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Welcome to the first issue of our SEVENTH year of STADIUM TECH REPORTS, the Spring 2020 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 visit to the new Dickies Arena in Fort Worth, a recap of the record-breaking Wi-Fi network usage at Super Bowl 54 at Hard Rock Stadium in Miami, an interesting look at a low-cost, home-grown Wi-Fi network deployment at Rutgers University, and a new Wi-Fi and DAS network for the basketball arena at the University of Colorado. We also take a quick look at the recent coronavirus outbreak and look ahead to when the fans return.

We'd like to take a quick moment to thank our sponsors, which for this issue include Corning, Boingo, MatSing, Cox Business/Hospitality Network, Comcast Business, Samsung, 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 like to thank the SEAT community for your continued interest and support. We'd also like to thank Phil Harvey for his excellent photos from Dickies Arena, including our cover shot.

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
Mobile Sports Report

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SPECIAL COMMENTARY

THE FANS WILL RETURN

BY PAUL KAPUSTKA

U.S. BANK STADIUM DURING THE 2019 FINAL FOUR.
CREDIT: PAUL KAPUSTKA, MSR

As Mobile Sports Report was putting the final touches on this issue of our Stadium Tech Report the sports world had a week that truly redefined the word “unprecedented.” The cancellation of the NCAA’s men’s and women’s basketball tournaments, which came after the NBA’s decision to suspend its season after a player tested positive for coronavirus, was quickly followed by the cancellation of every live sporting event out there. That’s a gut punch sports had never seen before.

Make no mistake: Everyone in sports, as disappointed as they may be, understands the rationale for the suspensions and cancellations. These are not normal times, and the spread of the coronavirus must be stopped before it wreaks any more havoc than it has already done. Lives everywhere are in danger, and if not holding some sports events makes us all safer, it is not just a wise choice but the only choice. There is no other side of the discussion.

Originally, I had slated a picture of a game being played in an empty stadium for this page, but eventually decided against that as we don’t really need any more reminders of the world we are all going to experience for the near-term future. As of this writing, it’s fair to say that nobody anywhere has any idea how long we will need to abstain from large public gatherings. But for the

safety of all of us it is a necessary evil, and one that in the end – compared to the rest of the challenges raised by the virus – are among the easiest to endure.

Yes, there will be pain. Mainly it will be felt not just by the athletes, but also by those who rely on full stadiums as a means of employment. Within days, other owners, players and teams followed the lead set by Dallas Mavericks owner Mark Cuban, who was already assembling plans to pay stadium workers who are facing an undetermined span of no income. Beyond the headaches of scheduling and determining how to move sports forward, there will likely be other pains we don’t even know how to guess about yet. But I am confident that at some point, the fans will return.

And when they do, there will be a renewed joy in the tribal pleasure of assembling together, to celebrate sports, a good show, and the camaraderie that makes live events so much more fulfilling than “sitting on the couch.” For people in our industry, the downtime can perhaps be used for all kinds of work that you can’t easily do when stadiums and arenas are filled up on a regular basis; because when the fans come back, they are going to want even more than ever to share that experience as much as they can. Let’s make sure we’re all ready to go when the lights come back on again.

And that’s when, not if. **—MSR—**

Small IT budget? Don't ignore the DIY option

BY PAUL KAPUSTKA



ere at Mobile Sports Report, we've made a habit of trying to report and write about the biggest networks, the bleeding-edge uses of technology, the venues pushing the envelope on what's possible. If you follow us here and online, it's no secret that we like writing about the biggest Wi-Fi days, the most cellular traffic used, and how venues handle the biggest events, like the Super Bowl and the Final Four.

Now watch us also go in the other direction. Our lineup can play small ball, too.

Why? Mainly while because we believe that covering the biggest events and leading users of technology still matters a lot – it shows us all what is possible and where the future is going – we are also realizing that it's time to fill in the gaps below the best of the best, and write some more about networking and technology for all the rest.

We realize, for example, that this issue's cover story subject, Dickies Arena, is a once-in-a-lifetime kind of deal that may not be replicated anywhere else, anytime soon. Same for our recent coverage of technology deployments at Chase Center, the new home of the Golden State Warriors in San Francisco. The budgets, expertise and direction necessary to deploy the kind of advanced installations found at those venues are at a level that few in the industry will ever be able to achieve.

THE 'RAC,' RUTGERS' HOME FOR HOOPS, HAS A NEW DIY WI-FI NETWORK. CREDIT: RUTGERS ATHLETICS.

But take a look at another story in this issue, the profile of Rutgers University's ingenious, do-it-yourself approach to bringing Wi-Fi to the campus basketball arena. For the total of about \$62,000 and a lot of elbow grease, the Rutgers IT team was able to deliver a solution that fit their school's needs – good, basic connectivity in a place where there was none. Like many other schools (and probably even some smaller professional teams) Rutgers had lots of commercial bids to help them bring Wi-Fi in, but the price was always way too steep. But instead of just shrugging their shoulders, Rutgers experimented, learned things on the way, and eventually got the job done.

It's a great story for any team, school or venue who's sitting on the fence about whether or not they can afford to bring connectivity to their building. And it's the kind of story we want to tell more of, going forward.

'Pop-up networks' can fill the gaps

The Rutgers story was just one of the things we learned while being a "fly on the wall" at this year's College IT peer conference, hosted in early February at the University of Michigan. Tops on our list of learning was that while we speak to college IT folks mostly about



THIS YEAR'S COLLEGE IT PEER CONFERENCE WAS HELD AT THE UNIVERSITY OF MICHIGAN.
CREDIT: PAUL KAPUSTKA, MSR.

the big picture of stadium wireless and technology deployments, their “regular working days” are filled with lots of other must-do tasks, which include mundane but necessary items like onboarding and offboarding athletic department employees, running scorekeeping and other event systems at a wide variety of events (with gymnastics being the runaway pain point due to the intracacies of keeping score across multiple events) and trying to keep order among a very empowered group of core users (meaning coaches).

If you want to hear a good story about how to bring a wireless network to a cross-country finish line in the middle of a field, hit up Virginia Tech's Tommy Regan the next time you see him and ask him about the spare coils of optical fiber he uses for what he calls “pop-up networks.” We also heard from other school representatives who related small-success stories about using Cradlepoint cellular modems to bring connectivity to hard-to-reach places where even just a minimum bandwidth of internet meant a lot of utility.

One story we're hoping to tell in the near future is about a low-cost app development platform that Dan FitzSimmons from Indiana University used to create a gameday staff instructions app – an app that was easily

For the total of about \$62,000 and a lot of elbow grease, the Rutgers IT team was able to deliver a solution that fit their school's needs – good, basic connectivity in a place where there was none.

repurposed for use when Indiana went to a bowl game. Again, it's not a hot/sexy topic like building an app for concessions delivery to fans, but the great and obvious utility of having a easily customizable app for staff operations that costs a couple thousand dollars (for the license) and just some DIY time sounds like a story our audience would find very interesting.

And according to the Rutgers team, by having to really get their own hands dirty, they felt they learned a lot more about Wi-Fi networking than they would have by just overseeing a contractor or a consultant, or by going to a class or a conference. Do you have a similar story to tell? Let us know – just reach out via email to me at kaps at mobilesportsreport.com and I can help you share a story that your peers may find of great use. **—MSR—**

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FORT WORTH'S

DICKIES ARENA

PUSHES ARENA EXPERIENCE
TO NEW HEIGHTS

BY PAUL KAPUSTKA





Without a professional or major college sports team as a main tenant, it's somewhat of a wonder that Dickies Arena in Fort Worth, Texas, got built at all. But once you step inside and attend an event there, the wonder shifts to the sheer excellence that surrounds you, in what may be simply the best-built arena-sized venue, anywhere.

It might seem like a Texas-sized stretch to make such a claim, but any other basketball-sized stadium similar to 14,000-seat Dickies Arena would be hard pressed to top the amenities, infrastructure and operations installed inside the new gem of Fort Worth. While first and foremost the venue serves as home of the annual Fort Worth Stock Show & Rodeo, a three-week-plus extravaganza that held its maiden run there earlier this year, Dickies Arena will also host concerts, ice shows and other sporting and non-sporting events, saving local folks from having to drive east to Dallas for a big-time experience.

But it's opulence, comfort and service that will be the hallmarks of a Dickies Arena experience going forward, with those attributes far outweighing the convenience of

just having a world-class venue in Fort Worth. During a visit by Mobile Sports Report during the middle of this year's rodeo program (which ran 23 straight days from Jan. 17 to Feb. 8) we saw not just the visible attributes of perhaps the most polished finish of any arena ever, but also the underpinnings of important infrastructure assets like the wireless networks and video operations, and the intense level of attention to detail in food and beverage operations, all aimed at raising the fan experience to the highest level.

The opera house meets the rodeo

When we last visited the under-construction Dickies Arena in the fall of 2019, the finishing touches weren't in place yet, even though we could see hints of what it was shaping up to be. For our late-January visit for a night of rodeo, we got to see the finished product in all its glory, and all we can say is, it may be some time before another venue even approaches the level of cosmetic finish achieved at Dickies Arena.

To be sure, not many venue ownerships may have the financial resources or the certainty of what they want out of a finished product as the team behind the creation of Fort Worth's newest centerpiece. 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. As the home of

FACING PAGE: OUTSIDE DICKIES ARENA. THIS PAGE: THE RODEO'S OPENING PARADE. CREDIT FACING PAGE, PAUL KAPUSTKA, MSR. CREDIT THIS PAGE, PHIL HARVEY, MSR.



Fort Worth's namesake rodeo, Dickies Arena is clearly meant to be that and so much more, cementing in place a building where people who know what they want got exactly what they wanted – and more.

While we didn't get to speak with Bass directly, his presence is felt in all areas of operation of the facility, with multiple stories of his direct involvement in making sure the smallest of details were adhered to. Even a first-time visitor to the rodeo could see and feel the devotion of leaders like Bass to their signature hometown event, from his riding a horse at the front of the event-opening parade to his video-board cameos of slapping bundles of cash into the hands of the event winners as the night progressed.

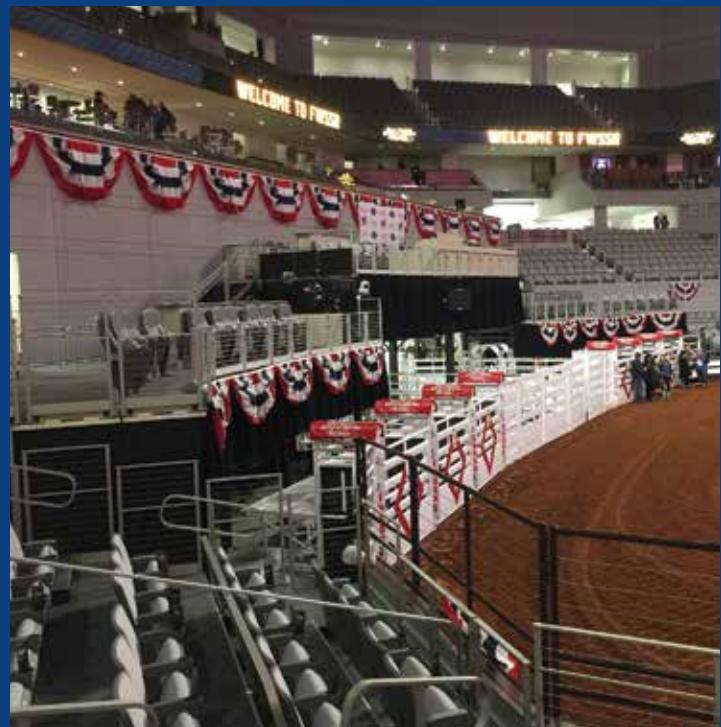
Behind the scenes, we heard stories about how Bass and the leadership team wanted very specific things done cosmetically – like making sure that no antennas for either the Wi-Fi or DAS networks were visible in any of the main public areas. To meet that challenge, main technical integrator AmpThink had to go outside the norm to design (and in some cases, custom-build) enclosures to hide the gear. Walking through the main concourses and seating areas, the only hint that wireless equipment might be overhead was the outline of flush-mounted panels, a design theme that even carried out to

CLOCKWISE FROM TOP LEFT: A CURVED LED BOARD; PATRONS ENTERING THE BUILDING; THE OUTDOOR PLAZA BAR. CREDIT ALL PHOTOS: PAUL KAPUSTKA, MSR.

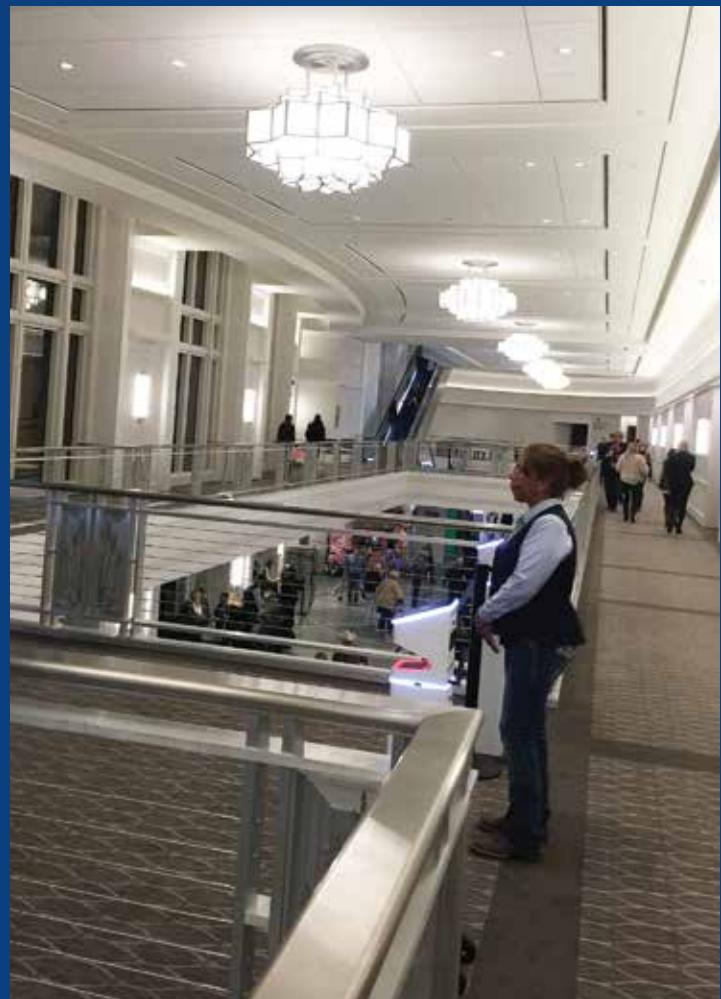
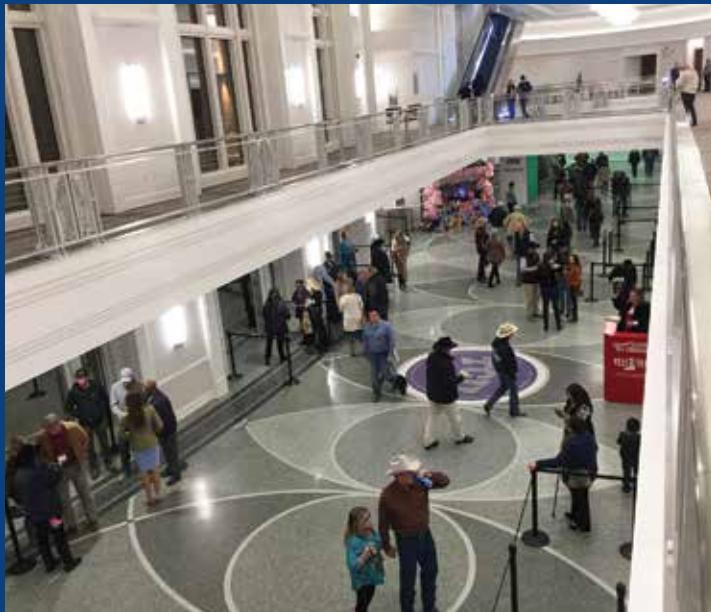
outside-wall mounting areas in the plaza areas around the arena's exteriors.

Once inside Dickies Arena, visitors may feel like they are in somewhere more like an opera house than a multi-purpose venue (which on this night had a "playing floor" of some finely raked dirt). Floors of decorative tiles are underfoot, and railings on the staircases enclose sculptures of a distinctive local grass plant. That same design is reflected on the plates used in one of the premium seating areas, where the dining choices include a sit-down, white-tablecloth experience that looks like a four-star steakhouse inserted into the concourse.

Bill Shaw, the assistant general manager for Dickies Arena, was courteous enough to give us a directed tour of the venue before the night's activities, pointing out things we might have noticed but not really realized, like the different tones and types of wood used for paneling, which changed as you moved from a higher premium seating area to a more general admission space. In the suites, Shaw showed us some especially comfy leather stadium chairs, which he said were the end result of a long process of determination to find out the best way to pad and tan the chair's components.



CLOCKWISE FROM TOP LEFT: WI-FI APs HIDDEN INSIDE FLUSH-MOUNTED PANELS; THE PREMIUM BOX SEATS ABOVE THE RODEO GATES; SECURITY SCANNING AT THE ENTRY TO THE SUITE LEVEL; AN OVERHEAD VIEW OF THE TILE WORK IN AN ENTRYWAY; THE TABLE SETTING IN THE HIGH-END DINING AREA. CREDIT ALL PHOTOS: PAUL KAPUSTKA, MSR.





CLOCKWISE FROM LEFT: DAS AND WI-FI ANTENNAS IN THE RAFTERS; A BOOT CLEANER FOR THOSE WHO WORK IN THE DIRT; A PREMIUM SUITE LEATHER CHAIR.
CREDIT ALL PHOTOS: PAUL KAPUSTKA, MSR.

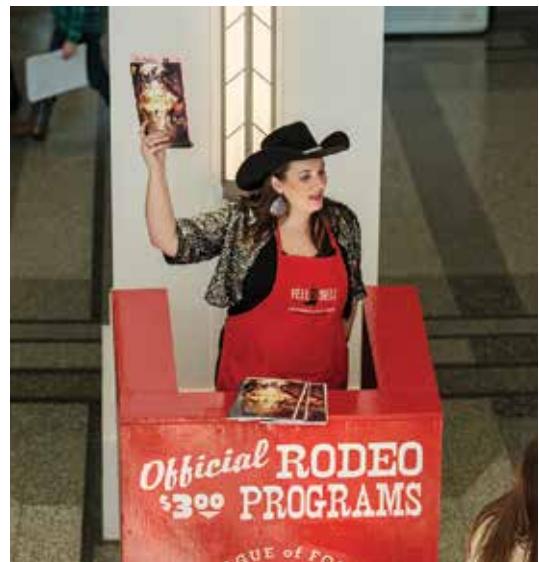
Even the construction of the wheeled chairs in the loge box where we were the guest of AmpThink for the night were subject to scrutiny by Mr. Bass, we were told, with a story about him using tape measures to ensure the seat width was correct, and discussions about having the proper types of armrests that wouldn't inadvertently snag the handles of a handbag.

"Mr. Bass spent a lot of time on all of that," said Shaw. "His fingerprints are everywhere."

To be sure, the somewhat unique ownership structure and the recurring revenue from the rodeo – which has sold-out status for all the premium seating spaces thanks to the families who have been supporting the event for generations – means in part that Dickies Arena doesn't have to saturate its public spaces with advertising. While its digital display arsenal includes striking elements like curved LED screens from LG and menu boards and other displays running the Cisco Vision dynamic signage system, Dickies Arena only has a small number of partner-sponsors whose messages run somewhat discreetly compared to other arenas that may have more need to have a higher number of displays and advertisements.

The layout of the arena in general also takes its cue from how the premium seating space is used for the rodeo. Instead of a normal sort of top-down arena seating with "courtside" seats being the most desired, the wide space needed for rodeo events and the family atmosphere (most premium packages, according to Shaw, are bought by families and not corporations) means that there are "boxes" of seats ringing the lower bowl, with a wide walkway behind them to facilitate the meeting and greeting (and the seeing and being-seen) that is part of the rodeo culture. Thanks to some very clever architecture and movable stands technology, the mid-bowl walkway can disappear for events like concerts and other sporting situations like basketball; but good luck trying to figure out how that works by walking by the stands, since all the moving parts are, of course, hidden from view.

While a ring of suites provides another premium seating option a bit higher up, at either end of the venue are two more unique gathering areas, with belly-up bars that stretch almost the full width of the space, providing a place for the premium box-seat patrons to mingle while still having a clear view of whatever action is taking place. Shaw noted that at one end of the arena the seating can collapse back to almost a straight line, providing ample space for concert stages that also gives Dickies Arena a concert-seating total that Shaw said is comparable to American Airlines Center in Dallas, which seats 20,000 for NBA and NHL games.



CLOCKWISE FROM TOP: THE DIRT IS READY FOR RODEO; A COWBOY RELAXES AT THE STOCK SHOW; CAN'T TELL THE RIDERS WITHOUT A PROGRAM; HOG NAPPING; TWO CUTE HATS; AND A LOOK AT THE RELIANT CLUB. CREDIT ALL PHOTOS: PHIL HARVEY, MSR.



CLOCKWISE FROM TOP LEFT: THE VIDEO CONTROL ROOM; ALL HATS ON FOR A FAMILY PHOTO; ANOTHER VIEW OF THE RELIANT CLUB; BILL SHAW GETS READY FOR ANOTHER NIGHT OF RODEO; AND TWO FANS WATCH THE OPENING PARADE. CREDIT ALL PHOTOS: PAUL KAPUSTKA, MSR.





THE 'LOCKER ROOM' AT DICKIES ARENA IS SOMEWHAT DIFFERENT DURING THE RODEO.
CREDIT: PAUL KAPUSTKA, MSR.

Then there are some more touches you can't see, like the bass-sound traps installed in the roof area to improve acoustics – and those you can see, like the soaring rooftop that is meant to mimic the open sky of Texas. As more fans attend different events scheduled in the future, including gymnastic meets, concerts, ice shows and NCAA regional basketball tournament games, they are no doubt going to be impressed and perhaps surprised by the "opera house" where boots and Stetsons are the local fashion of choice.

Well wired for wireless

In our early fall visit to Dickies Arena we detailed 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.

According to AmpThink president Bill Anderson, one of those future needs became necessary this past fall, when Verizon wanted to bring its 5G millimeter-wave services as a late addition to the arena. To support the four 5G antennas that are now mounted up in the catwalk, Anderson said AmpThink was able to just allocate some of the spare optical fiber it has in place throughout the building, making it possible to bring in the service "in a very affordable way."

In addition to the numerous custom enclosures used throughout the venue, Anderson said AmpThink also designed a pre-fabricated combination Wi-Fi and DAS antenna unit design that it could then hoist up into the rafters in a single pull. By having the green light to lead and innovate, AmpThink was able to develop and learn things it will draw on well into the future, Anderson said. "This is really our master class [on stadium network design]," Anderson said.

Since we spent most of our January time at the venue touring the spaces and talking to different representatives, we didn't have that much time for network speed tests but the ones we did get showed the typical strong performances of an AmpThink-built network. On one of the concourses behind the suite levels we got a Wi-Fi speedtest of 67.0 Mbps on the download side and 65.0 Mbps on the upload.

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Up at the highest level of seating, which is served from the rafter-mounted APs, we got a speedtest of 28.3 Mbps / 39.5 Mbps, during the night's final event.

Though we didn't get down there for a speedtest, the lower-bowl seats are served by under-seat Wi-Fi enclosures. According to Anderson there are approximately 550 Cisco Wi-Fi APs used throughout the venue, all of which are now the latest versions supporting the new Wi-Fi 6 standard. The DAS, which is overseen by ExteNet Systems, uses the Corning ONE DAS hardware system with approximately 258 active antennas in 11 zones for the DAS.

Keeping video and food and beverage operations in-house

Having never been to a live rodeo event before, Mobile Sports Report was somewhat in awe of the video production inside the arena, with multiple camera angles repeatedly in use on the large-screen centerhung videoboard. With no pauses, halftimes or timeouts, action was constant, and reflected as such on the main video screens.

We are simply going to have to revisit the arena for a more in-depth exploration of the video production operation itself, which is run entirely by the Dickies Arena team and even provides live feeds itself to cable channels covering rodeo. One of the more innovative

CLOCKWISE FROM LEFT: A TOUCH-SCREEN DISPLAY LETS FANS PICK AND CHOOSE REPLAYS TO DRAG AND DROP TO THE MAIN SCREEN FOR WATCHING; AN UNDER-SEAT WI-FI AP ENCLOSURE; A CEILING WI-FI AP ENCLOSURE. CREDIT, UNDER-SEAT PHOTO: DICKIES ARENA. CREDIT, OTHER PHOTOS: PAUL KAPUSTKA, MSR.

twists inside the building is a concourse-level fan booth, where a large interactive video board can serve up multiple instant replays of rodeo action by clicking and dragging screenshots to the main display area.

The three-plus weeks of back to back rodeo action was somewhat of a stress test for the video crew, since almost every night there were different types of competitions (for instance, the night we attended there was a team competition, with scores from multiple events tabulated into a final team score) requiring custom programs to populate the video board displays. According to the video team there were no fewer than seven different scoring programs in play each night, but they were able to coordinate the results so quickly that they actually had to introduce a time delay into the reporting from judges to the video screens, so that the announcers could add some drama to their live play-by-play.

On the food and beverage side of operations, the do-it-ourselves theory of Dickies Arena meant that the arena controls all aspects of F&B operations, instead of contracting much of the work to a third-party caterer.



Julie Margolin, director of food and beverage operations at Dickies Arena, said it starts with little things, like not having to live with a certain brand of hot dog because that is the brand a caterer carries. But then it expands into what is possible, and why you would try to do things like provide in-seat delivery service to 4,000 premium seats while also balancing the F&B needs for a diverse operation that includes white-tablecloth dining, suite operations, high-end bar areas, and mobile point-of-sale to support cotton-candy sales on the concourses.

"We do everything we can to make sure every experience is the best," said Margolin. "That's a task not a lot of people are willing to take on."

But Margolin, who previously held a similar title at the Honda Center in Los Angeles, is like other top performers who found the opportunity and challenge presented by Dickies Arena too good to pass up.

"This building is very different than others in the industry," said Margolin, citing the close working atmosphere that rapidly built between operations and construction and information technology teams as the building opened late in 2019 ahead of the real debut, the rodeo season.

"If something needed fixing, nobody went home until it was done," Margolin said. And while like others she's always looking for ways to improve, Margolin said the whole idea of a venue owning and operating its own F&B was an exciting challenge.

"If you go with someone else's [catering] model, you're serving two masters," Margolin said. But trying to meld numerous different types of fan experience operations, she said, is a challenge worth pursuing.

DICKIES ARENA HONORS THE PAST WHILE BRINGING THE FUTURE OF ARENA EXPERIENCES TO FORT WORTH.
CREDIT: PHIL HARVEY, MSR.

"If you stick with the status quo, you're going backwards," she said.

Dickies Arena: As good as it gets?

Standing outside the arena on a clear-sky night, from one of the outdoor plazas, fans have a pleasing view back toward the lighted buildings of downtown Fort Worth. Legend has it that Ed Bass purchased the land Dickies Arena sits on more than three decades ago, with the vision that someday he would help build an arena with that signature view back toward downtown. Now that that dream is reality, the sky's the limit for what Dickies Arena future may be.

Though the coronavirus has effectively put all arena schedules somewhat on hold, prior to the outbreak Dickies Arena had already announced future bookings for big-name concert acts as well as family events like Disney on Ice, Cirque du Soleil and even the U.S. Gymnastics Championships. Clearly, the events market will make use of a venue of Dickies Arena's size and stature.

According to Shaw, patrons with rodeo season tickets get first dibs on other events, but it's a good bet that the diversity of action inside the Dickies Arena walls will mean that a wide number of fans will be able to experience the wide range of seating options available. But even those attending on the least-expensive tickets will still be able to experience the overall quality of all aspects of the arena, which will be hard for other venues to match. —MSR—

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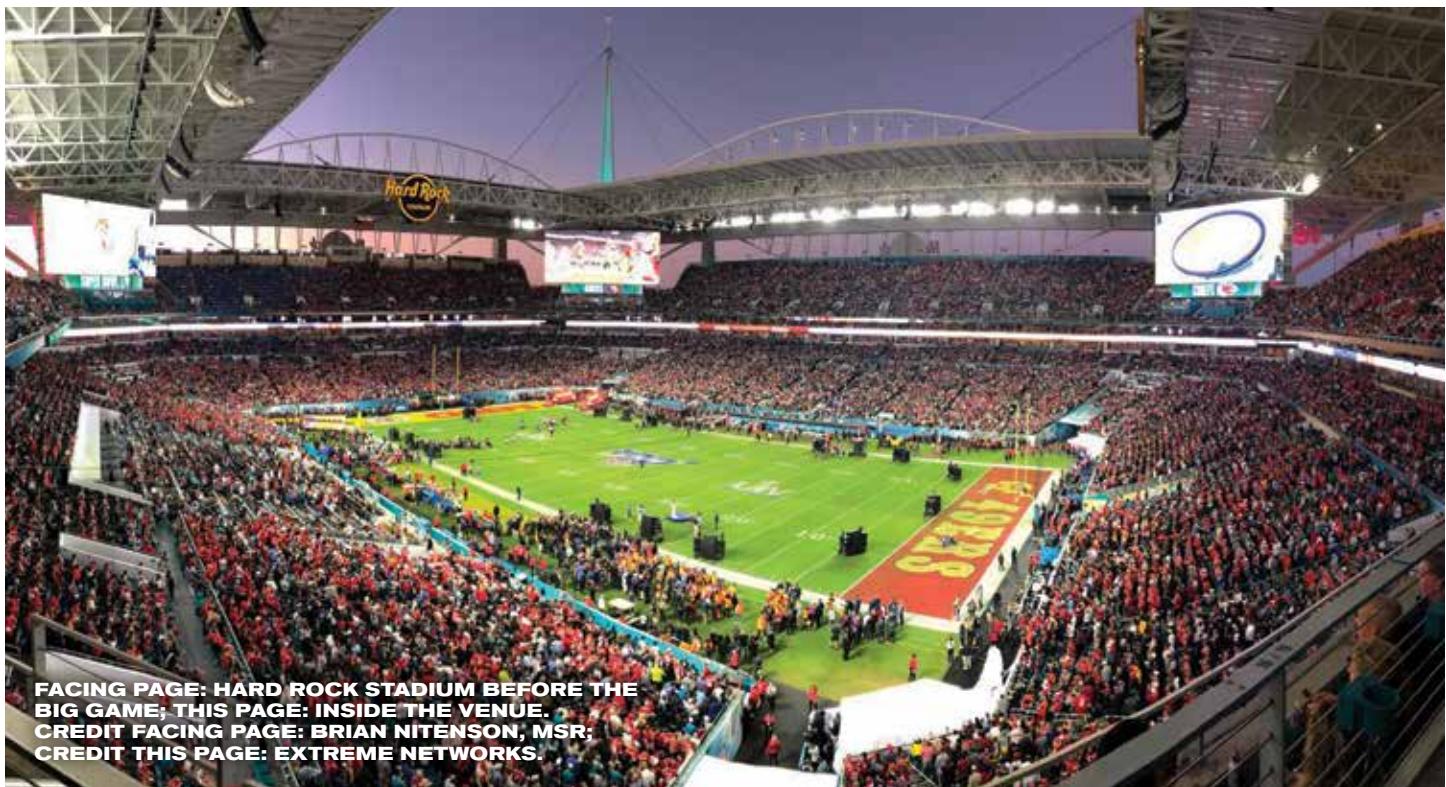
BEYOND FAST

BACK ON TOP

RECORD WI-FI AT SUPER BOWL
FUELED BY HUGE INCREASE
IN BANDWIDTH PER USER

BY PAUL KAPUSTKA





FACING PAGE: HARD ROCK STADIUM BEFORE THE BIG GAME; THIS PAGE: INSIDE THE VENUE.
CREDIT FACING PAGE: BRIAN NITENSON, MSR;
CREDIT THIS PAGE: EXTREME NETWORKS.

The big game is back on top of the unofficial Mobile Sports Report single-day Wi-Fi rankings, with a mark of 26.42 terabytes of data used at Super Bowl LIV in Miami, according to figures reported by Extreme Networks.

What's most interesting (to us) about the number is that it was generated in a venue that had approximately 8,000 fewer fans in attendance than last year's Super Bowl (70,081 in Atlanta for Super Bowl 53 vs. 62,417 for Super Bowl 54). It was also the second-lowest Super Bowl attendance figure ever, just above the 61,946 fans who attended Super Bowl 1.

So not surprisingly the fans who connected to the Wi-Fi network at Miami's Hard Rock Stadium also set a new record for average data consumed per connected user, at 595.6 megabytes per user — a big jump from last year's average data per user total of 492.3 MB. Going forward, we here at MSR think this statistic is even more important than the overall data-used or total tonnage mark, since it more accurately reflects how the network is performing for fans.

"I think the average [data] per user is the metric we're most proud of," said John Brams, director of sports and entertainment for Extreme Networks. Extreme, which has a sponsorship deal with the NFL to provide network

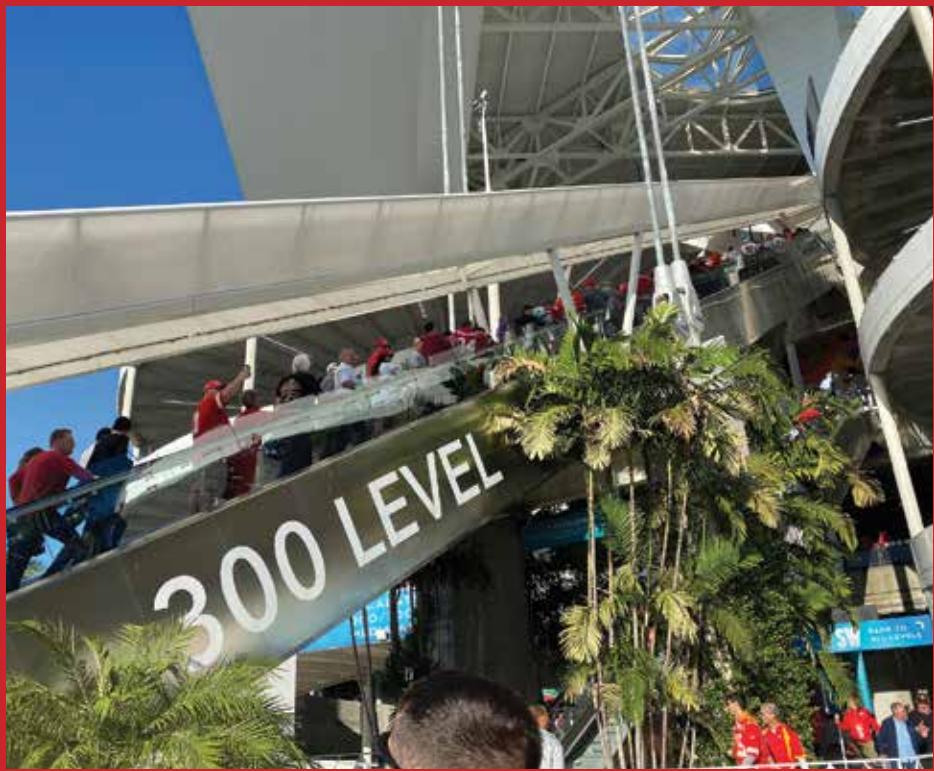
statistics from every Super Bowl, was also the gear provider for the network at Hard Rock Stadium, the first Super Bowl for Extreme gear since Super Bowl 51 at Houston's NRG Stadium back in 2017. According to Extreme, the Wi-Fi setup at Hard Rock Stadium uses some 2,000 APs, many of which are deployed in under-seat enclosures in the bowl seating.

The average data used per device, Brams said, is to Extreme the proof of how well each user is served by the network, and is perhaps a more important metric than the simple total of data used.

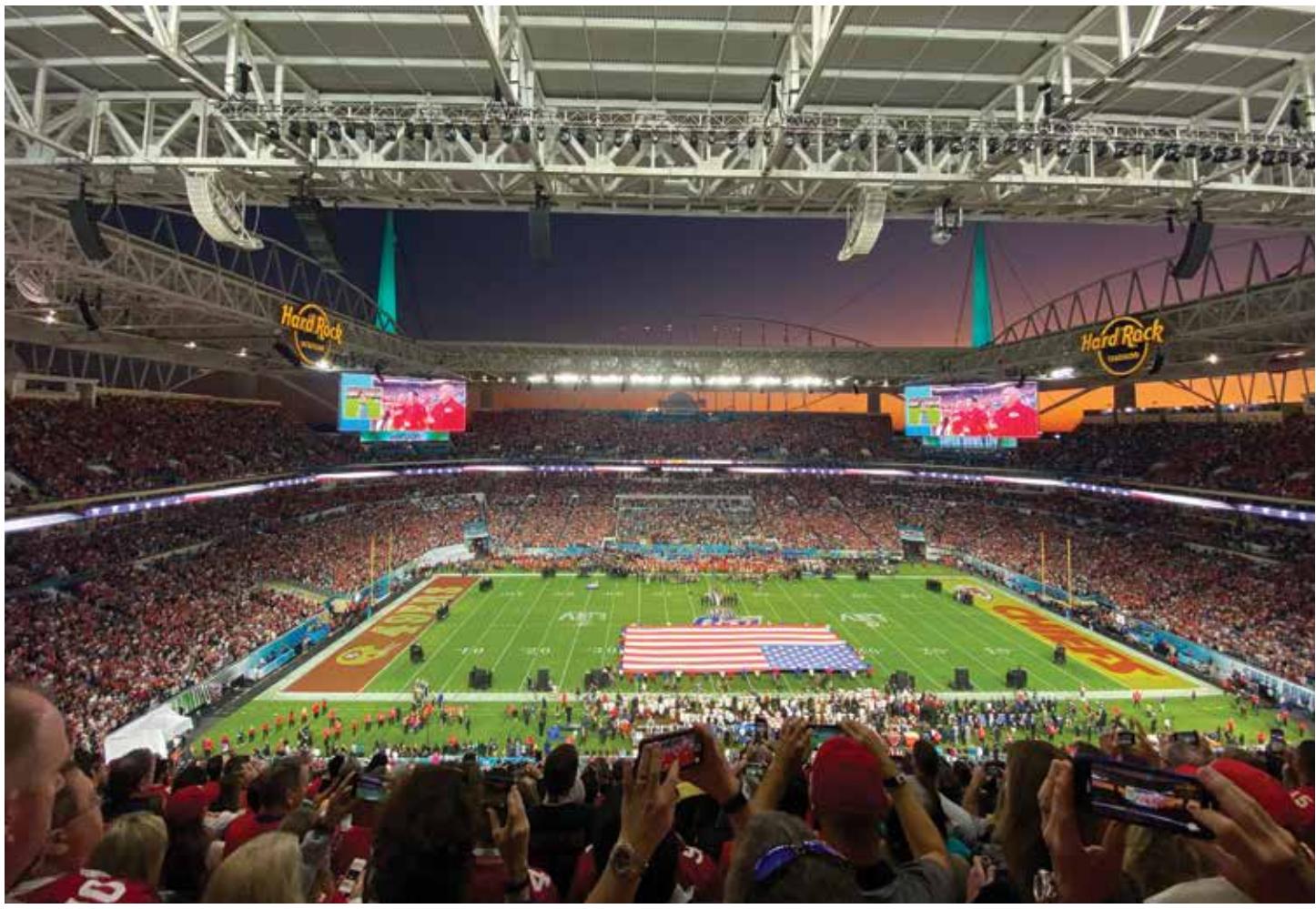
"If you are asking what is the health of a network, the average [data used] per user is a good metric for that," Brams said. Brams, like MSR, also believes that the average data used per user is a metric that can be used to compare network performances between different-sized stadiums, like football stadiums and basketball arenas, which might be very far apart in total data used simply because of the capacity differences.

Verizon autoconnect helps out on the Wi-Fi usage

With a reported 44,358 unique devices connected to the network this year's Super Bowl also set a new mark for Super Bowl take rate at 71 percent; the top overall take rate mark still belongs to Ohio State, which saw 71.5 percent of its fans connected when Ohio Stadium saw 25.6 TB of Wi-Fi used this past fall during a game against



CLOCKWISE FROM TOP LEFT: WI-FI COACHES HELPED FANS CONNECT; THERE WAS EVEN A GONDOLA TO HELP FANS GET TO THE GAME; FORMER MVPS IN A PREGAME CEREMONY; A LOOK AT HARD ROCK AS THE STADIUM FILLED UP; AND A LOOK AT ONE OF THE BIG VIDEO DISPLAYS. CREDIT, COACHES PHOTO: EXTREME NETWORKS. CREDIT, ALL OTHERS: BRIAN NITENSON, MSR.



SUNSET AND THE FLAG DURING PREGAME CEREMONIES. PLUS, A MASTING BALL ANTENNA IS VISIBLE UPPER RIGHT.
CREDIT: BRIAN NITENSON, MSR.

Michigan State. It's worth noting that the average data per user mark from the Ohio State game was 341.6 MB.

Like at Ohio State, at Hard Rock Stadium fans whose devices were on a Verizon cellular subscription could be automatically connected to the Wi-Fi network, a factor that often results in high take rates. Verizon has similar deals with a number of NFL stadiums and some large college venues, including Ohio State, Florida and Brigham Young. Verizon would not reveal what percentage of its customers were included in the overall unique Wi-Fi connection number at Super Bowl LIV.

Peak network usage hits 10 Gbps

Some more info from the great list put together by Extreme: The peak concurrent user number of 24,837 devices was seen during pre-game activities; the peak network throughput of 10.4 Gbps also occurred before the game started, according to Extreme. Of the final data total, 11.1 TB was used before the game started, with the balance of 15.32 TB being used after kickoff.

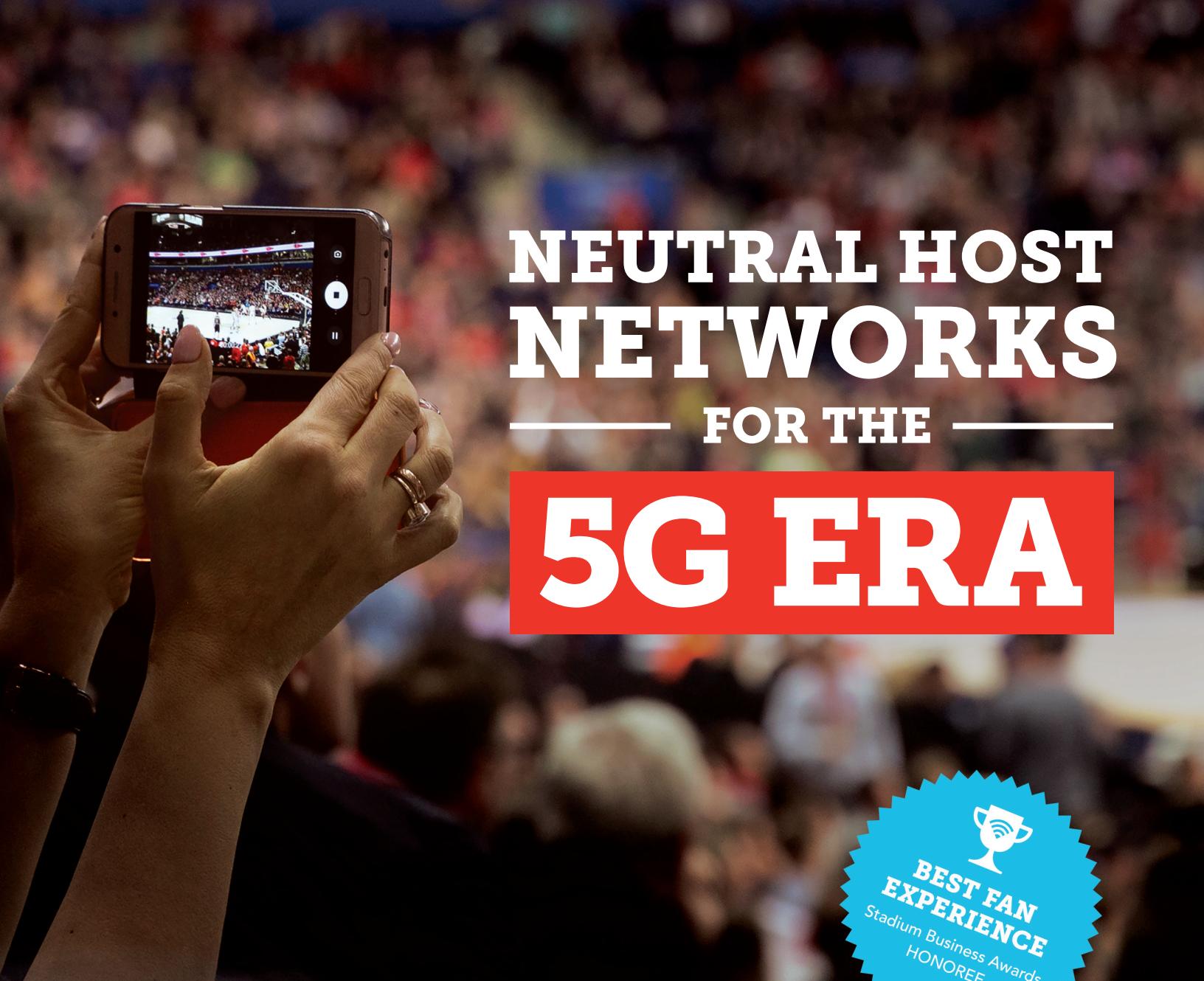
"We've seen the highest data rates right before the game started at the last four Super Bowls," said Brams. According to Brams, this statistic may be caused by the

fact that people at Super Bowls tend to arrive very early for the games, and by the NFL's attempts to keep things interesting with plenty of pregame entertainment.

The most used streaming apps by fans at Super Bowl LIV were, in order of usage, Apple iTunes, Apple Streaming, YouTube, Spotify and Netflix; the most used social apps in order of usage were Facebook, Instagram, Twitter, Snapchat and Bitmoji. For sports apps, the most used in order of usage were ESPN, NFL, NFL OnePass, CBS Sports and ESPN Go.

When reading through the list of apps, MSR wondered out loud who would be watching Netflix at a Super Bowl. But Brams thinks Extreme's network statistics have an answer.

"It's amazing how many people bring kids to a big game," he said. "And those kids may not be that interested in everything going on at the game, so in between they are streaming shows [on Netflix]." Brams said the Netflix-at-games is a trend at NFL games in general, with Netflix consistently showing up in the top 5 of apps used on a stadium network. **-MSR-**



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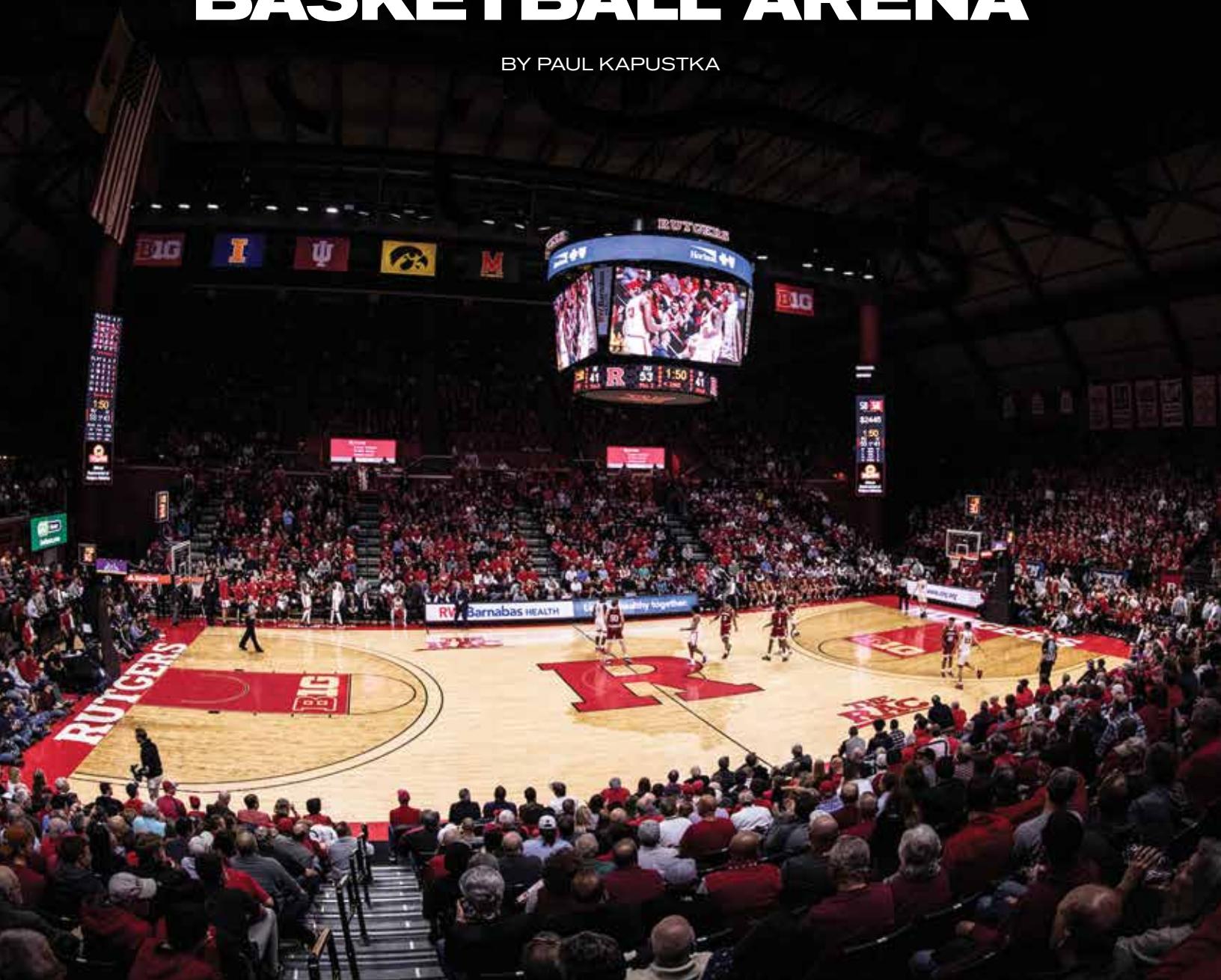
LET'S TEAM UP

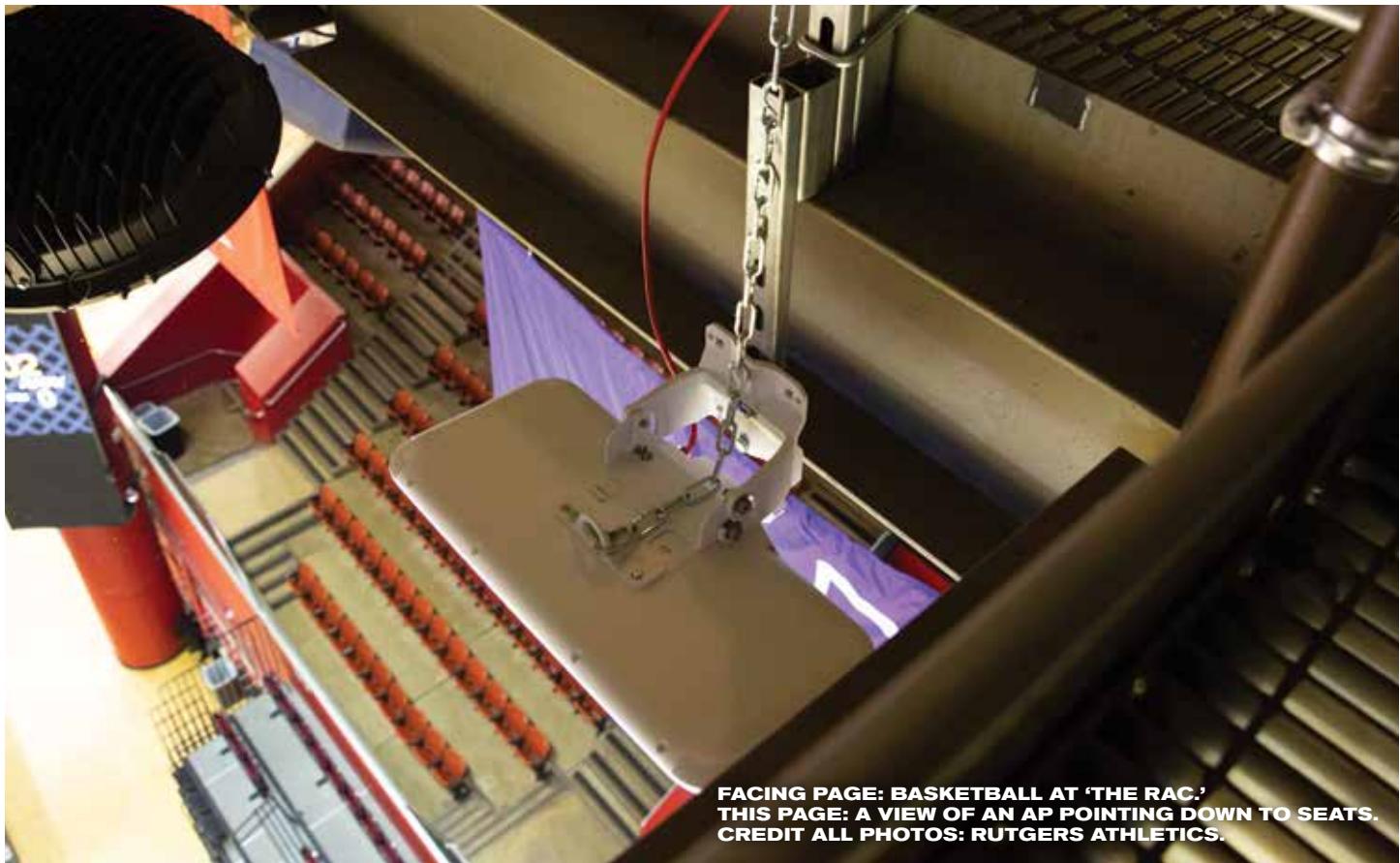
Doug Lodder, SVP, Business Development | dlodder@boingo.com | 310-586-4023



DIY METHOD BRINGS WI-FI TO **RUTGERS** BASKETBALL ARENA

BY PAUL KAPUSTKA





FACING PAGE: BASKETBALL AT 'THE RAC.'
THIS PAGE: A VIEW OF AN AP POINTING DOWN TO SEATS.
CREDIT ALL PHOTOS: RUTGERS ATHLETICS.

t was a bit more complicated than a trip to Home Depot, but when the Rutgers University IT team wanted to bring fan-facing Wi-Fi to the school's basketball arena but didn't have the budget for a big-name contractor or vendor deal, it did what many weekend warriors do when faced with the same build vs. buy decision:

They did it themselves.

By purchasing lower-cost Wi-Fi gear and doing almost all of the design and deployment work in-house, the Rutgers IT team was able to bring a satisfactory level of coverage to the 8,000-seat Rutgers Athletic Center for a total price tag of about \$62,000, according to representatives from the school's athletic IT department. The Rutgers team first told their story at this year's College Athletics IT peer conference in Ann Arbor, Michigan, and then provided more details in a follow-up interview with Mobile Sports Report.

The success of the DIY Wi-Fi deployment now has the Rutgers IT team looking at a similar method for bringing Wi-Fi to the school's football stadium, starting with a localized deployment in the student section where it anticipates needs will be the highest. While fans at events in the "RAC" are probably happy for the connectivity, what

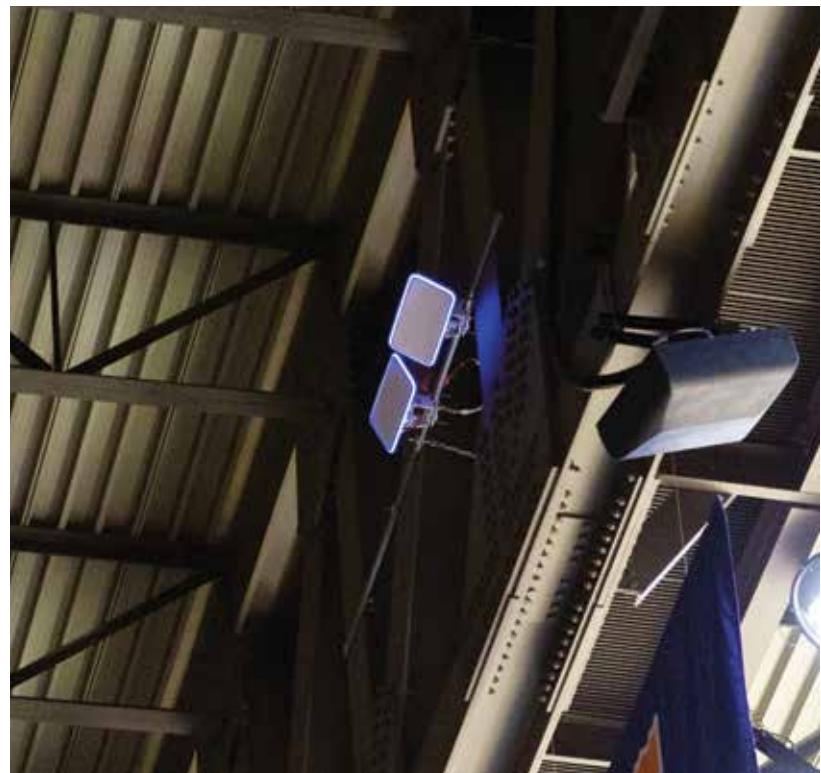
might even be more important is the confidence and experience gained by the IT team by rolling up its sleeves and finding a way to deliver the network at a very reasonable price.

"The practical experience of doing this ourselves was just so much more interesting than attending conferences or networking classes," said Jonathan Beal, systems administrator for the Rutgers athletics IT team. "I'd encourage smaller schools to look into something like this."

Turnkey system prices 'out of range'

Though Rutgers isn't exactly small (enrollment is just more than 50,000 at the main campus in New Brunswick, N.J.) and while its teams are part of the major Big Ten conference, the school simply doesn't have the athletic-department budgets that some of its conference brethren do. And while Beal said that the school is regularly approached by technology vendors with stadium Wi-Fi pitches, the million-dollar-plus price tags for deployments are a non-starter for Rutgers.

"We get approached year after year, but the quotes are always out of our [budget] range," Beal said. But at the college IT conference in 2019, Beal said the Rutgers team was interested in a presentation from the IT department at the University of Virginia, where that school used low-



FROM LEFT: WI-FI ANTENNAS ARE INTERSPERSED WITH OTHER RAFTERS GEAR; RIGHT, TWO APs TILTED AT DIFFERENT ANGLES (NEAR A DAS ANTENNA)

er-cost equipment from Wi-Fi gear provider Ubiquiti to bring Wi-Fi to Virginia's football stadium.

While Beal said the Virginia team detailed some initial failures in their deployment program, eventually they got it on track, and inspired the Rutgers crew to see if they could chart a similar path.

"We took notes, came back to New Jersey, made some phone calls, and asked 'how far could we go?'" Beal said. At the beginning, the team guessed they might be able to get the school to "absorb the cost" of a test deployment either in the basketball arena or the football stadium. What tipped the project in the basketball arena's favor was the existence of some recently installed conduits leading to the rafters, where some biometric tracking equipment and some previous DAS gear had been installed.

"For the football stadium, the [conduit] pathways are challenging – it's going to be costly when we do that," Beal said.

After trying out a few test APs sent over by Ubiquiti the Rutgers team felt confident in their choice of hardware, and submitted a budget for \$60,000 – which was quickly approved.

"It was an easier sell than we thought," said Beal. "They [the administration] trusted us."

Overhead vs. under seat

Choosing to put Wi-Fi in the rafters pointing down instead of under the seats pointing up was another conscious choice Rutgers made after noticing a difference between how football fans and basketball fans use in-venue wireless.

"We noticed that at football games fans download [data] and watch stuff, then go back to watching the game," Beal said. "For basketball it's a totally different user experience. People aren't watching things on their phones, but they are uploading to Instagram."

So instead of solving for density and coverage (where under-seat offers a generally better experience) the Rutgers team aimed for the best upload experience for the money – which meant they could do top-down APs using line-of-sight tuning.

With a blend of a 3D rendering of the entire seating bowl (done with 360-degree cameras) and some help from Ekahau survey tools, the Rutgers team pinpointed the optimal placement points for the APs in the rafters. Since the seating in "The RAC" is mostly only on the two



THE RUTGERS IT TEAM TAKES GREAT PRIDE IN KNOWING THAT MORE EVENTS CAN BE HELD IN THE ARENA WITH GOOD CONNECTIVITY – INCLUDING MORE POTENTIAL MONEY-MAKING EVENTS LIKE CAREER FAIRS AND CONCERTS.

sides of the court – and not behind the baskets – the deployment became a fairly uncomplicated tale of two halves, with two APs for each sector.

Some tuning revealed a need to tilt the top AP down from a straight horizontal mount top since the tin roof of the RAC (which contributes to the venue's historic reputation for being loud and an intimidating place to play) also reflects RF signals.

"Everything bounces around up there off the roof, including the RF," said Beal. With 20 APs in the rafters (and four more down at court level for other areas) Rutgers was able to get the kind of coverage they wanted. After installing the APs with help from campus technicians – including installing backup chains to keep APs from falling onto any guests – it was time for the next step: Seeing what happened when fans joined the network.

Captive portal or free access?

Like almost every other venue that has installed Wi-Fi for guests, Rutgers struggled with how to make access available. Should it just be free to use with no restrictions, or should they try to use some kind of captive portal to get an email address or other identifying information so that the school could market to event attendees?

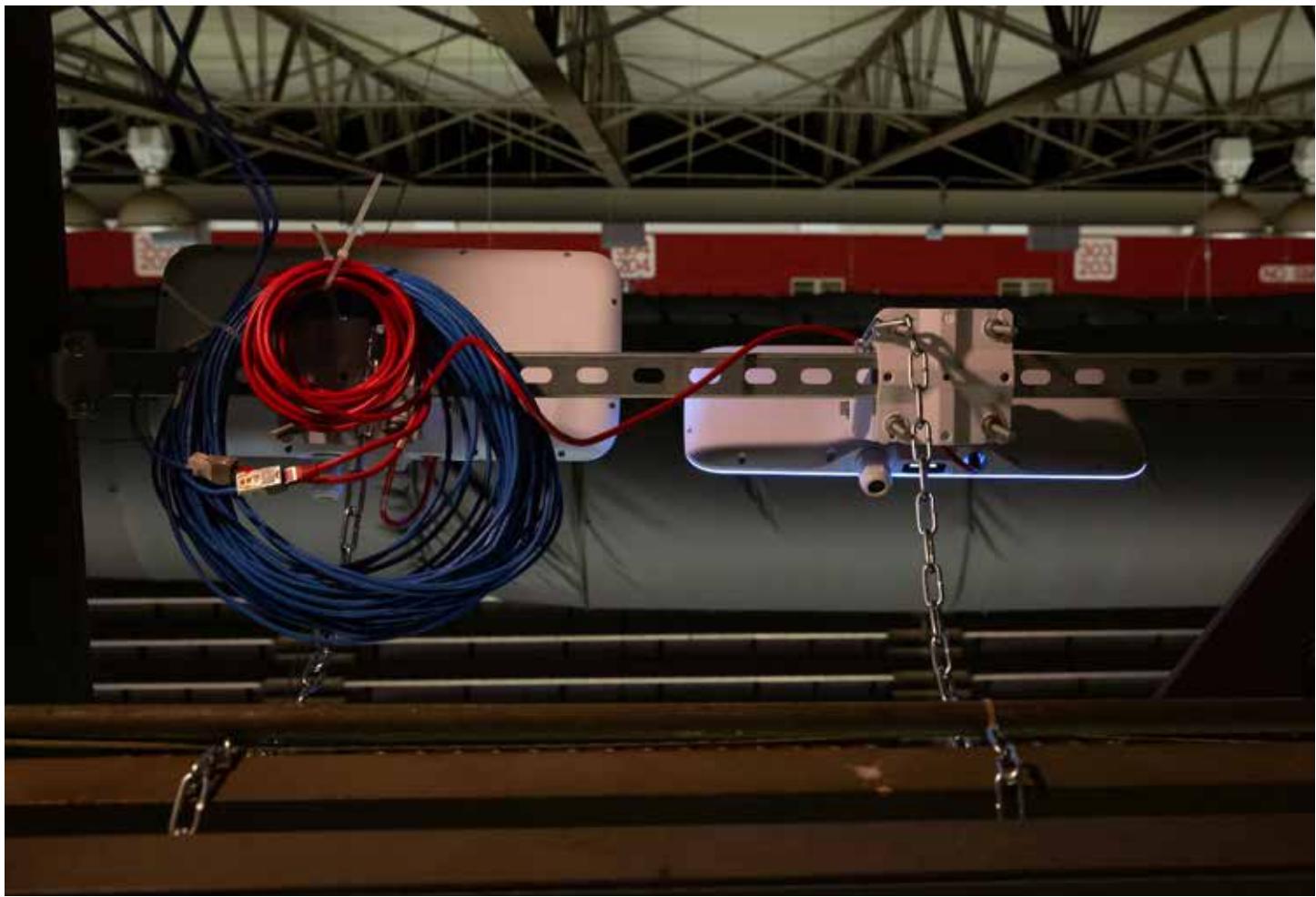
Joe Vassilatos, unit computing manager for the Rutgers athletics IT team, said there was some favor of a Facebook sign-in method from the Rutgers marketing team, because of the ease of identification. But Vassilatos said the IT team was "wary" of using a Facebook method, something Beal agreed with.

"We got some feedback from other schools that if you put that [Facebook sign-in] in, nobody uses the network," said Beal.

Instead, the team opted for a sign-in method that uses a one-time SMS code with a 4-digit number that fans must enter to get access to the network. But both Beal and Vassilatos hoped that in the future there might be other ways to monetize the network – like doing offload for cellular carriers – that would allow them to make access even easier.

With the network in place during this past basketball season, Rutgers saw good numbers on the usage side, with anywhere from 600 to 800 people using the network at games this winter. Beal said network statistics showed

A GOOD PHOTO SHOWING THE TWO DIFFERENT TILT ANGLES USED FOR THE WI-FI ANTENNAS.



A TOP-DOWN LOOK AT THE ANTENNA MOUNTING SOLUTION.

that at most games, 20 percent of the visitors connected to the network at least once, with 10 percent having dwell times in the 20- to 50-minute range.

"That shows they're a real user, and not just a visitor," Beal said.

For the last three games of the season, the Rutgers network got a promotional boost from a pregame light show that included fans using their mobile devices. Part of the promotion included instructions to log on to the Wi-Fi.

But according to Beal, the network wasn't ever a secret.

"The first thing people do in any place is check for free Wi-Fi," Beal said. "And if people are happy with it, it's good enough."

Next steps: Planning for football

For this offseason, the new project for the Rutgers IT team is bringing Wi-Fi to the student section of the football stadium, where they are planning to go with an under-seat approach. According to both Beal and Vassilatos deployment there is going to be more of a tuning

challenge since Rutgers students rarely sit in one place, but instead crowd the area and even stand on bleachers trying to cram in.

But with a functional Wi-Fi network now inside inside the basketball arena, a place known as "The Trapezoid of Terror" (for its unique sloped-walls architecture), the Rutgers IT team is confident of its deployment chops, and takes great pride in knowing that more events can be held there with good connectivity, including more potential money-making events like career fairs and concerts.

"In the past when we had graduation ceremonies or other events [in the RAC] we had to bring out portable Wi-Fi," Beal said. "Now we can take that load on the stadium network."

For Vassilatos, the Wi-Fi is a reason for a little bit of chest-beating.

"IT is usually very inward-facing, and this was our chance to utilize our skill set to add to the bravado of the athletic experience," Vassilatos said. "We took this on our own to implement, and we're better from the experience."

-MSR-



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WI-FI, DAS ARRIVE AT COLORADO'S EVENTS CENTER

BY PAUL KAPUSTKA





FACING PAGE: THE CU BAND GETS THE HOME CROWD READY FOR A GAME. THIS PAGE: ABOVE, A LOOK AT GEAR IN THE RAFTERS; BELOW, WI-FI APs THAT COVER ENTRYWAYS. CREDIT ALL PHOTOS: PAUL KAPUSTKA, MSR.

The basketball side of the plan to bring Wi-Fi and DAS coverage to the University of Colorado's main athletic facilities is complete, as both networks were live and operational during the recently concluded men's and women's hoops seasons at the CU Events Center.

Coverage for the 11,064-seat facility on the Boulder, Colo., campus was built by Connectivity Wireless, using Wi-Fi gear from Cisco and the Teko distributed antenna system (DAS) gear from JMA. The deal was first announced last year, and includes a plan to also bring both DAS and Wi-Fi to Folsom Field, CU's football stadium. Originally scheduled to be available for the past football season, the Folsom Field networks are still under construction, with availability slated for later this year, according to Connectivity Wireless.

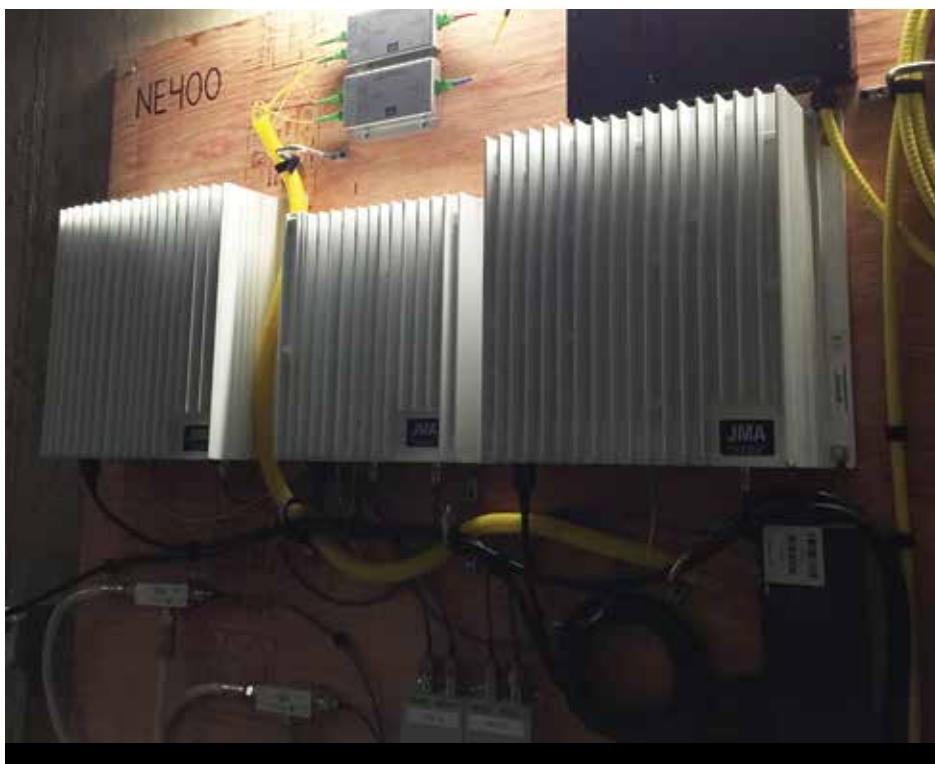
The model brought to CU is a classic neutral-host operation, where a provider like Connectivity Wireless will build a school's Wi-Fi and DAS networks under a revenue-sharing deal with the school where the carriers help some with upfront payments and then provide payments over a long-term lease to operate on the DAS. The neutral-host option is one good way for schools or teams with smaller budgets or lightly used facilities to bring connectivity to arenas.



Solid Wi-Fi performance during a sellout

According to Connectivity Wireless, the basketball arena's fan-facing network equipment is installed completely in the catwalks above the court. With a low-hanging roof and a single-tier seating bowl, the CU Events Center is laid out somewhat perfectly for the traditional top-down coverage method, with the distance close enough for Wi-Fi equipment.

For Wi-Fi, the final count for APs in the catwalk was 58, and for DAS the final count was 44 antennas in eight sectors. There is also some additional Wi-Fi in the building, including a small deployment that is part of the CU campus network as well as some additional APs Connectivity Wireless deployed to help cover entrance doorways for mobile-device ticket scanning.



CLOCKWISE FROM TOP LEFT: A DAS ANTENNA COVERS THE CONCOURSE; CABLING IN THE CONCOURSE; A GOOD WI-FI SPEEDTEST; SOME NEW HOLES HAD TO BE DRILLED FOR CABLE RUNS; JMA DAS GEAR IN A WIRING CLOSET.

At a Feb. 8 sellout afternoon game against Stanford, Mobile Sports Report attended and got solid Wi-Fi marks throughout the venue. In our seats in row 23, we got a pregame Wi-Fi speedtest of 44.9 Mbps on the download side and 59.2 Mbps on the upload. Roaming around the bowl before tipoff, we got a speedtest of 21.2 Mbps / 45.0 Mbps just behind the student section in the south end zone seating area. Moving toward midcourt we got a speedtest of 38.2 Mbps / 35.5 Mbps in row 19 of a corner section, and then a top test of 63.2 Mbps / 68.2 Mbps in the sixth row of a midcourt section, showing that the closest seats to the action were well covered.

Since only AT&T is active on the DAS, we were not able to get a speedtest with our Verizon phone. Accord-

ing to Connectivity Wireless, negotiations with Verizon and T-Mobile are in process to participate on the DAS; the DAS is also set up to handle Sprint and its 2.5 GHz spectrum, according to Connectivity Wireless.

Both the football and basketball venues' networks are served by a central head-end room located in an old telephone PBX space near the center of campus. Fiber links run from there to both Folsom Field and the Events Center, through an old system of steam tunnels that used to be the primary method of bringing heat to campus buildings. [-MSR-](#)

CU COACH TAD BOYLE KEEPS AN EYE ON WARMUPS
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Boulder, CO 80301
(720) 668-9842
kaps@mobilesportsreport.com