The CBRS Opportunity

New Spectrum, Stakeholders, Networks and Devices

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Content

The CBRS Opportunity: New Spectrum, Stakeholders, Networks and Devices

This white paper is meant to be an educational tool and reflects the views of the authors.

Abstract

Even as Citizens Broadband Radio Service (CBRS) spectrum will help U.S. cellular carriers better manage traffic on their networks, it also will enable many new entrants as neutral-host providers, cable and internet providers and enterprises themselves seek to manage their own wireless devices and traffic. This report explores the CBRS spectrum opportunity as well as the impact on existing and new networks.

Introduction

The Federal Communications Commission's (FCC) vision of making spectrum available on a shared basis is now a commercial reality. The Citizens Broadband Radio Service (CBRS) band includes 150 megahertz of spectrum in the 3.5 GHz band (3550 MHz-3700 MHz) that will be available to both licensed and lightly licensed users for applications ranging from industrial internet of things (IoT) to fixed-wireless access and private LTE networks. The FCC first started proceedings on the CBRS band in 2012, but the band, associated products and services have gained momentum over the past couple of years. This band is a perfect addition to the mid-band 5G spectrum portfolio for cellular and cable operators as well as other new entrants.

Historically, CBRS spectrum has been reserved mainly for the Department of Defense, which uses it for U.S Navy radar operations, including ship-borne radar that typically operates offshore. As an incumbent licensee, the Navy will continue to have priority access to the band. While the Navy will be protected from interference, the FCC authorized unused spectrum in the band to be made available on a shared basis. As such, the government opened the spectrum nationwide to two other tiers of users. Other incumbents include broadband wireless providers and fixed satellite earth stations.

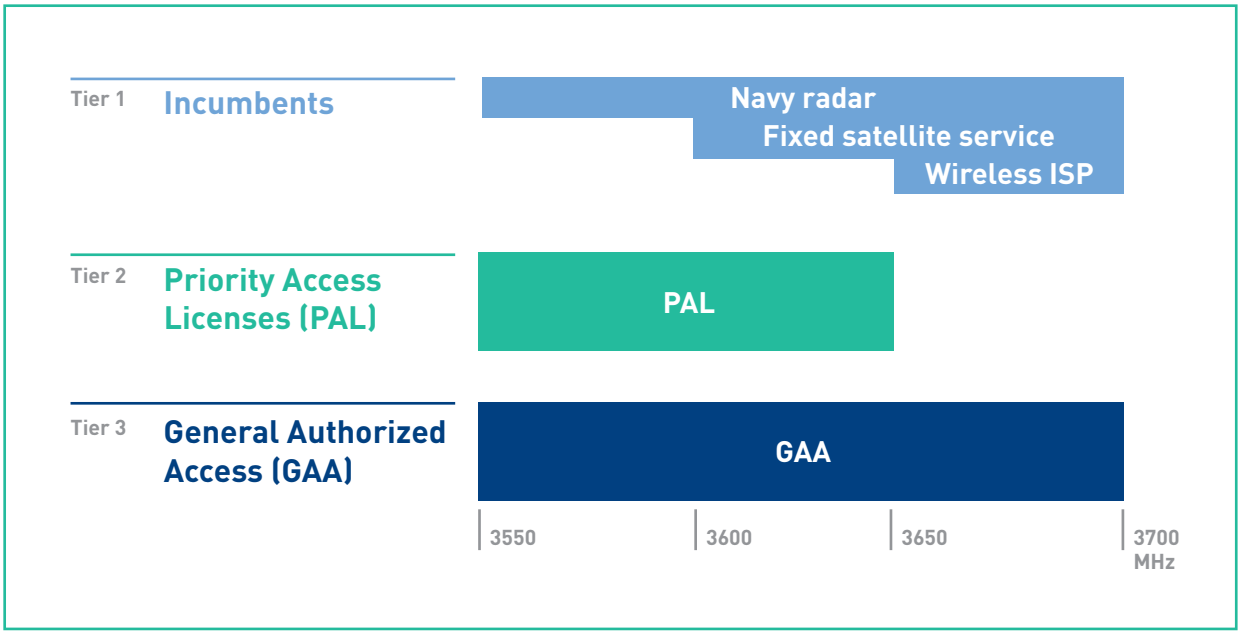
Licensing in the CBRS band is neither exclusive nor completely open unlicensed spectrum. Instead, the FCC adopted a hybrid approach to the band, marrying elements of licensed and unlicensed use in a novel sharing regime. Similar to how companies like Uber and Airbnb have enabled the so-called sharing economy by leveraging existing assets owned and controlled by third parties to maximize their value through technology and sophisticated algorithms, so too does the FCC's licensing regime in the CBRS band by taking underutilized government spectrum and making it available for commercial use. The hallmark principle of the CBRS band is that usage rights are available on an opportunistic basis — spectrum in the band is generally available for commercial use on a use-it-or-lose-it basis.

The Rules

The FCC has implemented three tiers for spectrum access — incumbent, PAL and GAA. Tier 1 is the incumbent government and satellite users, plus broadband wireless users (until April 2020). Tier 2 is Priority Access Licenses (PALs) that will have access to 70 megahertz of the total 150 megahertz available through a competitive bidding process. General Authorized Access (GAA) users, which can access the spectrum on an opportunistic basis, will have access to 80 megahertz of spectrum in every market as well as the 70 megahertz of PAL spectrum when it is not being used by PAL licensees. In other words, GAA users get cellular spectrum available free of charge if they can make good use of it.

The spectrum is managed and assigned on a dynamic, as-needed basis using a Spectrum Access System (SAS), across these three tiers of access. The FCC certified CommScope, Federated Wireless, Google and Sony as Spectrum Access System administrators in January 2020. Amdocs expects to be certified this year as well.

The FCC is planning to auction PAL licenses in June 2020. PAL license areas will be issued by county. Each PAL will consist of a 10-megahertz unpaired channel within the county. The FCC will auction up to 70 megahertz of spectrum per county, but PAL auction participants can hold no more than four PAL licenses (40 megahertz) per county. PALs will be renewable licenses with 10-year terms. However, potential auction participants should recognize that PALs are unlike other traditional spectrum licenses, for several reasons.



Source: Qualcomm

First, PAL licensees will not be issued for specific channel blocks within the license area. Instead, licensees will have the right to use a 10-megahertz channel block that will be assigned dynamically by SAS providers. As the designated CBRS spectrum frequency coordinators, SAS providers are responsible for assigning specific channels on a dynamic basis. The dynamic assignment process is necessary to accommodate other users in the same geographic area, including any incumbent users that have priority rights over the PAL licensees.

Second, PAL licensees are also unique because they will be subject to the "use it or share it" principle, which distinguishes CBRS spectrum from other commercially available spectrum bands. As a result, PAL licensees that are not using the allocated 10-megahertz channel blocks that they hold would see unlicensed users operating in the GAA tier using such spectrum.

Third, PAL licensees also face the unique obligation of having to register their CBRS-related network devices, known as Citizens Broadband Radio Service Devices (CBSDs) with a SAS before operating such devices in the band.

Finally, the FCC is permitting certain bidders that qualify as small businesses or rural providers to use bidding credits in the auction. Specifically, an entity with average annual gross revenues for the preceding three years not exceeding $55 million will be eligible to qualify as a "small business" for a bidding credit of 15%, while an entity with average annual gross revenues for the preceding three years not exceeding $20 million will be eligible to qualify as a "very small business" for a bidding credit of 25%. Further, entities providing commercial communication services to a customer base of fewer than 250,000 combined wireless, wireline, broadband and cable subscribers in primarily rural areas will be eligible for the 15% rural service provider bidding credit.

The total amount of available bidding credits will be capped. The FCC has proposed that the total amount of the bidding credit cap for small businesses should be $25 million, and the bidding credit cap for rural service providers should be $10 million.

CBRS CHRONOLOGY OF SHARED SPECTRUM FRAMEWORK

2012: President's Council of Advisors on Science and Technology (PCAST) Report

Recognizes government's spectrum holdings, and limited use of same

Recommends spectrum sharing, rather than exclusive licensing, as new model to increase available commercial spectrum

2015: FCC Report & Order

- Adopts PCAST sharing framework
- Dynamically assigns spectrum to facilitate sharing
- Protects incumbent users (incl. Federal government)
- Licensed (PAL) and unlicensed (GAA) access

2018: FCC Updates Rules

- Shrinks license area (counties)
- Lengthens license terms (10 years)
- Adds renewal expectancy
- Permits secondary market transactions
- Imposes performance requirements and
- Makes available bidding credits

2019: PAL Auction Public Notice

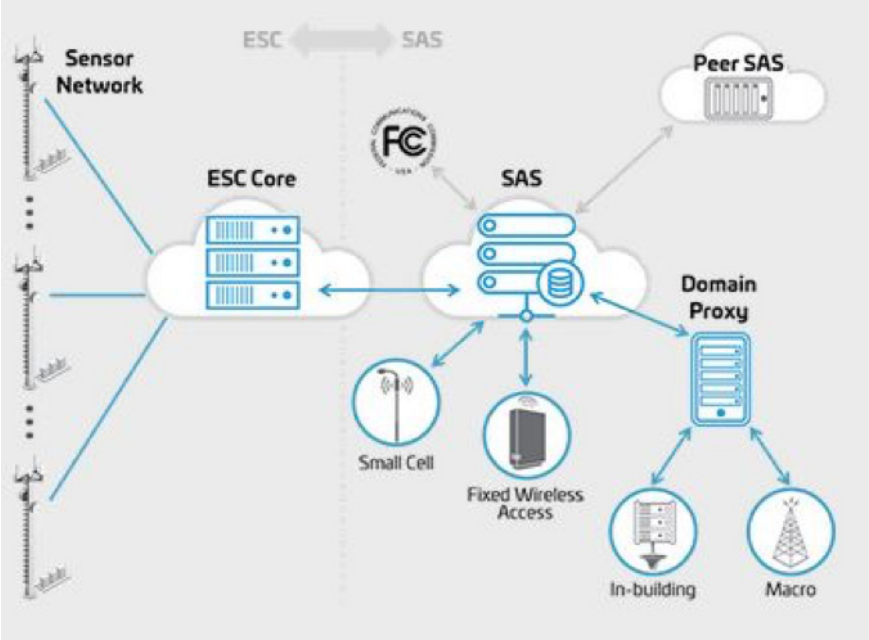
- In September, FCC issues proposed framework for auctioning PAL licenses
- Unique licensing approach: rights to dynamically assigned 10-megahertz channel blocks, not a traditional geographic-based license
- Leaves open possibility of aggregate bidding on larger CMA basis

2019: Initial Commercial Deployments Begin

- In September, FCC certifies five entities to serve as SAS Administrators
- CommScope, Federated, Google, Amdocs and Sony satisfied lab testing and may begin initial commercial deployments

The Role of the SAS

The SAS will ensure that every CBRS radio, known as a CBSD, that transmits in this band complies with FCC Part 96 rules for sharing spectrum. To protect against interference with Navy radar, the SAS will be connected to a network of sensors called Environmental Sensing Capability (ESC). The ESC network will monitor for Navy radar operation and will alert the SAS when it detects activity. In such an event, the SAS will coordinate the CBSD transmit levels and channels to ensure that no harmful interference is caused.



Source: CommScope

If this experiment in sharing spectrum succeeds, and all indications are that it will, it could open the door to sharing in several other frequency bands, which could spawn more innovation and many more interesting applications.

Ready, Set, Innovate

CBRS is an important tool in the tool chest of carriers and enterprises that can be used on its own or in tandem with cellular, Wi-Fi and other network solutions to provide reliable communications to the public, employees and machines. Most of the mobile applications available on cellular devices today are successful because they use LTE technology, which offers much faster speeds, among other things, than previous generations of cellular. Because CBRS spectrum will also use LTE technology, it can offer true mobility, as well as strong security and higher quality of service than unlicensed Wi-Fi networks.

It's relatively easy to hack into Wi-Fi gateways, but CBRS provides additional layers of security to thwart bad actors. Enterprises are particularly interested in developing network solutions that protect sensitive data and help them avoid financial and reputation difficulties associated with data breaches.

Quality of service will be higher using CBRS spectrum because it will improve speed, bandwidth and data transfer capacity, which will be a major differentiator over existing private network options.

Additional benefits of CBRS include capacity, flexibility, control and accessibility.

Experts believe CBRS will democratize LTE wireless technology. Many whitepapers and technical seminars by SAS administrators, OEM vendors, and standards bodies alike highlight CBRS use cases from a wide variety of entities and numerous verticals, including:

- Mobile Network Operators (MNOs)
- Cable Operators (MSOs)
- Wireless Internet Service Providers (WISPs)
- Third-party Neutral Host infrastructure providers
- System integrators
- Utilities
- Hospitality industry
- Enterprises
- Manufacturing facilities
- Warehouses
- Transportation hubs
- Smart cities

The diversity of companies participating in and developing the CBRS ecosystem is remarkable. There is tremendous interest and participation from small to large operators and OEMs, startup companies and technology stalwarts such as Facebook and Amazon.[1]

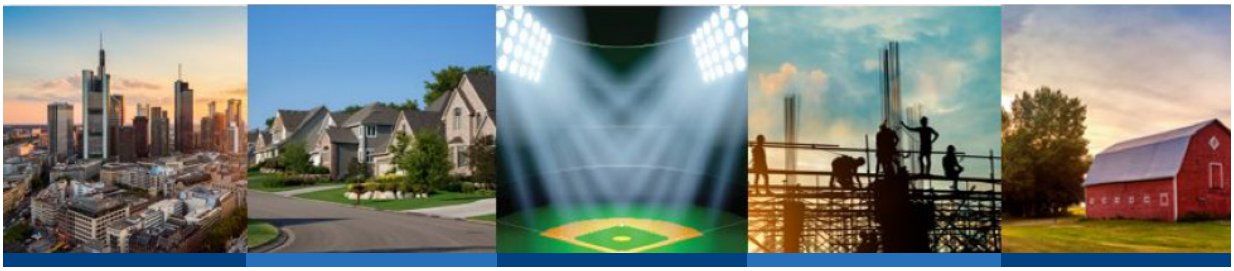
The CBRS supplier ecosystem is already looking beyond 4G-LTE and into 5G-NR. CBRS may be the first mid-band spectrum in the United States to observe 5G deployments at scale. Industry is promoting many innovative 5G use cases, including cloud gaming, extended reality and healthcare.

CBRS will expand the value of mobile networks and take on more new use cases than have been possible with an unlicensed and licensed spectrum regime, empowering many new connected services and entrants.

The Players

One remarkable aspect of the potential use cases for CBRS is that it is expected to play a pivotal role across multiple industry sectors, not just the mobile sector. For example, as illustrated below, many expect that CBRS will be a key spectrum platform for distributed antenna system (DAS) operators, fixed wireless internet service providers (WISPs), and cable operators. While many expect mobile operators will use CBRS to expand small cell capacity for mobile LTE, other service providers such as cable and WISPs, are expected to utilize CBRS to enhance last-mile and access solutions, often over fixed wireless architecture. The CBRS Alliance is driving shared use of the 3.5 GHz spectrum and certifies devices that can be used under the name OnGo.

Mobile Network Opps	Cable Service Providers	Neutral Host Networks	Industrial / IoT Applications	Fixed Wireless ISPs
• Densify indoor networks • Add network capacity • Fixed wireless 5G offerings	• Offload of MVNO nets • Enable mobility • Fixed wireless • Expand on Wi-Fi wireless offerings	• DAS-like deployments • Stadiums, convention centers, hotels, etc. • HetNet • IaaS	• Private LTE networks • Industrial (mission critical) • Smart cities • Augmented reality	• Last mile • Point to multipoint • Expand to unserved and underserved • Rural, exurban markets



Source: Davis Wright Tremaine

Mobile Network Operators (MNOs)

With CBRS, mobile network operators can secure a cost-effective solution for expanding capacity and coverage as well as building out their 5G networks. Moreover, CBRS provides better coverage for both indoor and outdoor mobile solutions compared to other unlicensed bands like 5 GHz. CBRS base stations can deliver a higher level of network quality control desired with LTE-based solutions without the challenges of sharing the band with Wi-Fi.

As such, carriers are likely to present one of the first use cases for CBRS. With data usage exploding for both consumer and machine communications, existing macro networks are experiencing increasing demands on network capacity. Carriers are expected to move quickly in the CBRS space to address their need for additional capacity. CBRS presents an opportunity for these carriers to offload network traffic onto local CBRS networks, resulting in less congestion and better data rates for both the offloaded traffic and for the traffic remaining on the macro network. This increases quality of service for all customers.

Verizon Wireless, for example, has said it plans to supplement its outdoor small cell network with CBRS small cells and that the first use it envisions for the spectrum band is offloading network traffic from other spectrum bands.[2]

New Entrants

Beyond the carrier use case, industrial and manufacturing operations are interested in CBRS to support emerging internet of things (IoT) applications involving sensors and beacons that constantly relay data about machine operations in factories and other automated systems to a control center. Using a local, secure, dedicated wireless network to control the delivery of machine data will be essential to the safe, cost-effective and efficient operation of IoT-connected equipment. Cable operators, neutral-host providers, enterprises and even utilities may enter the CBRS space.

Private networks are another primary use case for the CBRS band. Enterprises, property owners, utilities, municipalities and others could set up private networks that offer the same voice and data communication capabilities that Wi-Fi provides today, but with better security features and other benefits. This allows small-cell solutions to become disassociated from the carrier and associated instead with the enterprise, creating a true private environment that is unconnected from the carrier network unless a connection is established.

Multiple Service Operators (MSOs)

For cable operators seeking to build out an LTE network, CBRS provides a smart traffic offload option. MSOs can enter the mobile wireless industry using a Mobile Virtual Network Operator (MVNO) strategy. CBRS solutions can help MSOs by reducing costs through the deployment of MSO-owned small cell networks, combining current networks to provide optimal coverage and capacity, as well as leveraging mobile network operators that need densification.

For the investment of a Wi-Fi solution, MSOs can build a valuable wireless LTE network that is dependable, fast and profitable.

MVNOs are also eyeing CBRS as a potential fixed broadband application solution that would allow them to gain a stronger foothold in broadband delivery, essentially transforming themselves into mobile operators in their own right. This is particularly likely in rural areas.

Neutral Hosts

With CBRS solutions, neutral hosts can deploy and manage a more robust enterprise-level network that is as powerful inside as it is outside. Perfect for large venues such as stadiums, airports, skyscrapers and hospitals, CBRS solutions are network-agnostic and can easily accommodate overflow traffic at sites that are too small for mobile operators to consider, yet too complex for enterprises to tackle alone.

Private LTE Networks

For large businesses that require a closed or private enterprise wireless network, CBRS offers more secure connectivity than Wi-Fi and at the high speeds and quality of an LTE wireless network. Whether business takes place in a tall office building, a college campus or a large remote site (e.g., the mining industry), CBRS solutions allow local private LTE networks to be built for the entire enterprise regardless if it is in-building or outdoors.

Facilities that serve both the public and back-of-house operations, both of which need communication capability, could benefit from a CBRS configuration. An enterprise or facility could, for example, deploy a small cell on their premises running CBRS that could provide both multicarrier support for public users and secure, private back-office communications for staff.

An example of this is stadiums or arenas that serve the public. In a football stadium, for example, CBRS networks could provide multi-carrier communications capabilities for fans attending an event while also supporting two-way radio communications for restaurant employees and office and security personnel working in the venue. CBRS could even augment or replace outdated UHF systems that coaches and players use today for sideline communications.

Other enterprise use cases are equally compelling. Many hospitals today run separate dedicated networks to track equipment and people within their campuses. CBRS networks could eliminate some of the layers that are needed today in complicated deployments. The hospitality industry could host back-office operations on a private, secure CBRS network while front-of-the-house, public communications could remain on public networks like Wi-Fi. Retailers could employ CBRS networks to track inventory and securely transfer sensitive customer data.

Wireless Internet Service Providers (WISPs) / Utilities

For businesses that depend on data transmissions from fixed-wireless access points, CBRS solutions using SAS-enabled shared spectrum can help create a robust network that is second to none. By utilizing the 3.5 GHz radio band, WISPs and utility companies can build highly reliable wireless networks that offer cost-effective fixed wireless access with low latency and deliver real-time communications to all their sensors, cameras and industrial IoT.

Similarly, cities and towns may find that CBRS provides them with an excellent opportunity to deploy municipal networks that can support IoT smart buildings and smart-city applications that promise to increase efficiency and save money.

End-User Devices

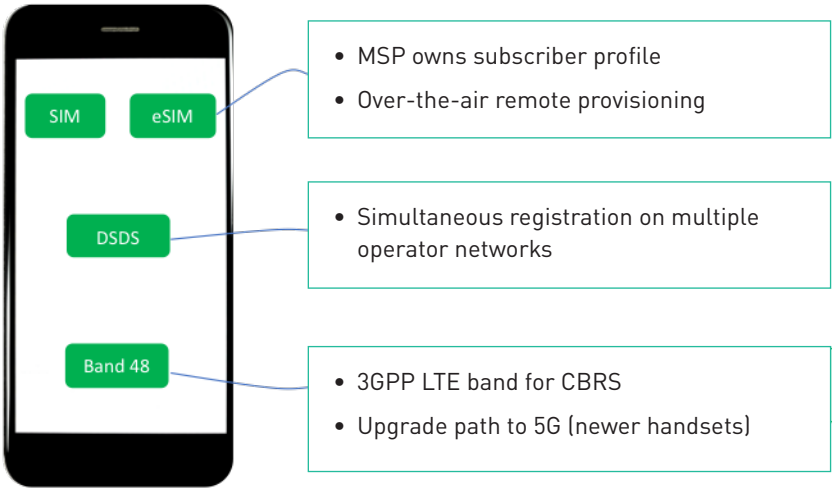
CBRS has a thriving end-user device ecosystem. As of this writing, more than 10 different makes and models of handsets from iconic vendors have already included support for the CBRS band (b48). Usually, it takes years for operators to build support for a new band in so many devices.

CBRS HANDSETS (OCTOBER 2019)

Source: Federated Wireless

Many of these handsets also support new and game-changing technologies called embedded Subscriber Identity Module (eSIM) and Dual SIM Dual Standby (DSDS). eSIM enables remote provisioning of multiple operator profiles on a single handset, providing an opening for business innovation and customer choices. DSDS allows the handsets to stay registered on multiple operator networks simultaneously. For example, customers can select which operator network they prefer for data or voice based on the service cost. Additionally, a customer can instruct the phone to prefer a particular operator's (e.g., CBRS) network for data services when more than one network is available.

ENABLERS ON END-USER DEVICES



Source: Federated Wireless

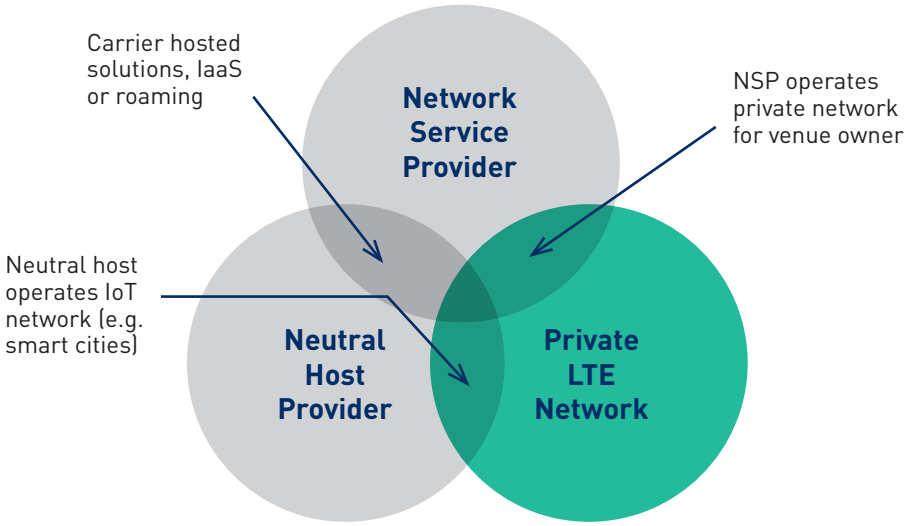
In addition to being pro-consumer, these handset innovations are anticipated to enable new business models (e.g., Private LTE) and improve the economics of existing businesses (e.g., MVNOs).

All nationwide wireless operators in the U.S. either support or are committed to support eSIM in one form or another. For example, as part of the T-Mobile and Sprint merger, the Justice Department requires that T-Mobile and DISH Network support eSIM technologies.[3]

The support for CBRS plus eSIM and DSDS in handsets has been received enthusiastically by the wireless industry, including new entrants and MSOs.

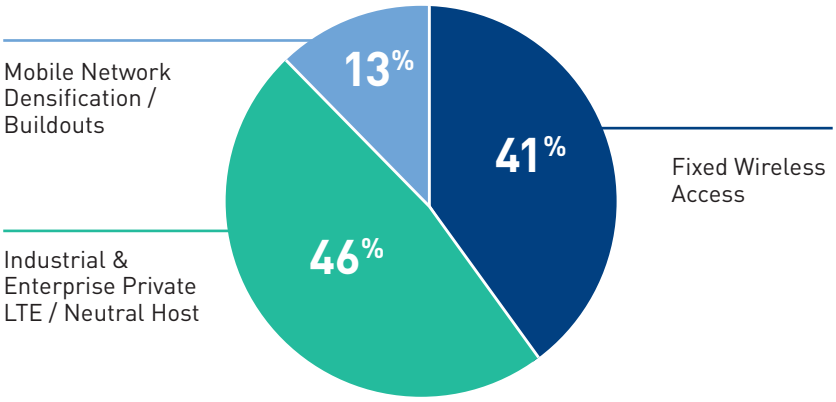
A Glimpse into the Future

Of course, many of these use cases present multiple opportunities, some of which may overlap. Thus, as illustrated below, network service providers, neutral host providers and private LTE network operators may offer competing services in certain markets or geographic areas.



Initial commercial deployment filings revealed that the greatest initial interest in the spectrum was among those providers pursuing private LTE and/or neutral-host solutions. In addition, fixed-wireless-based network solutions were also a significant focus of initial commercial deployments. As the following table illustrates, these two categories of service represented the greatest percentage of planned initial commercial deployments.

INITIAL COMMERCIAL DEPLOYMENTS BY USE CASE*



*Sample data from one SAS Admin Proposal

Source: CBRS Alliance

Impact on in-building solutions – DAS, Small Cells, Wi-Fi

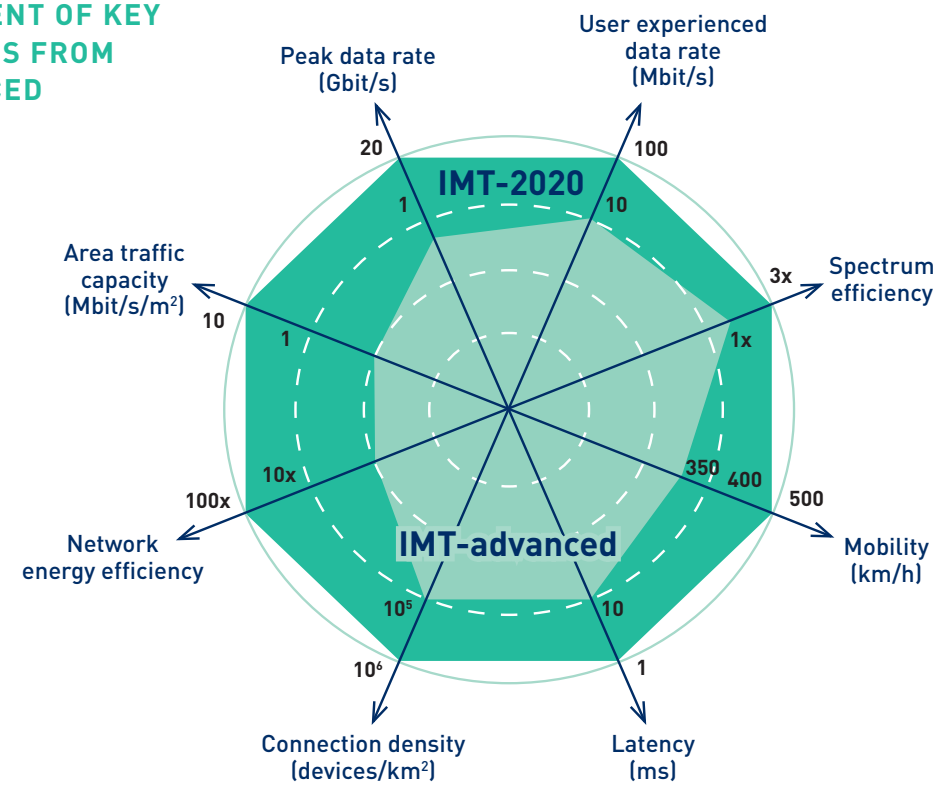
CBRS vendors are likely to build modular CBRS infrastructure that feels similar to Wi-Fi equipment to help IT departments considering CBRS as a network option feel more comfortable and confident with the equipment. CommScope-owned Ruckus Networks, for example, has developed a suite of LTE-based products, including access points and a SAS, aimed at the enterprise market.[4] This type of product suite could alleviate concerns IT departments might have about managing carrier agreements and spectrum interference, which are spectrum-related considerations and often not part of their core competency.

Further, because the amount of data transmitting over networks only continues to climb, networks using CBRS spectrum will complement existing networks, regardless of whether they are wired, Wi-Fi or cellular.

5G in CBRS

5G is next-generation wireless technology, which Includes new spectrum, radio interface called New Radio or NR for short, and network architecture. NR provides significant performance gains over LTE Advanced including speed, latency, and more as shown in the picture below.

ENHANCEMENT OF KEY CAPABILITIES FROM IMT-ADVANCED TO IMT-2020



Source: International Telecommunication Union

MNOs have begun large-scale 5G buildouts. Cable companies are also actively investigating 5G. Analysts expect significant capital investments in 5G infrastructure over the next five years. Standards organizations (e.g., 3GPP) have announced major releases in support of 5G and continue to make enhancements. Infrastructure, chip and test vendors are also announcing and launching new 5G products.

5G is fast becoming a necessity to stay competitive nationally and internationally. U.S. operators have developed on millimeter-wave spectrum for 5G, although characteristics of the band have underscored the importance to industry and the FCC to also expand mid-band spectrum options. The release of new spectrum, however, usually takes time and CBRS will benefit from the fact that it is ready today for 5G deployments. For example, MNOs can pair CBRS-5G with 4G networks in other licensed bands (e.g., AWS).

Conclusion

CBRS spectrum coming to market will create new network providers, new methods of spectrum sharing and a new ecosystem of devices. While mobile operators will likely be first to market to take advantage of offloading capability, many new players will enter the space. Neutral-host providers will offer infrastructure as a service to smaller enterprises. Larger enterprises will be able to develop their own private LTE networks, where they can gain operational efficiencies that come from the greater capacity, quality of service and security that is a characteristic of the LTE protocol. As the market develops, lessons learned through network deployments will encourage adopters to invent new ways to communicate whether by data or voice that were not imagined at launch.

About the Authors

Rikin Thakker, Ph.D.

Vice President of Telecommunications and Spectrum Policy, MMTC
Faculty at ECE Department, University of Maryland

Dr. Rikin Thakker is the Vice President of Telecommunications and Spectrum Policy at the Multicultural Media, Telecom and Internet Council (MMTC). He possesses nearly 20 years of experience in the field of cellular and wireless communications. He has helped design, deploy, and maintain cell sites with 3G and 4G technologies for major cellular operators in the United States. He also advises operators, regulators, OEMs, and vendors around the world on 5G strategies including densification, spectrum allocation, and broadband deployment. He analyzes impacts of future use-cases of 5G on spectrum consumption and provides recommendations on broadband infrastructure deployment strategies involving Small Cells. Dr. Thakker represents MMTC at the FCC's Broadband Deployment Advisory Committee (BDAC) where he serves as the co-chair of the "Broadband Infrastructure Deployment Job Skills and Training Opportunity" working group.

Dr. Thakker is also a faculty member in the Department of Electrical and Computer Engineering at the University of Maryland, College Park (UMD). He has designed several graduate level courses related to Cellular Network Infrastructure, 5G Technologies, Wireless LAN (Wi-Fi) Technologies, and DAS/Small Cells for the Master's in Telecommunication program at UMD. He received Instructor of the Year award in 2018 and 2014.

Dr. Thakker is also a co-founder of RF Academics - an initiative started by a group of elite professors to cater to the industry's need of quality education at corporate speed. The initiative planted the seeds for the Telecommunications Education Center (TEC) at the Wireless Infrastructure Association (WIA). Dr. Thakker chairs the CBRS Working Group at the Innovation and Technology Council of WIA. He also serves on the Editorial Review Board for the International Journal of System Dynamics Application (IJSDA). Dr. Thakker earned his Ph.D. in Systems Engineering with a concentration in Mobile Communications and Spectrum Management from George Washington University, his M.S. in Telecommunications from UMD, and his B.E. in Electronics and Communications from the Gujarat University.

Mark Gibson, CommScope

With over 35 years of spectrum management experience, Mark Gibson is responsible for developing domestic and international business opportunities for CommScope. In addition to leading technical and business development efforts for numerous wireless and spectrum-related products and services, he has led efforts to address spectrum sharing between Federal government and commercial users. He leads CommScope's CBRS efforts on the Spectrum Access System/Environmental Sensing Capability. He is a board member of the CBRS Alliance and an officer on the board of the Wireless Innovation Forum. He is a member of the Commerce Spectrum Management Advisory Committee, where he has also co-chaired working groups related to spectrum sharing and data exchange issues. He has led spectrum management efforts including the development of the SAS and ESC, TV White Space, spectrum sharing analysis protocols and sharing criteria, as well as development of Comsearch's engineering services and software products. He has led efforts in working with the American Hospital Association as their technical partner for WMTS frequency coordination. He has authored several papers on spectrum sharing and relocation and has advised numerous wireless participants in their system design. He is a Life Member of IEEE.

Eric Toenjes, Graybar

Eric Toenjes, MBA, serves as National Market Manager of Wireless Solutions at Graybar, a leading distributor of electrical and data networking products and solutions. In his role at Graybar, Eric is responsible for setting strategy and working with manufacturers, system integrators, neutral hosts, contractors and sales teams to bring best-in-class wireless solutions to customers. He has more than 20 years of experience in the wireless market working with cellular carriers, system integrators and distribution providing solutions to end users and enabling contractors. He works with organizations like the HetNet Forum and Safer Buildings Coalition to understand issues facing building owners, influence codes and help develop an understanding of business drivers behind the solutions. He is a frequent speaker at industry events and currently serves as Vice President of the Board at the Safer Buildings Coalition.

Federated Wireless also contributed to this report. Founded in 2012, Federated Wireless has long led the industry in development of shared spectrum CBRS capabilities, taking a lead role in the formation of the CBRS Alliance, being the first to complete a wide range of trials with its Spectrum Controller, and deploying the industry's first nationwide ESC network. The company's partner ecosystem includes more than 40 device manufacturers and edge partners, all of which are dedicated to collaboration to advance development and proliferation of CBRS services. Federated Wireless' customer base includes companies spanning the telecommunications, energy, hospitality, education, retail, office space, municipal and residential verticals, with use cases ranging from network densification and mobile offload to Private LTE and Industrial IoT.

Endnotes

1. https://www.lightreading.com/cloud/iot-and-edge/verizon-t-mobile-amazon-hint-at-cbrs-35ghz-ambitions/d/d-id/749463

2. https://www.aglmediagroup.com/verizon-promises-smaller-lighter-small-cells/

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