# WiFi Challenges

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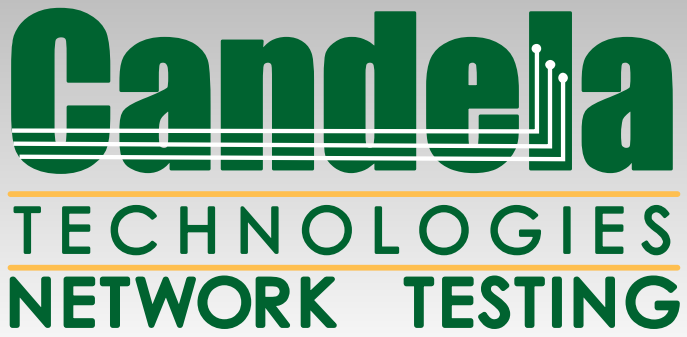
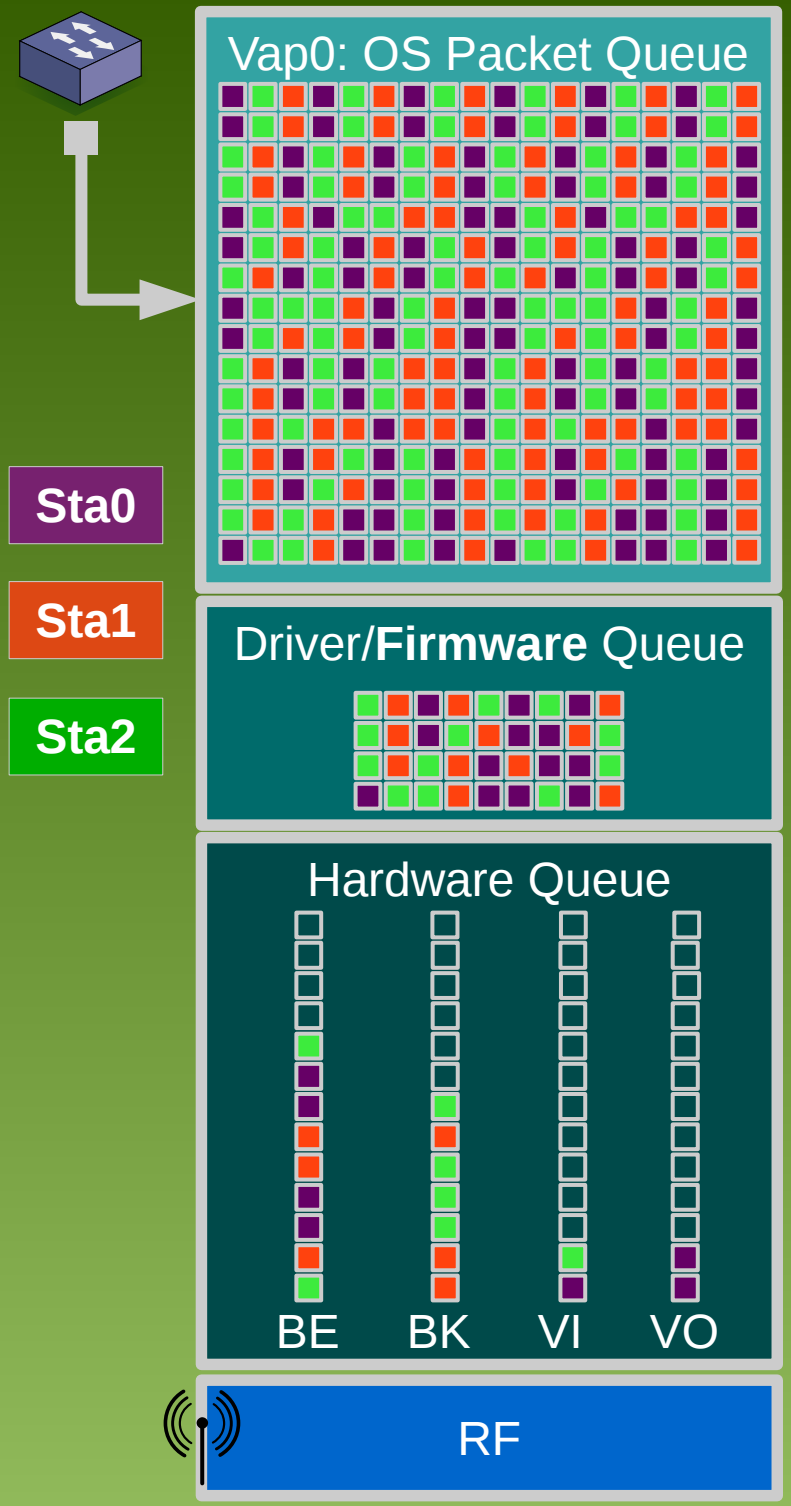
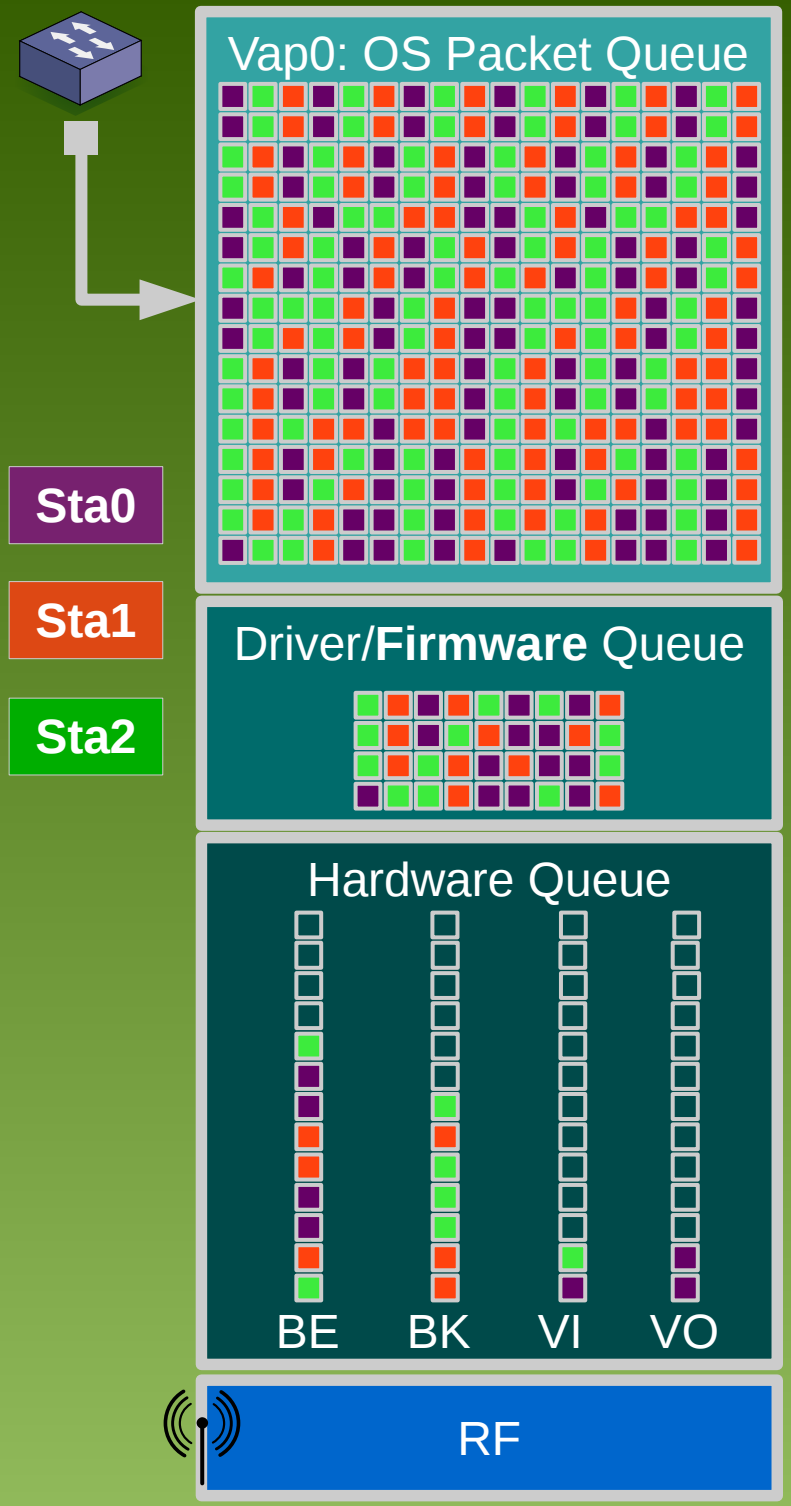


# Overview

- Performance degradation with many active stations.
  - Total throughput suffers.
  - Fairness suffers.
  - Latency suffers.
- Difficult to debug failures.
  - Networks can be complex.
  - Hard to find what is at fault.
- LANforge can help!




- Current implementations may not take good advantage of modern WiFi (HT/VHT)
- A-MSDU
  - 1-3 Ethernet frames in one WiFi-frame
  - All or nothing for those 3 frames.
- A-MPDU
  - Up to 64 frames
  - Block ACK allows re-transmits of missing frames.
  - Requires buffering frames to build A-MPDU

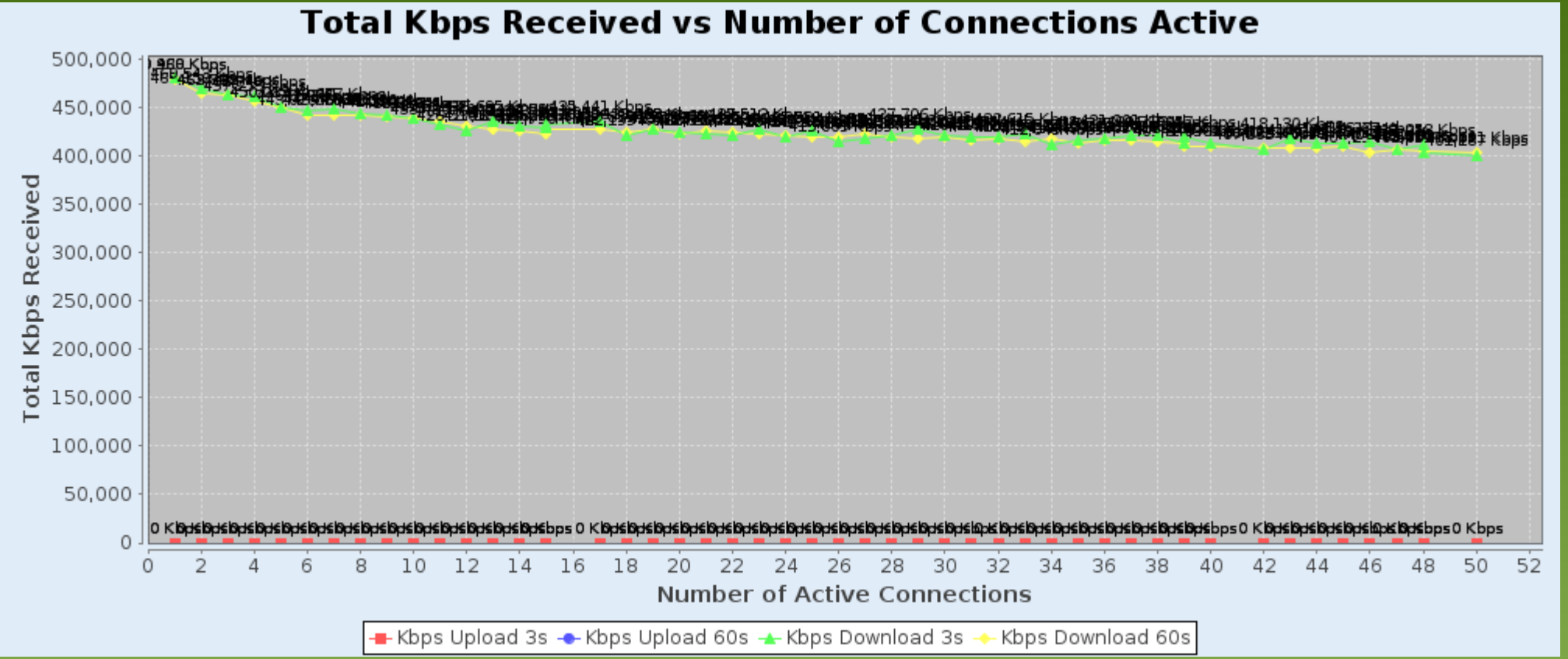



# A-MPDU

- Hard to build A-MPDU in driver or firmware without excessive packet queuing
- Hard to ensure fairness between many stations.

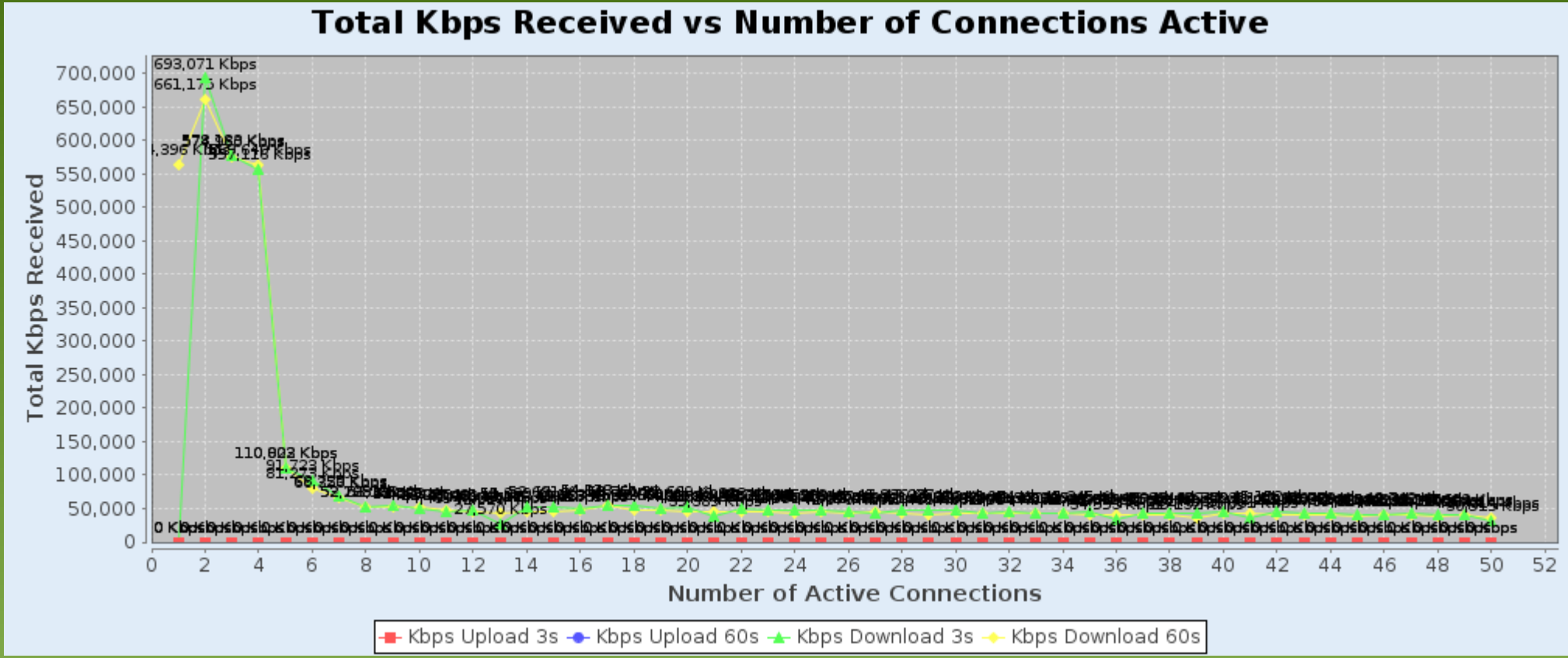
More stations and lower tx-rates make it harder to take advantage of MPDU.

# Throughput vs Stations (Asus + Broadcom)




* Over-the-Air, UDP, LANforge WiFi capacity test on CT521 with 802.11AC NIC, download from AP to station.

# Throughput vs Stations (Linksys + Marvel)

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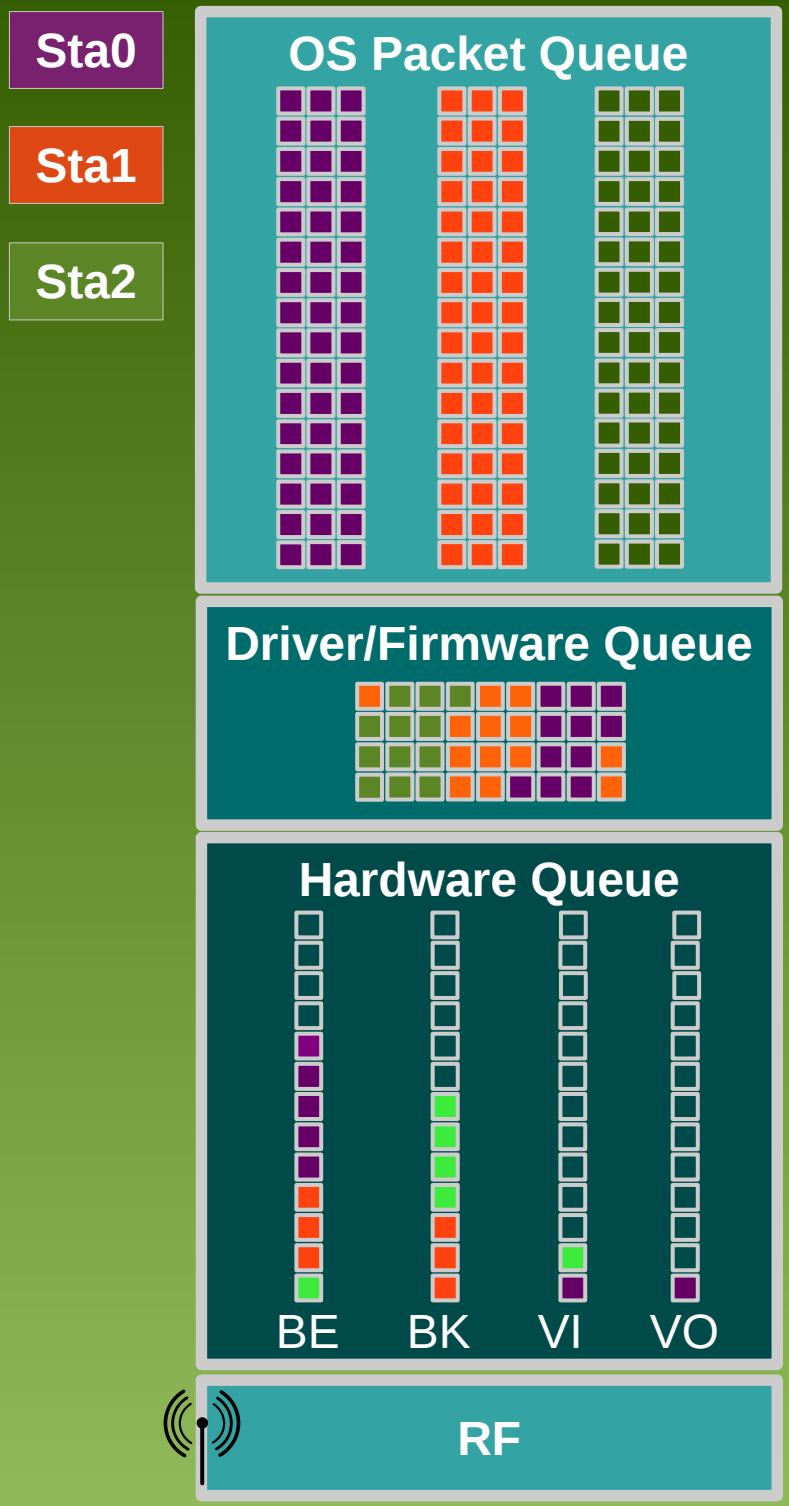
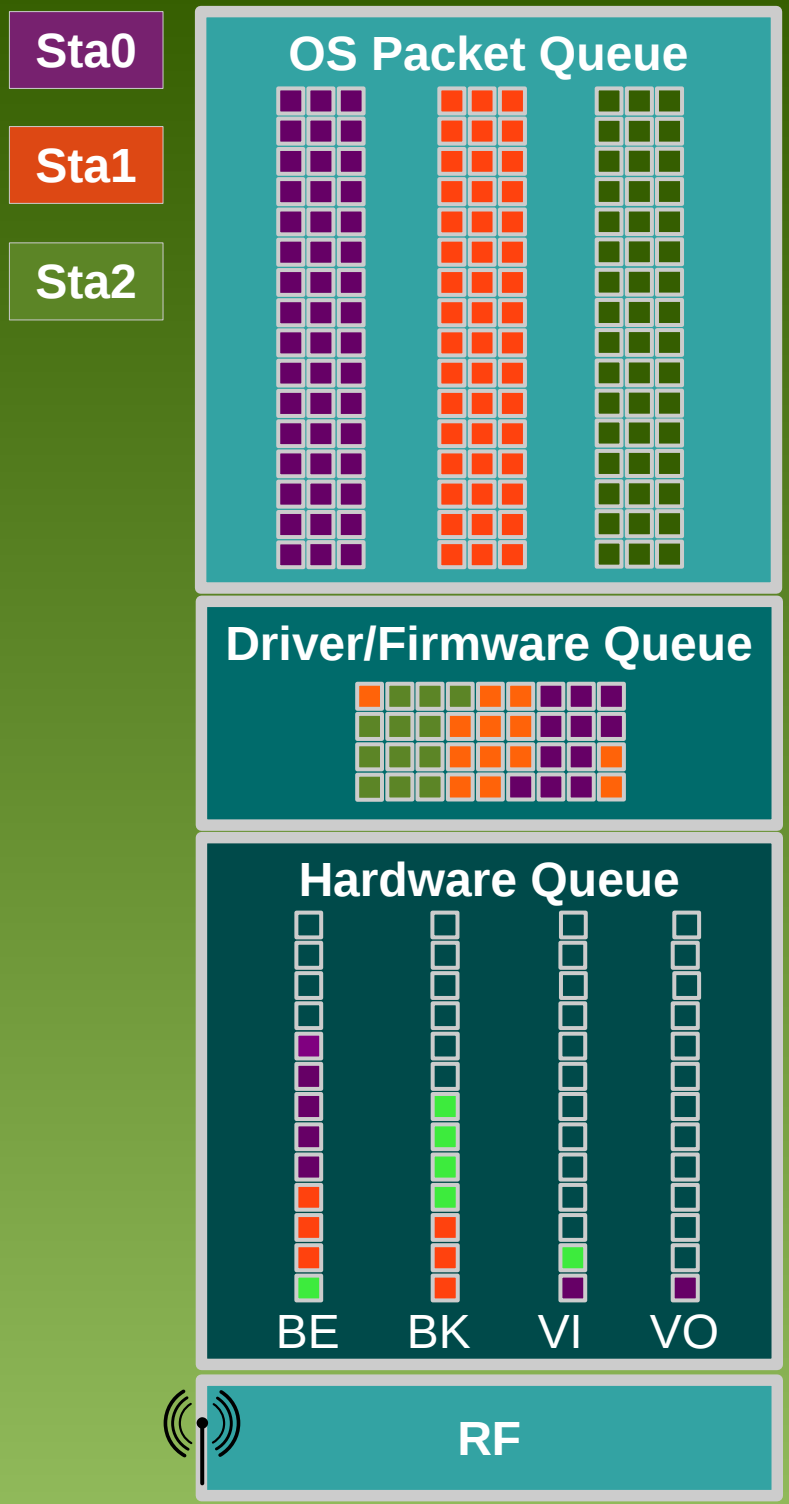


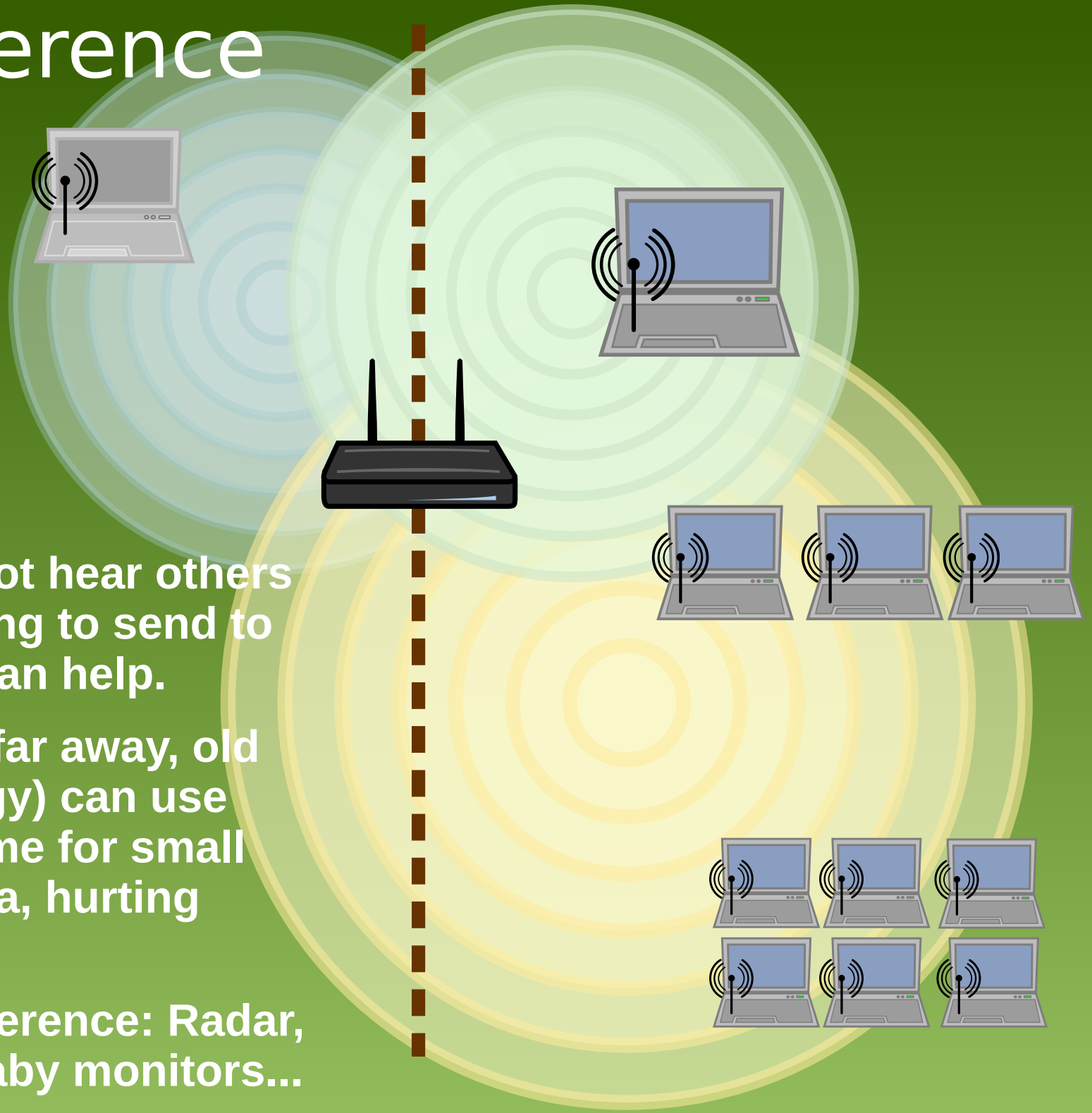

# Possible Improvements

- Per Station queues could help.
- Easier to ensure fairness higher in the OS.
- Can feed driver chunks of frames likely to consolidate into A-MSDU and A-MPDU (same peer, same TID)
- Driver queues can be short and simple for less buffer-bloat.



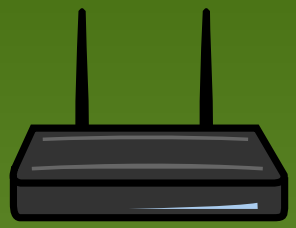

- FQ-CODEL and other smart queuing algorithms could help.
- Better rate control would help.
- Broadcast is sent at slowest rate.
- Station isolation, routed instead of bridge mode can decrease broadcast frames on the network.
- Initial work by Felix Fietkau looks promising.

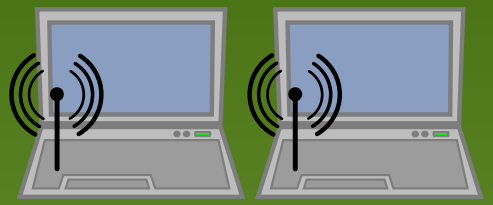
# RF Interference



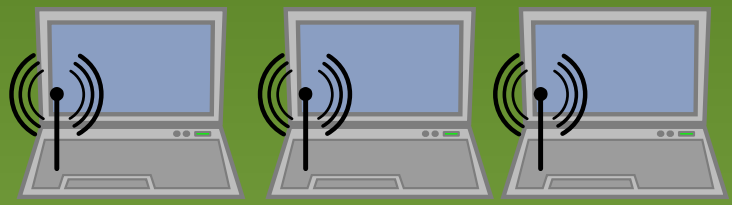
- **Stations may not hear others and collide trying to send to AP.  RTS/CTS can help.**
- **Slow stations (far away, old hardware, buggy) can use excessive airtime for small amounts of data, hurting everyone.**
- **Non-WiFi interference: Radar, microwaves, baby monitors...**

# Fairness

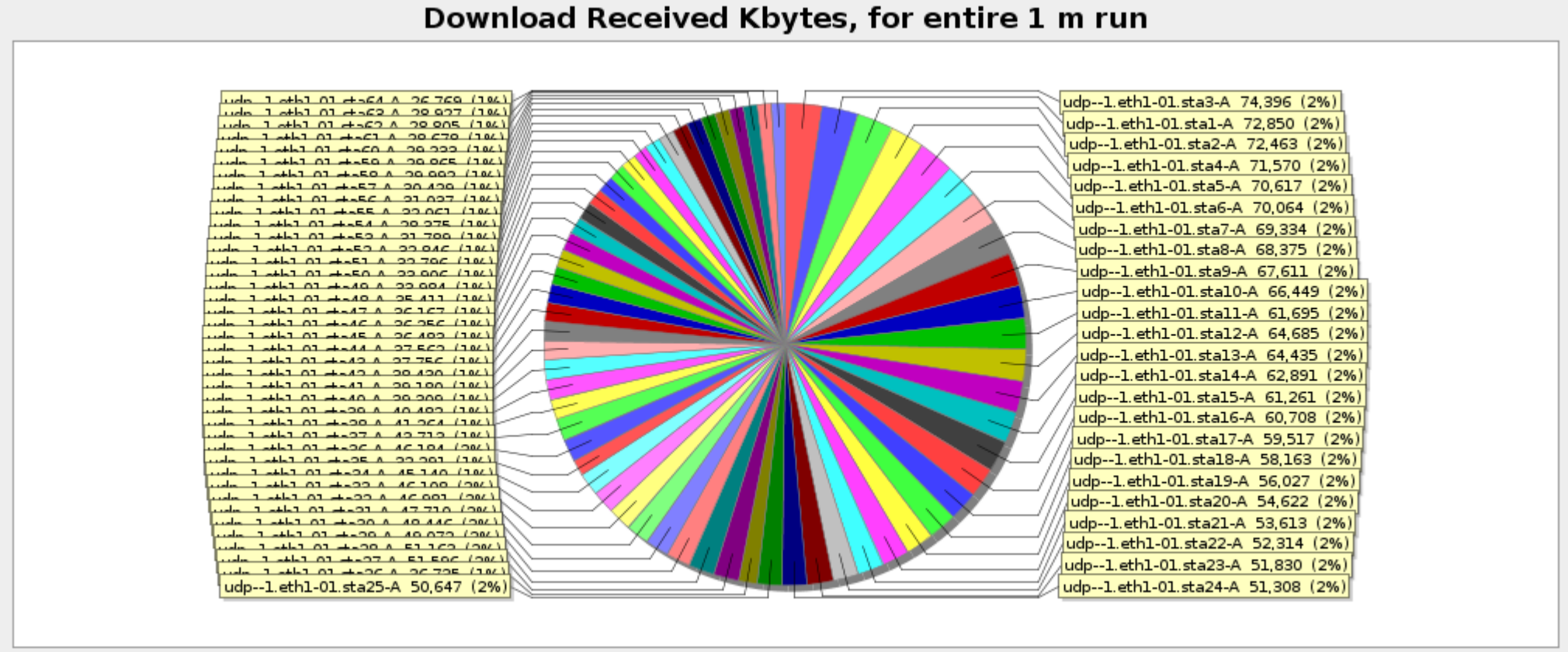




- **For download, AP should ensure fairness.**
- **For upload, stations must play by the rules and try to be nice.  AP could attempt to ensure fairness, but cannot guarantee it.**



# Download Fairness (Asus + Broadcom)

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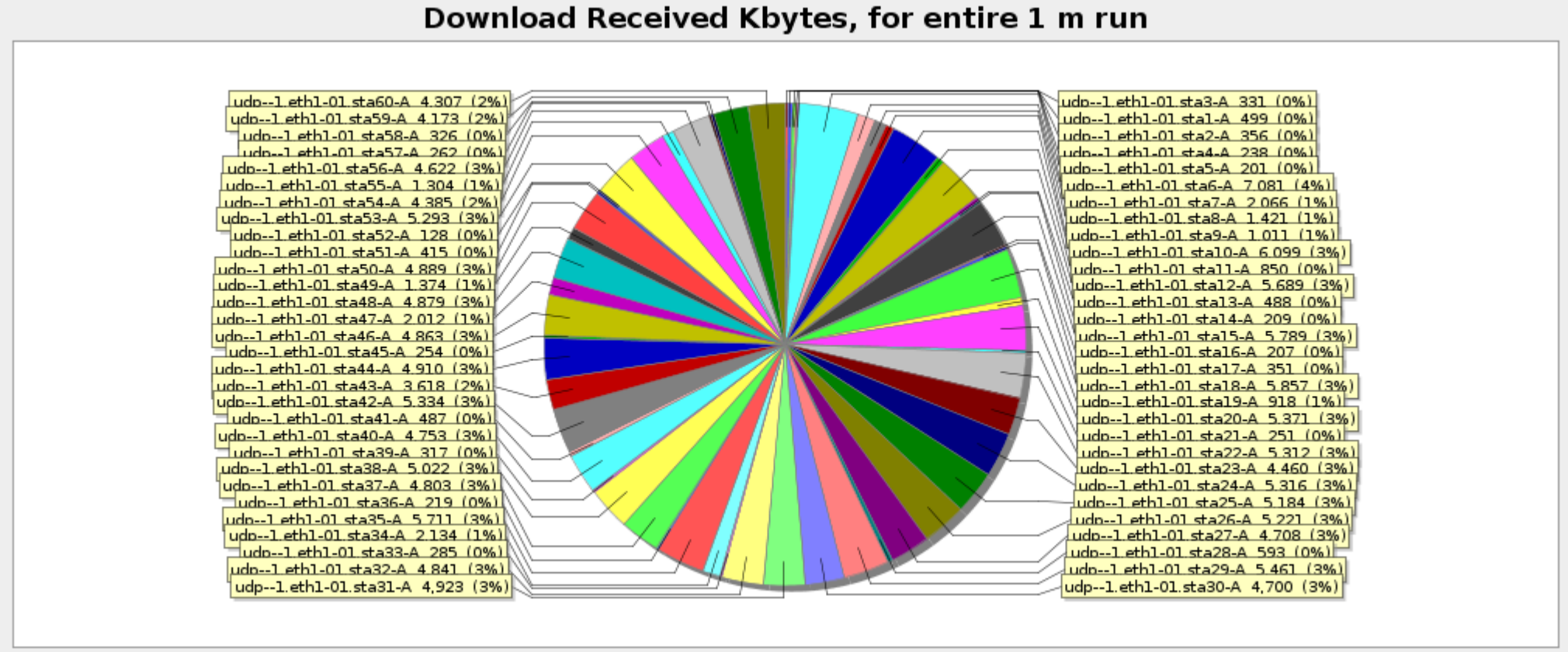


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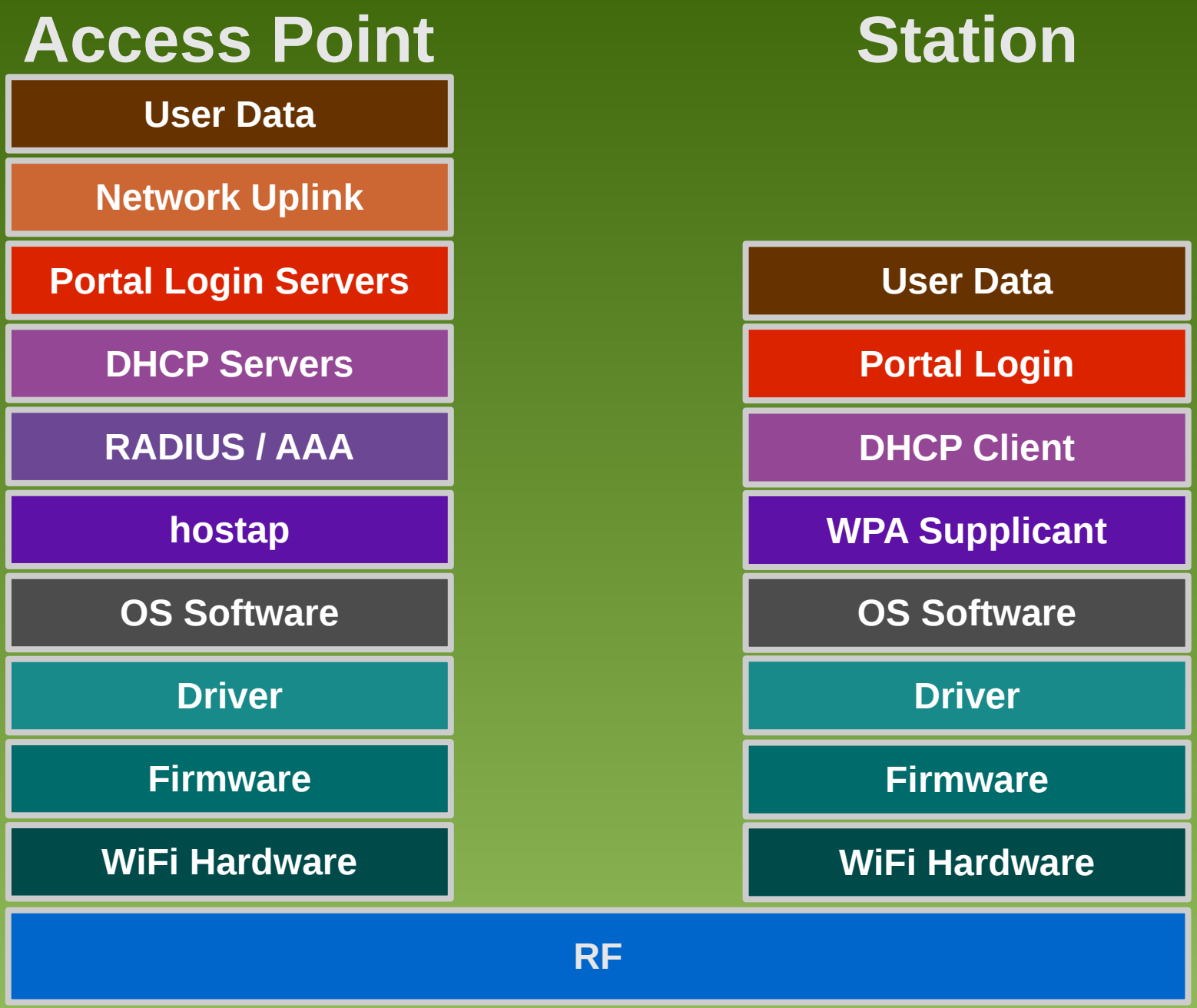
# Potential Failure Points



- **Network Uplink:  Ping from AP to Internet.**
- **DHCP Servers:  Check lease pool exhaustion, decrease lease duration, provide larger pool.**
- **RADIUS/AAA:  Normally shows up as station being unable to authenticate with AP.  Check RADIUS server and AP (hostapd) logs.  Check station is actually configured properly.**
- **Hostapd/supplicant:  Check logs and configuration.  Check AP's connectivity to RADIUS if using 802.1x.**
- **OS software:  Check kernel logs, regulatory domain**
- **WiFi Driver:  Enable debugging, check kernel logs, check debugfs files (on Linux).**
- **Firmware:  Check driver logs for info about firmware troubles.  Ask your vendor to provide open-source firmware so that you have the ability to fix their bugs!**

- **Hardware:  Sniff on-air to make sure frames are sent and received properly.  Check antenna orientation (or cable quality).**
- **RF Environment:  Sniff and/or use spectrum analyzer to check for overly busy RF environments.  Check low-level driver stats (retransmits, CRC errors, channel-busy-time).**

- **LANforge can test and verify all of this!**

# General Problem Solving

- Network and WiFi sniffers are often required to understand difficult problems.
- May have to sniff at multiple locations concurrently.
- Check kernel, driver, hostap/supplicant, RADIUS and other logs.

# How LANforge can Help

- Emulate many stations in one piece of test equipment.
- Easy creation of various test cases through GUI.
- CLI support for automated testing.
- Statistics and events reporting.
- Excellent customer support.
- Often Candela can add customer feature requests quickly.

# LANforge WiFIRE Platforms

Model **CT520**
- Single Radio
- Max. 128 virtual STAs

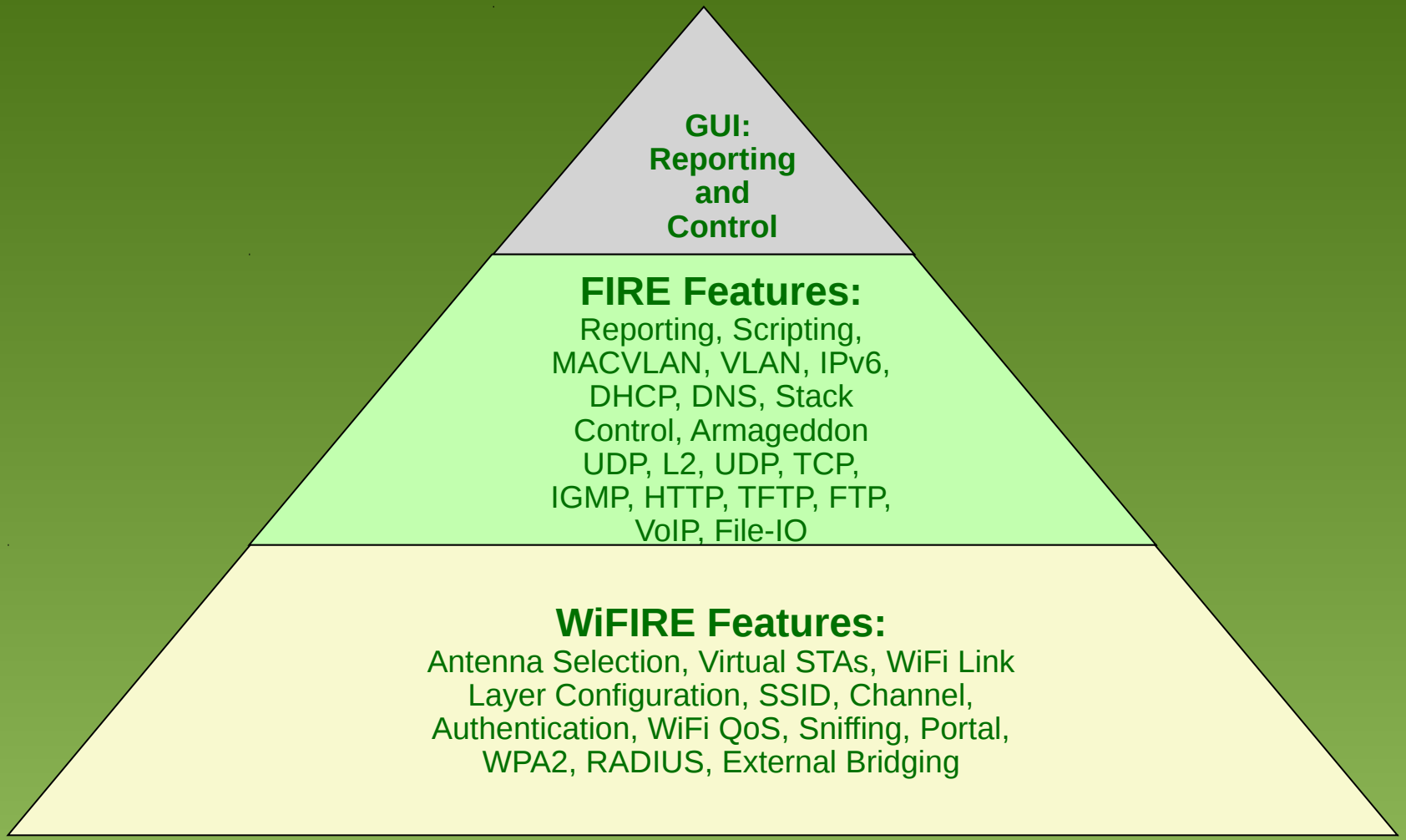
Model **CT521**
- Dual Radio
- Max. 400 virtual STAs

Model **CT523**
- Triple Radio
- Max. 600 virtual STAs

Model **CT525**
- Hex Radio
- Max. 1200 /n virtual STAs


-Model **CT703**
- 3 Channel Attenuator
- Controlled via LANforge or Manually
- Rate vs Attenuation Scripting

# LANforge Feature Hiearchy



# LANforge WiFIRE Applications

- WiFi station functional testing
  - Scan and Associate
  - Authenticate (Open, WPA2, 802.1x, …)
  - DHCP & Network Traffic Generation
  - Migration (Code-17)
- Multiple traffic flows across WiFi clients.
- QoS verification.
- Automated WiFi client capacity testing.
- Captive Portal login, logout, and verification.
- Mobility Roaming  [802.11r/u/Hotspot 2.0(HS2.0)/802.1X FT]
- 802.11w Management Frame Protection.

# LANforge WiFIRE Features

Reported Statistics:

Rate, Link Status, Channel Utilisation, RSSI/Signal Strength, Noise, Decrypt Failures, WiFi Dropped, WiFi Retry, Missed Beacons, SSID, IP Address, Regular Packet Statistics.

WiFi radio settings:

Country, Frequency, RTS, Antenna configuration.

Virtual STA is realistic, with unique MAC address and routing table.

Virtual STA settings:

SSID, Authentication, AMPDU, AMSDU, AP MAC, abgn Mode, MCS rates, WiFi Bridge, HT40, Guard Interval (SGI)

Continued…

# LANforge WiFIRE Features

## Automated Tests

- Rate vs Attenuation Scripting.
- WiFi Capacity testing.
- Station re-association testing.
- Hunt highest throughput rate vs packet size (and attenuation)
- Java plugin API to allow customers to write their own automation.

# References

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