2004-09-02

Conceptual System of Systems Enabling Maritime Dominance in the Littorals

Holmes, Matt; Huynh, Tom; Kline, Jeff; Winslow, Jeff

Monterey California. Naval Postgraduate School

https://hdl.handle.net/10945/42182

SEA5 Executive Summary
Maritime Dominance in the Littorals

With the Soviet decline as a combat competitor to the United States, operational concerns shifted from blue water to littoral regions. Unlike blue-water combat operations, the responsive reaction time of the warfighter in littoral combat operations is reduced, as he is now closer to the threat, and sensor response and performance are degraded by the rapidly changing littoral environment. A shift towards littoral combat operations thus requires that a System of Systems (SoS) be capable of overcoming the challenge of short reaction times imposed by littoral environments. (A System of Systems is an aggregation of independent systems interlinked to execute a military mission.)

In this AY 2004 integrated project, Deputy Chief of Naval Operations Office for Warfare Requirements (CNO N7), tasked the Systems Engineering and Analysis Cohort-5 (SEA5) to define alternatives for a conceptual System of Systems (SoS) and then recommend a future SoS with its concept of operations that would enable key SEA POWER 21 concepts of SEA BASING and SEA STRIKE. The SoS is to **gain maritime dominance in the littorals** in the 2020 timeframe.

The Department of the Navy (DoN) defines SEA BASING as the massing of supplies and equipment on a seaborne platform hosting a family of systems that maximize projection of Naval Power. SEA STRIKE is the projection of power from sea-based assets to all littoral targets.

The SoS would consist of manned and unmanned systems. The unmanned systems would include future platforms and programs of record. The manned systems would include current platforms, future platforms, and programs of record. Assuming a South China Sea scenario described in the Joint Campaign Analysis study [3], the SoS would operate in a littoral area of 200 nautical miles inland to 200 nautical miles off shore. The SoS development would take into account cost, risk to personnel, and its maritime dominance mission effectiveness.

To execute this tasking, SEA5, as project manager and as lead systems engineer, developed a project management plan (PMP) to manage the integrated project, and employed the Systems Engineering Design Process (SEDP) [4] to design the recommended SoS. The PMP provided guidelines and procedures for team formation, project schedule tracking, configuration management, quality assurance, risk mitigation, and contingency planning. The SEDP provided a system design framework for scoping the project problem, generating SoS alternatives, modeling, analyzing and scoring the SoS alternatives, and selecting and implementing the most cost effective and best performing SoS.

Three SoS alternatives were considered: a system of only manned platforms (architecture 1), a system of primarily unmanned platforms (architecture 3) , and a balanced hybrid system of manned and unmanned platforms (architecture 2). These architectures are described at Figures 5 through 7. A cost analysis and a simulative analysis, supported by EXTEND™, Autonomous Littoral Warfare Systems Evaluator (ALWSE), Shallow Water Acoustic Toolset (SWAT), and Microsoft Excel. [5], led to the following findings of this project.

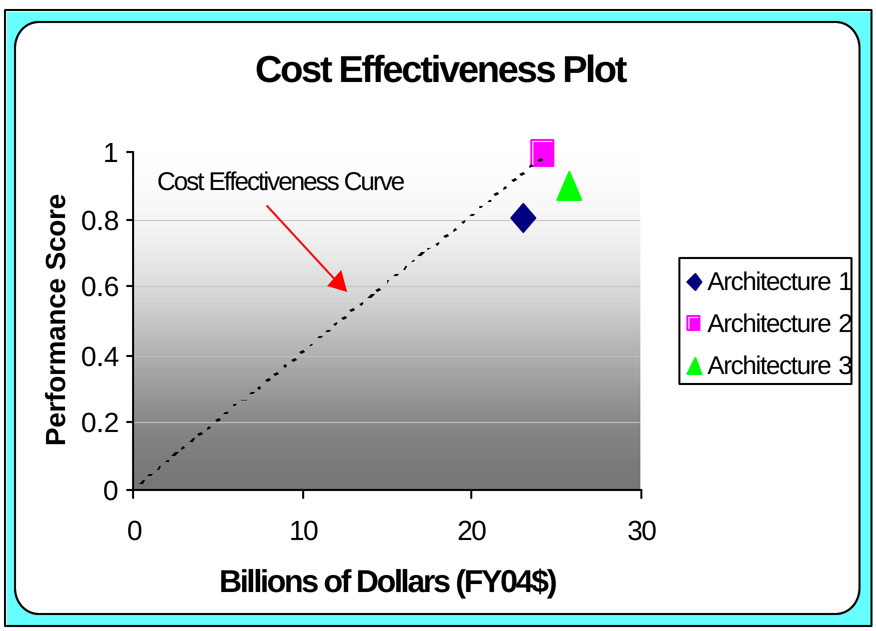

Figure 1. SoS Cost-Effectiveness Plot of Littoral Maritime Dominance Achievement

- Enabling SEA BASING and SEA STRIKE for achieving maritime dominance in the littorals in the 2020 timeframe in a cost effective manner (Figure 1) requires a balanced hybrid system of manned and unmanned platforms in an unmanned-to-manned vehicle ratio of about 1.5 to 1. As shown in Figure 2, the unmanned platforms include medium-class unmanned surface vehicles, large-class unmanned sub-surface vehicles, and three classes of unmanned aerial vehicles (large, medium, and small). The manned platforms are the CVN and its Air Wing (AW) consisting of the F/A-18 and JSF, CG, DDG, LCS, Seawolf SSN, and ship-borne rotor-wing aircraft.

Figure 2. Hybrid System of Manned and Unmanned Systems

- Within each of the three architectures, we evaluated alternate approaches to command and control with the following results:
    - Communications: Platforms in separate enclaves within an enclave communications network communicate with each other through interconnecting hubs. In a distributed communication network, any platform can communicate with any other platform without interconnecting hubs. Compared to enclave and enclave/distributed networks, distributed networks provide for faster dissemination of information and shorter message delays, as shown in Figure 3. In the South China Sea scenario, average message delays for the distributed network are, respectively, one-tenth and one-hundredth of those of the enclave/distributed and enclave networks.

- Command and control: A decentralized C2 systems was shown to be more effective than a centralized structure. While command and control authority resides at a single platform in a centralized command and control structure, decentralized command and control disperses C2 authority to multiple subordinate platforms. Unlike centralized C2, decentralized C2 reduces single-node workload and prevents C2 collapse in the event of C2 node loss. Decentralizing command and control also results in a decrease in command message delays by a factor of 10, as shown in Figure 4.

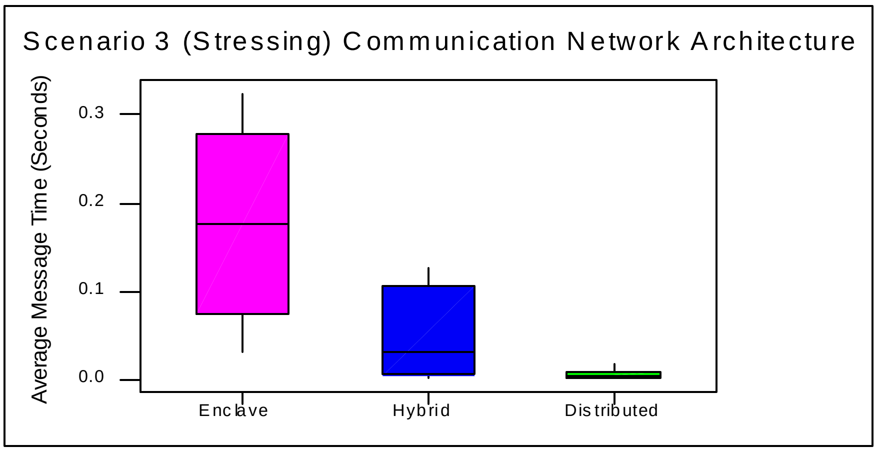

Figure 3. Message Delays for COMMS Network Architectures

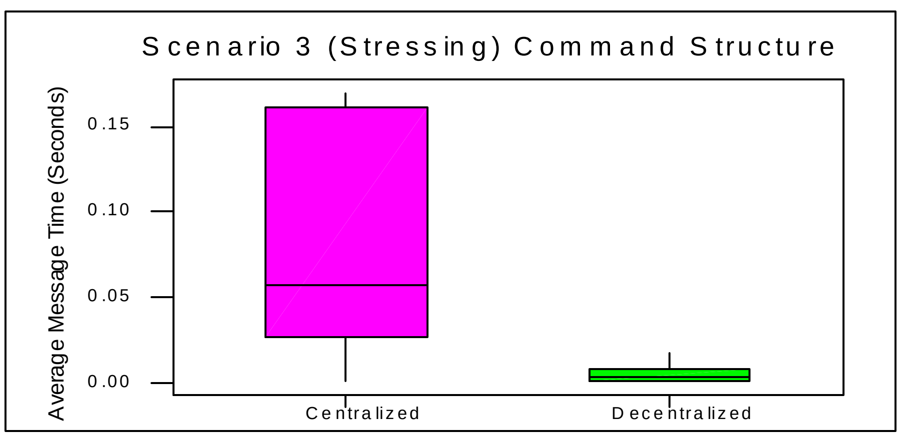

Figure 4. Message Delays for Command and Control Architectures

As implied by the project findings, a system of only unmanned platforms does not provide a silver-bullet solution to the problem of maritime dominance in the littorals;

unmanned platforms thus complement but cannot replace manned systems. Manned platforms are still required to implement crucial operational decisions. Unmanned vehicles in the 2020 timeframe by themselves will not have the ability to adapt to dynamic threat environments. Manned platforms will therefore remain an essential command and control element in military force structures. Furthermore, limited in endurance and thereby requiring manned system support, unmanned vehicles cannot completely keep personnel out of harm's way; yet they greatly reduce the level of risk to which personnel are exposed.

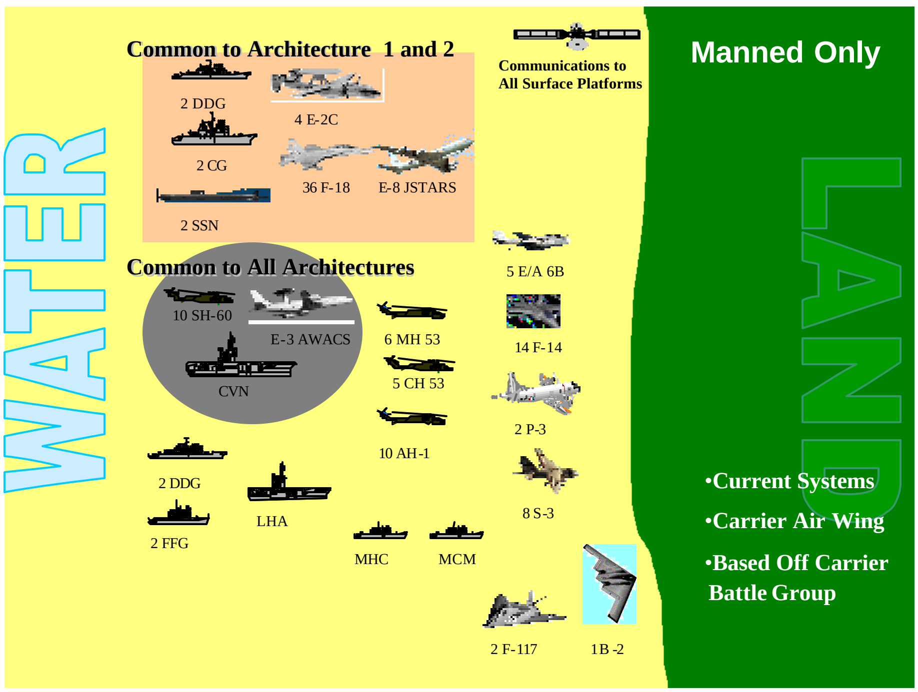

Figure 5. Architecture 1, current programs of record. Items common to other architectures are identified by shaded regions.

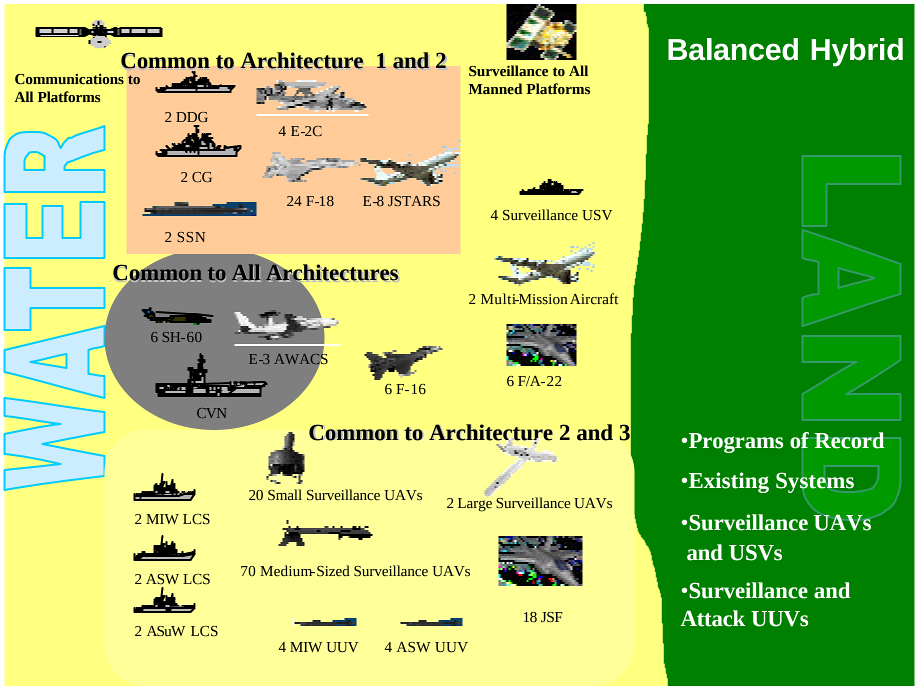

Figure 6. Architecture 2, the balanced manned and unmanned systems approach. Systems common to other architectures are identified in shaded regions.

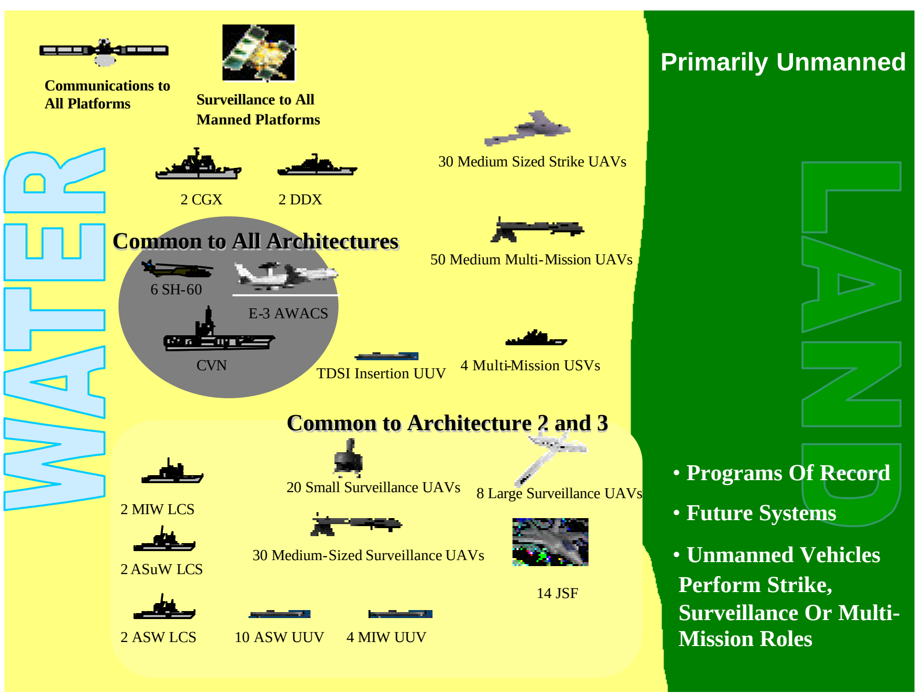

Figure 7. Architecture 3, the predominantly unmanned architecture. Systems common to other architectures are identified in the shaded regions.