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January 26, 2022

Aviation Concerns Regarding the Rollout of 5G Wireless Telecommunications Networks

The rollout of fifth-generation (5G) wireless telecommunications networks in the United States has roiled passenger and cargo airlines and other aviation operators over fears that certain mid-band or C-band 5G signals could interfere with aircraft radio altimeters. These concerns prompted the Federal Aviation Administration (FAA) to issue alerts to aircraft operators in late 2021 about possible flight safety risks. FAA asked aircraft operators for related data, urged them to educate pilots about potential disruptions, and prohibited certain flight procedures as a safety precaution. At the urging of FAA, the Department of Transportation, the White House, and some Members of Congress, telecommunications companies agreed to voluntarily delay the rollout of 5G service near airports, originally scheduled for early December 2021, until July 2022, to avoid air travel disruptions. This will give FAA and avionics equipment manufacturers additional time to more thoroughly assess whether C-band 5G signals might interfere with flight operations and whether equipment upgrades or other mitigation actions will be needed to adequately shield aircraft systems from 5G interference.

Radiofrequency Spectrum and 5G Signals

5G networks are being installed all around the world, but are being assigned different frequency bands in different countries. While low-band (below 1 gigahertz (GHz)) and high-band (above 24 GHz) 5G frequencies are not the focus of current concerns raised by FAA and aviation stakeholders, the assignment of C-band frequencies in the range of roughly 3 to 5 GHz has alarmed the aviation industry over potential interference with radio altimeters. Europe has allocated spectrum between 3.4 and 3.8 GHz for C-band 5G, while in Japan, frequencies from 3.4 to 4.1 GHz are assigned. In the United States, the Federal Communications Commission (FCC) approved use of spectrum between 3.7 and 3.98 GHz for 5G in 2020, and subsequently auctioned licenses in this band to telecommunications providers. U.S. providers paid over $81 billion for C-band licenses, and are eager to launch service in order to recoup these costs and realize a return on investment in 5G technology that will give wireless customers faster data transmission speeds and greater reliability than fourth-generation (4G) wireless service.

Potential Interference with Radio Altimeters

Worldwide, aviation operators have long used a slice of radiofrequency spectrum between 4.2 GHz and 4.4 GHz that is exclusively reserved for radio altimeters. These devices, frequently installed on airliners, regional and business jets, turboprops, advanced helicopters, and military aircraft measure aircraft altitude above the ground by timing how long it takes for a directional radio transmission to reach the terrain below and bounce back to an onboard receiver. Radar altimeters provide input to aircraft terrain alerting systems that provide pilots with information and warnings about terrain and obstacle clearance. Radar altimeters also provide data to automated flight control systems used for vertical flight guidance at low altitude, especially during approach to landing. While airplanes can rely on other systems, including precision instrument landing systems, to descend to about 200 feet above the ground, radar altimeters are essential to providing vertical guidance below 200 feet in low-visibility conditions when pilots are unable to clearly see the runway. While such capabilities are essential for all-weather commercial flight operations, radar altimeters are not commonly found on small general aviation aircraft.

FAA, along with aviation regulators from other countries, first raised concerns about wireless deployments in the C-band in 2015. They cautioned that 5G signals transmitted on nearby frequencies could potentially interfere with radio altimeters, particularly if high-powered 5G base stations are placed close to airport runways. Although not required by regulation, most radio altimeters currently in use have mask filters to block signals on nearby frequencies that could be mistaken for reflected radio altimeter signals. However, it is uncertain whether these filters will adequately block more powerful 5G signals in all cases.

A study by RTCA, an aviation industry technical advisory group founded as the Radio Technical Commission for Aeronautics, concluded that expected interference levels from fundamental 5G emissions in the 3.7-3.98 GHz range and spurious or stray 5G emissions that bleed over into the 4.2-4.4 GHz band were likely to exceed safe interference limits for all envisioned 5G transmitter configurations across all categories of airplanes and helicopters equipped with radio altimeters. Moreover, it determined that stray 5G emissions that might bleed over into the band reserved for radio altimeters would not be considered compliant with international recommendations for radiofrequency protection criteria.

The FCC countered that the RTCA findings assume a worse-case scenario, and that alternative testing found that FCC-mandated protections, including limits on the strength of 5G signals and 220 MHz of spectral separation between 5G signals and radio altimeters, would mitigate the potential for interference. Further, the FCC argued that properly engineered radio equipment should not be prone to harmful interference from 5G signals.

Near-Term Mitigation Actions

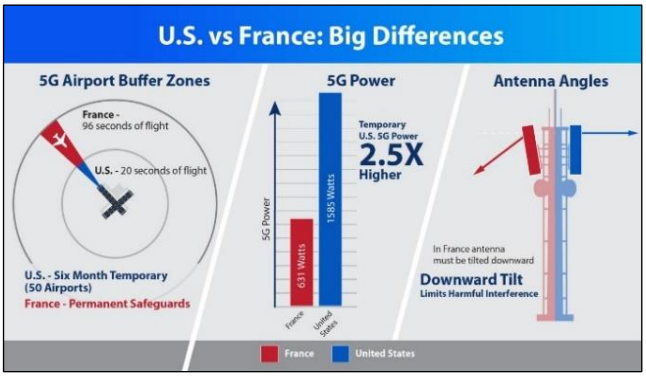
Telecommunications providers voluntarily pushed back 5G launch schedules from early December 2021 to January

2022 to provide FAA with additional time to address radio altimeter interference concerns. As C-band 5G deployments were slated to launch in early January 2022, FAA initially restricted the use of approach procedures and automated landing system operations at 88 airports where it determined that the presence of C-band 5G signals could pose a risk of radio altimeter interference. However, service providers subsequently agreed to voluntarily delay activation of 5G transmitters located close to airports until July 5, 2022, thus creating temporary "buffer zones" around airports during the first six months of the 5G rollout. If, after this time, FAA decides to restrict certain flight procedures due to lingering 5G concerns, aircraft operators could be forced to execute costly flight diversions in poor weather or cancel flights of aircraft using radio altimeters not approved by FAA for low-visibility approaches in the presence of 5G. Despite agreements to create temporary 5G buffer zones around U.S. airports, some airlines, including some international airlines, canceled flights and modified service in January 2022, apparently in response to continued uncertainty regarding possible disruptions to low-visibility operations over 5G interference concerns.

Approaches in Other Countries

Other countries, including Canada, have initially restricted the installation of 5G transmitters near airports. The 5G rollout in Europe over the past three years has not generated the same concerns from aviation, in part because the approved frequencies have greater separation from radio altimeter bands than in the United States, reducing the likelihood of interference. Moreover, some European countries, notably France, have insisted that telecommunications providers implement additional mitigation measures to reduce potential conflicts between 5G signals and radio altimeters, including restricting power output of 5G towers, restricting placement of 5G antennas in buffer zones near airports, and requiring that 5G antennas near airports be tilted downward to reduce the likelihood of interference with flight operations (see **Figure 1**).

Figure 1. Comparing 5G Source Mitigation in France and the United States



Source: Federal Aviation Administration.

In Japan, where frequencies up to 4.1 GHz allocated for 5G are even closer to radio altimeter frequencies than in the United States, the government has restricted the placement of 5G transmitters within 200 meters of airport approach paths. In the United States, however, 5G providers have been reluctant to agree to such measures, as they could reduce the availability and quality of 5G service in areas around airports. Moreover, reducing the power of these 5G transmissions could give competitors that do not rely on these frequency bands a competitive advantage.

Potential Long-Range Resolution

It will ultimately be up to FAA to decide whether existing radio altimeter systems adequately protect against 5G interference or if new replacement units that meet future operational performance standards will be required. As of late January 2022, FAA has provisionally approved roughly 90% of the U.S. commercial airline fleet equipped with radio altimeters to conduct low-visibility landings at airports with nearby 5G towers.

FAA is working with industry groups led by RTCA and its Europe counterpart, the European Organization for Civil Aviation Equipment or EUROCAE, to develop minimum operational performance standards for future radio altimeters that will not be susceptible to potentially harmful radiofrequency interference. Once these standards are established and adopted by FAA, manufacturers can begin to design, build, and supply units that are not prone to potential impacts from C-band 5G. Replacement of radio altimeters, however, might prove costly to aircraft operators, including the military. The airline industry and other civilian operators might ask for federal relief if faced with significant costs to upgrade radio altimeters.

The potential impacts of 5G are not limited to operations around airports. Helicopters responding to medical emergencies also rely on radio altimeters when landing to pick up patients. Citing the critical societal importance of helicopter emergency medical operations, FAA has granted temporary regulatory relief from radio altimeter requirements for medical helicopters conducting night vision goggle operations, so long as ground observers remain in radio contact with pilots to guide them regarding terrain and obstacle clearance around landing zones. This exemption expires in 2024, at which point medical helicopters may also need upgraded radio altimeters.

Lingering Policy Implications

The ongoing concerns over potential aviation safety impacts from the 5G rollout in the United States point to broader concerns that may be of particular interest to Congress. These include coordination between FAA and the National Telecommunications and Information Administration, the federal agency that represents federal agency spectrum concerns to the FCC; FAA's relationship with other regulatory agencies such as the FCC; and FAA's ability to address complex challenges brought about by the proliferation of wireless technologies and the rapidly evolving technical landscape in which aviation must operate.

Bart Elias, Specialist in Aviation Policy

IF12028

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