

5G

IN SPORTS



Fundamentals of 5G
Applications & Opportunities in Sports
Effects on Fans and Business Models



SPORTSTECHX

Co-developed with SportsTechX

FOREWORD

Technology is ever evolving: new devices, new means of distribution, new standards. The latest mobile connectivity standard 5G enables a fundamental change of **how content will be produced, distributed, consumed and augmented** in the future. We observe and also drive this development with a high level of excitement, as sports will play a major role within this process. Thus, the intention of this whitepaper is to put the latest developments into the context of sports.

Also in the **sports industry** 5G has found its way into headlines, first driven through early adopters who tested 5G's capabilities and limitations in the realm of sports, later with prototypes of 5G-supported venues made ready to use the potential of the technology. A true **large-scale implementation however, has yet to be established.**

But when looking at recent news and the development that 5G has taken in the sports industry to date, it seems that we are **not far away from the first major breakthroughs** in terms of mass usage, with many stadiums, more and more smartphones and soon also broadcasters increasingly ready for what is potentially a new era of sports consumption.

This situation above was one of the main reasons to develop the whitepaper at hand. The other one was that **an extensive overview about 5G in sports did not exist yet.** So what to expect on the upcoming pages?

CHAPTER 1: ABOUT 5G

Understand the fundamental elements, advantages, applications and requirements of the technology

CHAPTER 2: 5G IN SPORTS

Overview of the most relevant applications and opportunities of 5G in the sports industry, covering media production & distribution, fan experiences & services and eSport, while also highlighting the risks

CHAPTER 3: EFFECTS OF 5G ON THE SPORTS INDUSTRY

Summarizes the affected areas within the sports industry and highlights the expected effects on fans and business models

All the above was developed with the **overarching goal to clarify how 5G technology will affect the entire sports industry** on various levels and to provide food for thought with regard to one's own handling of these possibilities.

With that being said, we wish you an insightful read.



ANDREAS HEYDEN

CEO
DFL Digital Sports

CHAPTER 1:

ABOUT 5G

To be able to present and assess the potential impact that 5G will have on the sports industry it is important to first understand the fundamental elements, advantages, applications and requirements of the technology itself.



WHAT IS 5G?

5G is the fifth generation of mobile network technology and a **new global standard**. Through a range of superior characteristics like higher speed, availability, flexibility and lower latency it is able to offer entirely **new consumer and business applications in various industries**. It is a big step for mobile technology and promises to take connectivity to the next level.

HISTORY

While the first generation of mobile network technology was limited to analog voice calls, the switch to digital technology through **2G/GSM** also allowed text messaging via SMS and later media messaging via MMS. A wider adoption took place in the early 2000s when **3G/UMTS** technology made media-rich applications like mobile internet browsing and video calling possible.

But the ultimate breakthrough for mobile network technology came with **4G/LTE** and its

significantly increased speed which introduced gaming, HD live streaming and emerging experiences like AR/VR to mobile devices. The roll-out of **5G/NR** however is set to be another transformational development, as it not only further enhances the mobile experience but also enables new mission-critical services and allows for mass connection of IoT (Internet of things) devices. Below is a comparison of the different generations.

COMPARISON OF DIGITAL MOBILE NETWORK TECHNOLOGY GENERATIONS*

Generation	Introduction	Technology	Theoretical Download Speed	Typical Latency	Services
2G / GSM	~1990	From GPRS to EDGE	120 Kb/s to 236 Kb/s	0.5 seconds	Digital voice calls, SMS, MMS
3G / UMTS	~2000	From 3G to DC-HSPA+	384 Kb/s to 42.2 Mb/s	0.1 seconds	Internet browsing, video calls
4G / LTE	~2010	From 4G to LTE-Advanced	100 Mb/s to 1 Gb/s	0.05 seconds	Gaming, HD live streams, AR/VR
5G / New Radio (NR)	~2020	From 5G Non-Standalone to Standalone	1Gb/s to 10 Gb/s	0.001 seconds	Mission-critical services, mass IoT connection

*First generation not displayed as it was analogue

5G CHARACTERISTICS & ADVANTAGES

HERE ARE THE MAIN CHARACTERISTICS OF 5G:

- 5G uses a **wide range of frequencies**, from very low bands (3 kHz upwards) to extremely high bands in the mmWave spectrum (up to 300 GHz), with especially the latter ones being capable of super-fast data transmission often described as “5G+”. For context, WiFi and bluetooth use a frequency band between 300 MHz and 3 GHz while 4G can operate between 5 and 20 MHz
- 5G allows for so-called **slicing**, which describes the ability to operate multiple subnetworks (slices) on the same infrastructure. This helps to serve the specific needs of both different applications and devices, e.g. regarding data, speed and capacities
- 5G utilizes the power of **edge computing**, meaning that data is managed closer to where it is needed, e.g. by IoT devices such as wearables and sensors, and without the need to access centralized data centers as applications are run in the cloud. This allows for ultra-low latency leading to real-time analysis and reaction.

AND THESE ARE THE KEY ADVANTAGES THAT DERIVE FROM THEM:

- 5G is not only up to **10x faster** than LTE-Advanced and up to **100x faster** than standard 4G, its speed is also comparable to that of fiber-optic cables. This allows the transport of **large data streams and fast downloads**
- 5G has up to **10x lower latency** than 4G, which is the time between performing an action and getting a response. This enables instant, **real-time data access and communication between devices** and supports technologies like Augmented and Virtual Reality
- 5G's capacity can serve up to **100x the amount of connected devices** per unit area than 4G, ensuring **undisturbed access** to the mobile network even in large crowds
- 5G promises a network **reliability** of 99.999%, basically **taking out downtimes** and network outages entirely
- 5G's **frequency range** supports a **broader portfolio of devices, sensors, and wearables** and therefore more use cases.
- 5G comes along with up to a 90% better **energy efficiency**, leading to **decreased costs and increased sustainability**. Low power consumption also allows connected objects to operate up to multiple years.

APPLICATION

5G significantly improves the mobile experience, same as 4G did compared to 3G, but does not stop there. It is expected to bring a **transformational shift in applications** technology.

ENHANCED MOBILE EXPERIENCE

5G's speed together with ultra-low latency boosts new immersive experiences such as Virtual and Augmented Reality, and allows fast downloads and live streaming of large data streams, all while being reliably available even in crowded areas.



MISSION-CRITICAL

5G can enable new services that heavily depend on high precision and instant reaction time. Any buffering, typical for 4G, can have a direct, often dramatically negative impact in industries like automotive or healthcare. Ultra-reliable, low-latency 5G however opens the option for services like remote control of critical infrastructure, vehicles, and medical procedures.



MASSIVE INTERNET OF THINGS (IOT)

5G can connect a large number of different sensors and devices through its broad frequency range and the ability to scale down in data rates, power, and mobility, which provides lean and low-cost connectivity solutions. At the same time it has the capacity to handle the massive amount of data and lets sensors and devices communicate with each other in real-time.



INDUSTRIES

The broad shift in applications through 5G also affects a broad range of **industries**. Below are a few key examples of what is possible in the future. The application of 5G in sports, affecting fans, media, venues, etc. will be part of chapter 2.

AUTOMOTIVE

The ultra-low latency of 5G will allow vehicles to interact with each other and the infrastructure around them in real-time through so-called V2X (**Vehicle-to-Everything**) communication. For context, vehicles could react about 250 times faster than a human being. This is a massive boost towards fully **autonomous self-driving vehicles** which don't have to decide individually on how to act within their environment but are embedded in **smart traffic management** systems.



HEALTHCARE

5G will allow more complex health tracking devices, including ones that are implanted into the human body, in order to expand **preventative measures**. Accuracy, speed and reliability of the network also opens opportunities for **telehealth practices**, ranging from remote diagnoses to surgical operations (telesurgery). Micro cameras will be able to live-stream from within the patient's bodies, while doctors are assisted by robotic systems. Other applications are affordable (video) analytics for **behavioural recognition** at home or in care centres to identify abnormal behaviour or AR/VR devices that support the **visually impaired** in their daily life while being connected in real time to an advisor or caretaker.

MANUFACTURING

5G will enable the integration of a broader range of sensors and devices into the workflow of factories. This enables the constant exchange of information between machines, so-called **Machine-to-Machine** communication, leading to increased efficiency and reliability, e.g. through automated *monitoring the performance and condition of equipment. Another major area for improvement is the enhanced usage of **Augmented Reality overlays**, which supports factory workers in their tasks.

The usage of 5G is not limited to the industries above, in fact there is hardly any industry which will not be affected. Other examples are **Entertainment** (e.g. Immersive Virtual Reality Gaming), **Retail** (e.g. Smart Shelves, AR Shopping), **Energy** (e.g. Smart Grid Management) or **Agriculture** (e.g. Precision Farming).

A study conducted by Qualcomm/IHS Markit estimated that by 2035 5G is expected to have driven **\$13.1 Trillion dollars of global economic output** with \$265B global 5G CAPEX and R&D annually and will have created 22.8 Million new jobs.

REQUIREMENTS

While the outlook and opportunities of 5G technology are highly promising it is important to note that 5G is not a “plug-and-play” solution that can be used on the current mobile network setup. Below are the three main areas that need to be addressed.

- To ensure line-of-sight and to extend coverage we'll see **larger numbers of small cells** being used. Compared to the cell towers that the telecom industry has been using for long they are easier to install and maintain, cheaper and more energy efficient. Small cells communicate with cell towers wirelessly and can sit in small objects such as traffic or street lights.
- To support full 5G availability more **fiber-optic infrastructure** is needed, as it connects data centers with cell towers and/or small cells. This way only the “last mile” is done wirelessly and the highest speed can be reached.
- To bring the high frequencies of 5G indoors, **fixed wireless antennas** are put on top of buildings to communicate with nearby cells. The antennas are connected to an internal modem/router by wire and can either distribute the 5G signal or convert it into WiFi.
- To utilize 5G in the best way, it is important to ensure the **smart usage of frequencies**, as the fast frequencies have a lower range while the slower frequencies have a higher range. This has to be kept in mind for the respective use cases, for example setting up 5G in a stadium is a different scenario than the usage for cars or in traffic.

OUTLOOK

While 5G needs yet to arrive fully there are already talks about the next generation of mobile network technology, **6G**, which is expected to arrive around 2030, keeping up the typical 10-year cycle. While early reports expect a speed that is 50x higher than 5G other interesting aspects are the introduction of **terahertz**

frequencies and flexible networks with adaptable infrastructure like flying platforms and satellites. The integration of satellites, also called non-terrestrial networks (NTN), is a step that is already expected to happen at 5G levels.

Sources

[European 5G Observatory](#), [CB Insights](#), [Fraunhofer](#), [Qualcomm 1](#), [Qualcomm 2](#), [Thales](#)

CHAPTER 2:

5G IN SPORTS

Sport has always been an important driver in the **development of media consumption and associated technological advancements**. Since decades, sport has been the main driver for TV sales, starting in the early days of commercial broadcasting in the 1940s.

That time, sport was popular amongst the viewership and cheaper to produce than movies. As a result the number of households with TVs increased from a few hundred thousand to multiple millions within a few years. The next big step for sports broadcasting came later with the introduction of instant replays and slow motion; today we get to enjoy content from aerial camera systems and drones in combination with AR graphics. Tracking systems in tennis and football leave no doubt as to whether a ball was in or out or across the line or not, and photo finish technology lets us decide on a winner in even the closest races. Radar guns precisely track the speed of a baseball while American Football coaches speak with their players via modern helmet communication systems in crowded stadiums. Referees can connect their microphone to the stadium sound system and thus explain decisions to the audience. The list goes on...

It is expected that **5G technology will be the next big step** in the joint journey of sports and technology, affecting the industry in multiple areas. This chapter is meant to provide an overview of the most relevant implications.



A) MEDIA PRODUCTION & DISTRIBUTION

Today's media production and distribution activities around sports events rely heavily on both fixed and wireless technology. They have to ensure **bandwidth availability for cameras, microphones and all the infrastructure** needed to transport a live broadcast signal. Usually, the more rights holders involved the more complex this system becomes. Furthermore, applications and services for fans, athletes, coaches and teams also want their part of the network. All this takes place in an **environment of high quality** implementation of media rights where technology needs to meet high reliability standards.

IMPROVED NETWORK OPERATIONS & INCREASED AVAILABILITY

One of the **main tasks around an event is to ensure a stable connection** for all involved parties, devices and offerings. This requires certain efforts for multiple reasons:

- Over the last years more and **more wireless devices and services** entered the setup of an event broadcast, all operating in the same range of spectrums. The result: The scarcity of available ranges increases and therefore also the risk of an unstable connection
- In order to avoid conflicting usage of ranges it is common to have a **frequency coordinator** for larger events. This inevitably results in extra efforts for all parties involved and creates room for mistakes
- Last but not least: **Large crowds of fans** at the game complicate the setup. They take and send pictures, check additional match data or live tickers and of course surf the web, all of which increases the traffic on the network

Before the arrival of 5G, **vendors had implemented workaround solutions** for these challenges by setting up a range of wireless hotspots and operating multiple networks, e.g. to separate the public network from the ones for broadcasting. To run this complex system it is often necessary to operate hundreds of access points. All this **requires certain efforts and therefore also drives costs**, in order to guarantee a stable network.

Even though broadcasters have managed to establish stable and well-running setups, especially for top-level events, **5G can further improve operations in multiple ways:**

- Via network slicing, a single connection can be cut into **separate, virtual networks** and assigned to different use cases, such as the above-mentioned media, fan and operation networks. This prevents network conflicts and simplifies frequency coordination
- The **overall capacity** of 5G is 100x higher than that of 4G/LTE, securing undisturbed access for fans in the stadium —something that not even the workarounds have solved yet— and for the media

All this combined with its **ultra-high reliability**, gives 5G the potential to introduce a new era of connectivity at sports events without the need of setting up a complex construction of hotspots and operating multiple networks, ultimately leading to **higher efficiency**. What needs to be taken into consideration however, is the specific **business case for each 5G implementation**, as the infrastructure has to be set up and maintained (see chapter 1), often as a collaboration between various parties such as telco companies, venue owners, etc.

LESS CABLES & NEW FLEXIBILITY

Media production and distribution is a **cable-heavy business**. The use of cables, especially for transporting video content from the cameras to the studios, enables the highest image quality with the greatest possible reliability, but also poses a number of challenges

- **Logistics & Operations:** The heavy cables must be transported for every event and stored in between. To ensure a seamless functionality the cables have to be laid and connected, and later rolled back in for every event, demanding manual efforts. Depending on event and location, several kilometers of cables have to be managed. For high-level content the setup process can take up to several days.
- **Positioning:** In general, fixed cameras are limited in their ability to change position. For covering the action on the pitch, all camera positions are well-established. The integration of wireless cameras—such as the steadycam—and the latest developments—as with the railcam—prove the efforts to achieve more flexibility and generate new views.

5G can not only **offer some alternatives but also open up new opportunities:**

- 5G is able to deliver what 4G/LTE is not capable of: **A wireless solution that** has the **bandwidth** for HD and 4K video signals and its ultra-low latency also guarantees high **speed** connections. Furthermore, 5G is future-ready with the ability to transport even an **8K signal** if needed, opening new opportunities

Being less dependent on cables can **simplify the coverage** of sports events, especially outside of stadiums, e.g. for all types of races, golf or various action sports, where quick and free movement is necessary. Overall 5G allows for content even from **remote and hardly accessible locations as well as action-driven content** on the move and from new angles, to be transmitted. Entirely new styles and creative shots can be expected

- 5G also comes with advantages for amateur/grass-root and less-covered sports as it can make high-quality coverage more accessible through a much cheaper and simpler setup, e.g. by using 4K smartphones to livestream.
- 5G also provides options for **remote productions** and a reduction of production-related resources in and around the venues
- 5G has the potential to become an enabler **for moving cloud-based components into the production chain** for localization and post production of content as well as the preparation and handoff of streams to the broadcasters. Production studios that rely heavily on on-site physical equipment can be transformed into lighter versions and/or brought closer to the entire chain of production. While not the entire production process will be moved into the cloud, there are interesting opportunities to have a **mixed setup of classic matchday infrastructure and cloud components** that are enabled by 5G and edge computing, with data being managed closer to where it is needed and without centralized data centers. 5G and cloud production should be seen as a package in which **5G can support, but is not mandatory** for the delivery of a cloud-based production.

QUOTE

“ **On the contribution inside, 5G enables us to position additional wireless camera systems and thus added value in content generation due to the high data rates and the short delay time.**

Camera perspectives that have never been seen before, the parallel production of vertical and horizontal streams and the generation of content using “on-site multi-feed producers” and “fan-generated content” are possible. The high bandwidths in the upload also enable us to feed the content to our production systems (on premise but also in the cloud) in real time. In the future, we will be supported by 100% availability and firmly defined bandwidths to ensure quality of service.

For production and finishing, real-time feeding using 5G has the great advantage that different system components within a production environment can be used in a better and more targeted manner. For example, a mix of existing infrastructure and demand-oriented expansion using, for example, cloud systems is possible, in order to be able to determine the cost of goods for the different product groups in the content workflow chain all the more economically. Furthermore, product scalability can be implemented much faster. A targeted display of the content for different target groups is becoming more and more important, which is why the speed in the design and display of the content is imperative.

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ALESSANDRO REITANO

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USE CASES AND OUTLOOK

Media production and distribution is a complex and sensitive topic. It is therefore no surprise that **the industry is testing 5G** to ensure a flawless delivery:

GOLF US OPEN (JUNE 2018):

FOX Sports, with Fox Innovation Lab, Ericsson, Intel and AT&T streamed 4K HDR video from two cameras over 5G through the FOX Sports production truck at Shinnecock Hills Golf Club to multiple platforms. It was the first available nationwide broadcast footage using 5G technology from a premier U.S. golf event. FOX Innovation Lab published a study after the event stating “As we demonstrated in this trial, 5G is an **excellent transmission method** for moving very high bitrate 4K camera images from the green to the on-site production compound and indicates potential **cost efficiencies**. Analysis of the U.S. Open use case indicates a 5G cellular system can produce an anticipated minimum savings of 34% over current methods”.

HANDBALL BUNDESLIGA GAME SG FLENSBURG-HANDEWITT AND FÜCHSE BERLIN (NOV 2021)

Sky Germany and O2 delivered a live 5G transmission with a production that was **executed fully in the cloud** with Vizrt’s switching, graphics and sports analysis tools, all deployed in Amazon Web Services (AWS). It included a mixture of broadcast and mobile phone cameras that used an uncomplicated and simple 5G transmission, powered by LiveU, to move the action from the playing field into the cloud. In the cloud, Vizrt worked seamlessly with LiveU, ensuring that the production was **near zero latency, scalable, all with an enhanced quality** to bring the game closer to audiences.

BUNDESLIGA FOOTBALL MATCH RB LEIPZIG VS. BORUSSIA DORTMUND (NOV 2021):

Vodafone Deutschland and Sky Deutschland have successfully tested a new **Sky 5G Multiview App**. The app is designed to provide a new in-stadium experience, making exclusive content and different camera angles available to Sky subscribers in the stadium. Trial participants in the Red Bull Arena were able to **view event highlights on their smartphones from various camera angles** in the stadium. For the trial, Vodafone activated what it claims to be the fastest ‘5G Turbo’ available. The app achieved speeds of up to 2.6Gbps via the Vodafone cellular network.

All 5G tests have achieved **promising outcomes** and show the potential for a range of different applications. More of them will have to be concluded, also with larger crowds of fans in the venue. This, coupled with the fact that the respective **infrastructure in forms of towers and cells** has to be implemented (see chapter 1) means that it will **still take some time** until the opportunities can be used in the world of sports and potentially be turned into the standard mode of operation, especially when it comes to top level productions and its need for high reliability. Once that is achieved 5G has the ability to **make media production and distribution easier, cheaper and more flexible**, and can also be the basis for **new types of content and experiences for fans**.

Sources

Digital TV Europe, FOX Sports, Intel, Kearney, Mebucom, Sky, SVG 1, SVG 2, TVU Networks

B) FAN EXPERIENCES & SERVICES

The very **core of sports has always been the matchday and the fans**. This is especially true for the venue or place of action itself, but also for the viewer at home, in a bar or on-the-go, and independent from whether sports is watched alone or with friends, colleagues or families. Sports teams rely on matchday visitors and revenues, while broadcasters, amongst others, need their audience to compensate for the acquisition of rights. Thus, the classic question around the sports industry is: How to **attract and retain** fans for live games, both at the venues and in front of screens? And in modern times specifically: How to **engage the**

hyper-connected millennials in the battle for attention against streaming services and other content creators? This was pushed further in recent times when the pandemic challenged the connection between sports and its followers (according to Nielsen data for 2020, viewership for the NBA finals went down 51%, for the NHL finals 61%, the U.S. Open 45% and the Super Bowl had the lowest ratings in the last 15 years - all while streaming services outside of sports went up 50% in the same year). **5G offers a range of new options** and has the potential to **influence the way sports is consumed** and how consequently, audiences are attracted.

1) VENUE-RELATED

NETWORK ACCESS

The most obvious point first: Getting a good **network connection in a crowded stadium can be a big challenge**, complicating the act of sending even a simple text message. This is true for both 4G/LTE and for many of the WiFi offerings of today's venues. For the **modern, ultra-connected, content-consuming fans** this is a challenge, as they want to also follow other games, chat with friends, share impressions around the stadium visit, order a taxi after a game or check the public transport connection. In order to meet their visitors' needs, especially when compared to the viewing experiences at home or on-the-go, venue operators are asked to offer a seamless connectivity. 5G promises to not only **solve the network issue with its higher capacity** compared to 4G/LTE but also **add significantly improved speed** to the mix, enabling fans to interact and consume the content they want while being in or around the stadium.

NEW EXPERIENCES

While a good network access ensures that the minimum expectations of fans are met, 5G also offers the **opportunity to bring enhanced experiences to the fans in the stadium.**

- A reliable high-speed connection within and around the stadium can **deliver entertainment elements** to the fans' devices. A big role in this area could be played by **Augmented Reality (AR)**. The technology allows experiences like taking selfies with favorite players, projecting holograms onto the stadium grounds or even entire AR worlds in which fans can virtually walk through the stadium. But the connectivity and speed of 5G open up **the opportunities for interaction and participation** wherever a sufficient connectivity has not been in place before. Fans can then be involved in **polls and games** that can be displayed on their devices or the large screens within the venues. An example would be a **voting between fans** in the audience about which player scores the next goal. Winners could then be rewarded with giveaways or discounts in the fan shop.
- But 5G also holds a range of exciting new opportunities **for the game itself**. In order to get the **most relevant stats** in real time or to identify which player is which, fans have to only hold up their phones and point them towards the game. Now that they are enjoying a real-time, reliable high-speed connection, fans can even **review the action on their phones**. As 5G allows for the easier deployment and involvement of more cameras in the venue, each fan can potentially even decide from which of the **different cameras and angles** he/she wants to see specific scenes (including slow-motion and the option to zoom in and out), **independent from the director's** decision on what to show the broad audience. All this being possible from their mobile devices.

- On top of this, 5G allows for **entirely new impressions**, as scenes and emotions can be captured spontaneously through standalone 5G cameras, whenever opportunities occur. This can lead to a more **agile and flexible content approach** bringing an experience that feels closer to the game than ever before.

5G can enable the **digital personalization of the matchday experience**. While this is currently only possible via 5G smartphones, the developments of AR glasses and at some point even AR lenses, promise increasingly more **seamless and immersive** experiences.

THE CREATOR FAN

Much has been said about today's **creator's economy** in which millions of independent individuals post a variety of content to their very own audiences, sometimes even making a living out of it. Seamless connectivity within venues **allows creators to connect with the live experience** in multiple ways.

- Fans can **share their excitement around their gameday experience** with friends – within regulations and media as well as event rights.
- Broadcasters and teams can benefit from this very personalized approach and additional reach of generated content, e.g. by showing the emotions from the ranks. Taken to the extreme, **content from select fans' devices can even be included as part of the livestream**. Many of today's phone cameras already come with 4K video quality, allowing broadcasters to enrich the viewing experience for the fans in front of the screens.

NEW SERVICES

All game and content related advantages aside, there are also a **range of services that can be introduced** with 5G which make the venue experience for fans **more personalized, convenient and safe**.

- The **way to and into the stadium** can be optimized. Starting with smart parking systems that indicate the easiest way to a free spot, 5G enables venue operators to deliver real-time information on the **parking and traffic situation through use of a large number of sensors**, in the best case even connected to a ticket holder's seat in the venue so that the route there is taken into consideration as well. And once self-driving cars become a reality, the way to the parking lot should be one smooth experience. When moving towards the venue the attendees will be able to receive real-time updates on **which queues are congested** and where the best place to enter is.
- Other applications will affect **access to and movement around** the venue. 5G simplifies opt-in **recognition technology** to identify registered ticket holders and allow them to quickly pass checkpoints in order to **keep the lines moving**. This is made possible by utilizing multiple cameras and ultra-low latency instead of cable-based solutions. These cameras can also be used to **scan for suspicious behavior** within the crowds and identify specific situations or persons, all within the data protection regulations. Additionally, **health aspects** can be included in the screening process, e.g. by implementing thermal-imaging technology that scans for elevated temperatures in large crowds without interrupting the flow of traffic, made possible by moving computing power to the edge.
- To **support stadium visitors**, graphical **AR overlays** on smartphones can **display directions** to help with finding seats, restrooms and concession stands, similar to the navigation systems in cars. **Food & beverage management** can also be improved, with use

cases like orders and deliveries right to the seats, potentially through targeted deals based on previous purchases and **other applications** like upgrading tickets within the stadium, paying for the parking ticket and even adjusting the seat heating.

Seamless connectivity within venues opens possibilities for **personalizing the stadium experience**, i.e. through interactions and AR overlays. It lets fans access **enriched content and services and curate their own experience**, involving them in the media mix as they become **empowered to create authentic, creative content** right from the point of action. From a business perspective this can help to pull fans not only into the venues but also in front of the screens, opening up new monetization options.

QUOTE

“ **We are happy that our Allianz Arena has been upgraded with the new 5G cellular standard. This service enables fans and visitors to receive and send high volumes of data much faster.**

This is the basis for further innovative functionalities that we will offer in the future. For example, augmented reality (AR) or virtual reality (VR) are only conceivable with this technology standard. Fans could then virtually arrive with the team as the twelfth man or participate in the celebration of the goal. Virtual competitions among the visitors and much more are now also conceivable. The sports experience and the visit to the Allianz Arena will be even more intense.

”



STEFAN MENNERICH

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2) REMOTE CONSUMPTION

5G inside the venue will also benefit those watching remotely and change the way in which some fans engage with broadcast productions. Below are the most important areas.

MORE CHOICES, MORE INDEPENDENCE

Not only will the fans in the venue have more options to choose from, but also the remote viewer can benefit from a **5G-supported media production**, if the broadcaster decides to implement such an offer. Running multiple streams simultaneously is not a new development, however, with 5G **every single viewer could be given the choice between multiple cameras or receive a fully personalized stream**, allowing them to see

the action from different points of views and locations. Such a service can be supported especially by additional wireless cameras in the stadium, delivering angles that were not or hardly accessible before via a 5G-connection. Switching to feeds that are licensed live streamed by fans from within the venue or exploring alternative commentary are other plausible offerings.

MIXED REALITY

The need for high-end hardware has been a hurdle for mass-adoption of Mixed Reality (MR) broadcast offerings such as Augmented Reality (AR) and Virtual Reality (VR) around sports. The ability of 5G to seamlessly connect (wireless) devices and broadcast data-intensive content with ultra-low latency in real-time can change this and allow **new ways of interactivity**.

- 5G simplifies capturing and sharing **volumetric content**, a visual representation in three physical dimensions - instead of planar content - which is displayed on 3D displays or viewed through AR or VR devices. This can be used for content **around the game**, e.g. for so-called 'holo interviews' where holograms of players are displayed in the viewer's environment, allowing them to move around and view the interviewees as they please. The same can be done with the **game itself** which is then shown as a live hologram, including graphical overlays and replay functionality. 5G can also be a **door opener for the Metaverse**, data-intensive virtual worlds which fans experience as digital avatars.
- An increased rendering rate through 5G enables high-quality **VR content**, bringing **viewers who can't physically be at the venue** closer to the game. Rights holders like the NBA and Euroleague Basketball have

tested **virtual tickets** to watch live content from afar, also **special experiences** like virtual stadium tours, VIP boxes and physical 5G lounges in various locations that provide VR headsets and create meeting points for like-minded fans are possible. These examples show the potential of VR as a **social enabler** for viewers who are not in the same location, e.g. friends living in different places. However, in order to generate a true value for fans the **right offering has to be selected** based on user adoption.

Giving fans the ability to make their own content decisions around a live broadcast and involving mixed reality options complements the existing TV delivery and **allows media partners to offer a more interactive, immersive and personalized experience** to their customers. At the same time it opens possibilities for **experimental production formats and alternative storytelling** angles. This combination promises to especially be a great **fit to the needs of the younger demographic** of sports fans who appreciate innovative and entertaining formats.

QUOTE

“ **Due to the low latency and significantly increased capacity 5G will help augmented reality applications achieve a breakthrough in sports. Such applications can be used both as a supplement during the game, but also before, during the breaks or afterwards for various use cases. The increased upload capacity combined with network slicing will also create new opportunities in the area of TV production (“remote production”). While production is still expensive and complex today due to various cabling, we can offer broadcasters more flexibility and additional application options with 5G**

Together with the DFL, Vodafone has developed a 5G-based augmented reality app for stadium visitors. In this way, we combine the emotional stadium experience with the digital world: fans can use the app in real time to call up a large number of statistics directly in the stadium via augmented reality. For example the current speed of the player or the distance already covered. Together with Airbus, Vodafone remotely controlled a 12-meter airship over the 5G network. The control signals are transmitted to the airship in real time via 5G cellular technology and executed ”

MICHAEL JAKOB REINARTZ

Director of Innovation & Consumer Services
Vodafone Deutschland



USE CASES AND OUTLOOK

What holds true for the production and distribution side also applies to the consumer perspective of 5G: It is **a sensitive endeavour that needs to be tested** before making it available to larger amounts of fans in venues and in front of screens. Here are some test cases:

SUPER BOWL (FEBRUARY 2021)

Verizon gave the Raymond James Stadium in Tampa a \$80m upgrade with 281 low power small cell antennas, free charging stations, and network boosters for first responders. The audience was able to enjoy **seven HD data streams** from stadium cameras to their phones while viewers at home had access to five angles. These streams allowed for simultaneous closeups of the players and the field, the “SkyCam” panorama, and AR overlays of NFL’s Next Gen Stats for players.

MLB POSTSEASON COVERAGE (OCTOBER 2020)

FOX Sports and Samsung delivered a 5G-enabled experience by implementing **more than 90 additional proprietary cameras** inside of Globe Life Park at Arlington, home to the NLCS and the World Series. Through an app-based **interactive video-player** fans were able to rotate around the action and to zoom in/out during the live games to have a better/closer look. They also had access to five new and unique camera angles on the field as well as highlights and a rewind feature during the game, effectively turning them into their own content director.

NBA CONFERENCE FINALS (OCTOBER 2020)

While the NBA playoff games were played in the so-called, pandemic-caused ‘bubble’, AT&T, TNT and ESPN partnered to connect analysts that were located in their studio in Atlanta with **interviewees** in Orlando by using 5G-enabled **holograms**. The respective counterparts appeared in **near real-time with lifelike clarity** and allowed for a natural interaction between each.

BUNDESLIGA FOOTBALL MATCH (SEPTEMBER 2019)

The DFL Deutsche Fußball Liga and Vodafone activated the 5G infrastructure in the VOLKSWAGEN ARENA as part of a live demonstration for the home match of VfL Wolfsburg vs TSG 1899 Hoffenheim. Select guests in the stadium tested the prototype of a **new real-time app** that was created together with immersiv.io. Spectators at the stadium received, among other things, **match statistics and individual players’ data** directly on their smartphones. In the future, spectators will be able to see further real-time insights.

The tests indicate that **5G will lead to new partnerships** between the sports industry and broadcasters, telecom operators and technology providers and offer opportunities to engage with fans. So far the **focus has mainly been on the content angle**, which is understandable given the fact that the attention of each fan is a rare commodity. But new in-venue services are expected to follow soon, especially when able to **drive monetization** for the involved parties. In either case it seems crucial to keep the fan in focus, both from an engagement and convenience point of view, in order to make the experience around the venue and in front of the screen **personal and exciting**. For stadium visitors however, one prerequisite is crucial for a potential mass adoption: **5G-ready smartphones are needed** in order to enjoy the new possibilities, which currently is seldom the case, but is expected to develop into the standard over time.

Sources

ATT, Bloomberg/Nielsen, DFL, Forbes, FOX Sports, Immersiv, Nokia, SVG, VentureBeat, Verizon 1, Verizon 1, Verizon 3

C) ESPORT

eSport has secured its spot in the world of sports with a **captive global audience of more than 300 million and revenues of over USD 1 billion**, according to the World Economic Forum. Market researcher Newzoo estimates that there are **over 3 billion gamers in 2021**, of which 2.8b are on mobile, 1.4b on PC and 0.9b on console (with many of them using multiple devices). It has become a societal trend that creates demand for the established sports brands and competitions, who as a reaction, found teams, organise competitions and create content and offerings for the respective target audience. 5G can have an impact on various elements.

PROFESSIONAL PERFORMANCE, EVEN ON MOBILE DEVICES

With a growing audience and bigger amounts of prize money at stake players look for **possible opportunities to improve their performance and to gain a competitive advantage**. 5G offers a range of options:

- In eSport even a **slightly delayed reaction can sometimes decide between a win or loss**. Example: A South Korean Dota 2 team relocated to Singapore in order to upgrade in network latency from 0.16 seconds to 0.06 seconds. 5G offers ultra-high latency as well as **network stability and high-speed connections**.
- **5G and edge computing** save processing power on the gamers' devices by offloading it onto data hubs and help with **synchronization** between multiple devices and players. The result is a **lag free, faster gaming experience** and a reduced dependency on a strong WiFi or ethernet connection.

- With 5G the computing power does not necessarily have to sit within **expensive training centers** anymore. This is considerable when a team cannot train in the same physical location or while traveling which often involves bad network connections, e.g. due to unoptimized WiFi and or unavailability of 4G/LTE.

5G can further increase the level of professionalism for top level eSport teams. And it has another effect: While most competitions are played on high-power PC, mobile-based eSport is a small but already rapidly growing sub-industry. 5G can potentially further **blur the lines between competing with a PC and a mobile phone**. This will make high quality gaming **available to a wider audience, allowing millions of aspiring gamers to participate** in tournaments. For top level teams this will affect their recruitment efforts and open the **opportunity for overlooked talent**.

GAMING GETS PHYSICAL

While 5G helps to ensure high-quality environments for professionals and can make top-level gaming accessible for aspiring gamers it can also have an **effect on how games are played**:

- By outsourcing the processing and removing redundancies 5G can lead to a **more enjoyable AR experience**, requiring less battery power. **The same is true for VR** gaming, which depends on fast feedback and response times to provide a realistic experience. 5G's ultra-low latency and increased rendering rates promises to enable **lag-free, immersive in-game experiences**.
- With 5G's capability to include more sensors and devices, and its ultra-low latency, **wearables can be embedded in a deeper way**. Games will have the option to include gloves, shoes and other equipment to incorporate **lifelike haptic feedback** into virtual worlds, in the best case leading to **fun and realistic** experiences. This potentially also makes games **more physically demanding**.

The above mentioned topics **bring a physical component into gaming**. AR demands you to move around, especially when done correctly and when it is engaging, while wearables bring games closer to exercise formats, potentially even requiring a certain fitness level of a person. This also **follows the global "exergaming" trend** where exercises and gaming elements merge into one offering.

NEW EXPERIENCES FOR FANS

eSport has developed into a **spectator sport**, largely due to **streaming platforms** like Twitch, which lets fans watch their favorite games and players. 5G can bring some new elements to this experience:

- Firstly, most of **what has been said before for traditional sports is true for eSport as well**: 5G's ability to transport large amounts of data with high speed allows for multiple streams from different angles simultaneously, giving the fan the option to choose what he/she wants to watch. The inclusion of AR and VR elements is also simplified with 5G.
- Above mentioned streaming platforms have been a great tool for eSport professionals to **build an audience and their personal brand**. Most top players now have a certain number of streaming hours written in their contracts, something that can become tricky due to packed schedules. 5G allows them to **stream in higher quality from their mobile devices** as compared with 4G/LTE, wherever they are and whenever they have the time for it.
- With 5G being an alternative to fixed broadband connection for tournaments, professional gaming can even **take place in locations where it has not or only hardly been possible** before, e.g. in busses, planes or rooftops, potentially bringing the action closer to the fan or creating entirely new setups.

The rules of today's attention economy apply for eSport as well, with an audience that demands to be entertained. 5G can bring **new elements and locations and more choices to the fan**, while helping the eSport professional to build and **strengthen their community**.

USE CASES AND OUTLOOK

Also in eSport it is crucial to run extensive 5G tests to learn about possibilities and limitations. Such tests and partnerships have been conducted in **various fields**:

MADDEN NFL MOBILE (2021)

Verizon and EA SPORTS are joining forces to launch a special EA SPORTS Madden NFL Mobile version. The partners will use Verizon's 5G labs to test and optimize gameplay and establish new standards in the future of gaming, with the goal to create a mobile game that will create the most dynamic player experiences while playing over a 5G network.

ESPORT TRAINING FACILITY (2020)

Verizon and Dignitas entered a strategic partnership to launch a 5,500-square-foot, state-of-the-art practice facility in Los Angeles, powered by Verizon's 5G Ultra Wideband network, this will be the home base for Dignitas' League of Legends teams. The goal is to explore how 5G can enhance the fan experience and player performance.

MILAN GAMES WEEK (2019)

The finals of the "Vodafone 5G ESL Open Mobile" was the first live mobile gaming tournament that took place over 5G network, with 40+ players playing in front of 200,000 visitors and hundreds of millions watching on Twitch, Facebook and YouTube. Milan was a pilot city for Vodafone's 5G trials ahead of the rollout and therefore used for this test case.

Tournament organizers, training centers and other commercial partners will have a close look at 5G use cases in order to **t** and to ensure future-readiness. Just as in traditional sports, new partnerships are expected to be closed, including potential new revenue streams.

Sources

[Dignitas](#), [Ericsson 1](#), [Ericsson 2](#), [Kearney](#), [Newzoo](#), [Polygon](#), [Techcrunch](#), [Verizon](#), [Vodafone](#)

CHAPTER 3:

EFFECTS OF 5G ON THE SPORTS INDUSTRY

As shown in the previous chapter, 5G can be embedded into the sports ecosystem in various ways. But stakeholders should not just rush into 5G for the sake of it and without a clear plan.

Before doing so it is worth having a look at touchpoints and potential effects, in order to identify promising opportunities and to be aware of risks. Advancements in technology, especially when still in early stages of adoption like 5G, typically come with a tempting upside potential, but should also be tested intensely and treated with caution.

What has become clear over the course of this white paper is that 5G can have an effect on the industry's business models, as it comes along with changes in how media content is produced and distributed and how/which fan experiences and services are designed and offered.



AFFECTED AREAS

MEDIA PRODUCTION & DISTRIBUTION

- **Network Access:** 5G promises to not only solve the network issue with its higher capacity compared to 4G/LTE but also adds significantly improved speed to the mix, enabling fans to interact and consume the content they want while being in or around the stadium.
- **New Experiences:** 5G enables seamless connectivity within venues and opens possibilities for personalizing the stadium experience, i.e. through interactions and AR overlays. While this is currently only possible via 5G smartphones, the developments of AR glasses and at some point even AR lenses, promise increasingly more seamless and immersive experiences.
- **The Creator Fan:** 5G lets fans access enriched content and services and curate their own experience, involving them in the media mix as they become empowered to create authentic, creative content right from the point of action. Broadcasters and teams can benefit from this very personalized approach and additional reach of generated content.
- **New Services:** 5G enables venue operators to deliver real-time information around the matchday, i.e. on the parking and traffic situation. Other applications will affect access to and movement around the venue, i.e. to identify registered ticket holders and allow them to quickly pass checkpoints in order to keep the lines moving. To support stadium visitors, graphical AR overlays on smartphones can display directions to help with finding seats, restrooms and concession stands.

REMOTE CONSUMPTION

- **More choices, more independence:** With 5G every single viewer could be given the choice between multiple cameras or receive a fully personalized stream, allowing them to see the action from different points of views and locations. This complements the existing TV delivery and allows media partners to offer a more interactive, immersive and personalized experience to their customers.
- **Mixed Reality:** 5G simplifies capturing and sharing volumetric content. An increased rendering rate through 5G enables high-quality VR content, bringing viewers who can't physically be at the venue closer to the game. This also opens possibilities for experimental production formats and alternative storytelling angles.

ESPORT

- **Professional performance, even on mobile devices:** 5G can further increase the level of professionalism for top level eSport teams through ultra-high latency as well as network stability and high-speed connections. And it can further blur the lines between competing with a PC and a mobile phone, contributing to the already growing mobile-based eSport sub-industry.
- **Gaming gets physical:** 5G can lead to a more enjoyable AR experience and a deeper embedding of wearables. This brings an entirely new physical component into gaming, following the global "exergaming" trend where exercises and gaming elements merge into one offering.
- **New experiences for fans:** 5G can bring new elements like camera angles or locations and more choices to the fan, while helping the eSport professional to build and strengthen their community.

EXPECTED EFFECTS

COST SAVINGS

5G can contribute to operational cost savings, mainly with regards to the media production and broadcasting side. This specifically targets the workaround solutions that have been implemented to ensure a stable and high-performing wireless network within venues (see chapter 2a), with 5G's potential for improvement already indicated in real-life tests, e.g. at the Golf U.S. Open in 2018.

NEW B2B PARTNERSHIPS

At its core 5G is mainly about live sports on matchday and incorporating the technology into the venue is the base for most use cases. Therefore the availability of 5G for fans and stakeholders is a key prerequisite. In order to secure this availability, stadium operators and telecommunication providers will enter partnerships to equip venues with the necessary infrastructure (see chapter 1). This can already be witnessed around the globe, e.g. with Bayern Munich's Allianz Arena and Deutsche Telekom or the SoFi Stadium in Los Angeles and Verizon. It is to be expected that in the not-so-far future most major sports venues will have entered these kinds of relationships.

But the enhanced experiences and upgraded services that come along with 5G also open the door for new sponsorship engagements. On the easiest level advertisements can be involved into the 5G offerings for fans within the venue, who can now be reached on a broader scale. Preferred partners or a bundling of offerings are thinkable as well, e.g. with local transportation or accommodation companies who want to reach fans during and after the game or special prizes for all current or upcoming 5G customers.

NEW B2B PARTNERSHIPS

5G can create both new experiences and services for fans within venues, removing obstacles and adding some extra value (see chapter 2b). The overarching goal is to build a service and experience ecosystem that enhances and personalizes the visitor's experience, ranging from access to the venue, the action itself to a smooth exit of the venue.

Already the sheer availability of a good and stable internet connection on matchday helps fans to share their experience via social media, potentially contributing to a good brand perception and indirectly supporting ticket or merchandise sales. An important task for the industry is to foster this process, e.g. by initiating creative initiatives and rewarding fans for participating.

More connected visitors also means more data to analyze and to find trends, e.g. regarding arrival and departure times, movements around and within the venue and food and beverage consumption. This is an opportunity to personalize offerings and to stay connected with fans after the game. Of course all this needs to happen within data & privacy regulations.

5G-boosted productions can also enhance the viewing experience at home or on the go, especially through new insights, angles and choices that the viewer gets (see chapter 2b). For streaming services this is an option to create additional offerings on top of the existing ones, giving fans the option to personalize their content. Venue operators and clubs can offer new experiences such as virtual stadium tours that can also happen independently from the matchday, likely a tempting offer for international fans who live too far away to visit in-person.

QUOTE

“ **5G has the potential to affect a broad range of industries and sports is no exception. Our goal is to guarantee global coverage of German professional football with the highest possible value for our fans and commercial partners and we therefore are excited about the possibilities that 5G presents.**

We believe that new offerings and services both on the broadcasting and viewer side can increase the value of our product on a domestic and international level. However, our approach is to test technological advancements extensively before they eventually develop into a standard mode of operation. In the case of 5G we have been active for multiple years already and the outcomes of our tests in a professional match environment have been very encouraging. We are well prepared and optimistic about a 5G-supported sports world.

”

STEFFEN MERKEL

Executive Vice President of Audiovisual Rights
DFL Deutsche Fußball Liga



SUMMARY

As shown in the previous chapter, 5G can be embedded into the sports ecosystem in various ways. But stakeholders should not just rush into 5G for the sake of it and without a clear plan.

Before doing so it is worth having a look at touchpoints and potential effects, in order to identify promising opportunities and to be aware of risks. Advancements in technology, especially when still in early stages of adoption like 5G, typically come with a tempting upside potential, but should also be tested intensely and treated with caution.

What has become clear over the course of this white paper is that 5G can have an effect on the industry's business models, as it comes along with changes in how media content is produced and distributed and how/which fan experiences and services are designed and offered.

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