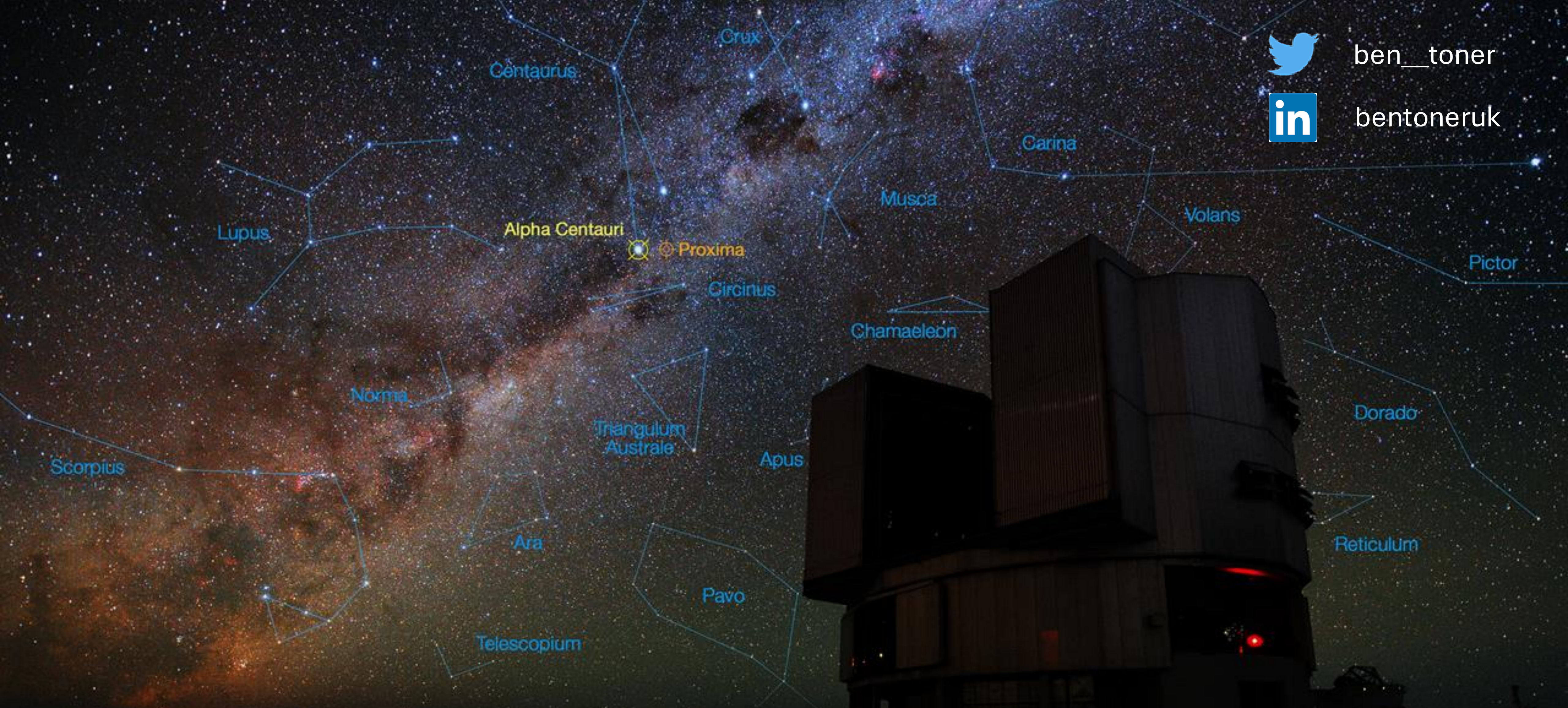
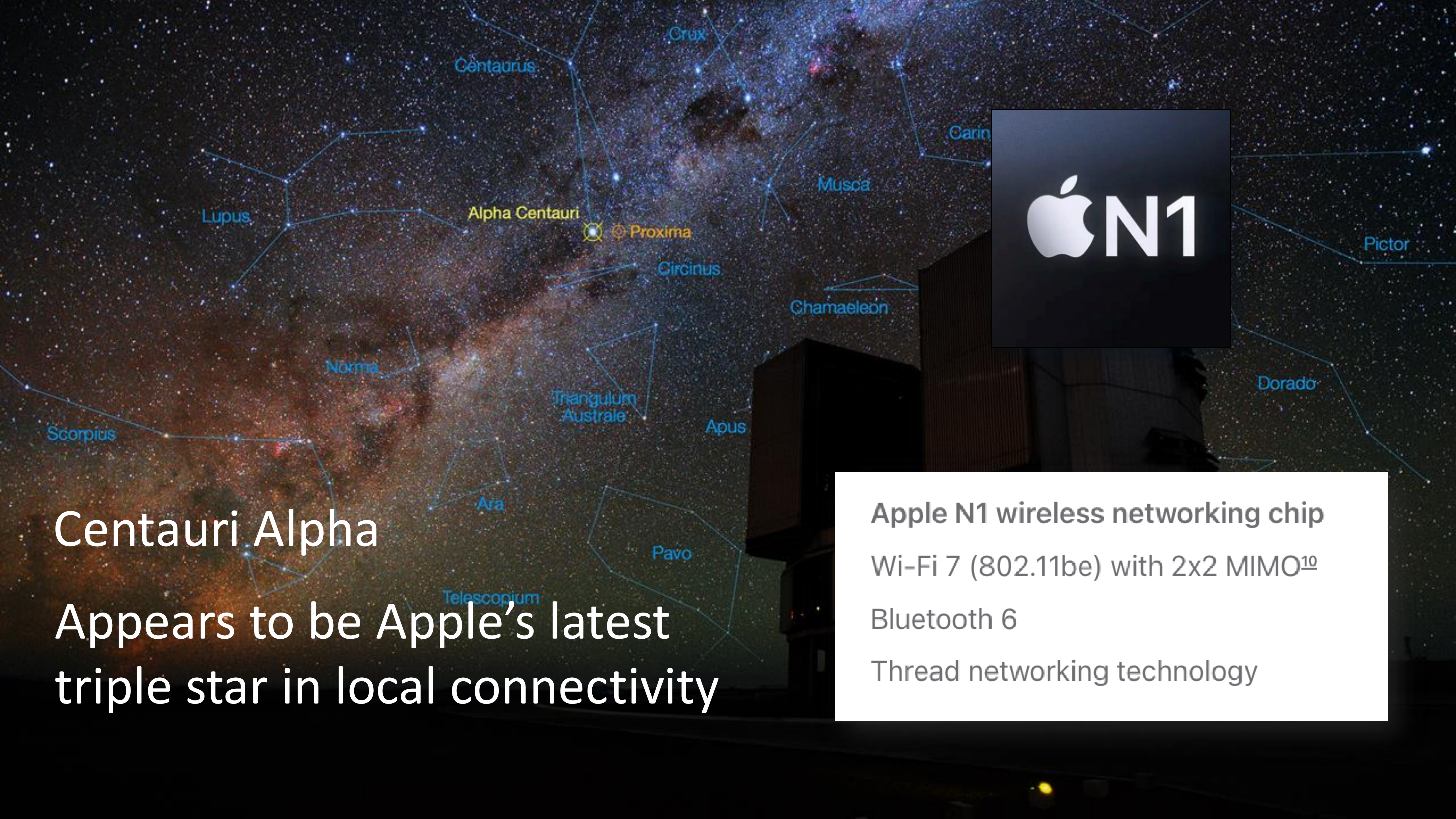


ben__toner
bentoneruk

Understanding Wi-Fi connections

Ben Toner

Alpha Centauri is a **triple star system** located just over four light years, or about 25 trillion miles, from Earth.



Centauri Alpha

Appears to be Apple's latest triple star in local connectivity

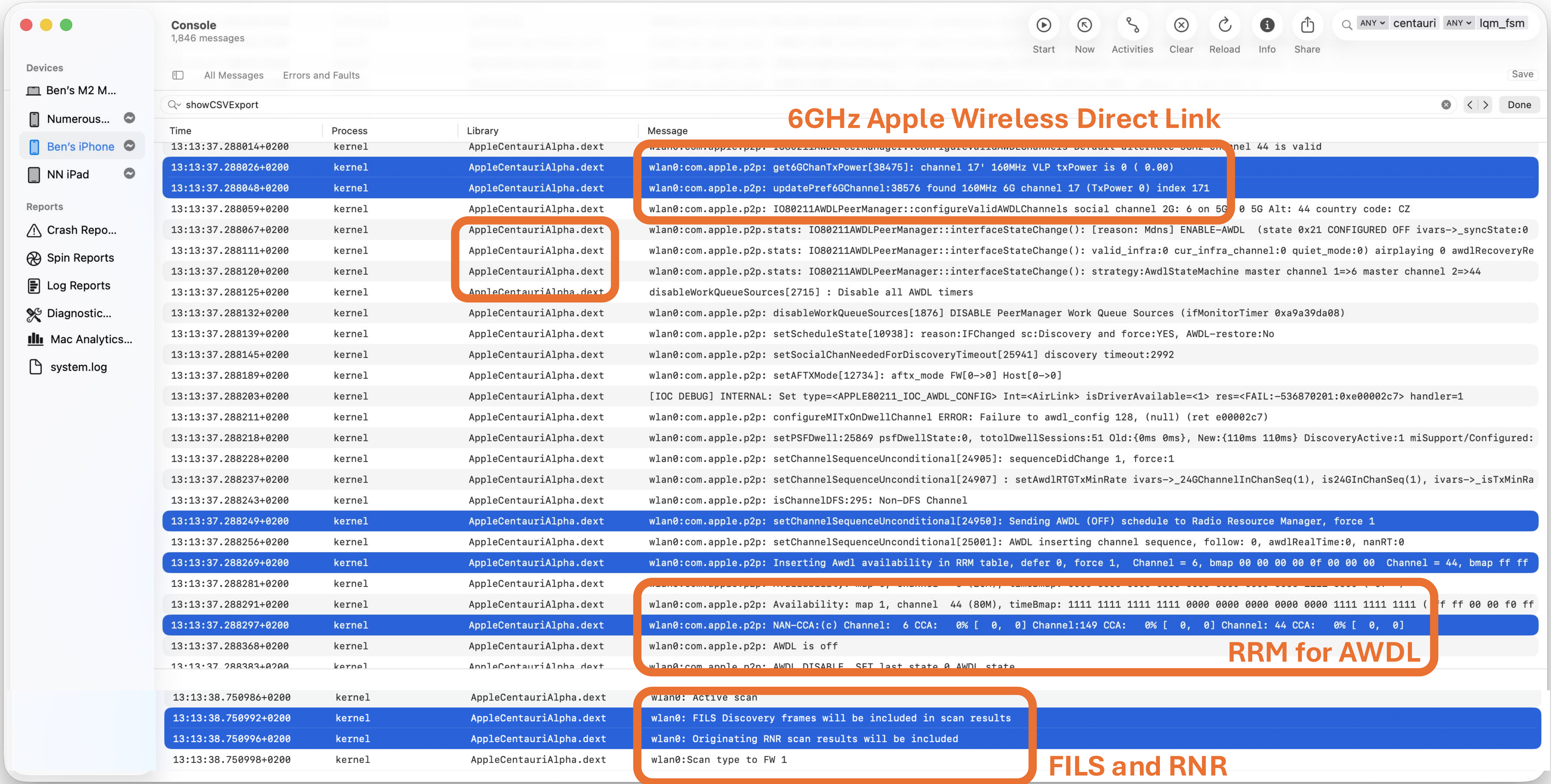
Apple N1 wireless networking chip

Wi-Fi 7 (802.11be) with 2x2 MIMO[10]

Bluetooth 6

Thread networking technology

The iPhone 17 lineup also introduces N1, a new Apple-designed wireless networking chip that enables Wi-Fi 7, Bluetooth 6, and Thread. In addition to powering the latest generation of wireless technologies, N1 improves the overall performance and reliability of features like Personal Hotspot and AirDrop.


Console
1,846 messages
Start
Now
Activities
Clear
Reload
Info
Share
ANY centauri ANY lqm_fsm
Devices
Ben's M2 M...
Numerous...
Ben's iPhone
NN iPad
Reports
Crash Repo...
Spin Reports
Log Reports
Diagnostic...
Mac Analytics...
system.log
All Messages
Errors and Faults
Save
showCSVExport
Done
6GHz Apple Wireless Direct Link
Time
Process
Library
Message
13:13:37.288014+0200 kernel AppleCentauriAlpha.dext
13:13:37.288026+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p: get6GChanTxPower[38475]: channel 17' 160MHz VLP txPower is 0 (0.00)
13:13:37.288048+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p: updatePref6GChannel:38576 found 160MHz 6G channel 17 (TxPower 0) index 171
13:13:37.288059+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p: IO80211AWDLPeerManager::configureValidAWDLChannels social channel 2G: 6 on 5G 0 5G Alt: 44 country code: CZ
13:13:37.288067+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p.stats: IO80211AWDLPeerManager::interfaceStateChange(): [reason: Mdns] ENABLE-AWDL (state 0x21 CONFIGURED OFF ivars->_syncState:0
13:13:37.288111+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p.stats: IO80211AWDLPeerManager::interfaceStateChange(): valid_infra:0 cur_infra_channel:0 quiet_mode:0) airplaying 0 awdlRecoveryRe
13:13:37.288120+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p.stats: IO80211AWDLPeerManager::interfaceStateChange(): strategy:AwdlStateMachine master channel 1=>6 master channel 2=>44
13:13:37.288125+0200 kernel AppleCentauriAlpha.dext disableWorkQueueSources[2715] : Disable all AWDL timers
13:13:37.288132+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p: disableWorkQueueSources[1876] DISABLE PeerManager Work Queue Sources (ifMonitorTimer 0xa9a39da08)
13:13:37.288139+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p: setScheduleState[10938]: reason:IFChanged sc:Discovery and force:YES, AWDL-restore:No
13:13:37.288145+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p: setSocialChanNeededForDiscoveryTimeout[25941] discovery timeout:2992
13:13:37.288189+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p: setAFTXMode[12734]: aftx_mode FW[0->0] Host[0->0]
13:13:37.288203+0200 kernel AppleCentauriAlpha.dext [IOC DEBUG] INTERNAL: Set type=<APPLE80211_IOC_AWDL_CONFIG> Int=<AirLink> isDriverAvailable=<1> res=<FAIL:-536870201:0xe00002c7> handler=1
13:13:37.288211+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p: configureMITxOnDwellChannel ERROR: Failure to awdl_config 128, (null) (ret e00002c7)
13:13:37.288218+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p: setPSFDwell:25869 psfDwellState:0, totolDwellSessions:51 Old:{0ms 0ms}, New:{110ms 110ms} DiscoveryActive:1 miSupport/Configured:
13:13:37.288228+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p: setChannelSequenceUnconditional[24905]: sequenceDidChange 1, force:1
13:13:37.288237+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p: setChannelSequenceUnconditional[24907] : setAwdlRTGTxMinRate ivars->_24GChannelInChanSeq(1), is24GInChanSeq(1), ivars->_isTxMinRa
13:13:37.288243+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p: isChannelDFS:295: Non-DFS Channel
13:13:37.288249+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p: setChannelSequenceUnconditional[24950]: Sending AWDL (OFF) schedule to Radio Resource Manager, force 1
13:13:37.288256+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p: setChannelSequenceUnconditional[25001]: AWDL inserting channel sequence, follow: 0, awdlRealTime:0, nanRT:0
13:13:37.288269+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p: Inserting Awdl availability in RRM table, defer 0, force 1, Channel = 6, bmap 00 00 00 00 0f 00 00 00 Channel = 44, bmap ff ff
13:13:37.288281+0200 kernel AppleCentauriAlpha.dext
13:13:37.288291+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p: Availability: map 1, channel 44 (80M), timeBmap: 1111 1111 1111 1111 0000 0000 0000 0000 0000 1111 1111 1111 (ff ff 00 00 f0 ff
13:13:37.288297+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p: NAN-CCA:(c) Channel: 6 CCA: 0% [0, 0] Channel:149 CCA: 0% [0, 0] Channel: 44 CCA: 0% [0, 0]
13:13:37.288368+0200 kernel AppleCentauriAlpha.dext wlan0:com.apple.p2p: AWDL is off
RRM for AWDL
13:13:38.750986+0200 kernel AppleCentauriAlpha.dext wlan0: Active scan
13:13:38.750992+0200 kernel AppleCentauriAlpha.dext wlan0: FILS Discovery frames will be included in scan results
13:13:38.750996+0200 kernel AppleCentauriAlpha.dext wlan0: Originating RNR scan results will be included
13:13:38.750998+0200 kernel AppleCentauriAlpha.dext wlan0:Scan type to FW 1
FILS and RNR

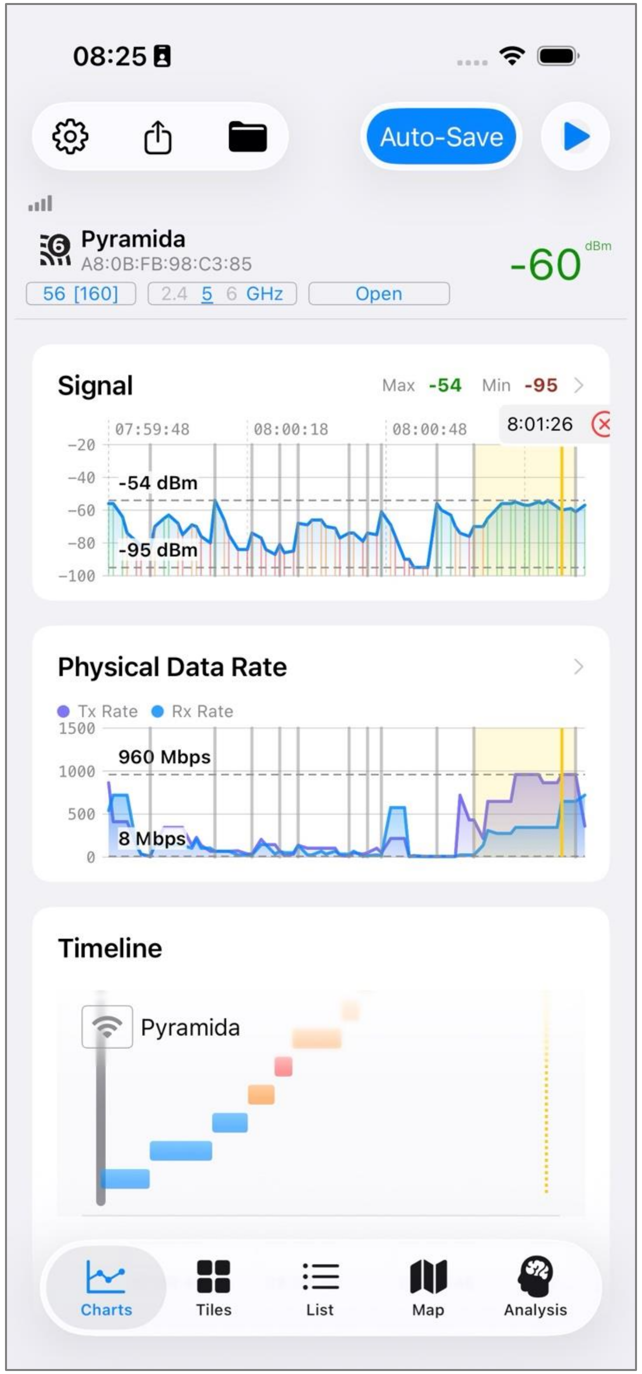
How can we monitor & understand Wi-Fi connectivity?

nOversight Update

Join the public beta

https://testflight.apple.com/join/Ekcmr5Jq

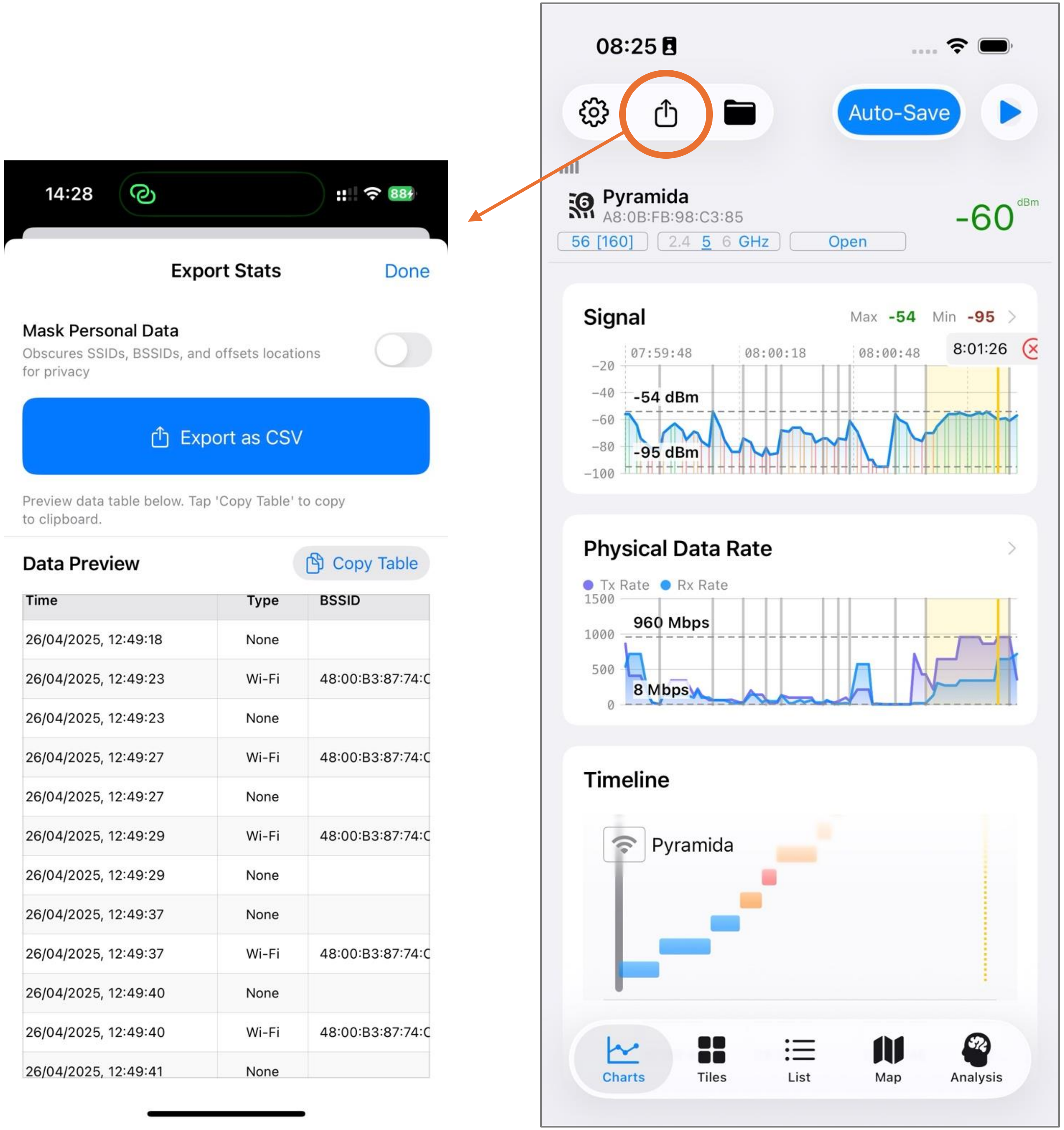
- Use nOversight for free during this next development phase
- Test your devices
- Understand connectivity
- Feedback



Let’s Embrace AI

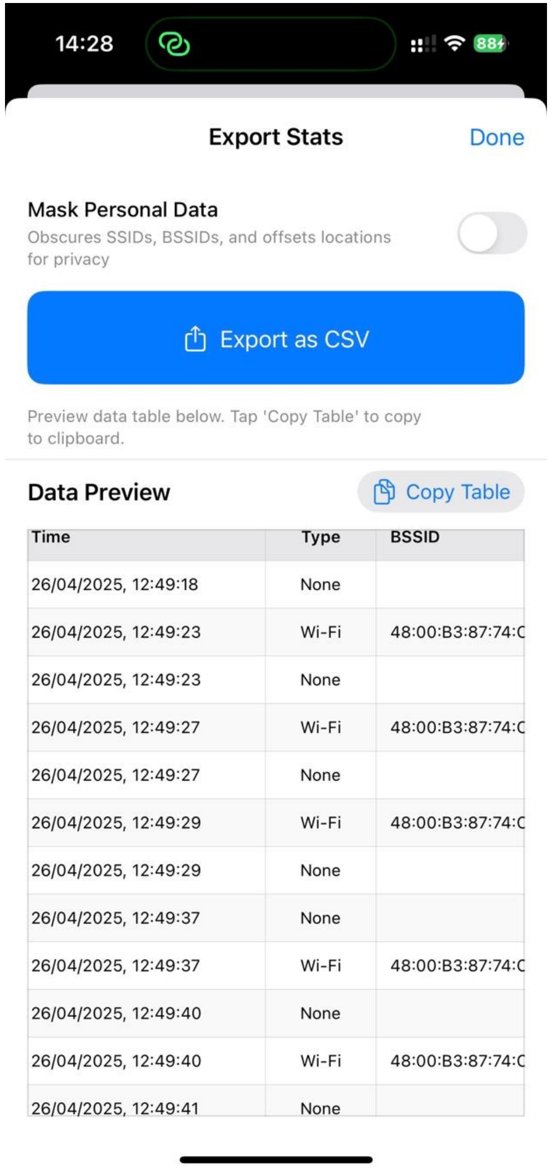
You can export your data for analysis

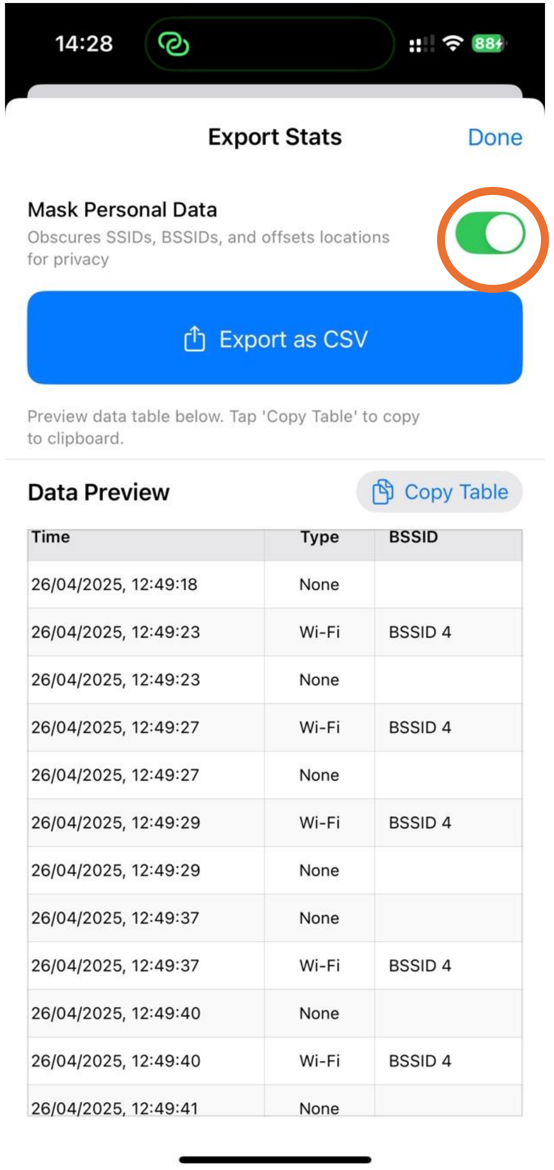
BUT

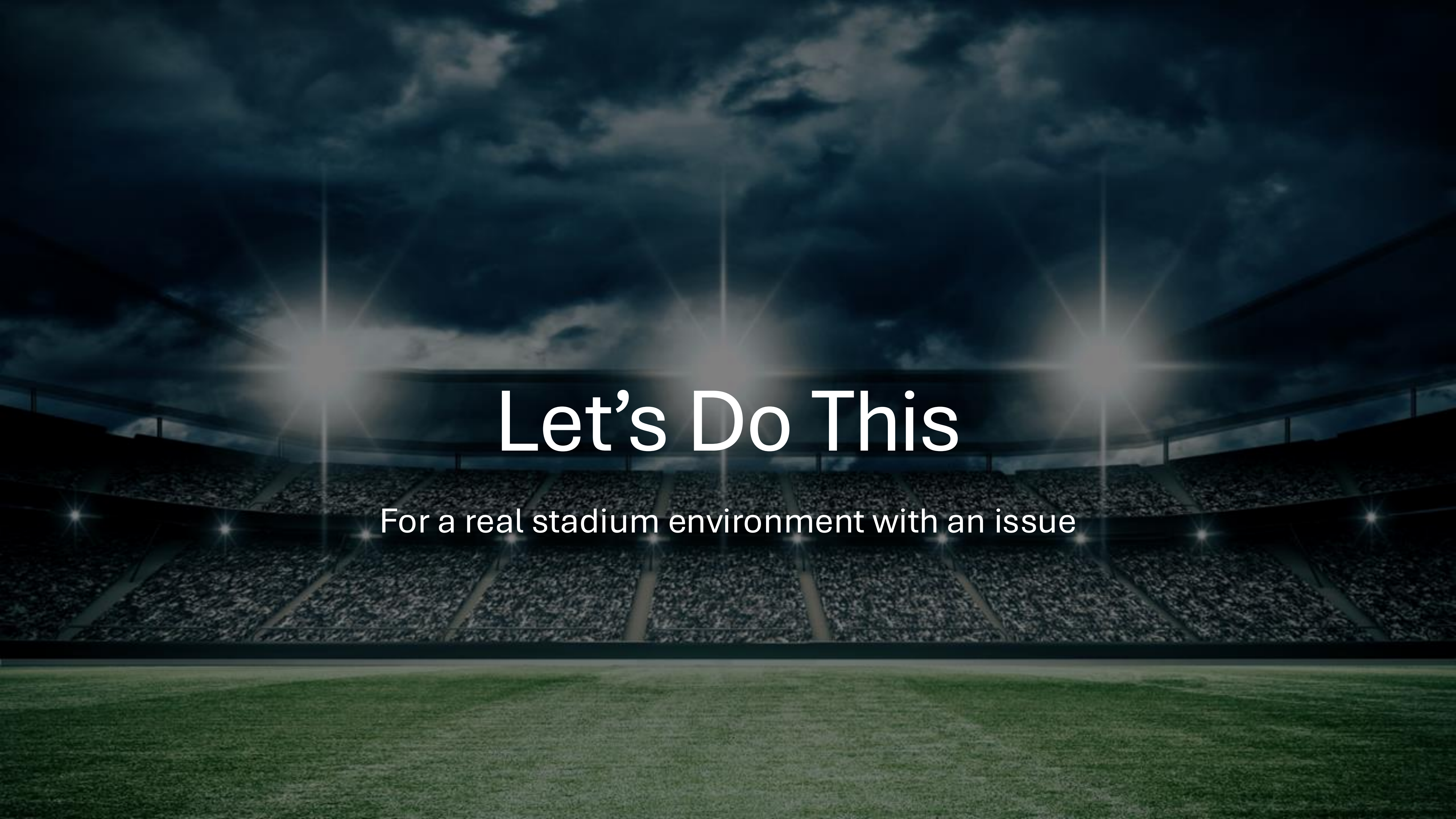


Let’s Embrace AI

BEWARE OF SHARING PRIVATE DATA






Let’s Do This
For a real stadium environment with an issue

Is the data enough for useful insight?

- **This is a csv file containing interval measurements of a Wi-Fi installation in a packed stadium.**
- **Can you analyse this file and determine if there are any concerns with the Wi-Fi.**
- Provide a summary of the overall performance in a way which can be understood by a network owner with no Wi-Fi knowledge.
- Secondary, provide information which is helpful to a professional.
- Provide remedy steps to any issues which can be taken by the network owner. They need to be fairly simple.
- Also help them understand how to measure benefits after any changes
- Provide investigation, logging and potential technical concern details for the professional.

AI Analysis

Suggests it might be worth spending more time

Overall Performance

- **Signal strength:**
  Average Wi-Fi signal (RSSI) was **–73 dBm**, which is **adequate but on the weak side** for reliable high-capacity use. Around **30%** of the measurements were weaker than –75 dBm — this often means the user's device is on the edge of the coverage cell.
- **Data speeds:**
  The **average download (Rx) rate** was **61 Mbps**, but it fluctuated a lot — some measurements dropped as low as **8 Mbps**, while others peaked at **286 Mbps**.
  This inconsistency suggests congestion or uneven signal quality in parts of the stadium.
- **Noise and interference:**
  The average **signal-to-noise margin** (RSSI–Noise) was around **15 dB**, which is **borderline**. Ideally, it should stay above **20 dB** for good throughput in crowded environments.

Plain-English View

- Wi-Fi mostly works, but **signal strength and quality vary too much** for a dense crowd scenario.
- In some parts of the stadium, people may experience **slow connections or drop-outs**, especially when it's full and devices compete for air time.
- The system performs **well when close to the access point**, but **coverage or capacity limits** show up further away.

AI Analysis

Useful Wi-Fi 101 for the customer. No real solution here

Simple Remedies You Can Request

1. **Ask for coverage verification:**
   Have the installer perform a "heat map" check on a match day to ensure consistent coverage across seating areas.
2. **Check AP power balance:**
   APs may need power level tuning so that strong cells don't drown out weaker ones.
3. **Increase capacity where crowds are densest:**
   If possible, add more APs or split channels between sectors.
4. **Review channel plan:**
   Avoid overlapping channels and ensure 5 GHz and 6 GHz radios are used effectively.
5. **After improvements:**
   Measure signal strength and download speed again during an event — you should see:
   - Average RSSI closer to **–65 dBm**
   - Fewer speed drops below **50 Mbps**
   - More stable connections (less variation)

AI Analysis

More value for the professional. Something to try out?

Interpretation

- The **PHY rate potential (TxRate)** is high — radios support fast modulation — but **application throughput (RxRate)** is limited, likely by medium contention or interference.
- The **SNR trend** and **RSSI spread** imply clients frequently operate at the edge of cell coverage or experience overlapping cells (cell breathing in dense load).
- Noisy floor (~–88 dBm typical noise from RSSI–Noise) suggests **adjacent channel interference** rather than external sources.
- Geographic data (lat/long) could be used to plot weak-signal zones — likely higher rows or oblique seating under structures.

Remediation Focus

- **Optimize power and channel allocation per sector.**
- **Validate client distribution** — too many clients on one AP will cause airtime collapse; load balancing and band-steering should be reviewed.
- **Use DFS/6 GHz channels** where allowed to reduce contention.
- **Confirm downlink airtime fairness and WMM configuration** on the controller.
- **Validate minimum RSSI thresholds** — raising them to disconnect distant clients can improve throughput for the remaining ones.

Seems like the Wi-Fi professional is still needed

Ben's Advice

Gather Data and Visualise

Device logs have many more details than we can easily consume & Understand

Connection Timeline with link metrics:

Signal & Performance

Chipset / System Metrics

What actually happened in the device

We have just seen these

Not too hard to understand and draw some conclusion from

Detailed Wi-Fi Tx/Rx chain readouts

Harder to understand and draw conclusion from (unless you really know the chipset architecture)

Chipset / System Data

- rxCrsGlitch=13 rxBphyCrsGlitch=0 rxStart=245 rxBadPLCP=0 rxBphyBadPLCP=0 rxBadFCS=9 rxFifo0Ovfl=0 rxFifo1Ovfl=0 rx_nobuf=0 rxAnyErr=2 rxResponseTimeout=0 rxNoDelim=2 rxFrmTooLong=0 rxFrmTooShort=0
- txRTSFrm=17 txRTSFail=0 rxCTSUcast=17 rxRTSUcast=4 txCTSFrm=4 txAMPDU=19 rxBACK=19 txPhyError=0 txAllFrm=59 txMPDU=0 txUcast=19 rxACKUcast=0 OfdmDesense=2 dB 04/26/2025
- rxBeaconMbss=10 rxBeaconObss=50 rxDataUcastMbss=32 rxMgmtUcastMbss=0 rxCNTRLUcast=40 txACKFrm=0 txBACK=19 ctxFifoFull=0 ctxFifo2Full=0 rxDataMcast=0 rxMgmtMcast=64
- RX AMPDU (HighBand) rxAmpdu=23 txBACK(Ucode)=19 rxMpduInAmpdu=36 rxholes=0 rxdup=0 rxstuck=0 rxoow=0 rxoos=0 rxaddbareq=0 txaddbaresp=0 rxbar=0 txdelba=0 rxdelba=0 rxQueued=0 rxRetryNoBA=0
- WME RX MPDUs (rxPER 0 %) in tids 0:42, 1:0, 2:0, 3:0, 4:0, 5:0, 6:0, 7:0
- rxToss=0 rxLastTossRsn=0 rxNoFrag=0 rxNoCmplId=0 rxNoHaddr=0 rxMulti=0 rxUndec=0
- TX(20:CC:27:7D:18:8C) AC<SU MS NB NRS NA CM EX TF FFP MRET FLE> BE<95 0 0 0 0 0 0 0 0 0 0> (4999ms)
- TX(20:CC:27:7D:18:8C) AC<SU MS NB NRS NA CM EX TF FFP MRET FLE> BK<0 0 0 0 0 0 0 0 0 0 0> (4999ms)
- TX(20:CC:27:7D:18:8C) AC<SU MS NB NRS NA CM EX TF FFP MRET FLE> VI<0 0 0 0 0 0 0 0 0 0 0> (4999ms)
- TX(20:CC:27:7D:18:8C) AC<SU MS NB NRS NA CM EX TF FFP MRET FLE> VO<0 0 0 0 0 0 0 0 0 0 0> (4999ms)
- L3 Control VO TX(20:CC:27:7D:18:8C) Success=0 NoACK=0 Expired=0 OtherErr=0 04/26/2025
- WeightAvgLQM rssi=-61 snr=28 txRate=286760 rxRate=206470

AI Analysis

Definitions

TX Path (Transmission-related Counters)

Term	Meaning
txRTSFrm / txRTSFail	RTS frames sent / failed (Request to Send), often used in congested or hidden node environments.
rxCTSUcast / rxRTSUcast / txCTSFrm	Control frame reception/transmission counts (CTS = Clear to Send).
txAMPDU / rxBACK / txBACK	Aggregate MPDU packets sent / Block ACKs received and transmitted — part of 802.11n/ac/ax efficiency features.
txPhyError	Transmission failed at PHY layer — possibly due to RF issues or bad rate selection.
txAllFrm / txMPDU / txUcast	All frames / MAC Protocol Data Units / Unicast frames transmitted.
rxACKUcast	Number of ACKs received for unicast transmissions.
OfdmDesense	OFDM desensitization — measure of signal degradation due to interference (e.g., Bluetooth or adjacent channel).

Beacon & Management Counters

Term	Meaning
rxBeaconMbss	Beacons received from the connected (MBSS) network.
rxBeaconObss	Beacons from other overlapping BSSes — indicator of channel contention.
rxDataUcastMbss	Unicast data frames received from our BSS.
rxMgmtUcastMbss	Unicast management frames (rare).
rxCNTRLUcast	Unicast control frames (e.g., ACKs, RTS/CTS).
txACKFrm	ACKs sent.
ctxFifoFull / ctxFifo2Full	TX FIFO overflows — transmit buffers filled before being sent (congestion or driver issue).
rxDataMcast / rxMgmtMcast	Multicast data / management frames received.

RX Path (Reception-related Counters)

Term	Meaning
rxCrsGlitch	Number of Clear Channel Assessment (CCA) glitches — indicates possible RF noise or false detection of activity on the medium.
rxBphyCrsGlitch	Same as above, but specific to 802.11b PHY.
rxStart	Number of received packets that passed the initial PHY check.
rxBadPLCP	Packets with corrupt PLCP headers (PHY header, pre-MAC). Usually due to RF issues.
rxBphyBadPLCP	Same as above, but for 802.11b packets.
rxBadFCS	Frames that failed the Frame Check Sequence (CRC error). Indicates RF noise, interference, or collisions.
rxFifo0Ovfl / rxFifo1Ovfl	FIFO overflows on receive buffers — the radio couldn't process packets fast enough. May indicate CPU or driver limitations.
rx_nobuf	Frames dropped due to no buffer being available (system resource exhaustion).
rxAnyErr	Aggregate counter for any type of RX error.
rxResponseTimeout	Timeout waiting for a response (e.g., ACK). May indicate link issues or hidden node problems.
rxNoDelim	Packet received without proper delimiter — usually malformed or partially corrupted packets.
rxFrmTooLong / rxFrmTooShort	Frames that were unexpectedly long or short (likely malformed or corrupted).

AMPDU (Aggregated MPDU) Metrics

Term	Meaning
rxAmpdu	Number of received AMPDU aggregates.
txBACK(Ucode)	Block ACKs transmitted by uCode (firmware).
rxMpduInAmpdu	MPDUs (individual frames) within AMPDU.
rxholes / rxdup	Gaps (lost packets) / duplicate packets in AMPDU.
rxstuck / rxoow / rxoos	Frames stuck / out-of-window / out-of-sequence — could indicate reordering or timing issues.
rxaddbareq / txaddbaresp / rxbar / txdelba / rxdelba	Add/Del Block ACK session negotiation.
rxQueued / rxRetryNoBA	RX frames queued / retries that occurred without BA support.

AI Analysis

📉 Primary Trend: Increasing Frame Errors

As Rx rate drops, the following metrics climb sharply:

- A **massive increase in frame errors** (rxBadFCS, rxBadPLCP).
- **Short or malformed frames** (rxFrmTooShort, rxNoDelim) **suggest PHY or MAC-level corruption.**
- **High rxCrsGlitch** values indicate **RF interference (carrier signal glitches due to noise or co-channel interference).**

📉 Primary Trend: Increasing Frame Errors

As Rx rate drops, the following metrics climb sharply:

Time	Rx Rate (bps)	`rxBadFCS`	`rxBadPLCP`	`rxFrmTooShort`	`rxNoDelim`	`rxCrsGlitch`
12:49:32.019	206,470	0	1	0	0	7
12:49:40.187	61,290	211	41	71	89	46
12:49:45.336	34,410	982	149	504	397	357
12:50:00.705	25,800	383	67	201	251	107

AI Analysis

- This was a high-density environment with overhead transmission from highly directional APs.
- Here's a clear and concise summary of your scenario and the likely contributing factors, along with actionable configuration areas to review:

AI Analysis

- Helpful areas to dig deeper into
  - **Hidden Node could well be an issue**

🔍 **Potential RF Layer Causes**

Issue	Likelihood	Description
Hidden Node Problem	🟡 Moderate	Dense crowd with poor client-to-client awareness may cause uplink collisions
Co-Channel Interference (CCI)	🔴 High	Likely in HD deployments if too many APs share the same channel or overlapping sectors
Configuration-Induced Contention	🔴 High	Suboptimal transmit power, channel reuse, or client steering policies could aggravate contention and roaming instability

- And We, the professionals, know how the directionality of the APs would mean other clients hear this but not the APs
  - This might be a good explanation of the Rx corruption
  - Which is less impactful on the Tx from device to AP

Seems like the Wi-Fi professional is still needed

Ben's Advice

Gather Data and Visualise