

# INTRODUCTION TO 5G

This guide provides an introduction to 5G and addresses some of the key questions that we have received from towns thus far.

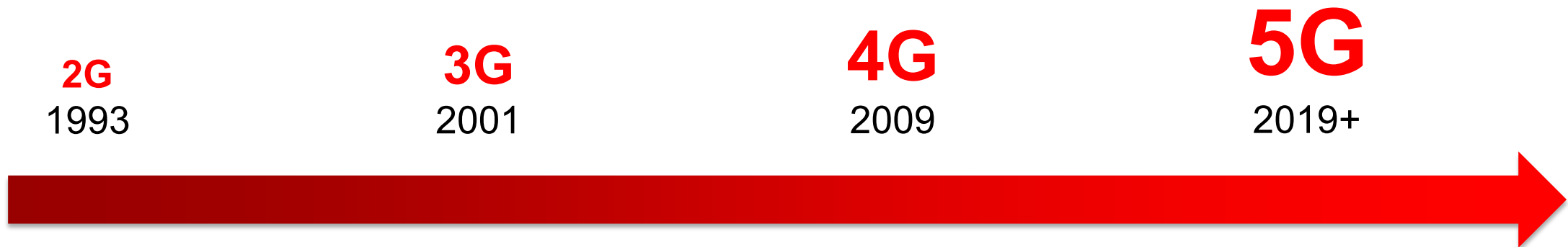


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# What is 5G?

**5G** is short for “Fifth Generation” and is the next generation of mobile networks being deployed that will augment and/or succeed 4G (LTE).



# What are the key features and capabilities of 5G?

## Key Features:



**Faster  
Connection  
Speeds**

*Up to 100x Greater than 4G*



**Lower  
Latency**

*1 millisecond or less*



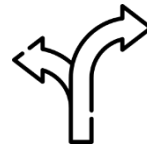
**Greater  
Capacity**

*Able to cope with higher  
bandwidth applications*



**Ultra  
Reliable**

*99.999% or greater  
allowing  
critical uses cases*



**Flexible**

*Physical networks sliced  
into multiple networks*

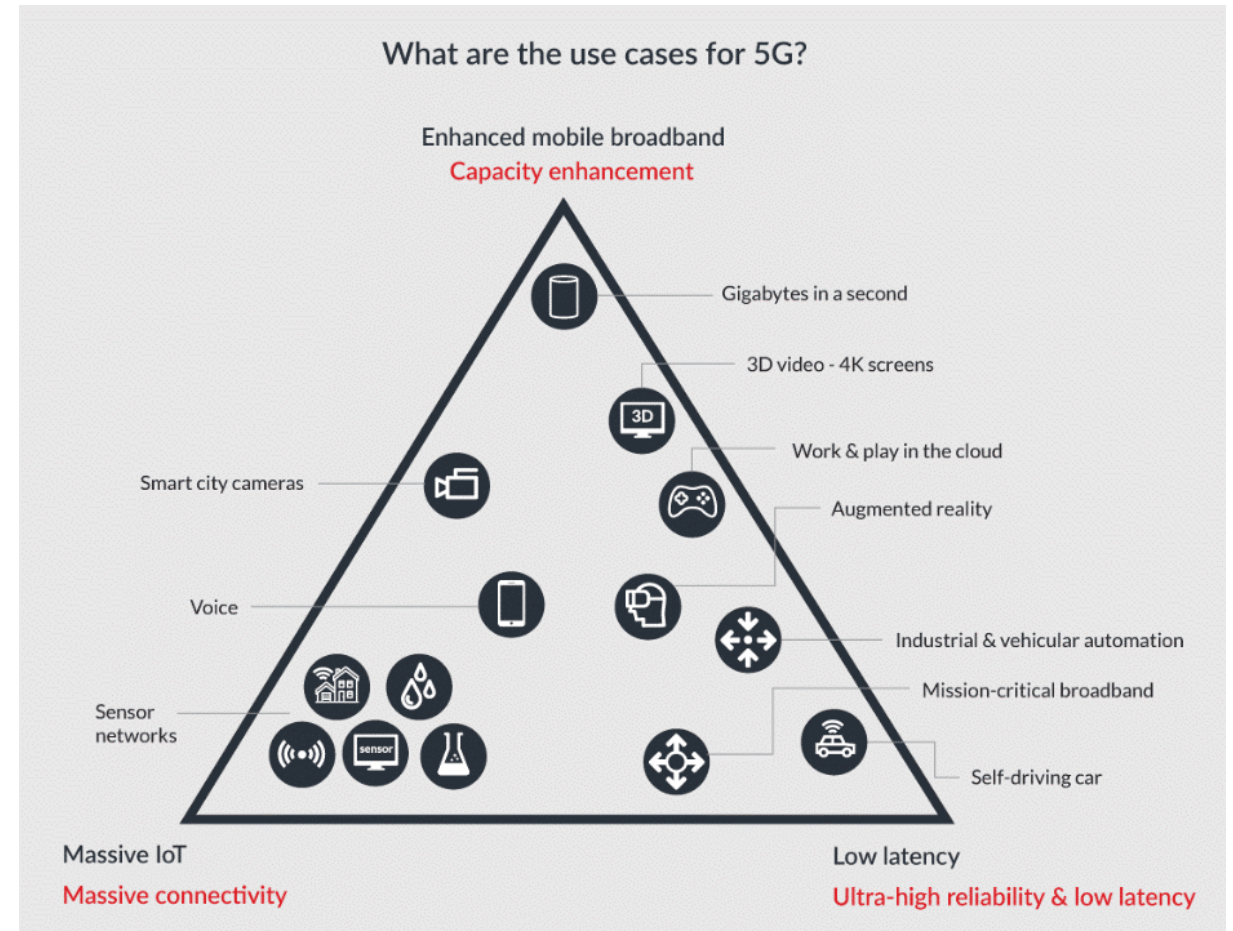


**Reduced  
Energy  
Usage**

*≥ 90% efficiency and  
improved battery life*

## Capabilities/Use Cases:

- **Enhanced Mobile Broadband** for immersive and cloud-connected experiences (such as VR/AR)
- **Ultra-Reliable Low Latency Communications** for critical services (such as driverless cars, smart grid control, industrial automation, robotics and drone control/coordination)
- **Massive IoT or Massive Machine-Type-Communications** for seamless connectivity of devices (for asset tracking, smart utilities and smart city applications)



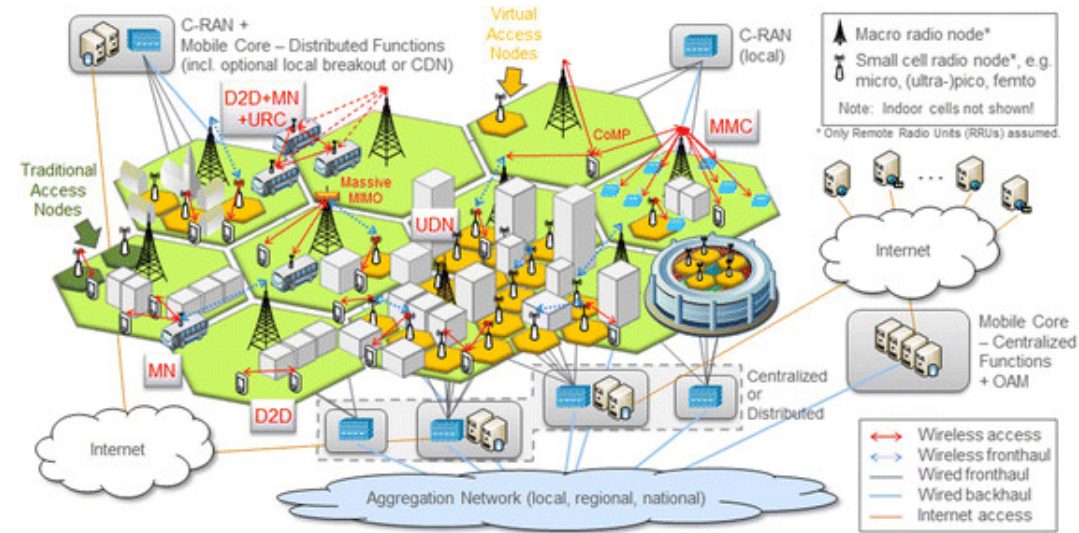
# How does 5G work?

Like previous mobile networks, 5G networks use a system of cell sites to send and receive encoded data through radio waves.

5G networks use a type of encoding called OFDM, which is similar to 4G LTE.

5G delivers higher speeds and lower latency through more efficient encoding, use of wider spectrum bands, more/smaller cells (i.e. densification) and advanced antenna technologies (Massive Multiple-Input Multiple-Output).

A major difference between 5G networks and previous mobile networks will be the ability to provide dedicated virtual networks, known as *Network Slices*, for specific services or customers over a common physical network infrastructure.



Generic 5G network architecture (high-level topological view).

Source: Monserrat, J.F., Mange, G., Braun, V. et al. (2015) METIS research advances towards the 5G mobile and wireless system definition. *J Wireless Com Network*, 53.

# 5G Roll-out and Speeds

## Roll-out Status - Overview:

The first 5G specification was officially signed-off by the 3GPP – the organization that governs cellular standards – in June 2018.

KT launched the world's first nationwide commercial 5G network on April 3, 2019, after successfully showcasing the world's first trial 5G services at the PyeongChang Winter Olympic Games in February 2018.

In the UK, commercial 5G network roll-outs commenced in 2019 and have largely been focused on major cities and towns.







EE's 5G Launch Event May 2019

Sources:

1. [https://www.prnewswire.com/news-releases/kt-launches-worlds-first-commercial-5g-network-300830635.html#:~:text=ABOUT%20KT%20CORP.%20\(&text=KT%20launched%20the%20world's%20first,Olympic%20Games%20in%20February%202018.](https://www.prnewswire.com/news-releases/kt-launches-worlds-first-commercial-5g-network-300830635.html#:~:text=ABOUT%20KT%20CORP.%20(&text=KT%20launched%20the%20world's%20first,Olympic%20Games%20in%20February%202018.)
2. <https://www.techradar.com/uk/news/5g-uk#:~:text=I%20want%205G%20right%20now&text=EE%20was%20the%20first%20network,Mobile%20on%20January%2016%2C%202020.>

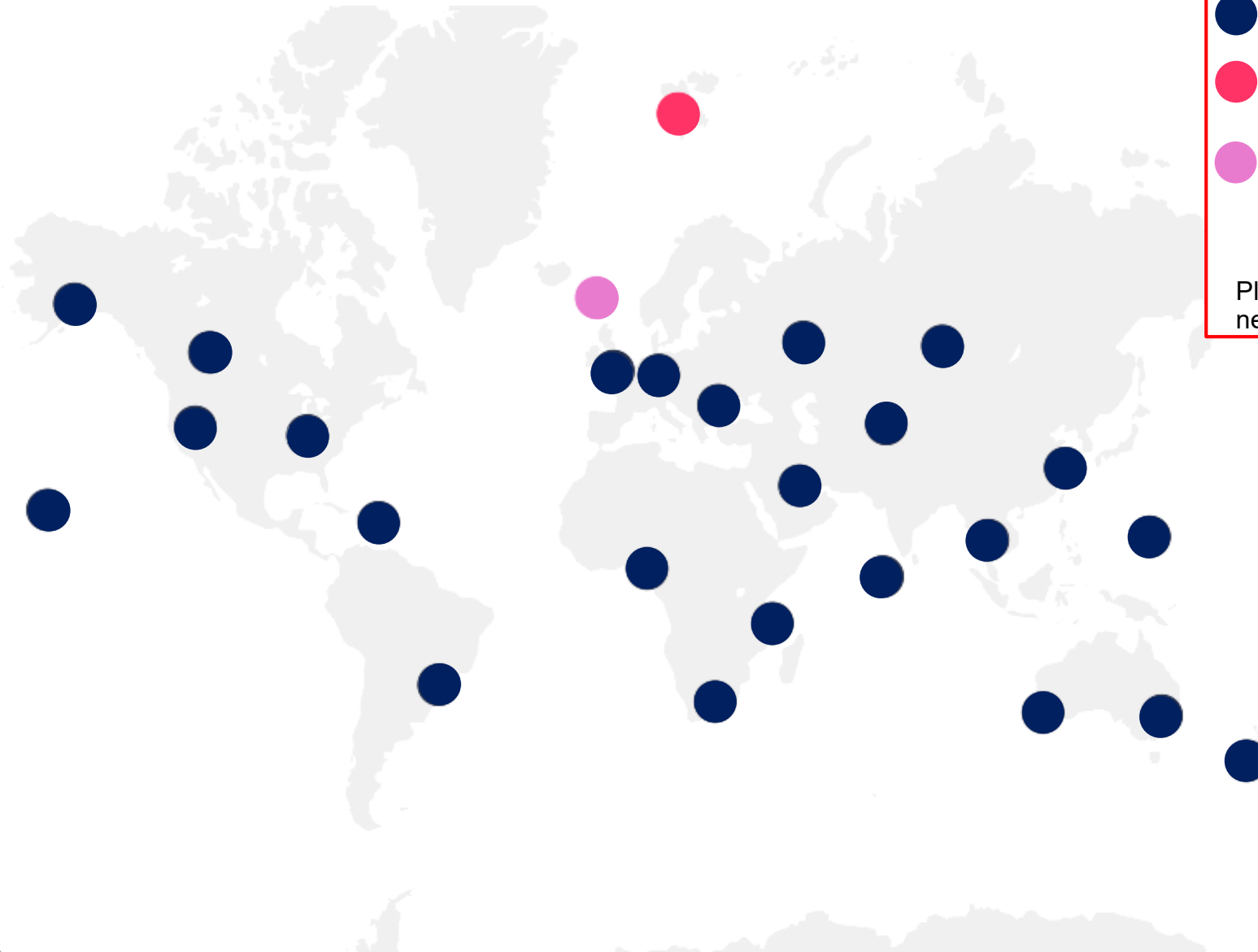
**Roll-out Status - UK:**

Network	5G Launch Date	Major cities and Towns with 5G
	May 2019	63
	July 2019	30
	February 2020	41
	October 2019	47

Source:  
1. [www.5G.co.uk/coverage](http://www.5G.co.uk/coverage) (updated 15/09/2020)



## Roll-out Status - Globally



Global deployments are at varying levels of maturity, including:

- Commercial Availability:** A 5G network is present and devices are available for users to purchase and use
- Limited Availability:** A 5G network is present but devices are limited to selected customers
- Pre-Release:** 5G network hardware is in place but is currently in testing and/or not yet accessible to consumers.

Please visit the Speed Test website to explore where networks are available in more detail.

## 5G Speeds in the UK

For 4G in the UK, EE median download speed is 35.9Mbps, while Vodafone 25.4Mbps.

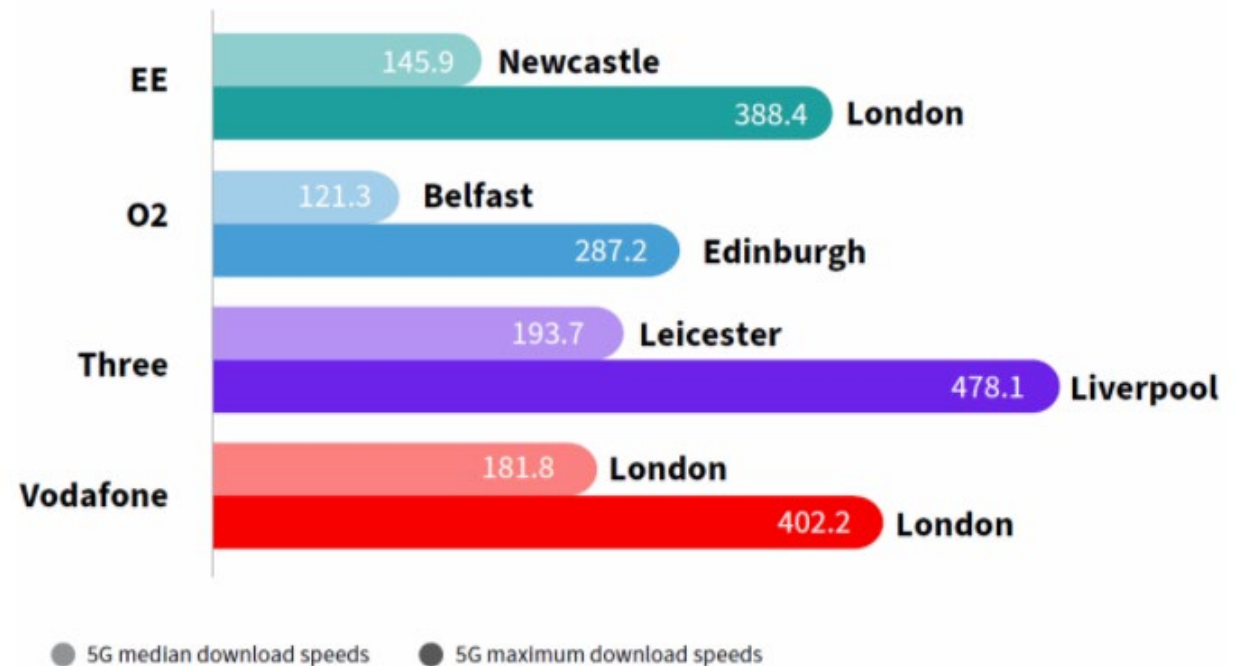
Average download speeds are currently up to six times faster than 4G and twenty five times faster than 3G, and 5G is already faster than fibre broadband in many areas around the UK.

This improvement is impressive given 5G is still in its infancy and using only limited spectrum (unlike 4G which utilises Carrier Aggregation).

### City with each operator's highest 5G availability (%)



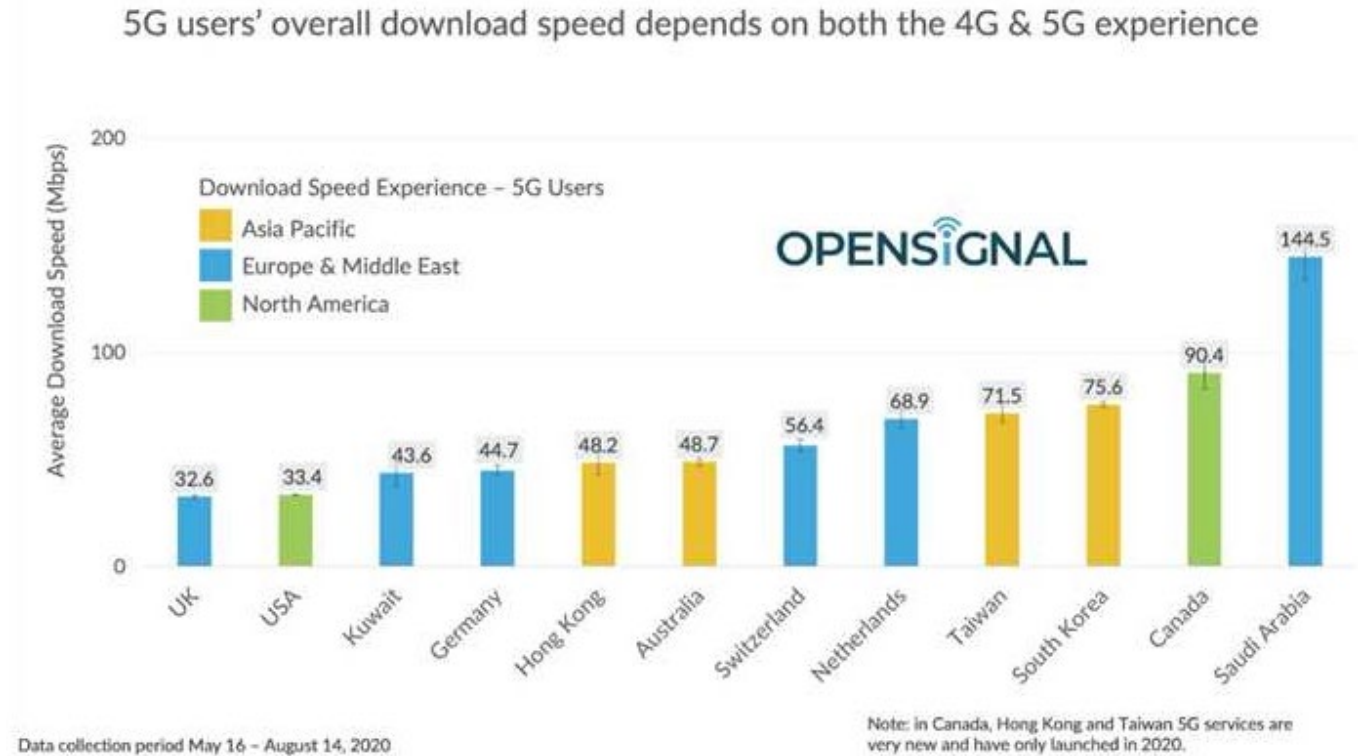
### Fastest 5G median & maximum download speeds (Mbps) by operator



Source:  
1. <https://www.ispreview.co.uk/index.php/2020/09/h1-2020-5g-mobile-broadband-speeds-and-availability-by-uk-city.html>  
2. <https://www.4g.co.uk/how-fast-is-4g/>  
3. <https://5g.co.uk/guides/how-fast-is-5g/>

## Global Speed Comparison

- Saudi Arabian users experience the fastest overall speed, with the country achieving a Download Speed Experience of 144.5 Mbps.
- Globally, 5G adoption is highest in South Korea. The average 5G download speed is over five times faster than South Korea's already fast 4G speeds.
- U.K. has the slowest overall Download Speed Experience with a score of 32.6 Mbps because the current 4G experience greatly brings down the overall score.



\*Download Speed Experience – 5G Users takes into account the average 3G and 4G Download Speed that 5G users see, as well as their average 5G Download Speed and time connected to each type of network to reveal the overall download speed experience.

# What spectrum bands are used for 5G?

5G will operate in three different spectrum bands:

- **Low-band spectrum** (sub 1GHz)
  - Good for wide area and outdoor to in-building coverage.
  - Peak data speeds of up to 100Mbps
- **Mid-band Spectrum**(1GHz – 6GHz)
  - Provide faster speeds (up to 1Gbps) and lower latency
  - Does not penetrate buildings well
- **High-band Spectrum** (mmWave – above 6GHz)
  - Potential to offer speeds up to 10Gbps and very low latency.
  - Limited coverage area and very poor building penetration.

# 5G Spectrum Allocation - UK

- Ofcom has auctioned 40 MHz of 2.3 GHz spectrum and 150MHz of 3.4GHz spectrum already.
- These auctions have provided enough viable spectrum for operators to begin launching their 5G networks.
- Plans are underway to auction spectrum in 700 MHz and 3.6 - 3.8 GHz in January 2021.

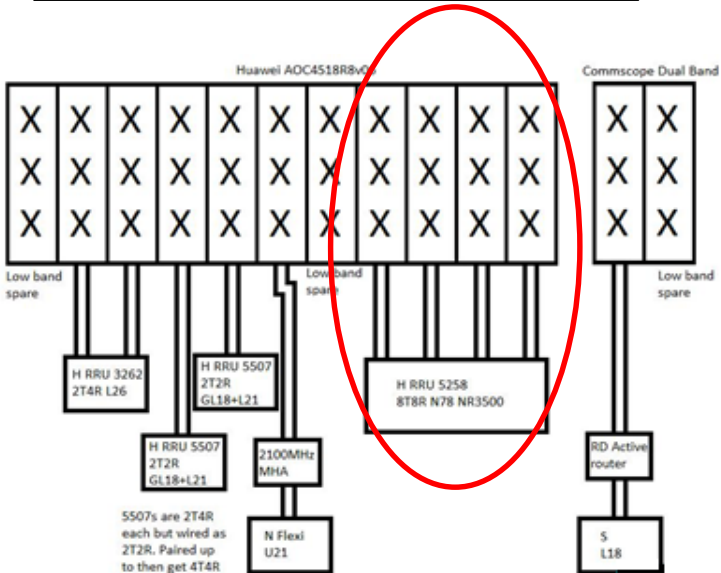
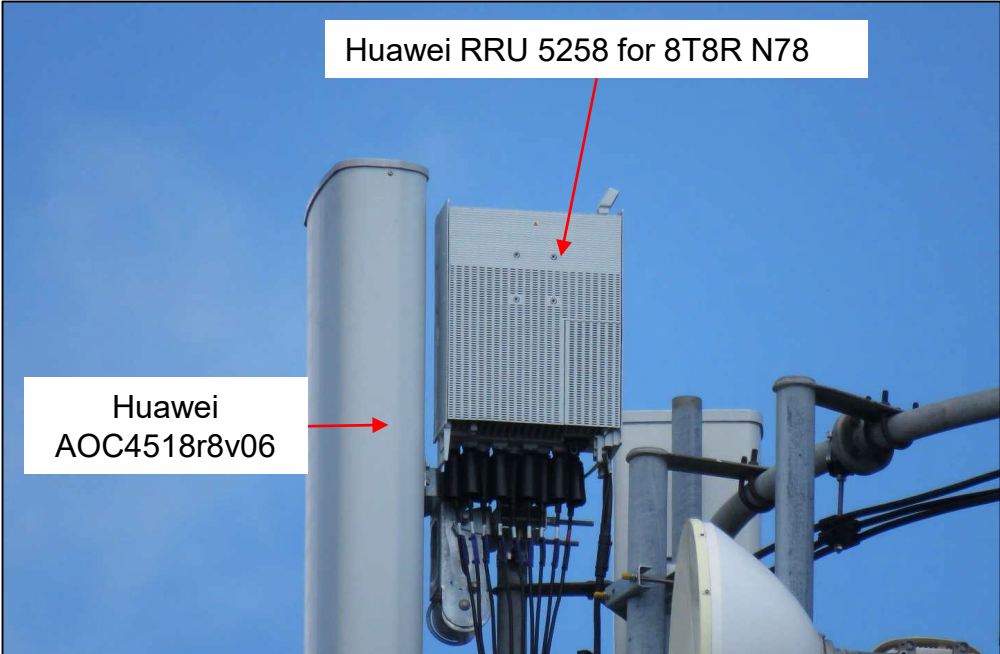
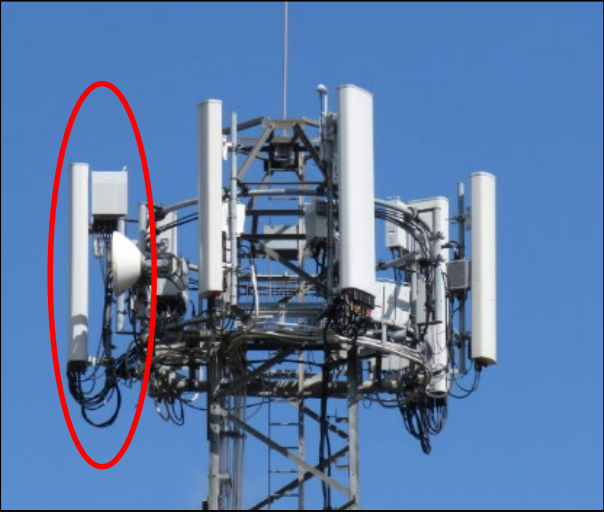
Operator	2.3 GHz Spectrum		3.4GHz Spectrum	
	Amount won	Price	Amount won	Price
O2	40 MHz	£205m	40 MHz	£317m
Vodafone	-	-	50 MHz	£378m
EE	-	-	40 MHz	£303m
Three	-	-	20 MHz	£151m

Source:

1. <https://5g.co.uk/guides/5g-uk-auction/>
2. <https://5g.co.uk/guides/5g-frequencies-in-the-uk-what-you-need-to-know/>
3. Table stats: <https://5g.co.uk/guides/5g-uk-auction/>
4. Delay to auction: <https://www.ispreview.co.uk/index.php/2020/08/ofcom-uk-aim-next-5g-mobile-spectrum-auction-at-january-2021.html>

# What does 5G infrastructure look like?

## Example 5G Outdoor Deployment (Marfleet, Hull):

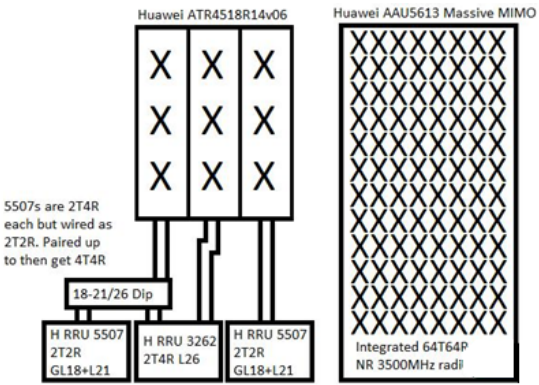
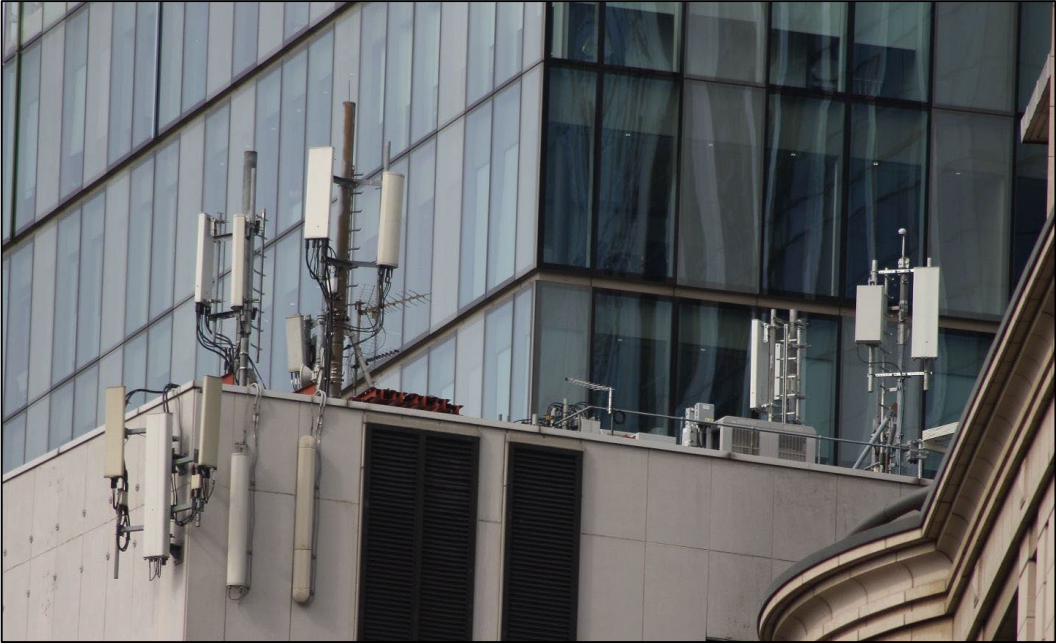


### Huawei RRU with 8T8R Array Antennas

- Antenna Weight = 35Kg
- Antenna Size = 2100mm (H) X 500mm(W) X 200mm(D)
- RRU Weight = 25Kg
- RRU size = 500mm(H) X 400mm(W) X 150mm(D)

Source:  
1. <https://beta.pedroc.co.uk/locations/hull-city-masts>

**Example 5G Outdoor Deployment (St Paul's, London):**

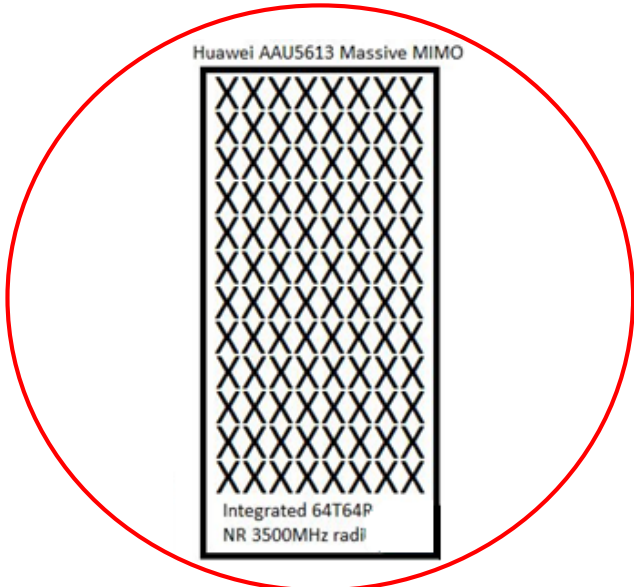


Huawei 64T64R Massive MIMO Active Antenna Unit 5613

- Weight = 65KG
- Size = 2100mm(H) X 400mm(W) X 300mm(D)

Source:  
1. <https://beta.pedroc.co.uk/locations/city-of-london-masts>

**Example 5G Outdoor Deployment (Trafford Exchange, Manchester):**



Huawei 64T64R Massive MIMO Active Antenna Unit 5613

- Weight = 65KG
- Size = 2100mm(H) X 400mm(W) X 300mm(D)

Source:  
1. <https://beta.pedroc.co.uk/locations/manchester-city-masts>



## Example 5G Outdoor Deployment (Smale House, London):



Ericsson 64T64R Massive MIMO Antenna Integrated Radio Unit  
6488

- Weight = 65KG
- Size = 1000mm(H) X 550mm(W) X 200mm(D)

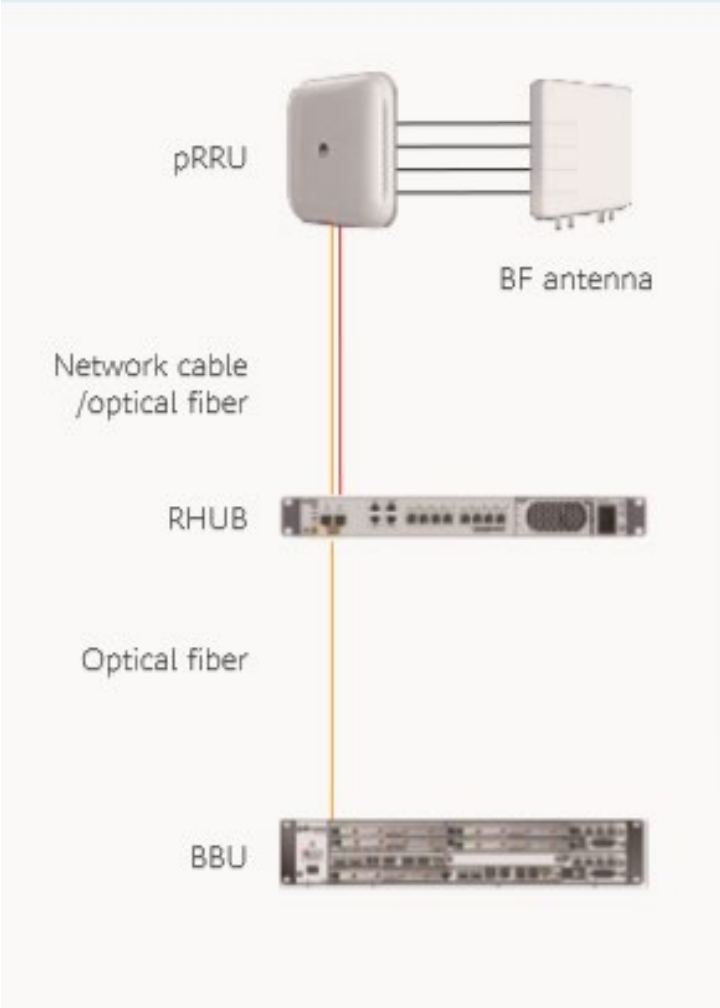
## Example 5G Outdoor Deployment (Vodafone HQ, Newbury):



Ericsson 64T64R Massive MIMO Antenna Integrated Radio Unit 6488

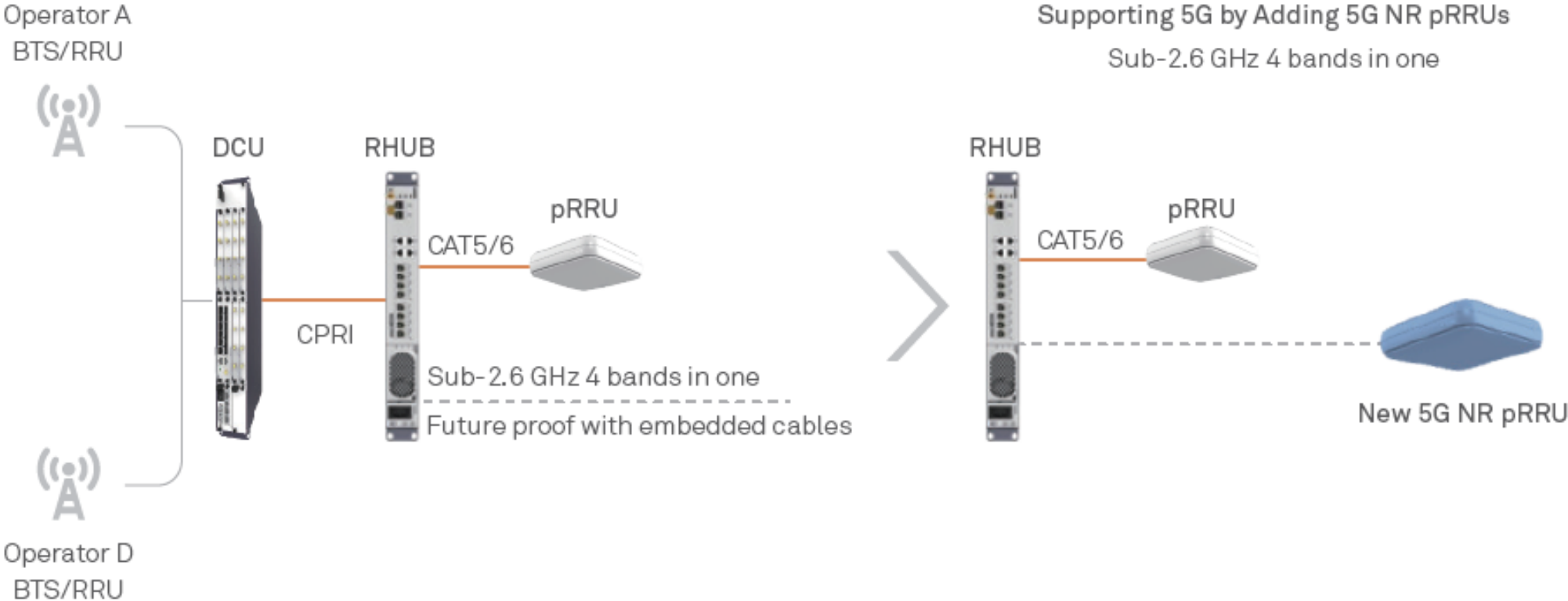
- Weight = 65KG
- Size = 1000mm(H) X 550mm(W) X 200mm(D)

# 5G In-building Solution – Huawei Lampsite:



Source:  
1. <https://e.huawei.com/uk/products/wireless/lampsite>

# 5G In-building Solution – Huawei Lampsite:



Source:  
1. <https://e.huawei.com/uk/products/wireless/lampsite>

## 5G In-building Solution – Huawei Lampsite:



Huawei 5G Base Band Unit

- BBU Weight = 15Kg
- BBU Size = 100mm(H) X 500mm(W) X 400mm(D)



Huawei 5G Digital Conversion Unit (Not 5G specific)

- DCU Weight = 15Kg
- DCU Size = 100mm(H) X 500mm(W) X 400mm(D)



Huawei 5G Radio HUB

- RHUB Weight = 8Kg
- RHUB Size = 50mm(H) X 500mm(W) X 400mm(D)



Huawei 5G Pico Remote Radio Unit

- pRRU Weight = 2Kg
- pRRU Size = 200mm(H) X 200mm(W) X 50mm(D)

## 5G In-building Solution – Ericsson Dot:

### Radio Dot (RD or "Dot")

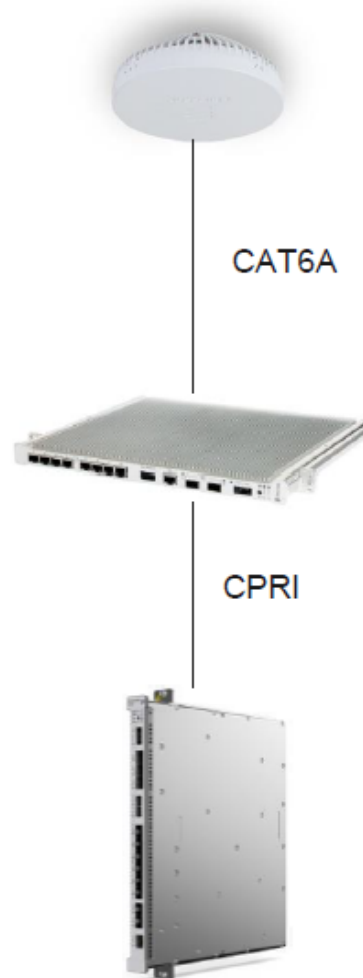
- Indoor optimized ultra compact radio
- Discreet and easy to install
- Single and dual band versions
- Radio and power over LAN cable

### Indoor Radio Unit (IRU)

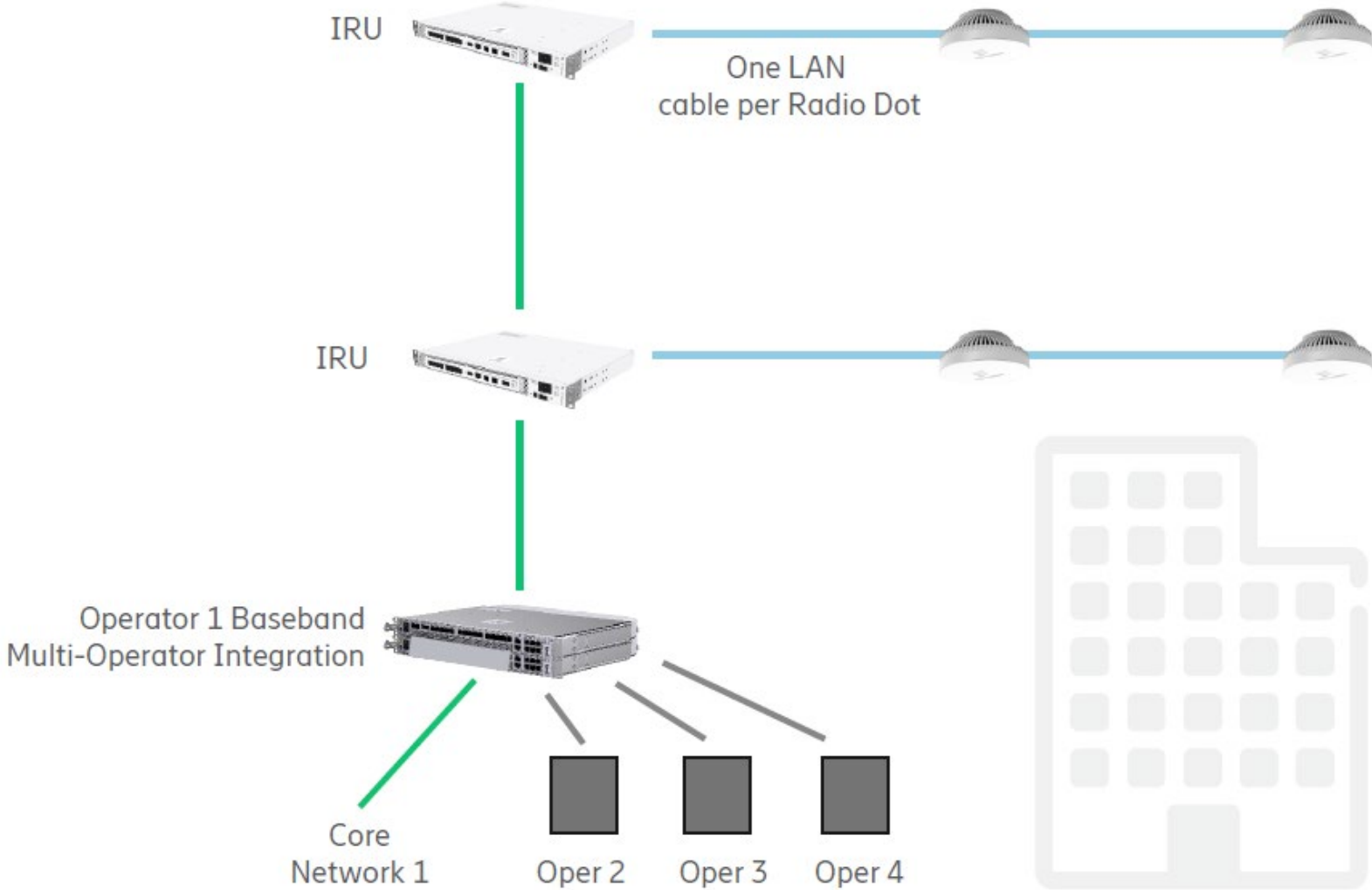
- Power and control for Radio Dots (8 Radio Dots)
- Frequency band independent
- FDD/TDD Software defined radio
  - Remote\* or co-located with baseband (\*up to 20km)

### Baseband

- › Main radio functionality processing
- › Up to 24 IRUs can be connected
- › Backhaul, synchronization and security

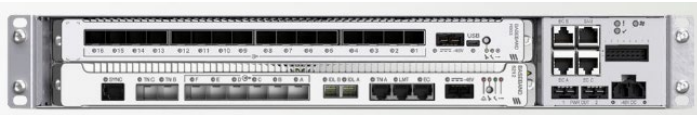


# 5G In-building Solution – Ericsson Dot:



Source:  
1. <https://www.ericsson.com/en>

## 5G In-building Solution – Ericsson Dot:



### Ericsson 5G Base Band Unit

- BBU Weight = 5Kg
- BBU Size = 50mm(H) X 400mm(W) X 300mm(D)



### Ericsson 5G Indoor Radio Unit

- IRU Weight = 4Kg
- IRU Size = 400mm(H) X 50mm(W) X 300mm(D)



### Ericsson 5G Radio DOT

- DOT Weight = 1kg
- DOT Size = 600mm(H) X 200mm (Diameter)



# Summary

- 5G is likely to be a complementary technology to 4G, not a replacement, for the foreseeable future.
- The roll-out of 5G is well underway in the UK and across the globe (but largely focussed on major cities).
- To date, the primary focus has been on delivering enhanced mobile broadband.
- It is likely initial Massive Machine-Type-Communication use cases will be addressed by NB-IoT(4G) and evolve to 5G.
- It is anticipated that ultra-reliable low latency services will be an overlay (and limited to certain geographic areas) and use case dependent. In addition, achieving the < 1 ms theoretical target is likely to be challenging.
- Outdoor tower and rooftop deployments are set to continue but are likely to be larger in scale i.e. Arrays of Active Antenna Units and Multiple Array Antennas with RRUs . In addition, it is expected that more street level deployments (e.g. small cells) will be required to achieve the full potential of 5G.
- A number indoor 5G solutions do currently exist. However, these are unlikely to be deployed in the UK until approved by mobile operators.

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