FROM LAB TO TENT
(Bringing Integrated C2ISR Technology to the Warfighter)

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ABSTRACT

The transition of new C2ISR technologies and capabilities to the warfighter in a useful and timely manner is a longstanding challenge, which is often met through unique solutions to specific warfighter problems, and often compromising interoperability in combat and other field operations. Interoperability is now a major concern and the focus of C2ISR development. The most effective way to address this concern is through the ***integrated*** development of C2ISR components. However, integration is not readily accommodated in the present acquisition and PPBS processes, one reason why there has been lots of discussion with modest results. In this paper we recommend a new approach to integration, namely that integration be viewed as an explicit ***result***, not just as an attribute of C2ISR systems. We then look at the processes and the problems from this perspective and make some recommendations for providing integrated and interoperable new technology to the warfighter in a timely manner.

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1. Introduction

Joint Vision 2010 [JV2010, 1996] defines Information Superiority as: *The capability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying an adversary's ability to do the same*. This represents an ambitious vision. It is our contention that many of the difficulties of DoD programs, which have addressed this vision, originate in the inadequate translation of integration requirements for this global vision into practical, specific results.

"Making Information Superiority Happen" is primarily a problem in consistency, coherence, and compatibility among the command, control, intelligence, surveillance, and reconnaissance (C2ISR) capabilities. Our existing C2ISR systems provide much of the information that is necessary, but because the systems are not integrated, and are not interoperable, the information is not readily available to the warfighter. There are a variety of reasons for this. For instance:

- The warfighter does not have access to one of the systems needed and only that system can access the data.
- The warfighter has access to the system but does not know how to use it because it does not behave like any of the systems with which he/she is familiar.
- The warfighter can operate the system but cannot relate the output to the products of other systems.

Today new technologies are still often fielded as stand-alone capabilities, which the warfighter may ignore or reject because it adds complexity to his/her operations. For new technologies to be readily acceptable, integration and interoperability (I&I) have to be "designed in." Consider Microsoft Office, the dominant office automation suite. It provides office information superiority because all components are well integrated and behave similarly to all other components. Once the user becomes familiar with any one component, getting started on any other component is relatively easy. In addition, the product of any component can be easily combined with the product of other components to provide an integrated result. This is the antithesis of our current C2ISR systems where each one is an island unto itself.

Our task, as the Integrated C2ISR System Program Office (IC2ISR SPO), is to make C2ISR I&I a reality by ensuring the I&I of fielded versions of new technologies and enhanced C2ISR systems into a compatible, coherent, and consistent system-of-systems: the Integrated C2ISR (IC2ISR). This paper examines the inherent difficulties in accomplishing this within the existing acquisition process.

2. Taxonomy

Terms such as integration, interoperability, architecture, and others used in discussing IC2ISR have as many definitions as there are participants. Although many of these definitions are effective for their intended audiences, they are often too specific and too detailed for our purposes. In particular, we believe that the focus on precision has blinded architects and system engineers to larger and more global issues, which may be the sources of many of the architectural and system integration problems of past DoD programs.

CJCS Instruction 6212.01A, *Compatibility, Interoperability, and Integration of Command, Control, Communications, Computers, and Intelligence Systems* [CJCS6212, 1995] defines integration and interoperability as follows:

- *Integration* — The arrangement of systems in an architecture so that they function together in an efficient and logical way.
- *Interoperability* — The ability of the systems, units, or forces to provide services to and accept services from other systems, units, or forces, and to use the services so exchanged to enable them to operate effectively together. The conditions achieved among communications-electronics systems or items of communications-electronics equipment when information or services can be exchanged directly and satisfactorily between them and/or their users.

These definitions address *attributes*, rather than *results*, a distinction that underlies the difficulties in achieving IC2ISR.

For purposes of this paper we will use the following definitions which explicitly include the notion of "result":

- *Integration* — The implemented set of requirements, designs, processes, documentation, training and tests that combine two or more entities into a larger whole to produce a *specific result*.
- *Interoperability* — The capability provided through detailed interfaces between two or more entities, which allow these entities to work together on common data or in a common environment without conflict, to contribute to a *specific result*.
- *Architecture* — The overall design of an entity that combines components in a coherent and organized fashion to deliver a *specific result*.

3. Integration Examined

A paper at last year's Command and Control Research and Technology Symposium entitled *Architecture: The Road to Interoperability*, [Curts and Campbell, 1999] examined some of the history of DoD interoperability and concluded that a DoD-wide interoperable C4I architecture was necessary. In the spirit of their paper we would like to subtitle our paper as "Integration: The Pavement for Interoperability." A good architecture under DoD-wide authority will only have an impact if the underlying pavement is sound. Integration is the practical engineering implementation of architectural plans.

In designing and erecting buildings, there is a significant gap between the architectural drawings and an operational functioning building. So too in creating C2ISR interoperable systems, there is a gap between the architecture and the working system-of-systems that implements the architecture. By our definition, integration bridges this gap as it implements the set of processes to bring individual component systems together in a coherent fashion to achieve a *specific result*.

3.1 Integration as a Result

The emphasis on *result* is quite intentional. It is our contention that most of the difficulties in achieving C2 Integration arise because integration is not recognized as a result in its own right. Too often, in our opinion, architectures have been interpreted as needing to provide all things to all warfighters, and as a consequence either fail completely or are delayed so long that technology advances render them obsolete before they are delivered. Successful integration includes the willingness of an IC2ISR program to compromise "architectural elegance" in favor of delivering *results*, particularly when addressing the boundaries of systems and connections to existing legacy systems.

An effective I&I process to deliver IC2ISR requires recognition that integration is not just an aesthetically pleasing property. It provides concrete value to systems, especially to systems-of-systems, making IC2ISR more than just the sum of its parts. The value of an IC2ISR lies in the result, which is achieved by subordinating individual component capabilities to the greater combined IC2ISR capabilities.

3.2 Cost of Lack of Integration

Integration in normal DoD program acquisition terms is considered an attribute of a system, similar to and comparable with other attributes such as reliability, supportability, performance, etc. This leads to thinking of integration as part of the trade space in developing systems, so that integration may be sacrificed to achieve some other system attribute. For example, valid technical tradeoffs may lead component X to choose to forgo integration with component Y in order to increase reliability, reduce network load or satisfy some other mission requirement. But this tradeoff, made multiple times across multiple components, leads to a C2ISR environment filled with special cases, exemptions, unique interfaces and partial interoperability that causes problems for the warfighter trying to work with the C2ISR system as a whole:

- Standard configurations are not developed because individual sites will not accept components that are not directly relevant to their mission in order to avoid component-specific issues.
- Site-specific development occurs to satisfy specific needs for component integration not provided by the system. Creative warfighters find solutions to their problems, but those solutions may not be generally applicable or supportable.
- The growth of site-specific components exacerbates the training problem since no two installations use the same tools and processes to accomplish a given mission. Training is complex because each component has its unique list of interfaces and exemptions and few general conclusions can be drawn about how things work.

3.3 Value of Integration

Integration as a result provides the following capabilities, which otherwise would be missing or weak in a comparable system where integration is considered an attribute.

- *Multiple pathways to achievement*. Focusing on integration provides a broader scope for technical analysis. Compromises among components, "glueware" interfaces and other techniques become realistic alternatives for achieving IC2ISR. If integration is merely viewed as an attribute, the range of evaluation will be limited to binary (e.g., "yes/no") or linear (e.g., "k% of the message formats processed") characteristics.

- *Greater flexibility in tradeoffs among product components.* The trade space in a system containing conflicts between components A and B is wider than it would be for a component alone as shown in the table below.

Component A Integration as Attribute Individual Tradeoffs	**Component B Integration as Attribute Individual Tradeoffs**	**Components A & B Integration as Result Combined Tradeoffs**
Get B to Change	Get A to Change	Change A
Drop integration with B	Drop integration with A	Change B
		Change A and B
		Introduce glueware G

Table 1. Comparative Trade-off Flexibility with Integration Viewed as Attribute versus Result.

- *Standardization and commonality in multiple installations.* The IC2ISR is less likely to be partially deployed or broken apart for local conditions.

- *Shared services and shared capabilities*. If components X and Y are integrated, a new capability in X will be relatively easy to share with Y, so Y will be less likely to build its own version of that capability.

- *Easier customization*. The IC2ISR provides an architectural base for "common look and feel" enhancements that fit directly into the integrated "environment." Consider adding a capability to Microsoft Office: by fitting into the integrated environment the compatibility of the added capability is assured.

- *Simplified training and operator refresh cycles*. Once people are familiar with the basic integrated environment they more easily learn new capabilities that come as upgrades or additions to the base system.

- *Reduced long-term costs*. Initially, integration appears costly, because in a fiscally constrained environment, integration costs may compromise the achievement of some desired system capabilities. Also, costs are incurred "up front" where there is greater visibility without corresponding visibility into the benefits of integration. However, as IC2ISR evolves, it becomes less costly, because new capabilities and new technologies are developed as integral to IC2ISR without incurring separate integration costs. Additional savings result from the reduced costs for training and sustainment because of the inherent commonality.

3.4 Principles for Integration projects

In *DoD Legacy System Migration Guidelines* [Bergey, et al., 1999], ten basic guidelines are presented to help "understand the perspective of development/system migration organization, in order to make smart technical choices and to follow a disciplined reengineering process." If you replace the word "reengineering" with "integration" it is almost perfectly applicable to IC2ISR.

To build IC2ISR will require literally reengineering the way we do business (i.e., integrate, develop, and deploy C2 and ISR systems). This paper addresses the challenge of working with legacy systems, which is a long-standing deterrent to IC2ISR. It contains some very sound, and thought provoking, information that applies directly to our tasks and identifies ways we may succeed or fail. Summaries of the ten guidelines are:

1. Develop a comprehensive strategy with achievable and measurable milestones for each *integration* project.
2. When outside systems engineering services are needed, carefully define and monitor their roles.
3. If new technology is used for a project, provide adequate training in both the technical content and the motivation for change.
4. Establish and maintain configuration management control of the legacy system.
5. There should be a carefully defined and documented process for the elicitation and validation of requirements.
6. Make software architecture a primary *integration* consideration.
7. There should be a separate and distinct *integration* process.
8. Create a team-oriented *integration* plan **...** and follow it.
9. Management needs to be committed for the long haul.
10. Management edicts should not override technical realities.

3.5 Integration Strategy

The complexity of integrating C2ISR systems greatly exceeds the ability of our development, testing, and certification resources to cope if we try to address the entire aggregate of C2ISR systems which have evolved independently as a loose collection of systems. Therefore, for integration to succeed, it must occur through an iterative process. Each iteration of the IC2ISR needs to be constrained to a manageable set of changes and a specific set of results, which we call a "Block." This type of iterative strategy is an example of Evolutionary Acquisition, as directed by Air Force Program Directive 63-1, *Acquisition System,* [AFPD63-1, 1993].

Building an IC2ISR Block includes balancing technology and system advancement against four categories of constraints:

- *Technology Refresh Cycle* — the amount of time required to replace the technology base to execute the Block. This is a function of both the rate of commercial-off-the-shelf (COTS) technology change and the investment capability of the organization.
- *Infrastructure Refresh Cycle* — the amount of time required to replace or upgrade the technology infrastructure (base networks, telephone capacity, etc.) that supports the Block.
- *Warfighter Training Refresh Cycle* — the amount of time required to educate all of the people who will interact with the Block. (Users, operators, system administrators, infrastructure administrators, etc.)

- *Funding Refresh Cycle* — the amount of time required to react and reprogram funds and resources to develop new Blocks, revise old Blocks, react to technology changes, etc.

Each IC2ISR Block specifies a manageable number of coherent, connected system changes that collectively provide a new or enhanced capability to the warfighter. For example, a given block may be focused on enhancing warfighter display technology. The major theme of the block might then revolve around delivering a Single Integrated Aerospace Picture (SIAP). Themes of the block would lie in:

- Technical development to enhance visual display, imaging, information fusion capabilities.
- Technology refresh for larger, better display systems.
- Infrastructure refresh for transmission, dissemination and distribution of visual information.

If on the other hand, a block is focused on improving system administration and reducing footprint, the themes of the block might lie in:

- Technical development of remote system management tools.
- Technology refresh of laptops, notebooks and handhelds.
- Infrastructure refresh for remote database support and faster long-haul circuits.

There is a set of mutually supporting reasons for constraining a block to one or two capability areas:

- The technology and infrastructure refresh cycles are limited in capacity and need to operate in harmony to keep the system in balance.
- Integration is a complex process and convergence cannot be assured if all parts of the system are free to change.
- Tradeoff analyses and risk mitigation need a prioritization process, which flows naturally from block themes.

3.6 Building IC2ISR Blocks

Building an IC2ISR, and adding new technologies and new capabilities, generates new requirements and requires new processes. There are new warfighter requirements, development activities, test and certification activities, and fielding and sustainment requirements inherent in developing IC2ISR. Part of every phase of the acquisition process of every component needs to be focused on identifying and satisfying I&I requirements. The table below describes some of the acquisition process tasks needed to deliver an IC2ISR Block, beyond what is needed to deliver an isolated system.

Task	Task Description
Current System Architecture Analysis	Perform and document current system architecture within the scope of the block.
Current Infrastructure Architecture Analysis	Document current infrastructure architecture within the scope of the block.
Current Training Architecture Analysis	Document current training architectures and resource materials.
New System Architecture Requirements & Analysis	Develop the block system architecture to support the new block requirements.
Risk Analysis	Develop the prioritized risk analysis & mitigation strategies.
Components' Entrance Criteria	Develop the components' entrance criteria for the block.
Infrastructure Change Proposal	Develop the required infrastructure changes needed to support the block. Perform comparative analysis on existing communications and COTS versus requirements.
Block Packaging Design	Develop packaging plan and design.
Integration Infrastructure	Set up simulated site infrastructure baseline.
Component Entrance Criteria Validation	Validate that the component has achieved all required entrance criteria.
Component-specific Installation	For each component, install on integration base (Comm/Sys/OS/Apps).
Integration	Make components work together as a block.
Glueware Development	Develop, or sponsor development, of any required glueware.
Develop Configuration Parameters	For each component, develop configuration and/or setup parameters that enable component to work in block.
Develop Installation Procedures	For each component, develop block installation and/or setup parameters that enable component to be installed in block.
Integration Validation	End-to-end block validation.
Compile Block Package	Develop block package comprising all components, configuration parameters, installation instructions, etc.
Integrated Site Training	Develop an integrated training package for sites with a common approach, common materials and Block-oriented focus.

Table 2. Integration-Specific Acquisition Process Tasks

More resources are needed to produce an interoperable, integrated product than to build a stovepipe system. However, it is more expensive to try to retrofit systems for interoperability than to build them as integrated, interoperable components of an IC2ISR. This means that future systems, and future versions of existing systems, must have IC2ISR requirements as a high priority in the individual system's requirements analysis process.

4. Acquisition Process versus Integration Programs

The current Defense Systems Acquisition Management Process, as documented in the DoD 5000 series documents, is not designed to support IC2ISR effectively. The major functional disciplines of the acquisition process are not structured for Integration Programs, as indicated by the problems identified with each in the following.

Acquisition Policy — The typical time frame for each phase of the typical process is measured in years. For IC2ISR programs, an entire Block cycle, as driven by COTS technology change, takes approximately three years from initiation to disposal. In particular, the ratio of time spent in development to time spent in operation ranges from $^{1}/_{6}$ to $^{1}/_{2}$ for traditional programs; for C2ISR integration programs, the ratio is close to 1. Evolutionary acquisition strategy, which is designed to reduce the time to field a capability, addresses one of the difficulties with the present acquisition process.

Program Management and Leadership — Given that integration is viewed as an attribute of individual programs, there are no "Integration Programs" per se, creating serious challenges.

- Planning – Integration programs include components that are separately funded, scheduled, and controlled, which greatly complicates planning.
- Organizing and Staffing – Integration programs place a premium on technical sophistication and continuity of architecture and goals, but they have relatively short time frames in which to build and sustain organizational memory.
- Controlling – As with planning, the relationship of the integration program to its components creates unique complexity for controlling, and for managing tradeoffs, risks and decision-making across, independent components.
- Leading – Programs are managed and funded through PEOs and DACs. There is no PEO for C2ISR integration, nor is there a single PEO for C2ISR programs. C2ISR programs are scattered across portfolios of several PEOs and DACs. With no single entity responsible for IC2ISR, there can be no program.

Earned Value Management — Integration programs are inherently complex, and integration activities at present are analogous to R&D efforts in that the effort required to produce the desired results is not clearly defined. The result is binary, either success or failure, and does not lend itself readily to measuring progress.

Contract Management — The contractor must provide an integrated C2ISR "whole" although he does not control components' costs and schedules. Contracting is complex, and standard processes for managing contracts do not address this complexity.

Funds Management — The basic funding process, the Planning, Programming, and Budgeting System (PPBS), has a cycle that exceeds the typical C2ISR integration program life cycle.

Funding for integration must be included in the PPBS process before there is much understanding of exactly what will be integrated or how complex the integration task will be. Funding can be justified only in generic integration terms, not as specific products. In this process, a "funding wedge" is required, which is at best a guess at what the required funding will be. In addition, there is a minimum level of funding required each year simply to maintain the integrity of the existing IC2ISR and deliver Block maintenance and support.

Systems Engineering — Current systems engineering addresses integration as an attribute. The requirements process reinforces this because integration as a result is not visible to the warfighters at this time. Where current C2ISR systems are adequate to their specific mission, the advantages of IC2ISR are not readily apparent. Where they are not, requirements focus on new capabilities, but not on integration. A significant change of focus is needed to view integration as a result. Once given an integrated environment, however, the benefits of integration will become obvious to the warfighter, and he/she will drive the requirements. But initially, requirements for integration must come from other sources to provide the necessary impetus.

Software Acquisition Management — Integration is predominantly a software phenomenon for C2ISR. Current processes are oriented toward development of new capabilities, but IC2ISR is not a "development" program in the traditional sense, because no software is planned as part of the program. Review, management and control procedures must be enhanced to focus on the "back-end" of the process where integration efforts are predominant.

Test and Evaluation — T&E processes must be enhanced to measure and assess integration as a specific result of a C2ISR system. Current methodologies are oriented toward either low-level functional testing or to specific mission-thread testing and not towards the overall analysis of the integrated C2ISR "whole."

Manufacturing and Production — Manufacturing and production must be redefined for delivery of integrated C2ISR systems, with emphasis on new and innovative packaging, baselining and configuration management capabilities to provide multiple components in a single package. The adoption of DII-COE with its processes and standards for segmentation, compliance and configuration management shows the way toward addressing these difficulties.

Acquisition Logistics — Support elements must be focused on the integrated C2ISR "whole". Current component-specific help-desks and maintenance procedures also must be integrated to become part of the integrated C2ISR support and sustainment processes.

5. Discussion

IC2ISR is an investment that provides added value for the warfighter through ease of training, operations, and maintenance, and is cost effective as well, over the long term. The standardization and commonality in installations, which results from integration, reduces training, installation, and support costs. These benefits are not realized immediately. Rather what is immediately apparent is that integration requires an investment up front, which either adds to the cost of developing new capabilities or requires that capabilities be compromised to support integration. Given the choice, integration is often sacrificed. Although it is commonly accepted that integration and interoperability are desirable, to date, there is no incentive for the initial investment.

Acquisition and funding processes, not defined with integration programs in mind, create additional problems. The evolutionary acquisition strategy approximates what is needed for the integration program, but other than addressing the time to fielding of a capability, it does not address the many other problems with the traditional acquisition process. Management of the IC2ISR program and processes also is an issue. The typical program management structure requires some modification to manage the IC2ISR effectively.

5.1 Management

The process of building an effective integrated C2ISR system requires some enhancements to the existing management process.

- *PEO for IC2ISR.* This PEO would be responsible solely for the execution of IC2ISR, cooperating with the PEOs and DACs of the C2ISR programs to develop integration strategies, schedules, and budgets. The IC2ISR program also should be assigned to a single Mission Area Director (MAD) for representation through the Air Force Corporate Process. This would give IC2ISR the focus and advocacy it now lacks in the PPBS process.

- *Management by C2ISR Integration Office comprised of IPTs.* Because the IC2ISR requires inputs from multiple programs that are controlled and funded independently, it cannot be managed as a typical development program. Rather than a systems program office (SPO), it should be a system integration office that leads the requisite IPTs to accomplish the integration. Several IPTs will be required, with membership to include representatives from the Joint Staff, OSD, other Services, other Product Centers, members from the SPOs providing Block components, and other IPT-specific members.

    - *C2ISR Interoperability Requirements IPT.* This IPT will introduce I&I requirements into the system acquisition process at an early stage and provide justification and rationalization during the typical risk management and tradeoff analysis activities that occur in the development phase. This IPT is responsible for coordinating I&I requirements across C2ISR systems and for identifying alternatives as needed. Since I&I requirements are inherently shared between systems, I&I implementation decisions cannot be made by an individual system. For example, if system A cannot fulfill a given I&I requirement, the IPT will be responsible for developing a technical, system, and/or operational alternative so that overall block I&I capabilities are not compromised.

    - *C2ISR Planning and Design IPT.* This IPT will define and plan the integrated development of each Block increment of the IC2ISR, coordinating designs and schedules among component developers. The IPT identifies the “glueware” necessary to integrate components and prepares a program plan for each block with appropriate schedules and funding requirements. Individual components are developed and managed by the SPOs, but the integration, and integration specific development is managed by the IPT, with SPO members.

- *C2ISR Configuration Management IPT.* This IPT will create an inventory of existing C2ISR systems and those under developmentincluding their present configurations and plans for future modification, upgrade, disposal, etc. The IPT will conduct site surveys to aid in defining the C2ISR baseline from which to begin integration. The configuration of the baseline, and of each Block as the IC2ISR evolves, will be controlled by the IPT.

- *C2ISR Certification & Deployment IPT.* This IPT will manage the Block certification and deployment process after each individual C2ISR system has completed its development and is ready for final OT&E. At that point, the individual C2ISR system is taken into the IPT for integration with the other Block components. An integrated OT&E is conducted of the new Block baseline and then the Block is deployed as an integrated entity with the support and resources of the component systems. Individual deployments of single C2ISR systems may occur in isolated cases, but generally the new C2ISR Block baseline is deployed as a single unit.

- *C2ISR Sustainment IPT.* This IPT will develop the integrated support and maintenance procedures required to sustain the IC2ISR. For the IC2ISR to be of value to the warfighter, support must be straightforward. There should be a single point of contact for support to the IC2ISR and any of its components. The IPT will consolidate the support for each individual component with support for the IC2ISR, and will manage the continued sustainment of the IC2ISR.

5.2 Changes to a Typical Acquisition Process

Current acquisition strategy and processes for C2 systems are not structured to provide adequate emphasis for I&I issues. By definition, I&I issues involve more than one system, but the focus of an acquisition program is on a single system. Because of this, typically, inadequate attention is paid to general I&I issues; only direct interface issues for the particular system are addressed.

To focus the necessary attention on I&I issues, four enhancements are proposed to the standard acquisition process. Figure 1 shows a typical system life cycle development process, from IEEE Std 1220: *IEEE Standard for Application and Management of the Systems Engineering Process* [IEEE 1998]. Figure 2 shows the same process with our proposed changes to facilitate the development of IC2ISR.

- Explicit IC2ISR *Definition* that provides a context for system definition.
- Explicit IC2ISR *Requirements* input as the system is being defined.
- Explicit IC2ISR *Design* as part of the design phase.
- Explicit IC2ISR *Test and Certification* for deployment as an integrated unit.

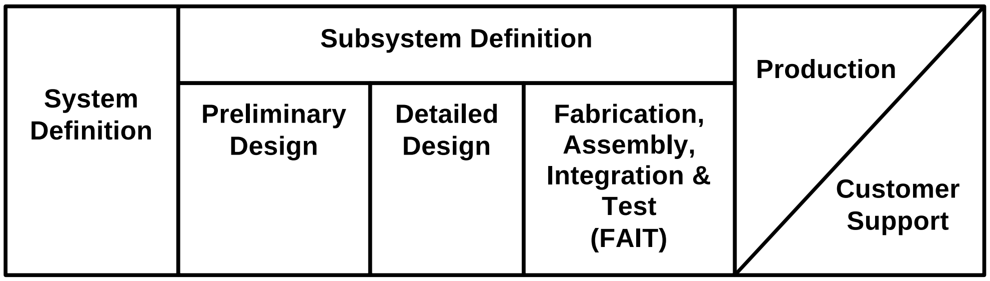

Figure 1 – Typical System Life Cycle: IEEE Std 1220

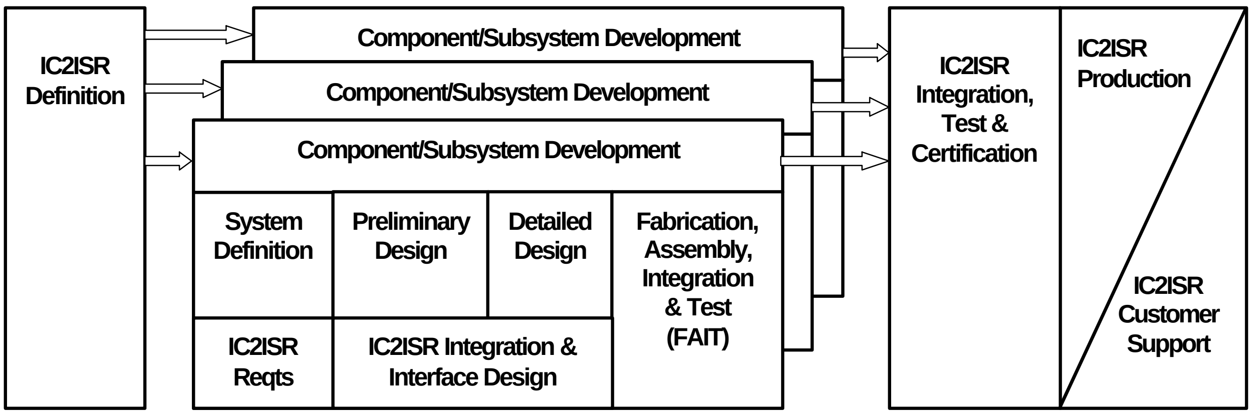

Figure 2 – Proposed IC2ISR System Life Cycle

Note that the internal process used to develop a component is not greatly impacted, and any effective system development process can be adapted for building the IC2ISR.

5.3 Changes to a Spiral Development Process

AF Instruction 63-123 *Evolutionary Acquisition for C2 Systems* [AF63-123] directs the use of an Evolutionary Acquisition Strategy with a Spiral Development Process. Evolutionary Acquisition is an acquisition strategy whereby a basic capability is fielded with the intent to develop and field additional capabilities as requirements are defined. It is being adopted by the Electronic Systems Center, the Air Force center for C2 systems, and other Air Force product centers, and by other services.

Spiral development is a process for rapid development and delivery of a capability to warfighters in the field. Characteristics of spiral development are as relevant and important for developing the IC2ISR as for other systems or components. They can be adapted as follows:

- The schedule for an increment is fixed from funding to delivery.
  - For components of an IC2ISR Block, delivery is contingent on delivery of the entire Block.
- The requirements are specified as performance objectives.
  - For components of an IC2ISR Block, the performance objectives must be interpreted in the context of IC2ISR.

- There can be tradeoffs of performance in order to maintain the schedule.
  - For components of an IC2ISR Block, tradeoffs must be interpreted in the context of IC2ISR.
- An Integrated Product Team (IPT) representing the operational user, the buyer, the testers, the Program Office, and any other stakeholders that may be affected by changes, makes tradeoff decisions on requirements.
  - For components of an IC2ISR Block, the IC2ISR Integration Office is a critical stakeholder.
- The operational user is continually involved to assure the utility of the system as requirements evolve and to make the decision to field.
  - For components of an IC2ISR Block, the IC2ISR operational users must also be involved.

5.4 Process Timeline Constraints

The various refresh cycles discussed in Section 3.5 interact and interlock, and drive the IC2ISR block schedules. New technology refresh implies new training. All refresh cycles require funding, etc. Integration and block development is destined for failure if these refresh cycles are ignored. For integration programs to succeed, the acquisition and funding processes all must accommodate these cycles. They define the integration program timelines.

6. Summary

The way we think about integration in the acquisition process needs to change. Integration is not an attribute of a system, it is the result the warfighter needs to accomplish the mission. When it is considered as a result, a C2ISR integration program does not adapt readily to the present acquisition process. The differences in timelines, and the diffusion of management and control in the development of the multiple components that comprise each block of the IC2ISR, impact all of the functional disciplines of the standard acquisition process.

The acquisition process can be modified to accommodate refresh cycles. An Evolutionary Acquisition Strategy with a Spiral Development Process can accommodate these timelines, but other modifications are needed to address problems with other functional disciplines. The most critical are management and funding. There is an irreducible minimum required to maintain the integrity of the IC2ISR, to provide the continuing support and sustainment for the system to remain viable. In addition, because integration costs can only be roughly estimated at this time, funding requirements cannot be accurately determined in advance.

To accommodate the PPBS process, rough estimates must be used to create a “funding wedge” in order to ensure adequate funding on an annual basis. Strong advocacy is needed to ensure the program is not jeopardized if/when costs vary considerably from estimates. The IC2ISR stakeholders must accept this approach and be prepared to defend it throughout the PPBS process. Assigning C2ISR programs, and IC2ISR, to a single MAD would ensure a focussed funding advocate.

A single C2ISR PEO is needed to facilitate C2ISR integration. Without a single focal point for IC2ISR, inadequate funding and conflicting requirements will typically lead to decisions favoring individual components or systems, rather than the IC2ISR. The integration program should be managed through an Integration Office reporting to the PEO. This Integration Office would lead IPTs to manage the integration effort.

When IC2ISR becomes a reality, components can be developed as integrated pieces of the whole, rather than pieces to be integrated into the whole. New technologies and capabilities can be developed and fielded as integrated components of IC2ISR, not as stand-alone systems. Integration costs will be reduced, and even eliminated in the long term. Costs of fielding new technologies will be reduced through leveraging of hardware and software in the integration environment.

The warfighter does not fully recognize the value of IC2ISR. The value will be apparent only when integrated C2ISR becomes a reality. It will be apparent when the multiplicity of systems is reduced, which, in turn, reduces the complexity of testing, documentation, training and sustainment. This, in turn, reduces costs, including manpower needs. Once IC2ISR is established, it will facilitate the development and fielding of new capabilities and new technologies for the warfighter, and simplify their utilization.

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8. References

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