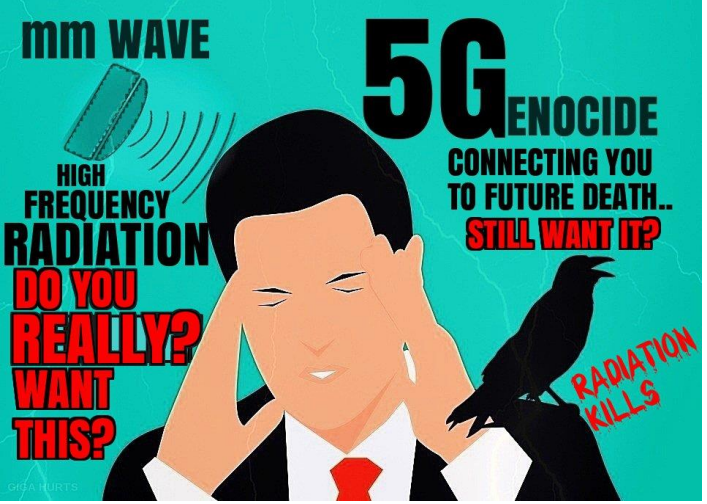
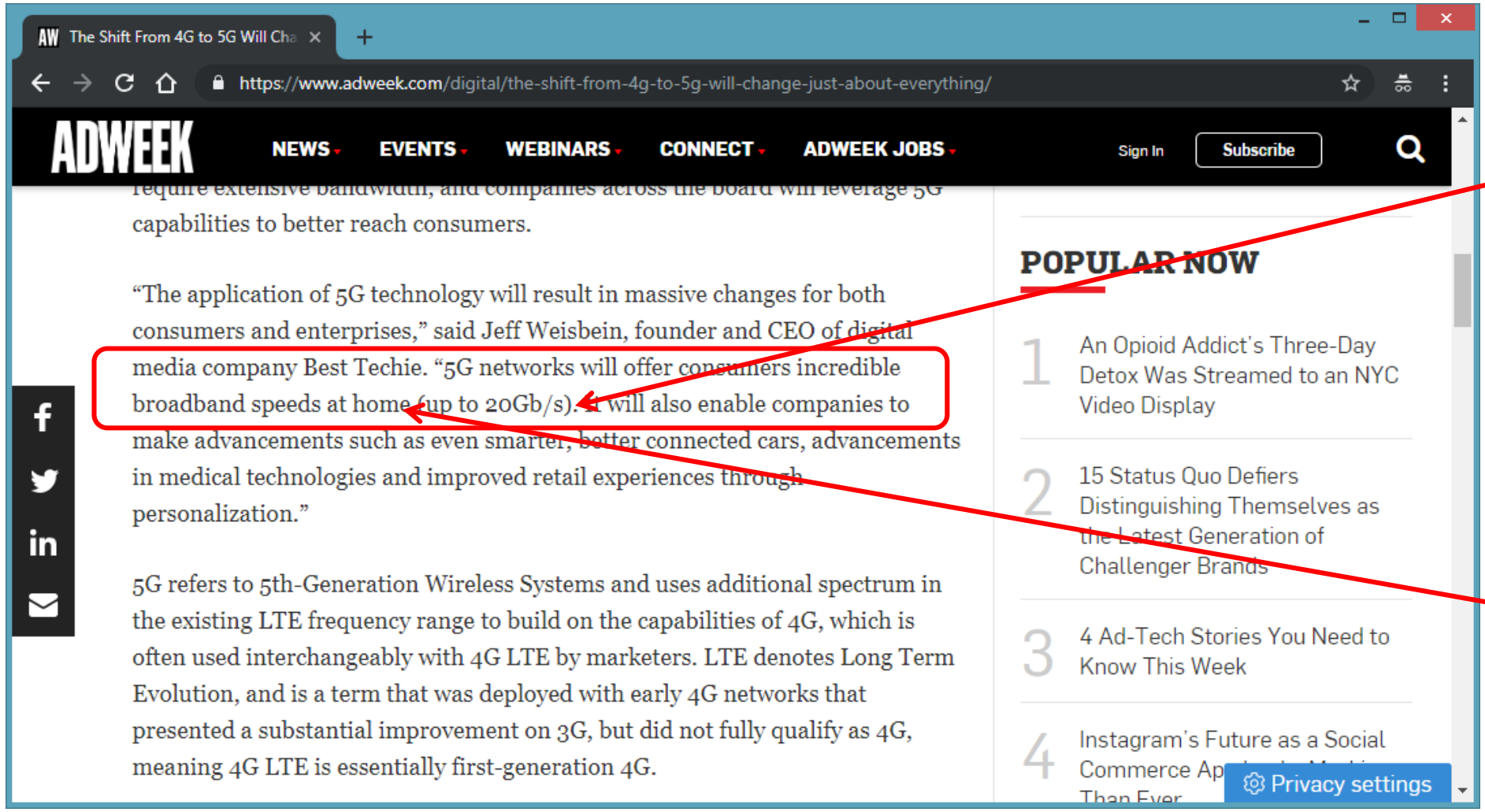


Top 10 Misconceptions About 5G

@3g4gUK

Misconception #1: 5G will be revolution, not Evolution

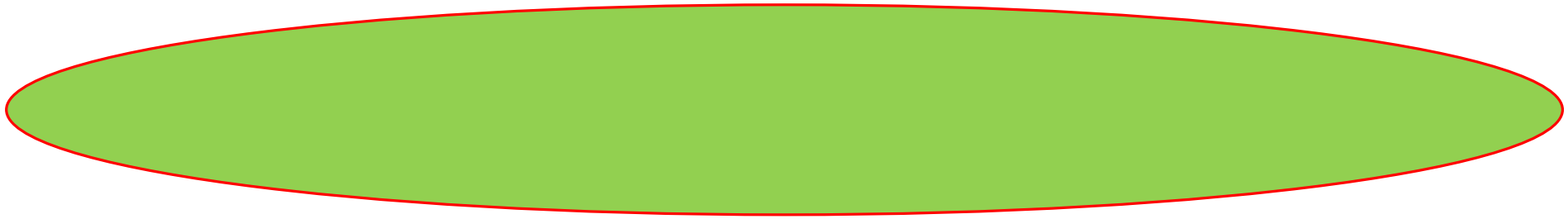


Misconception #1: 5G will be revolution, not Evolution

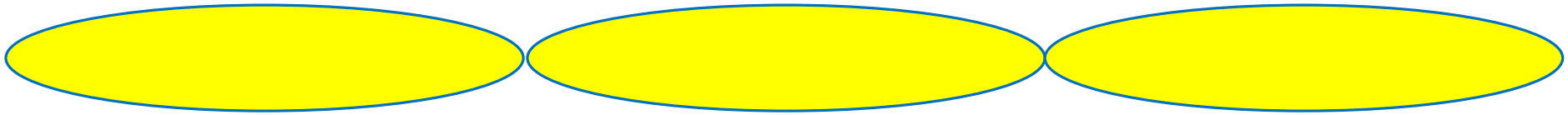
- The initial 5G will be very similar to 4G, just a bit faster in most places
- In other places there will be islands of very fast coverage
- But the initial 5G will just be an evolution – the revolution part will come after a few years
- We will look at some of these points while discussing other misconceptions

Misconception #2: 5G requires millimetre waves (mmWave)

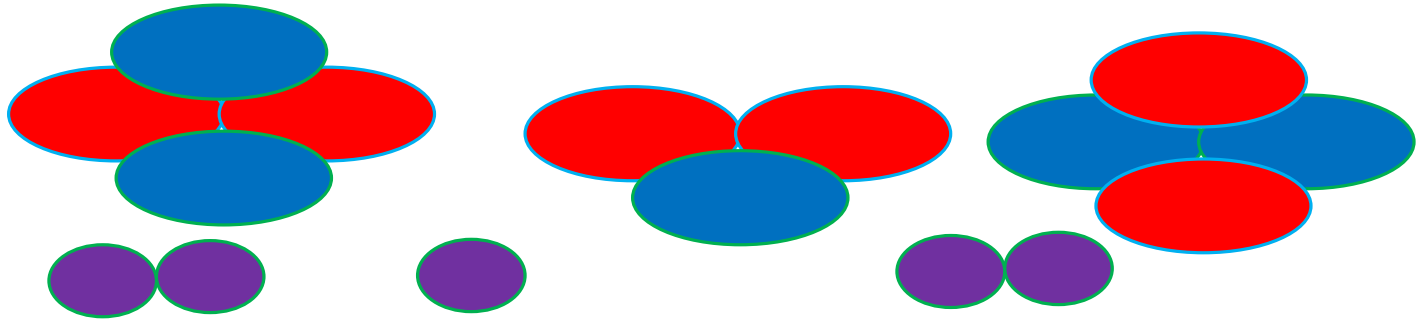
Coverage Layer
Sub-1GHz



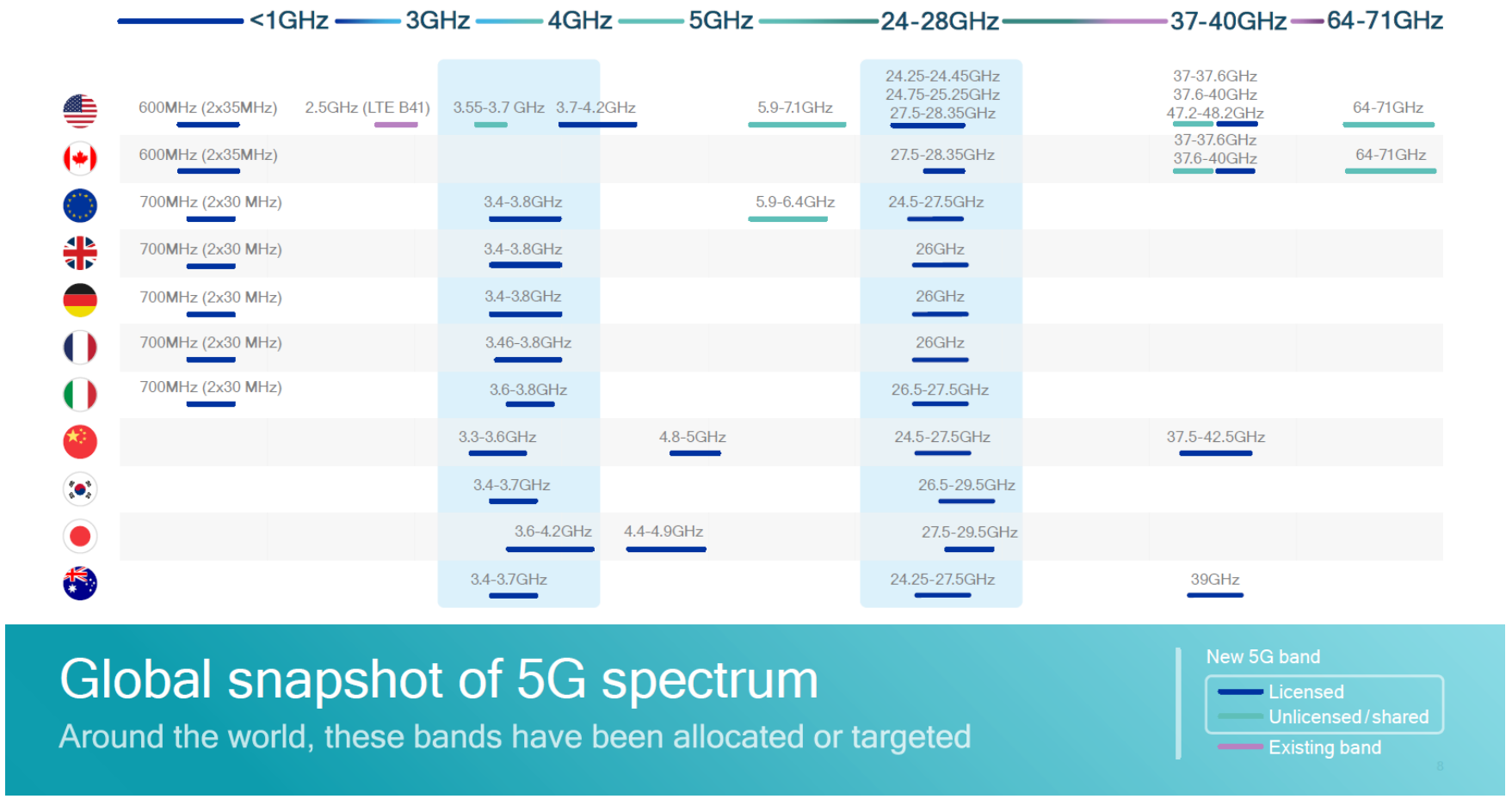
Capacity Layer
1GHz – 6GHz



High Throughput Layers
6GHz – 100GHz



Misconception #2: 5G requires millimetre waves (mmWave)



Picture Source: Qualcomm

Misconception #2: 5G requires millimetre waves (mmWave)

26/28 GHz – most popular band

3.5 GHz – most popular band

700 MHz – most popular band

Picture Source: Deutsche Telekom / T-Mobile USA

Misconception #3: 5G needs new spectrum

You can roll out 5G in new spectrum but no one is stopping you from using an existing spectrum / band

Misconception #3: 5G needs new spectrum

Release 15

3GPP TS 38.101-1 V15.3.0 (2018-09)

Table 5.2-1: NR operating bands in FR1

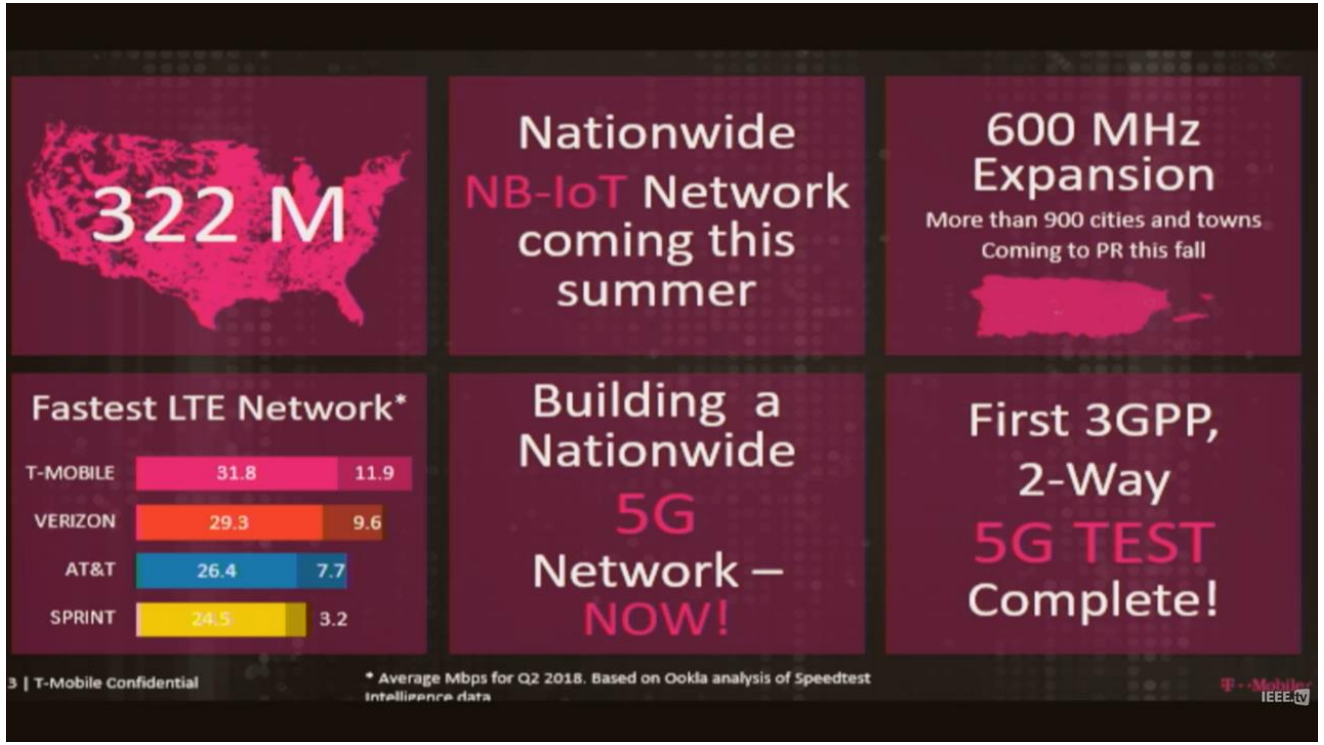
NR operating band	Uplink (UL) *operating band* BS receive / UE transmit F_{UL_low} – F_{UL_high}	Downlink (DL) *operating band* BS transmit / UE receive F_{DL_low} – F_{DL_high}	Duplex Mode
n1	1920 MHz – 1980 MHz	2110 MHz – 2170 MHz	FDD
n2	1850 MHz – 1910 MHz	1930 MHz – 1990 MHz	FDD
n3	1710 MHz – 1785 MHz	1805 MHz – 1880 MHz	FDD
n5	824 MHz – 849 MHz	869 MHz – 894 MHz	FDD
n7	2500 MHz – 2570 MHz	2620 MHz – 2690 MHz	FDD
n8	880 MHz – 915 MHz	925 MHz – 960 MHz	FDD
n12	699 MHz – 716 MHz	729 MHz – 746 MHz	FDD
n20	832 MHz – 862 MHz	791 MHz – 821 MHz	FDD
n25	1850 MHz – 1915 MHz	1930 MHz – 1995 MHz	FDD
n28	703 MHz – 748 MHz	758 MHz – 803 MHz	FDD
n34	2010 MHz – 2025 MHz	2010 MHz – 2025 MHz	TDD
n38	2570 MHz – 2620 MHz	2570 MHz – 2620 MHz	TDD
n39	1880 MHz – 1920 MHz	1880 MHz – 1920 MHz	TDD
n40	2300 MHz – 2400 MHz	2300 MHz – 2400 MHz	TDD
n41	2496 MHz – 2690 MHz	2496 MHz – 2690 MHz	TDD
n50	1432 MHz – 1517 MHz	1432 MHz – 1517 MHz	TDD[1]
n51	1427 MHz – 1432 MHz	1427 MHz – 1432 MHz	TDD
n66	1710 MHz – 1780 MHz	2110 MHz – 2200 MHz	FDD
n70	1695 MHz – 1710 MHz	1995 MHz – 2020 MHz	FDD
n71	663 MHz – 698 MHz	617 MHz – 652 MHz	FDD
n74	1427 MHz – 1470 MHz	1475 MHz – 1518 MHz	FDD
n75	N/A	1432 MHz – 1517 MHz	SDL
n76	N/A	1427 MHz – 1432 MHz	SDL
n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	TDD
n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD
n79	4400 MHz – 5000 MHz	4400 MHz – 5000 MHz	TDD
n80	1710 MHz – 1785 MHz	N/A	SUL
n81	880 MHz – 915 MHz	N/A	SUL
n82	832 MHz – 862 MHz	N/A	SUL
n83	703 MHz – 748 MHz	N/A	SUL
n84	1920 MHz – 1980 MHz	N/A	SUL
n86	1710 MHz – 1780MHz	N/A	SUL

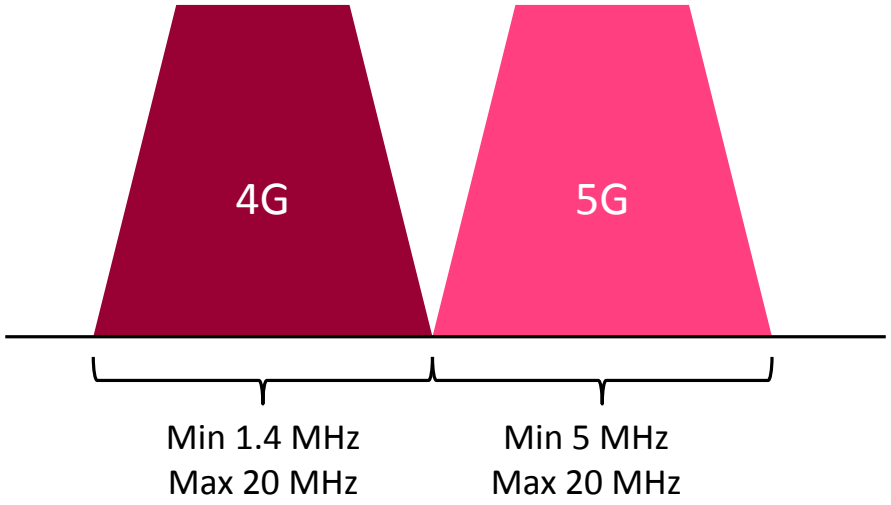
NOTE 1: UE that complies with the NR Band n50 minimum requirements in this specification shall also comply with the NR Band n51 minimum requirements.

New Bands in 5G, not in LTE

Misconception #3: 5G needs new spectrum

- T-Mobile USA launching 5G in 600 MHz
  - 600 MHz used for 4G at present





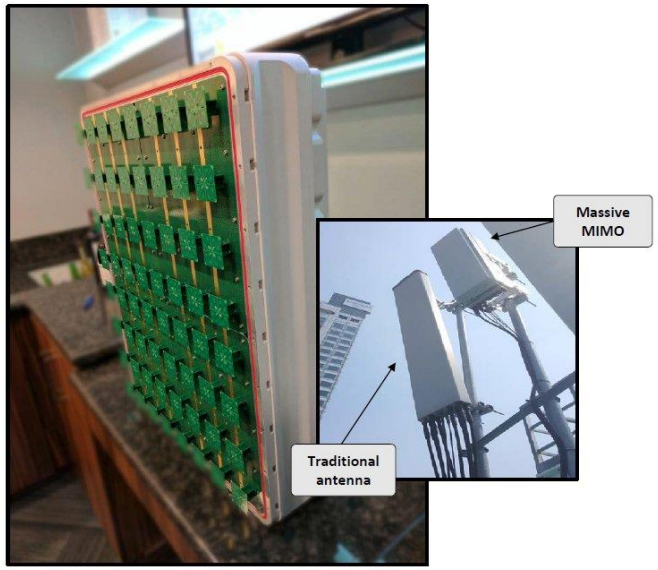
	NR band / SCS / UE Channel bandwidth								
NR Band	SCS kHz	5 MHz	$10^{1,2}$ MHz	15^{2} MHz	20^{2} MHz	25^{2} MHz	30 MHz	40 MHz	50 M
n71	15	Yes	Yes	Yes	Yes				
	30		Yes	Yes	Yes				
	60								

Misconception #3: 5G needs new spectrum

- Sprint USA launching 5G in 2.5 GHz
  - 2.5 GHz used for 4G at present

TDD-LTE Massive MIMO for 5G

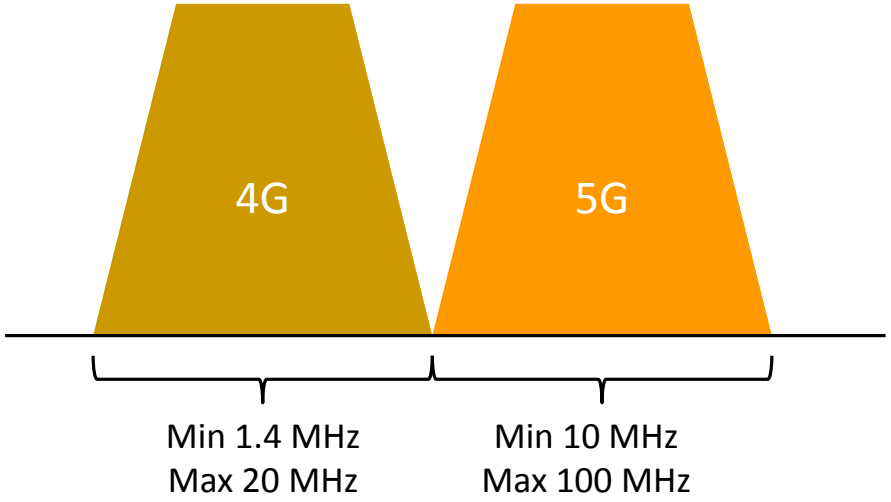
Sprint



Massive MIMO leverages a massive number of antennas and advanced antenna beamforming to improve performance

- Sprint will deploy 64T64R Massive MIMO (128 Antenna Elements) at 2.5 GHz
- Upgrade thousands of 2.5 GHz sites with Massive MIMO to support LTE and 5G simultaneously at existing sites

5



	NR band / SCS / UE Channel bandwi								
NR Band	SCS kHz	5 MHz	10[1,2] MHz	15[2] MHz	20[2] MHz	25[2] MHz	30 MHz	40 MHz	50 MH
n41	15		Yes	Yes	Yes			Yes	Ye
	30		Yes	Yes	Yes			Yes	Ye
	60		Yes	Yes	Yes			Yes	Ye

Misconception #4: 5G needs large amounts of bandwidth

- 3GPP defines new NR (New Radio) bands in FR1 and FR2 in 3GPP Rel.15 NR
- FR1: 450 MHz – 6 GHz
- FR2: 24.25 GHz – 52.6 GHz

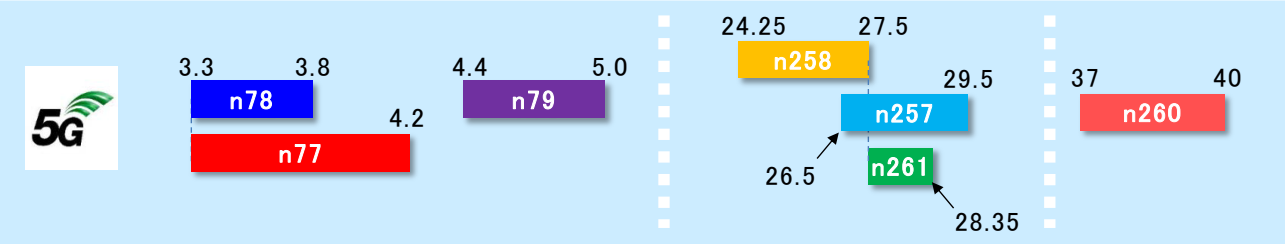


Table 2 NR bands specified in this WI

NR operating band	Uplink (UL) operating band	Downlink (DL) operating band	Duplex Mode	Bandwidth
n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	TDD	900 MHz
n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD	500 MHz
n79	4400 MHz – 5000 MHz	4400 MHz – 5000 MHz	TDD	600 MHz
n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD	3000 MHz (3 GHz)
n258	24250 MHz – 27500 MHz	24250 MHz – 27500 MHz	TDD	3250 MHz (3.25 GHz)
n260	37000 MHz – 40000 MHz	37000 MHz – 40000 MHz	TDD	3000 MHz (3 GHz)
n261	27500 MHz – 28350 MHz	27500 MHz – 28350 MHz	TDD	850 MHz

Misconception #4: 5G needs large amounts of bandwidth

	NR band / SCS / UE Channel bandwidth												
NR Band	SCS kHz	5 MHz	10[1,2] MHz	15[2] MHz	20[2] MHz	25[2] MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n1	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60		Yes	Yes	Yes								
n2	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60		Yes	Yes	Yes								
n3	15	Yes	Yes	Yes	Yes	Yes	Yes						
	30		Yes	Yes	Yes	Yes	Yes						
	60		Yes	Yes	Yes	Yes	Yes						
n5	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60												
n7	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60		Yes	Yes	Yes								
n8	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60												
n12	15	Yes	Yes	Yes									
	30		Yes	Yes									
	60												
n20	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60												
n25	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60		Yes	Yes	Yes								
n28	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60												
n34	15	Yes	Yes	Yes									
	30		Yes	Yes									
	60		Yes	Yes									
n38	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60		Yes	Yes	Yes								
n39	15	Yes	Yes	Yes	Yes	Yes	Yes	Yes					
	30		Yes	Yes	Yes	Yes	Yes	Yes					
	60		Yes	Yes	Yes	Yes	Yes	Yes					

	NR band / SCS / UE Channel bandwidth												
NR Band	SCS kHz	5 MHz	10[1,2] MHz	15[2] MHz	20[2] MHz	25[2] MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n71	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60												
n74	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60		Yes	Yes	Yes								
n75	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60		Yes	Yes	Yes								
n76	15	Yes											
	30												
	60												
n77	15		Yes	Yes	Yes			Yes	Yes				
	30		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes
	60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes
n78	15		Yes	Yes	Yes			Yes	Yes				
	30		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes
	60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes
n79	15							Yes	Yes				
	30							Yes	Yes	Yes	Yes		Yes
	60							Yes	Yes	Yes	Yes		Yes
n80	15	Yes	Yes	Yes	Yes	Yes	Yes						
	30		Yes	Yes	Yes	Yes	Yes						
	60		Yes	Yes	Yes	Yes	Yes						
n81	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60												
n82	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60												
n83	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60												
n84	15	Yes	Yes	Yes	Yes								
	30		Yes	Yes	Yes								
	60		Yes	Yes	Yes								
n86	15	Yes	Yes	Yes	Yes			Yes					
	30		Yes	Yes	Yes			Yes					
	60		Yes	Yes	Yes			Yes					

NOTE 1: 90% spectrum utilization may not be achieved for 30kHz SCS.
NOTE 2: 90% spectrum utilization may not be achieved for 60kHz SCS.
NOTE 3: This UE channel bandwidth is applicable only to downlink.

Misconception #4: 5G needs large amounts of bandwidth

Table 5.3.5-1: Channel bandwidths for each NR band

Operating band / SCS / UE channel bandwidth					
Operating band	**SCS kHz**	**50 MHz**	**100 MHz**	**200 MHz**	**400 MHz**
n257	60	Yes	Yes	Yes	
	120	Yes	Yes	Yes	Yes
n258	60	Yes	Yes	Yes	
	120	Yes	Yes	Yes	Yes
n260	60	Yes	Yes	Yes	
	120	Yes	Yes	Yes	Yes
n261	60	Yes	Yes	Yes	
	120	Yes	Yes	Yes	Yes

Misconception #5: 5G will give super-high speeds

BUSINESS INSIDER UK TECH

Your internet speeds will be insanely fast when 5G arrives

Antonio Villas-Boas
Mar. 4, 2017, 3:00 PM 48,972

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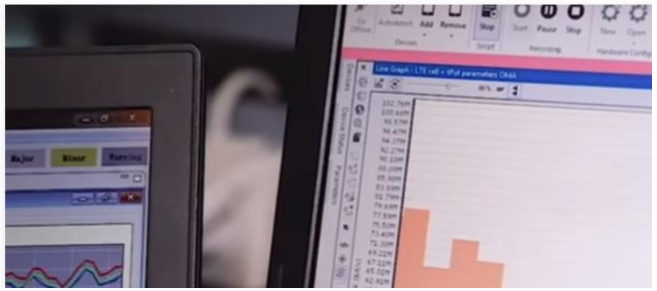
When the 5G wireless standard hits the mainstream, our hoi
the potential to be so fast that we'll be downloading 4K mov
any other large form of content at a fraction of the time we'r

Source

AH Android News Tech News Brand News Google News Reviews Special Features Best Tech Dea

New 5G Test Shows 14x Better Real-World Speeds Over 4G LTE

By Dominik Bosnjak February 15, 2018, 11:24pm



Source

MOBILE

5G isn't going to be much faster than LTE when it launches next year

Chris Mills @chrisfmills
April 26th, 2018 at 2:48 PM

Share Tweet

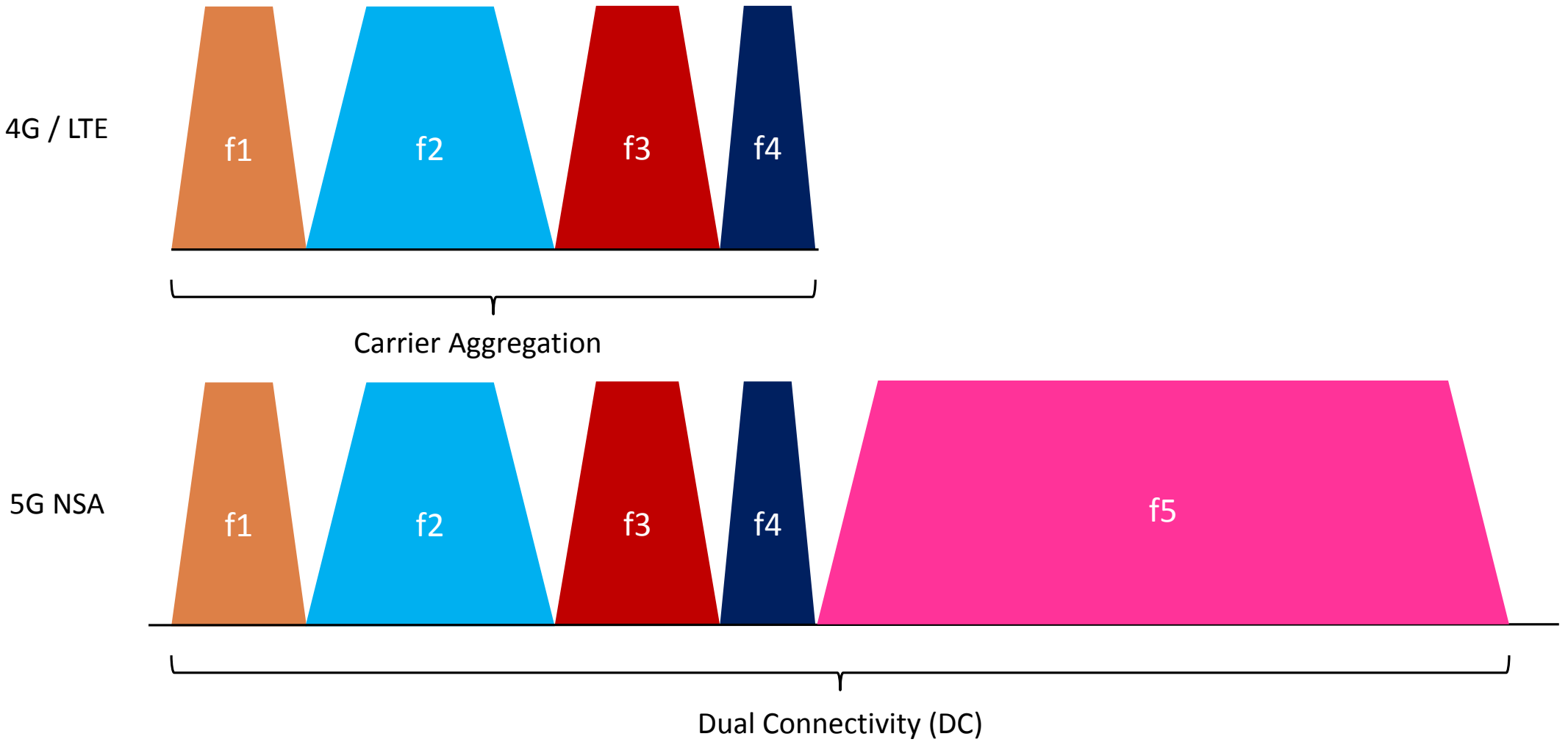
Wireless networks and smartphone makers are gearing up to launch the world's first 5G networks early next year. Chipmakers have already unveiled their first 5G modems, and the carriers have already started the war for public perception of the best network.

But according to comments made by Karri Kuoppamaki, T-Mobile's VP of radio network technology development and strategy, 5G isn't going to start out as much of an improvement over LTE, at least from the perspective of users.

Source

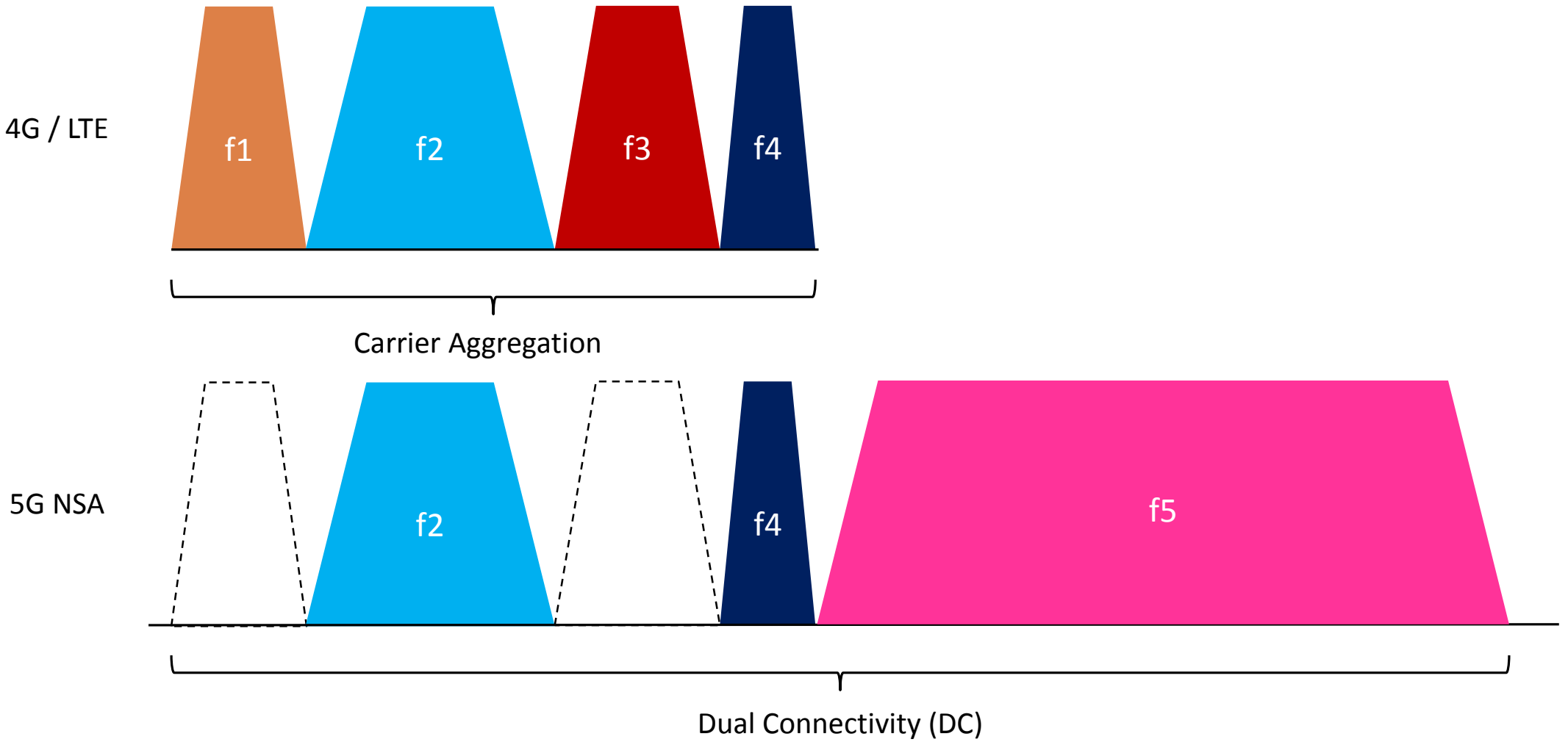
Misconception #5: 5G will give super-high speeds

- In theory

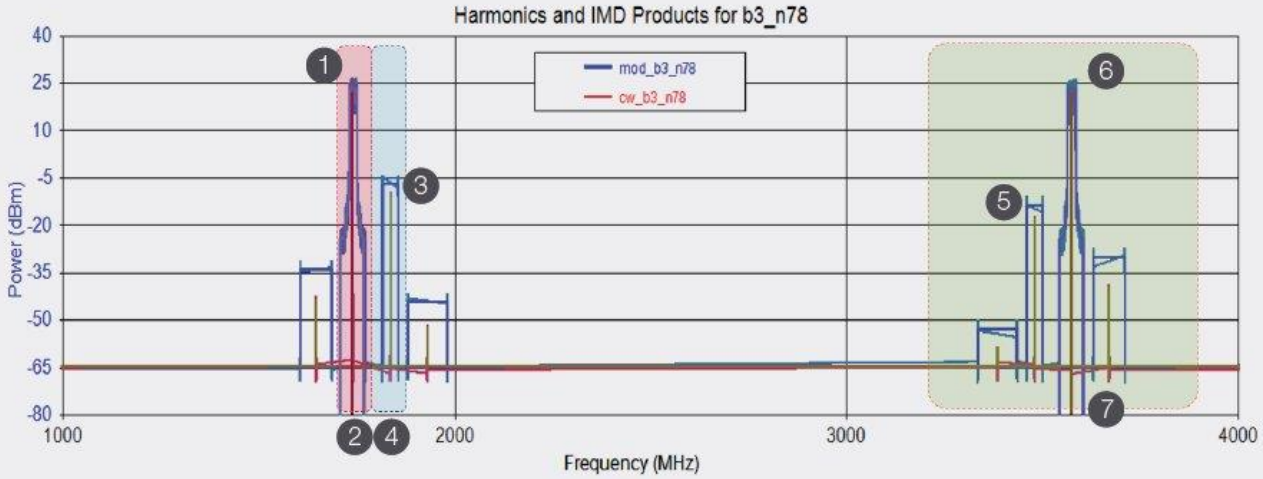


Misconception #5: 5G will give super-high speeds

- In practice



Misconception #5: 5G will give super-high speeds



1. b3 uplink signal 1740 MHz
2. b3 uplink band 1710 MHz ~ 1785 MHz
3. IMD's landing on b3 receive frequency 1835 MHz
4. b3 downlink band 1805 MHz ~ 1880 MHz
5. IMD product at 3480 MHz, self-interference for the TDD band?
6. n78 TDD band 3300 MHz ~ 3800 MHz
7. n78 uplink signal 3575 MHz

Figure 3a: Intermodulation and harmonic analysis with two modulated signals at 1740 MHz and 3575 MHz.

- With so many different bands in use, there is a small possibility of interference between them
- A recent whitepaper from Keysight points out that the 5G Uplink transmission in 3.5 GHz band might significantly interfere with 4G in the 1.8 GHz band in downlink direction. Maybe bad news, especially in Europe, where these are heavily used

Misconception #5: 5G will give super-high speeds

Qualcomm has a good blog on real-user experience with standalone 5G NR - Link

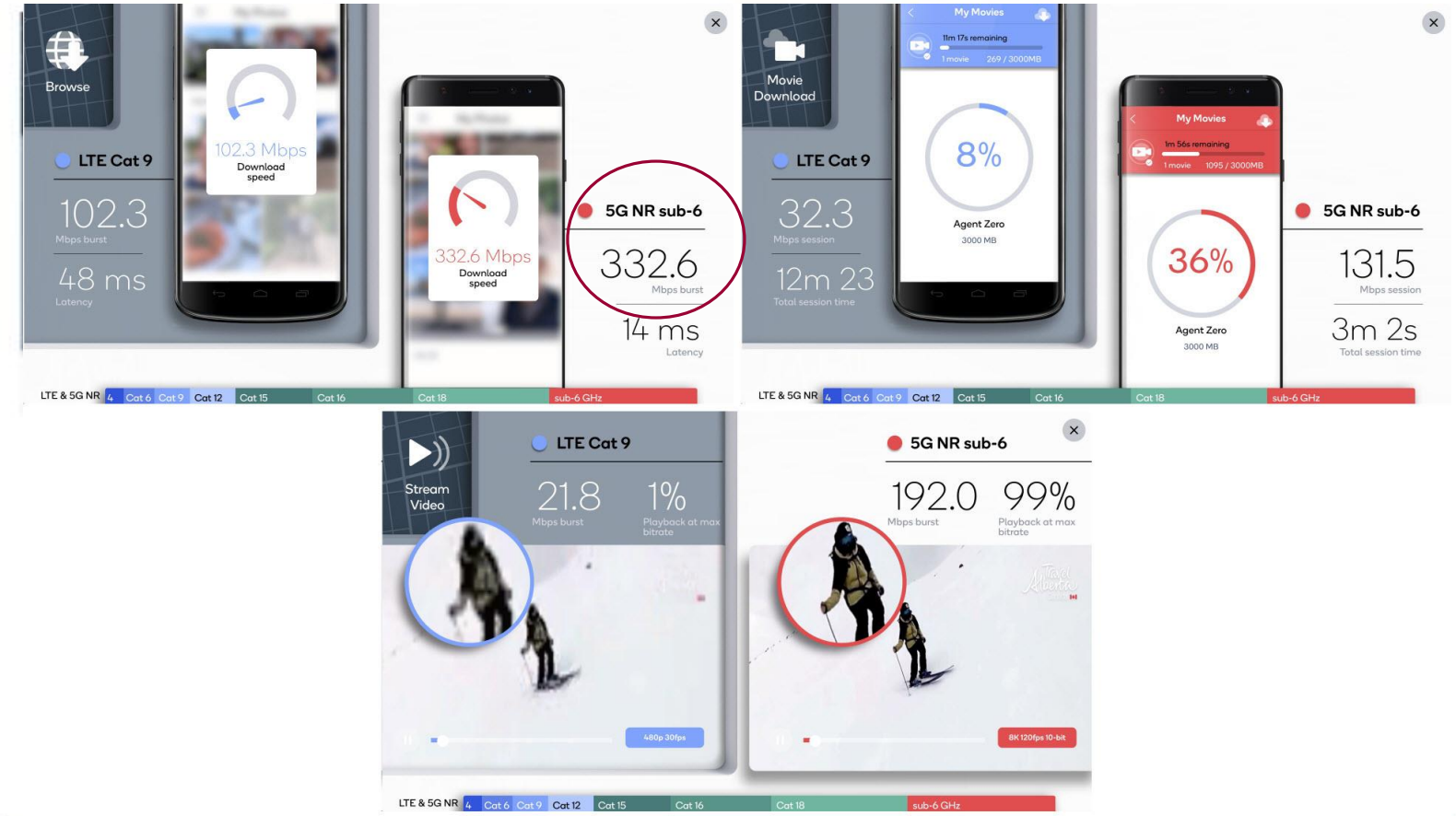


Figure 3: Cat 9 vs 5G NR use experience comparison

Misconception #5: 5G will give super-high speeds

- This is our view of rough real-world speeds

400 – 1500 Mbps
(100 MHz bandwidth)

100 – 300 Mbps
(40 MHz bandwidth)

10 – 50 Mbps
(10 MHz bandwidth)

Picture Source: Deutsche Telekom / T-Mobile USA

Misconception #6: 5G networks will have less than 1ms latency

Latency is generally defined as the time it takes for a source to send a packet of data to a receiver. In simple terms, half of Ping time. This is also referred to as **one way latency**.

Sometimes the term **Round trip latency** or round trip time (RTT) is also used to define latency. This is the same as ping time.

Misconception #6: 5G networks will have less than 1ms latency

In 3GPP and ITU, control-plane latency and user-plane latency is discussed for a particular technology

Control-plane latency is defined as the transition time from idle state to connected state.

The **user-plane latency**, also known as transport delay, is defined as the one-way transit time between a packet being available at the IP layer of the origin and the availability of this packet at IP layer of the destination.

Misconception #6: 5G networks will have less than 1ms latency

End-to-end (E2E) latency: the time that takes to transfer a given piece of information from a source to a destination, measured at the communication interface, from the moment it is transmitted by the source to the moment it is successfully received at the destination.

Misconception #6: 5G networks will have less than 1ms latency

5G Latency Requirements – Industry Targets

NGMN 5G Requirements

- 5G E2E Latency (eMBB) = **10ms** (i.e. RTT from UE-Application-UE)
- 5G E2E Latency (URLLC) = **1ms** (i.e. RTT from UE-Application-UE – or just UE-UE)

In both cases, the values are defined as capabilities that should be supported by the 5G System.

GSMA 5G Requirements

- 5G E2E Latency = **1ms** (again, defined as a capability target, not as a universal requirement)

ITU-R IMT-2020 Requirements

- eMBB User Plane Latency (one-way) = **4ms** [radio network contribution]
- URLLC User Plane Latency (one-way) = **1ms** [radio network contribution]
- Control Plane Latency = **20ms (10ms target)** [UE transition from Idle to Active via network]

Low Latency Use Case Requirements (various sources)

- Virtual Reality & Augmented Reality: **7-12ms**
- Tactile Internet (e.g. Remote Surgery, Remote Diagnosis, Remote Sales): < **10ms**
- Vehicle-to-Vehicle (Co-operative Driving, Platooning, Collision Avoidance): < **10ms**
- Manufacturing & Robotic Control / Safety Systems: **1-10ms**

Source: Prof. Andy Sutton

BT

Misconception #6: 5G networks will have less than 1ms latency

Qualcomm has a good blog on real-user experience with standalone 5G NR - Link

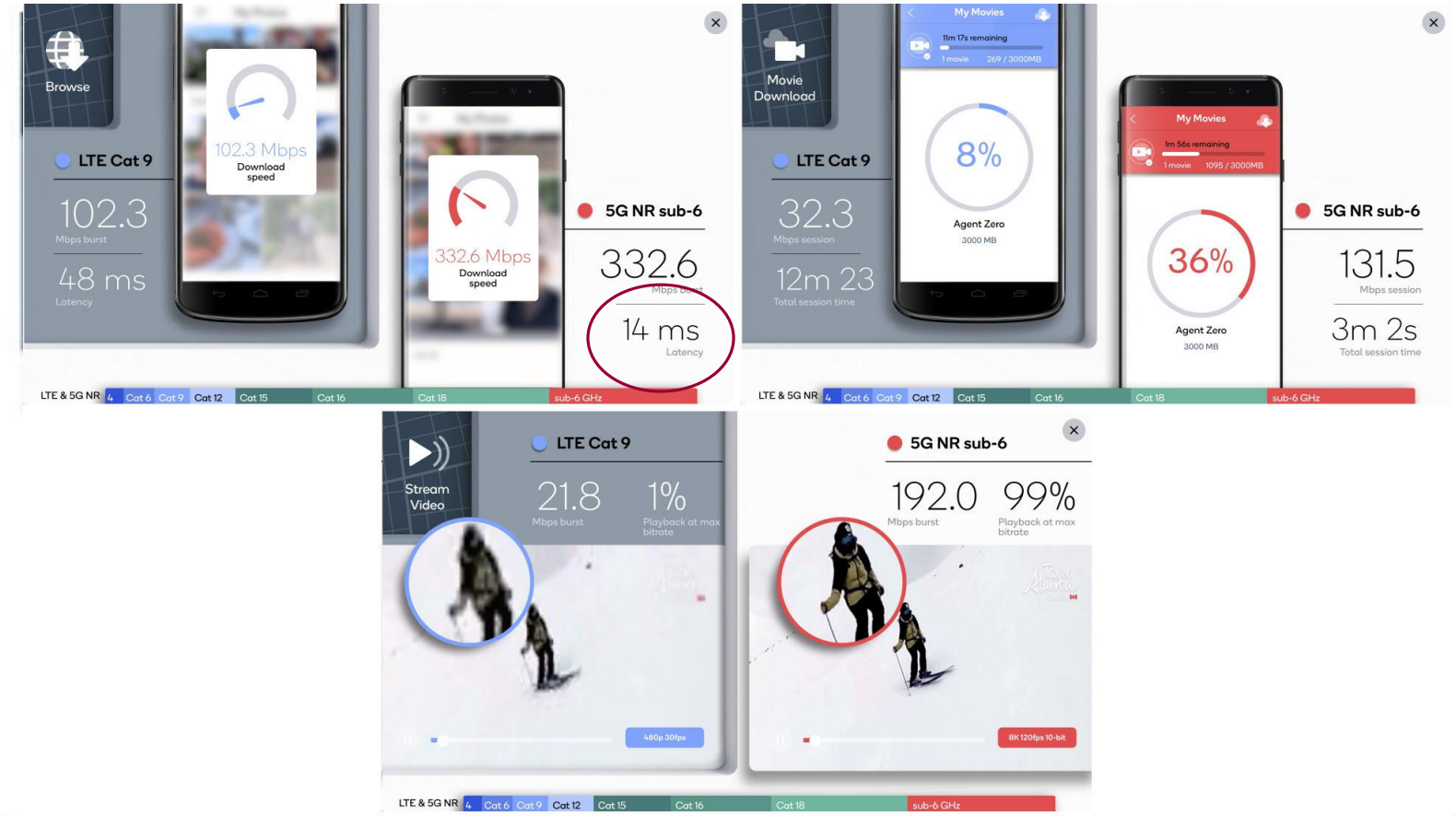


Figure 3: Cat 9 vs 5G NR use experience comparison

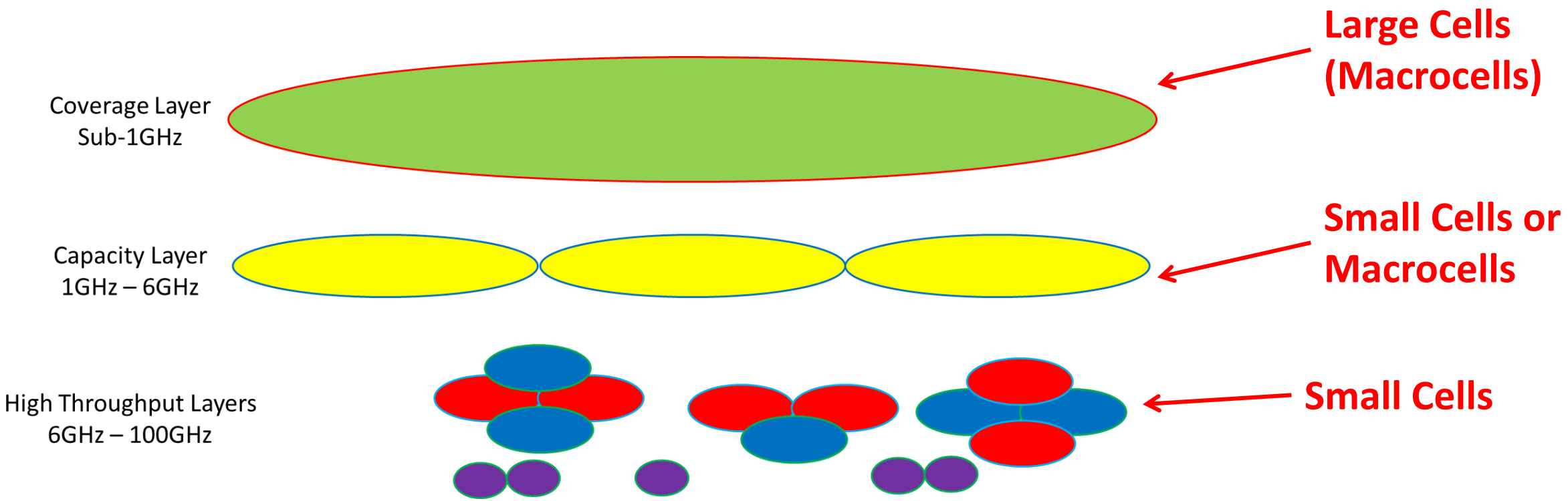
Misconception #6: 5G networks will have less than 1ms latency

Verizon 5G Speed Test (10 ms) - link

Vodacom Lesotho Commercial 5G (9 ms) - link

Telstra 5G Test (6 ms) - link

Misconception #7: 5G networks will be small cells



Misconception #8: 5G needs Massive MIMO

Massive MIMO (128x128) or (256x256)

4T4R / 8T8R / 64T64R (Massive MIMO)

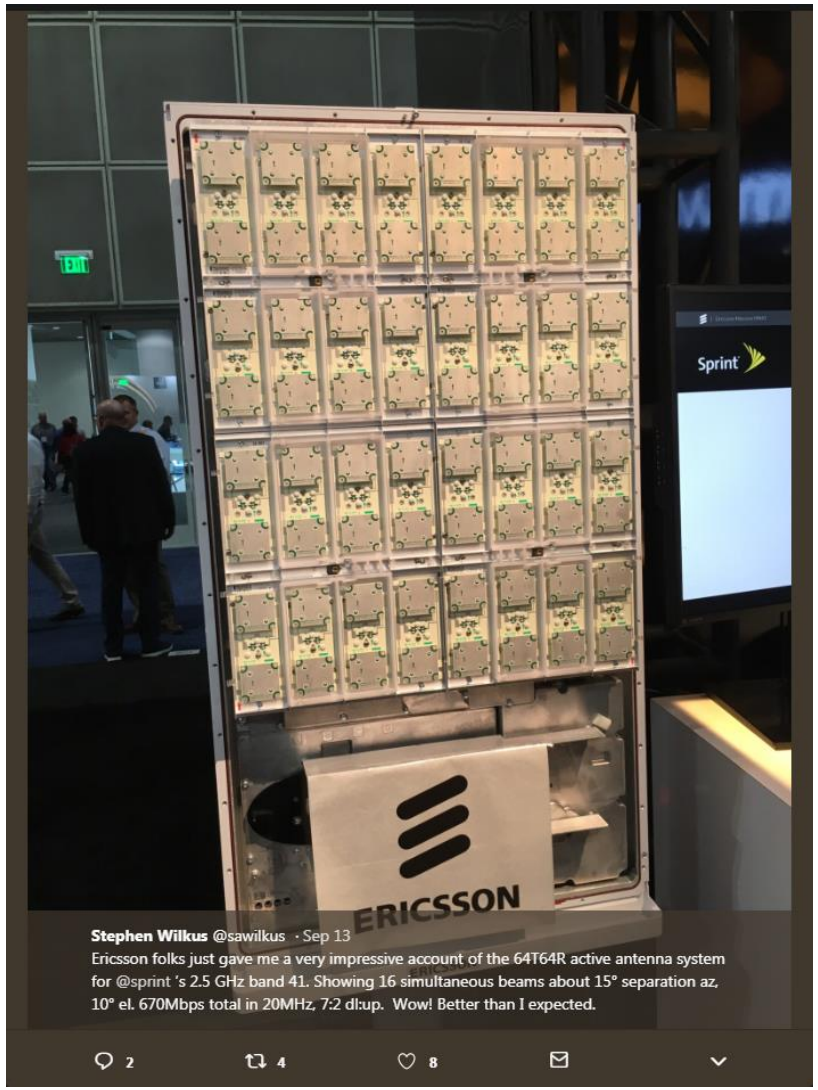
2x2 MIMO generally

Picture Source: Deutsche Telekom / T-Mobile USA

Misconception #8: 5G needs Massive MIMO

Picture: Sprint shows off 64T64R active antennas (Massive MIMO)

↑ Source Tweet



Source Tweet →

Misconception #8: 5G needs Massive MIMO

- 5G Massive MIMO will introduce its own challenges. Mainly:
  - The antennas will be heavier, meaning that the existing poles may not be able to bear the load. Upgrade would be required
    - It can work for some sites but may not be economical for all sites
  - Power upgrade would be required too as the new active antennas would consume more power
  - Since each site serves multiple sectors and frequencies, it is quite possible that backhaul upgrades would be necessary as well. Existing backhaul may not be able to cope with massive increase in data traffic

Misconception #9: 5G is needed for Autonomous Cars

Dictionary

Enter a word, e.g. 'pie'

autonomous

/ɔːˈtɒnəməs/

adjective
adjective: **autonomous**

(of a country or region) having the freedom to govern itself or control its own affairs.
"the federation included sixteen autonomous republics"

- having the freedom to act independently.
  "school governors are legally autonomous"
  synonyms: self-governing, independent, sovereign, free, self-ruling, self-determining, autarchic; self-sufficient
  "an autonomous republic"
- (in Kantian moral philosophy) acting in accordance with one's moral duty rather than one's desires.

Origin

GREEK
autonomos
having its own laws
ENGLISH
-ous
→ autonomous
early 19th century

early 19th century: from Greek *autonomos* 'having its own laws' + -ous.

↑ Source Tweet

Misconception #9: 5G is needed for Autonomous Cars

- Autonomous cars require sensors to work autonomously
  - Connectivity is a bonus, not must have.

- Interesting news and discussions links:
  - Tesla's 'enhanced autopilot', full self-driving update
  - Quora discussion on Tesla's autonomous driving hardware
  - Tesla's Lack Of LIDAR For Autopilot Is Legit & Provides Competitive Edge, Research Hints

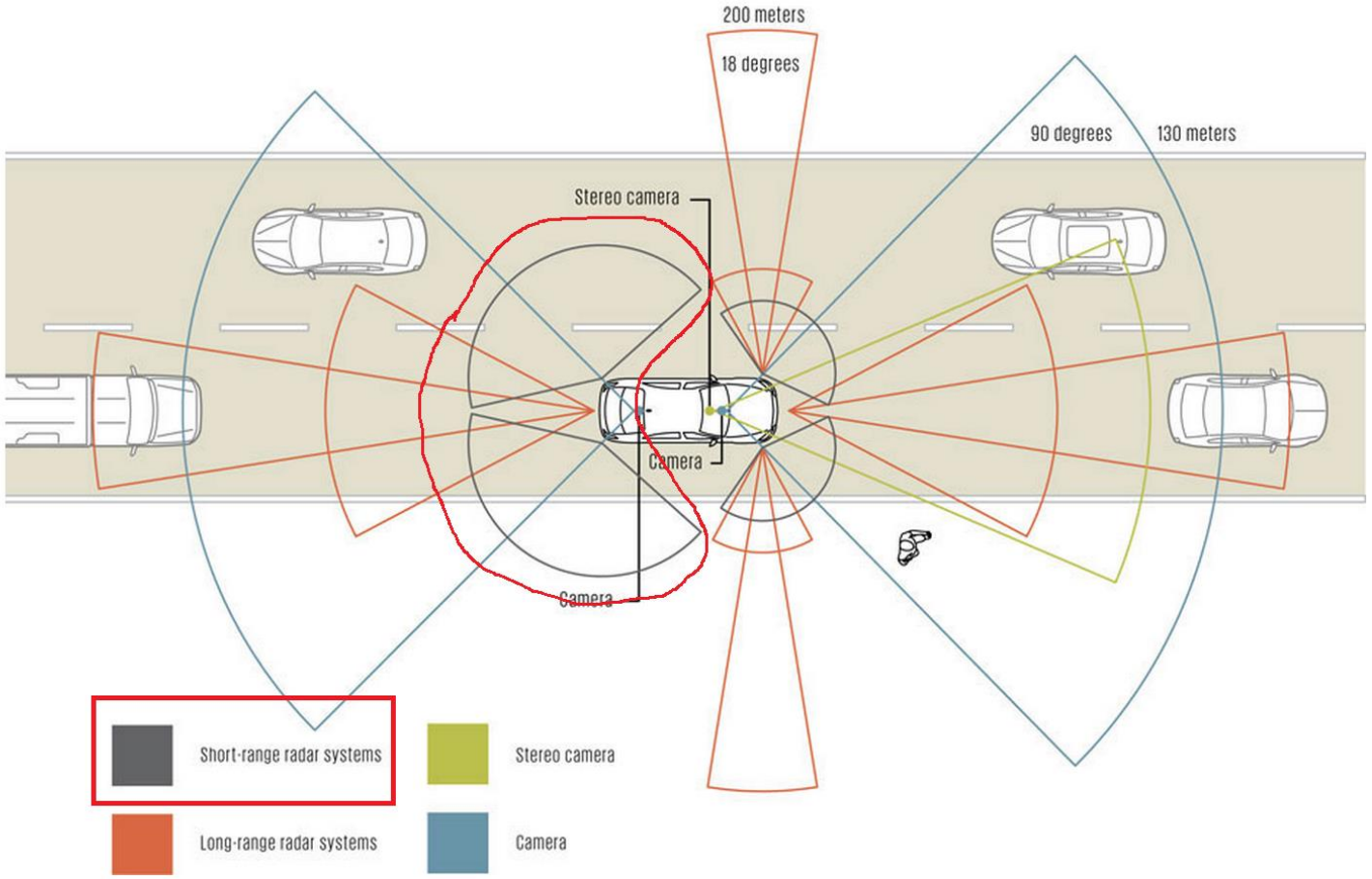
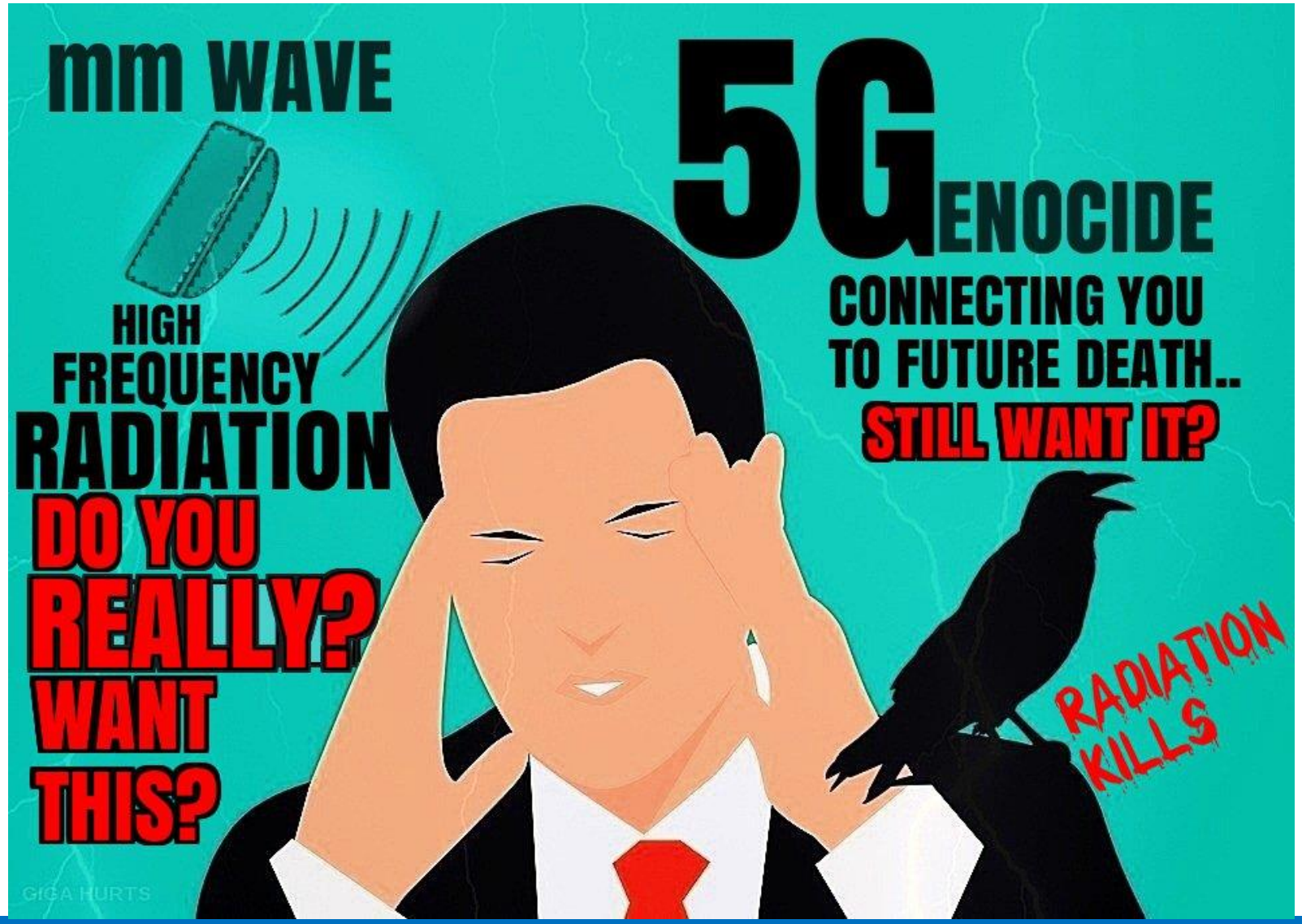


Illustration: John MacNeill

Sensors of different capabilities cover 360 degrees, with overlapping fields of view.

Misconception #10: 5G is dangerous for health



Misconception #10: 5G is dangerous for health

- Every new generation of mobile technology gives rise to many news and research items suggesting that this new technology is dangerous to health.
- For example, back in 2004, Stewart Report looked at all the health concerns and reported that there is no real evidence of health risk. It however also said:

> "A recent paper has suggested possible effects on brain functioning form the use of **3G or third generation mobile phones**. Populations are not homogenous and people can vary in their susceptibility to environmental and other challenges. It was considered that children might be more vulnerable to any effects arising from the use of mobile phones because of their developing nervous system, the greater absorption of energy in the tissues of the head and a longer lifetime exposure."

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Numerous articles have been written mentioning that there is no real evidence of any health issues because of mobile phones.

- The Observer: Mobile phones and cancer – the full picture
- The Argus: New superfast internet won't kill you: expert calms 5G safety fears
- Forbes: Is 5G a CIA plot?

Finally:

- RADIATION HAZARDS - A dabbler's perspective by Jess H. Brewer

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- International Commission on Non-Ionizing Radiation Protection (ICNIRP): An independent organization provides scientific advice and guidance on the health and environmental effects of non-ionizing radiation (NIR) to protect people and the environment from detrimental NIR exposure.
  - NIR refers to electromagnetic radiation such as ultraviolet, light, infrared, and radiowaves, and mechanical waves such as infra- and ultrasound. In daily life, common sources of NIR include the sun, household electrical appliances, mobile phones, Wi-Fi, and microwave ovens.

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- As mentioned earlier, the coverage layer 5G and capacity layer 5G (sub-6GHz) have similar properties. With regards to mmWave frequencies, ICNIRP have set safety margins far higher than those for below 6GHz

- ICNIRP also provided a Health risk assessment literature with an interesting list of research references. Here is the conclusion regarding Cancer:

  "Studies of exposure to environmental radiofrequency EMF fields, for example from radio and television transmitters, have not provided evidence of an increased cancer risk either in children or in adults. Studies of cancer in relation to occupational radiofrequency EMF exposure have suffered substantial methodological limitations and do not provide sufficient information for the assessment of carcinogenicity of radiofrequency EMF fields. Taken together, the epidemiological studies do not provide evidence of a carcinogenic effect of radiofrequency EMF exposure at levels encountered in the general population. In summary, no effects of radiofrequency EMF on cancer have been substantiated."

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- In Summary:
  - There is no research or proof that can conclusively blame any brain issues or cancer on current mobile technologies
  - The power levels in new mmWave 5G is designed to be much lower than that used for current mobile cellular systems. This means that the risk is even further removed.

Bonus Misconception: 5G & Remote Surgery

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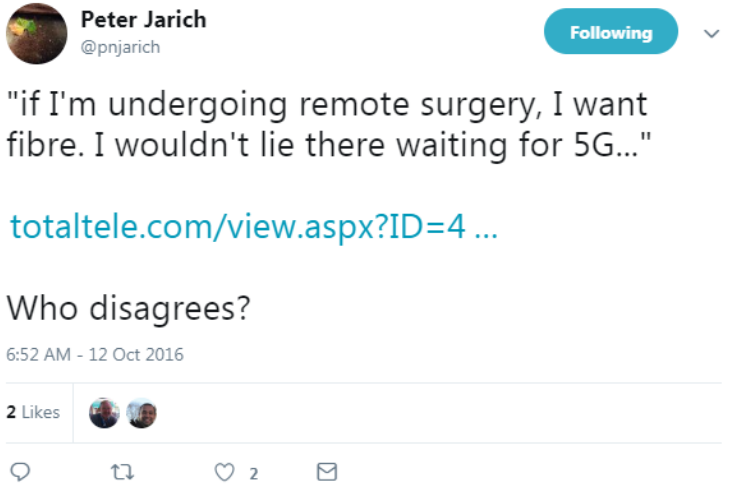

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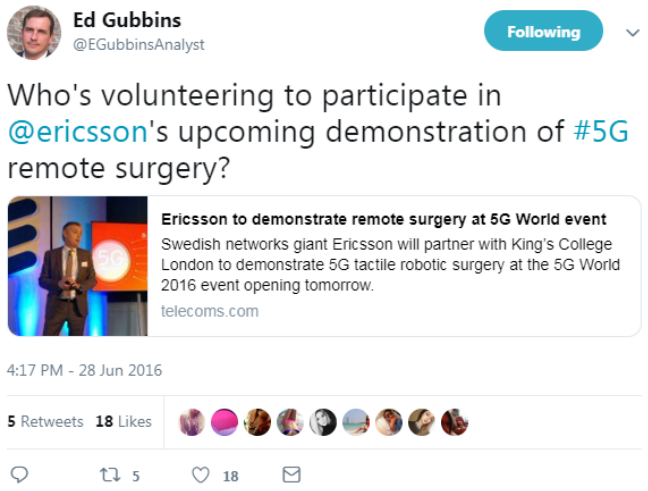

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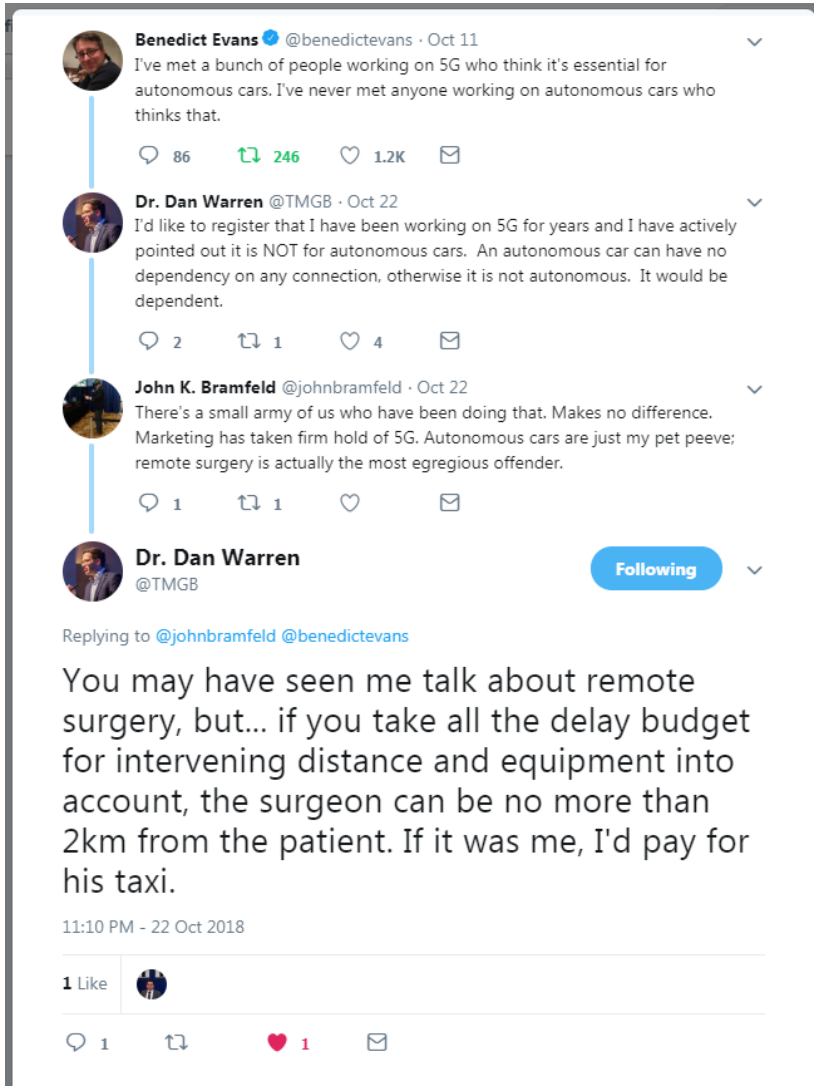

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