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5G communication technology – Do they interfere with flight communication signals

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Abstract

Several airlines have cancelled flights to the United States as a result of the country's 5G rollout, claiming that 5G signals could interfere with critical safety equipment such as the altimeter, which pilots rely on for takeoff and altitude readings. The proposed C-band spectrum extends from 3.7 to 3.98 gigahertz whereas the aviation altimeters use the 4.2 to 4.4 gigahertz. This narrow gap between the frequencies isn't nearly enough to ensure that a mobile carrier signal isn't mixed with or corrupted by an altimeter signal. Though the chance of an in-flight issue due to 5G interference may be low, it is important to treat any potential dangers seriously because it is about human safety. In this paper the measures taken by various countries to avoid this signal interference is discussed in detail. Also the possible solutions for communication and aviation sectors to avoid signal interference are discussed.

Keywords: *5G, Aviation, Altimeter, Communication.*

1. Introduction

Since the early 1970s, the mobile wireless business has been creating, revolutionising, and evolving technologies [1]. Mobile wireless technologies have gone through four or five generations of technological revolution and evolution in the last few decades. Within the previous few years, the world's telecommunication service has greatly evolved. It is found that the many generations of cellular systems as studied in the evolution of mobile communications from 1st generation to 5th generation because there are 6 billion individuals sue mobile phones.

In the present time, there are four generations in the mobile industry. These are respectively 1G- the first generation, 2G- the second generation, 3G- the third generation, and then the 4G- the forth generation, 5G-the fifth generation.

1.1 Evolution from 1G to 5G

1G stands for first-generation communication technology, which is an analogue transmission system meant to deliver basic voice services. The radio transmissions employed are analogue in nature and do not support data transmission [2].

2G technology supplied the first digital systems as overlays or parallels to analog-based systems, bringing digitisation to cellular networking. 2G was able to deliver greatly enhanced voice quality, as well as the first (although limited) data service offering in the evolution of cellular networks [3].

3G refers to a set of dedicated digital networks for delivering broadband and multimedia services. 3G design supports a higher data rate (throughput speed) QoS, thanks in part to advancements in internet and IP network technologies.

4G stands for the fourth generation of mobile cellular communication technology, which is expected to meet the growing need for broadband data transmission and broadcasting, as well as very high-volume voice users [4].

5G refers to the fifth-generation mobile network. It is a new global wireless standard that follows 1G, 2G, 3G, and 4G networks. 5G enables the development of a new network that connects practically everyone and everything, including machines, objects, and gadgets. Multi-gigabit per second peak data speeds, ultra-low latency, better reliability, massive network capacity, increased availability, and a more consistent user experience for a larger number of users are all features of 5G wireless technology. New user experiences and industry links are enabled by improved performance and efficiency [5].

OFDM (Orthogonal frequency-division multiplexing) is a technology for decreasing interference by modulating a digital transmission across many channels, which is used in 5G.

5G will be able to operate in both lower bands (e.g., sub-6 GHz) and mm Wave (e.g., 24 GHz and higher), bringing extraordinary capacity, multi-Gbps throughput, and low latency.

2. 5G frequency in electromagnetic spectrum

The electromagnetic spectrum shown in figure 1 refers to the range of electromagnetic radiation frequencies, as well as their wavelengths and photon energies. It covers electromagnetic waves with frequencies ranging from below one hertz to above 10^{25} hertz. Based on the frequency the spectrum is divided in to separate bands. The band is designated radio waves, micro waves, infrared, visible light, ultraviolet, X-rays, and gamma rays from the beginning of low frequency to the end of high frequency. The millimetre wave bands between 30 GHz and 300 GHz will be used in 5G, as will frequencies from 600 megahertz and upwards.

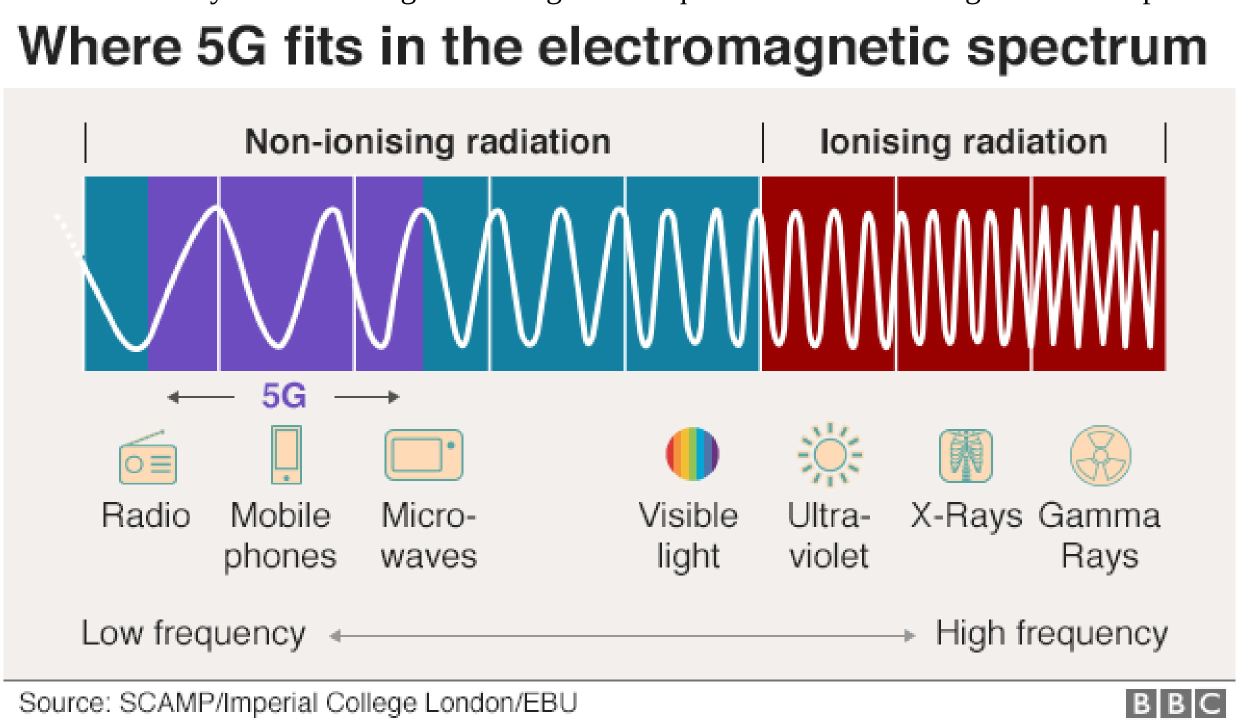

Figure 1: 5G frequency range in electromagnetic spectrum.

3. Wireless Signals

Wireless signals are electromagnetic waves travelling through the air. Waves occur around a piece of metal, such as a wire or an antenna, as electric energy travels through it. These waves can go a long distance depending on the energy's strength. Radio waves are used to transmit wireless signals. The electromagnetic spectrum includes the radio spectrum, which runs from 3 hertz to 3,000 gigahertz [6].

4. How 5G puts airplanes at risk in US

It is learnt that both 5G frequencies and wireless signals used in the U.S aircrafts works in the radio frequency range. Garbled noise is produced when two wireless transmissions in the same area use the same frequency. This can be heard when receiver is in the middle of two radio stations transmitting their information on the same or similar frequency ranges. The signals become jumbled, and receiver may hear one station one time and the other the next, all while being bombarded by noise [7].

Modern airplanes utilize altimeters, which calculate the time it takes for a signal to bounce back from the ground to determine the plane's height. These altimeters are a vital part of automated landing systems that are especially beneficial in circumstances where there is low visibility. If an altimeter perceives a signal from a wireless carrier as the ground's bounced signal, it may incorrectly believe that the ground is closer than it is an attempt to drop the landing gear and do other landing operations before the ground is reached. If the altimeter's radio signals are corrupted and garbled due to interference from wireless carrier signals, the altimeter may not detect the reflected signal and so be unable to determine how near the plane is to the ground. Airplanes and cellular carriers use distinct areas of the radio frequency spectrum. Aviation altimeters operate in the 4.2 to 4.4 gigahertz region, but wireless carriers' recently sold – and previously underused – C-band spectrum spans 3.7 to 3.98 gigahertz. It turns out that the 0.22 gigahertz gap between the frequencies isn't nearly enough to ensure that a mobile carrier signal isn't mixed with or corrupted by an altimeter signal.

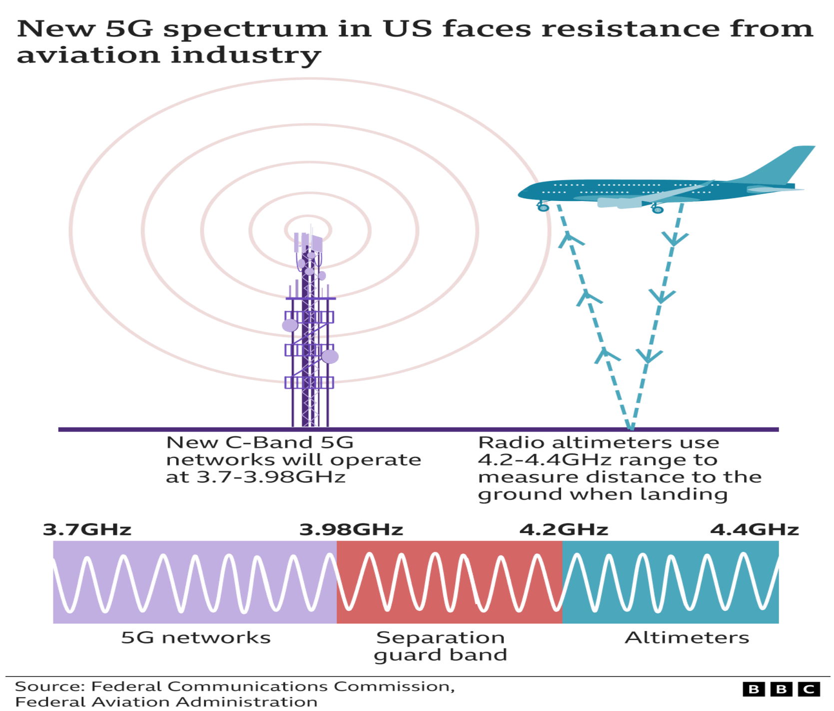

Figure 2: Separation guard band between 5 network and altimeters

5. Steering clear of trouble – for now

The telecommunications industry claims that the 0.22 gigahertz gap is sufficient and that no interference will occur. The airline sector, on the other hand, has been more cautious. Even though the risk is low, it feels that the repercussions of a plane crash would be catastrophic. Although the chances of such interference are extremely remote, there isn't enough evidence to conclude that it will never occur. The sensitivity of the receivers in the altimeters determines whether or not there will be interference. There's no way to be sure that such stray interfering signals won't reach altimeters. If the altimeters can identify stray signals as noise and filter them out, they will work properly. However, upgrading airplane altimeters is a costly proposition, and it's unclear who will pay the costs. For the next six months, telecommunication companies have agreed not to install 5G transmitters and receivers near the 50 busiest airports until a solution is found. In the short term, this has averted a severe crisis, but it isn't a long-term solution.

6. What other countries have done?

Certain countries have chosen to deploy C-band 5G with radio frequencies that are spaced further away than frequencies used by radar altimeters.

In several countries maximum transmit power levels authorized have been significantly lower than those authorized in the U.S.

Transport Canada placed restrictions on 5G deployment near 26 large airports. They also implemented a national antenna down-tilt requirement to protect aircraft used in low altitude. France has created “safety and precaution” zones around CAT III airport runways (low visibility approach) and prohibited 5G operators from orienting their beam upwards in these areas with low altitude helicopter ops.

7. Indian scenario:

India wants to keep pace with latest technological advancements in mobile and communications. 5G helps for internet-of-things, machine-to-machine learning and smart cities. ITU APT Foundation of India said proposed 5G services rolled out in India will be in spectrum bands that will have sufficient safeguards and will not interfere with civil aircraft altimeters. There is no chance of 5G services affecting airplanes in India [8], it is completely protected because it is assigning 3.3-3.67 gigahertz, which is more than 0.5 gigahertz below the altimeter spectrum.

8. So what can be done?

To avoid interference, some countries run their 5G networks on a frequency that is slightly different from that of airplane equipment [9].
In the long run, the ideal option for 5G would be to use a considerably higher band, such as 24GHz to 47GHz. Data speeds are substantially faster at these frequencies, but each cell's coverage area is significantly reduced. However, more towers are required.

It's also possible to lower the signal intensity from towers near airports. It's not about adjusting the frequency; instead, it's about restricting the signal's power. This can decrease the probability of interfering with adjacent bands.

Adjusting the frequency range of radio altimeters is another possible approach. However, this would take a long time and use a lot of funds in the aviation sector.

Though the chance of an in-flight issue due to 5G interference may be low, it is important to treat any potential dangers seriously because it is about human safety.

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