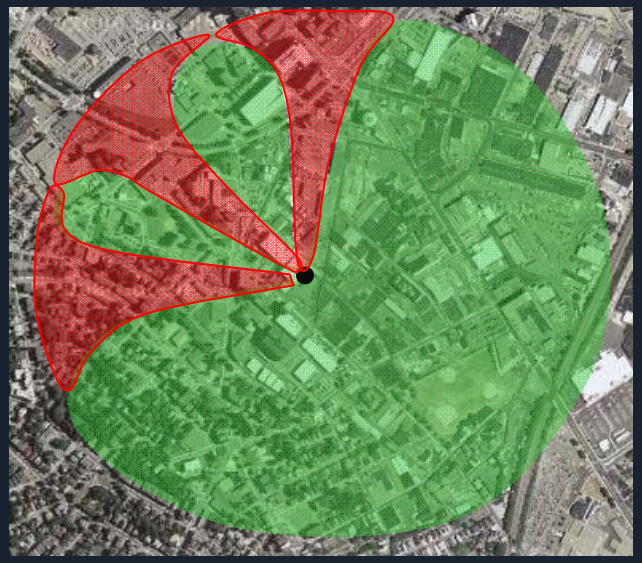
ADEPT – **AD**vanced **E**lement **P**anel **T**echnology

- Patent-pending multi-antenna panels
- Integrated panels placed at 90 degrees to provide omni-directional coverage
- Antenna combining technology to combine and separate streams

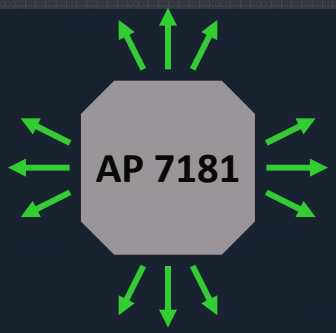
The Affect of Multiple Stick Antennas

Self Shadowing





Nearby antennas “shade” or “notch” the desired omni-directional antenna pattern leading to unpredictable coverage holes.



AP 7181 provides true omni-directional coverage for predictable deployments and reliable connections.

ADEPT Technology Delivers

Polarization Diversity

Panel antennas enable 2 spatial streams in an outdoor line of sight by creating two dimensions using polarization diversity (horizontal and vertical). A parallel stream is key for an 802.11n network, to offer large increase in range and throughput.

Self Shadowing Avoidance

The panel antenna system delivers uniformed gain (+/- 1 db at overlapping edge) after all losses due from multiplexing and beam tilting taken into account.

Software Electronic Down-tilt

If access points are installed at greater heights, ground coverage can be remotely adjusted with 15 degrees of electronic down tilt.

AP 7181 – The Right Solution

Motorola has designed the AP 7181 to be the best solution for municipal, transit and enterprise deployments.

Best in Class Coverage – **50% Less Access Points**

Reduces network purchase costs now - and operating costs in the future

TRUE 11n Mesh Layer – **300 Mbps Mesh Rates**

Supports more high bandwidth clients so you won't outgrow your network

Integrated Antenna – **Zero Antenna Sticks**

For better coverage and no "porcupines"

802.11n Modulation Coding Scheme

Data rates differ based on the Guard Interval for a channel width of **20** MHz.

Modulation Coding Scheme (MCS) Index	MCS Data rates	Modulation used	Data Rate when GI=800ns	Data Rate when GI=400ns
0	1	BPSK	6.5	7 2/9
1	1	QPSK	13	14 4/9
2	1	QPSK	19.5	21 2/3
3	1	16-QAM	26	28 8/9
4	1	16-QAM	39	43 1/3
5	1	64-QAM	52	57 7/9
6	1	64-QAM	58.5	65
7	1	64-QAM	65	72 2/9
8	**2**	**BPSK**	**13**	**14 4/9**
9	**2**	**QPSK**	**26**	**28 8/9**
10	**2**	**QPSK**	**39**	**43 1/3**
11	**2**	**16-QAM**	**52**	**57 7/9**
12	**2**	**16-QAM**	**78**	**86 2/3**
13	**2**	**64-QAM**	**104**	**115 5/9**
14	**2**	**64-QAM**	**117**	**130**
15	**2**	**64-QAM**	**130**	**144 4/9**

Data rates differ based on the Guard Interval for a channel width of **40** MHz.

Modulation Coding Scheme (MCS) Index	Number of spatial streams	Modulation used	Data Rate when GI=800ns	Data Rate when GI=400ns
0	1	BPSK	13.5	15
1	1	QPSK	27	30
2	1	QPSK	40.5	45
3	1	16-QAM	54	60
4	1	16-QAM	81	90
5	1	64-QAM	108	120
6	1	64-QAM	121.5	135
7	1	64-QAM	135	157.5
8	**2**	**BPSK**	**27**	**30**
9	**2**	**QPSK**	**54**	**60**
10	**2**	**QPSK**	**81**	**90**
11	**2**	**16-QAM**	**108**	**120**
12	**2**	**16-QAM**	**162**	**180**
13	**2**	**64-QAM**	**216**	**240**
14	**2**	**64-QAM**	**243**	**270**
15	**2**	**64-QAM**	**270**	**300**

Note: *You can see that data rates are doubled from MCS 8 - MCS 15*

Summary of 802.11n Advantages

Throughput

Greater transfer of the high bit rates in Greenfield deployments

Even in mixed mode deployments with legacy 802.11 devices greater effective throughput, although significantly less than the Greenfield mode

Predictable Coverage

MIMO provides high data rate while MRC provides better coverage

Reliability

Greater SNR in radio link translates directly to more reliable communication at higher data rates

Higher SNR means that more interference is needed to corrupt a transmission

Clients can be reached further from the site, in worse coverage

Thank You!