STADIUM TECH REPORT

SPRING 2021

FC CINCINNATI'S WEST END STADIUM

TECHNOLOGY FUELING A SAFE, FUN FAN EXPERIENCE

FREQUENCY NEUTRAL NETWORKS

WIRELESS NETWORKS USAGE AT SUPERBOWL LV

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STADIUM TECH REPORT

Welcome to the first issue of our EIGHTH year of STADIUM TECH REPORTS, the Spring 2021 issue!

These 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-depth profile of the wireless technology deployments inside West End Stadium, the new home for Major League Soccer's FC Cincinnati, which will be opening this year. We also have a recap of wireless usage from Super Bowl LV in Tampa, and a column on Frequency Neutral Networks from Bill Anderson. Also look for our second "Design Vision" interview, where we talk to Kevin Devore from ME Engineers.

We'd like to take a quick moment to thank our sponsors, which for this issue include Corning, Boingo, MatSing, Cox Business/Hospitality Network, American Tower, CommScope, AmpThink and ExteNet Systems. 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.

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
Stadium Tech Report

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Paul Kapustka

FOR STADIUM CONCESSIONS, THE DIGITAL REVOLUTION IS HERE

Goodbye, old-style walk-up concessions stand. I won't miss you. I won't miss waiting in line behind someone who is "buying for everyone," trying to remember food and drink combinations for the family or the group of friends, then watching concession-stand employees ring up an order, put food items together, take payment and make change.

These things should have disappeared from stadiums long ago, but they persisted. If there is one silver lining to the Covid pandemic, it may be that the safety and security precautions needed to bring fans back into large public venues — which include being able to feed and water those people spending time in your building — have finally pushed needed change upon stadium concessions operations.

From conversations we've had here at Stadium Tech Report with industry thought leaders as well as with stadiums and venues that have been moving forward during the past year, it's become clear that one of the biggest areas of technology activity and experiments is around concessions. Some of that has to do with the need to keep fans socially distanced during the pandemic, and also to reduce human-to-human contact as much as possible. But it's also clear that some ideas being tested right now might well become the "new normal" going forward. And that's good news all around.

SPEEDING UP THE PROCESS

To be sure, the process toward things like digital tickets and cash-free concessions has been building in the stadium ecosystem for some time. In many such businesses like fast food and airlines, kiosks and mobile ordering systems have replaced talking to another human across a counter, perhaps with some loss of personality but with huge leaps in efficiency, safety and getting exactly what you ordered with much less waiting.

SO WHY DID THE PAST PERSIST AT STADIUMS?

For the majority of venues who kept the old methods, you could point to the fact that they may have felt there was no compelling reason to "fix what wasn't broke." There might be some grumbling about lines, but it wasn't a deal-breaker for most fans. All was well, right?

Well, not really. For the non-premium attendee, many events in many buildings still had the problem of old-fashioned walk-up concession stands, where you could spend a full baseball inning or a good chunk of a football quarter just waiting for a simple hot dog and a beer.

It's not like teams and venues didn't ever try to address the issue of fans having to spend active game time waiting for food or drink (or for restrooms). When the San Francisco 49ers opened Levi's Stadium in 2014,

the plan was to allow fans to place a mobile concessions order and have it delivered — to any seat in the stadium. While it was a commendable effort, there were too many things wrong with the attempt, including the human equation of just having enough runners to deliver the goods.

There were also some new ideas, like the line-length signs powered by new systems from companies like WaitTime, that began sprouting up — but what those technologies didn't really address was why there were lines in the first place.

ENTER THE PANDEMIC

If there was one "simple" fix to shortening lines, it would be eliminating cash payments — it's simple math, since it is far faster to swipe a card than it is to pass bills and coins back and forth.

While some stadiums, like Mercedes-Benz Stadium in Atlanta, actually took the plunge to a cash-free concessions environment before the pandemic, the balance of venues kept the ability for fans to use paper money

But the Covid-19 pandemic — and the safety measures needed to safely allow fans back in big public buildings — made cash transactions undesirable. In just about every venue that opened to limited attendance during the past 12 months, all concessions transactions were digital.

So far, I haven't heard any widespread complaints about the practice, which leads me to believe that cashless, or cash-free concessions, will likely become the norm going forward. And for fans, teams and venues, I think it's a good idea.

WHAT YOU CAN DO WHEN EVERYTHING'S DIGITAL

From a venue owner's or operator's point of view, all-digital payments are a far superior choice, for many reasons. Beyond the streamlining of business processes that come with eliminating cash drawers comes better security, and faster and more accurate business data tracking.

An all-digital environment also allows teams and stadiums to more closely integrate loyalty programs and things like points with actual payments; it also gives fans an incentive or purpose to use a team or stadium app, something many fans have historically avoided. Stadium app provider Venuetize, for one, has racked up a few recent customer wins (Globe Life Field, San Jose Sharks) as teams seek to put more transactional power into their stadium and team apps.

Greater integration of payment technology was one of the main reasons behind the recent purchase of app and transaction-process software provider VenueNext for $72 million by Shift4, a large payment-processing company.

From a fan's point of view, the improvements in concessions technology should be sudden and noticeable. Already, we've seen forward-thinking venues like Sacramento's Golden 1 Center and Denver's Empower Field at Mile High take bold steps to reformat concessions with an eye toward grab-and-go functionality.

KIOSKS AND EXPRESS OR TIMED PICKUPS

Concessions back-end software and hardware provider Appetize has been bullish on kiosk systems going forward, with multiple business wins during the pandemic for new installations at places like the Green Bay Packers' Lambeau Field, getting ready for the eventual return of fans.

And while the shift might mean an end to some desirable jobs, like the row-by-row beer salesperson, the idea of passing a cup of draft from hand to hand down a row — and then also passing paper money back and forth — is something that is probably never going to return.

As a young adult going to games at my beloved home venue Wrigley Field, the remembered calls of "Old Style! Cold Beer!" evoke warm memories and were part of the great ballpark experience. As much as I might miss that, I'm looking forward to a future of returning safely to venues and spending much, much less time in lines.

STR STADIUM TECH REPORT.

FC CINCINNATI'S WES END STADIUM USING TECHNOLOGY TO SUPPORT SAFER, EAS FAN EXPERIENCE

When West End Stadium opens its gates for the first time this season, there will be a lot of technology working behind the scenes to make sure the fans of FC Cincinnati have an enjoyable time at their brand-new home.

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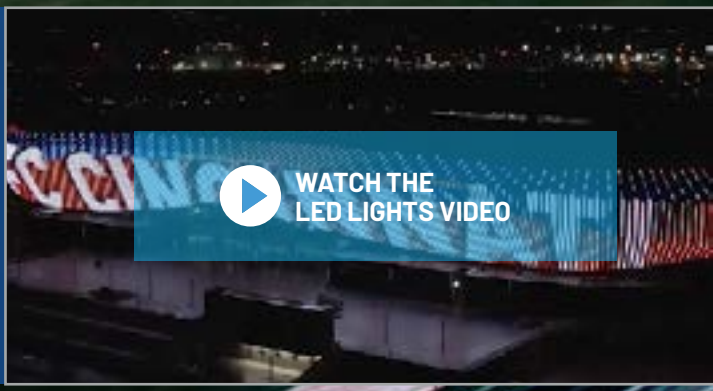

ST

SIER

\\ BY PAUL KAPUSTKA

While there will be state-of-the-art wireless connectivity and the newest versions of entry, concessions and ticketing applications in play in the new 26,000-seat venue, the team owners were not looking to install technology for technology's sake. Instead, they said their tech mission was to "solve problems" and create a unique, "frictionless" environment that would make going to games safer, easier and more enjoyable — thereby making West End Stadium that new "home" where fans would want to visit again and again.

"When you're moving into your first home, it's very exciting," said Meg Ryan, chief marketing officer for Cincinnati's Major League Soccer franchise, as it prepares to open its new $250 million home. Previously, FC Cincinnati had played its games at the University of Cincinnati's Nippert Stadium, a 40,000-seat facility designed for American football.

But when the MLS opens its 2021 season, the "orange and blue" will have their own dedicated stadium, one that at first glance from the outside should add a sparkling highlight to the Cincinnati skyline with its unique "vertical fins" LED lighting system that will produce "moving" light displays. (The stadium is scheduled to open with a game against Inter Miami CF on May 16, 2021.)

If the outside fins and the inside video boards from Daktronics are the most visible displays of stadium technology, there is a wide range of other technology deployments meant to make the actual in-person visit an easier and safer experience by eliminating "friction" points that have long been a part of game-day sports.

West End Stadium is scheduled to open on May 16. Credit all photos: Atomic Data/FC Cincinnati

‘We wanted to be innovative from a technology standpoint, but mainly what technology does is allow us to solve problems’

“We wanted to be innovative from a technology standpoint, but mainly what technology does is allow us to solve problems,” said Ryan, who joined FC Cincinnati last year after previous stints with the NBA’s Denver Nuggets and the Atlanta Hawks. And a lot of those technology decisions, Ryan said, come from FC Cincinnati’s fans, who were surveyed about game-day visits prior to the construction of the new venue.

BEING SAFE AT THE GAME

Even before the Covid pandemic hit the world, the plans for West End Stadium called for innovative use of technology in all phases of operations. According to Ryan, the team got a real “inspiration” of what its new home could be when the owners visited Allianz Field in St. Paul, Minnesota, during an MLS game against Minnesota United FC.

Looking around that new facility, which was also designed with an innovative technology strategy, gave FC Cincinnati ideas about what its new home could be. The team “experienced something that aligned with where we wanted to go,” Ryan said. And while there, FC Cincinnati also found the firm it would use to help it get to its desired technology future — Atomic Data, the Minneapolis-based company that built and ran the networks and other technology at Allianz Field.

Signed on first as FC Cincinnati’s technology owner’s representative — a role that would expand over time — Atomic Data helped FC Cincinnati in the evolving journey of stadium technology deployments in the face of the pandemic. According to Yagya Mahadevan, Atomic’s enterprise project manager, that shift included some distinct changes to both technology deployments and how technology was used, in places like stadium entry.

“When we opened Allianz Field we wanted to have people taking tickets with handheld scanners, to greet fans by looking them in the eyes,” Mahadevan said. “But the pandemic has changed things. Now, nobody wants to touch anything, so instead of hand scanners we’ll have pedestals.” Mahadevan also said that Atomic Data

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Underseat Wi-Fi enclosure

helped design in extra wireless coverage for the new stadium's main entry, where more than 60 percent of a game-day crowd is expected to enter.

The pandemic also provided a final push toward a fully cash-free and as contact-free as possible concessions operation. FC Cincinnati selected app provider Venuetize to help build a stadium app that will support more contact-free transactions, including an in-seat delivery option that Ryan said will be trialed early on.

"From the fans, one of the biggest [previous] complaints was about wanting to get back to their seats more quickly when buying concessions," Ryan said. "They also wanted us to make sure the experience was truly safe."

ENABLING THE EXPERIENCE: WI-FI 6, DAS AND IPTV

To support the fan-facing technology, Atomic Data first helped FC Cincinnati pick its key underlying infrastructure providers — and then also helped with the design, installation and network operation as Atomic Data's role expanded from owner's rep to technology integrator.

"When something is working, adding a new partner [as integrator] is not always the best solution," Ryan said. "Atomic Data really helped us make our ideas happen, and we started asking how do we maximize the relationship."

On the Wi-Fi side, Atomic Data is following its game plan from Allianz Field in Minnesota, where it installed a mix of under-seat AP placements in the bowl seating and overhead and wall placements in other areas. Using gear from Aruba, a Hewlett Packard Enterprise company, Atomic Data said it used about 350 APs in the bowl out of a total of approximately 650 APs. All the devices support the new Wi-Fi 6 protocol.

For the cellular DAS, Mobilitie is leading the deployment, which according to Mobilitie will include approximately 200 antennas, including eight MatSing Lens antennas. On the IPTV side FC Cincinnati picked Vitec to install the approximately 350 TV-size screens that will be used around the stadium.

CREATING A GREAT EXPERIENCE

And not all the technology is wireless or digital. According to FC Cincinnati, its new ultra-fan section — called "The Bailey" after a castle's stronghold — will give its most ardent fans some neat perks, including counters with cupholders (so you can stand and cheer and not have to hold your beverage while doing so) as well as "built-in overhead wire and pulley and lever systems" to allow any "tifos" to be safely held aloft over the fans' heads.

'We want this stadium to be a community connector, to be the crown jewel of the city.'

"We really want this stadium to be a community connector, to be the crown jewel of the city," said FC Cincinnati's Ryan. "We want fans to have the desire to come back every day."

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Kevin Devore

Principal, ME Engineers

Our second 'Design Vision' interview is with Kevin Devore, principal and wireless technology director for ME Engineers. He works with owners, architects, contractors, and wireless providers to set project program and budget expectations, work that includes pricing review, design coordination, production of construction documents, and construction oversight. He was personally involved in recent projects featured in STR including Dickies Arena, Allegiant Stadium and SoFi Stadium.

DESIGN VISION

INSIGHTS

EXPERTISE: Evaluating products and solutions for stadium technology deployments

EDUCATION: Degree in architectural engineering, Kansas State University

WHAT YOU MIGHT KNOW: Likes to ski, likes to hike

WHAT YOU DON'T KNOW: Climbed Mount Kilimanjaro with his wife

MAC OR PC: "Everything at home is iPad, Apple TV, iPhone, Apple Watch."

TECHNOLOGY INTRESTS OUTSIDE OF VENUES: Self-driving vehicles, 3D printing

FAVORITE APPS: Scribd

SPORTS MEMORY: Attending Game 4 of the 2007 World Series

SPORTS EVENT HE'D LIKE TO ATTEND: The British Open

VENUE HE LIKES BUT DIDN'T DESIGN: The Colosseum in Rome — "It's always been kind of the stadium of all stadiums."

WORK PHILOSOPHY: An engineer who doesn't want to stop learning

Continue reading...

DESIGN VISION

Our conversation with Kevin showed that his 18-year career at ME Engineers has been almost a perfect mirror of the growth of importance of technology in stadium design and build. Coming out of his hometown college, Kansas State University, Kevin started on projects where the emphasis was more about "doing low-voltage technology scope and also power and lighting design." Starting out, he said ME Engineers only had a couple people focusing on technology design, but after working on his first "big projects" for the Arizona Cardinals and the St. Louis Cardinals' ballpark, the practice and his responsibilites started growing.

When Kevin talks about his background and growing up as a kid who was interested in all kinds of projects around engineering and architecture, it's easy to see how he fit in well with the culture at ME Engineers, where there is expertise in numerous disciplines including mechanical, electrical, and plumbing design. And as clients who work with ME Engineers know, the company is not one that simply signs off on a design and lets outside contractors do the work. Like many at the company, Kevin — who has expertise in telecom Wi-Fi, DAS, security and A/V systems design — enjoys getting involved in a project early on, working with the owners and architects to "help them to define the technology vision of the project, and what's specific to the project."

What's interesting to hear from Kevin is how he has seen that vision change over time. Early on, he saw

systems like security cameras and stadium TV on their own separate networks with their own separate infrastructure. Now, ME Engineers is at the forefront of the trend of more converged stadium technology builds, where getting in early to influence the design and

deployment is even more crucial, he notes, since it plays across all levels of a building's construction.

"It's thinking about all those systems holistically," he says. " You've got shared technology spaces, [where] you're sharing a room with A/V and IT systems and wireless systems. How do they relate to each other? What's the impact on mechanical and electrical systems that support those?"

Kevin then talks about how all the technology is "wrapped up in my mind" under an umbrella that also considers the impact on the building architecture, and how all that can be built so that all the systems perform optimally. That's because, he jokes, nobody is looking to buy anything other than the best for their building.

"I've not ever once been in a room with an athletic director or a CTO of an organization, as we were talking about wireless, where they've said to me, I want the second-best wireless connectivity," Kevin noted, tongue firmly in cheek.

Once a design vision has been set, that's when ME Engineers gets to work, setting up budgets, recommending products, and "rolling up our sleeves" to enable the vision "and turn it into something tangible at the end of the day, like a brand new sports venue."

Kevin stresses his approach is to listen to and work with all stakeholders to define clear project goals early in design, Then the ME team focuses on developing a final design that considers all aspects of technology, including how the various systems overlap and the overall impact and integration into the building architecture.

STR
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TECH REPORT

CREATING A TOUCHLESS FAN EXPERIENCE WITH BOINGO WIRELESS

There is no question that live sports and entertainment are changing as a result of the COVID-19 pandemic. With neutral host 5G and Wi-Fi 6 networks from Boingo, stadiums and arenas can meet new health and safety protocols, while delivering the immersive mobile experience fans expect.

The Path Forward

Boingo has identified key use cases to rebuild fan confidence and foster a safe environment. World-class stadiums partner with Boingo to design, build and manage converged wireless networks that move contactless experiences from concept to reality.

USE CASE	CHALLENGE	COMPONENTS	CONNECTIVITY SOLUTION
Social distancing		Cameras; sensors	
Security measurement and monitoring		Cameras; sensors	
Personal identification checkpoints (e.g. ticketing)		Touchless, self-service facial/ biometrics recognition devices and kiosks	
Concessions and point of sale		Touchless, self-service payment; direct-to-consumer delivery and pickup; dispersed concession areas and mobile kiosks	
Guest communications		Digital signage; Wi-Fi connection portal; push notifications	
Staff and first responder communication		Push-to-talk devices	
Cleaning and maintenance tracking		Robotics; cameras; sensors	
Health check screening		Infrared scanners; sensors	

= Health = Monitoring = Communication

= Wi-Fi = Wired Internet = 4G or 5G DAS = Private LTE

Your Partner for the Road Ahead

For 20 years, Boingo has helped the world's leading venues navigate a complex technological landscape with state-of-the-art cellular DAS, Wi-Fi, CBRS and 5G networks. As stadiums and arenas prepare for a new age of live entertainment and sports, Boingo is here to help with technology to facilitate the new touchless venue – and beyond.

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Austin FC Stadium


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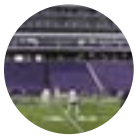
Vivint Smart Home Arena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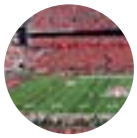
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THE 'MAGIC' YOU SEEK IN WIRELESS IS FREQUENCY NEUTRAL NETWORKS

\\ BY BILL ANDERSON

5G VS WI-FI ISN'T THE QUESTION

There is a heated debate in the wireless industry; 5G vs. Wi-Fi. Proponents of 5G claim that massive speed increases and ubiquitous coverage will render Wi-Fi networks obsolete. Wi-Fi pundits claim that Wi-Fi has adopted the same technology that underpins 5G using chipsets that cost less because they are burdened by a lighter licensing load from patent holders. 5G proponents tell us that mobile network operators will have such a large, robust footprint and delivered at such a competitive price that no responsible business owner would build and operate a Wi-Fi network. Wi-Fi proponents tell us that 5G will never find its way into all of the devices that rely on Wi-Fi.

Who are these proponents? In very simple terms, they are the original equipment manufacturers (OEMs) of 5G and Wi-Fi technology. With few exceptions, the loudest voices are suppliers who have something to gain from the conversation. But look and listen carefully. While the debate rages on, the same players who lobby for one technology are quietly developing capabilities to support both. Why? Because the truth is that 5G and Wi-Fi aren't competitive technologies, they are complimentary; they are just different ways to use spectrum.

MY 'AHA' MOMENT

Several years ago after speaking at a Wi-Fi Now conference in Berlin, I was approached by a gentleman from Deutsche Telekom. I had just spent 30 minutes speaking on how Wi-Fi portals were being used in U.S. stadiums to capture fan data and how that data was being used to sell more tickets, merchandise, and concessions. He politely asked questions about a few statements I made and then left me with a final rhetorical question. That question was:

> **'When you landed in Berlin, what did you have to do to receive a phone call?' The answer was - 'Nothing!'**

"When you landed in Berlin, what did you have to do to receive a phone call?" The answer was - "Nothing!" I simply waited for my phone to ring. In the background, that call might have originated on a desktop handset attached to a Verizon network in New Jersey, which was then forwarded to the AT&T network to which I was subscribed, crossed the Atlantic on a fiber trunk, passed across another European carrier's circuits before finding its way to a Deutsche Telekom tower which lit up my handset. I didn't need to attach my phone to the local network, register with the carrier, or provide any personal information. Everything required to complete a very complex international commercial transaction was invisible to me and executed instantly. It was "Magic."

5G proponents stick with me, because my conclusion probably doesn't fall where you predict. Neither 5G nor Wi-Fi address the future. Both are simply stops on the journey to a frequency-neutral future. The magic of my experience in Berlin wasn't that I was attached to a ubiquitous global network running on pre-5G (LTE) technology, it was that the experience was effortless. Wi-Fi can provide the same joy. My life is full of things that are connected to the Wi-Fi network at my house. My sprinkler system sends me messages to let me know my grass is being watered. I can change the temperature in my house from my phone. My scale in the bathroom beams my weight to my watch, and when I'm looking to escape for a couple of hours, my SmartTV brings me a world of content. All without the slightest effort on my part.

TECHNOLOGY IS THE PATH TRAVELED, NOT THE DESTINATION

In spite of all of the marketing dollars being applied to the "wireless wars," no one wants Wi-Fi or 5G. What they really want is inexpensive ubiquitous connectivity that enables their life. And if you can look past the debate about which technology is most efficient, least expensive, most secure, fastest, easiest to manage, and so on, you might realize that most users just need a little data to be delivered reliably at a speed that is sufficient to accommodate the experience they want to have. Rarely is that more than 1 Mbps. For reference, consider that streaming a 4K movie consumes about 7 GB per hour, or 120 MB per minute, or 2 MB per second - a meager speed achievable long before Wi-Fi 6 or 5G entered the market.

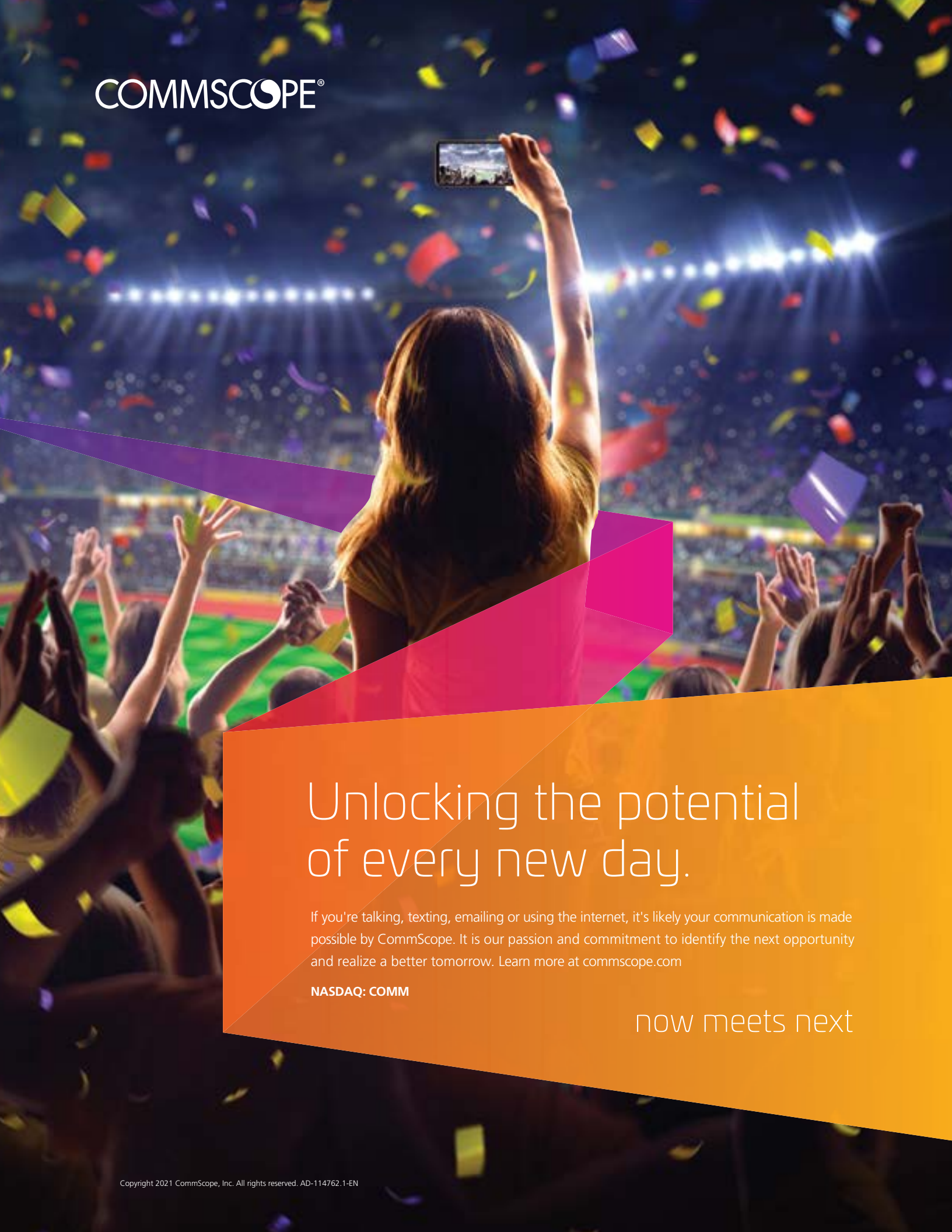
The problem has been that reliably delivering that simple experience to everyone all at once wasn't a solved problem. The constraint was not the technology, but rather the available spectrum. The solution over time has been a combination of improving the use of the available spectrum and securing new spectrum.

Today, we are at an inflection point. Governments around the world are rethinking spectrum allocation, opening the door for what may be the final push to the fully wireless home, the wireless office, and the wireless stadium. Someone will have to make the decision about which technology or technologies they should use. This will be decided by what it costs and who is paying for it. But we can be sure that whatever technology is selected, end-user happiness will be greatest when the technical aspects of using a network are invisible.

To achieve this experience, few would argue that a single frequency band is sufficient. Successful networks use a bucket of frequencies, shifting users from one radio to the next adapting to the density of the environment, the proximity to infrastructure, system utilization, and environmental interference. This is true for 5G and it is true for Wi-Fi. Within each ecosystem, the experience can be seamless - "magic." However, when network boundaries are crossed and the financial agendas of the network provider are thrown into the mix, the experience can quickly degrade from "magic" to frustration, and often leave you angry.

The future of the wireless industry will be found in a frequency-neutral approach to networking — something we call "Frequency Neutral Networks." Devices will be equipped with a variety of radios supporting a range of frequencies and multiple technologies. Networks will consist of a diversity of radios operating on different frequencies, at different power levels, using a variety of antennas; each radio configuration serving a purpose. As a device roams, it will switch radios without interruption, traveling over public and private networks without interrupting the phone call, pausing a video, or delaying a chat.

Today, the software required to provide this experience is in development. Passpoint (formerly HotSpot 2.0) is a proven technology, used by vendors like Hewlett



INTERESTED IN FREQUENCY NEUTRAL NETWORKS?

Below we've included links to some of the provider efforts to make Frequency Neutral Networks part of networking infrastructure.

Cisco Open Roaming: https://www.cisco.com/c/en/us/solutions/enterprise-networks/802-11ax-solution/openroaming.html

Aruba AirPass: https://www.arubanetworks.com/assets/so/SO_Air-Pass.pdf

Passpoint - Wi-Fi Alliance: https://www.wi-fi.org/discover-wi-fi/passpoint

Google Orion: https://www.orion.area120.com/

Packard Enterprise to move transparently between public and their customers' private networks with Air Pass. The Wireless Broadband Alliance (WBA) has standardized a technology, developed by Cisco and adopted by Samsung, Google, Boingo and others, called OpenRoaming which builds on Passpoint to enable automatic, seamless and secure onboarding. Tech giants like Google are creating ecosystems that plug local Wi-Fi networks into the Mobile Network Operators with Orion. And Mobile Network Operators like Verizon are dabbling in frequency-neutral operations, by automatically switching users from cellular to Wi-Fi in stadiums where both networks are present.

OUR FUTURE IS 'FREQUENCY NEUTRAL NETWORKS'

For businesses of all kinds, customer satisfaction is a universal aspiration. In the world of wireless services, customer satisfaction is best achieved by an experience that is frequency neutral. Despite all the branding, commercials and marketing, most consumers don't know or don't care about the differences between 5G and Wi-Fi. They just want their phones to work.

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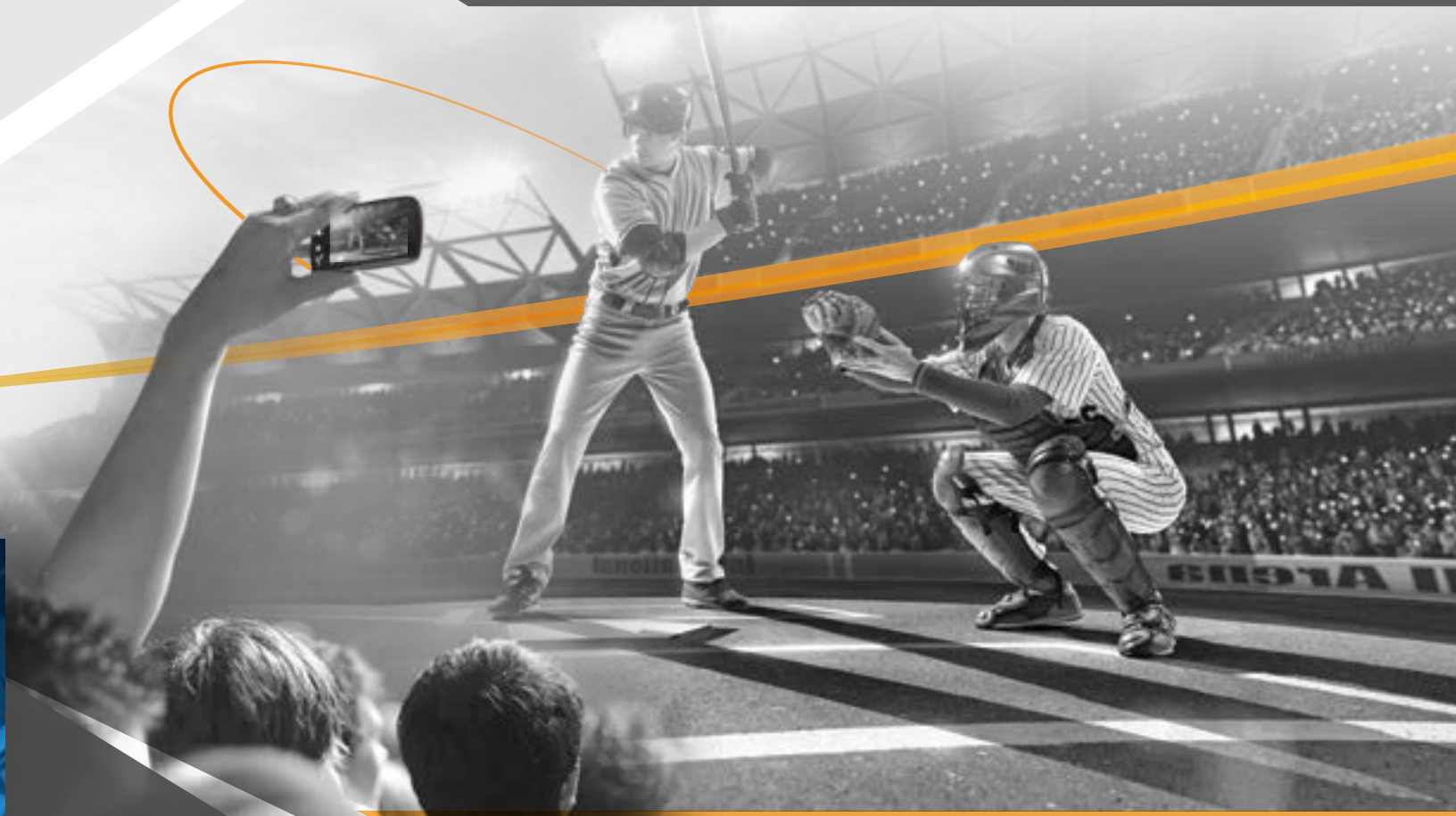

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PER-DEVICE WIRELESS USAGE STAYS STEADY AT REDUCED-CROWD SUPER BOWL LV

Fans record the pregame ceremonies at Super Bowl LV at Tampa's Raymond James Stadium. Credit all photos: Tampa Bay Buccaneers

\\ BY PAUL KAPUSTKA

Thanks to the reduced crowd size due to the Covid pandemic, the total Wi-Fi and cellular data used by fans at Super Bowl LV was well below previous years' numbers — but for Wi-Fi the data used per device was nearly equal to last year's number, showing that fans are still using their devices at the "big game" with gusto.

Because of needs to socially distance, this year's Super Bowl LV at Tampa's Raymond James Stadium only saw 24,835 fans in attendance, much lower than the sellout crowds usually seen at the NFL's championship game. According to numbers compiled by Extreme Networks, fans who connected to the stadium's Wi-Fi network used a total of 13.97 terabytes of data, far below last year's total of 26.42 TB used at Super Bowl LIV at Hard Rock Stadium in Miami, when 62,417 fans were at the game.

The fans watching Tampa Bay's 31-9 victory over the Kansas City Chiefs live, however, used almost as much data per device as last year. According to Extreme 23,766 devices were seen on the stadium's Wi-Fi network before and during the game. That works out to a per-user bandwidth usage rate of 587.8 MB per device, comparable to the 595.6 MB per user mark seen at last year's big game.

CELLULAR PER-DEVICE USE ALSO HIGH

On the cellular side, the bottom line from the big game was a total of 17.7 terabytes combined for AT&T and Verizon (with no numbers reported by T-Mobile), about half the usage when compared to last year's game.

Once again, it is impossible to compare apples to apples as Verizon's reported total of 4G and 5G data used, 7 TB, is from Raymond James Stadium only. AT&T, meanwhile, reported 10.7 TB of 4G and 5G data used, but from an area "in and around the stadium,"

with no exact description of how far out "around the stadium" meant.

Still, taken at the highest totals the traffic pales compared to that seen at the most recent Super Bowls, where cellular traffic reported was above 35 TB for AT&T and Verizon last year and somewhere north of 50 TB two years ago, when Sprint (now part of T-Mobile) also reported numbers.

Verizon, which did say that 56 percent of the attendees were Verizon customers (which if you use the official attendance as a starting point gives you 13,907 Verizon customers at the game), gave us a chance to do some bandwidth-per-user math. Our unofficial calculations show Verizon customers using an average of 503 megabytes per user, a fairly solid metric when compared to the Wi-Fi per-device totals. According to Verizon, its 5G customers saw an average download speed of 817 Mbps, with peak speeds reaching "over 2 Gbps."

AT&T, meanwhile, claimed that its average 5G customer download speed was 1.261 Gbps with a peak download speed of 1.71 Gbps. However, since AT&T didn't give us any way to calculate approximately how many customers it had at the game, it's hard to measure its speeds directly with Verizon's since there is no way of comparing how many devices AT&T had to support. T-Mobile, which claimed before the game that it had done as much as anyone else to support its customers at the game with 5G services, does not report traffic statistics from big events.

PLANNING FOR LOWER CAPACITY

Usually at Super Bowls, the challenge for wireless providers is how to handle record-breaking demands. This year with the reduced crowd sizes, the challenge was in reverse, with network operators having to tune their systems for the lower capacity.

"It's all about optimization of RF [radio frequency]," said John Brams, senior director, venues, retail and logistics at Extreme Networks, the supplier of the gear behind the fan-facing Wi-Fi network in the Tampa Bay Buccaneers' home stadium.

When Extreme put a new Wi-Fi network into the venue a couple years ago, it installed approximately 1,400 Wi-Fi access points, including 950 in the seating bowl with most of those in under-seat enclosures. Like most under-seat deployments, the network at Raymond James Stadium was designed to use the bodies of fans — known in the RF industry as "waterbags" — to block wireless signals in a beneficial way, allowing network operators to place APs closer to each other without generating interference.

Tampa Bay was the first team to play the Super Bowl in its home stadium.

With fewer fans in the building, Extreme and the Raymond James Stadium IT team had to figure out just how to "tune" the network to balance connectivity with potential interference.

While Brams said Extreme and the stadium had "five different scenarios" planned for various attendance

levels, from empty to full, the last few home games during the Bucs' regular season gave the network operators a good testing ground for the eventual Super Bowl plan. At the team's last home game on Jan. 3, there were 16,009 fans in the stands, enough to give Extreme a way to test the eventual network operation plan for Super Bowl LV.

Hometown fans cheered on Tom Brady and the Bucs to a Super Bowl win.

The limited crowd, Brams said, "gave us a broad sense of what we would have to work with" for Super Bowl LV. One benefit of the under-seat deployment is that by being under seats, the APs are less likely to cause interference with other APs, unlike top-down Wi-Fi deployments where signals are more out in the open.

In total, the venue had 1,522 APs ready for use at the Super Bowl, with 1,439 permanent placements and 83 temporary devices. Some of those APs were mounted on poles installed by Verizon to cover the parking lots, blending 4G LTE, 5G cellular and Wi-Fi to provide complete coverage for fans' devices. According to Extreme, the Wi-Fi APs at Raymond James Stadium are all 802.11ac Wave 2 (Wi-Fi 5) devices.

PLANNING FOR THE POST-PANDEMIC FUTURE

According to representatives from the cellular carriers, upgrades to systems in and around Raymond James Stadium were made with an eye not just for this year but for the post-pandemic future, when sellout crowds hopefully return. As a venue that typically sees a high share of hosting big events — it has hosted Super Bowls, college football championships and has Wrestlemania coming in its near future — Raymond James Stadium got the latest and greatest equipment, according to the carriers.

"This is all being built for the next Super Bowl, or when the WWE [Wrestlemania] comes to town," said Brian Mecum, vice president for device technology and sports partnerships for Verizon. At Raymond James Stadium, Verizon has put in place a renovated DAS as well as a "robust" 5G millimeter wave deployment that will bring the next level of wireless connectivity to cellular customers across the board.

Verizon said it has also installed 281 small cell antennas to provide permanent extended cellular coverage around town, both in and around Raymond James Stadium as well as in downtown Tampa, the Tampa Riverwalk, and in nearby Ybor City. Both AT&T and T-Mobile also said they had extensive improvements in coverage to the stadium and the greater Tampa downtown area ahead of the Super Bowl, also with an eye toward ensuring that future events with bigger crowds can still connect at the highest speeds possible.

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