



5G-powered smart stadiums

The future of spectator experience

5G networks today are being commercially deployed worldwide. 5G brings with it a broad array of features such as 1Gbps throughput, low-mid-high band spectrum coverage (enhanced mobile broadband), network efficiency, ultra-low latency (ultra-reliable low latency communications) customisation, virtualisation and a connection density of one million internet of things (IoT) devices (massive machine-type communications or mMTC) per square kilometre. 5G is highly beneficial for operators and network service providers and hence, there is an increased interest in the benefits that 5G network connectivity harbours for IoT devices.

IoT's limitless potential can truly be explored when it is juxtaposed with 5G technology. There has been a recent boom in the application of IoT devices and it is predicted that between 2022–2030, their usage will expand exponentially along with the upgrade from 4G to 5G connectivity.

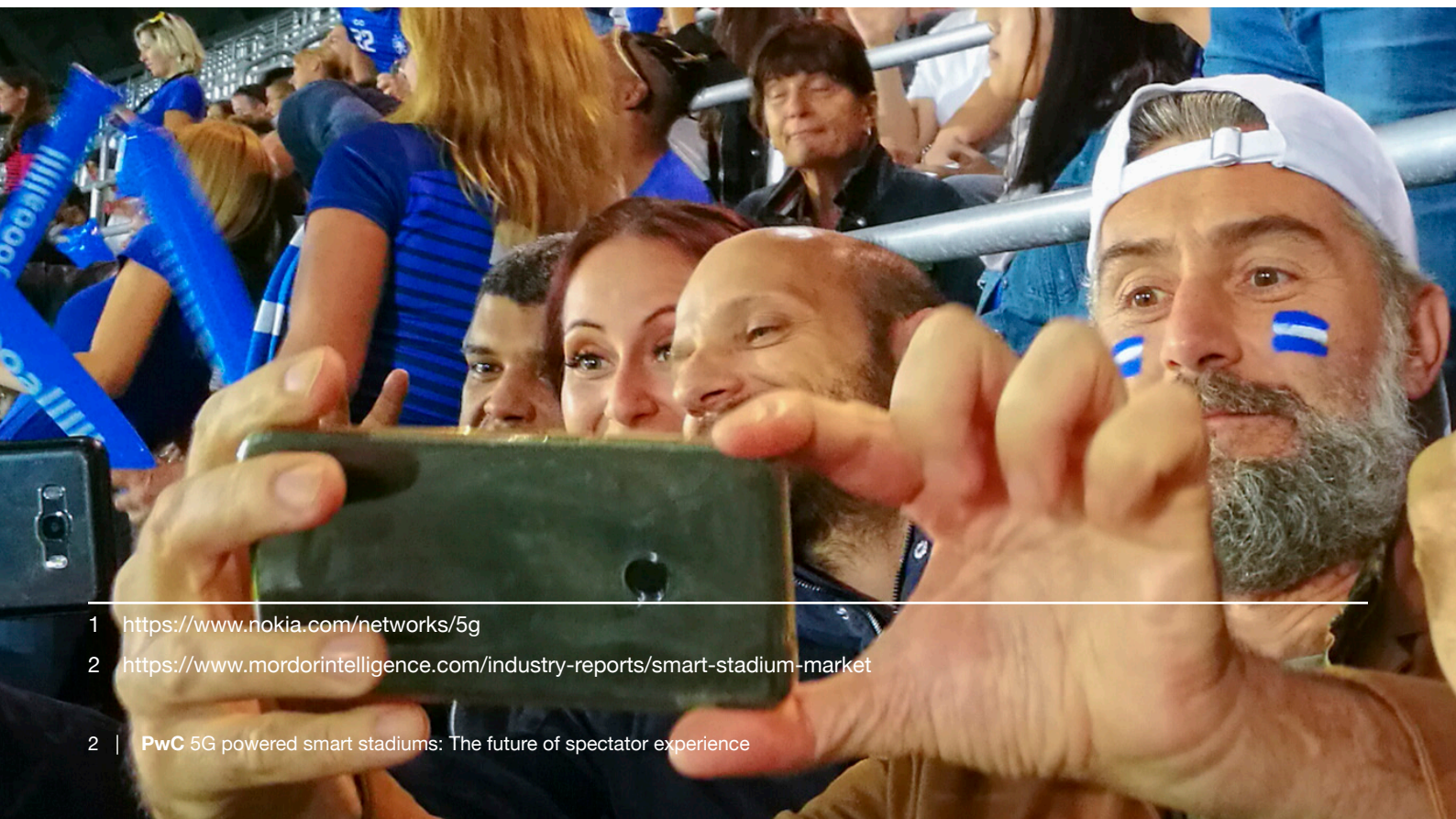
A 5G cell tower in an area can connect to a multitude of devices and this congregation of IoT devices runs on negligible data transfer rates. This results in massive volumes of data transmission over a distinct 5G network. As the network is optimised to handle massive data transfer rates, it can support a variety of applications and use cases. With the proliferation of IoT devices, cities, enclosed environments, homes, and stadiums would be suitable use cases for everyone to understand the full potential of 5G.¹

Use case: Smart stadium

Sporting events and their subsequent demand have increased in recent years before the pandemic affected such large-scale gatherings worldwide. The tendency to view and assemble for sporting events has increased due to the rising fanfare over social media, low ticket pricing, uncomplicated ticketing procedures and a surging number of sponsors facilitating such gatherings. With spectators going to stadiums in large numbers to cheer their sporting heroes and teams, it is imperative that the location warrants a technological overhaul that will suit and prolong audience participation in the event.

In 2020, the smart stadium market was valued at USD 6.8 billion but is projected to grow at a compound annual growth rate (CAGR) of 21.53% between 2021–2026, reaching USD 18.23 billion by 2025.²

Governments of European countries have already taken multiple research and development (R&D) initiatives to transform their usual stadiums into smart stadiums by integrating IoT solutions and 5G connectivity. The market concentration is very high since the transformations are heralded by major IT players from around the globe. Therefore, it can be safely said that the amalgamation of the 5G network with IoT solutions is the perfect combination of technologies that can render a far better spectator experience of various sporting events compared to earlier.



1 <https://www.nokia.com/networks/5g>

2 <https://www.mordorintelligence.com/industry-reports/smart-stadium-market>



Screens with **customised** user interface to view every minute of the game from various angles.



Real-time online data visualisation of players on the field and interaction with other fans.



With multitudes of **sensors** present at the venue, viewers at home can enjoy the spectacle in 3D.



Food and drinks can be ordered from the seat via user equipment and without any network congestion and **minimal latency**.



Supplemented by edge computing, the 5G network can also be used to enable crowd density **analytics**.



5G to enable **AR services**, such as player statistics, live win probabilities and animated celebrations.



Once **LIDAR** data is handled by 5G with edge computing capacity, it can be analysed to determine traffic flow and congestion patterns in near real time.



5G can help teams to **optimise** training, health and safety and game-day operations.



Buy, sell and locate sport merchandise on the fly at the venue using **secure wireless** payment methods.



5G **Ultra-Wideband network** can enable fans inside a stadium to access high-definition multimedia services.



Equipped with **computer vision**, crowd analytics and other 5G-enabled applications could significantly reduce queues for amenities within the stadium.



As they become equipped with 5G, stadiums could host a wider range of events. For example, **high-speed reliable connectivity** could be used to temporarily transform stadiums into digital arenas that can host mobile-gaming events with real-time and on-site multiplayer action.

Sources: GSMA 5G Transformation Hub and AtoS

Connectivity

Connectivity within a smart stadium runs using a private cellular network. Wi-Fi hotspots located in various indoor and outdoor locations cover most of the arena during a sporting event. Usage of transmission and reception points within a private 5G network can provide elevated levels of bandwidth with minimum latency and connect to a vast number of IoT devices. Not only can sports aficionados enjoy high-speed internet, but stadium administration authorities can also receive data from various sensors to gather valuable insights using applications running on a nearby multi-access edge computing (MEC) server in real time.

The integration of IoT and 5G in stadiums will facilitate the digital engagement of fans from all sections of the venue with excellent connectivity and communication between hotspots. As a result, the stadium operations will be enhanced, with optimised crowd handling capabilities like:

efficient traffic management facilitating fans and officials to enter and exit the stadium in an organised manner, find suitable parking spaces and commuting to other areas of the venue by guidance from mobile applications that pick up navigation data from cameras and sensors

enhanced stadium security by monitoring crowd behaviour, spotting riot instigators and identifying unclaimed or abandoned luggage using a high-definition live feed from surveillance cameras and facial matches

enhanced environmental management such as monitoring building systems from a centralised location via multiple sensors and cameras connected through the 5G network that will help manage infrastructure performance, water usage and temperature at fire-prone areas like kitchens, prompt alert maintenance notification at peak times when restroom visits surpass threshold numbers and effective stadium lighting operations

superior fan engagement using their smartphones, sensors, and other interactive interfaces to use several enhancements such as real-time statistics, social media integration, and mobile apps.

Unlike smart stadiums, the technology and infrastructure in modern stadiums are slowing down in areas of crowd management and not effectively functioning its operations, players, and fans, all in unison. The authorities should recognise these drawbacks and effectively address the challenges by leveraging 5G with IoT to its fullest extent.

Experience

During the 2019 Amir Cup final and at the grand opening of the Al Janoub Stadium (one of the stadiums scheduled to host the FIFA World Cup 2022 in Qatar), the arena exhibited the ground-breaking 5G-based virtual stadium immersive fan experience.

The Elastic Cloud Radio Technology and antenna with High Order Massive-MIMO were used to demonstrate the memorable experience of watching a live sporting spectacle. For sports fans to experience any sensational sports event like cricket or football World Cup matches, virtual stadiums hosted at shopping arcades can showcase a virtual immersive experience of the actual game in real-time for the fans from any corner of the world by employing virtual reality.

The booth enabled the fans to administer their own match broadcast by letting them control the camera angles and select cameras to switch between views as per their choice/convenience to completely personalise and enjoy a never-before viewing experience.

5G network technologies like New Radio (NR), IP Multimedia Subsystem (IMS), Elastic Cloud Radio Technology, antennae with High Order MIMO, radio systems and microwave solutions are used to reach a data speed of 1.2 Gbps, mobile traffic surpassing 6TB and a set-up success rate of 99.5%.

The remotely operated spectacle ran for 90 minutes and with the 5G network bandwidth, spectators were able to enjoy the real-time streaming experience that far surpassed the quality of conventional media in terms of audio quality and video resolutions. This was possible due to the multitudes of IoT devices or cameras installed at the venue to capture every corner of the field.

Stores within the stadium premises, together with mobile edge computing capacity, can utilise the full potential of 5G Ultra-Wideband connectivity inside stadiums to:

Help customers locate stores from the customer user device equipped with real-time navigation routes of the stadium's inner premises



Enable contactless autonomous shopping that allows shoppers to avoid long checkout queues while shopping for sports merchandise



With 5G connectivity, an interactive augmented reality (AR) experience can allow fans to engage in in-stadium virtual interactions using applications to access live high-definition 360-degree video coverage from novel locations like the goalpost or the centre of the field, but in virtual reality (VR) and within the application. Smartphones used by fans in the stadium can leverage the in-built professional-grade camera technologies to capture their own footage and share it on social media. Fans can also enjoy extended reality (ER) application scenarios which include interacting with the game in new ways, such as using AR to view player stats, engage in match analysis, view tailored playbacks and more.³

³ <https://www.verizon.com/business/solutions/5g/stadium-venue-experience/>

Merchandise

A 5G-enabled smartphone is the first device that people should own for the network's capabilities to become popular. This user equipment comes with a high-performance camera, a better e-sports experience and more, and can be bought at an affordable price.

Using Multi-access Edge Computing (MEC) with a 5G network has strong potential and benefits in terms of reduction of network latency, localised video/data processing, improvement in the speed of photography and video capturing, uploading-downloading, data consumption, and delivery of high-quality, real-time streaming services to the end-user devices. Consumers or fans can select tailored content using the application and may request a viewing angle or a shot from a location that is not available from their seat or section. Their request is directed to the MEC platform, running video applications in the stadium and the network edge.

The use of cells covering each corner and vantage point of the stadium will transmit a large amount of data across various short-range transmission and reception points in much higher radio frequencies. Therefore, users can enjoy multi-gigabyte service across the venue.

Outside an arena, fans can participate in the indoor action from adjacent plazas with ultra high-definition audio and video screens. It's no longer only about watching the big game but also enjoying unique and fun experiences in and around the venue. Restaurants and eateries, merchandise outlets near the stadium frequented by fans will require 5G network connectivity that can exhibit a buffer-free experience of the game.⁴

Monetisation

5G monetisation is a business model which creates avenues and opportunities for communication service providers (CSPs) to deliver 5G connectivity in the sporting arena with ultra-low latency, faster network speeds and bandwidth, and a multitude of connected IoT devices, and reaches out to fans more intimately by utilising more secure, interactive, and user-friendly networks and computing services.⁵

To effectively monetise diverse services within the arena, 5G network operators can utilise the following:

Network service: With sophisticated user equipment, fans tend to use a high amount of data while in the stadium. Customised subscription service plans for spectators to tap into the 5G networks inside stadiums can help the CSPs levy a high price that scales up alongside the amount of data expended. Fans looking for personalised experiences during the game can access exciting applications from their phones, including augmented and virtual reality sessions that require higher network bandwidth, which can only be availed with a price set by the CSPs of the stadium.

Network slicing: This 5G technology enables and opens up new business opportunities. As for use cases involving smart stadiums where fans can use multiple applications to interact with the ongoing game, slicing enables dedicated network resources for specific applications that the fans use, with low latency and high bandwidth as required to run the applications.

Value-added services: Operators in the arena can utilise 5G connectivity to cater to various mobile applications and sports OTT services, and fans are the perfect audience who already trust and pay for such services. Sports entertainment is an easy entry point for numerous CSPs who can take advantage of newer and interactive entertainment models like AR and VR as a value-added service.

4 <https://techcrunch.com/sponsor/vivo/powering-the-smart-football-stadiums-of-tomorrow/>

5 <https://www.stl.tech/network-software-products/5g-monetization/>

How PwC can help you achieve more

Globally, the sports industry has a steady dynamism and the power to create an identity for nations by transforming individuals, communities, society, states, and countries. India is currently one of the epicentres of large-scale sporting events. The country has massive arenas to enjoy these spectacles and they are suitable for providing larger-than-life experiences by using the strength of connectivity, bringing spectator experience under a canopy of 5G.

PwC's outlook and indulgence towards 5G connectivity can prove to be extremely beneficial once introduced in sporting arenas. Our experience with technology and insights can help sporting arenas shape their 5G strategy. PwC has always been adept at bringing together service expertise, industry insights and collaboration with diverse clients, helping them reach an optimum level of the technological stratum. At PwC, we believe that 5G-powered businesses will be able to see, do and achieve more. The technology can help stadium authorities uncover opportunities and when combined with strategy, it will enable them to commercialise themselves better and thrive in the market. With strategic guidance from PwC, stadiums can leverage 5G-enabled opportunities by solidifying connections, managing risks, and reimagining and reconstructing the ecosystem. Spectators can actively indulge in the game from all corners of the field as they tap into the speed and reliability of 5G.

Conclusion

A major wireless network operator has been collaborating with Bundesliga to implement 5G connectivity systems in German football stadiums. A US-based telecommunications enterprise has been deploying the technology in NBA and NFL stadiums.⁶ Therefore, the goal is to reduce the dissatisfaction among the fans present in the stadium who are unable to effectively engage with the ambience of the arena, communicate and enjoy with their compatriots as well as share key moments from the event on social media. Fans at home can also enjoy a greater experience through 5G network by not only relishing the live streaming of a match in 4K or 8K but also engaging with the immersive experience of AR and 3D imagery to savour the statistics, overlay replays, live gameplay, and other in-stadium experiences.

6 <https://www.gsma.com/5GHub/stadiums>

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