

U3A Science & Technology Online

Part I

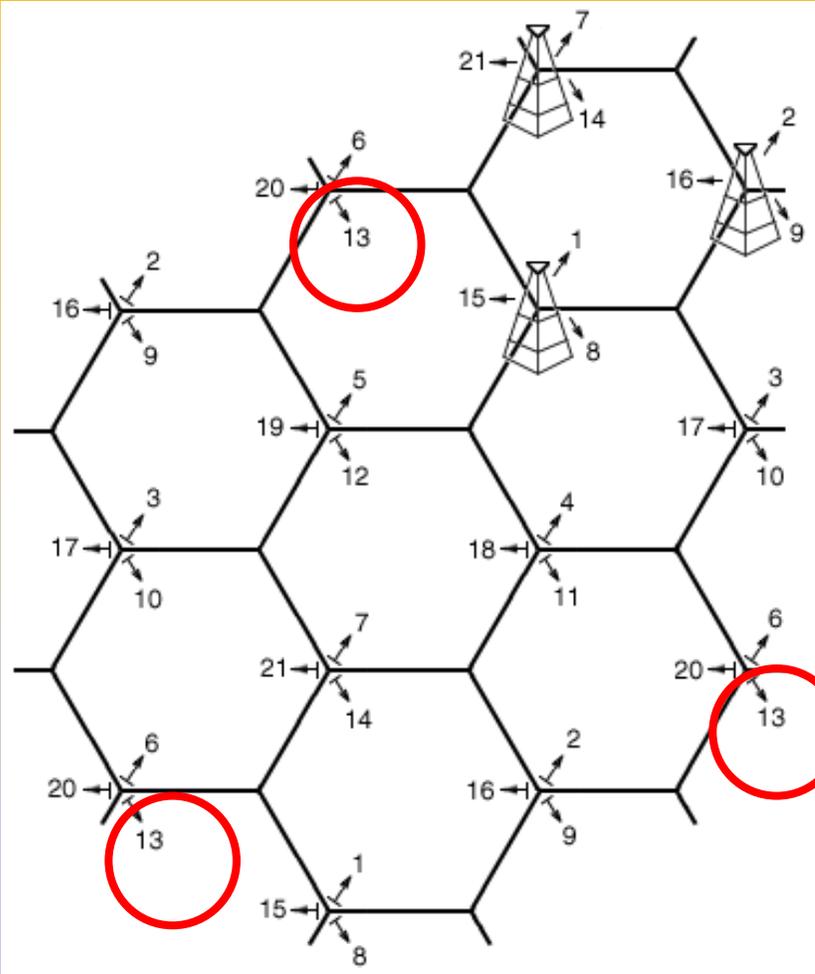
A revision introduction to
Cellular Communications

You're never alone with a phone

With apologies to the
Backfiring Strand cigarette
advert of the 60s!



The Basic Cellular Concept



- Each base station antenna points in three
- Directions
- In the matrix opposite there are 20 frequencies on which the cell can communicate
- Any one frequency can be reused without interference if two adjacent cells do not use the same frequency
- Macrocells - up to 30km range
- Small cells - 10m to 1km
- Subdivided into femtocells, picocells and microcells

The Basic Cellular Concept

It becomes very much more complex and I do not propose to go into the concepts associated with things such as:

- ❖ Antenna beam forming (well - perhaps a bit later = MIMO antennae)
- ❖ Packet switching
- ❖ Channel capacity
- ❖ Uplink
- ❖ Downlink
- ❖ Handover
- ❖ Backhaul
- ❖ Modulation techniques such as Time Division or Frequency Division Multiplex

Examples of cellular antennae



And how to disguise them



Even in the desert



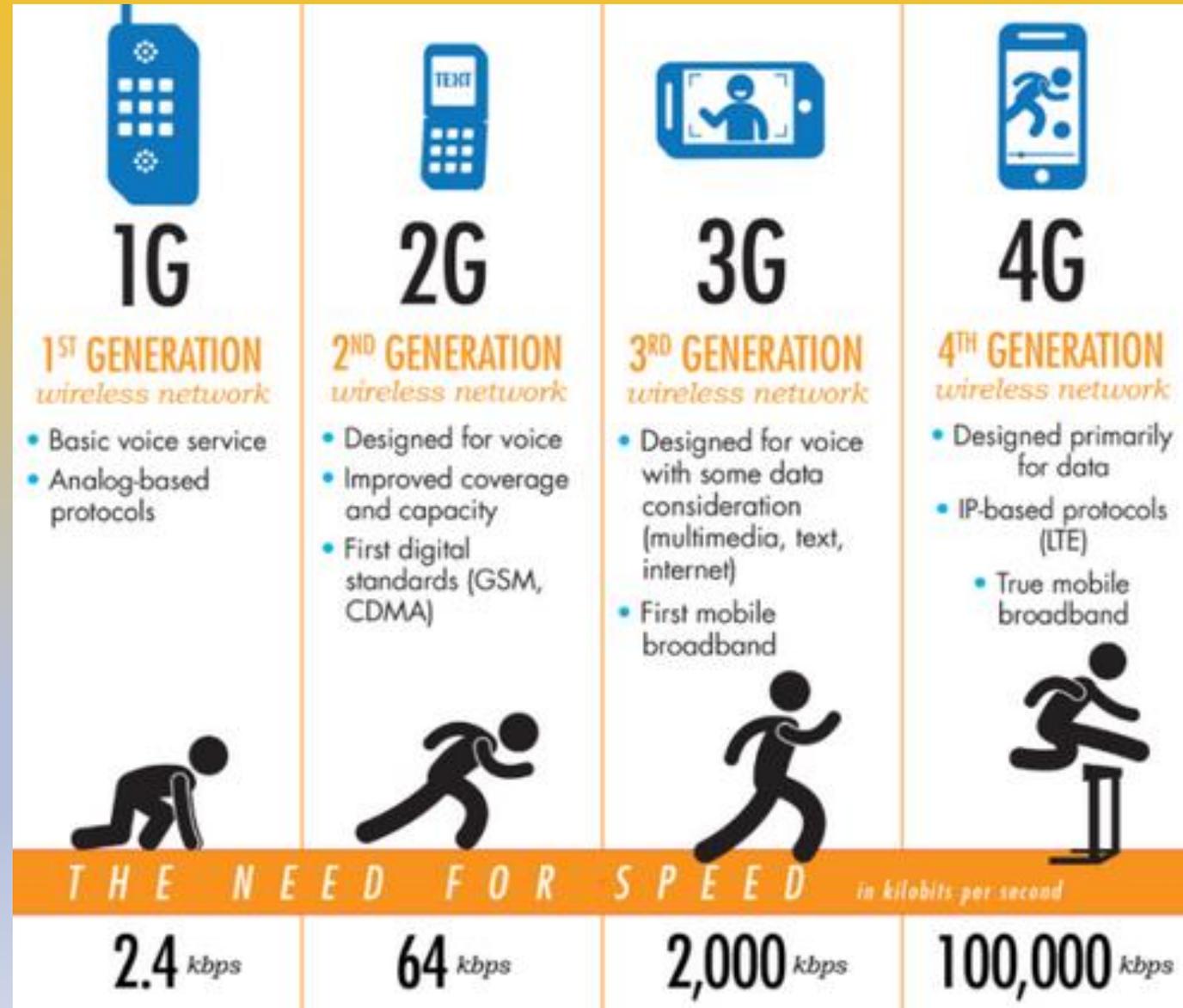
There is even a disguised antenna
in Tilgate forest!

Visible from the M23 south of Crawley

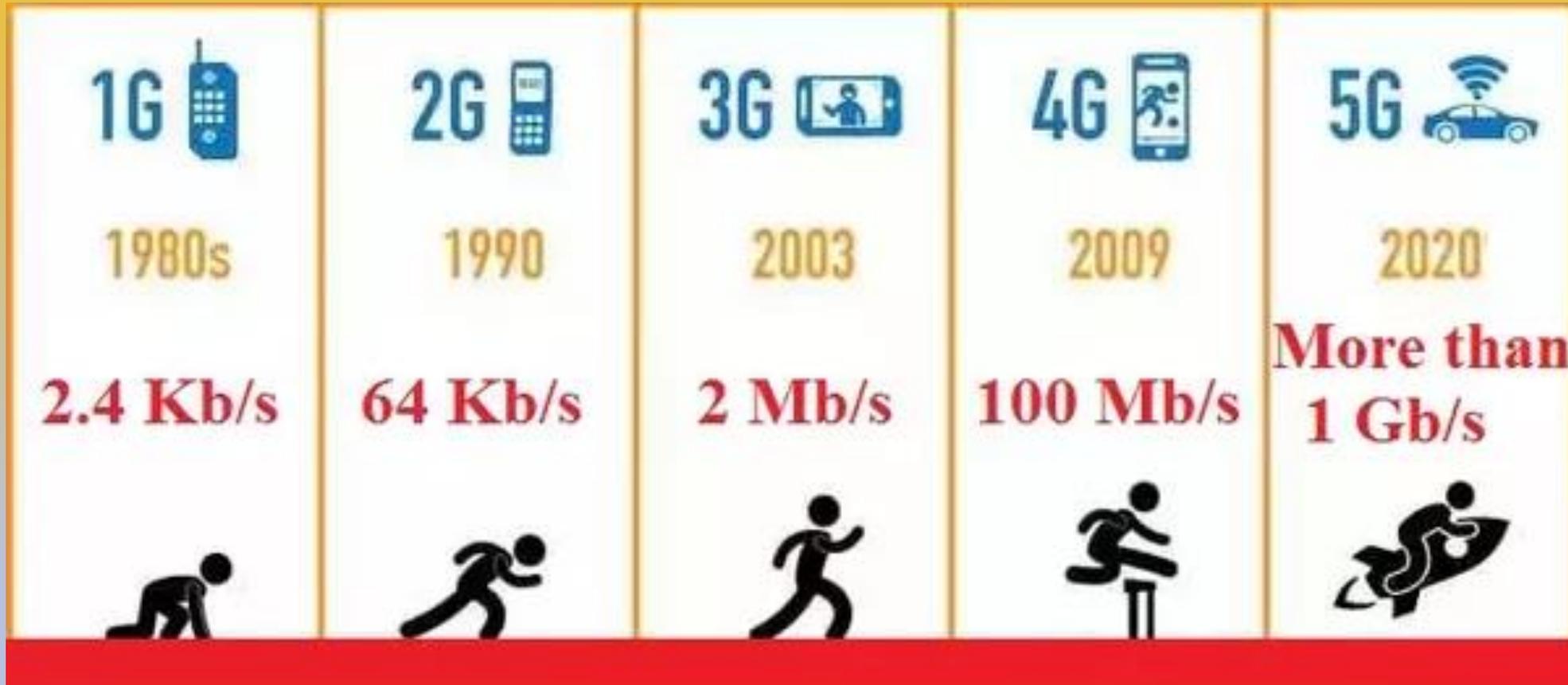
It looks like a very stilted pine tree.

The give-away is the set of climbing rungs!

What are 1G, 2G, 3G and 4G?



What are 2G, 3G, 4G and 5G?



Evolution of the mobile phone - I



Motorola
8900X-2



Nokia
2146



Nokia
3210



Nokia
6210



Ericsson
T39



Alcatel
OT511



Samsung
E250



Apple
iPhone



BlackBerry
Curve 8900



Samsung
Galaxy S2



Samsung
Galaxy S4



Sony Xperia
Z Ultra

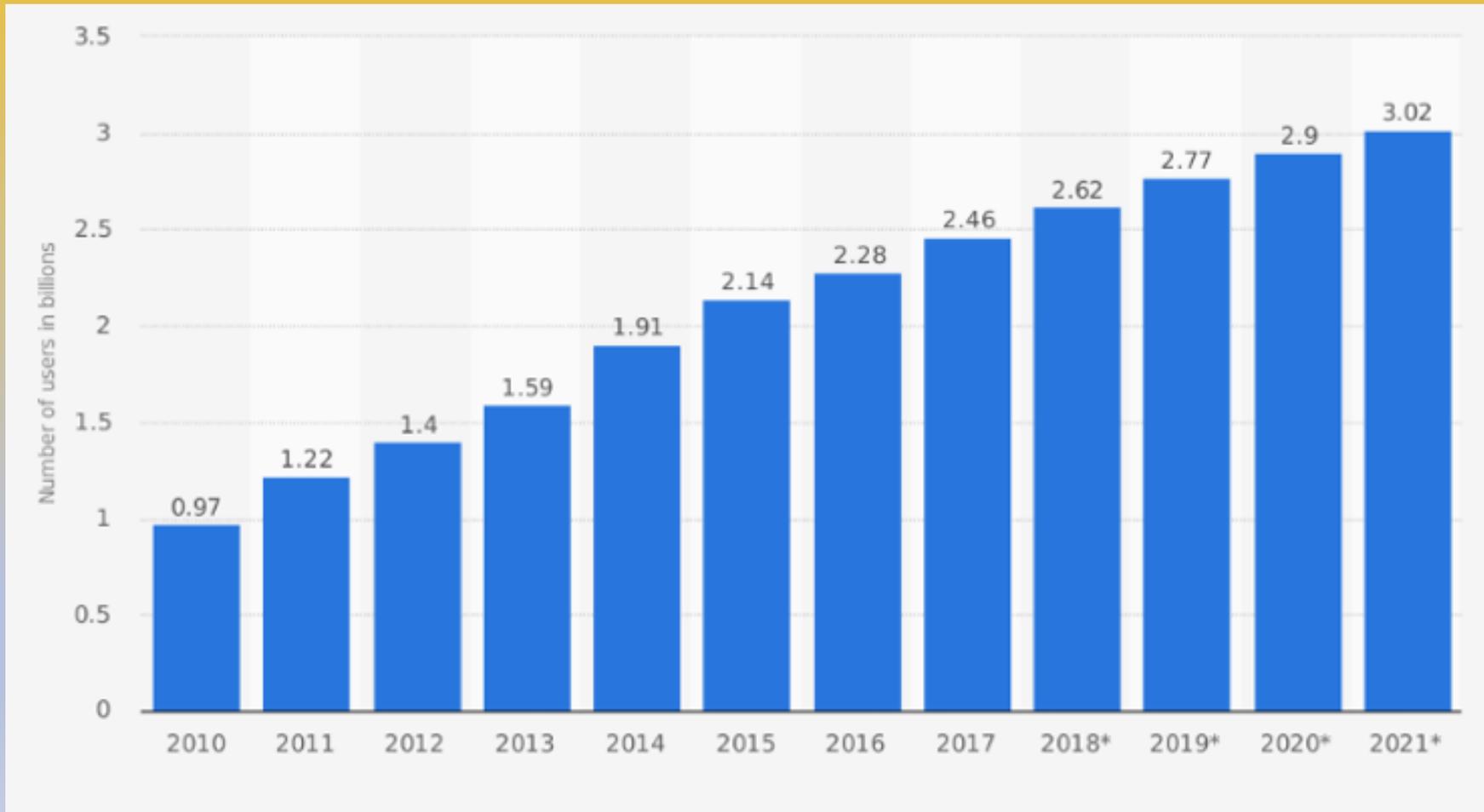
Evolution of the mobile phone - II



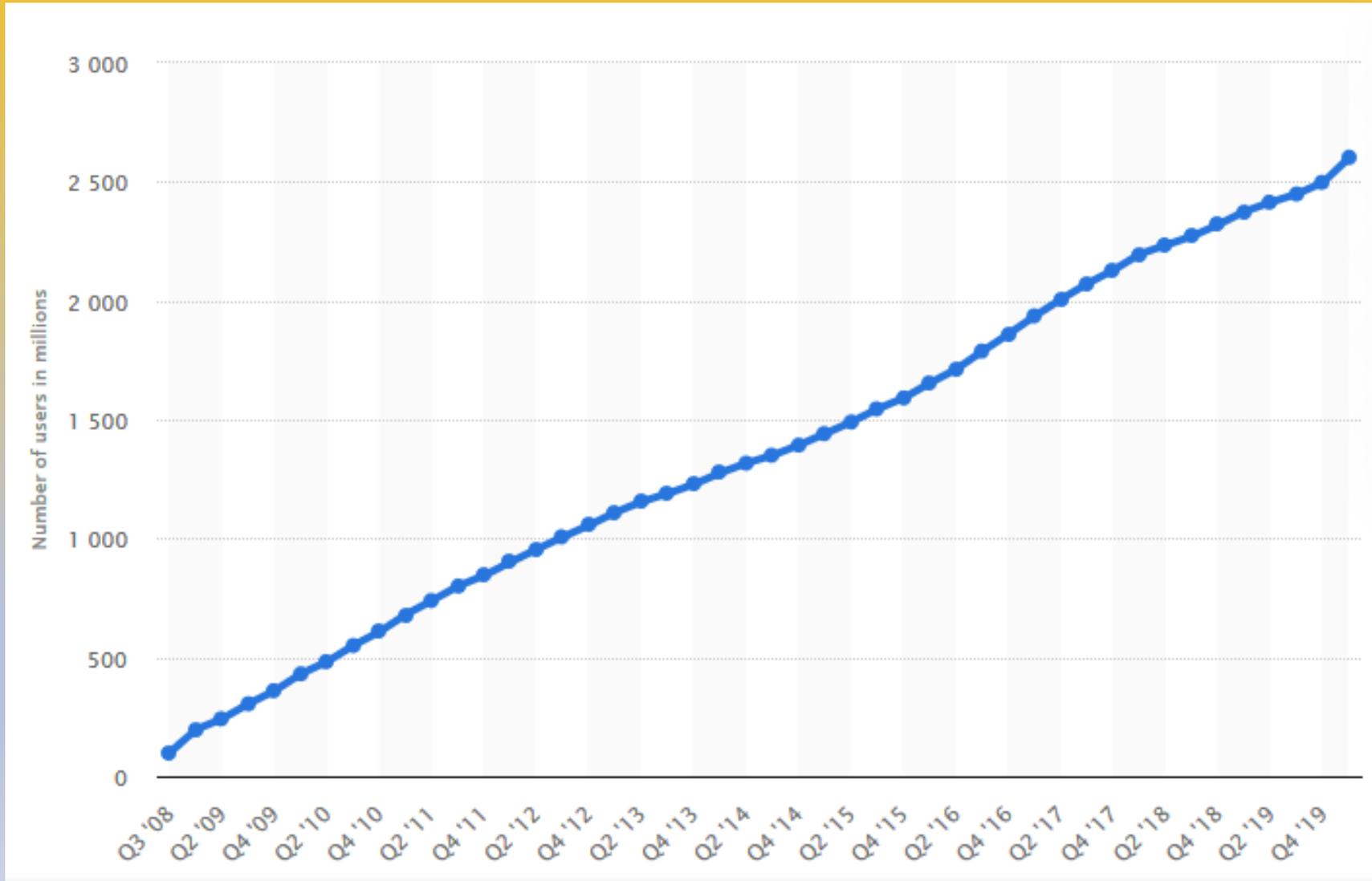
The MOBILE phone

**A few statistics about
how often we use
mobile communications**

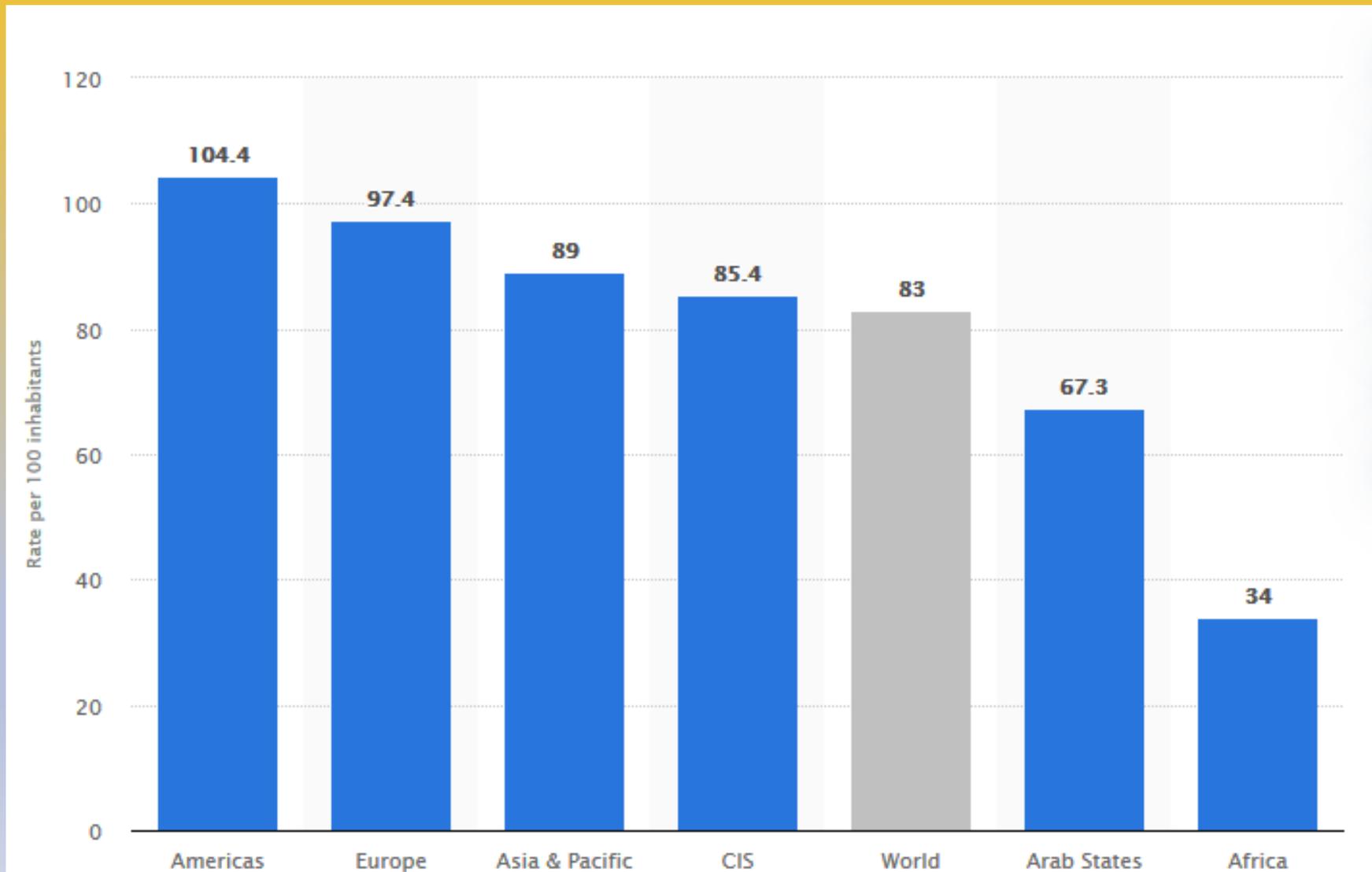
Number of social network users worldwide from 2010 -2021 (in billions)



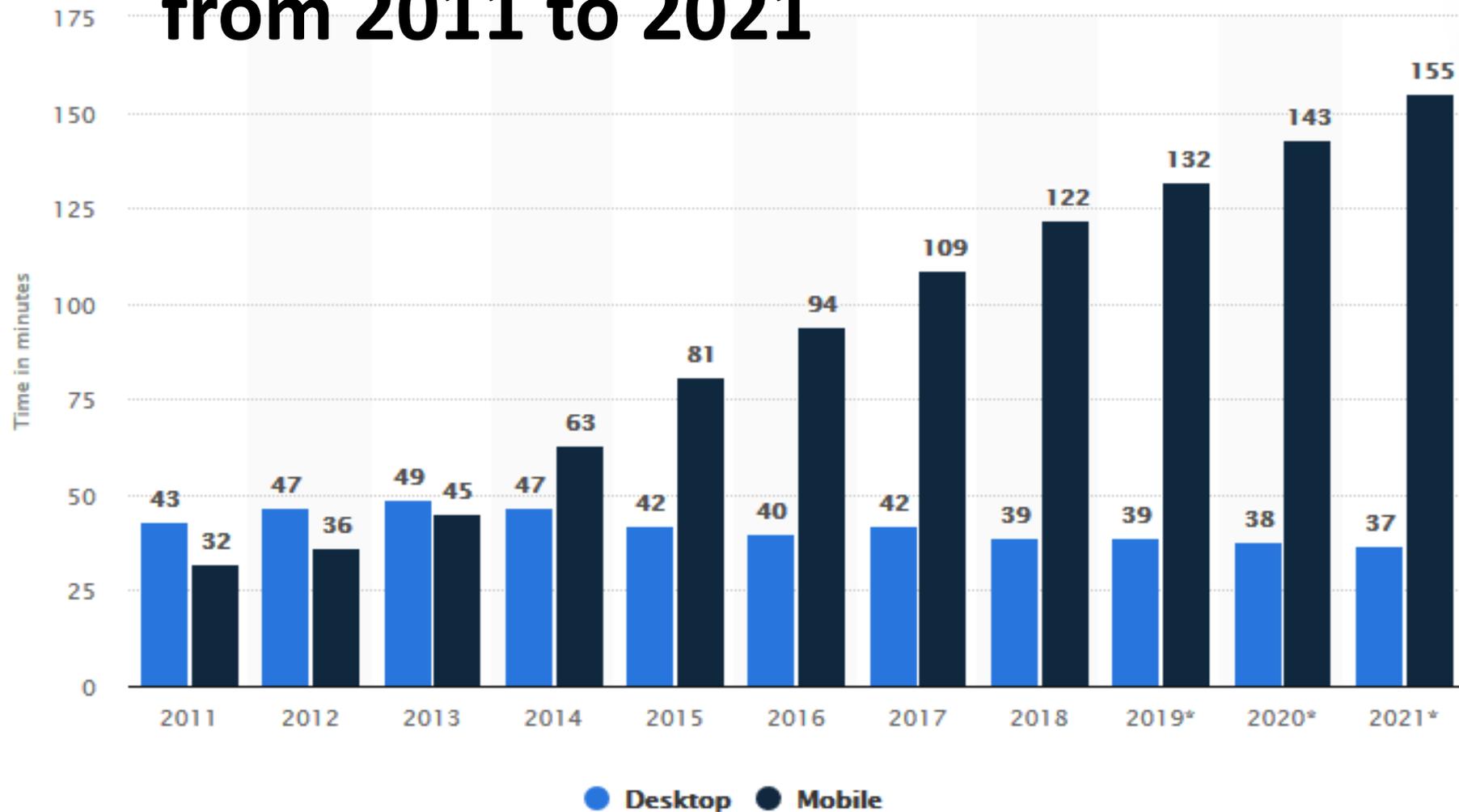
Number of monthly active Facebook users worldwide as of 1st quarter 2020



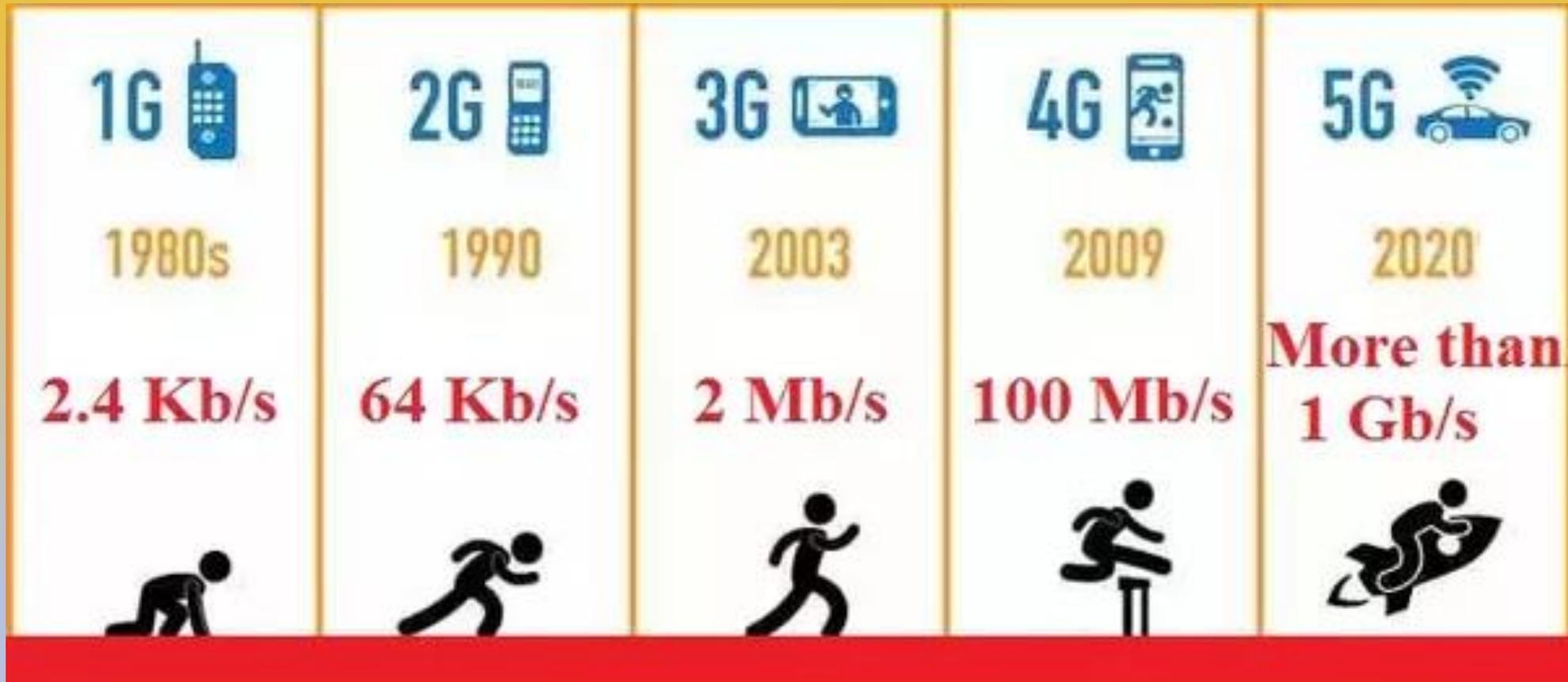
Mobile broadband internet subscription rate in 2019



Daily time spent with the internet per capita worldwide from 2011 to 2021



What are 2G, 3G, 4G and 5G?



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Dog & Bone III

5G revealed

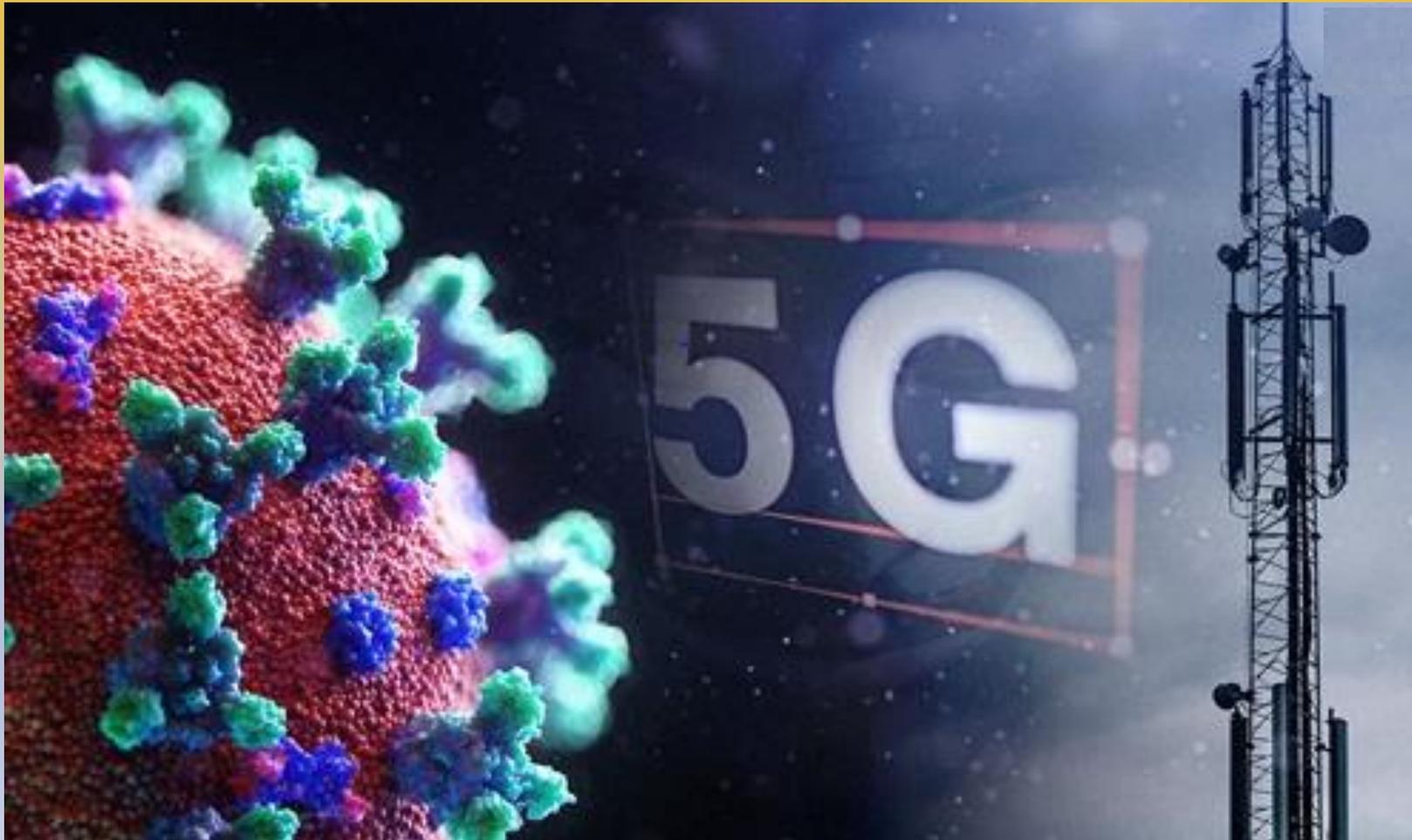


The 5G revolution

John Wells
11th June 2020



5G and COVID19 Conspiracy theory





5G – and your health





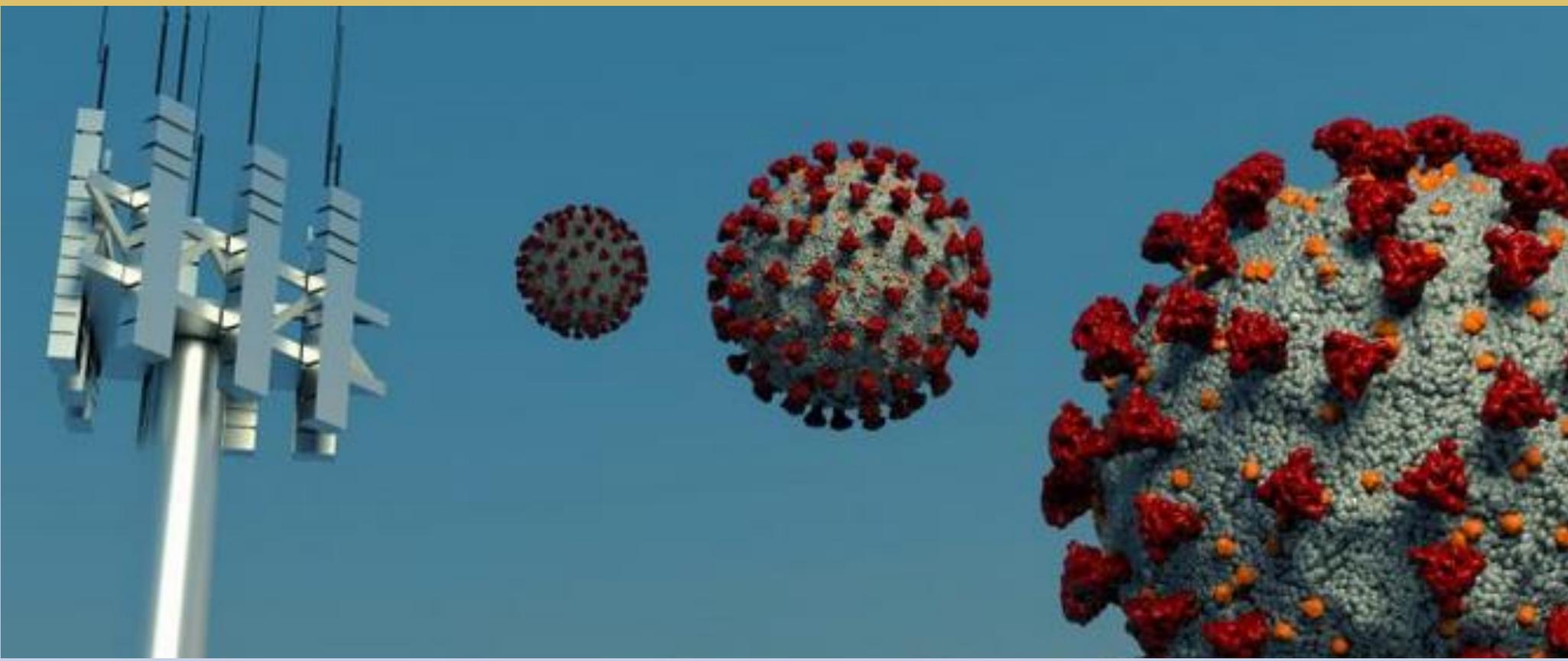
5G – Radiation hazards – the conspiracy theory

5G radiation and the dangers to your health:

- **Is 5G radiation dangerous to your health?**
- **Is there a conspiracy by “them” to take control of “us”?**
- **Was the COVID19 virus generated by 5G radiation?**



5G – Radiation hazards – the conspiracy theory





The 5G Health Hazard That Isn't

How one scientist and his inaccurate chart led to unwarranted fears of wireless technology





The 5G Health Hazard That Isn't

How one scientist and his inaccurate chart led to unwarranted fears of wireless technology

It goes right back to 2000.

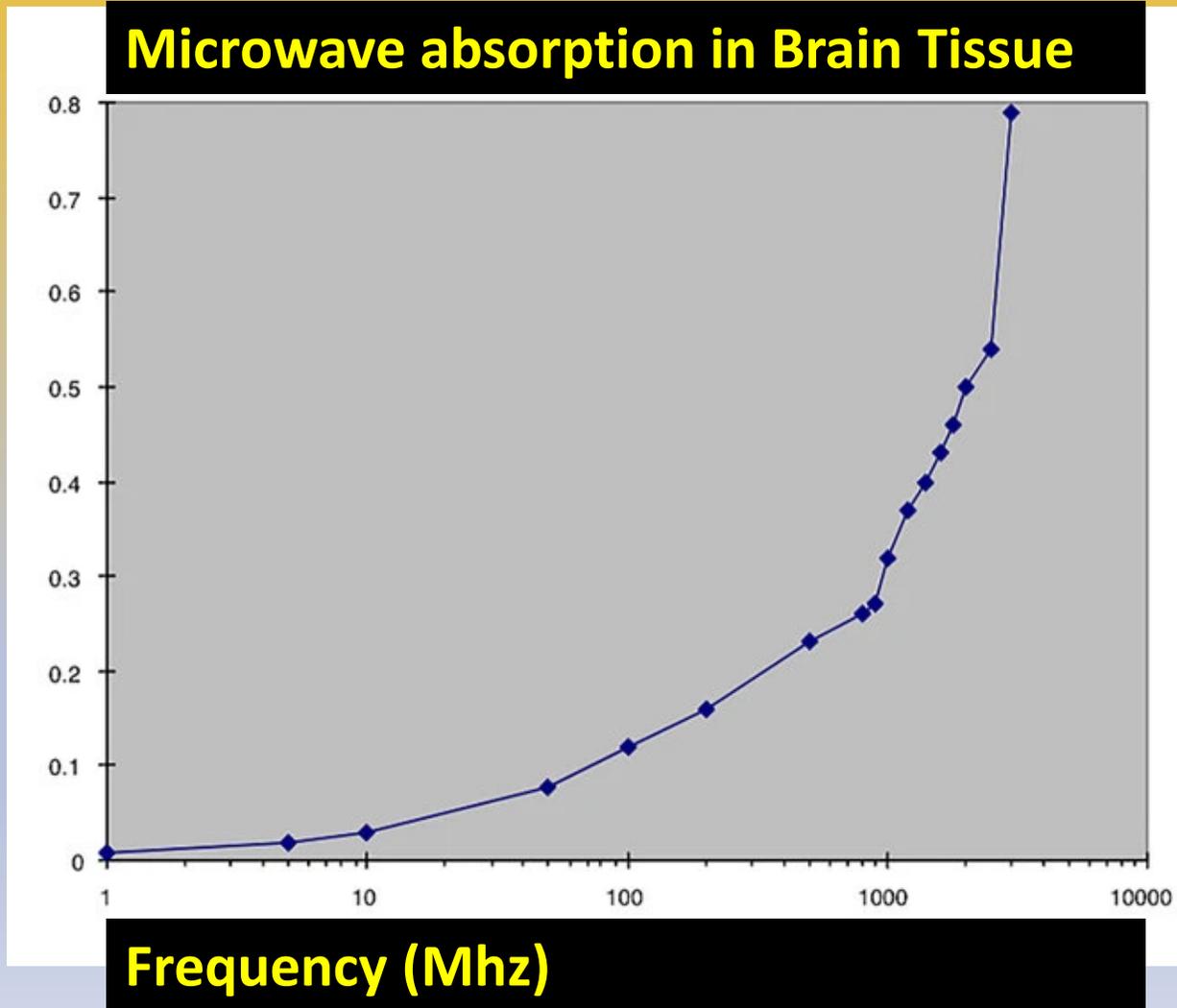
In 2000, the Broward County Public Schools in Florida received an alarming report. Like many affluent school districts at the time, Broward was considering laptops and wireless networks for its classrooms and 250,000 students. Were there any health risks to worry about?

The district asked Bill P. Curry, a consultant and physicist, to study the matter. The technology, he reported back, was “likely to be a serious health hazard.” He summarized his most troubling evidence in a large graph labeled “Microwave Absorption in Brain Tissue (Grey Matter).”



The 5G Health Hazard That Isn't

How one scientist and his inaccurate chart led to unwarranted fears of wireless technology





The 5G Health Hazard That Isn't

How one scientist and his inaccurate chart led to unwarranted fears of wireless technology

- **Except that Dr. Curry and his graph got it wrong.**
- **According to experts on the biological effects of electromagnetic radiation, radio waves become safer at higher frequencies, not more dangerous. (Extremely high-frequency energies, such as X-rays, behave differently and do pose a health risk.)**
- **In his research, Dr. Curry looked at studies on how radio waves affect tissues isolated in the lab, and misinterpreted the results as applying to cells deep inside the human body. His analysis failed to recognize the protective effect of human skin.**
- **At higher radio frequencies, the skin acts as a barrier, shielding the internal organs, including the brain, from exposure. Human skin blocks the even higher frequencies of sunlight.**



5G – Radiation hazards – the conspiracy theory





Some of the fake news about 5G

But you can't keep a good bit of fake news about conspiracy down.

- ❖ **5G is the actual cause of COVID-19**
- ❖ **5G acts as an accelerator for the coronavirus**
- ❖ **5G can kill birds and plant life**
- ❖ **5G kills trees and other plant life**
- ❖ **5G is a military grade weapon**
- ❖ **The lockdown is a government cover-up**
- ❖ **Viruses can communicate through the radio airwaves**



5G – Radiation hazards – the facts

5G radiation and the dangers to your health:

- ✓ **There is NO danger to your health**
- ✓ **There is NO conspiracy by “them” to take control of “us”**
- ✓ **There is absolutely nothing to do with the COVID19 virus**



5G – Radiation hazards – the conspiracy theory

When or how did the conspiracy theory arise, and why?

It started, in earnest, with a lamppost.

- In April of 2018, a man from the Gateshead took a ladder and scaled a streetlight before vandalising the very top.**
- According to local newspapers, the man had become convinced that Gateshead Council had placed "5G antenna" across the town's streetlights, and that these antenna were, in turn, "killing everyone".**



5G – Radiation hazards – the conspiracy theory

When or how did the conspiracy theory arise, and why?

Exactly two years later, during the first days of April, 2020, mobile phone masts were set alight in Birmingham, Liverpool and Merseyside. In total, over 50 masts were burned or vandalised in the early April, with arsonists believing that:

- 1) they were setting fire to 5G masts (they often weren't because they only had 3G or 4G onboard), and
- 2) that 5G is a harmful technology that damages human health (wrong again!).



5G – Radiation hazards – the conspiracy theory

When or how did the conspiracy theory arise, and why?

- In the 24 months since the Gateshead streetlight was vandalised, conspiracy theories about 5G had flourished and diversified.
- Some said it caused miscarriages. Others thought it killed trees.
- More and more came to believe it was linked to the worldwide Covid-19 pandemic.



5G – Radiation hazards – the conspiracy theory

When or how did the conspiracy theory arise, and why?

- The lonely lamppost vandal was no longer so alone.
- High profile believers swelled the ranks of conspiracy theorists:
- Actor Woody Harrelson, boxer Amir Khan and reality star Lucy Watson were among the celebrities who began expressing distrust of 5G technology.



5G – Radiation hazards – the conspiracy theory

In January 2020 it all started to smoulder again...

- **Here is the logic: Wuhan has a big 5G rollout...COVID19 seems to have started in Wuhan...therefore COVID19 is either a result of 5G or else was accelerated by 5G.**
- **Unfortunately for these conspiracy theorists they ignore facts. For example COVID19 is rampant in Iran – which has NO 5G infrastructure at all**
- **Since 30th March the UK has now suffered over 90 arson attacks on towers and cabinets, and very little of the damaged equipment had any 5G equipment on board**



So much for conspiracy
theories

What is 5G? What is it used
for and why is 5G radiation
no problem?



The radiation “problem”

There isn't one!

Radiation damage is **only** caused by ionising radiation, which is a function of frequency

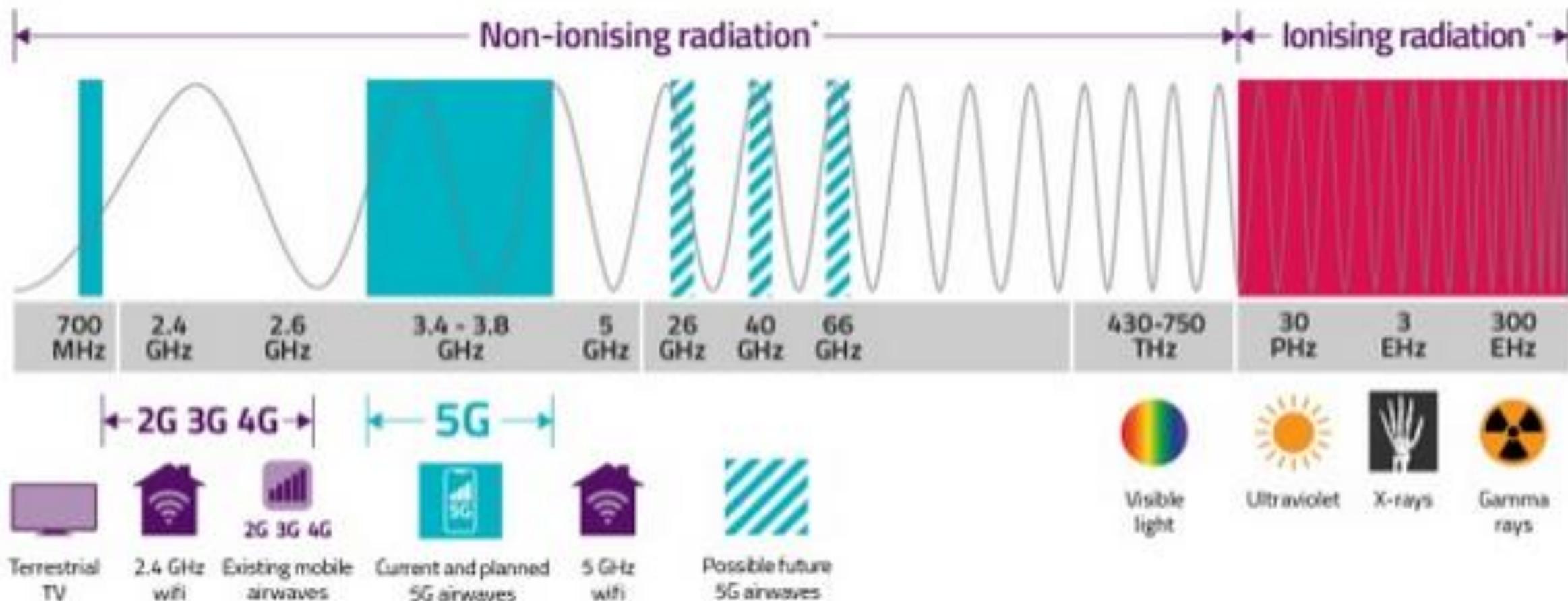
5G is designed to move massive amounts of information around with minimal “latency” (more of that in due course)

- To gain more bandwidth which is the capacity to transmit information you need a very much higher frequency**
- The higher the frequency, the more POTENTIALLY damaging the radiation**
- Really high frequencies – like UV light, X rays, or Gamma rays, have the potential to strip off atomic electrons. But the frequencies used for 5G are orders of magnitude below that**
- The higher frequencies used in 5G require many more communicating cells and people could be worried by this requirement – whether or not they are conspiracy theorists!**
- Microwave ovens do heat thing up of course. But that is a HEATING effect, not an IONISING effect. And the level of microwave radiation is way down on anything that could produce a heating effect**

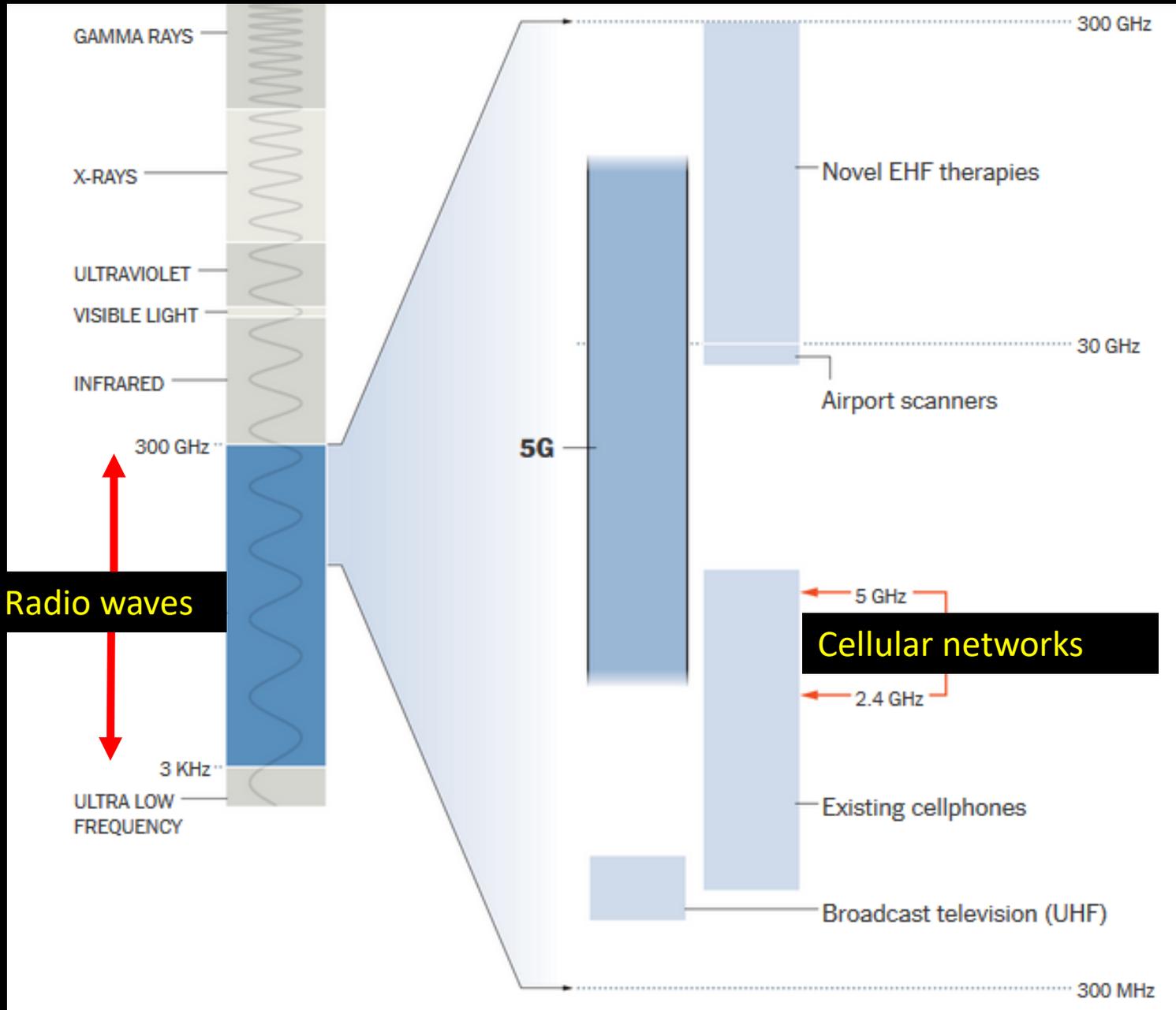


The electromagnetic spectrum

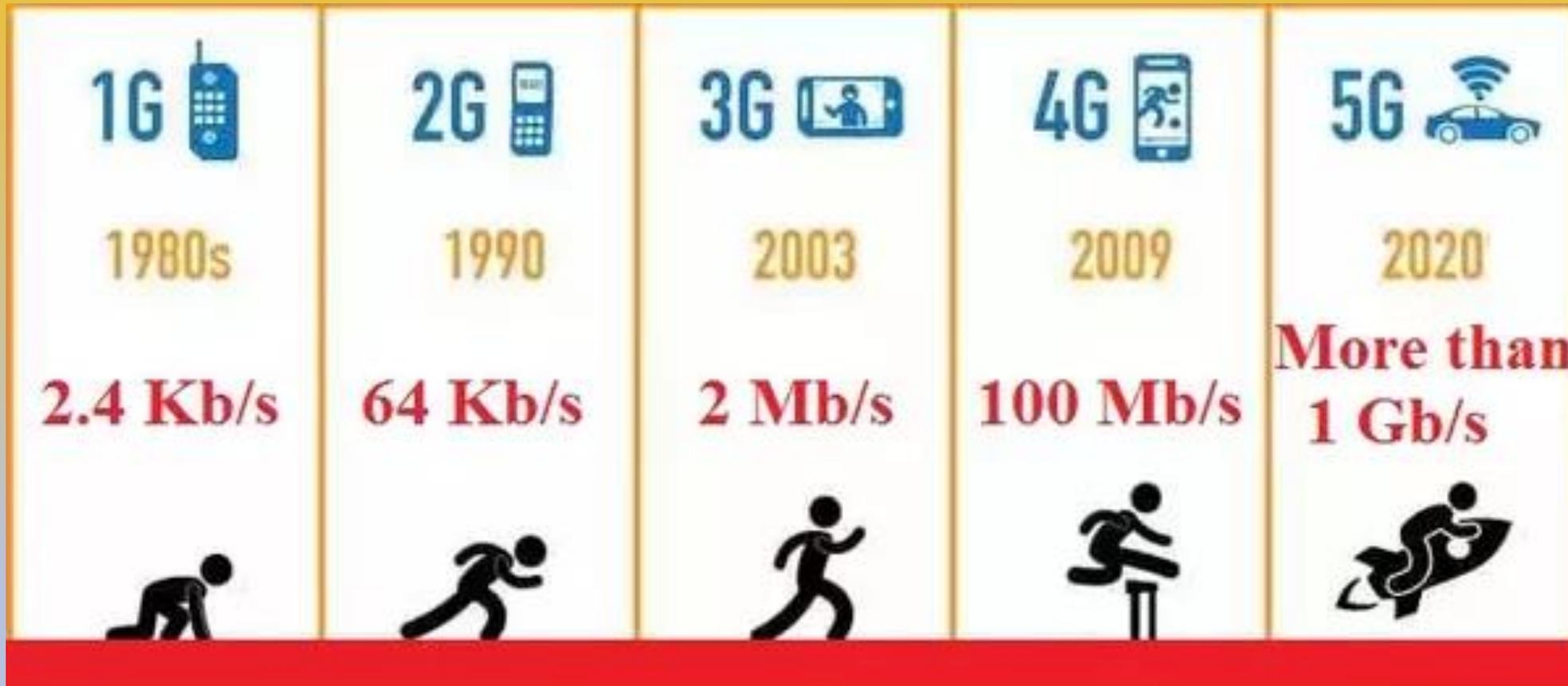
The Electromagnetic Spectrum



The electromagnetic spectrum – another view



What are 2G, 3G, 4G and 5G?



- 5G is the 5th generation of mobile networks, a significant evolution of today's 4G networks.
- 5G has been designed to meet the very large growth in data and connectivity of today's modern society
- 5G has been designed for the internet of things with billions of connected devices, and tomorrow's innovations
- 5G will initially operate in conjunction with existing 4G networks before evolving to fully standalone networks in subsequent releases and coverage expansions

Beyond speed improvement, 5G is expected to unleash a **massive IoT (Internet of Things) ecosystem** where networks can serve communication needs for billions of connected devices, with the right trade-offs between speed, latency, and cost.

5G technology is driven by 8 specification requirements:

- **Up to 10Gbps data rate - > 10 to 100x improvement over 4G and 4.5G networks**
- **1-millisecond latency**
- **1000x bandwidth per unit area**
- **Up to 100x number of connected devices per unit area (compared with 4G LTE)**
- **99.999% availability**
- **90% reduction in network energy usage**
- **Up to 10-year battery life for low power IoT device**

The importance of Latency

5G technology offers an extremely low **latency rate**, the delay between the sending and receiving of information. From 200 milliseconds for 4G, we go down to 1 millisecond (1ms) with 5G.

- The average reaction time for humans to a visual stimulus is 250 ms or 1/4 of a second.
- People are capped at around 190-200 ms with proper training.
- Imagine now that your car could react 250 times faster than you.
- Imagine it could also respond to hundreds of incoming information and can also communicate its reactions back to other vehicles and road signals all within milliseconds.
- At 60 mph (100km/h), the reaction distance is about 33 yards (30 metres) before you pull on the brakes.
- With a 1ms reaction time, the car would only have rolled a bit more than one inch (less than 3 centimetres)!!
- This is virtually instantaneous opening up a new world of connected applications

The three prime user cases for 5G

5G will provide the speed, low latency and connectivity to enable a new generation of applications, services and business opportunities that have not been seen before

The Internet of Things (IoT) that involves connecting billions of devices without human intervention at a scale not seen before. This has the potential to revolutionise modern industrial processes and applications including agriculture, manufacturing and business communications.

Ultra-reliable low latency communications – mission critical including real-time control of devices, industrial robotics, vehicle to vehicle communications and safety systems, autonomous driving and safer transport networks. Low latency communications also opens up a new world where remote medical care, procedures, and treatment are all possible

Enhanced mobile broadband – providing significantly faster data speeds and greater capacity keeping the world connected. New applications will include fixed wireless internet access for homes, outdoor broadcast applications without the need for broadcast vans, and greater connectivity for people on the move

The state of 5G art - worldwide

- Japan and Korea started to work on 5G requirements in 2013.
- NTT Docomo did the first 5G experimental trials in 2014.
- Samsung, Huawei, and Ericsson started prototype development in 2013.
- South Korean SK Telecom demoed 5G in 2018 at the Pyeongchang Winter Olympics.
- Ericsson and TeliaSonera made commercial services available in Stockholm and Tallinn in 2018.
- North America 5G is available in some locations in 2019. It won't take off in most areas until 2020.
- In the US, more precisely, AT&T is announcing nationwide coverage in the first half of 2020. Verizon 5G was the first carrier to roll out 5G.
- Deutsche Telekom started 5G in Berlin, Darmstadt, Munich, Bonn, and Cologne in Sept 2019.
- In the UK, many cities will see 5G in 2019 and more in 2020. EE, Vodaphone, and O2 are actively deploying 5G since mid-2019.
- India is targeting 2020 for 5G roll-out
- Japan's target is to launch 5G for the 2020 Tokyo summer Olympics.
- China Unicom has set up 5G in a few locations in 2019. 460 million 5G connections are expected by GMSA in China by 2025.

The 5G numbers as at January 2020

- 5G has been deployed in 378 cities across 34 countries as of January 2020
- Leading the pack is South Korea with coverage in 85 cities
- China takes second place with 57 cities
- The United States has 50
- The United Kingdom has 31
- The remaining countries in the top ten for 5G are Saudi Arabia, Spain, the United Arab Emirates (UAE), Australia, Germany, and Romania.