



High Performance Wi-Fi Essentials

BICSI Rome

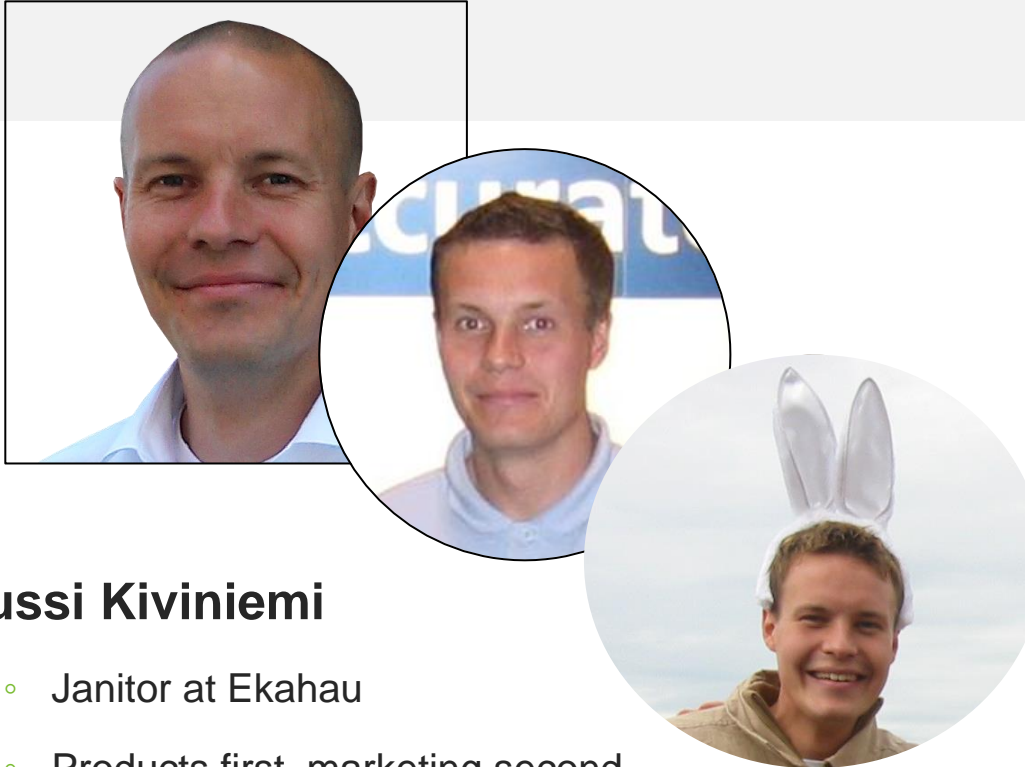




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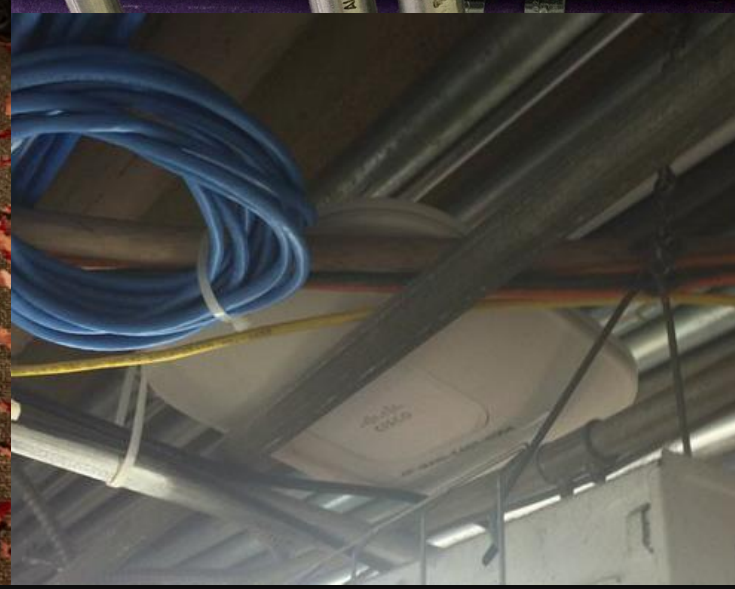
Agenda



- 10 Essential Tips for High Performance Wi-Fi
- Some hands-on illustrations here & there
- Q&A
- Duration: 60 minutes



Let's NOT deploy this:



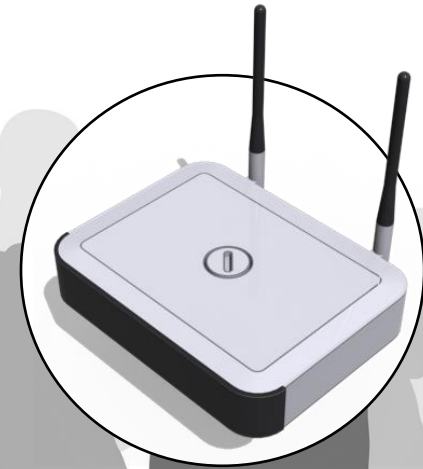


Tip #1:

Setting up
Wi-Fi network
is like...

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A white arrow pointing to the left, containing the binary code "0101110001".

0101110001

Not High Capacity





High Capacity



Tons of clients

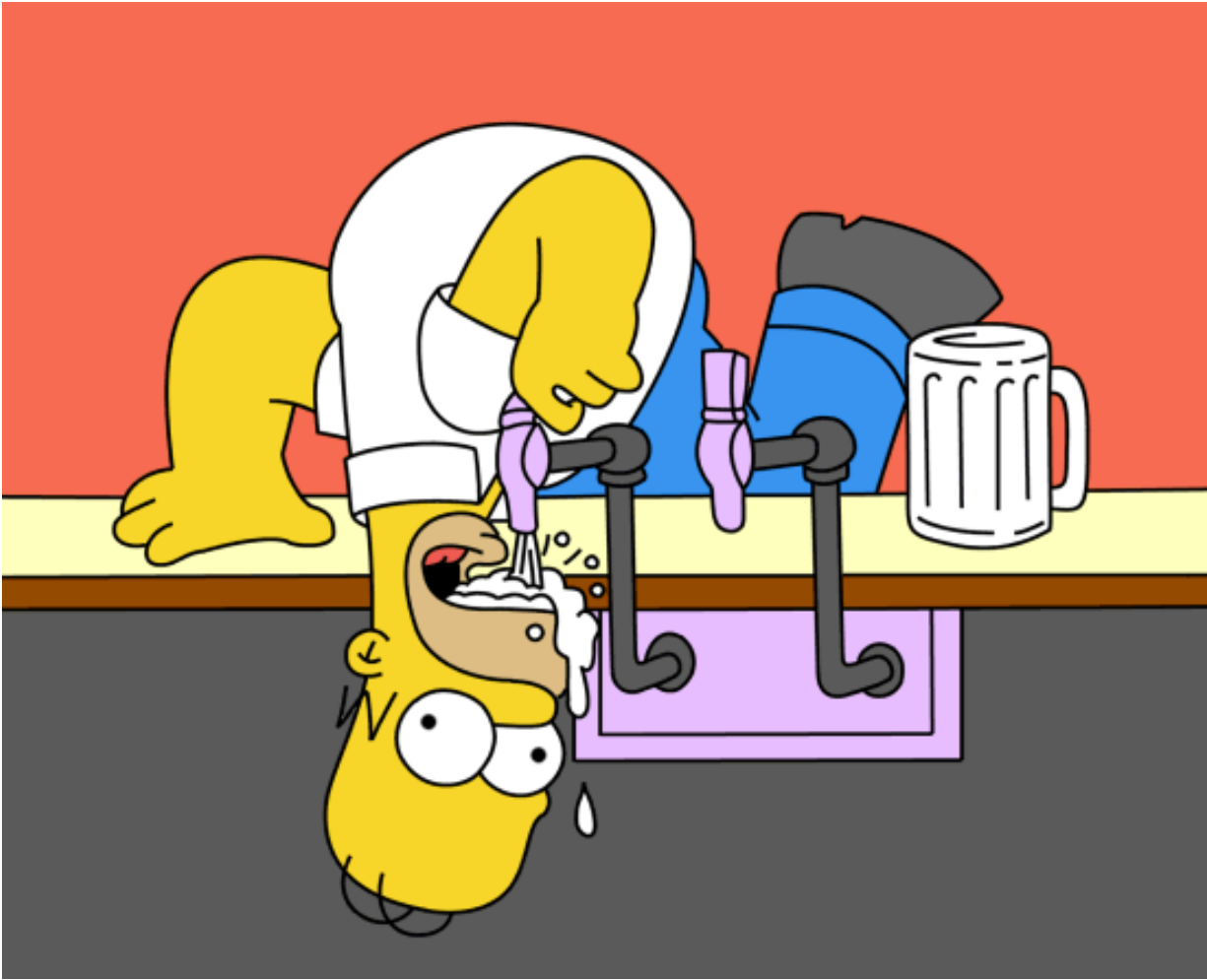
High data demand

Lots of access points

Wired Ethernet



Simpsons © 20th Century Fox



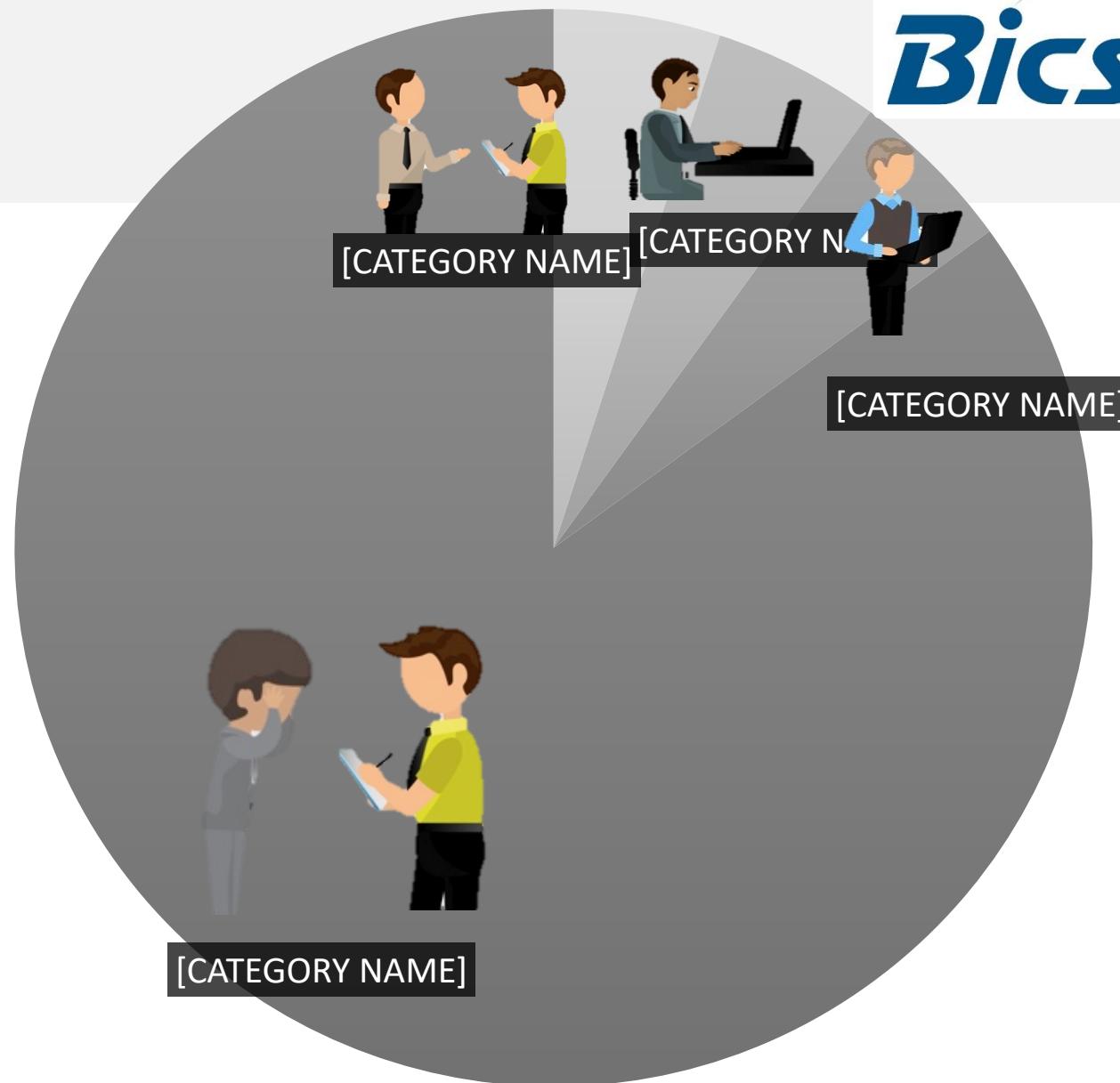


Tip #2:

To care or not to care?

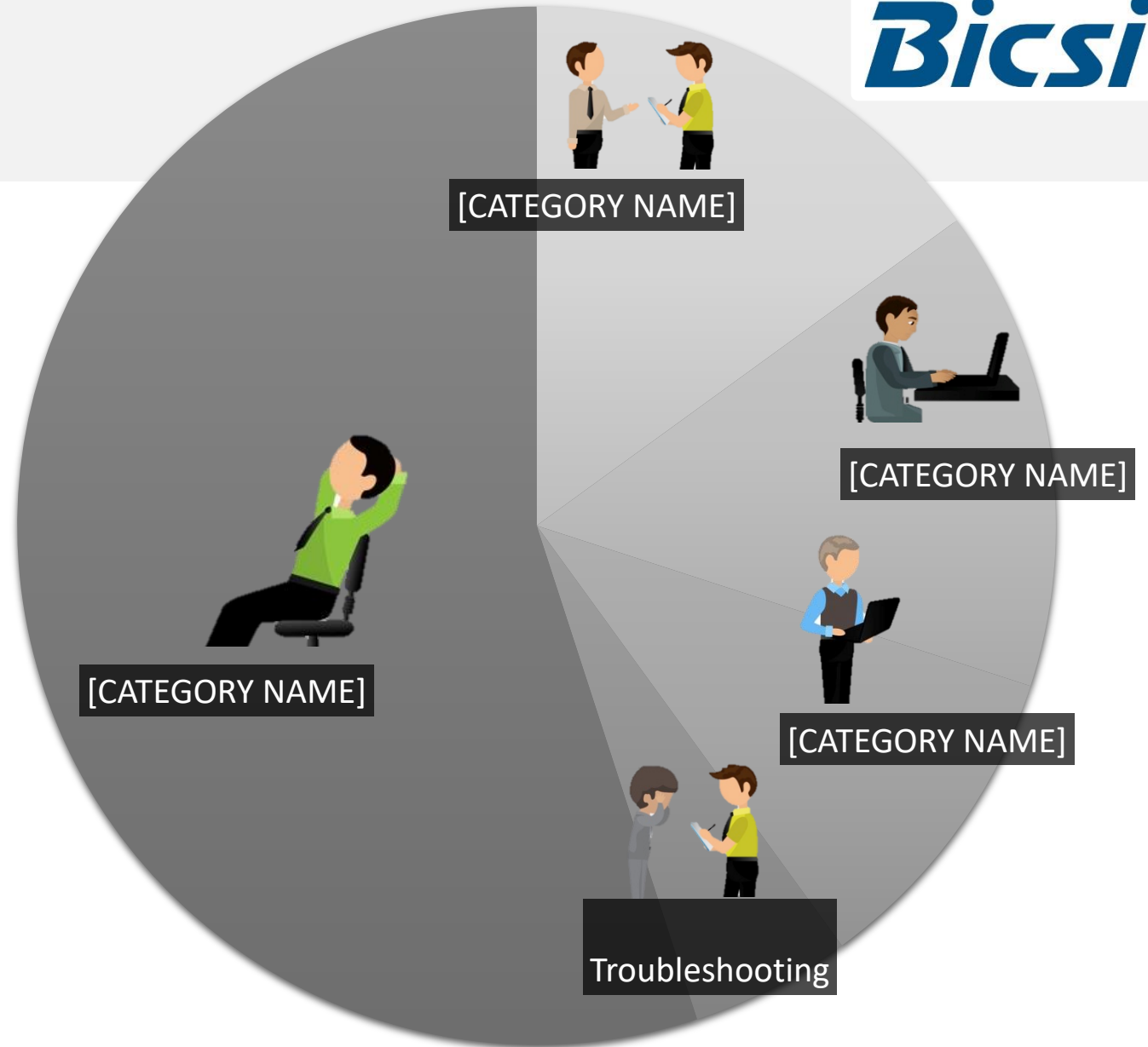
“Worry later”

Little or no
best practices,
processes or tools



“Design Approach”

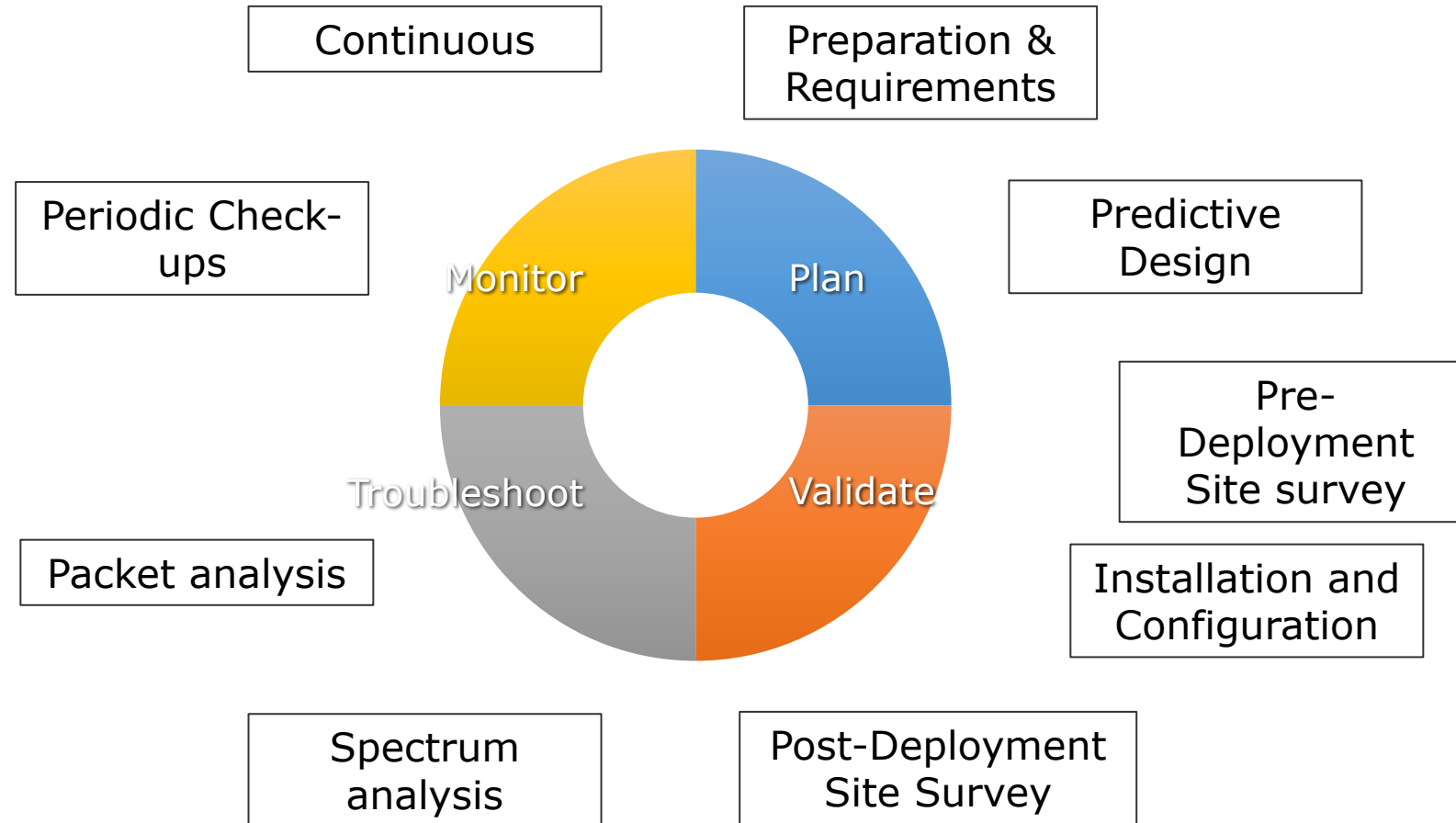
Interview network users, then design using best practices and tools.



Which guy would you like to be?



Life Cycle of a Wi-Fi Network





Tip #3:

Blueprint quality
has a direct correlation with
Wi-Fi design efficiency

• CAD drawings

- Eliminates the drawing of walls
- Provides scale automatically
- Pro tip: Charge customer more if no CAD drawings available

• Blueprint essentials

- Up-to-date
- White background
- Room numbers visible
- Wiring closets marked
- Existing AP placements marked
- If non-CAD, width / height between 1000px and 5000px is ideal.
- If CAD, ask blueprint manager to only give you wall / door / window infrastructure, not plumbing / furniture / plants



Tip#4: Aim for high data rates

Entering the network (authentication & association)



Low
Signal
Strength



Authenticate

High Signal Strength



A Bartender Serves One Customer At a Time

- One device can only talk for a short period at a time...
- ... and then it's somebody else's turn



High Data rate is vital

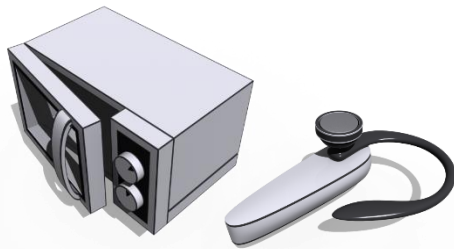
- How long it takes for a device to send its transmission, depends mostly on **data rate**
- The higher the data rate of all the devices, the more everyone can transmit per second
- Data rate depends on signal strength / SNR



Contributors to low data rate



Noise



Channel Interference



Low client capabilities





What have we learned so far?

Why is this guy unhappy?



High data rates here

High noise level

Low signal strength, very low SNR





Tip#4: Not all client devices are equal

Not everybody should be let in

Just like no kids or intoxicated adults in your bar –

To maximize airtime, disable

- Legacy client access (802.11b/g)
- Low data rates in general



Low data rates



- You know those guys who pay with pennies?
- Low data rate clients are just like that: They slow down everyone in the network



Client device efficiency



3 spatial streams
high efficiency



1 spatial stream
low efficiency


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A racing driver in a white Mercedes-AMG Petronas Formula 1 suit is celebrating a victory. The driver is wearing a black helmet with yellow accents and a Pirelli logo. They are holding a large bottle of Mumm champagne, which is being opened, causing a large spray of white foam to erupt from the neck. The driver's suit features various sponsor logos, including Mercedes, Petronas, Qualcomm, Allianz, and Epson. The background is a dark, textured surface, possibly a track or pit lane.

MU-MIMO

Not all clients are transmitting data all the time



Client (idle,
processing
data)

Client
sniffing
other
client's
data?

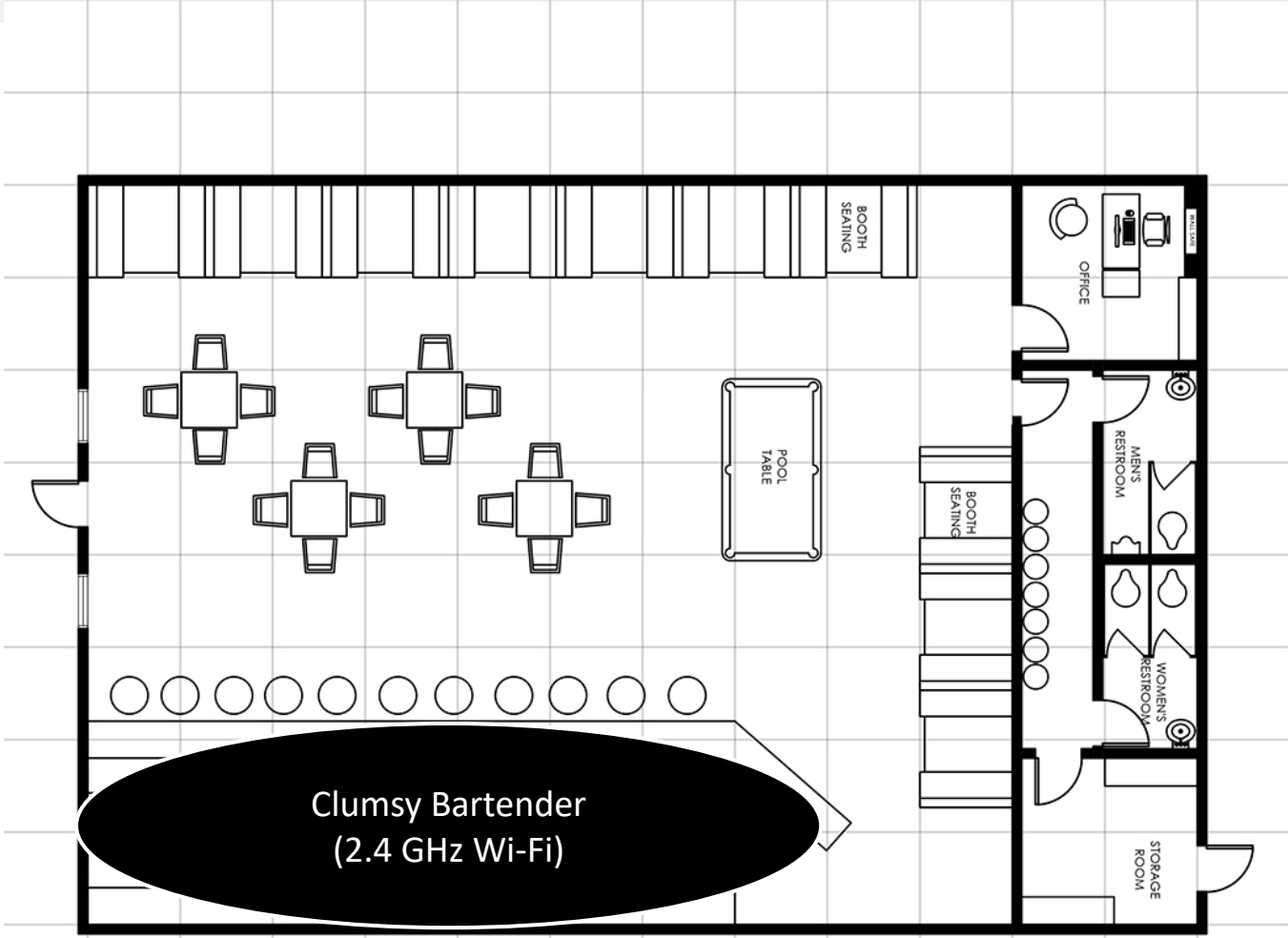
Client
working on
data
previously
transmitted

Access
Point

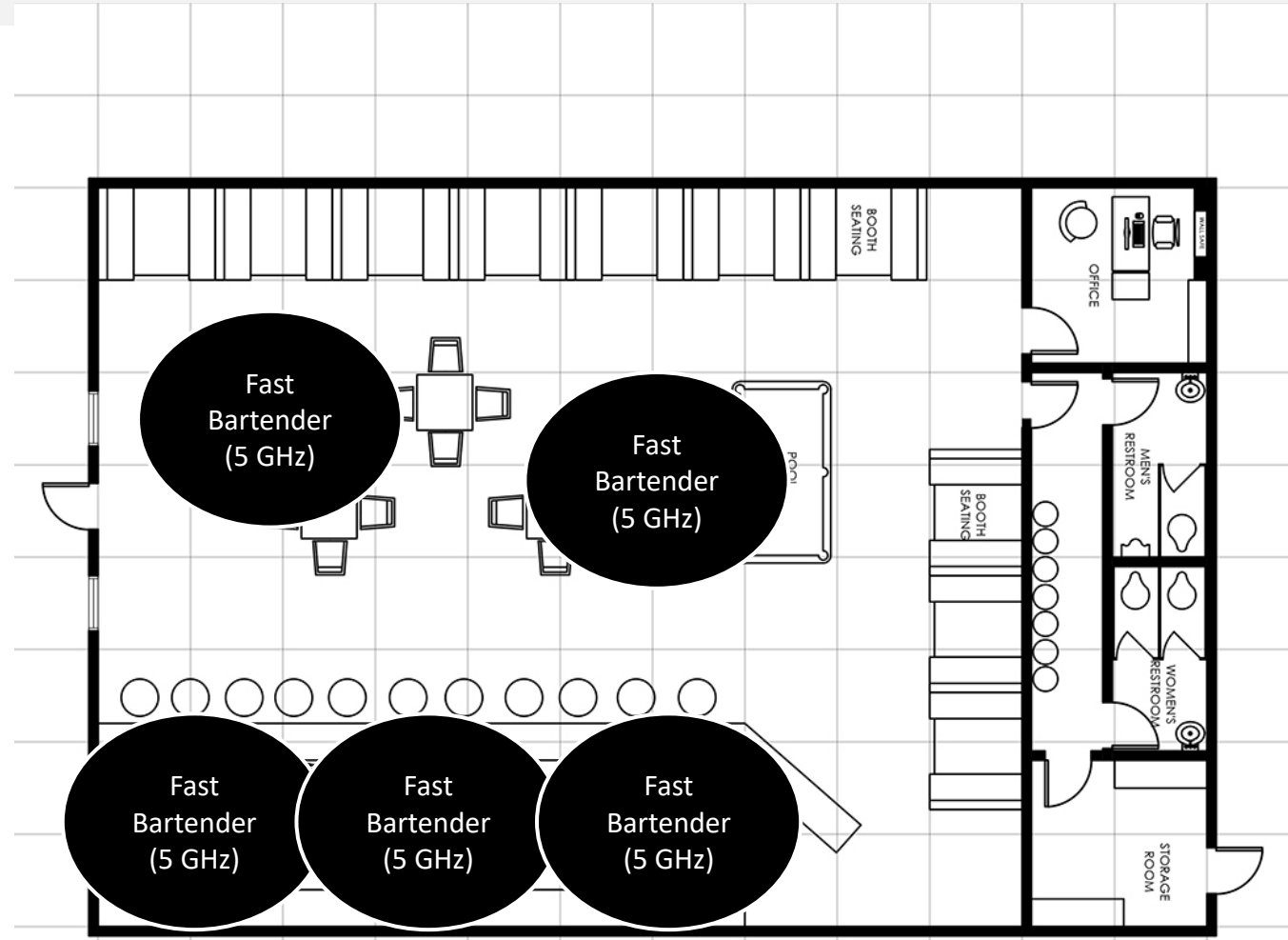


Tip#5: Is More Better?

Adding more bartenders doesn't always help!

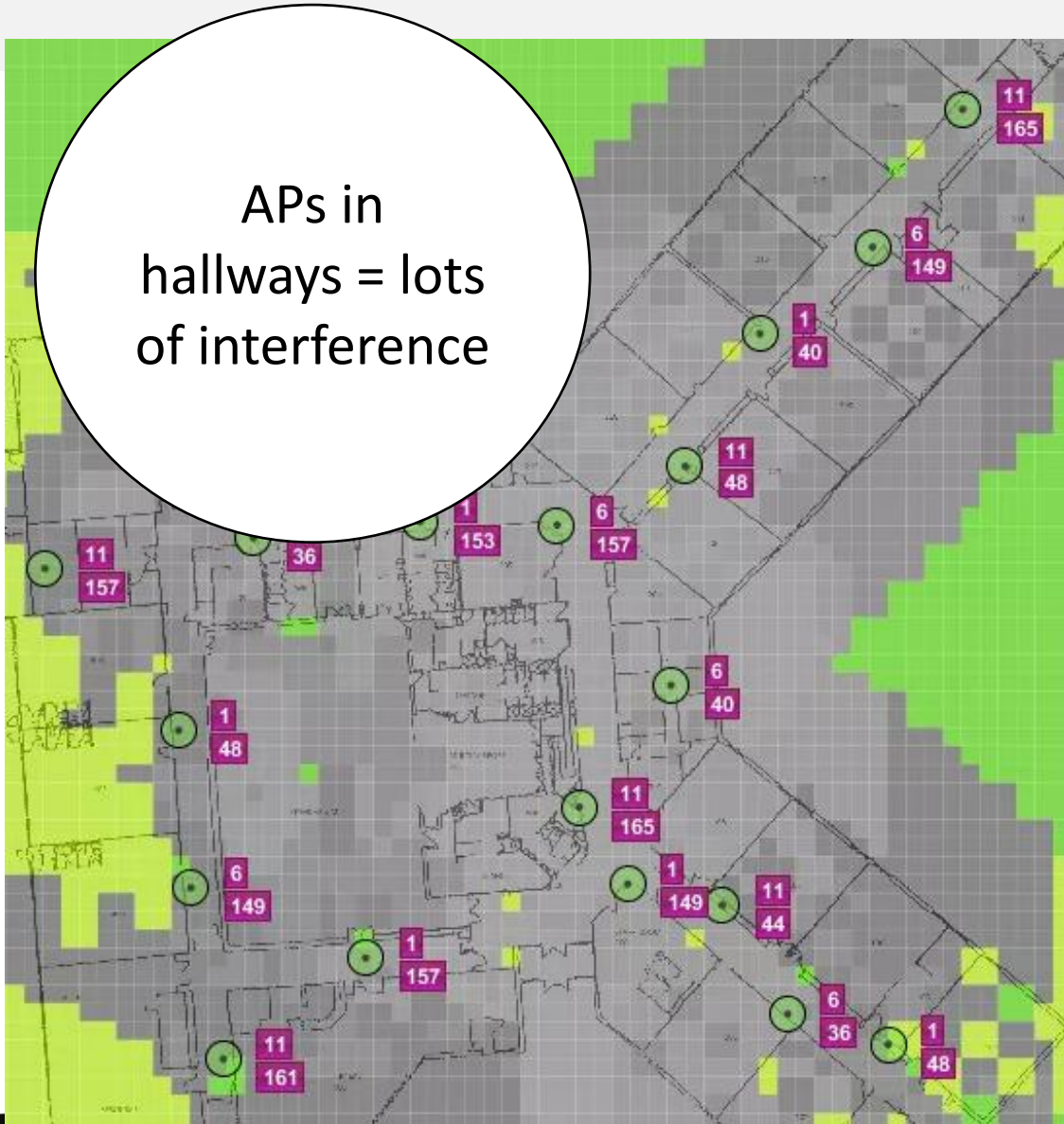


Using 5GHz Wi-Fi is like having skilled bartenders

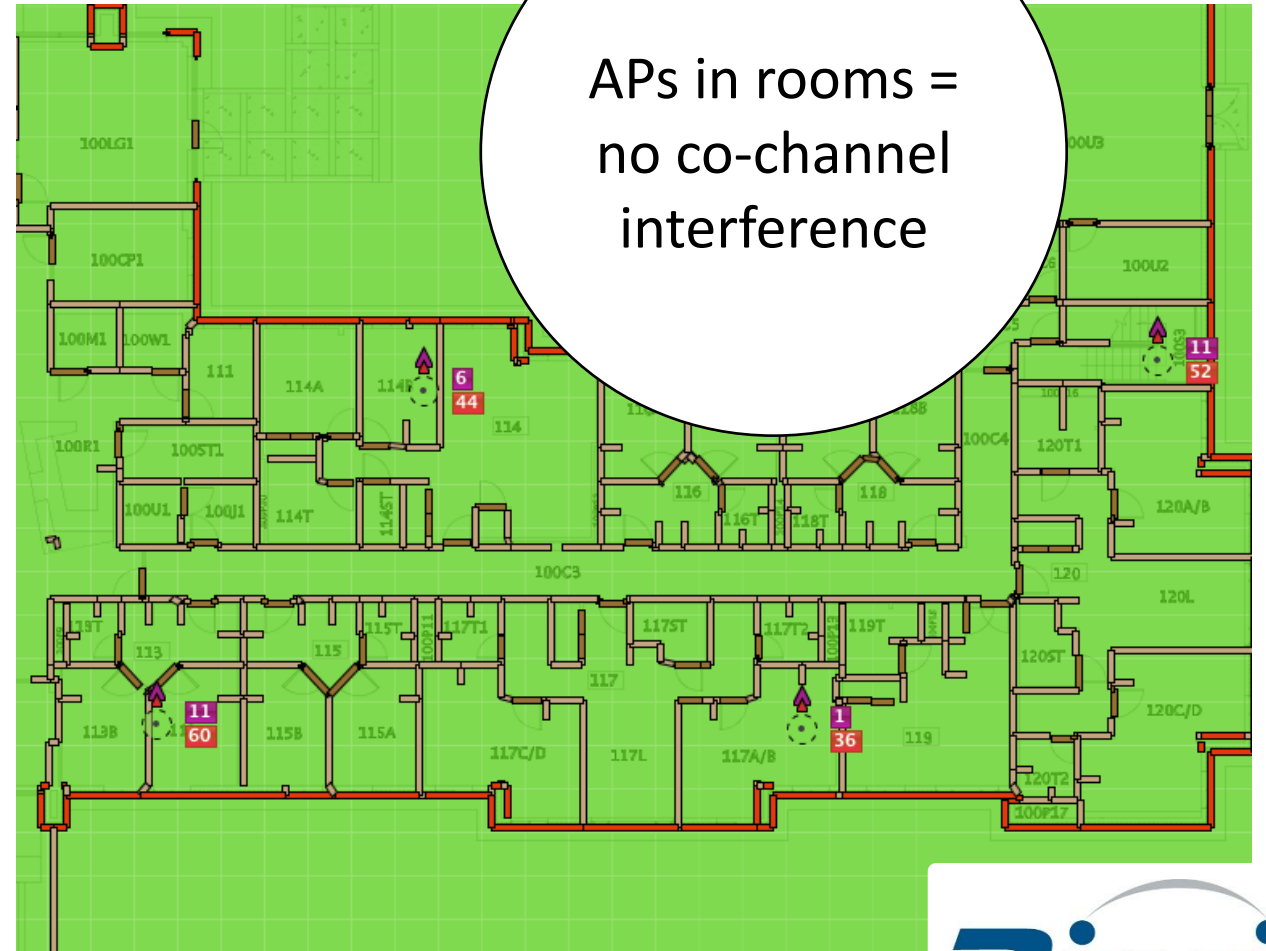


Reduce Channel Overlap by Strategic AP Placement

APs in hallways = lots of interference

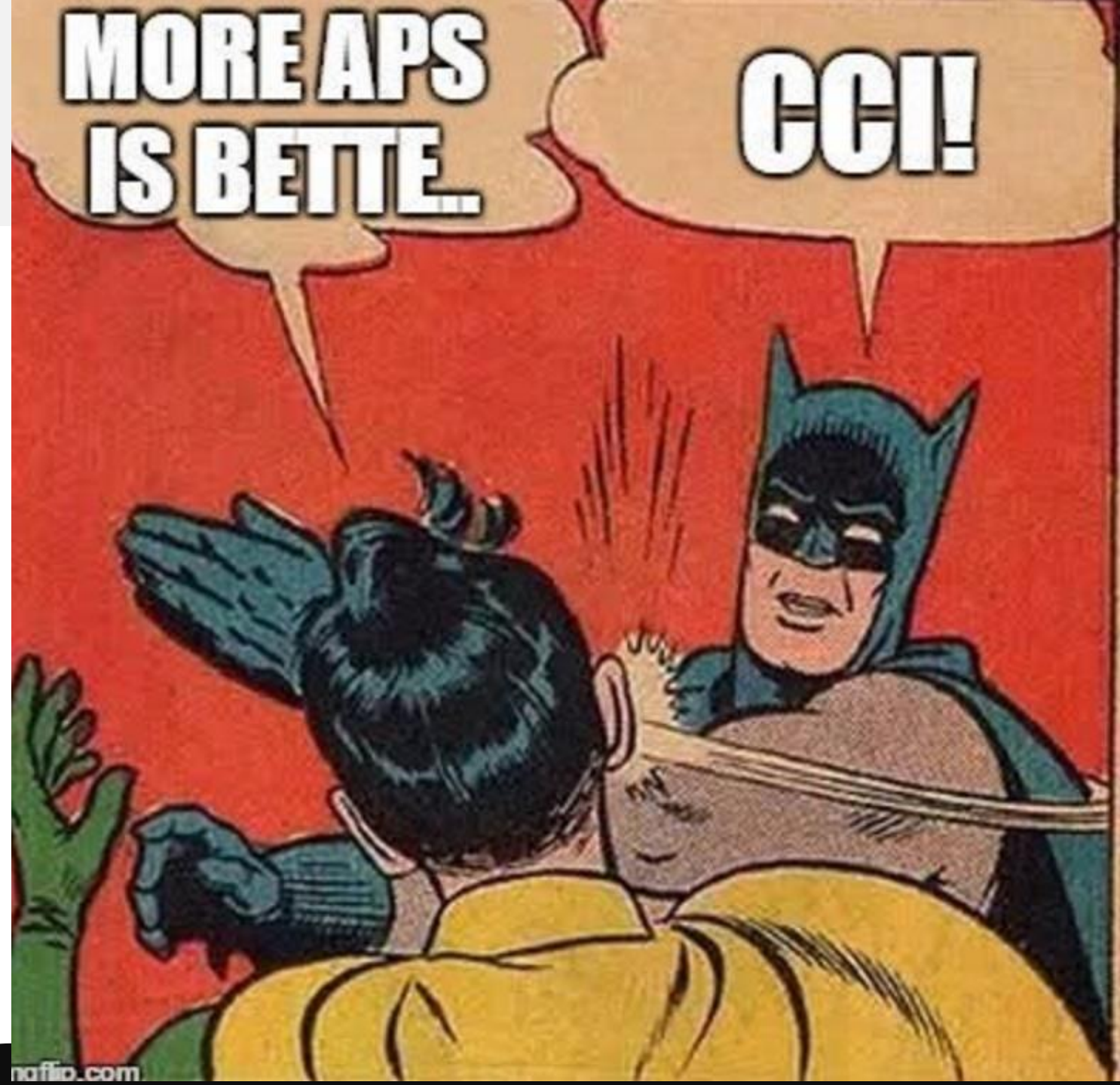


APs in rooms = no co-channel interference



**MORE APS
IS BETTE..**

GGI!



There's Always Some Overhead



- Waiting for your turn
(Clear Channel Assessment)
- Mixing the drink (Management traffic)
- Paying for the drink
(Acknowledgement)
- Phrases like
 - "How are you", "good thanks"
(Probe request / response)



Complex Drinks Are Like Extra SSIDs...



- Mixing complex drinks eats up the usable “airtime”

Drink complexity

of bartenders

Number of APs on Channel*	Number of SSIDs					
	1	2	3	4	5	6
1	3.22%	6.45%	9.67%	12.90%	16.12%	19.35%
2	6.45%	12.90%	19.35%	25.80%	32.25%	38.70%
3	9.67%	19.35%	29.02%	38.70%	48.37%	58.04%
4	12.90%	25.80%	38.70%	51.59%	64.49%	77.39%
5	16.12%	32.25%	48.37%	64.49%	80.62%	96.74%
6	19.35%	38.70%	58.04%	77.39%	96.74%	100.00%



Tip#6: The spectrum police academy



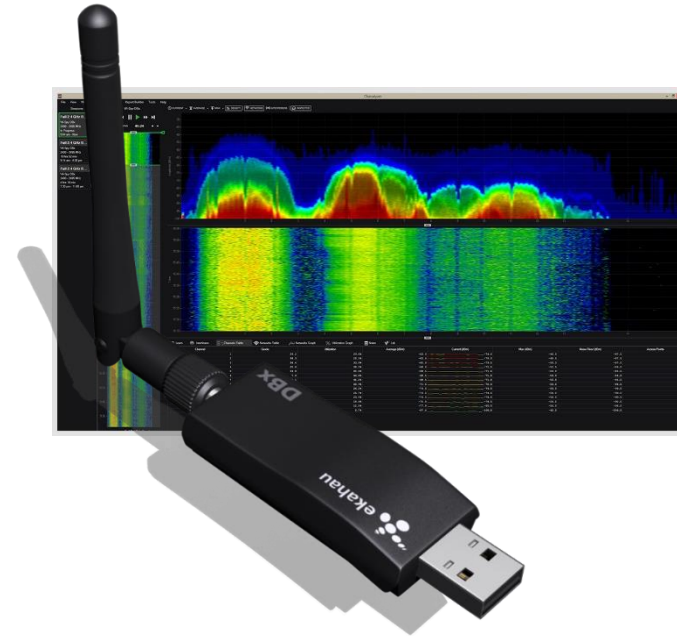
What Can Interfere with Wi-Fi

- Microwave Ovens
- Cordless phones
- Wireless cameras
- Baby monitors
- Wireless audio systems
- Bluetooth
- Radar
- GSM networks!



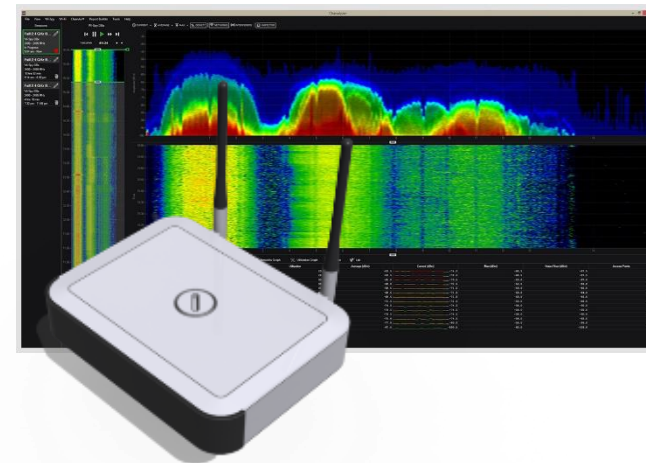
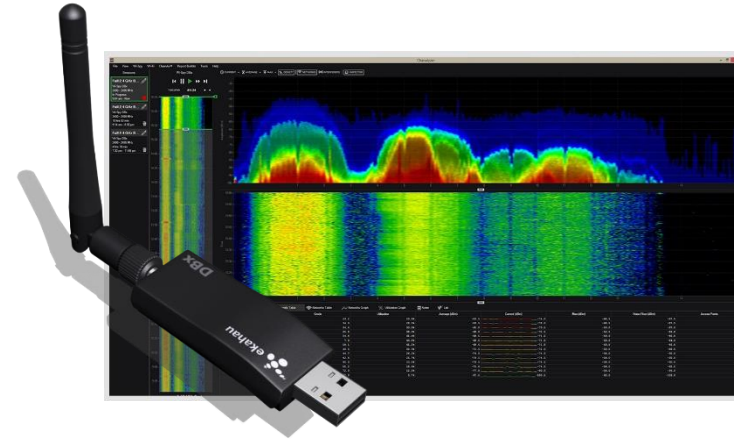
Tools to Fight Interference

- Spectrum analyzer
- Site survey tool
- A hammer ;)



Two types of Spectrum Analyzers

- External device
 - Floor level measurement
 - Can be taken anywhere
- Built into access point
 - Always out there
 - Measures where the AP is (=ceiling)



CSI it like Horatio

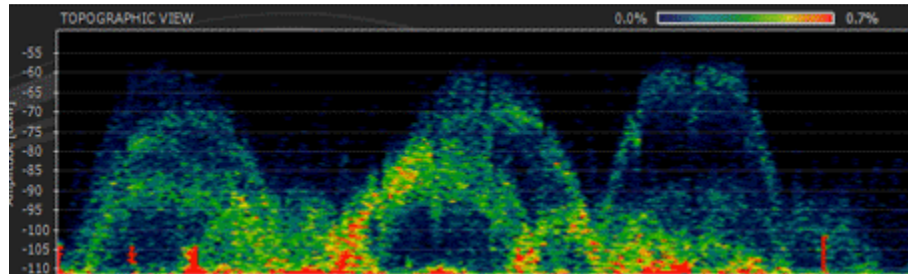
1. What's Wi-Fi, what's not
2. How bad is the interferer – amplitude, duty cycle and channel
3. Is the interferer constant or periodic in nature?



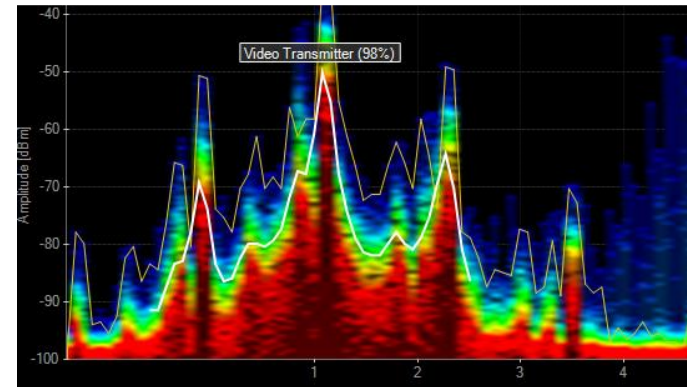
Wi-Fi vs Not Wi-Fi



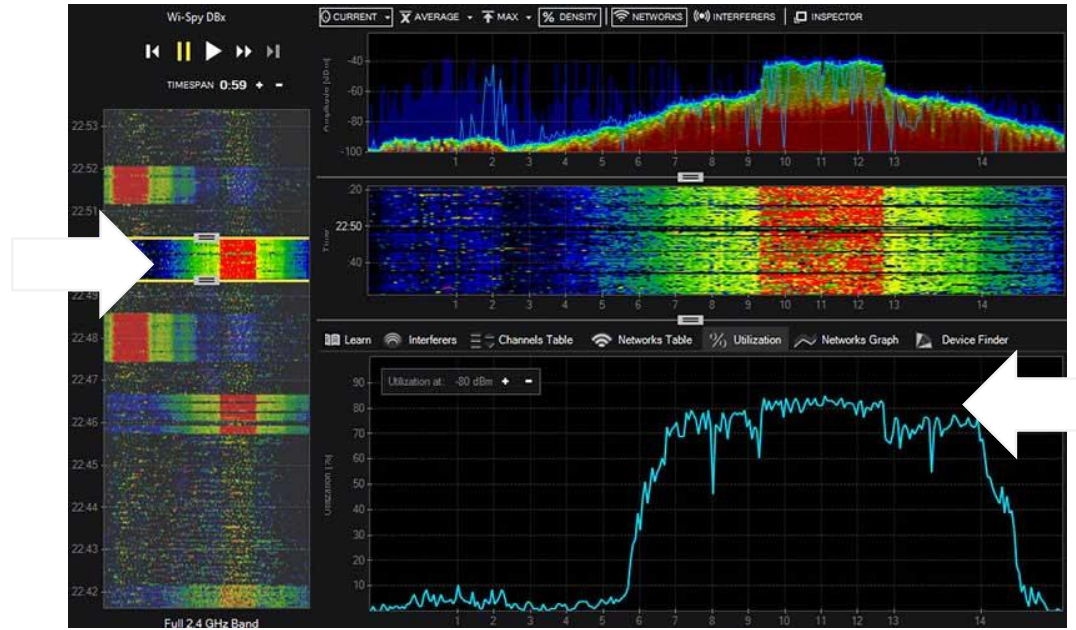
Wi-Fi



Not Wi-Fi



Periodic interferer



Questions before acting



- Is the interferer impacting your network?
- Can the interferer be eliminated?
- Will adjusting the network fix the problem?
- Is there a Wi-Fi substitute for the interferer?
- Can you break it ;)



Tip#8: “Site survey just slows down everything”



Survey Phase

Question



Predictive site surveys

(network plan, simulation)

“How many APs? Where?
Power? Channels? Antennas”?

Pre-Deployment site surveys

(AP on a stick)

“What does the real world RF look like”

Post-Deployment site surveys

(validation)

“Does this network actually work?”

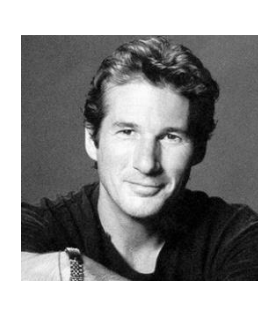
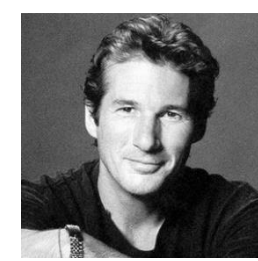
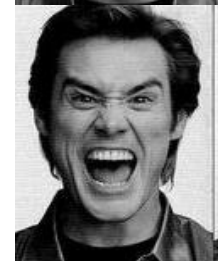
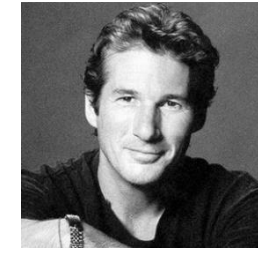
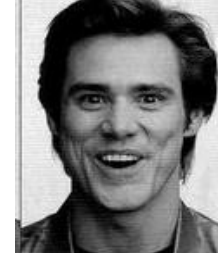
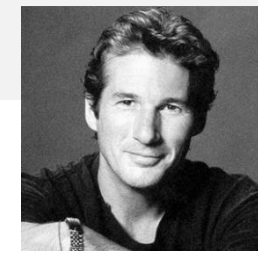
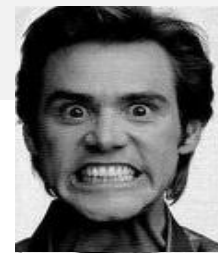
Periodic site surveys

(health check)

“Does it **still** work? What has changed?”

Survey Happiness Scale Jim Carrey Richard Gere Paris Hilton

- No surveys
- Post-deployment validation
- +
 - Predictive
- +
 - Periodic check-ups, AP on a stick



Survey Type

The process

Result

Predictive Survey

Simulate RF by defining walls,
placing simulated APs

Simulated heatmaps
of capacity & coverage

Passive Survey

Walk around, collect beacons and probes,
measure things like Signal strength,
Interference, SNR for **all** APs.

SNR, RSSI, interference
heatmaps for all APs

Active Survey

Walk, connect to the network, test
things like packet loss, RTT, association

Heatmaps and deeper
analysis like roaming, ...

Throughput Survey

Measure throughput (Mbit/s, # of packets)
and jitter, often spot checks

Momentary capacity
analysis, voice analysis

Spectrum Survey

Detect all RF energy / interference

Interferers, duty cycle, etc.



Tip#9: High Capacity
Means
Asking the Right Questions

Calculating Capacity



Number of clients

The background of the slide is a grayscale silhouette illustration of a busy bar or restaurant. In the foreground, a dark silhouette of a person is shown in profile, holding a wine glass. Behind them, several other silhouettes of people are visible, some standing and some sitting at a bar. A bottle is on the bar in the lower-left corner. The overall scene is dimly lit, with the silhouettes standing out against a lighter background.

Distribution of clients

Client types

Beer, wine or shots?

Number of Thirsty People?

- Number of wireless users
- Number of devices per user
 - One often active at a time
 - Idle devices eat some capacity, too
- The device type of the user
 - 802.11ac/n/g/a/b?
 - Number of spatial streams supported
 - MU-MIMO capable?



Capacity Requirements

In my network, there are

15	11ac AC Laptop
30	11n Laptop
20	11bg VoIP Phone
100	11n Smartphone
35	11n Tablet

Peak Hour Usage:

Add Wi-Fi Devices:

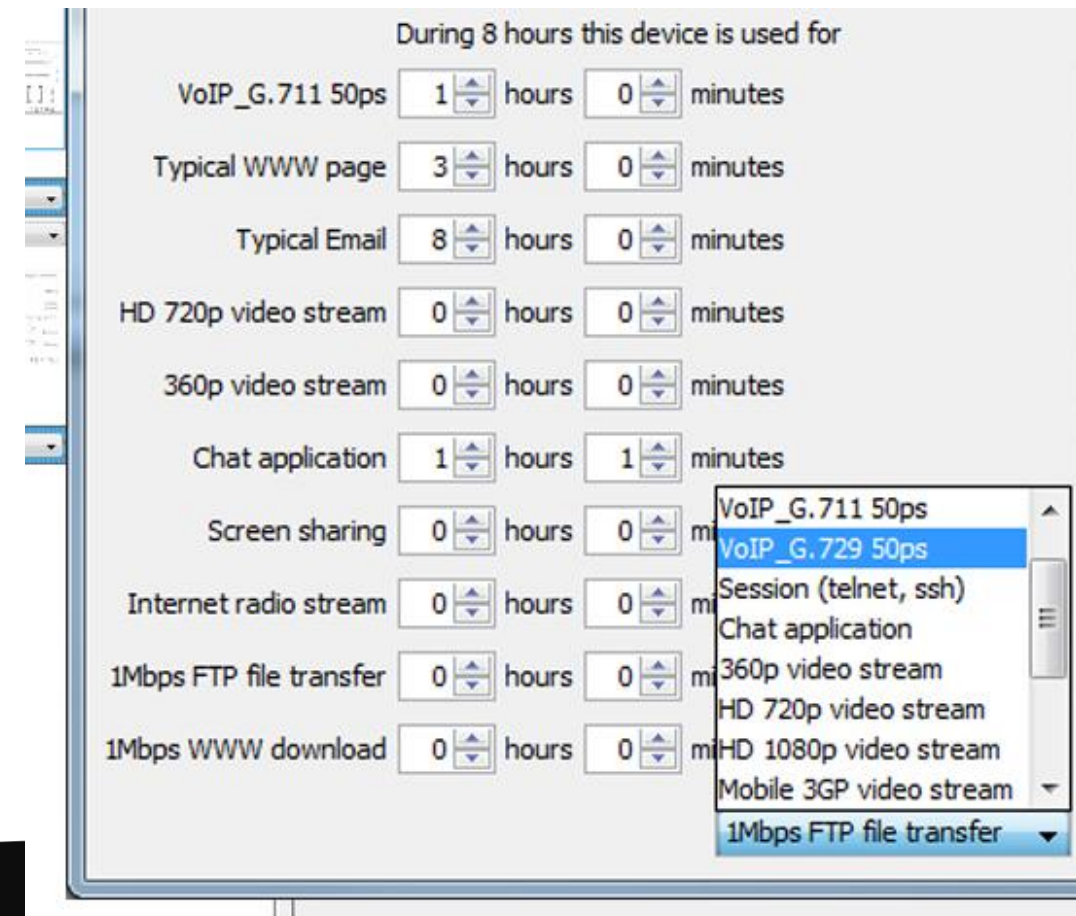
35	11n Tablet
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How Thirsty Are the Customers?



- **Applications**

- What applications are the users primarily using
- How frequently are the applications used



Calculating capacity need



- **Excel based tools / calculators**

- Calculates the required number of Aps
- Can go to great detail
- Revolution Wi-Fi capacity calculator

- **Map-based tools**

- Calculates number of APs
- Suggests AP placement and channels
- Predicts coverage & capacity
- Ekahau Site Survey Pro

Process for Designing High Capacity Wi-Fi



Folks want beer.	1.	Business need	Wireless access everywhere
They want it cold and fast.	2.	Tech Requirements	Every user 5MB/sec
Enough taps & bartenders.	3.	Infrastructure	# of access points (APs)
Placement of counters, taps.	4.	Predictive design	AP placement & antennas
Build the bar, buy the beer.	5.	Deployment	Set up the network
Check that the taps work.	6.	Verification	RF walk—through site survey
Keep things clean & working.	7.	Maintenance	Keep network running



Tip#10: Learn More

Summary





Thank you!

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