



**Cambium Networks™**

**Wireless That Just Works**  
CBRS Updates and Experience

# Cambium Networks at a Glance

- Spun out of Motorola Solutions in October 2011
- Pioneer in Point-to-Multipoint & Point-to-Point IP Wireless Broadband Solutions
- Industry leader in High-Density Wi-Fi solutions
- Emerging leader in IIoT and 5G like solutions
- HQ outside of Chicago, IL with 700+ employees across 6 continents
- More than 5,000 channel partners in 150+ countries
- More than 7 million nodes shipped totaling over \$1.5B
- IPO on NASDAQ in June 2019



**Cambium Networks™**

Wireless That Just Works

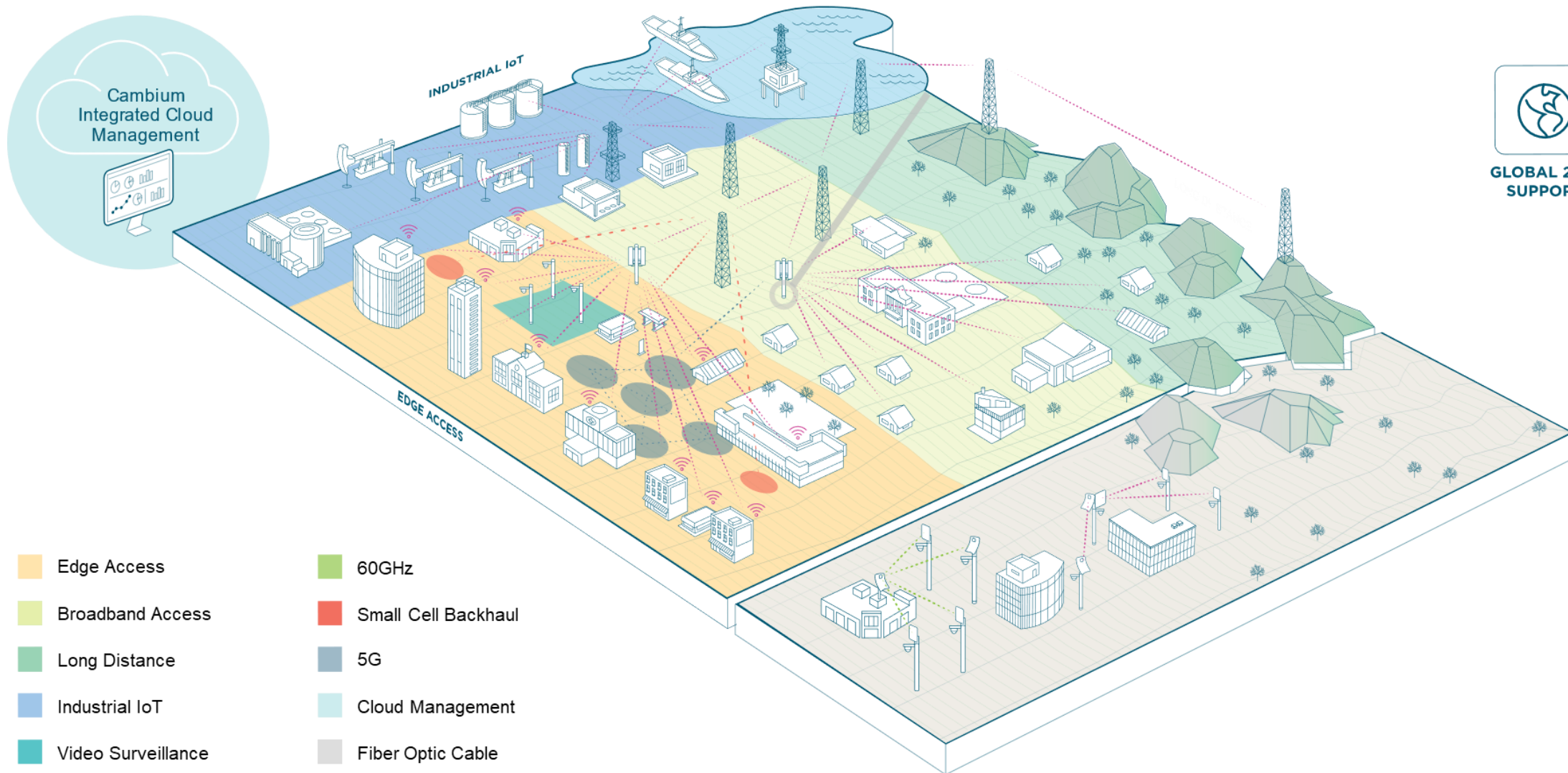


- ✓ Education
- ✓ Enterprise connectivity
  - Federal and defense communications
- ✓ Industrial IoT connectivity
  - Rapid connectivity for disaster recovery
- ✓ Remote facility connectivity
- ✓ Rural connectivity
  - Video surveillance

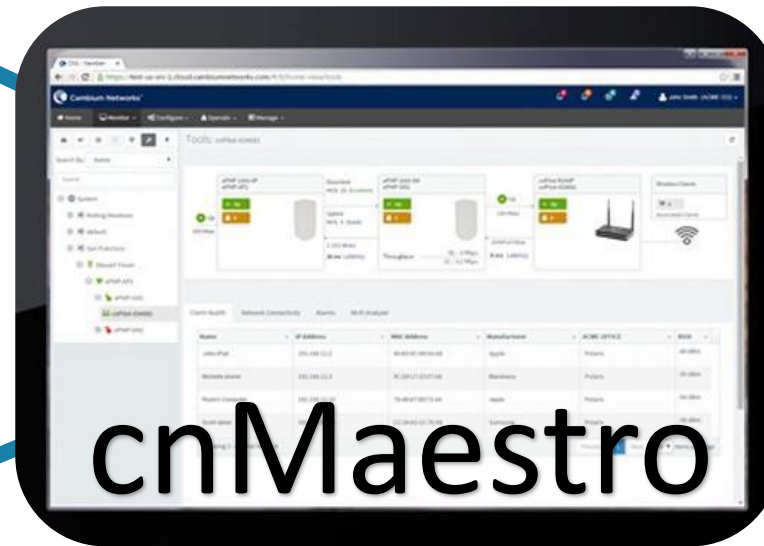
✓ CBRS Solutions



# Cambium Networks' Gb Wireless Fabric



# Cambium Vision: Convergence, Zero-IT, It Just Works



**Connect the Unconnected – People, Places and Things with Proactive Capacity and Automation**

Wireless expertise

Broad portfolio of technology

Centralized cloud management

Global network of partners

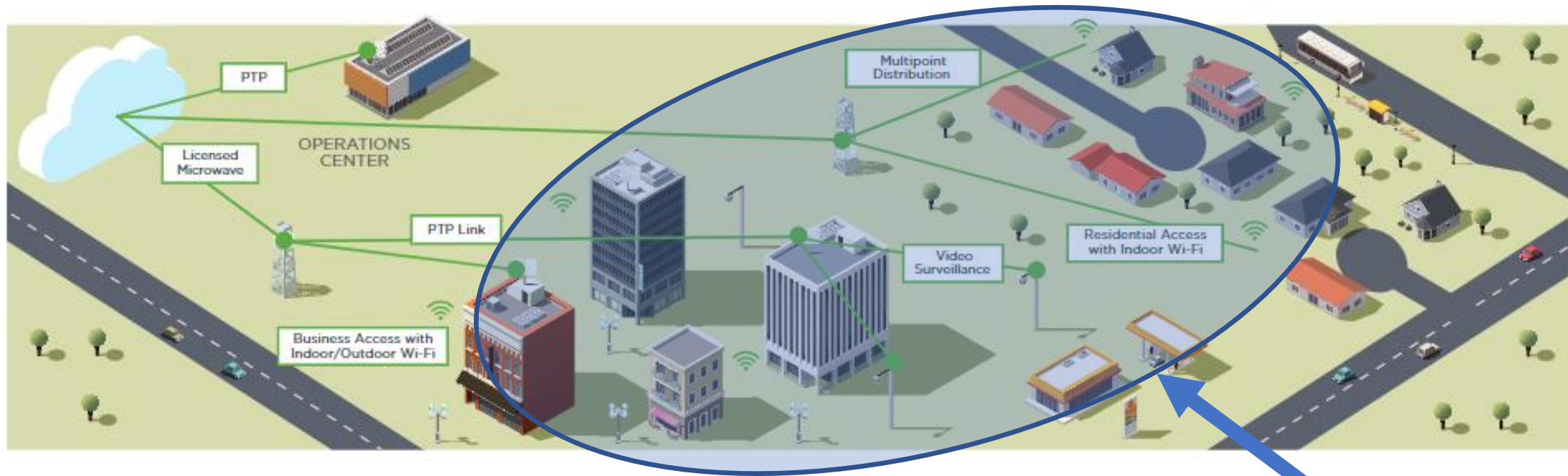
Proven business case and TCO

Wireless That Just Works



# CBRS Market Solutions





**Business and residential access**

**High capacity connectivity for streaming video, voice, and data**

**Licensed, unlicensed, and defined use frequencies**

**Proven reliability with millions of modules deployed**

**CBRS Solutions**



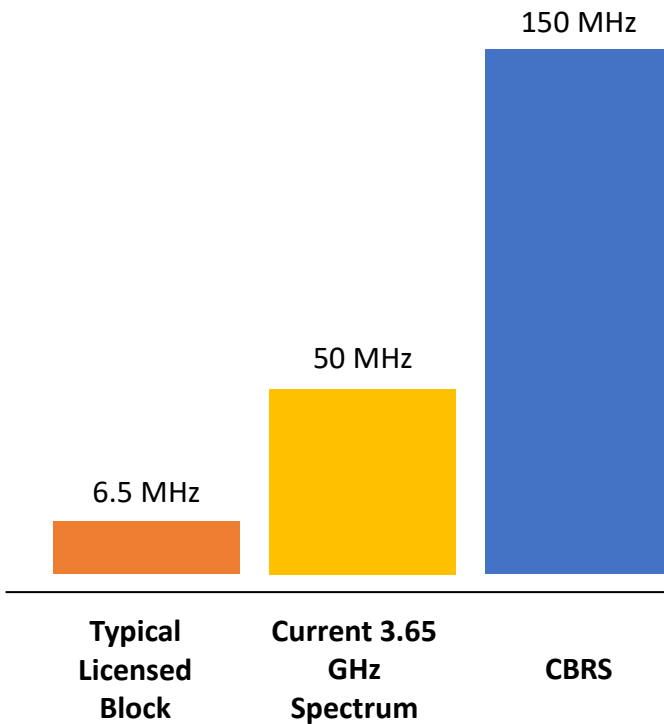
- Dynamic Spectrum Sharing model can be applied to any spectrum globally
  - Tiered approach to protect several classes of users of the spectrum
  - Allows sharing of unused portions of spectrum, while mitigating interference caused

- **CBRS** itself is quite complex

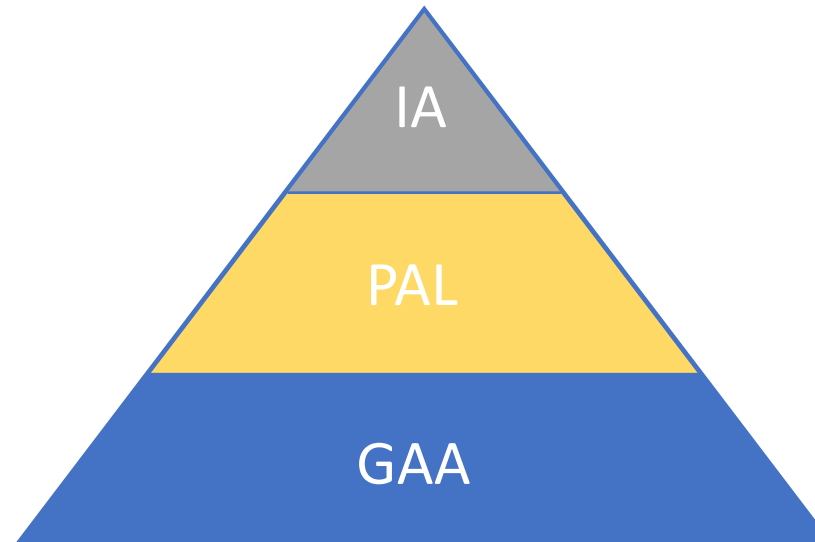
Pros	Cons
Lower Frequency than unlicensed 5 GHz (better penetration)	Spectrum sharing has a cost
Higher EIRP allowed	Hype around uses could cause congestion
Spectrum is actively managed	Equipment in this band slightly more expensive than traditional unlicensed
Incumbents protected	Standards-based (LTE) kit is predominant, and top of mind
Option to purchase license for priority use	Rules and requirements very complex

- When success is demonstrated, it's expected that many other regions and bands may adopt similar models

## Opportunity



## Tiered Flexible Use



### Incumbents

- DoD Radars (coastal areas)
- Satellite Earth Stations

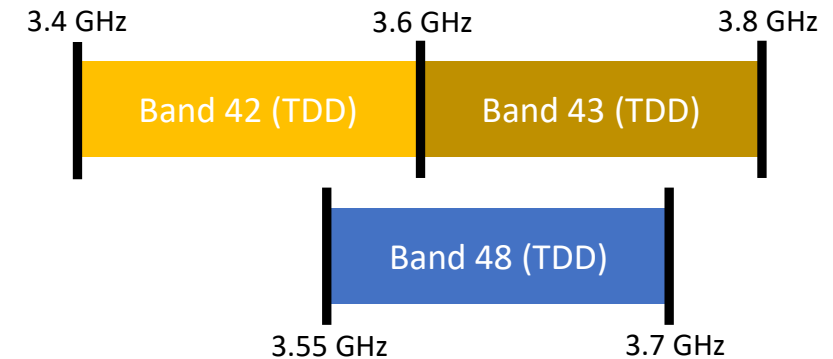
### Priority Access Licenses (PAL)

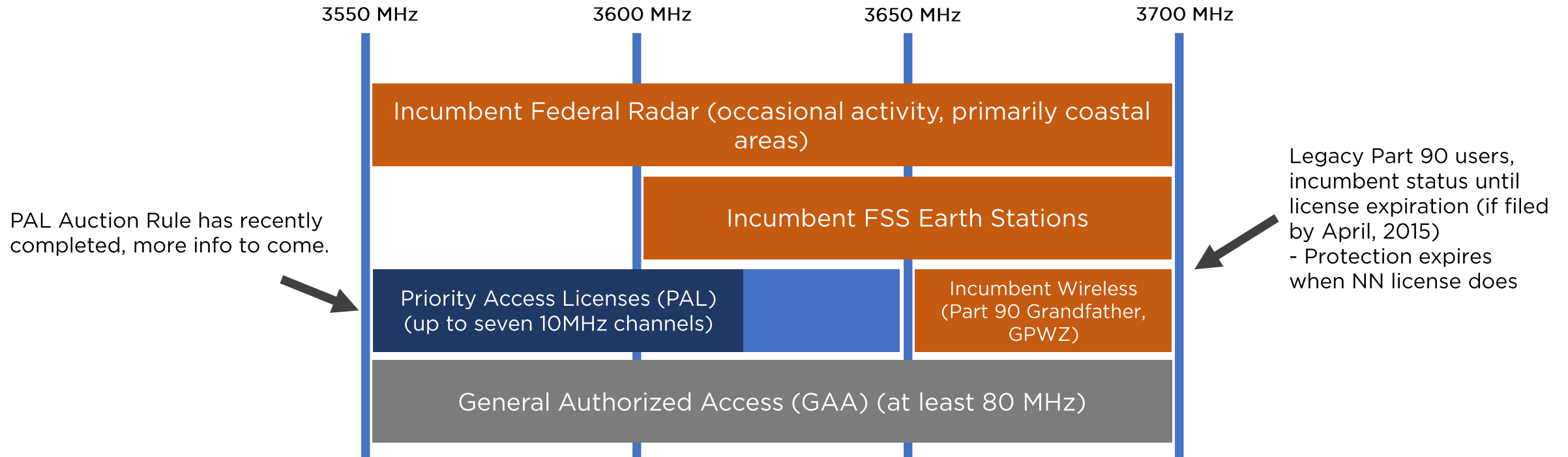
- Up to 70 MHz of spectrum licensed by auction

### General Authorized Access (GAA)

- At least 80 MHz nationwide

## Establishing a New Common Band



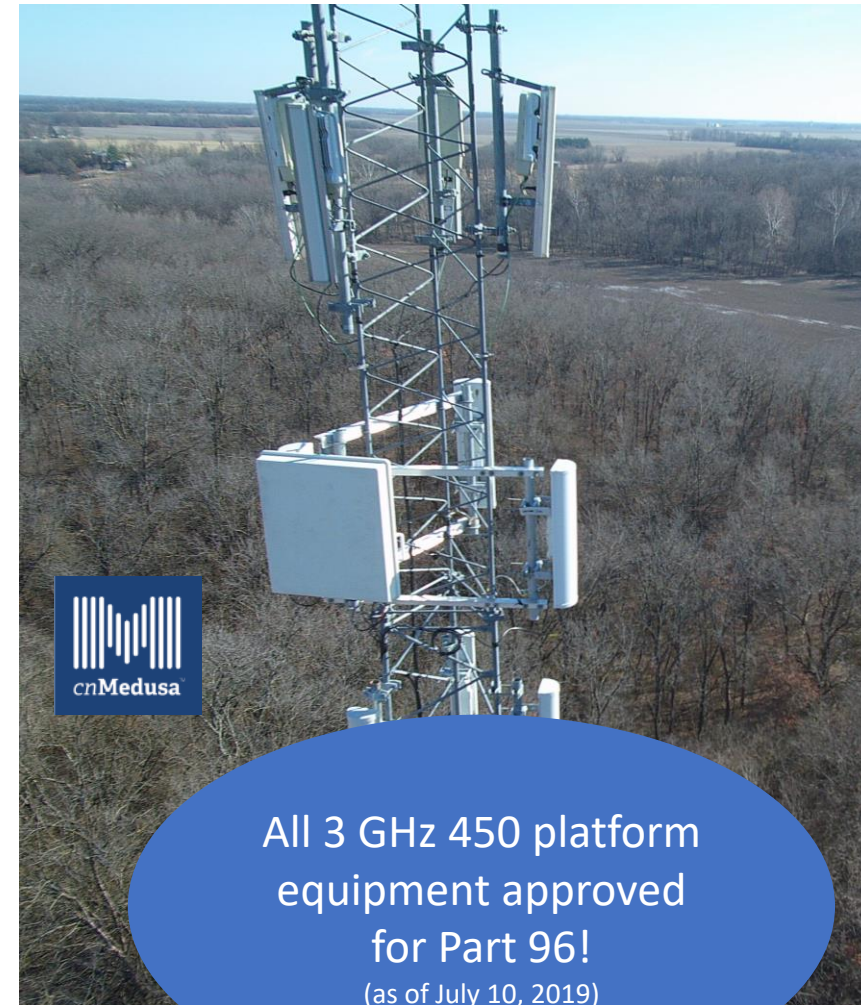


Cambium expects that many of its customers have won PAL licenses in counties in which they are operating, affording them some protection in using CBRS, and assuring the continued use and expansion of their networks.

- 450 platform readiness and works with all major SAS providers



- Customer enters into *direct* business relationship with Cambium, but can choose SAS they like
- Complete 3 GHz portfolio capable of graceful migration to CBRS
  - Continue to operate under Part 90 subpart Z until license expires (For most, the deadline to transition has passed!)
  - Gracefully transition to Part 96 (CBRS) without changing equipment (clever software makes this easy!)

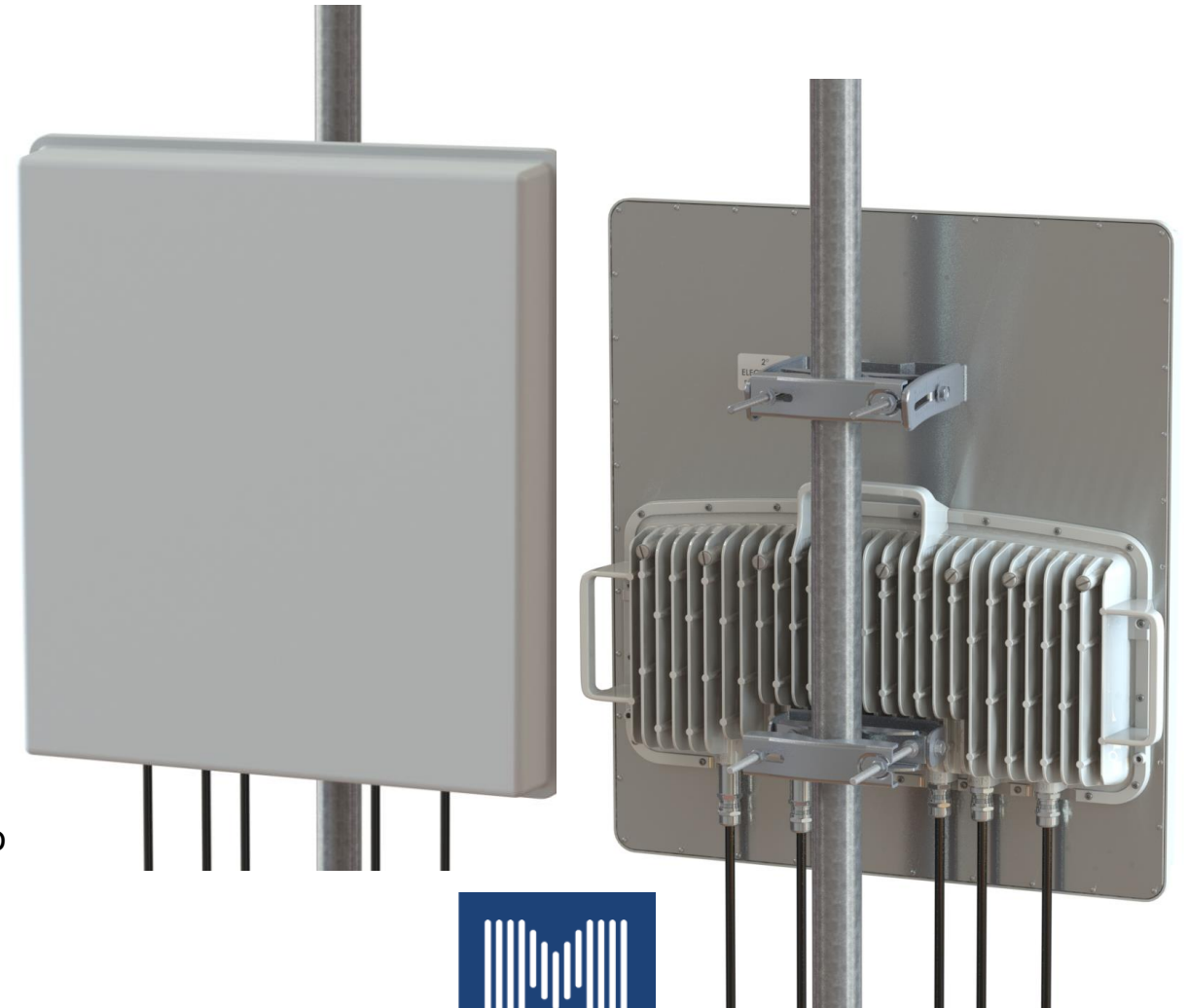


- **Leading-Edge Technical Innovation**

- **More than 3x Capacity vs. 450/450i**
  - *cnMedusa*<sup>™</sup> 8x8 MU-MIMO technology allows simultaneous communication with up to four SMs
- **Supreme Spectral Efficiency**
  - DL and UL MU-MIMO supported
  - Achieve up to 750 Mbps in a 40 MHz channel
- **Protect Your Investment**
  - 3.3GHz to 3.9GHz range
  - >47dBm EIRP
  - Continue using existing SMs
- **Enhanced Link Stability**
  - Uplink Interference mitigation due to beamforming
  - Uplink Rx Sensitivity improvements (4-5 dB better)
- **Advanced Processing Capability**
  - >200k PPS

- **One Simple device to install**

- Simple Installation and Increased Reliability
- Integrated 90° sector beam-forming array, **ZERO** RF cables to connect or weatherproof
- Direct DC powering
- SFP and Gigabit Ethernet Support
- 27" x 24" x 7" (70x61x17 cm)
- 44 lbs. (20 kg)

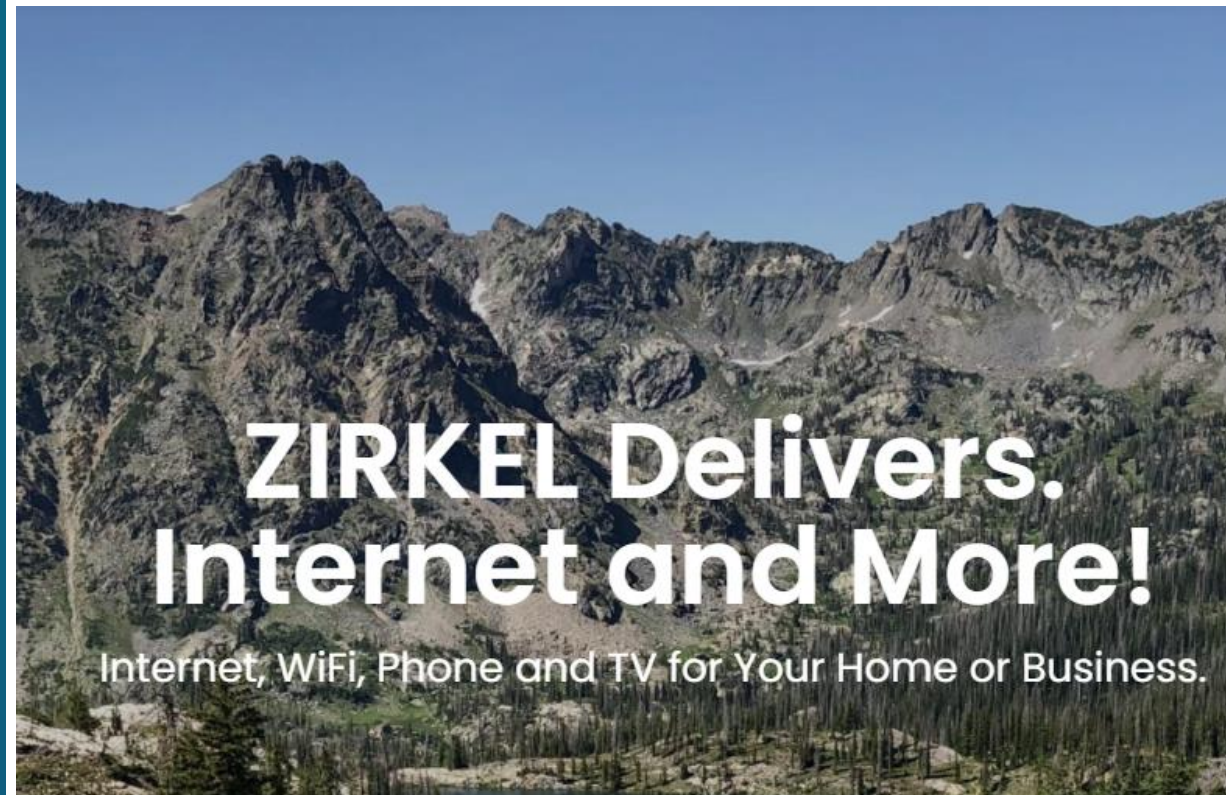


- **Form Factor**
  - High Gain integrated antenna (20 dBi), similar to 5 GHz 450b High gain
  - Up to 29 dBm Tx Pwr, or 49 dBm EIRP
- **New FPGA / SoC architecture**
  - Next-gen processor, Enhanced Packet Processing
  - Better support for wider channels → more throughput
  - Wideband support (3.3 – 3.9 GHz) – **CBRS Approved!!**
- **I/O changes**
  - Single Gigabit Ethernet port
  - Audio jack for alignment tone
- **Re-use of 30 VDC Power scheme**
  - Same power supply as current 450 SM
  - Polarity Agnostic – Both “Canopy” or “UBNT” 30 VDC
- **Considerations**
  - Packaging of devices will follow the 5 GHz version
  - LEDs moved to make more visible and installation-friendly

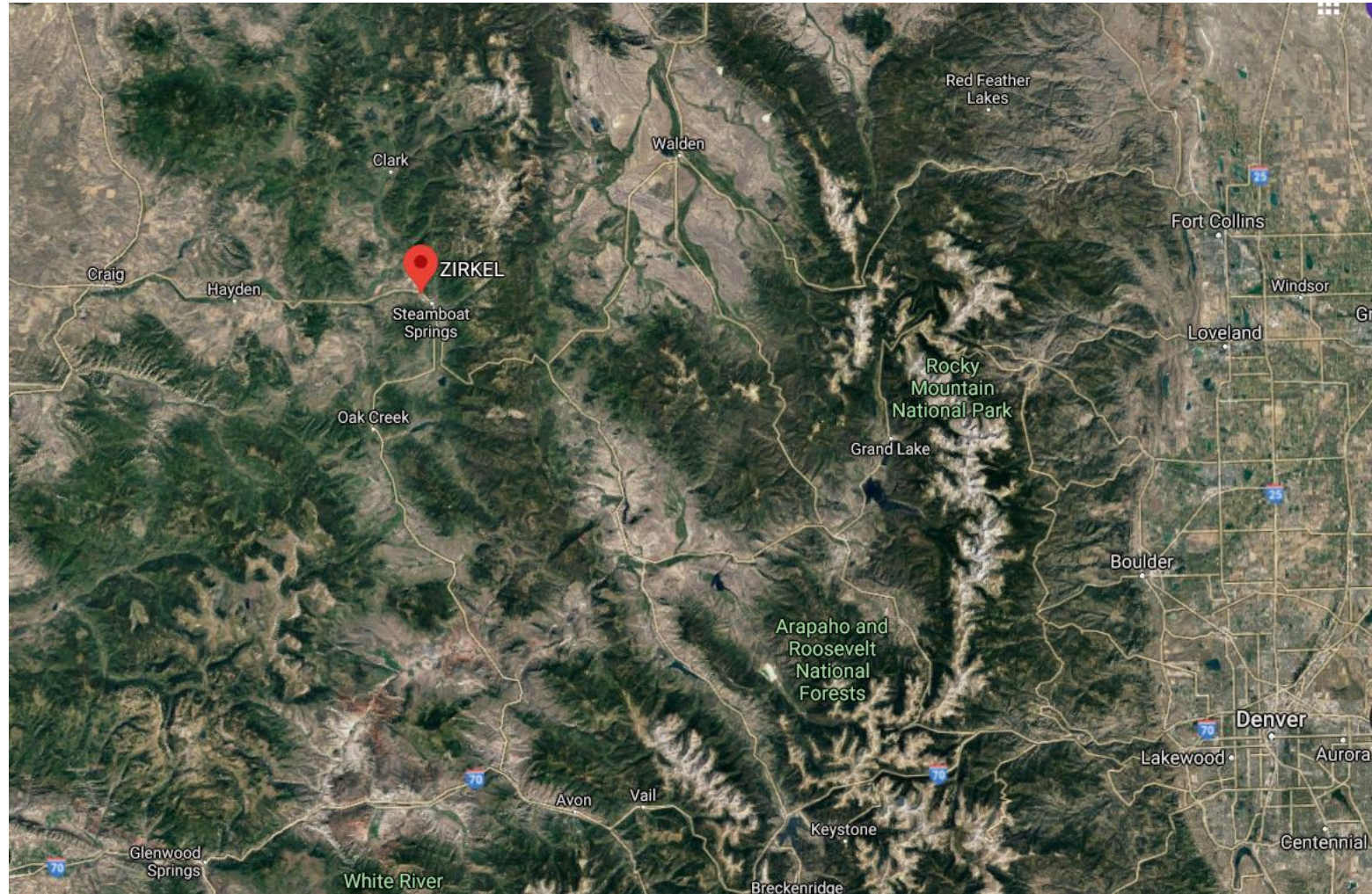


High Gain Released March, 2020

# Experience in CBRS



- Location: Steamboat Springs, CO
- Started in 2001
- Covers approximately 1,500 sq. mi.
- Mountainous and forested terrain causes challenges with nLOS and NLOS
- Became a Cambium (then “Canopy” from Motorola) network in 2006
- Began using 3.65 GHz with Telrad in 2014, but found 450 platform equipment easier to deploy and manage





- Eleven separate sites operate in CBRS

- Mixture of 450, 450i and 450m APs
- Hundreds of SMs
- All Part 90 devices have been migrated to Part 96

- Busiest site has 2 450m operating 30 MHz channels

- Serving >90 Subscribers
- Excess capacity available



- **Mostly Good**
  - CBRS allows higher power, some customers as far as 24 Miles out
  - Cleaner spectrum (compared to 5 GHz) results in 2 to 3 times capacity than 5 GHz
- **Migration required careful consideration**
  - Geolocation of existing devices took work and auditing to get right
  - The Cambium CBRS Import Spreadsheet tool helped with triangulation calculations to get the correct Azimuth data
  - Some of the registrations under Part 96 took a long time (up to 20m!)
- **Early Struggles**
  - Takes longer to install under CBRS than not, sometimes requiring manual intervention (if connection to the internet is spotty prior to registration)
  - Grant Expirations were an issue – This is resolved with current software (a grant renewal request occurs prior to the original grant expiration)
  - GPWZ (our own) are impeding the use of 3650-3700 MHz – Resolution happened just last week!
- **Future Plans for CBRS?**

# Upcoming Changes to CBRS



- **Commercial Operations for Cambium Networks started in April**
  - There are tens of thousands of subscribers taking full advantage of additional spectrum and higher power!
- **Part 90 was allowed until **October 17, 2020****
  - This has now passed, and ~85% of Part 90 licenses are no longer valid.
  - ALL GPWZ (GWBLs) that were associated with those expired licenses have been removed from the SAS, freeing up the upper 50 MHz in many areas.
  - **IMPORTANT NOTE: Some entities did receive waivers until Dec, 2020 or Feb, 2021, so some GPWZ remain**

- **PALs**

- Many customers had the opportunity to win these, others considering secondary market
- What happens next?
- How and when will they be usable?

- **Coexistence Groups**

- What are CoEx group?
- How might these affect operation?

- **DPA Events**

- What are these?
- What can I do about them?

- **CBRS Community Forum**

- <https://community.cambiumnetworks.com/c/technology/cbrs/63>
- This webinar, and lots of other information resides here, and is continually updated
- Great place to ask questions and get answers

- **CBRS Consolidated Procedure Guide**

- <https://support.cambiumnetworks.com/files/pmp450/#r6>
- Step-by-step instructions for getting devices deployed in CBRS

- **Cambium YouTube channel**

- <https://www.youtube.com/user/CambiumNetworksLtd>
- (subscribe to the WISP playlist for more applicable videos to CBRS)
- Cambium continues to release training videos and content related to CBRS, tools and procedures to get you moving in the right direction



# Cambium Networks™

Questions

---