Link : <https://github.com/Lorenzo-Cel/5G-Project-/wiki/5G-Wireless>

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# 5G Wireless Communication System

![Image 1](https://github.com/Lorenzo-Cel/5G-Project-/blob/master/5G/Documentation/08Techfix-illo-jumbo.gif)

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## Introduction

### Why are we studying 5G ?

The fact that we are studying 5G is because it’s a service that we’ve been waiting for since December 4, 2009, after the launching of 4G, the telecommunication companies were hyped about 5G and what benefit it’ll bring to the world with the fastest connection from the previous generations.

### Why 5G is important

At the moment 5G is the fastest connection technology available, it allows people to connect and have the capacity to support millions of user devices connected at the same time but it’s not available all over the world, it was only launched in the US, Europe, few countries in Asia and Africa

### Relation between 5G and the course

Since it's a computer information system, we need to know the latest information about technology to stay up to date with all the information so that’s why we chose this subject because it’s a trend that just got on nowadays.

### What is 5G ( brief definition )

5G is the fifth generation of phone services, it’s a network or a wireless standard that came after the 1G,2G,3G, and 4G, this network is meant to connect everyone and everything together it may be a Smartphone, computers or machines with a higher rate of connection.

### History of this technology

![image 5](https://github.com/Lorenzo-Cel/5G-Project-/blob/master/5G/Documentation/unnamed.png)

1st Generation (1G): The story of this technology started 40 years ago precisely in 1980, the first generation was made for radios and Walkie talkies but it came with a benefit, instead of point to endpoint communication it allowed communication to all people all around the world using cell towers and base stations. The only services offered by the first generation was voice calls, the internet was not a thing yet back in 1980.

2nd Generation Network or 2G came around 1990, precisely 10 years after the first generation, and it represented a transition from analog transmission to the digital transmission of the voice. The quality of the audio was improved in the second generation because it was able to do correction of the bits, the International Telecommunications Union (ITU) appeared and organized and agreed on radio frequencies that telecommunication companies should use, another feature brought by 2G is to be able to send data over the airwaves and this when Mobile data was introduced into mobile devices and give people access to the internet (Mobile data was invented in 1996 - 6 years after), and one of the last features that 2G brought was texting.

3G or third generation came around 2000 and it didn’t come with only one but it came with two Crucial 3G technologies 3GPP which stand for [(Third generation partnership project) and 3GPP2 , the third generation came with the idea to increase the capacity of the VOIP and start using it around 2009 just before the appearance of 4G and VOiP mean Voice-over IP that let people communicate and call all over the world without paying a cent using their IP. VOIP appeared in 1995 but was rarely used because of the low signal .3GPP designed a subsystem for it which was based on the SIP Voip protocol ( Session initiation protocol ) and The subsystem was named IMS (IP multimedia subsystem) . and so 3G brought mobile broadband data (wide bandwidth data who allow better transmission)

4G or fourth generation appeared December 14 , 2009 and launched by teliasonera , it regrouped all the features of previous generations and offered a high speed quality who reached 10 times more than 3G connection could reach and made computer and tablets much comparable to laptops and computers by giving a developed multimedia and a better connection for gaming. Symbol of 4G was LTE and in the last years we could’ve seen the appearance of LTE+ or what is also called LTE advanced.

## Methodology

5G is the fifth generation of wireless data networks, the upgrade of the 4G network. 5G is expected to change how people work and live in the future. Countries are already fighting and competing to be the first in having this new technology as soon as possible because of all the benefits that it comes with not only for users but for businesses. 5G uses new radio technology and radio frequencies in a band known as sub 6 from 600 megahertz to 6 gigahertz, which is also used by 4G. 5G will use radio frequencies from 24 gigahertz to 86 gigahertz.

![image 3](https://github.com/Lorenzo-Cel/5G-Project-/blob/master/5G/Documentation/unnamed%20(1).png)

3 key abilities of the 5G:

1. High Bandwidth: 4G only carries up to 200 megabits per second of data and 5G can handle up to 1 gigabit or more a second

2. Low Latency: 4G has a response or delay of a 100 milliseconds. However, 5G reaction time is only about 1 millisecond, what makes everything almost instantly

3. Dense connections: In a ratio of a km, 4G can only connect with 1/10 the amount of devices as 5G can.

We always dream about our computers or devices being the fastest and the safest. Well, with 5G this is possible and a reality. However, this technology is still in process of development and we are not sure when it will be released. 5G will come thanks to some new technologies such as Millimeter Waves, Small Cells, Massive MIMO, Beamforming, and Full Duplex.

1. Millimeter Waves: we have been using frequencies from 3 kHz to 6 GHz so 5G will work on shorter millimeter waves between 30 and 300 GHz on the radio frequency spectrum, which allows a better and faster connectivity. The problem is that these waves can not travel through building and rain.

2. Small Cells: Here comes the small cells networks. Small cellular towers help big cell as a relay team to transmit the signal around obstacles. As soon as the user is moving, the tower switches to the one that is closer.

3. Massive MIMO: MIMO stands for Multiple Input Multiple Output. 4G base stations have 12 ports for all cellular traffic. Massive MIMO will improve that by allowing 100 ports where the capacity of networks increases by 22 times. However, that reflects an increase as well of interferences caused by the crossing of the signals.

4. Beamforming: Here comes Beamforming. Beamforming is like a traffic signaling system for cellular signals. It regulates the traffic of data transmitted and received. Instead of broadcasting the signal in every direction, it will focus and send this data in one direction that is the user.

5. Full Duplex: With 5G, the transceiver for example cell phones, will be able to give and receive data at the same time and with the same frequency, which will make the waiting time way shorter, and the carrying capacity way bigger. This technology is already used in the military on bulky equipment.

Companies that already adopted 5G

First starting with T-Mobile: T-mobile had a trial run in New York, Los Angeles, Dallas and Las Vegas in 2019, the only type of mobile who was able to have 5G was Samsung Galaxy S10 5G, then in 2020 T-mobile partnered with regional carriers as sprint so they can expand their 5G network reaching all the 50 states.

Second company will be Sprint: Sprint had a trial run in May 2019, in Chicago, Atlanta, Dallas, Kansas City, After their merge with T-mobile in 2020, they improved their 5G quality and now sprint customers all over the states have a faster and reliable 5G data reception.

Third company will be AT&T : AT&T didn’t invest in the 5G as the other companies did , and their investment was one of the most limited. They only offered 5G as a hotspot possibility when you buy the Netgear nighthawk. So AT&T was criticized for their non-interest on the 5G Technology.

The last company will be Verizon: Verizon started a 5G home network which was very different from the other companies. Verizon was the first carrier to go global with the new 5G network. Throughout this process they managed to get their data speeds up to 1.4 Gbps which was a huge jump from their original 4G data they had. The only flaw is they couldn't get their speeds in little towns or areas with less population than average cities.

![image 2]( https://github.com/Lorenzo-Cel/5G-Project-/blob/master/5G/Documentation/pasted%20image%200.png)

### How fast is 5G

In a recent study the first half of the year, the average for AT&T 5G speeds was 46 Mbps, only a little faster than 4G LTE speed of 43 Mbps. At T-Mobile, speeds increased more as a percentage, but its average 5G speed of 25 Mbps still can’t even compete 5G networks are 10 times faster than 4G LTE, according to the wireless industry. Which means for us we can quickly upload photos and download movies and shows, without glitches and lagging to occur, among other things. 5G is used to bring faster internet services directly into your home. 5G is fast enough that it could be an alternative to cables for transmitting different types of data. It's also suited for new and experimental innovations, such as providing a continuous stream of speed-sensitive data that's required for many self-driving-car systems that are being tested as of right now.

![image 4](https://github.com/Lorenzo-Cel/5G-Project-/blob/master/5G/Documentation/unnamed%20(2).png)

### Evolution of society

The first Industrial Revolution was characterized by the power of steam, which allows people to create all kinds of interesting things, and this process arrived till the third Industrial Revolution, with an incredible communication system related to the smartphone, personal computer, television, etc. Nowadays, the fourth one is bringing together digital, physical, and biological systems, and according to Klaus Schwab, founder and executive chairman of the world economic forum "The Fourth Industrial Revolution doesn't change what we are doing, but it changes us".

### Impact on the society

The characteristic piece of this revolution is 5G, which brings an incredible increase in downloading and uploading speed for every wireless device. In modern society, this type of technology is a consequence of the new upgrading for the economic system, which is going to see a lot of innovation and transformation of today's society. First of all, the economic effect that 5G is going to be huge: in fact, according to the World Economic Forum, in the article "The Impact of 5G" "An IHS Markit study estimates that $ 13.2 trillion in global economic value will be made possible by 2035, generating 22.3 million jobs in the 5G global value chain alone." The cite means that it is going to be more opportunity for people to find a job and more money in circulation for future works and projects, being able to invest again in the sector. But this new technology is still expensive, and not all companies are able to afford it, the small one in particular. In fact, the total amount for 5G infrastructures at the end of the year is going to be $2.7 trillion. The huge cost for these new infrastructures is justified because it brings to us a new type of society more efficient, more accessible, and mainly faster, which makes us understand that it is not for everyone. The casual user, who uses his devices just for web browsing or chatting, will not notice the difference because this technology is not made for that. Talking about all the industries, which work in much more specific sectors, the advantages are beginning to be noticed.

### Healthcare

For example, all the healthcare industry will be allowed to receive important patient information fastly, or the opportunity to operate remotely, which thanks to 5G micro-lags are 1ms, and so on. The same reasoning is possible to apply to the automotive industries. With the 1ms response, it is possible to create sensors for cars capable of detecting obstacles along the way, thus leading to the creation of a completely autonomous vehicle, able to accelerate and brake automatically.

### Cons

But this technology is not perfect in fact, there are some cons: Firstly, the 5G uses high-frequency waves to make the speed faster, but at the same time it means that they are not able to travel far like the low-frequency waves and they are more easily blocked by common objects, so they will need more antennas to repeat the signal, which means higher costs. Another problem you may encounter is coverage. In fact, many areas, particularly in the United States, will not have the possibility of being covered by 5G as the impossibility of building special infrastructures. all this will lead to a lack of exploitation of technology in many areas that will suffer economically.

## Results

Benefits:

1. Downloads and streamings will have no delay or at least the will be so much shorter

2. Cars will be able to communicate to each other to prevent collisions, and also 5G will help to the self-driving technology

3. Virtual reality will finally be achieved with real-time response

4. Remote surgery

5. Precise drone control

6. Home broadband

## Conclusions

In this project we learned a lot of new information about the development of this technology. Since it started in 1980 and kept going until 2020 approximately for 40 years and kept giving a higher technology every year. We also went over the impact that the 5G have on the economy, the society, the healthcare system and the industries, and also over the cons and pros of this technology.

## Future Work

Keep in touch and see the different countries that will adopt the 5G technology in the future.

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