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What can CBRS
do for venues?

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About MSR Research

MSR Research, the research arm of Mobile Sports Report, is a provider of timely market intelligence and advisory services addressing large venue communications technology, as well as venue display technology and in-venue apps and operations tech. MSR Research is the next step for our coverage and analysis of the venue technology market, providing look-ahead intelligence that stadium tech professionals can use to make informed buying decisions.

Our CBRS research report, titled 'What can CBRS do for venues,' is the first in a series of predictive looks at the rapidly changing marketplace for stadium and large public venue connectivity issues. To prepare the report, MSR Research spent several months interviewing subject matter experts from a wide range of CBRS service providers and product manufacturers, as well as early adopter end-users, FCC and government regulatory experts, and other informed professionals in the wireless deployment world.

Our editorial conclusions and analysis are all our own; this report was prepared in the same fashion as our news and analysis reports from our Mobile Sports Report website and Stadium Tech Report series, with no paid influence and no sponsor preference. We thank all the sponsors of this report for their support and hope you benefit from their added expertise.

Mobile Sports Report and MSR Research is led by editor and founder Paul Kapustka, and is an independent, editorially focused publication that uses traditional journalistic methods to break stories, offer informed takes and reflect on trends for the stadium technology marketplace.

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Executive Summary: Venues need more spectrum, now - and CBRS is one answer

Imagine this scenario: A sports venue eagerly awaits the launch date of its new mobile-device parking app, which will theoretically let fans quickly pay for parking with their phones at the gate. On the back end, the team will not only cut down on the traditional losses associated with cash transactions, but it will also reap reams of digital data on its customers' parking habits that can be used for future analysis. At least in theory.

What happens in reality this time is somewhat different. Since the mobile app's parking lot device relies on a cellular connection to verify credit card transactions, the real-world dilemma of thousands of cars showing up at once to an ocean-wide sea of asphalt -- far from any antennas -- quickly overwhelms the cellular macro networks. As transactions stall and increase in time, a traffic jam of angry fans builds up quickly, forcing the team and venue to make the triage call of just opening the gates without charging, to make sure people can get to their seats by kickoff. Lost forever is the revenue, the data, and no small chunk of ticketholders' patience.

At another venue, a large, outdoor festival-type establishment, a similar problem arises just before the start of a big event, when fans are jamming remote concession stands, trying to make purchases before things get underway. Again, the flood of cellular-based traffic quickly overwhelms the processing systems, leading to not just lost sales but possible fraudulent transactions as staff just start taking credit-card numbers by hand to process later. You can blame the operations teams for not thinking through these potential issues, but at the bottom of it all is the root cause: There simply isn't always enough cellular spectrum to go around.

If these stories sound familiar, and have maybe happened at your venue, you are not alone. Even as many venues are beefing up their overall connectivity options by adding in

distributed antenna systems (DAS) for cellular coverage and Wi-Fi networks for in-venue use, many operations, especially those involving money transactions, can still overwhelm cellular systems that rely on small chunks of licensed bandwidth. While Wi-Fi is being used in some transactional situations, the appeal of the built-in security of the PIN-based cellular device infrastructure means that the balance of mobile purchase operations in venues are still cellular-based, putting them at the mercy of whatever bandwidth the carriers are able to supply.

But what would happen if the venue owner could provide its own network, with far more bandwidth than even the largest carriers possess? And what if that same network could be used to run mission-critical and data-sensitive applications of all kinds, including transactional ones like ticketing and point-of-sale, as well as security cameras and in-house video, freeing up more space on the internal Wi-Fi network to serve the ever-growing data demands of fans? This might sound too good to be true, especially when you add in the facts that this new bandwidth would not only be basically free to venue owners, but that it would also support devices using LTE, the main protocol for almost all cellular devices in the market.

All the benefits of cellular without having to pay carriers, with an ease of deployment that is similar to Wi-Fi? That seemingly imaginary service is actually starting to become commercially available now in the United States, as vendors and service providers launch initial commercial deployments of private networks using the CBRS (Citizens Broadband Radio Service) band, a 150-MHz chunk of wireless spectrum in the 3.5 GHz range. While there are still many questions to be answered about how CBRS networks will work, the potential uses for stadiums and other large public venues -- and the solid backing from a wide range of manufacturers and service providers -- are so compelling that they deserve a close look from any venue as part of a near-term and future connectivity strategy.

The purpose of this report is to look at potential early use cases for CBRS networks in venues, as well as long-term possibilities for a unique slice of spectrum with compelling characteristics. By talking with a wide range of subject-matter experts from CBRS vendors and service providers, as well as with early adopter customers, government telecom policy experts and other informed sources, MSR Research was able to outline some of the most likely initial application and service needs for venues that might be able to make great use of the potential that CBRS networks can offer. We have also put together a quick guideline of the deployment complexities venues can expect as they consider adding CBRS networks to their overall wireless services mix.

Our overall conclusion for this report is that venues of all sizes should immediately add consideration of CBRS networks to their ongoing wireless connectivity strategic plans. Even though many factors regarding overall CBRS operations still need to be finalized or proven, there appears to be enough promise and industry backing for venue owners and operators to confidently start pilot programs or tests to get up to speed on CBRS as the market matures.

CBRS for venues: a complement to cellular and Wi-Fi

For the past couple years, there has been no shortage of reporting on the imminent arrival of networks using the CBRS spectrum. While the origin and delivery of the spectrum to the public markets is worthy of deep research itself, this report will focus mainly on the use cases of CBRS for venues. For more background on how the spectrum moved from basically being the property of the U.S. Navy to a unique shared-spectrum system with intriguing technological checks and balances, we suggest visiting the CBRS Alliance website (www.cbrsalliance.org) or the FCC's website (www.fcc.gov; search for "3.5 GHz band overview").

And while there are still important specifics about CBRS networks that have yet to be determined -- such as an auction in 2020 for the priority access portions of the spectrum -- the good news for venues is that inside venue walls, CBRS networks should work pretty much like Wi-Fi networks do today, mainly under control of the owners of the real estate. Since CBRS rules allow for a wide chunk of spectrum to remain for open or basically free but shared use, venue owners should not have to worry about having to pay for CBRS licenses, especially for closed venues like arenas.

So why should venues consider CBRS as an addition to Wi-Fi and cellular networks? According to vendors and service providers who are currently in trial deployments, as well as from early adopter end users, the main lure of CBRS services is to provide connectivity with cellular-like mobility and security at the cost levels and deployment ease -- and network ownership characteristics -- of Wi-Fi. Across the board, CBRS providers are quick to point out that the networks are not meant to replace cellular or Wi-Fi services, but instead designed to provide another layer of connectivity with very specific use cases in areas that matter most to venue operations.
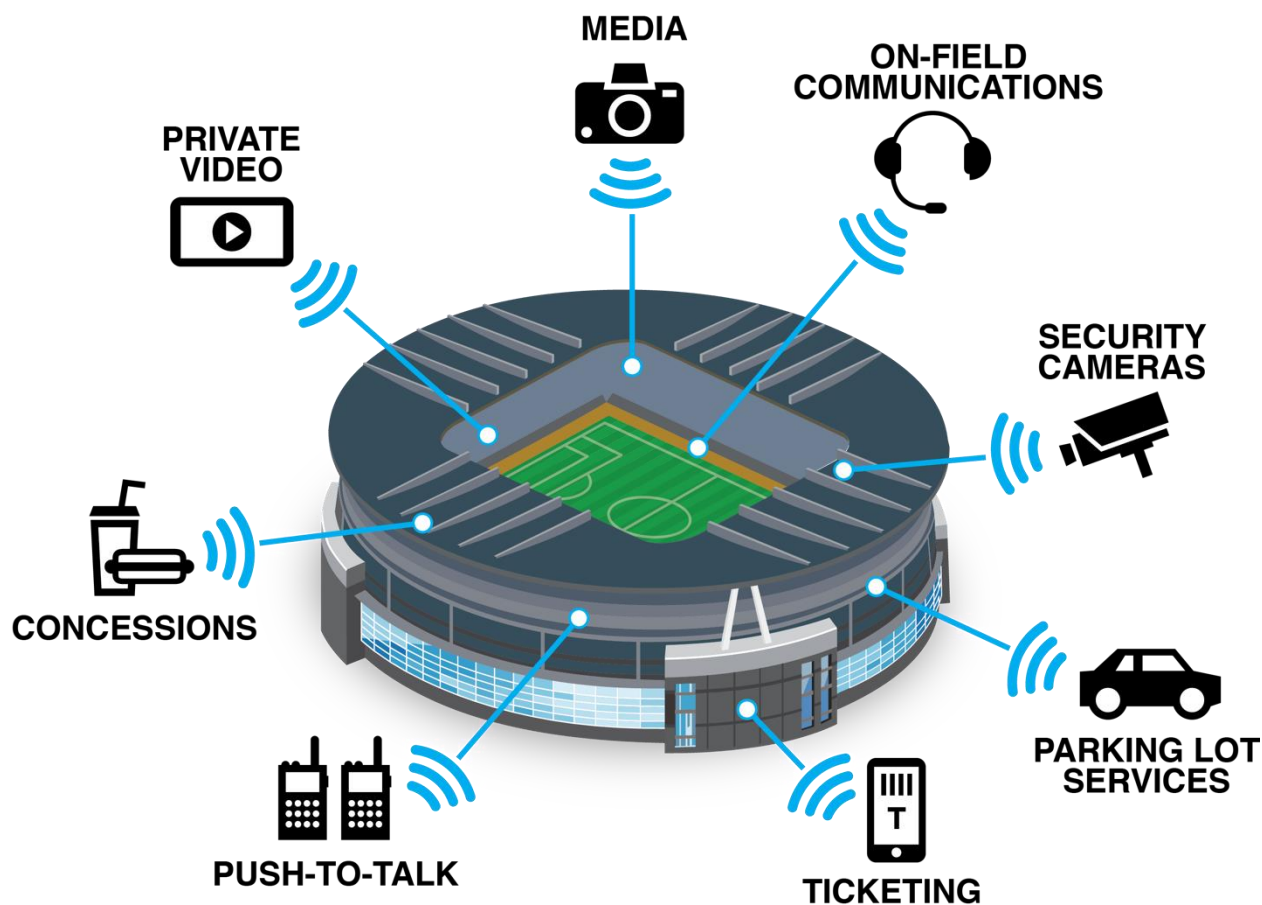
CBRS networks provide connectivity for uses that matter most to venue operations.

Services like mobile payment systems, point of sale, back of house operations, security video, push-to-talk operations and other latency-sensitive applications are all being targeted by early CBRS deployments currently underway. Other possible applications include the aforementioned on-field communications, as well as player performance tracking and even in-stadium gambling operations. At a September industry event where the FCC's approval for initial commercial deployments was announced, a short list of actual customer networks under development were revealed, with more announcements expected this fall (including a short CBRS network trial at Angel Stadium, home of Major League Baseball's Los Angeles Angels).

Over the longer term, CBRS networks may also be used as a sort of "super-DAS," with venues able to use their CBRS networks to directly connect cellular customers to carriers who participate, much like distributed antenna systems work today. To get to this place the industry still needs to solve some non-trivial business and technical issues, including the necessity to be able to support multiple SIM card identities in client devices, either via multiple cards or through the developing eSIM technology, or through business relationships that support multiple networks over a single SIM.

But even as the longer-term issues get resolved, many venues are already interested right now in the use cases for a more secure, more mobile and non-carrier dependent network. What follows is a deeper look at the applications and services that may drive CBRS adoption in venues, and the benefits and challenges of deployment.

Use cases: The power of cellular protocols, and of owning your own spectrum

One of the first rumored tests of CBRS technology and spectrum involved the NFL and Verizon, with the league looking at CBRS as a potential way to provide a private, high-bandwidth way to ensure that on-field communications between coaches, players and staff weren't interfered with in any way, shape or form. While neither Verizon nor the NFL has yet to confirm any specifics surrounding the rumored tests, it's the kind of potential in-venue application that fits the CBRS model like a wide receiver's glove: A wide range of spectrum using a well-known, secure mobile technology, that is completely controlled by the venue owner and operator.

The key to determining whether or not a venue application might be better off running on CBRS can be determined by simply asking whether or not it can be run on Wi-Fi or on cellular -- and if so, what are the comparative costs and functionality tradeoffs of those options compared to the potential of using CBRS.

While Wi-Fi networks have proven to be extremely cost-effective in providing bulk bandwidth for fan usage, the inherent characteristics of Wi-Fi and its spectrum -- shared, unlicensed airwaves -- makes it a more challenging choice for operations that need tight security, like point-of-sale systems or ticket scanning. Since initial CBRS deployments will use the cellular industry's Long Term Evolution (LTE) protocol, all the work done by the carrier community over the years to make mobile or handheld devices more secure will now be available for use in a private fashion, without having to pay carriers a premium for use of their licensed spectrum. LTE is also designed from the ground up to support voice communications, while voice over Wi-Fi is possible but still a challenge in many situations. To imagine how this might work in a venue, consider the simple idea of push-to-talk (PTT) services, now still handled in many venues with walkie-talkie type radios. In a CBRS environment, off-the-shelf PTT devices would be configured to run on the stadium's own

CBRS airwaves, providing PTT capabilities that would be free of any cellular charges, and would keep working even if the local cellular networks went offline.

And even as Wi-Fi gets more performance and better security as the new Wi-Fi 6 standard evolves and populates networks, the ability to use LTE communications for sensitive in-house operations like point of sale, ticketing and security cameras is appealing to many potential venue customers. As mobile payment systems have proliferated worldwide, it's worthwhile to note that LTE is the dominant protocol used by that market's device makers, meaning that it should be easier to bring those devices into the CBRS world fairly quickly.

COMMUNICATIONS
Push-to-Talk
On-field Communications
Local Voice Services

OPERATIONS
Digital Signage
Media/Video
Internet of Things

SECURITY
Cameras
Emergency Location
Wayfinding

COMMERCE
Ticketing
Parking Lots
Concessions/Merchandise

In a CBRS environment, off-the-shelf PTT devices are configured to run on the stadium's own CBRS airwaves, providing PTT capabilities free of any cellular charges.

Since CBRS network gear will have more power and greater reach than a Wi-Fi AP, CBRS communications can also conceivably "fill the gaps" between where Wi-Fi can't reach, and where cellular either gets overwhelmed or is not available due to cost or other budget decisions. One IT director for a U.S. professional sports team who is looking at CBRS said it is a possible solution to the need for temporary networks, like being able to host TV production studios and large fan gatherings outside the stadium during playoff games. Such spaces don't need or warrant the cost of dedicated networks, but they do need situational connectivity, and a slice of CBRS spectrum could easily be turned on for such uses when needed.

The parking-lot scenarios in the opening examples of this paper are perfect illustrations of where CBRS's potential can complement existing networks, by providing secure, mobile communications in an area (parking lots) that might be cost-prohibitive to cover with Wi-Fi, or where carriers haven't invested enough to provide adequate commercial services. One of the announced early commercial deployments of CBRS is using the network to run traffic management system video displays in a new large retail and entertainment complex parking area, functionality that might be attractive to venues with similar operations. In this case, a single radio CBRS solution could be more efficient than a larger number of small cells or antennas on light poles, a method that can be unsightly and even require pole replacements.

Another CBRS test deployment announced this past year involved using CBRS as a kind of wireless backhaul to distant RV parking lots at a large racetrack. Track officials there said they are looking at CBRS as a cost-effective way to bring connectivity to the far-flung fans, many of whom may spend up to a week at the venue prior to big events.

Other possible first-use scenarios for CBRS networks include security camera networks, which will also benefit from CBRS's ability to reach farther from network access point (or small cell) to the end device, as well as the ability to keep the network operations safe from

any prying eyes. Venue owners and operators may also turn to CBRS to provide dedicated channels for video operations, both internal and perhaps even for visiting media.

With multiple channels of spectrum available, a venue could potentially set up separate 10 MHz-chunks of spectrum for different applications and services, all run from the same core system. An added bonus of moving such "gold" type applications to a private CBRS venue network would be the freeing up of space on the Wi-Fi side of things for more fan or general-use applications. As the "owners" of the spectrum -- the power of owning the real estate that surrounds the unlicensed airwaves -- venue owners and operators are now free to pursue any networking ideas they might have, without having to ask for (or pay for) carrier permission.

Costs and deployment: How CBRS private networks can happen

While on one level CBRS networks might be comparable to Wi-Fi deployments in terms of costs and complexity of in-the-field network gear, and a distributed, local-processing architecture that gives venue owners more control over security and service deployment flexibility, the LTE support and the government spectrum-sharing requirements make the back end of CBRS networking a completely different story.

Without diving too deeply into the particulars, to make the spectrum available to the public markets an extensive system of network sensing and spectrum allocation was developed for CBRS. The Environmental Sensing Capability, or ESC, involves networks that have been set up mainly on the country's coasts to detect any Naval activity in the spectrum; the Spectrum Access Systems, or SAS, will be used to allocate spectrum available for use, depending on the information received from the ESC. Multiple private companies are running these networks with government approval and will offer their services to the market.

The other main thing that makes CBRS much different than Wi-Fi from an owner/operator viewpoint is the support needed for LTE. Because of all the processing necessary to supply LTE devices with the characteristics that make them so useful, private LTE networks must have some of the same back-end equipment found in a DAS deployment, including core network services from an Evolved Packet Core (EPC), as well as a Radio Access Network (RAN) to support communications out to LTE devices. Venues will also need to provide a discrete SIM (subscriber identification module) or SIM card or support eSIM for devices that will use the private network, much like carriers do for cellular-service subscribers.

Especially in the sports venue world, few expect stadium and team or school IT departments to take on the time and expense necessary to bring RAN, EPC or CBRS service knowledge in-house. Instead, venues seeking CBRS services will be able to pick from a wide range of service and equipment partners, who will either provide the necessary cellular-market expertise in a neutral-host manner, or provide such services bundled into the CBRS equipment deployment, with many functions available as a cloud-based service.

What will make CBRS networks different from DAS in private-LTE deployments is the need for racks of carrier gear on-site, since initially few CBRS networks will need to or want to connect to the public carriers. When and if that situation arises in the future, venues will likely look to partner with existing neutral-host DAS providers or other companies with cellular market track records, simply because of the experience those companies already have in connecting venue networks with the carriers' operations.

Architecturally, there are also different paths venues might choose to deploy CBRS, with some manufacturers offering network gear that looks like a Wi-Fi access point, while others will be offering small-cell type products or radios that more closely mimic a traditional cellular deployment. There are also multiple offerings for the back-end networking services, including virtualized RAN offerings that can help reduce cost and equipment needs or even provide such capability as a networked service.

Currently, the CBRS Alliance -- the main industry group backing the deployment of networks in the CBRS spectrum space -- has almost 150 members representing all parts of the equipment, service and installation ecosystem. Under the "OnGo" brand name that the alliance has coined for CBRS products and services, the alliance is providing a certification program to ensure interoperability and performance levels, to better promote marketplace acceptance.

Like Wi-Fi networks, the costs of deploying CBRS will vary greatly depending upon the size and extensiveness of network desired. While the extra back-end services required might make CBRS networks slightly more expensive than Wi-Fi networks of a comparable size, CBRS deployments will still be much less expensive than traditional cellular deployments simply because there won't be any need to pay carriers or to purchase costly licensed spectrum.

And if the Wi-Fi market is any indication, owners and operators of larger venues or those used by high-profile teams may be able to reduce CBRS up-front networking costs through team or venue sponsorship deals, using the visibility of the venue or team to help promote the new technologies. With so many companies already pursuing the CBRS market opportunity, and some already forming partnerships to offer combined services and products, the next year should be an interesting one when it comes to pricing for deployment of CBRS networks.

What's in the future: Carrier offload, Super DAS and 5G support

Beyond the immediate benefits of private LTE networked applications, the long-term possibilities for CBRS networks in venues may end up having even greater appeal and return on investment. The easiest and lowest-hanging fruit of the so-called "Phase 2" applications may simply be Internet access or cellular offload. With most device manufacturers moving in some direction toward dual SIMs or eSIM technology, it should only be a matter of time before off-the-shelf devices can be configured to connect to either a public carrier network or a private CBRS network. That would allow fans entering venues to jump on a local CBRS network as easily as they now can switch from cellular connectivity to Wi-Fi.

Apple's decision to support the CBRS band with radio connectivity in its new iPhone 11 line is a clear indication that the giant of mobile devices sees enough promise in the future of CBRS networks to include support for it early in the game. Apple joins Google, Samsung and other device makers in adding CBRS radio support to their latest models, a good sign for anyone questioning the viability of CBRS networks going forward.

With its spacious chunk of bandwidth, and its use of cellular standards, CBRS is also a great candidate to be the place where the DAS of the future, or the "Super DAS" may emerge, again especially for large public venues. Unlike current DAS deployments, which must use licensed carrier spectrum for connectivity inside a venue's walls, a CBRS-powered DAS would use the wide spectrum of CBRS for in-venue connectivity, and then connect participating carriers to their customers on the back end. Given the lack of a need to procure licensed spectrum, such a Super DAS should theoretically be much cheaper to set up and run than current DAS deployments -- or at the very least, a CBRS DAS might not have to try to charge the so-called "ransom" fees that sometimes discourage carriers from participating, especially if a venue isn't significantly large enough in size. Several CBRS

industry insiders see CBRS DAS deployments as being particularly cost-effective for smaller venues, since they can build it themselves (or with a neutral-host partner) and charge low enough fees to encourage carriers to participate.

Such CBRS DAS deployments may become even more attractive as carriers move toward 5G networks, since the CBRS industry is already working on a version of the new 5G air interface (called NR) for CBRS. A single CBRS 5G neutral network could provide 5G coverage while keeping separate network deployments to a minimum.

Conclusion: Much to prove, but much to possibly gain for venues from CBRS

While the lack of existing deployments and hard pricing models may lead many venues to tread conservatively in the path toward CBRS networks, there is nothing for venues to lose and much to potentially gain by immediately adding CBRS to the list of possible technologies for future wireless-needs consideration. The complementary nature of the CBRS infrastructure also means it is possible for venues to "test drive" the CBRS products and services with a small deployment focused on specific applications.

Again, it is worth noting the widespread vendor and service-provider support for CBRS, from small specific device manufacturers all the way up to the largest public cellular carriers, with many entities in between. With many of the same vendors from the Wi-Fi space entering the CBRS market, venue owners and operators should be able to leverage existing relationships as they seek out the best possible partners and providers for potential CBRS deployments. Some of the CBRS monetization strategies may take some time to shake out, as carrier strategies emerge more clearly after the 2020 FCC auctions for the licensed portions of CBRS airwaves. Venue owners and operators would be wise to restrict carrier and/or third-party wireless rights in the CBRS space until more information is available.

And even as the Wi-Fi market pushes its own evolution with exciting developments like the emerging Wi-Fi 6 standard, and as the carriers step up their inevitable march toward 5G, there will always likely be room for systems with a dedicated swath of wireless spectrum that is basically free to use inside your own walls, especially when that Wi-Fi-like characteristic comes with much of the performance upside that is the heritage of the cellular standard known as LTE. So, what can CBRS do for venues? If all unfolds as promised, there may be many answers to that simple question.

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