STADIUM
TECH REPORT ™

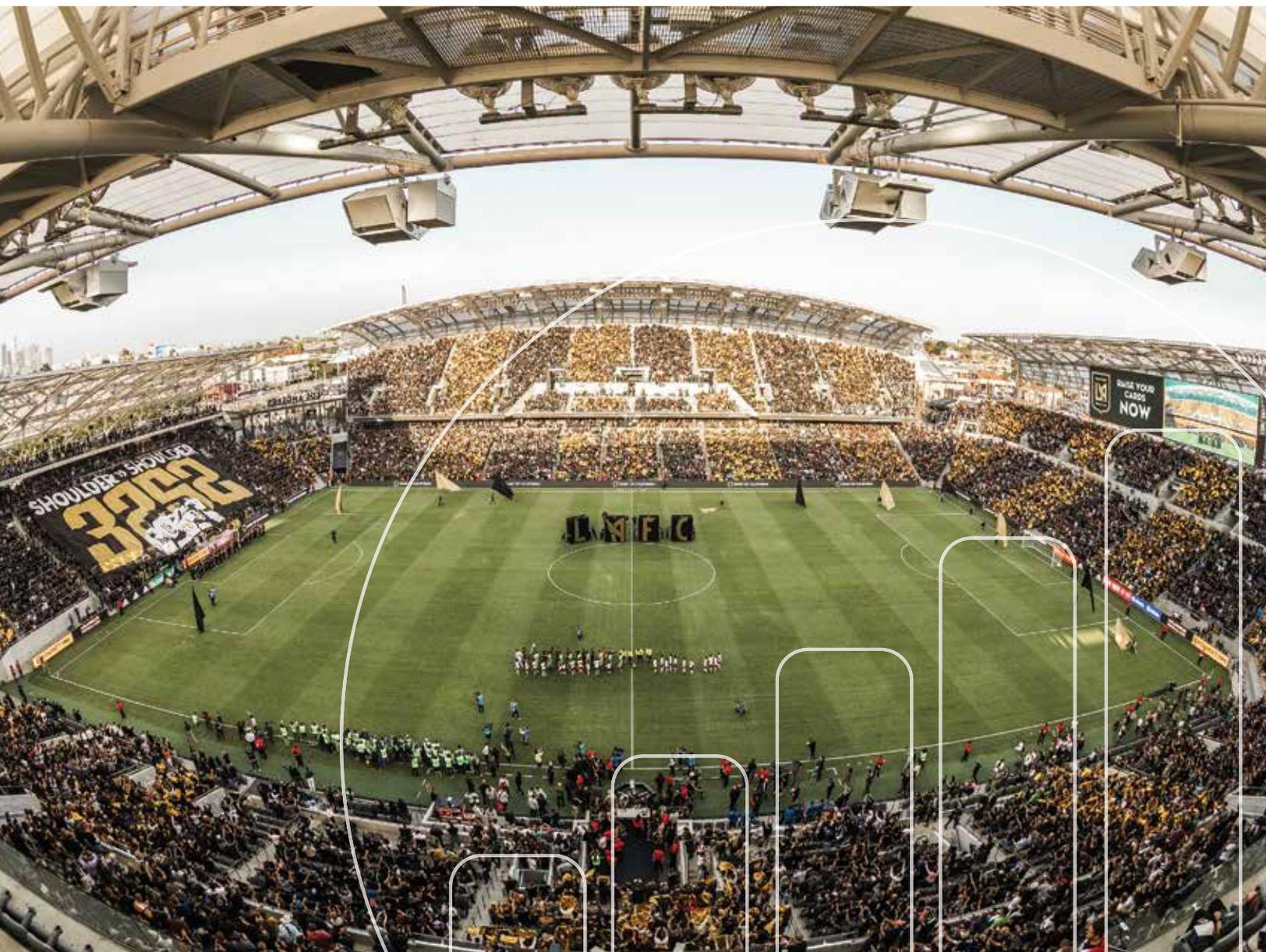## WI-FI ARRIVES AT
OHIO STADIUM

**SINGLE FIBER NETWORK
AT DICKIES ARENA**

**MAJOR LEAGUE WI-FI
AT LAS VEGAS BALLPARK**

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![msr/mobile sports report — STADIUM TECH REPORT logo]

Welcome to the third issue of our SIXTH year of STADIUM TECH REPORTS, the Fall 2019 issue! These quarterly long-form reports are designed to give stadium and large public venue owners and operators, and digital sports business executives a way to dig deep into the topic of stadium technology, via exclusive research and profiles of successful stadium technology deployments, as well as news and analysis of topics important to this growing market.

Our stories for this issue include an in-person profile of the new Wi-Fi 6 network at venerable Ohio Stadium, the "horseshoe" known and loved by fans of THE Ohio State University. We also have an in-person profile of the Wi-Fi network at the hottest (literally) ballpark in Minor League Baseball, the Las Vegas Ballpark, plus a look at the converged fiber network installed at the soon-to-open Dickies Arena in Fort Worth. Plus, a "sneak peek" inside the Golden State Warriors' new Chase Center, and a progress report on Allegiant Stadium, the upcoming home of the Las Vegas Raiders!

We'd like to take a quick moment to thank our sponsors, which for this issue include Mobilitie, JMA Wireless, Corning, Boingo, MatSing, Cox Business/Hospitality Network, Connectivity Wireless, and American Tower. Their generous sponsorship makes it possible for us to offer this content free of charge to our readers. We'd also like to welcome readers from the Inside Towers community, who may have found their way here via our ongoing partnership with the excellent publication Inside Towers. We'd also like to thank the SEAT community for your continued interest and support.

As always, we are here to hear what you have to say: Send me an email to kaps@mobilesportsreport.com and let us know what you think of our STADIUM TECH REPORT series.

Paul Kapustka, Founder & Editor
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DO THE MATH
Wi-Fi 6 MAKES $ENSE

BY PAUL KAPUSTKA

Even with the September introduction of Apple's iPhone 11 line, which all include support for the new Wi-Fi 6 standard, it is likely to be some time – maybe a year or two – before the balance of devices fans carry to stadiums will support Wi-Fi 6. So if the question is, do you upgrade your network now or keep milking Wi-Fi 5 until devices catch up – the answer here is, move to Wi-Fi 6 as soon as you can. The math on all fronts just makes too much sense to wait if you don't have to.

For new stadium installs, the move to Wi-Fi 6 seems to be the educated choice. New networks at Oklahoma and Ohio State (see profile in this issue) fully embraced the new standard, even if the Wi-Fi 6 software in those venues isn't operational yet. According to AmpThink president Bill Anderson, whose firm did the design and deployment at both stadiums, the math is simply a no-brainer, especially given the long capital budget expenditure schedules at most public universities.

"The question to ask is when can you afford to replace your network?" said Anderson in a recent discussion during an MSR visit to Fort Worth, Texas, where AmpThink is building out a converged fiber network at

GAME DAY PHOTOS CAN NOW BE INSTANTLY SHARED OVER OHIO STATE'S WI-FI 6 NETWORK. CREDIT: PAUL KAPUSTKA, MSR

"Wi-Fi 6 is making us rethink how we can provide capacity... now with what Wi-Fi 6 can support, things are going to get really interesting."

the new Dickies Arena (see profile in this issue), which will also have Wi-Fi 6 gear when it is finished. According to Anderson, if you accept the premise that any technology you install will "not be current" within 3 years after its deployment, the question then becomes, when will you have the money for an upgrade?

While most big operations like universities like to operate on 10-year budget cycles, some venues do have money set aside to keep communications current on a faster time frame. But even an accelerated schedule might not be fast enough, Anderson argues.

"The thing about Wi-Fi 6 is that it is NOT a minor change," said Anderson, whose firm put together a report on Wi-Fi 6's new capabilities that was distributed in the last issue of the Stadium Tech Report. Calling it a "super significant" upgrade, especially for venues, means that if you pass on moving to Wi-Fi 6 now, that means with normal upgrade cycles it could be anywhere from 5 to 10 years before your venue catches up. By that time, most of the devices fans bring to your venue will likely support Wi-Fi 6, but they won't be able to take advantage of any of the new standard's features if the stadium network is stuck on Wi-Fi 5.

"If you're sitting on the fence, it's time to get off the fence" and move forward with Wi-Fi 6, said Chuck Lukaszewski, Vice President of Wireless Strategy & Standards at Aruba, a Hewlett Packard Enterprise company. "If you have the opportunity to deploy Wi-Fi 6, you should. It just makes a lot of sense."

And while Wi-Fi 6 gear may be more expensive right now, the things it will allow – such as greater capacity and higher connection speeds, for starters – will provide other benefits of their own that right now may be unseen, like the ability to reap more revenue from new services supported by better networks. And with the biggest network usage days (like at Super Bowls or other big events) pushing network spectrum use to near capacity, can you afford to stick with the current Wi-Fi technology as user wireless demands continue to grow rapidly with no end in sight? How much will that bet cost if you are incorrect?

"Wi-Fi 6 is making us rethink how we can provide capacity," Anderson said. "We used to joke about stadiums having huge [backbone] pipes," Anderson said, because it was thought that venues would never need the capacity. "But now with what Wi-Fi 6 can support, things are going to get really interesting."

Wi-Fi hardware vendors clearly believe in Wi-Fi 6 as well, with Aruba supplying gear for both Ohio State and Oklahoma, and Cisco following up with its own Wi-Fi 6 equipment with several installs already underway. Extreme Networks, which just announced a Wi-Fi 6 deployment at Lucas Oil Arena in Indianapolis, will likely have other NFL venue announcements coming soon. Extreme also recently announced a deal to put a Wi-Fi 6 network into Houston's BBVA Stadium, home of Major League Soccer's Houston Dynamo and the National Women's Soccer League's Houston Dash.

Ruckus, now a part of CommScope, also has Wi-Fi 6 gear and the Wi-Fi Alliance recently announced the availability of Wi-Fi 6 certification, so venue owners and operators should have a wide range of choices to help reduce potential prices through competition.

"We took a pretty hard look [at Wi-Fi 6], and the timing worked out pretty well," said Jim Null, Ohio State's CIO. With huge Wi-Fi numbers in its first few games, Ohio State's network is only going to get better when the Wi-Fi 6 features are enabled. "The risk was worth the reward," Null said. –MSR–

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WI-FI ARRIVES AT OHIO STADIUM

BY PAUL KAPUSTKA

With its long tradition of excellence in all things pertaining to college football, is it any surprise that when the Ohio State University finally got Wi-Fi installed at Ohio Stadium the network would instantly be one of the best around?

Over this past offseason, the school oversaw the first comprehensive installation of a fan-facing Wi-Fi network inside the venerable "Horseshoe," with almost 2,000 access points, some 600 of which were installed in handrail enclosures that all sport the Ohio State logo engraved on each side. Live and operational for the Buckeyes' home opener on Aug. 31, the network saw just more than 47,000 unique users its first day and carried more than 13 terabytes of data, instantly lifting Ohio State to the front of the class in single-day collegiate football Wi-Fi records.

Impressive as its first stats might be, the network will only get significantly better in the near future as device technology catches up with it. A decision to use the new Wi-Fi 6 standard, also known as 802.11ax, in as many of the APs as possible, will let Ohio State take advantage of the technology's promise of higher throughput and the ability to handle more clients per AP when more fans get their hands on devices that support Wi-Fi 6 and bring them to games.

During a visit by Mobile Sports Report for the Aug. 31 game, close-up inspection of many of the APs in a pre-game walkaround saw no evidence of the frenetic summer of hard work getting the equipment installed. Using Wi-Fi gear from Aruba, a Hewlett Packard Enterprise company, and installed with with a design by AmpThink (which also manufactured the AP enclosures), the deployment does an excellent job of looking like it's been part of the almost 100-year-old stadium for a long time, with discreet wall and overhead antenna placements complementing the standout handrail enclosures. And with connectivity finally in their house, the Ohio State fans wasted no time jumping on the network, with many fans expressing great joy at being able to use their wireless devices at the game.

A bumpy road to Wi-Fi

Built in 1922 as one of the then-largest poured-concrete structures, the building known officially as Ohio

FOR THE FIRST TIME, FANS IN THE 'HORSESHOE' HAD ACCESS TO HIGH-DEFINITION WI-FI. CREDIT ALL PHOTOS: PAUL KAPUSTKA, MSR

Stadium (and also as "the Horseshoe," or just "the Shoe") is among the biggest of the big, with capacity reaching 104,944 after renovations in 2014. That number actually decreased a bit with a recent round of renovations that removed some seats in favor of some new suite areas, but even with capacity of around 102,000, Ohio Stadium is still among the top echelon of Saturday afternoon shrines for its scarlet- and grey-clad followers.

While the venue is long held in reverence by not just Ohio State fans but by football fans in general, the things that make it a great place to watch a game – the big, open seating bowl and the historic concrete structure – also make it a challenge to equip with modern wireless technology. Back in 2012, it looked like the school had solved the problem by signing a deal with Verizon to bring Wi-Fi to the football stadium and basketball arena. But according to several reports, the installation never occurred and now the school and Verizon are still involved in a lawsuit concerning the non-deployment.

Fast forward to 2018, and the school finally approved a measure that will bring connectivity not just to the stadiums, but in many other places across campus as well. Jim Null, senior associate athletic director and chief information officer for Ohio State, noted that as a digital program partner with Apple, the school gives all students iPads as freshmen, leading to demands for coverage not just in classrooms but anywhere students may wander.

"There were a lot of coverage gaps on campus," Null said. The new deal, reached in the spring of 2018, approved $18.6 million in spending for wireless coverage

in the stadiums and across campus. According to Null, the sports stadiums' portion of that deal was approximately $10 million. Null also said the stadium has a 30 Gbps backbone pipe, courtesy of the Ohio Academic Resources Network (OARnet), the 100 Gbps network that connects the state's major cities and research institutions.

Handrails and Wi-Fi 6

With a bill of material in hand for the deployment, Null said that Aruba asked if the school wanted to use Wi-Fi 6 gear, which was available this spring when construction was to begin.

"It was good timing in a sense – Aruba came back to us and said, why not go with Wi-Fi 6, and everyone here [at the school] decided that was a good idea," Null said. While the new version of the standard will improve Wi-Fi performance in any kind of network, at large sports venues the improvements will likely be significant. AmpThink president Bill Anderson, who is urging most new-construction Wi-Fi clients to install Wi-Fi 6 if possible, calls the new standard "a significant game-changer" for in-venue networks.

AmpThink's Anderson, whose company has designed and helps run networks in the biggest stadiums that see the biggest events – including last year's Super Bowl and last year's men's NCAA Final Four – says that over the past year or so, networks based on older Wi-Fi standards are reaching some theoretical limits, mostly with spectrum

CLOCKWISE FROM TOP LEFT: WI-FI ABOVE A CONCESSION STAND; A MONITOR TELLS FANS HOW TO LOG ON; AN OVERHEAD LOOK AT AN AP WITH TWIN ANTENNAS POINTING DOWN TOWARD SEATS IN THE B DECK.

re-use. "We are getting to the cutting edge of what we can support," with the older Wi-Fi 5 technology (also known as 802.11ac), Anderson said.

Wi-Fi 6, however, promises to deliver more capacity per access point, along with better techniques for communication between devices and access points, which most industry followers agree should produce significant benefits, especially in venues where spectrum re-use is necessary given the large numbers of APs needed to provide coverage. While it's true that it may take some time before Wi-Fi 6 technology is on both the access point and the balance of user devices in stadiums (both sides of the equation need to support Wi-Fi 6 for the full range of benefits to be realized), the fact that many new devices – including the recently announced Apple iPhone 11 line – contain support for Wi-Fi 6 means that the full improvements will likely be seen sooner rather than later.

"Ohio State made the right choice to go with Wi-Fi 6," Anderson said.

Putting the APs into handrail enclosures was another decision point, but one Null said the school was unified on. Though Aruba has traditionally preferred to deploy Wi-Fi in under-seat placements, like in deployments at Levi's Stadium and Mercedes-Benz Stadium, Null said the combination of aesthetics, performance and cost made railing enclosures the preferred choice at Ohio State.

"The combination of all three led us to the handrails," Null said, noting that with the ability to place two APs into a single handrail enclosure, Ohio State was able to approximately cut in half the number of holes it would have to drill into the concrete to string cable to the devices, a huge savings in cost and construction time. With bleachers in most of its seating areas, Ohio Stadium would have cut into under-seat spaces significantly with under-seat APs, Null said.

Though some lower-bowl areas without handrails did get under-seat AP placements, the 600 handrail enclosures – all manufactured by AmpThink and custom-stamped with an Ohio State logo – now wrap around the entire seating bowl, from near the field to way up at the top of Deck C. Null said performance from some other recent AmpThink deployments that primarily used handrail enclosures – including Notre Dame Stadium and U.S. Bank Stadium – led Ohio State to believe that handrail installation techniques would be "very comparable in performance" to under-seat.

And if the first two games with the network are any indication, the Ohio Stadium handrail enclosures are working just fine. According to the school the network saw 47,137 unique connections out of 103,228 in attendance for the home opener against Florida Atlantic on Aug. 31, with a peak concurrent connection number of 28,900. Total bandwidth tonnage for the first game

was 13.3 terabytes, a mark which already puts Ohio State in fifth place in the unofficial all-time Wi-Fi single-day record list kept by MSR.

Ohio State's second home game of the season, a week later versus Cincinnati, was nearly equal in performance statistics. According to figures provided by Ohio State, on Sept. 7 the network saw 47,579 unique connections out of 104,089 in attendance, with a peak concurrent connection mark of 28,900. Total tonnage for the second game was 12.7 TB, good enough for sixth place on the MSR list. Peak bandwidth rates were just over 10 Gbps for the home opener, and just above 6 Gbps during the second game.

Solid tests throughout the venue

An unofficial walk-around testing process by MSR before and during the home opener showed solid performance in just about every part of the venue, from outside the entry gates to all the seating areas low and high, and on concourses and other busy walkways. Inside of Gate 14, we got one of the highest Wi-Fi speedtest marks in the stadium, at 62.7 Mbps on the download side and 72.1 Mbps for upload. According to Null the entryways are well covered, with four access points hidden behind a directional sign that simply blends into the structure.

Inside the stadium, we got a mark of 49.2 Mbps / 42.9 Mbps in the seats in the lower bowl around the 45-yard line, an area covered primarily by handrail enclosures. Closer to the field in seats along the goal line on the press box side of the stadium we got a mark of 51.2 Mbps / 32.0 Mbps; in the same spot we tested the DAS coverage for cellular and got a Verizon network speedtest of 20.1 Mbps / 1.34 Mbps. According to Null Verizon runs a neutral-host DAS inside the stadium, with AT&T as a client.

Back on Wi-Fi with the stadium still closed to fans we went up into the metal bleachers in the non-curved end zone and got a speed test of 38.6 Mbps / 18.7 Mbps. In the concourse below these same stands we got a test mark of 47.2 Mbps / 48.5 Mbps.

An elevator ride to Deck C and a hike up the steep steps found us at the top row of the stadium, where the Wi-Fi was still strong, with a mark of 42.0 Mbps / 35.6 Mbps in row 41. We then went down to Deck B on the non-press box side of the stadium, where some concrete overhangs make for interesting placements. There, we saw Wi-Fi APs mounted above the seating areas pointing down. With fans starting to come into the stadium we got a mark there of 24.3 Mbps / 45.2 Mbps; in the same area the DAS provided a test of 21.8 Mbps / 12.6 Mbps, again on the Verizon network.

The one place we found with poor Wi-Fi coverage – down near the field in section 28AA – was one of the few areas where Null said that the network deployment
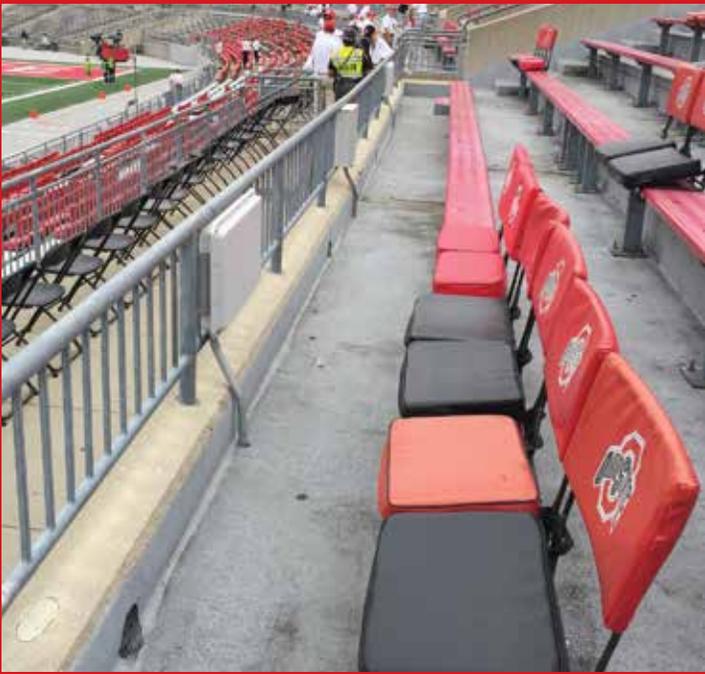
CLOCKWISE FROM TOP LEFT: AN OVERHEAD DEPLOYMENT IN THE B DECK OVERHANG; HANDRAIL ENCLOSURES IN THE LOWER DECK; A CUSTOM JERSEY-SHOPPING KIOSK; DAS ANTENNAS ON THE TOP RAILS; BACKWARDS-FACING APS FOR THE LOWER-BOWL SEATS.
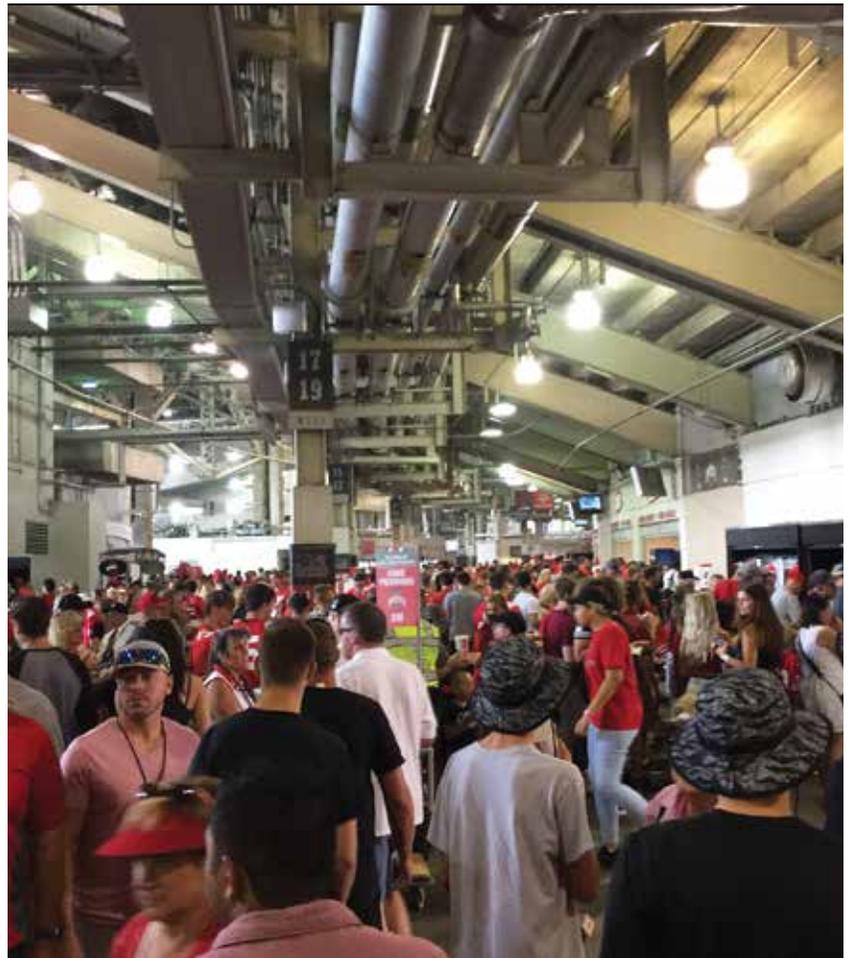
CLOCKWISE FROM TOP LEFT: A HANDRAIL ENCLOSURE; WI-FI WAS STRONG EVEN IN CROWDED CONCOURSE AREAS; A SIGN TO HELP FANS GET THEIR DIGITAL TICKETS READY.

was not yet complete. (The Speedtest.net app we use for testing dropped during the test here; the same area did have DAS coverage, with a mark of 16.9 Mbps / 4.66 Mbps on the Verizon network.)

That the network was near complete for the opening game was a testament to extra work from all suppliers. AmpThink, which outfitted three major college fields this summer, had overtime shifts to manufacture enough enclosures, while Aruba had to produce enough Wi-Fi 6 APs not just to fill Ohio State, but also Oklahoma, whose stadium is of similar size.

"It was quite a ballet dance the last nine months," said Jeff Weaver, director of high density consulting at Aruba. "Hats off to the construction team."

Perhaps the most impressive tests we got were taken during live game action, one just after an Ohio State touchdown. In section 13 up on the C deck we wandered out into the middle of celebrating fans and got a speedtest of 59.9 Mbps / 57.9 Mbps. Walking down to section 27AA on the press box side after yet another OSU touchdown we sat in the aisle and got a speed test of 54.7 Mbps / 70.2 Mbps, from an area covered by handrail enclosures.

Fans happy now, likely to be even happier in the future

If Ohio State is known widely for its football excellence (Ohio State has eight national championship titles to its name), its fans have known mostly wireless frustration over the recent years, a situation that has now changed 180 degrees. In several conversations with fans MSR heard how happy OSU fans were now "that we can actually use our phones!" And as good as the network speed tests and overall performance is now, it's worth noting that the Wi-Fi 6 advancements are not yet even being used – meaning that when more fans have Wi-Fi 6 enabled devices the network should perform even better, leading to faster connections and more capacity for all.

Null said that Ohio State will also be deploying the Passpoint software in the future, which allows for automatic sign-on to the Wi-Fi network and better support for device roaming. Ohio State does not ask fans to log in with any sort of email information or personal identification – all they need to do is select the OSUfanWiFi SSID and connect. And if the first two games are any indication, many Ohio State fans will continue to do so with great appreciation for the foreseeable future. –MSR–

CLOCKWISE FROM TOP LEFT: SELF-SERVE SOFT DRINK STATIONS ARE ANOTHER NEW ADDITION TO THE FAN EXPERIENCE; FAN PHOTOS IN ACTION; A LOOK AT THE EXPANSE OF RAILING ENCLOSURES IN THE LOWER BOWL.
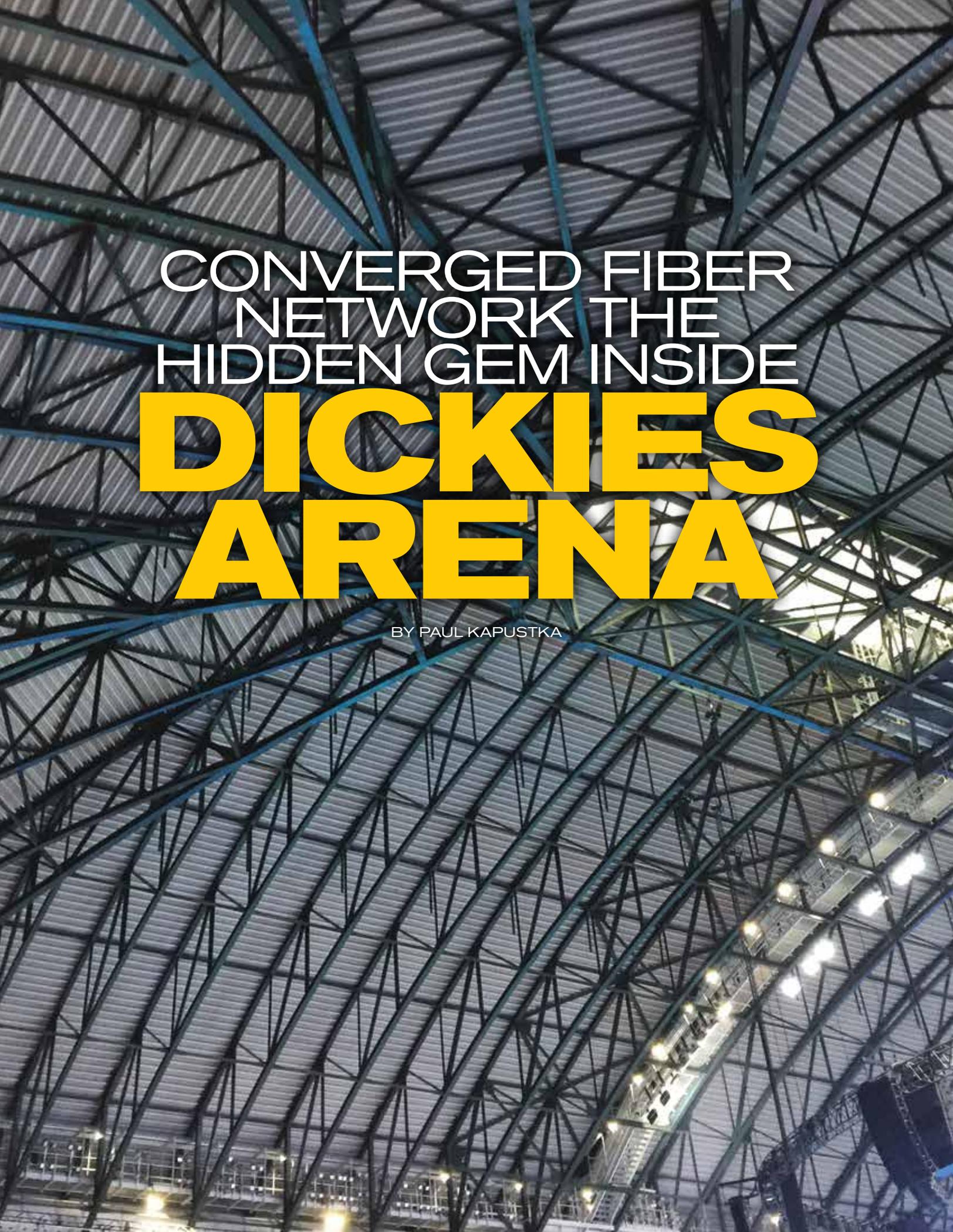
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CONVERGED FIBER NETWORK THE HIDDEN GEM INSIDE DICKIES ARENA

BY PAUL KAPUSTKA

FACING PAGE: THE 'BIG AS THE TEXAS SKY' ROOFLINE
AT DICKIES ARENA. THIS PAGE: THE MAIN BOWL
AND THE LARGE CENTER-HUNG VIDEO BOARD.
CREDIT ALL PHOTOS: PAUL KAPUSTKA, MSR

With its soaring roof and its high-end cosmetic finishes, Fort Worth's new Dickies Arena will be a wonder to look at when it opens for events later this fall.

But what may be even more impressive, certainly from an IT perspective, is something you can't see: The single, converged fiber network that supports all network operations, including the cellular DAS, the arena Wi-Fi and the IPTV operations, in an orderly, future-proofed way.

Built by AmpThink for the arena, the network is a departure from what has long been the norm in venue IT deployments, where multiple service providers typically build their own networks, with multiple cabling systems competing for conduit space. At Dickies Arena, AmpThink was able to control the fiber systems to follow a single, specific path, allowing the company to save costs and space for the client while building out a system with enough extra capacity to handle future needs for bandwidth, according to AmpThink.

"This is really our master class [on stadium network design]," said AmpThink president Bill Anderson, during a recent MSR visit and tour of the almost-ready arena. If you're not familiar with the Dickies Arena story, the arena is part of a public-private venture between the city of Fort Worth and a consortium of investors and donors led by local Fort Worth philanthropist Ed Bass. Though it doesn't have a professional basketball or hockey tenant, the NBA-sized venue will fill an arena-sized need for events in the growing Fort Worth area, while also serving as the new home for the Fort Worth Stock Show and Rodeo. The venue is scheduled to open this November.

Following the lead of AT&T Stadium, where high-end finishes were a hallmark of Dallas Cowboys owner Jerry Jones' influence, Dickies Arena appears to take cosmetic matters a full step further, with intricate tile flooring and art-quality finishes on areas like stairway handrails and bar facades. In an early September walkaround while workers were still completing finishing touches like polishing concrete floors to make the surfaces shine, MSR also got to see the results of owners' requests of "not having a single cellular or Wi-Fi antenna visible," according to AmpThink's Anderson.

No fiber allowed outside of the single path

In the suite and concourse areas, for example, Wi-Fi APs and DAS antennas are hidden behind ceiling panels, with no electronics in sight. But what's even more impressive from an engineering and construction standpoint is what's happening further down the network path from the endpoints, where all cable and fiber follows a structured pathway, first to an IDF and then back to the head end rooms in the arena's basement.

"No fiber is allowed to follow a path that doesn't tie to an IDF, or directly to the head end," said Anderson. "And we didn't allow DAS vendors to be outside the closet. It's the venue's fiber network. Nobody else could come in and build their own."

CLOCKWISE FROM TOP LEFT: THE LIVESTOCK HOLDING PENS IN THE ARENA BASEMENT; NETWORK GEAR IN THE HOLDING PEN AREA; THE STREAMLINED FIBER PATH INTO THE MAIN HEAD END ROOM; RACKS OF POWER CORDS; FIBER BANKS READY TO BE CONNECTED TO DAS CARRIER GEAR.

ooking from the end of the project back, it's clear why you might want to pursue such a path: With a single, converged network, design and planning and eventually operations are streamlined, since there aren't multiple infrastructures to deploy and maintain. The conditions also allowed AmpThink to fully pre-design and perform many construction techniques like splicing and cable measurement and cutting beforehand – according to Anderson, there was not a single fiber termination done in the field.

"For venues it used to be, use the 'brute force' method and just go figure it out in the field," Anderson said. At Dickies Arena, that method simply wasn't the case. In addition to fiber cabling and splicing work, AmpThink also built many custom enclosures (the company has a large machine shop at its Dallas-area headquarters where it can design and manufacture parts like metal wiring boxes and the plastic enclosures it uses for stadium Wi-Fi and DAS deployments) to simplify installation while complying with the strict aesthetic requirements.

"AmpThink helped us think proactively so we are prepared to build on this solid foundation for the future," said Matt Homan, president and general manager of Trail Drive Management Corp (TDMC), the not-for-profit operating entity for Dickies Arena. "This has allowed us to have a much more cost-effective approach, which is important for us as a 501c3 organization operating Dickies Arena. The AmpThink team has done a phenomenal job of assisting with the architectural integrity of the building to ensure that no Wi-Fi or DAS antennas were seen."

Jeff Alexander, senior vice president at ExteNet Systems, said Dickies Arena was the first time ExteNet ever participated in a converged network design for a large public venue. But Alexander also said ExteNet, which is responsible for the DAS design and 5G cellular installations at Dickies Arena, had years of experience in situations where service providers had to work together.

"Most [other] DAS deployments give no consideration for Wi-Fi, or anything else," said Alexander in a phone interview. "Given ExteNet's experience and our track record, these are things we were forced to think about 10 years ago."

According to Alexander, the directive to work with a single converged fiber network wasn't "harder" than a regular installation.

"It was unique," Alexander said of the Dickies Arena installation experience. "It made us think of things we hadn't

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thought about, and challenged us to consider other things than the typical DAS installation, which isn't a bad thing. I consider it a success."

At Dickies Arena, the DAS uses the Corning ONE DAS hardware system with approximately 500 active antennas in 12 zones for the DAS.

As future-proofed as possible

As part of the overall fiber network design, AmpThink's Anderson said the company maximized capacity throughout the building, with hundreds of extra fiber strands available to support future capacity needs. By using optical fiber with hundreds of strands wound together – including some stretches with 864 different fiber strands inside a single cable – AmpThink actually saved time, money and space by preventing the need for additional infrastructure or future cable pulls.

"The bulk of the cost [of fiber deployments] is the labor to pull the fiber," Anderson said. By using large-bundle fiber, Anderson said AmpThink was able to drive the cost per strand to "a very low number," while also clearing conduit space since a large-bundle fiber strand saves a huge amount of space when compared to multiple smaller-bundle strands which must each have their own insulation.

While ExteNet's Alexander contends that no network design can ever be truly "future-proofed" – if you ask him he will tell you a story about a large sports venue where ExteNet is currently replacing 864-strand fiber put in 5 years ago with 1,728-strand fiber – he does agree that putting in as much fiber as the design and cost allows buys a venue time to support the always-growing demand for bandwidth.

"The industry is full of venues that didn't do that, and 12 months later they're expanding their fiber plant," Alexander said. AmpThink's Anderson noted that even during the arena's construction, there were demands for additional fiber – such as for a densification in the LED ribbon boards – that were easily addressed.

"People came back to us, and said they needed more fiber, and we had it to give to them, no problem," Anderson said. "It didn't cost us a lot to do it [add in more fiber strands]. It's a model everyone should look at." –MSR–

DICKIES ARENA IS DESIGNED TO BLEND IN TO THE HISTORIC WILL ROGERS MEMORIAL CENTER ARCHITECTURE.

CLOCKWISE FROM TOP LEFT: HIGH-END FINISHES ON STAIRWAYS AND BAR FACADES; THE WILL ROGERS MEMORIAL CENTER; RODEO GATES AT THE READY; THE VIDEO PRODUCTION ROOM; AN END ZONE BAR AREA.

COLLEGE STADIUMS

Mobile Connectivity at College Football Stadiums is a Must

Clemson University

JMA Wireless Solutions Meet Your Game Day Needs

The air is turning crisper, students are returning to school and college football games are kicking off at stadiums across the country. However, today's students expect a much different fan experience when watching the big game onsite. These students live in a world where smart phones are always in reach, ensuring every exciting game play can be captured and shared with family and friends. Chief Information Officers (CIOs) at these higher education facilities know that the campus' wireless network must not only provide

adequate coverage, but capacity per user is critical too with over 92 percent of Millennials using a smart phone. And, now with Generation Z starting to enter college, capacity is becoming even more important. Like Millennials, the device of choice for this younger generation is the smart phone, which they use on average for over four hours per day. So, when these students converge on a football stadium on game day the wireless network better be ready to transport terabytes of data in a few short hours.

Wireless Solutions to Satisfy Fans and Overcome CIO Challenges

JMA Wireless is no stranger to the world of collegiate sports. Our wireless connectivity solutions have been enabling the ultimate fan experience at college football stadiums in the Heartland, along the East Coast, and out to Colorado and beyond. To combat today's wireless communications challenges and prepare football stadiums for future technologies, CIOs at numerous institutions of higher learning have turned to the following JMA Wireless innovations:

XRAN® - The industry's first 100 percent software solution runs on off-the-shelf servers and completely virtualizes the full baseband protocol stack (layers 1-3). This offering not only is cost-effective, but future-proof with its ability to adapt for 5G, IoT and applications for new services and business processes that today's CIO may want to implement. As a flexible RAN alternative, it enables high capacity support for multiple operators and can even apply resources to a football stadium as utilization demands increase on game day.

FUZE™ - Colleges can deploy this platform to address heterogeneous networks. It offers integrated IDF mounting and cabling kits for DAS and Wi-Fi delivery. And with its Digital Electricity™ feature, it is perfect for addressing wireless connectivity in large football stadiums or even across a college campus since it provides power up to over one mile away.

NWAV Antennas - As college CIOs have come to realize, capacity is the critical factor when it comes to providing robust cellular communications nowadays. Our NWAV antenna portfolio offers solutions with FRO (Fast Roll-Off) technology, which helps increase data capacity without compromising coverage. The horizontal beam produced by this technology increases the SINR (signal-to-interference-plus-noise ratio) by eliminating overlap between sectors. The increased SINR results in higher throughput, which is particularly critical at events such as college football games, concerts or commencement. Furthermore, the horizontal beam produced by Fast Roll-Off technology reduces harmful

Rutgers University

Kansas State University

interference between adjacent cells, making them especially useful in these dense environments.

TEKO® DAS - Our industry leading modular DAS (distributed antenna system) platform supports multiple operators, multiple bands, and several mobile technologies. This robust solution has been deployed in numerous college football stadiums or even off-premise to enable cellular coverage and capacity. Our DAS platform not only offers the smallest footprint in the market, but also saves time and money by delivering multiple operators, bands, and technologies to the remote units (RU) using just a single strand of fiber optic cable per RU. This flexible and future-proof offering can readily integrate with any of our latest innovations, resulting in even further cost savings for colleges.

Looking to the Future Game Day

JMA Wireless has enabled cellular connectivity at dozens of college football stadiums, and is now ready to help sports facilities take the next step to fully utilize the opportunities 5G will present. Just like today's college CIOs, we are looking for ways to make stadiums smarter with technology that will connect fans, devices and machines like never before. To learn more about our software and hardware offerings and how they will turn 5G possibilities into reality, visit JMAWireless.com.

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THE NEW STADIUM'S HIGH-END FINISHES, FAN-FRIENDLY AMENITIES AND HIGH-DEFINITION WI-FI NETWORK ARE NOT ONLY THE TALK OF MANY TRIPLE-A TEAMS, BUT THE BIG LEAGUES AS WELL

MAJOR-LEAGUE WI-FI

BY PAUL KAPUSTKA

SUNSETS ARE SPECTACULAR AT THE NEW LAS VEGAS BALLPARK. CREDIT ALL PHOTOS: PAUL KAPUSTKA, MSR

Maybe for some late-night behavior, the old "What happens in Vegas stays in Vegas" rule still applies...

But when it comes to minor-league baseball, the tale of what's happening at Las Vegas Ballpark is being spread far and wide, as the high-end finishes, fan-friendly amenities and high-definition Wi-Fi network at the new venue are the talk not only of many Triple-A teams, but of other sports and possibly even Major League Baseball as well.

The $150 million ballpark, which opened this season in the Vegas suburb of Summerlin, is the new shining jewel in minor-league baseball, with features like a huge video screen, party porches and club-level suites that feel more major-league than minor. So far the facility has been a smash hit with Vegas baseball fans, setting a new season-attendance record halfway through the summer and leading the minor leagues in attendance, despite the fact that the 10,000-seat venue is the seventh-smallest park in the PCL.

During a quick summer visit for a game at the park, Mobile Sports Report found that the fan-facing Wi-Fi network was at the same quality level as all the other amenities, with speed tests in the 60 Mbps range for both download and upload at most locations around the stadium. Built by Cox Business/Hospitality Network us-

ing Cisco gear, the network uses both under-seat and overhead AP deployments, as well as some on poles, to make sure all visitors have solid connectivity no matter where they roam inside the venue. With that kind of bandwidth, it's no wonder that selfies, videos and other social-media reports are helping make Las Vegas Ballpark one of the worst-kept secrets in Vegas.

Major amenities for minor league park

"What's happening here isn't staying in Las Vegas," said Branch Rickey, president of the Pacific Coast League, during a recent press conference to announce that the 2020 Triple-A National Championship Game will be played at Las Vegas Ballpark on Sept. 22 next year. Rickey, the grandson of the famous baseball executive with the same name, noted that the new facility is "resonating with players, coaches and executives" throughout the league.

While Las Vegas may have an outsized reputation for what happens with visitors to the legendary strip of casinos, the reality of the larger Las Vegas is that it's like many other U.S. cities of a similar size, with families and residents who have been hungering for quality sports entertainment. The instant success of the NHL's Las Vegas Golden Knights – who sold a ton of season tickets to locals – is reflected in the embrace of the Las Vegas Aviators' new home, which is about as anti-Vegas as you can get.

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CLOCKWISE FROM TOP LEFT: A BUFFET LINE ON ONE OF THE STADIUM'S PARTY PORCHES; AN UNDER-SEAT WI-FI AP; A SIGN TO TELL FANS HOW TO LOG ON TO THE NETWORK

Free parking, in a location far away from the Vegas Strip (Summerlin is about a 20-minute drive from the casinos at rush hour), and family-friendly features like a grassy hill beyond the right-field fence where kids can roll around – or ping-pong tables on an outfield patio for kids who can't stay focused on baseball – make Las Vegas Ballpark a perfect place for families. And the more adult-focused sections, like the suites – or the party porches along each side of the stadium and the outfield swimming pool area, provide easy entertainment options for companies or other large groups looking to have a "team" event with baseball as a backdrop.

But in this day and age, no public sports place would seem complete without good wireless connectivity, and with its major-league Wi-Fi network, Las Vegas Ballpark covers that base completely. With 380 APs covering the entire park, MSR couldn't find a single spot without consistent coverage, including even outside the entry gates. According to Cox, approximately 130 of the APs are installed under seats, a trickier than usual deployment since the ballpark uses mesh seats in all seating areas – a construction that could dip fans' bottoms closer to the APs than a regular hard plastic seat.

Mike Fredericks, vice president for IT development for stadium owners the Howard Huges Corporation, said the network was built to "major league standards," and our unofficial speed tests seemed to confirm that quality. According to Cox, a 10 Gbps backbone powers the network. The Las Vegas Convention and Visitors Authority is the naming sponsor of the park, under an $80 million, 20-year deal.

As the technology sponsor, Cox Business/Hospitality Network is the exclusive solutions provider for the Las Vegas Ballpark, supporting both back-of-house networking as well as the fan-facing technology.

Solid Wi-Fi everywhere in the park

If there is one place that venues seem to consistently overlook when building out wireless, it's the space just outside the ticketing gates toward the parking lot, an omission that can cause severe fan headaches in these days of increasing use of digital ticketing. There was no such problem at Las Vegas Ballpark, where outside the outfield (east) entryway we got a speed test of 51.5 Mbps on the download and 46.9 Mbps for upload. If there is one hitch to the free Wi-Fi it is the need to provide a name and a valid email address to log in, a registration process that seems to be generally falling out of favor in other stadiums.

Once inside the park MSR started a circumnavigation beginning with a path behind the centerfield wall, where we got a speed test of 57.1 Mbps / 58.6 Mbps. We

A MATSING BALL ANTENNA PROVIDES CELLULAR COVERAGE FROM CENTER FIELD; THE CLUB-LEVEL MAIN LOUNGE; A VIEW FROM THE RIGHT FIELD PARTY DECK.

walked directly underneath the 31-foot-high by 126-foot wide Daktronics video board, the largest in minor league baseball. We also walked directly underneath a MatSing ball cellular antenna, which Verizon is currently using to provide cellular coverage for its customers.

Until the DAS gets fully built out inside the stadium, AT&T, according to the stadium IT crew, plans to cover the stands using a macro tower on a nearby building; T-Mobile was providing service to the stadium using a COW (cell on wheels) unit in the main parking lot.

In both the left- and right-field corners of the stands, Las Vegas Ballpark has some "loge" type seating, with a fixed tabletop in front of several rows of seats. Under-seat Wi-Fi deployments on both sides seemed to work well, with speed tests of 65.6 Mbps / 68.9 Mbps in the left-field loge seats and 66.4 Mbps / 55.5 Mbps in right field. On the upper deck seating areas along both base lines are party decks, both of which were hosting private events on the night we attended; MSR was able to sneak in and get a speed test of 66.5 Mbps / 67.5 Mbps on the left-field deck; where Wi-Fi coverage was in part provided by a couple of APs mounted on a low pole.

We didn't get a speed test at the centerfield pool area – another private party had the space reserved – but we did get a solid 43.8 Mbps / 57.3 Mbps mark at "The Hangar," the centerfield bar. And even though the connectivity, architecture and trappings at the stadium had a major-league feel, the between-inning promotions – like kids racing on the field on bouncy blow-up horses – and local sponsors (like a land-surveying company for home-run distance measures) made sure the game kept the charm that only a minor-league game can provide.

At the press conference (held earlier in the day of our visit) executives from minor league baseball waxed eloquently about the park's attributes. "This ballpark exceeded expectations, if that was possible," said Pat O'Conner, president of Minor League Baseball. And while he stressed that he was no wireless expert, PCL's Rickey did say that having major-league connectivity was an essential part of the minor league experience.

"If we are looking to find avenues to younger fans, we realize that they are very more connected," said Rickey in a separate interview with MSR. "Our fans are reliant on their mobile devices, and they can be used to provide so much information about our game. Having great wireless is where we have to be. It's essential to where we are headed."

At Las Vegas Ballpark, that base is covered. Feel free to spread the word. –MSR–
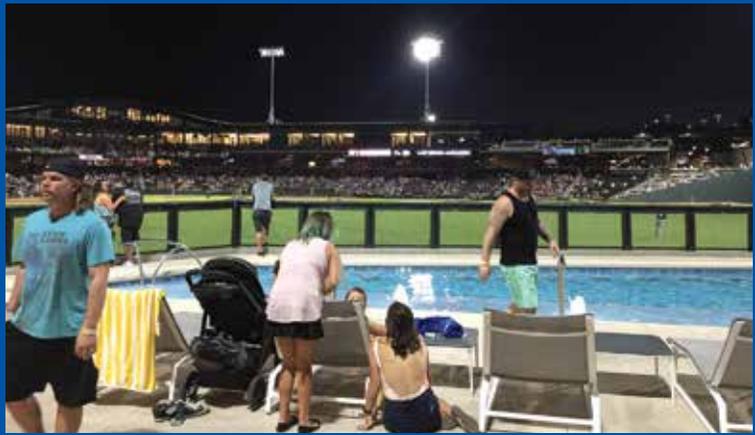
CLOCKWISE FROM TOP LEFT: AN UNDER-SEAT AP ENCLOSURE IN THE LOGE SEATING; A VIEW FROM THE SWIMMING POOL; AN UNDER-SEAT AP IN THE LOWER BOWL; A LOOK AT THE DISTANT VEGAS STRIP ON THE HORIZON; A PARTY PORCH AP TOWER IN SILHOUETTE.
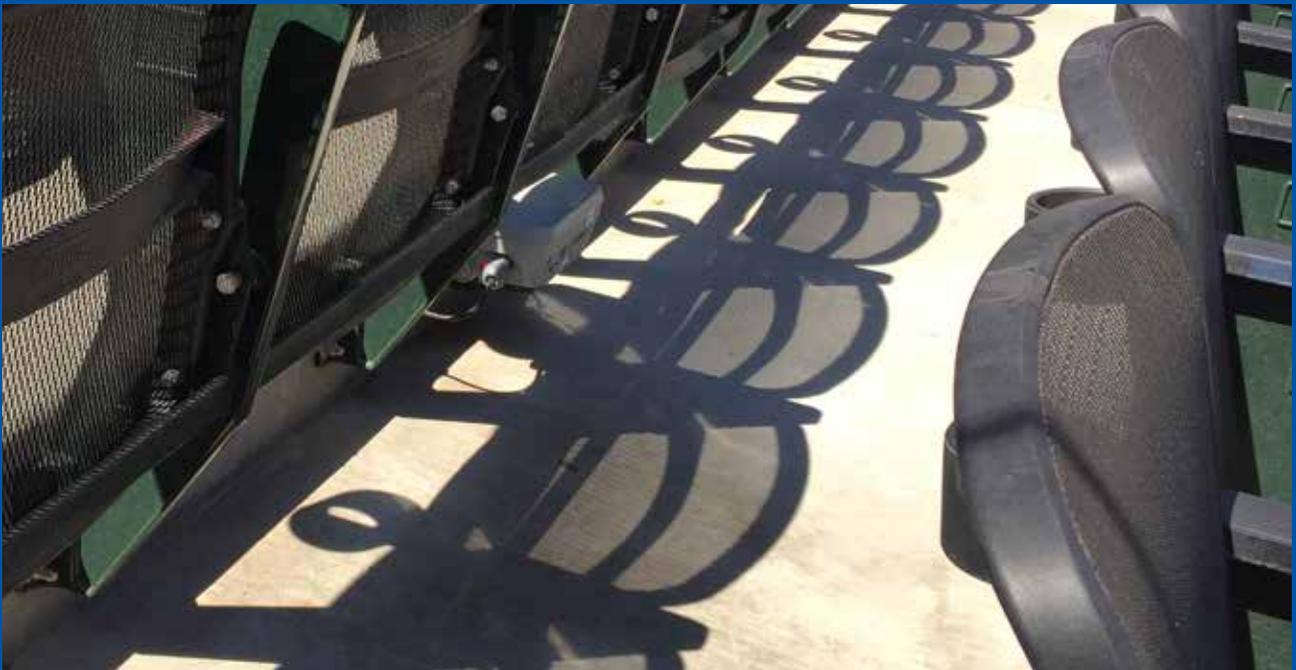
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CHASE CENTER

NEW HOME OF THE GOLDEN STATE WARRIORS

BY PAUL KAPUSTKA

Chase Center, the new home of the Golden State Warriors, officially opened in September to concerts and other events, with preseason basketball scheduled to take place on the new court in early October.

MSR field scout Brian Nitenson attended a season ticket-holders event in late August and got us these wonderful views of the new venue, including its stunning video screens (including the now biggest screen in the NBA) and its striking architecture.

Look for a complete profile of the venue and all its technology components in the next issue of Stadium Tech Report!

CREDIT ALL PHOTOS: BRIAN NITENSON, MSR
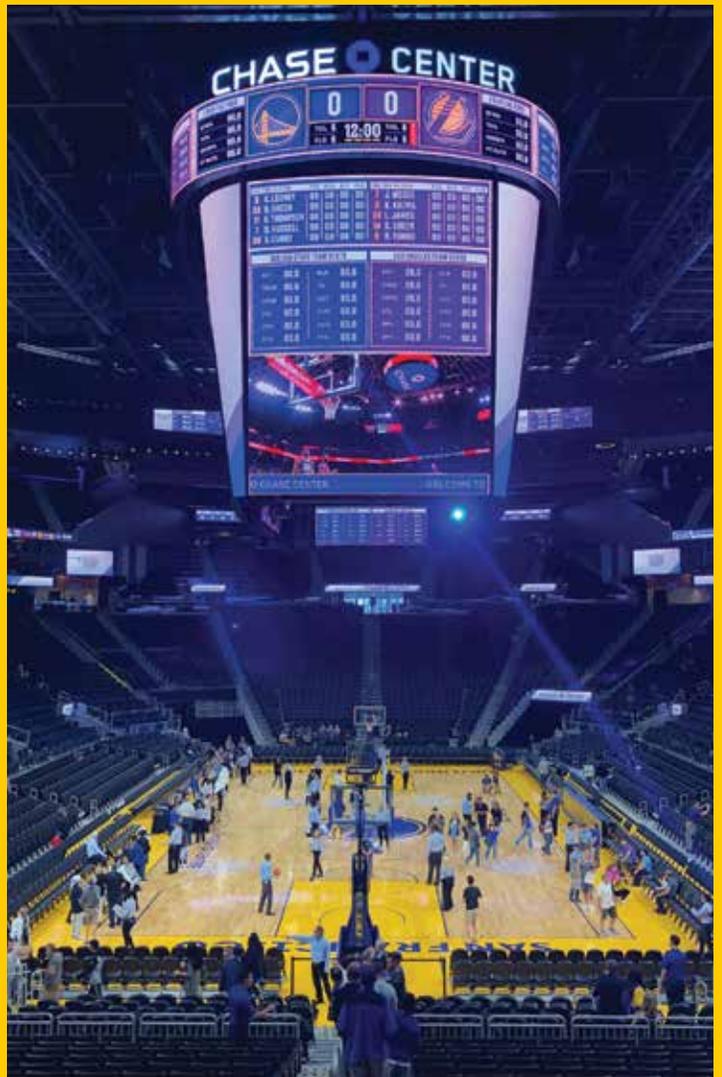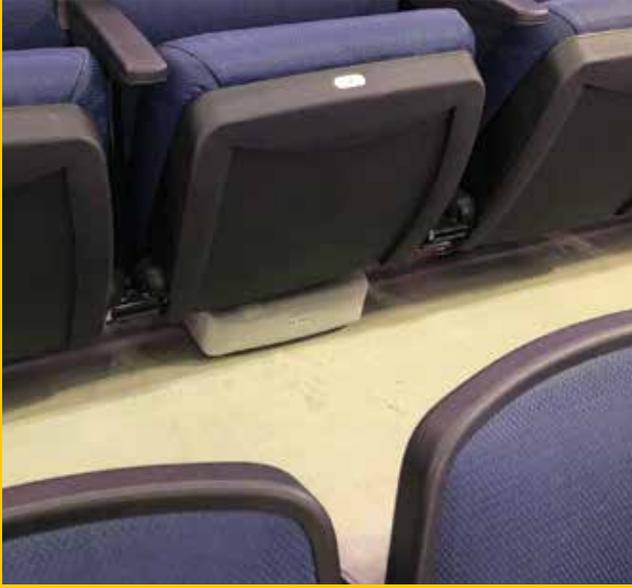
CLOCKWISE FROM TOP LEFT: AN UNDER-SEAT WI-FI ENCLOSURE; ANTENNAS PAINTED TO BLEND IN; THE MASSIVE CENTER HUNG VIDEO BOARD; A LOOK UNDERNEATH THE MAIN BOARD; THE THEATER-BOX SEATING IN THE UPPER DECK.

TOP ROW: ENTRY ARCHITECTURE AND A CLUB VIEW; MIDDLE, A LOOK FROM UP HIGH; BOTTOM ROW, DAS AND WI-FI ANTENNAS IN THE RAFTERS AND THE HUGE OUTSIDE VIDEO BOARD.

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ALLEGIANT STADIUM
RAIDERS' NEW HOME TOPS OUT

This summer marked more progress for the Las Vegas Raiders' new home, with a title sponsor – the venue will be called 'Allegiant Stadium' – and a topping-out ceremony in early August, where the highest beam was put in place.

With construction progressing, the Raiders are still planning to play NFL games in the new venue in the 2020 season.

CREDIT ALL PHOTOS: PAUL KAPUSTKA, MSR

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Mobilitie is the largest privately-held wireless infrastructure provider in the United States, helping people stay connected wherever they are. Mobilitie funds, installs, and operates indoor and outdoor neutral host DAS, Small Cell, and Wi-Fi networks, communication tower sites, as well as other infrastructure used by wireless carriers to enable high speed mobile communications. Mobilitie engineers wireless solutions at the largest and most complex venues across all major industries, including sports and entertainment, real estate, hospitality, education, healthcare, government, and transportation. Mobilitie is headquartered in Newport Beach, California with regional offices across the United States. To learn more about our wireless coverage solutions, visit us at www.mobilitie.com.

JMA Wireless is the leading global innovator in mobile wireless connectivity solutions that assure infrastructure reliability, streamline service operations, and maximize wireless performance. Employing powerful, patented innovations their solutions portfolio is proven to lower the cost of operations while ensuring lifetime quality levels in equipment and unrivaled performance for coverage and high-speed mobile data. JMA Wireless solutions cover macro infrastructure, outdoor and indoor distributed antenna systems and small cell solutions. JMA Wireless corporate headquarters are located in Liverpool, NY, with manufacturing, R&D, and sales operations in over 20 locations worldwide. For more information visit jmawireless.com or follow on Twitter at @JMAwireless

Corning is a leading provider of wireless infrastructure solutions, offering flexible architectures in the rapidly growing wireless market. With a portfolio of products ranging from converged cellular and Wi-Fi solutions for enterprises, to distributed antenna systems for wireless operators, Corning offers in-building infrastructure solutions that cover the needs of venues of all types and sizes. www.corning.com

Boingo Wireless (NASDAQ: WIFI) is a leading provider of cellular and Wi-Fi networks at stadiums and arenas, universities, airports, military bases, convention centers and commercial properties. You'll find Boingo connecting people at sports and entertainment venues that include Soldier Field, Vivint Smart Home Arena, Philips Arena, University of Arizona's Arizona Stadium, University of Nebraska's Pinnacle Bank Arena and more. Boingo's industry-leading Distributed Antenna System (DAS) networks leverage state-of-the-art design to deliver comprehensive stadium coverage and maximize carrier participation to ensure more fan access. As a global leader in managed Wi-Fi services, the company maximizes access to networks through global roaming agreements via carrier offload and major brand sponsorships through the Boingo Media Platform. For more information, visit www.boingo.com.

MatSing is a pioneer company with several years of experience in bringing high performance RF lens solutions to industries including wireless broadband, satellite, measurement and big venues. MatSing has had a strong focus on meta-material development and design, allowing them to construct the worlds lightest and largest RF lenses. Having developed unique high-performance lens antennas for multiple industries, MatSing is now driven to transform 4G networks to lens technology. Holding several RF MetaLenzTM technology patents, MatSing Inc. has led the development of a new approach to antenna design, focusing on using RF Lenses to outperform traditional phased-array (panel) or dish antennas, providing a needed solution to growing capacity demands. www.matsing.com

American Tower brings building and venue owners more than 15 years of experience deploying and monitoring in-building and outdoor wireless infrastructure solutions. We manage more than 420 networks in offices, malls, campuses, hospitals, airports, resorts, casinos, and other venues, covering more than 390 million square feet of real estate, and own lease rights to nearly 1,000 commercial properties throughout the U.S. As one of the largest Real Estate Investment Trusts (REIT) in the country, we have the financial strength and scale to support any in-building wireless communications needs. Our leading portfolio of sites provide a wide array of options for customers looking to optimize their wireless networks.

Connectivity Wireless Solutions is a leading provider of next-generation wireless solutions to venues throughout the U.S. In partnership with Neutral Connect Networks, Connectivity Wireless offers end-to-end services and solution management to deliver carrier-grade distributed antenna systems (DAS), managed Wi-Fi, and small cell networks on behalf of properties and service providers. Having delivered world-class systems and turnkey services across virtually every industry, Connectivity Wireless takes pride in matching each customer with exactly the right technology to ensure their voice, data and multimedia needs are met today and in the future. For more information, visit www.connectivitywireless.com or www.neutralconnect.com and follow Connectivity Wireless on Twitter and LinkedIn.

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