

5G Networks

Com Sci 35L
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Introduction



- The fifth generation of cellular wireless network
- Features:
 - Vastly increased capacity,
 - higher speed frequency,
 - lower latencies (which means faster response time)
 - more reliable
- 5G mobile networks deployment has been started in this year 2019
 - Korea being the first country deployed 5G in April 2019
 - Verizon's 5G service in Chicago
- Some of the first real deployments are anticipated in 2020.

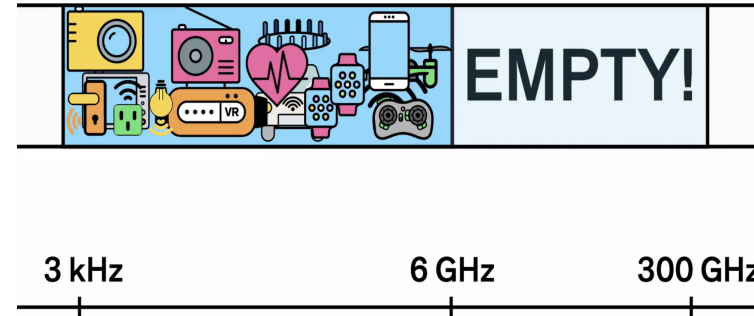
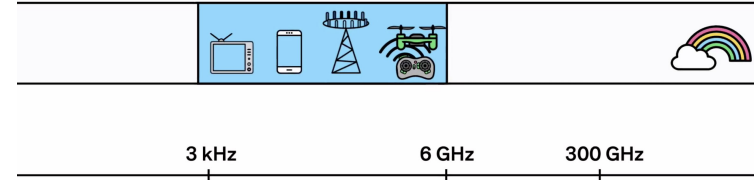


Technologies applied in 5G

- Millimeter waves
- Small cells
- Massive MIMO
- Beamforming

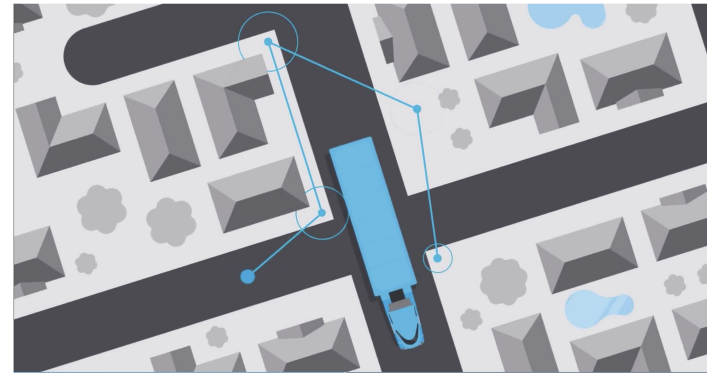
Millimeter Waves

- High frequency millimeter waves (30 - 300 GHz)
 - <https://spectrum.ieee.org/video/telecom/wireless/5g-bytes-millimeter-waves-explained>
- shorter wavelengths making the beam narrower and make the transmission speed faster.
- Due to the limited range of transmission, it cannot travel through walls and large objects, therefore it needs to operate with small cells



Small cells

- Foundation of 5G network
- Mini base station
- Small cells densification - efficient and inexpensive solution
 - it requires a large number of small cells covered in the service area.

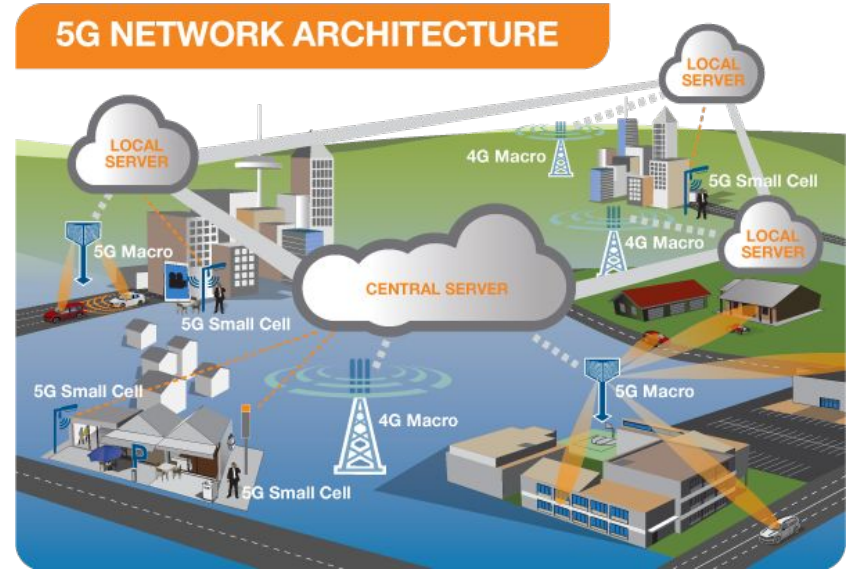


<http://committeeof100.net/uncategorized/5gsmallcell/>

<https://www.qorvo.com/design-hub/videos/5g-why-it-is-massively-awesome>

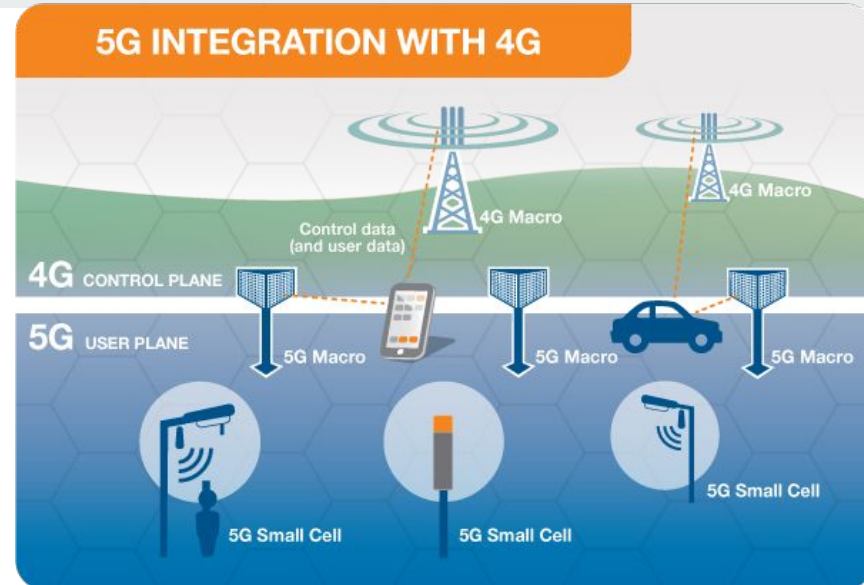
5G Network Architecture

- 5G networks performing with 4G networks
- The Radio Access Network
 - Small cells, towers, antennas
- The Core Network
 -



5G Integration with 4G

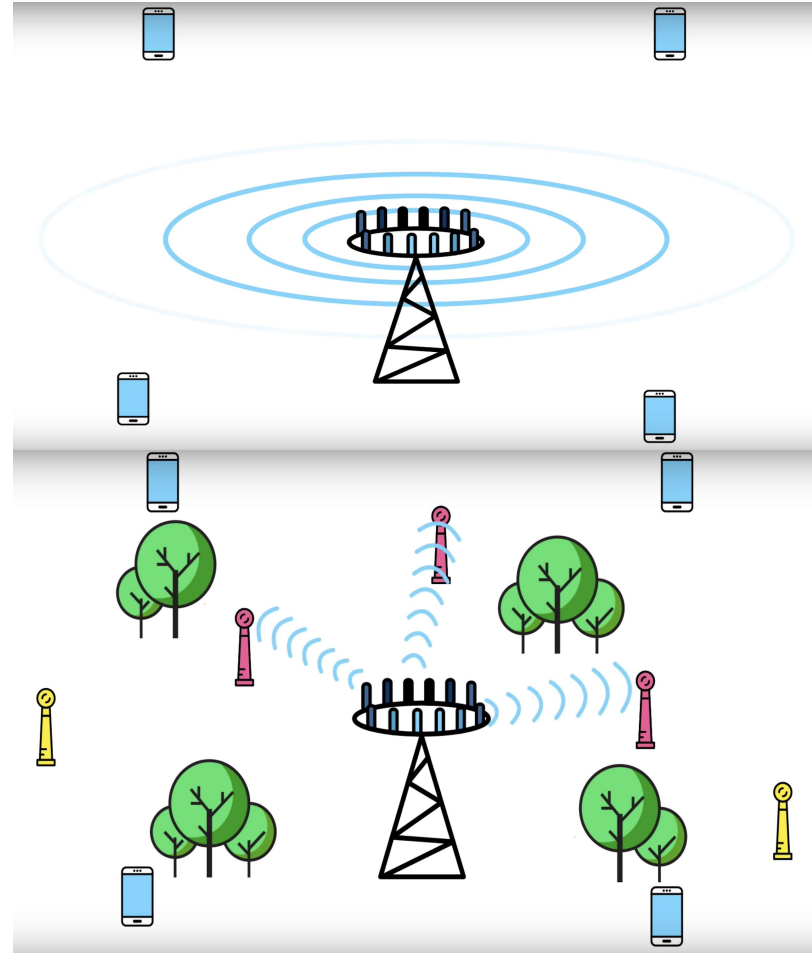
- Non-stop connection
- UE (user equipments) will connect to both 4G and 5G network



Comparing 4G to 5G

- millimeter wave band range in 30 - 300 GHZ, with 4G frequencies being below 6 GHZ,
 - Shorter waves
 - significantly reduce traffic
 - allows more users and faster speed
- Lower Latency, meaning shorter response time
 - 5G: 1-5 ms vs 4G: 20-30 ms
- 5g speed 20 Gb/s, 4g: 1 Gb/s
- 20 Gb/s peak data rate vs 1 Gb/s peak data rate for 4G network

https://www.youtube.com/watch?v=GEx_d0SjvS0



Massive MIMO

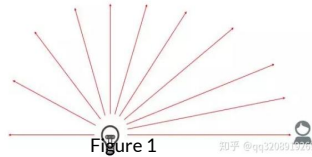


Figure 1



Figure 2

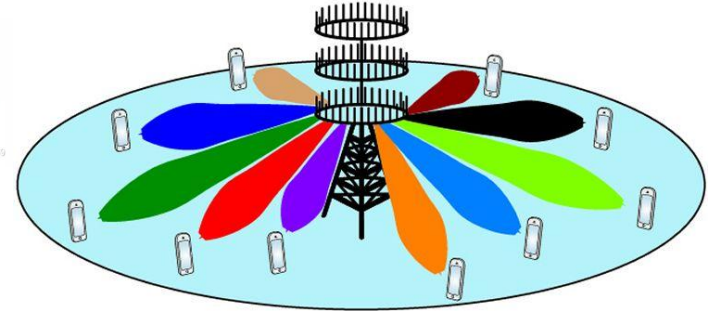


Figure 3

MIMO stands for Multiple-Input Multiple-Output. It allows the transmitting and receiving of more than one data signal simultaneously over the same radio channel.

Contrast

Before: **Broadcasting** information in every direction at once, which causes serious interference.

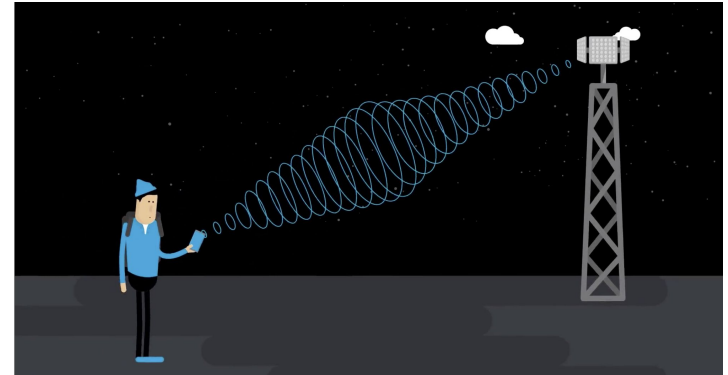
Now: **Beamforming**.

Send a focus stream of data to a specific user.

This precision prevents interference, and is way more efficient.

Method

signal processing algorithms. Triangulate user's exact position.



<https://www.zhihu.com/search?type=content&q=5g>

<https://www.qorvo.com/design-hub/videos/5g-why-it-is-massively-awesome>

<https://5g.co.uk/guides/what-is-massive-mimo-technology/>

Test



Korea

- **Samsung** claimed to have supplied the greatest number of 5G base stations to South Korean operators, which lit their commercial consumer services on 5 April, 2019.
- **Korea's new 5G Futuristic Hospital:**

Very sick patients in isolation rooms can visit with holograms of their loved ones. Visitors will find their way around the hospital using an augmented reality (AR)-based indoor navigation system. Authorized medical workers will use facial recognition to enter secure areas. Patients can call a nurse and control their bed, lights, and TV with an Alexa-style voice assistant.

US

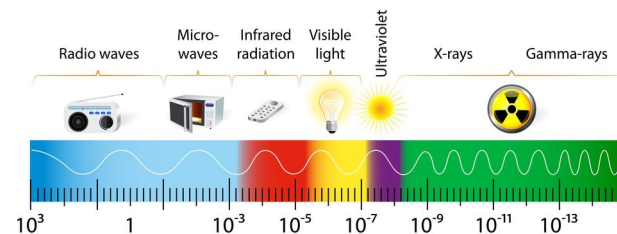
- **Verizon** announced that it has officially deployed its 5G mobile service in certain parts of Chicago and Minneapolis, which are the first two of 30 cities where it plans to bring its 5G wireless network this year.

<https://spectrum.ieee.org/the-human-os/biomedical/devices/koreas-new-futuristic-hospital>
<https://www.gsmaintelligence.com/research/?file=67a750f6114580b86045a6a0f9587ea0&download>

Downside

- **Shorter range**
 - a. Millimeter waves tends to be absorbed by rain and plants.
- **Higher cost**
 - a. Verizon says extra \$10 per month.
- **Health issues**
 - a. Radio Frequency (RF) Radiation.
 - b. Ultra high frequency an ultra high intensity.
 - c. densification of small cells deployed around people.
- **Spy activities**
 - a. Not easier to hack, but the huge amount of connections is of great concern.

THE ELECTROMAGNETIC SPECTRUM



Future Applications

- Smart phones, mobile devices
- Internet of Things (IoT)
- VR & AR
- Autonomous vehicles
- Real time translation



Enabling

A growing set of consumer and commercial drone use cases



Flying cameras

Consumer flying cameras

Movies and news media

Real estate



Delivery

Package delivery

Transport of medicines and vaccines



Public safety

Emergency services

Cellular coverage for first responders

Search and rescue



Agricultural

Crop visual inspections

Automated planting

Livestock tracking



Inspection

Critical infrastructure inspection (e.g. cell towers, bridges)

Inspection of hard-to-reach assets (e.g. oil & gas, wind turbines)

Reference



<https://talkingpointz.com/downloads/subscription/>

https://en.wikipedia.org/wiki/5G#5G_NR

<http://committeeof100.net/uncategorized/5gsmallcell/>

<https://www.qorvo.com/design-hub/videos/5g-why-it-is-massively-awesome>

https://www.youtube.com/watch?v=GEx_d0SjvS0

<https://www.zhihu.com/question/56932531>

<https://www.gsmintelligence.com/research/?file=67a750f6114580b86045a6a0f9587ea0&download>

<https://www.qorvo.com/design-hub/videos/5g-why-it-is-massively-awesome>

<https://5g.co.uk/guides/what-is-massive-mimo-technology/>