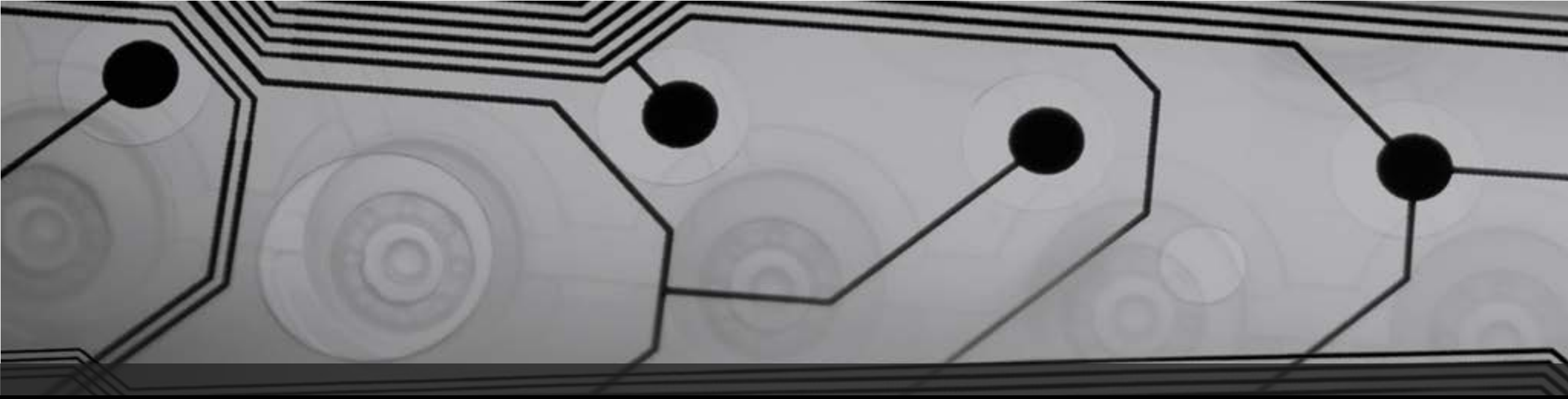
IP Connectivity to transmitter sites



It’s not as bad as you may think!

Why extend your LAN to a transmitter site?

- Most of the modern equipment needs an ethernet port!
- Better monitoring and remote control of equipment
- With addition of audio CODEC, it can become your main or backup STL
- Extension of IP-based phone system
- Internet access for site PCs
- Off-site backups

Why unlicensed?

- Lower cost
- No need for coordination
- No need for recoordination
- Available bands have some advantages over licensed bands
- Advances in technology have made them more reliable and more robust

Why *not* unlicensed?

- No protection from interference

Most widely used bands

- 902-928MHz
- 2.40-2.48GHz
- 5.15-5.875GHz
- 24.0-24.250GHz

Rules of 902-928MHz

- Maximum transmitter power output of 1 watt
- Maximum Effective Isotropic Radiated Power (EIRP) is 4 watts

902-928MHz

Advantages

- Stations likely already have hardware available for this band
- Can be combined with existing 950MHz STL with minimal loss
- Not limited to ethernet, so antennas can be higher
- Best propogation

Disadvantages

- Channel space is limited
- Harmonics fall in licensed spectrum

Rules of 2.40-2.485GHz

- Maximum transmitter power output is 1 watt (30dBm)
- Maximum EIRP is 4 watts (36dBm)
- Antenna gain can be raised to be above 36dBM, but for every 3 db of gain, you must reduce transmitter power output 1 db

2.40-2.4835GHz

Advantages

- Better tolerance for path obstructions
- 40-50 miles possible

Disadvantages

- Most used by consumer products
- More prone to interference
- Can increase antenna gain, but must reduce transmitter output power
- Fewer channels to operate simultaneously on

50 shades of 5Ghz

- Band is divided into 4 ranges
  - Low 5.15-5.25GHz
  - Mid 5.25-5.35GHz
  - Worldwide 5.47-5.725 GHz
  - Upper 5.725-5.825GHz

Rules of 5Ghz

- Power levels are limited in lower band to 160mW EIRP
  - 800mW in Middle band
- In Worldwide band must protect against radar interference

Rules of 5.8GHz – Upper Band

- Maximum transmitter power output is 1 watt (30dBm)
- Maximum EIRP is 12 watts (53dBm)

5.725-5.825Ghz

Advantages

- Less interference
- Can increase antenna gain without having to reduce TX output power.
- Higher number of available channels
- 30 Miles possible

Disadvantages

- Less tolerant of path obstructions
- Not good for long shots

24.0-24.250GHz

Advantages

- Less interference
- Large throughput

Disadvantages

- Subject to rain fade
- Only works over very short distances

Optimizing Use

Optimizing use

- Utilize vertical real estate to “rise above” the interference
- Take advantage of built-in spectrum analyzers to select best channel
- More interference means more latency
- Difference in radios, chips, etc… can add latency

Optimizing use

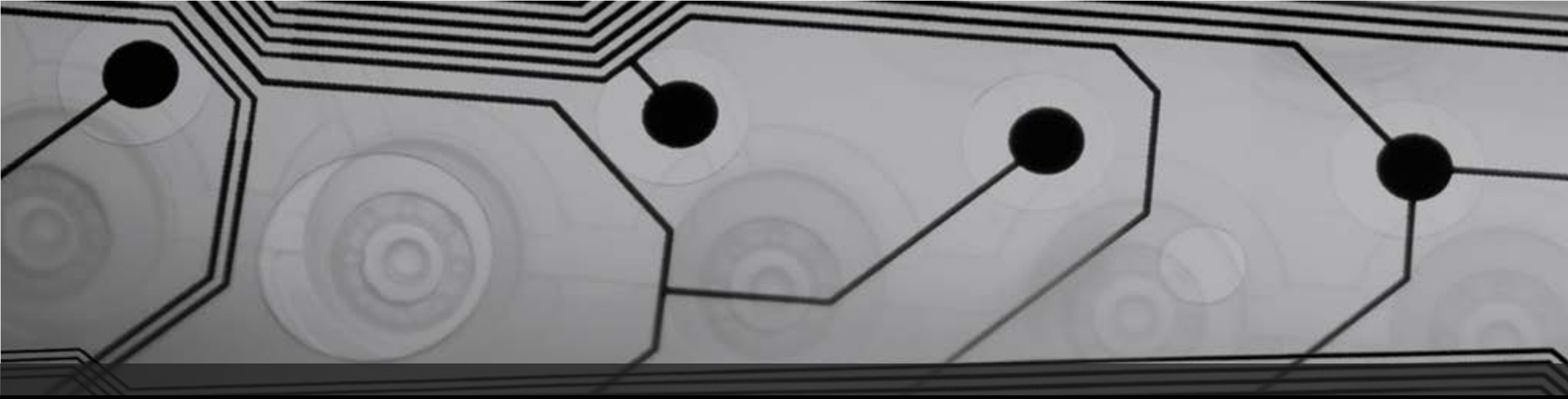
- Keeping devices to a minimum, using point-to-point mode, reduces latency
- Turn off any firewalls, DHCP, etc… to reduce latency
  - Keeping latency low adds ability to run codecs in PCM mode, ability to multicast
- Use shielded cable, ground, and use ferrite chokes
- Cat 6 cable is preferred

Optimizing use

- For redundancy, setup multiple radios in different bands
- Reduce bandwidth to improve signal level and reliability, and minimize interference

Things to look out for

- Rural areas may have congested bands, due to WISPs
- Many radios are smart enough to hop frequencies and adjust bandwidth automatically, but may create more problems than it solves
- Coming 802.11ac devices may create more interference due to simultaneous use of multiple channels
- For integrated radio/antennas, height is limited to ethernet limitations

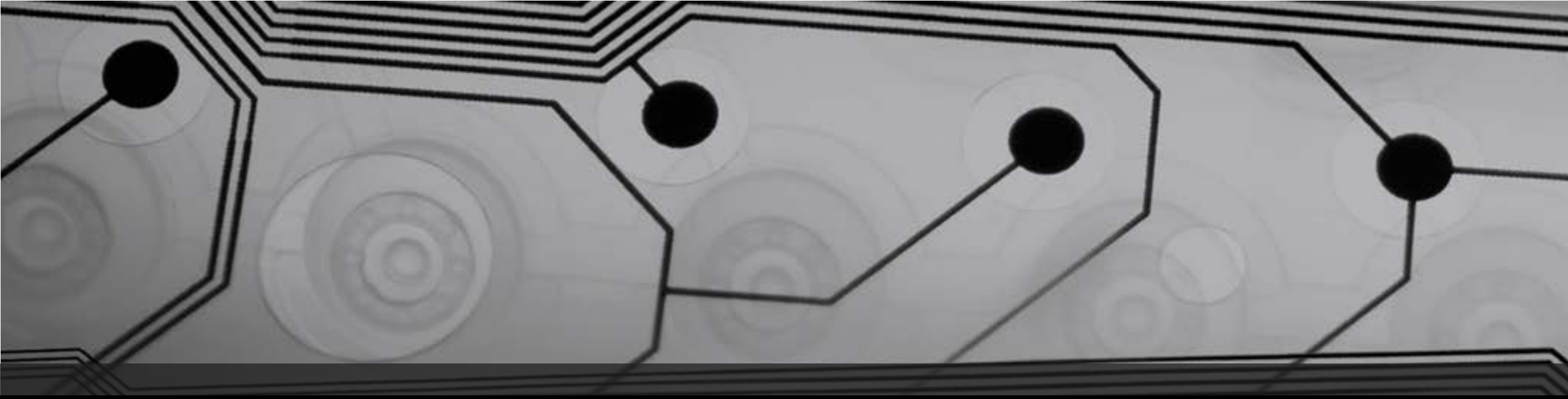


Security

Take it seriously!

Security

- Security works similar to wi-fi
- Hide SSID
- Restrict access to specific MAC addresses
- Utilize proprietary encryption



Real world use

5.8 GHz link at WHA-AM

The need for a new STL

- Existing STL was equalized phone line with limited bandwidth
- Had a number of backups, including licensed options
- Good line of site path just over 2 miles

The need for a new STL

- Selected Ubiquiti Air Grid 5.8GHz radios, with 27dbi antenna
- Total cost for hardware-$350

How it worked out

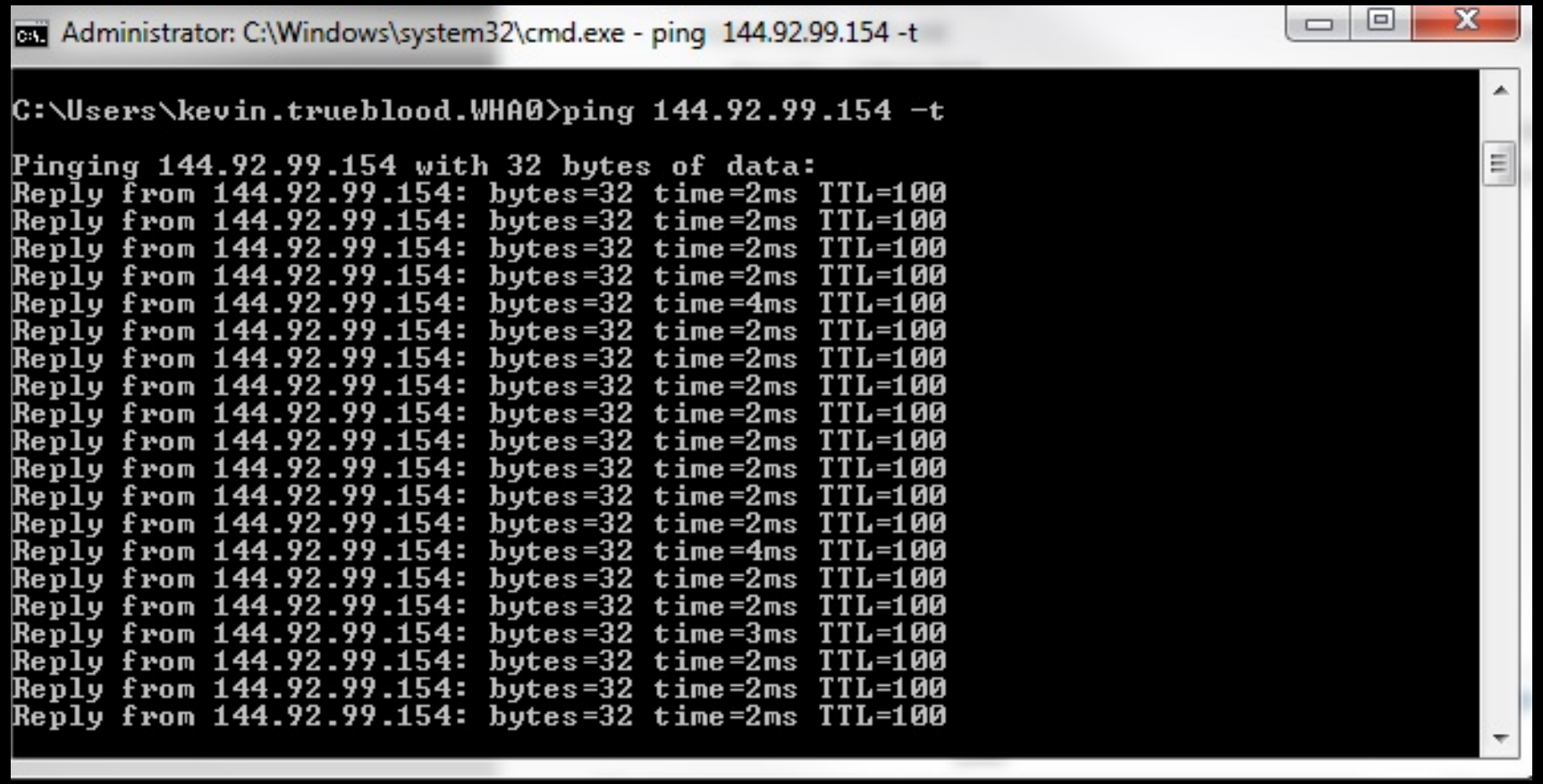
- Using 40MHz bandwidth
- Getting 100MB of throughput
- Averages 2-3MS latency
- Running Barix audio codecs in PCM mode for STL
- Backhauling redundant satellite audio to studio, also in PCM mode.

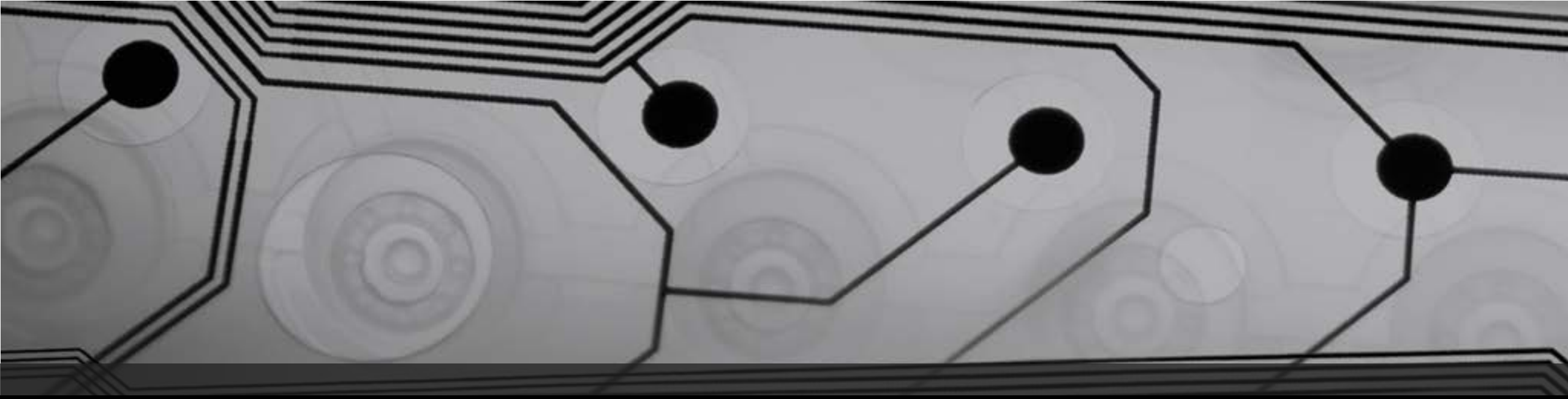
How it worked out

- When first started, latency was inconsistent
- Noted intermittent interference
- Moving channels, zero problems in nearly a year

Small footprint!

Network latency



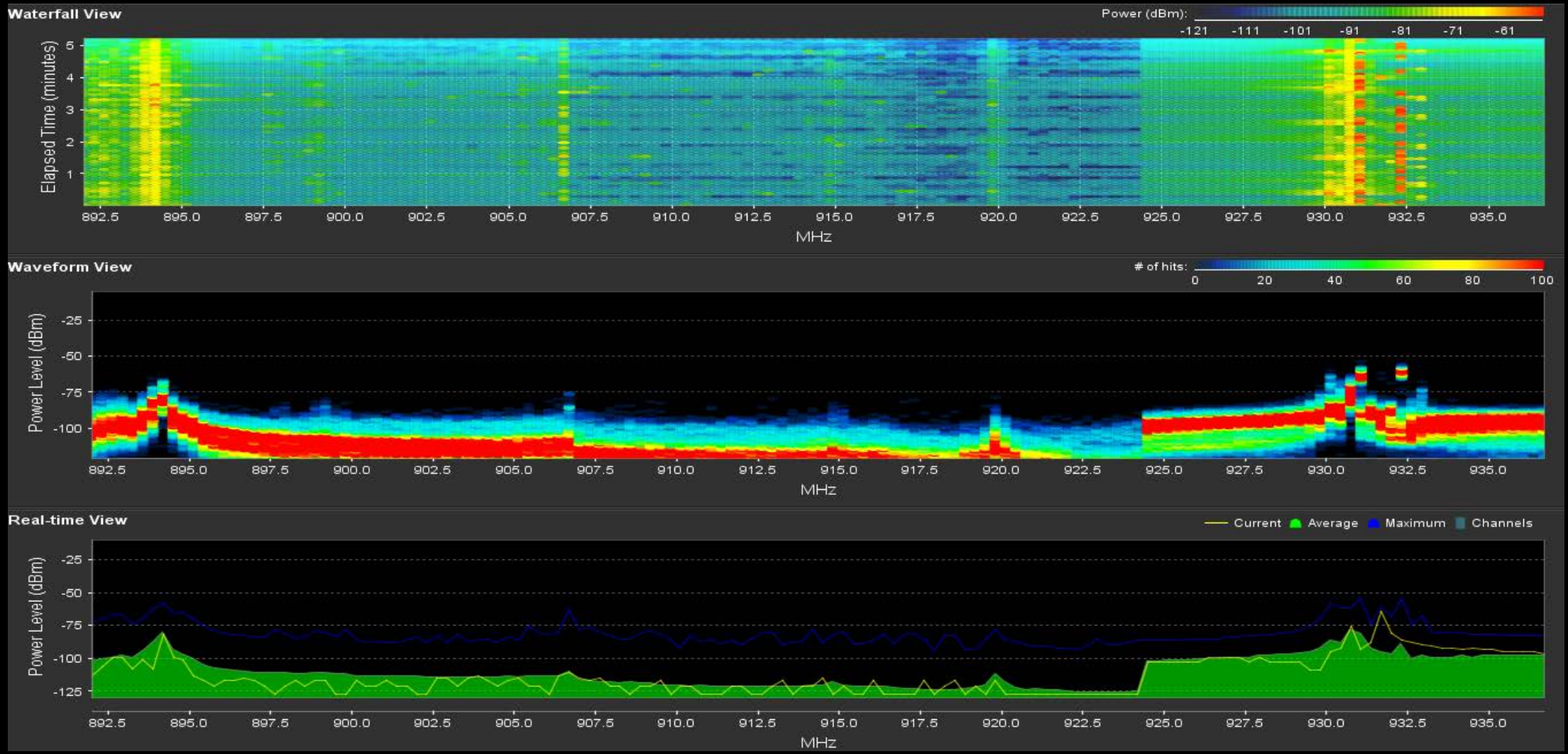


Real World Use

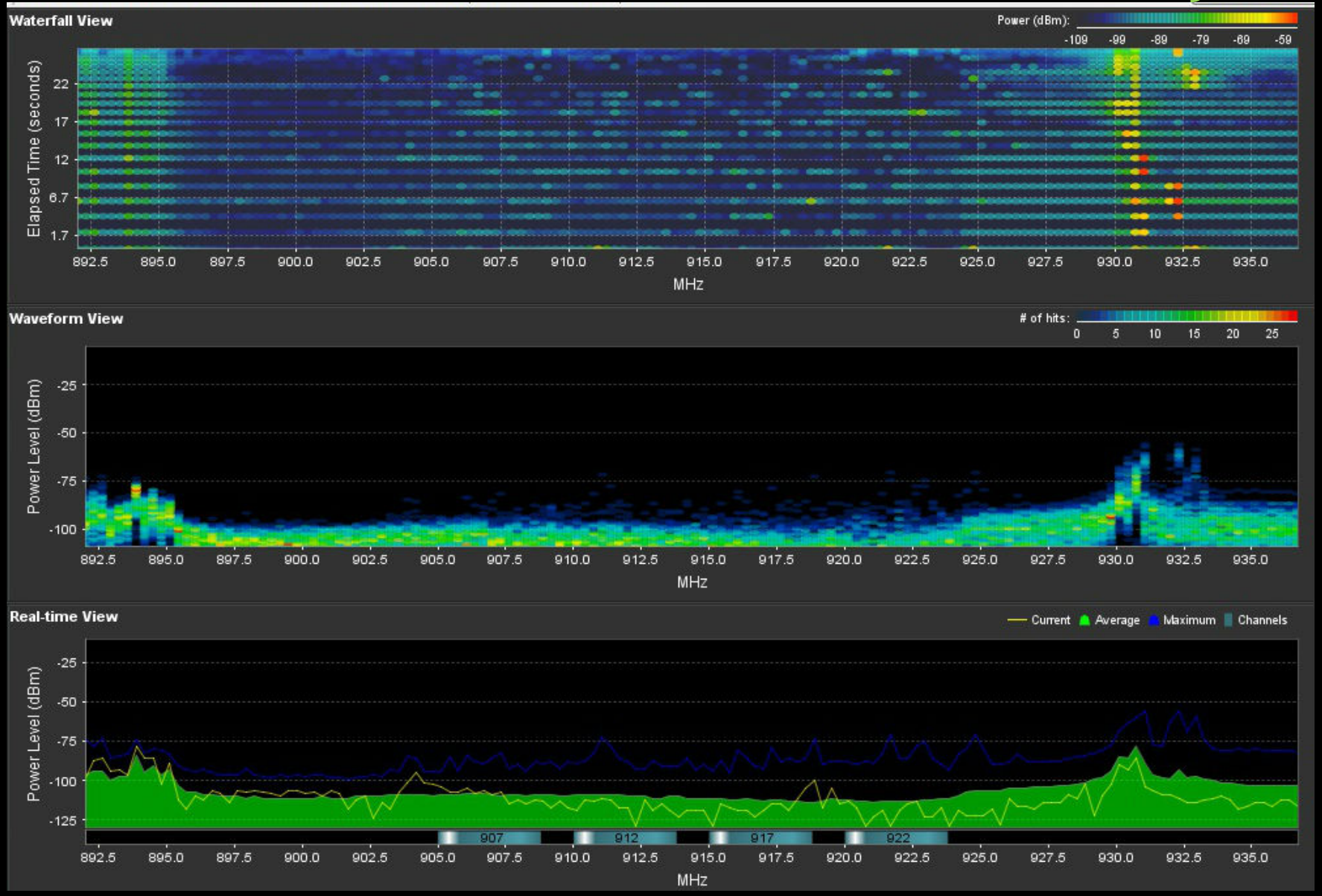
What the bands look like

5.7-5.8GHz band, Downtown Madison, WI

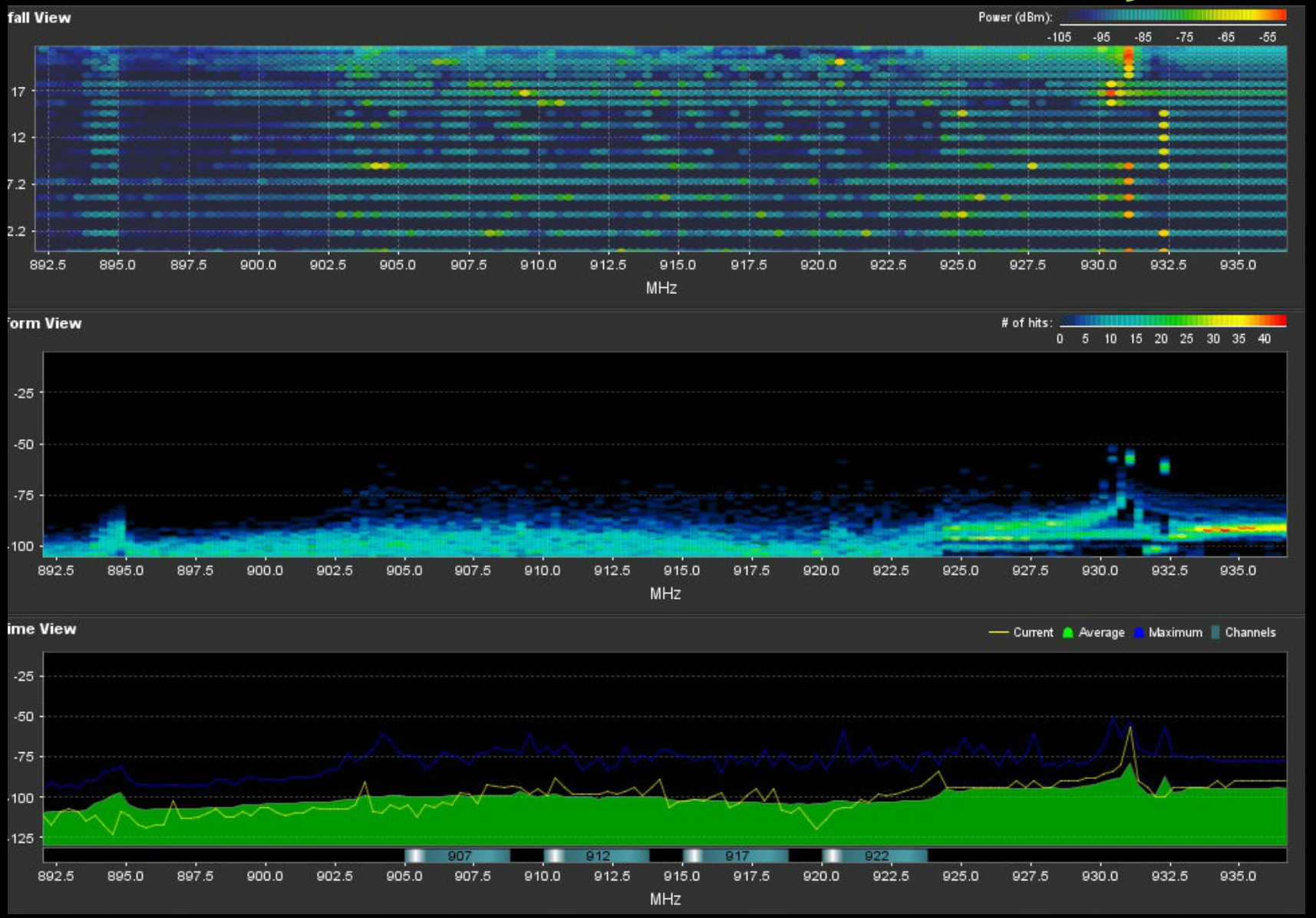
902-928MHz, Downtown Madison, WI

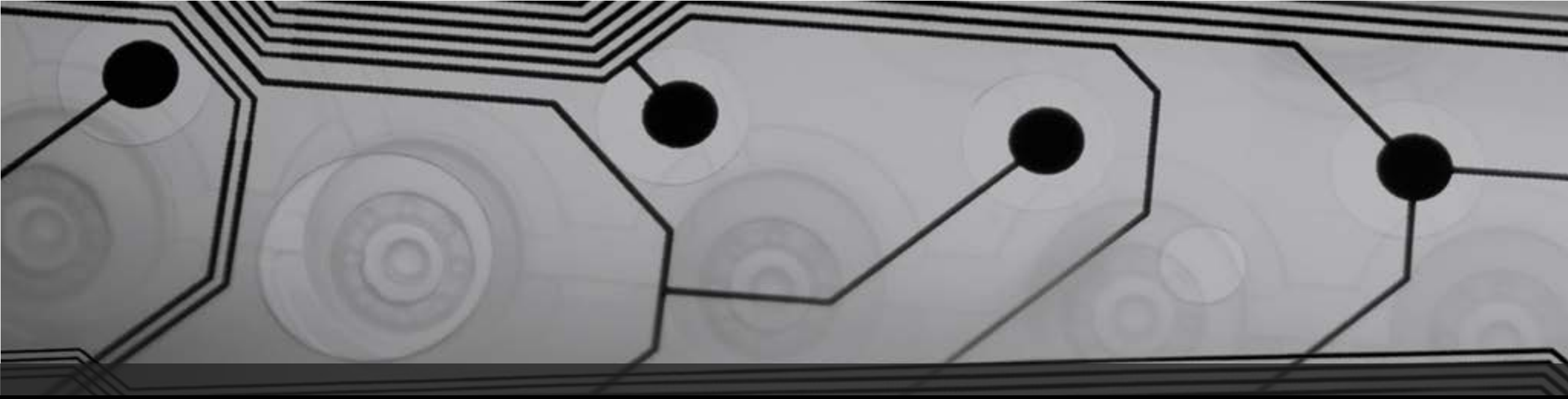


902-928MHz rural area near Paoli, WI



902-928MHz “The Hill” Duluth, MN





Thank you!

Kevin Trueblood
Broadcast Engineer
Wisconsin Public Radio
kevin.trueblood@wpr.org