
TOMORROW
starts here.

Design and Deployment of Wireless LANs for Voice and Video

BRKEWN-2000

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#clmel

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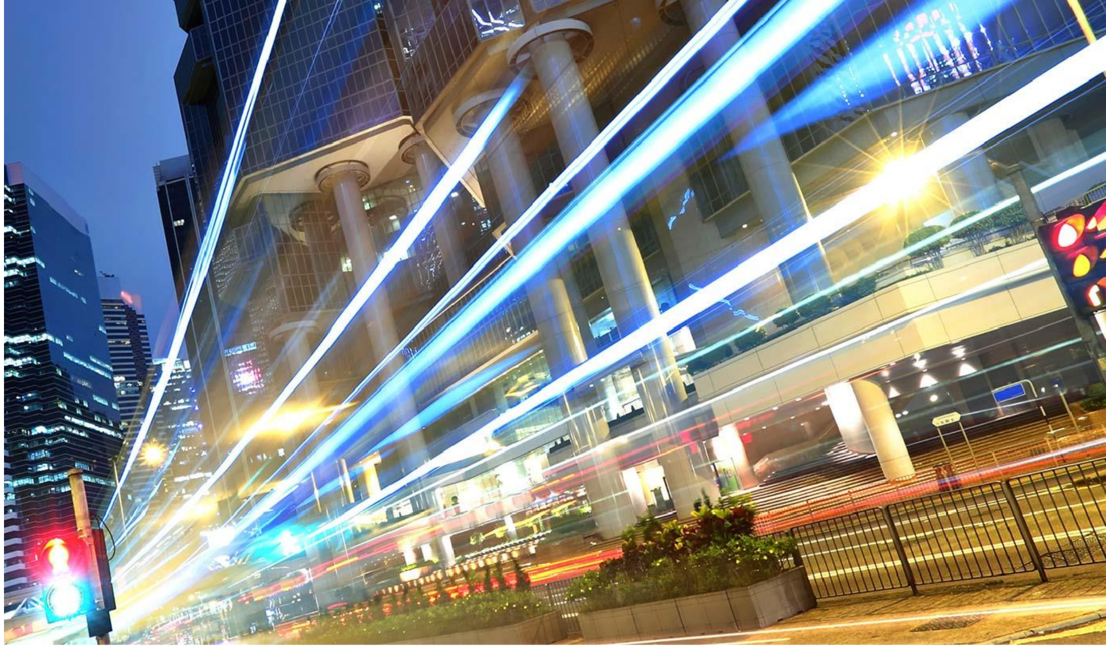
Agenda

- Determine Voice/Video Requirements
  - What kind of wireless design is needed?
- Build the Cell
  - Efficient and fast for a variety of mobile applications
- Improve for QoS
  - Prioritise traffic that cannot wait
- Fine Tune for the Specific Device
  - Help applications that need priority, but don't
- What will **NOT** be covered
  - Collaboration Manager configurations, Voice protocols comparison, Voice Gateways…



Determine Application Requirements

Build the Cell, Improve for QoS and Fine Tune for the Specific Device

How Much Bandwidth Is Required?

- Often Less than You May Think

- It is most likely that you won't be supporting just one application
- Design for the highest bandwidth demand that you intend to support
  - What you need is the minimum acceptable throughput that the application will require
  - Most users use only ONE high performance demanding application at a time
- Multiply this number by the number of devices that you need to support
- This is the aggregate bandwidth you will require in your space

Application – By Use Case	Throughput – Nominal
Web - Casual	500 Kbps
Web - Instructional	1 Mbps
Audio - Casual	100 Kbps
Audio - instructional	1 Mbps
Video - Casual	1 Mbps
Video - Instructional	2-4 Mbps
Printing	1 Mbps
File Sharing - Casual	1 Mbps
File Sharing - Instructional	2-8 Mbps
Online Testing	2-4 Mbps
Device Backups	10-50 Mbps

How Much Bandwidth is Required?

- It all depends on how you use them!

- Example, Skype (Up/Down):

Call type	Audio	Video/screen share	Video HD	Group Video (5 people)
Typical Bandwidth	30Kbps/30kbps	130kbps/130kbps	1.2 Mbps/1.2 Mbps	130 kbps/2 Mbps

- Now that you get the picture, a few other examples:
  - Fring (video): 135 kbps,
  - Facetime (video, iPhone 4S): 400 Kbps, (audio) 32 kbps
  - Viber (video) 120 kbps, (audio) 30 kbps
  - Skype/Viber/other chat: around 850 to 1000 bytes (6.8 to 8 kb) per 500 character message
  - Netflix (video), from 600 kbps (low quality) to 10 Mbps (3D HD), average 2.2 Mbps
  - This bandwidth consumption is one way, you need to double for 2-way conversations

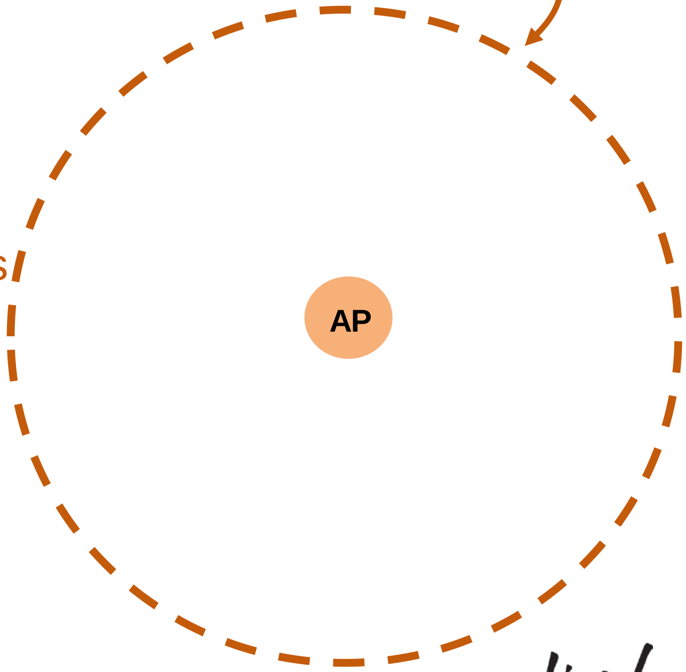
Real Life Example?

Medical Centre

- Density studies show 12 users / cell on average
  - Expected 2 HD video calls (Skype type)
  - 5 audio calls
  - All users may browse
- Let's do the maths:
  - 2 HD video calls = 1.2 Mbps x 2 x 2 ways = 4.8 Mbps
  - 5 audio calls… mmm what application?
    - Skype too? 30 kbps x 5 x 2 ways = 600 kbps
  - Others are browsing (5 people)… 250 kbps /people?
  - Total = **6.65 Mbps needed**

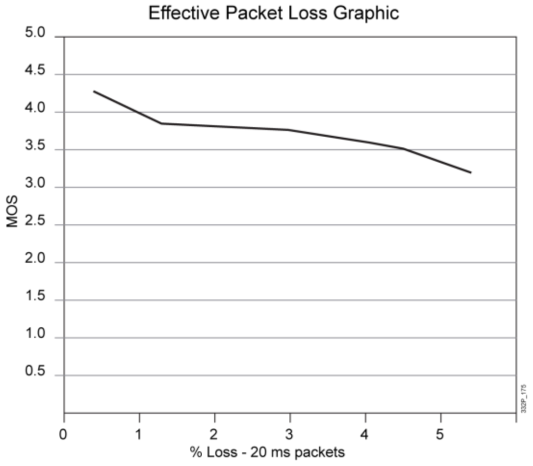
Of course browsing requires more than voice
But should I design for browsing?

I need 6.65 Mbps throughput
everywhere in the cell
\- > therefore I need it here



VoIP Requirements

- VoIP carries voice sound with UDP and Real Time Protocol (RTP), voice control traffic uses Real Time Control Protocol (RTCP)
  - Voice sound is converted to digital packets using codecs
  - Resulting packet size ranges from 8 to 64 bytes per packet (+40 bytes L4/L3 headers, +L2 header)
- Voice has very strict requirements as an “application”
  - Packet Error Rate (PER) <=1%
  - As low jitter as possible, less than 100ms
  - Retries should be < 20%
  - When these values are exceeded, MOS reduces
  - Your mission is to keep MOS high



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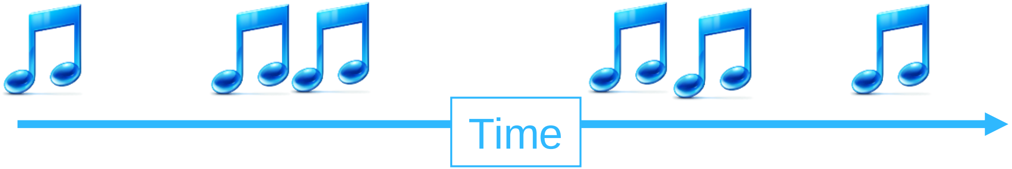
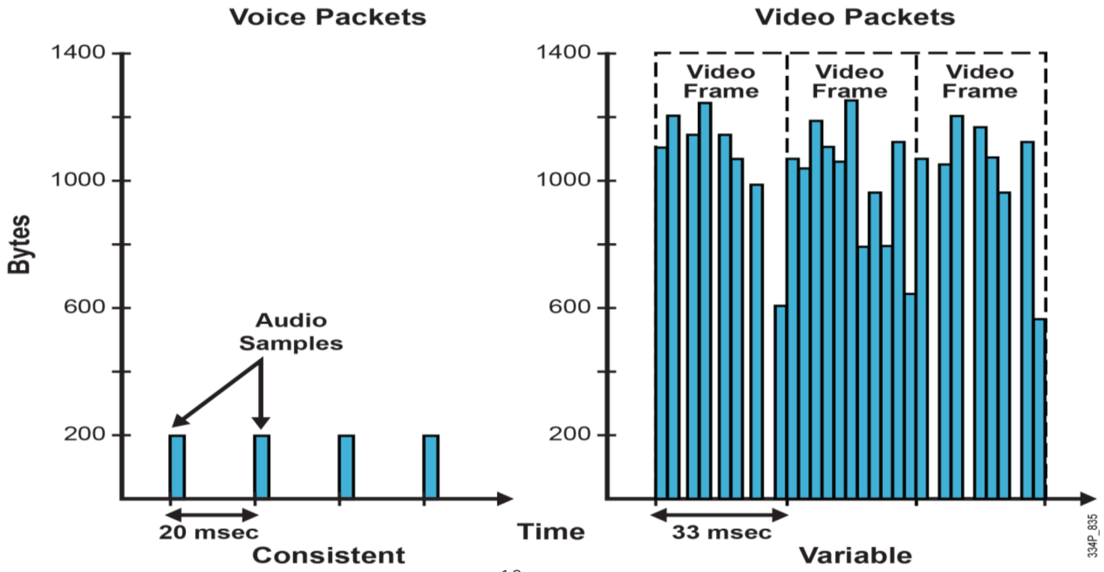
VoIP Requirements

- Voice audio quality perception varies:
  - Depends on the codec selected
  - Depends on the percentage of lost packets, delay and jitter
  - Delay is the end-to-end travel time of each packet, target for the local 802.11 cell is less than 30 ms, and 150 ms end to end
  - Long delays create disturbing silences and conversation overlaps
  - Excessively delayed packets may be dropped at the receiving end
  - Jitter is the variation of delay between packets
  - High jitter generates audio quality issues (clicks, metallic audio or silences)
    - Jitter should be less than 30 ms



Video Applications

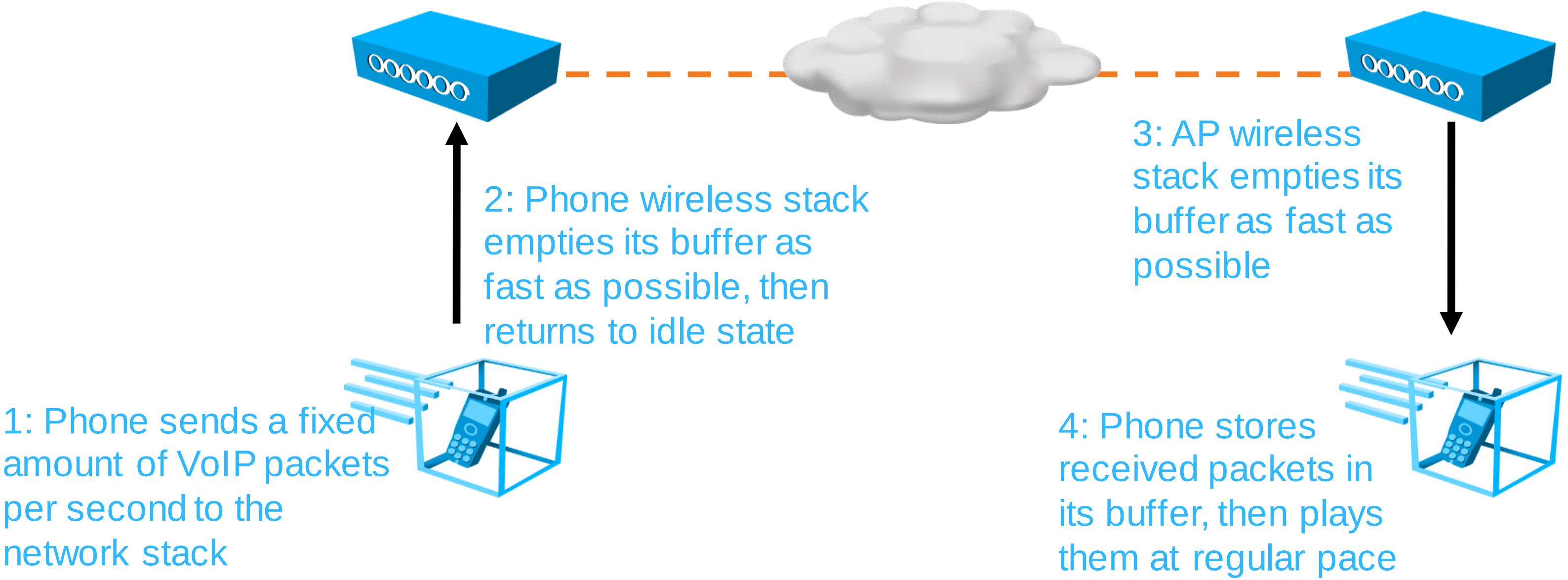
- Video uses video and audio codecs
  - Some codecs are built for real time exchange, some for streaming
  - Video algorithms refresh entire images when large changes occur
  - The changes generate traffic bursts



Building the Cell

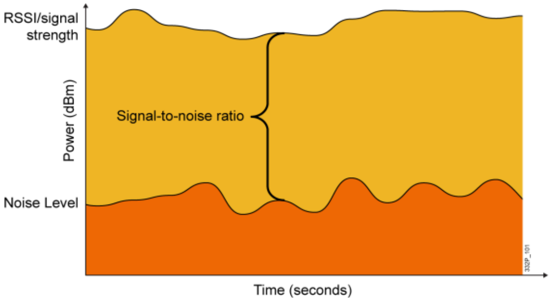
VoIP (and Video!) over Wireless Data Flow

– VoIP packet rate (e.g. 50 packets/second) is not wireless transmission rate (0.03 milliseconds per packet at 54 Mbps)



Cell Size – Depends on Protocol and Rates

- Higher power does not always mean higher SNR…



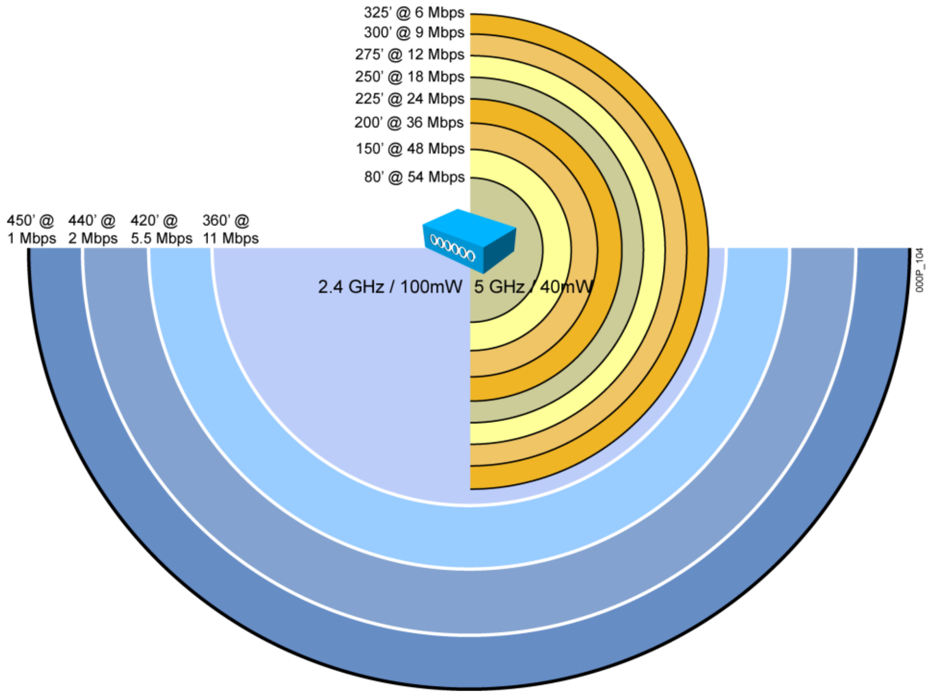
Assuming 10% PER

Speed	Required SNR	AP Sensitivity
1	0	-91
2	3	-91
5.5	6	-91
6	2	-87
11	9	-88
12	6	-86
24	11	-85
36	13	-85
48	17	-78
54	19	-77

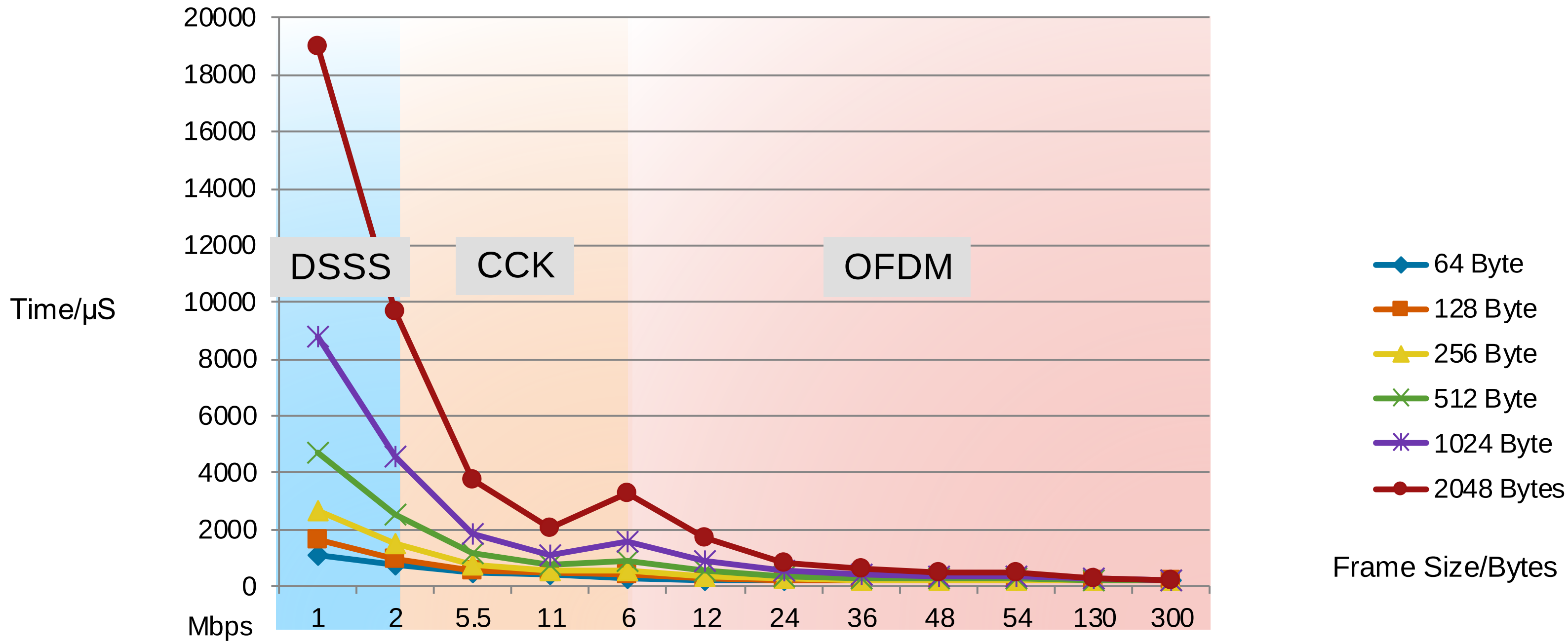
This for data, for voice, add 25 dB to SNR

Cell Size – Depends on Protocol and Rates

- Data rates decrease with the increase of distance from the radio source and client power will increase
- Individual throughput (performance) varies with the number of users
- Performance degrades with radio interference from other sources
- Critical deployment design goal is to achieve high data rate at cell boundary
  - High signal AND low noise



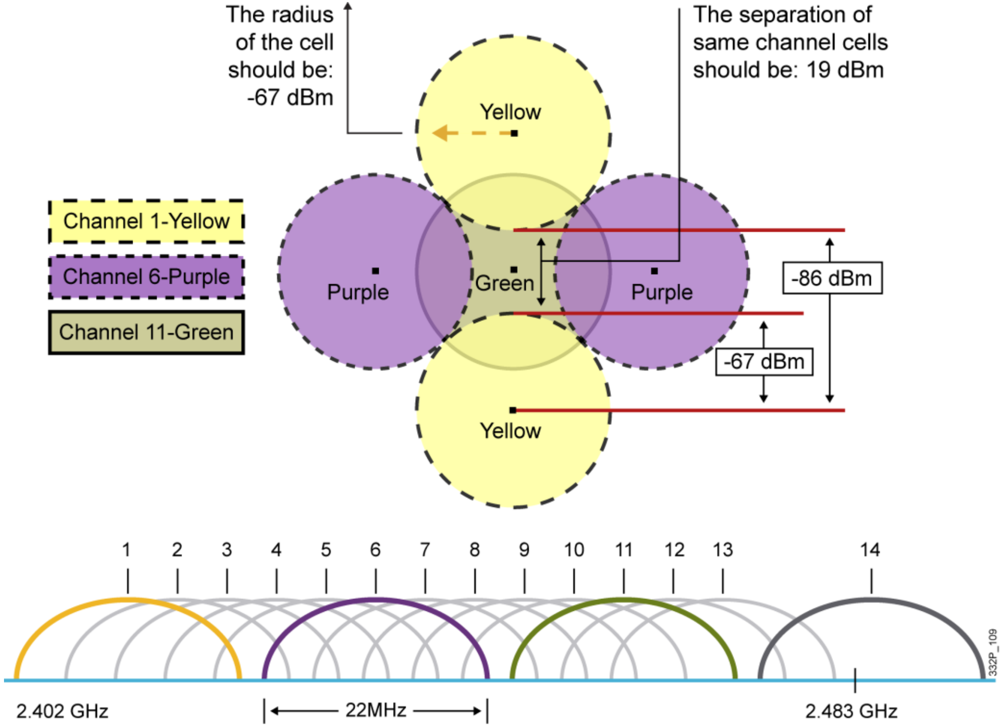
Moving Away From the AP Degrades Performances

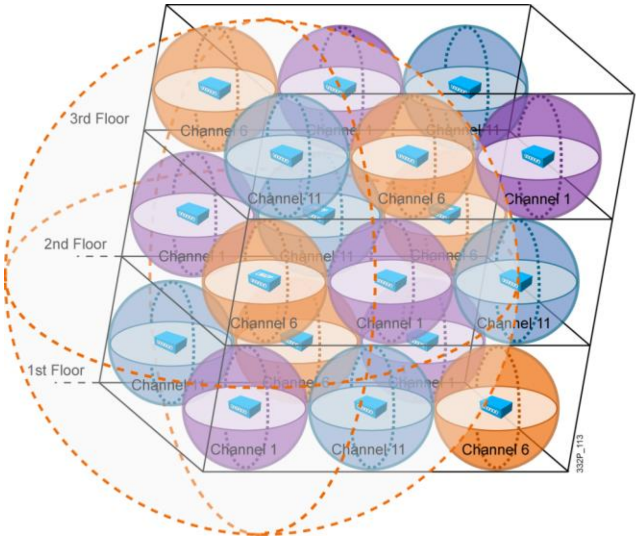


Spectrum is a Shared Finite Resource

2.4-GHz Network Design

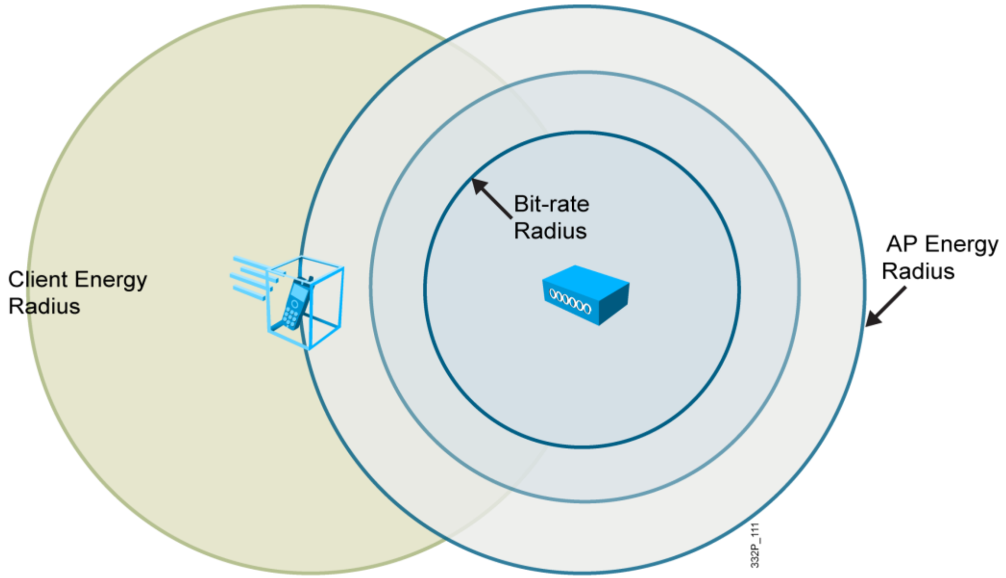
- Conclusion: try to design small cells, with clever overlap…

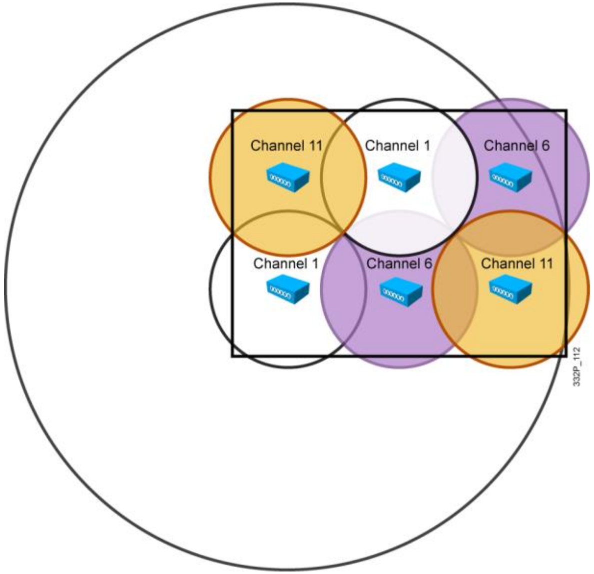




2.4-GHz Network Design

- The cell useful size is different from the AP footprint… And clients do not make it easier…





Channel Coverage Sizing Recommendations

- Coverage must be designed for your Client Devices

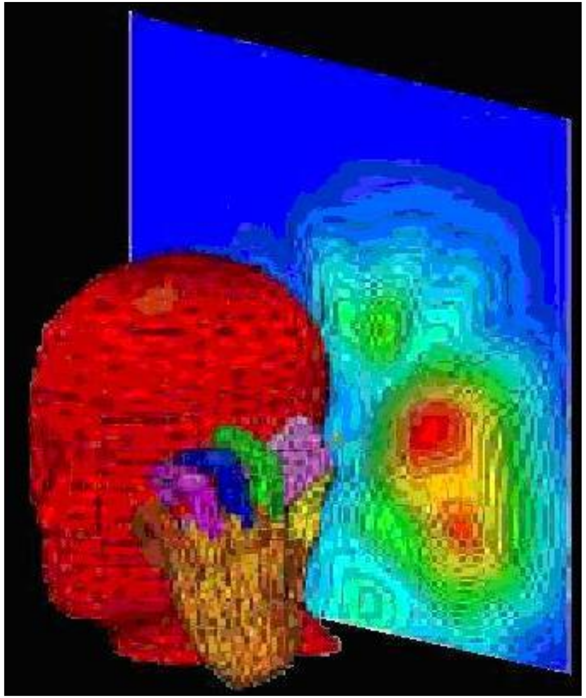
- Not all clients are created equal !!!
    1. Live call test with the actual client to determine its coverage

- Removing legacy DSSS data rates and slower OFDM data rates from the WLC configuration equals:
    1. Less Co-Channel Interference
    2. Better throughput in the cell
    3. More usage of ClientLink and MRC
    4. Smaller coverage cells

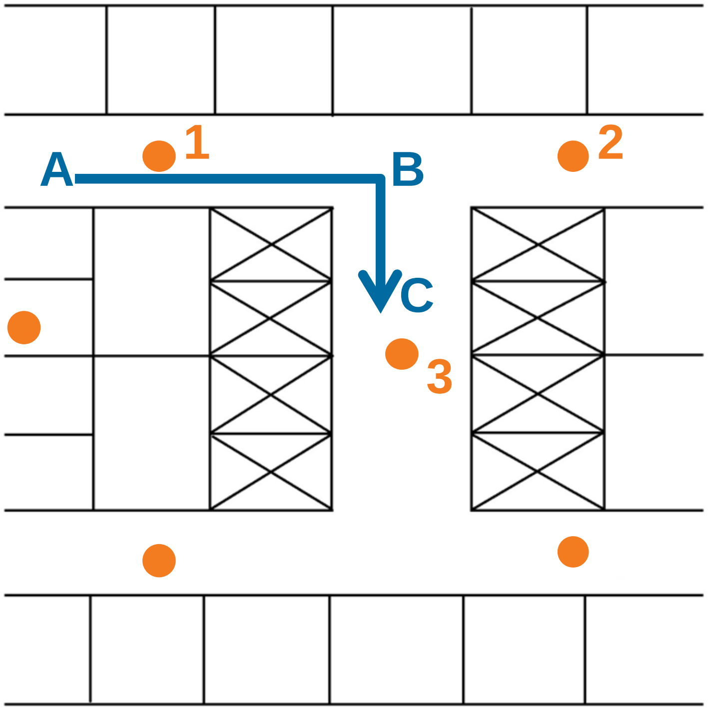
- Smaller Coverage Cell Sizes equals:
    1. More cells in a given coverage area
    2. More cells equals more call with better voice and video quality

Signal Attenuation

Object in Signal Path	Signal Attenuation Through Object
Plasterboard wall	3 dB
Glass wall with metal frame	6 dB
Cinderblock wall	4 dB
Office window	3 dB
Metal door	6 dB
Metal door in brick wall	12 dB
Phone and head position	3 - 6 dB

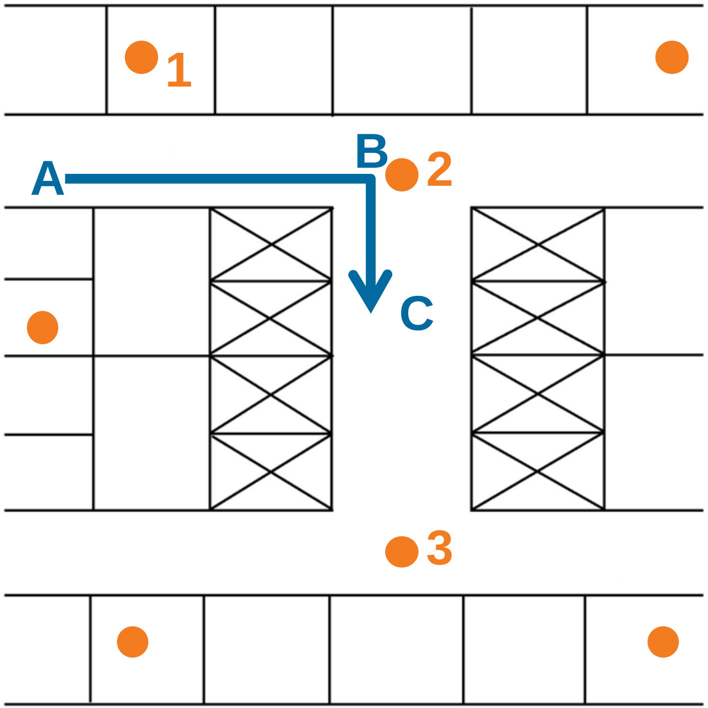


VoWiFi Rate Shifting



- At “A” the phone is connected to AP 1
- At “B” the phone has AP 2 in the neighbour list, AP 3 has not yet been scanned due to the RF shadow caused by the elevator bank
- At “C” the phone needs to roam, but AP 2 is the only AP in the neighbour list
- The phone then needs to rescan and connect to AP 3
  - 200 B frame @ 54 Mbps is sent in 3.7 μs
  - 200 B frame @ 24 Mbps is sent in 8.3 μs
  - Rate shifting from 54 Mbps to 24 Mbps can waste 1100 μs

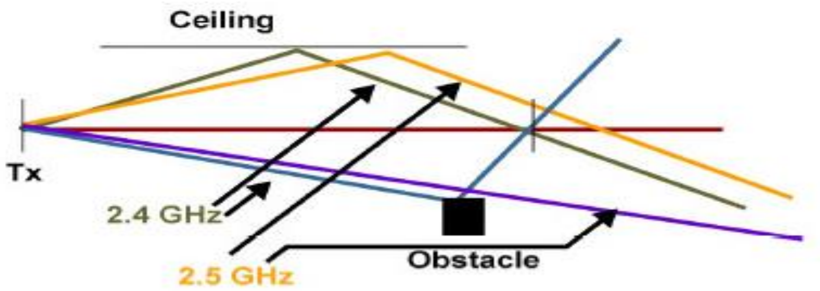
VoWiFi Rate Shifting



- At point A the phone is connected to AP 1
- At point B the phone has AP 2 in the neighbour list as it was able to scan it while moving down the hall
- At point C the phone needs to roam and successfully selects AP 2
- The phone has sufficient time to scan for AP 3 ahead of time

RF Design – Don't Do Anything Stupid

- Highly reflective environments
- Multipath distortion/fade is a consideration
- Legacy SISO technologies (802.11a/b/g) are most prone
- 802.11n/ac improvements with MIMO
- Devices are susceptible
- Things that reflect RF
  - Irregular metal surfaces
  - Large glass enclosures/walls
  - Lots of polished stone



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RF Design – More Bad Examples

- Site Survey
- Site Survey
- Site Survey
- Site Survey!

Verify coverage after deployment

Mmm…

Every SSID Counts!

- Each SSID requires a separate Beacon
- Each SSID will advertise at the minimum mandatory data rate
- Disabled – not available to a client
- Supported – available to an associated client
- Mandatory – Client must support in order to associate
- Lowest mandatory rate is beacon rate
- Highest mandatory rate is default Mcast rate

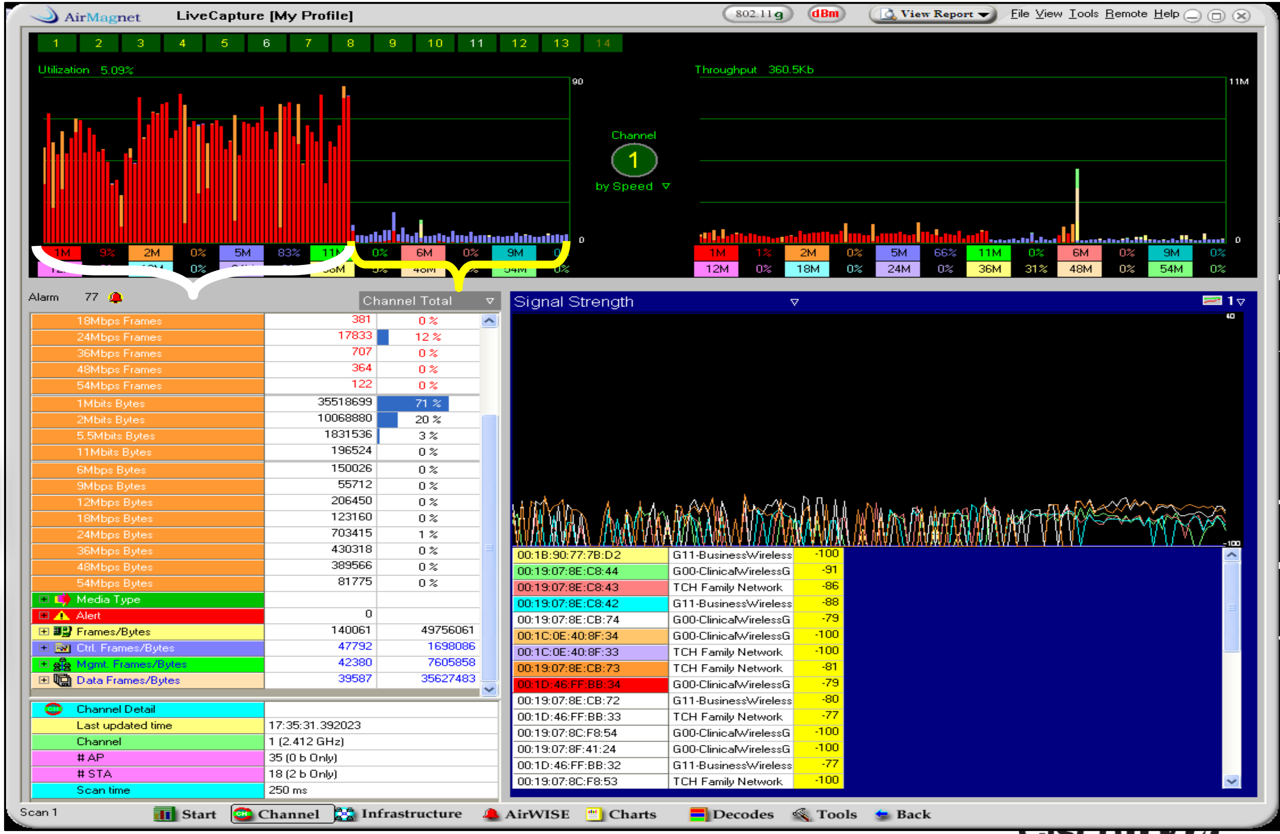
Data Rates**

Rate	Setting
1 Mbps	Disabled
2 Mbps	Disabled
5.5 Mbps	Disabled
6 Mbps	Disabled
9 Mbps	Disabled
11 Mbps	Disabled
12 Mbps	Supported
18 Mbps	Supported
24 Mbps	Mandatory
36 Mbps	Supported
48 Mbps	Supported
54 Mbps	Mandatory

BAD EXAMPLE! (good example in 2 slides)

"bad" if you overlap at 12 Mbps

Channel Utilisation - What Made the Difference?

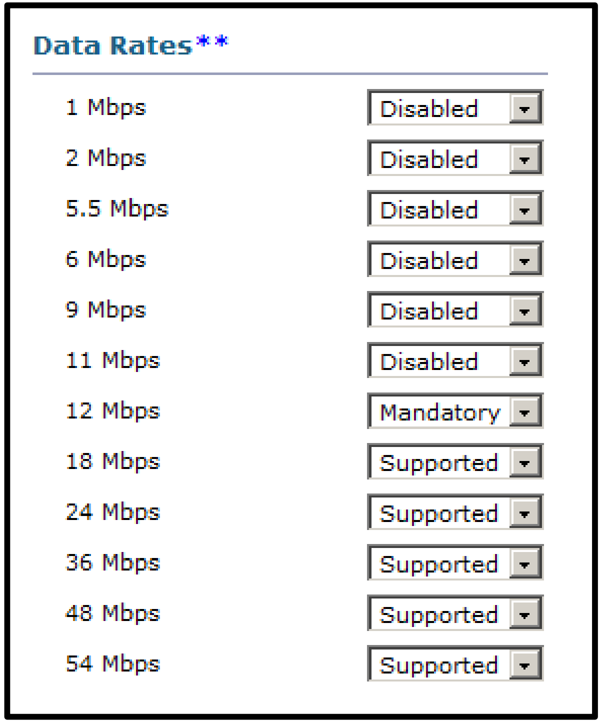


60% Before

5% After

Channel Design – Use the Tools

- Disable low, unused rates (802.11b)
- Let RRM control channel and power levels
- If you can, use 3600/3700 APs, with ClientLink and BandSelect:
  - BandSelect to push 5 GHz-able to the 5 GHz band
  - ClientLink to provide better throughput for 802.11a/g/n clients

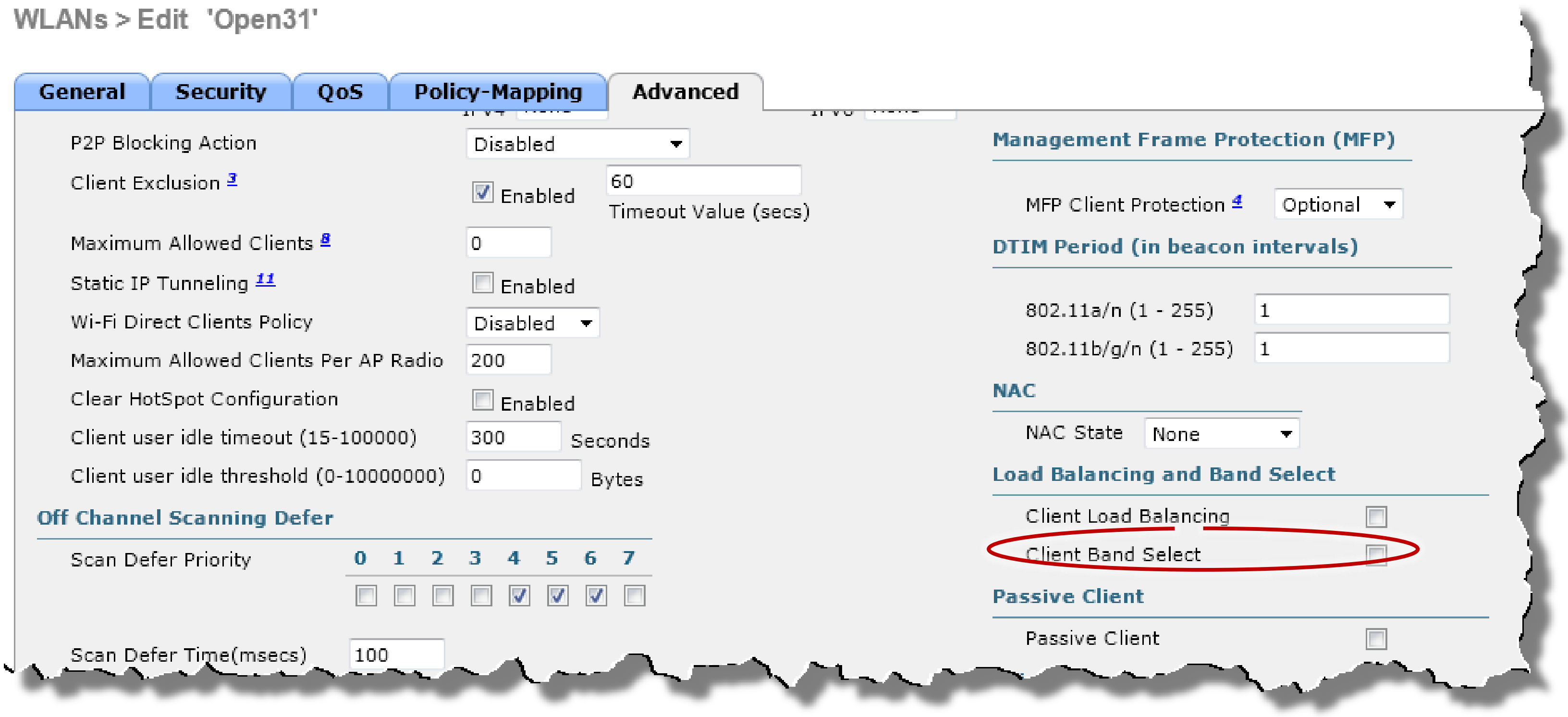


Cisco BandSelect Technology

- Automatic Band Steering and Selection For 5GHz Capable Devices

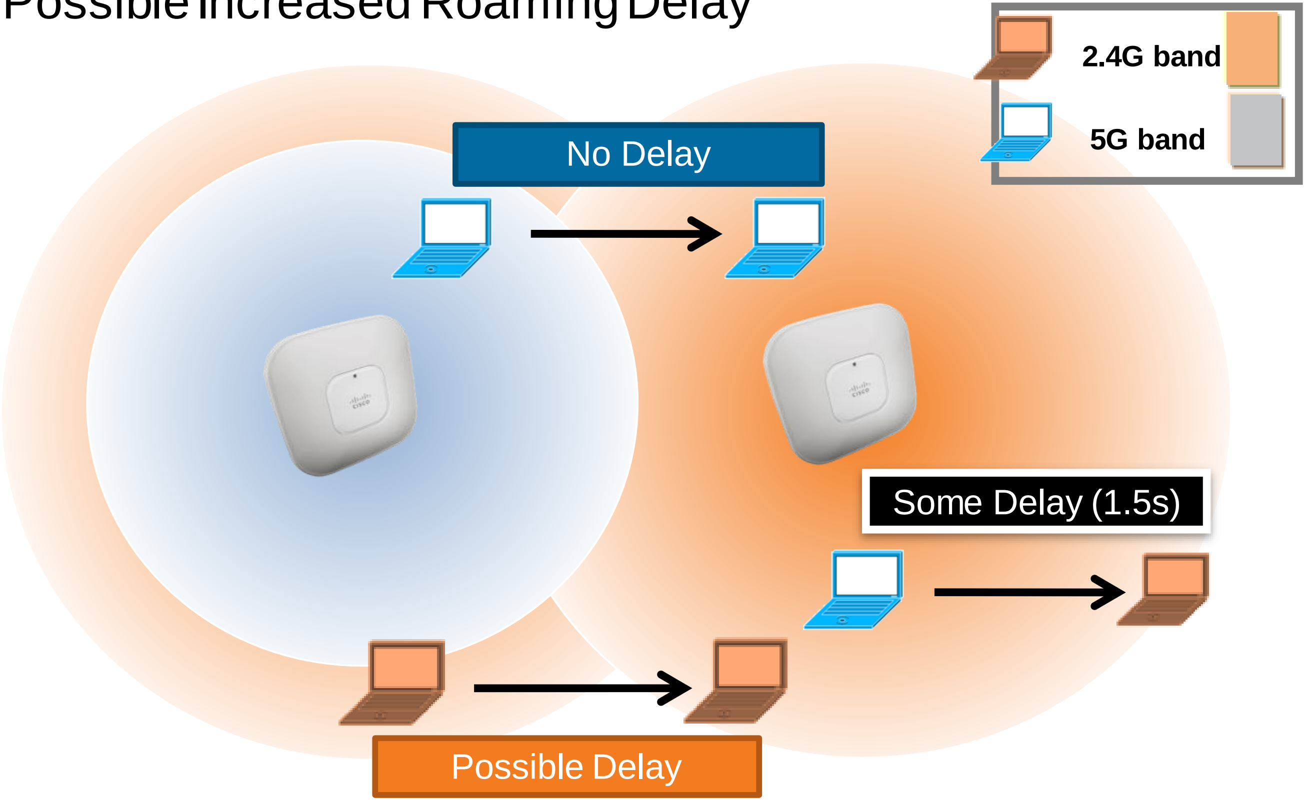
Configuring Band Select

- Enabled on a per WLAN basis (disabled by default)



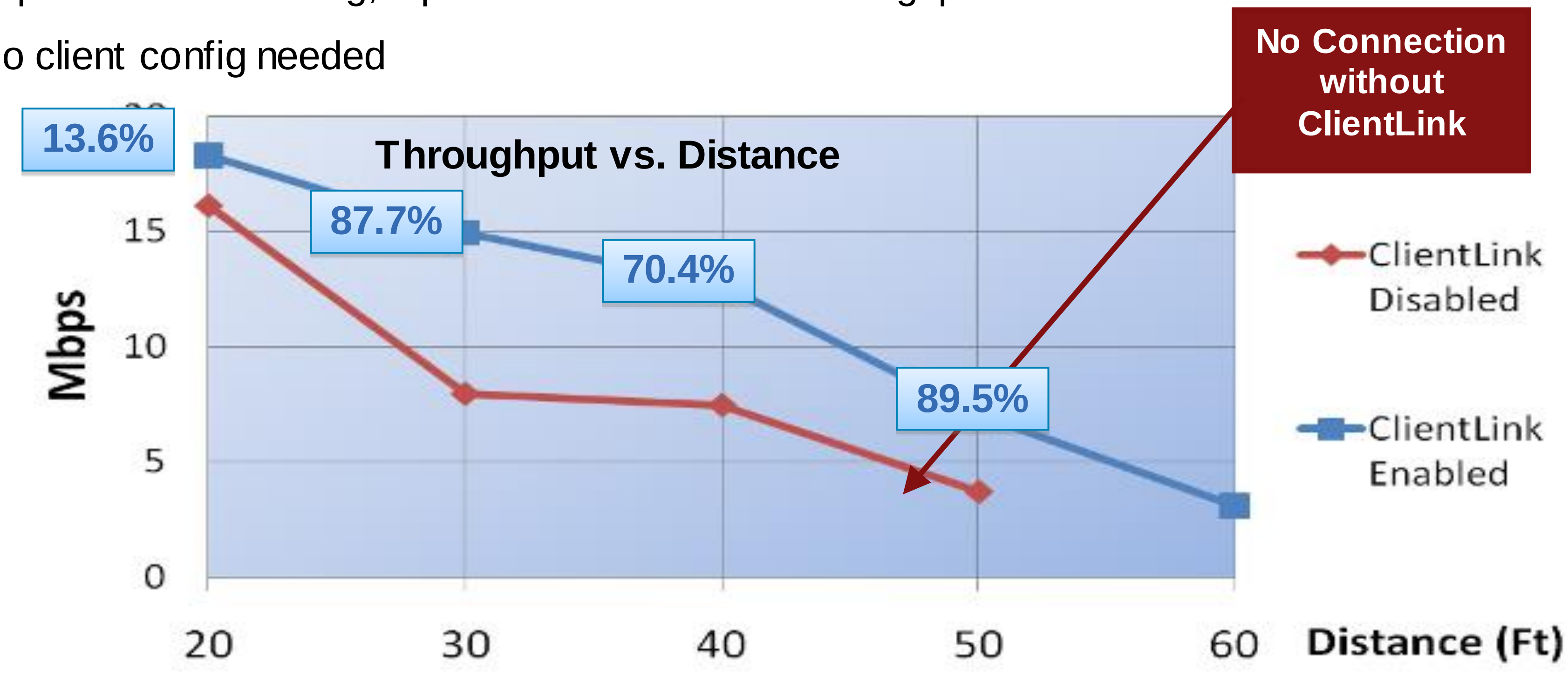
BandSelect – Test Before Full Deployment

- Caveat – Possible Increased Roaming Delay



Cisco ClientLink 3.0

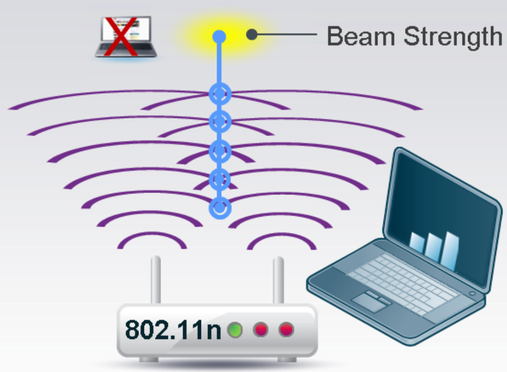
- Implicit Beam Forming, Up to 65% Increase in Throughput
- No client config needed



Cisco's ClientLink Technologies

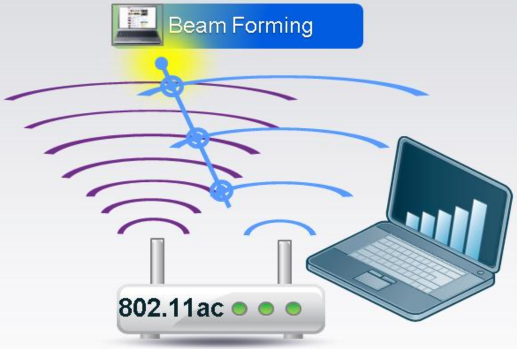
Advanced Beam Forming Technologies Improve Wireless Client Performance

BEFORE
Beam not directed towards clients resulting in inconsistent performance



AFTER
Beam directed towards client resulting in consistent experience and better performance

802.11a/g (ClientLink)
802.11a/g/n (ClientLink 2.0)
802.11ac (ClientLink 3.0)

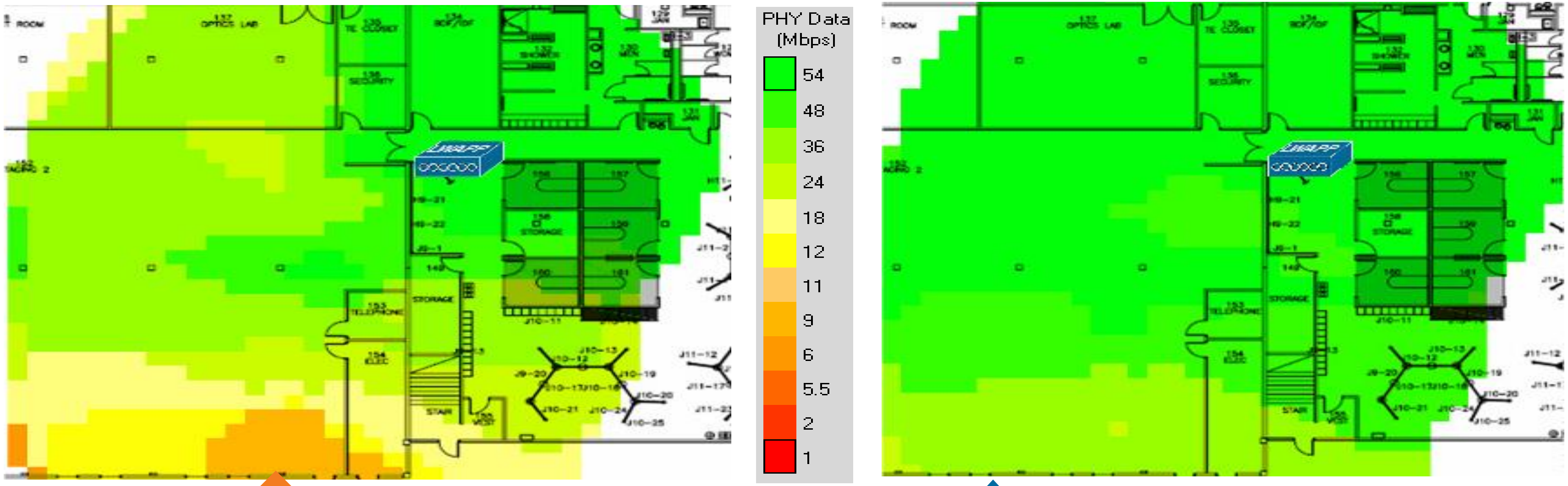


Cisco ClientLink—Improves Predictability and Performance

Client Link: Reduced Coverage Holes

Higher PHY Data Rates

- **ClientLink Disabled**
- **ClientLink Enabled**



Lower Data Rates

Higher Data Rates

Source: Miercom; AirMagnet/Fluke Iperf Survey

ClientLink: Battery Life Improvement

- 30ft Distance from Access Point to Motorola Xoom
- Download a file via FTP till complete and observe battery drop.

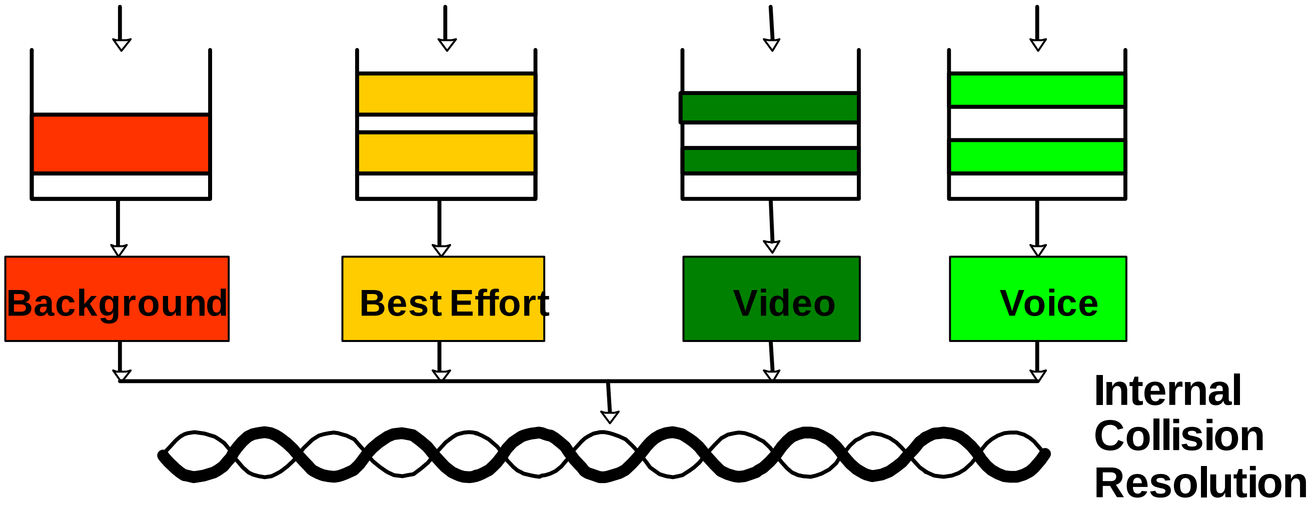
Improve for QoS

IEEE 802.11e WMM Access Categories

Access Category	Description	802.1d Tags
WMM Voice Priority	Highest Priority (Multiple Calls, Low Latency and Toll Voice Quality)	7, 6
WMM Video Priority	Traffic Other Than Data	5, 4
WMM Best Effort Priority	Legacy Devices or Applications That Lack QoS Capabilities	0, 3
WMM Background Priority	Low Priority Traffic (File Transfers, Printing)	2, 1

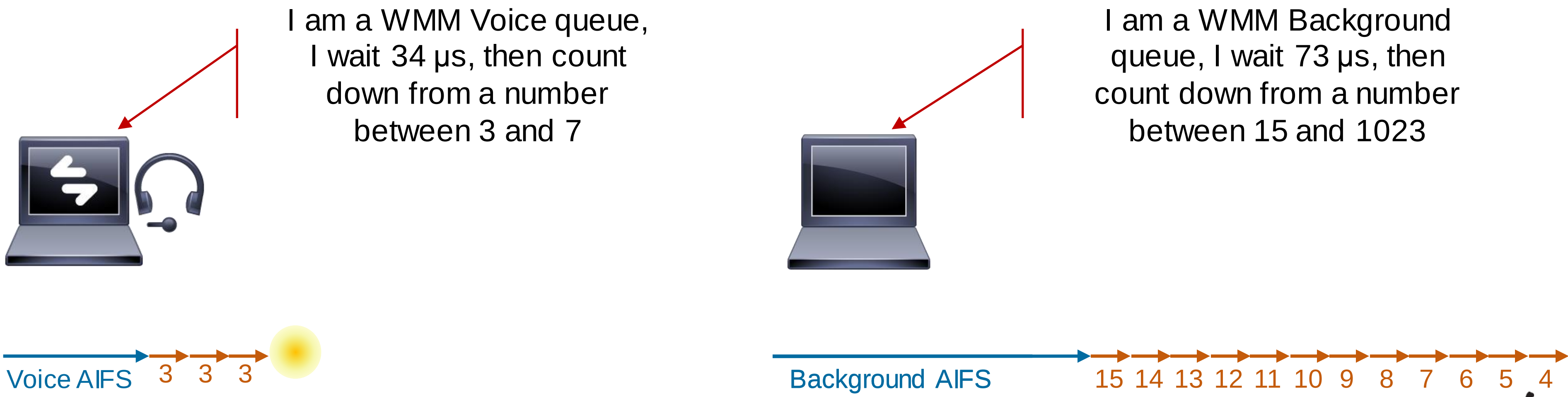
802.11e / WMM Media Access Classifications

- Separates traffic types in to 4 QoS access categories (AC)
- Background, Best Effort, Video, Voice
- These 4 ACs also have unique delay and random back off characteristics for accessing the RF channel (EDCA)



802.11e / WMM Media Priority

- When you want to send a frame, you need to wait a silence (with QoS, AIFS, Arbitrated Interframe Space), then count down from a random number (CW, Contention window) to zero
- WMM trick to prioritise traffic: higher priority queues wait a shorter silence (called the AIFSN, Arbitrated Interframe Space Number), and pick up a random value in a smaller number range



AIFS, CW… Okay, it's complicated

- Good Countdown recipe with WMM:
- **1. Pick your queue, this will give you your initial AIFS Number**
  - Default AIFSN is different for Voice (2), Video (2), Best Effort (3) and Background (7)
- **2. Then, you need 2 other ingredients:**
  - The band where you operate – this is because the recipe incorporates the Short Interframe Space (SIFS), shortest possible silence
  - SIFS = 10 µs for 2.4 GHz, 16 µs for 5 GHz
  - The slot time, tempo at which you count: 9 µs for 802.11agn (802.11b has a longer one)
- **3. Then add the ingredients together!**
  - The time you wait before counting down is:
    AIFS = SIFS + AIFSN x Slot Time
- **4. Then, pick up a number between CwMin and CwMax (you usually pick up CwMin the first time you try), and wait that on top of the AIFS**

AIFS, CW… Okay, it's complicated

- Example!
  - You are a nice shinny phone using AC_VO in 5 GHz
    - You pick 2 as your AIFSN, you know that SIFS is 16 µs in 5 GHz, and slot time is 9 µs for 802.11agn
    - Your AIFS is: AIFS = SIFS + AIFSN x Slot Time = 16 + (2 x 9) = 34 µs
    - Suppose you pick CwMin, you count down 3 slots
    - As a slot time for 802.11agn is 9 µs, that's 27 µs
    - So you wait: 34 µs + 27 µs = 61 µs then you send
  - Another one? You are a data device in 2.4 GHz:
    - You wait: 10 µs + 3 x 9 µs (->AIFS=37 µs), then 15 x 9 µs, total: 172 µs then you send

Default values (Configurable)						Resulting total wait time (µs)			
AC	AIFSN	AIFS (2.4 GHz)	AIFS (5 GHz)	CwMin	CwMax	2.4 GHz min	2.4 GHz max	5 GHz min	5 GHz max
VO	2	28	34	3	7	55	91	61	97
VI	2	28	34	7	15	91	163	97	169
BE	3	37	43	15	1023	172	9244	178	9250
BK	7	73	79	15	1023	208	9280	214	9286

AIFS = SIFS + AIFSN x Slot Time

SIFS = 10 µs for 2.4 GHz, 16 µs for 5 GHz

Slot time = 9 µs for 802.11.agn

TXOP

- IFS, ACK and other overheads waste time
- 802.11e/WMM allows you to send more than one frame, when you can access the medium
- The AP sets a TXOP value to tell you for how long you can send in a row
  - This is set in ms (or units of 32 μs) and covers the time you take to send, regardless of the data rate you use and the size of your frame

In beacons

AC	TXOP (in ms)
VO	1.504
VI	3.008
BE	0
BK	0

"If you gain access to the medium you can send: for up to 1.504 ms for voice, 3.008 ms for video, or 1 frame only if you send BE or BK traffic"

0 means that you can send only one frame at a time

```
⊞ IEEE 802.11 Beacon frame, Flags: ........C
⊟ IEEE 802.11 wireless LAN management frame
  ⊞ WME QoS Info: 0x80
    Reserved: 00
  ⊞ Ac Parameters ACI 0 (Best Effort), ACM no , AIFSN 3, ECWmin 4 ,ECWmax 10, TXOP 0
  ⊞ Ac Parameters ACI 1 (Background), ACM no , AIFSN 7, ECWmin 4 ,ECWmax 10, TXOP 0
  ⊞ Ac Parameters ACI 2 (Video), ACM no , AIFSN 2, ECWmin 3 ,ECWmax 4, TXOP 94
  ⊞ Ac Parameters ACI 3 (Voice), ACM no , AIFSN 2, ECWmin 2 ,ECWmax 3, TXOP 47
```

QBSS IE

- Sent by WMM APs in beacons and probe responses
- Helps clients decide which AP to associate or roam to
- No real interaction between client and AP

Bytes	1	1	2	1	2
	Element ID (11)	Length (5)	Station Count	Channel utilization	Available Admission Capacity

332P_357

How many stations in the cell

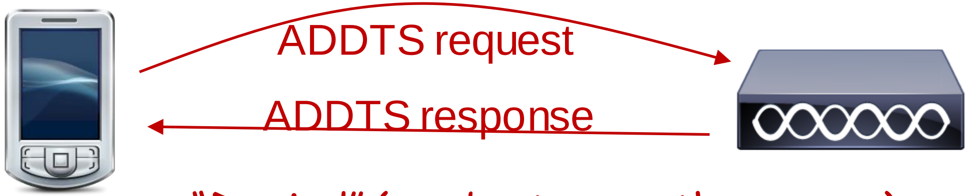
Percentage of time the channel was seen as busy by the AP

How many slots are still available for stations using ACM

Last Brick, TSPEC

- 802.11e/WMM allows Access Control Mandatory for some queues
- When ACM is on, clients are supposed to ask for permission before sending new traffic flow

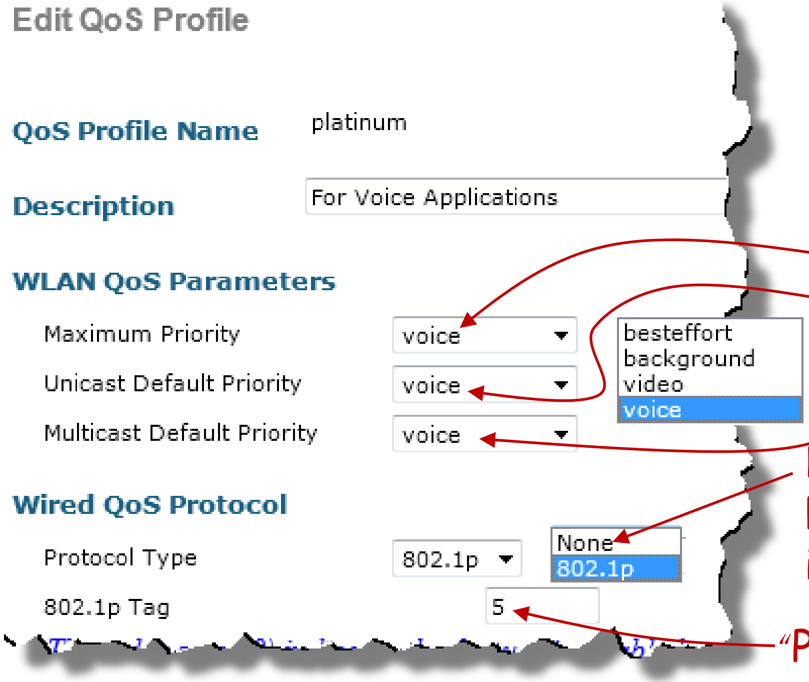
I need to place a call, this is my traffic specification (packet size, rate up and down, etc.



"Denied" (maybe try another queue)
Or "Accepted", your traffic is deduced from my available bandwidth

Setting QoS for the AP-WLC Part and Defaults

- Wireless > QoS > Profiles > Edit



Max allowed Queue for tagged traffic

Queue for untagged traffic

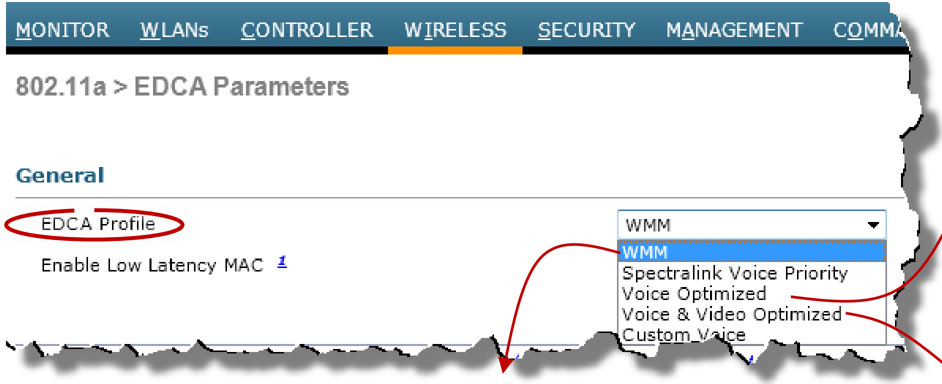
Queue for multicast traffic

Default is None -> traffic is not tagged between WLC and AP (not a good idea if you need QoS)

"Platinum" 802.1p tag between WLC-AP

Optimising WMM

- Wireless > 802.11a | 802.11bg > EDCA Parameters



AC	AIFSN	CwMin	CwMax	TXOP
VO	2	2	4	0
VI	5	3	5	0
BE	5	6	10	0
BK	12	8	10	0

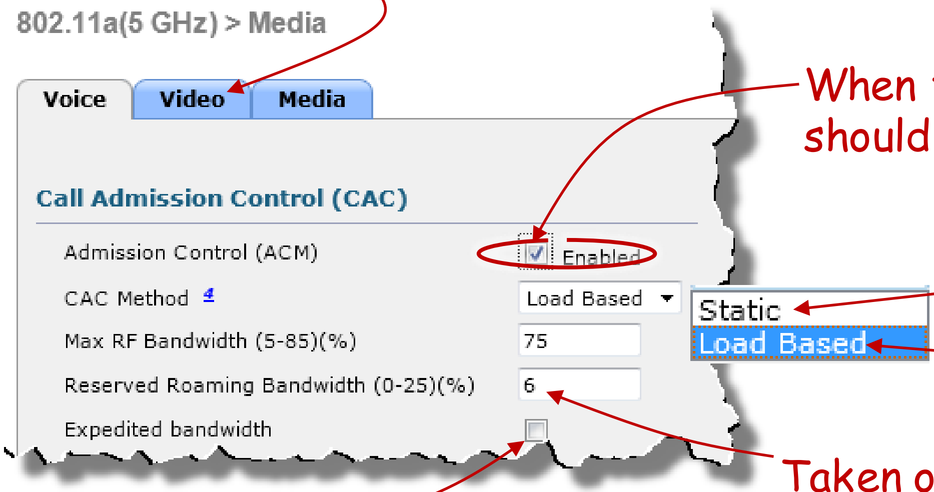
AC	AIFSN	CwMin	CwMax	TXOP
VO	2	2	3	47
VI	2	3	4	94
BE	3	4	10	0
BK	7	4	10	0

AC	AIFSN	CwMin	CwMax	TXOP
VO	2	2	4	0
VI	5	3	5	0
BE	12	6	10	0
BK	12	8	10	0

ACM

- Wireless > 802.11a | 802.11bg > Media

Same options now exist for Video



When this is Enabled, VO devices should use ADDTS/TSPEC

For bandwidth calculation:
Only takes cell clients traffic
Includes all 802.11 activity on the channel

Taken out of Max RF Bandwidth value

Allows CCXv5 clients to exceed Max RF Bandwidth for emergency calls

Where are we now?

- We have:
  - ✓ QoS Profile tagging all traffic, between WLC-AP and to the cell
  - ✓ QoS profile applied to the WLAN
  - ✓ EDCA optimised for voice/video
  - ✓ CAC to block excessive flows and guarantee ongoing calls quality
- Let' see if we are ready…

FaceTime Voice Packet: iPad

Packet	Transmitter	Source	Destination	BSSID	Protocol
141	F0:CB:A1:5F:BE:6A	192.168.0.10	192.168.0.2	Cisco:FC:3B:10	UDP
142	Cisco:FC:3B:10	192.168.0.10	192.168.0.2	Cisco:FC:3B:10	UDP
143	F0:CB:A1:5F:BE:6A	192.168.0.10	71.74.127.200	Cisco:FC:3B:10	UDP
144	A4:67:06:7C:BA:D7	192.168.0.2	192.168.0.10	Cisco:FC:3B:10	RTP Dynamic
145	A4:67:06:7C:BA:D7	192.168.0.2	192.168.0.10	Cisco:FC:3B:10	RTP Dynamic
146	A4:67:06:7C:BA:D7	192.168.0.2	192.168.0.10	Cisco:FC:3B:10	RTP Dynamic
147	A4:67:06:7C:BA:D7	192.168.0.2	192.168.0.10	Cisco:FC:3B:10	RTP Dynamic

```
Source:                     A4:67:06:7C:BA:D7 [10-15]
Seq Number:                 2958 [22-23 Mask 0xFFF0]
Frag Number:                0 [22 Mask 0x0F]
QoS Control Field:          %0000000000000110 [24-25]
                              --------- ........ AP PS Buffer State: 0
                              ......... 0....... A-MSDU: Not Present
                              ......... .00..... Ack: Normal Acknowledge
                              ......... ...0.... EOSP: Not End of Triggered Service Period
                              ......... ....0110 UP: 6 - Voice
802.2 Logical Link Control (LLC) Header
Dest. SAP:                  0xAA  SNAP [26]
Source SAP:                 0xAA  SNAP [27]
Command:                    0x03  Unnumbered Information [28]
Vendor ID:                  0x000000 [29-31]
Protocol Type:              0x0800  IP [32-33]
Version:                    4 [34 Mask 0xF0]
Header Length:              5  (20 bytes) [34 Mask 0x0F]
Differentiated Services:%11000000 [35]
                              0011 00.. Class Selector 6
                              .... ..00 Not-ECT
Total Length:               173 [36-37]
```


FaceTime Video Packet: iPad

Packet	Transmitter	Source	Destination	BSSID	Protocol
222	A4:67:06:7C:BA:D7	192.168.0.2	192.168.0.10	Cisco:FC:3B:10	RTP Dynamic
223	Cisco:FC:3B:10	192.168.0.2	192.168.0.10	Cisco:FC:3B:10	RTP Dynamic
224	A4:67:06:7C:BA:D7	192.168.0.2	192.168.0.10	Cisco:FC:3B:10	RTP Dynamic
225	Cisco:FC:3B:10	192.168.0.2	192.168.0.10	Cisco:FC:3B:10	RTP Dynamic
226	F0:CB:A1:5F:BE:6A	192.168.0.10	71.74.127.200	Cisco:FC:3B:10	UDP

```
BSSID:               00:21:1B:FC:3B:10  Cisco:FC:3B:10 [4-9]
Source:              A4:67:06:7C:BA:D7 [10-15]
Destination:         F0:CB:A1:5F:BE:6A [16-21]
Seq Number:          1858 [22-23 Mask 0xFFF0]
QoS Control Field:   %0000000000000101 [24-25]
                        -------- ........ AP PS Buffer State: 0
                        ........ 0....... A-MSDU: Not Present
                        ........ .00..... Ack: Normal Acknowledge
                        ........ ...0.... EOSP: Not End of Triggered Service Period
                        ........ ....0101 UP: 5 - Video
Dest. SAP:           0xAA  SNAP [26]
Source SAP:          0xAA  SNAP [27]
Command:             0x03  Unnumbered Information [28]
Vendor ID:           0x000000 [29-31]
IP Header - Internet Protocol Datagram
Version:             4 [34 Mask 0xF0]
Header Length:       5  (20 bytes) [34 Mask 0x0F]
Differentiated Services: %10000000 [35]
                        0010 00.. Class Selector 4
Total Length:        1279 [36-37]
```


Skype Voice Packet – iPad

Packet	Transmitter	Source	Destination	BSSID	Protocol
13	Cisco:FC:3B:10	192.168.0.2	192.168.0.10	Cisco:FC:3B:10	UDP
14	A4:67:06:7C:BA:D7	192.168.0.2	192.168.0.10	Cisco:FC:3B:10	UDP
15	Cisco:FC:3B:10	192.168.0.2	192.168.0.10	Cisco:FC:3B:10	UDP
16	Cisco:FC:3B:10	192.168.0.2	192.168.0.10	Cisco:FC:3B:10	UDP

```
BSSID:                        00:21:1B:FC:3B:10  Cisco:FC:3B:10 [4-9]
Source:                       A4:67:06:7C:BA:D7 [10-15]
Destination:                  F0:CB:A1:5F:BE:6A [16-21]
Seq Number:                   3611 [22-23 Mask 0xFFF0]
Frag Number:                  0 [22 Mask 0x0F]
QoS Control Field:            %0000000000000000 [24-25]
                                 --------- ........ AP PS Buffer State: 0
                                 ......... 0....... A-MSDU: Not Present
                                 ......... .00..... Ack: Normal Acknowledge
                                 ......... ...0.... EOSP: Not End of Triggered Service Period
                                 ......... ....0000 UP: 0 - Best Effort
802.2 Logical Link Control (LLC) Header
Dest. SAP:                    0xAA  SNAP [26]
Source SAP:                   0xAA  SNAP [27]
Command:                      0x03  Unnumbered Information [28]
Vendor ID:                    0x000000 [29-31]
Protocol Type:                0x0800  IP [32-33]
IP Header - Internet Protocol Datagram
Version:                      4 [34 Mask 0xF0]
Header Length:                5  (20 bytes) [34 Mask 0x0F]
Differentiated Services:%00000000 [35]
                                 0000 00.. Default
                                 .... ..00 Not-ECT
Total Length:                 56 [36-37]
Identifier:                   36547 [38-39]
Fragmentation Flags:          %000 [40 Mask 0xE0]
                                 0.. Reserved
```

Skype Video Packet – iPad

Packet	Transmitter	Source	Destination	BSSID	Protocol
1983	Cisco:FC:3B:10	Cisco:FC:3B:10	A4:67:06:7C...		802.11 CTS
1984	A4:67:06:7C:BA:D7	192.168.0.2	192.168.0.10	Cisco:FC:3B:10	UDP
1985	Cisco:FC:3B:10	Cisco:FC:3B:10	A4:67:06:7C...		802.11 BA
1986	Cisco:FC:3B:10	192.168.0.2	192.168.0.10	Cisco:FC:3B:10	UDP

```
Source:                      A4:67:06:7C:BA:D7 [10-15]
Destination:                 F0:CB:A1:5F:BE:6A [16-21]
Seq Number:                  3721 [22-23 Mask 0xFFF0]
Frag Number:                 0 [22 Mask 0x0F]
QoS Control Field:           %0000000000000000 [24-25]
                               -------- ........ AP PS Buffer State: 0
                               ........ 0....... A-MSDU: Not Present
                               ........ .00..... Ack: Normal Acknowledge
                               ........ ...0.... EOSP: Not End of Triggered Service Period
                               ........ ....0000 UP: 0 - Best Effort
802.2 Logical Link Control (LLC) Header
Dest. SAP:                   0xAA  SNAP [26]
Source SAP:                  0xAA  SNAP [27]
Command:                     0x03  Unnumbered Information [28]
Vendor ID:                   0x000000 [29-31]
Protocol Type:               0x0800  IP [32-33]
IP Header - Internet Protocol Datagram
Version:                     4 [34 Mask 0xF0]
Header Length:               5  (20 bytes) [34 Mask 0x0F]
Differentiated Services:     %00000000 [35]
                               0000 00.. Default
                               .... ..00 Not-ECT
Total Length:                1375 [36-37]
Identifier:                  31655 [38-39]
Fragmentation Flags:         %000 [40 Mask 0xE0]
```

What are we missing?

- If you are an operating system vendor, which application would you allow to get higher priority than the others? What are the risks?
- From the wireless infrastructure side, the conclusion is that we should enable QoS… but can't trust that all applications on all devices will use proper marking.
- So… what else can we do to improve traffic quality for our mobile applications?

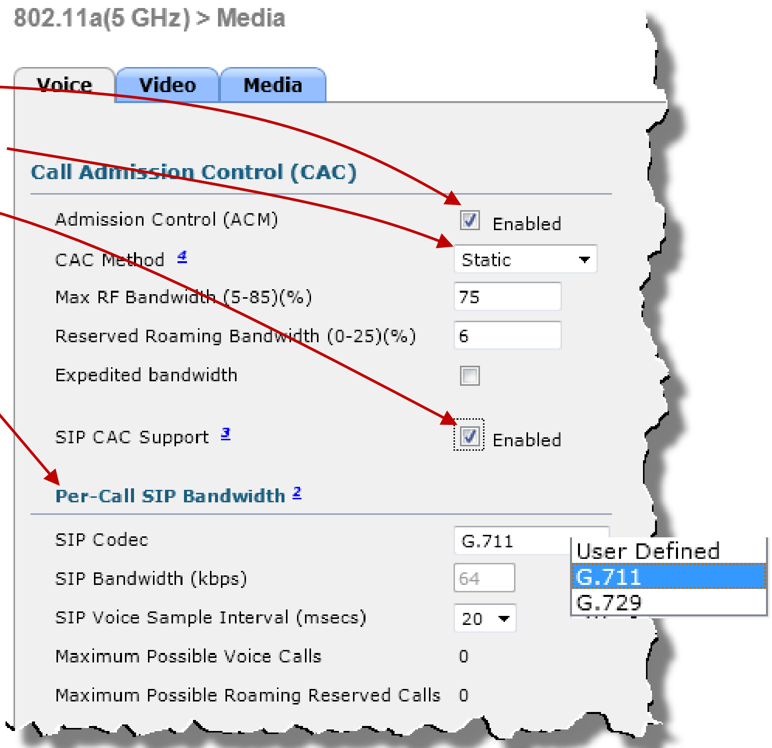
Fine Tune for the Specific Device

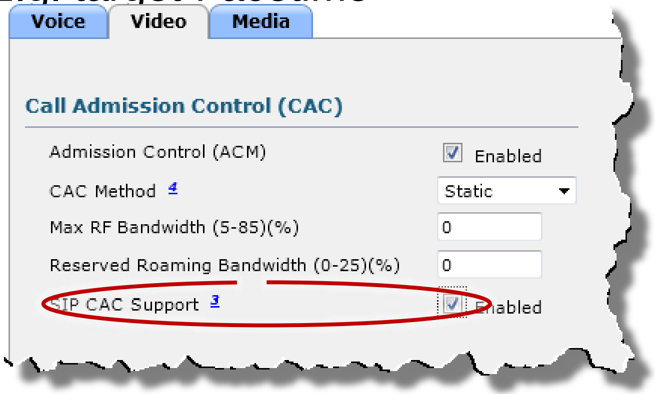
Let's Think the Problem in Terms of Directions

- In a standard cell, 70% of traffic is downstream (from AP to client)
- 30% is upstream
- We can definitely control downstream, especially as 802.11n/ac stations are necessarily WMM
- Can we control the upstream? Not directly, but we may have an indirect way of controlling it…

If Your Traffic is Targeted

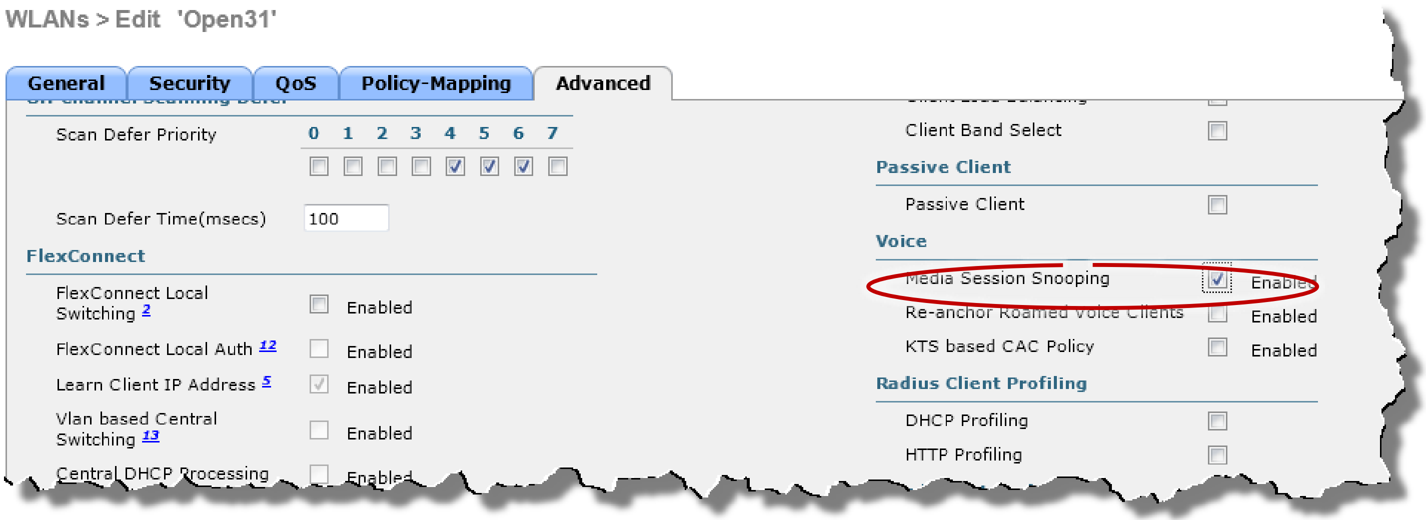
- For example, you want to prioritise SIP:
  1. Enable ACM
  2. Make sure to use Static (not Load-based)
  3. Check SIP CAC Support
  4. Determine the expected SIP specs
- You can also prioritise SIP VIDEO
  - E.g. target Facetime





If Your Traffic is Targeted

- For example, you want to prioritise SIP:
  5. Enable SIP support on the WLAN:



SIP Audio, SIP Video (e.g Facetime)

- How do they do it?:

- The AP uses the port (SIP audio or video), and also use the User-agent field (video) to further identify the SIP type:

```
⊟ Session Initiation Protocol
  ⊞ Status-Line: SIP/2.0 200 OK
  ⊟ Message Header
    ⊞ Via: SIP/2.0/UDP 10.142.57.139:16402;brancPo⊠⊠\212w4bK5134351a145c7415
    ⊞ To: "1010" <sip:user@10.78.78.253:16402>;tag=879704656
    ⊞ From: "1009" <sip:user@10.142.57.139:16402>;tag=649104684
      Call-ID: 34e0ceea-5bb6-11y1-ab17-9aedbfc04012@10-142-57-Y39
    ⊞ \222@Seq: 1 INVITE
    ⊞ Contact: <sip:user@10.78.78.253:16402>;isfocus
      User-Agent: Viceroy 1.5.0/GK
      Content-Type: application/sdp
```

Apple (outgoing call)

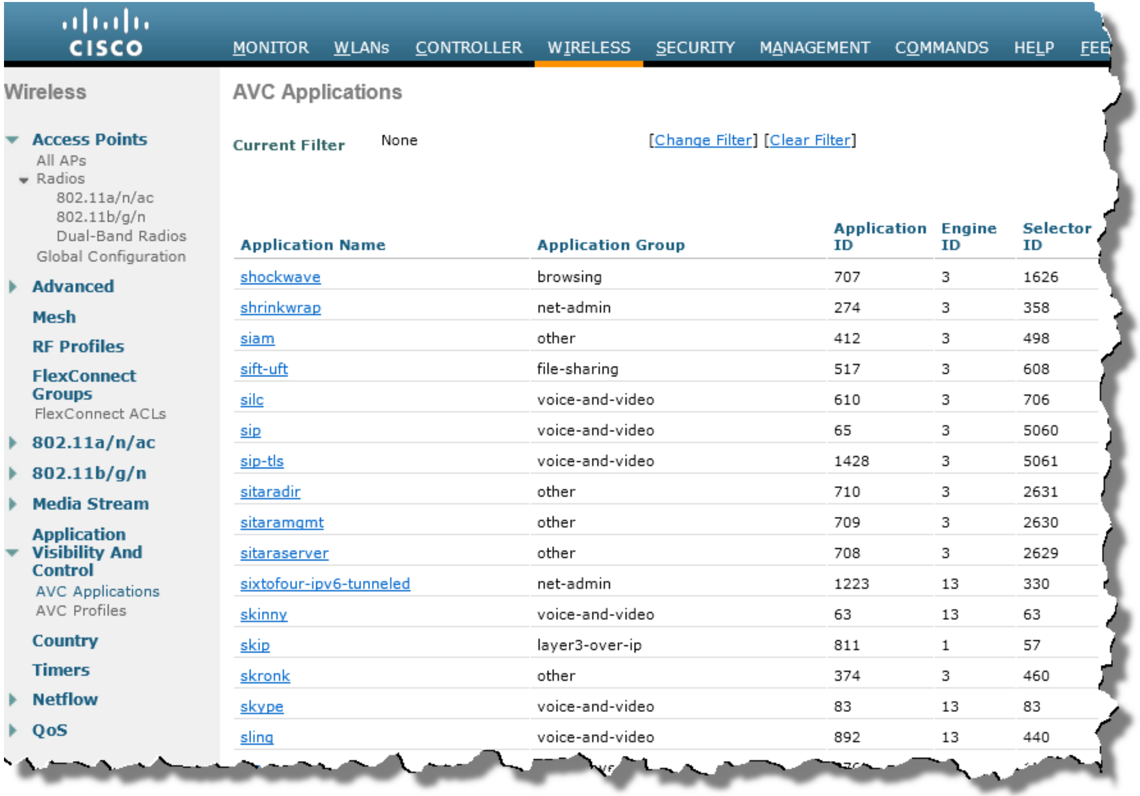
Can’t tell (incoming call from CUCM), use ports

```
⊟ Session Initiation Protocol
  ⊞ Request-Line: INVITE sip:f302a196-3214-412e-a87b-df181bb0136c@9.11.99.101:47500;transport=tcp SIP/2.0
  ⊟ Message Header
    ⊞ Via: SIP/2.0/TCP 9.1.0.112:5060;branch=z9hG4bK6549071867
    ⊞ From: <sip:2086@9.1.0.112>;tag=458~d37011b0-81bc-48d9-a1a7-b0a8098c7dbf-21073507
    ⊞ To: <sip:2085@9.1.0.112>
      Date: Wed, 08 Feb 2012 04:02:14 GMT
      Call-ID: ada92c80-f311f3c6-2e-70000109@9.1.0.112
      Supported: timer,resource-priority,replaces
      Min-SE:  1800
      User-Agent: Cisco-CUCM8.6
⊟ Transmission Control Protocol, Src Port: sip (5060), Dst Port: 47500 (47500), Seq: 1, Ack: 1, Len: 982
```


If you have Several Traffic Types to Target:

Use Application Visibility and Control

- Internal application recognition engine based on NBAR
- More than 1000 applications recognised, including Netflix, Skype, MS Lync audio, MS Lync video viber, ventrilo, etc.



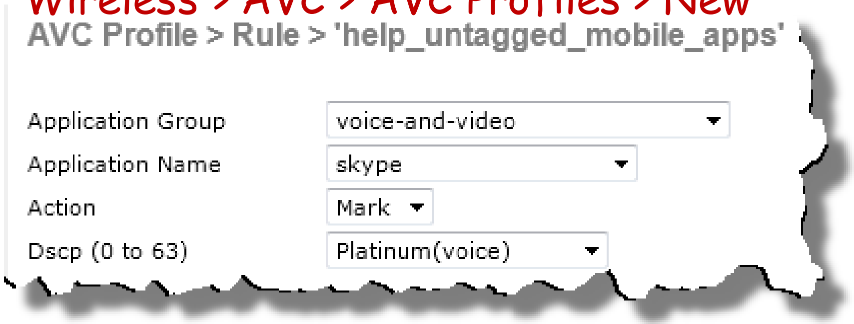
Application Name	Application Group	Application ID	Engine ID	Selector ID
shockwave	browsing	707	3	1626
shrinkwrap	net-admin	274	3	358
siam	other	412	3	498
sift-uft	file-sharing	517	3	608
silc	voice-and-video	610	3	706
sip	voice-and-video	65	3	5060
sip-tls	voice-and-video	1428	3	5061
sitaradir	other	710	3	2631
sitaramgmt	other	709	3	2630
sitaraserver	other	708	3	2629
sixtofour-ipv6-tunneled	net-admin	1223	13	330
skinny	voice-and-video	63	13	63
skip	layer3-over-ip	811	1	57
skronk	other	374	3	460
skype	voice-and-video	83	13	83
sling	voice-and-video	892	13	440

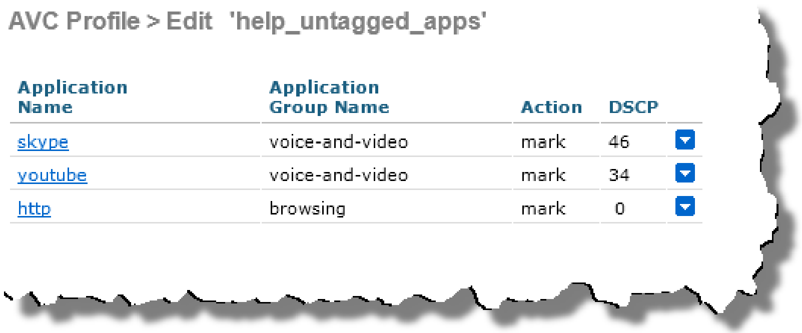
Application Visibility and Control

- With AVC, you can create rules to mark untagged applications (but also to permit or deny some application traffic!):

1. Create a new policy
2. Add rules, including what application to recognise, and what to do with it:

Wireless > AVC > AVC Profiles > New



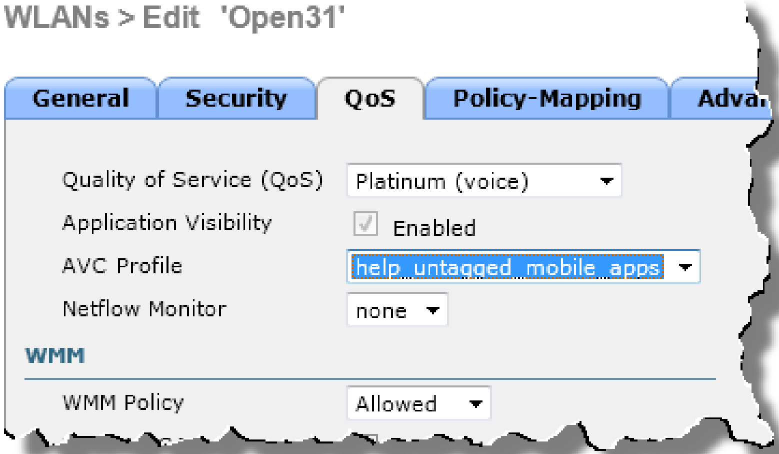

AVC Profile > Edit 'help_untagged_apps'

Application Name	Application Group Name	Action	DSCP
skype	voice-and-video	mark	46
youtube	voice-and-video	mark	34
http	browsing	mark	0

- Marking application will help prioritisation between AP and WLC, and from AP to the cell

Application Visibility and Control

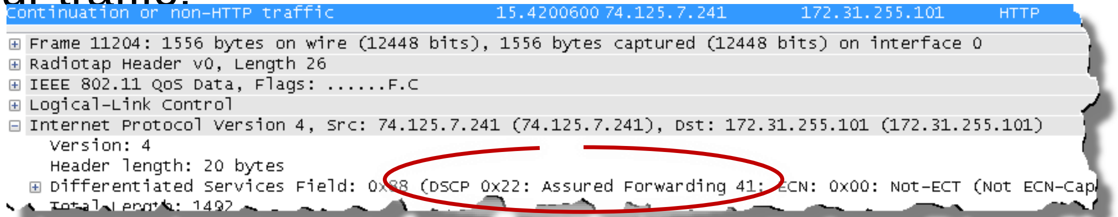
3. Apply your policy to the WLAN:



Top Applications

Application Name		Packet Count	Byte Count
youtube	(U)	5855	535032
	(D)	9608	14489305
ssl	(U)	377	66319
	(D)	320	315143
google-services	(U)	72	15000
	(D)	72	53810
skype	(U)	20	2984
	(D)	19	1507
dns	(U)	9	1018

4. Watch your traffic:



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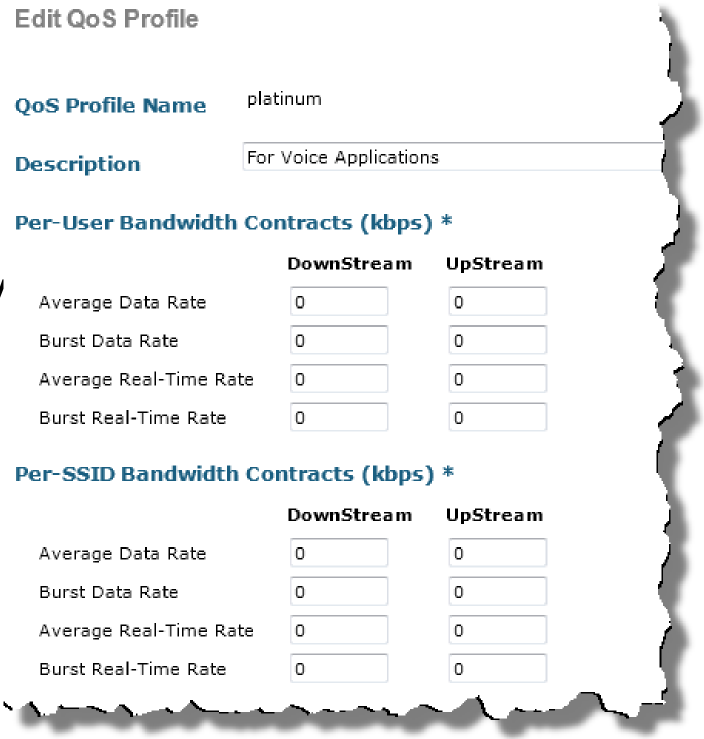
Bandwidth Control – per User

- You can also control upstream and downstream bandwidth consumption:

- For each QoS profile, per user or per SSID
- The limitation will apply to each WLAN to which you apply the QoS profile


Edit QoS Profile

QoS Profile Name: platinum

Description: For Voice Applications

Per-User Bandwidth Contracts (kbps) *

	DownStream	UpStream
Average Data Rate	0	0
Burst Data Rate	0	0
Average Real-Time Rate	0	0
Burst Real-Time Rate	0	0

Per-SSID Bandwidth Contracts (kbps) *

	DownStream	UpStream
Average Data Rate	0	0
Burst Data Rate	0	0
Average Real-Time Rate	0	0
Burst Real-Time Rate	0	0

Wireless > QoS > Profiles > Edit

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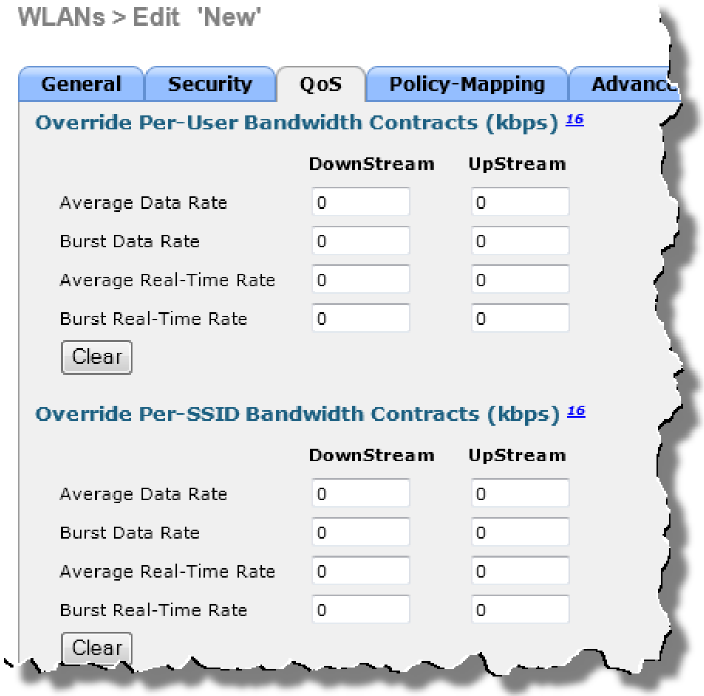
Bandwidth Control – per User

- You can also control upstream and downstream bandwidth consumption:

- But if your QoS profile is not right for one WLAN, you can override for that WLAN!

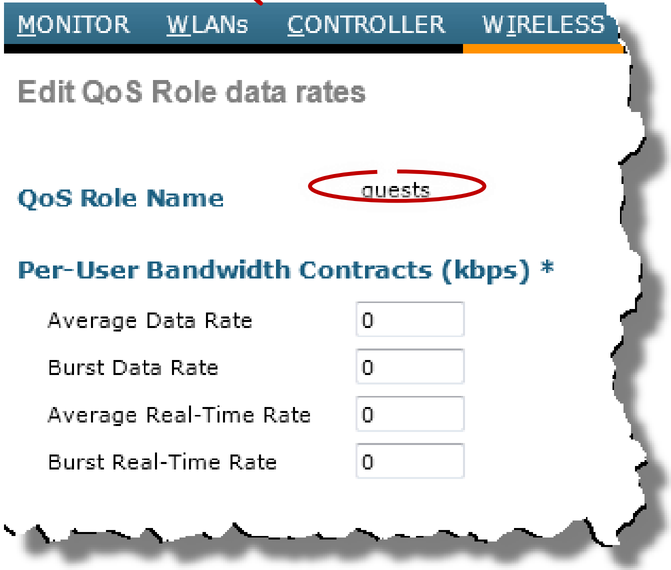


Bandwidth Control – per User

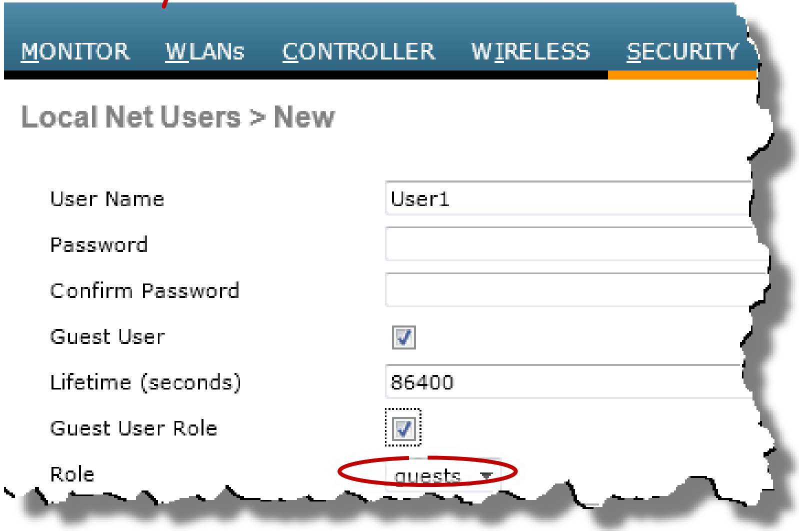
- You can also control upstream and downstream bandwidth consumption:

- There is even a specific bandwidth control for Webauth WLAN users (guests)

Wireless > QoS > Role > New



Security > Local Net User > New

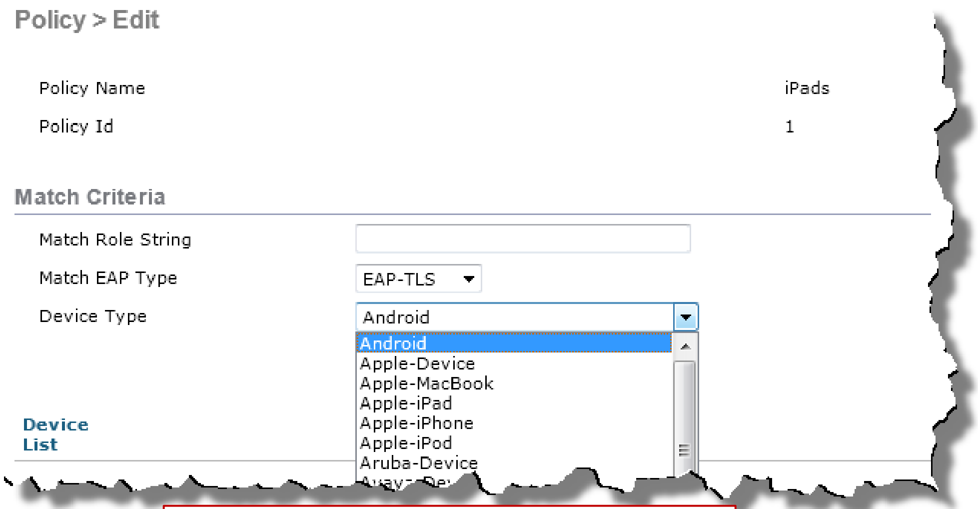


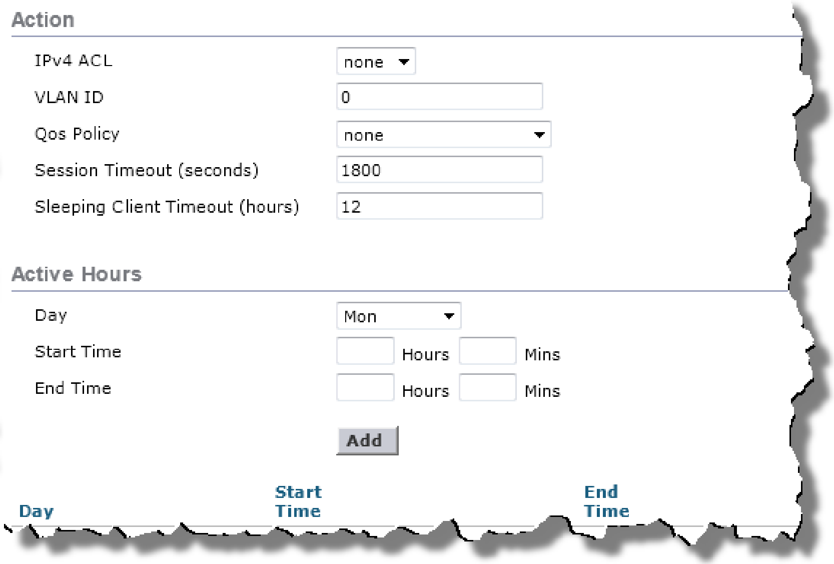
Bandwidth Control – per Device Type

- You can also identify connecting devices, from the WLC or though Cisco ISE, and create a policy based on what they are:

What policy to apply

How to identify that device





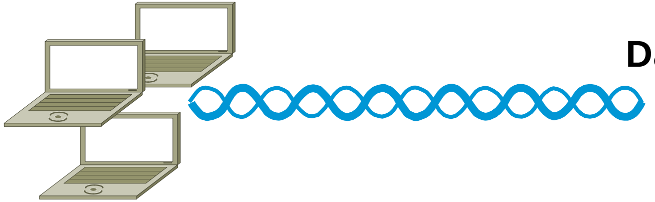
Close to 100 types on WLC

Configuring Policies

- You can then apply the policies to the WLANs, in the order you want them to be applied, up to 16 policies per WLAN:

- Each policy can group several devices

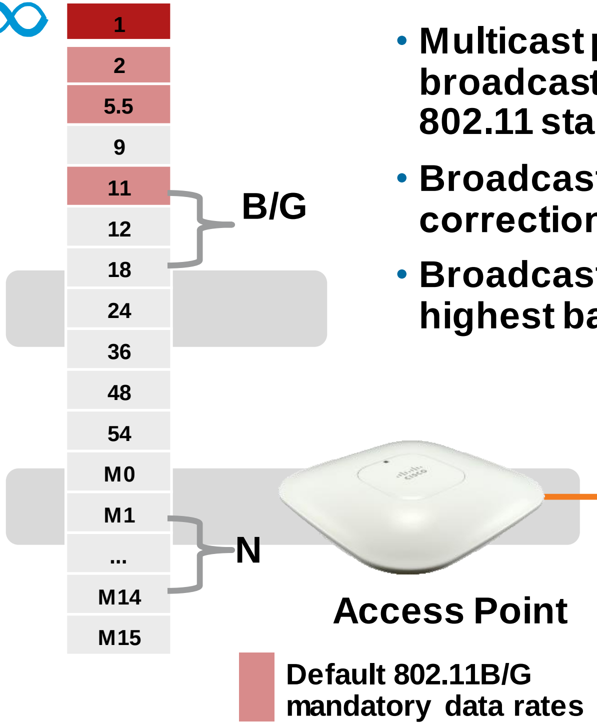
Video Multicast Delivery Challenges

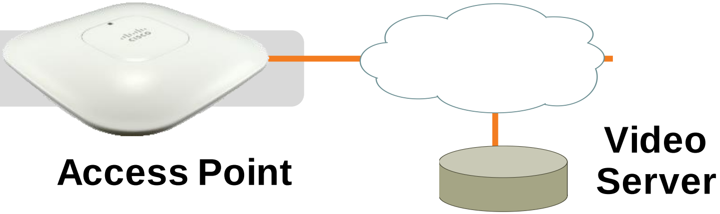


Video Impact

Choppy, Unreliable Video

- Video streaming does not utilise 802.11n/ac High Throughput data rates
- Heavy utilisation of channel due to high rate of slower packets
- Video delivery is not reliable causing poor Quality of Experience





Technical Challenges

- Multicast packets (UDP) are sent as broadcast packets over the air per 802.11 standard
- Broadcast packets do not use error correction: “fire and forget”
- Broadcast packets are sent at highest basic/mandatory data rate.

Video Multicast Delivery Solution - VideoStream

Video Impact

- Smooth, Reliable Video delivered to multiple clients
- Quality of Video protected in varying channel load conditions
- Prevents video flooding
- Prioritises Business Video over other video

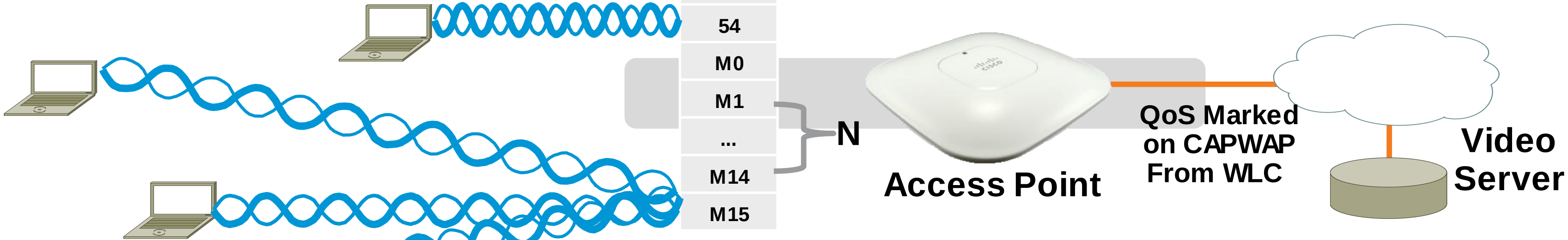
802.11 Data Rates

1
2
5.5
9
11
12
18
24
36
48
54
M0
M1
...
M14
M15

B/G
N

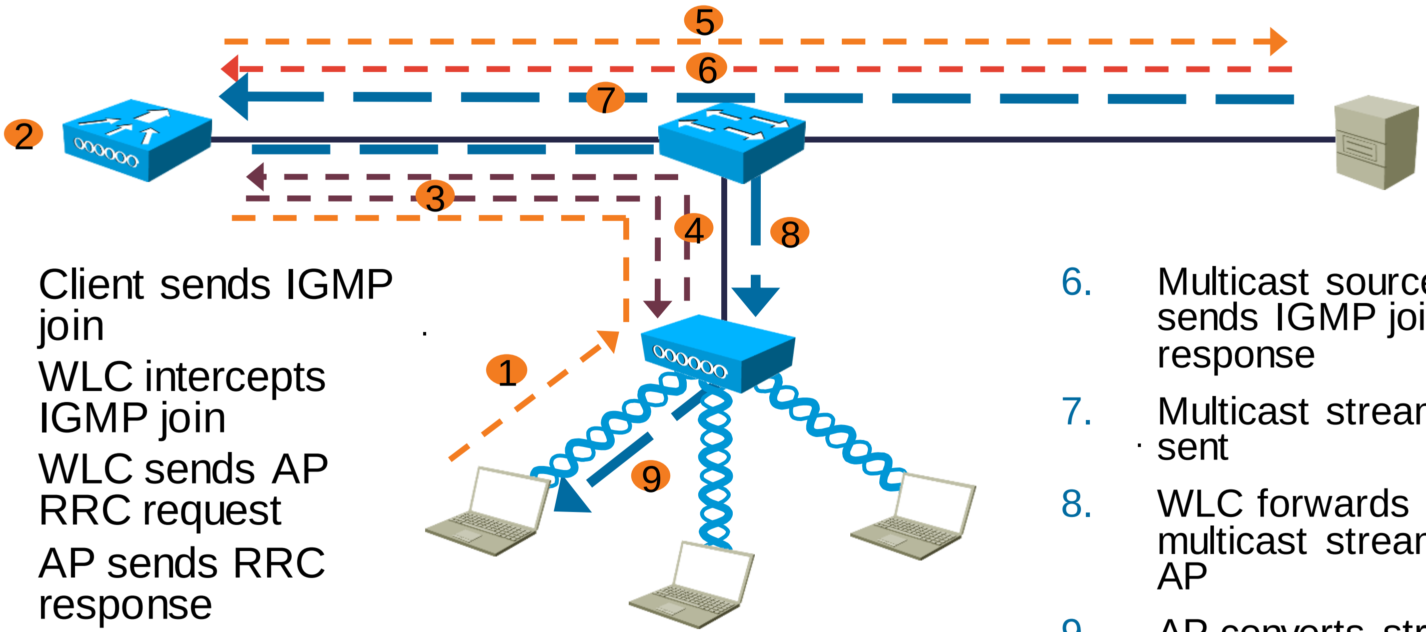
Technical Solution

- IGMP state monitored for each client. We only send video to clients requesting it
- Multicast packets replicated at AP and sent to individual clients at their data rate
- Resource Reservation Control (RRC) is used to prevent channel oversubscription. Works in conjunction with Voice CAC
- Stream Prioritisation ensures important videos take precedence over others
- SAP/SNMP error message created when Channel Subscription is violated



Default 802.11B/G mandatory data rates

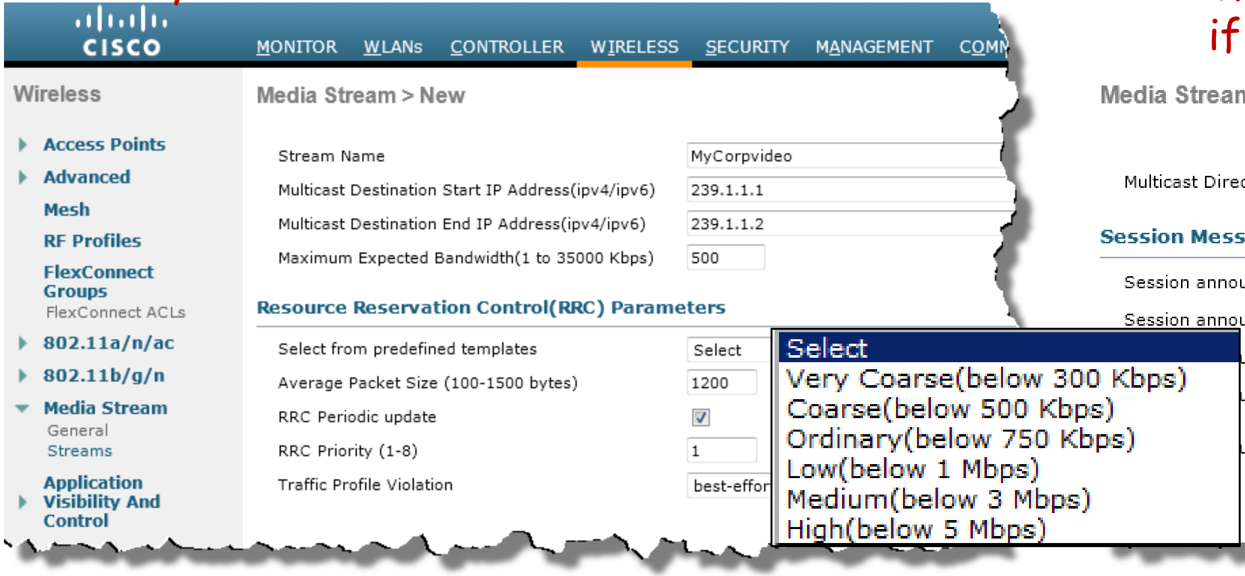
Cisco VideoStream - How Does it Work?



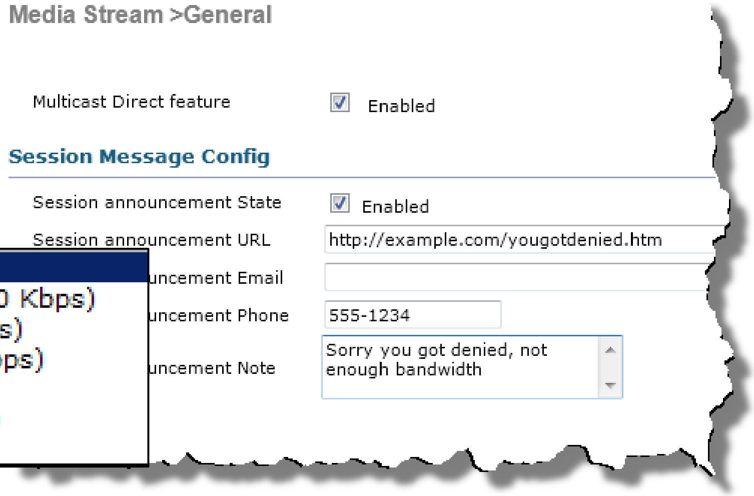
1. Client sends IGMP join
2. WLC intercepts IGMP join
3. WLC sends AP RRC request
4. AP sends RRC response
5. WLC forwards join request
6. Multicast source sends IGMP join response
7. Multicast stream sent
8. WLC forwards multicast stream to AP
9. AP converts stream to unicast and delivers to client

Cisco VideoStream - Configuration

Create your streams



What do you tell your users if you deny a stream



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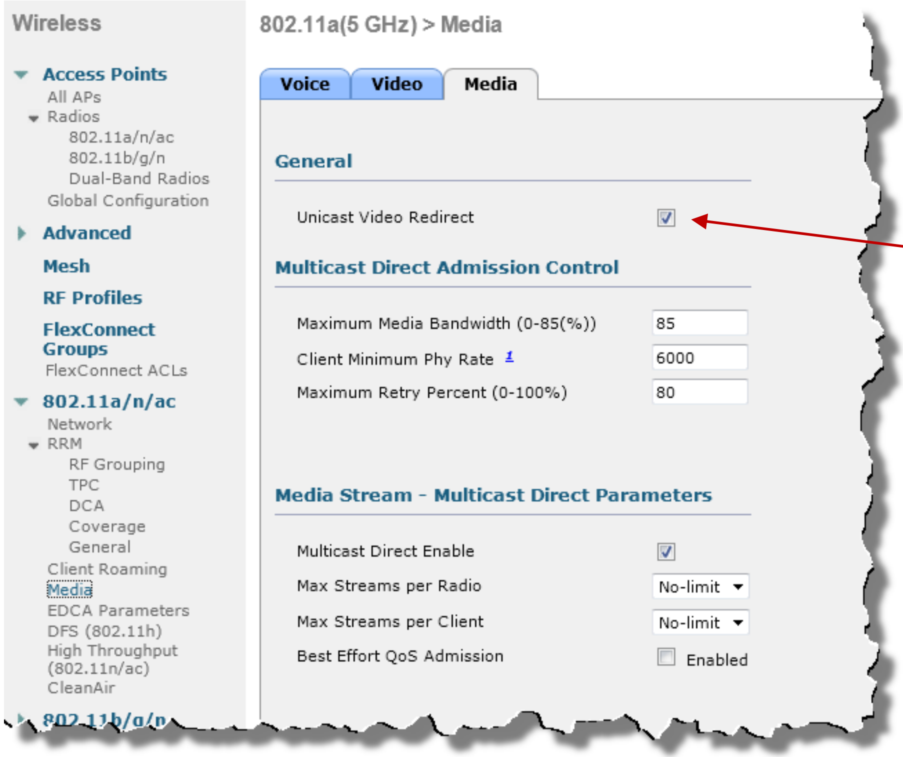
Cisco VideoStream - Configuration

Fine tune Video BW consumption



- Do not forget to enable VideoStream:
- Globally (Wireless > Media Stream > General > Multicast Direct)
- Or per band

Where are We Now?

- We have:
  - ✓ Cell built based on device types and density (AP power level matches client power, settings tested)
  - ✓ Good overlap and roaming optimisation (20% overlap, -65 dBm at edge, roaming configuration optimised)
  - ✓ QoS for wireless and wired traffic (end to end)
  - ✓ EDCA optimised for voice/video (Right TXOPs, right WMM profiles)
  - ✓ CAC (to block excessive flows and guarantee ongoing calls quality)
  - ✓ AVC (to mark and filter traffic)
  - ✓ VideoStream (to optimise video delivery)
- No network is perfect, but this checklist should help you make sure that your wireless network is optimised for mobile applications

Q & A

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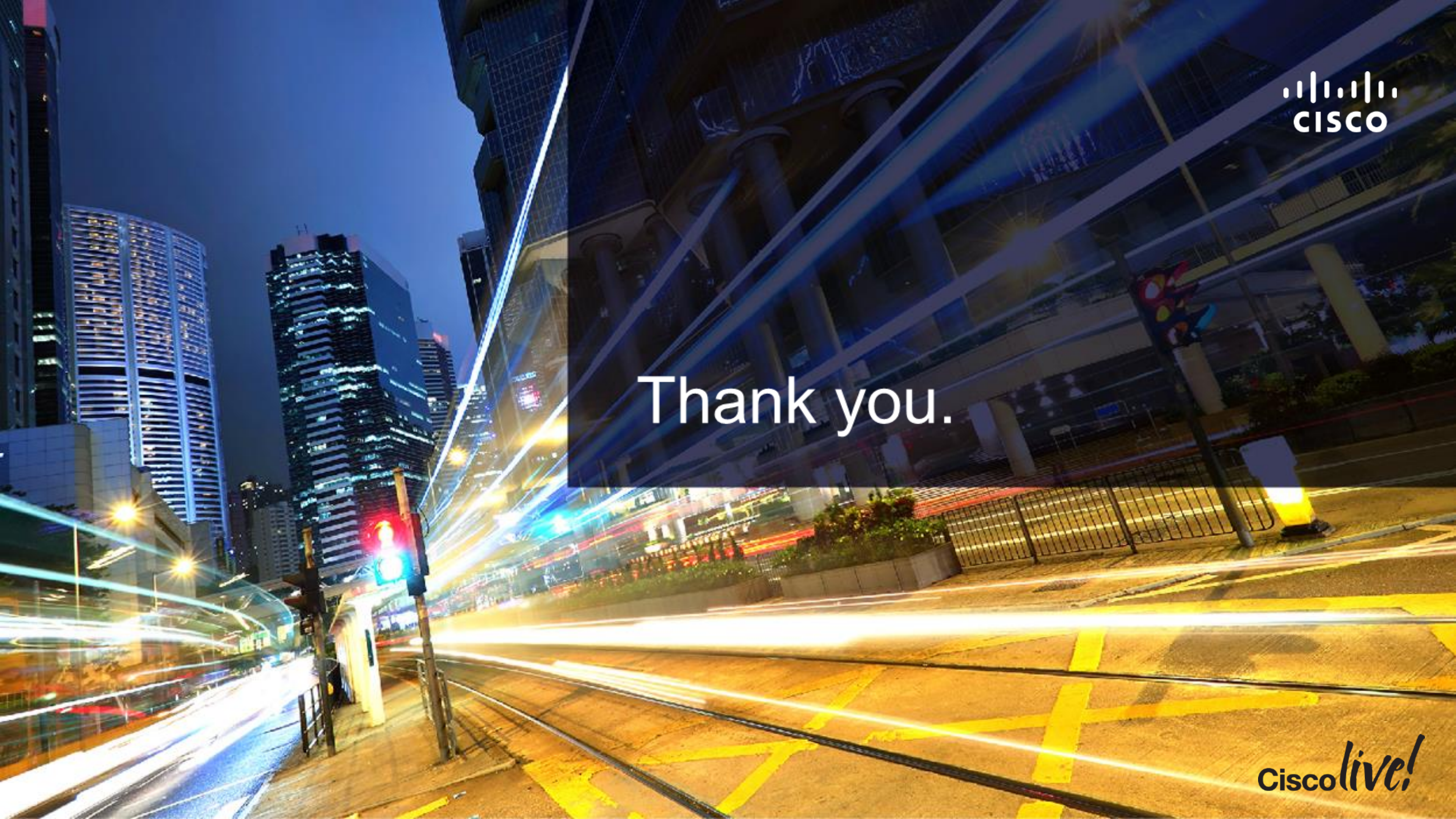
Thank you.

CISCO