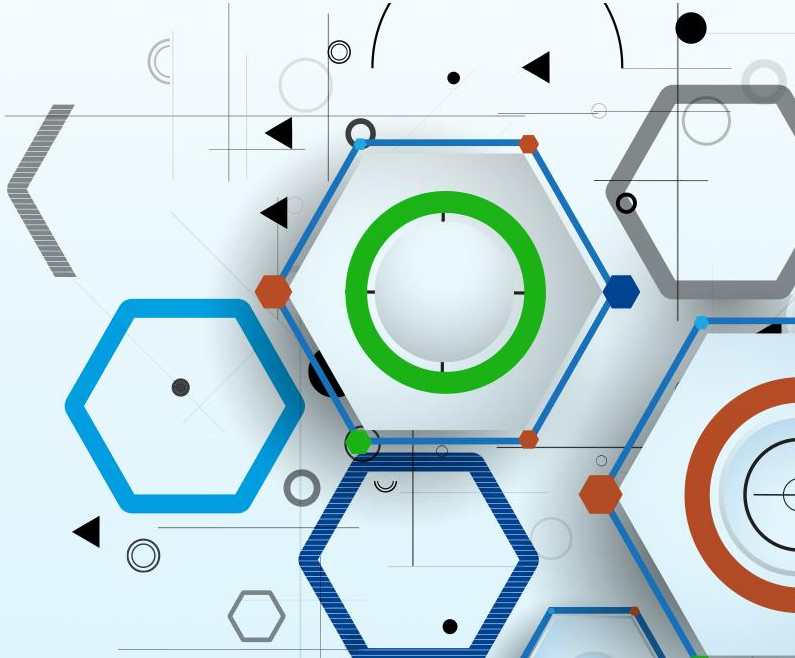
Návrh a nasazení bezdrátových sítí pro real time aplikace

- MOB1 - *DESIGN/L2*

Jaroslav Čížek, Cisco
Michal Fikejs, Networksys



Agenda

- Building the first cell
  - Shape, Size (AP Power, Protocols and Rates, Channel Width)
- Taking Care of the Roaming Path
  - AP Placement Strategies, antennas, overlaps
- NETWORKSYS – Case Study
- Optimizations
  - Tweaking the WLC and AP configurations for difficult clients
- Conclusion
  - Last Words and where to go when things go wrong

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NETWORKSYS

25 LET

- ✓ Dlouhodobá působnost na trhu ICT v ČR – založena 1991
- ✓ Technologický leader v ČR – optické sítě, RaS, datová centra
- ✓ Hlavní strategický partner - networking

Cisco Gold Partner

- ✓ Partneři – datová centra

NetApp Silver Partner

EMC² Velocity Solution Provider Program

vmware Partner Enterprise Solution Provider

Veeam pro partner

- ✓ Vysoká přizpůsobivost požadavkům zákazníka

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First…How Many Devices You Expect and How Much Bandwidth do you Need?

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Bandwidth Cheat Sheet

People use only one real time application at a time!!!

1. Check the bandwidth of each expected applications in your network,
2. Multiply by number of users of that application in the cell:

   -> ***This is the bandwidth you need at the edge of the cell***

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

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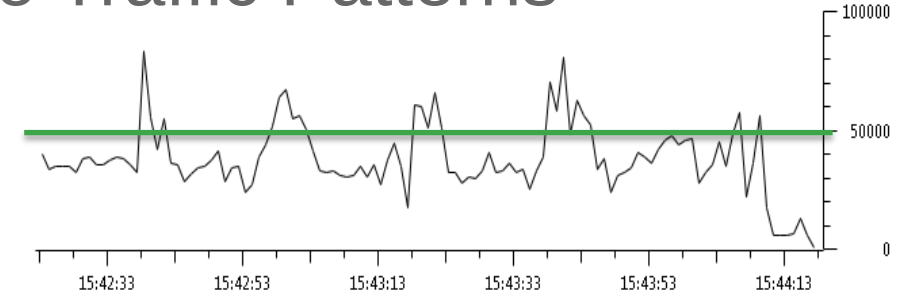
Wi-Fi Calling and Video Traffic Patterns

- Normal call bandwidth consumption (both sides are talking, sometimes at the same time

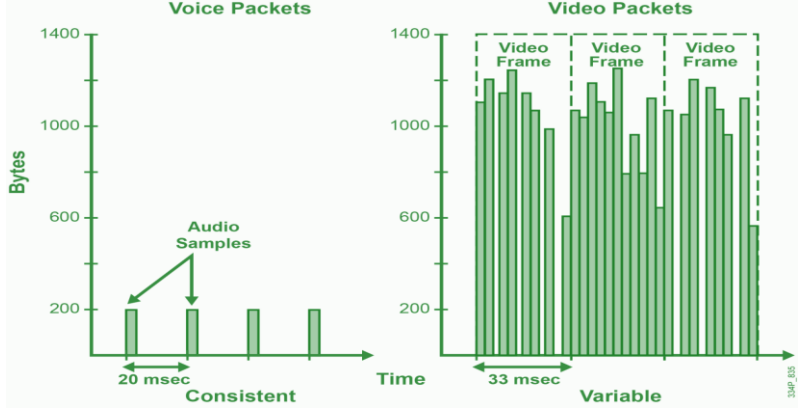


50 kB/s mark

- Skype Pro / Lync (Up/Down):

Call type	Audio	Audio HD	Video	Video HD
Typical Bandwidth	51Kbps/51kbps	86Kbps/86kbs	190kbps/190kbps	2.5 Mbps/2.5 Mbps

- Now that you get the picture, a few other examples:
  - Facetime (video, iPhone 4S): 400 Kbps, (audio) 32 kbps
  - Viber, Skype (video) 130 kbps, (audio) 30 kbps
  - Netflix (video), from 600 kbps (low quality) to 10 Mbps (3D HD), average 2.2 Mbps



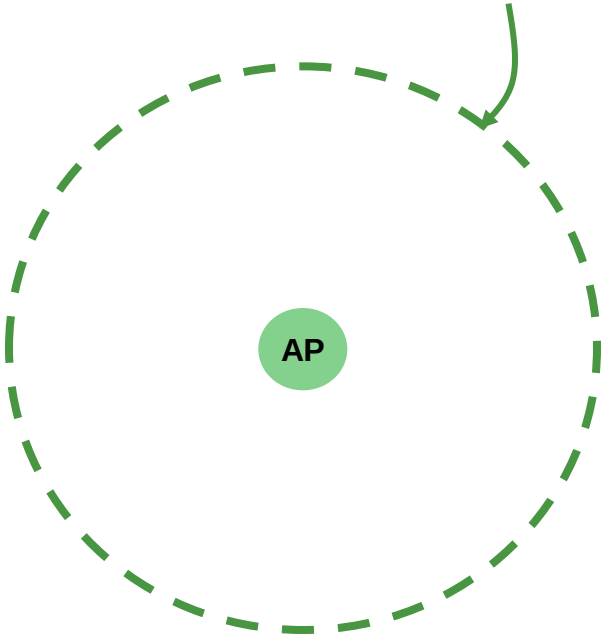
Real Life Example?

Medical Center

- Density studies show active 12 users / cell on average
  - Expected 2 HD video calls (Skype type)
  - 5 audio calls
  - Other users may browse
- Let's do the math:
  - 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 / user?
  - Total = **6.65 Mbps needed**

Funny that browsing requires more than voice
Should I design for browsing?

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



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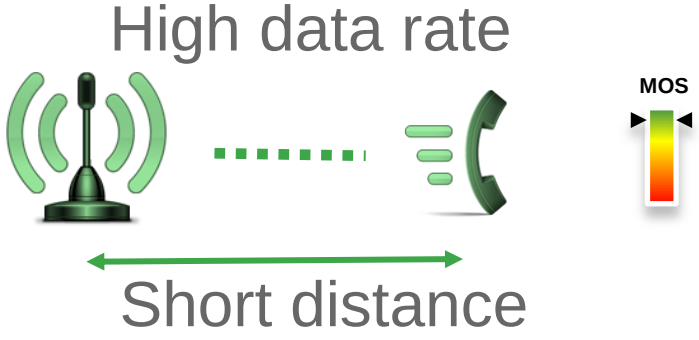
Voice QoE relates to MOS measurement

VoIP MOS Degrades with Distance and Congestion



Higher data rate = less time in the air

+

Shorter distance = less chances to hit interference on the way

=

Lower risk of loss or retries

Medium is half duplex
Congestion increases delays and retries
AP 50% CU is “gaping threshold”

Below 4.1, VoIP Quality Changes from “Good” to close to “Fair” (“slightly annoying”)

QoE – Quality of Experience
MOS – Mean Opinion Score

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VoIP Golden Rules for Wi-Fi

- Packet Error Rate (PER) <=1%
- As low jitter as possible, less than 100ms
- Retries should be < 20%
- End to end delay 150 – 200 ms, 30 ms in cell
- When these values are exceeded, MOS reduces too much
- **Your mission is to keep MOS high (>4.1)**

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Next… Design your Cell Shape and Size

Rodiče si přijdou pro dítě do školky. Slunce svítí, děti sedí v pískovišti s tablety a učitelka si dříme na lavičce.
„Haló, paní učitelko, nebojíte se, že se vám nějaké dítě ztratí?!“
*„Ne, kam by chodily, wifina je **jenom** na pískovišti!“*

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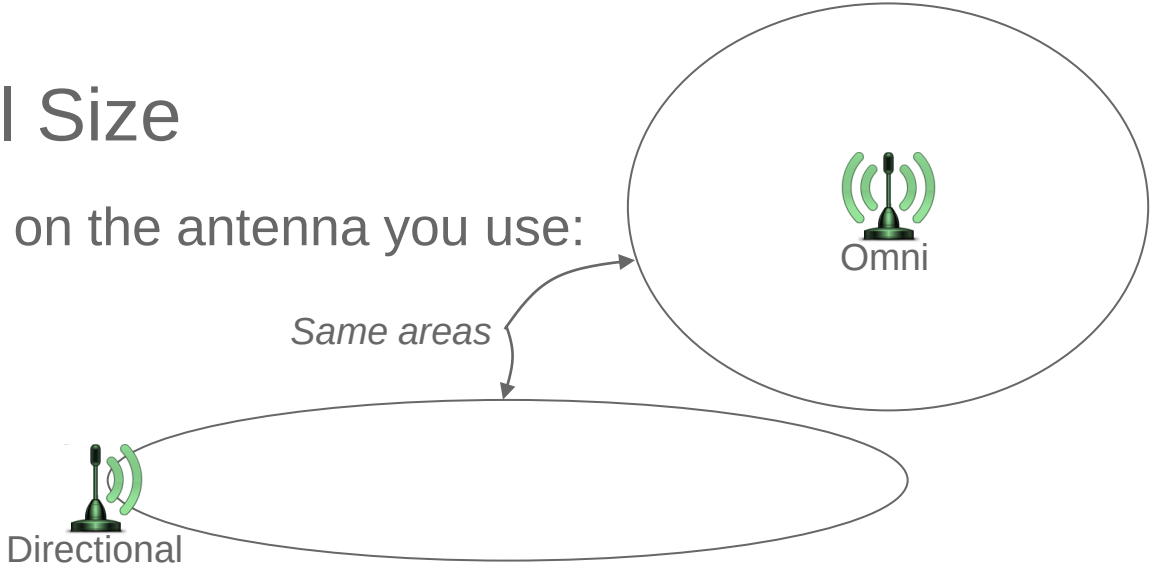
Cell Shape and Cell Size

- Your cell shape depends on the antenna you use:

  - Directional
  - Omnidirectional



- The cell size depends on 3 parameters:

  1. The AP power level
  2. The standard you use (802.11a/b/g/n/ac)
  3. The Data rates you allow

All this assumes open space… in real world, you also need to account for RF obstacles

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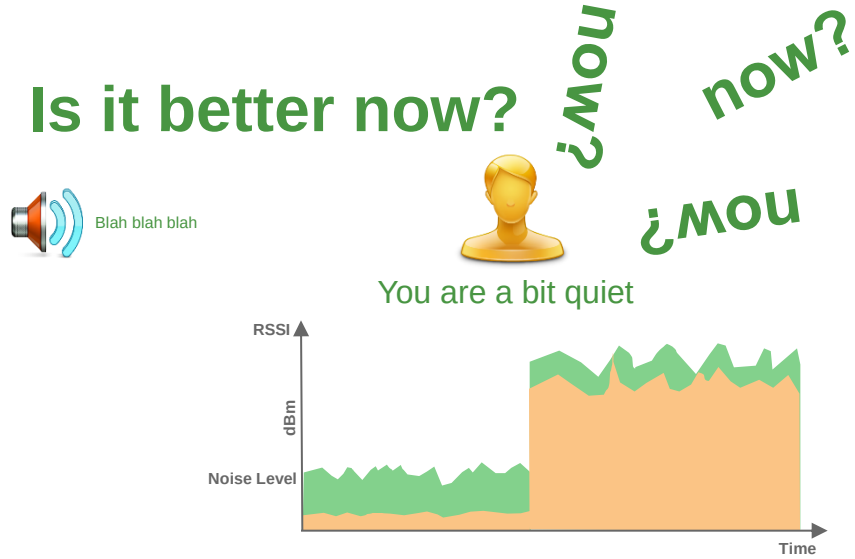
The AP power level

Higher Power Does not Always Mean Better Signal



Aim for:

- Noise level ≤ -92 dBm
- RSSI ≥ 67 dBm

-> 25 dB or better SNR

- Channel Utilization under 50%.

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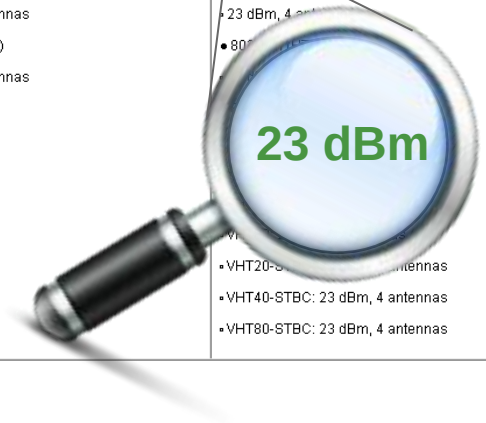
Modern Devices are Created Unequal

3700i AP
(+4 dBi antenna on 2.4 GHz,
+6 dBi antenna on 5 GHz)

Maximum transmit power	2.4 GHz	5 GHz
	• 802.11b	• 802.11a
	▪ 23 dBm, 4 antennas	▪ 23 dBm, 4 antennas
	• 802.11g	• 802.11n (HT20)
	▪ 23 dBm, 4 antennas	▪ 23 dBm, 4 antennas
	• 802.11n (HT20)	• 802.11n (HT40)
	▪ 23 dBm, 4 antennas	▪ 23 dBm, 4 antennas
		• VHT20-STBC: 23 dBm, 4 antennas
		• VHT40-STBC: 23 dBm, 4 antennas
		• VHT80-STBC: 23 dBm, 4 antennas



Iphone 5

Band	Max Tx Power
2.4 GHz ISM	16 dBm
UNII-1	**14 dBm**
UNII-2	13.5 dBm
UNII-2e	12 dBm
UNII-3	13 dBm
ISM (Ch 165)	13 dBm

Source: FCC

Frequency (GHz)	Gain (dBi) Type: Pifa
2.400-2.480	-1.4
5.150-5.250	0.14
5.250-5.350	-1.66
5.47-5.725	-0.83
5725-5850	-2.85

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Some Client Max EIRPs

Model	EIRP 2.4 GHz	Worst* EIRP 5 GHz
Iphone 6S	14.8 dBm	10.3 dBm
Ipad 4	15.2 dBm	22.67 dBm
Samsung S3	14.9 dBm	10.18 dBm
Samsung S4 tab	12.05 dBm	11.24 dBm
Samsung S6	13.5 dBm	10.66 dBm
HTC One	14.4 dBm	13.8 dBm
Nokia Lumia 1520	13.1 dBm	11.6 dBm
ASUS PCE-AC66	22 dBm	22.83 dBm

* EIRP varies with sub-band, displaying worst of all sub-bands

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802.11 devices decide of their transmission rate based on the received signal

Okay when AP and client had same HW specs*… in 1997

*Tx/Rx sensitivity, antennas, power level

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If AP Signal is Strong, Client Uses High Data Rate

Client power can be low, noise at the AP high, HW specs may be different…

- Bad design example: HTC One @ 12 dBm, AP @20 dBm

17	0.039879000	172.31.255.101	172.31.255.103	UDP	1420	34	-35 55 dB	54.0	Source port: 50857 Destination port: search-agent
18	0.040266000	172.31.255.101	172.31.255.103	UDP	1420	34	-35 55 dB	54.0	Source port: 50857 Destination port: search-agent
19	0.040648000	172.31.255.101	172.31.255.103	UDP	1420	34	-34 56 dB	54.0	Source port: 50857 Destination port: search-agent
20	0.041938000	172.31.255.101	172.31.255.103	UDP	1420	34	-34 56 dB	54.0	Source port: 50857 Destination port: search-agent
21	0.042217000	172.31.255.101	172.31.255.103	UDP	1420	34	-29 61 dB	36.0	Source port: 50857 Destination port: search-agent
22	0.043444000	172.31.255.101	172.31.255.103	UDP	1420	34	-29 61 dB	12.0	Source port: 50857 Destination port: search-agent
23	0.043445000		Cisco_0a:04:2e (RA)	802.11	40		-45 45 dB	12.0	Acknowledgement, Flags=........C
24	0.043850000	172.31.255.101	172.31.255.103	UDP	1420	34	-34 56 dB	54.0	Source port: 50857 Destination port: search-agent
25	0.044245000	172.31.255.101	172.31.255.103	UDP	1420	34	-34 56 dB	54.0	Source port: 50857 Destination port: search-agent
26	0.044641000	172.31.255.101	172.31.255.103	UDP	1420	34	-34 56 dB	54.0	Source port: 50857 Destination port: search-agent
27	0.045023000	172.31.255.101	172.31.255.103	UDP	1420	34	-35 55 dB	54.0	Source port: 50857 Destination port: search-agent
28	0.045750000	172.31.255.101	172.31.255.103	UDP	1420	34	-29 61 dB	36.0	Source port: 50857 Destination port: search-agent
29	0.046223000	172.31.255.101	172.31.255.103	UDP	1420	34	-29 61 dB	36.0	Source port: 50857 Destination port: search-agent
30	0.047450000	172.31.255.101	172.31.255.103	UDP	1420	34	-29 61 dB	12.0	Source port: 50857 Destination port: search-agent
31	0.047450000		Cisco_0a:04:2e (RA)	802.11	40		-47 43 dB	12.0	Acknowledgement, Flags=........C

```
Frame 29: 1420 bytes on wire (11360 bits), 1420 bytes captured (11360 bits) on interface 0
Radiotap Header v0, Length 26
IEEE 802.11 QoS Data, Flags: ....R.F.C
  Type/Subtype: QoS Data (0x28)
⊟ Frame Control: 0x0A88 (Normal)
    Version: 0
```

Based on Rx AP signal, BYOD thinks 54 Mbps rate is okay…

But client message is too weak, and AP does not ACK until rate falls to 12 mbps

How can you tell the AP and Client Power level?

- **AP** - WLC global level gives you the overall resulting power (this is what you care about):

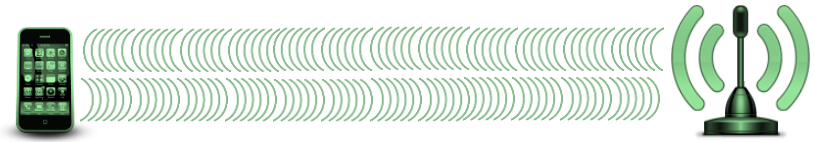
```
(Cisco Controller) >show advanced 802.11a txpower
…/…
AP Name                          Channel     TxPower         Allowed Power Levels
-------------------------------- ----------- -------------- ------------------------
AP702W                           157         *1/8 (20 dBm)  [20/17/14/11/8/5/2/-1]
AP2602                           48           1/4 (14 dBm)  [14/11/8/5/5/5/5/5]
AP3702                           (52,56)     *2/5 (12 dBm)  [15/12/9/6/3/3/3/3]
AP3602                           (40,36)     *2/7 (12 dBm)  [14/12/10/8/5/-1/-4/-4]
```

- **Client** - You can check, live the client power levels on the AP (useful to check symmetry in AP to client and client to AP signal when building your cell edge):

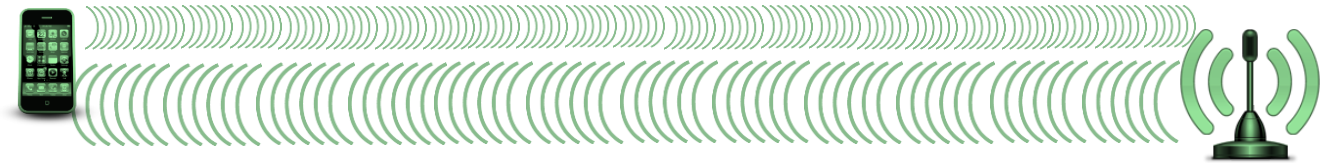
```
AP7cad.74ff.36d2#debug dot11 dot11Radio 1 trace print rcv

*Jun  1 04:11:43.663: D5B70D90 r  6      49/46/42/48 54- 0803 000 m010B85 477AAF m010B85 33E0 477AA0 146
*Jun  1 04:11:43.664: A2CEF918 r m15-2s  53/63/54/61 40- 8841 030 1A096F A36F20 m333300 76B0 q0 1100
```

So, what is the right Power?

- In short: **half your worst client max power**
  - E.g. you design for 5 GHz, worst client max is at 11 dBm, set your AP power to 8 dBm



- Otherwise, you get this:



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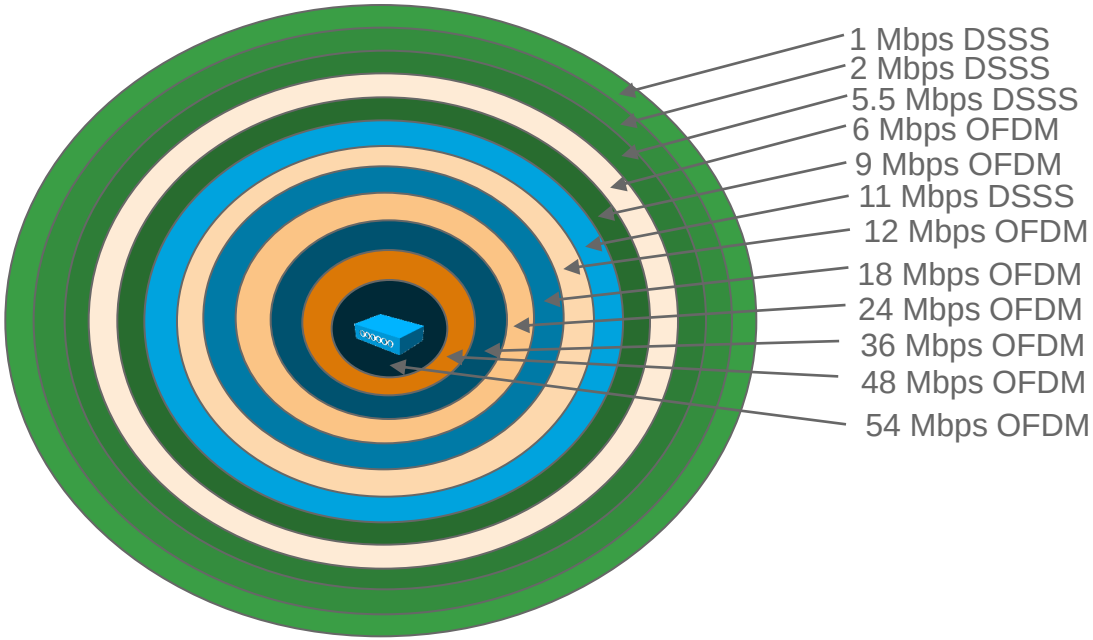
802.11 Standards - Cell Useful Radius is Determined by Minimum Allowed Data rate

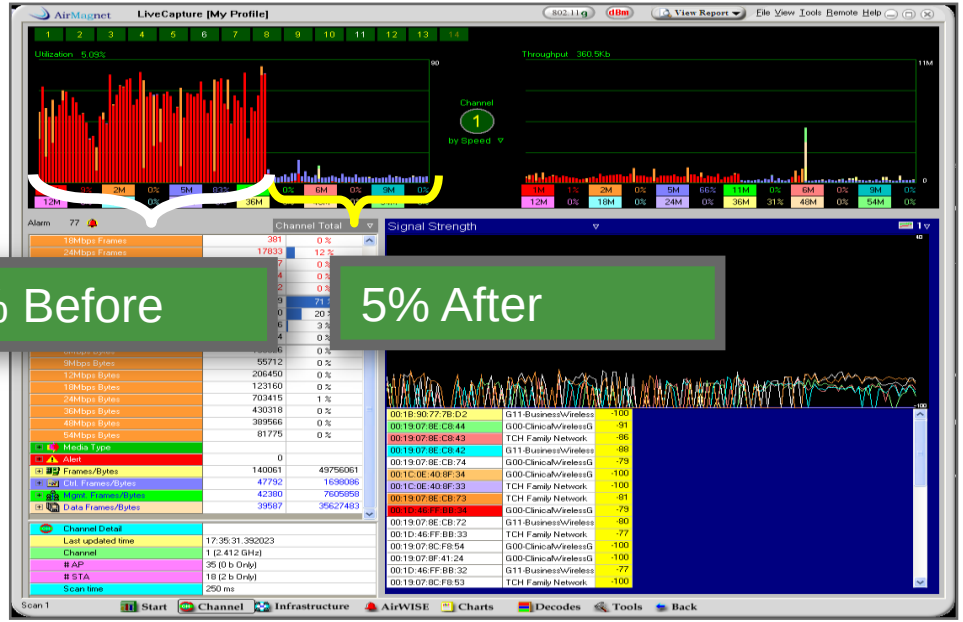


Cell Throughput by Protocol:

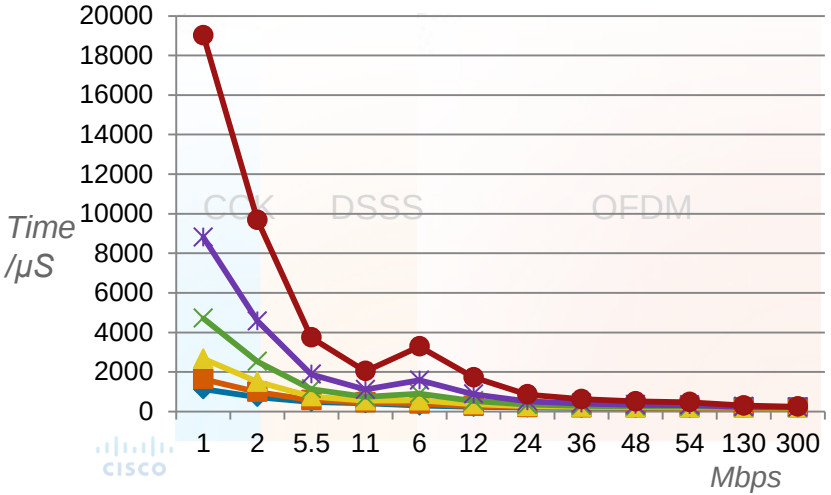
Protocol	Throughput (Mbps)
802.11b	7.2
802.11b/g mix (1 b client)	9.5
802.11g	22.5
802.11a	22.5
802.11n (HT20 1ss MCS7)	35
802.11n (HT20 2ss MCS15)	75*
802.11n (HT20 3ss MCS23)	110
802.11ac (VHT80 3SS MCS 9)	630**

These are average throughputs, with one client close to the AP (high SNR/RSSI)
** Two spatial streams – note most PDA's are SISO (MCS 7) 35 Mbps max*
*** You could have guessed that ☺: 256-QAM max PHY is 1.3 Gbps, max throughput is typically less than half of max PHY*

SSIDs and Low Rates Consume Air Time



Low rates impact depends on frame size…



- 64 Byte
- 128 Byte
- 256 Byte
- 512 Byte
- 1024 Byte
- 2048 Bytes

Frame Size/Bytes

- Before: 8 SSIDs, all rates allowed
- After: 2 SSIDs, 802.11b rates disabled

=> Assess your CU often

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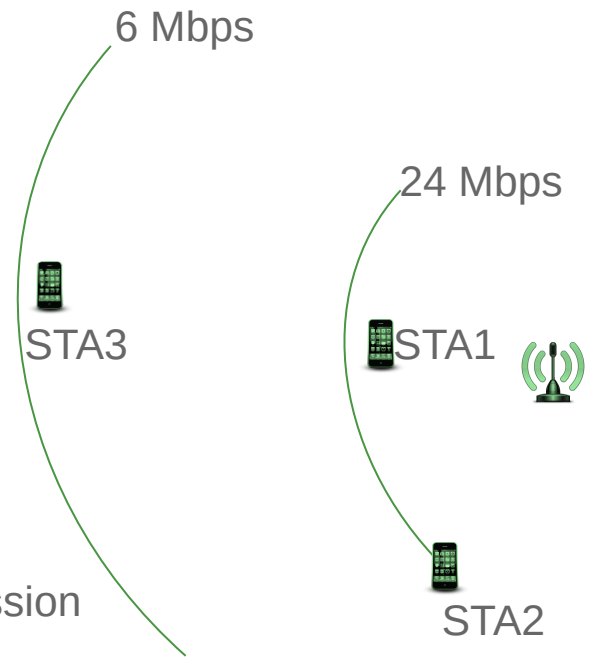
Data rates - What Should Your Minimum Rate Be?

- Stop your cell where:

  1. Signal to your clients is still strong
  2. Clients and overhead traffic still “reasonably fast”
  3. Retries are low

- Beyond that point, clients should be able to get to another AP if they want to.

- On the right:
  - STA1 and STA2 hear each other -> less collisions
  - STA 1 and STA2 send @ 54 Mb/s -> short delays
  - STA3 is far from AP -> lower data rate (longer transmission delay), higher PER and loss risks
  - STA3 does not hear STA1 and STA2 -> higher collision risk



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So…What Should Your Minimum Signal Level Be?

- Multiple measurements show a **“sweet spot” by -67 dBm**:

802.11n client still communicates at 72 Mbps (MCS 7)

Source	Destination	Protocol	Length	DSCP	Timestamp	RSSI	SNR	Rate	Detail	p
	18:af:61:67:10:29 (RA)	802.11	40			-67	22 dB	24.0	Clear-to-send, Flags=.....C	
	SamsungE_c6:e5:98 (RA)	802.11	40			-67	22 dB	6.0	Acknowledgement, Flags=.....C	
	SamsungE_c6:e5:98 (RA)	802.11	40			-67	22 dB	24.0	Clear-to-send, Flags=.....C	
df:52:34:a7:9f:e2	e7:a7:5e:15:a2:38	802.11	190			-67	22 dB	72.0	QoS Null function (No data), SN=2125, FN=13, Flags=	
	SamsungE_c6:e5:98 (RA)	802.11	40			-67	22 dB	24.0	Clear-to-send, Flags=.....C	
08:cc:68:b4:2f:8a (TA	SamsungE_c6:e5:98 (RA)	802.11	46			-67	22 dB	24.0	Request-to-send, Flags=.....C	
		802.11	173			-67	22 dB	72.0	Unrecognized (Reserved frame), Flags=opmP...T.	

Management/control frames still sent fast (24 Mbps)
But you start seeing devices (here the AP) dropping rate because signal starts to degrade

- What minimum configured data rate is that? Depends… **Clients will stay connected until they decide to roam, unless your minimum data rate does not allow them to stay below -67 dBm**

Hand and Phone Position Affect Signal

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 body position	**3 - 6 dB**
Phone near field absorption	Up to 15 dB

iPhone 5, Antenna is at bottom

Samsung S5, antenna is at bottom, behind button

There can be a 20 dB difference between these photos

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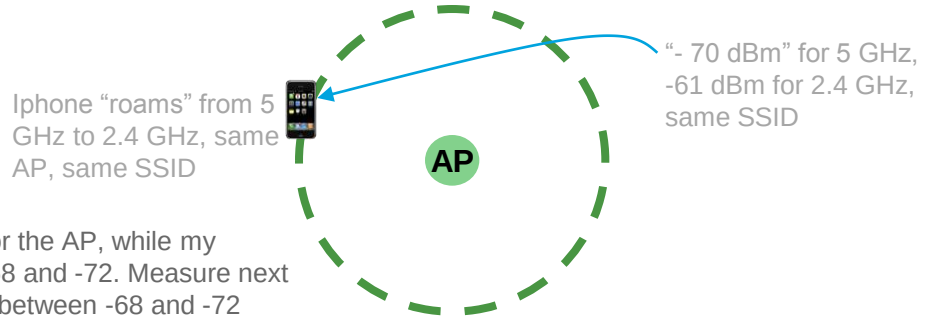
IOS 8 Devices Expected? Adjust the Cell Edge

IOS 8 Scans when AP signal falls below -70 dBm

- 2.4 GHz signal, at same distance from the AP, is commonly 7 dB better than 5 GHz signal
- IOS8 is “supposed to” roam to next BSSID only if its signal is at least 8 dB better than previous one (this in theory avoid the 5 GHz to 2.4 GHz poor roaming behavior)
- BUT measurement sensitivity uncertainty in mass silicon is 3 to 4 dB*
- To limit roaming, limit the SSID to one band (5 GHz if possible). With dual-band SSIDs, expect frequent 5 Ghz -> 2.4 GHz roams
- This behavior also forces cell edge at -65 dBm and 15-20% overlap



* This means that your Iphone can show -70 dBm for the AP, while my Iphone at exact same position can show between -68 and -72. Measure next day on your Iphone and you may also see anything between -68 and -72

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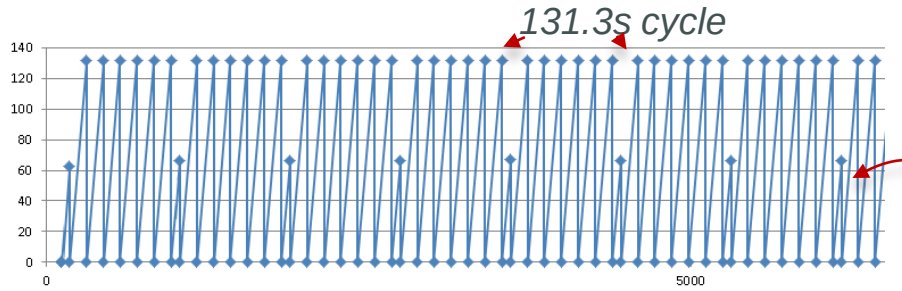
Determining Android Probing Behavior

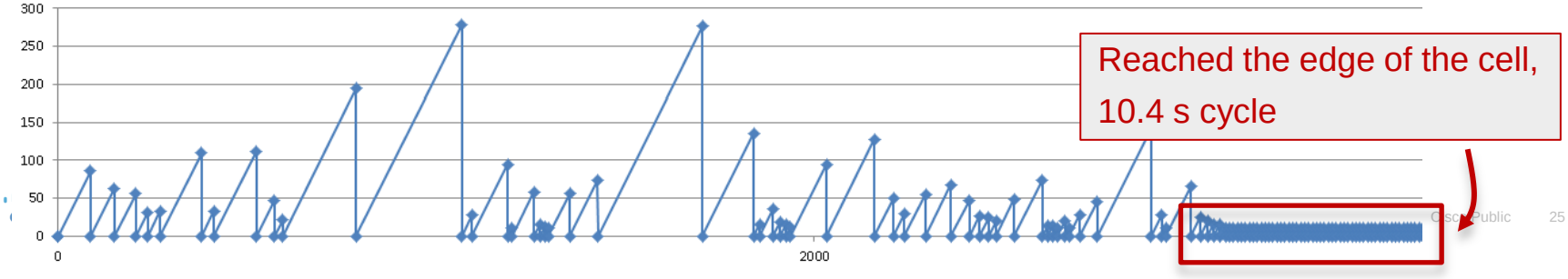
Use Probe as Happiness Index

- Try to determine when your BYOD gets to the edge of the cell (from its perspective): at that time, it will start probing repeatedly to find te next AP
- When at the edge of the cell, and idle (or moving with AP signal at low level), S5 settles to a 10.4 s cycle
- **When you observe this kind of behavior change, you know that there is the edge of your cell**

Samsung S5 when idle and not associated (baseline)

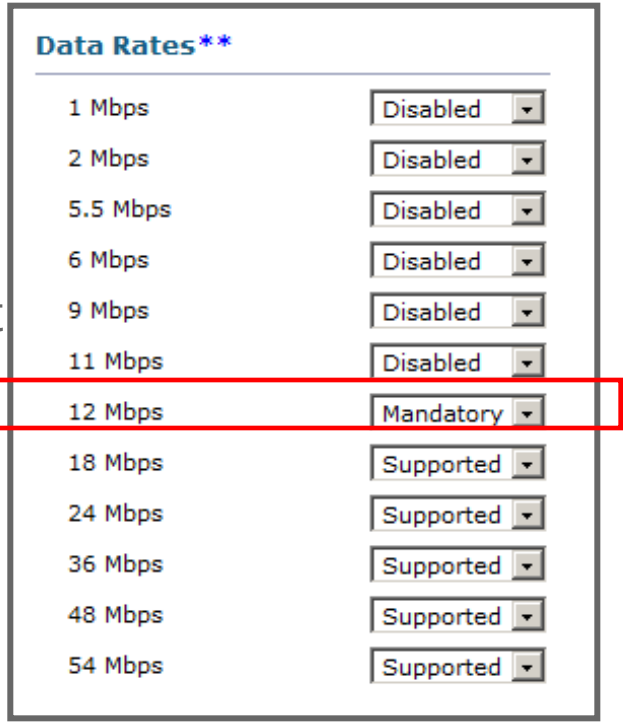


Samsung S5 associated



Reminder About Rates Configuration

- 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



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In **Standard Density Environment**, Stop Your Cell @ -67 dBm

- **When power is @ 11 or 14 dBm, this is about 12 Mbps***
  - Everything below 12 Mbps is disabled (but NOT 802.11n low rates)
  - First allowed rate (12 Mbps) is mandatory

**Supposing a "decently clean" RF environment, 10% max retries, no loss.*

- **Disable 802.11b but not 802.11n Low Rates!**
  - Many BYODs rely on the beacon to validate that the AP is still there (and sync their clock)
  - **Many BYODs also ignore AP instructions about supported 802.11n rates** (disable them, and your client talks at a speed the AP will ignore)

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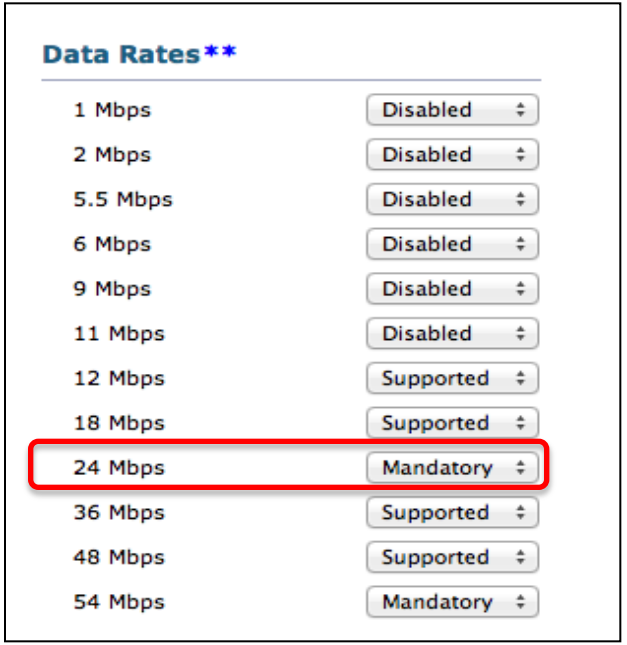
In **HIGH Density Environment**, also stop your cell @ -67 dBm.

- Power is usually low, 14 dBm or lower
- Cells are smaller than in standard density environment
- Roaming occurs faster
- Rate @ -67 dBm is more commonly 24 Mbps
- You want to allow your client to roam at that point -> 24 Mbps is set to Mandatory (below 24 Mbps, client does not hear the beacons and typically scans to find alternate AP)
- You still want the client to communicate with the AP while getting into panic scan
- Set lower rates (18, 12 Mbps) to Supported



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Rates Recommendations So Far

- Disable low rates
- If your real time applications are Voice only, disable rates higher than 24 Mbps, and set channels to 20 MHz
- If your real time applications are Voice AND Video, then you need higher rates
  - In 5 GHz, set channels to 40/80 MHz… if your clients support 40/80 MHz
- Leave all 802.11n / ac rates enabled (if your clients support 802.11n and 802.11ac)

HT MCS Index (Data Rate [1])		SS and VHT MCS Index [4]		
0	(7 Mbps)	1	0	Supported
1	(14 Mbps)	1	1	Supported
2	(21 Mbps)	1	2	Supported
3	(29 Mbps)	1	3	Supported
4	(43 Mbps)	1	4	Supported
5	(58 Mbps)	1	5	Supported
6	(65 Mbps)	1	6	Supported
7	(72 Mbps)	1	7	Supported
-	-	1	8	Supported
-	-	1	9	Supported
8	(14 Mbps)	2	0	Supported
9	(29 Mbps)	2	1	Supported
10	(43 Mbps)	2	2	Supported
11	(58 Mbps)	2	3	Supported
12	(87 Mbps)	2	4	Supported
13	(116 Mbps)	2	5	Supported
14	(130 Mbps)	2	6	Supported
15	(144 Mbps)	2	7	Supported
-	-	2	8	Supported
-	-	2	9	Supported
16	(22 Mbps)	3	0	Supported
17	(43 Mbps)	3	1	Supported
18	(65 Mbps)	3	2	Supported
19	(87 Mbps)	3	3	Supported
20	(130 Mbps)	3	4	Supported
21	(173 Mbps)	3	5	Supported

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Agenda

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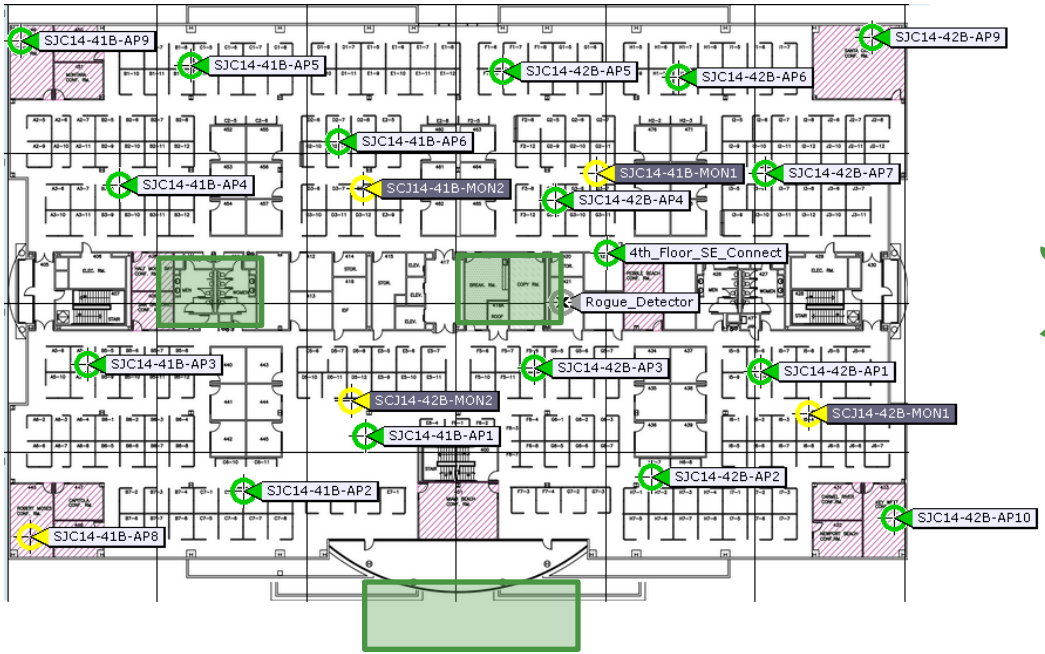
Where do You Need Coverage?

- Talk to end-users. Think what they will need and when, look for roaming paths

Bathroom?

Elevator?

Stairs?



Outdoor smoking Area?

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AP Placement Guidelines

- Mount APs so that antennas are vertical (we use vertical polarization)

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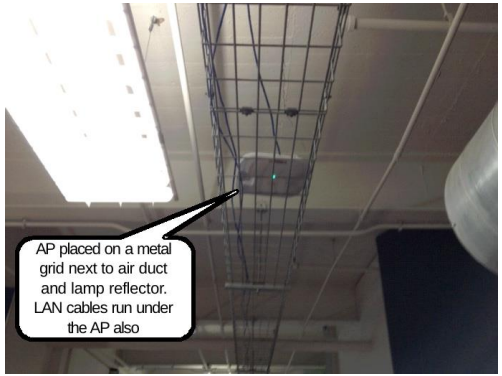
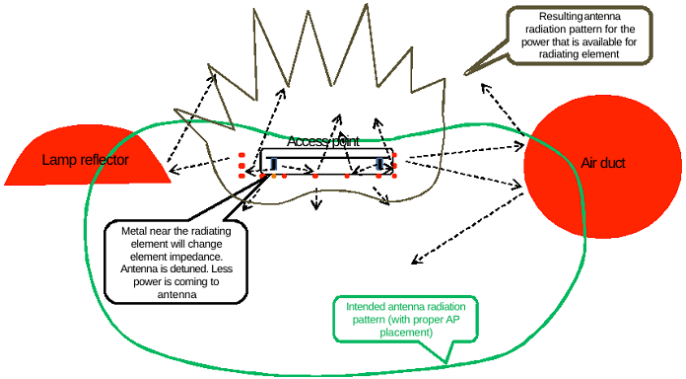
AP Placement – Bad Examples

- Avoid metallic objects that can affect the signal to your clients





- AP too high:
  - Low rate to the ground
  - Client signal too weak at the AP level

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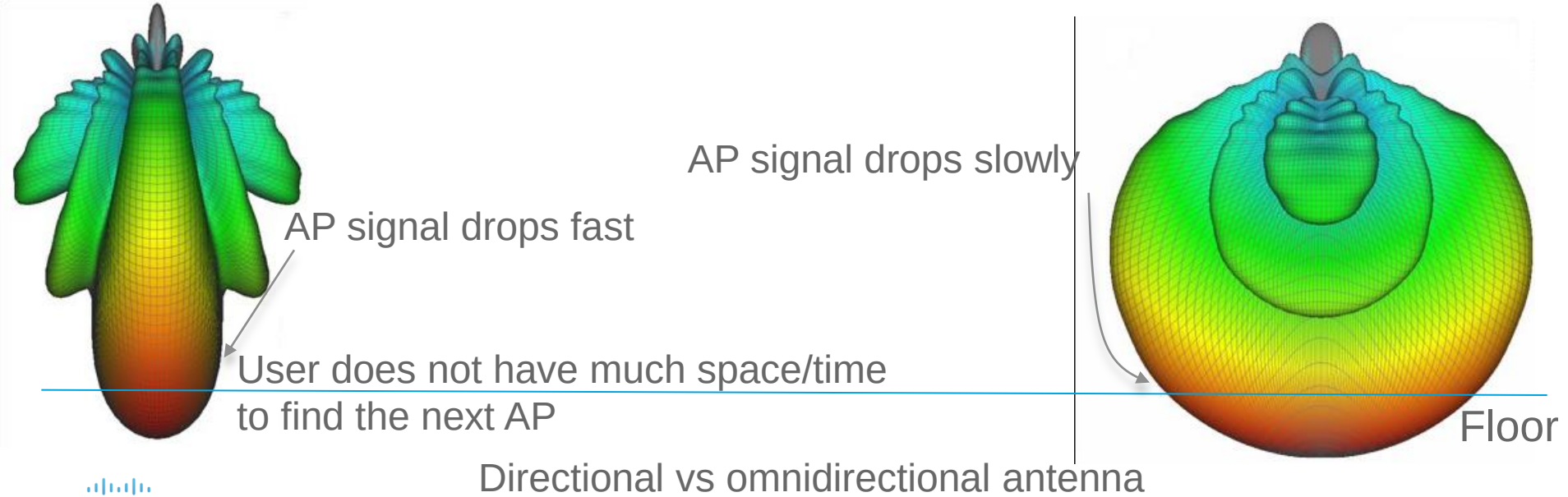
Radiation Pattern and Roaming Buffer

- When users are expected to roam while communicating, make sure their BYOD can detect neighboring APs BEFORE roaming



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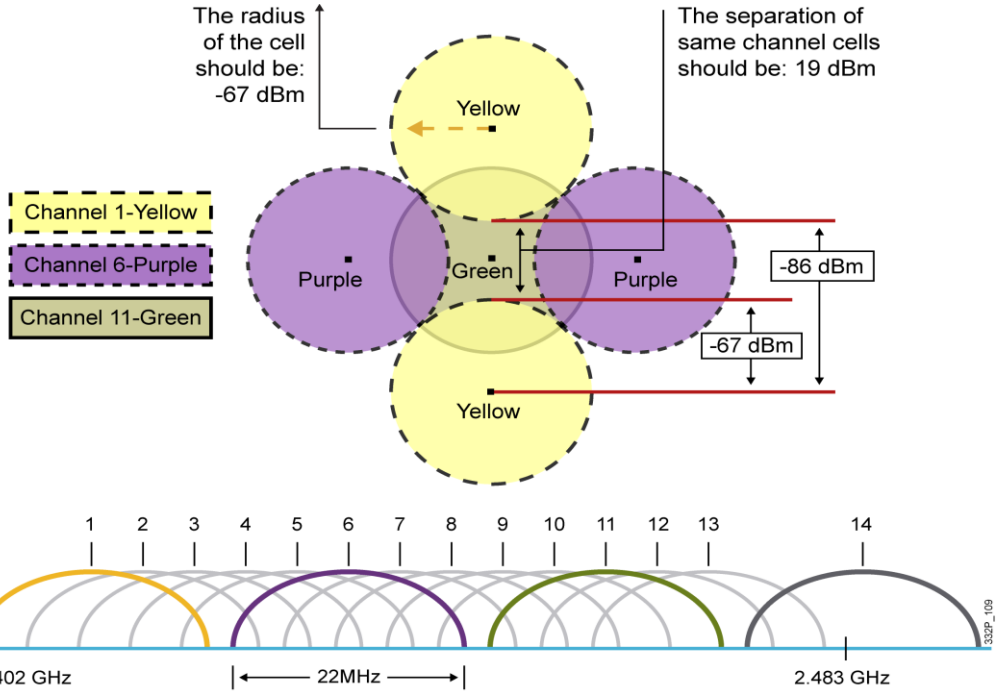
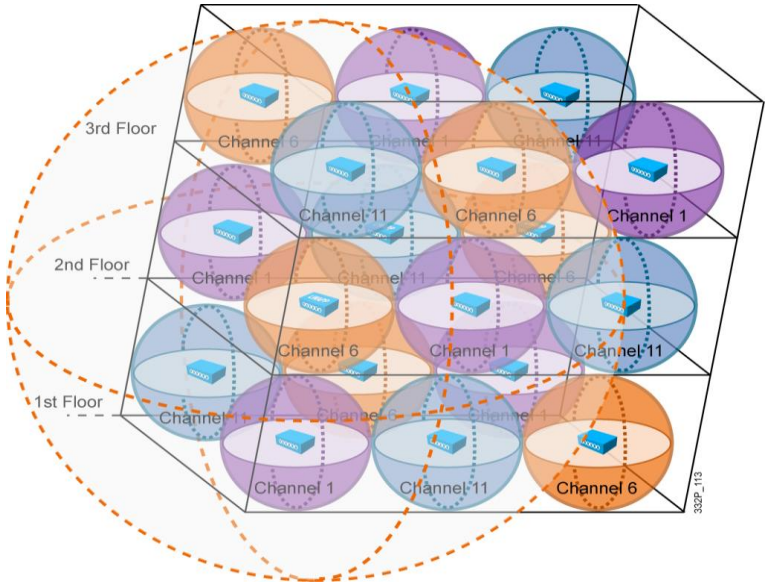
Try to design small cells, with clever overlap





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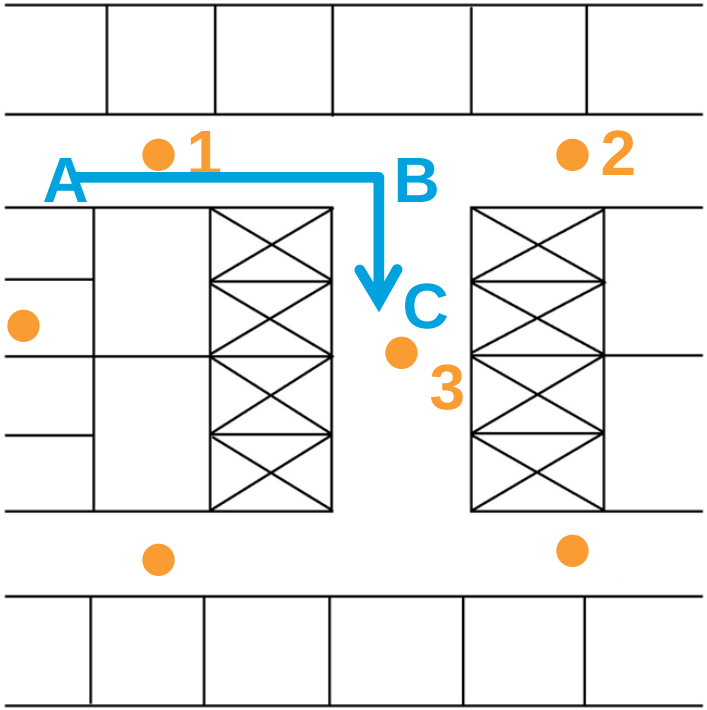
Strategically Position Your Transition Aps



- At “A” the phone is connected to AP 1
- At “B” the phone has AP 2 in the neighbor 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 neighbor 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

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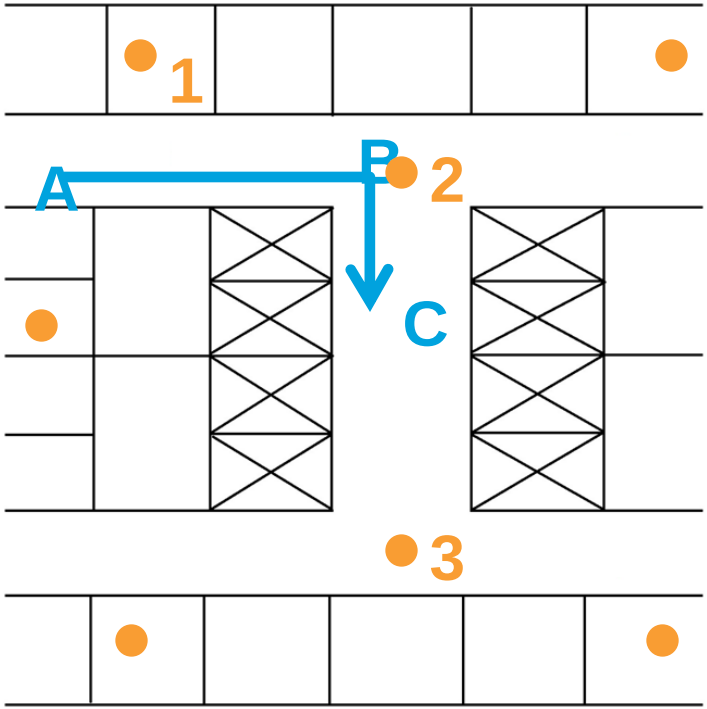
Strategically Position Your Transition APs



- At point A the phone is connected to AP 1
- At point B the phone has AP 2 in the neighbor 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

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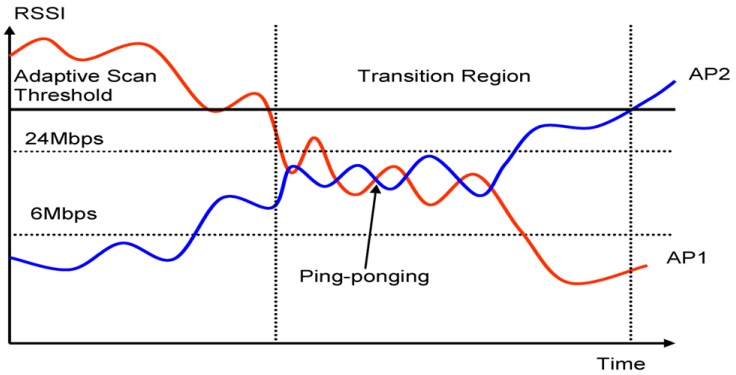
Avoid Ping Pong Zones



Ping-pong effect occurs when a wireless client is at the edge of two cells and hops between them.

Ping Pong zone recipe:
Set overlap along pacing path
Let user head force the roam

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NETWORKSYS

Příklad ze života – projekt Celoplošné pokrytí WiFi na **VŠCHT Praha**

cisco

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NETWORKSYS

Kolik vlastně bude potřeba AP? - **Pre deployment survey**

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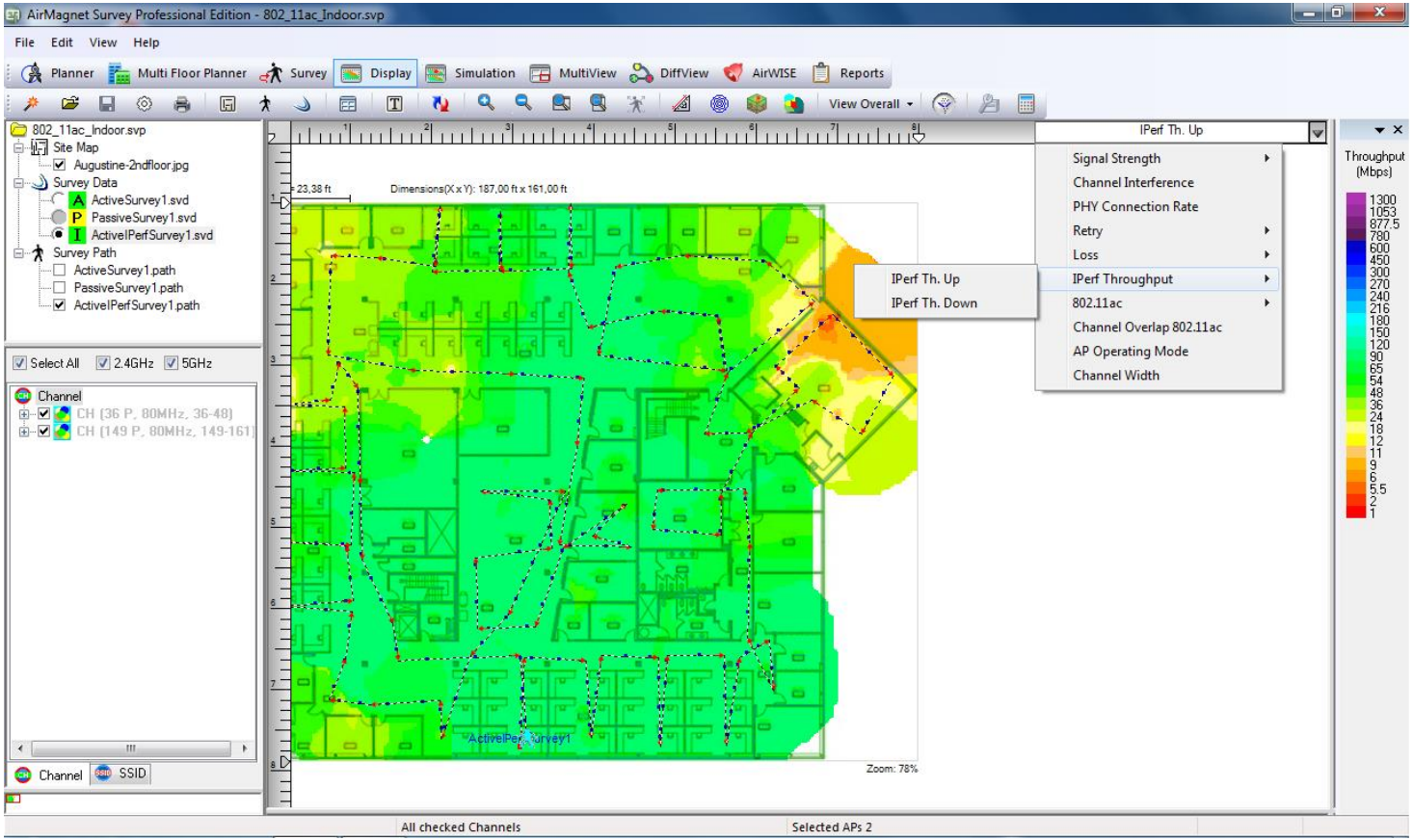
NETWORKSYS

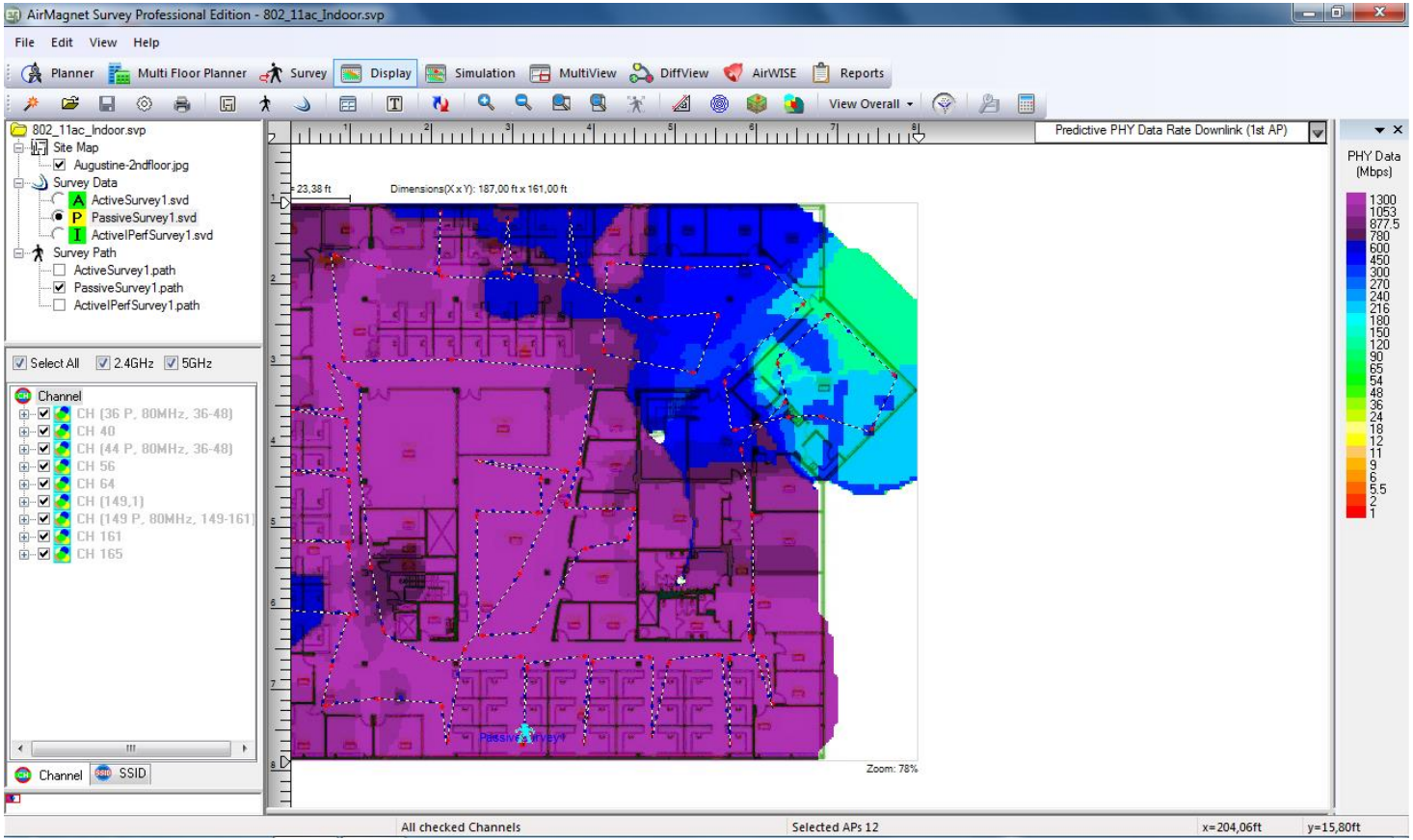
Active vs. Passive Survey



Cisco Public

NETWORKSYS

Active vs. Passive Survey



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NETWORKSYS

Počet instalovaných AP v rámci projektu - 400

Prime Infrastructure

nwsfikejs - ROOT-DOMAIN

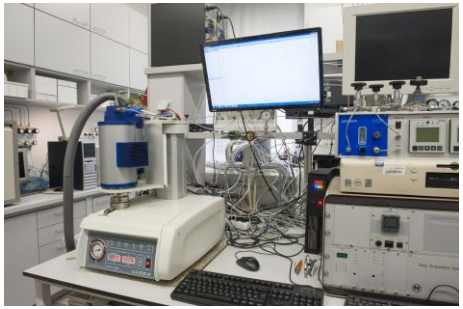
Coverage Area | View Maps

Total APs not yet assigned to maps - Unified: 20 | Autonomous: 0

Name	Total APs	Radios	
		5 GHz	2.4 GHz
Dejvice	461	461	461
OfficeExtendedAP	2	2	2
Kralupy	19	18	18
Litvinov	4	4	4
JM	4	4	4
Holesovicky	1	1	1

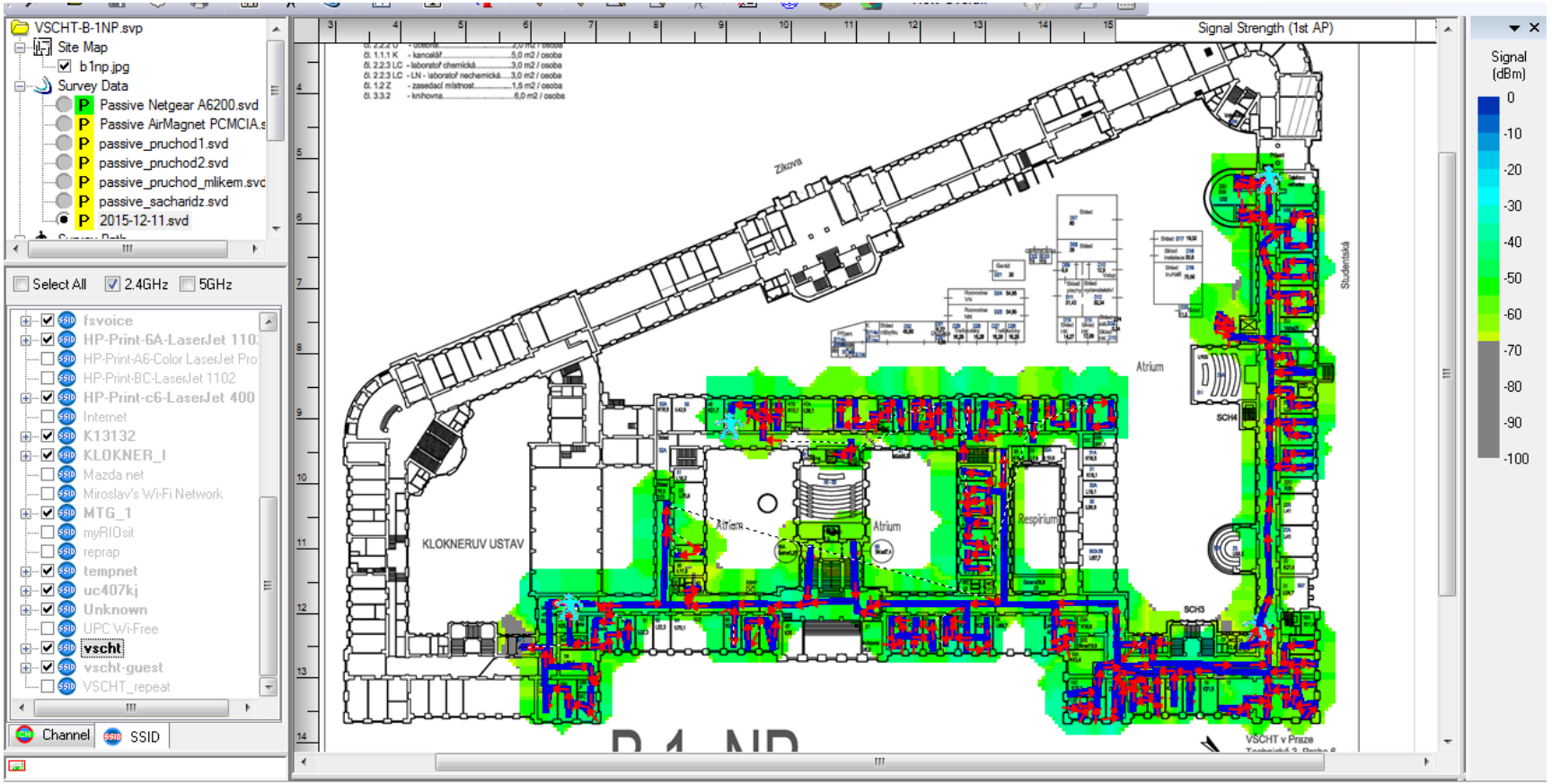
NETWORKSYS

Jak umístit AP?



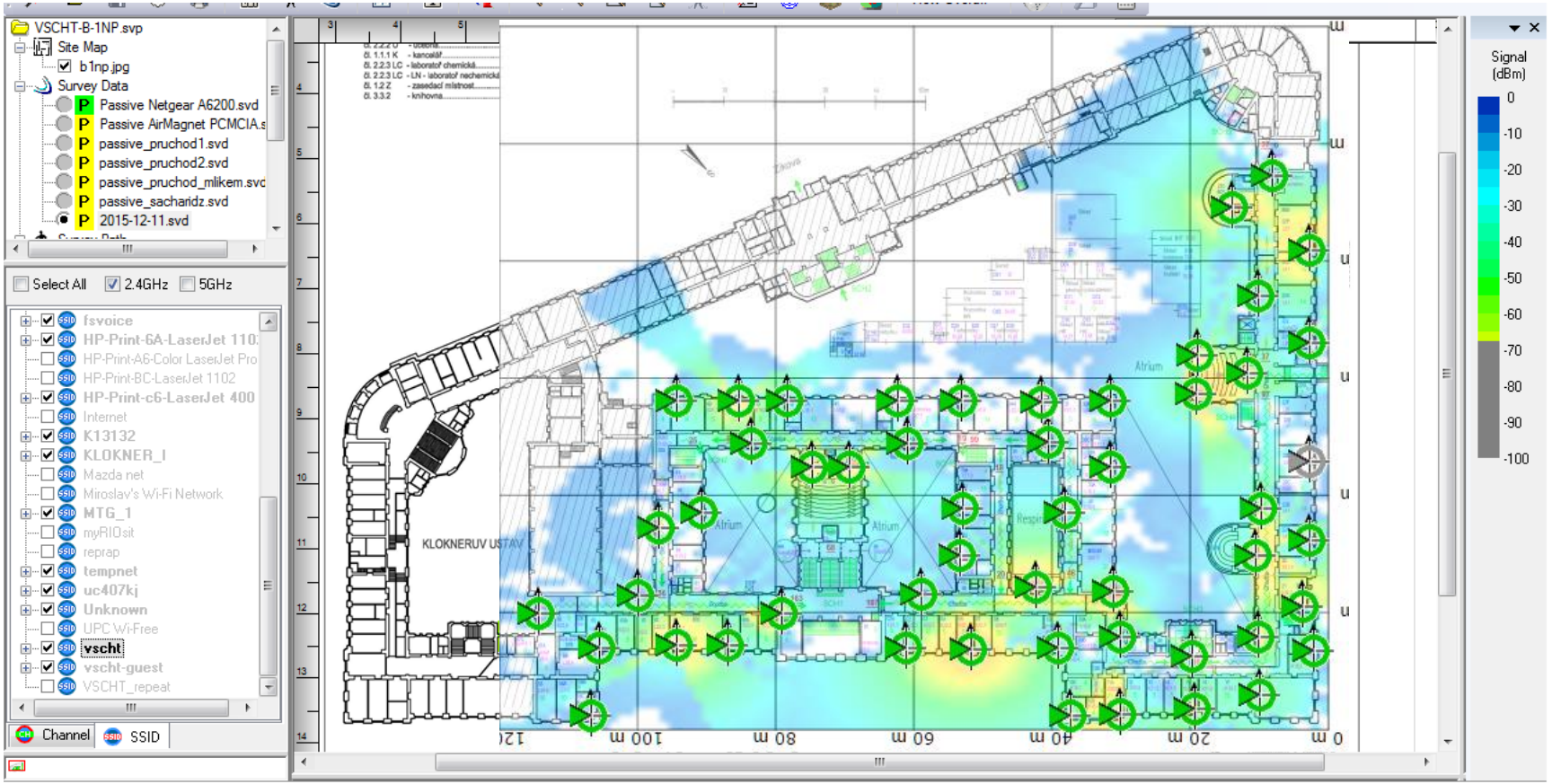
NETWORKSYS

Nejsilnější AP (2,4 GHz)



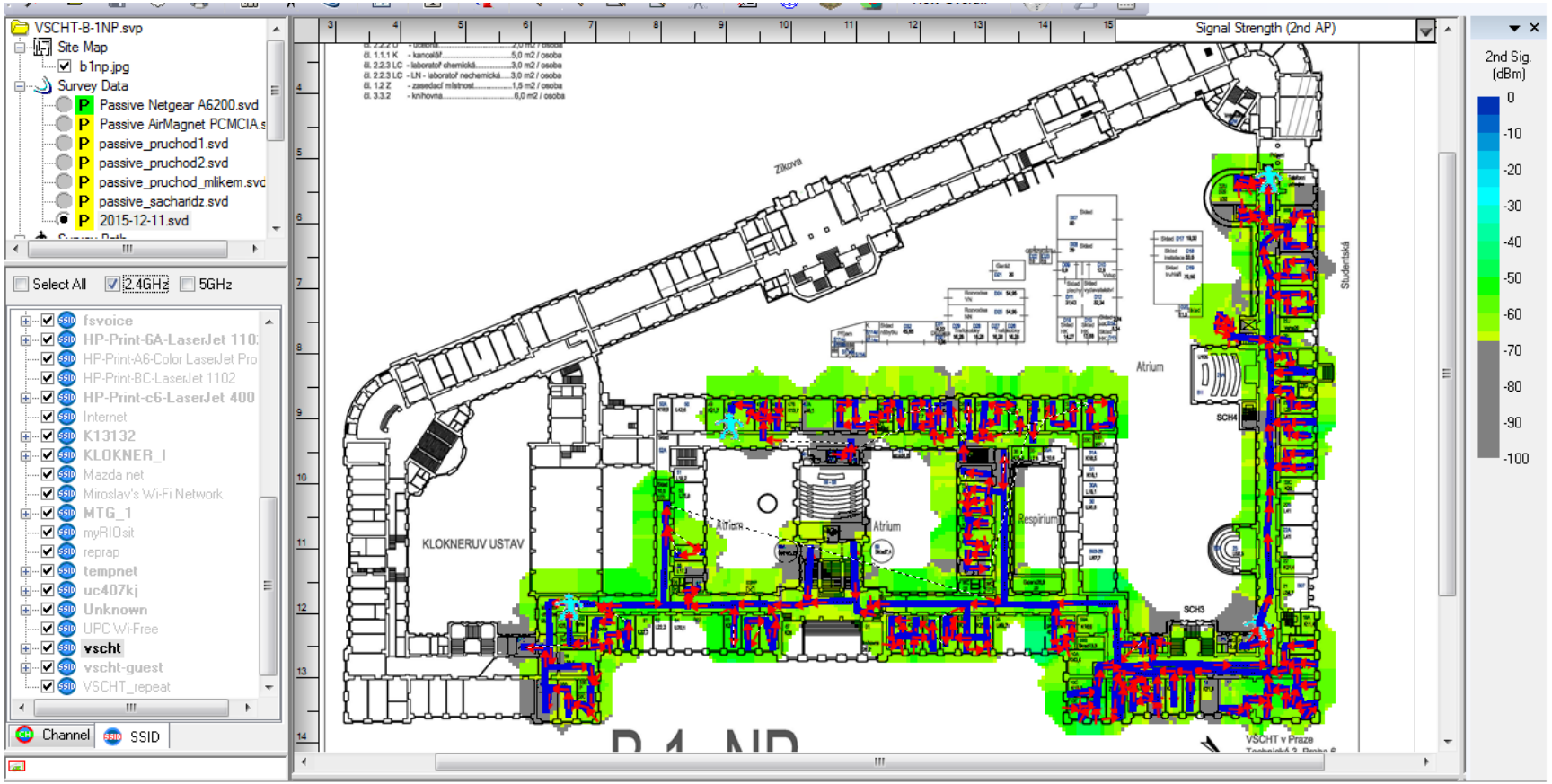
NETWORKSYS

Nejsilnější AP (2,4 GHz) jak to vidí Prime



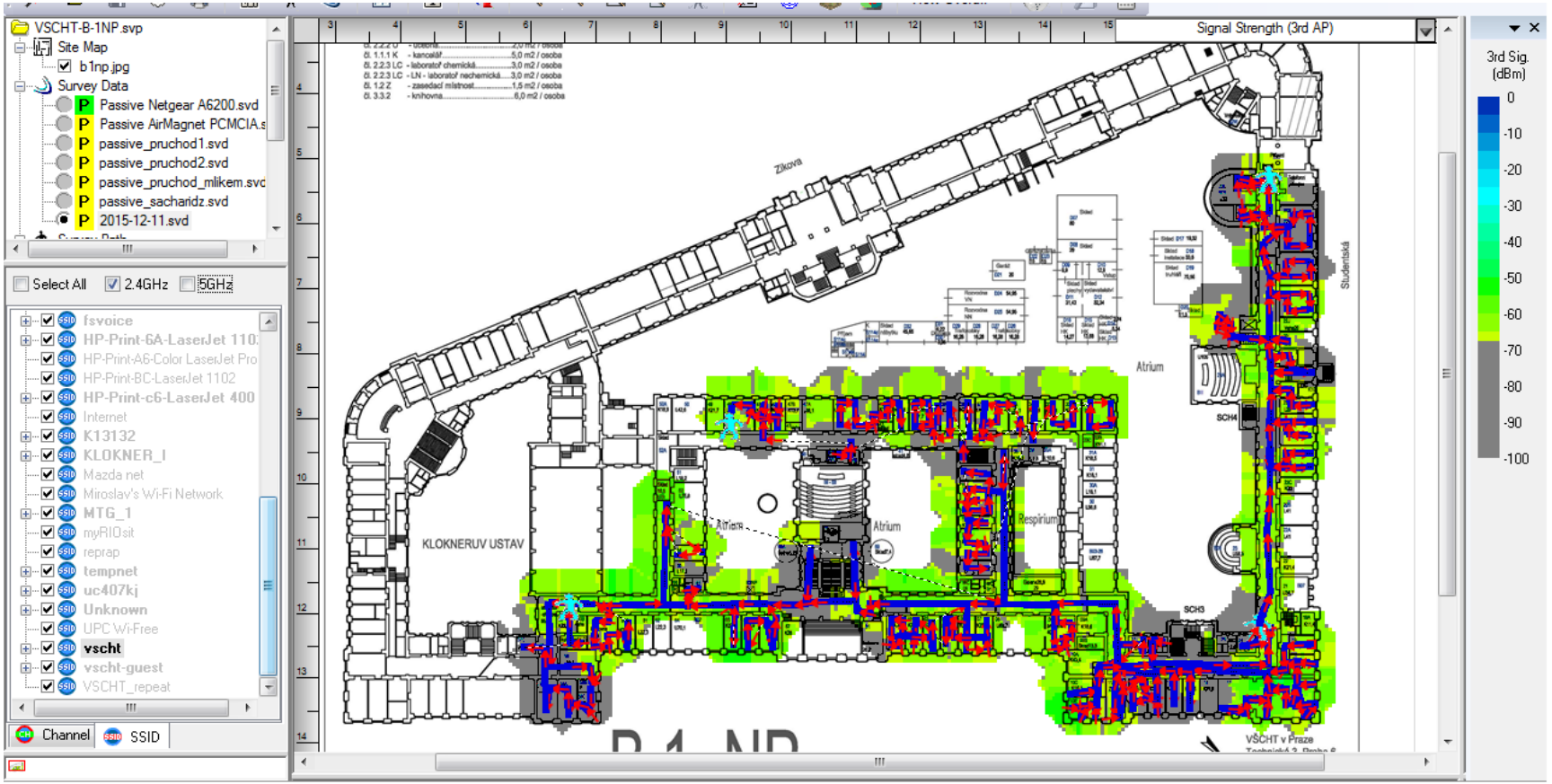
NETWORKSYS

Druhé nejsilnější AP (2,4 GHz)



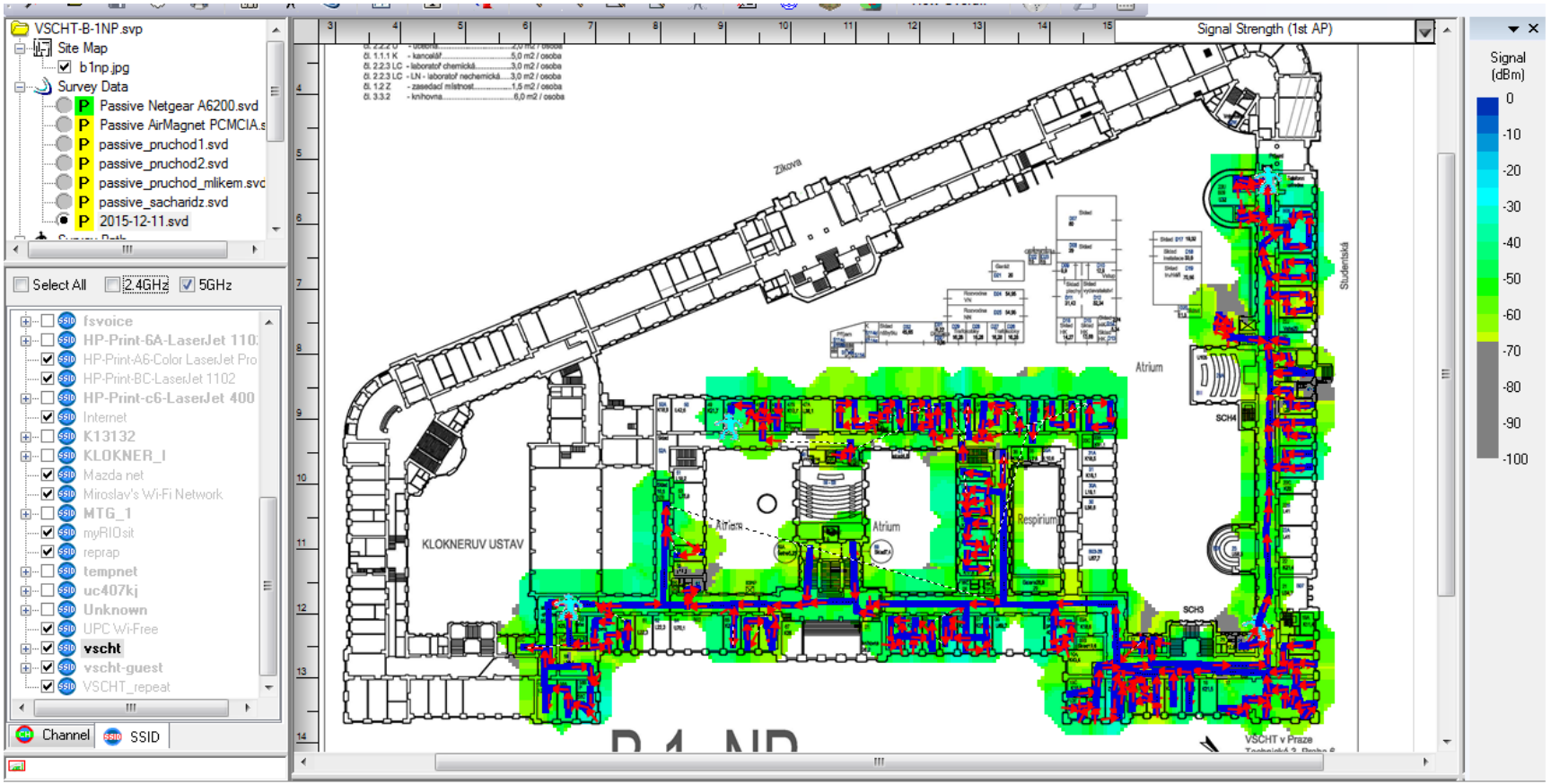
NETWORKSYS

Třetí nejsilnější AP (2,4 GHz)



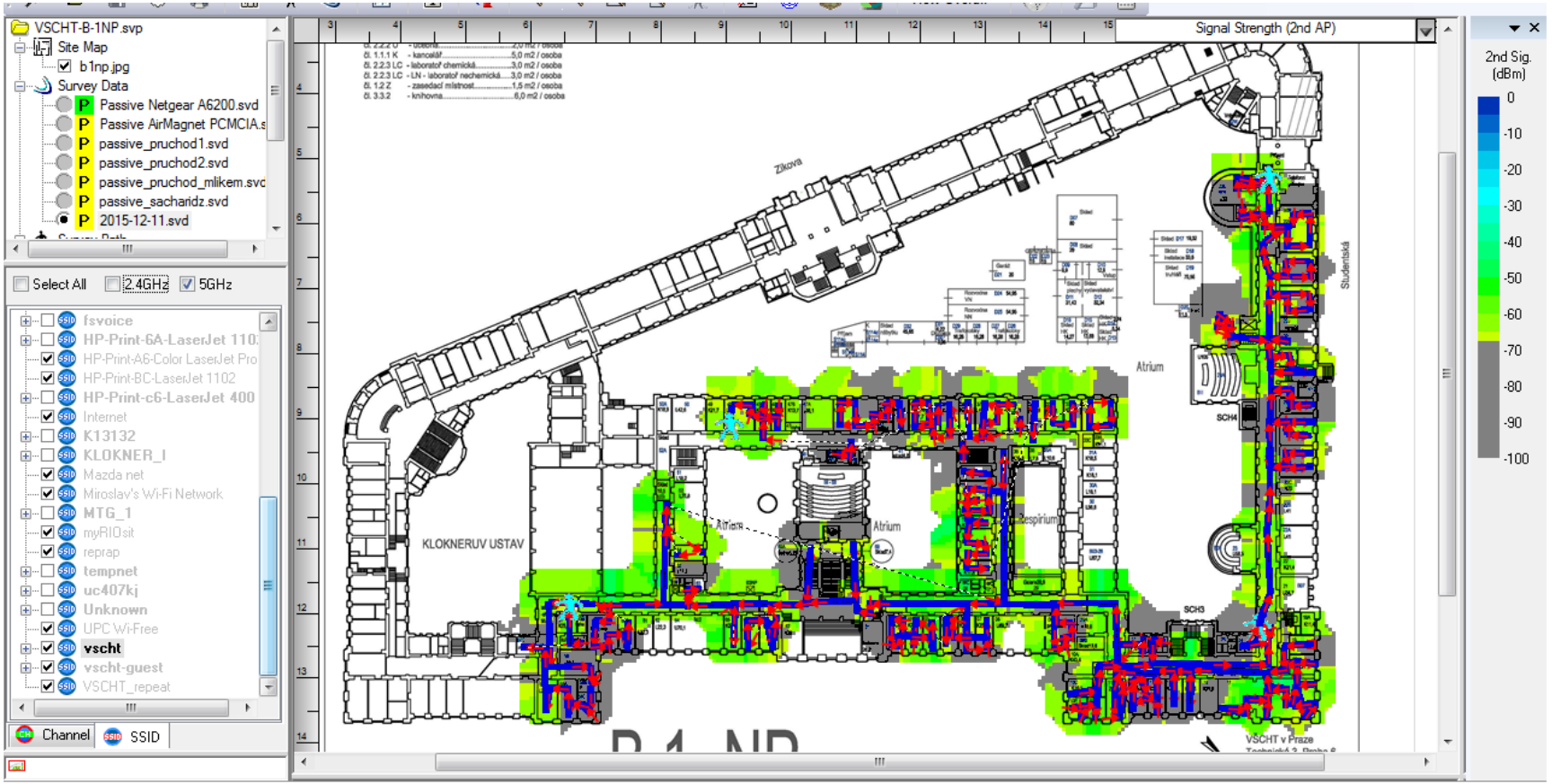
NETWORKSYS

Nejsilnější AP (5 GHz)



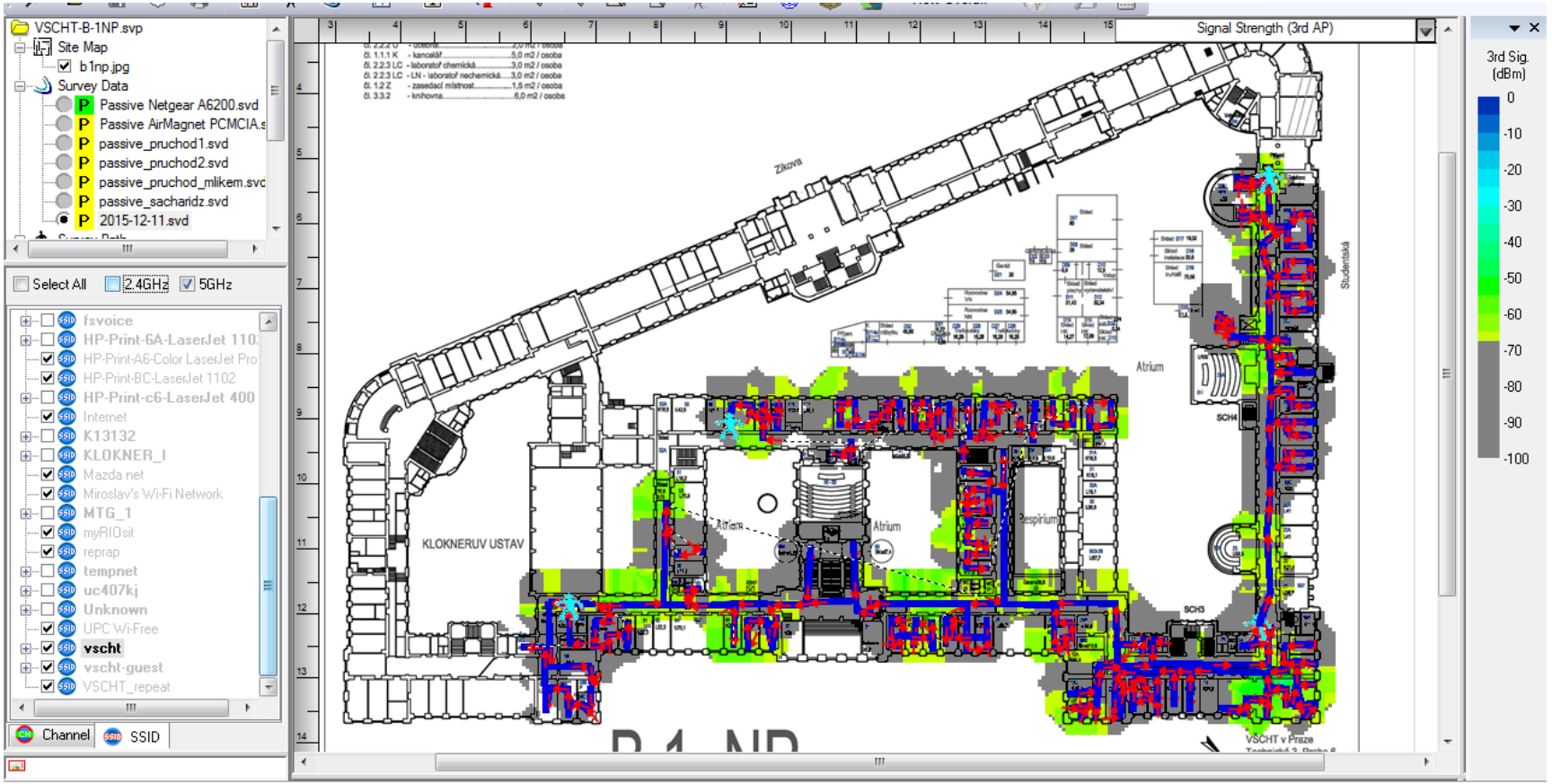
NETWORKSYS

Druhé nejsilnější AP (5 GHz)



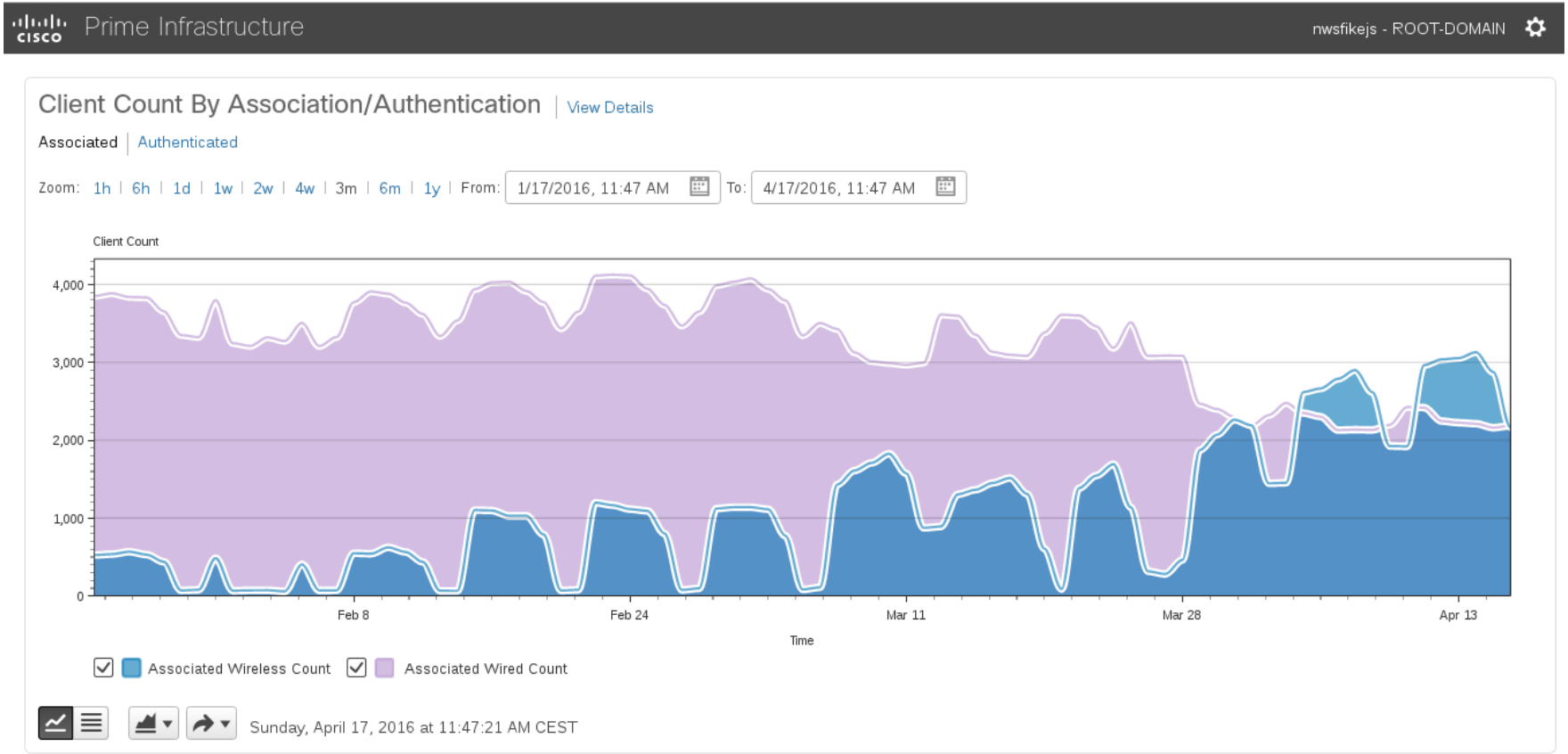
NETWORKSYS

Třetí nejsilnější AP (5 GHz)



NETWORKSYS

Počty klientů od spuštění celoplošné WiFi sítě



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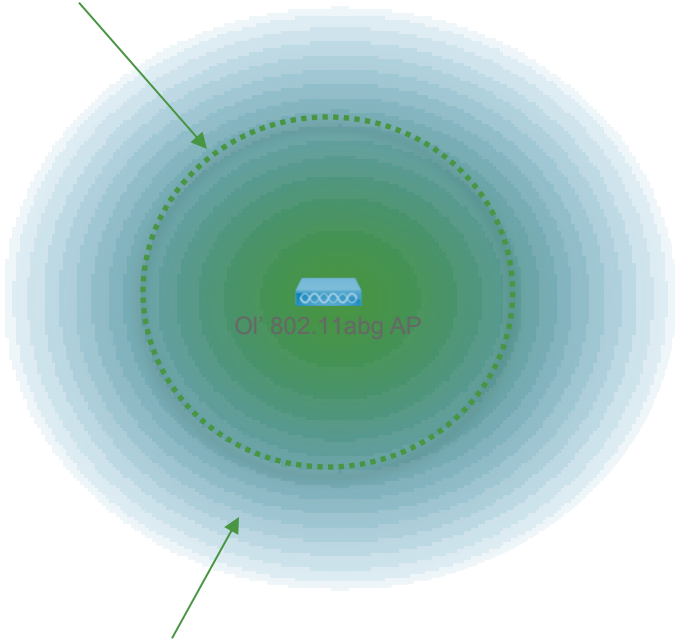
Useful Cell vs RF Cell Edges

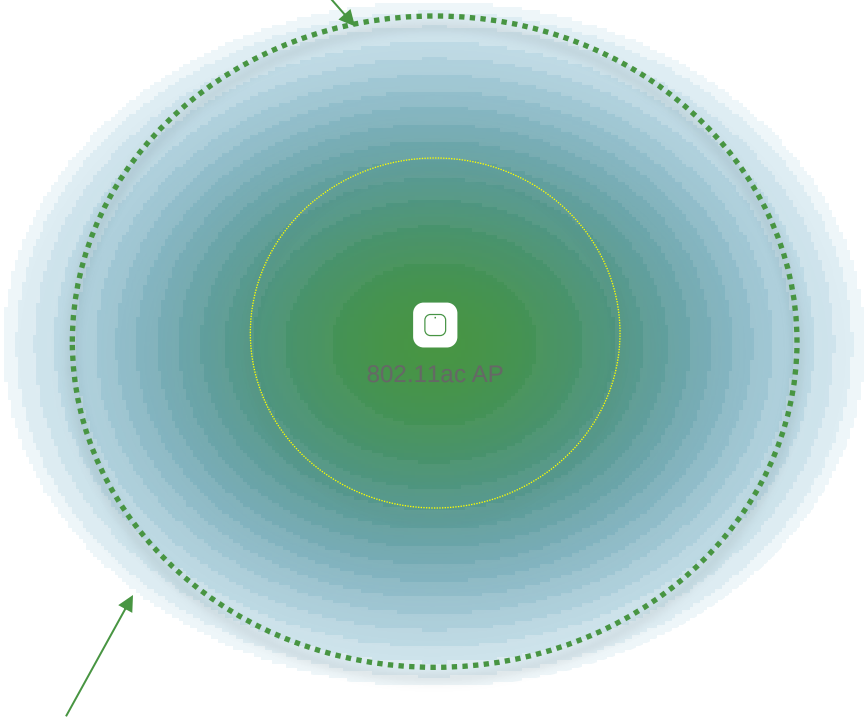
Get RF Help From Cisco RX-SOP

-91 dBm point, can receive 1 Mbps



Signal beyond is “noise”

-101 dBm point, can receive 1 Mbps



Signal beyond is “noise”

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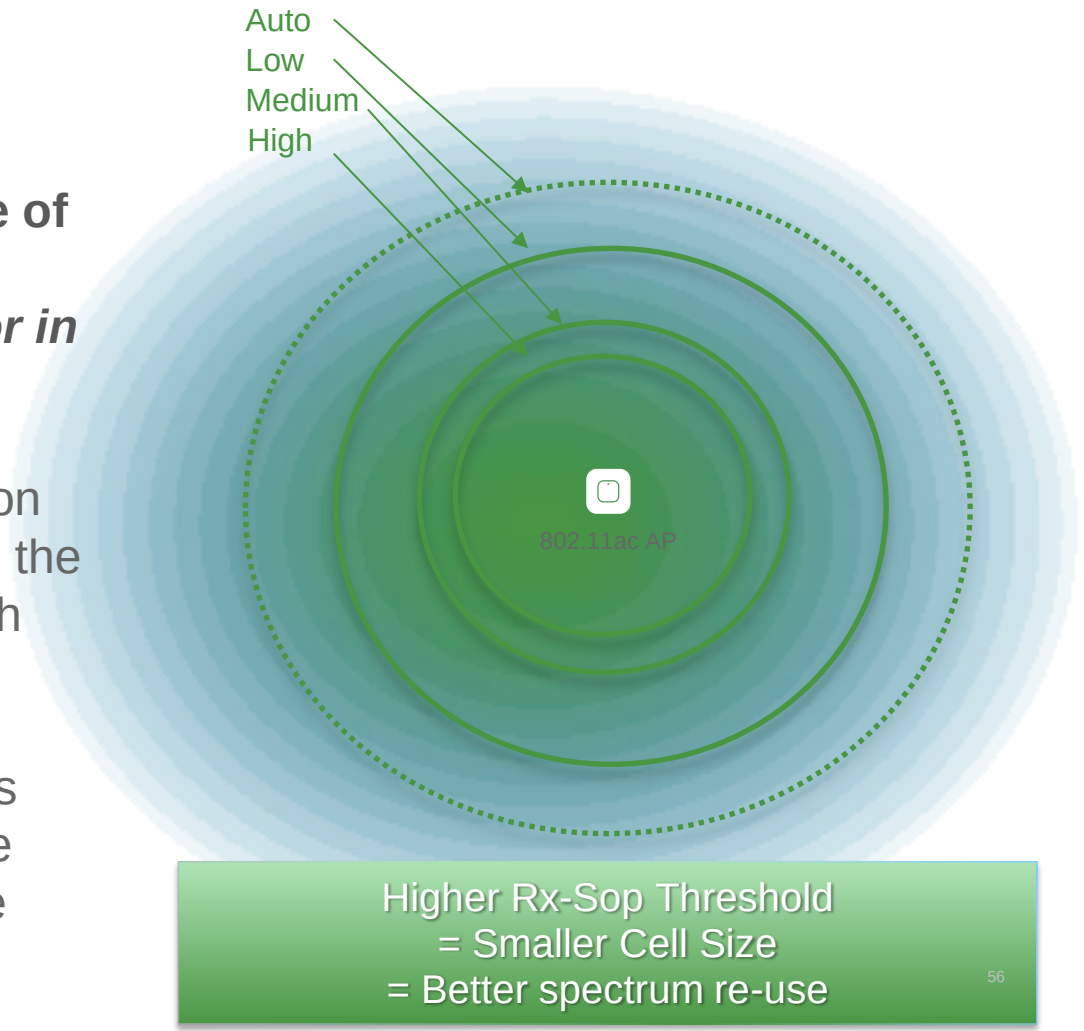
Cisco RX-SOP

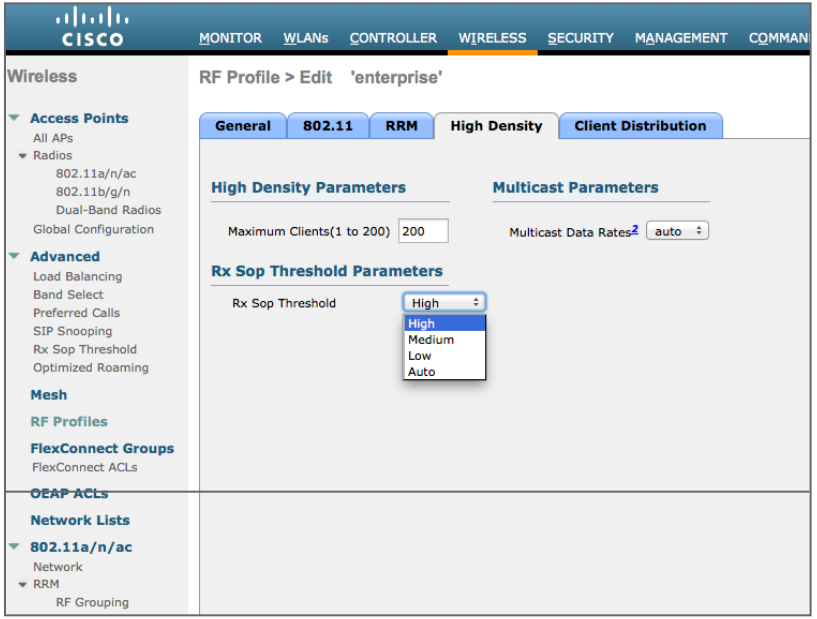
- **Allows you to regulate the size of your cell and set receive edge barrier *(Cisco key differentiator in High Density environment)***

- Receiver Start of Packet Detection Threshold (RX-SOP) determines the Wi-Fi signal level in dBm at which an AP radio will demodulate and decode a packet.
  - The higher the level, the less sensitive the radio is and the smaller the receiver cell size will be



RX-SOP configuration

- Settings High, Medium, Low, Auto
- Auto is default behavior, and leaves RX-SOP function linked to CCA threshold for automatic adjustment
- Most networks can support a LOW setting and see improvement
- This affects all packets seen at the receiver



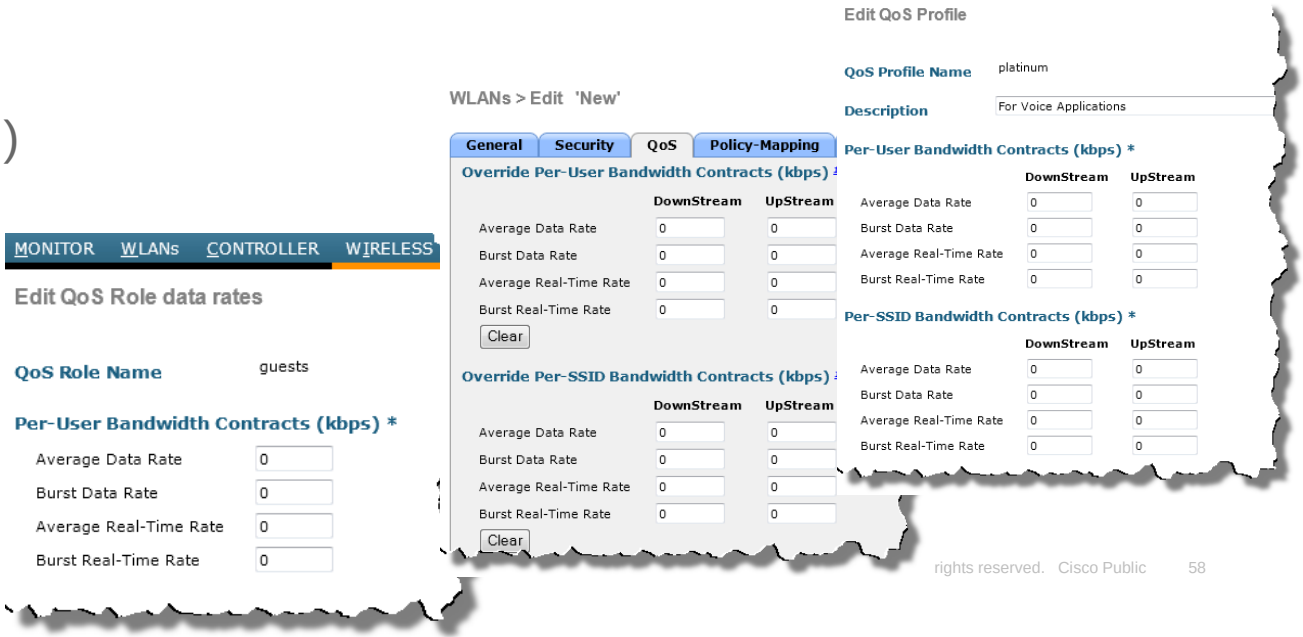
RX SOP Thresholds			
802.11 Band	High Threshold	Medium Threshold	Low Threshold
5 GHz	-76 dBm	-78 dBm	-80 dBm
2.4 GHz	-79 dBm	-82 dBm	-85 dBm

```
(Cisco WLC) > config [802.11a| 802.11b] rx-sop threshold <value> [ap <name> | default]

<value>          Configures the radio receive Sensitivity SOP threshold, (0, -60 to -100) dB. The default is 0 where the
configuration is disabled and the value would be the manufacturing burned in value.

(Cisco WLC) > config [802.11a| 802.11b] cca threshold <value> [ap <name> | default]

<value>          Configures the radio CCA threshold, (0, -60 to -100) dB. The default is 0 where the configuration is disabled
and the value would be the manufacturing burned in value.
```

Control Upstream and Downstream Bandwidth Consumption

- Can we control the upstream? Not directly, but we may have an indirect way of controlling it…

- Per QoS Profile (Gold etc.)
- Per SSID
- Per user type (guest etc)
- Per device type
- Per individual user



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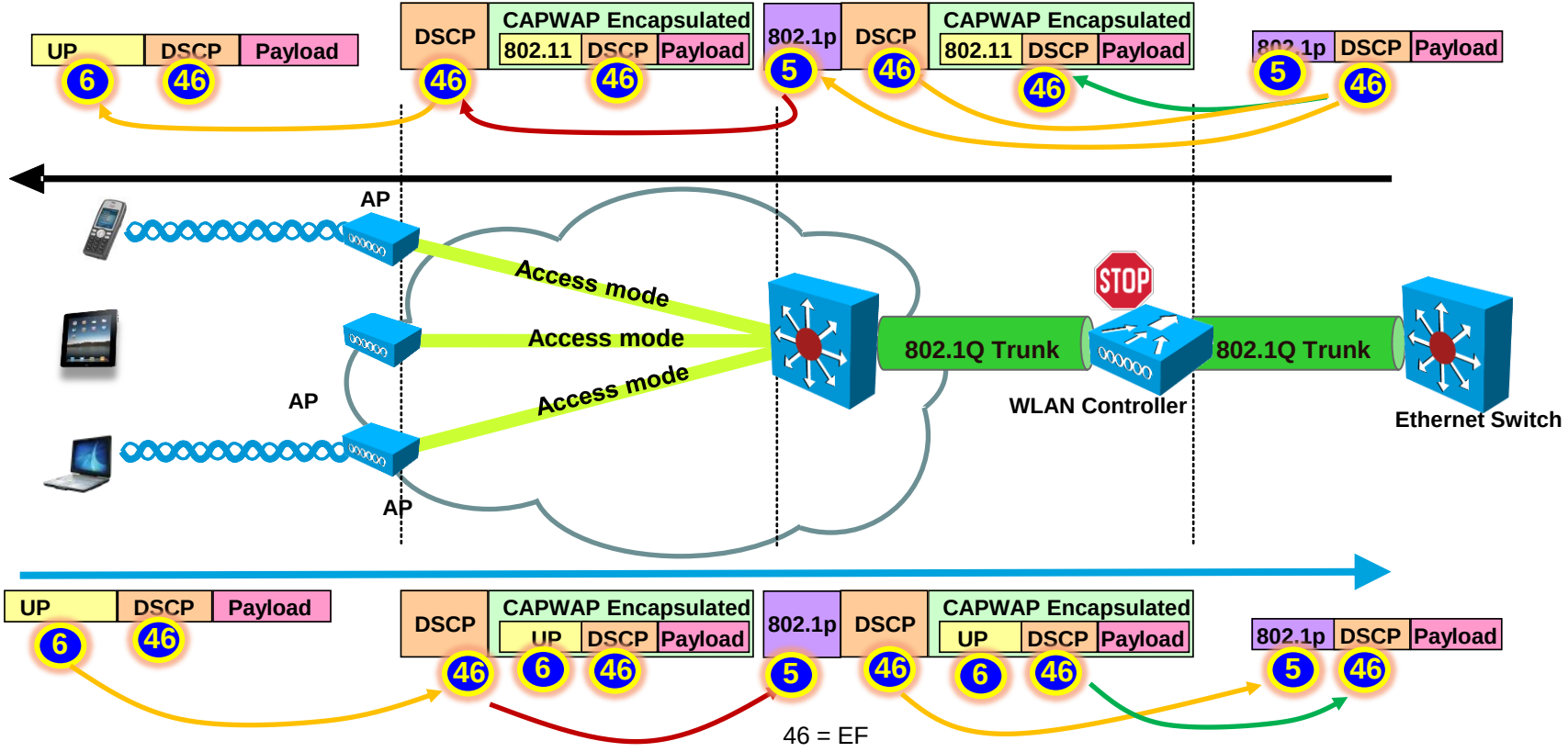
AireOS QoS Profile Marking Logic

- Platinum Profile – Voice Stream



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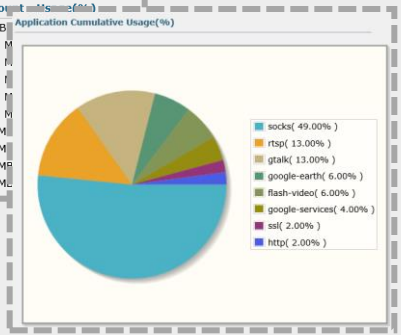
Use Application Visibility and Control

Identify Applications using NBAR2

Application Cumulative Stats

App Name	Packet Count	Byte Count
socks	850095	1.12 GB
rtsp	268447	307.75 M
gtalk	615380	301.97 M
google-earth	123565	157.04 M
flash-video	97594	138.67 M
google-services	89859	105.98 M
ssl	72917	60.44 M
http	100566	54.34 M
rtp	142895	17.96 MB
google-plus	24245	13.49 M



Control Application Behavior

Application Name	Application Group Name	Action	DSCP
bittorrent	file-sharing	drop	NA
facebook	browsing	drop	NA
citrix	business-and-productivity-to	mark	34
ms-lync	business-and-productivity-to	mark	46
webex-meeting	voice-and-video	mark	46
pandora	voice-and-video	mark	10

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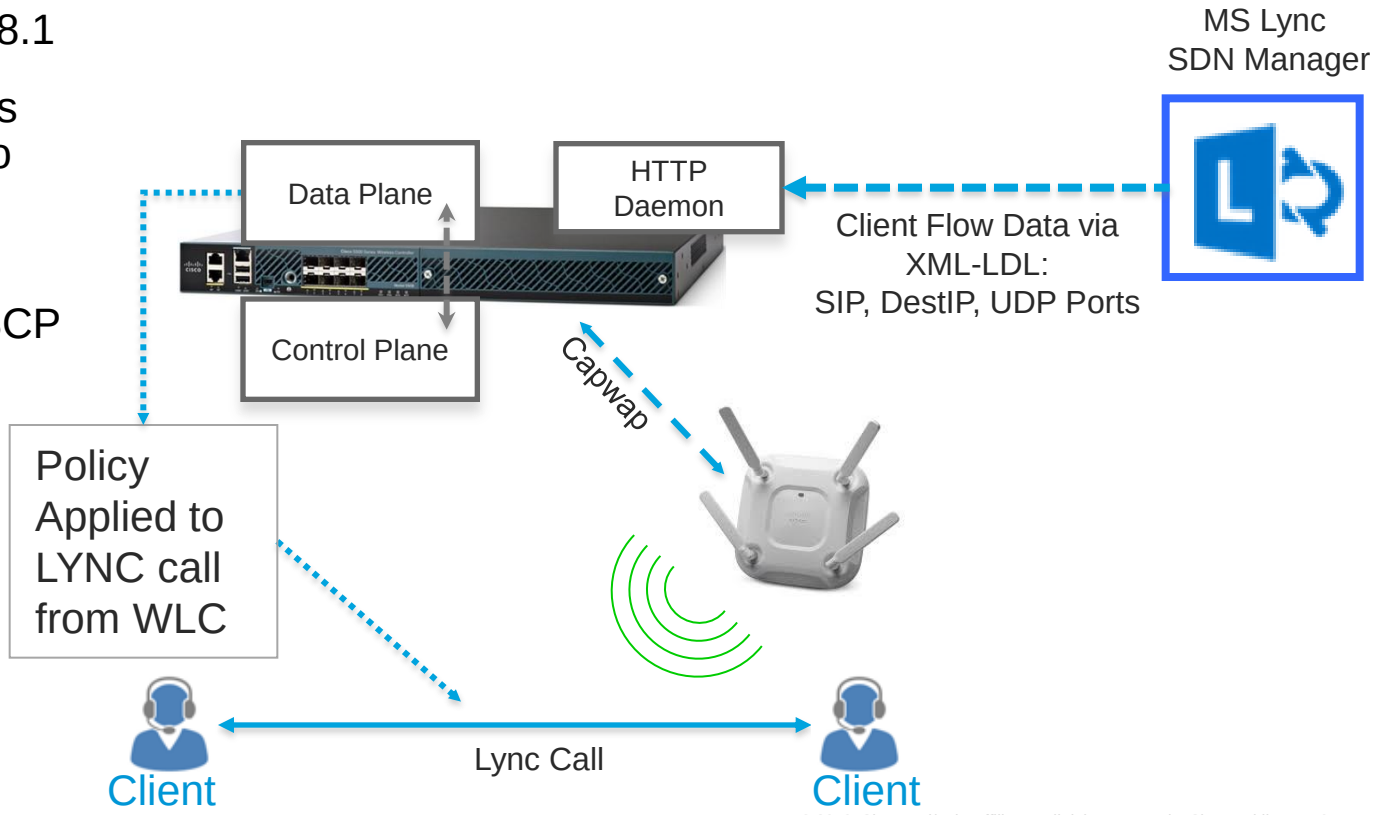
The Lync / Skype SDN API Integration

- Introduced in AireOS 8.1
- MS Lync Server sends call flow information to WLC
- WLC remarks Lync application packet DSCP value to a new value
- WLC can report Lync voice and video performance



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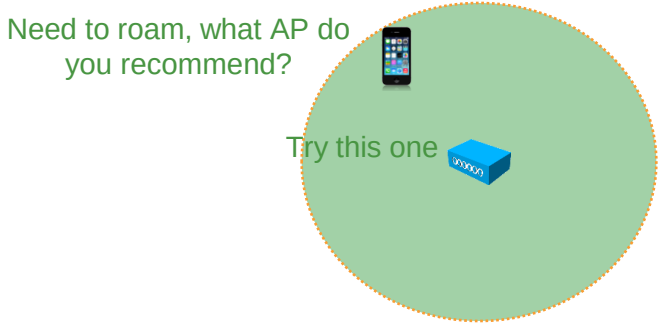
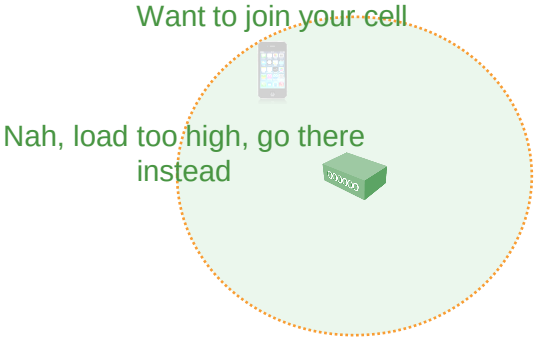
802.11k,v: Send your BYOD to the Next (Better) Cell

802.11k Neighbor List vs 802.11v BSS Transition Management

802.11k neighbor list



802.11v Solicited request



802.11v Unsolicited request

WLANs > Edit 'none'

General | Security | QoS | Policy-Mapping | Advanced

Lync

Lync Server: Disabled

11k

Assisted Roaming Prediction Optimization: Enabled

Neighbor List: Enabled

Neighbor List Dual Band: Enabled

PMIP Mobility Type

PMIP NAI Type: Hexadecimal

PMIP Profile: None

PMIP Realm

Universal AP Admin Support

Universal AP Admin

11v BSS Transition Support

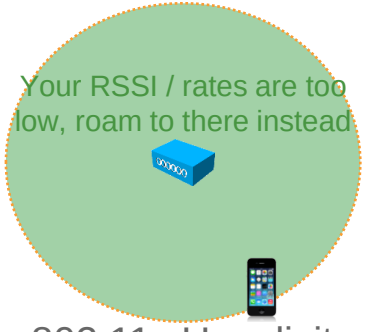
BSS Transition

Disassociation Imminent

Disassociation Timer(0 to 3000 TBTT): 200

Optimized Roaming Disassociation Timer(0 to 40 TBTT): 40

Tunneling



802.11v Unsolicited Optimized Roaming request

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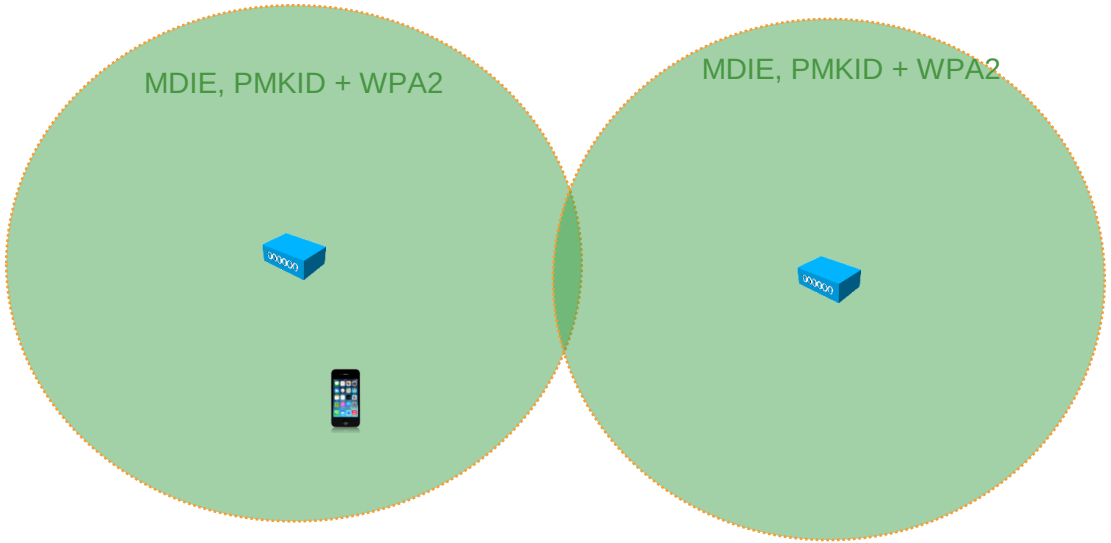
802.11r (FT): Speed Up Roaming Credentials

- WARNING: 802.11r is different from pure WPA2



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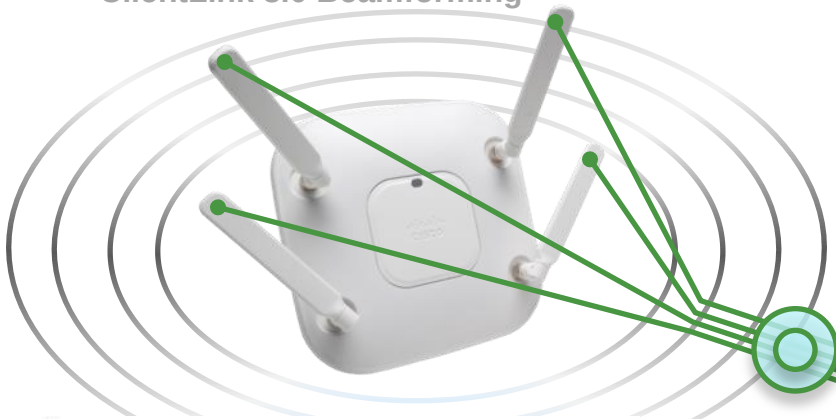
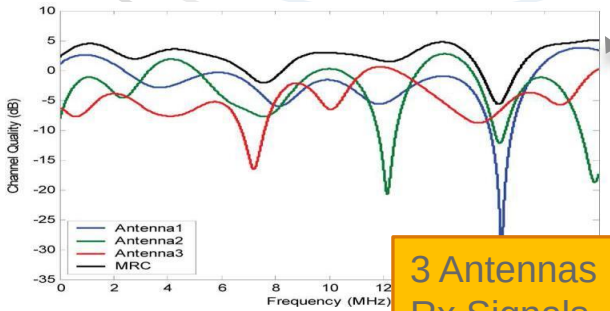
Cisco ClientLink and MRC

Improves Downlink and Uplink Performance

ClientLink 3.0 Beamforming



Improved Performance For All Clients



MIMO MRC

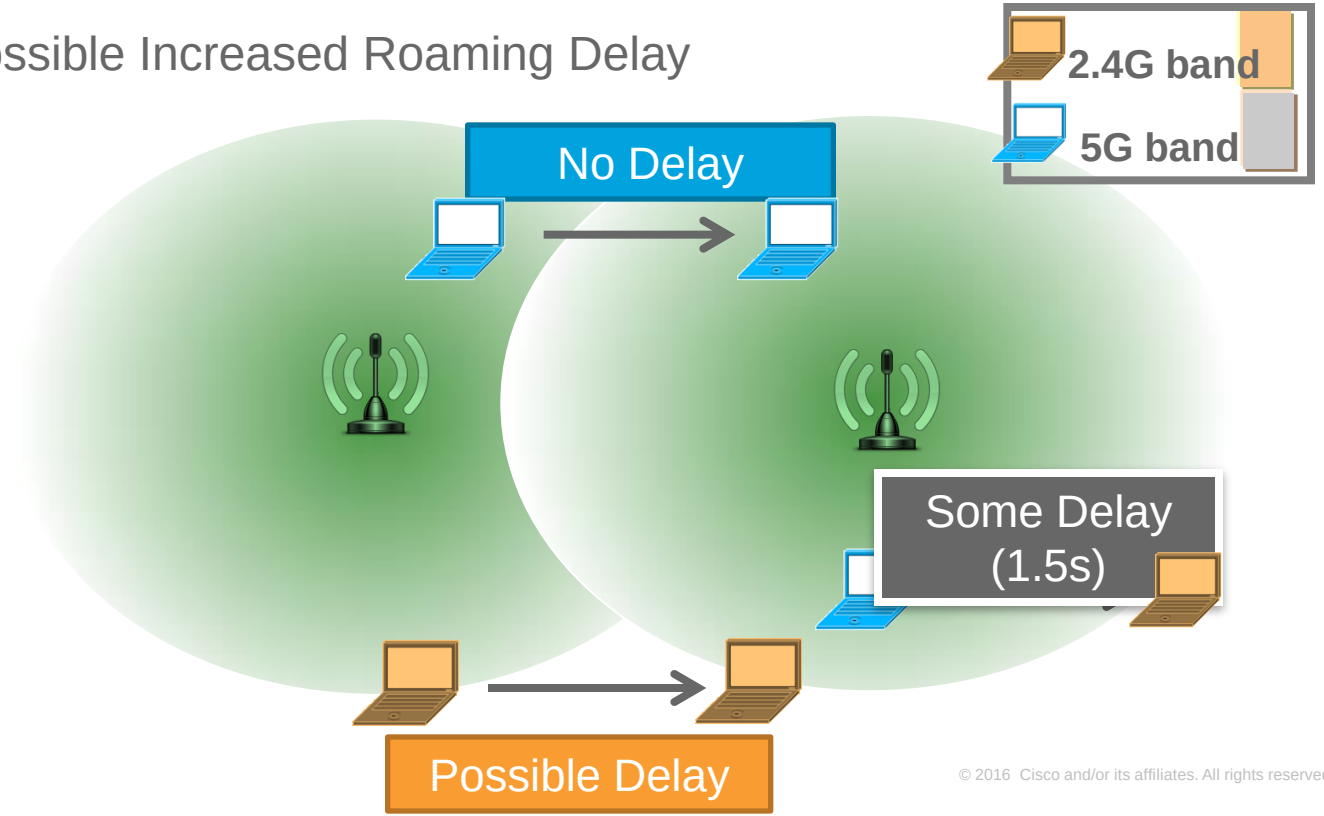
3 Antennas Rx Signals

Combined Effect (Adding all Rx Paths)

Boost signal strength as you move for 802.11a/g/n/ac clients
MRC performs on the upstream at the AP level

BandSelect – Test Before Full Deployment

- Caveat – Possible Increased Roaming Delay



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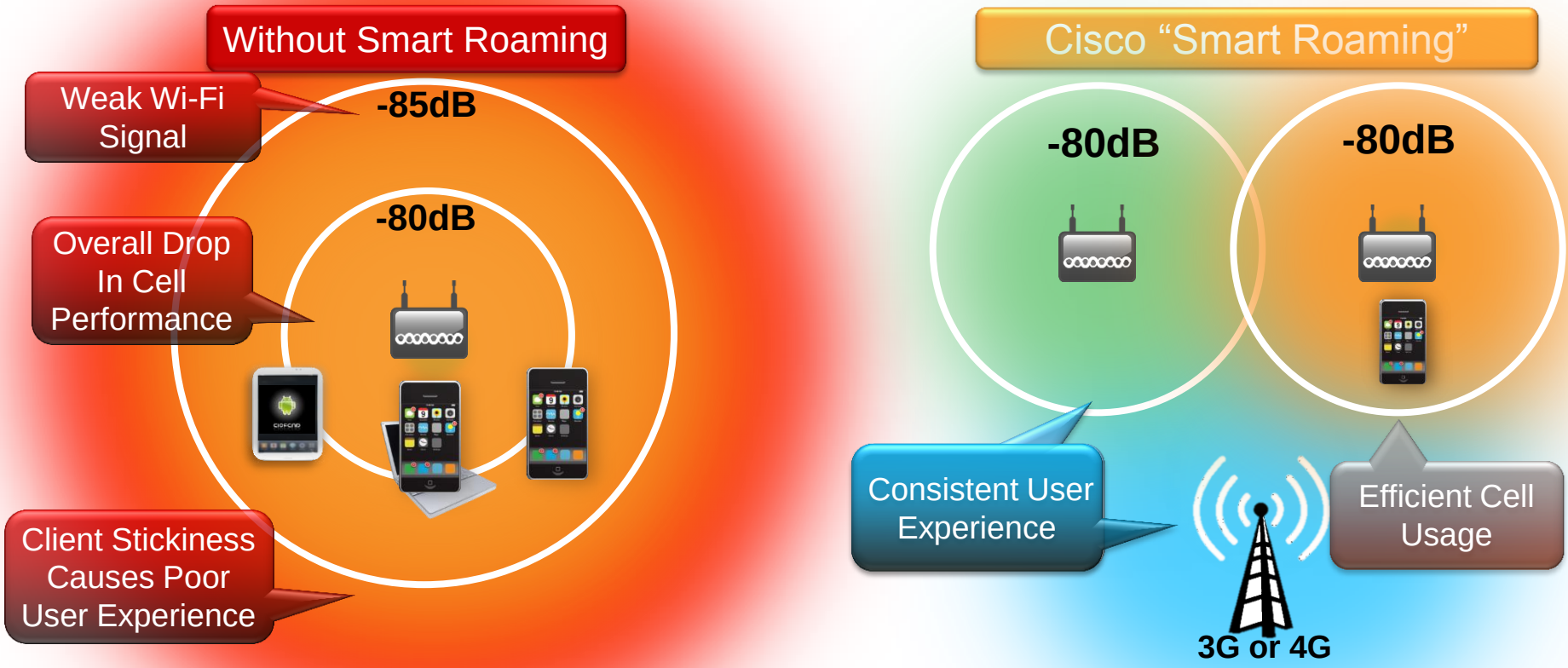
Optimized Roaming- help for clients that are not so smart…



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Agenda

- Building the first cell
  - Shape, Size (AP Power, Protocols and Rates, Channel Width)
- Taking Care of the Roaming Path
  - AP Placement Strategies, antennas, overlaps
- NETWORKSYS – Case Study
- Optimizations
  - Tweaking the WLC and AP configurations for difficult clients

- **Conclusion**
  - **Last Words and where to go when things go wrong**

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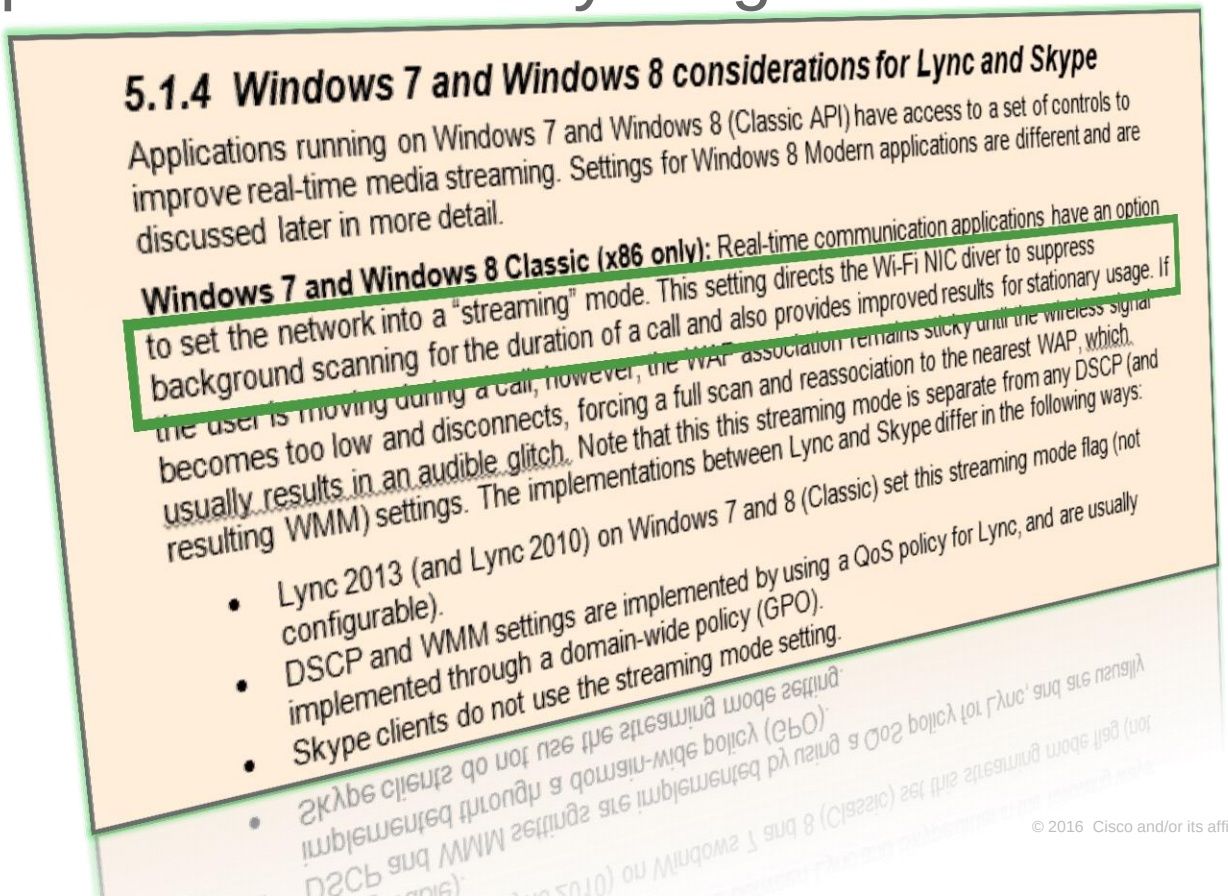
You Did Your Best, But Good Design Cannot Compensate For Everything



5.1.4 Windows 7 and Windows 8 considerations for Lync and Skype

Applications running on Windows 7 and Windows 8 (Classic API) have access to a set of controls to improve real-time media streaming. Settings for Windows 8 Modern applications are different and are discussed later in more detail.

Windows 7 and Windows 8 Classic (x86 only): Real-time communication applications have an option to set the network into a "streaming" mode. This setting directs the Wi-Fi NIC diver to suppress background scanning for the duration of a call and also provides improved results for stationary usage. If the user is moving during a call, however, the WAP association remains sticky until the wireless signal becomes too low and disconnects, forcing a full scan and reassociation to the nearest WAP, which usually results in an audible glitch. Note that this this streaming mode is separate from any DSCP (and resulting WMM) settings. The implementations between Lync and Skype differ in the following ways:

- Lync 2013 (and Lync 2010) on Windows 7 and 8 (Classic) set this streaming mode flag (not configurable).
- DSCP and WMM settings are implemented by using a QoS policy for Lync, and are usually implemented through a domain-wide policy (GPO).
- Skype clients do not use the streaming mode setting.

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MS Lync QoS Mappings

*Note: Lync DSCP is set globally by Group Policy

MS Lync Application	Recommended DSCP Value	Resulting 802.11e UP Value	Recommended WMM Values
Voice	46 (EF)	5	6 (AC_VO)
Video	34 (AF41)	4	5 (AC_VI)
Call Signaling	24 (CS3)	3	4 (AC_BE)
Lync File Transfer (bulk data)	10 (AF11)	1	2 (AC_BK)
Lync App Sharing	Default (0)	0	0 (AC_BE)

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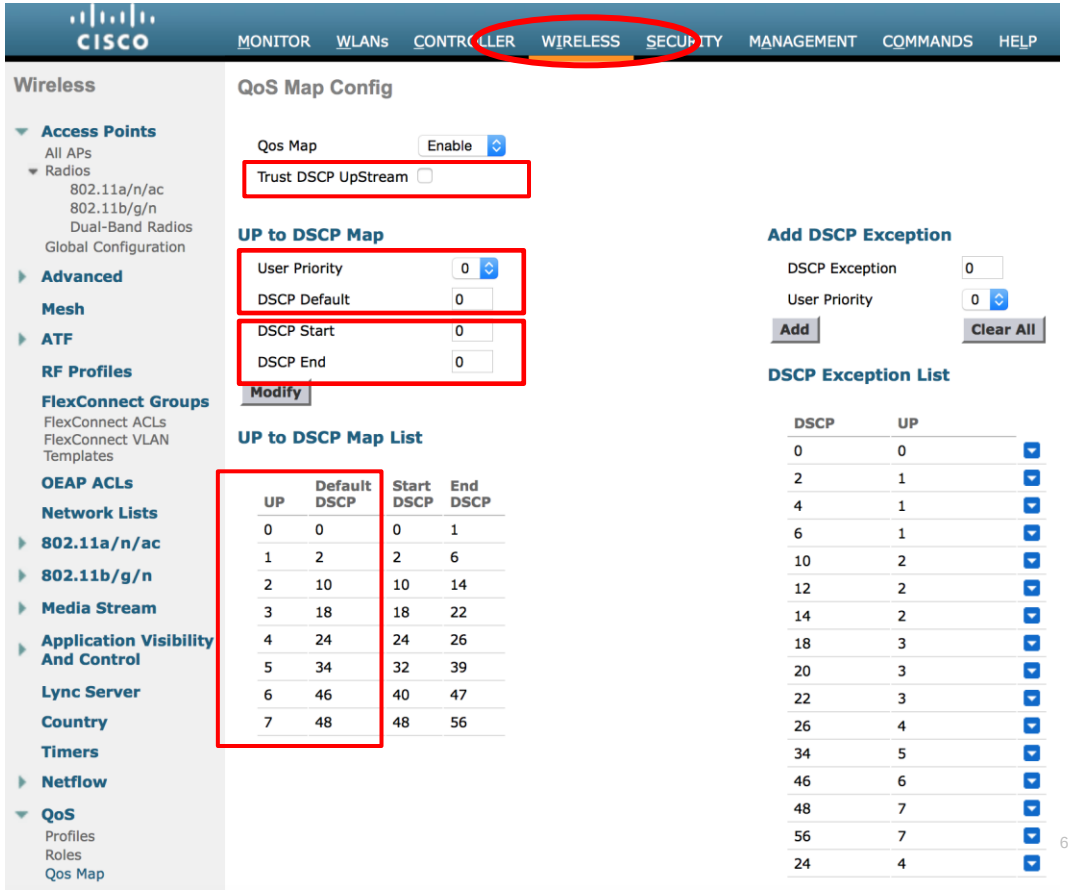
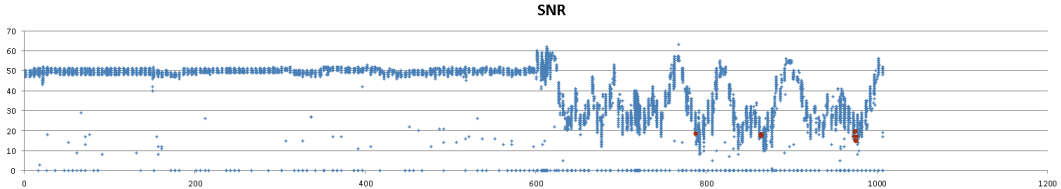
A Better Approach: AireOS 8.2 QoS Maps

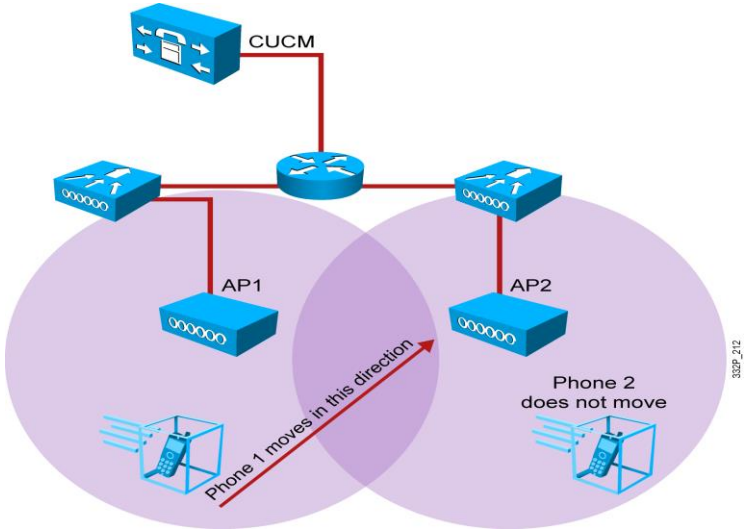


Troubleshooting Tools

Wireless Captures, RF Analysis, Configuration Analysis

- Wireless sniffer
  - Omnipeek/Wireshark (multichannel, for roaming issues)
  - Mac with OS X 10.6 and above, Windows 7 with Netmon 3.4
  - AP in Sniffer mode
- L1 analysis: SpectrumExpert
- WLCCA (WLC Configuration Analyzer) – TAC support
- Cisco Prime Infrastructure for Historical view and « Client Troubleshooting tool »





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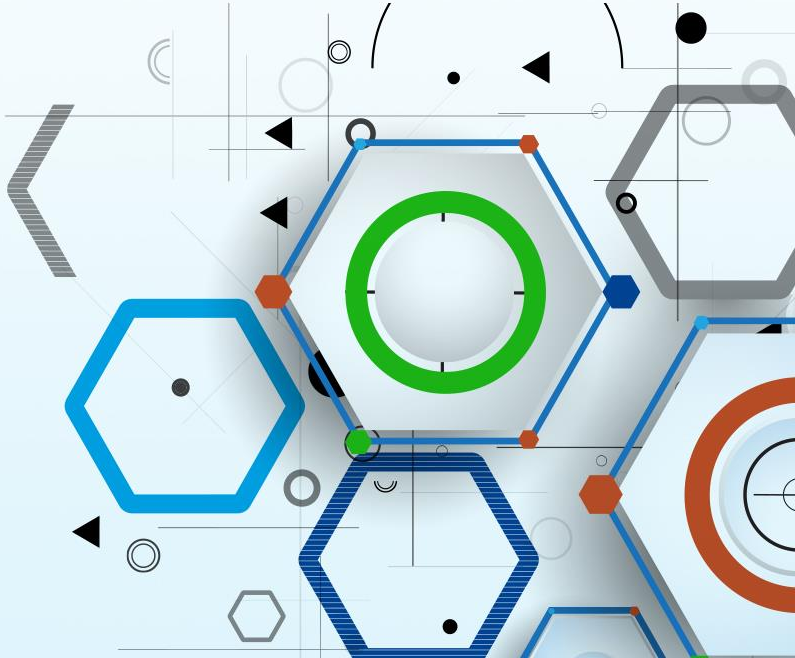
Děkujeme za pozornost.