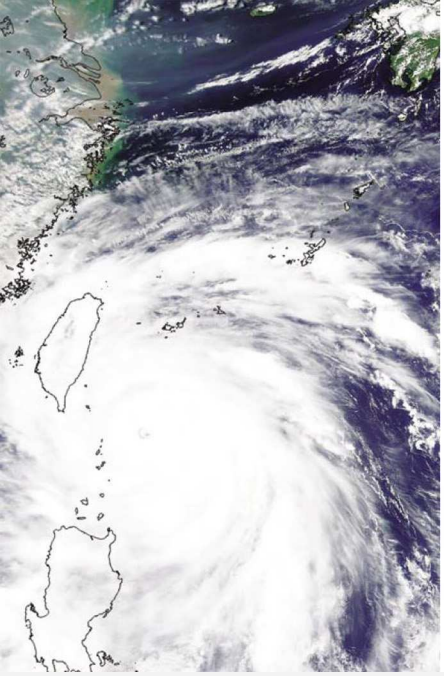

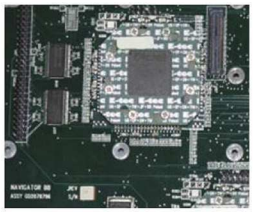

National Aeronautics and
Space Administration

Sensors

The Navigator GPS Receiver

A GPS navigation system built for high Earth orbits

Until now, Global Positioning System (GPS) receivers, while providing an accurate and inexpensive means of navigation, have been limited to low Earth orbit (LEO) missions. This innovative new receiver technology developed by NASA Goddard Space Flight Center is a leap forward for GPS technology. The Navigator is an autonomous, real-time, fully space-flight-qualified GPS receiver with exceptional capabilities for fast signal acquisition and weak signal tracking. These features enable the use of GPS navigation in high Earth orbit (HEO), geostationary orbit (GEO), and other high altitude applications. The Navigator receiver can quickly and reliably acquire and track GPS signals at 25 dB-Hz and lower.

Because GPS signals at altitudes above the GPS constellation are 10 to 100 times weaker and less densely populated, GPS receivers have not been feasible for use above LEO. The Navigator is a radiation-hardened GPS receiver specifically designed for use in high Earth orbits. It is capable of significantly faster acquisition times and tracking for both strong and weak signals. It requires no external data, and its fast acquisition enables it to be powered down in any orbit until needed.

BENEFITS

- Enables GPS in high Earth orbit: Because it can acquire and track even very weak signals and requires no external data, the Navigator receiver enables use of GPS in HEO, GEO, and other high altitude uses
- Acquires signals faster: By employing efficient Fast Fourier Transform (FFT) algorithms and Field Programmable Gate Arrays (FPGA) to implement a massively parallel search, even weak signals can be acquired thousands of times faster than in traditional searches
- Operates autonomously: With the exception of GPS signals, the receiver requires no external data for operation
- Is robust and reliable: The radiation-hardened receiver can reliably operate in the harsh environment of space
- Improves Use for LEO: When used in LEO, the receivers fast acquisition rate eliminates the approximately 20-minute cold start delay time, acquiring GPS signals in only seconds

technology solution

THE TECHNOLOGY

To enable it to acquire GPS signals very quickly and also track weak signals, the radiation-hardened Navigator receiver utilizes a bank of hardware correlators, a ColdFire microprocessor, and a specialized fast acquisition module (see figure 1). The hardware is implemented in VHSIC Hardware Description Language (VHDL) to target radiation-hardened Field Programmable Gate Arrays (FPGA) rather than Application-Specific Integrated Circuits (ASIC), in order to maintain flexibility for growth and design modifications.

The Navigator was designed to operate autonomously to enable the use of GPS for onboard navigation in high altitude space missions. With the exception of GPS signals, Navigator requires no external data (e.g., current time estimate, recent GPS almanac, or converged navigation filter estimate of the receiver dynamics).

By double buffering data up front in 1ms blocks, data can be processed as it is acquired. A discrete Fourier transform (DFT) is used to calculate the 1ms correlations, significantly reducing computing time. Computational efficiency is optimized and tradeoffs among sampling rate, data format, and data-path bit rate are carefully weighed in order to increase performance of the algorithm.

In addition, the Navigators hardware-independent receiver software includes both a hardware interface to perform low-level functions as well as basic navigation. Onboard orbit determination and accurate state estimation/propagation during periods with no GPS access are accomplished by integration with the GPS Enhanced Onboard Navigation System (GEONS).

Exploiting the properties of Fourier transform in a massively parallel search for the GSP signal, the Navigator has been tested and proven capable of acquiring signals at 25dB-Hz and below.

APPLICATIONS

The technology has several potential applications:

- High Altitude Spacecraft (e.g., Geostationary Operational Environmental Satellite (GOES), Magneto Multiscale Science (MMS), other geostationary orbit (GEO) satellites)
- Low Earth Orbit spacecraft (offers enhanced GPS navigation via Navigators fast-acquisition capability)

PUBLICATIONS

Patent No: 7,548,199

More Information

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NP-2015-04-1659-HQ

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GSC-14793-1
GSC-TOPS-67