Space Command and Control Program - Kobayashi Maru

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CONFERENCE PAPER

This paper provides an overview of the Space Command and Control (C2) "Kobayashi Maru" program to deliver capabilities to the National Space Defense Center (NSDC), Combined Space Operations Center (CSpOC), and Mission Partners. The Kobayashi Maru program provides capabilities that bring critical services to our Warfighters to support quality battlespace decisions within a short timeline.

1. KOBAYASHI MARU ACQUISITION IMPERATIVES

The Kobayashi Maru program develops Space Domain Awareness, Coalition and Theater Support, Battle Management Command and Control, and Indications and Warning (I&W) capabilities via a Development, Security, and Operations (DevSecOps) approach that links users with mission application developers to leverage Open Mission Systems/User Control Interface messaging standards. This results in recurring capability delivery to the operations floor.

Kobayashi Maru provides capabilities that bring critical services to our warfighters to facilitate timely, quality driven battlespace decisions. The program provides infrastructure and enterprise services, as well as develops mission applications to enable responsive, resilient operational-level Space C2 capabilities for the NSDC, CSpOC, 18 SPCS, and other C2 centers. Employing an agile-based Rapid Delivery Framework (RDF) with a 90-day Program Increment (PI) construct fosters a collaborative and integrated environment for the community to effectively plan and deliver C2 capabilities.
Space C2 SW factory focuses on rapidly delivering operational capabilities to our warfighters. Portfolio Program Management (PPM) and the Portfolio Requirements Management Team (PRMT) establish and break down large requirements into manageable batch sizes for rapid processing on the factory floor. Development teams further break down requirements into user stories that are processed through Space C2's Continuous Integration/Continuous Deployment (CI/CD) pipeline. Mission capable applications are continuously delivered to the space operations centers. Figure 1 provides a graphical representation of the Kobayashi Maru SW factory operation.

Kobayashi Maru's mission product lines include Battle Management, Comand and Control (BMC2), Space Domain Awareness (SDA), Data Analytics and Visualization (DAV), and Theater and Coalition Support; all focus on developing operational echelon Space C2 mission applications to deliver multi- domain effects. Development, Security and Operations (DevSecOps) Infrastructure is the Kobayashi Maru-enabling product line, providing the foundation of the enterprise CI/CD pipeline, DaaS, and other enterprise infrastructure and platform services. The Kobayashi Maru Enterprise Engineering product line, also referred to as C-Deck, provides overarching systems engineering, architectural integration, and requirements management functions to ensure Space C2 delivers integrated, responsive capabilities that meet user needs.

Space C2 dubbed our overarching effort Kobayashi Maru after the training exercise in Star Trek designed to test the character of Starfleet Academy cadets in a no-win scenario. Only one individual, James T. Kirk, was able to beat the scenario by doing things differently and changing the code. We aim to do that with the approach to delivering Space C2 mission capabilities as well. #ToBoldlyCode

With respect to acquisition imperatives, the current Space and Missile Systems Center (SMC) Commander and Air Force Program Executive Officer for Space, Lt Gen John T. Thompson, stated [1]:

"SMC has embarked on a bold transformation to improve how we deliver resilient, war-winning space capabilities faster. With the re-architecting effort, SMC began implementing rapid acquisition tools and embodying the aspirations of Enterprise, Partnership, Innovation, Culture, and Speed (EPIC Speed). We will enhance existing partnerships and seek new opportunities with DoD agencies, other national space entities and our industry partners, to drive and deliver war-winning capabilities to our warfighters."

In addition, Dr Will Roper, Assistant Secretary for Acquisition, Technology, and Logistics, stated [2]:

"We've got to kill the major defense acquisition program as it is today, and replace it with something that looks more like the Century Series [when the Air Force fielded six new fighters from five different manufacturers in just five years] development of the early Air Force."

To address both of these statements, Kobayashi Maru has created critical development and operational enablers such as IT architecture, DevSecOps processes, and enterprise services to enable rapid capability deployment by the Space C2 product lines across multiple security levels. In addition, the program is working to implement agile acquisition and contracting that is able to deliver on demand.

2. KOBAYASHI MARU STRATEGIC THEMES

Kobayashi Maru's strategic themes are defined in the context of Lean Portfolio Management. Lean Portfolio Management (LPM) is applying lean thinking to managing enterprise, program and product portfolios to provide a fast and flexible flow of high-value work. This approach focuses on delivering the most valuable work first while limiting work-in-process, limiting interruptions and aligning the work to the organization's intended outcomes and team capacity. LPM prioritizes alignment and achievement of business outcomes over focusing on work and deliverables. It is a results-based approach incorporating adaptive planning in quarterly or less increments, high visibility and alignment and inspection and validation of real results.

The strategic themes for Kobayashi Maru below are a sample of a broader set of defined themes that connect business objectives of the portfolio to the strategy of the Enterprise. They influence portfolio strategy and provide business context for portfolio decision-making and drive the future state of the portfolio. The following are the current strategic themes for the portfolio:

1. Rapidly deliver capability to warfighter through DevSecOps and Commercial Infrastructure

The key enabler to delivering capability rapidly is the Government ownership of the DevOps framework, which eliminates vendor lock through open standards and standard interfaces. The capabilities developed within this framework are cloud agnostic applications. In addition, commercial applications and sensors can be licensed as a service within this framework. Finally, the system is compliant with Open Mission System (OMS) and Universal C2 Interface (UCI) standards for interoperability with other C2 systems.

2. Leverage new commercial sensors, services, and applications

Space Domain Awareness (SDA) is a critical input for Space C2. To improve sample size, timeliness, persistence and access to all orbital regimes, the Kobayashi Maru program is actively gaining access to additional data sources to include DoD, Mission Partner, Civil and Commercial sensors. Kobayashi Maru is working with these data owners to establish an on-demand access to their data with standards on metadata tagging and aggregating data libraries at multiple security levels. Where applicable, Kobayashi Maru is implementing UCI messaging standards.

3. Flexible information sharing, integration & interoperability environment

An integrated operations picture is enabled through information sharing across multiple security levels. This sharing supports unity of effort with multinational partners to both produce and consume information within the environment.

3. KOBAYASHI MARU SOFTWARE FACTORY

The Kobayashi Maru software factory focuses on rapidly delivering operational capabilities to our warfighters. Portfolio Program Management (PPM) and the Portfolio Requirements Management Team (PRMT) establish and break down large requirements into manageable batch sizes for rapid processing on the factory floor. Development teams further break down requirements into user stories that are processed through Space C2's CI/CD pipeline. Mission capable applications are continuously delivered to the space operations centers. The figure below illustrates the process and informs product lines and team roles and responsibilities.

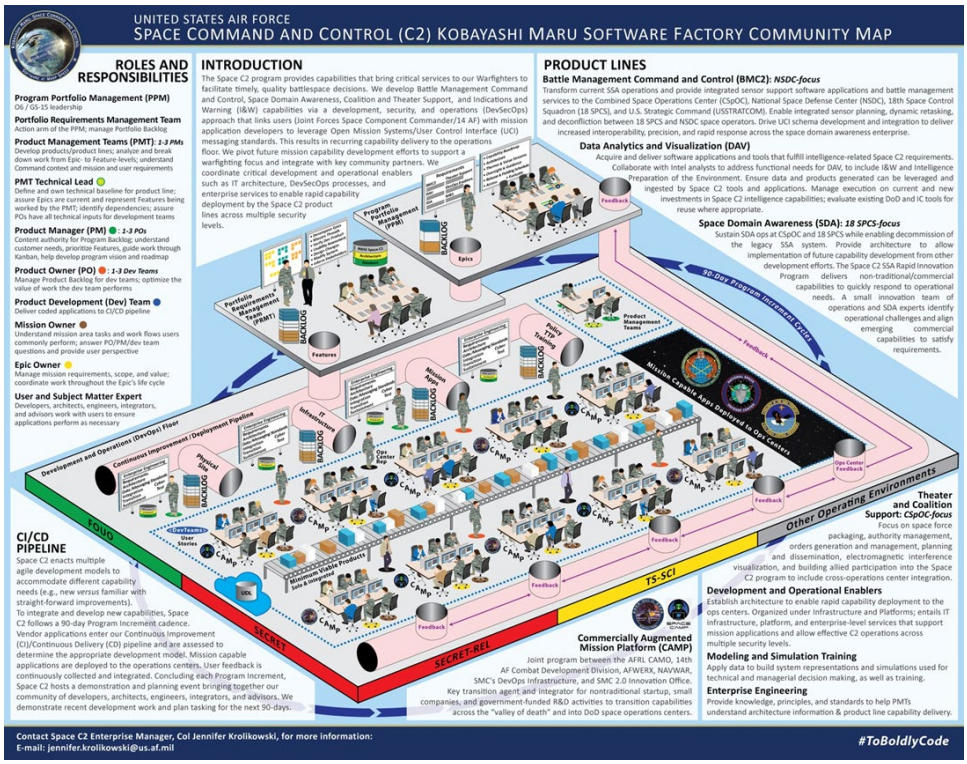

Figure 1. Kobayashi Maru Software Factory Community Map

Kobayashi Maru has built a capability development community with governance that spans vertically to encompass all development teams at the lowest level and ties them together with the program and portfolio leadership. The roles and responsibilities are defined at each level and ultimately prioritize the capability features within the backlog. The software factory is a community that is organized flexibly with a structure shown in Figure 2 below.

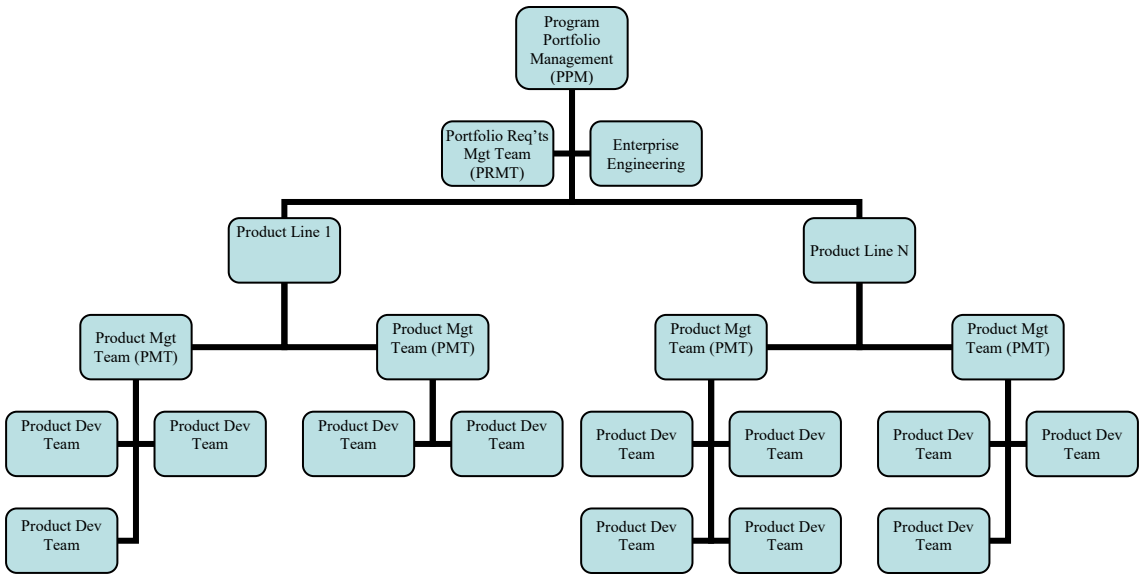

Figure 2. Software Factory Structure

The overarching construct that governs how the software factory delivers capability, is captured in the Rapid Development Framework (RDF). The RDF enables an agile acquisition approach for converging related efforts across the community and providing continuous capability delivery. Kobayashi Maru follows a 90-day Program Increment (PI) cadence to integrate and develop new capabilities. This cadence enables Kobayashi Maru to deliver capabilities continuously as available or per quarter at minimum. Vendor applications enter the continuous integration (CI)/continuous deployment (CD) pipeline where they are assessed and integrated into mission capabilities, then deployed for ops center use. The PI structure begins and ends with a multi-day PI event where stakeholders and users engage to witness accomplishments and demos, as well as plan and prioritize the backlog for the next 90-day PI cycle. Figure 3 illustrates the Kobayashi Maru RDF operating model.

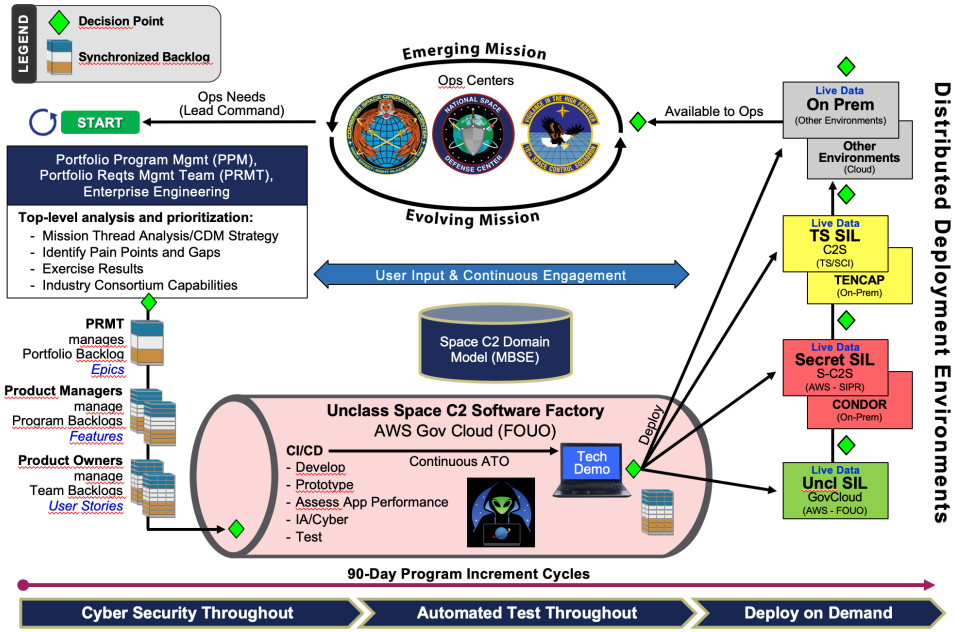

Figure 3. Kobayashi Maru RDF 2.0 Operating Model

The Rapid Delivery Framework supports several software development methodologies used to improve software quality and responsiveness to changing customer requirements. Two examples are Extreme Programming (XP) and Agile Software Development. XP advocates for frequent releases in short development cycles. When done correctly, XP improves productivity and is very responsive to new customer requirements. Other elements of XP include programming pairs, extensive code review and unit testing, not programming features until they are actually needed, a flat management structure, and code simplicity. Agile Software Development is a conceptual framework for undertaking software engineering projects. The main goal of agile methods is minimizing the risk by developing software in short iteration timeboxes that are typically one to four weeks long. Each timebox is a mini software project that includes all the tasks necessary to release the new functionality. The iteration may not add enough functionality to warrant releasing the product, but an agile software project intends to be capable of releasing new software at the end of every iteration. The Kobayashi Maru program has developed its RDF to be flexible to allow any software development methodology to exist within the framework. Figure 4 depicts the multiple development models enacted by the enterprise.

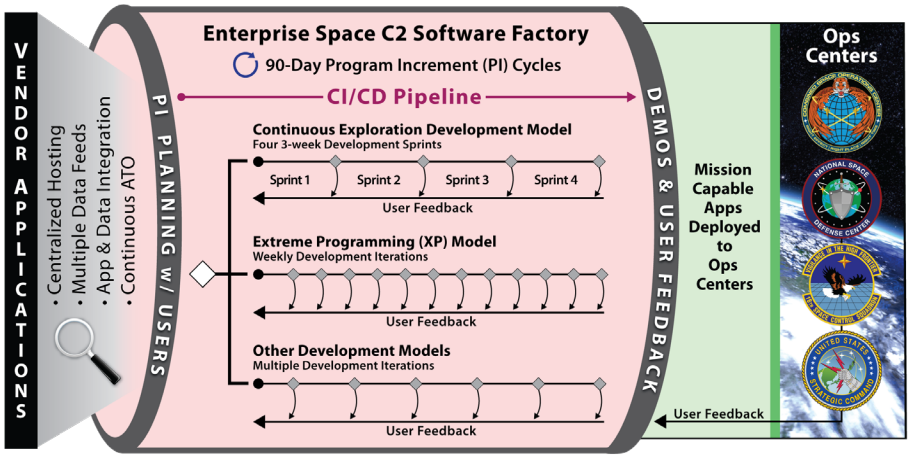

Figure 4. Kobayashi Maru RDF 2.0 Product Development Models

The program has implemented a category scale to quantify the current state of a mission application's relative maturity, availability and usefulness to the operators. This category scale is agnostic to the development model being used by a developer. The categories are:

1. CAT-I: In early development and accessible for use. This is a pre-MVP (Minimum Viable Product) capability. Relevant data feeds may still be missing and user feedback is required to pursue user-centered design
2. CAT-II: Available, but use at your own risk. This is a initial MVP delivery. Relevant data feeds may be missing, but it is useful to the operators. It may be complimenting other operational tools.
3. CAT-III: Approved for use with caveats. May still be missing some data feeds, but it is an acknowledged capability that supports primary operational decision making or command and control.
4. CAT-IV: Fully approved for use and operationally accepted.

C-Deck, or Enterprise Engineering Team, also employs a model based systems engineering (MBSE) Mission Engineering approach that traces and maps user requirements, Epics, and Features to mission activities within the Space C2 Government Reference Functional Architecture (GRFA) to establish capabilities and functions required across the various mission applications to meet mission needs. The Space C2 MBSE model exercises a functional mapping to ops (FM2OPS) method to functionally decompose the mission application software being developed by the product teams to understand how they map to operational and tactical echelon activities. This identifies any redundancies in function across the various applications being built. It also identifies gaps and serves as tool suite for trade studies. This model supports improved prioritization of features by improving communications between the Ops floor and the Kobayashi Maru program office.

4. KOBAYASHI MARU PRODUCT LINES

Kobayashi Maru has several product lines that together constitute the full Space C2 system. These product lines are:

1. DevSecOps Infrastructure
2. Battle Management Command and Control (BMC2)
3. Data Analytics and Visualization
4. Space Domain Awareness
5. Theatre and Coalition Support

The DevSecOps infrastructure is critical to the agile capability development ecosystem. Kobayashi Maru has been working to get the development environment in Cloud One stood up. This supports the standup of CI/CD pipelines.

The Battle Management Command and Control (BMC2) product line is comprised of the Integrated C2 and Integrated Sensor Support Services (IS3) PMTs. BMC2 is focused on providing the NSDC with battle management services. Additionally, the BMC2 product line integrates new and legacy systems into the NSDC to close on critical mission needs. Battle management encompasses processing and assessing intel to generate indications and warnings (I&W) alerts and threat assessments. These alerts support the tactical timelines required to rapidly generate campaign plans, proactive course of action plans, execution plans, and monitoring status through execution. IS3 is a dynamic sensor task management system must be tightly integrated throughout the kill chain to manage sensor tasks, generate sensor plans, and task sensors in the execution of the chosen plan.

Data Analytics and Visualization (DAV) product line acquires and delivers SW applications and tools that fulfill intelligence-related Space C2 requirements and decision-maker level visualization capabilities. The DAV PMT collaborates with analysts at the CSpOC and NSDC to address functional needs for I&W. I&W functionality ensures generated data and products can be leveraged and ingested by other Space C2 tools and applications. This initiative manages execution on current and new investments in Space C2 intelligence capabilities and evaluates existing DoD and mission partner tools for reuse where appropriate.

The Theater and Coalition Support product line PMT focuses on space force packaging, authority management, orders generation and management, planning and dissemination, EMI visualization, and building allied participation into the Space C2 program.

5. SPACE DOMAIN AWARENESS PRODUCT LINE

This section has a more detailed discussion on the Kobayashi Maru's SDA product line. This product line is comprised of multiple PMTs that includes a partnership with the Space and Missile Systems Center (SMC) Special Programs Directorate (SPG) to deliver SDA via Agile development and commercial capabilities. The product line is focused on sustaining SDA operations for the Combined Space Operations Center (CSpOC) and Space Delta 5. It also is focused on the 18th SPCS under Space Force Delta 2 as a user. The primary thrust for the SDA product line has been to support the decommissioning of Space Defense Operations Center (SPADOC), the current legacy system, through incremental deliveries of capabilities.

SDA is fundamental to conducting space operations. The SDA product line focuses on capabilities that support the effective identification, characterization and understanding within the space domain. The challenges to accomplishing SDA continue to grow as larger constellations of small satellites like SpaceX Starlink are launched into orbit. The capabilities delivered by the SDA product lines must deliver an ability to perform rapid catalog updates, conjunction analysis, and space object custody in a congested and contested environment.

The SDA Rapid Innovation Program specifically addresses the onboarding of commercial capabilities as they exist today. This activity focuses on identifying data and capabilities from the Commercially Augmented Mission Operations (CAMO) providers to deliver non-traditional/commercial capabilities to the 18 SPCS, CSpOC, and NSDC enabling quick response to operational needs. A small innovation team of operations and SDA experts identify operational challenges and align emerging commercial capabilities to satisfy requirements.

6. INTERNATIONAL PARTNERSHIPS

The Kobayashi Maru program is strongly committed to building relationships with our international partner community. Through these partnerships, we will be able to meet the challenges for Space Domain Awareness using global resources. There are already opportunities to leverage capabilities across this global community. Today, Kobayashi Maru has developed an initial capability called Space Board, that is currently is use to our FVEY partners at the CSpOC, UKSpOC and CANSpOC. This capability provides a unified picture of the high interest events. SpaceDesk and Relay are other capabilities being rolled out with accounts for our FVEY partners. SpaceDesk manages space support requests from the tactical units. Relay is being developed and will provide space tasking management tools.

These initial tools are being developed using the agile methodologies discussed above. These tools are being developed with feedback from our international partners to identify features and user stories to be placed in our backlog.

Kobayashi Maru will continue to expand the breadth of international partner participation.

7. CONCLUSION

The Kobayashi Maru program provides capabilities that bring critical services to our Warfighters to support quality battlespace decisions within a short timeline. The program provides infrastructure and enterprise services, as well as develops mission applications to enable responsive, resilient operational-level Space C2 capabilities for the space operations centers.

Kobayashi Maru employs an Agile-based Rapid Delivery Framework with a 90-day Program Increment (PI) construct fosters a collaborative and integrated environment for the community to work together to efficiently and effectively deliver C2 capabilities. The Space C2 program software factory is the key infrastructure for agile capability development and deployment. This factory focuses on rapidly delivering operational capabilities to our Warfighters. Enterprise Engineering supports the decision making arms of the program. This includes the Portfolio Program Management (PPM) and Portfolio Requirements Management Team (PRMT). These bodies establish and break down large requirements into manageable batch sizes for rapid processing on the factory floor. The development teams further break requirements down into user stories that are processed through our Continuous Improvement (CI)/Continuous Deployment (CD) pipeline using a variety of software development methods. Mission capable applications are then delivered to the space operations centers.

8. REFERENCES

1. Thompson, John T., Lt Gen, SMC Commander, statement in Los Angeles AFB website article, "'Hacking the 5000' – SMC/SY Space C2 wins the 'Tailored 5000' Award, 25 Apr 2019
2. Roper, Dr Will, Assistant Secretary for Acquisition, Technology, and Logistics, Breaking Defense, 12 Apr 2019.