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Defense Primer: Nuclear Command, Control, and Communications (NC3)

The Department of Defense (DOD) is replacing many elements of the U.S. nuclear command, control, and communications (NC3) architecture as part of the United States' ongoing efforts to recapitalize its nuclear forces. This architecture—composed of what some estimate as 204 individual ground, space, and airborne systems spread across military services, combatant commands, and DOD components—supports the President's exercise of nuclear employment authority. (See CRS In Focus IF10521, *Authority to Launch Nuclear Forces*.)

U.S. NC3 systems must operate at all times, including during and after an attack on the United States, to sense and assess the operational environment; facilitate planning and decisionmaker conferencing; and transmit orders from the President to U.S. nuclear forces: bombers in the air, ballistic missile submarines (SSBNs) underwater, and intercontinental ballistic missiles (ICBMs) deployed in silos across the Midwest. (See CRS In Focus IF10519, *Defense Primer: Strategic Nuclear Forces*.)

According to DOD, “U.S. [NC3] is necessary to ensure the authorized employment and/or termination of nuclear weapons operations, to secure against accidental, inadvertent, or unauthorized access, and to prevent the loss of control, theft, or unauthorized use of U.S. nuclear weapons.”

The 2010, 2018, and 2022 Nuclear Posture Reviews (NPRs)—periodic executive branch assessments of U.S. nuclear weapons policy—highlighted the importance of modernizing NC3. According to April 2024 testimony of then-Principal Assistant Deputy Secretary of Defense for Space Policy Vipin Narang, the Biden Administration requested \$11.4 billion for NC3 architecture modernization in FY2025. The Congressional Budget Office (CBO) estimated in 2025 that DOD efforts to sustain and modernize NC3 would cost \$154 billion from 2025 through 2034. Through defense authorization and appropriation legislation and hearings, Congress provides funding for and oversight of NC3 sustainment and modernization.

Selected NC3 System Elements

Early Warning Radars

The Space Force operates a number of missile warning radars to detect and track potential incoming ICBMs and submarine-launched ballistic missiles. These radars include capabilities like the Precision Acquisition Vehicle Entry Phased Array Warning System (PAVE PAWS), the

Perimeter Acquisition Radar Attack Characterization System (PARCS), and the COBRA DANE radar system. These missile warning radars are periodically upgraded.

Missile Warning and Tracking

In 2011, the Space Force began deploying the Space-Based Infrared System (SBIRS), a series of satellites and ground systems to detect and track the launch of adversary missiles. SBIRS satellites operate in geosynchronous (GEO) and highly elliptical orbits to observe missile launches worldwide. SBIRS is DOD's replacement of the 1970s Defense Support Program satellites. The Space Force is implementing the Next Generation Overhead Persistent Infrared (Next-Gen OPIR) program to eventually replace SBIRS. Next-Gen OPIR is composed of several GEO satellites, several polar-orbiting satellites, and a ground system. In May 2024 testimony, then-Assistant Secretary of the Air Force for Space Acquisition and Integration Frank Calvelli described Next-Gen OPIR “as a bridge to enable the eventual transition” to a “proliferated and resilient missile warning” and tracking architecture in low and medium Earth orbits. The FY2025 budget request included \$4.7 billion for space-based missile warning.

Hardened Satellite Communications

The Advanced Extremely High Frequency (AEHF) constellation is a group of hardened communications satellites operated by the Space Force. AEHF, first launched in August 2010, replaced the Milstar constellation from the 1980s. Paired with the Family of Beyond Line-Of-Sight Terminals (FAB-T) command post terminals, AEHF aims to provide assured communications for nuclear and conventional forces. In February 2024 congressional testimony, U.S. Strategic Command (STRATCOM) Commander General Anthony Cotton stated that the AEHF “constellation is fully deployed,” while the “command post terminals leveraging it are nearing fully-fielded status.” The Space Force is developing a new series of satellites under the Evolved Strategic SATCOM (ESS) program to eventually replace AEHF. The FY2025 budget request included \$1 billion for ESS research, development, testing, and evaluation activities. According to Calvelli's May 2024 congressional testimony, the Space Force aims for ESS to achieve initial operational capability by 2032.

Integrated Tactical Warning/Attack Assessment

The goal of the Integrated Tactical Warning/Attack Assessment (ITW/AA) system is to integrate and collate warning data from terrestrial and space-based sensors, including ones detecting nuclear detonations, to assess “whether an attack is occurring against North America or U.S. assets or allies.” ITW/AA utilizes “dual phenomenology”—a process that draws on data from “two

independent information sources using different physical principles, such as radar and infrared satellite sensors” to render and communicate its assessment to the President and U.S. military leaders. This system is periodically upgraded.

E-4B National Airborne Operations Center

The E-4B National Airborne Operations Center (NAOC) is designed to be a survivable command center for the President and Secretary of Defense in the event of a “national emergency or destruction of ground command and control centers,” according to the Air Force. Based at Offutt Air Force Base, NE, the E-4B is a modified Boeing 747 based on the E-4A originally delivered to the Air Force in the 1970s. The Air Force is recapitalizing the system under the Survivable Airborne Operations Center (SAOC) program. The Air Force’s FY2025 budget request included \$1.6 billion for hardened “commercial derivative” aircraft for the SAOC mission. In April 2024, DOD announced that it awarded the SAOC contract to Sierra Nevada Corp.

E-6B Mercury

The E-6B Mercury serves as a command relay to SSBNs under Navy’s “Take Charge and Move Out” (TACAMO) mission. It also currently serves as an airborne launch control system under STRATCOM’s Airborne Command Post (Looking Glass) mission. Operating primarily out of Tinker Air Force Base, OK, the E-6B is a modified Boeing 707 aircraft originally delivered to the Navy as E-6A in 1989 and updated to the E-6B in 1998. The Navy is upgrading the E-6B to extend its operational life until FY2038. The Navy requested \$775 million for TACAMO modernization in FY2025. The E-XX, a modified version of a C-130J-30 aircraft, will execute the “TACAMO mission only,” according to General Cotton. In 2025, General Cotton stated that an ongoing “trade space study” will help to determine the future of the Looking Glass mission.

Issues for Congress

Congress has provided and may continue to consider funding for and oversight of DOD efforts to modernize and sustain the NC3 architecture. Areas of recent congressional focus have included the following:

NC3 Governance and Prioritization

Some Members of Congress have expressed concern about DOD’s ability to prioritize NC3 modernization. In Section 1052 of the FY2014 NDAA (P.L. 113-66), Congress established the Council on Oversight of the National Leadership Command, Control, and Communications System (10 U.S.C. §171a). Following a 2018 DOD NC3 governance review, then-Secretary of Defense Jim Mattis designated U.S. STRATCOM as the single operational commander for NC3. The FY2019 NDAA conference report (H.Rept. 115-874) stated that “conferees expect[ed] to see clear improvements in lines of authority and decision-making” after this change. More recently, in Section 1631 of the FY2024 NDAA (P.L. 118-31), Congress established a “unified major force program” for NC3 and required an annual budget assessment of NC3 sustainment and modernization. In April 2025 congressional testimony, General Cotton highlighted an ongoing assessment of the NC3 enterprise and the development of next generation NC3 capabilities.

Oversight of Costs and Schedule

Congress has tracked the development of NC3 systems. Government Accountability Office (GAO) reports have recommended that DOD provide Congress with additional information about costs and schedules of NC3 systems to improve congressional oversight. GAO’s June 2024 *Weapons Systems Annual Assessment* report suggests potential cost and schedule challenges for some NC3 systems. Section 1634 of the FY2023 NDAA (P.L. 117-263) required DOD to establish a portfolio management framework for nuclear forces.

NC3 Vulnerability to Adversarial Attacks

Some Members of Congress have expressed concerns about NC3 resilience to adversarial kinetic and other attacks. DOD officials have discussed integration between nuclear and conventional military command, control, and communications systems. DOD has also sought to leverage commercial systems for future NC3 improvements. U.S. intelligence community assessments have described Russia’s and China’s development of counterspace systems that could disrupt or destroy U.S. satellites. DOD officials have stated that an adversarial attack on U.S. NC3 assets would be highly escalatory in a conflict, pointing in particular to U.S. government concerns about Russia’s development of a space-based nuclear capability.

Some Members of Congress have expressed concerns about NC3 ability to operate while under cyberattack. Title 10, Section 499, of the *U.S. Code* directs DOD to conduct an annual assessment of NC3 cyber resiliency. Section 1512 of the FY2024 NDAA (P.L. 118-31) added a requirement for DOD to develop and implement a “threat-driven cyber defense construct” for NC3. Section 1644 of the FY2022 NDAA (P.L. 117-81) directed DOD to conduct “an independent review of the safety, security, and reliability” of nuclear weapons, NC3, and ITW/AA to, inter alia, “prevent cyber-related and other risks that could lead to the unauthorized or inadvertent use of nuclear weapons.” The 2022 NPR endorsed this “Failsafe Review.”

“Human in the Loop”

Some Members of Congress have expressed concern about the potential for autonomous systems to authorize a nuclear weapons launch. The 2022 NPR stated that the United States will maintain a human “in the loop ... for all actions critical to informing and executing decisions by the President to initiate and terminate” nuclear employment. The Biden Administration has also sought to discuss the need for a “human in the loop” with other nuclear weapons states. Section 1638 of the FY2025 NDAA (P.L. 118-159) included a policy statement that the use of artificial intelligence (AI) “should not compromise the integrity of nuclear safeguards, whether through the functionality of weapons systems, the validation of communication from command authorities, or the principle requiring positive human actions in execution” of a presidential employment decision. General Cotton has said that STRATCOM will use AI “to enable and accelerate human decision-making,” but will also “maintain a human ‘in the loop.’”

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