Simplifying Wi-Fi Troubleshooting

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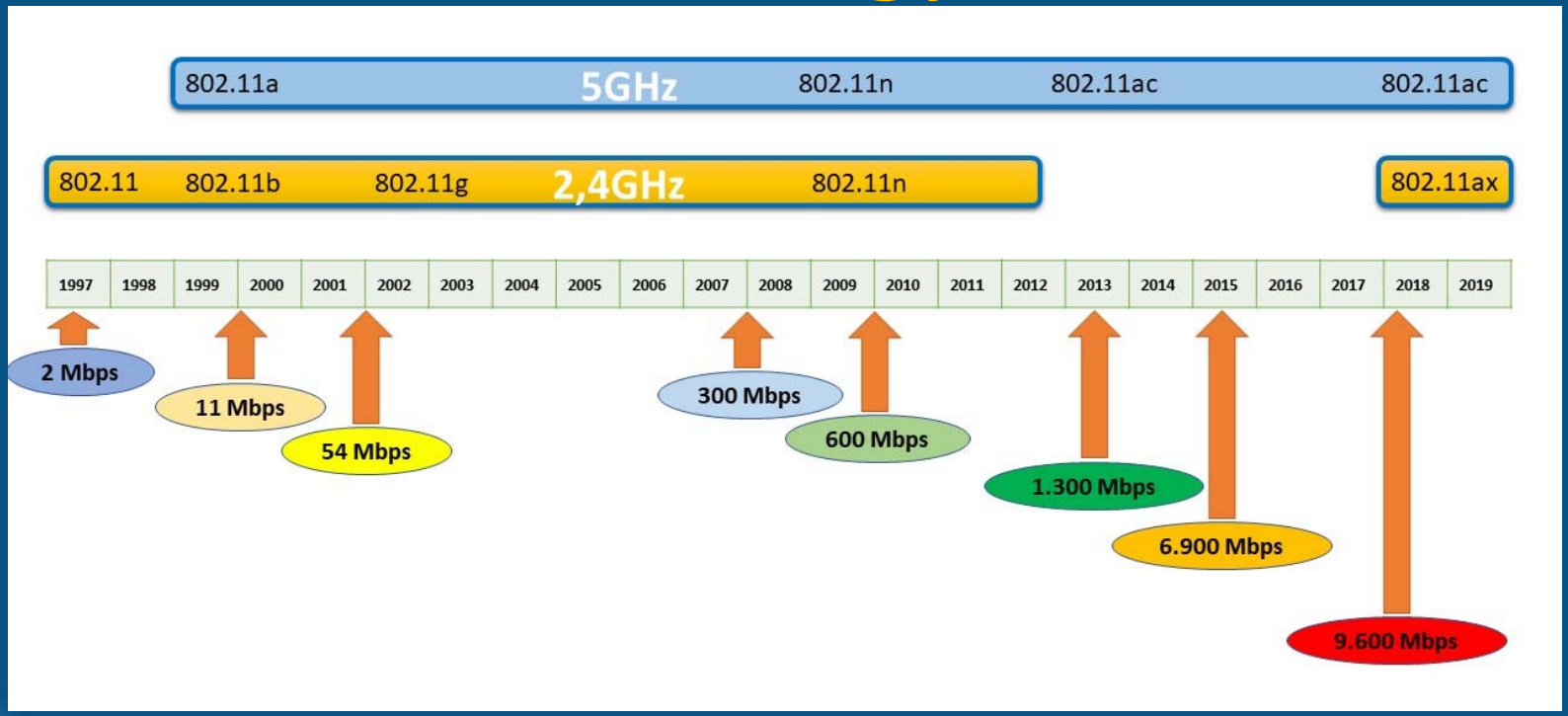
Wi-Fi Technology Evolution



First 21 years was all about speed, now it is **efficiency**

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Wi-Fi Technology Evolution (cont.)

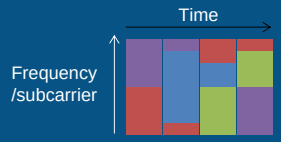
New Name	Standard	Modulation Meth.	Max. data rate	Frequency
	802.11		2 Mbit/s	2,4 GHz
WiFi 1	802.11b	DSSS/HR-DSSS	11 Mbit/s	2,4 GHz
WiFi 2	802.11a	OFDM	54 Mbit/s	5 GHz
WiFi 3	802.11g	OFDM	54 Mbit/s	2,4 GHz
WiFi 4	802.11n	OFDM	600 Mbit/s	2,4 GHz & 5 GHz
WiFi 5	802.11ac	OFDM	6.900 Mbit/s	5 GHz
WiFi 6	802.11ax	OFDM & OFDMA	9.600 Mbit/s	2,4GHz & 5 GHz

802.11ac versus 802.11ax

	11ac (Wi-Fi 5)	11ax (Wi-Fi 6)
Frequency Band	5 GHz	2,4 & 5GHz
Channel Wide	20,40, 80, 160 MHz	20,40, 80, 160 MHz
Spatial Streams Max	8	8
MIMO Use Mode	Multi-user	MU-MIMO und OFDMA
Modulation	+ 256 QAM	1024 QAM
Sub-Carrier	312,5 KHz	78,125KHz
Beam forming	optional, standardised	optional, standardised
PHY Data Rate (Max)	6.933 Mbps	Bis 9.607 Mbps
Automatic Power Save	Same like 11.a/b/g/n	Target Wakeup Time (TWT)

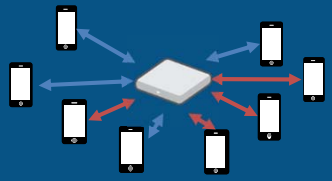
802.11ax
= High Efficiency (HE)

Wifi6 (802.11ax) – What's New?



OFDMA

✓ Network Capacity

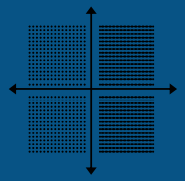


MU-MIMO

✓ Network Capacity

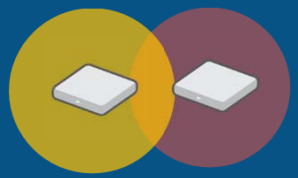
Effective. Power use (TWT)

✓ Battery Live



1024-QAM

✓ Max. data rate



BSS Colouring

✓ Network Capacity

✓ Adjacent Wi-Fi

Long OFDM Symbol

✓ Outdoor Reliability

✓ Max. data rate

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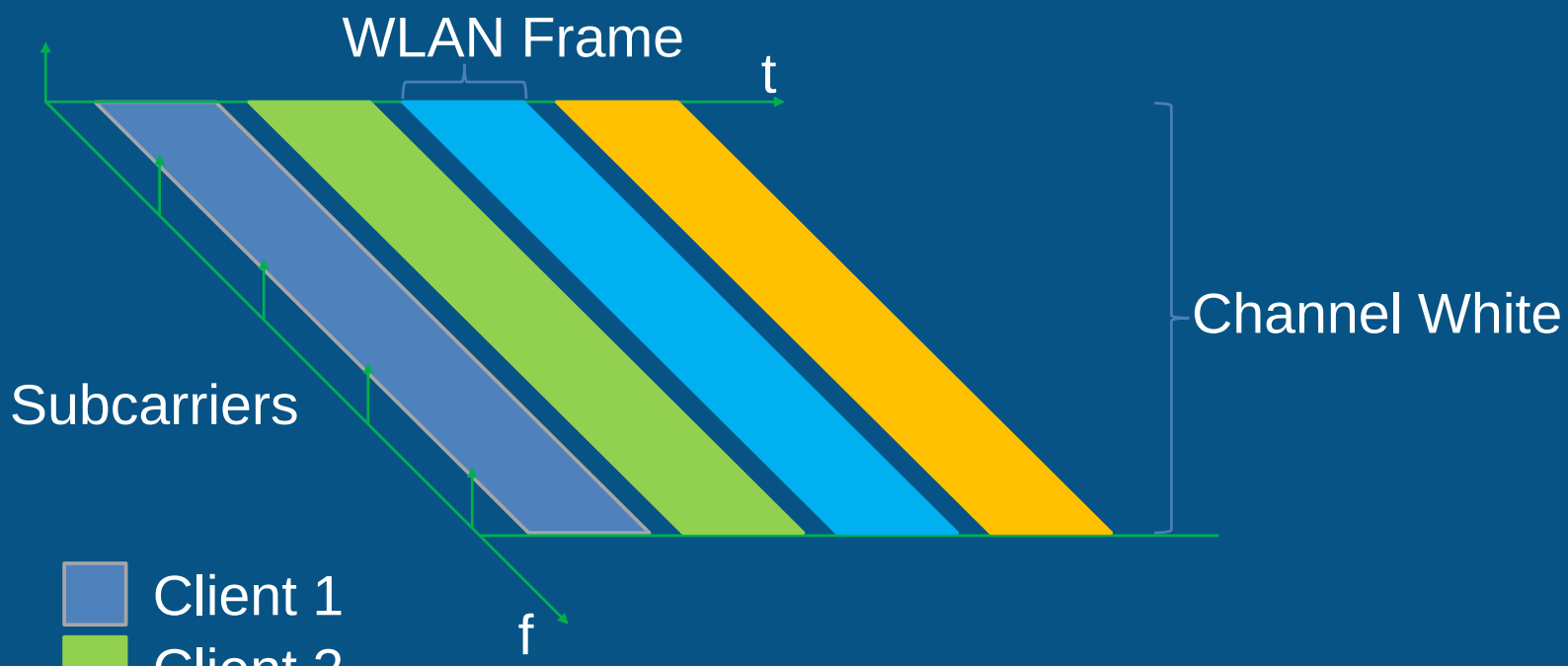
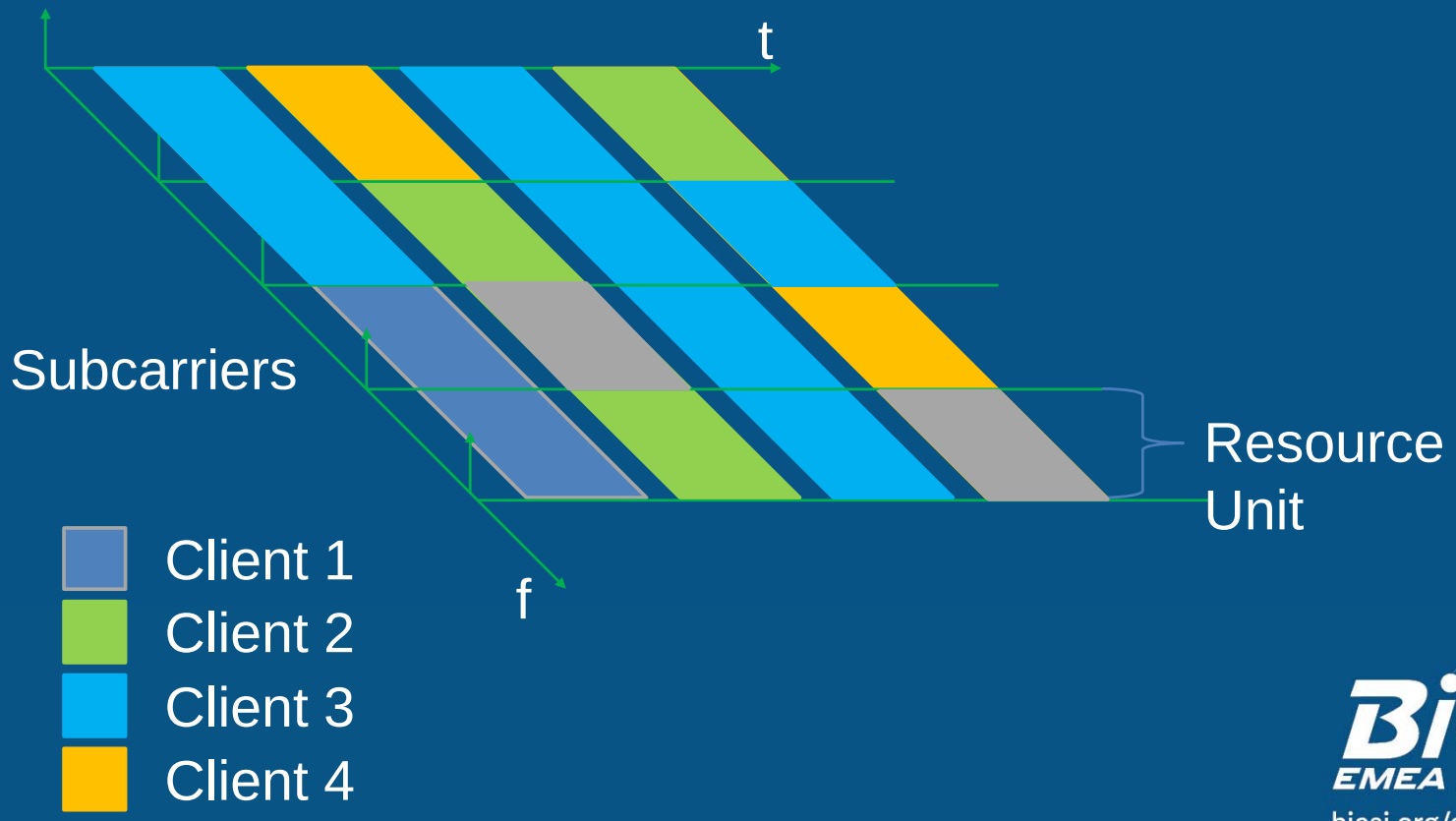
Multi-User OFDM



Multi-User OFDMA



Simplifying Wi-Fi Troubleshooting

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WLAN Troubleshooting starts with…

- What's the problem?
- What are the requirements for this specific WLAN situation?
  - Location
  - Application
  - Number of Users
  - Signal quality
- What is different to 'normal'?

What's Different to 'Normal', Starts With Planning

- WLAN requirements
- Planning
  - Pre-Deployment Survey, cabling for AP's, floorplan with AP-location etc.
- AP deployment
- Post-deployment Survey

***** Critical *****

It's possible to certify the cabling, but not Wi-Fi. But you can validate the Wi-Fi deployment

Wi-Fi Troubleshooting Starts Simply - Walkthrough?

Wi-Fi Walkthrough's are used to:

- Perform a passive scan
- Detect and identify all Wi-Fi devices
- Verify coverage
- Gain visibility on metrics like Noise, SNR, Utilization, etc.

PROBLEM: Signal Quality

We start with the big picture and move to the easier things!

Signal Coverage

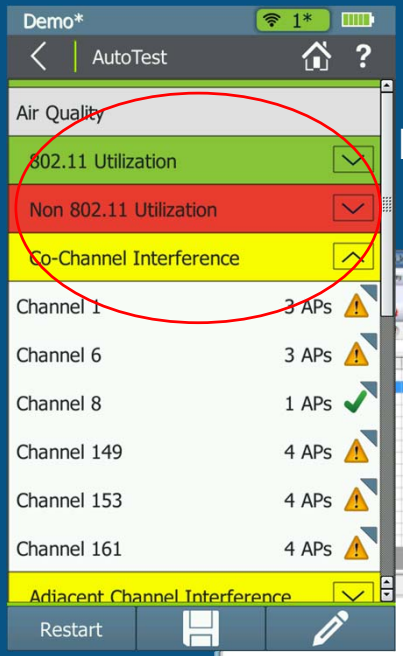
Identifying Coverage Problems:

- Troubleshoot a problem area
- Survey a site
- Find the difference to ‘normal’

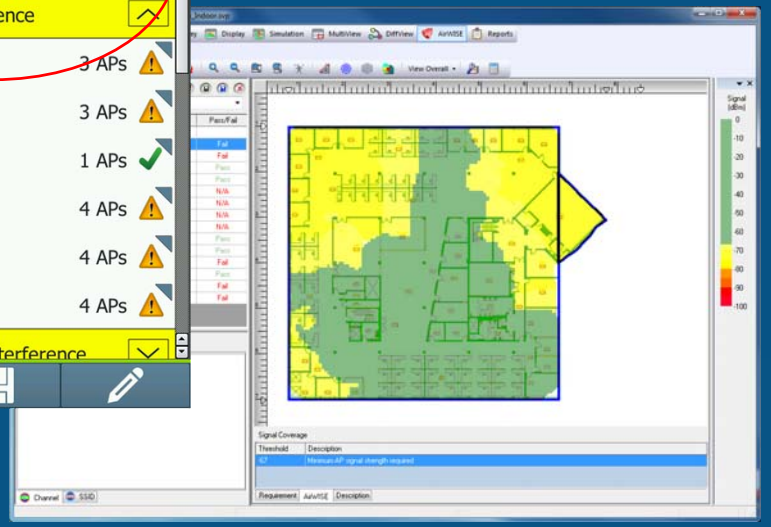
Site Survey for troubleshooting could be simple!

Site Survey for Troubleshooting Could be Simple!

Missing Coverage area

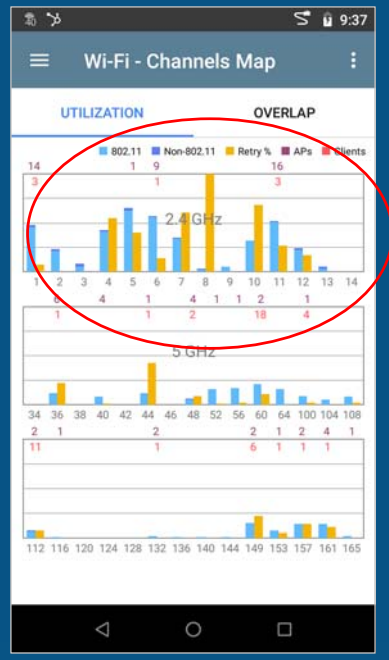


Interference



Pass/Fail results

Channel 1/6/11??



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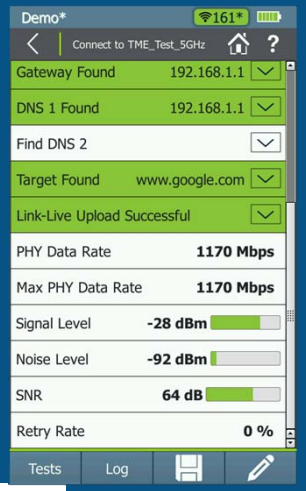
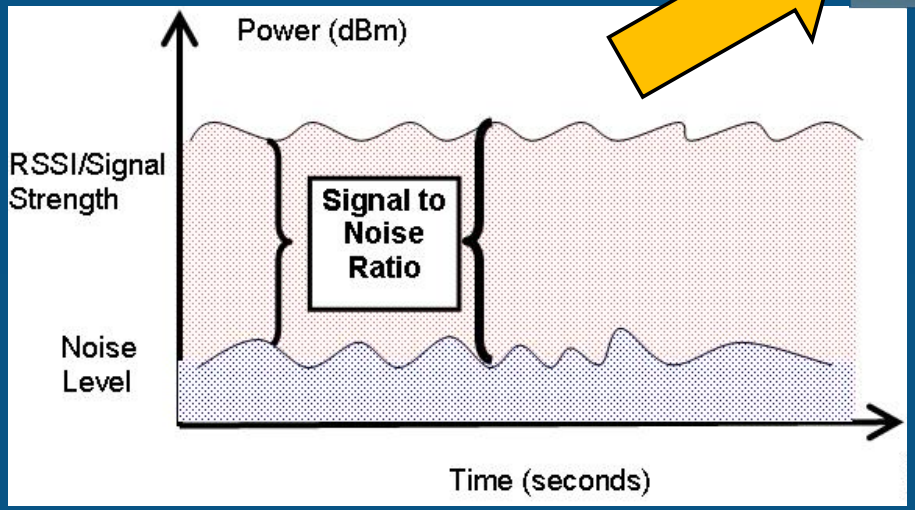
Signal to Noise Ratio

Signal to Noise Ratio can be affected by:

- Signal Strength
- Noise Levels
- Easy to discover





Signal to Noise Ratio (Cont.)

Identifying Signal to Noise Ratio problems:

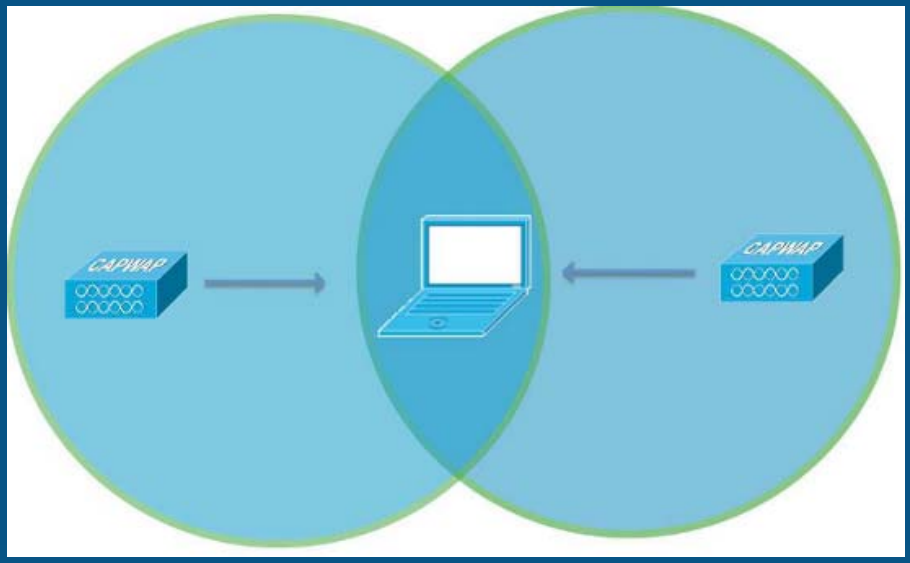
- Use a dedicated Wi-Fi test tool that will allow you to measure Signal Strength and Noise

Note: Not many Wi-Fi adapters can measure Noise anymore

Co-Channel Interference

Why is it a problem?

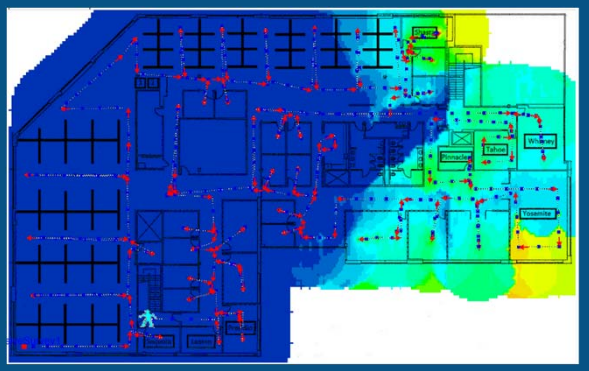
- Clients and AP's have to time-share
  - Wi-Fi is Half-Duplex

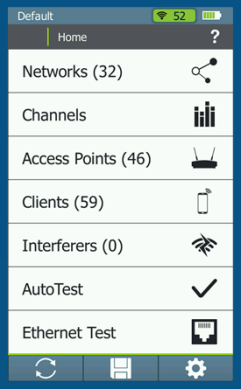


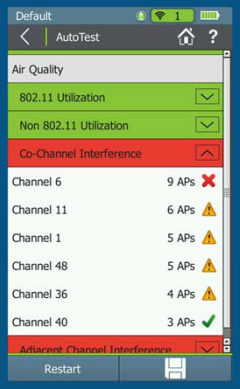
Co-Channel Interference (Cont.)

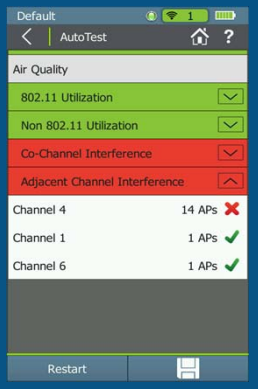
Identifying CCI Issues:

- Use a Wi-Fi test tool that will determine the number of AP's per channel, and their signal strength
- Perform a site survey









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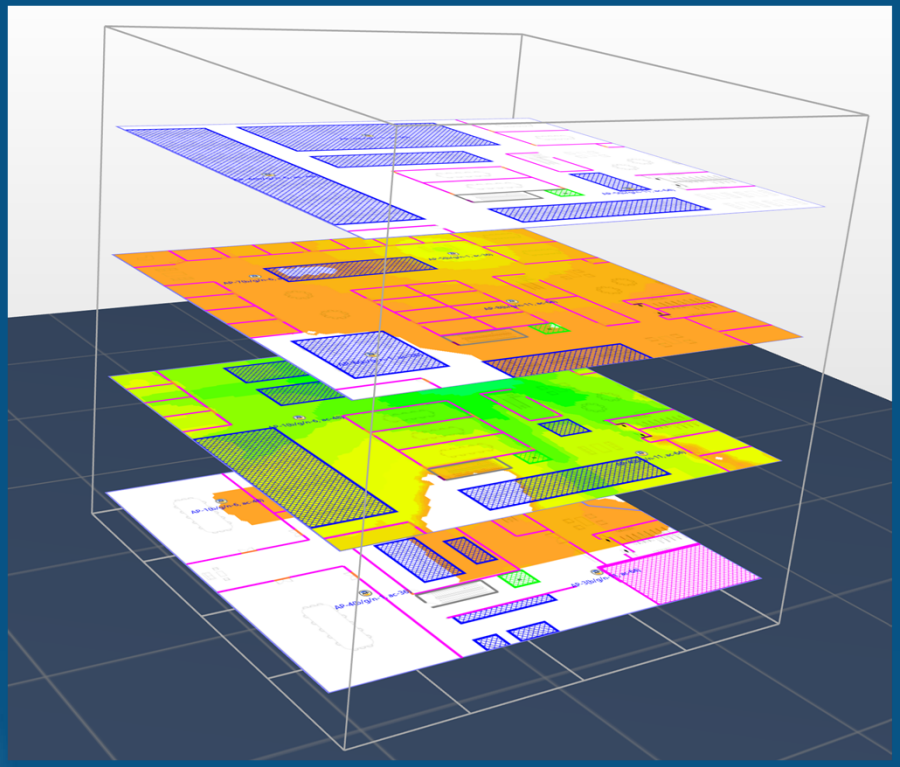
Co-Channel Interference (Cont.)



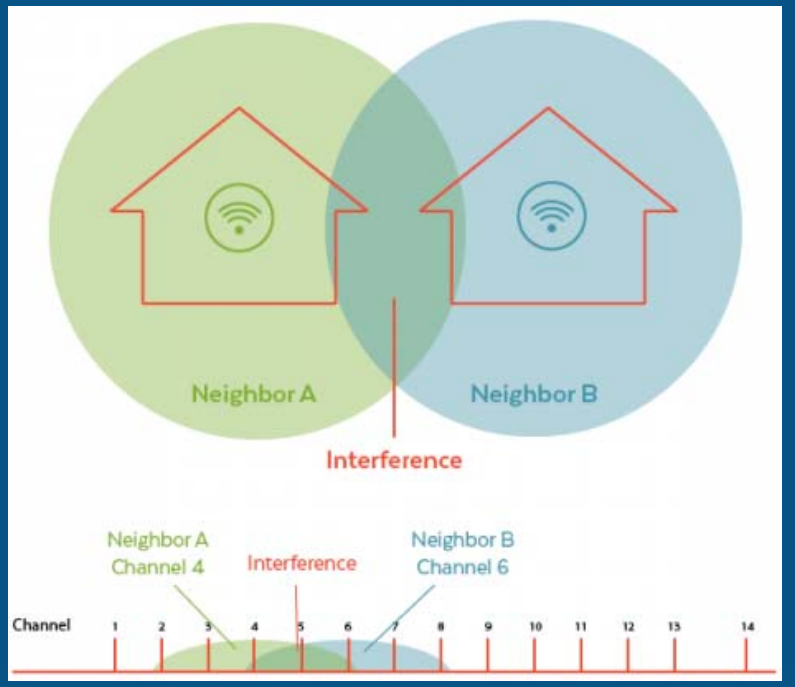
Resolving CCI Issues:

- Allow the controller to assign channels automatically
- Use a planning tool
  - Depending on the building, CCI is 3D!

Adjacent Channel Interference

Why is it a problem?

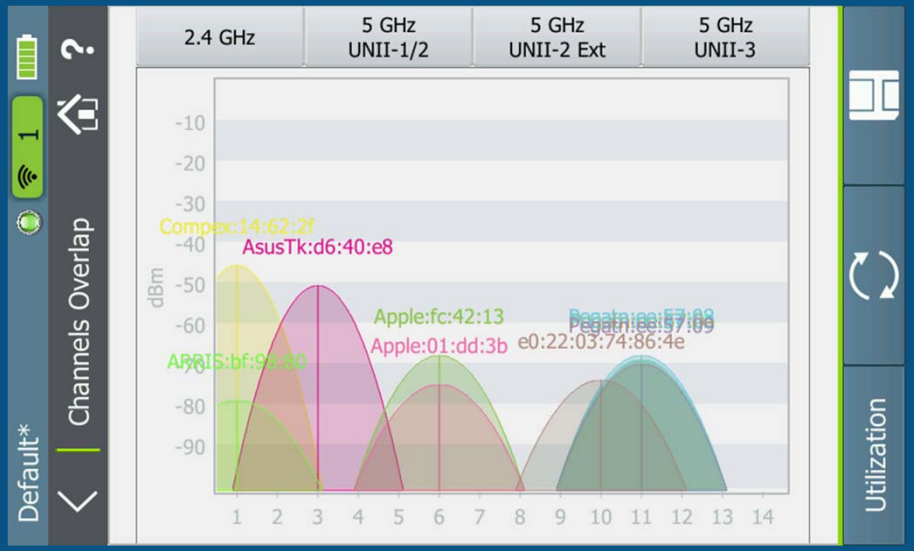
- Interference between channels
  - Clients and AP's have to time-share
  - Mostly happens on the 2.4 GHz



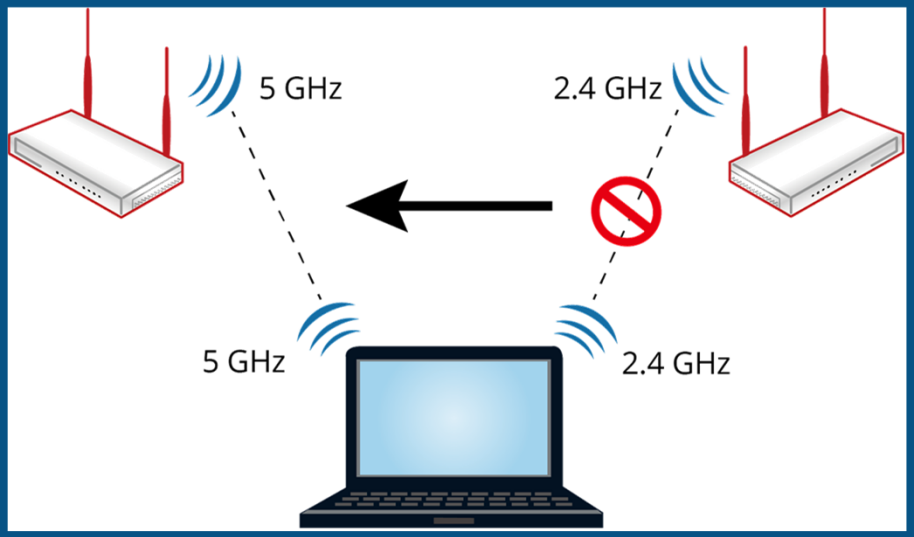
Adjacent Channel Interference (Cont.)

Identifying ACI Issues:

- Use a Wi-Fi test tool that will determine number of AP's per overlapping channel, and their Signal Strength
- Perform a site survey



Adjacent Channel Interference (Cont.)



Resolving ACI Issues:

- Enable Band Steering
- Allow the Controller to Assign Channels Automatically
- Use a Planning tool

Non-Wi-Fi Interference

Why is it a problem?

- Don’t obey the same airtime sharing rules
- Significant source of interference
- Critical for 2,4GHz
  Check DFS (Radar-Detection) for 5GHz

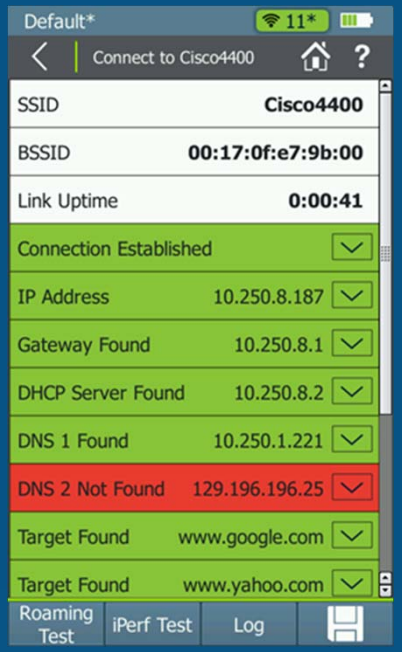
Non-WiFi Interference ▾ View By

Name	Peak Power dBm	Avg Power dBm	Last Seen Channel	Affected Channels	Center Frequency GHz	Duty Cycle
Type: Bluetooth (1)						
Bluetooth (Id 2)	-73	-76	13	1..14	2.474	0.00
Type: Digital Cordless Phone (1)						
FHSS Cordless Phone (Id 3)	-68	-72	6	1..8	2.438	0.00
Type: Possible Interferer (1)						
Possible Interferer (Id 1)	-79	-79	9	2..11	2.451	80.19

PROBLEM: WLAN Connection

The most common problem

Duplicate the Problem: Dedicated Test Tool



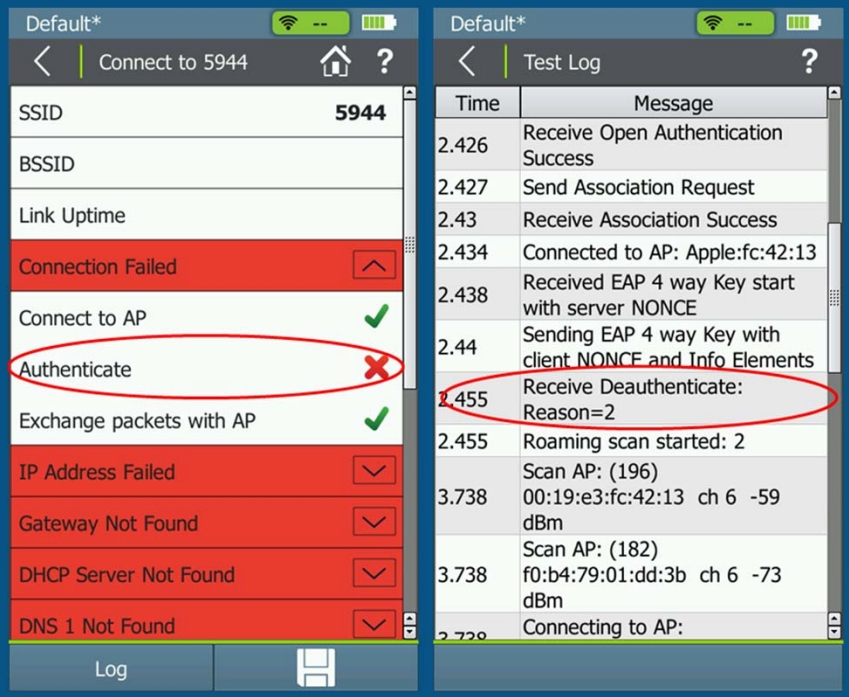
Useful Information:

- Connection Status and Time
- Authentication Status and Time
- Gateway Status and Response Time
- DHCP Status and Response Time
- DNS Status and Response Time
- Target Found
- Connection PHY Data Rate
- Retry Rate

Security (Cont.)

Identifying Security Configuration Problems:

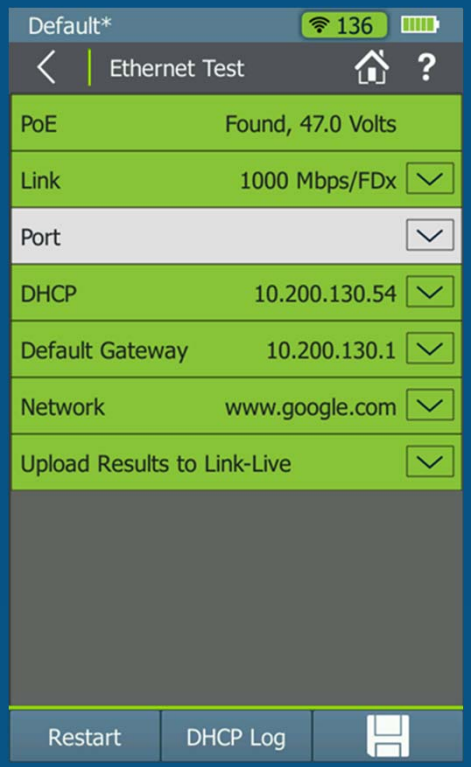
- Problem User Device
  - Passphrase
  - Credentials and Certificates
  - Device is on the Authorized List
- Dedicated Wi-Fi Test Tool
  - Authentication Server availability



PROBLEM: WLAN not available
Access Point is working?

The non-Wi-Fi problem

Wired Issues



Identifying Wired Issues:

- Perform a Connection Test
- Verify connectivity to a specific IP address or URL
- Verify PoE and Switch Power Load

Wired Issues (Cont.)

Resolving Wired Issues:

- Configuration and availability of the DHCP or DNS server
- Configuration of your Ethernet switch and VLAN's
- PoE configuration
- Physical condition of the Ethernet cables
- Ethernet cable length (328 ft or 100 m)
- Switch power load

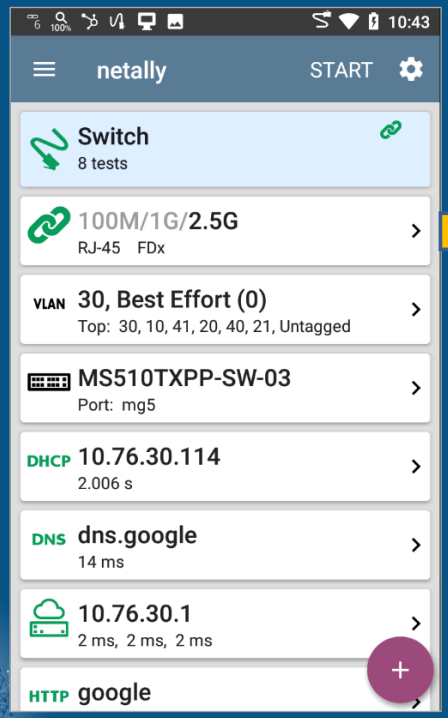
Uncertainty Grows with Multi-Gig Deployments

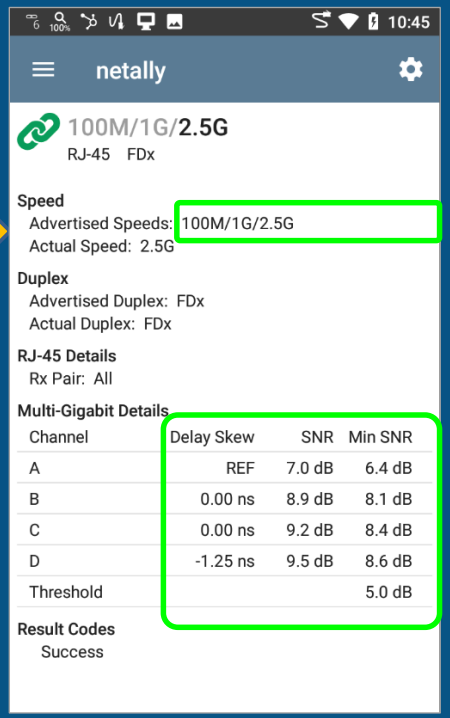
- **What is Multi-Gig?**
  - Switch ports delivering >1Gbps link speed
  - 1 / 2.5 / 5 / 10 Gbps
  - Driver: need to deliver >1 Gbps to APs, certain IoT devices, etc.
  - "new bandwidth over old media"

- **What's the problem?**
  - Not all cable plants will support it.
  - Requires Cat5e minimum
  - Excess noise (insufficient SNR) results in "downshifting" to lower speed.
  - Difficult to troubleshoot

"The quality, length, and install workmanship is also a major factor when it comes to multigigabit. When you begin pushing the copper to run at faster speeds, flaws in the cable plant become more easily exposed."

Cable SNR Test for Multi-Gig Media Assurance





- From AutoTest, drill in on Link
- Shows Link metrics
- Verify configurations
- Measures Multi-Gig parameters
  - Delay Skew
  - SNR

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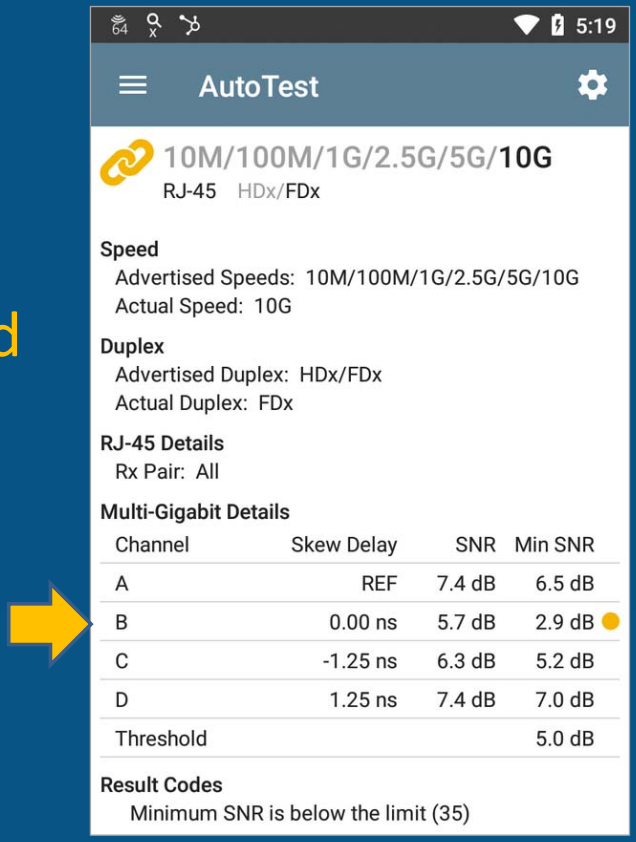
Cable SNR Test for Multi-Gig Media Assurance

- Example “bad” result
- “Channel B” (pair) < threshold



PROBLEM: WLAN Security

The most forgotten problem?

Locate Unauthorized Devices

How it works:

- Focus scan on desired device
- Measure Signal Strength
- Walk toward the stronger signal
- Until the signal won't increase

Note: Using an External Directional Antenna could make the location process easier

Identify the Root Cause

Common Reasons for Wi-Fi Connection Problems:

- Signal Coverage
- Signal to Noise Ratio (SNR)
- Legacy 802.11 Devices
- Security
- Capacity
- Wired Issues

PROBLEM: AP Not Working

Testing the cabling and PoE

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PoE for Wi-Fi 6 – The New Challenge

IEEE Standard	Input Power (Watt)	Output Power (Watt)	EA Class	Powered Device Type	# of pairs
802.3 af (PoE)	12,95	15,4	0	1	2
	3,84	4	1	1	2
	6,49	7	2	1	2
	12,95	15,4	3	1	2
802.3 at (PoE+)	25,5	30	4	2	2
802.3 bt (PoE++, 4-pair PoE, 4PPoE, UPOE)	40	45	5	3	4
	51	60	6	3	4
802.3 bt (higher-power PoE)	62	75	7	4	4
	73	90	8	4	4

PoE Consumer (Power Device)

Ruckus R850

POWER CONSUMPTION

Mode	Power Consumption	System Configuration	Wi-Fi Radios
DC Power, PoH, uPoE (Idle)	16.1W	• 5Gbps Ethernet Enabled • 1Gbps Ethernet Enabled • USB Enabled (3W) • Zigbee/BLE Enabled (0.5W)	2.4GHz (4x4) Enabled 5GHz (8x8) Enabled *(No Clients Associated)*
DC Power, PoH, uPoE (Max)	31.0W	• 5Gbps Ethernet Enabled • 1Gbps Ethernet Enabled • USB Enabled (3W) • Zigbee/BLE Enabled (0.5W)	2.4GHz (4x4) Tx 20 dBm 5GHz (8x8) Tx 22 dBm

Cisco Catalyst 9130

- 802.3at Power over Ethernet Plus (PoE+), Cisco Universal PoE (Cisco UPOE®)
- Cisco power injector, AIR-PWRINJ6=
- 802.3af PoE
- Cisco power injector, AIR-PWRINJ5= (Note: This injector supports only 802.3af)

Catalyst 9130AXI

PoE power consumption	2.4-GHz radio	5-GHz radio	Link speed	USB	Link Layer Discovery Protocol (LLDP)
802.3at (PoE+)	4x4	8x8	5G	N	25.5W
802.3at (PoE+)	4x4	4x4	5G	Y **[4.5W]**	25.5W
802.3bt (Cisco UPOE)	4x4	8x8	5G	Y **[4.5W]**	**30.5W**

PoE Switch (Power Source Equipment)

Ruckus ICX7150-48ZP

ICX7150-48PF-4X10GR-A	Ruckus ICX 7150 Switch, 48×10/100/1000 Mbps PoE+ ports, 2×1 GbE RJ45 uplink-ports, 4×10 GbE SFP+ stacking/uplink-ports, 740 W PoE budget, Layer 3 features (OSPF, VRRP, PIM, PBR), TAA-compliant.
ICX7150-48ZP-E8X10GR2-A	Ruckus ICX 7150 Z-Series switch, 16×100/1000 Mbps/2.5 Gbps PoH ports, 32x10/100/1000 PoE+ ports, 8×10 GbE SFP+ stacking/uplink-ports (max 4 for stacking), 2x920 W AC power supply, 2 fans, 1480 W PoE budget, L3 features (OSPF, VRRP, PIM, PBR). TAA compliant.

Ruckus R850
48 x 31,00W = 1488W
Cisco Catalyst 9130AXE
48 x 30,50W = 1464W

Would you use a switch on almost 100% PoE output?

Monitoring & Troubleshooting

- WLAN Management systems
  - Most WLAN AP vendors can provide ‘system’ health and alerting, (e.g. ‘red light/errors), but not a complete view or detailed understanding
- Troubleshooting needs a more flexible view
  - From the client level (not just the AP level)
- Most monitoring systems just give a ‘snap-shot’ or quick view of the RF/Wi-Fi environment
  - Not an independent analysis
- WiFi Troubleshooting needs Wi-Fi tools
  - Not ‘free-apps, packet analysis or wired based tools. Only vendor-neutral purpose-built dedicated tools can fulfil these detailed requirements

WLAN Troubleshooting Can Be Simple…

- Try to identify the root-cause of the problem as opposed to the symptom
  - User, Device, Airtime, Network (DHCP, DNS, Proxy), Server, Application, Internet, Network Performance
- Use the RIGHT tool for the RIGHT job for the users' RIGHT level of knowledge
- For a fast start for WLAN troubleshooting:
  - Ask for WLAN and RF basics training, because any good tool for network troubleshooting should be easy to use

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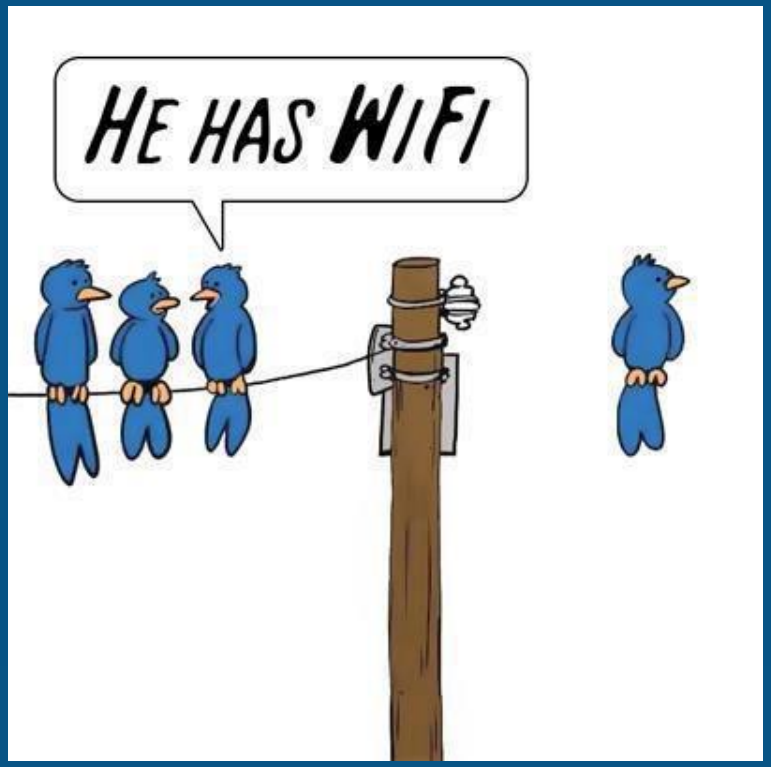

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