GPS Satellites

The Global Positioning System (GPS) enables users in the air, on land, or at sea to determine their precise location by receiving signals from distant satellites placed into orbit by the U.S. Department of Defense (DoD) more than 30 years ago.

The DoD continues to maintain this constellation of 24 satellites that orbit the Earth in a very predictable way, continuously transmitting signals back to Earth. GPS receivers then process the signals using trilateration and compute precise position, velocity, and timing data that helps guide a wide range of activities.

These include aeronautical navigation and collision avoidance, public safety dispatch and tracking, automotive navigation, precision farming, fleet management, marine navigation and harbor management, building and road construction, timing of business and financial transactions, synchronizing wireless, computing and utility networks as well as a host of other systems upon which millions of us rely every day.

Since the first GPS satellites were launched, the system has become an indispensable and extremely reliable part of our national infrastructure. Billions of dollars in public and private investment in GPS-based technologies and services have produced a steady stream of innovations, making the U.S. the global leader in this technology sector.

The GPS industry continues to innovate at a rapid pace, and the importance of GPS is ever increasing. In recognition of the critical nature and unbounded potential of this technology, the European Union, Russia, China, and India have all committed to deployment of substantial satellite constellations similar to GPS.

Quiet Neighborhood

The Federal Communications Commission (FCC) has historically maintained a “quiet neighborhood” for GPS and other technologies that utilize faint radio signals and sensitive receivers – a spectrum neighborhood populated by similar users.

This same type of policy is applied elsewhere as well. For example, because of the strong interference that would inevitably result, FM radio stations are not placed on adjacent channels to one another in the same city. It should not be surprising, then, that the FCC has traditionally maintained adequate separation between the spectrum used for satellite signals and the spectrum used for high-powered terrestrial signals.

Threats to GPS

While there are numerous potential threats to GPS service, the primary threat posing imminent danger is that of high-power terrestrial signals operating in the spectrum immediately adjacent to GPS. These high-power signals would cause devastating interference to GPS, greatly impeding both its reliability and functionality.

To put it another way, interference occurs when two signals, one faint and one blaring, are placed right next to each other – only the blaring signal is heard. What's more, the term "blaring" actually considerably understates the situation. As astonishing as it might sound, the strength of the signal received from a typical cellular base station is more than a billion times greater than the signal received from a GPS satellite.

Why Such a Difference in Signal Strength?

GPS satellites orbit high above the Earth and use solar panels to generate the electricity needed to send GPS signals back to Earth. The signals are transmitted from the satellite with a power level equivalent to that of a 50 watt light bulb and, after traveling more than 12,000 miles, they arrive on Earth with a signal power of less than one millionth of a billionth of a watt. This necessitates extremely sensitive receivers to track the GPS signal.

Cellular base stations, on the other hand, can transmit at powers measured in kilowatts and can be located within a few tens of meters of an easily overwhelmed receiver. One way to think of this disparity is to consider the amount of light you'd expect to see from a small light bulb located far away while an intense spotlight located just a few feet away is shining directly in your eyes. You would never see the small light bulb until the spotlight was removed from your eyes. The same is true for GPS receivers. Unless there is adequate spectral separation, the high-power terrestrial transmitters completely overwhelm the low-power GPS receivers.

Long-Term Spectrum Policies

Some have contended that GPS receivers should be redesigned to "filter out" these high-powered signals so that "underutilized" spectrum can be repurposed for high-power mobile broadband use.

It is important to note, first of all, that GPS receivers already use state-of-the-art filtering. So the question is not whether receivers should be redesigned to add filters; rather, the question is whether enhanced filters exist that could enable better spectrum utilization without compromising the performance or integrity of a given GPS receiver. With the many different types of GPS receivers that users rely on for various activities, this is a huge question with few easy answers. Fundamentally, though, the lower the spectral separation between high-power transmitters and GPS, the more difficult the filtering problem becomes.

Given the extraordinary success of GPS technology and the many critical commercial and military applications that depend on it, these issues must be considered with utmost caution. Long-term spectrum policies that preserve the "quiet neighborhood" surrounding GPS by repurposing underutilized adjacent spectrum for more compatible, low-power uses would entail far less risk.

Given these risks, it is not surprising that a recent research report commissioned by Google concluded that "vigilance is required to protect GPS spectra and other core investments."

# # #