



Chapter Title: Introduction

Book Title: Assessing Aegis Program Transition to an Open-Architecture Model

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Published by: RAND Corporation

Stable URL: <https://www.jstor.org/stable/10.7249/j.ctt5hhsmj.9>

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Introduction

The Navy's transition from its legacy Aegis business model to its new Integrated Warfare Systems (IWS) business model¹ may introduce new challenges and risks for the fleet and for the enterprise that develops and fields the Aegis weapon system (AWS). Under the legacy business model, the AWS used proprietary software operating on military-specification (MILSPEC) computing hardware. Upgrades to the Aegis combat system (ACS) were developed every five to six years and fielded only to new-construction ships and those receiving a midlife upgrade.² Older baselines were upgraded to support additional capabilities, fix computer software errors, and support upgrades to ACS elements. Upgrades or modifications to deployed Aegis systems to support ACS element upgrades put a significant demand on the Aegis technical infrastructure. The new IWS business model will use open-architecture (OA) software operating on commercial off-the-shelf (COTS) computing hardware. The IWS model will also involve periodic upgrades to all ships, both new and in-service. Software will be upgraded through advanced capability builds (ACBs) every four years. These upgrades will occur independently of computing hardware

¹ The IWS business model is articulated in the Program Executive Office (PEO) Integrated Warfare Systems Acquisition Management Plan (2013).

² AWS refers specifically to the computer software and hardware, radar system (SPY-1), and vertical launch system onboard an Aegis ship. The additional sensors, communication systems, weapons, and countermeasures are part of the broader ACS.

upgrades, called technology insertions (TIs), which will take place every four years, with individual ships receiving every other upgrade.³

The IWS business model for managing the acquisition of AWS upgrades has four critical components. First, the model periodically distributes capability upgrades to both new and in-service ships using concurrent development and sequential integration and testing (I&T). Second, the IWS business model aims to improve the efficiency of weapon system development and support by using modern software engineering processes that enable continuous development rather than the sequential process inherent under the legacy business model. Third, the IWS business model attempts to foster competition by allowing the Navy to seek bids from multiple commercial vendors for developing individual components of the weapon system software. Finally, the model ideally allows the Navy to leverage points of overlap in capability development across weapon systems. For example, each weapon system has a software component that manages detected threat tracks (a so-called track manager). Under the legacy business model, track managers were developed and implemented separately, but under the IWS business model, the Navy intends to develop a single track manager that would be available to all systems.

The IWS business model pertains primarily to a development program (see PEO for Integrated Warfare Systems, 2013). However, this business model will affect the entire Aegis lifecycle. The development, integration, and testing schedule will quicken to support a four-year cycle time. The Navy will have to support multiple ship upgrades each year. The in-service support infrastructure will no longer have to maintain MILSPEC software and hardware for the life of the ship; rather, it will maintain a constantly evolving set of COTS-based computing hardware and middleware. In this report, we focus on the development, integration and testing, and fielding of Aegis upgrades. Specifically, the report attempts to answer the following questions:

³ Individual ACBs and TIs are named according to the year of their fielding, so ACB-08 is the name of the ACB schedule for fielding in 2008.

- How does the Navy currently develop, test, and field upgrades to the AWS, and how will that process change under the IWS business model?
- How does the IWS business model affect AWS modernization and fielding rates in terms of both the technical infrastructure and fleet capabilities?
- What modernization rate under the IWS business model should be recommended to the Navy to balance fleet capability, risk, and cost?

It is important for the Navy to answer these questions in a timely manner. The Navy's surface fleet has already begun to transition to an OA construct operating on COTS computer equipment. Without a well-thought-out modernization program, the fleet will experience increasingly challenging obsolescence issues. Additionally, the introduction of new capabilities into the Aegis fleet is likely to quicken over the next decade due to ballistic and cruise missile defense requirements. The Aegis fleet is the backbone of the Navy's surface fleet and, with these new capabilities, it will remain so for decades.

Research Approach

In the first decade of the 21st century, the Navy's PEO for Integrated Warfare Systems fielded four configurations of the AWS. This report examines the technical infrastructure required to develop future versions of OA Aegis upgrades.

First, we conducted semistructured interviews with industry and government representatives from the Aegis enterprise, including PEO Integrated Warfare Systems, Lockheed Martin, the Aegis Technical Representative (Aegis TECHREP), the Naval Surface Warfare Center (NSWC) Dahlgren Division, the NSWC Port Hueneme Division, the NSWC Corona Division, the Surface Combat Systems Center (SCSC), and the Combat Systems Engineering Development Site (CSEDS). These interviews focused on characterizing the legacy approach to developing, fielding, and supporting the AWS and on understanding

each representative's view of how the IWS business model might affect the enterprise.

Second, we interviewed industry and government representatives from the Acoustic Rapid COTS Insertion (ARCI) and Ship Self-Defense System (SSDS) enterprises, including Raytheon and PEO Submarines. These interviews focused on understanding lessons learned from ARCI's and SSDS's unique experiences in transitioning to an OA-based approach.

Third, we collected historical workforce and facility usage data from key organizations and facilities in the Aegis enterprise. These data allowed us to characterize the historical effort involved in developing, integrating, and testing legacy baselines and ACBs and provided a basis for characterizing the choices and trade-offs involved in transitioning to the IWS business model.

Fourth, we developed a simulation model to estimate the effect of both the IWS business model and the Aegis modernization rate on the fleet. The simulation model allows the drumbeat of software and hardware upgrades to vary independently of each other. In the context of this report, *drumbeat* refers to the periodicity of an update. For example, a software update drumbeat of two years means that PEO Integrated Warfare Systems develops and fields an AWS software upgrade every two years. Additionally, the simulation model allows individual ships to receive either every upgrade or every other upgrade.

Finally, we developed a spreadsheet model to estimate the technical infrastructure required to develop, integrate, and test AWS upgrades. Using Naval Surface Warfare Center (NSWC) and prime contractor data on personnel, facility usage, and cost, we applied the model to varying assumptions regarding upgrade drumbeats and level of effort.

This report focuses on the development, integration, testing, and fielding of periodic updates to the Aegis fleet under the proposed IWS business model. Decisions made by the Navy in implementing the model will strongly affect Aegis training resources. Training resources—including instructors, equipment and laboratory space—are limited and could be a constraint during implementation. This

report, however, does not assess the impact of the IWS business model on Aegis training resources.

A previous report documented the methods and findings of this research effort but incorporated proprietary information. This report does not contain any proprietary information and incorporates the most recent Navy Aegis modernization approach.

Organization of This Report

Chapter Two describes the IWS business model and the Aegis fleet's transition to an OA-based approach. Chapter Three describes the scope of the Navy's Aegis technical enterprise, as well as addresses the organizations that participate in deploying and maintaining the Aegis fleet and examines the nature of their participation. Chapter Four describes the impact of Aegis modernization rates and PEO Integrated Warfare Systems decisionmaking on the Aegis fleet. Chapter Five discusses the implications of that decisionmaking for the Aegis development enterprise. Chapter Six explains the risks that PEO Integrated Warfare Systems will face as it implements its business model. Chapter Seven examines the lessons learned from ARCI and SSDS as they apply to the AWS. Chapter Eight presents our proposed implementation of AWS upgrades and summarizes our analysis.

