Preface

Central to the transformation of U.S. Forces are development and fielding of integrated Joint Battle Management Command and Control (JBMC2) capabilities to enable U.S. forces to collaboratively plan and rapidly share an accurate picture of the battlespace. This roadmap provides an overview of JBMC2 capability and Global Information Grid (GIG) development efforts in the Department of Defense. It is intended to assist policymakers and decisionmakers in aligning and integrating Service and Combatant Command doctrine, concept development and acquisition efforts. The goal of this roadmap is to provide a coherent and executable plan for fielding integrated JBMC2 capabilities to U.S. Forces.

Management Initiative Decision (MID) 912 assigns Joint Forces Command (JFCOM) the responsibility for overseeing and directing joint BMC2 capabilities for joint integration and interoperability. This roadmap reflects JFCOM plans for developing complete mission capability packages, joint doctrine, joint operating concepts, and the tactics, techniques, and procedures (TTP) and doctrine, organization, training, materiel, leadership, people, and facilities (DOTMLPF) solutions needed for achieving a robust JBMC2 capability.

An interoperable JBMC2 system of systems is essential in this endeavor. The Department of Defense has developed new acquisition guidance, the new 5000 Series of regulations that specifically address system of systems development. This roadmap is consistent with this guidance, as well as with the new CJCSM 3170.01 Joint Capabilities Integration and Development System (JCIDS), as well as with CJCSI 6212.01C, Interoperability and Supportability of National Security Systems, and Information Technology Systems and with joint architectural constructs. This roadmap endeavors to align and synchronize three major architectural elements: operational concepts and doctrine; BMC2 systems; and underlying joint technical architecture standards and GIG infrastructure. It embraces a multiprong spiral development and joint testing approach guide the evolution of Service and Agency JBMC2 programs.

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Executive Summary

Central to the transformation of U.S. forces, and their ability to operate in a coalition environment, are effective Joint Battle Management Command and Control (JBMC2) capabilities. The goal of this roadmap[1] is to develop a coherent and executable plan that will lead to integrated JBMC2 capabilities and interoperable JBMC2 systems that in turn will provide networked joint forces:

- *Real-time shared situational awareness at the tactical level and common shared situational awareness at the operational level*
- *Fused, precise, and actionable intelligence*
- *Decision superiority enabling more agile, more lethal, and survivable joint operations*
- *Coherent distributed and dispersed operations, including forced entry into antiaccess or area-denial environments*
- *Integrated real time offensive and defensive fires.*

This roadmap provides a strategy with four major parts for integrating current and planned JBMC2 capabilities. These are described below.

Warfighter Driven Concept Developments. The first part of the strategy will provide the joint warfighting concept derived products shown in Figure S.1.

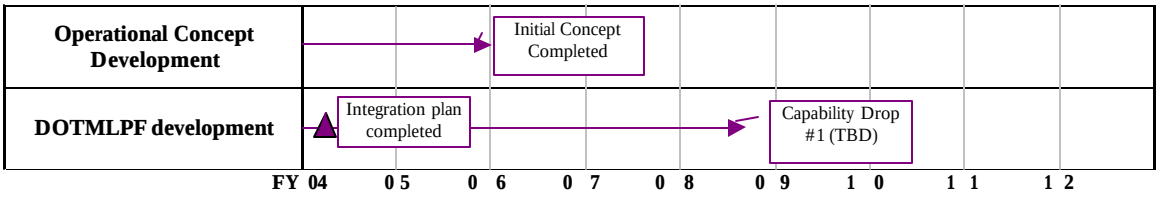


Figure S.1—Elements for the Warfighter

The first product is the U.S. Joint Forces Command (JFCOM) plan for developing an overarching JBMC2 operations concept consistent and integrated with Service JBMC2-related operational concepts. A comprehensive plan to develop this operations concept will be completed by the end of Fiscal Year (FY) 2004, which the complete concept completed by the start of FY 2006.

The second product is the development of the nonmateriel aspects of the full JBMC2 DOTMLPF capability. JFCOM will develop a comprehensive, overarching outline for the joint approach to provide nonmateriel part of integrated JBMC2 capability solutions to the warfighter by February 2004.

[1] *Joint Battle Management Command and Control (BMC2) Roadmap*, Memorandum from the Under Secretary of Defense for Acquisition, Technology, and Logistics, June 9, 2003 (see Appendix C).

Plans to Make Interoperable or Converge JBMC2 Programs. The second part of the strategy addresses the materiel portion of the JBMC2 capability. It provides plans to make interoperable or converge JBMC2 programs, as shown in Figure S.2.

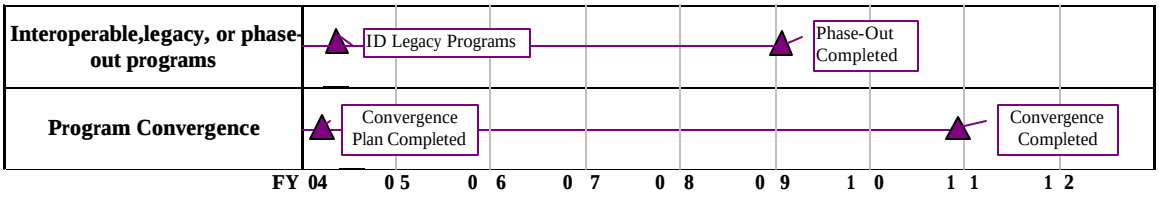
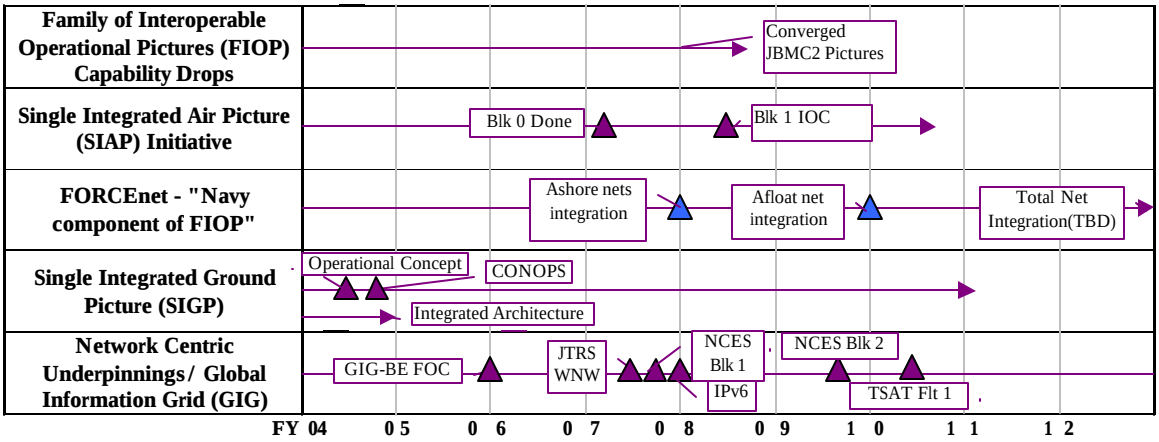


Figure S.2—Plans to Make Interoperable or Converge JBMC2 Programs

The first row of Figure S.2 shows how JBMC2 system interoperability and legacy phase-out criteria will be developed and applied to designate systems as interoperable, as capable of being made interoperable, (and hence to be maintained as programs of record), or as legacy systems (to be phased out). Draft criteria for identifying interoperable and legacy systems are presented in this first-order roadmap. Comprehensive system interoperability and legacy phase-out criteria will be completed by February 2004. Legacy systems will be identified by February 2004 with the objective of making them interoperable by FY 2008 or completing their phase-out by the end of FY 2008. The second row of Figure S.2 shows that a program convergence plan will be completed by February 2004, with the objective of converging selected programs into a smaller set of interoperable programs by the end of FY 2008.

JBMC2 Initiatives. The third part of the strategy addresses the battlespace picture initiatives and net-centric underpinnings, which are key to providing the JBMC2 capability. The key milestones for these initiatives are shown in Figure S.3.



Current Agreed Upon Program or Initiative Milestones shown in Purple
Recommended Milestones shown in Blue

Figure S.3—JBMC2 Initiatives

In accordance with MID 912, some of the battlespace picture initiatives have recently been transferred to JFCOM. These key elements include JFCOM's Family of Interoperable Operational Pictures (FIOP), the Single Integrated Air Picture (SIAP) initiatives, the Navy's FORCEnet Maritime Picture (FnMP) initiative, and the Army-led, multi-Service Single Integrated Ground Picture (SIGP) initiative.

The FIOP initiative is developing web-based applications and network-based services for insertion into programs of record or that can be used to integrate JBMC2 systems. These FIOP capability drops are not shown explicitly in Figure S.3 but are discussed in detail in this roadmap. These will be used to help ensure that all battlespace picture programs converge to provide a unified "picture" of the battlespace by FY 2008.

The SIAP initiative is developing executable software, algorithms, and data models for use by or insertion into programs of record. Block 0 of SIAP is developing systems engineering products for program design and integration, and should be complete in FY 2007. The first SIAP deliveries of executable software to programs of record will be in Block 1. SIAP Block 1 IOC is scheduled to occur in FY 2008. It will be fielded to a number of programs shortly thereafter.

Several major recommended milestones for the Navy's FnMP initiative are shown in Figure S.3. These recommended milestones ensure that FORCEnet ashore communications networks can be integrated into the Global Information Grid (GIG) and that afloat communications networks can rapidly assimilate SIAP and FIOP capability drops. The integration of JC2 into the FORCEnet afloat JBMC2 architecture is recommended to occur by FY 2009.

SIGP is being initiated in FY 2004 and is anticipated to fall under JFCOM MID 912 oversight in the FY 2005 timeframe. SIGP will develop DOTMLPF operational products under the leadership of JFCOM; in FY2004 and FY2005, these include the SIGP Operational Concept, Concept of Operations, and Integrated Operational Architecture. These will initially be developed to define the operational context and scope for SIGP. Interoperability gaps will be identified, and interoperability enhancements spirally developed and tested to provide increased capability to the warfighter.

Net-centric communications and services will underpin the evolving JBMC2 capabilities and applications for the joint warfighter. Key GIG development milestones are shown in the last row of Figure S.3. The GIG-Bandwidth Expansion (GIG-BE) program will reach full operational capability (FOC) in FY 2005. The first block of Network-Centric Enterprise Services (NCES) will be spirally developed over a two-year period and become available in FY 2007. NCES Block Two will be spirally developed in this period as well and reach IOC in FY 2009. A major upgrade of the GIG will occur in FY 2008 when it is transitioned to Internet Protocol Version 6 (IPv6). Another key component of the GIG, the Joint Tactical Radio System (JTRS) Wideband Networking Waveform (WNW) will reach IOC in FY 2008. JTRS WNW will provide high-capacity communications links and dynamic Internet protocol routing capabilities to tactical users. The first Transformational Communications Satellite (TSAT) will be launched in FY 2010 and provide an initial element of a high-capacity laser communications backbone in space. This set of GIG programs will provide the network-centric underpinnings for all JBMC2 programs and initiatives.

Joint Interoperability Test Plans. The Deputy Secretary of Defense has directed that legacy systems should be interoperable, with respect to critical command and control functions, by the end of FY 2008.[2] To meet this deadline, the fourth part of the JBMC2 integration strategy presents test plans for making JBMC2 systems interoperable (and / or successfully converged) by or shortly after this date. Figure S.4 shows the major milestones for these testing plans.

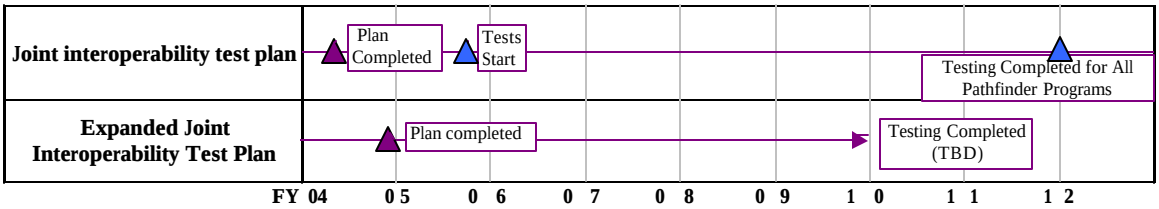


Figure S.4—Joint Interoperability Test Plans

The first row of Figure S.4 shows the timeline for a test plan for an initial set of programs, described in this first-order roadmap. The capabilities that the MID 912 initiatives will provide to programs of record will increase the level of interoperability between JBMC2 systems. However, even the best-designed architectures, software, and systems may be flawed in subtle ways and subject to unforeseen interoperability problems. Therefore, the JBMC2 integration strategy is based not only on the MID 912 JBMC2 initiatives described above and emerging GIG standards and applications but also on a series of joint interoperability tests for an initial select group of JBMC2 systems (hereby designated as "pathfinder programs" because they will be the first to go through this joint interoperability test process). This first-order roadmap presents a joint interoperability test plan for the initial set of pathfinder JBMC2 programs. As shown, test events will commence at the end of FY 2005, and will be complete by the end of FY 2011. (The post FY 2008 end date is needed to account for BMC2 programs that will not reach IOC until after FY 2008.)

The second row of Figure S.4 of the JBMC2 integration strategy is expansion of the JBMC2 system interoperability test plan to include a set of JBMC2 systems larger than just those included in the pathfinder set of programs. Additional programs will be added to the roadmap configuration control process and to an expanded joint interoperability test plan. This joint interoperability test plan for a larger set of JBMC2 systems will be completed by the end of FY 2004. Further research is required to determine when this expanded set of joint interoperability tests can be completed.

Where possible, these joint interoperability tests will first test software models of JBMC2 systems using Joint Distributed Engineering Plant (JDEP) capabilities so that interoperability problems can be caught early and corrected before more expensive hardware-in-the-loop or operational testing is done.

[2] *Command and Control (C2) Legacy Interoperability Strategy and Milestone Action Plan*, Memorandum from the Deputy Secretary of Defense, October 12, 2001 (see Appendix D).

Additional Future Steps

Only program joint interoperability testing milestones have been added to the already established JBMC2 or GIG program plans presented in this roadmap. Future versions of the JBMC2 roadmap will contain the results of critical path program analysis and may recommend program schedule changes, the integration of MID 912 initiative capabilities, and other system design changes to improve JBMC2 interoperability, better align planned programs, and ensure that integrated JBMC2 capabilities are delivered in a series of coherent well-planned "capability drops." Options for recommended program changes will involve time, capability, and resource trade-offs. Supporting analyses for such trade-off decisions will be conducted to assess how much JBMC2 integration is needed to support the conduct of specific military missions. An important element to consider in these analyses is how quickly new JBMC2 capabilities will actually flow to Combatant Commanders and warfighting units. These issues will be addressed in future iterations of the roadmap.

Implementation of the JBMC2 integration strategy described above will help ensure that future joint forces possess interoperable and well-integrated JBMC2 capabilities in future conflicts. If Service JBMC2 programs and DOTMLPF initiatives are not aligned and synchronized effectively and if these systems are not tested thoroughly in a realistic joint environment, then Service programs and doctrine will continue to evolve independently for the most part, and new and unpredictable interoperability problems and doctrinal conflicts will likely emerge, to the detriment U.S. joint forces in future conflicts.

1.0 Introduction

1.1 Overview

In January 2003, the U.S. Joint Forces Command was given a new mission and mandate by the Office of the Secretary of Defense. This mandate was officially codified in Management Initiative Decision (MID) 912, titled Joint Battle Management Command and Control (JBMC2), and signed by the Deputy Secretary of Defense. MID 912 greatly expands the role of JFCOM oversight to a wide range of efforts that together will create and foster a coherent battlespace for U.S. combat forces. The JBMC2 goals articulated in MID 912 result from lessons learned in recent operations where significant joint interoperability problems have occurred at all echelons. To provide an appropriate focus to these joint interoperability issues JFCOM has developed a working draft definition of JBMC2, which is given in Figure 1.1.

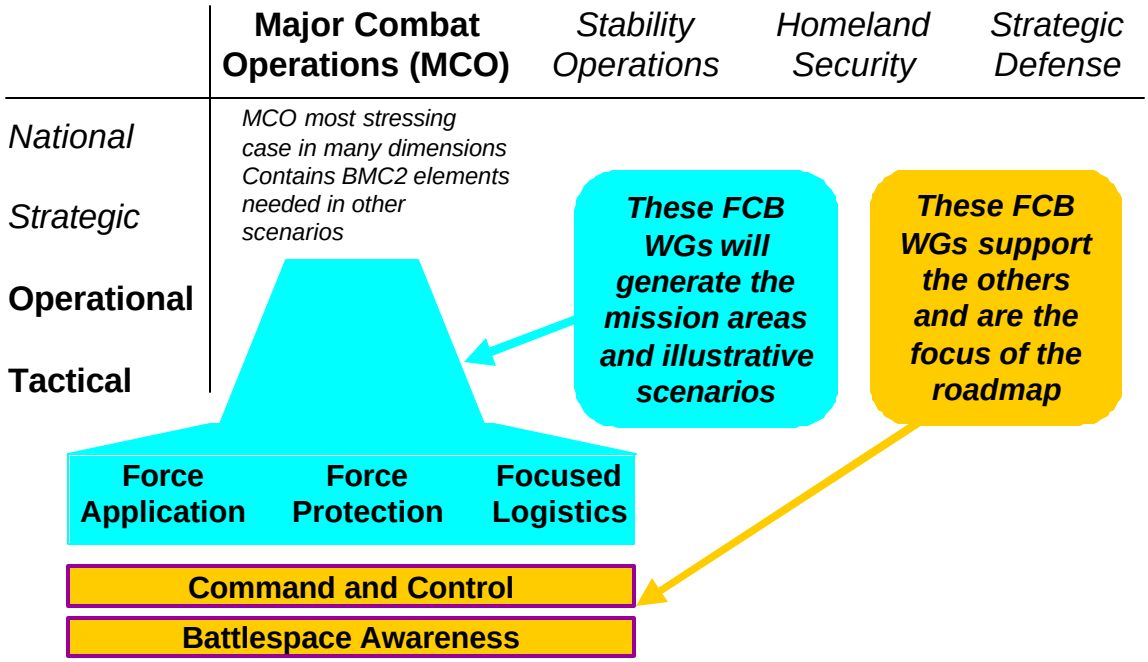
- **JBMC2 consists of the processes, architectures, systems, standards, and command and control operational concepts employed by the Joint Force Commander. The Joint Force Commander executes joint operations by employing the entire array of JBMC2 capabilities during the planning, coordinating, directing, controlling, and assessing of joint force operations from interface with the strategic level through the tactical level.**

- **JBMC2 aims at providing an integrated, interoperable, and networked joint force that will:**
  - **Ensure common shared situational awareness**
  - **Allow fused, precise and actionable intelligence**
  - **Support coherent distributed and dispersed operations, including forced entry into anti-access or area-denial environments**
  - **Ensure decision superiority enabling more agile, more lethal, and survivable joint operations**
  - **Integrated real time offensive and defensive fires**

Figure 1.1—Joint Battle Management Command and Control Definition

This definition of JBMC2 encompasses important defense planning goals, including the provision of shared situational awareness at all levels of the joint force, and the ability to provide fused, precise, and actionable intelligence.[3]

Integrated JBMC2 capabilities are needed by U.S. forces to successfully execute a broad array of joint missions. The array of integrated JBMC2 capabilities and systems needed to support all joint mission areas is potentially quite large. To bound the problem and make it tractable, the initial focus of the JBMC2 roadmap will be on identifying and developing DOTMLPF solutions to provide the JBMC2 capabilities needed to effectively support the Joint Mission Areas in Major Combat Operations (MCO) that are highlighted in Figure 1.2.



Source: "JWCA Portfolios", Presentation by BG Goldfein, 27 Mar 2003

Figure 1.2—Mission and Functional Focus of the First-Order JBMC2 Roadmap

Figure 1.3 provides further operational context for the initial focus of the first-order JBMC2 roadmap. Only specific aspects of the force application and force protection mission areas will be considered:

- Land operations
- Air operations
- Maritime operations
- Conventional attack
- Joint targeting

[3] These goals are elucidated in the Defense Planning Guidance (DPG) FY 2004–2009 and the current Transformation Planning Guidance.

- Joint fire support
- Missile defense.

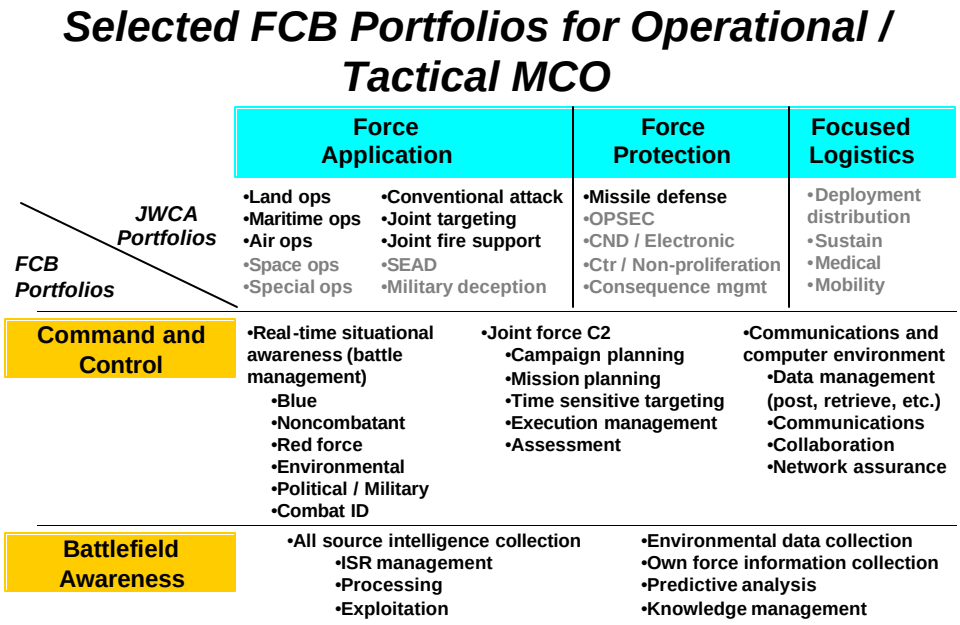


Figure 1.3—Operational Context for JBMC2 Functional Capabilities Considered

The JBMC2 functional capabilities (command and control and battlespace awareness) relevant to these mission areas and operations are shown in Figure 1.3.

1.2 "Thick" and "Thin Clients" in the Tactical Context

The all-encompassing capabilities provided by JBMC2 will be delivered via the proper combination of network-centric ("thin client") and platform-based ("thick client") solutions as indicated in the example systems architecture (in this case, for the Army's Future Combat System, FCS) shown in Figure 1.4. Without taking away any ability of the individual warfighter to control how he sights, identifies, or targets an opponent, JBMC2's umbrella will be one of linked and netted forces, systems, and practices. Either way, a thick-thin balance must be capable in times of stress, persistent during restoration of network operations, tailored to suit commanders' needs, capable of supporting real-time defensive and offensive fires, and configured for net-centric attention for immediate updates. In the balance, the joint warfighter requires a harmonized core set of "killer applications" to support warfighting functions at all levels.

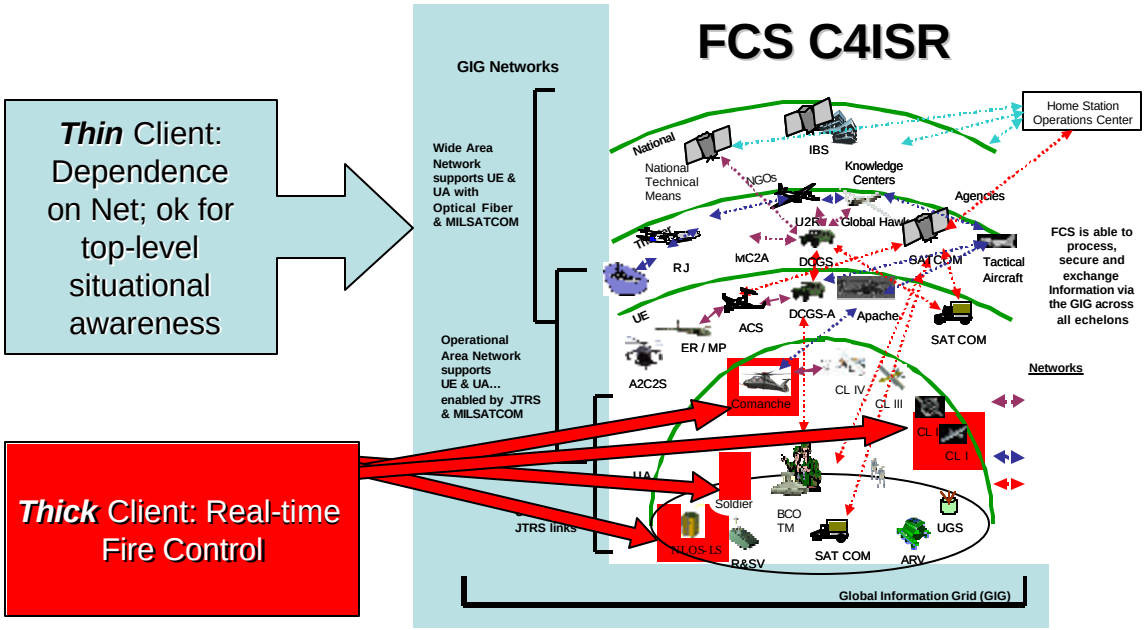


Figure 1.4—Proper Allocation of "Thick" and "Thin" JBMC2 Clients

The proper balance of data distribution among thin and thick clients will be an important system of systems architecture consideration that will depend on mission domain context. For example, for missile defense where time delays and network latency may be the source of mission failure, thick client solutions will likely be preferred for the foreseeable future. On the other hand, for operational-level command and control applications, thin client solutions may provide acceptable levels of performance. Thorough systems engineering analyses will be required to determine the proper balance of data distribution in tactical networks.

1.3 Capabilities Based Methodology and Acquiring JBMC2 Capabilities

The first-order edition of the roadmap will primarily be a compendium of programmatic, exercise, test, and concept development information, with a limited number of recommendations in focused areas. Future editions of the roadmap will provide more-detailed cross-program analysis. It will identify cross-program conflicts, gaps, and synchronization options. It will consider all JBMC2 programs, activities, and initiatives of the services, agencies, and Combatant Commands and options for integrating these to achieve integrated JBMC2 capabilities. It will translate the transformation vision of the Secretary of Defense and other leaders and the lessons learned from recent operations into concrete plans to improve existing JBMC2 capabilities. The roadmap implements the Joint Capability Integration and Development (JCIDS) process, including the development of integrated architectures. It also builds on the "net-centricity" initiatives of ASD NII and the "picture" integration efforts sponsored by USD(AT&L).

As stated in Department of Defense Instruction 5000.2, Operation of the Defense Acquisition System, and as recently clarified in a memo by the USD(AT&L),[4] the USD(AT&L), ASD(NII), the Joint Staff, the Military Departments, the defense agencies, and Combatant Commanders will work collaboratively to develop joint integrated architectures for capability areas as agreed to by the Joint Staff, as follows—

- The Joint Staff (or Principal Staff Assistant [PSA] for business areas) and the JROC (or FCBs on behalf of the JROC) will lead development of the operational views to describe the joint capabilities that the user seeks and how to employ them, with the Services, Defense Agencies, USD(AT&L) and ASD(NII) participating. The FCBs will be the forum for the creation of operational views, with AT&L participating or co-chairing the FCBs as appropriate.
- The USD(AT&L) (or PSA for business areas) will lead development of the systems view, with the Joint Staff, JROC (or FCBs on behalf of the JROC), Services, and Agencies participating in the development. The systems view will identify the kinds of systems and integration needed to achieve the desired operational capability. The FCBs will be the forum for the development of the systems views, with AT&L as co-chair.
- USD(AT&L) and ASD(NII) will lead the development of technical views in parallel with the development of the systems views.
- The DoD Chief Information Officer (CIO), the ASD(NII), will lead the development and facilitate the implementation of the GIG integrated architecture; OSD, the Services, Defense Agencies, Joint Staff, and Intelligence Community will participate in the development of the architecture. ASD(NII) will fund GIG architecture development and DoD Architecture Repository System maintenance. The GIG Architecture Integration Panel (GAIP) / CIO EB will be the forum for development of the GIG integrated architecture. Integration with other integrated architectures shall be performed via the FCBs.
- USD(AT&L) and ASD(NII) will lead the development of integrated plans or roadmaps, with the Joint Staff, JROC (or FCBs on behalf of the JROC), Program Analysis & Evaluation, Services, and Agencies participating. The forums for the development of roadmaps will be patterned after the JBMC2 Roadmap Flag Officer / General Officer group, with an AT&L or NII chair, and an FCB co-chair. The DoD will use these roadmaps to conduct capability assessments, guide systems development, and define the associated investment plans as the basis for aligning resources and as an input to defense planning guidance, program objective memorandum development, and program and budget reviews.
- At the program level, the Program Executive Officer and / or Program Manager must demonstrate how the programs fit into the broader joint mission context (i.e., describe how the program supports, enables or improves the

[4] *Synchronization of Capability Identification and Program Acquisition Activities*, Memorandum from the Under Secretary of Defense for Acquisition, Technology and Logistics, November 10, 2003.

ability to execute joint concepts and missions, and how the program fits into the relevant integrated architectures).

JCIDS, CJCSI 3170.01C, is based on the need for a joint concepts-centric capabilities identification process that will allow joint forces to meet the full range of military challenges of the future. It will assess existing and proposed capabilities in light of their contribution to future joint concepts. It must also produce capability proposals that consider the full range of DOTMLPF solutions to advance joint warfighting. JCIDS must be supported by a robust analytical process that incorporates innovative practices—including best commercial practices, collaborative environments, modeling and simulation, and electronic business solutions.

1.4 JBMC2 Roadmap Integrated Capability Goals

The goals of the JBMC2 roadmap are to deliver the capabilities identified in the definition of JBMC2. This in turn leads to the following integrated JBMC2 capability goals:

- Focus on interoperability at the tactical level, per the direction of the Secretary of Defense
- Ensure that current essential JBMC2 capabilities are integrated and interoperable to support key mission areas (e.g., missile defense, joint fires)
- Make legacy C2 systems interoperable or phase them out by 2008, per the direction of the Deputy Secretary of Defense.
- Ensure that planned future C2 capabilities are integrated and/or interoperable, especially for such major, high-priority systems as the Future Combat System (FCS) and the Multi-Mission Command and Control Aircraft (MC2A).
- Support JFCOM in utilizing MID 912 and related initiatives to ensure an integrated family of interoperable operating pictures, including Deployable Joint C2 (DJC2), Joint C2 (JC2), Single Integrated Air Picture (SIAP), Family of Interoperable Operational Pictures (FIOP), Single Integrated Ground Picture (SIGP), and other relevant initiatives.

The values to warfighters of this roadmap are that it will help deliver the following to U.S. forces: integrated and dynamically scalable command and control of a joint force, comprehensive situation awareness in all domains (land, sea, air, and space), improved planning and collaboration capabilities, improved targeting and postengagement assessments, rapid and effective target-weapon pairing, and effective use of munitions and supplies.

1.5. Scope of JBMC2

PLACEHOLDER. This section will describe the scope of JBMC2, in terms of the range of military operations (ROMO) addressed by JBMC2, and the range of corresponding operational elements, programs, and systems. Figure 1.5 shows that JBMC2 will incorporate C2 for joint warfighting from the Tactical level to C2 interfaces with combatant commanders at the Strategic level. Interfaces with the Strategic level will be governed by a 3 July 2003 Memorandum of Agreement between USD(I), ASD(NII), the US Strategic Command (STRATCOM), and JFCOM.

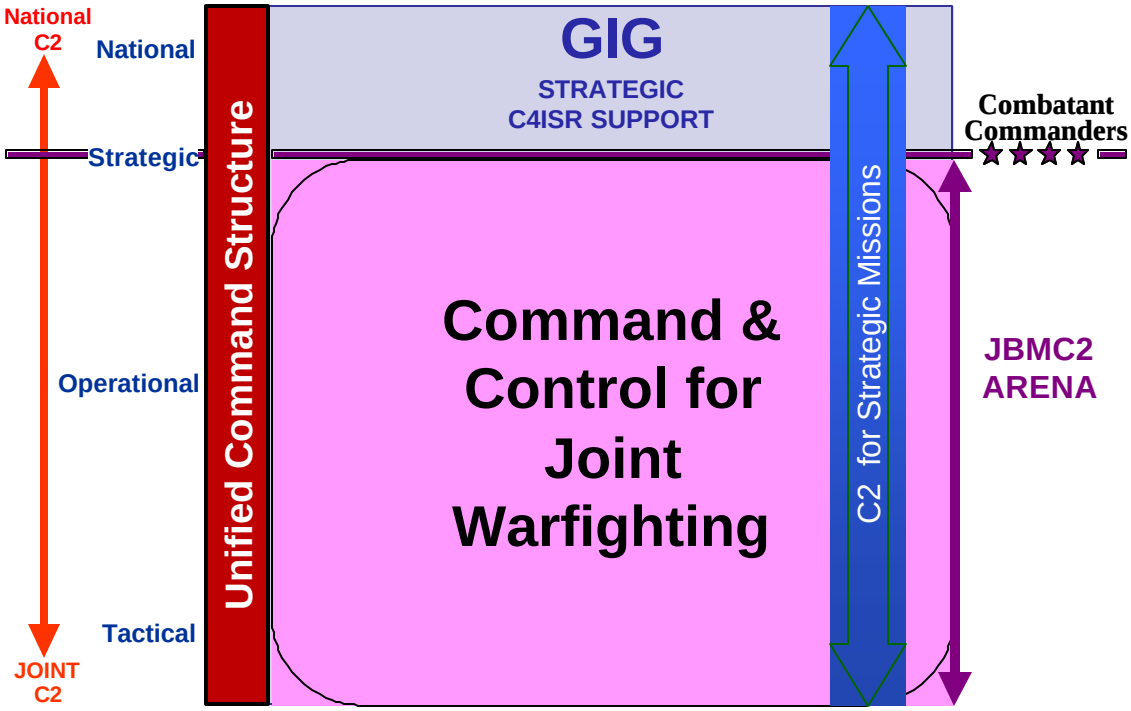


Figure 1.5—Scope of JBMC2

2.0 JBMC2 Operational Concepts, Architectures, and Capabilities

2.1 Operational Concept

The JBMC2 operational concept will be part of a capabilities-based analytical construct that supports Joint Capabilities Integration and Development System (JCIDS) and Joint Requirements Oversight Council (JROC) decisionmaking. The concept will provide the framework for evaluating the command and control investment options needed to implement JBMC2, and for assessing those investment decisions. Initial assessment will be of the Major Combat Operations Joint Operating Concept (JOC) and will focus on points of convergence as well as gap analysis of existing functional concepts. Subsequent to the MCO effort, this approach will be applied to the other three joint operating concepts: stability operations, homeland security, and strategic deterrence. Traditionally, DOD has employed a threat-based force-planning construct to develop forces, systems, and platforms based on a specific threat and scenario. Requirements are often developed, validated, and approved as stand-alone solutions to counter specific threats or scenarios, not as participating elements in an overarching system of systems. This fosters a "bottom-up, stovepiped" approach to acquisition decisions that, in a joint context, are neither fully informed by, nor coordinated with, other components. New programs often fail to foster interoperability and in the end must be deconflicted either by the warfighter or at the department level. Additionally, acquisition management frequently focuses on materiel solutions without considering potential nonmateriel implications that DOTMLPF changes may hold for the advancement of joint warfighting.

In contrast, a capabilities-based construct facilitates force planning in an uncertain environment and identifies the broad set of capabilities that will be required to address the challenges of the twenty-first century. This methodology defines strategic direction and considers the full range of DOTMLPF (materiel and nonmateriel) solutions to develop joint warfighting capability. The intent is to employ a synchronized, collaborative, and integrated approach that links strategy to capabilities.

The JROC approved the Range of Military Operations (ROMO), which captures 43 activities that focuses DoD preparation. The ROMO is the foundation for operating concepts; and it provides the operational context for the JOCs.

JOCs are explanations of how a future Joint Force Commander will plan, prepare, deploy, employ, and sustain a joint force against potential adversaries' capabilities or crisis situations specified within the range of military operations. There are four Joint Operating Concepts: major combat operations, homeland security, stability operations, and strategic deterrence. JOCs guide the development and integration of joint functional and service concepts to provide joint capabilities. They identify the measurable detail needed to conduct experimentation and allow decisionmakers to compare alternatives. Focusing at the operational-level and above, JOCs integrate functional and enabling concepts to describe how a Joint Force Commander will plan, prepare, deploy, employ, and sustain a joint force given a specific

operation or combination of operations. The JOCs will also provide a detailed conceptual perspective for joint experimentation and assessment activities. JOCs must be developed with a narrow scope to guide the development of desired operational capabilities. These capabilities must be examined in terms of potential capabilities-based force packages and subordinate tasks.

The JBMC2 operations concept, using those ROMO activities associated with the Major Combat Operations JOC, will use a sequential approach to highlight joint force capabilities, identify associated attributes of that force that enables it to have those capabilities, present a set of assumptions to help understand risk, provide a framework for evaluating command and control capability options, and assess those options against required tasks.

Figure 2.1 presents the operational concept development timeline.

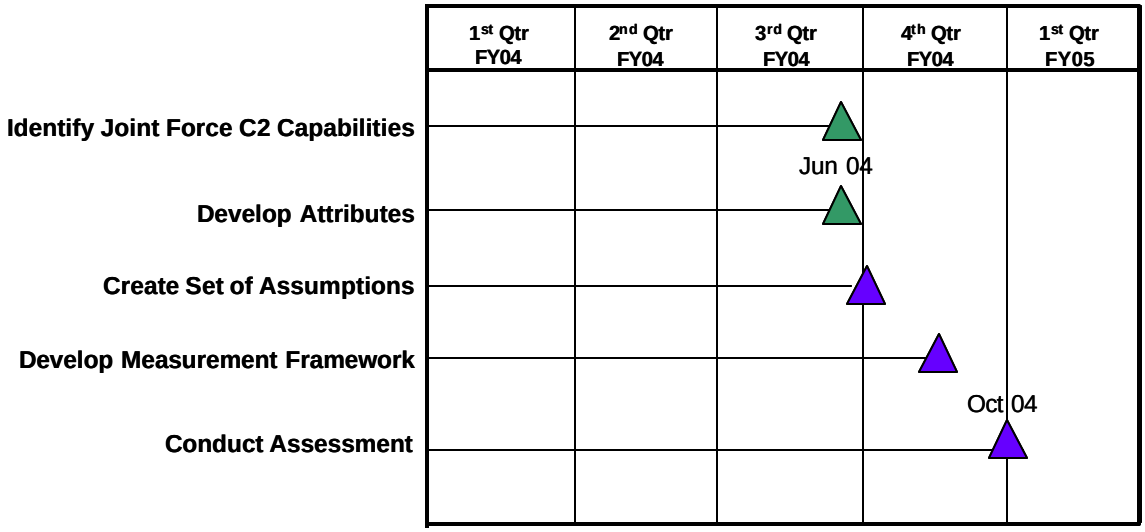


Figure 2.1—Timeline for Operational Concept Development

By June 2004:

- Identify joint force command and control capabilities
- Develop attributes that define those capabilities
- Create set of assumptions.

By October 2004:

- Develop measurement framework – MOEs/MOPs (Measures of Effectiveness / Performance)
- Conduct assessment.

Note that the JBMC2 operational concept will provide guidance to developing the JBMC2 Operational Architecture.

2.2 Operational Architecture

The JBMC2 architecture development is based upon a family of architecture efforts as shown in figure 2.2.

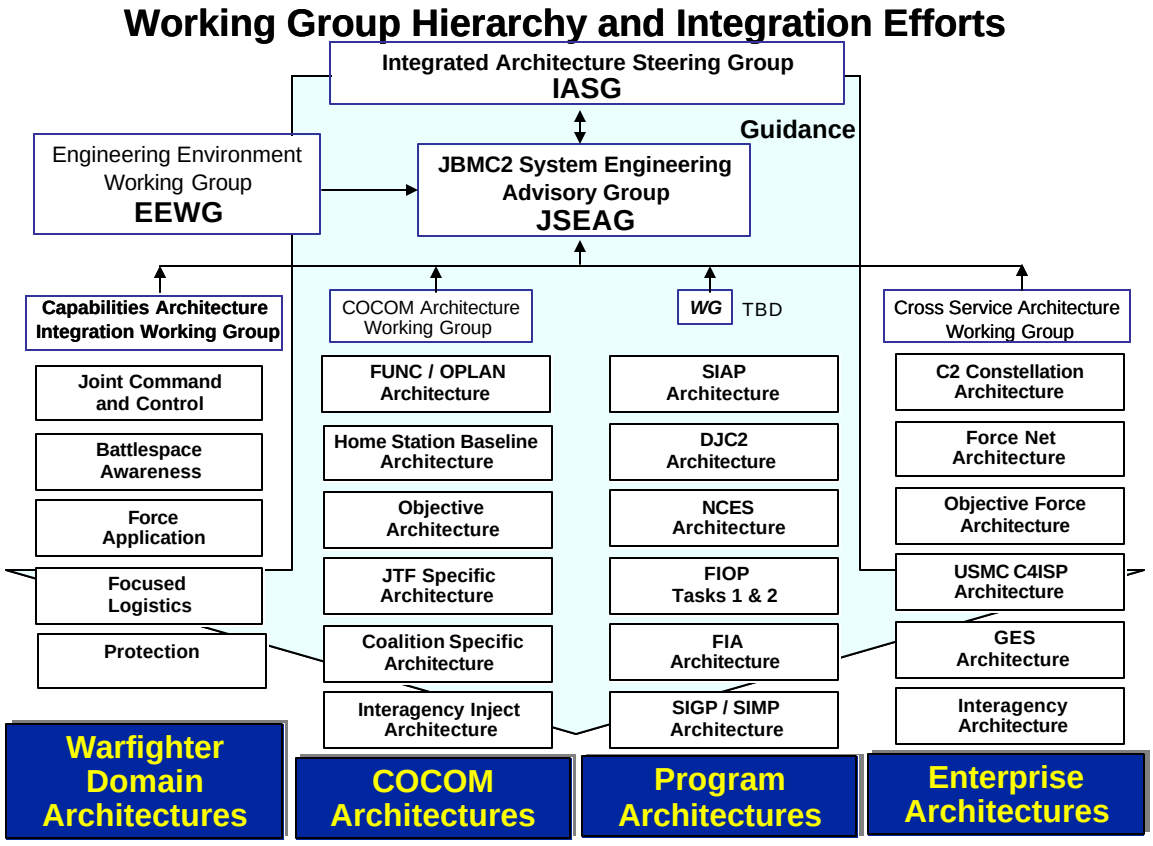


Figure 2.2—JBMC2 Architecture Approach

The JBMC2 architecture development will follow the DoD framework process. Initially, services will collect data on legacy systems to develop the "as-is" architecture. The JBMC2 working group, led by JFCOM, will use a capabilities-based process to assess requirements and develop a future vision, determine which products are required, and translate the architectural plans into a coordinated way ahead. This effort will be bounded by the following methodology:

- Develop JBMC2 integrated architectures in conjunction with services/agencies/COCOMS and the Joint Staff.
- Perform system analysis to address multiple programmatic issues identified by COCOM, services, agencies, Joint Staff, and industry.
- Assess gaps and overlaps in capability developments among proposed and developing systems through architecture analysis.
- Assess traceability of system products to requirements and joint operational concepts.

- Identify synchronization issues among multi-Service and agency programs impacting a single mission area or capability.
- Community approach required for success.

The following six-step process will be used in the development of the architecture:
Step 1: Determine the intended use of the architecture.
Step 2: Determine the scope of the architecture.
Step 3: Determine the characteristics to capture.
Step 4: Determine the views and products to be built.
Step 5: Iteratively build the requisite products.
Step 6: Use architecture for intended use and continue iterating.

The six-step process will be executed in three program phases.

Phase I (October 2003–March 2004)

- Initial Interchange Configuration
- Recommendation for Decision Support Environment
- Investigate data correlation and data analysis approach
- Explore SLATE (Systems-Level Automation Tool for Engineers) integration
- Strategy for JMACA (Joint Methodology to Assess C4ISR Architecture) integration.

Phase II (April 2004–July 2004)

- Tool integration options
- Implement data correlation and data analysis approach.

Phase III (August 2004–December 2004)

- Implement M&S interface to support executable architectures
- Implement HWIL interface (JDEP).

2.3 Relationships Between JOCs, JFCs, Joint Mission Threads, and JBMC2 Capabilities (Placeholder)

PLACEHOLDER. This section will describe a core set of JBMC2 capabilities, The list of exact capabilities is yet to be determined, but will be derived from the Joint Operational Concepts and the Joint Functional Concepts, as well as other guidance listing JBMC2 capabilities.

Of primary importance in defining the JBMC2 capabilities will be the Joint Command and Control Functional Concept. This document contains a list of key joint C2 capabilities, along with a list of key joint C2 attributes that the capabilities are to support. Table 2.X, copied from the current draft of the Joint C2 Functional Concept (revision date 31 October 2003),

identifies the current capabilities and attributes being supported. These capabilities and attributes will be adapted for the JBMC2 Roadmap.

Table 2.1—Major Capabilities and Attributes in the Joint C2 Functional Concept

Capability	Superior Decision Making	Shared Understanding	Flexible Synchronization	Simultaneous C2 Processes	Dispersed C2	Responsive & Tailorable Orgs.	Full Spectrum Integration	Shared Quality Information	Robust Networking
Basic C2 Capabilities									
The ability to monitor and collect data	X	X	X	X	X		X	X	
The ability to develop a situational understanding	X	X	X	X	X		X	X	
The ability to develop courses of action and select one	X	X	X			X	X	X	
The ability to develop a plan	X	X	X		X		X		
The ability to execute the plan including providing direction and leadership to subordinates	X		X	X			X		
The ability to monitor the execution of the plan and adapt as necessary	X	X	X	X	X	X	X	X	
The ability to execute the C2 process	X	X	X	X	X	X	X	X	X
Collaborative C2 Capabilities									
The ability to network	X	X	X	X	X	X	X	X	X
The ability to share information	X	X	X	X	X	X	X	X	
The ability to interact	X	X	X	X	X	X	X	X	
The ability to develop shared awareness	X	X	X	X	X	X	X	X	
The ability to develop shared understanding	X	X	X	X	X	X	X	X	
The ability to decide in a collaborative environment	X		X	X	X	X	X		
The ability to synchronize	X		X	X		X	X		
The ability to execute the collaborative C2 process	X	X	X	X	X	X	X	X	X

2.4 Joint Mission Threads For Guiding JBMC2 Capability Integration Efforts

PLACEHOLDER. JBMC2 integration efforts will be defined and prioritized using joint mission threads (JMTs). These mission threads will be used to design joint interoperability FoS test event objectives and designs, training event objectives and designs, and other JBMC2 capability integration initiatives.

This section will describe a set of JMTs for generic joint mission capability packages. The full list of JMTs is yet to be determined, but will include the following Force Application Joint Operational Concept JMTs:

- Joint Ground Maneuver Operations
- Responsive Joint Close Air Support
- Time Sensitive Target Attack Operations – Ground Targets

One additional Force Protection JOC JMT will also be included: Joint Integrated Air and Missile Defense.

The JMTs will be derived from the Joint Operational Concepts (JOCs), Joint Functional Concepts, existing Joint and Service operational concepts, as well as other guidance and doctrine. JBMC2 task, purpose, and capability objectives will be defined for all JMTs in the roadmap. Each JMT will be defined and analyzed as an end-to-end process. Each definition will describe how the JMT depends on the JBMC2 capabilities, as described in the previous subsection. All JBMC2 operational elements, systems, organizations, and information flows that are involved or contribute significantly to the process will be included in the description.

Network-centric JBMC2 capability performance measures will be developed for the JBMC2 capabilities needed to execute each JMT. As mentioned in the previous section, JBMC2 capabilities will be derived from the JC2 Functional Concept. Where applicable JBMC2 capability performance measures will be based on the Network Centric Operations (NCO) Conceptual Framework developed by the Office of Force Transformation and NII. These measures are generally consistent with the metrics the SIAP initiative have developed for an integrated air picture, but are more general in nature and can be applied to the full spectrum of needed JBMC2 capabilities. Only a core subset of the NCO conceptual framework measures will be employed as JBMC2 capability performance measures.

The OFT/NII NCO conceptual framework provides generic capability performance measures. Specific required performance values will depend on specific mission needs, or JMTs. Subject matter experts from each of the Services will provide specific required performance values.

Once defined, the JMTs will be used to modify and precisely define the program interoperability test clusters in Section 3.3 to be those supporting specific JMTs and their subsidiary major activities. Further the JMTs will guide programmatic analysis (both materiel and non-materiel programs). JBMC2 programs will be associated with specific JMTs, and evaluated with respect to whether they will enable, or fail to enable, achievement of JMT objectives. If performance parameters are not met by desired dates, decisionmakers will be able to choose from the following corrective actions:

- If no program supports a JMT activity appropriately, declare a need for a new joint program and / or initiative.
- If multiple programs principally support the same activity, identify an opportunity for convergence – especially if there are interoperability issues between the multiple programs. Thus, use of the JMTs will lead to an expansion of the plans for convergence specified in Section 3.
- If a program fails to support a specific JMT in a required manner, it is a candidate for phase out.
- If particular programs' characteristics will lead to unsatisfactory mission performance, modify the KPPs of the programs.
- If particular programs' milestones will lead to the tardy implementation of a JMT, modify the program schedules. (Similarly, if a program milestone will not result in a mission capability improvement until well after other milestones are met, the program may be a candidate to be pushed back.)

In addition to the above corrective actions, the JMTs will also provide guidance for interoperability system-of-systems testing. Using the provisions from the new testing plan (Section 10), the roadmap will insert appropriate testing milestones to ensure that the JMTs' performance criteria will be satisfied on the desired due dates.

3.0. Plans to Make JBMC2 Programs Interoperable, Convergent, or Phased Out by 2008

3.1 Introduction: A Philosophy Shift

DoD has recently made a philosophical shift in the way service programs will be structured with respect to one another, as shown in Figure 3.1. In the new approach, programs will be structured to maximize, where appropriate, common elements for joint capabilities across the services. Previously, JBMC2 capabilities depended on independently conceived service programs that shared only a set of joint interfaces. Frequently, these program interfaces were defined by joint standards. However, this standards-based approach has been found insufficient and costly to implement successfully. With the new philosophy, BMC2 capabilities will depend predominantly on a common core of joint applications, defined by joint standards that make use of the common joint computing and communications infrastructure standards. Service-unique programs will be limited to providing service-unique applications, with these unique programs incorporating as much of the JBMC2 infrastructure as possible. Instead, Services largely will create common, GIG-compliant services and applications that will be used across the joint force. These services and applications frequently will be specific to particular capability domains, but will not be unique to a Service.

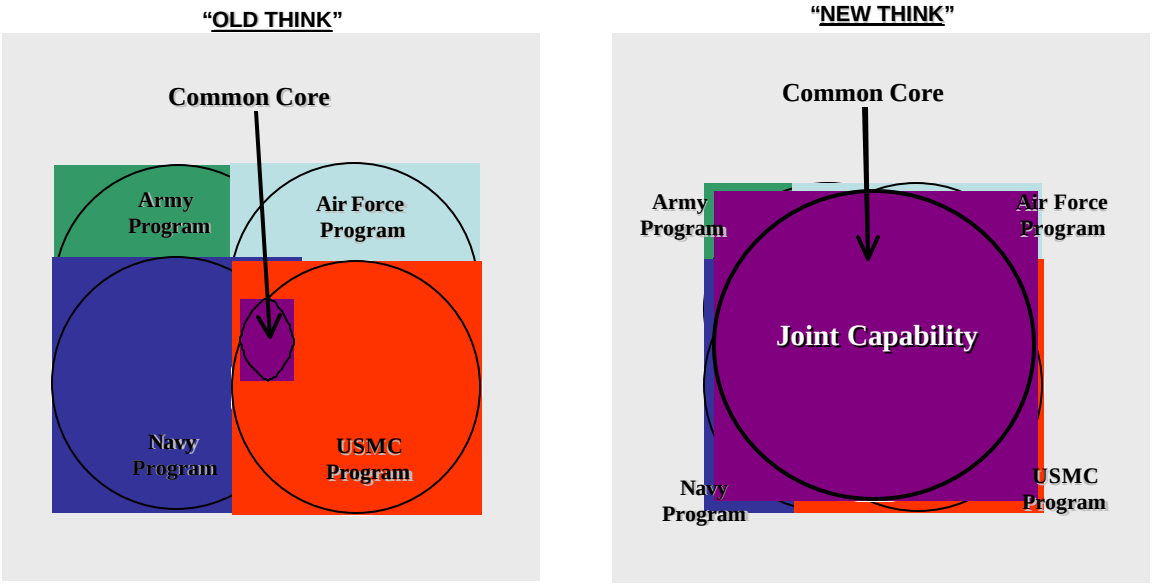


Figure 3.1—DoD's Philosophical Shift

3.2 JBMC2 Pathfinder Programs

As described in the introduction, the overall scope of the JBMC2 roadmap will eventually include all JBMC2 programs; the total cost of all JBMC2 has been estimated at more than $47 billion over the FY 2004–FY 2009 POM and is growing rapidly. Because the scope of current JBMC2 programs is so large, the roadmap will be developed in phases. In the first phase, only a subset of all JBMC2 programs will be aligned programmatically with the objective of ensuring that these JBMC2 systems will be effectively integrated and interoperable. Subsequent phases of the roadmap will address progressively larger sets of JBMC2 systems with the ultimate objective of making the majority of JBMC2 systems interoperable by 2008.

The first phase of the roadmap will focus on a subset of programs we designate as "Pathfinder" programs. These are shown in Figure 3.2.

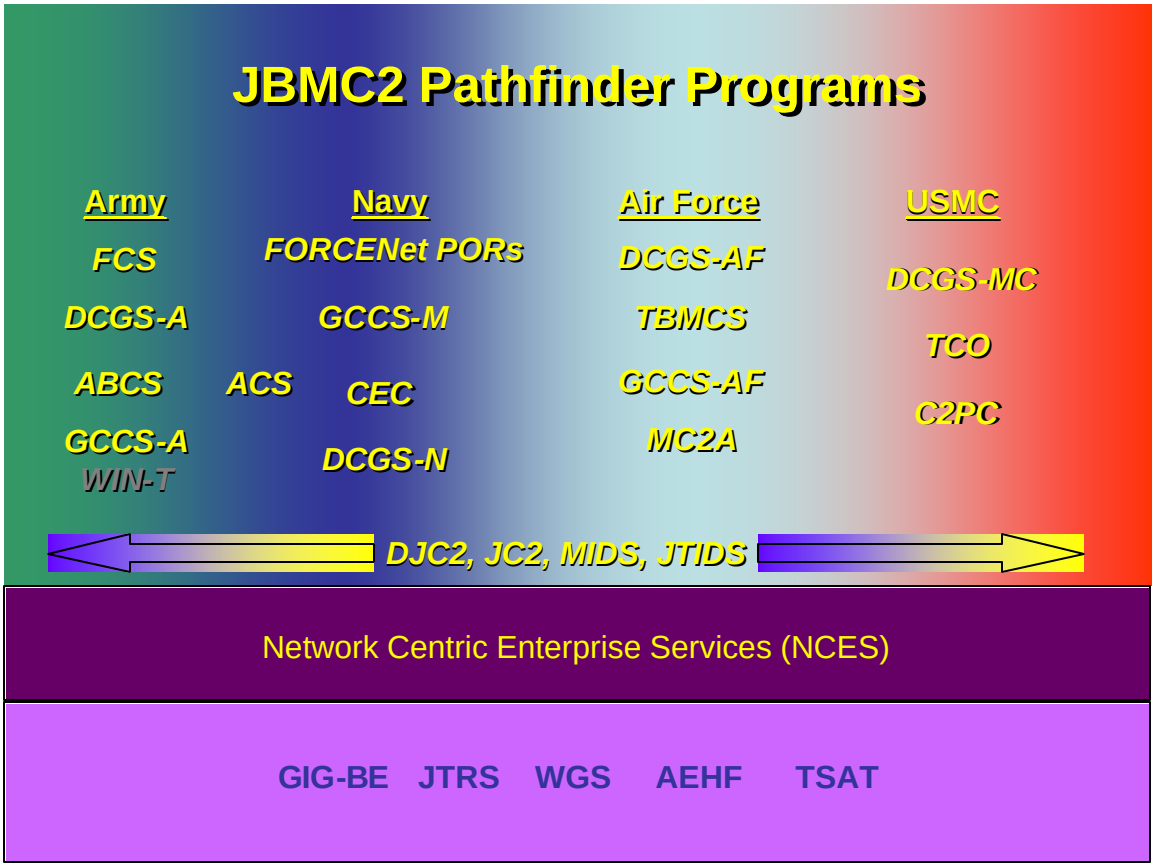


Figure 3.2—Pathfinder Programs for the JBMC2 Roadmap

Included in the set of pathfinder programs are major current and planned service and joint programs for operational-level C2, selected tactical C2 programs, selected ISR programs, selected tactical communications programs, and major programs that provide the network-

centric underpinnings for JBMC2 systems.[5] We discuss these below. First we describe the P3I plans for current programs, and then we will consider the major JBMC2 programs under development by each of the services and other defense agencies.

In the POMed programs that immediately follow, we summarize the following information:

- Program IOC milestones
- Milestones for the major interoperability events, including major system test events and recommended joint interoperability test events.

[*PLACEHOLDER: ADDITIONAL PROGRAMS TO BE ADDED*

We will ask JFCOM and the Services for other programs that must be included in order to support effective execution of the JCTs. The JCTs will be used as organizing principals for relating and grouping JBMC2 systems together and for identifying missing systems.

We will request the Services provide scheduling information on complete list of programs. This information should be provided in a common format, such as MS Project. We should also provide the services with a "minimum" set of milestones that need to be provided (e.g., MS B, MS C, IOC, FOC, major increments / blocks, major testing periods).]

3.3 Joint Interoperability Strategy

In this first-order roadmap, we have established joint interoperability goals and test plans based on the known interoperability shortcomings between specific pathfinder programs and on lessons learned from recent operations where interoperability problems cropped up. The primary goals we have used in constructing the joint interoperability test strategy described below can be found in the definition of JBMC2 presented in Figure 1.1 and in the specific goals established for each of the MID 912 initiatives. Within this context key test measures for joint interoperability will relate directly to the quality of battlespace "picture" and situation awareness data (tactical and/or operational, depending on the JBMC2 systems and mission thread under consideration).[6]

From these we identify six program interoperability test groups:

- Programs related to the creation of the ground battlespace situation awareness data for for Joint Ground Maneuver (JGM) and other joint operations, allowing the warfighter to more precisely and decisively command and control that

[5] All of the programs listed in the figure are included in version 1.0 the roadmap except for the Army's Warfighter Information Network-Tactical (WIN-T) program which is indicated in gray. WIN-T will be included in subsequent versions of the roadmap.

[6] Battlespace "picture" quality metrics have been developed by the SIAP initiative for the air battlespace picture. Quality of information metrics for the general battlespace "picture" have been developed by the Office of Force Transformation (OFT) and ASDNII. These metrics are included in the ASDNII/OFT Network-Centric Operations Conceptual Framework (NCO-CF). This framework and its associated metrics are available on the ASDNII CCRP website.

battlespace. Programs within this group will incorporate SIGP initiative products or standards. This grouping largely comprises major Army and USMC JBMC2 programs.

- Programs that primarily provide battlespace awareness functional capabilities, such as the Services' DCGS programs.
- Future "Flagship" JBMC2 programs or integration efforts that are under development by the services, such as the Army Future Combat Systems (FCS) program. These will probably need to be tightly integrated in several ways to support joint forces effectively in the future—for example, to support joint employment of emerging Network-Centric Warfare (NCW) concepts. These programs will depend on GIG and NCES capabilities directly, so tests within this group will include these infrastructure programs, as well.
- Programs related to the creation of the air battlespace picture. Major air defense–related programs and other programs will make use of capabilities developed by the SIAP initiative.
- Programs that provide operational-level C2 capabilities, such as JC2 and DJC2. As with the Flagship JBMC2 grouping, tests within this group will include GIG and NCES capabilities.
- Programs that will depend critically on GIG-BE and NCES capabilities. Examples of these include operational C2 programs and FORCEnet.

Within these joint interoperability test groups, we have identified several *program clusters* for interoperability testing. Each program in a cluster is to be made interoperable with every other program in that cluster.

SIGP-Related Clusters:

- Cluster 1: Army JBMC2 Systems (as defined in Software Block X Upgrades)/USMC JBMC2 programs. This cluster seeks to ensure that the current systems being upgraded as part of the Army's software blocking process (notably the ABCS components) are interoperable with the current Marine Corps systems and that these Army and USMC systems can responsively exchange increasingly sophisticated forms of Joint Blue Force Situation Awareness (JBFSA) information.
- Cluster 3: Army System Upgrades/FCS. This cluster seeks to ensure that current Army programs will be interoperable with the FCS, and that these JBMC2 systems can responsively exchange JBFSA information as well as exchange targeting information to support future Army fire support and Army precision engagement (PE) mission threads.[7]
- Cluster 4: Army System Upgrades/USMC/FCS. A direct follow-on from Clusters 1 and 3, this cluster seeks to ensure that all current and future ground systems will be interoperable with each other and enable responsive sharing of JBFSA, joint ground force PE, and integrated logistics information. It is the last

[7] It is understood that FCS is already scheduled to be a participating program in Army Software Block (SWB) Three. Cluster 3 will be kept in this roadmap until the details of SWB three become available.

of the SIGP-related clusters, with testing for this cluster not beginning until FCS reaches a fairly advanced state of maturity.

These SIGP-related clusters will be refined and prioritized base on the JFCOM-led DOTMLPF operational products such as the JBMC2 Operational Concept and CONOPS. Changes and additions to Joint interoperability test clusters 1, 3, and 4 will be published in future editions of the roadmap.

Battlespace Awareness-Related Clusters:

- Cluster 2: Service DCGS variants. This cluster seeks to ensure that the main service's main battlespace awareness programs are interoperable with each other to allow for genuinely joint and dynamic ISR operations and analysis. These tests will also evaluate progress in incorporating the DCGS Integration Backbone's common software services in such areas as data management and common imagery analysis (see Section 3.8).
- Cluster 6: DCGS variants/MC2A/ACS. An extension of Cluster 2, this cluster seeks to ensure that all of the major "pathfinder" programs supporting the battlespace awareness capability are interoperable with each other, allowing for truly joint and dynamic ISR operations and analysis. Testing for this cluster will not begin until the MC2A and ACS programs have reached a reasonable state of maturity.

"Flagship" BMC2-Related Clusters:

- Cluster 5: FCS/MC2A/GIG/NCES. This cluster seeks to ensure that the two future flagship programs of the Army and the Air Force can effectively support Joint Close Air Support (JCAS) and Joint Fire missions and are interoperable with each other, in accordance with the relevant information infrastructure programs.
- Cluster 7: FORCEnet/ACS/FCS/MC2A/GIG/NCES. This cluster seeks to ensure that the leading "pathfinder" programs are interoperable with each other to provide integrated JBMC2 capabilities, particularly for Theater Missile Defense / Cruise Missile Defense (TMD/CMD), TST operations, and dynamic BA and JFC2. (For FORCEnet, the concept is that appropriate programs within the Navy's integrated architecture will be interoperable with ACS, FCS, and MC2A Joint mission threads for the types of missions and operations given above will be used to define Navy JBMC2 systems in critical paths.)

SIAP-Related Clusters:

- Cluster 8: MC2A/FORCEnet/Army Software Upgrades. This cluster comprises the primary pathfinder programs that are significant contributors or consumers of the air battlespace picture. For Army Software Upgrades, the cluster includes those programs that will be part of the SIAP portfolio, such as Patriot and FAADC2 (Forward Area Air Defense C2).

Operational C2-Related Clusters:

- Cluster 9: DJC2/JC2/GCCS/NCES. This cluster seeks to ensure that the software programs supporting operational C2 are fully integrated and/or converged (see Section 3.2.3), to include the NCES underpinnings.

- Cluster O: DJC2/JC2/GCCS/FCS/MC2A/USMC/GIG/NCES. This cluster seeks to ensure that the joint force and service operational C2 programs are interoperable with each other. It also seeks to ensure that the pathfinder programs communicating directly with the operational C2 programs are interoperable with these programs.

GIG-BE/IPv6 Expansion-Related Clusters:

- Cluster G: FORCEnet/JC2/DJC2/GCCS/NCES/GIG-BE/IPv6. This cluster seeks to ensure that the pathfinder programs that will first use the GIG-BE/IPv6 expansions, can do so properly. As shown, these programs consist of the operational C2 programs along with relevant components of FORCEnet.

These clusters are by no means intended to be a complete list. Further clusters of programs and additions to the above clusters will be added to the February 4 version of the roadmap. In addition, the above clusters and additional clusters will be formally aligned with JBMC2 capabilities and functions, as defined by appropriate operational concepts and architectural views. Section 3.8 describes in more detail what types of requirements will need to be met for program to be certified as "interoperable" with each other. For now, it is known that achieving interoperability will be demonstrated by undertaking a series of realistic joint tests, including both a set of JDEP simulation testing and software- and hardware-in-the-loop testing. Figure 3.3 provides a key for the major joint interoperability test events recommended in this roadmap. Figure 3.4 presents the schedule of major program milestones for all pathfinder programs except the operational-level C2 programs. Overlaid on those program schedules are tentative dates for JDEP-like software-based and hardware-in-the-loop test events for JBMC2 programs within each cluster. (Note that JDEP events are marked with triangles, and hardware-in-the-loop events are marked with diamonds.) Where possible, these tentative dates were set to coincide with existing program test events.

It should be noted that this proposed master joint interoperability test schedule implies a paradigm shift with respect to joint interoperability testing. Previously, all "tests" were thought of as pass-fail events that a program had to "pass" to enter service. The new paradigm creates a sequence of tests, the first of which are strictly designed to identify interoperability issues and provide guidance on how to improve systems. For example, the first system-in-the-loop test for Cluster 1 (Army/Marine Corps) is scheduled for FY 2005. The Army and Marine Corps systems included are not intended to be fully operational at this time; rather the test is intended to help the Army and Marine Corps identify what will need to be done. Then, future tests will ascertain further areas for improvement, as well as track progress against previously diagnosed problems, with the goal of having test events that demonstrate real system interoperability by FY 2008. Chapter 8 describes this paradigm shift in more detail.

- SIGP-Related
  - 1 – Army Software Block X, USMC
  - 3 – Army Software Block X, FCS
  - 4 – Army Software Block X, USMC, FCS
- Battlespace Awareness-Related
  - 2 – DCGS–A, DCGS–AF, DGCS–N, DCGS–MC
  - 6 – DCGS–A, DCGS–AF, DGCS–N, DCGS–MC, MC2C, ACS
- "Flagship" BMC2-Related
  - 5 – FCS, MC2C, GIG, NCES
  - 7 – FORCEnet, ACS, FCS, MC2C, GIG, NCES
- SIAP-Related
  - 8 – MC2C, FORCEnet, Army Software Block X
- Operational C2-Related
  - 9 – DJC2, JC2, GCCS, NCES
  - O – DJC2, JC2, GCCS, FCS, MC2C, USMC, NCES, GIG
- GIG-BE / IPv6-Related
  - G – FORCEnet, JC2, DJC2, GCCS, NCES, GIG-BE/IPv6

Figure 3.3—Legend for the JBMC2 Interoperability Test Plan Figures

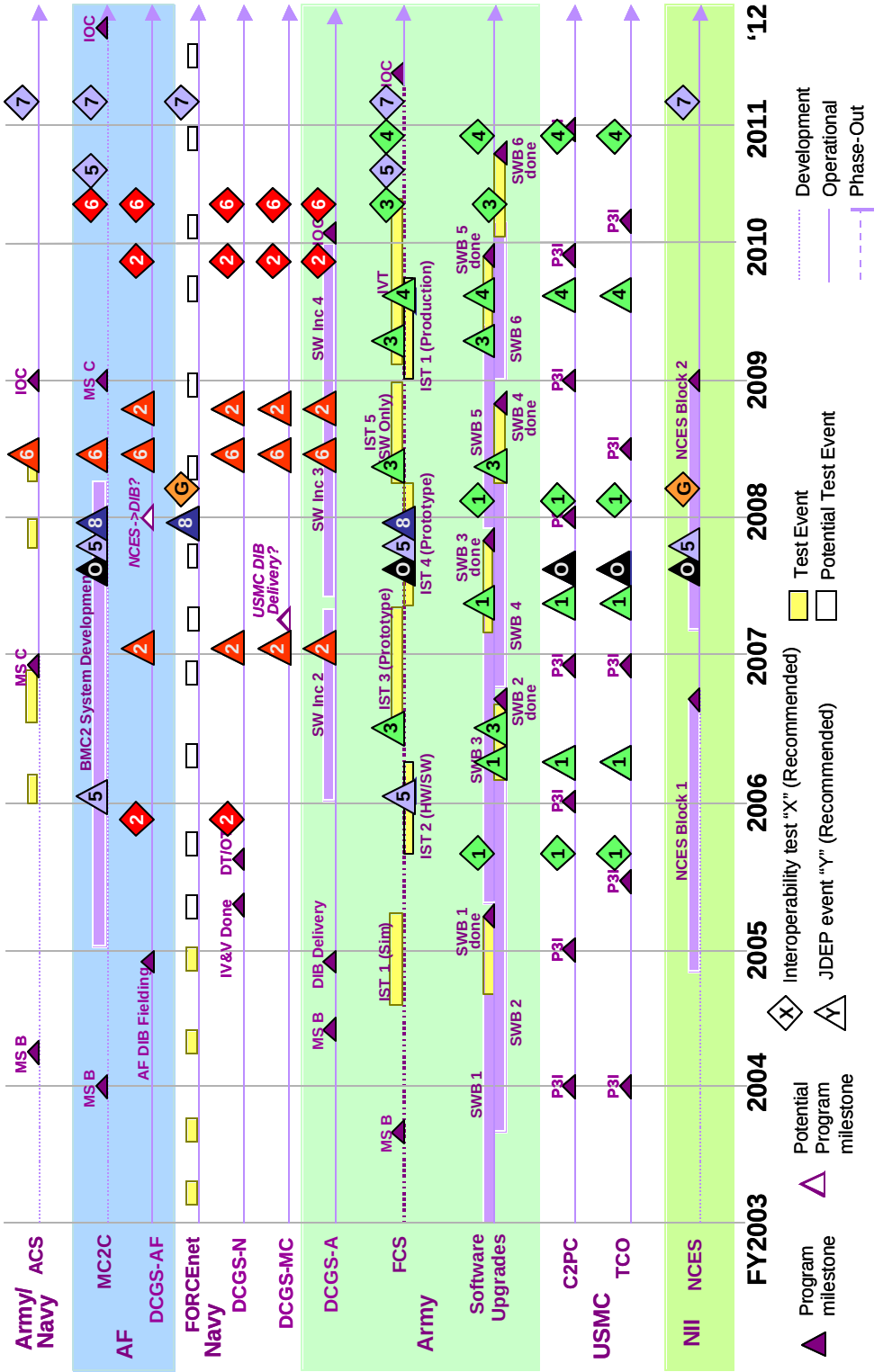


Figure 3.4—Draft JBMC2 Interoperability Test Plan

3.4 Program Convergence

[*PLACEHOLDER FOR EXPANSION OF PROGRAM CONVERGENCE SECTION:*

The convergence section of the roadmap will initially provide a methodology to assist AT&L and JFCOM decision makers in making program convergence decisions or recommendations. The expanded program convergence analysis will follows from the JCT-based analysis discussed previously. The program convergence section should be expanded to incorporate opportunities for convergence, and feasible schedules for these opportunities, resulting from the JCT-based analysis.

Certain JBMC2 program convergence options are now being actively considered by some Services (e.g., the Army and USMC Joint Blue Force Situation Awareness initiative). The working group will monitor these developments and bring them to the attention of AT&L and JFCOM leadership where appropriate. These program convergence options or decisions will be reflected in a timely fashion in updates of the roadmap.

Opportunities for program convergence would be developed by sub-teams of the Tiger Team and Working Group, and reviewed by the Working Group and the JBMC2 BoD.

Emerging guidance and Service software application transition and development efforts from GCCS to the JC2 program will be actively monitored to adjust and expand the guidance in this section.]

In addition to showing interoperability milestones and test events, this first-order roadmap also shows currently planned convergence milestones. With respect to the pathfinder programs, the most significant instance of convergence is the proposed transition from the GCCS "family of systems" to the unified JC2 system for operational JFC2.[8]

Figure 3.5 shows the current proposed timelines for JC2, DJC2, and the GCCS variants, as provided to us by the JC2 program office. Also shown are the timelines for the rollout of the SJFHQs, which will rely on DJC2 as their IT solutions, as well as NCES, which will provide key computing infrastructure services employed by JC2 and DJC2.

GCCS to JC2 Convergence. As shown, the current convergence plan for GCCS-variant convergence to JC2, proposed by NII, is to have Block 1 of JC2 enter preliminary service at the start of 2006. GCCS-J and the service GCCS variants will port their functionality to JC2 services and applications over the next two years, with JC2 reaching Milestone C by the start of 2008. Past this point, GCCS-J and the service GCCS variants will enter a transition

[8] "Global Command and Control System (GCCS) will evolve from its current state of joint and Service variants to a single joint C2 architecture and capabilities-based implementation comprised of joint mission capability packages and Service-unique applications based on Global Information Grid (GIG) enterprise services enabling shared access to Service/Agency/joint-provided data sources." JC2 ORD, 22 August 2003.

period, being phased out completely by the end of 2009. (The services will probably retain successors to their GCCS-variant program offices to develop and deliver service-specific, JC2-compliant capabilities.

The possible exception in this above plan is GCCS-AF. A current proposal would treat a number of legacy programs as members of a "GCCS-AF Family of Systems". The status of this proposal, as well as determination of which members of the proposed "GCCS-AF FoS" should be ported into JC2 and then phased out as separate programs, will require further examination.

The above timelines presume that the GCCS service variants will be completely phased out by 2009. Several alternative plans have been suggested. The first is to retain separate "GCCS" program offices for the services, but these offices would strictly build service-specific applications or services for JC2. The second would be to retain a "family of systems" structure for JC2, featuring a core program that interoperates with a family of service-specific systems.

In addition to the form of the GCCS-to-JCS migration plan, is not yet determined how far from the operational level down to tactical echelons JC2 will extend. The host of legacy service system programs serving operational-to-tactical users will require a recognized architecture to aim at, either as migrating their capabilities to JC2 Mission Capability Packages or as some combination of GIG-compliant applications and GIG enterprise services. Future versions of the roadmap will consider this issue in more detail.

Rollout of DJC2. At the same time that the GCCS variants are being ported into JC2, successive versions of the GCCS variants and JC2 will be installed on the DJC2 hardware systems.[9] Initially, DJC2 will host GCCS capabilities and tools from the Collaborative Information Environment; successive increments of DJC2 will host JC2 capabilities and tools. Figure 3.5 shows the timelines for the installations. It also shows when DJC2 will first enter service with the SJFHQs (at the end of 2005). Also shown are the uses of the current COE interoperability standards and the future NCES services by JC2 and the GCCS variants.

Proposed Testing. Finally, Figure 3.5 describes the test events for the aforementioned clusters 9, O, and G, consistent with the notation of Figures 3.3 and 3.4.

[9] "The Deployable Joint Command and Control (DJC2) System will provide Regional Combatant Commands (RCCs) with an integrated, rapidly deployable Joint command and control (C2) capability, specifically tailored to support the Standing Joint Force Headquarters (SJFHQ) and the Joint Force Commander (JFC) in executing Joint Task Force Headquarters (JTF HQ) operations." DJC2 ORD, 29 July 2003.

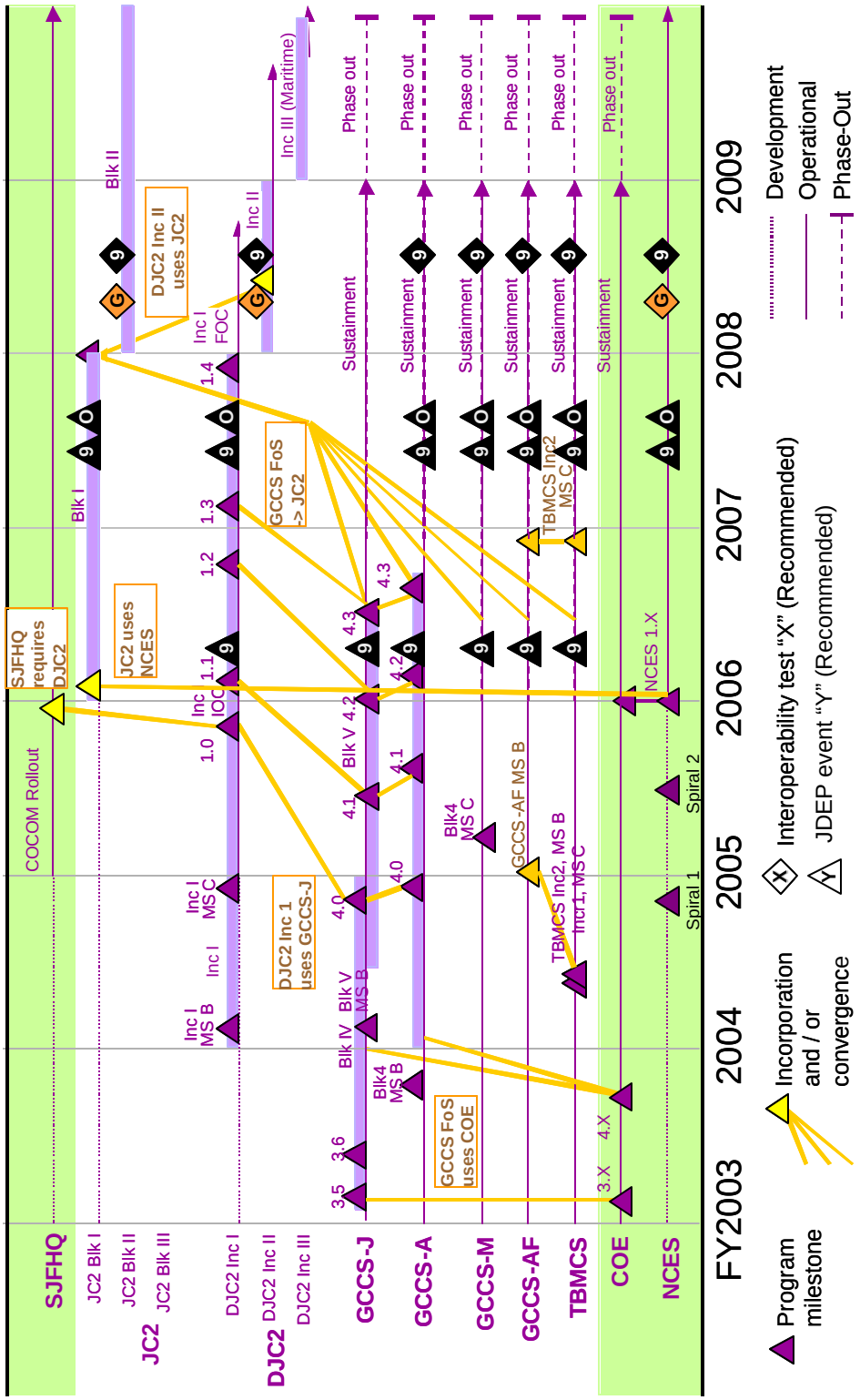


Figure 3.5—Convergence of JC2/GCCS Service Variants and Suggested Interoperability Test Plan

3.4.1 Distributed Common Ground Systems (DCGS)

The DCGS systems of each of the services are in turn composed of a number of subsystems that are PORs. These are listed in Figure 3.6.

DCGS – A

- Common Ground Station (CGS)
- Integrated Processing Facility (IPF)
- Guardrail Information Node (GRIFN)
- All Source Analysis System (ASAS)
- Counter intelligence/Human Intelligence Information Management Systems (CHIMS)
- Home Station Operations Center (HSOC)
- Tactical Exploitation Systems (TES)

DCGS-N

- Battle Group Passive Horizon Extension System (BGPHES)
- Joint Service Imagery Processing Systems – Naval (JSIPS-N)
- Ships Signal Exploitation Equipment (SSEE)
- Tactical Exploitation Systems – Naval (TES-N)
- Maritime Intelligence Broadcast System (MIBS)
- Common High-Bandwidth Data Link / Common Data Link (CHBDL/CDL)

DCGS – MC

- Common Ground Station (CGS)
- Intelligence Analysis System (IAS)
- Technical Control and Analysis Center (TCAC)
- Tactical Exploitation Group (TEG)

AF-DCGS

- Deployable Ground Intercept Facility (DGIF)
- Deployable Shelterized Systems (DSS)
- Deployable Transit-Cased Systems (DTS)
- Ground Control Processor (GCP)
- Core Sites
- ISR Management/C2 of ISR
  - ISRM, ISRW, Remote CSP
- MOBSTR/Extended Tether Program (ETP)
- Wide-Area, Campus-Area, Local-Area Networks/Comms

Figure 3.6—Subsystems of the DCGS

The DCGS programs will achieve data-level interoperability through common use of the Air Force-developed DCGS Integration Backbone (DIB), as directed in a 16 September 2003 Acquisition Decision Memorandum by the USD(AT&L). The DIB provides:

- Common data repositories;
- Common data services, including web and portal services, system services, collaborative services, integration support services, search and query services, workflow management services, and security services; and
- Common applications, most notably in the area of imagery, including a common imagery exploit support system, a common imagery processor, and imagery and geospatial data repositories.

Figure 3.7 shows the planned timelines for the rollout of the hardware components of the DIB, as well as the first software drops. This slide shows the milestones for the initial deployment of the DIB.

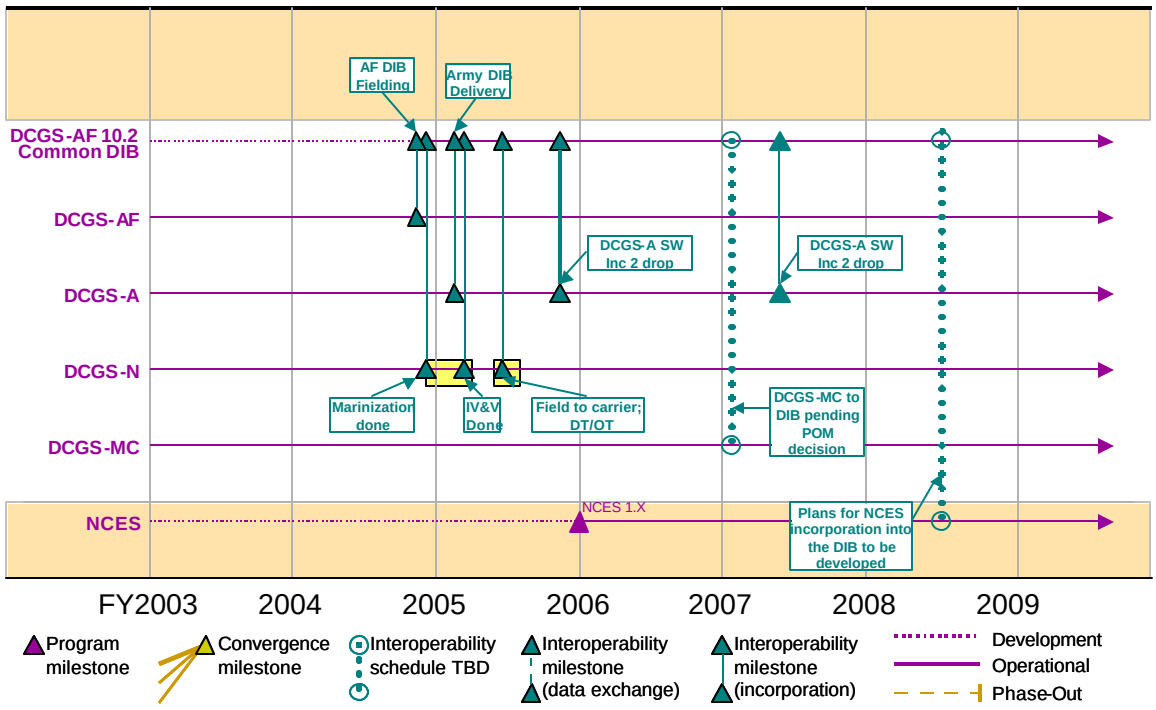


Figure 3.7—Milestones for the Initial Deployment of the DIB

It should be noted that the USMC DCGS plans to incorporate the DIB, but plans for this incorporation are pending a POM decision. In addition, plans to incorporate NCES into the DIB (and other DCGS programs, as applicable) are to be done.

Note that the Navy specifically includes IV&V milestones, while the Army has identified dates to receive DIB software drops. These types of information should be incorporated on future BMC2 Roadmap scheduling charts.

3.4.2 Joint Fires Network (JFN)

The "Joint Fires Network" (JFN) is an approach to achieving multi-Service integration of the Navy's Naval Fires Network (which includes TES-N and JSIPS-N), the Army's TES-A, the Air Force's ISR Manager, and the USMC's TEG.[10] Managed by JFCOM, the approach was established in a 26 February 2003 memorandum from the Principal Deputy Undersecretary of Defense for AT&L.

Figure 3.8 shows a candidate schedule for the programs that are part of JFN, briefed at a recent OIPT on DCGS. The status of the candidate perspective is under discussion. As shown, the next three significant milestones for JFN are JFN 6.1, JFN 7.0, and JFN 8.0, which are associated primarily with corresponding upgrades to the TES software systems (TES 6.1, 7.0, 8.0).

[10] This approach is separate from the Navy's Joint Fires Network ("Navy JFN") program. Formerly referred to as the Naval Fires Network (NFN), this program is converging JSIPS-N into TES-N. To avoid confusion, we refer to Navy JFN as NFN throughout this document.

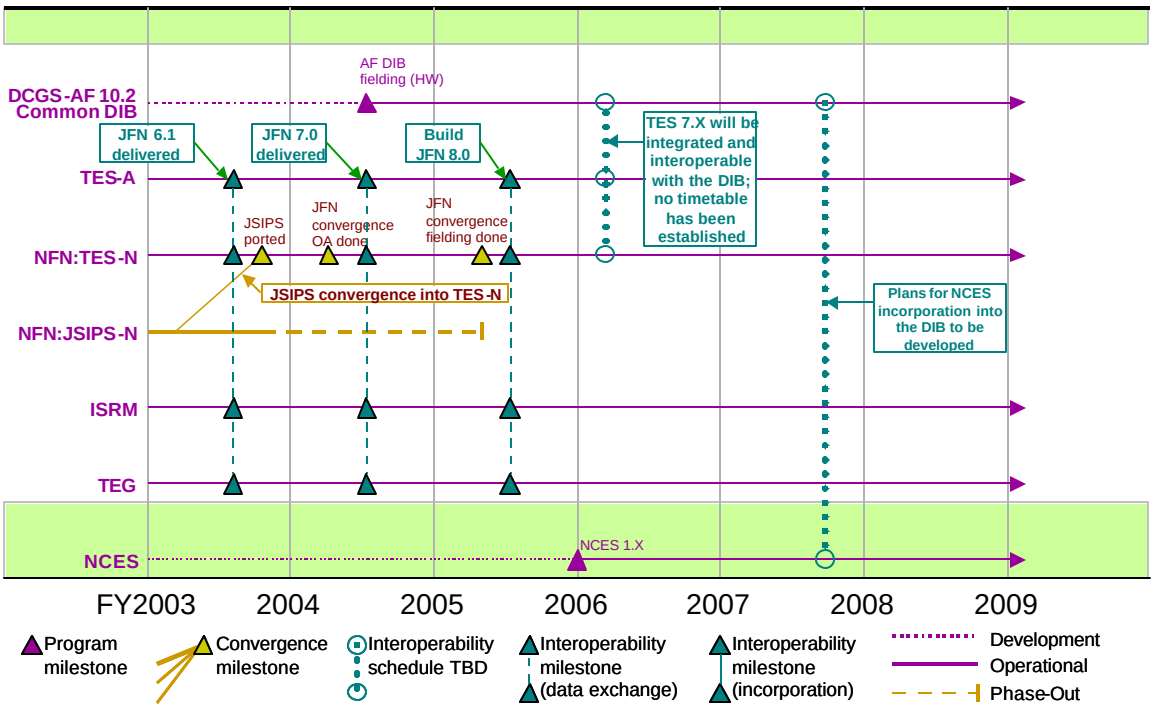


Figure 3.8—Candidate Joint Fires Network Schedule

It should be noted that within the Navy's Naval Fires Network (NFN) portfolio, the JSIPS program will soon converge into TES-N.

The two TES programs (TES-A and TES-N) are to incorporate the DIB as part of the TES 7.X software upgrade. However, a timetable to do so has yet to be established. In addition, as previously noted, plans to incorporate NCES into the DIB, and the TES programs, are to be determined.

3.4.3 Aerial Common Sensor (ACS)

The Aerial Common Sensor (ACS) will replace the Crazy Horse (now retired), Guardrail Common Sensor, and Airborne Reconnaissance Low airborne intelligence, surveillance, and target acquisition systems. The Navy will also use a modified version of ACS in place of its initially planned Multimission Aircraft (MMA). Figure 3.9 describes the timelines for the development, testing, and rollout of the Army and Navy variants of the ACS.

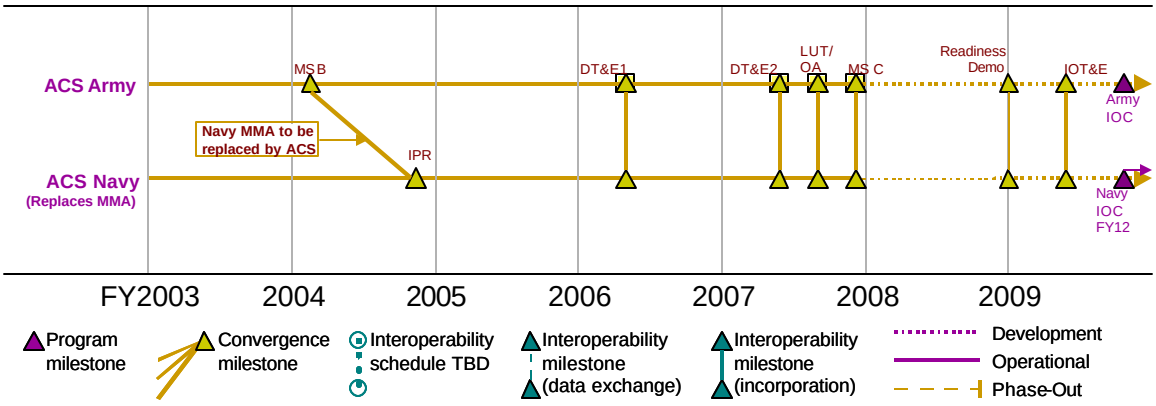


Figure 3.9—Schedule for the Army and Navy Versions of the ACS

3.4.4 Tactical Data and Voice Communications

Joint Tactical Information Distribution System

A joint program directed by OSD, JTIDS provides tactical data and voice communication at a high data rate to Navy tactical aircraft and Marine Corps units. It has been integrated into numerous platforms and systems, including U.S. Navy aircraft carriers, surface warships, amphibious assault ships, F-14D Tomcat and E-2C Hawkeye aircraft, U.S. Air Force AWACS aircraft, and Marine Corps TAOCs and TACCs. JTIDS is the first implementation of the Link-16 message standard. (Source: U.S. Navy Program Guide 2003 ed.) Program began Full-Rate Production in March 1995

Multifunction Information Distribution System

MIDS is a multinational cooperative development program to design, develop, and produce a tactical information distribution system equivalent to JTIDS but in a low volume, lightweight, compact terminal designed for fighter aircraft, with applications in helicopters, ships, and ground sites. As a P3I of the JTIDS terminal, MIDS LVT will employ the Link-16 message standard. MIDS is fully interoperable with JTIDS. Current tactical data link systems will not converge into MIDS or JTIDS but will be replaced by and will migrate to systems using the Link-16 waveform and the J-series message standard. (Source: U.S. Navy Program Guide 2003 ed.)

Program IOC 2003

The migration path for other data links began in 2003. Figure 3.6 shows when these other links will make the transition to the J series of messages, making this datalink FoS interoperable at the message level. Note that LINK 11 continues until FY15 to support interoperability with Coalition and disadvantaged platforms. LINK 4A continues until FY15 because it serves as the backup landing system for aircraft until the Joint P Aircraft Landing System (JPALS) is fielded.

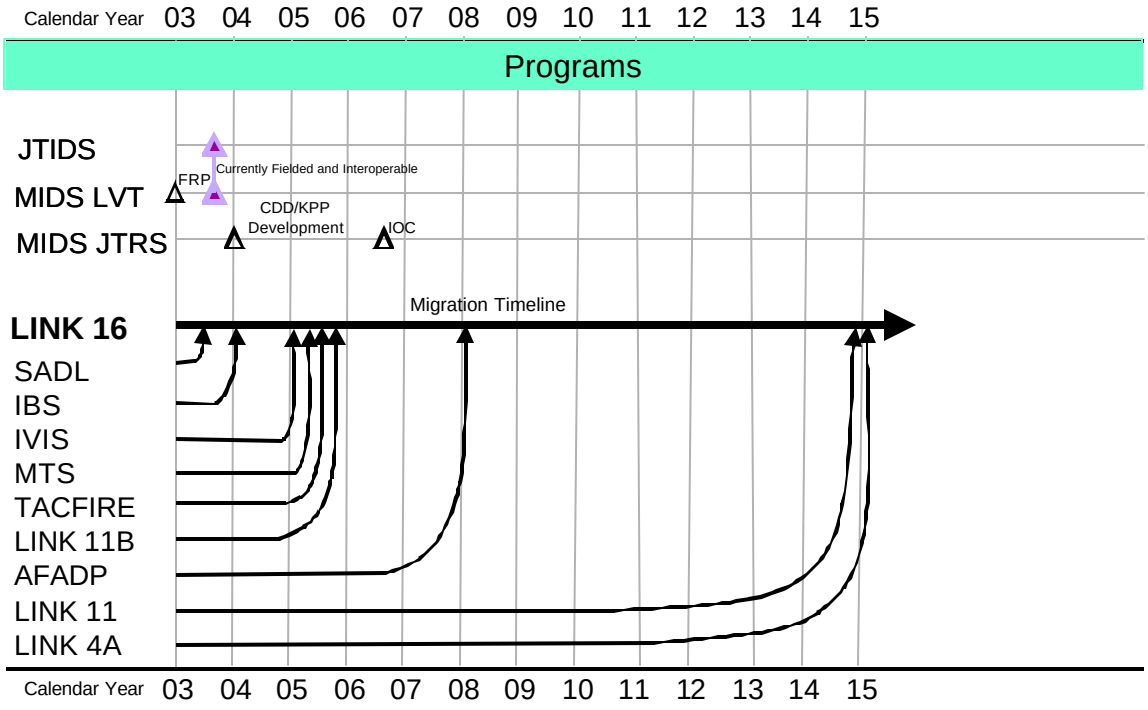


Figure 3.10—Navy JTIDS/MIDS Program Milestones

3.5 Army Interoperability Milestones

Army Software Blocking. First, we consider existing Army JBMC2 programs. For these the Army has implemented a system of systems approach to the upgrade of their existing JBMC2 systems that they call software blocking (see Fig 3.11). Software upgrades for the system of systems considered in each block are developed during the preparation phases of each software block. Testing and BMC2 program P3I are accomplished in the execution phase of each software block. The number of C2 systems integrated into each software block increases with increasing block number and is subject to budget constraints.

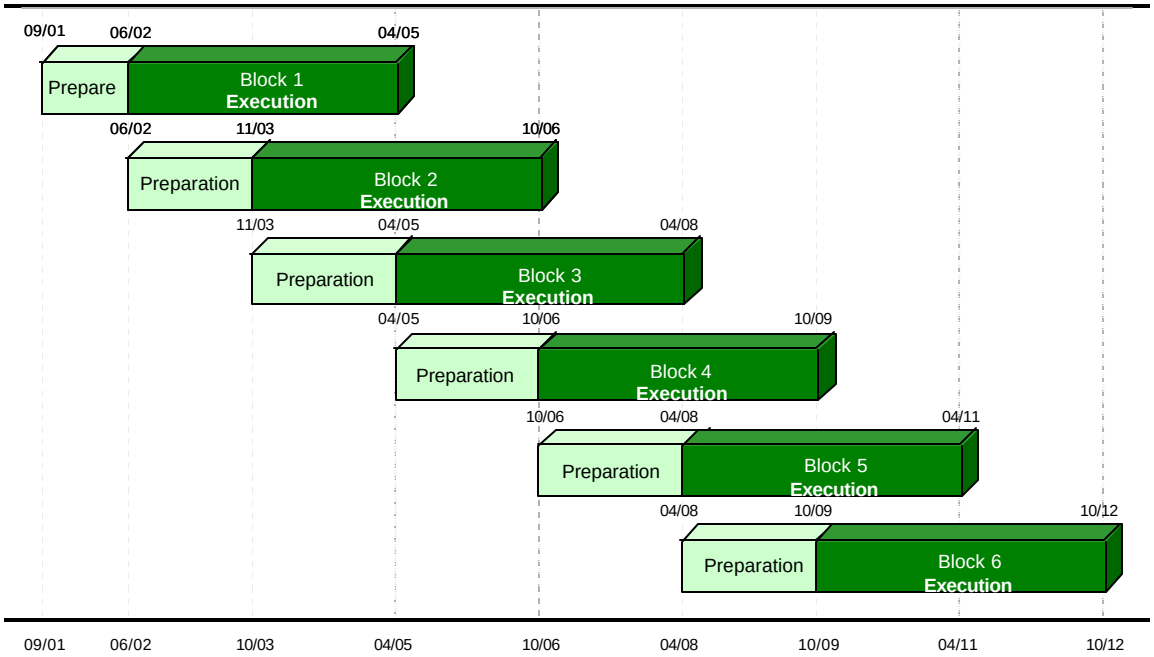


Figure 3.11—The Army's Software Block Upgrade Schedule

The generic software block schedule for Army C2 systems is given in the figure above. The goal is to have a fully integrated/interoperable set of Army BMC2 systems for the system of systems of each block at the conclusion of each P3I cycle.

The Army BMC2 systems to be upgraded in Block 1 are shown in Figure 3.12. Key test and fielding schedules are shown. At the conclusion of Block 1 these programs will be interoperable. It should be noted that software blocking aligns system development schedules only. System fielding schedule is a separate activity programmed and scheduled by the Army. The operational evaluation testing does not replace statuary testing individual systems must undergo.

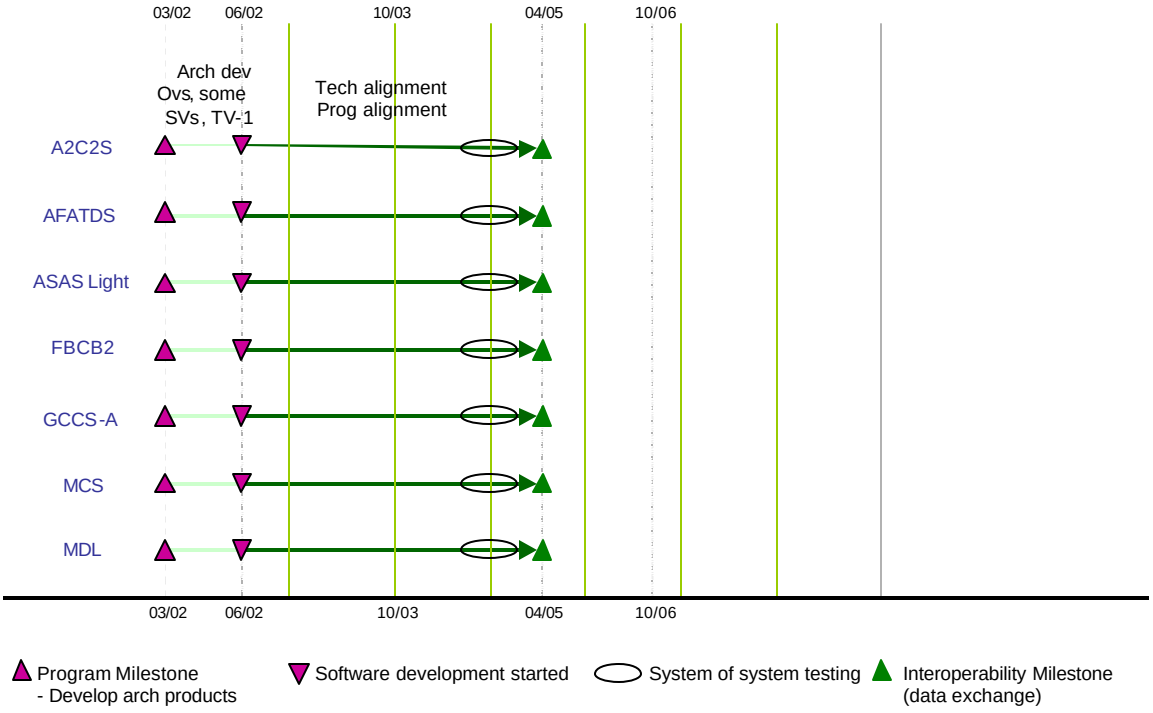


Figure 3.12—Army BMC2 Systems to Be Upgraded in Block 1

The Army BMC2 systems to be upgraded in Block 2 are shown in Figure 3.13. Key test and fielding schedules are shown. At the conclusion of this software block all the programs listed above will be interoperable (by FY 2007). FCS and WIN-T associated only in Block 2, in design only. Block 3 includes FCS, WIN-T and Comanche (will have deliverables in this time frame).

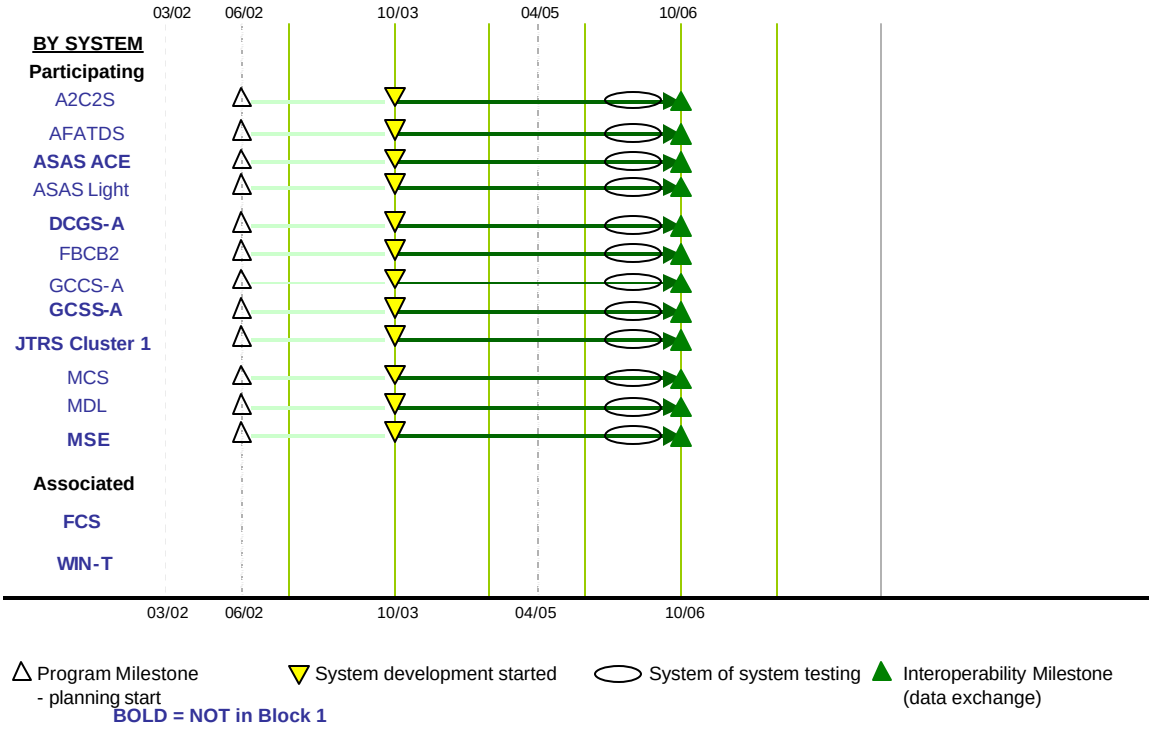


Figure 3.13—Army Systems to Be Upgraded in Block 2

Future Combat Systems. The FCS will need to interface with a large number of programs. Figure 3.14 graphically displays the subsidiary FCS core systems, along with the Unit of Action (UA), Unit of Employment (UE), joint systems, and multinational systems with which the FCS core systems will need to interoperate.

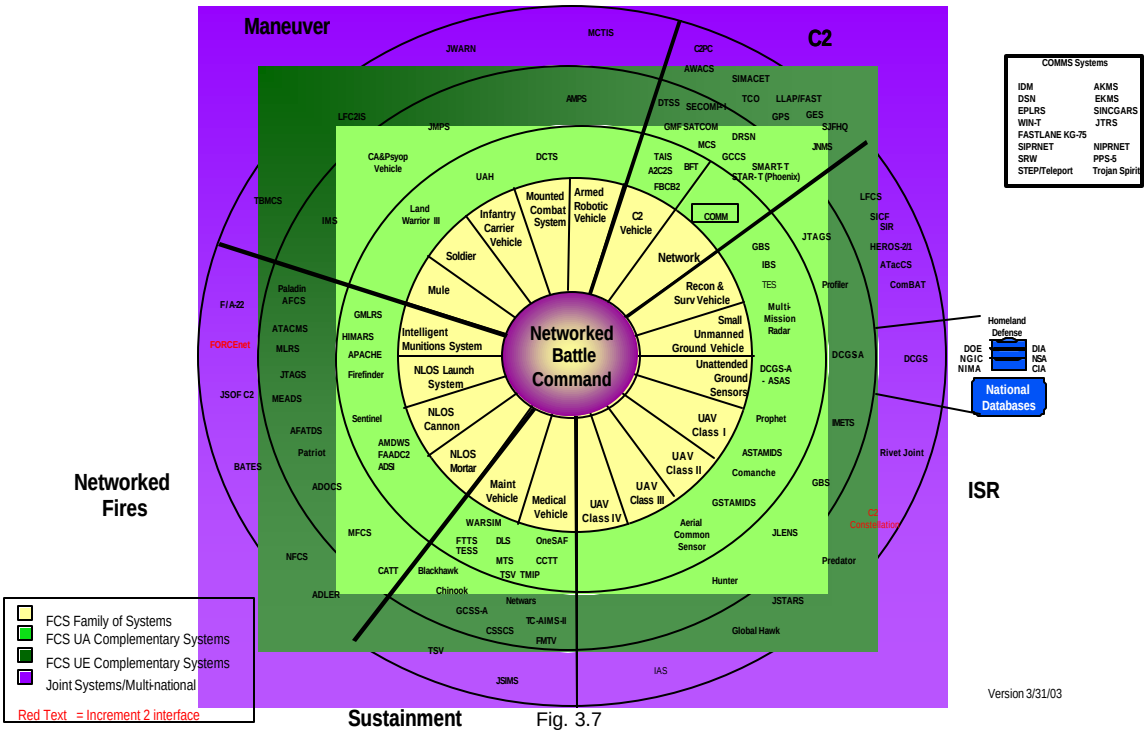


Fig. 3.7

Figure 3.14—The Systems with Which FCS Will Interoperate

FCS is a complex program, involving multiple software-intensive JBMC2 systems and multiple spiral development design phases. An overview of the FCS program schedule, including software architecture builds, major program milestones, and spiral development test events is shown in Figure 3.15. Complementary army communications programs are also shown in the figure, with key milestones and test events identified. These complementary communications programs will be incorporated into FCS systems and vehicles and are vital ingredients to the envisioned capability of FCS as a robust network-centric "operating system".

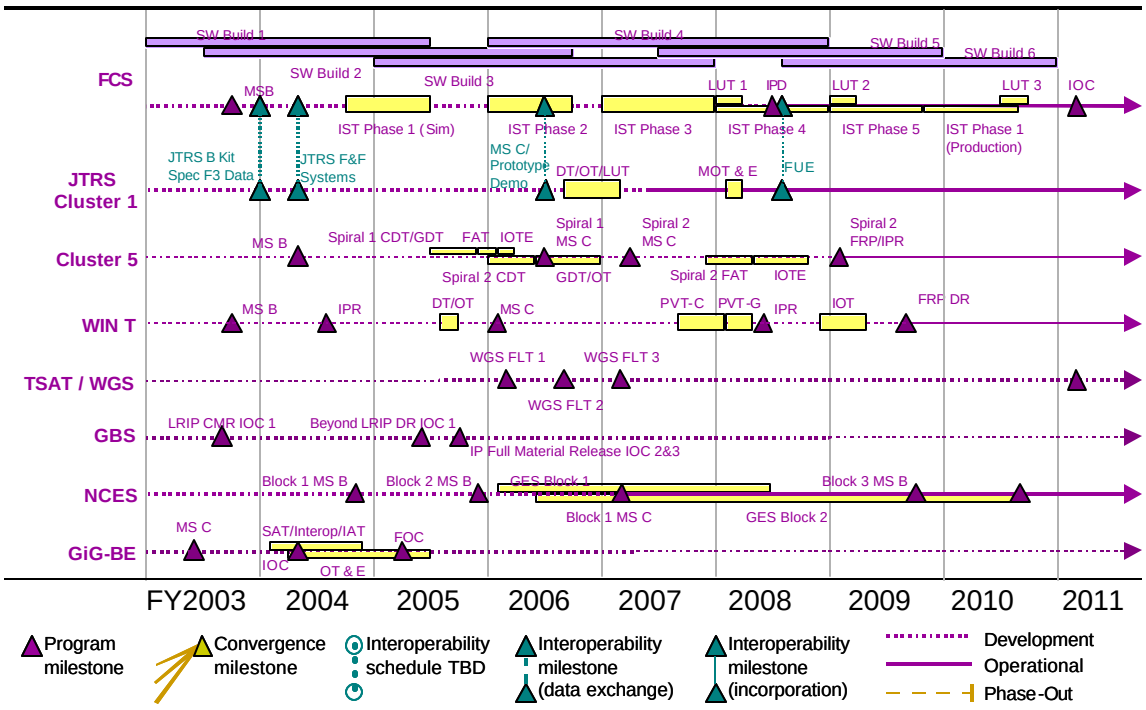


Figure 3.15—FCS and Communications Programs Schedules

As such, FCS performance depends on the timely development and interoperability assurance of the complementary programs. The programs must be delivered along the specified timelines to ensure that FCS has the communications capabilities it requires to fulfill its envisioned performance ability.

JTRS programs will provide short-range communications capabilities in the FCS systems. JTRS Cluster 1 radios provide the vital communications link between FCS vehicles within line –of sight of each other. This vehicle-to-vehicle communication forms the robust backbone of the FCS network. JTRS Cluster 5 radios connect dismounted soldiers to the network of FCS vehicles, and to the numerous communications capabilities available on the network.

WIN-T connects FCS vehicles beyond line –of sight, providing the link between localized groups of FCS vehicles to distant groups and connecting joint warfighting elements and C2 centers. WIN-T also provides the overall network management for Army forces and will integrate the vehicle- and personnel-mounted JTRS to the satellite networks—WGS, TSAT—identified in Figure 3.14.

WGS operates at the Ka and X bands and provides high-capacity links to small terminals incorporated on FCS vehicles. Toward the end of the decade, the first TSAT satellite will be launched and will provide higher-capacity satellite links.

The entire architecture of FCS and these complementary systems is designed to be compatible with NCES and GiG-BE (please refer to Chapter 7 for more details on NCES and GiG-BE systems). The convergence layer for FCS and the complementary communications systems means that all will be IPv6 compatible.

Figure 3.16 aligns the FCS and JC2/GCCS program schedules.

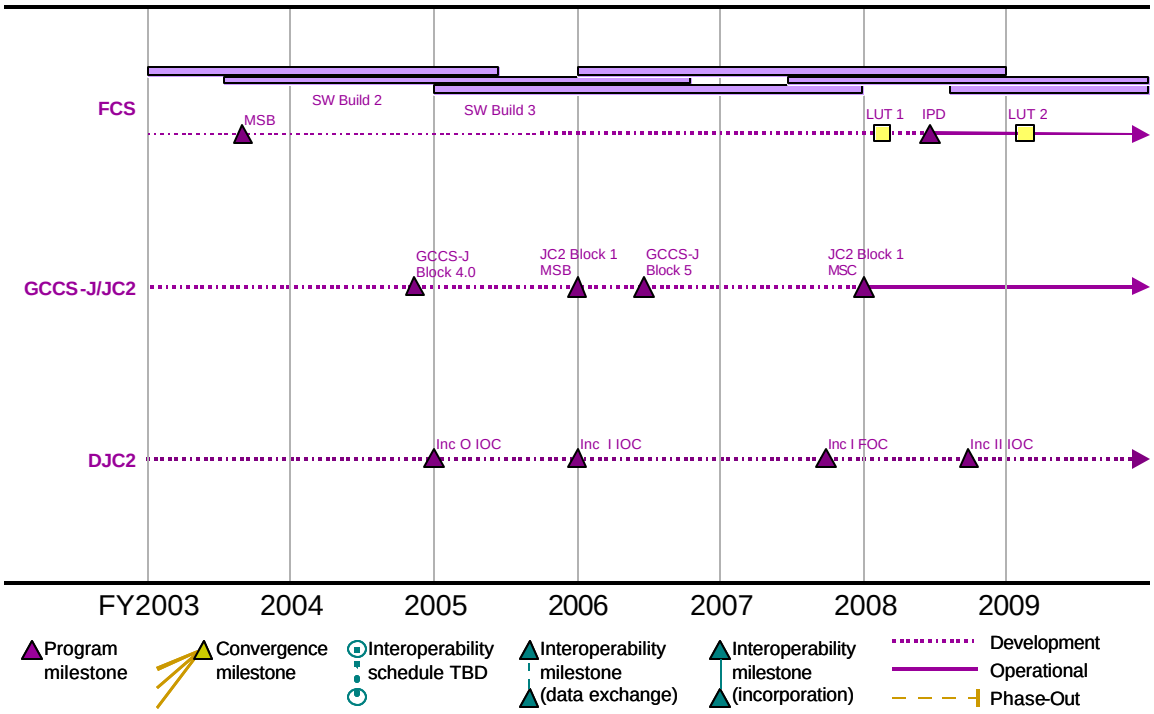


Figure 3.16—FCS and JFC2 Program Schedules

FCS must be aligned with JBMC2 programs, including GCCS-J, JC2, and DJC2. As we analyze the program further and learn more about the JC2 program, we can devise appropriate interoperability design and testing events between FCS and JC2. Based on our current understanding of these program schedules, a JDEP event in FY 2007 that incorporates FCS and JC2 systems would be useful.

Combined Schedule for Major Army Programs. The following figure (from the ACS documentation) displays the schedules for three major Army programs simultaneously—FCS, DCGS-A (including incorporation of the DIB, part of DCGS 10.2), and ACS. The figure can be used to compare the milestones of the different programs to ensure that certain cross-program warfighting capabilities are achieved by particular dates. Although not on this current version, the same figure can be used to map out dates for interoperability tests between these major programs (presumably as part of the Army's software blocking efforts). The February 4 version of the roadmap will examine cross-program synchronization with respect to BMC2 capability goals in some detail.

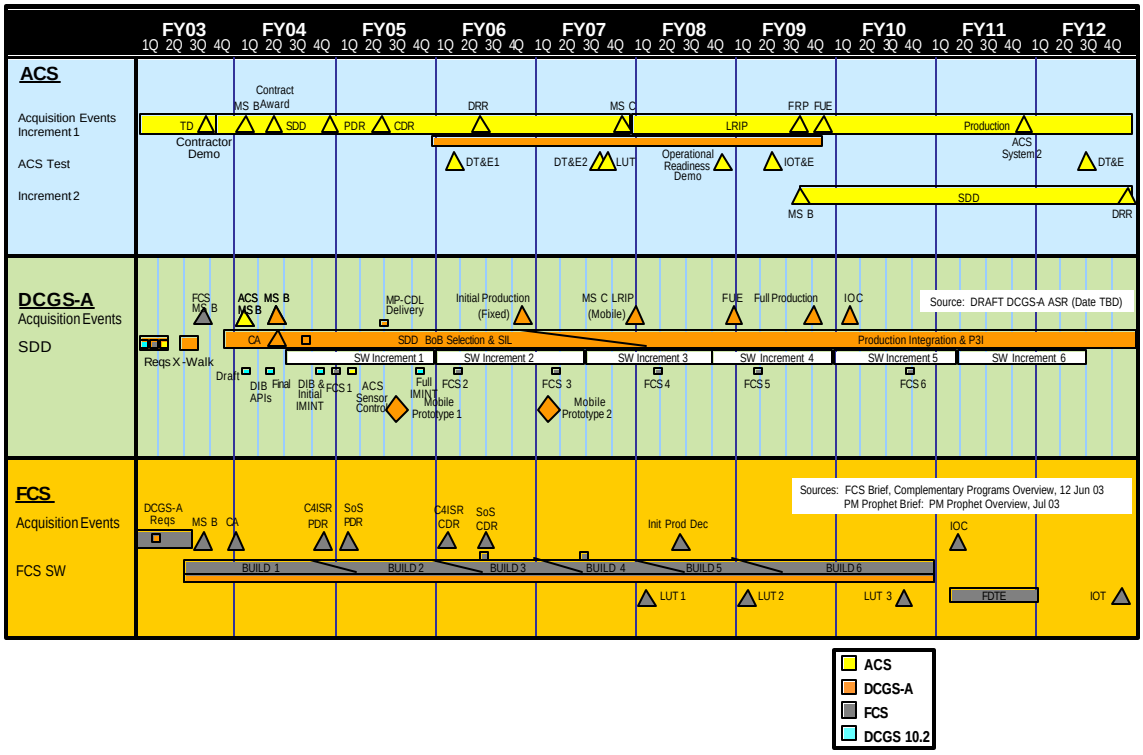


Figure 3.17—Schedules for ACS, DCGS-A, and FCS

3.6 Navy Interoperability Milestones

The Navy's interoperability milestones are largely reflected in its FORCEnet initiative. "FORCEnet is the operational construct and architectural framework for Naval Warfare in the Information Age which integrates warriors, sensors, networks, command and control, platforms and weapons into a networked, distributed combat force, scalable across the spectrum of conflict from seabed to space and sea to land." (CNO SSG XXI, 22JUL02 Briefing)

The Navy's FORCEnet concept is a large-scale naval transformation initiative closely tied to the guidance initially laid out in "Naval Transformation Roadmap" and refined in "Sea Power 21." FORCEnet acts as the Department of the Navy's embodiment of DoD network-centric warfare and operations (NCW/NCO) principles. The scope and strategy behind FORCEnet has evolved with the realization of NCO and grown from the broad initial formulation by the CNO's Strategic Studies Group into a more specific initiative focused on enhancing and creating precision Navy and Marine Corps warfighting capabilities and networked effects.

Current activities have centered on fully developing the necessary strategies, architectural products and operational concepts before pursuing an enterprise-wide technology alignment and migration. By continuously developing and phasing together systems, the intent is to define an evolutionary solution set while increasing efficiencies and identifying potential synergies of integration. Implementation will also require a comprehensive approach;

transforming the doctrine, organization, technology, materiel, leadership, personnel and facilities (DOTMPLF) and other elements of warfighting that will be essential to achieving a lasting structural foundation. Rollout of FORCEnet will occur in blocks, some of which may correspond to the recently developed concept of "Engagement Packs." This phased approach includes evolutionary steps for existing systems in the near term and validated requirements as testing and development identify the need for future systems in the "Navy after Next."

FORCEnet is an embodiment of a new way of doing business for the Navy, all centered on building the most networked, efficient and capable enterprise possible. Programmatically, the Navy has chosen to use the FORCEnet initiative as a driver without combining all funding under a single program element. This approach will be successful because FORCEnet architectural concepts and requirements are incorporated into everything the Navy does. Not consolidating everything under a single Program Element provides the flexibility to respond to evolving/changing requirements and needs as testing and experimentation identify newer/better ways of equipping the fleet and decreasing risk. However, because FORCEnet is not a program per se, such as Army's Future Combat System, it cannot be represented simply with milestones and an IOC.

Approved FORCEnet architectural guidance documents are forthcoming and are currently in revision within the Navy. They provide guidance and direction for the FORCEnet initiative:

- FORCEnet Campaign Plan
  - Formalizes processes with respect to FORCEnet roles and responsibilities
- FORCEnet Architecture and Standards Volume I
  - Contains FORCEnet vision statements and top level operational requirements
- FORCEnet Architecture and Standards Volume II
  - Contains top-level drivers, architectural products, use case scenarios and standards
- FORCEnet Master Plan
  - Will contain detailed design and implementation guidance
  - Will contain assessment of alternatives, design studies, and Programs of Record (PORs)
  - Will contain detailed reviews of functional and performance requirements.

The Naval Transformation Roadmap identified four Naval Capability Pillars (NCP): Sea Strike, Sea Shield, Sea Basing and FORCEnet. For POM development, the FORCEnet NCP was further broken down into three Mission Capability Packages (MCP): Communication & Data Networks, Intelligence, Surveillance & Reconnaissance, and Common Operational & Tactical Picture. Figure 3.18 shows these MCPs and the FORCEnet capability hierarchy.

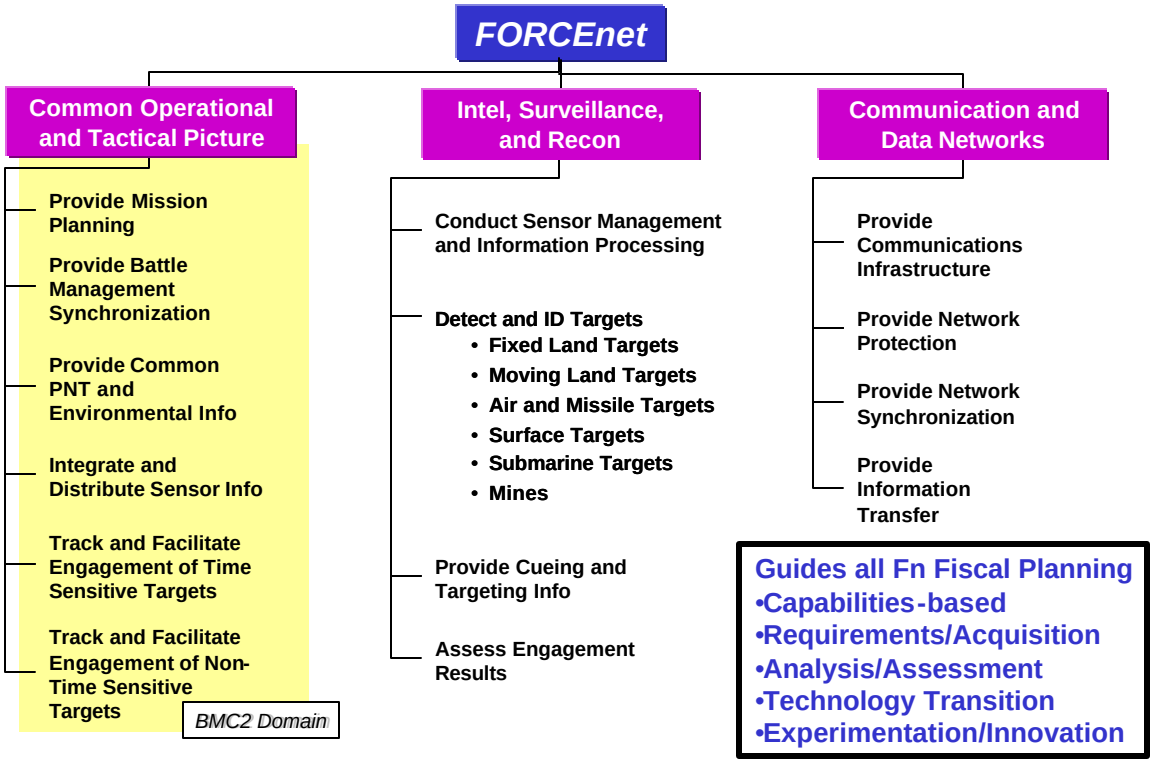


Figure 3.18—FORCEnet Capability Hierarchy

The mission capabilities identified above influence key Navy transformational capabilities and allow assessment of the development of Sea Strike, Sea Shield and Sea Basing. While FORCEnet's COTP MCP provides many of the capabilities under the BMC2 domain, all of its MCPs contribute to the overall capability set of BMC2.

- "Provide mission planning" – mission planning provides a strategy-to task framework for battle management command and control.
- "Provide battle management synchronization" – the coordination and synchronization of naval and joint assets in an operational context is the foundation for network-centric operations to achieve the goals of the national strategy.
- "Provide common PNT and environmental information" – Consistent geolocational references and precision navigation and time generation (PNT) establishes the technical boundaries for the working environment.
- "Integrate and distribute sensor information" - relevant and timely data feeds of decision-making quality must be shared as needed between users to allow NCO-based collaboration and flexible command and control.
- "Track and facilitate engagement of time sensitive and non-time sensitive targets" - Faultless interoperability from sensors to shooter is required to successfully prosecute high-priority mission targets.

Designated by the Chief of Naval Operations as Director of FORCEnet, OPNAV N6/N7 identified current generation programs and systems that are affected by FORCEnet and fall under its 3 MCPs. As directed by its leadership, the Navy is continuously combining and phasing out systems to create a minimum number of systems while increasing both cost efficiencies and operational capabilities. FORCEnet is an enterprise wide alignment and integration effort that looks across all programs to enable capabilities and efficiencies that would not otherwise be realized. This approach supports the DoD goal of making the services more interoperable and eliminating redundant systems.

The FORCEnet Innovation Continuum accomplishes FORCEnet testing. Developed by NETWARCOM in close collaboration with Navy and Marine Corps stakeholders to address the required FORCEnet capabilities, the Innovation Continuum brings together wargaming, modeling and simulation, lab and field experimentation, advanced technology demonstrations, sustainable prototype development, and accelerated Program of Record enhancements to provide operationally relevant capability to the Fleet and Fleet Marine Force. Technologies are inserted into FORCEnet solution sets collaboratively, with other Service laboratories, industry and academia.

Figure 3.19 illustrates the extensive test schedule currently developed for the FORCEnet initiative. The middle set of tests (prototype path) includes some FORCEnet only tests. Tests along the "prototype path" may be the most directly relevant to Joint BMC2 interoperability experiments to augment the intra-Navy FORCEnet testing.

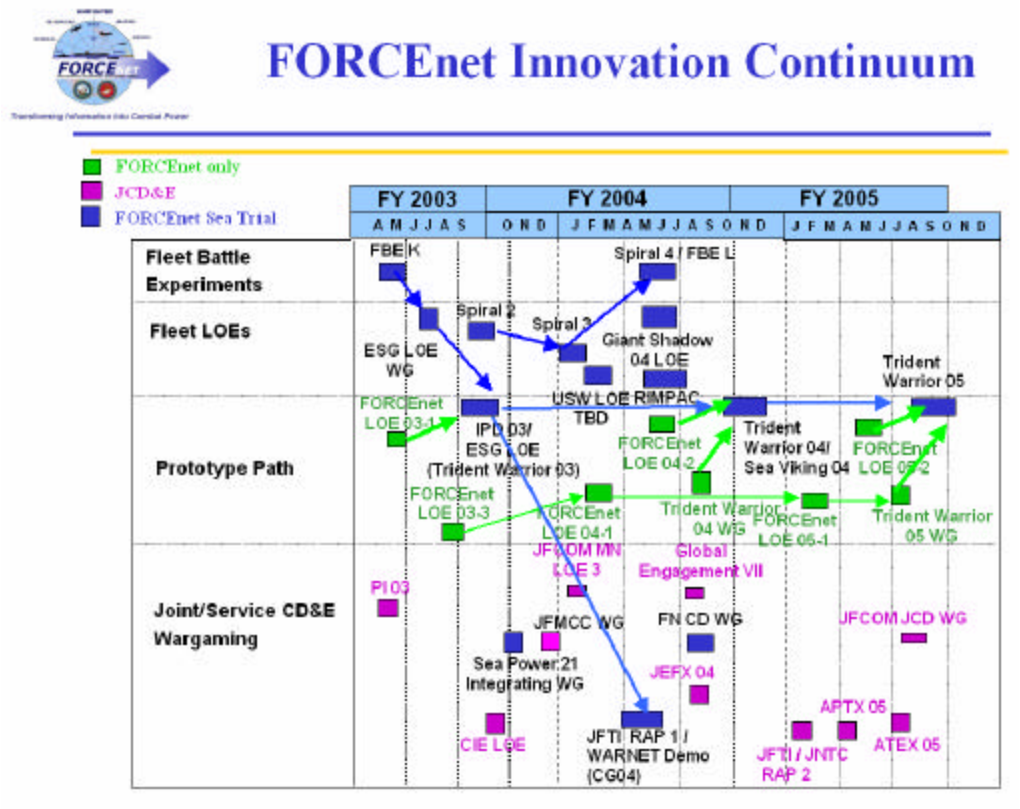


Figure 3.19—FORCEnet Innovation Continuum

Based on our current understanding of the Navy's FORCEnet plan and DoD-wide JBMC2 integration initiatives, we recommend the following high-level milestones for FORCEnet communications network development and C2 integration efforts. The Navy's efforts to upgrade and integrate their command and control, situational awareness and communications networks systems are judged to be of critical importance for achieving a single integrated picture of the battlespace for maritime forces and for achieving joint interoperability. We therefore recommend the following:

- By fourth quarter of 2007, integrate Ashore networks (NMCI, BLII, NOCs, etc) into a global ashore network.
- By fourth quarter of 2008, make Navy networks ashore IPv6 compliant and integrate these networks into the GIG.
- By fourth quarter of 2008, integrate JC2 into Navy afloat JBMC2 systems architecture.
- By fourth quarter of 2009, integrate afloat networks (ISNS, NFN components)
- Examine feasibility of integrating all Navy networks together by 2015 (total network integration in real time mission critical combat systems)

3.7 Marine Corps Interoperability Milestones

C2PC. C2PC is the software backbone of all Marine Corps Ground C2. It is also formally designated (via DISA MOA) as the Tactical COP Workstation and is used by all services, COCOMs, and JTF commanders. USMC PM Ground C2 is the Executive Agent for C2PC and manages it under a native MARCORSYSCOM contract.

Within the Marine Corps, it is fully fielded to all operational and tactical staffs, including the force commanders, divisions, wings, service support groups, regiments, battalions, and platoons. It is partially fielded to USMC mobile units at echelons below battalions, largely to units that have been under OPCON of CENTCOM during the past year (Operation Iraqi Freedom and Operation Enduring Freedom).

C2PC is interoperable with other C2PC systems, with GCCS-J and GCCS-I3 servers, and with the family of GCCS service variants. It receives the Common Operating Picture from any GCCS system (GCCS-J, GCCS-M, GCCS-A, GCCS-AF). C2PC is not interoperable with FBCB2. The JROC has tasked the Army and Marine Corps to fix Blue Force Tracking information flow across their systems. The two services are developing a response to the JROC tasking. Planning is underway for an integrated architecture and design of a solution which includes making C2PC and FBCB2 interoperable.

TCO. TCO is the program that procures the IT hardware to support operational and tactical staffs including the force commanders, divisions, wings, service support groups, regiments, and battalions. The sources for these items include the Navy-Marine Corps Intranet (NMCI) and the Marine Common Hardware Systems programs.

These systems are currently fully fielded. Funding in the TCO program is also used to upgrade software to operating systems and common operating environment modules from

GCCS and the COE. Security upgrades and related systems hardware refreshment are on an 18 to 24 month technology refreshment cycle.

TCO provides the hardware platforms for the GCCS-J, GCCS-I3, and C2PC software, among others. The hardware systems are interoperable with physical connections to the Internet and the GIG.

Since TCO is post-FOC, its schedule maintains software upgrades in pace with GCCS and COE modifications, as well as an 18 to 24 month hardware technology refreshment cycle.

Figure 3.20 shows the schedules for C2PC and TCO.

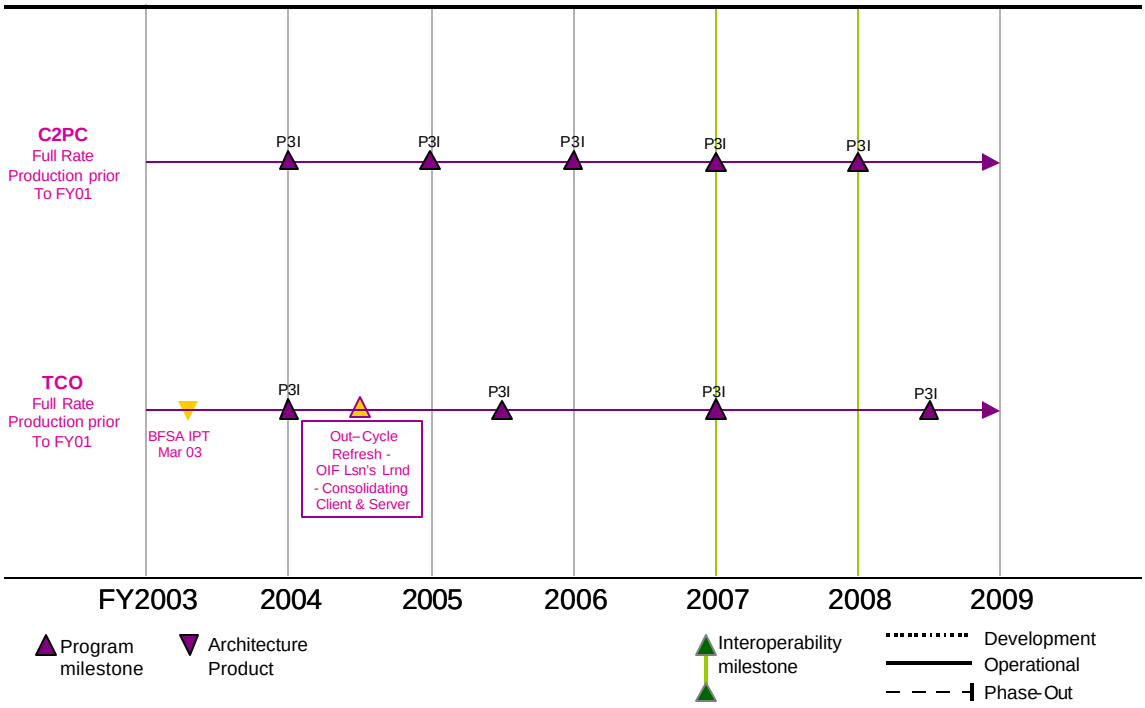


Figure 3.20—USMC C2 Program Schedules

3.8 Air Force Interoperability Milestones

GCCS-AF Family of Systems. A current proposal would treat a number of legacy Air Force programs as members of a "GCCS-AF Family of Systems." The status of this proposal, as well as determination of which of these legacy programs should be ported into JC2 and then phased out as separate programs, will require further examination. Figure 3.21 shows the consolidated FY 2003-2005 schedule for the two major Operational C2 programs: GCCS-AF (the current program, not the proposed "Family of Systems") and the Theater Battle Management Core System (TBMCS). For reference, the timelines for three programs the GCCS-AF portfolio will use, JC2, COE, and NCES, are shown as well.

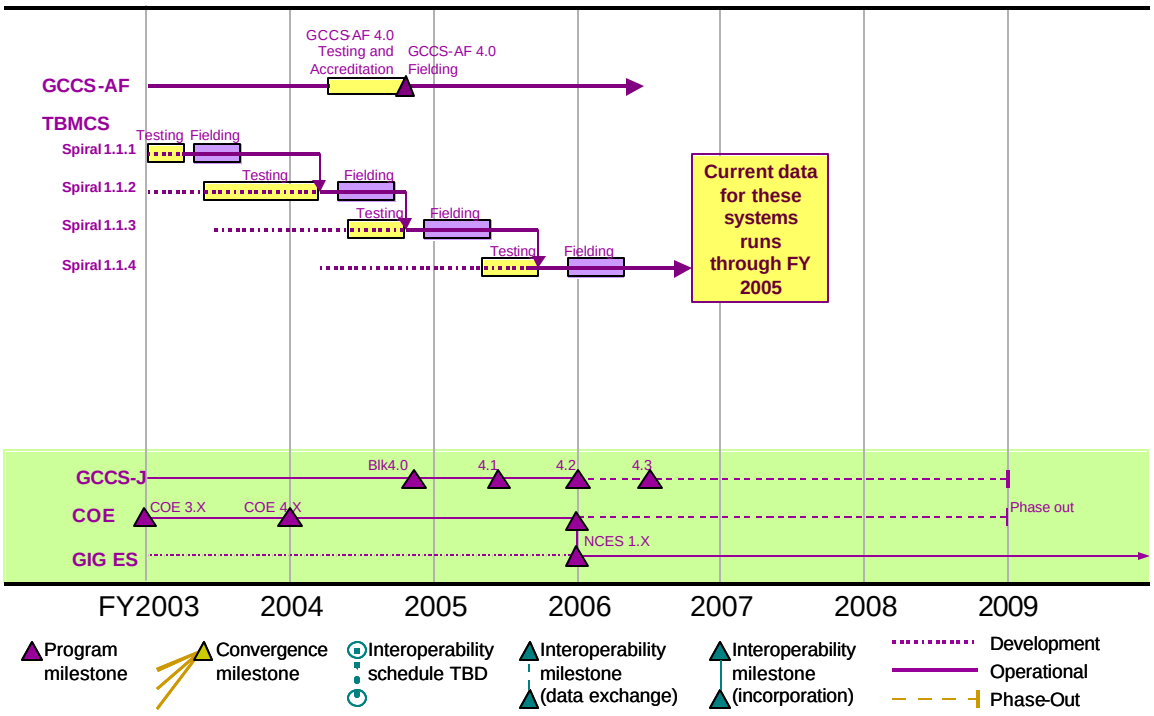


Figure 3.21—Consolidated Schedule for Core GCCS-AF Systems

DCGS-AF. Figure 3.22 shows the schedule for the development and fielding of the major versions of DCGS-AF. Note that the Air Force's schedule includes the development of the CONOPS and Requirements documents needed to support the development of the DCGS-AF versions.

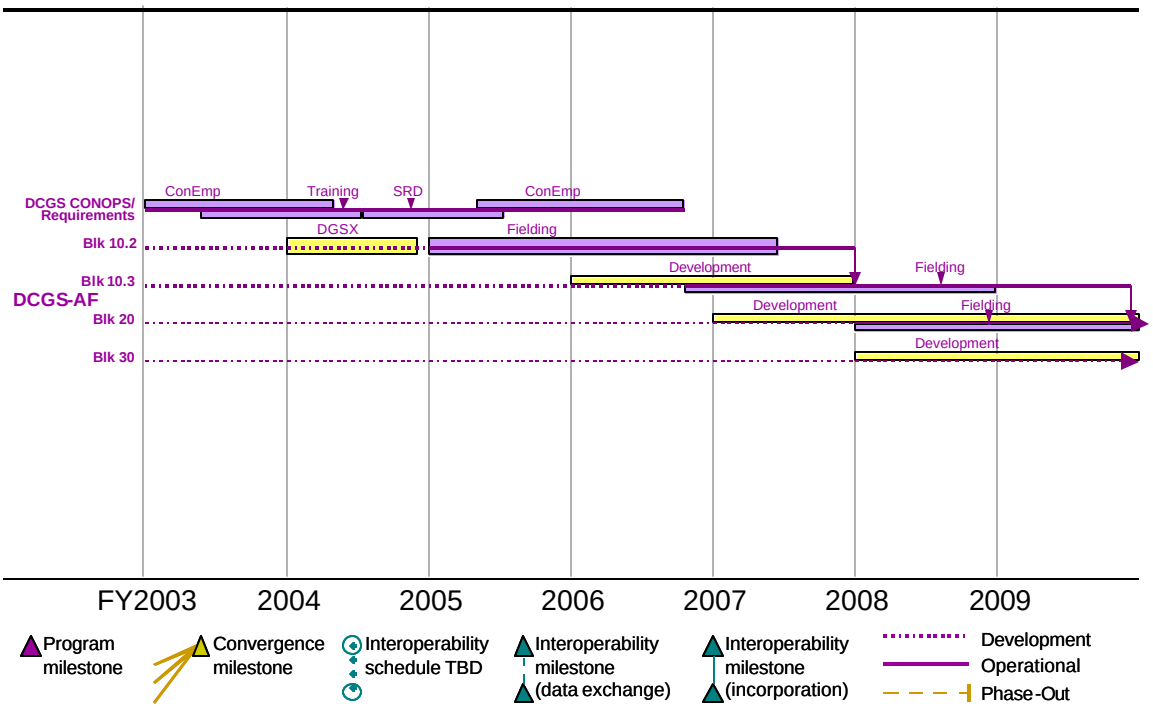


Figure 3.22—DCGS-AF Schedule

Development of DCGS-AF 10.2 includes development of the DCGS Integration Backbone (DIB), which will provide common hardware and software services for all of the Services' DCGS variants (see Section 3.4 for more information on the DIB).

C2 Constellation. The Command and Control Constellation (C2C) will provide future C2 and ISR capabilities for air and space operations. It will replace the existing JSTARS, Compass Call, Rivet Joint, U-2, and Airborne Command and Control Centers with a family of Multi-Sensor Command and Control Aircraft (MC2A) and unmanned aerial vehicles (UAVs), such as Global Hawk. C2C will also provide enhanced capabilities for AWACS. Figure 3.23 shows the integrated program schedule for C2C's major components: MC2A, Global Hawk, JSTARS, and Global Hawk. Also shown are C2C's interfaces to the Army's DCGS-A, and the contributions of two programs producing common components for C2C, namely the Multi-Platform Radar Technology Insertion Program (MP-RTIP), which is providing common modular radar units, and the Multi-Platform Common Data Link (MP-CDL), which is providing common high capacity data links for disseminating sensor information to multiple nodes.

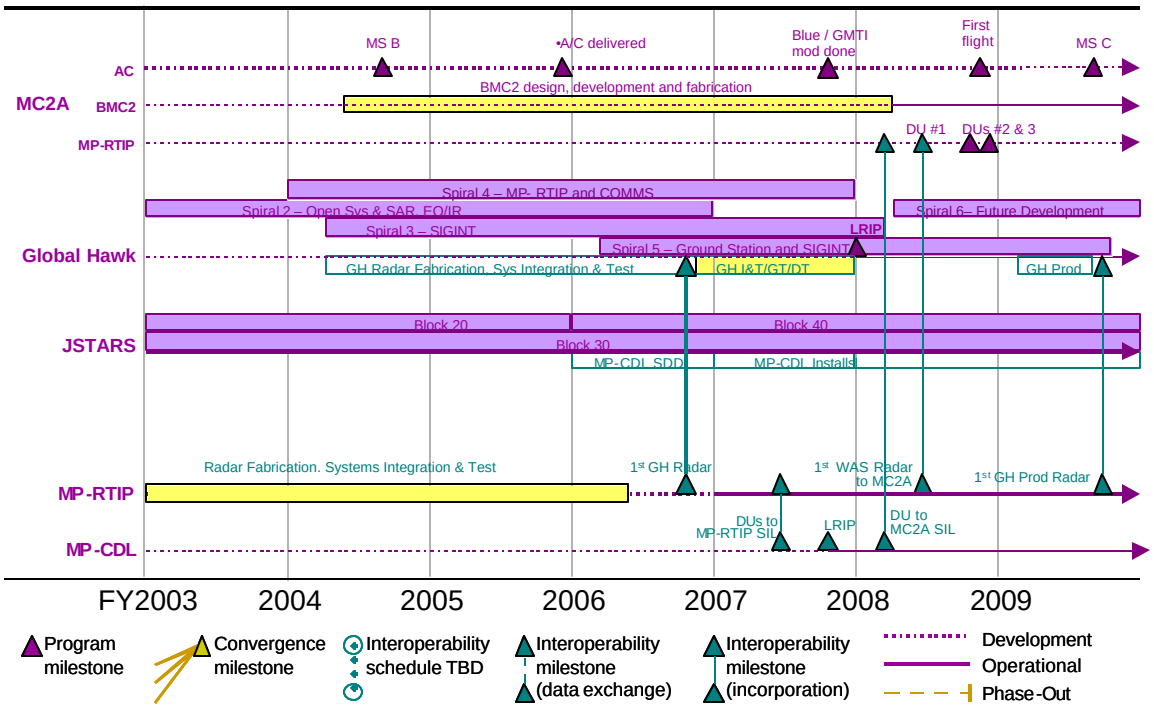


Figure 3.23—C2C Integrated Program Schedule

3.9 JBMC2 Capability Integration Assessment Tenets

3.9.1 Assessment Tenets

JBMC2 capability integration assessment tenets are the guiding concepts that structure the development of refined assessment metrics, criteria, methodology, and rules. The tenets are translated through these components of the assessment in their application to roadmap programs and initiatives.

The JBMC2 roadmap provides consolidated information on the planned evolution of a family of Joint C2 systems. Application of the roadmap as a decision tool requires an assessment of activities in a context that now transcends their individual programs and performance. The assessment tenets must have attributes that support a transparent evaluation of programs and initiatives. These assessments may indicate changes to ongoing plans and will need to clearly capture rationale for all stakeholders. The tenets will help guide the development and comparison of alternative roadmap strategies. Utility of the tenets should derive not only from their use in sorting programs into different categories (e.g., “make interoperable,” “phase out,” etc.) but also as a structure to indicate directions for the future and as measures of merit for candidate directions. The assessment tenets will be applied to support recommendations for

the direction of future initiatives. Here, they will guide decisions about the continuation, phase-out, or migration approach for elements of JBMC2. Attributes of the tenets illuminate the relationship to the roadmap goals.

The assessment tenets should have characteristics that support the development, use, and maintenance of the roadmap. For the decisionmakers using the roadmap, the tenets should provide structure, transparency, relevance, and flexibility. The structure of the tenets maps the potential disposition of roadmap components. Here, they may be continued, modified, or phased-out. These dispositions provide an implementation of the roadmap goals. The tenets must support transparency in roadmap decisions. That is, they must be objective and repeatable, reducing the opportunity for biases to artificially change the structure of the JBMC2 solution and the global balance of priorities for timely satisfaction of capability needs. The transparent methods should support understanding of the logic underlying decisions and make the results reproducible by other stakeholders. In light of the diversity of systems and initiatives in the current JBMC2 portfolio and the potential for further expansion, the tenets must be applicable and adaptable across diverse system types. In general, they must provide for analysis that invokes global JBMC2 measures of merit or objectively invokes more tailored measures for comparison. The implication of this is that the tenets should support assessment of programs and initiatives in a context that extends beyond their autonomous performance and capabilities to a trade space characteristic of the performance and capabilities of JBMC2 as a whole. The tenets must be relevant to the goals of the roadmap. The underlying demand for integration and interoperability must persist in the tenets. In addition, the phase-out of persisting, noninteroperable capability must be addressed. Finally, as the roadmap is used beyond its current embodiment to support evolution of JBMC2, the tenets must be flexible enough to apply to emerging capabilities and operational concepts that may be included beyond the current time horizon. Here, the ability to include or extend tenets in evolving assessment structures as opposed to static tenets that lose relevance demands adaptable characteristics. Overall, the tenets must support clear, actionable decisions in the present and into the future.

The initial utility of the tenets is in assessing the current state of programs and initiatives in the JBMC2 domain. The tenets provide a framework for the application of criteria in the assessment of the JBMC2 roadmap. Specifically, tenets guide the recommendations for migration to interoperability for known programs and initiatives as part of the JBMC2 architecture. The tenets allow us to characterize existing and planned interoperability. They also support assessment of the ability of a roadmap component to migrate to interoperability. Finally, they handle exceptions to these baseline cases where compelling motivations exist to maintain autonomy or where no gain is made from investment in modifications for interoperability. These same tenets should support future iterations of the roadmap.

As the environment and technology change, the roadmap must evolve. The assessment tenets should provide a framework for ongoing, iterative assessment to support future decisions to maintain the JBMC2 architecture and deliver desired capability. New interoperability demands or operational concepts may demand reevaluation for future phase-out. These same changes may drive us to adapt exiting efforts to provide new dimensions of interoperability and demand assessment of ongoing efforts' ability to conform in a cost-effective response. Finally, future exceptions should also be accommodated as critical elements of joint capability that emerge to fill gaps or provide special capability that lack requirements for interoperability or are

justifiably noninteroperable. The draft JBMC2 capability integration assessment tenets provide such a framework.

Assessment Recommendations	Tenets
Consider Phase Out	• Not interoperable, neither cost-effective nor mission-essential to make interoperable • Not required once interoperable capability achieved • Does not fit into future concepts of operation • Cannot be made interoperable • Is not planned to converge
Integrate in JBMC2 capability	• Currently interoperable with JBMC2 • Not interoperable now but mission need and cost-effective to make interoperable • Soon to be (planned) interoperable, with mission need
Do not integrate	• Service-unique application and no requirement for interoperability now or in the future

Figure 3.24—Draft Program Assessment Tenets

Figure 3.24 summarizes the draft assessment tenets. These provide the requisite attributes to support the roadmap goals and utilization in assessments. The tenets support one of three mutually exclusive recommendations. First is the recommendation to phase out an initiative or program. Second, the recommendation may be made to make interoperable by migration to a state where it meets interoperability criteria within JBMC2. Finally, to identify and validate exceptions where interoperability does not benefit JBMC2 in the planned future. These recommendations must be supported with conclusions consistent with the tenets.

The phase-out tenets support an assessment of a combination of persistent, rigid noninteroperability; undesired redundancy; or divergence from operational needs. The failure to meet interoperability criteria is in itself necessary but insufficient to support a phase-out recommendation. In addition, the assessment must conclude that the cost of achieving such interoperability is prohibitive and that the interoperability is not essential to capability. Another case for recommending phase-out is identified in undesired duplication of a capability once interoperability is achieved in JBMC2. Gap-filling efforts or gateways that provide point-to-point interoperability workarounds provide illustrations that would be identified under this tenet. The phase-out case also includes a more conventional life-cycle conclusion where the evolution of concepts of operations eliminate, change, or absorb a function provided by a program or initiative making it obsolete. In some cases, systems may be so brittle that they cannot be made to interoperate. When the assessment concludes that such a rigid design exists, the assessment would recommend a phase-out when the capability is provided by an interoperable future solution. These cases would indicate and help prioritize interoperability gaps for development of solutions. The phase-out tenets support assessment of cases where existing work does not fit in the JBMC2 architecture.

Tenets for making programs and initiatives interoperable define inclusion in the evolving JBMC2 architecture. Initially, the baseline roadmap may identify some existing interoperability supporting the JBMC2 capability. As the roadmap evolves with execution of convergence and interoperability milestones, the assessment of roadmap programs and initiatives as integrated in the architecture should become more common. Here, satisfaction of JBMC2 integration and interoperability criteria will support conclusions of existing JBMC2 compatibility. Noninteroperable systems may be recommended for migration into the JBMC2 architecture where their existing lack of interoperability at some time may submit to an affordable solution and where a compelling mission need exists. In some cases, while not currently interoperable, existing paths for integration may be identified and assessed to satisfy criteria for JBMC2 architecture integration. These tenets will steer the roadmap toward a cohesive, integrated capability through integration of compatible solutions and migration of programs and initiatives into the JBMC2 baseline.

Other programs and initiatives may exist as part of the JBMC2 architecture with no interoperation with other nodes. The exception tenets are set to support very narrow, verifiable assessment of a program's or initiative's autonomy within the JBMC2 portfolio. Here, service-uniqueness defines a case where JBMC2 interoperability criteria do not apply. This must be a strictly applied criterion, with clear anticipation of the potential for interoperability to become desirable with evolving operational concepts. Autonomy in the architecture providing a stand-alone capability might be justifiable under other narrow circumstances. Special security rationale or critical capability, for example, could provide a situation where continuation of a non-interoperable component in the JBMC2 architecture would remain desirable. Critical judgment would be required to validate that the value of the solution as a stand-alone capability outweighs the value it could bring to the networked JBMC2 family. In general, the tenet allowing continuation in the roadmap without integration must be applied with a very narrow interpretation, strict criteria, and guided by an "assumption of interoperability" which emphasizes the value of information exchange and demands a compelling reason for exception.

3.9.2 Assessment Criteria

The assessment criteria for JBMC2 Capability Integration are integration, interoperability, and convergence. These are invoked by the assessment tenets. The criteria are interpreted in the context of the JBMC2 architecture. Here, the architecture answers the "with what" question implicit in the application of the criteria. The criteria establish refined definitions that make the tenets executable, establishing scales for evaluation.

Integration. The formal definition of integration (JFCOM reference) is: *A collection of activities whose purpose is the synergistic blending of Doctrine, Organization, Training, Materiel, Leadership, Personnel, and Facilities (DOTMLPF) from different Military Services to improve interoperability and enhance joint capabilities.*

At a systems level, integration involves *the progressive testing and linking of system components to merge their technical and functional characteristics into a comprehensive, interoperable system. Integration of data systems allows data on existing systems to be shared or accessed across functional or system boundaries.*

'Systems integration' has connotations of welding hardware, software, databases and applications into a single self-sufficient system or system of systems. This can be unnecessary or counterproductive to achieving system-to-system interoperability affordably, or in expanding to accommodate information exchange with, e.g., coalition partners. Care must be taken in applying the concept 'integration' to the efforts encompassed in this Roadmap.

Interoperability. The formal definition of interoperability (JFCOM reference) is *the ability of systems, units, or forces to provide services to and accept services from other systems, units or forces and to use the services exchanged to enable them to operate effectively together*.

The key enabler of the joint services net-centric warfare effort is interoperability. Without a fully integrated force structure made possible by interoperability, the Joint Force cannot fully exploit smaller force structures and emerging capabilities. Neither will it be able to provide the necessary agility to meet the demands for continuous alignment with emerging military needs. Basically, interoperability is a measure of the degree to which various organizations or individuals can operate together to achieve a common goal.

Interoperability enablers include: standardization of services and interfaces, common processes, and standard products; the integration of units, forces, organizations, teams, and individuals leading to cooperation among these entities: and collaboration between and among communities of interest. Interoperability is important on all levels including the strategic and political levels, the operational and tactical levels, and the technical level.

Mission-critical information exchanges must be identified at the operational level and traced down to system-to-system interfaces at the technical level. Then technical specifications can be developed that will provide guidance for achieving interoperability. For example, the Army Software Blocking program defines an acquisition and development policy that will enable the Army to evolve its systems so that they are interoperable both with respect to other Army systems and also with Joint Force systems. Some tenets regarding this process follow.

The program assessment process entails systems to be certified as "interoperable" or "integrated" at the acquisition level. To be certified as such, a BMC2 program's products (applications, services, etc.) must be *compatible*[11] with the following layers.

- On the policy layer, the product must be compatible with the appropriate policy guidance, operational concepts, architectures, and nonmateriel DOTMLPF provisions.
- On the transport layer, the product must become compatible with relevant NII sponsored infrastructure programs, including:
    - Hardware: GIG bandwidth expansion programs, JTRS
    - Software: GIG communications protocol (IPv6).
- On the network services layer, it must become compatible with relevant DoD net-centric services, including:
    - NII sponsored: NCES

[11] Here, we define "compatible" as "satisfying all the requirements associated with that layer."

- Others (as appropriate): FIOP NBS, SIGP standards, DCGS DIB common services.

NII has developed a Net-Centric Checklist of standards for a program's products to meet transport layer and network services-layer requirements, shown in Figure 3.25.

Net-Centric Checklist

Title	Description	Metric	Source
Internet Protocol (IP)	Data packets routed across network, not switched via dedicated circuits	Net-Centric Operations and Warfare Reference Model (NCOW RM) compliance	NCOW RM, GIG Arch v2, IPv6 Memos (9 Jun 03 and 29 Sep 03)
Black, dumb, end-to-end networks	Encrypted, black core only	TCA compliance	TCA
Only handle information once (OHIO)	Data posted by authoritative sources and visible, available, usable to accelerate decision making	Reuse of existing data repositories	Community of interest policy (TBD)
Post in parallel	Business process owners make their data available on the net as soon as it is created	NCOM RM compliance: Data tagged and posted before processing	NCOW RM, DoD Net-Centric Data Strategy (9 May 03)
Smart pull (vice smart push)	Applications encourage discovery; users can pull data directly from the net	NCOW RM compliance: Data stored in public space and advertised (tagged) for discovery	NCOW RM, DoD Net-Centric Data Strategy (9 May 03)
Data centric	Data separate from applications; apps talk to each other by posting data	NCOW RM compliance: Metadata registered in DoD Metadata Registry	NCOW RM, DoD Net-Centric Data Strategy (9 May 03)
Application diversity	Users pull multiple apps to access same data; may choose same app for collaboration	NCOW RM compliance: Apps posted to net and tagged for discovery	NCOW RM
Dynamic allocation of access	Trusted accessibility to net resources (data, services, apps, people, collaborative environment, etc.)	Access assured for authorized users; denied for unauthorized users	Security/IA policy (TBD)
Quality of service	Data timeliness, accuracy, completeness, integrity, and ease of use	Net-ready key performance parameter	Service level agreements (TBD)

Figure 3.25—Net-Centric Checklist

- On the applications layer, the product must meet two types of requirements. First, it must become compatible with the standards and products developed by all applicable battlespace picture efforts (discussed in Chapter 4—SIAP, SIGP, etc) to include incorporating the specific data models from each picture. Second, the product must become compatible with relevant architectural and

other technical standards relevant to the capabilities that the product will support.[12]

- Integration. In addition to the above requirements, sets of programs being integrated will need to incorporate all the requirements (operational, systems, and technical) of the architecture for the comprehensive, interoperable system being created by the integration effort. In all such integration efforts, the same net-centric checklist above must be rigorously applied to ensure that the integration product is not a closed system-of-systems.

The interoperability/integration certification process described repeated references to making a program "compatible" with a layer. To be certified as "compatible" with a particular layer at the acquisitions level, a program must meet the following requirements. Becoming compatible will involve a set of technical requirements (implementing particular data models in software, etc.); these must be identified. The schedule of tasks involved in implementing must be an alignment. The tasks and milestones in the implementation must be logically arranged. The compatibility implementation must pass a simulation test, a software- and/or a hardware-in-the-loop test (as appropriate), and a pilot fielding test during an exercise. Finally, a transition period must be established for the roll out of the implementation.

Convergence. A draft definition of convergence is *the ability to provide the same or similar services to all users regardless of the current technology or networking being used in the organization.*

We differentiate between program convergence and partial convergence. With program convergence, one or more entire programs will make the transition into another program, leaving only the latter program as a POR. With partial convergence, a program incorporates materiel (usually software) needed to provide a common service.

Programs must satisfy several criteria to be certified as "convergent" at the acquisition level. The programs being converged and the program they are converged into—their successor program—must be identified. Also mandatory are timelines for: the development of each set of converging programs' successor program, functionality ports from each set of converging programs to the successor program, and finally the transition period during which each set of programs is phased out and the successor program is implemented.

The implementation of the convergence effort must meet the following criteria to be certified. The schedule of tasks involved in the implementation effort must be an alignment. The

[12] The overall list of JBMC2 capabilities, much less capability architectures and standards, have not yet been identified, but will be future in future versions of the roadmap. For now, JFCOM's Operation Iraqi Freedom Lessons Learned document has identified the following capabilities, matched with their parent FCBs (note that capabilities shown in italic were identified as needing the most improvement):

- Force application: SOF-conventional force integration, urban operations, information operations, *BDA*, joint fires, TST, overmatching strike.
- Force protection: *Fratricide prevention.*
- Focused logistics: *Deployment*, theater logistics.
- C2: Joint integration and adaptive planning, joint force synchronization. (looking at both operational and tactical layers here).
- Battlespace awareness: ISR, *coalition information sharing.*

tasks and milestones in the implementation must be logically arranged. The implementation must pass a simulation test, a software- and/or hardware-in-the-loop test (as appropriate) and a pilot-fielding test during an exercise.

4. Milestones for Key JBMC2 Initiatives

4.1 Battlespace Picture Integration

In January 2003, the U.S. Joint Forces Command was given a new mission and mandate by the Office of the Secretary of Defense. This mandate was codified in Management Initiative Decision (MID) 912, Joint Battle Management Command and Control (JBMC2).

MID-912 expanded the role of U.S. JFCOM to include oversight and directive authority for the Single Integrated Air Picture System Engineering Office, oversight and direction of the Family of Interoperable Operational Pictures beginning in FY 2004, and oversight and directive authorities to the Single Integrated Ground and Maritime Pictures (SIGP, SIMP) beginning in FY 2005 (SIMP is now FORCEnet Maritime Picture, sometimes called FnMP in shorthand).

In light of this expanded USJFCOM role, a need exists to outline a time-phased methodology for ultimate integration of existing DoD-sponsored "picture" efforts into a coordinated joint engineering team under USJFCOM oversight and management IAW MID 912. At the time of writing this version of the roadmap, JFCOM and the individual picture communities are formulating their shared approach to fulfill this mandate. The approach described here is necessarily preliminary, and will mature and evolve by the time of the February 2004 release of this document.

These battlespace picture efforts seek to evolve coherent and consistent battlespace awareness for each of the environmental domains (air, space, ground, and maritime—see Figure 4.1). From this perspective, all objects that are suborbital and above the ground are in the SIAP domain, all objects on the ground are in the SIGP domain, all objects in orbit are in the SISP domain, and all objects residing on or below the surface of seas or oceans are in the FORCEnet domain. Each picture effort is responsible for ensuring that each object in its domain has a consistent, correct, unambiguous, and shareable representation. This includes addressing information needs across the time continuum from real time to acceptable delay. Each effort was independent before MID-912 and had different approaches and schedules—although their general goal was roughly the same: Consistent, correct, and suitable data representation and management of the tactically and operationally relevant objects in these domains. Furthermore, it must be clear that these picture efforts neither sought to deliver a single system nor were they service-unique. These efforts do share a general need to model the physical world and to use systems and infrastructure common to other picture efforts—hence the need to harmonize and integrate them.

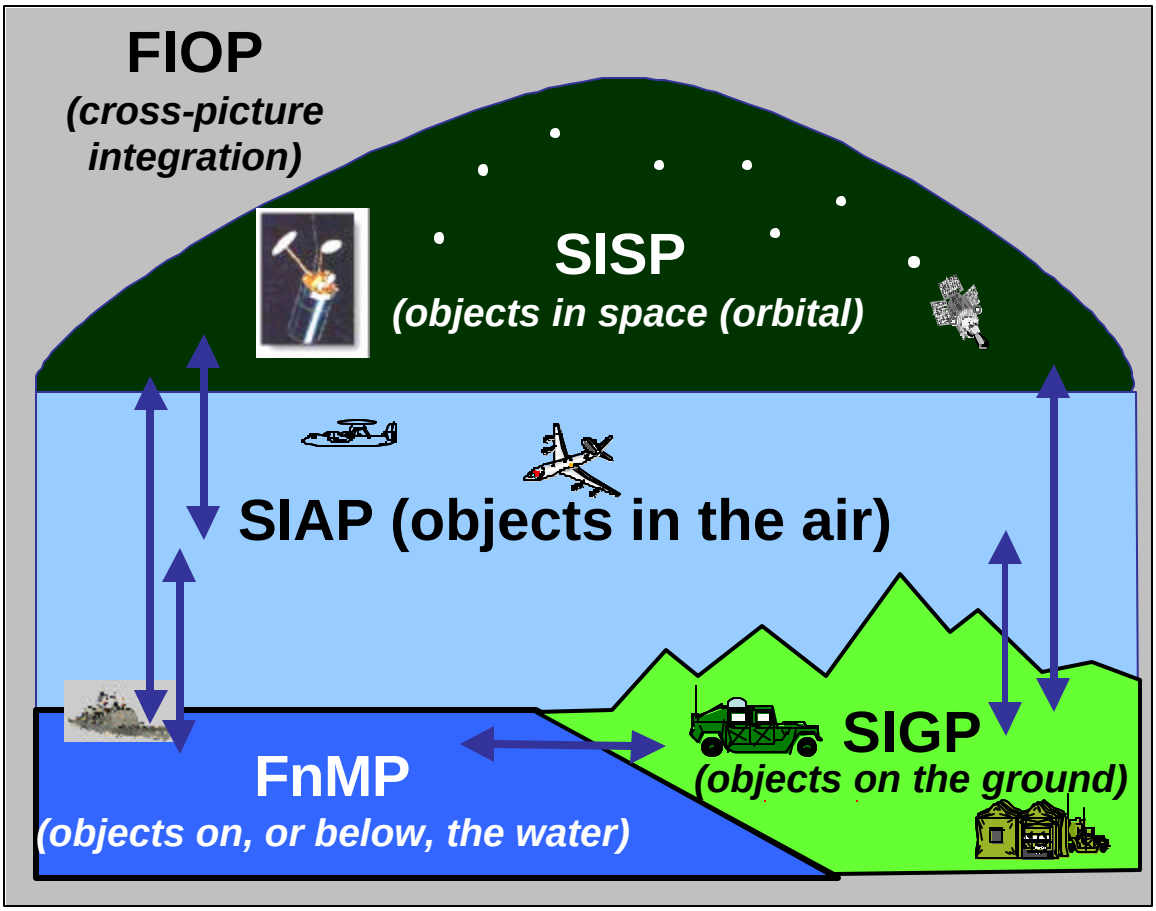


Figure 4.1—Integrated Picture of the Battlespace

This harmonization requires multidisciplinary, operational and engineering orchestration to ensure that they produce operationally meaningful increments of improved capability. The goal is a single coordinated operational and engineering approach producing incremental developments of the user-defined operational pictures. The products to ensure this are a single operationally prioritized list of improvements, an integrated master schedule of the incremental deliveries across these efforts, and single execution management of these efforts.

The objective for this plan is to effect integrated and coordinated engineering initiatives to create respective domain information for shared awareness of the operational and tactical situation across any user-defined operational picture. Figure 4.2 is a top-level depiction of the scope of the integration task. Regarding coordination across battlespace pictures, one must recognize that FIOP, SIAP, SIGP, FnMP, and SISP are *efforts* and not systems in their own right. The promise of the efforts will be realized in *systems*, as shown in the upper right hand corner—for example, command and control systems and intelligence systems. Therefore, coordination across the efforts must ultimately focus on systems, their interfaces, their data syntax and semantics, and an infrastructure of common information services that support capabilities to the warfighter. Figure 4.2 illustrates this truth, and also introduces another key

perspective: that mission objectives (e.g., tracking blue forces; tracking and striking time sensitive targets) drive the need for pictures in the first place.

Especially in a joint operation, mission objectives require combinations of air, ground, maritime, and space information, thereby "cross-cutting" the picture efforts. An important derived principle is that there are only four picture efforts, because the four-way division of the physical world depicted in Figure 4.2 is comprehensive and complete. On the other hand, there can be many crosscutting mission-oriented efforts.

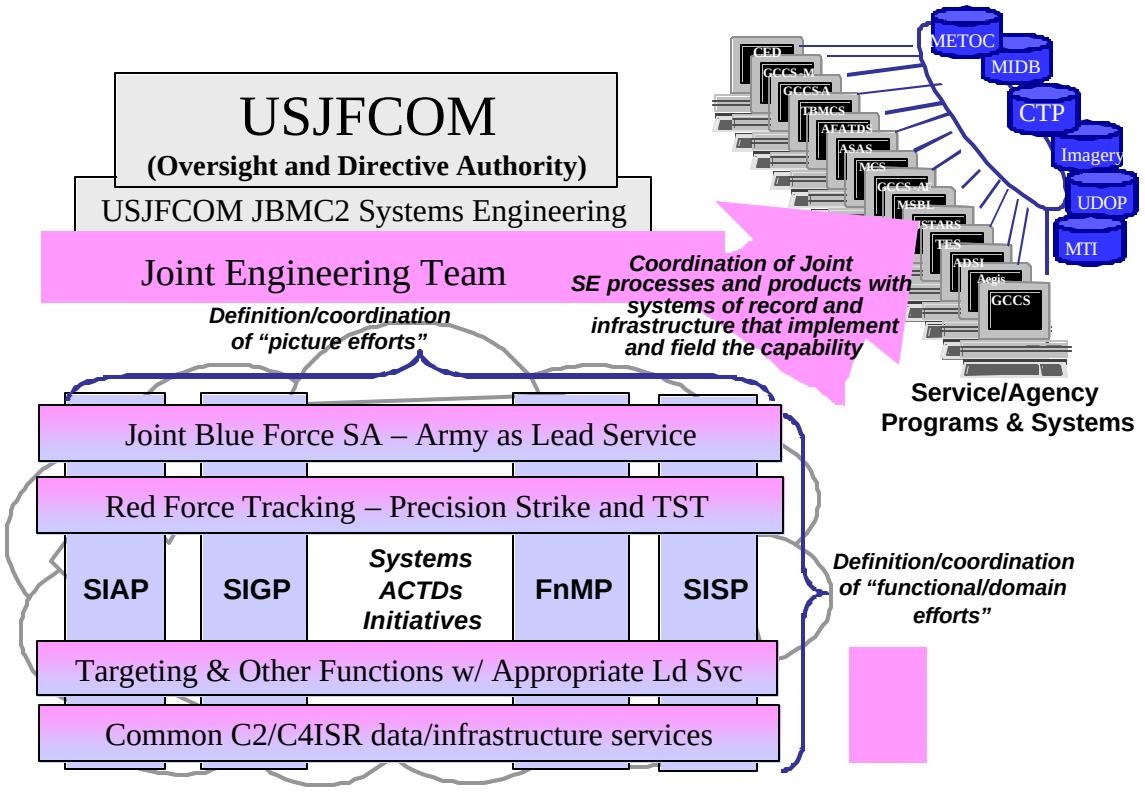


Figure 4.2—Integration of the Four Picture Efforts into Programs and Systems

The proposed methodology to integrate these picture efforts uses a four-stage, time-phased plan:

- Initial coordination and integration of the tasks currently underway across the five picture efforts, and planning a robust integration effort
- In the near-term (FY 2004), assessments of the current tasks with the goal of deconflicting and prioritizing tasks and identifying complementary activities
- In the midterm (FY 2005–2006), establishment of an effective joint engineering team and process to integrate, coordinate, and converge toward user-defined operational pictures

- In the long-term (FY 2007), agreement on one set of initiatives, managed centrally through a joint engineering process, with appropriate task assignments to the individual picture efforts.

Establishing a robust cross-picture process requires instituting and maturing a number of supporting elements: deconflicting tasks, instituting and implementing standard architectures, standardizing data, evolving acquisition policy, and establishing an integrated master schedule. The joint engineering team must begin work on these elements at once, even though the payoff will be in the midterm or long term. This roadmap shall address these elements after discussing the various phases.

Current Activity: Initial Coordination and Planning.

JFCOM has begun coordination and integration across FIOP, SIAP, SIGP, and FnMP Maritime. The community has commenced joint forums with services to develop concept of operations and operational architectures and definition of a Picture Roadmap Plan.

Near Term: Deconflicting and Prioritizing Tasks

Initial efforts to pull the picture efforts together will focus on the "Task Deconfliction" element as described below. Organizationally, JFCOM will lead the effort across the existing picture efforts, with participants including the FIOP Systems Engineering Working Group (SEWG), the SIAP Systems Engineering Task Force, and cadres from the other picture efforts as they organize themselves. JFCOM might use the JBMC2 Working Group or stand up a Picture Coordination Council of Colonels to help bring operational expertise to the deconfliction effort. A principal product during the near term will be approval and publication of the Picture Roadmap Plan in FY 2004

Midterm: Establishment of Joint Engineering Team

The USJFCOM JBMC2 Systems Engineering Division will provide oversight and leadership to the development of the cross-picture integrated engineering and architecture task. The Cross-Picture Coordination Joint Engineering Team will be chartered as a formal, virtual organization, probably including engineering expertise from each of the picture efforts. At this point, payoffs from the Integrated Master Schedule, Data Standardization, and Architecture Guidance elements begun earlier and described below will begin to add value. The FIOP SEWG will facilitate this immensely complex task. This effort will be joint and all development will be worked concurrently at the basic engineering and data standardization level with the SIAP, SIGP, FnMP, SISP, and other appropriate engineering teams throughout the development, spiral testing, delivery, and life cycle of this cross-picture effort. The FIOP SEWG is tasked to identify established technologies, develop data standards, and outline the requirements of what will be built. Additionally, the FIOP SEWG will be tasked to provide integrated architecture (AV-1 and AV-2) views that show how a "born joint" product will be reflected in each services operational picture at the appropriate level to include strategic, operational and tactical levels of war

The FIOP SEWG will establish and maintain a traceable process for any modification or improvement to the joint technical "common picture" solution. This process serves to establish a common and level playing field when discussing current capabilities and also address

deficiencies at various levels of employment. It also provides the consistent starting point for JBMC2 roadmap that incorporates proposed improvements to the baseline.

Long Term: Single Set of Initiatives

At this point, the Cross-Picture Coordination Joint Engineering Team (JET) is well established and functioning effectively. The JET is providing JFCOM J8 a single list of ongoing and proposed picture improvement efforts that are not merely deconflicted but synergized, crosscutting, and complementary. JFCOM is reviewing and prioritizing the proposed efforts for operational payoff to the warfighter and providing a single update of efforts to the Cross-Picture Integrated Master Schedule. Based on available resources and expertise, the JET will recommend to JFCOM the best OPRs to develop each effort.

These key engineering activities that will integrate these picture efforts are:

- Deconfliction of Tasks
- Architectural Guidance
- Data Strategy
- Integrated Master Schedule (IMS)
- Policy.

Deconfliction of Tasks

This first step raises the level of awareness across current picture efforts. The simple sharing of information across efforts on current activities accomplishes this objective. Sharing detailed information allows participants to gain insight into the problem areas (i.e., interoperability gaps/deficiencies) being worked. Understanding what problem areas are being worked will assist in deconflicting the picture efforts.

As a first step, each "picture" owner needs to provide the following information:

- Task Statement—A detailed explanation of the specific problem area under investigation, what operational requirements may be satisfied, and what current capabilities are not being provided to the warfighter based on the deficiency.
- Proposed Solution to Deficiency—Once the problem area is well understood, potential technical and programmatic solutions can be considered and need to have near-term applicability and demonstrate consistency with DoD's architectural objectives
- Block Diagram—To the extent practicable, includes high-level operational- and systems-level views of the problem; highlights the operational deficiency and various systems involved, and identifies joint interoperabilities and interfaces (OV-1, OV-2, SV-1, SV-2).
- Schedule—Projected schedule to develop a solution.
- System Matrix—Each picture effort should contribute to a matrix depicting what technologies are being applied (solutions) to what systems, platforms, etc. This matrix can help identify synergies and overlaps across the picture efforts or just facilitate drill-down to next level of detail.

A joint engineering process (see Figures 4.3 and 4.4) designed to translate shortfalls into tasks will produce the information necessary to deconflict, prioritize, and align tasks across the picture efforts. The JET consults external stakeholders to begin the task definition phase. Rigorous engineering analysis of picture shortfalls leads to candidate tasks to solve them. JFCOM leads an effort to review and approve the candidates, and select those that give the most warfighter benefit within existing resource constraints.

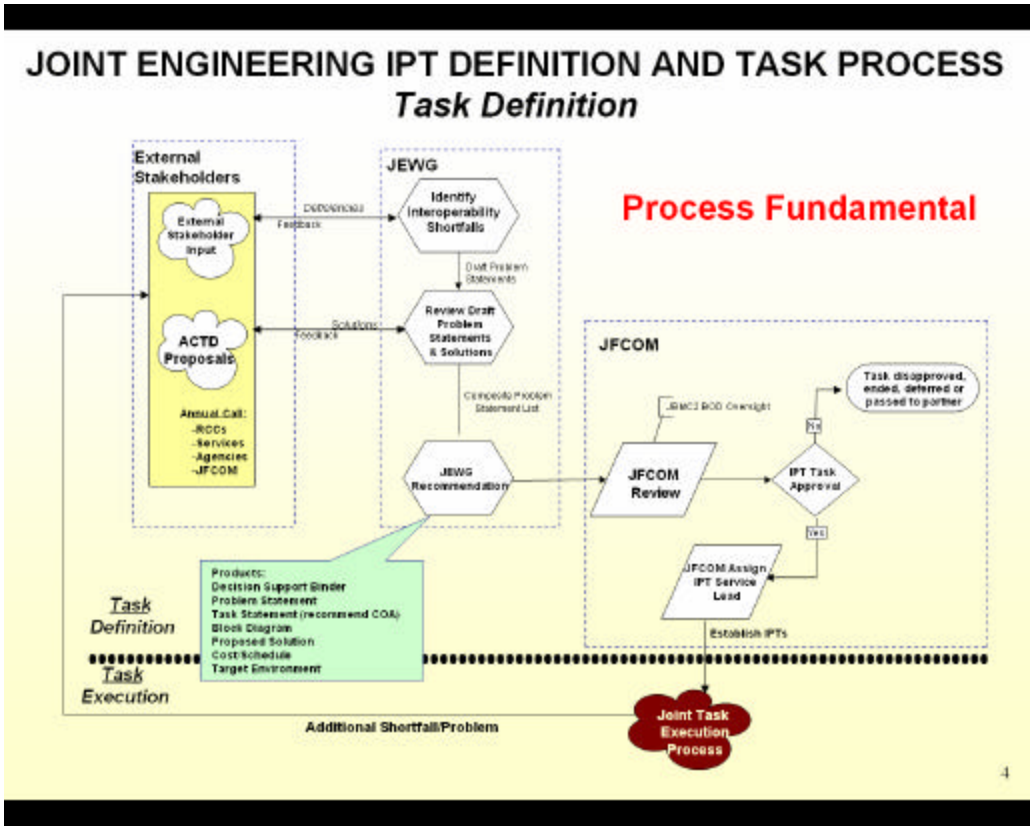


Figure 4.3—**The Task Definition Phase of the Joint Engineering Process**

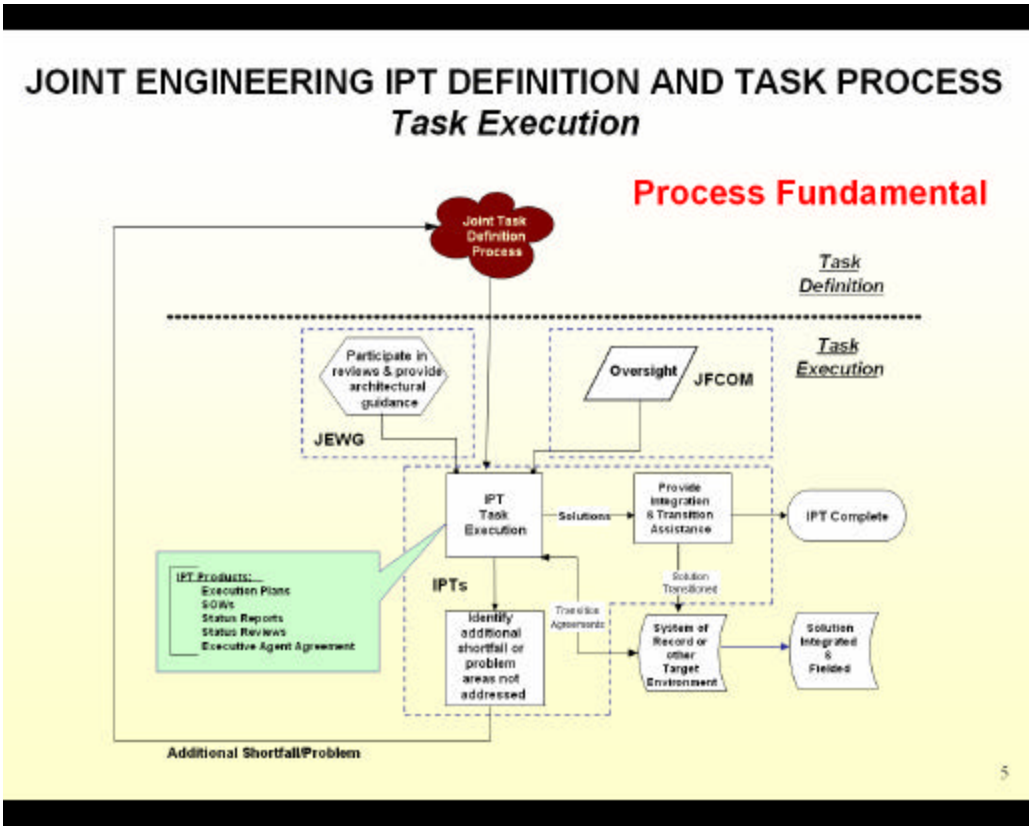


Figure 4.4—Task Execution Phase of the Joint Engineering Process

In the task execution phase, an IPT is formed from the best available and applicable domain expertise and executes each task. JFCOM maintains oversight of each effort, and the JET participates in periodic reviews and provides architectural guidance. The IPT's product will be a measurable improvement in warfighter capability, usually provided through a materiel upgrade or addition to a command and control or intelligence system, as noted above and shown in Figure 4.2.

Architectural Guidance

The USJFCOM JBMC2 Systems Engineering Division will provide oversight and leadership to the development of the cross-picture integrated engineering and architecture task. A Joint Engineering Working Group (JEWG) will facilitate this immensely complex task. This effort will be joint and all development will be worked concurrently at the basic engineering and data standardization level with the FIOP, SIAP, SIGP, FORCEnet MP, SISP and other appropriate engineering teams throughout the development, spiral testing, delivery, and life cycle of this cross-picture effort. The JEWG is tasked to identify established technologies, develop data standards, and outline the requirements of what will be built. Additionally, the JEWG will be tasked to provide integrated architecture (AV-1 and AV-2) views that show how a "born joint" product will be reflected in each services operational picture at the appropriate level to include strategic, operational and tactical levels of war.

The JEWG will establish and maintain a traceable process for any modification or improvement to the joint technical "common-picture" solution. This serves to establish a common and level playing field when discussing current capabilities and also addresses deficiencies at various levels of employment. It also provides the consistent starting point for JBMC2 roadmap that incorporates proposed improvements to the baseline.

The JEWG is to follow the below JFCOM System Engineering Division architecture development guidelines as appropriate to support the development of an actionable decision quality picture for each of the services.

1. Determine intended architecture use (e. g., document capabilities, assess issues). The Integrated Cross-Picture architecture will be used to compare and assess COCOM and service-integrated single relevant operational picture requirements against similar technical solutions to similar operational picture services to identify a potential technological and data standardization strategy and solution to develop a single joint system.

2. Determine architecture scope, context, environment, and assumptions.

- Focus on the identification of common data standardization (i.e., data strategy) that can be utilized by all service systems. This data standardization approach must support both "thin" and "thick" clients and be available to the operator(s) closest in the kill chain.
    - Focus on information flow and exchange. The focus has been narrowed:
    - Scope problem solving down to one issue (the "Common Format" issue) derived from an identifiable set of issues. This represents additional narrowing of scope.
- Maintain development of the architecture at an unclassified level where it is possible to facilitate collaborative development.
- Focus on comparison of picture capabilities, independent of programmatics, in issue identification and problem solving.

3. Based on the intended use and the scope, determine which characteristics this architecture needs to capture. This architecture needs to show:

- A high-level functional description of picture depictions and representations
- Activities that are supported by one or more of the services
- Key nodes (receive or transmit) that support each of the picture services
- Activities that each node performs
- Systems used by each node.

Possible issues related to activities:

- In-depth view of additional formatting requirements and attributes
- Issue-specific detail (i.e., formatting requirements, attributes, and information exchange)
- Provide definitions of terms that will facilitate a common understanding by all by creating a common taxonomy.

4. Based on the characteristics to be displayed, determine which architecture components/ products should be built. The Architecture Development Matrix below helps determine what products need to be built; and the rationale for each product.

Table 4.1

The Architecture Development Matrix

Characteristic Needed	Why Characteristic Needs to be Captured	Product to Build to Capture Characteristic
High- level activities	Get disparate group reading off "same sheet of music"	Generic activity model
Activities supported by one or more of the services.	One-page comparison of functional scope	Color-coded hierarchy chart
Information exchanges	Comparison of services information exchanges, functional complexity	Activity models of each service
Definitions of terms used	Get disparate group reading off same sheet of music	Integrated dictionary
Key nodes (transmit/receive) that support the services	Facilitate comparison of nodes' functional redundancy	Basic node connectivity model of each service
Activities keyed to nodes	Facilitate comparison of nodes' functional redundancy	Basic node connectivity model of each service
Systems used by nodes	Examine system redundancies	Systems overlays to node connectivity models
Possible issues related to activities	Frame issues for selection (format issue selected)	Overlays to activity model (possible issue areas highlighted)
In-depth view of additional formatting requirements and attributes	Issue selected may require more depth	Overlays to activity model (annotations on arrows)
Detail of services' formatting processes	Issue selected requires more depth	Overlays to activity models (decomposition)

Further detail on information exchanges as appropriate	Need to illustrate issue for group discussion	Overlays to activity models (further decomposition)

5. Timeline—A fundamental tenet of the joint engineering initiative is to deliver short-term capability to the warfighter while building toward a longer-term net-centric architecture. Work across *all* picture efforts needs to be accomplished with this longer-term view, and a need exists to transform the Enterprise Reference Architecture (ERA) into a Joint ERA. There also needs to be architectural guidance available for Global Information Grid Enterprise Services (GIG ES) and Net-Centric Enterprise Services (NCES) along with documented criteria against which we can measure compliance so that efforts can measure progress against longer-term objectives. The intent of JEWG working across picture efforts will not only be to adopt this guidance; but also to provide a mechanism to ensure that picture communities adhere to this guidance.

6. C2 Enterprise Technical Reference Architecture—An approach to transforming an ERA to a Joint ERA is the C2 Enterprise Technical Reference Architecture (C2ERA) reflected by the GIG ES, Unified Command System (UCS) and U.S. Air Force, which provides the technical direction for designing, acquiring and integrating the computing and communications capabilities of the C4I Enterprise. The Reference Architecture responds to demands for greater interoperability, information sharing, and integration of the C2 information systems that comprise the Enterprise. The Reference Architecture supports C4I applications and must also support integration with C2 systems from other services and our multinational partners.

The Reference Architecture supplies a technical design pattern to a program office, contractor and user architects and developers with the goal of guiding and constraining key system integration and interoperability decisions. This architecture document describes an enterprise architectural plan, one that subscribes to common standards, utilizes pervasive commercial technologies, is based on a computing services-oriented approach, and is in effect an "information-centric" view (as opposed to a weapon system, platform, or communications network-centric view).

The *C2 Enterprise* is the set of all mission applications, computing infrastructure, processes, and users with primary responsibility for command and control. The C2 Enterprise includes the communications networks (or portions of their capability) used for C2. It does not include sensors per se but does include all data feeds from sensors to C2 systems.

There are mission workflows that span picture community boundaries regardless of how carefully these communities are defined. The enterprise infrastructure connects these communities to support mission workflows with minimal technical and administrative coordination. Connecting communities via loosely coupled architecture allows for independent evolution of IT capabilities based on community requirements.

Achieving consistency in these workflows and trying to advocate across the picture efforts for Joint C2ERA is an objective of the cross-picture coordination effort and JEWG has allocated resources to work this activity. This effort will also contribute to JFCOM's reference architecture developed in support of JBMC2.

Potential products from this approach include a FIOP "as-is" architecture. This high level representation will help improve understanding across the various picture efforts. This "as-is" architecture will include information exchanges for systems with identified interoperability shortfalls. This work will then be used to help create a composite list of systems that need to be accounted for as part of a Joint Integrated Architecture effort with JFCOM.

7. Build products and use the architecture—One of the most important steps in architecture development is providing an integrated dictionary of terms to facilitate a common understanding of all picture activities and related terms of reference used in the architecture. A joint taxonomy is required.

Data Strategy Development

Reaching agreement on the long-range architecture for DoD is an important consideration, it is equally important to consider actual transactions of information content. Details regarding information transactions need to be captured as part of a data strategy as tasks are executed. They need to be compatible with DoD's data strategy efforts and leverage work already accomplished.

A potential approach, under JFCOM's lead, would be to identify Community of Interests (COI) across the service lead-picture initiatives. A cross-picture coordination team would develop a data strategy consistent with DoD's Net Centric Data Management Strategy.

To codify the COIs, certain groundwork-laying activities must be completed:

1. Create a Domain Vocabulary (Community Ontology).
2. Identify and Inventory Existing Data Assets.
3. Develop COI Data Access Plans for Enterprise-wide Utilization of Applicable Functional Area Data
4. Select Data Assets as Authoritative Data Sources.
5. Register Metadata
6. Create a COI Logical Data Model (LDM) –
7. Establish Functional Data Area Processes

As an example, an initial COI could be Battlespace Awareness/Situational Awareness.

Many users require Battlespace Awareness/Situational Awareness information updated periodically (e.g., on a tens of seconds update cycle), and the communications system will deliver that content in variety of distribution mechanisms (push, pull, sampling, etc.). All users draw from the same mix of sources of surveillance data, although they may not be synchronized in time, and thus their respective picture representation may not be precisely identical (but will be operationally identical in the context of their mission objectives). Some users, such as weapon systems, may require faster updates and will launch an "information pull" request when they require content to update their picture representation. The quality or accuracy of the information depends on the composite servicing requirements of all the suppliers of requested information. Couple the source features with the ability of the consumer to process this information and the resultant product, actionable decision quality data, is delivered to the warfighter, which is of importance to all of the picture efforts. Selecting an initial data strategy

across *all* picture efforts to be consistent within a DoD strategy is an outcome of this cross picture coordination group.

Integrated Master Schedule

Having specific task activities aligned as complementary efforts and ensuring consistency of work areas and their applicability to other picture efforts are challenging endeavors. Development of an integrated master schedule is intended to assist with synchronization of developed solutions across the programs of record and can also be used to support transition plan development work with those targeted systems of record. Products can also be used to support the development of the JBMC2 roadmap

Products from this approach include:

- Development strategies and deployment strategies documented. When is the projected completion date for a developed product, and when is it going to be fielded resulting in the delivery of capability to the warfighter?
- Recommendations to IPTs and or WGs within picture efforts—on an as-needed basis, provide guidance and support to specific efforts under way.
- Producing a composite baseline list of tasks across the community of picture efforts.

4.2 Family of Interoperable Operational Pictures (FIOP)

The overarching goal of FIOP is to "provide an all-source picture of the battlespace containing actionable, decision-quality information to the warfighter through a fusion of existing databases…" (JROCM 156-01, 17 Oct 01). Its main products are:

- Mission applications usable by systems of record. In other words, FIOP does not produce new systems of record with the resultant resource drains of creating support and sustainment processes and organizations. Rather, it produces enhancements to legacy systems and transitions them to those systems' existing support and sustainment chains.
- Modifications to COE as required, as well as leading Service programs on the technical path to conformance with GIG-ES.
- Network-based services not directly associated with a system but that likewise help the services transition to the GIG-ES environment.
- Other products identified as necessary to solve interoperability issues.

The detailed FIOP tasks are as follows:

Task 1, FY 2003 Starts

1.1. Web-Enabled Execution Management Capability (WEEMC): Migrate ADOCS-like capabilities into systems of record. Focus for initial delivery is Joint Fires mission manager as demonstrated in MC02 and continued by JFCOM J9 in their Joint Fires Initiative. Target SORs: TBMCS, GCCS-J, C2PC. Additional comments: Technical architecture should lend

itself to straightforward interfaces through GIG Enterprise Services to any other netted application

1.2. Tactical COP Workstation: Develop a Tactical COP Workstation to provide interactive tactical and operational pictures on mobile platforms over tactical (unreliable) communication equipment. The requirement is defined in the GCCS RID (Dated 6 Oct 00) and other service-specific ORDs, such as the Marine Corps DACT and the Army FBCB2 ORDs. Based on performance analysis conducted between the COP Client and C2PC, C2PC was selected as the basis for tactical functionality within the COP infrastructure. The effort also provides for the capability to run selected GCCS mission applications from the C2PC environment as a bridge between tactical and operational functions. Target SOR: C2PC. Additional comments: USA/USMC are leveraging this effort in their system migration and consolidation effort to create a single suite of C2 systems from corps down to platoon. GCCS FoS, C2PC, and FBCB2 will be the family of systems.

1.3. COE VMF: Implement COE processing of VMF messages to improve interoperability between applicable Army, USMC, and Navy systems to provide a scalable COP infrastructure for limited bandwidth environments. The requirement for Task 1.3 is defined in the GCCS RID (Dated 6 Oct 00) and supports a scalable COP infrastructure. Target SORs: C2PC, ABCS, GCCS FoS.

Task 2, FY 2004 starts

2.1.1. Joint Blue Force Situational Awareness (JBFSA). Integrate JBFSA across services and systems by developing operational concept for JBFSA; creating JBFSA integrated architecture; developing and fielding incremental improvements in JBFSA capability; and harmonizing service efforts across POMs. Target SORs: All systems creating, propagating, and displaying JBFSA information with emphasis on transitioning from legacy to GIG-ES based.

2.3.1. Precision Fire Support (PFS). Give USMC and USAF unit-level systems capability to pass target information and tasking to USN, USA, USAF, and USMC shooter platforms. Target SORs: USMC's Target Location, Designation, and Handoff System (TLDHS) and USAF's Tactical Air Control Party (TAC-P). Additional comments: Technical approach will leverage XML technology and DoD data standardization processes—migration to GIG-ES environment should be relatively straightforward.

2.5.1. Tactical Data Link Integration (TDL). Develop a JITC-certified Multi-TADIL Capability (MTC) that is a conduit for data exchange between the Joint Planning and Joint Data Networks (JPN, JDN). This will also bring in data from the IBS network. VMF networks are also potential data sources and may be linked up in a future spiral. Tasking includes performing the engineering analysis to determine the appropriate level of data exchange between the various networks. Potential JPN data includes Blue Force tracking data, imagery, and threat warnings. MTC will also allow time-sensitive targeting (TST) applications to disseminate targeting data and orders to Link-16, and potentially VMF-equipped platforms. So as not to overload the JDN and its participants, the task will include developing a set of recommended CONOPs inputs and corresponding filters for the MTC capability. Target SORs: GCCS FoS, including TBMCS; ADSI; JTIDS, and Integrated Broadcast Service (IBS). Additional comments: The 2.5.1 IPT will coordinate with the USA and USMC to evaluate potential future uses.

2.6.2. Situational Awareness Data Interoperability (SADI). Create generic gateway and interface control document between COE-based situational awareness systems and non-COE-based situational awareness systems, including allied and coalition systems. Target SORs: GCCS FoS, ABCS, and allied systems participating in Multilateral Interoperability Program (MIP).

2.6.3. Network-Based Services (NBS). Foster the migration of service SORs from platform-centric applications to GIG-ES ready information services for greater interoperability. FY 2004 products include a weapon-target pairing (WTP) information service interfaces to USAF's Time-Critical Targeting Functionality (TCTF) system and the initial leveraging of Army Advanced Field Artillery Tactical Data System (AFATDS) information services. A Cross-System WTP service is concurrently being developed to better provide joint coordination across the SoRs, including Navy Fire Control System (NFCS) functionality. Architectural products include an Information Services Software Development Kit (SDK) for use across FIOP activities and by the services and agencies to develop their own information services. The SDK will include best practices, guidance, and utilities for Community of Interest (CoI) information services. (These CoI services are deconflicted from primary services being developed under NCES). Target SORs: TBMCS' TCTF, AFATDS, and NFCS. Additional comments: Intent is to develop information services annually through FYDP and produce architectural products every other year.

Products for FY 2005 include follow-on spirals to the above and a draft set of information services are defined, with high priority given to meeting seams consistent with the FIOP philosophy while evolving to the target architecture for CII while continuing to support the warfighter community.

Task 2, FY 2006 Starts

2.2.1. Red Force Picture Distribution Service. Create information service(s) that link disconnected islands of Red Force information, pulling from the Red Force data sources and pushing it to subscribers. First increment is to create a COE-compliant information service for GCCS FoS (operational level); second increment will extend to tactical level, to include C2PC and AFATDS; subsequent increments will add more systems and address intelligence feed interfaces. Target SORs: All operational and tactical systems creating and displaying Red Force information. Additional comments: Technical approach will leverage XML technology and DoD data standardization processes—migration to GIG-ES environment should be relatively straightforward.

2.3.2. Targeting Interoperability. Extend efforts in Precision Fire Support and Network-Based Services to create and improve automated tools supporting timely and effective Time-Critical Targeting. Possible focus is development of a single "target file" data service that supports both web-level and data-level push and pull data services and integration. Target SORs: include GCCS FoS, JTT, DTSS, AFTATDS, C2PC, TCTF, JSWS, and Naval Fires Network (NFN). Additional comments: Technical approach will leverage XML technology and DoD data standardization processes—migration to GIG-ES environment should be relatively straightforward.

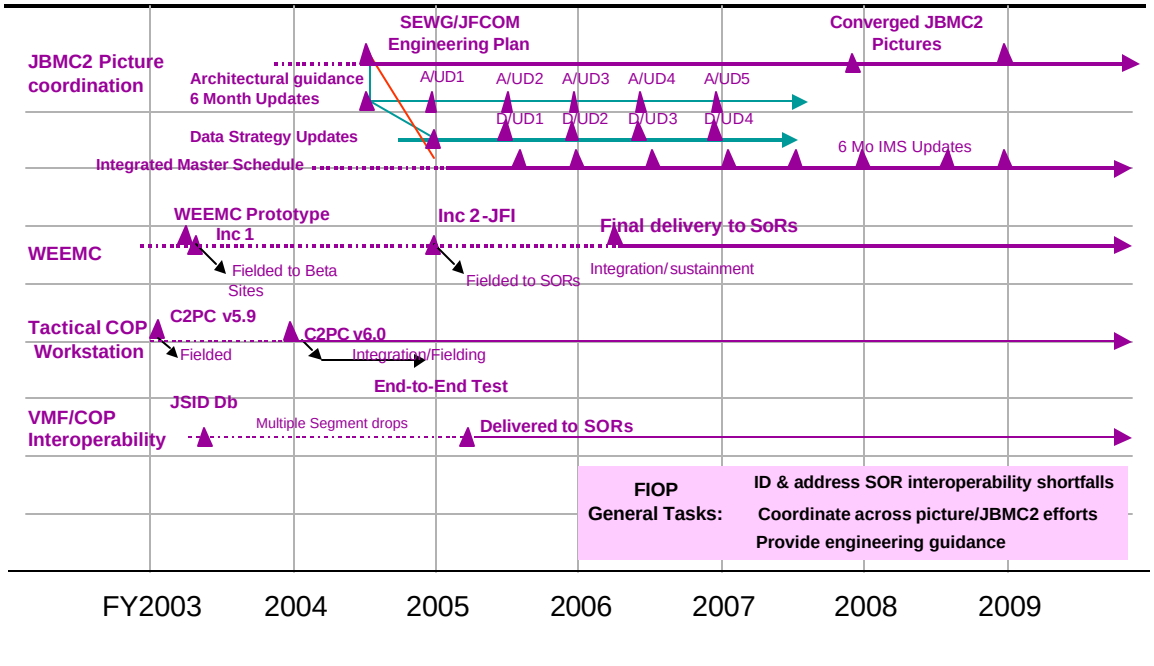
2.4.1. Ground Moving-Target Indicators (GMTI). Create information service that pulls GMTI information from any MTI information source (e.g., JSWS, MTIX, JSTARS) and

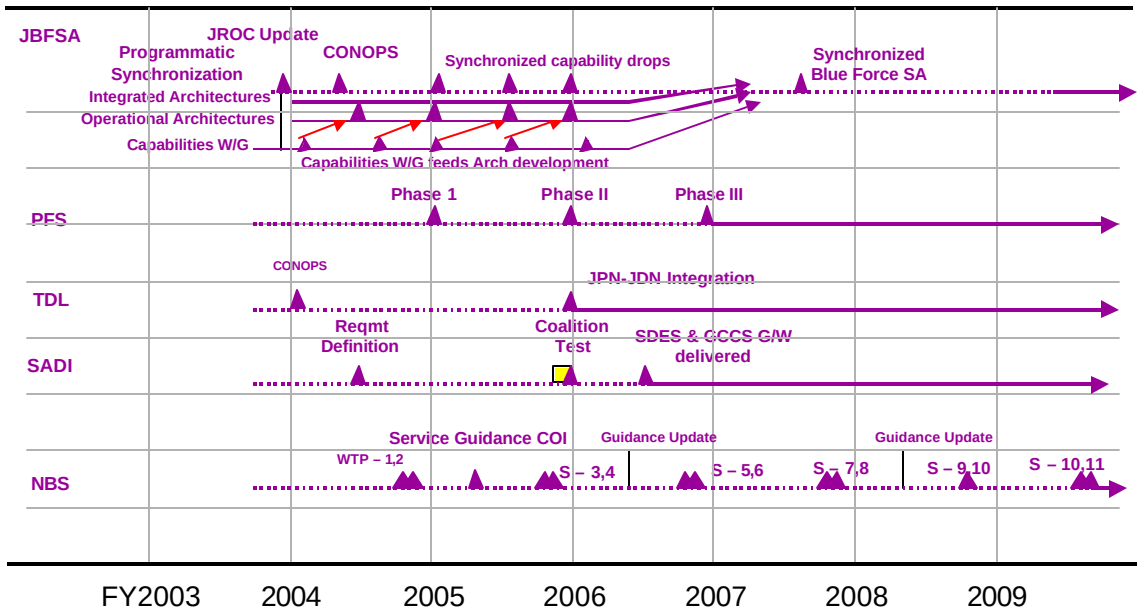
pushes it to any GMTI user. Target SORs: GCCS FoS, JSWS, MTIX, JSTARS, others TBD. Additional comments: Technical approach will leverage XML technology and DoD data standardization processes—migration to GIG-ES environment should be relatively straightforward.

2.6.1, METOC Services. Create information service that pulls weather information from a number of sources and provides it to all weather information users. Target SORs: GCCS FoS, all operational or tactical system creating or displaying environmental situational awareness. Additional comments: Technical approach will leverage XML technology and DoD data standardization processes—migration to GIG-ES environment should be relatively straightforward.

Schedule

Figures 4.5–4.7 shows the current schedule of tasks for FIOP.





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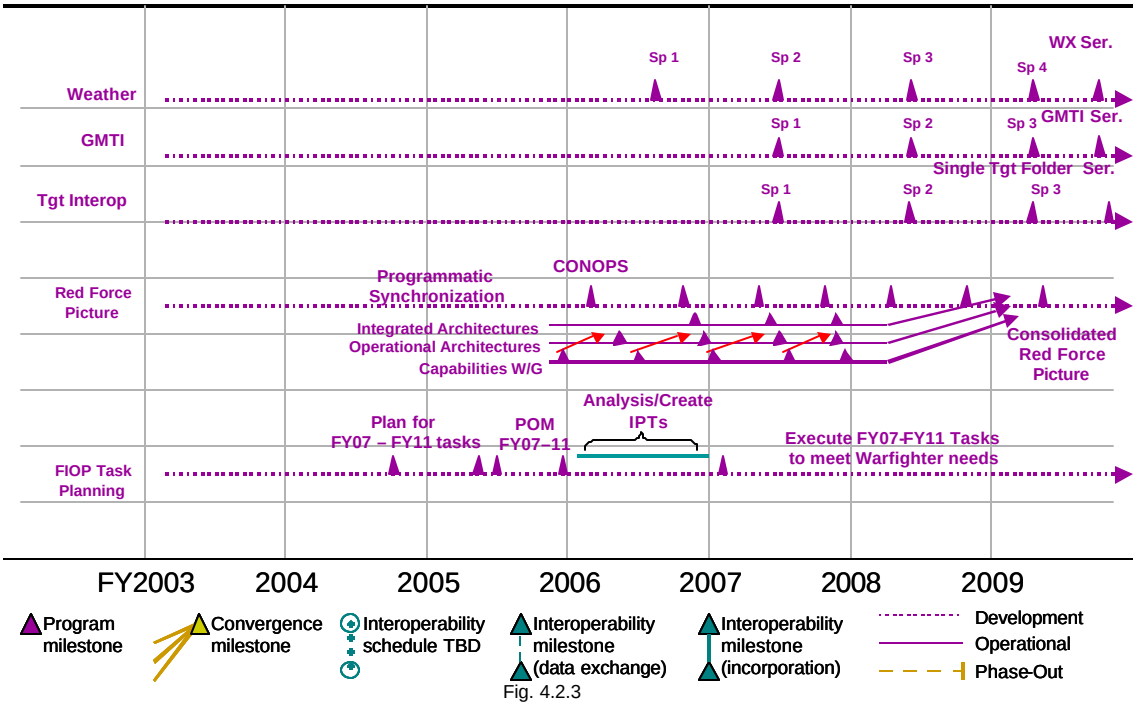

Fig. 4.2.3

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Figures 4.5–4.7—Current Schedule of Tasks for FIOP

4.3 Single Integrated Air Picture (SIAP)

SIAP is an initiative that provides the warfighter "a single integrated air picture which is the product of fused, common, continual, unambiguous tracks of airborne objects in the surveillance area." (TAMD CRD)

4.3.1 SIAP Block 0

The primary purpose of SIAP Block 0 is to fix problems leading to redundant reporting on Link-16, focusing on the areas of identification and correlation. Block 0 will provide participating systems with the same rules and a common language to process Link-16 data the same way. SIAP Block 0 will enable the following capabilities:

- Common ID Taxonomy (ref ICP TJ00-004 Ch. 2) standardizes the language used on the radio to identify friend, hostile, neutral, unknown, assumed friend, or suspect.
- Joint ID Conflict Resolution Matrix (ref ICP TM94-005 Ch. 10) reduces operator workload by setting rules to eliminate nuisance alerts and chooses a preferred solution when two different IDs are used to identify a single target.
- Common Correlation Algorithm (ref ICP TM98-035 Ch. 10) is the result of an almost 20-year effort to define specific rules and techniques for agreeing on whether two or more platforms are looking at the same target.
- Formation Tracking Rules provide a standard that allows operators to group tracks into formations and provide definitions that systems need to interpret a symbol representing multiple targets and assign IDs to other specific targets held locally by other platforms.

Figure 4.8 shows the timelines for programs participating in SIAP Block 0, with the right end of the bars showing the dates by which the programs are expected to have implemented the Block 0 functionality.

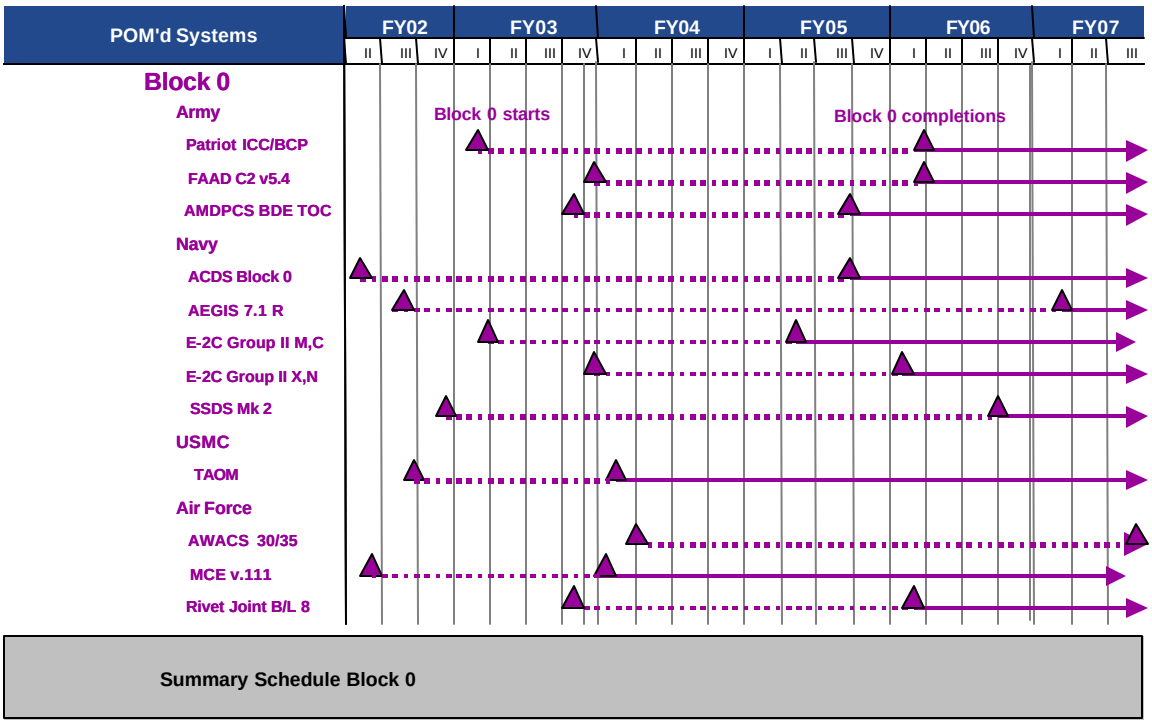


Figure 4.8—Timelines for Programs Participating in SIAP Block 0

4.3.2 SIAP Block 1

SIAP's Block 1 (as approved by JFCOM) addresses the following issues:

- Further reduce dual tracks (reduce operator confusion)
  - Common time reference/standard
  - Data registration
  - Track quality
  - Tracking/track management
  - PPLI
  - Consistency of distributed track databases
  - Improve combat identification capabilities
  - CID.
- Improve combat identification capabilities
  - CID
  - IFF/SIF.
- Improve TBMD performance (reduce confusion and ordnance wastage)
  - Reporting
  - Data association/correlation
  - EW impact point prediction
- Improve data sharing (improve network capability)
  - Link-16 throughput
  - Multilink translation/forwarding

- Engage on remote (EOR)
- Engagement coordination

As shown in Figure 4.9, in Block 1, SIAP provides participating programs with data models and algorithms (actual code) to implement, as opposed to paper standards. This approach allows for great technical detail in specifying standards to achieve interoperability, reducing the risk that a system can meet the required interoperability standard and still not be interoperable in practice due to low-level technical conflicts.

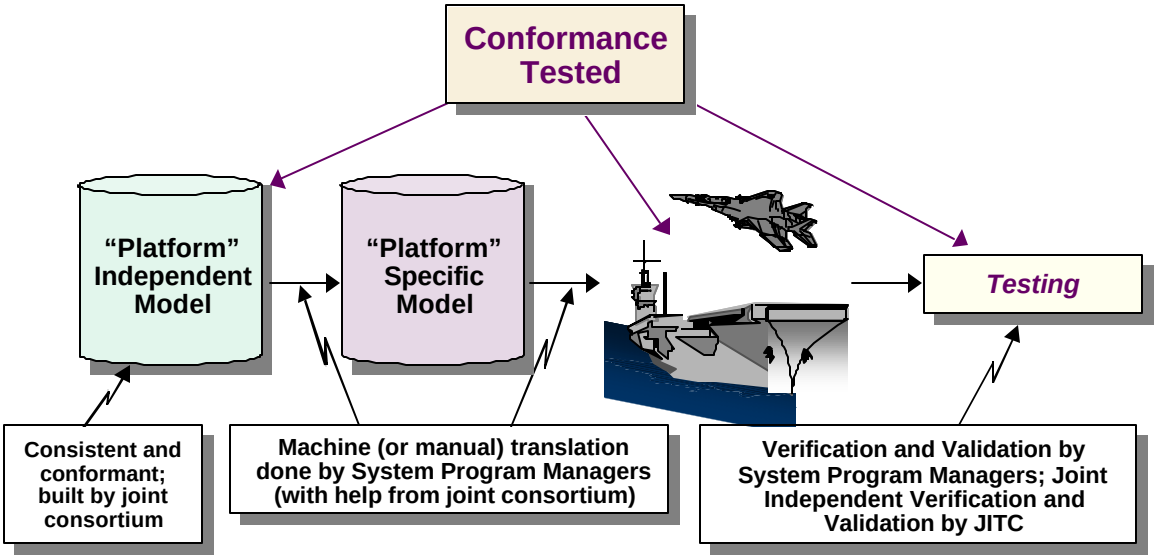


Figure 4.9—SIAP Block 1 Model Development and Implementation Process

SIAP first creates a "platform-independent model" (PIM), using MDA standards. The PIM is then compiled into a "platform-specific model," (PSM) that contains the code to implement the PIM on a particular system. SIAP also subjects its models to multiple stages of verification and validation, involving both system program manager review and simulation testing. The latter simulates both the models and the modified systems (system-in-the-loop testing).

To date, 10 programs are committed to participating in Block 1, and another 21 are potential candidates. Figure 4.10 shows the programs in each category.

Block 1/PIM 05 users

1. AWACS 40/45
2. AEGIS
3. SSDS MK II
4. E-2C
5. Patriot
6. Rivet Joint
7. FAAD C2
8. AMDPCS
9. CAC2S
10. BCS (f)

Potential Block 1 users

11. FCS
12. JLENS
13. ACS
14. WIN – T
15. A2C2S
16. T UAV
17. MMA
18. DDX
19. CVN-21
20. BAMS
21. DJC2
22. E-10A
23. Tactical Dtlnk Gateway
24. B-1
25. F-22
26. PUMA
27. LRR (TPS-59)
28. MRRS
29. F-35
30. JC2
31. GES

Figure 4.10—Committed and Candidate Programs for SIAP Block 1

The following figure shows the tentative schedule for SIAP and the 10 committed programs, marking when each program is to receive its PIM and when each program is expected to have the PIM implemented.

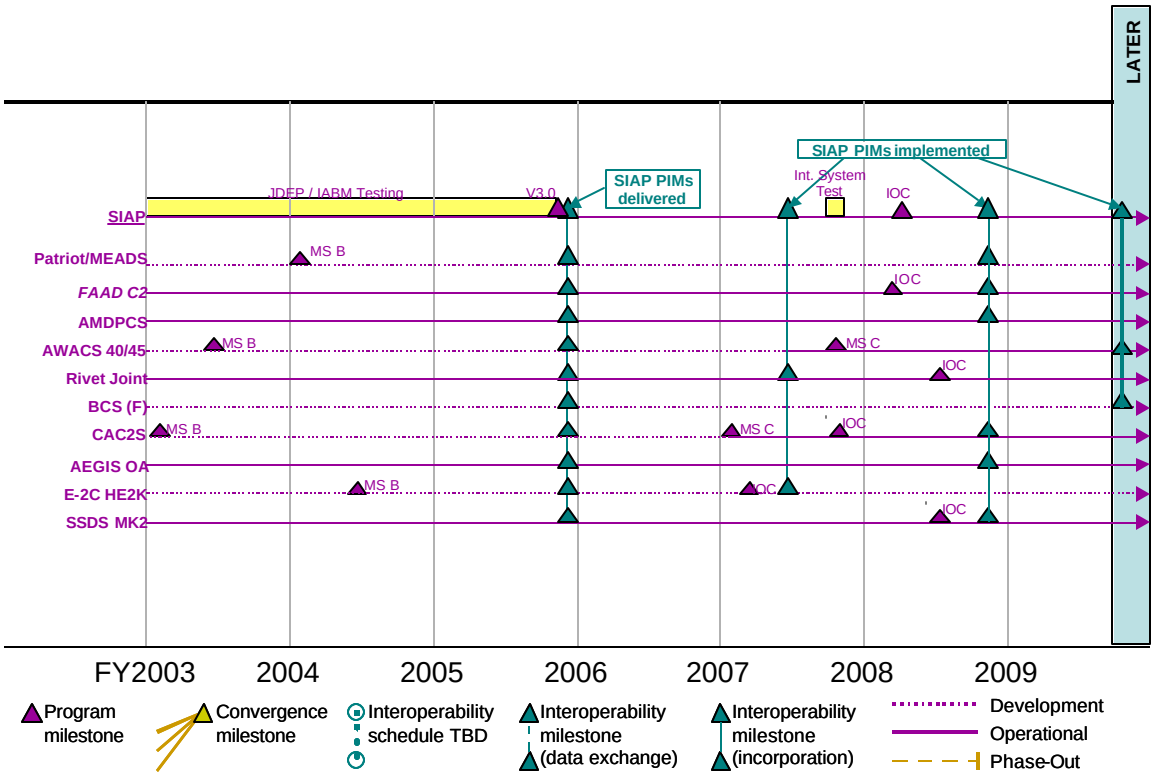


Figure 4.11—Timelines for Programs Participating in SIAP Block 1

4.3.3 SIAP Block 2

Planning for SIAP Block 2 is just starting. To date, the candidate themes for Block 2 include the following:

- Host implementation consistency
- Distributed database consistency improvement
- Network latency reduction
- Interface with GCCS/JC2 and ground systems
- Improve single and multiunit missile defense performance.

4.4 Single Integrated Ground Picture (SIGP)

The Single Integrated Ground Picture (SIGP) provides a coordinated battlespace situational awareness to the warfighter through the use of advanced integrated sensors, innovative information transport technologies/architectures, data fusion, decision aids, and human systems interfaces to maximize effectiveness of execution, and significantly enhance the capabilities of existing Ground (Army, Marine, SOF and Coalition) and Objective Forces. The SIGP will support the four overarching concepts of the Objective Force; See First, Understand First, Act First and Finish Decisively.

The Single Integrated Ground Picture (SIGP) comprises the joint processes, methods, architectures, standards, operational concepts and CONOPs. It will provide the warfighter with enhanced situational awareness of the battlespace, allowing the warfighters to more precisely and decisively command and control the battlespace. SIGP will provide the following products:

- DOTML-PF Joint Operational products, such as the SIGP Operational Concepts and SIGP Concepts of Operations.
- Integrated Architectural products, including joint C4ISR standards and enterprise architecture products (OVs, TVs, SVs, AVs). These efforts will leverage ongoing DoD activities and will include metrics development.
- Joint gap analyses, incorporating recent lessons learned from Operation Enduring Freedom and Operation Iraqi Freedom, and joint roadmaps for ground systems interoperability solutions.
- Interoperability enhancements to provide joint capabilities for the warfighter as refined by JFCOM-led DOTML-PF operational products.
- A net-centric migration plan.
- Joint experimentation products for risk reduction, including experimentation and documentation of mission threads to test block capabilities.
- A transition capability to transfer prototype interoperability solutions to Program/Systems of Record for implementation.

The Single Integrated Ground Picture (SIGP) consists of multiple joint mission threads. SIGP is an information broker of ground tactical and operational information to the other JBMC2/FIOP elements and requires seamless interoperability with all JBMC2/ FIOP elements to ensure that warfighter mission/knowledge requirements are met. SIGP's System to Human Interface adapts to the commanders' needs leading to decisive optimal decisions. SIGP cuts across the five JWCA functional areas (see Figure 4.12).

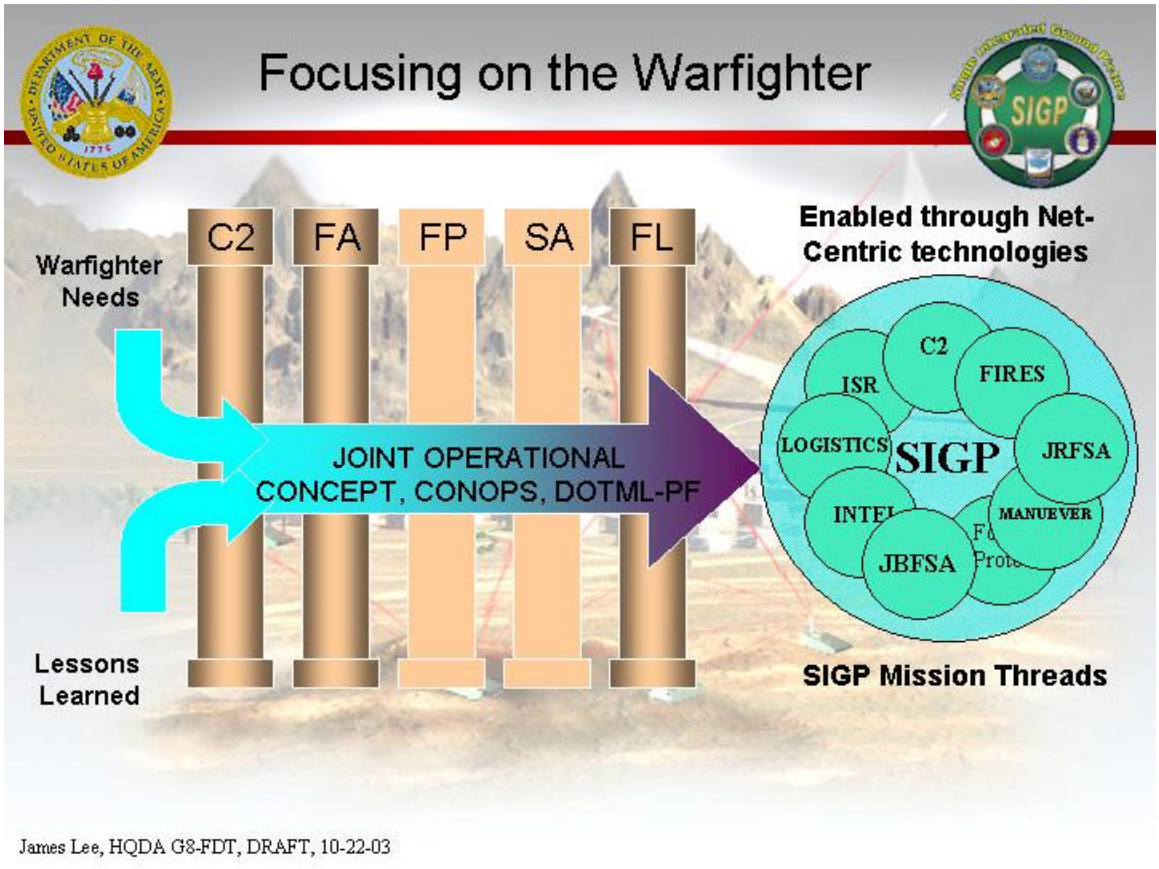


Figure 4.12—SIGP Mission Threads

SIGP is a new program that is being initiated in FY04, and its planned long-term activities/strategies are preliminary, and are currently being refined/developed. As a result, it does not have a detailed, multiyear schedule comparable to more established programs like the Single Integrated Air Picture. SIGP's anticipated tasks for the next two years are as follows:

FY 2004 Tasks

- Joint SIGP Operational Concepts and Joint CONOPS
- Joint SIGP Inteoperability Gap Analysis
- Joint SIGP Integrated Architecture
- Joint SIGP Interoperability Metrics
- Joint/Coalition SIGP Net-Centric Demonstration (STGP)
- SIAP/SISP/FORCEnet/JBMC2/FIOP/JBFSA Integration

FY 2005 Anticipated Tasks

- Complete FY 2004 Efforts
- SIGP NCES Migration Plan
- SIAP/SISP/FORCEnet/JBMC2/FIOP/JBFSA Integration
- Joint SIGP Interoperability Capability Enhancements development

- Joint SIGP Experimentation/Integration
- Strategy for Integration/Migration/Synchronization of Joint SIGP Interoperability Capability Enhancements based on JFCOM-led DOTML-PF operational products (e.g., Operational Concept and CONOPS)

To meet the joint interoperability testing timelines recommended earlier in the roadmap, it is recommended that an initiatl set of SIGP JBFSA products be completed by the fourth quarter of FY 2005 (so that it can be incorporated into software models of Army and USMC JBMC2 pathfinder systems by the first quarter of FY 2006). This will enable the inclusion of these products in the recommended FY 2006 JDEP test events for Clusters 1 and 3, as described in Section 3.2 (Army Software Block Upgrades 2/Marine Corps and Army Upgrade Block 2/FCS).

It is also recommended that enhanced versions of SIGP JBFSA products be developed by second quarter of FY 2007 and be included in the second spiral development of Army and USMC JBMC2 systems. It is similarly recommended that this SIGP "Block 2" be included in the recommended FY 2007 JDEP test events for Clusters 1 and 3 (Army Software Upgrades Block 3, FCS, Marine Corps).

4.5 FORCENet Maritime Picture (FnMP)

PLACEHOLDER. The February 2004 edition of the roadmap will include a description of the FORCENet Maritime Picture.

4.6 Single Integrated Space Picture (SISP)

PLACEHOLDER. The February 2004 edition of the roadmap will include a description of the Single Integrated Space Picture as it relates to JBMC2.

4.7 Single Integrated Special Forces Picture (SOFP)

PLACEHOLDER. The February 2004 edition of the roadmap will include a description of the Single Integrated Special Forces Picture as it relates to JBMC2.

5. Management JBMC2

PLACEHOLDER. This chapter is under development. When it is finished it will describe the management and oversight mechanisms for programs placed under the oversight of the JBMC2 roadmap. Management and oversight mechanism for the first and subsequent sets of JBMC2 Pathfinder programs will be consistent with current guidance. Additional supplementary guidance will be developed and contained in this section to ensure Pathfinder programs can be governed effectively as an interoperable family of systems (FoS). This section will begin with a summary of current management and oversight functions, based on MID 912 and the JFCOM-led JBMC2 Board of Directors. Specific consideration will also be given to current 5000 and 3170 regulations, and,the 10 November 2003 "Synchronization of Capability Identification and Program Acquisition Activities memo signed by USD(AT&L). Additional FoS management guidance will be developed by using lessons learned and current practice from the GCCS FoS management structure, and other programs where applicable.

This section will describe how the JBMC2 Board of Directors will govern key JBMC2 initiatives and programs included in the roadmap. It will include a description of the BoD process for making recommendations to the USD(AT&L) and informing the JROC. This includes:

- Adding material solutions and programs of record to the roadmap.
- Deciding on network-centric interoperability standards and requirements.
- Deciding on adding testing requirements and joint test events to program schedules.
- Deciding on adding new requirements to programs (i.e., requirements to incorporate SIAP drops, etc.)
- Resolving conflicts between Service-specific DOT_LPF developments
- Developing integrated multi-Service JBMC2 warfighter and unit training plans
- Integrating Service and joint JBMC2-related experiments
- Assessing Service and joint JBMC2-related experiments
- Deciding on modifying a program's KPPs.
- Deciding on requiring convergence between a set of programs, and creating the convergence strategy and schedule.
- Deciding on program phase-out.

Normative decision criteria for making the decisions identified above will be specified in general terms in the roadmap. These criteria will be capabilities-based. Objective JBMC2 capabilities will be derived using a "mission thread" approach that is applied to generic joint mission capability packages.

5.1 JBMC2 Roles and Responsibilities

The subsection will describe how the JBMC2 Board of Directors and subordinate bodies will govern key JBMC2 initiatives and programs included in the roadmap.

5.1.1 Establishing Program Integration Priorities

5.1.2 Resolving Conflicts Between Service-Specific DOT_LPF Developments

5.1.3 Developing Integrated Multi-Service JBMC2 Warfighter and Unit Training Plans

5.1.4 Integrating and Assessing Service and Joint JBMC2-Related Experiments

5.1.5 Establishing JBMC2 Program Convergence Direction, and Creating Convergence Strategy and Schedule

5.1.6 Deciding on Legacy Program Phase-Out

Normative decision criteria for making the decisions identified above will be specified in general terms in the roadmap. These criteria will be capabilities-based. Objective JBMC2 capabilities will be derived using a "mission thread" approach that is applied to generic joint mission capability packages.

5.1.7 PLACEHOLDER: TEMPORAL WAIVERS:

[This section will describe the process to be followed by a Service when requesting a waiver (or delay) in achieving JBMC2 interoperability or integration goals. The organizations responsible for considering, denying, or granting waiver requests will be specified. A two stage process may be recommended. Initial waiver requests could be sent to the JBMC2 BoD. The BoD could deny the request or it could send the request for decision to a higher level review body. The higher level review board may consist of representatives from AT&L, NII, the Joint Staff and JFCOM, or of principals from these organizations.

Suggested decision criteria for waivers will also be specified in the roadmap in general terms. Criteria for interoperability waiver decisions will be written once the first round of JCT-based analysis has been completed, as this round will provide a sense of what is really necessary to provide by the end of FY 2008.

These criteria will also include cost and schedule trade-off information that may be specific to particular cases.

Grounds for interoperability waivers might include:

- *The system will not be operational until after FY 2008 (e.g., FCS, MC2A, etc.)*
- *System does not need to become operational to provide required FY 2009 mission capability.*
- *Delaying system interoperability would provide resources the Service or agency to provide higher-priority mission capability.*]

6. JBMC2 Data Strategy

PLACEHOLDER. This chapter will describe an overall JBMC2 data strategy. The proposed strategy will combine elements of top down and bottom-up data strategies. The top-down strategy referred to here is the NII data strategy. The overall JBMC2 data strategy will be fully consistent with NII data standardization and meta-data registration guidance.

The bottom up data strategy will be based on existing Service data strategies and on the data representations employed in current JBMC2 systems. The bottom-up elements will include a small number of JBMC2 Communities of Interest (COIs) that will define data and meta-data standards for specific JBMC2 capabilities (notably, those capabilities described in Section 2.4), such as the SIAP Community of Interest. The JBMC2 data strategy will define linkages between and across the top-down and bottom-up elements, enabling achievement of genuinely joint BMC2 capabilities in the short term (through FY 2008). The JBMC2 strategy will also describe the transition of the various top-down and bottom-up elements into an integrated, net-centric schema over time (FY 2008 and beyond), consistent with the complexities of transitioning tens of thousand of warfighting platforms and current tactical data links to new technologies.

6.1 JBMC2 Data Communities of Interests and Domains

This section will describe JBMC2 COIs and major data domains to be used in each domain, to include the SIAP, SIGP, SISP, SOFP and FORCEnet Maritime Picture domains. The COIs will seek to ensure that domain-specific data can be understood by those needing to use it, and that the data will be used properly, in accordance with the relevant joint capability and mission threads. Common and unique data domains in each community of interest will be listed and in some cases described. The section will also identify the roles and responsibilities of COIs, to include developing and managing domain-specific ontologies (subject area vocabularies) and corresponding data and metadata dictionaries. Such management will include identifying and tasking ontology and dictionary owners, setting relevant standards, and generating schedules for the creation and implementation of ontologies, dictionaries and standards.

6.2 Policy for Developing JBMC2 Data and Meta Data Standards

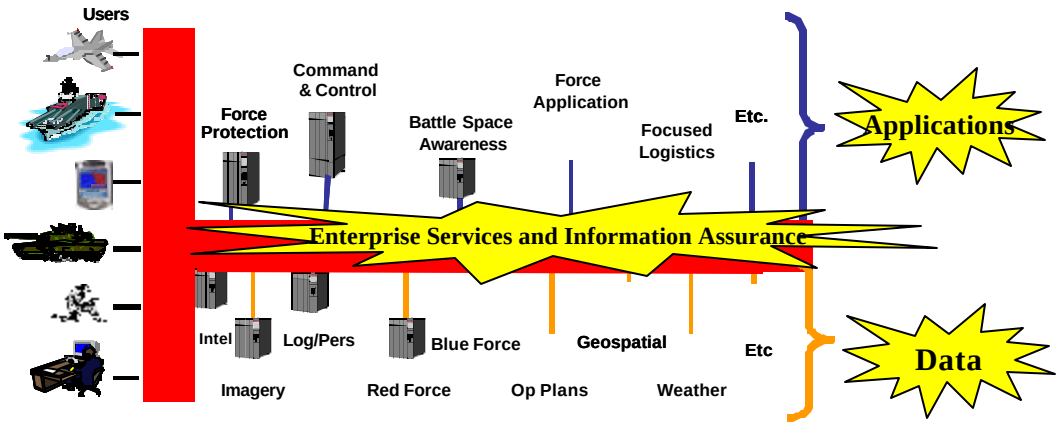
This section will describe a data strategy governance structure, to include a definition of a process for providing data strategy guidance and requirements to program managers. Note that the FIOP initiative will be given the overall JBMC2 data coordination and oversight task, and will ensure that emerging JBMC2 COI data models are consistent with NII guidance. FIOP will also develop additional JBMC2 COI data models not covered by SIAP, SIGP, FORCEnet Maritime Picture, SOFP, or SISP. In accordance with NII guidance, the section will also provide policy that supports users in obtaining the data they need. This will include

policy for posting, tagging, securing, and retrieving data. It will also include policy for storing data in commonly interpretable formats. Finally, the section will consider policy for the technical implementation of the DoD-wide and COI ontologies and corresponding data dictionaries, as described above.

7. Net-Centric Underpinnings to JBMC2

"Netcentricity" is the Department of Defense strategy for global, secure, web-enabled, user-driven information sharing that enables all users to post data; to discover, pull, and use data posted by others; and to collaborate. The strategy is designed to support all DoD users of information: warfighters, business people, and members of the intelligence community.

7.1 Net-Centric Underpinnings



- **Network Connectivity:** Transport infrastructure interconnecting all users
- **Enterprise Services**: Services that provide basic computing capabilities across the enterprise
- **Data:** Entity composed of data, sets of data, records, output files, databases, documents, or web pages
- **Information Assurance:** Information integrity, availability, confidentiality, non-repudiation, and authentication
- **Applications:** Specific program to post, process, exploit, exchange and display data

Figure 7.1 – Net-Centric Underpinnings

Department of Defense conformation environments can be divided into the elements shown above in Figure 7.1. The goal of Net-centricity is to enable all users, especially those at the edge, to exploit the robust transport, computing power, data richness, and a variety of information technology services to perform their mission. The goal of NII programs is to enhance network connectivity using robust transport infrastructure and internet protocol to make all data accessible and eliminate stove-pipe circuit-based communities. NII is developing Net-Centric Enterprise Services (NCES) to provide common computing capability and discovery techniques for finding and retrieving data and converting it to information for the user. NII is also developing data registration tools and repositioning to advertise and register data so that

applications can find pertinent information, understand the format, and then be utilized. NII is developing an Information Assurance architecture to provide protection of the data and identification of the user and his role to establish the need for data. NII is working to transform applications to use open architectures so they are executable by any user on the enterprise computing resources or replicated and executed at an operational site.

7.2 Key Milestones for Net-Centric Programs

High-level schedules and key milestones for the three of the four net-centric programs described in this section are depicted in Figure 7.2. The figure provides an overview of key NII Net-Centric initiatives. Each of these initiatives will be described in detail later in this briefing.

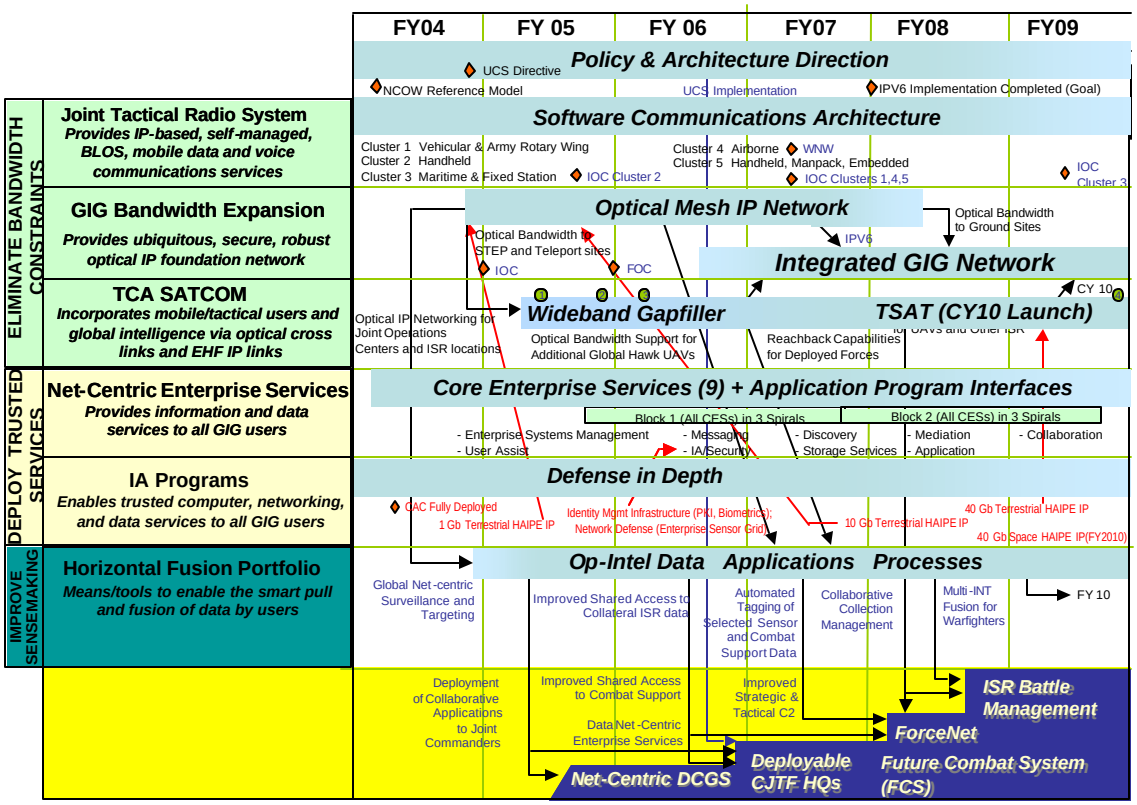


Figure 7.2 – A Roadmap of Key Net-Centric Initiatives

7.3 Joint Tactical Radio System (JTRS)

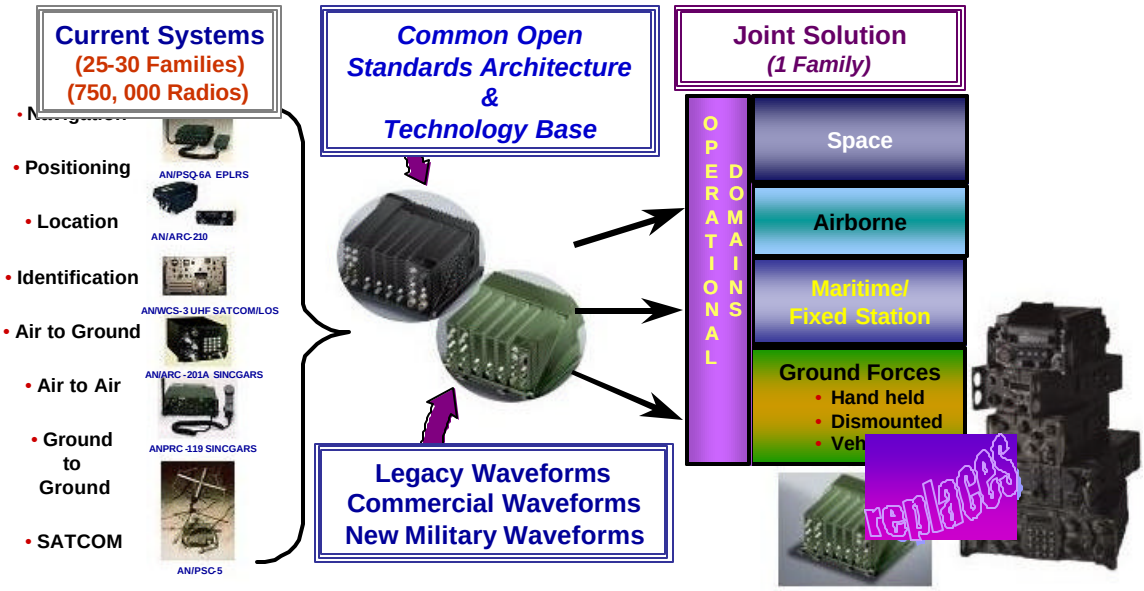


Figure 7.3 – Joint Tactical Radio System (JTRS)

JTRS provides a family of SW programmable radios to enable Network Centric Warfare. The United States Department of Defense currently has about twenty-five to thirty different families of radios and approximately 750,000 radios. They are used for many purposes such as navigation, communications between air and ground, between air and air, between ground units, and using satellite as a relay.

The JTRS design is based on a common open architecture for these new computer radios. With a common open architecture, waveforms can be developed as a computer program separate from the computer or radio. Legacy radio waveforms, commercial waveforms, or even new military waveforms can be loaded similar to computer programs onto a computer. That way, a single family of radios based upon a common architecture can meet the needs of ground forces, maritime forces, airborne or space based systems. JTRS is a family of common computer radios and waveforms built around a standard open architecture.

The JTRS SCA enables waveforms to be stored as software with the ability to reconfigure. It is modular, scaleable, and possesses a flexible form factor. It can be tailored for specific platforms and user needs. JTRS SCA also allows for increased interoperability (ultimate solution), technology insertion, and spiral development. It eliminates duplicative radio development efforts and multiple legacy radio systems by consolidating requirements within functional domains, and enables connectivity to allied/coalition, civil and national authorities.

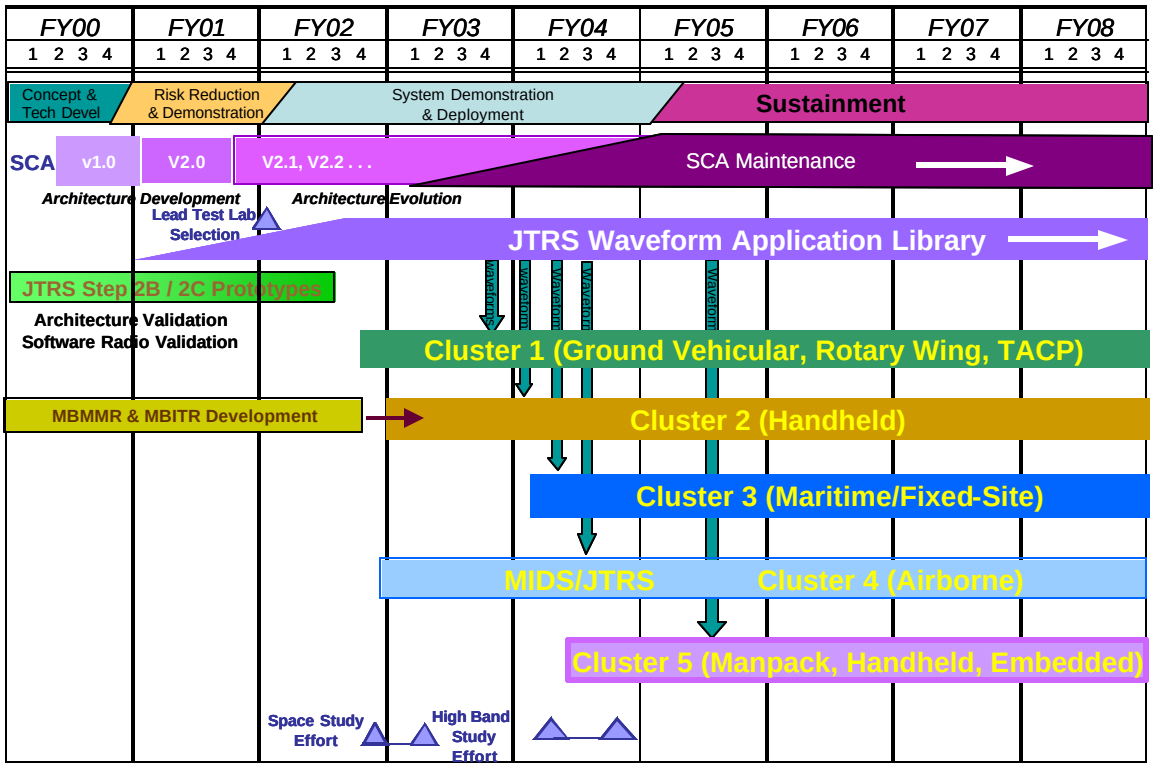


Figure 7.4 – JTRS Program Schedule

Figure 7.4 shows how each of the JTRS cluster programs work together. The JTRS program will develop a family of radios with different power, weight, and volume attributes, but have common joint waveforms. Their radio systems are called clusters. Dates are listed across the top with the next line showing the typical program development phases. The SCA line shows it is evolving and will continue to be upgraded as new technology is introduced. NII's Joint Program Office will own the waveforms for the Department of Defense, and make them available to the military. Each cluster will acquire radios for all military services for a specific area. As new requirements are identified, new clusters will be formed. Figure 7.5 shows a more detailed schedule for JTRS, which incorporates known program milestones and test events.

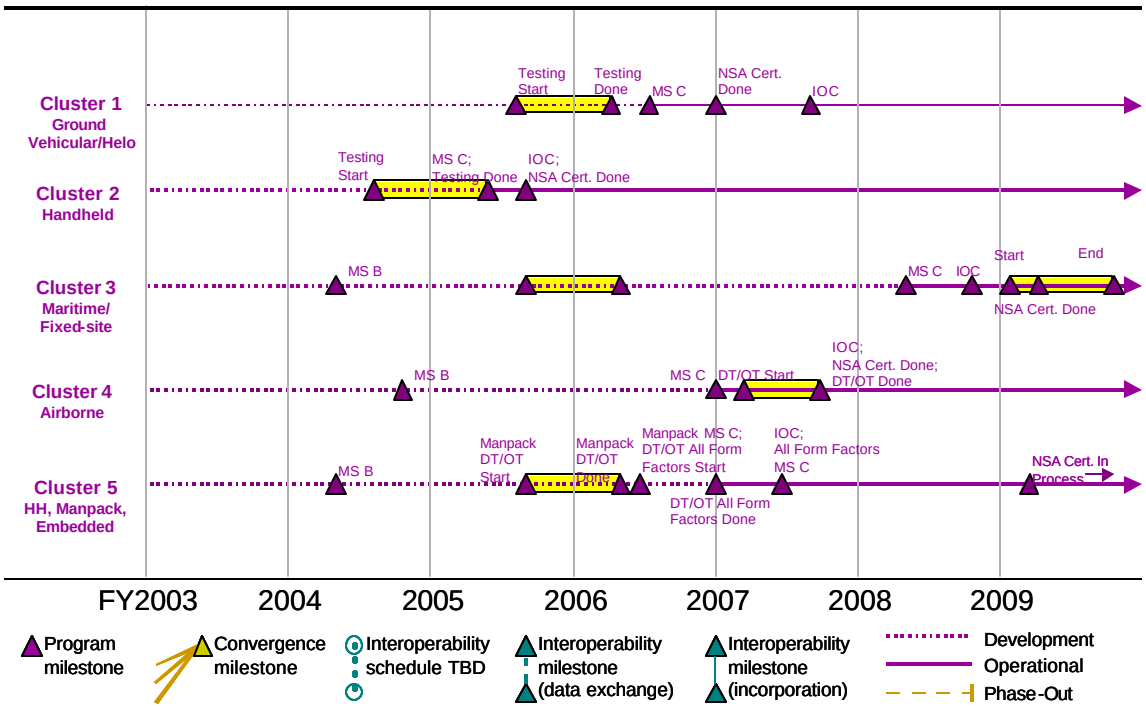
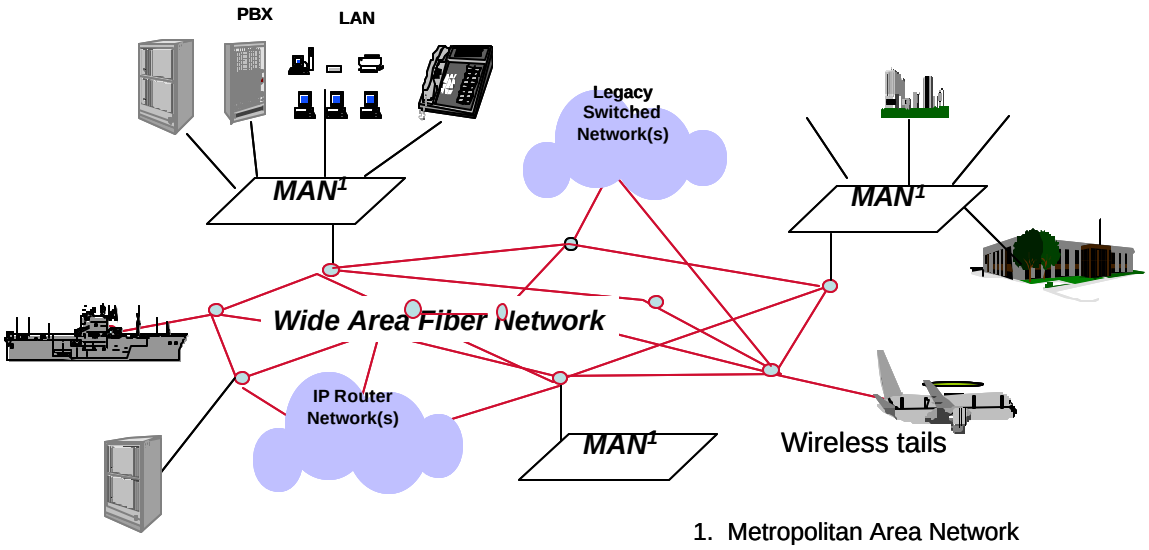


Figure 7.5—Detailed JTRS Program Schedule

7.4 Global Information Grid Bandwidth Expansion



Provides ubiquitous, secure, robust optical Wide Area Network Internet Protocol (IP) foundation network

Figure 7.6 – GIG Bandwidth Expansion

The Global Information Grid Bandwidth Expansion (GIG-BE) program will provide increasing bandwidth to OC-192 levels on a Wide Area Network. A problem today is that network access bandwidth is often the chokepoint. GIG-BE addresses this problem. Requirements for increased bandwidth include the need to: make large amounts of data quickly available (e.g., ISR data), access/fuse data in near real time (e.g., situational awareness), support Service/Agency transformation efforts (e.g., enterprise computing), and to support bandwidth-intensive applications such as collaboration and reachback.

The GIG-BE program will provide diverse physical access to the network. A problem today is that network access (from the point of presence at the base to the WAN/MAN access point) often has single points of failure. GIG-BE will provide better physical network access diversity that will enhance survivability and availability; the enhanced survivability will ensure connectivity of locations with time critical functions by minimizing vulnerability to intentional/accidental disruptions (e.g., physical attack), while the enhanced availability will ensure there is non-critical single point of failure (e.g., multiple nodes, diverse fiber routes, dynamic alternate routing).

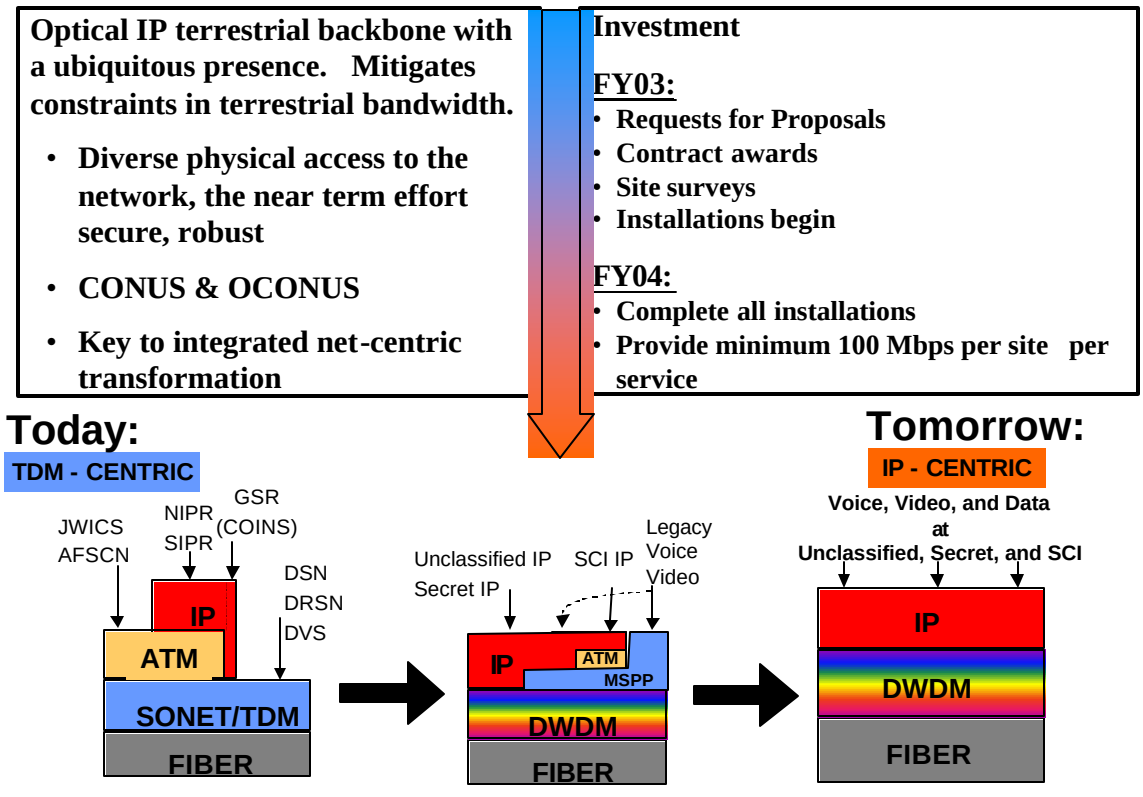


Figure 7.7 – GIG Internet Protocol (IP) Convergence

GIG-BE will be transitioned to support existing "legacy" customer interfaces while transforming communications to meet high-end requirements. Legacy services continuing in the near-term include voice (DSN, DRSN), data (SIPRnet, NIPRnet, JWICS), and video (DVS). GIG-BE initial implementation does not fundamentally change the existing ways that DoD users access the DISN; service delivery will remain consistent for voice, data, video, and transport. As new, more bandwidth-intensive capabilities are developed and required by GIG users, WAN service delivery will be adapted appropriately. This will be done consistent with horizontal fusion vision, for example, by the introduction of Dense Wavelength Division Multiplexing (DWDM). This will require user coordination to identify requirements and timing for transition to DWDM. NII will employ a dominantly optical design (80%+) with primary implementation in CONUS and Europe. Exceptions to full optical design will be based on availability and affordability of fiber. NII will satisfy these user needs through combination of wavelength and bandwidth services. NII will use GIG bandwidth investment to stay within the envelope of DWCF money outside of CONUS.

Figure 7.8 shows key milestones for the GIG Information Assurance Portfolio (GIAP), while Figure 7.9 describes the objectives of GIAP programs and initiatives.

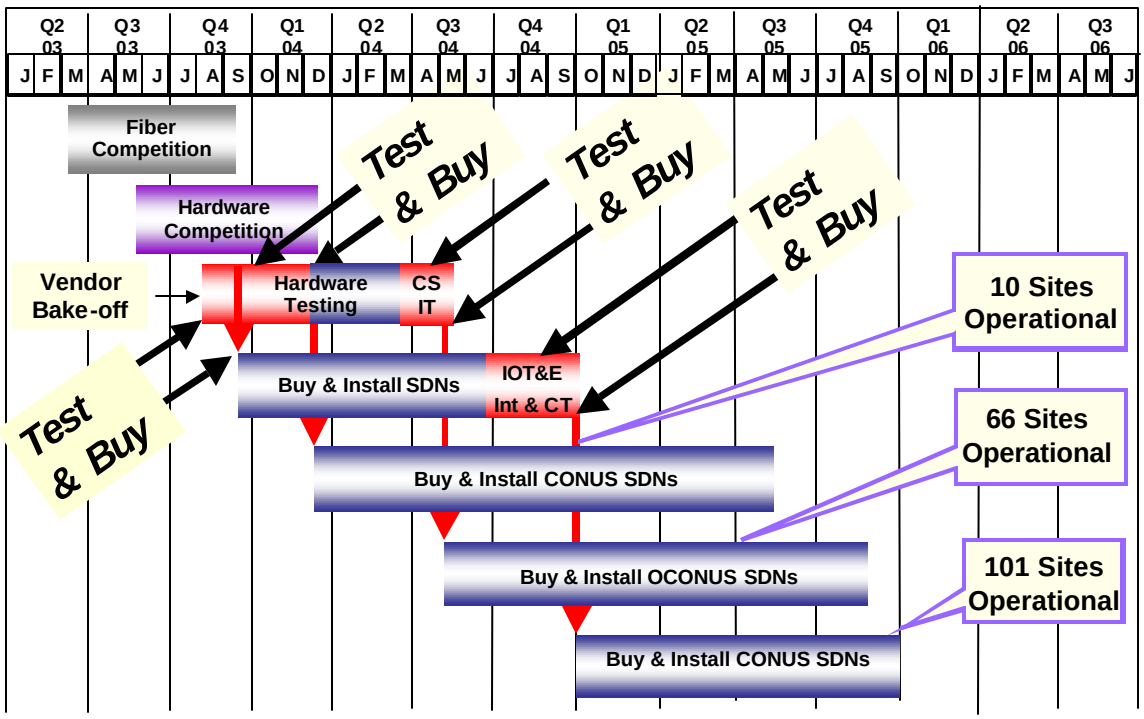


Figure 7.8 – GIG Information Assurance Portfolio (GIAP)

IA in GIG Architecture	GIG reference architecture to ensure the end-to-end integration and interoperability of IA across all GIG networks, systems, services and applications. CND Baseline and To Be Architectures. IA Core Enterprise Servcie Architectures.
High Speed Encryption	Incremental evolution of high speed encryption capabilities to match increasing data rates for weapon and communication platforms. Very fast encryption for IP and optical networks that are fixed terrestrial, tactical and aerial, and space-borne. Target capability: -- 40Gbps Ethernet encryption for terrestrial networks in FY09 to maintain QoS, multiprotocol label switching (MPLS), cacheing, security, and server load balancing at very high speeds. -- 10Gbps optical transport networks in FY06 and 40Gbps in FY10 for backbone communications. -- If funding is made available, will provide 10Gbps IP encryption for satellite transmissions in FY08, and 10-40Gpbs IP encryption for aerial and tactical platforms in FY09/10.
NCES	Incremental evolution of enterprise IA/security services to include: -- globally recognized digital identities for each GIG entity, to include devices, individuals, and software objects, that persist throughout the life of the entity -- securely bound data tags that include information about classification, releasability, and handling caveats -- dynamic information access and resource allocation based on the rules and privileges associated with the identities and data tags -- Assured sharing across security domain boundaries / ability to access multiple security domains from a single level.
Defense	Incremental evolution of global network defense to include: -- consolidation of command and control under USSTRATCOM -- automated IAVA management -- separate network segments (DMZs) for high risk network traffic -- integrated network monitoring and detection both at selected gateways and throughout the internal networks
Corps of IA Professionals	Ability to identity IA positions and IA skills in DoD civilian and military personnel systems. Systematic establishment and achievement of baseline standards of training and certification for IA workforce. The commercial certification requirement will ensure a baseline level of knowledge across the DoD IA workforce commensurate with one's level of responsibility. This includes DoD military, civilians, and contractors. FY05 – Identify IA workforce positions across DoD; FY06 - Assess DoD Schoolshouses and ensure training and skills certifications programs are on target; FY06 – 33% of personnel certified; FY07 – 66% certified; FY08 – 100% certified; FY09-11 -- Recertify 1/3 per year.
Research	Identification and resolution of IA "Hard Problems" through government and industry sponsored research.

Figure 7.9 – GIG Objectives

7.5 Transformational Satellite Communications

History has shown the migration toward an ever-increasing demand for SATCOM connectivity. The concept behind Transformational SATCOM was to reevaluate the satellite communications programs and determine if there is a more effective and efficient way to provide service to the global warfighter.

The approach with the most beneficial return was the migration toward an IP-based solution and the use of technology improvements in waveforms and space qualified communications elements, such as routers, speed packet encryption and laser crosslinks to answer the growing capacity requirements. This approach piggy backs on commercial investments and extends capability in areas needed for warfighting, such as Classified Information Transport and Protected RF links.

With all users having an individual IP address, Communities of Interest can be easily created and changed to reflect the need to synchronize forces independent of geographic location.

Some major Net-Centric capabilities are the "Black Core" dynamic routing capability, IPv6 implementation, Software Communications Architecture compliance for all terminals and Communications On The Move (COTM) for terrestrial forces.

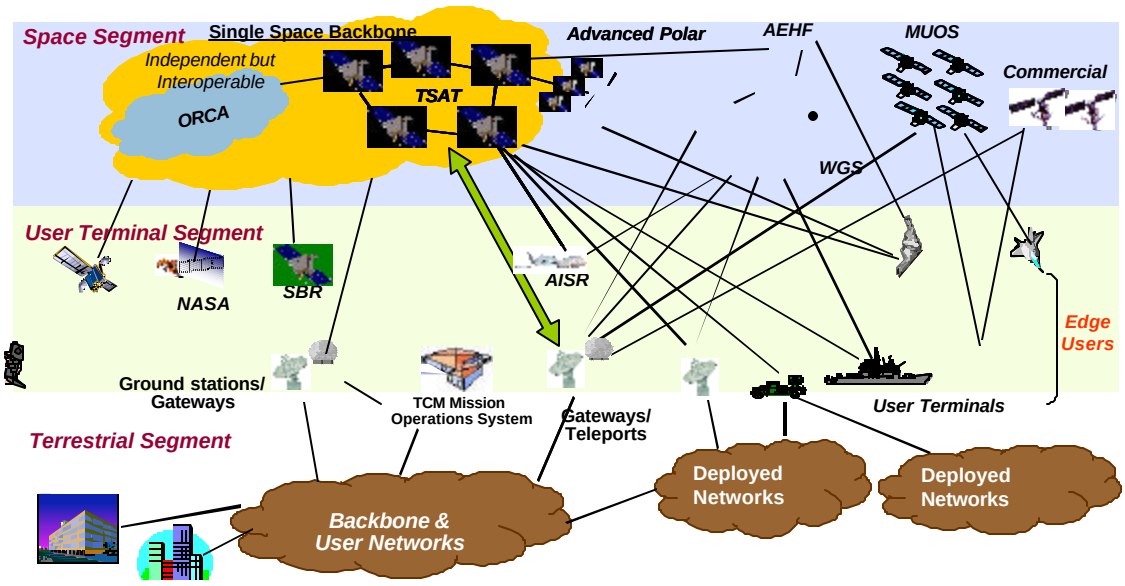


Figure 7.10 TCM (TSAT/APS) Architecture (2015)

This chart shows the Transformational Communications Military Satellite Command's (TCM) APS/TSAT constellation in 2015 as a central component to warfighter operations. (APS is the Advanced Polar System; TSAT is the Transformational Satellite.) It provides the narrowband, wideband and protected communications services with the infrastructure standards and agreements to implement a fully networked interoperable connectivity between all users.

The vastly improved capacity will help provide the Quality of Service and prioritization to support voice, video and data services seamlessly whether users are connected to terrestrial, wireless or SATCOM elements of the architecture.

The ability to quickly organize networks for Communities of Interest also assists in supporting the COTM capability that the terrestrial warfighters have desired for many years.

This program also represents a link between other key elements of the government who are involved with space programs. Through appropriate arrangements a synergy of effort is allowing the crossfeed of technology and sharing of capability.

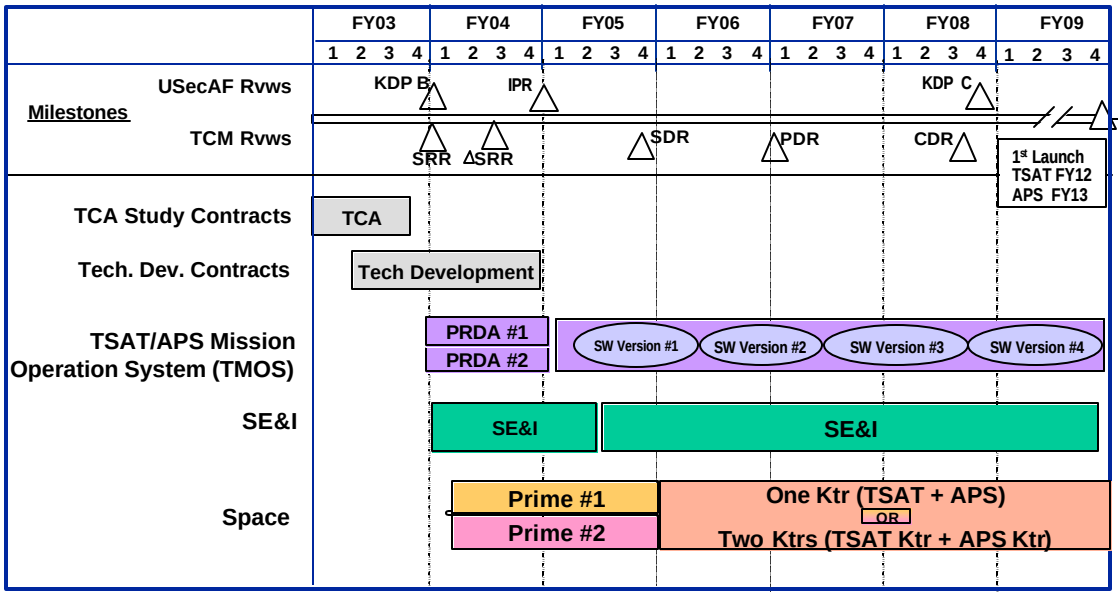


Figure 7.11 – TCM (TSAT/APS) Acquisition Schedule

Under the current schedule, the first TSAT will be launched in the fall of 2011 (FY12) with the first Advanced Polar Satellite launch scheduled for FY13. The Under Secretary of the Air Force is currently conducting reviews in support of making a KDP B decision this quarter.

Substantial funds were approved by Congress to initiate a number of key contracts in FY04. These contracts involve separate competition for Mission Operation System, System Engineering and Integration, and Satellite procurement.

While these efforts are on-going major pieces of the TCA are being launched:

- Advanced EHF Satellite – MAR 07, MAR 08 and APR 09
- Wideband Gapfiller Satellite – FEB 05, AUG 05, MAR 06, FY09 & FY10
- Mobile User Objective System – FY09, FY10, FY11, FY12, & FY13.

7.6 Net-Centric Enterprise Services (NCES)

Enables rapid exploitation of diverse data sources by GIG users in a manner that can be customized to meet specific mission demands

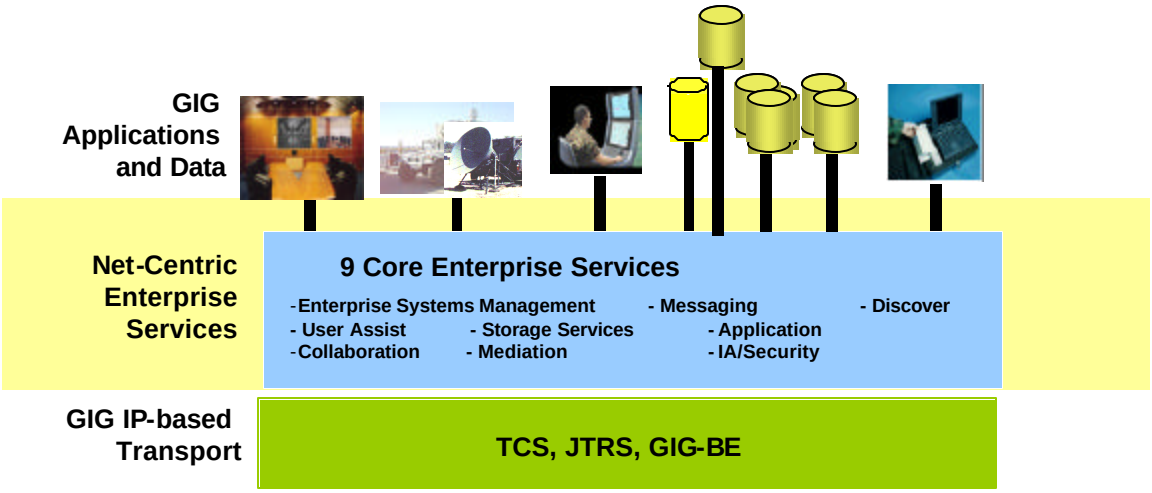


Figure 7.12 – Net-Centric Enterprise Services (NCES)

The Net-Centric Enterprise Services (NCES) Program aims to develop and deploy a suite of Core Enterprise Services (CESs) to provide GIG users and GIG applications common computing capabilities and capabilities-based service infrastructure for ubiquitous access to timely, secure, decision quality information. The CESs will enable information providers to post any information they hold, and enable edge users to rapidly and precisely discover and pull information resources and dynamically form collaborative groups for problem solving. The CESs will also provide security for, and coordinated management of, netted information resources. To support a global DOD net-centric environment, enterprise users will integrate NCES capabilities into their daily mission operations. This includes the integration of CES capabilities into applications and systems as well as architecting data systems to build upon the CES to create additional enterprise capabilities.

The goal of the NCES Program is to enable the widespread deployment of high-value enterprise services that allow data and services to be discovered and securely accessed throughout the DoD and mission partners. This increased use of networked data capabilities requires a ubiquitous, high-speed, dependable communications infrastructure. Accordingly, the NCES CESs will be deployed on the GIG and will leverage the expanded bandwidth and network availability provided by TCS, JTRS, and GIG-BE activities.

7.7 Net-Centric Data Strategy

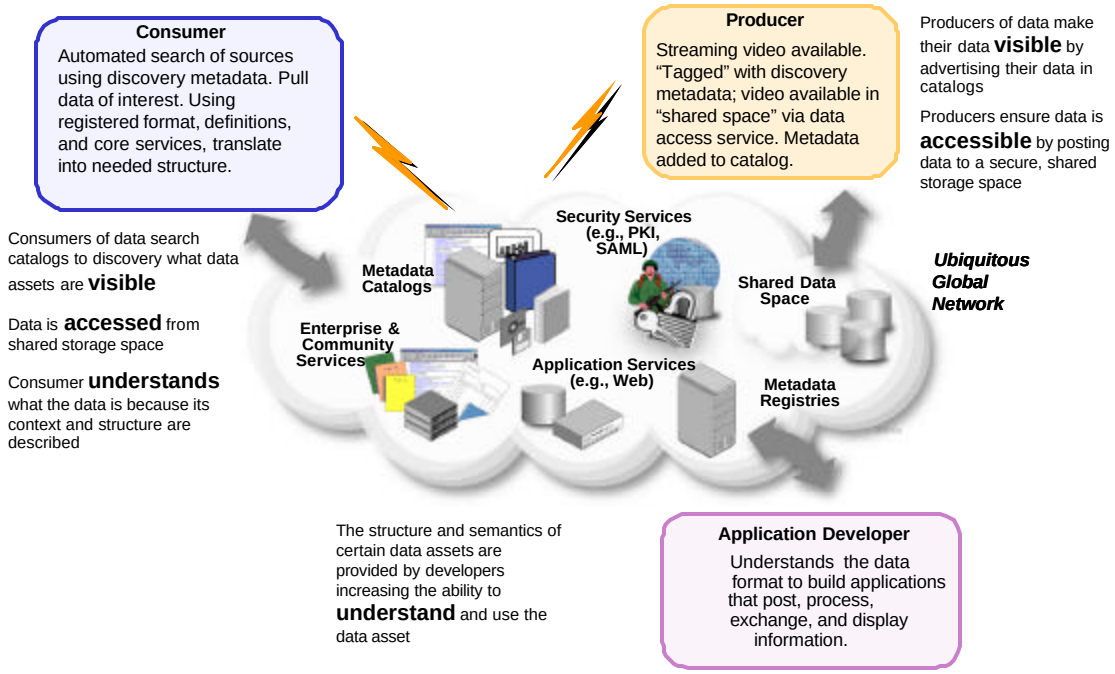


Figure 7.13 – Net-Centric Data Strategy

The Net-Centric Data Strategy (signed out on May 9, 2003) describes the DoD CIOs vision, goals, and objectives for providing a robust data environment to support Net-Centric operations throughout the various DoD missions.

This strategy is driven by the goals of net-centricity such as empowering users through increased access to data, and faster availability of data as a result of posting before processing. The strategy builds on related net-centric efforts involving bandwidth enhancements, and the development of services and capabilities to exploit data.

Key to the success of the Net-Centric Data Strategy is the institutionalized process of describing data assets through the use of "tagging with metadata". As data assets are tagged, they are quickly entered into data catalogs and posted to shared network storage locations. Cataloging and posting data to searchable, shared locations allow any GIG-user with the ability to discover what data assets are available to support their specific decision making and analysis requirements. As users (both human and automated systems) discover the data they need, they can make high-value use of the data through a detailed understanding (both contextually and structurally) provided by the 'metadata tags'.

To facilitate interoperability, the Net-Centric Data Strategy asks that manageable, well-scoped communities of interest (COIs) define the semantic and structural 'standards' to be applied to their data assets. This promotes consistency in representation and meaning for data that is exchanged within COIs. Additionally, COIs enter their definitions and format standards into a catalog that provides visibility for others (outside of the COI) to understand the meaning and structure of their data. As COIs define their semantic and structural standards, the Net-

Centric Data Strategy details the importance of ensuring that each stakeholder has input into the definition process (including the target end-users, developers, architects, etc). Accordingly, all data produced within COIs should be described with metadata tags, entered into searchable catalogs, and posted to easily accessible, secure network storage locations.

7.8 Horizontal Fusion

Horizontal Fusion (HF) ensures that warfighters and analysts have timely and assured access to critical data and the leading edge capabilities to make sense of that data

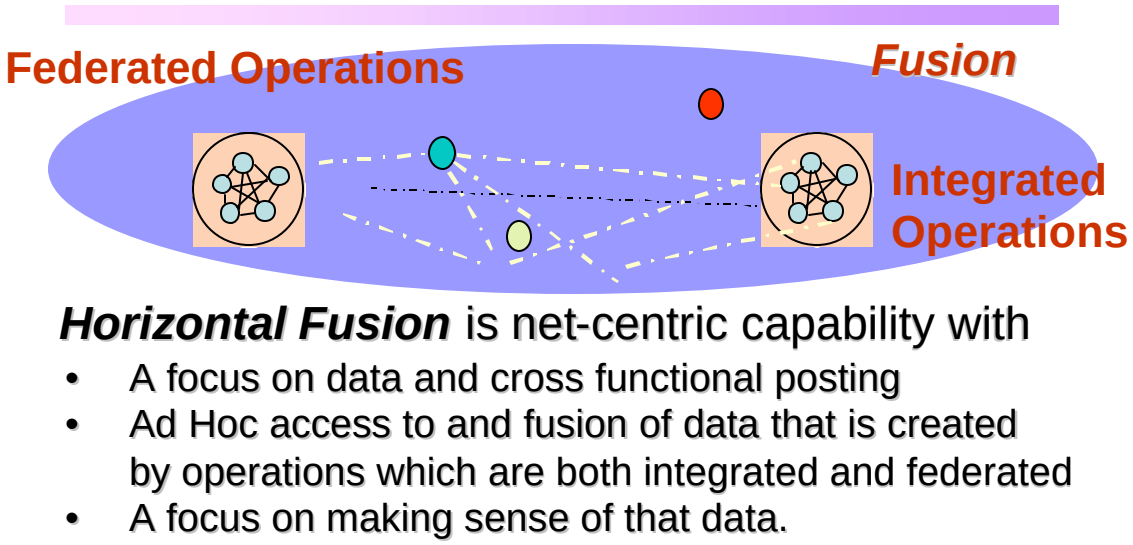


Figure 7.14 – Horizontal Fusion

Horizontal Fusion is a new initiative sponsored by the Department of Defense Chief Information Officer. It is a critical element in Secretary of Defense Donald Rumsfeld's vision of force transformation -- to "think differently and develop the kinds of forces and capabilities that can adapt quickly to new challenges and to unexpected circumstances." An important factor in force transformation is "Power to the Edge" – equipping warfighters across the entire battlespace with the ability to access needed information at the right time to make the right decisions. "Power to the Edge" means making information available on a network that people can depend on and trust, populating the network with new, dynamic sources of information to defeat the enemy while denying the enemy advantages and exploiting their weaknesses.

Achieving "Power to the Edge" means achieving net-centricity. Net-Centricity is a global, web-enabled environment that leverages existing and emerging technologies. It assures user-focused information sharing, information fusion, sense making (of complex and ambiguous situations) and decision making across the battle-space. Net-Centricity makes it possible to move beyond traditional communities of interest such as command and control or intelligence, to full information exchange across the battlespace.

To support Net-Centricity, Horizontal Fusion provides Net-Centric applications and content needed to provide analysts and warfighters the ability to make sense of complex and ambiguous situations. Horizontal Fusion is the user-oriented catalyst for net-centric transformation of the Department. It will provide real-time situational awareness across the battle chain, sense-making tools, collaboration among multiple communities of interest and critical intelligence information sharing.

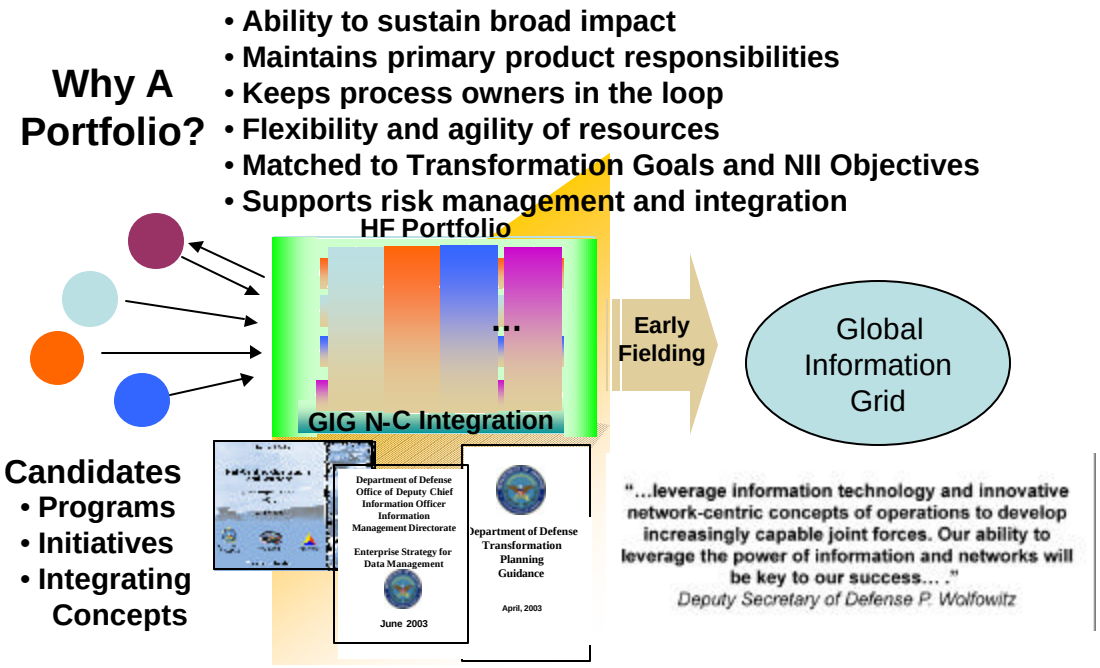


Figure 7.15 – Horizontal Fusion's Portfolio Concept

Horizontal Fusion is not a single program, but a portfolio of net-centric initiatives. Using a common architecture and integration process, these initiatives are woven into an information tapestry called the Collateral Space, which is accessed via a portal. The portal's main characteristic is that users can control and tailor the pull and portrayal of information. Users are able to broadly search or set preferences and subscribe to military operations and intelligence information that support their mission.

The 2003 Horizontal Fusion Quantum Leap-1 (QL-1) effects-based assessment and demonstration involves warriors at the edge of the network who can tap various communities of interest and achieve the speed of command and performance improvement needed to neutralize a time-critical target. The scenario for QL-1 was chosen to assess the value of the Collateral Space as the warriors' ready source of situational awareness in a net-centric environment. All capabilities successfully demonstrated remain in place and available for operational use.

Horizontal Fusion does not end with QL-1 – activities are programmed through 2008. In 2004, we will concentrate on expanding to other communities of interest with the Collateral Space and piloting additional enterprise services. Cross-domain information sharing and secure wireless communications are major investment areas. We will continue to add edge users and

data sources to the Collateral Space. Working with the Intelligence Community, we will demonstrate cross-domain information sharing and collaboration in QL–2.

As the Horizontal Fusion Initiative progresses, it will be collaborative and contributory to other transformational efforts such as the Office of Force Transformation, USSOCOM (focused on Force Transformation) and Joint Forces Command (focused on inter-service interoperability) as well as current and emerging efforts to transform warfighting and intelligence paradigms into 21st Century realities. The Horizontal Fusion portfolio will continue to provide value to the warfighters in several ways by: incorporating and tagging data from all sources and allowing it to be seen and used in innovative ways; providing sense-making tools to analyze and understand this diverse and immense data set; assuring that data pulled are qualitative, not quantitative; achieving rapid insertion of tools and capabilities that will implement net-centricity across the Department; and leveraging legacy investments while influencing future investments and introducing new technologies. With these activities, the overarching goal of Horizontal Fusion is to be the catalyst for net-centric transformation of the Department. It will support DoD and the Intelligence Community in accelerating efforts to achieve superiority in the transformed battlespace.

8. DOTMLPF Strategy for JBMC2

8.1 Introduction to DOTMLPF Strategy

An important catalyst for transforming military capability is the development joint concepts and supporting experimentation that account not only for materiel solutions but treat doctrine, organization, training, materiel, leadership, personnel, and facilities (DOTMLPF) considerations as well. As the JBMC2 operational concept and architecture are developed, consideration will be given to the impact of JBMC2 across the spectrum of DOTMLPF. An assessment of the required changes to Tactics, Techniques, and Procedures (TTP), doctrine, training and training pipelines, manning, and organization will accompany JBMC2 assessments in the form of Transformational Change Packages proposed under the JCIDS process. The change packages will address each element of DOTMLPF, describing impacts, including:

- Doctrine:
  - Does change require an update to, or a revision of, existing doctrine?
  - Which organization will be responsible for drafting changes?
- Organization:
- Will the current organization accommodate change, or will changes be required?
- Training:
  - What additional joint and individual training will be required?
  - When will the training need to be in place?
  - Which JNTC-sponsored exercises will be leveraged to develop training?
  - Which organizations will develop the training curriculum?
- Materiel:
  - Which JFCOM joint experimentation venues will be used to test the prototypes?
  - What are the alternative courses of action?
  - What bridging funding will be required if the systems are to transition to POMed programs?
  - What performance or capability enhancements are realized?
- Leadership:
  - Are any special leadership skill sets required?
  - Which JNTC sponsored exercises will be used to validate the skill sets?
- Personnel:
  - Are the service billet and manning structures sufficient to provide the required manpower?
  - What changes to manning plans will be required?
  - Can the Combatant Commander support the required manpower changes?
- Facilities:
  - What changes to the infrastructure will be required?
  - What are the costs associated with those changes?

8.2 The Path Ahead

The DOTMLPF strategy focuses on developing two distinct approaches as the result of a two-path strategy on which JFCOM bases its approach to innovation. The first approach consists of the prototypes that evolve from concept experimentation in concert with our partners. These prototypes are designed to improve near-term warfighting capabilities. The second approach consists of generation of actionable recommendations that result from collaborative experimentation with new concepts and capabilities that focus on the next decade. The second approach takes the form of Transformational Change Packages, which provide recommendations to guide the DOTMLPF strategy for a given capability.

To improve near-term warfighting capabilities, the campaign pursues a strategy of rapid prototyping, and this effort takes place along the joint prototype pathway. This strategy takes new ideas or concepts that originate on the joint concept development pathway and converts them into physical form, as prototypes. From there, these prototypes are put into the hands of joint warfighters as quickly as possible.

The prototype pathway began to take shape during and after Millennium Challenge 02 as combatant commanders saw the power of the Rapid, Decisive Operations body of concepts being explored in the experiment. As a result of this compelling demonstration, coupled with the need to field Standing Joint Force Headquarters by FY 2005, we have been aggressively partnering with regional combatant commanders. The sooner we take nearly completed concepts into the field and get them into the hands of the users in their own warfighting environments, the more quickly we can incorporate their feedback and make improvements. While commanders feel that a number of new concepts offer greater promise than current capabilities, they use them with the understanding that they are part of the continuing refinement process.

Concepts are generated along the joint concept development pathway through a series of experiments that span two years. In collaboration with our service, combatant commander, Joint Staff, defense agency, and multinational peers, we are exploring three major challenges and 18 specific areas of warfighting. As promising new ideas or concepts emerge, we begin to refine them through an experimentation process that involves testing hypotheses and demonstrating results. Concepts that meet certain requirements are eventually handed off to teams of specialists who convert them to prototypes. Based on how these concepts perform, we make recommendations to senior leaders that help them decide how to invest military resources in the next decade. Work performed on the joint concept development path is dedicated to making long-term improvements to military capability. The focus is on making next-decade improvements to joint warfighting.

In conjunction with the proposed operational concept, CONOPs, and architecture efforts, JFCOM will identify existing joint venues for opportunities to assess incremental JBMC2 nonmateriel capability improvements. As capability drops are determined, associated DOTMLPF needs will be specified and programmed for development to meet required training timelines. Appropriate organizations will be equipped, trained, and certified prior to participation to ensure assessment validity. Adjustments will be made based on lessons learned, and capabilities will be validated for fielding. JFCOM will have a comprehensive overarching outline of this approach for the February 2004 JBMC2 roadmap. The outline will be developed

based on an initial operational concept/CONOPs and architectural assessment and prioritization, as well as timing, of developing service and joint capabilities. Figure 6.1 shows the multiple, synchronized paths of tasks needed to bring about future JBMC2 capabilities.

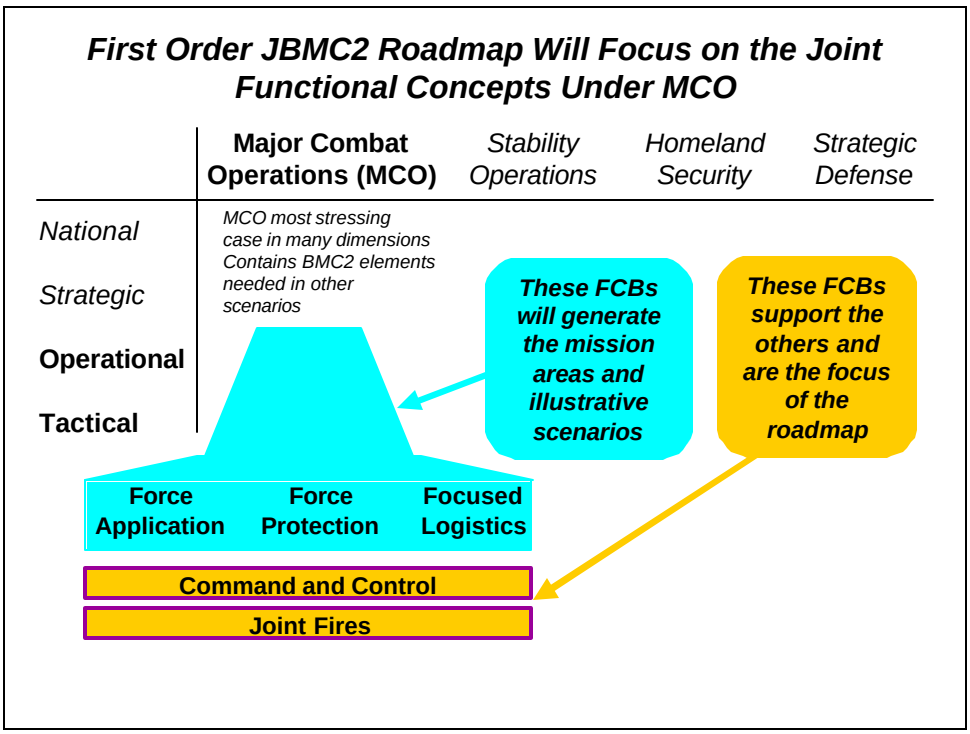


Figure 8.1—A Process for Synchronizing JBMC2

8.3 Joint Force Command and Control

Joint forces enabled with Joint Force Command and Control (JF C2) tailored situational awareness and networked communications will employ maneuver and fires throughout the depth of the battlespace to defeat adversary forces. JF C2 will provide improved warning of emerging crises, identify critical targets for effects-based campaigns, measure and monitor the progress of the campaign, and provide indicators of effectiveness. JF C2 reachback capabilities will exploit global expertise and information centers of excellence. Users' ability to rapidly access distributed, non-deploying information centers of excellence from the theater of operations reduces; the Joint Force's in-theater footprint, the demands on scarce transportation resources, and the protection and sustainment requirements while enhancing the overall agility of the force. JF C2 will provide the following C2 mission capabilities:

- Force Projection. Within deliberate and crisis planning: deployment/redeployment planning and execution, identification of forces and total assets, force movement; provision of personnel, logistic, sustainment, and other support required to execute military operations until assigned missions are accomplished

- Force Readiness. Assessing the readiness of the Department of Defense and its subordinate components to execute the National Military Strategy as assigned by the Secretary of Defense in the Defense Planning Guidance, Contingency Planning Guidance, Theater Security Cooperation Guidance and the Unified Command Plan. Assessing US forces' ability to undertake missions as assigned in peacetime and wartime.
- Intelligence. Joint Intelligence Preparation of the Battlefield (JIPB), targeting, Intelligence, Surveillance, and Reconnaissance (ISR) management
- Situational Awareness. Fused battlespace awareness tailored to provide current and projected disposition of BLUE/RED/GRAY forces through near real time (NRT)/real time (RT) sensor data and Service/Agency/joint-provided data sources
- Force Employment - Air and Space Operations. Transition from force-level planning to execution including C2 activities associated with management of air and space assets
- Force Employment - Joint Fires/Maneuver. Transition from force-level planning to execution including C2 activities associated with management of joint fires/maneuver assets
- Force Protection. Warning and planning required to minimize vulnerability of joint, multinational, and US organizations from enemy/terrorist threats. Activities include integrated air and missile defense, Homeland Security /Homeland Defense (HLS/HLD), consequence management, and related crisis response operations.

JF C2 will be employed through emerging concepts designed to streamline, standardize, and enhance command and control. As an example the Standing Joint Force Headquarters is an initiatives within JF C2 designed to reside, pre-crisis, within the RCC staff. It has a daily focus on warfighting readiness and is a fully integrated participant in the RCC staff's planning (both deliberate and crisis) and operations. The SJFHQ provides each RCC with a trained and equipped standing joint C2 capability specifically organized to conduct Operational Net Assessment (ONA) and Effects Based Planning (EBP). The concept is intended to reduce the historically *ad hoc* nature of establishing a joint force headquarters to meet an emerging requirement.

The SJFHQ will have the personnel, equipment, training, and procedural enhancements needed to become the core around which the staff of an RCC or a JTF commander can operate across the spectrum of operations, from daily routine through pre-crisis and crisis response. The SJFHQ will enable commanders to anticipate and respond to a national or regional security threat with a credible force that is directed by a highly flexible and robust C2 capability. Most importantly, it will be the catalyst of transformation of JF C2.

Primary tasks of JF C2 include:

- Support deliberate and crisis response EBP from pre-crisis through transition to peace
- Maintain day-to-day situation understanding within the focus area and awareness in the AOR

- Build operating relationships within the staff infrastructure of tools, procedures and people
- Build and maintain a comprehensive "systems" understanding of the battlespace through the ONA process and through collaboration with the J2 in management of Joint ISR assets
- Conduct internal training and support RCC training and exercises
- Build and maintain relationships within the Joint Interagency Coordinating Group (JIACG) and other Federal agencies, non-government agencies, and international and regional organizations
- Provide logistics incorporating the six tenets of focused logistics: Joint Theater Logistics Management, Joint Deployment/Rapid Distribution, Information Fusion, Multinational Logistics, Force Medical Protection, and Agile Infrastructure

Collaboration capability is crucial to the success of the SJFHQ concept. Like all capabilities, this depends not just on a materiel solution but also on DOTMLPF synchronization (i.e. SOPs, TTP, and training.)

8.3.1 Assessment of Current Programs and Plans

Current JFHQ C2 elements are manned by collateral duty personnel who are not fully dedicated to preparing for joint operations. Operating procedures vary between theaters and in some cases between individual HQs within a theater.

Current C2 systems are deficient in commonality, deployability and scalability, integration of applications, and interoperability between Joint and Service variants. Applications have limited Web-enabled capabilities, and do not provide an adequate CIE. In addition, current systems do not support the Joint Force Commander while enroute to the objective/operations area, causing a "leadership blackout" while in transit and during early stages of establishing the deployed headquarters.

The assessment is summarized in the mission thread timeline below, which displays the milestones and actions directed to achieve the capability objectives described above:

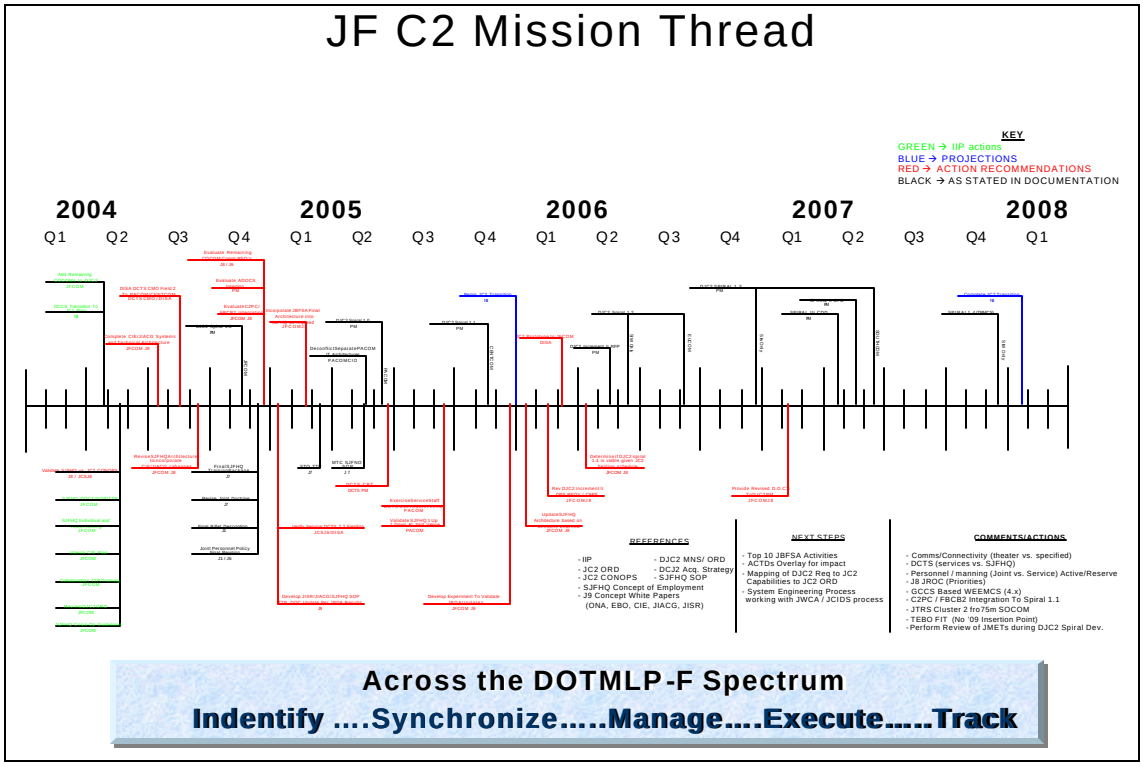


Figure 8.2—JF C2 Mission Thread

8.3.2 Joint Force C2 FY 04 Action Plan

FY 04-00 **JF C2 Fiscal Year 2004 (Actions FY04-01 through FY 04-10 have been previously assigned by the DoD Integrated Interoperability Plan of 01 October 2003, and are in progress)**

FY04-01 USJFCOM, in coordination with C/S/A, manage implementation of SJFHQ DOTMLPF change package approved by the JROC, first report due 01 March 2004.

FY 04-02 USJFCOM, in coordination with C/S, develop the doctrine and standard operating procedures/TTPs for SJFHQ, to include the intelligence support component by 01 March 2004.

FY 04-03 USJFCOM, in coordination with C/S, develop and conduct individual and team training for the SJFHQ by 01 March 2004.

FY 04-04 USJFCOM, in coordination with C/S, finalize the plan to provide an interim CIE, to include collaboration software, hardware, and procedures, with initial standup of SJFHQs by 01 March 2004.

FY 04-05	USJFCOM, in coordination with C/S, lead development of collaboration TTP and training, and incorporate into the SJFHQ concept by 01 March 2004.
FY 04-06	USJFCOM, in coordination with COCOMs, DISA, and ASD (NII), lead effort to improve multi-national information sharing and provide action plan to the Secretary of Defense by 1 March 2004.
FY 04-07	US Navy, in coordination with C/S, DISA, and DIA, ensure SJFHQ requirements, including information interoperability needs, are reflected in the DJC2 ORD and in system development by 01 March 2004.
FY 04-08	USJFCOM, in coordination with C/S/A, develop plan to incorporate SOCOM, STRATCOM, TRANSCOM, and NORTHCOM capability needs in the SJFHQ and DJC2 requirements documents by 01 March 2004.
FY 04-09	USJFCOM, in coordination with C/S/A, include guidelines for integration of SJFHQ concept into existing staffs, before and during crisis operations, in the SJFHQ CONOPS by 01 March 2004.
FY 04-10	USJFCOM utilize the Joint Concept Development and Experimentation process to ensure a tight coupling between training and interoperability and integration, to support the desired end state by 01 March 2004.
FY04-11	USJFCOM, in coordination with the UCCs, develop a plan to incorporate additional communications requirements imposed on SJFHQ in order to respond to JROCM 167-03 direction to add NORTHCOM, SOCOM, TRANSCOM, and STRATCOM to fielding by 30 Sep 2004.
FY 04-12	USJFCOM J8, in coordination with the UCCs, USA, and USMC, evaluate the progress made towards the development of the Ground portion of the Common Operating Picture through the USA lead FBCB2/C2PC integration effort. If the effort proves successful, provide a plan, no later than 30 Sep 2004, for incorporation of the capability into SJFHQ.
FY 04-13	USJFCOM J8, in coordination with FIOP, evaluate the potential for migrating the Automated Deep Operations Coordination System (ADOCS) functionality into DJC2 Spiral 1.1, vice waiting for FIOP Web Enabled Employment Management Capability in Spiral 1.2. If feasible, develop funding and fielding plan as a change to DJC2 baseline by 15 Sep 2004.
FY 04-15	USJFCOM completes the systems and technical architectures for CIE and JIACG initiatives in order to facilitate incorporation of those capabilities into the JF C2. The architecture shall be completed no later than 01 June 2004.

FY 04-16 USJFCOM revise SJFHQ architecture to incorporate updates to the CIE and JIACG architectures no later than 15 Sep 04.

FY 04-17 USJFCOM, in coordination with ALSA and RCCs, revise the SOP, TTP, and Doctrine to incorporate OIF LL and JBDA results no later than 30 Sep 04.

FY 04-18 Army, USMC, USSOCOM in coordination with USJFCOM submit plan by 30 June 2004 to migrate diverse systems to common, secure, low-cost system interoperable with GCCS/JC2 and tactical C2 systems; equip all ground units by 30 Sept 2006

FY 04-19 USJFCOM present latest updates to JF C2 timeline to JBMC2 BoD to validate inclusion of recommendations generated from the Joint Center for Lessons Learned semi-annually in the 2nd and 4th quarter

FY 04-20 USJFCOM, in coordination with RCCs, USSTRATCOM, and USD AT&L, develop alignment recommendations for incorporation of systems supporting the JF C2 Acquire Information activity (C2PC, TBMCS, Autodin, DSN/DSRN, Radiant Mercury) into the DOTMLP strategy no later than 30 March 2003. Recommendations will be aligned to the Joint C2 Architecture and Concept of Operations.

8.3.3 Joint Force C2 FY 05 Action Plan

FY 05-00 Joint Force C2 Fiscal Year 2005

FY05-01 DISA DCTS CMO, in coordination with ASD (NII), verify the Services are fielding DCTS 2.2 as directed. Coordinate with JFCOM to develop plan by 1st quarter FY 05 to address shortfalls in order to ensure SJFHQ CIE capability is fully functional when DJC2 Spiral 1.0 fielded to PACOM in the 2nd quarter of FY 05.

FY 05-02 USJFCOM, in coordination with C/S, develop the doctrine, TTP and standard operating procedures changes to SJFHQ that result from Joint Battle Damage Assessment analysis, to include the intelligence support component by 01 Nov 2004.

FY 05-03 DCTS Program office develops and field DCTS 2.2 computer based training designed to allow Service personnel assigned to organizations that will participate with SJFHQ CIE to rapidly learn to use system. DCTS CBT shall be initially available no later than 2nd quarter FY 05.

FY 05-04	USPACOM, in coordination with USJFCOM and Services, incorporate SJFHQ training event into appropriate Joint Training Exercise in 3rd quarter FY 05, following DJC2 Spiral 1.0 fielding to USPACOM.
FY 05-05	USPACOM, in coordination with USJFCOM and Services, provide assessment of the initial SJFHQ readiness, based on Joint Training Exercise results, along with recommendations for material and non-material updates needed to fully realize capability by 30 Sep 2005.
FY 05-06	***USJFCOM, in coordination with COCOMs, JCS J2, and USD(I), develops experimentation plan by 30 Sep 2005, the plan shall generate revised JBDA TTP and material requirements needed to incorporate appropriate JBDA recommendations into SJFHQ capability.***
FY 05-07	USJFCOM, in coordination with Army G8, determine need to incorporate JBFSA architecture into SJFHQ capability, and complete the revision to the SJFHQ and JF C2 architectures no later than 15 Nov 2004.
FY 05-08	USJFCOM, in coordination with RCCs and UCCs, develop FY 2008 target JF C2 architecture no later than 01 July 2005.

9. Experimentation and Technology for JBMC2

9.1 Advanced Concept Technology Demonstrations

Advanced Concept Technology Demonstrations (ACTDs) are a proven mechanism of rapidly developing new warfighting capabilities and potentially an important source of new and enhanced BMC2 capabilities. Current ACTDs have been mapped to the five functional capabilities areas identified by the Joint Staff. The JBMC2 roadmap will identify opportunities for including the outputs from ACTDs into JBMC2 test events. The DUSD (AS&C) is coordinating with the Functional Capabilities Boards (FCBs) to identify areas where ACTDs could lead to potentially important new JBCM2 capabilities. Currently, ACTD proposals are submitted by the Combatant Commanders, Services, Agencies, and industry to address joint capability shortfalls identified through operations, exercises, training or experimentation. The process and associated timeline for selecting ACTDs for FY2005 start is depicted in Figure 9.1.

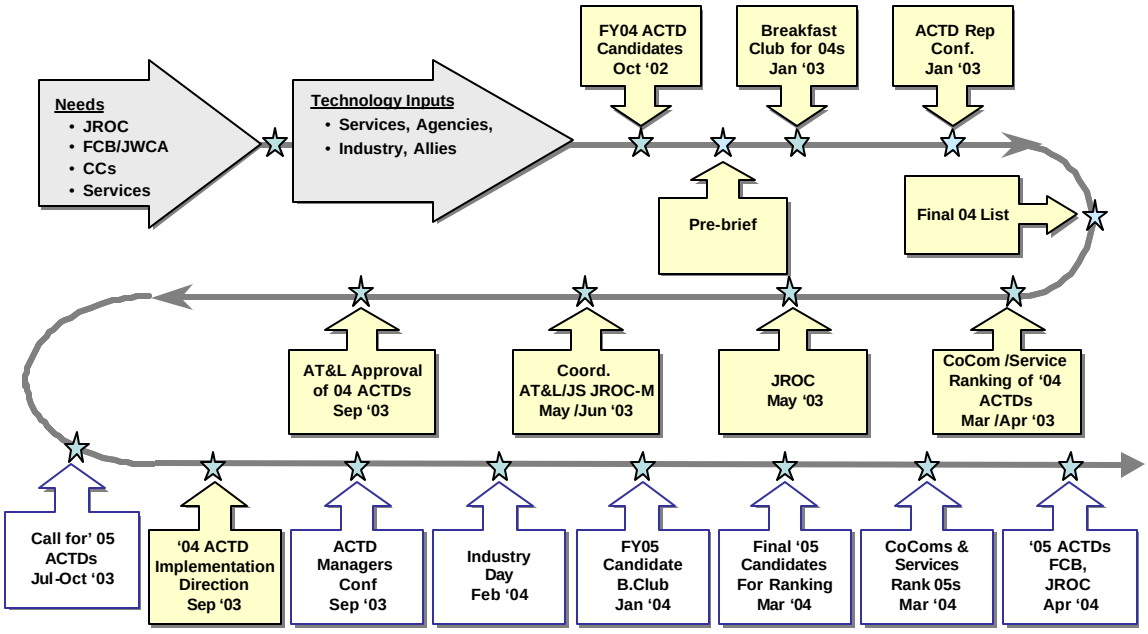


Figure 9.1—ACTD Selection Process and Timeline

The ACTD process is characterized by its flexibility and avoidance of excessive rigidity and formality. (See Figure 9.2)

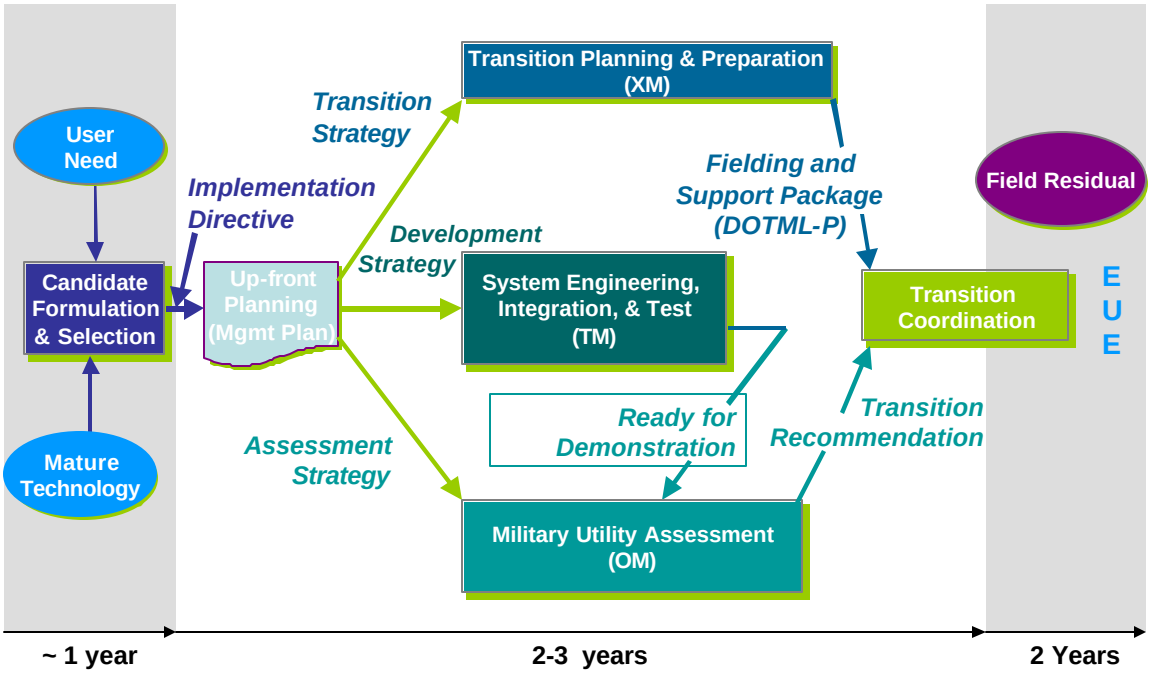


Figure 9.2—ACTD Process

The annual process starts early in the first quarter of each fiscal year (October) with selections taking place the following January. The Combatant Commanders, Services, Agencies, and Joint Staff participate in the selection process. Key attributes for selection include: significant, urgent military problem or need; credible technical solution(s); applicability to a joint environment; high potential for success; and operational or tactical user participation.

The process starts with a written proposal that provides a statement of the military problem, a concept for solving the problem and identification of the technology under consideration. The proposals are reviewed by operational and technology representatives from the Combatant Commanders, Services and Agencies. The Combatant Commanders and Services then provide independent prioritization that is consolidated and briefed through the Functional Capabilities Boards to the Joint Requirements Oversight Council (JROC). The process concludes with approval of the selected proposals by the USD (AT&L). The goals, resource commitments and timelines for each ACTD are then formally documented in an individual Implementation Directive coordinated at the three-star level (user sponsor (Combatant Commander or equivalent), lead Service Operations Deputy and Service Acquisition Executive) and approved by DUSD (AS&C). In about three pages, the Implementation Directive defines major objectives, the overall approach, the key participants, the top-level schedule, and funding profile and sources.

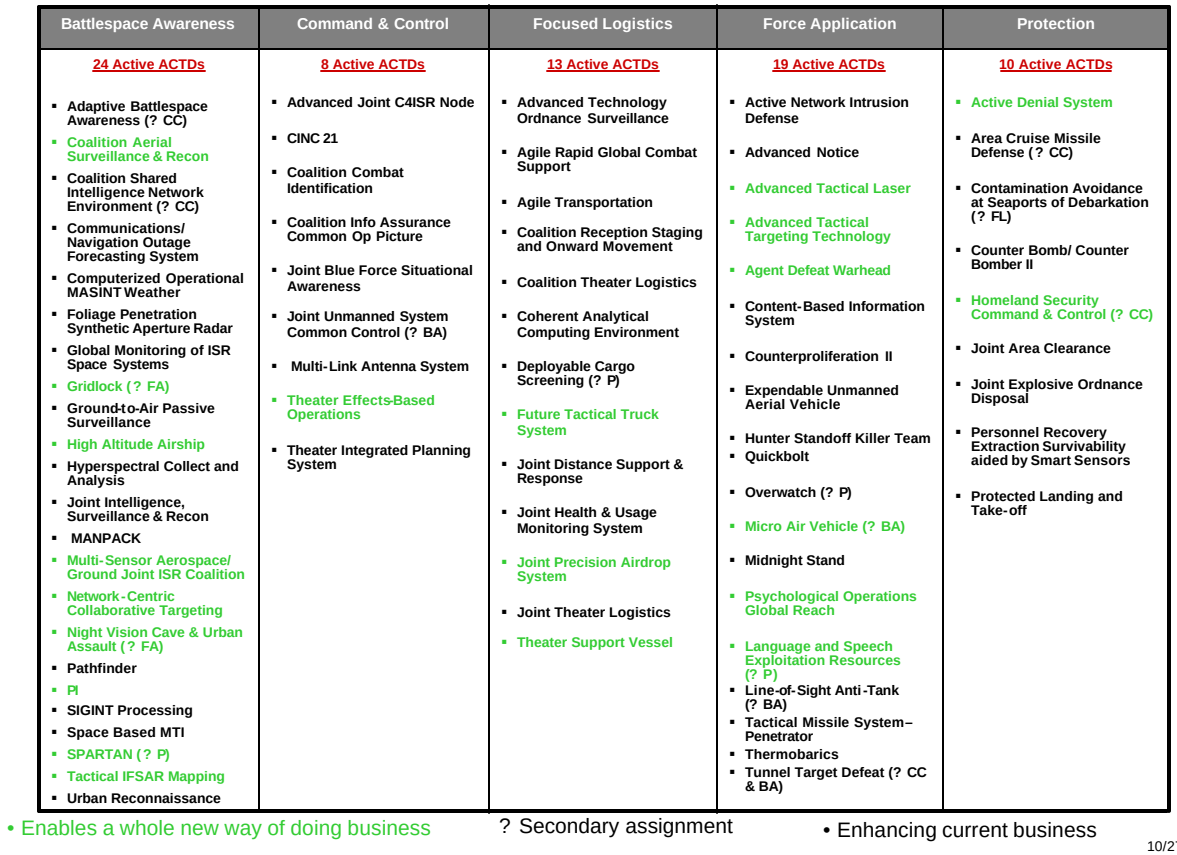
The Management Plan to implement the directive is due 90 days after the Implementation Directive is signed. While the Implementation Directive speaks to the "what," the Management Plan speaks to the "how." It serves as a management document for the Oversight Group and as a management tool for the Operational Manager (OM) who "owns" the user requirements input and plans the Military Utility Assessment, the Technical Manager

(TM) who executes the technology integration plan and delivers capability to the OM for assessment, and the Transition Manager (XM) who is responsible for coordination with the acquisition organizations for insertion of successfully demonstrated technologies into programs of record (PORs). The Management Plan presents a Development Strategy, Assessment Strategy, and Transition Strategy to guide efforts in those three lanes.

With respect to JBMC2, the goal of the ACTD process should be to produce and demonstrate significantly enhanced JBMC2 capabilities. While too late to directly affect the FY2005 ACTD selections, the February 2004 roadmap will contain more detailed process recommendations for future selection and shaping of ACTDs that may have the potential to provide enhanced JBMC2 capabilities. A few preliminary and general recommendations follow:

- The objectives of JBMC2 should be incorporated into appropriate ACTDs, which will help guide the development of ACTDs to maximize BMC2 capabilities.
- The process should consider the candidate ACTDs' interoperability properties. Ideally, the ACTD should be interoperable with relevant architectures and systems. Certainly, the ACTD should allow for interoperable implementations of demonstrated technology. The ACTDs in JBMC2 related areas are focused on joint problems, and necessarily address interoperability issues. The more critical issue for interoperability is strong operational sponsor engagement, careful technical implementation and early assessment planning to ensure interoperability is addressed.
- The BMC2 Board of Directors should have a role in reviewing related ACTDs. JFCOM should have a role in the systems engineering, integration, and testing (process block TM) of the ACTDs, as well. The organizations represented on the JBMC2 BoD are also represented at the FCBs and JROC. In addition, the early reviews of ACTD proposals by Combatant Commanders, Services and Agencies for operational problem, technology maturity and possible duplication or overlap serve to address appropriate selection inputs. Where the JBMC2 BoD can have the largest influence is in assisting to coordinate the interim demonstrations and military utility assessments with JBMC2 interoperability test events.
- Finally, the process should assist in the development of ACTD transition plans. These plans should seek to make the transition from ACTD to POR as smooth as possible. Consequently, the plans should consider the ramifications to the BMC2 architecture if an ACTD is adopted, including considering what sorts of changes might be necessary (both desirable and undesirable) should the ACTD be implemented. DUSD (AS&C) has mandated each ACTD selected for execution have an identified Transition Manager (XM) at ACTD approval. The XM has the authority and responsibility to coordinate with the activities and organizations that are targeted for integration of successfully demonstrated ACTD output products. In some cases, DOT_LPF change inputs have potentially greater impact than the insertion of specific hardware or software solutions. The JBMC2 process should identify methods and opportunities to assist the successful integration of ACTD output into in JBMC2 capabilities.

Figure 7.3 shows the ACTDs ongoing or recently completed as of this writing, mapped to their corresponding Functional Capabilities Area. ACTDs shown in green are designed to enable entirely "new ways of doing business," while ACTDs shown in black are designed to enhance "existing ways of doing business." The roadmap will consider which of these are related to JBMC2 in its February 2004 version.



Battlespace Awareness	Command & Control	Focused Logistics	Force Application	Protection
24 Active ACTDs	8 Active ACTDs	13 Active ACTDs	19 Active ACTDs	10 Active ACTDs
▪ Adaptive Battlespace Awareness (? CC)	▪ Advanced Joint C4ISR Node	▪ Advanced Technology Ordnance Surveillance	▪ Active Network Intrusion Defense	▪ Active Denial System
▪ Coalition Aerial Surveillance & Recon	▪ CINC 21	▪ Agile Rapid Global Combat Support	▪ Advanced Notice	▪ Area Cruise Missile Defense (? CC)
▪ Coalition Shared Intelligence Network Environment (? CC)	▪ Coalition Combat Identification	▪ Agile Transportation	▪ Advanced Tactical Laser	▪ Contamination Avoidance at Seaports of Debarkation (? FL)
▪ Communications/ Navigation Outage Forecasting System	▪ Coalition Info Assurance Common Op Picture	▪ Coalition Reception Staging and Onward Movement	▪ Advanced Tactical Targeting Technology	▪ Counter Bomb/ Counter Bomber II
▪ Computerized Operational MASINT Weather	▪ Joint Blue Force Situational Awareness	▪ Coalition Theater Logistics	▪ Agent Defeat Warhead	▪ Homeland Security Command & Control (? CC)
▪ Foliage Penetration Synthetic Aperture Radar	▪ Joint Unmanned System Common Control (? BA)	▪ Coherent Analytical Computing Environment	▪ Content-Based Information System	▪ Joint Area Clearance
▪ Global Monitoring of ISR Space Systems	▪ Multi-Link Antenna System	▪ Deployable Cargo Screening (? P)	▪ Counterproliferation II	▪ Joint Explosive Ordnance Disposal
▪ Gridlock (? FA)	▪ Theater Effects-Based Operations	▪ Future Tactical Truck System	▪ Expendable Unmanned Aerial Vehicle	▪ Personnel Recovery Extraction Survivability aided by Smart Sensors
▪ Ground-to-Air Passive Surveillance	▪ Theater Integrated Planning System	▪ Joint Distance Support & Response	▪ Hunter Standoff Killer Team	▪ Protected Landing and Take-off
▪ High Altitude Airship		▪ Joint Health & Usage Monitoring System	▪ Quickbolt	
▪ Hyperspectral Collect and Analysis		▪ Joint Precision Airdrop System	▪ Overwatch (? P)	
▪ Joint Intelligence, Surveillance & Recon		▪ Joint Theater Logistics	▪ Micro Air Vehicle (? BA)	
▪ MANPACK		▪ Theater Support Vessel	▪ Midnight Stand	
▪ Multi-Sensor Aerospace/ Ground Joint ISR Coalition			▪ Psychological Operations Global Reach	
▪ Network-Centric Collaborative Targeting			▪ Language and Speech Exploitation Resources (? P)	
▪ Night Vision Cave & Urban Assault (? FA)			▪ Line-of-Sight Anti-Tank (? BA)	
▪ Pathfinder			▪ Tactical Missile System–Penetrator	
▪ PI			▪ Thermobarics	
▪ SIGINT Processing			▪ Tunnel Target Defeat (? CC & BA)	
▪ Space Based MTI				
▪ SPARTAN (? P)				
▪ Tactical IFSAR Mapping				
▪ Urban Reconnaissance				

• Enables a whole new way of doing business ? Secondary assignment • Enhancing current business

10/27/03

Figure 9.3—FY 2003 ACTDs Mapped to JWCA Functional Concepts

9.2 JBMC2 Exercise Strategy

A new joint training strategy is being developed to keep pace with training transformation and to define the operational requirements for implementation of a Joint National Training Capability (JNTC). The Joint National Training Capability (JNTC) is a cooperative collection of interoperable training sites, nodes, and events that synthesizes Combatant Commander and service training requirements with appropriate "joint context." Founded on the

four pillars of realistic combat training, an adaptive and credible opposing force, common ground truth, and high-quality feedback, the JNTC underpins a global, information age joint national training capability that advances Defense Department transformation efforts, including enabling multinational, interagency, and intergovernmental network-centric operations. JNTC will provide "an integrated live, virtual and constructive training environment. The ultimate goal is to develop a transformed training capability that provides accurate, timely, relevant, and affordable training and mission rehearsal in support of operational needs."

JTNC affords the opportunity to synchronize training and exercises with program testing milestones to train combatant commanders, staffs, SJFHQs, components, and assigned forces from strategic, operational, and tactical levels; train JFCOM-assigned forces, including JFCOM SJFHQ at the operational and tactical levels; leverage training environment to link event analysis with requirements-based capability assessment to identify and remedy shortfalls; and to integrate and advance joint capabilities by incorporating JCD&E and JT&E concepts. The JBMC2 roadmap will use JTNC events and venues as opportunities to evaluate, validate, and certify proposed concepts and capabilities of selected programs. Alignment and synchronization plans will be completed by April 2004.

9.3 JBMC2 Experimentation Strategy

USJFCOM's Joint Concept Development and Experimentation Campaign Plan serves as a mechanism to synchronize the efforts of combatant commanders, Services, and interagency partners to collectively develop concepts and plan experiments in the course of transforming the military. USJFCOM's Joint Concept Development and Experimentation Campaign Plan Serves as a mechanism to synchronize the efforts of combatant commanders, Services, and interagency partners to collectively develop concepts and plan experiments in the course of transforming the military. The Joint Concept and Experimentation campaign focuses on developing two distinct products: prototypes that evolve from concept experimentation in concert with our partners and actionable recommendations that result from collaborative experimentation with new concepts and capabilities that focus on the next decade.

To improve near-term warfighting capabilities, the campaign pursues a strategy of rapid prototyping, and this effort takes place along the joint prototype pathway. This strategy takes new ideas or concepts that originate on the joint concept development pathway and converts them into physical form, as prototypes. From there, these prototypes are put into the hands of joint warfighters as quickly as possible.

Concepts are generated along the joint concept development pathway through a series of experiments that span two years. In collaboration with our Service, combatant commander, Joint Staff, defense agency and multinational peers, we are exploring three major challenges and eighteen specific areas of warfighting. As promising new ideas or concepts emerge, we begin to refine them through an experimentation process that involves testing hypotheses and demonstrating results. Concepts that meet certain requirements are eventually handed off to teams of specialists who convert them to prototypes. Based on how these concepts perform, we make recommendations to senior leaders that help them decide how to invest military resources in the next decade. Work performed on the joint concept development path is dedicated to making long-term improvements to military capability. The focus is on making next

decade improvements to joint warfighting. Following is a description of current prototyping efforts:

Collaborative Information Environment (CIE) is a means to distribute common situational awareness about the state of adversarial and friendly forces to decision-makers across all levels of conflict and crisis. The CIE provides a means to effectively tailor and rapidly update individual information requirements and increases the pace and quality of planning, coordination, direction, and assessment during operations. Prototype end state: January 2004.

Operational Net Assessment (ONA) provides for the production of coherently aggregated and synthesized information that results in better knowledge and understanding of situations. The ONA is a continuous analysis of the enemy's total war-making capability. It identifies those capabilities, assets, connections, loyalties, networks and other assets (both physical and non-physical) that are important and most valuable to the adversary. It provides U.S. commanders with a set of effects-based courses of action from which to choose for implementation. The ONA is performed through network links to a national complex of "centers of excellence," allowing combatant commanders to access the full analysis capabilities of the U.S. interagency community, participating non-governmental entities, and allied and coalition partners. ONA places the specific battlespace effects at the very center of the analysis process and serves to connect widely disparate pieces of information into useful knowledge for the commander. Prototype end state: October 2004.

Joint Interagency Coordination Group (JIACG) is an advisory element on the commander's staff that functions as a liaison between U.S. military forces and the interagency community by providing civilian agency perspectives on operations and plans, and helps to develop a coordinated use of total national power during contingencies. When a joint task force forms and deploys, the JIACG supports the commander's staff to ensure that the commander has considered the full range of diplomatic, informational, and economic interagency activities and their operational implications. The JIACG informs civilian agencies of the combatant commander's and JTF's operational requirements, concerns, capabilities and limitations, in a collaborative information environment, without infringing on staff responsibilities or bypassing existing agency lines of authority or communications. Interagency collaboration through the JIACG allows a better integration of campaign-planning efforts between the strategic and operational levels. Prototype end state: October 2004.

Joint Fires Initiative (JFI) provides a singular fires support mechanism that incorporates joint intelligence, surveillance and reconnaissance and command and control architectures into a single fires prosecution mechanism. Through a common set of automated tools and processes, JFI coordinates the efforts of various Department of Defense fires and fire support efforts to enable the management of time sensitive targets.

Joint Intelligence, Surveillance, and Reconnaissance (JISR) is a net-centric approach to the management of intelligence, surveillance, and reconnaissance capabilities aimed at better supporting the demands of the joint warfighter across all levels of war. It enables development of the battlespace awareness necessary to make decisions, to perform operations, assess effects, and enhance synchronization of intelligence activities with combat operations. JISR emphasizes collaboration among commands, national agencies, and multinational organizations; automates current manual collection management processes; and provides new tools for faster, multilevel information sharing.

As with the JTNC, the JBMC2 roadmap will synchronize selected program activities with prototyping events. This alignment should be complete by April 2004.

A representative list of Joint Concept Development and Experimentation Campaign Plan events for JBMC2 activities are shown in Figure 7.4.

Major Prototype Path Events FY04-05*

Events	Partners	Date
SJFHQ IOC Event	SOUTHCOM	Nov 03
Terminal Fury	PACOM	Dec 03
Agile Leader	Combatant Commands	Mar 04
JNTC Thrust III	Second Fleet	Jun 04
Determine Promise	NORTHCOM	Aug 04
Joint Fires/JNTC	PACOM	Oct 04
Internal Look	CENTCOM	Nov 04
Joint Deployment Process	Combatant Commands	Feb 05
Multi National Spiral 2-3	MN & RCCs	May 05
Ulchi Focus Lens	USFK	Aug 05

*** Representative, not all inclusive**

Figure 9.4— Near-Future Joint Concept Development and Experimentation Plan Events

The materiel portion of these prototyping efforts, if successful, need a reliable transition path to migrate their capabilities into programs of record (POR). A current approach is FIOP Subtask 1.1's coordination with JFCOM's Joint Fires Initiative (JFI) to transition JFI-developed capabilities in ADOCS into the GIG-compliant WEEMC application. This type of activity should be beneficial if extended to all JFCOM prototyping activities. Subsequent versions of this Roadmap should discuss methods and timely decision points for identifying successful prototypes and planning transition to PORs.

10. Joint System-of-Systems Development Testing

A detailed discussion of joint SoS testing will be added to the February 4 edition of the JBMC2 roadmap. For now, we present several principles that will be used to guide testing and evaluation in the future.

- *[PLACEHOLDER: The testing plan will include the following elements:*
  - *An expansion of the basic principles currently in this section.*
  - *Standard sequences of testing milestones. These sequences will be used to generate the specific testing milestones in Section 3.*
  - *Definitions of JBMC2 capability objectives for each test series that are specific to each JCT to be tested in the test series*
  - *JCT-based test standards and KPPs that network centric are based where applicable and which are based on the Office of Force Transformation and ASDNII NCO Conceptual Framework.*
  - *Resources and working group expertise availability permitting a plan for expanding the capabilities of the JDEP to extend software based testing to all JBMC2 systems (in well defined increments) will be included in this section).*
  - *Resources and working group expertise availability permitting a plan for linking major Service JBMC2 system development and test centers with the JITC and SIAP initiative offices using a common GIG backbone will be developed and included in this section. This initiative may be crucial to enabling early and cost effective software-based testing of JBMC2 systems.]*

Testing throughout the development process. Traditionally, joint test events have occurred very late in the development of a program, so that making any required changes to programs ends up being difficult, expensive, and time-consuming. In the future, joint testing will be an integral part of the development process, such that joint test events will be regular occurrences from initial architecture testing all the way through final operational testing, identifying and fixing interoperability problems as early as possible.

Software and Hardware-in-the-loop testing. Program development should include more robust joint software and hardware-in-the-loop testing. In the future, program development will include both types of these tests at regular increments, as appropriate.

Early tests are to learn. Traditionally, joint "tests" have been thought of as pass-fail events that a program had to pass to be continued. In future sequences of joint tests, early tests should be designed to learn what changes need to be made to system designs, not "grade" the program. For example, in Section 3.3, we discussed how the first hardware-in-the-loop test for Cluster 1, Army and Marine Corps systems, was intended to help the Army and Marine Corps what the interoperability issues between the two sets of systems are. Such "discovery testing"

would otherwise traditionally be done only during actual deployments (such as OEF or OIF). Later joint tests will then ascertain whether the issues identified during the early tests have been resolved properly.

Net-centric testing. Traditionally, joint tests have been point-to-point, between individual pairs or small groups of system, which has been an inefficient, "N^2" process. Further, in future mission concepts, large numbers of systems will need to interoperate seamlessly to bring about true JBMC2 capabilities. Thus, future sequences of joint tests will bring together portfolios of systems related to particular JBMC2 capabilities simultaneously. The tests will evaluate system interoperability with respect to the layered model of interoperability described in Section 3.9, gauging compliance to infrastructure, transport-layer, and enterprise services-layer requirements (as governed by NII), battlespace picture requirements (as directed by the picture programs), and the application-layer requirements for the tested capability (as represented in operational concepts and architectures developed by JFCOM and the Services). Testing will assess the capability attributes and KPPs of the 'cluster under test' in addition to interoperability. As an example, one can think of the Army's software blocking approach, used for its BMC2 systems, applied to cross-service groups of Service and agency programs related to particular JBCM2 capabilities.

The draft interoperability-testing plan, presented in Section 3.3, is a first step towards implementing the testing principles described above. The February 4 version of the roadmap will incorporate a more detailed description of how to implement the principles described above, as well as a revised interoperability-testing plan. In particular, the testing plan in this section will include:

- An expansion of the basic principles listed above.
- Standard sequences of testing milestones. These sequences will be used to generate the specific testing milestones in Section 3.3.
- Definitions of JBMC2 joint capability thread (JMT) objectives for each test series that are specific to each JMT to be tested in the test series.
- JMT-based test standards and KPPs. These will be network centric and based, where applicable, on the Office of Force Transformation and ASDNII NCO Conceptual Framework.
- (Tentative, resources permitting) A plan for expanding the capabilities of the JDEP to extend software based testing to all JBMC2 systems (in well defined increments) will be included in this section.
- (Tentative, resources permitting) A plan for linking major Service JBMC2 system development and test centers with the JITC and SIAP initiative offices using a common GIG backbone will be developed and included in this section. This initiative may be crucial to enabling early and cost effective software-based testing of JBMC2 systems.

11. Summary and Conclusions

The high-level integrated JBMC2 capability goals of the DoD embodied in the following capabilities are envisioned for networked joint forces:

- *Real-time shared situational awareness at the tactical level and common shared situational awareness at the operational level*
- *Fused, precise, and actionable intelligence*
- *Coherent distributed and dispersed operations, including forced entry into antiaccess or area-denial environments*
- *Decision superiority enabling more agile, more lethal, and survivable joint operations*.

The traditional acquisition management and technology standard mechanisms employed within the DoD have failed to provide the integrated JBMC2 capabilities needed to realize the above goals. Lessons learned from recent operations and exercises indicated that independently developed service-specific JBMC2 systems, operational concepts, and TTPs have frequently led to significant interoperability problems. In some cases these differences and incompatibilities are not evident or discovered during operational planning, making it exceedingly difficult to remedy or compensate for these problems and integrate joint forces effectively during the heat of battle.

Despite these shortfalls recent progress has been made by providing theaterwide Blue Force Tracking (BFT) capabilities and other JBMC2 capabilities, such as the Automated Deep Operations Coordination System (ADOCCS), to warfighters. This progress provides a glimpse of the transformational capabilities that genuinely integrated JBMC2 capabilities can provide to joint forces. This roadmap is designed to build on this recent limited progress, our understanding of joint interoperability problems encountered in recent operations and exercises, and ASDNII's ambitious plans for increasing the capabilities of operational- and tactical-level communications networks, and information management and discovery capabilities.

11.1 DoD's Philosophical Shift and the JBMC2 Capability Strategy

DoD has recently made a philosophical shift in the way service programs will be structured with respect to one another, as shown in Figure 11.1. In the new approach, programs will be structured to maximize, where appropriate, common elements for joint capabilities across the services. Previously, JBMC2 capabilities depended on independently conceived service programs that shared only a set of joint interfaces. Frequently, these program interfaces were defined by joint standards. However, this standards-based approach has been found insufficient and costly to implement successfully. With the new philosophy, BMC2 capabilities will depend predominantly on a common core of joint applications, defined by joint standards that make use of the common joint computing and communications infrastructure standards. Service-unique programs will be limited to providing service-unique applications, with these unique programs incorporating as much of the JBMC2 infrastructure as possible.

Instead, Services largely will create common, GIG-compliant services and applications that will be used across the joint force. These services and applications frequently will be specific to particular capability domains, but will not be unique to a Service.

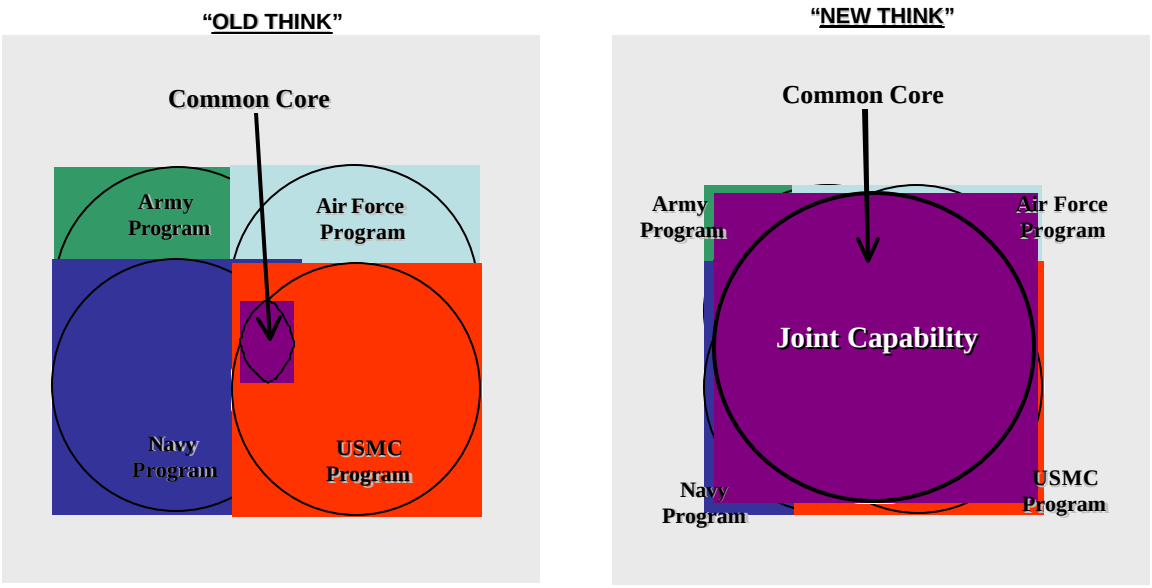


Figure 11.1—DoD's Philosophical Shift

In this first draft of the roadmap, we have identified a strategy with 11 major elements for integrating current and planned JBMC2 capabilities. These elements and associated milestones are shown in Figure 11.2.

Operational Concept. The first is the U.S. Joint Forces Command (JFCOM) plan for developing an overarching JBMC2 operations concept consistent and integrated with service JBMC2-related operational concepts.

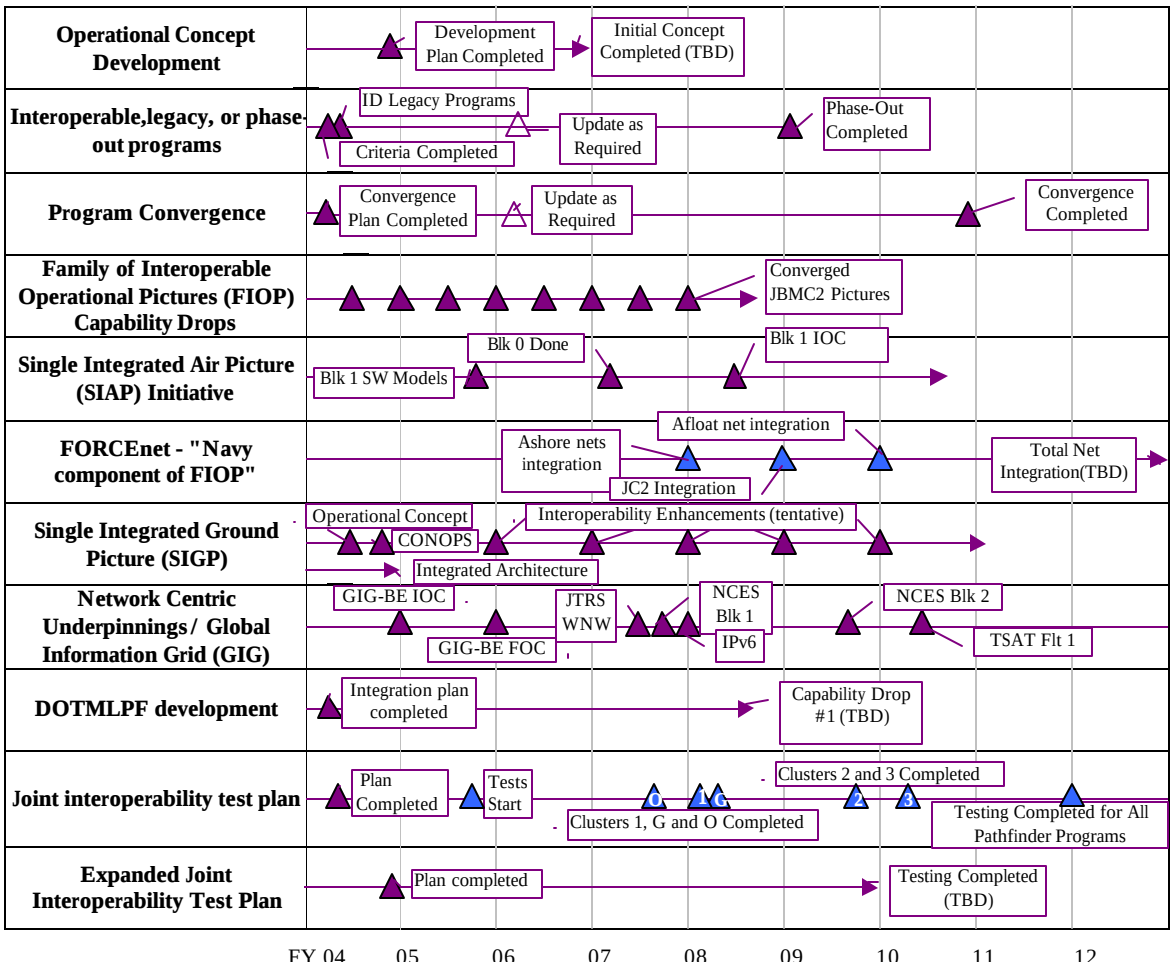


Figure 11.2—JBMC2 Capability Integration Strategy

Planning to Make Programs Interoperable, Legacy, or Phased Out. For the second element of the strategy, JBMC2 system interoperability and legacy phase-out criteria will be developed and applied to designate systems as interoperable, as capable of being made interoperable (and hence to be maintained as programs of record), or as legacy systems (to be phased out). Draft criteria for identifying interoperable and legacy systems are presented in this first-order roadmap. Comprehensive system interoperability and legacy phase-out criteria will be completed by February 2004. Legacy systems will be identified by February 2004 with the objective of making them interoperable FY 2008 or completing their phase-out by the end of FY 2008.

Program Convergence Plan. The third element of the JBMC2 integration strategy is a program convergence plan. This plan will be completed by February 2004 with the objective of converging selected programs to a smaller set of interoperable programs by the end of FY 2008.

Battlespace Picture Programs. The fourth through seventh elements are the battlespace picture programs. These include the MID 912 initiatives that have recently been transferred to JFCOM: the Family of Interoperable Operational Pictures (FIOP) and the Single Integrated Air Picture (SIAP) initiatives. The FIOP initiative is developing web-based applications and network-based services for insertion into programs of record or that can be used to integrate JBMC2 systems . These FIOP capability drops are not shown explicitly in Figure 11.2, but are discussed in detail in Section 4.2 of this roadmap.

The SIAP initiative is developing executable software, algorithms, and data models for use by or insertion into programs of record. Block 0 of SIAP is developing systems engineering products for program design and integration. The first SIAP deliveries of executable software to programs of record will be in Block 1. SIAP Block 1 IOC is scheduled to occur in FY 2008. It will be fielded to a number of programs shortly thereafter.

Several key milestones for the Navy component of FIOP, FORCEnet, are shown in Figure 11.2. These recommended milestones ensure that FORCEnet ashore communications networks can be integrated into the GIG and afloat communications networks can rapidly assimilate SIAP and FIOP capability drops. The integration of JC2 into the FORCEnet afloat JBMC2 architecture is recommended to occur by FY 2009.

A fourth recently created MID 912 initiative is the Single Integrated Ground Picture (SIGP) initiative, which will be transferred to JFCOM at the end of FY 2004. Recommended SIGP milestones for delivery of executable software or design information (message or other architectural standards) are shown in Figure 11.2. The delivery milestones for these capability drops are approximate and are aligned to coincide with the development of software upgrades for Army JBMC2 systems.

Net-Centric Underpinnings. The eighth element of the JBMC2 integration strategy is the network centric underpinnings to be provided by key ASDNII programs. These include the GIG-Bandwidth Expansion (GIG-BE) program; Network-Centric Enterprise Services (NCES), which will provide information management and discovery and network management capabilities for GIG users; and the Joint Tactical Radio System (JTRS) and its new Wideband Networking Waveform (WNW). Another major GIG bandwidth expansion program is the Transformational Communications Satellite (TSAT) program. This set of GIG programs will provide the network-centric underpinnings for all JBMC2 programs and initiatives. Milestones for these GIG infrastructure programs are shown in the second row of Figure 11.2.

DOTMLPF Testing. The ninth element of the JBMC2 integration strategy is the development of the nonmateriel "DOTMLPF," components associated with the JBMC2 systems that will be spirally developed in joint interoperability tests. JFCOM will develop a comprehensive overarching outline for the joint approach to providing nonmateriel JBMC2 solutions to the warfighter by February 2004.

Joint Interoperability Test Plan. The tenth element is the creation of a Joint Interoperability Test Plan; several requirements for this plan follow. First, the MID 912 initiatives need to be incorporated into JBMC2 interoperability system testing. Second, while JTA standards are necessary for JBMC2 system interoperability, they are not sufficient. Industry pointed out at the second JBMC2 summit that the current JTA does not have the prescriptive powers to ensure interoperability because so many incompatible standards are part of the JTA. While ASDNII is currently undertaking efforts to reduce the size of JTA and

increase its level of internal consistency, a joint network-centric test approach is needed to discover and correct interoperability problems between JBMC2 systems. Third, as described earlier in the roadmap, joint interoperability testing is required early in the life cycle of new programs and software-based JDEP testing should be implemented throughout the program life cycle to ensure early detection and correction of interoperability problems. Early software-based testing can be much more cost-effective than less frequent hardware-based testing that occurs later in the program upgrade or life cycle.

Fourth, the interoperability test plan will need to incorporate specific tests for "pathfinder" JBMC2 systems. The capabilities the MID 912 initiatives will provide to programs of record will increase the level of interoperability between JBMC2 systems. However, even the best-designed architectures, software, and systems may be flawed in subtle ways and subject to unforeseen interoperability problems. Therefore, the initial JBMC2 joint interoperability test plan cannot be driven solely by the MID 912 JBMC2 initiatives described above and emerging GIG standards and applications. It is also based on a series of joint interoperability tests for an initial select group of JBMC2 systems (hereby designated as "pathfinder programs" because they will be the first to go through this joint interoperability test process). Section 3.3 in this first-order roadmap presented a draft joint interoperability test plan for the initial set of pathfinder JBMC2 programs; the following section reviews this plan. Where possible, these joint interoperability tests will first test software models of JBMC2 systems using Joint Distributed Engineering Plant (JDEP) capabilities, so interoperability problems can be caught early and corrected before more expensive hardware-in-the-loop or operational testing is done.

Expanded Joint Interoperability Test Plan. The last element of the JBMC2 integration strategy is expansion of the JBMC2 system interoperability test plan to include a larger set of JBCM2 systems than just those included in the pathfinder set of programs. This joint interoperability test plan for a larger set of JBMC2 systems will be completed by the end of FY 2004. Further research is required to determine when this expanded set of joint interoperability tests can be completed.

11.2 Recommended Joint Interoperability Testing

The draft interoperability test plan, first presented in Section 3.3, is of such central importance to the roadmap that we briefly review it in this concluding chapter. In this first-order roadmap we established joint interoperability goals and test plans based on the known interoperability shortcomings between specific pathfinder programs and on lessons learned from recent operations where interoperability problems were encountered. The primary goals used in constructing the joint interoperability test strategy described below can be found in the definition of JBMC2 presented in Figure 1.1 and in the specific goals established for each of the MID 912 initiatives. From these we identified six program interoperability test groups:

- Programs related to the creation of the ground battlespace picture, as needed for Joint Ground Maneuver (JGM) operations. Programs within this group will incorporate SIGP initiative products. This grouping largely comprises major Army and USMC JBMC2 programs.
- Programs that primarily provide battlespace awareness functional capabilities, such as the Service DCGS programs.
- Future "Flagship" JBMC2 programs or integration efforts that are under development by the Services, such as the Army Future Combat Systems (FCS) program. These will probably need to be tightly integrated in several ways to effectively support joint forces in the future, for example to support joint employment of emerging Network Centric Warfare (NCW) concepts. These programs will depend upon GIG and NCES capabilities directly, so tests within this group will include these infrastructure programs, as well.
- Programs related to the creation of the air battlespace picture. Such programs, such as major air defense-related programs, will make use of capabilities developed by the SIAP initiative.
- Programs that provide operational-level C2 capabilities, such as JC2 and DJC2. As with the Flagship JBMC2 grouping, tests within this group will include GIG and NCES capabilities.
- Programs that will depend critically on GIG-BE and NCES capabilities. Examples of these include operational C2 programs and FORCEnet.

Within these joint interoperability test groups, we identified several *program clusters* for interoperability testing (see Section 3.3 for more detail on these). The following set of charts describes the currently scheduled testing events in the plan. Figure 11.3 provides the legend, showing which colors correspond to which interoperability test groups, and which numbers correspond to which program clusters within those test groups. Figure 11.4 shows testing events for most of the Service pathfinder programs, while Figure 11.5 shows the testing events for the Joint Operational C2 programs such as JC2, DJC2, GCCS, and the GCCS variants being converged into JC2. As in Section 3.3, note that triangles correspond to JDEP / software-in-the-loop test events, and diamonds correspond to hardware-in-the-loop test events.

The proposed draft joint interoperability test schedule implies a paradigm shift with respect to joint interoperability testing, discussed in detail in chapter 10. We reiterate that

regularly scheduled testing is to be made a core component of JBCM2 program development. Such testing will include both software- and hardware-in-the-loop testing. Program test series will incorporate both early, "learning" test events in addition to the more traditional, pass/fail evaluations towards the end of program development. Finally, test events themselves will become net-centric, assessing portfolios of programs with respect to technical infrastructure, the battlespace picture (MID 912) program requirements, and capability-specific application requirements as developed by JFCOM and the Services.

- SIGP-Related
  - 1 – Army Software Block X, USMC
  - 3 – Army Software Block X, FCS
  - 4 – Army Software Block X, USMC, FCS
- Battlespace Awareness-Related
  - 2 – DCGS–A, DCGS–AF, DGCS–N, DCGS–MC
  - 6 – DCGS–A, DCGS–AF, DGCS–N, DCGS–MC, MC2C, ACS
- "Flagship" BMC2-Related
  - 5 – FCS, MC2C, GIG, NCES
  - 7 – FORCEnet, ACS, FCS, MC2C, GIG, NCES
- SIAP-Related
  - 8 – MC2C, FORCEnet, Army Software Block X
- Operational C2-Related
  - 9 – DJC2, JC2, GCCS, NCES
  - O – DJC2, JC2, GCCS, FCS, MC2C, USMC, NCES, GIG
- GIG-BE / IPv6-Related
  - G – FORCEnet, JC2, DJC2, GCCS, NCES, GIG-BE/IPv6

Figure 11.3—Legend for the JBMC2 Interoperability Test Plan Figures

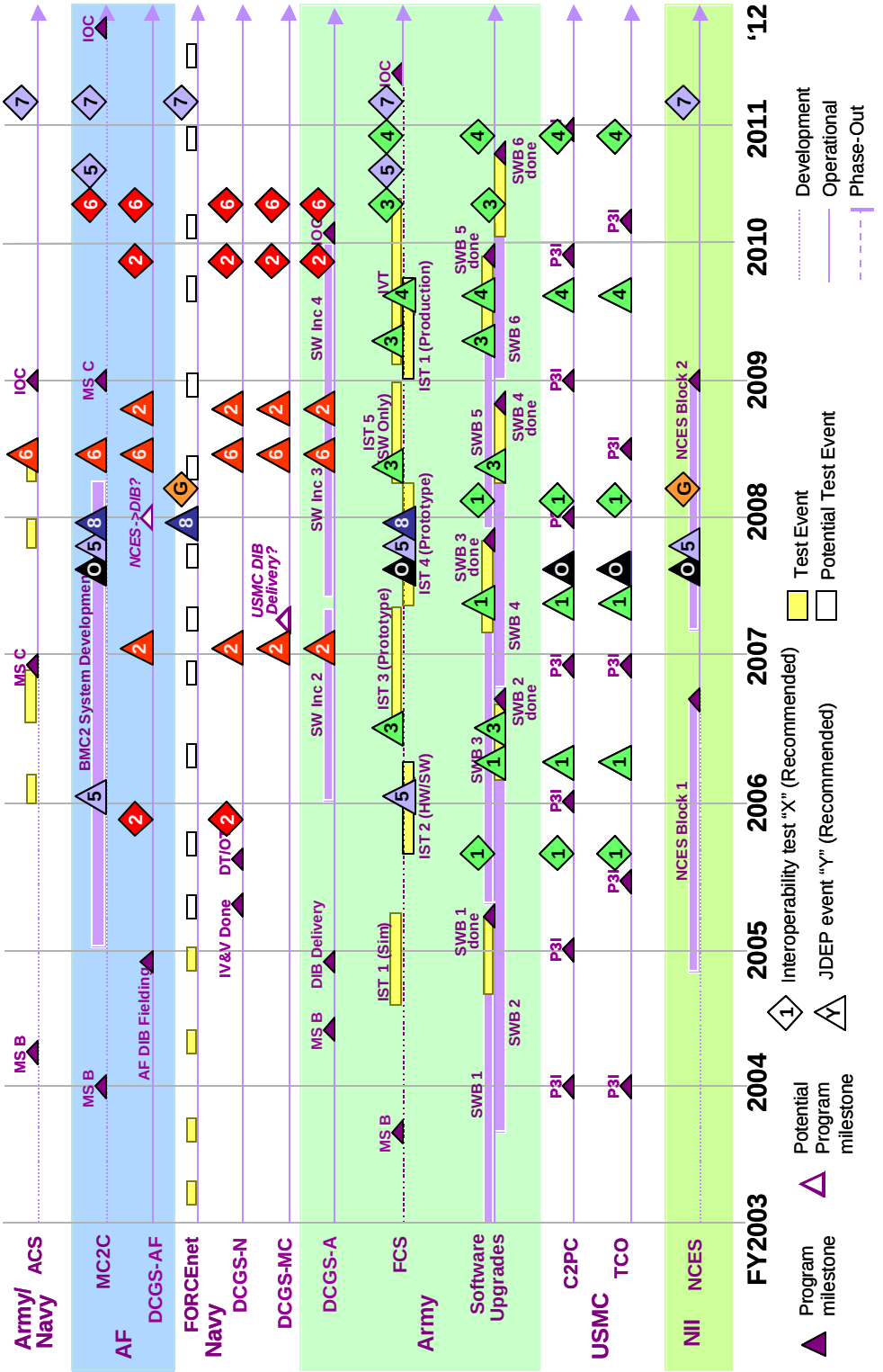


Figure 11.4—Draft JBMC2 Interoperability Test Plan

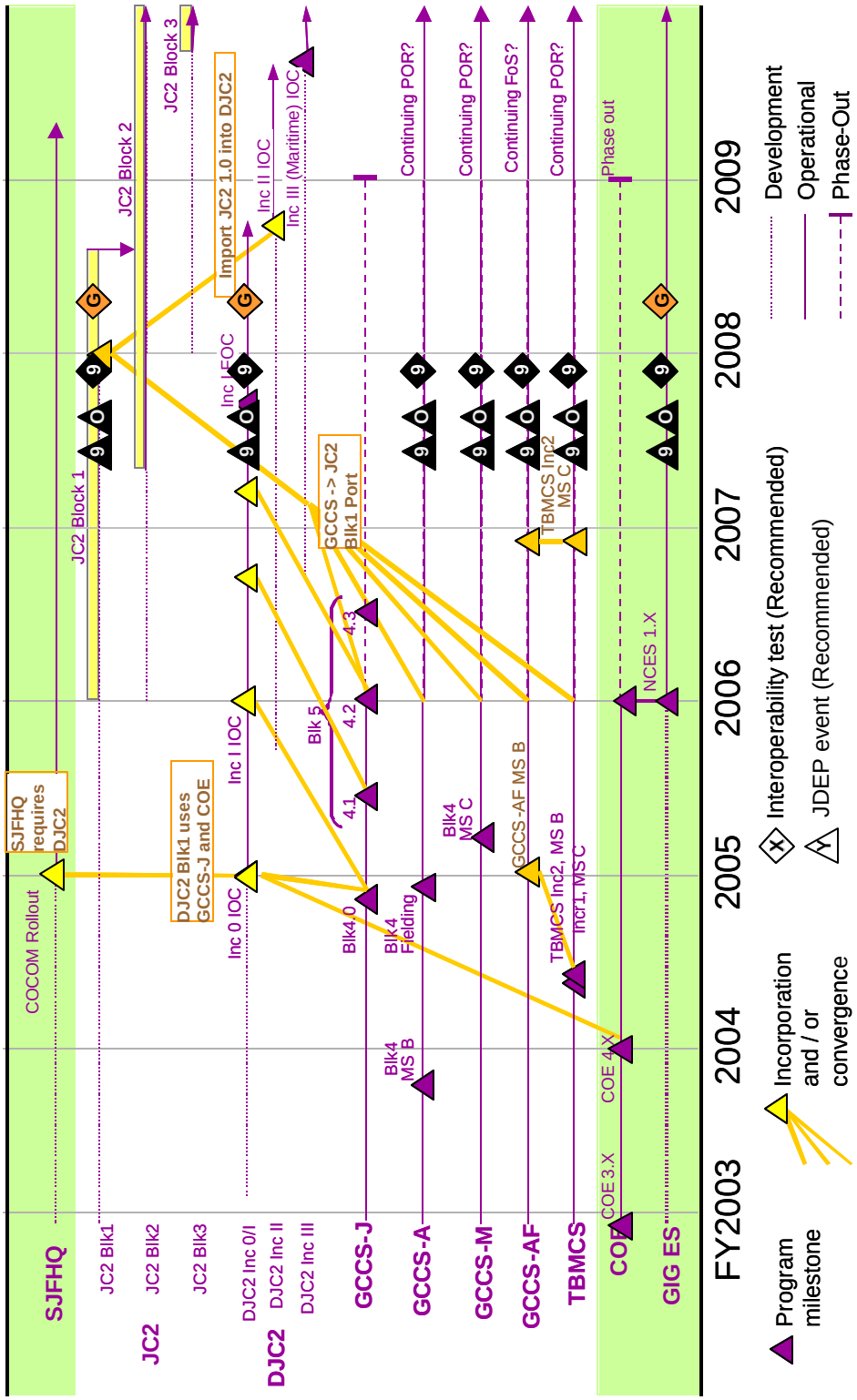


Figure 11.5—Convergence of JC2/GCCS Service Variants and Suggested Interoperability Test Plan

11.3 Additional Future Steps

Only program joint interoperability testing milestones have been added to the already established JBMC2 or GIG program plans presented in this roadmap. Future versions of the JBMC2 roadmap will contain the results of critical path program analysis and may recommend program schedule changes, the integration of MID 912 initiative capabilities, and other system design changes to improve JBMC2 interoperability, better align planned programs, and to ensure that integrated JBMC2 capabilities are delivered in a series of coherent well-planned "capability drops." Options for recommended program changes will involve time, capability, and resource trade-offs. Supporting analyses to support such trade-off decisions will be conducted to assess how "much" JBMC2 integration is needed to support the conduct of specific military missions. An important element to consider in these analyses is how quickly new JBMC2 capabilities will actually flow to Combatant Commanders and warfighting units. These issues will be addressed in future iterations of the roadmap.

Implementation of the JBMC2 integration strategy described above will help ensure future joint forces possess interoperable and well integrated JBMC2 capabilities in future conflicts. If Service JBMC2 programs and DOTMPF initiatives are not aligned and synchronized effectively, and if these systems are not tested thoroughly in a realistic joint environment, then Service programs and doctrine will continue to evolve largely independently, and new and unpredictable interoperability problems and doctrinal conflicts will likely emerge, to the detriment of U.S. joint forces in future conflicts.

A. Policy Recommendations From Industry

An important part of the roadmap process is to realize the crucial role industry plays as the DoD transitions to future programs and capabilities. By way of background, representatives from industry, academia and DoD federally funded research and development centers have been active participants throughout the roadmap process. The following items are highlights of industry's feedback to DoD, provided as key thoughts to keep in mind as the JBMC2 roadmap develops and evolves.

Legacy Phase-Out Recommendations

- If DoD keeps the roadmap process open and fair, with specific criteria, industry will cooperate. Industry understands that achieving programmatic interoperability or retirement by 2008 is an appropriate, though challenging, goal that requires a systematic process to ensure success. Industry offers specific trade-off criteria: performance, life-cycle cost, suitability, transition value, etc., as well as the need to develop a list of systems with interoperability problems and JBMC2 problems.
- One assessment method offered is to have industry compete in the consolidation, or "necking down" of systems; consequently, they recommend an active part in coordinating all initial operational test and evaluation efforts.
- It is also important to manage risk by using incremental changes instead of a "big block" approach.
- Use of the "national team model" for addressing complex system-of-system (SoS) problems is one of a few options that is viable.
- It is important to ensure that a plan exists for the overlap of systems as new ones come online (and legacy systems are phased out) because interim implications and periods are often not thought out fully.

Standards Recommendations

- It is possible to build closed, proprietary systems that comply with all mandatory standards, so commercial industry standards may be insufficient for JBMC2.
- Industry needs to be included in the definition and management of the JTA.
- It is very difficult to make high-fidelity interfaces with basic web technology, so relying on web standards may be insufficient for JBMC2.

Culture/Organization Recommendations

- The DoD needs to foster systems engineering expertise, including supporting training and education, in government and industry using real systems engineers.
- Within the government, have a program office competition to head a program.

- The government should provide a list of systems requiring synchronization and a gap analysis.
- It is crucial to establish a single chief engineer for JBMC2 at JFCOM.
- The government should consider the establishment of a system of rewards or industry incentives to foster collaboration.
- It is essential to ensure connectivity of the roadmap to the program managers. Industry invariably reports to program managers, so providing incentives to program managers with no unfunded mandates could be a helpful solution.

Testing Recommendations

- Project-centric focus and acquisition orientation are no longer adequate for the JBMC2 environment.
- JDEP is valuable but it needs to be extended and matured.
- Less detailed models of C2 (cognitive behavior models) exist and have some utility but need further development.
- Cross-system evaluation: evaluation versus compliance
- It may not be appropriate to use the word "test" because of its connotations. Might we use "discovery" or "assessment" instead?
- The government needs a process to break the "N-squared" problem (in which achieving interoperability requires custom testing of every pair of systems to be made interoperable) in cross-system testing.
- Think beyond traditional operational testing to incorporate modeling and simulation.

Acquisition Strategy Recommendations

- Tie JBMC2 to the specific program manager. The arena of program management is replete with policy, law, etc, even while a sleeker, faster-moving industry is bound to report directly to program mangers through these layers.
- The government needs to be open to establishing consistent, detailed criteria to prompt industry ease of cooperation.
- Congress is a key stakeholder.
- NCES definition and implications currently lack an adequate level of detail that makes specification in contracts difficult.

Risk Mitigation Recommendations

- Formalized reporting of progress is necessary for the roadmap.
- The government should maximize the decoupling of programs.
- We should use the analogy of what we do when we have real world operations to do interoperability exercises—e.g., a JBMC2 "Millennium challenge" type of event.

Process Recommendations

- There is a need to provide checks and balances against institutionalized thinking. CJCSI 3170 and DoD 5000 are steps in the right direction, but a process existing within the realm of clear JBMC2 criteria is needed.

B. Definitions and Acronyms

B.1 Definitions

Convergence. Advances in technology that make it possible to use different media (e.g.., networks, radio relay systems, computers) to carry and process all kinds of information and services, including sound, images, and data. Convergence facilitates the ability to propose the same services for all users, regardless of the technology or networks used.

FIOP. A multiservice effort under JFCOM oversight and direction to "provide an all-source picture of the battlespace containing actionable, decision-quality information to the warfighter through a fusion of existing databases…" according to JROCM 156-01, 17 Oct 01**.** The FIOP management and engineering teams are currently supporting JFCOM J8 in determining the best approach to ensure coherence, synergy and interoperability across the other picture efforts.

Integration. The progressive testing and linking of system components to merge their technical and functional characteristics into a comprehensive, interoperable system. Integration of data systems allow data on existing systems to be shared or accessed across functional or system boundaries.

Interoperability (general definition). The ability of 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.

Interoperability (DoD-specific definition). The condition 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. The degree of interoperability should be defined when referring to specific cases (Joint Publications 1-02, January 2003).

Net-Centric Warfare. An information superiority-enabled concept of operations that generates increased combat power by networking sensors, decisionmakers, and shooters to achieve shared awareness, increased speed of command, higher tempo of operations, greater lethality, increased survivability, and a degree of self-synchronization. (Definition taken from *Network-Centric Warfare,* 2nd edition, by David S Alberts, John J. Garstka, and Frederick P. Stein.)

Picture. Useful and usable representation of all relevant Blue, Red, Gray, and environmental information with operationally meaningful timeliness and accuracy. Tailorable to meet individual operator's needs and preferences.

Picture Effort: Multiservice effort to define and develop part of the COP/CTP for a particular group of users—e.g., air picture, ground picture, space picture. Effort involves defining the goal and objective capability, identifying constraints and limitations to achieving it, and building approach to overcome them. A great deal of variance exists across the picture efforts—e.g., SIAP is systems engineering- and architecture-focused, SIGP and SISP are just beginning to stand up. All are envisioned, planned, managed, and executed in different fashions,

but the picture effort with the least commonality with any other is the Family of Interoperable Operational Pictures (FIOP), which is why it has its own definition.

Spiral Development. A cyclic approach for incrementally increasing a system's degree of definition and functionality while decreasing its degree of risk. The process provides the opportunity for interaction between the user, tester and developer. In addition, spiral development can consist of a single or multiple spirals.

Systems Engineering. An interdisciplinary approach to evolve and verify an integrated and life-cycle-balanced set of system product and process solutions that satisfy customer needs. Systems engineering: encompasses the scientific and engineering efforts related to the development, manufacturing, verification, deployment, operations, support, and disposal of system products and processes; develops needed user training equipments, procedures, and data; establishes and maintains configuration management of the system; develops work breakdown structures and statements of work, and provides information for management decisionmaking. (MIL-STD-499B)

B.2 List of Acronyms

Symbol	Definition
A/C	Aircraft
A2C2S	Army Airborne Command and Control System
ABCS	Army Battle Command System
ACAT	Acquisition Category
ACDS	Advanced Combat Direction System
ACS	Aerial Common Sensor
ACTD	Advanced Concept Technology Demonstrator
ADSI	Air Defense System Integrator
AEHF	Advanced Extremely High Frequency
AFATDS	Advanced Field Artillery Tactical Data System
AFE	Automated Feature Extraction
AMDPCS	Air/Missile Defense Planning and Control System
AOC	Air Operations Center
APS	Advanced Polar System
ARGUS	Advanced Remote Ground Unattended Sensor
ASAS	All-Source Analysis System
ASDNII	Assistant Secretary of Defense for Networks and Information Integration
AT&L	Acquisition, Technology, and Logistics
ATC	Automatic Target Classification
ATR	Automated Target Recognition
AV	Architectural View
AWACS	Airborne Warning and Control System
BAMS	Broad-Area Maritime Surveillance

BCS	Battle Control System
BFSA	Blue Force Situational Awareness
BMC2	Battle Management Command and Control
C2	Command and Control
C2C	Command and Control Constellation
C2ERA	Command and Control Enterprise Technical Reference Architecture
C2IP	Command and Control Initiatives Program
C2PC	Command and Control PC
C4ISR	Command, Control, Computers, Communications, Intelligence, Surveillance, and Reconnaissance
CAC2S	Common Aviation Command and Control System
CCICCS	Combatant Commanders Integrated Command and Control System
CEC	Cooperative Engagement Capability
CES	Core Enterprise Services
CENTCOM	Central Command
CID	Combat ID
CJCSI	Chairman of the Joint Chiefs of Staff Instruction
CJCSM	Chairman of the Joint Chiefs of Staff Memorandum
COCOM	Combatant Commander
COE	Common Operating Environment
COI	Community of Interest
CONOP	Concept of Operations
COP	Common Operational Picture
COTM	Communications On The Move
CRD	Capstone Requirements Document
CSI	Commercial Satellite Imagery
CTP	Common Tactical Picture
DACT	Data Automated Communications Terminal
DCAPES	Deliberate Crisis Action Planning Execution Segments
DCGS-A	Distributed Common Ground System—Army
DCGS-AF	DCGS—Air Force
DCGS-MC	DCGS—Marine Corps
DCGS-N	DCGS—Navy
DDMS	DoD Discovery Metadata Specification
DIB	DCGS Integration Backbone
DII COE	Defense Information Infrastructure Common Operation Environment
DISA	Defense Information Systems Agency
DJC2	Deployable Joint Command and Control
DoD	Department of Defense
DOTMLPF	Doctrine, Organization, Technology, Materiel, Leadership, Personnel, and Facilities

DPG	Defense Planning Guidance
DT	Development Test
DTSS	Digital Topographic Support System
DU	Deployed Unit
EOR	Engage on Remote
ERA	Enterprise Reference Architecture
FAAD	Forward-Area Air Defense
FBCB2	Force XXI Battle Command Brigade and Below
FCB	Functional Capabilities Board
FCS	Future Combat Systems
FFRDC	Federally Funded Research and Development Center
FIOP	Family of Interoperable Operational Pictures
FnMP	FORCEnet Maritime Picture
FoS	Family of Systems
FOT&E	Follow-On Test and Evaluation
FUE	First Unit Equipped
GCCS-A	Global Command and Control System—Army
GCCS-AF	GCCS—Air Force
GCCS-J	GCCS—Joint
GCCS-M	GCCS—Maritime
GCSS-A	Global Combat Support System—Army
GIG ES	Global Information Grid Enterprise Services
GIG-BE	Global Information Grid Bandwidth Expansion
GIS	Geospatial Information System
GMI	General Military Intelligence
GMTI	Ground Moving-Target Indicator
HAIPE	High-Assurance Internet Protocol Encryption
HWIL	Hardware in the Loop
IBS	Integrated Broadcast Service
ICP	Interoperability Change Proposal
IER	Information Exchange Requirements
IFF/SIF	Identification Friend or Foe/Selective Identification Feature
IMS	Integrated Master Schedule
INCOSE	International Council on Systems Engineering
IOC	Initial Operational Capability
IP	Internet Protocol
IPT	Integrated Program Team
ISNS	Integrated Services Network System
ISR	Intelligence, Surveillance, and Reconnaissance
ISRM	ISR Manager
IT	Information Technology
IVIS	Intervehicular Information System
JBFSA	Joint Blue Force Situational Awareness

JBMC2	Joint Battle Management Command and Control
JC2	Joint Command and Control
JCD&E	Joint Concept Development and Experimentation
JCIDS	Joint Capability Integration and Development Process
JDEP	Joint Distributed Engineering Plant
JDN	Joint Data Network
JET	Joint Engineering Team
JEWG	Joint Engineering Working Group
JFC2	Joint Force Command and Control
JFCOM	Joint Forces Command
JFN	Joint Fires Network
JITC	Joint Interoperability Test Command
JLENS	Joint Land-Attack Cruise Missile Defense Elevated Netted Sensor
JNTC	Joint National Training Capability
JOC	Joint Operating Concept
JPN	Joint Planning Network
JROC	Joint Requirements Oversight Council
JROCM	Joint Requirements Oversight Council Memorandum
JSIPS-N	Joint Service Imagery Processing Systems—Naval
JSTARS	Joint Surveillance Target Attack Radar System
JSWS	Joint Services Workstation
JT&E	Joint Test and Evaluation
JTA	Joint Technical Architecture
JTIDS	Joint Tactical Information Distribution System
JTRS	Joint Tactical Radio System
JTT	Joint Targeting Toolbox
JWCA	Joint Warfighting Capabilities Assessment
KPP	Key Performance Parameter
LDM	Logical Data Model
LRIP	Low Rate Initial Production
LRR	Long-Range Radar
M&S	Modeling and Simulation
MARCORSYSCOM	Marine Corps Systems Command
MASINT	Measurement and Signatures Intelligence
MC2A	Multisensor Command and Control Aircraft
MCE	Modular Control Equipment
MCO	Major Combat Operations
MCP	Mission Capability Package
MCS	Maneuver Control System
MDL	Mobile Data Link
MEFF	Marine Expeditionary Force Forward
METOC	Meteorology and Oceanography
MID	Management Initiative Decision

MIDS	Multifunctional Information Distribution System
MIL-STD	Military Standard
MIP	Multilateral Interoperability Program
MMA	Multimission Aircraft
MN	Multinational
MP-CDL	Multi-Platform Common Data Link
MP-RTIP	Multi-Platform Radar Technology Insertion Program
MRRS	Multirole Radar System
MS B	Milestone B
MS C	Milestone C
MSE	Mobile Subscriber Equipment
MTC	Multi-TADIL Capability
MTI	Moving-Target Indicator
MTIX	Moving-Target Information Exploitation
MTS	Message Transfer System
NBS	Network-Based Services
NCES	Network-Centric Enterprise Services
NCO	Network-Centric Operations
NCOW RM	Net-Centric Operations and Warfare Reference Model
NCP	Naval Capability Pillar
NCW	Network-Centric Warfare
NFCS	Navy Fire Control System
NFN	Naval Fires Network
NITF	National Imagery Transmission Format
NMCI	Navy-Marine Corps Intranet
NORTHCOM	Northern Command
NSA	National Security Agency
NSS	National Security Systems
OPCON	Operational Concept
OPR	Office of Primary Responsibility
ORD	Operational Requirements Document
OSD	Office of the Secretary of Defense
OT	Operational Test
OV	Operational View
PACOM	Pacific Command
PFS	Precision Fire Support
PIM	Platform Independent Model
PNT	Precision Navigation and Time
POM	Program Objective Memorandum
PPLI	Precise Participant Location and Identification
PSM	Platform-Specific Model
RID	Requirements Implementation Document
ROMO	Range of Military Operations

S&W	Surveillance and Warning
SADI	Situational Awareness Data Interoperability
SADL	Situational Awareness Data Link
SATCOM	Satellite Communications
SBMCS	Space Battle Management Core Systems (SBMCS)
SDK	Software Development Kit
SEWG	Systems Engineering Working Group
SEWS	Shared Early Warning Systems
SHI	System to Human Interface
SIAP	Single Integrated Air Picture
SIF	Standard Interchange Format
SIGP	Single Integrated Ground Picture
SISP	Single Integrated Space Picture
SJFHQ	Standing Joint Force Headquarters
SLATE	Systems-Level Automation Tool for Engineers
SOCOM	Special Operations Command
SOFP	Special Operations Force Picture
SOR	Statement of Requirements
SoS	System of Systems
SOUTHCOM	Southern Command
SSDS	Ship Self-Defense System
SSEE	Ships Signal Exploitation System
STGP	Shared Tactical Ground Picture
SV	Systems View
TACFIRE	Tactical Fire
TAC-P	Tactical Air Control Party
TADIL	Tactical Digital Information Link
TAMD	Theater Air Missile Defense
TAOM	Tactical Air Operations Modules
TBD	To Be Done
TBMCS	Theater Battle Management Core System
TBMD	Theater Ballistic Missile Defense
TC G/W	Transformation Gateway
TCM	Transformational Communications Military Satellite Command
TCO	Tactical Combat Operations
TCS	Transformational Communications System
TCT	Time-Critical Targeting
TCTF	Time-Critical Targeting Functionality System
TDL	Tactical Data Link
TEG	Tactical Exploitation Group
TES-A	Tactical Exploitation Systems—Army
TES-N	TES—Naval
TLDHS	Target Location, Designation, and Handoff System

TPG	Transformation Planning Guidance
TPPU	Task, Post, Process, Use
TSAT	Transformational Communications Satellite
TTPs	Tactics, Techniques, and Procedures
UA	Unit of Action
UAV	Unmanned Aerial Vehicle
UCS	Unified Command System
UE	Unit of Employment
USA	U.S. Army
USAF	U.S. Air Force
USD AT&L	Undersecretary of Defense for Acquisition, Technology, and Logistics
USFK	U.S. Forces Korea
USMC	U.S. Marine Corps
VMF	Variable Message Format
WEEMC	Web-Enabled Execution Management Capability
WG	Working Group
WGS	Wideband Gapfiller Satellite
WIN-T	Warfighters Information Network - Tactical
WNW	Wideband Network Waveform
WTP	Weapon Target Pairing
XML	Extensible Markup Language

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C. List of Guiding Documents

Many of the following documents are subject to change. We used the most recent drafts available and will revise the roadmap if need be as these documents change.

- DoDD 4630.5: Interoperability and Supportability of IT and NSS, 11 January 2002
- DoDI 4630.8: Procedures for Interoperability and Supportability of IT and NSS, 2 May 2002 DoDD 5000.1: The Defense Acquisition System, 12 May 2003
- DoDI 5000.2: Operation of the Defense Acquisition System, 12 May 2003
- CJCSI 3170.01C / CJCSM 3170.01: Joint Capabilities Integration and Development System (JCIDS), Operation of the JCIDS
- CJCSI 6212.01B: Interoperability and Supportability of NSS, and IT Systems, 8 May 2000
- Draft CJCSI 6212.01C: Interoperability and Supportability of NSS, and IT Systems

The following two memoranda that form the basis of the roadmap are reprinted below.

- Command and Control (C2) Legacy Interoperability Strategy and Milestone Action Plan, Memorandum from the Under Secretary of Defense, Paul Wolfowitz, October 12, 2001.
- Joint Battle Management Command and Control (BMC2) Roadmap, Memorandum from the Under Secretary of Defense for Acquisition, Technology, and Logistics, Michael W. Wynne, June 9, 2003.

D. Detailed Schedule Information for Selected Pathfinder Programs

D.1 CEC

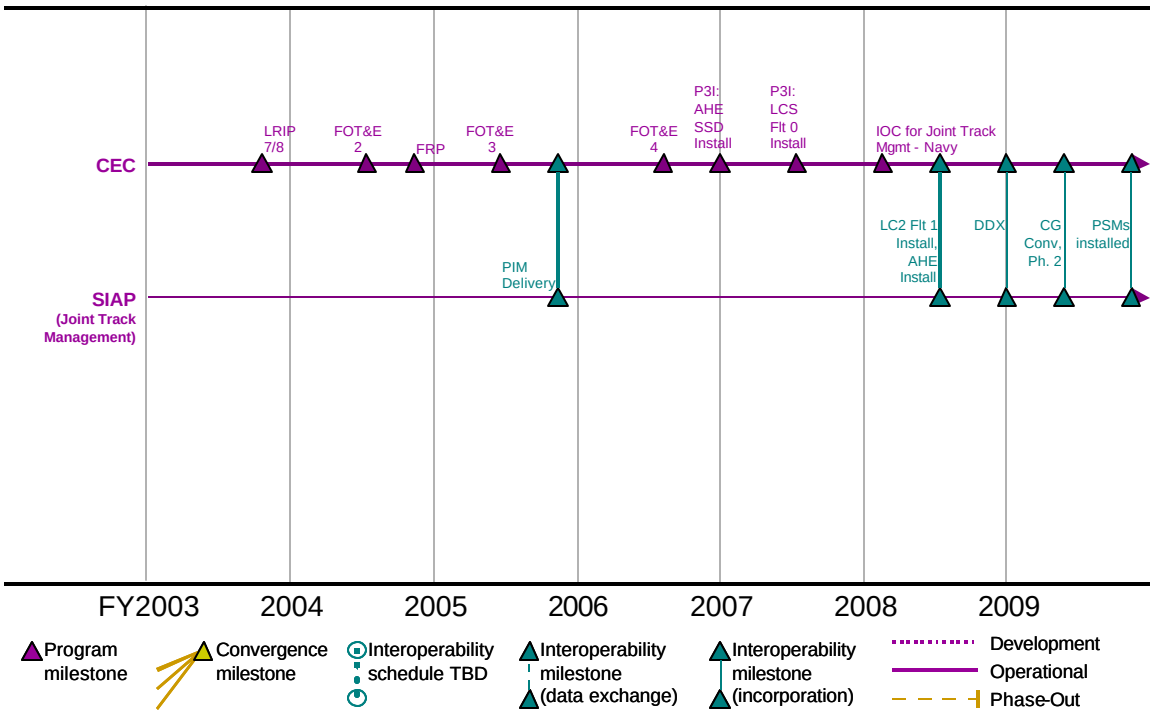

Figure D.1—CEC

D.2 MC2A

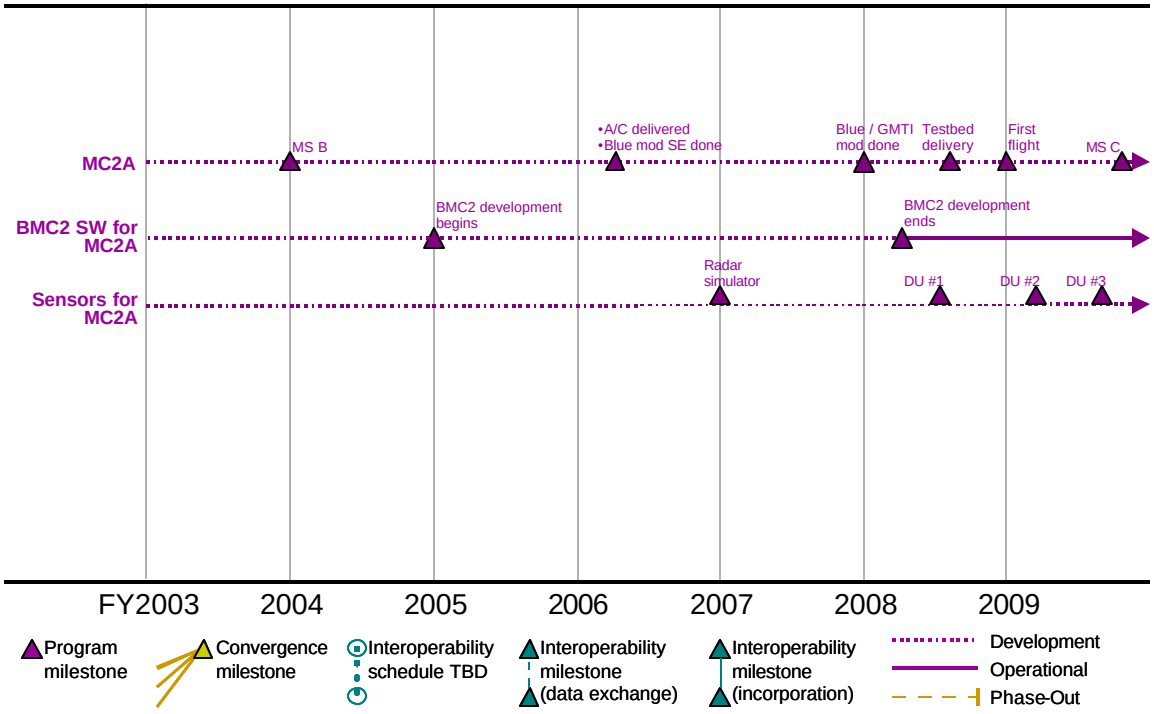

Figure D.2—MC2A Timelines

D.3 DCGS Integration Backbone (DIB)

The primary means through which the DCGS programs will achieve interoperability (and, to some extent, convergence) is through common use of the USAF-developed DCGS Common Integration Backbone (DIB). The DIB provides common hardware infrastructure, common data services, common data repositories, and common applications (especially in the area of imagery). Services currently planned to be part of the DIB are shown in orange (with a dashed border) on this chart. Note that the Air Force is considering producing other common applications, as well; these are shown in italicized text.

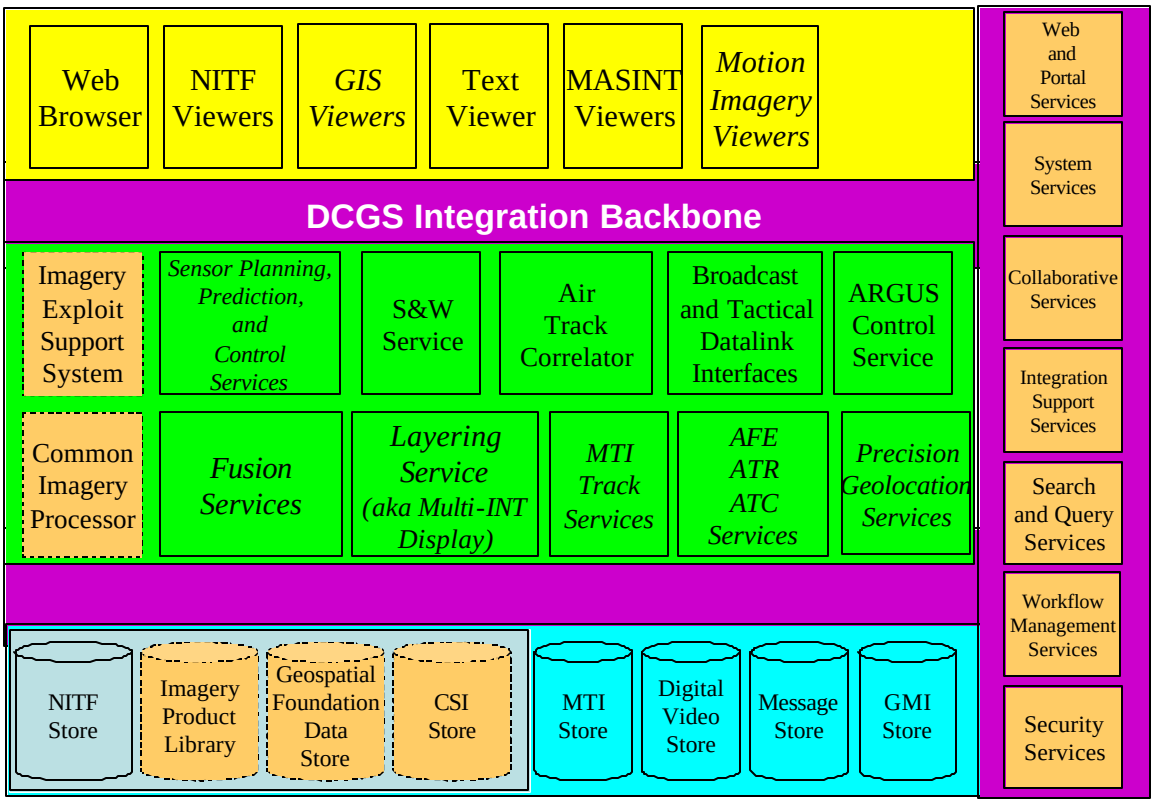

Figure D.3—Services Migrating to the DIB