5G Networks

Com Sci 35L
Vincent Liu
Sophie Zhan

https://www.cobham.com/communications-and-connectivity/wireless/network-validation/news/cobham-delivers-industry-first-5g-network-test-solution/

Contents

- Introduction of 5G network
- Key Technologies behind 5G
- Comparison with 4g
- Test
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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
  - South korea being the first country deployed 5G in April 2019
  - Verizon's 5G service in Chicago, Boston, Washing DC, etc.
- Widespread of 5G service is expected to be available in five years.

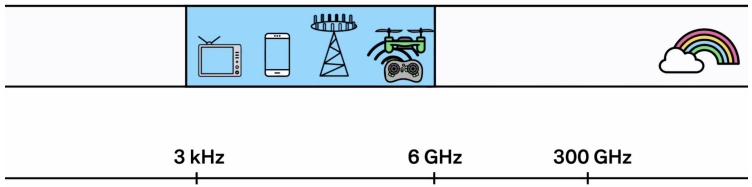
https://en.wikipedia.org/wiki/5G

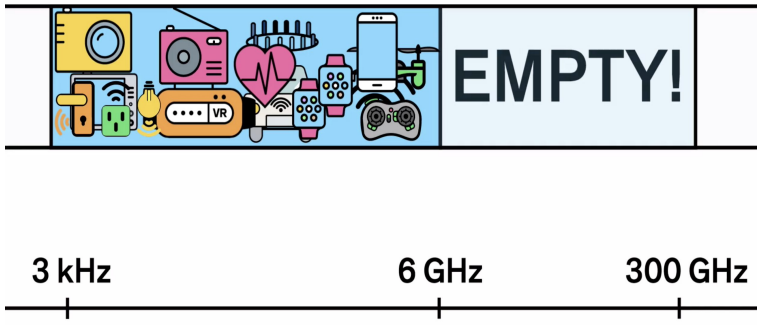
Technologies applied in 5G

- Millimeter waves
- Small cells
- Massive MIMO
- Beamforming

Millimeter Waves

- High frequency millimeter waves (30 - 300 GHZ)
- shorter wavelengths making the beam narrower and the transmission speed faster.
- Relieve devices traffic.
- Due to the limited range of transmission, it cannot travel through walls and large objects, therefore it needs to operate with small cells

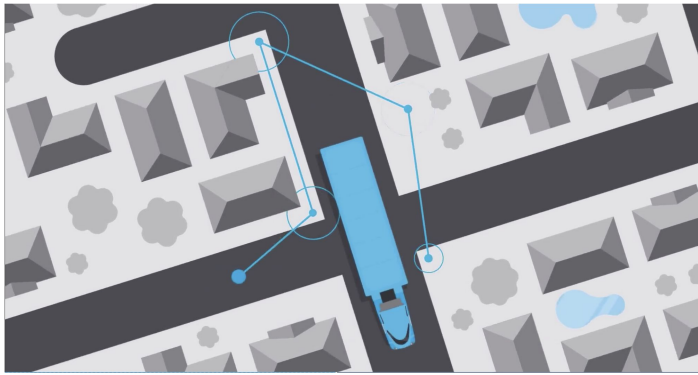




- https://spectrum.ieee.org/video/telecom/wireless/5g-bytes-millimeter-waves-explained

Small cells

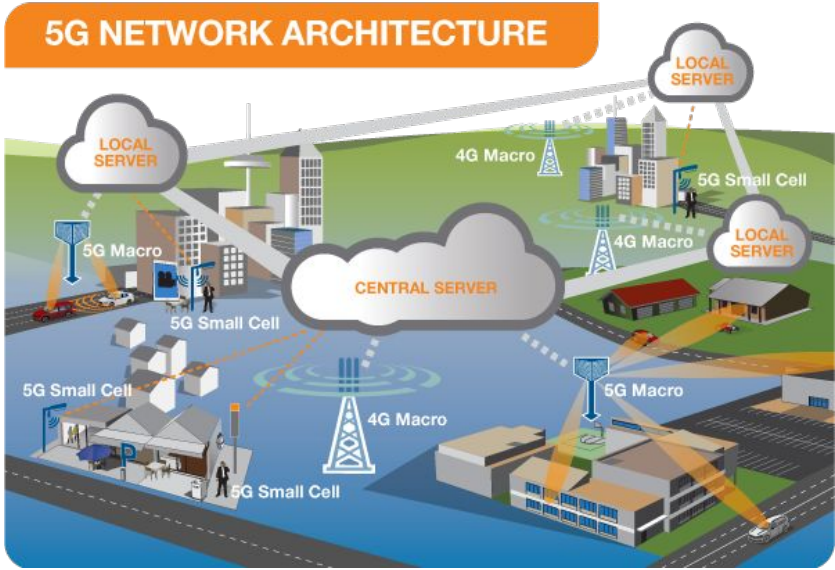
- Small cells densification
  - Foundation of 5G network
  - Requires a large number of small cells covered in the service area.
  - Efficient solution
- Mini base station



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

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

5G Network Architecture

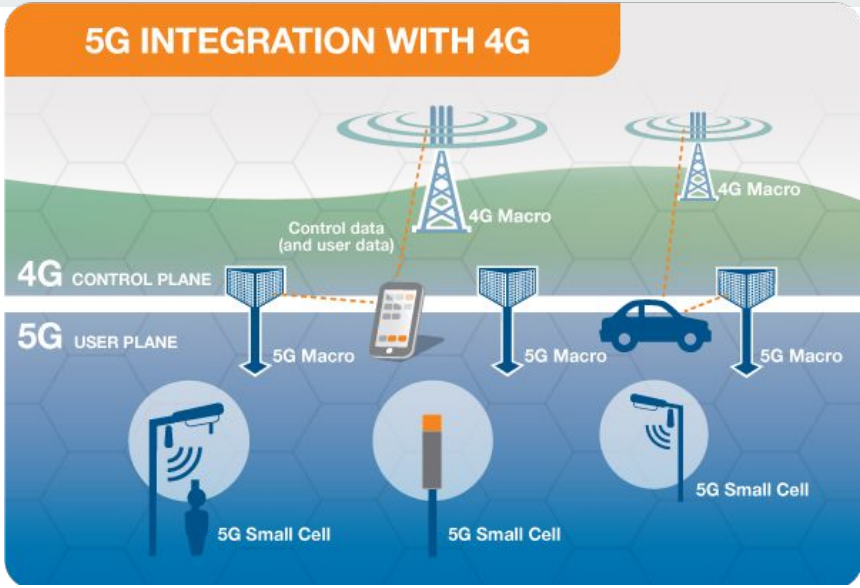


- 5G networks performing with 4G networks
- The Radio Access Network
  - Small cells, towers, antennas
- The Core Network
  - Manage all the mobile voice, data and internet connections
  - Better integrate with the Internet and cloud-based services
  - reduce latency

http://www.emfexplained.info/?ID=25916

5G Integration with 4G

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



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Massive MIMO

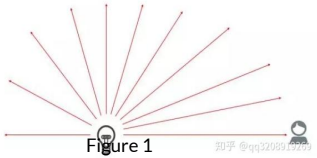


Figure 1

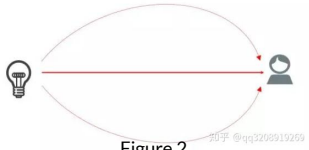


Figure 2

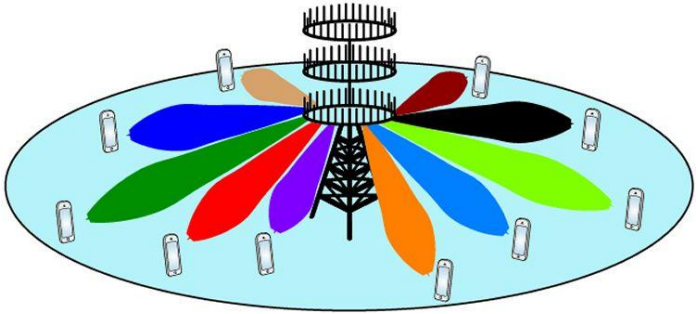


Figure 3

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.

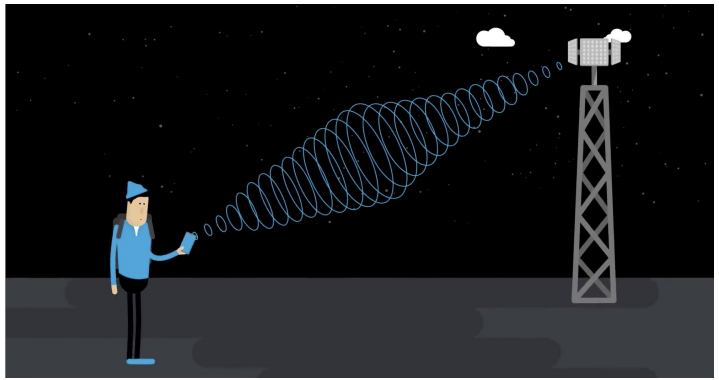
Now: **Beamforming**.

Send a focus stream of data to a specific user.

This precision prevents interference, increases cell capacity, and is way more efficient.

Method

signal processing algorithms. Triangulate user's exact position.



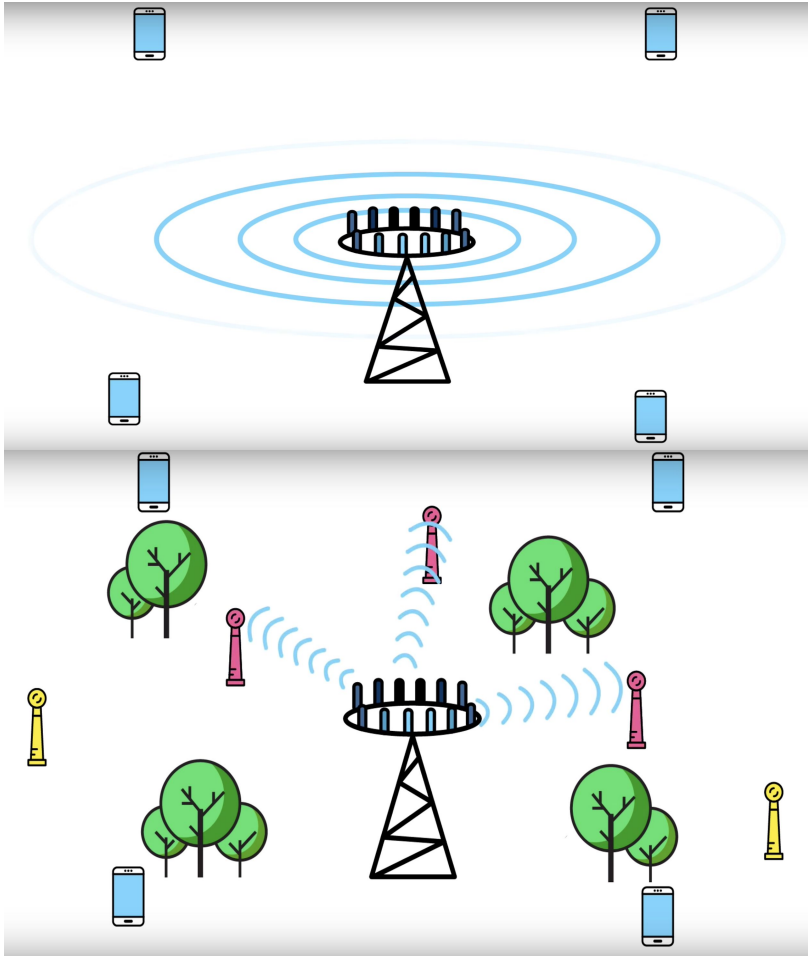
https://www.zhihu.com/search?type=content&q=5g

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

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

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
- 20 Gb/s peak data rate for 5G vs 1 Gb/s peak data rate for 4G network



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

Test

South 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.

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

US

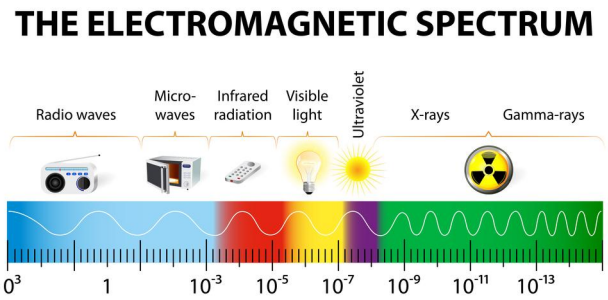
- **Verizon** announced that it has officially deployed its 5G mobile service in certain parts of Chicago and Minneapolis, which are the first two of **30 cities** where it plans to bring its 5G wireless network this year.

China

- The **government** controls all three of the country's mobile operators (China Mobile, China Telecom, and China Unicom) and has been "guiding" them to deploy large-scale 5G test networks in dozens of cities, including Beijing, Shanghai, and Shenzhen.
- China Mobile claims that its tests alone represent the world's **largest 5G trial network**.

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 and ultra high intensity.
  c. densification of small cells deployed around people.
- **Web security**
  a. Not easier to hack, but the huge amount of connections is of great concern.
  b. Nation's safety.



https://www.radiationhealthrisks.com/5g-cell-towers-dangerous/

Future Applications

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

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.gsmaintelligence.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/

http://www.emfexplained.info/?ID=25916