5G Opportunities

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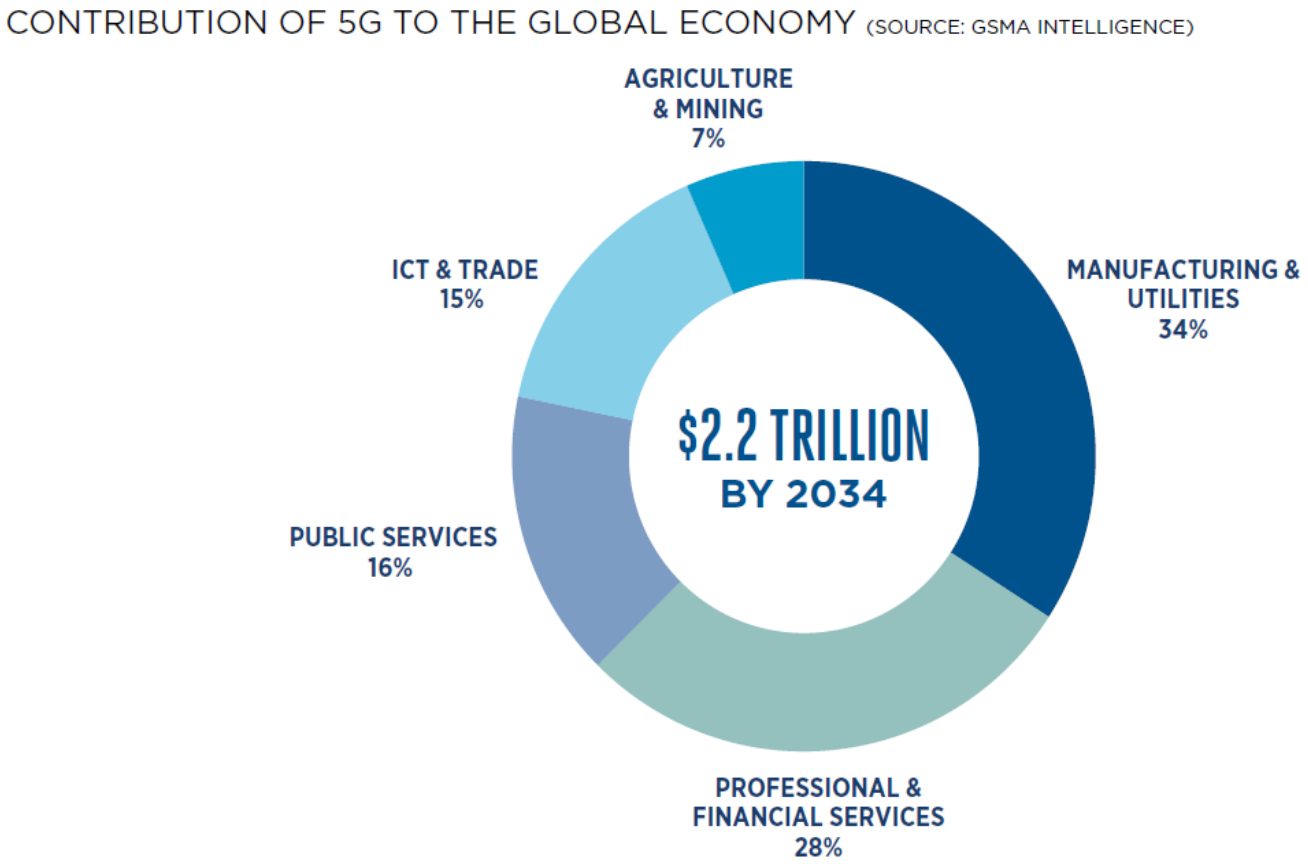
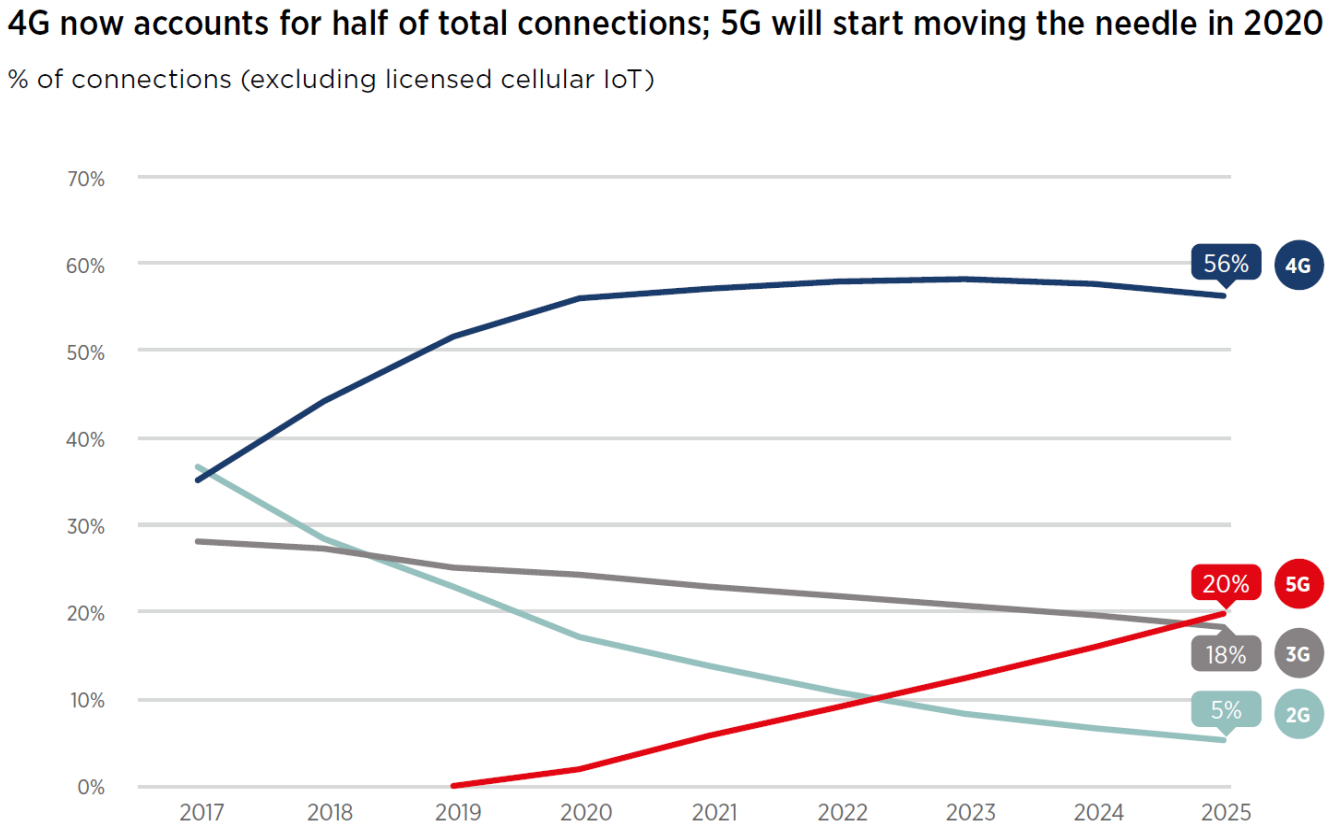
October 2020

5G impact on the global economy



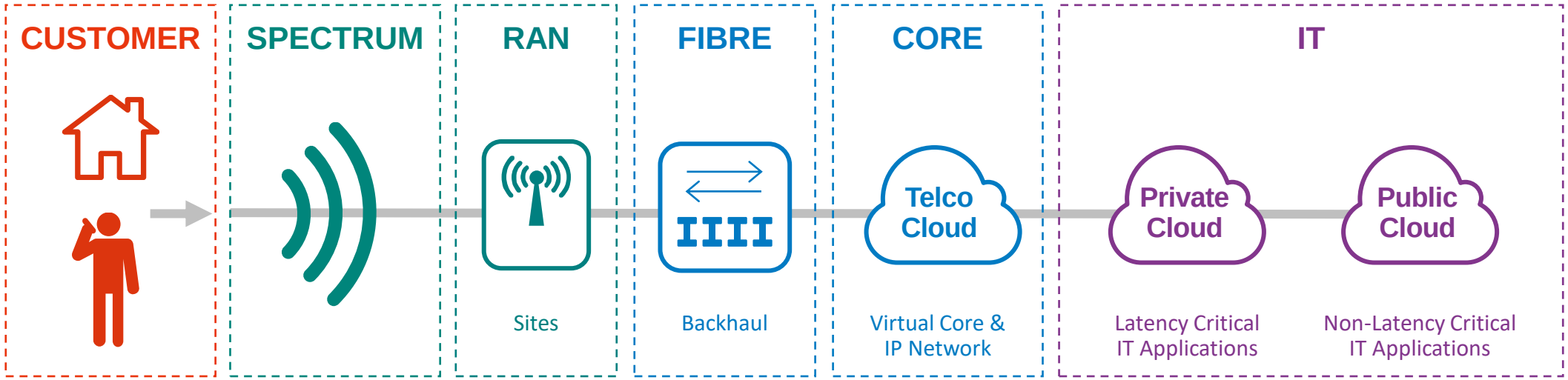
5G contribution to the global economy over the next 15 years

5G connections forecast



Source: The Mobile Economy 2020

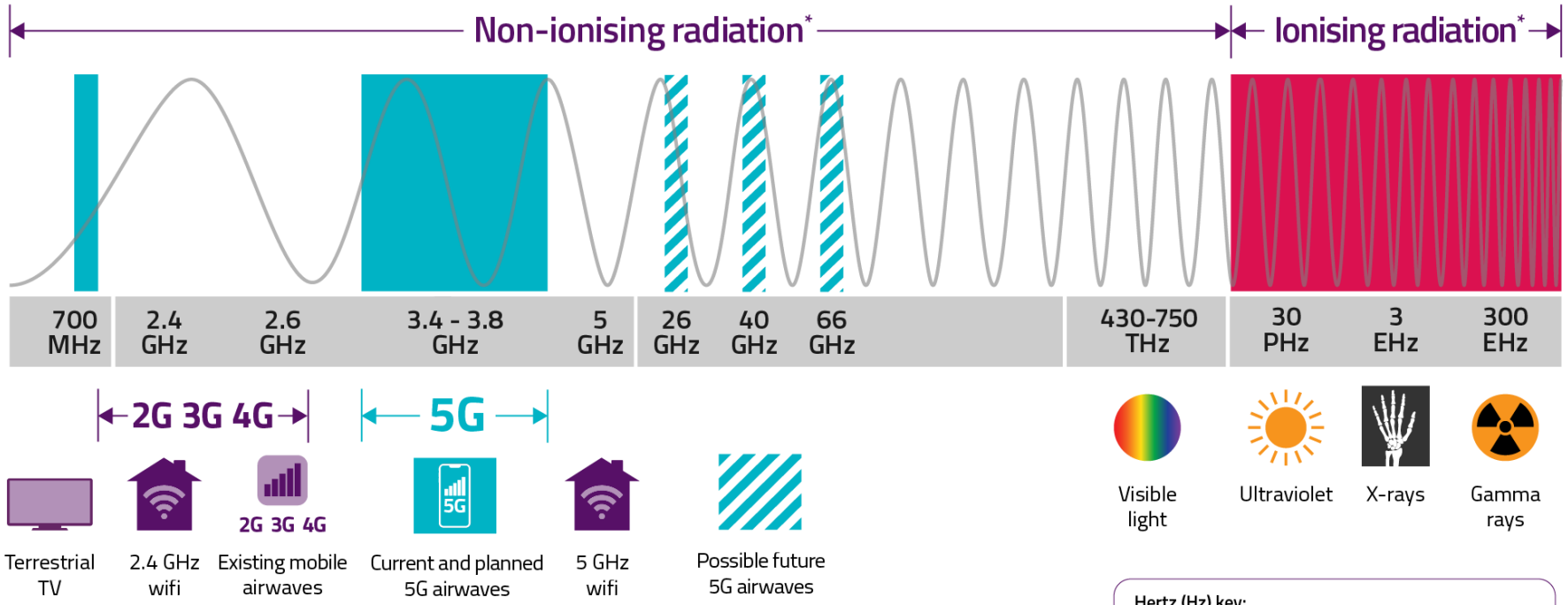
A mobile network



Spectrum

The Electromagnetic Spectrum

Ofcom stay connected

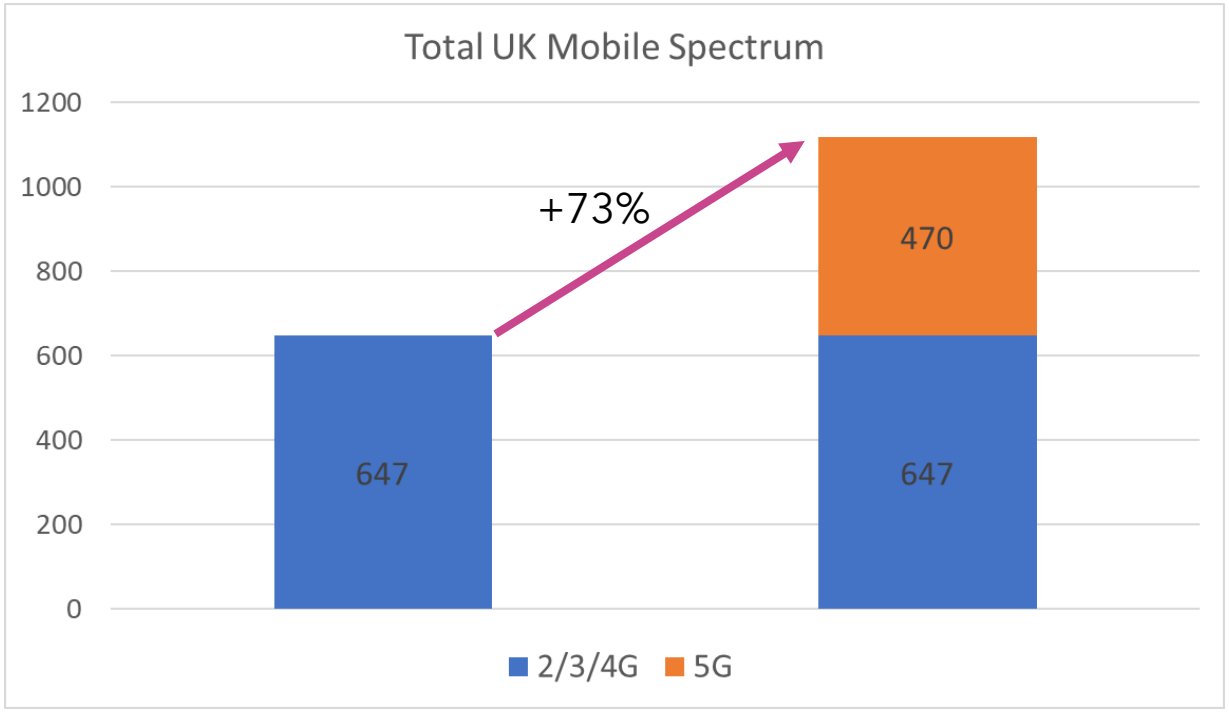


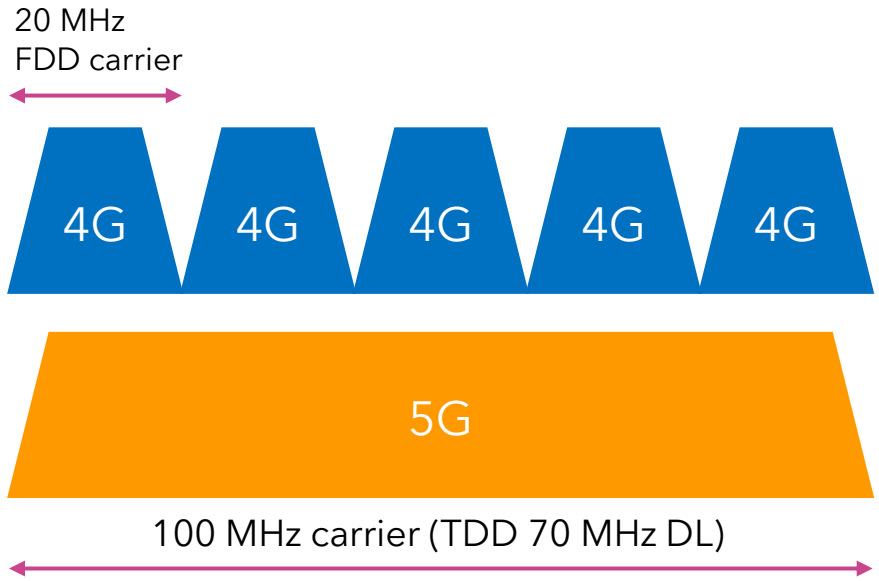
*Radio frequencies needed for common household items to work, from televisions to microwave ovens (usually between 3KHz and 300GHz), produce radiation which is classed as 'non-ionising'. This means that it does not have sufficient energy to break chemical bonds or remove electrons, as opposed to 'ionising radiation,' which occurs at much higher frequencies and is generally considered to be hazardous to humans. **(Source: International Commission for Non-Ionizing Radiation Protection (ICNIRP))***

Hertz (Hz) key:

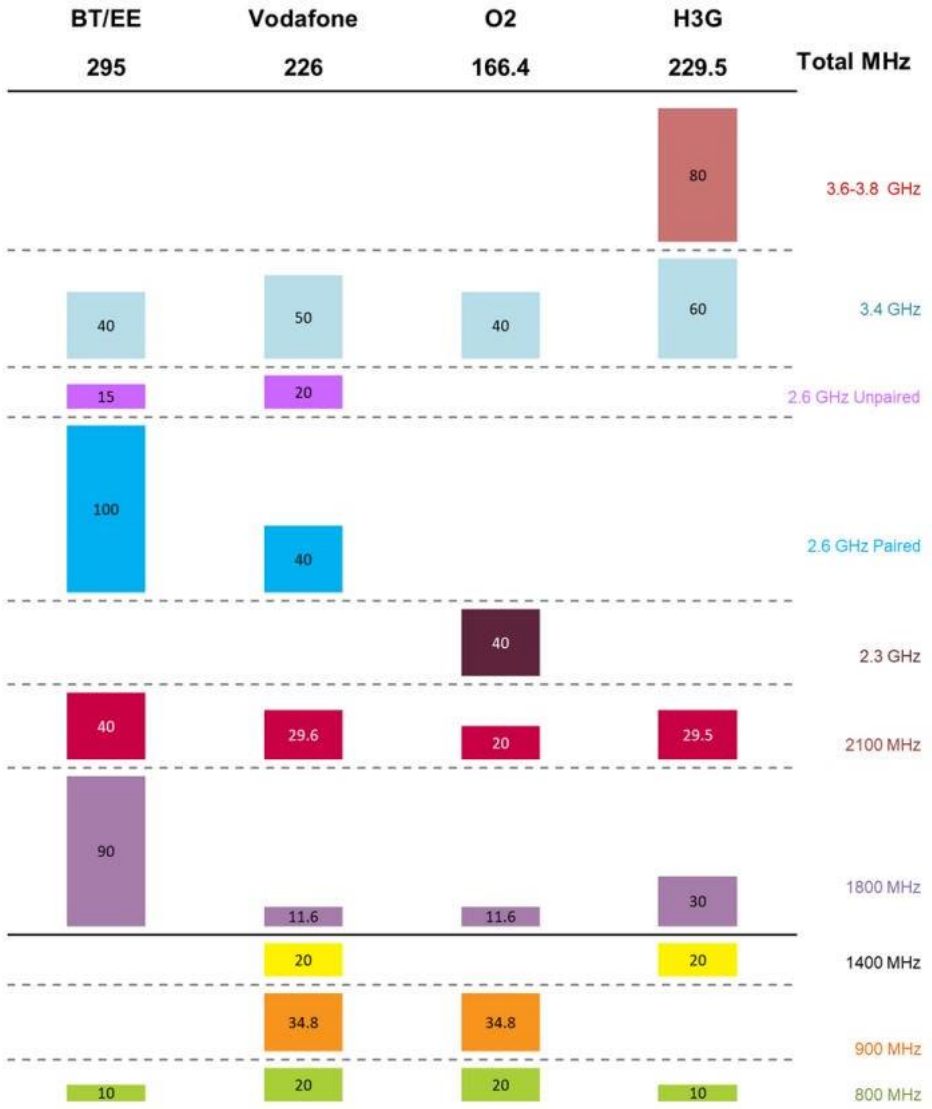
kHz: kilohertz = 10^3 Hz	THz: terahertz = 10^{12} Hz
MHz: megahertz = 10^6 Hz	PHz: petahertz = 10^{15} Hz
GHz: gigahertz = 10^9 Hz	EHz: exahertz = 10^{18} Hz

5G Spectrum


Total UK Mobile Spectrum
1200
1000
800
600
400
200
0
+73%
470
647
647
2/3/4G
5G


20 MHz
FDD carrier
4G
4G
4G
4G
4G
5G
100 MHz carrier (TDD 70 MHz DL)

UK mobile spectrum holdings

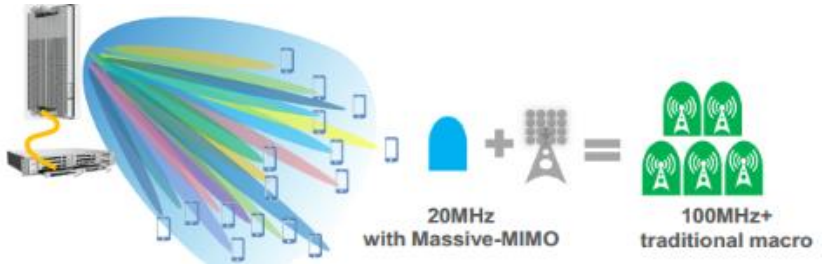


Source: Ofcom “Award of the 700 MHz and 3.6-3.8 GHz spectrum bands”

Antenna technology

4T4R

M-MIMO



3.4-3.8 Ghz	2T2R	4T4R	64T64R Beam Forming
Coverage	No improvement	Small improvement	Nearly matches 1.8Ghz
Capacity	1x	1.7x	3-5x

Radio site

4G site:

- Radio units to create & receive 4G signals
- Antennas to transmit and receive the 4G signals
- Supporting mast structure

5G is then added:

- Either ‘massive MIMO’ (radio unit & antenna combined)
- or additional radio unit.

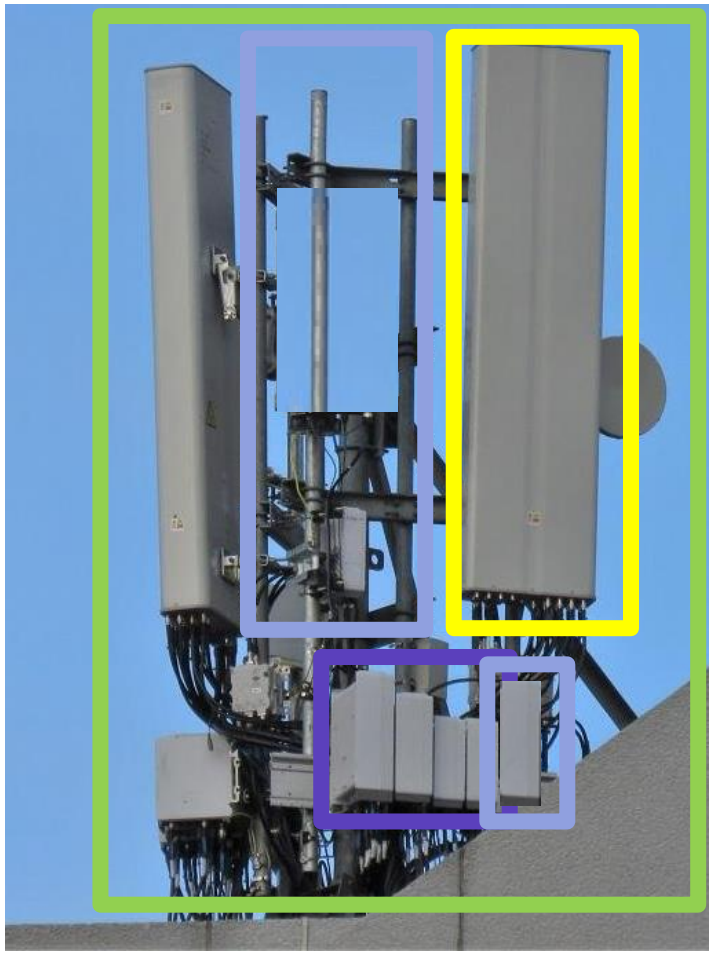


Image Courtesy Twitter/Peter Clarke
Thanks to Paul Rhodes for slide

5G Applications

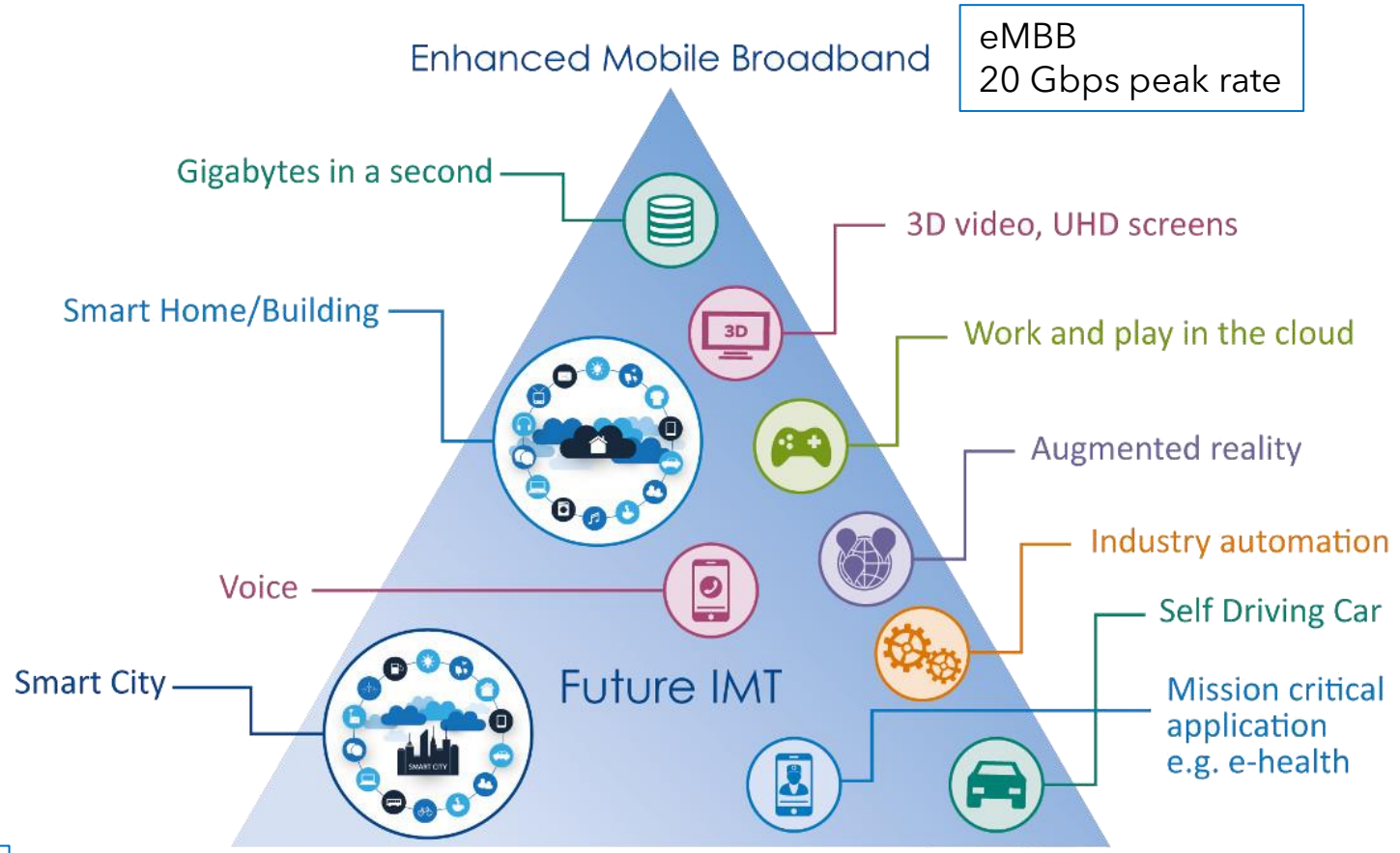
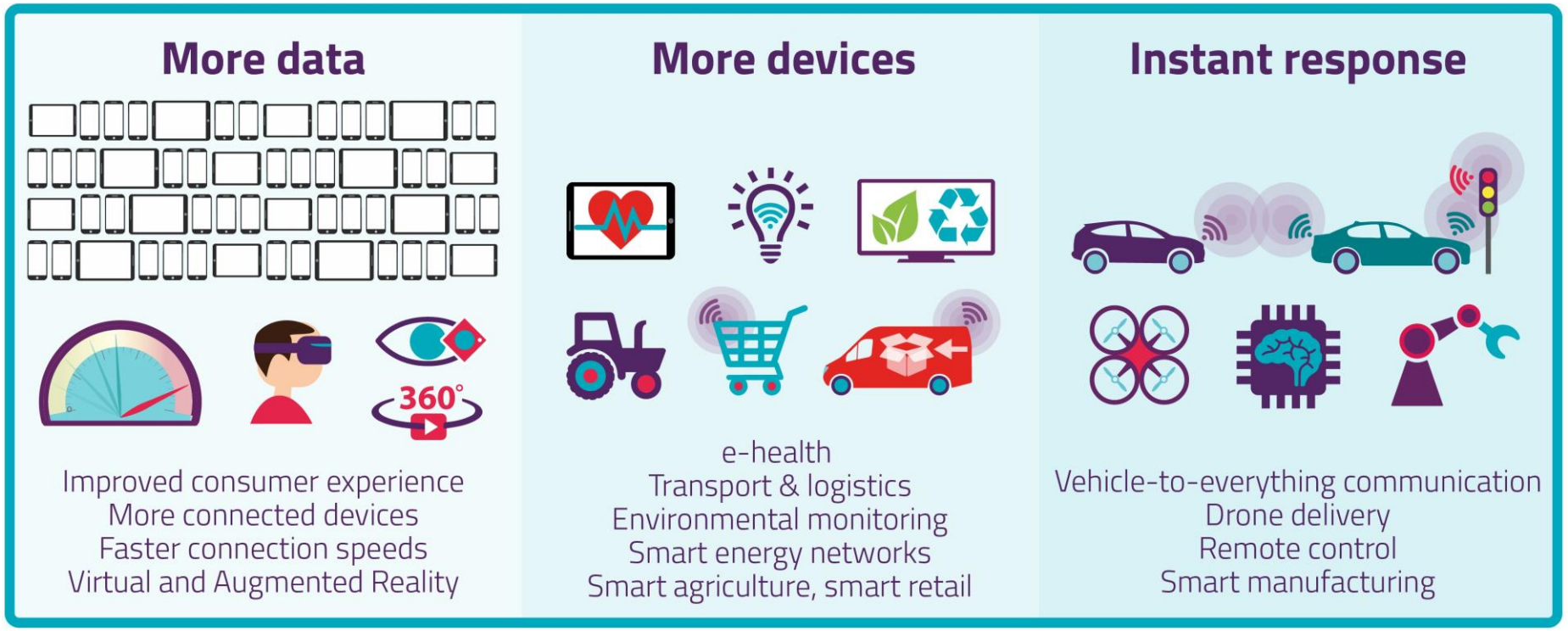


Image credit: ETSI

5G Opportunities

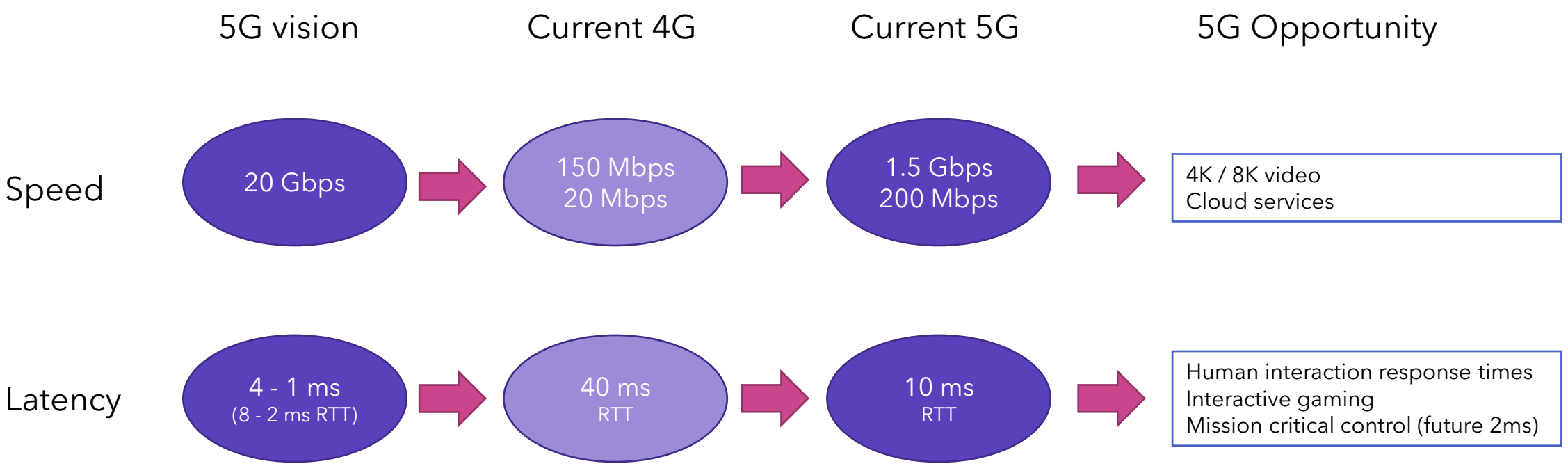


Source: Ofcom

Attributes of 5G

- Capacity
- **Speed**
- **Latency**
- Massive number of devices
- Architecture, e.g. Network Slicing

Reality of 5G*



* For wide coverage area 5G networks

Human interaction experience shift

Large bandwidth, no buffer

Low latency: Victory or defeat

Panoramic video reality check

360° Video Resolution	Transmission	Data Rate (Mbps)	Latency * (ms)
4K (3840x2160)	Sphere	20–40	≤ 50
8K (7680x4320)	Sphere	90–130	≤ 20
	Field of View (FOV)	30–50	
12K 3D (11520x6480)	Sphere	500–700	≤ 10
	FOV	200–300	



Source: GSMA, Cloud AR/VR Whitepaper, 26 April 2019

Cloud Gaming reality check

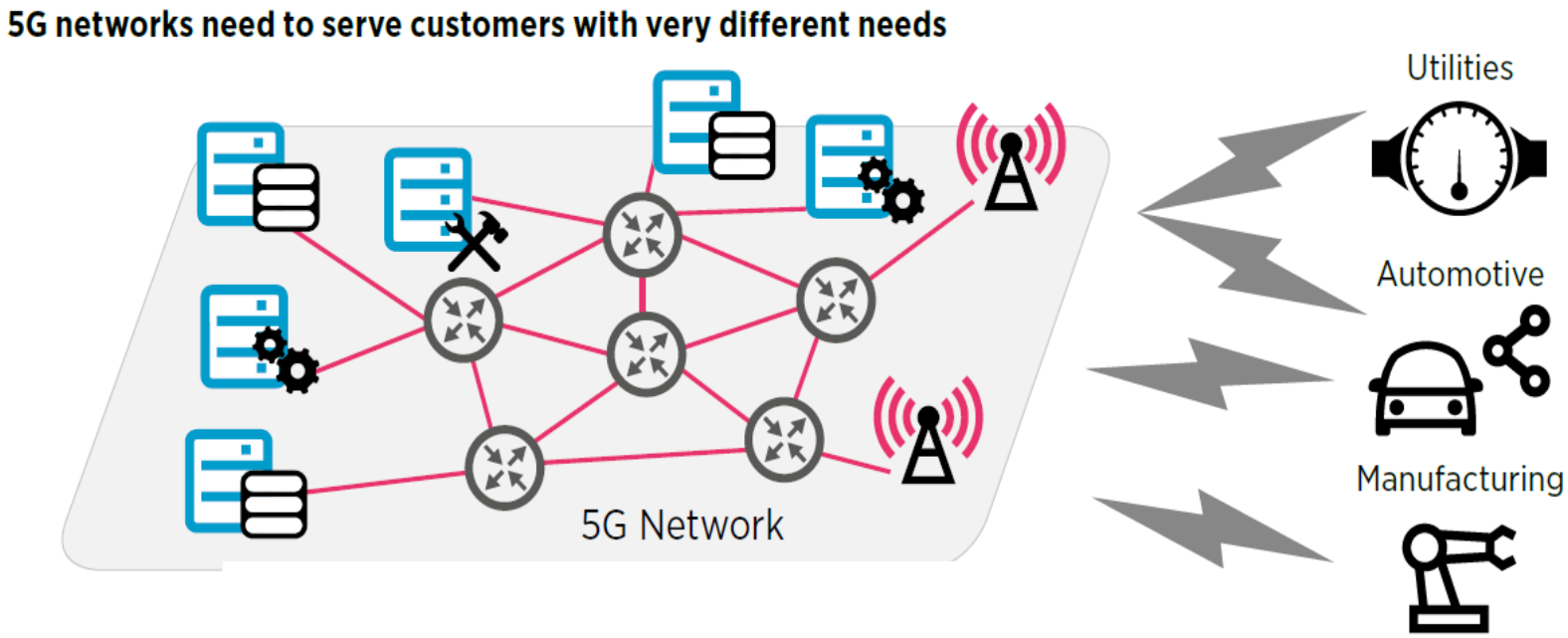
CG	Data Rate (Mbps)	Latency* (ms)
2K (2560x1440)	30–50	≤ 20
4K (3840x1920)	50–200	≤ 16
8K (7680x3840)	200–800	≤ 10

Source: GSMA, Cloud AR/VR Whitepaper, 26 April 2019

Attributes of 5G

- Capacity
- Speed
- Latency
- Massive number of devices
- **Architecture, e.g. Network Slicing**

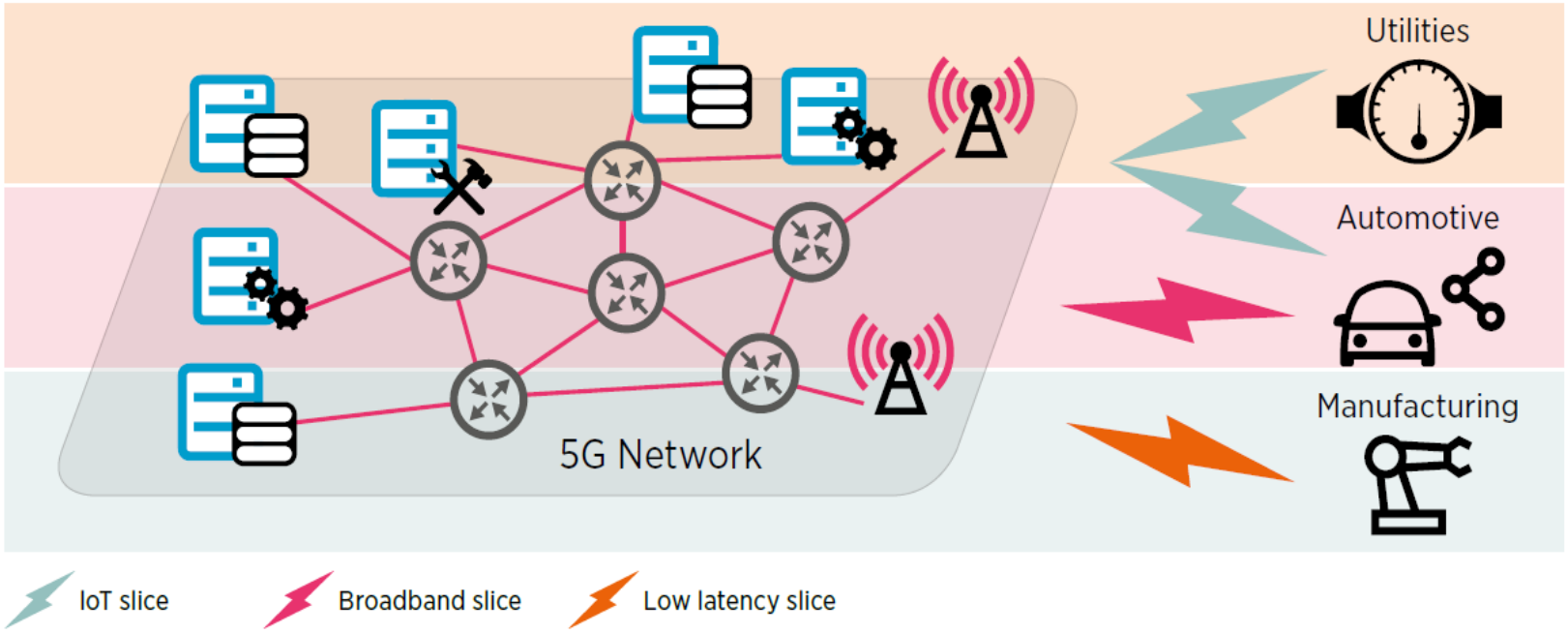
Network Slicing



Source: GSMA – An introduction to network slicing

Network Slicing

5G networks subdivided into virtual networks each optimised for one business case



Source: GSMA – An introduction to network slicing

Use Cases | An Increasingly Broad Spectrum

Mobile Broadband Enhanced

- High Throughput
- Low latency
- Large data volume

Campus

Stadium/Venue

Critical Communications

- Ultra Reliability
- Ultra Low latency
- Very high availability

Remote Assets

Healthcare

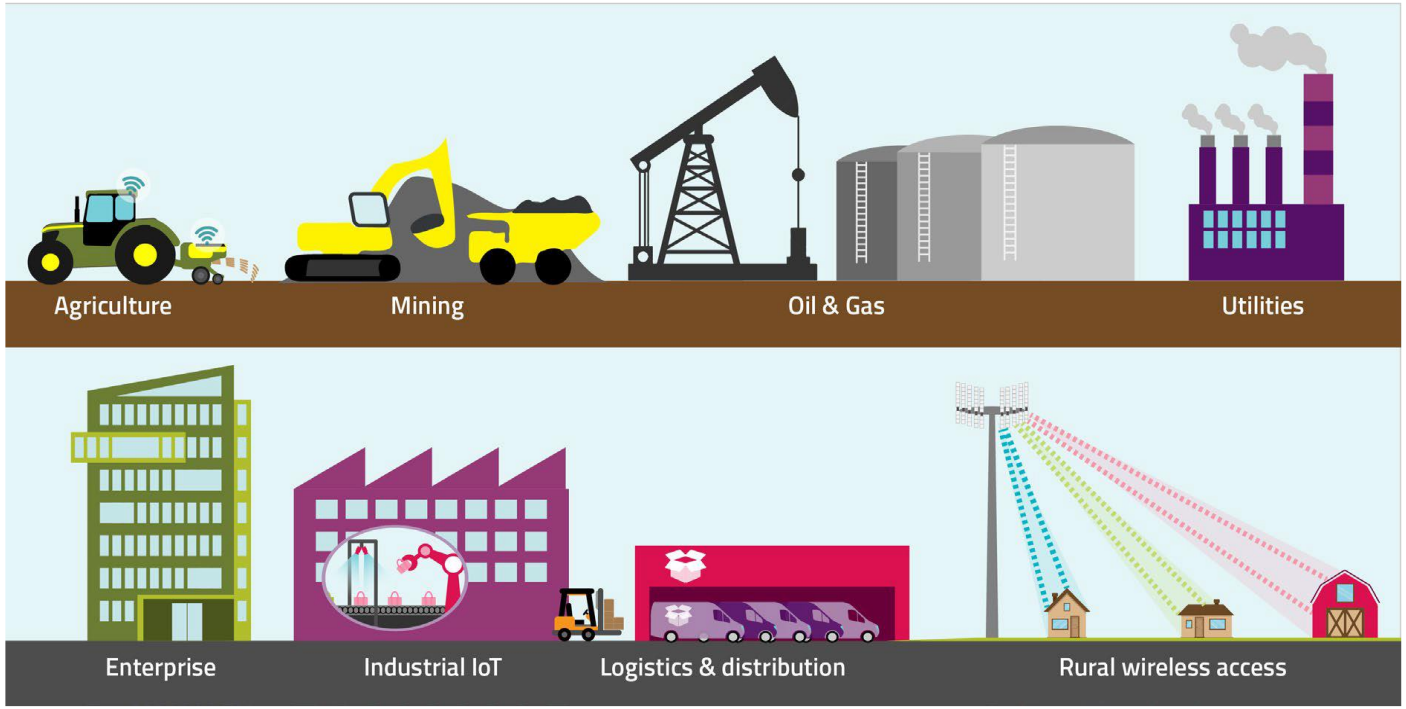
Industrial IoT

- Industrial protocols
- High Device density and Edge computing
- Precise indoor positioning

Industrial Automation

Automated Warehouses

MAVENIR



Source: Ofcom "Shared Access License" Guidance document

Private networks opportunities

5G can use unlicensed, shared and traditional licensed spectrum

Opportunity for significant growth in private networks

UK 5G Shared Access licenses

- 3.8-4.2 GHz
- 26 GHz

Summary

5G creates new opportunities

- Much improved human interaction
- New services enabled by network slicing
- Private networks

It is important to reality check

Be positive but realistic!