

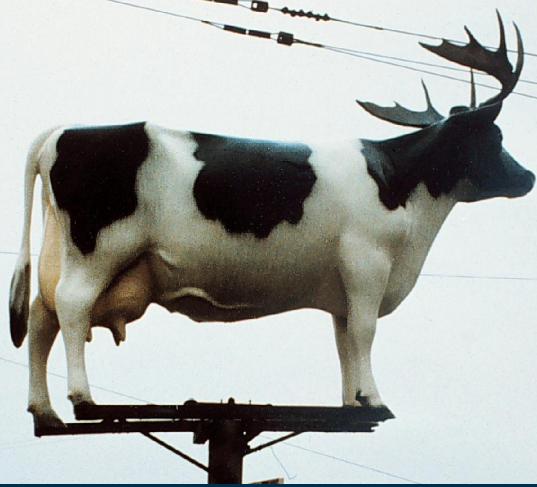
# Wireless Technologies

CENIC Report to the Board | Wednesday September 23, 2020

# Introductions

**George Dolidze** - Network Engineer, *CENIC NOC Engineering*

**Gary Kazaryan** - Network Engineer, *CENIC Core Engineering*



# Why Wireless Technologies?

**Wireless technologies may be a cost-effective option to connect unserved and underserved communities.**

**One of CENIC's values and a strategic plan goal is addressing the digital divide, extending equal access for all.**

**School closures due to COVID-19 and evacuations due to wildfires have highlighted the importance of delivering connectivity to all Californians for education and work.**

# Common Wireless Terms



**LTE:** Stands for **Long Term Evolution** and is sometimes referred to as 4G LTE. It's a standard for wireless data transmission.

**5G:** The fifth generation of mobile networks, a significant evolution of today's 4G LTE networks.

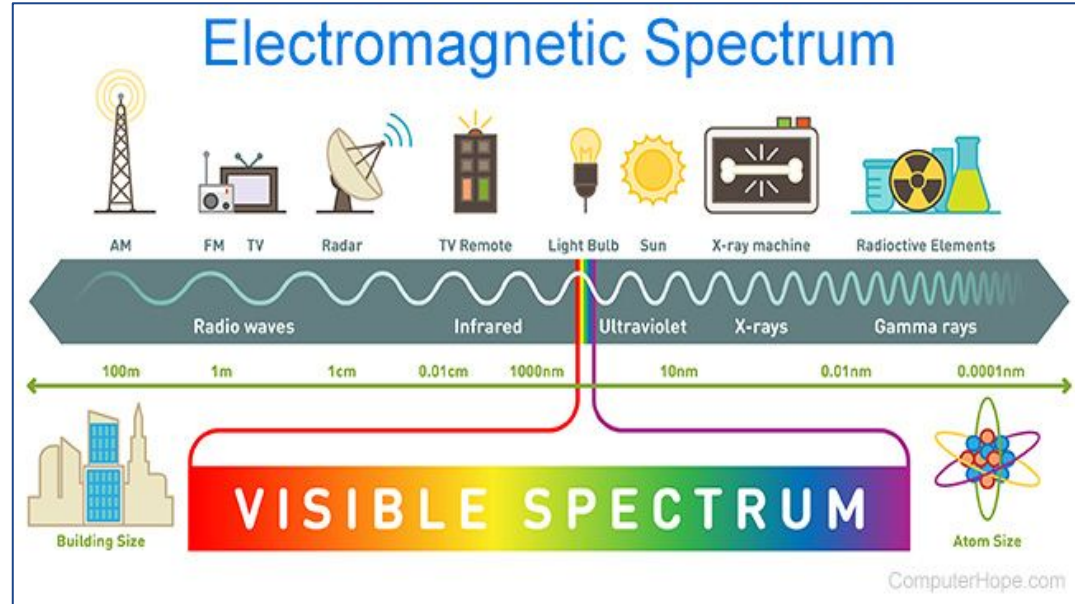
The four spectrum bands that are actively being discussed in wireless networks are **WiFi, EBS, CBRS,** and **TVWS.**

**Fixed Wireless:** Any wireless implementation requiring fixed (immobile) receivers/customer premise equipment

**Spectrum:** The invisible radio frequencies that wireless signals travel over. It's because of spectrum that we can watch television, send emails, listen to the radio, talk and text on a cell phone, and surf the Internet. The FCC allocates spectrum with different policies governing different bands.

# Wireless & Spectrum

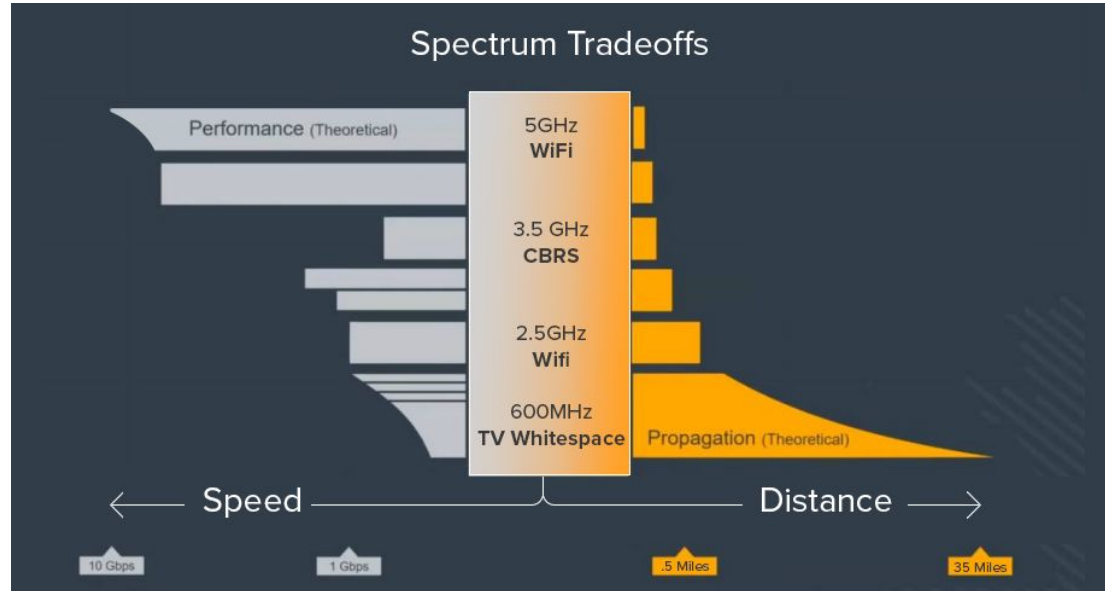
- Wireless communications require transmission of data over spectrum
- There are many everyday use cases that each employ different bands of the spectrum: **AM, FM, TV, CB, LTE**
- There are limited amounts of usable bands/frequencies for each technology



# Wireless Spectrum Bands and Frequencies

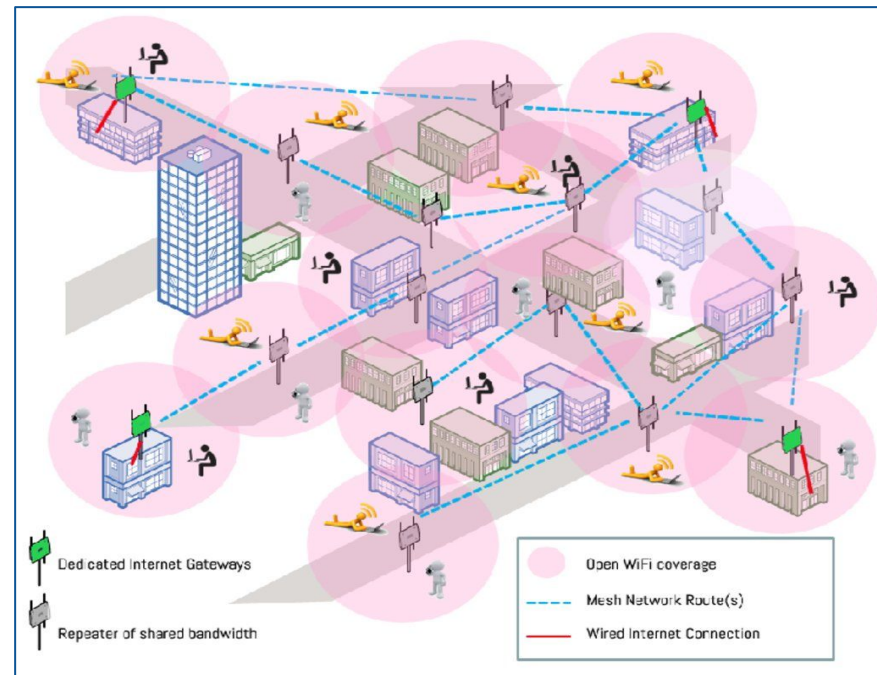
The key concept for spectrum and frequencies is that using lower frequencies gains distance but loses speed, while higher frequencies gain speed but lose distance.

- Spectrum is divided into different frequencies. The most common frequencies used are 5GHz on the low end, 3.5, 2.5, and 600GHz.
- A group of adjacent frequencies create a band.
- The use of bands has been defined and use is regulated by the FCC.



# WiFi Mesh: Overview

- Similar technology as at home/office, but utilizing outdoor equipment
- Mesh technology
- Capacity quickly decreases with distance from wired connection



# WiFi Mesh: Pros & Cons

## Pros:

- Offers higher speeds than the lower radio frequencies such as cellular.
- Offers the flexibility of mesh networking.
- Simple deployment, familiar technology.
- Easier to set up in public spaces.
- Well established cybersecurity due to mature/widespread use of WiFi.
- Most devices have built-in WiFi - no special equipment required.

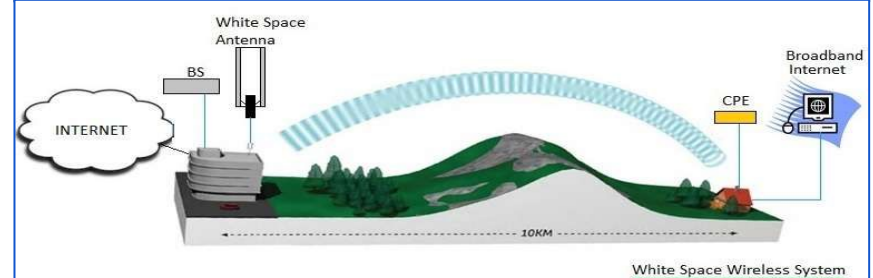
## Cons:

- Need a direct line of sight to access points, and between other access points. Signal is easily obstructed.
- Capacity decreases as you get further away from central point.
- Signal penetration exists primarily to homes that face street/campus. Difficult to penetrate larger multifamily housing structures.
- Cities with high population densities may be more challenging, and costly to serve.



# TV White Space (TVWS): Overview

- Employs unused TV channel space for communication.
- Requires a database to correlate location and available channels.
- Highly dependent upon local channel availability.



# TV White Space: Pros & Cons

## PROS:

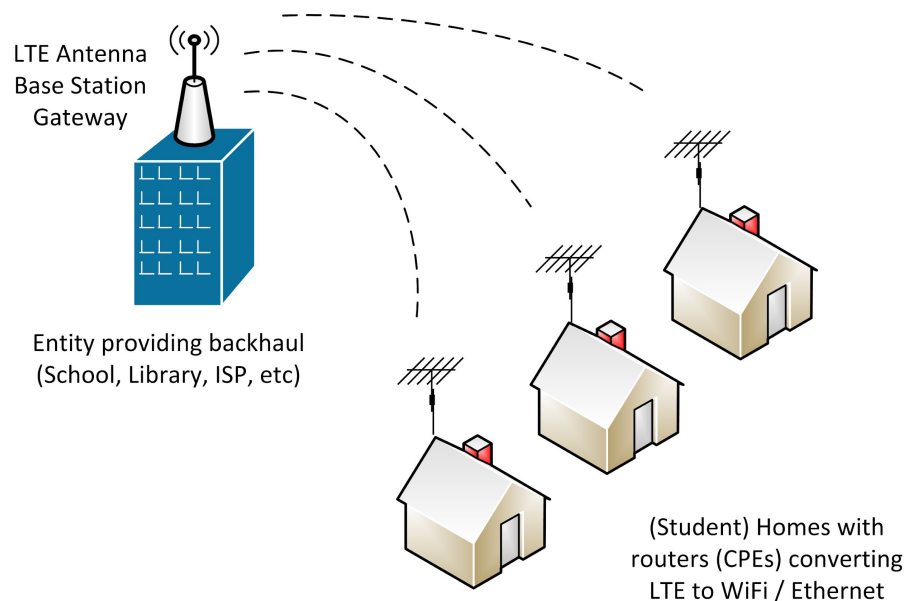
- **Much better range than point-to-point outdoor WiFi**  
(signals may be beamed out 10-20 km depending on terrain).
- **Line of sight not required, as signal is able to penetrate buildings.**
- **Broadband-comparable, delivering around 20-50 Mbps speeds.**

## CONS:

- **Each user requires a TVWS-enabled CPE to receive the signal.**
- **Signals from TV stations and industrial/commercial areas can contribute noise.**
- **Requires careful radio analysis prior to deployment.**
- **Less developed encryption/security than the more widespread wireless technologies.**
- **Physical security could be a concern. Broadcast towers have to be installed in public spaces.**

# Educational Broadband Services: Overview

- **EBS is licensed and is assigned by auction (open eligibility)**
- **Buildout requirements for the new EBS licensees**
- **EBS band is most commonly used in LTE deployment**



# Educational Broadband Services: Pros & Cons

## PROS:

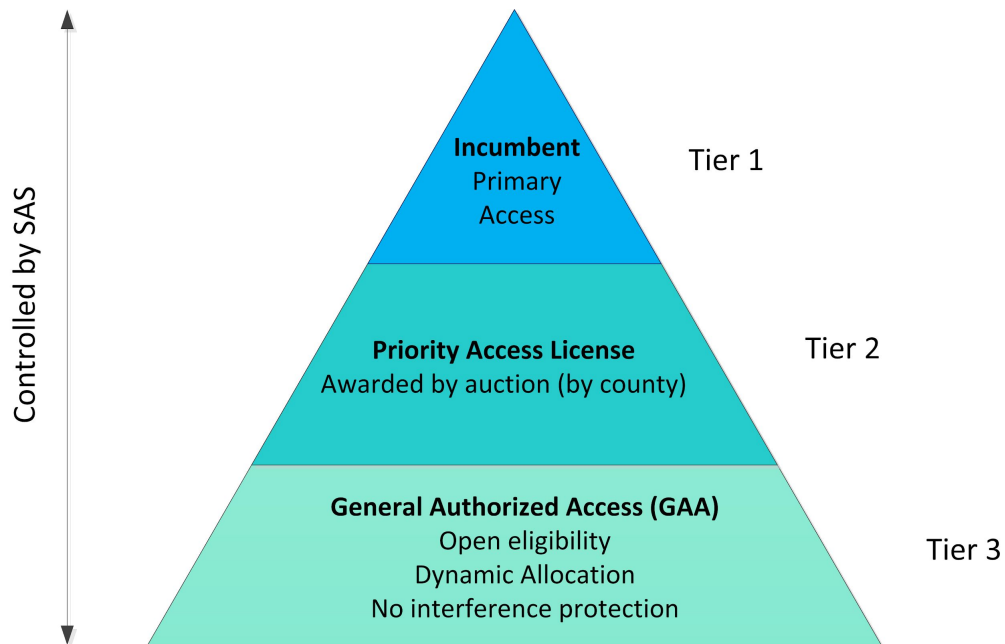
- **Allows for high traffic rates**
- **Relatively low cost (of equipment) and easy adoption (of technology) for existing mobile service providers**
- **Major network equipment suppliers have developed a new wave of FWA-optimized solutions**
- **Interference free wireless connectivity**
- **License(s) might already be available for use at some education institutions**

## CONS:

- **Doesn't travel far (8-10 miles) compared to low frequency bands**
- **EBS spectrum cannot penetrate barriers that lower frequencies can**
- **EBS license will likely be nearly impossible for an educational institution to obtain due to FCC's Report and Order 19-62 that removed all restrictions and eligibility requirements for licensees for competitive bidding auction**

# Citizens Broadband Radio Service: Overview

- **Three-tiered access framework was created for CBRS**
- **Access and operations is managed by a Spectrum Access System (SAS)**
- **CBRS band is most commonly used in LTE deployment**



# CBRS: Pros & Cons

## PROS:

- **Affordable (licenses are easier/cheaper to obtain)**
- **Capable of faster speed compared to EBS**
- **Major network equipment suppliers have developed a new wave of FWA-optimized solutions**

## CONS:

- **Connections that use GAA licenses might not be interference free**
- **Using CBRS is more complex than using EBS as the former requires communication with an FCC-approved SAS**
- **Limited reach (up to 5 miles)<sup>s)</sup>**

# Spectrum & Technology Comparison

Technology	Frequency	Speed/ Capacity	Complexity	Licensed	Ideal Topography or Geography	Distance
WiFi Mesh	2.4GHz, 5GHz	50-300Mbps	Simpler	No	Smaller neighborhoods	.5 Miles
TVWS	470 MHz - 790 MHz	20-50Mbps	More difficult	No	Rural	35 Miles
EBS	2.5 GHz	Up to 100Mbps	More difficult	Yes	Rural	8-10 Miles
CBRS	3.5 GHz	Up to 150Mbps	More difficult	Yes	Rural	Up to 5 Miles

# Use Cases for Wireless Technologies

**Innovative applications of these wireless technologies have the potential to address a number of common challenges facing the CENIC community.**

- K-12 “homework gap”
- On-line learning (K-20) during the current pandemic and beyond
- Telehealth for remote diagnosis, treatment, monitoring, follow-up
- Remote sensors for agricultural use
- Data collection for scientific research (e.g., NOAA’s ReCON)
- Wildfire prevention, early detection, containment, assessment

*A more detailed look at a few exemplars from the broader Research & Education community can be viewed in the appendices to this slide deck.*



# Summary

**We hope this presentation has helped inform you about wireless technology options, as activity in this arena is significant.**

**These wireless technologies might provide members with cost-effective options to better connect unserved and underserved communities.**

**If your organization is thinking about one of these solutions, please contact CENIC if you would like to leverage our expertise.**

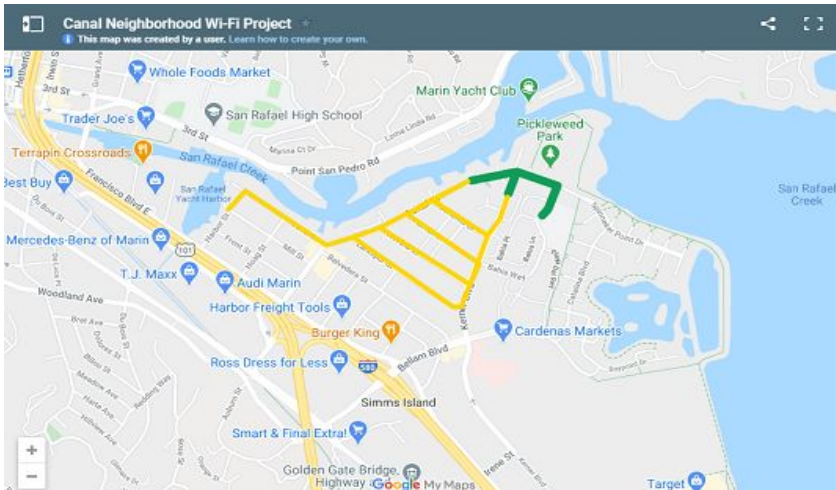
# Thank You

References and Resource links, and **link to PDF of your full report.**

# WiFi Mesh Use Case: San Rafael

## The Problem:

- About 2,000 students and their families in the city's Canal neighborhood needed Internet access for the 2020-2021 school year.
- The neighborhood is primarily populated by low-income workers and was hit hard by the coronavirus pandemic.



## The Solution:

- Local government, a community nonprofit, and generous stakeholders came together to build a WiFi mesh network for the neighborhood.
- The network and its hardware is owned and administered by the Marin Information and Data Access Systems' institutional network, called MIDAS, which connects municipal and community buildings throughout the county.
- The group is looking at options to connect to CENIC.

Source: [How San Rafael, CA, Built a Neighborhood Mesh Network That Turned Into Something More](#)

# TV White Space Use Case: Huron Public Library



## The Problem:

- The library in Huron, SD, wanted to extend broadband access to community parks, as many immigrants frequently visited these recreation areas, but were less likely to come to the library.

## The Solution:

- The Institute of Museum and Library Services awarded grant funding to HPL to buy and install TV white space base stations that can transmit broadband WiFi to remote hotspots they place in the community.
- Other communities are using the same grant and similar networks to provide broadband service to farmers markets, senior populations that are dispersed throughout the community, students who lack Internet access at home, and other groups.

# CBRS Use Case: Murray City School District



## The Problem:

- Murray district in Salt Lake City wanted to provide broadband to students who lack Internet access at home.
- The district qualifies for federal E-Rate funding, but can't use it to build or operate a CBRS network because federal regulations prohibit schools from competing with ISPs by delivering Internet service off-campus.

## The Solution:

- District funds were used to buy Ruckus CBRS radios, state funds to buy the initial core network, and charitable donations to finance hotspots for students to access the network from their homes.
- Plans are in the works for an even more robust network. The Utah Education and Telehealth Network (UETN) has applied for a CARES grant to fund a new core network. UETN wants to host core network functions for any Utah school or college that wants to use CBRS.
- The goal is to use CBRS to connect students from their homes to their school curriculum and teachers. By extending school networks, UETN can give students connectivity that enables access to their curriculum but not to the broader Internet.

# EBS Use Case: Kings County Office of Education



## The Problem:

- **Agricultural county with a relatively small population. Thirteen individual school districts and about 28,000 K-12 students.**
- **Few broadband options for families and those that are available could be cost-prohibitive to the population. Nearly 70% of the County's students are eligible for free or reduced lunches.**

Source: [Rural California County Helps Close Academic and Digital Divides](#)

**“They somehow managed, for pennies on the dollar for broadband, to build this system that not only covers low-income students, but covers every single student in the school and in the school district where the system is up and running.”**

## The Solution:

- **Kings COE leveraged existing technology assets across the county — which included a robust network connectivity to schools — used the 2.5 GHz EBS spectrum to build a private network, and developed partnerships with other agencies within the county.**
- **Students in participating schools received a handheld WiFi device that they take home. The cost is \$10 per month and allows up to six computers with fast access to the Internet.**