Space Situation Awareness Integration Office Overview and Spiral 2 Results

Lt Col Dan Wilson (USAF), Jeffery A. Marshall (SPARTA Inc), and David S. Newton (SPARTA Inc)

HQ AFSPC/A5CC Space Situation Awareness Integration Office

The poster presented at the AMOS Conference illustrates the process and presents recommendations for space and terrestrial environment the Headquarters Air Force Space Command (HQ AFSPC/A5CC) uses to detail and describe Space Situation Awareness (SSA). The poster and this paper is broken into 16 slides with the “Background on SSAIO” slide the first “Contact Information” the last one. Each section of the paper tracks to the section of the poster.

BACKGROUND ON SSAIO

This slide describes the history of the office. The SSAIO (Space Situation Awareness Integration Office) was stood up as a direct result of the USAF (United States Air Force) designation as the Lead Service System Integrator (LSSI) for SSA. Responsibilities of the office included: Establishing and recommending overall direction for National SSA capabilities, Build National SSA Enterprise Architecture; Allocate requirements; and Support SSA Community budget builds. The definition for SSA is presented in the bottom right corner of the figure. These are further described in the graphic below (Figure 1).

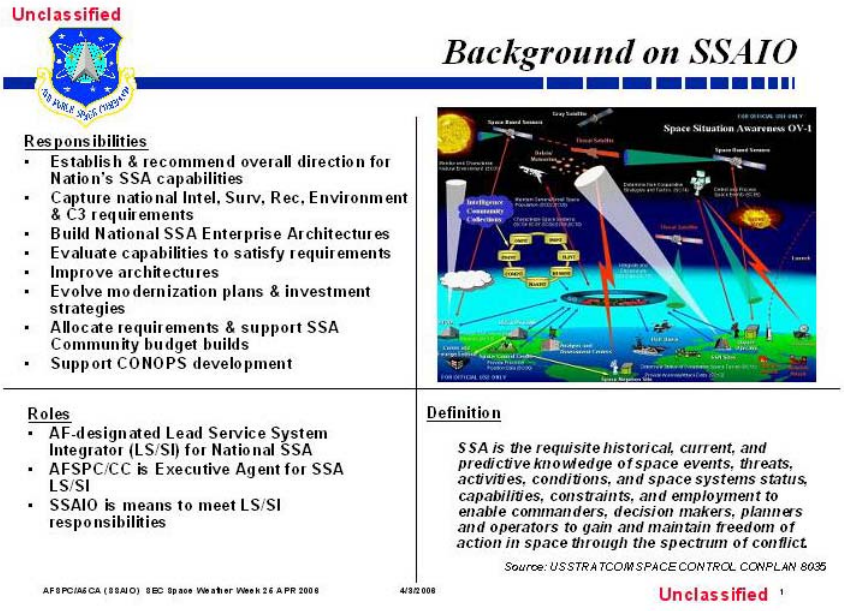

Figure 1: Background on SSAIO

15 NATIONAL SSA CAPABILITIES

To accomplish these responsibilities, the SSAIO separated SSA into 15 discrete building blocks or SSA Capabilities (SCs). These 15 SCs fully describe SSA to include the intelligence aspects and the dissemination of information. Additionally, with Joint Requirements Oversight Council (JROC) approval of the United States Strategic Command (USSTRATCOM) Joint Capabilities Document (JCD); the 15 SCs used in Spiral 2 map very favorably to the JCD 10 that is currently being used to describe SSA.

The SCs are additive, that is one cannot do one well without doing the previous ones. For example, with little or no knowledge of the environment maintaining the catalog would be more difficult. Precision position data would be difficult to develop without coarse position data.

Figure 2: 15 National SSA Capabilities

For this forum, the authors used SC-01 to describe SSAIO processes and present results of the analysis. The definition of the capability is presented in the figure below. Please note this capability maps favorably to the recently approved JCD for environment published by USSTRATCOM.

SC-01 MONITOR AND CHARACTERIZE THE NATURAL ENVIRONMENT

Essentially this definition, as shown in Figure 3, describes weather monitoring, both terrestrial and space with its contribution to SSA. If environmental monitoring is not accomplished effectively, the performance of SSA and its companion missions Defensive Space Control and Offensive Space Control will not be as timely, efficient, or effective.

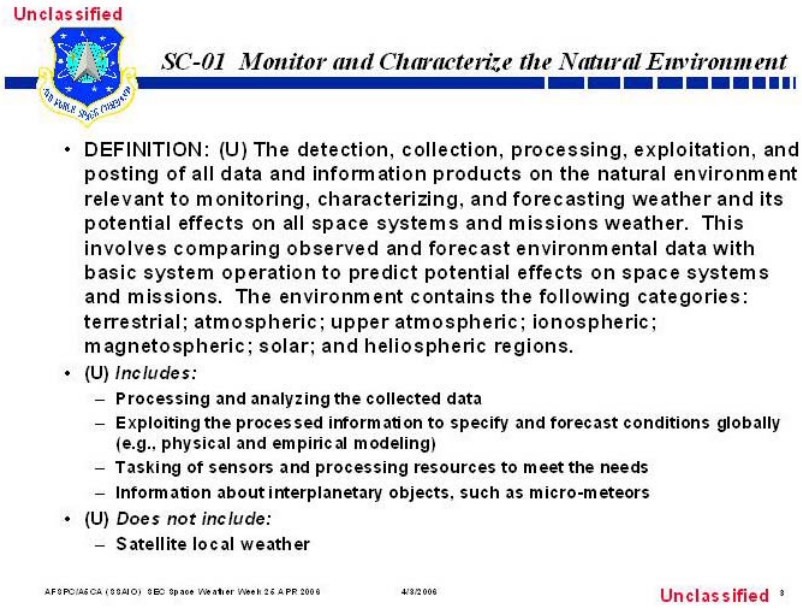

Figure 3: SC-01 Monitor and Characterize the Natural Environment

SPIRAL 2 TECHNICAL APPROACH

The SSAIO was organized in multiple branches: Cost, Architectures, Capability Assessment (CA), Requirements or Capability Needs (CN), and Plans and Programs (Production). Each branch contributed to the overall success of the office. The Architecture branch produced the (Department of Defense Architecture Framework) DoDAF-products and the attributed systems lists for the study epochs:

- 2010 ('As-Is')
- 2016 (Four 'To-Bes': IPP (Integrated Planning Process), IPP+Non-Traditional Sensors, Material, and Non-Material
- 2025 ('Should-Be' – National Security Space Office (NSSO) Architecture).

Costing produced how much each architecture or systems list cost based on validated budget data. CN gathered the requirements for SSA and codified them into the database. The captured requirements ranged in primacy from approved JROC capability needs to organizational requirements (produced within an organization, but not yet validated or approved by the JROC or the Service ROC). Sources for these requirements include the US Army, USAF, NASA, HQ

AFSPC, ORDs (operational requirements documents like CCIC2S ORD), etc. Requirements or capability needs were gathered from a national perspective, not a particular service. The CA branch graded the architectures against requirements using vetted measures of effectiveness. All data described in the above paragraph is housed within a relational SQL database and visualized using Troux® Metis. Other applications used by the office to accomplish the mission include Telelogic ® Popkin System Architect, Microsoft ® Visio, IBM ® Rational ReqPro, and Microsoft ® Office.

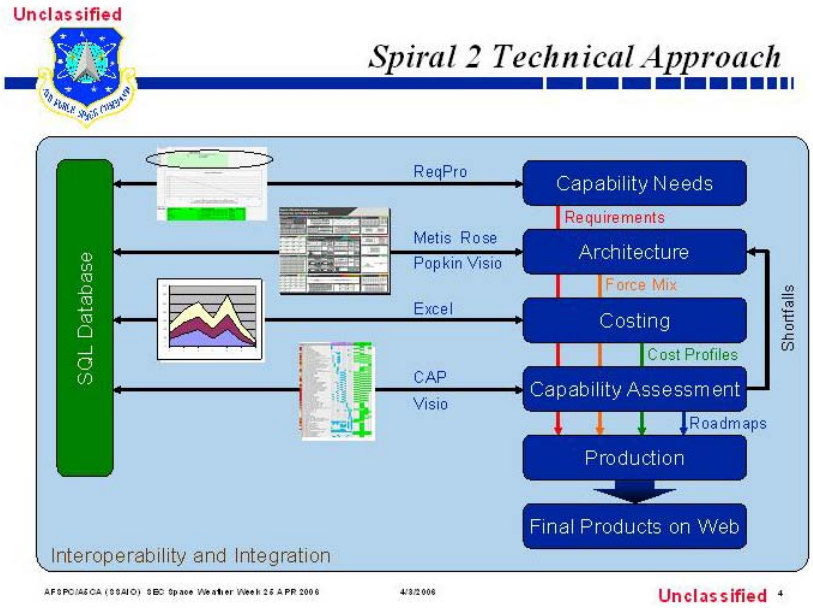

Figure 4: Spiral 2 Technical Approach

SPIRAL 2 SSA EA RELATIONSHIPS

Troux ® Metis graphically portrays the data entered into the database providing the user with the ability to visualize the data and its relationships and its relevance to SSA. Relationships are replicated within Metis as lines. An innovation performed by the SSAIO was relationship classification. Lines shown in green represent unclassified data; lines in blue show confidential data; lines in red show secret data. This has been extended to the containers as well. This 'system-high' representation of classification assists the user to as to what is classified within the metamodel and what is not. At the end of Spiral 2 there

were in excess of 85,000 relationships in the overall SSAIO EA. The expanded view within the figure depicts the relationships emanating from the SC-01 container. These relationships show linkages to requirements, systems, technologies, joint space missions, etc. This is shown in Figure 5.

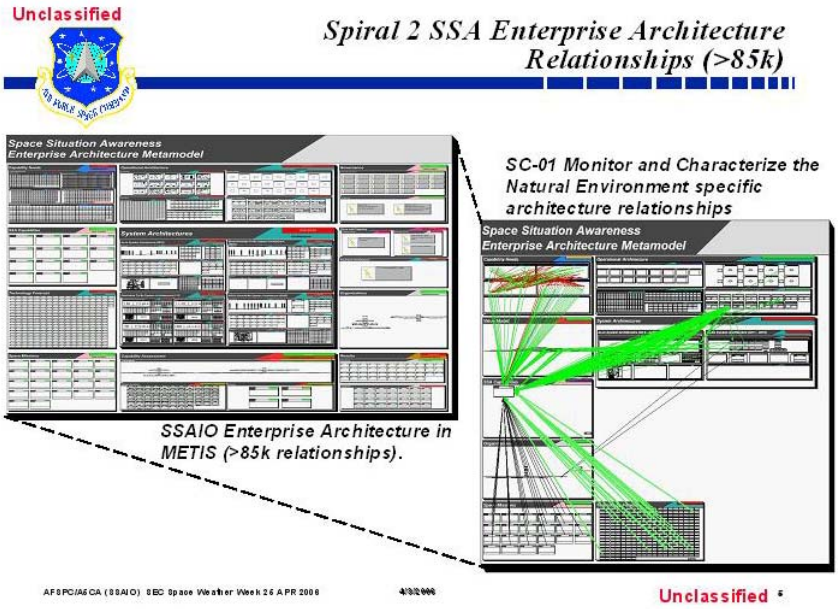

Figure 5: Spiral 2 SSA Enterprise Architecture Relationships (>85k)

CAPABILITY NEEDS ANALYSIS PROCESS

As mentioned previously, requirements the support SSA are drawn from a variety of sources and documents. These range from JROC-validated requirements to MOAs between NASA and the OSD, and all document spectra in between. Each requirement is extracted from its source document using Rational ReqPro assigned attributes and stored in the relational database. During the requirements assignment process, SAAIO personnel discovered that numerous agencies/organizations request/demand essentially the same capability. These requirements have been labeled SSAREQs. These requirements are consolidated into one overarching requirement. The linkage to the original requirement is preserved and shown in the metamodel. For SC0-01, over 300 requirements were discovered and assigned.

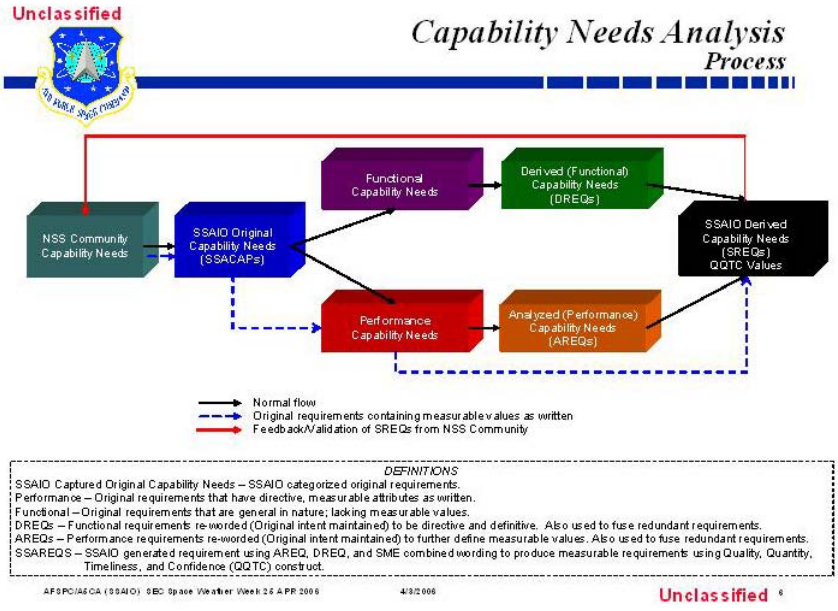

Figure 6: Capability Needs Analysis Process

The figure below details the types of requirements that were allocated to SC01. Sixteen percent of the requirements were JROC validated. Analyzed Performance and Analyzed Functional Requirements are those requirements that are basically similar needs from different organizations. For example, NASA may have a need to measure electron density in space. The USAF may have a similar need. The needs are combined and reflect one need with multiple owners.

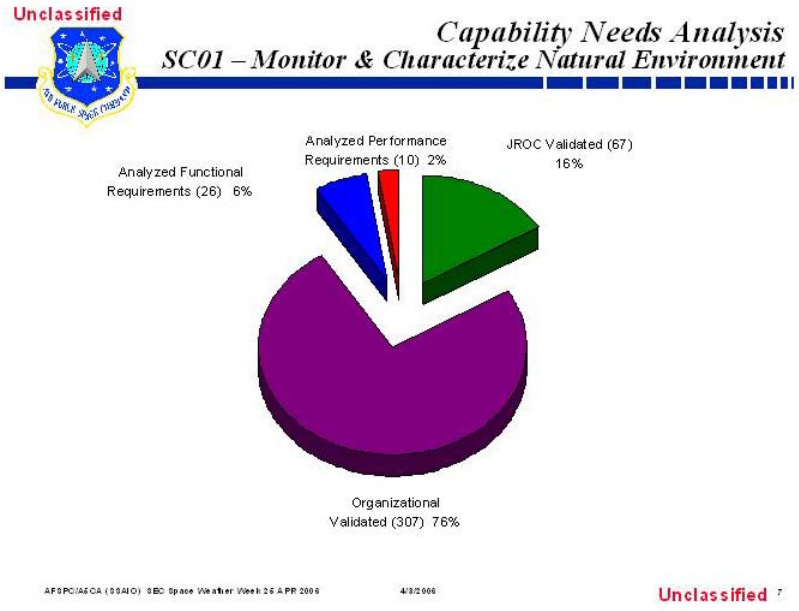

Figure 7: Capability Needs Analysis SC-01 – Monitor & Characterize Natural Environment.

ARCHITECTURE PROCESS

Previously it was noted there were six architectures developed, an ‘As-Is’ for 2010, four ‘To-Bes’ for 2016, and one ‘Should-Be’ for 2025. These architectures or ‘systems-lists’ were drawn from validated Mission Area Plans (MAPs), the Space Surveillance Network (SSN) Handbook, and other validated documents and presentations. IOC, FOC, EOL, Owner, Operator, Description, record classification, data classification, pertinent architecture are just a sample of the attributes for the data captured in the Systems table in the database. After the ‘As-Is’ architecture was developed, subject matter experts (SMEs) were invited to determine shortfalls in that architecture. Potential material and non-material to solutions and costs estimated the shortfalls defined by the SMEs. These recommended solutions became the SSAIO’s Material and Non-Material architectures. The other two architectures used by the SSAIO were the Integrated Planning Process (IPP) architecture and the IPP plus non-traditional sensors. These were developed independently and provided to the SSAIO. From these four architectures, a fifth called ‘best-of-breed’ was developed based

on the scores against requirements and prioritized shortfall satisfaction provided by the CA Branch. This will be described later in the paper.

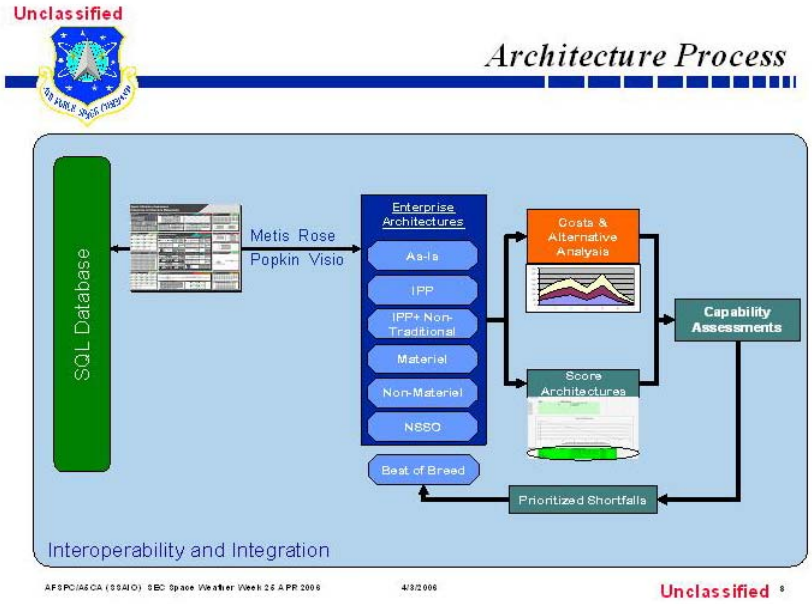

Figure 8: Architecture Process.

ARCHITECTURE PRODUCTS

Within the EA Metamodel DoDAF products were created and reproduced for visualization. Please remember that all products, containers, and relationships are stored and drawn from the database. The products depicted in the poster show an Operational View (OV)-1, OV-5, Systems View (SV)-1, and SV-10c. These are just examples of the DoDAF products developed by the SSAIO to show the architectural side of SSA. The SSAIO architectural development process allowed the engineers on the team to focus on the data and not the architectural tool. The SSAIO was allowed to be tool agnostic. We were fortunate enough to be able to choose the best tool for the product. That is why the four different architectural products shown in Figures 9 and 10 have a different look and feel. The OV-1 is in PowerPoint, the OV-5 is in Metis, the SV-1 is in Popkin System Architect, and the SV-10c is in Visio.

To illustrate the strength of the process developed at the SSAIO, a request to change data that rippled throughout the architecture took two to three weeks to

accomplish, using the previous process. Under the Spiral 2 process a more complex change took less than two hours.

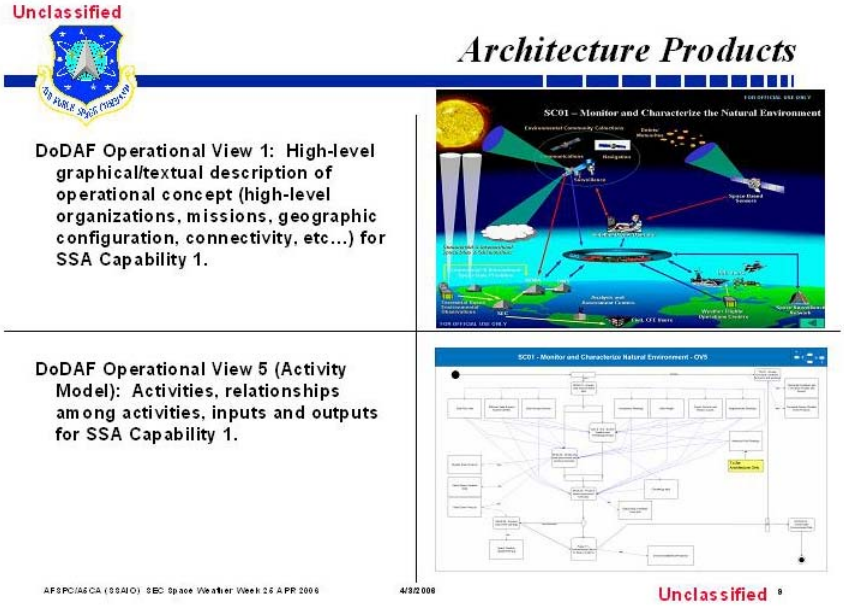

Figure 9: Architecture Products

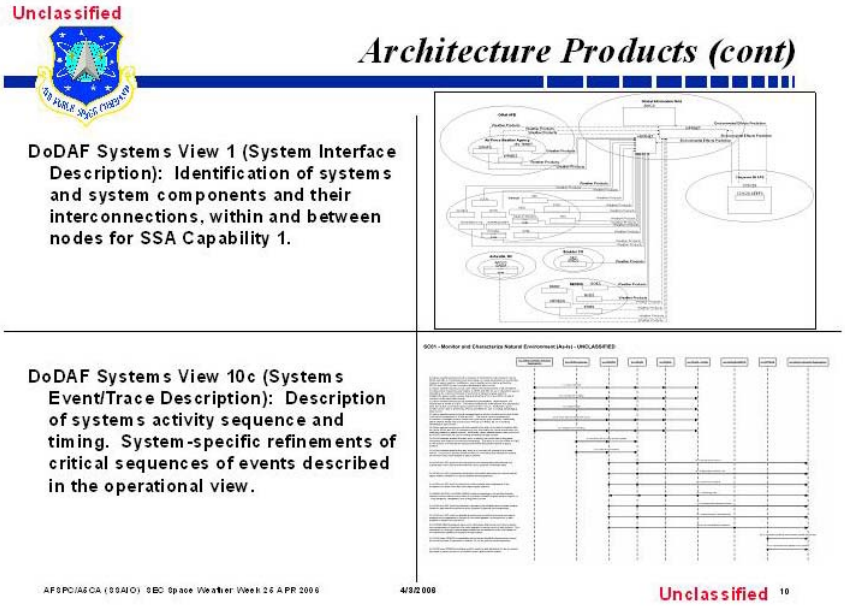

Figure 10: Architecture Products (Cont).

CAPABILITY ASSESSMENT PROCESS

As the bumper sticker on the slide states, “We measure at System level; Assess at Architecture level; recommend at Capability level.” This is the essence of the SSAIO. Many offices produce architectures only, the SSAIO assesses the architectures. Architectures (lists of systems with attributes) with costs to procure/maintain are assessed based on the architecture’s satisfaction of requirements. For Spiral 2, over 300 SC-01 requirements and 20 technologies that applied to the SC were assessed against four mission activities and seven measures of performance. Figure 11 illustrates the process. The assessment decomposed the SC into defined components (measures of effectiveness and measures of performance). It was accomplished in this manner to simplify assessment. The MS® Excel charts show excerpts from the final delivery showing how the different system mixes among the architectures produced different contributions to the SC for the environment.

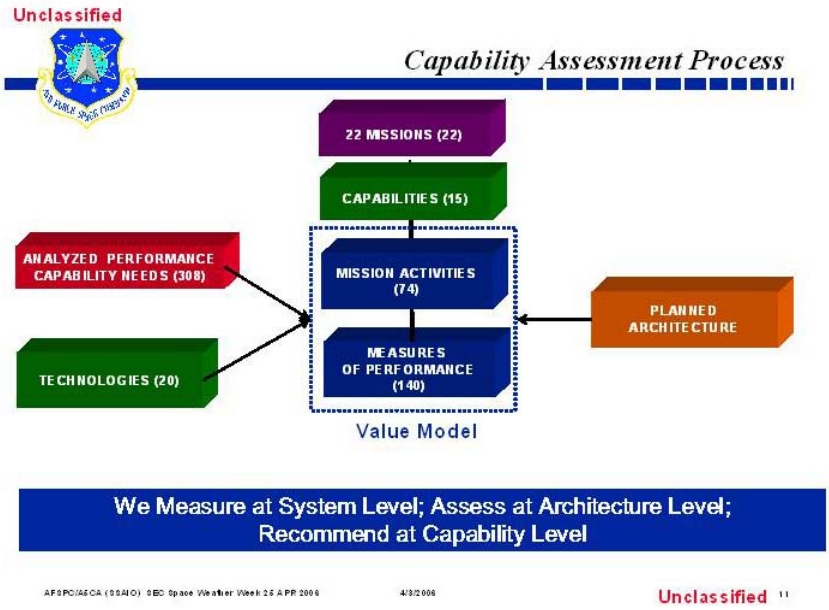

Figure 11: Capability Assessment Process

Figures 12 and 13 illustrate the results of the assessment. The charts show the relative assessment of the shortfalls for Space Weather Collection, Characterization, and Assessment.

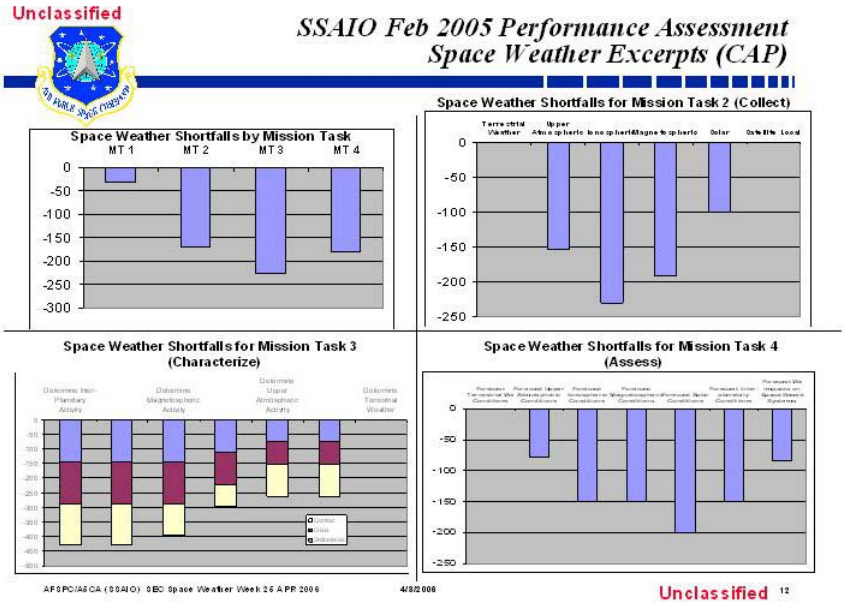

Figure 12: SSAIO Feb 2005 Performance Assessment Space Weather Excerpts (CAP)

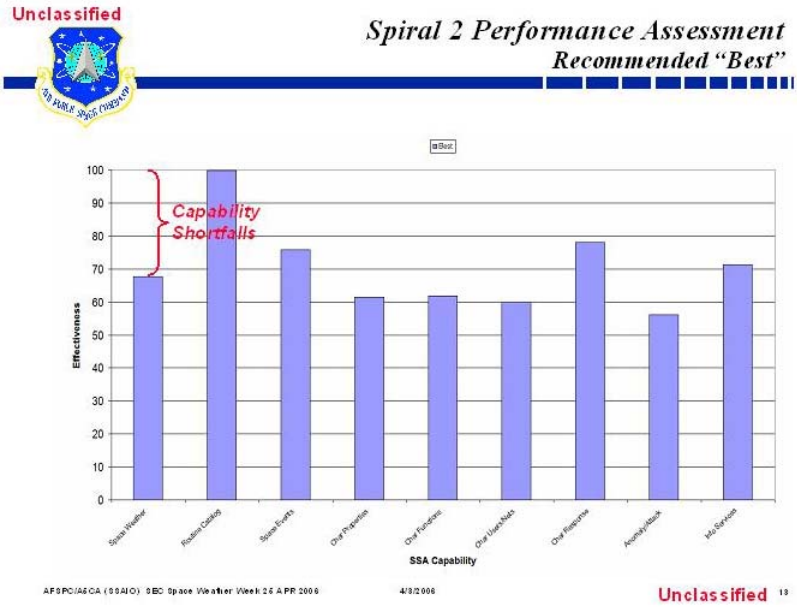

Figure 13: Spiral 2 Performance Assessment Recommended 'Best'

SPIRAL 2 PRODUCTS

The slide below depicts the breadth and depth of products during Spiral 2. Each branch contributed to the overall success of the Office. DoDAF-compliant architectural products were created from the SSAIO database. Assessments

were provided based on the architectures and their relative costs. Requirements (capability needs) were documented and allocated and assigned to architectures. Prospective technologies were examined to alleviate capability shortfalls and requirements satisfaction.

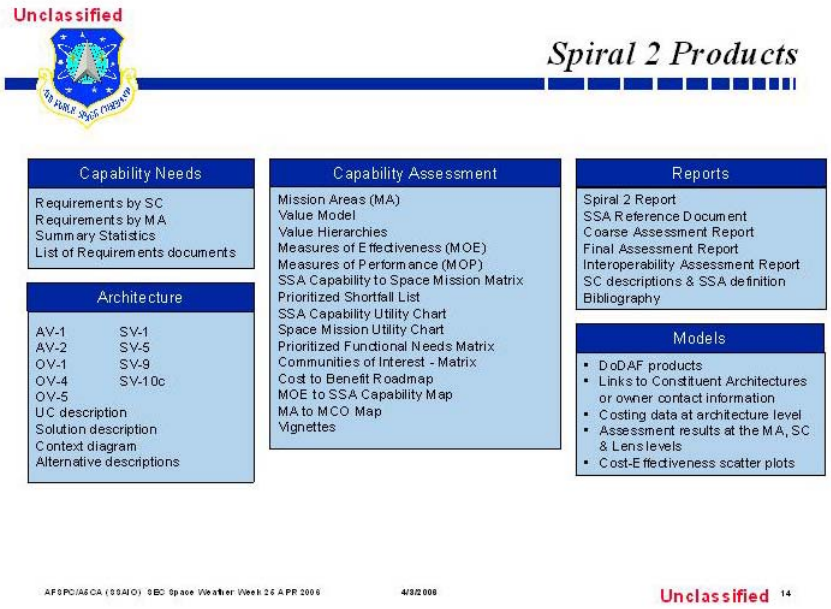

Figure 14: Spiral 2 Products

SPIRAL 2 RESULTS AND KEY FINDINGS

Numerous weather findings were discovered during the analysis performed during Spiral 2. One of the most critical is that two early warning space weather satellites are beyond EOL and no follow-on program has been manifested to replace them. Funding for the replacement capability has not been identified.

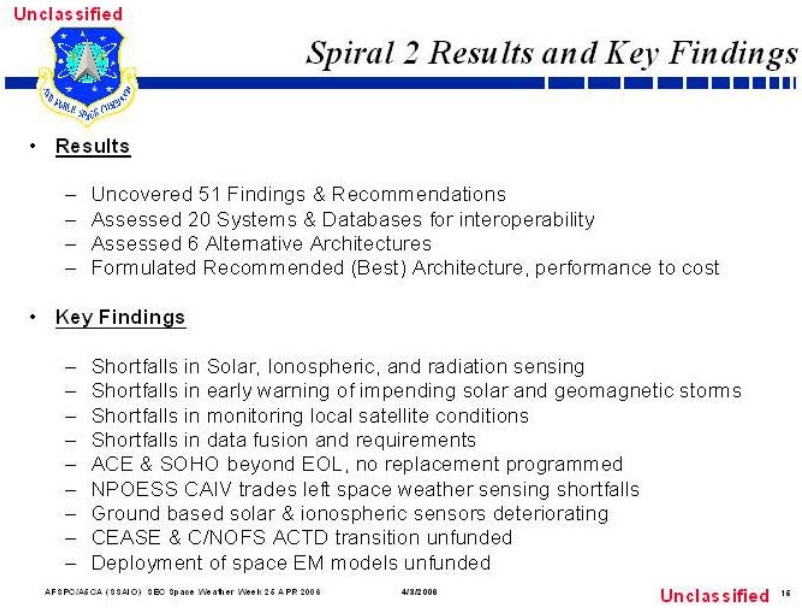

Figure 15: Spiral 2 Results and Key Findings

CONTACT INFORMATION

Presented below in Figure 16 are the email addresses and telephone numbers for the authors. Additionally, results of the Spiral in multiple formats are available at the SIPRNET URL presented below. A limited subset of unclassified information is available at the NIPRNET URL shown below.

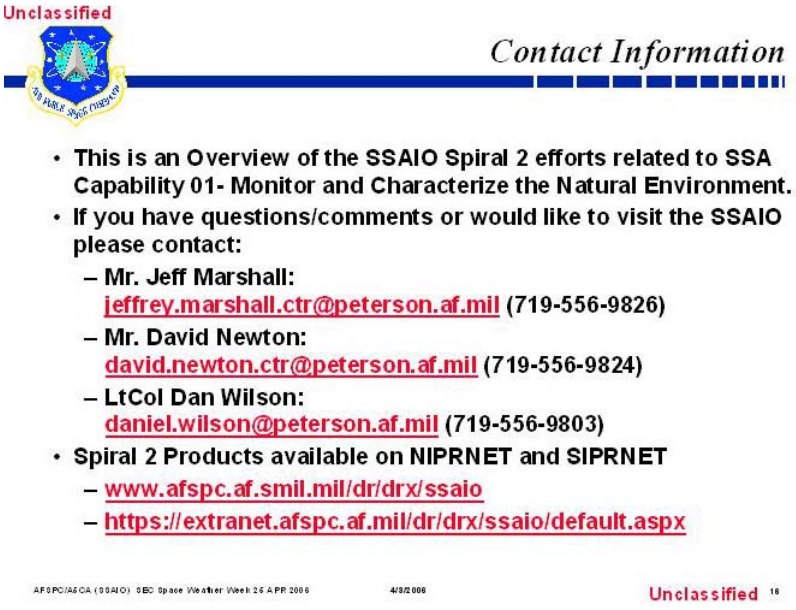

Figure 16: Contact Information.