



Wireless That Just Works

CBRS Updates and Experience

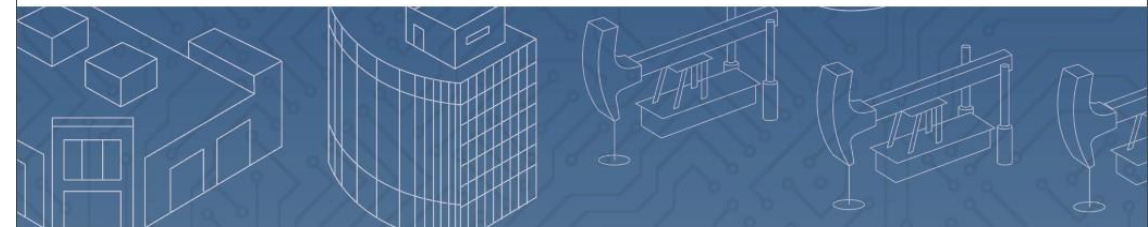
Cambium Networks at a Glance

- 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

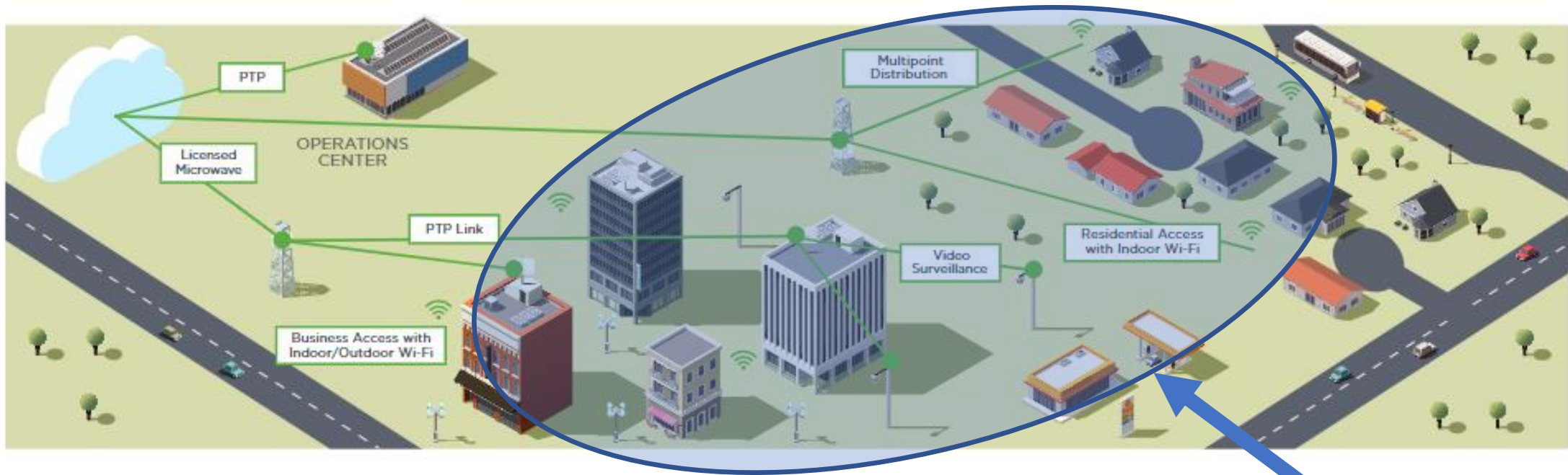


Cambium Networks™

Wireless That Just Works



Fixed Wireless Service Provider Use Case



Business and residential access

High capacity connectivity for streaming video, voice, and data

Licensed, unlicensed, and defined use frequencies

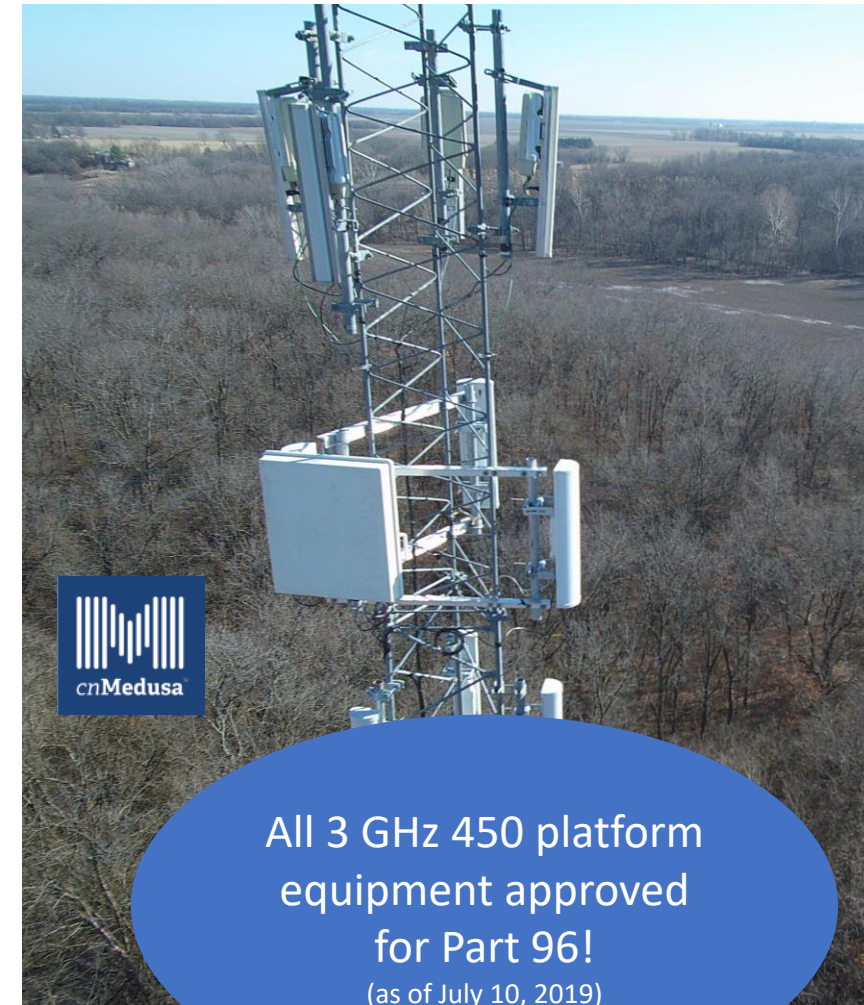
Proven reliability with millions of modules deployed

CBRS Solutions

- 450 platform readiness and works with all major SAS providers

federated wireless  COMMSCOPE[®]

- Customer enters into *direct* business relationship with Cambium, but can choose SAS they like
 - Migration from one SAS to another is not painless, but easy to do
- Complete 3 GHz portfolio capable of graceful migration to CBRS
 - Estimate that ~75-80% of Part 90 installed base has now migrated to CBRS
 - Very few valid Part 90 licenses remain, and we suspect there are some customers that need a nudge or reminder



Case Study



The banner features a low-angle photograph of a telecommunications tower against a clear blue sky. The tower is covered in various antennas and equipment. The website's navigation bar is visible at the top, including links for Home, F.A.Qs, Support, and Contact. The main heading "Wireless ETC" is prominently displayed in green and black, with "Etc." in a smaller, orange script font above it. Below the heading, the text "Internet Service Real People" is shown, followed by a paragraph stating: "We Understand That Real People Don't Want Limits When It Comes To Internet Services."

WIRELESS
Etc.
Wireless ETC

**Internet Service
Real People**

We Understand That Real People
Don't Want Limits When It Comes
To Internet Services.

Home F.A.Qs Support Contact

Case Study – Wireless Etc. – Hot Springs, AR

- Problem:
 - Connecting Rural America
- Solution: *cnMedusa* (both 3 and 5 GHz)
- Results: Able to offer high throughput (25/15 Mbps) packages, and increase coverage area with replacement of Base Stations to *cnMedusa*.
- Update: Since CBRS implementation, increased power levels have allowed
 - Enhanced coverage
 - Higher rate plans
 - Allows connection of additional subscribers



Wireless Etc. Powers Their Network With *cnMedusa* Technology

The Challenge

LOCATED IN HOT SPRINGS, ARKANSAS, Wireless Etc. has been providing connectivity to Garland County since 2003. Today, Wireless Etc. sells broadband to local homes & businesses and delivers services to local electric co-ops, industries and hospitals. Some of their solutions include enterprise-class PTP links, managed firewall security updates and indoor, complete Wi-Fi coverage.

Their customers range from families that need Wi-Fi for their homes to businesses that need massive upload capacity to push product designs to satellite companies. An increasing demand for video and voice pushed Wireless Etc. to update their technology, streamlining services to end users.

With little marketing opportunities, Wireless Etc. needed a way to provide for local businesses and industries while maintaining their reputation for reliability and performance. To align with their values, they needed a solution that would keep up with the rising need for Wi-Fi coverage in their area.

The Solution

CAMBIUM NETWORKS' PMP 450, PMP 450i and PMP 450m solutions were Wireless Etc.'s go-to choice for connectivity. A combination of this equipment provided Wireless Etc. with the ability to overcome growth as subscribers' expectations rose, providing both primary service and failover service. As they added each product, it became clear that each one had more capacity and performance to meet those expectations.

In the 3 GHz band, the PMP 450m Access Point (AP) with *cnMedusa*™ Massive MU-MIMO technology allows Wireless Etc. to quickly connect more people, places and things. Not every site requires a PMP 450m, and a PMP 450i or PMP 450 can handle almost any quantity of subscribers in their area. To ensure successful network design and paths for backhaul services needed by each sector, Wireless Etc. uses Cambium Networks' LINKPlanner™.

Capacity Increase Compared to Previous Service

Service	Capacity Increase
Post-PMP 450 Average	2x
Post-PMP 450i Maximum	5x

CS WLTC 1132019

The PMP 450 platform provides high-performance, cost-effective wireless broadband connectivity.

Narrow beams created in MU-MIMO mode increase coverage and throughput while reducing system interference.

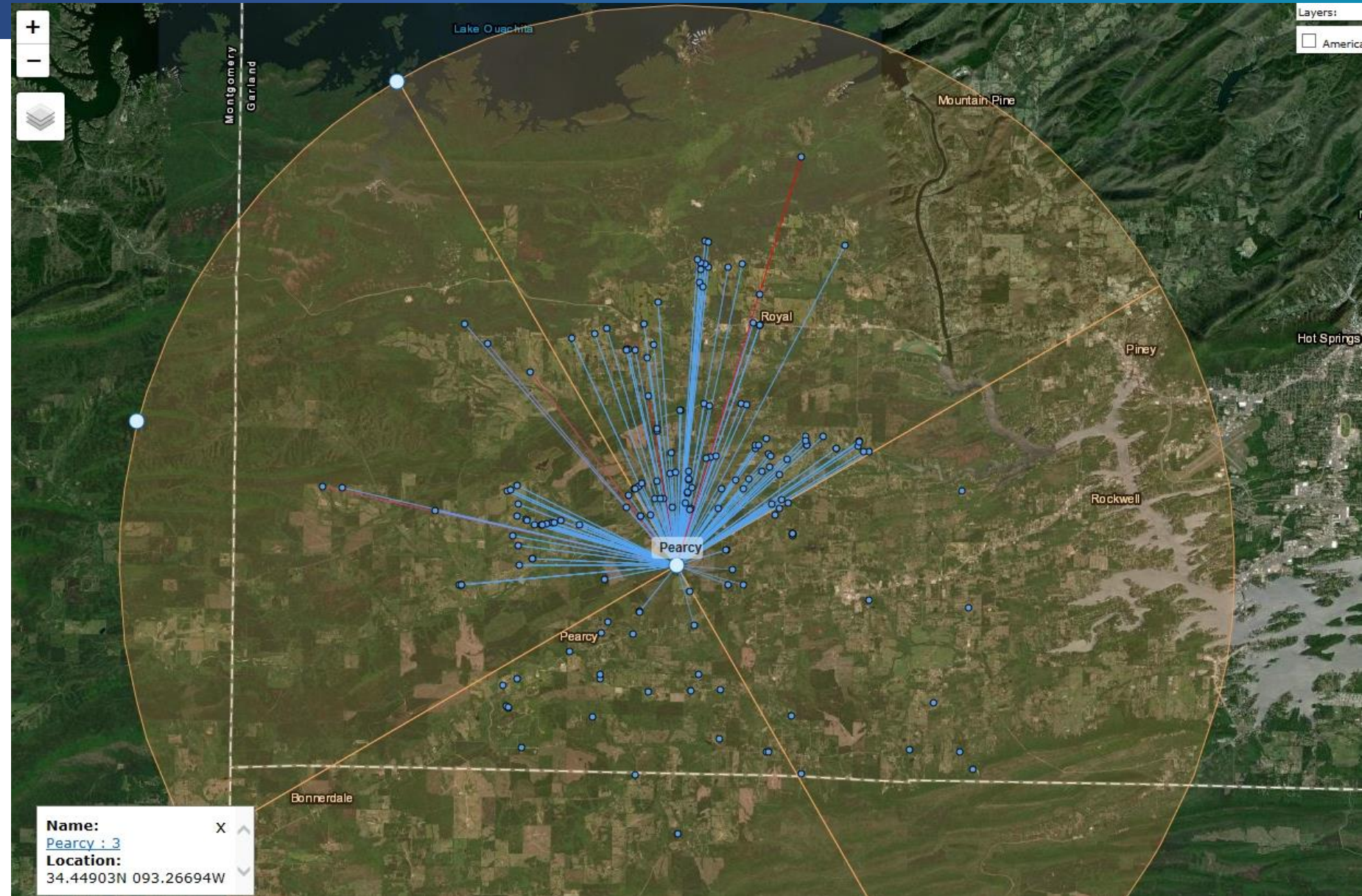
Main BTS Site

- Four 90 degree sectors using 3GHz 450m for increased range / coverage
- Two 5 GHz 450m sectors to supplement bandwidth requirements for LOS customers

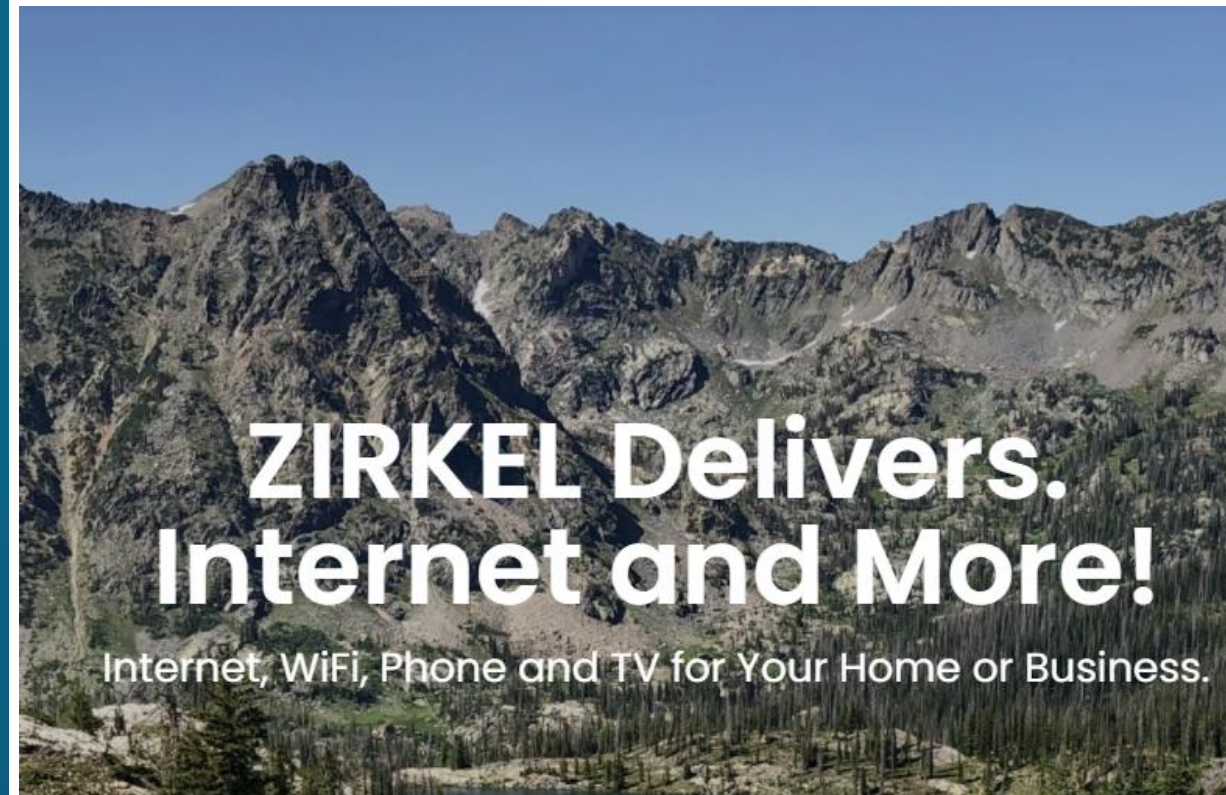


CBRS BTS Site

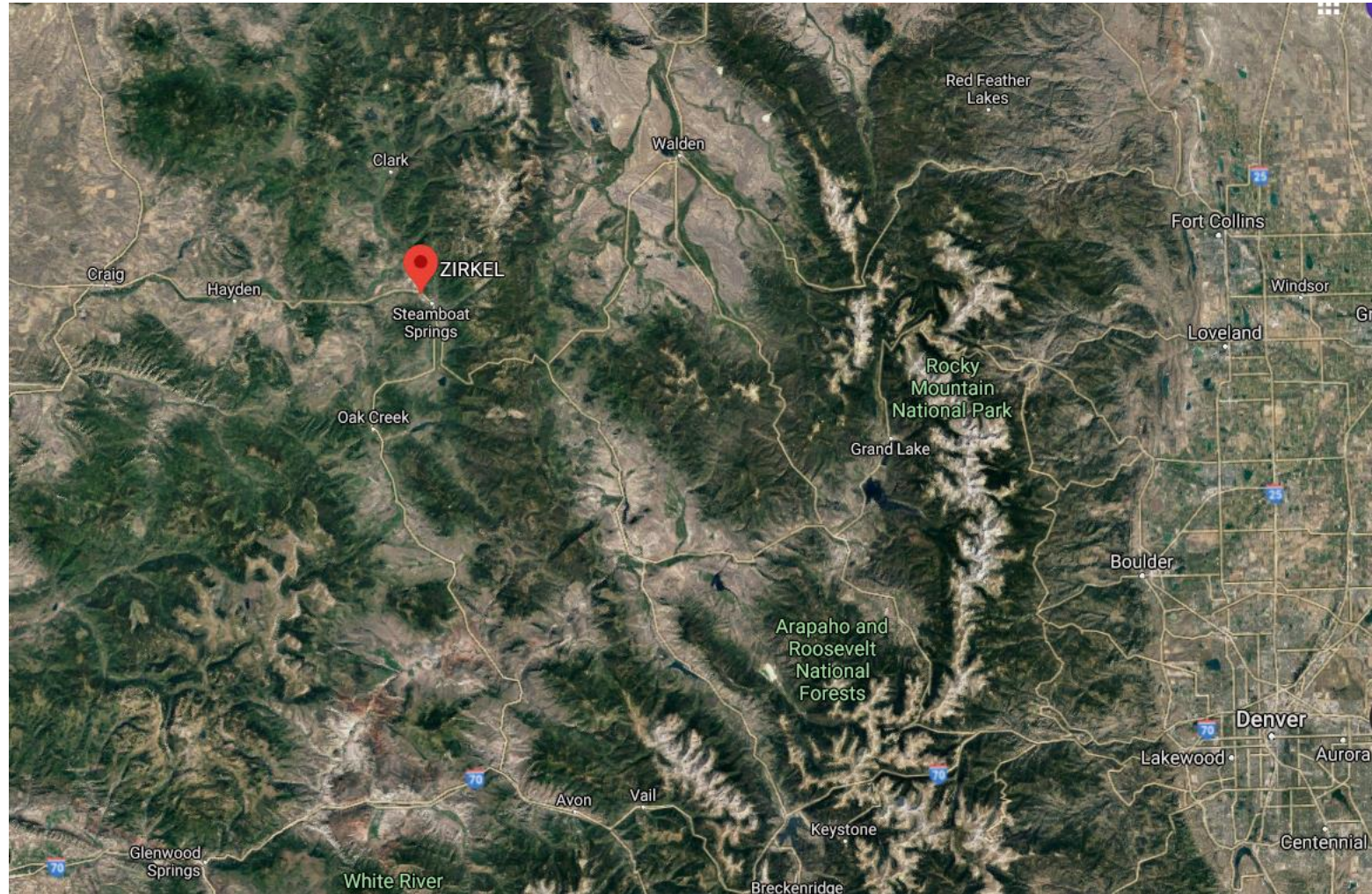
- Over 300 customers are currently connected, with capacity to service many more
- Service is available out to >8 miles from tower using CBRS



Case Study



- 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



- **Great Results deploying CBRS**

- 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
- Allows additional customers and extended coverage

- **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
- By and large Cambium customers were able to complete this activity and had great success in doing so

- **Fantastic Support for Service Providers**

- Cambium Support ramped quickly and resolves issues as they arise – Feedback from customers is great
- Relationships with all SAS Administrators is a strength of the CBRS spectrum use
 - Collaboration, fairness and transparency all lead to overall improvements to the band and its use

- Early on customer expectations were unrealistic
 - CBRS was to assign channels and manage interference automatically from day 1
- DPA/ESC Issues plagued some users in coastal regions
 - Growing pains and learning curves with various aspects of ESC affected some
 - DPA activations are still an issue (though much reduced in scope and frequency)
- PALs – Implementation has been challenging for some
 - Cross-county or inter-county deployments were not really considered in the rules
 - Channel selection wasn't well-understood by some winners, so some feel as though they have not gotten their money's worth
- New Features of CBRS:
 - Co-Existence
 - Alternate channel support – Currently, our radios do it... but the SAS should
 - Channel assignment enforcement – Today, recommendations are made, but nothing is forced
 - Device measurement feedback could make SAS more informed and accurate in making decisions



Cambium NetworksTM

Questions
