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5G Network in Media and Entertainment

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ABSTRACT

5G is the promise of a tetherless world. It often tops the list of the many up-and-coming technologies discussed today. Innovators and technologists are investigating its potential across numerous industries, and one of the most prominent industries to come up is the media and entertainment industry. 5G technology is set to revolutionize the media and entertainment industry by enabling faster data transfer speeds and lower latency, leading to enhanced streaming quality, immersive experiences, and new content creation possibilities. As media and entertainment businesses explore 5G's potential, they are focusing on promising use cases in four areas: immersive and interactive media, streaming, live and remote productions. By unleashing the power of private 5G networks, media and entertainment studios can leverage the agility, speed, and security needed to ride the next wave of cutting-edge use cases. This paper explores several applications of 5G in the media and entertainment industry.

Key Words: 5G network, 6G, 7G, Media & entertainment (M&E), M&E industry.

1. INTRODUCTION

Delivering digital media, entertainment, and advertising material have historically been problematic due to technical limitations, such as slow and unreliable networks. Since the dawn of broadcasting, technology advancements have enabled the industry to continually create ever-more entertaining and informative experiences for audiences everywhere. In today's competitive market, virtualized production environments, AI-generated imaging, remote streaming connectivity, and other advanced digital technologies are key enablers for media and entertainment providers. The entertainment industry has always been one of the quickest industries to adopt the latest technologies with 5G being no exception. This technology has the potential to transform the way content is created and consumed [1]. 5G can bring fundamental change to the entertainment broadcasting industry.

In recent years 5G has very much been the talk of the technological town in general and increasingly in the media industry. The rollout of 5th generation networks (or 5G), has caused a seismic shift in the world of media technology since becoming widely available to the public in the early 2020's. People expect it to play a significant role in live production and contribution as well as distribution to consumers. The media and entertainment industry is undergoing rapid digital transformation, exploring the potential of emerging technologies like 5G. The advent of 5G is certain to further the already developing entanglement between technology and entertainment companies.

5G network shows great promise in solving several issues on both the production and consumption end of media and entertainment. 5G promises, among other things, data speeds 100 times faster than 4G, 10 times lower latency, 100 times more network capacity and significantly more reliable connections. Faster download speeds and lower latency will produce high-quality, interactive video experiences without any form of interference.

Figure 1 shows the symbol of 5G [2], while Figure 2 shows how 5G will impact industries [3].

2. OVERVIEW OF 5G NETWORK

5G is the fifth-generation wireless cellular technology that will provide faster and more reliable communication with low latency. Compared to its predecessor, it is estimated that the 5G mobile network allows 1,000 times more data transmission compared to 4G.

Like its predecessors—3G, 4G, and 4G —5G utilizes radio waves to transmit data.

Evolution from 1G to 5G is depicted in Figure 3 [4], while the relationship between 3G, 4G, and 5G is portrayed in Figure 4 [5]. Like any other cellular network, 5G

networks send data through radio waves and operate on a cellular infrastructure, where geographic regions are partitioned into cells, each supported by an antenna and a base station. Each cell is connected to a network backbone through a wired or wireless connection. 5G may transmit data over the unlicensed frequencies currently used for Wi-Fi. It promises a smarter, faster, and more efficient network. The goal of 5G is to have far higher speeds available, at higher capacity per sector, and at far lower latency than 4G. To increase network efficiency, the cell is subdivided into micro and pico cells [6]. 5G will be a new mobile revolution as it is expected to provide gigabit-per-second data rates anytime, anywhere. 5G uses towers, as typically shown in Figure 5 [7]. 5G towers are telecommunications sites capable of transmitting 5G signals for wide-area coverage. 5G cell towers use a combination of low, mid, and high-frequency bands for various connectivity use cases. Towers themselves are not 5G; it is the equipment on the tower that makes it 5G. Figure 6 shows how 5G works [8].

In a 5G wireless network, every mobile phone will have an IPv6 address depending on the location and network being used. 5G utilizes the user-centric network concept World Wide Wireless Web (WWWW) instead of operator-centric as in 3G or service-centric as in 4G [9]. WWWW will be capable of supporting applications and services and interconnecting the whole world. 5G includes the latest technologies, such as cognitive radio, the Internet of things, nanotechnology, and cloud computing.

The key features of 5G include high throughput, improved spectrum efficiency, reduced latency, better mobility support, and high connection density. 5G technology has the following advanced features [10]:

- Architecture will be device-centric, distributed, programmable, and cloud-based
- High data rates
- One to 10 Gbps connections to endpoints
- One millisecond end-to-end round trip delay
- Low battery consumption
- Better connectivity irrespective of location
- Larger number of supporting devices
- Lower cost of infrastructure development

Some of these features are illustrated in Figure 7 [11]. The development of 5G will not be from scratch but will gradually build on 4G LTE. Major technologies enabling 5G include:

- *D2D Communication*: Direct connectively is achieved through device-to-device (D2D) technology. 5G cellular network will implement D2D mm wave communication technology to provide high-speed data rate, improve coverage, and offer peer-to-peer services. Much research has been invested in characterizing D2D connections as part of LTE [12].
- *M2M Communication:* While D3D communication targets mobile radios, machine-to-machine (M2M) expands the scope and facilitates ubiquitous connectivity among mobile devices. It is estimated that there will be over 100 billion connected devices using M2M communications in the 5G backbone [13].
- *MIMO:* Multiple-input-multiple-output (MIMO) technology plays a crucial role in 4G and is expected to play an important function in 5G. Massive MIMO extracts the benefits of MIMO on a large scale by increasing the throughput and spectrum efficiency.

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Other enabling technologies of 5G include mmWave communication, ultra-dense network (UDN), all-spectrum access (ASA), OFDM (orthogonal frequency division multiplexing), and the Internet of things. Industries that use 5G technology are shown in Figure 8 [4].

This section would be incomplete without mentioning the successors of 5G [14]:

- *6G Network:* Fifth-generation cellular technology is replaced by sixth-generation wireless or 6G. The bandwidth and latency of 6G networks will be significantly higher than those of 5G networks due to their ability to operate at higher frequencies. The main purpose of 6G internet is to provide communications with one-microsecond latency. 6G will employ satellites to connect the current 5G networks.

- *7G Network:* Globally, the 7G Network provides a faster means of communication. The advanced cellular technology that will be the successor for 5G and 6G. A 7G network is the quickest way to make a call, whether it is local or international. Voice over Internet Protocol (VoIP), or 7G, requires access to all local and international telecommunications. 7G will be able to satisfy the requirements of extremely high bandwidth, almost zero latency, and universal integration. Although 7G will not be generally available until 2030, a handful of countries are currently using it. These include Norway, Netherlands, South Korea, and Hungary. They are the nations in the world to provide the fastest Internet speeds.

3. 5G NETWORK IN MEDIA AND ENTERTAINMENT

In today's fast-paced digital world, technology continues to evolve at an astonishing rate. With its promise of lightning-fast speeds, low latency, and enhanced connectivity, 5G is set to revolutionize the media and entertainment industries by facilitating new types of content creation and consumption, and by opening up existing markets to enterprising new players. As 5G technology takes root in North America, it presents transformative opportunities for media and broadcast companies, especially those in the middle-market sector. 5G will bring astonishing growth to the media and entertainment industries over the next few years. The enhanced, 5G networks have enabled users with faster streaming, new interactive experiences, including a revolution in mobile gaming, content creation, and accessibility by connecting all our internet connected devices more seamlessly. As shown in Figure 9, 5G is transforming entertainment landscape [15].

Perhaps the clearest implementation of 5G in the immediate future will be the enhancement of streaming services. Today, we have become accustomed to streaming apps providing the majority of our favorite series. As the power of 5G connectivity becomes harnessed by the streaming world's leading apps, viewers can expect a revolution in how shows and movies can be watched, particularly on the go. 5G also brings greater network capacities that enable more ultra-high-definition (UHD) content for fully immersive streaming experiences. Through the use of integrated technology, we may soon see streaming services offer real-time entertainment experiences such as live or on-demand concerts, movie premieres, sporting events, and multiplayer video games [15]. As shown in Figure 10, 5G will change the business of media and entertainment [16].

4. APPLICATIONS OF 5G NETWORK IN MEDIA AND ENTERTAINMENT

5G opens new pathways for the media and broadcast sector to push boundaries, enhance viewer experiences, and drive operational efficiency. By leveraging the capabilities of 5G, companies can enhance service delivery, streamline operations, optimize costs, and spur innovation, positioning themselves advantageously in an increasingly competitive landscape. Common application areas include the following [17-20]:

- *Live Productions:* Today's live productions can be complex, costly, and infrastructure-intensive endeavors. A vast array of resources and personnel are required to shoot a television show on location or broadcast a sporting event in progress, including production trucks, miles of cabling, specialty field gear and, of course, a full crew to configure it, operate it, maintain it, and then tear it all down again afterward. 5G network slicing could allow media and entertainment businesses to deliver live productions over the cellular communications network without compromising on the high standards that are required.

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- *Remote Production:* Remote production involves filming a scene or a live event at one location and production and dissemination of that content happening at a different location. With remote production, filming is typically done with multiple remotely operated cameras that feed data to the cloud or a production facility where it is further processed and transmitted. 5G remote production offers the same reliability of cables with the convenience of being wireless. It also has the capability of transmitting data at a faster speed without compressing to maintain higher quality. Media and entertainment businesses could also use 5G network slicing to transform remote production workflows. In addition to ensuring cost-effective live production capabilities, this technology can also allow remotely located personnel to mix and edit content just as quickly and efficiently.

- *Content on Demand:* Content on demand is one of the most significant developments in media and entertainment over the last few years. As audiences demand superior quality, no buffering, and no outages, the adoption of 5G networks by content creators has become imperative. 5G offers the added advantage of seamless content streaming even in congested areas.

- *Power Streaming:* Our next generation will grow up in a world where they know nothing less than high speed, highly reliable connectivity. 5G will bring about new ways in which the younger generation consumes content thereby leading to new and innovative ways of content creation. The next generation of super creators will be able to take things to the next level with 5G.

- *Immersive Media*: Augmented reality (AR), virtual reality (VR) and the combination of the two called mixed reality (XR) are a new and much sought-after form of entertainment. Sports leagues and entertainment companies are exploring 5G network slicing's potential to bring the metaverse to life, beginning with fan experiences involving extended reality (XR) technologies such as AR and VR. Immersive experiences will rely on high-performing 5G network connections that can meet the low latency requirements associated with AR and VR environments.

- *Cloud-Based Gaming*: 5G has opened a world of possibilities for the rapidly growing gaming industry. 5G technology has the ability to create a platform-agnostic experience in gaming through cloud gaming. 5G is also the catalyst for a mobile gaming revolution, allowing gamers to play on-the-go with previously unseen connectivity and speed. The high speeds and low lag times of 5G are expected to provide a breakthrough for cloud-based gaming. 5G allows for cloud-based gaming, enabling users to stream games from remote servers with minimal latency. Cloud gaming services, like Steam, Xbox Live, and NVIDIA GeForce Now, can deliver a vast library of games to mobile devices. Video games require the transmission of large amounts of data and minimal latency in transmission for optimal playing experience. With 5G, complex processing can be done at a centralized server and transmitted seamlessly, directly to consumers. Perhaps more interestingly, video game developers may themselves decide to market directly to their customer base. Figure 11 shows an example of gaming [21].

- *Over-the-Top TV*: Another sector of the entertainment industry marked by a small number of dominant players is television distribution. With relatively few cable companies in a given area, consumers generally face little selection when choosing a television provider. Although over-the-top television (“OTT TV”) has been gaining momentum in recent years, the attractiveness of these offerings has been limited by the fact that OTT TV service is currently still dependent on a hard-wired Internet connection. This has allowed cable companies to preserve their role across both the television and Internet service markets, and has constrained the value proposition of OTT TV.

5. BENEFITS

One of the key benefits of 5G network is its ability to handle high-bandwidth content, such as VR, AR and XR. 5G could help open up new business opportunities for the media and entertainment sector. 5G technology is set to revolutionize the way we consume media and content, with its faster speeds, lower latency, and enhanced connectivity. As the demand for video quality and the loading speed is rising, 5G technology has become mainstream. Other benefits of 5G for media & entertainment include the following [22]:

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- *Personalized Experiences*: A key advantage that 5G supplies streaming services over traditional digital viewing comes in the form of personalization. For customers and businesses alike, personalized ads can help bring relevance and build better viewing experiences. 5G-powered networks can deliver personalized content and advertising, leading to increased viewer engagement and revenue opportunities. 5G can help make ads more intrinsic and personalized.

- *High-Quality Video Content*: One of the most significant advantages of 5G technology in the realm of media and content is its ability to support higher-quality video content. However, the bandwidth limitations of previous generations of wireless technology have often resulted in buffering issues and reduced video quality. 5G technology eliminates these concerns by providing faster speeds and greater capacity, allowing for uninterrupted streaming of 4K and even 8K resolution videos. 5G allows for higher-resolution streaming with minimal buffering and lag, offering a superior viewing experience. With the improvement in bandwidth and lower latency, media companies will be able to deliver more high-quality content to their audiences, which can lead to increased audience engagement.

- *Increased Speed:* 5G's lightning-fast speeds and ultra-low latency allow for rapid data transfer, empowering broadcast teams with real-time editing, streaming, and production tools. This leads to faster turnaround times and improved flexibility, especially critical for live events where agility and rapid response are essential.

- *Low Latency:* 5G delivers high-speed connectivity and ultra-low latency, making it ideal for live broadcasts and remote production. With 5G, the low latency and high bandwidth capabilities enable seamless VR and AR experiences, making them more accessible to a wider audience. From gaming to virtual tours and live events, 5G technology has the potential to transform the way we engage with digital content. With the improvement in bandwidth and lower latency, media companies will be able to deliver more high-quality content to their audiences, which can lead to increased audience engagement.

- *Accessibility:* With its improved transmission speeds and lower latency, the 5G network enables more widespread access to media content, particularly in rural and remote areas. This can lead to increased audience reach and opportunities for new business models.

- *Innovative Storytelling:* Interactive storytelling and personalized experiences are made possible by the low latency and high bandwidth capabilities of 5G. The advent of 5G technology in media and content will pave the way for innovative storytelling techniques. With faster speeds and reduced latency, content creators can explore new avenues for interactive storytelling.

- *Immersive Content:* 5G opens up new possibilities for immersive virtual reality (VR) and augmented reality (AR) experiences, making them more accessible to a wider audience. VR and AR technologies have gained traction in recent years, offering users a more interactive and immersive experience. 5G facilitates the creation and delivery of virtual reality (VR), augmented reality (AR), and other immersive experiences, such as interactive gaming and personalized content. Owing to the ability of 5G to deliver high-resolution graphics and faster loading times, the sky could well be the limit for the incorporation of TV series and movies into the world of virtual reality.

6. CHALLENGES

5G, while promising significant advancements in media and entertainment, faces several challenges. These include the need for infrastructure development, the cost of 5G devices and services, and the evolving nature of the technology. A challenge is to close the huge gaps between the promised performance and the current or imminent 5G network deployments. Live streaming and on-demand video face challenges such as buffering, lag, and poor quality, especially in high-traffic areas. Other challenges of 5G networks in M&E industry include the following [23]:

- *Limitations:* 5G is only available in a few urban locations around the world, and much of it is still a beta version. It will take longer for 5G to become mainstream since it necessitates large infrastructure modifications and relies on users purchasing new technology. Unfortunately, we still need to understand

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where we stand with this latest telecom discovery. Traditional content creation and production workflows often face limitations in terms of speed, efficiency, and collaboration.

- *Security:* The increased data transmission and interconnectedness of 5G raise concerns about data security and privacy. Robust cybersecurity measures are crucial to protect sensitive information and ensure user trust. Ensuring the security and privacy of data transmitted over 5G networks is crucial for protecting users from cyber threats. 5G itself is not a security risk. But the new technologies that will surround and be enabled by 5G could be. In fact, the future of mobile wireless cyber security will become nearly synonymous with media and entertainment cyber security. Of course, 5G will usher in a new world of devices that can be compromised, like headsets, glasses, holographic displays, and more. And these devices could be another new point of vulnerability and impact media and entertainment cybersecurity.

- *Device Compatibility:* With 5G's capacity to support large-scale IoT deployments, broadcasters can manage multiple connected devices—from cameras and sensors to editing stations and servers—more effectively. Not all devices are 5G-compatible, and the cost of 5G-capable devices can be a barrier for some consumers. The lack of standardized practices and interoperability between different 5G devices and platforms can hinder seamless content delivery.

- *Collaboration:* Collaboration between content creators, network providers, and technology companies is crucial for the successful integration of 5G into the entertainment industry. As a catalyst for collaboration, 5G powered technology will create a more efficient production process with the added benefit of reaching teammates in remote locations. 5G technology enables real-time collaboration, remote production, and high-resolution streaming, revolutionizing content creation workflows.

- *Infrastructure and Availability:* The widespread adoption of 5G is hindered by the need for further infrastructure development, especially in areas with limited access.

- *Cost and Affordability:* The cost of 5G-enabled devices and subscription plans remains relatively high, potentially limiting access for some users.

7. CONCLUSION

The 5G revolution is taking the world by storm. From streaming high-quality videos to immersive virtual reality experiences, 5G technology has the potential to reshape the entertainment industry as we know it. In the era of digital transformation, the media and entertainment industry is experiencing a seismic shift propelled by the proliferation of 5G technology. The global deployment of 5G technologies is a certainty. As we have seen with every wireless generation shift before, this will drive the proliferation of richer entertainment, media, and advertising experiences.

Even though 5G networks are not yet widely available, most media and marketing professionals believe they will change the way entertainment, sports, and news are produced, disseminated, and consumed in the future. 5G technology is poised to revolutionize the broadcasting media industry in several ways. With its improved bandwidth and lower latency, it allows for faster and more reliable streaming of media content. As the demand for video quality and the loading speed is rising, 5G technology will become mainstream. 5G is changing the business of broadcasting entertainment and transforming the audience experience. With the dawn of 5G, a new vision of the future of media and entertainment will be defined. To stay ahead in this rapidly evolving landscape, it is essential for professionals in the media and content industry to stay informed and adapt to changes. More information on the implementation of 5G networks in the M&E industry is available from the books in [24-31].

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Figure 1 The symbol of 5G [2].

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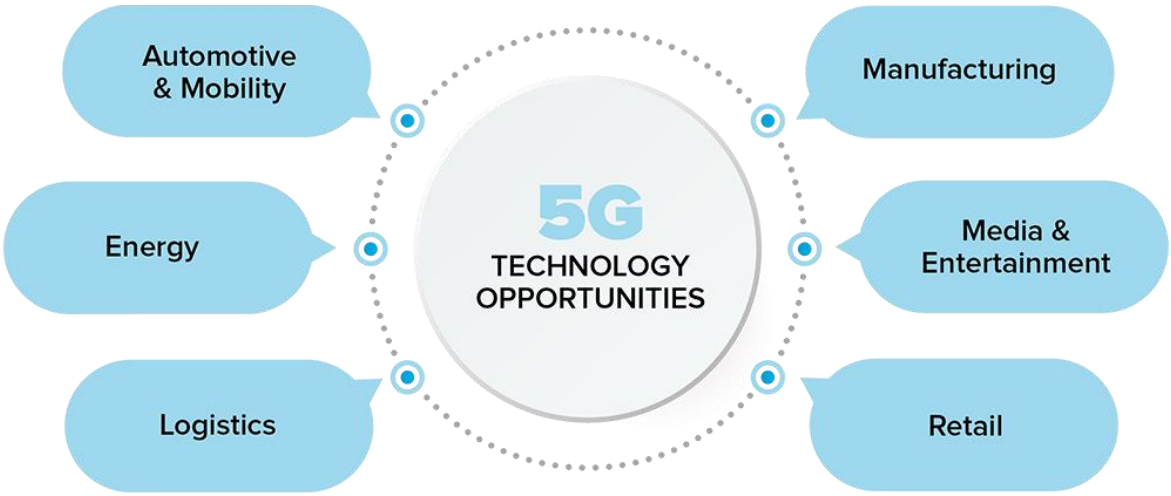

Figure 2 How 5G will impact industries [3].

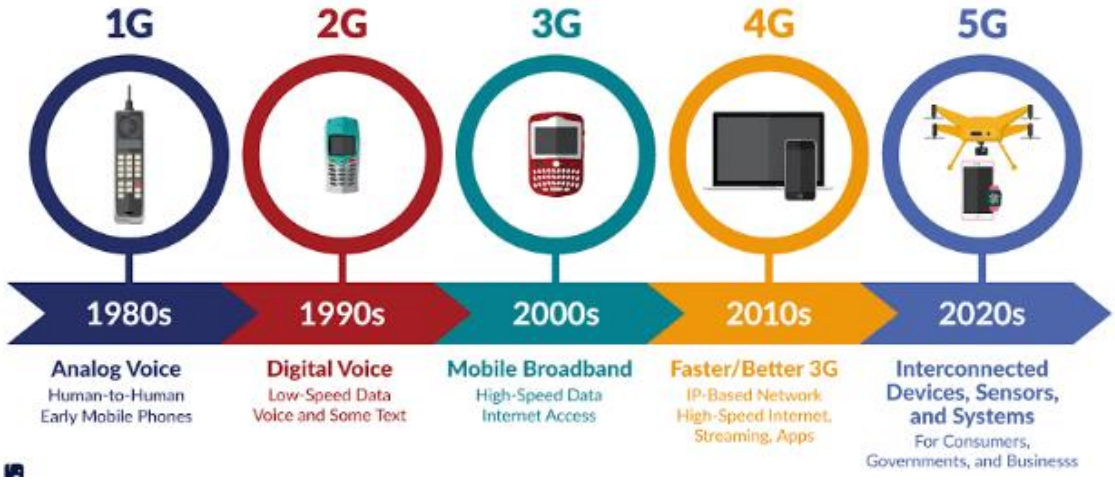

Figure 3 Evolution from 1G to 5G [4].

Figure 4 Relationship between 3G, 4G, and 5G [5].

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Figure 5 A typical 5G towers [7].

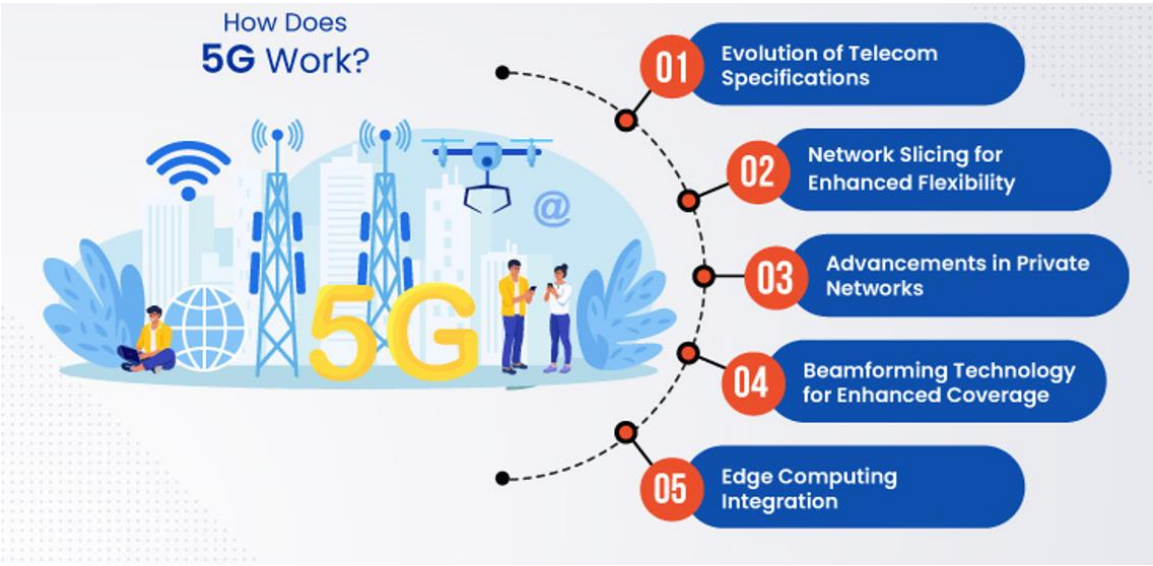

Figure 6 How 5G works [8].

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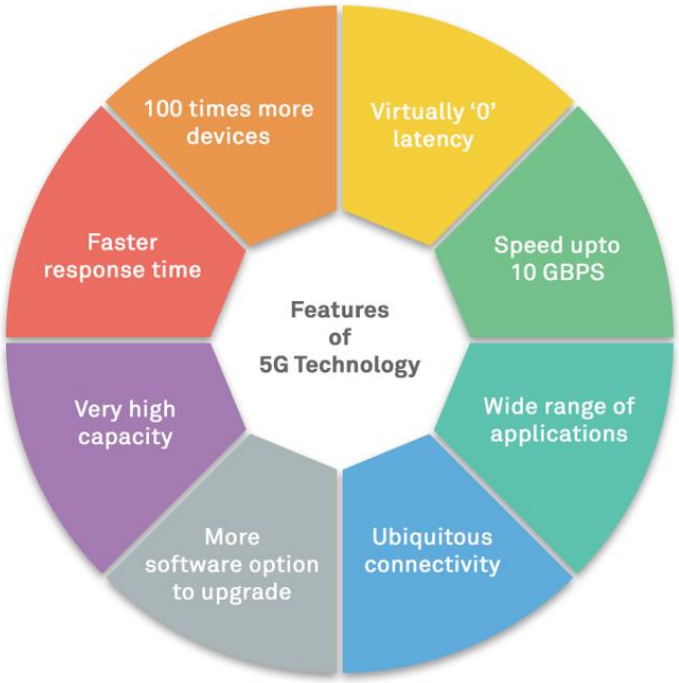

Figure 7 Some of the features of 5G [11].

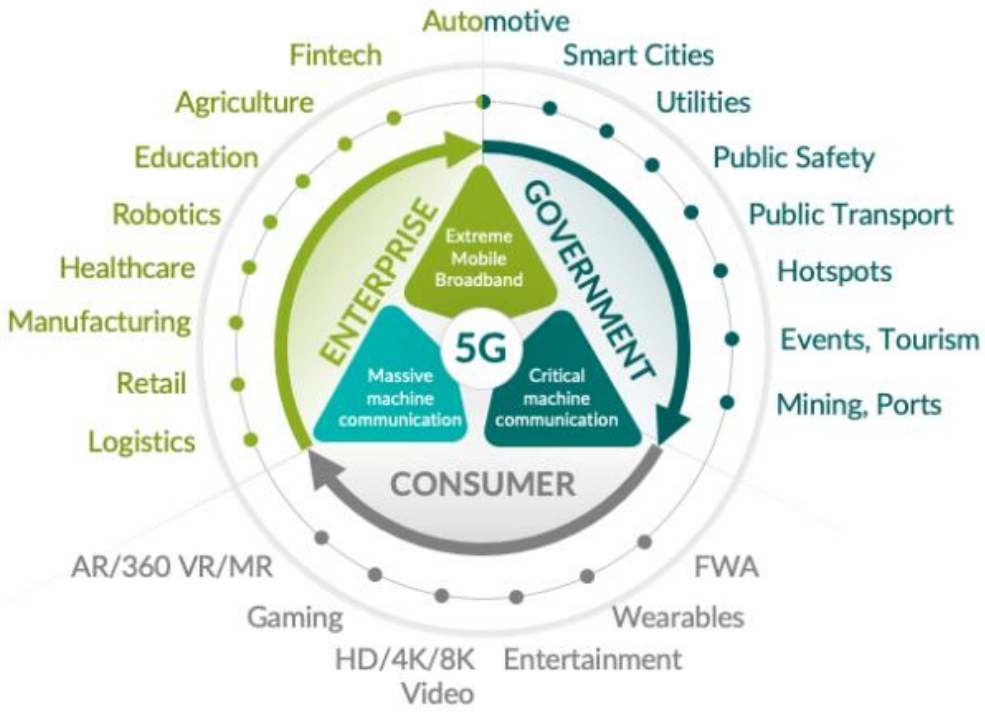

Figure 8 Industries that use 5G technology [4].

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Figure 9 5G is transforming entertainment landscape [15].

Figure 10 5G will change the business of media and entertainment [16].

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Figure 11 An example of gaming [21].

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