

The Joint Space Operations Center (JSpOC) Mission System (JMS) and the Advanced Research, Collaboration, and Application Development Environment (ARCADE)

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ABSTRACT

The Joint Space Operations Center (JSpOC) is a command and control center focused on executing the Space Control mission of the Joint Functional Component Command for Space (JFCC-SPACE) to ensure freedom of action of United States (US) space assets, while preventing adversary use of space against the US. To accomplish this, the JSpOC tasks a network of space surveillance sensors to collect Space Situational Awareness (SSA) data on resident space objects (RSOs) in near earth and deep space orbits. SSA involves the ingestion of data sources and use of algorithms and tools to build, maintain, and disseminate situational awareness of RSOs in space. On the heels of emergent and complex threats to space assets, the JSpOC's capabilities are limited by legacy systems and CONOPs. The JSpOC Mission System (JMS) aims to consolidate SSA efforts across US agencies, international partners, and commercial partners.

The JMS program is intended to deliver a modern service-oriented architecture (SOA) based infrastructure with increased process automation and improved tools to remove the current barriers to JSpOC operations. JMS has been partitioned into several developmental increments. Increment 1, completed and operational in early 2013, and Increment 2, which is expected to be completed in 2017, will replace the legacy Space Defense Operations Center (SPADOC) and Astrodynamics Support Workstation (ASW) capabilities. In 2017 JMS Increment 3 will continue to provide additional SSA and C2 capabilities that will require development of new applications and procedures as well as the exploitation of new data sources. Most importantly, Increment 3 is uniquely postured to evolve the JSpOC into the centralized and authoritative source for all Space Control applications by using its SOA to aggregate information and capabilities from across the community.

To achieve this goal, Scitor Corporation has supported the JMS Program Office as it has entered into a partnership with AFRL/RD (Directed Energy) and AFRL/RV (Space Vehicles) to create the Advanced Research, Collaboration, and Application Development Environment (ARCADE). The ARCADE formalizes capability development processes that hitherto have been ad hoc, slow to address the evolving space threat environment, and not easily repeatable. Therefore, the purpose of the ARCADE is to: (1) serve as a centralized testbed for all research and development (R&D) activities related to JMS applications, including algorithm development, data source exposure, service orchestration, and software services, and provide developers reciprocal access to relevant tools and data to accelerate technology development, (2) allow the JMS program to communicate user capability priorities and requirements to developers, (3) facilitate collaboration among developers who otherwise would not collaborate due to organizational, policy, or geographical barriers, and (4) support market research efforts by identifying outstanding performers that are available to shepherd into the formal transition process.

Over the last several years Scitor Corporation has provided systems engineering support to the JMS Increment 3 Program Office, and has worked with AFRL/RV and AFRL/RD to create a high performance computing environment and SOA at both unclassified and classified levels that together allow developers to develop applications in an environment similar to the version of JMS currently in use by the JSpOC operators. Currently the ARCADE is operational in an unclassified environment via the High Performance Computing Modernization Program (HPCMP) Portal on DREN and on SECRET and TOP SECRET environments on multiple networks.

This presentation will cover the following topics: (1) Scitor's role in shaping the ARCADE into its current form, (2) ARCADE's value proposition for potential technology developers, and (3) ARCADE's value proposition for the Government.

1. KEY ELEMENTS OF THE ARCADE

Scitor Corporation has supported the JMS Program Office as it has entered into a partnership with AFRL/RD (Directed Energy) and AFRL/RV (Space Vehicles) to create the Advanced Research, Collaboration, and Application Development Environment (ARCADE). The ARCADE formalizes capability development processes that hitherto have been ad hoc, slow to address the evolving space threat environment, and not easily repeatable. Therefore, the purpose of the ARCADE is to: (1) serve as a centralized testbed for all research and development (R&D) activities related to JMS applications, including algorithm development, data source exposure, service orchestration, and software services, and provide developers reciprocal access to relevant tools and data to accelerate technology development, (2) allow the JMS program to communicate user capability priorities and requirements to developers, (3) facilitate collaboration among developers who otherwise would not collaborate due to organizational, policy, or geographical barriers, and (4) support market research efforts by identifying outstanding performers that are available to shepherd into the formal transition process. Previous AMOS Conference papers have done an excellent job summarizing the salient features of the ARCADE. Reference [1] and [2] provide the following synopsis:

Overview: AFRL and the JMS program are partnering to develop the ARCADE. The end state of this environment will give various user groups (e.g., software developers, SSA experimenters, and JSpOC users) the documentation, building block JMS services, modeling and simulation tools, relevant test scenarios, data sources, JMS user requirements/priorities, SOA integration tools required to support JMS development, and establish a structured Governance Process. The environment will also provide these user groups with a framework that enables and encourages multi-organizational collaboration. This environment is envisioned as a means for the JMS program to become a more agile acquisition system that accelerates the delivery of prototypes into Service Packs (SPs).

Although this environment is not a so-called cloud computing paradigm it is being implemented in a manner that shares characteristics of well-known computing clouds, such as Amazon's Elastic Compute Cloud or Google's Compute Engine. These characteristics include:

- **Infrastructure as a Service:** JMS ARCADE will provide computational storage and networking resources available on demand
- **Platform as a Service:** JMS ARCADE will provide the JMS SOA and SDK; AFRL will investigate methods to optimally integrate SOA technologies with Cloud technology
- **Software as a Service:** JMS ARCADE will provide all the development tools needed to build a JMS-compatible service as well as modeling and simulation tools for SSA experiments
- **Data as a Service:** JMS ARCADE will provide both simulated and real data sources to application developers and SSA experimenters formatted according to data standards as defined by the JMS common data model

The JMS development environment will provide some or all of these services as applicable to each type of user. User profiles will catalog each user attribute according to the type of service required.

MHPCC Portal-based Application Development Environment Foundation: AFRL is making upgrades and expansions to existing network environments as the foundation of the JMS application development environment. For the unclassified environment, which is critical to the application developer user segment, JMS will leverage the existing DOD High Performance Computing Modernization Program (HPCMP) Portal capability developed at the Maui High Performance Computing Center (MHPCC) and JMS technologies developed within the AFRL/RV Battlespace Evaluation and Assessment SSA Testbed (BEAST). The HPC portal capability is easily accessible through the Internet, leverages existing hardware, account management, and user support services. It currently uses PKI-CAC and Yubikey authentication, which allows DOD and DOD contractors to access HPCMP systems via the Internet and modern web browser with no additional user-side software requirements.

The ARCADE Portal was designed to provide the ability for users to develop, integrate, and evaluate services prior to SOA integration. As shown in Fig. 2, the ARCADE Portal chiefly provides:

- JMS software development kits and resources
- A suite of software development tools including terminal, integrated development environments, editors, compilers, debuggers, and configuration management applications
- File transfer capabilities
- A Workflow tool for service generation and testing of services

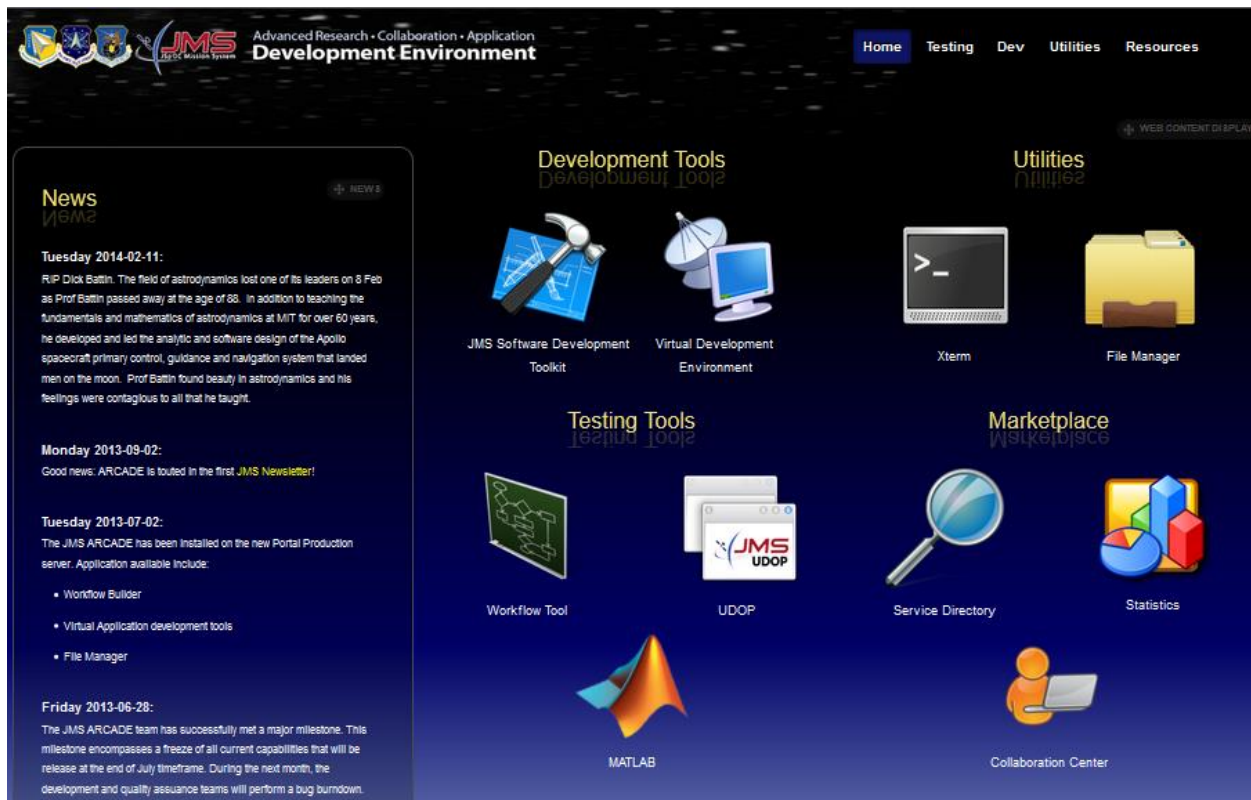


Fig. 1: The ARCADE Portal Home Page

The Workflow tool one of the most important aspects of the ARCADE Portal. It enables two capabilities : 1) generation of service wrappers, and 2) testing of services in system-of-systems scenarios. One of the challenges for scientist and engineers when working with JMS is lack of SOA knowledge. Almost all technology developers can provide stand-alone applications that take input as command line arguments or from files and provide output to files or standard out. The ARCADE Portal Workflow tool provides a basic mechanism for developers to create JMS-compatible service wrappers around applications like these, provided the applications use standard data inputs and outputs. This is expected to be a significant enabler for scientists and engineers to create JMS SOA-ready services without having to understand SOA technology or Java programming.

Once a service is generated, it can be tested in a closed-loop scenario with other data processing components to gauge how well the new service impacts the overall system. The current workflow tool is limited to the cataloging process, as shown in Fig. 2, with components for:

- Input- generates the “truth” data for simulations
- Scheduler- tells the sensors when and where to look for simulations
- Observation Generator- this generates sensor observations
- Correlator- this compares the sensor observations against the known catalog
- UCT Resolution- as associates uncorrelated tracks (UCTs) and build new catalog entries

- Catalog Update- updates the catalog given correlated observations

Efforts are underway to add Indications and Warnings and Command and Control components to the workflow. The user can assign a given service to each of these components. The services can be hosted within the ARCADE Portal computing environment or externally hosted. Once execution begins, the services are called in sequence at defined time steps until the scenario time is completed. Intermediate and output files are available for on-line viewing or for download. Efforts are underway to provide pre-configured scenarios in which a developer can test their services and compare results against performance benchmarks. The JMS program can then use these performance benchmarks when deciding whether to acquire a given service.

With benchmarking in mind, the Workflow tool was designed to work primarily with simulations; however, real data observation generation services have been demonstrated. The dynamic nature of the scenarios becomes moot with real data since the system cannot direct future data collection based upon present processing. For simulation scenarios, care has been taken to implement truth generation with six degree of freedom special perturbations trajectory modeling, relevant satellite material models, and state of the art sensor simulation (currently limited to optical sensors).

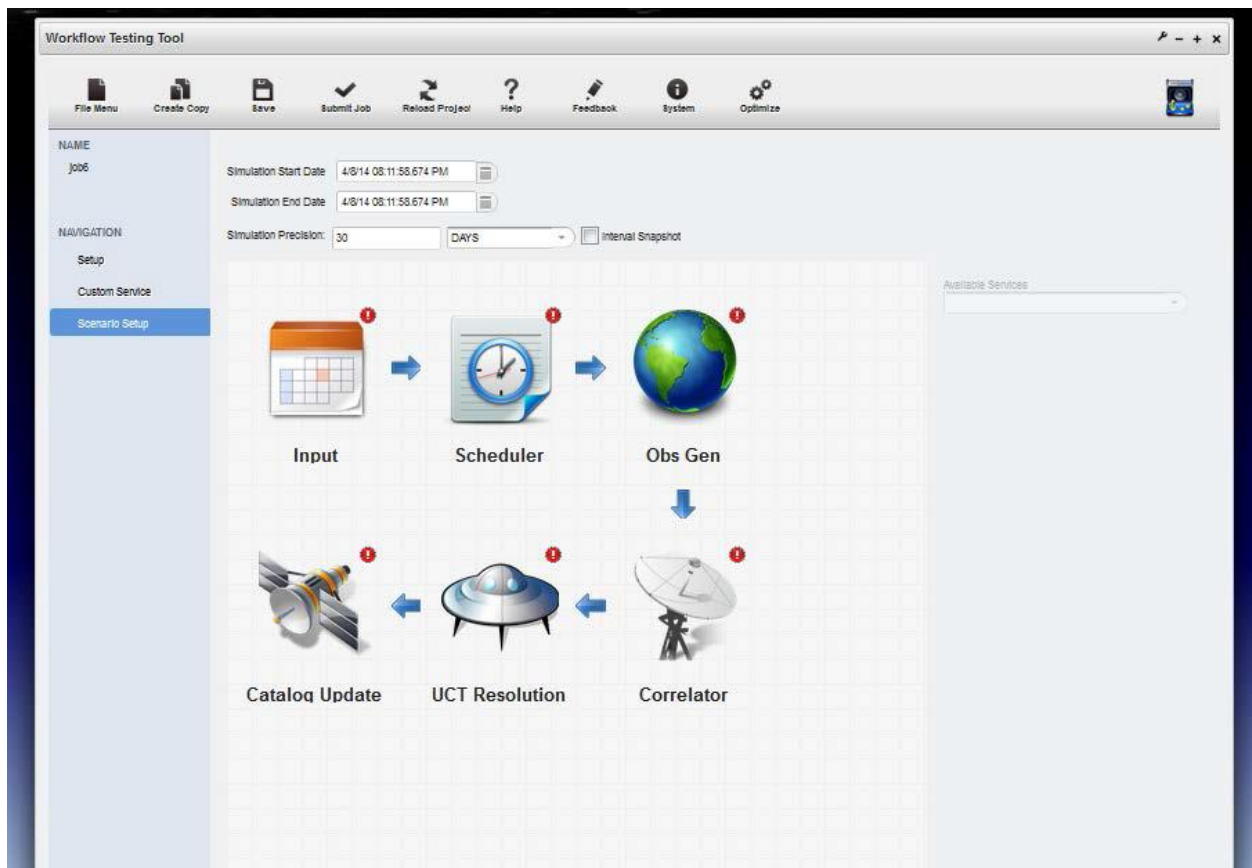


Fig. 2: The ARCADE Portal Workflow Tool Scenario Set-Up

To recap the role of the ARCADE Portal, consider a person who has an idea on how to improve SSA, whether it is building a new sensor or a smarter method to manage data collection or data exploitation, the ARCADE Portal provides the software development tools for that person to develop an application from that idea. The Workflow tool then allows the person to wrap that application as a JMS-compatible service. Then the impact that service has on relevant scenarios can be quantified using the Workflow tool as well. The person only needs a web-browser and the intellectual ability to build their application.

Additional information on the Portal ARCADE can be found at (<https://www.mhpcc.hpc.mil/portal/arcade/>). Efforts are currently underway to host the ARCADE Portal at classified levels as well.

JMS SOA BASED DEVELOPMENT ENVIRONMENT: Due to the restricted nature of JMS data sources, the services of which are an integral part of the JMS infrastructure, only on restricted enclaves of ARCADE will host the JMS SOA for software application developers to interact with. The decision to only host the JMS SOA in a restricted computing environment may be reversed in the future, but there are policy issues that must be sorted through prior to release of the JMS SOA at an open level. Although access to the computing networks severely limits the communities who may access the restricted portions of ARCADE, still there is a broad community of government, industry, and academia who can access these restricted ARCADE enclaves, and participate in software development, collaboration, and research, with the JMS SOA. To be specific, the JMS SOA supplied on the ARCADE is a near-copy of the JMS SOA that is currently operational. The JMS SOA available through the ARCADE provides access to user groups that range from large industry to rapid prototyping shops in academia, government, and small business (as shown in Fig. 3) and will protect the intellectual property rights of these users through roles defined within the SOA's underlying security system. The controls will also give JMS personnel the accesses necessary to review prototypes while in the development and integration phases. This review may support JMS market research efforts and allows the JSpOC operators to get early exposure to development applications as well as give government experts the opportunity to provide feedback to the developer on usability, the viability of the processing algorithms, scalability to relevant or operationally-sized data feeds, and more.

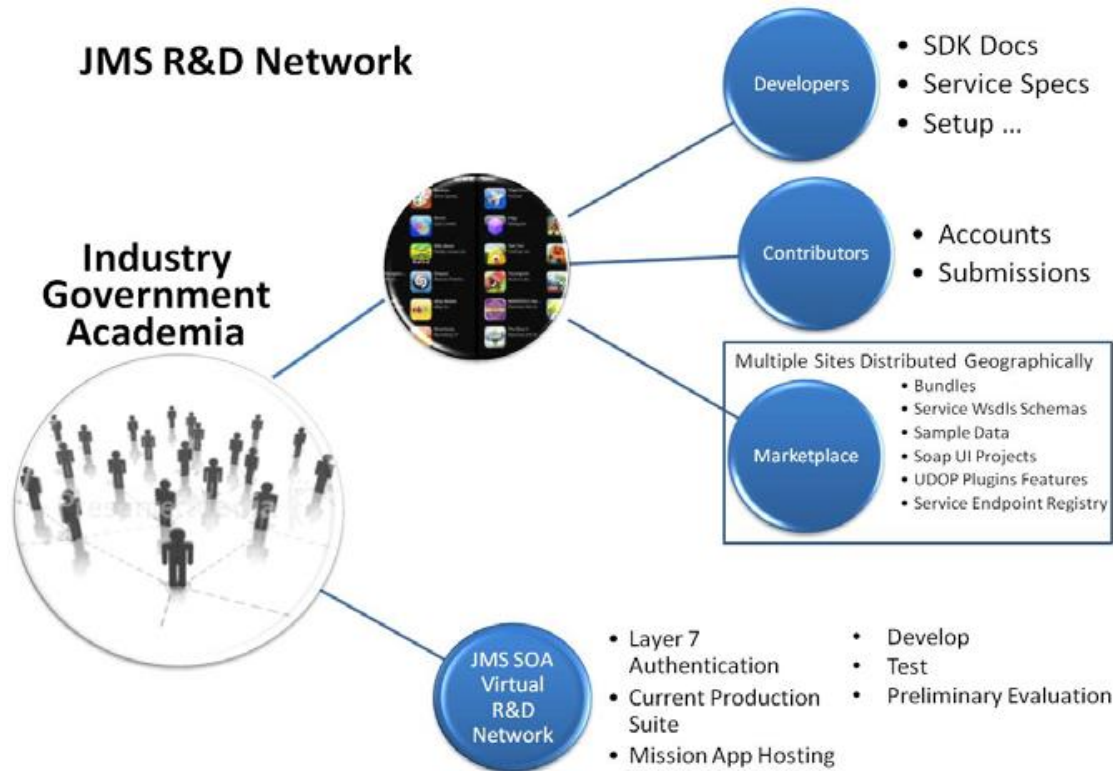


Fig. 3: Features of the JMS ARCADE on a Network

Transition to Operations: The mission application path to transition will incorporate a phased progression from development to operations. Though the ARCADE emphasis is placed on maturation of applications to TRL 6 (see Fig. 7). Technical Readiness Levels 6-9 are all defined relative to an operational environment, in this case the currently operational version of JMS. After maturation in ARCADE if an application is deemed a viable candidate for JMS inclusion and after appropriate security checks and contracting requirements are completed the candidate application will be transitioned to the JMS Enterprise Development and Integration (JEDI) environment, which is the official integration environment hosted by SPAWAR. Capability integration occurs in accordance with a formalized gating process within the JEDI, after which, if the candidate application graduates, and the application progresses to the Mission Integration Enclave (MIE). The MIE is a testing environment, co-located with the JSpOC, where the 46th Test Squadron performs official Development Testing and Operational Testing. Once the candidate

application goes through the MIE it is assessed at TRL 8. An assessment of TRL 9 is only possible if an application is employed in operations, JSpOC operations.

The aforementioned process of transition is complex, which is a motivator for the creation of the ARCADE test-bed, in order to supply developers with the necessary knowledge, software development kits, exposure to test data sources, and environments such that candidate applications are at a sufficient level of technical maturity to facilitate transition through the subsequent steps, JEDI and MIE integration and testing. Whereas the barrier to entry for the JEDI and MIE are quite high, the barriers to entry into ARCADE are very low. ARCADE accounts, at the appropriate classification level are currently being approved for any US Government, US Government Contractor, or DoD CRADA members who apply. ARCADE or ARCADE-like services may be extended in the future to foreign partners and academia. Software development kits, test-data, and a copy of the JMS environment are all included with ARCADE accounts at the appropriate classification levels. More about the ARCADE governance process is described in the next sub-Section. A downside to this migration approach is that there are multiple development environments to develop, deploy, and maintain. However, the transition is believed to be the most agile means to acquire and deploy mission applications as well as the best strategy to mobilize the broadest possible community of developers and experimenters. Accessibility is a fundamental strength of this approach.

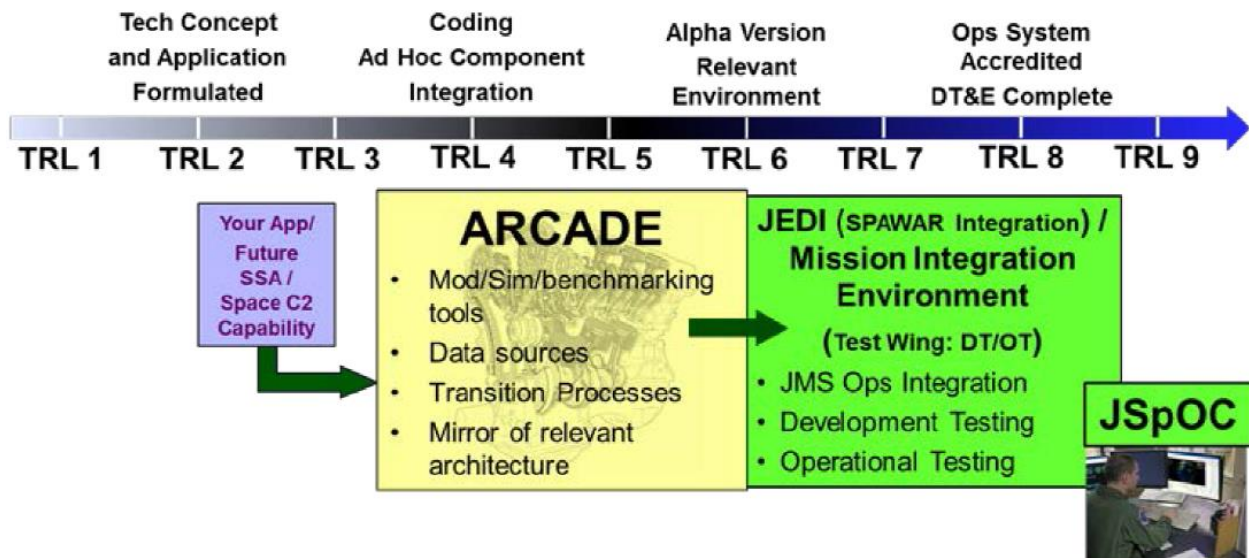


Fig. 4: ARCADE-JMS Tech Maturation Process

ARCADE Governance Process: Governance refers to the mechanism, processes, roles and responsibilities by which the ARCADE Program and Key Stakeholders maintain control over the process of software application maturation. The Governance of ARCADE is still in a draft format, planned to be completed by Fall 2015. The ARCADE Governance Process is currently directed by the ARCADE Governance Board, chaired by the senior-level officials from key Government stakeholders: AFRL and SMC/SY. The senior-level ARCADE Governance Board meets biannually; assumes responsible for the overall Governance process; assesses the ARCADE Program’s value, plans, and goals; and assists with Application transition by formulating recommendations to the JMS Requirements and Planning Council.

In addition to directing the ARCADE Governance process at the Board level, the key Government stakeholders—AFRL, SMC/SY, and JSpOC—perform work at the execution level. As ARCADE host, AFRL supplies assistance and may, upon request, furnish evaluations of Application development in four main areas: Information Assurance, System Engineering, Military Utility, and Information Veracity. The JMS Program Office (SMC/SY) is the transition agent and additionally performs independent evaluation on the subjects of Information Assurance, System Engineering, Military Utility, and Information Veracity. It is planned that in FY 2016 the overall Governance and evaluation portion of ARCADE will transition to SMC/SY. It is planned that evaluations will be tiered. For

example, a System Engineering assessment will be Tiered with the lowest Tier being unassessed and the highest being fully compatible, proven by test running on live test-data feeds with the JMS SOA and if applicable JMS UDOP. Military Assessment will be handled with a similar Tiered grading scheme, with highest weight placed on the JSpOC's evaluation of a technology; the JSpOC, the operational stakeholder is uniquely qualified to assess Military Utility of a technology. Thus far the most challenging assessment to define and staff is the need for Info Veracity. The proposed Tiered approach is that the highest-Tier assessment will be documented by successful comparison of an application results with benchmarks accepted by a Community of Interest. For orbit determination algorithms there are benchmarking tools, with varied levels of acceptance in the Astrodynamics Community of Interest, and importantly the MHPC Portal ARCADE currently hosts some and has capability to host more simulation tools for these benchmarking purposes. Unfortunately similar benchmarks are not available for all algorithm technologies. For example, the Community of Interest for Space Environmental Effects does not currently possess such benchmarks. Proposed middle-Tier Information Veracity assessment is evaluation with quantifiable measures by an independent evaluator and proposed lower-Tier assessment is qualitative evaluation by an independent evaluator. Both of these assessments are essentially peer-review processes with varying degrees of rigor. Although the ARCADE Program recognizes the need to assess the truthfulness of information offered to JSpOC operators, the ARCADE Program does not currently have the resources nor expertise to perform peer-review for all conceivable algorithm technologies. It is important to note that Information Veracity is for ARCADE purposes only, and the language Information Veracity assessment is used purposefully instead of Verification because official Validation and Verification is performed by the Test Authority, the 46th Test Squadron. In all evaluations the base-level assessment will be reserved for unassessed technologies.

AFRL as the ARCADE Host, the JMS Program Office in its cardinal role as transition agent, and the JSpOC as recipients of ARCADE-matured software applications represent three primary Government stakeholders for ARCADE. The fourth, last but *not* least important role in the ARCADE paradigm is that of Application Developer. Application developers may be from Small Business, Industry, Government Labs to include Federally Funded Research and Development Centers, and Academia. The ARCADE Governance Process describes the roles of Application Developers in ARCADE for the purposes of defining what support an Application Developer may expect and a model for how application installation, maturation, and transition may proceed.

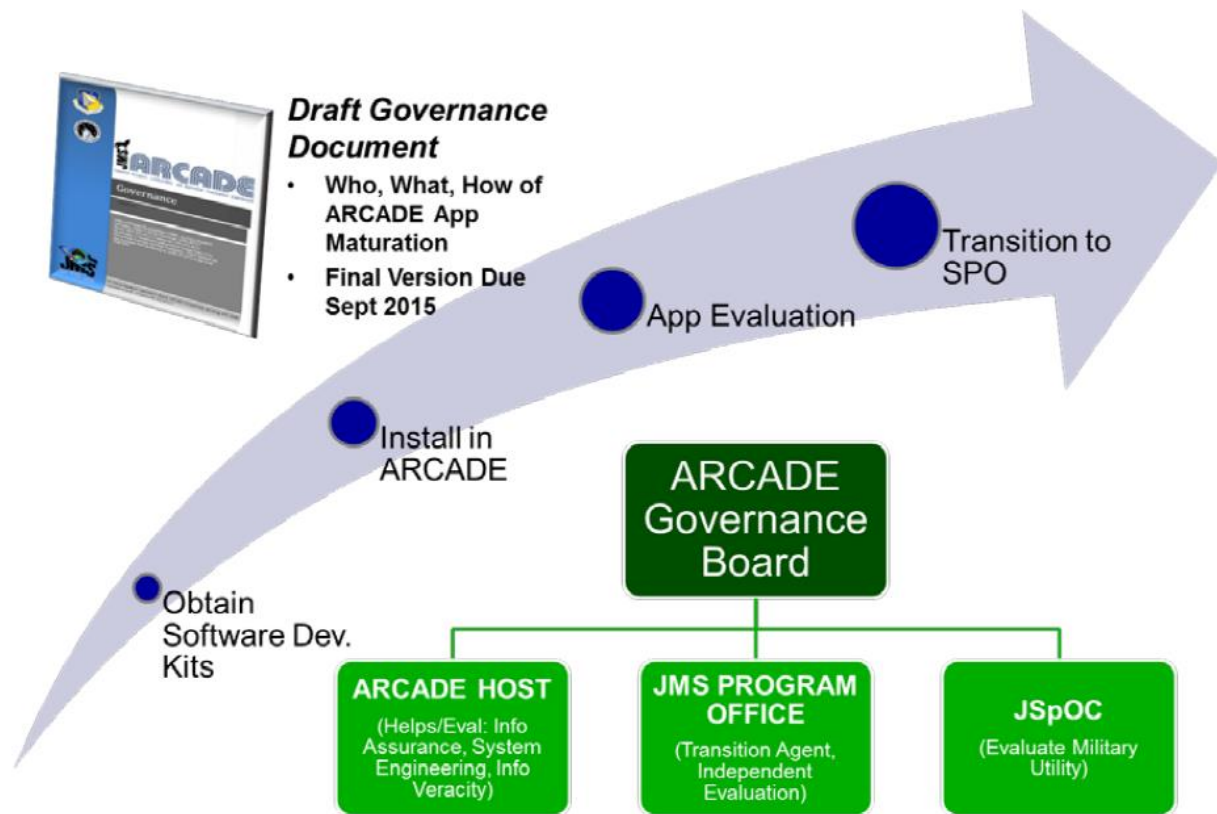


Fig. 5: High-level Diagram of ARCADE Governance

Figure 5 shows the high-level steps: Obtain Software Development Kits, Install in ARCADE, Application Evaluation, and Transition to the Program Office (SPO). Details of the high-level steps toward transition are still being finalized. The details will likely be captured in an ARCADE User’s Manual, consistent with the high-level descriptions included as part of the Governance Process. The ARCADE User’s Manual is also in draft format currently. Some of the steps are already well fleshed out, for example the Software Development Kits and Installation Processes, both of which are relatively straightforward to define, have been defined as a series of steps with defined expected outcomes. Other parts of the Governance Process, App Evaluation and Transition to SPO, are currently inadequately defined but will be fleshed-out completely by Fall 2015.

2. SCITOR CORPORATION OVERVIEW

Our History: Scitor was founded in 1979 with a simple philosophy: enable employees to fully dedicate themselves to delivering excellence by creating a special environment that empowers individuals and to keep obstacles out of their way. Empowered individuals are inspired and motivated to constantly surpass expectations. That is what has always defined best value for our customers. It is the standard we have exceeded for more than 30 years.

The name “Scitor” is pronounced <si’tôr>. It is derived from the Latin word which means “to seek to know.” We call ourselves “Scitorians.” Our name signifies our commitment to continuously strive for knowledge in a rapidly changing world. The logo, a long “I”, stands for the emphasis on providing meaningful and actionable information to satisfy customer needs.

Today, Scitor is headquartered in Reston, Virginia. We locate our operating facilities throughout the United States so we can be as close as possible to the customers that we support.



Fig. 5: Scitor Locations

We proudly serve outstanding customers in the Intelligence Community, Department of Defense and other federal, state and local agencies. Scitor is recognized as a trusted advisor by our customers. That is because the focus of our

relationships is on total collaboration, confidence and trust. By consistently exceeding expectations and delivering innovative Total Solutions for our customers, they achieve mission success.

It is our customer-Scitor partnership that enables our success. We work hand in hand with our customers, as part of their team. We believe that our employees, who are in constant contact with our customers and totally committed to their missions, understand how to best meet and exceed their expectations.

Our reputation has received notice beyond our founding customer boundaries, enabling us to extend and expand our customer horizons. We believe our Total Solutions™ approach and the skills our world-class workforce provide to our current customers directly apply to other arenas. As we delve into these new areas, we are excited to continue to deliver mission success to all current customers.

We do not allow our expansion desires to get in the way of continuing to deliver on our mission success promises to current customers. This same expertise and knowledge will be delivered by Scitor's diverse group of forward thinking leaders. For all industries, we can demonstrate how our experience developing seamlessly integrated tools, products, processes for large, complex systems will achieve success for any customer mission. We are proud of our reputation for integrity, innovation and excellence, along with the results of Scitor's Total Solutions™ methodology.

Scitor's world-class workforce is comprised of professionals from broadly diversified backgrounds such as former military, government and intelligence officers, business leaders from wide-ranging industries, multi-disciplinary scientists, mathematicians, information and financial analysts, and all disciplines of engineers. We collaborate with customers and across our business areas to support all phases of complex systems and programs — from initial concept and requirements definition, to acquisition, development and deployment, to operations and maintenance.

Scitor Focus: The pinnacle of Scitor's business success is total customer focus. We deliver Total Solutions™, by developing tools, products and processes seamlessly integrated to guarantee mission success. We are renowned for providing solutions before our customers even know there is a problem. By constantly surpassing expectations and acting decisively, we gain the confidence and earn the trust of our customers.

Each individual of our world-class workforce, in lockstep with their customer, understands the best way to satisfy current needs and anticipate future needs. Customers and their operating environments are all unique. We build enduring partnerships focused on mission success by working hard, and doing whatever it takes, demonstrating best value with innovative, yet practical Total Solutions.

Mission success drives our business decisions. We actively structure everything we do to make it easy to do business with Scitor. Our flat organizational structure empowers the decision process by placing the customer at the closest point of a decision authority — the employee. Our business processes and policies are well defined, easy to understand and simple to follow. Each employee, supported and valued by Scitor, brings superior skills, meaningful information and contagious enthusiasm to work every day.

Addressing Customer Needs:

End to End Mission Focus: Our customers demand a Total Solutions approach that addresses a myriad of needs. We understand the full mission context across all aspects of the Intelligence cycle from tasking, processing, exploitation and dissemination. This ensures support to the full spectrum of warfighters.

The Full Lifecycle: Our customers require a comprehensive, big picture understanding of their current and future environments. With our collaborative, forward-looking perspective, Scitor is uniquely capable of considering all phases of the lifecycle from research, acquisition, development, operations and maintenance.

Increasing Interdependence of Systems: Today's systems are more connected than ever before. Whether those systems are weapons and sensors to prosecute hard targets or critical infrastructure components of the electrical grid, Scitor's Total Solutions™ approach delivers value across entire integrated networks. We design solutions to address challenges spanning missions, systems and organizations.

Joint Warfare and Intelligence Agency Integration: Collaboration is more critical than ever before for Scitor's federal customers. We develop solutions to address programmatic, budgetary and organizational aspects of multi-service, multi-agency and joint programs.

The Rapid Pace of Technology: Our customers' systems are increasingly complex and the pace of change is unprecedented. Scitor fully exploits technology advances with disciplined and agile approach.

Total Solutions™: Scitor Corporation is the forward-thinking provider of a pioneering service concept called Total Solutions™. We are proud of our reputation for integrity, innovation and excellence. And we are proud of the results our Total Solutions methodology produces for our customers. Scitor provides Total Solutions engineering, management consulting and information services.



Fig. 6: Scitor Total Solutions™

We integrate technical, programmatic and acquisitions disciplines to build fully defined and executable solutions. The Scitor Total Solutions™ difference begins with our world-class workforce. Our project teams blend government, industry and academic experience to create extraordinary Total Solutions. The Scitor Way delivers continuity, even as our customers transition to new roles throughout their careers. We retain our people well beyond the industry average. Our world-class workforce delivers the thought leadership our customers expect when they think of Scitor. We understand lifecycle costs and interdependencies of even the most complex solutions. The Scitor Way enables us to see into the future to recommend and deploy solutions for our customers before problems are fully manifested.

Core to our Total Solutions™ approach is disciplined agility. Scitor employs smaller, more capable, tailored teams to exceed mission needs by working smarter, integrating more, collaborating better, and delivering unprecedented innovation. With disciplined agility, Scitor brings our customers greater efficiency and effectiveness, even in the face of growing threats. We bring total collaboration to each customer's mission and work hand in hand as part of their team. Many times, multiple Scitor teams touch programs from requirements to launch. We actively look for ways to apply this experience and innovation, and lessons learned, for the benefit of all of our customers. This approach is not easy. It takes time and discipline, especially when faced with deadlines and focused on execution.

3. SCITOR'S ROLE IN SHAPING ARCADE

Scitor has been an integral part of the development of the ARCADE since the very beginning. Since the JMS program moved to LA AFB for execution under SMC in May of 2011, Scitor has had personnel working in all phases of development and delivery of the JMS program Increments and Service Pack deliveries. At one point Scitor personnel made up the entire Increment 3 program office as the precursor to what ARCADE would become. This team relentlessly traveled garnering support and finding collaboration to create the vision that would later become ARCADE in its current form. As the program office filled out with military and government civilian leadership Scitor continued to provide continuity and strong leadership in the development of requirements and building solid

foundational relationships to ensure ARCADE is an effective and efficient program. Scitor continues to be an integral and influential aspect of the JMS program execution.

4. ARCADE'S VALUE PROPOSITION FOR TECHNOLOGY DEVELOPERS

Colonel Mike Wasson, former Chief, Combat Operations Division, 614th Air and Space Operations Center, stated [4]:

“The JSpOC requires highly responsive SSA capabilities that rapidly detect, track, and characterize objects in space. As such, new developments in SSA tools and capability to assess and respond to events in space are imperatives for the future.”

The ARCADE framework provides the perfect methodology to enable the development of and efficient deployment of these new and critical SSA capabilities/tools that Col Wasson refers to as imperatives for the future. ARCADE accomplishes this by being readily accessible to developers of all sizes through account creation and obtaining the “kit”. This “kit” consists of the UDOP Development Kit (UDK), the Software Developers Tool Kit (SDK), and the WISDLs and Schemas used in JMS. These developer enablers allow any new developer access to the fundamental critical interfaces and guidelines upon which to build and test new functionality and rapidly move it through to higher Technical Readiness levels (TRL).

ARCADE has two aspects a developer can interact with in starting the development and maturation process. These are the Maui High Power Computing (HPC) side and the SOA managed at Kirtland AFB. The ARCADE on the HPC side enables basic research at entry level coding and first principles testing. The HPC allows non-optimized code to be run in order to test theory and application before code refinements are made. This process allows the developer to work through the potentially relevant applications to JMS without significant overhead investments in code refinements. Conversely developers wishing to enter at the TRL 2-4 level can start on the SOA side of ARCADE. Those with more optimized code who do not need to rely on the power of the HPC for efficient code execution can focus more on application running with necessary interfaces and relevant environments. Applications at this stage have more refined understanding of direct relevance to SSA functions and their role in space control. These developers will gain experience interacting with the larger system and can achieve TRL 6 with all the features provided by ARCADE.

An additional benefit to the developer in ARCADE is the rapid communication of Government priorities via the Requirements and Priorities Council (R&PC) as illustrated in the center of Fig 7. This body meets at least twice a year and decides the core direction JMS should follow based on current development progress and current events. As a member of ARCADE a developer has access to the decisions made by the R&PC and can adjust their investment and development priorities accordingly.

A key milestone for developers maturing their new functionality is the climb up the TRL ladder. A major benefit of ARCADE is access to the “relevant environment” necessary to do testing to achieve the TRL 6 benchmark. This testing and achievement well ahead of the integration accomplished in the JEDI and the MIE provides exposure and functional ringing-out of features of the new application. ARCADE provides exactly what the developer needs to accomplish.

5. ARCADE'S VALUE PROPOSITION FOR THE GOVERNMENT

The former commander of Air Force Space Command, General William L. Shelton, stated [3]:

“The JMS program will have a huge impact on just about everything we do in space. Acting as the hub, JMS will revolutionize Space Situational Awareness capabilities, taking inputs from a huge variety of radar and optical, ground- and space-based, space weather, and many other types of sensors. JMS is a great example of how an industrial age acquisition system just isn't agile enough for an information age program. The system is too slow, too stodgy, and the requirements it places on program developers are too cumbersome. Streamlined acquisition requires everyone to streamline their expectations and process.”

ARCADE is an example of a modern technology enabler for the Government to achieve this needed infusion of new and relevant technologies outside the traditional Air Force acquisition process. Borrowing from concepts such as

crowd sourcing for solutions and application development for smart phones and tablets ARCADE provides the Government an exciting tool for attracting, vetting, and maturing critical functionality needed to manage the technology needs of JMS.

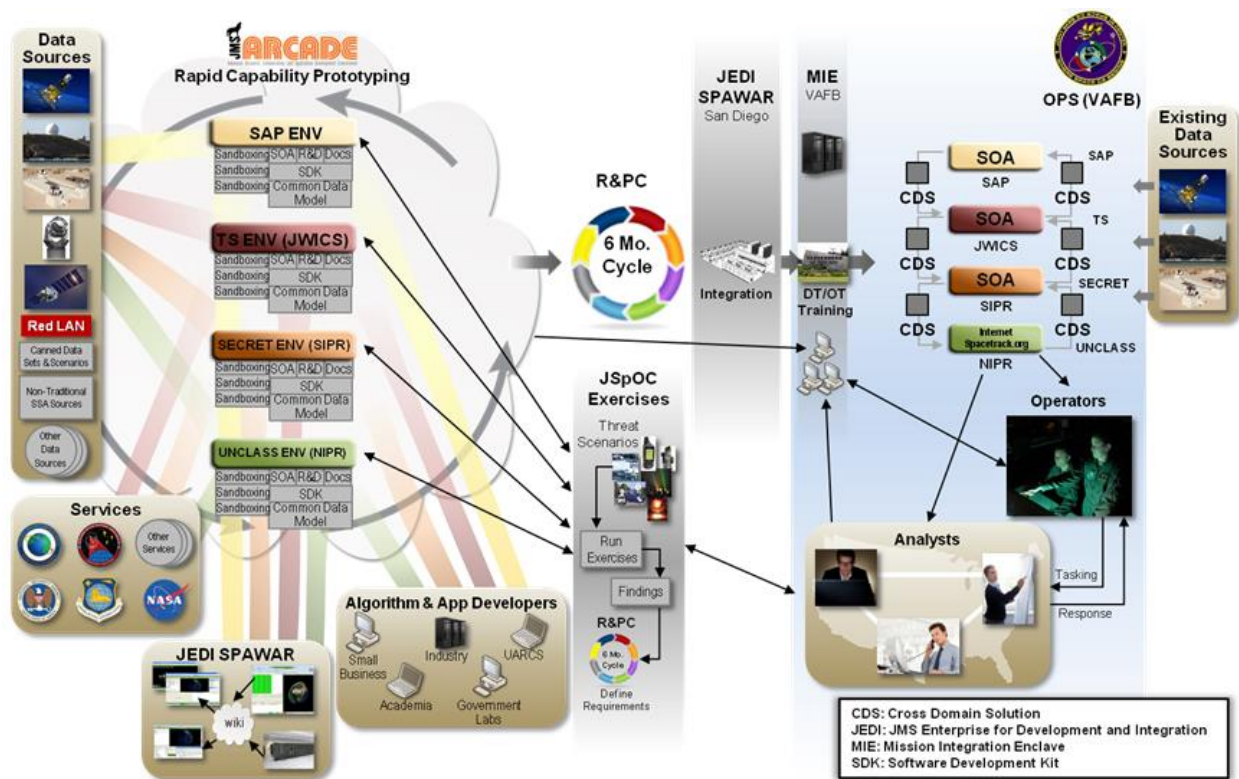


Fig 7. ARCADE in JMS

A significant feature of ARCADE which benefits the Government is the ability for ARCADE to act as a tool for market research. As the R&PC releases priorities to the community, all developers in the US are equally exposed to the statement of needs and properties and can choose to respond through development. As developers register and start interacting, ARCADE provides the logging of metrics of the number of responses and relative maturity level of entrants in direct response to the R&PC priorities. This feedback can be utilized to gauge industries ability in technological ability and/or in number of companies technologically adept in the particular needed function. No response, low response, or high responses all provide extremely useful information about the mindset of industry and where their capabilities are. The Government can then use this information to springboard other acquisition activities to take advantage of industries response.

A related function ARCADE provides to the Government is that of providing metrics which help determine interest and interaction amongst released priorities. When the R&PC releases multiple priorities the level of interest received in various areas of the ARCADE through developer interest provides an insightful picture to the Government on industries ability or interest as a reaction to released priorities. For example, the R&PC and/or Government at large may choose to use this feedback from industry to adjust technology priorities or to augment resources to develop a slow technology or create more competition or refine statements of need based on an overwhelming response.

The most significant benefit the ARCADE provides the Government is that of risk management. Specifically ARCADE deflects integration risk away from the Government onto the developer in the process of maturing new technologies relevant to SSA and Space control. In a traditional acquisition process consisting of studies or technology demonstrations, these need to be funded to get a technology mature enough for a "normal" source selection to take place. In some circumstances sole source development can be an option, however in both cases the Government ends up with a contract and timeline in hopes of achieving a particular capability in a planned timeline. Contrast this with ARCADE development utilizing the ARCADE, where announced priorities find a balance with

technology push (bottoms up) from industry. The timeline for this is open, versus a directed procurement, allowing a greater market and opportunity for creative solutions. In this process it is the developer working to submit a matured product, proven in a relevant test environment, who bears the bulk of the risk instead of the Government. This shifting of the risk allows the Government to more rapidly move from new technology to fully integrated functionality, in a reduced time and risk.

6. REFERENCES

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