

Troubleshooting Wi-Fi / WLAN Networks

Presentation to Oklahoma Broadband Association – August 2024

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Some initial points....

- Troubleshooting Wi-Fi network issues can be methodical and straightforward if you follow a rigorous process to assessing and researching the problem
- Troubleshooting WLAN Networks is <u>Not Easy</u>
- Troubleshooting WLAN's is First: Evidence Gathering



Unlike the picture, gathering digital evidence on WLAN's is dealing with things we can't see. Wireless signals are invisible. Connections come and go. Witnesses are difficult to find and sometimes understand. There is rarely a "smoking gun".

So you must be rigorous in gathering evidence – facts – and then assembling this information into a meaningful possible cause.

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- "Your network is slow?"
- "Can you unplug and restart the router?" or
- "Can you unplug and restart the AP/modem?" or
- "Can you reboot the computer?"
- These are not "fixes".
- These are not troubleshooting.
- These practices may temporarily mask actual problems.





Troubleshooting WLAN Networks is Not Easy

- Follow a process one that makes sense to you
- Always consider the Layered Model when initially thinking about the problem
- Before diving into WLAN issues:
 - Is the problem on the wired LAN or the Wireless LAN?
 - Is the problem client side or Access Point side?
 - Is the problem a WLAN issue meaning Layer 2 and down?
 - If the problem is Layer 3 and up, may be better off troubleshooting using packet capture without Monitor Mode
 - Do not want to confuse WLAN retries and TCF re-transmissions
 - We may need decrypted traffic to do troubleshooting of user sessions

OSI 7- Layer Model	Possible Problem Areas
Layer 7 - Application	DNS Radius Active Directory
Layer 6 - Presentation	DHCP, NTP, User Applications
Layer 5 - Session	[tools: ping, <u>ipert</u> , ixia]
Layer 4 - Transport	UDP or TCP ports, Firewalls, Proxy Server
Layer 3 - Network	IPv4 or IPv6 Addressing, Routing
Layer 2 – Datalink	PSK, 802.1X, Roaming, VLAN, Encryption, Density
Layer 1 – Physical	RF Issues, Power, Configuration, Drivers

Anything above Layer 2 is not actually a WLAN issue



Keep the end goal in mind...

- What is the root cause of the issue?
- We don't want to just fix the issue...
- You have to be able to justify why a corrective action was the ultimate cure





□ Identify and define the problem Checking Physical Connections Check the Wi-Fi Physical Layer Integrity □ Check Interference Types/Levels □ Check Wi-Fi Network Settings □ Update any Firmware/Drivers Check General Network Configuration Check for Network Overloading □ Analyze Packet Data □ Factory Reset / Reboot □ Test and Verify the problem is corrected,



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Further Defining the Problem – 1st Step

- Parse the problem statement/reported
 problem
- Define all terms used
- Expand and Explain
- Ensure the problem statement includes as many answers as possible to:
 - What?
 - When?
 - Where?
 - How?
 - Who?
 - How much? How Many?
 - Which?

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 "When people on my network stream Netflix, my latency while gaming goes to a constant 500+ms, making any online game completely unplayable."

Further Defining the Problem

- □ Search for Possible Symptoms:
 - Slow speeds, intermittent connectivity, or no connection
- □ Identify Devices Affected:
 - Check if the issue is with one device or multiple devices
- □ Verify Service Status:
 - □ Check for outages or service issues
- □ Prior Support:
 - □ What steps have already been taken?

- □ Further Questions:
 - □ When does the problem occur?
 - Does the problem impact a single device/station or all stations?
 - How often does this problem occur? Is it constant?
 - □ Is the problem reproduceable? If so, how?
 - Did the problem emerge from recent changes?
 - Has this problem occurred previously? Is it new?
 - □ Did the problem change?
- □ Other questions.....

Hint for Success:

• Take a team effort to this first challenge to properly define the problem



CSR – Customer Service Representative



FSR – Field Service Representative



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Check the Physical Connections

- □ Router/Modem:
 - Ensure the router and modem are plugged in and powered on
 - □ Is the power cable loose on either end?
- Cables:
 - Verify all Ethernet cables are securely connected
 - Do they fall out? Are they clicked in place?
- □ Antennas:
 - Are the antennas securely connected? Broken? Loose?
- Any other devices such as a switch connected? Are their connections good?



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- Evaluate Location: Ensure you are within range of the router
- Evaluate Obstructions: Consider any obstacles that might block the signal (walls, furniture)
- Evaluate possible sources of Interference: determine what frequencies are being used, what channels are being used

- Notes:
 - Checking Wi-Fi signal integrity involves using various tools and methods to measure how well the Wi-Fi signal is being transmitted/received by devices
 - The Personal Computer/Laptop is one of the best tools for the job



Mandatory – on every truck roll - A Quick Wi-Fi Scan/Survey

- Pick a GUI tool that you like
- Use your vendors' web interface/management tool
- Use the command line/terminal
- Get an understanding of the environment and the AP/STA players

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II Wi-Fi	11 3 31 00:0 Radios Scan Frames Leng	0 th													Complete	()	م :
BSSID	Network Name		RSSI	~	Beacon	Min Rate	Max Rate	Band	СН	Width	802.11	сс	Gen	AP Uptime	Security	Se	en
58:2F:F7:73:48:36	CellStream Inc.	-53 dBm			102.4 ms	7.2 Mbps	216.7 Mbps	2.4 GHz		20 MHz			4	25d 03:52:39	WPA2 Personal	n	ow.
A0:63:91:B6:E3:46	BEAM	-54 dBm			102.4 ms	7.2 Mbps	216.7 Mbps	2.4 GHz	8	20 MHz	ac			25d 01:21:52	WPA2 Personal	n	ow.
1E:2F:F7:73:48:33	Spectrum Mobile	-63 dBm			102.4 ms	32.5 Mbps	1733.2 Mbps	5 GHz	44	80 MHz	ac	US		10d 03:59:27	WPA2 Enterprise	n	ow.
58:2F:F7:73:48:37	CellStream Inc.	-65 dBm			102.4 ms	32.5 Mbps	1733.2 Mbps	5 GHz	44	80 MHz	ac	US		10d 03:59:27	WPA2 Personal	n	w
A0:63:91:B6:E3:48	BEAM-5G	-76 dBm			102.4 ms	32.5 Mbps	1733.2 Mbps	5 GHz	153	80 MHz	ac	US		25d 01:23:40	WPA2 Personal	nc	bw
74:C6:3B:21:9C:6A	WM219c6a 0	🛇 -83 dBm			204.8 ms	1 Mbps	54 Mbps	2.4 GHz		20 MHz	g			25d 03:53:03	Open	n	ow
D6:40:D0:40:BB:AA	<-HIDDEN->	-84 dBm			204.8 ms	15 Mbps	300 Mbps	2.4 GHz		40 MHz	ac			25d 03:50:30	WPA2 Personal	n	W
CE:9E:43:69:43:84	TsugaNetG	-85 dBm			102.4 ms	17.2 Mbps	573.5 Mbps	2.4 GHz	8	40 MHz	ax	US	6	25d 03:50:39	WPA2 Personal	n	ow.
C8:9E:43:69:41:AC	<-HIDDEN->	-90 dBm			102.4 ms	17.2 Mbps	573.5 Mbps	2.4 GHz	8	40 MHz	ax	US	6	25d 03:50:40	WPA2 Personal	n	ow
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		10 11 12	Z	26		40				140		152		157	161	165	



Built-In Operating System Tools

On Windows Systems

• In a CMD window: netsh wlan show networks mode=bssid

```
Microsoft Windows [Version 10.0.14393]
(c) 2016 Microsoft Corporation. All rights reserved.
C:\Users\Andrew>netsh wlan show networks mode=bssid
Interface name : Wi-Fi
There are 7 networks currently visible.
SSID 1 : ATT9c9R495
                            : Infrastructure
   Network type
                            : WPA2-Personal
    Authentication
   Encryption
                            : CCMP
   BSSID 1
                            : b0:77:ac:ca:df:d0
        Signal
                            : 99%
                            : 802.11n
        Radio type
        Channel
                            : 1
        Basic rates (Mbps) : 6.5 16 19.5 117
        Other rates (Mbps) : 18 19.5 24 36 39 48 54 156
SSID 2 : A Rose in the city
    Network type
                            : Infrastructure
   Authentication
                            : WPA2-Personal
   Encryption
                            : CCMP
   BSSID 1
                            : dc:7f:a4:1b:18:86
        Signal
                            : 65%
        Radio type
                            : 802.11n
        Channel
                            : 9
        Basic rates (Mbps) : 6.5 16 19.5 117
         Other rates (Mbps) : 18 19.5 24 36 39 48 54 156
SSID 3 : ATTNzZju8s
   Network type
                            : Infrastructure
   Authentication
                            : WPA2-Personal
   Encryption
                            : CCMP
   BSSID 1
                            : 64:55:b1:5f:d5:90
        Signal
                            : 93%
         Radio type
                            : 802.11n
         Channel
                            : 1
         Basic rates (Mbps) : 6.5 16 19.5 117
                            : 18 19.5 24 36 39 48 54 156
```

On Mac Systems

 Wi-Fi Menu: Hold down the Option key and click on the Wi-Fi icon in the menu bar to see detailed information including RSSI (Received Signal Strength Indicator) and noise

On Linux Systems

 Use the nmcli dev wifi command in the terminal to see a list of available networks with their signal strengths.



Interpreting Signal Strength

- RSSI (Received Signal Strength Indicator): Measured in dBm
- Higher negative values indicate weaker signals
 - -30 dBm: Excellent
 - -50 dBm: Very good
 - -60 dBm: Good
 - -70 dBm: Fair
 - -80 dBm: Poor
 - -90 dBm: Very poor



Distance and Speed in WLAN's





Consider the Problem of Asymmetric Tx Power



- Asymmetric power occurs because all WLAN communications is two-way
 - AP's can usually transmit further than clients
 - So client sees the AP, but the AP cannot see the client
- Therefore we need to ask about device types, distances

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Test and Verify the problem is corrected, document



Is there Interference? Let's Define Interference Types!



Non Wi-Fi Noise

• These are non Wi-Fi devices emitting radio communications noise or competing for spectrum



Co-Channel

 Where every Wi-Fi device (AP's and Clients) compete for time to talk on the same channel



Adjacent Channel

 Where the Wi-Fi devices (AP's and Clients) are talking on overlapping channels, talking over each other



Necessary Tools: Wi-Fi Scanners vs. Spectrum Analyzers

- Spectrum Analyzers listen to all frequencies in a particular range
 - We may see that there is outside interference from non-Wi-Fi devices
 - Need hardware and software
- Wi-Fi Scanners will use information from a Wi-Fi adapter to chart what frequencies and channels are being used
 - The problem is they do not show how much data exists on a given channel
 - Nor do they show interference from non-Wi-Fi devices
 - Usually just software
- Therefore, the technician may need both!





Where is that coming from?



- Green signal is the AP, but what is the blue one?
- What could we do?

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The Top Wi-Fi Settings to Watch Out For

- Channel Interference
 - Channel Overlap: Using a crowded or overlapping channel, especially in the 2.4 GHz band, can cause interference and slow speeds
 - Auto Channel Selection: Some routers may not effectively choose the best channel, leading to interference
- Incorrect SSID and Password Settings
 - Wrong SSID: Devices are trying to connect to a different network with a similar name watch out for Extenders that use the same SSID as AP
 - Incorrect Password: Entering the wrong Wi-Fi password will prevent devices from connecting
- Advanced Wi-Fi Settings Misconfiguration
 - Beamforming and MIMO: Misconfigured advanced features like beamforming or MIMO (Multiple Input Multiple Output) can lead to connectivity issues
 - QoS (Quality of Service): Incorrect QoS settings can prioritize the wrong traffic, causing performance issues

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Making Sure Device Drivers are Up To Date

- There is an unfortunate problem in the industry: the rush to release products does not balance with the complexity of networking
- Never enough testing
- This leads to performance and security issues
- Result is a constant stream of software and driver updates
- A critical step in troubleshooting is to ensure all the latest firmware/drivers/software is in place
- That may eliminate problems troubleshooting complete!

Router Firmware: Check for and install any available updates for your router.

Device Drivers: Update the Wi-Fi drivers on your computer or other devices.





Drivers and Firmware

- Always check that the latest drivers and firmware are in use
- 802.11 amendments to the specifications lean heavily on backwards compatibility
- Legacy client-side drivers do not know how to handle new capability information/information elements/bits in the management frames
 - Be wary of issues that arise from new AP's and older client devices
 - Also update your own tools/sniffers so that they can process/dissect newer protocol formats





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General Network Settings – part 1

- Security Settings Issues
 - Outdated Security Protocols: Using outdated security protocols like WEP instead of WPA2/WPA3 can make the network vulnerable and may cause compatibility issues
 - Incorrect Security Settings: Mismatched security settings between the AP and client devices can prevent connections
- IP Addressing Problems
 - **DHCP Configuration**: Issues with the DHCP server can lead to IP address conflicts or devices not getting an IP address
 - Static IP Conflicts: Static IP addresses set on devices that conflict with the DHCP range can cause connectivity problems
 - **Network Address Translation**: Are the correct translation rules in place (look at addresses and ports)
- Network Mode Compatibility
 - Mixed Mode Issues: Using mixed mode (e.g., 802.11b/g/n) can cause performance degradation if older devices are connected
 - **Unsupported Modes**: Some devices may not support newer modes like 802.11ac or 802.11ax
- MAC Address Filtering

- Incorrect Filters: Enabling MAC address filtering without properly configuring allowed devices can block access to the network
- Whitelist/Blacklist: Misconfigured whitelists or blacklists can prevent devices from connecting

General Network Settings – part 2

- Roaming and Handoff Issues in Multi AP deployments
 - Inconsistent Settings: Inconsistent settings across multiple APs can cause roaming issues where devices don't seamlessly switch between APs
 - Fast Roaming: Misconfigured fast roaming settings (e.g., 802.11r) can cause connectivity issues
 - Is it easily possible to determine which AP or Extender the customer device is connected to?
- Bandwidth and Traffic Management
 - **Bandwidth Limiting**: Limiting bandwidth for certain devices can affect their performance
 - **Traffic Shaping**: Misconfigured traffic shaping settings can lead to poor network performance
- Guest Network Possible Issues
 - Isolation Settings: Guest networks with improper isolation settings can prevent access to necessary resources or the internet
 - Limited Bandwidth: Guest networks might have bandwidth limits that affect performance

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How Many Connected Devices?

- Two answers:
 - 1: Look at the AP/Management ACS
 - 2: Use an ARP scan

😂 at&t

<u>Device</u>	Broadband	l I	lome Network	<u>Voice</u>	Firewall	Diagnostics		
Status	Configure	IPv6	HPNA Configure	<u>Wi-Fi</u>	MAC Filtering	Subnets & D	HCP I	P Allocati
Home N	Network St	tatus						
Device IP DHCPv4 DHCPv4 DHCPv4 DHCP Le DHCP Le DHCP Pri Secondar Public Su Cascader IP Passth	v4 Address Netmask Start Address End Address ases Availabl ases Allocate imary Pool ry Subnet ibnet d Router Status rough Status	e ed us	192.168.1.254 255.255.255.0 192.168.1.64 192.168.1.253 174 16 Private Disabled Off (private IP add	ress)				
Interface	es							
Interface Ethernet Wi-Fi HPNA			Status Enabled Enabled Enabled	Active De 2 5 0	vices Inac 0 0 0	tive Devices		

💐 Colasoft MAC Scanner

File Edit View So	can Setting Help								
Setting Local Subnet	192.168.1.0/255.255.255.0	Start Pause Stop							
Scan Network									
IP Address	MAC Address	Host Name							
3 192.168.1.64	B 00:1A:DE:02:D5:86								
302.168.1.65	B 00:23:EE:DF:4B:6F								
302.168.1.70	B 18:B4:30:02:3C:3C								
😼 192.168.1.71	30:8C:FB:5F:9D:58								
302.168.1.215	EC:20:E8:D7:D3:A9								
302.168.1.220	34:DE:1A:54:08:EE								
302.168.1.255	34:DE:1A:54:08:EE								
3 192.168.1.254	B0:77:AC:CA:DF:D0								



How busy is the WAN or WLAN Link?

- You can identify delays or lost packets by sending ping packets from your wireless client
- If there is more than 10ms of delay, there may be a problem such as:
 - Weak transmit signal from the client (the host does not reach the AP)
 - The AP could be saturated with connected clients)
 - Interference (a third party signal could degrade your AP or client's ability to detect signals between them)
 - Weak transmit power from the AP (the AP does not reach the host) not common in a properly deployed network, unless the client is too far away
- Keep in mind that water will also cause a reduction in radio signal strength for those making use out of outdoor APs or wireless on a boat



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Do We Need to do Packet Capture?

- Generally, not for interference issues Layer 1
 - Possibly for Co-channel interference
- Yes for:
 - Association
 - Authentication/Deauthentication
 - Roaming
 - Other Layer 2 MAC behavior issues
 - Delays

- Retransmissions
- Packet Loss
- Sanity Checks



📕 Apply a display filter = <crt-></crt->													
	Time	Time Delta	Duration Source	Destination	Protocol	Length PHY type	Channel F	Rate (Mb/s) Frequency	Signal dB Noise d	B 802.11 SEQ# 802.11	Retry SSID	BSS Id	WEP ESS capabilities
	0.00000	0.000000000	592µs Cisco 9f:0b:6c	Broadcast	802.11	481 802	165	6,6 5825M	-57 dB	30	"SF21VUS"	04:eb:40:9f:0b:6c	Fal. Transmitt
	0.10241	0.102418321	592µs Cisco 9f:0b:6c	Broadcast	802.11	481 802	165	6,6 5825M	-57 dB	31	"SF21VUS"	04:eb:40:9f:0b:6c	Fal. Transmitt
	0.20479	0.102371893	592µs Cisco 9f:0b:6c	Broadcast	802.11	481 802	165	6,6 5825M	-57 dB	32	"SF21VUS"	04:eb:40:9f:0b:6c	Fal. Transmitt
	0.30734	0.102555739	592µs Cisco_9f:0b:6c	Broadcast	802.11	481 802	165	6,6 5825M	-57 dB	33	"SF21VUS"	04:eb:40:9f:0b:6c	Fal. Transmitt
	0.40960	0.102262879	592µs Cisco_9f:0b:6c	Broadcast	802.11	481 802	165	6,6 5825M	-57 dB	34	"SF21VUS"	04:eb:40:9f:0b:6c	Fal. Transmitt
	0.51212	0.102513291	592µs Cisco_9f:0b:6c	Broadcast	802.11	481 802	165	6,6 5825M	-57 dB	35	"SF21VUS"	04:eb:40:9f:0b:6c	Fal. Transmitt
	0.61441	0.102296423	592µs Cisco_9f:0b:6c	Broadcast	802.11	481 802	165	6,6 5825M	-58 dB	36	"SF21VUS"	04:eb:40:9f:0b:6c	Fal. Transmitt
	0.71704	0.102622714	592µs Cisco 9f:0b:6c	Broadcast	802.11	481 802	165	6,6 5825M	-57 dB	37	"SF21VUS"	04:eb:40:9f:0b:6c	Fal. Transmitt
	0.81921	0.102175232	592µs Cisco 9f:0b:6c	Broadcast	802.11	481 802	165	6,6 5825M	-57 dB	38	"SF21VUS"	04:eb:40:9f:0b:6c	Fal. Transmitt
•	0.92161	0.102397100	592µs Cisco_9f:0b:6c	Broadcast	802.11	481 802	165	6,6 5825M	-57 dB	39	"SF21VUS"	04:eb:40:9f:0b:6c	Fal. Transmitt
L I	1.02399	0.102384376	592µs Cisco 9f:0b:6c	Broadcast	802.11	481 802	165	6,6 5825M	-57 dB	40	"SF21VUS"	04:eb:40:9f:0b:6c	Fal. Transmitt
2	1.12640	0.102404637	592µs Cisco_9f:0b:6c	Broadcast	802.11	481 802	165	6,6 5825M	-57 dB	41	"SF21VUS"	04:eb:40:9f:0b:6c	Fal. Transmitt
3	1.19413	0.067735087	172µs IntelCor_98:38:f7	Broadcast	802.11	166 802	165	6,6 5825M	-49 dB	304	"SF21VUS"	ff:ff:ff:ff:ff:ff	Fal
	1.19544	0.001304365	584µs Cisco_9f:0b:6c	IntelCor_98:38:f7	802.11	475 802	165	6,6 5825M	-57 dB	3198	"SF21VUS"	04:eb:40:9f:0b:6c	Fal. Transmitt
	1.19545	0.000010728	44µs	Cisco_9f:0b:6c (0	802.11	70 802	165	6,6 5825M	-50 dB				Fal
	1.20435	0.008902708	172µs IntelCor_98:38:f7	Broadcast	802.11	166 802	165	6,6 5825M	-50 dB	305	"SF21VUS"	ff:ff:ff:ff:ff:ff	Fal
	1.20581	0.001458409	584µs Cisco_9f:0b:6c	IntelCor_98:38:f7	802.11	475 802	165	6,6 5825M	-57 dB	3199	"SF21VUS"	04:eb:40:9f:0b:6c	Fal. Transmitt
	1 20592	0.000009342	44µs	Cisco_9f:0b:6c (0	802.11	70 802	165	6,6 5825M	-50 dB				Fal
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	1.22880	0.022984669	592µs Cisco_9f:0b:6c 72µs IntelCor_98:38:f7	Broadcast Cisco_9f:0b:6c	802.11	90 802	165	6,6 5825ML.	-48 dB	42 51	5F21V05	04:eb:40:9f:0b:6c	Fal Transmitt
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ame dio 2.1 EE EE	1.2980 1.2280 1.2301 1.	0.022954659 0.001383735 0.00013856 0.00013856 tes on wire (v0, Length 5 formation con frame, F1 eless Managem	592μs (isco 9f:0b:0c 72μs IntelCor_98:38:f7 44μs 3848 bits), 481 bytes captu 6 ags:C	Broadcast Cisco_9f.00:6c IntelCon_98:38:f7.	802.11 802.11 802.11	90 802 70 802 e wlan2, id	165 165 165 θ	0,0 36/3N, 6,6 5825N, 6,6 5825N,	-37 00_ -48 dB. -57 dB.	42 51 0000 00 00 00 0010 61 d6 0020 00 00 0040 ff ff 0056 16 07 0060 32 16 0070 a5 05 0080 01 16 0090 18 40 0080 74 01 18 0000 61 18 40 0080 74 01 18 0000 61 18 40 0080 74 01	38 60 2f 40 40 a0 56 30 60 </td <td>01 20 240 27 100 36 01 20 240 37 100 36 20 06 00 20 30 20 08 00 10 0 C C1 16 40 01 C7 65 0f C1 3b 00 00 00 00 00 00 00 0f ff ff 64 cb 40 91 50 6C co 88 24 b0 48 60 6C co 98 24 b0 48 06 6C co 11 86 C0 118 70 01 18 80 01 18 74 01 19 51 12 09 01 16 90 01 60 20 26 co 10 10 10 10 10 10 00 10 10 10 00 100 10 10 00 100 100 100 100 10 00 100 100 100 100 10000000000</td> <td>Fal_ Transmitt Fal_ Fal_ Fa</td>	01 20 240 27 100 36 01 20 240 37 100 36 20 06 00 20 30 20 08 00 10 0 C C1 16 40 01 C7 65 0f C1 3b 00 00 00 00 00 00 00 0f ff ff 64 cb 40 91 50 6C co 88 24 b0 48 60 6C co 98 24 b0 48 06 6C co 11 86 C0 118 70 01 18 80 01 18 74 01 19 51 12 09 01 16 90 01 60 20 26 co 10 10 10 10 10 10 00 10 10 10 00 100 10 10 00 100 100 100 100 10 00 100 100 100 100 10000000000	Fal_ Transmitt Fal_ Fal_ Fa
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Insist on Windows? Here is what you need...

- My Windows Networking Tool
 - https://www.cellstream.com/download/windows-networking-toolkit/
- For accurate packet capture of Wi-Fi Traffic you must be able to place the wireless interface in MONITOR MODE
- Windows can do this with a USB Wi-Fi interface, not the native one
 - https://www.cellstream.com/2024/03/25/a-list-of-usb-wi-fi-adapters-that-supportmonitor-mode/
- You will need a free tool WIRESHARK
 - www.wireshark.org
 - My WLAN Wireshark profiles <u>https://www.cellstream.com/wireshark-profiles-repository/</u>
- A good dose of skills and knowledge



Wireless Capture = Three Types of Frames

Data frames	"wlan.fc.type==2"	
Control frames	"wlan.fc.type==1"	
 Acknowledgeme Request to Send Clear to Send 	nt J	
Management fra	ames "wlan.fc.type==0"	
 Beacons Probe Requests Association Req Reassociation R Disassociations Authentications 	/ Probe Responses uests / Association Responses equests / Reassociation Responses / Deauthentications	

Comparing AP and STA Capabilities

- Only discernable with a packet capture
- Step 1: Capture on the correct channel
- Step 2: Filter for Beacons from the SSID in question
 - wlan.fc.type_subtype == 0x0008 && wlan.ssid=="CellStream Inc."
- Step 3: Look for Associations from the STA in question
 wlan.fc.type subtype == 0x0000 && wlan.addr==de:ad:be:ef:ca:fe
- Step 4: Compare in Tagged Parameters of AP Beacon and the STA association requests:
 - HT, VHT, and HE capabilities
 - Inside HT capabilities:
 - Is LDPC supported?

- Is SGI (Short Guard Interval) supported?
- Under MCS in HT, VHT and HE how many special streams are supported?

- \checkmark Identify and define the problem
- ✓ Checking Physical Connections
- ✓ Check the Wi-Fi Physical Layer Integrity
- ✓ Check Interference Types/Levels
- ✓ Check Wi-Fi Network Settings
- ✓ Update any Firmware/Drivers
- ✓ Check General Network Configuration
- ✓ Check for Network Overloading
- ✓ Analyze Packet Data
- □ Factory Reset / Reboot
- Test and Verify the problem is corrected, document



- This is not a first step!
- However, it can often be a final step once the issue is identified:
 - Clearing Memory and Cache: Over time, a router's memory can become cluttered with temporary data, cache, and
 processes that can slow down its performance. A reboot clears this memory, allowing the router to start fresh, which can
 improve performance
 - Resolving Connectivity Issues: Sometimes, devices may experience connectivity issues due to stale or corrupted network settings. Rebooting the router can reset the connections and resolve issues like dropped Wi-Fi, slow speeds, or devices not being able to connect
 - IP Address Refresh: If the router is having trouble assigning IP addresses to devices (DHCP Pool exhaustion), or if there's
 a conflict in the network, rebooting the router can force it to reassign IP addresses, which can resolve issues related to
 connectivity and access
 - Clearing Network Congestion: A reboot can help alleviate network congestion, especially in situations where multiple
 devices are competing for bandwidth, by resetting connections and reducing the load on the router
 - **Updating Configuration Settings**: If you've made changes to the router's settings, such as modifying the SSID, password, or security protocols, a reboot is often required to apply and activate these changes
 - **Fixing Software Glitches**: Like any electronic device, routers can occasionally experience software glitches or bugs. A reboot can resolve these temporary issues by restarting the router's firmware
 - Improving Performance and Stability: Regular reboots can maintain the overall performance and stability of the router, especially in environments with heavy usage or complex network setups
 - **Applying Firmware Updates**: After a firmware update, a reboot is usually necessary to complete the installation process and ensure that the router operates with the latest improvements and security patches



- \checkmark Identify and define the problem
- ✓ Checking Physical Connections
- ✓ Check the Wi-Fi Physical Layer Integrity
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- ✓ Check for Network Overloading
- ✓ Analyze Packet Data
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- Test and Verify the problem is corrected, document



Testing and Verification

- Ensure Functionality: To confirm that the corrections or adjustments you made actually work as intended and do not introduce new issues
- Optimize Performance: To check if the changes have improved network performance, such as increased speed, better coverage, or reduced latency
- Identify Hidden Issues: Testing can reveal any unexpected problems that may arise from the changes, such as interference, signal dropouts, or compatibility issues with certain devices
- Security Verification: Ensuring that security settings, such as encryption or authentication methods, are correctly configured to protect the network from unauthorized access
- User Experience: To verify that the network provides a reliable and satisfactory experience for all users, including those with various types of devices
- Compliance and Documentation: Testing provides documentation and evidence that the network meets required standards or specifications, which can be important for compliance in certain environments, such as businesses or educational institutions
- Avoid Downtime and Callbacks: Verification helps prevent network outages or connectivity issues, which can be disruptive, especially in a critical environment



- \checkmark Identify and define the problem
- ✓ Checking Physical Connections
- ✓ Check the Wi-Fi Physical Layer Integrity
- ✓ Check Interference Types/Levels
- ✓ Check Wi-Fi Network Settings
- ✓ Update any Firmware/Drivers
- ✓ Check General Network Configuration
- ✓ Check for Network Overloading
- ✓ Analyze Packet Data
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- Test and Verify the problem is corrected, document





Some Examples of Wi-Fi Issues You are Likely to Find

Interference

- Co-channel & Adjacent channel
- Narrowband only on one channel
- Wideband several channels
- All band all channels in a frequency range
- Clients connecting at slow rates
- Misconfigured AP
- Too many AP's on a channel
- Too many SSIDs broadcasting
- Neighbor AP on the same channel
- Too many users on a channel

- Excessive Retries on a given channel
- Channel Traffic congestion
- Channel Device congestion
- Poor Signal to Noise Ratio (SNR)
- Range, RSSI
- Too many users on the same AP
- Client misconfiguration
- Legacy 802.11B clients present ERP and 802.11N protection
- Beyond range, No secondary AP coverage
- Line of sight and antenna orientation for directional antennas

Thank you for your time Questions





Author Biography and Details

Author: Andrew Walding

Biography of the Author



Mr. Walding is President of CellStream Inc., a global computing and telecommunications consulting group based in Texas. He holds multiple patents in telecommunications and has been in the industry since 1978. Additionally, Mr. Walding is an industry leading consultant, lecturer, author, instructor and course developer focusing on optical, packet switching, routing, and control protocols.

CellStream Inc. provides a diverse range of consulting services, serving the computing and telecommunications service providers and equipment manufacturers. CellStream has always been focused on emerging key technologies, enabling its clients to master new concepts in products and offerings with minimized lead times. CellStream consultants bring hundreds of years of front-line experience across a wide range of technologies and responsibilities. CellStream offers requirements/architecture definition, design support, RFP creation and response support, sales force enlightenment, solutions brainstorming, white paper and collateral creation/review services and much more.

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Wa	lding	[45]	Dat	te of I	Patent:	Feb. 29, 2000		
[54] [75]	ALLOCATION OF BANDWIDTH TO CALLS IN A WIRELESS TELECOMMUNICATIONS SYSTEM Inventor: Andrew M. Walding, Sunninghill, United Kinzdom	91 95 96 96 Primari	08629 12257 24802 37081 38994 / Exami	6/1991 5/1995 9/1995 11/1996 12/1996	WIPO WIPO WIPO WIPO WIPO	H04U 3/24 H04B 7/00 H04Q 3/00 H04Q 7/24 H04Q 7/32		
[73]	Assignce: Airspan Communications Corporation, Wilmington, Del.	Attorne [57]	s, Ageni	l, or Fir	m—Baker Bot ABSTRACT	us, L.L.P.		
[21] [22] [30]	Appl. No.: 08/969,183 Filed: Nov. 12, 1997 Foreign Application Priority Data	The pre system, calls be a wirele telecom	The present invention provides a bandwidth managemet system, a subscriber terminal, and a method for managin calls between a central terminal and a subscriber terminal a wireless telecommunications system, a number of items telecommunications equipment being connectable to the obscriber terminal. The reductibut terminal is asymptotic					
May [51] [52] [58]	(14, 1997 [GB] Uaited Kingdom 970980 Int. Cl. ⁷	2 pass ca 4 equipms 1 wireless 0, predeter 1; tem cos	er term Il data ant and link be mined of said	the centring pro- maximutical data	e subscriber i 1 said items o tral terminal v vided on a free m call data ba ta. The bandw width manage	criminal is arranged to of telecommunications via a wireless link, the quency channel with a undwidth for the trans- ridth management sys- r for maintaining in a		

United States

Patent Application Publication

T Pub. Date: Jul. 2, 19

Google	COURSE CERTIFICATE	Cisco Systems Certificate of Completion
Andrew M. Walding		HAS BEEN PRESERVED TO ANDREW WALDING
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INTEGRATED ELEMENT MANAGER AND INTEGRATED MULTI-SERVICES ACCESS PLATFORM	OTHER PUBLICATIONS Matsuura, et al., "Architecture and Network Configuration	
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signee: Alcatel USA Sourcing, L.P., Plano, TX (US) tice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.	of the Diefense Red Swinkh Network (DRSN)", Proceedings of the Millavy Communications Conference (MILCOM), Long Beach, NJ, Oct. 2–5, 1994, vol. 2, pp. 664–668. (List continued on next page.) Primare Forwardsman—Ait Pack	This certificate confirms that the aforementioned individual, having completed training and testing with Nephos6, has attained the status
pl. No.: 09/342,740 cd: Jun. 29, 1999 Related U.S. Application Data	Assistant Examiner—Hohn Pezzlo (74) Attorney, Agent, or Firm—Biker Botts L.L.P. (57) AIBSTRACT An integrated multi-services access platform includes a time	C. Popoviu
nited States Patent	US064817108 (0) Patent No.: US 6,181,710 B1 (2) Dete of Patent: Jun 30 2001	The Hutter Prove Four nephos N
HANDLING OF TELECOMMUNICATIONS	OTHER PUBLICATIONS	at Boulder
SIGNALS PASSED BETWEEN ELEMENTS OF A TELECOMMUNICATIONS NETWORK Inventors: Ian L. Cooper, Basingstoke; Jonathan A. Thompson, Newbury; Martin Lysejko, Baghot; Joemanne Chi	Ashok Jhunjhuwala, et al., "Wireless in Local Loop: Some Key Issues", IETE Technical Review, vol. 12, No. 5–6, SopDec. 1957, pp. 300–314. Karim Khakzar, "V5 Interfaces Between Digital Local Exchange and Access Networks", Frequenz, vol. 48, No.	Interdisciplinary Telecommunications Program Centifies that
Cheung Yeung, Wootloo; Andrew M. Walding, Sunninghill; Guy A. Cooper, Windsor, all of (GB) Assignce: Alcatel USA Sourcing, L.P., Plano, TX (US)	1/2, Jan./teb. 1994, pp. 44–50. PCT Search Report, dated Jan. 22, 1999. Primary Examinere—Hassan Kizou Assistant Examiner—John Pezzlo Cith Aground Annual Comparison of the Comparison of	Andrew Walding
ice: Under 35 U.S.C. 154(b), the term of this patent shall be extended for 0 days. I. No.: 09/001,023	(57) ABSTRACT The present invention provides a system for handling tele- communications signals passed between a first and second element of a telecommunications network, the first element	 Has Breedshilly complete the Required TRA Consess and Passed the Written Completension Lesis for Certification as a Common participation of the Republic of a part Christian to Common participation of the Republic of the Republic Common participation of the Republic of the Republic of the Republic Common participation of the Republic of the Republic of the Republic Common participation of the Republic of the Republic of the Republic Common participation of the Republic of t
Dec. 30, 1997	having an interface for transmitting and receiving signals in	
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12) United States Patent Walding	US006600815B1 (10) Patent No.: US 6,600,815 B1 (45) Date of Patent: Jul. 29, 2003	
 TELEPHONE NETWORK ACCESS ADAPTE Inventor: Andrew M. Walding, Plano, TX (US) Assignce: Alcatel USA Sourcing, LP, Plano, T (US) 	R 5,056,133 A 101991 Ida	National Association of Communication
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 PCT No.: PCT/U897/24276 § 371 (c)(1), (2), (4) Date: Sep. 24, 1999 PCT Path. No.: WO98/28002 	(74) Attorney Agent, or Firm—Baker Botts, LLP; V. Lawrence Sewell; Jesska W. Smith (57) ABSTRACT A telephone network access adapter for a computer includes	ALLEN M. WILLING In error the designation

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