cisco

Cisco Connect

Riyadh, Saudi Arabia

April 29-30, 2014

TOMORROW starts here.

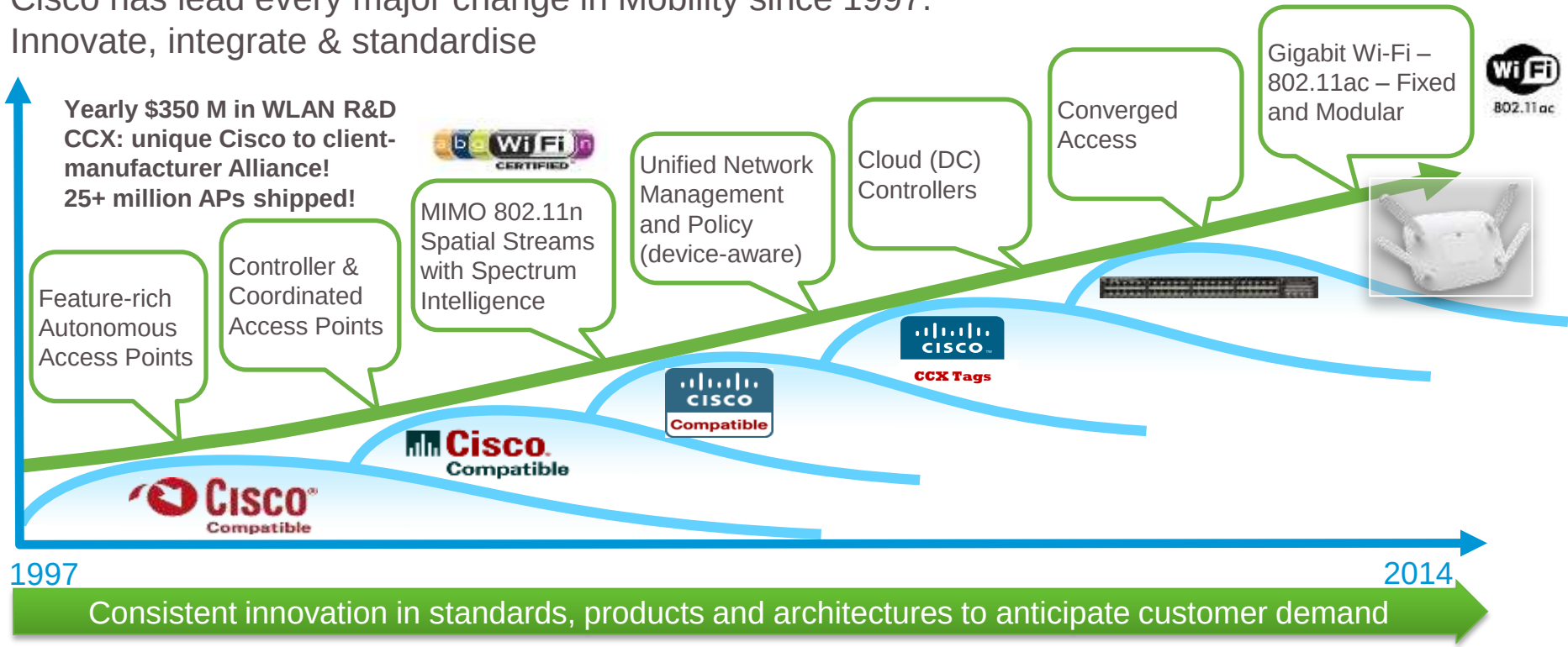
Are you ready for Gigabit WiFi ?

Bader Alotaibi

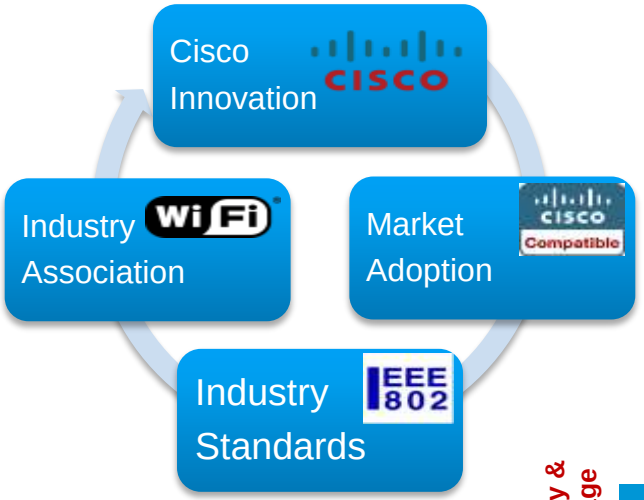
MEA Mobility CSE

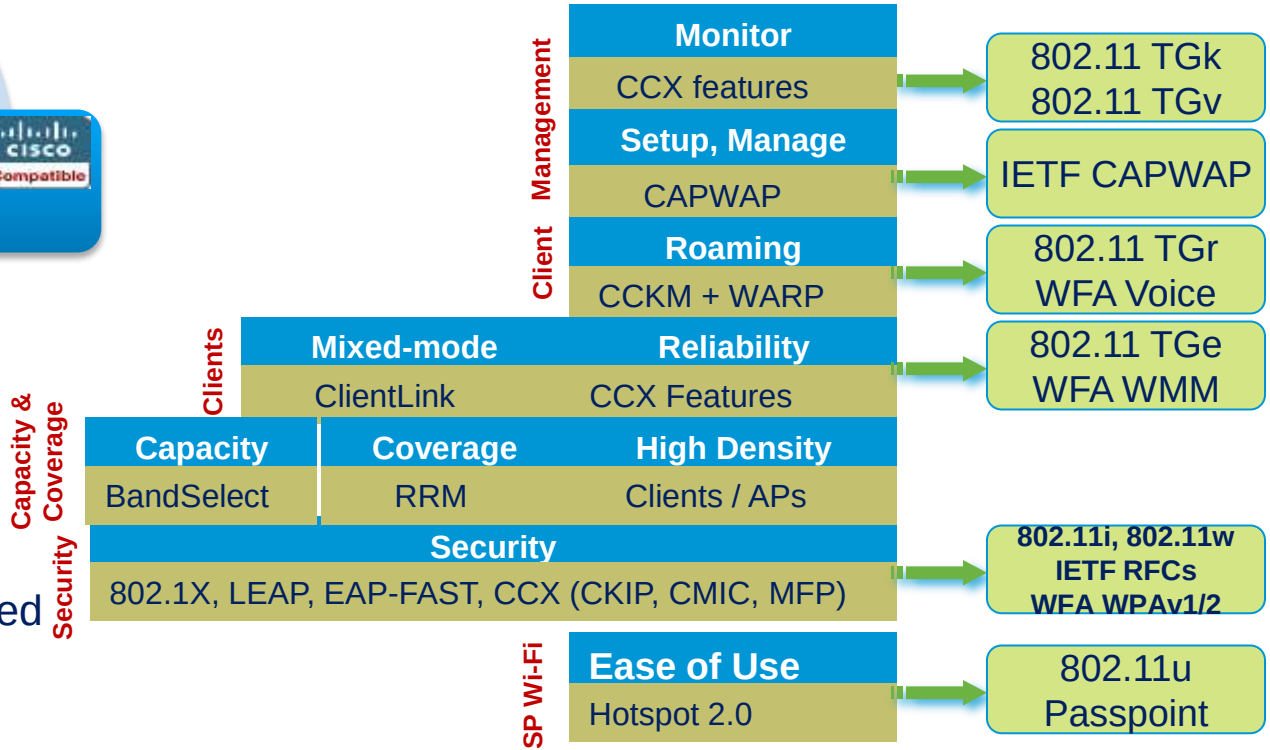
Mobility is Evolving fast, innovation is key

Cisco has lead every major change in Mobility since 1997.
Innovate, integrate & standardise



Cisco's Role in WiFi Standards: 17 years! and counting…

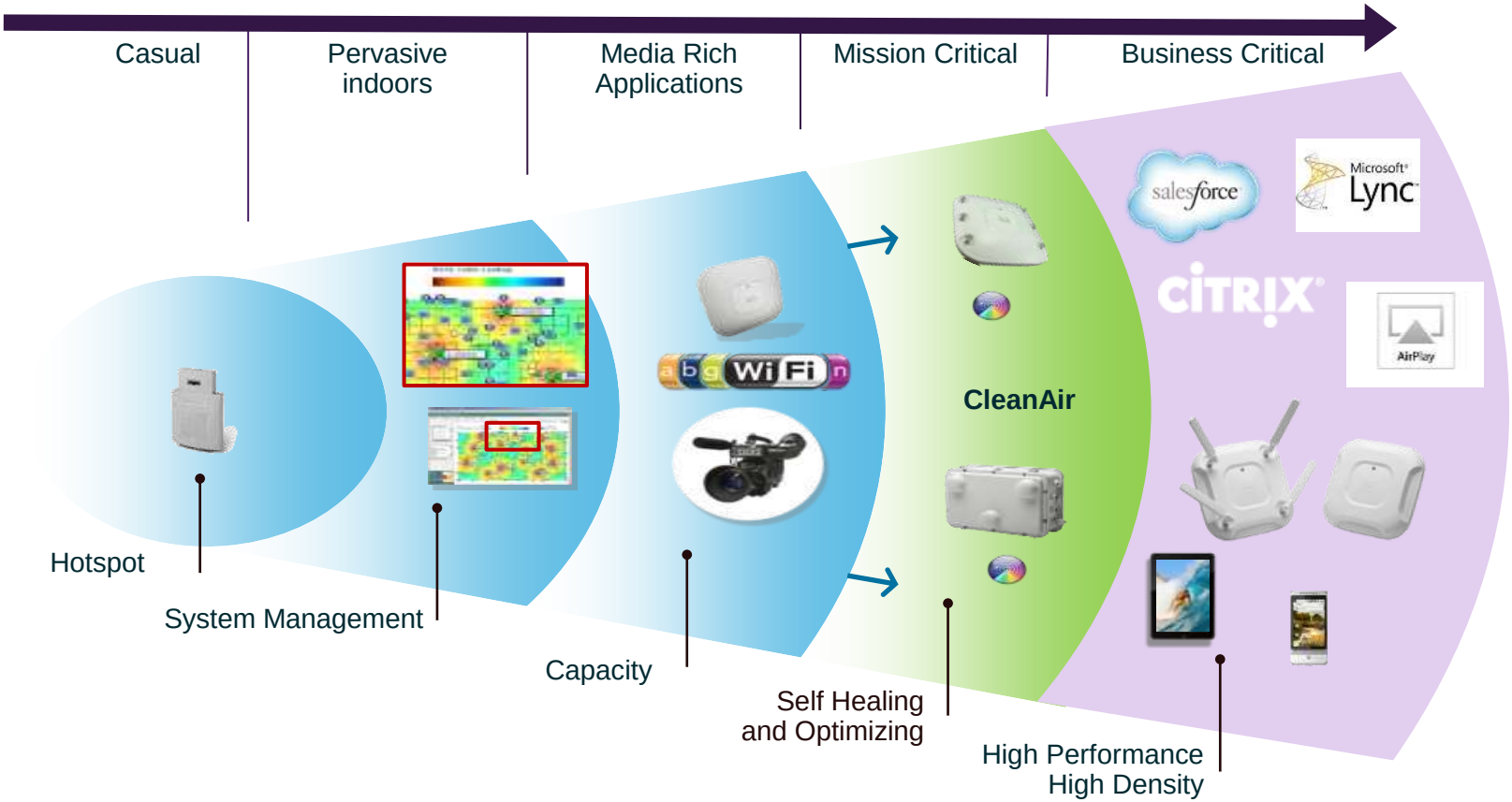




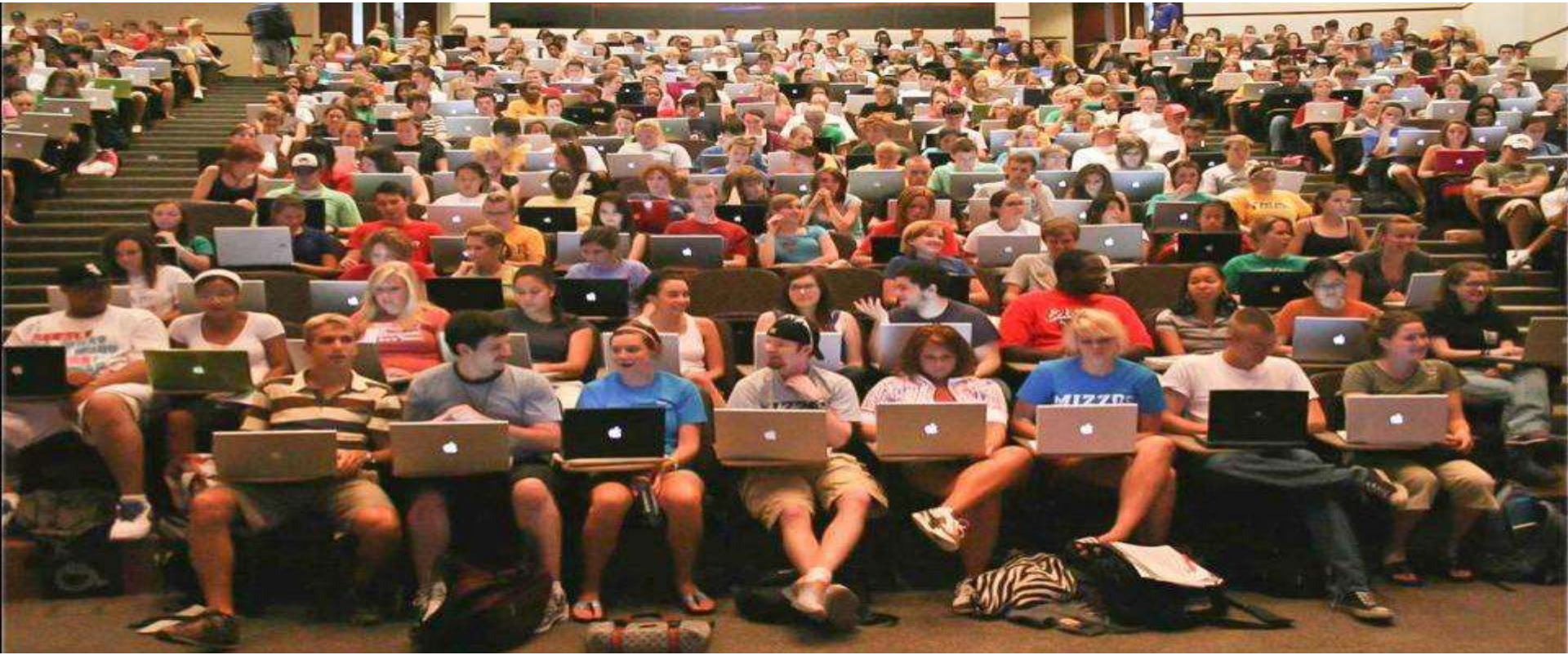
Cisco innovations have addressed customer needs and driven standards and WFA testing, making Wi-Fi pervasive

Enterprise Wireless Evolution –

From Best-Effort to Business Critical



The new Normal



Market drivers around 802.11ac

- **Natural migration** – refresh period – pre-11n and early 11n networks – Wave 2 still 18-24 months off
- **Bandwidth** requirements growing rapidly, i.e. Higher Ed bandwidth doubling ever 6 months
- **Density** challenges and concerns in portions of the network – moving to newer technology
- Increased planning for **Video and Voice** along with data, large file transfers
  - Real time MRI imaging in Healthcare, MRI and CAD files in Healthcare and Manufacturing
- Building out for **growth** and **next-generation** work environments
- Extending existing 11n networks e.g. new Healthcare and Surgical Clinics

IEEE 802.11ac – The Next Generation in Wi-Fi

What is 802.11ac?

- Most efficient Wi-Fi standard to date
- Optimized for high bandwidth applications
- Backwards compatible with 802.11n and .11a
- Provides better coverage in dense environments
- Optimized for better client battery life

What Are the Features?

- Wider Channels and More Spatial Streams than 802.11n
- Data rates Up to 1.3 Gbps (Wave 1) & 2.6/3.5 Gbps (Wave 2)
- Operates in 5GHz Band only
- Multi-user MIMO mode

What to expect with 802.11ac when deployed on your network?

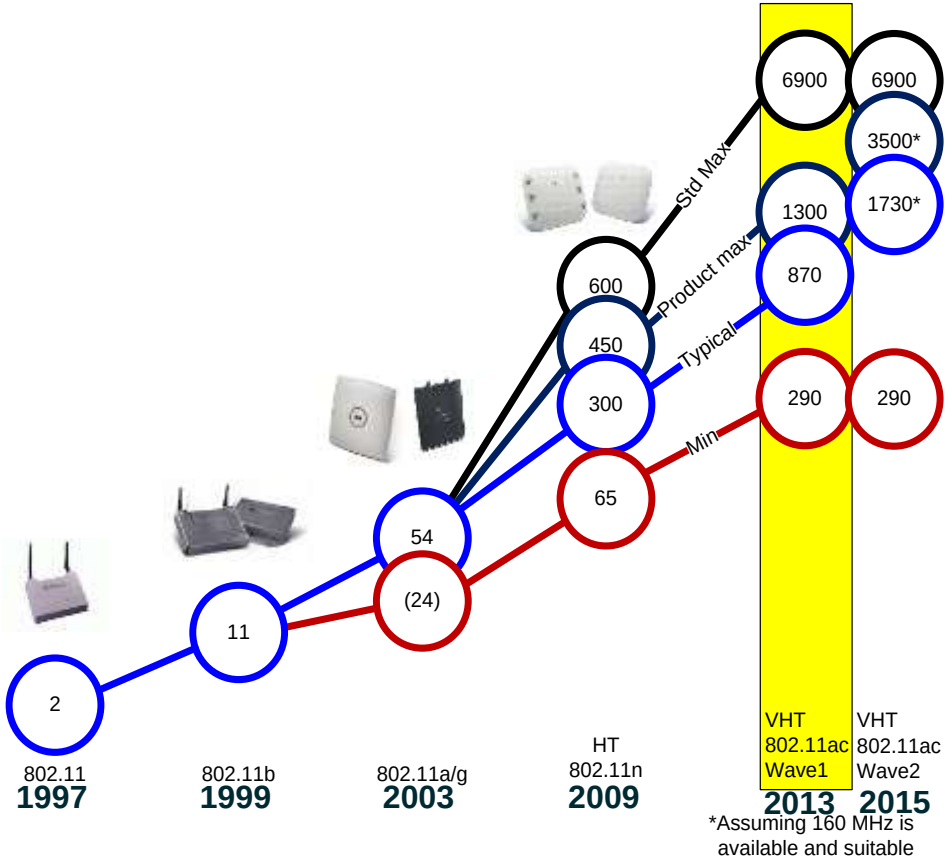
- **Noticeably faster connectivity enabling an enhanced Quality of Experience for the end user**
- **Wired-like experience at higher speed**
- **Significantly better client battery life**
- **Much higher client density because of greater efficiency for the entire cell**

What is 802.11? What is WiFi?

- Wi-Fi products are designed to implement the IEEE-802.11 standard and be certified for interoperability through the WiFi Alliance to get the logo
- The 802.11 technology has evolved over time, with new standard enhancements designated using a letter, e.g., 802.11a, 802.11b, etc.
- Lower case letter denotes the specific technology standards enhancements to the original 802.11 standard
- **Five main 802.11 generations** already, with the latest being 802.11ac Wave 1, but still only half-duplex (like a hub was)
- Each generation defines performance enhancements for devices operating in one or both 2.4 GHz and 5 GHz bands
- Sixth generation will extend to other bands (3.5 GHz, 900 MHz, 60 Ghz etc.)

Wi-Fi Technology	Frequency Band	Bandwidth or Maximum data rate
802.11b	2.4GHz	11 Mbps
802.11a	5GHz	54 Mbps
802.11g	2.4GHz	54 Mbps
802.11n	2.4GHz and 5GHz	450 Mbps
802.11ac	5 GHz	6900 Mbps

Fact: 802.11ac is here - is your network ready?



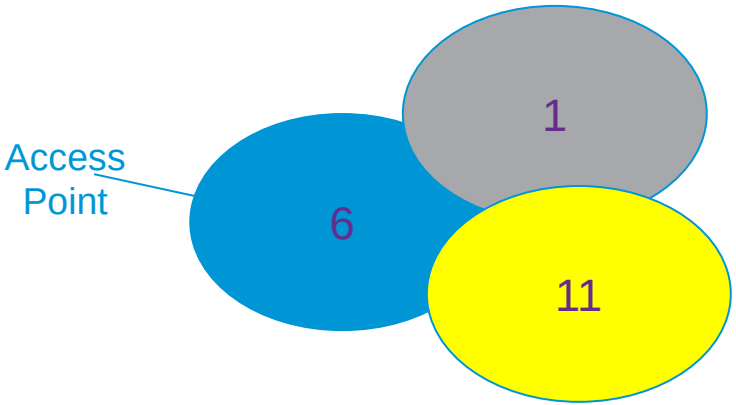
1997 – 2 mbps of data rate = 1 SD video flow max.
(level 2: 352x288, 30 img/sec, Extended profile H.264)

2013 – 870 mbps = 400+ SD video flows, or 50+ HD video flows
(Level 3.1: 1280×720, 30 img/sec, Extended profile – 14mbps peak)

Channel reuse scheme in the Network

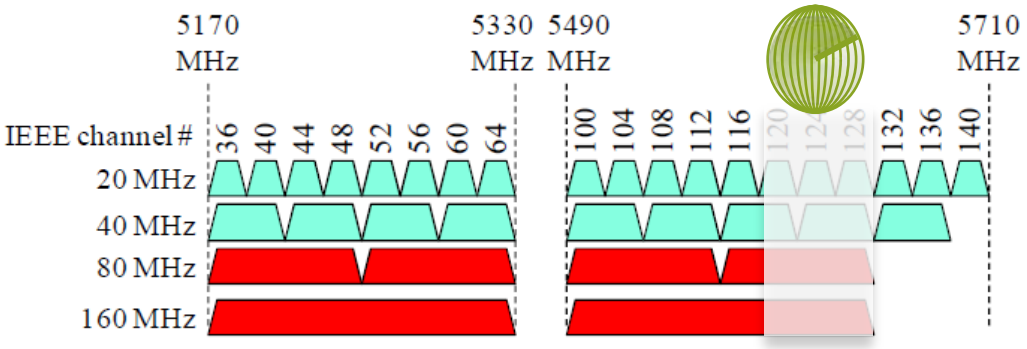
Neighboring APs use different channels to reduce interference.

On 2.4 GHz, the “Reuse cluster” size is equal to 3



802.11b / 802.11g / 802.11n

On 5 GHz, the “Reuse cluster” size varies depending on channel width:



802.11a / 802.11n / 802.11ac

Why is 802.11ac important today?

This section will guide you in understanding 802.11ac Wave-1 and Wave-2

802.11ac devices have started to emerge especially mobile devices so there is a customer need for improved performance

Cisco AP-3600
with .11ac module

Cisco AP-3700
802.11ac 5GHz
802.11n 2.4GHz

New .11ac clients starting to emerge

BEST LIST FOR IDENTIFYING NEW 802.11AC HARDWARE http://wikidevi.com/wiki/List_of_802.11ac_Hardware

WFA & IEEE Timelines

Wi Fi CERTIFIED Wave 1

IEEE 802.11ac Ratification

Wi Fi CERTIFIED Wave 2

CY 2012				CY 2013				CY 2014			
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4

Consumer class devices from Linksys and Netgear

Linksys 1x1 AC USB

802.11ac mobile devices

Samsung S 4

ZTE Grand Memo

HTC One

Intel® Dual Band Wireless-AC 7260 shipping

Cisco 802.11ac Module for AP3600

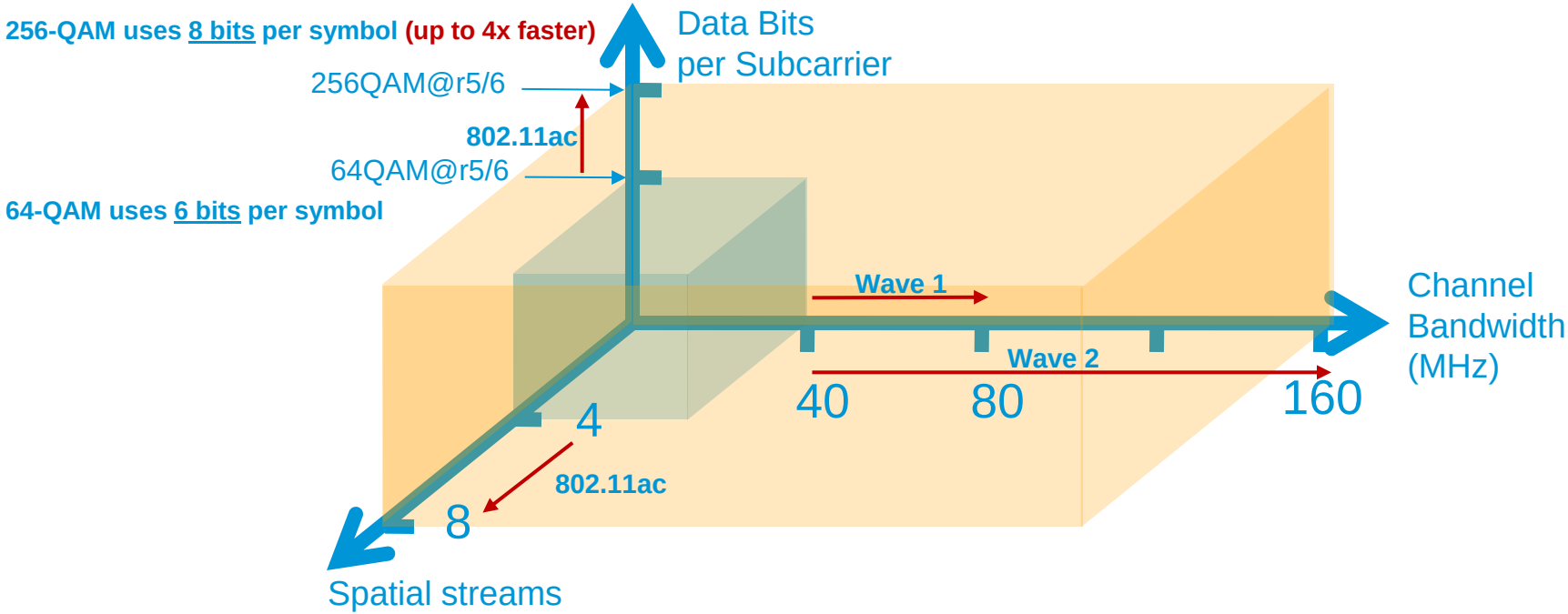
Apple release MacBook Air with 11ac

Apple release MacBook Pro Retina with 11ac

AP3700 Dual-band 802.11ac Wave 1

802.11ac Wave2 Starts to Roll 1H 2015

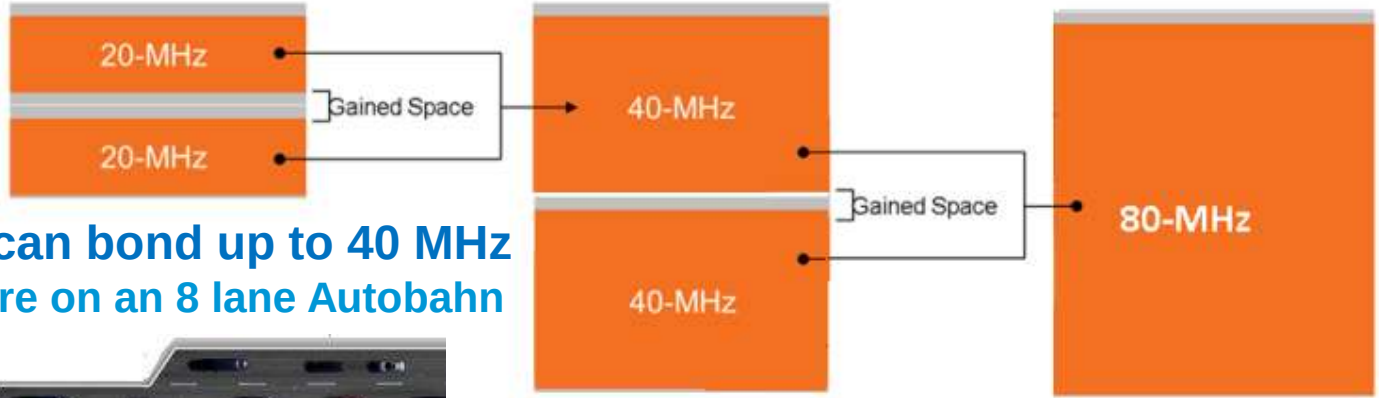
802.11ac goes faster than 802.11n with more bits/carrier, bandwidth & spatial streams



So let's talk about 802.11ac - How is it like .11n?

What about channel bonding?

Wave-1 allows up to 80 MHz channel bonding



802.11n can bond up to 40 MHz

Now we are on an 8 lane Autobahn

802.11ac can bond up to 80 MHz (Wave-1)

***up to 160 MHz (Wave-2)**

But why is channel bonding so important?

MCS rates @ 1 Spatial Stream in Mbps

MCS	Modulation	Ratio	20 MHz channel	40 MHz channel	80 MHz channel WAVE-1
			400 ns GI	400 ns GI	400 ns GI
0	BPSK	1/2	7.2	15	32.5
1	QPSK	1/2	14.4	30	65
2	QPSK	3/4	21.7	45	97.5
3	16-QAM	1/2	28.9	60	130
4	16-QAM	3/4	43.3	90	195
5	64-QAM	2/3	57.8	120	260
6	64-QAM	3/4	65	135	292.5
7	64-QAM	5/6	72.2	150	325
8	256-QAM	3/4	86.7	180	390
9	256-QAM	5/6	N/A	200	433.3

Phones such as the HTC One & Samsung S 4 have support for 802.11ac Wave-1 and 1-SS

More than 1-SS requires that the client have more radios which draw more power.

The goal is to enable devices to have more throughput with less battery draw

Most mobile devices will use 1-SS

Tablets & laptops can use 2-SS or more

Future phones such as the Samsung Galaxy S5 will even support 2x2 MIMO 802.11ac for the first time on Mobile devices

Channel Bonding Wave-1 and Wave-2

.11ac MCS Rates @ 1-spatial stream -- (Wave1) typically supports up to 3-ss

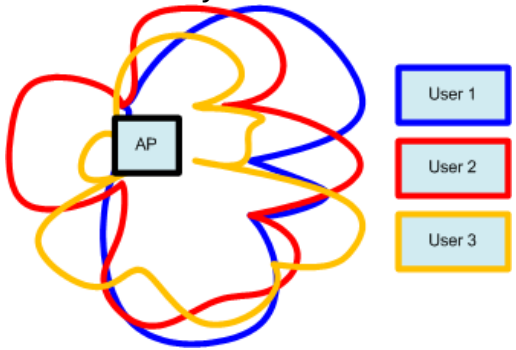
MCS	Modulation	Ratio	20 MHz channel		40 MHz channel		80 MHz channel WAVE-1		160 MHz channel WAVE-2	
			800 ns GI	400 ns GI	800 ns GI	400 ns GI	800 ns GI	400 ns GI	800 ns GI	400 ns GI
0	BPSK	1/2	6.5	7.2	13.5	15	29.3	32.5	58.5	65
1	QPSK	1/2	13	14.4	27.	30	58.5	65	117	130
2	QPSK	3/4	19.5	21.7	40.5	45	87.8	97.5	175.5	195
3	16-QAM	1/2	26	28.9	54	60	117	130	234	260
4	16-QAM	3/4	39	43.3	81	90	175.5	195	351	390
5	64-QAM	2/3	52	57.8	108	120	234	260	468	520
6	64-QAM	3/4	58.5	65	121.5	135	263.3	292.5	526.5	585
7	64-QAM	5/6	65	72.2	135	150	292.5	325	585	650
8	256-QAM	3/4	78	86.7	162	180	351	390	702	780
9	256-QAM	5/6	N/A	N/A	180	200	390	433.3	780	866.7

What about Multi-User MIMO (MU-MIMO)
Does it work? Any caveats?

WFA Wave 2 only, and optional

- **802.11ac MU MIMO is like 802.11n MIMO, except instead of one client, there are up to four clients**
  - AP does pre-coding for all the clients within the MU group simultaneously
  - In MU pre-coding, when AP beam-forms space-time streams to one client, it simultaneously null-steers those space-time streams to the rest.
  - All users' MPDUs are padded to the same number of OFDM symbols

- **MU-MIMO is technically risky and challenging:**
  - Needs precise channel estimation (CSI) to maintain deep nulls
  - Precise channel estimation adds overhead
  - Rate adaptation is more difficult
  - Throughput benefits are sensitive to MU grouping



Null-steering:To send data to user 1, the AP forms a strong beam toward user 1, shown as the top-right lobe of the blue curve. At the same time the AP minimizes the energy for user 1 in the direction of user 2 and user 3. This is called "null steering" and is shown as the blue notches. Same logic applies to red and yellow beams.

Beamforming – What did and didn't happen

Review – Beamforming 802.11n and now 802.11ac

	802.11n (EBF) Enhanced Beam Forming	Client Link 2.0 (CVBF) Cisco Vector Beam Forming
WLAN Client		
Works for Multiple Spatial Stream HT Clients	Not yet	All
Works for 1 SS HT Clients	Not yet	All
Works for Legacy Clients (11 a/g)	None	All
General Requirements/Dependencies		
Requires Client Cooperation/Support	Yes	No
Requires Use of Channel Time for Sounding	Yes	No
Can be Used w/ Clients Currently on Market	No	All 11a/g/n

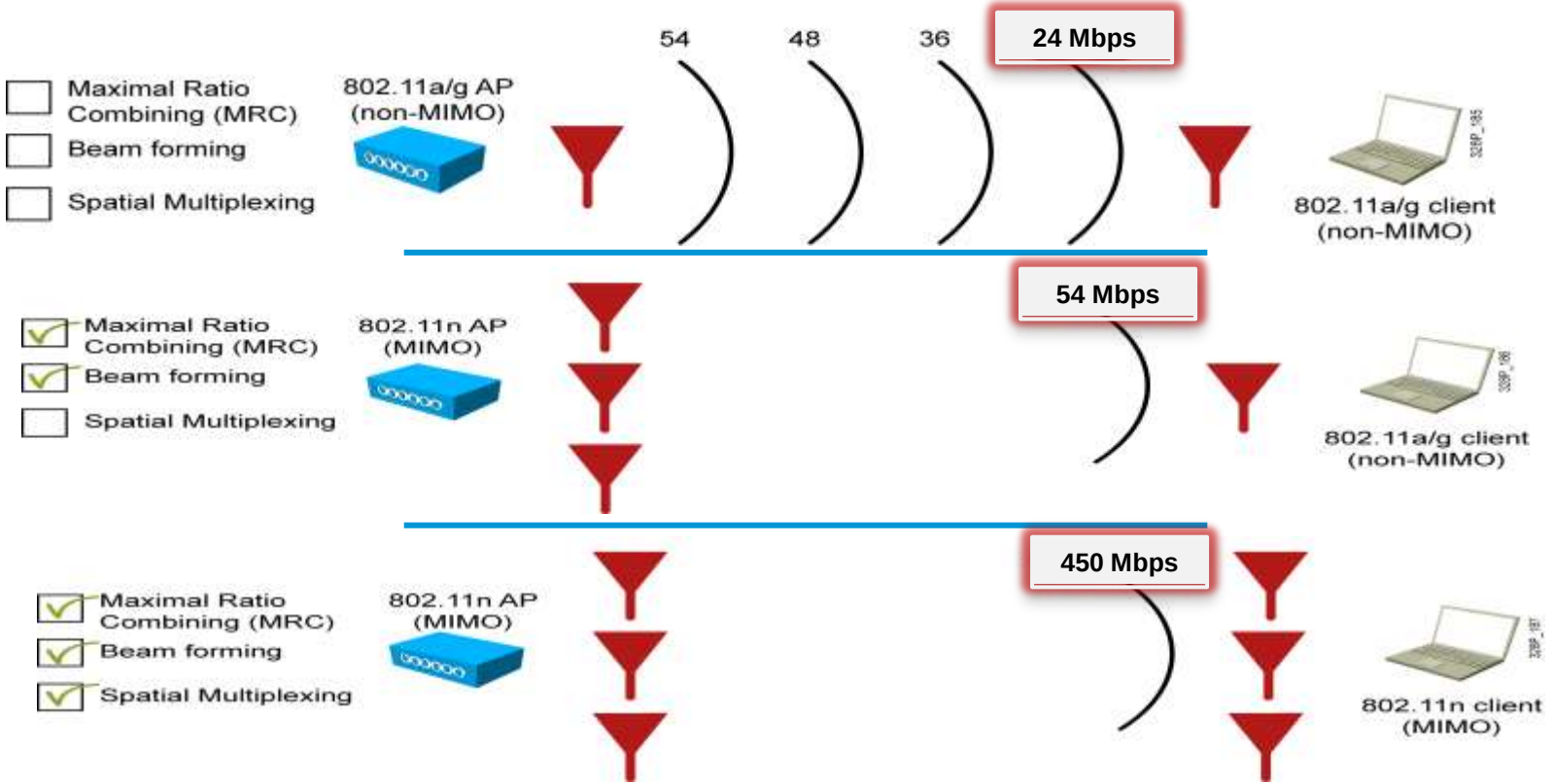
EBF Enhanced Beam-forming didn't make it in 802.11n but it's now in 802.11ac

Lots of channel sounding mechanisms and the industry could not decide at the time which one to use so everything was proprietary

This got a lot better with 802.11ac after a single sounding method was agreed upon.

Note: EBF changed to ECBF Explicit Compressed Beam Forming

Advanced Techniques Improve Data Rates for All Clients



The same applies exactly to 802.11ac

Client cell sizes are similar between .11n and .11ac

Using the internal .11n radio on the AP-3600i, we performed cell size characterization measurements with .11n rates using several .11n clients.

Switching to .11ac clients and the .11ac radio module, it performs similar @40 MHz with clients having a cell size similar to the .11n clients.

Take-away 11n/11ac are similar in range, but of course @80 MHz and 256-QAM, you get a significant data-rate boost

A facility in Ohio used for competitive testing

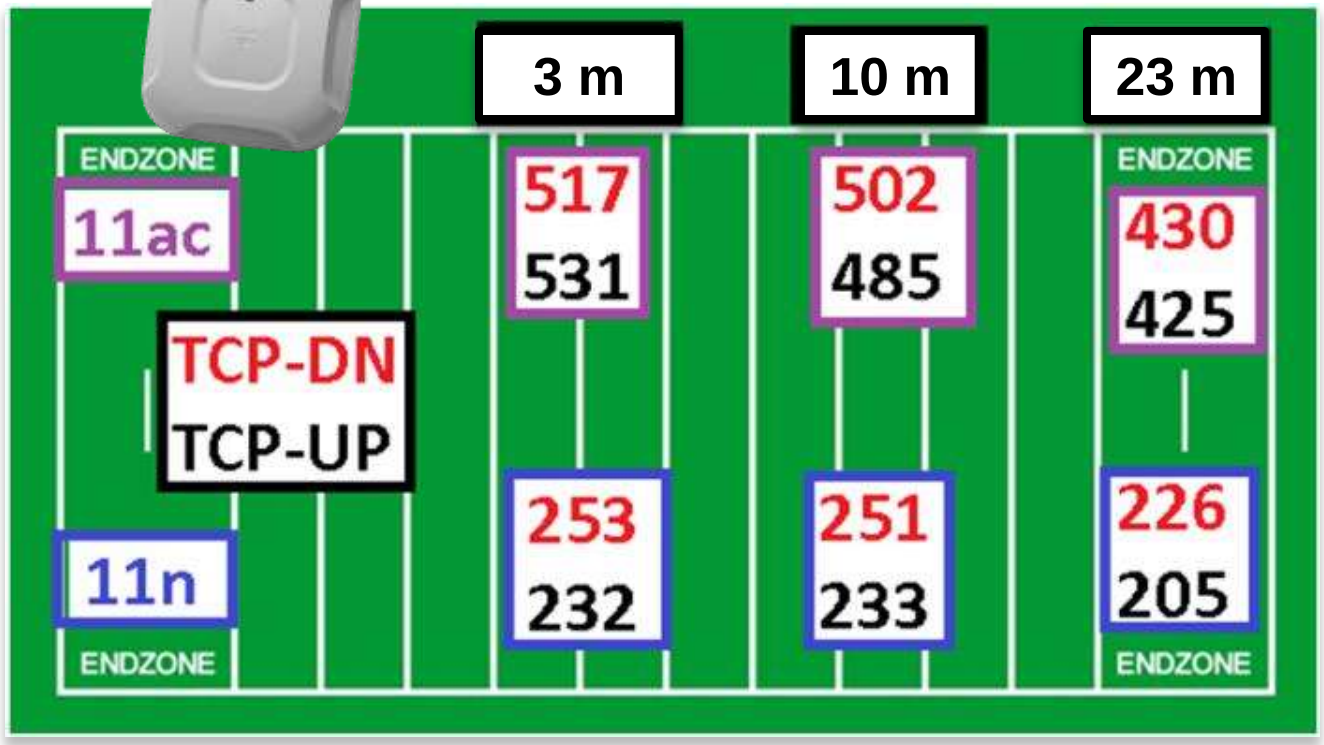
Any Rate over Range data?

Comparing 802.11ac versus 802.11n using 3-SS clients

11ac client
Dell E6430 with
Broadcom 3-ss

Vs.

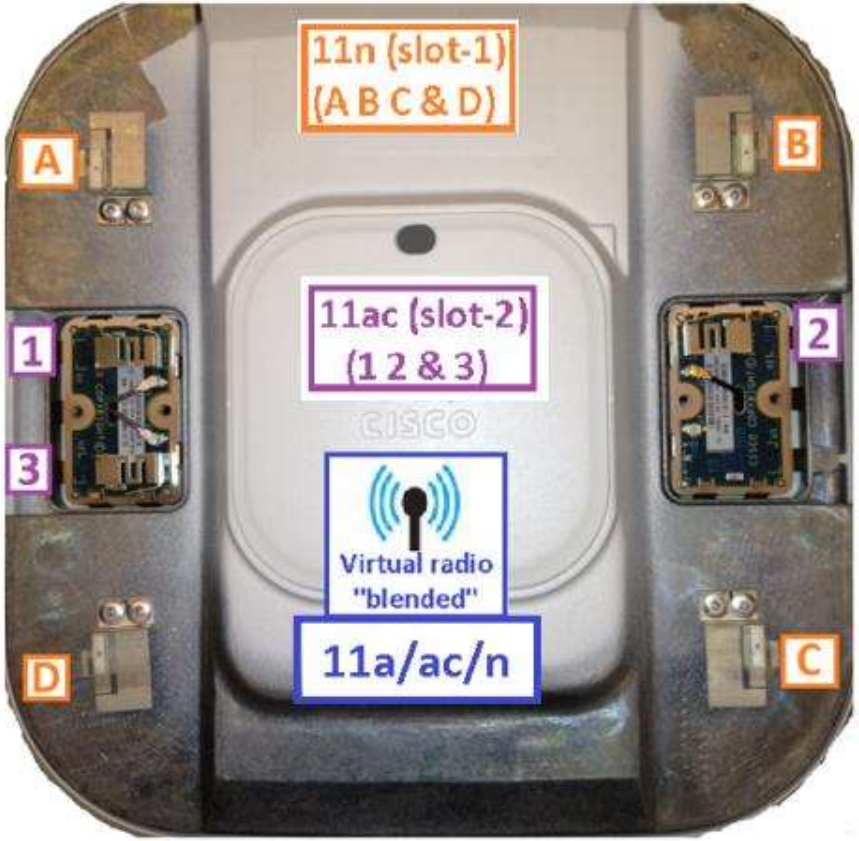
11n client
Apple 3-ss
Macbook Pro



(Take-away) 802.11ac client @ 3-ss is able to get twice the speed than 802.11n

Cisco RF Innovations

Access Point modularity



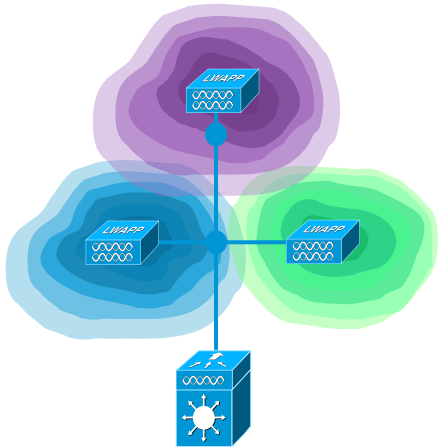
Working as ONE virtual radio

Radios work together in tandem (blended) to maintain proper radio isolation and performance

Will be pushed for Wave-2 radios the same way in AP-3600 and AP-3700

RF High Availability – RRM – also for 80MHz

- What are Radio Resource Manager's objectives?
  - Provide a system wide RF view of the network at the Controller even for 80MHz channels (only Cisco!!)
  - Dynamically balance the network and mitigate changes
  - Manage Spectrum Efficiency so as to provide the optimal throughput under changing conditions
- What's RRM
  - DCA—Dynamic Channel Assignment
  - TPC—Transmit Power Control
  - CHDM—Coverage Hole Detection and Mitigation
- RRM best practices
  - RRM settings to auto for most deployments (High Density is a special case)
  - Design for most radios set at mid power level (lever 3 for example)
  - Survey for lowest common client type and technology supported
  - RRM doesn't replace the site survey and doesn't create spectrum



For more info: http://www.cisco.com/en/US/tech/tk722/tk809/technologies_tech_note09186a008072c759.shtml

What are Some WiFi Typical Challenges?

- Interference from other WiFi networks in the venue
- Interference from non-WiFi systems operating in the same band
- Co-channel interference: Many APs in the venue, but effectively no more capacity

- Clients operating at low data rates (ex. 802.11b) pull down the performance of the network
- Clients mistakenly choose a 2.4 GHz radio (louder signal) instead of 5 GHz (less load)
- Sticky Clients: Clients mistakenly stay on the same AP, even when the person has moved from one end of the venue to another

- Limitations on mounting assets. Hard to put APs where you want them
- Probe storms: 2.4 GHz clients probe on all 13 overlapping channels
- Ad Hoc Viruses: Clients forming bogus ad hoc networks such as “Free Public WiFi”

All of these require more than just a great Adaptive Algorithm for channel and power

Cisco High Density Experiences (HDX)

CLEAN AIR

Spectrum Intelligence

CLIENT LINK

Optimized Wireless Client Performance

Performance

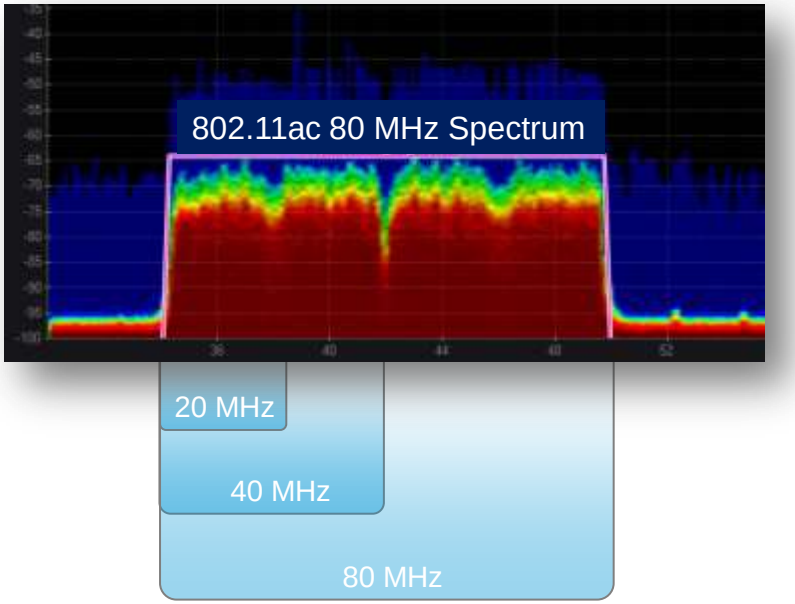
Multi-Client Performance

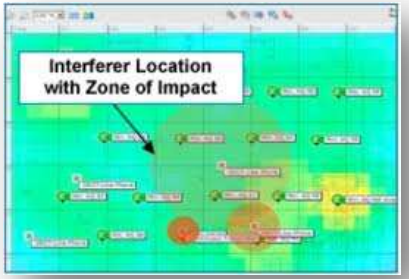
Smart Roaming

Seamless Roaming Experience

Clean Air

- Provides continual, system-wide discovery without performance impact
- Accurately identifies source, location, and scope of interference
- Takes automatic action to avoid current and future interference, with full history reporting
- Cisco AP 3700 provides complete visibility over 80 MHz 11ac spectrum

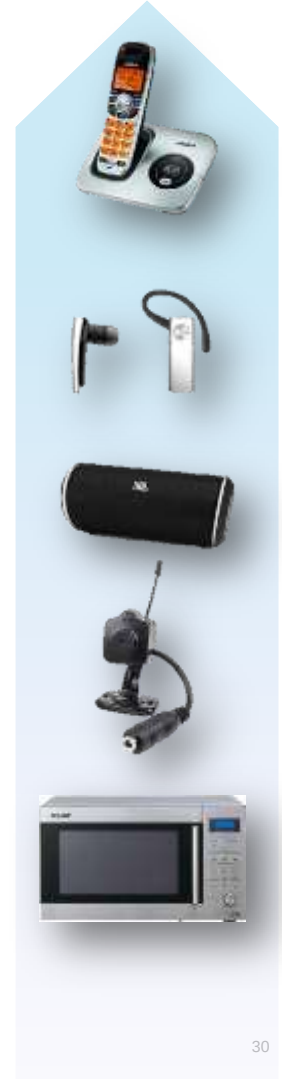




Spectrum Intelligence

- Dedicated hardware chipset for monitoring spectrum
- Identifies interferer signatures by penetrating beyond Layer 1

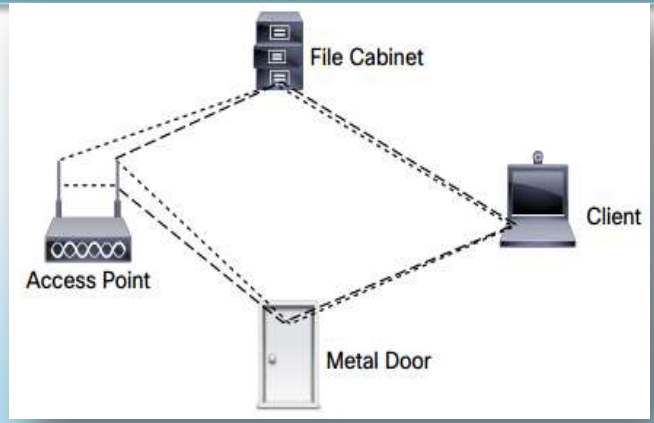
  (Records pseudo MAC address to avoid duplication)
- Quick and Accurate Interference Detection to Reduce False Positives
- Aggregation of all alarms/ alerts on Prime level to monitor health of entire network



What is ClientLink? Beamforming!

Sound Bar (5.1 Virtual Channels)

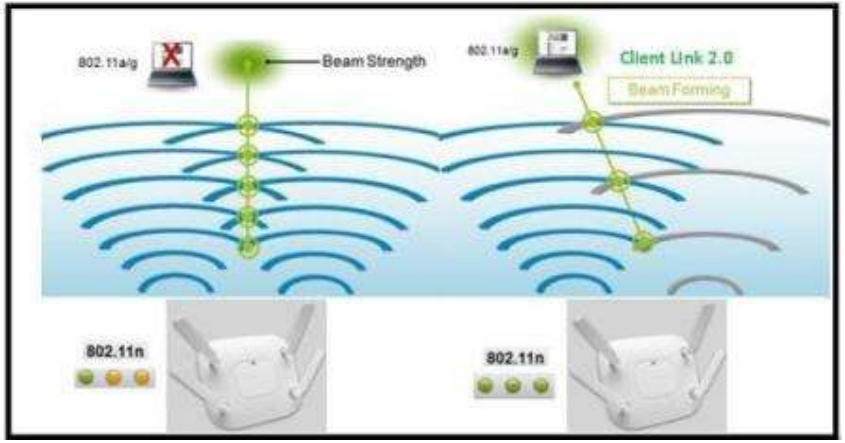
Cisco AP 3700 with 4 TX/RX Antennas



http://www.cisco.com/en/US/prod/collateral/wireless/ps5678/ps11983/at_a_glance_c45-691984.pdf

Cisco's innovation in Beamforming

Why You Want More Receivers and Client Link 2.0/3.0



3600 and 3700 with multiple transceivers have ONE EXTRA RADIO PER BAND then the competition
Increases fidelity creating a more predictable and reliable 802.11n/ac performance

The picture above is an example of a 1-SS beam-form similar to what is done in Client Link 1.0 however – using Client Link 2.0/3.0 we can do this with multiple spatial streams.

The AP-3600/AP-3700 support three spatial streams with four transceivers for even greater performance, and then adds Client Link 2.0/3.0 enhancements

Client Link 2.0 benefits 802.11a/g/n 1-SS, 2-SS and 3-SS clients. ClientLink 3.0 also benefits 802.11ac 1-SS, 2-SS and 3-SS clients.

Note: You need 4 radios to beam-form to 3-ss clients - no one else has this

256QAM Heat Map: Cisco 3702i vs. Competition

- ClientLink 3.0 helps the 3700 achieve 256 QAM with m9 rate
- AP 3700 has a significant 256 QAM advantage over the competition 11ac AP
- The Test:

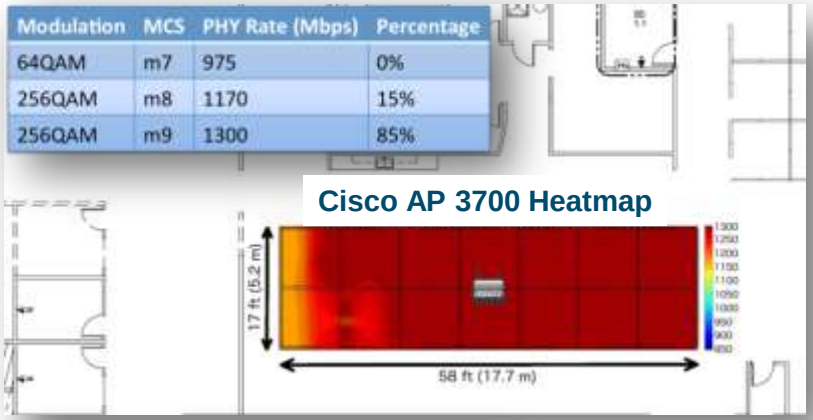
  Use a MacBook Pro (3ss) and record the data rate in 40+ locations in a cubicle environment while running traffic to the client.

ClientLink 3.0 YouTube video:

http://www.youtube.com/watch?v=0q_shbSpOIA

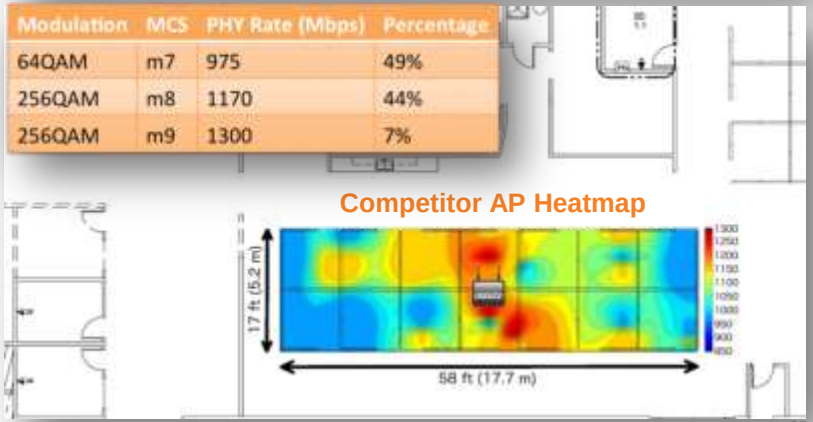
Modulation	MCS	PHY Rate (Mbps)	Percentage
64QAM	m7	975	0%
256QAM	m8	1170	15%
256QAM	m9	1300	85%

Cisco AP 3700 Heatmap



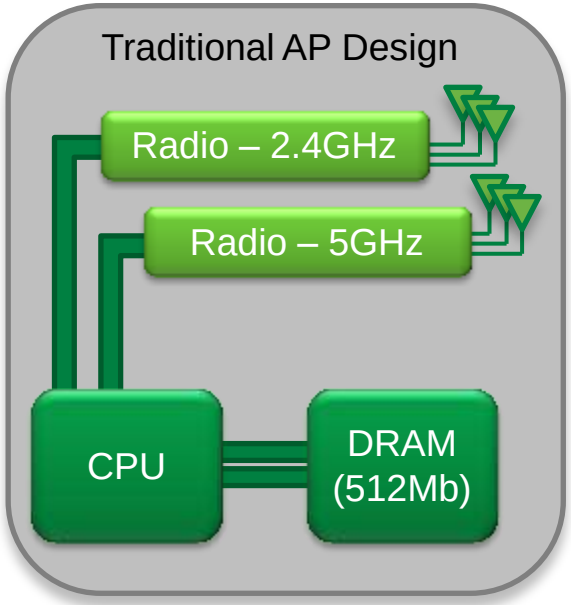
Modulation	MCS	PHY Rate (Mbps)	Percentage
64QAM	m7	975	49%
256QAM	m8	1170	44%
256QAM	m9	1300	7%

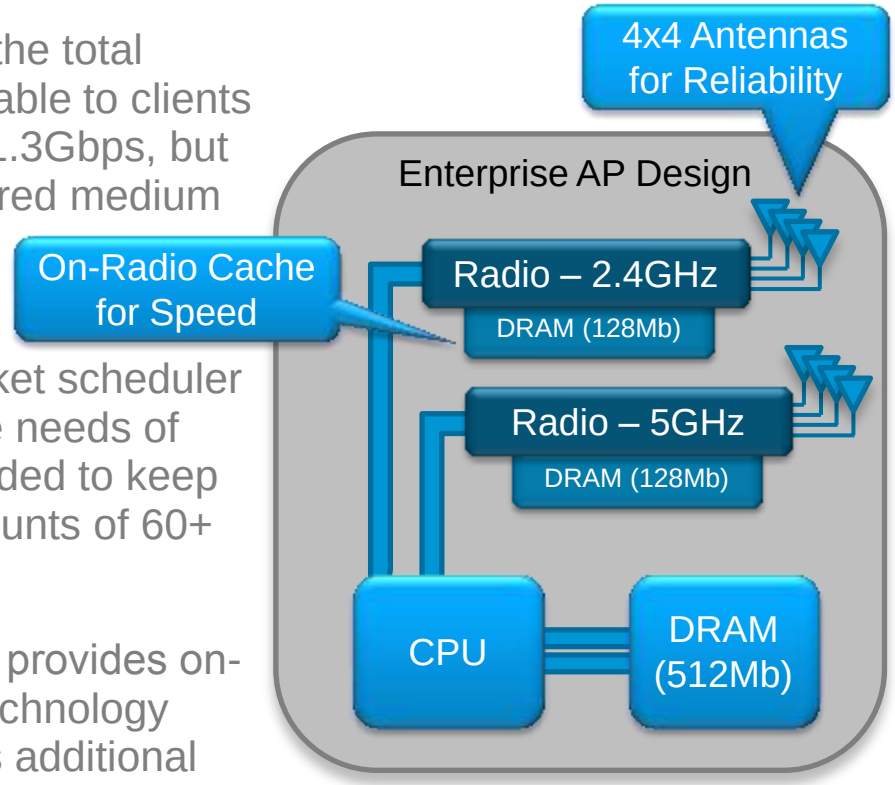
Competitor AP Heatmap



Multi-Client Performance Innovation

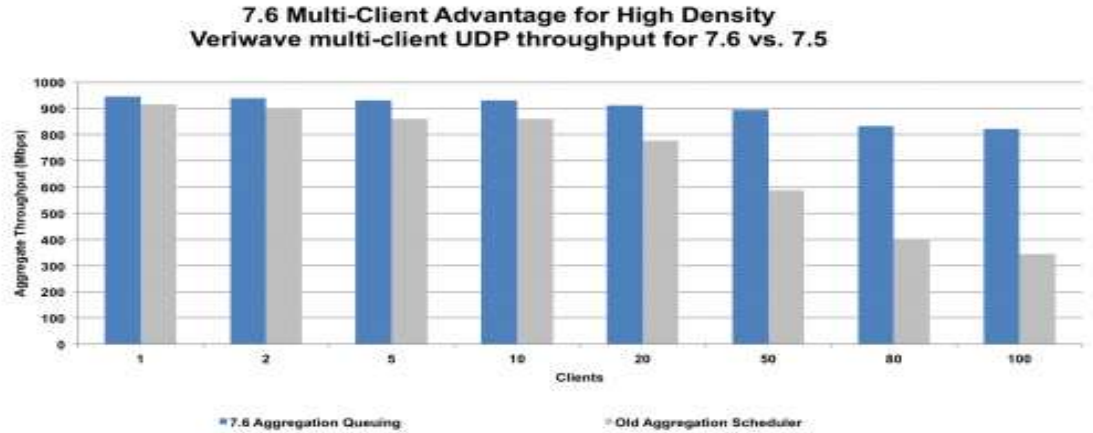
- With 802.11ac, the total bandwidth available to clients is increased to 1.3Gbps, but this is still a shared medium technology.
- An efficient packet scheduler designed for the needs of 802.11ac is needed to keep up with client counts of 60+ per radio.
- Cisco's AP3700 provides on-radio caching technology which leverages additional RAM for per-client queuing techniques.



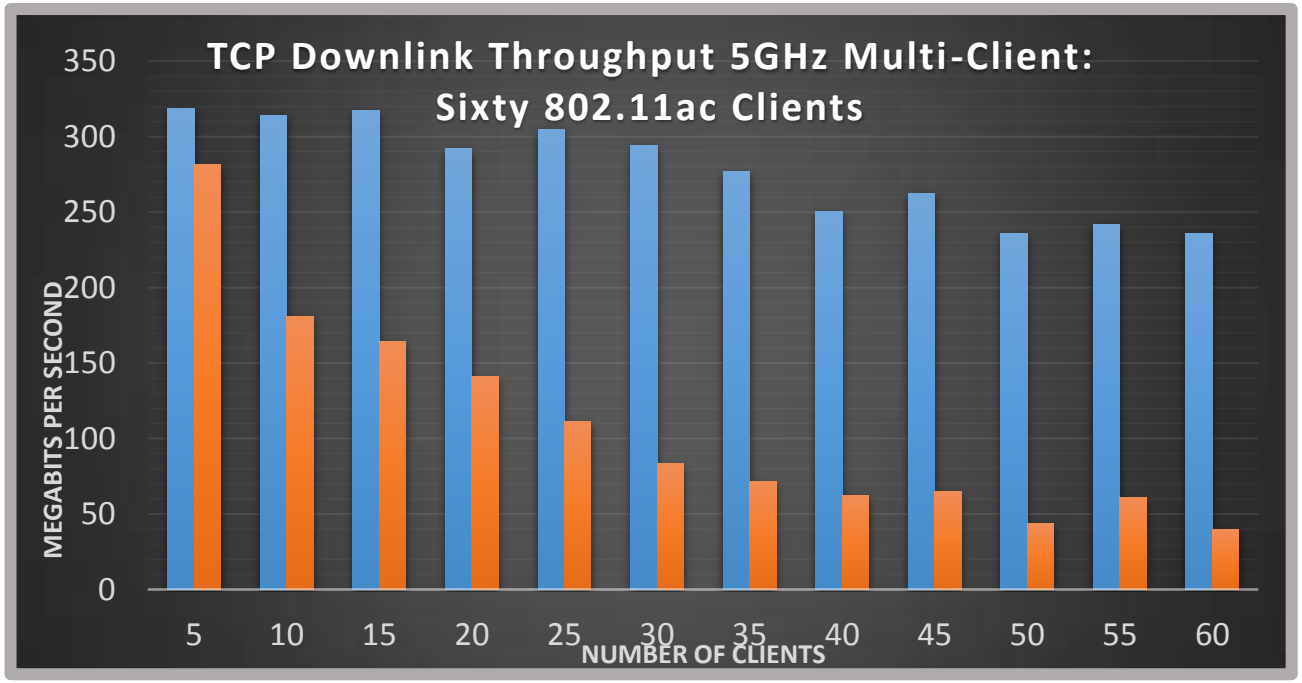


Optimum High-density MAC scheduling

- Challenge: best 802.11n/ac MAC efficiency (throughput) only achieved when air-time usage (TXOP) is maximized
- AP “bursts” all IP packets to each user during each TXOP regardless of protocol, packet-size and # clients
- **Only Cisco’s 3700 AP architecture can achieve this!**



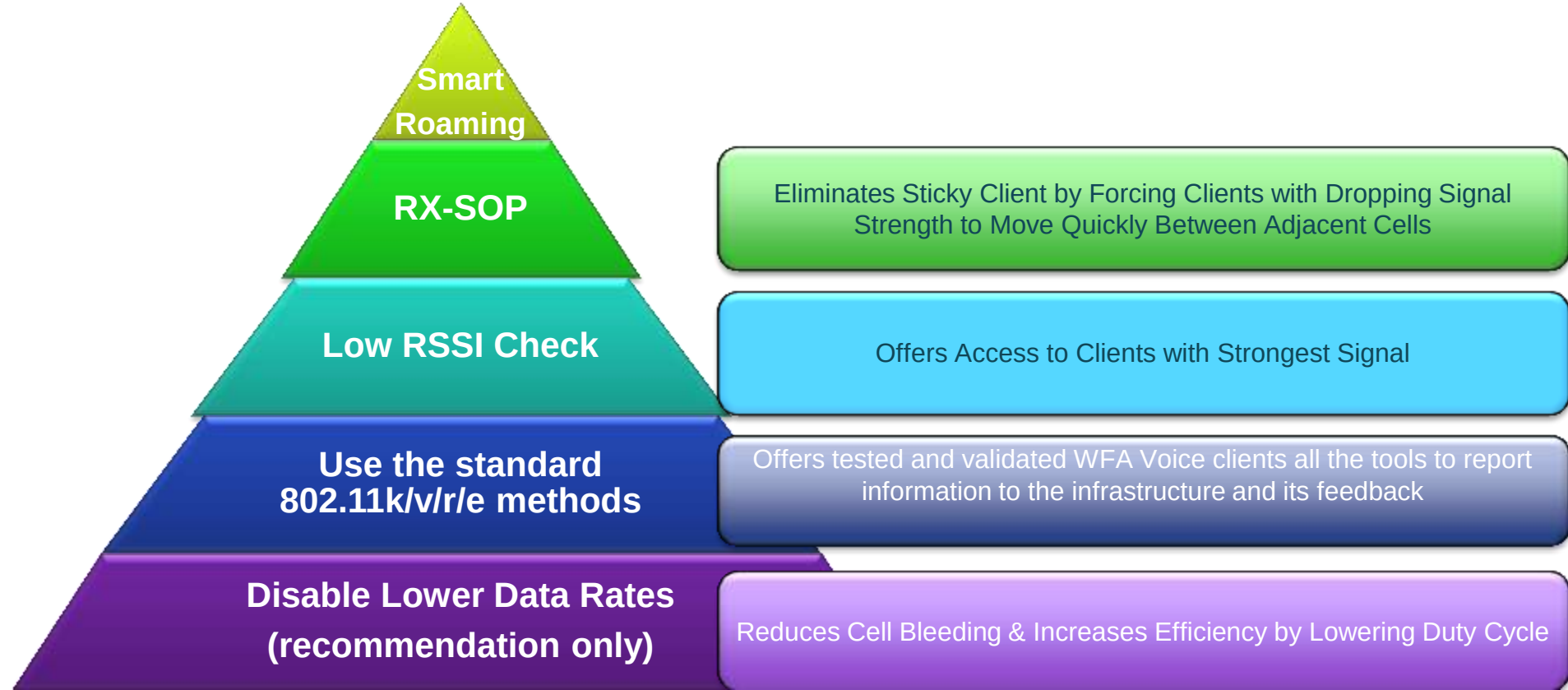
Multi-Client Performance Results



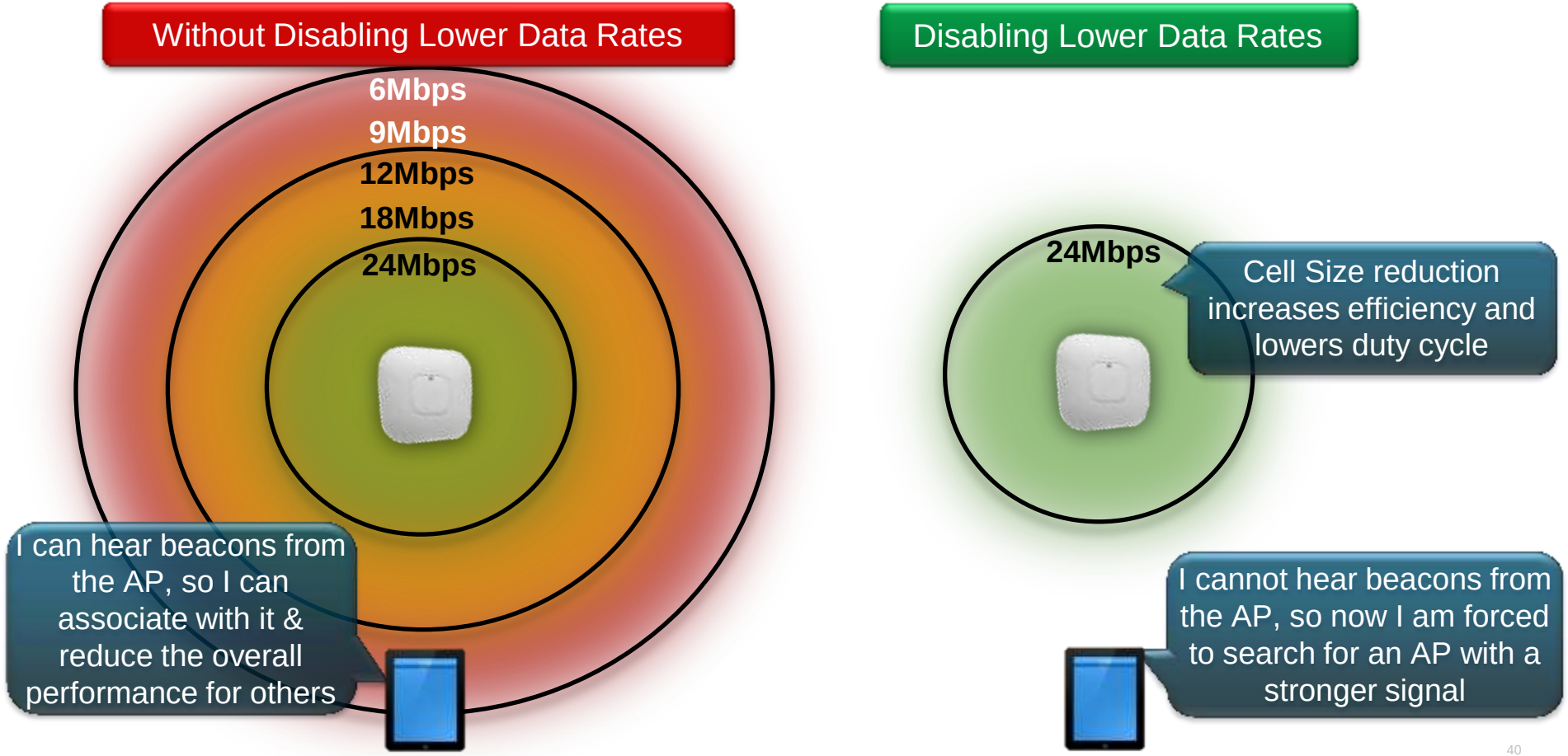
HDX Multi-Client YouTube video:

http://www.youtube.com/watch?v=C8gfnCVm-3o&

How do we provide optimized roaming experience?



Disable Mandatory Lower Data Rates



Intra-network roaming-related standards – Voice Enterprise Certification

Measurement

802.11k based measurement

- Clients measure the radio environment on behalf of AP & to troubleshoot performance
- AP summarises data for clients so they can choose BSS

Management

802.11v based management

- APs recommend BSS transitions to clients to move to another AP based on network load & network topology

Wi-Fi CERTIFIED

Voice Enterprise

Roaming

802.11r based transition

- Client is enabled to transition quickly to new AP within the same mobility domain, by re-use of 802.1X security keys
- Transition within 50ms

Performance

802.11e based performance

- Uses WMM-AC (based on 802.11e) to reduce congestion
- Clients required to satisfy limits on latency, jitter, packet loss & consecutive lost packets

Challenges with roaming

- 802.11k/v part of Enterprise Voice certification BUT

  Many devices do NOT support this fully

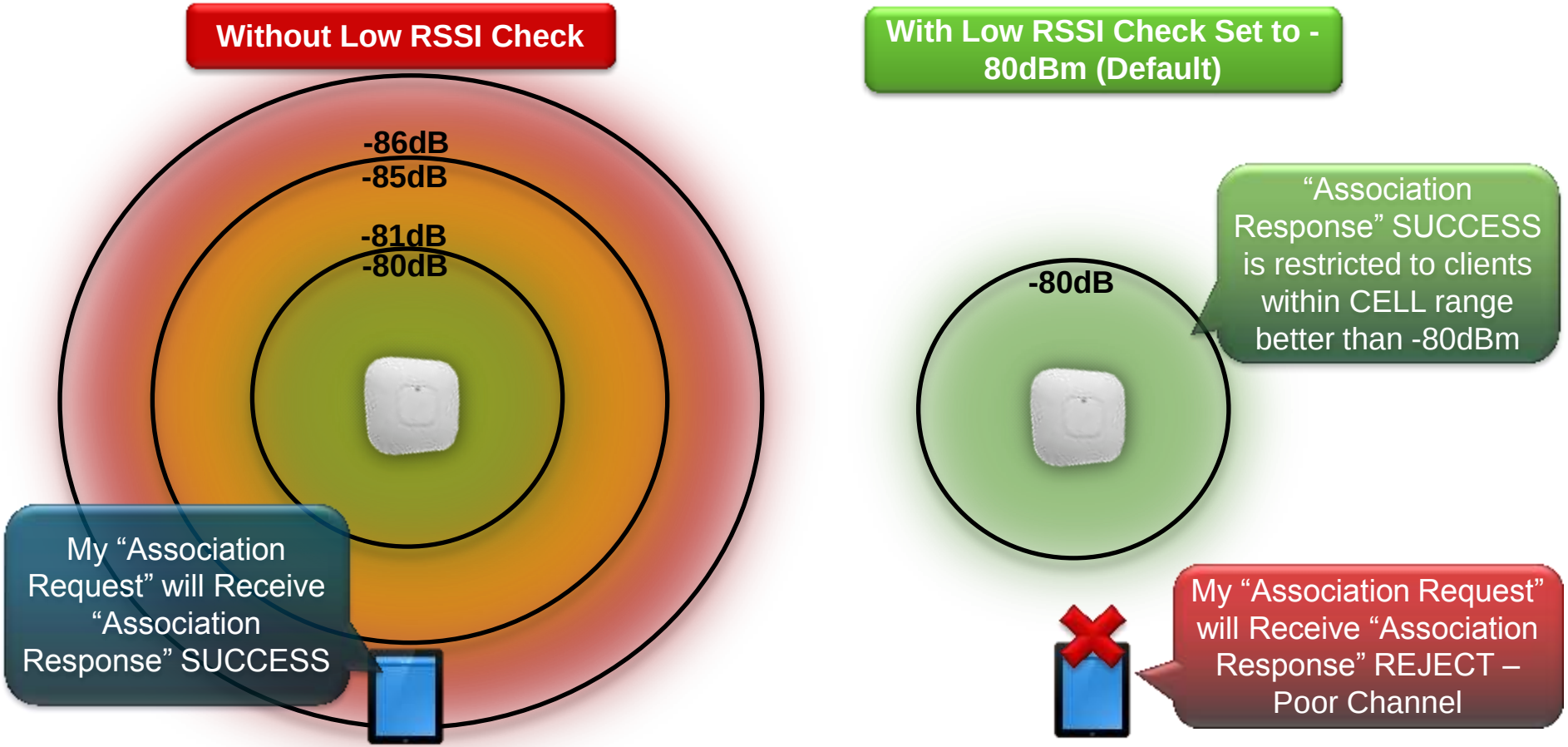
  Devices don’t always “take the hint” (i.e. to handoff)

  RSSI thresholds are static BUT WiFi channel is dynamic

  Thus, client’s can still be “sticky” and not roam when directed by standards

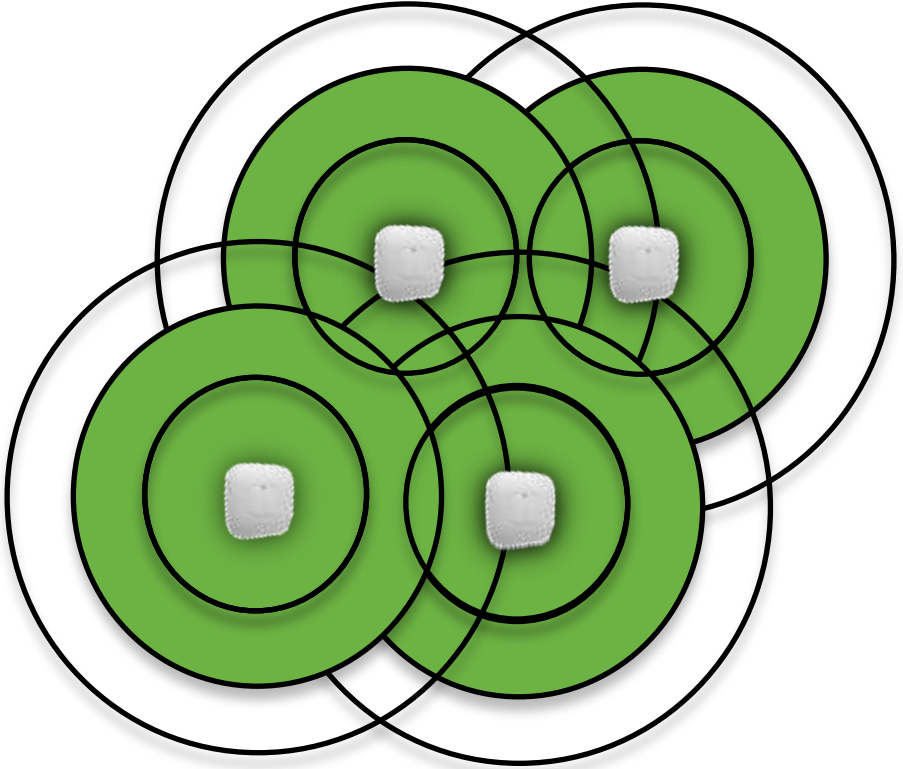
- Cisco’s approach is to:
  - Address the “Sticky client” problem irrespective of 802.11k/v support
  - Use optimized roaming decisions based on real-time conditions
  - Use techniques to ensure other currently associated clients don’t suffer

Low RSSI Check



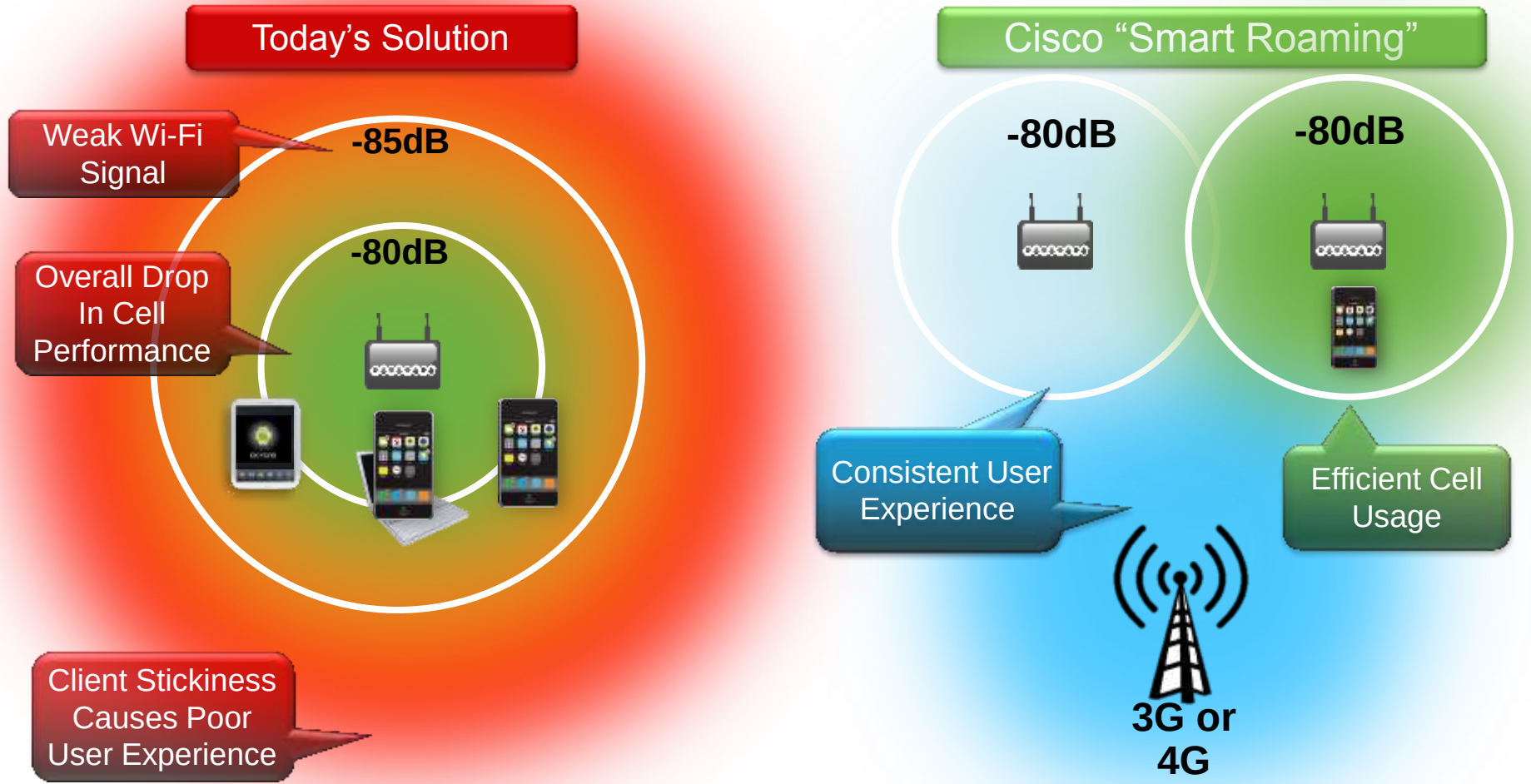
Rx-Sop

- Rx Sop is **radio's receiver sensitivity** – How well AP can hear clients
- Decreasing Rx-SOP to low level (-95 dBm) increases cell size
- Raising Rx-SOP to high level (-75 dBm), reduces the cell size, which provides much better spatial re-use
- Smaller cell size and efficient re-use of spectrum is key in the High Density

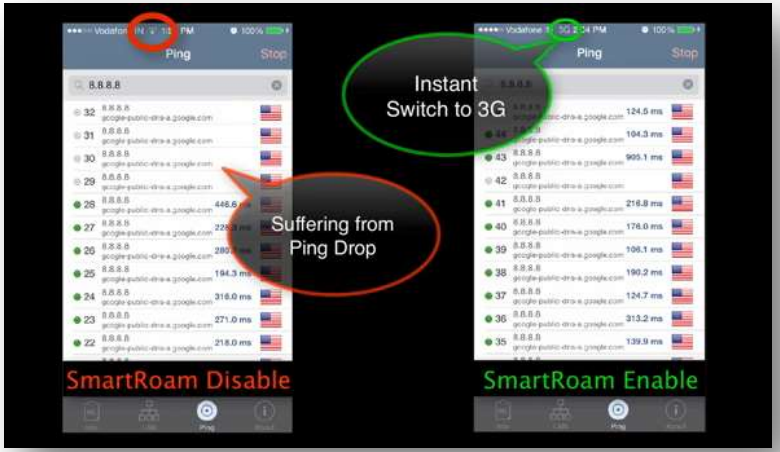


Higher Rx-Sop Threshold = Smaller Cell Size = Better spectrum re-use

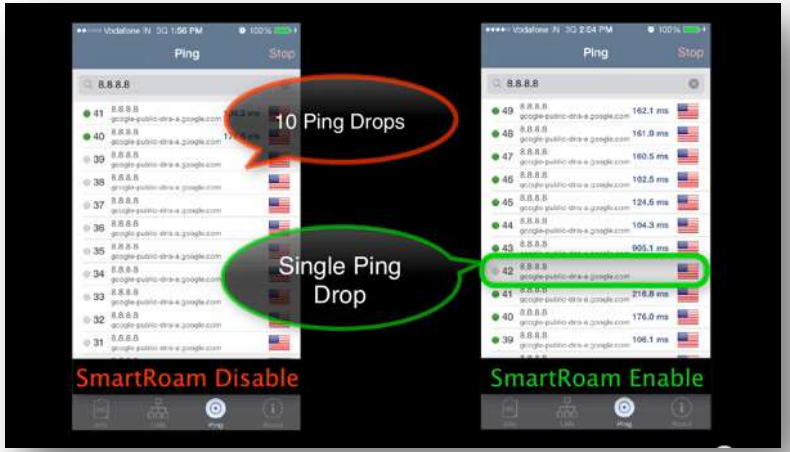
Introducing Cisco “Smart Roaming” innovation



Seamless roaming across Wi-Fi and/or Cellular network



~10 x Faster transition to available stronger network

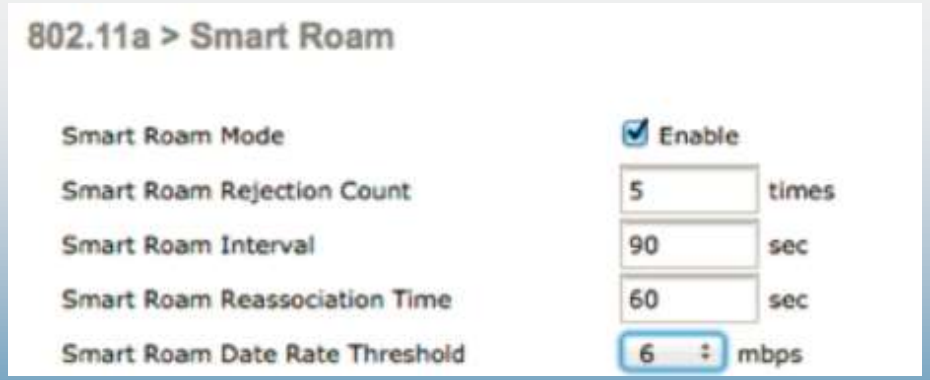


Always ON device with very minimum downtime

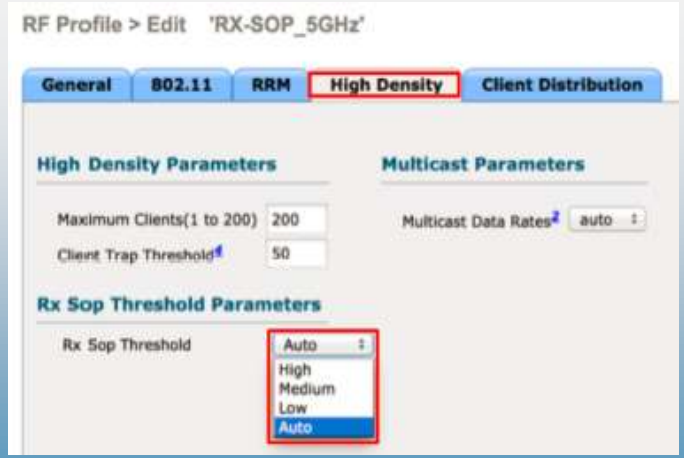
“Smart Roam” is Agnostic of Mobile Device & OS Type

Controller Parameters (in upcoming 8.0 software)

Smart Roam



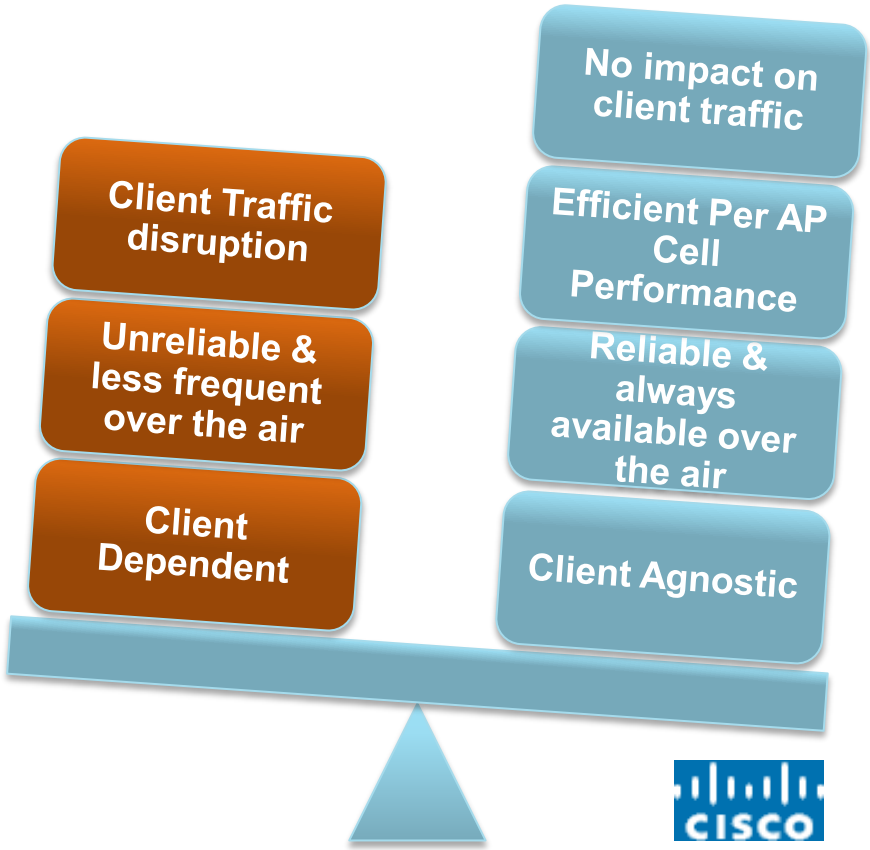
RX-SOP



RX-SOP Threshold	High	Medium	Low	Auto
2.4 GHz	-76 dBm	-78 dBm	-80 dBm	Radio default
5 GHz	-79 dBm	-82 dBm	-85 dBm	Radio default

Why Cisco “SmartRoam” is Better than Competitors?

Client Steering decisions are based on RSSI retrieved from **Probe Request**



Client Steering decisions are based on RSSI retrieved from **Data Packets**

Case Studies of very High Density experiences

Cisco Live Orlando 2013

Over 20,000 attendees

Over 600 access points

Cisco Prime for Management

Cisco MSE for Analytics

Network reliability: 99.999%

http://www.cisco.com/en/US/prod/collateral/wireless/ps5678/ps11983/case_study_c36-729140.html

Super Bowl XLVII (2013)

Over 30,000 simultaneous connections

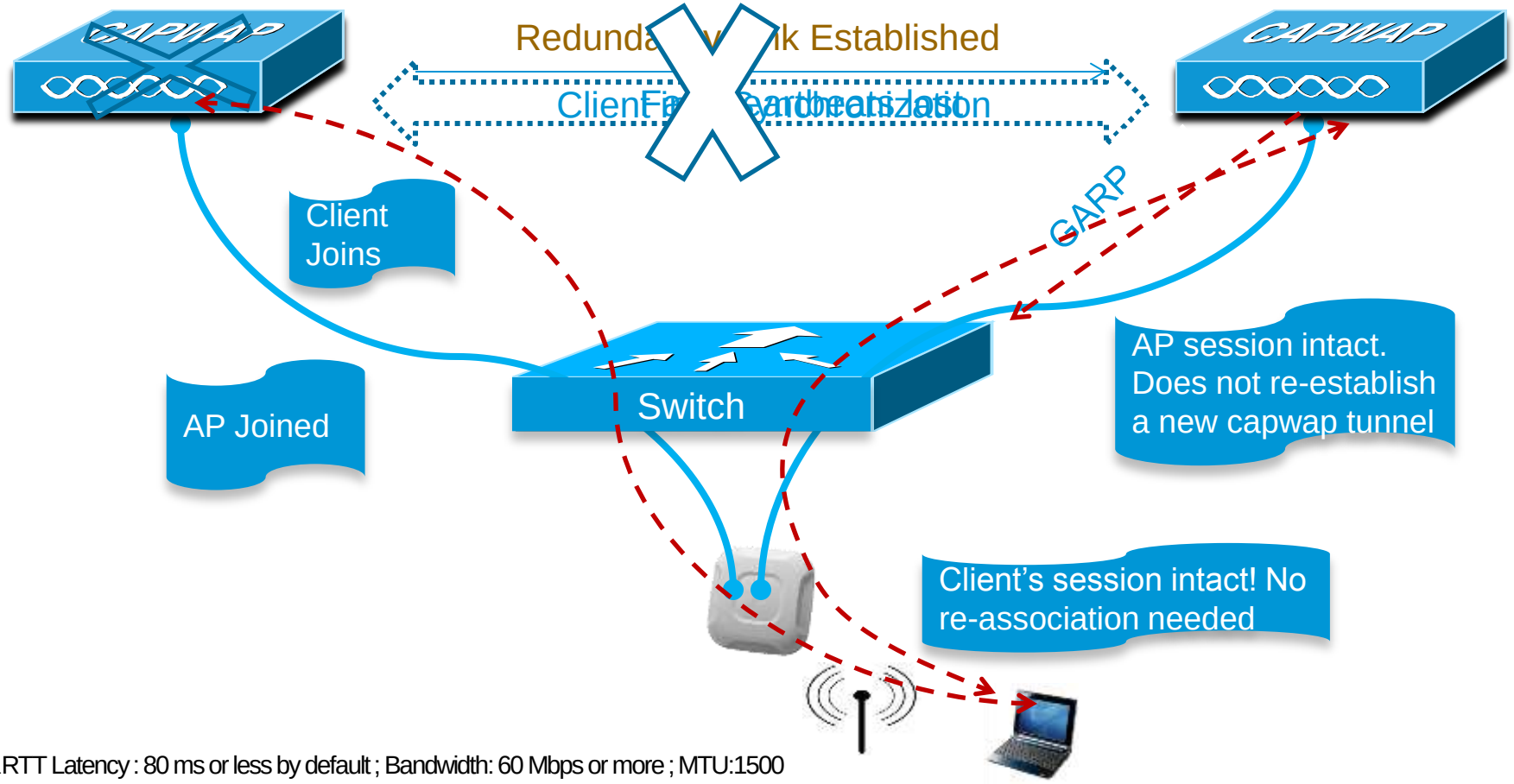
Over 600 access points

Over 370 GB of data transfer over Wi-Fi

Always ON wireless network

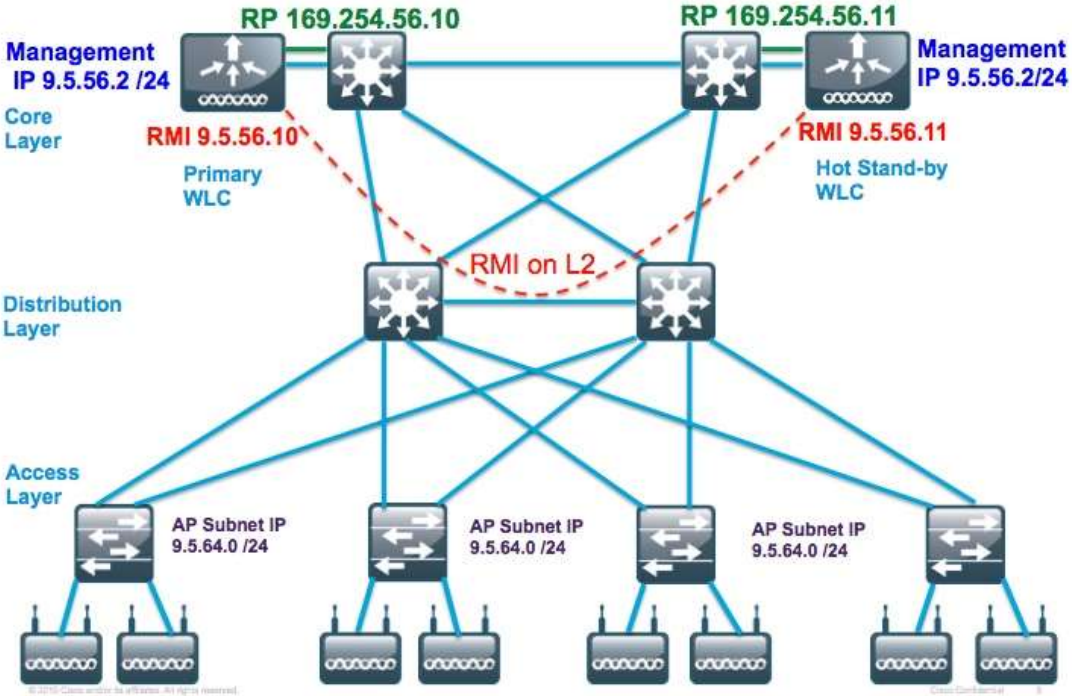
http://arstechnica.com/information-technology/2013/02/super-bowl-plans-to-handle-30000-wi-fi-users-at-once-and-sniff-out-rogue-devices/

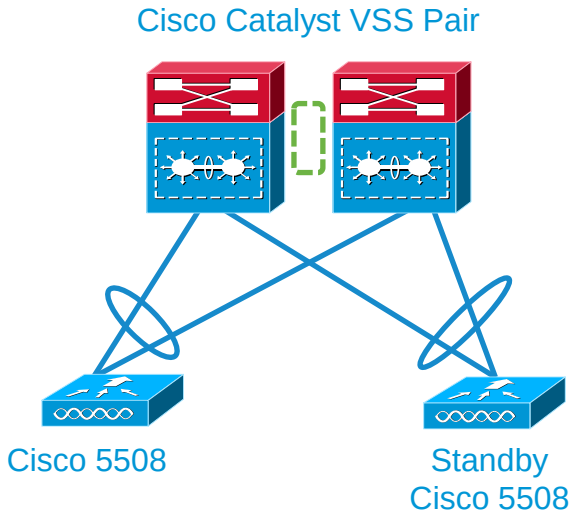
Stateful High Availability end-to-end with Client SSO



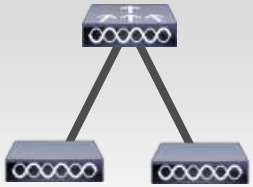
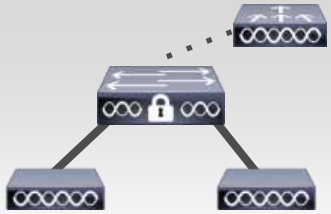
.RTT Latency : 80 ms or less by default ; Bandwidth: 60 Mbps or more ; MTU:1500

Full infrastructure resiliency support





One Network: Wireless Deployment Modes **options**

	Autonomous	FlexConnect	Centralized	Converged Access
	 Standalone APs	 Traffic Distributed at AP	 Traffic Centralized at Controller	 Traffic Distributed at Switch
Target Positioning	**Small Wireless Network**	**Branch**	**Campus**	**Branch and Campus**
Purchase Decision	Wireless only	Wireless only	Wireless only	Wired and Wireless
Benefit	• Simple and cost-effective • Enterprise Class AP quality • Provides Bridge functionality	• Highly scalable for large number of branches • No controller at branch	• Most feature rich solution • Wireless Traffic visibility at the controller	• Wired & Wireless common operations • One Enforcement Point • One OS (IOS) • Traffic visibility at every network layer
Key considerations	• Limited features • First step to Controller based • Sell when price is the only factor	• L2 roaming only • Branch with WAN bw and latency requirements	• Top Performance and Scalability	• Access layer refresh (3650/3850)

Summary: Cisco Unified Access = Innovation Leadership

One Network

Converged Access	Common LAN and WLAN Fabric (UADP ASIC) – Common OS (IOS) – SDN Ready (API/SDK)
Gigabit Wi-Fi	**802.11ac** standard leadership – the transformational technology for the new Gigabit Wi-Fi Edge
SSO	**Stateful Switchover** / Non-stop operation of both the LAN and WLAN
AVC	**Application Visibility & Control** across LAN and WLAN using 1,000+ dynamically updated signatures
BSD	**Bonjour Services Directory** – Multicast DNS discovery & advertisement
CMX	**Connected Mobile Experiences** - Advanced location services & analytics for business intelligence
CleanAir	Automatic chip level innovation for interference mitigation & RF reconfiguration

One Policy & One Management

ISE

Prime

Innovative questions?


Thank you.