

AFRL

NAVIGATION TECHNOLOGY SATELLITE - 3 (NTS-3) PROGRAM

The U.S. Air Force's Global Positioning System (GPS) constellation was created to provide unprecedented position and timing accuracy to the warfighter and has since become a staple of the global economy. Air traffic control, ATM machines, Wall Street, search-and-rescue crews, and cell phones all depend on uninterrupted GPS coverage. At the same time, the space domain is becoming increasingly contested by foreign actors. NTS-3 will push the boundary of today's position, navigation, and timing (PNT) technology to meet the technical challenges of tomorrow in this new environment.

AFRL's PNT Frontier

PNT is a key mission area for the Air Force Research Laboratory (AFRL) in New Mexico. Together with industry, we are developing advanced techniques and technologies to detect and mitigate interference to PNT



Artist's concept for NTS-3 in geostationary orbit. Harris Corporation will integrate NTS-3 using Northrop Grumman's ESPASat bus, building on EAGLE's flight heritage. Graphic Credit: 2d Lt Jacob Lutz, AFRL/RV

capabilities and increasing satellite navigation system resiliency for military, civil, and commercial users. As a unique testbed in geostationary orbit, NTS-3 will enable experimentation with multiple integrated advanced technologies and development of new concepts of operations. These include experimental antennas, flexible and secure signals, increased automation, and use of commercial assets. Technologies matured and knowledge gained from NTS-3 are expected to transition to future generations of GPS and potential augmentations to national PNT capabilities.

Giving PNT Signals a Suit of Armor

NTS-3 will experiment with a new digital signal generator that can be reprogrammed on-orbit, enabling it to broadcast new signals, improve performance by avoiding and defeating interference, and adding signatures to counter spoofing. AFRL will explore phased array antenna configurations to provide Earth coverage and steerable regional beams in multiple frequencies and signal codes. These technologies advance signal availability and utility for terrestrial and space users.

"Bounce-Back" Capabilities

The space environment poses a persistent challenge to our on-orbit capabilities. Orbits degrade, the Van Allen belts bathe spacecraft with radiation, and solar flares affect the ionosphere. Multiple nations compete for dominance in space.

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Therefore, ensuring PNT signals can be maintained through interruption or interference is crucial to system operability and availability.

Specific improvements to the ground segment will enable experimentation with automated “lights-out” operations and near-real time environment sensing and generation of error correction and tailored waveforms. On-board systems will monitor signal integrity, clock accuracy, and orbit parameters to mitigate errors and notify the user.

Planned resilience experiments emphasize maintaining accurate timing and position knowledge following loss of contact with ground control, maintaining user position accuracy following satellite maneuvers, and detection and correction of a timing or signal anomaly. Resilience will be enabled in part by the improvement of on-board signal integrity detection and user notification. Data collected throughout on-orbit operations will inform the design of next-generation PNT satellites.

A New Era in Ground Control

The NTS-3 ground control system is compatible with the Enterprise Ground Services (EGS) architecture. Once fully established, EGS will not only save the Air Force millions of dollars by streamlining user training and operations, it will leverage big data and facilitate easier data sharing, situational awareness, and collaboration. This allows old data and platforms to be used for new purposes. NTS-3 is designed to work with both EGS and legacy ground system elements, while exploring the capability to incorporate commercial ground sites. The result will be a multi-user (DoD, civil, academic, and commercial), multi-mission platform that will help set the standard for space system architectures moving forward.

A User-Friendly Experience

In the field, good equipment can save time and lives. The NTS-3 program is developing software-defined GPS receivers that can rapidly respond to changing conditions. Like the on-orbit signal generator, the receivers are reprogrammable, increasing security and flexibility. NTS-3 will pave the way for a new generation of GPS receivers. They will readily adapt to warfighter needs and incorporate signals from the Galileo, GLONASS, and Beidou constellations.

The Long Line of Navigation Technology

- NTS-1 launched in 1974 with new standards that advanced timing and navigation precision
- NTS-2 launched in 1977 as the first NAVSTAR GPS Phase 1 satellite
- Launch of NTS-3 is anticipated in 2022, the first experimental PNT spacecraft in over 40 years



NTS-1, NTS-2, and NTS-3. Graphic Credit: 2d Lt Jacob Lutz, AFRL/RV

