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INSIGHT

The FCC-Approved Ligado Network and Potential Technical Issues for DOD Use of GPS

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On April 20, 2020, the Federal Communications Commission (FCC) unanimously authorized an application by Ligado Networks LLC (Ligado) to "deploy a low-power [9.8 decibel watts (dBW)] terrestrial nationwide network in the 1526-1536 MHz, 1627.5-1637.5 MHz, and 1646.5-1656.5 MHz bands [of the electromagnetic spectrum] that will primarily support Internet of Things (IoT) services." These frequency bands are traditionally used for satellite operations. The Department of Defense (DOD) opposed this decision—along with the Departments of Homeland Security, Transportation, the Interior, and Justice; the Federal Aviation Administration; and others—due to concerns that Ligado's proposed network could interfere with signals from satellites to Global Positioning System (GPS) receivers. Congress may consider the FCC's decision, as well as DOD and other federal agency concerns about the decision, as it conducts oversight of the FCC. Congress may also consider broader issues related to fifth generation (5G) mobile technologies, such as the allocation of spectrum among competing users and the impact of spectrum decisions on national security and GPS modernization.

How GPS Works

GPS consists of a constellation of at least 24 satellites in six orbital planes to provide global coverage, ground-based receivers, and user equipment such as smartphones. The satellites are positioned approximately 12,500 miles above the Earth's surface, in what is termed Medium Earth Orbit (MEO). Because of the distance the radio waves have to travel from MEO to GPS receivers on Earth, the satellite signals arriving to the earth's surface are extremely weak—approximately negative 160 dBW (see **Figure 1**). GPS satellites broadcast two primary signals, which are used for position, navigation, and timing: L1, an unencrypted course acquisition signal (broadcast around 1575 MHz), and L2, also known as P(Y) code—the encrypted signal used by the military for improved accuracy (broadcast around 1227 MHz). L2 in turn enables advanced military capabilities like precision-guided munitions. Other military applications using GPS include navigation systems, communications encryption, and command and control platforms, such as blue force tracker, which monitors the location of friendly forces. Due to the complexity of L2 encryption, military GPS equipment must first acquire an L1 signal to identify its relative position before acquiring an L2 signal.

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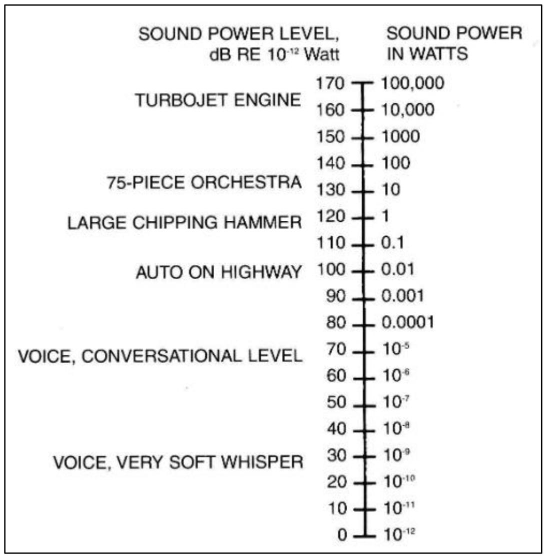
Figure 1.Illustrative Sound Levels, by Decibel Watts



Source: https://www.aiha.org/public-resources/noise-hearing-loss.

GPS Modernization

DOD started the GPS modernization program to upgrade GPS features and increase performance. GPS modernization includes new civilian and military GPS signals to enhance the capabilities of the traditional L1 and L2 bands. M code, the new military signal, uses a signal across the traditional L1 and L2 frequencies to increase power and provide improved anti-jam capability, more secure and flexible encryption, and the ability to detect false signals.

To reach initial operational capability, three new segments of M Code for GPS are required: the space segment, user equipment to receive the new signal, and ground control system to control beam forming and additional encryption. According to Section 913 of the FY2011 National Defense Authorization Act (P.L. 111-383), DOD is not authorized to purchase GPS user equipment after FY2017 unless—with certain exceptions—the equipment is capable of receiving M code from GPS. There have been significant program delays, however, in all three segments of GPS modernization, and although currently operational GPS IIF and GPS III satellites are equipped with M code, they do not yet offer the full M code capability.

Potential Technical Issues

According to Under Secretary of Defense for Research and Engineering Michael Griffin, the effect on GPS of the proposed Ligado network would be akin to attempting to listen to the rustling of leaves (the GPS signal) while 100 jet aircraft simultaneously took off (Ligado's potential transmission). Specifically, the FCC authorized Ligado to operate ground-based transmitters that will generate very strong signals or noise near the same frequency range where GPS sends its signals. DOD and some civilian GPS users contend that the level of potential interference would affect not only military applications but also potentially civilian applications, including aviation, agriculture, telecommunications, and finance, among others. To mitigate this potential interference, the FCC authorization requires Ligado to operate a 23 MHz "guard band"—a part of the spectrum designated as a quiet zone to buffer/prevent interference; however, some analysts argue that the size of the guard band is insufficient to prevent inference.

DOD and the FCC disagree about the standard that should be used to determine "harmful interference" to GPS. While the FCC used a "performance-based" standard in assessing and approving the Ligado network, DOD used the International Telecommunication Union (ITU) standard of a 1 decibel (1 dB) increase in noise within the GPS frequency range during its own classified testing in 2016. Using this more restrictive standard, DOD asserts that the Ligado network would cause harmful interference to GPS.

While GPS modernization could potentially offset interference challenges to military systems that could be presented by the Ligado network, it would require that all three segments of GPS (space, ground control, and user equipment) be available to the end users. The modernized GPS receivers equipped with M code are unlikely to be complete before around 2035. Even when available, some legacy military GPS receivers will not be upgraded, therefore potentially adversely affecting their performance.

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