DISSERTATION

ACCELERATING CAPABILITY TO THE FLEET: RAPID FIELDING OF SMALL UNMANNED SURFACE VEHICLES

Submitted by

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ABSTRACT

ACCELERATING CAPABILITY TO THE FLEET: RAPID FIELDING OF SMALL UNMANNED SURFACE VEHICLES

The urgency to more rapidly field capability is critical to the US Navy's future; particularly as senior naval leadership has challenged the naval enterprise to accelerate fielding of robotics and autonomous systems. However, traditional requirements, resourcing, and acquisition processes often take over a decade to field needed capability. The objective of this dissertation is to describe a novel framework developed to meet this challenge, which is demonstrated using a case study for fielding small Unmanned Surface Vehicles (sUSVs) for the US Pacific Fleet from 2022 to 2025. The framework begins with an adaptation of the innovation pipeline, executing a 12-week sprint process of problem sourcing, curation, discovery, incubation, and scaling. The results of the sprint process provide the case that a solution has warfighting utility, is technically feasible, and has a path to scale. This output is provided to leadership to make an informed decision to transition into a prototype project phase, which aims to continue learning while validating sprint results. The second part of this framework uses the sUSV prototypes to build a campaign of learning, leveraging Fleet experiments while implementing a DevOps model utilizing both government and industry to rapidly learn, adapt, and improve the capability. This step focused on demonstrating warfighting utility, technical feasibility, and building advocacy to the path to scale. The third step implements an in-parallel but collaborative approach to acquisition, systems engineering, and Fleet adoption, leveraging the lessons learned from the previous steps to more rapidly field and employ the sUSV capability at scale. This dissertation provides an overview and lessons learned from a real Navy case study in which time to field capability was reduced significantly. While this may not be applicable to all Navy programs, this research offers insights to help the naval enterprise when challenged to rapidly field capability.

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LIST OF ACRONYMS

AoA: Analysis of Alternatives
ASN RDA: Assistant Secretary of the Navy for Research, Development, and Acquisition
C2: Command and Control
CBA: Capabilities Based Assessment
CCMD: Combatant Command
CDD Capability Development Document
CDD: Capability Development Document
CGA: Capability Gap Assessment
CNO: Chief of Naval Operations
CONOP: Concept of Operation
DAS: Defense Acquisition System
DAU: Defense Acquisition University
DCO: Disruptive Capabilities Office (Navy)
DCR: DOTmLPF-P Change Recommendation
Dir CAPE: Cost Assessment and Program Evaluation
DOD: Department of Defense
DON: Department of Navy
DOTMLPF-P: Doctrine, Organization, Training, Material, Logistics, Personnel, Facilities, and Policy
EMD: Engineering Maturation and Development
FMB: Office of Budget
FO: Flag Officer
FOC: Full Operational Capability
FY: Fiscal Year
FYDP: Future Years Defense Program
GFE: Government Furnished Equipment
GO: General Officer
ICD: Initial Capabilities Document
ICD: Initial Capabilities Document
IOC: Initial Operational Capability
IPL: Integrated Priority List.
IPT: Integrated Product Team
JCB: Joint Capabilities Board.
JCIDS: Joint Capabilities Integration & Development System
JEON: Joint Emergent Operational Need
JRAC: Joint Rapid Acquisition Cell.
JROC: Joint Requirements Oversight Council.
JUON: Joint Urgent Operational Need
KPP: Key Performance Parameter.
KSA: Key System Attribute. Of lesser importance than KPPs.

LIMFAC: Limiting Factor
LOE: Line of Effort
LRIP: Low Rate Initial Production
MCA: Major Capability Acquisition
MDA: milestone decision authority
MS: Milestone
MSA: Material Solution Analysis
MTA: Middle Tier Acquisition
NDAA: National Defense Authorization Act
NIWC: Navy Information Warfare Command
NR&DE: Naval Research and Development Establishment
NSWC: Naval Surface Warfare Center
OMN: Operations and Maintenance, Navy
OQE: Objective Quality Evidence
OSA: Other System Attribute. Of lesser importance than KSAs. OSD: Office of Secretary of Defense
P&D: Production and Deployment
PACFLT: Pacific Fleet
PEO: Program Executive Office
PMS: Program Management Ships
POM: Program Objective Memorandum (Budget)
POR: Program of Record
PPBE: Planning, Programming, Budgeting & Execution
RAP: Resource Allocation Plan
RDT&E: Research, Development, Test, and Evaluation (color of money)
RFI: Request for Information
RIC: Rapid Innovation Cell (Unmanned Task Force)
S&T: Science and Technology
SES: Senior Executive Service (GO/FO Civilian equivalent)
sUSV: Small Unmanned Surface Vehicle/Vessel
TLR: Top Level Requirement
TMRR: Technology Maturation and Risk Reduction
TRL: Technical Readiness Level
TTP: Tactics, Techniques, and Procedures
UCA: Urgent Capability Acquisition
UON: Urgent Operational Need (Navy specific)
USD(A&S): Under Secretary of Defense (Acquisition & Sustainment)
USD(C): Under Secretary of Defense (Comptroller)
USD(R&E): Under Secretary of Defense (Research & Engineering)
USFFC: United States Fleet Forces Command
USVRON-3: Unmanned Surface Vessel Squadron 3
UTF: Unmanned Task Force (Navy)

CHAPTER 1: INTRODUCTION

The current process of delivering a needed warfighting capability to the Navy is lengthy, with the Defense Acquisition System (DAS) major capability acquisition programs generally taking 7-12 years to field capability (Webster, 2024). Compounding this challenge, the 7-12 year timeframe does not account for the full requirements, resourcing, and acquisition process to include Joint Capabilities Integration and Development System (JCIDS) requirements generation process, and the Planning, Programming, Budgeting, and Execution Process (PPBE) leading up to the acquisition. It has come to be expected that this process takes 10+ years from first identifying need to fielding. This process results in capabilities potentially being fielded late to need and leaving the United States Navy at risk of being unprepared for future conflicts. This problem is magnified by the recent shift to more disruptive, technology-driven warfare (e.g., drones), as observed in global conflicts such as the war in Ukraine, attacks in the Red Sea, and the Azerbaijan-Armenia conflict. As a result, it is necessary to find ways to develop, acquire, field, and implement capability to the warfighter faster.

Recognizing this evolving landscape of technology-driven warfare, former Chief of Naval Operations ADM Lisa Franchetti emphasized the need for these advanced systems in her 2024 NAVPLAN, stating, “By 2027, we will integrate proven robotic and autonomous systems for routine use by the commanders who will employ them (Franchetti, 2024).” However, with 2027 just two years away, meeting this timeline requires novel approaches to accelerate capability fielding.

The primary objective of this dissertation is to develop a repeatable process that can be used to more rapidly develop, acquire, field, and implement new capabilities to the Navy as compared to the traditional requirements, resourcing, and major capability acquisition process. This novel process is demonstrated using a real US Navy case study for the fielding of small Unmanned Surface Vehicles (sUSVs). This dissertation is comprised of the following three aims:

- *Research Aim 1*: Adapt the innovation pipeline approach to problem sourcing, curation, discovery, incubation, and transition to develop the case determining that sUSVs have warfighting utility, are technically feasible, and have a path to scale.
- *Research Aim 2*: Utilize the sUSV prototype(s) to execute a campaign of learning through Fleet experimentation with a DevOps approach.
- *Research Aim 3*: Identify, explore, and implement a new process to adapt the traditionally in-series process to deliver capability to the Fleet into a new parallel line of effort approach.

The framework developed in this research to accelerate delivery of capability to the Fleet originated from support to the Navy Unmanned Task Force (UTF), Navy Disruptive Capabilities Office (DCO), and a Navy program office. This work began with the UTF sUSV sprint in May of 2022. Through these efforts, significant progress has been made in the fielding of capability aligned to the vision documented in this dissertation. In order to avoid any breaches of classification, information related to the specific missions, customers, stakeholders, gaps in capabilities, and platform names are omitted.

CHAPTER 2: LITERATURE REVIEW

The US Navy has held a global technological advantage in capabilities for decades, dating back to the end of the Cold War, and many could argue even as far back as World War II. This technological advantage has only been exemplified by conflicts with less developed adversaries, as witnessed in the Iraq and Afghanistan conflicts. In the post-Cold War era, there has been little urgency to field new capabilities, as the US already possessed far superior capabilities than our adversaries. According to a 2019 Government Accounting Office report, major defense acquisition programs face challenges delivering innovative technologies to the warfighter to keep pace with evolving threats (Oakley, 2019).

The Navy's traditional requirements, resourcing, and acquisition processes were developed for large acquisitions, often in billions of dollars, such as for aircraft carriers, submarines, and large quantities of aircraft, with an emphasis on avoiding large financial mistakes to the determent of expediency. However, the rise of disruptive capabilities such as drones and artificial intelligence, coupled with the increasing capabilities of peer adversaries such as China, has created a renewed sense of urgency. The Navy must now accelerate the development, acquisition, fielding, and implementation of new capabilities. Most optimistically, the Navy would be able to implement these capabilities to deter a future conflict. In the event a conflict was unavoidable, the Navy would be equipped to defeat any adversary promptly, minimizing casualties and worldwide disruption. The following literature review is focused on providing an understanding of the traditional DOD requirements, resourcing, and acquisition process as well as existing options to expedite the process.

2.1 Big Picture of the Requirements, Resourcing, Acquisition and Beyond Process

Figure 1 provides a summary of the current process of fielding capability to the Fleet from identification of need to the end of the service life. The illustration of this 16-step process is an oversimplification of a much more complex process.

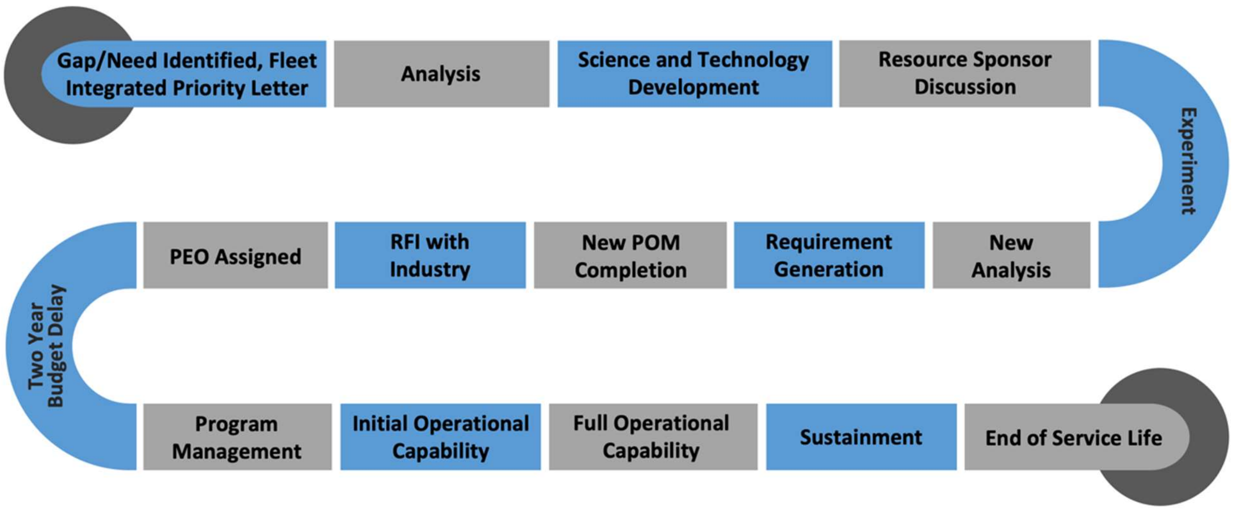
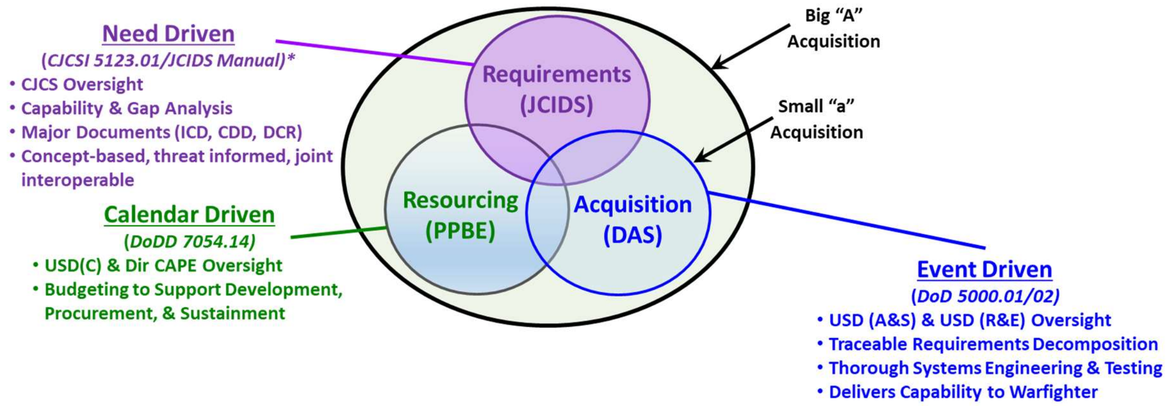


Figure 1: Summary of Current Requirements, Resourcing, and Acquisition Process

The illustration of the above 16 step process is an oversimplification of a much more complex process with numerous steps under each of these steps. Figure 2 provides an illustration of the Requirements, Resourcing, and Acquisition interrelationships.



DCR: DOTmLPF-P Change Recommendation	DAS: Defense Acquisition System
ICD: Initial Capabilities Document	JCIDS: Joint Capabilities Integration & Development System
CDD: Capability Development Document	PPBE: Planning, Programming, Budgeting & Execution
USD(C): Under Secretary of Defense (Comptroller)	USD(A&S): Under Secretary of Defense (Acquisition & Sustainment)
Dir CAPE: Cost Assessment and Program Evaluation	USD(R&E): Under Secretary of Defense (Research & Engineering)

Figure 2: Requirements, Resourcing, Acquisition Interrelationship (Moore, 2023)

Each of these circles represent each element of the Requirements, Resourcing, and Acquisition Triad. Remove any element of the requirements, resourcing, and acquisition triad and the program will not succeed, but equally this process can only work as fast as the slowest portion of the larger process to field a capability. To simplify this diagram these three circles can be divided into three separate distinct processes:

The *Requirements* process is needs driven from the Joint Force (all services) Combatant Commands (e.g., United States Indo-Pacific Command, INDOPACOM) and Navy Component Commands (e.g., US Pacific Fleet, PACFLT) providing the demand signal to the Pentagon through Office of Secretary of Defense (OSD) and Office of the Chief of Naval Operations (OPNAV) (Manual for the Operation of the Joint Capabilities Integration and Development System, 2021). The requirements process relies on the lengthy Joint Capabilities, Integration, and Development System (JCIDS) process, but can also be expedited through the urgent needs process. According to the Acquisition Innovation Research Center Report on JCIDS the process takes an average of 852 days just to get to the requirement being defined (Anton et al., 2022).

The *Resourcing* process currently follows the Planning, Programing, Budgeting, and Execution process anchored by the Navy Program Objective Memorandum (POM), which is controlled by OPNAV aligned to the Chief of Naval Operations. PPBE is the primary resource allocation process in the Department of Defense. OPNAV prepares for future Navy employment, evaluates readiness, develops Navy strategy/policy and provides resource sponsorship (Planning, Programming, Budgeting, and Execution, 2024). The primary resource sponsors in the Navy are aligned under OPNAV N9 Deputy Chief of Naval Operations for Warfighting Requirements and Capabilities. N9 is further broken down into specific resource sponsors aligned to warfighting areas N95 (expeditionary warfare), N96 (surface warfare), N97 (undersea warfare), and N98 (air warfare). PPBE has been described as a good, rational, logical system that works well within given constraints, however there is no streamlined approach to making changes once the budget is submitted (Cardon, McGrath, Tao, 2024). It is not agile, or flexible, with only $4B of the $855B budget (0.5%) capable of General Transfer Authority, meaning you can move the money (Cardon, McGrath, Tao, 2024). This means if anything is going to be accomplished in less than two years, it has to be by an alternative means. The primary way to do this in the traditional structure is to utilize execution year funding of internal sweep-up or reallocation funds from underspent programs, or with congressional supplemental funding.

The *Acquisition* process which for the Navy, Acquisition authority flows from the Service Secretary, ASN RD&A is Component Acquisition Executive (CAE). The Program Executive Office

(PEOs) are direct reports to ASN RD&A which are matrixed to systems commands (syscom) (Department of Defense, 2022). In the case of small USVs, a Navy PEO and PMS were assigned, referred in this dissertation as Navy PEO and Navy program office. The Navy program office is focused on the buying portion of the acquisition program but then relies on the Naval Research and Development Establishment of Warfare Centers to execute the systems engineering, development, integration, and fielding of both government and industry capability under their purview.

The simplest definition of this process would be that the JCIDS process generates validated capability requirements, leading to resources programmed through the PPBE process, with execution then shifting to the DAS (Cardon, McGrath, Tao, 2024). The PPBE process is calendar driven, but the requirements and acquisition process are activity driven. In order to meet requirements with an acquisition solution, the entire system relies on the funding coming out of PPBE, which is at the mercy of a 2-year long calendar driven cycle. There are numerous publications speaking to the challenges of the JCIDs, PPBE, and DAS processes and innovative approaches to overcome those challenges, but extremely few that speak to the full process to field capability.

In an ideal world the INDOPACOM Combatant Commander would tell the PACFLT Naval Component Commander the problem they need to solve. That clearly defined problem/need/gap would go to OPNAV to provide funding to solve that problem and clear requirements. That funding and clear requirements would be sent to the Secretariat and ultimately to a program office to go find a solution that meets the clearly defined requirements OPNAV generated, the customer (the Fleet) would be involved throughout the process to make sure the requirement will meet the need and agree that the solution would meet the requirement. The Fleet would then be ready to receive the solution. This sounds fairly straight forward, but this process typically takes 10+ years. To understand how to accelerate the overall process, first we must fully understand the traditional processes within the Resourcing, Requirements, and Acquisition processes, and then we must take advantages of opportunities to leverage the most accelerated approaches to each of those three processes.

2.2 Pre-Requirement Phase

Most often when discussing providing capability to the Fleet there is an emphasis on the Requirements, Resourcing, and Acquisition process, however there are several steps that come before the more well discussed topics can even begin. These steps are identified in steps 1-6 of Figure 1.

2.2.1 Fleet Integrated Priority Letter (FIPL) and CONOP Development

Each year US Fleet Forces Command and in some years US Pacific Fleet develop a Fleet Integrated Priorities Letter (FIPL). This letter is typically a combined product from the three Four-Star Echelon 2 commands of US Fleet Forces Command (Norfolk), US Pacific Fleet (Honolulu, HI), and US Naval Forces Europe/Africa (NAVEURAF), and it communicates a prioritized list of the Fleet Needs to OPNAV. The output of this list is aligned to step 1 (gap/need identified, fleet integrated priority letter) in Figure 1. The ultimate goal of this list is to inform the Navy's POM process of issues of greatest concern to the Fleet commanders. OPNAV Instruction 3000.16 released in 2019 provides guidance on the FIPL focusing the Type Commanders (TYCOMs), Naval Fleet Commands, even the Navy Systems Commands to observe the importance of the FIPL in aligning priorities (Richardson, 2019). It is important to note that the Fleet Integrated Priority Letter is supported by a series of Integrated Prioritized Capabilities Lists (IPCLs) that are developed at lower echelon commands through a series of conferences called the Warfare Improvement Program. The IPCL's are aligned to different warfighting areas to include surface, undersea, expeditionary, etc. This is a long way of saying that even before the Pentagon Requirements process starts the Fleet requirements process starts with a series of recurring meetings on an annual cycle. If a need is able to get enough attention and concurrence to make the IPCL, and ultimately the IPL it may then be considered to start the requirements process.

It is also important to note that according to OPNAV Instruction 3000.16 provides additional guidance on Concepts of Operations (CONOPs) that are to be developed by US Fleet Forces Command and US Pacific Fleet and approved by the CNO (Richardson, 2019). These CONOPs can then be used to inform planners and operators on how to integrate capabilities both today and in the Future. CNO Richardson goes on to instruct OPNAV, Systems Commands, Fleet Commands, TYCOMs to support developing the CONOPs (Richardson, 2019). Having a viable CONOP to start the process ensures an easier transition to the requirements process.

To simplify this dissertation the steps of the Fleet developing their IPCL and ultimately the FIPL, and the CONOP can be estimated to take two years.

2.2.2 Science and Technology Development and Analysis to Meet Needs

While the Fleet desires for the FIPL to directly and immediately inform the POM there are several steps that typically take place between the FIPL submittal and the POM submission. As indicated in Figure 1, typically the FIPL response is informing the Science and Technology Development through the Office of Naval Research and the larger Naval Research and

Development Establishment (step 3). The results coming out of the S&T development typically lead to a conversation with the Resource Sponsors in OPNAV (step 4) to determine if there is a path forward for scaling the capability. Additionally, OPNAV through OPNAV N81 and others conducts analysis that informs discussion among the resource sponsors to ensure these priorities are suitable for a POM submission, ultimately leading to a POM issue paper. OPNAV typically does not want to put capabilities into the POM unless they know there is a material solution able to meet that need. This all sounds simple, but if a solution does not exist to a problem typically the Science and Technology process takes years to complete. In addition to the Fleet Even if the capability exists that can potentially meet the need the analysis to determine if it is a viable option takes time as well. For steps 2-6 (analysis through new analysis) that are pre-requirement process this can often take 1-5 years depending on technical maturity of potential solutions. While this process is generally lengthy there is an increased push to accelerate the science and technology process. There is a sense of urgency and an emphasis in leveraging the expertise of industry combined with the Naval Research and Development Establishment. The Department of the Navy released an S&T strategy in 2024 that provides guidance that Industry is a vital partner, and we must adopt and adapt private sector technologies to more rapidly meet the needs of our Navy and Marine Corps (Del Toro, 2024).

2.3 Requirements Process

The Requirements process most often discussed is the JCIDs process, however for rapid fielding the urgent operational needs process is typically more suitable for defining requirements. This Requirements process is most closely aligned to step 7 of Figure 1.

2.3.1 Traditional JCIDs Process

The traditional requirements process is typically very lengthy. It is important to note in the use case of rapidly fielding sUSVs this is not a viable option.

Summary of the steps:

Initial Capabilities Document (ICD)

The ICD Summarizes Capabilities Based Assessment (CBA). Documents and prioritizes capability gaps. ICD is focused on gaps, not solutions. This is required for Material Development Decision, and there are also unique ICD formats and processes for Information Systems and for software development: the IS-ICD and SW-ICD (Manual for the Operation of the Joint Capabilities Integration and Development System, 2021).

Analysis of Alternatives (AoA)

Analytical comparison of operational effectiveness, suitability, & life-cycle cost of alternatives that satisfy capability needs. This is where the process starts to think of solutions, and it can identify preferred materiel or non-materiel solutions (Manual for the Operation of the Joint Capabilities Integration and Development System, 2021).

Capability Development Document (CDD)

The CDD defines authoritative, testable performance criteria in the form of Key Performance Parameters (KPPs), Key System Attributes (KSAs) and Other System Attributes (OSAs), that a system must be able to achieve in order to fill a capability gap. This is required for program initiation (typically Milestone B, but Milestone A for ship programs). There is also a unique CDD format and process for Information Systems: the IS-CDD (Manual for the Operation of the Joint Capabilities Integration and Development System, 2021).

CDD Update (formerly known as a Capability Production Document or CPD)

The CDD update refines KPPs, KSAs, and OSAs of the system that will go into production using lessons learned during development process (Manual for the Operation of the Joint Capabilities Integration and Development System, 2021).

DOTMLPF-P Change Recommendation (DCR)

The Fleet focuses on DOTMLPF-P as the way they will actually use a capability. DOTMLPF-P = Doctrine, Organization, Training, materiel, Leadership and Education, Personnel, Facilities, and Policy. This phase focuses on how to change, institutionalize, or introduce new DOTMLPF-P solutions and policy (Manual for the Operation of the Joint Capabilities Integration and Development System, 2021).

According to the Acquisition Innovation Research Center Report on JCIDS the process takes an average of 852 days just to get to the requirement being defined (Anton, 2022). This is the point that the Resourcing would be begin, but we have to be able to communicate the need and build the requirement faster.

2.3.2 Urgent Needs Requirements Process

There are four options for Navy Urgent Operational Needs. Three are actually completed by the Combatant Commander at the Joint (all services) Level (INDOPACOM), so the Component Command (PACFLT) in this case would have to work with the Combatant Commander to have the first three options submitted from the Combatant Commander. These three options are defined above with the critical difference being urgency. The Joint Urgent Operational Need (JUON) process indicates that a solution needs to be fielded within two years and is only applicable for current conflicts. In the case of PACFLT this would not apply, but an example where it would apply would be for CENTCOM/NAVCENT in Bahrain if there was a need to protect ships in the Red Sea. The next option is the Joint Emergent Operational Need (JEON), which also indicates the same need to be fielded within two years, but it is for an anticipated or pending conflict. This could apply to INDOPACOM and PACFLT if it was anticipated that we would have a conflict with a country in their area of responsibility in the near future. The third joint option is the Deliberate Urgent Need, but this just follows the JCIDs process and does not make a difference for speed (Manual for the Operation of the Joint Capabilities Integration and Development System, 2021). The fourth option is Navy specific and is the Navy Urgent Operational Need. It would be submitted by PACFLT not by INDOPACOM. Figure 3 provides an outline of the four bins of operational needs.

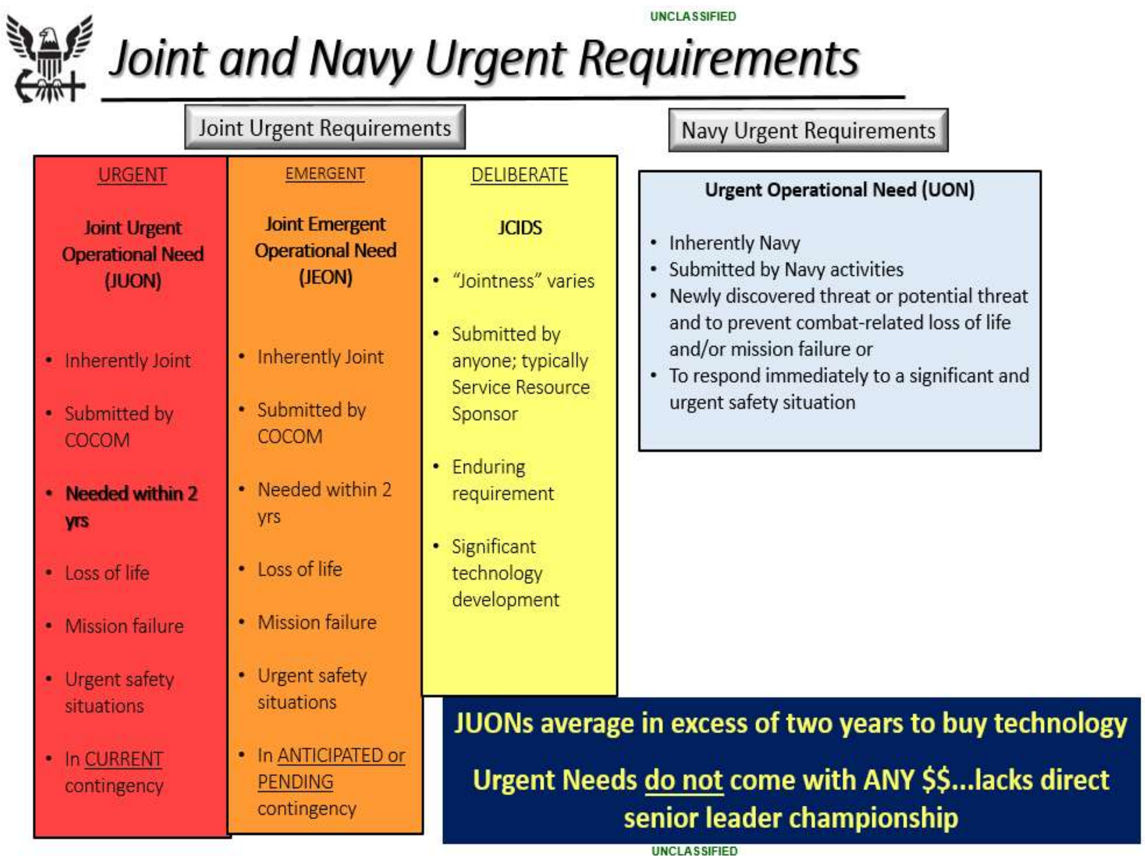


Figure 3: Joint and Navy Urgent Requirements (Couchman, 2024)

Figure 4 provides an outline of the Urgent Needs Process. Of importance this process starts with the Combatant Commander or the Navy Echelon 2 Command, shifts to OPNAV to develop the plan for resourcing and gain approval, and then shifts to ASN RDA to execute a solution. If executed properly Urgent Needs Statements should be able to get through this process in ~6 months. Reducing the Requirements time from 852 days to ~180 days.

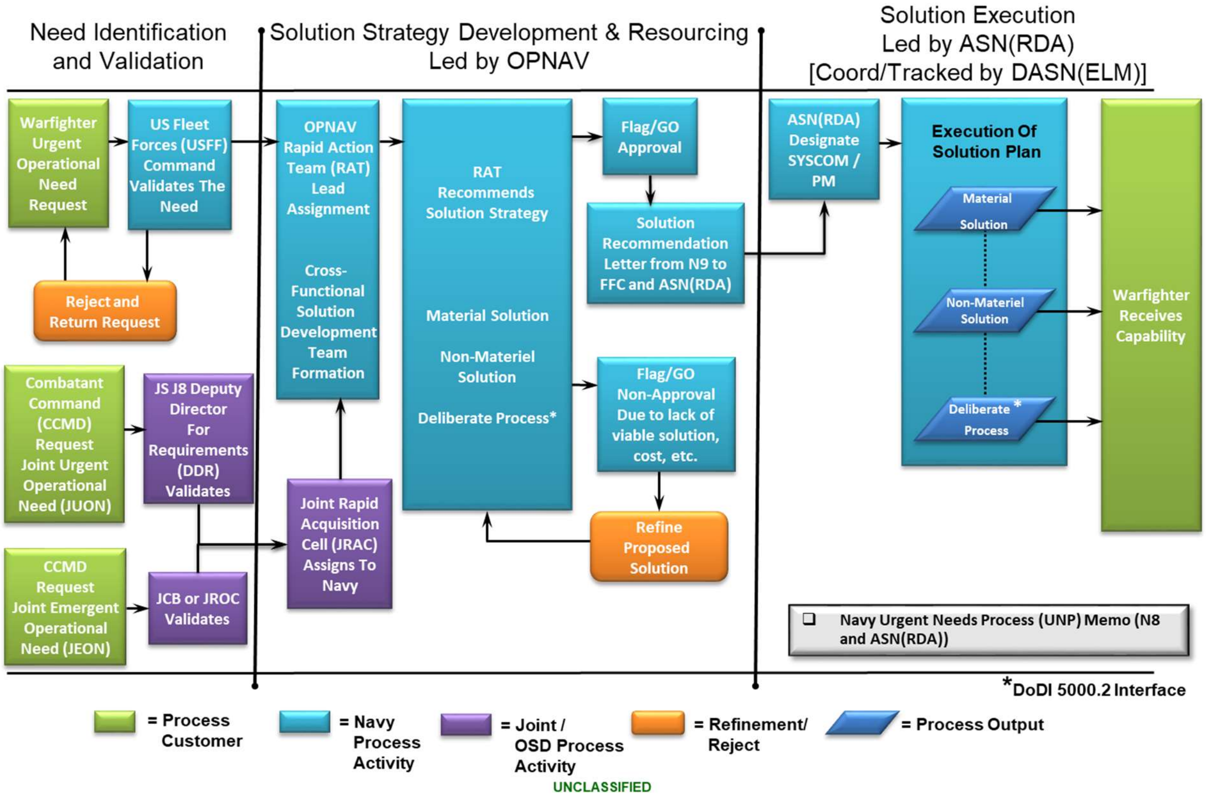
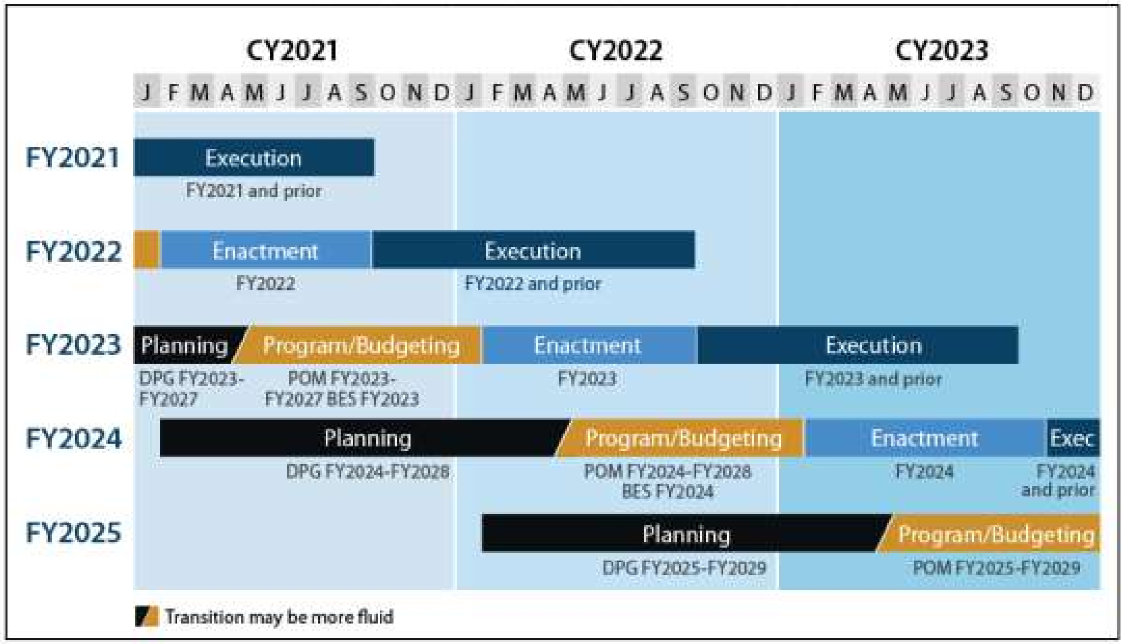


Figure 4: Urgent Capability Acquisition Process (Urgent Capability Acquisition, 2024)

In order to accelerate a capability fielding process a well communicated and approved urgent need is extremely beneficial.

2.4 Resourcing, Planning, Programming, Budget, and Execution

Once there is a clear agreed upon requirement the traditional process is for that requirement to enter into the Planning, Programming, Budget, and Execution process to gain entry into the Navy Program Objective Memorandum (POM). This is step 8 in Figure 1. The Navy POM is essentially the Navy's budget. The final product of the programming process is the POM provides the resource allocation decisions of the military department aligned to the Defense Planning Guidance (DPG). The POM shows programmed needs for 5 years (Planning, Programming, Budget, and Execution, 2024). Once the requirement makes it into the POM to be funded that is when the request for information (Step 9) goes out to find solutions across industry and government and the Program Executive Office (PEO) is assigned to execute the acquisition (Step 10). Once a requirement makes it into the POM the PPBE process leads up to step 11 in Figure 1 provides for a two-year budget delay.



Source: Figure created by CRS based on DAU references.

Notes: Timeline is notional. CY is calendar year; FY is fiscal year. Execution as shown is based on appropriations available for one year.

Figure 5: PPBE timeline snapshot of today (McGarry, 2022)

Figure 5 provides a depiction of the PPBE process when this document was being written. The POM process is continuous and was working through POM 26 finalizing, shifting to planning for POM 27. This ultimately leads into the Navy submission to the National Defense Authorization Act (NDAA) that after considerable influence from the House armed services committee and Senate Armed Services Committee Influence, making it through the OPNAV and OSD in the Pentagon, is signed into law by the President each year. This creates what is called the Future Years Defense Program (FYDP), which amounts to a five-year spending plan for the services. If you are planning to field any capability in less than two years it has to be an alternative means. The primary means to do this in the traditional structure is to tap into execution year funding of internal sweep-up or reallocation money, or with congressional supplemental funding. This means there is a strict budget that for anything you want to do within the two years to three years prior to POM funding being allocated that funding is being taken away from something else, or funding is provided from under spending programs (sweep up funds) (Planning, Programming, Budgeting, and Execution, 2024).

2.5 Acquisition

Once funding is allocated the acquisition process can occur. The acquisition process is more complex than purchasing the solution. It involves program management (Step 12) that includes sub tasks such as systems engineering and testing, ultimately leading to fielding of the Initial Operational Capability (Step 13), Full Operational Capability (Step 14), Sustainment (Step 15), and the end of service life (step 16).

2.5.1 Major Capability Acquisition

The primary means of acquisition for the Navy follows the major capability acquisition path. This process was designed to reduce risk by creating a series of checks and balances all of which create substantial schedule impacts. While this path typically takes several years, it is valuable to understand the primary path for large acquisition programs. This understanding allows those looking to execute alternative methods to highlight the need to use such methods and better explain the risks they are taking on by expediting the process. Figure 6 provides the Major Capability Acquisition Framework.

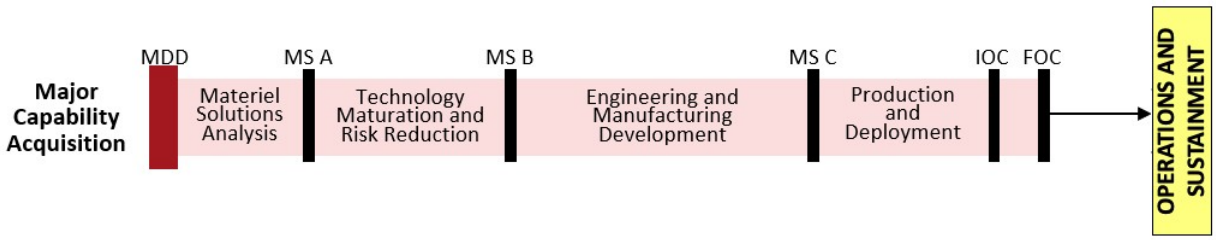


Figure 6: Major Capability Acquisition (Adaptive Acquisition Framework, 2024)

Material Solution Analysis Phase: (Warfighting Utility)

Phase activity will focus on identification and analysis of alternatives, measures of effectiveness, key trades between cost and capability, life-cycle cost, schedule, concepts of operations, and overall risk. The Analysis of Alternatives will inform and be informed by affordability analysis, sustainment considerations, early systems engineering analysis, threat projections, and coalition interoperability as identified in the ICD (Department of Defense, 2021).

During this phase, the CAE will select a PM and establish a program office to complete the actions necessary to plan the acquisition program and prepare for the next decision point. MDAP MDAs will establish program goals. An independent cost estimate (ICE) and independent technical risk assessment (ITRA) will be conducted before granting Milestone A approval for an MDAP. Product support (PS) and sustainment planning begin during this phase and support the determination of core logistics capability requirements. The phase ends when the DoD Component has completed the necessary analysis and the activities necessary to support a decision to proceed to the next decision point/phase in the acquisition process (Department of Defense, 2021).

Major activities include conducting an analysis of alternatives, analysis to support selection of preferred material Solution, analysis to operational analysis of preferred material solution (CONOPS, Operational Mission Summary, Mission Profile), perform engineering and technical analysis on preferred materiel solution, and establishing program framework and strategies (Department of Defense, 2021).

Milestone A: Approve to Technology Maturation and Risk Reduction (TMRR) (technical feasibility)

Milestone A approves program entry into the technology maturation and risk reduction (TMRR) phase. This approval of the program acquisition strategy, and release of the final request for proposals (RFPs) for TMRR activities leads to a draft capability development document (CDD) approved by the DoD Component informs the acquisition strategy and the RFP for TMRR (Adaptive Acquisition Framework, 2024).

The primary purpose of Milestone A is to Develop the Navy's business case and initial risk identification/mitigations with drafting the Capabilities Development Document (CDD) as the key deliverable (Adaptive Acquisition Framework, 2024).

Principal considerations include: justification for and the affordability and feasibility of the preferred military solution, identification of the technologies that must be matured during the TMRR phase, the scope of the capability requirement trade space and an understanding of the priorities within that trade space, technical, cost and schedule risks, and the plans and funding to offset them during the TMRR phase, a proposed acquisition strategy, including intellectual property (IP), program protection, and exportability and acquisition planning, the test strategy, a life-cycle mission data plan for each intelligence mission data-dependent program and the projected threat and its impact on the materiel solution (Adaptive Acquisition Framework, 2024).

Coming out of milestone A, The Milestone Decision Authority decides:

- The acquisition strategy to determine the materiel solution
- the strategy for the TMRR phase
- PM waiver requests
- release of the final RFP for the TMRR phase
- Exit criteria required to complete TMRR, and entrance criteria for the Engineering and Manufacturing Development (EMD) Phase (Adaptive Acquisition Framework, 2024).

Milestone B: Approve Entry to Engineering Maturation and Development (EMD) (technical feasibility)

The Milestone B decision authorizes a program to enter into the Engineering and Maturation Development Phase. This also allows the program to commit the required investment resources to support the award of phase contracts. Requirements for this milestone may be satisfied at the Development RFP release decision point. If significant changes have occurred between the two decisions that would alter the decisions made at the earlier point, those changes will be addressed at the Milestone B review (Adaptive Acquisition Framework, 2024). This milestone is focused on how the DOD mitigates the risk associated with the design, development, and production.

Principal considerations include: commit required investment resources to support award of phase contracts, requirements for this milestone may have been satisfied at the development request for proposal release decision point, demonstration that all sources of risk have been adequately mitigated to support a commitment to design, development and production, validated capability requirements are required for all programs, full funding in the FYDP, compliance with affordability/program goals demonstrated through technical assessments and initial capability evaluations are required for MDAPs and programs in other categories when directed (Adaptive Acquisition Framework, 2024).

Decisions: The MDA will approve

- The MDA will approve entry into the EMD phase and formally initiate the program by approving the acquisition program baseline (APB).
- The program decisions, EMD phase exit criteria, approval of the LRIP quantity, and specific technical event-based criteria for initiating production or fielding at Milestone C will be documented in an Acquisition Decision Memorandum (Adaptive Acquisition Framework, 2024).

Milestone C: Approve to Production and Deployment (P&D) Phase (Path to scale)

Milestone C is the point that the program will be approved to progress into Production and Deployment. There is a body of evidence that is collected to be considered going into Milestone C to include any test and evaluations, operational assessments, production and manufacturing assessments that will consider the capability ready to be scaled (Adaptive Acquisition Framework, 2024).

Principal considerations include: the results of developmental tests and evaluations and any early operational test and evaluation, the body of evidence that the production design is stable, the results of an operational assessment, the maturity of the software, any significant manufacturing risks, the status of critical intelligence parameters and intelligence mission data requirements, relative to fielding timelines, full funding (Adaptive Acquisition Framework, 2024).

Decisions: The MDA will approve

- The MDA's decision to approve Milestone C will authorize the program to proceed to the Production and Deployment Phase, enter low-rate initial production or begin limited deployment, and award contracts for the phase (Adaptive Acquisition Framework, 2024).

Figure 7 shows a more detailed process map of the Major Capability Acquisition Process for the DOD with clear milestones and phases. This is a deliberate and methodical process aimed at reducing risks, but it takes several years to complete.

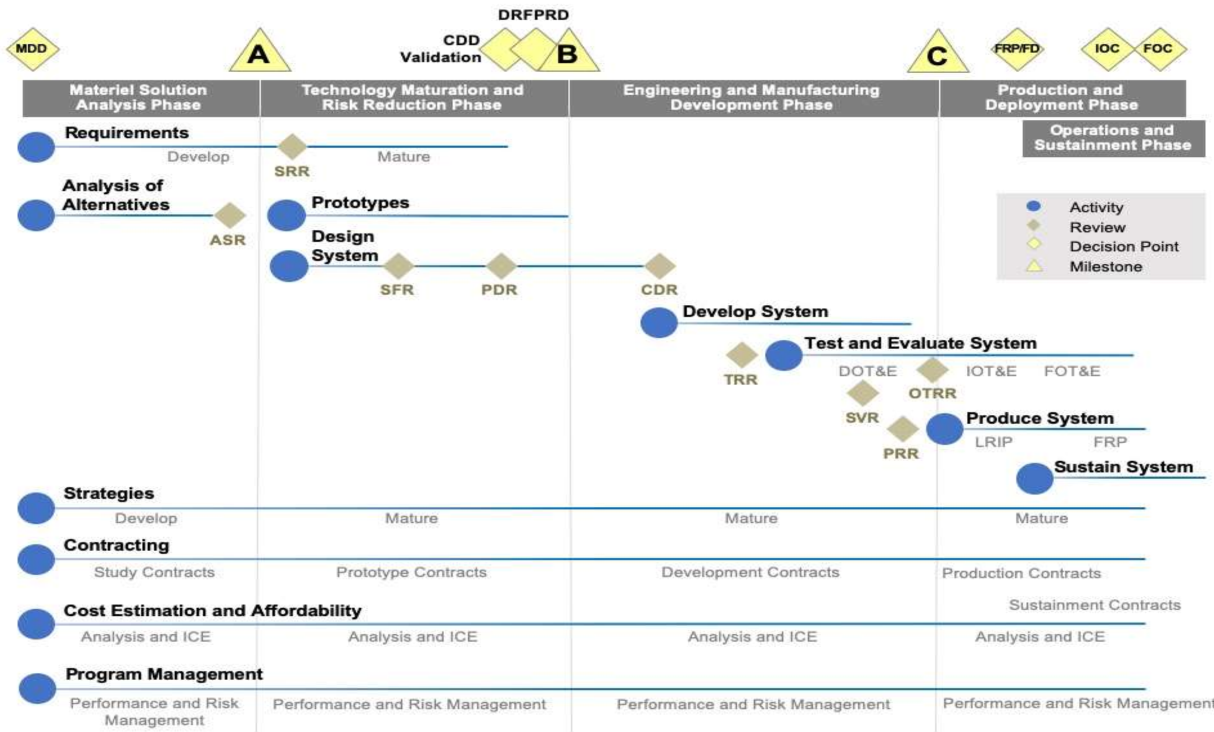


Figure 7: More detailed Traditional Navy Acquisition Process (Department of Defense, 2022)

2.5.2 Middle Tier Acquisition

A more suitable means to rapidly acquire systems is the Middle Tier Acquisition path as seen in Figure 8.

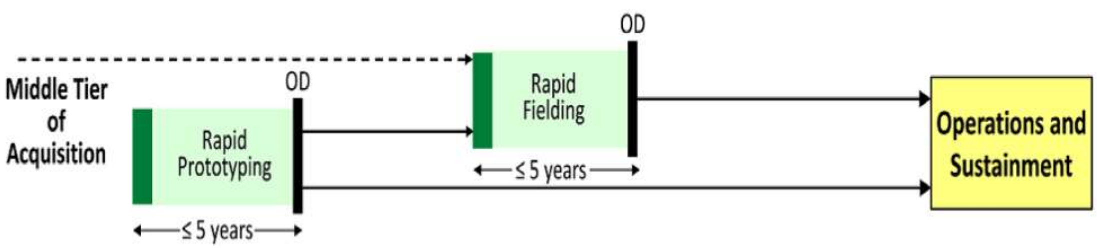


Figure 8: Middle Tier Acquisition Path (Adaptive Acquisition Framework (MTA), 2024)

The Government Accountability Office produced a 2023 report titled *Middle-tier defense acquisitions: Rapid prototyping and fielding requires changes to oversight and development* *approaches*, that provides a review and recommendations on the use of middle tier acquisitions (MTA). In that report GSA highlights that while DOD established policies and guidance for MTAs they were not being used to the full potential due to implementation and oversight issues.

Middle Tier Acquisition was established on 30 December 2019, through DOD INSTRUCTION 5000.80 OPERATION OF THE MIDDLE TIER OF ACQUISITION (MTA). This instruction provides the policy and procedures for using both rapid prototyping and rapid fielding MTAs in Section 804 of Public Law 114-92 (Department of Defense, 2019).

Middle Tier Acquisition provides two different pathways, the rapid prototyping path and the rapid fielding path. These two pathways can work together where the MTA can be used to accelerate capability maturation before transitioning to another acquisition pathway or to develop a capability before fielding (Middle Tier of Acquisitions, 2024).

Rapid Prototyping Middle Tier Acquisition

The rapid prototyping path provides an opportunity to rapidly develop and field prototypes that can meet emerging Navy needs. This pathway provides the ability to field a prototype to meet defined requirements that can be demonstrated in an operational environment. Often these prototypes provide instant residual operational capability 2 to 5 years from the start date. MTA programs may not be planned to exceed 5 years to completion and, in execution, will not exceed 5 years after MTA program start without Defense Acquisition Executive (DAE) waiver (Adaptive Acquisition Framework, 2024).

There are numerous benefits to prototyping including rapid learning, accelerated demonstration, rapid fielding of capability, and informing decisions rapidly to save money. Prototyping should follow a test-analyze-fix-test again approach to capability development that helps to achieve continuous learning. Prototyping also assists in accelerated demonstrations. The value of military demonstration is often in the demonstration of new concepts that can inform both the technological development and the warfighting concepts. Prototyping also has the potential to rapidly field capability to the Fleet. While these are not typically scaled solutions and is not usually the primary goal to prototyping rapid prototyping can result in the ultimate award of meeting a Fleet need much earlier than expected. When these prototypes are deemed viable solutions, they are often left in the field to be used by operators as solutions to their pressing needs. Prototyping can also help inform decisions early through success and failure to ultimately save the DOD money (DOD Rapid Prototyping Guidebook, October 2022).

The Rapid Prototyping process is outlined in Figure 9 below. Of note, while it's a more rapid process of continuous development and multiple tests over the course of 2 to 5 years it still aims to deliver a capability 2 to 5 years from time of the acquisition start. Keep in mind this is after the first eleven steps in Figure 1 have been completed. This means that it can still take several years just to get to this stage, and the output is typically prototypes not a full operational capability, which may have to rely on another acquisition path.

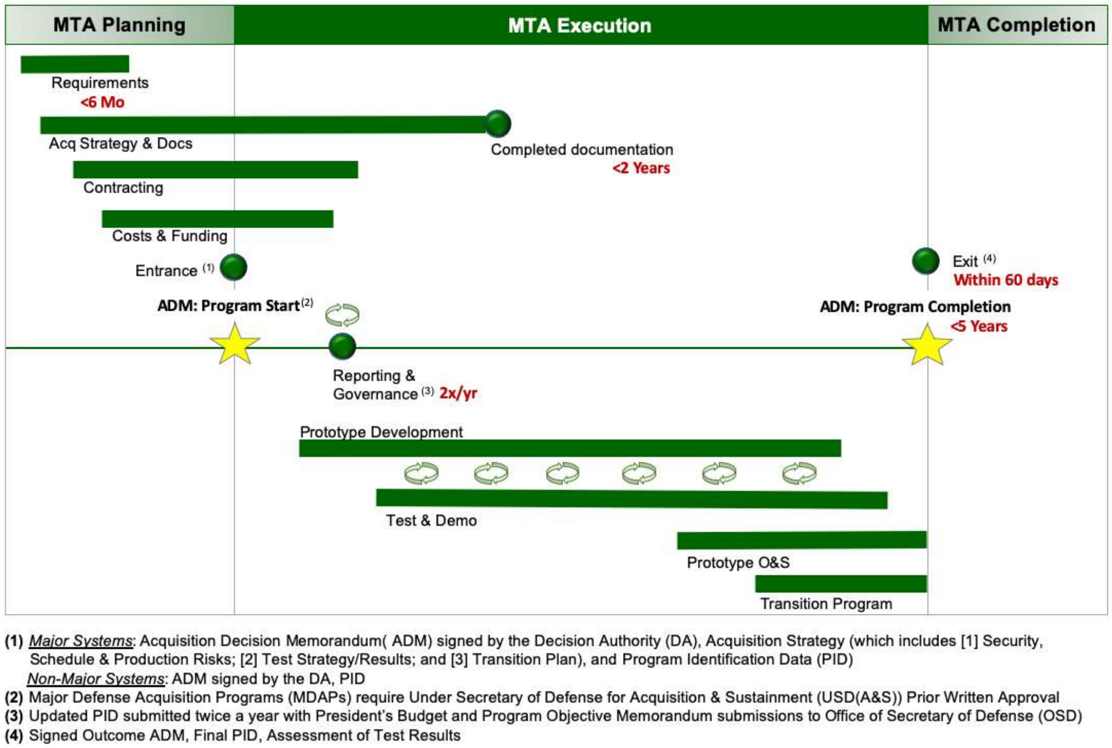
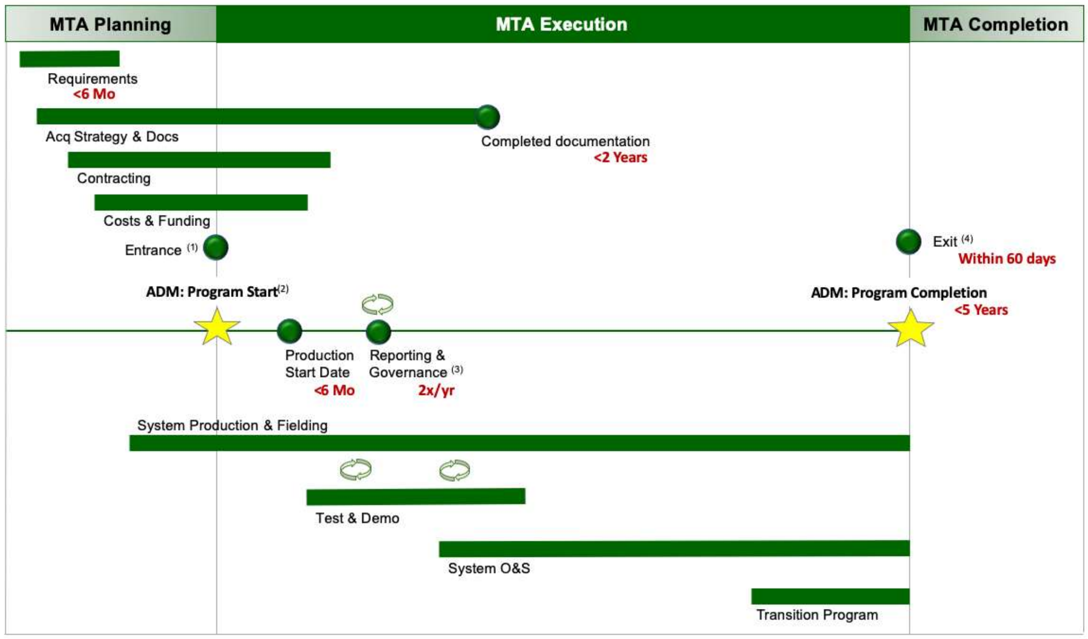


Figure 9: MTA Rapid Prototyping Path (Middle Tier of Acquisition, 2024)

Rapid Fielding Middle Tier Acquisition

The rapid fielding path (MTA) provides for the use of proven technologies to field production quantities of new or upgraded systems with minimal development required. The objective is to begin production within 6 months and complete fielding within 5 years of the MTA program start date. MTA program production start date will not exceed 6 months after MTA program start date without DAE waiver. MTA programs may not be planned to exceed 5 years to completion and, in execution, will not exceed 5 years after MTA program start without DAE waiver (Middle Tier of Acquisition, 2024).

This rapid fielding path for MTAs provides an opportunity to quickly acquire and filed proven technologies to scale systems with minimal development. This pathway is most useful for industry solutions to Navy problems. If in the case of sUSVs there was a vendor that was selling a commercial off-the-shelf solution that would meet the need this would be the perfect acquisition path.



(1) Major Systems: Acquisition Decision Memorandum(ADM) signed by the Decision Authority (DA), Acquisition Strategy (which includes [1] Security, Schedule & Production Risks; [2] Test Strategy/Results; and [3] Transition Plan), and Program Identification Data (PID)
Non-Major Systems: ADM signed by the DA, PID
(2) Major Defense Acquisition Programs (MDAPs) require Under Secretary of Defense for Acquisition & Sustainment (USD(A&S)) Prior Written Approval
(3) Updated PID submitted twice a year with President's Budget and Program Objective Memorandum submissions to Office of Secretary of Defense (OSD)
(4) Signed Outcome ADM, Final PID, Assessment of Test Results

Figure 10: MTA Rapid Fielding Path (Middle Tier of Acquisition, 2024)

The MTA policy was the first approved of the adaptive acquisition framework pathway policy and was the most sweeping change to acquisition in decades (Middle Tier of Acquisition, 2024). One of the largest benefits of the MTA policy is that it delegates authority down to much lower levels that promotes rapid decisions. Only programs exceeding the Major Defense Acquisition Program (MDAP) dollar thresholds require written approval from the USD(A&S) prior to using the MTA pathway. All other management, document approval, and decision-making is conducted by the Services or Agencies executing the programs. It is important to note that the similar rigor to the milestones and phases required of the traditional major capability acquisition process is also exercised under middle tier acquisition to reduce risk, but that in this condensed process it's more of good practice than a requirement with senior leader oversight.

2.5.3 Urgent Capability Acquisition

The most suitable formalized path for rapid acquisition is the Urgent Capability Acquisition path as seen in Figure 11.

Figure 11:Urgent Capability Acquisition (Adaptive Acquisition Framework, 2024)

DOD INSTRUCTION 5000.81 URGENT CAPABILITY ACQUISITION established the Urgent Capability Acquisition path on 31 December 2019 (one day after MTA). This provides a path to fulfill urgent operational needs and other quick reaction capabilities that can be fielded in less than 2 years (Department of Defense, 2019). It is important to note that this path is aligned to urgent operational needs, so the first step is to have an urgent operational needs requirement.

A key excerpt from DOD 5000.81 that provides permissions that are rarely see enacted but critical to this dissertation and the ensuing effort to rapidly field sUSVs, "f. Employ, to the extent possible, parallel rather than sequential processes to identify and refine capability requirements, identify resources, and execute acquisitions to expedite delivery of solutions (Department of Defense, 2019)."

There are several rules to prevent abuse of the urgent capability acquisition process. The first is that you must have an approved urgent needs statement. Urgent needs statements need senior level approval at the highest levels and can be difficult to staff unless clearly the need exists as outlined in Figure 3 under the requirements section of this chapter. The needs are critically important as it is DoD's highest priority to provide warfighters involved in conflict or preparing for imminent contingency operations with the capabilities needed as described in DoDD 5000.71 (Urgent Capability Acquisition, 2024). Another rule to stress is that the estimated cost for acquisition programs that provide capabilities to fulfill urgent operational needs and other quick reaction capabilities that can be fielded in less than 2 years must not exceed $525 million in research, development, and test and evaluation, or $3.065 billion for procurements in Fiscal Year 2020 constant dollars (Urgent Capability Acquisition, 2024). Because of the importance of these urgent needs the normal acquisition processes are aggressively streamlined. The goal is to plan for the capability in a few weeks with development and production measured in months. The imperative is to quickly deliver useful capability to the warfighter in a timely manner. Typically, these are solutions that can be purchased and fielded without any development or with very minimal development.

As outlined in Figure 12 the urgent capability acquisition process can be broken into four primary steps:

1. Pre-Development – assess and develop acquisition and fielding plan to deliver a quick capability (Urgent Capability Acquisition, 2024).
2. Development - Assess the performance, suitability, safety, survivability, supportability, and lethality of the intended solution. Work closely between the provider of the

capability and the warfighting to determine the solution meets the need (Urgent Capability Acquisition, 2024).

3. Production and Deployment – It is interesting that these are combined as one item because the need is so urgent that production immediately leads to deployment. The acquiring organization immediately provides the warfighter with the desired capability, including training, spares, technical data etc. (Urgent Capability Acquisition, 2024).
4. Operations and support – These capabilities are designed to be immediately fielded, but the program manager has to continue to support post fielding. The program manager will provide a supportability strategy that meets both the material needs but ensures the solution continues to meet the needs/requirements. Planning for Operations and Support, beings during pre-development and will be documented in the acquisition strategy (Urgent Capability Acquisition, 2024).

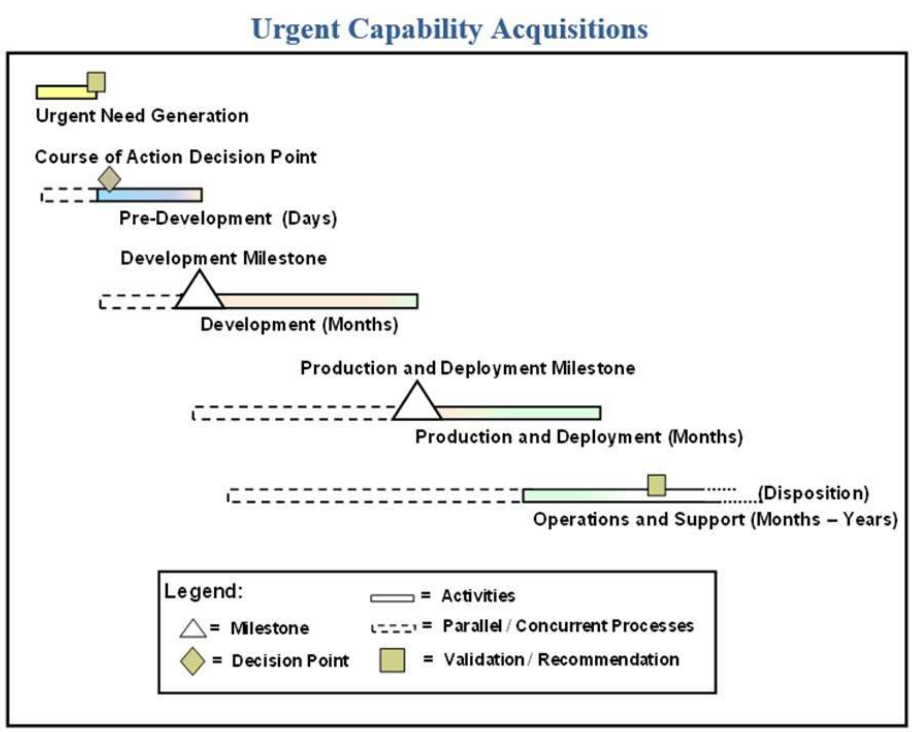


Figure 12: Urgent Capability Acquisition Process (Urgent Capability Acquisition, 2024)

Urgent capability acquisitions are typically used to meet warfighting needs for existing conflicts, due to the requirement to have an urgent needs statement to support this urgent capability acquisition, however there are urgent needs that do not need an ongoing conflict such as the Joint Emergent Operational Needs Statement outlined in figure 3. In an ideal world the sUSV use case covered in this dissertation would be acquired under and urgent capability acquisition, but there was not an urgent needs statement provided for that use case. Figure 13 provides a summary of the three options outlined here of major capability acquisition (longest), Middle Tier Acquisition (faster), and urgent capability acquisition (fastest) along with three other options of software, business systems, and contracted services that are not the focus of the acquisition options for consideration in this dissertation.

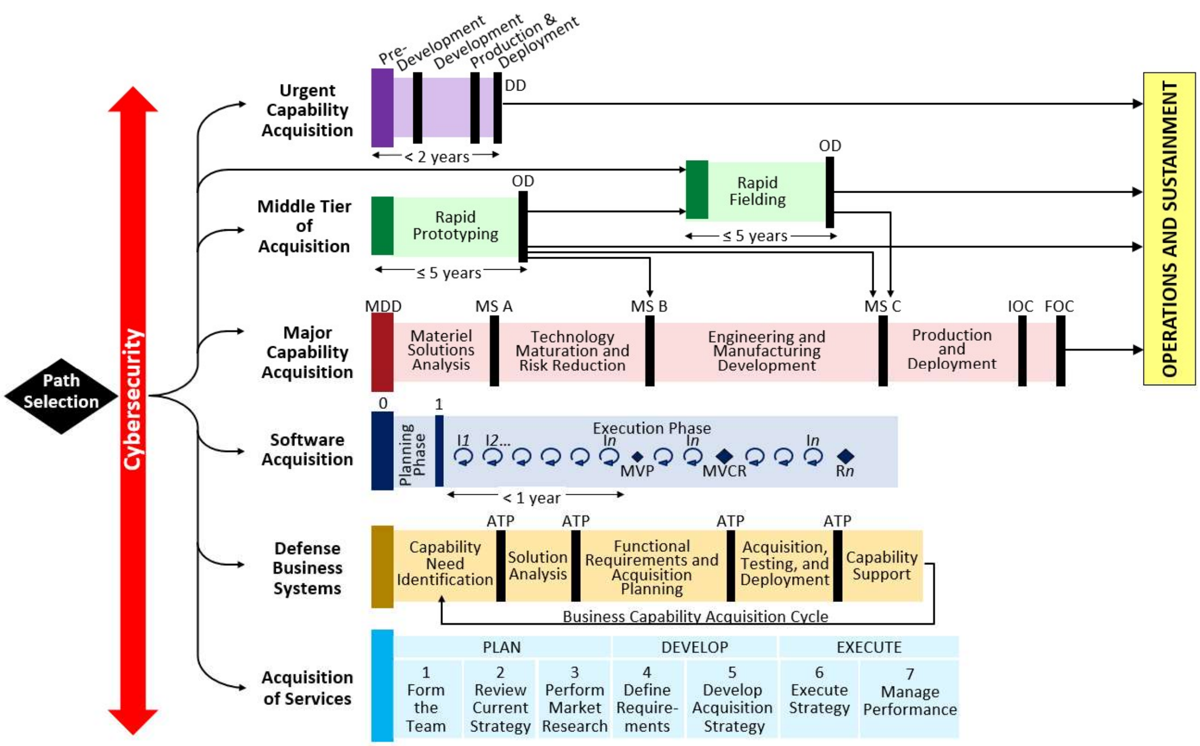


Figure 13: Adaptive Acquisition Framework (Adaptive Acquisition Framework, 2024)

2.5.4 R&D 4001

R&D 4001 is not a well understood or commonly used acquisition path. Under 10 USC 4001, the Secretary of Defense or the Secretary of a military department has the authority to engage in various research and development (R&D) activities, including basic, applied, and advanced research, as long as these activities are necessary for their department's responsibilities (US House of Representatives, 2024). These projects must either be related to military needs, such as weapon systems, or be of potential interest to the Department of Defense.

Additionally, the Secretary has several authorized means to perform these projects. They can do so through military departments, using Defense Department employees and consultants, through agreements with other government departments or agencies, or through transactions other than contracts, cooperative agreements, and grants, as outlined in sections 4021 or 4022 (US House of Representatives, 2024). The Secretary may also use procurement for experimental purposes as specified in section 4023 (US House of Representatives, 2024).

In the case of sUSVs, a significant amount of R&D was still needed, and there was clear interest from both the Office of the Secretary of Defense and the Secretary of the Navy to move forward with this development. Therefore, R&D 4001 became a relevant and applicable path. While using R&D 4001 for procuring sUSVs might seem unconventional, it aligns with the guidelines found in FMR 2.13.3.5.4, which allows procurement funding for items that support approved R&D programs and are not consumed during testing (US House of Representatives, 2024). Additionally, the financing for R&D test and evaluation can come from RDT&E funding.

Section 10 USC 4001, item 5, authorizes transactions for prototype projects that are not in the form of contracts, cooperative agreements, or grants, as long as they comply with the provisions of section 4021 or 4022 (US House of Representatives, 2024). Under Section §4022, the Secretary of a military department has the authority to carry out prototype projects that enhance the mission effectiveness of military personnel and are relevant to the Department of Defense's acquisition or development efforts (US House of Representatives, 2024). This section includes provisions for prototype projects costing between $100 million and $500 million, with the approval of the senior procurement executive (US House of Representatives, 2024).

Given that Section §4022 allows competitive prototyping and follow-on procurement, and that it falls under the broader framework of Section §4001, R&D 4001 provides a valid acquisition path and leave behind capability sUSVs under contracts valued between $100 million and $500 million. R&D 4001 can be risky, as it was designed for research and development to demonstrate capability. However, this pathway provides the ability to test new technologies and provide leave behind capability with a substantial funding limit. As technology continues to develop, and the DOD is challenged to move faster to field new systems R&D 4001 may be used more frequently.

2.6 Recently Released Guidance to the Department of Defense

The Federal Government is heavily affected by administration changes and with a Presidential election occurring in 2024 and a President Trump taking office in 2025 the final stages of this dissertation occurred over a time of substantial change. In late 2024 and early 2025 prior to inauguration many organizations were attempting to provide guidance prior to the change in administration. After the inauguration even more substantial guidance came from the new administration that have the potential to have a meaningful effect on efforts to more rapidly field capability to the warfighter.

2.6.1 GAO study: DOD ACQUISTION REFORM Military Departments Should Take Steps to Facilitate Speed and Innovation

On December 12, 2024, the Government Accountability Office released a study that was directly in line with this dissertation. According to the study, the DOD revamped its acquisition policies in 2020, with the intent to deliver innovative technologies to the user more quickly. These reforms, known collectively as the adaptive acquisition framework, established four pathways: urgent capability, middle tier, major capability, and software (Oakley, 2024). Each military department issued policies in alignment with DOD's goals and framework, but these policies do not consistently reflect leading practices (Oakley, 2024). GAO found that leading companies use an iterative development structure that includes continuous cycles of design modeling, validation, and production. These iterative processes enable the companies to get products that combine hardware and software—known as cyber-physical products—to market quickly (Oakley, 2024). The continuous cycles allow the companies to gain specific knowledge, such as assurance that the design meets the most essential user needs (Oakley, 2024). The study uses the following diagram in Figure 14 to illustrate this recommended approach.

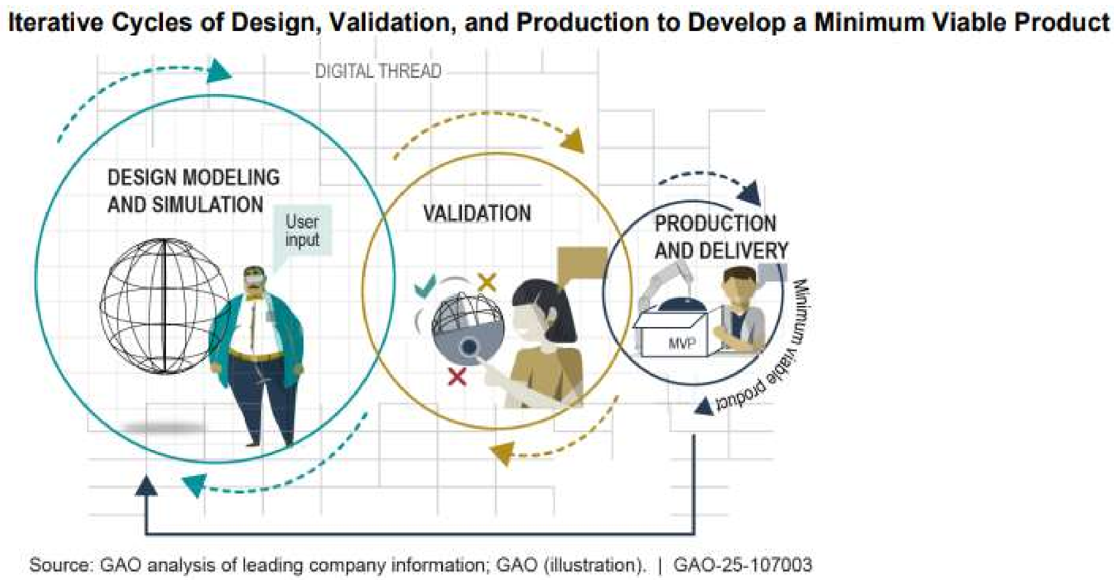


Figure 14: Iterative Cycles of Design, Validation, and Production to Develop a Minimum Viable Product (Oakley, 2024)

The two primary recommendations to the Navy in the report were:

1. Revise Navy acquisition policies and guidance to more mirror effective commercial industry practices. These practices should facilitate speed and innovation, using what could be described as a DEVOPs model of continuous iterative cycles that ensure the design meets the operational need, leads to the development of a minimum viable product, and the is the process is optimized to produce continue to refine the product to more effectively meet the operational need (Oakley).
2. Designate one or more pilot programs using “cyberphysical” capabilities that can be used to provide lessons learned on using leading practices to facilitate speed and innovation for programs on each acquisition pathway aligned to the adaptive acquisition framework (Oakley 2024).

It is critical to highlight the example used in this case study follows a similar model to that which GAO recommends and was in execution well ahead of the GAO report. It may be valuable to share this dissertation with the GAO team to attempt to address their concerns, as well as provide a model for future use.

2.6.2 2025 Presidential Executive Orders

On April 9, 2025, an executive order was signed by President Trump titled, Modernizing Defense Acquisition and Spurring Innovation in the Defense Industrial Base. This executive order emphasized the need to utilize other transaction authorities (OTAs), apply rapid capabilities office policies, and to promote streamlined acquisitions under the adaptive acquisition framework (Trump, 2025). It also called for a review of JCIDS within 180 days of the order with the goal of streamlining and accelerating acquisition (Trump, 2025).

On April 15th, 2025, an executive order was signed by President Trump titled, Restoring Common Sense to Federal Procurement. This executive order emphasized the need to revise the Federal Acquisition Regulation (FAR) within 180 days, pointing out the harmful effects to rapid procurement of needed systems (Trump, 2025).

These two executive orders emphasized acquiring commercial solutions to rapidly meet warfighting needs, and these mandates may have an effect on utilization of the methods described in this dissertation. However, this dissertation provides a more tactical example of a use case that combines industry solutions with government expertise to rapidly deliver a capability, and in many ways was ahead of the mandates and recommendations coming out to streamline approaches to acquisition.

2.6.3 Secretary of Defense Guidance

On 6 March 2025, Secretary of Defense Pete Hegseth released a memo titled *Directing Modern Software Acquisition to Maximize Lethality.* In that memo the Secretary of Defense clearly directs the DOD to utilize commercial solutions openings and other transaction agreements to acquire commercially software solutions whenever it is considered a reasonable pathway to reaching a desired end state (Hegseth, 2025). This directive immediately had impacts on the future of small USV software and will likely impact the future of the small USV outlined in this dissertation.

2.7 Literature Review of Acquisition Options Summary

Now that we have explored Major Capability Acquisitions, Middle Tier Acquisitions, Urgent Capability Acquisitions, and R&D 4001 paths, a summary is provided of key decision factors in which is the best acquisition path for given conditions. In the case of sUSV, MCA is too long of a process, and there was not an urgent needs statement which leaves only Middle Tier Acquisition or R&D 4001 as viable paths to consider in the methodology and results sections to follow. Table 1 provides an overview of the different acquisition approaches that can be implemented when fielding capability, summarized from relevant documentation (Major Capability Acquisition, 2024; Adaptive Acquisition Pathway, 2024; US House of Representatives, 2024). In recent years, there has been a push to adaptive innovative approaches through the adaptive acquisition framework (Adaptive Acquisition Framework, 2024). There are numerous publications touting the benefits to utilizing Middle Tier Acquisition or Urgent Capability Acquisition, but this dissertation aims to also provide insight into the R&D 4001 that was used to rapidly acquire the sUSVs that are the focus of this dissertation. It is important to note that R&D 4001is not a traditional acquisition pathway. It is being used to procure demonstration assets that at a high degree of risk tolerance can be transitioned into operational assets. This effectively supplements traditional acquisition pathway.

Table 1: Summary of Acquisition Options

Acquisition Category	**Barriers *(Given Compressed Timeline to Deliver)***	**Speed *(Time to Initiate)***	**Advantages**	**Documents to Initiate *(Slows Process)***
Major Capability Acquisition	Timeline to develop performance requirements. Extensive list of documentation requirements	~3-5 years for requirements development	DoDI 5000.02 pathway, very deliberate and understood process that limits spending risk, but at the cost to schedule	ICD, AoA, CDD, ADM, Acq Strategy, Cost Estimate, etc.
Middle Tier Acquisition	Timeline to codify performance requirements. Several artifacts required to initiate the pathway (e.g., cost estimate, acquisition strategy, DCNO approved Top Level Requirements)	~1 year for sponsor to approve performance requirements	DoDI 5000.02 pathway, it's fast compared to MCA	ADM, Approved Requirement (TLR), Acq Strategy, Cost Estimate, Life-Cycle Sustainment Plan
Urgent Capability Acquisition	Requires approved JUON or JEON or UON to initiate	~ 1 year to formalize urgent need and material solution Course(s) of Action	Fastest DoDI 5000.02 pathway	JUON or JEON or UON; Course of Action (COA)
R&D 4001	Stakeholder approval of R&D approach given 10 U.S.C. and ASN(RD&A) memo Alignment of Appropriations to project plan	Minimal – Program Executive Office can approve the approach at the SES/Flag Officer Level	Flexible, much easier, approval down to the Program Executive Office to initiate	Acquisition Decision Memorandum, but needs Senior Executive Level Approval (SES/Flag Officer)

2.8 Literature Review Conclusion

Now that we have considered the traditional processes for Requirements, Resourcing, and Acquisition, this dissertation will focus on how to leverage the most expedient options for each of these paths.

Table 2: Timeline to Fielding Capabilities for sUSV within Adaptive Acquisition Framework Categories

Acquisition Category	Fleet Need/ Pre-Requirement	Requirement Development	Resourcing	Acquisition	Total Timeline
Major Capability Acquisition	1-2 years	2-3 years	1-2 years +2 year delay = 3-4 years	7-12 years	13-18 years
Middle Tier Acquisition	Immediate to 2 years	6 months to 2 years	Immediate to 2 year delay	2-5 years	3-11 years
Urgent Capability Acquisition	Immediate (weeks/months)	1 year (urgent need)	Immediate	Immediate to 1 year	1-2 years
R&D 4001	Not needed	Not needed	Can be Immediate	Immediate to 5 years	1-5 years

In recent years the Department of Defense has taken significant steps to provide options along every step of the process to more rapidly field capability. As indicated in this Literature Review, there are several options to assist in expediting the process, however these options are still risk adverse and typically rely on an in-series path of a series of questions and gates that slow down the process.

According to the Vice Chairman of the Joint Chiefs of Staff, Admiral Grady, in an article from April 2023,

> "A lot of things that we have done in the past has been in-serial," he said. "We do this, then we do this, and then we come to the end — we have achieved the end state that we're shooting for…(an example would be) We can do and embed the testing apparatus in the acquisition process as we work our way along, such that when we're

> ready at the very end, all we have to do is that final test, as opposed to then starting the whole testing process (Lopez, 2024)."

I have personally witnessed the DOD not effectively work processes in parallel. The DOD needs to approach the acquisition process with this mentality and in the use case of small USV's this dissertation will provide an example of how the Navy can leverage the Naval Research and Development Establishment to execute the parallel paths while relying on industry for a major portion of the overall acquisition and enablers effort. This dissertation will heavily leverage the approach of the Navy's Unmanned Task Force and Navy's Disruptive Capabilities Office through my role in support of those two organizations.

Additionally, this dissertation will heavily leverage the investment of a purposely undisclosed OSD program as an alternative resourcing option. This funding answers the resourcing question by outside of the typical PPBE to POM process.

This dissertation will provide an actual ongoing use case of the rapid fielding of sUSVs in support of PACFLT to demonstrate a more streamlined process as demonstrated through the Navy's Unmanned Task Force and Navy Disruptive Capabilities office that will follow a similar process, but with a much more rapid sprint analysis approach. From a systems engineering standpoint this dissertation will focus on gaps in the traditional process that may not be accounted for how to leverage the Naval Research and Development Establishment to buy down those risks through three parallel paths of Acquisition, Systems Engineering of enabling capability, while the Fleet builds their detailed plan for use of the capability.

The processes described in this background chapter work well when we have a combination of ample time, clearly defined requirements/use cases, a technical solution, and a clear path to scaling that technical solution. This dissertation will attempt to provide an alternative to what the process could be if challenged to more rapidly field capability by implementing three parallel yet intertwined paths of acquisition, systems engineering, and Fleet adoption.

2.9 Gaps in Literature

There are numerous opinion based articles on how the DOD should more rapidly field capability to the warfighter. Most of which are very industry focused with solutions being offered on how to more quickly contract and buy capabilities. There are also several articles on the Navy's Unmanned Task Force and the Navy's Disruptive Capabilities Office, and all of these initiatives will be leveraged throughout the methodology and results section of this dissertation. There are, however, gaps in literature that make this research particularly novel.

First there is very little literature on the role the Naval Research and Development Establishment can serve with respect to rapidly fielding capability. The Naval Research and Development Establishment falls under the Assistant Secretary of the Navy for Research Development and Acquisition (ASN RDA), and is comprised of 50,000+ government scientists and engineers across the Office of Naval Research, the Naval Research Laboratory, the Naval Surface Warfare Centers, the Naval Undersea Warfare Centers, the Naval Information Warfare Centers, the Naval Air Warfare Centers, and the University Applied Research Centers. As a NSWC Carderock employee supporting the Navy's Disruptive Capabilities Office and PMS-XXX, I am a member of the NR&DE and have the critical role the NR&DE can serve to with respect to rapidly fielding capability. Most notably this systems engineering effort includes development, integration, and testing to ensure the fielded capability meets the Fleet need. I attribute this gap in literature to the NR&DE is not a for profit company, they are not in the business of selling the government because they are the government. Many of the articles I mentioned are ultimately geared towards generating a shift to purchasing industry capabilities, so business development teams are incentivized to emphasize the importance of a change in the DOD acquisition process. The NR&DE does not need to do this, so there are seldom articles posted on the role of the NR&DE.

The second gap in literature is the use of parallel path lines of effort approach of: Acquisition of platforms, Systems Engineering to support critical enablers, and Fleet planning and adoption. This is largely a gap in literature because to my knowledge it has not been done in the way we are doing it to rapidly field sUSVs with any other capability fielding in the past. The majority of articles on more rapidly fielding capability are focused on the role of the Acquisition community, but very little are focused on the other two paths. There are articles that allude to DOD needing to take more of a parallel path approach, but they are typically generic statements with little value.

The third gap in literature is the Fleet's role in planning and adopting the sUSV capability. This is new, the US Navy just stood up their first sUSV detachment in USV Squadron 3 in San Diego. This dissertation centers on the fielding of that capability. The Fleet has a critical role to play as they are the ones who are developing the detailed concepts of operation, tactics techniques and procedures, and DOTMLPF-P plans that will ultimately make the use of the capability feasible. These gaps are what I will focus on throughout this dissertation, as the gaps I am attempting to address to rapidly field sUSV capability are what makes this approach particularly novel.

CHAPTER 3: METHODS

In order to properly convey the methodology that will be used in this research I will begin by revisiting the research aims from the introduction:

- *Research Aim 1:* Adapt the Innovation Pipeline approach to problem solving of Problem Sourcing, Curation, Discovery, Incubation, and Transition to applied to sUSVs to determine that has the capability has warfighting utility, is technically feasible, and has a path to scale.
- *Research Aim 2:* Utilize the sUSV prototype(s) to develop a campaign of learning through Fleet experimentation with a DEVOPs approach.
- *Research Aim 3:* Identify, explore, and implement a new process to adapt the traditional in-series process to deliver capability to the Fleet into a new parallel line of effort approach.

3.1 Research Aim 1: UTF/DCO Sprint Process Utilizing the Innovation Pipeline

The 2018 National Defense Strategy by Former Secretary of Defense Mattis was a strategic shift in the way the DOD was instructed to conduct business, providing what appeared to be at the time senior leader guidance to take risks, make some mistakes, but with a focus on more rapidly fielding capability (Mattis, 2018). In an article from War on the Rocks in February of 2018, Steve Blank, makes the case that innovation in the DOD was typically only accomplished by small groups through heroic efforts because culture change was in large organizations (Blank, 2018). Fast Forward to 2021, and it was time to create another small team to perform heroics within the DOD in the Unmanned Task Force. The DOD still had not created the culture of innovation envisioned in the 2018 National Defense Strategy, but the Unmanned Task Force was a step in the right direction.

The Navy Unmanned Task Force (UTF) stood up in August of 2021 as a Chief of Naval Operations pilot program to demonstrate the rapid fielding of capability to the Fleet with a focus on unmanned systems. The UTF approach was to conduct a deep dive into specific Fleet problems. In the early stages of the Unmanned Task Force, the team attended a course in Palo Alto taught by BMNT titled the Innovation Navigators Course. According to the Creating Innovation Navigators publication that accompanied the course, in order to innovate you must think differently to deliver different outcomes with an emphasis placed on culture, mindsets, processes and policies, obstacles, and opportunities (Horne, 2022). The course was primarily informed by the teachings of Steve Blank, a famous entrepreneur turned educator, credited with starting the lean startup movement and the innovation pipeline.

The innovation pipeline is a repeatable and scalable process to introduce and manage innovation that develops validated solutions to difficult problems to deliver results to meet mission needs (Horne, 2022). This process consists of the following steps: problem sourcing, curation, discovery, incubation, and transition (Horne, 2022).

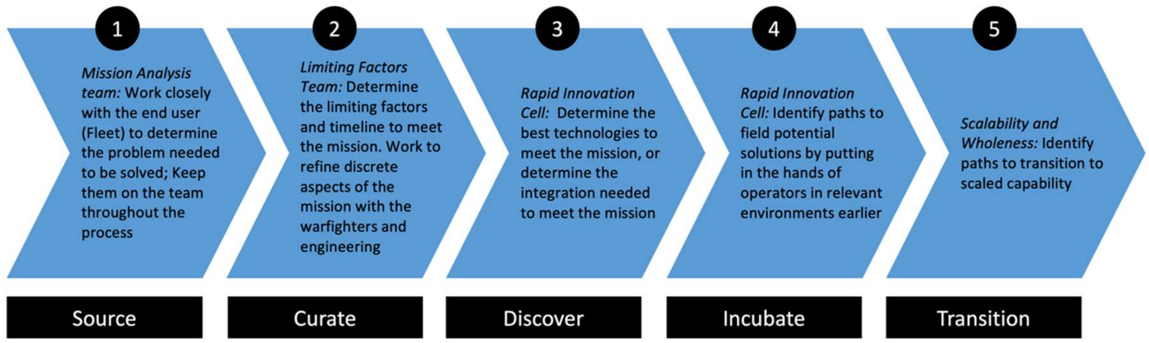


Figure 15: Innovation Pipeline Aligned to UTF Teams

This innovation pipeline approach was adopted by UTF leading to the development of the UTF sprint process supported by distinct teams, as shown in Figure 15. In this figure, the UTF sprint phases and the teams supporting those phases are described in blue, which align to the innovation pipeline steps in the black rectangles below each spring phase. The UTF sprint process has been described publicly as a venture capital model by identifying a limited number of small investments that have the potential to provide the greatest impact to the US Navy. Throughout this five-step innovation pipeline process, the UTF focuses on answering the following three questions:

1. Is there **warfighting utility**, meaning will solving a given problem with a given solution provide a measurable improvement to how the Navy would operate if required to today?
2. Is a solution **technically feasible**, meaning can a technical solution actually achieve the intended mission?
3. Is there a **path to scale**, meaning is there a solution that can meet the need within the timeframe, typically by 2027 as called out in the CNO NAVPLAN, and can that solution be provided at the scale needed to have a desired mission effect? In order to move rapidly to

scaling it is also important during the sprint phase to identify the acquisition contract options such as leveraging a SBIR phase III or a Commercial Solutions Opening enabling an Other Transaction Authority contract.

If the UTF sprint indicates that there is warfighting utility, the solution is technically feasible, and there is a path to scale, then it is recommended to senior naval leadership to proceed into the UTF project phase. This is critical as you need a champion at senior Navy levels that has the ability to direct money to be moved within the execution year.

3.2 Research Aim 2: Utilize the sUSV prototype(s) to develop a campaign of learning through Fleet experimentation with a DEVOPs approach.

Once a UTF sprint is transitioned to a project it is envisioned that in order to build the case to make a proper recommendation it is advised that the sprint includes at a minimum three items: a documented operational needs statement from the problem owner, an analysis that provides confidence that the solution potentially can meet the need, and the plan of action and milestones along with cost estimate to execute the solution will field a capability in within 1-3 years. Not every UTF or DCO project are created equal. Some are looking at how to buy something and field it immediately, others are looking at ways to move a capability from one Fleet command's theater (area of responsibility) to another, in the case of sUSVs it was a bit more complicated as we were exploring how to build a prototype, experiment, and learn from the capability to inform a future fielding decision. All of this was in an effort to verify and validate the three focus areas of warfighting utility, technical feasibility, and path to scale.

In the case of the sUSVs the UTF project phase focused on three major items:

Warfighting Utility: Partner with Fleet Commands of PACFLT, USFFC, and Fourth Fleet to conduct a campaign of learning aligned to multiple Fleet Experiments to validate the capability can be used for its intended purpose and has warfighting utility. Use this knowledge to build formal concepts of operations (CONOPs), Tactics, Techniques, and Procedures (TTPs), and a Doctrine, Organization, Training, Material, Logistics, Personnel, Facilities, and Policy Plan to support future fielding and operations at scale.

Technical Feasibility: Partner with PMS-YYY and Naval Research and Development Establishment of Warfare Centers and University Applied Research Centers (UARCs) to build upon the platform to provide autonomy with a supporting sensor package, better communication capability, and an integrated Command and Control Software. Conduct a campaign of learning building on each event to test the capability to verify that the system is progressing towards meeting the need.

Path to Scale: Partner with PMS-XXX to buy initial prototypes, but work with PMS-XXX to investigate alternative means to verify and validate that the manufacturer and the developers can scale the capability if determined it would be a valuable capability.

The original intent was to build a DEVOPs model where we would provide four of the initial prototypes to US Pacific Fleet to be fielded to one of their subordinate commands, while keeping a fifth platform with the developers to continue to iterate on the design. This system would create an operator to developer feedback loop for continual improvement followed by validation and verification to progress the capability. This approach is well aligned to the systems engineering V with an emphasis on building and maintaining feedback loops from the operators to the developers feedback loops.

Related to the Systems Engineering V-model, the UTF Sprint and Project phases work on each of these steps, but not to the level of rigor required by standard Navy programs. This resulted in many lessons learned that will be discussed later in the results section of the dissertation. Although the original intent was to first learn from the prototypes and the envisioned DEVOPs model, that was original plan was not able to be fully executed as envisioned due to the decision to pursue scaling prior to the completion of the original UTF project plan.

3.3 Research Aim 3: Identify, explore, and implement a new process to adapt the traditionally in-series process to deliver capability to the Fleet into a new parallel line of effort approach.

Although not a part of the original plan, due to external influences we were challenged to shift to delivering at scale in early 2024. This shift required us to move faster than anticipated before our full scope of learning and understanding were achieved from the UTF project and will be described more in depth in the results section of this dissertation.

This new challenge has forced the acquisition community, the Naval Research and Development Establishment, and the Fleet out of their comfort zone, as we have taken what was traditionally an in-series model of delivering capability and shifted to a continually informed, three lines of effort, parallel approach to fielding and implementing capability.

As discussed in the background section of the dissertation, the traditional process of going from Fleet need to fielded capability can take 10+ years and we are attempting to cut that to ~2 years. In order to do this, we have what I would describe as three parallel yet intertwined lines of effort, that are also closely aligned to the three paths outlined in the prototype phase. These three parallel lines of effort are:

1. The Acquisition Line of Effort: Buy platforms from a vendor. Assist in producing top-level requirements. Questions to be answered regarding the acquisition path:
   - What acquisition pathway do we use, Major Capability Acquisition, Middle Tier Acquisition, Urgent Capability Acquisition, or R&D 4001, and why?
   - Can we verify chosen acquisition path by getting through buying platforms?
   - Can the vendor meet the requirements for quantities?
   - Can the quality of the platform maintain?
   - Can we develop defined Top-Level Requirements to test against in series while still purchasing platforms?
   - Can an Integrated Product Team (IPT) Structure that develops a plan of action and milestones be utilized to assist with rapidly meeting program goals and keeping control of the larger team through a team of teams?
   - Do we need modifications from the platforms acquired through the UTF project for production capability?
2. The Systems Engineering Line of Effort - Development, Integration, and Testing of enabling capability: Develop capability with the NR&DE, integrate capability, and test capability, to make the platform capable of doing the mission as intended. Questions to be answered:

- Who/What/When/Where/How will we use the NR&DE to develop or acquire the enabling capabilities of autonomy and perception, comms, C2, and payload needed to execute the mission?
- Who/What/When/Where/How will we use the NR&DE to integrate the enabling capabilities onto the platforms purchased from the vendor at scale?
- Who/What/When/Where/How can we do with the NR&DE to verify and validate through testing and analysis that the capability can meet the mission.
- Can an Integrated Product Team (IPT) structure that develops a plan of action and milestones approach be utilized to assist with rapidly meeting program goals and keeping control of the larger team of teams?

3. The Fleet Adoption Line of Effort: Develop concepts of operations, TTPs, DOTMLPF assessment, Experiment, refine plans and inform development community. Questions to be answered for the Fleet Path:
    - Who/What/When/Where/How will the Fleet develop CONOPs, TTPs, and DOTMLPF-P considerations for this capability while it is still being developed, and requirements are not clearly defined?

As you can see from comparing the UTF project methodology with the Larger Project methodology the UTF project gave the larger project a head start, and it could be argued it would not have been possible at the timelines requested without the initial UTF project. Had the UTF project had more time to be more formally completed the larger project would have had a much easier path to success, but the timeline would not allow for any further delay.

CHAPTER 4: AIM 1 RESULTS – APPLYING THE INNOVATION PIPELINE TO AN UTF SPRINT

This chapter outlines the results for research aim 1, which was to adapt the innovation pipeline approach for application to a UTF sprint. The success of research aim 1 allowed continuation into research aim 2. In May of 2022, the Unmanned Task Force led a sUSV focused sprint to determine the warfighting utility, technical feasibility, and path to scale for the use of small Unmanned Surface Vehicles for the US Navy. In order to rapidly execute the sprint process, assembling the team of teams is critical to developing the case. Each of these teams have sprint leaders that reach into their network to build the proper cross functional team that can make a clear and concise case to move forward into the project phase. The team is more critical than the process. The UTF was divided into a series of smaller teams, these teams and their respective roles were as follows:

4.1 Mission Analysis Team – Innovation Pipeline Problem Sourcing -> Curation.

Owns the Problem Sourcing portion of the innovation pipeline. Worked closely with the Fleet Command being supported to determine the problem. Aligned that problem to Department of Defense and Department of the Navy Priorities such as the National Defense Strategy, Defense Planning Guide, and the CNO's NAVPLAN Implementation Framework (NIF) objectives. For the case of sUSVs it was determined by the mission analysis team that the solution was well aligned to the problem the Fleet provided.

Desired end of sprint product: Clearly articulated operational need. It is recommended for future sprints that the need would be expressed in an actionable context with a Top-Level Requirement or Urgent Operational Needs Statement.

4.2 Limiting Factors Team – Innovation Pipeline Curation -> Discovery.

Owns the Problem Curation and overlaps with the Rapid Innovation Cell in the Problem Discovery Portion of the innovation pipeline. Provided an analysis indicating if a given capability meets mission needs, partially meets mission needs, does not meet mission needs, and if there is a likelihood that it will change in the future. These capabilities to investigate would initially be the current capability and later would be new capabilities provided by the Rapid Innovation Cell. An example of this analysis framework is seen in Figure 16. Under the actual sUSV sprint there were additional layers that took a more in depth look at each of the dots. In the case of the sUSVs the primary limiting factors were the autonomy, comms, and C2 software.

Desired end sprint product: Limiting factors analysis documenting current state of proposed capability with risk burn down plan worked in conjunction with the Rapid Innovation Cell to mature areas that do not meet mission needs.

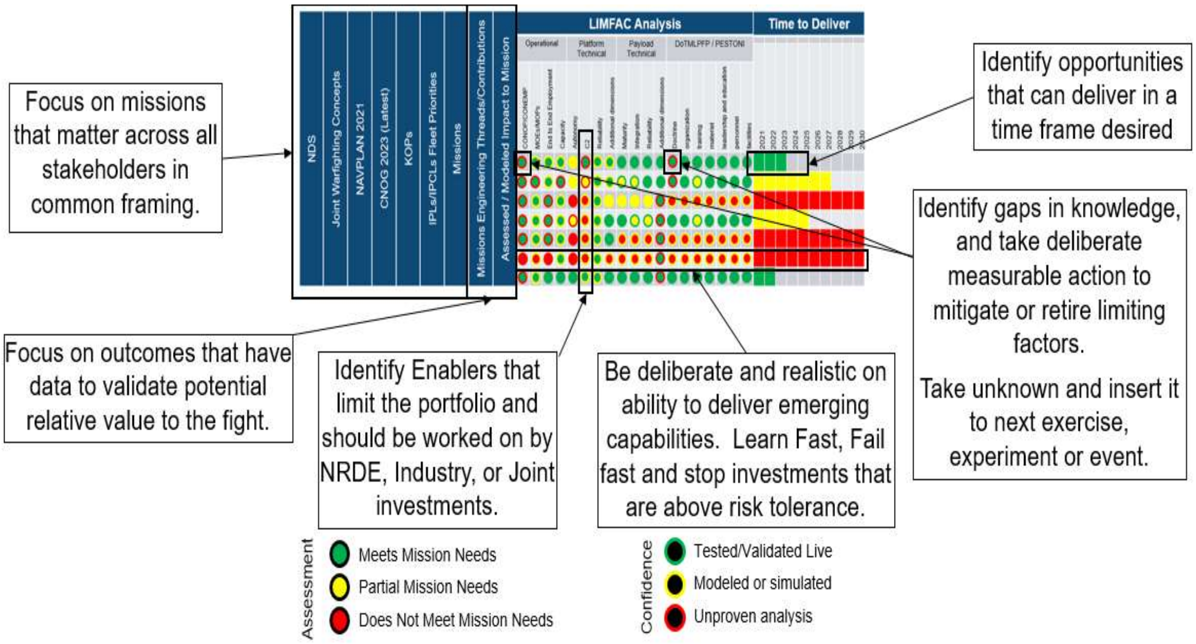


Figure 16: Example framework for Mission Analysis and Limiting Factors

4.3 Rapid Innovation Cell – Innovation Pipeline Discovery -> Incubation.

Overlaps with the Limiting Factors Team on the Problem Discovery portion of the innovation pipeline and owns the problem incubation portion of the innovation pipeline. The Rapid Innovation Cell was primarily engineers and scientists that would perform a tech scan of options to meet the need. In the case of the sUSV study at the time there was not a commercial off-the-shelf solution that could fully meet the need. What was proposed was a combination approach of a commercially available platform (specific vendor omitted to avoid combined classification), paired with government furnished autonomy, comms, C2, and payload(s) to accomplish the mission as outlined by the Mission Analysis team, and to reduce the risk areas identified by the Limiting Factors Team.

Desired end of sprint product(s): Recommended solution that is technically feasible to meet mission needs with a Plan of Action and Milestones (POAM) and a cost estimate to build and demonstrate the proof-of-concept prototype.

4.4 Scalability and Wholeness (SAW) – Innovation Pipeline Transition.

Owns the transition portion of the innovation pipeline. Investigates the path to scale to determine if it is feasible that a recommended capability can be scaled during the timeline required. This includes investigating the capabilities of each of the performers to build a capability, including the vendor and the government team within the Naval Research and Development Establishment that would assist in building the mission capable system. Additionally, the scalability and wholeness team would have to determine the contract vehicle to be used to rapidly acquire the capability. In the case of the sUSVs a Small Business Innovative Research (SBIR) Phase III contract that would provide the ability to rapidly purchase the platforms was identified.

Desired end of sprint product(s): POAM and cost estimate for fully scaled capability with an identified contract vehicle to execute plan.

Each of these teams need to work closely together, along with consulting experts from across Naval Enterprise to build the business case to senior naval leadership to proceed to the project phase. At the end of the sprint process the results were briefed to the Unmanned Task Force leadership and to leadership across the Navy. It was determined to proceed to the project phase of buying a limited quantity of five small USVs to field to the specific Navy customer. To do this, the Unmanned Task Force went to OPNAV N9, who went to the Office of Budget (FMB). FMB provided $2M of end of year underspent expiring funds often referred to as "sweep up funds" to get us started with the sUSV procurement from the vendor. The result of the sprint was a success, in that it led to an agreement that there was value to this plan, and more importantly the providing of funding to proceed with the plan identified.

Coming out of UTF sUSV sprint the team developed a plan of action and milestones to execute as the effort shifted from an on-paper sprint to an operational experimentation project. This plan, as seen in Figure 17, provided the framework for the execution team to buy the sUSVs, develop the enabling capabilities for the sUSVs, and leverage Fleet experimentation venues to verify and validate the warfighting utility and technical feasibility of the capability.

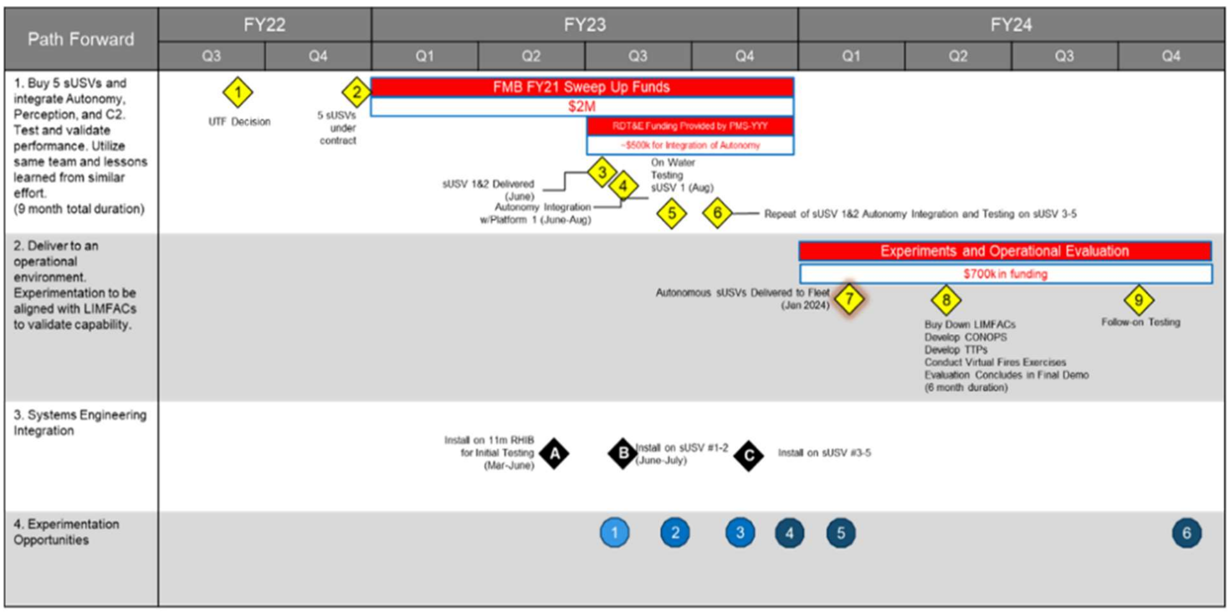


Figure 17: sUSV Plan of Action and Milestones FY22-24 Original Plan

This plan would be used to execute Aim 2: utilize prototypes to execute a campaign of learning.

4.4 Aim 1 Conclusions

At the end of the Sprint process the results were briefed to the Unmanned Task Force leadership and to leadership across the Navy. It was determined that we should proceed to the project phase of buying a limited quantity of five small USVs to field to the specific Navy customer. To do this the Unmanned Task Force went to OPNAV N9, who went to the Office of Budget (FMB). FMB provided $2M of end of year “sweep up funds” to get us started with the sUSV procurement from the vendor. The result of the sprint was a success in that it led to agreement that there was value to this plan, and more importantly the providing of funding to proceed with the plan being identified. Equally as important, we rapidly advanced this process from the typical timeline of 3+ years down to ~12 weeks. At the end of this 12-week sprint, the team and leadership successfully reached the decision to move forward to a project phase. This was determined with the justification of the sUSV’s ability to provide warfighting utility, that it was technically feasible, and that there would be a path to scale. This was a significant achievement, as this novel adaptation of the innovation pipeline reduced the process to just 3 months. This adapted process does not fall directly in line with traditional processes described in Table 2 but is estimated to have saved 3+ years by advancing the Fleet need/pre-requirements process with elements of the requirements generation and the beginning of identifying resources.

CHAPTER 5: AIM 2 RESULTS – UTILIZING PROTOTYPES THROUGH CAMPAIGN OF LEARNING

This chapter outlines the results for research aim 2, which was to utilize the sUSV prototype(s) to develop a campaign of learning through Fleet experimentation with a DEVOPs approach. The success of research aim 2 allowed continuation into research aim 3. Now that we had backing and $2m of funding to get started I then partnered with the acquisition program office of PMS-XXX and NAVSEA contracts to leverage the SBIR contract identified by the Scalability and Wholeness team to procure the five USV's. These sUSVs were put under contract in September of 2022, roughly 4 months from when the Sprint process began with an estimated delivery date of Fall of 2023. At this point we had already drastically decreased the timeline from understanding the operational need to contracting for prototypes.

As I transitioned from leading the team from the UTF sprint into the project of acquisition, development, integration, and fielding of the five prototypes I focused on developing the capability aligned to the focus areas of warfighting utility, technical feasibility, and path to scale.

While the sprint phase was an initial analysis within the Unmanned Task Force partnered with the specific Navy customer to determine if the capability could meet the mission, the project relied on partnerships to execute the intent. My vision leading this UTF project was to procure the initial platforms through a partnership with PMS-XXX and then partner with the Naval Research and Development Establishment to integrate the needed capability enablers onto those platforms to meet the customer's mission needs. I relied heavily on relationships I had built throughout my career to build coalitions of willing supporters to build this capability into executing the plan as developed through the UTF Sprint. Not every answer was yes, but thankfully I was able to stitch together enough of the community to build the capability. These platforms would then be provided to the Fleet customer to better assess capability, build concepts of operations (CONOPs), tactics, techniques, and procedures (TTPs), and DOTMLPF infrastructure, while simultaneously working with the developers to refine the capability. If after this plan was executed, it was determined to be a valuable capability we would then scale the capability beyond the five original prototypes as needed to meet mission needs informed by the experimentation of these prototypes and products built by the customer. The specific approach was aligned to the previously defined areas of determining technical feasibility, warfighting utility, and path to scale.

5.1 Technical Feasibility Determined through Prototyping

From the sprint phase it was determined that the technical feasibility of the platform to perform the desired mission was not met with the baseline platform we were procuring from the vendor, however it was determined with the proper integration of enabling capability onto the baseline platform from the Naval Research and Development Establishment to include Naval Warfare Centers and University Applied Research Centers, it was likely that the fully integrated resultant capability would meet the mission needs. Understanding that the capability still needed to be developed, the project would focus on maturing the five initial platforms to the point that it was technically feasible that the platforms could then meet mission needs.

The sprint determined that the baseline platform lacked the necessary autonomy and perception sensors, command and control (C2), and communication equipment needed to perform the mission. These are all areas where partnerships with the NR&DE would help. I initially reached out to NSWC Carderock and the Office of Naval Research to partner on providing autonomy and C2 to the platforms. Unfortunately, they both had too much current workload to support, however later I will describe how due to keeping positive relationships we were able to bring Carderock and ONR more into the process later. After the initial negative response, I shifted to reaching out to PMS-YYY out of PEO-USC. PMS-YYY runs a program called Common Control System (CCS) that appeared to be a good fit for the platform, additionally they were kicking off a new autonomy program referred to as Autonomy Baseline. I was able to work out an agreement where in exchange for agreeing to assist in the development of the platform autonomy and C2 one of the five sUSVs would be provided to PMS-YYY as a test article they would maintain and refine their autonomy. With these partnerships with PMS-XXX for the platforms and PMS-YYY for the autonomy and C2, the DEVOPs model for this program was born. The vision was to integrate the best autonomy and C2 capability available once the platforms were delivered onto the first five platforms. Four of these platforms would be provided to a Fleet in order to build the Concepts of Operations (CONOPs), Tactics, Techniques, and Procedures (TTPs), and Fleet infrastructure needed to support sUSV operations often referred to as DOTMLPF-P (Doctrine, Organization, Training, Material, Logistics, Personnel, Facilities and Policy). The fifth platform was to be the development platform in order to receive and implement Fleet feedback into the design of the platforms. PMS-YYY was able to fund Johns Hopkins Applied Physics Laboratory and NSWC Carderock to develop autonomy on surrogate platforms with a plan to integrate autonomy onto the specific sUSV platform of interest once they were to be delivered to the government in fall of 2023. NIWCPAC was also funded by PMS-YYY to integrate a C2 system to control the platforms. We then continued to build the team by bringing in the team from NIWC PAC and the communication experts at NSWC Panama City and NIWCLANT to integrate additional autonomy for specific missions and communication equipment to be integrated on the platform, as well as assist with develop plans for future testing of the platforms. All of these capabilities were continually developed on surrogate platforms throughout the time while we awaited delivery of the five sUSVs, so that when the sUSVs were delivered to the government the capability would be installed onto the sUSVs.

5.2 FY23 Campaign of Learning with Single Prototype (Warfighting Utility Combined with Technical Feasibility)

At the time we placed the five sUSV's under contract the Navy through PMS-XXX owned a single of the same sUSV through the SBIR effort referenced earlier in this dissertation. As part of the project phase to determine warfighting utility and technical feasibility of the capability I developed a campaign of learning of a series of experiments for that small USV as we awaited the arrival of the five small USV's. The purpose of this campaign of learning was to build the case for the warfighting utility and technical feasibility that the sUSV was a valuable capability to the Fleet mission, and to progressively advance the capability from one event to the next. I worked closely across the Fleet to experiment with the platform in four experimentation events from October of 2022 until July 2023 to demonstrate. These events are highlighted in Figure 18 below.

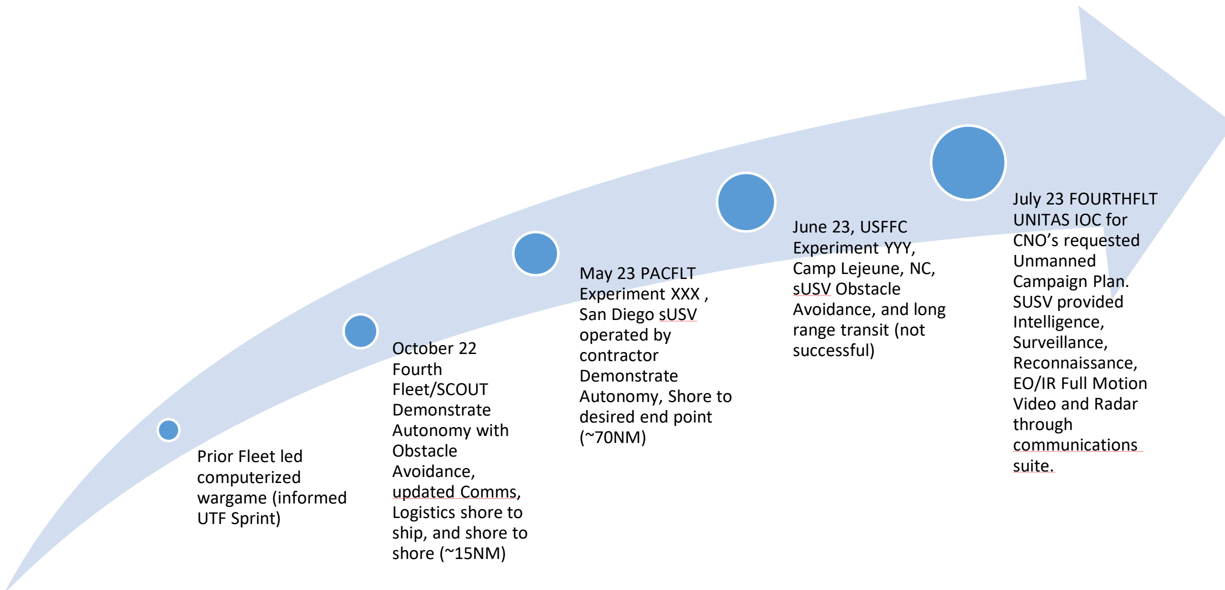


Figure 18: FY23 sUSV Initial Prototype Experimentation Campaign of Learning

A summary of each experiment in FY23 is provided below.

5.2.1 Experiment/Event 1

Introduction October 2022 Fourth Fleet/SCOUT Fleet experimentation focused on using the sUSV for logistics missions, off coast of Key West, Florida.

Goal(s):

1. Demonstrate the ability for the sUSV to deliver variety of logistics payloads from shore to ship and from shore to shore.
2. Collect data on the fuel burn at different speeds and payloads.
3. Demonstrate ability to autonomously transit with sense and avoid in open water.

Methods: In order to accomplish these three goals, we had a team of engineers and scientists from the boat builder as well as the lab that was assisting to operate the sUSV from shore to ship and between two shore-based locations. Chase boats were used to escort the sUSV.

Open ocean transit was autonomous, but close quartering around ships and piers was accomplished with hand controller.

Results: All goals were achieved. The sUSV delivered 250-pound and 750-pound packages from shore to ship. The sUSV delivered a small package from one shore location to another. The sUSV position and speed were tracked through GPS, and through the onboard computer fuel burn data was collected at different displacements and speeds. To demonstrate the autonomous operation the sUSV was put into autonomous mode with a chase boat following with an operator observing with an emergency stop hand controller. The sUSV was able to safely avoid obstacles and other vessels in open water around Key West.

Importance/Lessons Learned: The Office of Naval Research released an article on 28 October 2022 chronicling the experiment titled, *Tech FLEX: ONR SCOUT Experimentation Event Showcases Value of Unmanned Vehicles* (Duffy, 2022). In that article I am quoted on the need for contested logistics solutions for all of the Navy and that the event was used to collect data on the expected ranges, payload capacity, speed, command and control, and autonomous capability of unmanned systems in all domains (Duffy, 2022). This event provided fuel burn data at different displacements that led to extrapolated range calculations that were used to inform the Fleet of a range of operations with which they could be employed. This event also proved autonomous operations could be achieved although the capability would need to be refined.

5.2.2 Experiment/Event 2

Introduction: May 2023 – Pacific Fleet Experiment XXX, off coast of San Diego.

Goals:

1. Demonstrate the Warfighting Utility of the sUSV with specific payloads of interest.

2. Demonstrate the ability to conduct a long-range autonomous transit of 70+ nautical miles.

Methods: A team of engineers and scientists were able to operate the boat and payloads to ensure a successful demonstration. Chase boats were used to escort the sUSV safely.

Results: All goals were met. The specific payload of interest was successfully demonstrated. The sUSV was able to transit 70+ nautical miles autonomously in open ocean.

Importance/Lessons Learned: For the sUSVs this event focused on specific mission payloads that were of interest to the Fleet. It also demonstrated the ability for the sUSV to perform an open ocean transit autonomously.

5.2.3 Experiment/Event 3

Introduction: June 2023 USFFC Experiment YYY off coast of NC/VA.

Goal(s):

1. Demonstrate long distance open ocean autonomous transit 200+ Nautical Miles.
2. Try new concepts for operations with Fleet commands.

Methods: Use Navy test vessel, Stiletto, to conduct open ocean transit from Southern North Carolina to Virginia Beach. SUSV to autonomously follow Stiletto with operators on board to take over with hand controllers if necessary. A team of scientists and engineers

Results: Open ocean transit goal was not met. Due to high sea states the arch that holds the perception and communication equipment was damaged. This resulted in the sUSV being towed back to shore. The goal of trying new concepts for operations with Fleet commands was met.

Importance/Lessons Learned: This experiment was the first time we suffered a casualty with the prototype that resulted in a failed goal. This was extremely important as we were able to learn and adapt the arch to be stronger to avoid similar failures in the future. It also helped shape the culture of the program that it was acceptable to fail in an experiment as long as the learning improved the product in the longer term.

5.2.4 Experiment/Event 4

Introduction: 11-21 July 2023 Unitas Fourth Fleet Hybrid Fleet Experiment, off coast of Columbia.

Goals:

1. Demonstrate beyond line-of-sight operational capability.
2. Demonstrate long endurance offshore operations.
3. Demonstrate seaworthiness of platform.
4. Demonstrate capability for the sUSV to be used in different CONOP of interest to the Fleet.

Methods: Operated sUSV from shore-based site over beyond line-of-sight communication link over the horizon offshore of Columbia over the course of several days. Did not use chase boat.

Results: All goals were met. The sUSV operated offshore for over two full days in large sea states.

Importance/Lessons Learned: This experiment was able to demonstrate the ability for the sUSV to be controlled via beyond line of sight communications and to survive large sea states over multiple days. This was also the first time a chase boat was not used, primarily due to the willingness to accept more risk at the experiment location. This demonstration increased overall confidence in the warfighting utility and technical feasibility of the sUSV. A Breaking Defense article by Megan Eckstein released on 20 July 2023 titled, *US 'operationalizes' drones in 4th Fleet Exercise* provides a recap of the experiment. The article highlights that air and surface drones were used throughout the two-week exercise which was the first major event after the Navy announced Fourth Fleet would be the second unmanned operations hub (Eckstein, 2023). The article also speaks to a sinking exercise in which a ship was sunk by anti-ship missiles but that the unmanned systems provided the surveillance, target identification and battle damage assessment in support of that sinking evolution (Eckstein, 2023).

5.2.6 Conclusions from FY23 Campaign of Learning with Initial Prototype sUSV

All of these events supported three primary objectives:

1. Addressing the UTF/DCO focus area of warfighting utility by providing the Fleet with insight into how they may use the sUSV platforms in an operational context.
2. Addressing the UTF/DCO focus area of technical feasibility by advancing the capability through pushing the systems engineering teams to meet milestones, and to determine the technical feasibility of the platform to conduct a range of operations.

3. Build advocacy for the future of the program beyond the initial five sUSVs.

The Campaign of Learning demonstrated success in all three of these areas, and this series of experiments assisted with all future developments related to the sUSV effort. These experiments were often referenced as justification to accelerate the acquisition decision.

5.3 FY24 Campaign of Learning UTF/DCO Prototypes Fielded

As the project transitioned from FY23 to FY24 (FY changes 1 October) the initial five prototypes began to be delivered throughout the Fall of 2023. The sUSVs were delivered to the government but were not yet ready for the Fleet. From October 2023 to January 2024 the four sUSVs intended for US Pacific Fleet executed the plan as described in the technical feasibility section and in Figure 17. The systems engineering development team was challenged to have functional prototypes delivered to US Pacific Fleet by February 1st, 2024, in order for operators to be trained on how to operate the sUSVs ahead of PACFLT Experiment 24XXX in March of 2024. As determined in the Unmanned Task Force Sprint 10A, the four platforms would be provided as experimental prototypes to the Fleet Customer in order to build the Concepts of Operations (CONOPs), Tactics, Techniques, and Procedures (TTPs), and Fleet infrastructure needed to support sUSV operations often referred to as DOTMLPF-P (Doctrine, Organization, Training, Material, Logistics, Personnel, Facilities, and Policy). This information would create a continual feedback loop between the Fleet operators and the capability developers aligned with a DEVOPs model as seen in Figure 19.

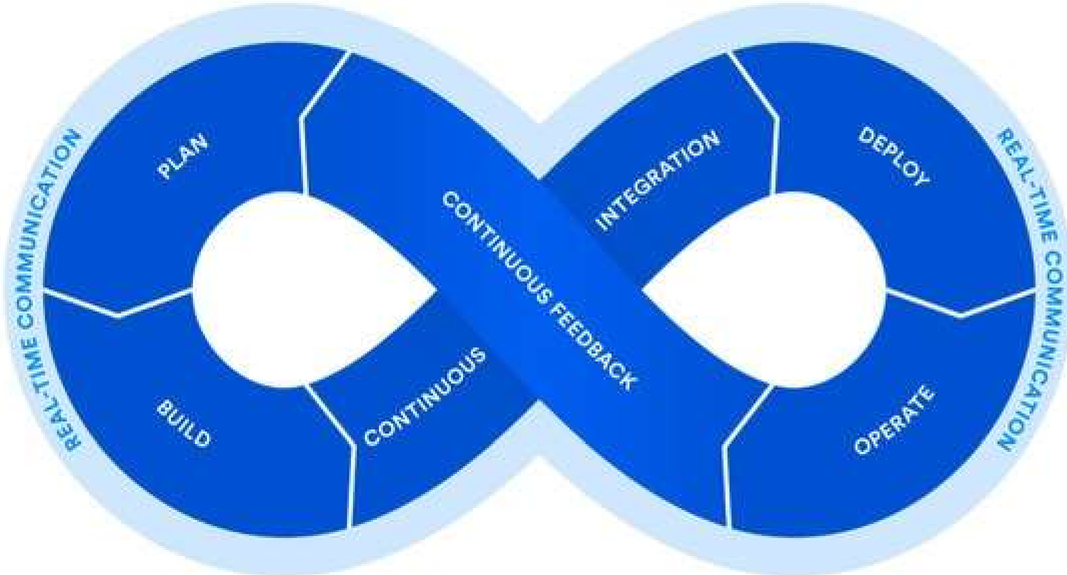


*Figure 19: DEVOPs model (*Karamitsos, Albarhami, Apostolopoulos, 2020)

The Naval Science and Technology Strategic Plan which was released in April 2024 also uses this DEVOPs language:

> "To prepare warfighters to use future technologies and ground those technologies in warfighter needs, ONR, which leads basic and advanced research and drives areas of rapid capability development and experimentation, will use the DevOps mindset with scientists and engineers informing Sailors and Marines and vice versa. This environment will give Warfighters familiarity and early training on future systems and better inform scientists and engineers in developing robust and optimized systems. To speed up technology development and capability delivery, we will focus on accelerating the system development life cycle by teaming between researchers, industry, and Sailors and Marines using experimentation and technology demonstrations. Today's Sailors and Marines grew up with technology, are savvy with it, adapt to it and, when we put it in their hands, they often innovate, find new uses, and offer insightful perspectives that benefit both sides of the equation. Our scientific and engineering community must leave the comfort of controlled events and expose their ideas and concepts to warfighters to realize earlier benefits (Del Toro, 2024)."

The sUSV project took this approach months before the release of the Naval Science and Technology Strategy with FY23 experimentation and even more so with the FY24 fielding of the initial prototypes.

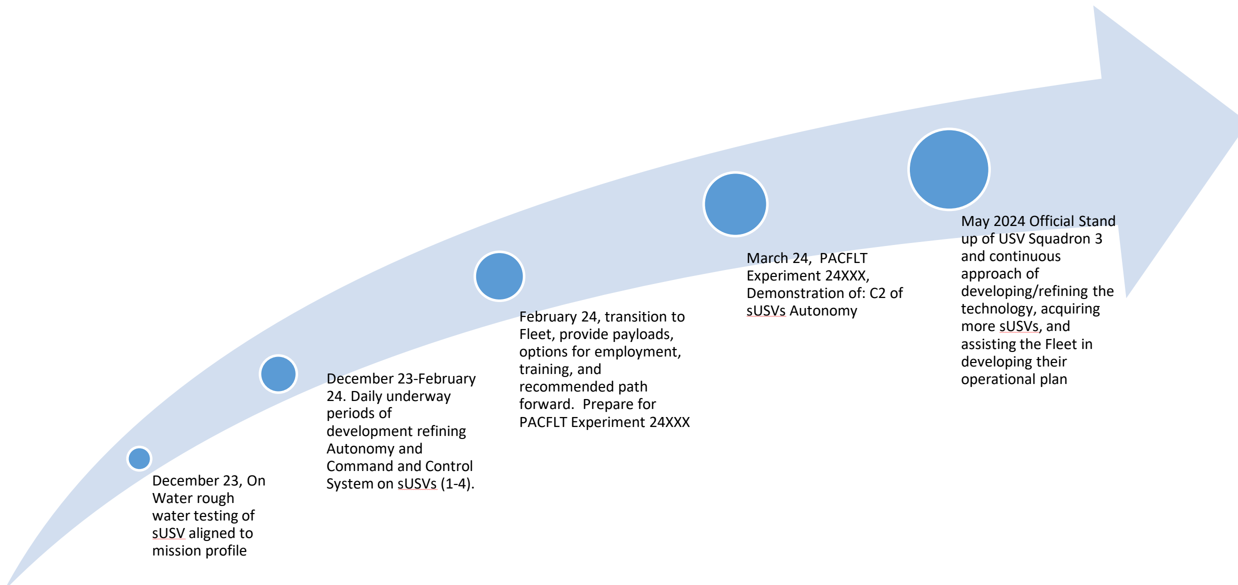


Figure 20: FY24 UTF Prototypes Campaign of Learning

Figure 20 provides the FY24 continued campaign of learning supported by the four UTF/DCO prototypes. This campaign was designed to provide a better understanding of the warfighting utility and technical feasibility of the sUSV capability.

5.2.1 Experiment/Event 1

Introduction: December 2023 Rough Water and Endurance Trials off Virginia Beach, VA, conducted by NSWC Carderock (NR&DE)

Goals:

1. Provide Government validated Test data for the performance of the sUSV in rough seas.
2. Provide Government validated test data for the fuel burn/endurance to better understand the ability of the sUSV to accomplish a specific mission profile.

3. Provide recommendations for improvement to the sUSV based on Government sUSV subject matter experts.

Methods: Transit from Norfolk offshore to rough water operation area in Atlantic Ocean. Chase boat used for safety. SUSV was equipped with fuel meters to measure fuel burn. SUSV was equipped with acceleration devices to measure G-Forces.

Results: All goals were met, however the initial plan for the full mission profile was not met. Fuel burn rates were obtained that were used to inform the operational use case. There were minor problems with equipment breaking free and fasteners breaking loose that led to the test being concluded prior to completion. At which point a team of small craft subject matter experts provided a recommendation list of improvements.

Importance/Lessons Learned: This test provided expectations to the Fleet on the upper limits of how they could operate the sUSVs. This was an opportunity to learn potential failure points to correct ahead of a larger acquisition. Recommended solutions to problems experienced during the testing were corrected ahead of a future contract to purchase more sUSVs.

5.3.2 Experiment/Event 2

Introduction: December 2023 – January 2024 – sUSV capability development/improvement, Baltimore, Maryland.

Goals:

1. Install Government Software Stack.
2. Prepare for delivery of sUSVs.

Methods: Underway every workday with the development team to install and work through software bugs.

Results: Goals were met. Initial Capability was delivered to the Fleet as requested for the 1 February 2024 deadline.

Importance/Lessons Learned: The sUSVs were underway every day to refine the autonomy, comms, and command and control capability, in an effort to provide a usable product. The most pressing issue here was the rush created a stressed workforce and several headaches. There were multiple teams working on the boat simultaneously which also created problems. The autonomy baseline team from PMS-YYY, NSWC Carderock, and JHU-APL was focused on providing platform autonomy, the NIWCPAC team partnered with NSWC Carderock was focused on providing collaborative autonomy for all four platforms, and NIWCPAC Common Control System (CCS) team was focused on providing a function command and control software to command the boats, and the NSWC Panama City and NIWCLANT team were focused on providing a comms architecture to make sure there was enough bandwidth for the sUSVs to be properly tasked. You can imagine with all of these teams from across the NR&DE trying to balance only four sUSV there was a lot of getting in the way of one another. That being said, the learning was tremendous, and the NR&DE developers proved their ability to rapidly deliver functional prototypes to facilitate learning.

5.3.3 Experiment/Event 3

Introduction: February 2024 – transition to the Pacific Fleet.

Goals:

1. **1.** Train the Fleet Operators
2. **2.** Begin learning how the Fleet should adopt sUSVs.

Methods: The sUSVs were delivered to what would become USV Squadron 3. The vendor and government software provided conducted training of the operators on how to use the sUSV.

Results: Goals were partially met. The operators were trained on the initial capability, and could operate the boats but needed consistent intervention from the developers due to software difficulties. The Fleet operators prepared for the mission in the upcoming Pacific Fleet 24 XXX and teamed up with NSW to learn more about boat operations.

Importance/Lessons Learned: The four sUSVs were provided to US Pacific Fleet the first week of February. Training started immediately to prepare the previously untrained operators to operate the boats in the next Fleet experiment PACFLT Experiment 24XXX. Operators came from Surface Development Squadron 1 based out of Coronado, CA. Biggest issue with this stage that continues to be experienced is the development spiral was continuing while the operators were being trained. This creates frustration with both the Fleet operators and developers, but it also quickly advances the capability through continuous learning through repetition.

5.3.4 Experiment/Event 4

Introduction: March 2024 – PACFLT Experiment 24XXX.

Goals:

1. **1.** Perform Mission with Fleet Operators.
2. **2.** Integrate with other capabilities.

Methods: SUSVs were primarily operated by Fleet Operators. Chase boats were used for safety. SUSVs were integrated with other robotics and autonomous systems.

Results: Goals were partially met. The Fleet Operators primarily operated the boats but there were several injections by the team of engineers and developers supporting the event to assist with problems that arose.

Importance: The follow-on event to the previous year PACFLT Experiment XXX. For the sUSV effort the largest accomplishment is that they were operated primarily by uniform Navy Sailors with support from engineers and technicians. In all previous events the sUSVs were operated primarily by the engineers and technicians subject matter experts that developed the systems. There were several injections by the engineers and technicians in areas where they had to adjust items in the code, but this was more due to the developmental nature than a lack of ability or understanding from the Fleet operators. PACFLT Experiment 24XXX indicated we made huge strides in a short amount of time but that we still had a long way to go.

5.3.5 Experiment/Event 5

Introduction: May 2024 - Stand up of USV Squadron-3

Goal(s):

1. Stand up a new sUSV squadron of Fleet operators, a first in the US Navy.

Method: Mostly ceremonial event made the establishment of the USV Squadron official.

Results: Goal met.

Importance: An article on this subject was released in February 2024 article in breaking defense titled, *US Pacific Fleet to stand up second unmanned surface vessel squadron this year*.

In that article Commander of U.S. Pacific Fleet highlights his plans to establish USV Squadron-3, but he purposely does not give any indication to what their capabilities or mission will be (Katz, 2024).

5.3.6 Conclusion from the FY24 Campaign of Learning

Although the specific sUSV capability had yet to be proven in a conflict, the campaign of learning of a series of experiments ultimately leading to the first small USV squadron being created in the US Navy was a testament to the belief that senior US Pacific Fleet leadership saw the warfighting utility of the capability. In addition to warfighting utility this series of experiments provided confidence that although the capability was not perfect, there was a reasonable path to get the capability to a point that it would be able to be used in a future conflict if ever called upon.

5.4 Path to Scale

In order for small Unmanned Surface Vehicles to provide warfighting utility for the missions intended by the Fleet they need to be fielded in larger quantities than the four initial prototypes fielded from the UTF Project. There was a multi-step approach we took to verify and validate there was a path to scale prior to making a larger investment in the capability. As we saw the demand for these capabilities continue to grow, PMS-XXX and I partnered to submit a proposal to an Office of Secretary of Defense program to get under contract 12 sUSVs in FY23 and additional 7 in FY24 for a total of 19 sUSVs from the same vendor. In addition to the 5 sUSVs that were already in production based off the sUSV sprint 10A this brought the total to 24 sUSVs from the same vendor as a Low Rate Initial Production (LRIP) effort.

Simultaneously PMS-XXX led an effort for a study conducted by an independent study agency that worked closely with the vendor to determine if it was feasible for the vendor to scale to larger quantities. This study was very comprehensive in that it investigated the vendor's production capability but also the full supply chain to make each sUSV. The only area it was lacking was in the NR&DE post production integration of capability as that was not part of the study.

5.5 UTF/DCO sUSV Project Concludes

The Unmanned Task Force was always envisioned to be a 12-24 month pilot program to discover methods for the Navy to more rapidly field needed capabilities. As I mentioned previously the Unmanned Task force stood up in August of 2021. In September 2023 in an article in Breaking Defense Magazine titled, *Navy stands up 'Disruptive Capabilities Office'* the new office is described to push the bounds of rapidly delivering warfighting capability (Katz, 2023). This would be accomplished through innovative application of both existing and new technologies well aligned to the growth we are seeing in technology as a society (Katz, 2023).

From the perspective of the sUSV effort, I continued to lead the overall project of the first 5 sUSVs after leading the UTF sprint. It then transitioned to the DCO, and the DCO stayed involved until the June 2024 timeframe when it was determined that OPNAV N9-, would take over as the lead OPNAV organization for this effort. With that decision I was the only member of the UTF/DCO still supporting sUSVs. It was determined by the DCO, N9-, and PMS-XXX that as one of the people with the most institutional knowledge of the sUSV that I continue to support the sUSV effort for the best interest of the Navy. This led to me shifting much of my workload from DCO support to PMS-XXX support. My title became lead systems engineer for the sUSV effort, and I stayed on to support transition into a much larger program. From a positive viewpoint the overall effort was much further ahead than where we would have been had we not done the UTF Sprint and UTF/DCO Project. From a more negative viewpoint due to a push beyond our control we transitioned to a much larger effort before we were able to complete the learning we expected from our initial prototypes. This dilemma put all of those supporting this effort to include OPNAV, the Secretariat down to the execution of the Acquisition at PMS-XXX, the Naval Research and Development Establishment of Warfare Centers and UARCs supporting, and the Fleet that would become the end user of this capability in a difficult position being asked to run full speed to meet a demanding timeline without having all the answers needed for a smooth transition.

5.6 Aim 2 Conclusions

The following outcomes were achieved through research 2 aim:

- Successfully led to transition from sprint to prototype to a larger scaled program in less than 2 years in what traditionally would have taken 5-7 years.
- Campaign of learning successfully demonstrated the ability to utilize Fleet Experiments to validate warfighting utility, technical feasibility, and build advocacy for transition into a larger program.
- Campaign of learning successfully demonstrated the value to creating a devops approach to more rapidly facilitate capability development working closely with the end user.

CHAPTER 6: AIM 3 RESULTS – PARALLEL PATH APPROACH TO FIELDING

This chapter outlines the results for research aim 3, which was to identify, explore, and implement a new process to adapt the traditionally in-series process to deliver capability to the Fleet into a new parallel line of effort approach. Due largely in part to the efforts of the Unmanned Task Force Sprint and Project phases to include the campaign of learning outlined above there was growing demand to scale the small USV capability to the Fleet. While the Navy was much better positioned to scale this capability to the Fleet then would have been the case had this UTF sprint and subsequent project not occurred, we had not yet fully executed the initial vision of using the prototypes to finalize CONOPs, TTPs, DOTMLPF plans, and to mature the capability to where it needed to be to meet the mission needs. The top-level requirements document was also still in draft form. With the Navy and larger Department of Defense being an extremely large organization with many outside influences beyond our direct control, we were forced to move faster than originally planned. This push to move faster to field a scaled capability presented a new challenge but also a new opportunity to develop new approaches to meet the demand.

6.1 Acquisition, Systems Engineering, and Fleet Adoption

This new challenge has forced the acquisition community, the Naval Research and Development Establishment, and the Fleet out of their comfort zone, as we have taken what was traditionally an in series model of delivering capability and shifted to, three parallel but collaborative lines of effort, to field and implement this capability.

As discussed in the background section of the dissertation, the traditional process of going from Fleet need to fielded capability can take 10+ years and we are attempting to cut that to ~2 years. The three parallel lines of effort that will frame the remainder of this dissertation are:

1. The Acquisition Line of Effort: Buy platforms from a vendor.
2. The Systems Engineering Line of Effort - Develop and integrate capability with the NR&DE, integrate capability, test capability.
3. The Fleet Adoption Line of Effort: Develop concepts of operations, TTPs, DOTMLPF assessment, experiment, refine plans, and inform development community.

Figure 21 provides a graphic representation of the process described above. I presented a variation of this slide to the Surface Warfare Improvement Program (SUWIP) Conference in San Diego in March of 2024.

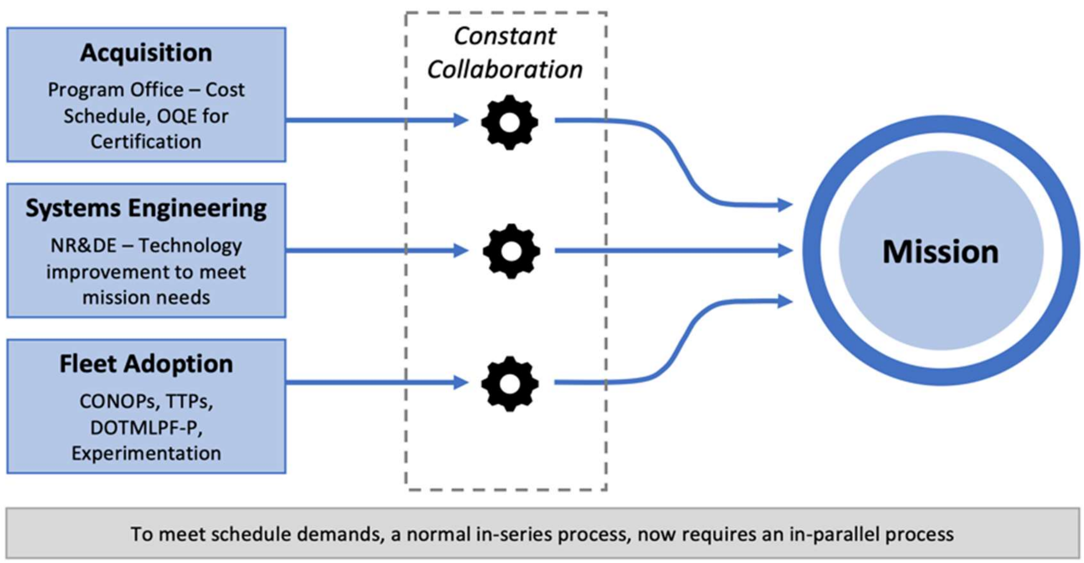


Figure 21: Parallel Lines of Effort with Constant Collaboration

6.2 My Role for the Larger Program

I want to make it clear that as this project transitioned from the initial UTF/DCO prototype delivery to a much larger project that I transitioned from leading the project and the much smaller team into a support role as a senior advisor of part of the larger project and much larger team. For this dissertation my primary contribution to the field was the UTF sprint that led into the project phase that ultimately transitioned to the larger program. This Senior Advisor role led me to be in a supporting role in crafting the plan of three parallel lines of effort described in the follow-on sections. For this dissertation I will provide my contribution of assisting with developing the plan with the three parallel lines of effort. I do not plan to capture the entirety of the execution of the program in this execution as it is no longer in my control and not my primary contribution to the field.

6.3 The Acquisition Line of Effort

PMS-XXX was assigned to execute and lead the acquisition plan for procuring the sUSVs from a vendor. Questions to be answered identified from the methodology section of this dissertation were as follows:

- What acquisition pathway do we use, Major Capability Acquisition, Middle Tier Acquisition, Urgent Capability Acquisition, or R&D 4001, and why?
- Can the vendor meet the requirements for quantities?
- Can the quality of the platform maintain?
- Can we develop defined Top Level Requirements to test against in series while still purchasing platforms?

- Can an Integrated Product Team (IPT) Structure that develops a plan of action and milestones be utilized to assist with rapidly meeting program goals and keeping control of the larger team through a team of teams?
- Do we need modifications from the prototypes acquired through the UTF project for the production capability?
- How do we execute all of this while maintaining the budget (cost), maintaining the schedule demand(schedule), and ensuring the capability can meet the mission (performance)?

This process started with an analysis with the vendor to ensure they could meet the quantities being requested. After a detailed review of the vendors' facilities, plans, and supply chain, it was decided to move ahead with the acquisition process with a single builder. Following this determination and money arriving from the program sponsor a lengthy negotiation with the vendor to put the boats on contract for a fixed price. A production readiness review was then conducted with the vendor for all to all agree to the specific details of the boat design and build process. The remaining two lines of effort are dependent on a successful acquisition of the platforms from the vendor. Table 3 provides an overview of the acquisition processes considered for the sUSV acquisition.

Table 3: Comparison of Top Two Acquisition Options for this Project

	Course of Action 1 MTA Approach	**Course of Action 2: § 4001 R&D Approach**
Summary	Rapid Prototyping Project or Rapid Fielding Project	Navy PEO invokes statute 4001 authority; operates as a non-POR under authorities delegated to PEO/SYSCOM by ASN (RDA)
Requirements	Approved Top Level Requirements	Potential DOD-Interest
Contracting	FAR Based contract or Other Transaction Authority (OTA)	FAR Based contract or Other Transaction Authority (OTA)
Time Restrictions	Rapid Fielding; production start less than 6 months; 5 years to complete	No time limitations
Funding/Budget Constraints and MDA	Prototyping supports RDT&E no strict limits, Production within 6 months of initiation, Navy PEO as the decision authority	May imply RDT&E funding, no strict limit Navy PEO has decision authority
Other Factors	Documents per MTA Policy per SNI 5000.26	Tailor-in approach to documentation opportunity to transition to an alt acquisition pathway to support resourced requirements
Next Steps	MTA/RF package prepared and forwarded to Navy PEO for approval (merit based assessment (a brief) to initiate), Navy PEO to be designated ADM for small USV as MTA/RF Project	Navy letter from Navy PEO to ASN (RDA) with intention to invoke statute 4001 authority for small USV interceptor, ADM from Navy PEO to Navy PMS designating statute 4001 authority for small USV.
Big Picture	Pros: established pathway to reduce program of record burden (no JCIDS for requirements); provides up to 5 years to deliver residual operational capability; RDTE and production path options for funding. Cons: Additional reporting requirements; burden on PMO; OPDEMO; TLR approved by DCNO to initiate pathway.	Pros: Minimal resources to invoke the authority; fewer decisions now; no JCIDs for requirements; preserves schedule; fewer reporting requirements; highly flexible in fiscally constrained environment; provides time to develop and demonstrate R&D in FY24 and beyond; applicable to all sUSV LOE transition to alternate path when ready. Used to procure demonstration assets with high degree of risk tolerance to be transitioned into operational assets. Cons: least formally structured COA; RDTE only

For this project PMS-XXX led the acquisition effort to use the R&D 4001 authorities to acquire the sUSVs from the vendor.

6.4 The Systems Engineering Line of Effort - Development, Integration, and Testing of Enabling Capability

The Systems Engineering Line of Effort is largely led by Government Civilians and contractors from the Naval Research and Development Establishment (NR&DE).

Questions to be answered as identified in the methodology section of this dissertation are as follows:

- Who/What/When/Where/How will we use the NR&DE to develop or acquire the enabling capabilities of autonomy and perception, comms, C2, and payload needed to execute the mission?
- Who/What/When/Where/How will we use the NR&DE to integrate the enabling capabilities onto the platforms purchased from the vendor at scale?
- Who/What/When/Where/How can we do with the NR&DE to verify and validate through testing and analysis that the capability can meet the mission.
- Can an Integrated Product Team (IPT) structure that develops a plan of action and milestones approach be utilized to assist with rapidly meeting program goals and keeping control of the larger team of teams?

The Systems Engineering Line of Effort for the sUSV development is following a very dynamic, complex, and expedited version of the systems engineering V aligned to the government processes shown in Figure 22.

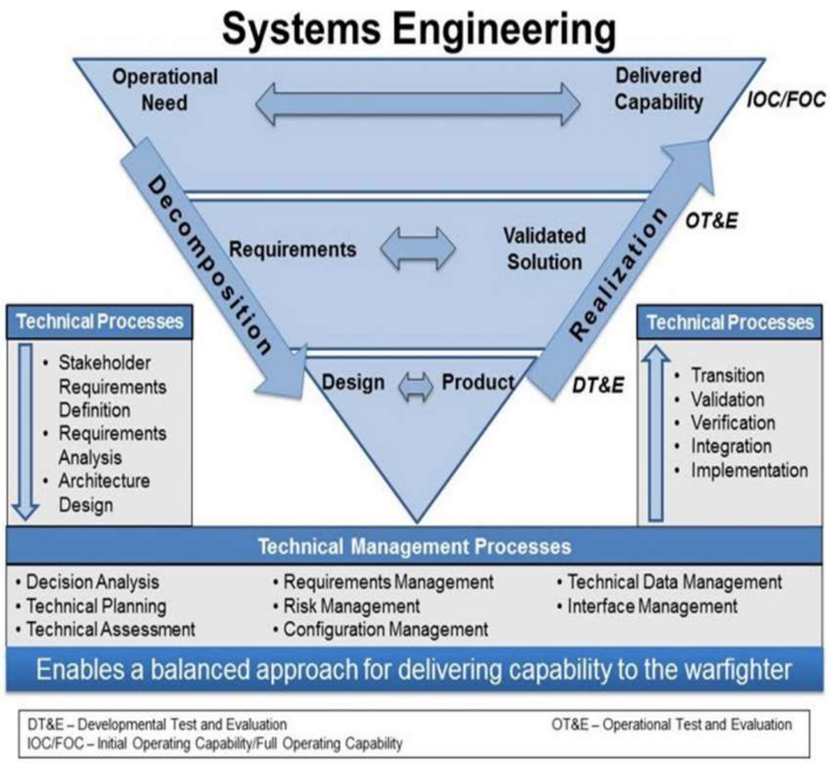


Figure 22: Systems Engineering V aligned to DOD approach to program management (Sinsay, 2018)

1. Operational Need: We started with PACFLT and the DCO working together to provide phases of the mission to articulate the clear need.
2. Requirements: The Fleet Operators and Capability Developers worked together to derive “requirements” from that clearly defined mission. These “requirements” became referred to as the minimum viable product (MVP) that would be delivered by the required scheduled date.
3. Design: Due to starting with what was previously a prototype project much of the design had already been completed. However, after building the specifics of the derived requirements, and comparing that to the data we had collected during experimentation

design modifications were made to better meet the mission. These design modifications included changing the fuel tank design, changing the communications suite, and better defining the autonomous behaviors that were needed to meet the mission need.

4. Product: The sUSV as it comes from the vendor was updated with the recommendations based on the new design. The vendor provided product is a 70% capability solution. After the product is received from the vendor a post production/production line supported by the NR&DE will outfit the sUSV with Government Furnished Equipment to include the communication suite, mission payloads and interfaces, and the software stack to include the autonomy and command and control software. Each IPT developed their own plans along with a Plan of Action and Milestones (POAM) as to how they would meet the Minimum Viable Product. These IPTs supported by the NR&DE refine the industry Each of the individual IPT lead plans was incorporated into a larger integrated plan by PMS-XXX sUSV program leadership.
5. Validated Solution: The Test and Evaluation IPT lead has a series of test events he has built with help from each of the IPT leads that will verify the sUSV was built right (aligned to the derived requirements) and validate the sUSV meets mission needs (aligned to the mission).
6. Delivered Capability: All of these plans are aimed at providing a delivered capability of an initial minimum viable product design for initial operational capability ahead of the required date set by senior leadership. This will then be matured into a full operational capability in subsequent months/years.

The intersection of the acquisition and systems engineering collaboration occurred through eight Integrated Product Teams (IPT) and one overarching IPT as seen in Figure 23. These teams along with the overarching IPT met weekly to ensure all working on their respective efforts were informed. The Fleet operators often participated in these meetings as well.

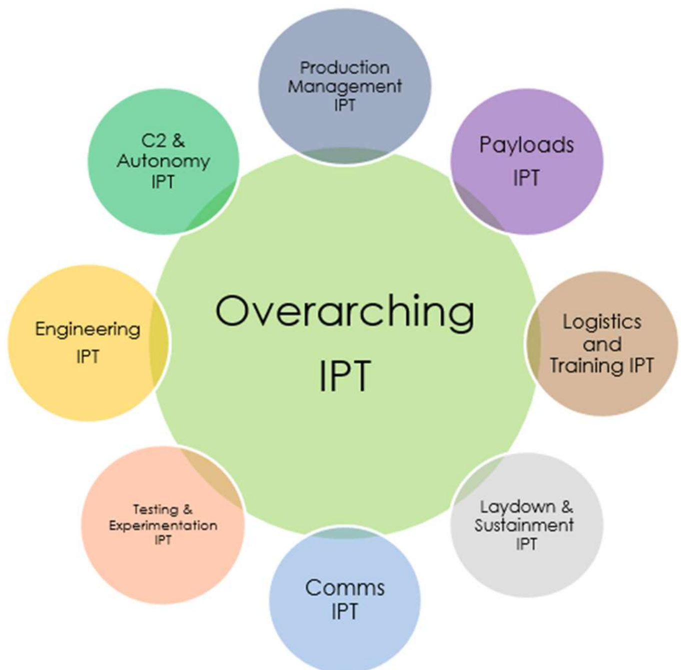


Figure 23: Program Integrated Product Team (IPT) Structure

Ideally this full systems engineering process up to delivery would have been completed prior to the acquisition and the sUSVs could have been purchased from the vendor ready to be fielded. For this project, however, in order to move faster before a product existed to meet mission needs, we took what I would estimate to be a 70% industry solution and developed a plan to advance the capability through the NR&DE to fully meet mission needs. There is a push from both government and industry to more quickly purchase industry solutions, however often industry solutions are not designed to do the exact military mission. This sUSV project was an example where industry provided a very beneficial starting point, that was able to be more rapidly advanced by the NR&DE than had we waited for Industry to provide a full solution or if we had waited for the NR&DE to develop a full technical data package. This partnership between the NR&DE and industry is one that is critical to moving fast although the exact balance between the industry contribution and the NR&DE contribution will vary from one project to another. In many circumstances an industry partner can provide a 100% solution to meet mission needs, in which case the NR&DE could be used to help build the requirements and then to verify that the capability was built to the requirements and validate that capability is going to meet the mission needs. In other circumstances industry can provide a 90% solution while the NR&DE may provide that final 10% of capability through mission payloads or integrating classified capability. This dissertation would like to highlight the value of both industry and the NR&DE to develop a combined solution. One downside of this industry and NR&DE partnership is that this created a complex capability development process. The NR&DE is spread across the country, and not vertically integrated with one another or with the vendor providing the sUSV. This created extreme complexity with the dispersed personnel, the different chains of command, the different funding lines, and in some cases stove pipes of capability development with downstream integration impacts on other capability developers.

6.5 The Fleet Adoption Line of Effort

US Pacific Fleet (PACFLT) is responsible for developing the Fleet adoption plan. The Navy refers to layers of command as echelons. The Navy organization known as OPNAV in the

Pentagon is referred to as Echelon 1. PACFLT is echelon 2 and can task their lower echelon commands to specific actions. In order to develop the Fleet path to incorporating sUSVs into their operations PACFLT tasked Naval Surface Forces Pacific (NAVSURFORPAC) who tasked Surface Development Group 1 (SURFDEVGRU-1) who then stood up and tasked USV Squadron 3 (USVRON-3) to execute the Fleet's path to operationalizing small USVs. Questions to be answered as identified in the methodology section of this dissertation are as follows: Who/What/When/Where/How will the Fleet develop CONOPs, TTPs, and DOTMLPF-P considerations for this capability while it is still being developed, and requirements are not clearly defined?

This LOE was divided into four secondary lines of effort, these were:

1. Develop Concepts of Operations
2. Experiment with prototypes
3. Develop Tactics, Techniques, and Procedures
4. Provide a DOTMLPF analysis and plan for how to execute.

Collaboration is critical between the three lines of effort to more rapidly field and implement capability to the needed capability to the Fleet.

6.6 Aim 3 Conclusions

Through the efforts of research aim 3, the following outcomes occurred:

- Successful implementation of plan to develop a parallel effort approach to acquisition, systems engineering, and Fleet adoption.

- Anticipated program completion resulting in a fielded capability at scale in 18 months in what would have traditionally taken ~5+ years.

CHAPTER 7: EVALUATION OF AIMS 1 – 3

Although the general tone of this dissertation is positive, not everything went perfectly throughout this process. There were several lessons learned and recommendations that should be considered for each step of the process. This section is intended to inform future use of the approach highlighted in this dissertation.

7.1 Recommended Best Practices for future use of this approach

7.1.1 Recommendations for Aim 1: Innovation Pipeline applied to a UTF Sprint

The intent of the innovation pipeline is to follow the steps of problem sourcing, curation, incubation, and transition in order to more rapidly and effectively meet needs. It is recommended to take a team of teams approach by bringing in all the proper stakeholders to include resource sponsors, program offices, technical community, analysis experts, and supported Fleet commands, right from the beginning. These stakeholders can help build the products needed to make the case and provide advocacy that the plan is feasible. In order to build the case to make a proper recommendation it is advised that the sprint includes at a minimum three items to avoid future complications:

1. A documented requirement or needs statement such as an urgent operational needs statement from the problem owner or a top-level requirement from the resource sponsor. This should be part of the problem sourcing phase. Starting with a problem is of value but making it a clearly defined need provides documentation that can more easily align the proper solution from the technical community. It also provides advocacy to break down barriers such as allowing for an urgent capability acquisition.

2. A clearly defined capability solution coming out of the Sprint believed to meet that need with a plan of action and milestones along with cost estimate to execute the solution for both a proof of concept but also for the future scaling decision if the proof of concept proves feasible. This should be built by the team that will execute building the solution in order to ensure alignment early before the funding arrives.
3. An analysis that provides confidence that the proposed solution potentially can meet the need. This analysis may have multiple aspects such as survivability or effectiveness and can assist with ensuring you are planning to use the right solution to solve the problem. This analysis would ideally be completed by a trusted source unbiased by investment and with access to classified content of competing opportunities. Organizations for consideration should include but not be limited to OPNAV N81, a university applied research center (UARC), federally funded research and development center (FFRDC), and/or Warfare Center.

7.1.2 Recommendations for Aim 2: Campaign of Learning

This phase of this overall effort was completed with severe limitations of funding to execute the most advantageous plan. Due to a lack of funding, Fleet experiments were used to attempt to verify and validate the sUSVs had warfighting utility, it was technically feasible that they could meet the mission need, and perhaps most importantly to build advocacy for the potential scaling of the capability. In an ideal process there would be funding to allow the proper development to occur through uninterrupted development cycles that would lead into controlled test events aimed at true product validation and verification.

The Fleet experiments would be used by the Fleet Commands to assist in better understanding the capability to build concepts of operations, tactics, techniques, and procedures, and understand the DOTMLPF-P implications. Fleet experiments would be strategically planned to have minimal interference with the development cycle.

This stage of the overall effort could have greatly benefitted from more time to fully execute the proof of concept plan from the original UTF sprint which would have resulted in a more mature product but also in a more defined concept of operation and greater DOTMLPF-P understanding. The schedule was placed as the highest priority, so the team did their best to meet demands without having all the answers.

Transparency here is critical to understanding the state of the capability and the plan to implement the capability prior to a scaling decision. Once the scaling decision is made it should be clear that the entire community between the Fleet, acquisition community, and technical community are on the same team with a common goal moving forward to meet the challenge. It should be understood and accepted that with a drastically compressed schedule to deliver it is not likely to be a smooth process, but that we will meet the challenge together.

7.1.3 Recommendations for Aim 3: Parallel Path Approach

This concept proved to be very difficult causing confusion and at times frustration across the larger team and supported stakeholders. Much of the confusion and frustration was due to a large cultural shift associated with this approach. This portion of this overall effort is still in process, and time will tell if the parallel path approach to acquisition, systems engineering, and fleet adoption is proven as a viable means to capability development for the Navy. The following are three recommendations for implementing this approach:

Communication: Establish clear channels for communication. Integrated product teams to execute at the working level, and senior steering groups to provide guidance at the higher level. The team(s) are going to grow very large. The teams supporting the three lines of effort of acquisition, systems engineering, and Fleet adoption do not always have the same perspective or short-term goals. This makes communication critical to mutual understanding and prioritization. One area that is not always clear is that between the Fleet, acquisition community, and the technical community there are multiple organizations with multiple chains of command. As a result, this makes communication critical for situational awareness but more importantly for decision making.

Decisions: Establish a clear decision process and clearly inform the larger team of decisions. With a large team of team's clear decisions and direction on how to proceed are critical to success. Multiple parallel paths can make sense to ensure there are back up plans, and other times it can slow down the most critical path. It's important for the team to know when a decision has been made, and the alternative is divested.

Honesty and Transparency: Everyone working these high-profile efforts to deliver capability have good intentions. With new approaches and large amounts of funding comes greater visibility and greater scrutiny. Due to this pressure individuals can be prone to providing optimistic views of the current state and setting unrealistic expectations for the future state. It is important to instill the lessons of the Navy's past "Get Real Get Better" approach to ensure decision makers, and the operational Commanders understand the risk and properly manage expectations.

The recommendations in this section are not intended to be disparaging to anyone that has put tremendous effort into the rapid fielding of sUSVs, but rather to highlight well executed areas and areas that could be improved upon for future use cases.

7.2 Alternative Rapid Fielding Concepts that Should be Considered

As outlined in this dissertation the sUSV effort documented used a parallel path approach of acquisition, systems engineering conducted by the NR&DE, and Fleet Adoption of the capability. Regarding the acquisition and systems engineering approach there are two alternatives I have seen that should be considered to reduce overall program risk. Each of these three approaches have their respective pros and cons and all have their place to more rapidly field capability to the Fleet.

7.2.1 Alternative Option 1: Acquiring a 95% solution from Industry

According to Clayton Christensen in his book the Innovators Dilemma, “Disruptive technologies typically enable new markets to emerge (Christensen, 2016).” There has been substantial progress made in the field of unmanned systems over the last decade. We see industry rapidly advancing capability, and foreign militaries utilizing unmanned capability on the battlefield. Due to this emergent market industry is now in a position to provide much more developed USVs than could be provided even 2-3 years ago. There has recently been a push for rapid acquisition of Program Executive Office to industry solutions, highlighted even further by the recently signed Presidential Executive Order titled Modernizing Defense Acquisitions and

Spurring Innovation in the Defense Industrial Base. This executive order shines light on the commercial solutions opening to other transaction authority approach to rapidly acquiring capability. In the case of rapidly fielding capability using a 95% industry solution it would be recommended to continue to bring the subject matter expertise of the Warfare Center scientists and engineers into the equation to ensure this approach will meet the mission needs while protecting the government investments. As far as Warfare Center Subject Matter Expertise, ideally the Warfare Centers along with the program office would start by serving a vital role in assisting with the building of the commercial solutions opening from Fleet needs and OPNAV generated requirements. This support can ensure that what is being asked for is reasonable from a technical feasibility perspective allowing for a more streamlined proposal process for industry and selection process back for the Program Office. Following the commercial solutions opening Warfare Center subject matter experts serve a vital role during the selection process to ensure the best capabilities move forward, while also alerting the program office of risks associated with vendor claims. These same subject matter experts would then support the design review process during the prototype test to steer the solutions in the right direction towards most closely meeting mission needs. Once the prototypes are acquired the Warfare Center subject matter experts would perform verification and validation testing to ensure the solutions meet the "requirements" from the commercial solutions opening. This would result in the program office being able to quickly acquire a scaled solution that is technically able to provide the warfighting utility needed to meet mission needs. Due to the specifics of military missions, it is likely that any industry solution would still need to be adapted with specific mission payloads and capabilities to make the industry solution effective at performing the intended mission.

One potential detriment of this approach could be the proprietary nature of commercially available capability. If not properly handled an industry supplied capability may create complications for future improvements to the platform and software such as new autonomous behaviors. Software intensive capability creates complications, so it is important to account for not just platform sustainment but software sustainment over the course of the life of the capability up front. In many aspects government owned solutions may be more complex to update because capability is provided from multiple different organizations across the establishment but may be more advantageous from a cost and capability retention perspective.

7.2.2 Alternative Option 2: Government and Industry design Prototyped then provided to Industry Partner to Scale.

Building the capability with the government and industry team integrated with the operators and providing the design to a systems integrator industry partner to mass produce is another potential option to rapidly field capability. The challenge of this approach is assembling the correct subject matter expertise centralized through a co-located team. The Naval Research and Development Establishment expands across the country, with expertise distributed to many different labs and Warfare Centers. Ideally capability development would occur with a co-located team. If a team of capability developers can be co-located with the end user during the development cycle that is the most ideal state for rapid prototype development. This model is very rapid and effective; however it can be difficult to scale, which is where industry comes in. A technical data package from the resultant prototype can then be provided to industry to scale the capability. This approach has many advantages such as alignment with warfighter needs by working side by side with the warfighter during the development and results in a government owned design that can be provided to industry to scale. The primary disadvantage is the ability to repeat this process as getting the right developers and operators co-located is difficult with the sheer size of the Naval Research and Development Establishment. This process can also take a considerable amount of upfront time to learn how to build the initial prototypes and has been demonstrated in the past as follow on efforts from large science and technology funded efforts as the path to transition. In a new development project with minimal upfront funding, it would be difficult to exercise this option from the beginning.

CHAPTER 8: CONCLUSIONS

In an ideal state any effort to field a new capability would start with clearly defined requirements, be fully resourced with the funding needed to meet those requirements, there would be an acquisition plan with a contract vehicle that could acquire a product that is already known to meet the requirements, and the end user would already have a capability adoption plan to include CONOPs and a DOTMLPF-P plan to be ready to receive that capability. Unfortunately, that process takes time, and the sUSV fielding effort highlighted in this dissertation did not have any of those luxuries when it started. My team and I only had a need and a potential path that carried tremendous risk to meet that need. These circumstances required my team and I to approach this problem differently through innovative thinking.

The innovation pipeline sprint process from the UTF provided enough justification that the sUSV capability demonstrated the potential to provide warfighting utility, be technically feasible, and have a path to scale, that justified obtaining $2M to transition from the sprint into a project to acquire 5 prototypes meant to provide answers to many of the questions identified above that we had not yet answered. As we awaited the arrival of the prototypes my team and I utilized the single existing government owned sUSV prototype without any supporting funding to lead a campaign of learning through a series of Fleet funded Experiments that built upon one another as a necessity to refine the assessments in the UTF sprint by validating the warfighting utility and refining the technical capability.

That then led to the fielding of the four UTF/DCO sUSV prototypes to the field to stand up USV Squadron 3, and the fifth UTF/DCO prototype being provided to PEO-xxx to refine the capability. This created a DEVOPs approach to developing the capability with a consistent feedback loop from the Fleet operators. All of this success created enough demand to expedite this process to scale the capability ahead of having all the answers. All of the learning that was conducted from the start of the UTF sprint, through the campaign of learning utilizing the government owned sUSV prototype, to the fielding of the UTF/DCO prototypes to stand up USV Squadron-3 all provided an advantageous starting point to the larger program, but the overall effort still had many challenges left to be met when the decision was made to scale.

This led to the need to create a structure of three parallel but intertwined lines of effort of acquisition, systems engineering, and fleet adoption as our only option to field the capability within the schedule demands the Navy was challenged to meet. The rapid fielding of sUSVs has been one of the most challenging, rewarding, and polarizing efforts I have had the opportunity to support in my nearly 20 years of Navy civilian service. There are numerous articles on how DOD needs to move faster, but cultural change is difficult. I am convinced that no matter what the final outcome there will be those of the opinion that we were a success, and no matter what the final outcome there will be those of the opinion that we were a failure. The only option now is to put all those thoughts behind us and to deliver the capability needed to meet the mission ahead of the mission need. In experiencing the challenges of moving faster there are numerous research contributions captured in this dissertation that are highlighted below.

8.1 Research Contributions

The traditional DOD requirements, resourcing, and acquisition process is long and complex. This is not a revolutionary finding but is well captured in the literature review of this dissertation. The speed of the traditional process will not meet the timeline the DOD is being challenged to meet with delivery of new capability. This challenge has pushed organizations such as the Navy's Unmanned Task Force and Disruptive Capabilities Office to consider different approaches to more rapidly field capability to meet Fleet needs.

8.1.1 Innovation Pipeline Applied to Accelerate Decisions

Successfully demonstrated how the Innovation Pipeline Sprint Process can be applied to US Navy problems to accelerate decisions, as demonstrated by the sUSV prototype project that led to a larger project to be fielded in support of US Navy needs.

The Innovation Pipeline Sprint process of Problem Sourcing, Curation, Discovery, Incubation, and Transition developed by Steve Blank and utilized by the Navy Unmanned Task Force and Navy Disruptive Capabilities Office is a rapid way to determine if a capability warrants further pursuit. The focus of every sprint should be on answering three primary questions of is their warfighting utility of a problem that can potentially be solved by a capability, is there technical feasibility that a solution will be able to meet mission needs, and is there a path to scaling the capability to the quantities need to have the desired mission effect? Following the Innovation Pipeline Sprint process can lead to an 80% answer in the 12-week sprint process. Unfortunately getting the other 20% of the desired answer takes time and will leave senior leaders with more questions than answers. This is where the cultural change is difficult. Making a decision to move forward while not having defined Requirements, Concepts of Operations, Tactics Techniques and Procedures, DOTMLPF-P, a refined acquisition plan, and a finalized capability that is ready to be purchased, will leave many decision makers uncomfortable. The initial plan was to transition from on paper sprint to the project phase with the extremely modest $2M investment for the acquisition of five prototypes that aimed to verify and validate the sprint findings while also providing answers to those critical questions identified by senior leaders that needed to be answered to ensure the program was set up for success. This plan was derailed by the decision to move even faster without getting all the answers expected from the UTF/DCO project phase. However, the only way to meet the timelines we have been challenged to meet by senior DOD leaders is to trust that the plan could be scaled and executed ahead of need before we had all the answers.

8.1.2 Campaign of Learning Approach to Experimentation

Successfully utilized sUSV prototypes and Campaign of Learning approach to experimentation to determine warfighting utility, technical feasibility, and build advocacy.

During the FY23 project phase, prototyping and experimentation provided valuable insight ahead of the larger acquisition program. In lieu of having funding to advance the capability using the sUSV prototype in Fleet experiments provided funding that assisted with the refining of the capability to provide greater warfighting utility and a more technically capable product all while building advocacy for the capability. This was only possible by creating a deliberate plan of multiple experiments that built on the success (or failure) of the prior experiment. In the case of sUSVs, a campaign of learning was developed with experiments that built upon each other to more clearly define the warfighting utility, technical feasibility, and path to scale. Each of these experiments provided valuable quantitative and qualitative data to assist with the verification and validation that the capability could potentially meet future mission needs. The campaign of learning executed by the sUSV team challenged the capability developers to continually evolve and refine the capability from one experiment to the next. The campaign of learning also provided valuable feedback to the developers from the

Fleet commands on how to adapt the capability to better meet Fleet needs. Perhaps most importantly the campaign of learning built advocacy that the capability provides warfighting utility, it was technically feasible that it could meet mission needs, and that it should be considered to be scaled to a fielded capability. The largest negative lesson learned from the campaign of learning is that in the vast majority of the experiments conducted the sUSVs were operated by a team of capability developers that could ensure experimentation objectives were meant with their technical expertise. This paradigm created a false sense of success, and that the capability was more mature than the actual state. As we transitioned from experimentation to the desire to field a Fleet Operated capability it became evident that the sUSV still needed to be refined in order to provide a useful Fleet Capability. All of this learning from the prototype and experimentation phase provided insight into the larger overall effort. I'm not aware of a similar approach that has been taken by any other efforts. There have been numerous sUSVs in repeated experiments, but none that took a similar campaign of learning approach to build the body of evidence of qualitative and quantitative data to demonstrate the warfighting utility and technical feasibility of the capability to meet mission needs.

8.1.3 Utilizing Prototypes to Assist with building CONOPs, TTPs, and DOTMLPF-P assessment.

Successfully used UTF/DCO prototypes to work with technology developers to advance the capability and with the Fleet to assist with the building of the CONOPs, TTPs, and DOTMLPF-P assessment.

While Fleet experiments are important to understand the warfighting utility and technical feasibility of capability, they are often set up for success. In order to truly understand a capability, it is critical to transition from large Fleet exercises into more deliberate smaller training and experiments with Fleet operators. This was first demonstrated during the February 2024 timeframe as we trained the Fleet operators how to operate the sUSVs, and they operated the sUSVs during PACFLT Experiment 24XXX in March of 2024. It was quickly evident while the Fleet operators were able to operate the sUSVs when all was going well, the capability developers had to intervene on multiple occasions. This experience provided a litmus test of the true state of the capability and while the team remained optimistic that the capability could get to a state it needed to be, there was still a significant amount of work to accomplish. Having the Fleet operators be trained on the sUSVs and operate the sUSV as part of Fleet experiments provided context needed to help the Fleet develop CONOPs for how to use the capability. As part of the CONOP development the Fleet operators began to explore tactics, techniques, and procedures that would be implemented during future operations, as well as better understanding the DOTMLPF-P (Doctrine, Organization, Training, Materiel, Logistics, Personnel, Facilities, and Policy) that needs to be considered. The use of the UTF/DCO prototypes in this manner was the original intent and has proved to be valuable to all involved. During the FY24 project phase creating the DEVOPs model by using four prototype sUSVs fielded to Fleet operators while providing a test platform to the capability developers proved valuable but difficult to execute with dispersed teams. This model continued to be expanded as more sUSVs began to arrive as part of the OSD program procurement. Many of these OSD program sUSVs were delivered to Warfare Centers to continue development and integration of the improved capability onto the sUSVs. Without these prototypes all involved would not have been able to work towards a logical approach on how to scale the larger effort. These prototypes and the lessons learned from testing and experiments on these prototypes were used to create a greater capability ahead of the production contract.

8.1.4 Creation of Parallel Lines of Effort Approach to Rapidly Field Capability at Scale

Successful creation of a parallel line of effort approach to rapidly field capability at scale focusing on acquisition, systems engineering, and fleet adoption occurring simultaneously.

As described throughout this dissertation shifting from a traditional lengthy in-series process to field capability to an in parallel but intertwined process is difficult and provided many lessons learned. This phase occurred after the initial UTF/DCO project phase as we transitioned into a larger project.

Acquisition

From the Acquisition standpoint, this approach works well for the base platform but creates challenges with the System Engineering and Fleet adoption feedback loop that has been created. In a traditional acquisition program, the requirements would be clearly defined, and the program office (PMS-XXX) in this case would go acquire a given solution. In the case of this sUSV program there was not a commercially available product that met all the mission needs. This created the need to rely on the NR&DE to fill the remaining gap of providing capability to meet mission needs including the software stack of autonomy and command and control capability, the communications suite, and the payload interfaces. Additionally, the NR&DE would be conducting rigorous testing after the production contract had already been awarded. While much of the early experimentation assisted in understanding the product there was still much to learn on how to improve the product. This meant that any changes would occur after the contract was already awarded, adding complexity and risk to cost and schedule.

Additionally, with prototypes being actively experimented with by the Fleet, the desires of the end state providing additional capability were continually expressed. This created conflict as the sUSVs to be acquired were already under contract so any changes to the sUSVs would incur cost and schedule risks either through engineering change proposals, or through after delivery work conducted by the NR&DE. Senior leaders provided direction to keep costs low to ensure the sUSVs were considered attritible, and that schedule was of the utmost importance. This combination led to very little flexibility on improving the capability from that was determined to be the minimum viable product.

Systems Engineering

Without having clear requirements, the systems engineering team attempted to work backwards knowing the basic phases of the mission to build derived requirements from each of the mission phases. The mission phases were developed with the Navy DCO working closely with PACFLT and subordinate commands to define the mission without the details of a signed out Concept of Operation. This clearly articulate mission along with a draft top level requirements document (later signed) was critical to setting the systems engineering effort up for success. The systems engineering team then developed derived "requirements" that would be needed to meet each phase of the mission. These derived requirements became known as the Minimum Viable Product. This presented a challenge as the "requirements" were not well agreed upon, and a common phrase of the technical team became, is this capability MVP?

Adding more confusion was the sheer size of the team, with the project growing in size the team grew from 5-10 hard workers to 100s in supporting roles. The team also became more dispersed with members of the systems engineering team located in Norfolk Virginia, Charleston South Carolina, Crane Indiana, Dahlgren Virginia, Arlington Virginia, Baltimore Maryland, San Diego California, and Panama City Florida. The acquisition team was primarily located in Washington DC, and the Fleet team was located primarily in San Diego and Hawaii. This combination of dispersed team of individuals with diverse backgrounds and diverse roles created consistent communication challenges. An sUSV IPT structure was established with the following teams: Engineering, Production, C2 and Autonomy (software), Communications, Laydown and Sustainment, Logistics and Training, Payload, and Testing and Experimentation. These IPTs individually met weekly in there smaller teams to ensure communication, but also met weekly at an sUSV sync meeting between all IPTs. This assisted in ensuring proper communication but also was not always efficient for those on multiple IPTs. Additionally, these IPTs met over VTC, and often the meetings were not very efficient. The greatest gains in the program were typically made when the developers and the operators were co-located working on solving problems together such as the work up time leading to PACFLT Experiment 24XXX, however with the dispersed team this was also difficult to occur regularly. If at all possible, a co-located team of developers and operators would improve the systems engineering process. This is very difficult with the size of the NR&DE and would likely require large sacrifices from all involved to either move or be away from home. It should be a recommended discussion ahead of similar future projects.

Another significant problem encountered can be documented as the teams grew very large, and it was not clear how decisions were made. Having a clear decision process and possibly an executive steering committee comprised of leaders from the Acquisition team (PMS-XXX), Resource Sponsor (OPNAV N9-), Secretariat Lead (DASN Ships Unmanned), Fleet

Customer (PACFLT designated to appropriate subordinate commands), and the Lead Systems Engineer that all involved agreed upon would be recommended for similar future programs attempting a similar more rapid in parallel path to Acquisition, Systems Engineering, and Fleet Adoption.

Fleet Adoption

The Fleet struggled with the parallel path approach with a continually changing sUSV capability. The sUSVs were not in a final design state when the Fleet operators were provided with the initial prototype sUSVs. This dilemma created issues as the sUSVs were continually changing while the operators were attempting to learn how to use the sUSVs. It created frustration that the capability that the operators were being trained on would change in a few months and they would need more training. This also created additional risk to the Fleet commands as the capability was still being refined in parallel with training events creating at times unintended risk. The other challenge the Fleet incurred was they were asked to develop concepts of operations, tactics, techniques, and procedures and a DOTMLPF-P plan on a capability that was not complete. It was difficult to balance the reality of the capability today with the promises of the future while simultaneously creating the concepts of operation of how the capability would be employed. This made CONOP, TTP, and DOTMLPF-P development a continuous cycle as the capability was continually being refined. The third challenge worth highlighting was the balance between acquisition, systems engineering, and Fleet Experiments. The Fleet customer desired for the capability to be in several experiments all while the acquisition program and systems engineering effort was ongoing. This created a constant battle for people and resources. Often, I had to explain to people from all three lines of effort that each supporting organization has a different view of what's important and what the purpose of the experiment is to the other organization. For the Fleet the Fleet Experiments were an opportunity to better understand how to use the capability to build CONOPs/TTPs, and to interoperate with other assets from across the larger joint force to understand the role the specific capability plays in the larger picture. For the systems engineering team the Fleet Experiments were usually thought of as a distraction from developing the capability as the same developers that needed to be advancing the capability were often called upon to support the experiment. At best the systems engineering team could leverage the experiments to test with systems usually difficult to test with such as large ships. The acquisition community usually struggled to find ways to best utilize the Fleet experiments to ensure continued advocacy from senior leaders and to ensure larger program test objectives were being met. Once again communication was key.

The Doctrine, Organization, Training, Materiel (sUSV), Logistics, Personnel, Facilities, and Policy (DOTMLPF-P) framework was likely the most difficult challenge for the USVRON-3 team for this parallel path approach. In order to move faster USVRON-3 was having to stand up without having any of the answers to the DOTMLPF-P. This created challenges that sound simple but are difficult for a 500,000 person organization of the US Navy. Part of the challenge imposed on USVRON-3 was to help in building the DOTMLPF-P plan, which created a dilemma of having to figure out the plan but without having all of the resources needed to create the plan.

8.1.5 Overall Accelerated the Fielding of a Capability from Concept to Scale from 10+ years to ~3 years.

Successfully accelerated the process of fielding a capability from concept to fielding of a scaled capability from 10+ years to ~3 years.

The primary objective of this research was to develop a repeatable process that can be used as a means to more rapidly develop, acquire, field, and implement new capabilities to the Navy as compared to the traditional requirements, resourcing, and major capability acquisition process. This effort was successfully able to demonstrate a means to go from an idea to a fielded and scaled capability in only three years. This process would usually take 10+ years. The path to get there was chaotic at times, but demonstrated repeatable path is the primary contribution of this research.

8.2 Publications

The results of this dissertation have been organized into three separate publications. Two of these publications are currently under review, and one has been published. These are described below.

Journal Article. A summary of research aims 1-3 have been compiled into a journal article and submitted to the American Society of Naval Engineers (ASNE) Journal. This journal was selected because of the strong alignment to the field of naval engineering.

- **Phillips, J.**, & Gallegos, E. E. (under review, submitted May 2025). Accelerating capability to the fleet: Rapid fielding of small unmanned surface vehicles. *Naval Engineers Journal.*

Article Targeting Peers. A second article has been submitted to the War on the Rocks and to the United States Naval Institute Proceedings. These two publications were selected because they are well respected in Defense circles and focus on providing a platform for those with extensive experience and expertise.

- **Phillips, J.** (under review, submitted April 2025). The role of naval warfare centers in accelerating fielding of capability to the fleet. *War on the Rocks.* May 3rd, asked to be a guest on new Podcast called Cogs on the Rocks, awaiting confirmation date and time.
- **Phillips, J.** (under review, submitted May 2025). The role of naval warfare centers in accelerating fielding of capability to the fleet. *United States Naval Institute Proceedings.* Submitted to USNI Proceedings after clearing with War on the Rocks that there would not be a conflict with my participation on their Podcast.

Technical Report. My third publication was more of a team effort through the Department of the Navy Science and Technology Board for which I served as the Executive Secretary. The DON S&T Board, *Path Forward for Unmanned Systems,* was cleared for publication on December 3rd, 2024, and posted on the Secretary of the Navy's website. I contributed to that publication, and I am included in that publication as the executive secretary of the DON S&T Robotics and AI team.

- Fox, C**., Phillips, J.**, Calderon, B., Work, B., Blank, S., Norman, J., Brasseur, M, Brown, M., Terlitsky, N., & Anderson, N. (2024). *The Path Forward on Unmanned Systems.* Department of the Navy: Science and Technology Board.

The most difficult part of the publishing process was getting through the public release approval process of the US Navy. I had to share my publications with numerous colleagues to get buy in and concurrence. Each iteration led to reducing the level of detail to ensure the material was appropriate for public release. Fortunately, this process also provided me with an overwhelmingly positive peer review.

8.3 Conference Presentations

In addition to these three publications, I briefed concepts from this dissertation to six different conferences listed below.

- Surface Warfare Improvement Plan Conference at Surface, Mine Warfare, Development Center. San Diego, CA: November 2023.
- Charleston Defense Contractors Association Conference. Charleston, SC: 8 December 2022.
- Fourth Fleet Hybrid Fleet Experiment Distinguished Visitors Day. Key West, Florida: 28 September 2024.
- Naval Innovation Science and Engineering Technical Exchange Meeting Conference, NSWC Crane. Crane Indiana: 10-12 September 2024.
- Unmanned Surface Vehicle Summit. NSWC Carderock, MD: 19 January 2025.
- Office of the Undersecretary of Defense for Research and Engineering, Maritime Portfolio Workshop, Johns Hopkins Applied Physics Laboratory, MD: 27 January 2025.

REFERENCES

Adaptive Acquisition Framework. (2024, October). *Defense Acquisition University*. https://aaf.dau.edu/

Anton, P., Mansouri, M., McGrath, M., Schlomer, D., & Verma, D. (2022). *Joint Capabilities Integration and Development System (JCIDS) - The Acquisition Innovation Research Center*. https://acqirc.org/publications/research/joint-capabilities-integration-and-development-system-jcids/

Blank, S. (2018, February 12). The National Defense Strategy: A Compelling Call For Defense Innovation. *War on the Rocks.*

Cardon, M., McGrath, M., & Tao, J. (2024). *Innovative Ideas and Insights for Improving Resourcing across Seams*. Naval Postgraduate School, Acquisition Research Program Excerpt From the Proceedings of the Twenty-First Annual Acquisition Research Symposium.

Couchman, D. (2024, August). *PPBE and JCIDs for the rest of us*.

Christensen, C.M. (2016). *The Innovator's Dilemma.* Harvard Business Review Press.

Del Toro, C. (2024). *Naval Science and Technology Strategy*. U.S. Department of Defense. https://media.defense.gov/2024/Apr/09/2003434522/-1/-1/0/2024%20NAVAL%20ST%20STRATEGY_FINAL.PDF

Department of Defense. (2008). *DOD Instruction 7000.14-R: Financial Management Regulation Volume 2A*. https://comptroller.defense.gov/Portals/45/documents/fmr/current/02a/02a_01.pdf

Department of Defense. (2019, December). *DOD Instruction 5000.80: Operation of the Middle Tier of Acquisition (MTA)*. Office of the Undersecretary of Defense for Acquisition and Sustainment.

Department of Defense. (2019, December). *DOD Instruction 5000.81: Urgent Capability Acquisition*. Office of the Undersecretary of Defense for Acquisition and Sustainment.

Department of Defense. (2021, November). DOD Instruction 5000.85: Major Capability Acquisition. Office of the Under Secretary of Defense for Acquisition and Sustainment.

Department of Defense. (2022, June). *DOD Instruction 5000.02: Operation of the Adaptive Acquisition Framework*. Office of the Undersecretary of Defense for Acquisition and Sustainment.

Department of Defense. (2022, July). *DOD Directive 5000.01: The Defense Acquisition System*. Office of the Under Secretary of Defense for Acquisition and Sustainment.

Department of Defense. (2022, October). *DOD Rapid Prototyping Guidebook.* Office of the Undersecretary of Defense for Acquisition and Sustainment.

Duffy, W. (2024, October 28). Tech FLEX: ONR SCOUT experimentation event showcases value of unmanned vehicles. *U.S. Navy*. https://www.navy.mil/DesktopModules/ArticleCS/Print.aspx?PortalId=1&ModuleId=523&Article=3203867

Eckstein, M. (2023, July 20). US Navy 'operationalizes' drones in 4th Fleet exercise. *Defense News*. https://www.defensenews.com/naval/2023/07/20/us-navy-operationalizes-drones-in-4th-fleets-unitas-event/

Franchetti, L. (2024). *Chief of Naval Operations Navigation Plan*. U.S. Department of the Navy.

Hegseth, P. (2025). *Directing Modern Software Acquisition to Maximize Lethality.* U.S. Office of the Secretary of Defense.

Horne, S. (2022). *Creating Innovation Navigators: Achieving Mission Through Innovation.*

Joint Requirements Oversight Council. (2021, October 30). *Manual for the operation of the Joint Capabilities Integration and Development System*. https://www.dau.edu/sites/default/files/2024-01/Manual%20-%20JCIDS%20Oct%202021.pdf

Karamitsos, I., Albarhami, S., & Apostolopoulos, C. (2020). Applying DevOps practices of continuous automation for machine learning. *Information, 11*(7), 363. https://doi.org/10.3390/info11070363

Katz, J. (2023, September 28). Navy stands up Disruptive Capabilities Office. *Breaking Defense*. https://breakingdefense.com/2023/09/navy-stands-up-disruptive-capabilities-office/

Katz, J. (2024, February 14). US Pacific Fleet to stand up second unmanned surface vessel squadron this year. *Breaking Defense*. https://breakingdefense.com/2024/02/us-pacific-fleet-to-stand-up-second-unmanned-surface-vessel-squadron-this-year/

Lopez, C. T. (2023). *Parallel processes can speed up weapons acquisition, vice chairman says*. U.S. Department of Defense. https://www.defense.gov/News/News-

Stories/Article/Article/3356205/parallel-processes-can-speed-up-weapons-acquisition-vice-chairman-says/

Mattis, J. (2018). *National Defense Strategy.* Department of Defense.

McGarry, B. (2022). *DOD Planning, Programming, Budgeting, and Execution (PPBE): Overview and Selected Issues for Congress.* Congressional Research Service.

Middle Tier of Acquisitions. (2024, November). *Defense Acquisition University*. https://aaf.dau.edu/aaf/mta/

Moore, D. (2023). Increasing technological innovation to the warfighter. *Defense Acquisition University*. https://www.dau.edu/sites/default/files/Migrate/EventAttachments/1085/DAU%20Tech%20Transition%20Dr%20Moore%20July%20262023Final.pdf

Oakley, S. (2019). *DOD Acquisition Reform: Leadership Attention Needed to Effectively Implement Changes to Acquisition Oversight.* Government Accountability Office https://www.gao.gov/products/gao-19-439

Oakley, S. (2023, February 7). *Middle-tier defense acquisitions: Rapid prototyping and fielding requires changes to oversight and development approaches* (GAO-23-105008). U.S. Government Accountability Office.

Oakley, S. (2024). *DOD Acquisition Reform: Military departments should take steps to facilitate speed and innovation*. Government Accountability Office. https://www.gao.gov/assets/gao-25-107003.pdf

Planning, Programming, Budgeting, Execution Process (PPBE). (n.d.). *Defense Acquisition University*. https://www.dau.edu/acquipedia-article/planning-programming-budgeting-execution-process-ppbe

Richardson, J. (2019, February 15). *OPNAV Instruction 3000.16: Navy integrated readiness*.

Sinsay, J. D. (2018). Re-imagining rotorcraft advanced design. *The Aeronautical Journal, 122*(1256), 1497–1521. https://doi.org/10.1017/aer.2018.107

Trump, D. (2025). *Modernizing Defense Acquisitions and Spurring Innovation in the Defense Industrial Base Executive Order.*

Trump, D. (2025). *Restoring Common Sense to Federal Procurement Executive Order.*

Urgent Capability Acquisition. (2024, November). *Defense Acquisition University*. https://aaf.dau.edu/aaf/uca/

U.S. House of Representatives. (2024). *10 USC 4001: Research and Development Projects*. https://uscode.house.gov/view.xhtml?req=granuleid:USC-prelim-title10-section4001&num=0&edition=prelim

Webster, J. (2024). *The Middle Tier of Acquisition: Speed vs Rigor*. Defense Acquisition University Journal.