

## HORIZONTAL SYSTEM-OF-SYSTEMS INTEGRATION VIA COMMONALITY

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**Problem** – The U.S. Army’s Future Force Unit of Action (UA) will implement advanced information technology to create a lightly armored, highly mobile, self sustaining force that trades tons of armor for gigabytes of information. Combat superiority will be achieved through a distributed, tightly coupled system of systems (SoS) that includes current forces and new offensive systems. These systems are coupled via information assets with a backbone of a distributed, secure, mobile, ubiquitous, *ad hoc*, communications network. This approach enables a revolutionary paradigm of: “see first, understand first, act first, and finish decisively.” The underlying technologies are: (1) accurate and timely data gathering; (2) high-speed networks to acquire and distribute the information; (3) high-performance computers to process the information; and (4) advanced weapons systems for use by highly trained soldiers. Item (1) involves Intelligence, Surveillance and Reconnaissance (ISR) to gather pertinent sensor data. Item (3) consists of computers on the battlefield and elsewhere. Item (4) includes (un)manned air/ground vehicles, sensors, weapon/munitions systems (lethal and non lethal). The UA basis for action and decision-making is the integrated combination of C4ISR: Command and Control (C2), Communications, Computers, Intelligence, Surveillance and Reconnaissance. Horizontal integration across all SoS components is essential, but current force systems lack such integration because (in a real-world technical sense) the methods for such integration have only recently become available or envisioned.

**Solution** – Our team is identifying examples of UA software commonality. A product of this effort is a methodology to assist the Lead Systems Integrator (LSI) in the integration of the complex UA SoS. Our work addresses the UA requirements (future goal), the LSI’s architecture (present), and M&S models (past). This effort includes the following FY04 tasks: (1) explicit enumeration of the necessary functions (functional decomposition) that comprise one UA Integrated Process (IP), as a sequence of well-defined steps to perform a specific mission for C2, communications, and sensors (including ISR); (2) correspondence of the functional decomposition from (1) with the ORD requirements and determination of any gaps; (3) characterization of three representative Army models and their correspondence to the functional decomposition from (1); and (4) determination of functions that are common (functional commonality, which is defined in detail below) across (1) - (3).

Three benefits arise from functional commonality, namely: (a) overlaps, where simulations, models and systems can be integrated; (b) opportunities for software re-use; and (c) assurance of necessary and sufficient horizontal SoS integration, in terms of data parameterization and algorithms. Present work focuses on a small portion (a narrow slice) of the available results of functional decomposition (FD). (Indeed, a number of different FDs exist, from which we have chosen one from the LSI as representative.) We seek a tractable and defensible approach that is also scalable and testable for the remainder of the UA domain. Functional decomposition is one tool to identify examples of commonality. The initial slice is the Networked Fires IP (IP03), which establishes the necessary ISR, invokes the necessary communications load and network infrastructure, and requires an appropriate level of C2 to represent a potentially rich arena for this fiscal year’s analysis.

The significant accomplishments to date are as follows:

- First, we have achieved a functional decomposition of the UA activities for planning, execution, assessment, and supporting use cases for the networked-fires Integrated Process (IP) on the basis of the LSI's hierarchical list of system functions.
- Second, we have developed a series of definitions for function, commonality at the level of input/output, commonality at the functional level, systems integration, etc. These concepts provide a framework for on-going methodology development.
- Third, we have identified functional commonalities within the networked-fires Integrated Process, among C2, ISR, and Communications. The presence of commonality just within the networked fires IP is very significant for software re-use, coding efficiency, and assurance of UA SoS horizontal integration.
- Fourth, we have begun characterization of the Army's current M&S models as sources (resources) toward identification of any useful commonality in those existing packages.

We find that the steps for the Air Defense IP and for the Conduct Cooperative Engagement IP are identical to the NF IP. Thus, our findings for functional decomposition and commonality apply to three IPs (not one).

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