TURNING ON 5G:
USING EDGE ARCHETYPES
TO IDENTIFY THE MOST
MATURE USE CASES

Entering the 5G Era

The deployment of 5G and the improvements it delivers in the areas of data throughput, edge computing, ultra-low latency, and efficiency is now imminent. While the investment case for 3G and 4G technologies were fueled by staggering cell phone adoption rates and corresponding demand for data capacity by net new users across the globe, the case for investment in 5G adds compelling opportunities and new value chain opportunities.

According to 451 Research, smartphone adoption globally is nearing saturation levels in mature economies and 5G will be needed to reduce the costs associated with delivering high quality broadband services for mobile and increasingly fixed broadband use cases. While the transitions from 2G to 3G and later, 3G to 4G were largely driven by consumer demand for mobile data services, 5G topologies bring several attributes that industrial enterprises can use beyond fatter pipes to Internet services. The challenge, for any operator considering 5G, will be choosing the use cases, verticals, and eco-systems where they can rightfully play a meaningful role.

Four Edge Archetypes

As a global leader in critical infrastructure, Vertiv has performed significant research into edge computing to support the development of edge infrastructure solutions, including those used in telecom sites. We evaluated more than 100 current and emerging edge use cases and conducted an in-depth analysis of the 24 most impactful to identify commonalities that could simplify infrastructure development and deployment.

This led to the identification of our edge archetypes that bring clarity to the complex edge landscape. These archetypes are characterized primarily by their bandwidth and latency requirements—both key drivers of 5G. Within each archetype, multiple use cases have characteristics that make them good candidates for 5G. Some will need 5G to achieve the performance required to support adoption of the use case while others are working without 5G today but will be inherently improved by the capabilities 5G delivers.
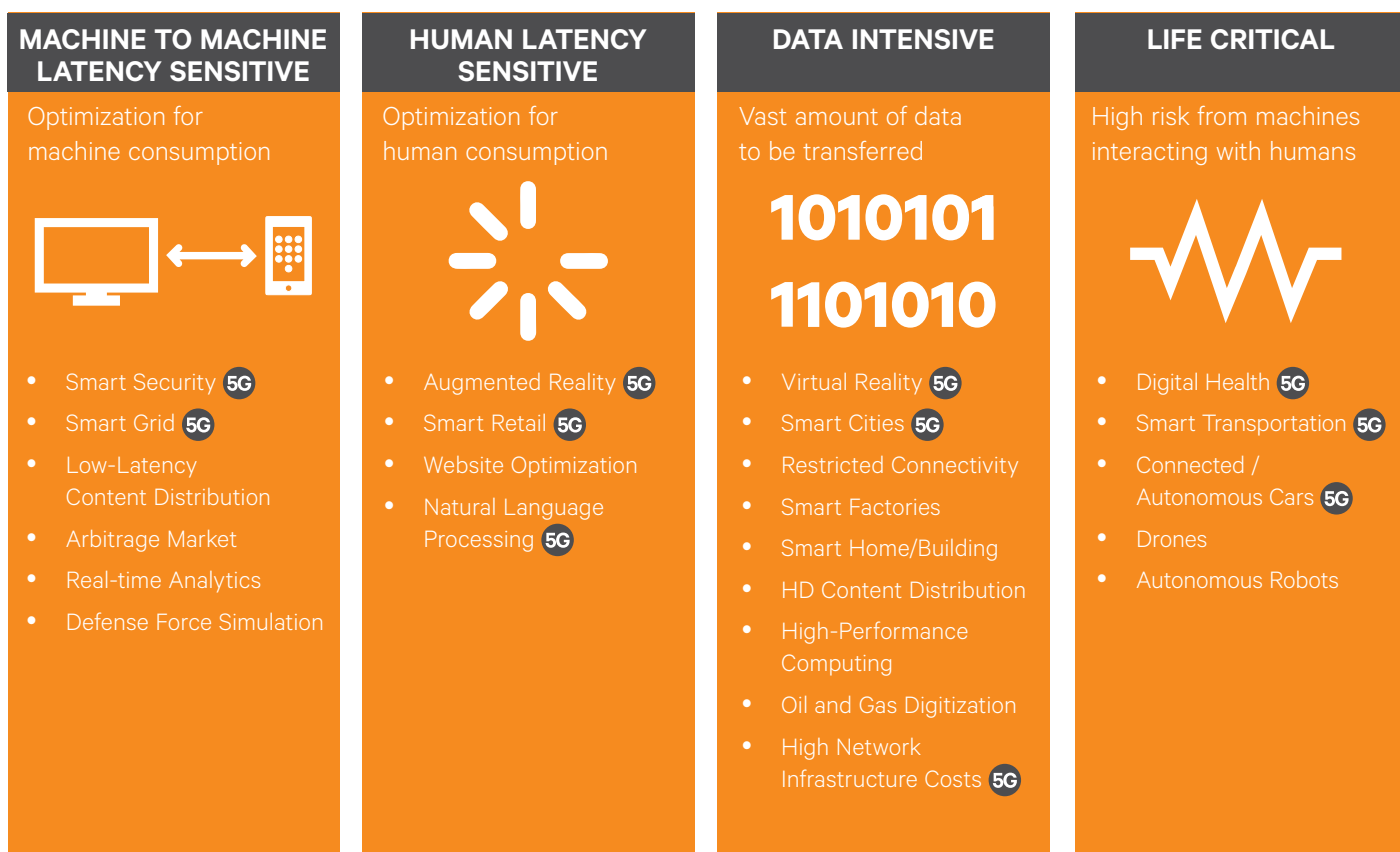
MACHINE TO MACHINE LATENCY SENSITIVE	HUMAN LATENCY SENSITIVE	DATA INTENSIVE	LIFE CRITICAL
Optimization for machine consumption	Optimization for human consumption	Vast amount of data to be transferred	High risk from machines interacting with humans
• Smart Security 5G	• Augmented Reality 5G	• Virtual Reality 5G	• Digital Health 5G
• Smart Grid 5G	• Smart Retail 5G	• Smart Cities 5G	• Smart Transportation 5G
• Low-Latency Content Distribution	• Website Optimization	• Restricted Connectivity	• Connected / Autonomous Cars 5G
• Arbitrage Market	• Natural Language Processing 5G	• Smart Factories	• Drones
• Real-time Analytics		• Smart Home/Building	• Autonomous Robots
• Defense Force Simulation		• HD Content Distribution	
		• High-Performance Computing	
		• Oil and Gas Digitization	
		• High Network Infrastructure Costs 5G	

Figure 1: 5G Indicates most mature 5G use cases.

Using 5G to Deliver Low-Latency Data for Machine Consumption

Machine-to-machine communications may represent the first frontier on which 5G can truly demonstrate its value. Machine-to-Machine Latency Sensitive use cases are characterized by extremely low latency requirements and some use cases are now in a stage where 5G technology may provide the boost required to advance their maturity. These include smart security and smart grid technologies (see figure 2).

SMART SECURITY

Smart security uses real-time, high-definition image and facial recognition to identify potential bad actors at a public event. This technology gained attention in 2018 when it was used at performances by the singer Taylor Swift. The security firm set up a kiosk outside the performance venue showing Swift's rehearsal videos. As attendees stopped to view the videos, their facial images were captured and sent to a command center where they were compared against images of known Swift stalkers. The theory behind the deployment was that Swift's stalkers would certainly take the time to watch her rehearsals and this application was possible without 5G because it focused on a very narrow target range and did not impact the wait times of those entering the event. At the same time, it helped ensure the safety of the singer and did not add significant costs to organizers or concertgoers.

Using 5G would enhance the latency and bandwidth of data transmission supporting this use case, allowing scanning of multitudes more concert goers, as well as simultaneous and instant access to multiple criminal databases. With 5G, concertgoers could pass by facial recognition cameras as they enter the venue without impacting wait times, enhancing overall event security without reducing concertgoers' quality of experience. For a limited technology investment, the venue creates competitive advantage that drives multiple increased revenue opportunities.

SMART GRID

5G may also be an important enabler of the continued evolution of smart grid technologies by supporting increased integration of renewable energy resources and improved demand management. Applying 5G and smart grid technologies all the way to residential and commercial meters will enable the grid to react more fluidly to sharp changes in demand driven by weather or other factors, cutting power to non-essential loads while ensuring essential loads have the power they need. The speed at which these decisions and actions can be made with 5G makes the smart grid business case more appealing.

> There are three major use cases for 5G; enhanced mobile broadband, ultra-reliable low-latency applications, and massive machine-type communications. Massive machine type communications (mMTC) targets the efficient and secure connection of millions of devices without overloading the network. These networks will excel at deep coverage, cost efficiency, low-power consumption, and long-term battery life. The access networks being rolled out today; NB-LTE and LTE-M will serve as the main 5G access technologies and co-exist with 5G NR via in-band operation.
>
> *Brian Partridge, Research Vice President, 451 Research*

MACHINE TO MACHINE LATENCY SENSITIVE ARCHETYPE Optimization for machine consumption

- Smart Security **5G**
- Smart Grid **5G**
- Arbitrage Market
- Real-time Analytics
- Low-Latency Content Distribution
- Defense Force Simulation

DATA PROFILE

Data Sources
Machines / Sensors

Activity
Write / Analyze

Linkage
Multiple Points

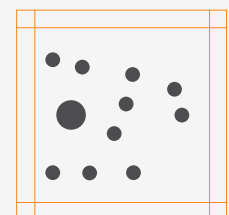**Connectivity**
Sometimes / Infrequent

CAPACITY PROFILE

Scale Driver
Competitive Landscape

Mobility
Fixed and Mobile

Locally Concentrated Data Footprint

INFRASTRUCTURE

Availability
Revenue Determined

Density
High

Locations
Local / Campus

Figure 2: Machine to Machine Edge Archetype Profile

Using 5G to Deliver Low-Latency Data for Human Consumption

Human-Latency Sensitive use cases require low latencies to optimize the experience of humans engaging with technology. While they typically feature a geographically disperse user base that may make it difficult to fully leverage limited 5G deployments, there will be opportunities to use 5G in conjunction with other data transmission methods to improve the user experience and enable new capabilities, particularly in regard to augmented reality/haptic computing and smart retail.

AUGMENTED REALITY AND HAPTIC COMPUTING

Potential applications for augmented reality extend from enhanced gaming to medical image visualization to equipment service to military training. Haptic computing, which can be used in conjunction with AR, is the ability to use touch as a way of controlling computer applications, such as interacting with virtual 3D objects in space.

With these technologies, medical students can practice delicate surgical techniques virtually, feeling what it's like to suture blood vessels or perform other procedures. Service technicians can quickly access 3-D models or other visualizations to help them diagnose and repair equipment or can work remotely with on-site personnel to resolve problems without visiting the site. In the defense field, augmented reality and haptic computing can help prepare for potentially dangerous tasks, such as defusing bombs.

Fundamental to the continuing maturity of these applications is the ability to move from supporting primarily fixed locations to supporting mobile users without impacting the quality of the experience. The higher throughputs and lower latencies 5G delivers is essential to this transition.

SMART RETAIL

5G also has the potential to accelerate the digital transformation currently occurring in retail. The addition of 5G technology to an existing network architecture can help power the strategies that allow retailers to adapt and thrive in the digital age, enabling increased personalization, greater use of analytics to identify trends and predict demand, and effective use of virtual and augmented reality to enhance the in-store experience.

Smart Retail is being implemented today without 5G as large retailers preemptively invest in store enhancements as a step toward a more lucrative future. The addition of 5G has the potential to enhance these efforts by reducing customer acquisition costs and improving customer retention and repeat purchases. When retailers can access multiple demographic databases, personalized search histories, previous purchases, and other datasets that influences purchase decisions in near real-time, they can custom tailor offers to shoppers while in-store or in close proximity to the store. They can also model data across a broad geography of stores and individuals to improve decision making. With current technology, this volume of data can't be accessed and processed fast enough to support this level of personalization and customization.
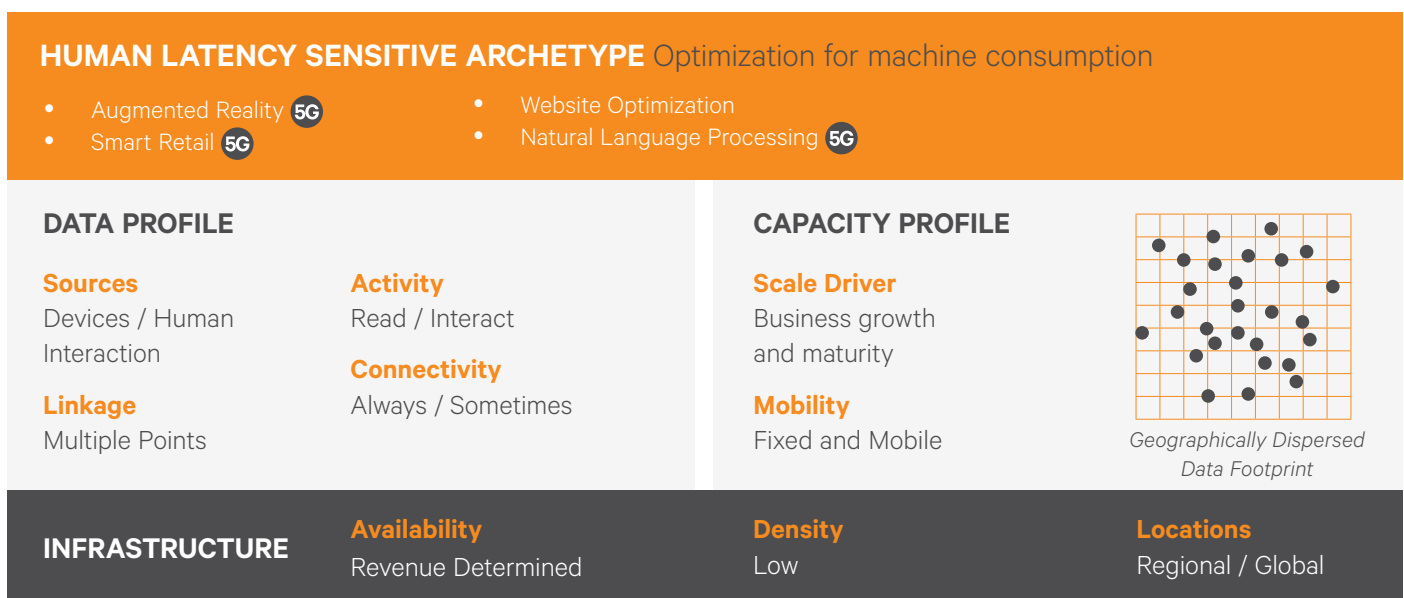

HUMAN LATENCY SENSITIVE ARCHETYPE Optimization for machine consumption

- Augmented Reality **5G**
- Smart Retail **5G**
- Website Optimization
- Natural Language Processing **5G**

DATA PROFILE		CAPACITY PROFILE	
Sources Devices / Human Interaction	**Activity** Read / Interact	**Scale Driver** Business growth and maturity	
Linkage Multiple Points	**Connectivity** Always / Sometimes	**Mobility** Fixed and Mobile	

Geographically Dispersed Data Footprint

INFRASTRUCTURE	Availability Revenue Determined	Density Low	Locations Regional / Global

Figure 3: Human Latency Sensitive Edge Archetype Profile

Using 5G to Support Data Intensive Edge Use Cases

A number of edge use cases can be characterized by the high volume of data being generated or consumed at the edge, making it impractical to directly support these use cases from a central or core data center. 5G will emerge as a valuable last-mile delivery solution for these high-bandwidth use cases. Two that show particular promise in the coming years are virtual reality and smart cities (see figure 4).

VIRTUAL REALITY

High-definition content delivery, the largest current edge use case in terms of data volume, has already undergone a transformation in which content has been pushed closer to users through local and regional data hubs, and there is a question of whether users will be willing to pay more for the lower latency/higher image quality 5G enables.

However, virtual reality amplifies the data challenges associated with content delivery to the point where 5G may become a necessity for this use case to flourish. Delivering VR video quality similar to HD TV quality requires bandwidth of 80-100 Mbits/second compared to 5 Mbits/second for HD video streaming. It will take 5G and its ability to leverage more spectral bands and wider bandwidths for a truly high-quality networked virtual reality experience, and there is reason to believe users are willing to pay for this experience.

The National Basketball Association first adopted VR technology for game broadcasts in the 2016-2017 season and has notably expanded its offering for 2018-2019. The league now offers one VR game a night, compared to one a week in the past, has expanded the number of VR headsets supported and enabled fans to watch games live alongside their friends in virtual courtside seats. The league sees VR as a way to grow its international fanbase by replicating the live experience for fans unable to attend games.

SMART CITIES

Another strong candidate to support early deployment of 5G is smart cities. Smart cities applications, like autonomous vehicles, require an immediate sensing and inference activity that happens locally and is based on continuously honed machine learning algorithms. However, the machine learning activity does not happen in real time but over days, weeks or months. Latency isn't an issue here as much as data volume.

5G is critical to managing the sheer volume of sensors and their data volumes, particularly as the data returns to the hub in the hub-and-spoke footprint characteristic of the Data Intensive Archetype. Aggregating hundreds or thousands of sensors at the hub that in turn has to access multiple external sources like weather, events, planned roadwork, and accidents makes 5G a critical component for the future of smart cities.

To get an idea of the volume of data that could be generated in a smart city, consider Santander, Spain, which serves as a smart city test bed. The city has deployed more than 12,000 sensors to support traffic intensity, irrigation, and environmental monitoring as well as event reporting. The variety of sensors within the city make over 300,000 observations daily just to support these functions. Moving beyond monitoring to proactive management will require faster transmission of even more data.
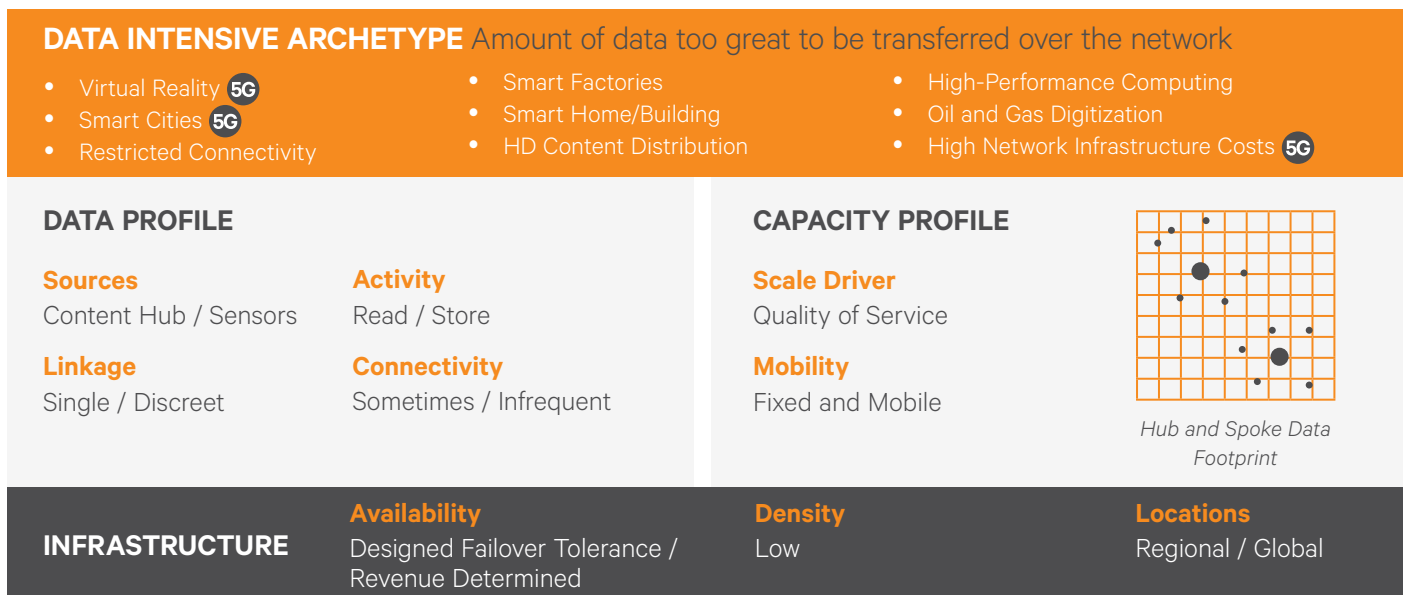

DATA INTENSIVE ARCHETYPE Amount of data too great to be transferred over the network

- Virtual Reality **5G**
- Smart Cities **5G**
- Restricted Connectivity
- Smart Factories
- Smart Home/Building
- HD Content Distribution
- High-Performance Computing
- Oil and Gas Digitization
- High Network Infrastructure Costs **5G**

DATA PROFILE		CAPACITY PROFILE	
Sources Content Hub / Sensors	**Activity** Read / Store	**Scale Driver** Quality of Service	
Linkage Single / Discreet	**Connectivity** Sometimes / Infrequent	**Mobility** Fixed and Mobile	

Hub and Spoke Data Footprint

INFRASTRUCTURE	**Availability** Designed Failover Tolerance / Revenue Determined	**Density** Low	**Locations** Regional / Global

Figure 4: Data Intensive Edge Archetype Profile

Using 5G to Support Life Critical Edge Use Cases

The Life Critical Archetype encompasses applications where edge analytics and computing support use cases that directly impact human health and safety. Life Critical use cases include digital health, smart transportation and logistics, autonomous vehicles, autonomous robots and drones (see figure 5).

Where other archetypes tend to have a dominant data characteristic, the Life Critical Archetype is characterized by the need for extremely high availability and low latency.

In general, these use cases are less mature than those in other archetypes and this lack of maturity, combined with their life-critical nature, makes them poorly suited for early adoption of 5G. While they will benefit greatly from 5G and may prove to be the most economically valuable edge use cases, 5G must prove its value and reliability in other applications before being used in life critical applications.

Autonomous vehicles, for example, could become one of the most widely used and disruptive edge applications to emerge in the future. But, while autonomous vehicles are being tested on the roads today, questions remain on how widespread deployment will be supported. For more information on the potential role 5G could play in autonomous vehicles, see Telcos at a Fork in the Road with Autonomous Vehicle Infrastructure on the Vertiv blog.

> In the case of AV, consumers are still far more comfortable with using driver assistance technologies such as adaptive cruise control and emergency braking. Only 15% of consumers 451 Research surveyed (Voice of the Connected User Landscape) indicate they would be comfortable riding in a fully autonomous (Level 5) car. In addition, regulation surrounding AV is far from harmonized globally which complicates development of systems that can be sold globally by OEMs. This, of course, raises both costs and risk.
>
> **Brian Partridge, Research Vice President, 451 Research**

LIFE CRITICAL ARCHETYPE High risk of injuries caused by machines interacting with humans

- Digital Health **5G**
- Smart Transportation **5G**
- Connected / Autonomous Cars **5G**
- Drones
- Autonomous Robots

DATA PROFILE

Sources
Machines / Sensors

Activity
Write / Analyze

Linkage
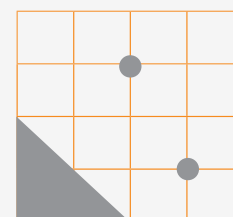Multiple Points

Connectivity
Sometimes / Infrequent

CAPACITY PROFILE

Scale Driver
Competitive Landscape

Mobility
Fixed and Mobile

Self-Sustained Frontier Data Footprint

INFRASTRUCTURE	**Availability** Maximum Resilience	**Density** Mid	**Locations** Local / Remote

Figure 5: Life Critical Edge Archetype Profile

The Value of Geographically Focused 5G Deployments

Virtually all edge use cases will ultimately benefit from 5G and you can see how these technologies can come together in a geographically focused 5G deployment, such as in a sports stadium. With technologies like virtual reality bringing the in-game experience into our living rooms, event organizers can use 5G technology to enhance the user experience, improve operations and open new revenue opportunities.

Here's how 5G technology could impact the experience of a couple of soccer fans going to see their favorite team.

- When they arrive at the stadium, IoT-enabled traffic management and parking guidance systems, similar to those used in smart city applications, help them navigate around congested areas and guide them to an open parking space. Then, autonomous vehicles shuttle them from the parking lot to the gate.

- As they enter the stadium, their facial images are scanned and compared to a known list of bad actors, reducing the likelihood of a security threat occurring during the game.

- Once they find their seats, guided by an in-stadium app, they use voice commands and autopay to order concessions that are delivered to their seats.

- Real-time analytics on the back end of the app enable stadium concession operators to manage inventory and stage food preparation to reduce waste and increase quality.

> 5G brings with it the opportunity to completely reinvent digital experiences in places where crowds congregate to work and play. We fully expect that stadium and venue owners will turn to 5G to significantly enhance the live fan experience, remote viewing experience and engagement, venue security and customer operations, and talent safety to name just a few. These new technologies built on 5G will drive experiences that make it more compelling than ever for fans to leave the house and attend a live event.
>
> **Brian Partridge, Research Vice President, 451 Research**

Natural Language Processing
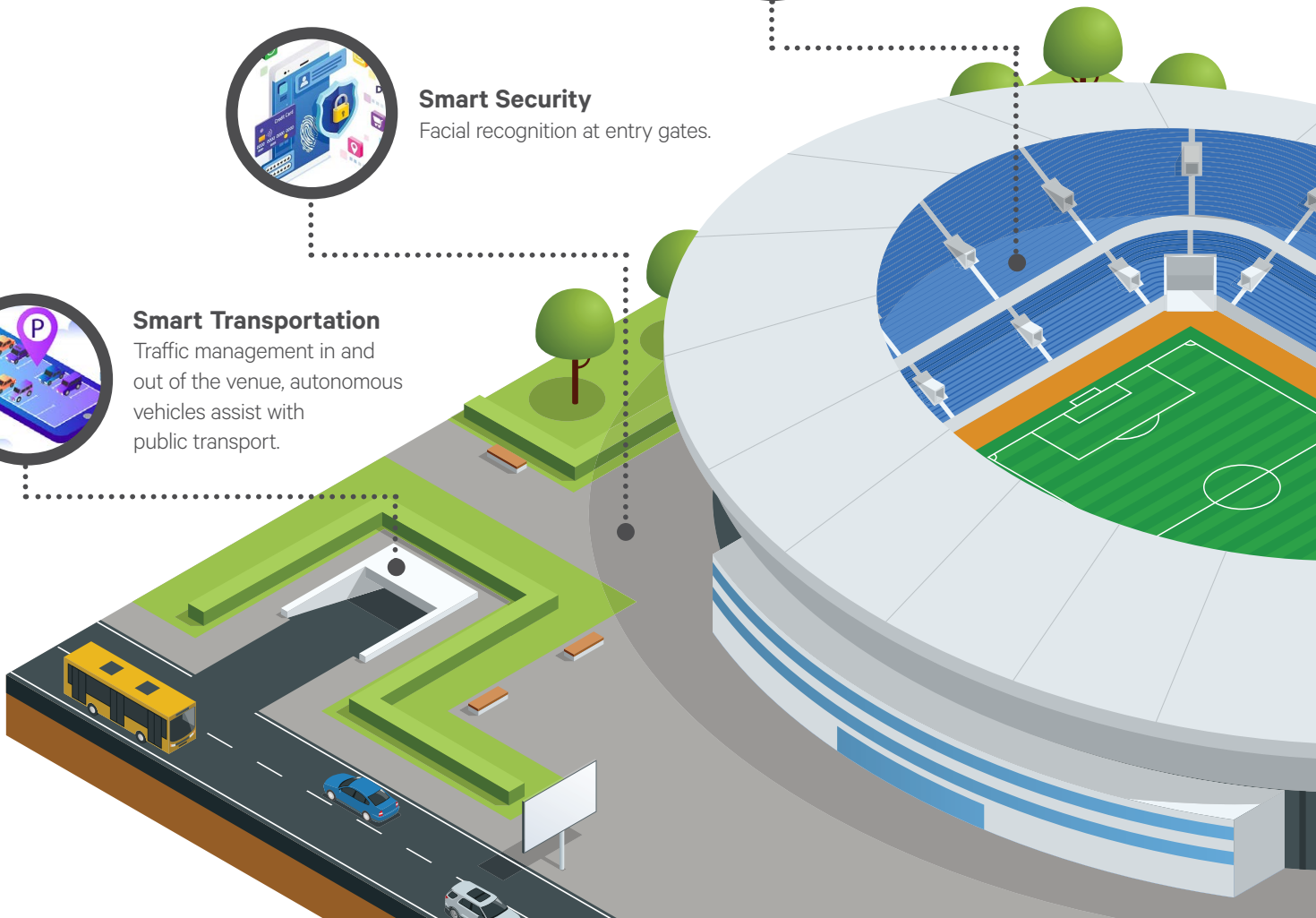Order a hotdog from your seat via Siri/smart phone, auto pay then pick up at concession or have delivery at your seat.

Smart Security
Facial recognition at entry gates.

Smart Transportation
Traffic management in and out of the venue, autonomous vehicles assist with public transport.
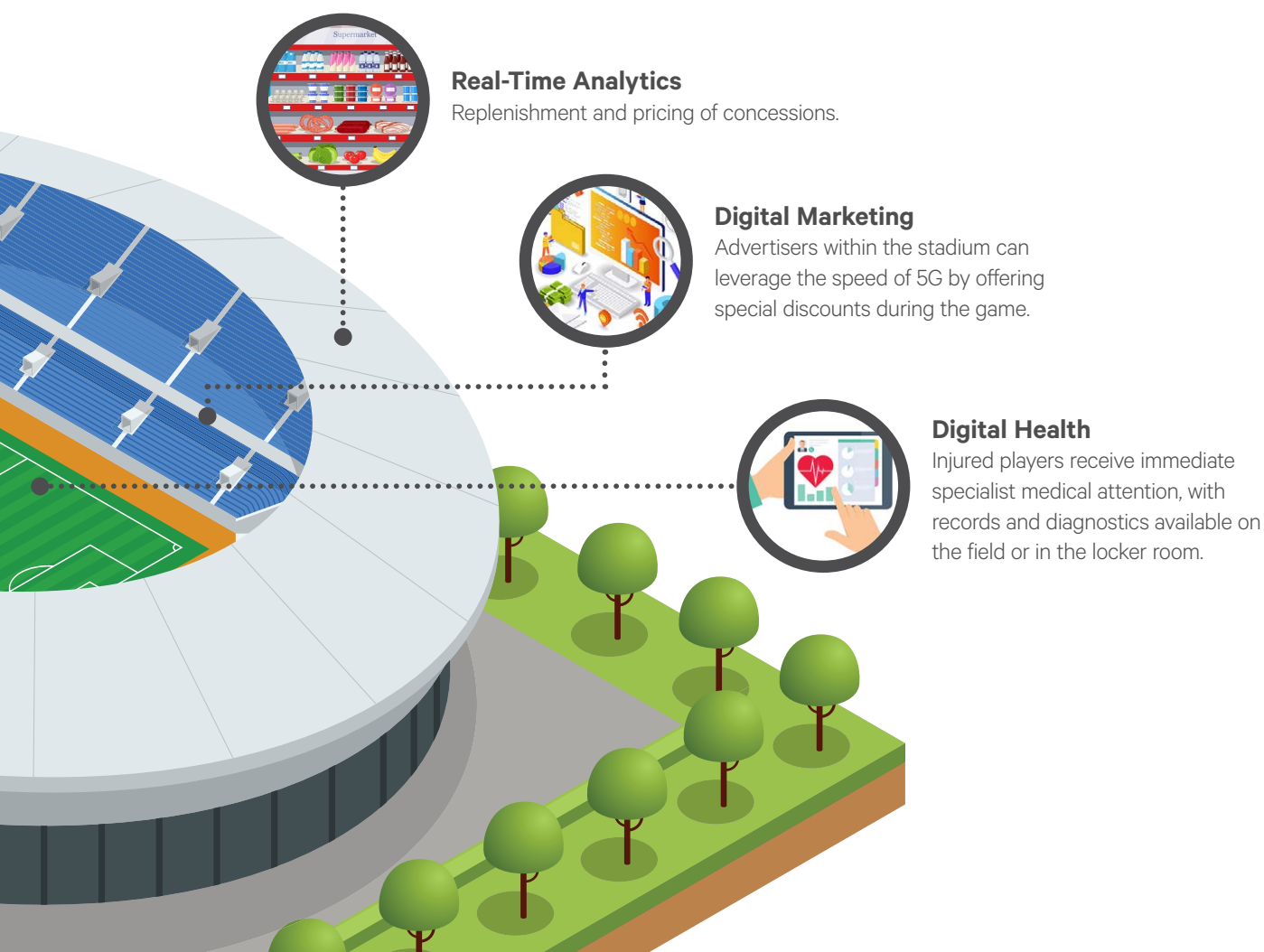
- During the game, they can watch high-definition replays of game action, choosing from multiple camera angles delivered to their devices by the speed and bandwidth of 5G. They also receive near real-time in-game and player statistics they can use to supplement the viewing experience or to place bets on game action without worrying about latency negatively impacting the outcome of a wager. Advertisers within the stadium can also leverage the speed of 5G by offering special discounts, which can be redeemed through 5G-optimized web sites that allow attendees to make purchases without missing any of the action.

- A player injured during the game is treated using digital health technologies that allow specialists to quickly access the player's medical data, tap into specialists outside the stadium and speed diagnosis and treatment.

- After the game, the same traffic management system that guided them in helps them get back on the road as quickly as possible — an optimized experience that ensures the fans are already excited about attending their next game.

Conclusion

While initial deployments of 5G will focus on software upgrades to existing cell towers with 4G radios, the need will come soon enough to both upgrade existing cell infrastructure that does not contain 4G radios and to expand the network to places where infrastructure does not currently exist. Funding that continued expansion will require identifying use cases and applications that will be quickly adopted and have a potential to create revenue.

This paper represents our initial perspective on how edge archetypes can be used to identify the use cases best suited to benefit from early deployment of 5G technology. We recognize the technology and the market are both changing quickly and welcome other perspectives on how the edge and 5G can grow synergistically.

For more information on edge archetypes and the use cases associated with them, see the Vertiv white paper, Defining Four Edge Archetypes and Their Technology Requirements.

Real-Time Analytics
Replenishment and pricing of concessions.

Digital Marketing
Advertisers within the stadium can leverage the speed of 5G by offering special discounts during the game.

Digital Health
Injured players receive immediate specialist medical attention, with records and diagnostics available on the field or in the locker room.

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