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PARTNERING NOT BOSSING: BETTER LEVERAGING INTERNATIONAL CAPABILITIES FOR SPACE DOMAIN AWARENESS

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Summary

The United States has found it difficult to incorporate space domain awareness (SDA) data from allies and partners due to both technical and policy obstacles. Here we examine current efforts to better integrate ally and partner data and what can be done in the future to foster stronger and more mutually beneficial agreements between the United States and its allies and partners.

Introduction

Observers have long called for the United States national security space enterprise to be more interoperable with allies to achieve U.S. and allied goals, but nations contributing to coalition space domain awareness (SDA) face barriers to such interoperability. The United States has found it difficult to incorporate SDA data from allies and partners due to many technical challenges and policy constraints. For example, the sensor calibration requirements the United States placed on its allies' sensors and the condition that the United States needs for the allied sensor data take priority over partner needs created roadblocks to greater integration.[1] However, recent U.S. adoption of a more flexible calibration approach; newly designed tiered data integration levels; and updated, reconceptualized sharing agreements showcase progress is being made in improving interoperability with international partners for space domain awareness.

These innovative solutions, accomplished by following current national and DOD-level policies and strategies, will allow the United States to better leverage international capabilities for SDA. These successes point to a way ahead for the United States and its allies to achieve closer integration in space operations. Shifting outmoded operational paradigms and questioning rigid legacy practices can do much to enable immediate integration of partner data.

The Value of SDA

The United States Space Force (USSF) seeks to act with speed and decisiveness to ensure the United States maintains its advantage in the space domain. SDA is critical for U.S. space forces in enabling early warning, supporting decision advantage, and monitoring safe and responsible behavior in space. Until recently, the United States depended exclusively on its own capabilities to collect SDA data, but the United States has left behind those days, reasoning in the 2020 U.S. space forces doctrine, "…expanding partnerships will improve our enterprise capability, capacity, and resilience."[2] The Space Force's international partners contribute geographically and phenomenologically diverse data that builds information superiority, enabling the United States and coalition leaders to make timely, well-informed decisions in a rapidly evolving, contested environment. With an increasingly challenging threat environment, the United States will need ever better SDA.

The Space Force defines SDA as "the effective identification, characterization and understanding of any factor associated with the space domain that could affect space operations and thereby impact the security, safety, economy, or environment of our Nation."[1] At its heart, SDA strives to understand any factor associated with the space domain that could affect space operations. Where space situational awareness (SSA) is mostly concerned about orbit determination, satellite catalog maintenance and event processing (which includes handling of discrete events such as conjunction assessment, reentry, launch, etc.), SDA builds on SSA to characterize on-orbit behavior, enable indications and warnings, and single out other indicators of adversary intent. Without SDA, U.S. forces are operating without a view of the threat and an understanding of potential adversary actions. Creating effective SDA requires the fusion of several types of data, including the location, direction, and speed of objects in orbit; the status of hostile and potentially hostile space forces; the status of friendly, neutral, and nonhostile activities; space and terrestrial environmental factors; and overall intelligence, surveillance, and reconnaissance data of the space domain.

Focusing on the Wrong Problem

The United States could reap advantages if it were to ingest its partners' SDA data. However, there have been many roadblocks to ingesting partner SDA data, and progress has been slow and difficult. Many observers attributed the lack of international partner data integration to flawed national-level and DOD-level policy and strategy, especially with regard to U.S. classification policies and data security and quality requirements.[3] While these are legitimate concerns, the challenges with integration were also related to legacy U.S. operational-level requirements for data compatibility. Without intending to, the United States levied data quality requirements and sensor calibration standards intended to drive our own Space Surveillance Network (SSN) on international partners, creating burdens on U.S. partners beyond simply imposing demands on partner sensors' availability. U.S. mission systems and operations were not previously able to accept diverse sensor data without detailed understanding of the sensor's accuracy (i.e., weights and biases) derived from a strict sensor calibration regimen.

Sensor calibration is a routine process throughout the life of a sensor. For USSF SSN sensors, the process begins during sensor integration with the SSN and continues periodically after operational acceptance, using calibration satellites as concrete reference points. A sensor collects observations on the calibration satellites, and the observation data is compared to the calibration satellites' "truth" data concerning its orbital position.[4] The calibration process reveals the sensor's measuring errors or its bias, and the required correction that must be applied to raw sensor data to account for that bias.[5] These processes and procedures lead to a highly precise understanding of the position of trackable space objects. Many space activities, such as conjunction assessment (CA) and rendezvous and proximity operations (RPO), require this high-level of data preciseness. In addition, regular calibration reduces errors, increases orbit determination accuracy, improves association of sensor observations with known objects, and enhances CAs.[6] The USSF integrates this information into the U.S. Satellite Catalog, and the publicly, releasable version is hosted on space-track.org.

[1]Space Capstone Publication, *Spacepower, Doctrine for Space Forces*. See pages 38 and 39 for an extensive discussion of SDA.

What is Space-Track.org?

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Space-Track.org is the Internet-accessible portal used to “promote spaceflight safety, protection of the space environment and the peaceful use of space worldwide by sharing space situational awareness services and information with U.S. and international satellite owners/operators, academia and other entities.”[7]

What is the SATCAT?

The SATCAT (Satellite Catalog) is the Department of Defense’s authoritative database on constructed space objects (space vehicles, rocket bodies, and debris). For SDA and spaceflight safety considerations, the catalog provides current position and velocity data on satellites in a standardized two-line element (TLE) format. Further, it holds historical background, including country of origin and launch details (e.g., date and location).[8]

A Better Way: Tiered Approach to Integrating Allies’ Space Surveillance Data

Instead of insisting that international partners first meet the highest standard, a more inclusive way is to ask them to meet the most minimal standards to start and, as the relationship develops, create paths to meet higher standards. The United States has begun exploring this tiered integration approach to work with partners on areas of mutual interest. The tiered integration enables closer cooperation and collaboration with allies and is grounded in specific data needs.

The tiered approach also educates foreign partners on *why* calibration is important and what it would take if they sought to become fully integrated within the SSN and work in a more collaborative environment. This new process uses variable criteria for calibration and acceptance of data based on the level of integration desired by the United States and multinational partners. The tiered approach allows the United States Space Command (USSPACECOM) and multinational partners to begin working together—even in a loose collaboration—and to progressively graduate to increased integration as confidence in operations and the relationship grows. As illustrated in Figure 1,[9] at the lowest level of integration (Level 4), partners agree to share information and analysis with USSPACECOM on a nonroutine basis and collaborate on areas of mutual interest.[10] At the highest level of integration (Level 1), partners provide data at the same level of integration as U.S.-owned SSN sensors.[11]

The USSF has been working with its international partners to help shape the calibration and acceptance criteria to be effective and suitable, considering foreign partner unique constraints and the 18th Space Control Squadron (18 SPCS) operational requirements. The USSF *Nontraditional Data Integration Concept of Operations* documents this new approach.

As one would expect, most allies and partners fall somewhere between reduced calibration (Levels 2 and 3) of sensor data and full integration with the SSN (Level 1). USSF’s updated calibration and assessment criteria enables USSPACECOM to employ data from multinational partners for specific missions based on confidence in precise sensor performance. In addition, USSF works with

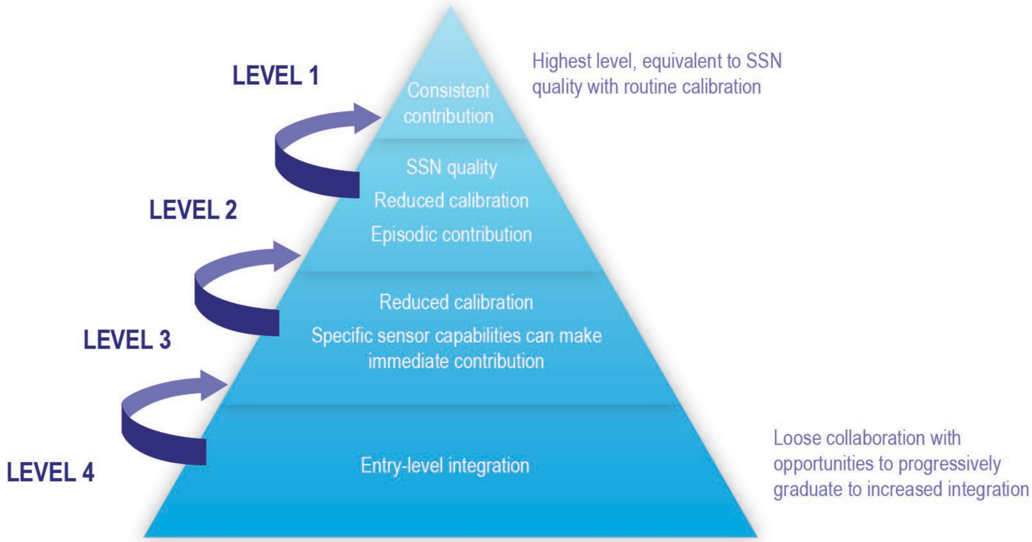

Figure 1: Tiered integration process enables variable sensor calibration.

international partners to document customized concepts of operations. For example, USSF uses customized concepts of operations and partner data plans to help operations teams identify the expected task-ability of foreign sensors, timeliness of data deliveries, and other areas of cooperation. Customized concepts of operations help focus specific 18 SPCS operational requests for data and enables SSN sensors to be tasked as efficiently as possible.

For now, the approach becomes less practical when working with significant volumes of data (e.g., commercial data purchases) because U.S. missions systems do not currently allow for automated application of SDA data as "fit for purpose," and so tiered data requires manually ingesting and applying observations to operations. USSF, through the Pivot SDA Executive Agent, continues to experiment with tools to integrate larger sets of nontraditional data sources. As USSF mission systems evolve, the service will be able to identify specific data gaps and create processes to purchase and ingest this data.

The USSF's first effort to implement the new tiered approach for integrating foreign partner sensor data into the U.S. Satellite Catalog is with the United Kingdom's Starbrook sensor. The Starbrook effort is a significant, first of its kind relationship. While the impetus for Starbrook integration came from exercise GLOBAL SENTINEL, U.S.-U.K. partnering and Starbrook integration efforts have continued independently from the operational exercise.

As part of the output from a GLOBAL SENTINEL multi-lateral exercise, the United Kingdom volunteered to serve as a pathfinder for the streamlined process, and U.K. SpOC proposed sharing Starbrook sensor data with the United States for incorporation into the U.S. Satellite Catalog. Representatives from the United States and the United Kingdom assessed Starbrook data to maximize the operational utility for the coalition. Based on the quality of data from the Starbrook sensor and mutual interest in automated machine-to-machine integration with the U.S. Satellite Catalog, the Starbrook sensor data is eligible to enter an evaluation period as a Level 1 sensor, the highest level. Starbrook's data will be recommended for full processing and automated machine-to-machine integration into the U.S. Satellite Catalog. The

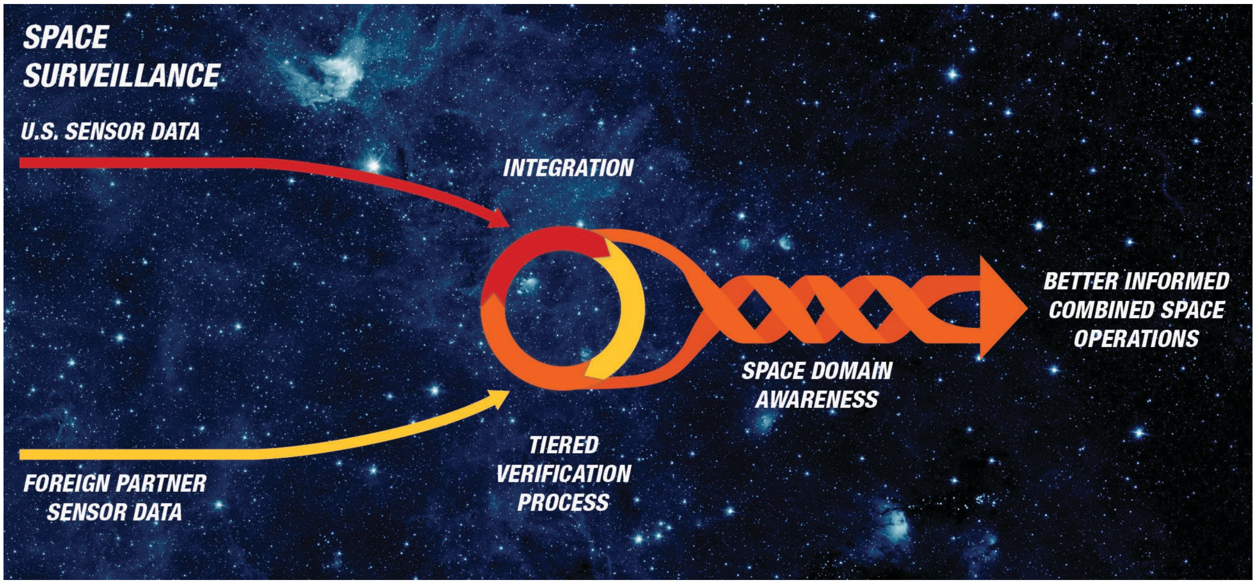

Figure 2: A new approach to coalition SDA.

bilateral team completed all steps required to support future integration of Starbrook as a Level 1 sensor. The U.K. SpOC continues to work toward prioritizing the purchase of operationally relevant quantities of Starbrook data to share with the United States, and, when U.K. priorities allow, the bilateral team will complete integration. While the evaluation process takes approximately three weeks, the overall process can be accomplished in approximately three months, depending on sensor performance. This partnership demonstrates to U.S. international partners and to U.S. leadership that U.S. space operations are preparing to accept partner data using the policies and procedures in place today, paving the way for broader application in coalition space operations.

Recent events provided an excellent opportunity for USSPACECOM and coalition partners to exercise the new SDA approach. On May 30, 2020, SpaceX DM-2 successfully launched two NASA astronauts to the International Space Station.[12] Coalition partners from Australia, Canada, France, Germany, the United Kingdom, and the United States created a plan to support surveillance and tracking of the SpaceX DM-2 human spaceflight mission. Germany's SSA Center, the U.K. SpOC and radar, and France's space surveillance radar monitored the launch and docking of Crew Dragon.[13] The other partners supported the event via their operations centers while supporting space surveillance within their area of responsibility. The partners interfaced with 18 SPCS via space-track.org for sensor observations and unclassified chat communications.

The coalition assembled its support for the human spaceflight mission on relatively short notice. Previous operational collaboration and close working relationships enabled the group to create and execute a complex sensor tasking and support plan. The coalition space community was able to support this event with their sensor observations, based on prior experience from operational exercises and a specific calibration scenario utilizing USSF's new sensor calibration criteria. Insight into sensor performance provided by calibration scenarios allowed partner sensor observations to be integrated into operations with confidence instead of adding uncertainty or noise to the observations. The success of the SpaceX DM-2 event stemmed from a combination of tiered integration of partner sensor data and the improved relationships created between the space operations centers.

The new, flexible set of calibration and acceptance criteria using the tiered approach demonstrates that much is possible when creativity and openness to new ideas carries the day. Space policy direction has emphasized collaboration for almost a decade, but other policies and practices still appeared to operators to stand in the way. Now, the operators are figuring out how to achieve the strategic intent without continually coming back for more policy and legal guidance on tactical implementation to share SDA data with partners.

The Next Step

But more can be done. In addition to the tiered process for integrating partner sensor data, the United States must develop a scalable and adaptable method for integrating allies and partners into space operations beyond just SDA. While enhanced SDA is the current focus, integration of a variety of different types of allied data could enhance U.S. capabilities in such activities as human spaceflight safety; position, navigation, and timing (PNT); and other activities, and those endeavors may have different parameters for integration of allied data contributions. To get to this new approach, however, the United States should reach agreements not by traditional methods (i.e. sensor-by-sensor agreements) but nation to nation, centered on SpOC-level agreements.

International partners have data and capabilities based on unique technology and sensor geography that may be otherwise unavailable to the United States. Historically, the U.S. Air Force (USAF) and USSF have pursued international SSA data-sharing relationships based on individual sensors. Sensor-level agreements may allow for full data integration into the SSN and enable direct sensor tasking and data requests from 18 SPCS, periodic sensor calibration tasking, and immediate U.S. integration of the sensor observations if agreed upon within the sharing agreement.

Moreover, holistic allied support is more meaningful than the use of a single allied resource. Lt. Col. David Ransom, USSF branch chief for Command and Control of Current Space Operations, said, "…at the principles of war level, it's always better to have an operations agreement than a sensor agreement," reinforcing the notion that while access to a single asset may be helpful, an overarching, collective mission focus is the compelling benefit from allied partnership.[14] Holistic, allied support is only one piece of a partnership. A true partnership forms and grows when the United States involves partners in mission planning to help partners understand the mission versus the United States asking or tasking them to provide sensor data for purposes that might not always be clear.

Discussing what happens when a multinational partner brings a new sensor online illustrates this point. The legacy approach begins with a new dedicated sensor-level agreement and close collaboration to author, negotiate, and approve the finished product. These focused discussions often result in close partnerships for common operations. However, in an effort to reduce the timeline for integration with U.S. operations and to provide national flexibility, some partners are shifting paradigms to pursue agreements between and among SpOCs. Table 1 provides an overview of how a relationship at this higher level enables the United States to cooperate with multinational partners in an asset-agnostic way. As multinational partners bring new capabilities online, the data created is collected and distributed by the partner's SpOCs in whatever way best serves both nations' interests by focusing on the data being shared instead of its source.

Table 1: Sensor-Level Agreements vs. SpOC-Level Agreements		
	Sensor-Level Agreement	**SpOC-Level Agreement**
Sensor Integration	Sensor can be integrated into SSN	Sensor exists outside SSN
Sensor Tasking	SSN sensors tasked directly by 18 SPCS	Sensor tasked by SpOC; U.S. tasking requests may be denied at the expense of multinational partner's priorities depending on agreement
U.S. Request of Partner Sensor Data	U.S. receives sensor data pursuant to agreement	U.S. receives sensor data pursuant to agreement
Work Required for New Assets	New sensor requires new individual agreement	New sensor data collected by SpOC and can then be shared under an existing agreement
Data Format Translation	Potentially required on a per-sensor basis	Potentially required on a per-SpOC basis

In the SpOC-level relationship, the United States does not exert direct control over the sensor and would not need to negotiate data formats for taskings and observations with individual sensors as has been the case with sensor-centered agreements. Instead, when agreements are worked at the SpOC level, the United States interacts with the partner SpOC, and the partner SpOC tasks its own sensor network and collects the data before relaying it back to United States. The United States never has a need to interface directly with the partner sensor, and the partner sensor never has a need to interface directly with the United States. The SpOC-level agreement contains standards for data formats without regard for individual sensors being tasked. This one change enables fewer data formats from fewer sources that need to be translated prior to use and will make the timely machine-to-machine transfer of observation data easier to maintain. The SpOC-level agreements allow both parties to build to a standard to minimize data format processing work and to easily and naturally use data from new assets as they come online. Moreover, SpOC-level sharing agreements enable a repeatable process and a deeper partnership between the two nations.

Building relationships early helps partners prioritize precious investments in areas that provide the most significant impact to their national operations, while enabling them to leverage resources shared by U.S. and coalition partners. Still, shaping SpOC-level sharing agreements to focus on operational relationships and data standards without regard for the source, as long as the sensor data is calibrated, could be the hallmark of maturing relationships with foreign partners.

Many nations are early in the process of standing up national SpOCs and developing the workforce to operate them. Working directly with partners as they build their national SpOCs may allow the United States to not only integrate data from a number of partner assets (instead of a single sensor) but enable collaboration with multinational space workforces. This space cadre cross-fertilization builds and strengthens relationships and stimulates creative solutions to problems as the benefits of diversity of thought and experience affect innovation in U.S. and coalition space operations.

Challenges to SpOC-Level Agreements

Despite the promise described above, many U.S. international partners do not yet have the capability to support SpOC-level agreements partly because partners have fewer resources than the United

States, and their SpOC development is recent and, in some cases, not yet complete. Working with partners at their current level of capability and capacity allows both the partner and the United States to make well-informed investments as resources and capabilities mature on both sides. Many international partners build SpOCs with significantly fewer resources (tools, funding, human capital) than the United States.

It is not just international partners who need to adjust, however. To best capitalize on allied contributions, the United States must accept the fact that it cannot demand its allies act just because the United States wants them to. Instead, the United States has to accept that it must request help. In addition, as alluded to above, previous sensor-level agreements allowed for the United States to task foreign partner sensors directly and preempt partner use of its own sensor. As the new national SpOCs come online among U.S. allies and those SpOCs begin tasking their national sensors, U.S. calls for data from allies will be in the form of a request rather than an order. As the partner SpOC is able, it will task its sensor network to meet U.S. needs, but it cannot be guaranteed that every U.S. call for data will be met. This presents a challenge for 18 SPCS, which will need to update its tasking algorithms to account for re-tasking of SSN sensors to cover requests that the coalition of partners are unable or unwilling to fulfill.

In addition, there are areas for improvement in regard to communication and information sharing, as summarized in Table 2. First, communication during specific operations between foreign partners and SpOCs must be coordinated in advance and synchronized with the tempo and timing of the operations they are supporting.[21] For example, when do they plan to share sensor observations? Will it be during normal business hours, or will they surge their SpOC's capabilities to send observations when they are received? Having these conversations prior

Table 2: Areas of Improvement to Integrate Foreign Partner Sensor Data
Communication between foreign partners and SpOCs must be coordinated in advance.[15] This coordination will include a discussion of staffing hours, language barriers, and communication formats. Are both SpOCs staffed 24/7? Do all personnel share a common language? Is text-based communication preferred over voice?
Communication between foreign partners and SpOCs must be synchronized with the tempo and timing of operations.[16] This coordination will need to be chiefly concerned with timeliness. SDA events happen at all times of the day and quick re-tasking of assets can mean the difference between success and failure. What is a reasonable response time to a quick-turn tasking request?
Information required to execute the operation must be planned and shared in a timely manner.[17] The availability to receive pointing angles is necessary to carrying out tasking requests. Before partner data can be available, the United States must design, test, and verify a way to share state and tasking data with partner SpOCs.
Partner access to information needs to be confirmed early.[18] Access to the space catalog is vital to supporting day-to-day SDA operations. In order to coordinate with partners, a catalog synchronization scheme must be designed and agreed upon.
Collaboration must consider the level of classification required for the operation.[19] Before any information can be shared, classification hurdles must be overcome. Each nation must protect its classified information and be confident that all partner nations are also protecting each other's classified information in the same way.
How all partners can collaborate in the required classification environment in a timely manner must be considered in advance.[20] Ensuring that all personnel are cleared to access classified partner data will require an investment in personnel training, recordkeeping, and clearing that all partners are comfortable with.

to a specific space operation will ensure partners understand each other's expectations. Next, the information required to execute the operation must be planned for and shared in a timely manner, and it must be confirmed that partners can access the required information.[22] This will help partners understand how quickly to plan for a response. Additionally, this collaboration must consider the level of classification required for the operation and how all partners can collaborate in that classification environment in a timely manner.[23] If the observations are classified, are the SpOCs equipped with the correct networks to receive and respond to U.S. taskings and requests? Even though the partners may be cleared for the information, their SpOCs may not have the infrastructure to support these requests.

Challenges exist. However, these challenges can be overcome by leveraging SpOC exercises and other exercises to refine the concept of combined space operations processes. Indeed, the overall impact of these innovations in coalition SDA extends into other coalition space activities as well. For example, USSPACECOM's Operation Olympic Defender provides a formal intergovernmental instrument, enabling partners to work within their respective governments and defense ministries to formalize multinational contributions to conduct combined space operations.[24] This flexible framework opens the door for broader collaboration in space activities with partner nations. In addition, the formal order that established the Multinational Space Collaboration Cell (MSC) within the U.S. SpOC also defined the requirement for international collaboration in support of combined space operations and routine SDA sharing with nations beyond the current membership.[25] Finally, the 2020 Combined Space Architecture Workshop (CSAW) included sharing of secret-level space architecture data for the first time so as to address long-standing international partner requests for U.S. insight on how and where partners could most effectively invest effort and resources to build coalition space capacity. New coalition SDA processes and activities act as a potential template for future, broader capability integration due to their proven ability to improve SDA, which in turn helps meet requirements and mission needs.

Conclusion

USSF and USSPACECOM innovators are lowering perceived barriers to SDA data sharing with fresh thinking, imaginative leadership and determination to find solutions while working within current high-level policy. Progress is being made in integrating space operations with partners, accepting multinational space surveillance data, and developing closer operational ties with multinational partners. Implementing a tiered sensor data integration process is an inclusive approach to incorporating foreign partner sensor data into the SSN. Applying a tiered approach to accepting calibrated sensor data from partners broadens U.S. opportunities for international cooperation. This new tiered sensor data integration approach is tailored in such a way to cooperate with foreign partners where they are and provide a roadmap to obtain machine-to-machine transfer of observations to the SSN. Additionally, this approach shifts the paradigm from sensor-focused to more holistic operations-focused, SpOC-level agreements offering improved collaboration with partner nations and a potential template for increasing combined operations in the space domain. Table 3 and Table 4 highlight these proposed methods, their impacts, limitations, and the way ahead to better leverage partners' capabilities for SDA.

Table 3: Better Cooperation and Collaboration: Tiered Integrations		
New Method	**Impact**	**Products**

Tiered integration of partner sensors
• Variable criteria for calibration
• Variable criteria for acceptance of data
	• Less time focused on calibration
	  ‣ Better partner sensor availability
	  ‣ More opportunities for the United States to gain valuable foreign sensor collection time
	  ‣ Better ability to integrate partner data
	• Create pathways for partners to meet higher standards
	• Educate partners on the importance of sensor calibration
	• Educate partners on requirements to become fully integrated in the SSN
		• Customized CONOPS for each partner
		• Customized data plans

Limitations		
• Specific data needs only. Currently requires manually ingesting and applying observations to operations. • Less practical for significant volumes of data (e.g., commercial data purchases)		
Way Forward		
• Identify specific data gaps. • Create processes to ingest lower-tired partner data automatically. • See Table 2 for a list of areas for improvement.		

Table 4: Better Partnering: SPoC-Level Agreement		
New Method	**Impact**	**Products**

SPoC-level agreements	• See Table 1.
	• Reduce the timeline for integration with U.S. operations.
	• Enable both parties to build to a standard to minimize data format processing work.
	• Enable both parties to easily use data from new assets as they come online.
	  ‣ Enable fewer data formats from fewer sources that need to be translated prior to use.
	  ‣ Enable timely machine-to-machine transfer of observation data.
	• Enable a repeatable process and a deeper partnership between the two nations.
	• Provide national flexibility.
	• Provide a formal intergovernmental instrument, enabling partners to work within their respective governments and defense ministries to formalize multinational contributions to conduct combined space operations.
	• Enable holistic allied support.
	  ‣ Provide a Scalable and adaptable method for integrating coalition partners into space operations beyond just SDA.
	  ‣ Make data and capabilities more available to the United States.
	• Inform partners as to where they may most effectively invest resources to build coalition space capacity.
	• Act as a potential template for future, broader capability integration.
	• Forge stronger relationships through space cadre cross-fertilization.
		• Customized, formal agreement.
		• Customized data plans.
		• Partner SpOC tasks its own sensor network and collects the data before relaying it to United States.
		• SpOC-level agreement contains the standards for data formats without regard for individual sensors being tasked.
		• Updates to 18 SPCS, tasking algorithms to account to cover unfulfilled requests.

Limitations		
• Constrained partner resources (e.g., tools, funding, and human capital). • The United States cannot task partner sensors directly. • Cannot be guaranteed that every tasking request can or will be met.		
Way Forward		
Improvements in regard to communication and information sharing. See Table 2 for a list of areas for improvement.		

Based on the initial successes of recent U.S. adoption of a more flexible calibration approach; newly designed tiered data integration levels; and modernized, higher-level sharing agreements, the United States should more broadly leverage the USSF's innovative ideas that make the U.S. national security space enterprise more interoperable with international partners. The USSF experience with coalition SDA provides an example from which others in the space community can use to learn how to overcome some of the roadblocks to greater data sharing with partners and inspire more efficient coalition space operations. These lessons may inform U.S. leaders and partners on ways forward in critical missions like SDA; environmental monitoring (EM); position, navigation, and timing (PNT); electronic warfare (EW); space traffic management (STM); and ever-safer human spaceflight.

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On classification policy roadblocks see: Gen John Hyten, Vice Chairman of the Joint Staff, Schriever Space Futures Forum on November 20, 2020, argued that the over-classification of space information by DOD delays the appropriate information sharing required to partner with U.S. allies and industry. Also see Robert Fahs, "Gen. Hyten Finds Over-classification of Space Information Undermines National Security, Promises Reform," December 1, 2020, https://transforming-classification.blogs.archives.gov/2020/12/01/gen-hyten-finds-over-classification-of-space-information-undermines-national-security-promises-reform/

[4] AFSPC Command Instruction 10-610, "Operations Space Situational Awareness Metric Data Integration Guidelines for Non-Traditional Sensors," 3 Jul 2019, pp. 130.

[5] Ibid.

[6] Ibid.

[7] Space-track.org. https://www.space-track.org/auth/login

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[9] Madsen, Anne, Jordan De Namur-Paul, "Non-Traditional Sensor Assessment Process." February 2019.

[10] Ibid.

[11] Ibid.

[12] Report on Allied Partner Support to SpaceX Demo-2 Launch on 30 May 20.

[13] Ibid.

[14] Lt. Col. Ransom, David. Personal interview. 06 May 2020.

[15] Report on Allied Partner Support to SpaceX Demo-2 Launch on 30 May 20.

[16] Ibid.

[17] Ibid.

[18] Ibid.

[19] Ibid.

[20] Ibid.

[21] Ibid.

[22] Ibid.

[23] Ibid.

[24] Gleason and Weeden, "Alliance Rationales and Roadblocks: A U.S. - Canada Space Study," The Aerospace Corporation, Center for Space Policy and Strategy, April 2018.

[25] The Multinational Space Collaboration Cell includes liaison officers from France, Germany, Japan, and the UK. U.S. Strategic Command, Fragmentary Order 48 to Operation Olympic Defender. 231303Z 16 Aug 2018.