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FALL 2020

STADIUM TECH REPORT™

SoFi Stadium

CONVERGED INNOVATION AT
SOFI
STADIUM

BILL ANDERSON ON TRANSFORMING VENUES
ALLEGIANT STADIUM TECHNOLOGY
PANDEMIC PLANNING FOR ENTRY AND CONCESSIONS

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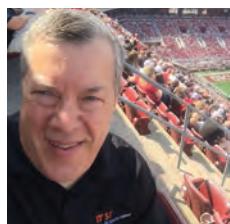
Welcome to the third issue of our SEVENTH year of STADIUM TECH REPORTS, the Fall 2020 issue! These quarterly long-form reports are designed to give stadium and large public venue owners and operators, and digital sports business executives a way to dig deep into the topic of stadium technology, via exclusive 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 profiles of two of the most innovative new venues to open – SoFi Stadium in Los Angeles and Allegiant Stadium in Las Vegas! While neither venue will host fans this NFL season, our profiles will dig in-depth to tell you about the technologies in place to make these stadiums the most advanced when it comes to the game-day experience. We also have a substantive news analysis story about how venues and product and service suppliers are planning to tackle two of the biggest venue issues when it comes to hosting fans during a pandemic – venue entry and concessions operations.

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, 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. 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
Stadium Tech Report



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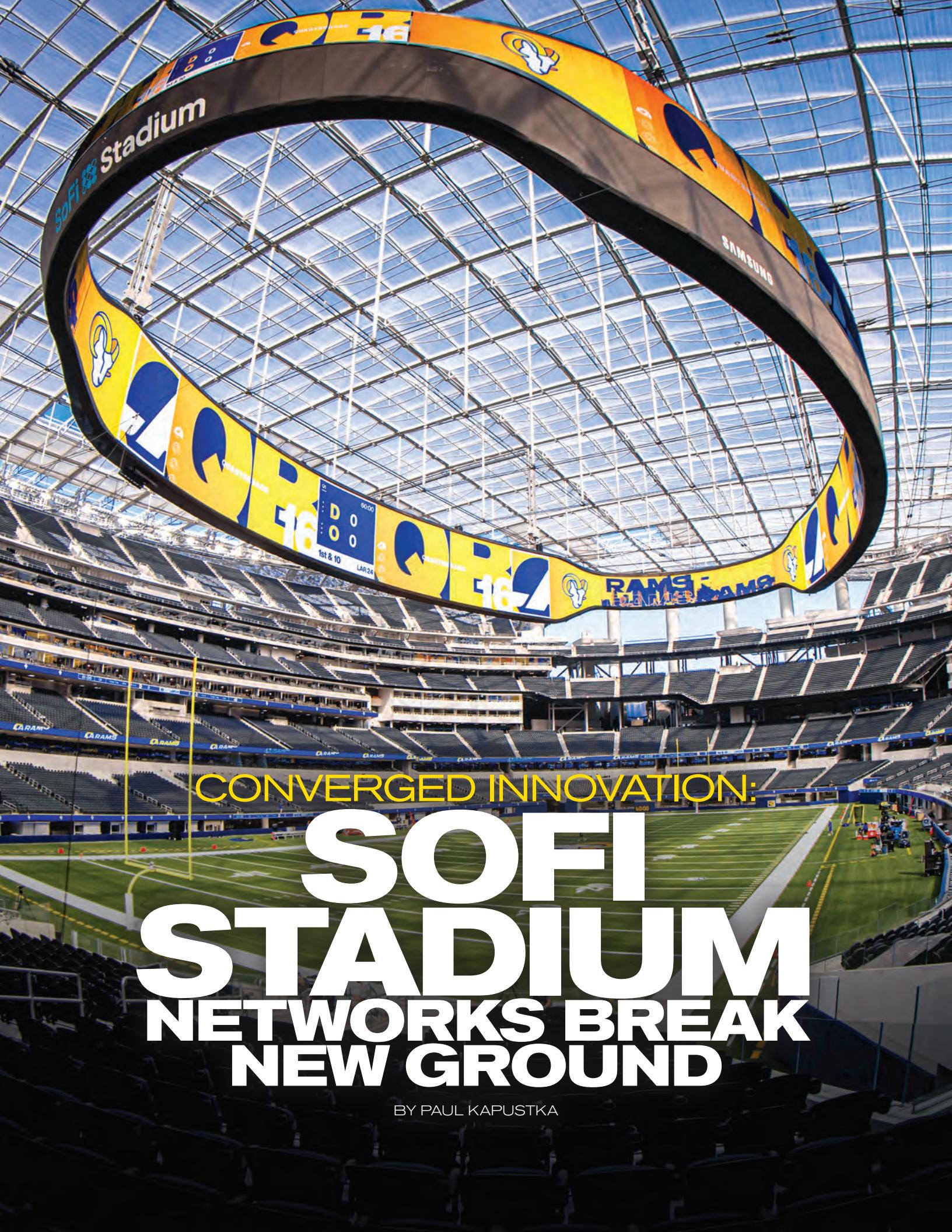


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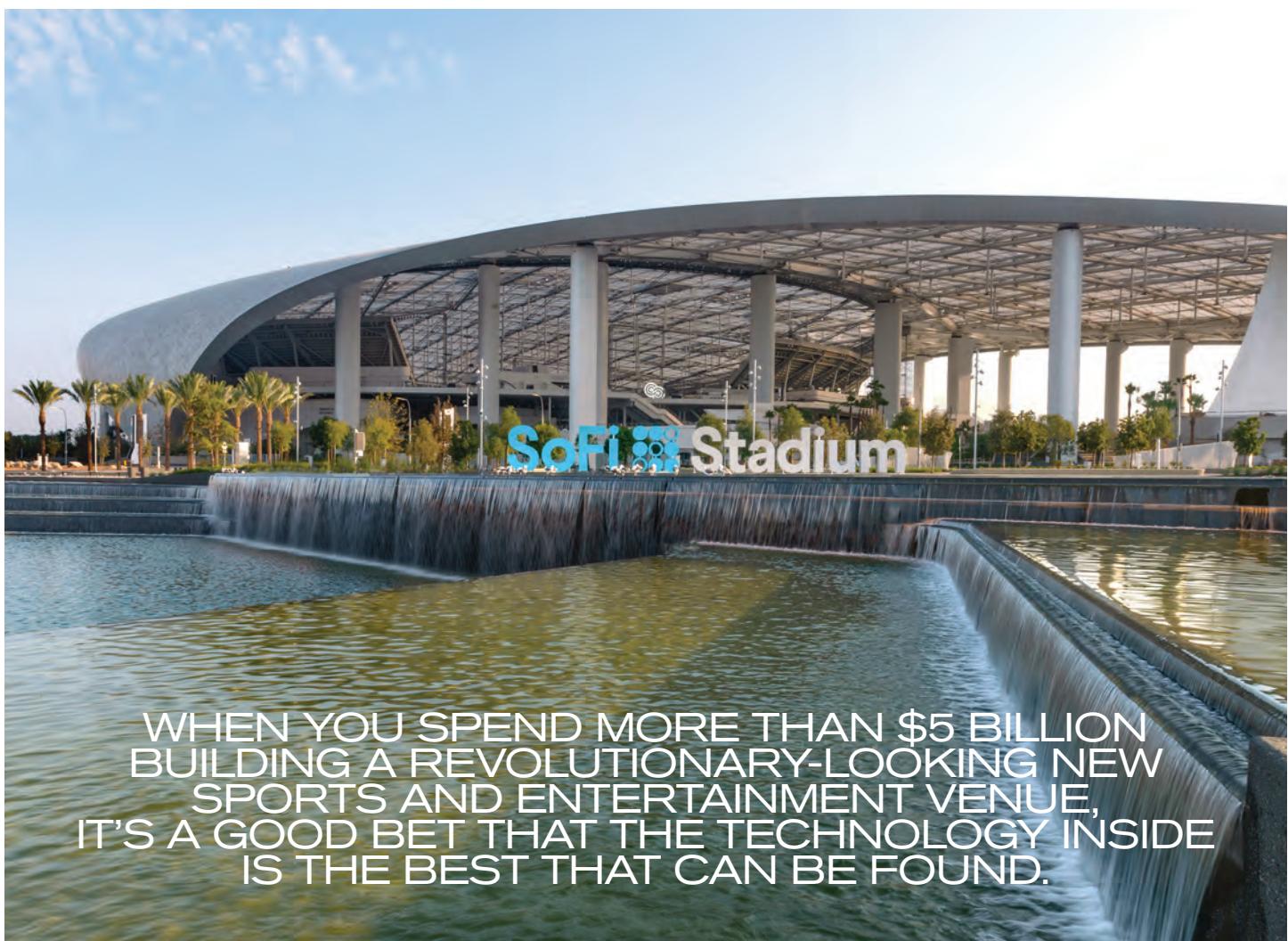


CONVERGED INNOVATION:

SOFI STADIUM

NETWORKS BREAK NEW GROUND

BY PAUL KAPUSTKA



WHEN YOU SPEND MORE THAN \$5 BILLION BUILDING A REVOLUTIONARY-LOOKING NEW SPORTS AND ENTERTAINMENT VENUE, IT'S A GOOD BET THAT THE TECHNOLOGY INSIDE IS THE BEST THAT CAN BE FOUND.

What's truly innovative at the new SoFi Stadium in Los Angeles is not just the quality and functionality of the technology's pieces and parts, but also the venue's embrace of a converged network design, where all network-attached devices connect to a single Cisco Catalyst-based network.

Led by Skarpi Hedinsson, chief technology officer, SoFi Stadium and Hollywood Park, and master technology integrator AmpThink, the networking and compute environment deployed inside the building (as well as in Hollywood Park's neighboring retail, commercial and residential area) is unlike most large venues, where different systems typically exist in their own silos, often with their own separate and different network.

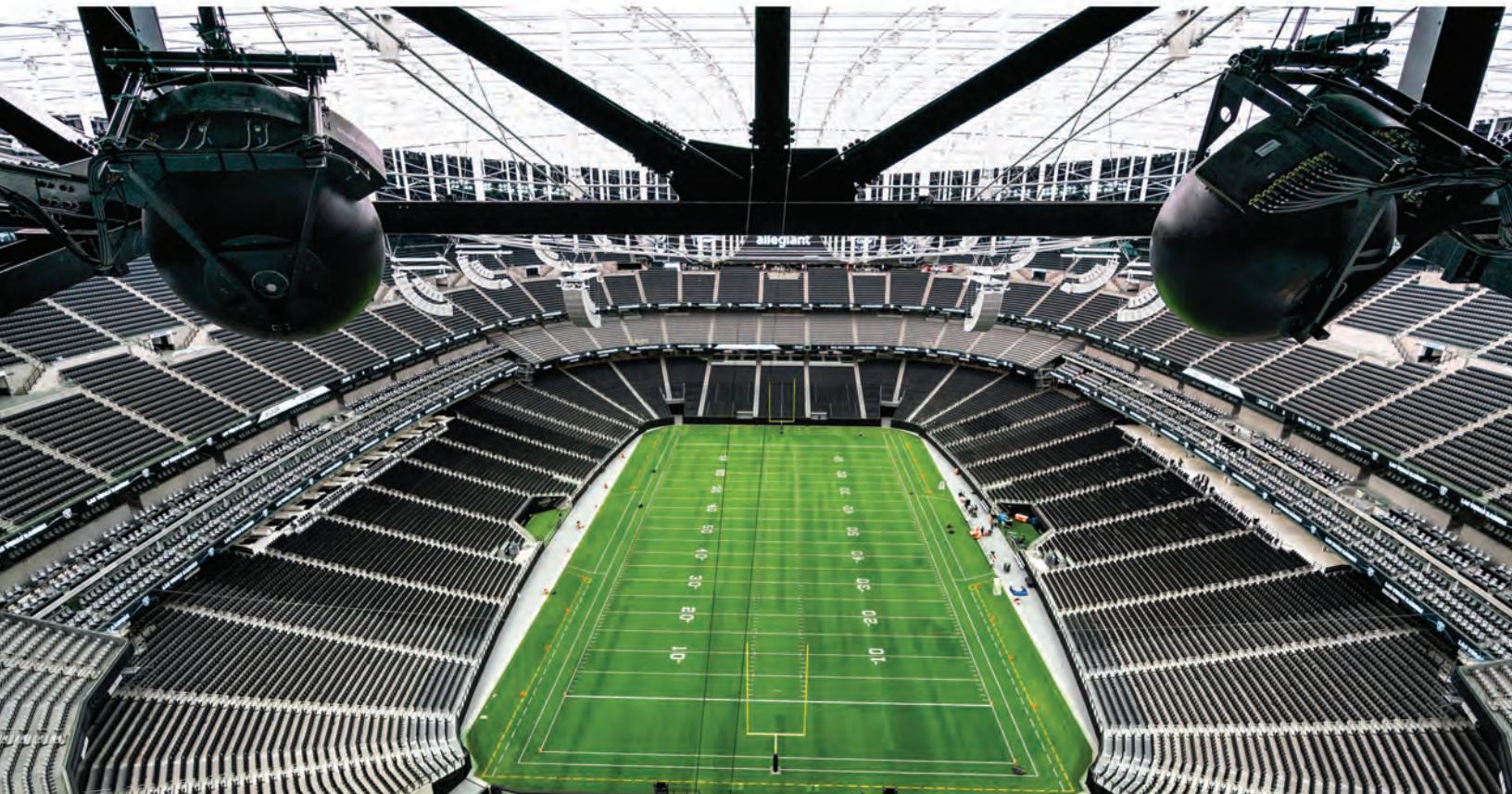
**FACING PAGE: THE OVAL, DUAL-SIDED VIDEOBOARD;
THIS PAGE: THE WATER FEATURE OUTSIDE SOFI STADIUM.
CREDIT ALL PHOTOS: SOFI STADIUM/LOS ANGELES RAMS
(EXCEPT WHERE NOTED)**

Instead, the SoFi Stadium network brings all building functionality – including the wireless networks (among the largest built anywhere), the server compute platform, the telephone system, the IPTV network, the indoor and outdoor digital signage (including the massive oval dual-sided 4K main videoboard), the television broadcast systems, and the building management systems – into one converged platform, with a single vendor/single format structure.

"What we delivered is a scalable platform that simplifies Day 2 operations on Day 1," said AmpThink president Bill Anderson.

Over the coming months, Stadium Tech Report plans to do deep technical dives on each segment of the stadium's different technology deployments. Consider this story a sort of "executive summary" that will attempt to at the very least introduce all the technology elements that are part of the stunning new venue, which hosted its first NFL games for both stadium tenants, the Los Angeles Rams and the Los Angeles Chargers, in early September.

Found at the Best Venues.



Allegiant Stadium, Las Vegas, NV.

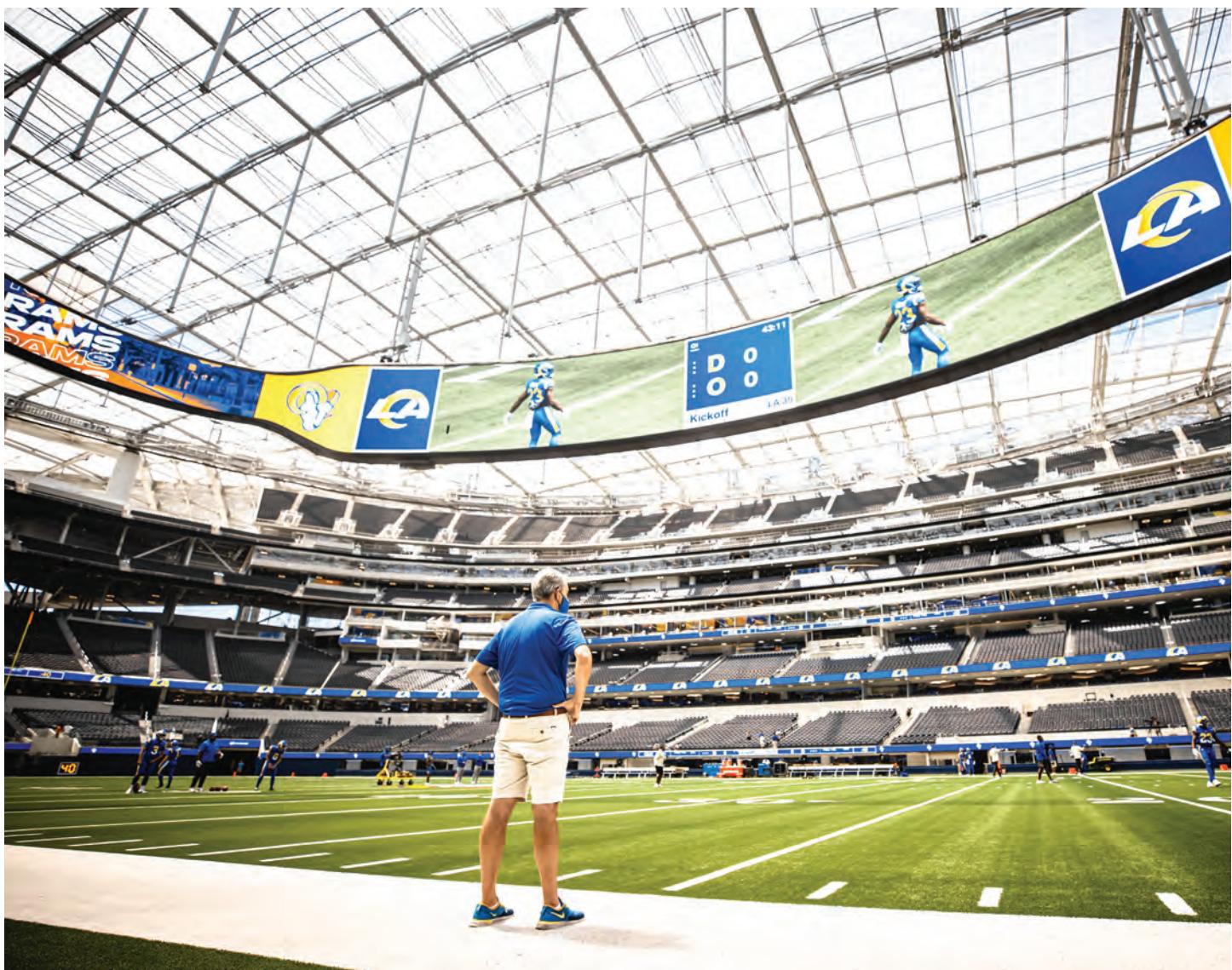
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A FIELD-LEVEL VIEW OF THE VIDEOBOARD AND THE STADIUM.

Converged network a revolution for stadiums

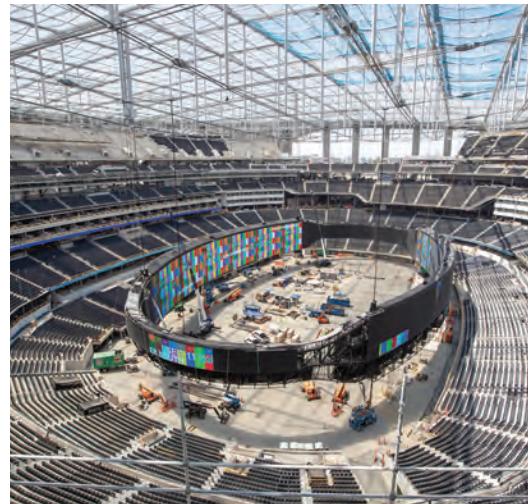
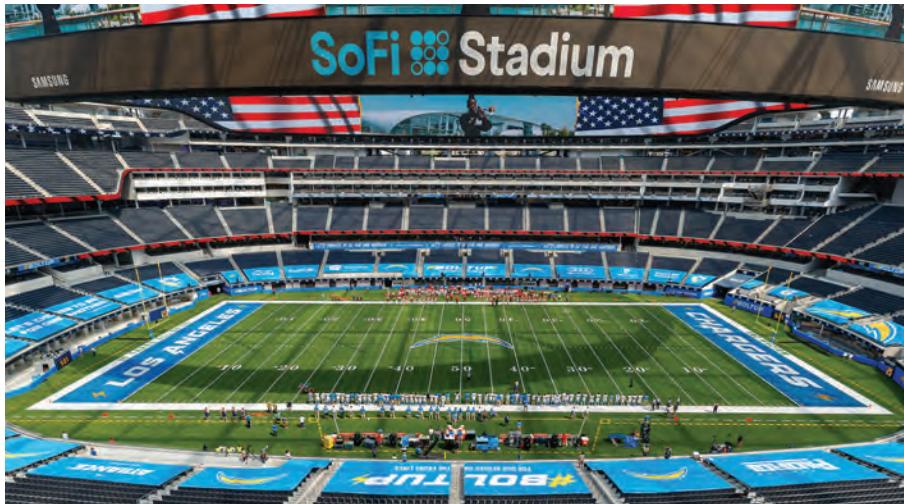
If the stunning architecture of SoFi Stadium and its innovative elements like the oval, dual-sided videoboard represent the realization of Rams owner and Hollywood Park developer Stan Kroenke's "art of the possible," then the converged network and its interlocking technologies perhaps represent "the art of the practical," at a scale somewhat unprecedented inside a large public venue.

If you poke your head inside older sports venues, you are most likely to see separate networks and operation centers for many of the different systems – wireless, wired networks, broadcast, and building operations. Historically the case has been made that those who know those systems best are responsible for building their operations – but the silo approach often brings headaches to those in charge of overall operations for the venue as a whole, as they deal with the proliferation of different systems to operate and manage.

AmpThink, which has deployed networks in more than 70 venues across the country, pioneered the idea of a single, converged stadium network when it built the prototype at the 14,000-seat Dickies Arena last year. But the size and scope of the converged network project at SoFi Stadium – which will hold 70,000 fans for NFL games and up to 100,000 for special events like the Super Bowl – was much larger. Still, according to AmpThink's Anderson, the planned outcome was the same: to deliver the best outcome for the customer.

"It all works together, because it's designed to work together," said Anderson. "Instead of fighting to see if one switch works with another, you can focus on the business."

With 120 separate remote telecommunications rooms – including some hardened for hot weather conditions in the outside areas of Hollywood Park – the SoFi Stadium converged network is designed to present a "single pane



CLOCKWISE FROM TOP LEFT: TEAMS ON THE FIELD AT THE CHARGERS' FIRST HOME GAME (CREDIT: TY NOWELL/LOS ANGELES CHARGERS); THE STADIUM DURING CONSTRUCTION; AN OUTSIDE STADIUM VIEW.

of glass" management structure, where there are no "islands" requiring special attention. Even the live video production system, usually a completely separate entity, is run on a connected Cisco Nexus switched environment. Every telecommunications closet or cabinet is directly connected via fiber to the campus core. According to AmpThink, all the telecom rooms have edge switches that use 25 Gbps optics and a minimum of two connections per closet/cabinet to provide an aggregate of 50 Gbps of campus interconnectivity.

The blanket of Wi-Fi and cellular coverage

On the Wi-Fi side, the SoFi Stadium network is the biggest AmpThink has built in a stadium, with approximately 2,400 APs inside the venue and another 300 in the surrounding Hollywood Park area. For the full Wi-Fi 6 Cisco deployment, AmpThink used an under-seat deployment in the main bowl. Before expanding to include full stadium technology integration, AmpThink

made its name in successful big-venue Wi-Fi network design and deployment, with networks built most recently at Mercedes-Benz Stadium in Atlanta, and last year at Ohio State and Oklahoma University, the first two large-stadium networks to move exclusively to the new Wi-Fi 6 standard.

In a commitment to offering the best possible connectivity to consumer devices no matter which network they use, the Wi-Fi and cellular distributed antenna system (DAS) at SoFi Stadium were both designed to each provide 100 percent venue coverage. The DAS, designed and deployed by DAS Group Professionals using gear from JMA Wireless, is the largest ever deployed. According to Hedinsson, the network has 2,400 antennas and 3,200 remotes, and is capable of covering all licensed spectrum bands between 600 MHz to 6 GHz.

As cellular carriers move toward the 5G future, the

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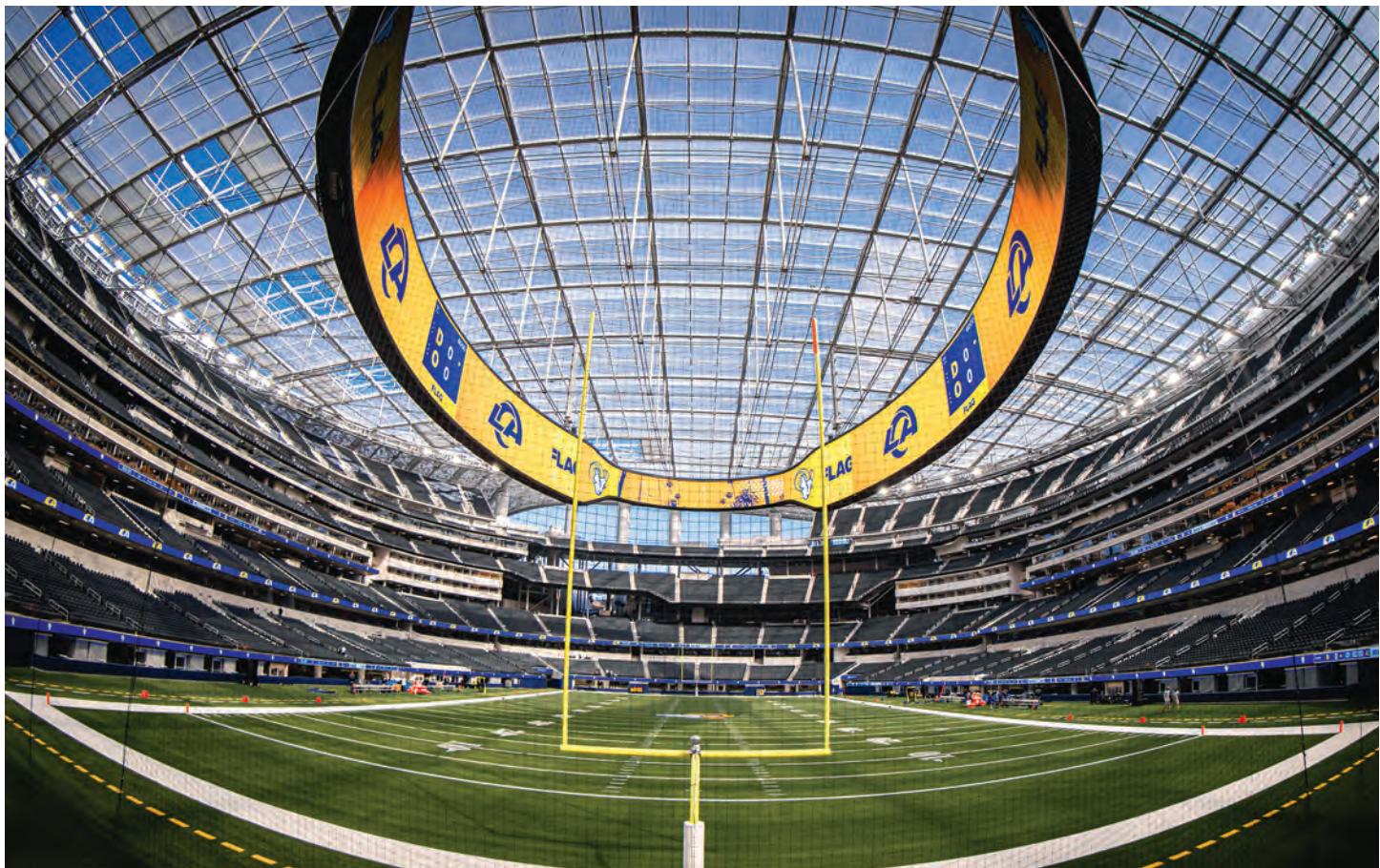


The image shows the exterior of Allegiant Stadium in Las Vegas, Nevada. The stadium has a distinctive curved, faceted design with a dark, reflective surface. The words "allegiant stadium" are prominently displayed in white and blue letters along the side of the building. A small red sunburst logo is positioned above the text. The sky is dark, suggesting it is nighttime. In the background, other city lights and buildings are visible, though slightly out of focus.

allegiant stadium

Photo by Matt Aguirre courtesy of the Las Vegas Raiders

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FANS IN THE LOWER BOWL WILL BE ABLE TO SEE VIDEO ON THE INSIDE OF THE OVAL BOARD.

DAS is capable of supporting all the low- and mid-band spectrum currently planned for use. According to Hedinsson, there will also be millimeter-wave 5G services in the stadium, from a carrier to be named later. The stadium networks are supported by 50 Gbps backbone links.

Bringing data center strategies to the stadium

While hyper-convergence of server use is common in the data center space, that has traditionally not been the case in sports and entertainment venue operations. But the eventual compute network built for SoFi Stadium's operations even surprised AmpThink's Anderson, whose company originally estimated a compute environment with perhaps 20 to 30 virtual machines.

As it stands now, Anderson said the compute environment has almost 100 VMs, which host applications for all the network operations as well as varied building management needs like power, light, HVAC, security, and even specialized systems like irrigation and seismic monitoring. Instead of a mix of servers running siloed applications on separate physical machines with different operating systems, the SoFi Stadium compute

environment is a unified platform and includes a seamless integration into Google Cloud, allowing it to be easily scaled to meet current and future needs.

A digital stadium with displays big and small

Any discussion of digital displays at SoFi Stadium has to start with the main videoboard, a one-of-a-kind design of a 120-foot long oval that circles the playing field, with dual-sided 4K screens, some 40 feet in height. (Please see our detailed profile of the main videoboard in our recent Venue Display Report.)

The digital display footprint goes far beyond the main screen, with some 2,600 other smaller boards deployed throughout the venue and in Hollywood Park. According to Hedinsson, the ability of the Cisco Vision display management system is a key part of the "digital stadium" design, especially when you consider that the venue has two main tenants, each with their own branding and look and feel.

"Being digital means we can switch over the branding [by changing displays] instead of physically having to move signs," said Hedinsson. "That's why we have Cisco Vision. We have digital 'playbooks' for the different scenarios, and we can just push them out as needed." [-STR-](#)

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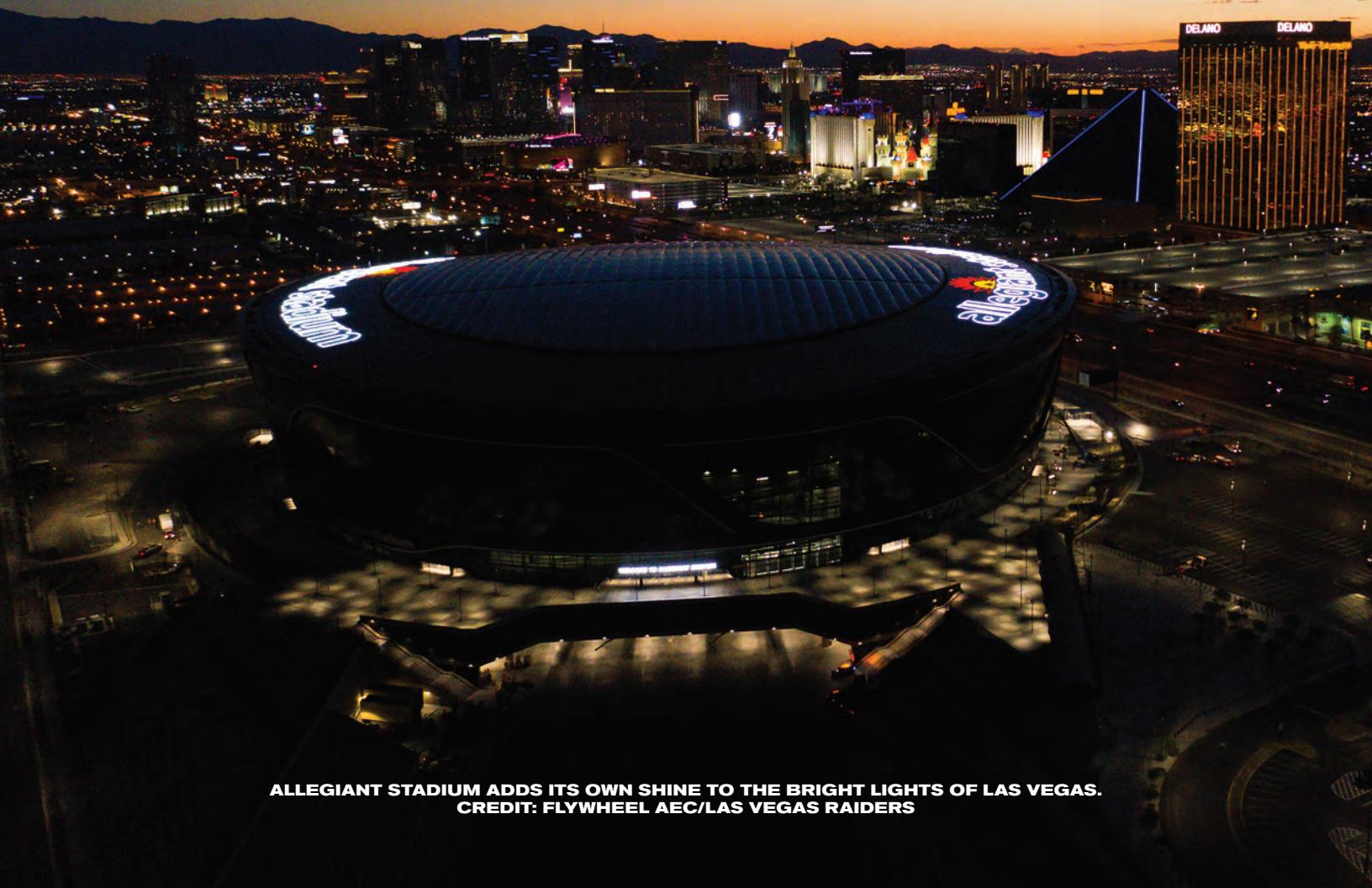
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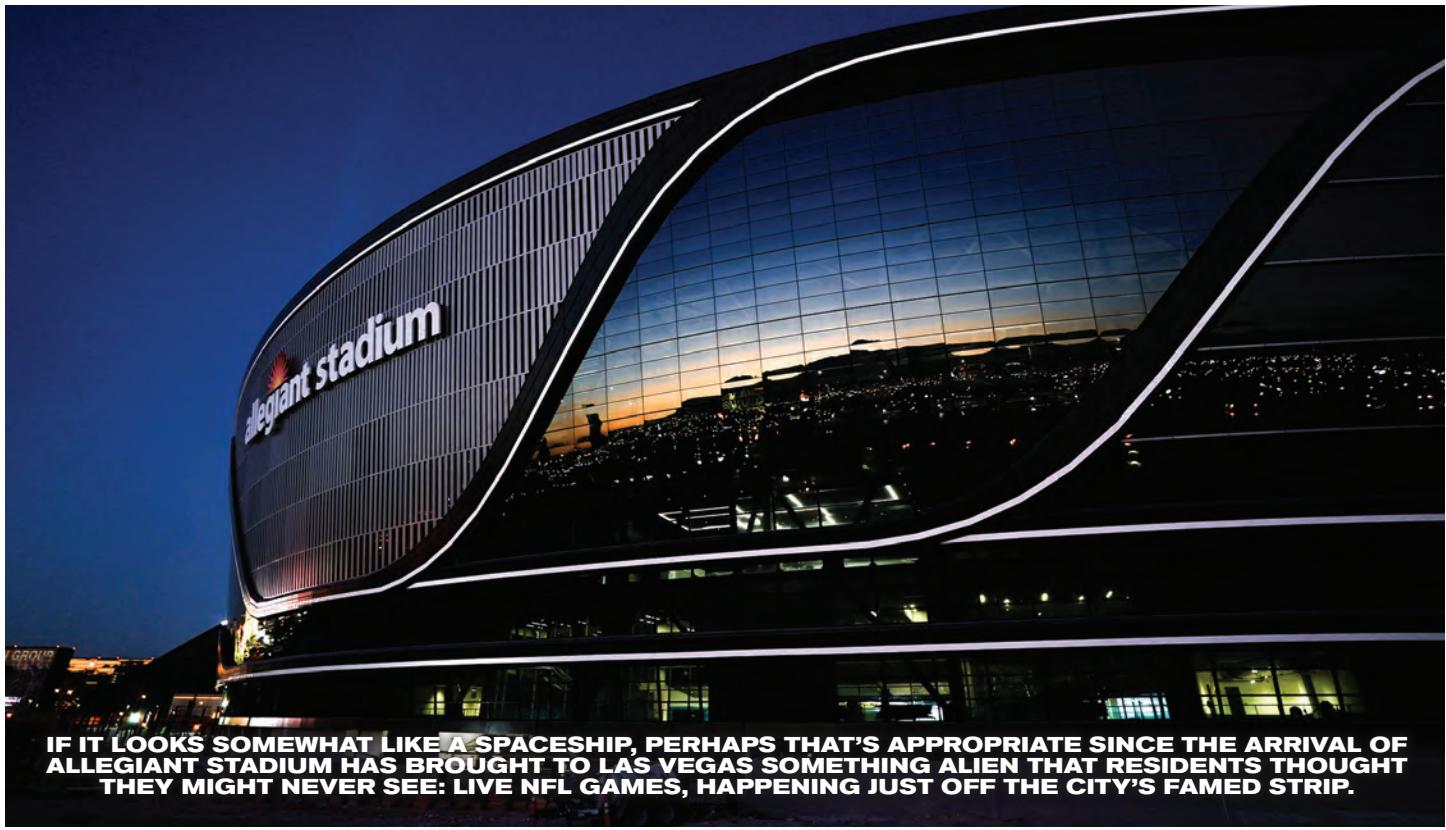
INNOVATION AND EXPERIENCE
LEAD THE TECHNOLOGY
DEPLOYMENT AT RAIDERS'

ALLEGIANT STADIUM

BY PAUL KAPUSTKA



ALLEGIANT STADIUM ADDS ITS OWN SHINE TO THE BRIGHT LIGHTS OF LAS VEGAS.
CREDIT: FLYWHEEL AEC/LAS VEGAS RAIDERS



IF IT LOOKS SOMEWHAT LIKE A SPACESHIP, PERHAPS THAT'S APPROPRIATE SINCE THE ARRIVAL OF ALLEGIANT STADIUM HAS BROUGHT TO LAS VEGAS SOMETHING ALIEN THAT RESIDENTS THOUGHT THEY MIGHT NEVER SEE: LIVE NFL GAMES, HAPPENING JUST OFF THE CITY'S FAMED STRIP.

As befits its futuristic appearance, the new home of the newly named Las Vegas Raiders is also fitted with the latest in fan-facing technologies, deployments that will have to wait a bit before their potential can be realized.

Though the \$1.9-billion, 65,000-seat stadium “officially” opened on Sept. 21 with a 34-24 Raiders victory over the New Orleans Saints, a decision made by the team earlier in the year meant that no fans were on hand to witness the occasion. But when fans are allowed to enter the building, they will be treated to what should be among the best game-day technical experiences anywhere, as a combination of innovation and expertise has permeated the venue’s deployments of wireless and video technologies.

With a Wi-Fi 6 network using equipment from Cisco, and an extensive cellular distributed antenna system (DAS) deployment by DAS Group Professionals using gear from JMA Wireless and MatSing, integrated fiber, copper and cable infrastructure from CommScope, backbone services from Cox Business/Hospitality Network, digital displays from Samsung, and design and converged network planning directed by AmpThink, the Raiders have used an all-star team of partners to reach the organization’s desire to provide what Raiders’ vice president of IT Matt Pasco calls “a top-notch fan experience.”

Finally getting to build a stadium network

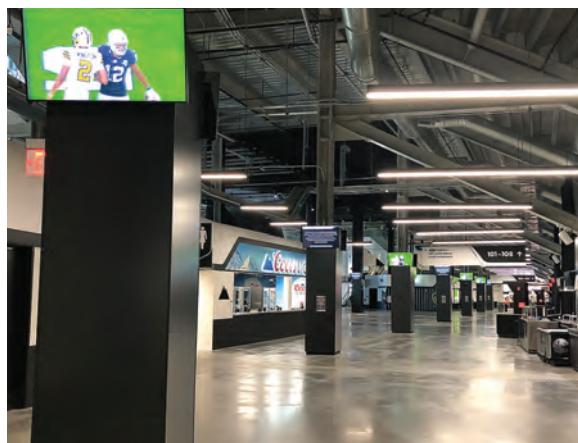
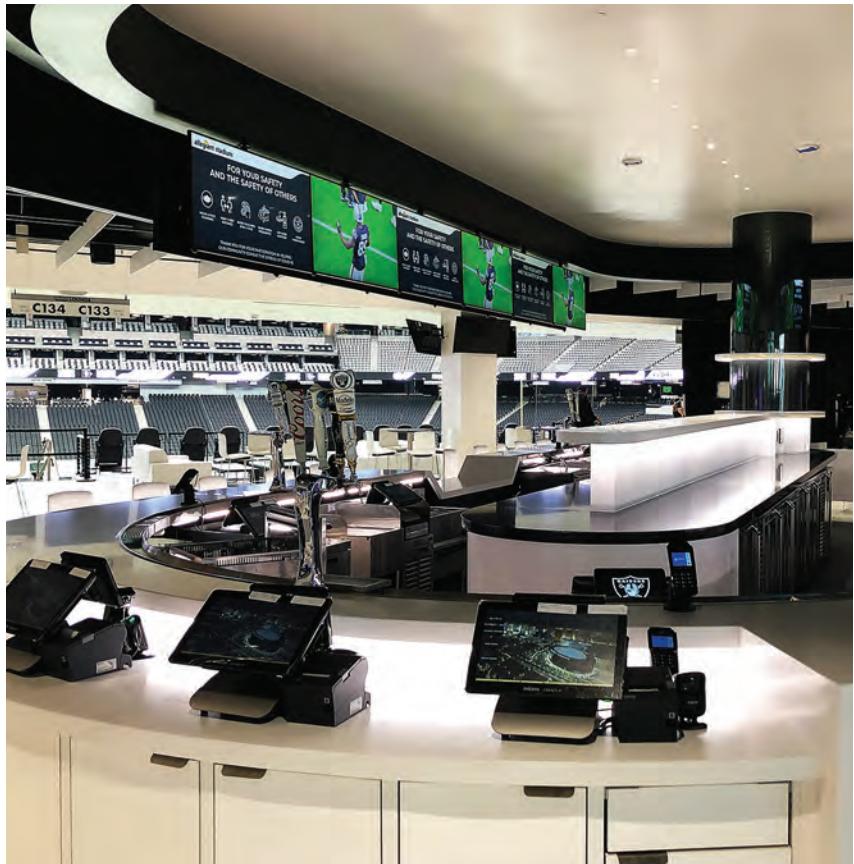
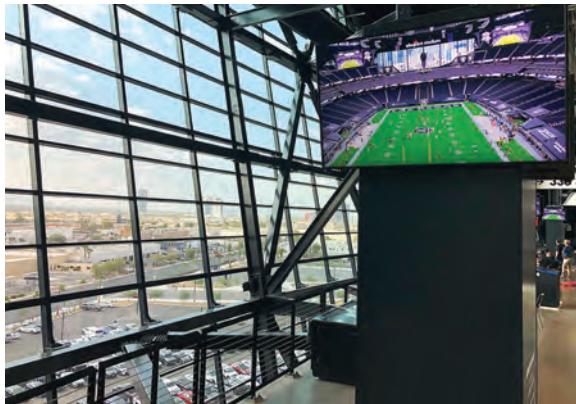
For Pasco, who is in his 19th year with the Silver and Black, the entity that became Allegiant Stadium was the realization of something he’d never had: A stadium network to call his own.

From 1995 until the end of last season, the then-Oakland Raiders played home games in the Oakland Alameda County Coliseum, where they were tenants and shared the building with MLB’s Oakland Athletics.

According to Pasco, since the Raiders didn’t have the ability to direct capital improvements, “we never got to build a sufficient DAS, and we never got to have sufficient Wi-Fi for all our fans.”

Fast-forward to the plans that eventually took shape with the move of the team to Las Vegas, and for a change Pasco was able to start thinking about what that meant from a technology perspective. With his long tenure and relationships around the league, Pasco said he embarked on a several years-long “stadiums tour” of accompanying the team for road games, looking at what other teams had done at their venues.

SUNSET REFLECTED IN ALLEGIANT STADIUM’S OUTSIDE WALL. CREDIT: MATT AGUIRRE/LAS VEGAS RAIDERS



"I kept a big notebook on what I liked, and what didn't seem to work," Pasco said. "I sat down with a lot of my counterparts and talked about what worked well, and what they had to spend time with. So I got a really good sense of what was possible."

Wi-Fi 6 arrives just in time

One fortunate event for Allegiant Stadium's wireless deployment was the 2019 arrival of equipment that supported the new Wi-Fi 6 standard, also known as 802.11ax. With its ability to support more connections, higher bandwidth and better power consumption for devices, Wi-Fi 6 is a great technology to start off with, Pasco said.

"We were very fortunate that Wi-Fi 6 was released just in time [to be deployed at Allegiant Stadium]," Pasco said. "The strength of 802.11ax will pay off in a highly dense stadium with big crowds."

The Raiders' choice of Cisco as a Wi-Fi provider wasn't a complete given, even though Pasco said that the team has long been "a Cisco shop" for not just Wi-Fi but for core networking, IPTV and phones.

VIDEO DISPLAYS LIGHT UP THE ALLEGIANT STADIUM CONCOURSES AND CLUB AREAS. CREDIT THESE PHOTOS: DAN GRIMSLY, AMPTHINK

"We did look at Extreme [for the new build] but Cisco just has so many pieces of the stack," Pasco said. "Things like inconsistencies between switch maker A and IPTV vendor B are a little less likely to happen. And they've done good things in so many buildings."

Pasco also praised the Wi-Fi network design and deployment skills of technology integrator AmpThink, which used an under-seat deployment design for Wi-Fi APs in the main seating bowl. Overall, there are approximately 1,700 APs total throughout the venue.

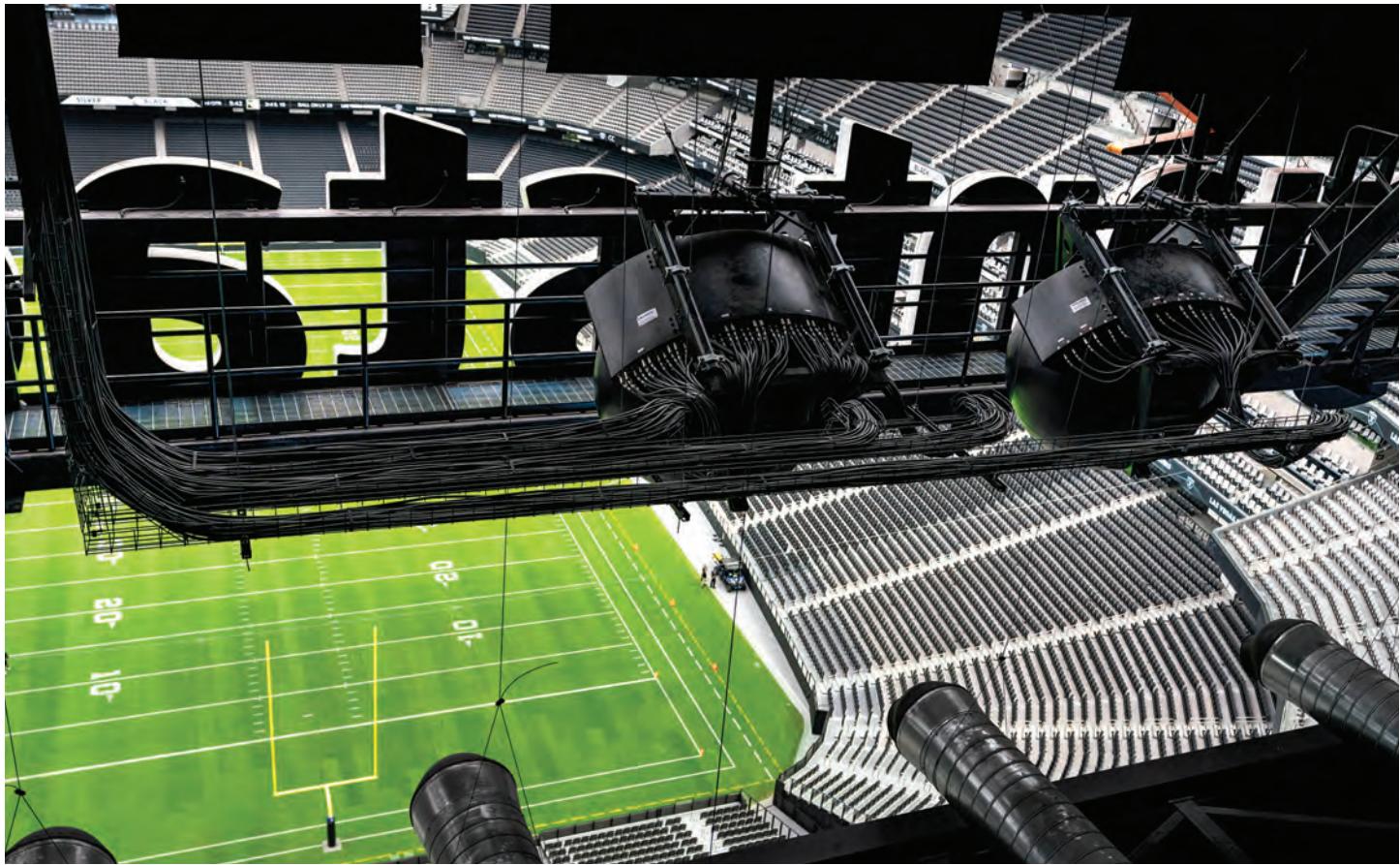
"I am thrilled with the work AmpThink has done," said Pasco, who admitted that as a network engineer, he had "never done" a full stadium design before.

"They [AmpThink] have built networks at more than 70 venues, so they came highly recommended," Pasco said. "And meeting their leadership early on sold me pretty quickly."

Part of what AmpThink brought to the stadium was a converged network design, where every connected device is part of the same network.

Innovation abounds in the DAS

If the Wi-Fi world is already moving forward with general availability of Wi-Fi 6 gear, the cellular side of the equation is in a much different place as carriers con-



THE WELL-HIDDEN MATSING LENS ANTENNAS COVER THE SEATS BELOW WITH CELLULAR SIGNALS.
CREDIT: MATT AGUIRRE/LAS VEGAS RAIDERS

template how to best move forward with their latest standard, 5G.

For venues currently adding or upgrading a DAS, the 5G question looms large. One of the hardest things about planning for 5G is that the main U.S. cellular carriers will all have different spectrum bands in use, making it hard to deploy a single “neutral host” DAS to support all the providers. Currently, all previous 5G deployments in stadiums have been single-carrier builds – but that won’t be the case in Allegiant Stadium, thanks to some new gear from JMA.

Steve Dutto, president of DGP – which used JMA gear at many of its other stadium DAS installations, including the San Francisco 49ers’ Levi’s Stadium and most recently at the Texas Rangers’ new home, Globe Life Field – said the DAS deployed at Allegiant Stadium “is like no other” NFL-venue cellular network.

“By selecting JMA DAS equipment we were able to deploy a [5G standard] NR radio capable system from day one,” Dutto said. “This means that all carriers can deploy 5G low- and mid-band technology without any additional cost or changes to the DAS system.”

According to Dutto and JMA, the JMA TEKO DAS

antennas cover all major licensed spectrum used, from 600MHz to 2500 MHz. and will provide ubiquitous coverage over the entire stadium.

“Carriers will be able to deploy their 4G technologies along with their low- and mid-band 5G technology over all of the stadium coverage area,” Dutto said. “No upgrades will be required. All carriers will need to do is provide their base radios in the headend.”

According to Todd Landry, corporate vice president, product and market strategy at JMA, the TEKO gear used at Allegiant Stadium “employs an industry unique nine-band split architecture, placing lower frequency bands in different radios than higher frequency bands.” This approach, Landry said, lets the stadium “optimize the density of higher band cells versus lower bands” while also reducing the total number of radios needed for low bands by half.

Landry said the JMA gear also has integrated support for the public safety FirstNet spectrum band, and is software programmable, allowing venue staff to “turn on” capabilities per carrier as needed, eliminating on-site visits to install additional radios or radio modules. According to DGP the DAS has 75 high-band zones and 44 low-band zones in the main seating bowl, with a total of 117 high-band and 86 low-band zones throughout the venue.



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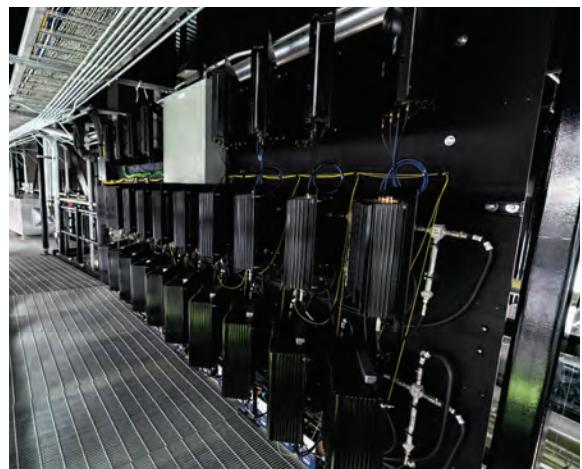
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CLOCKWISE FROM LEFT: A VIEW FROM THE SEATS (CREDIT: MICHAEL CLEMENS/LAS VEGAS RAIDERS); LAS VEGAS REFLECTED IN THE STADIUM WALLS (CREDIT: DAN GRIMSLY/AMPthink); JMA DAS GEAR IN THE RAFTERS (CREDIT: MATT AGUIRRE/LAS VEGAS RAIDERS).

Adding in the MatSing antennas from above

One twist in the DAS buildout was the addition of 30 MatSing lens antennas to the cellular mix, a technology solution to potential coverage issues in some hard-to-reach areas of the seating bowl. According to Pasco the Raiders were trying to solve for a typical DAS issue – namely, how to best cover the premium seats closest to the field, which are the hardest to reach with a traditional top-down DAS antenna deployment.

"We looked at a hybrid approach, to use under-seat [DAS] antennas for the first 15 or 20 rows, but the cost was astronomical," Pasco said. "We also heard that [an underseat deployment] may not have performed as well as we wanted."

The MatSing antennas, which are ball-shaped and support greater distance between antenna and end-device, were already designed for use in the Allegiant Stadium "Peristyle" gathering area, where there is a large open space where fans are expected to gather – with a large top-down distance between the area and the structures where antennas are mounted.

"I had heard about the full MatSing deployment at Amalie [Arena] and wondered if we could do that," said Pasco. Fortunately for the Raiders, the architecture

of the stadium, with a high ring supporting the transparent roof, turned out to be a perfect place to mount MatSing antennas, which use line-of-sight transmission to precisely target broadcast areas. For Pasco, a move toward more MatSings was a triple-play win, since it removed the need for other antennas from walkways and overhangs, was less costly than an under-seat network, and should prove to have better performance, if network models are correct.

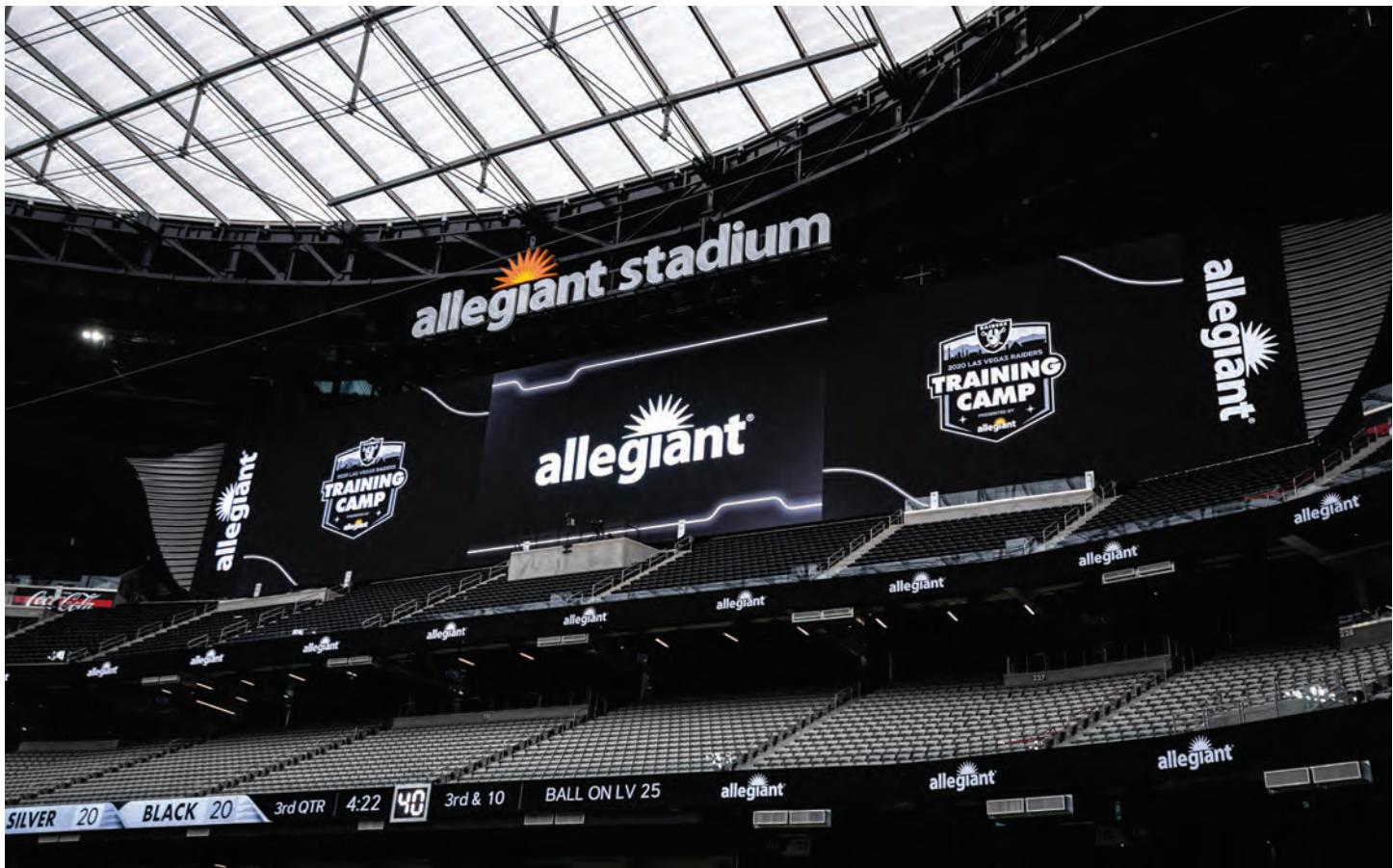
"It is the perfect marriage of cost reduction, better performance and aesthetics," said Pasco of the MatSing deployment. "We even painted them black, like little Black Holes," Pasco said. "It's one of the most innovative decisions we made."

"We are excited to be part of the Allegiant Stadium network," said MatSing CEO Bo Larsson. "It is a great venue to show the capability of MatSing Lens antennas."

Supporting wireless takes a lot of wires

Behind all the wireless antenna technology in Allegiant Stadium – as well as behind the IPTV, security cameras and other communications needs – sits some 227 miles of optical fiber and another 1.5 million feet of copper cable, provided by CommScope.

A good balance of the 100 Gbps fiber connections



THE SOUTH END ZONE VIDEOBOARD STRETCHES 250 FEET WIDE AND IS 49 FEET HIGH.
CREDIT: MICHAEL CLEMENS/LAS VEGAS RAIDERS

are used to support the stadium's DAS network, with the capacity built not just for current needs but for expected future demands as well. According to CommScope senior field applications engineer Greg Hinders the "spider web of single-mode fiber" includes multiple runs of 864-strand links, which break out in all directions to support all the networking needs.

For the cable connections to the Wi-Fi gear, CommScope's design went with Cat 6A cable, which has double the capabilities and a longer reach than standard Cat 6.

"The new APs really require it [Cat 6A] so we went standard with Cat 6A throughout the building," Hinders said.

And if the job wasn't tough enough – limited construction space at the stadium required that CommScope and its distribution partner Anixter had to stage its network in an offsite warehouse – CommScope also had to make sure that exposed wiring was colored silver and black to match the stadium design and the team's colors.

While single-mode fiber is usually colored yellow, Hinders is enough of a football fan to know that Pittsburgh Steelers colors wouldn't fly in the Raiders' home.

"It all had to be black and grey," said Hinders. "Black and yellow isn't good for the Raiders."

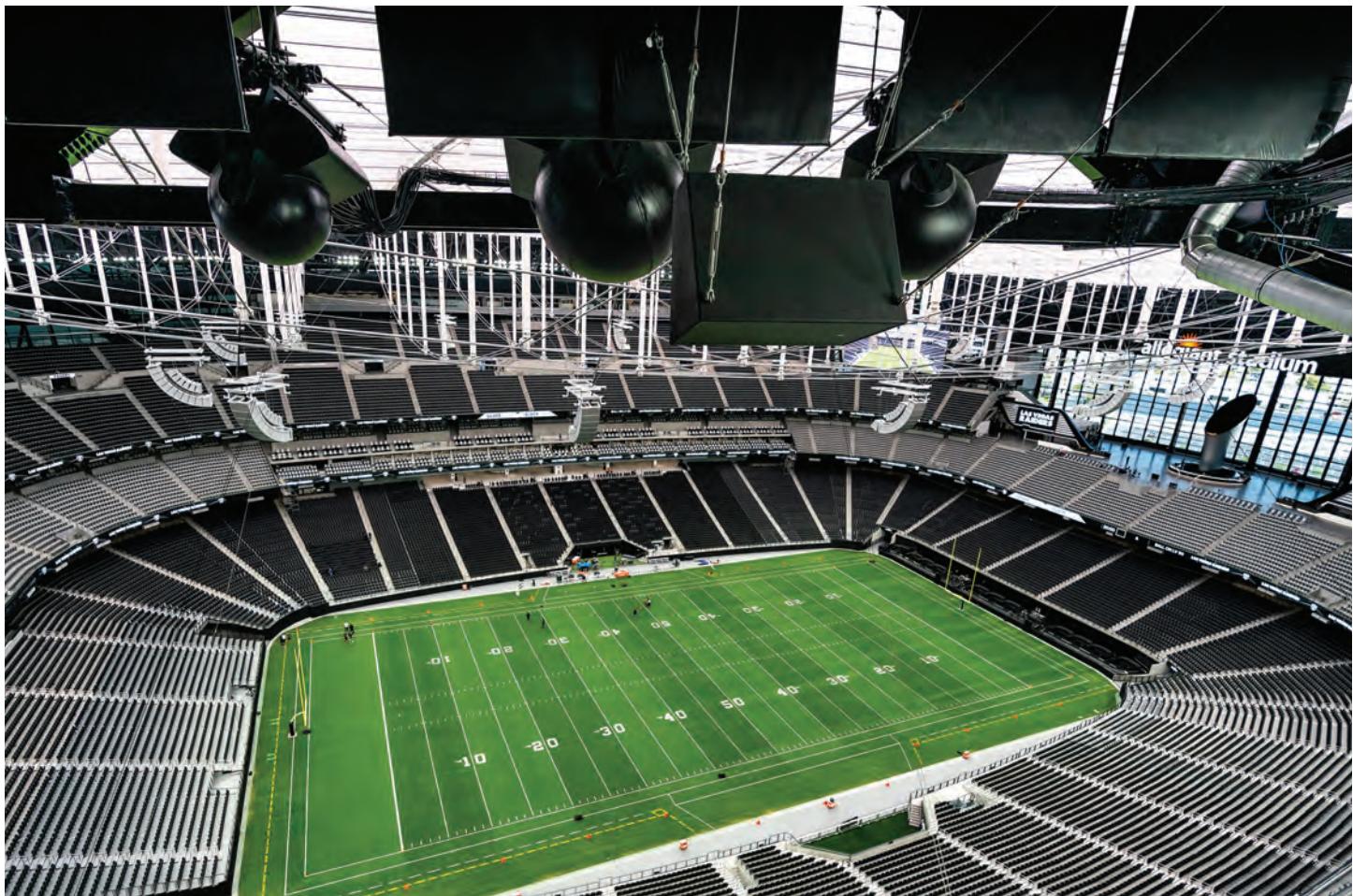
The MatSing antennas also posed a challenge for CommScope, since each MatSing antenna requires 48 individual connections for all the radios in each device.

"It was [another] logistical challenge," said Hinders. "But it was great to see [the entire network] all come to fruition. It's nice to know we had a part in putting it all together."

Providing enough backbone bandwidth

To ensure that Allegiant Stadium had enough backbone bandwidth to support all its communications needs, the Raiders turned to Cox Business/Hospitality Network, a partner with considerable telecom assets in the Las Vegas area.

Jady West, vice president of hospitality for Cox, noted that not only does Cox have experience in providing data services to high-demand venues (including State Farm Stadium in Glendale, Ariz., which routinely hosts big college games and the Super Bowl), it also has a wealth of resources in and around Las Vegas, providing services to the big casino hotels and the Las Vegas Convention Center.



MATsing LENS ANTENNAS POINT DOWN FROM THE ROOF'S OUTER RING. CREDIT: MATT AGUIRRE/LAS VEGAS RAIDERS

With a 100 Gbps regional network, West said Cox is able to bring “quite a bit of power and flexibility” to the equation. Having supplied services to big events like CES at the LVCC, West said, “takes a specialized skill, and that’s what my team does. This is what we do.”

Specifically for the Raiders, Cox built two 40-Gbps redundant pipes just to serve the needs of Allegiant Stadium. Additionally, Cox built a 10 Gbps metro Ethernet link between the stadium and the team’s headquarters and practice facility in nearby Henderson, Nev., a connection that Pasco said would be essential for stadium operations as well as the on-field football business.

“Both the video production staff and the football staff can now push information back and forth like we’re in the same building,” said Pasco, who gave high praise to Cox’s work. From a production side, crews at headquarters can create content for videoboards and displays, and have it at the stadium instantaneously; similarly, video from the stadium’s field of play or from practices can be shared back and forth as needed, in a private and real-time fashion.

West said Cox, which also provides game-day network support and a “NOC as a service” solution,

knows that the data demands of the big-time events that will likely be held at Allegiant Stadium will only keep increasing, and it built its systems to support that growth.

“The most demanding events are things like CES, and NFL games,” West said. “This network is built for the future, to hold up for all those events.”

Videoboards to fit the design

Last but certainly not least in the technology arsenal at Allegiant Stadium are the Samsung videoboards. Above the south end zone, the largest board measures approximately 250 feet long by 49 feet high, according to Pasco. Two identical sized boards of 49 feet by 122 feet are in the corners of the north end zone. Including ribbon boards, Pasco said there is a total of 40,000 square feet of LED lights inside the seating bowl.

On the stadium’s exterior there is another large videoboard, a 275-foot mesh LED screen that fits in perfectly with the bright lights of the city’s famed Strip. Inside, the venue will also have approximately 2,400 TV screens for information and concessions, with all the systems controlled by the Cisco Vision display management system. —STR—

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USE CASE	CHALLENGE	COMPONENTS	CONNECTIVITY SOLUTION
Social distancing	+	Cameras; sensors	Wi-Fi 6 • Wired Internet • Private LTE
Security measurement and monitoring	Monitoring	Cameras; sensors	Wi-Fi 6 • Wired Internet • Private LTE
Personal identification checkpoints (e.g. ticketing)	Health • Monitoring • Communication	Touchless, self-service facial/biometrics recognition devices and kiosks	Wi-Fi 6 • Wired Internet • Private LTE
Concessions and point of sale	Health • Monitoring • Communication	Touchless, self-service payment; direct-to-consumer delivery and pickup; dispersed concession areas and mobile kiosks	Wi-Fi 6 • Wired Internet • 4G or 5G DAS • Private LTE
Guest communications	Monitoring • Communication	Digital signage; Wi-Fi connection portal; push notifications	Wi-Fi 6 • Wired Internet • 4G or 5G DAS
Staff and first responder communication	Monitoring • Communication	Push-to-talk devices	4G or 5G DAS • Private LTE
Cleaning and maintenance tracking	Health • Monitoring	Robotics; cameras; sensors	Wi-Fi 6 • Wired Internet • Private LTE
Health check screening	Health • Monitoring	Infrared scanners; sensors	Wi-Fi 6

= Health

= Monitoring

= Communication

= Wi-Fi

= Wired Internet

= 4G or 5G DAS

= Private LTE

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Soldier Field



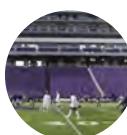
Austin FC Stadium



State Farm Arena



Vivint Smart Home Arena



Kansas State University



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SPECIAL COMMENTARY

OPPORTUNITIES TO TRANSFORM VENUES UNDER THE 'COVER OF COVID'

BY BILL ANDERSON
President, AmpThink

The Covid-19 pandemic, which has ground many venue operations to a halt, provides the opportunity... “under the cover of the new normal” ... to think about how we can transform a system that has operated with evolutionary change since the time that Romans staged gladiator fights.

While the venues of today are bigger, more comfortable, and have more amenities, the flow of people and method of service remains unchanged. Fans enter the building perpendicular to the playing surface, they circulate on a concourse that is parallel to the playing surface, and they reach their seats arranged parallel to the playing surface by walking down an inclined aisle that is perpendicular to the playing surface. Once seated, fans are separated by inches in seats that haven’t grown much in spite of the generally larger humans that occupy them.

Efforts to provide an orderly experience are complicated by the fans that the venues serve. During an engaging event, fans remain seated in the bowl clinging to the excitement of the developing play. Concourse traffic dwindle; concessionaires sit idle; and bathrooms are empty. Breaks in the action send fans scrambling to the concourse, over-running the venue amenities. But that was then. Now, venue operations must change, at least in the near term.



To open venues to fans while the pandemic is still active, keeping venue attendees, workers and performers safe will require using technology and procedures to effect social distancing, reducing the risk of transmitting an infection. For many reasons, “the way we always did things” will not work anymore. Only live events will tell us how many fans will attend live events encumbered by hurdles imposed by some of the existing venue-opening plans. Examples include timed entry and exit and seating “pods” to enforce fan separation.

But what if some of the ideas that have surfaced for Covid-19 compliance are simply a better way of doing things? What if, in addition to providing social distancing and less human interaction, Covid-induced changes produce a better fan experience, generate more revenue, and/or improve operational data for venue owners and operators? If technologies and practices that have been resisted in the past are a better fit, even in the absence of the pandemic, why not make those changes now when fans, owners, and operators are more receptive, or forced to try something new?

In our research conversations this year with Stadium Tech Report we heard from several venue-business insiders who all agreed that many facets of venue opera-

"NEVER LET A GOOD CRISIS GO TO WASTE"

WINSTON CHURCHILL

tions – especially activities like ticketing and concessions – have long been governed by the sentiment of “if it ain’t broke, don’t fix it.” As long as concessions were still a profitable business – even with the inevitable losses and lack of customer data that come with people paying for things with cash – many stadiums and teams were loath to even think about jeopardizing the income from the ever-dwindling percentages of fans who didn’t want to use credit cards or other digital payment methods.

Here’s a quick list of things we envision many venues deploying “under the cover of Covid” that could become part of “the new normal.”

Digital ticketing or ticketless entry

As detailed in the profile of new venue entry methods found in this issue, some teams and venues have already implemented technology that lets fans enter the stadium without showing any ticket at all, using near-field communications or other digital technologies to confirm (via mobile device) that the entering fan has a valid ticket. For Covid-19 compliance, the ability to reduce the biggest lines any venue has – for entry – makes this idea almost a necessary one if you want to eliminate long queues of people who are all trying to get inside before the game starts.

If this idea sounds futuristic to you, remember that in just a few years airlines migrated plane tickets from paper to digital with great success. That change has improved the air travel experience. While digital ticketing has become the norm in many sports venues, it still faces challenges (like sunlight affecting screen readers) that make ticketless entry a logical improvement.

Better stadium apps or web apps for in-stadium transactions

The evolution of the “stadium app” has shifted slowly over the past few years from something envisioned as mainly a content platform (watch replays from many different angles!) to more of a transaction platform (digital ticketing, experience upgrades, and mobile payments). This evolution was primarily driven by fans’ reluctance to embrace “official” team apps because there was not enough value to convince fans to download the app and interact via a platform that was different for each venue. According to data we’ve seen from numerous events where wireless networking was available, most fans in venues use their devices mainly to interact with popular social-media platforms while official team or venue app activity are lightly used.

Under pandemic conditions digital ticketing is a necessity and contact-free concessions are a goal. We see

teams and venues doubling down on their stadium app platforms with an emphasis on transactions over content. In another profile in this issue, we also talk about some of the leading venue-application providers offering packages that include not just an app and app services, but also an option for fans to simply scan a QR code that produces a web page with app-like functionality – for example to order and pay for a beer and a hot dog – without forcing them to download and negotiate a traditional app.

More self-service and new retail options

The pandemic will force teams to rethink their concessions in a big way. Think fewer stands with counter service and more grab-and-go or order-and-pick-up options. Will these types of operations end up being more popular than those of the past and become the new normal? At the Denver Broncos’ Empower Field at Mile High stadium last year, some self-serve beverage concession stands with checkout systems that used cameras to automatically tally up whatever cans fans had grabbed proved to be immensely popular, seemingly both quicker and “more fun” to some of the fans interviewed by Stadium Tech Report.

A recent trend in concessions has been for venues to offer a wide range of food and beverage options such as special sandwiches or craft beer stands. Perhaps the current need for simplicity will diminish this interest in special foods or drinks. It will also be interesting to see the statistics from a wider implementation of ideas like kiosk-ordering or mobile ordering and payment with express (or timed) order pickup, ideas that had limited trials in the past. Could the speeding up concessions make the old walkup windows a thing of the past?

The same thoughts can be applied to team merchandise stores, which typically consume valuable in-venue real estate. Covid-19 has forced huge changes to shopping outside of venues; more online ordering and less in-store browsing. Will the team-store experience change in venues? Instead of a big area with T-shirts on racks and hats on shelves, venues are experimenting with “virtual shopping” kiosks or displays, where fans can see what a T-shirt or hat might look like and then order it on their phone for delivery to their home, a suite, or even to a code-secured nearby locker.

As the great Winston Churchill said during World War II, “Never let a good crisis go to waste.” Now might be the time to overhaul venue operations for greater efficiency and a better fan experience. **-STR-**



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COVID-19 AND THE RETURN TO VENUES:

PANDEMIC PLANNING PUTS FOCUS ON VENUE ENTRY, CONCESSIONS

BY PAUL KAPUSTKA

As some venues take baby steps forward in allowing limited fan attendance at events, for most venues the ongoing effects of the Covid-19 pandemic are forcing owners and operators to take a longer look at the technologies and procedures that can help provide safer situations for large crowds inside public spaces for the foreseeable future.

And if keeping fans farther apart from each other is one of the simplest and best methods of enabling safer gatherings, it makes sense that many venues and technology and service providers are currently concentrating on venue entry and concession operations, with an eye toward using technology and procedures to cut down or eliminate the long lines that have long been a part of a game-day experience.

Before the pandemic changed events forever, many venues and fans were stuck in the systems and practices that had been the same for decades. While some forward-looking venues were experimenting with innovative digital technologies for entry and concessions operations, most were still caught somewhere in between the past and the future, with a mix of digital ticketing, paper tickets, cash transactions for parking and concessions, and bottleneck walkway traffic situations often caused by the random geography of stadiums, some built as long as 100 years ago. Fan behavior often contributed to these crowded situations, with the last-minute crush of entries from people who stayed at tailgate gatherings until just before kickoff a somewhat unwanted tradition at many stadiums across the country. But now, all that has changed.

The forced changes of Covid

In a wide series of interviews with venue owners and operators, team representatives, and technology manufacturers and service providers, we've seen general agreement with the idea that many of the "old ways of doing things" at events will no longer be possible as the pandemic continues, and most likely even after it subsides from its current critical state. Going forward, events in large public venues will need to adopt technologies and procedures aimed at not just keeping fans safe, but also to make them feel safe, and confident that the stadium operation is doing all it can in those regards.

The two areas of operations we are focusing on with this story are the two that easily account for the highest potential of long lines: Stadium entry, and concessions. While historically these two operations have been

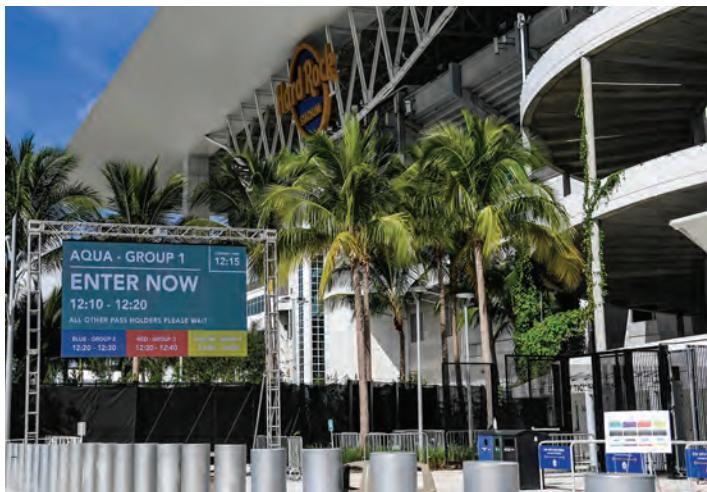
fan-experience pain points in almost every venue, the good news is that mature technologies already exist to help solve for problems in both areas – and some best practices have already emerged from forward-looking venues and providers who embraced these ideas prior to the pandemic. What follows is a look at some of the technologies and services available for entry and concessions operations, with insights from early adopters and from the companies involved in the deployments.

Digital tickets and faster scanning

Just like when airline ticketing went from printed paper to mostly mobile-device systems, so has the stadium and event entry business been changing. Prior to the pandemic, most venues of any size had at least some kind of digital ticketing system in place, with many moving to digital-only processes over the past few years. While there were still some holdouts, most of the people we interviewed agreed that the desire to make activities like parking lot and stadium entry faster and contact-free is now driving venues to adopt digital ticketing at a rapid pace.

"The tone has completely changed," said Karri Zaremba, who until recently was chief operating officer at stadium app developer Venuetize (Zaremba is now a senior vice president with Major League Baseball, for ballpark experience and ticketing). According to Zaremba, this past summer teams and venues were showing "an eagerness and hunger" for digital ticketing systems that Venuetize hadn't seen before.

"Everyone is scrambling to figure out a plan to reform venues and remove humans from the [interaction] equation," Zaremba said.



SIGNAGE OUTSIDE (LEFT) AND INSIDE HARD ROCK STADIUM HELPS KEEP DOLPHINS FANS SOCIALLY DISTANCED WHILE ATTENDING GAMES. CREDIT: MIAMI DOLPHINS

George Baker, founder and CEO of parking technology provider ParkHub, agreed that the need to reduce hand-to-hand or face-to-face transactions is driving more technology in venue entry, beginning at the gate to the parking lot. ParkHub, which recently signed a deal with venue management firm Spectra to provide parking-lot technology to Spectra-managed properties, also raised an additional \$15 million in venture funding this spring to help accelerate its business.

According to Baker, while fans may have long resisted any changes to the way things have always been done, he is confident that the safety of digital transactions, plus the expanding features available via digital platforms – such as premium lot differentiation and the ability to reserve spots ahead of time – will accelerate the use of technology in parking lot entry as well as many other game-day transactions. And as more fans use digital payment methods for parking, teams and venues can also better manage their inventory, with real-time updates.

"For venues, it's no longer a nicety, it's a necessity," said Baker of digital transactions.

One venue that has made a name for itself by its use of innovative fan-facing technology is the Los Angeles Football Club's Banc of California Stadium, which opened in 2018. Christian Lau, chief technology officer for Major League Soccer's LAFC, said contact-free entry and transactions have always been a part of the venue's plan.

In fact, before the pandemic started the club was working with security technology provider Patriot One to help develop a new entry-gate system that would include innovations including eliminating the need for the single-person metal detectors as well as future support

for entry via facial recognition technology. LAFC is using entry gate technology from Axess, a Salzburg, Austria-based provider.

"It is all part of redefining our great fan experience, and redefining the security stack," said Lau. "We want to let you walk into the stadium like you're walking into a Target store."

"Everyone is scrambling to figure out a plan to reform venues and remove humans from the interaction equation."

Other venues, including the University of Oklahoma, are already borrowing from the airline playbook, by putting in more self-scanning ticket kiosks. The NFL's Jacksonville Jaguars, one of a small number of pro football teams who are allowing fans to attend in limited numbers, said they have installed new metal detectors that allow fans to keep things like keys and cell phones in their pockets when entering. Kim Rometo, vice president and CIO for the Miami Dolphins, said that Miami's Hard Rock Stadium now has "walk-through, multi-zone metal detectors" that let fans keep items in their pockets to speed up entry.

Temperature scans are a costly addition

One technology that got a lot of attention this summer was thermal detection devices, usually cameras that could scan people to detect a high body temperature, one of the signs of a possible Covid-19 infection. While such cameras are already in use in some places like airports, we have yet to find a major U.S. sports venue that has committed to installing thermal cameras for fan entry. The reason why? A combination of high costs (each scanner device can cost \$10,000 or more) and unclear results, especially when used in large-scale operations like fans coming in to an event.



ATTENDANTS CAN SCAN PARKING PASSES, ELIMINATING THE NEED FOR CASH TRANSACTIONS. CREDIT: PARKHUB

While many sports teams are using thermal detection devices to help keep staff and players safe as they enter team buildings and the stadiums, the prospect of trying to extend those operations to thousands of fans is a problem that requires an extra level of operational procedures. Chip Swisher, director in the smart solutions practice at CenturyLink, said venues looking to install thermal detection systems need to consider placement (since the cameras do not work as well in bright sunlight) and other mitigating factors, like fans just getting hot from being in the sun at a tailgate party. Teams will also need to develop procedures on how to handle fans who do show a high temperature, either with cooling tents (where they can be re-tested after a short time period) or with further testing or ways to refuse entry.

At some venues temperature checks are being performed, by staff members with handheld devices, a process that may possibly introduce more safety issues than it solves by forcing the person-to-person proximity. For most venues, the temperature-check process is currently a “wait and see” item, as they monitor what other venues are doing and what, if any, requirements for temperature checks are made by local government or health officials.

Spacing and timed entry and departure

If television views of some of the first games with fans allowed in the stands are any proof, the idea of keeping fans spaced far apart in the stands seems to be working,

except at some college games where students apparently violated safety precautions by massing together once inside the venue, often without masks.

For most teams that are starting to allow fans into stadiums, the digital ticket and the team or stadium application is the primary vehicle for keeping fans at safe distances when they enter and stay at the venue.

“We stretched existing solutions to meeting the need [for distancing],” said the Dolphins’ Rometo. “Ticketmaster introduced the ability to define seating pods for social distance and space them six feet from one another. We [also] program the digital tickets to display the preferred gate for social distancing along with a specific entry time. All social distancing signage will be displayed on Cisco Vision throughout the concourses and we augmented eight LED boards at entrances to communicate entrance times.”

While some venues have floated the idea of having set departure times, Rometo said that at Hard Rock Stadium fans can leave at any time they choose. If they stay until the end, she said, ushers will try to dismiss rows in an order to keep social distancing – but added that the space available inside the venue should keep crowds from forming.

“Hard Rock Stadium can hold more than 65,000 so



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LEFT: FANS ORDER AND PAY VIA KIOSKS IN DENVER LAST SEASON; RIGHT: CHASE CENTER IN SAN FRANCISCO HAD STANDS WITH KIOSKS AND CARD-ONLY PAYMENT DURING LAST FALL'S SEASON. CREDIT: PAUL KAPUSTKA, STR

we fully expect dismissing 13,000 will still occur in a timely fashion," said Rometo of the team's expected early attendance allowance.

And while some teams are eliminating tailgating completely, others like the Kansas City Chiefs are implementing spacing protocols in the parking lots, with every other space blocked off so that fans can't park side by side.

Concessions: Lessons learned from retail, fast food

If there was one place in many stadiums that needed an overhaul even before the pandemic, it was concessions. According to Moon Javaid, chief strategy officer for the San Francisco 49ers, customer experience surveys have consistently shown concessions to be "the lowest-rated aspect" across all sports.

Anothy Perez, CEO of stadium app developer VenueNext, explained why that experience has been poor at so many venues for so long.

"Deviating from the normal is a risk," Perez said. "If you stick to the old wisdom and something goes wrong, it's not your fault."

Venues are realizing that if they didn't have contact-free concessions systems in place, they need to rapidly do so, "because it's the future."

But the advent of the Covid-19 pandemic, Perez said, "gives you cover to try something new. It's a paradigm shift."

With her Venuetize hat on, Zaremba said that many venues might not have moved forward faster with innovative concessions strategies in part to avoid alienating older customers.

"All that is now out the window," Zaremba said. New methods of contact-free or lower-contact transactions, she said, are "going to be demanded" by fans who have gotten used to such interactions in the daily life of the pandemic, where most restaurant meals are now primarily consumed by to-go pickup or via delivery, with payments made electronically or via phone by credit card.

According to our interviews, many venues are quickly moving to change as much of their concessions operations as they can to more contact-free or even contactless transactions, where fans don't have to talk face to face with concessions staff. Last year, the Denver Broncos had several new options along these lines at Empower Field at Mile High, including grab-and-go beverage stores that were basically rows of coolers where fans could take whatever canned or bottled beverages they wanted, and pay for them using an optical scanner (manufactured by Mashgin). Other options in Denver included kiosk ordering for a chicken stand and several grab-and-go formats where prepackaged food was available to fans to take and pay for, again at a Mashgin scanner.

Kevin Anderson, chief strategy officer for stadium point-of-sale systems developer Appetize, said venues are realizing that if they didn't have contact-free concessions systems in place, they need to rapidly do so, "because it's the future." Appetize, which powered the systems at the Broncos' stadium, is currently in the process of bringing more than 50 self-service kiosks to the Green Bay Pack-



LEFT: CHASE CENTER'S PICKUP SCREEN; RIGHT: AN EXPRESS PICKUP LINE AT FLORIDA'S BEN HILL GRIFFITH STADIUM LAST FALL. CREDIT: PAUL KAPUSTKA, STR



ers' Lambeau Field, which hopes to be able to host fans sometime later this season.

Though kiosks do involve the process of touching a screen, Anderson said most people have confidence that a finger touch is a low-risk possibility of virus transmittal.

"The highest likelihood of transmittal is person to person," Anderson said, voting for kiosks as a safer alternative. To help keep the process even safer, Anderson said Appetize's new screens have a "hospital grade" screen protector that resists contamination. The kiosks, he said, will also have hand sanitizer bottles attached for fans to use.

The Niners' Javaid said the team had already made a decision to bring in more kiosk stations for some of its regular concessions areas, because it not only reduces lines, but it also reduces the staffing requirements of a regular concession stand.

"Staffing is expensive, and for us [in Silicon Valley] it's hard to get people," said Javaid of the part-time work that maybe involves 10 events a year. For regular concession stands, Javaid said, the Niners would use four cashiers and four food expediters. But with a kiosk system, he said, one person can handle the same number of orders, allowing the team to repurpose the staff to other positions.

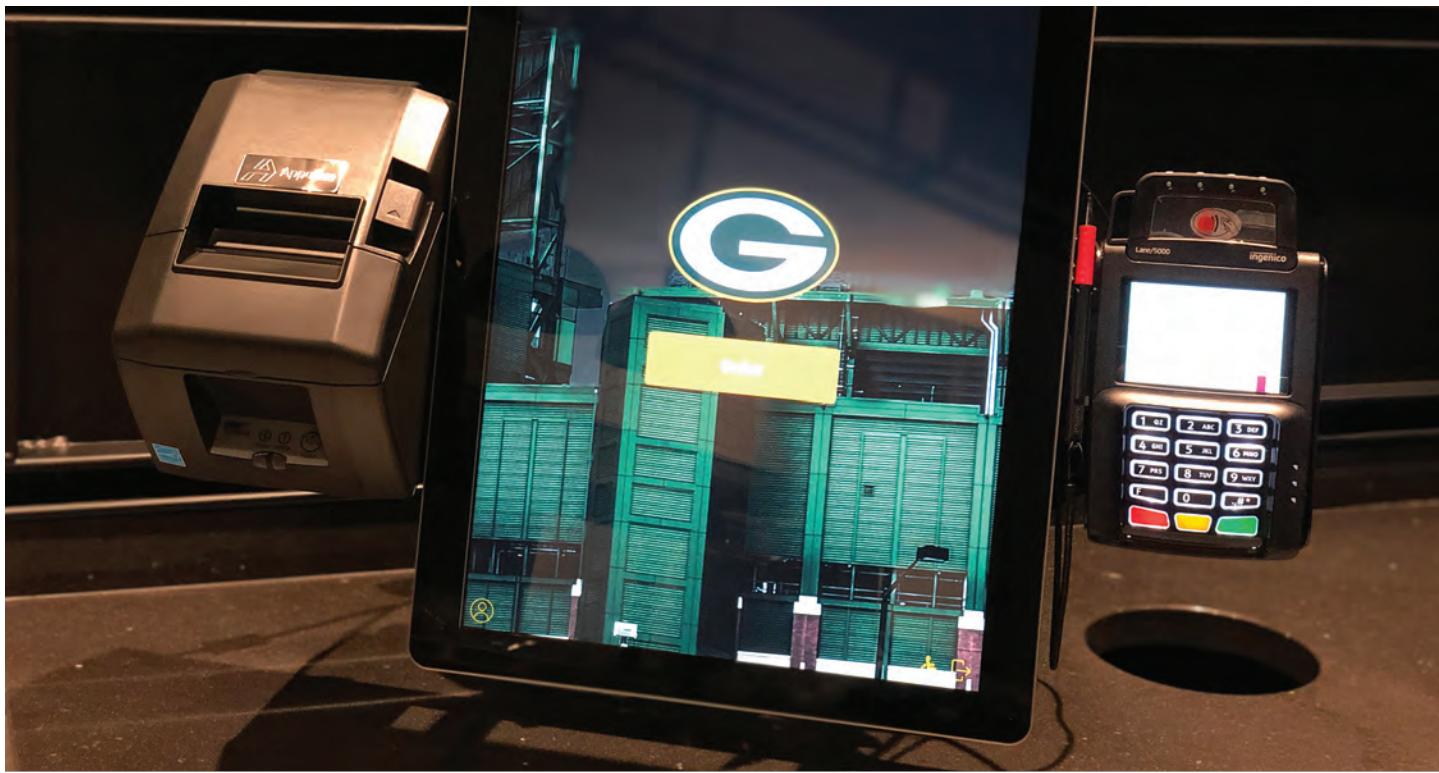
"And with kiosks, people can stand wherever [to wait for their orders]," Javaid noted. "You don't have to stand in line."

Team and stadium apps get a new life with concessions

Appetize, like other POS developers, also supports mobile ordering and payment for their concessions customers, another area where many venues are stepping up current order-by-phone operations or adding them if they didn't previously support them. At LAFC's Banc of California Stadium fans have been able to use several methods to order concessions digitally, including via the team's Venuetize-built app, or by using Apple Business Chat, or by simply scanning a QR code on a sign near a stand, which brings up a web page with menus, ordering and payment instructions, making such transactions available on the fly.

With kiosks, people can wait anywhere for their orders. They don't have to stand in line.

When VenueNext was born as the provider of the stadium app for the Niners' Levi's Stadium in 2014, the company was an all-or-nothing proposition for doing everything inside the app, including the venue's since-discontinued feature of having in-seat delivery available to every seat in the house. Perez, who took over the CEO spot in 2018, has shifted the company's strategy to embrace other mobile-ordering options like web-based QR-code menus, and added a POS back-end system to support more mobile-ordering options. VenueNext debuted its new mobile systems last season at the University of Florida's Ben Hill Griffin Stadium, aka "The Swamp."



ONE OF APPETIZE'S NEW KIOSK ORDERING SYSTEMS FOR THE GREEN BAY PACKERS' LAMBEAU FIELD.
CREDIT: APPETIZE

Venues going all-mobile or mostly mobile for concessions may allow teams and venues to rethink their concourse real estate and possibly innovate by adding space for fan engagement or sponsor activation, Perez said.

"What really gets interesting is how you can open up spaces" in the venue by streamlining concessions operations, Perez said. "The beauty of mobile is that you can completely decouple shopping, ordering, paying and fulfillment."

LAFC's Lau noted that there is still an operational component to the contact-free experience, namely designing systems that have necessary nuances, like scheduling pickup times so that fans aren't all in the same area at the same time.

"You don't want the pickup lines to back up," Lau said. "You need to eliminate lines, eliminate the friction of lines."

O ne more concessions trend that some stadiums (like Atlanta's Mercedes-Benz Stadium) had experimented with, having completely cashless transactions, will now likely be the norm going forward given the safety concerns associated with exchanging paper money.

"Venues were dipping their toes in the water before, on cashless, but now they're leapfrogging ahead," said Zaremba, whose former company Venuetize is exploring

options that include biometrics that would allow fans to "order with their face." At Seattle's CenturyLink Field, the venue has partnered with security provider Clear for a few concession stands that let fans pay for concessions with a fingerprint reader, after first signing up to the Clear system.

A mobile app that helps fans locate where lines are the shortest, is now using data to improve Covid safety and contact-free concessions.

If there is one other cutting-edge idea emerging, it's the Niners' plan to make concessions all-inclusive for season ticket holders, a plan that was developed before the pandemic as part of the team's overall overhaul of its concessions operations.

When the Niners have fans present to roll out their all-inclusive concessions operations – where all season-ticket holders will have a menu of the most popular food and non-alcoholic beverages available as part of their ticket prices – they will use technology to assist the deployment, including using the Cisco Vision display management system to provide menu and directional information via TV screens, and to also incorporate the camera-based fan movement technology system developed by WaitTime to gather information on how fans move about in the concourse and concession areas.



GRAB-AND-GO STANDS LIKE THIS BEVERAGE ONE IN DENVER LAST YEAR SHOULD BECOME MORE POPULAR IN MANY VENUES GOING FORWARD. CREDIT: PAUL KAPUSTKA, STR

As part of a plan developed before the pandemic, the Niners will roll out an all-inclusive concessions operation – where season-ticket holders will have a menu of the most popular food and non-alcoholic beverages available as part of their ticket prices – they will use technology to assist the deployment, providing menu and directional information via TV screens.

WaitTime, which originally developed a mobile app to help fans find out where concession and restroom lines were shortest – and then added a version teams could broadcast on digital displays – is now pivoting to add more granular data from its camera-based systems for Covid safety and contact-free concession deployments.

Zachary Klima, WaitTime CEO, said that teams are going to need better information on where fans are moving inside venues to build reliable, safe procedures for the new normal.

"Tape on the floor can only go so far," Klima said.

"It's better for teams to know where people are, and where they aren't."

The Niners' Javaid agreed with the data-driven approach.

"How are people queueing? I need to understand that," Javaid said. "We've never done this before, so I need data." **-STR-**

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Boingo Wireless (NASDAQ: WIFI) is a leading provider of cellular and Wi-Fi networks at stadiums and arenas, universities, airports, military bases, convention centers, multifamily communities and commercial properties. You'll find Boingo connecting people at sports and entertainment venues across the NFL, NBA, MLS, NCAA and more. These venues include Soldier Field, Vivint Smart Home Arena, State Farm 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 and meet the demands of the 5G era. 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 world's 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.

MATSING®

LENS TECHNOLOGY ENABLED

Holding several RF MetaLenz™ 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

Hospitality Network, an affiliate of Cox Business, is a premier provider of choice for Managed Wi-Fi, Location Based Services and In-Room Entertainment to convention centers, arenas, stadiums and hotels across the nation. Our custom tailored, technology solutions are created to meet the specific needs of each of our customers. HN has proven solutions that benefit our customers, their guests and visitors from coast to coast. Visit us at www.coxhn.com to learn more.



SPONSORS SHOWCASE

American Tower brings building and venue owners more than 15 years of experience deploying and monitoring in-building and outdoor wireless infrastructure solutions, including Distributed Antenna Systems (DAS), In-Building Small Cells, and Carrier Grade Wi-Fi. Today, we manage more than 400 networks, covering 390 million square feet, in offices, malls, campuses, stadiums, arenas, casinos, and other venues. Our multitenant networks support mobile coverage, high-speed internet, building automation, security, and the Internet of Things, while enabling a path to 5G coverage. As one of the largest Real Estate Investment Trusts (REIT) in the U.S., we have the financial strength and scale to support any in-building wireless communications needs.



Creating a great customer experience requires data, speed and security, and that requires a great network solution. Imagine your venue with a secure, high-performance, scalable network solution, designed for heavy data processing loads, enhanced application performance, and secure access to cloud or data center resources. Advanced network solutions help to create those memorable experiences. Beyond our advanced network, Comcast Business also offers voice and mobile options for a unified communications approach that helps improve communication and collaboration for a mobile workforce, HD entertainment options to help keep your customers informed and entertained, advanced Wi-Fi for customers and staff, and Managed Services for technology supported by a team of service professionals. Advanced network solutions help create memorable experiences, enhance customer satisfaction and boost employee productivity. Our connectivity can power the fan experience beyond the game.
Learn more at business.comcast.com/stadiums

ExteNet Systems, Inc. is a leading provider of converged communications infrastructure and services addressing outdoor and in-building wireless, fiber and other advanced connectivity needs of its customers. Our customers include mobile network operators (MNOs), real estate owners, property managers, wholesale carriers, enterprises, municipalities and rural carriers. ExteNet's outdoor networks are deployed in a variety of urban, suburban and rural environments while indoor networks are typically deployed in property verticals like commercial office buildings, sports and entertainment venues, hotels and convention centers, healthcare facilities and transit systems. For more information, please visit <https://extenetsystems.com>.



CommScope pushes the boundaries of communications technology with game-changing ideas and groundbreaking discoveries that spark profound human achievement. We collaborate with our customers and partners to design, create and build the world's most advanced networks. It is our passion and our commitment to identify the next opportunity and realize a better tomorrow. Discover more at commscope.com.



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