GPS DEFENSE APLICATIONS AND PROTECTION OF PRECISE POINT POSITIONING

Omnetics Connector Corporation

Bob Stanton - Director of Technology

Advanced GPS systems have opened the world with exciting and exacting new technologies ranging from global surveying and reconnaissance to remote guidance and positioning of unmanned systems. Packages are being delivered by autonomous delivery devices, drones are used to monitor nuclear plants and active battlefields are in constant surveillance from above. Civilian navigation has entered our highways and sea-lanes. GPS systems also support our military, airspace and individual soldiers in the field with personal monitoring, and remote control of weapons that may be miles from away.

The constant evolution from multiple nations is deploying GNSS offerings, modernized geological navigation and time information that has filled the skies with satellites. We are seeing additions from BeiDo, Galileo, Glosnoss, Michibiki, and NavIC among others. Each year a new constellation is being added and will begin sending millions of transmission and reception signals to and from earth.

Position accuracy begins with placing each satellite in orbit and keeping it in correct attitude with earth. BCT Star Trackers are often used to establish reference positioning of the GPS satellites within the constellation. GPS basic transmission frequencies are being saturated as we invent new signal pulse methods and signal modulation formats to isolate and separate signals for their individual purpose. GPS level one, transmits at 1.57 GHz separately from level 2 operating at 1.23GHz and higher rate transmissions are using PRS (pseudo random sequencing) to transmit additional data with minimum interruptions. In addition to the standard frequency levels, an international commission has added specialty signal frequencies for Levels 3 and level 4 that are reserved for critical factors, such as Nuclear detection and NASA route and mapping of satellites. Level 5 has been added for transmitting pulsed data regarding critical safety and life support information internationally.

Beyond position and navigation data, tracking devices are dependent upon exact time information from atomic clocks on-board satellites and are coordinated with companion satellites to increase accuracy. By using real-time positioning, accuracy of devices on earth is significantly improved. The new GPGPS (carrier phased GPS) positioning method includes measuring satellite signals phase-angle to reduce signal-time-delay issues. Geospatial distancing and position relations have improved dramatically.

As our atmosphere is becoming saturated with GPS type signaling, we see a serious era of potential signal and noise management challenges. Many GPS systems depend upon coordinating PTD (positioning and timing data) from four satellites prior to sending the final data signals to GPS Receivers on earth. Receivers and trackers on earth must separate the signal from the noise as well as respond to data modulated on the carrier signal.

Gray Eagle Armed UAV

Basic EMI (electro-motive-interference) and jamming, whether directed or random, can also occur. Circuitry and signal receivers must be well designed to protect and isolate the intelligent data from random electronic and electromagnetic interference.

Defense systems are highly dependent on reliability and use discrete signaling that cannot be jammed or monitored by unauthorized systems. Transmission frequencies with specific modulation formats like MGUE (Military GPS user Equipment) and M-codes are examples of device standards employed to support coordination of new defense products.

To meet and upgrade satellites, the design and fabrication of military transmitters and receivers on space and on earth-based equipment, are continuing to adapt improved material specifications and electrical circuitry. Satellite control and monitoring of autonomous weapons and surveillance devices has changed significantly. Device signal speed and data volume are escalating rapidly. Products waiting on land or loitering in space are exposed to more extreme elements than those mounted inside ground based equipment. Metal shells, and military specification plating and ruggedized connectors protect the systems physically.

In addition to environmental and physical effects, new electronics must be used within the potentially noisy environment. Frequency filtering and shielded insulation systems are used to isolate and bleed-off unwanted frequencies that may ingress the operating system. Multiple layers of foil-wrapping over critical cable wiring are connected to a shield or ground plane to collect and drain renegade noise from running up and down the wiring inside the device.

Metal connectors and backshells offer a 360-degree metal sealing to machine-braided cable that can be plated and isolate outside frequencies to over 90% efficiency.

Defense Field-Com. Padx

This reduces the possibility of the cable becoming an antenna that radiates and or receives unwanted electrical noise or jamming frequencies.

Unique frequency modulation signaling, such as PGM (precision guided munitions) is being added to insure safety and control of autonomous defense munitions. Filtered connectors and specially designed cable are helping to protect signal integrity as signal speed increases and modulation becomes more detailed.

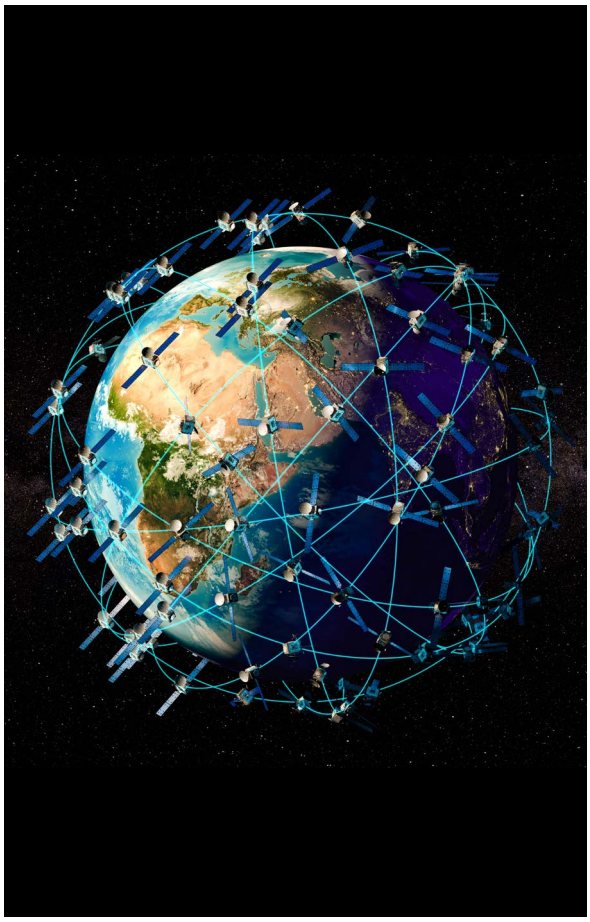
Ground troop position management and tracking requirements have greatly increased to support recent dismounted soldier activities in recent battlefields. New MIMS (micro-electronic-mechanical system) chips are being added provide inertial analysis to the positioning and tracking data. Monitoring field pads receive specially filtered signals that can include geospatial and hazard mapping to plan their attack. The soldiers can control hand launched drones and capture UAV images while remaining out of harm's way. On the same field-pads, strategic communications are sent to and from the battle-management center via the same satellite. Somewhat larger but significantly advanced airborne systems are being used, such as the LN-251 navigation system, that supports real-time kinematic data that can be phase-shifted data, can include high-speed accuracy of airborne inertial data through the GPS transmission and include anti-spoofing electronics.

A key to future battlefield is in serving the complex mix of many positioning, travel speeds, data mapping and analysis simultaneously from satellites, to command centers. Information must be flowing to and from field troops, autonomous weapons, airborne munitions and even ship positions that are far out of

immediate range at sea.

GPS designers are being challenged with a universe of great application opportunities. New satellite constellations are employing advanced beacon and star coordination technologies that are serving us well. The challenge for our future appears to be handling massive data transmission, simultaneously, and avoiding jamming and or redirecting our communications to and from the LEO and MEO based satellites in the sky.

As the number of constellations increases our atmosphere will be filled with signals, electromagnetic noise, pulsed modulation and even laser based signaling. Satellites will need to talk to each other as well as with earth. High speed signal coding, transmission formats and noise immunity will be needed.



GPS designers are realizing and adapting to the many advanced positioning and sensor technologies required.

Electrical circuitry used in both transmitters and receivers are handling volumes of high-speed digital information and finding electrical solutions in managing EMI, Signal Noise, Jamming and other interference issues. Specialty shielding, filtering and pulsed modulation techniques have become a key element in protecting and isolating GPS in today's crowded world.