BY ORDER OF THE COMMANDER
AIR FORCE SPACE COMMAND

AIR FORCE SPACE COMMAND
INSTRUCTION 10-610

3 JULY 2019

Operations

SPACE SITUATIONAL AWARENESS METRIC DATA INTEGRATION GUIDELINES FOR NON-TRADITIONAL SENSORS

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RELEASABILITY: There are no releasability restrictions on this publication.

OPR: HQ AFSPC/A3/6Z

Certified by: HQ AFSPC/A3/6Z
(Mr. Timothy P. Payne)
Pages: 139

This instruction implements Air Force Instruction (AFI) 10-601, *Operational Capability Requirements Development*; AFI 63-101/20-101, *Integrated Life Cycle Management*; AFI 99-103, *Capabilities-Based Test and Evaluation* and Air Force Space Command (AFSPC) Instruction (AFSPCI) 10-605, *Operational Acceptance Process*. This instruction outlines the data quality and compatibility requirements to guide operational decisions for non-traditional sensors or data sources for use by AFSPC systems. It assigns the roles and responsibilities of the data providers, numerical validation analysts, operators, and approving officials. It describes the overall processes for evaluating new data sources or modifications to fielded systems. This instruction applies to Headquarters Air Force Space Command (HQ AFSPC); Space and Missile Systems Center (SMC); Air Force Life Cycle Management Center (AFLCMC) for those systems owned and operated by AFSPC and acquired or maintained by AFLCMC for AFSPC, or under the Space Program Executive Officer (PEO); Battle Management PEO; Air Force Network Integration Center (AFNIC); 14th Air Force (14 AF); 21st Space Wing (21 SW); 50th Space Wing (50 SW); Air Force Reserve; and Air National Guard. It also applies to all domestic and foreign military, government, civil, academic and commercial entities which provide or plan to provide data to supplement the Space Surveillance Network (SSN).

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Chapter 1

INTRODUCTION

1.1. Introduction. This instruction outlines the Space Situational Awareness (SSA) data quality and compatibility requirements and guidelines to inform operational decisions centered on the integration of non-traditional data from sensors and other sources into Air Force Space Command (AFSPC) systems in operational and tactical mission centers. These systems and mission centers include the Space Defense Operation Center (SPADOC) system, Astrodynamics Support Workstation (ASW), Mission Processing System (MPS), Combined Space Operations Center (CSpOC) systems, 18th Space Control Squadron (18 SPCS) systems, 18 SPCS, Detachment 1 systems, the Enterprise Space Battle Management Command and Control (ESBMC2) systems, and other Battle Management Command and Control (BMC2) systems at the joint and cross-domain level. Non-traditional SSA data supplements data provided by the Space Surveillance Network (SSN). This instruction also provides guidance on how the Operational Acceptance (OA) process for traditional sensors is modified for non-traditional data sources (NTDS). This document is not intended to duplicate information contained in other instructions (Department of Defense (DoD), United States Strategic Command (USSTRATCOM), Air Force (AF), or HQ AFSPC) except for those situations where amplification or clarification is required.

1.1.1. Constraints. The overall process for accepting NTDS is constrained by (1) current technical limitations of the command and control systems in their ability to ingest and process non-traditional data and by (2) the quality standards data must meet to be blended with SSN data for use in automated mission processes. The data utility assessment process described in this instruction considers the limitations of the current systems, while it acknowledges that these limitations may be overcome in the future. This acknowledgement highlights the need to expand the ability of ESBMC2 systems to process data from a variety of new and novel sources.

1.1.2. Data Quality Hierarchy. This instruction establishes a hierarchical data construct to help prescribe appropriate techniques for data ingestion and processing. Within this hierarchy, this instruction establishes data quality requirements that help communicate potential application to SSA mission threads, including those threads that do not require high accuracy data. Some NTDS may have utility despite an inability to meet data quality and compatibility requirements.

1.1.3. Operational Acceptance (OA). For the purposes of NTDS, OA refers to approving the data for operational use. Sources meeting data compatibility requirements are deemed eligible for consideration to supplement the SSN, and if selected by the Director of Operations and Communications (HQ AFSPC/A3/6), will enter the operational acceptance process. This process is guided by AFSPCI 10-605, *Operational Acceptance Process*, and is explained in further detail in **Chapter 5** and **Chapter 6** of this instruction. The OA process protects the SSA mission while recognizing that not all steps in the traditional acceptance paradigm are necessary for NTDS. Specific exceptions to the OA process are determined on a casebycase basis.

1.1.4. Waivers. Waivers and requests for clarification and guidance regarding this instruction will be forwarded through appropriate channels to HQ AFSPC/A3/6.

1.2. Purpose and Applicability. This instruction provides a set of guidelines and requirements that can be shared with current and potential data providers in order to optimize compatibility in format, structure, and theory while ensuring quality standards required for the most stringent processing (e.g. human spaceflight safety) are met. It also lays out a new paradigm for integration of non-traditional data in general, and/or utilization of data of lesser quality for less restrictive purposes. While AFSPC has no authority over data quality and compatibility standards for systems it does not own, this instruction is intended for use as a reference by all domestic and foreign military, government, civil, academic and commercial entities which provide or plan to provide data to AFSPC systems. Any direct processing of sensor data by space operations squadrons or tactical units is outside the scope of this AFSPCI.

1.3. Definitions. This instruction focuses on metric observations for SSA, defined as time, position, velocity and acceleration data with accompanying sensor-specific characterization data if available. There are multiple definitions of non-traditional sensors and non-traditional data that are used throughout the SSA community. AFSPC uses the following criteria to determine non-traditional status:

1.3.1. Non-Traditional *Sensor*. Sensors that meet one or more of the following criteria are considered non-traditional:

1.3.1.1. Data is not transmitted through secure US DoD communication pathways.

1.3.1.2. Sensor accuracy cannot be determined using normal AFSPC and 18 SPCS calibration techniques.

1.3.1.3. Metric observation accuracy is insufficient to support high accuracy orbit determination, or other issues are present that increase risk to the quality of data products.

1.3.1.4. Metric observations are not formatted in a standard transmission format. The accepted standard format is the Command and Control Space Situational Awareness Community of Interest (C2 SSA COI) Extensible Markup Language (XML) format. This is the only approved observation format that can hold a 9-digit satellite number. See **Attachment 4** for details.

1.3.1.5. The US DoD does not have a role in at least one of the following functions: ownership, operations or maintenance of the sensor.

1.3.1.6. Sensor changes are not managed with an adequate configuration control system to ensure consistent performance and data quality.

1.3.1.7. Sensor availability for conducting the SSA mission is not assured and is not coordinated with the CSpOC. This includes sensors with a primary mission other than SSA that do not coordinate with CSpOC on hours of availability or data collection responsibilities.

1.3.1.8. The sensor has not been approved for operational use through the Operational Acceptance process described in AFSPCI 10-605.

1.3.2. Non-Traditional *Data*. Data that meet one or more of the following criteria are considered non-traditional:

1.3.2.1. Data that is non-metric in nature (e.g. voice reports, narrowband Space Object Identification (SOI), wideband SOI, radar cross section, photometry, passive radio frequency, or other intelligence data).

1.3.2.2. Metric data that cannot be used to automatically update the High Accuracy Catalog (HAC).

1.3.3. Waivers for traditional status may be granted by AFSPC on a case-by-case basis.

1.3.4. **Attachment 1** contains a list of references, acronyms, and definitions.

Chapter 2

ORGANIZATIONAL ROLES AND RESPONSIBILITIES

2.1. United States Strategic Command (USSTRATCOM). Commander USSTRATCOM (CDRUSSTRATCOM) is responsible for planning and conducting SSA and exercising Combatant Command (COCOM) of all dedicated and collateral SSN assets. CDRUSSTRATCOM interfaces with the Chairman of the Joint Chiefs of Staff, other Combatant Commanders, civilian and foreign entities, and has the responsibility for prioritizing, de-conflicting, integrating, synchronizing, and executing SSA operations.

2.2. USSTRATCOM/J3. USSTRATCOM Director of Global Operations is responsible to CDRUSSTRATCOM for providing guidance and policy on space surveillance operations to USSTRATCOM components. CDRUSSTRATCOM has delegated authority to USSTRATCOM/J3 for directing USSTRATCOM space operations. The heart of this Command and Control (C2) structure is centralized planning of all space forces at USSTRATCOM with decentralized execution through component commands.

2.2.1. USSTRATCOM/J3 is responsible for coordinating with SSA mission stakeholders to maintain a continuously updated list of prospective NTDS in priority order.

2.3. USSTRATCOM/J5. USSTRATCOM Director of Plans and Policy is responsible for the development and implementation of national security policy and guidance, military strategy and guidance, space and weapons employment policy and concepts, and joint doctrine as they apply to the execution of the Command's global mission.

2.3.1. USSTRATCOM/J51 is responsible for coordinating SSA Sharing Agreements with external organizations to establish formal relationships with each NTDS.

2.4. USSTRATCOM/J6. USSTRATCOM Director of Command, Control, Communications, and Computers (C4) Systems is responsible to CDRUSSTRATCOM for performing certification assessments of the control and mission integrity of strategic and space warning, theater warning, and missile defense systems IAW the certification process outlined in USSTRATCOM Instruction 535-01, *System Certification Process*.

2.4.1. USSTRATCOM Systems Certification Division (J65) is responsible for analyzing all pertinent data and artifacts, including requirements documents and test results in order to assess whether the system achieves its mission(s) without degradation. Certification decisions are determined at the USSTRATCOM Systems Integrity Board. In addition, J65 is responsible for the day-to-day oversight of the system integrity for systems performing strategic warning, space warning, theater warning, and missile defense missions.

2.5. Joint Force Space Component Command (JFSCC). CDRUSSTRATCOM delegated Space Coordinating Authority (SCA) to CDR JFSCC. CDR JFSCC is responsible for coordinating, planning, integrating, synchronizing and executing assigned joint space operations with supported and supporting organizations and designated theater SCAs to ensure delivery of relevant and responsive space effects. As the operational manager for SSA, CDR JFSCC is also responsible for maintaining the space Common Operating Picture (COP) and coordinating sensor tasking responsibilities within the CSpOC.

2.5.1. JFSCC/J3 is responsible for managing all aspects of the Space-Track.org website, which is a key external input/output interface among NTDS, CSpOC and 18 SPCS.

2.5.2. JFSCC/J3 is also responsible for providing operational guidance and direction on Space-Track.org utilization.

2.6. Air Force Space Command (AFSPC). Headquartered at Peterson AFB, CO, AFSPC organizes, trains, and equips United States Air Force (USAF) space forces for USSTRATCOM to perform SSA, space control, space support to operations (formerly space force enhancement), and space service support missions.

2.7. HQ AFSPC/A3/6 (Directorate of Operations and Communications).

2.7.1. In accordance with the Operational Acceptance process, executes delegated AFSPC/CC acceptance responsibilities such as approval of NTDS for operational use.

2.7.1.1. Convenes Trial Period Review Panel (TPRP) for Trial Period (TP) entry/exit and decisions to accept data for operational use.

2.7.1.2. Advises USSTRATCOM/J3 regarding compatibility and utility of data from NTDS.

2.7.2. The appropriate HQ AFSPC/A3/6 Division develops criteria for operational transition in conjunction with the NTDS's technical and overall capabilities, operating and system concepts and data integrity analysis.

2.7.2.1. HQ AFSPC/A3/6 establishes formats and information content standards for data and products sent to 18 SPCS by NTDS.

2.7.2.2. HQ AFSPC/A3/6 ensures non-traditional data is in an acceptable format and compatible with 18 SPCS processing to enable integration. This process may involve coordination with the NTDS to define required data conversions to be performed by the data recipient, data provider, or an agreed intermediary to enable data exploitation and integration.

2.7.2.3. HQ AFSPC/A3/6 provides input to the technical requirements for the development of new Nontraditional Data Preprocessor (NDPP) plug-ins or plug-in modifications. NDPP was created to improve access to NTDS; it streamlines the transmission pathway by leveraging Internet-based connectivity and allows for a nearly unlimited number of data formats by providing a flexible configuration interface. NDPP consists of a set of plug-in software that translates the external NTDS observation format into the 18 SPCS internal format.

2.7.2.4. HQ AFSPC/A3/6 leads the numerical validation process for each NTDS and advises on quality and functional compatibility with 18 SPCS systems.

2.7.2.5. HQ AFSPC/A3/6 provides a recommendation for the level of compatibility (Levels 1 through 4) and utility class (Classes I through V) based on criteria defined in **Chapter 4** of this instruction and on findings identified during the acceptance process.

2.7.3. The appropriate HQ AFSPC/A3/6 division prepares letters for AFSPC/CC, or the delegated authority documenting the acceptance for operational use of the data.

2.7.4. Reviews cybersecurity packages for risk-determination and cyber authorization consideration.

2.7.5. Reviews computer resources, communications data traffic requirements, cross domain issues, cryptologic concerns, and information technology documents as required.

2.7.6. Issues Interim Authorization to Test (IATT) and Authority to Connect (ATC) and related authorizations based on an acceptable level of cybersecurity and cyber risk, as necessary.

2.7.7. Serves as Air Force Space Command (AFSPC) Authorizing Official (AO) for the Air Force Information Network (AFIN) and AFSPC Mission Systems. Receives recommendations regarding cyberspace security posture and issues appropriate Authorization to Operate (ATO), IATT or ATC authorization decisions based on the assessed level of risk.

2.7.8. The appropriate HQ AFSPC/A3/6 division assumes lead responsibility of the system or capability after a positive OA decision.

2.7.9. Performs data integrity and accuracy analysis.

2.7.10. Performs Military Utility Assessments (MUA) in conjunction with HQ AFSPC/A5/9.

2.7.11. HQ AFSPC/A3/6 coordinates with HQ AFSPC/A5/9 to define requirements and funding needed for execution of requirements in this AFSPCI.

2.8. HQ AFSPC/A4 (Directorate of Logistics, Installations and Mission Support).

2.8.1. HQ AFSPC/A4 is responsible for managing the System Modification Process through the use of Air Force Form 1067, *Modification Proposal*, IAW AFI 63-101/20-101, and AFI 10-601.

2.9. HQ AFSPC/A5/9 (Directorate of Strategic Requirements, Architectures and Analysis).

2.9.1. HQ AFSPC/A5/9 is the focal point for international policy and foreign disclosure for satellite operations.

2.9.2. They are responsible for performing Military Utility Assessments.

2.9.3. They are responsible for identifying concerns and benefits of incorporating non-US Government and/or non-traditional sensors and data sources.

2.9.4. HQ AFSPC/A5/9 is also responsible for providing direction required to implement the requirements of this AFSPCI, including architectural relevance assessments for NTDS.

2.10. HQ AFSPC/A8 (Directorate of Plans, Programs, and Financial Management).

2.10.1. HQ AFSPC/A8 serves as the Command focal point for Planning, Programming, and Budgeting Execution (PPBE) processes, unit activation/deactivation, strategic basing and alignment issues.

2.11. HQ AFSPC/SE (Safety Office).

2.11.1. HQ AFSPC/SE is responsible for reviewing incorporation plan documents for safety issues if US personnel or assets will be collocated with or directly affected by non-US and/or non-traditional sensors and data sources.

2.12. 14th Air Force (14 AF). Located at Vandenberg AFB, CA, 14 AF organizes, trains and equips forces for space operations. 14 AF is responsible for managing the generation of Air Force space forces to support USSTRATCOM operational plans and missions. 14 AF is responsible for performing the following activities.

2.12.1. They participate in AFSPC training conferences if required for non-US and/or non-traditional sensors and data sources. Training includes any US involvement in operating the sensor/data source and any source-unique activities needed to exploit the sensor/data source. **(T-3)**.

2.12.2. They act as Office of Collateral Responsibility (OCR) to provide operator input to AFSPC during installation readiness reviews for each operational capability and ensure any deficiencies are identified and documented. **(T-2)**.

2.12.3. They support testing activities as required. **(T-3)**.

2.12.4. They are stakeholders in the OA process and ensure units are ready to assume operations and maintenance responsibilities associated with the receipt and correct interpretation of NTDS data as appropriate upon the OA decision. **(T-2)**.

2.13. 18th Space Control Squadron (18 SPCS). 18 SPCS, located at Vandenberg AFB, CA, falls directly under the 21st Operations Group (21 OG). 18 SPCS's overall mission is to deliver foundational SSA to assure global freedom of action in space. Specific missions include 24/7 support to US, foreign government, civil, academic and commercial entities, including SSN sensor tasking and Satellite Catalog maintenance, sensor calibration and optimization, orbital decay and deorbit assessments, reentry/breakup assessments, conjunction assessments, support to human spaceflight safety, launch support, and execution of USSTRATCOM's SSA Sharing Program. In performing these missions, 18 SPCS is responsible for the following activities.

2.13.1. Within the OA process for new sensors, new data sources, and sensor/source upgrades, 18 SPCS makes use of the data during Trial Periods to determine the contribution the data make to SSA operations and to ensure that the data causes no adverse operational effects. **(T-2)**.

2.13.2. 18 SPCS performs routine tasking of all sensors that are taskable. **(T-3)**.

2.13.3. The 18 SPCS Sensor Optimization Section performs passive calibration of NTDS as required. Passive calibration is the computation of weights and biases for a sensor after the data has been received by 18 SPCS. These weights and biases are then applied in the orbit determination (OD) processes. This differs from active sensor calibration where hardware or software adjustments are made to the sensor system on site. **(T-2)**.

2.13.4. As part of the SSA Sharing Program, 18 SPCS, in coordination with JFSCC/J35, operates SpaceTrack.org, a DoD website that provides users the ability to upload and download SSA data and information. **(T-2)**.

2.13.5. 18 SPCS conducts functional tests on the data feeds from NTDS. **(T-2)**.

2.13.6. As required, 18 SPCS adds new sensors to the mission systems using the Database Change Request process (SPADOC Form 023). **(T-3)**.

2.13.7. As required, 18 SPCS provides input to the NDPP SPO in the creation and modification of NDPP plug-ins to enable use of data from accepted NTDS. **(T-3)**.

2.13.8. 18 SPCS conducts the Integrated Life Cycle Management process (AFI 63-101/20-101) to update the Special Perturbations Tasker (SP-Tasker) application. This is done to either enable tasking of new sensors or to account for the productivity of new sensors to potentially reduce tasking or to reprioritize tasking among the SSN sensors. SP-Tasker is the software used within 18 SPCS to manage sensor workloads. Daily, SP-Tasker automatically generates a list of objects and tracking requirements for each sensor based on Satellite Catalog maintenance needs and expected tasking fulfillment from each sensor. The daily routine tasking messages are called Consolidated Tasking Lists (CTLs). **(T-2)**.

2.13.9. As required, 18 SPCS uses the Deficiency Reporting process to update software related to the sensor calibration function. **(T-3)**.

2.13.10. As required, 18 SPCS updates Orbital Data Request filings to ensure the new NTDS provider has access to the data required for routine calibration activities. **(T-3)**.

2.13.11. With respect to TP, 18 SPCS, in coordination with 614th Air and Space Operations Center (614 AOC), develops a process to disconnect the new data source from the mission system if directed. **(T-2)**.

2.13.12. 18 SPCS supports the HQ AFSPC/A3/6 presentation of TP results and provides recommendations to OA Approval Authority on operational use of the data. **(T-3)**.

2.13.13. 18 SPCS ensures compliance with cyber security of 18 SPCS-owned systems. **(T-2)**.

2.13.14. 18 SPCS updates internal procedure documentation and training materials relevant to the use of each NTDS, as needed. **(T-3)**.

2.13.15. 18 SPCS provides training to 18 SPCS operators and maintainers, as needed. **(T-2)**.

2.14. 18th Space Control Squadron, Detachment 1 (18 SPCS, Det 1). Det 1, located in Dahlgren, VA, is the alternate processing C2 and communications interface for the SSN. Det 1 provides backup for selected 18 SPCS capabilities. Det 1 maintains a complete current database of all space objects and "hot shadows" 18 SPCS space surveillance processing and tactical implementation of 18 SPCS and CSpOC tasks at all times. This allows Det 1 to assume immediate control of the SSN for space event tasking when necessary. In performing these missions, Det 1 is responsible for the following activities.

2.14.1. Within the OA process for new sensors, new data sources, and sensor/source upgrades, Det 1 makes use of the data during Trial Periods to determine the contribution the data make to SSA operations and to ensure that the data causes no adverse operational effects. **(T-2)**.

2.14.2. Det 1 performs routine tasking of all sensors that are taskable. **(T-3)**.

2.14.3. The Det 1 Sensor Optimization Section performs passive calibration of NTDS as required. **(T-2)**.

2.14.4. Det 1 conducts functional tests on the data feeds from NTDS. **(T-2)**.

2.14.5. As required, Det 1 adds new sensors to the mission systems using the Database Change Request process (SPADOC Form 023). **(T-3)**.

2.14.6. Det 1 conducts the Integrated Life Cycle Management process (AFI 63-101/20-101) to update the SP-Tasker application. This is done to either enable tasking of new sensors or to

account for the productivity of new sensors to potentially reduce tasking or to reprioritize tasking among the SSN sensors. **(T-2)**.

2.14.7. As required, Det 1 uses the Deficiency Reporting process to update software related to the sensor calibration function. **(T-3)**.

2.14.8. As required, Det 1 updates Orbital Data Request filings to ensure the new NTDS provider has access to the data required for routine calibration activities. **(T-3)**.

2.14.9. With respect to TP, Det 1, in coordination with 614 AOC, develops a process to disconnect the new data source from the mission system if directed. **(T-2)**.

2.14.10. Det 1 supports the HQ AFSPC/A3/6 presentation of TP results and provides recommendations to OA Approval Authority on operational use of the data. **(T-3)**.

2.14.11. Det 1 ensures compliance with cyber security of 18 SPCS-owned systems. **(T-2)**.

2.14.12. Det 1 updates internal procedure documentation and training materials relevant to the use of each NTDS, as needed. **(T-3)**.

2.14.13. Det 1 provides training to Det 1 operators and maintainers, as needed. **(T-2)**.

2.15. Combined Space Operations Center (CSpOC). The CSpOC is CDR JFSCC's current operations center providing systems needed to plan, task, direct, monitor, and assess the execution of joint and combined space operations on behalf of CDRUSSTRATCOM. Through the CSpOC, JFSCC integrates and collaborates with other operations centers at multiple levels, to include HQ USSTRATCOM, other Joint Functional Component Commands (JFCCs), Joint Task Forces, allies and coalition, domestic, international, civil and commercial partners. CDR JFSCC postures units and systems within the CSpOC in order to manage and execute strategic and operational tasks necessary to support the diversity of space operations while maintaining situational awareness of worldwide threats and events. The CSpOC is linked to the USSTRATCOM Global Operations Center (GOC) in order to facilitate data-sharing and collaboration, to support CDRUSSTRATCOM and CDR JFSCC's strategic and operational planning activities.

2.16. 614th Air and Space Operations Center (AOC). 614 AOC provides Air Force staffing and resources to JFSCC to operate CSpOC for US space surveillance activities. They are responsible for performing the following activities.

2.16.1. They update procedure documentation and training materials relevant to the use of each NTDS. **(T-2)**.

2.16.2. They provide training to 614 AOC and CSpOC operators and maintainers as needed. **(T-2)**.

2.17. National Space Defense Center (NSDC). The NSDC is a partnership organization that develops and improves the ability to rapidly detect, warn, characterize, attribute and defend against threats to our nation's vital space systems. It works across the space enterprise to aid on-orbit activity characterization and provides enhanced indications and warnings.

2.18. National Air and Space Intelligence Center (NASIC). NASIC provides a rapid and timely combination of scientific, technical and combat-related support for space control operations. NASIC provides evaluation of adversary space capabilities and predictive assessments on potential adversaries' use of space in support of Joint Intelligence Preparation of the Operational Environment (JIPOE), Space Intelligence Preparation of the Battlefield (SIPB),

conducts Space Object Identification (SOI) analysis on Resident Space Object (RSO) characteristics to determine the object's function and operational status, and maintains the Defense Intelligence Space Order of Battle (DISOB). In performing these missions, NASIC is responsible for the following activities.

2.18.1. They evaluate the quality and utility of SOI data. SOI is provided as legacy signatures or in the NASIC Electro-Optical Space Situational Awareness (EOSSA) format.

2.18.2. They evaluate the quality and utility of NTDS for SOI purposes.

2.19. Non-Traditional Data Sources (NTDS). These consist of any sensor, C2 system, or other source that sends SSA data to the AFSPC systems identified in **paragraph 1.1** and meets the definitions in **paragraph 1.3**. NTDS capability will be used to determine the utility of the data and how the data will be used. Communication systems (i.e. COMSATs, or other pass-through systems) are not required to meet the requirements stipulated by this instruction as they are not considered NTDS.

2.20. NTDS Sponsor. The responsible organization for non-DoD NTDS will vary depending on the ownership (commercial, government, civil, academic and foreign military). Therefore, the term NTDS Sponsor is used to recognize that NTDS will typically be represented by an intermediary or supervisory organization such as a relevant National Space Operations Center, or a parent company or body. The NTDS Sponsor needs to be empowered to act on behalf of the NTDS and to interact with AFSPC and the organizations involved in the NTDS integration process as defined by this AFSPCI. The Tier levels only apply if the NTDS Sponsor is a unit subordinate to HQ AFSPC. The NTDS Sponsor is responsible for:

2.20.1. For non-commercial non-AFSPC NTDS, the NTDS Sponsor will make a subjective determination of whether an NTDS sensor or data source warrants nomination as a potential source for SSA metric data and/or SOI data. This determination is based on discussions with and presentations and/or documentation from the potential data supplier. The nomination is initiated through a nomination letter submitted by the NTDS Sponsor to USSTRATCOM/J3. Additional coordination with Headquarters Air Force, Operations Directorate (HAF/A3) and Office of the Secretary of Defense (OSD) Policy may also be necessary. For commercial NTDS, the sensor or data source is chosen through a competitive bidding process to address specific requirements gaps or shortfalls. This acquisition process for commercial NTDS is beyond the scope of this AFSPCI. For AFSPC-owned NTDS, the new sensor or sensor modification will also have undergone a formal acquisition process beyond the scope of this AFSPCI. **(T-2)**.

2.20.2. Defining the data types (metric observations and SOI) and formats that will be provided, to enable analysis of the data to be provided and to support NDPP plug-in creation or modification as required. **(T-2)**.

2.20.3. Applying necessary corrections and compatibility adjustments IAW the guidelines presented in this AFSPCI. **(T-2)**.

2.20.4. Ensuring internal quality control measures are in place to ensure consistent data quality. **(T-2)**.

2.20.4.1. In coordination with 18 SPCS, defining the requirement and process for processing periodic calibration observations. **(T-2)**.

2.20.5. Providing data to support the conduct of a Military Utility Assessment (MUA) of the NTDS being considered. **(T-2)**.

2.20.6. In conjunction with HQ AFSPC/A3/6, 18 SPCS, and other stakeholders, the NTDS Sponsor is responsible for developing a Concept of Operations (CONOPS) for the NTDS being considered. **(T-3)**.

2.20.7. Supporting the development of the Operational Acceptance Plan in coordination with the OA Approval Authority (HQ AFSPC/A3/6) and other stakeholders. **(T-3)**.

2.20.8. Providing training to operators and maintainers. **(T-2)**.

2.20.9. Supporting and participating in the TPRP for OA Approval Authority's TP entry decision. **(T-2)**.

2.20.10. Supporting the conduct of Trial Period. **(T-2)**.

2.20.11. Supporting and participating in Deficiency Review Board(s) (DRB) as necessary. **(T-2)**.

2.20.12. Supporting and participating in the TPRP for OA Approval Authority's TP exit decision. **(T-2)**.

2.20.13. Supporting and participating in TP results brief(s) to the OA Approval Authority. **(T-2)**.

2.20.14. Following OA approval of TP exit and OA of the NTDS.

2.20.14.1. Ensuring configuration control processes are in place to notify 18 SPCS, the CSpOC, and HQ AFSPC/A3/6 of any system changes that could impact mission performance. Additional coordination and data validation may be necessary depending on the nature of the changes and the level of the source's integration. **(T-2)**.

2.20.14.2. Conducting periodic calibration observations and providing those observations to 18 SPCS for ongoing quality analysis and reporting. **(T-2)**.

2.20.14.3. Interfacing with the CSpOC and 18 SPCS as necessary to support SSA mission needs, and IAW applicable Memorandums of Agreement (MOAs) or SSA Sharing Agreements. **(T-3)**.

2.20.15. A more detailed set of guidelines for reporting space surveillance data is provided in **Attachment 2**.

2.21. Rapid Integration Roles and Responsibilities. In the event of a rapidly emerging threat or critical operational need, HQ AFSPC/A3/6 may direct; or USSTRATCOM/J3, JFSCC/J3, or 18 SPCS/CC may request that Trial Period be waived and HQ AFSPC/A3/6 convene an acceptance panel to approve automated operational use of non-traditional data with the understanding that certain acceptance criteria will be incomplete. The Operational Assessments Division (HQ AFSPC/A3/6Z) reviews and validates any data accepted using this abbreviated process within one month of OA of the data. As a safety precaution and prerequisite for accelerated acceptance, all data feeds must be able to be disconnected from operational use if directed. 18 SPCS/CC may also authorize the non-automated use of non-traditional data by experienced orbital analysts. In this case, the data must be evaluated before being ingested into the mission system for use in

Satellite Catalog updates. The accelerated acceptance could drive the need for additional funding to write a new NDPP plug-in module.

2.21.1. Rapidly Emerging Threat capabilities that challenge SSN find, fix or track capabilities.

2.21.1.1. Launch capabilities or profiles

2.21.1.2. Orbital transfer trajectories or profiles

2.21.1.3. Orbital maneuvers and proximity operations

2.21.2. Critical Operational Needs for SSN find, fix or track capabilities.

2.21.2.1. Objects with low photometric reflectivity (e.g. >18.5 visual magnitude)

2.21.2.2. Object with low radar cross section (e.g. < 10 cm)

2.21.2.3. Highly maneuverable, high interest objects requiring persistent tracking

2.21.2.4. Close object discrimination at GEO (e.g. < 2 km)

2.21.2.5. Task, search, identify and recatalog lost objects.

2.21.3. Rapid Acceptance Criteria. NTDS may be considered for rapid acceptance, waived Trial Period, and approval for automated operational use, based on one or more of the following conditions being met, or at the discretion of an approving authority in the case of an unforeseen event.

2.21.3.1. Operational use of the NTDS by other trusted government organization or partner

2.21.3.2. Existing test results of NTDS by other trusted government organization or partner

2.21.3.3. Existing mission assurance/data assurance capabilities

Chapter 3

GOALS AND CONSTRAINTS

3.1. Commander's Intent. The AFSPC Commander's intent is to improve SSA through the utilization of a wide variety of sensor data and ephemeris data, of varying fidelity and accuracy, from an array of United States Government (USG), non-DoD, commercial, civil and foreign data providers. This means that the quality and compatibility criteria for new data sources should be set as broadly as possible.

3.2. Operational Considerations. The existing SSA processing systems, including SPADOC and ASW, now have the necessary processing capabilities to support and appropriately leverage sources that provide diverse data types of varying quality. They also possess adequate computational algorithms to leverage operational utility from these sources to support various functions. NDPP and ASW can be enhanced to translate data from an increasing number of NTDS for use in SSA operations. As more message translation software plug-ins are built for NDPP, these systems will increasingly be able to automatically ingest non-standard message types. The ability to maximize C2 access to new data sources will grow in the coming years. The following are data attributes that must be considered while ingesting an increasing amount of non-traditional SSA data:

3.2.1. Data Quality. Data quality requirements for CSpOC and/or 18 SPCS systems are driven by the need for authoritative space data with sufficient accuracy to support the critical missions of conjunction assessment, human spaceflight safety, and space control, without corrupting the Satellite Catalog on which the international space community depends. Data of lesser quality may still have utility to other SSA missions due to unique characteristics of the data source (e.g., location or sensor phenomenology). Other SSA mission areas include, but are not limited to launch processing, maneuver detection, reentry, new object discovery and lost object processing. With an evolved future C2 system, each of these mission areas would have its own data quality requirements that the C2 system would be able to process and differentiate independently.

3.2.2. Data Compatibility. Currently, traditional data sources must adhere to the data processing limitations established by AFSPC, especially for metric observation messages (see **Attachment 4** for observation format descriptions). The format recommended for metric observation data from NTDS and new SSN sensors is the C2 SSA COI XML format (Version 3.4.2). Data may be transmitted through legacy communication pathways or through NDPP. Owner/operator-provided ephemerides are also increasingly being used, but this data is currently limited to specific processing routines (i.e. conjunction assessment).

3.2.3. Cyber Security. Ingestion of data from diverse sources directly into CSpOC and/or 18 SPCS systems provides a potential avenue for illicit cyber intrusion. Vulnerability must be assessed and adequate security measures must be implemented to ensure that operational C2 systems are protected at the highest level possible.

3.2.4. A more detailed description of 18 SPCS operational considerations is provided in **Attachment 3**.

3.3. Short Term Improvements. The process laid out in this instruction differs from the legacy sensor integration process by allowing new data sources to provide data that would have been

unusable in the past. This is being accomplished through three key enablers, 1) eliminating strict dependence on DoD communication systems by allowing providers to submit through an internet-based interface (e.g., Space-Track.org or SIPRNet), 2) utilizing NDPP to handle basic data format conversions, and 3) introducing a multi-level sensor concept that enables the use of new data sources that would not have otherwise met the Operational Acceptance criteria applied to traditional sources.

3.4. Risk Mitigation. Loosening the acceptance criteria introduces new risks by allowing data sources that have greater potential to degrade SSA processing functions if the data is not well understood or is mishandled by the processing system. The multi-level sensor concept introduced herein attempts to balance these risks by isolating potentially hazardous data from the authoritative space database while still providing a conduit for operational use.

Chapter 4

UTILITY AND CHARACTERIZATION OF DATA SOURCES

4.1. Data Usability. Meeting all the performance specifications for Level 1 systems, as defined in **Table 4.1**, confirms the new data provided is both compatible and of sufficient quality to benefit the SSA mission, but provides no guarantee of selection to enter the acceptance process. Consideration must be made for cost, uniqueness, timeliness, throughput, cyber security, and other factors. Systems that do not meet the requirements for Level 1 status may still be approved for operational use as Level 2 data as long as the data are compatible and quality meets the minimal requirements, which can vary depending on the specific mission application. Military Utility Assessments on NTDS may help to characterize data and sensor utility to the SSA mission, but is not always required.

4.2. Military Utility Assessments (MUA). The Director of Operations and Communications (HQ AFSPC/A3/6) has the discretion to authorize an MUA to determine if any system provides sufficient added value to the SSA mission to justify inclusion in SPADOC, ASW or any other AFSPC-owned SSA system. Results of the MUA shall also be used to inform CONOPS-development. The MUA and any other assessment activities other than those described in this instruction and AFI 99-103 are not operational test activities and cannot be used as sole support for fielding, operational acceptance, early operational use, trial period entry or Full Rate Production (FRP) decisions.

4.2.1. The criteria used in MUAs for NTDS are as follows:

4.2.1.1. Accuracy. For optical sensors, accuracy is measured in arcseconds (right ascension and declination). For radar sensors, accuracy is measured in degrees (azimuth and elevation), kilometers (range), and kilometers per second (range-rate). For SOI data, accuracy is measured in visual magnitude for optical sensors and in decibel square meters (dBsm) for radar cross section from radars.

4.2.1.2. Capacity. This is measured in tracks per day, observations per day, and objects per day.

4.2.1.3. Sensitivity. This is measured in visual magnitude for optical sensors and object diameter in meters for radars (for Low Earth Orbit (LEO) objects and for Geosynchronous Earth Orbit (GEO) objects).

4.2.1.4. Field of Regard/Orbit Coverage. This is generally measured in steradians of solid angle or percentage of an orbital regime that may be observed.

4.2.1.5. Search Rate. This is usually measured in square degrees per day for a particular orbital regime.

4.2.1.6. Tasking Responsiveness. This is generally measured in terms of data latency of the response (in minutes) to tasking to collect observations on a specific object that is within the sensor’s field of view.

4.2.1.7. Unique Capability. This characteristic is qualitative in nature, but can be measured as the number of orbital objects or space events for which the sensor provides unique data or significantly better data than the rest of the network.

4.2.1.8. Availability and Reliability. This is generally measured as the percentage of time the sensor or data source is operational and available for use in SSA operations.

4.2.1.9. Cost. This is usually measured in millions of dollars per year.

4.2.2. For non-metric data and data sources other than optical sensors and radar sensors, HQ AFSPC/A3/6 will determine the appropriate criteria for the purposes of an MUA.

4.2.3. Data that is not compatible with current systems, but is otherwise deemed to be of sufficient value, must either be modified for ingestion, or evaluated for potential analytical use by prototype tools or environments.

4.3. Source Characterization. In order to move from a paradigm where all data must meet high quality standards to support human spaceflight safety, to one utilizing data with diverse data sources and varying quality to support applicable mission threads, sensors may be characterized using factors that describe compatibility, utility, and quality.

4.3.1. The NTDS Compatibility Level is a suitability characterization of the data from a non-traditional source. It reflects the overall reliability of the source to consistently perform within tolerance in order to support automatic ingestion and processing functions. See **Table 4.1** for a description of Compatibility Levels 1 through 4.

Table 4.1. NTDS Compatibility Levels.

Level 1	Data can be utilized in a fully automated fashion within the SSA system with no or minimal preprocessing.
Level 2	Data requires manual processing within the SSA system. This can be due to either a lack of algorithms within the SSA system capable of processing the data, or a lack of automated messaging to get the data into the SSA system.
Level 3	Metric data has been assessed as not suitable for use within the system. This is typically due to significant data quality issues or other data compatibility problems. However, sensors can provide non-metric characterization information.
Level 4	Entry level sensor; data has not yet been assessed.

4.3.2. The NTDS Utility Class is a characterization of the value or usefulness of the data or data source to the SSA mission, especially the need for authoritative space data to support the missions of conjunction assessment and human spaceflight safety, while not corrupting the Satellite Catalog. Utility Class considers such factors as location, field of regard/view, sensitivity, search capabilities, capacity, timeliness, response to tasking, and availability. Support to space event processing and other SSA mission needs is considered within this characterization. Systems that provide capabilities that are either not provided by other SSN assets, or are otherwise not well covered, are considered unique data providers. There is no requirement for unique data capabilities, but it is a significant factor in the overall mission utility. Unique capabilities include, but are not limited to: small object tracking, low inclination / near-earth orbit coverage, near-earth coverage in the southern hemisphere (for perigee south orbits), daytime infrared (IR) for optical systems, unique geographic location, coverage of high area-to-mass ratio (HAMR) objects, and persistent tracking / rapid maneuver detection. Systems that have unique capabilities are encouraged to coordinate with the CSpOC, 18 SPCS and AFSPC to ensure that they can be leveraged as appropriate. The five Utility Class values are described in **Table 4.2** as follows:

Table 4.2. NTDS Utility Class.

Class I Critical	Provides unique capabilities that are critical to the SSA mission.
Class II Significant	Provides significant contributions to the SSA mission, but is either redundant with other SSA systems, or would not represent a critical degradation if the resource was not available.
Class III Niche	Important for specific mission areas but not appropriate for all mission processing threads.
Class IV Marginal	System provides some utility to the SSA mission but is redundant to other systems and would not cause an appreciable degradation if the source was not available.
Class V Low or None	System provides little or no utility to the SSA mission.

Chapter 5

OPERATIONAL ACCEPTANCE PLANNING

5.1. Operational Acceptance Planning Process. The following section outlines the process for selection and operational acceptance (OA) planning for prospective NTDS. OA planning should be tailored based on the sensor or data source and how it will be employed. OA planning for NTDS is briefly discussed in AFSPCI 10-605, *Operational Acceptance Process*.

5.1.1. For non-commercial non-AFSPC NTDS that plan to provide their data at no cost, CDRUSSTRATCOM identifies and selects a NTDS for SSA and drafts a data-sharing agreement between the NTDS parent organization and the USG for integration into JFSCC operations.

5.1.2. For commercial NTDS, CDRUSSTRATCOM does not need to identify a NTDS for SSA nor draft a data-sharing agreement because the sensor or data source will already have been chosen through a competitive bidding process. This acquisition process whereby commercial entities compete for the provision of data that satisfies specific requirements gaps or shortfalls is beyond the scope of this AFSPCI.

5.1.3. For new AFSPC-owned NTDS, CDRUSTRATCOM will have approved of the acquisition, development, and integration before operational acceptance planning begins. Therefore, there is no need to identify the new system for SSA or draft a data-sharing agreement.

5.1.4. The designated HQ AFSPC/A3/6 Division will identify Subject Matter Experts (SMEs) and Points of Contact (POCs) for top-level stakeholders who will participate in the NTDS OA planning and assessment processes.

5.1.5. HQ AFSPC/A3/6Z is responsible for assigning a sensor number and for collecting information on the sensor location, sensor specifications, and other information required for evaluating the data and for drafting a Database Change Request (DCBR) if the sensor data is accepted for integration within the C2 system databases.

5.1.6. HQ AFSPC/A3/6Z conducts a preliminary assessment of the quality and military utility of the data before an OA Plan is drafted.

5.1.7. OA Plans for system modifications are developed at the discretion of the responsible HQ AFSPC/A3/6 Division. A decision to generate an OA Plan for a modification will be made by the responsible HQ AFSPC/A3/6 Division within five days from lead command certification and approval of the modification proposal for AFSPC NTDS, and within five days of being notified of the NTDS modification for non-AFSPC NTDS.

5.1.8. If an OA Plan is required, the SME and POCs will work with the NTDS or sponsor to develop an OA Plan tailored to the NTDS.

5.1.8.1. For AFSPC NTDS, the OA Plan is focused on activities following certification by the Program Executive Officer (PEO), from developmental and operational testing through trial period to OA. For non-AFSPC NTDS, the OA Plan is focused on activities following USSTRATCOM's drafting of the data-sharing agreement, through trial period to OA.

5.1.8.2. Responsibility for developing the OA Plan resides with the HQ AFSPC/A3/6 Division that has, or will have, overall responsibility for integrating the NTDS. The designated HQ AFSPC/A3/6 Division will update the OA Plan when a significant change to the development, fielding, or sustainment of the program or system impacts the ability to execute the plan. The OA Plan is then coordinated and approved at a level commensurate with the OA Approval Authority defined in AFSPCI 10-605, Table 2.1. Coordination for AFSPC NTDS will include the PEO or Program Management Office (PMO), appropriate HQ AFSPC Directorates, and the responsible Numbered Air Force (NAF). Coordination for non-AFSPC NTDS will not include the PEO or PMO.

5.1.8.3. The OA Plan will address key decision points with corresponding criteria for success (i.e. trial period entry, trial period exit, and OA decision). For AFSPC NTDS, the OA decision points may coincide with Initial Operational Capability (IOC) and Full Operational Capability (FOC) declaration. AFSPCI 10-605, *Operational Acceptance Process*, Attachment 3 contains an OA Plan Template that may be adapted to either AFSPC NTDS or non-AFSPC NTDS.

5.1.9. Develop an Employment Concept.

5.1.9.1. Describe the data to be used and under what circumstances it will be used (solution sets for optimal use of the data from the NTDS).

5.1.9.2. Identify the data format to be used (see **Attachment 4** for details).

5.1.9.3. Determine the anticipated days and hours of operation and expectations for data timeliness.

5.1.9.4. Define the communications architecture including which C2 processing system(s) will integrate the data (e.g., SPADOC and/or ASW).

5.1.9.5. Develop a technical plan to integrate the NTDS into JFSCC operations, which includes the data source definition, specifications, and submission of modification proposals (AF Form 1067) to appropriate configuration management boards (e.g., SPTasker, Correlation, Analysis and Verification of Ephemerides Network (CAVENet), NDPP, and required communication system(s)).

5.1.9.6. Define the Command and Control relationship(s), tasking authorities and process(es) and availability/Operations Capability (OPSCAP) reporting process(es).

5.1.9.7. Identify whether or not SOI data will be collected and describe customer delivery method.

5.1.9.8. Describe data integrity controls that will be used for quality control (e.g., weekly monitoring and sensor calibration). **Attachment 5** documents the technical aspects of sensor calibration.

5.1.9.9. Develop configuration control or change management concepts and procedures.

5.1.10. Identify employment costs.

5.1.11. Develop a timeline and identify required resources to complete integration of the NTDS.

5.1.12. Ensure stakeholders develop a cybersecurity plan for attaining cyber authorization and an end-to-end demonstration plan (i.e. sensor through end user).

5.1.13. Define the process by which data samples and other pertinent information for data processing and assessment are collected and delivered to HQ AFSPC/A3/6Z and/or 18 SPCS for analysis. Identify target(s) for sample data collects. Ensure this process is followed.

5.1.14. Ensure Memorandums of Understanding (MOU)/MOAs required to execute this OA Plan are agreed upon, signed, and maintained. Ensure that appropriate contractual documents are in place if appropriate.

5.1.15. Present analysis of the data and acceptance criteria to the OA Approval Authority for final decision on integration of the NTDS.

5.1.16. Identify any potential impediments and/or challenging issues.

Chapter 6

OPERATIONAL ACCEPTANCE PROCESS AND CRITERIA

6.1. Operational Acceptance Process. The Operational Acceptance (OA) Process is the formal process by which AFSPC accepts delivery of a new system/data source or a modification to an existing system/data source. In addition to acceptance of new systems or system modifications, OA for non-traditional SSA data sources also applies to the approval to use the data provided to the network operationally. The complete OA process is defined in AFSPCI 10-605, *Operational Acceptance Process.*

6.2. Operational Acceptance. For the purpose of NTDS, OA means the data is approved for operational use and meets the quality and usability standards while not adversely affecting SSA. Recommending OA of a NTDS is the responsibility of the appropriate division in HQ AFSPC/A3/6 IAW AFSPCI 10-605. Reference AFSPCI 10-605 for more information on the Operational Acceptance Process.

6.2.1. OA Process Intent. The OA process is used to assess risk to the space command and control systems that could be adversely affected by the inclusion of the new sensor, data source, capability or modification. Depending on operational and technical requirements, the OA decision authority has the prerogative to accept a sensor with a high degree of risk in one or more areas. At a minimum, there needs to be analysis of the compatibility of incoming data to determine what modifications would be required to use the data.

6.2.2. HQ AFSPC/A3/6 is responsible for recommending the level of utilization of a system or data source based on the quality of information and level of configuration control. Sensors with usable, but substandard data quality or that lack configuration control may be recommended for manual orbital analyst processing in lieu of direct incorporation into the Satellite Catalog.

6.2.3. Threat Response. In the event of a rapidly emerging threat or critical operational need, USSTRATCOM/J3, JFSCC/J3 or 18 SPCS/CC may request, or HQ AFSPC/A3/6 may direct, that TP be waived and convene an OA panel to approve automated operational use of data from a NTDS. In such an instance, all acceptance criteria are reviewed and discussed with the understanding that certain requirements, such as numerical validation or training (for AFSPC NTDS only), may be incomplete. Any data accepted in this manner is followed by a mandatory review and validation of the data by HQ AFSPC/A3/6Z and/or 18 SPCS within one month of OA of the data. To be considered for accelerated OA, all data feeds must be able to be disconnected from operational use, if directed. Data must also be compatible; if not, a prototyping environment might provide the only viable option for near-term use of the data.

6.2.4. Operational Acceptance Denial. If a NTDS is not operationally accepted, USSTRATCOM/J3, JFSCC/J3, 18 SPCS/CC, the sensor manager and/or NTDS Sponsor receives justification for the decision in writing. Any sensor not accepted for operational use may be resubmitted for TP once all relevant concerns have been addressed.

6.2.5. Early Operational Acceptance for rapidly emerging threats and critical operational needs is detailed in Section **2.21**.

6.3. Operational Acceptance Criteria. AFSPCI 10-605, *Operational Acceptance Process*, provides extensive detail regarding the OA process for AFSPC "traditional" materiel solutions.

For NTDS, several factors may be reviewed prior to operational inclusion in the SSN. In addition to a description of the sensor and supporting network architecture, the HQ AFSPC/A3/6 sponsor may request any of the following criteria be met, as appropriate for the individual sensor and planned utilization of data.

6.3.1. Stakeholder Concurrence. Stakeholders should reach a consensus on the value of the NTDS before deciding to integrate that source into SSA operations.

6.3.2. Tasking/Response/Priorities. Based on the stakeholders' conclusions about the utility of the new data source, they need to establish priorities on how the new source will be tasked.

6.3.3. Facilities (includes physical security). The appropriate facilities for handling the non-traditional data must be identified.

6.3.4. Communications paths. The communications paths over which the non-traditional data will be sent need to be identified.

6.3.5. Security Classification Guidance (as required). If the non-traditional data is classified, security classification guidance must be provided to describe what aspects of the data are classified and to whom this classified data may be released.

6.3.6. Personnel in place. If a new NTDS requires additional personnel to process the data for SSA operations, then these persons must be in place prior to TP.

6.3.7. Training Approach/Materials. Training approach and materials must be developed so that the data users know the appropriate way to use the data.

6.3.8. Procedures in place. This criterion refers to the interaction between the NTDS and CSpOC/18 SPCS and is satisfied when the procedures have been documented and integrated into the training systems at the end user and the NTDS (for AFSPC systems). Typical procedures include outage reporting, routine and event tasking, and voice reporting.

6.3.9. Test and Evaluation Planned/Accomplished (for AFSPC NTDS only). Developmental Test and Evaluation (DT&E) and Operational Test and Evaluation (OT&E) must have been performed to ensure the sensor and associated hardware and software is functioning as designed.

6.3.10. Equipment Cyber Authorization. This paragraph applies only to AFSPC sensors. After successful OT&E and DT&E have been completed, the equipment of the new sensor system or system upgrade will be certified and authorized as part of the Installation and Checkout (I&C) process. Cyber authorization includes an assessment of the data source to determine whether it has an acceptable level of risk given the security controls chosen and emplaced. Accreditation assumes the data coming from the system or source is trustworthy. According to the Risk Management Framework (RMF), designating a system as "accredited" is not sufficient. Once authorized, the system providing and receiving the data must be subject to Information Security Continuous Monitoring (ISCM) (Ref: NIST SP 800-137). Cybersecurity specialists must ensure continuous risk mitigation consistent with RMF safeguards to assure the confidentiality, integrity and availability of NTDS systems/products; and that the security of the interfaces to the SSN are assured through currently supported standards, processes and cybersecurity practices.

6.3.11. Data Compatibility Assessment (required). This assessment is performed to ensure the data can be received, translated and ingested for use in SSA operations. Prior to this assessment, specific NDPP plug-in software may have to be developed.

6.3.12. Data Quality Assessment (required). This assessment is performed to ensure the data is of sufficient accuracy and integrity to be of value to SSA operations and will not cause a degradation in operational performance.

6.3.13. Operational TP Success Criteria/Results. During TP, 18 SPCS will monitor the value of the data for the intended SSA operations and will identify any adverse effects the data might have. Significant results will be reported during the TPRP for TP exit consideration.

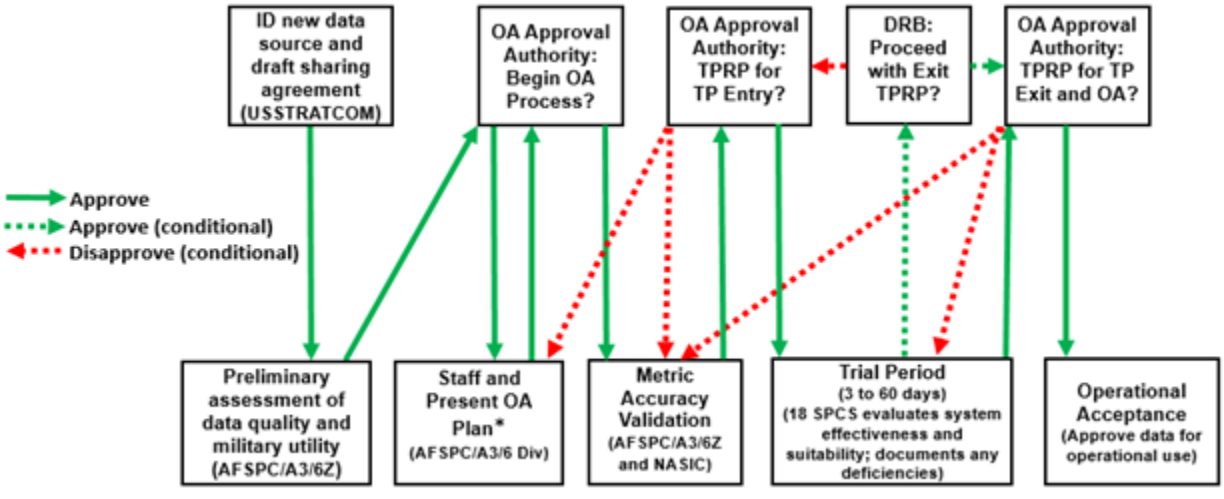
6.3.14. Long Term Sustainment/Funding Considered. Any long-term organic sustainment or sustainment funding will be identified if needed to maintain the software and hardware required to translate and process the NTDS data within SSA operations.

6.3.15. End-of-Data Plan. If the data becomes obsolete or no longer available (e.g., end of space-based mission life), a plan may be needed for how and when to turn off the data feed and to establish storage and archiving requirements.

6.4. OA Process Steps.

6.4.1. **Non-AFSPC NTDS Systems.** This section applies to new non-AFSPC NTDS systems or modifications made to these systems. The OA Process is used to verify data quality and operational use of non-AFSPC NTDS systems, and requires close coordination and working relationships between all stakeholders and the NTDS Sponsor. The responsible HQ AFSPC/A3/6 Division will execute the OA Plan for accepting the data. The OA Acceptance Authority is based on the authority level depicted in AFSPCI 10-605, Table 2.1. The steps and products developed for the OA Process described below may be tailored to meet the operational need for the data provided by the specific new system or system modification being implemented. Any of these steps may be repeated if the OA Approval Authority identifies deficiencies that must be addressed. **Figure 6.1.** (System View 1 for Operational Acceptance of a New or Modified Non-AFSPC System or Capability) outlines the following steps.

Figure 6.1. System View 1 for Operational Acceptance of a New or Modified Non-AFSPC System or Capability.



6.4.1.1. The first step for non-commercial NTDS is USSTRATCOM's identification of a new NTDS or NTDS system modification for integration with SSA data processing. For commercial data sources, a competitive bidding process will already have taken place.

6.4.1.2. USSTRATCOM then drafts a data-sharing agreement for non-commercial NTDS.

6.4.1.3. HQ AFSPC/A3/6Z conducts a preliminary assessment of the quality and military utility of the data.

6.4.1.4. The OA Plan and Employment Concept are drafted and staffed by the responsible HQ AFSPC/A3/6 Division.

6.4.1.5. The NTDS Sponsor identifies and documents any deficiencies. If there are no deficiencies, proceed to the verification and validation (V&V) of the observation data quality

6.4.1.6. Once all issues are resolved, the new NTDS system or system modification is ready for V&V of the astrometric and photometric accuracy and overall performance.

6.4.1.7. As required, HQ AFSPC/A3/6Z and NASIC validates the astrometric accuracy/performance and photometric accuracy/performance, respectively. Multiple sensors may be validated at one time if the sensors have similar characteristics.

6.4.1.8. If modifications to the SP-Tasker, new NDPP plug-ins or DCBR are required to accommodate the new NTDS, these will also be validated and documented by the responsible SPO.

6.4.1.9. The responsible HQ AFSPC/A3/6 division, in coordination with 18 SPCS and the NTDS Sponsor develops a TP entry briefing to include metric accuracy numerical validation results, operator training procedures for the use of the observations, changes to publications or technical orders related to the use of the data, information assurance actions, confidence factors, risk factors, and a process to disconnect an external data feed from operational use, if directed.

6.4.1.10. 18 SPCS in coordination with the NTDS Sponsor reviews TP entry criteria to determine readiness to enter TP.

6.4.1.11. HQ AFSPC/A3/6 convenes a TPRP for the OA Approval Authority's TP entry decision.

6.4.1.12. OA Approval Authority approves (or disapproves) TP entry. If approved, TP entry approval is provided via memorandum.

6.4.1.13. Conduct TP.

6.4.1.14. The NTDS Sponsor and 18 SPCS identify and document any deficiencies.

6.4.1.15. Convene Deficiency Review Board (DRB) as required so that stakeholders may review any deficiencies identified during TP.

6.4.1.16. Once all issues are resolved, HQ AFSPC/A3/6 convenes a TPRP for TP exit and OA decision to accept or reject the data source.

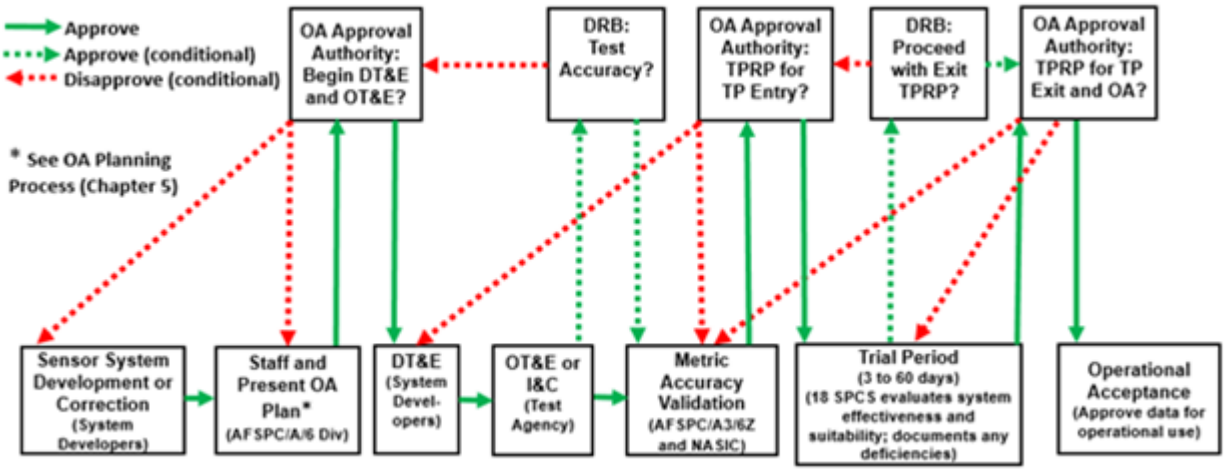
6.4.1.17. Brief TP results to OA Approval Authority.

6.4.1.18. OA Approval Authority approves (or disapproves) TP exit and OA of the new nonAFSPC NTDS system or system modification.

6.4.1.19. **Attachment 6** provides an example of a TP entry memo and a TP exit memo.

6.4.2. **New AFSPC NTDS Systems or Capabilities.** The steps and products developed for the OA process described below may be tailored to meet the operational need for the specific capability being integrated for operational use. These steps begin after the new system or capability has been developed. The OA Acceptance Authority for these modifications is based on the authority level depicted in AFSPCI 10-605, Table 2.1. The responsible HQ AFPSC/A3/6 Division will execute the OA Plan for accepting the new AFSPC NTDS system. Any of these steps may be repeated if the OA Approval Authority identifies deficiencies that must be addressed. **Figure 6.2.** outlines the following steps.

Figure 6.2. System View 2 for Operational Acceptance of a New AFSPC NTDS System or Capability.



6.4.2.1. The NTDS SPO, together with the SMEs and POCs identified in Section **5.1.**, staffs the OA Plan and Employment Concept with requisite stakeholders. These are typically various agencies within the data user community who have an interest in integrating the new system or capability into SSA operations.

6.4.2.2. Present OA Plan to the OA Approval Authority. If approved, proceed to test and evaluation processes.

6.4.2.3. The system developers perform DT&E.

6.4.2.4. Generally, an independent test agency performs OT&E and Installation and Checkout (I&C).

6.4.2.5. Convene DRB as required to review, prioritize, and document status. Once all issues are resolved, the new system/capability is ready for validation of astrometric and photometric accuracy and overall performance.

6.4.2.6. As required, HQ AFSPC/A3/6Z and NASIC validate the astrometric accuracy/performance and photometric accuracy/performance, respectively.

6.4.2.7. The NTDS SPO, in coordination with 18 SPCS and requisite stakeholders, develops the TP entry briefing to include DT&E, OT&E, I&C and metric accuracy numerical validation results, operator training procedures, changes to publications or technical orders, cyber security actions, confidence factors, risk factors, and a process to disconnect an external data feed from operational use, if directed.

6.4.2.8. The NTDS SPO, in coordination with 18 SPCS and requisite stakeholders, reviews TP entry criteria to determine readiness to enter TP.

6.4.2.9. HQ AFSPC/A3/6 convenes a TPRP for OA Approval Authority's TP entry decision.

6.4.2.10. OA Approval Authority approves (or disapproves) TP entry. If approved, TP entry approval is provided via memorandum.

6.4.2.11. Conduct TP.

6.4.2.12. The NTDS SPO and 18 SPCS identify and document any deficiencies.

6.4.2.13. Convene a DRB as required so that stakeholders may review any deficiencies identified during TP.

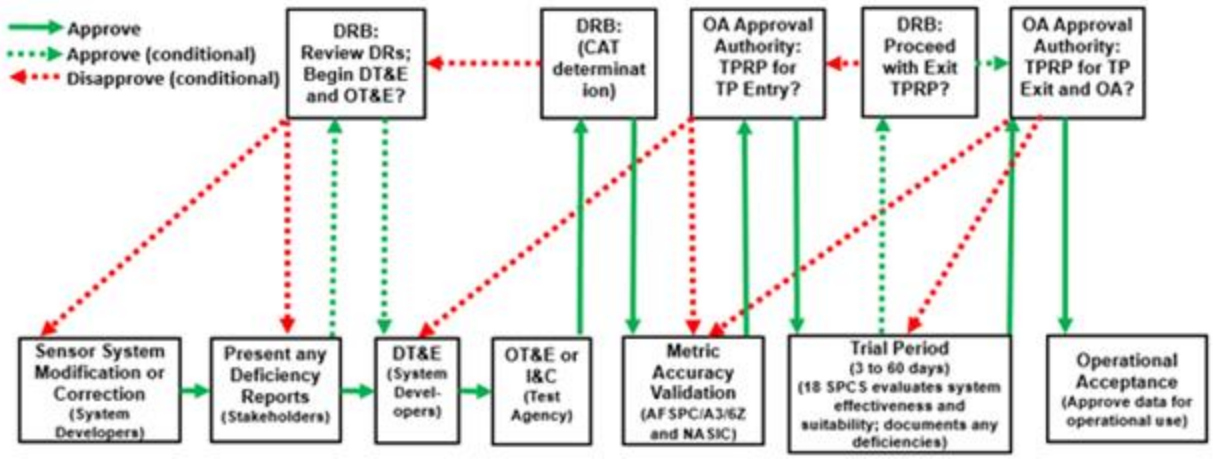
6.4.2.14. Once all issues are resolved, HQ AFSPC/A3/6 convenes a TPRP for TP exit and OA decision.

6.4.2.15. Brief TP results to OA Approval Authority.

6.4.2.16. OA Approval Authority approves (or disapproves) TP exit and OA of new system or capability.

6.4.3. AFSPC NTDS System Modifications. The OA Process is also used to verify data quality and operational use after modifications have been made to fielded systems, and requires close coordination and working relationships between all stakeholders and the operational unit. The OA Acceptance Authority for these modifications is based on the authority level depicted in AFSPCI 10-605, Table 2.1. The responsible HQ AFPSC/A3/6 Division will execute the OA Plan for accepting the modified AFSPC NTDS system. The steps and products developed for the OA Process described below may be tailored to meet the operational need for the specific modification being implemented. Any of these steps may be repeated if the OA Approval Authority or DRB identifies deficiencies that must be addressed. **Figure 6.3** outlines the following steps.

Figure 6.3. System View 3 for Operational Acceptance of a Modified AFSPC NTDS System or Capability.



6.4.3.1. The appropriate SPO identifies and documents any deficiencies. If there are no deficiencies, proceed to the test and evaluation processes.

6.4.3.2. Convene a DRB as required to review any deficiency reports. Once all deficiencies are suitably resolved, proceed to the test and evaluation processes.

6.4.3.3. The system developers perform DT&E.

6.4.3.4. Generally, an independent test agency performs OT&E and I&C.

6.4.3.5. Convene a DRB to review, prioritize, and document status. Once all issues are resolved, the system modification is ready for validation of astrometric and photometric accuracy and overall performance.

6.4.3.6. As required, HQ AFSPC/A3/6Z and NASIC validates the astrometric accuracy/performance and photometric accuracy/performance, respectively.

6.4.3.7. 18 SPCS in coordination with the NTDS SPO develops a TP entry briefing to include DT&E, OT&E, I&C and metric accuracy numerical validation results, operator training procedures, changes to publications or technical orders, information assurance actions, confidence factors, risk factors, and a process to disconnect an external data feed from operational use, if directed.

6.4.3.8. 18 SPCS in coordination with the NTDS SPO reviews TP entry criteria to determine readiness to enter TP.

6.4.3.9. HQ AFSPC/A3/6 convenes a TPRP for the OA Approval Authority's TP entry decision.

6.4.3.10. OA Approval Authority approves (or disapproves) TP entry. If approved, TP entry approval is provided via memorandum.

6.4.3.11. Conduct TP.

6.4.3.12. The NTDS SPO and 18 SPCS identify and document any deficiencies.

6.4.3.13. Convene DRB as required so that stakeholders may review any deficiencies identified during TP.

6.4.3.14. Once all issues are resolved, HQ AFSPC/A3/6 convenes a TPRP for TP exit and OA decision.

6.4.3.15. Brief TP results to OA Approval Authority.

6.4.3.16. OA Approval Authority approves (or disapproves) TP exit and OA of system modification.

DEANNA M. BURT
Brigadier General, USAF
Director of Operations and Communications

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

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AFI 99-103, *Capabilities-Based Test and Evaluation*, 6 Apr 17

AFSPCI 10-605, *Operational Acceptance Process*, 20 Jun 16

AFMAN 33-363, *Management of Records*, 1 Mar 08

National Institute of Standards and Technology (NIST) Special Publication (SP) 800-137, *Information Security Continuous Monitoring (ISCM) for Federal Information Systems and Organizations*, Sep 2011

TO 00-35D-54, *USAF Deficiency Reporting, Investigating and Resolution*, 1 Sep 15

Space Situational Awareness (SSA) Operating Concept, 2017

USSTRATCOM Space Situational Awareness (SSA) Non-Traditional Data Integration Concept of Operations, 22 May 2018

USSTRATCOM Instruction 535-01, *System Certification Process*

Adopted Forms

Air Force Form 847, *Recommendation of Change of Publication*

Air Force Form 1067, *Modification Proposal*

SPADOC Form 023, *Database Change Request*

Abbreviations and Acronyms

14 AF—14th Air Force

18 SPCS—18th Space Control Squadron

21 OG—21st Operations Group

21 SW—21st Space Wing

50 SW—50th Space Wing

614 AOC—614th Air and Space Operations Center

A3/6—Directorate of Operations and Communications (AFSPC)

A3/6S—Global Space Operations Division (AFSPC)

A3/6W—Space Superiority Operations Division (AFSPC)

A3/6Z—Operational Assessments Division (AFSPC)

A4—Directorate of Logistics, Installations and Mission Support (AFSPC)

A5/9—Directorate of Strategic Requirements, Architectures and Analysis (AFSPC)

AFB—Air Force Base

AFI—Air Force Instruction

AFIN—Air Force Information Network

AFLCMC—Air Force Life Cycle Management Center

AFMAN—Air Force Manual

AFRIMS—Air Force Records Information Management System

AFSPC—Air Force Space Command

AFSPCI—Air Force Space Command Instruction

AOC—Air and Space Operations Center

A_p—Daily Geomagnetic Index

a_p—3-hourly Geomagnetic Index

ASCII—American Standard Code for Information Interchange

ASW—Astrodynamics Support Workstation

Az—azimuth (angle)

BMC2—Battle Management Command and Control

C2—Command and Control

C4—Command, Control, Communications and Computers

CAT—Category

CAVENet—Correlation, Analysis and Verification of Ephemerides Network

CDDIS—Crustal Dynamics Data Information System

CDR—Commander

CDRUSSTRATCOM—Commander United States Strategic Command

CIO—Conventional International Origin

COCOM—Combatant Command

CONOPS—Concept of Operations

COP—Common Operating Picture

CSpOC—Combined Space Operations Center (formerly known as JSpOC)

CTL—Consolidated Tasking List

dBsm—decibel square meters

DCE—Distributed Computing Environment

Dec—declination (angle)

Det 1—Detachment 1 (18 SPCS)

DISOB—Defense Intelligence Space Order of Battle

DMSP—Defense Meteorological Satellite Program

DoD—Department of Defense

DR—Deficiency Report

DRB—Deficiency Review Board

DT&E—Developmental Test and Evaluation

DUT1—Delta Universal Time 1

ECEF—Earth-Centered Earth-Fixed

ECI—Earth-Centered Inertial

ECR—Earth-Centered Rotating

EFG—Earth-Fixed Greenwich

EGM—Earth Gravitational Model

El—elevation (angle)

Elset—Element Set

EOSSA—Electro-Optical Space Situational Awareness

ESBMC2—Enterprise Space Battle Management Command and Control

ETRO—Estimated Time to Return to Operations

$F_{10.7}$—Solar radio flux at 10.7 cm wavelength; measured in solar flux units (sfu)

F3I—Form, Fit, Function, Interface

FOC—Full Operational Capability

FOR—Field Of Regard

FOV—Field of View

FRP—Full Rate Production

GEO—Geosynchronous Earth Orbit

GOC—Global Operations Center

GPS—Global Positioning System

HAC—High Accuracy Catalog

HAE—Height Above Ellipsoid

HAF—Headquarters Air Force

HAF/A3—Headquarters Air Force, Operations Directorate

HAMR—High Area-to-Mass Ratio

HASDM—High Accuracy Satellite Drag Model

HQ—Headquarters

Hz—hertz (frequency)

I&C—Installation and Checkout

IAW—In Accordance With

ID—Identification

IERS—International Earth Rotation and Reference Systems Service

ILRS—International Laser Ranging Service

IR—Infrared

ISCM—Information Security Continuous Monitoring

ITRF—International Terrestrial Reference Frame

J3—Directorate of Global Operations (USSTRATCOM and JFSCC)

J35—Future Operations Division (JFSCC)

J5—Directorate of Plans and Policy (USSTRATCOM)

J51—Space Situational Awareness Sharing Division (USSTRATCOM)

J6—Directorate of C4 Systems (USSTRATCOM)

J65—Systems Certification Division (USSTRATCOM)

JFCC—Joint Functional Component Command

JFSCC—Joint Force Space Component Command

JIPOE—Joint Intelligence Preparation of the Operational Environment

JSpOC—Joint Space Operations Center (former name of CSpOC)

km—kilometer(s)

km/s—kilometers per second

LEO—Low Earth Orbit

LLR—Lunar Laser Ranging

LRDR—Long Range Discrimination Radar

MAJCOM—Major Command

MEME—Mean Equator / Mean Equinox

MOA—Memorandum of Agreement

MOU—Memorandum of Understanding

MPS—Mission Processing System

MUA—Military Utility Assessment

N/A—Not Applicable

NAF—Numbered Air Force

NASA—National Aeronautics and Space Administration

NASIC—National Air and Space Intelligence Center

NDPP—Nontraditional Data Preprocessor

NGA—National Geospatial-Intelligence Agency

NIST—National Institute of Standards and Technology

NORAD—North American Aerospace Defense Command

NTDS—Non-Traditional Data Source(s)

OA—Operational Acceptance

ob—observation

obs—observations

OCR—Office of Collateral Responsibility

OD—Orbit Determination

OPR—Office of Primary Responsibility

OPSCAP—Operations Capability

OSD—Office of the Secretary of Defense

OSF—Open Software Fondation

OT&E—Operational Test and Evaluation

PEO—Program Executive Office(r)

PMO—Program Management Office

POC—Point of Contact

PPBE—Planning, Programming, and Budgeting Execution

RA—right ascension (angle)

RCS—Radar Cross Section

RDS—Records Disposition Schedule

RMS—Root Mean Square

RSO—Resident Space Object

SCA—Space Coordinating Authority

SE—Safety Office (AFSPC)

sfu—solar flux unit(s); 1 sfu = 10^{-22}watt $m^{-2}Hz^{-1}$

SIPB—Space Intelligence Preparation of the Battlefield

SIPRNet—Secure Internet Protocol Routing Network

SLR—Satellite Laser Ranging

SMC—Space and Missile Systems Center

SME—Subject Matter Expert

SOI—Space Object Identification

SP—Special Perturbations

SP—Special Publication

SPADATS—Space Detection And Tracking System

SPADOC—Space Defense Operation Center (computer system)

SPDC—Special Perturbations Differential Correction

SP-Tasker—Special Perturbations Tasker

SSA—Space Situational Awareness

SSN—Space Surveillance Network

SST—Space Surveillance Telescope

SW—Space Wing

TBD—To Be Determined

TDR—True of Date Rotating

TDRSS—Tracking & Data Relay Satellite System

TDT—Terrestrial Dynamical Time

TEME—True Equator / True Equinox

TP—Trial Period

TPRP—Trial Period Review Panel

UCT—Uncorrelated Target

UHF—Ultra High Frequency

US—United States

USAF—United States Air Force

USG—United States Government

USSTRATCOM—United States Strategic Command

UTC—Coordinated Universal Time

UUID—Universally Unique Identifier

VHF—Very High Frequency

WGS—World Geodetic Survey

XML—Extensible Markup Language

Terms

Acceptance for Operational Use—A deliberate decision by AFSPC/CC (or delegate) to accept use of a new or modified system capability from a NTDS in order to authorize it as an operational capability.

Acquisition—The conceptualization, initiation, design, development, testing, contracting, production, deployment, and disposal of a directed and funded effort that provides a new, improved, or continued materiel, weapon, information system, logistics support, or service capability in response to an approved need.

Capability—The ability to achieve a desired effect under specified standards and conditions through combinations of ways and means to perform a set of tasks. It is defined by an operational user or through joint Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities, and Policy (DOTMLPF-P) construct.

Collateral Sensor—A sensor assigned to USSTRATCOM, but with a primary mission other than SSN support

Contributing Sensor—A sensor not assigned to USSTRATCOM that is under contract or agreement to support the SSN

Conventional International Origin (CIO)—A conventionally defined reference point fixed to Earth's surface corresponding to the rotational pole's average location on Earth's surface over the year 1900. The time-varying position of Earth's rotational axis is typically measured relative to the CIO.

Dedicated Sensor—A sensor assigned to USSTRATCOM with a primary mission of SSN support

Deficiency—The degree of inability to successfully accomplish one or more mission tasks or functions required to achieve mission or mission area objectives. In contract management – any part of a proposal that fails to satisfy the government's requirements (Defense Acquisition Acronyms and Terms).

Deficiency Report (DR)—Report governed by TO-00-35D-54, USAF Deficiency Reporting, Investigation, and Resolution, that documents deficiencies.

Deficiency Review Board (DRB)—The DRB provides a forum for capturing, documenting, and discussing deficiencies encountered during the test and trial period phases of program. The DRB evaluates anomalous system behavior, assigns (or updates) a problem category and subcategory IAW TO-00-35D-54, USAF Deficiency Reporting, Investigation, and Resolution.

Developmental Test and Evaluation (DT&E)—Test and evaluation conducted to evaluate design approaches, validate analytical models, quantify contract technical performance and manufacturing quality, measure progress in system engineering design and development, minimize design risks, predict integrated system operational performance (effectiveness and suitability) in the intended environment, and identify system problems (or deficiencies) to allow for early and timely resolution.

Earth-Centered Earth-Fixed (ECEF)—The Cartesian coordinate frame defined by the prime meridian and the Conventional International Origin (CIO), which is a fixed point on Earth's crust about which Earth's true rotational pole wanders. The x-coordinate is from the geocenter to the point where Earth's prime meridian crosses the plane perpendicular to the CIO. The z-axis is from the geocenter to the CIO, and the y-axis completes the x-y-z right-handed coordinate frame. At Air Force Space Command, this coordinate frame is often referred to as the Earth-Centered Rotating (ECR) coordinate frame.

Earth-Centered Inertial (ECI)—The Cartesian coordinate frame defined by the celestial equator, celestial pole, and the vernal equinox direction. In CSpOC operations, the standard ECI coordinate frame for Special Perturbations (SP) orbit integration is defined by the mean equator and mean equinox for January 1st 12:00 Terrestrial Dynamical Time (TDT) in the year 2000. This frame is known as the mean equator/mean equinox (MEME) coordinate frame for the J2000.0 epoch. Another standard used for outputting Special Perturbations (SP) ephemerides is a similar coordinate frame where the celestial equator has been precessed and nutated (true equator) to the date/time corresponding to each output ephemeris point. This coordinate frame uses the mean equinox of the date/time of interest and is referred to as the true equator/mean equinox (TEME) of date coordinate frame. The x-axis is from the geocenter to the mean equinox, the z-axis is from the geocenter to Earth's rotational pole (mean pole for MEME or true pole for TEME as appropriate), and the y-axis completes the x-y-z right-handed coordinate frame. MEME coordinate frames corresponding to other epochs are also used.

Earth-Centered Rotating (ECR)—This is another term for ECEF. ECR is more commonly used than ECEF at Air Force Space Command.

Earth-Fixed Greenwich (EFG)—This rotating coordinate frame is similar to the ECEF frame except that the z-axis is defined from the geocenter to Earth's true rotational pole (not the CIO), the xaxis lies at the intersection of the Earth's prime meridian and the true equator, and the yaxis completes the x-y-z right-handed coordinate frame. The EFG frame may be transformed to/from the ECEF frame by applying/removing polar motion whose magnitude changes dynamically and has a maximum value of ~20 meters at Earth's surface. This magnitude is the distance of the true rotational pole from the CIO. The EFG frame may be transformed to/from the ECI TEME of date frame by removing/applying the Greenwich Hour Angle of the prime meridian east of the mean equinox which specifies the orientation of Earth about its rotational axis (z-axis).

Equinox—The direction in the sky where the ecliptic intersects the celestial equator. The mean equinox is the intersection with the mean celestial equator; the true equinox is the intersection with the true celestial equator.

Fielding—Occurs when supported and supporting commands collaboratively plan and execute the delivery and bed-down of an operationally effective and suitable platform or system, or a major system modification/upgrade, from a total system capability perspective, that is sustainable over its planned life cycle.

Field of Regard (FOR)—The total area that can be captured by a sensor. A sensor with no viewing limits may have FOR that includes everything above the horizon. Some sensors have identical FOV and FOR coverage.

Field of View (FOV)—The area that can be captured by a sensor at a particular instant. For a dish radar this may be the beam width of the transmitter, or for a telescope it is usually referenced as degrees of optical coverage that can be captured in one exposure.

High Accuracy—This term refers to products derived from the use of special perturbations (SP) model parameters and numerical integration techniques.

Interface—Involves the common boundary where two or more assets converge and act upon one another (i.e., communicate, transfer data, etc.). Interface may also include the physical, electronic, electrical, functional, and/or the human-system integration characteristics two or more assets must exhibit in order to create a functional system.

Life Cycle—The span of time associated with a system, subsystem, or end item that begins with the conception and initial development of the requirement, continues through development, acquisition, fielding, and sustainment until the time it is either consumed in use or disposed of as being excess to all known materiel requirements.

Metric—Metric data or metric observations typically refer to time-tagged position and/or velocity measurements (i.e. right ascension (RA), Declination (Dec), RA Rate and Dec Rate) and time-tagged position, velocity and/or acceleration measurements (i.e. Azimuth (Az), Elevation (El), Range, Az Rate, El Rate, Range Rate, and Range Acceleration). Metric data can also include photometric brightness data (i.e. apparent visual magnitude) and size data (i.e. radar cross section). Metric data does not include space object identification data such as imagery or signature information.

Modification—For the purposes of this instruction, a modification is defined as a change to the form, fit, function, or interface (F3I) of an in-service, configuration-managed Air Force asset. Modifications are primarily defined by their purpose. A capability modification alters the F3I of an asset in a manner that requires a change to the existing system, performance, or technical specification of the asset. Such modifications are generally accomplished to add a new capability or function to a system or component, or to enhance the existing technical performance or operational effectiveness of the asset. A sustainment modification alters the F3I of an asset in a manner that does not change the existing system, performance, or technical specification of the asset. Such modifications are generally accomplished to correct product quality deficiencies, or to bring the asset in compliance with, or to maintain the established technical or performance specification(s) associated with the asset. Sustainment modifications may also include efforts that are accomplished for the primary purpose of improving the reliability, availability, maintainability, or supportability of an asset, or to reduce its ownership costs.

Non-Traditional Data Source (NTDS)—A sensor or other data source that provides SSA data but differs from traditional space surveillance sensors or sources in at least one of several distinct factors; these include but are not limited to communication pathways, data types, data structure, measurement accuracy, timeliness, availability, compliance with Air Force instructions, acquisition differences, country or agency with ownership and maintenance, configuration control, and compliance with nominal operational acceptance processes. Paragraph **1.3** provides an in-depth definition of NTDS.

Operational Acceptance (OA)—The final decision point in the Operational Acceptance Process when the Approval Authority declares the new system, new capability or modification of a fielded system is able to support its operational mission and is ready for presentation to the Combatant

Command if required. OA signifies that the new system, new capability, or modification to an existing system meets operational mission requirements, that necessary resources and support are in place, and that system and capability risks are acceptable to employ it as an operational capability. It is the point in time at which operational responsibility and maintenance support officially transfers to AFSPC as lead Major Command (MAJCOM) and to the operational organization that will operate and maintain the system.

Operational Test and Evaluation (OT&E)—Test and evaluation conducted in as realistic an operational environment as possible to estimate the prospective system's operational effectiveness and operational suitability. In addition, operational test and evaluation provides information on organization, personnel requirements, doctrine and tactics. In turn, it also provides data to support or verify material in operating instructions, publications, and handbooks.

Operational Transition—Formal process executed by the operational community that culminates in an operational acceptance decision of a new acquisition or modification of a fielded system, ensuring it meets the minimum requirements and can efficiently, effectively, and safely support mission operations.

Risk—A measure of future uncertainties in achieving program performance goals within defined cost and schedule constraints. It has three components: a future root cause, a likelihood assessed at the present time of that future root cause occurring, and the consequence of that future occurrence.

Risk Analysis—The activity of examining each identified risk to refine the description of the risk, isolate the cause, and determine the effects and aiding in setting risk mitigation priorities. It refines each risk in terms of its likelihood, its consequence, and its relationship to other risk areas or processes.

Space Object Identification (SOI)—A sub-discipline within SSA in which radar, imaging and other collection resources are used to determine, size, shape, orientation, motion characteristics and identity of space objects.

Space Situational Awareness (SSA)—The requisite current and predictive knowledge of space events, threats, activities, conditions, and space system (space, ground and link) status, capabilities, constraints and employment – current and future, friendly and hostile – to enable commanders, decision-makers, planners and operators to gain and maintain space superiority across the spectrum of conflict. SSA is the cornerstone of space operations, all-inclusive of space force enhancement, space support and space control.

Space Surveillance Network (SSN)—The worldwide network of space surveillance sensors, communications and data processing/command and control centers.

Stakeholders—Individual or organizational entities (users, developers, acquirers, technologists, testers, budgeters, sustainers, and industry) that are, or will be, associated with implementing and supporting the associated system, subsystem, or end-item capability requirements.

Sustainment—Continuing materiel support which consists of the planning, programming, and execution of a logistics support strategy for a system, subsystem, or major end item to maintain operational capabilities from OA through disposal.

System—Any organized assembly of resources and procedures united and regulated by interaction or interdependence to perform a set of specific functions.

Uncorrelated Target (UCT)—Any space object detected in orbit that cannot be correlated with the orbital elements of any other object in a sensor site's database.

Attachment 2

SPACE SURVEILLANCE DATA REPORTING GUIDELINES

Table A2.1. Metric Observation Report Contents.

TOPIC	Recommendation	Allowable Exceptions	Remarks
***** Requirements listed in bold *****			
A.2.1. Metric Observations			
A.2.1.1. Core Metric Components			
Recommendations listed in this section pertain to traditional data sources as well as NTDS.			
A.2.1.1.1. Sensor Identification	AFSPC-assigned sensor number	Any unique alpha-numeric identifier.	All sensors are assigned a unique numeric identifier. Providers that do not use the 18 SPCS sensor number may assign their own unique identifier for the sensor. NDPP uses this identifier to map to the corresponding 18 SPCS sensor number. Data providers may request a dedicated sensor number by contacting HQ AFSPC/A3/6Z. Some radars are capable of transmitting in multiple frequency bands. In these cases it may be necessary to assign multiple sensor numbers to represent observations collected in disparate bands.

TOPIC	Recommendation	Allowable Exceptions	Remarks
***** Requirements listed in bold *****			
A.2.1.1.2. Satellite Identification	NORAD Satellite Number. Unknown objects, i.e. uncorrelated targets (UCTs), may use any 9xxxx number.	Using the International Designator is acceptable, but may require additional processing and cause unnecessary delay. Unknown objects should be listed as "UNKNOWN".	The NORAD Satellite Number is currently a 5-digit integer. In order to allow expansion of the catalog beyond 5 digits, systems will now be expected to support 9-digit satellite numbers. Satellite common name is not a unique identifier and should not be used.

TOPIC	Recommendation	Allowable Exceptions	Remarks
***** Requirements listed in bold *****			
A.2.1.1.3. Time	Time Standard: **Coordinated Universal Time (UTC)** Fields: **-Year (4 digits)** **-Day of Year (3 digits)** **-Hour** **-Minute** **-Seconds** Time Tagging for Radar: **Time tag of the observation must correspond to the midpoint between pulse transmit and pulse receive times.** Time Tagging for Optical: **Time tag of the observation must correspond to the instant the photons arrive at the sensor.**	Month and day may be substituted for day of year. 2-digit year may be substituted for 4-digit year Seconds may be reported as a floating point value or as separate integers representing seconds, milliseconds and/or microseconds (if applicable). Time precision may be reported to any level between milliseconds and microseconds.	Leap Seconds: **Considerations must be made for handling leap seconds. If a system is live when a leap second is applied, it must account for the change instantaneously.** Optical Considerations: Optical systems reporting in Az/El are not properly handled by the C2 system due to the light-time correction issue. C2 assumes Az/El measurements are only used for radar systems. Likewise, RA/Dec systems are always assumed to be optical. Certain electro-optical laser ranging systems may report in Az/El only if the time tag conforms to the radar requirement (midpoint of transmit/receive).

TOPIC	Recommendation	Allowable Exceptions	Remarks
***** Requirements listed in bold *****			
A.2.1.1.4. Angle Measurements	<u>Radar Systems</u>: Azimuth (Az) and Elevation (El) <u>Optical Systems</u>: **Right Ascension (RA) and Declination (Dec)** <u>Preferred units</u>: Degrees	<u>Alternative units</u>: - Radians - Degrees, Minutes, Seconds - Hours, Minutes, Seconds	Angle measurements from radar are optional only if range and/or range rate measurements are of sufficient quality to obviate the need for angle measurements. Allowable radar reporting options are: - Az/El/Range/Range-rate - Angles only - Range only - Range-rate only Az/El measurements are topocentric and relative to the surveyed location of the computational center of the sensor. RA/Dec measurements are referenced to the astronomical celestial sphere.

TOPIC	Recommendation	Allowable Exceptions	Remarks
***** Requirements listed in bold *****			
A.2.1.1.5. Range Measurements	<u>Radar</u>: Distance to target, preferred units are kilometers (km) <u>Optical</u>: N/A	Alternative Units: Any common unit of length	Range measurements from radar are optional only if angle or range rate measurements are of sufficient quality to obviate the need for range measurements. Allowable radar reporting options are: - Az/El/Range/Range-rate - Angles only - Range only - Range-rate only Electro-optical laser ranging systems should report data according to radar specifications (e.g., Az/El/range with radar equivalent time tagging)

TOPIC	Recommendation	Allowable Exceptions	Remarks
***** Requirements listed in bold *****			
A.2.1.1.6. Range-Rate Measurements	<u>Radar</u>: Velocity relative to range vector, preferred units are kilometers/second (km/s) <u>Optical</u>: N/A	Alternative Units: Any common units for velocity	Range-rate measurements from radar are optional. If reported, range-rate should be a measured value (i.e. do not report if computed from range and time measurements) Allowable radar reporting options are: - Az/El/Range/Range-rate - Angles only - Range only - Range-rate only

TOPIC	Recommendation	Allowable Exceptions	Remarks
***** Requirements listed in bold *****			
A.2.1.1.7. Equinox (only applies to optical observations)	**Allowable Optical Coordinate Frames (with equinox indicator numbers 0, 1 and 2):** **0: True Equator /Mean Equinox (TEME) corresponding to the date/time of observation (obs)** **1: Mean Equator /Mean Equinox (MEME) at Jan 0.0 of the year obs were collected (i.e. Dec 31 00:00 TDT of previous year)** **2: MEME at 2000.0 (i.e. 1999 Dec 31 00:00 TDT) (2000.0 ≈ J2000.0)**	Equator and equinox may be assigned as a static value associated with the sensor identification (ID) and does not need to be reported with each metric observation. Alternatively, equator and equinox may be specified in the metric observations in either the header, footer, or as part of the metric observation string using any clear alpha numeric identifier.	The standard J2000.0 reference frame corresponds to MEME at 12:00 Terrestrial Dynamical Time* on January 1st of the year 2000. The difference (36 hours) between 2000.0 (1999 Dec 31 00:00 TDT) and J2000.0 is negligible with respect to the effects of precession and nutation. Sensors reporting in J2000.0 do not need to correct for this difference. *Note: Terrestrial Dynamical Time (TDT) was formerly called Ephemeris Time (ET) and is 32.184 seconds ahead of International Atomic Time (TAI)

TOPIC	Recommendation	Allowable Exceptions	Remarks
***** Requirements listed in bold *****			
A.2.1.1.8. Classification	UNCLASSIFIED is assumed if classification is not provided. Preferred convention: U=Unclassified S=Secret	Alternative labels may be used to identify classification only if they are sufficiently clear (e.g., SECRET or UNCLASSIFIED).	Current C2 systems and the NDPP are limited to UNCLASSIFED and SECRET observations. The UNCLASSIFIED interface with the NDPP is through Space-Track.org SECRET interfaces with the NDPP require SIPRNet connectivity.
A.2.1.1.9. Sensor Position (only applies to mobile/orbiting sensors)	Mobile sensors must report their location corresponding to the moment the observation is time tagged. Report sensor position in EFG Cartesian coordinates (see glossary for definition). Preferred units: kilometers (km) Preferred accuracy: <5 meters error.	Alternate units may be provided as long as they are clearly identified.	**Sensor position is required for mobile sensors.** Sensors with fixed locations do not need to report sensor location with each observation since the location files are stored in an internal 18 SPCS database.

TOPIC	Recommendation	Allowable Exceptions	Remarks
***** Requirements listed in bold *****			
A.2.1.2. Optional Metric Components			
A.2.1.2.1. Track Indicator	Flag to identify position of a particular observation (obs) within a track consisting of multiple observations. Preferred convention: 2 = Single observation, no other obs in track 3 = First obs of track 4 = Obs from middle of track 5 = Last obs of track	Other descriptors may be acceptable as long as they clearly define start, middle, and end of track.	Track indicator is not a required component and does not impact processing; however, it can be useful for analysis, particularly for SSN network forensics and other studies.

TOPIC	Recommendation	Allowable Exceptions	Remarks
***** Requirements listed in bold *****			
A.2.1.2.2. Radar Cross Section (RCS)	RCS may be reported if it is collected during the track. Preferred convention: Decibels normalized to one square meter (dBsm)	RCS may be reported in other units as long as it is clearly defined.	RCS is an optional field but can be extremely useful for event forensics and other analyses. It may also be used by the 18 SPCS tasking algorithm to optimize network task requests (by only tasking sensors that have sufficient sensitivity for detection). **Only report RCS if it is actually measured.** Values from the Satellite Catalog or other sources should not be reported as part of the observation.
A.2.1.2.3. Visual Magnitude	Apparent visual magnitude may be reported if it is collected during the track.	N/A – apparent visual magnitude is a standardized unitless measurement.	Visual magnitude is an optional field but can be extremely useful for event forensics and other analyses. It may also be used by the 18 SPCS tasking algorithm to optimize network task requests (by only tasking sensors that have sufficient sensitivity for detection). **Only report visual magnitude if it is actually measured.**

Table A2.2. Track Formation.

Category	Guidelines	Remarks
A.2.2. Track Composition		
A.2.2.1. Number of Observations per Track	Tasked Sensors: Sensors tasked by the 18 SPCS should respond according to the applicable category and suffix definitions or through a Memorandum of Agreement (MOA). Radar or Optical: Minimum of 3 observations per track.* Maximum for routine tracking is 10 observations. Maximum for high interest objects is 50 observations per track, but tracks may be scheduled back-to-back to maintain persistent coverage. This level of tracking should be limited to situations where it is explicitly requested by the 18 SPCS.	Observation quality may vary as an object passes through the sensor field of view. Whenever possible, the sensor should attempt to collect the track through the portion of coverage that produces the best quality. Sensors should attempt to sample different portions of an objects orbit in different tracking attempts (e.g., do not track a GEO object at the same time every day). Track composition exceptions granted per AFSPC and 18 SPCS direction.

Category	Guidelines	Remarks
A.2.2.2. Spacing of Observations	Near Earth Sensors: Minimum of 6 seconds.* Deep Space Sensors: Minimum of 30 seconds.*	Exceptions granted per 18 SPCS and AFSPC direction.
A.2.2.3. Track Spacing	Tracks should typically be separated by a minimum of 10 minutes, unless otherwise directed by the CSpOC (e.g., persistent coverage scenarios).	Exceptions granted per 18 SPCS and AFSPC direction.
A.2.2.4. Observation Thinning and Smoothing	Smoothing and thinning algorithms may need to be applied if the sensor's observation production rates exceed those listed in this table.	A common example is Kalman filtering which is often applied to radar tracking data in order to convert noisy high density pulse-by-pulse data into a smoothed track that meets the recommended track composition guidelines. Exceptions granted per 18 SPCS and AFSPC direction.

Table A2.3. Phenomenology Corrections.

Category	Required / Optional	Remarks
A.2.3. Corrections		

Category	Required / Optional	Remarks
A.2.3.1. Atmospheric Corrections	Radar: **Required for radar operating within affected frequencies.** Optical: **Required for affected optical systems.**	Due to atmospheric refraction and pulse delay, most lower-frequency radars (e.g., UHF/VHF) must apply ionospheric corrections prior to transmitting metric data to 18 SPCS. The atmosphere primarily affects range measurements, but also affects angular components to a lesser extent. In many cases the corrections may require dynamic adjustments over 24-hour intervals in order to account for diurnal changes in the total electron content. Additional corrections may need to be applied to various sectors of sensor coverage depending on the variability of the measured data. Higher frequency sensors (S-band and above) are typically less susceptible to ionosphere-induced error and may not need to be corrected for ionospheric refraction. However, they are still susceptible to troposphere-induced error. Atmospheric corrections should be applied in such a manner that the sensor accuracy stays within the sensor accuracy requirements outlined in this AFSPCI. Level 1 and Level 2 systems should continue to meet the requirement through all diurnal cycles and through periods of high solar and geomagnetic activity. Most optical systems utilizing in-frame metrics do not need to apply tropospheric refraction correction. This is because the calibration stars are being refracted along with the observed Earth-orbiting space objects.

Category	Required / Optional	Remarks
A.2.3.2. Aberration Corrections	Radar: Not applicable Optical: Diurnal – Optional **Annual – Required** Space Based Optical: **Annual – Required** **Orbital – Required**	Aberration corrections compensate for the optical distortion caused by the relative motion of the observing platform. There are three primary components that should be considered: Diurnal – caused by the motion of ground based sensors as a result of Earth's rotation. Annual – caused by the motion of Earth in its orbit around the sun. Orbital – caused by the motion of the viewing platform/satellite.
A.2.3.3. Timing Corrections	Determined on a case-by-case basis for systems that are not in compliance with this AFSPCI	Timing corrections are not typically applied as long as the observations are time tagged in accordance with the guidelines outlined in this AFSPCI. **Optical sensors should time tag their data to the moment the photons arrive at the sensor. Radar systems should time tag data to the halfway point between transmit and receive pulses.**

Category	Required / Optional	Remarks
A.2.3.4. Mount Model Corrections	Radar: Mechanical or hybrid radar may be required to apply mount model corrections depending on the extent of the contribution to the overall error budget. Optical: Mount model corrections are required for optical systems that do not use in-frame metrics, or when no reference stars are available for sensors that do use in-frame metrics.	Mount model corrections for radar are usually applied to handle errors caused by physical deflection/distortion in the pointing of the antenna array as it moves through its full range of motion. For optical systems it usually requires regular calibration of the mount position encoders by accounting for the pointing offset computed from the position of known stars.

Category	Required / Optional	Remarks
A.2.3.5. Calibration Corrections – Systematic Biases	Usually optional; may be required if errors are significant, or if they cannot be removed by the 18 SPCS using single factor bias corrections.	18 SPCS-produced calibration reports may identify sensor errors that are not handled by known correction processes. In some cases, if the errors remain consistent over time, it may be beneficial to apply correction factors to remove systematic biases prior to transmission to 18 SPCS. 18 SPCS systems can account for constant biases in each component of angles, range, and range-rate. Biases that are not handled include those that are a function of spatial or temporal factors. (e.g., a range bias that changes as a function of azimuth (i.e. sensor location error) or biases due to solid body rotation of the topocentric coordinate frame about some axis) or timing biases.
A.2.3.6. Other Errors	TBD depending on nature and extent of the error.	Any other source of systematic error not discussed explicitly in this table, but that could prevent the sensor from meeting accuracy requirements, should be identified and corrected prior to transmission to 18 SPCS.

Table A2.4. Sensor Accuracy.

Category	Level 1 Sensor Requirements	Level 2 Sensor Requirements	Remarks
A.2.4. Sensor Accuracy			
A.2.4.1. Metric Accuracy			

Category	Level 1 Sensor Requirements	Level 2 Sensor Requirements	Remarks
Note: Sensors submitting data to the C2 center must provide routine tracking data on specific calibration satellites in order to facilitate performance characterization for trending and fault detection, as well as proper configuration of the orbit processing system. For more information refer to the Sensor Calibration section of this AFSPCI. Sensor Biases: Biases are computed for angle, range, and range-rate components and are based on the mathematical mean of the calibration observation residuals. Sensors should make every attempt to minimize biases; however, 18 SPCS processing systems can apply corrections for biases that are not adequately handled by the sensor as long as they remain constant over time. Biases that change frequently may necessitate downgrading a sensor to Level 2, and depending on the extent, may be grounds for terminating the flow of all data from the sensor.			

Category	Level 1 Sensor Requirements	Level 2 Sensor Requirements	Remarks
A.2.4.1.1. Timing Accuracy	Optical and Radar: 0.001 seconds	Optical and Radar: 0.004 seconds	Time accuracy is not computed in the sensor calibration process but timing errors degrade accuracy of other metric components. The most common errors involve timing biases, which are identifiable in radar data as a distinct slope in a plot of range-rate vs range residual. It is more difficult to identify timing errors for optical systems.
A.2.4.1.2. Angles Sigma*	Angles Only Systems: <0.0008 degrees (<3 arcseconds) per component Range Capable Systems: <0.04 degrees (<145 arcseconds)	Angles Only Systems: <0.0014 degrees (<5 arcseconds) per component Range Capable Systems: <0.10 degrees (<360 arcseconds)	Sigma is calculated separately for each component of Az/El or RA/Dec. The allowable Level 2 error of 0.10 degrees corresponds to ~1 km error at ~600 km slant range.

Category	Level 1 Sensor Requirements	Level 2 Sensor Requirements	Remarks
A.2.4.1.3. Range Sigma*	<30 meters	<1 kilometer	Level 1 near earth radars with angle sigmas <0.003 degrees may be permitted to have range sigmas larger than the requirement. This represents a rare case and to be evaluated individually. Three millidegrees at ~600 km slant range is roughly equivalent to the Level 1 range requirement.
A.2.4.1.4. Range-Rate Sigma*	Range-Rate Only Systems: TBD Range Capable Systems: No specific requirement. Range-rate <0.20 meters/second preferred.	Range-Rate Only Systems: TBD Range Capable Systems: No specific requirement. Range-rate <5.0 meters/second preferred.	The current SSN does not have any sensors that submit range-rate only observations. Future studies should establish criteria for range-rate only systems should any become available for use by the SSN.
*Computed as 1 standard deviation from a normal distribution of the calibration satellite residuals (minus outliers)			

Table A2.5. Timeliness.

Category	Guideline	Remarks
A.2.5. Timeliness		
A.2.5.1. Observation Transmission Timeliness	Sensors that receive a daily Consolidated Tasking List (CTL) from the 18 SPCS, are required to follow the tasking and reporting guidelines outlined in a MOA. Sensors that are tasked by other sources should make every attempt to transmit data at the soonest possible opportunity, preferably within 8 hours of collection, and within 5-30 minutes for high priority objects.	Observation Transmission Requirements: Near Earth Sensors: Cat 1: 5 minutes Cat 2: 1 hour Cat 3: 8 hours Cat 4: 8 hours Cat 5: 8 hours Optical Deep-Space Sensors: Cat 1: 30 minutes Cat 2: 30 minutes Cat 3: 2 hours Cat 4: 4 hours Cat 5: 8 hours All other Deep-Space Sensors: Cat 1: 5 minutes Cat 2: 30 minutes Cat 3: 2 hours Cat 4: 4 hours Cat 5: 8 hours The term Category (Cat) refers to mission priorities.

Table A2.6. Sensor Parameters.

Category	Guidelines	Remarks
A.2.6. Sensor Parameters		

Category	Guidelines	Remarks
Note: Fixed location sensors are required to submit precise sensor location data to the 18 SPCS to support orbit processing of the metric observations. Mobile/Orbiting sensors must include the sensor location as part of the metric observation report (i.e. Type 8 or 9 observation format, or as defined by the provider).		
A.2.6.1. Sensor Location and Orientation	Fixed Location Sensors: **Geodetic Latitude, Longitude, and Height Above Ellipsoid (HAE) of the sensor in WGS-84 coordinates (required)**. To accurately account for sensor orientation, it is advantageous to provide the local vertical deflection computed from the EGM-96 Geoid (optional), if that is the vertical defining the horizon from which elevation angle is measured. Otherwise provide the deflection of the vertical that defines the horizon from which elevation is actually measured. Mobile/Orbiting Sensors: **Sensor location must be included in the metric observation report.** Location should be specified in EFG coordinates **(required)**.	WGS-84 coordinates must reference the computational center of the sensor. This is usually the center of the Az/El or RA/Dec rotational axis for mechanical mounts, the center of the phased array face for a single face radar, or the intersection of the bore site vectors on a multi-face phased array radar.

Category	Guidelines	Remarks
A.2.6.2. Sensor Field of View (FOV) / Field of Regard (FOR)	**Sensor FOV/FOR parameters must be provided to the 18 SPCS.** These values are usually provided in terms of Azimuth/Elevation/Range limits, or as bore site Az/El and half cone angle for phased array systems. Optical systems usually report both the limits of the focal plane FOV as well as the Az/El/Range constraints for the system **(required)**. Space-based systems should report in terms of half cone angle around orbit vectors (e.g., half cone angle from the in-track, radial, or cross-track vectors) (optional).	Field of View: This is defined by the viewing limits of the instrument. For example, a telescope might have a 1× 1 field of view based on the focal plane; or a pedestal-mounted phased array could have a variable bore site with a half-cone angle of 20. Field of Regard: Viewing limits of the sensor system. Using the above FOV examples, the 1× 1 telescope may have 0-360 Az limits and 5-90 El limits, with a predicted maximum effective range of 70,000 km. Whereas, the pedestal-mounted phased array could have a FOR of 60-180 Az and 10-60 El with a maximum effective range of 2000 km. Sensors that have dedicated surveillance fences that occupy a portion of their field of view should report the limit parameters specific to the surveillance fence (optional).

Category	Guidelines	Remarks
A.2.6.3. Sensitivity	**Sensitivity parameters are required for systems that receive 18 SPCS tasking.** Sensitivity parameters for other sensors are desirable but not required.	Sensitivity parameters for radar are usually provided in terms of minimum detectable object size in a given orbit regime (typically near earth or GEO), and for optical sensors it is usually reported as the limiting apparent visual magnitude of the system. Other parameters may be acceptable per AFSPC and 18 SPCS discretion. More detailed sensitivity information may be beneficial to the 18 SPCS tasking algorithm. It is recommended that tasked sensors coordinate with the 18 SPCS to provide additional details if applicable.

Attachment 3

OPERATIONAL CONCEPT CONSIDERATIONS

A3.1. Sensor Tasking.

A3.1.1. This section refers specifically to the 18 SPCS process that uses the Special Perturbations Tasker (SP-Tasker) to generate the Consolidated Tasking List (CTL). Data providers may also choose to receive standing order tasking, voice only tasking, no tasking at all, or tasking via an intermediary such as a national space operations center depending on the agreed level of support for the system in question**.**

A3.1.2. Data providers may choose to receive sensor tasking through a daily CTL message in order to better align data collections with CSpOC and 18 SPCS mission needs. There are several aspects that must be considered prior to committing a system to this process.

A3.1.3. Sensor Compatibility Level status:

A3.1.3.1. Most Compatibility Level 1 sensors are fully integrated with the sensor tasking process; however, sensors that operate solely using a survey-based strategy do not need to participate in the tasking process. Sensors that implement hybrid survey and tasked-based strategies need to coordinate with the 18 SPCS to implement the appropriate operational solution.

A3.1.3.2. Systems with a Compatibility Level of 2 must be considered for sensor tasking on a case-by-case basis. Tasking algorithms rely on consistent sensor performance, availability, OPSCAP reporting, and other factors that must be considered in order to ensure proper function of the network and are used to determine whether a system with a Compatibility Level of 2 should be included in the tasking process.

A3.1.4. Data Utility:

A3.1.4.1. Integration with the sensor tasking process is likely to improve the overall mission utility for tasked-based systems.

A3.2. Sensor Status and Downtime Reporting.

A3.2.1. Space Surveillance Operations Capability (OPSCAP)

A3.2.1.1. OPSCAP is an assessment of a site's capability to perform the space surveillance mission, it is particularly important for systems that are integrated into the 18 SPCS CTL process. OPSCAP reporting is not required for NTDS; however, it is recommended for most Level 1 systems and may be useful for some Level 2 systems. OPSCAP represents its functionality based on equipment status, personnel availability and/or communication status; the overall sensor OPSCAP reflects the most critical assessment from any of the contributing factors.

A3.2.1.2. Criteria (GREEN, YELLOW and RED)

A3.2.1.3. GREEN. No degradation to space surveillance mission accomplishment.

A3.2.1.4. YELLOW. Partial degradation to space surveillance mission accomplishment. Data communication lines to the C2 are down ***or*** all means of voice communication with the C2 are non-operational.

A3.2.1.5. RED. Significant degradation to space surveillance mission accomplishment. Data communication lines to the C2 are down ***and*** all means of voice communication with the C2 are non-operational.

A3.2.2. Reporting. When an outage (OPSCAP change) occurs that exceeds or is expected to exceed 2 minutes, site personnel immediately report the outage, color, cause and Estimated Time to Return to Operations (ETRO) to the CSpOC and/or18 SPCS within 5 minutes of initial indications. Do not report outages with duration of 2 minutes or less.

A3.2.3. Planned Downtime Reporting. Sensors that are integrated into the 18 SPCS CTL process should report planned downtime at least 24 hours prior to the scheduled period in order for the tasking algorithm to account for the change and make adjustments to optimize network balancing.

A3.3. System Change Notifications.

A3.3.1. System change notification refers to reporting any significant software, hardware, or other system changes that could affect any key data characteristics that relate to quality, availability, throughput, sensitivity, or any other relevant factor.

A3.3.2. System change notification is required for all Level 1 systems and is useful for most Level 2 systems.

A3.3.3. Reporting. System change notifications should be made to the Space Superiority Operations Division (HQ AFSPC/A3/6W), HQ AFSPC/A3/6Z, 18 SPCS and USSTRATCOM/J65 prior to implementation and with as much lead time as possible. In most cases, Level 1 sensors must provide sensor calibration data generated using the new software/hardware configuration to HQ AFSPC/A3/6Z for evaluation prior to operational use by the 18 SPCS. Coordination with the appropriate HQ AFSPC Division and Trial Period evaluation need to be accomplished per the discretion of HQ AFSPC/A3/6W, HQ AFSPC/A3/6Z, 18 SPCS and USSTRATCOM/J65 SMEs.

A3.4. Search and Event Support.

A3.4.1. Search. Systems that are capable of search should provide specifications, limitations, and parameters to the 18 SPCS in order to be considered and included in event support requiring searchbased operations (e.g., non-cooperative launches, lost objects, breakups, etc.). Search support figures prominently in the overall utility of the sensor.

A3.4.2. Search Methodologies. Searches are usually based on a number of minutes before and after the location of the propagated orbit state if it is available (e.g., Elset for Satellite 25544 ±10 minutes). They may also be defined by specific azimuth/elevation limits relative to the site, by orbit types, or by leveraging natural orbit phenomenology (e.g., GEO pinch points).

A3.4.3. Events. The ability of a sensor to support data collection on various events is not required but may be very beneficial to the utility of the system for the CSpOC and/or 18 SPCS mission. Events of interest typically include cooperative and non-cooperative launches, satellite maneuvers, breakups, reentries/deorbits, conjunction assessment, close proximity operations, and anti-satellite threat processing. Systems that are capable of supporting events are encouraged to coordinate with the CSpOC, 18 SPCS, and AFSPC to ensure that the capability can be leveraged as appropriate.

Attachment 4

RECOMMENDED OBSERVATION DATA REPORTING FORMATS

A4.1. Metric Observation Reporting Pathways.

A4.1.1. Observation data may be transmitted through either legacy communication pathways or through NDPP. Legacy communication pathways are typically used for militarily sensitive systems requiring robust survivability, assured information protection, and dedicated connectivity. As such, the process for establishing connectivity through legacy communication systems requires long lead times and significant process compliance. The NDPP was created as an alternative pathway to improve DoD access to NTDS. It streamlines the transmission pathway by leveraging Internet-based connectivity through Space-Track.org, or through SIPRNet for classified sources. It also allows for a nearly unlimited number of data formats by providing a flexible configuration interface.

A4.1.2. Systems that require robust and secure communication pathways should consider interfacing with the CSpOC and/or 18 SPCS using legacy communication systems. Observations transmitted over these pathways by traditional legacy sensors use the American Standard Code for Information Interchange (ASCII) metric observation transmission format known as the Space Detection And Tracking System (SPADATS) AA07 format. This legacy format supports only 5digit satellite numbers. Therefore, this format will be retired when the satellite numbers exceed 5 digits. Other options may become available with the transition from SPADOC to replacement architectures.

A4.1.3. In order to facilitate rapid sensor integration while reducing the risk of format translation problems, it is recommended that data providers format their metric observations utilizing the XML schema (see paragraph **A4.3** of this attachment) developed by the Command and Control Space Situational Awareness Community of Interest (C2 SSA COI). Currently this is the only approved format that can support 9-digit satellite numbers and does not limit precision in the observations. Other custom formats can be supported but require additional processing time and developer support. Delays for uncommon formats, or for other interoperability issues, can be substantial depending on the level of complexity and may require technical exchange and development work by the data provider and integrators at the CSpOC, 18 SPSC, and AFSPC.

A4.2. Observation Transmission Formats.

A4.2.1. The legacy observation transmission format (SPADATS AA07) has been an officially recognized text-based format that is readily processed by SPADOC, and can also be ingested by the NDPP system. The text characters are defined by the ASCII standard. SPADATS AA07 is restricted to a 5-digit satellite number and has other limitations in precision and the number of data fields. It is projected that the Satellite Catalog will run out of 5-digit satellite numbers in the year ~2023. At that time the SPADATS AA07 message will be largely retired and replaced with the new C2 SSA COI XML Observation Message format. The latest version of this XML format is Version 3.4.2. If a newer version replaces this version, an update to this AFSPCI will be published as soon as possible. We recommend data providers use the C2 SSA COI XML formats documented in this section. These formats are already being used by the Air Force S-Band Space Fence. The Long Range Discrimination Radar (LRDR) and the Space

Surveillance Telescope (SST) are also designed towards these XML formats. Additionally, NDPP is set up for XML message format ingestion.

A4.2.2. Example XML Metric Observation Track Messages (Types 0 through 10): This section documents example XML files for sending metric observations (Types 0 through 10). These XML files are consistent with the schema documented in paragraph **A4.2.3.** The latest C2 SSA COI schema is version 3.4.2. Types 0, 1, 2, 3 and 6 are subsets of Type 4 and are used by radar sensors. There are plans for LRDR to use XML Type 4 and for the Space Surveillance Telescope (SST) to use XML Type 5. Type 7 is used to transmit state vector information (position, velocity and acceleration). Future space-based and mobile sensors will use Type 8 for radar sensors and Type 9 for optical sensors. Type 10 is a new type used to transmit state vector and associated state error covariance information.

Table A4.1. TYPE 0 (Radar Cross Section and Range Rate)

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<MetricObservationTrackMsg xmlns="http://www.C2SSA.gov/C2SSADomain/Common/Types/v3" xmlns:ns2="urn:us:gov:ic:ism"
schemaVersion="3.4.2" ns2:resourceElement="false" ns2:createDate="2017-11-17"
ns2:classification="U" ns2:ownerProducer="USA" ns2:DESVersion="9">
   <CommonHeader>
      <SenderInfo messageID="bfee7b54-08d4-44c6-a07e-eb6b719b17f4"/>
      <SourceID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">310</SourceID>
      <MsgCreationTime>2017-11-17T07:31:07.727Z</MsgCreationTime>
      <MsgContentPriority>routine</MsgContentPriority>
      <DataEnvironmentIndicator>test</DataEnvironmentIndicator>
   </CommonHeader>
   <MetricObservationTrackCollection>
      <MetricObservationTrack trackID="118497" passIDRef="cf25e1c6-0550-40e5-9809-e53c43457048"
obsCount="3" ns2:classification="U" ns2:ownerProducer="USA">
         <SatelliteNumber>10962</SatelliteNumber>
         <SensorLocation>
            <Position srsName="EFG">1274.27705047795 -4725.66998351987
4075.94343159046</Position>
         </SensorLocation>
         <SensorID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">310</SensorID>
         <StartTime>2017-11-17T07:29:14.94259Z</StartTime>
         <StopTime>2017-11-17T07:29:37.72279Z</StopTime>
         <MetricObservationCollection>
            <MetricObservation>
               <Time>2017-11-17T07:29:14.94259Z</Time>
               <RCSMedian polarization="unpolarized">
                  <RCSValue errorEstimate="2.759346805460851"
uom="m2">6.984323263168335</RCSValue>
               </RCSMedian>
               <Type0>
                  <RangeRate errorEstimate="0.02792813070882898"
uom="km/s">3.0479371242881945</RangeRate>
               </Type0>
            </MetricObservation>
            <MetricObservation>
               <Time>2017-11-17T07:29:26.20642Z</Time>
               <RCSMedian polarization="unpolarized">
                  <RCSValue errorEstimate="3.8864645498636357"
uom="m2">5.684051513671875</RCSValue>
               </RCSMedian>
               <Type0>
                  <RangeRate errorEstimate="0.013417346114780864"
uom="km/s">3.403214475389969</RangeRate>
               </Type0>
            </MetricObservation>
            <MetricObservation>
               <Time>2017-11-17T07:29:37.72279Z</Time>
```

```
               <RCSMedian polarization="unpolarized">
                  <RCSValue errorEstimate="2.491095695195026"
uom="m2">4.430830001831055</RCSValue>
               </RCSMedian>
               <Type0>
                  <RangeRate errorEstimate="0.008648148414743982"
uom="km/s">3.7374654637366995</RangeRate>
               </Type0>
            </MetricObservation>
         </MetricObservationCollection>
      </MetricObservationTrack>
   </MetricObservationTrackCollection>
</MetricObservationTrackMsg>
```

Table A4.2. TYPE 1 (Radar Cross Section, Azimuth and Elevation)

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<MetricObservationTrackMsg xmlns="http://www.C2SSA.gov/C2SSADomain/Common/Types/v3"
xmlns:ns2="urn:us:gov:ic:ism" schemaVersion="3.4.2" ns2:resourceElement="false"
ns2:createDate="2017-11-17" ns2:classification="U" ns2:ownerProducer="USA" ns2:DESVersion="9">
   <CommonHeader>
      <SenderInfo messageID="bfee7b54-08d4-44c6-a07e-eb6b719b17f4"/>
      <SourceID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">310</SourceID>
      <MsgCreationTime>2017-11-17T07:31:07.727Z</MsgCreationTime>
      <MsgContentPriority>routine</MsgContentPriority>
      <DataEnvironmentIndicator>test</DataEnvironmentIndicator>
   </CommonHeader>
   <MetricObservationTrackCollection>
      <MetricObservationTrack trackID="118497" passIDRef="cf25e1c6-0550-40e5-9809-e53c43457048"
obsCount="3" ns2:classification="U" ns2:ownerProducer="USA">
         <SatelliteNumber>10962</SatelliteNumber>
         <SensorLocation>
            <Position srsName="EFG">1274.27705047795 -4725.66998351987
4075.94343159046</Position>
         </SensorLocation>
         <SensorID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">310</SensorID>
         <StartTime>2017-11-17T07:29:14.94259Z</StartTime>
         <StopTime>2017-11-17T07:29:37.72279Z</StopTime>
         <MetricObservationCollection>
            <MetricObservation>
               <Time>2017-11-17T07:29:14.94259Z</Time>
               <RCSMedian polarization="unpolarized">
                  <RCSValue errorEstimate="2.759346805460851"
uom="m2">6.984323263168335</RCSValue>
               </RCSMedian>
               <Type1>
                  <Azimuth errorEstimate="0.051850013724801296"
uom="rad">1.7812709671409483</Azimuth>
                  <Elevation errorEstimate="0.028054566159910154"
uom="rad">0.6293058811398505</Elevation>
               </Type1>
            </MetricObservation>
            <MetricObservation>
               <Time>2017-11-17T07:29:26.20642Z</Time>
               <RCSMedian polarization="unpolarized">
                  <RCSValue errorEstimate="3.8864645498636357"
uom="m2">5.684051513671875</RCSValue>
               </RCSMedian>
               <Type1>
                  <Azimuth errorEstimate="0.050096194429550996"
uom="rad">1.848831348812598</Azimuth>
                  <Elevation errorEstimate="0.03217362170990656"
uom="rad">0.5965393640833311</Elevation>
               </Type1>
            </MetricObservation>
            <MetricObservation>
               <Time>2017-11-17T07:29:37.72279Z</Time>
               <RCSMedian polarization="unpolarized">
```

```
                <RCSValue errorEstimate="2.491095695195026"
uom="m2">4.430830001831055</RCSValue>
             </RCSMedian>
             <Type1>
                <Azimuth errorEstimate="0.033920839708952995"
uom="rad">1.9110826800396508</Azimuth>
                <Elevation errorEstimate="0.02886900219254102"
uom="rad">0.5635970497310231</Elevation>
             </Type1>
          </MetricObservation>
       </MetricObservationCollection>
    </MetricObservationTrack>
  </MetricObservationTrackCollection>
</MetricObservationTrackMsg>
```

Table A4.3. TYPE 2 (Radar Cross Section, Azimuth, Elevation and Range)

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<MetricObservationTrackMsg xmlns="http://www.C2SSA.gov/C2SSADomain/Common/Types/v3"
xmlns:ns2="urn:us:gov:ic:ism" schemaVersion="3.4.2" ns2:resourceElement="false"
ns2:createDate="2017-11-17" ns2:classification="U" ns2:ownerProducer="USA" ns2:DESVersion="9">
  <CommonHeader>
    <SenderInfo messageID="bfee7b54-08d4-44c6-a07e-eb6b719b17f4"/>
    <SourceID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">310</SourceID>
    <MsgCreationTime>2017-11-17T07:31:07.727Z</MsgCreationTime>
    <MsgContentPriority>routine</MsgContentPriority>
    <DataEnvironmentIndicator>test</DataEnvironmentIndicator>
  </CommonHeader>
  <MetricObservationTrackCollection>
    <MetricObservationTrack trackID="118497" passIDRef="cf25e1c6-0550-40e5-9809-e53c43457048"
obsCount="3" ns2:classification="U" ns2:ownerProducer="USA">
      <SatelliteNumber>10962</SatelliteNumber>
      <SensorLocation>
        <Position srsName="EFG">1274.27705047795 -4725.66998351987
4075.94343159046</Position>
      </SensorLocation>
      <SensorID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">310</SensorID>
      <StartTime>2017-11-17T07:29:14.94259Z</StartTime>
      <StopTime>2017-11-17T07:29:37.72279Z</StopTime>
      <MetricObservationCollection>
        <MetricObservation>
          <Time>2017-11-17T07:29:14.94259Z</Time>
          <RCSMedianPair>
            <RCSMedian polarization="principal">
              <RCSValue errorEstimate="2.759346805460851"
uom="m2">6.984323263168335</RCSValue>
              <SpectralWidth uom="Hz">2000.0<\SpectralWidth>
            </RCSMedian>
            <RCSMedian polarization="orthogonal">
              <RCSValue errorEstimate="5.365068701452752"
uom="m2">3.8563655614852905</RCSValue>
              <SpectralWidth uom="Hz">2000.0<\SpectralWidth>
            </RCSMedian>
          </RCSMedianPair>
          <Type2>
            <Azimuth errorEstimate="0.051850013724801296"
uom="rad">1.7812709671409483</Azimuth>
            <Elevation errorEstimate="0.028054566159910154"
uom="rad">0.6293058811398505</Elevation>
            <Range errorEstimate="0.34591554793956836" uom="km">1162.2083236238232</Range>
          </Type2>
        </MetricObservation>
        <MetricObservation>
          <Time>2017-11-17T07:29:26.20642Z</Time>
          <RCSMedianPair>
            <RCSMedian polarization="principal">
              <RCSValue errorEstimate="3.8864645498636357"
uom="m2">5.684051513671875</RCSValue>
```

```
                  <SpectralWidth uom="Hz">2000.0<\SpectralWidth>
               </RCSMedian>
               <RCSMedian polarization="orthogonal">
                  <RCSValue errorEstimate="2.6562586929615484"
uom="m2">5.744205474853516</RCSValue>
                  <SpectralWidth uom="Hz">2000.0<\SpectralWidth>
               </RCSMedian>
            </RCSMedianPair>
            <Type2>
               <Azimuth errorEstimate="0.050096194429550996"
uom="rad">1.848831348812598</Azimuth>
               <Elevation errorEstimate="0.03217362170990656"
uom="rad">0.5965393640833311</Elevation>
               <Range errorEstimate="0.18263076555129748" uom="km">1198.497486926645</Range>
            </Type2>
         </MetricObservation>
         <MetricObservation>
            <Time>2017-11-17T07:29:37.72279Z</Time>
            <RCSMedianPair>
               <RCSMedian polarization="principal">
                  <RCSValue errorEstimate="2.491095695195026"
uom="m2">4.430830001831055</RCSValue>
                  <SpectralWidth uom="Hz">2000.0<\SpectralWidth>
               </RCSMedian>
               <RCSMedian polarization="orthogonal">
                  <RCSValue errorEstimate="3.2710476456332205"
uom="m2">3.298504114151001</RCSValue>
                  <SpectralWidth uom="Hz">2000.0<\SpectralWidth>
               </RCSMedian>
            </RCSMedianPair>
            <Type2>
               <Azimuth errorEstimate="0.033920839708952995"
uom="rad">1.9110826800396508</Azimuth>
               <Elevation errorEstimate="0.02886900219254102"
uom="rad">0.5635970497310231</Elevation>
               <Range errorEstimate="0.12732701866202645" uom="km">1239.6691955159697</Range>
            </Type2>
         </MetricObservation>
      </MetricObservationCollection>
   </MetricObservationTrack>
</MetricObservationTrackCollection>
</MetricObservationTrackMsg>
```

Table A4.4. TYPE 3 (Radar Cross Section, Azimuth, Elevation, Range and Range Rate)

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<MetricObservationTrackMsg xmlns="http://www.C2SSA.gov/C2SSADomain/Common/Types/v3"
xmlns:ns2="urn:us:gov:ic:ism" schemaVersion="3.4.2" ns2:resourceElement="false"
ns2:createDate="2017-11-17" ns2:classification="U" ns2:ownerProducer="USA" ns2:DESVersion="9">
   <CommonHeader>
      <SenderInfo messageID="bfee7b54-08d4-44c6-a07e-eb6b719b17f4"/>
      <SourceID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">310</SourceID>
      <MsgCreationTime>2017-11-17T07:31:07.727Z</MsgCreationTime>
      <MsgContentPriority>routine</MsgContentPriority>
      <DataEnvironmentIndicator>test</DataEnvironmentIndicator>
   </CommonHeader>
   <MetricObservationTrackCollection>
      <MetricObservationTrack trackID="118497" passIDRef="cf25e1c6-0550-40e5-9809-e53c43457048"
obsCount="3" ns2:classification="U" ns2:ownerProducer="USA">
         <SatelliteNumber>10962</SatelliteNumber>
         <SensorLocation>
            <Position srsName="EFG">1274.27705047795 -4725.66998351987
4075.94343159046</Position>
         </SensorLocation>
         <SensorID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">310</SensorID>
         <StartTime>2017-11-17T07:29:14.94259Z</StartTime>
         <StopTime>2017-11-17T07:29:37.72279Z</StopTime>
         <MetricObservationCollection>
```

```
            <MetricObservation>
               <Time>2017-11-17T07:29:14.94259Z</Time>
               <RCSMedianPair>
                  <RCSMedian polarization="principal">
                     <RCSValue errorEstimate="2.759346805460851"
uom="m2">6.984323263168335</RCSValue>
                     <SpectralWidth uom="Hz">2000.0<\SpectralWidth>
                  </RCSMedian>
                  <RCSMedian polarization="orthogonal">
                     <RCSValue errorEstimate="5.365068701452752"
uom="m2">3.8563655614852905</RCSValue>
                     <SpectralWidth uom="Hz">2000.0<\SpectralWidth>
                  </RCSMedian>
               </RCSMedianPair>
               <Type3>
                  <Azimuth errorEstimate="0.051850013724801296"
uom="rad">1.7812709671409483</Azimuth>
                  <Elevation errorEstimate="0.028054566159910154"
uom="rad">0.6293058811398505</Elevation>
                  <Range errorEstimate="0.34591554793956836" uom="km">1162.2083236238232</Range>
                  <RangeRate errorEstimate="0.02792813070882898"
uom="km/s">3.0479371242881945</RangeRate>
               </Type3>
            </MetricObservation>
            <MetricObservation>
               <Time>2017-11-17T07:29:26.20642Z</Time>
               <RCSMedianPair>
                  <RCSMedian polarization="principal">
                     <RCSValue errorEstimate="3.8864645498636357"
uom="m2">5.684051513671875</RCSValue>
                     <SpectralWidth uom="Hz">2000.0<\SpectralWidth>
                  </RCSMedian>
                  <RCSMedian polarization="orthogonal">
                     <RCSValue errorEstimate="2.6562586929615484"
uom="m2">5.744205474853516</RCSValue>
                     <SpectralWidth uom="Hz">2000.0<\SpectralWidth>
                  </RCSMedian>
               </RCSMedianPair>
               <Type3>
                  <Azimuth errorEstimate="0.050096194429550996"
uom="rad">1.848831348812598</Azimuth>
                  <Elevation errorEstimate="0.03217362170990656"
uom="rad">0.5965393640833311</Elevation>
                  <Range errorEstimate="0.18263076555129748" uom="km">1198.497486926645</Range>
                  <RangeRate errorEstimate="0.013417346114780864"
uom="km/s">3.403214475389969</RangeRate>
               </Type3>
            </MetricObservation>
            <MetricObservation>
               <Time>2017-11-17T07:29:37.72279Z</Time>
               <RCSMedianPair>
                  <RCSMedian polarization="principal">
                     <RCSValue errorEstimate="2.491095695195026"
uom="m2">4.430830001831055</RCSValue>
                     <SpectralWidth uom="Hz">2000.0<\SpectralWidth>
               </RCSMedian>
                  <RCSMedian polarization="orthogonal">
                     <RCSValue errorEstimate="3.2710476456332205"
uom="m2">3.298504114151001</RCSValue>
                     <SpectralWidth uom="Hz">2000.0<\SpectralWidth>
                  </RCSMedian>
               </RCSMedianPair>
               <Type3>
                  <Azimuth errorEstimate="0.033920839708952995"
uom="rad">1.9110826800396508</Azimuth>
                  <Elevation errorEstimate="0.02886900219254102"
uom="rad">0.5635970497310231</Elevation>
                  <Range errorEstimate="0.12732701866202645" uom="km">1239.6691955159697</Range>
                  <RangeRate errorEstimate="0.008648148414743982"
uom="km/s">3.7374654637366995</RangeRate>
               </Type3>
```

```
            </MetricObservation>
         </MetricObservationCollection>
      </MetricObservationTrack>
   </MetricObservationTrackCollection>
</MetricObservationTrackMsg>
```

Table A4.5. TYPE 4 (Radar Cross Section, Azimuth, Elevation, Range, Range Rate, Azimuth Rate, Elevation Rate, and Range Acceleration)

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<MetricObservationTrackMsg xmlns="http://www.C2SSA.gov/C2SSADomain/Common/Types/v3"
xmlns:ns2="urn:us:gov:ic:ism" schemaVersion="3.4.2" ns2:resourceElement="false"
ns2:createDate="2017-11-17" ns2:classification="U" ns2:ownerProducer="USA" ns2:DESVersion="9">
   <CommonHeader>
      <SenderInfo messageID="bfee7b54-08d4-44c6-a07e-eb6b719b17f4"/>
      <SourceID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">310</SourceID>
      <MsgCreationTime>2017-11-17T07:31:07.727Z</MsgCreationTime>
      <MsgContentPriority>routine</MsgContentPriority>
      <DataEnvironmentIndicator>test</DataEnvironmentIndicator>
   </CommonHeader>
   <MetricObservationTrackCollection>
      <MetricObservationTrack trackID="118497" passIDRef="cf25e1c6-0550-40e5-9809-e53c43457048"
obsCount="3" ns2:classification="U" ns2:ownerProducer="USA">
         <SatelliteNumber>10962</SatelliteNumber>
         <SensorLocation>
            <Position srsName="EFG">1274.27705047795 -4725.66998351987
4075.94343159046</Position>
         </SensorLocation>
         <SensorID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">310</SensorID>
         <StartTime>2017-11-17T07:29:14.94259Z</StartTime>
         <StopTime>2017-11-17T07:29:37.72279Z</StopTime>
         <MetricObservationCollection>
            <MetricObservation>
               <Time>2017-11-17T07:29:14.94259Z</Time>
               <RCSMedianPair>
                  <RCSMedian polarization="principal">
                     <RCSValue errorEstimate="2.759346805460851"
uom="m2">6.984323263168335</RCSValue>
                     <SpectralWidth uom="Hz">2000.0<\SpectralWidth>
                  </RCSMedian>
                  <RCSMedian polarization="orthogonal">
                     <RCSValue errorEstimate="5.365068701452752"
uom="m2">3.8563655614852905</RCSValue>
                     <SpectralWidth uom="Hz">2000.0<\SpectralWidth>
                  </RCSMedian>
               </RCSMedianPair>
               <Type4>
                  <Azimuth errorEstimate="0.051850013724801296"
uom="rad">1.7812709671409483</Azimuth>
                  <Elevation errorEstimate="0.028054566159910154"
uom="rad">0.6293058811398505</Elevation>
                  <Range errorEstimate="0.34591554793956836" uom="km">1162.2083236238232</Range>
                  <RangeRate errorEstimate="0.02792813070882898"
uom="km/s">3.0479371242881945</RangeRate>
                  <AzimuthRate uom="rad/s">0.006472946777688766</AzimuthRate>
                  <ElevationRate uom="rad/s">-0.0025868333147236688</ElevationRate>
                  <RangeAcceleration uom="km/s2">0.0</RangeAcceleration>
               </Type4>
            </MetricObservation>
            <MetricObservation>
               <Time>2017-11-17T07:29:26.20642Z</Time>
               <RCSMedianPair>
                  <RCSMedian polarization="principal">
                     <RCSValue errorEstimate="3.8864645498636357"
uom="m2">5.684051513671875</RCSValue>
                     <SpectralWidth uom="Hz">2000.0<\SpectralWidth>
                  </RCSMedian>
```

```
                <RCSMedian polarization="orthogonal">
                   <RCSValue errorEstimate="2.6562586929615484"
uom="m2">5.744205474853516</RCSValue>
                   <SpectralWidth uom="Hz">2000.0<\SpectralWidth>
                </RCSMedian>
             </RCSMedianPair>
             <Type4>
                <Azimuth errorEstimate="0.050096194429550996"
uom="rad">1.848831348812598</Azimuth>
                <Elevation errorEstimate="0.03217362170990656"
uom="rad">0.5965393640833311</Elevation>
                <Range errorEstimate="0.18263076555129748" uom="km">1198.497486926645</Range>
                <RangeRate errorEstimate="0.013417346114780864"
uom="km/s">3.403214475389969</RangeRate>
                <AzimuthRate uom="rad/s">0.005788310378808207</AzimuthRate>
                <ElevationRate uom="rad/s">-0.002740168350918811</ElevationRate>
                <RangeAcceleration uom="km/s2">0.0</RangeAcceleration>
             </Type4>
          </MetricObservation>
          <MetricObservation>
             <Time>2017-11-17T07:29:37.72279Z</Time>
             <RCSMedianPair>
                <RCSMedian polarization="principal">
                   <RCSValue errorEstimate="2.491095695195026"
uom="m2">4.430830001831055</RCSValue>
                   <SpectralWidth uom="Hz">2000.0<\SpectralWidth>
                </RCSMedian>
                <RCSMedian polarization="orthogonal">
                   <RCSValue errorEstimate="3.2710476456332205"
uom="m2">3.298504114151001</RCSValue>
                   <SpectralWidth uom="Hz">2000.0<\SpectralWidth>
                </RCSMedian>
             </RCSMedianPair>
             <Type4>
                <Azimuth errorEstimate="0.033920839708952995"
uom="rad">1.9110826800396508</Azimuth>
                <Elevation errorEstimate="0.02886900219254102"
uom="rad">0.5635970497310231</Elevation>
                <Range errorEstimate="0.12732701866202645" uom="km">1239.6691955159697</Range>
                <RangeRate errorEstimate="0.008648148414743982"
uom="km/s">3.7374654637366995</RangeRate>
                <AzimuthRate uom="rad/s">0.0051734728123 4832</AzimuthRate>
                <ElevationRate uom="rad/s">-0.0027821101542279563</ElevationRate>
                <RangeAcceleration uom="km/s2">0.0</RangeAcceleration>
             </Type4>
          </MetricObservation>
       </MetricObservationCollection>
    </MetricObservationTrack>
  </MetricObservationTrackCollection>
</MetricObservationTrackMsg>
```

Table A4.6. TYPE 5 (Visual Data, Declination and Right Ascension)

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<MetricObservationTrackMsg xmlns="http://www.C2SSA.gov/C2SSADomain/Common/Types/v3"
xmlns:ns2="urn:us:gov:ic:ism" schemaVersion="3.4.2" ns2:resourceElement="false"
ns2:createDate="2017-11-17" ns2:classification="U" ns2:ownerProducer="USA" ns2:DESVersion="9">
  <CommonHeader>
    <SenderInfo messageID="bfee7b54-08d4-44c6-a07e-eb6b719b17f4"/>
    <SourceID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">271</SourceID>
    <MsgCreationTime>2017-11-17T07:31:07.727Z</MsgCreationTime>
    <MsgContentPriority>routine</MsgContentPriority>
    <DataEnvironmentIndicator>test</DataEnvironmentIndicator>
  </CommonHeader>
  <MetricObservationTrackCollection>
    <MetricObservationTrack trackID="118497" passIDRef="cf25e1c6-0550-40e5-9809-e53c43457048"
obsCount="3" ns2:classification="U" ns2:ownerProducer="USA">
      <SatelliteNumber>38780</SatelliteNumber>
      <SensorLocation>
```

```
            <Position srsName="ECEF">1274.27705047795 -4725.66998351987
4075.94343159046</Position>
         </SensorLocation>
         <SensorID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">271</SensorID>
         <StartTime>2017-11-17T07:29:14.94259Z</StartTime>
         <StopTime>2017-11-17T07:29:37.72279Z</StopTime>
         <MetricObservationCollection>
            <MetricObservation>
               <Time>2017-11-17T07:29:14.94259Z</Time>
               <VisualData>
                  <AbsoluteVisualMagnitude uom="Vm">6.9843233</AbsoluteVisualMagnitude>
                  <AssumedRangeToTarget uom="km">6378.137</AssumedRangeToTarget>
                  <SignedSolarPhaseAngle uom="rad">1.37592176</SignedSolarPhaseAngle>
                  <ObservedVisualMagnitude uom="Vm">4.84628365</ObservedVisualMagnitude>
                  <StarsFound>34</StarsFound>
                  <StarsUsed>30</StarsUsed>
                  <SkyBackground>0.00157283</SkyBackground>
                  <PrimaryExtinction>0.00284620</PrimaryExtinction>
                  <InstrumentZero>0.12824853</InstrumentZero>
               </VisualData>
               <Type5>
                  <YearOfEquinox>ob_date_time</YearOfEquinox>
                  <Declination errorEstimate="0.028054566159910154"
uom="rad">0.6293058811398505</Declination>
                  <RightAscension errorEstimate="0.051850013724801296"
uom="rad">1.7812709671409483</RightAscension>
               </Type5>
            </MetricObservation>
            <MetricObservation>
               <Time>2017-11-17T07:29:26.20642Z</Time>
               <VisualData>
                  <AbsoluteVisualMagnitude uom="Vm">7.0843233</AbsoluteVisualMagnitude>
                  <AssumedRangeToTarget uom="km">6378.137</AssumedRangeToTarget>
                  <SignedSolarPhaseAngle uom="rad">1.12378428</SignedSolarPhaseAngle>
                  <ObservedVisualMagnitude uom="Vm">5.23481945</ObservedVisualMagnitude>
                  <StarsFound>30</StarsFound>
                  <StarsUsed>28</StarsUsed>
                  <SkyBackground>0.00134583</SkyBackground>
                  <PrimaryExtinction>0.00173434</PrimaryExtinction>
                  <InstrumentZero>0.12342797</InstrumentZero>
               </VisualData>
               <Type5>
                  <YearOfEquinox>ob_date_time</YearOfEquinox>
                  <Declination errorEstimate="0.03217362170990656"
uom="rad">0.5965393640833311</Declination>
                  <RightAscension errorEstimate="0.050096194429550996"
uom="rad">1.848831348812598</RightAscension>
               </Type5>
            </MetricObservation>
            <MetricObservation>
               <Time>2017-11-17T07:29:37.72279Z</Time>
               <VisualData>
                  <AbsoluteVisualMagnitude uom="Vm">7.1843233</AbsoluteVisualMagnitude>
                  <AssumedRangeToTarget uom="km">6378.137</AssumedRangeToTarget>
                  <SignedSolarPhaseAngle uom="rad">1.11262357</SignedSolarPhaseAngle>
                  <ObservedVisualMagnitude uom="Vm">4.78934663</ObservedVisualMagnitude>
                  <StarsFound>33</StarsFound>
                  <StarsUsed>27</StarsUsed>
                  <SkyBackground>0.00149238</SkyBackground>
                  <PrimaryExtinction>0.00194623</PrimaryExtinction>
                  <InstrumentZero>0.12923139</InstrumentZero>
               </VisualData>
               <Type5>
                  <YearOfEquinox>ob_date_time</YearOfEquinox>
                  <Declination errorEstimate="0.02886900219254102"
uom="rad">0.5635970497310231</Declination>
                  <RightAscension errorEstimate="0.033920839708952995"
uom="rad">1.9110826800396508</RightAscension>
               </Type5>
            </MetricObservation>
```

```
         </MetricObservationCollection>
      </MetricObservationTrack>
   </MetricObservationTrackCollection>
</MetricObservationTrackMsg>
```

Table A4.7. TYPE 6 (Radar Cross Section and Range)

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<MetricObservationTrackMsg xmlns="http://www.C2SSA.gov/C2SSADomain/Common/Types/v3"
xmlns:ns2="urn:us:gov:ic:ism" schemaVersion="3.4.2" ns2:resourceElement="false"
ns2:createDate="2017-11-17" ns2:classification="U" ns2:ownerProducer="USA" ns2:DESVersion="9">
   <CommonHeader>
      <SenderInfo messageID="bfee7b54-08d4-44c6-a07e-eb6b719b17f4"/>
      <SourceID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">310</SourceID>
      <MsgCreationTime>2017-11-17T07:31:07.727Z</MsgCreationTime>
      <MsgContentPriority>routine</MsgContentPriority>
      <DataEnvironmentIndicator>test</DataEnvironmentIndicator>
   </CommonHeader>
   <MetricObservationTrackCollection>
      <MetricObservationTrack trackID="118497" passIDRef="cf25e1c6-0550-40e5-9809-e53c43457048"
obsCount="3" ns2:classification="U" ns2:ownerProducer="USA">
         <SatelliteNumber>10962</SatelliteNumber>
         <SensorLocation>
            <Position srsName="EFG">1274.27705047795 -4725.66998351987
4075.94343159046</Position>
         </SensorLocation>
         <SensorID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">310</SensorID>
         <StartTime>2017-11-17T07:29:14.94259Z</StartTime>
         <StopTime>2017-11-17T07:29:37.72279Z</StopTime>
         <MetricObservationCollection>
            <MetricObservation>
               <Time>2017-11-17T07:29:14.94259Z</Time>
               <RCSMedian polarization="unpolarized">
                  <RCSValue errorEstimate="2.759346805460851"
uom="m2">6.984323263168335</RCSValue>
               </RCSMedian>
               <Type6>
                  <Range errorEstimate="0.34591554793956836" uom="km">1162.2083236238232</Range>
               </Type6>
            </MetricObservation>
            <MetricObservation>
               <Time>2017-11-17T07:29:26.20642Z</Time>
               <RCSMedian polarization="unpolarized">
                  <RCSValue errorEstimate="3.8864645498636357"
uom="m2">5.684051513671875</RCSValue>
               </RCSMedian>
               <Type6>
                  <Range errorEstimate="0.18263076555129748" uom="km">1198.497486926645</Range>
               </Type6>
            </MetricObservation>
            <MetricObservation>
               <Time>2017-11-17T07:29:37.72279Z</Time>
               <RCSMedian polarization="unpolarized">
                  <RCSValue errorEstimate="2.491095695195026"
uom="m2">4.430830001831055</RCSValue>
               </RCSMedian>
               <Type6>
                  <Range errorEstimate="0.12732701866202645" uom="km">1239.6691955159697</Range>
               </Type6>
            </MetricObservation>
         </MetricObservationCollection>
      </MetricObservationTrack>
   </MetricObservationTrackCollection>
</MetricObservationTrackMsg>
```

Table A4.8. TYPE 7 (Position, Velocity and Acceleration)

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<MetricObservationTrackMsg xmlns="http://www.C2SSA.gov/C2SSADomain/Common/Types/v3"
xmlns:ns2="urn:us:gov:ic:ism" schemaVersion="3.4.2" ns2:resourceElement="false"
ns2:createDate="2017-11-17" ns2:classification="U" ns2:ownerProducer="USA" ns2:DESVersion="9">
   <CommonHeader>
      <SenderInfo messageID="bfee7b54-08d4-44c6-a07e-eb6b719b17f4"/>
      <SourceID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">551</SourceID>
      <MsgCreationTime>2017-11-17T07:31:07.727Z</MsgCreationTime>
      <MsgContentPriority>routine</MsgContentPriority>
      <DataEnvironmentIndicator>test</DataEnvironmentIndicator>
   </CommonHeader>
   <MetricObservationTrackCollection>
      <MetricObservationTrack trackID="118497" passIDRef="cf25e1c6-0550-40e5-9809-e53c43457048"
obsCount="3" ns2:classification="U" ns2:ownerProducer="USA">
         <SatelliteNumber>10962</SatelliteNumber>
         <SensorLocation>
            <Position srsName="EFG">1274.27705047795 -4725.66998351987
4075.94343159046</Position>
         </SensorLocation>
         <SensorID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">551</SensorID>
         <StartTime>2017-11-17T07:29:14.94259Z</StartTime>
         <StopTime>2017-11-17T07:29:37.72279Z</StopTime>
         <MetricObservationCollection>
            <MetricObservation>
               <Time>2017-11-17T07:29:14.94259Z</Time>
               <Type7>
                  <ObjectPosition uom="m" srsName="ECI_date">-5817030.76068577 710103.95601475
4239291.27359913</ObjectPosition>
                  <ObjectVelocity uom="m/s" srsName="ECI_date">-4425.51160008 -920.80523654
5968.56920012</ObjectVelocity>
                  <ObjectAcceleration uom="m/s2" srsName="ECI_date">3.79238745 -2.86345791 -
1.05236901</ObjectAcceleration>
               </Type7>
            </MetricObservation>
            <MetricObservation>
               <Time>2017-11-17T07:29:26.20642Z</Time>
               <Type7>
                  <ObjectPosition uom="m" srsName="ECI_date">-5804937.04573457 719723.09843572
4345237.72300364</ObjectPosition>
                  <ObjectVelocity uom="m/s" srsName="ECI_date">-4362.04763576 -932.58347638
5836.48725021</ObjectVelocity>
                  <ObjectAcceleration uom="m/s2" srsName="ECI_date">3.74836691 -2.73827572 -
1.08492635</ObjectAcceleration>
               </Type7>
            </MetricObservation>
            <MetricObservation>
               <Time>2017-11-17T07:29:37.72279Z</Time>
               <Type7>
                  <ObjectPosition uom="m" srsName="ECI_date">-5730030.56739473 726474.34523873
4474839.25020342</ObjectPosition>
                  <ObjectVelocity uom="m/s" srsName="ECI_date">-4284.68935838 -944.56831802
5823.37819160</ObjectVelocity>
                  <ObjectAcceleration uom="m/s2" srsName="ECI_date">3.71372391 -2.60476291 -
1.11945364</ObjectAcceleration>
               </Type7>
            </MetricObservation>
         </MetricObservationCollection>
      </MetricObservationTrack>
   </MetricObservationTrackCollection>
</MetricObservationTrackMsg>
```

Table A4.9. TYPE 8 (Radar Cross Section, Azimuth, Elevation, Range and Sensor Position)

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
```

```
<MetricObservationTrackMsg xmlns="http://www.C2SSA.gov/C2SSADomain/Common/Types/v3"
xmlns:ns2="urn:us:gov:ic:ism" schemaVersion="3.4.2" ns2:resourceElement="false"
ns2:createDate="2017-11-17" ns2:classification="U" ns2:ownerProducer="USA" ns2:DESVersion="9">
   <CommonHeader>
      <SenderInfo messageID="bfee7b54-08d4-44c6-a07e-eb6b719b17f4"/>
      <SourceID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">551</SourceID>
      <MsgCreationTime>2017-11-17T07:31:07.727Z</MsgCreationTime>
      <MsgContentPriority>routine</MsgContentPriority>
      <DataEnvironmentIndicator>test</DataEnvironmentIndicator>
   </CommonHeader>
   <MetricObservationTrackCollection>
      <MetricObservationTrack trackID="118497" passIDRef="cf25e1c6-0550-40e5-9809-e53c43457048"
obsCount="3" ns2:classification="U" ns2:ownerProducer="USA">
         <SatelliteNumber>10962</SatelliteNumber>
         <SensorLocation>
            <Position srsName="EFG">1274.27705047795 -4725.66998351987
4075.94343159046</Position>
         </SensorLocation>
         <SensorID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">551</SensorID>
         <StartTime>2017-11-17T07:29:14.94259Z</StartTime>
         <StopTime>2017-11-17T07:29:37.72279Z</StopTime>
         <MetricObservationCollection>
            <MetricObservation>
               <Time>2017-11-17T07:29:14.94259Z</Time>
               <RCSMedianPair>
                  <RCSMedian polarization="principal">
                     <RCSValue errorEstimate="2.759346805460851"
uom="m2">6.984323263168335</RCSValue>
                  </RCSMedian>
                  <RCSMedian polarization="orthogonal">
                     <RCSValue errorEstimate="5.365068701452752"
uom="m2">3.8563655614852905</RCSValue>
                  </RCSMedian>
               </RCSMedianPair>
               <Type8>
                  <Azimuth errorEstimate="0.051850013724801296"
uom="rad">1.7812709671409483</Azimuth>
                  <Elevation errorEstimate="0.028054566159910154"
uom="rad">0.6293058811398505</Elevation>
                  <Range errorEstimate="0.34591554793956836" uom="km">1162.2083236238232</Range>
                  <SensorPosition uom="m" srsName="ECI_date">-5817030.76068577 710103.95601475
4239291.27359913</SensorPosition>
               </Type8>
            </MetricObservation>
            <MetricObservation>
               <Time>2017-11-17T07:29:26.20642Z</Time>
               <RCSMedianPair>
                  <RCSMedian polarization="principal">
                     <RCSValue errorEstimate="3.8864645498636357"
uom="m2">5.684051513671875</RCSValue>
                  </RCSMedian>
                  <RCSMedian polarization="orthogonal">
                     <RCSValue errorEstimate="2.6562586929615484"
uom="m2">5.744205474853516</RCSValue>
                  </RCSMedian>
               </RCSMedianPair>
               <Type8>
                  <Azimuth errorEstimate="0.050096194429550996"
uom="rad">1.848831348812598</Azimuth>
                  <Elevation errorEstimate="0.03217362170990656"
uom="rad">0.5965393640833311</Elevation>
                  <Range errorEstimate="0.18263076555129748" uom="km">1198.497486926645</Range>
                  <SensorPosition uom="m" srsName="ECI_date">-5804937.04573457 719723.09843572
4345237.72300364</SensorPosition>
               </Type8>
            </MetricObservation>
            <MetricObservation>
               <Time>2017-11-17T07:29:37.72279Z</Time>
               <RCSMedianPair>
```

```
                <RCSMedian polarization="principal">
                   <RCSValue errorEstimate="2.491095695195026"
uom="m2">4.430830001831055</RCSValue>
                </RCSMedian>
                <RCSMedian polarization="orthogonal">
                   <RCSValue errorEstimate="3.2710476456332205"
uom="m2">3.298504114151001</RCSValue>
                </RCSMedian>
             </RCSMedianPair>
             <Type8>
                <Azimuth errorEstimate="0.033920839708952995"
uom="rad">1.9110826800396508</Azimuth>
                <Elevation errorEstimate="0.02886900219254102"
uom="rad">0.5635970497310231</Elevation>
                <Range errorEstimate="0.12732701866202645" uom="km">1239.6691955159697</Range>
                <SensorPosition uom="m" srsName="ECI_date">-5730030.56739473 726474.34523873
4474839.25020342</SensorPosition>
             </Type8>
          </MetricObservation>
       </MetricObservationCollection>
    </MetricObservationTrack>
 </MetricObservationTrackCollection>
</MetricObservationTrackMsg>c
```

Table A4.10. TYPE 9 (Visual Data, Right Ascension, Declination, Range, Sensor Position and Sensor Velocity)

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<MetricObservationTrackMsg xmlns="http://www.C2SSA.gov/C2SSADomain/Common/Types/v3"
xmlns:ns2="urn:us:gov:ic:ism" schemaVersion="3.4.2" ns2:resourceElement="false"
ns2:createDate="2017-11-17" ns2:classification="U" ns2:ownerProducer="USA" ns2:DESVersion="9">
   <CommonHeader>
      <SenderInfo messageID="bfee7b54-08d4-44c6-a07e-eb6b719b17f4"/>
      <SourceID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">555</SourceID>
      <MsgCreationTime>2017-11-17T07:31:07.727Z</MsgCreationTime>
      <MsgContentPriority>routine</MsgContentPriority>
      <DataEnvironmentIndicator>test</DataEnvironmentIndicator>
   </CommonHeader>
   <MetricObservationTrackCollection>
      <MetricObservationTrack trackID="118497" passIDRef="cf25e1c6-0550-40e5-9809-e53c43457048"
obsCount="3" ns2:classification="U" ns2:ownerProducer="USA">
         <SatelliteNumber>10962</SatelliteNumber>
         <SensorLocation>
            <Position srsName="EFG">1274.27705047795 -4725.66998351987
4075.94343159046</Position>
         </SensorLocation>
         <SensorID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">551</SensorID>
         <StartTime>2017-11-17T07:29:14.94259Z</StartTime>
         <StopTime>2017-11-17T07:29:37.72279Z</StopTime>
         <MetricObservationCollection>
            <MetricObservation>
               <Time>2017-11-17T07:29:14.94259Z</Time>
               <VisualData>
                  <AbsoluteVisualMagnitude uom="Vm">6.98432331</AbsoluteVisualMagnitude>
                  <AssumedRangeToTarget uom="km">6378.137</AssumedRangeToTarget>
                  <SignedSolarPhaseAngle uom="rad">120.37592176</SignedSolarPhaseAngle>
                  <ObservedVisualMagnitude uom="Vm">4.84628365</ObservedVisualMagnitude>
               </VisualData>
               <Type9>
                  <RightAscension errorEstimate="0.051850013724801296"
uom="rad">1.7812709671409483</RightAscension>
                  <Declination errorEstimate="0.028054566159910154"
uom="rad">0.6293058811398505</Declination>
                  <YearOfEquinox>ob_date_time</YearOfEquinox>
                  <Range errorEstimate="0.34591554793956836" uom="km">1162.2083236238232</Range>
                  <SensorPosition uom="m" srsName="ECI_date">-5817030.76068577 710103.95601475
4239291.27359913</SensorPosition>
```

```
                <SensorVelocity uom="m/s" srsName="ECI_date">-4425.51160008 -920.80523654
5968.56920012</SensorVelocity>
             </Type9>
          </MetricObservation>
          <MetricObservation>
             <Time>2017-11-17T07:29:26.20642Z</Time>
             <VisualData>
                <VisualMagnitude uom="Vm">7.0843233</VisualMagnitude>
                <AssumedRangeToTarget uom="km">6378.137</AssumedRangeToTarget>
                <SignedSolarPhaseAngle uom="rad">120.12378428</SignedSolarPhaseAngle>
                <ObservedVisualMagnitude uom="Vm">4.23481945</ObservedVisualMagnitude>
             </VisualData>
             <Type9>
                <RightAscension errorEstimate="0.050096194429550996"
uom="rad">1.848831348812598</RightAscension>
                <Declination errorEstimate="0.03217362170990656"
uom="rad">0.5965393640833311</Declination>
                <YearOfEquinox>ob_date_time</ YearOfEquinox >
                <Range errorEstimate="0.18263076555129748" uom="km">1198.497486926645</Range>
                <SensorPosition uom="m" srsName="ECI_date">-5804937.04573457 719723.09843572
4345237.72300364</SensorPosition>
                <SensorVelocity uom="m/s" srsName="ECI_date">-4362.04763576 -932.58347638
5836.48725021</SensorVelocity>
             </Type9>
          </MetricObservation>
          <MetricObservation>
             <Time>2017-11-17T07:29:37.72279Z</Time>
             <VisualData>
                <VisualMagnitude uom="Vm">7.1843233</VisualMagnitude>
                <AssumedRangeToTarget uom="km">6378.137</AssumedRangeToTarget>
                <SignedSolarPhaseAngle uom="rad">120.11262357</SignedSolarPhaseAngle>
                <ObservedVisualMagnitude uom="Vm">4.78934663</ObservedVisualMagnitude>
             </VisualData>
             <Type9>
                <RightAscension errorEstimate="0.033920839708952995"
uom="rad">1.9110826800396508</RightAscension>
                <Declination errorEstimate="0.02886900219254102"
uom="rad">0.5635970497310231</Declination>
                <YearOfEquinox>ob_date_time</YearOfEquinox>
                <Range errorEstimate="0.12732701866202645" uom="km">1239.6691955159697</Range>
                <SensorPosition uom="m" srsName="ECI_date">-5730030.56739473 726474.34523873
4474839.25020342</SensorPosition>
                <SensorVelocity uom="m/s" srsName="ECI_date">-4284.68935838 -944.56831802
5823.37819160</SensorVelocity>
             </Type9>
          </MetricObservation>
       </MetricObservationCollection>
    </MetricObservationTrack>
  </MetricObservationTrackCollection>
</MetricObservationTrackMsg>
```

Table A4.11. TYPE 10 (Radar Cross Section, Position, Velocity and Covariance)

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<MetricObservationTrackMsg xmlns="http://www.C2SSA.gov/C2SSADomain/Common/Types/v3"
xmlns:ns2="urn:us:gov:ic:ism" schemaVersion="3.4.2" ns2:resourceElement="false"
ns2:createDate="2017-11-17" ns2:classification="U" ns2:ownerProducer="USA" ns2:DESVersion="9">
  <CommonHeader>
    <SenderInfo messageID="511acd21-0cbc-46b9-ae67-62784bf3719f"/>
    <SourceID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">310</SourceID>
    <MsgCreationTime>2017-11-17T12:38:59.616Z</MsgCreationTime>
    <MsgContentPriority>routine</MsgContentPriority>
    <DataEnvironmentIndicator>test</DataEnvironmentIndicator>
  </CommonHeader>
  <MetricObservationTrackCollection>
    <MetricObservationTrack trackID="119919" passIDRef="c9a7cc51-4a98-4b2f-b448-788a95d59367"
obsCount="1" ns2:classification="U" ns2:ownerProducer="USA">
      <SatelliteNumber>2001167</SatelliteNumber>
      <SensorLocation>
```

```
          <Position srsName="EFG">1274.27705047795 -4725.66998351987
4075.94343159046</Position>
        </SensorLocation>
        <SensorID codespace="codespace" ns2:classification="U"
ns2:ownerProducer="USA">310</SensorID>
        <StartTime>2017-11-17T12:38:20.46706Z</StartTime>
        <StopTime>2017-11-17T12:38:56.32094Z</StopTime>
        <MetricObservationCollection>
           <MetricObservation>
              <Time>2017-11-17T12:38:56.32094Z</Time>
              <RCSMedianPair>
                 <RCSMedian polarization="principal">
                    <RCSValue errorEstimate="6.808619723362926"
uom="m2">13.756572246551514</RCSValue>
                 </RCSMedian>
                 <RCSMedian polarization="orthogonal">
                    <RCSValue errorEstimate="1.4466304737304612"
uom="m2">2.4276540875434875</RCSValue>
                 </RCSMedian>
              </RCSMedianPair>
              <Type10 srsName="ECI_date">
                 <ObjectPosition uom="m" srsName="ECI_date">-5817030.760685771
710103.9560147497 4239291.27359913</ObjectPosition>
                 <ObjectVelocity uom="m/s" srsName="ECI_date">-4425.511600076919 -
920.8052365436581 -5968.569200118006</ObjectVelocity>
                 <CovarianceMatrix category="POSITION_VELOCITY">75093.48186306635 -
196879.8678444352 1.8001015283938102E7 380937.1549048277       -711191.1550025939
1976496.375990394 605.7523306462165 -5426.398158960634 2437.988544940148 71.81483439428939
-3085.8373322956395 305556.9016783291 -10727.240620410086 -103.78760326086329
7049.8285481299545 12135.335367850847 -9818.969440229446 63514.84764501761 246.7023155430433 -
163.3949048844933 2944.1630817601313</CovarianceMatrix>
              </Type10>
           </MetricObservation>
        </MetricObservationCollection>
     </MetricObservationTrack>
   </MetricObservationTrackCollection>
</MetricObservationTrackMsg>
```

A4.2.3. XML Schema for Metric Observation Track Messages (Types 0 through 10): This paragraph documents the C2 SSA COI schema for the metric observation track messages. Version 3.4.2 is the latest version of the XML schemas. Upon receipt at the CSpOC, the schema below will be used to validate the XML messages documented in paragraph **A4.2.2**. In the original schema, all the type definitions run together. For better readability, the various type definitions were separated by white space with the name of each type provided in bold as a title.

Table A4.12. Schema Header Information

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<xs:schema xmlns="http://www.C2SSA.gov/C2SSADomain/Common/Types/v3"
xlmns:ns2="urn:us:gov:ic:ism" schemaVersion="3.4.2"
ns2:resourceElement="false" ns2:createDate="2017-11-17" ns2:classification="U"
ns2:ownerProducer="USA" ns2:DESVersion="9">
  <xs:annotation>
     <xs:documentation>
        <cdoc:SchemaDoc ism:resourceElement="true" ism:createDate="2016-02-22"
ism:compliesWith="DoD5230.24" ism:classification="U"
ism:ownerProducer="USA" ism:noticeType="DoD-Dist-C" ism:noticeReason="Administrative or
Operational Use" ism:noticeDate="2013-06-26">
           <cdoc:FullName>Metric Observation Track Message</cdoc:FullName>
           <cdoc:Description>This schema contains messages and types associated with metric
              observations.</cdoc:Description>
           <ism:NoticeList ism:classification="U" ism:ownerProducer="USA">
              <ism:Notice ism:classification="U" ism:ownerProducer="USA" ism:noticeType="POC">
                 <ism:NoticeText ism:classification="U" ism:ownerProducer="USA"
ism:pocType="DoD-Dist-C">SMC/SYF, 483 North Aviation Blvd, El Segundo,
                    CA 90245</ism:NoticeText>
```

```
            </ism:Notice>
         </ism:NoticeList>
      </cdoc:SchemaDoc>
   </xs:documentation>
</xs:annotation>
```

Table A4.13. MetricObservationTrackMsg (principal schema element)

```
<xs:element name="MetricObservationTrackMsg" type="ctyp:MetricObservationTrackMsgType">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Metric Observation Track Message</cdoc:FullName>
            <cdoc:Description>The top level element of a metric observation track message. The
message contains one or more tracks of metric observations.</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
</xs:element>
```

Table A4.14. MetricObservationTrackMsgType

```
<xs:complexType name="MetricObservationTrackMsgType">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Metric Observation Track Message Type</cdoc:FullName>
            <cdoc:Description>A message type containing one or more tracks of metric
observations.</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
      <xs:sequence
         <xs:element name="CommonHeader" type="ctyp:CommonHeaderType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Common Header</cdoc:FullName>
                  <cdoc:Description>This element is of the CommonHeaderType defined in the
C2SSA-COI schema.</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="MetricObservationTrackCollection"
type="ctyp:MetricObservationTrackCollectionType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Metric Observation Track Collection</cdoc:FullName>
                  <cdoc:Description>A collection of one to many tracks of metric
observations.</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
   </xs:sequence>
</xs:complexType>
```

Table A4.15. CommonHeaderType

```
<xs:complexType name="CommonHeaderType">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Common Header Type</cdoc:FullName>
```

```
            <cdoc:Description>Includes the elements to be located at the top of every XML
message document. The common header includes information about the message, the sending system
and the source system.</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:sequence>
      <xs:element name="SenderInfo" type="ctyp:SenderInfoType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Sender Information</cdoc:FullName>
                  <cdoc:Description>Includes elements describing the system sending and/or
publishing the message.</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="SourceID" type="ctyp:CodeListRestrictedType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Source Identifier</cdoc:FullName>
                  <cdoc:Description>Identifier of reporting sensor or ground system. This is
commonly referred to as the site name.</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="MsgCreationTime" type="ctyp:UTCDateTimeType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Message Creation Time</cdoc:FullName>
                  <cdoc:Description>Time the message was created</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="MsgContentPriority" type="ctyp:MsgContentPriorityType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Message Content Priority</cdoc:FullName>
                  <cdoc:Description>Indicates the relative priority of the information body
content. If this information is not provided by the sensor, the value will be set to
"routine".</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="DataEnvironmentIndicator" type="ctyp:DataEnvironmentIndicatorType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Data Environment Indicator</cdoc:FullName>
                  <cdoc:Description>Indicator defining the environment of the data, as based
on the system sending the message (i.e. the net-centric sidecar)</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
   </xs:sequence>
</xs:complexType>
```

Table A4.16. SenderInfoType

```
<xs:complexType name="SenderInfoType">
   <xs:annotation>
      <xs:documentation>
```

```
            <cdoc:StructuredDoc>
               <cdoc:FullName>Sender Info Type</cdoc:FullName>
               <cdoc:Description>Includes a sender specific unique identifier for the
message.</cdoc:Description>
            </cdoc:StructuredDoc>
         </xs:documentation>
      </xs:annotation>
      <xs:attribute name="messageID" type="ctyp:AnyURILengthRestrictedType" use="required">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Message Identifier</cdoc:FullName>
                  <cdoc:Description>The unique identifier for the message, generated by the
system sending the message (ex: the sidecar).
Refer to implementer documentation for specifics.</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:attribute>
   </xs:complexType>
```

Table A4.17. AnyURILengthRestrictedType

```
   <xs:simpleType name="AnyURILengthRestrictedType">
      <xs:annotation>
         <xs:documentation>
            <cdoc:StructuredDoc>
               <cdoc:FullName>Any URI Length Restricted Type</cdoc:FullName>
               <cdoc:Description>A generic URI Type that bounds the maximum number of characters
allowed to satisfy IA requirements.</cdoc:Description>
               <cdoc:ConstraintRationale>The upper bound value was chosen to satisfy IA
requirement for bounds in schema.  The selected value is meant to capture or surpass the order
of magnitude of the worst-case limit, and is not representative of functional requirements for
implementing systems.</cdoc:ConstraintRationale>
            </cdoc:StructuredDoc>
         </xs:documentation>
      </xs:annotation>
      <xs:restriction base="xs:anyURI">
         <xs:maxLength value="9999"/>
      </xs:restriction>
   </xs:simpleType>
```

Table A4.18. CodeListRestrictedType

```
   <xs:complexType name="CodeListRestrictedType">
      <xs:annotation>
         <xs:documentation>
            <cdoc:StructuredDoc>
               <cdoc:FullName>Code List Restricted Type</cdoc:FullName>
               <cdoc:Description>A generic representation of a code list that restricts the
codespace and code value based on restricted types designed to satisfy IA requirements for
bounds in schema.  Contact the data provider for access to the specific code list .xml files,
as they should be provided as part of the data provider&amp;amp;s ICD.  COI-provided Code Lists are
in the Code Lists folder at the top of the
registration package.</cdoc:Description>
               <cdoc:Notes>
                  <cdoc:Note>The code space attribute value must be the value of the "Canonical
Version URI" of the specified code list .xml file.</cdoc:Note>
                  <cdoc:Note>The element&amp;amp;s text value must be one of the "Code" values from
the specified code list .xml file.</cdoc:Note>
                  <cdoc:Note>The ICISM security attributes group should be used to capture the
security markings of the code value provided.</cdoc:Note>
               </cdoc:Notes>
            </cdoc:StructuredDoc>
         </xs:documentation>
      </xs:annotation>
      <xs:simpleContent>
         <xs:extension base="ctyp:CodeValueLengthRestrictedType">
            <xs:attributeGroup ref="ism:SecurityAttributesGroup"/>
```

```
         <xs:attribute name="codespace" type="ctyp:AnyURILengthRestrictedType"
use="required">
            <xs:annotation>
               <xs:documentation>
                  <cdoc:StructuredDoc>
                     <cdoc:FullName>Code Space</cdoc:FullName>
                     <cdoc:Description>URI that references an externally-defined Genericode
code list
                        which defines the valid list of values for the element's
content.</cdoc:Description>
                     <cdoc:References>
                        <cdoc:Reference>http://www.genericode.org/</cdoc:Reference>
                     </cdoc:References>
                  </cdoc:StructuredDoc>
               </xs:documentation>
            </xs:annotation>
         </xs:attribute>
      </xs:extension>
   </xs:simpleContent>
</xs:complexType>
```

Table A4.19. CodeValueLengthRestrictedType

```
<xs:simpleType name="CodeValueLengthRestrictedType">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Code Value Length Restricted Type</cdoc:FullName>
            <cdoc:Description>A generic representation of a code list value that bounds the
maximum number of characters allowed to satisfy IA requirements.</cdoc:Description>
            <cdoc:ConstraintRationale>The upper bound value was chosen to satisfy IA
requirement for bounds in schema. The selected value is meant to capture only the order of
magnitude of the real-world limit, and is not representative of functional requirements for
implementing systems.</cdoc:ConstraintRationale>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:restriction base="xs:token">
      <xs:maxLength value="9999"/>
   </xs:restriction>
</xs:simpleType>
```

Table A4.20. UTCDateTimeType

```
<xs:simpleType name="UTCDateTimeType">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Universal Coordinated Time Date and Time Type</cdoc:FullName>
            <cdoc:Description>A Gregorian date combined with a time referenced to the
Universal Coordinated Time (UTC) time scale.  Time must be specified to the second. Fractions
of seconds are optional and should be specified to the precision available. The format is YYYY-
MM-DDThh:mm:ss[.ssss]Z where T and Z are literals. 16 July 1995, Midnight UTC would be
expressed as 1995-07-16T00:00:00Z</cdoc:Description>
            <cdoc:ConstraintRationale>The specified pattern assures the use of 'Z' (UTC) for
Time Zone, and disallows the use of negative years, but otherwise conforms to the lexical space
of xs:dateTime as per the XML Schema Part 2.</cdoc:ConstraintRationale>
            <cdoc:References>
               <cdoc:Reference>http://www.w3.org/TR/xmlschema-2/#dateTime</cdoc:Reference>
            </cdoc:References>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:restriction base="xs:dateTime">
      <xs:pattern value="\d{4}-\d{2}-\d{2}T\d{2}:\d{2}:\d{2}(.\d+)?Z"/>
   </xs:restriction>
</xs:simpleType>
```

Table A4.21. MsgContentPriorityType

```
  <xs:simpleType name="MsgContentPriorityType">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Message Content Priority Type</cdoc:FullName>
              <cdoc:Description>Indicates the relative priority of the information body content.
If this information is not provided by the sensor, the value will be set to
'Routine'</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:restriction base="xs:token">
        <xs:enumeration value="emergency"/>
        <xs:enumeration value="flash"/>
        <xs:enumeration value="immediate"/>
        <xs:enumeration value="priority"/>
        <xs:enumeration value="routine"/>
     </xs:restriction>
  </xs:simpleType>
```

Table A4.22. DataEnvironmentIndicatorType

```
  <xs:simpleType name="DataEnvironmentIndicatorType">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Data Environment Indicator Type</cdoc:FullName>
              <cdoc:Description>Indicator defining the environment of the data, as based on the
system sending the message.</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:restriction base="xs:token">
        <xs:enumeration value="real"/>
        <xs:enumeration value="test"/>
        <xs:enumeration value="exercise"/>
        <xs:enumeration value="training"/>
     </xs:restriction>
  </xs:simpleType>
```

Table A4.23. MetricObservationTrackCollectionType

```
  <xs:complexType name="MetricObservationTrackCollectionType">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Metric Observation Track Collection Type</cdoc:FullName>
              <cdoc:Description>A collection of one to many tracks of metric
observations</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:sequence>
        <xs:element name="MetricObservationTrack" type="ctyp:MetricObservationTrackType"
maxOccurs="9999">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Metric Observation Track</cdoc:FullName>
                    <cdoc:Description>A track of metric observations.</cdoc:Description>
                    <cdoc:ConstraintRationaleCollection>
                       <cdoc:ConstraintRationale constraintRef="maxOccurs">The upper bound value
was chosen to satisfy IA requirement for bounds in schema.  The selected value is meant to
capture only the order of magnitude of the real-world limit, and is not representative of
functional requirements for implementing systems.
Note: The multiplicity of the Track element was included to allow for aggregation of multiple
passes or shooting periods.</cdoc:ConstraintRationale>
```

```
                  </cdoc:ConstraintRationaleCollection>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
   </xs:sequence>
</xs:complexType>
```

Table A4.24. MetricObservationTrackType

```
<xs:complexType name="MetricObservationTrackType">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Metric Observation Track Type</cdoc:FullName>
            <cdoc:Description>A Metric Observation Track is one or more observations of one
satellite collected by one Sensor during one time period while the object was in
view.</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:sequence>
      <xs:element name="SatelliteNumber" type="ctyp:SatelliteNumberType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Satellite Number</cdoc:FullName>
                  <cdoc:Description>The RSO number of the object being
tracked</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="SensorLocation" type="ctyp:SensorLocationType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Sensor Location</cdoc:FullName>
                  <cdoc:Description>See Base Description</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="SensorID" type="ctyp:CodeListRestrictedType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Sensor Identifier</cdoc:FullName>
                  <cdoc:Description>The unique identifier for the sensor producing the metric
observation(s).</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="StartTime" type="ctyp:UTCDateTimeType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Start Time</cdoc:FullName>
                  <cdoc:Description>The date/time of the first metric observation of this
track.</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="StopTime" type="ctyp:UTCDateTimeType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Stop Time</cdoc:FullName>
```

```
                  <cdoc:Description>The date/time of the last metric observation of this
track.</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="MetricObservationCollection"
type="ctyp:MetricObservationCollectionType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Metric Observation Collection</cdoc:FullName>
                  <cdoc:Description>A collection of metric observations</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
   </xs:sequence>
   <xs:attribute name="trackID" type="ctyp:AnyURILengthRestrictedType" use="required">
      <xs:annotation>
         <xs:documentation>
            <cdoc:StructuredDoc>
               <cdoc:FullName>Track Identifier</cdoc:FullName>
               <cdoc:Description>Represents a unique identifier for the
track.</cdoc:Description>
            </cdoc:StructuredDoc>
         </xs:documentation>
      </xs:annotation>
   </xs:attribute>
   <xs:attribute name="passIDRef" type="ctyp:UUIDType" use="optional">
      <xs:annotation>
         <xs:documentation>
            <cdoc:StructuredDoc>
               <cdoc:FullName>Pass Identifier Reference</cdoc:FullName>
               <cdoc:Description>Associates all the data collected within the same pass for an
optical or radar sensor. A pass is a contiguous collection of data from a radar sensor.  For
optical sensors, a pass is a consecutive collection of field of views (FOVs) on the same
object. </cdoc:Description>
            </cdoc:StructuredDoc>
         </xs:documentation>
      </xs:annotation>
   </xs:attribute>
   <xs:attribute name="obsCount" type="xs:positiveInteger" use="optional">
      <xs:annotation>
         <xs:documentation>
            <cdoc:StructuredDoc>
               <cdoc:FullName>Observation Count</cdoc:FullName>
               <cdoc:Description>The number of metric observations in this
track.</cdoc:Description>
               <cdoc:DeprecationReason>Observation Count should be retrieved from the actual
number of child elements in the MetricObservation Collection.</cdoc:DeprecationReason>
            </cdoc:StructuredDoc>
         </xs:documentation>
      </xs:annotation>
   </xs:attribute>
</xs:complexType>
```

Table A4.25. SatelliteNumberType

```
<xs:simpleType name="SatelliteNumberType">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Satellite Number Type</cdoc:FullName>
            <cdoc:Description>The catalog number assigned to the object by USSTRATCOM. The
satellite numbering scheme is based on the Satellite Catalog Renumbering Working Group Final
Report, v0.2, 25 July 2013  (Appendix B-2, Section 6). Though not inherently enforceable by the
schema validator, this definition is intended to only allow a 9-digit formatted value and is
not intended to also support the legacy 5-digit format.
            </cdoc:Description>
```

```
            <cdoc:References>

  <cdoc:Reference>https://gem.spawar.navy.mil/C2SSACOI/c2ssacoiwiki/moin.cgi/C2SSACOI?action=At
tachFile&amp;
httpsdo=get&amp;target=Satellite_Catalog_Renumbering_Working_Group_Final_Report</cdoc:Reference
>

  <cdoc:Reference>https://gem.spawar.navy.mil/C2SSACOI/c2ssacoiwiki/moin.cgi/C2SSACOI?action=At
tachFile&amp;do=get&amp
target=Satellite_Catalog_Renumbering_Working_Group_Final_Report</cdoc:Reference>
            </cdoc:References>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:restriction base="xs:int">
      <xs:minInclusive value="1"/>
      <xs:maxInclusive value="999999999"/>
   </xs:restriction>
</xs:simpleType>
```

Table A4.26. SensorLocationType

```
<xs:complexType name="SensorLocationType">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Sensor Location Type</cdoc:FullName>
            <cdoc:Description>The location of the sensor, modeled as either a position or an
orbital element set.</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:sequence>
      <xs:choice>
         <xs:element name="Position" type="ctyp:PositionRequiredSRSType">
            <xs:annotation>
               <xs:documentation>
                  <cdoc:StructuredDoc>
                     <cdoc:FullName>Position</cdoc:FullName>
                     <cdoc:Description>See Base Description</cdoc:Description>
                  </cdoc:StructuredDoc>
               </xs:documentation>
            </xs:annotation>
         </xs:element>
         <xs:element name="OrbitalElementSet" type="ctyp:OrbitalElementSetType">
            <xs:annotation>
               <xs:documentation>
                  <cdoc:StructuredDoc>
                     <cdoc:FullName>Orbital Element Set</cdoc:FullName>
                     <cdoc:Description>See Base Description</cdoc:Description>
                  </cdoc:StructuredDoc>
               </xs:documentation>
            </xs:annotation>
         </xs:element>
      </xs:choice>
   </xs:sequence>
</xs:complexType>
```

Table A4.27. PositionRequiredSRSType

```
<xs:complexType name="PositionRequiredSRSType">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Position with Required SRS Type</cdoc:FullName>
            <cdoc:Description>A representation of position coordinates, in any supported
coordinate system. Coordinate systems are referenced by URI. For the supported list, see
SupportedSrsNamesType.  The values provided in the double list appear in the order and unit of
measure defined by the spatial reference system.</cdoc:Description>
```

```
            <cdoc:Notes>
               <cdoc:Note>This is meant to be functionally similar to the COI Global
PositionType, except with manditory srsName attribute.</cdoc:Note>
            </cdoc:Notes>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:simpleContent>
      <xs:restriction base="gml:DirectPositionType">
         <xs:minLength value="2"/>
         <xs:maxLength value="3"/>
         <xs:attributeGroup ref="ctyp:RequiredSRSReferenceAttributeGroup"/>
      </xs:restriction>
   </xs:simpleContent>
</xs:complexType>
```

Table A4.28. RequiredSRSReferenceAttributeGroup

```
<xs:attributeGroup name="RequiredSRSReferenceAttributeGroup">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Required SRS Reference Attribute Group</cdoc:FullName>
            <cdoc:Description>
            The attribute group RequiredSRSReferenceAttributeGroup provides a reference to the
Coordinate Reference System (CRS) used by this geometry, with optional additional information
to simplify the processing of the coordinates when a more complete definition of the CRS is not
needed.
            </cdoc:Description>
            <cdoc:References>
               <cdoc:Reference>Based on GML's SRSReferenceGroup</cdoc:Reference>
            </cdoc:References>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:attribute name="srsName" type="ctyp:SupportedSrsNamesType" use="required">
      <xs:annotation>
         <xs:documentation>
            <cdoc:StructuredDoc>
               <cdoc:FullName>Spatial Reference System Name</cdoc:FullName>
               <cdoc:Description>The name of the spatial reference system (SRS) to be used
when
               interpreting coordinate values.
               </cdoc:Description>
            </cdoc:StructuredDoc>
         </xs:documentation>
      </xs:annotation>
   </xs:attribute>
   <xs:attribute name="srsDimension" type="xs:positiveInteger">
      <xs:annotation>
         <xs:documentation>
            <cdoc:StructuredDoc>
               <cdoc:FullName>Spatial Reference System Dimension</cdoc:FullName>
               <cdoc:Description>Number of dimensions in the coordinate
data.</cdoc:Description>
               <cdoc:Omissions>
                  <cdoc:Omission>srsDimension is defined for compatibility with GML. For C2
SSA COI applications it is expected that the SRS Name provides sufficient definition of the
Coordinate Reference System, and therefore the srsDimension is unnecessary and should be
omitted.
                  </cdoc:Omission>
               </cdoc:Omissions>
            </cdoc:StructuredDoc>
         </xs:documentation>
      </xs:annotation>
   </xs:attribute>
   <xs:attributeGroup ref="gml:SRSInformationGroup"/>
</xs:attributeGroup>
```

Table A4.29. SupportedSrsNamesType

```
  <xs:simpleType name="SupportedSrsNamesType">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Supported Spatial Reference System Names Type</cdoc:FullName>
              <cdoc:Description>List of enumerations representing Spatial Reference
Systems.</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:restriction base="xs:anyURI">
        <xs:enumeration value="ECI_J2K">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>J2000.0 Mean Equator and Mean Equinox Coordinate Reference
System</cdoc:FullName>
                    <cdoc:Description>Geocentric inertial coordinate reference system based on
mean equator and mean equinox at the time (epoch) denoted by J2000.0.</cdoc:Description>
                    <cdoc:References><cdoc:Reference>Dr. J.C. Lander and C2 SSA COI Data Model
Working Group, "Recommended Coordinate Reference Systems for C2 SSA COI Use", MITRE Technical
Report, March 2014.</cdoc:Reference></cdoc:References>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:enumeration>
        <xs:enumeration value="ECI_date">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Earth-centered Inertial (ECI) Coordinate Reference System
with True Equator and Mean Equinox (TEME) of Date</cdoc:FullName>
                    <cdoc:Description>Legacy coordinate reference system used in the U.S. Space
Object Catalog</cdoc:Description>
                    <cdoc:References><cdoc:Reference>Dr. J.C. Lander and C2 SSA COI Data Model
Working Group, "Recommended Coordinate Reference Systems for C2 SSA COI Use", MITRE Technical
Report, March 2014.</cdoc:Reference></cdoc:References>
                    <cdoc:Synonyms><cdoc:Synonym>ECI TEME of Date</cdoc:Synonym></cdoc:Synonyms>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:enumeration>
        <xs:enumeration value="EFG">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Earth-Fixed Greenwich (EFG) Coordinate Reference
System</cdoc:FullName>
                    <cdoc:Description>Geocentric rotating coordinate reference system that does
not correct for polar motion but uses the true equator and mean equinox of
date</cdoc:Description>
                    <cdoc:References><cdoc:Reference>Dr. J.C. Lander and C2 SSA COI Data Model
Working Group, "Recommended Coordinate Reference Systems for C2 SSA COI Use", MITRE Technical
Report, March 2014.</cdoc:Reference></cdoc:References>
                    <cdoc:Synonyms><cdoc:Synonym>NASAs True of Date Rotating
(TDR)</cdoc:Synonym></cdoc:Synonyms>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:enumeration>
        <xs:enumeration value="PLACEHOLDER_FOR_ECI-J2K">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Earth Centered Inertial Reference System J2000 Epoch NOTE:
Need to search for an official URI</cdoc:FullName>
                    <cdoc:Description/>
```

```
                  <cdoc:DeprecationReason>This was a placeholder enumeration that has since
been replaced.  The ECI_J2K encoding should be used instead.</cdoc:DeprecationReason>
                  </cdoc:StructuredDoc>
               </xs:documentation>
            </xs:annotation>
         </xs:enumeration>
         <xs:enumeration value="WGS84C_3D">
            <xs:annotation>
               <xs:documentation>
                  <cdoc:StructuredDoc>
                     <cdoc:FullName>World Geodetic System 1984 - Earth Centered, Earth Fixed
(ECEF) Coordinate Reference System</cdoc:FullName>
                     <cdoc:Description>Three-dimensional position based on World Geodetic System
1984 (WGS84)</cdoc:Description>

  <cdoc:References><cdoc:Reference>https://metadata.ces.mil/dse/ns/GSIP/crs/WGS84C_3D</cdoc:Ref
erence></cdoc:References>
                     <cdoc:Synonyms><cdoc:Synonym>ECEF</cdoc:Synonym></cdoc:Synonyms>
                  </cdoc:StructuredDoc>
               </xs:documentation>
            </xs:annotation>
         </xs:enumeration>
         <xs:enumeration value="WGS84E_2D">
            <xs:annotation>
               <xs:documentation>
                  <cdoc:StructuredDoc>
                     <cdoc:FullName>World Geodetic System 1984 - Geographic 2D Coordinate
Reference System</cdoc:FullName>
                     <cdoc:Description>Geodetic (geographic) position based on World Geodetic
System 1984 (WGS84)</cdoc:Description>

  <cdoc:References><cdoc:Reference>https://metadata.ces.mil/dse/ns/GSIP/crs/WGS84E_2D</cdoc:Ref
erence></cdoc:References>
                  </cdoc:StructuredDoc>
               </xs:documentation>
            </xs:annotation>
         </xs:enumeration>
         <xs:enumeration value="WGS84E_3D">
            <xs:annotation>
               <xs:documentation>
                  <cdoc:StructuredDoc>
                     <cdoc:FullName>World Geodetic System 1984 - Geographic 2D + HAE Coordinate
Reference System</cdoc:FullName>
                     <cdoc:Description>Geodetic (geographic) position based on World Geodetic
System 1984 (WGS84), extended by ellipsoidal height position ('Height Above Ellipsoid':
HAE).</cdoc:Description>

  <cdoc:References><cdoc:Reference>https://metadata.ces.mil/dse/ns/GSIP/crs/WGS84E_3D</cdoc:Ref
erence></cdoc:References>
                  </cdoc:StructuredDoc>
               </xs:documentation>
            </xs:annotation>
         </xs:enumeration>
         <xs:enumeration value="4326">
            <xs:annotation>
               <xs:documentation>
                  <cdoc:StructuredDoc>
                     <cdoc:FullName>WGS-84 Latitude and Longitude</cdoc:FullName>
                     <cdoc:Description>Geodetic coordinate system. Ellipsoidal 2D coordinate
system. Axes: latitude, longitude. Orientations: north, east. Used by the GPS satellite
navigation system and for NATO military geodetic surveying.</cdoc:Description>

  <cdoc:References><cdoc:Reference>http://epsg.io/4326</cdoc:Reference></cdoc:References>
                     <cdoc:DeprecationReason>Geopotential Intelligence Structure Implementation
Profile (GSIP) encoding, supported by the Time-Space-Position Information (TSPI) Specification,
is preferred over EPSG encoding. The WGS84E_2D encoding should be used
instead.</cdoc:DeprecationReason>
                  </cdoc:StructuredDoc>
               </xs:documentation>
            </xs:annotation>
         </xs:enumeration>
```

```
        <xs:enumeration value="4978">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>WGS-84 ECEF</cdoc:FullName>
                    <cdoc:Description>Geocentric coordinate system. Earth centered, earth fixed,
righthanded 3D coordinate system, consisting of 3 orthogonal axes with X and Y axes in the
equatorial plane, positive Z-axis parallel to mean earth rotation axis and pointing towards
North Pole. Used by the GPS satellite navigation system.</cdoc:Description>

  <cdoc:References><cdoc:Reference>http://epsg.io/4978</cdoc:Reference></cdoc:References>
                    <cdoc:DeprecationReason>Geopotential Intelligence Structure Implementation
Profile (GSIP) encoding, supported by the Time-Space-Position Information (TSPI) Specification,
is preferred over EPSG encoding. The WGS84C_3D encoding should be used
instead.</cdoc:DeprecationReason>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:enumeration>
        <xs:enumeration value="4979">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>WGS-84  Latitude, Longitude and Ellipsoid
Height</cdoc:FullName>
                    <cdoc:Description>Geodetic 3D coordinate system. Ellipsoidal 3D coordinate
system. Axes: latitude, longitude, ellipsoidal height. Orientations: north, east, up. Used by
the GPS satellite navigation system.</cdoc:Description>

  <cdoc:References><cdoc:Reference>http://epsg.io/4979</cdoc:Reference></cdoc:References>
                    <cdoc:DeprecationReason>Geopotential Intelligence Structure Implementation
Profile (GSIP) encoding, supported by the Time-Space-Position Information (TSPI) Specification,
is preferred over EPSG encoding. The WGS84E_3D encoding should be used
instead.</cdoc:DeprecationReason>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:enumeration>
     </xs:restriction>
  </xs:simpleType>
```

Table A4.30. MetricObservationCollectionType

```
  <xs:complexType name="MetricObservationCollectionType">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Metric Observation Collection Type</cdoc:FullName>
              <cdoc:Description>A collection of metric observations</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:sequence>
        <xs:element name="MetricObservation" type="ctyp:MetricObservationType" maxOccurs="99">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Metric Observation</cdoc:FullName>
                    <cdoc:Description>A metric observation defines which object was observed,
when it was observed, where the object was observed and, if rate data is included, where the
object is going.  Metric observations represent the fundamental data product of SSN sites.  An
observation is generated from a site-filtered ('averaged') collection of one-to-many radar
returns/track filter updates.  Metric observations are used by the CSpOC to update orbital
element sets.  The observation elements (i.e., Look Geometry) depend on sensor
type.</cdoc:Description>
                    <cdoc:ConstraintRationaleCollection>
                       <cdoc:ConstraintRationale constraintRef="maxOccurs">The upper bound value
was chosen to satisfy IA requirement for bounds in schema.  The selected value is meant to
capture only the order of magnitude of the real-world limit, and is not representative of
functional requirements for implementing systems.
```

```
Note: It is assumed that a sensor would never produce more than 99 metric observations within a
single track. As an example, the standard Eglin metric observation track contains 3 metric
observations per track, for Near Earth objects.</cdoc:ConstraintRationale>
                  </cdoc:ConstraintRationaleCollection>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
   </xs:sequence>
```

Table A4.31. UUIDType

```
  <xs:simpleType name="UUIDType">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Universally Unique Identifier (UUID)</cdoc:FullName>
              <cdoc:Description>A Universally Unique Identifier (UUID) is a 16-byte identifier
standard used in software construction, standardized by the Open Software Foundation (OSF) as
part of the Distributed Computing Environment (DCE). The intent of UUIDs is to enable
distributed systems to uniquely identify information without significant central coordination.
Thus, anyone can create a UUID and use it to identify something with reasonable confidence that
the identifier will never be unintentionally used by anyone for anything else. Information
labeled with UUIDs can therefore be later combined into a single database without needing to
resolve name conflicts.

A UUID consists of 32 hexadecimal digits, displayed in 5 groups separated by hyphens, in the
form 8-4-4-4-12 for a total of 36 characters (32 digits and 4 hyphens). For example: 550e8400-
e29b-41d4-a716-446655440000
UUIDs are not assigned sequentially; they are generated by one of several algorithms.
Implementers should, to the greatest extent possible use the provided algorithm for their
target platform. For example: System.Guid.NewGuid() in the .Net Framework
java.util.UUID.randomUUID() in Java SYS_GUID() in Oracle databases NEWID() in Microsoft SQL
Server databases
              </cdoc:Description>
              <cdoc:References>
                 <cdoc:Reference>http://www.ietf.org/rfc/rfc4122.txt</cdoc:Reference>
              </cdoc:References>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:restriction base="xs:token">
        <xs:pattern value="[0-9A-F]{8}-[0-9A-F]{4}-[0-9A-F]{4}-[0-9A-F]{4}-[0-9A-F]{12}|[0-9a-
f]{8}-[0-9a-f]{4}-[0-9a-f]{4}-[0-9a-f]{4}-[0-9a-f]{12}"/>
     </xs:restriction>
  </xs:simpleType>
```

Table A4.32. MetricObservationType

```
  <xs:complexType name="MetricObservationType">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Metric Observation Type</cdoc:FullName>
              <cdoc:Description>A metric observation defines which object was observed, when it
was observed, where the object was observed and, if rate data is included, where the object is
going.  Metric observations represent the fundamental data product of SSN sites.  An
observation is generated from a site-filtered ('averaged') collection of one-to-many radar
returns/track filter updates.  Metric observations are used by the CSpOC to update orbital
element sets.  The observation elements (i.e. Look Geometry) depend on sensor
type.</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:sequence>
        <xs:element name="Time" type="ctyp:UTCDateTimeType">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
```

```
                  <cdoc:FullName>Time of Observation</cdoc:FullName>
                  <cdoc:Description>The time the observation occurred</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:choice minOccurs="0">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:Description/>
                  <cdoc:Omissions>
                     <cdoc:Omission>Data providers will determine when this data can be
included. See provider documentation for more details.</cdoc:Omission>
                  </cdoc:Omissions>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
         <xs:element name="RCSMedian" type="ctyp:RCSExtendedType">
            <xs:annotation>
               <xs:documentation>
                  <cdoc:StructuredDoc>
                     <cdoc:FullName>Radar Cross Section Median</cdoc:FullName>
                     <cdoc:Description>The median of the RCS hits that participated in the
formation of the observation</cdoc:Description>
                  </cdoc:StructuredDoc>
               </xs:documentation>
            </xs:annotation>
         </xs:element>
         <xs:element name="RCSMedianPair" type="ctyp:RCSMedianPairType">
            <xs:annotation>
               <xs:documentation>
                  <cdoc:StructuredDoc>
                     <cdoc:FullName>Radar Cross Section Median Pair</cdoc:FullName>
                     <cdoc:Description>A collection of two RCS median values, one per
polarization.</cdoc:Description>
                  </cdoc:StructuredDoc>
               </xs:documentation>
            </xs:annotation>
         </xs:element>
         <xs:element name="VisualData" type="ctyp:VisualDataType">
            <xs:annotation>
               <xs:documentation>
                  <cdoc:StructuredDoc>
                     <cdoc:FullName>Visual Magnitude Data</cdoc:FullName>
                     <cdoc:Description>Contains data related to visual
magnitude.</cdoc:Description>
                  </cdoc:StructuredDoc>
               </xs:documentation>
            </xs:annotation>
         </xs:element>
      </xs:choice>
      <xs:choice>
         <xs:element name="Type0" type="ctyp:Type0Type">
            <xs:annotation>
               <xs:documentation>
                  <cdoc:StructuredDoc>
                     <cdoc:FullName>Type 0</cdoc:FullName>
                     <cdoc:Description>The observation elements associated with a particular
sensor type.  Type 0 = Rgrt (used by ASCC)</cdoc:Description>
                  </cdoc:StructuredDoc>
               </xs:documentation>
            </xs:annotation>
         </xs:element>
         <xs:element name="Type1" type="ctyp:Type1Type">
            <xs:annotation>
               <xs:documentation>
                  <cdoc:StructuredDoc>
                     <cdoc:FullName>Type 1</cdoc:FullName>
                     <cdoc:Description>See Base Description.</cdoc:Description>
                  </cdoc:StructuredDoc>
```

```
      </xs:documentation>
   </xs:annotation>
</xs:element>
<xs:element name="Type2" type="ctyp:Type2Type">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Type 2</cdoc:FullName>
            <cdoc:Description>See Base Description.</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
</xs:element>
<xs:element name="Type3" type="ctyp:Type3Type">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Type 3</cdoc:FullName>
            <cdoc:Description>See Base Description.</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
</xs:element>
<xs:element name="Type4" type="ctyp:Type4Type">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Type 4</cdoc:FullName>
            <cdoc:Description>See Base Description.</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
</xs:element>
<xs:element name="Type5" type="ctyp:Type5Type">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Type 5</cdoc:FullName>
            <cdoc:Description>See Base Description.</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
</xs:element>
<xs:element name="Type6" type="ctyp:Type6Type">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Type 6</cdoc:FullName>
            <cdoc:Description>See Base Description.</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
</xs:element>
<xs:element name="Type7" type="ctyp:Type7Type">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Type 7</cdoc:FullName>
            <cdoc:Description>See Base Description.</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
</xs:element>
<xs:element name="Type8" type="ctyp:Type8Type">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Type 8</cdoc:FullName>
            <cdoc:Description>See Base Description.</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
```

```
            </xs:annotation>
         </xs:element>
         <xs:element name="Type9" type="ctyp:Type9Type">
            <xs:annotation>
               <xs:documentation>
                  <cdoc:StructuredDoc>
                     <cdoc:FullName>Type 9</cdoc:FullName>
                     <cdoc:Description>See Base Description.</cdoc:Description>
                  </cdoc:StructuredDoc>
               </xs:documentation>
            </xs:annotation>
         </xs:element>
         <xs:element name="Type10" type="ctyp:Type10Type">
            <xs:annotation>
               <xs:documentation>
                  <cdoc:StructuredDoc>
                     <cdoc:FullName>Type 10</cdoc:FullName>
                     <cdoc:Description>See Base Description.</cdoc:Description>
                  </cdoc:StructuredDoc>
               </xs:documentation>
            </xs:annotation>
         </xs:element>
      </xs:choice>
   </xs:sequence>
</xs:complexType>
```

Table A4.33. RCSExtendedType

```
<xs:complexType name="RCSExtendedType">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Radar Cross Section (RCS) Extended Type</cdoc:FullName>
            <cdoc:Description>The radar cross section measurement data, extended to include
information regarding the sensor's polarization and an optional spectral width
measurement.</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:sequence>
      <xs:element name="RCSValue" type="ctyp:RCSValueType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>RCS Value</cdoc:FullName>
                  <cdoc:Description>The measured value of RCS.</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="SpectralWidth" type="ctyp:HertzType" minOccurs="0">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Spectral Width</cdoc:FullName>
                  <cdoc:Description>The spectral width of a satellite, produced a result of
performing coherent integration. This information can help determine if an object is stable or
tumbling which is often useful to distinguish a rocket body from an active stabilized payload
or to deduce the rotational period of slowly tumbling objects at GEO.</cdoc:Description>
                  <cdoc:Omissions>
                     <cdoc:Omission>A null value implies this information is not available as
it was not produced by the sensor source. This measurement can only be expected for radars that
use long coherent processing intervals.</cdoc:Omission>
                  </cdoc:Omissions>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
   </xs:sequence>
   <xs:attribute name="polarization" type="ctyp:PolarizationBaseType" use="required">
```

```
        <xs:annotation>
           <xs:documentation>
              <cdoc:StructuredDoc>
                 <cdoc:FullName>Polarization</cdoc:FullName>
                 <cdoc:Description>The sensor's polarization when collecting the
data</cdoc:Description>
              </cdoc:StructuredDoc>
           </xs:documentation>
        </xs:annotation>
     </xs:attribute>
  </xs:complexType>
```

Table A4.34. RCSMedianPairType

```
  <xs:complexType name="RCSMedianPairType">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>RCS Median Pair Type</cdoc:FullName>
              <cdoc:Description>A pair of RCS median values, used for sensors with dual
polarizations.</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:sequence>
        <xs:element name="RCSMedian" type="ctyp:RCSExtendedType" minOccurs="2" maxOccurs="2">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Radar Cross Section Median</cdoc:FullName>
                    <cdoc:Description>The median of the RCS hits that participated in the
formation of the observation</cdoc:Description>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
     </xs:sequence>
  </xs:complexType>
```

Table A4.35. RCSValueType

```
  <xs:complexType name="RCSValueType">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Radar Cross Section Value Type</cdoc:FullName>
              <cdoc:Description>A generic representation of an observed radar cross section
(RCS) value, measured in square meters, with optional error estimate
information</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:complexContent>
        <xs:extension base="MetersSquaredType">
           <xs:attribute name="errorEstimate" type="ctyp:ErrorEstimateType">
              <xs:annotation>
                 <xs:documentation>
                    <cdoc:StructuredDoc>
                       <cdoc:FullName>Error Estimate</cdoc:FullName>
                       <cdoc:Description>See Base Description.</cdoc:Description>
                       <cdoc:Omissions>
                          <cdoc:Omission>Lack of presence the error estimate value means the
error is unreported.</cdoc:Omission>
                       </cdoc:Omissions>
                    </cdoc:StructuredDoc>
                 </xs:documentation>
              </xs:annotation>
           </xs:attribute>
        </xs:extension>
```

```
    </xs:complexContent>
  </xs:complexType>
```

Table A4.36. MetersSquaredType

```
  <xs:complexType name="MetersSquaredType">
    <xs:annotation>
      <xs:documentation>
        <cdoc:StructuredDoc>
          <cdoc:FullName>Meters Squared Type</cdoc:FullName>
          <cdoc:Description>A generic representation of area, measured in meters
squared</cdoc:Description>
        </cdoc:StructuredDoc>
      </xs:documentation>
    </xs:annotation>
    <xs:simpleContent>
      <xs:restriction base="gml:MeasureType">
        <xs:attribute name="uom" type="gml:UomIdentifier" use="required" fixed="m2">
          <xs:annotation>
            <xs:documentation>
              <cdoc:StructuredDoc>
                <cdoc:FullName>Unit of Measure</cdoc:FullName>
                <cdoc:Description>Abbreviation for square meters as defined by Unified
Code for Units of Measure</cdoc:Description>
                <cdoc:References>
                  <cdoc:Reference>http://unitsofmeasure.org/ucum.html</cdoc:Reference>
                </cdoc:References>
              </cdoc:StructuredDoc>
            </xs:documentation>
          </xs:annotation>
        </xs:attribute>
      </xs:restriction>
    </xs:simpleContent>
  </xs:complexType>
```

Table A4.37. ErrorEstimateType

```
  <xs:simpleType name="ErrorEstimateType">
    <xs:annotation>
      <xs:documentation>
        <cdoc:StructuredDoc>
          <cdoc:FullName>Error Estimate Type</cdoc:FullName>
          <cdoc:Description>A generic representation of an error estimate of a reported
measurement value, where the unit of measure is assumed to be that of value it&amp;apos;s
estimating. A value of 0 implies an exact measurement.</cdoc:Description>
          <cdoc:ConstraintRationaleCollection>
            <cdoc:ConstraintRationale constraintRef="pattern">The pattern restriction of up
to 15 mantissa and 4 exponent digits was chosen to satisfy IA requirement for bounds in schema.
The selected value is meant to capture only the order of magnitude of the real-world limit, and
is not representative of functional requirements for implementing
systems.</cdoc:ConstraintRationale>
          </cdoc:ConstraintRationaleCollection>
        </cdoc:StructuredDoc>
      </xs:documentation>
    </xs:annotation>
    <xs:restriction base="xs:double">
      <xs:pattern value="[0-9\-\+\.eE]{1,22}"/>
    </xs:restriction>
  </xs:simpleType>
```

Table A4.38. HertzType

```
  <xs:complexType name="HertzType">
    <xs:annotation>
      <xs:documentation>
        <cdoc:StructuredDoc>
          <cdoc:FullName>Hertz Type</cdoc:FullName>
```

```
            <cdoc:Description>A generic representation of a Frequency measured in
Hertz</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:simpleContent>
      <xs:restriction base="gml:MeasureType">
         <xs:minInclusive value="0"/>
         <xs:attribute name="uom" type="gml:UomIdentifier" use="required" fixed="Hz">
            <xs:annotation>
               <xs:documentation>
                  <cdoc:StructuredDoc>
                     <cdoc:FullName>Unit of Measure</cdoc:FullName>
                     <cdoc:Description>Abbreviation for Hertz, i.e., cycles per second as
defined by Unified Code for Units of Measure</cdoc:Description>
                     <cdoc:References>
                        <cdoc:Reference>http://unitsofmeasure.org/ucum.html</cdoc:Reference>
                     </cdoc:References>
                  </cdoc:StructuredDoc>
               </xs:documentation>
            </xs:annotation>
         </xs:attribute>
      </xs:restriction>
   </xs:simpleContent>
</xs:complexType>
```

Table A4.39. PolarizationBaseType

```
<xs:simpleType name="PolarizationBaseType">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Polarization Base Type</cdoc:FullName>
            <cdoc:Description>The base polarization type. Polarization is a property of
electromagnetic waves that describes the orientation of their oscillations.</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:restriction base="xs:token">
      <xs:enumeration value="circular">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Circular</cdoc:FullName>
                  <cdoc:Description/>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="horizontal">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Horizontal</cdoc:FullName>
                  <cdoc:Description/>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="left_circular">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Left-Hand Circular</cdoc:FullName>
                  <cdoc:Description/>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="linear">
```

```
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Linear</cdoc:FullName>
                  <cdoc:Description/>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="orthogonal">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Orthogonal</cdoc:FullName>
                  <cdoc:Description/>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="principal">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Principal</cdoc:FullName>
                  <cdoc:Description/>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="right_circular">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Right-Hand Circular</cdoc:FullName>
                  <cdoc:Description/>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="unpolarized">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Unpolarized</cdoc:FullName>
                  <cdoc:Description/>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="vertical">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Vertical</cdoc:FullName>
                  <cdoc:Description/>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:enumeration>
   </xs:restriction>
</xs:simpleType>
```

Table A4.40. VisualDataType

```
<xs:complexType name="VisualDataType">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Visual Data Type</cdoc:FullName>
            <cdoc:Description>Contains visual magnitudes and related data.</cdoc:Description>
```

```
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:sequence>
      <xs:element name="AbsoluteVisualMagnitude" type="ctyp:VisualMagnitudeType"
minOccurs="0">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Absolute Visual Magnitude</cdoc:FullName>
                  <cdoc:Description>Also known as the "normalized visual magnitude".  The
calibrated visual magnitude scaled to the object being at some reference distance known as the
assumed range-to-target.</cdoc:Description>
                  <cdoc:Omissions>
                     <cdoc:Omission>Data providers will determine when this data can be
included. See provider documentation for more details.</cdoc:Omission>
                  </cdoc:Omissions>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="AssumedRangeToTarget" type="ctyp:AssumedRangeToTargetType"
minOccurs="0">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Assumed Range-to-Target</cdoc:FullName>
                  <cdoc:Description>The estimated distance to the object which was used to
compute the absolute visual magnitude value.</cdoc:Description>
                  <cdoc:Omissions>
                     <cdoc:Omission>Data providers will determine when this data can be
included. See provider documentation for more details.</cdoc:Omission>
                  </cdoc:Omissions>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="SignedSolarPhaseAngle" type="ctyp:NegativePiToPiType" minOccurs="0">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Signed Solar Phase Angle</cdoc:FullName>
                  <cdoc:Description>The angular distance between the sun and the earth from
the satellite (i.e., the sun-satellite-earth angle).</cdoc:Description>
                  <cdoc:Omissions>
                     <cdoc:Omission>Data providers will determine when this data can be
included. See provider documentation for more details.</cdoc:Omission>
                  </cdoc:Omissions>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="ObservedVisualMagnitude" type="ctyp:VisualMagnitudeType"
minOccurs="0">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Observed Visual Magnitude</cdoc:FullName>
                  <cdoc:Description>Also known as the "apparent" or "instrument" visual
magnitude.  The measured brightness of an object in visual magnitudes (Mv) at the time it was
tracked.  The observed visual magnitude is the actual measured value adjusted for atmospheric
extinction, sky background, and instrument sensitivity.</cdoc:Description>
                  <cdoc:Omissions>
                     <cdoc:Omission>Data providers will determine when this data can be
included. See provider documentation for more details.</cdoc:Omission>
                  </cdoc:Omissions>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="StarsFound" type="xs:nonNegativeInteger" minOccurs="0">
```

```
          <xs:annotation>
             <xs:documentation>
                <cdoc:StructuredDoc>
                   <cdoc:FullName>Stars Found</cdoc:FullName>
                   <cdoc:Description>Stars Found is the Number of Stars detected in the Field
of View (FOV) with the detected object. This helps identify frames with
clouds.</cdoc:Description>
                   <cdoc:Omissions>
                      <cdoc:Omission>Data providers will determine when this data can be
included. See provider documentation for more details.</cdoc:Omission>
                   </cdoc:Omissions>
                </cdoc:StructuredDoc>
             </xs:documentation>
          </xs:annotation>
       </xs:element>
       <xs:element name="StarsUsed" type="xs:nonNegativeInteger" minOccurs="0">
          <xs:annotation>
             <xs:documentation>
                <cdoc:StructuredDoc>
                   <cdoc:FullName>Stars Used</cdoc:FullName>
                   <cdoc:Description>Stars Used is the Number of correlated stars in the Field
of View (FOV) with the detected object.</cdoc:Description>
                   <cdoc:Omissions>
                      <cdoc:Omission>Data providers will determine when this data can be
included. See provider documentation for more details.</cdoc:Omission>
                   </cdoc:Omissions>
                </cdoc:StructuredDoc>
             </xs:documentation>
          </xs:annotation>
       </xs:element>
       <xs:element name="SkyBackground" type="xs:double" minOccurs="0">
          <xs:annotation>
             <xs:documentation>
                <cdoc:StructuredDoc>
                   <cdoc:FullName>Sky Background</cdoc:FullName>
                   <cdoc:Description>Sky Background refers to the incoming light from an
apparently empty part of the night sky.</cdoc:Description>
                   <cdoc:Omissions>
                      <cdoc:Omission>Data providers will determine when this data can be
included. See provider documentation for more details.</cdoc:Omission>
                   </cdoc:Omissions>
                </cdoc:StructuredDoc>
             </xs:documentation>
          </xs:annotation>
       </xs:element>
       <xs:element name="PrimaryExtinction" type="xs:double" minOccurs="0">
          <xs:annotation>
             <xs:documentation>
                <cdoc:StructuredDoc>
                   <cdoc:FullName>Primary Extinction</cdoc:FullName>
                   <cdoc:Description>Primary Extinction is the coefficient applied to the
airmass to determine how much the observed visual magnitude has been attenuated by the
atmosphere. Extinction in general is the term used in astronomy to describe the absorption and
scattering of electromagnetic radiation by dust and gas between an emitting astronomical object
and the observer. </cdoc:Description>
                   <cdoc:Omissions>
                      <cdoc:Omission>Data providers will determine when this data can be
included. See provider documentation for more details.</cdoc:Omission>
                   </cdoc:Omissions>
                </cdoc:StructuredDoc>
             </xs:documentation>
          </xs:annotation>
       </xs:element>
       <xs:element name="InstrumentZero" type="xs:double" minOccurs="0">
          <xs:annotation>
             <xs:documentation>
                <cdoc:StructuredDoc>
                   <cdoc:FullName>Instrument Zero</cdoc:FullName>
                   <cdoc:Description>Instrument Zero is the difference between the instrument
measured magnitudes and standard values.</cdoc:Description>
                   <cdoc:Omissions>
```

```
                     <cdoc:Omission>Data providers will determine when this data can be
included. See provider documentation for more details.</cdoc:Omission>
                  </cdoc:Omissions>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
   </xs:sequence>
  </xs:complexType>
```

Table A4.41. VisualMagnitudeType

```
  <xs:complexType name="VisualMagnitudeType">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Visual Magnitude Type</cdoc:FullName>
              <cdoc:Description>A generic representation of light intensity in visual magnitudes
(Mv)</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:simpleContent>
        <xs:restriction base="gml:MeasureType">
           <xs:attribute name="uom" type="gml:UomIdentifier" use="required" fixed="Mv">
              <xs:annotation>
                 <xs:documentation>
                    <cdoc:StructuredDoc>
                       <cdoc:FullName>Unit of Measure</cdoc:FullName>
                       <cdoc:Description>Abbreviation for Visual Magnitude</cdoc:Description>
                       <cdoc:References>
                          <cdoc:Reference>http://unitsofmeasure.org/ucum.html</cdoc:Reference>
                       </cdoc:References>
                    </cdoc:StructuredDoc>
                 </xs:documentation>
              </xs:annotation>
           </xs:attribute>
        </xs:restriction>
     </xs:simpleContent>
  </xs:complexType>
```

Table A4.42. AssumedRangeToTargetType

```
  <xs:complexType name="AssumedRangeToTargetType">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Assumed Range-to-Target Type</cdoc:FullName>
              <cdoc:Description>The estimated distance to the object which was used to compute
the absolute visual magnitude value.</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:simpleContent>
        <xs:restriction base="ctyp:KilometerType">
           <xs:minInclusive value="100"/>
           <xs:maxInclusive value="1000000"/>
           <xs:attribute name="uom" type="gml:UomIdentifier" use="required" fixed="km">
              <xs:annotation>
                 <xs:documentation>
                    <cdoc:StructuredDoc>
                       <cdoc:FullName>Unit of Measure</cdoc:FullName>
                       <cdoc:Description>Abbreviation for kilometers as defined by Unified Code
for Units of Measure</cdoc:Description>
                       <cdoc:References>
                          <cdoc:Reference>http://unitsofmeasure.org/ucum.html</cdoc:Reference>
                       </cdoc:References>
                    </cdoc:StructuredDoc>
                 </xs:documentation>
```

```
            </xs:annotation>
         </xs:attribute>
      </xs:restriction>
   </xs:simpleContent>
</xs:complexType>
```

Table A4.43. KilometerType

```
<xs:complexType name="KilometerType">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Kilometer Type</cdoc:FullName>
            <cdoc:Description>A generic representation of a length measured in
kilometers</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:simpleContent>
      <xs:restriction base="gml:LengthType">
         <xs:attribute name="uom" type="gml:UomIdentifier" use="required" fixed="km">
            <xs:annotation>
               <xs:documentation>
                  <cdoc:StructuredDoc>
                     <cdoc:FullName>Unit of Measure</cdoc:FullName>
                     <cdoc:Description>Abbreviation for kilometers as defined by Unified Code
for Units of Measure</cdoc:Description>
                     <cdoc:References>
                        <cdoc:Reference>http://unitsofmeasure.org/ucum.html</cdoc:Reference>
                     </cdoc:References>
                  </cdoc:StructuredDoc>
               </xs:documentation>
            </xs:annotation>
         </xs:attribute>
      </xs:restriction>
   </xs:simpleContent>
</xs:complexType>
```

Table A4.44. NegativePiToPiType

```
<xs:complexType name="NegativePiToPiType">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>-Pi to Pi</cdoc:FullName>
            <cdoc:Description>A generic representation of an angle in radians from negative Pi
up to Pi Radians</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:simpleContent>
      <xs:restriction base="ctyp:RadianType">
         <xs:minInclusive value="-3.1416"/>
         <xs:maxInclusive value="3.1416"/>
         <xs:attribute name="uom" type="gml:UomIdentifier" use="required" fixed="rad">
            <xs:annotation>
               <xs:documentation>
                  <cdoc:StructuredDoc>
                     <cdoc:FullName>Unit of Measure</cdoc:FullName>
                     <cdoc:Description>Abbreviation for radians (angle measure) as defined by
Unified Code for Units of Measure</cdoc:Description>
                     <cdoc:References>
                        <cdoc:Reference>http://unitsofmeasure.org/ucum.html</cdoc:Reference>
                     </cdoc:References>
                  </cdoc:StructuredDoc>
               </xs:documentation>
            </xs:annotation>
         </xs:attribute>
      </xs:restriction>
```

```
    </xs:simpleContent>
  </xs:complexType>
```

Table A4.45. RadianType

```
  <xs:complexType name="RadianType">
    <xs:annotation>
      <xs:documentation>
        <cdoc:StructuredDoc>
          <cdoc:FullName>Radian Type</cdoc:FullName>
          <cdoc:Description>A generic representation of an angle in
radians</cdoc:Description>
        </cdoc:StructuredDoc>
      </xs:documentation>
    </xs:annotation>
    <xs:simpleContent>
      <xs:restriction base="gml:AngleType">
        <xs:attribute name="uom" type="gml:UomIdentifier" use="required" fixed="rad">
          <xs:annotation>
            <xs:documentation>
              <cdoc:StructuredDoc>
                <cdoc:FullName>Unit of Measure</cdoc:FullName>
                <cdoc:Description>Abbreviation for radians (angle measure) as defined by
Unified Code for Units of Measure</cdoc:Description>
                <cdoc:References>
                  <cdoc:Reference>http://unitsofmeasure.org/ucum.html</cdoc:Reference>
                </cdoc:References>
              </cdoc:StructuredDoc>
            </xs:documentation>
          </xs:annotation>
        </xs:attribute>
      </xs:restriction>
    </xs:simpleContent>
  </xs:complexType>
```

Table A4.46. Type0Type

```
  <xs:complexType name="Type0Type">
    <xs:annotation>
      <xs:documentation>
        <cdoc:StructuredDoc>
          <cdoc:FullName>Type 0 Observation</cdoc:FullName>
          <cdoc:Description>The observation elements associated with a particular sensor
type.  Type 0 = Rgrt (used by ASCC)</cdoc:Description>
        </cdoc:StructuredDoc>
      </xs:documentation>
    </xs:annotation>
    <xs:sequence>
      <xs:element name="RangeRate" type="ctyp:KilometersPerSecondType">
        <xs:annotation>
          <xs:documentation>
            <cdoc:StructuredDoc>
              <cdoc:FullName>Range Rate</cdoc:FullName>
              <cdoc:Description/>
            </cdoc:StructuredDoc>
          </xs:documentation>
        </xs:annotation>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
```

Table A4.47. Type1Type

```
  <xs:complexType name="Type1Type">
    <xs:annotation>
      <xs:documentation>
        <cdoc:StructuredDoc>
          <cdoc:FullName>Type 1 Observation</cdoc:FullName>
```

```
            <cdoc:Description>The observation elements associated with a particular sensor
type.  Type 1 = AzEl (used by AFSSS)</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:sequence>
      <xs:element name="Azimuth" type="ctyp:AzimuthType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Azimuth</cdoc:FullName>
                  <cdoc:Description>The direction of the celestial object from the observing
radar. It is measured clockwise from true North (0 degrees).</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="Elevation" type="ctyp:ElevationType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Elevation</cdoc:FullName>
                  <cdoc:Description/>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
   </xs:sequence>
</xs:complexType>
```

Table A4.48. Type2Type

```
<xs:complexType name="Type2Type">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Type 2 Observation</cdoc:FullName>
            <cdoc:Description>The observation elements associated with a particular sensor
type.  Type 2 = AzElRg (used by Eglin 399: near-earth, non-coherent
processing).</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:sequence>
      <xs:element name="Azimuth" type="ctyp:AzimuthType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Azimuth</cdoc:FullName>
                  <cdoc:Description>The direction of the celestial object from the observing
radar. It is measured clockwise from true North (0 degrees).</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="Elevation" type="ctyp:ElevationType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Elevation</cdoc:FullName>
                  <cdoc:Description/>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="Range" type="ctyp:RangeType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Range</cdoc:FullName>
```

```
                  <cdoc:Description/>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
   </xs:sequence>
</xs:complexType>
```

Table A4.49. Type3Type

```
<xs:complexType name="Type3Type">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Type 3 Observation</cdoc:FullName>
            <cdoc:Description>The observation elements associated with a particular sensor
type.  Type 3 = AzElRgRgrt (used by Eglin 398: deep space, coherent
processing).</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:sequence>
      <xs:element name="Azimuth" type="ctyp:AzimuthType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Azimuth</cdoc:FullName>
                  <cdoc:Description>The direction of the celestial object from the observing
radar. It is measured clockwise from true North (0 degrees).</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="Elevation" type="ctyp:ElevationType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Elevation</cdoc:FullName>
                  <cdoc:Description/>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="Range" type="ctyp:RangeType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Range</cdoc:FullName>
                  <cdoc:Description/>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="RangeRate" type="ctyp:RangeRateType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Range Rate</cdoc:FullName>
                  <cdoc:Description/>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
   </xs:sequence>
</xs:complexType>
```

Table A4.50. Type4Type

```
<xs:complexType name="Type4Type">
```

```
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Type 4 Observation</cdoc:FullName>
              <cdoc:Description>The observation elements associated with a particular sensor
type.  Type 4 = AzElRgRgrtAzrtElrtRgac (used by BMEWS/PP and PARCS).</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:sequence>
        <xs:element name="Azimuth" type="ctyp:AzimuthType">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Azimuth</cdoc:FullName>
                    <cdoc:Description>The direction of the celestial object from the observing
radar. It is measured clockwise from true North (0 degrees).</cdoc:Description>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
        <xs:element name="Elevation" type="ctyp:ElevationType">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Elevation</cdoc:FullName>
                    <cdoc:Description/>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
        <xs:element name="Range" type="ctyp:RangeType">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Range</cdoc:FullName>
                    <cdoc:Description/>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
        <xs:element name="RangeRate" type="ctyp:RangeRateType">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Range Rate</cdoc:FullName>
                    <cdoc:Description/>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
        <xs:element name="AzimuthRate" type="ctyp:RadiansPerSecondType">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Azimuth Rate</cdoc:FullName>
                    <cdoc:Description/>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
        <xs:element name="ElevationRate" type="ctyp:RadiansPerSecondType">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Elevation Rate</cdoc:FullName>
                    <cdoc:Description/>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
```

```
        <xs:element name="RangeAcceleration" type="ctyp:KilometersPerSecondSquaredType"
minOccurs="0">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Range Acceleration</cdoc:FullName>
                    <cdoc:Description/>
                    <cdoc:Omissions>
                       <cdoc:Omission>Not all data providers will provide this element. Consult
provider documentation before relying on the presence of this element.</cdoc:Omission>
                       <cdoc:Omission>Omission is equivalent to a zero-padded value in legacy
formats</cdoc:Omission>
                    </cdoc:Omissions>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
     </xs:sequence>
  </xs:complexType>
```

Table A4.51. Type5Type

```
  <xs:complexType name="Type5Type">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Type 5 Observation</cdoc:FullName>
              <cdoc:Description>The observation elements associated with a particular sensor
type.  Type 5 = DeRa and Year of Equinox (used by GEODSS).  Also allows for additional data
which is not considered part of the "Type5" legacy message format but some sensor types may be
able to expose.</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:sequence>
        <xs:element name="YearOfEquinox" type="ctyp:YearOfEquinoxType">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Year of Equinox</cdoc:FullName>
                    <cdoc:Description>The time reference for the observation</cdoc:Description>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
        <xs:element name="Declination" type="ctyp:NegativePiOverTwoToPiOverTwoType">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Declination</cdoc:FullName>
                    <cdoc:Description>The angular distance to the object measured North or South
from the celestial equator.</cdoc:Description>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
        <xs:element name="RightAscension" type="ctyp:ZeroToTwoPiType">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Right Ascension</cdoc:FullName>
                    <cdoc:Description>The angle measured along the celestial equator, starting
from the March equinox.</cdoc:Description>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
     </xs:sequence>
  </xs:complexType>
```

Table A4.52. Type6Type

```
  <xs:complexType name="Type6Type">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Type 6 Observation</cdoc:FullName>
              <cdoc:Description>The observation elements associated with a particular sensor
type.  Type 6 = Range (used by ASCC)</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:sequence>
        <xs:element name="Range" type="ctyp:KilometerType">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Range</cdoc:FullName>
                    <cdoc:Description/>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
     </xs:sequence>
  </xs:complexType>
```

Table A4.53. Type7Type

```
  <xs:complexType name="Type7Type">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Type 7 Observation</cdoc:FullName>
              <cdoc:Description>The observation elements associated with a particular sensor
type.  Type 7 = EFG (used by ASCC and legacy), ECEF (not considered part of the Type7 legacy
message format but added to support other sensor types)</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:sequence>
        <xs:element name="ObjectPosition" type="ctyp:PositionType">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Object Position</cdoc:FullName>
                    <cdoc:Description>See Base Description.</cdoc:Description>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
        <xs:element name="ObjectVelocity" type="ctyp:MetersPerSecondVectorType">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Object Velocity</cdoc:FullName>
                    <cdoc:Description>See Base Description.</cdoc:Description>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
        <xs:element name="ObjectAcceleration" type="ctyp:MetersPerSecondSquaredVectorType"
minOccurs="0">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Object Acceleration</cdoc:FullName>
                    <cdoc:Description>See Base Description.</cdoc:Description>
                 </cdoc:StructuredDoc>
              </xs:documentation>
```

```
         </xs:annotation>
      </xs:element>
   </xs:sequence>
   <xs:attributeGroup ref="ctyp:EFG_ECEF_SRSReferenceAttributeGroup"/>
</xs:complexType>
```

Table A4.54. Type8Type

```
<xs:complexType name="Type8Type">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Type 8 Observation</cdoc:FullName>
            <cdoc:Description>The observation elements associated with a particular sensor
type. Type 8 = AzElRgEFG. </cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:sequence>
        <xs:element name="Azimuth" type="ctyp:AzimuthType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Azimuth</cdoc:FullName>
                  <cdoc:Description>The direction of the celestial object from the observing
radar. It is measured clockwise from true North (0 degrees).</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="Elevation" type="ctyp:ElevationType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Elevation</cdoc:FullName>
                  <cdoc:Description/>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="Range" type="ctyp:KilometerType" minOccurs="0">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Range</cdoc:FullName>
                  <cdoc:Description/>
                  <cdoc:Omissions>
                     <cdoc:Omission>Not all data providers will provide this element. Consult
provider documentation before relying on the presence of this element.</cdoc:Omission>
                  </cdoc:Omissions>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
      <xs:element name="SensorPosition" type="ctyp:PositionType">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Sensor Position</cdoc:FullName>
                  <cdoc:Description>See Base Description.</cdoc:Description>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
   </xs:sequence>
   <xs:attributeGroup ref="ctyp:EFG_SRSReferenceAttributeGroup"/>
</xs:complexType>
```

Table A4.55. Type9Type

```
  <xs:complexType name="Type9Type">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Type 9 Observation</cdoc:FullName>
              <cdoc:Description>The observation elements associated with a particular sensor
type.  Type 9 = RgDeRaYearOfEquinoxEFG, Sensor Velocity (not considered part of the Type9
legacy message format but added to support other sensor types)</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:sequence>
<xs:element name="YearOfEquinox" type="ctyp:YearOfEquinoxType">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Year of Equinox</cdoc:FullName>
                    <cdoc:Description>The time reference for the observation</cdoc:Description>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
        <xs:element name="Declination" type="ctyp:NegativePiOverTwoToPiOverTwoType">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Declination</cdoc:FullName>
                    <cdoc:Description>The angular distance to the object measured North or South
from the celestial equator.</cdoc:Description>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
        <xs:element name="RightAscension" type="ctyp:ZeroToTwoPiType">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Right Ascension</cdoc:FullName>
                    <cdoc:Description>The angle measured along the celestial equator, starting
from the March equinox.</cdoc:Description>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
        <xs:element name="Range" type="ctyp:KilometerType" minOccurs="0">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
<cdoc:FullName>Range</cdoc:FullName>
                    <cdoc:Description/>
                    <cdoc:Omissions>
                       <cdoc:Omission>This element is expected to be provided, but some sources
may not be able to provide this. Provider documentation should provide detail about how to
interpret the absence of this element (ex: MU18 and AA07 message formats defined in
IWSD).</cdoc:Omission>
                    </cdoc:Omissions>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
        <xs:element name="SensorPosition" type="ctyp:PositionType">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Sensor Position</cdoc:FullName>
                    <cdoc:Description>See Base Description.</cdoc:Description>
                 </cdoc:StructuredDoc>
              </xs:documentation>
```

```
         </xs:annotation>
      </xs:element>
      <xs:element name="SensorVelocity" type="ctyp:MetersPerSecondVectorType" minOccurs="0">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Sensor Velocity</cdoc:FullName>
                  <cdoc:Description>See Base Description.</cdoc:Description>
                  <cdoc:Omissions>
                     <cdoc:Omission>Not all data providers will provide this element. Consult
provider documentation before relying on the presence of this element.</cdoc:Omission>
                     <cdoc:Omission>This element is not represented in legacy
formats</cdoc:Omission>
                  </cdoc:Omissions>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:element>
   </xs:sequence>
   <xs:attributeGroup ref="ctyp:EFG_SRSReferenceAttributeGroup"/>
  </xs:complexType>
```

Table A4.56. Type10Type

```
  <xs:complexType name="Type10Type">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Type 10 Observation</cdoc:FullName>
              <cdoc:Description>The observation elements associated with a particular sensor
type. This type is not supported by the legacy Space Surveillance Network
(SSN).</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:sequence>
        <xs:element name="ObjectPosition" type="ctyp:PositionType">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Object Position</cdoc:FullName>
                    <cdoc:Description>See Base Description.</cdoc:Description>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
        <xs:element name="ObjectVelocity" type="ctyp:MetersPerSecondVectorType">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Object Velocity</cdoc:FullName>
                    <cdoc:Description>See Base Description.</cdoc:Description>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
        <xs:element name="CovarianceMatrix" type="ctyp:CovarianceMatrixType" minOccurs="0">
           <xs:annotation>
              <xs:documentation>
                 <cdoc:StructuredDoc>
                    <cdoc:FullName>Covariance Matrix</cdoc:FullName>
                    <cdoc:Description>See Base Description.</cdoc:Description>
                    <cdoc:Omissions>
                       <cdoc:Omission>May be omitted if the system does not have the data
available.</cdoc:Omission>
                    </cdoc:Omissions>
                 </cdoc:StructuredDoc>
              </xs:documentation>
           </xs:annotation>
        </xs:element>
```

```
      </xs:sequence>
      <xs:attributeGroup ref="ctyp:ECI_SRSReferenceAttributeGroup"/>
   </xs:complexType>
```

Table A4.57. AzimuthType

```
   <xs:complexType name="AzimuthType">
      <xs:annotation>
         <xs:documentation>
            <cdoc:StructuredDoc>
               <cdoc:FullName>Azimuth Type</cdoc:FullName>
               <cdoc:Description>A generic representation of an observed azimuth value, measured
in radians, with optional error estimate information</cdoc:Description>
            </cdoc:StructuredDoc>
         </xs:documentation>
      </xs:annotation>
      <xs:complexContent>
         <xs:extension base="ZeroToTwoPiType">
            <xs:attribute name="errorEstimate" type="ctyp:ErrorEstimateType">
               <xs:annotation>
                  <xs:documentation>
                     <cdoc:StructuredDoc>
                        <cdoc:FullName>Error Estimate</cdoc:FullName>
                        <cdoc:Description>See Base Description.</cdoc:Description>
                        <cdoc:Omissions>
                           <cdoc:Omission>Lack of presence the error estimate value means the
error is unreported.</cdoc:Omission>
                        </cdoc:Omissions>
                     </cdoc:StructuredDoc>
                  </xs:documentation>
               </xs:annotation>
            </xs:attribute>
         </xs:extension>
      </xs:complexContent>
   </xs:complexType>
```

Table A4.58. ZeroToTwoPiType

```
   <xs:complexType name="ZeroToTwoPiType">
      <xs:annotation>
         <xs:documentation>
            <cdoc:StructuredDoc>
               <cdoc:FullName>Zero to two PI</cdoc:FullName>
               <cdoc:Description>A generic representation of a positive angle in radians up to
2*Pi Radians</cdoc:Description>
            </cdoc:StructuredDoc>
         </xs:documentation>
      </xs:annotation>
      <xs:simpleContent>
         <xs:restriction base="ctyp:RadianType">
            <xs:minInclusive value="0"/>
            <xs:maxInclusive value="6.2832"/>
            <xs:attribute name="uom" type="gml:UomIdentifier" use="required" fixed="rad">
               <xs:annotation>
                  <xs:documentation>
                     <cdoc:StructuredDoc>
                        <cdoc:FullName>Unit of Measure</cdoc:FullName>
                        <cdoc:Description>Abbreviation for radians (angle measure) as defined by
Unified Code for Units of Measure</cdoc:Description>
                        <cdoc:References>
                           <cdoc:Reference>http://unitsofmeasure.org/ucum.html</cdoc:Reference>
                        </cdoc:References>
                     </cdoc:StructuredDoc>
                  </xs:documentation>
               </xs:annotation>
            </xs:attribute>
         </xs:restriction>
      </xs:simpleContent>
   </xs:complexType>
```

Table A4.59. ElevationType

```
<xs:complexType name="ElevationType">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Elevation Type</cdoc:FullName>
            <cdoc:Description>A generic representation of an observed elevation value,
measured in radians, with optional error estimate information</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:complexContent>
      <xs:extension base="NegativePiOverTwoToPiOverTwoType">
         <xs:attribute name="errorEstimate" type="ctyp:ErrorEstimateType">
            <xs:annotation>
               <xs:documentation>
                  <cdoc:StructuredDoc>
                     <cdoc:FullName>Error Estimate</cdoc:FullName>
                     <cdoc:Description>See Base Description.</cdoc:Description>
                     <cdoc:Omissions>
                        <cdoc:Omission>Lack of presence the error estimate value means the
error is unreported.</cdoc:Omission>
                     </cdoc:Omissions>
                  </cdoc:StructuredDoc>
               </xs:documentation>
            </xs:annotation>
         </xs:attribute>
      </xs:extension>
   </xs:complexContent>
</xs:complexType>
```

Table A4.60. NegativePiOverTwoToPiOverTwoType

```
<xs:complexType name="NegativePiOverTwoToPiOverTwoType">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>-PI/2 to PI/2</cdoc:FullName>
            <cdoc:Description>Angle from -PI/2 to PI/2 radians</cdoc:Description>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:simpleContent>
      <xs:restriction base="ctyp:RadianType">
         <xs:minInclusive value="-1.5708"/>
         <xs:maxInclusive value="1.5708"/>
         <xs:attribute name="uom" type="gml:UomIdentifier" use="required" fixed="rad">
            <xs:annotation>
               <xs:documentation>
                  <cdoc:StructuredDoc>
                     <cdoc:FullName>Unit of Measure</cdoc:FullName>
                     <cdoc:Description>Abbreviation for radians (angle measure) as defined by
Unified Code for Units of Measure</cdoc:Description>
                     <cdoc:References>
                        <cdoc:Reference>http://unitsofmeasure.org/ucum.html</cdoc:Reference>
                     </cdoc:References>
                  </cdoc:StructuredDoc>
               </xs:documentation>
            </xs:annotation>
         </xs:attribute>
      </xs:restriction>
   </xs:simpleContent>
</xs:complexType>
```

Table A4.61. RangeType

```
<xs:complexType name="RangeType">
   <xs:annotation>
```

```
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Range Type</cdoc:FullName>
              <cdoc:Description>A generic representation of an observed range value, measured in
kilometers, with optional error estimate information</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:complexContent>
        <xs:extension base="ctyp:KilometerType">
           <xs:attribute name="errorEstimate" type="ctyp:ErrorEstimateType">
              <xs:annotation>
                 <xs:documentation>
                    <cdoc:StructuredDoc>
                       <cdoc:FullName>Error Estimate</cdoc:FullName>
                       <cdoc:Description>See Base Description.</cdoc:Description>
                       <cdoc:Omissions>
                          <cdoc:Omission>Lack of presence the error estimate value means the
error is unreported.</cdoc:Omission>
                       </cdoc:Omissions>
                    </cdoc:StructuredDoc>
                 </xs:documentation>
              </xs:annotation>
           </xs:attribute>
        </xs:extension>
     </xs:complexContent>
  </xs:complexType>
```

Table A4.62. RangeRateType

```
  <xs:complexType name="RangeRateType">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Range Rate Type</cdoc:FullName>
              <cdoc:Description>A generic representation of an observed range rate value,
measured in radians, with optional error estimate information</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:complexContent>
        <xs:extension base="ctyp:KilometersPerSecondType">
           <xs:attribute name="errorEstimate" type="ctyp:ErrorEstimateType">
              <xs:annotation>
                 <xs:documentation>
                    <cdoc:StructuredDoc>
                       <cdoc:FullName>Error Estimate</cdoc:FullName>
                       <cdoc:Description>See Base Description.</cdoc:Description>
                       <cdoc:Omissions>
                          <cdoc:Omission>Lack of presence the error estimate value means the
error is unreported.</cdoc:Omission>
                       </cdoc:Omissions>
                    </cdoc:StructuredDoc>
                 </xs:documentation>
              </xs:annotation>
           </xs:attribute>
        </xs:extension>
     </xs:complexContent>
  </xs:complexType>
```

Table A4.63. KilometersPerSecondType

```
  <xs:complexType name="KilometersPerSecondType">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Kilometers Per Second Type</cdoc:FullName>
              <cdoc:Description>A generic representation of velocity in kilometers per
second</cdoc:Description>
```

```
            </cdoc:StructuredDoc>
         </xs:documentation>
      </xs:annotation>
      <xs:simpleContent>
         <xs:restriction base="gml:MeasureType">
            <xs:attribute name="uom" type="gml:UomIdentifier" use="required" fixed="km/s">
               <xs:annotation>
                  <xs:documentation>
                     <cdoc:StructuredDoc>
                        <cdoc:FullName>Unit of Measure</cdoc:FullName>
                        <cdoc:Description>Abbreviation for kilometers per second as defined by
Unified Code for Units of Measure</cdoc:Description>
                        <cdoc:References>
                           <cdoc:Reference>http://unitsofmeasure.org/ucum.html</cdoc:Reference>
                        </cdoc:References>
                     </cdoc:StructuredDoc>
                  </xs:documentation>
               </xs:annotation>
            </xs:attribute>
         </xs:restriction>
      </xs:simpleContent>
   </xs:complexType>
```

Table A4.64. RadiansPerSecondType

```
   <xs:complexType name="RadiansPerSecondType">
      <xs:annotation>
         <xs:documentation>
            <cdoc:StructuredDoc>
               <cdoc:FullName>RadiansPerSecondType</cdoc:FullName>
               <cdoc:Description>A generic representation of angular velocity in radians per
second</cdoc:Description>
            </cdoc:StructuredDoc>
         </xs:documentation>
      </xs:annotation>
      <xs:simpleContent>
         <xs:restriction base="gml:MeasureType">
            <xs:attribute name="uom" type="gml:UomIdentifier" use="required" fixed="rad/s">
               <xs:annotation>
                  <xs:documentation>
                     <cdoc:StructuredDoc>
                        <cdoc:FullName>Unit of Measure</cdoc:FullName>
                        <cdoc:Description>Abbreviation for radians (angle measure) per second as
defined by Unified Code for Units of Measure</cdoc:Description>
                        <cdoc:References>
                           <cdoc:Reference>http://unitsofmeasure.org/ucum.html</cdoc:Reference>
                        </cdoc:References>
                     </cdoc:StructuredDoc>
                  </xs:documentation>
               </xs:annotation>
            </xs:attribute>
         </xs:restriction>
      </xs:simpleContent>
   </xs:complexType>
```

Table A4.65. KilometersPerSecondSquaredType

```
   <xs:complexType name="KilometersPerSecondSquaredType">
      <xs:annotation>
         <xs:documentation>
            <cdoc:StructuredDoc>
               <cdoc:FullName>Kilometers Per Second Squared Type</cdoc:FullName>
               <cdoc:Description>A generic representation of acceleration in kilometers per
second squared</cdoc:Description>
            </cdoc:StructuredDoc>
         </xs:documentation>
      </xs:annotation>
      <xs:simpleContent>
         <xs:restriction base="gml:MeasureType">
```

```
          <xs:attribute name="uom" type="gml:UomIdentifier" use="required" fixed="km/s2">
             <xs:annotation>
                <xs:documentation>
                   <cdoc:StructuredDoc>
                      <cdoc:FullName>Unit of Measure</cdoc:FullName>
                      <cdoc:Description>Abbreviation for kilometers per second squared as
defined by Unified Code for Units of Measure</cdoc:Description>
                      <cdoc:References>
                         <cdoc:Reference>http://unitsofmeasure.org/ucum.html</cdoc:Reference>
                      </cdoc:References>
                   </cdoc:StructuredDoc>
                </xs:documentation>
             </xs:annotation>
          </xs:attribute>
       </xs:restriction>
    </xs:simpleContent>
  </xs:complexType>
```

Table A4.66. YearOfEquinoxType

```
  <xs:simpleType name="YearOfEquinoxType">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Year of Equinox Type</cdoc:FullName>
              <cdoc:Description>The time reference for the observation.</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:restriction base="xs:token">
        <xs:enumeration value="ob_date_time"/>
        <xs:enumeration value="ob_0_Jan_in_year_of_date"/>
        <xs:enumeration value="ob_0_Jan_2000"/>
        <xs:enumeration value="ob_0_Jan_1950"/>
     </xs:restriction>
  </xs:simpleType>
```

Table A4.67. PositionType

```
  <xs:complexType name="PositionType">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Position Type</cdoc:FullName>
              <cdoc:Description>A representation of position coordinates, in any supported
coordinate system. Coordinate systems are referenced by URI. For the supported list, see
SupportedSrsNamesType.  The values provided in the double list appear in the order and unit of
measure defined by the spatial reference system.</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:simpleContent>
        <xs:extension base="ctyp:AbstractVectorBaseType"/>
     </xs:simpleContent>
  </xs:complexType>
```

Table A4.68. AbstractVectorBaseType

```
  <xs:complexType name="AbstractVectorBaseType" abstract="true">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Abstract Vector Base Type</cdoc:FullName>
              <cdoc:Description>A representation of a two or three dimensional vector of
coordinates, in any supported coordinate system. Coordinate systems are referenced by their
Spatial Reference System Name (@srsName) attribute. For the supported list of Spatial Reference
System names, see SupportedSrsNamesType. The values provided in the simple content double list
appear in the axis order defined by the named spatial reference system.  For positional
```

```
vectors, the units of measure for values are also defined by the spatial reference system.
Other Vector types will define appropriate units via a Units of Measure (@uom) attribute.
            </cdoc:Description>
            <cdoc:Notes>
               <cdoc:Note>Vector Base Restricts the xs:double list from the underlying GML
Direct Position Type to contain only 2 or 3 members.</cdoc:Note>
            </cdoc:Notes>
            <cdoc:ConstraintRationale>The simple content double list requires at least two
values; for Scalar values, use the appropriate type from Unit Of Measure Types.  IA
considerations dictate placement of an upper bound on all list types. A value of 3 was chosen
as the practical upper bound for real
            coordinate reference systems.
            </cdoc:ConstraintRationale>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:simpleContent>
      <xs:restriction base="gml:DirectPositionType">
         <xs:minLength value="2"/>
         <xs:maxLength value="3"/>
         <xs:attributeGroup ref="ctyp:OptionalSRSReferenceAttributeGroup"/>
      </xs:restriction>
   </xs:simpleContent>
</xs:complexType>
```

Table A4.69. MetersPerSecondVectorType

```
<xs:complexType name="MetersPerSecondVectorType">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Meters Per Second Vector Type</cdoc:FullName>
            <cdoc:Description>A representation of the rate of change of position along the
axes of any supported coordinate system. Coordinate systems are referenced by URI. For the
supported list, see SupportedSrsNamesType.
            The values provided in the double list appear in the order defined by the spatial
reference system.</cdoc:Description>
            </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:simpleContent>
      <xs:extension base="ctyp:AbstractVectorBaseType">
         <xs:attribute name="uom" type="gml:UomIdentifier" use="required" fixed="m/s">
            <xs:annotation>
               <xs:documentation>
                  <cdoc:StructuredDoc>
                     <cdoc:FullName>Unit of Measure</cdoc:FullName>
                     <cdoc:Description>Abbreviation for meters per second as defined by
Unified Code for Units of Measure</cdoc:Description>
                     <cdoc:References>
                        <cdoc:Reference>http://unitsofmeasure.org/ucum.html</cdoc:Reference>
                     </cdoc:References>
                  </cdoc:StructuredDoc>
               </xs:documentation>
            </xs:annotation>
         </xs:attribute>
      </xs:extension>
   </xs:simpleContent>
</xs:complexType>
```

Table A4.70. MetersPerSecondSquaredVectorType

```
<xs:complexType name="MetersPerSecondSquaredVectorType">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Meters Per Second Squared Vector Type</cdoc:FullName>
            <cdoc:Description>A representation of the rate of change of velocity along the
axes of any supported coordinate system. Coordinate systems are referenced by URI. For the
```

```
supported list, see SupportedSrsNamesType.  The values provided in the double list appear in
the order defined by the spatial reference system.</cdoc:Description>
          </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:simpleContent>
        <xs:extension base="ctyp:AbstractVectorBaseType">
           <xs:attribute name="uom" type="gml:UomIdentifier" use="required" fixed="m/s2">
              <xs:annotation>
                 <xs:documentation>
                    <cdoc:StructuredDoc>
                       <cdoc:FullName>Unit of Measure</cdoc:FullName>
                       <cdoc:Description>Abbreviation for meters per second squared as defined
by Unified Code for Units of Measure</cdoc:Description>
                       <cdoc:References>
                          <cdoc:Reference>http://unitsofmeasure.org/ucum.html</cdoc:Reference>
                       </cdoc:References>
                    </cdoc:StructuredDoc>
                 </xs:documentation>
              </xs:annotation>
           </xs:attribute>
        </xs:extension>
     </xs:simpleContent>
  </xs:complexType>
```

Table A4.71. CovarianceMatrixType

```
  <xs:complexType name="CovarianceMatrixType">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>Covariance Matrix Type</cdoc:FullName>
              <cdoc:Description>A general representation of a covariance matrix. Covariance data
is always associated with a state vector; therefore, the units of the covariance matrix are not
given, but are derived from the units of the state vector.</cdoc:Description>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:simpleContent>
        <xs:extension base="gml:doubleList">
           <xs:attributeGroup ref="ctyp:OptionalSRSReferenceAttributeGroup">
              <xs:annotation>
                 <xs:documentation>
                    <cdoc:StructuredDoc>
                       <cdoc:FullName>Optional SRS Reference Attribute Group</cdoc:FullName>
                       <cdoc:Description>See Base Description.</cdoc:Description>
                       <cdoc:Omissions><cdoc:Omission>The srsName may only be omitted if the
EQUINOCTIAL matrix category is represented. For all other matrix types, the srsName is critical
for understanding the position and velocity terms represented.</cdoc:Omission></cdoc:Omissions>
                    </cdoc:StructuredDoc>
                 </xs:documentation>
              </xs:annotation>
           </xs:attributeGroup>
           <xs:attribute name="category" type="ctyp:CovarianceMatrixCategoryEnumType"
use="required">
              <xs:annotation>
                 <xs:documentation>
                    <cdoc:StructuredDoc>
                       <cdoc:FullName>Category</cdoc:FullName>
                       <cdoc:Description>See Base Description.</cdoc:Description>
                    </cdoc:StructuredDoc>
                 </xs:documentation>
              </xs:annotation>
           </xs:attribute>
        </xs:extension>
     </xs:simpleContent>
  </xs:complexType>
```

Table A4.72. OptionalSRSReferenceAttributeGroup

```
<xs:attributeGroup name="OptionalSRSReferenceAttributeGroup">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Optional SRS Reference Attribute Group</cdoc:FullName>
            <cdoc:Description>The attribute group OptionalSRSReferenceAttributeGroup is an
optional reference to the Coordinate Reference System (CRS) used by this geometry, with
optional additional information to simplify the processing of the coordinates when a more
complete definition of the CRS is not needed.
            </cdoc:Description>
            <cdoc:References>
               <cdoc:Reference>Based on GML's SRSReferenceGroup</cdoc:Reference>
            </cdoc:References>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:attribute name="srsName" type="ctyp:SupportedSrsNamesType" use="optional">
      <xs:annotation>
         <xs:documentation>
            <cdoc:StructuredDoc>
               <cdoc:FullName>Spatial Reference System Name</cdoc:FullName>
               <cdoc:Description>The name of the spatial reference system (SRS) to be used
when interpreting coordinate values.
               </cdoc:Description>
               <cdoc:Omissions>
                  <cdoc:Omission>If no srsName attribute is given, the coordinate reference
system shall be specified as part of the larger context of which this geometry element is part.
                  </cdoc:Omission>
               </cdoc:Omissions>
            </cdoc:StructuredDoc>
         </xs:documentation>
      </xs:annotation>
   </xs:attribute>
   <xs:attribute name="srsDimension" type="xs:positiveInteger">
      <xs:annotation>
         <xs:documentation>
            <cdoc:StructuredDoc>
               <cdoc:FullName>Spatial Reference System Dimension</cdoc:FullName>
               <cdoc:Description>Number of dimensions in the coordinate
data.</cdoc:Description>
               <cdoc:Omissions>
                  <cdoc:Omission>srsDimension is defined for compatibility with GML. For C2
SSA COI applications, it is expected that the SRS Name provides sufficient definition of the
Coordinate Reference System, and therefore the srsDimension is unnecessary and should be
omitted.
                  </cdoc:Omission>
               </cdoc:Omissions>
            </cdoc:StructuredDoc>
         </xs:documentation>
      </xs:annotation>
   </xs:attribute>
   <xs:attributeGroup ref="gml:SRSInformationGroup"/>
</xs:attributeGroup>
```

Table A4.73. CovarianceMatrixCategoryEnumType

```
<xs:simpleType name="CovarianceMatrixCategoryEnumType">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>Covariance Matrix Category Enumeration Type</cdoc:FullName>
            <cdoc:Description>Specifies what terms in the covariance matrix are being
represented. The terms are provided in order of appearance in the lower triangular half of the
matrix from element 1,1 (item 1) through the last element used in the correction. The diagonal
terms are the variances of the solution parameter, and the off-diagonal terms are the
covariances.</cdoc:Description>
         </cdoc:StructuredDoc>
```

```
      </xs:documentation>
    </xs:annotation>
    <xs:restriction base="xs:token">
      <xs:enumeration value="EQUINOCTIAL">
        <xs:annotation>
          <xs:documentation>
            <cdoc:StructuredDoc>
              <cdoc:FullName>Equinoctial</cdoc:FullName>
              <cdoc:Description>A 6x6 symmetric matrix consisting of 21 values, where
terms 1-6 represent the following equinoctial elements of the solution parameter:
                Af -- Equinoctial (f) Component of Apsidal Vector
                Ag -- Solstitial (g) Component of Apsidal Vector
                Chi -- CHI Orbit Plane Descriptor
                Psi -- PSI Orbit Plane Descriptor
                L -- Mean Longitude
                N -- Mean motion
              </cdoc:Description>
            </cdoc:StructuredDoc>
          </xs:documentation>
        </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="EQUINOCTIAL_PARAMETERS">
        <xs:annotation>
          <xs:documentation>
            <cdoc:StructuredDoc>
              <cdoc:FullName>Equinoctial</cdoc:FullName>
              <cdoc:Description>A 7x7 or larger symmetric matrix consisting of 28-120
values, where the equinocital elements (terms 1-6) are followed by one or more additional terms
(terms 7-15) representing the model parameters of the solution:
                Equinocital Elements:
                Af -- Equinoctial (f) Component of Apsidal Vector
                Ag -- Solstitial (g) Component of Apsidal Vector
                Chi -- CHI Orbit Plane Descriptor
                Psi -- PSI Orbit Plane Descriptor
                L -- Mean Longitude
                N -- Mean motion


                Model Parameters:
                B -- Ballistic Coefficient
                BDot -- First derivative of Ballistic Coefficient
                Agom -- Radiation Pressure Coefficient
                T -- Constant duration in-track thrust
                C1, C2...CN -- Optional consider parameters
              </cdoc:Description>
              <cdoc:References>
                <cdoc:Reference>Reference developer documentation for the specific model
parameter terms used and ordering of terms as they vary from system to system.</cdoc:Reference>
              </cdoc:References>
            </cdoc:StructuredDoc>
          </xs:documentation>
        </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="POSITION">
        <xs:annotation>
          <xs:documentation>
            <cdoc:StructuredDoc>
              <cdoc:FullName>Position</cdoc:FullName>
              <cdoc:Description>A 3x3 symmetric matrix consisting of 6 values, where the
terms represent the position of the solution parameter (ex: lat/lon/height,
x/y/z)</cdoc:Description>
              <cdoc:References>
                <cdoc:Reference>Reference the srsName for specifics regarding the
reference frame and coordinate system utilized.</cdoc:Reference>
              </cdoc:References>
            </cdoc:StructuredDoc>
          </xs:documentation>
        </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="POSITION_VELOCITY">
        <xs:annotation>
```

```
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Position, Velocity</cdoc:FullName>
                  <cdoc:Description>A 6x6 symmetric matrix consisting of 21 values, where
terms 1-3 represent the position and terms 4-6 represent the velocity of the solution
parameter.</cdoc:Description>
                  <cdoc:References>
                     <cdoc:Reference>Reference the srsName for specifics regarding the
reference frame and coordinate system utilized.</cdoc:Reference>
                  </cdoc:References>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="POSITION_VELOCITY_PARAMETERS">
         <xs:annotation>
            <xs:documentation>
               <cdoc:StructuredDoc>
                  <cdoc:FullName>Position, Velocity, and Model Parameters</cdoc:FullName>
                  <cdoc:Description>A 7x7 or larger symmetric matrix consisting of 28-120
values, where the position and velocity (terms 1-6) are followed by one or more additional
terms (terms 7-15) representing the model parameters of the solution.</cdoc:Description>
                  <cdoc:References>
                     <cdoc:Reference>Reference developer documentation for the specific model
parameter terms used and ordering of terms as they vary from system to system.</cdoc:Reference>
                     <cdoc:Reference>Reference the srsName for specifics regarding the
reference frame and coordinate system utilized.</cdoc:Reference>
                  </cdoc:References>
               </cdoc:StructuredDoc>
            </xs:documentation>
         </xs:annotation>
      </xs:enumeration>
   </xs:restriction>
</xs:simpleType>
```

Table A4.74. EFG_ECEF_SRSReferenceAttributeGroup

```
<xs:attributeGroup name="EFG_ECEF_SRSReferenceAttributeGroup">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>EFG or ECEF SRS Reference Attribute Group</cdoc:FullName>
            <cdoc:Description>The EFG_ECEF_SRSReferenceAttributeGroup provides a reference to
either the Earth Fixed Greenwich (EFG) or the Earth Centered Earth Fixed (ECEF) Coordinate
Reference System (CRS) used by this geometry. Additional information can be provided via
optional attributes to simplify the processing of the coordinates when a more complete
definition of the CRS is not needed.
            </cdoc:Description>
            <cdoc:References>
               <cdoc:Reference>Based on GML's SRSReferenceGroup</cdoc:Reference>
            </cdoc:References>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:attribute name="srsName" type="ctyp:EarthFixedSRSNamesType" use="required">
      <xs:annotation>
         <xs:documentation>
            <cdoc:StructuredDoc>
               <cdoc:FullName>Spatial Reference System Name</cdoc:FullName>
               <cdoc:Description>See Base Description.</cdoc:Description>
            </cdoc:StructuredDoc>
         </xs:documentation>
      </xs:annotation>
   </xs:attribute>
   <xs:attribute name="srsDimension" type="xs:positiveInteger">
      <xs:annotation>
         <xs:documentation>
            <cdoc:StructuredDoc>
               <cdoc:FullName>Spatial Reference System Dimension</cdoc:FullName>
```

```
               <cdoc:Description>Number of dimensions in the coordinate
data.</cdoc:Description>
               <cdoc:Omissions>
                  <cdoc:Omission>srsDimension is defined for compatibility with GML. For C2
SSA COI applications it is expected that the SRS Name provides sufficient definition of the
Coordinate Reference System, and therefore the srsDimension is unnecessary and should be
omitted.
                  </cdoc:Omission>
               </cdoc:Omissions>
            </cdoc:StructuredDoc>
         </xs:documentation>
      </xs:annotation>
   </xs:attribute>
   <xs:attributeGroup ref="gml:SRSInformationGroup"/>
 </xs:attributeGroup>
```

Table A4.75. EFG_SRSReferenceAttributeGroup

```
 <xs:attributeGroup name="EFG_SRSReferenceAttributeGroup">
   <xs:annotation>
      <xs:documentation>
         <cdoc:StructuredDoc>
            <cdoc:FullName>EFG SRS Reference Attribute Group</cdoc:FullName>
            <cdoc:Description>The EFG_SRSReferenceAttributeGroup provides a reference to the
Earth Fixed Greenwich (EFG) Coordinate Reference System (CRS) used by this geometry. Additional
information can be provided via optional attributes to simplify the processing of the
coordinates when a more complete definition of the CRS is not needed.
            </cdoc:Description>
            <cdoc:References>
               <cdoc:Reference>Based on GML's SRSReferenceGroup</cdoc:Reference>
            </cdoc:References>
         </cdoc:StructuredDoc>
      </xs:documentation>
   </xs:annotation>
   <xs:attribute name="srsName" type="ctyp:SupportedSrsNamesType" use="required" fixed="EFG">
      <xs:annotation>
         <xs:documentation>
            <cdoc:StructuredDoc>
               <cdoc:FullName>Spatial Reference System Name</cdoc:FullName>
               <cdoc:Description>The spatial reference system name indicating that this
geometry refers to the Earth Fixed Greenwich (EFG) Coordinate Reference System
(CRS)</cdoc:Description>
            </cdoc:StructuredDoc>
         </xs:documentation>
      </xs:annotation>
   </xs:attribute>
   <xs:attribute name="srsDimension" type="xs:positiveInteger">
      <xs:annotation>
         <xs:documentation>
            <cdoc:StructuredDoc>
               <cdoc:FullName>Spatial Reference System Dimension</cdoc:FullName>
               <cdoc:Description>Number of dimensions in the coordinate
data.</cdoc:Description>
               <cdoc:Omissions>
                  <cdoc:Omission>srsDimension is defined for compatibility with GML. For C2
SSA COI applications it is expected that the SRS Name provides sufficient definition of the
Coordinate Reference System, and therefore the srsDimension is unnecessary and should be
omitted.
                  </cdoc:Omission>
               </cdoc:Omissions>
            </cdoc:StructuredDoc>
         </xs:documentation>
      </xs:annotation>
   </xs:attribute>
   <xs:attributeGroup ref="gml:SRSInformationGroup"/>
 </xs:attributeGroup>
```

Table A4.76. ECI_SRSReferenceAttributeGroup

```
  <xs:attributeGroup name="ECI_SRSReferenceAttributeGroup">
     <xs:annotation>
        <xs:documentation>
           <cdoc:StructuredDoc>
              <cdoc:FullName>ECI SRS Reference Attribute Group</cdoc:FullName>
              <cdoc:Description>The ECI_SRSReferenceAttributeGroup provides a reference to the
Earth-centered Inertial (ECI) Coordinate Reference System with True Equator and Mean Equinox
(TEME) of Date used by this geometry. Additional information can be provided via optional
attributes to simplify the processing of the coordinates when a more complete definition of the
CRS is not needed.
              </cdoc:Description>
              <cdoc:References>
                 <cdoc:Reference>Based on GML's SRSReferenceGroup</cdoc:Reference>
              </cdoc:References>
           </cdoc:StructuredDoc>
        </xs:documentation>
     </xs:annotation>
     <xs:attribute name="srsName" type="ctyp:SupportedSrsNamesType" use="required"
        fixed="ECI_date">
        <xs:annotation>
           <xs:documentation>
              <cdoc:StructuredDoc>
                 <cdoc:FullName>Spatial Reference System Name</cdoc:FullName>
                 <cdoc:Description>The spatial reference system name indicating that this
geometry refers to
                       the Earth-centered Inertial (ECI) Coordinate Reference System with True
Equator and Mean Equinox (TEME) of Date.</cdoc:Description>
              </cdoc:StructuredDoc>
           </xs:documentation>
        </xs:annotation>
     </xs:attribute>
     <xs:attribute name="srsDimension" type="xs:positiveInteger">
        <xs:annotation>
           <xs:documentation>
              <cdoc:StructuredDoc>
                 <cdoc:FullName>Spatial Reference System Dimension</cdoc:FullName>
                 <cdoc:Description>Number of dimensions in the coordinate
data.</cdoc:Description>
                 <cdoc:Omissions>
                    <cdoc:Omission>srsDimension is defined for compatibility with GML. For C2
SSA COI applications it is expected that the SRS Name provides sufficient definition of the
Coordinate Reference System, and therefore the srsDimension is unnecessary and should be
omitted.
                    </cdoc:Omission>
                 </cdoc:Omissions>
              </cdoc:StructuredDoc>
           </xs:documentation>
        </xs:annotation>
     </xs:attribute>
     <xs:attributeGroup ref="gml:SRSInformationGroup"/>
  </xs:attributeGroup>
</xs:schema>
```

A4.3. Custom Text Formats for NTDS Sensors.

A4.3.1. The NDPP system is designed to accommodate text files in virtually any format and structure, as long as the basic data elements are available. The system is capable of parsing data from any part of the following components: filename, message header, message body, or message footer.

A4.3.2. Unique formats require additional time for sensor integration in order to accommodate development of new NDPP plug-ins. The extent of time required depends on the complexity of the format and on the availability of developer resources.

A4.3.3. Systems submitting custom data formats should ensure all required information is provided and that it conforms to the reporting guidelines addressed in this AFSPCI.

A4.3.4. Detailed format description documents must be provided to HQ AFSPC/A3/6Z and 18 SPCS/DOU.

A4.4. Non-Metric Reporting.

A4.4.1. The existing CSpOC and 18 SPCS systems, including SPADOC, do not have interface capabilities that enable automatic ingestion of non-metric data (e.g., SOI data, head count, no show, and time off element set) through a machine-to-machine interface. Non-metric data must be transmitted over email, through voice protocols, or as agreed upon through a MOA between the provider and the CSpOC.

Attachment 5

SENSOR CALIBRATION

A5.1. Sensor Calibration Concept.

A5.1.1. The U.S. Space Surveillance Network (SSN) Sensor Calibration System uses Satellite Laser Ranging (SLR) data and precision state vectors on certain satellites to construct independent, precision reference orbits to be used as "truth" data for comparison to "observed" data from SSN sensors and non-traditional sensors. This data enables accurate and timely determination of sensor data quality. Within the calibration process, data quality is represented in statistically familiar terms of mean (bias), standard deviation (sigma), and root-mean-square (RMS) error. The mean represents a general offset in the observational data which, if relatively stable, may be corrected by simple subtraction. The standard deviation value represents the general variability (scatter), or "noise", in the observational data which is usually difficult to correct because it is inherent to the sensor hardware systems. For this reason, the standard deviation values are often used to represent the inherent precision of a sensor and are often used to weight a particular sensor's observations within the orbit determination (OD) process. Once known for each sensor, sigmas and biases can be accounted for in the orbit determination processes and sensor sigmas can be applied to covariance error propagation. Performing periodic sensor calibration ensures the mission systems relying on SSN data are continuously updated with any changes in sensor performance. The benefits of the on-going calibration process include error reduction, improved OD accuracy, better association of sensor observations to known objects, and enhanced conjunction assessments.

A5.1.2. SLR Data. SLR and Lunar Laser Ranging (LLR) use short-pulse lasers and state-of-the-art optical receivers and timing electronics to measure distance from 40+ world-wide ground stations to retroreflector arrays on 50+ Earth orbiting satellites and the Moon. Laser ranging activities are organized under the International Laser Ranging Service (ILRS), which develops the necessary global standards/specifications for laser ranging activities. The ILRS provides laser ranging data and their derived data-products to support research in geodesy, geophysics, and fundamental constants. These products contribute to the International Terrestrial Reference Frame (ITRF), which is established and maintained by the International Earth Rotation and Reference Systems Service (IERS) [Ref: **http://ilrs.gsfc.nasa.gov/**]. For calibration purposes, 18 SPCS typically uses SLR observations collected from 15 objects representing multiple orbital regimes. 18 SPCS obtains this SLR data from the online archives of the Crustal Dynamics Data Information System (CDDIS), National Aeronautics and Space Administration (NASA) Goddard Space Flight Center, Greenbelt, MD (i.e., **http://cddis.gsfc.nasa.gov/slr/data/**). Typically, the SLR data is made available with a one-day delay.

A5.1.3. Precision State Vectors. In addition to SLR data, 18 SPCS can use propagated precision state vectors to produce high-accuracy special perturbation (SP) ephemeris data. For example, 18 SPCS uses National Geospatial-Intelligence Agency (NGA) state vector data for the following satellites: Defense Meteorological Satellite Program (DMSP), Global Positioning System (GPS), and Tracking & Data Relay Satellite System (TDRSS).

A5.1.4. SSN Data. During normal operations and during trial period, the SSN sensor collects metric observational data daily on "calibration" satellites (i.e., the same satellites used for

reference orbits). Each legacy SSN sensor collects data on all calibration satellites in its coverage and sends the data to 18 SPCS in the legacy observation transmission format (SPADATS AA07), which is to be replaced by the C2 SSA COI Version 3.4.2. XML observation message. Metric observations from radar sensors generally include azimuth, elevation, range, and range-rate measurements, while the metric observations from optical sensors are usually in the form of right ascension and declination. Before entering trial period, test observations are typically collected over a two-week period. For calibration of these test observations, ~30 to ~50 tracks of data containing a total of ~200 to ~400 observations are needed assuming the sensor collects ~5 to ~10 observations per track. Observation spacing for near Earth calibration satellites should be no less than 6 seconds; observation spacing for deep space calibration satellites should be no less than 30 seconds. Tracks should be separated by a minimum of 10 minutes.

A5.1.5. Observation sets from SSN sensors frequently include a small number of observations that are extreme outliers and do not represent the data as a whole. It is usually beneficial to eliminate the outliers from calibration analyses in order to make the results more meaningful. This is generally accepted as long as the analyst ensures elimination of this data does not conceal any indications of sensor degradation that would not otherwise be detected.

A5.1.6. Orbit Determination. 18 SPCS employs its core astrodynamics program to perform precision orbit determination (OD) and prediction. This program processes either SLR or SSN satellite observation data using a batch least squares special perturbation differential correction (SPDC) method. The 18 SPCS SPDC technique includes the following options for the state vector update:

A5.1.6.1. Earth Constants (gravitational constant, mean Earth radius, etc.), Time Constants, and Polar Motion data—inputs to 18 SPCS's SPDC include updated data provided by the IERS. The IERS provides earth orientation data in the form of bulletins or data files which are used by 18 SPCS to perform weekly updates to polar motion parameters, leap seconds, and Delta Universal Time 1 (DUT1), the correction between Universal Time determined by the Earth's rotation and Coordinated Universal Time defined by a network of precision clocks.

A5.1.6.2. Which geopotential model is used—including the degree (D) and order (O) of the spherical harmonic coefficients applied in SPDC.

A5.1.6.3. Which atmospheric density model is used—for satellites in the drag regime, 18 SPCS uses the High Accuracy Satellite Drag Model (HASDM), which determines temporally and spatially-dependent atmospheric density values. As an input to the HASDM model, 18 SPCS receives solar flux and geomagnetic data multiple times per day. This data includes the daily values of solar flux, $F_{10.7}$ and $F_{10.7}$ monthly average; as well as the values of Geomagnetic Index, a_p, which is produced in three-hour intervals.

A5.1.6.4. Which n-body gravitational perturbations are considered (e.g., Sun, Moon, etc.).

A5.1.6.5. Whether or not perturbations due to solar radiation pressure are included.

A5.1.6.6. Whether or not perturbations due to solid earth and ocean tides are included.

A5.1.6.7. Whether or not the sensor observations used in the SPDC are weighted using the operational sigma values for each sensor.

A5.1.7. The results of this processing are state vectors describing the satellite orbit. These state vectors are used to generate predicted ephemeris data used by a separate program to piece together long-term reference orbits.

A5.1.8. Reference Orbits. 18 SPCS maintains a long-term reference orbit for each calibration satellite composed of regularly-spaced ephemeris points. These reference orbits are appended with each state vector update performed during the calibration cycle using predicted ephemeris data. The predicted ephemeris data is calculated over a portion of the SLR observation span used in SPDC (approximately the middle 50% of the SLR observation span). Subsequent cycles make use of a sliding window of SLR observations to produce additional predicted ephemeris in the same manner. In this way, a continuous high precision reference orbit is produced by the abutment of these sequential ephemerides over time. The reference orbits, in general, overlap by one point. The difference between the end point of one segment and the starting point of the following segment is called an abutment error. The vector magnitude of the abutment error is used as an indicator of the accuracy and consistency of the reference orbit. There may be gaps in some reference orbits due to failed or rejected differential corrections, but because multiple reference orbits are used, the calibration process is not interrupted.

A5.2. Calibration Process.

A5.2.1. Once the reference orbits have been updated, they can be used in the calibration process [**Note**: The reference orbit coordinate system is Earth Centered Inertial (ECI), True Equator/Mean Equinox of Date (TEME)]. In this process, metric measurements from each SSN or non-traditional sensor are compared to the precise reference orbits to calculate the differences (residuals). 18 SPCS calculates residuals for each metric component of every sensor observation within a specified time interval and uses them to perform a statistical analysis that produces standard deviations (sigmas) and biases for each sensor. Typically, 18 SPCS performs calibrations weekly and uses the most recent 14 days of SSN observations and a corresponding 14day portion of reference orbit ephemeris data. Since reference orbits are as close to the true position of the satellite as possible (1 to 5 meters root mean square (RMS) error), the sigmas and biases thus produced are accurate statistical estimates of the measurement errors—assuming appropriate sample size to ensure statistical significance. The residuals are computed as the measured observation minus the "truth" observation computed from the reference satellite ephemerides. The residuals are computed for right ascension, declination, azimuth, elevation, range and range rate respectively as follows in **Figure A5.1.**:

Figure A5.1. Computing Residuals.

$$\Delta\alpha_i = (\alpha_i' - \alpha_i)\cos\ \delta_i$$

$$\Delta\delta_i = \delta_i' - \delta_i$$

$$\Delta a_i = (a_i' - a_i)\cos\ \varepsilon_i$$

$$\Delta\varepsilon_i = \varepsilon_i' - \varepsilon_i$$

$$\Delta r_i = r_i' - r_i$$

$$\Delta\dot{r}_i = \dot{r}_i' - \dot{r}_i$$

A5.2.1.1. The right ascension residuals and the azimuth residuals are multiplied by and to avoid the singularity at the pole and zenith respectively, and are thus referred to as *traverse* residuals. The overall result is that the azimuth/right ascension residuals are reduced in proportion to their proximity to the zenith/celestial pole.

A5.2.2. 18 SPCS employs a slightly modified Gaussian distribution (normal distribution) routine for sensor calibration analyses. The Gaussian distribution may be applied to observational data to determine bias, sigma, and RMS error values. The equations for computing the right ascension statistics (bias, sigma and RMS error respectively) are as follows in **Figure A5.2.**:

Figure A5.2. Right Ascension Statistics.

$$\mu_\alpha = \frac{1}{n}\sum_{i=1}^{n} \Delta\alpha_i$$

$$\sigma_\alpha = \sqrt{\left(\frac{1}{n-1}\right)\sum_{i=1}^{n} (\Delta\alpha_i - \mu_\alpha)^2}$$

$$RMS_\alpha = \sqrt{\left(\frac{1}{n}\right)\sum_{i=1}^{n} \Delta\alpha_i^2}$$

A5.2.2.1. Azimuth residuals may be substituted for right ascension residuals in the above equations to obtain the azimuth statistics. Similar equations are used to compute the declination statistics.

Figure A5.3. Declination Statistics.

$$\mu_\delta = \frac{1}{n}\sum_{i=1}^{n} \Delta\delta_i$$

$$\sigma_\delta = \sqrt{\left(\frac{1}{n-1}\right)\sum_{i=1}^{n} (\Delta\delta_i - \mu_\delta)^2}$$

$$RMS_\delta = \sqrt{\left(\frac{1}{n}\right)\sum_{i=1}^{n} \Delta\delta_i^2}$$

A5.2.2.2. Elevation residuals may be substituted for declination residuals in the above equations to obtain the elevation statistics. Similar equations are used to compute the range statistics.

Figure A5.4. Range Statistics.

$$\mu_r = \frac{1}{n}\sum_{i=1}^{n} \Delta r_i$$

$$\sigma_r = \sqrt{\left(\frac{1}{n-1}\right)\sum_{i=1}^{n} (\Delta r_i - \mu_r)^2}$$

$$RMS_r = \sqrt{\left(\frac{1}{n}\right)\sum_{i=1}^{n} \Delta r_i^2}$$

A5.2.2.3. Range rate residuals may be substituted for range residuals in the above equations to obtain the range rate statistics.

A5.2.3. The 18 SPCS calibration process is designed with the philosophy that the "operational" value should not be changed unless the sensor's performance has clearly changed over a long span of time (or a problem is detected and reported by a sensor site). The results of each sensor calibration run are compared to the operational data and the analyst is alerted when the change is significant. In such cases, sensor calibration analysts evaluate and change the operationally-used values as necessary. These values are stored in the Sensor Location, Sigmas & Biases file (see sample entry below).

Figure A5.5. Sample Sensor Location, Sigmas & Biases file.

```
Sensor Number = 399
Classification = UNCLASSIFIED
Sensor Location = EGLIN (FPS-85)
Sensor Type = Phased Array
Time Tag Of Sensor Record (UTC) = 1998077000000.000
Astronomical Latitude  (deg +N) =    30.572440000000000
Astronomical Longitude (deg +W) =  -273.785140000000010
EFG Position X (m) =   362839.0000000000000
EFG Position Y (m) = -5484292.0000000000000
EFG Position Z (m) =  3225189.0000000000000
Computed Range Bias                          (km) =    -0.002448751210676
Computed Azimuth/Right Ascension Bias       (deg) =    -0.001309082904694
Computed Elevation/Declination Bias         (deg) =     0.005887768629170
Computed Range Rate Bias                 (km/sec) =     0.000000000000000
Computed Time Bias                          (sec) =     0.000000000000000
Computed Range Sigma                         (km) =     0.040399461429368
Computed Azimuth/Right Ascension Sigma      (deg) =     0.016600766551201
Computed Elevation/Declination Sigma        (deg) =     0.020092552144288
Computed Range Rate Sigma                (km/sec) =     0.000000000000000
Computed Range RMS                           (km) =     0.040441073432010
Computed Azimuth/Right Ascension RMS        (deg) =     0.016627575431110
Computed Elevation/Declination RMS          (deg) =     0.020921961199293
Computed Range Rate RMS                  (km/sec) =     0.000000000000000
Operational Range Bias                       (km) =     0.000000000000000
Operational Azimuth/Right Ascension Bias    (deg) =     0.000000000000000
Operational Elevation/Declination Bias      (deg) =    -0.010000000000000
Operational Range Rate Bias              (km/sec) =     0.000000000000000
Operational Time Bias                       (sec) =     0.000000000000000
Operational Range Sigma                      (km) =     0.040000000000000
Operational Azimuth/Right Ascension Sigma   (deg) =     0.015000000000000
Operational Elevation/Declination Sigma     (deg) =     0.020000000000000
Operational Range Rate Sigma             (km/sec) =     0.000000000000000
Calibration Span (days)                           = 7.000000000000000
Total Observations                                = 625
Total Tracks                                      = 36
Number of Time Observables                        = 625
Number of Range Observables                       = 620
Number of Azimuth/Right Ascension Observables     = 624
Number of Elevation/Declination Observables       = 623
Number of Range Rate Observables                  = 0
```

A5.2.4. Sensor Calibration Report. One of the outputs of 18 SPCS's calibration process is the Sensor Calibration Report. An example calibration report is included below. In this example, 797 observations collected between day 99 and 109 of 2002 were used to produce the results shown in the table. The observation and residual data listed below the table includes the metric measurements and calculated residuals for each observation included in the analysis (the list has been truncated in the interest of space, but may contain up to 10,000 observations) [**Note**: for this product, the azimuth and right ascension residuals listed are "traverse" (meaning they have been multiplied by the cosine of the elevation or declination).] As shown in the figure, the 18 SPCS calibration process evaluates residuals for each metric component mean, standard deviation, and RMS error. The standard deviation values listed in the calibration report represent the 1-sigma value. This infers (for a normal distribution) that about ⅔ (~67%) of the residuals lie between bias ±1 sigma. Accordingly, about 95.5% of the data lies between bias ±2 sigma, and nearly all of the data (~99.7%) resides between bias ±3 sigma.

Figure A5.6. Sample Sensor Calibration Report.

```
CLASSIFICATION: UNCLASSIFIED
CALIBRATION SUMMARY INFORMATION FOR SENSOR 388 (                    BEALE (S))
MESSAGE GENERATION TIME 02 126 18 04 20.000
CALIBRATION START  TIME 02 099 00 00 00.000
CALIBRATION STOP   TIME 02 109 00 00 00.000
TOTAL OBSERVATIONS:   797
                                                        OBS
                         MEAN      STDDEV       RMS     USED
                     ------------ ----------- ----------- -----
AZIM/RA      (DEG):       0.0208      0.0267      0.0320   797
EL/DEC       (DEG):       0.0075      0.0269      0.0279   797
RANGE         (KM):       0.0304      0.0625      0.0695   797
RANGE RATE (M/SEC):       0.1889      2.5252      2.5307   797

OBSERVABLES/
RESIDUALS
                             AZIM/RA     EL/DEC      RANGE     RANGE RATE
SATNO YY DDD HH MM SS.SSS     (DEG)       (DEG)       (KM)       (KM/SEC)
----- ------------------   ---------- ---------- ------------ -----------
26405 02 099 00 20 53.887   142.3632     8.9157     1567.0550      5.9590
                            -0.0048     0.0181        0.0203      0.0011
26405 02 099 00 21 04.878   143.9787     7.9912     1633.1740      6.0731
                             0.0017     0.0447        0.0136      0.0008
26405 02 099 00 21 16.946   145.6002     7.0013     1707.1390      6.1803
                             0.0072     0.0565        0.0226     -0.0014
                                .          .             .           .


                                .          .             .           .
```

Attachment 6

SAMPLE MEMORANDUMS

Figure A6.1. Trial Period Entry Approval Memorandum

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE SPACE COMMAND

DATE

MEMORANDUM FOR DISTRIBUTION

FROM: HQ AFSPC/A3/6S
150 Vandenberg St Ste 1105
Peterson AFB, CO 80914-4250

SUBJECT: Trial Period Entry for Sapphire

1. Sapphire is a Canadian Space Surveillance Sensor which provides optical, angles-only metric observations on Deep Space Resident Space Objects. Sapphire launched 25 February 2013, was commissioned, and successfully completed Operational Test and Evaluation. All U.S. systems are ready to task Sapphire. All Canadian systems are ready to operate Sapphire as a foreign contributing sensor to the Space Surveillance Network (SSN). Metric observation accuracy was confirmed to meet SSN standards.

2. Sapphire is approved to enter operational trial period effectively 21 Oct 18 as a foreign contributing sensor to the SSN.

3. Fallback procedures and times for this trial period are not applicable as it is a new contributing sensor.

4. A Trial Period Review Panel will convene prior to trial period exit to review results of trial period.

5. Forward questions to HQ AFSPC OAP. POC on this matter is Mr. Pete Mount, HQ AFSPC/A3/6XR, (719) 554-4954 (DSN 692), peter.mount.1@us.af.mil.

SIGNATURE BLOCK
Chief, Space Operations Division

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HQ AFSPC/A3/6C
HQ AFSPC/A3/6W
HQ AFSPC/A3/6Z
14 AF/A3/6O
21 OG
18 SPCS
AFLCMC/HBQ
614 AOC/SSD

GUARDIANS OF THE HIGH FRONTIER

Figure A6.2. Trial Period Exit Approval Memorandum

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE SPACE COMMAND

DATE

MEMORANDUM FOR DISTRIBUTION

FROM: HQ AFSPC/A3/6S
150 Vandenberg St Ste 1105
Peterson AFB, CO 80914-4250

SUBJECT: Trial Period Exit and Acceptance of Sapphire Data for Operational Use

1. Sapphire, a Canadian Space Surveillance Sensor, provides optical, angles-only metric observations on Deep Space Resident Space Objects. Sapphire launched 25 February 2013, was commissioned, and successfully completed Operational Test and Evaluation. Sapphire was approved to enter operational trial effective 21 Oct 18 as a foreign contributing sensor to the Space Surveillance Network (SSN).

2. Sapphire has successfully met all trial period exit criteria. Metric observation accuracy was confirmed to meet SSN standards. No Category I deficiencies occurred during trial period.

3. Request USSTRATCOM/J65 complete certification of Sapphire as a foreign contributing sensor to the SSN.

4. Forward questions to HQ AFSPC OAP. POC on this matter is Mr. Pete Mount, HQ AFSPC/A3/6XR, (719) 554-4954 (DSN 692), peter.mount.1@us.af.mil.

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