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December 8, 2020

Nuclear Command, Control, and Communications (NC3) Modernization

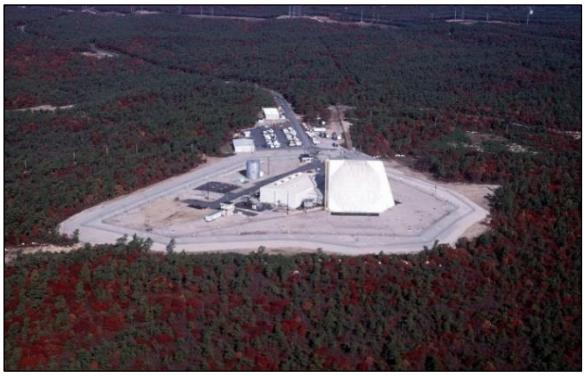
The U.S. military is currently recapitalizing its nuclear arsenal; one effort in this regard is the replacement of many of the systems that make up its nuclear command, control, and communications (NC3) architecture. According to the 2018 Nuclear Posture Review (NPR), the "NC3 system performs five crucial functions: detection, warning, and attack characterization; adaptive nuclear planning; decision-making conferencing; receiving Presidential orders; and enabling the management and direction of forces." NC3 relies on a number of systems that enable the national command authority—the chain of command running from the President through the Secretary of Defense and the Joint Staff to U.S. Strategic Command—to issue orders to strategic forces. These systems must operate at all times to transmit orders from the President and communicate with bombers in the air, ballistic submarines underwater, and intercontinental ballistic missiles dispersed throughout the United States. (For a more detailed discussion, see CRS In Focus IF10521, *Defense Primer: Command and Control of Nuclear Forces*, by Amy F. Woolf.)

The Department of Defense (DOD) has identified a number of expanding threats that might challenge current NC3 systems and thus create a need to procure new systems. The NPR states that China and Russia have developed capabilities that could potentially threaten space-based systems; in addition, the introduction of modern information technologies poses potential cyber vulnerability, which "has created new challenges and potential vulnerabilities for the NC3 system." Moreover, many NC3 systems entered service in the 1970s, so some, like the Strategic Automated Command and Control System, are reaching the end of their life or are facing parts obsolescence. This makes maintenance either impractical or extremely expensive. According to some experts, the NC3 architecture is composed of up to 160 individual systems; the following discussion highlights select NC3 systems that the Pentagon might consider replacing in the near term.

Early Warning Radars

DOD employs a number of long-range early warning radars to detect potential incoming missiles. One example of these radars is the Precision Acquisition Vehicle Entry Phased Array Warning System (PAVE PAWS), located in Massachusetts (see **Figure 1**), California, and Alaska. These radars are designed to detect potential submarine-launched ballistic missiles. The Air Force plans to replace PAVE PAWS radars with the new Solid State Phased Array Radar System.

Figure 1. PAVE PAWS Radar at Cape Cod, MA



Source: https://en.wikipedia.org/wiki/PAVE_PAWS#/media/File:PAVE_PAWS_Cape_Cod_AFS_1986.jpg.

Space-Based Infrared System (SBIRS)

The Space-Based Infrared System is a series of 10 satellites designed to detect the launch of adversary missiles to provide early warning. These satellites operate in both geosynchronous and highly elliptical orbits that are designed to observe missile launches globally. During its development, SBIRS struggled with a number of cost overruns, resulting in a series of budget overruns, ultimately reducing the number of satellites that DOD procured. The Air Force is designing the Next Generation Overhead Persistent Infrared (OPIR) program to replace SBIRS. According to DOD budget documents, the first geosynchronous satellites are required by FY2025 to begin replacing satellites reaching the end of their service life, and the first polar satellites are scheduled to enter the force by FY2027. DOD intends to have Block 0 satellites operational by FY2029, with Block 1 ready to launch satellites to orbit beginning in FY2030.

Advanced Extremely High Frequency

The Advanced Extremely High Frequency (AEHF) constellation is a group of communications satellites that provides both tactical communications (i.e., for conventional forces like Army brigade combat teams) and strategic communications (i.e., for nuclear forces). AEHF, first launched in August 2010, replaced the Miltstar constellation from the 1980s. Paired with the Family of Beyond Line-Of-Sight Terminals (FAB-T), AEHF provides assured communications to nuclear forces like the Minuteman III intercontinental ballistic missile, the B-2 Spirit, and the E-4B National Airborne Operations Center. The Space Force has begun developing a new series of communications satellites called the Evolved Strategic Satellite (ESS) program. This program originally envisioned procuring new satellites capable of providing both tactical and strategic communications, essentially

replacing the current AEHF system. However, the FY2021 budget created two separate programs instead.

E-4B National Airborne Operations Center (NAOC)

The E-4B National Airborne Operations Center (**Figure 2**) is designed to be a highly survivable command center for the President and Secretary of Defense (or their successors) in the event of a "national emergency or destruction of ground command and control centers." The E-4B, a heavily modified 747, was first delivered to the Air Force in the 1980s and serves as the Secretary of Defense's primary mode of transportation when flying. According to the Air Force, at least one E-4B is always on alert and ready to fly to support the national command authority. The Joint Staff performed a study on the system from 2014 through 2016. This study recommended recapitalizing both E-4B NAOC and the E-6 Mercury with a single platform called the Survivable Airborne Operations Center.

Figure 2. E-4B NAOC

Source: https://www.af.mil/About-Us/Fact-Sheets/Display/Article/104503/e-4b/.

E-6B Mercury

The E-6B Mercury (**Figure 3**), operated by the Navy, is a modified Boeing 707 designed to facilitate communication between the national command authority and naval nuclear forces (i.e., ballistic submarines). This aircraft is designed to support the "Take Charge and Move Out" (TACAMO) mission, utilizing a 5-mile long antenna communicating with submarines on very low frequencies. It is also able to serve as an airborne launch control system. These aircraft were originally delivered to the Navy in 1989 and were updated to the E-6B in 1998.

Figure 3. E-6B Mercury

Source: https://www.navair.navy.mil/product/E-6B-Mercury

Cost of Modernizing NC3

According to a 2019 Mitchell Institute report on NC3 modernization, DOD spends approximately $4 billion annually to operate, maintain, and upgrade NC3 systems. In FY2021, DOD requested funding to develop replacements for many of the NC3 systems discussed above. The Space Force requested $2.3 billion to develop a follow-on system to replace SBIRS (program element 1206442SF) and $71 million to develop the ESS Communications program (program element 1206855SF)—an AEHF replacement. The Air Force requested $76 million for the E-4B recapitalization (program element 0604288F). All of these programs are projected to increase funding in subsequent fiscal years through FY2026, which is the final year projected. Finally, the Space Force requested $66 million for procurement of the Family of Beyond Line-of-Sight terminal program.

The Congressional Budget Office (CBO) estimates that plans to replace legacy NC3 systems will cost $77 billion from 2019 through 2028. According to CBO, this is an increase of nearly $17 billion from its previous estimate in 2017. The increase is attributed largely to changes in the Air Force's approach to the E-4B NAOC program.

Potential Questions for Congress

- How would changes to nuclear strategy—such as the possible elimination of a leg of the nuclear triad—affect NC3 systems?
- How does DOD plan to mitigate potential cyber vulnerabilities as it incorporates modern technologies?
- Would NC3 modernization, as currently planned, leverage developments from the Joint All Domain Command and Control (JADC2) concept?
- The Defense Science Board identifies potential benefits of fifth generation (5G) communication technologies for NC3. How would the department leverage 5G technologies to modernize NC3?
- Are NC3 modernization efforts meeting their schedule, performance, and budget metrics? How might an increase in budget requirements for NC3 affect other DOD priorities?

Related CRS Products

CRS In Focus IF10521, *Defense Primer: Command and Control of Nuclear Forces*, by Amy F. Woolf

CRS Report RL33640, *U.S. Strategic Nuclear Forces: Background, Developments, and Issues*, by Amy F. Woolf

John R. Hoehn, Analyst in Military Capabilities and Programs

IF11697

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