COMMUNITY CBRS NETWORKS
WHAT YOU NEED TO KNOW

In the wake of the pandemic, the federal government is directing billions of dollars to state and local governments in an effort to connect all residents to fast, affordable, reliable Internet service. The funding is a welcome investment as communities work to connect the unconnected. However, it also means community leaders need to move quickly to evaluate technologies and broadband deployment strategies.

WHAT IS CBRS?

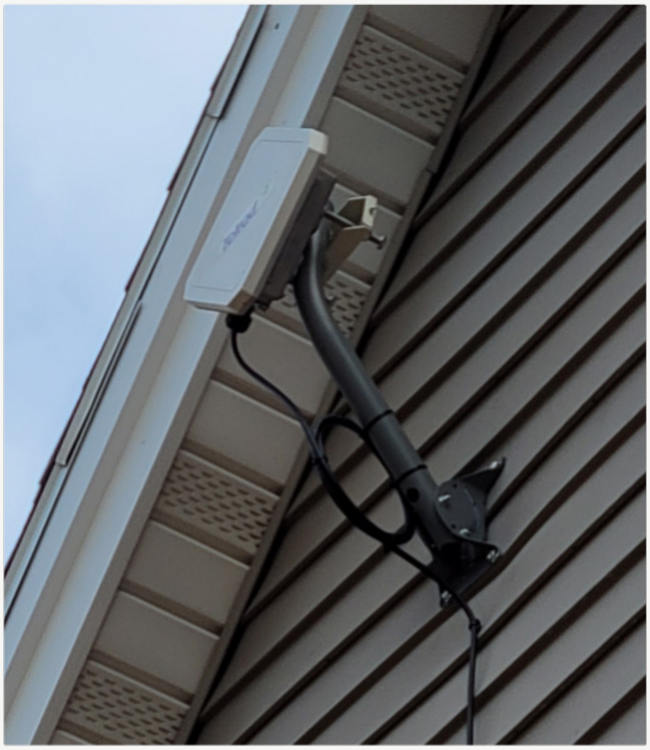
Many municipalities and other community groups are testing Citizens Broadband Radio Service (CBRS) technology as a way to expand Internet access and reach unserved and underserved populations. CBRS is based on wireless spectrum that non-traditional providers can use to provide cellular connectivity. While the nation's wireless carriers and some federal entities are also using CBRS, there is a portion of the spectrum that has been set aside for general use.

HOW IS CBRS DIFFERENT FROM WIFI?

CBRS networks use long-range technology that reaches farther than WiFi can from a single access point. That means that one piece of radio equipment can potentially provide connectivity to a large venue or a whole neighborhood, rather than just an individual home. CBRS also delivers mobile connectivity. If multiple radios are connected to the same network, users can move between overlapping areas of coverage without dropping Internet service.

Despite the differences between CBRS and WiFi, it is still possible for users on a CBRS network to access Internet service from their existing devices. While new computers and phones are being developed to support CBRS directly, it's also possible to convert CBRS signals to WiFi with the help of specific customer premises equipment (CPE). This CPE uses a cellular SIM card to receive CBRS signals, which are then typically transported over Ethernet to a WiFi router. (In some cases, the CPE and WiFi router may be combined in one device.) The CPE can either be mounted outside a home or other building, or inside near a window.

BUFFALO CASE STUDY – CUSTOMER PREMISES EQUIPMENT (CPE), CLUTTER, AND SIGNAL PROPAGATION



In the Fruit Belt neighborhood of Buffalo, New York, the University of Buffalo partnered with leading local technology-focused and community-based organization Mission:Ignite to deploy a CBRS network designed to extend Internet access to local underserved residents. The team scoped out a location for a CBRS base station, and through a network modeling exercise, determined they could serve the most subscribers by installing indoor-mounted customer premises equipment (CPEs) at each consumer home. Indoor CPEs are easier and cheaper to deploy than outdoor ones because they don't need to be mounted on the exterior of the home. This would make it theoretically possible to stretch project dollars further and reap a greater return on investment.

However, when the Buffalo team started testing the new network, they discovered that real-world performance didn't come close to matching their theoretical model. The team had calculated that the height and proximity of their base station would be enough to provide robust connectivity across a wide footprint. They didn't foresee the dramatic effect of leaves and other small objects – known as "clutter" – on signal propagation. Combined with the loss of signal strength caused by needing to pass through an exterior wall to reach indoor CPE devices, that clutter effect meant the Buffalo network couldn't reach the majority of homes the project had planned to cover.

The team subsequently switched to an outdoor CPE model for their network. While more expensive up front, the outdoor CPE proved critical for achieving overall performance goals.

HOW FAST IS INTERNET SERVICE ON A CBRS NETWORK?

CBRS networks operate in the band of spectrum between 3.55 and 3.7 gigahertz. That's a significant amount of bandwidth, but it's not all available for everyone. First, only some of that spectrum is set aside for general use. Some of it is owned by network operators who bought private licenses, and some of it is used by US Navy systems. Second, with the bandwidth that is available for general use, the speed that users can get depends on several variables. If there is one antenna active that is accessing 20 megahertz of spectrum, that will provide reliable broadband with top symmetrical speeds of around 150 to 200 megabits per second (Mbps), enough to support at least 25 simultaneous HD video conference calls or HD video streams. If multiple 20-megahertz channels are aggregated together (carrier aggregation), then those top speeds can be multiplied accordingly.

However, the more users are accessing a CBRS network at the same time, the less bandwidth is available for each user. Additionally, environmental conditions affect network performance, which means if conditions are poor, there is a reduction in connection speed and reliability.

Today, CBRS networks operate in 4G, but they will be upgradeable to 5G in the future. Upgrading to 5G will mean these networks can use the spectrum that's available more efficiently, and thus provide better service than CBRS networks operating in 4G mode.

OTHER FACTS ABOUT CBRS

A CBRS network enables wireless service, but it still needs a connection to the Internet to deliver Internet access. This is similar to how a WiFi router at home only works if the resident has an Internet subscription. In order to expand broadband access with CBRS, communities need to consider what backhaul network can be used to get Internet to a CBRS base station, and also how that Internet service is funded separately from the CBRS network itself.

Because the technology is relatively new, the hardware and software associated with CBRS networks is also new. Vendors may still be working out the kinks in their solutions, particularly if those solutions are being used in novel ways, or need to interface with other older systems. CBRS equipment may also require a certified installer to deploy.

Finally, CBRS networks include an element not seen in traditional networks called a Spectrum Access System (SAS). This is because CBRS allows for spectrum sharing through a tiered system of spectrum access, with some users having greater priority over others. The Incumbent Access tier is dedicated to US Navy systems and protected from interference by lower-priority users. The Priority Access tier makes certain channels available to users who bought Priority Access Licenses (PALs) and protects against interference from general users. (These PAL licenses cover much smaller geographic areas than typical spectrum licenses, making them accessible to entities like municipal governments, and not just large wireless companies.) The General Authorized Access (GAA) tier provides access to yet another set of channels available to a broad base of users, and also allows those users to access Priority Access channels on an opportunistic basis.

The SAS controls spectrum usage with CBRS, and anyone operating a CBRS network must be registered with a SAS provider. Usually, a CBRS solution vendor maintains that certification with a commercial SAS.

CBRS SPECTRUM ACCESS TIERS

Incumbent Access
Dedicated to the US Navy and protected from interference by lower-priority users.

Priority Access Licenses (PALs)
Reserved for private networks and purchased to cover small geographic areas; protected against interference from general users.

General Authorized Access (GAA)
Available for general use; users can also access Priority Access channels on an opportunistic basis.

LESSONS LEARNED IN THE REAL WORLD

Communities are still learning from early tests with CBRS technologies. Here are three lessons learned in real-world network deployments.

Lesson 1: Understand the ownership of physical assets locally

CBRS base stations are best mounted high on a tall tower or building with a line of sight to receiving radios. However, accessing these assets usually requires a permit or other permission from the asset owner that's not always easy to procure. In addition, base stations need to be connected to both electricity and an Internet link, which may not be available on site. These variables can add time and money to a planned deployment.

Lesson 2: Get an accurate signal propagation model before deployment

There are a number of environmental factors that interfere with CBRS signals including leaves, rain, and buildings or other fixed construction. (See Buffalo Case Study above.) It is critically important to get an accurate signal propagation model ahead of any deployment to understand what level of performance can be expected from the network investment. Any consultant offering to provide a propagation model should be well-vetted in order to decrease the risk of a negative performance outcome.

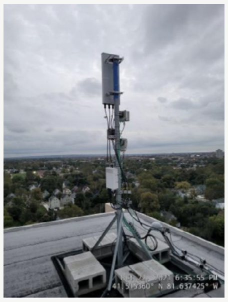
Lesson 3: Be aware of the impact of network congestion

In some regions, there will be little competition for spectrum in the CBRS band, but in some urban areas, CBRS networks are already filling up with users, causing performance declines. In addition, some cities close to Navy traffic are finding that network performance with a GAA license is poor, and sometimes users are even kicked off the network altogether.

For example, Arlington County, Virginia, located adjacent to Washington, DC, is also home to a significant federal presence. While deploying CBRS on GAA frequencies, the county found that on more than one occasion, they were required to stop using the frequencies they were registered to use due to conflict with incumbents.

CLEVELAND CASE STUDY – POWER AND PERMITTING

Nonprofit wireless provider DigitalC has been working for years to connect the unconnected in Cleveland, Ohio, and is using CBRS technology to expand its network reach. One thing the organization has learned is the importance of including specialists in site surveys before a new deployment project begins. Without the right expertise up front, it's possible to run into numerous challenges that increase project costs and delay implementation. For example, even if there is a good source of electrical power near a proposed deployment site, there may be local permitting issues that prohibit using the route necessary to connect to that source. Consulting a structural engineering and permitting specialist up front exposes challenges like this early and allows project leaders to adapt before actual deployment work begins.



Areas of specialty include:

- Structural Engineering
- RF Engineering
- Real Estate/Permitting
- Safety/OSHA
- Electrical and Grounding
- Equipment Vendor/Contractor
- Property Management
- Network Backhaul

TO CBRS OR NOT TO CBRS?

There are many options for expanding connectivity in a community. CBRS is a good choice for some use cases, but not all. For example, if environmental conditions are favorable, CBRS may be the fastest and most effective way to bring students online in unserved and underserved neighborhoods. CBRS networks offer significant administrative control via SIM card provisioning, meaning it's relatively easy to prioritize access in a distance learning scenario to ensure that connectivity is maximized for educational use.

A school campus, sports arena, or recreation center could also be a good fit for CBRS if the space is too large to be served cost effectively by WiFi. And CBRS is ideal for some Internet of Things (IoT) applications where network reach is important, and there is more bandwidth needed than certain low-throughput network technologies can provide.

On the other hand, sometimes CBRS isn't the best choice. Among other notable connectivity options:

- WiFi is easier to install than a CBRS network, easier to access with existing devices, and there's no spectrum management or license required.
- Commercial cellular service is expensive if not subsidized, but it has the advantage in both reliability and performance. The same may be true with traditional fixed wireless service offered by commercial providers, although costs vary significantly.
- Fixed wireless service using unlicensed millimeter wave spectrum is another strong option for community connectivity. While range is limited and millimeter wave signals don't reach through walls, these networks deliver faster speeds than networks using CBRS spectrum.
- Low-Power Wide-Area Network (LoRAWAN) technology is good for many IoT applications, particularly when the use case requires little bandwidth, but wide reach.
- Finally, fiber is the gold standard for Internet connectivity. It is costly, labor intensive, and difficult to deploy, but it offers superior throughput and speeds, and will hold up against future network demands.

Communities should always take a holistic approach to connectivity, and that often means combining network technologies to deliver service that is robust, far-reaching, and cost-effective. In the right environment, CBRS can be an excellent option for expanding Internet access, complementing broadband services that already exist and ensuring that new connections enable the applications people need to succeed.

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Want to learn more about smart communities and broadband connectivity? Get in touch with our communities team at US Ignite at communities@us-ignite.org, and visit our website, www.us-ignite.org.

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