

# Healthcare Design

Wireless design for healthcare and large enterprises

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IT Professional Wi-Fi Trek 2015  
#wifitrek



# Presenter BIOD



**Shawn M. Jackman**  
**Clinical Mobility**

No relation to Hugh Jackman

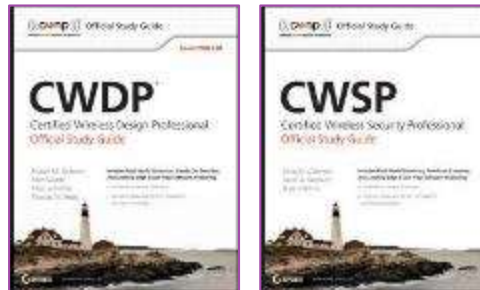
- Lead author for the *CWDP Certified Wireless Design Professional Official Study Guide*
- Co-author of *CWSP Certified Wireless Security Professional Official Study Guide*
- Co-chair, AAMI Wireless Strategy Task Force
- Co-author, *mHIMSS Roadmap*
- CWNE #54.



**Chris O'Donnell**  
**Solutions Architect**  
**Cisco Advanced Services**

No relation to Chris O'Donnell (CSI)

- CWNE Roundtable Member
- 10+years experience in the WiFi industry specializing in WiFi analysis and VoWLAN
- Co-author on "Triple Blendy" WP with Devin Akin
- CWNE #64.



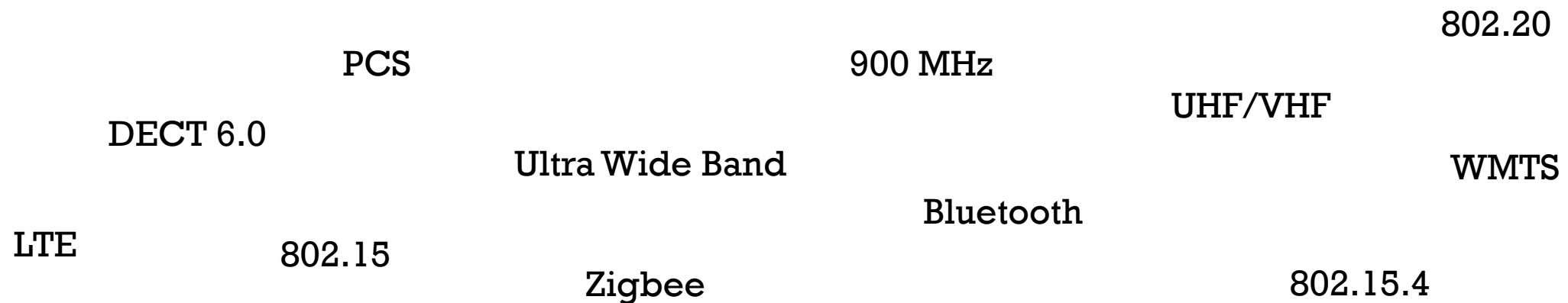
# Agenda Topics

- Big Picture of Wireless
- Trends in Healthcare
- Where demand for wireless is heading
- New wireless technologies to watch
- Existing wireless use in healthcare

# Big Picture of Wireless

Does wireless mean Wi-Fi?

What about...



# Wireless in Healthcare

## WLAN

Foundational utility for mobile applications, devices and users.



## Member Benefits

Guest access and cellular signal augmentation in our facilities.



## RFID and Real-time Location Systems

Asset tracking, inventory management, patient tracking, HUGS and temperature monitoring.



## In-building Voice and Video

Voice and video over WLAN, 900 MHz phone systems and DECT 6.0 phone & headset audio.



## Wide Area Data

3G/4G, DR facility connectivity, temporary, mobile connectivity.



## Mobile Messaging

SMS, legacy and 2-way paging systems, nurse call paging and wireless waveform.



## Patient Monitoring

Telemetry (WMTS), home healthcare device monitoring.



## Indoor extension of cellular/public safety

A two-way radio signal that provides in-building coverage for cellular phones and first responder (police, fire, ambulance)



# Spectrum Management – OSI Layer 1

Ever see a well running network with bad cabling?

What's the bigger picture...

- Managing and leveraging your most fundamental resource
- Spectrum use is always dynamic

Certified Wireless Professional...Expert?

What expectations does management/your customer have of you?

# Macro Trends in Healthcare

- High device density – new device types, old device types, things that move, things that don't
- High security requirement – highly regulated; protecting reputation
- Users are highly mobile – need in-building and between
- Critical to business – wireless is now the primary access layer

Sound familiar to anyone? Is this just healthcare?

# Micro Trends

- Increase in devices and critical use cases for efficiency and quality of care.
- Increase in user expectations – users expect (and need) wireless to work.
- Building management systems – HVAC, electricity, lighting, access control, amenities...sensors! Lots of them.
- ISP/hospitality services – not just for customers & visitors.
- New efforts to engage patient, family and visitors inside and outside facilities.
- Security – much higher priority at every level. Reputation and fines at risk.



# Security

- Monetization of health record vs. credit card
  - Some reports exceed 10x in black market value
- Seems as if everything is getting a network connection.  
Why?
  - Removes human error
  - Reduces time
  - Take readings more frequently. Identify negative trends before risk to patient.

# Security of Traditionally Non-networked Devices

Would you assume same security competency?



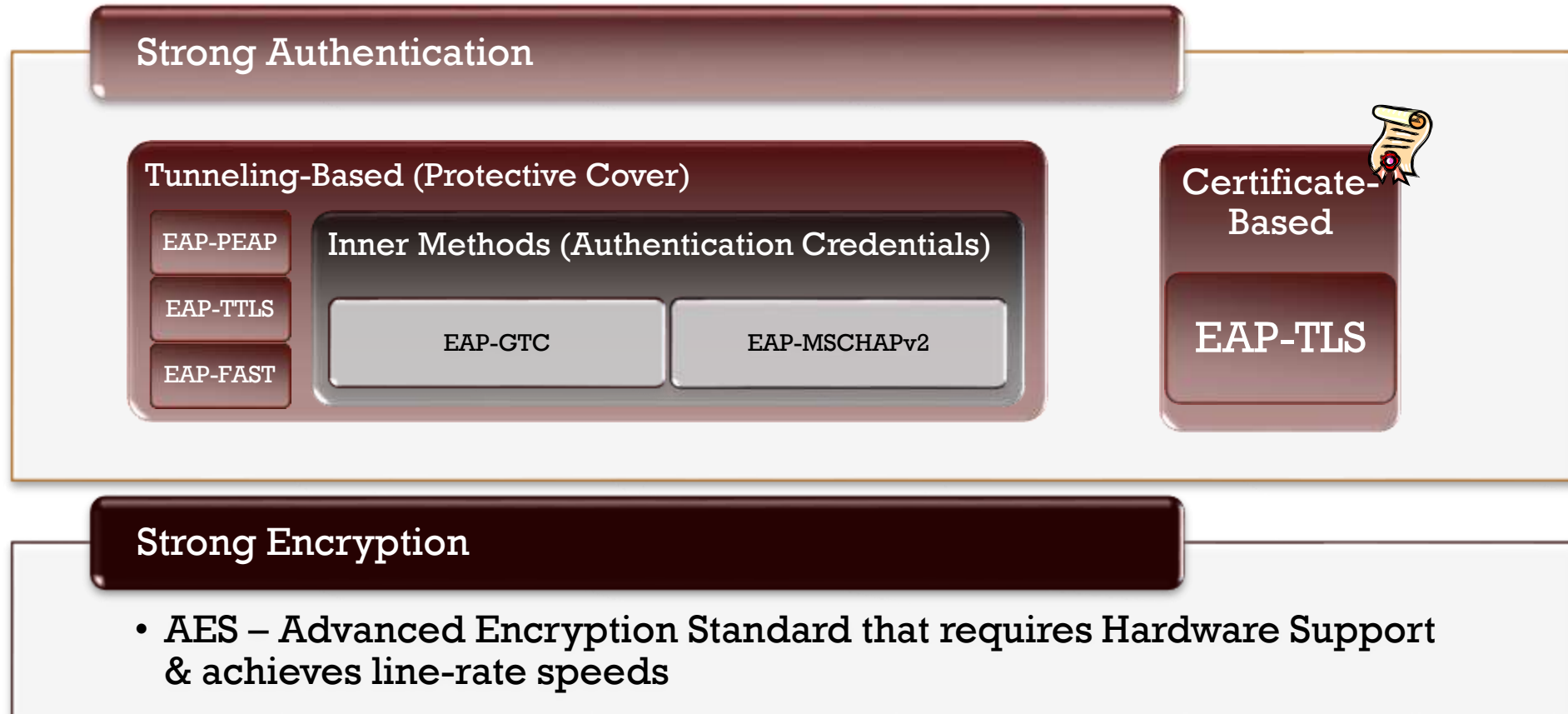
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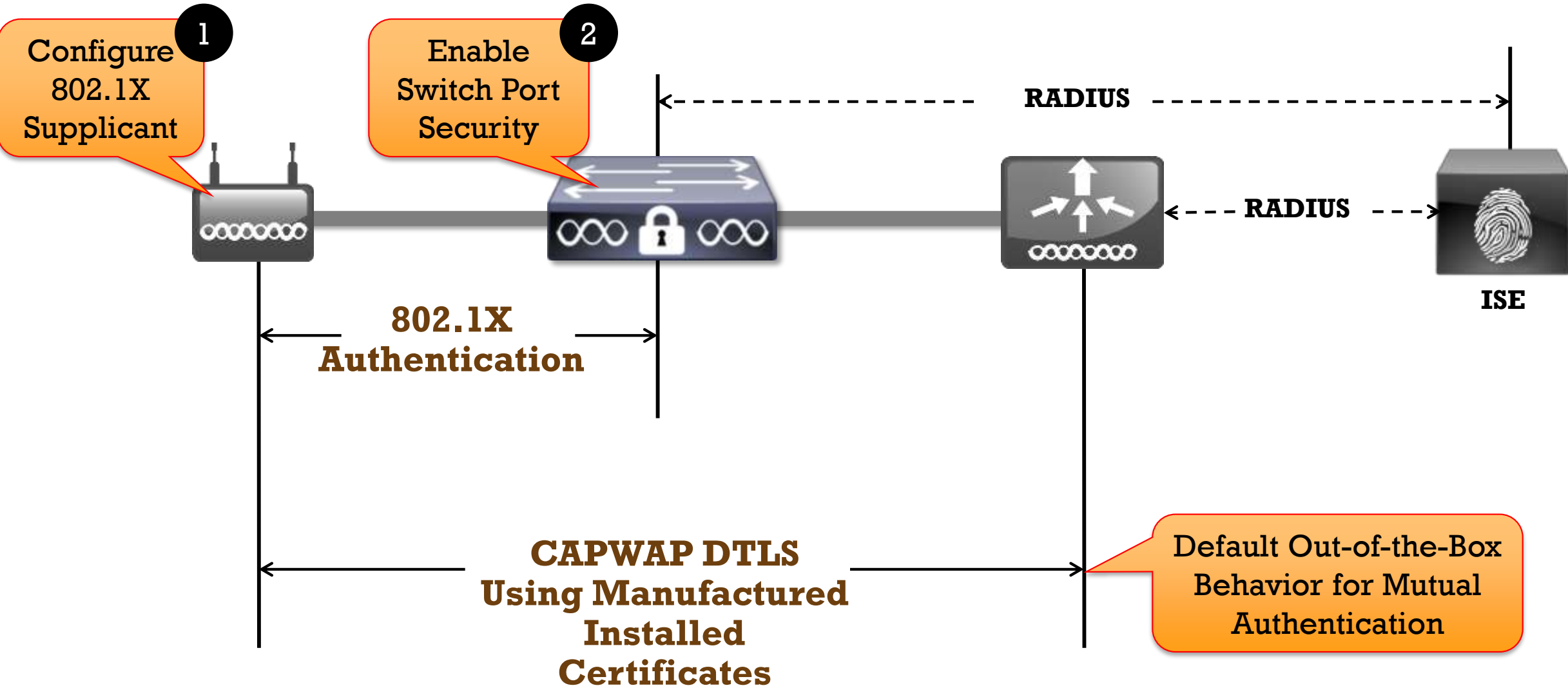
# PSK...Good Enough?

- Use of PSK is still too prevalent
- Why use it?
- Why not?
  - Changing 100...1,000...10,000 devices isn't a problem, right?
  - When your network admin leaves (or fired), no risk, right?
  - Nobody ever shares the key, right?
  - All of your PSKs are cryptographically complex, right?

# Authentication Best Practices: Use WPA2-Enterprise



# Secure Your Wireless Infrastructure End-Points



# Devices – Why WLANs Exist



What Wi-Fi Certified means to the enterprise.

Most of the challenges we face with 802.11 based devices are the details.



Based on what?

What is the test plan? What specific features are you testing for? How is that relevant to the enterprise? Why do certified devices still not work!

It feels like the early days of Ethernet incompatibility still.

- Basic roaming challenges
- 802.1X authentication
- Supported bands...support within bands

# Guest Access

Not just for guests. Wait, what is a guest?

- Person?
- Device?
- Non-company device?

Wireless carriers love corporate guest access networks.

Expectations of your visitors, patients, family members? Is it OK if your healthcare provider's mobile app doesn't work inside their facilities?

For a large healthcare company / enterprise, how much can this cost?

# Spectrum Use

Is 2.4 GHz  
a junk band?

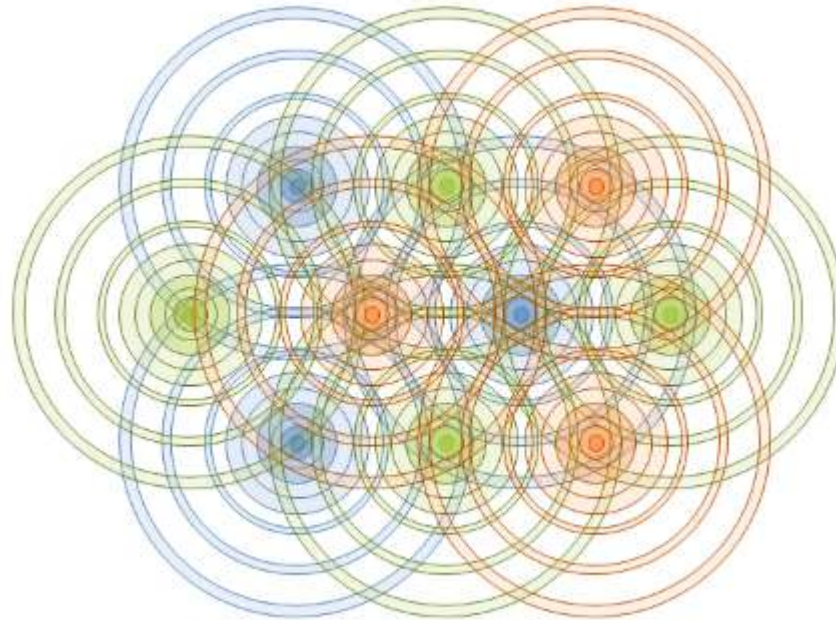
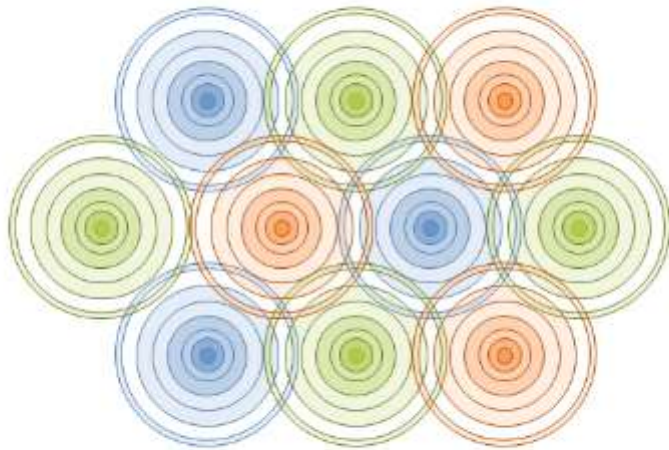
12 active voice  
streams





# Goldilocks Principle

- PHY rates are directly proportional to signal quality
- The number of transmitters on the same channel is inversely proportional to performance



## Key Takeaways:

- Keep signal quality high and therefore the PHY rate. Manage *time* of transmission.
- More APs do not manufacture Wi-Fi capacity.

# Infrastructure Design Considerations

## Wi-Fi design considerations

- Design for RF performance
- Consider 3D RF propagation
- Gigabit every 1,800 sq. ft.
  - WAN capacity typically less than 1 Gbps for facility.



**A look at now and into the future...**

# Power of Commoditization

Shawn's little project...what I learned.



Arduino Uno



Arduino Nano



ESP8266

## Specs:

802.11n (2.4GHz)

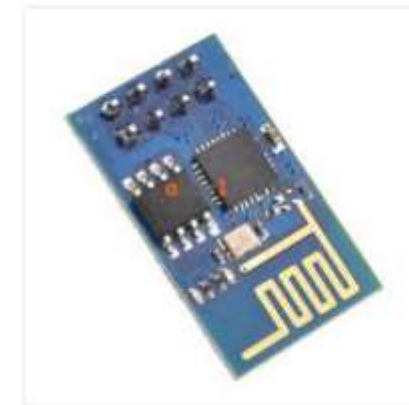
AP, STA, AP+STA

Microcontroller built in

Built in TCP/IP stack

GPIO ports

Etc...



ESP8266 Serial WiFi  
AP+STA A

**\$2.66**

Buy It Now

11074 sold

Where is this heading?

# Indoor Cellular Coverage

Do patients, family members, visitors, customers care whether they are on Wi-Fi or cellular?

As a wireless professional, how do you embrace cellular?

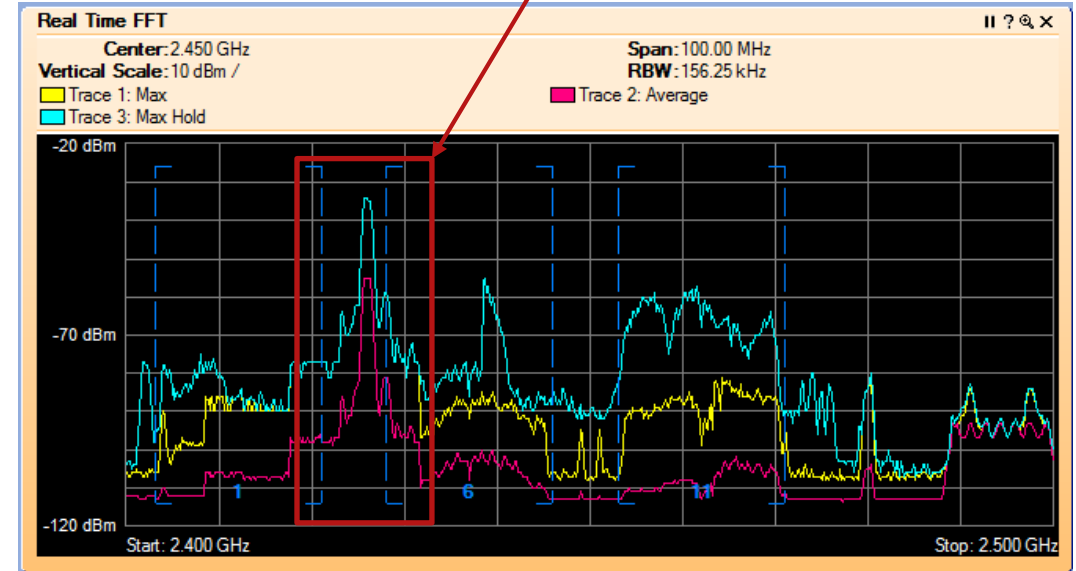
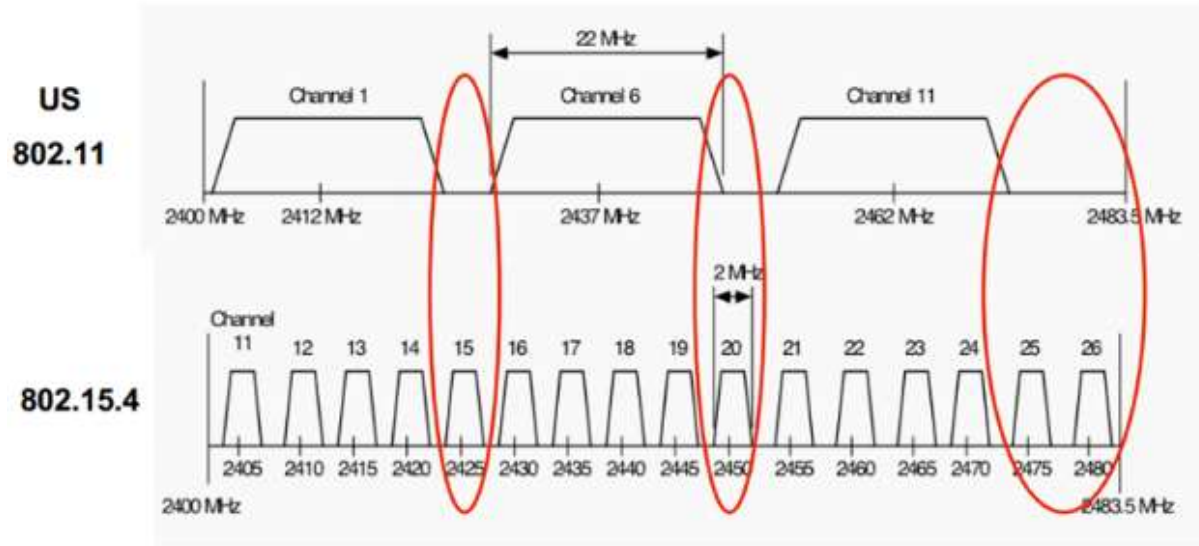
Big shift: DAS → Small Cell → Small Cell + new bands

- LTE-U / LAA
- 3.5 GHz Innovation Band

# Bluetooth – The New Kind

Behaves more like Zigbee when beaconing

Bluetooth Low Energy spectral footprint.



Expect to see more and more of BLE for indoor location initiatives.

# WMTS – Wireless Medical Telemetry Services

FCC dedicated spectrum for healthcare use. Use of spectrum for medical telemetry has moved three\* times.

608-614 MHz – still in use at many facilities

TVWS use and channel 37

FCC's latest direction is about spectrum re-use. Days of dedicated allocations is largely dead.

Patient telemetry devices moving to Wi-Fi. Open standard versus proprietary.



\* Including spectrum use pre-establishment of official WMTS spectrum allocation

# Emerging Network Devices

All of these require wireless in various forms.

Consumer product constraints often at odds with enterprise requirements.

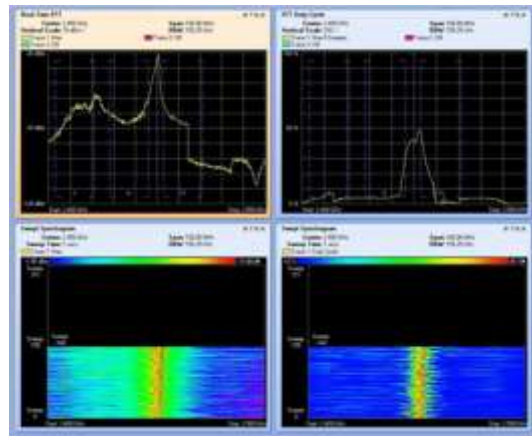




# Design Process – Tips and Best Practices

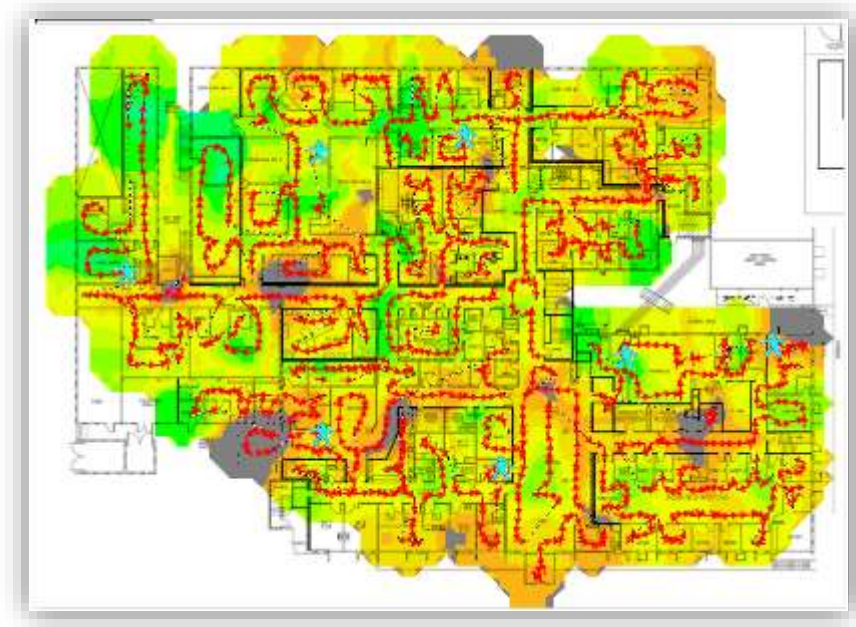
# Tools for Design and Validation

- RF Site Survey Tool (Fluke AirMagnet, Ekahau ESS)
- Packet Capture Utilities (Wireshark, Omnipcap)
- Spectrum Analyzer (Metageek Wi-Spy, Cisco Spectrum Expert, Fluke Spectrum XT)
- Backtrack/Kali NetHunter (really?)



# RF Site Survey Process

- Snapshot of the Wi-Fi signal at the moment in time present in a visual “Heatmap”
- Identify areas of low coverage that may present connectivity and transmission issues.
- Depicts the following in a visual:
  - Signal Strength Heatmap
  - SNR Heatmap
  - Channelization
  - And other
- Can capture both 2.4 and 5 GHz



# Application Testing

Walk in your customer's shoes!

Understand intended use of devices

- How devices are held & carried
- Discover orientational variances

Know the applications being deployed

- Healthcare (Vocera)
- Distribution/Manufacturing (scanning)
- High Density Stadium (POS, upstream/downstream traffic, social media)



# Frame Captures

- Test for lowest common dominator client device (if known) and primary business application
- VoWLAN testing (802.11 frame flow)
- Manufacturing Facility (scanning)
- Video



# Mobile Spectrum Analysis

- Capture RF layer data in the deployment (layer 1)
- Correlate with application testing/packet (frame) capturing to get the “whole” story
- Critical data for in-depth troubleshooting



# WIPS Testing/Validation and Threshold Tuning



OR



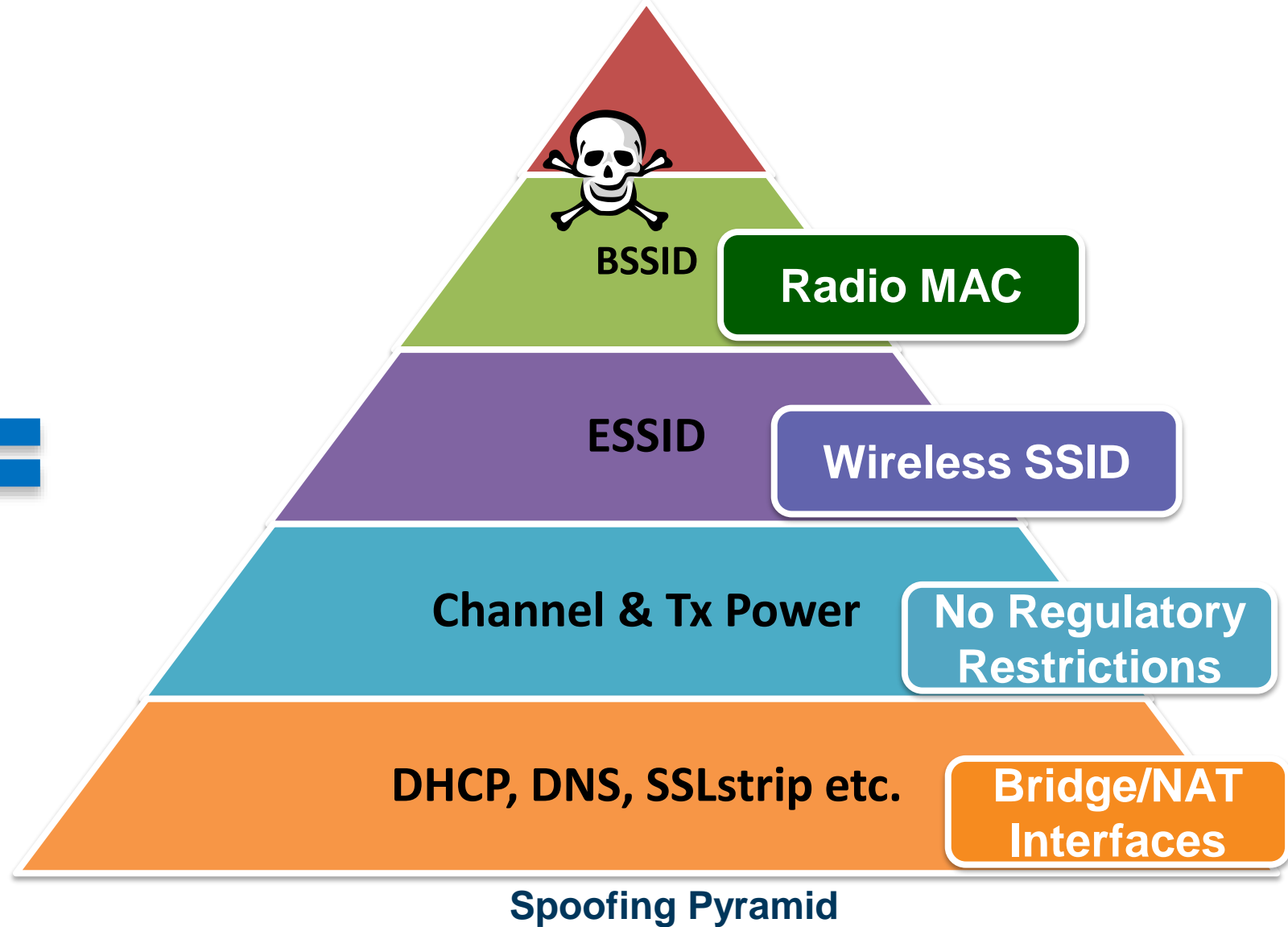
**Kali NetHunter  
(Post-2014)**



OR



**USB Wireless Cards**



Certified Wireless Network Professional



# Putting it all together

- Always gather **multiple** verification data points and not just RF site survey data alone
- VoWLAN deployments must be tested with product to be or actually deployed
- Lots of “problems” are blamed on RF coverage issues (is it really???)
- “Must be interference,” says man with no clue.
- Quantify roaming/BSS transition performance and behavior





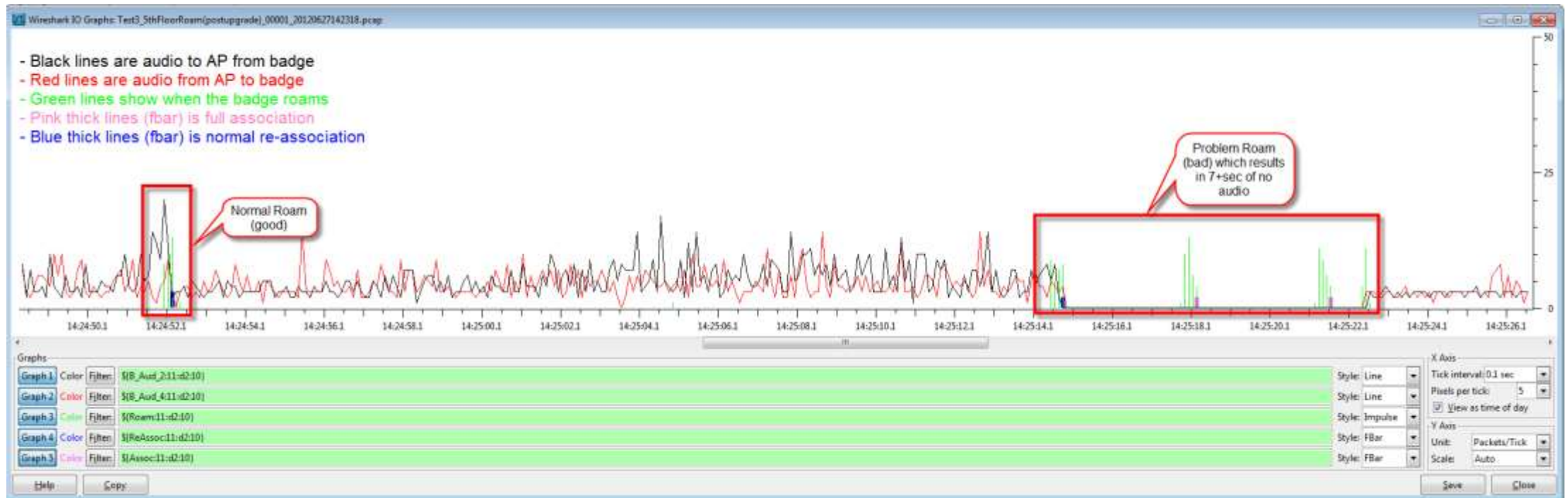
# Data Driven Design Changes

- Let data be your guide



# Data Driven Design Changes (continued)

- VoWLAN Roaming performance and issues
  - Audio loss for many seconds
  - WPA2-PSK Security



# Installations Gone Bad

# AP/Antenna Installs Gone Bad (please don't repeat) 😊



# AP/Antenna Installs Gone Bad (please don't repeat) 😊



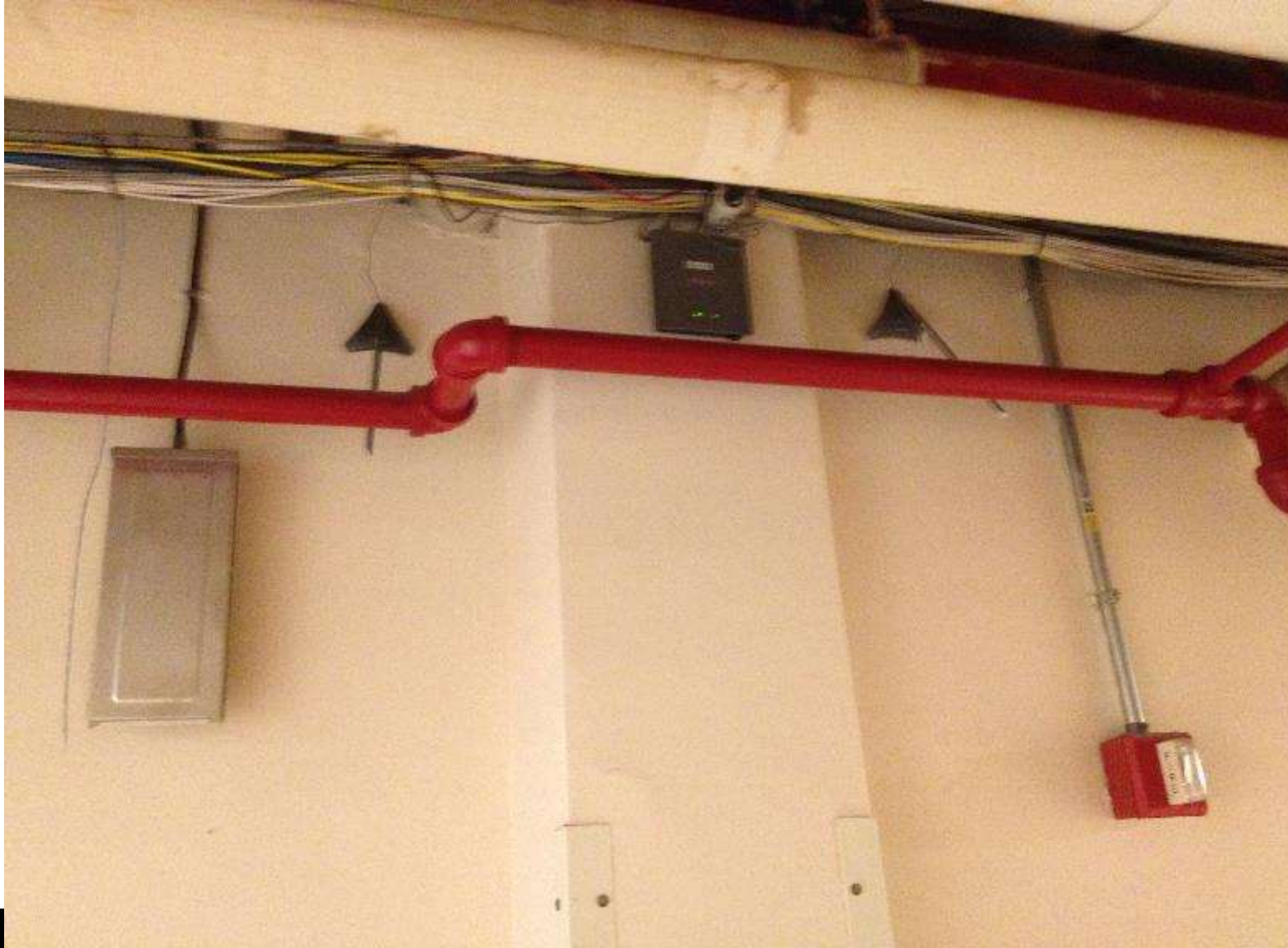
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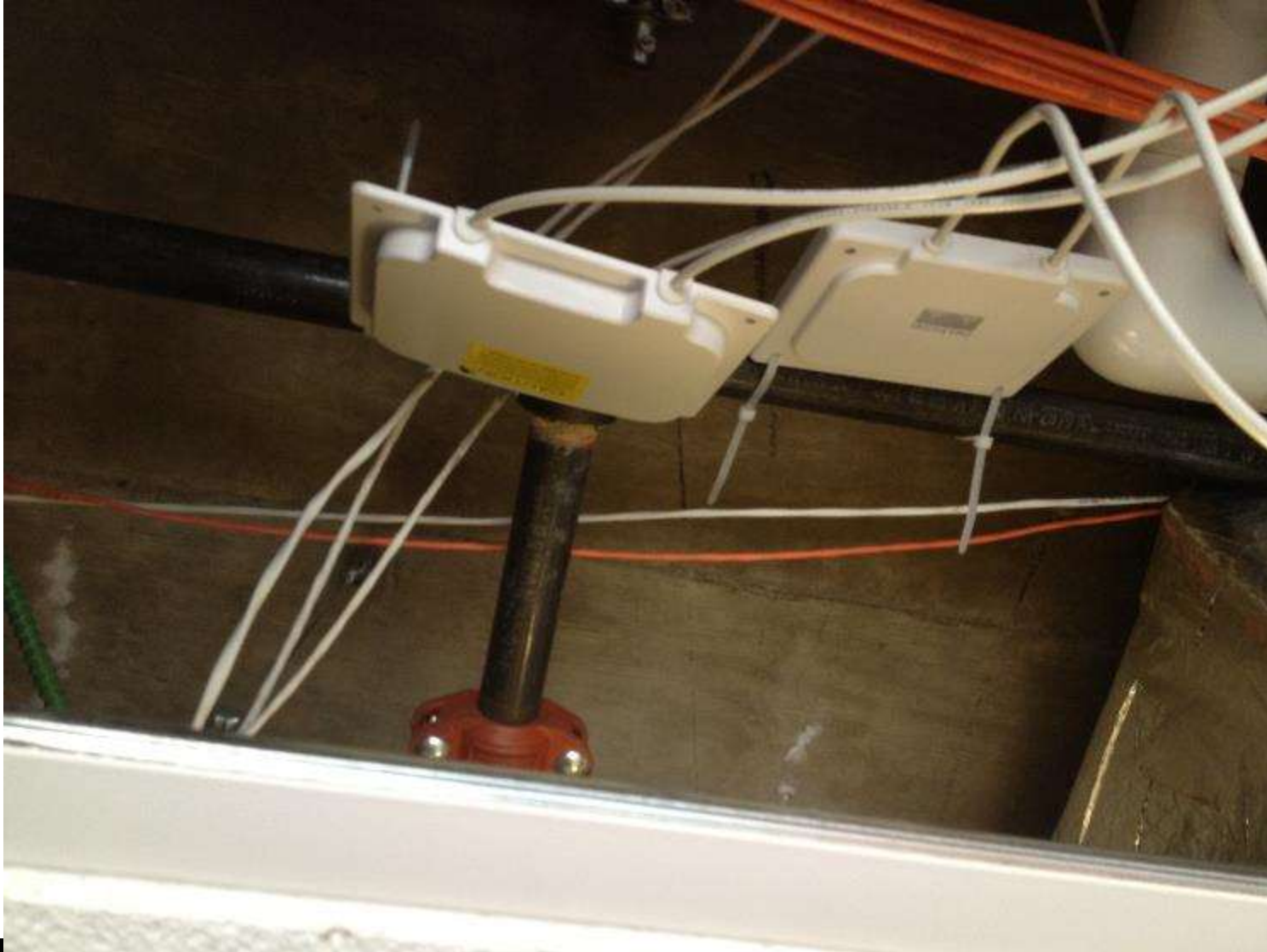


# AP/Antenna Installs Gone Bad (please don't repeat) 😊





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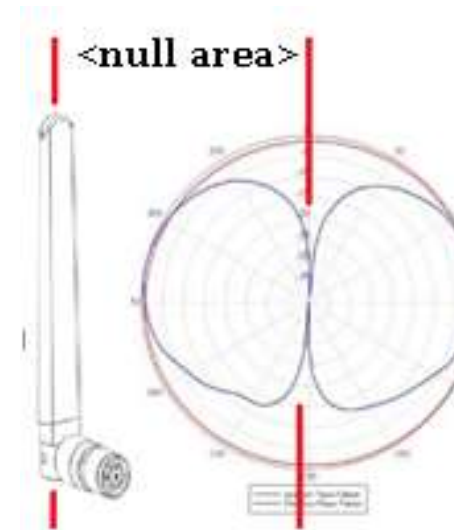
# AP/Antenna Installs Gone Bad (please don't repeat) 😊



## NEVER EVER MIX ANTENNA TYPES

Antennas should always  
cover the same RF cell

Watch dipole orientation



Watch Polarity



**Patch antenna shooting across a metal fence  
Multipath distortion causing severe retries**



**Mount the box horizontal and  
extend the antennas down and not  
right up against the metal  
enclosure**

# Above ceiling installs that went wrong

Yes it Happens and When it Does it is Expensive to Fix and No One is Happy



**Dipole antennas up against a metal box and large metal pipes. This creates unwanted directionality and multipath distortion – This also creates nulls (dead areas) and creates packet retries**

**When a dipole is mounted against a metal object you lose all Omni-directional properties.**

**It is now essentially a directional patch suffering from acute multipath distortion problems.**

**Add to that the metal pipes and it is a wonder it works at all**

**Tip: Access Points like light sources should be in the clear and near the users**

# Above Ceiling Installs that Went Wrong

You Mean it Gets Worse?



# Other Installations that Went Wrong



**Ceiling mount AP mounted on the wall up against metal pipe (poor coverage)**



**Outdoor NEMA box not weatherized (just keeping the packets on ice)**



**RADIO WAVES DO NOT LIKE METAL CAGES**

**Thank You**



# Appendix

# Non-Wi-Fi Infrastructure

- 900 MHz
- Medical telemetry (WMTS)
- Zigbee / 802.15.4
- Bluetooth
- DECT 6.0
- Short range wireless solutions (many)
- Pico and femto-cells
- DAS

# 900 MHz ISM

900 MHz ISM Band  
*902 – 928 MHz*

## Attributes:

- Favorable propagation (not always your friend)
- Slow speeds
- Has a history of being congested
- Most organizations have divested; manufacturers not leveraging

## Common uses:

- Telephone systems (personal and enterprise)
- Point to point data networks
- Low speed, long range data networks
- Temperature monitoring
- Paging systems
- Security systems



# Zigbee / 802.15.4



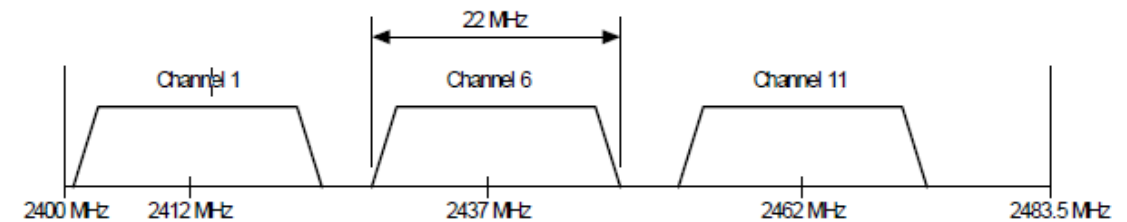
2.4 GHz ISM band  
2400 – 2483.5 MHz

## Attributes:

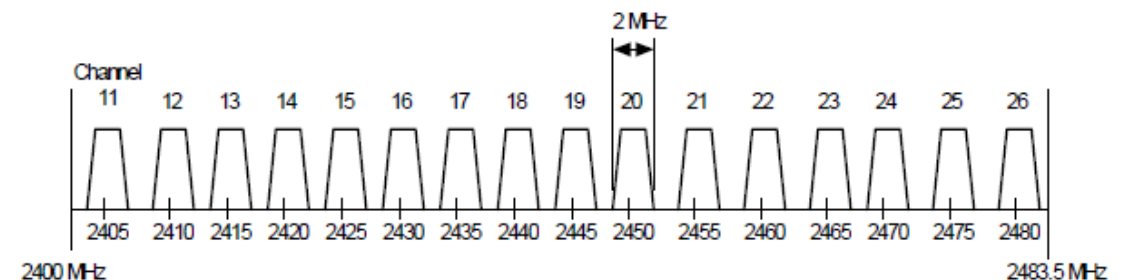
- Some devices configurable for specific channels
- Very low bandwidth
- Low transmit power
- Potential for long battery life

## Common Uses:

- Control systems
- RTLS
- Niche healthcare products



a) IEEE 802.11b North American channel selection (nonoverlapping)



c) IEEE 802.15.4 channel selection (2400 MHz PHY)

# DECT 6.0

Digitally Enhanced Cordless Telecommunications (DECT)  
*1.92 – 1.93 GHz (UPCS band)*



## Attributes:

- Wi-Fi Interference Free
- Scalability is high
- Gaining a great deal of traction
- Specifically designed for voice
- Different frequency of operation in most non-US regions

## Common Uses:

- Enterprise phone systems
- Headsets

# Short Range Wireless



- RFID/RTLS granular positioning – excitors & chokepoints
- Wireless personal area networks (PANs)
  - Wireless USB
  - Wireless HDMI
  - Wi-Fi Direct
  - Infrared
  - Bluetooth
  - IEEE 802.11ad (60 GHz)
  - UWB
- Near field communications (NFC)
- Ultra-sound

# Bluetooth / 802.15.1



2402 – 2480 MHz (entire 2.4 GHz ISM band)

Interferes with 802.11, 802.11b, 802.11g, 802.11n(2.4)

Not all created equal

Most of what we see is Bluetooth Class 2

Bluetooth 2.0 +EDR capable of 3 Mbps data

Bluetooth 3.0 +HS looks to leverage “AMP” to gain speeds up to 24 Mbps. This included only 802.11 in the initial publishing.

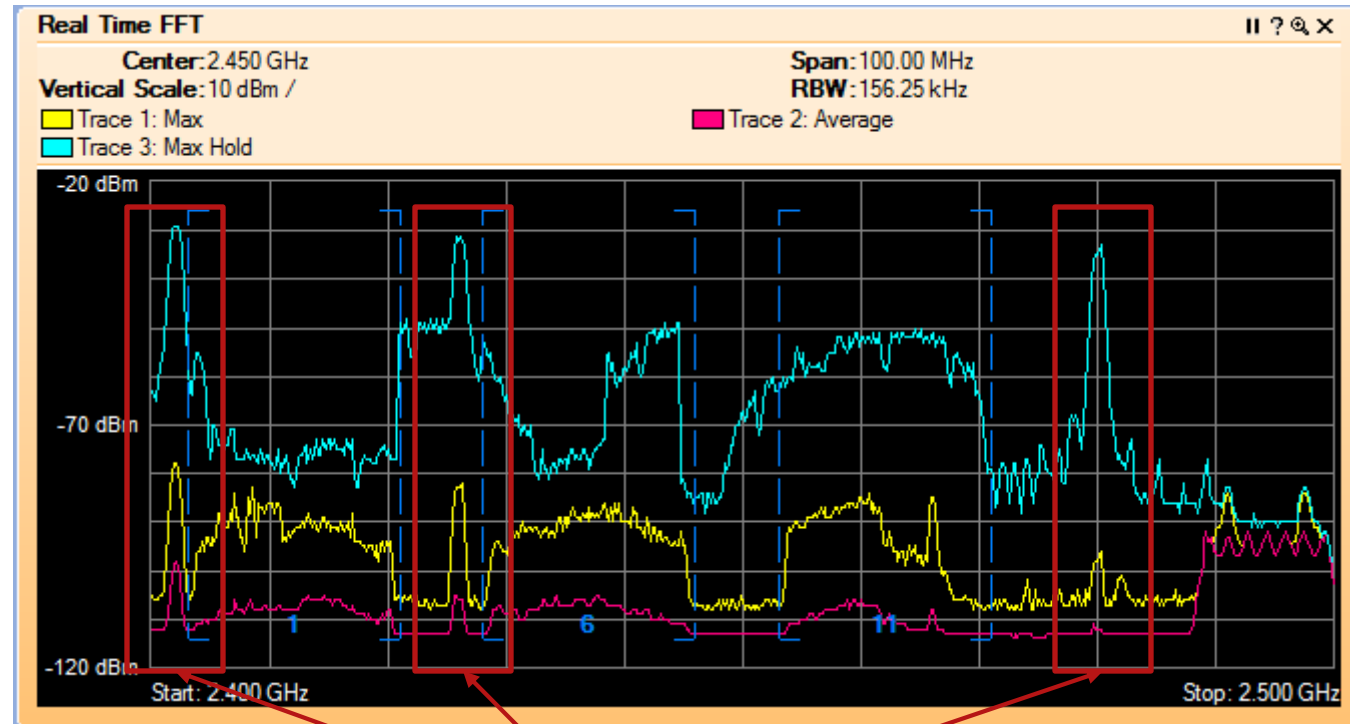
Bluetooth 4.0 (low energy) simple link. Gaining massive popularity.

## Uses:

- Barcode scanners
- Tablet and smart phone accessories
- VoWiFi device accessories
- Indoor wayfinding/RTLS
- ...too many to list

Device Class	Power (mW)
Class 1	100
Class 2	2.5
Class 3	1

# BLE Beacon Frequencies



3 frequencies used for beacon transmissions



# Wi-Fi Alliance 2014 Annual Report

