The A-RCI Process — Leadership and Management Principles

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Abstract

In the mid 1990s, it became clear that the U.S. submarine force had lost the acoustic advantage over contemporary Soviet new construction submarines. At the same time, investment in undersea warfare suffered a marked reduction as the total obligation authority within the services continually eroded the means to develop capabilities in the traditional manner. New acquisition processes had to be created to grapple with the need to rapidly increase warfighting performance while continuously decreasing cost. The keys to solving this dilemma are based on three fundamental truths. First, meaningful competition for ideas always yields a better product at reduced cost. Second, the commercial marketplace readily provides low cost, high performance general purpose processing technologies. Third, the U.S. forward deployed naval forces can provide rapid, hands-on customer feedback. These three elements are the centerpiece of the Submarine Acoustic-Rapid Commercial-Off-the-Shelf Insertion (A-RCI) Program, which provided the vision and strategy to institutionalize a rapid acquisition process through new leadership and management approaches, that has delivered to the Fleet a seven-fold increase in submarine towed array sensor performance, while realizing a 60-fold decrease in real processing costs.

Introduction — Why Change?

In the wake of the dissolution of the Soviet Union, we have experienced a series of regional conflicts, including the current global war against terrorism. Thus, the threat we face today is multi-faceted, often trans-national and generally asymmetric to our current combat forces and capabilities. Our forces must adopt new capabilities to address each new threat, on timelines never before experienced. Our acquisition processes must evolve to meet this challenge.

The rate of change of information technology has been increasing steadily for the last two decades. The focus has evolved from hardware to software, from data management to knowledge management, while the time to obsolescence of new information technology continues to decrease.

A new approach to acquiring and fielding warfighting capabilities is required to take advantage of new information technologies as they emerge, while affordably maintaining a decisive operational advantage with respect to our increasingly sophisticated adversaries.

Today's Constraints

In light of the rapidly changing operational and technological environment, it is imperative that the acquisition community become able to rapidly deliver appropriate warfighting capabilities. In undertaking to deliver this new, enhanced combat power to the Fleet, there are four fundamental issues constraining the traditional acquisition process

First, the closed business environment. Dominance of our combat system development process by a small number of industry giants inhibits the exploitation of rapidly improving performance and the reduced costs of commercially-derived equipment and systems that are "open" to other vendors. The Navy should not be inhibited by the business environment from engaging additional independent sources.

Second, the acceptance of a traditional development time. Increasingly, the inability to update previously developed software or change out hardware in a timely manner inhibits software refresh and hardware modernization. The Navy desires rapid technology re-fresh and capability improvement on timelines inconsistent with the traditional approaches.

Third, the competition of ideas is often inhibited. Competition by industry and laboratories for limited funding creates an environment where it is not in any participant's best interest, either government or industry, to share information and scientific breakthroughs with others, especially true in the current, closed environment.

The Navy should desire and encourage an arrangement to engage all the brightest scientists and engineers in a process that fosters cooperation and rewards participation by all possible contributors. True competition of ideas improves the product.

Fourth, Fleet participation is detached from the acquisition process. Today, the end user (the Fleet) is too often not a party to the design and engineering process. There is a need for direct feedback from the Fleet in all acquisition stages: requirements generation, concept development, design and engineering, test and evaluation, and delivery, including training and logistics support. The complex systems and capabilities being developed require an iterative process explicitly incorporating Fleet warfighter input, in each stage.

A-RCI — An Example of a Relevant Success in the Submarine Community

In the mid 1990s, the U.S. Navy was at a critical juncture. The U.S. nuclear submarine force was losing its acoustic superiority over potential adversaries. The traditional response would have been a multi-billion dollar development program stretched over 12 or more years, unacceptable in the austere fiscal environment of the 1990s. America's edge in undersea superiority had significantly eroded, and something needed to be done quickly. The Navy undertook a novel approach to solving this loss of warfighting advantage by formulating the Acoustic-Rapid COTS Insertion (A-RCI) Program. A-RCI was structured to overcome the four constraints discussed above through the introduction of five innovative approaches.

First, a program was initiated to create an open business environment, with the goal of forcing industry collaboration and creating incentives for individuals to excel. A new business model was adopted. The Navy used the competitive format of the small business innovation research (SBIR) program to select a company able to develop a new acoustic processing system composed of commercial-off-the-shelf hardware, a multi-purpose processor (MPP), to be used for all submarine towed array acoustic processing. The advantage of using the right small business over larger, traditional defense businesses is their agility, flexibility, and adaptability.

Second, new explicit architectural concepts were developed that allowed engineers to decompose new systems along natural and logical boundaries, at the functional string and thread level, to enable focused, iterative design and assessment. The application software was segmented along natural and logical boundaries, and then isolated in functional modules. Each functional module can stand-alone or be re-used and installed in another system application. The result is that modules of software developed for nuclear attack submarines can readily be used on different computer processing hardware for surface ship ASW functions and shore-based acoustic intelligence analysis, even though the hardware and specific end applications are different.

Third, a process was established that explicitly recognized that the development of adaptive, complex systems requires an iterative design and development approach that explicitly incorporates Fleet feedback at all stages. Toward this end, a new collaborative work environment known as advanced processing builds (APB) was undertaken, for the development of modular application software. The Navy established a work environment of active peer review using a build-test-build process and using "real world" data sets to evaluate advanced processing techniques. This process accomplished the key objective of developing and delivering new, "best of breed" capabilities in a short period of time through collaboration among industry, naval laboratories and acquisition program headquarters participants. Using the results of each APB, the Navy was able to implement the new software builds quickly and systematically. The builds included not only the tactical software but also the training for each new detection technique.

Fourth, a new software concept, transportable middleware (TM), was used. Transportable middleware isolates the hardware and associated operating system software from the application software, thereby allowing rapid insertion of new technology to be made to the software applications. Additionally, TM is hardware independent, so that application software can be readily transported to other host hardware computing platforms.

Fifth, because of the short life span of COTS products and the ever-increasing requirement for more computing processing capability, a specific hardware refresh cycle, known as technical insertion (TI), was established. The TI cycle ensures that the latest commercially available processing hardware is used in each yearly APB software refresh cycle. As shown in **Figure 1**, the TI cycle assures the Fleet the same high-performance processors available in the commercial marketplace. Production baselines last for two fiscal years, and all PC technology can be procured within 12 months. Production contracts are cost plus rather than fixed price and provide the flexibility that allows lead ships to go to sea with hardware that was procured only six months after the product was delivered to the commercial market. Delivery of APB's and TI's are tied to each submarine's deployment schedule. Typically, within a four year window, a submarine deploys twice. The ship gets a new APB package for each

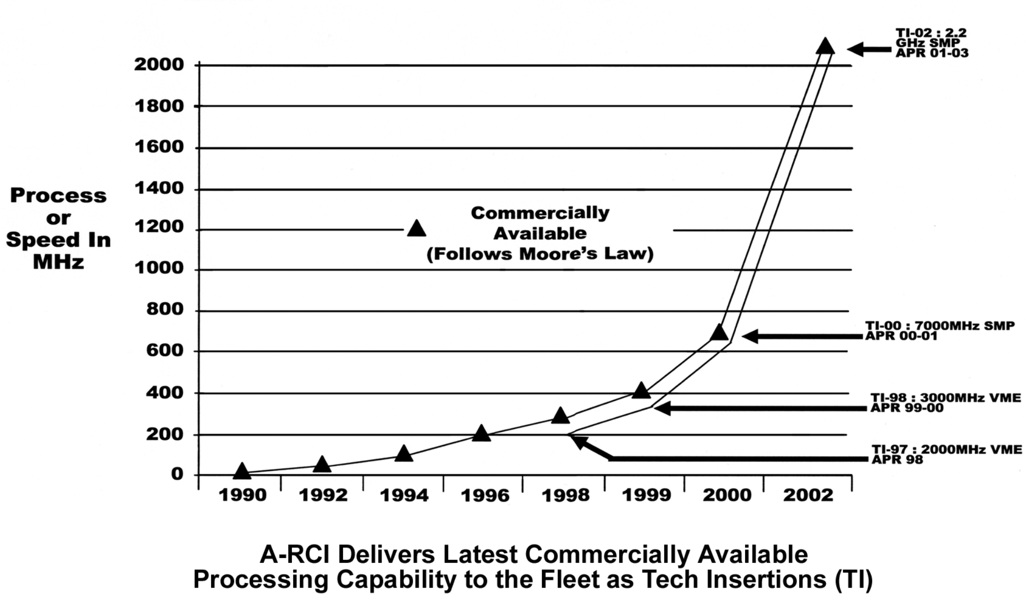

FIGURE 1
A-RCI archives rapid COTS insertion fleet deliveries mirror commerical availability

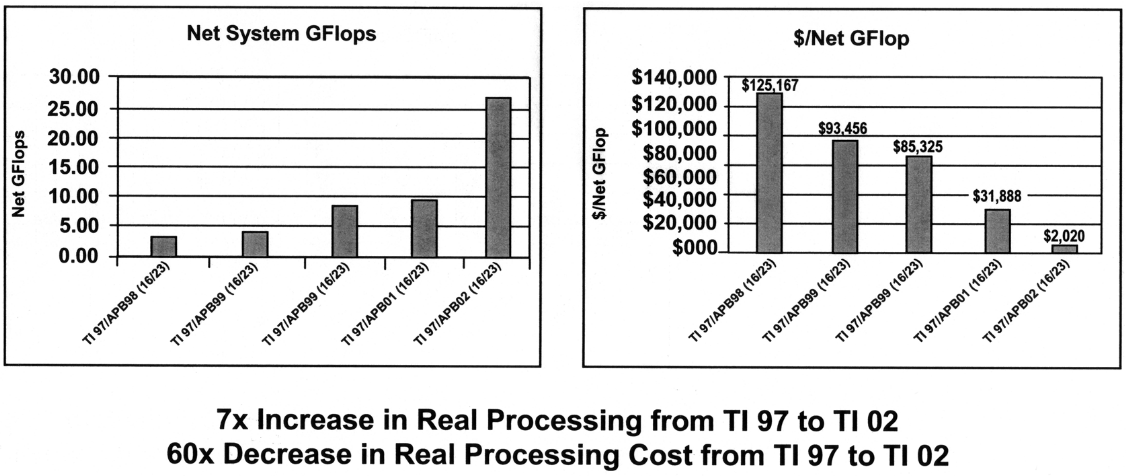

FIGURE 2
A-RCI system processing improvement and cost savings

deployment; prior to every other deployment, it gets a technology insertion build, providing enhanced computing power that translated to faster response time.

An early example of an APB timeline is APB 99. This effort included towed array (TB-16/29) processing improvements involving in excess of 1,000,000 source lines of code and included concurrent training development and delivery. The effort was initiated in January 1999, Lab evaluations were completed in July 1999, and a sea test was successfully conducted in November 1999. A tactical program integration and delivery for USS *Memphis* (SSN 691) was conducted from December 1999 through March 2000. USS *Memphis* deployed on an operational mission in the summer of 2000 with widely publicized positive results.

Then Assistant Secretary of the Navy (Research, Development & Acquisition) the Honorable Lee Buchanan stated that " the ARCI program, leverages recent commercial computer hardware and software advances to significantly increase signal processing speed. Early test reports have been outstanding, suggesting up to a seven-fold increase in towed array…tracking ranges and very significant improvements in exploiting unique submarine transient noise." Admiral F. L. Bowman, Director, Naval Nuclear Propulsion, wrote that: "If we are serious about technology deployment, we need to start creating opportunities to deploy new capabilities quickly. Today's successful example of this is A-RCI " (Bowman 2002). **Figure 2** illustrates the dramatic improvements in system and cost performance, in a very short period of programmatic time, yielded by the A-RCI process.

Leadership and Management Principles

Our defense acquisition system is designed to seek concurrence from a number of legitimate stakeholders within the services and OSD. It falls to the program manager to provide leadership and management in order to deliver necessary warfighting capability to the Fleet. To be successful, the program manager must create an environment that addresses all legitimate programmatic needs, balancing the cost, schedule, performance, and risk dimensions of complex systems. In order to accomplish this daunting task, the program manager must develop and adhere to a set of principles that guide effort to a successful outcome. The program manager must:

- Set and maintain the vision,
- Develop a strategy to implement the vision,

- Develop and cultivate allies at all levels,
- Instill within the team a sense of empowerment and entrepreneurial spirit, and
- Set the expectations for excellence and the operational pace.

1. Set and Maintain the Vision

The program manager, with his team and stakeholders, develops a shared vision for the program. The ideal: keep the message simple and consistent, and jargon free. In A-RCI, emphasis was on phased introduction of new capabilities providing improved performance, and measurement of actual performance of the new capabilities when deployed. A-RCI vision development always heeded the primary Rule of Paleontology: "Complication precedes extinction."

2. Develop a Strategy to Implement the Vision

To make the vision a reality, the program manager requires a clear strategy, capturing both long and short-term perspectives. The strategy must define the top program objectives so team alignment is possible, as well as ensure that stakeholders' issues and concerns are addressed. This approach is characterized by flexibility, rapid movement, and leverage, in order to implement and institutionalize the vision across the enterprise. This type of management approach was characterized in Harvard Business Review in 1999 as a "judo strategy" (Yoffe and Cusumano 1999). A-RCI principles to consider in strategy development include:

- Creating an open technical architecture reducing the barriers to competition.
- Requiring that all systems and components "design to a 'virtual machine' such as a transportable middleware interface, to decouple from the accelerating changes in the COTS hardware and software markets.
- Acquiring as much management decision authority, as well as funding and contract tasking authority, as possible.
- Stressing the traditional infrastructure to create a business focus rewarding rapid change and innovation.
- Exploiting rapid contracting mechanisms for industry to allow rapid development, integration, and deployment of "best of breed" ideas.
- Using small, highly trained teams, mandating minimal reporting requirements, and obviating the natural creep in bureaucratic staff review.
- Ensuring a continuous resource stream in all necessary appropriations, supporting continuous introduction of new capabilities.
- Fostering an iterative design and development process explicitly incorporating user feedback.
- Publishing and widely promulgating successful results in simple, easy to understand language.

3. Develop and Cultivate Allies at all Levels

The strongest ally is the Fleet user — the ultimate customer. Including the Fleet in all phases of the program galvanizes relationships and creates mutual trust and respect essential for success. The program manager must continuously develop and nurture allies in a range of communities. From the experience of A-RCI, other key allies included the science & technology (S&T) community, other undersea warfare platform communities, the Congress, and senior leadership of the acquisition community. A-RCI principles to consider when cultivating allies include:

- Creating allies in industry and at all levels of government who have the power to obstruct, but can also be extraordinarily helpful.
- Creating informal relationships with key enabling stakeholders, including multi-platform and associated systems stakeholders.
- Creating an organizational structure to allow the best experienced individuals in government/industry to influence the

design of critical components at a functional string or thread level.

- Implementing changes during the tours of individual sailors who will become program advocates, increasing demand pull for more performance improvements.

4. Instill within the Team a Sense of Empowerment and Entrepreneurial Spirit

The program manager is responsible for maintaining the motivation, enthusiasm and entrepreneurial spirit of his program team. Participants in the enterprise should see themselves and their contributions mirrored in the successful product. Rapid development, integration, and successful deployment of enhanced warfighting capability provide powerful gratification. A-RCI principles used to create empowerment and develop entrepreneurial spirit include:

- Creating incentives for individuals to excel.
- Requiring continuous technical competition at component, subsystem, and system levels.
- Using open and collaborative business environment to determine "best of breed" alternatives for introducing new capabilities, forcing industry collaboration.
- Continually assessing deployed operational performance, incorporating Fleet feedback and explicit data gathered from real-world operations.

5. Set the Expectations for Excellence and the Operational Pace

Finally, the program manager must articulate his expectations and define the operational pace by example. This includes setting clearly defined specific, quantified, challenging goals and demanding data-driven analysis and assessment as part of the decision process at component, subsystem and system levels. Perfection may be unachievable; however, excellence in behavior and action should be expected. Speed to deployment is an essential driver of the process. A key to success from the Fleet's point of view, in additional to performance, is the quality and responsiveness of the logistics support and training. Some specific A-RCI principles that apply to setting expectations for excellence and operational pace include:

- Creating a sense of "urgency of action" by mandating and holding to a disciplined annual deployment of new capabilities.
- Using interlocking award fee structures such that if one contractor fails, all fail — to ensure cooperative collaboration and participation. Mandating specific terms and conditions to insure collaboration among participants (one fails, all fail).
- Conducting annual well defined at- sea test routines to verify performance prior to commitment to deploy.
- Demanding data-driven analysis and assessment as part of the decision process at component, subsystem, and system levels.
- Including the Fleet in the system design process and training definition; end user performance matters.
- Institutionalizing a development test & evaluation environment using "real world" standard, site-specific data sets for analysis, modeling and simulation.
- Requiring independent testing, assessment, and validation of the system (component) based on Fleet-defined performance value.
- Rapid change mandates that providing logistics support must be part of upfront engineering. COTS based components require a modern logistics support approach.

Why Did It Work?

The driving energy in the A-RCI process is competition — at every level. At the product level, the commercial marketplace treats computers, networks and displays as commodities. Customer demand in the commercial marketplace creates competition, drives down costs, and increases speed to market. The Navy must take advantage of these phenomena. At the component level that integrates COTS products into a system component, competition is also realized. In A-RCI, the towed array signal processing, called the multi-purpose processor (MPP), was a substantial and complex part of the acoustic system that was competed. At the intellectual level, there is competition for new, innovative ideas and engineering excellence. The A-RCI developed the advanced processor build process to create an environment where the "best of the breed" ideas and engineering approaches were constantly being sought, identified, and rewarded.

In the traditional acquisition process, the power of competition at both the system integrator level and the system prime developer level can be seen. Both approaches offer significant one-time enhancements, but can leave the customer tied to a single developer, who can inhibit or slow change and modernization. Innovation will then become very costly. A-RCI overcame this constraint by introducing real competition at every level.

When products are considered commodities, competition drives down costs. When considering the applicability of the A-RCI process to one's program, one should assess the maturity and adequacy of system performance and the design-constrained performance envelope. When the program or system performance is deemed adequate and system hardware and software components can be perceived as commodities, a larger competitive base can be established — driving down costs at system, component, software and hardware levels.

Summary

In summary, budget constraints will continue to be a consideration for all combat system development. Nonetheless, the world and the operational environment in which our naval forces must fight continue their rapid rate of change. The A-RCI process provides an approach to acquiring and fielding capabilities required to take advantage of new information technologies and capabilities as they emerge, and affordably maintain a decisive operational advantage with respect to our increasingly sophisticated adversaries.

By the very nature of the way they operate far forward today, the Fleet itself is the most knowledgeable regarding what new or enhanced capabilities are required. As a consequence, it is vital that the Fleet warfighters be involved in every step of system design and the development process. Every surface ship and aircraft combat system should be considered as potential candidates for employment of the A-RCI leadership and management principles. ■

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