

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 committed to continuously delivering Operational C2 software that United States Space Force (USSF) operators love. These capabilities support the National Space Defense Center (NSDC), Combined Space Operations Center (CSpOC), and other C2 centers. The Kobayashi Maru program provides capabilities that bring critical services to our Warfighters to support quality battlespace decisions at the speed of relevance.

1. KOBAYASHI MARU IMPERATIVES

The Kobayashi Maru Software Factory develops Space Domain Awareness, Coalition and Theater Support, Space Defense, Delta Status and Reporting, Indications and Warning (I&W), Electronic Warfare and Defensive Cyber Operations 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.

Employing an agile-based operating model with a 90-day Program Increment (PI) construct fosters a collaborative and integrated environment for the community to plan and deliver C2 capabilities. 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 Kobayashi Maru’s Continuous Integration/Continuous Deployment (CI/CD) pipeline. Mission capabilities are continuously delivered to the space operations centers. Figure 1 provides a graphical representation of the Kobayashi Maru Software Factory operation.

Kobayashi Maru’s software product portfolios include Space Domain Awareness, Space Defense, Space Tasking Cycle, Electronic Warfare, Delta Status and Reporting and Defensive Cyber Operations - Space (DCO-S). DevSecOps Infrastructure is the Kobayashi Maru enabling product line, providing the foundation of the enterprise CI/CD pipeline, Data as a Service (DaaS), Information Assurance, Network Operations and other enterprise infrastructure and platform services.

Kobayashi Maru's name was inspired by 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 our approach to delivering Space C2 mission capabilities as well. #ToBoldlyCode

With respect to acquisition imperatives, the outgoing 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 fundamentals and enterprise services to enable rapid capability deployment by the product portfolios across multiple security levels. In addition, the program is working to implement a gile acquisition and contracting that is able to deliver on demand.

2. KOBAYASHI MARU SOFTWARE FACTORY

The Kobayashi Maru software factory is focused on continuously delivering Operational Command & Control (C2) software that United States Space Force operators love. Kobayashi Maru’s strategic theme is defined in the context of lean management practices. Lean management applies lean thinking to managing enterprise 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. Lean management prioritizes working software as the greatest thing to learn from. It requires a disciplined results-based program management approach encouraging iterative planning followed by validation of results and adaptation of plans. From requirements flow to development teams working directly with users, mission capabilities are able to be delivered to the space operations centers.

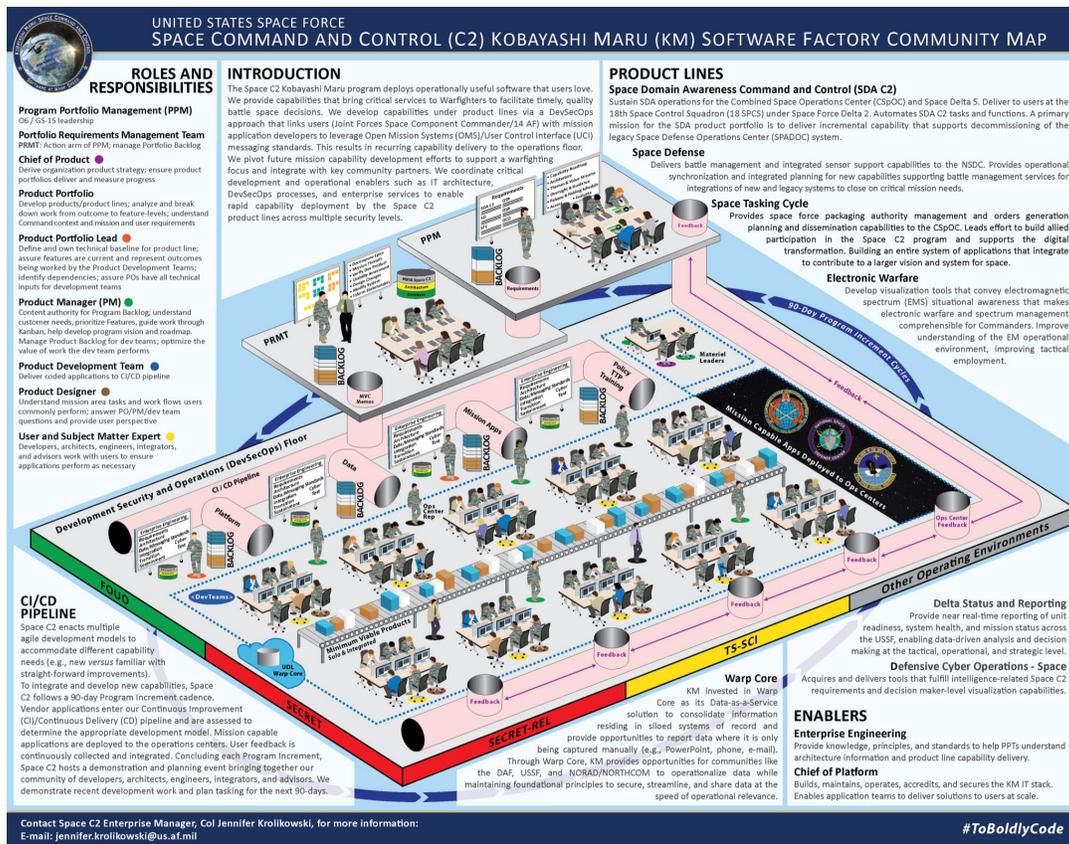


Figure 1 Kobayashi Maru Software Factory Community Map

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. Roles and responsibilities are defined at each level and ultimately prioritize the capability features within the backlog. The software factory is a community able to adapt quickly to change and is organized according to the structure shown in Figure 2 below.

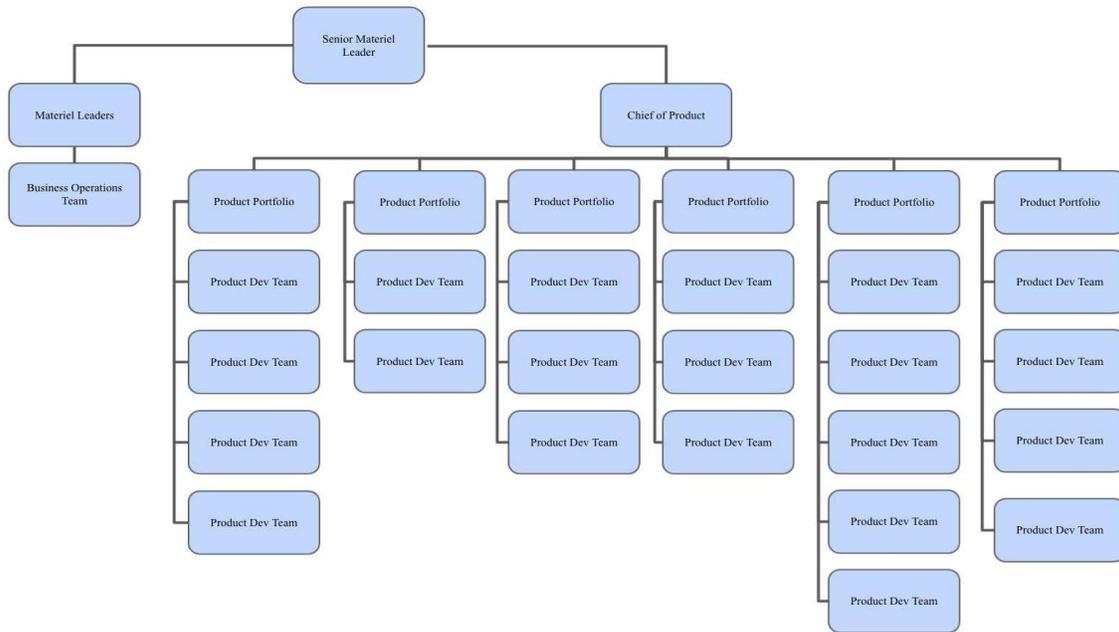


Figure 2 Software Factory Structure

Kobayashi Maru follows a 90-day Program Increment (PI) cadence to integrate and develop new capabilities across the product portfolios. This cadence enables Kobayashi Maru to deliver capabilities continuously as available or per quarter at minimum. Vendor applications enter the Continuous Improvement/Continuous Development (CI/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 portfolio leads engage to learn from previous quarter events, as well as plan for the next 90-day PI cycle.

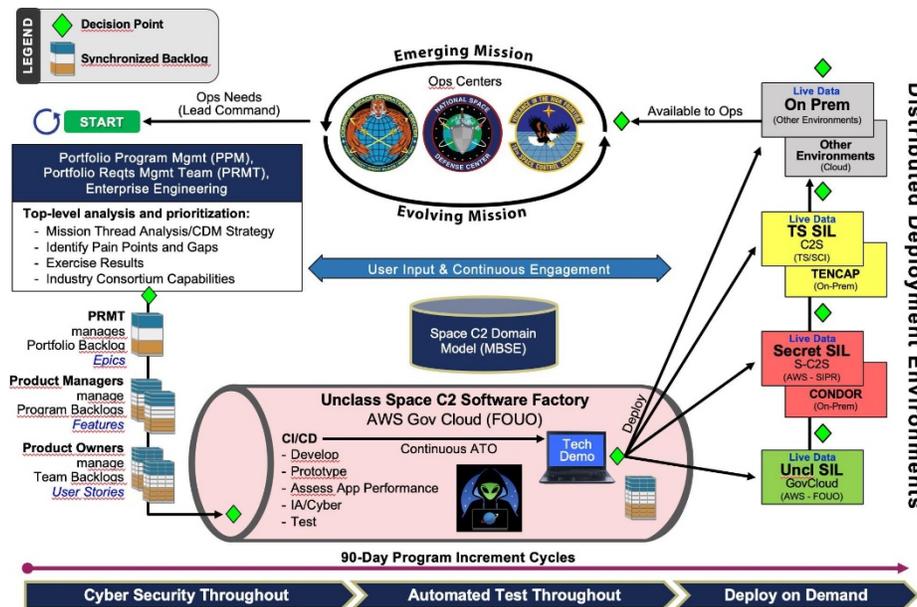


Figure 3 illustrates the Kobayashi Maru operating model

The operating model supports several agile software development methodologies used to improve software quality and responsiveness to changing customer requirements. One example is Extreme Programming (XP). 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, programming features according to user need, and code simplicity. The main goal of agile methods is to minimize 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. Kobayashi Maru has developed its operating model to be flexible to allow any software development methodology to exist within the framework. Figure 4 shows how the multiple development methods deliver in the software factory.

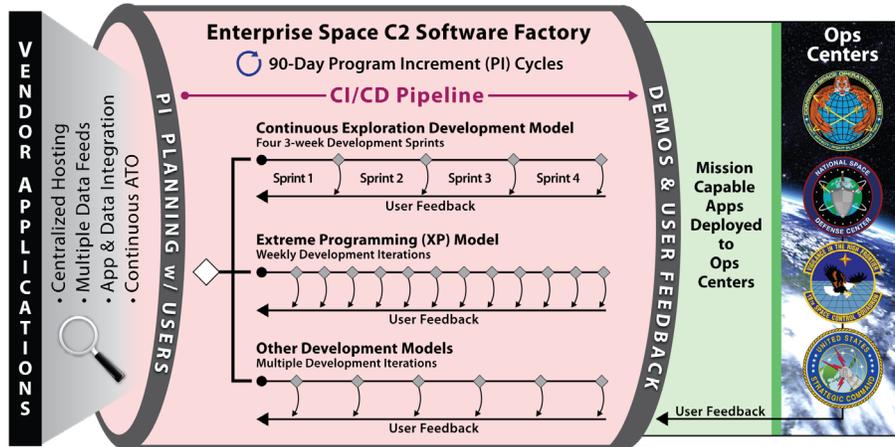


Figure 4 Kobayashi Maru Product Development Methods

At the core of most problems, regardless of the mission area, the common challenge is not only how do we enable decision makers at all levels to have access to the right data to make relevant decisions but also how do we maintain data provenance to ensure that the information they are basing their decisions on is current, timely, and reliable. Kobayashi Maru has invested in Warp Core as its Data-as-a-Service solution to not only consolidate information that currently resides in siloed systems of record, but also provide opportunities to formally report data where it is only being captured through manual actions like PowerPoints, phone call, and emails. Through Warp Core, Kobayashi Maru continues to provide opportunities for various communities like the Department of the Air Force, U.S. Space Force (USSF), and North American Air Defense Command/U.S. Northern Command (NORAD/NORTHCOM) to operationalize their data while maintaining its foundational principles to **Secure**, **Streamline**, and **Share** data at the speed of operational relevance.

1. Secure:
 - Maintain originating data source standards and protections
 - Maintain data provenance
2. Streamline
 - Enable machine-to-Machine connections when available
 - Provide cleansed and curated data to operational users
 - Provide opportunities to report data where no system of record exists
3. Share
 - Expose data to be used IN and OUT of the Warp Core platform

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 method being used by a developer. The categories are:

1. CAT-I: In early development. This is a pre-MVP (Minimum Viable Product) capability. Initial development teams are stood up and are exploring the problem space with users.

2. CAT-II: Available, but use at your own risk. This is an initial MVP delivery. Relevant data feeds may be missing, but it is useful to the operators, who are looked to for usability feedback. It may complement other operational tools.
3. CAT-III: Capability is staged for Operational Acceptance (OA). 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. Continuous development of new capabilities is supported by Kobayashi Maru.

3. KOBAYASHI MARU PRODUCT PORTFOLIOS

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

Space Domain Awareness	Electronic Warfare
Space Defense	Delta Status and Reporting
Space Tasking Cycle	Defensive Cyber Operations - Space

The Space Defense product portfolio is focused on providing the National Space Defense Center (NSDC) with an operational C2 capability and supporting battle management services for integrations of new and legacy systems to close on critical mission needs.

The Space Tasking Cycle product portfolio supports the digital transformation of the Space Tasking Cycle at the Combined Space Operations Center (CSpOC). The portfolio is building an entire system of applications that come together to contribute to a larger vision and system for space.

The Electronic Warfare product portfolio is focused on providing tools that enable the directed energy and electronic warfare mission.

The Delta Status and Reporting product portfolio is focused on providing near real-time reporting of unit readiness, system health, and mission status across USSF enabling data-driven analysis and decision-making at the tactical, operational and strategic level.

The Defensive Cyber Operations – Space (DCO-S) product portfolio provides a proactive, cyberspace layered defense approach throughout the Ground Enterprise Next to ensure built-in cyberspace security and early integration of intelligence informed defensive cyberspace capabilities focused on active cyber threats.

4. SPACE DOMAIN AWARENESS PRODUCT PORTFOLIO

This section has a more detailed discussion on Kobayashi Maru’s Space Domain Awareness (SDA) product portfolio. This product portfolio consists of several products that are working in partnership with the Space Systems Command (SSC), Special Programs Directorate (SPG) to deliver SDA via a agile development and commercial capabilities. The product portfolio is focused on developing the next generation SDA operations for the Combined Force Space Component Command (CFSCC), Space Delta 2, and to users at the 18th Space Control Squadron (18SPCS), & Joint Task Force-Space Defense (JTF-SD). The primary mission for the SDA product portfolio has been to deliver incremental capability that supports the deprecation of the current, legacy Space Defense Operations Center (SPADOC) system.

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

The Advanced Tracking and Launch Analysis System (ATLAS) is focused on the foundational space catalog management as well as tracking specific space events like launch, maneuver, and re-entry. Iris is a messaging product focused on sending and receiving the legacy message sets that currently flow through SPADOC as well as posturing the C2 system for future IP-based (Internet Protocol) sensor connections. Hyperion is a set of products focused on

providing accurate automated calibration while increasing the number of calibration sensors available for use. Finally, Osiris is a JTF-SD product of choice to support their efforts in Space Defense.

5. 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 Command and Control using global resources. There are already opportunities to leverage capabilities across this global community.

Today, the Space Tasking Cycle product portfolio has developed a capability called SpaceBoard, that is currently in use with our Five Eyes (FVEY) partners at the CSpOC, United Kingdom Space Operations Centre (UKSpOC), Australian Space Operations Centre (AUSSpOC), and Canadian Space Operations Centre (CANSpOC). This capability provides a unified picture of high interest events. Several other tools within the Space Tasking Cycle product portfolio are being delivered with accounts for our FVEY partners as well.

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.

6. CONCLUSION

Kobayashi Maru provides capabilities that bring critical services to 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 operating model with a 90-day Program Increment (PI) construct that fosters a collaborative and integrated environment for the community to work together to efficiently and effectively deliver C2 capabilities. 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 software factory floor. The development teams further break requirements down into user stories that are processed through our Continuous Improvement/Continuous Deployment (CI/CD) pipeline using a variety of software development methods. Mission capabilities are then delivered to the space operations centers where feedback is gathered and products are further iterated on to provide value to the Warfighters.

7. REFERENCES

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

Roper, Dr Will, Assistant Secretary for Acquisition, Technology, and Logistics, Breaking Defense, 12 Apr 2019