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Understanding, Managing, and Reporting U.S. Space Force Readiness



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About This Report

As the newest branch of the U.S. armed services, the U.S. Space Force (USSF) must understand, manage, and report its *readiness*—its ability to fight and execute operational missions. This project’s objective is to recommend a readiness framework for the USSF. Starting with a “blank slate” mandate and a review of the readiness practice of the other services, we studied the current readiness system for the USSF and considered the unique needs of the military space community. We find that the current readiness reporting system does not address the range of USSF needs and has failed to objectively report the readiness of the space forces. We recommend a readiness framework that measures the USSF’s ability to keep pace with adversary threats. It proposes three distinct “views” of readiness: (1) given today’s resources, (2) against the near-peer threat, and (3) progress in transforming to meet the near-peer threat. We also recommend a transition plan to improve readiness reporting for the USSF.

The research reported here was sponsored by the Director of Space and Cyber Operations, Headquarters Space Operations Command, and conducted within the Force Modernization and Employment Program of RAND Project AIR FORCE as part of a fiscal year 2021 project, “Space Force Readiness.” It should be of interest to reporters and consumers of readiness information within the USSF and national security community more broadly, those involved with creating and sustaining readiness reporting systems, and those in the military space operations community.

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That we received help from those acknowledged above should not imply that they concur with the views expressed in this report or bear any responsibility for its content, including any errors or oversights.

Summary

Issue

As a branch of the U.S. armed services, the U.S. Space Force (USSF) must understand, manage, and report its *readiness*. The readiness-related systems of the U.S. Department of Defense, like many systems that support and govern the USSF, were not designed to meet the unique demands of the military space community. The newly independent USSF has an opportunity to create systems that work better given the unique characteristics of operations in and through outer space. This report recommends a readiness framework for the USSF.

Approach

To develop the recommended framework, we began with a review of the readiness policy and practice of other military services, continued with the study of the current USSF readiness reporting system (including related areas of organizational and mission design), and identified areas of improvement. We then developed the framework for USSF readiness. The research used a mixed methods approach, including literature reviews, unstructured subject matter expert and stakeholder interviews, and analysis of recent Defense Readiness Reporting System–Strategic (DRRS-S) data. The framework design relied on team-based exercises and discussions and the specifics of use case examples. The primary outputs of this research are the recommended framework and a transition plan to implement the framework.

Key Findings

The USSF has unique organizational, operational, and technological characteristics that affect how its readiness should be understood and reported.

1. While it is mandatory for DRRS-S to be used for reporting to the U.S. Congress, other U.S. military services have created frameworks to augment DRRS-S and meet their internal needs.
2. The USSF’s highest-priority need for a readiness framework is one that can measure readiness against the full range of threats, including its ability to evolve to confront those threats. This includes elements of organizational and mission design.
3. Heritage measures of readiness, and the enterprise systems that support them, focus on today’s organize, train, and equip (OT&E) posture and are not suited to measuring an evolving force.
4. Current reporting systems cannot provide objective measures of the risks of unfunded requirements, unrealized capability development, and incomplete reorganizations.

5. Readiness reporting in the USSF is currently broken.
 1. Sources of readiness data, inherited from the U.S. Air Force, spoil readiness information because critical resources are not included, classified information is not supported, and organizational dependencies in the USSF are not captured.
 2. Objective measures of readiness can be inaccurate due to data quality issues.
 3. Units are being asked to report too much (including readiness against the range of emerging threats) given the capabilities of the reporting systems.
 4. Commander remarks contain much of the critical readiness information, but that information is often not readily actionable.

Recommendations

The USSF should adopt a readiness framework that augments DRRS-S and measures readiness against a complete range of threats; this framework includes three views of readiness (see Figure S.1):

1. **readiness given today's resources** measures unit readiness considering currently authorized resources and expected capabilities
2. **readiness based on needed capabilities** measures unit readiness considering resources and capabilities needed to be ready against the full range of identified threats
3. **readiness based on the pace of transformation** measures the USSF's ability to change and adapt to new threats.

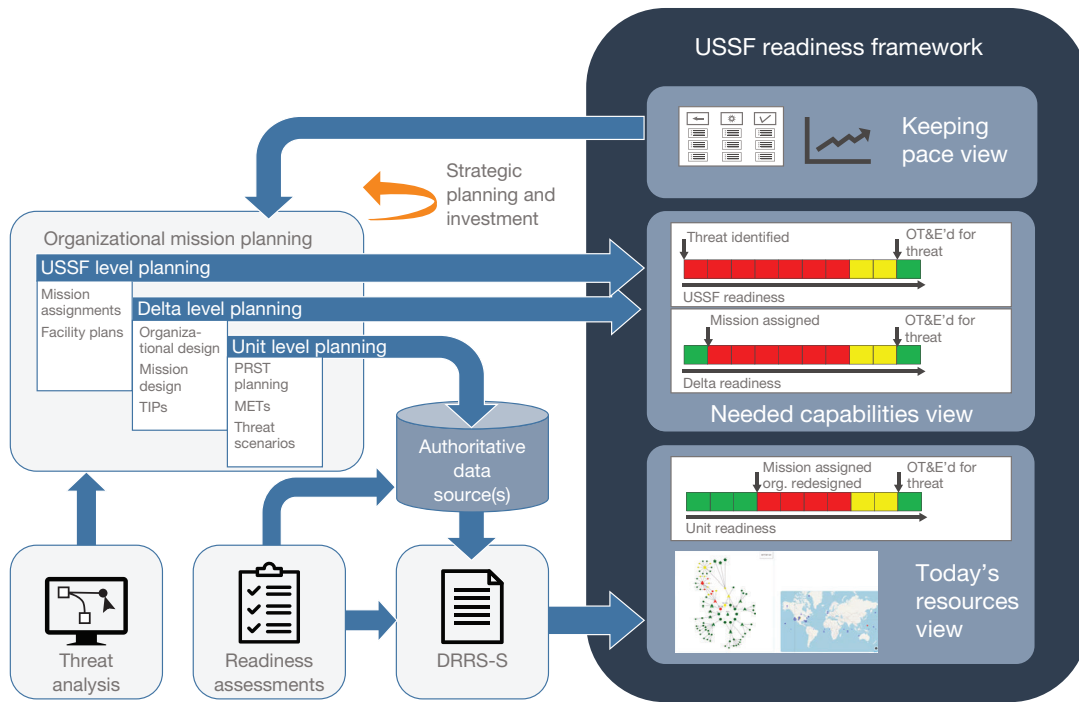
In transitioning to this new framework, the USSF should take four major steps to improve the reporting of readiness:

1. Improve readiness reporting given today's resources by correcting errors and omissions in readiness data sources and focusing DRRS-S data on this view of readiness.
2. Improve the reporting of readiness based on needed capabilities by publishing guidance, identifying reporting requirements, and creating a data repository for this view of readiness.
3. Implement reporting on the pace of transformation by establishing measures and reporting responsibilities.
4. Manage the USSF's processes to increase the pace of USSF transformation using the readiness reporting information.

Actions that can improve readiness in the shorter term include the following:

1. Redefine authoritative data sources (ADSs) to better match the security needs of the space community, capture all critical equipment, and better represent the interdependencies of space systems and organizations.
2. Implement USSF force presentation models, when prepared, in personnel readiness reporting.
3. Capture readiness of supporting units (e.g., engineering, security, etc.) as part of Delta-level assessments.

Figure S.1. The Proposed USSF Readiness Framework



NOTE: METs = Mission Essential Tasks; PRST = Personnel, equipment Readiness, Supply, and Training; TIPs = Tactic Improvement Proposals; OT&E'd = organized, trained, and equipped.

While we describe current USSF readiness reporting as broken, we believe that the creation of an independent USSF provides an opportunity to improve the systems by which readiness is understood, managed, and reported, and hope that this report is helpful in achieving that goal.

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Chapter 1. Background Regarding the U.S. Space Force, Readiness, and Our Research

The core of readiness is ensuring military space forces are prepared to prevail against any adversary.¹

Facing increasing threats from other military powers in outer space, the United States established a Space Force as a branch of the U.S. armed forces in December 2019. Military operations in space are different from those of other domains, but military space activity has often been governed by the same doctrine, policy, systems, processes, and standards as other Department of Defense (DoD) communities. The creation of the U.S. Space Force (USSF) presents an opportunity to depart from their U.S. Air Force legacy to make such things better match the unique characteristics and demands of the space domain.

One such opportunity is the creation of a framework for how the USSF understands, manages, and reports readiness. For the purpose of this report, we define *understanding readiness* as providing objective and accurate measures that support USSF leadership’s ability to make data-driven decisions regarding how best to improve the USSF’s readiness and/or the USSF’s ability to achieve readiness. Readiness itself is defined by the Joint Staff (JS) as the “ability of military forces to fight and meet the demands of assigned missions.”² “Being ready” means that warfighters have the teams, training, and equipment to complete their missions.³ Building and sustaining readiness is a primary objective of the organize, train, and equip (OT&E) missions of the military services. Each military service collects, analyzes, and reports readiness information as required by statute, DoD policy, and joint instruction.⁴ These functions are contained within various systems, including the Defense Readiness Reporting System–Strategic (DRRS-S), the

¹ USSF, *Spacepower: Doctrine for Space Forces*, Washington, D.C., Space Capstone Publication, June 2020b.

² JS, *Doctrine for the Armed Forces of the United States*, Washington, D.C., Joint Publication 1, incorporating Change 1, July 12, 2017, p. GL-10.

³ Congressional Research Service (CRS), *The Fundamentals of Military Readiness*, Washington, D.C., R46559, October 2020a.

⁴ U.S. Code, Title 10, Section 117, Readiness Reporting System, 2019a, effective January 24, 2020; U.S. Code, Title 10, Armed Forces, Subtitle A, General Military Law, Part I, Organization and General Military Powers, Chapter 3, Miscellaneous Studies and Reports, Section 482, Readiness Reports, 2019b, effective January 24, 2020; Department of Defense Directive (DoDD) 7730.65, *Defense Readiness Reporting System (DRRS)*, Washington, D.C.: U.S. Department of Defense, May 11, 2015, incorporating Change 1, effective May 31, 2018; Department of Defense Instruction 7730.66, *Guidance for the Defense Readiness Reporting System (DRRS)*, Washington, D.C.: U.S. Department of Defense, July 8, 2011; Chairman of the Joint Chiefs of Staff Instruction (CJCSI) 3401.02B, *Force Readiness Reporting*, Washington, D.C.: Joint Chiefs of Staff, May 31, 2011, directives current as of July 17, 2014.

Chairman's Readiness System,⁵ and the *Semiannual Readiness Report to Congress*,⁶ among other service-specific tools and measures.

Understanding, managing, and reporting USSF readiness are critical needs. However, as has been stated by USSF senior leaders,⁷ and as we will demonstrate throughout this report, current readiness-related policies, processes, and tools are not working for the USSF.⁸ **The objective of this report is to recommend a readiness framework that is better suited to the challenges faced by the USSF.**

In this chapter we provide a brief overview of the creation of the USSF and its missions and a discussion of those missions. We follow that with a discussion of readiness governance, goals, and objectives. We then return to the subject of the USSF and discuss unique attributes of its missions and makeup that influence how it should understand, manage, and report readiness. The chapter concludes with a discussion of the goals we established for our proposed framework and the research questions we sought to answer.

An Overview of the USSF and Its Missions

Traditional Space Missions

DoD has a long history of militarized use of space, beginning in the 1960s with weather reporting enabled by the Defense Meteorological Satellite Program (DMSP) and secure worldwide communications enabled by the Initial Defense Satellite Communications Program. The military's first early missile warning satellites, for the Defense Support Program, were launched in 1970. Later in the 1970s, DoD use of space expanded to navigation and timing services with the Navstar navigational system tracking and range program, the forerunner to today's Global Positioning System (GPS). Today, space assets continue to provide critical weather sensing, secure communications, early missile warning, navigation, and timing services to U.S. troops deployed around the globe. These uses form the traditional missions of the USSF and are termed *support missions* in that they allow the United States to project power into terrestrial theaters of war and across the globe more generally.

⁵ JS, *CJCS Guide to the Chairman's Readiness System*, Washington, D.C., CJCS Guide 3401D, November 15, 2013, directive current as of November 25, 2013.

⁶ This report was required quarterly until passage of section 361 of the National Defense Authorization Act (NDAA); see Public Law 116-92, National Defense Authorization Act for Fiscal Year 2020, December 20, 2019.

⁷ John A. Tirpak, "Space Force Grappling with How to Define Readiness," *Air Force Magazine*, October 18, 2020; Clifford M. Theony, "Infrastructure Readiness in the United States Space Force," *Over the Horizon Journal*, April 20, 2020.

⁸ We hesitate to term the current set of policies, processes, and tools a *readiness framework*; they appear to be primarily focused on reporting, as opposed to managing, readiness.

Weather. Over time, meteorological data gathered by satellites have become central to both terrestrial and space weather prediction. The National Oceanic and Atmospheric Agency operates both newer satellites and DoD’s original DMSP satellites to provide data to the National Weather Service and to DoD.⁹ The National Oceanic and Atmospheric Agency is supported in these efforts by a small detachment of USSF personnel. While the military use of weather services is distinct from civilian use, the satellites and their operations are not. Going forward, DoD may forgo building its own satellites, and is exploring the acquisition of weather data as a service.

Satellite Communication. The use of space for communication links was originally a commercial endeavor, and commercial communications satellites are by far the largest users of space,¹⁰ with military satellite communication (MILSATCOM) focused on providing secure, jam-resistant, and nuclear-hardened systems. MILSATCOM includes systems that are designed for tactical forces (e.g., the Wideband Global SATCOM constellation) and for strategic purposes (e.g., the Advanced Extremely High Frequency constellation). Historically, the operation of military communications satellites has been broadly shared across DoD—with, for example, the U.S. Navy acquiring and operating narrowband communications (e.g., Fleet Satellite Communications System and Mobile User Objective System) and the U.S. Army responsible for planning and operating the communications services provided by the Wideband Global SATCOM system. Military communications satellites do not supply the full bandwidth needed for tactical operations and are supplemented by commercial satellite communication services purchased through the Defense Information Services Agency. With the standing up of the USSF, DoD plans for all acquisitions, planning, and operations of satellite communications in support of the U.S. defense enterprise to be consolidated under the USSF.¹¹

Missile Warning/Missile Defense. The USSF operates satellites that provide nuclear detection, missile warning, and missile tracking in support of the Missile Defense Agency and a wide variety of other stakeholders. Of the support missions, missile warning is perhaps undergoing the most sweeping transition, given the advent of hypersonic glide vehicles. This is because the task of maintaining custody of a maneuverable glide vehicle is more difficult than maintaining custody of a ballistic missile.¹² Additionally, as is discussed in the “Organizational Change Use

⁹ One of the newest satellites is the Deep Space Climate Observatory (launched in 2015), specifically designed for the space weather sensing mission. Space weather data and predictions are an output of the Space Weather Prediction Center, which makes data available on its website; see Space Weather Prediction Center, “Forecasts,” webpage, undated.

¹⁰ The first commercial communications satellite launch predated the first military communications satellite.

¹¹ USSF, *United States Space Force Vision for Satellite Communications (SATCOM)*, Washington, D.C., January 2020a.

¹² The trajectory of an unpowered ballistic missile is largely deterministic, governed only by the forces of gravity and winds aloft.

Case” section of Chapter 4, missile warning based on space sensors is increasingly used for theater missile defense—a significant expansion of the USSF’s mission.

Precision Navigation and Timing. Today’s GPS has become critical infrastructure not just for the United States but for the larger international community. It provides uninterrupted position and precise time information 24 hours a day to millions via the smartphones in our pockets and the navigation systems in our cars. The timing service is essential to global financial transactions. Yet GPS is also essential to the U.S. military, and not just for precision strike capability. The USSF operates GPS with the support of the National Geospatial-Intelligence Agency (NGA) and provides real-time status of the system via the U.S. government’s GPS website,¹³ which is administered by the National Coordination Office for Space-Based Positioning, Navigation, and Timing. The military use of the information supplied by GPS is coordinated through the Joint Navigation Warfare Center.

The Protect-and-Defend Mission: Evolving for the Near-Peer Fight

Although the U.S. space community has never taken access to space for granted,¹⁴ in recent years it has become clear that the “force multiplier” U.S. space systems provide in terrestrial conflicts makes those systems increasingly attractive targets.¹⁵ It has also become clear that any nation with rudimentary cyber warfare, electronic warfare, or space expertise is capable of attacking U.S. space systems. While most existing space systems are designed to be robust to routine cyber warfare, jamming, and dazzling attacks (and those systems used for nuclear command and control [C2] are designed to be robust to more advanced threats), none has been designed to be robust to kinetic attack by direct ascent missiles or the full range of co-orbital attacks. In large part, this lack of robustness is due to an assumption that such attacks would be unlikely either because adversaries do not have the capability to carry out the attack or, if they have the capability, an attack would be more expensive than the benefit it might provide.

However, given the U.S. reliance on space to project power, it is unrealistic to assume that a near-peer adversary would ignore these vulnerabilities. Major space-faring nations, including

¹³ USSF, “GPS: The Global Positioning System,” homepage, last updated May 10, 2022.

¹⁴ In 1954, before the first satellite was launched, RAND Corporation researchers proposing such a system included a description of possible threats the satellite might face. Included was the threat of a direct ascent missile (Soviet capability was assessed as “probable”) designed to release debris (flak) or to detonate an atomic warhead. See J. E. Lipp and Robert M. Salter, eds., *Project Feedback Summary Report*, Vol. I, Santa Monica, Calif.: RAND Corporation, R-262/1, 1954.

¹⁵ Operation Desert Storm is sometimes called the first space war. Then, for the first time, it became commonplace for commanders located in the continental United States to have direct communication with and persistent overhead reconnaissance of a distant battlefield, all enabled by satellites. Desert Storm also demonstrated the wide range of military activities that were transformed by the use of GPS-generated position and timing information. This discussion is laid out by U.S. Army historian Sharon Watkins Lang in “SMDC History: 25 Years Since First ‘Space War,’” *Army News*, January 20, 2016.

China, India, Russia, and the United States, have demonstrated the ability to destroy satellites in near earth orbit using kinetic-kill direct ascent missiles.¹⁶ China, Russia, and the United States (i.e., the near peers in space) currently operate satellites designed to rendezvous with and operate in close proximity to other satellites, a position from which any number of electronic, directed energy or kinetic attack vectors might be launched.¹⁷ These threats exist, and both uncoordinated and coordinated close approaches are being demonstrated *today*, whether or not the USSF is ready to meet those threats.

We must also assume that U.S. near peers will continue to innovate in space weapons and will develop and employ increasingly more sophisticated attack vectors, to include advanced jammers, advanced cyberattacks, and perhaps even weapons-quality lasers. All of this means that the USSF must evolve not just to better protect traditional space systems but to successfully keep pace with a determined near-peer adversary who may see advantage in extending conflict into the space domain.¹⁸

The Mission Statement of the U.S. Space Force

With this evolution in mind, in approximately 2007 an increasingly vocal cadre of policymakers began to advocate for a separate armed service to focus on the space domain. Proponents argued that creation of a separate service was an essential step in developing space warfighting doctrine and tactics. Furthermore, they argued that such a move was necessary to give leadership independence to OT&E personnel to be ready for the space warfighting task. In February 2019 the Executive Branch issued a directive that DoD stand up a separate armed service to focus on the space domain, and in December 2019 the U.S. Congress approved funds to do so. In January 2020, Gen John W. (Jay) Raymond was sworn in as the first Chief of Space Operations (CSO) of the USSF. Today, the mission statement of the USSF states that it

organizes, trains, and equips space forces in order to protect U.S. and allied interests in space and to provide space capabilities to the joint force. USSF responsibilities will include developing Guardians, acquiring military space

¹⁶ The United States first demonstrated a direct ascent weapon in 1985; a more recent demonstration took place in 2008. A Chinese demonstration took place in 2007, an Indian demonstration in 2020, and a Russian demonstration in late 2021. See Laura Grego, *A History of Anti-Satellite Programs*, Cambridge, Mass.: Union of Concerned Scientists, January, 2012; T. S. Kelso, “Analysis of the 2007 Chinese ASAT Test and the Impact of Its Debris on the Space Environment,” in *AMOS 2007 Conference Proceedings*, Kihei, Maui, Hawaii: Maui Economic Development Board, 2007, p. 321; Lucas Steinhauser and Scott Thon, “Operation Burnt Frost: The Power of Social Networks,” *ASK Magazine*, June 1, 2008; and Brian Weeden and Victoria Samson, “India’s ASAT Test Is Wake-Up Call for Norms of Behavior in Space,” *SpaceNews*, April 8, 2019.

¹⁷ See Nathan Strout, “Russian Satellite Creeps up to Intelsat Satellite—Again,” C4ISRNET, September 3, 2019; and Colin Clark, “China Satellite SJ-17, Friendly Wanderer?” *Breaking Defense*, April 18, 2018.

¹⁸ While our framework does include metrics to measure the USSF’s ability to keep pace, this should not be interpreted as an attempt to extend readiness reporting to include the USSF’s ability to address threats that are over the horizon. The processes used for force modernization are outside the scope of this study.

systems, maturing the military doctrine for space power, and organizing space forces to present to our Combatant Commands.¹⁹

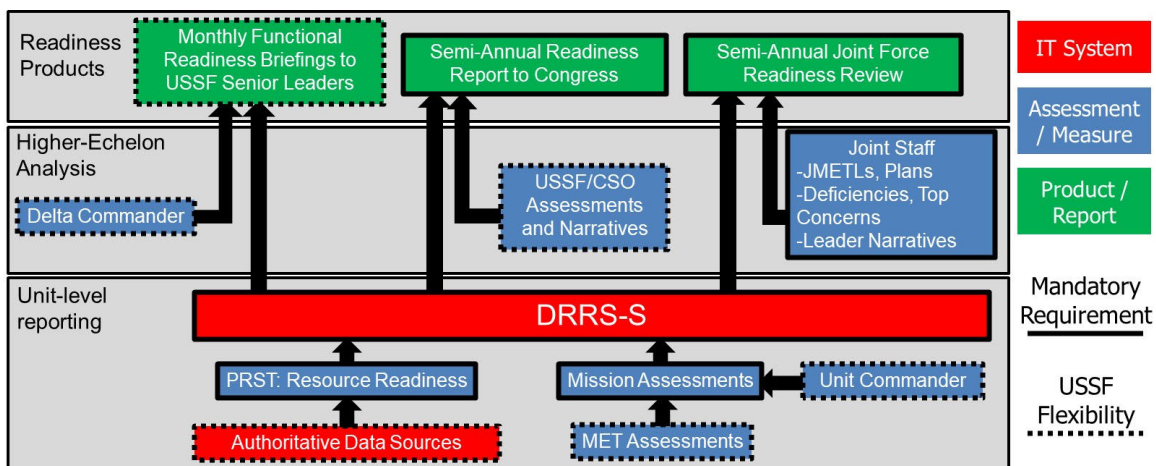
Readiness and Its Reporting

The joint force requires a holistic, rigorous, and analytical framework to assess readiness properly. Over past decades, readiness has become synonymous with “availability”—largely a measure of military units available for immediate deployment and ready to “fight tonight.”²⁰

Readiness is a broad term that is used in many ways by different communities within DoD. From a doctrinal perspective, readiness is the degree to which a military unit, and collectively all units, can accomplish operational missions.²¹ In this report, we focus on readiness reporting by DoD services and the USSF. Other DoD organizations, including combatant commands and defense agencies, also report readiness data and may in some cases provide more information that goes beyond the tactical unit level.

Figure 1.1 shows the current readiness reporting framework for the USSF. In brief, unit-level readiness reports, using both objective and subjective measures, are collected in DRRS-S. Analysis and assessments build upon the unit-level data at the Delta staff level,²² service headquarters (HQ)

Figure 1.1. The Current USSF Readiness Reporting Framework



SOURCES: Authors’ analysis of Air Force Instruction (AFI) 10-201, Air Force Space Command Supplement, *Force Readiness Reporting*, Washington, D.C.: Department of the Air Force, September 6, 2017, certified current, February 8, 2021; CJCSI 3401.01E, *Joint Combat Capability Assessment*, Washington, D.C.: Joint Chiefs of Staff, April 13, 2010, directives current as of May 19, 2014; CJCSI 3401.02B, 2014; CRS, 2020a.

NOTE: CSO: Chief of Space Operations; IT = information technology; JMETLs = Joint Mission Essential Task Lists; PRST: Personnel, equipment Readiness, Supply and Training.

¹⁹ USSF, “What’s the Space Force: Mission,” webpage, undated.

²⁰ Charles Q. Brown, Jr., and David H. Berger, “Redefine Readiness or Lose,” *War on the Rocks*, March 15, 2021.

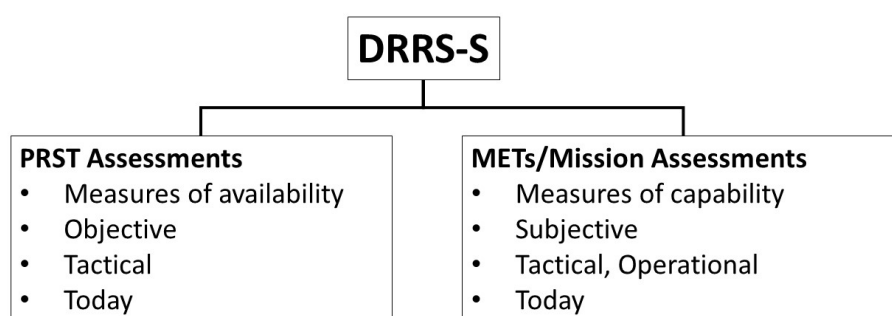
²¹ CRS, 2020a.

²² A USSF Delta is the organizational level above squadron and below field command.

level, and within the combatant command staff. These data and assessments are communicated in several major venues: (1) to USSF senior leaders to manage the force; (2) to Congress in the form of semiannual reports to support appropriations decision-making; and (3) to Joint Staff (at combatant commands and the Pentagon) to communicate the current and predicted availability of forces.

DRRS-S “provides a means to manage and report the readiness of the DoD and its subordinate Components.”²³ It is the primary readiness reporting tool, is used across DoD, and is considered by Congress to be the single authoritative source for readiness information. Figure 1.2 shows the information reported within DRRS-S.

Figure 1.2. The Structure of the Defense Readiness Reporting System–Strategic



SOURCE: Authors’ analysis of readiness data reported via DRRS-S in 2021.

There are two primary types of data. The first are commonly referred to as “resource levels,”²⁴ which track the availability of a unit’s resources. When properly measured against a baseline,²⁵ these data are objective measures of today’s resource availability at the tactical unit level.²⁶ Category levels (C-levels) represent the collective degree to which a unit meets resourcing standards; they are typically assessed as the lowest levels of personnel, equipment readiness, supplies, and training.

²³ DoDD 7730.65, 2015.

²⁴ Resource levels are based on reports on the availability of PRST in readiness policy. Each unit will have a list of “packets,” essentially discrete resources (e.g., a person, a piece of equipment, a successfully completed training course, etc.) that are designated as important to mission success, on which they are required to report the readiness status. In this report, we will often refer to the items the USSF should report readiness on as personnel, facilities, equipment, and training, as these are a better fit for the USSF’s employed-in-place missions.

²⁵ As used in this report, a *baseline* establishes the thresholds or criteria against which readiness is measured. If the baseline is incorrect, then the measure will be meaningless. This baseline must be captured in one or more authoritative data sources (ADSs) and must be “managed” to ensure that it accurately provides actionable measures of USSF readiness. In Chapter 4, we propose rules for managing baselines to ensure accurate and objective readiness assessments as the USSF evolves to meet new and emerging threats.

²⁶ The notion of “today” is used imprecisely here. In some cases, such as in deployable combat aircraft units in the U.S. Air Force (USAF), units report their predicted readiness in the near future—typically, 72 hours.

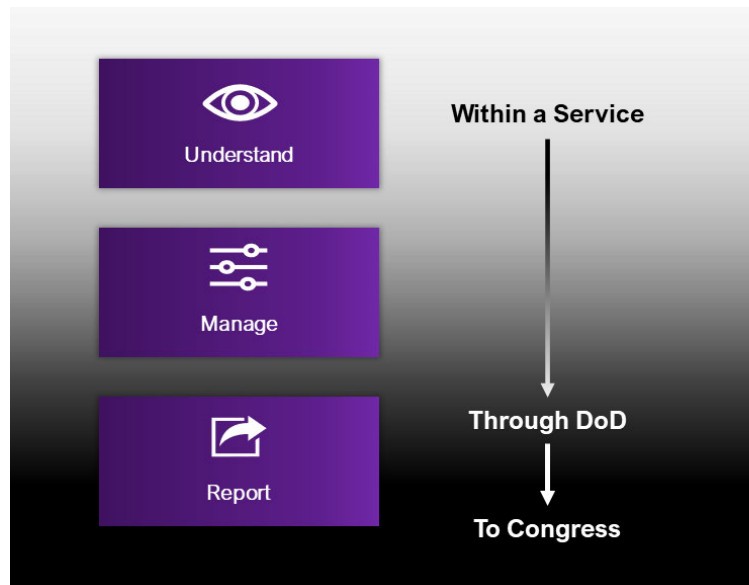
Capability assessments make up the other type of data in DRRS-S. Capability assessments provide subjective determinations of capability by the unit commander regarding whether the unit can fulfill its operational missions today as captured by METs and assigned missions.²⁷ These assessments are typically supported by long-form remarks that help to explain the assessments. They are also primarily focused on the tactical, though some comments and other narrative material may reach into operational and strategic issues.

These data make up a report of the military's readiness that is **focused on tactical availability for today's fight**. The framework recommended in Chapter 4 is designed to better convey this information but also to include other information that gives a more comprehensive picture of USSF readiness.

Understanding, Managing, and Reporting Readiness

Given the relatively narrow focus of DRRS-S, many communities throughout the military services leverage a broader framework for understanding readiness that goes beyond current mission readiness. Our analysis of those frameworks suggests that readiness includes three activities: understand, managing, and reporting. As shown in Figure 1.3, these activities vary in one crucial way: Each focuses on a different user of readiness information.

Figure 1.3. The Understand–Manage–Report Information Ecosystem



²⁷ An MET is “a specified or implied task that an organization must perform to accomplish the mission”; CJCSI 3401.02B, 2014, p. GL-4. Missions are collections of tasks and are either core missions (the missions the unit is designed to accomplish) or assigned missions (missions tasked to a unit as part of a named operation or top-priority level 4 plan; CRS, 2020a).

Understanding readiness. The goal of *understanding* a military unit’s readiness is to increase the service’s awareness of the unit’s current capabilities, which informs decisions about availability and resource allocation. There are three components of understanding:

1. **Situational awareness** is a resource-based understanding of a service’s readiness (what is available), and a capability-based understanding of a service’s ability to accomplish METs (what is needed).²⁸
2. **Commanders’ critical information** is information that enables commanders to see the readiness of their units and understand the complex environment in which they may be called to operate by helping them prioritize which situations they should be ready for.²⁹
3. **Readiness models** are a mix of different models that services use to assess their own resource and capability readiness, such as the Army Strategic Readiness Assessment (ASRA). These models complement DRRS-S but are not closely integrated with it.³⁰

Managing readiness. The goal of *managing* readiness is to help services invest in areas that need improvement. This involves using information from the *understanding* phase to balance the current availability of resources against what is needed for the fight. Managing readiness includes reallocating current resources to best meet pressing demands and investing in additional resources to improve readiness in the longer term.

Reporting readiness. Congress and DoD need readiness information that informs higher-level awareness and decisionmaking. DRRS-S reports primarily unit-level readiness data.³¹

As we will discuss in more detail later in this chapter and in Appendix B,³² we find that all services have additional tools that complement DRRS-S. We believe these additions are essential if a service is to understand and manage readiness in the face of changing missions and operating environments.

Dimensions of Readiness

To describe the potential scope of readiness, we use doctrine and a review of the readiness practice of other military services to define four dimensions of readiness, as shown in Figure 1.4.

²⁸ U.S. Code, Title 10, Section 117, 2019a; U.S. Code, Title 10, Section 482, 2019b; AFI 10-201, *Force Readiness Reporting*, Washington, D.C.: Department of the Air Force, December 22, 2020.

²⁹ Zoltán Pozderka, “Commander’s Critical Information Requirements,” *Applied Military Sciences*, DR2018/1, 2018, p. 126; Joint Staff J7, Deployable Training Division, *Insights and Best Practices Focus Paper: Commander’s Critical Information Requirements (CCIRs)*, 4th ed., Suffolk, Va.: Joint Staff J7, January 2020, p. 1.

³⁰ Note that for the purposes of this paper, we chose to discuss the readiness ecosystem within the context of the broad Defense Readiness Reporting System (DRRS) landscape. DRRS-Strategic—(i.e., the DoD-wide DRRS reporting system) contains tactical unit-level readiness data, and thus does not incorporate strategic or operational data that is useful to the services as they attempt to see and manage their readiness.

³¹ DoD, *Report to the Congressional Defense Committees on Defense Readiness Reporting Systems Reform*, Washington, D.C., February 2020a, pp. 10–15.

³² Appendix B provides more detail on how the other DoD services augment DRRS-S to understand, manage, and report readiness considering their internal needs. While this report is focused on the USSF, the fact that other services confront some similar challenges suggests that some themes from this report may have broader applicability.

Figure 1.4. The Four Dimensions of Readiness Reporting

Purpose: • Force Assessment • Resource Decision Support • Force Management • Legal/Policy Compliance	Time Horizon: • Today • Contingency Ops (Weeks to Prepare) • Strategic Escalation (Months to Prepare) • Future Needs (PPBE Centered)
Level of War: • Strategic • Operational • Tactical	Range of Military Operations: • Deterrence and Security Cooperation • Crisis and Limited Contingency Ops • Major Operations • High-End Near-Peer War

SOURCES: Authors' analysis of JS, 2017.

These dimensions capture the most important aspects of a specific readiness assessment or report. The first, and likely most important dimension, is the purpose of a readiness assessment. Purposes include force assessment, supporting resource decisionmaking, force management and generation, and maintaining legal and policy compliance. The time horizon upon which the assessment is conducted is also a critical dimension and ranges from “today” through different operational timelines, such as shorter-term contingency operations and/or strategic escalation, through a longer-term force modernization lens centered on the Planning, Programming, Budgeting, and Execution (PPBE) process.³³ From a doctrinal standpoint, the level of war (tactical, operational, and strategic) and the range of military operations are also important potential dimensions when considering a readiness assessment or report. As noted earlier, DRRS-S readiness reporting appears to be focused on reporting readiness for “today’s fight,” which covers only a limited range of these dimensions.

From interviews with a wide range of stakeholders in the readiness community, we have seen that there can be a long-standing tension between those who believe that readiness information can and should be contained within a single system and those who believe that it is necessary to develop distinct tools and systems with specific purposes.³⁴ Given the range across the above dimensions, we believe that (1) no single tool or system can address all elements well, and

³³ PPBE refers to the methodology used to allocate resources within the USSF and the Department of the Air Force (DAF).

³⁴ U.S. Code, Title 10, Section 117, 2019a, requires that there be a “single authoritative readiness reporting system for the Department, and that there shall be no military service specific systems.” In practice, we find that the result is that DRRS-S is the single authoritative source for reporting readiness to Congress. Indeed, information not contained within DRRS-S may be excluded from appropriations decisionmaking for operations and maintenance. However, as discussed above, there are numerous clear examples across the services of other readiness systems being developed and applied to serve the service’s internal needs.

(2) when a deeper analysis is required to meet service-specific needs, capabilities beyond that of DRRS-S are required.³⁵

Conventional readiness reporting by a military service through DRRS-S is bottom-up, focused on tactical units, and not always well suited for strategic decisionmaking. Other military services have created readiness assessment and reporting frameworks that better meet their needs. The Navy, for example, has created the Personnel, Equipment, Supply, Training, Ordnance, Networks, and Infrastructure (PESTONI) framework,³⁶ which is designed to inform resourcing decisions as part of the Navy’s modernization process and to better meet strategic future needs. The U.S. Army developed ASRA to better conduct force assessments at the operational and strategic levels of war and through time-phased force and deployment data timelines. Organizational differences between services can also affect how readiness is understood and reported. For example, the U.S. Marine Corps and the U.S. Navy report their readiness independently and have separate service-level policy and guidance but do coordinate higher-echelon readiness narratives across the Department of the Navy when required to understand joint Marine Corps and Navy missions (such as amphibious operations).³⁷ These readiness models inform decisions affecting readiness at the highest levels.

Thus, while DRRS-S is the system that services are required to use for reporting readiness data to Congress, it is not the only system that services can or should use to understand and manage their readiness internally.³⁸ The creation of the USSF is an opportunity to identify the most critical needs for the new service and develop frameworks that can meet those needs.

Goals of a Readiness Framework

Our project began with a “blank slate” mandate to consider readiness and readiness reporting for the USSF.³⁹ However, some fundamental goals apply to all readiness frameworks no matter their specific scope. All readiness frameworks should strive to

1. provide “actionable” information that can guide decisionmaking
2. provide accurate information

³⁵ Capabilities of DRRS-S refers here to the MET/mission assessment data and PRST, as shown in Figure 1.2.

³⁶ PESTONI is sometimes called PESTOF (Personnel, Equipment, Supply, Training, Ordnance, and Facilities). In thinking about whether these factors are applicable to space operations, we note that networks and infrastructure are critical to space operations, but there is little dependence on supplies or ordnance.

³⁷ For examples of service-level readiness policy documents, see: Commandant of the Marine Corps, *Marine Corps Combat Readiness Evaluation (MCCRE)*, MCO 3501.1E, February 25, 2019; and Chief of Naval Operations, *Navy Integrated Readiness*, OPNAVINST 3000.16, February 15, 2019.

³⁸ Appendix B gives more detail on the precedents from the sister services of readiness frameworks that augment DRRS-S, and a brief discussion on the legal and policy requirements surrounding readiness reporting and the use of DRRS-S.

³⁹ This project is focused on the USSF rather than space systems more broadly. Other government space systems, outside the responsibility of the USSF, are not included in the research and were not considered during the design of our framework except for where those dependencies affect USSF readiness.

3. be based on objective measures where practical
4. reduce the burden on reporters and consumers of readiness information
5. leverage reliable and known data sources
6. consider the specific needs of the generators and consumers of readiness data.

Throughout the project, we considered whether the current readiness reporting system is meeting these goals for the USSF and how other services try to meet these goals. In the next section we examine how unique attributes of the USSF might affect how it should understand, manage, and report readiness.

Unique Attributes of Space Operations and the USSF That Affect Understanding, Managing, and Reporting Readiness

Operations in outer space are different from those of other military domains. Many of these differences change how the USSF should understand, manage, or report its readiness. We identified the following major characteristics that differentiate the USSF and its readiness from other services.

1. An Accelerating Need to Operate in Environments That Are Contested, Denied, or Operationally Limited by an Adversary

As noted above, today's U.S. military space organizations, systems, and missions were designed to respond to and mitigate only a subset of potential adversary threats.⁴⁰ The USSF is not ready for the full array of threats it may confront and is "embarking on the most significant transformation in the history of the U.S. national security space program."⁴¹ While the other services are also confronting a renewed focus on potential near-peer conflicts, none are starting from a position of architectures that were designed with little protection from a large range of

⁴⁰ The history of "sanctuary" in space policy is complex and can be contentious. Antisatellite weapons have been considered since before the first satellite was launched, and the Soviet Union and United States both started antisatellite missile programs in the late 1950s. The Soviet Union successfully tested a co-orbital antisatellite weapon in 1968 and declared it operational in 1973; see Grego, 2012. Until the second half of the 1970s, however, the United States primarily responded diplomatically, politically, and legally to make attacks to space systems untenable. Since then, a policy recognizing increasingly contested outer space has consistently, though not steadily, come to define U.S. military thinking; see Robin Dickey, *The Rise and Fall of Sanctuary in Space Policy*, El Segundo, Calif.: Center for Space Policy and Strategy, Aerospace Corporation, September 2020. In combination with limited resources and the very long lifetimes of most space systems, today's space system architectures have not been designed to be resilient to the full range of adversary threats. Recent military space strategic documents (e.g., DoD, *Defense Space Strategy Summary*, Washington, D.C., June 2020b; USSF, 2020b) and analytic reports (e.g., Gary McLeod, George Nacouzi, Paul Dreyer, Mel Eisman, Myron Hura, Krista Langeland, David Manheim, and Geoffrey Torrington, *Enhancing Space Resilience Through Non-Material Means*, Santa Monica, Calif.: RAND Corporation, RR-1067-AF, 2016; and Brien Alkire, Yool Kim, Matthew Berry, David Blancett, James Dimarogonas, Niraj Inamdar, Sherrill Lingel, Nicholas Martin, George Nacouzi, Joel B. Predd, and William B. Williams, *Enhancing Assessments of Space Mission Assurance*, Santa Monica, Calif.: RAND Corporation, RR-2948-AF, 2020) highlight today's urgent need to increase capabilities against a wider array of possible threats, particularly from potential near-peer adversaries.

⁴¹ DoD, 2020b.

existing adversary threats. In this context, readiness must address not only whether the USSF is ready for its day-to-day missions but whether it can adapt to meet and then keep pace with the adversary threat.

2. A Predominance of Operational Personnel That Are Employed in Place

The practice of assessing and reporting readiness can vary between services and has changed over time, but in practice has primarily focused on managing the supply and demand of *expeditionary* forces.⁴² The USSF, however, is overwhelmingly conducting missions where its personnel are employed in place (EIP)—conducting their missions from static locations, many of which are in the continental United States.⁴³

3. A Predominance of 24/7 Service-Providing Missions to Enable Fights in Other Domains

The current readiness reporting system is primarily designed to report whether forces are ready to take action to deploy for a mission now or at some specific time in the future. However, as we discussed when describing the USSF supporting missions, the USSF conducts many of its missions every day, providing critical services such as navigation, missile warning, satellite communications, and weather prediction to the joint force (and in some cases beyond the military). The USSF protects and defends these missions from routine cyberattacks and electronic warfare attacks every hour of every day.

4. An Operational Dependence on External Military, Civil, and Commercial Organizations

The USSF is relatively dependent on other organizations for its operational effectiveness. Beyond the mission dependencies on external agencies that we noted earlier in our descriptions of USSF support missions, there are two other dependencies that must be included in USSF readiness:

- Contractors provide essential technical expertise to many satellite missions.⁴⁴
- Facilities are often dependent on local utilities to function; may be in other countries; and are dependent on the Army, Navy, or USAF for support functions such as civil engineering and security.

Because the current readiness system is designed for deployable units with fewer such dependencies in their operations, it is not well suited to capture dependencies.

⁴² Tirpak, 2020; DoD, “Sequestration’s Impact to Regaining Readiness,” fact sheet, undated.

⁴³ Notable exceptions are deployable space electronic warfare and intelligence, reconnaissance, and surveillance units. The USSF also employs personnel in place at locations outside the continental United States: in Alaska, Guam, and Hawaii, and on allied territory (e.g., Diego Garcia [British Indian-Ocean Territory], Flyingdales [United Kingdom], and Thule [Greenland]).

⁴⁴ Anthony D. Rosello, Muharrem Mane, and Paul Emslie, *Assessing the Readiness of Contractor-Provided Space Operations Capabilities*, Santa Monica, Calif.: RAND Corporation, RR-A649-1, 2022.

5. Compared with Other Services, a Reliance on Highly Autonomous Systems for Both the USSF's Service-Providing and Space-Warfighting Missions

Space systems are designed to function without human intervention for long periods of time and to autonomously protect themselves when adverse conditions are encountered. This is because communication links back to the terrestrial operations center are often unavailable due to both naturally occurring and adversary-induced events. For some missions, the readiness of space capabilities may be less dependent on human-guided functions and at least as dependent on the systems themselves and the resilience of their autonomous systems. Existing systems are not, however, designed to detect and properly respond to the full range of adversarial threats. In the short term, the readiness of space capabilities will depend on man/machine collaborations that current satellites, simulators, user interfaces, and training aides were never designed to support. New tools and measures may be needed to properly address the complexity of these collaborations.

6. A Limited Ability to Realistically Train for Space Warfighting Missions

Training is a core component of readiness, and defining training requirements is a key component of answering the question “Ready for what?” However, the USSF is currently limited in its ability to train for some missions, particularly for a near-peer conflict in space. Training on live systems is limited by availability, operational security concerns, and the risk to highly valuable systems. High-fidelity simulators of each spacecraft and the space environment are in limited supply; and those that exist were not designed to include adversary threats or the tactics, techniques, and procedures (TTP) needed to counter those threats.⁴⁵ This complicates the definition of readiness requirements and reporting requirements.

Research Approach

The objective of this project is to recommend a readiness reporting framework for the USSF. The analysis to build this recommendation consisted of four tasks:

1. reviewing the readiness policy and practice of other military services
2. studying the current USSF readiness reporting system
3. identifying areas of improvement for the USSF readiness reporting system
4. developing and recommending a USSF readiness reporting framework.

⁴⁵ For instance, a typical high-fidelity simulation environment used for training operators to change or maintain a satellite's orbital position are designed to emphasize the small perturbations (such as gravity or solar wind) that affect maneuver efficiency. These simulations do not include the large-scale dynamics and controls needed to manage the satellite's orbit position relative to a co-orbital satellite that is being actively maneuvered in an adversarial manner. There is a related problem, however, in that even when adequate simulators exist, operations centers do not have sufficient operational equipment, personnel, or facility space to set up a dedicated training environment. For those dedicated training environments that do exist, such as those used for the annual Space Flag exercise, after action reports we reviewed discussed significant limitations.

Each of these steps used a mixed methods approach, including literature reviews (policy documents, news articles, previous research reports), unstructured subject matter expert (SME) interviews, and analysis of DRRS-S data. Preliminary findings were corroborated through discussions with select stakeholders. Development of the framework was an iterative and collaborative effort by the team through brainstorming exercises, structured and unstructured discussion, and working through the specifics of use case examples. Appendix A gives more detail on the methods and data sources used.

The Organization of This Report

This first chapter has defined the missions of the USSF and notes that the service is going through a time of dramatic evolution, argues that traditional measures of readiness do not align with the unique characteristics of military space operations and organizations, and notes that other services have augmented DRRS-S to meet their needs. It also outlines the approach used to develop a recommended readiness framework for the USSF.

The remainder of this report is organized as follows: Chapter 2 introduces some of the fundamental challenges to understanding and reporting readiness for the USSF, and particularly how the military space mission and operational concepts are evolving across the dimensions of doctrine, organization, training, materiel, leadership, personnel, facilities, and policy to better meet the near-peer threat, which motivates how the USSF's readiness should be understood and reported. Chapter 3 presents research findings and recommendations on the current state of readiness reporting in the USSF. In some cases, those recommendations are "tactical" in that they can be implemented to improve the effectiveness of reporting readiness within existing systems. In other cases, the USSF's unmet needs are more fundamental and drive the design of our recommended readiness framework. That framework is presented in Chapter 4, which includes a discussion on guiding principles, a description of the framework, and two use cases to give examples of how the framework may be applied. Chapter 5 recommends a transition plan to build toward the full implementation of this framework while also improving readiness reporting in the shorter term.

There are also three appendixes. Appendix A gives a longer description of the research methodology used in this project. Appendix B provides a comparison of readiness policy and practice across the U.S. military services, which helped to inform and scope our research focused on the USSF. Appendix C gives some of the detailed evidence and examples that support the findings in Chapter 3.

Chapter 2. Challenges to USSF Readiness

In this chapter we explore how the unique characteristics of space and space warfare may affect how well the USSF performs its OT&E mission and how well it is able to track performance. These characteristics will help to understand some of the shortfalls described in Chapter 3 and motivate the design of the readiness framework described in Chapter 4.

The Challenge of the Near-Peer Fight

To organize our thinking regarding current challenges to USSF readiness and the desired end state that will be needed for the near-peer fight, we considered impacts on readiness of doctrine, organization, training, materiel, leadership, personnel, facilities, and tactics. In each of these areas, Table 2.1 lists the key challenges we identified from our research and counterposes a list of desired end-state characteristics that would improve USSF's readiness for the near-peer fight.

Table 2.1. Current Challenges and Desired End State of USSF Readiness Enablers

Factor/Element	Current Challenges	Desired End State
Doctrine/policy	Emergent	Socialized and mature
	Under development in parallel across major stakeholders	Rules of engagement codified
Organization	Design in progress (continuous organizational change)	Aligned to the near-peer fight
	Informed by legacy USAF	Aligned to mission
	Spread across services, reserve and guard personnel, civilians, contractors	Clear organizational identity
		Readiness reporting is aligned to organization
Training	New advanced training programs for some operations squadrons are immature	Training infrastructure (simulators, instructors, etc.) aligned with threat environments and multidomain operations
	Awaiting training resources/infrastructure	
		Training curriculum aligned to tactics
Materiel (equipment)	Vulnerable to near-peer threat	Robust to near-peer threat
	Designed for permissive environment	Ability to plan for future emergent threats while balancing current missions
	Difficult to assess at major systems level (in DRRS-S)	
	Contractor equipment not in DRRS-S (but is tracked)	Includes mission essential contractor equipment

Factor/Element	Current Challenges	Desired End State
Leadership ^a	Difficult to obtain good data for decisionmaking Misleading quantitative measures given DRRS-S data quality Harder-to-digest info (e.g., commander remarks)	Ability for leaders to • understand and manage readiness levels • secure funding by articulating needs better • prioritize needs.
Personnel	Dependent on contractors and external expertise Tied to out-of-date manning/personnel studies Misaligned people and jobs	Organic technical excellence Efficient and innovative ways to acquire, use, and retain a mix of talent Up-to-date manning studies The right people doing an appropriate job
Facilities/infrastructure	Demands not totally articulated Lacking real estate Limited resilience	Demands understood Resource planning for supply
Tactics	Limited interaction with partners for tactics development and testing Lack of tactics and procedures to harden or protect assets from evolving threats	Guided by threat analysis Rapidly evolvable

^a Here we use a definition of *leadership* that includes providing leaders with the resources required to correct problems, which goes beyond the education used to prepare leaders to lead the fight.

In the area of doctrine and policy, a primary challenge to readiness is the current immaturity of rules of engagement for space warfare. Rules of engagement are the constraints placed on how warfare is conducted. As such, those rules affect the tactics employed and the training of personnel. Our readiness framework must accommodate and make visible the impact that evolving rules of engagement, and adversary actions, will have on tactics and training. Throughout this report we will highlight tactics and training issues. One of the use cases selected to validate our proposed framework explores this topic in detail (see Chapter 4).

We offer thoughts on organizational design and personnel in the next sections, where we discuss challenges in defining a force presentation construct for the USSF and in assessing USSF organizational dependencies. As with tactics and training, we assume that the USSF organizational constructs will evolve substantially over the next decade as the USSF matures. Therefore, the other use case selected to validate our proposed framework (also documented in Chapter 4) is centered on the need to track and maintain readiness throughout the organizational and mission redesign process.

Equipment and facilities will not, we believe, evolve as rapidly as tactics, training, and organizations. The challenge for our readiness framework is to make visible where investments in equipment and training will have the largest impact on improving readiness.

In the area of leadership, the largest challenge to USSF readiness is the current readiness reporting system itself. As we will discuss in considerable detail in Chapter 3, the current system is not providing either accurate or actionable intelligence on which leadership can base decisions. A primary goal of our research is to recommend a transition plan that mitigates this situation.

The Challenge of Defining Force Presentation for Space Systems

As we noted in Chapter 1, the individual armed services use their own readiness reporting schemes to complement the information in DRRS-S. In USAF, for example, readiness reporting is aligned with its force presentation construct—that is, “the preferred organizational construct through which a service offers its capabilities to the combatant commanders.”⁴⁶ In the USAF force presentation construct, units are responsible for producing a certain number of unit type codes (UTCs). Each UTC defines a grouping of people and/or equipment that represents a package of capability that can be deployed in combat.⁴⁷ Readiness is then assessed for each UTC. For the USSF’s largely 24/7/365 EIP missions, it is not clear (1) whether UTCs should be used and (2) if they are used, what elements should be packaged within a UTC.⁴⁸

Stepping back to take the broadest view of what is required to offer a warfighting service to the combatant commanders, we find that the *force* presented to the terrestrial combatant commanders by the USSF is not easily packaged.⁴⁹ Two common options, geography and personnel, are not well suited to the space mission. Imposing a geography-oriented force presentation construct seems to contradict the very nature of space itself. The U.S. military has chosen to project warfighting power from space specifically to take advantage of the fact that a small set of equipment and personnel can provide global service, removing geographic dependencies. For supporting missions, the USSF may be able to provide *more* or *better* service to a particular combatant command by moving or reconfiguring satellites; but those actions are part of normal operations and do not require unique personnel, equipment, or training resources. While USSF expeditionary units help theater commanders achieve the best use of the space

⁴⁶ We have borrowed this definition of force presentation from Alan J. Vick, *Force Presentation in U.S. Air Force History and Airpower Narratives*, Santa Monica, Calif.: RAND Corporation, RR-2363-AF, 2018. As Vick notes, among DoD services, only the USAF uses the particular terminology of “force presentation,” but all services have an organizational construct used to size, deploy, and employ forces; sustain operational effects; manage force rotations; and articulate service purpose.

⁴⁷ Department of the Air Force, “Department of the Air Force Guidance Memorandum to DAFI 10-401, *Air Force Operations Planning and Execution*,” January 18, 2022.

⁴⁸ Given the strong association within the DAF of UTCs with deployment, it might be best to invent some other term for the unit of readiness reporting within the USSF.

⁴⁹ In this discussion we distinguish between terrestrial combatant commands and space combatant commands. Of the seven geographic combatant commands, only one operates in space: U.S. Space Command (USSPACECOM). Of the functional combatant commands, which have no geographic boundaries, U.S. Strategic Command and U.S. Cyber Command are the most likely to conduct operations in space. A reasonably simple and clear explanation of combatant commands is provided in Theo Dyessan, “What Is a Combatant Command?” *Sandboxx Blog*, December 1, 2020.

services at their disposal, these expeditionary units make up a very small percentage of overall USSF personnel and equipment. For these reasons, a geographic packaging of USSF resources is of limited use as a force presentation construct.

Using a personnel-based construct is incompatible with the autonomy of space systems. Autonomy ensures the continuity of warfighting services to the combatant commanders even when personnel, operations centers, or ground antennas are lost to attack. For as long as the autonomous system survives, the USSF will continue to provide service to the combatant commanders, although with degraded performance. In contemplating autonomy and the man/machine relationship, humans and machines seem to us to be distinctly more “separable” in space systems than in air, naval, or ground systems. It is normal to say that an air squadron assigned to a combatant command is “equipped” with 12 aircraft. Those aircraft travel with their humans. Spacecraft do not travel with their humans (although the equipment to access them does). And, as we pointed out earlier, the humans largely do not travel at all but are instead EIP.

In examining force presentation constructs to provide space support for the terrestrial fight, we considered the following options:

1. grouping by individual crew positions (such as orbital analysts, payload operations specialists, or network and IT support personnel)
2. grouping by space crew, where the crew is defined to include all on-console and backroom support positions in an operations center needed for an eight- or 12-hour shift of operations⁵⁰
3. grouping together all personnel and equipment, including backups and spares, required to accomplish a given space mission (e.g., missile warning, weather data collection, satellite communications).

Our research leads us to favor the third option. A force presentation construct can fulfill a variety of purposes: to size, deploy, or employ forces; to sustain operational effects; to manage force rotations; and to articulate service purpose.⁵¹ Of these, a construct describing sustainment of operational effects, as the mission-centric grouping does, may be best suited to presenting USSF capabilities to the combatant commands. The operational effect of power projected through space is more important to the terrestrial combatant commander than the number of crew on console or analysts available.

The same is not true of the space combatant commander. As we noted in Chapter 1, humans will need to carry the burden of defending against a wide array of near-peer threats for existing space systems. Despite their autonomy, these systems were not designed to operate through the

⁵⁰ On-console positions include those Guardians who monitor real-time displays of information and are authorized to send command to the satellites or other control elements. Backroom positions typically include mission planners, orbital analysts, and a small rapid-response team to sustain the critical networks and computing infrastructure used for space operations.

⁵¹ This list of construct types is from Vick, 2018.

multitude of attack vectors that a near-peer adversary might devise. Options for presenting force to the commander of USSPACECOM include

1. grouping together all personnel and equipment needed to defend specific regions of space (e.g., geosynchronous versus low earth sun synchronous orbit)
2. grouping together all personnel and equipment needed to defend against specific attack vectors (e.g., cyberattack, ground jammer attack, direct ascent or co-orbit attacks)
3. grouping by “strike teams” that have the skills to defend against the full range of attack vectors, and assigning strike teams to the systems they are designed to defend (e.g., communications versus missile warning systems).

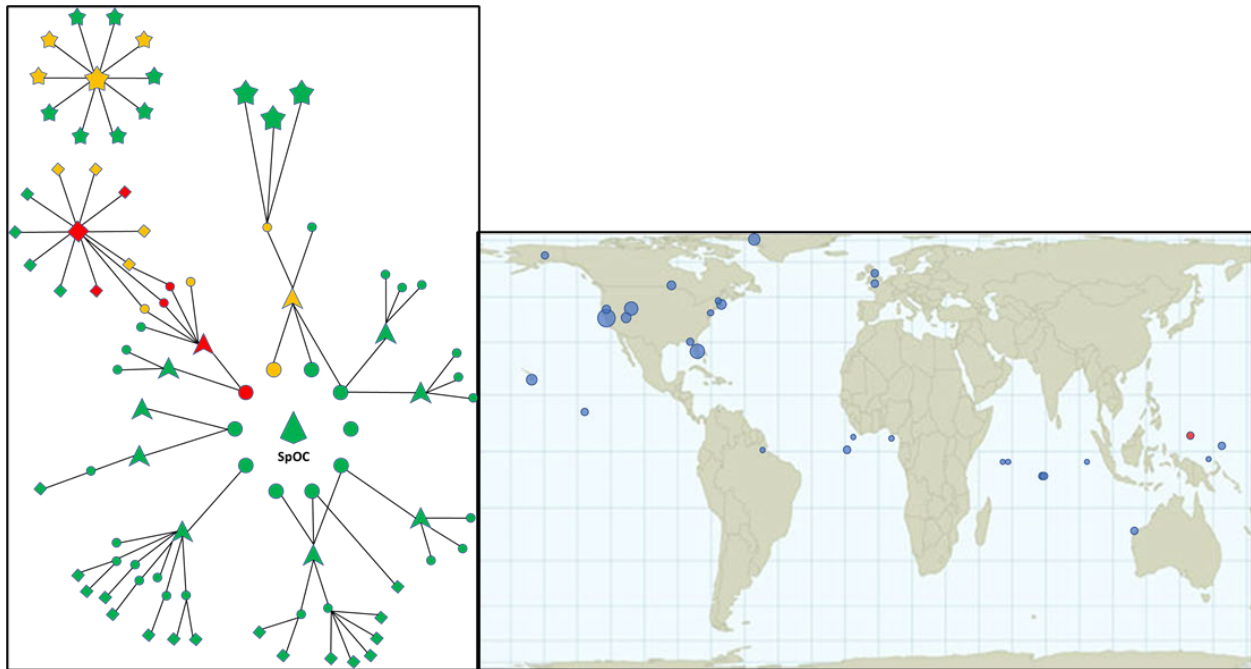
While the same force presentation construct does not need to be used for both the terrestrial and space combatant commands, the last of these options may be the most compatible with a mission-centric force presentation approach.

The Challenge of Interdependencies in Fulfilling the Space Mission

We believe it will be unrealistic to expect that any decision on force presentation construct will map cleanly to missions. This is due to the complex interdependencies of resources and missions prevalent in existing U.S. space systems. For instance, a given ground station and antenna complex will often support multiple operations centers. Satellites often carry secondary payloads that support missions other than the satellite’s primary mission. Therefore, some operations centers support multiple missions, while in other cases a mission may rely on operations at multiple centers. These interdependencies exist largely because of the scarcity of resources in space—space system designers have prioritized resource usage efficiency above modularity.

To aid in understanding the dependencies among existing squadrons, equipment, and facilities in providing space services, a tool could map those interdependencies in a network graph and to terrestrial geography, as shown in Figure 2.1. Second- and third-order effects of a readiness problem in one system or unit may be more intuitively seen by the dependencies and color-coded status markings. We believe that integrating this type of dependency mapping into the USSF readiness reporting framework will be essential, independent of USSF decisions on force presentation. A good visualization, such as that provided by the network graph, can quickly show how the loss or degradation of a single facility, piece of equipment, or person affects the entire USSF enterprise (i.e., how loss of a shared resource affects specific missions). The geographic map then provides context to understand the mission impact on the terrestrial combatant commands. Headquarters Space Operations Command S9A (HQ SpOC/S9A) is developing a tool intended to provide an operational picture including such interdependencies, using graphics similar to those in Figure 2.1.

Figure 2.1. Graphs and Maps Displaying the Impact of Complex Dependencies on USSF Readiness



SOURCE: Authors' analysis of graphics from a tool under development by HQ SpOC/S9A.

NOTES: All data is illustrative/notional. The mission-dependency graph maps outages to missions. The map then contextualizes those mission impacts on the space services available to a geographic combatant command.

As we noted in the supporting mission descriptions in Chapter 1, most missions rely on organizations outside the USSF, which further complicates force presentation. In addition to other U.S. armed service branches and agencies, the USSF is heavily reliant on reserve forces, civilians, contractors, other government organizations, and even foreign partners. For instance, the positioning, navigation, and timing mission relies on inputs from the NGA's GPS division and the U.S. Naval Observatory, as well as the 19th Space Operations Squadron (SOPS), which remains under the Air Force Reserve Command. If readiness only looks at units organic to the USSF, critical pieces will be missed that contribute to space capabilities.

When considering readiness reporting for space capabilities that involve interdependencies outside the USSF, it is important to account for all the pieces of the mission to assess readiness and resilience. There are personnel, equipment, and training elements that cross organizational barriers, and these organizations do not report using similar measures that feed to a centralized entity. We recommend that the USSF assign responsibility of reporting on critical external equipment, facilities, or personnel to the unit most closely aligned with those external entities. If these external items are not accounted for in the readiness reporting framework, the USSF will be blind as to the impact of their possible loss.

The USSF is confronting several fundamental challenges to defining its readiness, including rapidly evolving to be more ready against a broader range of threats, presenting forces in a way that is both consistent with space operations and useful to combatant commanders, and including organizational and technical interdependencies critical to readiness. These challenges—and particularly the first—inform the research findings and recommendations in Chapter 3 and motivates the design of the framework in Chapter 4.

Chapter 3. The Current State of USSF Readiness Systems: Findings, Risks, and Recommendations

Reporting the readiness of a very complex organization such as the USSF is an immense challenge. It remains constrained by the legacy of USAF policy and a system that was designed for expeditionary units. Problems stem from technical details and from fundamental differences between DRRS-S capabilities and USSF needs. As we have stated, the creation of the USSF is an opportunity to create a readiness framework that works for the space domain. In some cases, there are steps that the USSF can take to improve its readiness systems, processes, and tools in the relatively near term. Those steps will be presented as recommendations in this chapter. In other cases, the problems are more fundamental; these challenges drive the design of our recommended readiness framework described in Chapter 4.

As we will demonstrate in this chapter, we find that current readiness systems, processes, and tools do not address the range of USSF needs and have long failed to objectively report the readiness of the space forces. The transition to the USSF has created new challenges—and particularly technical challenges regarding IT systems and processes. However, fundamental problems existed long before the standing up of the USSF. One USSF officer we spoke with stated that readiness reporting “**is so broken, we cannot tell you how broken we are**”; our team’s assessment agrees.

In this chapter we discuss each of our findings regarding the current state of USSF readiness systems in light of the risks each represents to USSF readiness and our recommendations for mitigating those risks.⁵² Our findings are as follows:

- The USSF does not effectively measure its readiness against the range of known threats.
- Legacy ADSs spoil readiness data.
- Critical information contained in commander’s remarks is not readily actionable.
- EIP missions are not supported.
- Complex organizational dependencies are not captured.
- Reporting is unnecessarily burdensome for units.

⁵² The findings, risks, and recommendations are presented throughout this chapter. A consolidated summary is given in Appendix D.

Finding: The USSF Does Not Effectively Measure Its Readiness Against the Range of Known Threats

As Chapter 1 describes, the USSF is undergoing a dramatic change in its OT&E posture to better confront the near-peer threat; its ability to do so effectively will drive its readiness for many years to come. DRRS-S has been designed to report readiness *given today's resources* and is not intended to provide multiple views of readiness. Given the dramatic changes many USSF units are undergoing to get ready for the near-peer threat, some units have expressed a need to better measure and report readiness aligned with near-peer threats, including different resource requirements and assigned missions. These two views of readiness—one based on **today's resources**, the other on **needed capabilities** to respond to threats—provide different information for the same unit, as shown in Figures 3.1 and 3.2.

Figure 3.1. Measuring Readiness Given Today's Resources

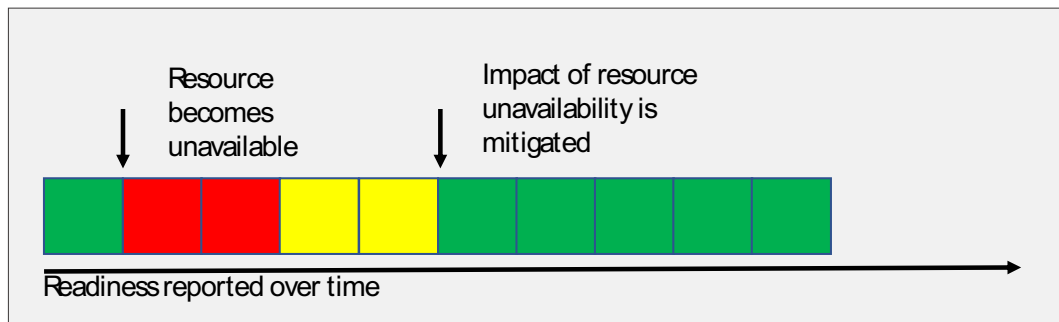


Figure 3.2. Measuring Readiness Based on Needed Capabilities



Figure 3.1 shows a notional example of measuring readiness against the threats the unit is currently OT&E'd to counter and given **the resources the unit has today**. In this view of readiness, the status of resources is readily apparent, and measured elements are under the control of the unit. It is primarily useful to help manage day-to-day readiness of the unit and to communicate setbacks in the availability of its authorized resources. It can be used to communicate the availability of operational capabilities and track progress toward resolving any temporary setbacks. This view of readiness does not show readiness for resources that the unit needs but is not authorized to receive, or against threats that the unit is not trained to counter.

Figure 3.2 shows a notional example of reporting readiness based on **needed capabilities** against today's near-peer threats. It requires the identification of the METs a unit will be called upon to perform through the potential range of conflict, the threats that it will face, and the resources that will be required to fulfill the unit's missions in the face of those threats. This view of readiness provides a measure of a unit's ability to counter the near-peer threat in "tonight's fight." However, the long period of unreadiness after a new threat is identified, and capabilities are developed to counter that threat, obscure valuable readiness information regarding the readiness of a unit for today's OT&E'd mission.

Reporting Tools Do Not Effectively Measure Multiple Views of Readiness

USSF units understand the need, in most cases, to communicate both views (the resources the unit has today, and needed capabilities) of their readiness. Because DRRS-S was designed for only one view of readiness (today's authorized and funded OT&E posture), many units are currently reporting on needed capabilities with long-form text remarks as part of both their resource and capability readiness sections. Unit commanders, as we read their reporting, are doing their best to provide situational awareness to consumers of readiness data given the communication venue they have available. But the resultant reporting is difficult to understand, does not provide easily actionable information, and is overly burdensome. While we heard calls for clear guidance to report *one* of these views of readiness (i.e., given today's resources versus needed capabilities), the view of readiness seen as most important differed depending on the unit's circumstance, and we believe there is value in both views.

However, DRRS-S is not well designed to clearly measure or report information on separate views of readiness. This results in burdensome reporting and readiness information that is not actionable for senior leaders. This USSF need and the challenge given the current readiness framework are fundamental motivating factors for the readiness framework and transition plan we have developed for the USSF and present in Chapter 4. In designing a new readiness reporting framework that incorporates both the *today's resources* and *needed capabilities* views of readiness, the following factors must be accommodated:

- **Alignment between responsibilities in reporting and execution.** Many aspects of capability development are not under the direct control of the operational unit, nor does the unit have the staff to manage activities such as PPBE decisions, organizational design, tactics development and validation, training, and the like. Units are nevertheless reporting on them because many such staff and development functions are not measured in DRRS-S.
- **Temporal concerns.** Neither today's resources or the needed capability view of readiness inherently measures the *pace* of change in a unit's readiness posture. Considering the current focus on evolving the USSF to better confront the near-peer threat, the ability of the service to rapidly adapt is its own critical measure of readiness. This may include changing the process of updating requirements (aspirational and authorized) to be more agile than it is today.

- **Disconnects between mission directives and real-world requirements.** Units that have been undergoing dramatic change require a reexamination and rewriting of their mission directives. We observed significant disconnects between mission directives and real-world requirements. While some of these disconnects can be driven by designed change to the way the units are OT&E'd, in the space community they are also driven by changes in how capabilities are used “in the field.” For example, the use of missile warning for theater support was more opportunistic than planned. Gradually, the joint force became dependent on that capability, and only recently has it become a documented use in USSF authorizing documents.⁵³

The Risk of Unallocated and Unfunded Resources Is Not Reported

In DRRS-S, units can only report objective readiness measures of resources it currently has authorized and funded. But choosing to not fund resources or capabilities in lieu of other priorities carries its own risks. These risks are not reported in DRRS-S and may be unknown. This omission may not be apparent to all observers and consumers of readiness information.

For personnel and equipment reporting, the unit reports on authorized packets, not on whether the packets represent the correct quantity and skill mix (personnel) or capabilities (equipment) needed for an evolving OT&E posture. For training reporting, the unit reports the percentage of personnel that have completed current training requirements, not on whether the training requirements reflect the near-peer threat. If packet authorizations and training requirements are not updated as missions evolve, the unit may report as “ready” in DRRS-S even though it is lacking necessary resources. This distinction, and the risks that follow, is difficult to discern from DRRS-S without spending substantial effort analyzing readiness reports and understanding the unit’s mission and composition.

Unallocated and unfunded resources are also found above the unit level due to disruptions related to the creation of the USSF. For example, there have been ongoing discussions focused on the potential role of reserve units in the USSF.⁵⁴ Entities in other services or in the reserves slated for transfer to the USSF risk becoming “orphaned.” By this we mean that their existing

⁵³ An example of “capability creep” is the relatively new demands and importance of the theater missile warning mission (relative to strategic missile warning, which for decades was the focus of the missile warning mission). Missile warning squadrons were organized for the strategic missile warning mission, and their authorizing documents continue to reflect that original mission in certain ways, such as the number of authorized billets and mission directives. As the capabilities of missile warning forces increased over time, theater missile warning became expected by the joint force. This can create strange discrepancies between the unit’s authorized resources and the analytic bases for those resources. For example, as personnel are added to missile warning squadrons to reflect the increasing demands of the theater missile warning mission, a unit appears to be *overmanned* by some measures because its mission directive and manpower assessment has not changed. This makes programming and planning decisions potentially more difficult.

⁵⁴ See, for example, Jacqueline Feldscher, “Proposed Space National Guard Gathers Momentum,” *Defense One*, May 4, 2021; Jaimi Chafin, “Senior Leaders Discuss Total Force Integration,” *Air Force News*, March 25, 2021; and Abraham Mahshie, “With Troops ‘Orphaned’ by the Air Force, Florida Guard Boss Calls for Space National Guard,” *Air Force Magazine*, August 13, 2021.

higher-HQ organization do not prioritize their needs.⁵⁵ While these units may be reporting readiness, during their orphan phase their readiness may not be tracked by the appropriate higher HQ, and the risk of unallocated or unfunded requirements in these units may not be known by the required parties. Presumably, once units are formally integrated in the USSF, this risk should dissipate. However, if those entities' capabilities are degraded during their orphan phase, the USSF will then have to shore up the unit. This risk can be mitigated by keeping transition periods as short as possible and by having the USSF manage and advocate for orphaned units until their transfer into the USSF. Otherwise, a persistent lack of resources may cause unit readiness to deteriorate in ways that take years or even decades from which to recover (e.g., due to the loss of critical expertise, loss of institutional knowledge, equipment or technical deterioration/lack of maintenance, or increased risk due to unstable resources).

Capabilities and Resources Required to Confront the Range of Known Threats Have Not Been Documented in an Authoritative Source

To inform debate and decisionmaking, and to report readiness against the range of near-peer threats, a credible source for required capabilities and resources is needed. These requirements will be aspirational and may be controversial, but there is a great need for a credible source to inform decisions and to create a baseline for the readiness measures recommended in Chapter 4. The threat environment conditions currently used within MET reporting can be a starting point for identifying such requirements, but these are currently specific to the readiness reporting community and may not be comprehensive. Identification of these requirements should be based on published guidance, and standards should be used to identify requirements for resources and capabilities. In that way, while there could be subjective differences in where to set requirements, the requirements are identified in a known way.

The study and identification of required capabilities and resources is related to ongoing processes in the USSF, such as the force design efforts of the Space Warfighting and Analysis Center. We intend to highlight here the benefits of tying the results of these efforts into the readiness discussion through an authoritative source that can be referenced across the readiness and planning communities.

The process for identifying aspirational requirements against the full range of adversary threats will likely benefit from being more “agile” than it has been. None of the units we spoke with believed they had a useful manpower assessment or mission directive. In many cases, the most recent manning study was conducted over a decade earlier, before major reorganizations or changes in mission. The lack of a useful manpower assessments makes it difficult to understand, at a unit level, what manning level is truly required (separate from what is authorized and assigned today).

⁵⁵ See, for example, Mahshie, 2021. Note that, at present, Air Force Reserve units that support the USSF are not planned to transition but will remain in USAF. This may result in those units becoming permanently orphaned.

Table 3.1 briefly summarizes the risks, recommendations, and supporting evidence regarding measuring readiness to confront the known threats.

Table 3.1. Summary Regarding Our Finding That the USSF Does Not Effectively Measure Readiness Against the Known Range of Near-Peer Threats

Risks	Recommendations	Evidence
The risks of not being ready against a full range of threats are obscured. Information to senior leaders may not be readily actionable because much is in commander's remarks in DRRS-S. Reporting may be burdensome for the unit.	Identify reporting requirements for today's near-peer threats.	Interviews with USSF units highlight the need for reporting readiness against the near-peer threat, in addition to today's OT&E posture.
	Publish guidance on what resources are to be measured.	
	Document requirements in a widely available and credible source.	Units had different priorities for their unit's readiness reporting (i.e., <i>today's resources</i> vs. <i>needed capabilities</i> views).
	Monitor orphaned units to identify and mitigate potential problems in their readiness until they are integrated into the USSF.	
	Assess the risks and benefits of process changes recommended in Chapter 4 to accelerate organizational change and update readiness reporting baselines while keeping pace with evolving threats.	DRRS-S remarks are regularly used to describe unit readiness against near-peer threats, but this information is not readily actionable.
	Implement the readiness framework and transition plan described in Chapter 4.	Interviews with USSF units reveal that some unit mission directives misrepresent either (1) their current missions or (2) their future missions.

Finding: Legacy Authoritative Data Sources Spoil Readiness Data

ADSs are the repositories for status data of the individual packets for resource readiness used in DRRS-S.⁵⁶ The USSF has inherited its ADSs from a time when the units belonged to USAF.

Critical Resources, Particularly Equipment, Are Sometimes Missing from Data

In some cases, the ADSs that track the availability of authorized and assigned resources cannot support an accurate measure of a unit's readiness because they are missing critical resources. This results in resource data and ratings that are not useful and can be dangerous for decision-making without significant correction or interpretation by experts who understand both the mission and the practice of readiness reporting within that unit.⁵⁷ The extremely rapid organizational change occurring due to the creation of the USSF has greatly worsened the

⁵⁶ To comply with DoD policy, units must report their resource data directly from a designated list of ADSs; see AFI 10-201, Air Force Space Command Supplement, 2021.

⁵⁷ Across the DRRS-S data we examined, we observe that significant effort is taken to explain the resource data and ratings within the commander remarks. In many cases, we found that reporting resource ratings alone, without looking at the long-form text comments, would give incorrect information about the actual readiness of a unit.

challenge of identifying and documenting a unit's authorized resources.⁵⁸ However, there are long-standing issues with the ADSs that the creation of the USSF did not cause. In our examination of critical mission systems and infrastructure, we found that, in many cases, critical resources are not owned by the operational unit and/or are not included in the proper databases.

We find that this problem is particularly acute in the tracking of equipment readiness. Appendix C gives the unclassified results of an audit we performed on equipment reporting in DRRS-S.⁵⁹ The data quality varies greatly. While for some missions the equipment data are clear and quite detailed, for other missions, critical equipment (such as satellites) is missing. In other cases, the data can be ambiguous or partial. This lack of objective and accurate data may not be obvious to consumers of readiness data who are less familiar with a given mission and system architecture.

Despite DoD's policy that requires designation and usage of ADSs "to the maximum extent possible,"⁶⁰ USSF equipment reporting is often not tied to ADSs. We found that 65 percent of USSF equipment reported in DRRS-S are manual entries (i.e., not from ADSs).⁶¹ Moreover, all packet entries for the DMSP, ground-based electro-optical deep space surveillance (GEODSS), and MILSATCOM systems are manual entries.⁶² Substantial reliance on manual entries is against DoD policy and could result in critical equipment missing from DRRS-S reporting. We do note, however, that use of an ADS is not a guarantee that mission critical equipment will be entered into those systems, and we have no evidence that manual entry is a source of error in readiness reporting. However, we do note that when many resource ratings are entered manually, rather than populated by ADS, the reporting burden on the unit is increased substantially.

Security Classification Misalignment Degrades Accuracy in Reporting

The security classification misalignment among ADSs, DRRS-S, and space operations' security classification guides also limits timely equipment reporting. Typically, the presence of any problem in a space capability is classified. However, the ADSs for USSF equipment readiness inherited from USAF (such as the Integrated Maintenance Data System) are only authorized to

⁵⁸ This reorganization is ongoing and includes the dissolution of a USAF major command, including numbered USAF wings and creation of the USSF HQ, three USSF field commands, nine Deltas, and three garrisons.

⁵⁹ Only unclassified information is provided in Appendix C, but it is consistent with our classified audit. Classification of ADS is its own topic of discussion later in this chapter.

⁶⁰ Department of Defense Instruction 8320.07, *Implementing the Sharing of Data, Information, and Information Technology (IT) Services in the Department of Defense*, Washington, D.C.: U.S. Department of Defense, August 15, 2015, incorporating Change 1, December 5, 2017, 3(d), p. 3.

⁶¹ We filtered the DRRS-S equipment and supply data from March 2021 by USSF unit identification codes and summed up the number of equipment line items with "(manual)" in the description. In DRRS-S, an entry with "(Manual)" in the packet name indicates that the packet is either not in an ADS or the ADS has not been set up to feed DRRS-S data.

⁶² MILSATCOM includes the Wideband Global SATCOM, Advanced Extremely High Frequency, Milstar, and Defense Satellite Communications Systems constellations.

contain unclassified data. This means that units can report a problem with equipment availability via DRRS-S only if they bypass the ADS or wait until after the equipment problem is fixed. Both options are prohibited, with the latter inevitably violating the timelines required by policy.⁶³

Furthermore, many USSF missions and their supporting equipment are classified above the *Secret* level and therefore not found *at all* in DRRS-S. The comment field in DRRS-S reflects this misalignment: One can find such comments as “Cannot report in DRRS-S due to classification reasons.”

Complex System Interdependencies Are Not Captured

The complex interdependencies of USSF missions and systems, as described in Chapter 2, create challenges when using legacy ADSs. DRRS-S line items do not reflect these interdependencies. Examples include (1) equipment and supply packets tracked independently of the space systems they support; and (2) METs and units tracked independently from other missions and units that rely on the same facilities, antennas, or even computing systems. Critical infrastructure, such as primary and secondary power, may not be reportable in DRRS-S, or it may not be clear what mission capabilities are dependent on that infrastructure. To illustrate this point, Table 3.2 shows notional DRRS-S data for a mission that depends on two operational Deltas and a garrison unit. There is no easy way to pull this data together from DRRS-S; it can only be assembled if one knows the dependencies.

Table 3.2. Illustrative DRRS-S Data for a Notional Mission That Depends on Multiple Deltas and Garrisons

Suborganization	Unit	Equipment Packet	Location	Quantity	Rating ^a
Peterson-Schriever Garrison	21st CES	Generator	Schriever SFB	2	3
Peterson-Schriever Garrison	821st SFS	Security vehicles	Thule Air Base	2	4
Delta 6	22nd SOPS	A/E24U-24 OAS	Schriever SFB	1	1
Delta 6	22nd SOPS	AN-FSQ213 RTS	Thule Air Base	2	2
Delta 8	4th SOPS	Satellite systems	Schriever SFB	4	1
Delta 8	4th SOPS	Critical spares	Schriever SFB	198	1

NOTES: Because actual ratings are classified, data in this table is illustrative, is simplified compared with real DRRS-S data, and does not correspond to any actual readiness report. SFB = Space Force Base; CES = civil engineering squadron; SFS = security forces squadron; OAS = orbit analysis system; RTS = remote tracking station.

^a These ratings, while only for illustrative purposes, represent the ratings (on a scale of 1–5) used in DRRS-S to evaluate the unit’s resource availability. The ratings are intended to indicate how many of the unit’s organized designed missions the unit is resourced to undertake. The rating 1 (the best rating) indicates that the unit is resourced “to undertake the full wartime missions for which it is organized or designed”; 4 indicates that the unit “requires additional resources or training to undertake its wartime missions”; and 5 indicates the unit is undergoing a “directed resource action and is not prepared . . . to undertake the wartime missions.” CRS, 2020a.

⁶³ AFI 10-201, Air Force Space Command Supplement, 2021, requires units to report changes to readiness within 24 hours of the relevant event.

Recognizing this deficiency in DRRS-S, HQ SpOC/S9A is developing a tool that maps interdependencies between unit and mission readiness in a way that is more intuitively understood (as illustrated in Figure 2.1).

These are just the more prevalent reasons the USSF is unable to utilize ADSs to their full extent. Units commonly enter substantial long-form comments into DRRS-S to explain and correct resource data. Entering this information is burdensome on the unit and does not result in readily actionable information for decisionmakers. Table 3.3 summarizes the risks, recommendations, and supporting evidence related to our finding that ADSs spoil readiness data.

Table 3.3. Summary Regarding Our Finding That Legacy Authoritative Data Sources Spoil Readiness Data

Risks	Recommendations	Evidence
Incorrect resource data may confuse or mislead PPBE decisionmaking.	Redefine ADSs to • better match security needs of space community • capture all critical mission equipment • better represent interdependencies of operational systems and units	Interviews with USSF units and analysis of DRRS-S remarks reveal the classification misalignment.
Reliance on manual entries is against DoD policy and may result in missing critical equipment from DRRS-S.	Engage with enterprise data system (e.g., the Unified Data Library) development to judge utility and leverage requirements to support readiness reporting.	DRRS-S equipment reports reveal a high number of manually entered packets.
Information may not be readily actionable for senior leaders or staff.	Review and revise resource requirements used in readiness assessment and reporting, with a focus on equipment.	DRRS-S remarks are regularly used to explain and correct resource ratings, often due to ADS limitations.
Second- and third-order effects of readiness issues may not be recognized or apparent in reporting due to complex dependencies.	Publish guidance on which resources are to be measured.	
Extensive manual entry is unnecessarily burdensome on units.	Catalog today's available resources.	

Finding: Critical Information in Commander Remarks Is Not Readily Actionable

Within DRRS-S there is a large quantity of information in the commander remarks associated with each MET and the resource ratings. For each MET remark, USAF instructions require there to be (1) a bottom line up front, (2) an issue description, (3) a statement of the impact of the issue, (4) a fix action specified, and (5) a get-well date—all in free-text format. Some remarks reiterate resource issues that may be corroborated in the resource ratings. In these cases, redundancy with

resource reporting may point to resource readiness reporting shortcomings, such as out-of-date authorized resource baselines, out-of-date business rule standards, or problems with the ADSs. Many commander remarks also describe how resource ratings oversimplify the picture and may not capture key readiness indicators. Similarly, other commander remarks serve to flag that the commander believes the conditions and standards associated with an MET, or sometimes whole METs, are inappropriate for the unit to be evaluated against.⁶⁴ In a sense, many comments report on the readiness of the readiness system in addition to the operational readiness of the unit.

Other commander remarks raise alerts to more strategic-level deficiencies where modernization or new tactics are needed. This means that arguably some of the most important information is found in the remarks, despite senior leaders primarily seeing the overall MET rating or C-level across units. One mitigation for this latter issue is the continued practice of units writing up their top concerns, which often reiterate the most pressing issues from their commander remarks. Some of the top concerns do filter up to higher echelons to support aggregated unit ratings in briefings. However, the issue remains that accurate reports of readiness problems seen at the unit level are mainly documented in DRRS-S as free text. Most of the information conveyed in the remarks cannot be easily rolled up with other METs or other units' assessments to present in aggregated form to leadership. That would require someone to read through each comment, analyze for trends, and present them in a new format.

Overall, while commander remarks often contain critical information (and are the only available venue within DRRS-S for communicating long-term strategic information), because the remarks are in long form, free text, contain much redundancy and repetition, and consist of a mix of correction and interpretation of other measures and additional information, they are not easily actionable for decisionmaking.⁶⁵ Therefore, much of their value is lost. Table 3.4 summarizes the risks, recommendations, and supporting evidence regarding our finding that critical information in commander remarks is not readily actionable.

⁶⁴ There is an established process for units to request revisions in their METs or resource baselines outside of writing a remark in DRRS-S; see AFI 10-201, Air Force Space Command Supplement, 2021. However, some unit leadership we spoke with felt that this process was not effective in practice.

⁶⁵ We would be remiss if we did not note another deficiency with most DRRS-S remarks. MOST DRRS-S COMMENTS ARE DISPLAYED IN ALL UPPERCASE LETTERS, WITH LIMITED FORMATTING, NEW LINES, AND LIMITED PUNCTUATION. THIS MAKES THEM VERY DIFFICULT TO PARSE. IMAGINE IF THIS FOOTNOTE WERE A HALF PAGE LONG AND SPANNED MULTIPLE UNRELATED TOPICS, AND WE WERE OBLIGATED TO FULLY PREFACE EVERY SENTENCE WITH THE SAME PREAMBLE. IT WOULD BE CHALLENGING FOR YOU TO FIND THE IMPORTANT ITEMS TO PROCESS. The use of all uppercase letters is a relic of the old teletype machines. We believe it should be abolished. Furthermore, commanders should use tables, indentations, **boldface**, and *italics* to delineate their comments.

Table 3.4. Summary Regarding Our Finding That Critical Information in Commander Remarks Is Not Readily Actionable

Risks	Recommendations	Evidence
Reporting information through long-comments may • result in a lack of data for force management and PPBE decisionmaking at mission and service levels • result in an inability to see structural problems or trends in the force • be unnecessarily burdensome on reporters and consumers of readiness data	Review historical remarks to determine if commonly communicated information can be moved out of comments and into objective measures. Implement the readiness framework and transition plan recommended in Chapters 4 and 5 of this report. By focusing DRRS-S reporting on reporting given today's resources, some information commonly included in DRRS-S today may have a different venue. Implement formatting standards (e.g., end lines, boldface section titles, etc.) to improve readability.	Review of readiness reporting guidance documents. DRRS-S commander remarks include substantial critical information, but is not easily used because • long-form free text is not easily aggregated • remarks are difficult to parse due to ALL CAPS, repetitive preambles, and lack of formatting • remarks are redundant between sections and repetitive across months Interviews with unit leadership reveal that they see a need to communicate a large range of information in their remarks.

Finding: Employed-in-Place Missions Are Not Supported by Standard Readiness Models

A major issue with the current readiness reporting tools is that they were built with deploying forces in mind. These forces train at the home station with occasional exercises off-site in preparation for when they will be deployed away from the home station.⁶⁶ In contrast, the majority of USSF missions are conducted from the home station, or EIP, on a 24/7/365 basis. The USSF fights *every* night. Yet USSF forces may still be expected to organize into UTCs, have designated pacing units, and use the readiness reporting system and standards designed for deploying forces.

Key factors to readiness that EIP forces do experience, such as the status of primary and backup power; heating, ventilation, and air conditioning; communications; and security systems are difficult to report via DRRS-S. Also, as we discussed earlier when considering the lack of support within ADS to track dependencies, critical mission infrastructure (including ground terminals or antennas) may or may not be owned by the operational unit. Finally, personnel

⁶⁶ A USAF example of readying for deployment that still lingers in USSF thinking is that of UTCs. Units in USAF are responsible for producing certain UTCs, which would be deployed in a specific sequence for many operational scenarios. The readiness of these sets of UTCs can be used as an indicator for how ready forces are if they must deploy at a designated time. In a recent readiness reform effort, *pacing units* were identified across DoD to track the readiness of the first wave of forces that would be deployed in a military campaign against a near-peer adversary. In this model of readiness production, the product that is output is a ready unit or force package.

readiness requires different considerations for an EIP mission. Individuals who may be nondeployable, such as someone suffering from a broken leg, may still be able to sit on console and thus are mission ready. Ideally, we might want our readiness framework to track shift schedules for 24/7/365 operations or the rotation of personnel from operations to training.

In examining readiness reporting in DRRS-S for EIP missions, we find that the space community does track the above key drivers—and does so to a greater extent than other communities—but there are still improvements that could be made. For example, the burden of tracking supporting facilities and infrastructure is put on the operational unit in the form of a MET or standard assessment associated with a MET, yet the operational unit is not responsible or in control of these factors and may not have direct knowledge of readiness status. Instead, supporting units, such as a civil engineering squadron, could report on facilities issues and have that feed into the operational squadron report.⁶⁷ As discussed in Chapter 2, we also recommend rethinking how force presentation should be best reflected in the DRRS-S reporting structure. Table 3.5 summarizes the risks, recommendations, and supporting evidence regarding our finding that EIP missions are not supported by standard readiness models.

Table 3.5. Summary Regarding Our Finding That Employed-in-Place Missions Are Not Supported by Standard Readiness Models

Risks	Recommendations	Evidence
Using the readiness models of deployable force may miss key readiness drivers such as facilities and infrastructure.	Refine personnel reporting to reflect • 24/7 mission • USSF force presentation model (see Chapter 2) • accounting for availability for EIP, rather than deployable, missions	DRRS-S reports for space units and other EIP units show how they account for key EIP readiness drivers such as critical infrastructure.
Using standards and requirements for deployable missions may result in readiness measures that are overly conservative for an EIP mission (e.g., medical readiness following minor injuries to individuals).	Refine equipment reporting to account for critical infrastructure and facilities not under the unit’s control.	Conversations with USSF readiness SMEs.

Finding: Complex Organizational Dependencies Are Not Captured

It is important to track the readiness of space support organizations, which enable core space missions.⁶⁸ These support organizations include DoD units that provide mission support, such as security forces, civil engineering, and logistics or reserve associate units. Support organizations can also include external organizations that augment space missions or provide critical inputs,

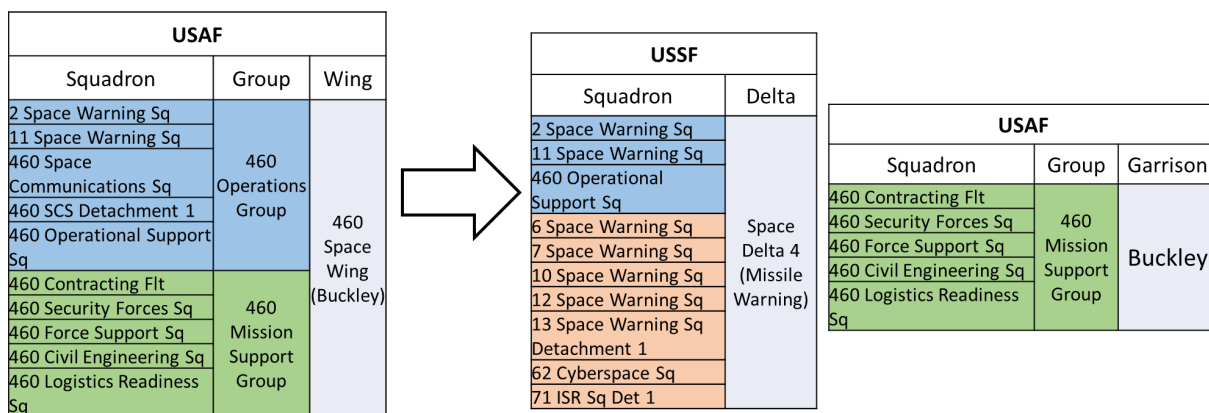
⁶⁷ This example, however, is too simplistic. Currently, civil engineering squadrons are not planned to be transferred to the USSF. Accessing their readiness to support the operational squadron’s report may be difficult.

⁶⁸ In many ways the space communities’ relatively high dependence on supporting organizations is enabled by their EIP missions. Because deployable units must be able to “pack up and go,” to a significant extent, their dependence on supporting organizations is limited, though not eliminated. Therefore, the importance of tracking readiness drivers due to EIP missions is often related to that of tracking how supporting organizations drive readiness.

such as the NGA and the U.S. Naval Observatory for the positioning, navigation, and timing mission.

Readiness reporting is organized and aggregated through chains of commands: squadrons aggregated by Delta and up to commander of the Space Operations Command (SpOC) in the USSF. This current readiness aggregation not only misses important external support organizations but also complicates accountability of support organizations that are now separated due to new seams created by the standing up of the USSF. For example, reserve associate units, such as the 19th SOPS, which supports launch and early orbit checkout of the GPS satellites, have not transferred into the USSF. Another example is the mission support units that will remain in USAF, as illustrated in Figure 3.3. As the figure illustrates, what was once the 460th Space Wing, containing both the operations and mission support groups for space warning, is now split into a USSF Delta that contains space warning operational squadrons and the USAF mission support group at Buckley Garrison. While both USSF and USAF are under the Department of the Air Force (DAF), a full view of the readiness of the space warning mission requires insight into both USSF and USAF reporting.

Figure 3.3. Support Organization Transition



NOTE: ISR = Intelligence, Surveillance, and Reconnaissance; SCS = Space Communication Squadron.

The rationale behind having the mission support units remain in USAF is that they are not unique to space, and thus it makes sense to continue leveraging the USAF recruitment and educational infrastructure required to sustain these types of units. The support units, termed *agile combat support units*, are managed through Air Force Materiel Command, which manages the like-named squadrons that support air wings in USAF. To mitigate concerns about losing accountability and advocacy, the agile combat support units that support space missions report readiness to the SpOC commander every other month.⁶⁹

⁶⁹ USSF officials, discussions with the authors, March 22, 2021.

In addition to having these supporting units brief the SpOC commander, we recommend creating a comprehensive view (or dashboard) for each space mission that shows all relevant organizations—regardless of their formal reporting channels—and their readiness status. This should be tracked at the Delta level and reported up to SpOC. In our research, we identified related efforts within the USSF that can be leveraged to create the framework for a comprehensive mission view.⁷⁰

Table 3.6 summarizes the risks, recommendations, and supporting evidence regarding our finding that complex organizational dependencies are not captured in readiness reporting tools.

Table 3.6. Summary of Our Finding That Complex Organizational Dependencies Are Not Captured in Readiness Reporting Tools

Risks	Recommendations	Evidence
Support organizations outside the USSF may be without proper advocacy for resources that enable space missions.	Create Delta- and SpOC-level readiness assessments that capture mission-level readiness, including support organizations outside the USSF.	Unit fact sheets give updated organization of the USSF and supporting USAF units.
Senior USSF leaders may miss readiness information for supporting organizations.	Assign responsibility of reporting on critical external equipment, facilities, or personnel to the unit most closely aligned with those external entities.	

Finding: Reporting Is Unnecessarily Burdensome on Units

The current readiness system places a significant time burden on unit staff, particularly for capability reporting. For some units, it takes a full day to complete a monthly report, even when there are no major changes, and then another full day to review and revise the same report. Other units may take slightly less time for a routine month, but when there are major changes to the METs or reporting guidance, the time commitment can become much longer.

Shortcomings of the relevant IT systems, issues with the readiness reporting system described in preceding sections, and the underlying reporting requirements all drive the burden on units. While the last is largely governed by congressional requirements, IT systems are something that could be improved (in addition to the recommendations made in previous sections of this chapter).

⁷⁰ At the time our research was conducted, the USSF Enterprise Strategy and Architectures Office kept track of the space architectures across different space capabilities and had developed associated visualizations to present that information graphically. Since then, these drawings/visualizations may have transferred to Space System Command’s System of Systems Integration Office. Also at the time of our research, staff at HQ SpOC/S9A were developing a tool that maps interdependencies between space unit and mission readiness in a way that is more intuitively understood. Their tool creates a commander dashboard (i.e., a commander of Space Forces tool) to see the status of all space missions and diagnose problems.

The IT systems could be made to autopopulate fields from connected ADSs,⁷¹ recall the data from the previous month, and only request input for areas where changes have occurred. To address some of the concerns with the readiness reporting burden, we urge the USSF to track the ongoing Headquarters Air Force (HAF) Directorate of Training and Readiness effort with the DRRS-S support contractors to streamline reporting and revamp underlying resource calculations. That effort was described to us as a “TurboTax-inspired” update to DRRS-S.

We also believe that implementing the readiness framework recommended in Chapter 4 will relieve some unnecessary reporting burden. Units are currently communicating longer-term information monthly within DRRS-S, which has not been designed for such data. This information rarely changes but is repeatedly reported in multiple sections within a single report and across many months. Our proposed framework would move this longer-term readiness improvement information out of DRRS-S into a new repository that supports the *needed capabilities* and *keeping pace* views, where the data repository and reporting frequency can be tailored to better collect such data.

Table 3.7 summarizes the risks, recommendations, and supporting evidence regarding our finding that reporting is unnecessarily burdensome on units.

Table 3.7. Summary Regarding Our Finding That Reporting Is Unnecessarily Burdensome on Units

Risks	Recommendations	Evidence
Unit leadership and reporting noncommissioned officers may have less time to dedicate to other important jobs in managing operational units.	Track and potentially leverage the HAF A3T effort to streamline DRRS-S reporting systems.	DRRS-S commander remarks and other narrative material is often very repetitive across METs and over time.
Changes to reporting guidance and requirements may continue to increase reporting’s time burden.	Improve ADS infrastructure to autopopulate resource data from ADSs in more cases.	Resource readiness statuses are often manually entered due to issues with ADSs.
	Implement the readiness framework recommended in Chapter 4.	

In this chapter we have reported on the current state of readiness reporting in the USSF and the risks that follow from current challenges, and we have made recommendations for improvement. A consolidated summary of this chapter is presented in Appendix D. Some problems, however, are fundamental and cannot be improved through relatively minor changes using typical readiness measures and tools. These fundamental problems and the challenges outlined in Chapter 2 motivate and drive the design of our recommended readiness framework, which we describe in Chapter 4.

⁷¹ Resource data are required to be automatically pulled from ADSs, but in our review of equipment data (discussed earlier in this chapter) and discussions with reporting units, it is clear that there are numerous issues with the implementation of ADSs that make this often impossible.

Chapter 4. A Framework for Readiness

The primary objective of this project is to recommend a readiness framework for the USSF. Chapter 1 discussed the evolving mission(s) of the USSF, the unique considerations of military space operations, and precedents from readiness reporting in other military services. Chapter 2 described the transformation to the USSF OT&E posture, force presentation challenges, and operational interdependencies. Chapter 3 assessed the current state of USSF readiness reporting, including problems that cannot be fully addressed through relatively minor improvements to the current measures, and tools for readiness. These characteristics of the USSF motivate and inform the design of the framework described in this chapter.

This framework consists of three views of readiness, including recommended measures and frequency of measurement. It is summarized by the first section of this chapter, “Views of Readiness: A Three-Pronged Approach,” Table 4.1, and Figure 4.1. In this chapter we also provide high-level recommendations for IT implementation and provide two examples of how to apply the framework.

Views of Readiness: A Three-Pronged Approach

We structure our proposed USSF readiness reporting framework around the need to report three basic views of readiness. The relationship among these views, the threat analysis, DRRS-S, and the USSF longer-term investment process is shown in Figure 4.1. The goal of each view and how each fits into the larger context is as follows:

1. The **today’s resources view** accurately and objectively reports the readiness of resources (personnel, equipment, facilities, and training) and measures for the METs of each USSF unit as it is currently OT&E’d.⁷² In this view of readiness, METs are reported for the subset of threats the unit is currently OT&E’d to counter; and the resource baselines reflect the current personnel, equipment, facilities, and training needed to counter that subset of threats.
2. The **needed capabilities view** accurately and objectively reports METs against the near-peer threat, whether or not units are currently OT&E’d to effectively counter that threat, and the resources the USSF needs to counter that threat.⁷³ Needed capabilities views are provided at the overall USSF level and at the Delta level. Currently we envision that

⁷² *Today’s resources view* indicates that this view portrays the readiness *that can be attained using today’s resources*; it is not limited to those items termed “resources” in DRRS-S. It pulls both capability and resource ratings from DRRS-S and displays that information in ways that allow commanders to understand the time history of readiness, the dependencies between units, and impacted geographic areas.

⁷³ Again, although we use the word *capabilities* in the name of this view, it is not limited to the capability rating type of information in DRRS-S. It is intended to track both the METs and the resources needed for the near-peer fight.

METs, overall force strength, and significant investments in equipment or facilities will be tracked in this view. It is intended to inform the PPBE process.

3. Finally, the **keeping pace view** accurately and objectively reports progress in transforming the USSF for the near-peer threat.⁷⁴ This readiness view measures and reports the USSF's ability to change and adapt to new threats—that is, to keep pace with the adversary and, ideally, to outpace it. It is intended to provide objective measures to guide investments related to USSF process improvement initiatives.

As the USSF evolves to meet each threat, reporting items (METs and resources) will transition from being *needed capabilities* into *today's resources*. Therefore, our framework includes guidelines for when and how to report readiness as a function of threat environments, and when and how to transition reporting from the *needed capabilities view* to the DRRS-S baselines that form the basis of the *today's resources view*. The guidelines recommended herein are designed to provide objective measures to monitor breakage that occurs when units are reorganized, reequipped, and retrained to meet threats. A summary of key features of these three views of USSF readiness is provided in Table 4.1; details are provided in the following sections.

These three views of readiness connect to USSF planning processes at different echelons. The *today's resources view* is tied most directly to unit-level management—identifying temporary and continuous challenges in resource availability and expected capabilities. The *needed capabilities view* is linked to Delta- and service-level planning, such as mission assignments and organizational design—those decisions that evolve the force. The *keeping pace view* is most directly linked to service-level strategic planning and provides factual data to guide investment priorities. It measures the USSF's ability to adapt to change but also provides indicators of where in the process of supplying ready units the production cycle has broken down and become bottlenecked.

⁷⁴ The *keeping pace view* measures for systemic issues affecting today's resources, not just the need for investments to counter new threats. For instance, if it routinely takes more than a week to recover from IT outages, this may be an indicator that investments in IT infrastructure are needed. Or, if it routinely takes six months or more to recover from breakage caused by reorganizations, this may be an indicator that investments are needed in human resources infrastructure or processes.

Figure 4.1. The Proposed USSF Readiness Framework

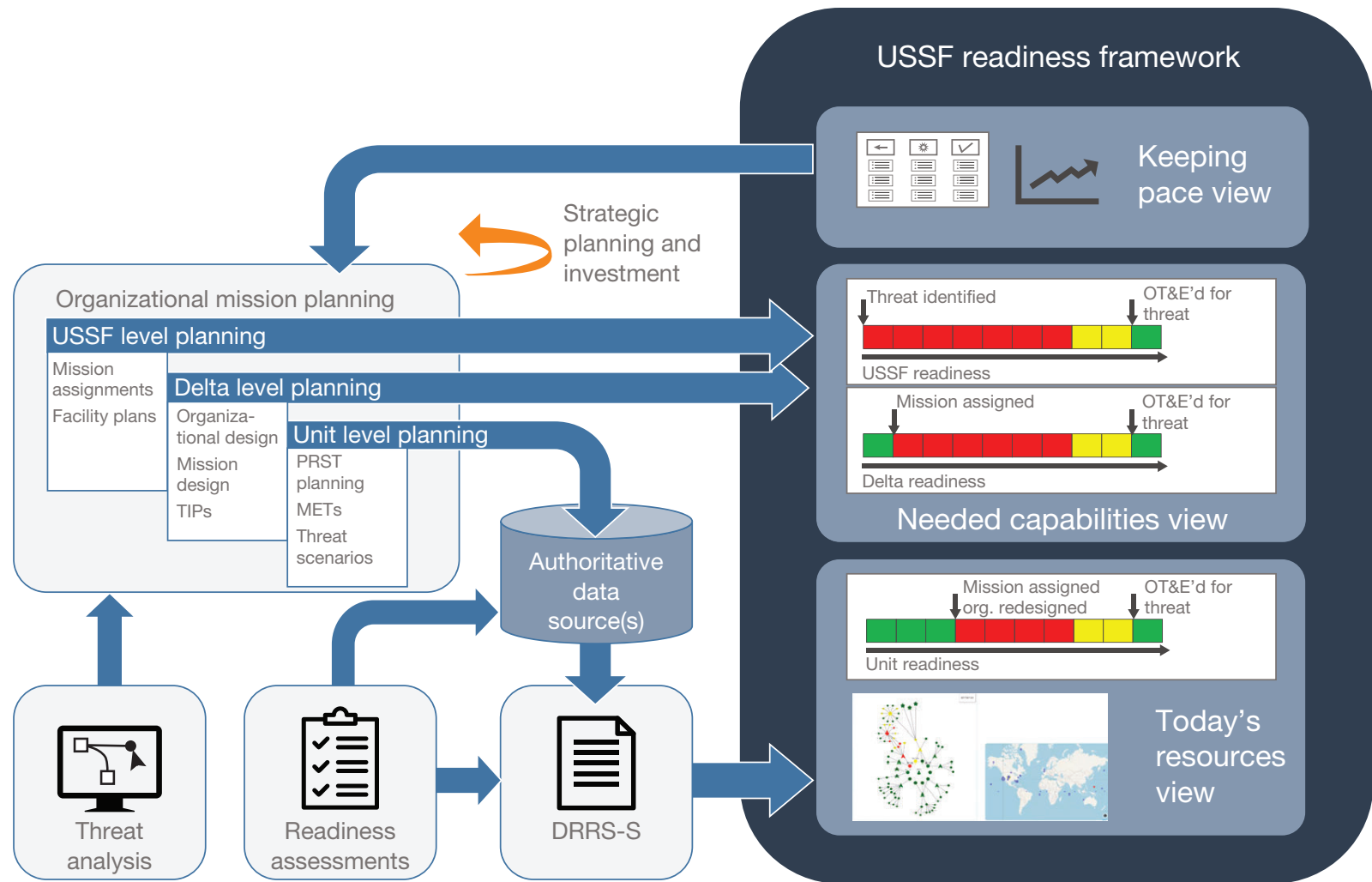


Table 4.1. Key Features of Our Readiness Framework

View	Granularity of Reporting	Key Measures	Key Gate/Criteria to Begin Measurement
Today's resources	Operational units; per resource, per MET; monthly or more	Availability of authorized resources Assessment of current capabilities consistent with today's OT&E posture Time to recover <i>ready unit</i> OT&E posture^a • after natural events • after adversary attack • after designed changes to OT&E posture Geographic impacts Mission/resource interdependencies	Updated OT&E posture: • personnel, readiness, and supply: planning complete • training: TTP validation complete • METs: new/revised measures are validated
Needed capabilities	Delta; per mission; infrequently but as needed	Availability of needed resources Assessment of current capabilities considering needed OT&E posture Time to achieve a <i>ready mission</i> capability for a new or substantially revised mission	Mission is assigned Need for MET update is identified
	USSF; per threat; infrequently but as needed	Availability of needed resources Assessment of current capabilities considering needed OT&E posture Time to mitigate a newly discovered or substantially evolved threat	Threat is identified
Keeping pace	USSF; per production process; timeline should depend on measure	Production flow: • TTP validated per quarter • average time to recover <i>ready unit</i> OT&E posture Indicators of production bottlenecks	Production process is modeled and instrumented

^a A unit's OT&E posture is defined by its authorized personnel, equipment, and supply; approved training curricula; and assigned METs.

The Today's Resources View

The *today's resources view* of readiness is focused on managing the day-to-day readiness of a unit. It is designed to track only those elements of readiness that are under a unit's direct control and to provide a quick snapshot of the unit's readiness to respond to threats it has been OT&E'd to counter. If the unit has been properly OT&E'd, then this view captures the impacts of damaged or degraded equipment or facilities, impacts due to illness or temporary reassignment of personnel, and impacts of normal training or force regeneration cycles. A notional view of readiness impact over time in response to a resource becoming unavailable was shown in Figure 3.1.

This view of readiness will also show the impact on readiness when a unit is reorganized, reequipped, or retrained. At defined gates, the DRRS-S baselines against which the units report will be updated to reflect new personnel, equipment, or training needed to counter additional threats or to take on additional missions. The timing of this baseline update is gated as a function of the maturity of the planning, tactics, procedures, and training curriculum needed to counter the new threat or perform the new mission.

The *today's resources view* is very close to that traditionally associated with reporting in DRRS-S. We believe, however, that it is not enough simply to use DRRS-S outputs for this view. The time dimension, which is very difficult to pull from DRRS-S, is essential if this view is to provide actionable insight. All units occasionally suffer setbacks—for example, equipment fails, power outages occur, COVID-19 sickens personnel. What leadership needs to know is how quickly the unit recovers from those setbacks. The time between when the setback occurs and when its impact is mitigated is a measure of resilience.⁷⁵ Currently the comments section in DRRS-S is used to both explain the nature of the setback and to provide estimates of time to recover. We recommend that estimated time to recover be made a required input for this readiness reporting view and that both estimated and actual recovery times be tracked over time. This will allow the USSF to track such things as estimated recovery time accuracy or improvements in resilience (i.e., demonstrated shorter recovery times).⁷⁶ We will return to this idea of measuring recovery times when we discuss the *keeping pace view*.

The Needed Capabilities View

The USSF also needs a readiness view that objectively measures their ability to counter today's threats, whether or not the units are currently OT&E'd to respond to that threat. This is the focus of our *needed capabilities view*, which is designed to provide objective evidence to guide program planning baselines and USSF's overall investment decisions. A notional view of readiness impact over time in response to a new threat being identified was shown in Figure 3.2.

In this case, units do not fully control the resources they need to respond to new threats and/or perform new missions. Therefore, this view of readiness is reported at two levels: at the

⁷⁵ The term *measure* can be defined as “the formal mechanisms for monitoring the delivery of services or the attainment of goals.” We use *measures* throughout the report, and at times discuss specific units of measurement. We do not use the term *metrics* to avoid confusion, as the terms *measures* and *metrics* are sometimes used interchangeably or inconsistently in previous literature; see Brian M. Stecher, Frank Camm, Cheryl L. Damberg, Laura S. Hamilton, Kathleen J. Mullen, Christopher Nelson, Paul Sorensen, Martin Wachs, Allison Yoh, Gail L. Zellman, and Kristin J. Leuschner, *Toward a Culture of Consequences: Performance-Based Accountability Systems for Public Services*, Santa Monica, Calif.: RAND Corporation, MG-1019, 2010.

⁷⁶ Although this view of readiness will allow the USSF to track these measures, we would be remiss if we did not caution, “Be careful what you measure.” Numerous economists have written on the phenomenon of measures creating perverse incentives for workers who then game the system to produce desired measures but undesirable outcomes. A common formulation of this is known as Goodhart's law: “When a measure becomes a target, it ceases to be a good measure.” See Marilyn Strathern, “Improved Ratings: Audit in the British University Systems,” *European Review*, Vol. 5, No. 3, 1997, pp. 305–321.

USSF level and the Delta level. The entrance criteria for tracking needed capabilities at the USSF level is a validated threat identification or a significant change to a current threat assessment.⁷⁷ Responding to this new or modified threat requires a new threat analysis. The outcome of the threat and mission analysis may include

- new mission assignments for some units or a reallocation of mission assignments
- for new missions, candidate MET statements and proposed measures of performance against those METs
- for existing missions, recommended threat scenarios for measuring performance of METs (which may include revision of METs and measures)
- a recommended list of TTP to be developed, validated, and incorporated into training materials
- recommendations for new facilities to be built or existing ones to be expanded.

Upon completion of the threat analysis, each impacted Delta will begin to report needed capabilities at the Delta level and engage with USSF HQ to finalize planning for the needed capabilities. The outcomes of this engagement are

- final METs and associated measures for each impacted unit, including threat scenarios for measuring performance against those METs
- an updated list of TTP to be developed, validated, and incorporated into training materials and a detailed plan for that work⁷⁸
- final planning and authorization to pursue new or updated facilities, including the equipment to be installed in those facilities.

At the conclusion of negotiations between HQ and the Delta, units will engage with the Delta to establish a plan for acquiring the needed personnel to reach the state where they will be OT&E'd to meet the new/revised threat. As part of this plan, the units and Delta will establish the criteria that determines when each impacted unit will be designated as being OT&E'd to respond to the new threat, and when to update the resource baselines and METs in DRRS-S that form the basis of their *today's resources view*. Our recommended criteria for transitioning from the *needed capabilities view* to the *today's resources view* are as follows:

- Billets for new positions, if needed, are opened or are ready to be opened.
- Billets for reassigned positions have been reallocated to the appropriate units.
- All plans for shifting personnel between organizations have been finalized (they need not yet be executed).

⁷⁷ Note that this view of readiness is not intended to address future threats, but only those threats that have a validated threat identification.

⁷⁸ For example, if an existing TTP needs an update to be responsive to the new/updated threat assessment, it may be prudent to assign that development to the Delta or perhaps even the unit for completion to avoid overburdening higher-level TTP developers and validators. In some cases it may be more efficient to develop USSF-wide training materials, while in other cases Delta- or unit-unique training materials are more appropriate.

- Response to the threat has been included in the advanced training materials for the unit (it need not yet be included in the continuation training materials).
- New/upgraded facilities are in place, and acquisition of the needed equipment has been initiated (equipment acquisitions need not yet be complete, but estimated time to complete should be less than six months).

The intended outcome of the above recommendation is that by updating DRRS-S baselines at the time when planning is finalized but execution is not yet completed, the *today's resources view* will track the breakage that occurs when units are reorganized, reequipped, or retrained to respond to new/updated threats.

The Keeping Pace View

Our last view of readiness is focused on accurately and objectively reporting progress in transforming the USSF to respond to the near-peer threat. The *keeping pace view* measures and reports the USSF ability to change and adapt to new threats—that is, to keep pace with the adversary and, ideally, to outpace it.⁷⁹

The measures proposed for this view of readiness derive from the business management literature on lean engineering and the Theory of Constraints (TOC). Our recommendations are designed not simply to measure the USSF's ability to adapt to change but also to provide indicators of where in the process of supplying ready units, updated TTP, or threat mitigations the production cycle has broken down and become bottlenecked.

Figure 4.2 provides an illustration of readiness as a production system as described in a recent CRS report and describes the cyclical steps that are used to improve flow through that production system as described in the TOC literature.⁸⁰

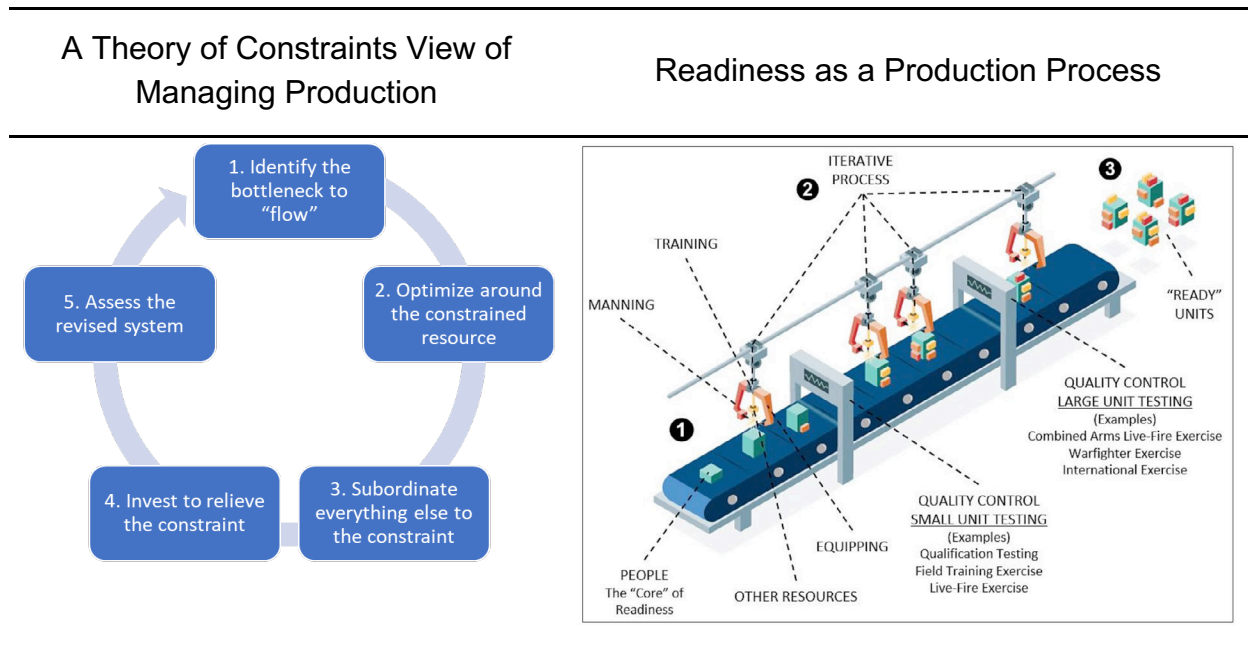
While the analogy of creating ready units to creating cars or other factory outputs is imperfect,⁸¹ we use the principles of production flow to obtain actionable metrics that measure *pace*. Under this concept, bottlenecks in production are identified by measuring the trend (growth or shrinkage) of inventory at each step in the production process. Where inventory backs up, there is a bottleneck. Using these objective measures of pace and indicators of bottlenecks, senior leaders can then make better decisions, including where and when to intervene, allocate

⁷⁹ The analogy often heard in the DAF to refer to the United States' ability to outpace the adversary is the ability to "get inside" the adversary's observe–orient–decide–act loop.

⁸⁰ In creating the simplified USSF production model and designing our proposed measures for keeping pace, we drew inspiration from David Anderson, *Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results*, Upper Saddle River, N.J.: Pearson Education, 2004. Anderson's work is one of the few lean engineering texts that apply TOC to production processes where the inputs to production are people and ideas rather than parts and machines.

⁸¹ For instance, we have no illusions that the process of creating ready units can be standardized in the same ways that car production is standardized.

Figure 4.2. Measuring the Flow of Value in a Production System



SOURCE: The left-hand illustration is derived from the authors' analysis of the TOC literature popularized by Eliyahu M. Goldratt. The right-hand illustration is from CRS, 2020a.

NOTE: A good short summary of TOC can be found at Lean Production, "Theory of Constraints," webpage, undated.

additional resources, or prioritize specific objectives. While the inventory shown in Figure 4.2 for the readiness production process is personnel, the factory model applies equally well to any unit of inventory, including product improvement ideas or strategic initiatives.

For the purposes of illustrating how to use a TOC view to manage production, suppose that in Step 1, shown in the diagram at the left in Figure 4.2, the USSF identifies training equipment (simulators) as a constrained resource—that is, threat simulators are the bottleneck that is slowing down the production of mitigated threats/ready units. Step 2 is thus to determine what the developers of simulators need to be able to increase their throughput. Throughput in this case might be measured on how quickly features to emulate the threats and/or explore mitigations for those threats are implemented and delivered to the TTP development team. Using a step analysis, USSF might find that it is lack of intelligence regarding the threat that is slowing the simulation development team down.

In that case, Step 3 would be to subordinate the rest of the readiness production “factory” to the intelligence generation constraint. This subordination recognizes that overall flow will not improve unless and until the flow of actionable intelligence regarding the threat increases. Idle downstream resources should be reallocated and upstream resources should be left idle so as not to produce waste. A strategy to leave upstream resources idle requires careful planning, however. It would be ill advised to stop manning simply because we cannot fully train personnel on a

new threat, but it may be very well advised to postpone buying the computing hardware for the simulators until more is known about the threat and the computing resources that will be needed to train for that threat.

Step 4 is to invest to relieve the constraint. In this case, the simulation team could assign itself the task of facilitating the interface to the intelligence group. This frees up the intelligence group to concentrate on threat characterization as opposed to the myriad details of facilitating the communication of that threat to the simulation team. Other investments may need to be coordinated at the Delta or USSF levels, such as investments to hire or train more intelligence officers and/or identify top performers in the intelligence group and design incentives to reward and retain them.

Generating actionable keeping pace measures to guide investment decision and to manage the overall readiness production process requires two things:

1. documented understanding of the flow of the production process, to include a concept of inventory
2. a measure of flow through the production process; this may require that we formulate a way to measure the value of inventory.

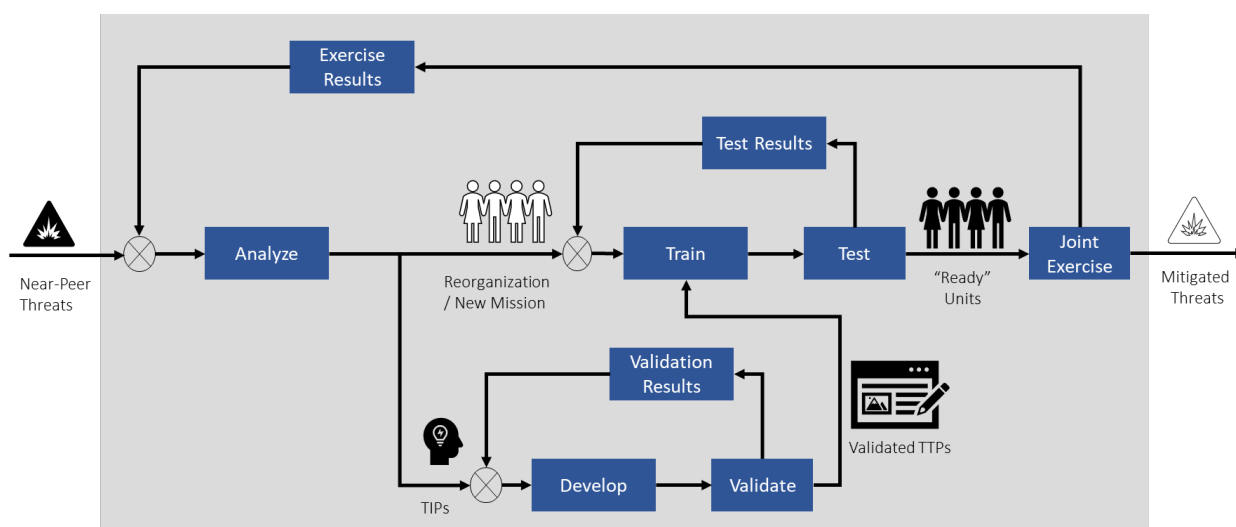
Figure 4.3 provides a highly simplified diagram of the USSF threat mitigation production process. Although simplified, it provides sufficient documentation of flow for the purposes of our research and is comprised of three production loops.⁸² These loops are named for the product they produce and are defined as follows:

1. **The mitigated threat production process:** the overall process of responding to a newly identified or more fully characterized threat and demonstrating that the USSF has been OT&E'd to mitigate that threat.
2. **The validated TTP production process:** the subset of steps within the overall mitigated threat production process that is focused on producing validated TTP to defeat the threat or otherwise ensure resilient operations in the face of that threat. As we will discuss later, the validated TTP production process is closely aligned with USAF's Weapons and Tactics development cycle.
3. **The ready unit production process:** the subset of steps within the overall mitigated threat production process that is focused on producing ready units that have demonstrated that they are OT&E'd to conduct effective warfighting operations against the threat.

The most straightforward measure of flow through any production system is the difference between output value and input value per unit of time. For example, if we want a dollar-denominated measure of throughput for a car factory, we might compute the value of produced cars minus the value of parts held in inventory per week. If the value of the input is negligible or

⁸² Other loops may be needed to fully account for all production processes needed to mitigate the near-peer threat, but these three appear to be fundamental. Additional processes the USSF might wish to measure include production of models and simulations, test-beds, training facilities, and test ranges.

Figure 4.3. The USSF Mitigated Threat Production Process



SOURCE: In creating this simplified USSF production model, we drew inspiration from Anderson, 2004.

fixed, the throughput can be measured more simply as output divided by time (e.g., number of cars per day). For the USSF, our recommended throughput measures for the three production processes included in our simplified flow model are as follows:

- **Validated TTP throughput.** This measure is indicated by validated tactics per month and validated procedures per month.⁸³
- **Ready unit throughput (Readiness_{Output} – Readiness_{Input}) per unit time.** This measure can be produced from the *today's resources view*, and we recommend mechanizing it as the average number of weeks (across the USSF) that units need to recover from a setback in readiness. It may be prudent to track this measure for different types of setbacks and/or units and to track not just the average number of weeks but also the standard deviation from that average.⁸⁴
- **Mitigated threat throughput measure (Threat_{OUT} – Threat_{IN}) per month.** This requires us to create a way to value the threats.

To formulate a measure of threat, we adopt established measures for quantifying risk and, more specifically, for quantifying cybersecurity risk. Risk is commonly quantified by multiplying a numeric scoring of the probability of an event occurring by a numeric scoring of the consequence

⁸³ The input to the validated TTP production cycle, and our recommended unit of inventory, is the TIP. Interviewees indicate to us that the cost of generating TIPs is negligible. In fact, they report a large TIP inventory, but low numbers of validated tactics or procedures produced per month for cybersecurity—indications that production is not *keeping pace*.

⁸⁴ We do not recommend that ready unit production throughput be tracked on a per-unit basis. The goal of the measure is not to micromanage individual units but to provide overall measures to guide USSF investment decisions.

to the system should such an event occur.⁸⁵ The cybersecurity community, however, was one of the first to formally recognize that the probability of an attack must include quantification of both the adversary's motivation and opportunity.⁸⁶ Therefore, we recommend that scoring of threat be a function of three things: (1) adversary motivation, (2) system vulnerability (such as the breadth of the attack surface), and (3) consequence if the threat is realized.⁸⁷

Threats are mitigated by the USSF's ability to avoid, absorb, or recover from attack.

Readiness affects all three factors in the threat equation:

- Readiness reduces *consequence* of a realized threat as measured by the ability to absorb or recover from attack. This reduction is measurable in exercises.
- Readiness reduces the *opportunity* for attack through good operational security and proactive defense. Objective measures of this effect are rarely obtained in exercises when personnel know they are being graded. Instead, measuring this effect is best done through covert assessments.
- Readiness reduces adversarial *motivation* by enhancing U.S. deterrence posture. While this may be the least measurable effect, it is also the most leveraged. Objective and transparent measures of readiness can dissuade adversaries of the notion that we may be bluffing and reassure allies of our capability to defend and protect.

Validation of Our Proposed Readiness Reporting Framework

To validate the proposed readiness reporting framework,⁸⁸ we examine two use cases where units undergo a readiness transition in response to a new threat. The first describes an organizational change, and the second describes new tactics development. Both are rooted in real-life examples. For each we describe how an impacted unit reported its readiness in DRRS-S during the transition (the “as-is” use case), describe issues that currently prevent accurate and objective reporting of readiness information, and how the unit would report readiness in the future using our framework (the “should-be” use case), including potential indicators of bottlenecks in the process of creating ready units through these example transformations. Figure 4.4 illustrates how the use cases map to the production processes.

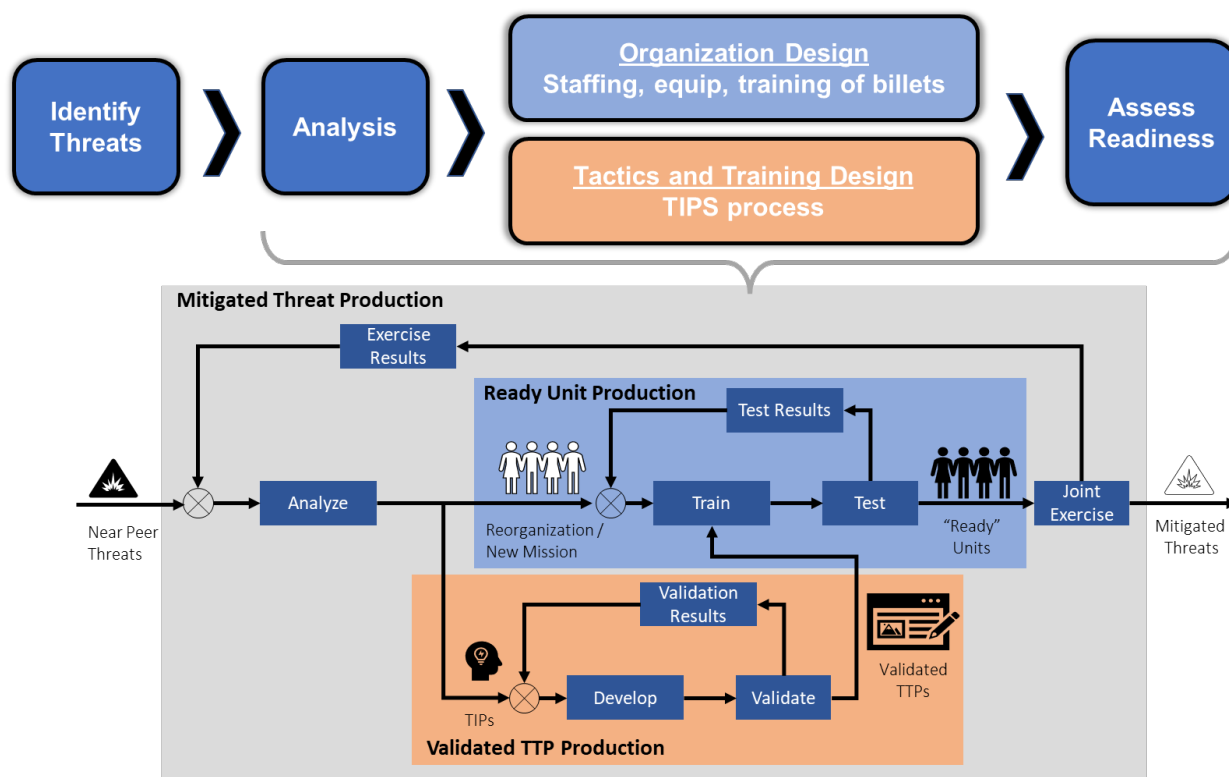
⁸⁵ An early reference regarding this approach to quantifying risk is Paul Garvey and Zachary Lansdowne, “Risk Matrix: An Approach for Identifying, Assessing, and Ranking Program Risks,” *Air Force Journal of Logistics*, Vol. 22, No. 1, 1998.

⁸⁶ A good text for understanding how to assess and manage cybersecurity risks is Atle Refsdal, Bjørnar Solhaug, and Ketil Stølen, “Cyber-Risk Management,” in *Cyber-Risk Management*, Cham, Switzerland: Springer, 2015, pp. 33–47.

⁸⁷ We recognize that this short description is not likely to be sufficient to fully describe threat quantification using these dimensions. However, we want to recommend and provide important resources (see the two previous footnotes) for threat and risk quantification that go beyond the common “likelihood x consequence” formulations.

⁸⁸ The term *validate*, as used here, denotes a process or set of steps taken to ensure that our framework addresses the operational need. Working through use cases is a best practice for validating need and proposed solutions to address that need. Our use of the word *validate* is not to imply that the two use cases documented here form a complete validation of need. Clearly, they are not comprehensive. However, we do believe they are representative of common issues we saw in current USSF readiness reporting and provide realistic examples of applying this readiness framework.

Figure 4.4. The Mapping of Production Processes to Use Cases



The Organizational Change Use Case

This first use case focuses on readiness of USSF units undergoing organizational transition. The focus of the use case is the *ready unit production process*. To properly scope the use case, it starts when organizational redesign is initiated and thus allows us to explore the steps taken to update resource baselines and METs in DRRS-S to reflect that reorganization. We selected a case where the organizational redesign was motivated by the need to accommodate a new mission. This use case ends when the reorganized unit is OT&E'd to perform the new mission.⁸⁹

⁸⁹ In this report we are using the term *organizational design* to indicate the process of determining how best to OT&E using existing resources to accomplish USSF mission and functions. In the Army, the process we describe here would be termed *force development* (which is one of three aspects of force management, the other two being force integration and force modernization). We elected not to use the term *force development*, however, because USAF uses the term to mean the development of “foundational and occupational competencies in all Airmen through education, training, and experience”—in other words, to produce ready airmen. For their respective use of the term *force development* see Department of the Air Force, “Department of the Air Force Guidance Memorandum to DAFI 36-2670, *Total Force Development*,” Reissued October 12, 2021; and Army Regulation 71-32, *Force Development and Documentation Consolidated Policies*, Washington, D.C.: Headquarters, Department of the Army, March 20, 2019.

The Organizational Change “As-Is” Use Case

The 11th Space Warning Squadron (SWS) is one of 12 units within Delta 4 of the USSF. The overall mission of Delta 4 is to provide strategic and theater missile warning using space-based sensors to detect signatures associated with missile launch. Space warning plays a critical role in U.S. and allied abilities to detect, track, and intercept incoming missiles. While originally designed for the strategic mission of detecting intercontinental ballistic missiles, the use of space-based sensors to warn of shorter-range missiles in theater has expanded greatly in the past decades. Two satellite constellations operated by Delta 4 are the Defense Support Program and the Space-Based Infrared System (SBIRS).⁹⁰ These systems provide what is known as overhead persistent infrared (OPIR) capabilities. The 11th SWS is located at Buckley Space Force Base, which is hosted by Buckley Garrison; and is considered a joint, Total Force, and coalition base.⁹¹

In mid-January 2021, the 11th SWS underwent a planned organizational change process that affected readiness in terms of the resources under the squadron’s control and its basic mission. Prior to the organization change, the 11th SWS mission included operation of the SBIRS satellite constellation and the synthesis of space warning data based on inputs from the satellites and a collection of ground radars. After the organizational change, the 11th SWS has been designed to be an OPIR battlespace awareness center (OBAC), a much broader and integrating role central to the USSF transformation into a warfighting service. The role of an OBAC is to aggregate, filter, and synthesize information from sensors (whether ground or space based) to provide early warning of missile attacks. As part of the reorganization, responsibility for operating the SBIRS satellites is transferred to the 2nd SWS, a sister unit.

In addition to its changed mission, some billets and personnel were transferred from the 11th SWS to the 2nd SWS and to the Delta 4 staff. In total, the 11th SWS lost nearly half of its personnel in these transfers. Given that standing up the USSF is a planned organizational change process, at some point the 11th SWS should expect to achieve a new organizational equilibrium (e.g., with mission, manpower, and resource alignment), but it is unclear how long that is expected to take.⁹² As of a few months after these changes took place, it was unclear from DRRS-S resource ratings if the 11th SWS was appropriately resourced.⁹³

⁹⁰ SpOC, “Fact Sheets: Space Delta 4,” webpage, undated.

⁹¹ A joint base is a locality from which the operations of more than two military departments are supported; the Total Force includes active, guard, and reserve forces; coalition forces are partners from other nations.

⁹² Personnel needs in the 11th SWS may be based on a decades-old manning study, and no one we spoke with could provide an estimate on when a manning study for the OBAC would be completed. Per our analysis, at least one of the 11th SWS METs should be removed to reflect the reorganization, and new METs for the OBAC need to be written. The unit’s request to update its METs have so far been blocked by what appear to be hurdles imposed by current USAF instructions governing readiness reporting. Issue of a USSF-specific instruction for readiness reporting is forthcoming.

⁹³ Readiness reporting for the 11th SWS in DRRS-S and in interviews with our team indicate mismatched (or lack of) resources related to facilities (e.g., floor space) and near-term manpower concerns.

While routinized readiness reporting for the 11th SWS continued within DRRS-S against invalid (old) baselines, the 11th SWS readiness reporting team used the written remarks section of DRRS-S and commander's top issues to communicate their actual readiness. Our analysis of its written remarks and objective resource reporting reveals two basic issues in its readiness reporting:

1. It is unclear if current personnel baselines fully reflect the new OBAC mission. The number or skill mix of billets listed in DRRS-S does not seem to match up with the actual needs or assignment of personnel to the OBAC mission. The remarks indicate that at least one ADS on which DRRS-S personnel reporting is based may contain erroneous numbers.
2. The 11th SWS equipment baselines in the ADS appear to not have been updated in response to the mission change. As a result, the 11th SWS has no way to report the readiness of equipment and facilities it needs for the OBAC role. Equipment reporting for the 11th SWS in DRRS-S showed one line item that was deemed not measured per service direction, and hence not applicable.

Issues Preventing Accurate and Objective Reporting of Readiness During Organizational Change

From the above “as-is” description, we highlight two key issues that our recommended readiness framework is designed to address:

1. **There is a disconnect between METs and core mission.** We presume the organizational change process that resulted in the 11th SWS being given the OBAC role had time-based milestones, one or more of which could have triggered changes to the DRRS-S resource baselines. Yet despite this having been a planned change (with a substantially revised mission), DRRS-S, as of five months after the organizational change was initiated, contains at least one unrevised MET and no additional OBAC specific METs and measures. While we encourage the USSF to retain its current process by which units can request changes to their METs, our framework recommends a more disciplined process for tracking MET changes that occur as the USSF reorganizes to respond to a new threat environment.
2. **Unit manning and personnel readiness is not reported clearly.** The ADS that contains the baseline against which the unit reports DRRS-S personnel resources appears to be erroneous, based on commander remarks.⁹⁴ From our reading of the commander's top issues, it appears that the unit does not have the appropriate skill-mix.⁹⁵ We were unable to ascertain whether it is under- or over-manned.

There is one additional issue from this use case that our framework does not fully address: facilities. It is highly likely, in our assessment, that the 11th SWS will need new facilities if it is

⁹⁴ As was noted in Chapter 3, inaccurate ADSs being used in USSF DRRS-S reporting is not an issue confined to the organizational change use case.

⁹⁵ As is common across the USSF, there is a lack of midcareer professionals and noncommissioned officers that commanders compensate for by substituting more highly skilled personnel. While this substitution does not affect readiness, there is an impact to efficiency. A well-designed reporting system would make skill-mix issues like this more visible.

to fully meet the expectation of the OBAC role. As currently planned, the USSF will not have its own civil engineering organization and will continue to be garrisoned on USAF managed bases. The process for requesting and obtaining new facilities is complicated by this new organizational seam, and we were not able to gain sufficient insight into that process to be able to recommend changes to it that would allow the USSF to accurately and objectively track the readiness of a new facility through the change process. A fiscal year (FY) 2022 RAND Project AIR FORCE study has been initiated to better understand that process and provide recommendations to the USSF for structuring this interface going forward.

The Organizational Change “Should-Be” Use Case

Effective readiness reporting depends on having a high-functioning ready unit production process. Particularly in the context of a major organizational transition, there is significant effort that must occur if the USSF is to effectively measure readiness through the transition. The issues identified above, the *disconnect between METs and core mission* and that *unit manning does not match mission needs*, could be improved by following the steps of our framework. As described earlier, the 11th SWS was reorganized to focus on the larger OBAC role, ostensibly to better respond to adversary missile attacks in theater. In performing the analysis step of the mitigated threat production process, the USSF ideally would formulate a new mission directive with candidate METs and tentative PRST measures for the Delta.⁹⁶ This formulation creates the key information reported in the *needed capabilities view*, and Delta 4 begins reporting against them to track the implementation process.

Implementation includes the organizational redesign of Delta 4. During such redesign, Delta 4 engages with HQ to finalize the new set of METs and PRST resource baselines and with the 11th SWS and the 2nd SWS to properly allocate those requirements downward. Billets represent the basic “inventory” of the organizational design workflow. Unless the USSF agrees to allocate additional billets to Delta 4, organizational redesign is basically a process of reallocating existing Delta 4 billets between the Delta and its units. It is not enough, however, to simply reallocate staff; the billets representing that staff must also be trained and equipped. Equipment and training requirements need to be transferred from the 11th SWS to the 2nd SWS, and new training and equipment must be defined for the new OBAC mission. Finally, Delta 4 and the 11th SWS must establish the criteria that determine the completion of OT&E. Once the implementation plan and any new baseline billets are approved, accepted, and validated, the PRST measures and METs for the new OBAC mission are entered into DRRS-S and are reflected in the *today’s resources view* of readiness.

Delta 4, the 11th SWS, and the 2nd SWS then carry out the implementation of the plans. Empty billets are filled, personnel are transferred, equipment is procured or transferred, and

⁹⁶ The analysis may also produce TIPs, but the next use case covers that eventuality. For this first use case, we simply examine the ready unit production process.

training curricula are updated. Finally, all personnel undergo the appropriate revised training. In the case of the 11th SWS, this would include demonstrating that it is fully capable of performing the OBAC role.

By following this process, the USSF will have consistent measures of how long it takes for analysis, organizational redesign, and implementation. These measures form the basis of the *keeping pace view* of readiness, but we also need indicators of where the process becomes bottlenecked. Without indicators of bottlenecks, it is impossible to know where to invest to improve throughput.

Indicators and Warnings in the Ready Unit Production Process

Unit manning. In interviews with individuals from several USSF organizations, manning was a dominant concern—for many, manning is the starting point in how they make sense of their perceived readiness. As part of the *keeping pace view* of readiness, we recommend that the USSF measure

- how long it takes to fill billets, whether through USSF recruitment, transfers from outside the Delta, or transfers internal to the Delta
- how long it takes to readjust the staffing mix; many USSF units have identified that their skill mix does not meet their needs
- the time from organizational redesign initiated to manning study completion; as we noted in Chapter 3, USSF unit manning studies (i.e., the analysis of what manning is required for a mission) are sometimes decades out of date, and we strongly suspect that the pace at which manning studies are produced is an early indicator that the *needed capabilities view* of readiness is not timely and, given the ongoing transformation in the USSF to be ready for the range of threats, lacking in accuracy.

If manning studies are not possible to obtain, or are planned for several years out, alternative forms of documentation should be considered to establish the *needed capabilities* baseline for PRST measures. As we noted in our discussion of TOC, if the manning studies are a constraint on organizational redesign throughput, USSF leadership needs to formulate a plan for how to mitigate the risk of outdated manning studies in both the short and long terms. Note that we do not advocate for eliminating manning studies or for compromising the objectivity of the manning studies. In the short term, it may be that the USSF can rely on contractor estimates of manning for new equipment and missions. In the long term, the USSF may need to form an organic capability to conduct manning studies or establish a service-level agreement with the DAF to incentivize timely completion of manning studies.

METs and measures. METs, or at minimum the measures associated with METs, must be updated when new threats are identified or new responses to those threats are planned. Therefore, we recommend that the USSF track the time from when the Deltas begin working with the units to establish the new DRRS-S baselines until those baselines are reflected in the *today's resources view*. With respect to workarounds for lack of timely MET and measure definition, we note that

writing a MET broadly (e.g., to imply that a unit should “provide training”), does not mitigate the underlying issue. Overly broad METs hamper a unit from reporting its actual readiness in sufficient detail. Instead, we advocate that METs and measures for needed capabilities be reported as such by the Deltas. Later, DRRS-S baselines for METs and measures reported in the *today’s resources view* by the units will be updated in conjunction with the new PRST baselines for the unit. Updating DRRS-S baselines in a piecemeal fashion should be avoided.

Timely, responsive feedback loops. Even with a strong ready unit production workflow, feedback mechanisms may break down. The USSF should measure how long it takes from when a unit first indicates that an MET, measure, or PRST baseline is inapplicable or in error until that issue is resolved. They may also wish to implement a straightforward and consistent mechanism within the USSF readiness views to indicate that a baseline may be in error or has open issues against it. If some METs and PRST items are no longer applicable, as in the case of the 11th SWS, that unit should be able to address this issue once and then have the readiness system reflect that open issue as opposed to the unit commander needing to restate the issue each month in his or her remarks. Because this use case focuses on what happens when a unit is changed in some way (e.g., reorganized, stood up, merged, etc.), the analysis and organizational design steps conducted before DRRS-S baselines are changed are critical. From this use case, we derived the requirements for a *needed capabilities view* to track progress of the organizational redesign and collect measures regarding the pace of organizational redesign.

The Tactics and Training Development Use Case

Whereas the above case focused on *organizing*, this second focuses on the *training* aspect of building readiness, where a change in adversary tactics will create a need for new training or equipment to create Guardians who can respond to the new tactics. The example we discuss here is the MILSATCOM mission, which must transition from operating in today’s relatively benign environment, where adversary attacks are confined to routine cybersecurity intrusions and radio frequency jamming, to being able to conduct operations in an environment where a near-peer adversary might employ a vastly more diverse set of attack strategies, tactics, and weapons.⁹⁷ Similar to the organization change use case, in this section we describe how an impacted unit reported its readiness in DRRS-S during the transition (the “as-is” use case); describe issues that currently prevent accurate and objective reporting of readiness information; and how the unit would report readiness in the future using our framework (the “should-be” use case), including potential indicators of bottlenecks in the ready-unit production process.

⁹⁷ The Center for Strategic & International Studies issues annual threat assessments for space systems. See Todd Harrison, Kaitly Johnson, Makena Young, and Joe Moye, *Space Threat Assessment 2021*, Washington, D.C.: Center for Strategic & International Studies, March 31, 2021. Threats against space assets are routinely referenced in the annual threat assessment report from the Office of the Director of National Intelligence; see, for example, Office of the Director of National Intelligence, *Annual Threat Assessment of the US Intelligence Community*, Washington, D.C., April 9, 2021.

The operational squadron that provides C2 for the relevant MILSATCOM constellations is the 4th SOPS, and the training for the space operators is the responsibility of the 50th Operations Support Squadron, which will soon become the 8th Combat Training Squadron (CTS). The Space Training and Readiness Command (STARCOM), which includes the 17th Test Squadron, is the entity that validates new TTP before they are directed back to the CTS to be integrated into training.⁹⁸

From the wide range of possible threats, we will discuss an attack vector that drives the demand for new tactics at the 4th SOPS: electronic radio frequency attack from sophisticated ground-based jammers. Jamming attacks corrupt or degrade the communication links between satellites and/or ground terminals. When those links carry critical strategic and tactical communications between warfighters, the result is a degradation or loss of vital C2 for the U.S. military and our allies. Jamming techniques continually evolve as adversaries innovate, spurring the need for new TTP. The important consideration for the 4th SOPS is that these threats exist today. While large acquisition efforts have been initiated in response to these threats,⁹⁹ the 4th SOPS needs tactics today to defend today's systems.

The Tactics and Training Development “As-Is” Use Case

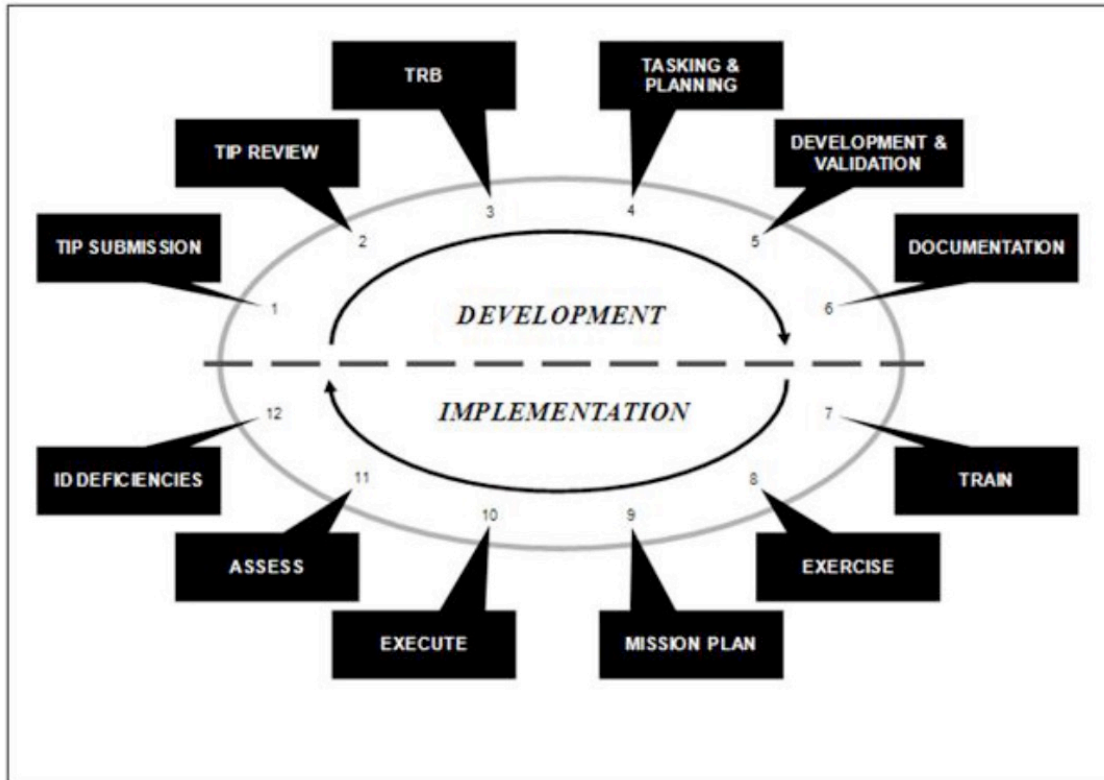
The legacy process for developing new tactics is illustrated in Figure 4.5.¹⁰⁰ TIPs are typically generated by the operational squadron and the OSS, and they are reviewed by the weapons and tactics shops to evaluate the urgency and potential validation and development needs. A Tactics Review Board (TRB) is a cross-community board that exists at different echelons, where a TIP may be moved forward provided the TRB assesses that the TIP has military utility and a capability to validate it exists. The top-level TRB meets at the annual weapons and tactics conference, and results are released within 30 days. If the TIP passes the TRB, an Integrated Validation Team, which includes the division chief for the system of consideration, will take on the tasking and planning to map out the validation. The validation timeline is estimated (current estimates range from 90 days to over one year). The next step is development and validation, where the 17th Test Squadron or possibly the relevant tactical squadron will conduct the necessary exercises or demonstrations to validate the new tactic, technique, and/or procedure.

⁹⁸ The 50th OSS maintains a standard space trainer, a high-fidelity simulator that integrates different mission areas that has potential for use in validating TTP.

⁹⁹ One such acquisition would build more jam-resistant satellites. See Theresa Hitchens, “Space Force Wants \$5B for Anti-Jam Satcoms,” *Breaking Defense*, February 20, 2020a.

¹⁰⁰ The Air Force Space Command Instruction 10-260, *Tactics Development Program*, Washington, D.C.: Department of the Air Force, February 23, 2016, certified current, April 24, 2018, is used here as the most recent instruction, but we note that an updated instruction for the USSF is currently in review.

Figure 4.5. The Legacy Space Tactics Development Cycle



SOURCE: Air Force Space Command Instruction (AFSCI) 10-260, *Tactics Development Program*, Washington, D.C.: Department of the Air Force, February 23, 2016, certified current, April 24, 2018.

Depending on time urgency, the documentation step is coordinated by the DAF weapons coordination team as either a USAF TTP, a tactics bulletin, or a flash bulletin. After documentation, the process shifts over to the implementation part of the cycle. It is then up to the relevant operational support or combat training squadrons to develop a training program for the new tactic and/or procedure and then make sure the tactical squadron completes the training. As the cycle implies, training and mission planning by the space crews is also an opportunity to generate new ideas for new tactics, thus feeding back into the beginning of the process with TIP submission.

In current practice within Delta 8, the operational squadrons like the 4th SOPS do advanced training, which includes ready space crew advanced training missions where a new threat is introduced. In response, space crews create a mission plan implementing a possible response tactic. If they deem the new tactic successful, they document it in a TIP, and the 50th OSS enters it into the TIP review process. If the TIP makes it through validation and documentation, the 50th OSS will be tasked with integrating the new tactic into the regular continuation training program. Table 4.2 documents the steps required to progress from a TIP to a unit that is ready to perform that tactic in response to an operational need.

Table 4.2. A Step Map for Tactics Development and New Training

Submit TIP	Review TIP	Tactics Review Board [annual, result in 30 days]	Tasking and Planning	Development & Validation [<=90 days to 1+ year]	Documentation	Design Training [120 days to train unit instructors]	Execute Training	Update PRST and Facilities Baselines
Responsible party: Any individual at any echelon	Weapons and Tactics shop of unit; up to Delta, SpOC	SpOC at WEPTAC	Integrated Validation Team	STARCOM, 17th Test Squadron or with tactical unit	SpOC, USAFWC	Delta CTS	Delta CTS, tactical unit	SpOC Readiness Branch
Inputs: threat, crew mission plan	Proposed development / validation needs; perception of urgency	Perceived military utility; capability to validate	Need for integration vs. independent validation	Exercises or demos	Formal USAF TTP vs. tactics bulletin vs. flash bulletin; coordination process	Training equipment, infrastructure, available instructors	Training equipment, infrastructure, available instructors, operators' "dwell" time	Baseline studies
Throughput metric: TIP/time	TIP/time	TIP/time; TIP success rate	TIP/time; number requiring 17th Test Squadron	Validations/time	Documents/time	Training updates/time	RSP completion/time	Baseline updates/time

SOURCES: AFSCI 10-260, 2018; USSF weapons and tactics SMEs, discussions with authors, July 21, 2021.

NOTE: USAFWC = U.S. Air Force War Center; WEPTAC = weapons and tactics.

Issues Preventing Accurate and Objective Reporting of Readiness During TTP Development

Note that although we use the 4th SOPS as the basis for this tactics and training development use case, we believe it to be representative of TTP development issues more generally across the USSF.¹⁰¹ A qualitative review of the 4th SOPS DRRS-S data from January to July 2021 highlighted several issues that bear relevance to the tactics development process outlined in Table 4.2. Foremost, remarks from the 4th SOPS commander discuss the need for validated TTP for training. In our review we noted multiple mentions of a backlog in TTP validation, which suggests the existence of key bottlenecks in the current process (see Figure 4.5). We hypothesize that these bottlenecks are preventing the 50th OSS from developing requisite training curricula to keep pace with modern threats. It is worth noting that any effect on readiness due to these process inefficiencies are rarely captured in top-line DRRS-S measures, making it difficult for higher-level leadership to determine the 4th SOPS readiness from capability and resource ratings alone.

Based on this observation of the DRRS-S reporting, we conducted several interviews with commanders involved in the TTP production process. They related significant concerns with a steadily increasing assessment burden on the 17th Test Squadron, and a notable lack of adequate simulator capabilities that make it difficult to train to standard even if validated TTPs are present.

One important note about the tactics development cycle from the perspective of readiness reporting is that there are many different organizations involved at different steps. Today no

¹⁰¹ We chose the 4th SOPS as the basis for this use case not because it has experienced outsize issues with respect to TTP production but because its mission allows us to provide some specifics in an unclassified report.

single unit tracks the status of TIPs through the full process. After a TIP is submitted, the progress is tracked informally in communications with other operational units or the 17th Test Squadron. Further, though the tactics development process does have ties with space readiness, it is not formally tracked in DRRS-S.¹⁰²

The Tactics and Training Development “Should-Be” Use Case

Our framework is designed to monitor the USSF’s readiness to adapt to changes in adversary tactics, including how quickly they can develop and validate new or updated tactics and procedures as well as how quickly and how effectively personnel are trained in those tactics and procedures. Currently, DRRS-S captures whether personnel have completed training but is largely silent as to whether that training is sufficient. While measures of effectiveness for a MET may address some aspects of sufficiency, commanders primarily communicate sufficiency of training and training equipment in their remarks.

Under our framework, suppose that a 4th SOPS operator originates a TIP suggesting a new approach to provide earlier detection of ground-based jamming activities. As in the current process, the 50th OSS evaluates the proposal and finds it to have value. Coincident with approving the TIP for development, the 50th OSS identifies the impacted MET, which we will notionally title “Protect against ground jammers.” It would then set a measurement goal for the MET that reflects the anticipated improvement in detection time, and Delta 8 would begin reporting against the updated measure in the *needed capabilities view* of readiness. As the TIP progresses through the validation process, performance against this new measure is updated, threat scenarios are developed, and impacts to existing TTP are noted. Perhaps most important, using the above process to track the performance improvement of the MET via the *needed capabilities view* provides leadership insight into how the projected improvement in detection time changes between TIP approval and tactic validation completed. This information can be used to inform decisions regarding longer term investments in anti-jam capabilities. For instance, if tactical changes greatly improve performance, there may be less need for larger investments. If tactical changes provide only marginal improvement, the urgency of making longer-term investments increases.

Suppose that, as part of the validation process, the new tactic is tested in 4th SOPS advanced training and is proven out. At this point, assuming no new equipment or facilities are needed, all proposed criteria for transitioning from the needed capability to the *today’s resources view* are met. The Delta then engages with the unit to update the PRST and MET baselines in DRRS-S. For instance, suppose that the new tactic involves slight adjustments to the satellite’s antennas and orbital position to better characterize the jammer. The training curricula then are updated to

¹⁰² Though it is not a PRST-type of objective readiness measure, we did see mention of a specific number of “TTPs to be validated” as an informal metric tracked in the remarks section written by the commander of an operations support squadron.

show that (1) payload operators must be trained in new procedures to mitigate the impact of those adjustments on the communications service; (2) space crew training (including mission planners, orbital analysts, and satellite operators) must be conducted first on simulators; and (3) training must finally be conducted on orbit. The Delta and the unit together define training packets in DRRS-S to reflect this new curriculum. With the update of the training packet requirements and the new measurement threshold for detection time of the “Protect against ground jammer” MET in DRRS-S, the *today’s resources view* begins to track the unit’s progress toward completing its training. Using the above process ensures that the USSF leadership has access to information regarding both the sufficiency and effectivity of unit training.

By following this process, the USSF will have consistent measures of how long it takes for both tactic validation and unit retraining. These measures form the basis of *the keeping pace view* of readiness, but we also need indicators of where the process becomes bottlenecked. Without indicators of bottlenecks, it is impossible to know where to invest to improve throughput.

Indicators and Warning for the Validated TTP Production Process

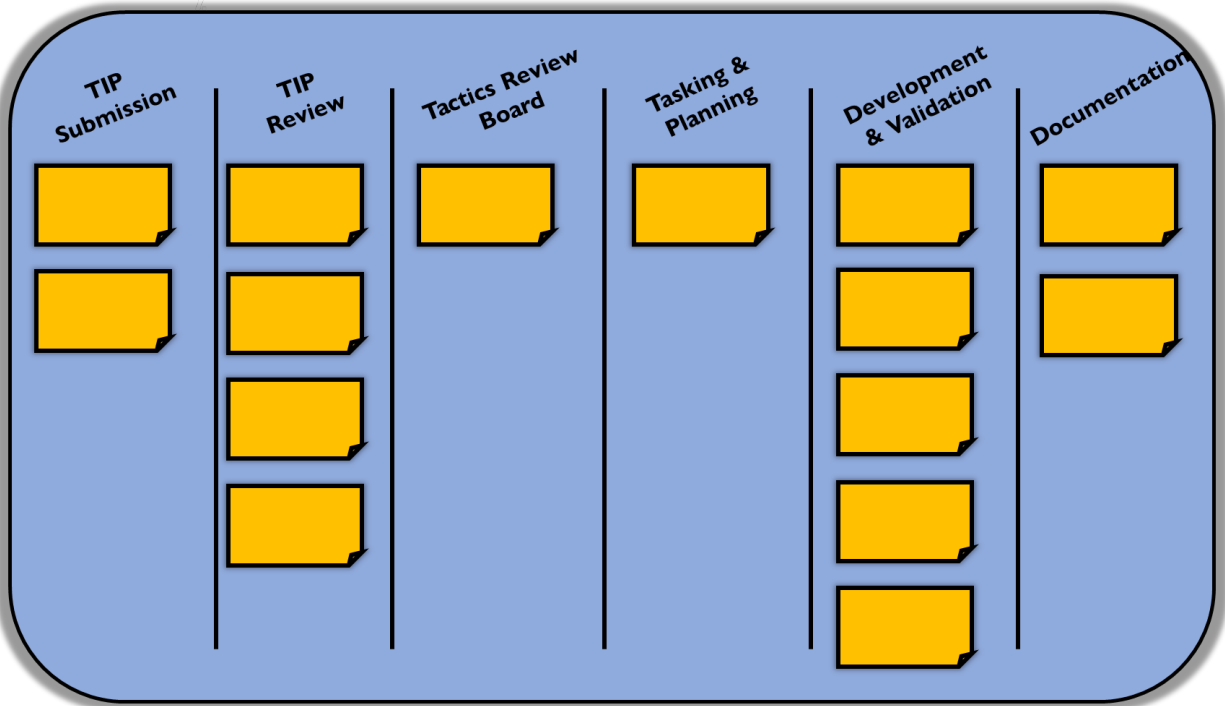
Validation of Tactics and Procedures. One likely bottleneck in the space tactics development process is at the independent validation step. If the TIP is complicated enough to need external validation, recall that the 17th Test Squadron is the main organization in charge of validating all TRB-approved TIPs across the USSF. One might anticipate a large demand for new tactics to address near-peer adversary threats from across the space missions, not simply from the MILSATCOM mission. Without sufficient surge capacity from the 17th Test Squadron, they could easily become the constrained resource in the validated TTP production process. We were also told that test-beds and simulators are constrained resources. One USSF official stated that across the USSF “we have hundreds of TIPs collecting dust” because they do not have the ability to validate them.

To provide indicators of these constraints, we recommend that the USSF instrument the validated TTP production process with a Kanban board, which simply tracks each TIP with a card that is placed on a board to reflect where that TIP is in the development and validation process. A notional example is shown in Figure 4.6. At the step where inventory builds up (as measured by the number of cards accumulating at a particular step), there is a bottleneck. If the USSF takes steps to unblock the production system, the success of that initiative should be immediately visible in the reduction of TIP buildup.¹⁰³ With a centralized tool like this, leadership can diagnose visually what steps are taking the longest and may require attention.¹⁰⁴

¹⁰³ Other ways to alleviate bottlenecks at the independent validation step might be to give the Deltas the authority to validate TTP that are unique to their mission. If the independence of the validator is maintained, we believe this is a viable option. An alternative option would be to have one member of the 17th Test Squadron act as an unbiased participant in a validation team made up primarily from the relevant tactical units.

¹⁰⁴ Note that Kanban boards can be nested to provide additional detail at finer granularity.

Figure 4.6. The Illustrative Kanban Board for Validated Tactics, Techniques, and Procedures Production



SOURCE: Authors' analysis of AFSCI 10-260, 2018.

NOTE: Inventory buildup at the TIP Review and the Development and Validation steps is an indicator that one or more bottlenecks are affecting the completion of these steps.

Centralization and transparency aid in communication and provide leadership critical information should they need to prioritize some TTP development over others.

Lack of training infrastructure or instructors to train against adversary tactics. Another likely issue to arise across the USSF is that once new tactics are established for responding to new adversary threats, the unit needs training infrastructure to train for the new tactics. Training infrastructure includes access to simulators to provide synthetic threat environments, space ranges, or even instructors. Our proposed framework addresses this issue by tracking the time from when the training curricula and training packets are updated in DRRS-S to the time when the unit has completed that training and is again at full readiness. The operational squadron, the associated OSS, or both should report an issue with training infrastructure in their equipment ratings and remarks, training ratings and remarks, or with the MET rating and/or its associated commander remarks. For the latter, the commander remark should note an inability to train for a specified threat level or specific threat scenario.¹⁰⁵

¹⁰⁵ In our review of commander remarks, we found several mentions of a lack of qualified instructors to assess and maintain readiness in key areas, increasing tactic implementation lag.

If the training infrastructure that is lacking is new simulator capabilities and/or space ranges, the constraint may not be something that can be quickly addressed. In the short term, the unit will need a training curriculum that uses the available infrastructure—perhaps mostly coursework or tabletop exercises. In the longer term, the USSF should use the measures provided by our framework to assess and prioritize training needs across the SpOC to inform training infrastructure investment decisions.

Inability to report on equipment or training not already assigned. Related to the issue of not having training infrastructure to train new tactics, as we noted in the first use case, DRRS-S lacks a clear mechanism to signal that the unit needs resources above and beyond those it is currently assigned. Whether it be equipment used in operations, training equipment, or specific training curricula, the only way to report the need for yet-to-be-assigned resources is in a commander remark or top concerns report; both are free-text format. Our readiness framework’s *needed capabilities view* remedies this situation. As soon as the training or equipment need is identified, the *needed capabilities view* should signal a decrease in readiness and track progress over time.

Lack of defined and prioritized threats from USSPACECOM. Doctrinally, the unified combatant commands produce joint contingency plans (e.g., operational plans) and guidance for what they will require from the services.¹⁰⁶ However, USSPACECOM is a relatively new combatant command, and it has yet to communicate its requirements for the USSF. Following the National Defense Strategy, and according to the USSPACECOM commander’s Strategic Vision,¹⁰⁷ the focus *is* on the near-peer fight, but a clear ranking of threats for space is yet to be developed. There is some hesitance for the USSF to come up with its own capability and threat-level readiness requirements before they are explicitly asked for by a combatant command.¹⁰⁸ This hesitancy constrains the validated TTP production process. Without additional guidance from the combatant commands, the USSF may find it difficult to prioritize scarce validation and training resources.

¹⁰⁶ For responsibilities of unified combatant commands, see JS, 2017.

¹⁰⁷ U.S. Space Command Public Affairs Office, “USSPACECOM Releases Commander’s Strategic Vision,” *CHIPS*, February 4, 2021.

¹⁰⁸ USSF official, discussion with the authors, August 2, 2021.

Chapter 5. Transitioning to a New Framework

The Transition Plan

We recognize that this framework is not simple to implement. Therefore, we have crafted a transition plan that improves readiness reporting of the USSF in the short term, builds over time, and prepares the service for the readiness systems and tools that meet the full range of its needs.

The first three major steps each correspond to implementing one of the three views of our readiness framework. For each view, assessment measures must be defined, reporting units must be designated, data sources must be recognized or created, and data recording tools must be implemented.¹⁰⁹

The first step is focused on correcting unit authorizing documents and fixing problems with the current readiness reporting processes and tools so that they can effectively report readiness given today's resources. The reporting baseline for this readiness view is the resources the unit is currently authorized, the missions it currently conducts, and the threats it trains for today. This view of readiness is what is typically thought of as readiness reporting by many, and especially Congress. Besides a review and revision of the unit authorizing documents, the ADSs will require updating to fully meet USSF needs for this assessment. While not trivial—because (1) DRRS-S is already structured to report this information, and (2) identifying currently authorized resources should demand relatively little analysis—this first step should require the shortest time to achieve.

The second major step is to implement the readiness assessment based on needed capabilities. Given the current state of the USSF OT&E posture relative to the full range of adversary threats, an objective, actionable, and accurate measurement of the readiness to confront these threats (including both resources and capabilities required) is needed. Identifying the required capabilities and resources will require more in-depth analysis. These requirements will be aspirational and may be controversial, but there is a great need for a credible source to inform debate and decisionmaking. Some of the current challenges in readiness reporting result from using DRRS-S to communicate multiple views of readiness when it is not designed for such use. Therefore, there will be a need to create a separate and parallel, though potentially similar in form, data repository for this view of readiness.

The third major step is to establish measures and tools for reporting the USSF's ability to keep pace with the range of adversary threats. This will require the use of different types of

¹⁰⁹ Note that this plan does not include a clear delineation of the specific organizations that should perform the steps of this transition plan. This is because, due to the rapid reorganizations occurring within the USSF, we believe there is a high probability that the organizational responsibilities will change several times prior to publishing this report.

measures than are typical for readiness assessments; rather than a static “status” of a unit, the measures will inherently include a time component (e.g., how many tactics are being validated per calendar quarter). And because much of the execution of this evolution are functions of staff and training units, the reporting units will be different from what is typical for readiness reporting. Because this change in measures draws on objective data from the other two views of readiness and may require a different type of assessment and recording tool, it is the third and last step in crafting original readiness assessments.

The fourth step is focused on managing the USSF’s ability to keep pace with adversaries and is based on using the data supplied by the different readiness views. We recommend using a TOC-based management cycle. In short, the primary constraints are identified and relieved in a cycle to increasingly improve the USSF’s ability to evolve rapidly. As the force evolves using these readiness measures, reporting requirements will shift among the different views.

Note that these steps are not necessarily sequential in time but are sequential in terms of priority.

- **Step 1:** Correct and improve readiness reporting given **today’s resources**:
 - a. Define the DRRS-S reporting units for USSF to match current operational space units.
 - b. Write a mission directive for each reporting unit that reflects the missions the unit is currently OT&E’d to perform.
 - c. Update personnel reporting requirements:
 - i. If necessary, update ADSs to reflect the authorized and assigned billets by number of personnel, rank, and specialty.
 - ii. Consider USSF force presentation construct (shift, geography, etc.), and determine if using subunit packets such as UTCs is helpful for understanding unit readiness.
 - iii. If helpful, segregate authorized personnel by force presentation/employment construct using resource packets.
 - iv. Implement new personnel reporting requirements in DRRS-S.
 - d. Update equipment reporting requirements:
 - i. Each unit should review current equipment packets in ADS and update as needed to match current mission-critical equipment.
 - ii. Create packets to track the following subcategories of equipment:
 1. satellites
 2. space system ground equipment (control and/or monitoring stations, antennas, gateways, user equipment)
 3. facilities (including training facilities under control of operational unit)
 4. other infrastructure (IT infrastructure; terrestrial networks; electrical generation; heating, ventilation, and air conditioning or other cooling systems; etc.)
 5. personal equipment.

For equipment whose status is held in an ADS above the *Secret* level, define and document the process for how and when that status is to be provided to upper echelons within the USSF and incorporated into DRRS-S.

- e. Update training reporting requirements:
 - i. Review and revise to ensure that training reflects current curricula.
 - ii. Create subcategories of training for
 - 1. standard operations
 - 2. advanced operations
 - 3. deployment.
- f. Review and revise METs to ensure that they reflect the mission directive.
- g. Continue to report readiness, given today's OT&E posture, within DRRS-S.
- h. Establish reporting requirements, guidelines, and tools to improve reporting readiness based on today's resources, including dependencies and time histories of DRRS-S-derived readiness ratings.
- **Step 2:** Establish reporting requirements, guidelines, and tools to improve reporting readiness based on **needed capabilities** for the near-peer fight:
 - a. Map USSF missions to USSF organizational structure, facilities, and equipment to understand the dependencies, including non-DRRS-S reporting units.
 - b. Identify the reporting units for needed capabilities based on who will require changes to resources and mission relative to today's OT&E posture.
 - c. Establish missions and reporting guidelines for units that report under this view of readiness.
 - d. Write mission directives to include the known threat environments and missions that each DRRS-S reporting unit will be organized, trained, and equipped to counter.
 - e. Write mission directives for non-DRRS-S reporting units that will report under this readiness view.
 - f. Develop guidelines for writing METs and reporting readiness versus threat environments
 - g. Write METs based on mission directives and threat environments.
 - h. Establish and document resource requirements for "needed capability."
 - i. Create a data repository for this view of readiness.
 - j. Develop guidelines for when to transition to the "today's resources" view (i.e., develop entrance and exit criteria between readiness views).
 - k. Begin reporting readiness for needed capabilities.
- **Step 3:** Establish measures and reporting tools to reflect USSF's ability to **keep pace** with the adversary.
 - a. Develop measures for assessing ability to evolve the USSF and keep pace with the full range of adversary threats for USSF functions:
 - i. training curricula development and implementation
 - ii. tactics development and validation
 - iii. PPBE analysis and decisionmaking
 - iv. organization redesign functions.
 - b. Establish offices of primary responsibility for assessing and reporting measures of pace for each function.
 - c. Create a data repository for this view of readiness.
 - d. Develop goals and thresholds for measures of pace; these goals can be dynamic.
 - e. Develop measures and offices of primary responsibility for assessing and reporting threat mitigation throughput at the USSF level.
 - f. Begin reporting USSF's ability to transform and keep pace.

- **Step 4:** Manage the USSF enterprise to increase throughput of the USSF “readiness factory.” (While Steps 1 through 3 describe how to measure and report, Step 4 focuses on monitoring and improving measures.)
 - a. Identify bottlenecks in USSF’s ability to execute functions.
 - b. Optimize around the constrained resource identified as the bottleneck.
 - c. Invest to relieve bottleneck in the long term.
 - d. Reassess the revised USSF functions, and continue to move reporting requirements among views of readiness as appropriate.

Collected Findings and Recommendations

In conclusion, we present a collection of the most important findings and recommendations from this project. They are collected, and condensed, from other sections of the report.

Table 5.1. Collected Key Findings and Recommendations

Findings	Recommendations
While it is mandatory for DRRS-S to be used for reporting to Congress, other U.S. military services have created frameworks to augment DRRS-S and meet their internal needs. The USSF’s highest-priority need for a readiness framework is one that can measure readiness against the full range of threats, including its ability to evolve to confront those threats. Readiness measures and tools currently in use do not support these broader conceptions of readiness. Units are reporting too much different information given DRRS-S capability, resulting in not easily actionable information and burdensome reporting. The Marine Corps and Navy have separate readiness reporting policies and processes, with only limited coordination of readiness narratives when required. The USSF has unique characteristics that change how its readiness should be understood, managed, and reported. The USSF does not effectively measure its readiness against the range of threats: • reporting tools do not effectively measure multiple views of readiness • the risk of unallocated and unfunded resources is not reported • capabilities and resources required to confront the near-peer threat are not documented.	Implement the readiness framework described in Chapter 4, which includes three views of readiness: 1. given today’s resources 2. based on needed capabilities 3. keeping pace with transformation as a service Advocate for and build toward readiness policy, measures, and tools designed specifically for the USSF (i.e., separate from USAF) as needed to accurately report USSF readiness. Publish guidance on what resources are to be measured to judge readiness against the full range of near-peer threats. Identify and document requirements for today’s near-peer threats. Assess risks and benefits of process changes recommended in Chapter 4 to accelerate organizational change and update readiness reporting baselines while keeping pace with evolving threats. Create and use a data repository separate from DRRS-S to report and store data on the <i>needed capabilities</i> and <i>keeping pace</i> views of readiness (see framework description for more detail).

Findings	Recommendations
Heritage ADSs, inherited from USAF, spoil readiness data: - critical resources, and particularly equipment, are sometimes missing from data - misaligned security classification among ADSs, DRRS-S, and space system classification guidance challenges accurate readiness reporting - complex system interdependencies are not captured	Redefine ADSs to - better match security needs of space community - capture all critical mission equipment - better represent interdependencies of operational systems and units Review and revise resource requirements used in readiness assessment and reporting, with a focus on equipment. Engage with enterprise data system (e.g., the Unified Data Library) development to judge utility to readiness reporting and potentially impose requirements to better support readiness reporting.
Important information in commander remarks is not readily actionable.	Review historical remarks to determine if commonly communicated information can be moved out of comments and into objective measures.
Reporting is unnecessarily burdensome on units.	Implement formatting standards (e.g., end lines, boldface section titles, etc.) to improve readability.
	Track and potentially leverage HAF A3T effort to streamline DRRS-S reporting systems.
	Improve ADS infrastructure to autopopulate resource data from ADSs in more cases.
	Implement the readiness framework recommended in Chapter 4.

Chapter 6. Conclusions

This report recommends a framework to understand, manage, and report readiness for the USSF. It is intended to improve readiness assessment not only for *today's* space forces but to support the USSF's ability to evolve its capabilities and keep pace with the threats. Military operations in outer space and the organizations that perform them are different from other domains for tactical reasons, but, fundamentally, the USSF today is challenged by an acute need to change the design of its forces, technology architecture, and operational concepts. Because the readiness reporting systems were primarily designed to report readiness for "tonight's fight" given the military forces that exist today, they often deliver poor information when called to capture broader understandings of readiness. Recognizing that the USSF's ability to evolve also drives its readiness, our framework more directly links mission and organizational design processes with readiness assessment. We believe this challenge affects the USSF particularly acutely due to the rapid change of the perceived threat in the space domain and the need for grand transformation in U.S. military space forces.

While details of the findings and recommendations (see Chapter 3) and transition plan (see Chapter 5) are specific to the USSF, the framework itself (see Chapter 4) could also be used by other military organizations to use readiness assessments to track and manage their ability to evolve their OT&E posture. Effectively reporting and consuming readiness information requires substantial investment from military units and staff. While proposing multiple views of readiness may imply a greater burden, we note that the readiness reporting system today is inefficient and unnecessarily arduous (see Chapter 3 for more detail). We believe that formalizing the different views of readiness and creating separate data systems will result in a readiness framework that is more efficient (and hopefully less burdensome on both units and staff) and more effective (and therefore worthy of that investment).

Implementing this framework should benefit from the recommendations and transition plan in this report; however, this transition plan is limited by the rapid organizational change within the USSF and uncertainty on where some responsibilities should lie. Details will depend on how the USSF organization and its interactions with other military communities continue to evolve over time. Force presentation models, organizational responsibilities, training practices, and mission threads are likely to continue changing for the USSF. As future research and analysis explore these and other topics for an evolving USSF, we suggest a similar perspective of clearly differentiating today's forces from tomorrow's requirements and managing to increase the pace of moving from one to the other.

Appendix A. Methodology and Data Sources

The analysis to build our recommended readiness framework consisted of the following activities:

1. Review the readiness policy and practice of other military services.
2. Study the current USSF readiness reporting system.
3. Identify areas of improvement for the USSF readiness reporting system.
4. Develop and recommend a USSF readiness reporting framework.

The analysis within each of these steps drew from several types of data: (1) literature reviews, (2) DRRS-S data, and (3) SME and stakeholder discussions. Development of the recommendations, particularly the framework and transition plan, followed an iterative and collaborative effort through exercises, structured and unstructured discussion, working through the specifics of use case examples, and informal requests for ideas from SMEs. Each of the types of data and the framework development are described in more detail in the following sections.

Literature Review

We reviewed news articles, research reports, U.S. law, and policy documents to better understand the readiness reporting system. As an important DoD system, much has been written on readiness as (1) a concept and term of military art, (2) a requirement levied on the military services, and (3) a detailed process and enterprise IT system to be used by reporting units.

We reviewed publicly available and, in some cases, draft policy documents from the Army, the Navy, the Marine Corps, USAF, and the USSF. As many anticipated policy guidance documents for the USSF have not yet been published, at times we depended on documents written for USAF that were still governing the USSF. We also reviewed Chairman of the Joint Chiefs of Staff (CJCS) policy documents for the requirements that the joint community places on the services. Title 10, Section 117 of the U.S. Code places its own requirements on the readiness reporting system.¹¹⁰ These policy documents, in general, speak to the specific requirements, processes, standards, and systems to be used in reporting readiness.

We drew on previous research reports from organizations like the CRS, DoD, federally funded research and development centers, and universities to give a more complete view of the readiness building and reporting systems and how they connect to other DoD concepts such as force presentation and concepts of operation. They also, in many cases, give a picture of previous research findings and where there was “fresh ground” to be covered in our work.

¹¹⁰ U.S. Code, Title 10, Section 117, 2019a.

News articles regarding readiness across the services and about readiness drivers for the USSF, while not foundational to our analysis, provided context and ideas for further investigation.

DRRS-S Data

Our team reviewed and analyzed DRRS-S data reported by space units throughout the course of this project. We also had access to historical reports from FY 2019, before the creation of the USSF. Because DRRS-S is a classified system and the current readiness status of DAF units is generally classified, readiness data is not presented directly in this report. Trends and patterns in recent readiness reporting, when mentioned, are presented qualitatively and independently from any individual unit or capability. However, as part of our research we attempted to assess the quality of information in DRRS-S and to develop an understanding of (1) what information is being reported, (2) how well it measures a unit's readiness given the characteristics of the space domain and an individual mission, (3) whether the reported information is accurate, and (4) whether the information is readily actionable for decisionmakers.

As the USSF is going through its reorganization into a new service, many systems are undergoing changes in their enterprise systems, and these transient changes can introduce temporary breakages (for example, changes to Unit Identification Codes in DRRS-S to reflect that the USSF is now separate from USAF). When assessing the quality of DRRS-S data, we sought to identify whether any deficiency is due to transient IT issues or more fundamental misalignment between DRRS-S capabilities and USSF needs. We then focused on the fundamental issues and thus do not address technical road bumps in this report.

Subject Matter Expert and Stakeholder Discussions

Another major source of information supporting this research was unstructured not-for-attribution discussions with readiness SMEs and stakeholders. These discussions included uniformed and civilian people in the staffs of several U.S. military services and the leadership of USSF mission operations units, support units, and Deltas. The topics of discussion changed depending on their role in the readiness ecosystem; we tried to focus on what they believed to be the greatest challenges and opportunities for the USSF. These conversations were frank, wide ranging, and extremely helpful to this project. They often provided new information through discussion and through sharing otherwise unavailable documentation, perspectives, and ideas for further study.

Due to the not-for-attribution and informal nature of these discussions, our research does not rely on information learned through these discussions that we could not corroborate with other sources of information, such as published documents or analysis of DRRS-S data.

Framework Development

Development of the framework and transition plan included both structured and unstructured methods employed in an iterative process. Identifying overarching goals for the framework began with a mapping of the potential scope of readiness assessment and reporting (see Figure 1.4) and determining the highest priority needs for the USSF.

The full project team contributed to the design of the framework, and we also asked interviewees what they would do to improve readiness reporting for the USSF. Structured design methods included brainstorming exercises to construct a vision of the end state, develop functional flow block diagrams, or conduct step analyses for the production processes. Unstructured methods included independent design and small and large group discussion. The final framework design uses concepts from academic work on lean engineering and TOC.

Appendix B. Sister Service Readiness Reporting Comparisons

This appendix uses the results of comparative analysis to draw lessons learned regarding

- external readiness reporting requirements (statutory, OSD, CJCS) and how other services meet them
- the readiness practices of other services.

This appendix begins with a discussion on the analytic construct we developed to explore and discuss the comparative analysis. It then provides our preliminary assessment of areas in which the USSF might need to pay particular attention as they continue to develop and refine their readiness systems. It concludes with a summary.

The Five W's and One H Lensing Construct for Analyzing Readiness

We leveraged a “five W's and one H” construct to frame our discussion of readiness reporting in the USSF and other services. We defined the components of the construct as follows:

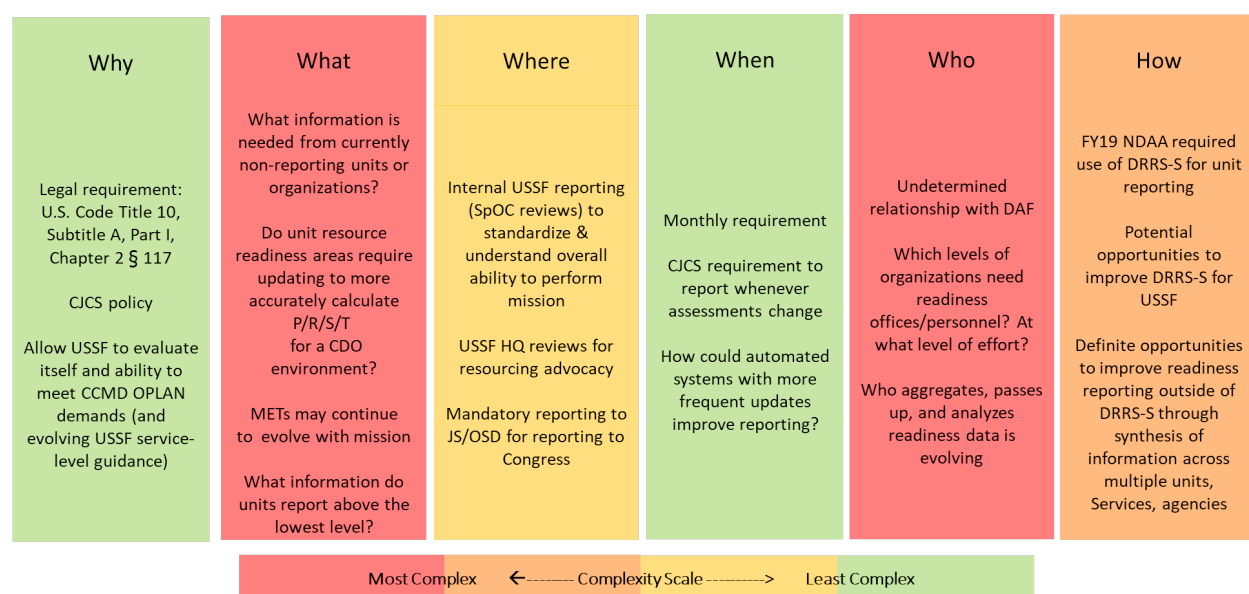
- Why?
 - Why are external reporting requirements being imposed on the services?
 - Other than complying with legal and policy requirements, why do the services report readiness?
- What?
 - What units report readiness data?
 - What unit-level information is reported?
 - What higher-echelon information and analysis is reported?
- Where?
 - Where is readiness reported and utilized—in what venues, and to whom?
- When?
 - When is readiness reported to comply with requirements and meet other goals?
- Who?
 - Who gathers, analyzes, communicates, and otherwise “touches” readiness data and its products?
- How?
 - How are systems, tools, frameworks, and other constructs used to report, analyze, understand, and communicate readiness?

A Preliminary Assessment of the USSF Using the Five W's and One H Construct

We begin with our assessment on the USSF needs. This is based primarily on our assessment of areas where other services have and continue to struggle, and on early discussions with USSF readiness stakeholders. Overall, we believe that the *what* and the *who* categories will require the

most attention, followed by *how*. This assessment was based less on issues the USSF might be experiencing to date and more on the complexities to be overcome in developing and refining how it manages readiness. Figure B.1 describes the attributes of each category and scores them based on their associated complexities within each category. The most significant added item of concern is the emergent and developing relationship between the DAF and the USSF—which is inevitable and present across all management areas and topics beyond just readiness, given that the USSF is a new service.

Figure B.1. An Overall Five W's and One H Assessment of the Complexities in USSF Readiness



Comparative Lessons Learned Across the Services

From our comparative analysis, the most pervasive theme is that USSF characteristics drive the need for independent processes, particularly via a synthesis of unit information into functional reporting. Expressed in more detail, we identified the following major lessons for USSF to consider:

- The characteristics of USSF drive the need for independent processes, particularly via the synthesis of unit information into functional reporting. There is a precedent to be found in the Marine Corps and Navy, which have independent readiness reporting systems, frameworks, and processes.
- The USSF will likely benefit from analytical frameworks and processes to support understanding and communicating readiness above the reporting-unit level (as we will discuss in more detail to close this appendix). Again, there is a precedent (e.g., the Army's Strategic Readiness Tenets and the Navy's Optimized Fleet Response Plan).
- USSF reporting units should consider the USSF's eventual force presentation model. More detail on this is provided in Chapter 2.

The What of Readiness Reporting

Lessons identified and learned under the *what* aspect of our construct focused on two primary questions:

1. What units report readiness data?
2. What information is reported?

Other services report unit-level resource and capability into DRRS-S; however, the services augment and integrate DRRS-S with other systems and programs to enable them to understand and manage readiness from a more strategic and enterprise-level perspective. Table B.1 provides a detailed discussion of *what* the services are reporting.

Table B.1. What Is Reported Across the Services

	U.S. Air Force	U.S. Navy	U.S. Marine Corps	U.S. Army
What units reports readiness data?	Primarily squadrons (includes ops, combat support, and combat service support)	Primarily individual ships and aviation squadrons	- Marine Air Ground Task Force (MAGTF) elements, - Intermediate Commands	- Deployable units able to operate independently of HHQ or other units - Variety of echelons, level of command and number of personnel
	Higher level organizations typically report only their staff and equipment, not an aggregation of subordinate units			
What information is reported?	Generally, the Same Across All Services for Each Reporting Unit			
	Resource Readiness C-rating (P/S/R/T) (data informed, objective) P-Rating: ability to deploy qualified personnel S-Rating: supplies on hand R-Rating: equipment condition T-Rating: how well trained		Commander's Unit Status Report (CUSR) - Same general info as other Services. - Distinguishes A-rating, which is the YQN for assigned missions	
	Capability Readiness (data informed, ultimately subjective) Ability to accomplish tasks contained in METLs, rated Y/Q/N			

NOTE: Y/Q/N = Yes, *qualified* yes, or *no* assessments.

The Who of Readiness Reporting

The primary question related to *who* concerns who gathers, analyzes, and communicates readiness. There is an ecosystem of actors and stakeholders involved in readiness reporting; and the services take a function-based approach to making sure readiness tasks related to understanding, managing, and reporting are accomplished. Across the services, staffs at the service HQ level assess readiness and act as liaisons to aggregate what is reported up from units. This unit-level readiness data is augmented with other data to provide to Congress and DoD a complete snapshot of the services' preparedness to meet mission demands.

We will again note here that the other services have augmented DRRS-S with other frameworks and processes to holistically understand, manage, and report readiness. Table B.2 provides a detailed snapshot of *who* is involved in reporting across the services.

Table B.2. Who Is Involved in Readiness Across the Services

	U.S. Air Force	U.S. Navy	U.S. Marine Corps	U.S. Army
Who gathers, analyzes, and communicates readiness data?	Readiness offices and personnel at multiple echelons - HAF/A3TR - MAJCOM/DRU/FOA/NAF readiness office coordinates with HAF and Joint Staff - Wing readiness office manages readiness reporting and reviews readiness monthly	Service-Level - OPNAV - N3/N5 (Fleet Operations, Plans & Strategy) tracks DRRS data as part of force management - N43 (Fleet Readiness) tracks materiel readiness - N1 (Manpower Personnel Training and Education) tracks personnel readiness	Readiness Branch (POR) - Leads, manages, and maintains USMC readiness data and related systems - Operational focus as part of HQMC – responsible for strategic readiness assessment Support to Working Groups - USMC Marine Requirements Oversight Council (MROC) - Deputies Management Action Group (DMAG) - Etc.	Service-Level - G3 Readiness and Mobilization Directorate has a readiness OPR - All DCS level entities (G-Staff) have readiness equities that track with readiness tenets for readiness discussions beyond unit status reporting. - Higher echelon units enforce reporting requirements, but to not modify information

NOTE: DCS = Deputy Chief of Staff; DRU = direct reporting unit; FOA = field operating agencies; HQMC = Headquarters Marine Corps; MAJCOM = Major Command; NAF = numbered air force; OPNAV = Naval Operations; OPR = Office of Primary Responsibility; POR = program of record.

The How of Readiness Reporting

Of particular note in the *how* of readiness reporting is that other services have created frameworks and processes outside DRRS-S to assess strategic-level readiness and to provide a more holistic view of their enterprise-level preparedness. Correspondingly, the *how* of readiness reporting focused on two primary questions:

1. How are unit-level data utilized?
2. How are readiness frameworks and related processes utilized?

Table B.3 provides a more detailed discussion of how readiness is reported and examples of the frameworks and processes established within the other services.

Table B.3. How Readiness Is Understood, Managed, and Reported Across the Services

	U.S. Air Force	U.S. Navy	U.S. Marine Corps	U.S. Army
	Congress , Resource readiness; Joint Staff Capability readiness			
How is unit-level data utilized?	HAF capability area reviews MAJCOMS Conduct readiness reviews based on subordinate unit reporting Commanders (at multiple echelons) Resources and Capability Readiness	Fleet commanders and Force managers - As a unit gets closer to workup cycle, commanders up to 4-stars get briefed on readiness status - Used to provide deploying units sufficient resources and to ensure they are on path to deploy on time	Deputy Commandant for Installations and Logistics is more focused on sustainment readiness Logistics Policy and Capabilities Branch is focused on ground equipment readiness (mainly R and S ratings) Intermediate Commands USMC Component Commands	Up the chain via Commander's Unit Status Report (CUSR) - Commander's unit assessment report to higher echelon (typically brigades) - Several venues across the levels of command to meet the submission requirements
How are readiness frameworks and related processes utilized?		Optimized Fleet Response Plan (OFRP) Process to train and certify ships and groups of ships before deployment PESTONI* *see notes page	Marine Corps Strategic Health Assessment (MCSHA) Framework - Focus on equipment at HQ rather than at MEF or unit level – link POM to MCSHA Marine Corps Combat Readiness Assessment - Training and certification before deployment	Army Strategic Readiness Assessment - Employs strategic readiness tenets - Reviews by senior leaders where synthesis and more analysis occurs - Not only (or even mostly) using DRRS data

NOTE: MEF = Marine Expedition Force; POM = Program Objective Memorandum.

Having discussed how important it is to understand, manage, and report readiness beyond a unit-level perspective, we turn to readiness reporting in more detail, and what services are doing to augment DRRS-S to better posture themselves for more holistic readiness assessments and reporting.

DRRS-S as a Required Component of the Tool Kit to Understand, Manage, and Report Service Readiness

This section elaborates on information presented in Chapter 1, which defined our readiness framework and the role DRRS-S plays in that framework. For ease of reading, we have repeated the description of our model (from Chapter 1) as a way into discussing in greater detail the role of DRRS-S and the mandates associated with it.

As noted in Chapter 1, we propose that readiness can be divided into three related activities: understanding, managing, and reporting. Figure 1.3 shows the readiness information ecosystem and consumers of readiness reporting for these three readiness activities.

Understanding Readiness

Understanding a military unit's readiness level is how a service is able to hold a mirror up to itself and increase its situational awareness, which informs availability and resource allocation decisionmaking. Specifically, there are three components of *understanding readiness*: (1) situational awareness, (2) commander's critical information, and (3) readiness models. Of these, we offer here additional detail on the readiness models used by other services to assess their resource and capability readiness (see Table B.4).

These models include and are additive to DRRS-S and provide the services with additional fidelity to make key operational and resource allocation decisions when needed. While DRRS-S is an integral part of the readiness tool kit, until it can functionally integrate and roll up information that these other systems interface with, it is good for the services to establish the necessary tools to see themselves as optimally as possible.

Managing Readiness

The goal of *managing readiness* is to invest in resource areas that need improvement—i.e., turning dials and making investments to improve readiness. However, managing readiness is not a trivial task—not only must a service first be able to *understand* its readiness, but it must also be able to *manage* its readiness in order to effectively balance current availability of resources with future modernization.

A 2017 Institute for National Strategic Studies report states that “traditional unit-level readiness measures are useful as part of a larger readiness management construct, but by themselves they

Table B.4. Readiness Models Across U.S. Military Branches

Service Branch	Readiness Model
Army	ASRA and the Regionally Aligned Readiness Modernization Model (ReARMM). In accordance with CJCSI 3401.01E, ASRA incorporates criterion that consist of six strategic readiness tenet assessments. ^a By 2022, the Army intends to move toward a new readiness model, ReARMM, which aims to better balance operational tempo with dedicated periods for conducting missions, training, and modernization. ^b
Navy	PESTONI: The U.S. Navy utilizes the PESTONI readiness construct to understand their readiness and is utilized internally to determine whether they are investing adequately in each area. ^c
Marine Corps	PRST: The U.S. Marine Corps utilizes PRST information to measure resource area readiness at the unit level. ^d Commander's assessments are articulated at C-levels based on the lowest PRST levels.
USAF	PRST: The USAF combines resource (PRST) and capability readiness. ^e Prior RAND research found that while related, USAF readiness data exists in three buckets that use different measures, criteria, and reporting rules to express readiness that when aggregated are meant to provide an assessment of a unit's readiness to perform its mission. ^f

^a CJCSI 3401.01E, 2014; Department of the Army Pamphlet 525-30, *Army Strategic Readiness Assessment Procedures*, Washington, D.C., 2015.

^b CRS, *The Army's New Regionally Aligned Readiness and Modernization Model*, Washington, D.C., IF 11670, March 9, 2021.

^c This insight was gained through interviews with readiness SMEs within the Navy.

^d Each service has its own method for determining its PRST levels. John C. F. Tillson et al., *Independent Review of DoD's Readiness Reporting System*, Alexandria, Va.: Institute for Defense Analyses, P-3569, November 2000. See Appendix C, "The Global Status of Resources and Training System (GSORTS)."

^e AFI 10-201, 2020.

^f Muharrem Mane, Anthony D. Rosello, Paul Emslie, Thomas Edward Goode, Henry Hargrove, and Tucker Reese, *Developing Operationally Relevant Metrics for Measuring and Tracking Readiness in the U.S. Air Force*, Santa Monica, Calif.: RAND Corporation, RR-A315-1, 2020.

do not provide enough information to proactively manage [readiness] strategically.”¹¹¹ Yet none of the key areas for improving DRRS-S identified in the report touch on how the services *should* manage their readiness.

Artificial intelligence could provide a solution to managing readiness by identifying patterns and the relationships between resource areas while also reducing the potential for human error in input and maintenance of readiness data. The Navy is currently working on artificial intelligence solutions to better manage and maintain its readiness information.¹¹² As stated in a 2017 Center for Naval Analysis report, “Predicting readiness and predicting operational effectiveness are different endeavors with different goals. To connect them requires a layered package of supporting processes and resources.”¹¹³

¹¹¹ Laura J. Junor, *Managing Military Readiness*, Washington, D.C.: Institute for National Strategic Studies, Strategic Perspectives 23, National Defense University Press, 2017, p. 2.

¹¹² Jared Serbu, *When Fixing Navy Readiness Problems, Money Helps. But So Does Data*. Federal News Network, December 17, 2020.

¹¹³ David Zvijac, *Risk and Reward in Investment Decisions*, Arlington, Va.: Center for Naval Analysis, 2017, p. 4.

Managing readiness requires far more than ensuring that troops are organized, trained, equipped, and available for “the fight tonight” with a near-peer adversary. Modernization is critical to ensure that the services are ready for “the fight tomorrow,” which requires that resource allocators be able to *understand* readiness to best *manage* the allocation of resources across competing current and future fight equities.

Connection to the Program Objective Memorandum Process

Readiness is tied to the POM process through the programming phase of the PPBE process; and prioritizes limited funding for force size, structure, training, and equipment.¹¹⁴ Thus, the POM process might be the most important parallel program that readiness information can inform. Operational decisionmakers have the onus to ensure that capable forces are available for the current fight while keeping an eye on future operational demands.

Traditionally, near-term operational (i.e., efficiency and effectiveness of individual elements of the force) and structural (i.e., available forces) readiness has been prioritized over all other aspects of readiness.¹¹⁵

It is important to note that the POM process is closely related to futures or modernization programs as well. Based on the technological refresh rates and in part to the design of the acquisition and capabilities and development processes, the services are often fighting with equipment that is more than 30 years old. In turn, the Army has instituted alongside its financial management and budgeting systems a process to account for this offset by managing “weapon systems from a holistic approach across a 30 year period,” including upgrades and service life extension programs. The Army’s Long-Range Investments Requirements Analysis process, not unlike readiness,

uses inputs from multiple organizations within the Army to synchronize across the modernization, sustainment, training, and installation communities, coordinating materiel development schedules, to eliminate production/sustainment gaps and redundant solutions for identified requirements.¹¹⁶

Reporting Readiness

Once the services are able to *understand* and *manage* their readiness, they must be able to *report* their readiness data in a way that enables DoD and congressional decisionmaking. The goal of reporting readiness is to establish a means for higher-level awareness and decisionmaking, and to fulfill presidential and congressional readiness reporting mandates. In 2019, Title 10, Section 117

¹¹⁴ CRS, *Defense Primer: Planning, Programming, Budgeting and Execution (PPBE) Process*, Washington, D.C., IF 10429, December 11, 2020b.

¹¹⁵ Richard K. Betts, *Military Readiness: Concepts, Choices, Consequences*, Washington, D.C.: Brookings Institution Press, 1995; Brown and Berger, 2021.

¹¹⁶ U.S. House of Representatives, *The Department of Defense’s Readiness Posture: Hearing Before the Subcommittee on Readiness of the Committee on Armed Services, House of Representatives, One Hundred Thirteenth Congress*, April 10, 2014, p. 145.

of the U.S. Code required that “the military services complete the transition to DRRS-S not later than October 1, 2020” and that “the Secretary of Defense shall notify the congressional defense committees upon the complete transition.”¹¹⁷ Figure C.1 shows the current state of the DRRS-S landscape.

In response to the 1999 NDAA, DoD evolved from a strictly resource-based understanding of readiness to “a resource-informed capability-based system—DRRS-S.” Readiness data reported to DRRS-S captures resource-based data along with capability-based MET data. A 2018 assessment of the DRRS-S system architecture revealed widespread issues, which preempted the consolidation of service-specific DRRS systems into DRRS-S.¹¹⁸

However, even if all existing issues with DRRS-S are remedied,¹¹⁹ one fundamental issue remains: the information reported in DRRS-S comprises tactical unit-level readiness data. The services should be able to understand and manage their operational readiness strategically for the “fight tonight” and the “fight tomorrow,” and report their readiness to a system that facilitates resource decisionmaking in the short term and long term.

Fulfilling Reporting Requirements and Providing Situational Awareness to the Chairman of the Joint Chiefs of Staff for Availability or Commitment

Each year DoD requests, and Congress authorizes and appropriates, billions of dollars in operations and maintenance (O&M) funding to support military readiness.¹²⁰ The National Defense Strategy defines DoD’s readiness goals, and DRRS-S readiness reporting is utilized in resource decisionmaking to

- justify DoD and the service’s O&M budget request to Congress
- articulate what Congress’s dollars are buying.¹²¹

However, the inability to connect marginal O&M investment with marginal changes in readiness is due in large part to the difficulty in connecting effective measures of readiness with detailed data on spending.¹²²

The mission of DRRS-S is to establish a collaborative environment for combatant commanders, military services, Joint Chiefs of Staff, Combat Support Agencies, and other key DoD users (such as the Secretary of Defense and the National Guard) to evaluate the readiness

¹¹⁷ U.S. Code, Title 10, Section 117, 2019a.

¹¹⁸ DoD, 2020a, pp. 2, 3.

¹¹⁹ DoD, 2020a, pp. 10–15.

¹²⁰ CRS, 2020a.

¹²¹ Christopher G. Pernin, Dwayne M. Butler, Louay Constant, Lily Geyer, Duncan Long, Dan Madden, John E. Peters, James D. Powers, and Michael Shurkin, *Readiness Reporting for an Adaptive Army*, Santa Monica, Calif.: RAND Corporation, RR-230-A, 2013, p. 63.

¹²² Congressional Budget Office, *Linking the Readiness of the Armed Forces to DoD’s Operation and Maintenance Spending*, Washington, D.C., April 2011.

and capability of the U.S. Armed Forces to carry out assigned and potential tasks.¹²³ According to Mackenzie Eaglen of the American Enterprise Institute, a challenge for lawmakers is

gaining greater reporting clarity on the relationship between resource readiness ratings and mission capability readiness ratings. When the status of personnel, equipment, supplies and training is improving for certain force elements, but their ability to accomplish designed missions is flatlining or declining, that's a tension worth examining and understanding in greater detail.¹²⁴

Existing Readiness Tool Kits

The 1999 NDAA added Section 117 to Title 10, which directed the Secretary of Defense to create a more complete and accurate readiness reporting system.¹²⁵ DoDD 7730.65 (2002) requires the use of DRRS-S to report readiness in order to stay in accordance with Title 10, Section 117, stating,

The DRRS-S shall build upon the processes and readiness assessment tools used in the Department of Defense to establish a capabilities-based, adaptive, near real-time readiness reporting system. All DoD Components will use the DRRS-S to identify critical readiness deficiencies, develop strategies for rectifying these deficiencies, and ensure they are addressed in program/budget planning and other DoD management systems.¹²⁶

Additionally, DoDD 7730.65 (2015) states that it is DoD policy that “DRRS-S provides a means to manage and report readiness.”¹²⁷ Thus, while DRRS-S is the required DoD readiness *reporting* system, it is not the only readiness tool for services to *understand* and *manage* their readiness.

DoD policy does not require the use of DRRS-S to understand readiness information in a way that is useful to commanders within the services. While DRRS-S is DoD's only authoritative readiness reporting system, each service can use additional assessment processes and systems to help determine readiness at different levels (e.g., strategic vs. operational vs. tactical/unit), which help the services understand and manage their readiness levels in DRRS-S. For example, Figure B.2 shows how the United States Navy has created frameworks to understand, manage, and ultimately report their readiness in a way that serves both internal and external purposes.

¹²³ Office of the Secretary of Defense (OSD), *FY16 DoD Programs: Defense Readiness Reporting System—Strategic (DRRS-S)*, Washington, D.C., 2016, p. 38.

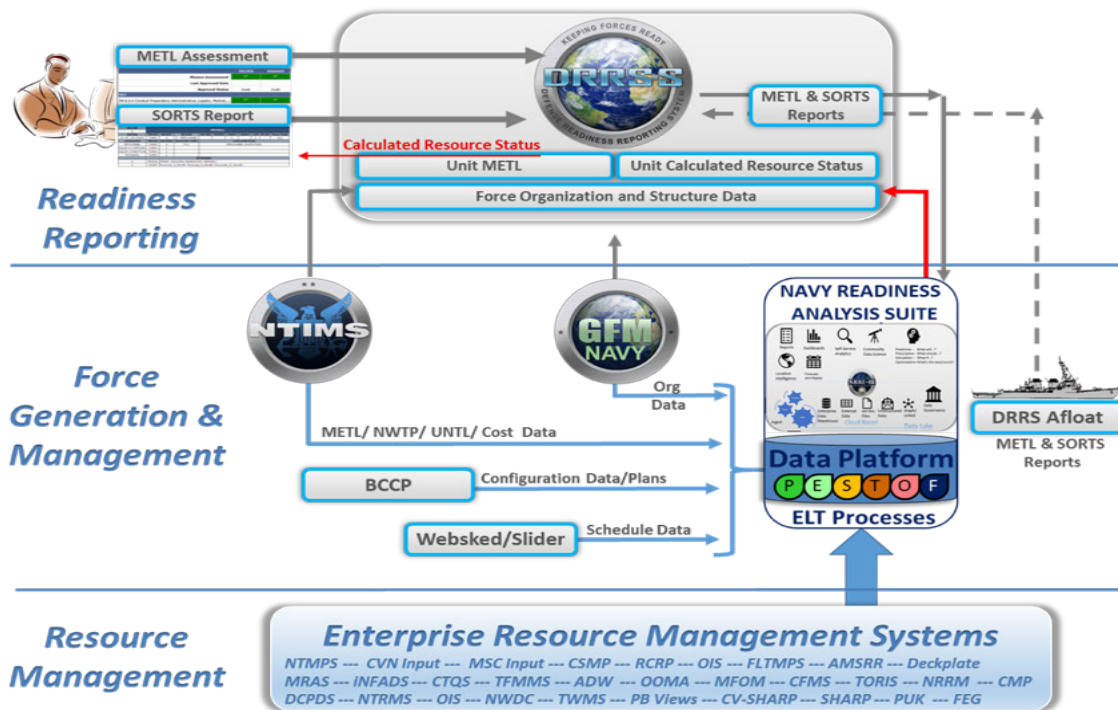
¹²⁴ Mackenzie Eaglen, quoted in Scott Maucione, “DoD Is Still Unbalanced on Readiness, but Is It Trying to Do Too Much?” Federal News Network, April 13, 2021.

¹²⁵ Public Law 105-261, Strom Thurmond National Defense Authorization Act for Fiscal Year 1999, October 17, 1998, pp. 281–282.

¹²⁶ DoDD 7730.65, *Department of Defense Readiness Reporting System (DRRS)*, Washington, D.C.: U.S. Department of Defense, June 3, 2002, certified current as of February 2, 2004, p. 3.

¹²⁷ DoDD 7730.65, 2015, p. 1.

Figure B.2. The Current State of the U.S. Navy’s Defense Readiness Reporting System



SOURCE: Supplied to the authors by Navy Headquarters in April 2021.

NOTE: According to SMEs within the Navy, the PESTOF readiness model predated PESTONI, which allows the Navy to tailor its readiness algorithms to each type of resource and community (e.g., Seabees vs. cybersecurity teams vs. submarines vs. destroyers vs. pilots).

Though the U.S. Navy has already transitioned to DRRS-S for its readiness reporting, Figure B.2 shows how the system does not allow the service to understand (e.g., the Navy Readiness Analysis Suite and the “Resource Management” row in the figure) and manage (e.g., “the Force Generation & Management” row in the figure) their readiness beyond the tactical unit level.

Without a suite of programs that plug into DRRS-S, it is unclear how the DoD system can provide an accurate window into how a service can understand and manage its readiness in the face of changing missions and operating environments. The U.S. Navy uses PESTONI in a way that is similar to how the U.S. Army uses ASRA. Conventional readiness reporting through DRRS-S is bottom-up and, according to some, less defined and intuitive for strategic decisionmaking. Readiness models like ASRA, PESTONI, and ReARMM are top-down approaches that allow strategic decisionmakers at the highest levels of the services to make informed decisions affecting readiness.

Thus, while DRRS-S is the system through which all services are required to *report* their readiness data to inform DoD and congressional resource decisionmaking, it is by no means the only system that services can or should use to *understand* and *manage* their readiness internally.

Readiness is a complex system that exists within a complex organizational environment, and the services should explore and utilize the readiness tools necessary to meet their needs.

Our research finds that other services have done this—designed and implemented other readiness assessment systems that augment DRRS-S. DRRS-S is used for congressional reporting, as required, but it is part of a wider framework that is intended to better meet service-specific needs. That fact provided much direction to our project and provides precedents for the sort of framework we recommend in Chapter 4.

Appendix C. Additional Evidence and Information Supporting Our Assessment of the Current State of USSF Readiness Reporting

Enterprise Systems Supporting USSF Readiness Reporting

The authoritative tool used for readiness reporting across DoD is DRRS-S. As is illustrated in Figure C.1, DRRS-S takes input from a variety of data sources across different services (the blue box at the top), and downstream feeds into a wide variety of consumers (the gray boxes on the right). Specifically for the DAF, data on personnel, equipment on hand (and condition), and training are extracted from ADSs each month using the Air Force Input Tool to provide objective assessments of squadron-level resources. Each resource area is given a discrete score from 1 to 4 (with 1 being the best) based on ADSs and established thresholds of readiness. The unit commander may provide additional remarks and explanations for manually adjusted ratings. The lowest rating of the four resource categories determines the unit's overall resource rating, or C-level. Figure C.1 shows the current state of the DRRS-S landscape.

The DAF also performs capability assessments at the squadron level, which feed into DRRS-S. The capability assessment is a discrete rating of yes (Y), qualified yes (Q), or no (N) for whether the unit can accomplish the task for the specified standards and conditions and based on how many of the unit's METs are rated as Y. The individual MET assessments are similarly rated either Y, Q, or N based on the unit commander's subjective assessment of the unit's ability. When a MET is rated as Q or N, or the commander upgrades the rating to a Y, the commander is required to leave a remark with a bottom line up front and a description of the issue, impact, and fix action as well as a "get-well" date.¹²⁸

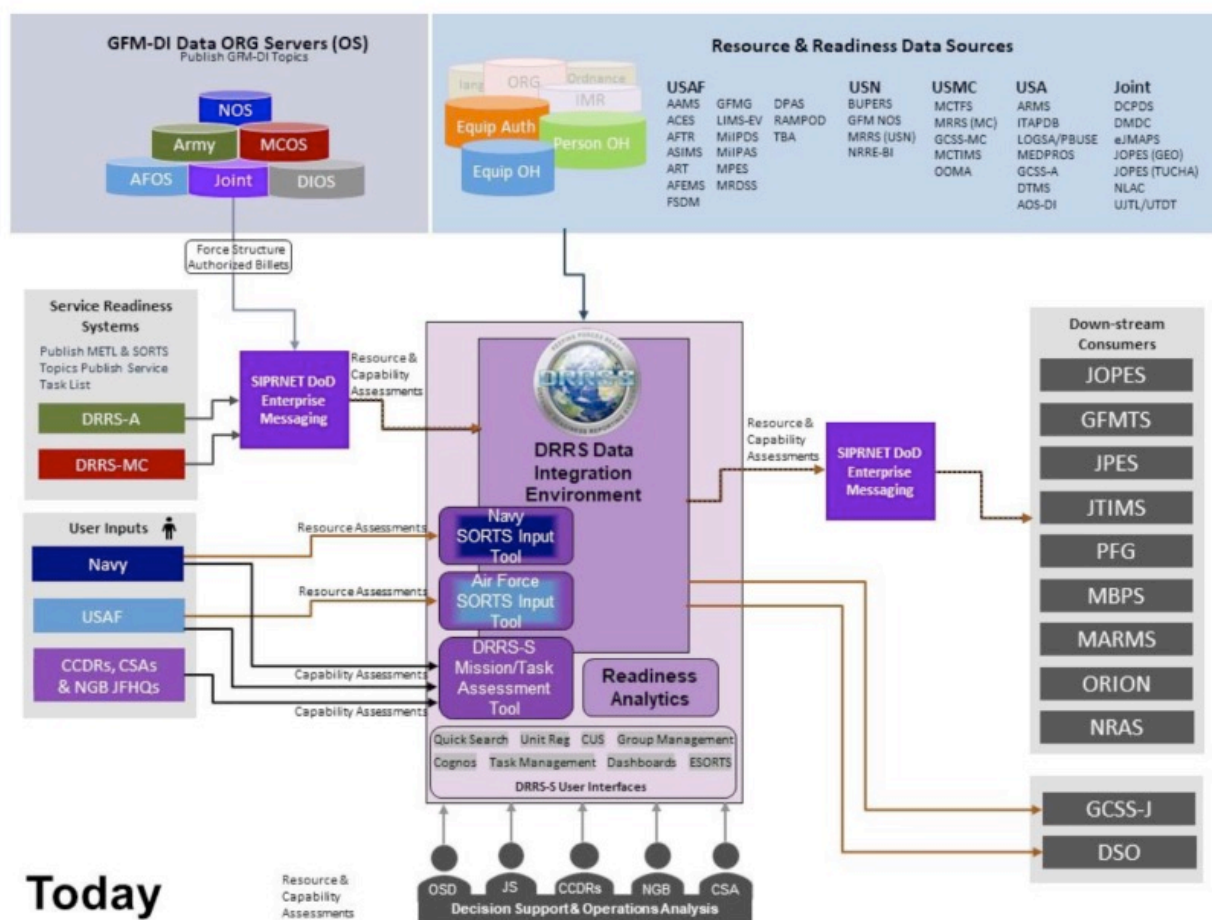
For use beyond the squadron level, DRRS-S data are aggregated, analyzed, and presented to leadership primarily by showing current rating or trends in C-level and capability assessment with accompanying discussions or briefing material on top concerns to pinpoint causes for lapses in readiness.

DRRS-S and related IT systems support this process, but there are limitations and shortcomings to the tools. Some are generic across all services, and some are unique to the USSF. Many of the deficiencies of DRRS-S have been well documented, and there are efforts underway to improve readiness reporting.¹²⁹ Here we review issues with the current readiness reporting tool that are common across services, and then those that are specific to the USSF.

¹²⁸ AFI 10-201, 2020.

¹²⁹ DoD, 2020a.

Figure C.1. Department of Defense Readiness Reporting Diagram



SOURCE: DoD, 2020a.

Example of Technical Challenges: Equipment Reporting

We conducted an in-depth review of the current state of equipment reporting in DRRS-S. The review involved assessing the types and level of detail of equipment reported and comparing it with real-world systems. We found that equipment reporting data vary in quality and lack consistency across units.

Table C.1 presents a stoplight chart of the quality of data found in DRRS-S for several major USSF operations systems by four equipment segments: (1) satellites (where applicable), (2) operations centers, (3) ancillary ground equipment, and (4) training equipment. The Air Force Satellite Control Network (AFSCN) is an exemplar of detailed equipment reporting. The AFSCN reported 82 equipment packets, with generally clear description of the packets, which allowed for unambiguous understanding of the reported equipment.

On the other hand, GPS- and MILSATCOM-related equipment packets lacked substance to clearly understand the reported equipment, with a minimal number of line items reported. There

Table C.1. Quality of Data for Equipment Reported on in DRRS-S

Equipment Reported on in DRRS-S (January 2021)				
System	Satellites	Operation Center Equipment	Ancillary Ground Equipment	Training Equipment
AFSCN	N/A	Yes, with good detail on reported items	Yes, with good detail on reported items	Yes, reported as “Test Equipment”
DMSP	2 primary satellites reported	Yes, critical items reported	Yes, critical items reported	2 simulators reported
GEODSS	N/A	Yes, computer and communication system for 3 sites	Yes, GEODSS sensors reported	None identified
GPS	None reported	Yes, but without detail and aggregated ambiguously as 8 “Master Control Stations”	Ambiguous items named “GPS Equipment”	6 simulators reported for the 50th OSS, but ambiguous as to which mission(s) is (are) supported by the simulators
MILSATCOM	4 satellite systems reported—possibly the 4 SATCOM constellations	Yes, but with ambiguous language about “Critical Spares”	Yes, but with ambiguous language about “Critical Spares”	6 simulators reported for the 50th OSS, but ambiguous as to which mission(s) is (are) supported by the simulators

Data on critical equipment is reported with clear identification	Data is partial or ambiguous	Data on critical equipment is not identified or not reported
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SOURCE: Authors’ analysis of DRRS-S data as reported on January 2021.

NOTE: This chart gives information on what equipment is reported on (i.e., authorized equipment), and does not give current or past readiness status; this information is unclassified (U) per Chairman of the Joint Chiefs of Staff Manual 3150.02B, *Global Status of Resources and Training System (GSORTS)*, Washington, D.C.: Joint Chiefs of Staff, March 25, 2011, directive current as of April 26, 2013; and AFI 10-201, Air Force Space Command Supplement, 2021.

were eight GPS equipment line items reported, with six “GPS Equipment,” one “Master Control Station” and one “Other Combat Essential Equipment,” all reported as having Schriever AFB as the location. Furthermore, we did not find any line item related to the 32 GPS satellites in DRRS-S.

The equipment packets for MILSATCOM were similar to GPS in terms of vagueness in description. While MILSATCOM-related items included a packet for “Satellite Systems,” the packet was for four authorized pieces of equipment, without further description of what the packet was reporting. We presumed that the line item was referring to the four MILSATCOM constellations under the management of USSF. As more than 30 satellites constitute MILSATCOM, such an approach to reporting at the constellation level could limit meaningful analysis of the relevant readiness.

Equipment packets for support units are also ambiguous in descriptions; this limits the understanding of the linkage between the equipment and the system supported by the equipment. For example, the 50th OSS reported a packet with “simulators.” As the 50th OSS supports both GPS and MILSATCOM missions, the description was not sufficient to identify which mission training the simulators supported.

Equipment reporting is particularly challenged by the limitations of ADSs described above. Space systems may not be included in ADSs because their status is tracked by supporting contractors. Classification sensitivities challenge timely reporting and descriptive packet information. Dependencies between mission and supporting equipment is not clear without separate knowledge of the system architecture.

Appendix D. Consolidated List of Findings, Risks, Recommendations, and Evidence from Chapter 3

Chapter 3 is a wide-ranging discussion on the current state of readiness reporting in the USSF and includes numerous recommendations on how to improve it. For convenience, we have created a consolidated list of findings, risks, recommendations, and evidence from that chapter here.

Table D.1. Consolidated List of Findings, Risks, Recommendations, and Evidence from Chapter 3

Findings	Risks	Recommendations	Evidence
1. The USSF does not effectively measure its readiness against the range of threats:	The risks of not being ready against a full range of threats are obscured.	1a. Identify reporting requirements for today's near-peer threats.	Interviews with USSF units highlight the need for reporting readiness against the near-peer threat, in addition to today's OT&E posture.
a. Reporting tools do not effectively measure multiple views of readiness	Information to senior leaders may not be readily actionable because much is in remarks.	1b. Publish guidance on what resources are to be measured.	Units had different priorities for their unit's readiness reporting (i.e., <i>today's resources</i> vs. <i>needed capabilities</i> views).
b. The risk of unallocated and unfunded resources is not reported	Reporting may be burdensome for the unit.	1c. Document requirements in a widely available and credible source.	DRRS-S "remarks" are regularly used to describe unit readiness against near-peer threats, but this information is not readily actionable.
c. Capabilities and resources required to confront the range of known threats have not been documented in an authoritative source		1d. Monitor "orphaned" units to identify and mitigate potential problems in their readiness until they are integrated with USSF.	
		1e. Assess risks and benefits of process changes recommended in Chapter 4 to accelerate organizational change and update readiness reporting baselines while keeping pace with evolving threats.	Interviews with USSF units reveal that some unit mission directives misrepresent either (1) their current missions, or (2) their future missions.
		1f. Implement the readiness framework and transition plan described in Chapter 4.	

Findings	Risks	Recommendations	Evidence
2. Legacy ADSs spoil readiness data: a. Critical resources, particularly equipment, are sometimes missing from data b. Security classification misalignment challenges reporting accurate information c. Complex system interdependencies are not captured	Incorrect resource data may confuse or mislead PPBE decisionmaking. Reliance on manual entries is against DoD policy and may result in missing critical equipment from DRRS-S. Information may not be readily actionable for senior leaders or staff. Second- and third-order effects of readiness issues may not be recognized or apparent in reporting due to complex dependencies. Extensive manual entry is unnecessarily burdensome on units.	2a. Redefine ADSs to • better match security needs of space community • capture all critical mission equipment • better represent interdependencies of operational systems and units 2b. Engage with enterprise data system (e.g., the Unified Data Library) development to judge utility and leverage requirements to support readiness reporting. 2c. Review and revise resource requirements used in readiness assessment and reporting, with a focus on equipment. 2d. Publish guidance on what resources are to be measured. 2e. Catalog today's available resources.	Interviews with USSF units and analysis of DRRS-S remarks reveal the classification misalignment. DRRS-S equipment reports reveal a high number of manually entered packets. DRRS-S remarks are regularly used to explain and correct resource ratings, often due to ADS limitations.
3. Critical information in commander remarks is not readily actionable.	Reporting information through long-form comments may • result in a lack of data for force management and PPBE decisionmaking at mission and service levels • result in an inability to see structural problems or trends in the force • be unnecessarily burdensome on reporters and consumers of readiness data	3a. Review historical remarks to determine if commonly communicated information can be moved out of comments into objective measures. 3b. Implement the readiness framework and transition plan recommended in Chapters 4 and 5 of this report. 3c. By focusing DRRS-S reporting on reporting <i>given today's resources</i>, some information commonly included in DRRS-S today may have a different venue. 3d. Implement formatting standards (e.g., end lines, boldface section titles, etc.) to improve readability.	Review of readiness reporting guidance documents. DRRS-S commander remarks include substantial critical information, but is not easily used because • long-form free text is not easily aggregated • remarks are difficult to parse due to ALL CAPS, repetitive preambles, and lack of formatting • remarks are redundant between sections and repetitive across months Interviews with unit leadership reveal that they see a need to communicate a large range of information in their remarks.

Findings	Risks	Recommendations	Evidence
4. The EIP mission is not supported.	Using the readiness models of deployable force may miss key readiness drivers such as facilities and infrastructure. Using standards and requirements for deployable missions may result in readiness measures that are overly conservative for an EIP mission (e.g., medical readiness following minor injuries to individuals).	4a. Refine personnel reporting to • reflect 24/7 mission • reflect USSF force presentation model (see Chapter 2) • account for availability for EIP, rather than deployable, missions 4b. Refine equipment reporting to account for critical infrastructure and facilities not under the unit's control.	DRRS-S reports for space units and other EIP units show how they account for key EIP readiness drivers, such as critical infrastructure. Conversations with USSF readiness SMEs
5. Complex organizational dependencies are not captured.	Support organizations outside the USSF may be without proper advocacy for resources that enable space missions. Senior USSF leaders may miss readiness information for supporting organizations.	5a. Create Delta- and SpOC-level readiness assessments that capture mission-level readiness, including support organizations outside the USSF. 5b. Assign responsibility of reporting on critical external equipment, facilities, or personnel to the unit most closely aligned with those external entities.	Unit fact sheets give updated organization of USSF and supporting USAF units.
6. Reporting is unnecessarily burdensome on units.	Unit leadership and reporting noncommissioned officers may have less time to dedicate to other important jobs in managing operational units. Changes to reporting guidance and requirements may continue to increase reporting's time burden.	6a. Track and potentially leverage HAF A3T effort to streamline DRRS-S reporting systems. 6b. Improve ADS infrastructure to autopopulate resource data from ADSs in more cases. 6c. Implement readiness framework recommended in Chapter 4.	DRRS-S commander remarks and other narrative material is often very repetitive across METs and over time. Resource readiness statuses are often manually entered due to issues with ADSs.

Abbreviations

ADS	authoritative data source
AFB	Air Force base
AF-IT	Air Force Input Tool
AFSCI	Air Force Space Command Instruction
AFSCN	Air Force Satellite Control Network
ASRA	Army Strategic Readiness Assessment
AT (RAM)	Advanced Training (Ready Spacecrew Program Advanced Training Mission)
C2	command and control
CES	civil engineering squadron
CJCS	Chairman of the Joint Chiefs of Staff
CJCSI	Chairman of the Joint Chiefs of Staff Instruction
C-levels	category levels
CRS	Congressional Research Service
CSO	Chief of Space Operations
CTS	combat training squadron
DAF	Department of the Air Force
DCS	Deputy Chief of Staff
DMSP	Defense Meteorological Satellite Program
DoD	Department of Defense
DoDD	Department of Defense Directive
DRRS	Defense Readiness Reporting System
DRRS-S	Defense Readiness Reporting System—Strategic
DRU	direct reporting unit
EIP	employed in place
FOA	field operating agencies
FY	fiscal year
GEODSS	ground-based electro-optical deep space surveillance

GPS	Global Positioning System
HAF	Headquarters Air Force
ISR	intelligence, surveillance, and reconnaissance
IT	information technology
JMETL	Joint Mission Essential Task List
JS	Joint Staff
MAJCOM	major command
MEF	Marine Expedition Force
MET	mission essential task
MILSATCOM	military satellite communication
NAF	numbered air force
NGA	National Geospatial-Intelligence Agency
O&M	operations and maintenance
OBAC	OPIR battlespace awareness center
OPIR	overhead persistent infrared
OPNAV	naval operations
OPR	office of primary responsibility
OSD	Office of the Secretary of Defense
OSS	operations support squadron
OT&E	organize, train, and equip
PAF	Project AIR FORCE
PESTOF	personnel, equipment, supply, training, ordnance, and facilities
PESTONI	personnel, equipment, supply, training, ordnance, networks, and infrastructure
POM	Program Objective Memorandum
POR	program of record
PPBE	Planning, Programming, Budgeting, and Execution
PRST	Personnel, equipment Readiness, Supply, and Training
ReARMM	Regionally Aligned Readiness Modernization Model
SBIRS	Space-Based Infrared System
SCS	space communication squadron

SFS	security forces squadron
SME	subject matter expert
SOPS	space operations squadron
STARCOM	Space Training and Readiness Command
SWS	space warning squadron
TIP	tactic improvement proposal
TOC	Theory of Constraints
TRB	Tactics Review Board
TS	test squadron
TTP	tactics, techniques, and procedures
USAF	U.S. Air Force
USAFWC	U.S. Air Force War Center
USSF	U.S. Space Force
USSPACECOM	U.S. Space Command
UTC	unit type code
WEPTAC	weapons and tactics
Y/Q/N	yes, qualified yes, no

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AFI—*See* Air Force Instruction.

AFSCI—*See* Air Force Space Command Instruction.

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As a branch of the U.S. armed services, the U.S. Space Force (USSF) must understand, manage, and report its readiness. The readiness-related systems of the U.S. Department of Defense, like many systems that support and govern the USSF, were not designed to meet the unique demands of the military space community and characteristics of operations in and through outer space. The newly independent USSF has an opportunity to create systems that work better meet their needs. The authors of this report have created a readiness framework for the USSF and a guide on how to implement it.

Starting with a “blank slate” mandate and a review of the readiness practice of the other services, the authors studied the current readiness system for the USSF and considered the unique needs of the military space community. They found that the current readiness reporting system does not address the range of USSF needs and has failed to objectively report the readiness of the space forces. They recommend a readiness framework that measures the USSF’s ability to keep pace with adversary threats. It proposes three distinct “views” of readiness: (1) given today’s resources, (2) against the near-peer threat, and (3) progress in transforming to meet the near-peer threat.

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