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GPS Squared

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The Global Positioning System (GPS) has a dominate role in navigation and positioning worldwide. Cars, trucks, and airplanes rely on receipt of GPS signals to confirm where they are and, in many cases, how to get to their destinations. Farmers use GPS to precisely plow their fields, sow their seeds, and fertilize their crops. Hikers and hunters use GPS to avoid getting lost in the wilderness. Perhaps as important, the modern financial system relies on the precise timing signal of GPS to regulate commerce. Credit card purchases and bank transactions utilize the timing signal to keep everything in relative order.

Unfortunately, as many are aware, the signal transmitted by the GPS constellation of satellites is extremely low power. As a result, it is subject to interference, whether accidental or intentional. Instances of temporary, localized interference with the GPS signal are legion. In 2009, the UK General Lighthouse Authorities conducted a test off Flamborough Head in the North Sea. A GPS jammer (illegal, but readily available) was activated. It disabled the ship's installed GPS receiver, which, among other things, caused erroneous AIS signals to be transmitted. It also disabled two handheld GPS receivers that were being tested. It should be noted that the ship's Loran equipment was unaffected.

One of the best documented instances of unintentional GPS jamming occurred in Moss Landing, California during April and May 2001. In early April, mariners in the harbor noted that they were unable to receive GPS signals. Some assumed that their receivers were defective and promptly purchased new ones – but they did not work either. In fact, no one was receiving GPS signals in the vicinity of Moss Landing and up to one mile offshore. It not only affected maritime GPS receivers, but also other electronics that relied on the GPS signal for precise timing. Extensive investigation revealed that the source of the jamming emission was a defective pre-amplifier on a VHF-UHF television antenna that had been installed on a yacht berthed in the harbor. Once that source had been identified and resolved, two more similar situations were discovered. The US Coast Guard issued a Safety Alert strongly recommending that vessels with television antennas installed check to ensure that they were not transmitting errant radio signals.

In January 2007, two US Navy ships in San Diego Bay were conducting a training exercise. To test procedures for when regular radio communications were lost, technicians

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jammed the standard radio frequencies used by the ships. Unknowingly, the jamming also blocked receipt of the GPS signal throughout the local area. Air traffic controllers had difficulty monitoring aircraft. The Coast Guard VTS became inoperative. Emergency pagers used by hospital personnel also quit working. Some mobile phones lost their signals. Local automated teller machines (ATMs) became inoperative. The problems continued for two hours while the Navy ships completed their training exercise. It was only several days later that the full story was discovered. Needless to say, similar exercises are no longer conducted in San Diego Bay.

In 2001, the Department of Transportation's Volpe National Transportation Systems Center in Cambridge, Massachusetts published a report entitled "Vulnerability Assessment of the Transportation Infrastructure relying on the Global Positioning System". It found that reliance on the GPS signal is increasing apace, not only for navigation and positioning, but also for precision timing in critical infrastructure such as the power grid, telecommunications, banking, commerce, and the internet. Due to the low power used in the GPS signal transmission, degradation or jamming of the signal may result from such things as solar flares, electrical storms, or accidental or intentional manmade radio interference. It recommended, among other things, improvements in the signal transmission process, improvements in GPS receivers, and maintenance of an alternative system (such as Loran) for use when GPS is unavailable.

The Volpe report is now ten years old. What has changed? As a cost-saving measure, the federal government recently shut down the Loran system, eliminating the sole electronic backup to GPS (but we still have our sextants). The cost of illegal GPS jammers and spoofers has decreased, while their availability has increased. Finally, the radio spectrum has become more crowded, making accidental radio frequency interference with the GPS signal more probable.

Internet service is widespread. Originally, users relied on wires (telephone landlines, television coaxial cables, etc.) for such service. Then, wireless internet via routers and local hotspots became the avenue of choice. Everyone now demands high-speed (broadband) internet access. The latest development in this regard in national wireless internet access.

A company named LightSquared has proposed the combined operation of a mobile satellite service (MSS) and a ground-based wireless communications network to provide a nationwide wireless high-speed internet system. The ground-based system would consist of approximately 40,000 base stations using the same "L-Band" radio spectrum as the satellites. It promises to bring high-speed internet service to all parts of the country, particularly rural and remote areas that are now off the wireless internet grid. There is a downside though. The frequency spectrum that LightSquared intends to use is directly adjacent to that currently used by GPS. The Federal Communications Commission (FCC) has authorized LightSquared as a MSS to utilize the 1525-1559 MHz band for downlink purposes and the 1626.6-1660.5 MHz band for uplink purposes. The spectrum allocation for GPS is 1560-1610 MHz.

The L-Band frequency spectrum (basically 1000-2000 MHz) has been historically reserved for low power communications between satellites and mobile earth stations. In addition

to GPS, the spectrum is utilized by Galileo, GLONASS, COSPAS-SARSAT, GSM mobile phones, Iridium, and Inmarsat, among others. In recent years, the FCC has authorized terrestrial transmissions in the L-Band as Ancillary Terrestrial Component (ATC) transmissions, intended to fill in gaps in the coverage of satellite signals and for terrestrial communications between satellite equipment. That was the basis on which the FCC originally approved use of a portion of the L-Band spectrum by LightSquared (previously named SkyTerra). Gradually, though, the LightSquared business plan moved more toward the ground-based portion of the project and placed less reliance on the MSS use. Up until now, the FCC has largely acquiesced in this evolution.

One of the problems highlighted by this controversy is the conflicting interests of the FCC. On the one hand, the agency is tasked with protecting the integrity of the radio frequency spectrum. On the other hand, it is tasked with maximizing revenues accruing to the federal government through auctioning portions of the radio frequency spectrum to commercial users. LightSquared and other commercial entities are willing to pay (and have paid) significant monies for licenses allowing use of a portion of the spectrum now lying fallow, just across the fence from that portion reserved (gratis) for GPS and similar services. The FCC is also charged with increasing the availability of broadband internet access. This situation reminds one of the schizophrenia within the old Minerals Management Service (MMS), at that time charged with both regulating the oil and gas industry and collecting revenues therefrom.

The Space-Based Positioning, Navigation & Timing National Executive Committee, a federal interagency organization, and the Department of Defense (DOD) coordinated two tests to assess the impacts of LightSquared terrestrial transmissions on GPS signals. The first test was conducted at White Sands Missile Range on April 4-7, 2011. The second test was conducted at Holloman Air Force Base on April 14-17, 2011. The tests were open to all federal agencies and various private sector stakeholders. The Federal Aviation Administration (FAA) found that all of its tested receivers lost GPS solution. The US Coast Guard found that its coastal dGPS service was impacted. NASA reported that all high-precision receivers for science were impacted. The National Geodetic Survey reported that its receivers lost GPS solution. John Deere Company reported that its receivers, used for precision farming, were also impaired.

Apparently anticipating difficulty in obtaining final approval from the FCC for its use of that portion of the L-Band spectrum adjacent to the GPA portion, LightSquared announced recently that it will utilize another part of the spectrum that it asserts will virtually eliminate interference with GPS signals. It also proposes to reduce the maximum authorized power of its base-station transmitters by more than 50%. LightSquared, though, is not surrendering its claim to later utilize its previously-proposed L-band transmissions. In its communications with the FCC, LightSquared also stressed the need for precision GPS receiver manufacturers to cooperate with LightSquared to produce solutions that would enable the coexistence of LightSquared's proposed LTE broadband network and precision GPS receivers that are designed to "listen" across the MSS L-band. The matter is now in the hands of the FCC to rule on the modified LightSquared license application. As of the date of this writing, 370 comments have been

submitted to the FCC docket for LightSquared's application (number 11-109) and it is difficult to find any comment that is not in opposition.

The positioning, navigation, and timing functions of GPS have become highly ingrained into the economy of the United States and the world. It is difficult to justify the business plan of LightSquared if that plan would adversely impact the Global Positioning System. In accordance with current FCC regulations, LightSquared should be required to limit its use of terrestrial transmissions to those that are ancillary to its satellite transmissions and to clearly demonstrate that its proposal would not have an adverse effect on established uses of GPS before the FCC moves forward on consideration of its license application.