

# Mitigation Efforts to Respond to Known GPS Vulnerabilities

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July 19, 2021

Tonight's training is a followup to our previous discussion of the vulnerabilities of the Global Positioning System (GPS) to atmospheric conditions and to malicious spoofing or jamming. We discussed problems arising from the very low power of GPS satellite transmissions and the unprotected nature of their signal.

These vulnerabilities are not new discoveries. They have been known for decades. In the earlier training we learned of the exploitation of these problems to capture both US Naval assets and commercial container ships.

What can be done to mitigate interference with existing GPS systems?

Present efforts to strengthen reliability of the GPS system are focused on three distinct areas:

Improving GPS Receiver technology to resist spoofing and jamming

Upgrading GPS system transmission capability with new Low Earth Orbit satellites, and

Augmenting existing GPS systems through Inertial Navigation technologies

**Improving GPS receiver technology** is an entire field of endeavor in itself. The Department of Defense and the US Space Force are utilizing multiple DOD contractors, including BAE Systems and Spirent Federal Systems, to design and build new GPS receivers capable of verifying genuine GPS signals from false (or spoofed) signals and also to suppress known attempts to interfere (or jam) genuine GPS signals.

Interestingly, as in much of radio technology, we can trace current concepts being pursued in this effort back many years to innovators who might truly be called the founding fathers of radio. In this case, an idea put forth by a Hungarian mathematician, Alfred Haar, in 1909, forms the basis for today's research into improving GPS receiving devices. He hypothesized the concept of Wavelets.

Despite reading and re-reading several articles on the topic, I cannot define them for you. However, wavelet analysis is used by the Federal Bureau of Investigation to compress digital versions of fingerprint images and is foundational to the efforts of BAE and Spirent to develop GPS receivers capable of identifying and suppressing jamming signals so that genuine GPS signals may be received.

**Upgrading GPS system transmission capability** is being tested using LOE, or Low Earth Orbit, satellites. From their position much closer to the earth these tiny satellites can transmit GPS signals toward earth at many magnitudes of the power of current GPS satellites, thus overcoming earthbound signal jamming.

These new LOE constellations offer much more redundancy in signal reliability simply because there will be many more of them in the sky at any point in time. A drawback, however, is that they are traveling at much higher velocity relative to earth and will be visible a much shorter time over any particular spot. Improvement in GPS receivers to hand off seamlessly from one to another of these LOE satellites is required.

Lastly, **augmenting existing GPS systems** is a primary focus of many private sector and defense contractors. Inertial Navigation technologies are centuries old, but still being improved upon today. Gyroscopes, accelerometers, barometric altimeters, magnetometers and the good old compass are now so miniaturized that they are all in your smart phone. By combining these sensors with GPS signal data it may become possible to “fill in the gaps” or “verify on the fly” the veracity of GPS signals that are being spoofed or jammed.

My interest in GPS issues is growing as I do more research. Consider this: on June 17, 2021, just over a month ago, a Falcon 9 rocket launched from Cape Canaveral, Florida, carrying a new 5,000 pound GPS satellite 20,000 kilometers high into MEO, or medium earth orbit. This will upgrade the Department of Defense satellite system to Initial Operation Capability for its new M-Code GPS system. Perhaps in the very near future our brave men and women in the armed services will have one less thing to worry about.

This concludes tonight’s training. This is KI5HHI, back to net control.

\*Special thanks to Mr. Richard Langley of GPS World magazine for his information and insights into GPS jamming mitigation. Also to BAE Systems Austin and to Spirent Federal Systems, both are DOD contractors also working to improve civilian GPS systems.