NPS-AM-09-019

EXCERPT FROM THE PROCEEDINGS

OF THE

SIXTH ANNUAL ACQUISITION RESEARCH SYMPOSIUM

IMPLEMENTATION OF A METHODOLOGY SUPPORTING A COMPREHENSIVE SYSTEM-OF-SYSTEMS MATURITY ANALYSIS FOR USE BY THE LITTORAL COMBAT SHIP MISSION MODULE PROGRAM

Published: 22 April 2009

by

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6th Annual Acquisition Research Symposium of the Naval Postgraduate School:

Volume I: Defense Acquisition in Transition

May 13-14, 2009

Prepared for: Naval Postgraduate School, Monterey, California 93943

The research presented at the symposium was supported by the Acquisition Chair of the Graduate School of Business & Public Policy at the Naval Postgraduate School.

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Implementation of a Methodology Supporting a Comprehensive System-of-systems Maturity Analysis for Use by the Littoral Combat Ship Mission Module Program

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Mr. Ken Michaud assumed his current responsibilities as Acquisition Manager for Littoral Combat Ship (LCS) Mission Modules Program Office (PMS 420) under the Program Executive Officer for Littoral and Mine Warfare in January 2008. Prior to that, he was the Anti-Submarine Warfare (ASW) Assistant Program Manager (APM) within PMS 420 for over four years. He has served in the ASW community for over 20 years. As the Acquisition Manager, Michaud is responsible for a full range of acquisition and business planning tasks, including financial planning, program control, production and manufacturing coordination, and lifecycle planning. He provides leadership in the areas of acquisition through policy development, performance measurement and training.

Abstract

A core tenet of spiral development and evolutionary acquisition concepts is the ability to insert new technologies into an existing system on an as-needed basis, as they mature, in order to minimize risk and maximize affordability. Through this continual rolling in of evolving components the system continues to offer more advanced capability. This creates an elaborate tradeoff scenario in which dissimilar attributes must be examined, weighted, and analyzed for best value and applicability to user needs and requirements, including timing. A further complication for system-of-systems is added by the need to give equal consideration and analysis to each technology's ability to be integrated with existing system components in a functional architecture as well as any impact on current and interconnected capabilities. To address this need for a multi-attribute decision-making tool, NAVSEA and the Northrop

Grumman Corporation, along with partners at the Stevens Institute of Technology and SPAWARSYSCEN Pacific, have collaborated to define a holistic approach for evaluating technology insertion options from a complex system-of-systems integration perspective. Through this paper, we will discuss the tool's potential to aid the decision-maker in the selection of best value technologies and its potential utility as a critical piece of the unified system engineering and acquisition process.

Overview of the Current System-of-systems (SoS) Acquisition Environment

Current Department of Defense (DoD) acquisition activities continue to push the integration envelope with the development of larger and more complex systems-of-systems. In many ways, this development paradigm invalidates many of the models, historical databases, and even engineering expertise that have been used for decades in the development of stand-alone systems. Similarly, the system-of-systems revolution has made management of acquisition programs more difficult, as keeping accurate and current control of the countless moving parts of systems development is nearly impossible due to the exponential growth of technologies and integrations being incorporated under a common system-of-systems banner. This fact necessitates the development of a new set of tools and best practices in order to manage the many unique aspects of development associated with system-of-systems.

Unique SoS monitoring, assessment, and management needs

Nowhere is the need for enhanced monitoring capabilities more visible than in the SoS development maturity. For the better part of two decades, the Technology Readiness Level (TRL) methodology has been key in gauging the current maturity status of a given piece of technology within the DoD. By monitoring capability development from concept definition through operations and support using the TRL series of nine levels of maturity, the readiness of a technology for integration into a system has been adjudicated. In countless development efforts, TRL has been key in indicating progress and has aided dramatically in keeping numerous programs on track. Indeed, it has been incorporated as a critical tollgate criterion in the Defense Acquisition Milestone process. However, when TRL is applied to components within a system-of-systems, the model of using individual technology maturity as a measure of readiness to integrate into system development quickly breaks down. TRLs do not account for integration maturity or the complexity of bringing together any number of independent technologies to function as a common system. Similar problems also become apparent with many other technology development tools when applied in a system-of-systems context. This lack of adequate system-of-systems level development monitoring tools and methodologies has resulted in a rash of complex development and acquisition projects going astray. The General Accounting Office (GAO) noted that a lack of insight into the technical maturity of complex systems during development has contributed to an environment of significant cost overruns, schedules slips leading to program delays, canceled acquisition efforts, and reduced system performance at fielding (2006). In case after case, failure is not commonly found at the technology development level, but rather at the point of combination of two or more elements.

In order to mitigate this identified risk, PMS 420, the Littoral Combat Ship Mission Module Program Office has previously implemented an emerging concept known as the System Readiness Level (SRL). By pairing the traditional TRL scale with a new series of criteria known as the Integration Readiness Level (IRL), a more complete look at true system maturity can be obtained (Sauser, Ramirez-Marques, Magnaye & Tan, 2008). Under this methodology the readiness of each technology is still considered, but instead of being a stand-alone metric for determining readiness for incorporation, it is analyzed in concert with both its integration requirements and the maturity of other technologies with which it interfaces. The SRL methodology has been highly successful on the program and has paid dividends in terms of both increasing decision-maker visibility into true system status and allowing for pre-emptive actions to be taken to mitigate potential developmental issues. PMS 420 is looking to expand upon the foundation of system readiness monitoring laid by the SRL concept and expand it to new uses in both guiding technology selection, insertion and tradeoffs as well as for use in cost modeling in order to understand the impacts of implementing technology options.

Initial Step—Understanding the Current System

A core tenet of systems engineering is to fully understand and capture the architectures of the system being developed. This includes obtaining a comprehensive background on the individual components and technologies as well as the ramifications of their proposed integration or networking. In case after case, however, it can be seen that programs have entered acquisition with incomplete or inaccurate mappings of these most basic of considerations. The SRL concept enforces a degree of accountability by requiring consideration be given to mapping of an architecture and the maturity of the individual pieces being brought together prior to action being taken.

Upon the start of the Mission Module Program, the ability to pull together and assess a wide variety of components at numerous developmental maturity states was a necessity. As the provider of a set of interchangeable and standards-based mission modules for the Littoral Combat Ship, PMS 420 was tasked to leverage a considerable amount of technology from existing programs of record in a “come as you are” development effort. This was done to facilitate quick fielding of desperately needed capability in the areas of mine countermeasures, anti-submarine warfare, and surface warfare. This rapid development environment resulted in the selection of technologies from a considerable mix of existing GOTS and COTS products along with new development efforts. Initially, integration of the capabilities was not an objective, but it rapidly became a necessity. Thus, the Mission Module Program needed to track not only the widely varying maturity status of the technologies but also the various integrations activities between them as a critical function of management control. The SRL methodology was used to capture this complex and diverse acquisition effort and provide snapshots of program status, technology maturity and integration risks and issues.

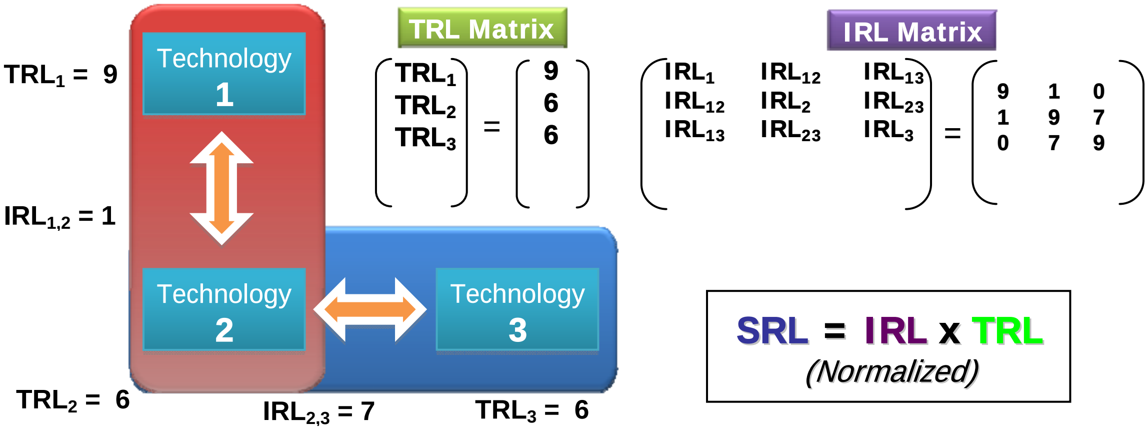
SRL Concept

Since being introduced by NASA in the early 1990’s, the TRL has steady gained widespread acceptance as a powerful tool for its use in assessing technology maturity. In order to build upon the successes of this tool, the SRL methodology leverages the traditional TRL scale as its core for assessing the maturity of individual technologies within the system-of-systems. The TRL scale is then paired with a parallel evaluation scale, known as the IRL, to capture integration status between individual components. Much like the TRL, IRL is a nine-level scale capturing evolving levels of maturity for two components. Though it is natural for integration to slightly lag technology maturity, the IRL closes follows the TRL scale as it tracks integration maturity development from concept to operational system. Table 1 provides a high-level definition of the IRLs (Gove, Sauser & Ramirez-Marquez, 2009). The development of SRL has been led by a joint team of researchers from the Stevens Institute of Technology, Northrop Grumman Corporation, SPAWARSYSCEN Pacific, and PMS 420. Full reports on the creation and validation of the SRL concept have been provided in a series of academic papers and presentations. The concept has powerfully displayed insight into complex system-of-systems development maturity.

Table 1. Integration Readiness Level Definitions

IRL	Definition
9	Integration is Mission Proven through successful mission operations.
8	Actual integration completed and Mission Qualified through test and demonstration, in the system environment.
7	The integration of technologies has been Verified and Validated with sufficient detail to be actionable.
6	The integrating technologies can Accept, Translate, and Structure Information for its intended application.
5	There is sufficient Control between technologies necessary to establish, manage, and terminate the integration.
4	There is sufficient detail in the Quality and Assurance of the integration between technologies.
3	There is Compatibility (i.e., common language) between technologies to orderly and efficiently integrate and interact.
2	There is some level of specificity to characterize the Interaction (i.e., ability to influence) between technologies through their interface.
1	An Interface between technologies has been identified with sufficient detail to allow characterization of the relationship.

One of the most commonly recognized shortcomings of readiness scales is their inherent subjectivity in evaluation due to the fact that ratings are often determined by individual assessors using qualitative data. The SRL methodology implements an analytical approach to help to mitigate some of these concerns. Steps have also been taken to enhance the quality of the TRL and IRL evaluations that feed it by creating detailed evaluation criteria to minimize the opportunity for subjective interpretation. In order to assess the SRL of a given system, each component of the end capability (i.e., single system or a system-of-systems) is rated with respect to its TRL or IRL. These are then combined into a TRL and IRL matrix as shown in Figure 1.



Component SRL = $\begin{pmatrix} SRL_1 & SRL_2 & SRL_3 \end{pmatrix}$ = $\begin{pmatrix} 0.54 & 0.43 & 0.59 \end{pmatrix}$

Component SRL_x represents Technology "X" and its IRLs considered

Composite SRL = 1/3 (0.54 + 0.43 + 0.59) = 0.52

The Composite SRL provides an overall assessment of the system readiness

Figure 1. SRL Calculation

After normalizing, the matrices are multiplied forming a SRL vector. This vector is known as "component SRL" and represents each of the technologies within the system, considering all its integrations. These individual technology SRL assessments provide powerful insight into the maturity and integration status of each technology from an end capability perspective. Additionally, they offer an indication of which elements are lagging and which are ahead in development within the system. The individual SRL scales can also be averaged to provide an overall SRL rating for total system-of-systems capability. This single score is known as a "composite SRL" and functions as a roll-up of the individual component SRLs, providing insight into the level of maturity and integration of the total capability. It is important to note that each assessment is critical to assessing the state of the overall system. Simply examining an overall SRL score does little without understanding the impact of maturity and integration status of each individual component. In a large system, a single immature piece could easily be masked in a composite SRL number but such an act would be evident when assessed at a component SRL level. Likewise, composite SRL provides a good indication of overall development status and the magnitude of remaining work, but it could mask the inability of the system to function due to a single capability with low levels of maturity or integration at a key juncture within the overall system-of-systems.

An overview of the overall SRL assessment is provided in Figure 2. It is important to note that the actual SRL calculation is one part of a larger exercise in defining and evaluating the overall system architecture.

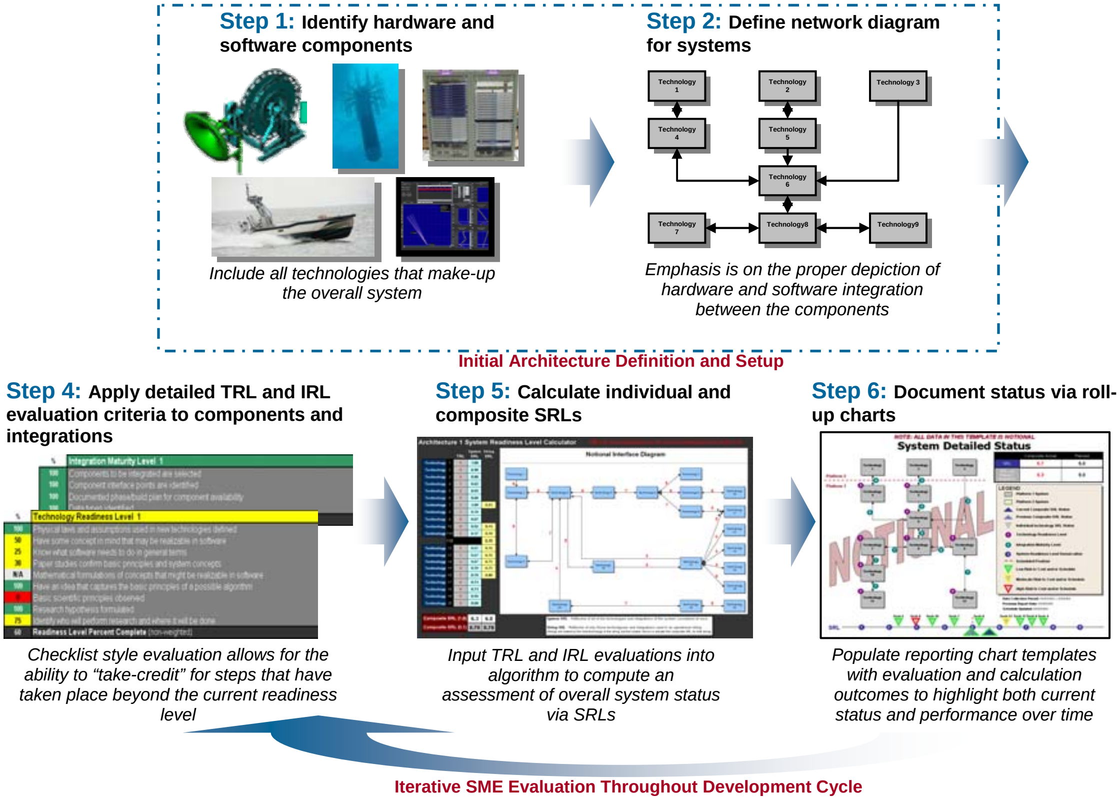


Figure 2. SRL Analysis Process

SRL Applications in Decision-making

The SRL methodology has proven to be of tremendous use and utility in evaluating current status and then providing the needed insight in order to determine the appropriate course of action. In a complex SoS environment, it is not always immediately clear where resources should be applied for most efficient application in order to maximize system maturity and minimize risk. By allowing for trade-off analysis and "what-if" scenarios, the SRL lends itself to analysis of overall system impact, which allows for a wide variety of combinations to be tried before dollars are ever spent. In this way, a new technology or development option can be inserted into the architecture and its impact on overall maturity analyzed. An example of this trade-off analysis as applied on the Mission Module program can be found in Figures 3 and 4.

The figures represent the architecture of one SoS on the Mission Modules Program. Technologies are located in blue boxes while the lines between them denote integrations. The assessed TRL and IRL ratings can be found in teal and purple boxes, respectively. The component SRL ratings are denoted by small triangles across the top of the development scale at the bottom of the figure, while the overall composite SRL readiness number appears underneath the scale. The overall system maturity is exceeding the scheduled development position, which is indicated by the dotted red line and is determined via an SRL to program Integrated Master Schedule mapping. However, one of the system technologies, the MVCS

(RMMV), has fallen significantly behind in planned development. This technology serves as a vital communication link in the command-and-control chain between the ship and an unmanned vehicle. With a risk item in the system development identified, mitigation options were generated, including increasing development resources or inserting an alternate technology. After examining projected performance, cost, and schedule numbers for each option as well the impact on overall system maturity, it was determined that a more mature technology would be inserted for initial spirals. While this option offered less capability in the near-term, it ensured performance requirements were met while enhancing overall system maturity and reducing risk.

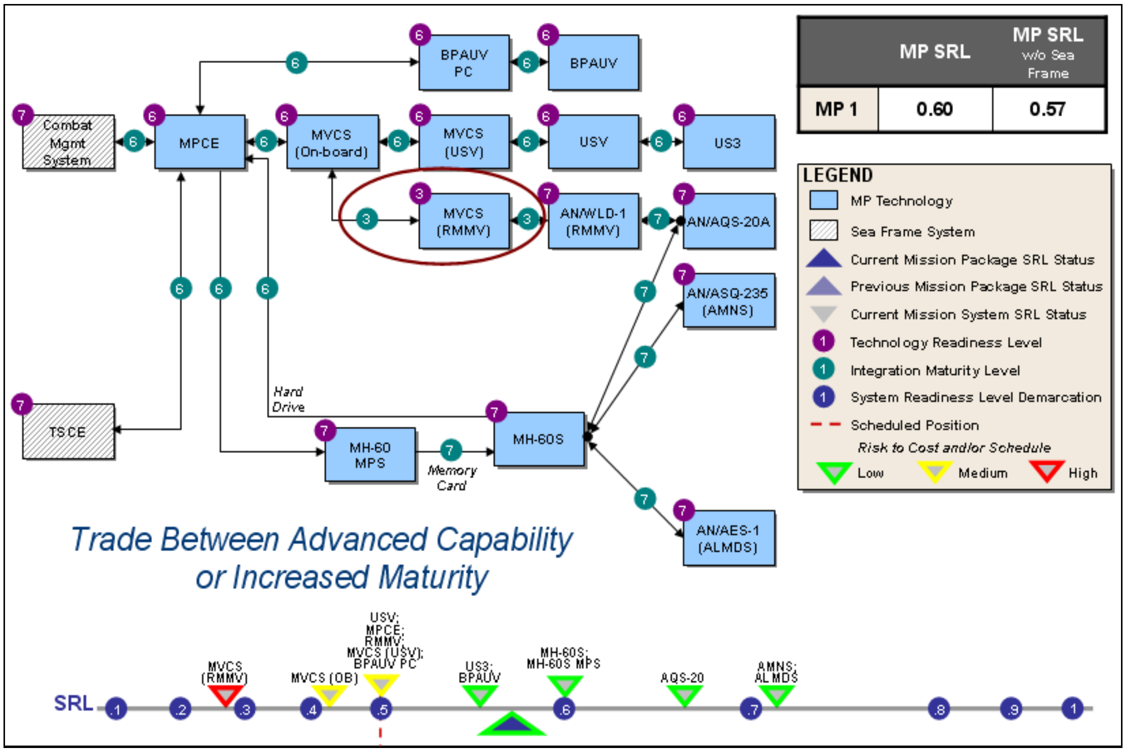


Figure 3. Initial System Readiness with Lagging Technology

The SRL assessment incorporating the insertion of the more mature technology is shown in Figure 4. By inserting this more mature technology, the component SRL of that element has risen above the scheduled development point along with the component SRLs of all of the technologies with which it integrates. Previously, these levels were determined to be held lower although they were mature because they were interfacing with a lower maturity component. Additionally, the overall composite SRL has seen a dramatic increase as indicated by the advancement of the indicator below the SRL development scale. Cleary this example indicates an instance in which the insight provided by both component and composite SRL was critical to identifying and assessing areas of system development risk.

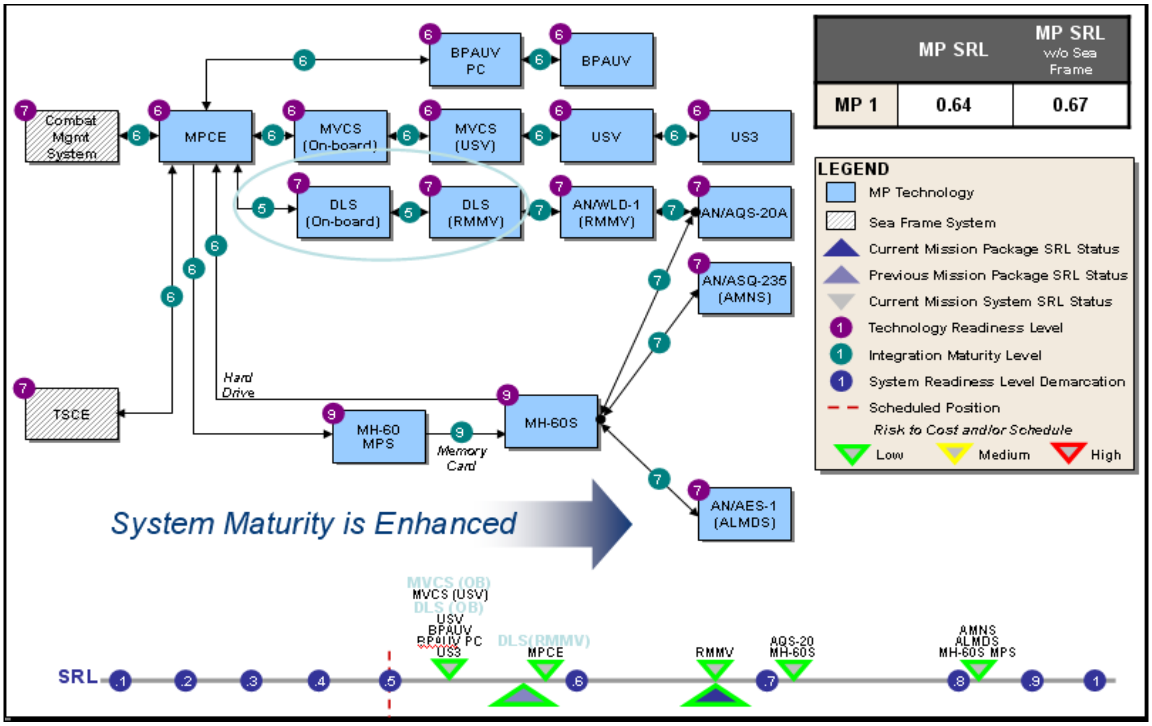


Figure 4. Enhanced Readiness via Capability Trade

Technology Insertion/Integration Challenge for Systems-of-systems

There are many reasons for the insertion of new technologies into existing systems-of-systems. Activities can range in scope from simple obsolescence work focused merely on keeping system functionality at a given level all the way to incremental elements of continued development. The latter case represents an opportunity for not only replacement of an element, but also potential changes to the existing architecture that is currently completely functional. The impacts of such insertion can be equally varied. Ideally, the new technology or set of technologies fit seamlessly with that of the old while increasing performance. However, this is seldom the case and, in some cases, the addition can cause a reduction in the current state of the system. Other impacts include forcing its functionality and performance to vary widely with impacts ranging from cost to reliability, maintainability, and availability. In most cases, failure of technology insertion can be traced back to a common failure cause—integration. This can include not giving proper consideration to the original requirements of the functional system or how the requirements have evolved due to the realities of operational use. Consideration must be given early and often to how original systems had been designed and what modifications must be made to allow the integration to proceed. It is also important to note that two mature (TRL 9), even operational technologies, will no longer be at an equivalent level of maturity when combined. Simply put, significant risk exists when two mature products are brought together as the combination often does not result in a product of equivalent maturity.

Instances in which integration of mature, proven technologies can produce unintended consequences are numerous both inside and outside of DoD acquisition. A perfect example of this occurred with the Massachusetts Bay Transit Authority (MBTA) in the mid 1990’s and took a full eight years to resolve (Fraser, Leary & Pellegrini, 2003). MBTA operates the oldest light rail system in North America with sections dating back over 100 years. In order to enhance handicapped accessibility it was determined that a new series of railcars would be needed. A competitive bid was sent out and the winner leveraged completely mature and well understood component technologies integrated into a new design. A prototype was constructed and entered into testing in 1998, less than three years after contract award. Testing proceeded as planned and the design entered revenue service in early 1999. However, this entry into service marked the beginning of a four-year period in which braking performance issues and derailments caused repeated withdrawal from service. During this time an extensive investigation into the performance issues was conducted.

The investigation noted many areas where integration of the well-proven technologies with each other and into the existing system infrastructure introduced unintended issues. These included difficulties in matching dynamic car acceleration and braking performance to those cars already in the fleet as well as the integration of the new wheel design to existing rails. In both cases the new car design met requirements, but failure to properly identify and account for the complexities involved with the integration of technologies, even well understood technologies, caused significant issues. In this case, the application of SRL could have been a significant aid as it would have allowed for the tracking of the technologies in the new design and their integration with one another as well as the overall integration to the existing system and operational environment. It cannot be sufficiently emphasized that performance of technology in a stand-alone environment does not mean that the technology can be inserted at a system level without significant planning, monitoring, and assessment.

Impact of Degree of "Design for Integratability" Inherent in Individual Systems (i.e., standards-based, common elements, non-planned, etc.)

In the command-and-control world, an approach to mitigate unplanned integration has been developed and is commonly referred to as Service-oriented Architecture. In this manner, a common set of standards are used to define interfaces and data types allowing a variety of elements from different developers to be quickly integrated into a common whole.

Depending on the system, the degree to which standards are applied and designed inherently brings about different levels of integratability. Two development projects beginning simultaneously can have drastically different trajectories based on the degree to which the technologies were designed to integrate. This difference can be seen by either enhanced IRL scoring or a far more rapid rise through the TRL maturation process due to significant amount of “pre-work” done via standards incorporation.

Another important consideration when it comes to integration is its multiple aspects. Depending on someone’s background, talk of integrating an avionics box into an airframe can have drastically different meanings. To a software engineer, integration means getting the box to exchange data with the countless other computers, sensors and control mechanisms on the pan. To an aerospace engineer, integration means the accounting of the systems weight in the overall performance of the plane. To a mechanical engineer, integration means ensuring the box fits in the rack; to an electrical engineer, integration means the type and amount of power required. Even to a human-factors expert, integration will mean balancing functionality with the pre-existing cockpit workflow. While these examples are relatively simplistic, it very rapidly becomes clear that integration is not just a single attribute that can be tracked as such; instead, it must be tracked at countless levels and, indeed, even the influence of the different types of integration must be taken into consideration.

In a real-life example of the above situation, the Army's canceled Aerial Common Sensor (ACS) program can be examined. In this instance, a highly capable intelligence gathering system was to be integrated onto an existing airframe design. Early focus on the intelligence system design and architecture produced a cutting-edge solution that met or exceeded customer requirements. However, it quickly became apparent that the design would be too heavy for the selected airframe, and the program was subsequently canceled after other mitigation attempts failed. In this case, it was not the integration of emerging technologies that posed a problem but rather the simple matter of vehicle payload, further underscoring the need for a comprehensive architecture analysis and integration monitoring methodology at all levels of systems design.

Consideration of Integration Types

In cases such as these, it is important to note that a single view of the previously discussed network diagram and SRL assessment may not be enough. In the PMS 420 program, IRL criteria have been broken into different types to account for software and hardware, in addition to physical aspects such as weight and clearances.

In essence, it looks at internal and external integration to a SoS. These can be considered individually for greater detail or summed up in a roll-up chart to appease management. In this way, countless implications and variations of integration can be tracked in a single place.

Reduction of Integration Risk in a System-of-systems

As discussed above, integration of components is one of the key areas of risk for developmental and production activities. While the SRL methodology will provide insight into the potential risk for mangers to understand, it does not inherently provide methods for reducing the risk. One way PMS 420 is seeking to reduce that risk is through the increased use of common components across the SoS in order to drive down integration uncertainty. Basically, an expansion of the open architecture concept, PMS 420 is seeking to define and manage the interfaces to be used by concepts seeking evaluation for insertion while allowing the technical capability to mature/change internally to the externally defined interfaces. An example of this process is how all mission package services were devised to operate upon a common operating system on common hardware. Within an individual mission package this capability was further allocated to individual mission systems, thereby providing processing and storage capabilities while requiring they support a minimal level of integration for use of common core capabilities. The drive towards Service Oriented Architectures for software base capabilities is another example of how integration risk can be minimized by increasing the use of common capabilities vice having each system try to provide an end-to-end solution.

Future Planned Expansion of the SRL Methodology

While the use of the present SRL methodology described above has helped the Mission Modules Program in terms of effectively managing system-of-systems procurement by providing additional insight into the technical and integration risks associated with the incremental acquisition or spiral development of capabilities, the efforts to date are just beginning to scratch the surface of providing management with the information required to make informed decisions and to apply these decisions in a predictive method for selecting technologies for future increments and spirals. Several areas have been identified as areas of investigation designed to further increase management insight in helping to resolve these deficiencies. These focus areas include the incorporation of methodologies designed to allow for the program office to gain better insight on the impact of inserting a new technology across the spectrum of the SoS's existing performance capabilities, the inclusion of cost factors and monitoring into the tool to allow for both predictive determination of "should cost" factors, and the use of the tool to provide insight into cost versus performance status monitoring. Additionally, for the Mission Module Program there is a desire to increase the use of common components across the warfare areas. This drive for commonality could impact performance and a method of analyzing the cost benefits versus performance risks prior to implementation is needed. All these focus areas are areas of growth for the methodology and will be discussed in the following paragraphs.

Technology Insertion/Integration Focus Area

One of the challenges of managing technology insertion into spiral or incremental programs is determining the value added and understanding the potential of a capability lost by inserting a new capability. Historically, technology insertion into a stand-alone system has only focused on the cost versus capability gained determination. In a system-of-systems, especially a constrained system-of-systems design such as the mission packages, the value of the capability gained on a individual system has to be assessed in terms of the impact and cost to that system as well as to the entire system of system. For example, Figure 4 is an example of how technology blocks for the MVCS control the present limitation on how far an unmanned surface vehicle (USV) can be from the LCS. A new manufacturer may devise a new communications capability that can greatly enhance the USV's operational range without increasing its cost or weight. While initially a great potential for improvement, the effectiveness of implementing the change is only beneficial if the greater range can be utilized and the impact of incorporating it does not impact the ability of the package to conduct all of its assigned missions. Thus, the impacts and limitations imposed by the directly linked components of the USV need to be understood but, more importantly, the total Mission Package impacts need to be understood. If the new capability added sufficient weight to the USV string, shown in Figure 4, it might create a condition in which the total weight of the package exceeded limitations, and a sensor might have to be removed from the helicopter to remain within the weight constraint. The loss of the sensor might mean that the Mission Package could no longer complete all assigned missions—so what appeared to be an improved capability at the start can turn into a negative if the impacts are not understood early enough to enable informed decision-making. One method that PMS420 is investigating for asserting this determination is using reliability block diagrams developed by the mission packages to predict end-to-end mission capability reliability, shown in Figure 5, and overlaying the TRL's and IRL's development through the SRL methodology to increase the understanding of the risk areas involved across a package when deciding to implement changes.

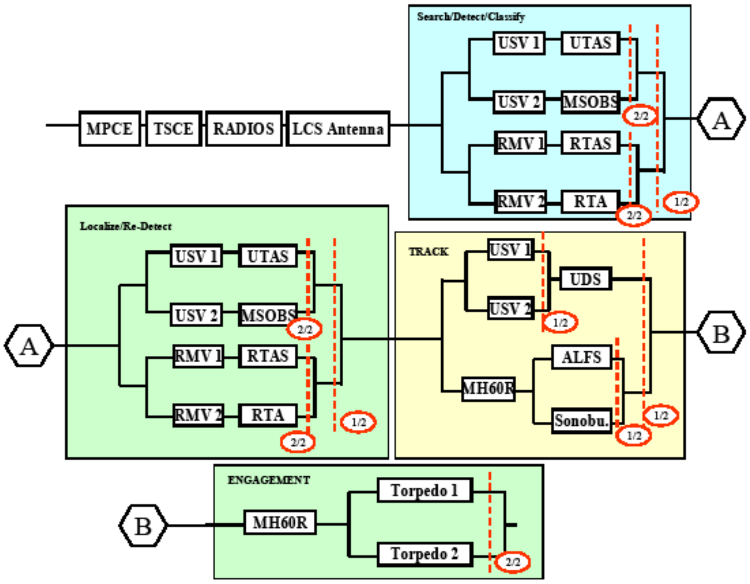


Figure 5. PMS 420 Reliability Block Diagram

Cost Prediction and Monitoring

Up until now we have been talking about the engineering implications of integration. As well all know, however, the real world is about more than just technical development. In order to have a successful system development effort, it is imperative that the design not only function, but also be built at the price that is affordable to the buyer. This is especially critical at a time when acquisition costs have soared, and it seems that even the most well-understood jobs cannot be completed on time or within budget. A fundamental failure in this area again relates to integration. Though the unique art and science that is cost estimation has been steadily expanding in experience for decades, the knowledge available for appropriately modeling and estimating the level of effort required to integrate various pieces of technology into a holistic capability is limited.

Degree of "Design for Integratability" Dramatically Impacts Cost Estimates

As with the previous examples of integration maturity being at different levels based on the degree to which technologies have been designed to integrate, cost is a similar and, in some sense, even more complicated operation. While there is a significant amount of data available to determine the cost of a new ship based on its displacement or on a new piece of software based on its lines of code, the understanding of how these two elements connect is far less understood. From the perspective of a cost estimator, who in many cases is outside the bounds of the program, the degree of work it takes to modify a pair of technologies to work together is somewhat of a mystery. The systems that have been designed with a standards-based approach may require little more than being brought together whereas other systems may require significant modification and extension of existing documents.

Cost Estimation Relationship Plans

In order to better capture this and estimate it for the PMS 420 effort, steps are being taken to categorize the integration at hand. In this way, a standards-based approach can be costed based on similar historical efforts while a dramatic revamping can be costed entirely differently. This information is being combined with technical status data to form an overarching assessment tool known as a System Maturity Model. In this effort, inputs on both technical development and factors impacting cost are collected side-by-side with cost and technical development information. Care is taken to specify the data types requested and examples are provided to ensure that the responses received are the type and quality requested. This requirement for data is then forwarded to subject matter experts for input. The data is then collected and used to populate algorithms that produce cost and technical assessments for the program. In the near-term, these assessments take the form of the CARD, PLCCE, and Milestone B documentation, but over the life of the program they will also form the foundation of program status reports and monitoring tools. By combining this information together from a system-of-systems perspective, the interdependencies of cost and technical development from a holistic perspective can be most accurately captured. As outlined above, the technical and integration maturity of the components are used to form the basis of cost estimates for development. From there, a variety of other information can be applied to expand that initial acquisition cost model into an estimate of total program lifecycle cost. Key elements include the operations and maintenance, CONOPS, as well as the technology insertion and obsolescence pans. By leveraging the architecture diagrams of how future technologies will be applied to the system over the course of time, a more accurate assessment can be obtained. A significant amount of unknowns and guess work can be reduced since detailed plans for what technologies may be inserted and in what manner that may happen. This eliminates surprise modernization service life extension efforts later in the program from running wildly out of control.

Conclusion

System-of-systems development is here to stay and will undoubtedly only grow more complex as the technologies that make up the systems continue to evolve, expand, and push the leading and often bleeding edge of technology. With this evolution, complex systems integration begins to require a paradigm shift in how assessment, analysis, and management techniques must be used and what tools are applicable. No longer can the development of individual technologies be considered in isolation; rather, these developments and their integration with one another must be defined and analyzed in new and enhanced ways. It is only by considering the impacts of all technologies and integrations as a whole that the acquisition approach can be improved. As discussed above, the implementation of a methodology that combines assessment of the technology maturity of component pieces with the assessment of their integration level has been shown to add value. The next step in improving this technique is to continue to expand its use in assisting in technology insertion assessments by using it as a predictive tool. Beyond that, the goal is to incorporate cost inputs into the tool to provide further insight to management on the existing risks thereby being accepted in the selection of technologies for incorporation into mature systems-of-systems.

List of References

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