

# Global Positioning System (GPS) Enterprise



As reported over the course of several years, ongoing development delays of the Next Generation Operational Control System (OCX) are continuing to delay full operational control of the U.S. Space Force's GPS modernized civil, Military Code (M-code), and navigation warfare functions and the fielding of operationally acceptable M-code capable receivers. These delays increase risk that U.S. and allied warfighters will be unable to conduct successful operations in future contested environments due to the lack of access to modernized GPS position, navigation, and timing (PNT) information.

## SYSTEM DESCRIPTION

The GPS Enterprise is a Space Force operated satellite-based global radio navigation system of systems that provides accurate and secure PNT information to users worldwide. It consists of three operational segments: space, control, and military user equipment. The space segment includes 31 operational satellites in the GPS constellation that transmit both civilian and encrypted military signals to users. The control segment (primary and alternate sites) operates the GPS constellation; supports launches, anomaly resolution, and disposal operations; and tasks navigation warfare effects in support of combatant commands. The user segment includes the Military GPS User Equipment (MGUE) intended to modernize military GPS receivers, including the ability to receive and use M-code. Beyond military GPS users, there are billions of daily civilian users freely using the civilian signal, including many federal agencies within the U.S. Department of Transportation (DOT) and other various state and tribal agencies.

## MISSION

GPS provides PNT information globally to military and civilian users, allowing them to conduct a wide variety of missions. GPS military receivers allow military commanders to navigate and maneuver within strategic, operational, and tactical theaters.



MGUE Increment 1 receivers will allow military users to access the more secure M-code signal, which is currently available for developmental and user equipment testing over the continental United States. MGUE Increment 2 receivers will include the ability to use Regional Military Protection, which will concentrate higher M-code signal power broadcast by GPS III Follow-On Production (GPS IIIF) satellites in a targeted region to ensure the warfighter has continued access to PNT data in contested environments.

## PROGRAM

The GPS Enterprise consists of multiple programs pursuing separate acquisition paths to advance the space, control, and user segments.

- GPS III Satellite – An Acquisition Category (ACAT) IC program which achieved Milestone C (MS C) in January

2011. The last of the GPS III satellites, Space Vehicle 10, was made available for launch in December 2022. To date, the Space Force has successfully launched six GPS III satellites since 2018 and plans to launch the seventh satellite in FY24, the eighth in FY25, and the last two GPS III launches in FY26.

- GPS IIIF Satellite – An ACAT IB program. These satellites will provide enhanced Regional Military Protection signals and support for search and rescue services. The Air Force made the GPS IIIF MS C decision in July 2020 following completion of the program's Critical Design Review. The Space Force plans to launch the first GPS IIIF satellite in FY27.
- Operational Control System (OCS) Architecture Evolution Plan (AEP) – The Air Force fielded OCS AEP in 2007. It features two ACAT III upgrades: M-code Early Use (MCEU) and Contingency Operations



(COPs). These upgrades allow the system to command and control GPS III satellites and provide core M-code capability from the existing GPS constellation while maintaining previous civilian and military services from older, non-M-code GPS IIR satellites.

- OCX – An ACAT ID program awarded in February 2010 with an initial expected completion date of early 2016. OCX achieved MS B in June 2017 and was relieved of MS C requirements. OCX will provide full control of modernized civil and M-code signals and navigation of warfare functions. OCX will replace OCS AEP following a successful constellation transfer that the Space Force currently plans in March 2025, a delay of 16 months from last year's Annual Report. This 16-month delay is in addition to last year's reporting of a 9-month delay from the FY21 Annual Report. The Space Force plans to operationally accept OCX in July 2025.
- OCX 3F – A tailored ACAT II program that builds on the software delivered by OCX. Contingent on successful OCX deployment, the subsequent OCX Block 3F upgrade will allow OCX to support launch as well as command and control GPS IIR satellites. The Space Force anticipates delivery from the vendor in FY25 and plans to operationally accept OCX 3F in FY27. Since OCX 3F builds on the software delivered by OCX, corresponding schedule slips to OCX affect operational acceptance and reduce any remaining margin in the OCX 3F delivery schedule.
- MGUE Increment 1 – An ACAT IC program that achieved MS B in January 2017 and was relieved of MS C requirements. The program was designed

to deliver personnel- and vehicle-based M-code receivers to the warfighter, including improved GPS signal availability in degraded threat environments. Due to program delays resulting in Application-Specific Integrated Circuit (ASIC) obsolescence and limited production, the Army and Marine Corps will not field their respective MGUE lead platforms (Joint Light Tactical Vehicle and Stryker) with the ground-based MGUE Increment 1 receiver cards. Instead, the Army and Marine Corps plan to use commercially available, MGUE-derived M-code receivers for their ground-based platforms. The commercially derived M-code receivers will undergo user evaluations in fielded platforms outside of the MGUE Increment 1 program of record. The MGUE Increment 1 program delivered an interim functional aviation/maritime receiver card in September 2022. Despite the delivery of subsequent builds, delays continue with both software and hardware builds by MGUE Increment 1 vendors, which impact the operational test schedules for the two remaining MGUE Increment 1 lead platforms (the B-2 aircraft and the *Arleigh Burke*-class destroyer). The B-2 aircraft with this capability is currently scheduled for operational testing in late FY24/early FY25, and the *Arleigh Burke*-class destroyer is scheduled for operational testing in July – August 2025.



- MGUE Increment 2 – The program is structured as two Middle Tier of Acquisition rapid prototyping efforts. The first is the Miniaturized Serial Interface receiver with next-generation ASICs that will deliver improved jam resistance, address MGUE Increment 1 ASIC hardware obsolescence, support the enhanced Regional Military Protection offered by GPS IIIF satellites, and support low-power applications (e.g., guided munitions). The second is the handheld receiver, which will incorporate the Miniaturized Serial Interface receiver with the prototype unit planned for FY27 availability. The Miniaturized Serial Interface development continues to experience challenges, and the handheld unit has technical challenges meeting battery life requirements.

DOT&E approved the GPS Enterprise Test and Evaluation Master Plan (E-TEMP) Revision C in August 2021. The Space Force continues to revise the GPS E-TEMP to update threat requirements, address cyber testing, and define the test strategies for OCX, MGUE Increments 1 and 2, Nuclear Detonation Detection System control system upgrades, GPS IIIF satellites, and OCX Block 3F. DOT&E approved TEMP annexes in February 2023 for the GPS IIIF and OCX 3F programs.



## » MAJOR CONTRACTORS

### Space Segment

- Lockheed Martin Space – Denver, Colorado (GPS III / IIIF satellites)

### Control Segment

- Lockheed Martin Space – Denver, Colorado (OCS AEP)
- Raytheon, a subsidiary of RTX (formerly Raytheon Technologies) – Aurora, Colorado (OCX)
- Raytheon, a subsidiary of RTX (formerly Raytheon Technologies) – Aurora, Colorado (OCX 3F)

### User Segment (MGUE Increment 1 and 2)

MGUE Increment 1 and 2:

- L3Harris Technologies, Inc. – Anaheim, California
- Raytheon, a subsidiary of RTX (formerly Raytheon Technologies) – El Segundo, California

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- BAE Systems – Cedar Rapids, Iowa

MGUE Increment 2 Handheld Device:

- Technology Advancement Group – Ashburn, Virginia
- Raytheon, a subsidiary of RTX (formerly Raytheon Technologies) – El Segundo, California
- BAE Systems – Cedar Rapids, Iowa

## TEST ADEQUACY

No operational testing was conducted in FY23 across the GPS Enterprise. The OCX cyber assessment that was scheduled for August 2023 has now been delayed until 4QFY24. The GPS Enterprise IOT&E that had been scheduled to commence in 4QFY23 has now been delayed until FY26.



DOT&E worked with the MGUE Increment 1 Program Office to address concerns identified in the FY22 Annual Report. The program office scheduled and conducted additional suitability testing to verify its updated software corrected encryption key concerns identified during the Joint Light Tactical Vehicle Field User Evaluation in August 2021. After reviewing the data from the evaluation, DOT&E concurs that the program office corrected the problem.

The current MGUE Increment 2 handheld operational test schedule does not align with the GPS IIIF launch strategy. The GPS IIIF family of satellites delivers a Regional Military Protection capability that the MGUE Increment 2 handheld provides to military units. Without GPS IIIF satellites on orbit, operational testers will not be able to verify that the MGUE Increment 2 handheld can take advantage of Regional Military Protection signals in a contested environment.

Currently, M-code is only available within the continental United States. While this is sufficient for initial testing, U.S. and allied forces are only able to test M-code outside of the United States by exception. The United States Space Command is developing a plan to transition military users to M-code as receivers are fielded.

The DOT and the Federal Aviation Administration have responsibilities for testing civilian GPS-based PNT systems outlined in the Federal Radionavigation Plan. OCX Transition office is incorporating DOT's request to

test OCX with a four GPS satellite "mini constellation" as a part of the formal constellation transition dress rehearsal. This is a key event, planned for FY25 ahead of full operational testing, to build confidence that OCX will support safe and effective commercial air transportation within the continental United States.

## PERFORMANCE

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### » EFFECTIVENESS

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Based on previous operational testing, the current OCS AEP control segment is operationally effective for legacy military signals, legacy civil signals, and M-code signals. GPS operators can command and control all GPS satellites except for the future GPS IIIF satellites. OCS AEP received the Contingency Operations upgrade to command and control the newer GPS III satellites. OCX requires the OCX 3F software upgrade to conduct launch and check out of the GPS IIIF satellites. The Space Force plans to operationally accept OCX in FY25 and OCX 3F in FY27, but the first GPS IIIF satellite is also expected to launch in FY27. Any additional delays of OCX 3F will likely impact the launch of the first GPS IIIF satellite.

Contractor system testing of OCX has been on-going since October 2022, with major delays caused by unstable mission control software, mission simulator, and training systems. Software delays and overall program schedule slips have been mainly

due to inadequate contractor testing, incomplete functional integration between various software components, and a lack of Agile coding experience by the contractor during development. The OCX Program Office is working to address these concerns with the contractor in future software deliveries. Space Systems Command leadership has engaged the vendor's senior leadership about the seriousness of these delays.

The MGUE Increment 1 aviation/maritime receiver card experienced software challenges that resulted in delays that the Space Force worked to address. The program is maintaining the current schedule to complete the final program milestone, B-2 Program Executive Officer Certification, in October 2024.

### » SUITABILITY

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From previous operational test reporting, both GPS III satellites and the OCS AEP command and control system are operationally suitable.

Ongoing OCX contractor and development testing continues to reveal software instability and sustainment concerns with operator training and maintenance technical orders that the program office is working to address. Previous DOT&E Annual Reports noted concerns with the OCX simulator, which the program office has addressed in software updates.

The OCX 3F's first critical capability release adds launch and checkout

capabilities to support the launch of GPS IIIF satellites. Delays to OCX, and consequentially OCX 3F, may put the GPS constellation at risk since OCS AEP will not be able to launch or command and control new GPS IIIF satellites to replenish older satellites as they exceed their service life.

Due to delays with the program, the MGUE Increment 2 Program Office does not have a customer for the MGUE Increment 2 handheld unit. Since operational testing would involve assessing a military unit's ability to carry out their mission using the handheld device, the current lack of a buyer complicates the development of an operational test plan.

## » SURVIVABILITY

As part of the recommendations from the 2016 Nunn-McCurdy program breach for OCX, the Air Force implemented additional cyber survivability improvements to OCS AEP due to the expected delay in OCX delivery. Due to these cyber improvements and ongoing further delays to OCX, the current instantiation of OCS AEP may now be more cyber secure than the initial delivery of the OCX system that will eventually replace it. DOT&E plans on performing a cyber survivability comparison and report between OCS AEP and OCX before the U.S. Space Command approves the transfer of the GPS constellation from OCS AEP to OCX in March 2025.

In last year's Annual Report, DOT&E recommended that the Space Force conduct a no-notice transfer of operations from the primary

OCX control station at Schriever Space Force Base, Colorado, to the backup at Vandenberg Space Force Base, California. Subsequently, the 2d Space Operations Squadron Commander initiated a no-notice transfer in April 2023 on OCS AEP and is following up on lessons learned from the event. Also mentioned in last year's Annual Report, the GPS IIIF Program Office continues to examine space threats to evaluate the survivability of the latest generation of satellites in a contested space environment.

## RECOMMENDATIONS

The Space Force should:

1. Synchronize the GPS IIIF and MGUE Increment 2 handheld programs to provide a realistic environment for fully testing all capabilities.
2. Work with the Services to identify a military unit to operationally use the MGUE Increment 2 handheld who can also support operational testing.
3. Discuss with Air Force senior leaders the mission impacts of fielding MGUE Increment 1 receiver technology that could affect B-2 mission effectiveness and ensure thorough testing of version 7.0 of the MGUE Increment 1 software.
4. Support an operational cyber assessment to compare OCS AEP and OCX cyber survivability scheduled in FY25.
5. Conduct a no-notice transfer of operations from the primary OCX control station at Schriever Space Force Base to the backup at Vandenberg Space Force Base.
6. Adequately address kinetic, cyber, electromagnetic spectrum, nuclear, and directed energy threats in future test plans.