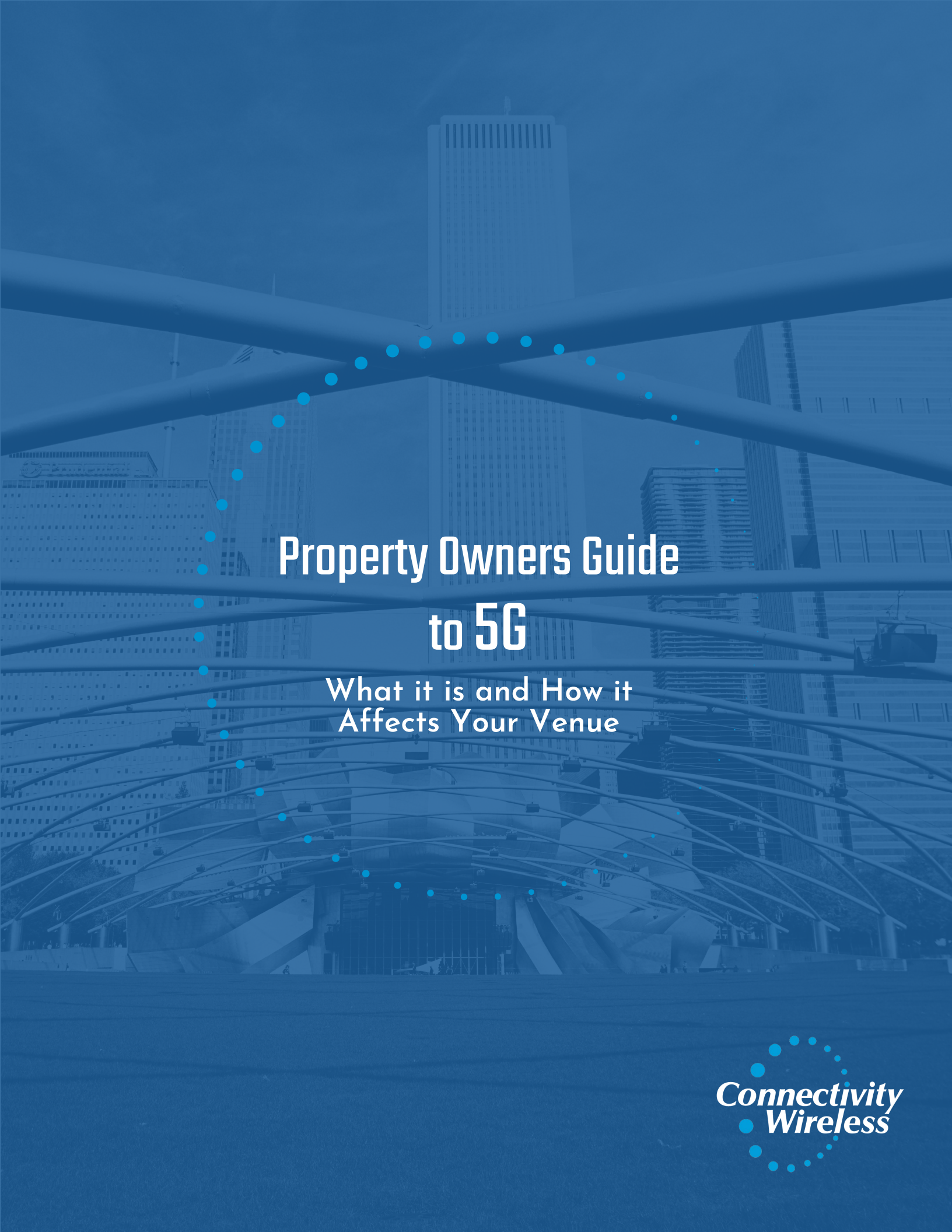


Property Owners Guide to 5G

What it is and How it Affects Your Venue

Connectivity Wireless

INTRODUCTION

Is 5G just another technology development and a step up from previous versions of mobile connectivity? Or something phenomenal? Are you a property owner who is wondering what this all means for your building? In this e-book, Connectivity Wireless will take you through an overview of 5G, explore all relevant details of the new technology, and discover key application aspects both now and in the future.

Through this e-book, we endeavor to arm you with all of the information you need to understand this technological advancement and how it affects you. In this eBook property owners will learn:

- What makes it different from 4G and previous G's?
- What to expect from this development and measures that can be put in place in preparation for what's to come.
- Performance capabilities of 5G now and in the future.
- How 5G will be applied in society.
- The impact of 5G on the network as a whole.
- Different Releases of 5G.
- 5G vs. 4G Expected realistic performance.
- Factors allowing 5G performance.
- 5G strategy for network carriers
- How 5G benefits the customer
- How can we position our customers for 5G?

5G IS OFFICIALLY HERE, BUT WHAT IS IT?

It has been almost a decade in the making, but its official, 5G, literally meaning 'fifth generation', is finally a reality. Experts are telling us that the emergence of 5G will be a revolution in our lives in an internet connected world. As the number of network users grows rapidly, so too does the demand for more bandwidth, more reliability, speed and coverage; requirements that the highly anticipated 5G is expected to tackle. This remarkable advancement is said to be transforming the world of tech as we know it, but does everyone understand what this really means for property owners?

It may appear that there are currently more questions about 5G than there are actual answers. Some people are still getting their heads around 4G and aren't sure what 5G is, while more tech-savvy folk are wondering if and when they'll ever see it in their city. Many people are wondering about the design of the highly sought after 5G smartphone, but we can't forget the emergence of the natural debate of who the best 5G network carrier will be!

5G is the next generation of mobile broadband that will eventually replace, or at least innovate, your 4G connection you've been using all along. With 5G, you'll witness dramatically faster download and upload speeds. The time it takes devices to communicate with other wireless networks, otherwise known as 'Latency', will also radically decrease.

WHAT MAKES IT DIFFERENT?

A new type of mobile network wouldn't be an improvement without, in some way, being fundamentally different than the existing one. Unlike previous network generations that we have been using such as 3G and 4G, 5G is not just built on technology, but defined based on capabilities and applications.

One of these necessary capabilities is 5G's use of unique radio frequencies to achieve what 4G networks cannot. What is meant by radio frequencies? Unlike 4g that uses towers to disperse data, 5G's radio spectrum is broken up into separate bands, each with unique features as you move up into higher frequencies. These shorter wavelengths are aimed at precise locations allowing for faster speeds and better coverage for users.

Some of the key features of 5G that stand out are:

FASTER SPEEDS

Some experts are telling us that 5G will be up to 100 times faster than existing and previous networks. For example, it's said we will have the ability to download a full HD movie in as little as 10 seconds.

REDUCED LATENCY

Latency refers to the amount of time it takes for a device to respond to a network. A decrease in latency means less downtime or a lower rate of network delay.

RELIABILITY

5G is set to be significantly more dependable than previous G's, meaning you can move around more while on a call without risk of drop off or issues with connectivity.

LARGER CAPACITY

The greater the network capacity, the more demand can be placed on it. 5G will be equipped to deal with a much higher volume of requirements from simple HD streaming all the way to virtual reality.

INCREASED RESILIENCE

5G is set to be significantly more reliable and allow for quicker transmission of data in adverse conditions. This flexibility is set to be consistent across a variety of devices, wearables and sensors.

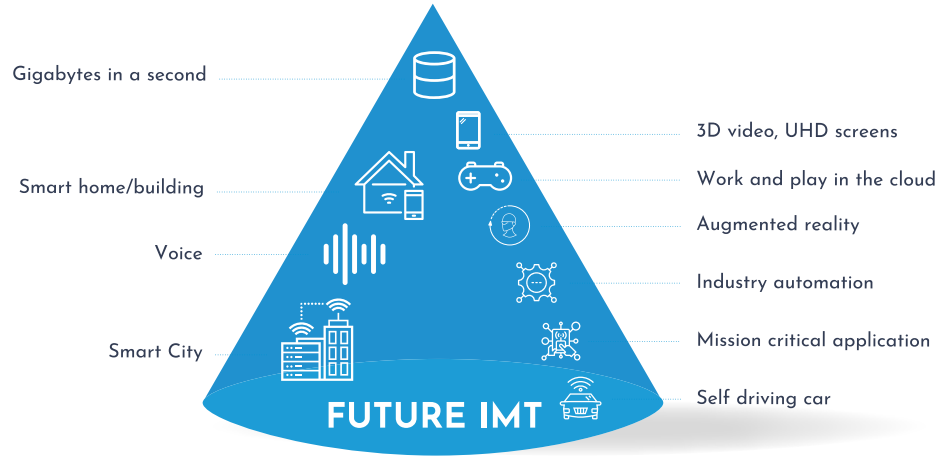
LONGER BATTERY LIFE

All of these key features beg the question, will it completely drain my battery? On the contrary, it's being promised that battery life will in fact be in improved with some forecasting that battery life could be up to ten times longer!

PERFORMANCE BEYOND OUR IMAGINATION

- **ENHANCED MOBILE BROADBAND** – it's forecasted that peak data speed will eventually be 10 to 20 Gbps (Gigabytes) per second.
- **ULTRA-RELIABLE AND LOW LATENCY COMMUNICATIONS** – meaning the time it takes devices to respond to one another over a wireless network is considerably less.
- **MASSIVE MACHINE TYPE COMMUNICATIONS** - this involves intelligent machines fully automating data generation, exchange, processing, and actuation. They send information to other machines, servers, clouds, or humans all without or with low intervention of humans.
- **AUGMENTED REALITY** - This will allow for a more efficient means of addressing building maintenance. AR can reveal internal issues in buildings that are not visible to the human eye. Through this, technicians in both commercial and industrial buildings will have the ability to combat issues virtually and as a result will reduce downtime, equipment failure and costly on-site visits.
- **IMPROVEMENTS IN THE CLOUD** – Building management systems that are cloud based could soon be revolutionised by becoming completely virtual. This greatly enhances building monitoring, allowing for less downtime and improved building user experience.
- **INDUSTRY AUTOMATION** – Automating processes, for example, warehouse transportation in factories speeds up production time and minimises downtime, therefore reducing costs. This will also allow for safer working environments. Having the ability to control machinery from a distance, instead of onsite or manually, means there is a reduced risk of injury or workplace accidents.
- **SPEED, RELIABILITY** – 5G is dramatically faster, meaning quicker upload and download speeds and ease of access to information overall.

ENHANCED MOBILE BROADBAND



HOW WILL IT BE USED IN SOCIETY?

This is probably the most important information for property owners across all verticals; commercial, hospitals, public venues, convention centers and industrial/municipalities.

COMMERCIAL

Properties such as real estate, offices and University campuses are expected to experience high bandwidth with little delay sensitivity. This means a much faster experience is essential in these sectors. 'Smart' buildings will allow for flexible office spaces and employ small radio sensors to monitor key day to day office needs such as occupancy, lighting and temperature. Property owners will have the ability to capture CCTV footage of these spaces and can have this streamed live to their mobile devices. In short, this will help provide more flexible, efficient, secure and ultimately cheaper workspaces for small businesses to operate in.

HOSPITALS

Hospitals have a slower rollout than other verticals, known to have medium to high bandwidth and sensitivity to network delays. That being said, services that will eventually be available to the healthcare system include but are not limited to; remote patient monitoring and patient records, and developments to remote and robotic surgery.

PUBLIC VENUES

Public venues should expect medium bandwidth as well as medium delay sensitivities. Public areas are often a hub for large groups of people that gather for a variety of reasons such as local festivals, events, and for leisure. From a safety perspective, if an emergency ever occurred in one of these areas, the inclusion of 5G means that information can be sent and received at a much quicker pace.

CONVENTION CENTERS

Convention canters, stadiums, arenas, and other high-volume spaces can expect high bandwidth and medium to low delay sensitivity. Often times, convention centers are home to technology seminars or video conferences where Augmented Reality may be showcased. In this instance, property owners of these large venues will have a broadened service offering with the implementation of 5G.

TRANSPORT

Commuting should become easier as a result of 5G with smart and automated transport systems expected to greatly decrease the risk of delays. It's even been forecasted that driverless trucks could be a reality in 10-15 years! In the nearer future however, commuters will experience faster internet, meaning a more productive and seamless journey overall.

THE IMPACT ON THE NETWORK AS WHOLE SOCIETY?

There are three different components to 5G, RAN, Transmission and Core.

5G RAN – meaning radio access network. RAN connects individual devices to other parts of a network through radio connections. A device is wirelessly connected to a core network that transmits a signal to various wireless endpoints, which then travels with other networks' traffic. In some cases, mmWave or millimetre wave, will be in place to allow for heavy internet users.

This is an essential component of 5G and will have vertical dependence from the areas mentioned above. The emergence of 5G has promised to have a more efficient radio interface, with the ability to submit more data, allowing for double the impact of previous networks.

TRANSMISSION – referring to how information will be transported across the network, will require vertical dependence.

CORE – There are different types of Core network, Circuit Switched Core (CS) and Packet Switched Core (PS).

CS has been mainly used for voice in 2G and 3G, whereas PS has been used mainly for data in 2G and 3G and data and voice for 4G and 5G. Communication in PS comes in the form of efficient IP (Internet Protocol) packets. Internet Protocol is essentially an effective transport system that delivers digital content over standard networks. Using these packets aids a smooth transition from CS technology to the more universal technology that is IP.

This involves vertical dependence through network slicing. This means the 5G core network will be 'sliced' into different isolated sections:

SMARTPHONES – High Bandwidth

AUTOMOTIVE – High Reliability and Low Latency

THE INTERNET OF THINGS OR IOT DEVICES such as smart TVs, smart appliances, wearables etc. – Low Energy and Low Bandwidth.

NETWORK SLICING

5G's core is said to allow for more versatile control over how resources are allocated and utilized by different services.

It also means they can be customized and have advanced security protection, its own network functions, isolated data and more, mainly down to this 'network slicing' component.

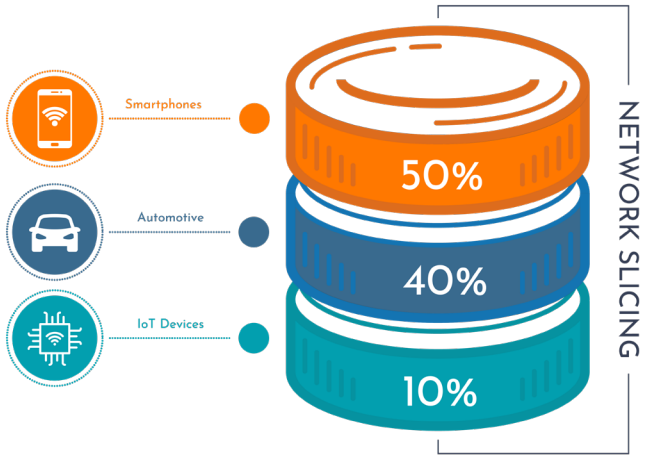
Network slicing is essentially a form of virtual network architecture, whereby multiple networks can be created in addition to a common shared physical infrastructure. These networks can then be edited to suit a variety of application services, devices and applications for both the customer and the operator. This is said to be a critical part of 5G, meaning that a unique and specific set of resources can be grouped into network portions for different use cases.

3GPP 5G RELEASES

The development of 5G has spanned since the beginning of 2017, while 5G marketing and implementation to all mobile users began at the start of 2019. The first phase of 3GPP 5G specifications, Release-15, is scheduled to be completed in 2019 and the second phase, Release-16, is due for completion in 2020.

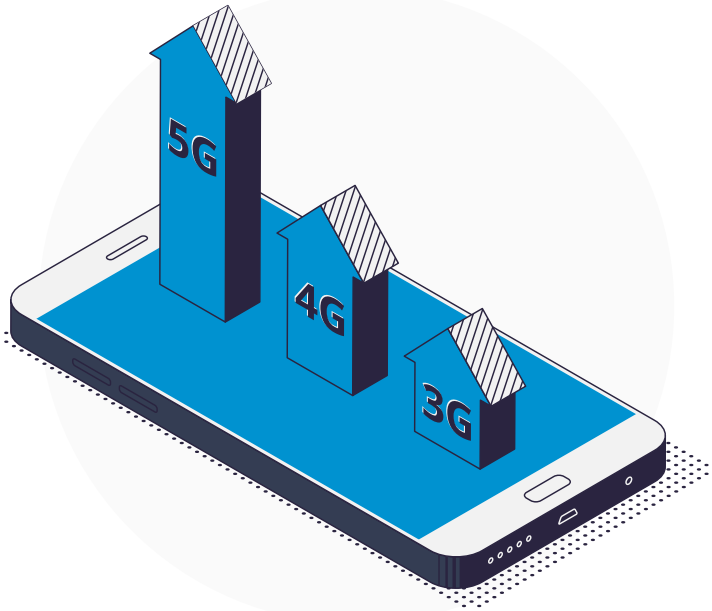
4G evolution (4G Evo) will act as the bridge for 5G, making 5G the first mobile network to rely on the previous one to be born and developed. 4G Evo is the evolution of the 4G network, which has data rate and latency improvements. 4G Evo and 5G will be closely integrated together to offer high speeds and capacity, latency and new possibilities in IoT (Internet of Things).

However, usage will be limited for the rest of 2019 and Apple iPhone's may not fully support the network until 2020. Expansion and enhancement of 5G will continue to grow throughout the rest of 2019 and well into 2020.



5G VS. 4G

EXPECTED REALISTIC PERFORMANCE



4G (fourth generation) got its' name around ten years ago. 4G made mobile speeds 500 times faster than 3G and set the network at a whole new level. 4G shook the tech world in its evolution of smart phone technology. By 2020 there is expected to be over 20 billion connected devices, so the demand for faster networks and downloads is a necessity. 4G will become the basic coverage everywhere and still provide great service throughout, including remote locations.

Performance values have significantly increased from 4G into 5G and will change the way we use our mobile devices. 5G is set to be a faster, smarter and more efficient system and promises data speeds that outrun the fastest broadband networks. There has been such an improvement in the 5G network, that we will be able to operate in high frequencies.

Switching from 4G into 5G, the average download throughput has increased by 80 Mbps (megabytes per second). The peak download throughput has increased speeds of up to 1Gbps (Gigabyte per second) and 4G's latency speed went from 40 to 65 milliseconds. 5G has considerably improved this to speeds of 1 to 10ms. The big difference on the spectrum is the bandwidth available to consumers. The maximum bandwidth for 5G is 100MHz and 4G is 20MHz. Megahertz is used to measure the transmission speed of any kind of electronic device.

GENERATION	SPEED	TECHNOLOGY	FEATURES
4G	100-300mbps	WiMax LTE	Incredibly fast download speeds, paved the way for HD Streaming
5G	10-30gbps	Developing	Ultra-fast internet, low-latency and improved reliability

You will be able to do all of the things you do now with more speed, lower latency, and stronger reliability in terms of connection. Don't expect revolutionary changes immediately, however. 5G networks are still only available in small areas in major cities and regional hubs across the country. 5G phones and 5G mobile broadband devices in the market are limited to the consumer but will be developed further in the next few years.

FACTORS ALLOWING
5G PERFORMANCE

- The system model of 5G is an Internet Protocol or IP based product designed for wireless and mobile networks. There are numerous factors which help improve and allow for 5G performance across Australia and worldwide.

- Higher throughput is the rate of production at which something is processed. Having a higher spectral efficiency (antenna technology), larger spectrum for channel bandwidth, and wider carrier aggregation and densification, allows for a higher success rate of messages to be delivered across communication channels.

- Having a lower latency allows the devices to process a higher volume of data messages with minimal delay. Lower latency nodes such as RAN and Core, faster processors, stronger optimized fronthaul and backhauls, and excellent proximities of users are designed to support any operations that require real-time access to rapidly changing data.

- A distributed group of servers that work together to provide fast internet content allow for strong content delivery. These servers allow for a quick transfer of assets and fast loading connection. This allows for fast virtualisation and commercial off-the-self (COTS) products to be widely available to all 5G users.

A range of modern mobile communications and resources (HetNet) allow for 5G performance such as small cells, macros, DAS (distributed antenna system), TDD (test driven development), FDD (Floppy Disk Drive), licensed and unlicensed bands and Wi-Fi. All these modern mobile networks are comprised of a combination of different cell types and access technologies.

CARRIERS
5G STRATEGY

5G services for carriers are expected to reach new heights of wireless connectivity. This high-tech feature comes down to three factors; connectivity, content and analytics. Verizon, AT&T, T-Mobile and Sprint will become users of the 5G network. Promises of mobile data speeds that outrun any other networks have been made. Each company has their own individual incentives and abilities.

VERIZON

- 2018 - Verizon demonstrated the first mobile 5G radio test in late in the year. They enrolled 5G to power its 5G Home broadband service in September.
- 2019 - The Samsung Galaxy S10 5G was the first mobile 5G device to be released. Verizon unveiled its mobile 5G plans and launched the insanely fast 5G Moto Mod for the Moto Z3 in March. It is now live in Chicago and Minneapolis.
- 5G Home broadband has no data cap and offers speeds ranging from 300Mbps to 1Gbps depending on location.

AT&T

- 2019 - AT&T released its Net gear Nighthawk 5G mobile hotspot.
- This addition expanded and enhanced the current 4G LTE network service in 400 markets.
- The 5G service will rely on the company's fibre network, which is expected to cover 14 million people by the end of 2019.
- Mobile 5G services will be in Houston, Dallas, Atlanta, Oklahoma City, Jacksonville, New Orleans, and San Antonio.
- AT&T expects to offer nationwide 5G service by the end of 2020.

T-MOBILE

- 2019 - T-Mobile won't roll out 5G until late in the year. They plan to deliver a 5G network using the 600MHz spectrum.
- There are no current devices that can utilize a 5G network within the 600MHz band.
- Some benefits of this network allow signals to travel long distances and through solid objects. This means there will be less of a need for new cell phone towers.
- The network will have higher latency and lower throughput speeds than both millimetre-wave networks and mid-band networks.

SPRINT

- Sprint is ready to deploy its 5G network but lacks funding. The 5G service will run on mid-band frequencies instead of upper bands.
- The 5G network is live in Atlanta, Dallas-Fort Worth, Houston & Kansas City.
- The LG V50 ThinQ is the first 5G phone and as of June will sell the Galaxy S10 5G. It will be available in all verticals such as smart cities, transportation, education, and healthcare facilities.

CCS Insight Global Mobile Phone Forecast, 2017-2021

CCS Insight

TOTAL MARKET IN 2021

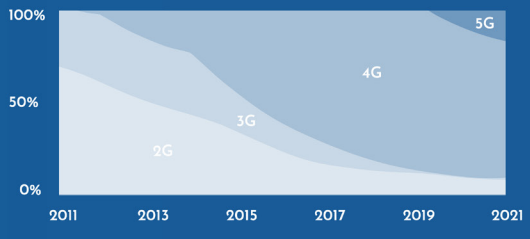
2.08 BILLION MOBILE PHONES

→

1.90 BILLION SMARTPHONES
1.71 BILLION 4G LTE PHONES
0.10 BILLION 5G PHONES

100 million 5G phones to be sold in **2021**

Technology transition: mobiles phones sold **2011-2021**



HOW 5G BENEFITS
MY CUSTOMER

5G may not bring immediate benefits to its customers as launching technologies every few years is not sustainable. You have to pay for license fees, radio frequency bands, renewing networks, and updates to existing infrastructures. However, more services become possible through 5G which results in revenue.

The biggest benefit of 5G will be the speed. 5G is expected to deliver network capabilities of up to 80-100Mbps. This will allow the consumer to experience fast and reliable broadband speeds at any time of day. This increased speed availability, will change the way consumers work and personally engage online. Whether downloading music and movies, or transferring large files, the 5G broadband will provide a more seamless process to the consumer.

Have you ever struggled to stream music or videos while you're out and about? Another large benefit of using the 5G is the data backup network. 5G will be able to handle strong download and streams more efficiently, seamless augmented reality experiences, gaming with no lagging and even a unified three-way call with friends. Its applications will have a higher demand by end users and services that are still yet to be created by the consumers of the 5G network.

5G enables the delivery of better customer experiences through enhanced broadband and revenue streams, which are both additional benefits of the 5G wireless network. Bandwidth is the amount of space available for data use. When you enter a crowded area such as a sports arena, airport or concert, you won't have the annoyance of a slow connection. The more bandwidth available, the more people can do with their mobile devices, making 5G smartphones more versatile than before.

HOW CAN WE POSITION OUR CUSTOMERS FOR 5G?

5G is available through specific carriers, they also offer non-standalone networks. 5G will become more prevalent within the next five years but is yet to replace DAS (distributed antenna systems). DAS is a network of spatially separated antenna nodes connected to a common source via a transport medium. It is a wireless service within a geographic area or structure. Current DAS may support 5G in low and mid bands but will not support mmWave.

At Connectivity Wireless, we specialize in connecting venues, carrier, and their customers future-proofed connectivity solutions around the United States. We leverage our team's operational and technological expertise for your business today.

People today expect to be connected to the world around them. In fact, their connectivity is often more important than a communal space or a gym. Did you know that 80% of all mobile data originates indoors? It's more vital than ever to provide a dependable wireless connection for your tenants. What you need is a partner that helps give you a competitive edge in the marketplace. Your connectivity is our mission, and we take our mission very seriously.

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