

Global Positioning System (GPS) Enterprise



Ongoing development delays of the Next Generation Operational Control System (OCX) and the Military-Code (M-code) GPS User Equipment (MGUE) program schedules are continuing to delay the U.S. Space Force's GPS-modernized civil, M-code, and navigation warfare functions and the fielding of operationally acceptable M-code-capable receivers. These delays put U.S. and allied warfighters at risk of a lack of access to modernized GPS position, navigation, and timing (PNT) capabilities to support operations.

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 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 signals, including many federal agencies within the U.S. Department of Transportation (DOT) and other various state and tribal agencies.

MISSION

Military and civilian users across the globe use GPS to access PNT information that allows 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 now available across the globe for developmental and user equipment testing. MGUE Increment 2 receivers will include the ability to use Regional Military Protection (RMP), 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.

OCX will provide full M-code and modernized civil signal operations, including: a more accurate Kalman filter to calculate satellite orbits, increased PNT monitoring capabilities, more robust and sophisticated cyber defense capabilities, and additional support to civil signals.

PROGRAM

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

- GPS III Satellite – An ACAT IB program. These satellites will provide enhanced RMP 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 3QFY27 and operationally accept it in 2QFY28.
- Operational Control System (OCS) Architecture Evolution Plan (AEP) – The Air Force fielded OCS AEP in 2007. It features two ACAT III upgrades: Contingency Operations (COps) and M-code Early Use. These upgrades allow the system to command and control (C2) GPS III satellites and provide core M-code capability from the existing GPS constellation while maintaining previous civilian and military services.
- 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 4QFY25 with operational acceptance in 1QFY26.
- OCX 3F – A tailored ACAT II program that builds on the software delivered by OCX.
- 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. Since 2018, the Space Force has successfully launched six GPS III satellites and plans to launch the remaining four satellites between FY25 and FY26.

Contingent on successful OCX deployment, the subsequent OCX Block 3F upgrade will allow OCX to support launch as well as C2 GPS IIIF satellites. The Space Force anticipates delivery from the vendor in FY27 and plans to operationally accept OCX 3F in FY28. 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 (i.e. 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. As reported in the FY23 Annual Report, delays continue with both software and hardware builds by MGUE Increment 1 vendors due to multiple open deficiencies. These delays impacted the planned operational test schedules for the two remaining MGUE Increment 1 lead platforms (i.e., the B-2 aircraft and the *Arleigh Burke*-class destroyer). The test schedule of both the B-2 aircraft and the *Arleigh Burke*-class destroyer is unknown, pending investigation into the operational impacts and resolution timeframe of these open deficiencies

- MGUE Increment 2 – The program is structured as two Middle Tier of Acquisition rapid prototyping efforts. The first is the Miniaturized Serial Interface (MSI) receiver with next-generation ASICs that will deliver improved jam resistance, address MGUE Increment 1 ASIC hardware obsolescence, support the enhanced RMP offered by GPS IIIF satellites, and support low-power applications (e.g., guided munitions). The second is the handheld receiver, which will incorporate the MSI receiver with the prototype unit planned for FY28 availability. The MSI development continues, and the test community is developing test plans for the prototype handheld unit.

DOT&E approved the GPS Enterprise TEMP (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 continues to actively support development of updates to the E-TEMP and its annexes, which should consider a full-spectrum threat environment – adequately addressing kinetic, cyber, electromagnetic spectrum, nuclear, and directed energy threats. In FY24, DOT&E supported the Department of Transportation's (DOT's) development of an E-TEMP annex and planned testing of civilian signals under OCX control.

» 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 – Aurora, Colorado (OCX)
- Raytheon, a subsidiary of RTX – Aurora, Colorado (OCX 3F)

User Segment (MGUE Increments 1 and 2)

- L3Harris Technologies, Inc. – Anaheim, California

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

TEST ADEQUACY

No operational testing was conducted in FY24 across the GPS Enterprise. In February 2024, the M-code signal became globally available, giving U.S. and allied forces the ability to conduct testing of the M-code signal anywhere in the world. The Program Management Office conducted initial integrated cyber testing of the GPS IIIF simulator, in preparation for cyber testing of OCX 3F with the first GPS IIIF satellite in FY27. The OCX cyber assessment originally scheduled for 2023 has been delayed until 4QFY25 (a change from 4QFY24 in last year's annual report), the GPS Enterprise IOT&E is scheduled for 1QFY26, and the GPS Enterprise OCX/GPS III/MGUE Inc 1 Multi-Service Operational Test and Evaluation is scheduled for 2QFY26.

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 is funding, through its Cyber Assessment Program, a base cyber evaluation of OCS AEP in 2QFY25 to assess the current cyber defense posture and inform the OCX cyber evaluation schedule for mid-late FY25. This will provide a baseline to measure the cyber defense improvements that OCX brings to the GPS Enterprise and inform the decision to transfer the GPS constellation from OCS AEP to OCX in 4QFY25.

The current MGUE Increment 2 handheld receiver operational test schedule does not align with the GPS IIIF launch strategy. The GPS IIIF family of satellites delivers an RMP capability that the MGUE Increment 2 user equipment provides to military units. Without GPS IIIF satellites on orbit, operational testers will be unable to verify that the MGUE Increment 2 user equipment can take advantage of RMP signals in a contested environment. Additionally, due to delays with the program schedule, the MGUE Increment 2 program office does not have a customer for the MGUE Increment 2 handheld receiver. Since operational testing would involve assessing a military unit's ability to carry out their mission using the MGUE Increment 2 user equipment, the current lack of a buyer has delayed the development of an operational test plan.

The DOT and the Federal Aviation Administration have responsibilities for testing civilian GPS-based PNT systems outlined in the Federal Radionavigation Plan. The PMO and operational test agency are incorporating

DOT's request to test OCX with a four-GPS-satellite "mini constellation" as a part of a risk reduction opportunity prior to the full constellation transition to OCX. This is a key event, planned for 4QFY25 – ahead of full operational testing – to build confidence the civil signal is compatible with OCX and will support safe and effective commercial air transportation within the United States.

PERFORMANCE

» EFFECTIVENESS

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 currently C2 all GPS satellites except for future GPS IIIF satellites. OCS AEP received the COps upgrade to C2 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 1QFY26 and OCX 3F in FY28; both dates are a year later than what was reported in last year's Annual Report. The first GPS IIIF satellite is still expected to launch in 3QFY27. Any additional schedule delays to 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 immature 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 the contractor's lack of agile coding experience during development.

The MGUE Increment 1 aviation/ maritime receiver card experienced software challenges that resulted in delays that the Space Force is working to address with the delivery of a new software build. Until the Space Force addresses these deficiencies, which likely affect operational performance, the operational test schedules for both the B-2 aircraft and the *Arleigh Burke*-class destroyer lead platforms are on hold. Delays in MGUE receivers have resulted in the Services developing their own M-code receiver capabilities, separate from the MGUE program.

» **SUITABILITY**

Based on previous operational test reporting, both GPS III satellites and the OCS AEP C2 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.

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 because OCS AEP will be unable to launch or C2 new GPS IIIF satellites to replenish older satellites as they exceed their service life.

» **SURVIVABILITY**

The Space Force is placing a renewed focus on understanding all threats to the GPS systems across the space vehicle, C2, and user segments to better evaluate the survivability of the GPS Enterprise in operational testing against realistic threats.

RECOMMENDATIONS

The Space Force should:

1. Work with the Services to identify a military unit to operationally use the MGUE Increment 2 handheld receiver and can also support operational testing.
2. Use the cyber survivability findings from the scheduled operational cyber assessments of OCS AEP and OCX to further strengthen the cyber posture of the GPS Enterprise and inform the OCX operational acceptance decision.
3. Adequately address kinetic, cyber, electromagnetic spectrum, nuclear, and directed energy threats to the GPS Enterprise in future TEMP updates and test plans.