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On Commonality

Introduction. This paper discusses one of the challenges that the Department of Defense faces in realizing the vision articulated in Joint Vision 2010 and Joint Vision 2020, and in implementing JROC-validated Capstone Requirements Documents. Left unresolved, experience shows this challenge will ensure present joint requirements cannot be met in today's resource-constrained environment.

Issue. The DoD drive toward reliance on networking systems to achieve a force-multiplier effect (a concept called Network Centric Warfare) should cause an examination of the effects observed by the warfighter that are caused by this trend to interconnect systems. As the robustness of communication channels has increased, so has the frequency of "interoperability" shortfall complaints. Communications-related data loss no longer completely masks the problems caused by disparate processing algorithms, and improvements in display technology cause warfighters to become increasingly unsatisfied with the confusing "picture" provided.

For an ensemble of systems to achieve a specified level of warfighting capability, several necessary conditions exist. First, a communication medium (or media) must be defined using a protocol that can be implemented by all participants. This can be a radio-frequency waveform and associated radio-to-radio protocol; devices such as JTIDS or MIDS terminals provide this functionality. These terminals are commodities; they are purchased and integrated into larger systems. Functions such as waveform generation and the packing of information into that waveform were intended to be accomplished in a common way to ensure compatibility and to avoid lifecycle costs that would be incurred by the necessity to qualify and maintain two or more configurations. We may have strayed from that goal, somewhat, but the original plan was fundamentally correct. The Cooperative Engagement Capability (CEC) is predicated upon common implementation for similar reasons. While the input stream received by each unit is not

necessarily identical, the processing that is done on each stream is identical so we can achieve as close to a consistent state among participants as possible.

Our present tactical command and control systems form a distributed, transaction-based, computing system that exchanges information for the purpose of supporting ordnance allocation and situational awareness, among other purposes. Network participants exchange messages, such as track starts and drops, track states, and force orders and unit state information. Most of the functions that must be performed to participate on the Tactical Data Link are not performed by the terminals, but by the "host" computers (or operators) in a given warfighting unit. The generation and processing of information that is exchanged by the terminals is done outside the terminals, and is accomplished in a different way in each participant. It is this different processing that results in the different "displays" that the warfighters see, and it is these different "displays" that cause reports of "interoperability problems".

Approach. We already employ common computer programs within DoD for certain functions. At the tactically (but not financially) trivial level, we have largely converged on a single implementation of office data processing, electronic mail, and World Wide Web browsing functionality. While some of this functionality is described by widely-adopted industry standards, most is described by *de facto* standards to which we are driven by market forces. Each Service is moving in this direction for computer programs that express mission-critical functionality. There are three reasons that are typically given for converging to a single implementation of critical functionality:

- Life-cycle cost avoidance by reducing the numbers of unique computer program configurations that must be maintained
- Time-to-market reduction by reducing the number of configurations that must be changed to implement new or modified functionality, and to reduce the time needed for regression testing and certification
- Interoperability through commonality of critical functionality implementation

If DoD were to objectively examine the functionality that is required to meet JROC-validated Capstone Requirements,

the allocation of that functionality to specific warfighting units, the level of system and ensemble performance that is required, and the options available to provide that level of performance, there will be increased pressure to reduce the number of independent configurations. Each Service is coming to that realization independently - what we lack is a unifying force to cause that realization to occur in a joint context.

Since the Services are already coming to the realization that convergence is necessary, we can leverage that understanding to take the next step. Use the requirement to build and maintain an integrated architecture to demonstrate functional commonality among the Services, then press to jointly acquire the computer programs that express this common functionality. The Services would integrate these computer programs into existing and emerging systems; this causes these computer programs to look like commodities such as JTIDS and MIDS terminals. Maintenance of these computer programs would be centralized, as well, to ensure commonality throughout the life-cycle.

While common implementations are very attractive from a cost and performance perspective, there are pitfalls that must be avoided or mitigated. These include:

- Cultural resistance
 - Centralized management of critical functionality will be perceived as a threat by Program Managers -- this is a somewhat specious and emotional argument, as PMs are already dependent on others for success; critical components of any moderately complex system are always made by others. Past studies have side-stepped this issue by asserting the need for "functionally equivalent" computer programs, leaving the implementation of "functional equivalence" as an exercise for the reader.
 - Programs that cross Service lines are even more difficult to manage than single-Service programs, because of Service agendas and the need to cross-link funding lines

- Reward mechanism

- If we continue to buy widgets, and not capabilities, we must change the reward mechanism so individuals are incentivized to make widgets that work as an ensemble

-Labor pool

- Defense industries are finding it increasingly difficult to attract and retain the skilled labor necessary to develop and maintain computer programs, particularly those that are mission-critical. Computer programs that express Tactical Command and Control functionality must be engineered to the stringent performance and reliability requirements used in other mission-critical systems. These systems do more than deliver a "picture" -- they allocate and control ordnance, among other important functions.

Recommendation. To realize the benefits described above (reduced life-cycle cost, reduced time required to field new and modified capability, and improved capability through common implementation of functionality), the Defense Acquisition Executive should direct that all systems that process data that is obtained from, or provided to, a tactical data link use common implementations for common functions, in addition to meeting well-defined and controlled interface standards.