JOINT BATTLE MANAGEMENT COMMAND AND CONTROL (JBMC2)

ROADMAP

Office of the Under Secretary of Defense
(Acquisition Technology and Logistics)

US Joint Forces Command
(USJFCOM)

Version 1.0
22 April 2004

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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 decision-makers in aligning and integrating JBMC2 integration initiatives with service 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 U.S. Joint Forces Command (USJFCOM) the responsibility for overseeing and directing the integration of a JBMC2 capability. This Roadmap reflects USJFCOM plans for developing complete mission capability packages, joint operating concepts, and the doctrine, organization, training, materiel, leadership, people, and facilities (DOTMLPF) solutions needed for achieving robust JBMC2 capabilities.

An interoperable JBMC2 family 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, 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; JBMC2 systems; and underlying joint technical architecture standards and GIG infrastructure. It embraces a multi-prong spiral development and joint testing approach to 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*
- *Responsive and precise targeting information for integrated real-time offensive and defensive fires*
- *The ability to conduct coherent distributed and dispersed operations, including forced entry into anti-access or area-denial environments.*

This roadmap will be the vehicle for prioritizing, aligning, and synchronizing Service JBMC2 architectural and acquisition efforts. Where policy and other acquisition initiatives are defined to drive JBMC2 developments and related activities, the specific means of application to JBMC2 will be via updates to this roadmap and decisions made by the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) and U.S. Joint Forces Command (USJFCOM) to ensure overall harmonization across affected efforts and programs. This roadmap provides a strategy with three major parts for integrating current and planned JBMC2 capabilities. These are described below.

JBMC2 Capabilities Development and Implementation. The first part of the strategy will focus on the development, implementation, and testing of the elements needed to provide enhanced JBMC2 capabilities for the warfighter. Figure S.1 shows major milestones for the components of this part of the strategy.

[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).

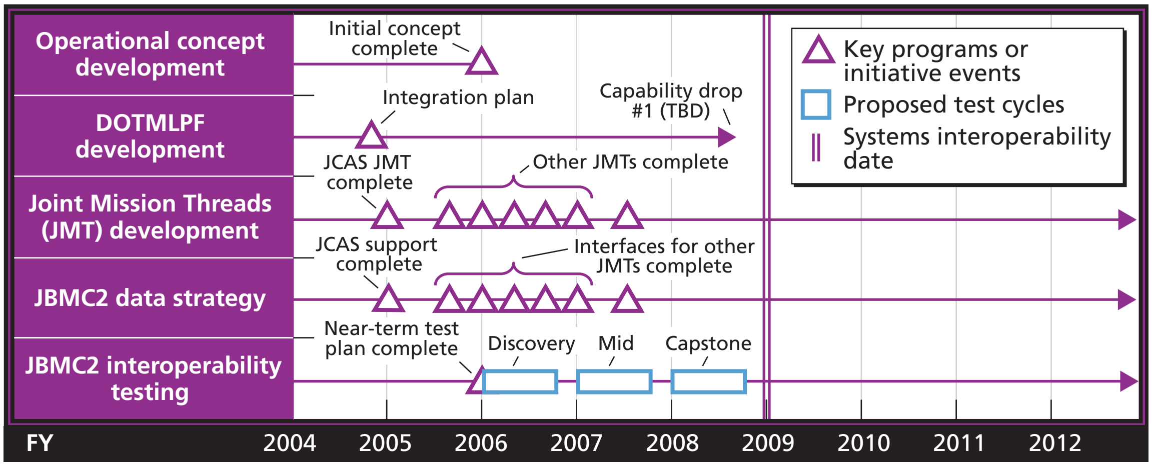

Figure S.1—JBMC2 Capabilities Development and Implementation

USJFCOM will devise a plan for developing an overarching JBMC2 operations concept that will guide integration of Service JBMC2-related Concepts of Operations. A comprehensive plan to develop this operations concept will be completed by the end of Fiscal Year (FY) 2004. The operational concept will be completed by the start of FY 2006.

USJFCOM will develop a comprehensive, overarching outline in FY 2004 for the joint approach to provide nonmateriel parts of integrated JBMC2 capability solutions to the warfighter.

In collaboration with the Services, USJFCOM will lead the development of JBMC2 Joint Mission Threads (JMTs), which are comprehensive descriptions of architectural elements (including associated operational requirements and the system of systems engineering approach), of how the joint force will execute seven key warfighting capabilities using major JBMC2 capabilities. The seven JBMC2 JMTs are:

- Joint Close Air Support (JCAS)
- Joint Ground Maneuver
- Time-Sensitive Targeting
- Joint Force Command and Control
- Integrated Air/Missile Defense
- Integrated Fires
- Focused Logistics.

A comprehensive approach for integrating the JMTs will be developed that will ensure that the situational awareness and collaboration capabilities defined in the JMTs are common across JMTs and therefore will be common across the joint force.

Figure S.1 identifies when the analyses for each JMT will be completed (the first JCAS JMT analysis will be completed by the end of FY 2004). All JMT analyses will be completed by FY 2007 to allow approximately two years for JBMC2 integration and interoperability testing prior to FY 2009, the deadline the Deputy Secretary of Defense has established for the integration or phase-out of legacy JBMC2 systems.[2] Evolutionary development of the JMTs will continue past FY 2006 to respond to lessons learned from capabilities testing. JMT development past the FY 2009 interoperability deadline will capitalize on the Global Information Grid (GIG) net-centric infrastructure improvements that will be available in FY 2009 and beyond.

In conjunction with JMT development, the JBMC2 Data Strategy defines how JBMC2 systems will interact with the network infrastructure (both current and future net-centric infrastructure) to share information. Key to this data strategy are *JBMC2 common interfaces,* which are comprehensive descriptions for how a set of information will be shared in common across JBMC2 systems, ranging from high-level models and rules for representing information to technical specifications for using the network infrastructure. The interfaces supporting the JCAS JMT will be completed by the end of FY 2004, in parallel with JCAS JMT development; the interfaces supporting other JMTs (different from those developed for JCAS) will be developed by the end of FY 2006. Evolution of the interfaces will continue after FY 2006 to respond to lessons learned from capabilities testing. As with the JMTs, USJFCOM will lead development of the common interfaces.

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 incorporates a series of joint interoperability tests that demonstrate how well planned improvements in JBMC2 capabilities are being implemented. Test plans will be developed for ensuring that JBMC2 systems are interoperable by or shortly after the start of FY 2009. Figure S.1 shows the major testing milestones and proposed test cycles between now and FY 2009. Each cycle will comprise a number of test events, to be determined in accordance with systems engineering needs. The first cycle, to be held in FY 2006, is intended to discover interoperability problems in providing JBMC2 capabilities. The second cycle, in FY 2007, is intended to evaluate progress in providing the capabilities. The final cycle, in FY 2008, is the only traditional capstone "test" series, intended to certify whether systems are providing the needed capabilities.

Interoperability test events within each cycle will examine the ability of each JBMC2 program cluster to jointly provide an end-to-end JBMC2 capability. The program clusters will parallel the seven JMTs described above. The cornerstone of the program clusters will be a set of JBMC2 Pathfinder Programs described later in this roadmap, which correspond to those major programs providing critical JBMC2 functionality across the JMTs. Each JBMC2 program cluster will undergo testing in each of the three cycles scheduled prior to FY 2009, as described above.

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

Where possible, these joint interoperability tests will employ hardware-in-the-loop and software models of JBMC2 systems using Joint Distributed Engineering Plant (JDEP)-like capabilities so that interoperability problems can be caught early and corrected before more expensive full-scale operational testing is done. In order to meet the ambitious test schedule presented in this roadmap, the JDEP-like capabilities of the DoD test community have to be expanded significantly. A plan for doing this is laid out in this roadmap.

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

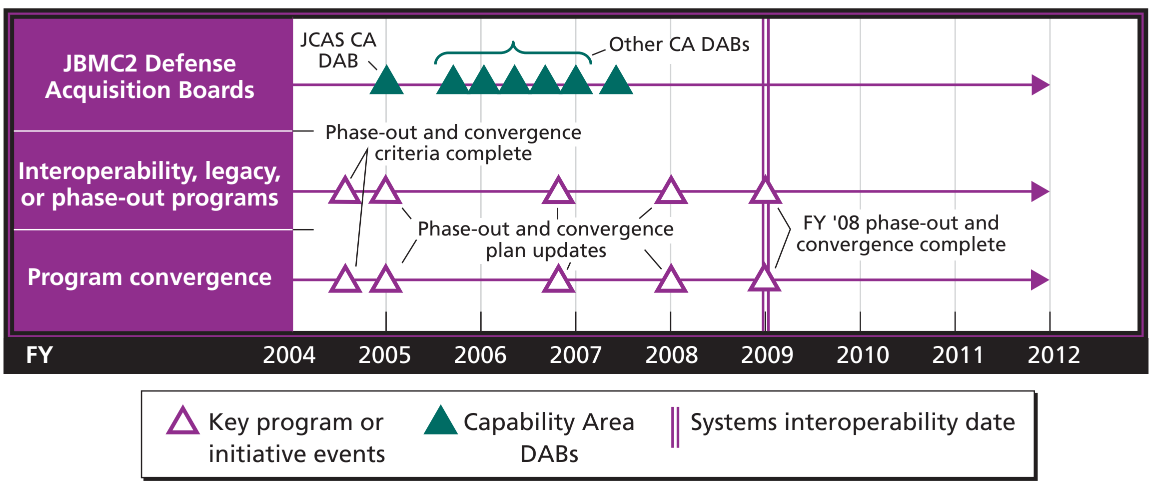

Figure S.2—Plans to Make Interoperable or Converge JBMC2 Programs

The integration strategy for JBMC2 program clusters defined by the USJFCOM JMT analysis will be approved by USD(AT&L). USD(AT&L) will be the Milestone Decision Authority for JBMC2 program clusters. The USD(AT&L) will convene Capability Area Defense Acquisition Boards (DABs) as required to assess progress in developing integrated JBMC2 capabilities for JBMC2 program clusters. The first DAB, for the JCAS JMT Program Cluster, will be conducted at the end of FY 2004, in conjunction with the completion of the JCAS JMT and supporting common interfaces. DABs for the remaining JMT program clusters will be held by the end of FY 2006.

The second row of Figure S.2 shows how JBMC2 system interoperability and legacy phase-out criteria will be developed and applied to designated 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). Objective and transparent criteria for identifying interoperable and legacy systems are presented in this first-order roadmap. Comprehensive system interoperability and legacy phase-out processes (that factor in potential value of JBMC2 initiatives) will be in place by the end of FY 2004. Legacy systems will be identified with the objective of making the majority of them interoperable or completing their phase-out by FY 2009. JBMC2 program convergence and phase-out plans will be updated as required to support JBMC2 Capability Area DABs. The third row of Figure S.2 shows that a program convergence process will be in place by the end of FY 2004, with the objective of converging selected programs into a smaller set of interoperable programs by the start of FY 2009.

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

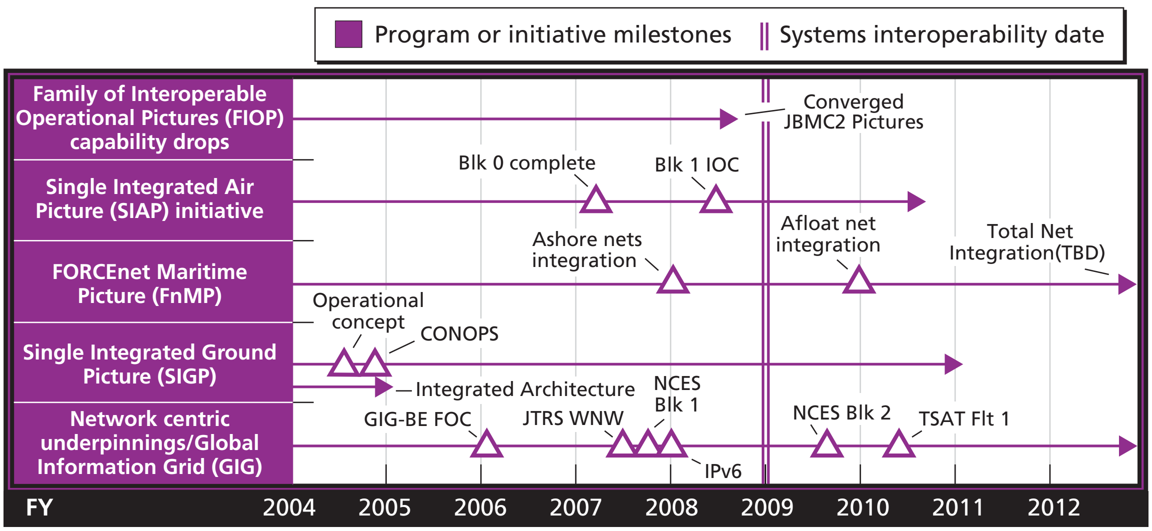

Figure S.3—JBMC2 Initiatives

In accordance with Management Initiative Decision (MID) 912,[3] the joint battlespace picture initiatives have been placed or will fall under the oversight and directive authority of USJFCOM. These key elements include USJFCOM's Family of Interoperable Operational Pictures (FIOP) and 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.

FIOP is developing a range of applications and services for insertion into programs of record, which 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 facilitate the ability to generate battlespace pictures relevant to the joint warfighter by FY 2008.

[3] *Joint Battle Management Command and Control*, Management Initiative Decision 912, January 7, 2003.

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

SIGP was initiated in FY 2004 and will fall under USJFCOM MID 912 oversight in the future. SIGP will develop Doctrine, Organization, Training, Materiel, Leadership, Personnel, and Facilities (DOTMLPF) operational products under the leadership of USJFCOM; in FY 2004 and FY 2005, 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 makes the transition 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.

JBMC2 Capability Development and Integration Management

USD(AT&L) leads the development of the JBMC2 Roadmap, in partnership with USJFCOM, and with the participation of the Joint Staff, Joint Requirements Oversight Council (JROC) (or FCBs on behalf of the JROC), Program Analysis & Evaluation, Services, and Agencies. In accordance with DoD 5000.2, Operation of the Defense Acquisition System, the DoD will use this roadmap to conduct capability assessments, guide systems development, and define the associated investment plans as the basis for aligning resources and as an input to Strategic Planning Guidance, Program Objective Memorandum development, and program and budget reviews.

USD(AT&L) also will review and approve the integration strategy for each JMT program cluster, and will be the milestone decision authority for JBMC2 program clusters. USD (AT&L) will convene Capability Area DABs as required to assess progress in developing integrated JBMC2 capabilities for specific JMTs and associated program clusters. JBMC2 Capability Area DABs will be chaired by USD(AT&L).

USJFCOM will lead development of JBMC2 capabilities, including the development of JMTs, and the integrated JBMC2 architectures that are based on approved operational systems. USJFCOM will also provide technical architecture views developed in accordance with DoDI 5000.2. and MID 912, which states that "USJFCOM, in coordination with the Chairman, Joint Chiefs of Staff, will lead Combatant Commanders in the development of joint doctrine, concepts, requirements, and integrated architectures for BMC2 interoperability and connectivity." The JBMC2 Board of Directors, chaired by the USJFCOM Deputy Commander, will be the principal forum for leading JBMC2 capabilities development and reviewing subsequent requirements.

The Joint Staff (or Principal Staff Assistant [PSA] for business areas) and the Joint Requirements Oversight Council (JROC) (or Functional Capabilities Boards (FCBs) on behalf of the JROC) will review and approve requirements associated with JBMC2 programs and will participate in the JMT development efforts described above, in accordance with the Joint Capabilities Integration and Development System (JCIDS) process (CJCSI 3170.01D). The Joint Staff and JROC will also review and approve requirements proposed by the USJFCOM-led JBMC2 development and engineering efforts as needed to bring about integrated JBMC2 capabilities.

Additional Future Steps

USD(AT&L) and USJFCOM are jointly developing, for inclusion into the next update of the JBMC2 Roadmap, a systems engineering approach linking the operational and tactical capabilities defined in the JMTs with the procurement and development expertise of the Services and agencies to ensure integrated JBMC2 capabilities result from the development and testing process defined herein.

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 of U.S. joint forces in future conflicts.

1.0 Introduction

1.1 Overview

Central to the transformation of U.S. forces are development and fielding of integrated Joint Battle Management Command and Control (JBMC2) capabilities to collaboratively plan and rapidly share an accurate picture of the battlespace. This Roadmap provides an overview of, and direction for, JBMC2 capability development, systems engineering, acquisition, and testing efforts in the Department of Defense (DoD). The purpose of this Roadmap is to provide a coherent and executable plan for fielding integrated JBMC2 capabilities to U.S. forces. To this end, the Roadmap endeavors to synchronize three major architectural elements: operational concepts and doctrine; JBMC2 systems; and underlying technical architecture standards and Global Information Grid (GIG) infrastructure. It embraces a multiprong, joint spiral development and testing approach to guide the evolution of Service and Agency JBMC2 programs.

To support its objectives, the Roadmap includes programmatic, exercise, test, and concept development information; a description of the DoD management structure for JBMC2; a description of the assessment methodology for phasing out or making interoperable legacy JBMC2 systems; a JBMC2 data strategy that is based upon the ASD(NII) (Assistant Secretary of Defense [Networks and Information Integration]) data strategy; and a JBMC2 interoperability testing strategy and top-level descriptions of joint mission threads that will be used to guide JBMC2 capability integration and DOTMLPF development efforts. The Roadmap builds upon the Joint Capability Integration and Development (JCIDS) process, including the development of integrated architectures, and is consistent with MID912. It also builds on the "net-centricity" initiatives of ASD(NII) and the "picture" integration efforts sponsored by the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD[AT&L]).

Future editions of the Roadmap will include the results of selected cross-program analysis designed to 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 them to achieve integrated JBMC2 capabilities.

1.2 Definition and Scope of JBMC2

In January 2003, the U.S. Joint Forces Command (USJFCOM) was given a new mission and mandate by the Office of the Secretary of Defense (OSD). 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 USJFCOM 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, USJFCOM has developed a working draft definition of JBMC2, which is given in Figure 1.1. 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.[4]

- **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**
  - **Integrate real time offensive and defensive fires.**

Figure 1.1—Joint Battle Management Command and Control Definition

The scope of JBMC2 includes the full range of military operations (ROMO) conducted by Combatant Commanders and the full range of corresponding operational JBMC2 elements, programs, and systems needed to execute these theater operations effectively. It does not specifically include the full range of global, national, or strategic C2 and ISR operations and capabilities that may be used support a theater-level operation from

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

other supporting Combatant Commands. However, the scope of JBMC2 includes all interfaces to global-, national-, and strategic-level C2 and ISR systems that would or can support theater-level operations. Interfaces with the strategic level will be governed by the Memorandum of Agreement between USD(I), ASD(NII), the U.S. Strategic Command (STRATCOM), and USJFCOM that is now under development. As approved details become available on the Unified Command System (UCS), JBMC2 interfaces with strategic-level systems will be synchronized and coordinated with appropriate governing organizations.

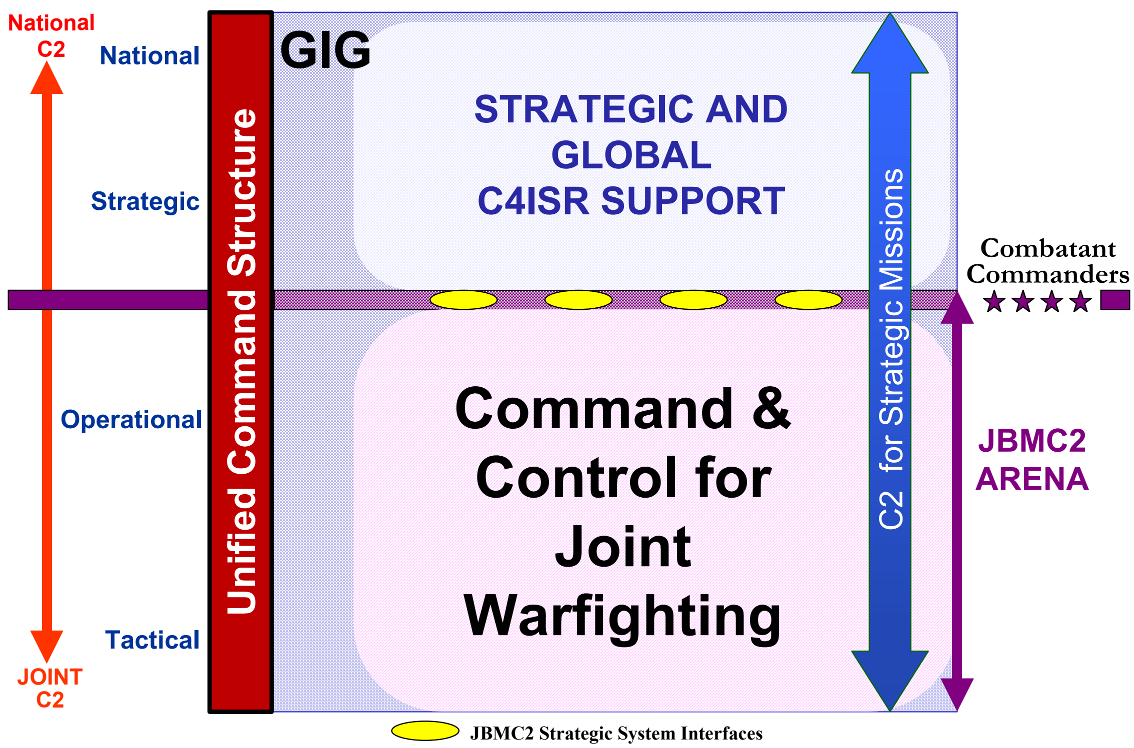

Figure 1.2—Scope of JBMC2

Figure 1.2 shows the arena of JBMC2 capabilities and that JBMC2 will incorporate C2 for joint warfighting from the tactical level through the operational level to C2 interfaces with Combatant Commands and supporting agencies at the strategic and global levels. Because the scope of JBMC2 includes the lowest tactical levels, standard interfaces have and will be developed to weapons systems. Not every weapon necessarily falls within the scope of JBMC2. Those that do are weapons systems that currently do or will in the future rely on shared situational awareness information for situational awareness and combat identification information for supporting weapon engagement decisions.

As indicated in the figure, the Global Information Grid underpins all level of C2. Hence, the GIG will provide many of the standard interfaces needed for interoperability between JBMC2 systems and national, global, and strategic C2 systems.

1.3 Scope of the JBMC2 Roadmap

Integrated JBMC2 capabilities[5] 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 integrated DOTMLPF (Doctrine, Organization, Training, Materiel, Leadership, Personnel, and Facilities) solutions to provide the JBMC2 capabilities needed to effectively support the Joint Mission Areas in Major Combat Operations (MCO) that are highlighted in Figure 1.3.

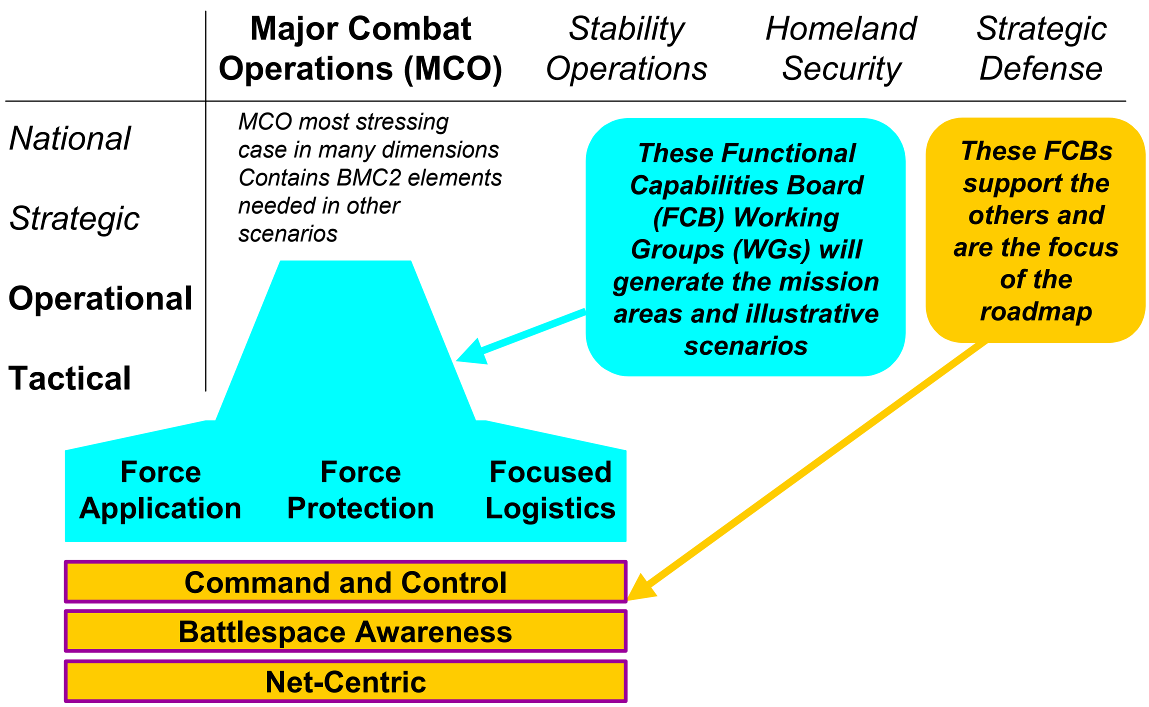

Figure 1.3—Mission and Functional Focus of the First-Order JBMC2 Roadmap

As shown in the figure, the JBMC2 capabilities fall under the domain of the Command and Control, Battlespace Awareness, and Net-Centric Functional Capabilities Boards (FCBs). JBMC2 provides capabilities necessary to plan and execute missions falling under the domain of the Force Application, Force Protection, and Focused Logistics FCBs.

To provide further operational context, the JBMC2 Roadmap focuses on seven core joint warfighting capabilities that depend critically on JBMC2 capabilities:

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[5] The definition of the term *capability*, according to *Joint Pub 1-02, DoD Dictionary of Military Terms,* is “the ability to execute a specified course of action.”

- Joint Task Force Command and Control (Operational C2)
- Joint Close Air Support
- Time-Sensitive Targeting
- Joint Ground Maneuver
- Integrated Air/Missile Defense
- Integrated Fires
- Focused Logistics.

The comprehensive description of how the joint force will execute one of these seven capabilities, to include key tasks, organizational roles, enabling systems, and other joint warfighting architectural products, is referred to as a *Joint Mission Thread* (JMT). Section 2 of this Roadmap discusses JMTs in detail.

In general, objectives for making systems interoperable and/or integrated are defined with respect to enabling these seven JMTs. Objectives are also defined with respect to providing core JBMC2 functions that integrate across the seven JMTs – notably, providing and distributing a common battlespace picture, and supporting collaboration. Figure 1.4 maps the seven JMTs to core JBMC2 functions and shows the C2, Battlefield Awareness, and Net-Centric FCB portfolios that will collectively support these.

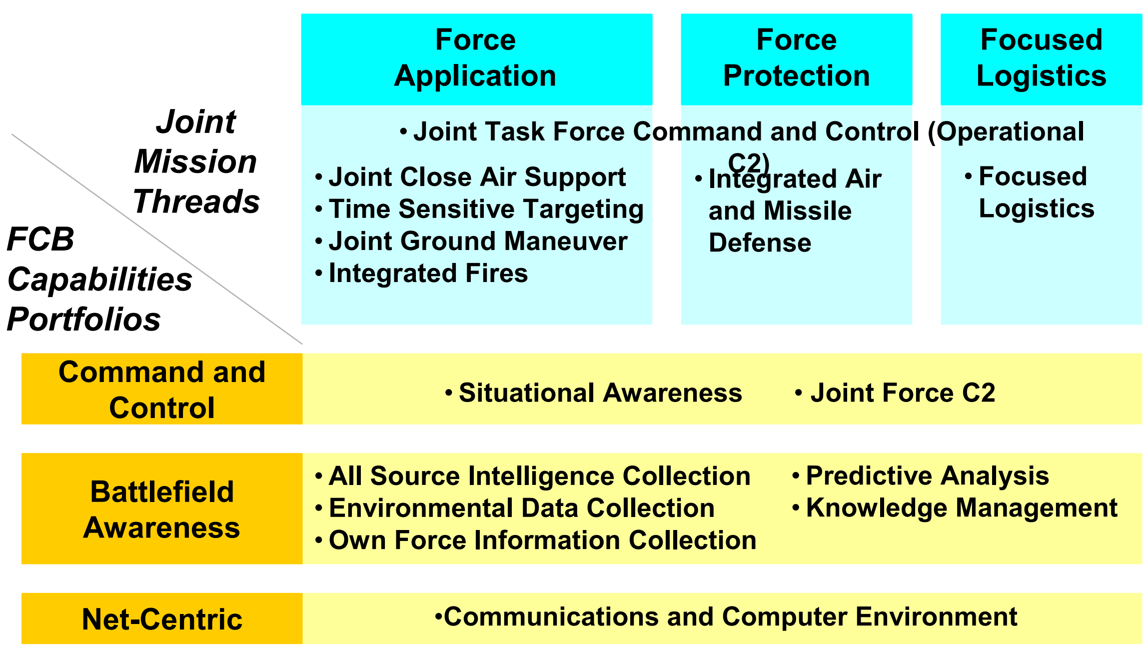

Figure 1.4—Operational Context for JBMC2 Functional Capabilities Considered

1.4 Objectives of the JBMC2 Roadmap

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 USJFCOM 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 value of this Roadmap to the warfighter is that it will help deliver the following to U.S. forces: integrated and dynamically scalable C2 of a joint force, comprehensive situation awareness in all domains (land, sea, air, and space), improved planning and collaboration capabilities, improved targeting and post-engagement assessments, rapid and effective target-weapon pairing, and effective use of munitions and supplies.

1.5 Net-Centric Capabilities Integration for JBMC2

Traditionally, enabling an integrated JBMC2 capability across multiple systems has meant engineering specific interfaces between systems. As the number of JBMC2 systems increases the number of system-to-system interfaces grows at the rate of $T = n^2 - n$ where T is the total number of interfaces to test for interoperability and "n" is the number of systems being tested. Thus attempting to achieve interoperability by interface testing alone quickly becomes unworkable unless truly standard interfaces are adopted.

The challenge becomes even greater when attempting to engineer an integrated JBMC2 capability across multiple systems. For capability-specific information to be propagated across multiple systems, the specific threads executed in support of missions have commonly had to be engineered into the systems, as well. Figure 1.5 shows this approach for several distinct sensor-to-shooter-to-weapon kill chains. In this approach, numerous specific threads have to be engineered. In addition to requiring duplicative and potentially conflicting efforts, the approach leads to inflexibility in meeting warfighter needs. Since, in practice, only a small number of specific threads can be engineered, a joint force commander frequently may not be able to tailor the use of all available joint warfighting resources to meet mission needs. Similarly, since in practice only a small number of information exchanges between systems are engineered, warfighters may not be able to get the information they need to complete their mission due to system incompatibility or interoperability problems.

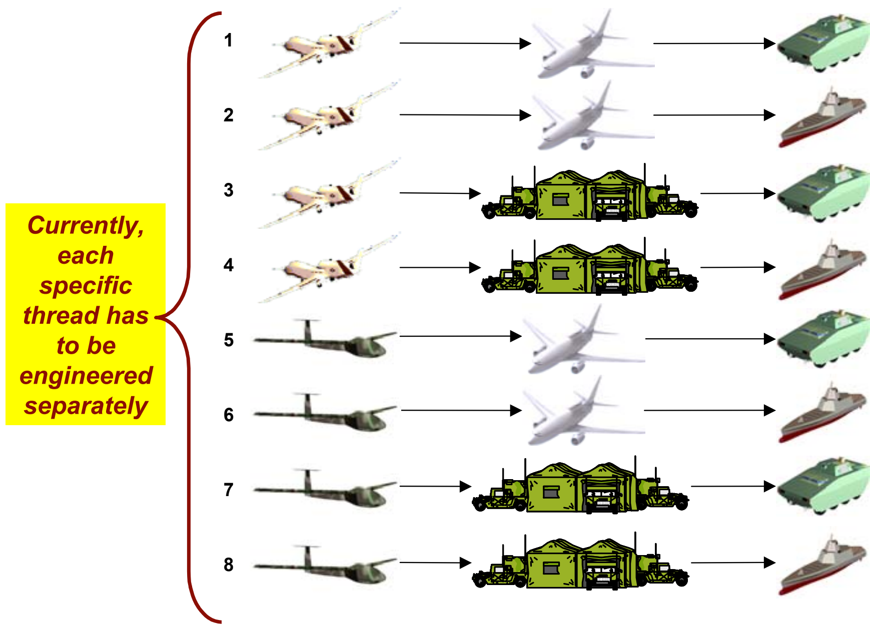

Figure 1.5—System Engineering of Specific Mission Threads

The emerging net-centric paradigm provides an alternative to the traditional system-to-system interoperability approach. In recognition of this systems-engineering reality, the Department of Defense began, under direction received in Defense Planning Guidance (DPG) 2003, 2004 and Strategic Planning Guidance (SPG) 2006, to move towards a Net-Centric Global Information Grid (GIG) and Network Centric Enterprise Services (NCES). When the GIG can supply sufficient bandwidth and mature bandwidth efficient NCES capabilities are available, JBMC2 systems will be tied to the Global Information Grid (GIG). By using the GIG for both posting and receipt of information, and moving towards common models and rules to share information across the GIG, the number of interfaces within each JBMC2 system will be significantly reduced and thus the number of tests "*T*" converges towards *T=n*. This NetCentic evolution has been the Department's transformational goal end-state for almost 4-years. However, the Department cannot move JBMC2 systems into this full Net-Centric environment without mature NCES capabilities that meet the quality of service needs associated with tactical warfighting missions, and until theater and tactical level communications networks can supply sufficient bandwidth to support full IP stack-based NCES capabilities.

Nonetheless, it is possible to migrate towards the benefits of net-centricity today, even while the NCES and GIG infrastructure are under development. As shown in Figure 1.6, the Roadmap envisions platforms and systems linked together in a standardized way to support the execution of a JMT by enabling JBMC2 information to flow seamlessly across standard GIG JBMC2 interfaces between sensors C2 centers or weapons platforms. Thus, systems or platforms capable of supporting a specific role may be used interchangeably, depending on the needs of the joint force.

Figure 1.6 also describes how this interchangeability of platforms and systems will be implemented. Systems resident at operational centers and platforms will post, retrieve, and receive information via the use of *common interfaces*, which are comprehensive and flexible specifications for how an entire family of systems shares a specified range of information, ranging from high-level models of describing common representations of information to technical specifications for using the available network infrastructure. The joint force's network infrastructure, built from the standard components the GIG provides for the physical sharing of information. The network infrastructure separates the storage and distribution of information from the system applications' use of the information, ensuring that the full family of systems needing the information will be able to access it. The nature of the network infrastructure resources provided to particular platforms and systems will vary significantly. At the tactical level, platforms generally will rely on tactical datalinks; at the operational level, platforms generally will rely on the Net-Centric Underpinnings such as the GIG Bandwidth Extension (GIG-BE) and Net-Centric Enterprise Services (NCES) – network components designed to transmit large quantities of information.

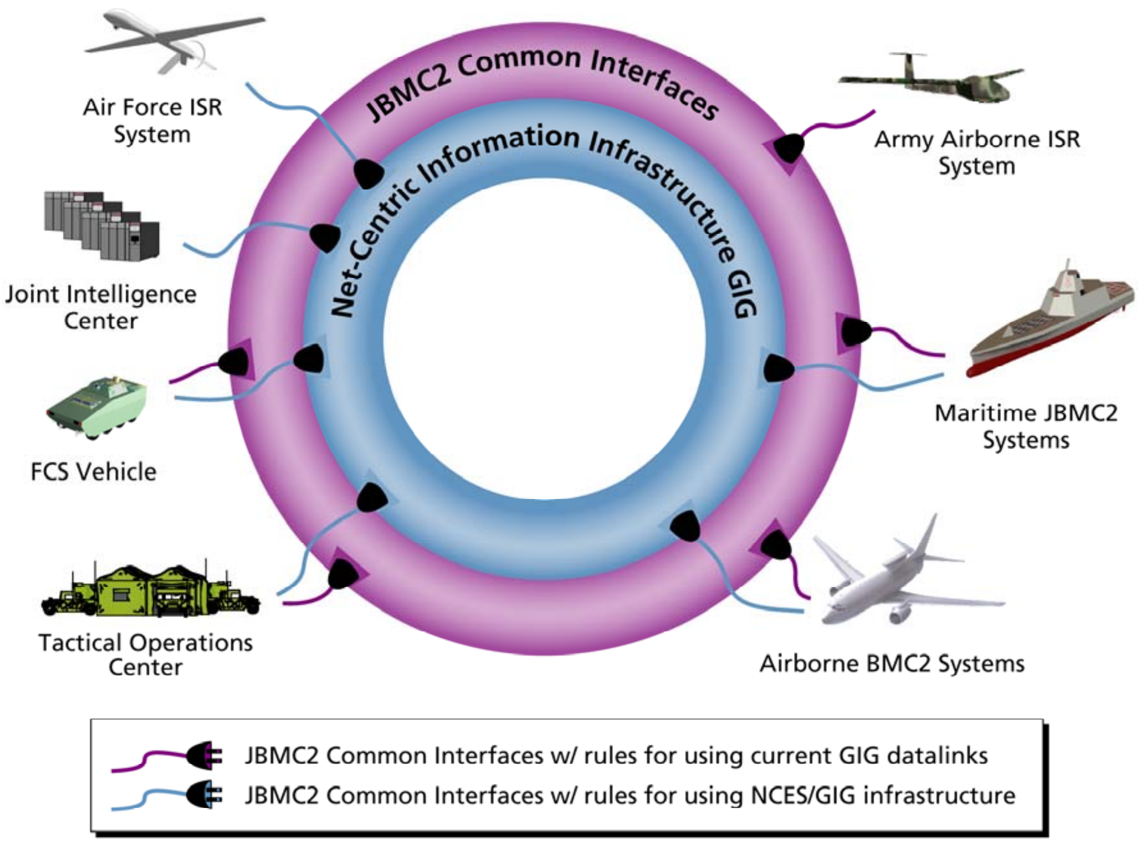

Figure 1.6—Net-Centric Enabling of Mission Threads

Figure 1.7 shows the layers comprising a common interface.

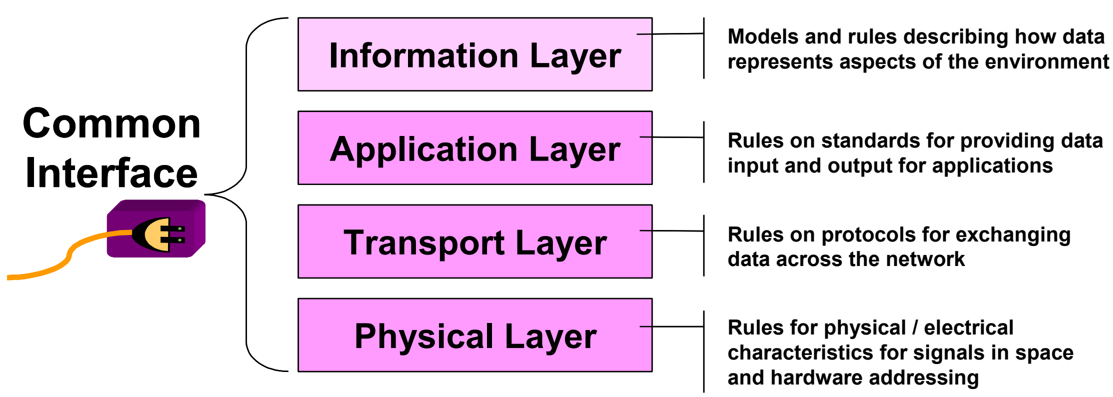

Figure 1.7—Layers of a Common Interface

The bottom three layers describe rules for using the network infrastructure to distribute a range of data, whether the infrastructure is the current infrastructure (e.g. tactical datalinks) or the future planned GIG / NCES infrastructure. The physical layer describes which physical components and signals in space or waveforms may be used to exchange information, such as the use of the Joint Tactical Radio System (JTRS) Wideband Networking Waveform (WNW) or Link-16 waveforms and the corresponding radios. The transport layer describes which protocols may be used to transmit the data across the network, such as the use of the Internet Protocol (IP) v. 6.0, or the use of messaging standards such as TADIL-J or VMF.[6] The application layer describes which standards will be used to provide data input and output to systems' applications, such as the use of Extensible Markup Language (XML), Simple Object Access Protocol (SOAP), and so on.[7] The use of flexible rules for these layers across the range of available infrastructure will allow information to be shared across different types of infrastructure, as well as allow for a smooth transition from the current network components to the planned NCES / GIG components.

Whereas the bottom three layers define the sharing of a range of data, the top layer defines the data's meaning and use. The information layer prescribes models describing how the data represents aspects of the environment (and thus provides information to the warfighter), as well as business rules describing how the data should be used and maintained.

It is important to note that the implementations of the common interfaces and communications engineering for each system will vary depending on warfighting needs, systems development considerations, and technical constraints. In particular the joint force network infrastructure that underlies all JBMC2 capabilities must allow the individual warfighter to control how he detects, identifies, or targets an opponent. A balanced data distribution and communications approach 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. Thus, the implementations will range from high-bandwidth, net-centric based interfaces in which platforms will work as integrated components of a larger network, to low-bandwidth, datalink-like interfaces in which platforms will be largely autonomous. The family of systems architecture shown in Figure 1.7 (in this case, the Army's Future Combat System) shows the range of JBMC2 interfaces needed to support mission needs.

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[6] It should be noted that prescribed joint manage standards are essential for joint interoperability. VMF is an example of a set of sometimes incompatible message standards that may have to be made reduced and self consistent to ensure joint interoperability.

[7] The three bottom layers of the common are a simplification of the industry-standard Open System Interconnection Reference Model (commonly referred to as the OSI 7-layer model). In particular, the physical layer maps to the OSI model's Physical and Data Link layers; the transport layer maps to the OSI model's Network, Transport and Session layers; and the application layer maps to the OSI model's Presentation and Application layers. For information about the OSI model, see Tanenbaum, *Computer Networks*, 2nd Ed, Prentice Hall, 1989.

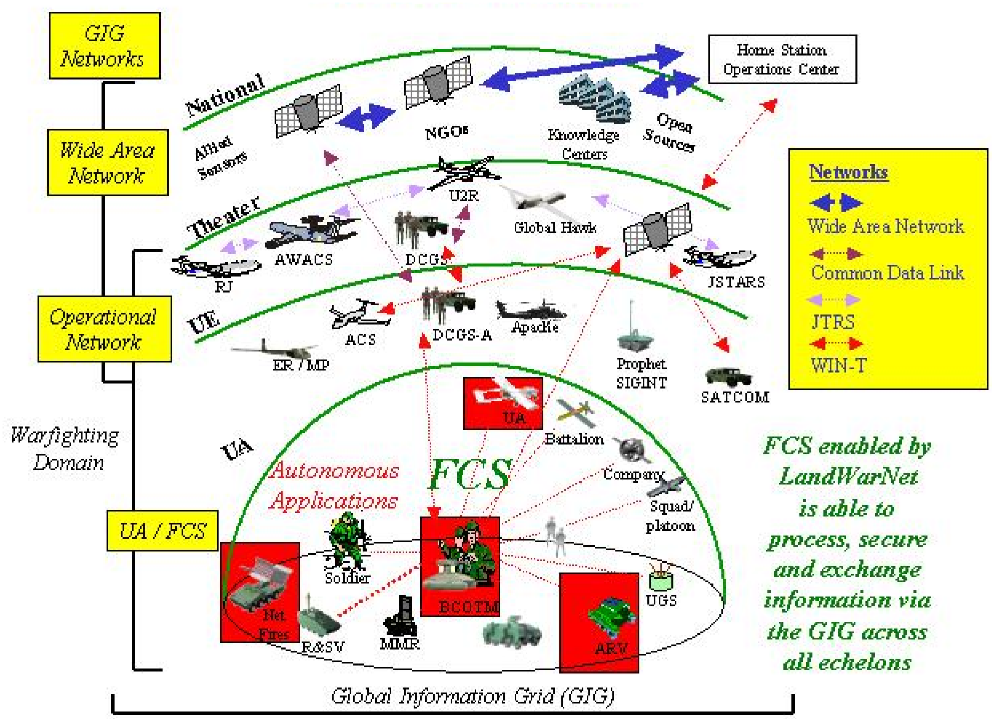

Figure 1.8—Proper Balance of Highly Integrated and Autonomous JBMC2 Capabilities is Needed by the Joint Warfighter

Engineering the appropriate means for information sharing and communications is a critical system of systems architecture consideration that will depend on the specific mission domain context. For example, for missile defense in which time delays and network latency are a critical source of mission failure, largely autonomous JBMC2 capabilities will likely be preferred for the foreseeable future. On the other hand, for operational-level applications, high bandwidth-dependent common services will likely provide acceptable levels of performance. Thorough systems engineering analyses will be required to determine the proper mix and integrated design of network based services and autonomous applications in tactical networks.

Both Net-Centric and non-Net-Centric JBMC2 systems will exist in the DoD for some time. In addition, the delivery date for NCES capabilities that can operate effectively without jeopardizing warfighting capabilities in bandwidth constrained tactical networks, has not yet been determined. Therefore a careful system's engineering review of individual programs will be needed to determine which ones can be transformed, when they should be transformed (i.e., when the necessary GIG supporting infrastructure is available and mature), and identification of those efforts that should be phased out and thus should not be made Net-Centric. This review process is an essential part of the JBMC2 Roadmap effort. Where it is technically feasible and can meet mission requirements, the preferred approach will be one that is fully consistent with the net-centric GIG and NCES architectures. This Roadmap provides a way ahead to perform such analyses.

It is expected that, over time, the topology of joint force networks will evolve from predominantly low-bandwidth, rigidly configured connections between small groups of platforms to high-bandwidth, flexible sharing of information across large segments of the joint force, with the latter relying on shared spaces to facilitate information distribution and common services to facilitate information use. It is also expected that the proposed net-centric infrastructure and services (NCES / GIG) will evolve towards supporting special modes of operation that gain efficiency, quality of service, and speed of response, such that it will be possible to support a full net-centric architecture at the tactical layer. This evolution toward full implementation of the GIG and NCES architecture will be driven by the rate at which technological developments can provide the following capabilities to the joint warfighter:

- High quality of service (QoS) for network services: to include guarantees of the data integrity, consistency, and assurance;

- "Sufficiently low latency," (SLL) guarantees of acceptable message receipt time delays under degraded battlefield conditions,[8]

- "Bandwidth on demand," as needed by the joint warfighter to complete particular mission tasks within required timelines; and

- Information sharing on demand, as needed by joint warfighters to complete a mission task within the required timeline.

1.6 Roles and Responsibilities

To bring about integrated JBMC2 capabilities in support of warfighting missions, the USD(AT&L), USJFCOM, ASD(NII), the Joint Staff, the Combatant Commanders, the Military Departments, and the Defense Agencies will work collaboratively, as follows:

[8] It is emphasized that *Bandwidth on Demand* and *SLL* do not literally refer to providing unlimited bandwidth with no latency. Instead, they refer to the operational objectives of never having a warfighter incurring a degraded mission capability as a result of having to wait for a network response, or not having the bandwidth to transmit or received mission-critical information. Thus, what Bandwidth on Demand and SLL mean depend on the mission. In missile defense missions, for example, SLL might mean a few milliseconds (needed to track a missile moving at Mach 5), whereas in ground maneuver it might mean a few seconds (needed to track a slow moving convoy).

- USD(AT&L) will lead the development of the JBMC2 Roadmap, in partnership with USJFCOM, and with the participation of the Joint Staff, Joint Requirements Oversight Council (JROC) (or FCBs on behalf of the JROC), Program Analysis & Evaluation, Services, and Agencies. In accordance with DoD 5000.2, Operation of the Defense Acquisition System, and as recently clarified in a memo by the USD(AT&L), the DoD will use this roadmap 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. USD(AT&L) will also lead a series of JBMC2 Capability Area Defense Acquisition Boards (DABs) to ensure that families of JBMC2 systems associated with the JMTs be able to effectively interoperate.

- USJFCOM will be responsible for the execution of the JBMC2 Roadmap, in accordance with MID 912. USJFCOM, in coordination with the Chairman, Joint Chiefs of Staff (CJCS), will lead the Combatant Commanders in the development of the JMTs, including the JMTs' joint doctrine, concepts, requirements, and integrated architectures for JBMC2 interoperability and connectivity with the participation of the ASD(NII), Services, and Agencies. Further, USJFCOM, in coordination with USD(AT&L), will lead the systems-of-systems engineering and common interface development efforts needed bring about integrated JBMC2 capabilities supporting the JMTs, with the participation of the Combatant Commanders, Joint Staff, ASD(NII), Services, and Agencies.

- The DoD Chief Information Officer (CIO), the ASD(NII), will lead the development and facilitate the implementation of the GIG integrated architecture supporting JBMC2 capabilities; OSD, the Services, Defense Agencies, Joint Staff, and Intelligence Community will participate in the development of the architecture.

- The Joint Staff (or Principal Staff Assistant [PSA] for business areas) and the JROC (or FCBs on behalf of the JROC) will review and validate requirements associated with the JBMC2 programs and will participate in the JMT development efforts described above, in accordance with the JCIDS process (CJCSI 3170.01D). The Joint Staff and JROC will also review and validate requirements proposed by the USJFCOM-led JBMC2 development and engineering efforts as needed to bring about integrated JBMC2 capabilities.

1.7 Outline of the JBMC2 Roadmap

The Roadmap provides prescriptions for the way ahead to achieve integrated JBMC2 capabilities and describes existing JBMC2-related programs and initiatives. The latter provide visibility into the current state of JBMC2 development and will be used to synchronize these programs and initiatives to achieve integrated JBMC2 capabilities.

- Section 2 describes the development of an operational concept for JBMC2, the development of the JMTs, and corresponding integrated architectures development. It also describes existing integrated architecture development efforts related to JBMC2. The end of the section describes work to date to develop the Joint Close Air Support, Time-Sensitive Targeting, and Joint Force C2 JMTs.

- Section 3 describes the general approach for working with programs to achieve integrated JBMC2 capabilities. It identifies families of programs needed to support the JMTs (program clusters), as well as a set of "Pathfinder Programs" providing core JBMC2 functionality across the JMTs, and describes how the program clusters will be tested. The section also describes a process for evaluating individual programs, determining whether they should be made interoperable or integrated as part of a program cluster, phased out, or converged into another program. The back portion of the section describes the Pathfinder Programs and their current major milestones (notably including interoperability milestones), as provided by the Services and agencies. Section 4 describes the general approach to system-of-systems engineering in support of the JMTs and to producing and disseminating a common battlespace picture across the JMTs. The back portion of the section describes the major JBMC2 initiatives dedicated to providing tools supporting system-of-systems engineering and the common battlespace picture, as provided by the initiatives. These include the Family of Interoperable Operational Pictures (FIOP), Single Integrated Air Picture (SIAP), Single Integrated Ground Picture (SIGP), and FORCEnet Maritime Picture (FnMP) initiatives.

- Section 5 describes the JBMC2 management roles and responsibilities, and management processes, in detail.

- Section 6 describes the JBMC2 Data Strategy, which guides the creation and management of the common interfaces for sharing information. The back of the section describes the existing Service and JBMC2 Initiative data strategies, as provided by the Services and initiatives.

- Section 7 describes the existing GIG Net-Centric Underpinning programs that will be relied upon to provide the core network infrastructure enabling JBMC2 capabilities. (There is no prescriptive analysis in this section of this version of the Roadmap.)

- Section 8 describes the development of DOT_LPF in support of the JMTs.

- Section 9 describes experimentation and technology in support of JBMC2. It describes the existing Advanced Concept Technology Demonstration process and portfolio, the current USJFCOM exercise and experimentation strategies, and the USD(AT&L)-sponsored Modular Open Systems Approach for designing systems and ensuring their interoperability and integration. (There is no prescriptive analysis in this section of this version of the Roadmap.)

- Section 10 describes the testing strategy for JBMC2. The section describes the way ahead for program cluster testing, as well as for enhancing testing infrastructure. The back of the section describes existing testing capabilities and the test status of the Pathfinder Programs.

- Section 11 summarizes and concludes the JBMC2 Roadmap.

- Appendix A summarizes policy recommendations from industry on the JBMC2 Roadmap.

- Appendix B presents definitions and acronyms.

- Appendix C provides a list of guiding documents.

- Appendix D provides detailed schedule information for selected pathfinder programs.

2.0 JBMC2 Operational Concept, Joint Mission Threads, and Integrated Architectures

2.1 JBMC2 Operational Concept

The Department of Defense has traditionally 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 (Doctrine, Organization, Training, Materiel, Leadership, Personnel, and Facilities) 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 21st 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. A capabilities-based approach provides a framework to define Combatant Command (COCOM) desired effects and the capabilities needed to achieve them. This approach shifts the framework from threat-based force development to forces planning based on a set of needed capabilities. These capabilities are derived from joint operating concepts describing how the joint force will operate with specified segments of the range of military operations (ROMO) and a set of joint functional concepts describing the desired capabilities within each functional area across the ROMO. The ROMO, approved by the Joint Requirements Oversight Council (JROC), captures 43 activities that focus DoD preparation and provide the foundation and operational context for the Joint Operating Concepts (JOCs).

The JBMC2 operational concept will be developed utilizing a capabilities-based analytical construct. The JROC will determine whether the JBMC2 operational concept is pursued as a Joint Operating, Joint Functional, or Integrating Concept. Regardless of which of these avenues the JBMC2 operational concept follows, it will be validated through joint experimentation and other rigorous analysis to a refined concept for JROC approval. With approval, the JBMC2 operational concept will support Joint Capabilities Integration and Development System (JCIDS) analysis. The JBMC2 operational concept will establish desired effects, highlight joint force BMC2 capabilities, identify associated attributes of that force that enable 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. In particular, the operational concept will focus on JBMC2 capabilities needed in support of the seven core joint warfighting capabilities identified in Section 1 (and described below).

The U.S. Joint Forces Command (USJFCOM) will partner with U.S. Strategic Command (USSTRATCOM) to develop a JBMC2 operational concept, with the participation of the Assistant Secretary of Defense (Networks and Information Integration) (ASD[NII]), Services, and Agencies. A timeline with development strategy will be provided in the next update to this Roadmap, scheduled for October 2004.

2.2 Joint Mission Threads

This subsection provides a description of Joint Mission Threads (JMTs), roles and responsibilities for JMT development, relationships of JMTs to guiding documents, and JMT integration. To date, the Joint Close Air Support, Time-Sensitive Targeting, and Joint Task Force C2 JMTs have undergone significant development; this work is described in the remainder of the section.

2.2.1 Description of Joint Mission Threads

Section 1 of the JBMC2 Roadmap identified a focus on seven core joint warfighting capabilities that depend critically on JBMC2 capabilities:

- Joint Task Force Command and Control (Operational C2)
- Joint Close Air Support
- Time-Sensitive Targeting
- Joint Ground Maneuver
- Integrated Air/Missile Defense
- Integrated Fires
- Focused Logistics.

A *Joint Mission Thread* provides a comprehensive description of how the joint force will execute one of these seven warfighting capabilities, using enhanced JBMC2 capability, focusing on improved interoperability and connectivity. For the JBMC2 Roadmap, JMTs provide the core framework for identifying needed JBMC2 capabilities, and hence requirements to provide those capabilities. A JMT includes the following elements:

- Warfighting capability needs, derived from joint doctrine and Lessons Learned documents

- DOT_LPF elements describing the execution of the capability, to include joint concepts of operations, doctrine, and tactics, techniques, and procedures (TTPs)

- Architectural products identifying key operational nodes, activities, shared information elements, and modes of communication and collaboration needed to execute the warfighting capability

- Performance measures and metrics evaluating the execution of the capability's activities and the capability as a whole, as well as evaluating the shared situational awareness, collaboration, and decisionmaking influencing capability performance[9]

- Identification of JBMC2 systems and technologies essential to execute the warfighting capability.

It is important to note that a JMT does not refer to a single, mission-specific, step-by-step execution chain but a more general description of how a capability will be provided. Thus, a JMT provides unifying direction for the full range of mission-specific execution chains. Mission-specific execution chains will be developed as part of JMT DOT_LPF and architectural product develop, to help provide context for the JMT.

It is also important to note that the specific elements of each JMT will vary, and evolve over time, depending on the needs for JMT products and the maturity of the warfighting capability (e.g., JMTs for capabilities that already have joint concepts and integrated architectures will be able to incorporate these). Early JMT products will tend to define desired warfighting capability at a high level and will be used in making high-level decisions, such as those made by the capability area Defense Acquisition Boards (DABs) (c.f. section 5). Later JMT products will provide more technical detail in direct support of systems engineering and testing efforts.

The JMTs will be used to generate requirements across the DOTMLPF spectrum. On the nonmateriel side, JMTs will provide direction for further DOT_LPF development

[9] Measures and metrics for situational awareness, collaboration, and decisionmaking will be derived from the Network Centric Operations Conceptual Framework, developed by the Office of Force Transformation and ASD(NII), as well as the Net-Ready KPP specified in CJCSI 6212.01.C, *Interoperability and Supportability of Information Technology and National Security Systems*, November 20, 2003.

efforts, including development of detailed doctrine, TTPs, and training programs (see Section 8).

On the materiel side, the JMTs will be used to identify the key set of JBMC2 programs enabling the JMT's warfighting capability—*the JMT program clusters*. JMT program clusters are described in more detail in Section 3. The JMTs will be used to generate capabilities requirements to the systems engineers seeking to make the systems in the cluster "interoperable" with respect to enabling the JMT's warfighting capability (c.f. section 4) and requirements for information sharing to the engineers developing common interfaces (c.f. section 6). The JMT's will also provide requirements for DT&E and OT&E tests of the program clusters that will analyze the progress the program clusters are making in jointly enabling warfighting capability.

The JMTs also support programmatic analysis. Cluster programs will be evaluated with respect to whether they can enable a warfighting capability as described by the JMT. If JMT-derived performance parameters are not met by desired dates, the JBMC2 Capability Area DABs will be able to choose from the following corrective actions:

- If no program supports an essential JMT objective or task 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 will be deemed a candidate for phase out. (Note that some programs may support more than one JMT; this will be considered prior to making a phase out decision.)

- If a particular program's characteristics will lead to unsatisfactory mission performance, modify the KPPs of the program.

- If particular a program's milestones will lead to the unacceptable delays in the 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.)

2.2.2 Roles and Responsibilities for Joint Mission Threads

USJFCOM, as chief executor of the JBMC2 Roadmap, and in accordance with MID 912,[10] will lead the Combatant Commanders in the development of the JMTs in coordination with the Chairman, Joint Chiefs of Staff, and with the participation of ASD(NII), Services, and Agencies. USJFCOM will sponsor JMT development groups for the purposes of developing and managing the JMTs.

The Joint Staff (or Principal Staff Assistant [PSA] for business areas) and the JROC (or Functional Capabilities Boards (FCBs) on behalf of the JROC) will review and validate requirements for the development of JMTs. The appropriate FCBs will cosponsor the JMT development groups and will lead development of operational architectural products for the JMTs in accordance with DoDI 5000.2. The Joint Staff and JROC will review and validate the DOT_LPF and architectural products for each JMT, and use the JCIDS process to define corresponding requirements to bring about integrated JBMC2 capabilities as specified by the JMT (c.f. CJCSI 3170.01D).

(Section 5 provides more information on JBMC2 management.)

2.2.3 Relationships Between JOCs, JFCs, Joint Mission Threads, and JBMC2 Capabilities

The JMTs will directly reflect guidance from the JBMC2 Operational Concept. There are several other overarching documents that will directly influence the development of the JMTs as well: the Joint Operations Concepts, the Joint Operating Concepts, and the Joint Functional Concepts. The JMTs will incorporate the relevant capabilities, attributes, and metrics specified in these documents.

The Joint Staff has developed a conceptual framework to describe the conduct of future joint military operations. The overarching concept, the Joint Operations Concepts (JOpsC) provides the operational context on how the future joint force will operate across the range of military operations. It focuses on the strategic and operational levels of war and crisis resolution. The JOpsC is based on a "capabilities-based" approach to joint warfare and provides the unifying framework for developing joint operating, concepts, joint function concepts, enabling concepts, and integrating capabilities. It assists in structuring joint experimentation and assessment of activities to validate these subordinate concepts.

A key tenet of the National Military Strategy is the development of a capabilities-based approach, which focuses on how to defeat a broad array of adversary capabilities vice a specific threat. Thus, this approach shifts from threat-based force development to force

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[10] MID 912 "expands the USJFCOM role in establishing joint BMC2 mission/capability area requirements and in identifying system-of-systems capability requirements. In this expanded role, USJFCOM, in coordination with the Chairman, Joint Chiefs of Staff, will lead Combatant Commanders in the development of joint doctrine, concepts, requirements and integrated architectures for BMC2 interoperability and connectivity. USJFCOM will coordinate proposed joint BMC2 mission capability area requirements and systems-systems capability requirements with the Joint Requirements Oversight Council (JROC), who will ensure USJFCOM's joint efforts are synchronized with other mission areas."

planning based on a set of desired capabilities for any given military operation. These desired capabilities are derived from a set of JOCs and joint functional concepts (JFCs). The JOCs are focused at the operational level and describe how a Joint Force Commander will plan, prepare, deploy, employ, and sustain forces. They are narrowly scoped to allow for development of desired operational capabilities. These capabilities are examined in terms of assumptions, attributes, and metrics in order to identify tasks. JOCs are measurable to allow for experimentation. The Joint Chiefs and Transformation Planning Guidance have identified four JOCs: Military Combat Operations, Stability Operations, Homeland Security, and Strategic Deterrence. The JFCs amplify a particular military function by describing how a future JFC integrates a set of related military tasks to attain capabilities required across the range of military operations. Individual functional concepts outline desired joint capabilities. The JROC provides guidance for joint functional concepts. The Joint Chiefs of Staff have identified six functional concepts: Joint C2, Battlespace Awareness, Force Application, Focused Logistics, Force Protection, and Net Centricity. These concepts are aligned with the FCBs, which develop the functional concepts.

Of primary importance in defining JBMC2 capabilities is 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. The Joint C2 Functional Concept focuses primarily on the operational level of war and describes how command and control will be performed to achieve success when executing missions and operations described in the Joint Operating Concepts. The concept provides the measurement framework for evaluating the command and control investment options needed to implement Joint C2 and for assessing those investment decisions. The Joint C2 Functional Concept also serves to

- Generate thought and discussion about new methods for performing command and control across the range of military operations
- Provide a starting point for the development of operational, system, and technical architectures
- Provide the basis for military experiments and exercises.

Table 2.1, copied from the Joint C2 Functional Concept (revision date 31 December 2003), identifies the major joint C2 capabilities and attributes, as well as which capabilities possess which attributes. The seven JMTs will directly incorporate these capabilities and attributes. For example, the Joint Close Air Support (JCAS) JMT will describe the monitoring and collection of data (such as target information and blue force data) needed by JCAS planners and operators, the desired development of situational understanding by JCAS planners and operators, and so on.

At the same time, JMTs will also incorporate the key capabilities and attributes of the other JFCs, as appropriate. For example, JCAS itself is predominantly a force application activity that includes elements of force protection (when JCAS is used to defend ground forces from an attack) and battlespace awareness (in terms of the intelligence, surveillance, and reconnaissance [ISR] systems used to generate targeting information). The relevant capabilities and attributes from all these JFCs will be incorporated into the JCAS JMT.

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

2.2.4 JMT Integration

USJFCOM will have the responsibility for JMT integration, which will occur in two major ways. The first is the Joint Task Force C2 Mission Thread, which largely defines operational-level JBMC2. This thread defines "top-down" integration of the JMTs. It encompasses all JTF-level joint command and control and battle management capabilities. USJFCOM is developing an integrated architecture for this JMT, the Joint Task Force Baseline Architecture, which is described in Section 2.5; this architecture will be the primary point of cross-cutting convergence layer for other JBMC2-related architectures.

The second way defines "bottom-up" integration and involves the development of core JBMC2 capabilities that underlay and support the other JMTs. USJFCOM will lead development of core DOT_LPF and architectural products that will be used in common across the JMTs, based on the Joint C2 Functional Concept's key capabilities and attributes. For example, USJFCOM will lead development of concepts and architectural products describing the collection and propagation of core situational awareness data across the joint force (such as combat ID and Blue Force Tracking information) and which enable collaboration across the joint force (such as core requirements for modes of communication).

Similarly, it was noted earlier that JMT elements include the identification of key JBMC2 systems and technologies needed to enable the JMT's warfighting capability. In the JMT integration process, a common core of JBMC2 systems and technologies that provide critical support across the range of JMTs will be identified and will be the focus of system integrated efforts and interoperability testing. These are the *JBMC2 Pathfinder Programs*, discussed at length in Section 3.

2.3 Joint Close Air Support Mission Thread

Close Air Support (CAS) is

> "air action by fixed-and rotary-wing aircraft against hostile targets which are in close proximity to friendly forces and which require detailed integration of each air mission with the fire and movement of those forces."[11]

The scope of the CAS mission area includes the basic definition of CAS as it appears in the Joint Dictionary and in the current revision of JP 3-09.3 (Joint TTPs for CAS). Once CAS is applied in the joint environment, the mission area becomes inherently more complex and dangerous. The processes involved in effectively providing CAS in the joint environment, i.e., JCAS, are reliant upon five operational elements:

- Planning
- Preparation

[11] (U) Joint Publication 1-02, DoD Dictionary.

- Execution
- JBMC2 (the backbone necessary for integrating all the elements above)
- Training (as a required foundation for success).

Serious shortcomings in the execution of the JCAS mission have been encountered in recent operations in Kosovo, Afghanistan, and Iraq. These shortcomings have led to a number of materiel and nonmateriel solution initiatives. The JCAS mission area is a high-priority joint mission area that requires tight and responsive linkages among weapons platforms and operational nodes of all four Services. Consequently, the leading JMT that will be used to define the first cluster of JBMC2 programs will be the JCAS JMT.

USJFCOM has been leading development of a JCAS integrated architecture, now approaching completion and initial validation. This preliminary architecture is the basis for this version of the Roadmap's identification of the key operational nodes, links, and systems involved in JCAS.

Figure 2.1 identifies the key operational nodes, communications links, and platforms involved in the JCAS mission. In the JCAS JMT, mission threads commonly start with the detection and identification of the target by a terminal attack controller (TAC). The TAC sends a request for CAS to the appropriate C2 node in the established chain of command. This C2 authority reviews the request and determines whether a suitable aircraft/weapon pair is available. As indicated in the figure, multiple C2 nodes may be involved in this decisionmaking process, depending upon the nature of the joint operation. JCAS target nomination, aircraft/weapon selection, and aircraft ingress and egress routes all depend on having an accurate and timely situational awareness (SA) of the battlespace. This battlespace SA has to be shared by all platforms, operational nodes, and C2 authorities involved in the JCAS mission thread. In the past, this shared SA was provided by the traditional "9-line" air support request (ASR) message. In recent operations, this shared SA has been provided digitally. This has resulted in significant increases in mission effectiveness.[12] Therefore, an essential element of the JBMC2 system integration strategy for the JCAS JMT is the sharing of accurate and timely SA data to all key participants.

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[12] NCO case study on air to ground operations for OFT, SAIC.

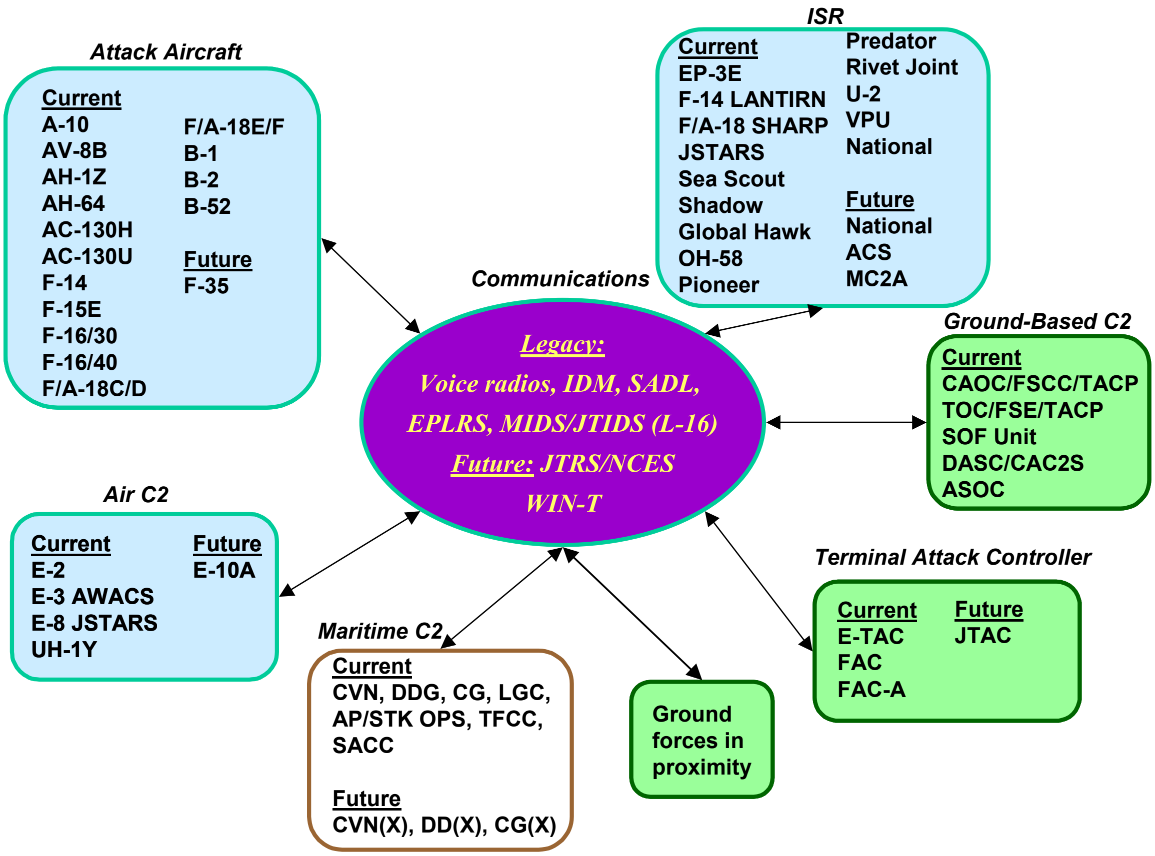

Figure 2.1—JCAS Platforms, Links, and Nodes

The full end-to-end execution of the JCAS mission and effective sharing of SA data involves many of the core JBMC2 programs identified as Pathfinder programs in this Roadmap. Some of the key JBMC2 programs that are essential for the end-to-end execution of the JCAS mission thread in the near term (before 2009) are shown in Figure 2.2. Both system and platform programs are shown; with the latter, the Roadmap's primary interest is in the JBMC2 capabilities the platforms possess that are or should be connected to the network.

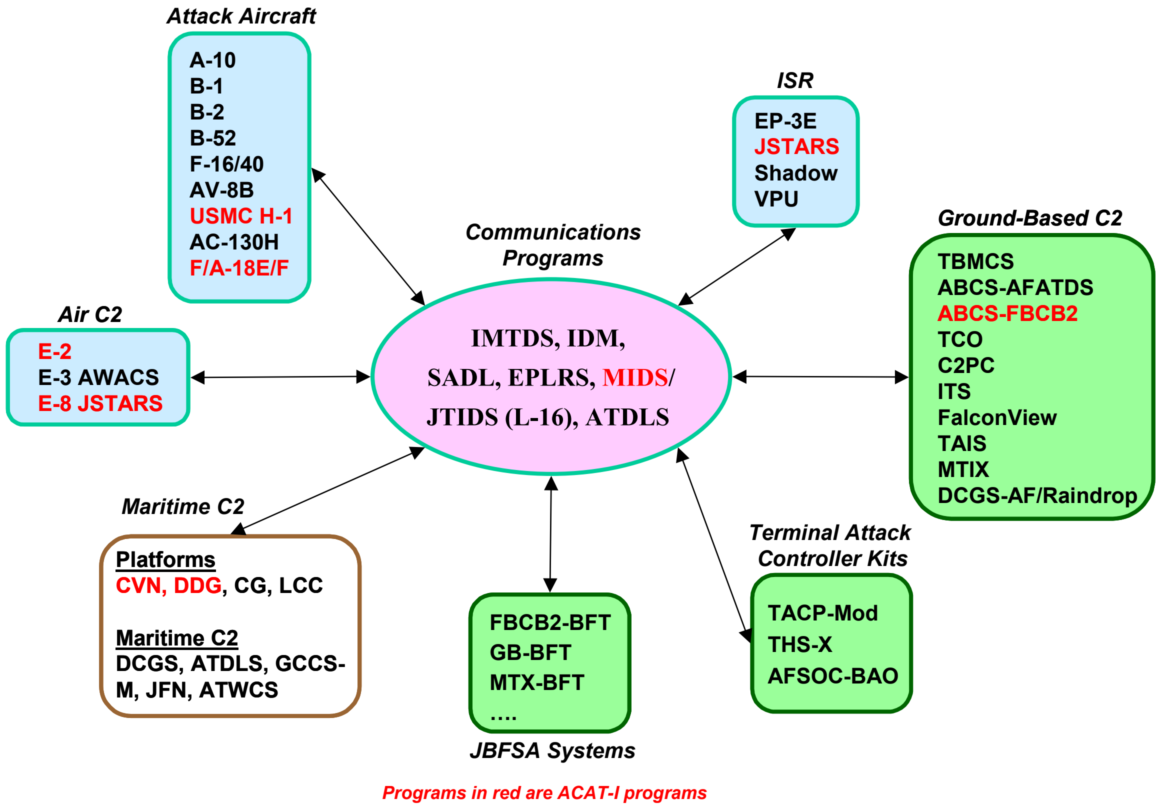

Figure 2.2—JCAS JBMC2 Programs (Near Term)

Figure 2.3 shows the key JBMC2 systems that will be involved in the JCAS mission in the far term (2012) in addition to the system in Figure 2.5 that will continue to be in service during this time frame. As is apparent from the table, many of these future systems that are now under development are Pathfinder programs. Current and developmental Pathfinder programs will comprise the core of the cluster of JBMC2 systems for the JCAS mission thread.

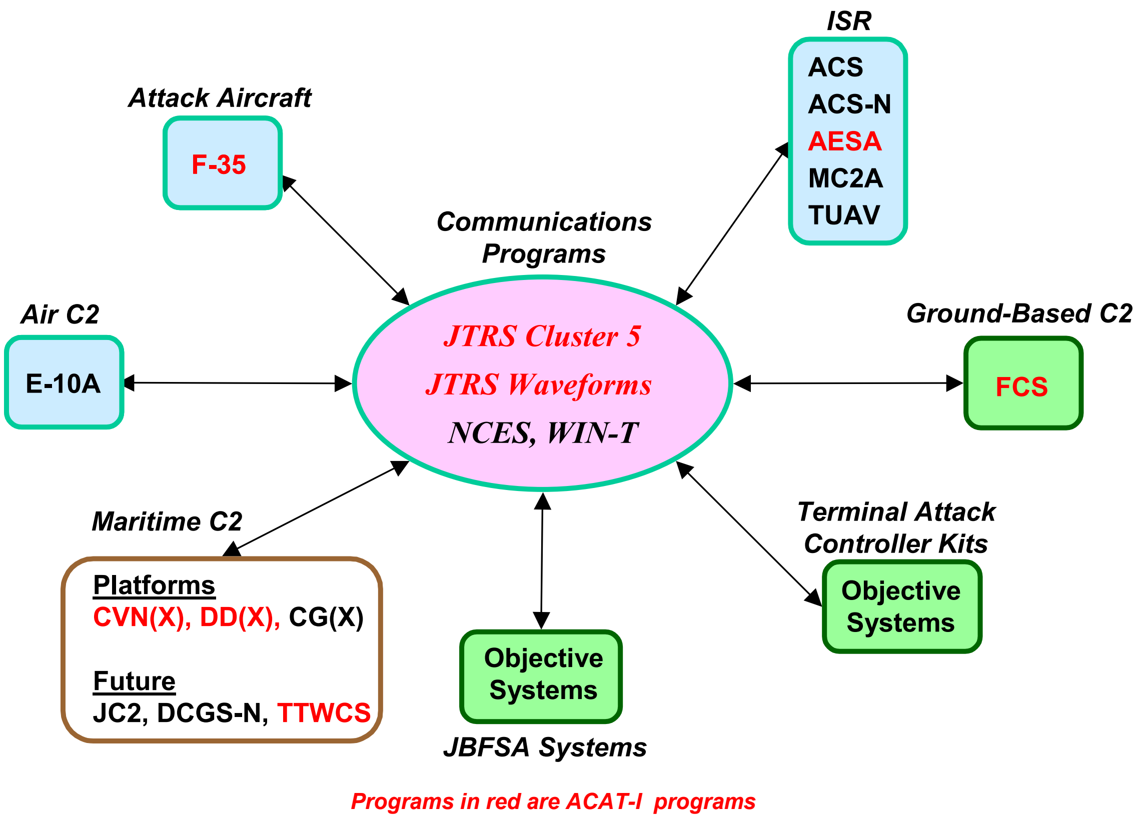

Figure 2.3—JCAS JBMC2 Programs (Far Term)

The full set of JBMC2 programs that will provide support for JCAS mission are listed in Appendix D. These programs are divided into two categories: Pathfinder programs, which form the core of this and other JMTs, and mission programs or systems that are unique to this particular mission thread or that provide limited functionality to this and other related mission threads. A subset of the full set of JBMC2 programs listed an Appendix D will be members of the first JBMC2 Capability Area DAB as described in Section 5.

2.4 Time-Sensitive Targeting Mission Thread

Time-Sensitive Targets (TSTs) are defined in Joint Publication 3-60 (Targeting) as:

Those targets of such high priority to friendly forces that the Joint Force Commander designates them as requiring immediate response because they pose (or will soon pose) a clear and present danger to a friendly force or are highly lucrative, fleeting targets of opportunity.

The TST JMT may be defined as comprehensive description for how the joint force will use JBMC2 capabilities to effectively engage the full range of TSTs likely to be confronted by theater COCOMs in future operations. Substantial architectural development work has been devoted to TST to date. A good deal of joint, multi-Service, and Service-specific work on TST threads and supporting DOTMLPF has been accomplished to date. However, this work has not yet been validated or codified in joint doctrine. USJFCOM will lead the integration of this material by developing the TST JMT.

Figure 2.4 compares the TST process descriptions from four joint and multi-Service sources, including:

- *Joint Command and Control Functional Concept*. While not examining TST directly, this JFC's "C2 Basic Cycle" is a framework for all C2 processes including TST. Figure 2.4 show the six steps in the C2 Basic Cycle.

- *Joint Publication 3-60, Targeting*. Figure 2.4 shows the six steps from this joint reference's process for TST.

- *Air Land Sea Application Center's (ALSA) Multi-Service Procedures for Targeting: Time-Sensitive Targets Multi-Service Tactics, Techniques and Procedures Package (MTTP).* This MTTP is an "interim manual" for TST and will be used by the training and doctrine communities of the four Services. Figure 2.4 shows the six steps in its process for TST, along with the subsidiary activities for each step.

- *Uniform Joint Task List (UJTL).* Figure 2.4 shows the UJTL tasks directly related to TST.

	Acquire Target			*Decide*		*Strike*	*Assess*
C2 FC	**Monitor**	**Understand**		**CoA**	**Plan**	**Execute**	**Assess**
JP 3-60	**Detect**	**Locate**	**Identify**	**Decide**		**Strike**	**Assess**
ALSA	**Find** • Intelligence preparation of the battlespace • Collection (ISR) • Emerging target detection and nomination	**Fix** • Focus sensors • Identify • Geolocate • Determine time available	**Track** • Prioritize ISR • Maintain track	**Target** • Determine desired effect • Weaponeer / Develop options • Satisfy restrictions • Deconflict • Risk assessment • Determine method • Final approval		**Engage** • Order engagement and transmit order • Monitor engagement	**Assess** • Bomb damage assessment • Report results
UJTLs	• OP 2.2.5 Collect Target Information • OP 2.3 Process and Exploit Collected Operational Information • OP 2.4 Evaluate, Integrate, Analyze Operational Information • OP 2.5 Disseminate and Integrate Operational Intelligence • TA 6.5 Provide for Combat ID			• OP 3.1.2 Apportion Joint Operational Resources • OP 3.1.3 Develop Operational Targets • OP 3.1.4 Develop High-Payoff and High-Value Targets • OP 3.1.5 Publish Air Tasking Orders • OP 3.1.8 Coordinate Immediate Targets for Two or More Components		• OP 3.2.3 Attack Aircraft and Missiles • OP 3.2.5 Interdict Operational Forces / Targets • TA 3.2.3 Conduct Interdiction Operations	• OP 3.1.6 Conduct Operational Combat Assessment

Figure 2.4—Comparison of Time-Sensitive Targeting Processes

As shown, all the process descriptions are roughly consistent, although subtle doctrinal differences may need to be resolved during JMT validation. Each can be fit into a core four-phase process, as follows:

- An "Acquire Target" phase, in which ISR resources collect and analyze information, identify and fix targets, and track the targets
- A "Decide" phase, which includes the planning and decisionmaking activities to determine desired effects, allocate resources to attack the targets, and develop target engagement orders
- A "Strike" phase, which includes the ordering and monitoring of the engagement
- An "Assess" phase, which includes assessing the results of the strike and whether a follow-up strike is needed.

While Figure 2.4 does not explicitly describe any of the Service-specific TST processes, a number of these have been reviewed and are broadly similar to the joint and multi-Service processes. Future TST JMT development and validation will resolve these potential differences and synchronize the doctrinal language and precepts of the Services, which is a necessary step toward achieving flexible and adaptive joint TST capabilities.

A number of the TST process diagrams described the systems needed to carry out the activities shown in Figure 2.4. Figure 2.5 shows the result of consolidating these process diagrams, and mapping them to the major joint TST processes—a consolidated list of major systems and platforms needed for TST.

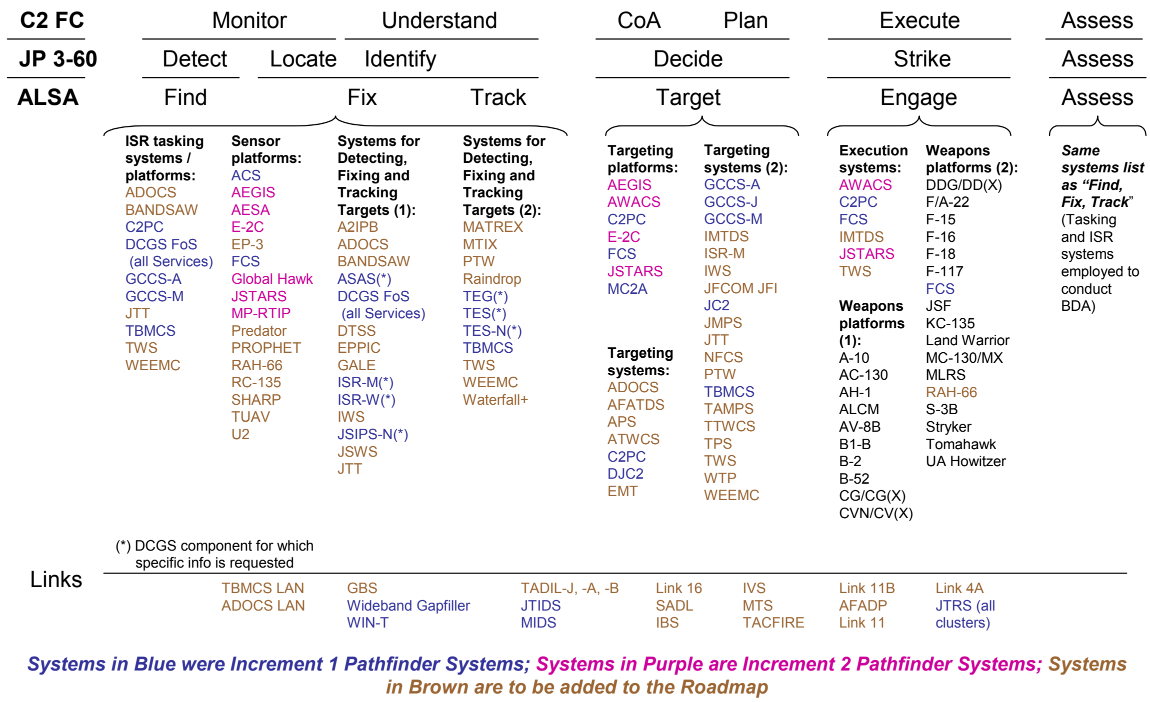

Figure 2.5—Major Systems and Platforms for Time-Sensitive Targeting

The large number of systems shown in brown has been identified as key to TST and will be incorporated in the Roadmap. Systems shown in blue have been previously identified as "Pathfinder Increment 1 Systems"; those shown in purple are hereby identified as crosscutting "Pathfinder Increment 2 Systems." Section 3 provides more information about Pathfinder programs, to include the full name and designations of the systems listed in Figure 2.8.

Time-Sensitive Targeting JMT Development. While the previously defined TST processes share overall similarities, there are significant differences in the details (as apparent even from the joint and multi-Service processes in Figures 2.4 and 2.5). It is vital, therefore, that a joint team develops a single overarching TST JMT for JBMC2. USJFCOM, in coordination with the appropriate FCB, will provide oversight and lead of the joint TST JMT development team, which will develop integrating DOT_LPF and architectural products for joint TST, as described in section 2.2. The team will include representatives from all agencies (joint and Service-specific) involved in developing TST threads and should include firsthand inputs from TST-related Service and joint experiments, so the latest and most advanced thinking on TST CONOPs, systems, and TTPs can be incorporated in the TST JMT. The JMT will evolve in its level of detail over time, starting with high-level products suitable for use by the TST Capability Area DAB (to be scheduled for some time in FY 2005) and providing more detailed descriptions to support planning for the first cycle of JMT cluster interoperability tests (currently, the initial diagnostic cycle of interoperability testing is scheduled for FY 2006). Further, JMT development should be able to correlate

TST activity inputs and outputs to the appropriate JBMC2 common interfaces by the start of the second quarter of FY 2005.

There are a number of lessons learned from Operation Iraqi Freedom (OIF) that should be evaluated explicitly by the TST JMT development team:

- There is a need to sustain and improve TST advances from OIF through joint training, development of joint TTPs, and development of advanced concepts (USJFCOM Lessons Learned (LL)).

- There were interoperability problems between the CAOC and the ground force units the CAOC supported (CAOC LL describes in more detail).

- There were interoperability problems, particularly with Army systems, in establishing the Integrated Air Picture (V Corps LL).

- The CAOC should be able to distribute the Air Tasking Order (ATO) and Airspace Coordination Order (ACO) to non-U.S. partners in OIF (CAOC LL).

- Battle Damage Assessment (BDA) was seen as major impediment to EBO during OIF. To improve BDA, the existing federated BDA process should be integrated and automated. Further, greater prioritization needs to be given for the use of ISR assets in poststrike collection, especially for time-sensitive targets (USJFCOM LL, CAOC LL).

2.5 Joint Task Force C2 Mission Thread

2.5.1 Joint Task Force C2 Development

Joint forces supported by the Joint Task Force Command and Control (JTFC2) capability will have tailored situational awareness and networked communications and will employ maneuver and fires throughout the depth of the battlespace to defeat adversary forces. JTFC2 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. JTFC2 reachback capabilities will exploit global expertise and information centers of excellence. Users' ability to rapidly access distributed, nondeploying 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. The JTFC2 JMT will describe the provision of 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 U.S. forces' ability to undertake missions as assigned in peacetime and wartime.

- Intelligence. Joint Intelligence Preparation of the Battlefield (JIPB), targeting, 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 U.S. organizations from enemy/terrorist threats. Activities include integrated air and missile defense, Homeland Security and Homeland Defense (HLS/HLD), consequence management, and related crisis response operations.

The JTFC2 JMT provides for the operational "command and control" of all other JBMC2 activities, including execution of the other JMTs. Thus, the JTFC2 JMT is a primary means for integrating the JBMC2 JMTs. (As discussed, the other is the development of the common battlespace picture and core collaboration functionality that will be shared across all JMTs).

2.5.2 JTFC2 JMT Architecture

USJFCOM is leading development of an integrated architecture for the JTFC2 JMT—the JTF Baseline Architecture. Figure 2.6 shows the timeline of the JTF Baseline Architecture, as well as the large number of architecture development efforts that will use the JTF Baseline Architecture as a point of convergence.

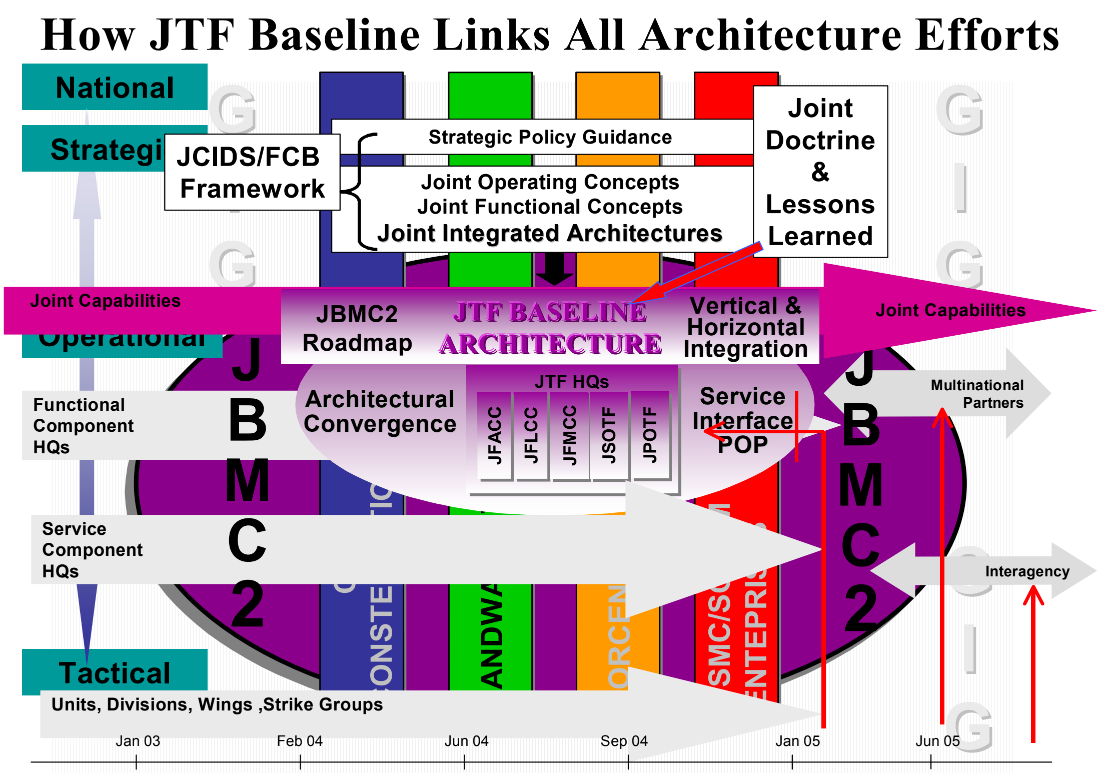

Figure 2.6—How the JTF Baseline Architectures Links All JBMC2 Architecture Efforts

The JTF Baseline Architecture provides an architectural area of convergence for the Service Enterprise Architectures, Functional and Service Component Headquarters, individual tactical units, and multinational and interagency partners, as shown in Figure 2.6. It provides an opportunity for horizontal and vertical integration that does not currently exist, but is needed to provide a common reference for participating in the JTF environment at the operational level of war. Once development is complete (between the 1st and 2nd quarter of FY05), the JTF Baseline Architecture will provide a point of presence (POP) that JTF participants can plug their enterprise architectures directly into and supply a vehicle for integration and interoperability that has never before existed.

For the JTF Baseline Architecture to be accepted in the operational and architectural communities, it will be vetted through architectural and operationally focused working groups and Integrating Product Teams. To begin this coordination process, the following seven-step methodology will be used by the JBMC2 Integrated Architecture team:

- Develop JTF HQ Core Architecture Baseline Views.
- Overlay Joint Mission Thread Views on step 1 Baseline Views.
- Provide Mission Thread Views to Services through integrated architecture working groups.
- Validate JTF HQ Core Architecture Baseline Views through USJFCOM architecture community.
- Provide Maintenance and Update of Validated Baseline Views from step 4.
- Provide JTF HQ Baseline Views to integrated architecture working groups and other standing groups that represent the "four pillar" architecture communities of interest.
- Working Groups in Step 6 will map the JTF HQ Baseline Views to the Integrated C2 Enterprise Architecture and other architectures under their oversight and authority.

2.5.3 Standing Joint Force Headquarters

The Standing Joint Force Headquarters (SJFHQ) is an initiative within the JTFC2 portfolio designed to reside, precrisis, within the Regional Combatant Command (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 precrisis 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 JTF C2.

Primary tasks of the SJFHQ include

- Support deliberate and crisis response EBP from precrisis through transition to peace
- Maintain day-to-day situation understanding within the focus area and awareness in the Area of Responsibility (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, nongovernment 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., Standard Operations Procedures (SOPs), TTP, and training).

2.5.4 Assessment of Current JTFC2 and Action Plan

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 collaborative information environment (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 following action plan describes the milestones and actions directed to achieve the capability objectives described above: Timeline charts are provided for each fiscal year from FY 2004 and FY 2008. Figure 2.7 shows the color key for each timeline entry.

KEY

GREEN → IIP actions
BLUE → PROJECTIONS
RED → ACTION RECOMMENDATIONS
BLACK → AS STATED IN DOCUMENTATION

Figure 2.7—Color Key for JTFC2 Timeline Charts

Figure 2.8 shows the timeline chart for the JTFC2 FY 2004 Action Plan. Descriptions of the specific action items follow.

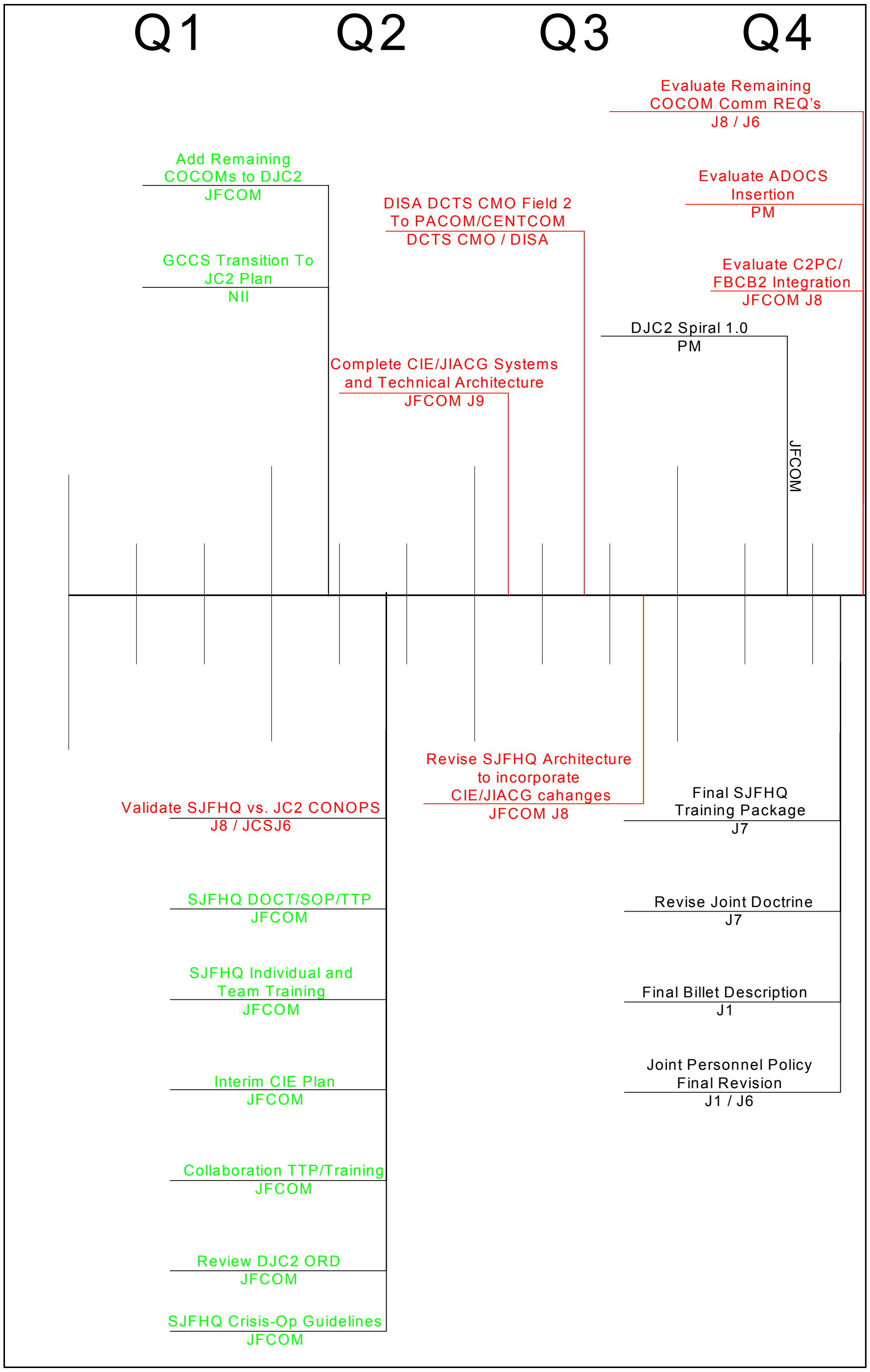

Figure 2.8—Timeline for JTFC2 Action Plan (FY 2004)

FY 2004-00 JF C2 FY 2004 (actions FY 2004-01 through FY 2004-10 have been previously assigned by the DoD Integrated Interoperability Plan of 01 October 2003 and are in progress).

FY 2004-01 USJFCOM, in coordination with the Chariman, Joint Chiefs of Staff, Services, and agencies (C/S/A) manage implementation of SJFHQ DOTMLPF change package approved by the JROC, first report due 01 March 2004.

FY 2004-02 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 2004-03 USJFCOM, in coordination with C/S, develop and conduct individual and team training for the SJFHQ by 01 March 2004.

FY 2004-04 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 2004-05 USJFCOM, in coordination with C/S, lead development of collaboration TTP and training and incorporate into the SJFHQ concept by 01 March 2004.

FY 2004-06 USJFCOM, in coordination with COCOMs, the Defense Information Systems Agency (DISA), and ASD(NII), lead effort to improve multinational information sharing and provide action plan to the Secretary of Defense by 1 March 2004.

FY 2004-07 U.S. Navy, in coordination with C/S, DISA, and Defense Intelligence Agency (DIA), ensure SJFHQ requirements, including information interoperability needs, are reflected in the Deployable Joint C2 (DJC2) Operational Requirements Document (ORD) and in system development by 01 March 2004.

FY 2004-08 USJFCOM, in coordination with C/S/A, develop plan to incorporate U.S. Special Operations Command (USSOCOM), USSTRATCOM, U.S. Transportation Command (USTRANSCOM), and U.S. Northern Command (USNORTHCOM) capability needs in the SJFHQ and DJC2 requirements documents by 01 March 2004.

FY 2004-09 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 2004-10 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.

FY 2004-11 USJFCOM, in coordination with the Unified Combatant Commanders (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 2004-12 USJFCOM J8, in coordination with the UCCs, USA, and USMC, evaluate the progress made toward the development of the Ground portion of the Common Operating Picture through the USA lead FBCB2/Command and Control PC (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 2004-13 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 2004-15 USJFCOM, complete 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 2004-16 USJFCOM, revise SJFHQ architecture to incorporate updates to the CIE and JIACG architectures no later than 15 Sep 04.

FY 2004-17 USJFCOM, in coordination with ALSA and RCCs, revise the SOP, TTP, and Doctrine to incorporate OIF LL and joint battle damage assessment (JBDA) results no later than 30 Sep 04.

FY 2004-18 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 the General Command and Control Systems and the Joint Command and Control System (GCCS/JCS) and tactical C2 systems; equip all ground units by 30 Sept 2006.

FY 2004-19 USJFCOM, present latest updates to JF C2 timeline to JBMC2 Board of Directors (BoD) to validate inclusion of recommendations generated from the Joint Center for Lessons Learned semiannually in the 2nd and 4th quarter

FY 2004-20 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, Theater Battle Management Core System (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.

Figure 2.9 shows the timeline chart for the JTFC2 FY 2005 Action Plan. Descriptions of the specific action items follow.

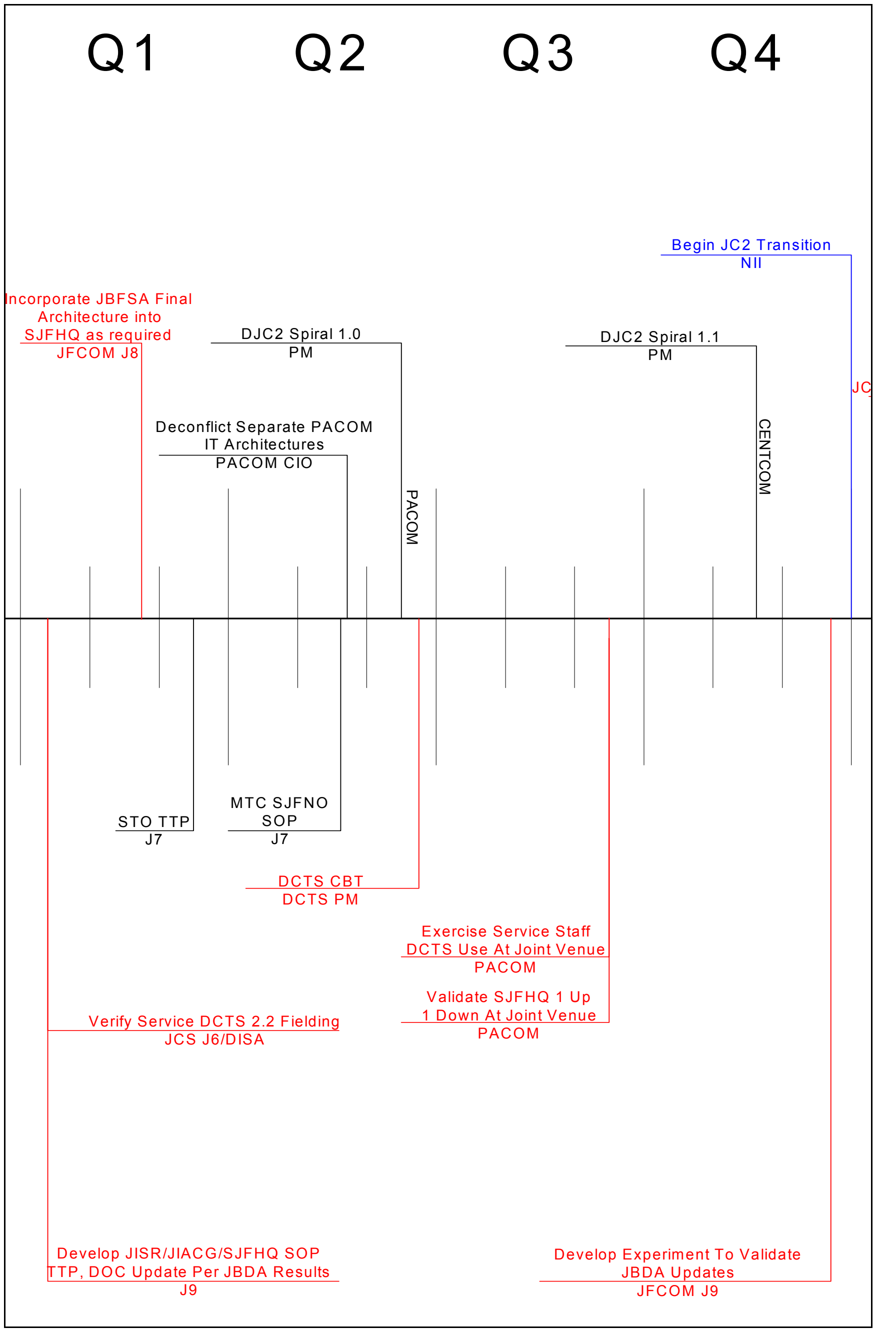

Figure 2.9—Timeline for JTFC2 Action Plan (FY 2005)

FY 2005-01 DISA Defense Collaborative Tool Suite (DCGS) CMO, in coordination with ASD(NII), verify the Services are fielding DCTS 2.2 as directed. Coordinate with USJFCOM to develop plan by 1st quarter FY 2005 to address shortfalls to ensure SJFHQ CIE capability is fully functional when DJC2 Spiral 1.0 fielded to the U.S. Pacific Command (USPACOM) in the 2nd quarter of FY 2005.

FY 2005-02 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 2005-03 DCTS Program Office, develop and fields 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 computer based training shall be initially available no later than 2nd quarter FY 2005.

FY 2005-04 USPACOM, in coordination with USJFCOM and Services, incorporate SJFHQ training event into appropriate Joint Training Exercise in 3rd quarter FY 2005, following DJC2 Spiral 1.0 fielding to USPACOM.

FY 2005-05 USPACOM, in coordination with USJFCOM and Services, provide assessment of the initial SJFHQ readiness, based on Joint Training Exercise results, along with recommendations for materiel and nonmateriel updates needed to fully realize capability by 30 Sep 2005.

FY 2005-06 USJFCOM, in coordination with COCOMs, JCS J2, and USD(I), develop 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 2005-07 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 2005-08 USJFCOM, in coordination with RCCs and UCCs, develop FY 2008 target JF C2 architecture no later than 01 July 2005.

Figure 2.10 shows the current timeline for the JTFC2 action plan for FY 2006–2008. Note that descriptions of the action items shown in the figure have not yet been prepared.

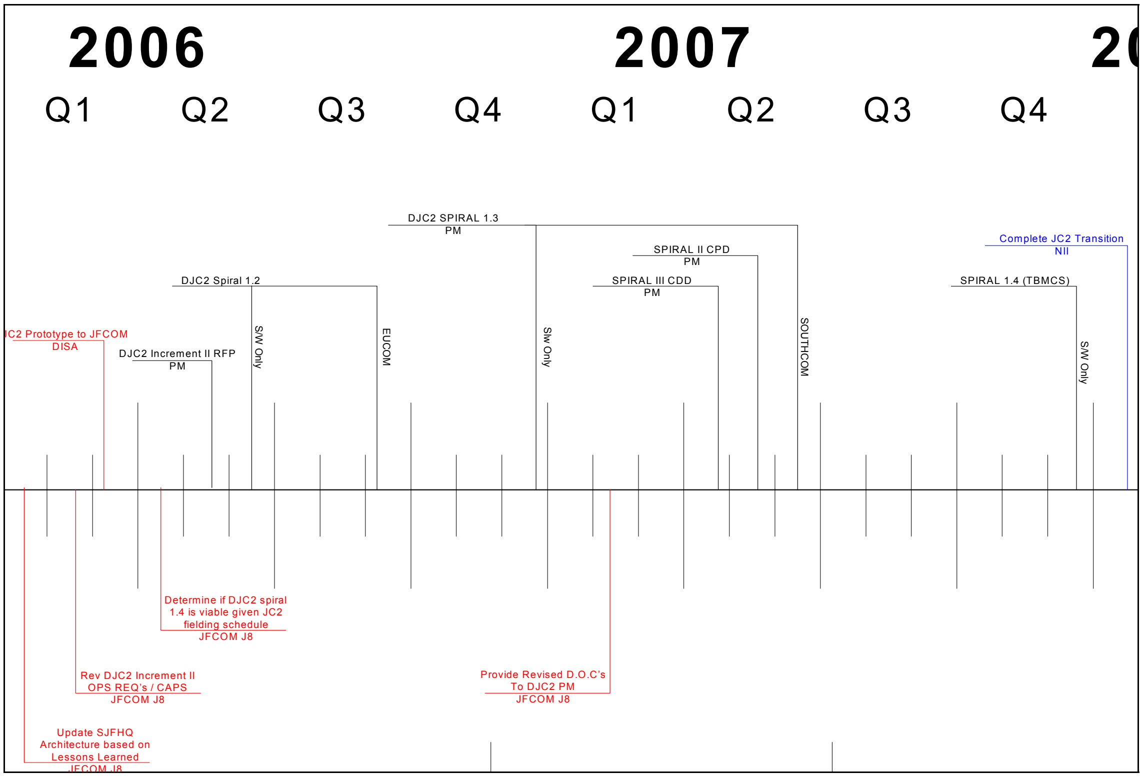

Figure 2.10—Timeline for JTFC2 Action Plan (FY 2006-2008)

2.6 Additional Joint Mission Threads

The remaining JMTs—Joint Ground Maneuver, Integrated Fires, Integrated Air/Missile Defense, and Focused Logistics—will be developed under the leadership of USJFCOM and in collaboration with the Services to help define additional JBMC2 capability and program clusters, and their related integration and interoperability test events. Descriptions of these JMTs will be included in future updates of the JBMC2 Roadmap.

2.7 JBMC2 Integrated Architectures

DoD Instruction 5000.2, *Operation of the Defense Acquisition System*, as clarified in a November 10, 2003, memo from USD(AT&L),[13] specifies that USD(AT&L), 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. DoDI 5000.2 specifies that the Joint Staff will lead development of operational views, the USD(AT&L) will lead development of systems views, and the

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

USD(AT&L) and ASD(NII) will lead development of technical views in parallel with the systems views. DoDI 5000.2 also specifies that the FCBs will be the forum for the development of the operational and systems views.

However, DoDI 5000.2 does not assign any organization a lead role in the overall development of integrated architectures, integrating across all three views. MID 912 gives USJFCOM this leading role for integrated architectures in the JBMC2 area by stating, "…USJFCOM, in coordination with the Chairman, Joint Chiefs of Staff, will lead Combatant Commanders in the development of joint doctrine, concepts, requirements, and integrated architectures for BMC2 interoperability and connectivity."

Developing integrated architectures is a challenging task. Various definitions for integrated architectures are also complex, yet do not adequately address the full scale of efforts required to develop JBMC2 integrated architectures. DoDD 4630.5 (11 Jan 2002) defines an integrated architecture as: "An architecture consisting of multiple views or perspectives (Operational View, Systems View, and Technical View) that facilitates integration and promotes interoperability across family of systems and system of systems and compatibility among related architectures." The DoDAF (30 Aug 03) states that an integrated architecture "has integrated Operational, Systems, and Technical Standards Views with common points of reference linking the Operational View and the Systems View and also linking the Systems View and the Technical Standards View. An architecture is defined to be an integrated architecture when products and their constituent architecture data elements are developed such that architecture data elements defined in one view are the same (i.e., same names, definitions, and values) as architecture data elements referenced in another view." However, these definitions do not address the need to horizontally and vertically integrate the four pillars of architecture efforts currently ongoing in the JBMC2 environment and the synchronization of the efforts within and between those pillars. Therefore, USJFCOM defines a JBMC2 integrated architectures as the "organizational and functional integration of the three (Operational, Systems, and Technical) architectural views and associated products that cross-cut multiple organizations (U.S. and/or multinational) vertically and horizontally at the National, Theater, CJTF and Tactical echelons with the purpose of obtaining synchronized delivery and improvements for a fully integrated and interoperable joint BMC2 capability." (USJFCOM System Engineering Division, 10 July 2003).

Each JBMC2 integrated architecture is to be derived from the relevant operational and functional concepts, developed in accordance with the OASD(NII)-developed *DoD Architecture Framework (DoDAF) v1.0,* and integrated with the latest version of the *Global Information Grid (GIG) Architecture V2.0* and mapped to the accompanying *Net-Centric Operations and Warfare Reference Model (NCOW RM).* The JBMC2 architectures built by the Combatant Commands, Services, and Agencies will be fully aligned with FCB joint integrated architectures (JIA). JBMC2 integrated architectures will also be aligned with, and support, the JBMC2 Operational Concept and the seven subsidiary JBMC2 JMTs. Services and Combatant Commands shall continue to develop and maintain the systems view of their individual segment of the Command enterprise architectures, but they should be compatible with all required JIAs.

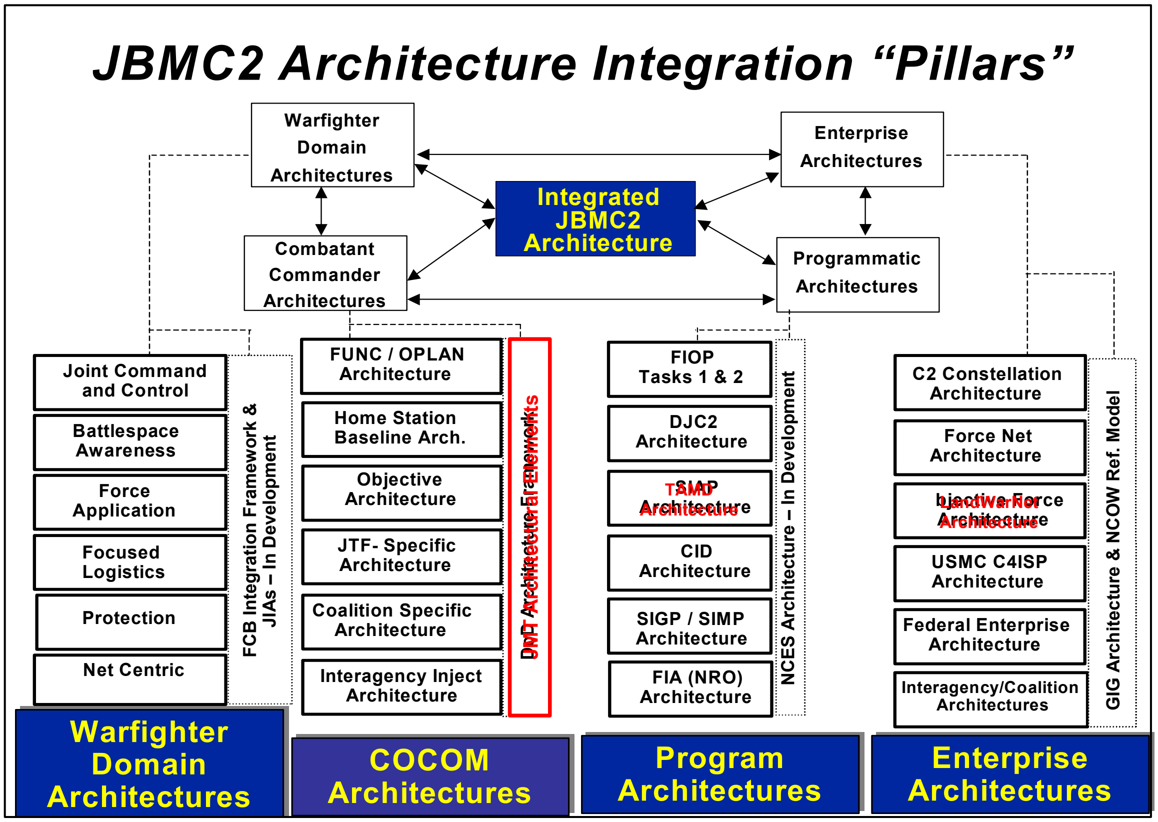

Figure 2.11—JBMC2 Architecture Integration "Pillars"

Figure 2.11 categorizes various ongoing architecture efforts. Several of these architectures include various JBMC2-related capabilities, even though they were built for different purposes at different levels of granularity. Despite these differences, many if not all of the architectures have to be integrated from a JBMC2 point of view to ensure development of interested JBMC2 capabilities. These vertical architecture efforts are:

- Warfighter Domain Joint Integrated Architectures, which are the result of the migration from the 11 joint mission areas (JMAs) to Joint Operational Concepts and Joint Functional Concepts. The efforts to provide an FCB Integration Framework to ensure all the FCBs have a common methodology in analyzing capability issues and the development of JIAs for each functional concept are shown as vertical integration activities across this pillar; although they, like all the vertical integrators shown, apply to all the other pillars as well.

- COCOM architectures that represent the regional and functional operational environments USJFCOM has been tasked to help improve. Since the DoD Architecture Framework (DoDAF) was developed as part of the OASD(NII) Command Information Superiority Architecture (CISA) Program that primarily supports the COCOMs, the DoDAF is shown as the vertical integration initiative in this pillar. Development of architectural products for the JMTs fall into this category, as they provide common descriptions of how the COCOMs will carry out core warfighting capability, integrating across the warfighting domains.

- Individual JBMC2 program and initiative architectures (Program Architectures) being built to support acquisition of material solutions for the JBMC2 environment are depicted in the third pillar. The Net-Centric Enterprise (NCES) program architecture is depicted as the cross-pillar vertical integration activity.

- Service/Agency architecture efforts, being developed to horizontally integrate programs and support POM processes are shown in the Enterprise Architectures pillar. The GIG Architecture and NCOW Reference Model cross-pillar vertical integrator was placed in this pillar to demonstrate the Services' requirement to map their enterprise architectures to the GIG Architecture and to provide a transition plan to mover toward enterprise net-centricity.

The activities in these four vertical pillars will be vertically integrated through the vertical integrators shown and horizontally integrated through USJFCOM leadership or participation on various working groups, shown in Figure 2.12. It is through a community approach to these integration efforts that USJFCOM will achieve a unified virtual, derived integrated JBMC2 architecture from the disparate JBMC2 architecture elements.

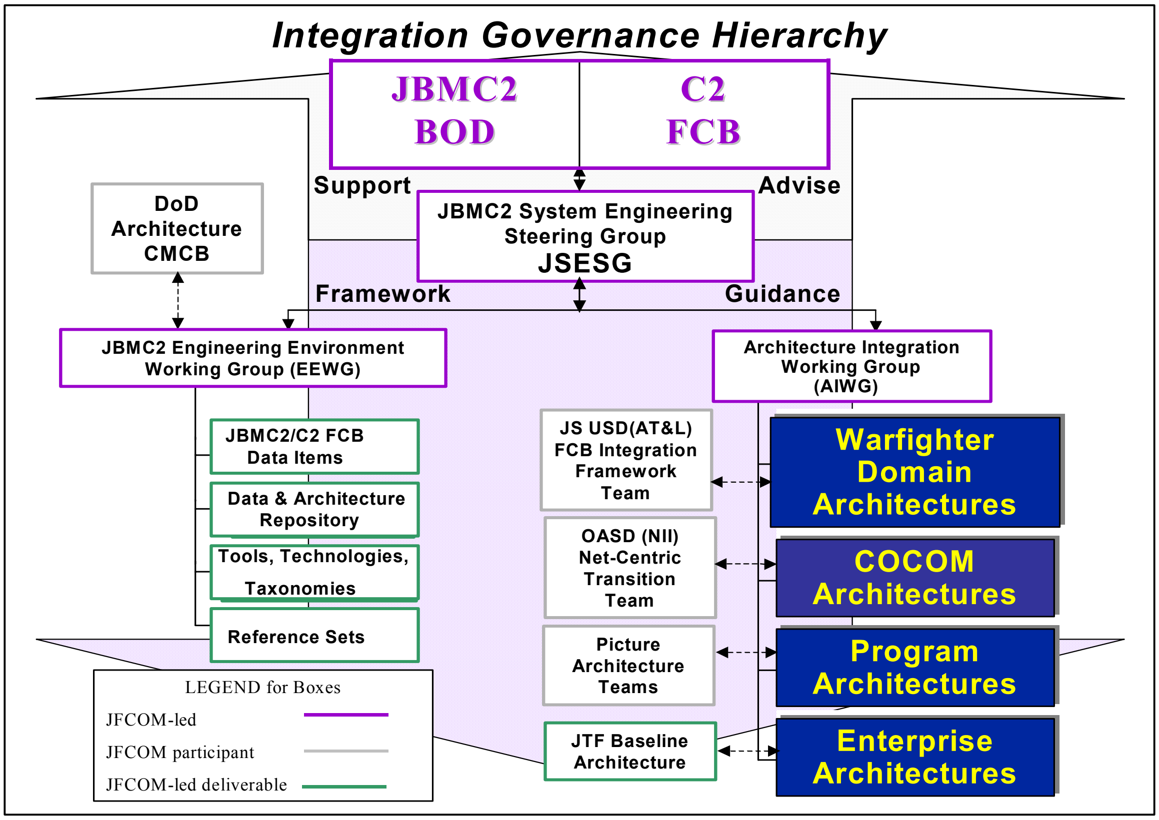

Figure 2.12—Integration Governance Hierarchy

This community approach allows the JBMC2 integrated architecture team to keep abreast of all architecture initiatives within each of the four pillars, as shown in Figure 2.12. The USJFCOM-led efforts will provide architecture framework references and guidance to the four pillars while providing support and advice to the USJFCOM-chaired C2 FCB and JBMC2 BoD. The JBMC2 BoD is the lead forum for the review and approval of integrated JBMC2 architectures, in accordance with MID 912; the C2 FCB (or other FCB, as appropriate) and USD(AT&L) are the lead organizations for developing the specific operational and systems views for the architectures, in accordance with DoDI 5000.2.

The gray boxes depict efforts that USJFCOM is a participant in, including the FCB Integration Framework team, a USD(AT&L) and Joint Staff-led effort that will provide direction to all the FCB leads. FCBs, chartered and approved by the JROC, are responsible per CJCSI 3170.01 for coordinating the development of an integrated architecture with corresponding views for each functional area with the assistance of the FCB Working Groups. The Joint Systems Engineering Steering Group will be the primary horizontal and vertical integrator for all architecture efforts and will provide both upward and downward direction and support to all echelons in the integration governance hierarchy. Integrated architecture deliverables are shown in the green boxes and include the development of the JTF Baseline Architecture, which is the centerpiece of the JBMC2 integrated architecture strategy. As previously discussed in sections 2.2.4 and 2.5, the JTF Baseline Architecture is part of the JTF C2 JMT development effort and is the principal convergence mechanism for all JBMC2-related architectures. The principal points for bottom-up convergence will be the architectural products for core JBMC2 capabilities shared across all JMTs and JBMC2 architectures, such as core situational awareness and collaboration, as discussed in section 2.2.4.

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

3.1 Introduction: A Philosophy Shift

The Department of Defense 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 programs incorporating as much of the JBMC2 infrastructure as possible. Instead, Services largely will create common, GIG (Global Information Grid)–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.

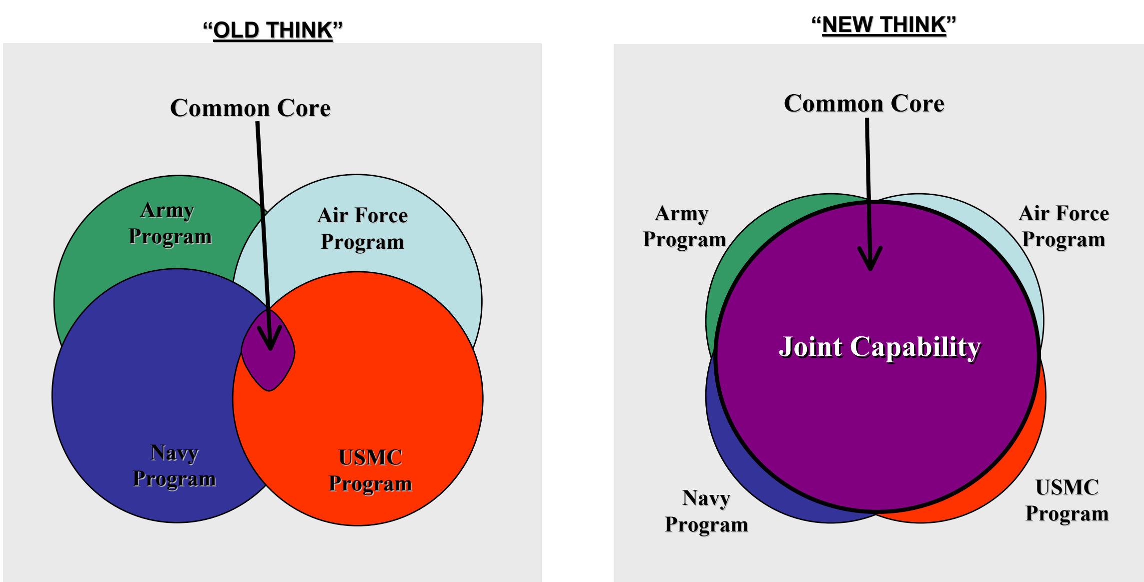

Figure 3.1—DoD's Philosophical Shift

3.2 Strategy for Making JBMC2 Programs Interoperable, Convergent, or Phased Out by 2008

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 programs will be considered in phases, beginning with a comparatively small set of programs and subsequently addressing progressively larger sets of systems, with the ultimate objective of making the majority of JBMC2 systems interoperable by the end of FY 2008.

Programs addressed in the JBMC2 Roadmap fall into several categories. The first two categories comprise programs that either are or will be under the oversight and direction of USJFCOM, in accordance with MID 912:

- *JBMC2 Battlespace Picture Initiatives* comprise the joint initiatives intended to achieve interoperable "pictures" of the battlespace, which are FIOP, SIAP, SIGP, and FORCEnet Maritime Picture. USJFCOM has (or will have) oversight and directive authority for these initiatives, in accordance with MID 912. The Battlespace Picture Initiatives are discussed in detail in Section 4.

- *MID 912 Programs* are other programs considered to be so central to JBMC2 that USJFCOM has been granted oversight and directive authority over them in accordance with MID 912. As of this version of the Roadmap, the sole program in this category is DJC2.

The remaining three categories apply to JBMC2-related programs that will remain under the direction and oversight of the Services and Agencies. While not under the oversight and direction of USJFCOM, these programs will be subject to interoperability requirements needed to provide an integrated JBMC2 capability. The processes for developing these requirements and testing their implementation are described in this Roadmap.

- *Service Interoperability Initiatives* comprise the major Service-sponsored integrated architecture development efforts, which are the Air Force's C2 Constellation, the Navy's FORCEnet, and the Army's LandWarNet. These are intended to describe how each Service's systems will be made interoperable to achieve capabilities within that Service. These initiatives are described in Section 3, along with the descriptions of Service programs.
- *JBMC2 Cluster Programs* are key programs, selected by AT&L using the advice of the JBMC2 Roadmap Working Group, which are critical enablers of a JBMC2 Joint Mission Thread (JMT). Collectively, the selected programs are part of a *program cluster* for that JMT. Section 2.4 identifies

the program cluster members for two of the seven JBMC2 JMTs: Joint Close Air Support and Time-Sensitive Targeting. Cluster members for the remaining five JMTs will be provided in future editions of the Roadmap.

- *JBMC2 Pathfinder Programs* are major programs selected by AT&L for special consideration as critical and cross-cutting enablers of JBMC2 capabilities across the JMTs. Effectively, the Pathfinders form the "program cluster" for cross-JMT integration. These core programs include Service and joint programs for operational-level C2, major tactical C2 programs, major ISR programs, major tactical communications programs, and major programs that provide the network-centric underpinnings for JBMC2 systems. The Pathfinder Programs are named in the following subsection, and the second half of this section provides a description of each Pathfinder program, along with major program milestones. The milestones include those for major interoperability events, including major system test events and recommended joint interoperability test events.

Once identified, USJFCOM will provide oversight and direction over the system-of-systems engineering and data interoperability efforts that will specify how each program cluster will become interoperable and so enable the corresponding JMT. Each program cluster will then undergo a series of interoperability tests to evaluate the cluster's implementation of the resulting specifications. Each series will incorporate both legacy systems and systems under development. Including systems under development will ensure interoperability when the systems become operational, and including legacy systems will ensure that the systems are interoperable during their gradual phase-out periods. Each JMT-based test series will focus on the quality of shared battlespace "picture" and situational awareness information (tactical and/or operational, depending on the JBMC2 systems and mission thread under consideration).[14]

JBMC2 programs will also undergo individual assessment to determine the best way to fit them into their corresponding clusters. The assessment process is described in sections 3.4–3.5. In summary, the process determines whether it is most efficient and effective to make the program interoperable (i.e., have the program directly implement the specifications prescribed for the corresponding JMT program clusters), converge the program into another program, or phased it out altogether, identifying other programs that will provide the phase-out system's functionality. Note that for the purposes of the Roadmap, "interoperable"

[14] As examples, battlespace "picture" quality metrics have been developed by SIAP for Theater Air Missile Defense (TAMD). Quality of information metrics for the general battlespace "picture" have been developed by the Office of Force Transformation (OFT) and ASD(NII). These metrics are included in the OFT/ASD(NII) Network-Centric Operations Conceptual Framework (NCO-CF). This framework and its associated metrics are available on the ASD NII Command and Control Research Program website (www.dodccrp.mil).

means that the program should directly implement the SoSE provisions and common interfaces prescribed as standards for the corresponding JMT program clusters.

3.3 JBMC2 Pathfinder Programs

For reference, Figure 3.2 lists the set of programs (and families of programs) that comprise the first increment set of Pathfinder Programs.[15] Major Service-sponsored programs and platforms appear in the top section, with the horizontal groups corresponding to C2 systems, ISR systems, and aerial JBMC2 platforms, respectively; joint C2 and common network service programs appear in the middle band; and network infrastructure programs appear in the bottom band.

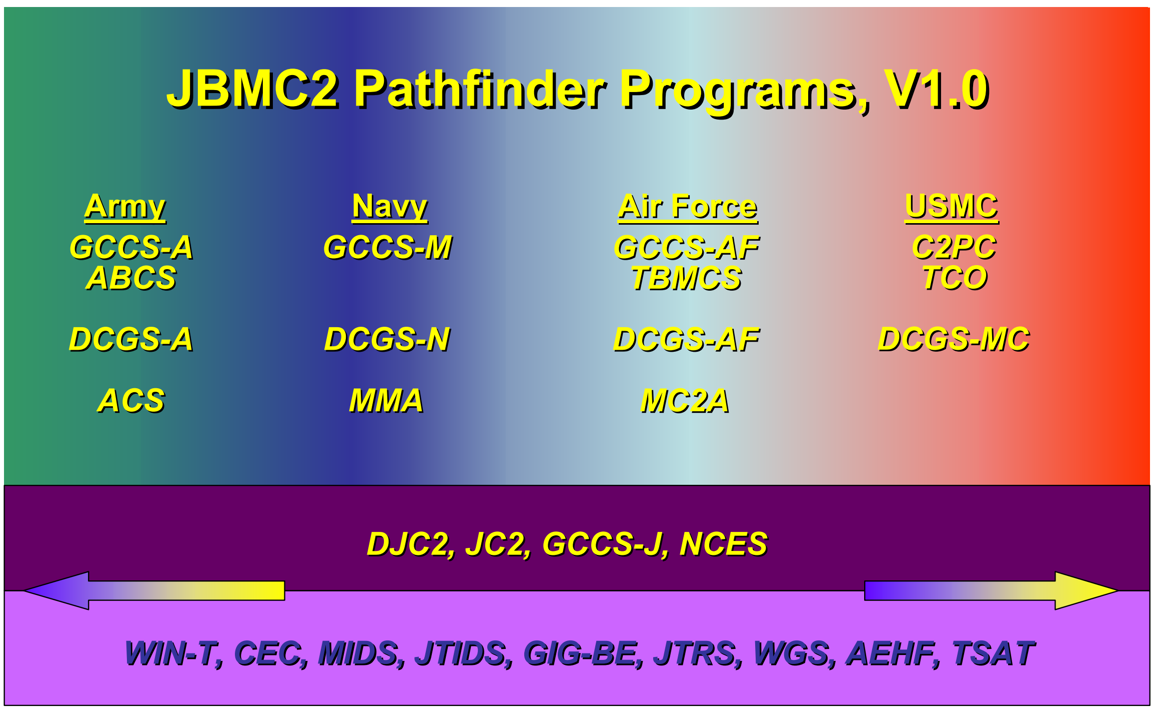

Figure 3.2—First Increment of Pathfinder Programs

Figure 3.3 lists the updated set of Pathfinder Programs that includes increment two Pathfinder Programs. In addition to adding a number of new programs (marked in red and italicized), the figure sorts the Pathfinder Programs into categories to identify why they were selected and provides more differentiation for some of the program families (notably, ABCS has been subdivided into its constituent programs).

[15] This figure is corrected and reformatted from the Version 1.x Pathfinder Programs figure. Notably, "FORCEnet PORs" have been removed, as the Navy's FORCEnet initiative comprises all Navy programs. The Navy's MMA program has been added (now retitled as Navy ACS). Finally, the programs have been regrouped, as described in the text.

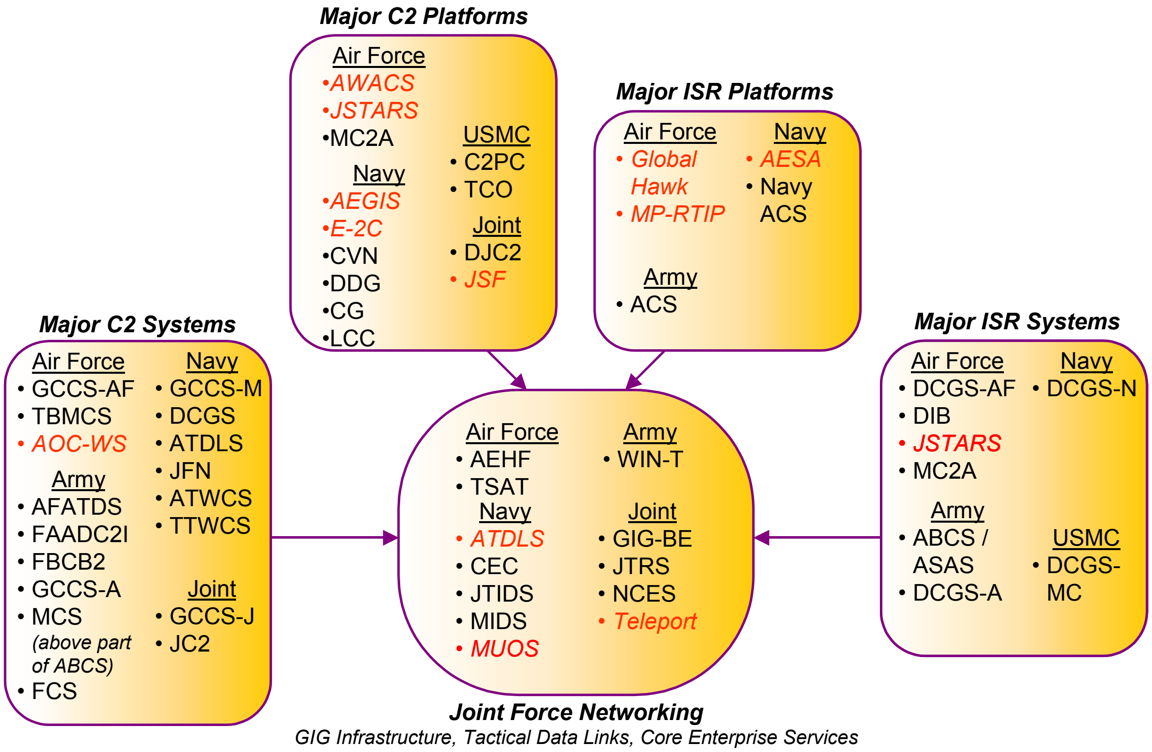

Figure 3.3—Updated Set of JBMC2 Pathfinder Programs

To date, enough is known about the JMTs and the Pathfinder Programs to assign them to five of the seven JMT program clusters and to the corresponding interoperability test series, as described below. Section 10 describes the testing strategy for program clusters.

Joint Close Air Support

- *Cluster 1: Joint Close Air Support.* (This list is an extract of the full program cluster list in section 2.4.) This JMT test series examines whether interim improvements to JCAS processes have been made, as well as early interoperability between JCAS systems and the net-centric underpinnings, and whether "net-centric" improvements to JCAS processes have been made, once future C2 systems and net-centric underpinnings are available. The cluster includes the following Pathfinder Programs:
  - Air Force: AWACS, DCGS-AF, JSTARS, MC2A, TBMCS
  - Army: AFATDS, DCGS-A, FBCB2, FCS, WIN-T
  - Navy: ATDLS, DCGS-N, JTIDS, MIDS
  - USMC: C2PC, DCGS-MC, TCO
  - Joint: JC2, JSF, JTRS, NCES, TSAT.

Joint Ground Maneuver

- *Cluster 2: Joint Ground Maneuver*. This JMT test series examines whether the current Army and Marine Corps ground maneuver systems achieve interim interoperability improvements, as well as early interoperability between JCAS systems and the net-centric underpinnings, and also the interoperability of ground maneuver systems once future C2 systems and net-centric underpinnings are available.
    - Army programs: AFATDS, ASAS, DCGS-A, FBCB2, FCS, GCCS-A, MCS, WIN-T
    - USMC programs: C2PC, TCO, DCGS-MC
    - Joint: JC2, JTRS, NCES, TSAT.

Time-Sensitive Targeting

- *Cluster 3: Time-Sensitive Targeting*. (This list is an extract of the full program cluster list in section 2.4.) This JMT test series examines whether interim improvements to TST processes have been made, as well as early interoperability between TST systems and the net-centric underpinnings, and whether "net-centric" improvements have been made to TST processes once future C2 systems and net-centric underpinnings are available.
    - Air Force: AWACS, DCGS-AF, GCCS-AF, GlobalHawk, JSTARS, MC2A, MP-RTIP, TBMCS
    - Army: ACS, AFATDS, ASAS, DCGS-A, FBCB2, FCS, GCCS-A, WIN-T
    - Navy: AEGIS, AESA, ATDLS, DCGS-N, E-2C, GCCS-M, JTIDS, MIDS, MMA
    - USMC: C2PC, DCGS-MC, TCO
    - Joint: DJC2, GCCS-J, JC2, JSF, JTRS, NCES, TSAT

Joint Task Force Command and Control

- *Cluster 4: Joint Task Force C2.* In the Joint Task Force C2 arena, there is already an established initiative to converge the existing joint and Service operational C2 systems (GCCS variants) to a single Service-based architecture (JC2) that relies on NCES to exchange information. This JMT test series will ensure that the planned convergence is progressing as desired and that the converged C2 systems successfully incorporate the net-centric underpinnings and successfully interoperate with the future Service Pathfinder Programs (FCS, MC2A, etc.).

  - Air Force: DCGS-AF, GCCS-AF, MC2A, TBMCS[16]
  - Army: DCGS-A, GCCS-A, FBCB2, FCS, MCS
  - Navy: DCGS-N, GCCS-M
  - USMC: C2PC, DCGS-MC, TCO
  - Joint programs: DJC2, GCCS-J, GIG-BE, JC2, NCES, TSAT.

Integrated Air and Missile Defense

- *Cluster 5: Integrated Air and Missile Defense.* This JMT test series examines the ability to provide for a cooperative, distributed air and missile defense using interim improvements and whether "net-centric" improvements to air/missile defense have been made once future systems and net-centric underpinnings are available. Note that the relationship between the proposed cluster and the existing scheduled JDEP tests for IA/MD needs to be established.
  - Air Force: AWACS, MC2A
  - Army: FAADC2I
  - Navy: AEGIS, ATDLS, CEC, JTIDS, MIDS
  - Joint: JC2, JTRS, NCES, TSAT

Integrated Fires

- No clusters have been established for this edition of the Roadmap.

Focused Logistics

- No clusters have been established for this edition of the Roadmap

Figure 3.4 presents the schedule of major program milestones for all pathfinder programs except the operational-level C2 programs. Overlaid on the program schedules are the tentative dates for the near-term program cluster test cycles, during which the various program clusters will be tested in accordance with the JBMC2 test strategy. Section 10 provides detail on the test cycles, but in summary each test series is scheduled to include events in each of three cluster test cycles. Each cycle is nine months in length, with a three-month evaluation period between cycles. The first cycle (FY 2006) is diagnostic in nature; the second cycle (FY 2007) evaluates each cluster's progress in supporting a JMT; and the last cycle (FY 2008) performs checkout testing so that each cluster can be certified as "interoperable." The exact scheduling of test events within each cycle will be determined starting in the FY 2005 time frame as a result of cluster system-of-systems engineering requirements and test management requirements.

It should be noted that this proposed master joint cluster test schedule implies a paradigm shift with respect to joint interoperability testing. Previously, all "tests" were

[16] Some of the above Pathfinder Programs are scheduled to converge to other programs, notably the GCCS variants (converging to JC2). Program convergence will be incorporated in the interoperability test series.

thought of as pass-fail events that a program had to "pass" to enter service. In the new paradigm, only the final events in each series "tests" interoperability in the traditional, "pass/fail" sense; the preceding tests are all diagnostic in nature.

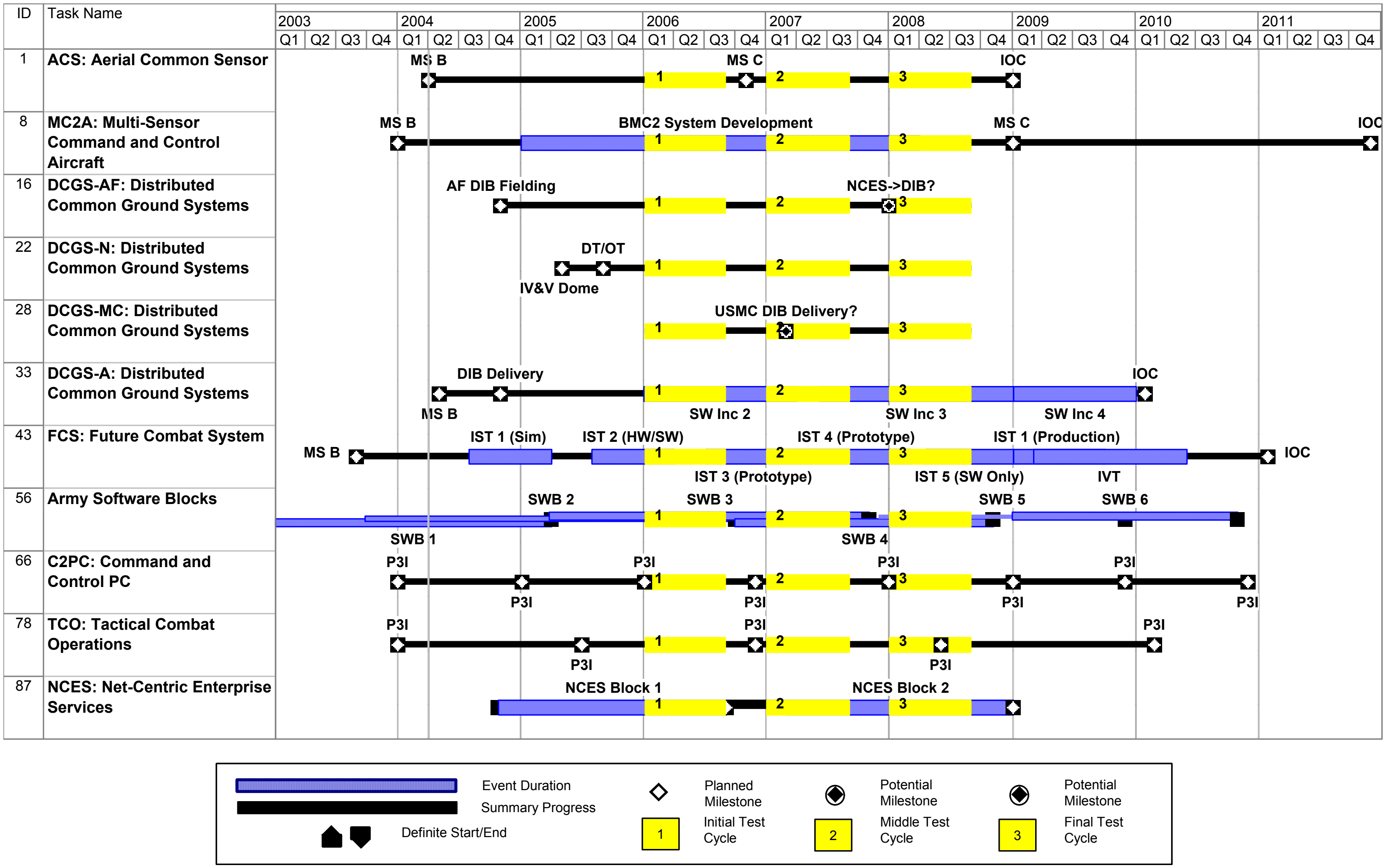

Figure 3.4—Draft JBMC2 Interoperability Test Schedule

3.4 JBMC2 Capability Integration Assessment Tenets and Criteria

Sections 3.4 and 3.5 present the capability integration assessment process used to evaluate individual systems. Section 3.4 presents the baseline tenets and criteria to be used in determining whether to phase out, converge, or make interoperable a JBMC2 program. Section 3.5 presents the detailed assessment process.

3.4.1 Assessment Tenets

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 for individual programs 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 ("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.

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 existing 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, and convergence would not be JMT essential
Integrate in JBMC2 capability	• Currently interoperable with JBMC2 • Not interoperable now but JMT-based 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, as drawn from JMTs and joint concepts

Figure 3.5—Draft Program Assessment Tenets

Figure 3.5 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. The second recommendation is to make interoperable by migration into a state in which it meets interoperability criteria within JBMC2. The final recommendation is to identify and validate exceptions in which 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; and 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 there are alternatives available to the system, with respect to providing the needed capabilities for a JMT. 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 in which 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, it would then 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 in which 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 its 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 or initiative's autonomy within the JBMC2 portfolio. Here, Service uniqueness defines a case in which 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 in which continuation of a noninteroperable 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" that emphasizes the value of information exchange and demands a compelling reason for exception.

3.4.2 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; the architecture answers the "integrated and/or interoperable 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 (USJFCOM 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 will be taken in applying the concept 'integration' to the efforts encompassed in this Roadmap.

Sets of programs being integrated will need to incorporate all the requirements (operational, systems, and technical) of the architecture for the comprehensive, unified system of systems being created by the integration effort. As a preliminary condition, the sets of programs will need to be compatible with the multilayered, net-centric approach to interoperability described below.

Interoperability. The formal definition of interoperability (USJFCOM 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.

Mission-critical information requirements 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 with respect to other Army systems as well as with Joint Force systems.

As discussed in Section 1, the JBMC2 Roadmap supports a net-centric approach to interoperability rather than the traditional point-to-point approach. Thus, to be certified as "interoperable," a program will need to be consistent with specifications allowing a large family of systems to jointly share a range of information. These specifications—the common interfaces—occur at multiple layers, initially described in Section 1.

- As an overarching requirement, the program's systems must be compatible with the appropriate policy guidance, operational concepts, architectures, and nonmateriel DOTMLPF provisions corresponding to the JMT clusters of which the program is a member.
- At the information layer, the program's systems must be compatible with the data models and business rules defining how JMT cluster programs use data to represent aspects of the environment and how the data should be used and maintained.
- At the application, transport, and physical layers, the program's systems must be compatible with the relevant specifications used by the JMT cluster to communicate data across the force network.
    - At the application layer, the systems must be able to input and output information (and requests for information) in specified formats; examples might include XML or SOAP.
    - At the transport layer, the systems must be able to transmit data in accordance with specified communications protocols; examples might include IP versions or standard message formats.
    - At the physical layer, the systems must be consistent with the physical components and waveforms used to transmit data; examples here include consistency with JTRS or Link-16 radio sets.

JMT cluster specifications at the application, transport and physical layers will follow from the Net-Readiness Key Performance Parameters (KPPs), as defined in CJCSI 6212.01C (20 November 2003). A summary of these standards in these KPPs—the Net-Centric Checklist[17]—is shown in Figure 3.6. To expedite families of systems sharing ranges of information (including systems that need information even if they were not initially "engineered" to receive it), the Net-Centric Checklist places an emphasis on posting information to, and receiving information from, common shared spaces using common formats and communications services.

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 decisionmaking	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 3.6—Net-Centric Checklist

[17] NII's "Net-Centric Checklist, Version 2.1," dated February 13, 2004, describes the checklist in detail.

For both integration and interoperability efforts, becoming compatible will involve a set of technical specifications (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 implementation must successfully pass a series of tests; these may include a simulation test, a software- and/or hardware-in-the-loop test, and a pilot-fielding test during an exercise, as appropriate. The implementation must also pass the appropriate series of JMT cluster interoperability tests (see Section 10 for more details). 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 Program of Record (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 tasks and milestones in the implementation must be logically arranged. The implementation must pass a series of tests, to include a simulation test, a software- and/or hardware-in-the-loop test (as appropriate), and a pilot-fielding test during an exercise. In addition, the newly converged systems must pass the appropriate series of JMT cluster interoperability tests.

3.5 JBMC2 Capability Integration Assessment Methodology

3.5.1 Introduction

Earlier, this Roadmap presents and discusses a draft set of assessment tenets that are guiding principles for the integration of programs and initiatives into JBMC2. The tenets will be used as a structure indicating directions and supporting decisions throughout the JBMC2 development and evolution. The *initial* application of the tenets is in assessing whether current programs and initiatives should be integrated, and this section presents a methodology for this initial application. The overall approach is shown in Figure 3.7.

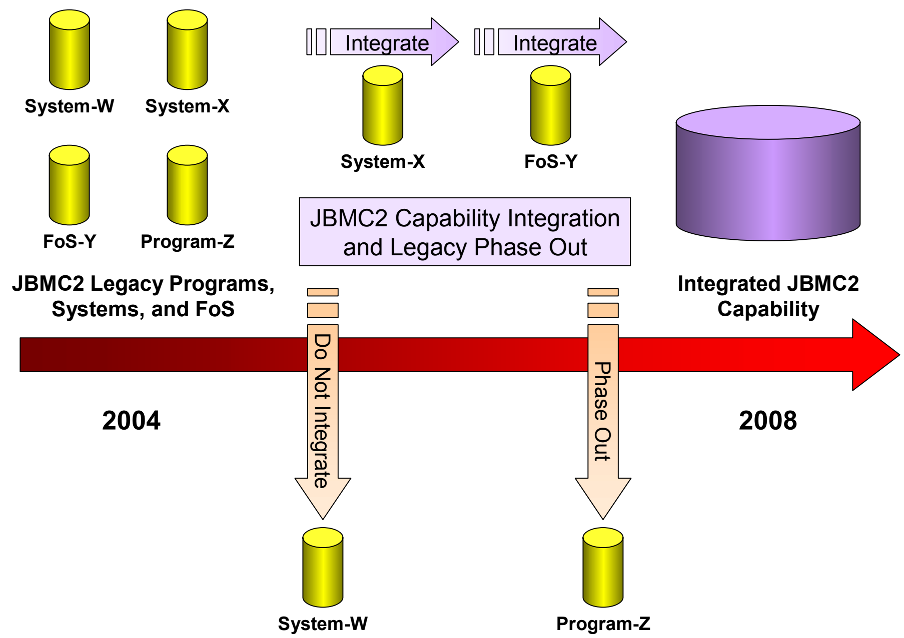

Figure 3.7—JBMC2 Capability Integration

Conceptually, some legacy[18] systems will be integrated into JBMC2 (System-X and FoS-Y in the figure), while others will be candidates for phasing out, according to criteria defined in the tenets (see Figure 3.5). Some systems (System-W) may continue to exist without interoperating with other systems and nodes, but such programs must satisfy strictly interpreted criteria. And the decision to phase out a system does not mean that it is terminated immediately. The tenets may support a phase-out decision based on future consideration. For example, the development of a replacement interoperable system may result in Program-Z being phased out before 2008, as depicted in Figure 3.7.

Methodology Scope and Context

The issues associated with the implementation of any capabilities-based methodology are extremely important, and a management structure is being implemented elsewhere to address these issues (see Section 5). Consequently, this section does not include management issues. The methodology does implicitly incorporate the guidance and

[18] DoDI 4630.8, "Procedures for Interoperability and Supportability of Information Technology (IT) and National Security Systems (NSS)," May 2, 2002, p. 40, uses the term "legacy system" and "fielded system" interchangeably.

processes of CJCSI 3170.01C (the JCIDS process) and CJCSI 6212.01C (Interoperability and Supportability of Information Technology and National Security Systems).

The methodology has been developed to satisfy three required characteristics. The methodology must be transparent to the operational community. To avoid bias or the appearance of bias, the methodology must be objective and repeatable. Finally, the methodology must be logical and flow explicitly from the tenets. The subsequent logic flow charts will serve to substantiate the satisfaction of these requirements.

Several very general assumptions have been incorporated into the methodology. The schedule guidance given to the Roadmap developers was to use 2008 as an objective date for legacy system capability integration. The Roadmap encompasses programs (of record), systems, and families of systems (FoS) and, as motivated above, does not accommodate legacy systems for which a convergence plan already exists.

Methodology Overview

The methodology is based on the identification of capability shortfalls. Shortfalls may be identified from any of three areas: operational deficiencies, interoperability gaps, and testing schedule incompatibilities.

Operational deficiencies are an inherent operating characteristic of a JBMC2 program, system, or FoS that does not adequately support the operational user in task execution. The methodology explicitly excludes operational deficiencies resulting from suitability (e.g., reliability, maintainability) issues as being outside the intent and scope of the Roadmap.

There are a number of slightly different definitions of interoperability (and therefore interoperability gaps) currently used in the community. The definition used in this methodology combines all three aspects of the JBMC2 Roadmap V 1.0 definition, Joint Publication 1-02 definition, and those of the CJCSI 3170.01C definition.

Interoperability:

1. 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. (JBMC2 Roadmap)

2. 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 uses. The degree of interoperability should be defined when referring to specific cases (Definitions 1&2, Pub 1-02).

3. Interoperability includes both the technical exchange of information and the end-to-end operational effectiveness of that exchanged information as required for mission accomplishment (CJCSI 3170.01C).

The methodology incorporates all three definitions of interoperability because they emphasize that there are different levels of interoperability and that supporting mission accomplishment is the key measure.

Testing schedule incompatibilities occur when programs, systems, or FoS that are dependent upon each other for operational and interoperability capabilities are not synchronized as to the respective achievement of developmental and operational testing (and resultant certifications).

In keeping with the legacy focus, the methodology is constructed in three parts. In Part One, the characteristics of a program, system, or FoS are analyzed to identify current shortfalls. In Part Two, the capabilities of the program, system, or FoS are projected to 2008; analyzed for future shortfalls; and alternative solutions are identified. In Part Three, the alternative solutions are analyzed with respect to (among other factors) cost, schedule, and operational utility.

The product of the analysis is a short list of feasible alternatives that are sufficient to support the final assessment: do not integrate; integrate; and consider phase out. The methodology need not necessarily be run to completion to make a final assessment. The methodology is designed to produce products and directly support the evaluation of systems, FoS, and programs against the tenets.

3.5.2 Methodology Description

Methodology Part One: Current Status

The first part of the assessment methodology is to establish the current characteristics of the legacy JBMC2 program, system or FoS. The first step of the methodology defines a set of observables for the legacy JBMC2 program, system, or FoS (see Figure 3.9). The observables are suggested by the assessment tenets (Figure 3.5) so that information extracted from the observables aids in the application of the tenet logic.

The observables are shown in the first column in Figure 3.8 and can be partitioned into five comprehensive groups:

- Experiential information, which are lessons learned from operations, and analysis of exercises, experiments, and war games. From these sources, the methodology extracts identified JBMC2 operational deficiencies and interoperability gaps. Other sources of information relating to operational experience may come from, for example, ACTD programs or operator feedback provided to the Service or the Program Manager.
- Requirements, acquisition, operational, and employment documents that describe the legacy program, system, or FoS capabilities and how they are used. The observables in this category contain information from both doctrine and acquisition documents, including Service CONOPS, TTP, MNS, and ORD; Joint CONOPS, TTP, ORD, and CRD; available architecture products (including the results of existing mission thread analyses); and specified Interoperability KPP (explicit use of threshold and

objective metrics will be included in the process). The extracted shortfalls in this category include unsatisfied information needlines and IERs. If necessary, technical details about the legacy program, system, or FoS such as Technical Requirements Documents, system specifications, etc., can be examined to identify additional shortfalls and remediation feasibility.

- Observables used to identify schedule incompatibility for Service and Joint interoperability testing. Testing schedule incompatibilities occur when programs, systems, or FoS that are dependent upon each other for operational and interoperability capabilities are not synchronized as to the respective achievement of developmental and operational testing (and resultant certifications). The methodology relies on the JBMC2 Roadmap and JITC test schedules, as well as documents such as the TEMP and CTEMP to extract the testing schedule for the legacy program, system, or FoS.
- Testing results for all tests that have been concluded, including Service interoperability testing, JITC certification, developmental testing (DT), and operational testing (OT). This process identifies existing testing requirements that are unfulfilled.
- CJCSI 3170.01C Joint Capabilities Integration and Development System documents: Initial Capability Document (ICD), Capability Development Document (CCD), Capability Production Document (CPD), and Information Support Plan (ISP). Of particular interest is the documentation submitted in response to the Net Ready KPP specified in 6212.01C. Although a legacy program, system, or FoS procured under previous acquisition regulations would not have produced the ICD, CCD, and CPD in support of its Milestone Decisions, CJCSI 6212.01C Interoperability and Supportability of Information Technology and National Security Systems specifies that "a CPD/ISP must be submitted for fielded systems in order to receive an interoperability/supportability review and certification."[19] By leveraging existing interoperability compliance requirements, the assessment methodology not only obtains authoritative and objective data, it also avoids duplication of effort.[20]

Although these five categories span the types of documentation required for Part One of the assessment methodology, the listing of the observables in Figure 3.8 should not be considered complete. The list of observables is intended to be flexible and able to accommodate any document that can aid the decision process. Individual Service and PM

[19] CJCSI 6212.01C, November 20, 2003, Enclosure A.

[20] Fielded (Legacy Systems) Information Technology (IT) and National Security Systems (NSS) interoperability process is described in DoDI 4630.8, May 2, 2002, and CJCSI 6212.01C, November 20, 2003.

support is crucial in the assembly of the observables and the subsequent extraction of shortfalls.

Observables	Extracted Shortfalls
Lessons Learned Exercises Experiments War games	Identified operational deficiencies and interoperability gaps
Service CONOPS, TTP, MNS, ORD Joint CONOPS, TTP, ORD, CRD Architectures, Interoperability KPP	Unsatisfied Information Needlines, IERs
Service and JITC Schedule for Interoperability Testing (TEMP/CTEMP)	Schedule Incompatibility
Service Interoperability Testing JITC Interoperability Certification DT & OT	Testing Results
ICD, CDD, CPD, ISP	Unsatisfied Information Needlines, IERs

Figure 3.8—Observables and Extracted Shortfalls

After the observables have been assembled, the current extent of the legacy program, system, or FoS shortfalls can be assessed. At this stage, an explicit evaluation document for the legacy program, system, or FoS under review will be produced. This document will describe the current shortfalls and explicitly document their derivation. This written product will be available to the JBMC2 community and decisionmakers for examination.

Figure 3.9 shows the assessment methodology flow chart, highlighting Part One in the left-hand side of the figure. Part One of the methodology has four flow chart elements. The process begins with an identified legacy program, system of FoS as input, shown in Flow Chart Element #1, or FC1. Subsequently, the observables are extracted (FC2) and assessed (FC3). Finally, the explicit product detailing the current shortfalls of the legacy program, system, or FoS in produced (FC4). At this point, the methodology reaches its first decision point. If no current shortfalls are identified, then the legacy program, system, or FoS satisfies the tenet “currently interoperable with JBMC2,” and the recommendation for integration in JBMC2 capability is reached. In this instance, the rest of the methodological process is not applied. Otherwise, the assembled information regarding the current state of the legacy program, system, or FoS and the documented shortfalls will be carried forward to Part Two of the methodology when the assessment horizon is projected to the 2008 time frame.

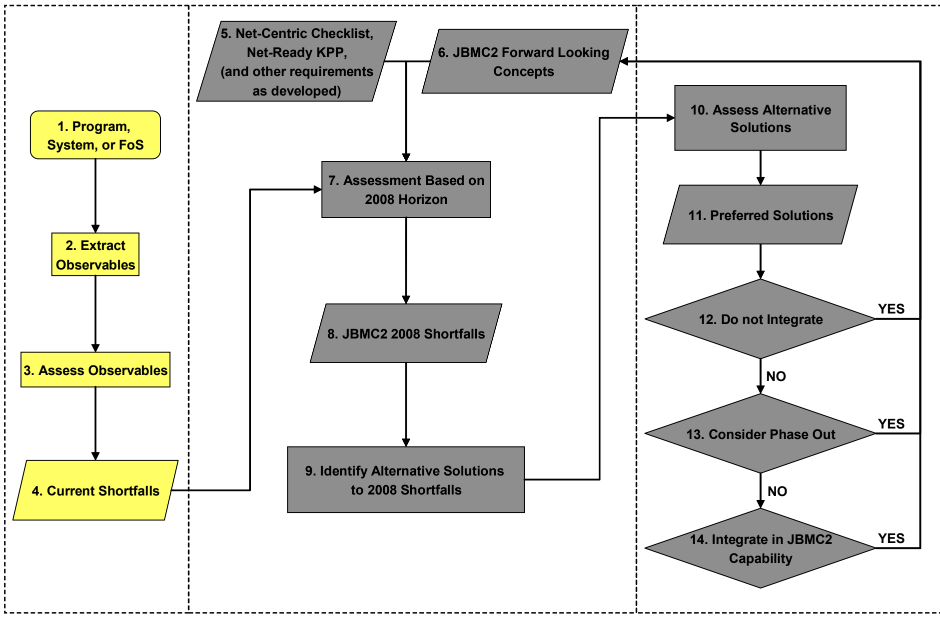

Figure 3.9—Assessment Process Flow Chart Part One: Current Status

Methodology Part Two: Project Forward to JBMC2 2008

The purpose of Part Two of the methodology is to establish future JBMC2 2008 shortfalls and to identify alternative solutions. Part Two of the methodology is shown by the yellow flow chart elements in Figure 3.10.

The first step of this part (FC5) is to evaluate the program, system, or FoS against applicable JBMC2 net-centric requirements. The Net Centric Checklist and Net-Ready Key Performance Parameter (NR-KPP) are identified in the figure. The requirement to fulfill this KPP is established in CJCSI 6212.01C, as are other interoperability "checklists" and assessment criteria: the Capstone Requirements Document (CRD) Checklist (I-KPP based) and Checklist (NR-KPP based); the ICD Interoperability Checklist; the CDD Assessment Criteria; the CPD Assessment Criteria; the ISP Assessment Criteria; and the Net Centric Assessment Criteria for the ICD, CDD, and CPD (reference enclosures D, E, F, G, H, and I). The program, system, or FoS will be evaluated against these requirements and will include other requirements as they are developed.

Concurrently, the program, system, or FoS will be evaluated against JBMC2 Forward Looking Concepts (FC6). These concepts are obtained from Joint Mission Thread Analyses, PM, and Service Inputs; Joint Interoperability Test Group results; and emerging relevant documents (e.g., GIG CRD) and architectures. The Joint Mission Threads, mentioned earlier in the Roadmap, will be used to design joint interoperability FoS test events, training events, and other JBMC2 capability integration initiatives. The threads are derived from the Joint Operational Concepts (JOCs), Joint Functional Concepts, and existing Joint and Service operational concepts as well as other guidance and doctrine. There are seven JMT program clusters in the Roadmap, each of which will undergo a series of interoperability tests in support of a JMT. Information will be gathered from the PMs and Services to provide visibility into the future plans of the program, system, or FoS under study.

Projected capabilities and shortfalls as well as current shortfalls identified in Part One are then assessed to determine if 2008 requirements are satisfied (FC7). As a result, some shortfalls from Part One might be satisfied. The result of this assessment is a written evaluation product explicitly describing the JBMC2 2008 shortfalls (FC8). For each of these shortfalls, alternative solutions will be identified (FC9). The PMs and Services are expected to provide considerable input. An additional source of alternative solutions is to consider alternative existing or future programs of record that might fill these shortfalls by 2008. Still another source of solutions comes from possible improvements to the program, system, or FoS. If any of these shortfalls are testing schedule incompatibilities, it might be possible to remedy them by rescheduling or harmonizing testing.

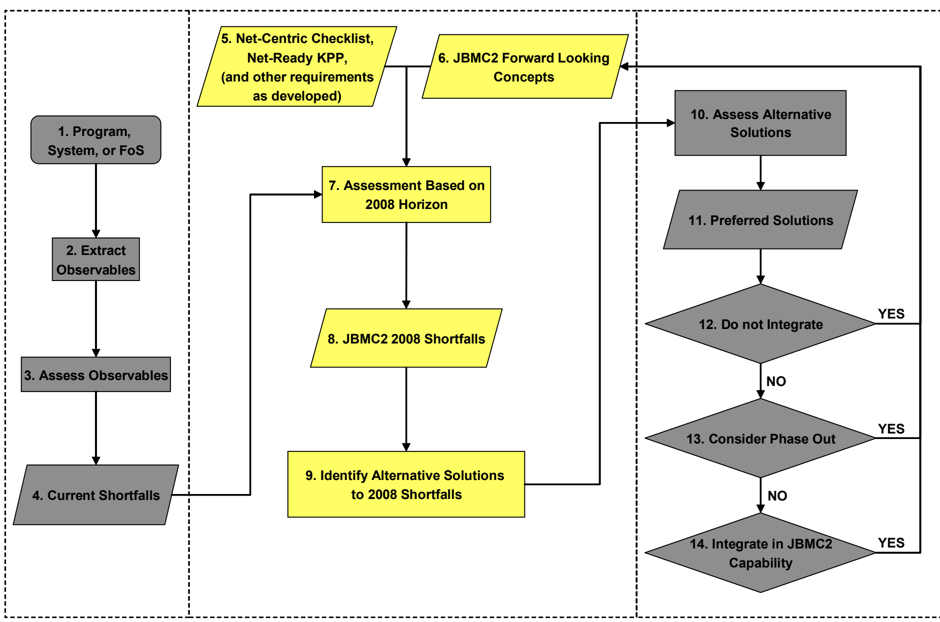

Figure 3.10—Assessment Process Flow Chart Part Two: Project Forward to JBMC2 2008

Methodology Part Three: Analysis of Alternatives and Final Recommendation

Assess Alternative Solutions

The third and final part of the methodology is to assess the alternative solutions (FC10), develop a preferred solution (FC11), and make a recommendation based on the assessment tenets (FC12, 13, 14).

In Part Two, alternative solutions addressing each shortfall were developed without considering their feasibility. The first step in Part Three is an assessment that develops costs, schedules, military utility, and operational impact (DOTMLPF considerations) for each alternative. For legacy systems (particularly software systems, which in general will be undergoing continuing upgrades), much of this information is likely to be obtainable from Program Managers and other Service sources.

Once each alternative solution is assessed, the next step is to construct a preferred solution. In simple cases, this may consist of selecting the obviously best alternative for each shortfall's solution. In more complex cases, different shortfalls and their solutions may be related so that an integrated preferred solution must be constructed. The alternative solution assessments and the preferred solution will be documented in a written evaluation.

The final steps in the methodology are to use the tenet logic for a recommendation. Figure 3.11 shows the entire methodology with emphasis on Part Three. In Figure 3.11, the final steps are shown as a decision block for each recommendation outcome, but the detailed decision process is a sequential evaluation of the assessment tenets and is described in the next section.

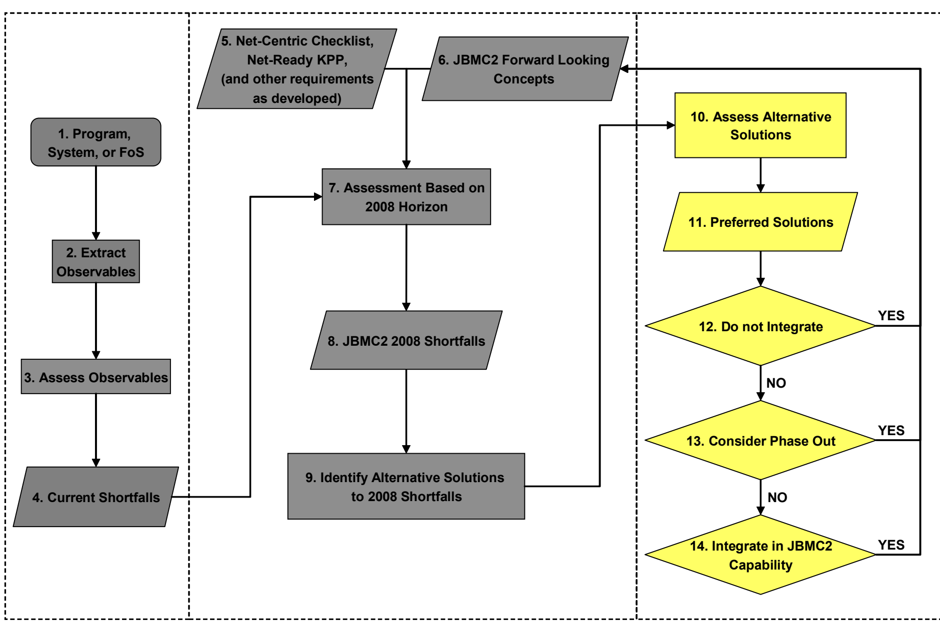

Figure 3.11—Assessment Process Flow Chart Part Three: Analysis of Alternatives and Final Recommendation

Assessing alternatives is likely to be the most demanding part of the methodology. It requires estimating the feasibility, cost, schedule, and impact of each alternative. In some cases, this part of the methodology may not be necessary. As mentioned in the descriptions of Parts One and Two, and described more fully below in developing the tenet assessment logic, information developed in Parts One and Two may enable tenets to be evaluated and a decision reached based on the current system status or its projected capability in 2008.

In the cases in which assessment of alternatives is required, the methodology does not specifically describe how best to perform the assessment. As noted above, it is expected that in many cases Program Managers and other Service elements will be able to provide most of the needed information. This should apply, for example, to alternatives that consist of accelerating planned system elements or incorporating new software capabilities. It should also be recognized that net-centric concepts are specifically intended to enable solutions to be interoperable and satisfy some kinds of operational shortfalls. Thus, satisfying the Net-Centric Checklist and other net-centric requirements (as discussed in section 1.2.2) should be the basis for many of the preferred solutions.

As an example, hypothetical shortfalls, alternative solutions, and preferred solutions are shown in Figure 3.12. Information exchange shortfalls are likely with legacy systems, and Shortfall 1 is a current interoperability shortfall. Planned net-centric software improvements will support data exchange, but only if supported by communications interfaces planned to be provided by JTRS. In this case, accelerating the JTRS program or providing another type of link is not acceptable, and the preferred solution is to accept the delay. Shortfall 2 represents a software limitation that is inherent in a system, and the alternative of adapting another system to provide the needed capability is preferred.

- **Shortfall 1: Information exchange System-YY to System-XX**
  - **Alternative 1.1: Accelerate JTRS Cluster 1 fielding by one year**
    - **Unacceptable cost and schedule risk**
  - **Alternative 1.2: Accept JTRS schedule, conduct Service interoperability testing in 2009, and JITC certification in 2010**
    - **Acceptable cost and operational impact**
    - **High utility**
    - **Temporal Waiver required**
  - **Alternative 1.3: Retrofit legacy System-XX Node 9 (replace existing radio) in 2007, test in 2008**
    - **Unacceptable cost and DOTMLPF implications**
- **Shortfall 2: Partial reuse of data repositories (Net-Centric Checklist shortfall)**
  - **Alternative 2.1: Accelerate planned improvements and test in 2008**
    - **Unacceptable cost**
  - **Alternative 2.2: Adapt Service-ZZ software in System-XX and test in 2006**
    - **Minimal cost, high operational utility, moderate DOTMLPF implications**

Figure 3.12—Example of Shortfalls and Preferred Solutions

Decision Logic for FC12, 13, and 14

The final step of the methodology is to make a decision between Do Not Integrate (FC12), Consider Phase Out (FC13), and Integrate into JBMC2 Capability (FC14). These are the last three elements of the flow chart, as seen in Figure 3.13. This process is expanded in this section to describe the sequential evaluation of the applicability of the tenets to a given system. Presented earlier in the Roadmap, the tenets are repeated in Figure 3.14, with each one numbered to enable references to them in figures and text.

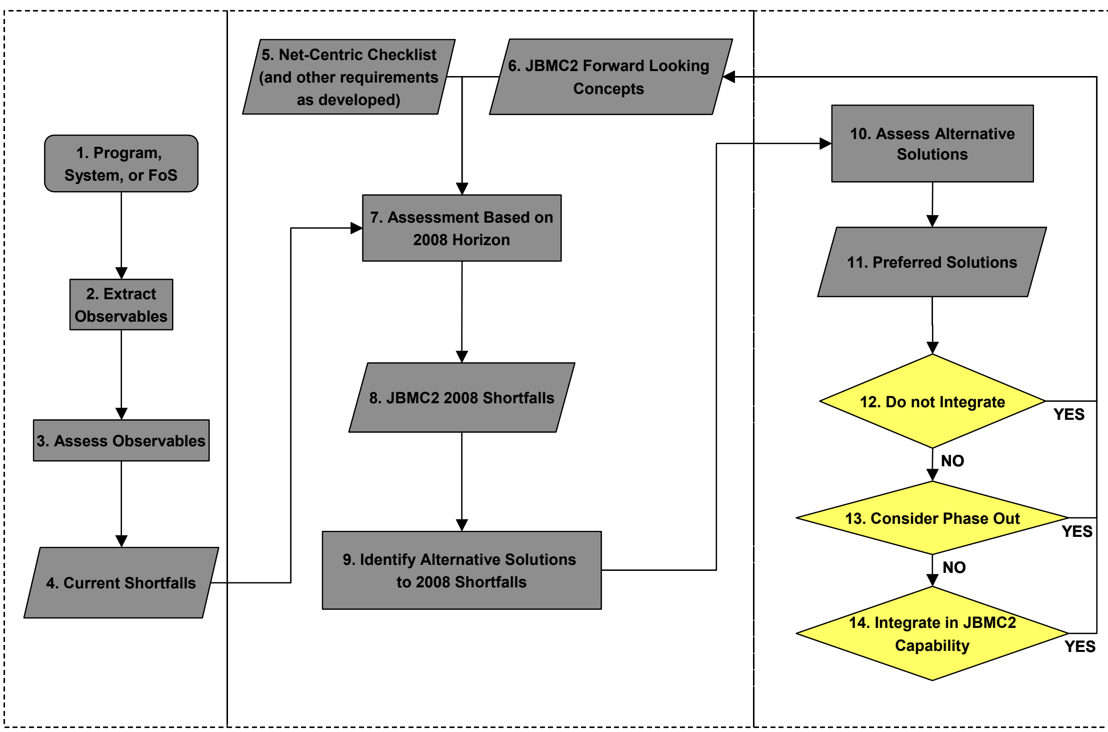

Figure 3.13—Example of Shortfalls and Preferred Solutions

Assessment Recommendations	Tenets
Consider phase out	1.1 Not interoperable, neither cost-effective nor mission-essential to make interoperable

Assessment Recommendations	Tenets
	1.2 Not required once interoperable capability achieved 1.3 Does not fit into future concepts of operation 1.4 Cannot be made interoperable 1.5 Is not planned to converge, and convergence would not be JMT essential
Integrate in JBMC2 capability	2.1 Currently interoperable with JBMC2 2.2 Not interoperable now but JMT-based need and cost-effective to make interoperable 2.3 Soon to be (planned) interoperable, with mission need
Do not integrate	3.1 Service-unique application and no requirement for interoperability now or in the future, as drawn from JMTs and joint concepts

Figure 3.14—Draft Program Assessment Tenets with Reference Numbers

The tenets can be evaluated independently to lead to one recommendation. Figure 3.15 shows a flow chart with the wording of the tenets shortened and in some cases changed to avoid any confusion caused by double negatives, and with their evaluation in the following order:

- Planned convergence (tenet 1.5)—if yes, evaluate successor system
- Current and planned interoperability (tenets 2.1 and 2.3)—if yes, integrate
- Lack of future requirement (tenets 1.2 and 1.3)—if yes, consider phase out
- Service unique with no need for interoperability (tenet 3.1)—if yes, do not integrate
- Feasibility, mission need, and cost-effectiveness to make interoperable (tenets 1.4, 1.1, and 2.2)—conduct an analysis leading either to integration or phasing out.

This precedence leads to reaching a decision as soon as possible: it has the property that the highest precedence is given to more easily evaluated tenets, those that are based on currently available information with relatively little analysis required. It also clarifies that, for systems requiring a cost-effectiveness analysis, tenets 1.1 and 2.2 should be interpreted as negatives of each other, with their evaluation leading to either an "integrate" or "consider phase out" recommendation. In addition, evaluating tenets 1.2 and 1.3 before tenet 3.1 implies that systems with no future requirement should be phased out rather than retained as Service-unique.

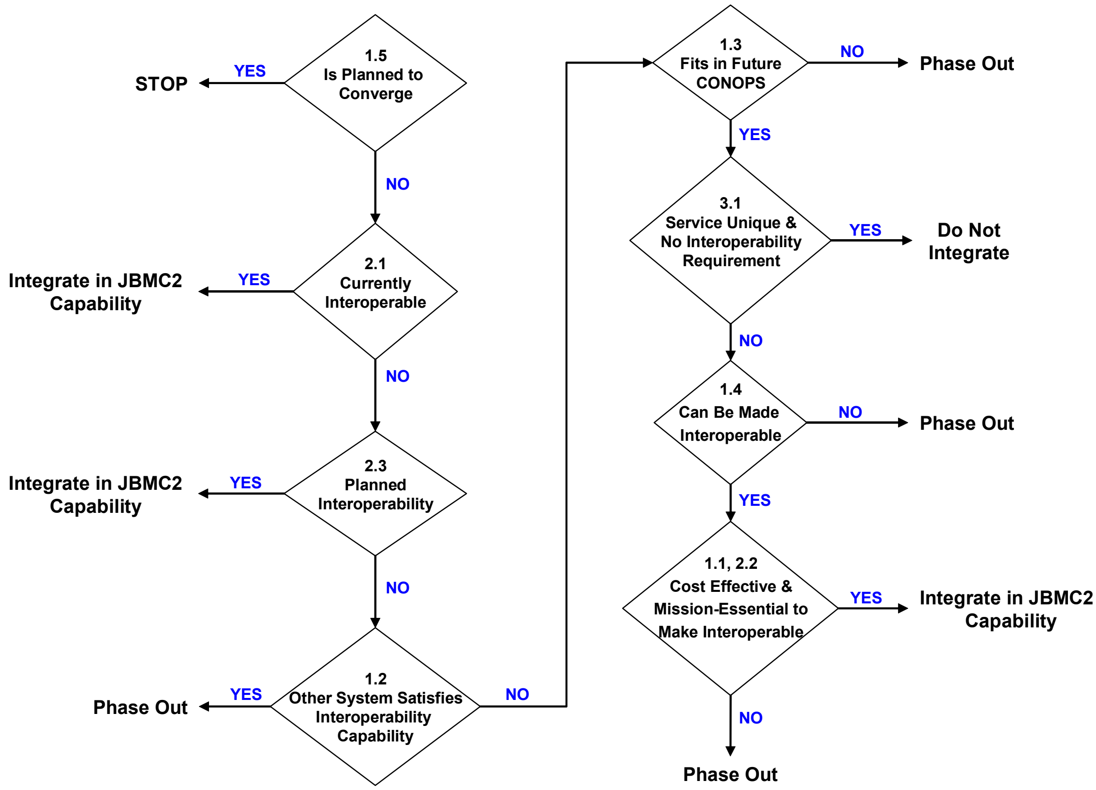

Figure 3.15—Assessment Recommendation Decision Process

A decision of whether or not to integrate a legacy system into JBMC2 will affect the evolving JBMC2 architecture and is likely to affect interoperability, and perhaps capabilities requirements for other systems. This is shown in the overall assessment process flow chart Figure 3.15 as a feedback loop from the decision recommendation back to the JBMC2 Forward-Looking Concepts (FC6), including feedback to Services and PMs.

3.5.3 Summary

This methodology defines a process for assessing legacy systems, families of systems, or programs according to a set of assessment tenets to determine whether they should be integrated into JBMC2. It is intended to be transparent, objective, logical, and repeatable. It is structured to begin with an examination of current status, followed by an update to projected future (FY 2008) status, and concludes with an analysis of how the system can be made compliant with JBMC2 requirements. This structure supports the documentation of results at each stage, both to enable a reexamination of the system (e.g., because requirements change as a result of JBMC2 architecture development) or, in some cases, to allow a recommendation to be made without completing the most demanding part of the methodology (based on the evaluation of certain of the tenets).

The tenets themselves constitute a consistent set of criteria: consider phasing out, integrate into JBMC2, or do not integrate (but retain as a Service-unique system). They are based on practical considerations of the current and future system status relating to interoperability with JBMC2 systems, mission utility, and integration difficulty. These considerations may at times point to different outcomes, most significantly when mission utility and integration difficulty are both high. In this case, the methodology will develop a documented preferred integration solution and enable an analytic judgment of its cost-effectiveness to be made.

3.6 Current Plans for Pathfinder Program Convergence

Sections 3.6 to 3.10 describe the "as-is" interoperability and convergence efforts and their milestones, in most cases in Sections 3.7-3.10, reprinting material the Services have provided. This first section describes as-is convergence milestones for the JBMC2 Pathfinder Programs. These as-is efforts and milestones will be integrated and synchronized to ensure an integrated JBMC2 capability, with the first major improvements in place by the end of FY 2008. Future versions of this Roadmap will track the progress of the integration.

3.6.1 Convergence Supporting Joint Force C2

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 Joint Force C2.[21] Figure 3.16 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 JC2 and DJC2 to be 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 in 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 period, with the stand-alone GCCS systems phased out completely by the end of 2009.

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

[21] "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).

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.[22] Initially, DJC2 will host GCCS capabilities and tools from the Collaborative Information Environment; successive increments of DJC2 will host JC2 capabilities and tools. Figure 3.16 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, for reference, Figure 3.16 shows the three scheduled interoperability test cycles, systems consistent with the notation of Figure 3.4. The convergence of the GCCS systems into JC2 and DJC2 will be examined as part of test events during these cycles (in particular, as part of the JTFC2 JMT).

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[22] "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).

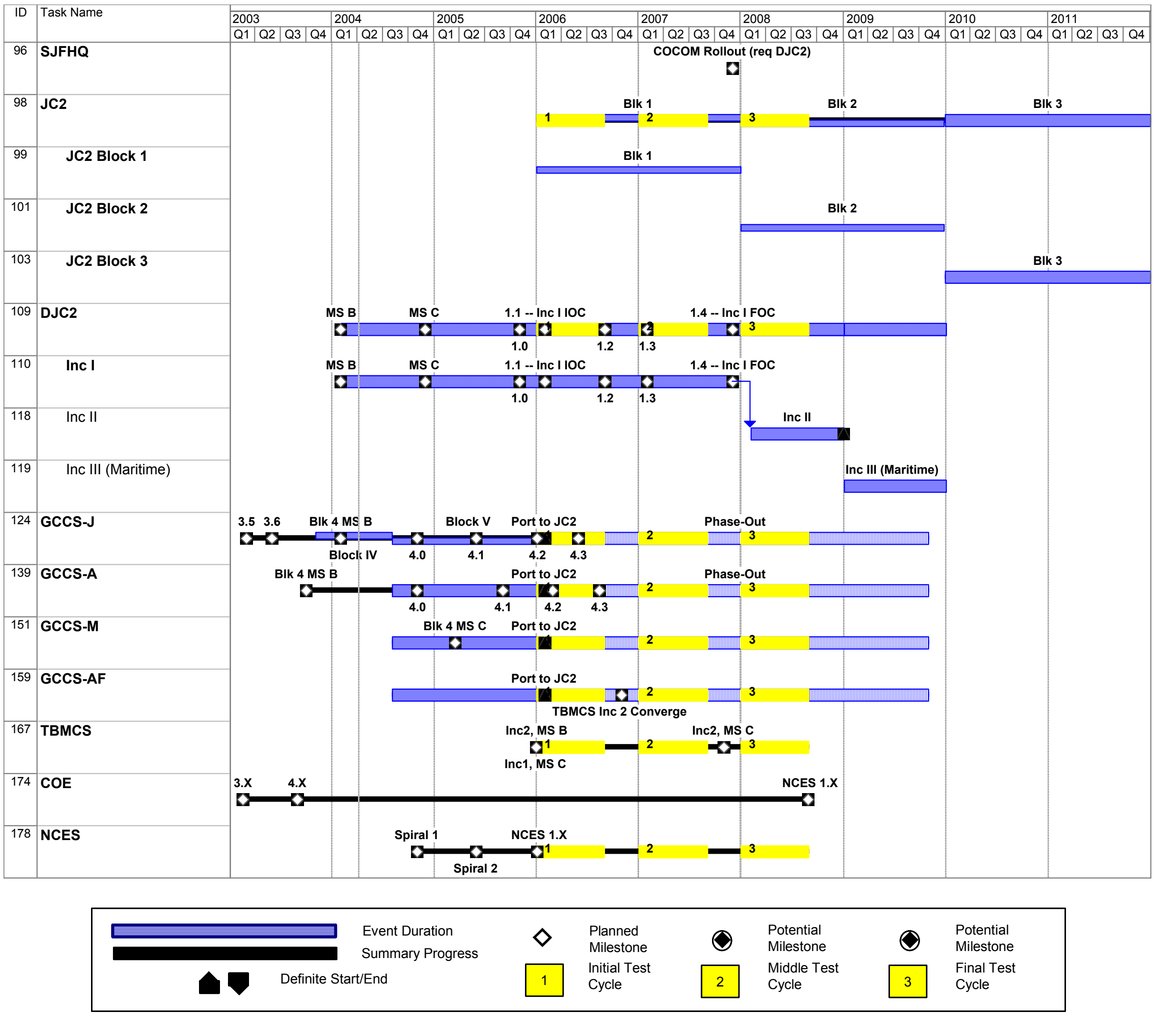

Figure 3.16—Convergence of JC2/GCCS Service Variants and Suggested Interoperability Test Plan

3.6.2 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 3.17.

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

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 – Navy (TES-N)
- Maritime Intelligence Broadcast System (MIBS)
- Common High-Bandwidth Data Link / Common Data Link (CHBDL/CDL)

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 3.17—Subsystems of the DCGS

USD(I) is developing a DCGS Roadmap, which will define capabilities, schedules, technology insertions, and intersections with BMC2 capabilities; it will be the source document for information about the DCGS systems. As discussed in Section 5, on JBMC2 Management, the DCGS Roadmap is a subsidiary roadmap that will be synchronized with the JBMC2 Roadmap and the USD(I) Roadmap.

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
- 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 3.18 shows the planned timelines for the rollout of the hardware components of the DIB, as well as the first software drops. The figure shows the milestones for the initial deployment of the DIB.

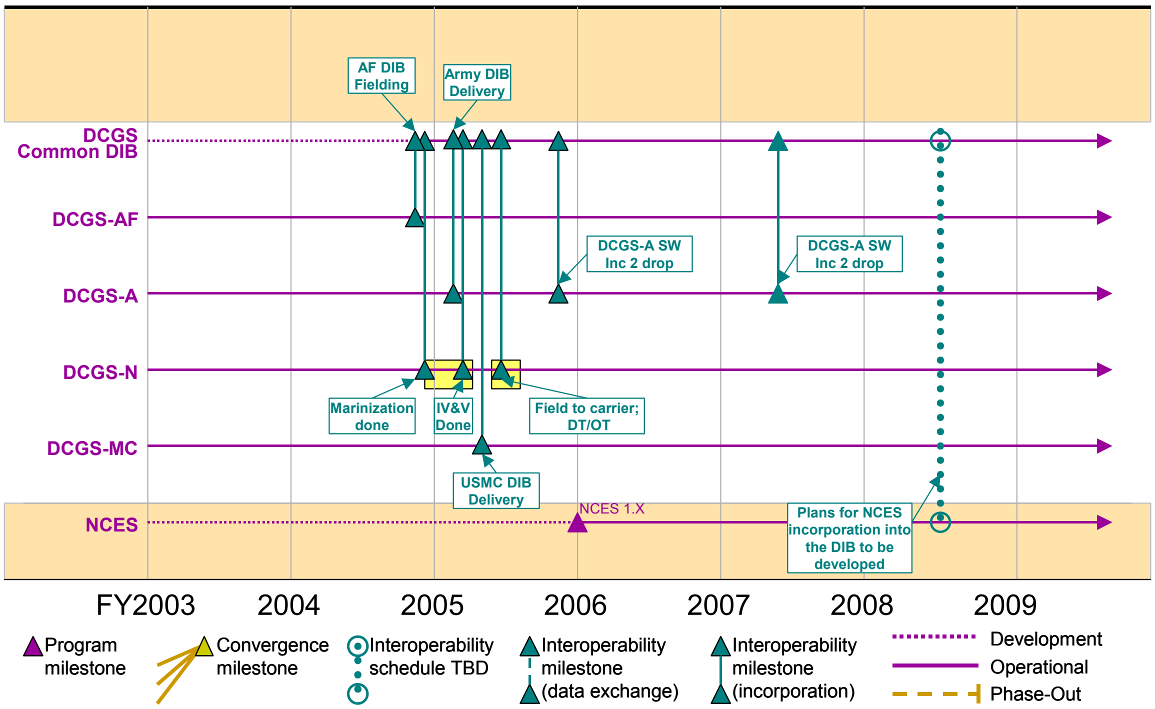

Figure 3.18—Milestones for the Initial Deployment of the DIB

It should be noted that the USMC DCGS plans to incorporate the DIB, but this is 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.

3.6.3 Joint Fires Network

The Joint Fires Network (JFN) serves as an approach to achieving multi-Service integration of the Navy's Naval Fires Network (NFN, which includes TES-N and JSIPS-N), the Army's TES-A, the Air Force's ISR Manager, and the USMC's TEG.[23] Managed by

[23] The referenced initiative 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. Note that Navy JFN has recently been renamed to be part of the DCGS-N initiative.

USJFCOM, the approach was established in a 26 February 2003 memorandum from the Principal Deputy Undersecretary of Defense for AT&L.

Figure 3.19 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).

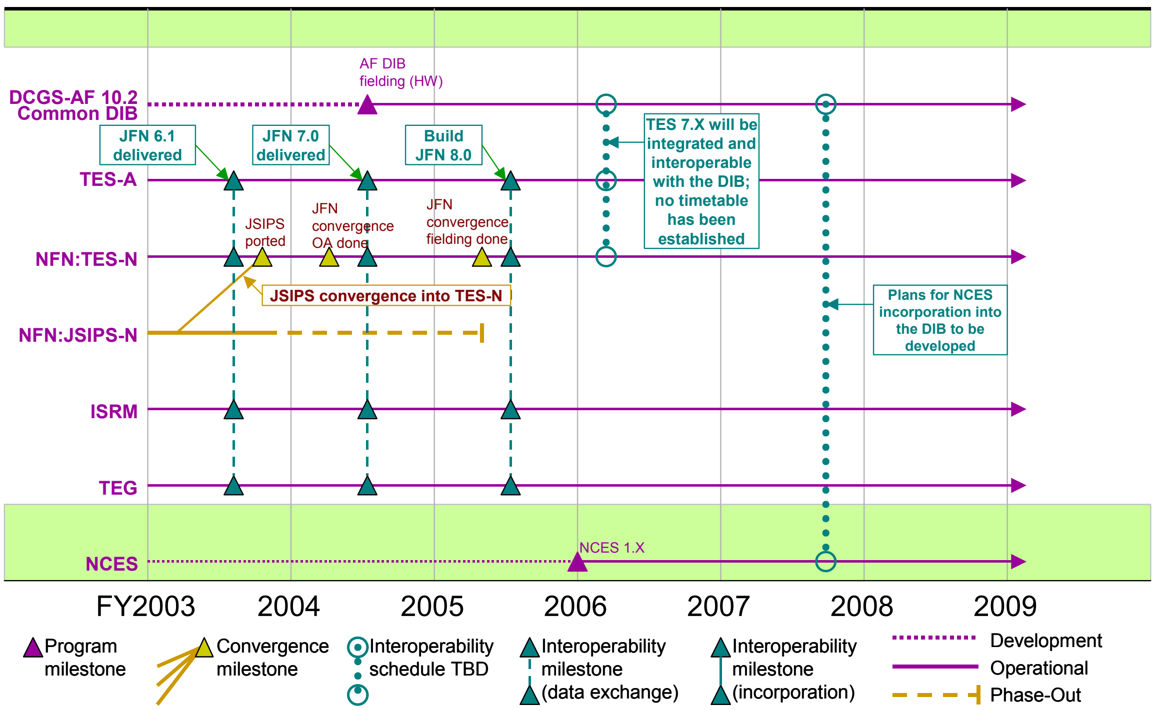

Figure 3.19—Candidate Joint Fires Network Schedule

It should be noted that, within the Navy's 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.

3.6.4 Aerial Common Sensor

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. A modified version of the ACS will be used by the Navy. The Navy's ACS will carry six workstations vice four in the Army version.

Figure 3.20 describes the timelines for the development, testing, and rollout of the Army and Navy variants of the ACS.

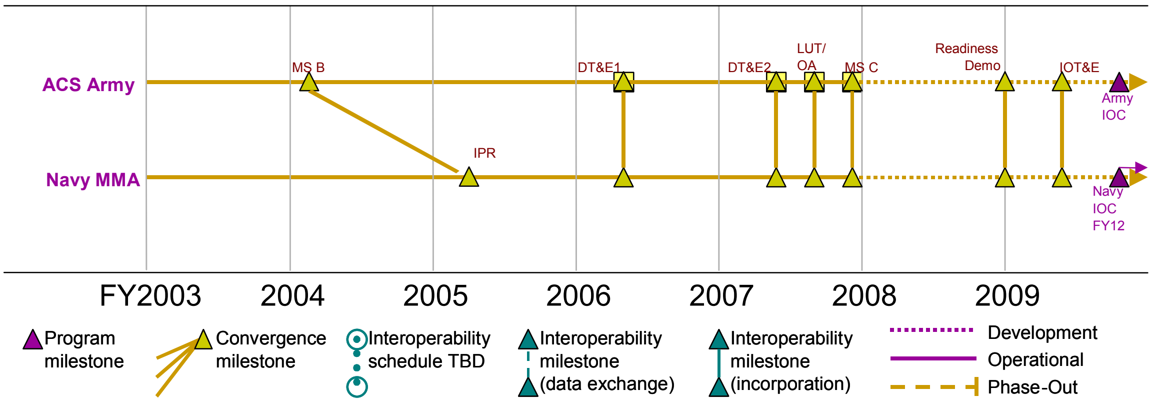

Figure 3.20—Schedule for the Army and Navy ACS

3.6.5 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 many tactical C2 and non-C2 (e.g., fighter aircraft) units from all Services and many allies. 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 Airborne C2 elements, and Marine Corps TAOCs and TACCs. JTIDS is the first implementation of the Link-16 message standard (U.S. Navy Program Guide, 2003 ed.). The 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 (U.S. Navy Program Guide, 2003 ed.).

Program IOC 2003

The migration path for other data links began in 2003. Figure 3.21 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 Precision Approach and Landing System (JPALS) is fielded. The IBS date is for interoperability between the IBS common message format and Link-16's TADIL-J message format; IBS is not actually migrating to Link 16.

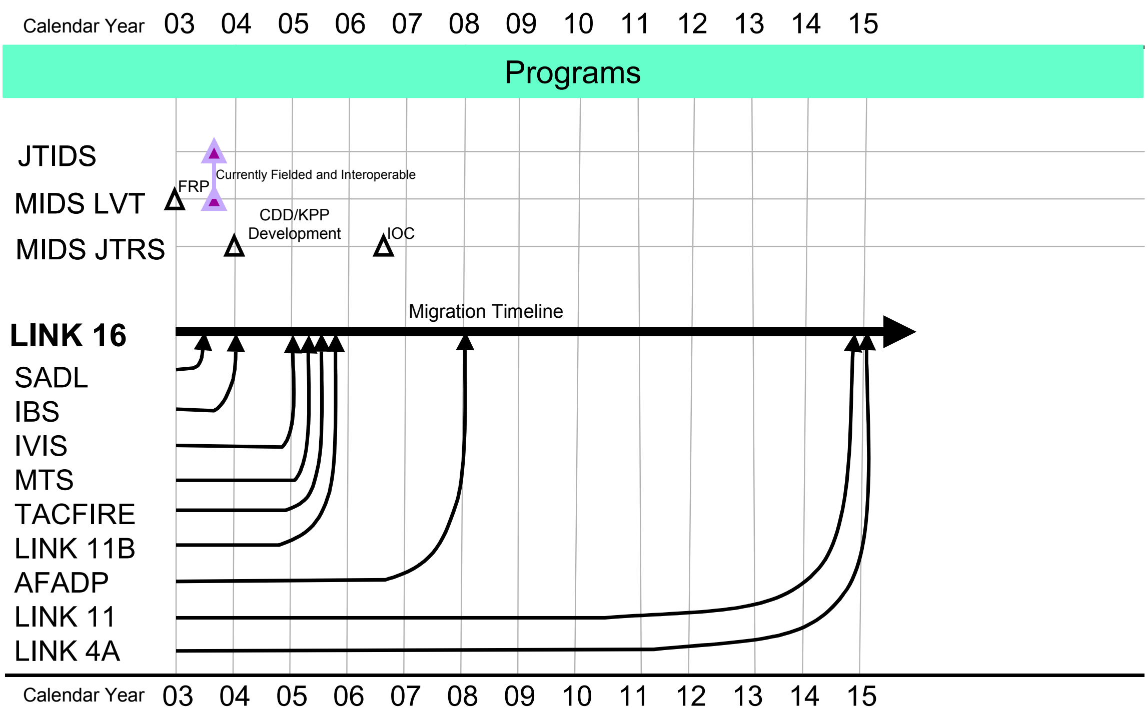

Figure 3.21—Navy JTIDS/MIDS Program Milestones

3.7 Current Army Interoperability Milestones

LandWarNet. LandWarNet is an initiative that describes the Army's integrated network capabilities that enable the Army's Battle Command requirements. It was originally conceived (in November 2003) as an initiative to shape how the Army supports networked combat operations but has also been adopted (February 2004) to incorporate all Army institutional networks under the Army Knowledge Management Strategy. LandWarNet is a strategy and an architecture, but most importantly, it is an integrating concept that supports the Army's Battle Command initiatives. LandWarNet will be the means by which the Army will achieve results by connecting elements of combat power and enabling decentralized Battle Command.

LandWarNet represents a logical grouping of the systems that will enable the future networked force. It is not a new system or a new requirement. LandWarNet will be used as a conceptual driver for supporting various programs of record such as Future Combat System (FCS), Warfighter Information Network-Tactical (WIN-T) and Joint Tactical Radio System (JTRS). Through this methodology, the Army intends to achieve a level of flexibility in an evolving environment to shape and mature future capabilities.

LandWarNet will seek to ensure that Future Force commanders receive the relevant information at the right time without tethering them to a traditional static tactical command post. The significance of this is that the communications network supporting the Infosphere must be as mobile as their maneuver forces. Commanders and leaders must have access to automated, collaborative decision support tools that enable them to effectively plan, synchronize, and virtually rehearse missions, no matter where they are in the battlespace. At the lower tactical echelons, commanders will be able to move with the same mobility as their soldiers while fulfilling their battle command functions.

For LandWarNet, then, as it does currently and in the past, the Operational Views determine the functions to achieve capabilities and defines tasks to accomplish those functions. It will continue to frame systems requirements and audit traceability between systems solutions and the warfighter's required capabilities. Additionally, it supports the Joint Capabilities Integration and Development System (JCIDS) process, analysis, modeling and simulation, and experimentation throughout the development process.

LandWarNet seeks to enable a unified Battle Command system as part of the Army's knowledge management strategy to provide the link from soldier to garrison (Home Station Operations Center) with tailored software applications that are optimized for the combined arms commander.

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 it existing JBMC2 systems that it calls software blocking (see Figure 3.22).

Although software blocking preceded the development of the current CJCSI 3170.01, its objectives are similar. Software blocking focuses on a materiel vice nonmateriel solution to gaps and shortfalls. This goal of software blocking is achieved through the establishment of a collaborative SoS process for the identification of a set of operationally relevant capabilities, architecture products, program interdependencies, system developments, and interoperability certification and evaluation criteria. Jointness is addressed at the beginning of each block. The full DOTMLPF solution is obtained when Army Unit Set Fielding is coupled with software blocking. The software blocking process is divided into two distinct phases: preparation and execution. The software blocking preparation phase most closely maps to the analytic front-end of the JCIDS process where concepts and architectures drive the identification of capability gaps and solutions (materiel and nonmateriel). In a similar fashion, software blocking leverages concepts and architectures to define the SoS block operational capabilities. (In the future, software blocking will take its output to inform the preparation phase). The execution phase takes the output from the preparation phase and focuses SoS development efforts toward achieving the defined increment of capability at the end of each block. Although each block has a defined nominal duration, the actual block timeline has been determined to ensure minimal risk to the entire block (C4ISR, weapons, C2, etc.) development, certification, and evaluation. Within each block, programs proceed at a variable pace, but must complete efforts in time to support certification and evaluation. Hence, completion is defined as a system baseline that successfully passes the necessary interoperability criteria in support of its materiel release. The five critical elements of software blocking are the definition of an affordable set of capabilities; the establishment of a technical profile (i.e., based on the army interoperability data strategy); formalizing a set of collaborative SoS stakeholder forums; SoS programmatic dependencies; and linking software blocking to institutional decisionmaking processes. The aim is to continuously balance equities throughout the software blocking cycle vice isolated program centric decision that have the potential to adversely affect interoperability and overall warfighter capability.

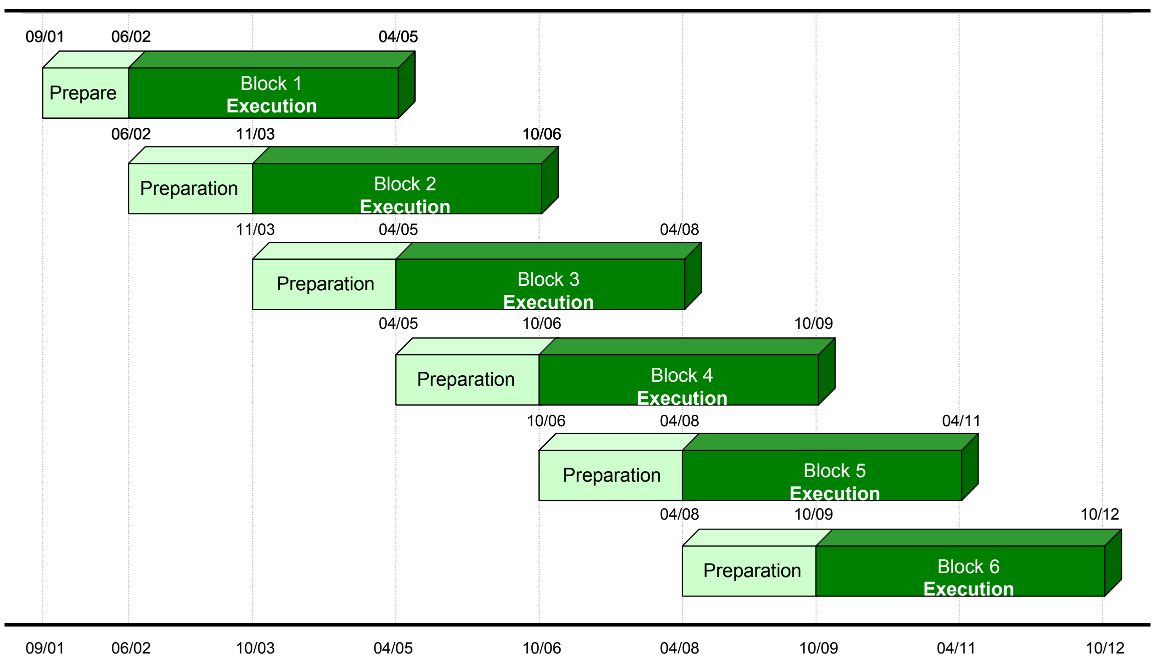

Figure 3.22—The Army's Software Block Upgrade Schedule

The Army BMC2 systems to be upgraded in Block 1 are shown in Figure 3.23. 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.

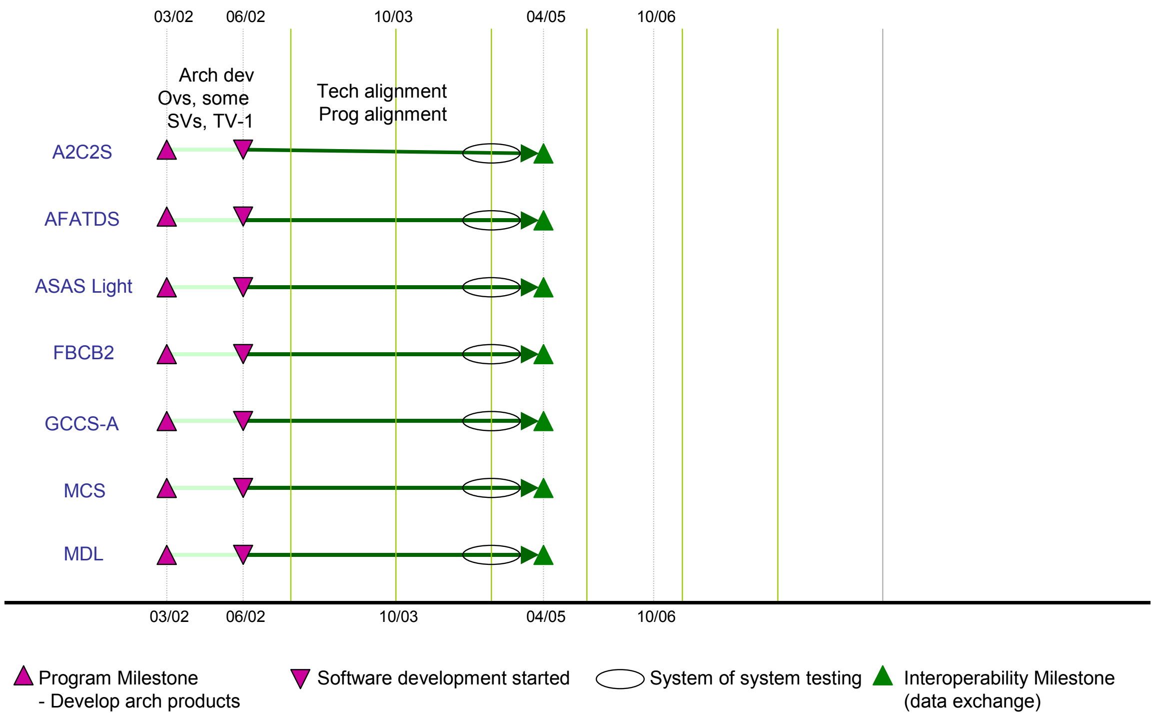

Figure 3.23—Army BMC2 Systems to Be Upgraded in Block 1

The Army BMC2 systems to be upgraded in Block 2 are shown in Figure 3.24. 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). Note that FCS and WIN-T will participate in Block 2 in design only. Block 3 includes FCS, WIN-T and Comanche (will have deliverables in this time frame).

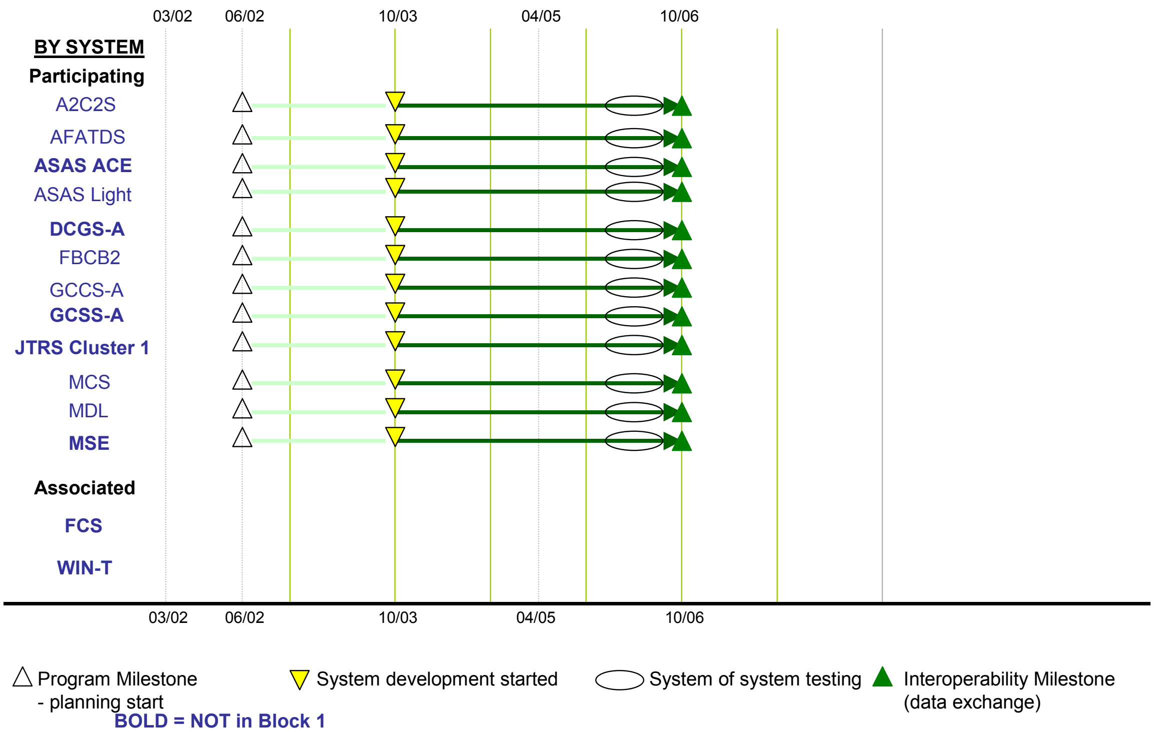

Figure 3.24—Army Systems to Be Upgraded in Block 2

Future Combat Systems. The FCS will need to interface with a large number of programs. Figure 3.25 graphically displays the subsidiary FCS core systems, along with the critical Unit of Action (UA), Unit of Employment (UE), joint systems, and multinational systems with which the FCS core systems will need to interoperate. Appendix D.5 shows the complete list of systems with which FCS will interoperate.

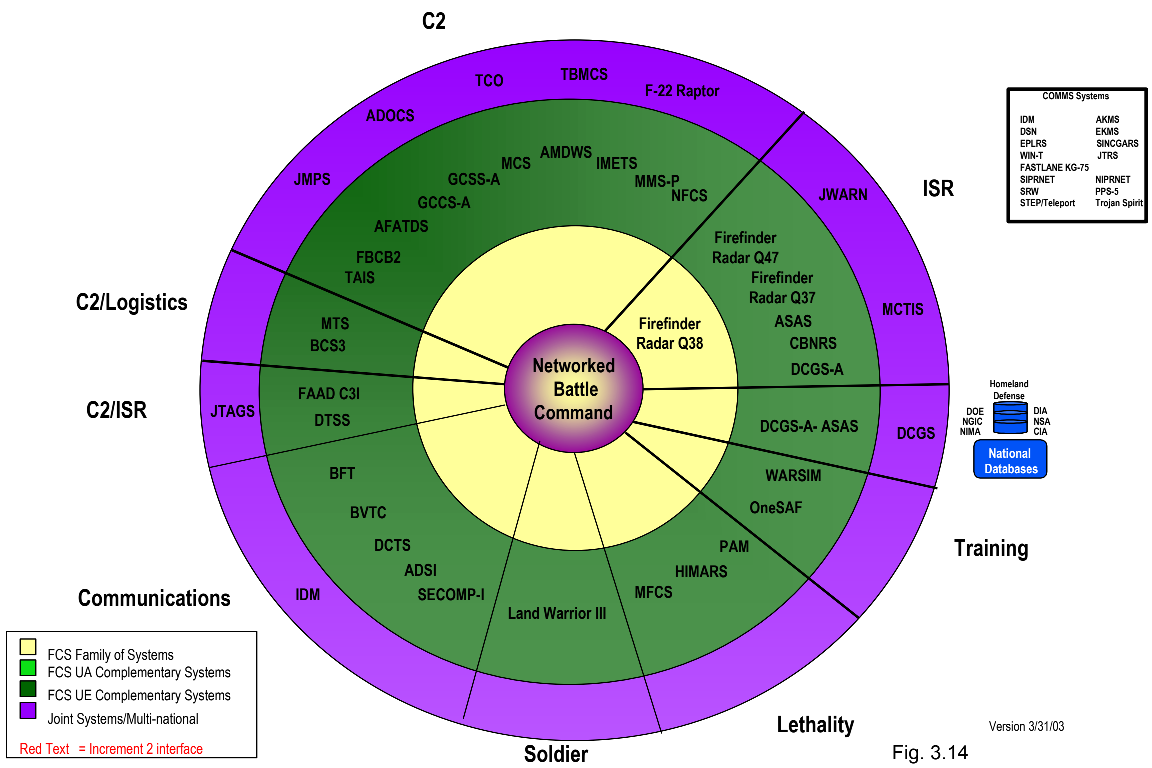

Figure 3.25—FCS Critical Systems

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 3.26. 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."

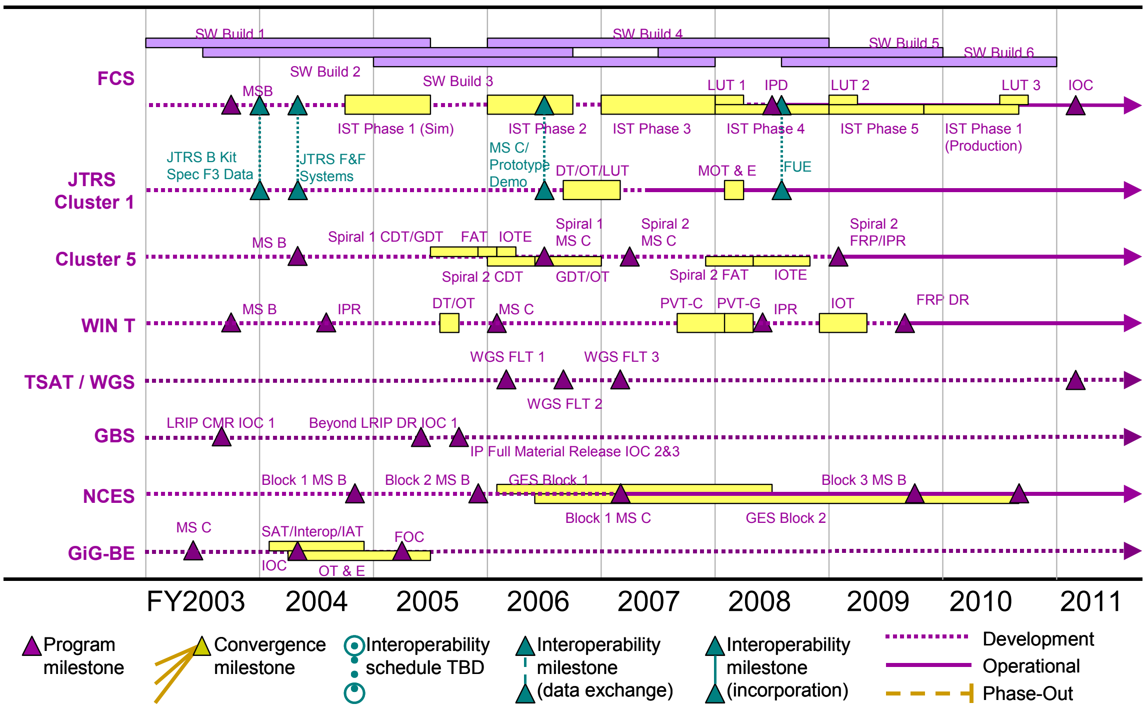

Figure 3.26—FCS and Communications Programs Schedules

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 3.26.

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 Section 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 3.27 aligns the FCS and JC2/GCCS program schedules.

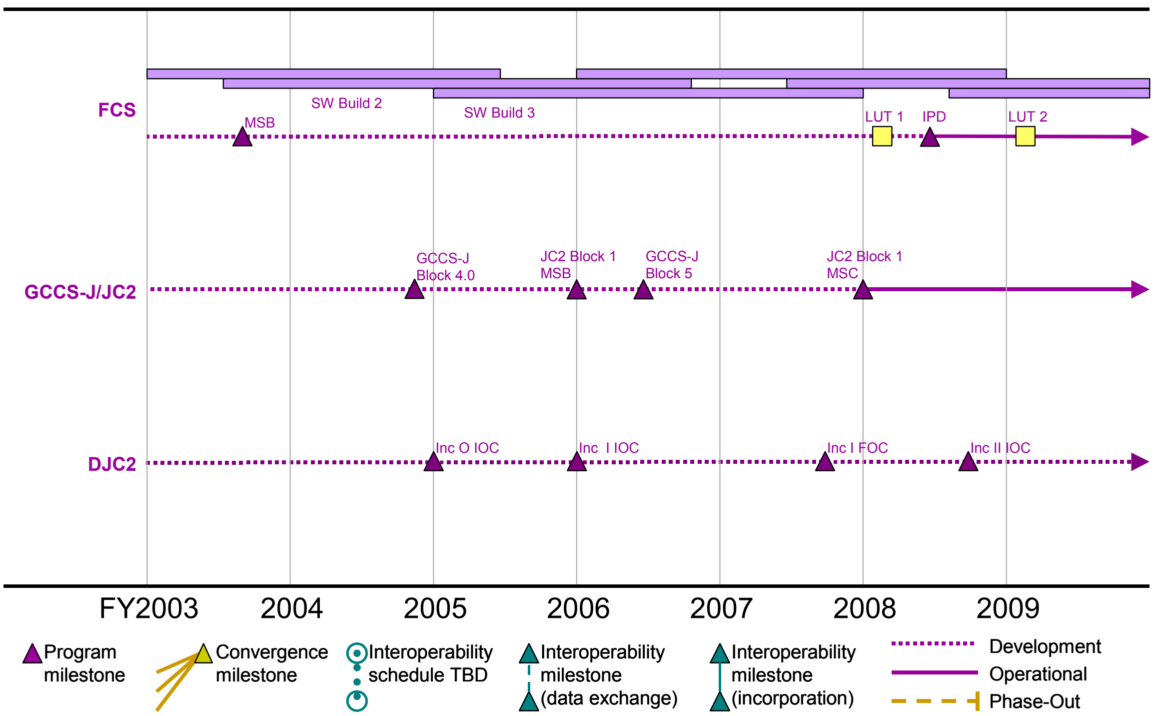

Figure 3.27—FCS and JFC2 Program Schedules

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.

Combined Schedule for Major Army Programs. Figure 3.28 (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).

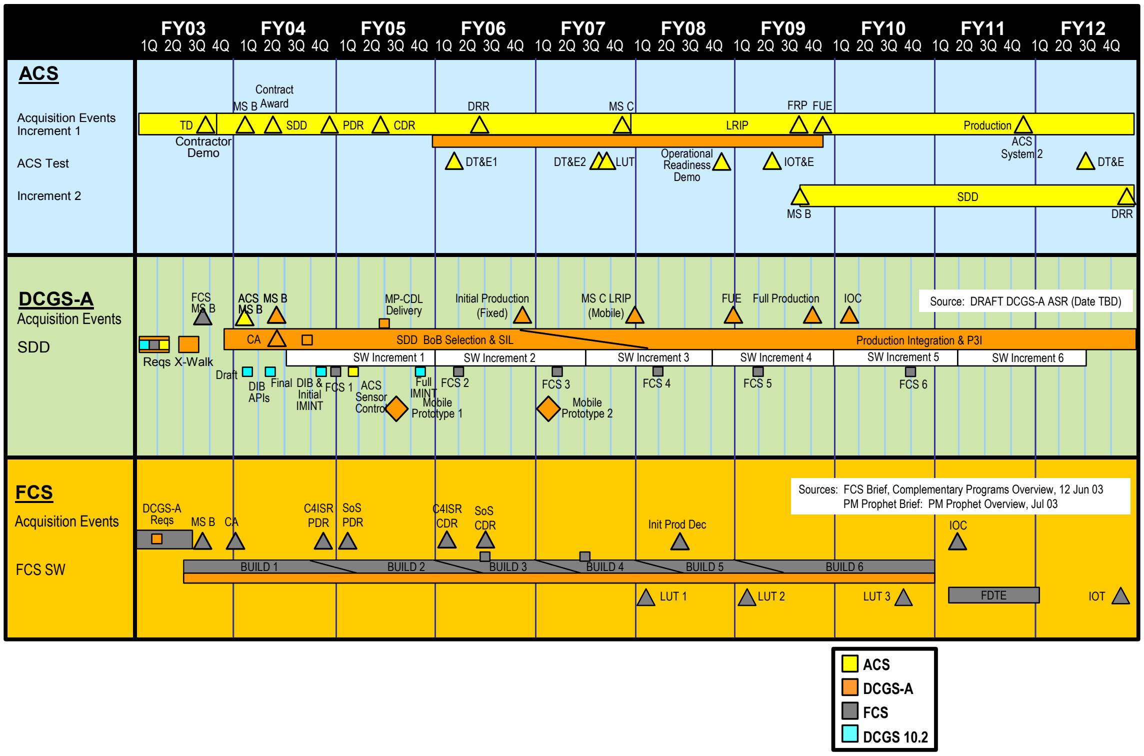

Figure 3.28—Schedules for ACS, DCGS-A, and FCS

3.8 Current Navy Interoperability Milestones

The Department of the Navy's plan for improving interoperability are guided by its FORCEnet effort: "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 "Sea Power 21" and "Naval Transformation Roadmap." 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.

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 3.29 shows these MCPs and the POM FORCEnet capability hierarchy.

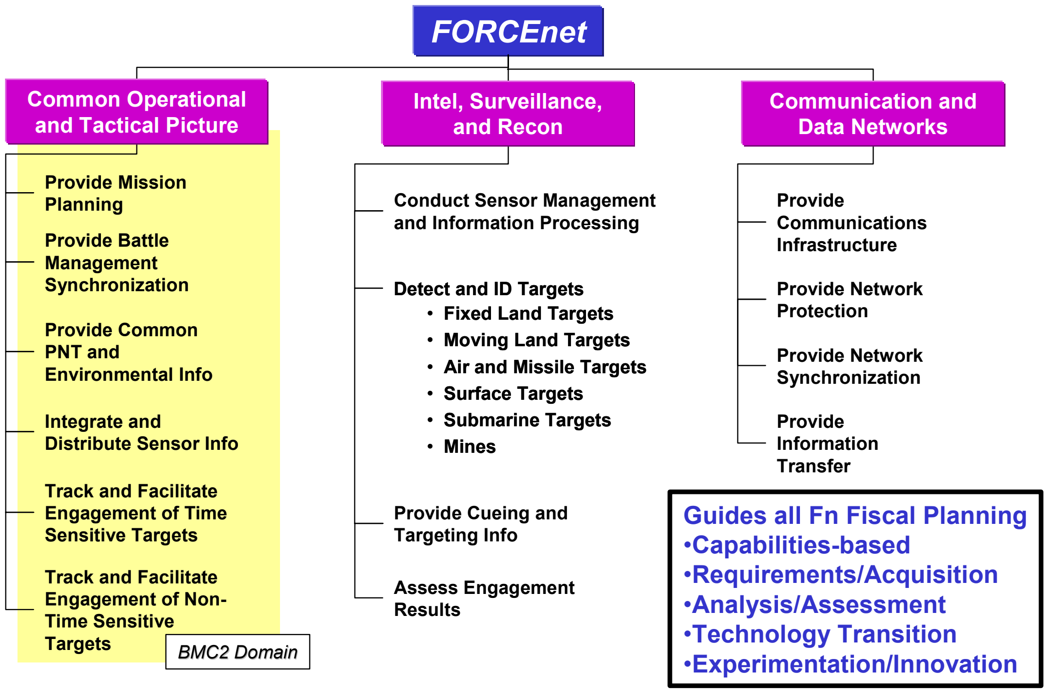

Figure 3.29—FORCEnet Capability Hierarchy

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) establish the technical boundaries for the working environment.

- "Integrate and distribute sensor information"—relevant and timely data feeds of decisionmaking 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 (CNO) 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.

Current activities have centered on developing the necessary strategies, architectural products and operational concepts for an enterprise-wide technology alignment and migration. By continuously developing and phasing together systems, the Navy will define an evolutionary solution set while increasing efficiencies and identifying potential synergies of integration. Implementation also requires a comprehensive approach that will transform the DOTMPLF and other elements of warfighting that are essential to achieving a lasting structural foundation.

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. However, because FORCEnet is not an acquisition program like the Army's Future Combat System, it cannot be represented by milestones and an IOC.

Key FORCEnet guidance documents are identified in the following list. They provide guidance and direction for the FORCEnet initiative:

- FORCEnet Vision
    - contains the 2020 FORCEnet Vision
- FORCEnet Campaign Plan
    - formalizes processes with respect to FORCEnet roles and responsibilities
- FORCEnet Architecture Vision

    - contains FORCEnet architectural vision as well as top-level requirements and drivers

- FORCEnet Architecture and Standards Volume I

    - contains top-level drivers, operational and systems views (in development), and use cases

- FORCEnet Architecture and Standards Volume II

    - contains standards applicable to FORCEnet

- FORCEnet Master (Materiel) Plan

    - will contain assessment of alternatives, design studies, and PORs implementation guidance.

The FORCEnet Innovation Continuum accomplishes FORCEnet "speed to capability." 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. The first FORCEnet warfighting capability was delivered to the ESSEX Expeditionary Strike Group in FY 2003 via Trident Warrior 03.

Figure 3.30 illustrates the extensive schedule currently developed for the FORCEnet initiative. Tests along the "prototype path" may be the most directly relevant to Joint BMC2 interoperability experiments to augment the intra-Navy FORCEnet testing.

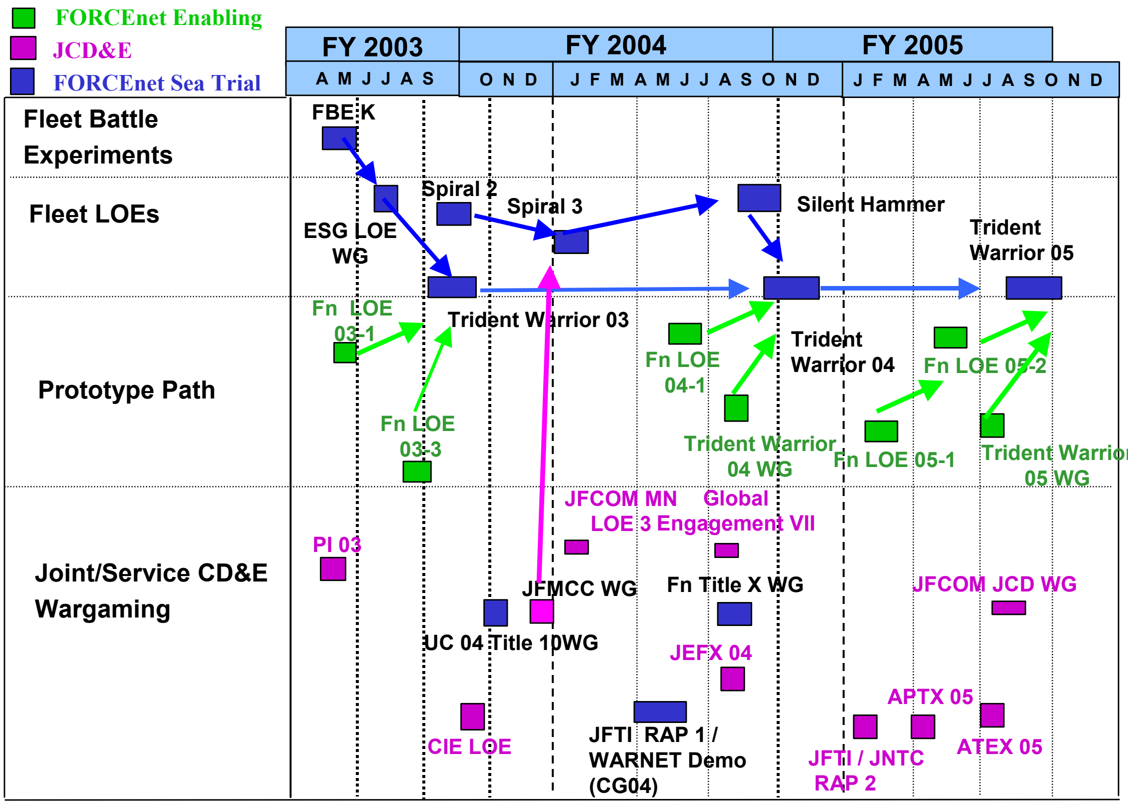

Figure 3.30—FORCEnet Innovation Continuum

3.9 Current 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 under way for an integrated architecture and design of a solution that 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 3.31 shows the schedules for C2PC and TCO.

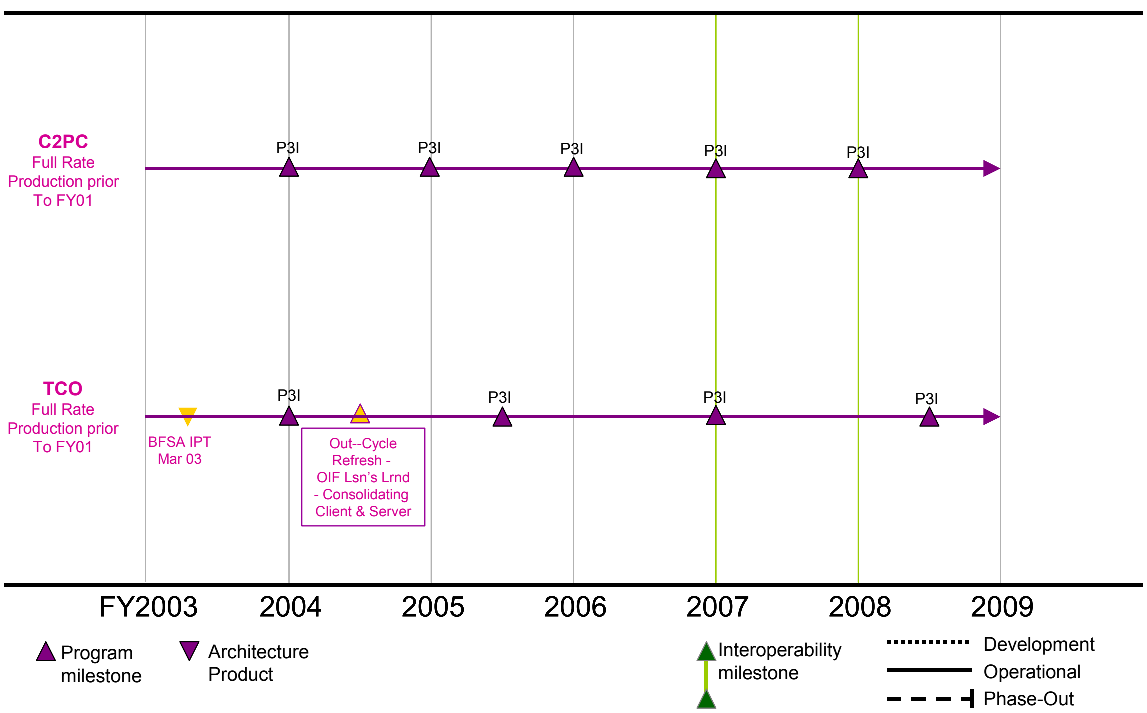

Figure 3.31—USMC C2 Program Schedules

3.10 Current Air Force Interoperability Milestones

C2 Constellation. The Command and Control (C2) Constellation Operational Concept provides an operational construct and architectural framework that will guide Air and Space forces, "tooth to tail" toward net-centric operations at the operational and tactical level of warfare through the full range of military operations. The operational concept draws on the capabilities identified in the Air Force's concepts of operation to establish the Battle Management Command and Control (BMC2) attributes that will provide actionable data more responsively to the warfighter. The goal is to fully integrate air and space forces and bring about desired effects against targets that cumulatively support the Joint Force Commander's (JFC's) guidance. The C2 Constellation will enable the development of decisive information superiority, collaborative planning, and synchronized operations for the warfighters by eliminating stovepipe connectivity within the Aerospace Expeditionary Force and between systems used by the supported and supporting Air and Space Operations Centers (AOCs), regardless of geographic location. Additionally, enhancing our ability to reachback to support units and databases available in the CONUS or in other theaters will support Predictive Battlespace Awareness, in turn enhancing Effects Based Operations. This integration will enable seamless C2 to conduct swift military operations on a global scale. The C2 Constellation supports Joint Vision 2020, the Joint C2 (JC2) Operational Requirements Document, the JBMC2 Road Map, and the USAF Transformation Flight Plan FY03–07.

The C2 Constellation's peer-based Network-Centric Infrastructure (NCI), called CONSTELLATIONnet, will provide standard network services that will integrate the C2 Constellation into the GIG. Additionally, CONSTELLATIONnet will enable a shared Combat Information Environment to C2 centers, support organizations, joint and coalition organizations, combat aircraft, and combat support aircraft to enable the flow of decision-quality information and support warfighter collaboration by creating an intuitive decision environment through full access to battlespace information. Current discrete air, ground, and space networks will be adapted and interconnected or replaced to form a seamless information dissemination grid.

C2 Constellation capabilities will be fielded across the Air Force enterprise. As a result, movement to net-centric operations may require optimization of the capabilities of the network as a whole over optimization of the individual networks and platforms in order to support integration and global connectivity. It will also require each fielded system to support the interoperability and connectivity standards of CONSTELLATIONnet and incorporate a core set of tools that will allow collaborative C2 environment.

Three stages mark the development of the C2 Constellation. First, the architecture will establish the network standards and protocols for both current and future systems integration and information exchange. The Air Force is currently in this stage. The second stage will bring legacy systems into Constellation compliance. Next-generation advanced technology command centers and sensors will be developed in the third stage, leveraging advancements by industry. The three-stage process will continue in an iterative fashion to evolve the C2 Constellation (including the standards and protocols) as needs dictate and technology allows.

The C2 Constellation is a function of networks enabling information integration from sensors, platforms, and nodes across the Air Force enterprise and applied by the people and processes of BMC2. The Constellation is a network of combat and combat support systems and other data sources sharing information through the Constellation grid of peer-to-peer,[24] networked sensors, platforms, and nodes. Within the framework of guidance established by the C2 Constellation, a variety of capabilities will be fielded in command centers—Ground Moving Target Indication (GMTI), Airborne Moving Target Indication (AMTI), Electronic Warfare (EW) aircraft, Remotely Piloted Vehicles (RPVs); ground-based, airborne, and space-based environmental awareness, surveillance, and reconnaissance systems; air refueling and airlift assets; missile defense assets; strike platforms; offensive and defensive information warfare assets; PSYOPS functions; and autonomous munitions.

As future capabilities approach, fielding the Constellation's operational concept requires each fielded system to support interoperability and connectivity standards both within the C2 Constellation and across the entire Joint Force. The Air Force will achieve interoperability and connectivity when Air and Space Expeditionary Force (ASEF) assets are horizontally and vertically integrated, optimized for machine-to-machine information exchange and providing decision-quality information to the warfighter. The Constellation's peer-based NCI will build decision-quality information for the warfighter. This information will support warfighter collaboration by creating an intuitive decision environment through full access to all data by all C2 centers, combat and combat support aircraft. In turn, the C2 decision cycle will shorten, providing the JFC the ability to adjust operations as the battlespace changes.

Joint C2 concept documents state the key to achieving Agile C2 is the ability to rapidly synchronize activities of disparate participants to achieve desired effects in a dynamic operational environment. Linking participants, regardless of location, within a networked collaborative information environment enables agility. This collaborative environment facilitates shared understanding, superior decisionmaking, and continual synchronization. Agile C2 empowers individuals and teams to take initiative in the context of the commander's intent. The operational information environment that will enable agile C2 is produced through the Constellation's sensors, platforms, and nodes enabled by the NCI created on the GIG.

In summary, the C2 Constellation Operational Concept establishes the way ahead to achieve capabilities identified in the Air Force's concepts of operation. Capabilities fielded under the C2 Constellation will also be interoperable with other Services and at the joint level while supporting multiple, geographically separated theaters of operations to achieve the JFC's desired effects.

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[24] Peer-to-peer is a communications model in which each party has the same capabilities and either party can initiate a communication session. Peer-to-peer communications is implemented by giving each communication node both server and client capabilities.

GCCS-AF and TBMCS. Figure 3.32 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 GCCS-AF and TBMCS will use, JC2, COE, and NCES, are shown as well.

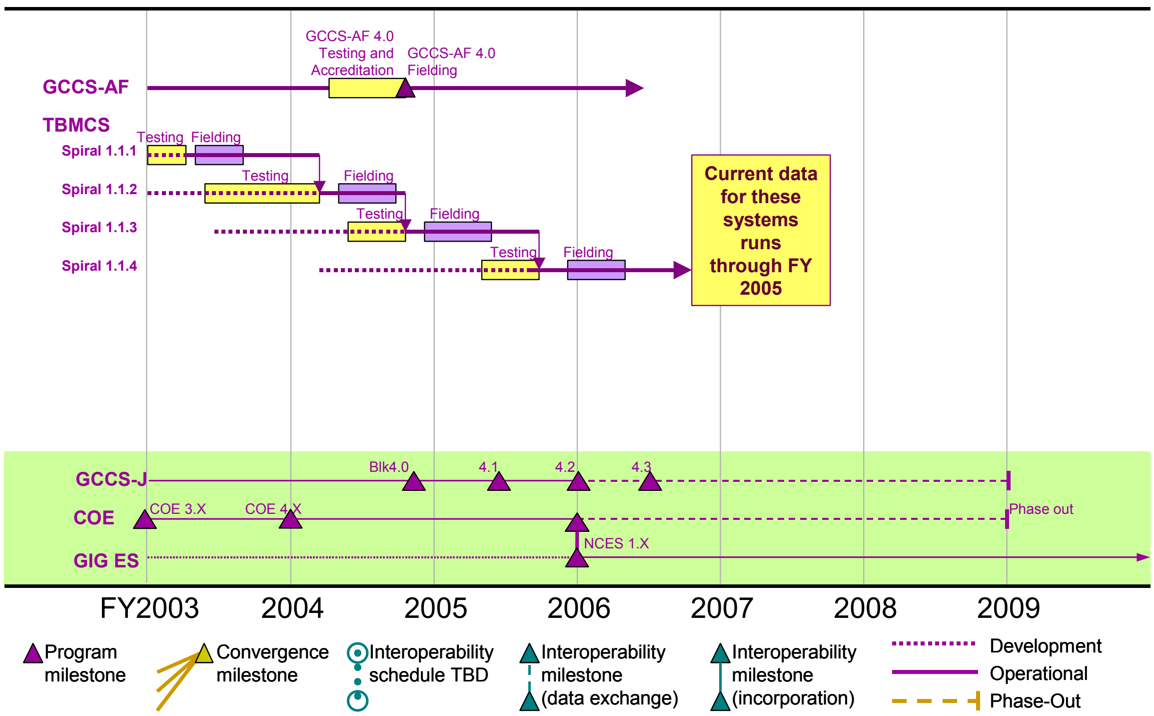


Figure 3.32—Consolidated Schedule for Core GCCS-AF Systems

DCGS-AF. Figure 3.33 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.

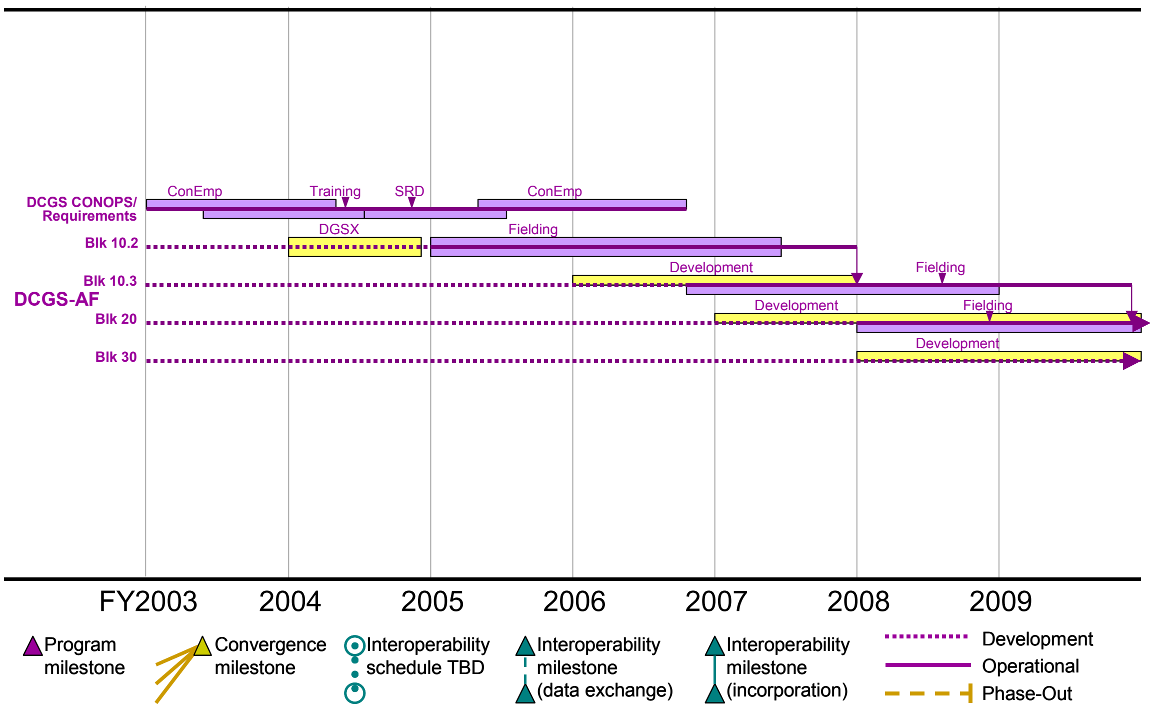


Figure 3.33—DCGS-AF Schedule

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).

Airborne C2 Elements. The Air Force plans to replace the existing JSTARS, U-2, and Airborne Command and Control Centers with a family of Multi-Sensor Command and Control Aircraft (E-10A / MC2A) and unmanned aerial vehicles (UAVs), such as Global Hawk. Figure 3.34 shows the integrated program schedule for several major airborne C2 elements: E-10A, Global Hawk, JSTARS, and Global Hawk. Also shown are interfaces to the Army's DCGS-A and the contributions of two programs producing common components for the airborne C2 elements, 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.

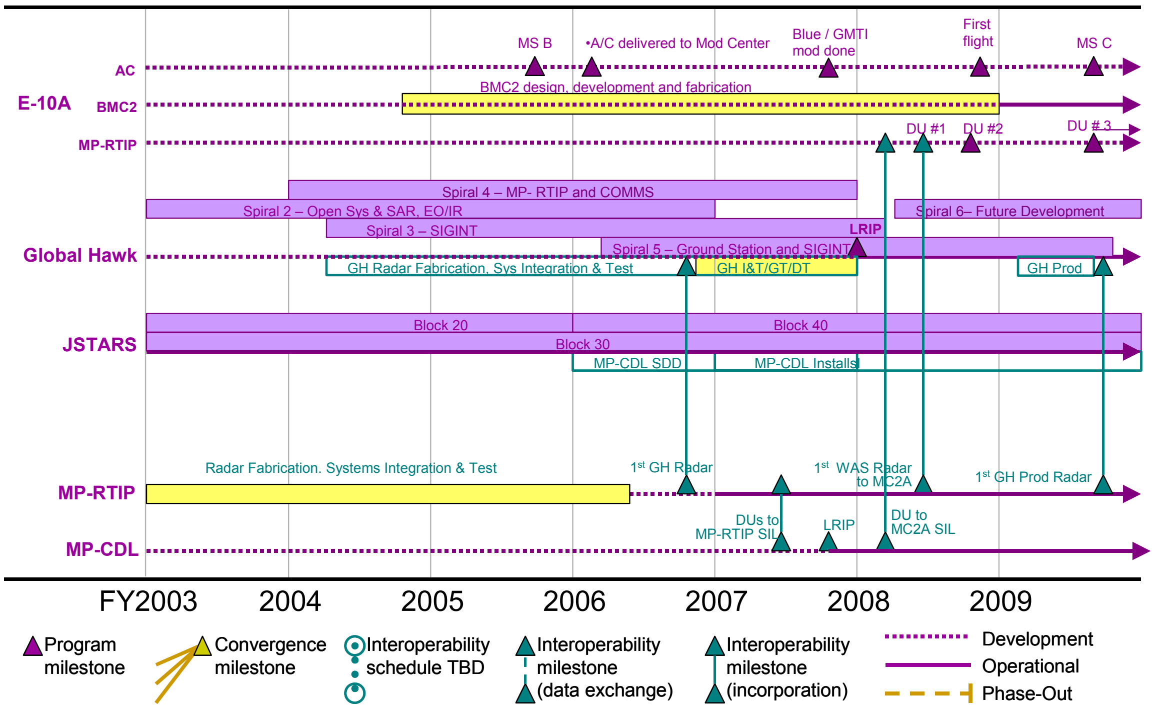


Figure 3.34—Integrated Program Schedule for Airborne C2 Elements

4.0 Milestones for Key JBMC2 Initiatives

4.1 Systems Engineering and the JBMC2 Engineering Team

4.1.1 Systems Engineering Approach

USD(AT&L) and JFCOM are jointly developing, for inclusion into the JBMC2 Roadmap, a systems engineering approach linking the functional capabilities defined by the Joint Staff with the procurement and development expertise of the services and agencies to ensure effective JBMC2 at the tactical level. In the approach, a joint mission thread (JMT) systems engineering analysis process will be followed. Key components of the approach will include net-centric concepts and alignments of net-ready key performance parameters (KPPs). The approach will include a system of systems (SoS) and family of systems (FoS) analysis that looks across multiple mission threads to ensure that full DOTMLPF recommendations within a mission thread consider the impacts in other mission areas. The first draft of this systems engineering approach will be included in version 2.0 of the JBMC2 Roadmap.

The major activities and products for the systems engineering approach are shown in Figure 4.1. As show, the activities and products will support and provide leverage for existing DoD efforts for requirements, acquisition, PPBS, and policy, and will contribute to four improved warfighter outcomes:

- Joint integrated capability with increasing effectiveness
- Improved allocation of scarce resources
- Interoperability
- Shorter time to deliver improved capabilities

4.1.2 JBMC2 Engineering Team (JET)

JFCOM, AT&L, and the integrated battlespace picture efforts (FIOP, SIAP, SIGP, FnMP, SISP, SISOP, SIBMP) in conjunction with the Services' Systems Commands, are in the process of developing a comprehensive JBMC2 Engineering Team (JET) to focus, integrate, and coordinate the joint engineering efforts necessary to support the development of integrated JBMC2 capabilities. The JET will support the capability area DABs' way ahead as well as the JBMC2 mission thread development and management. The structure and organization of the JET is under consideration at the time of this edition of the Roadmap. A full description will be included in the next update of the Roadmap.

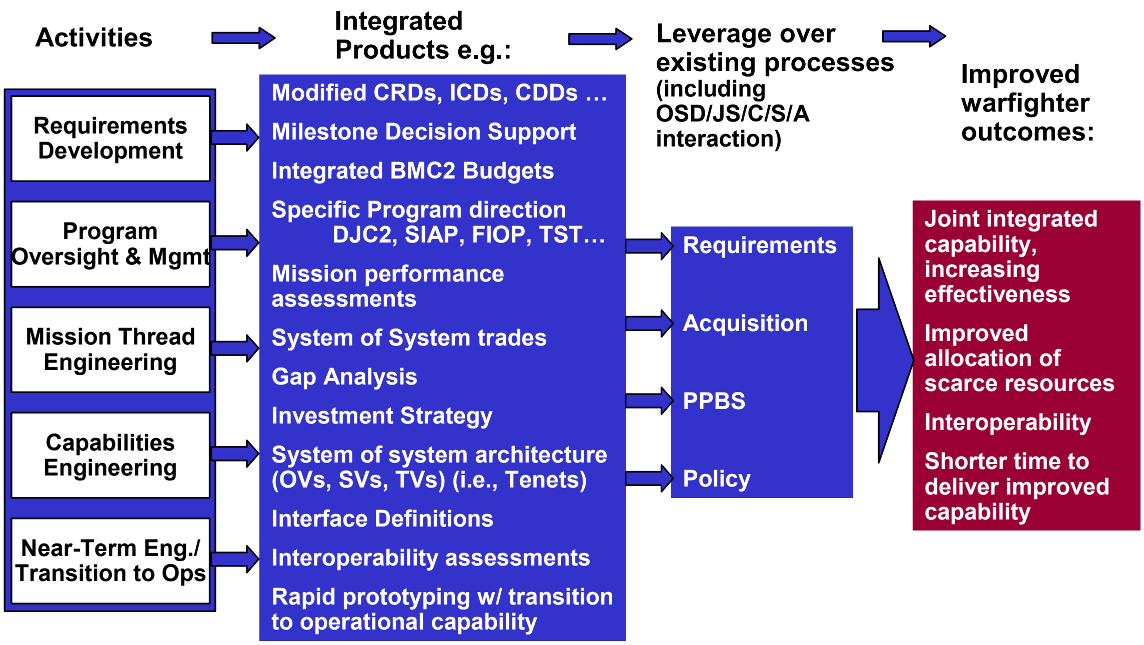


Figure 4.1—Activities, Products, and Improved Outcomes of the JBMC2 Systems Engineering Process

4.2 Battlespace Picture Integration *(Cross-Picture Coordination)*

U.S. forces must have the ability to take away an opponent's capability to disrupt or prevent the United States from meeting its operational objectives. ...We must have the ability to operate inside an opponent's decision and execution cycle. To this end, correct and complete information that characterizes the battlespace provides a distinct advantage for U.S. forces. The fact that "information" is an element of our national power and is becoming a weapon of choice has given rise to several initiatives in the form of "picture initiatives" geared toward providing that battlespace information—e.g. FIOP, SIAP, SIGP, SIMP, SISP, SISOP, and SIBMP. Each of these picture initiatives has different management/control structures; different planning, programming, budgeting, and funding execution guidance, and control; and different engineering approaches, and they produce different deliverables, making a coordination process challenging. Within the context of the JBMC2 Roadmap, this section proposes a framework to coordinate "picture efforts" so that:

- The picture initiatives have prioritized capability needs to guide their development activities,
- The picture initiatives have DOTMLPF requirements to assist with alignment and synchronization with systems of record,

- The completeness, correctness, accuracy, and timeliness of the air, ground, maritime, and space information represents the objects in these domains to the degree necessary for successful execution of assigned tasks.

Common Integration Framework: Picture initiatives are not programs in their own right. The deliverables of these initiatives will be realized in the systems of record that form the JBMC2 program clusters (see Chapter 10). The goal is to establish a framework that provides the capability to align and synchronize the activities of these initiatives to avoid duplication, aid in acquisition decisions, determine resource allocation, and ensure that picture initiatives address operational capability needs identified by the JCIDS. The objective for this framework is to influence the engineering activities of the picture efforts to create respective domain information for shared awareness of the operational and tactical situation. The picture leads become the authoritative information source for their respective domains and, as such, provide source information for user-defined operational pictures.

USJFCOM will lead the JET, which will be responsible for cross-picture coordination. The JET will include participants from the Services, selected agencies as required, and the picture leads. The JET will:

- Provide validated and prioritized capability needs to picture leads
- Perform a coordinating function for alignment and synchronization of picture activities with target systems of record timelines to afford implementation of solutions provided by picture efforts
- Ensure that picture engineering activities address requirements of the JBMC2 program clusters approved by the cluster DAB
- Ensure that picture engineering activities comply with the means proposed for achieving SoS interoperability within the cluster, the data strategy for the cluster, and the interoperability test strategy for incrementally improving cluster interoperability performance
- Provide advice regarding resource allocation and acquisition decisions
- Assist with tradeoff analysis of available material solutions
- Coordinate with PORs to minimize duplication with respect to JMT-related capability.

The elements of this approach will be captured as part of what shall be referred to as a Common Integration Framework.

The elements of the common integration framework, not all-inclusive, include:

- Coordination of various picture efforts
- Architectural strategy
- Data strategy compliance
- Integrated master schedule.

Common Integration Framework: Coordinating Efforts: In support of the near-term approach, the first step is to raise the level of awareness across current picture efforts. The simple sharing of information across efforts on current activities accomplishes this objective. Each picture will need to provide a description of the problem(s) being worked, engineering approaches to address these problems, potential DOTMLPF implications, and what systems of record are transition targets. Each "picture owner" is requested to provide:

- Task Statement—A detailed explanation of the specific problem area under investigation, what operational capability need may be satisfied, and what current capability is not being provided to the warfighter based on the deficiency.
- Proposed Solution to deficiency—Once the problem area is well understood, potential technical/programmatic solutions can be considered that need to have near-term applicability and need to show consistency with DoD's architectural objectives.
- Block Diagram—To the extent practicable, includes high-level operational and systems-level as-is views of the problem. Highlights the operational deficiency and various systems involved. (e.g., OV-1, OV-2, SV-1, SV-2).
- Schedule—Schedule for the development of a solution.
- System Matrix—Each picture effort should contribute to a matrix depicting what systems are targeted and what technologies are being applied (solutions) to what systems, platforms, etc. This matrix can help identify synergies and overlaps or just facilitate drill-down to next level of detail.

4.2.1 Common Integration Framework: Architectural Strategy

Relative to cross-picture coordination, the JET will advocate compliance with guidance as outlined in Section 2 from the JBMC2 Systems Engineering Steering Group and the FCB joint integrated architectures and encourage participation in this group as appropriate. As stated in the guidance, the JET will also ensure that picture architectures map to the GIG Architecture and provide a transition plan to move toward enterprise net-centricity. As the JBMC2 Integrated Architecture initiative matures, the architecture strategy for cross-picture coordination will be updated/revised.

4.2.2 Common Integration Framework: Data Strategy Compliance

An essential ingredient of accomplishing cross-picture coordination is data strategy compliance. Simply stated, the JET will facilitate compliance with the data strategy described in Chapter 6 of this roadmap. In particular, the JBMC2 COI, which has overall responsibility for developing data interoperability solutions for JBMC2, will be a branch of the JET.

To successfully work a data strategy across the picture efforts, certain other groundwork-laying activities should be considered:

- Data terms of reference—ensure common terms are used.
- Hierarchy (taxonomy) that shows the relationship of the various data models in the picture domains to include relationships, mediation strategies, etc.—work to establish common battlespace objects.
- Development of long-term, objective, engineering-level data strategy and forcing functions for compliance—design to the User Defined Operational Picture (UDOP), NCES, JC2, etc.

4.2.3 Common Integration Framework: 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. An integrated master schedule should help synchronize development of solutions and their transition into the targeted programs of record.

Products from this approach include:

- Documented development and deployment strategies. When is the projected completion date for a developed product? When will it be fielded (when will the warfighter get increased capability?)?

- Recommendations to IPTs and or WGs within picture efforts—on an as-needed basis—provide guidance and support to specific efforts under way.
- A composite baseline list of tasks across the community of picture efforts.

These products should feed the DOTMLPF strategy outlined in this Roadmap.

To preclude stovepipe solutions, this process will address both long-term and short-term aspects of solving interoperability issues across all of the picture efforts. To achieve this goal the following objectives must be achieved:

- Initially coordinating and integrating the tasks currently under way
- Assessing the current tasks to identify complementary activities
- Agreeing on a set of battlespace initiatives.

The remainder of this section provides as-is descriptions and milestones of the battlespace picture initiatives, including FIOP, SIAP, and SIGP. The summer 2004 update of the roadmap will provide information on FnMP, SISP, and SOFP.

4.3 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-ES 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 October 6 2000) 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 FoS.

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 October 6, 2000) 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 systems.

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 (TACP). 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 (TDL) Integration . 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 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 to be defined, with high priority given to meeting seams consistent with the FIOP philosophy while evolving to the target architecture for CII and 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, including 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.

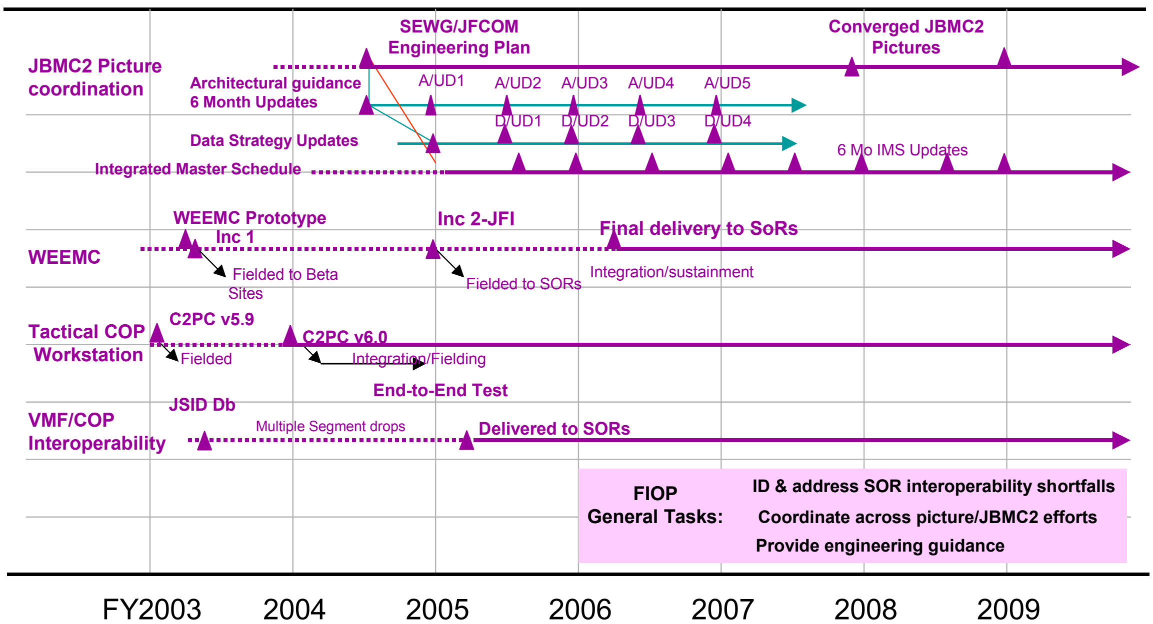
2.3.2. Targeting Interoperability. Extend efforts in Precision Fire Support and Network-Based Services to create and improve automated tools supporting timely and effective TCT. Possible focus is development of a single "target file" data service that supports both web-level and data-level push and pull data services and integration. Target SORs: include GCCS FoS, JTT, DTSS, AFATDS, 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.

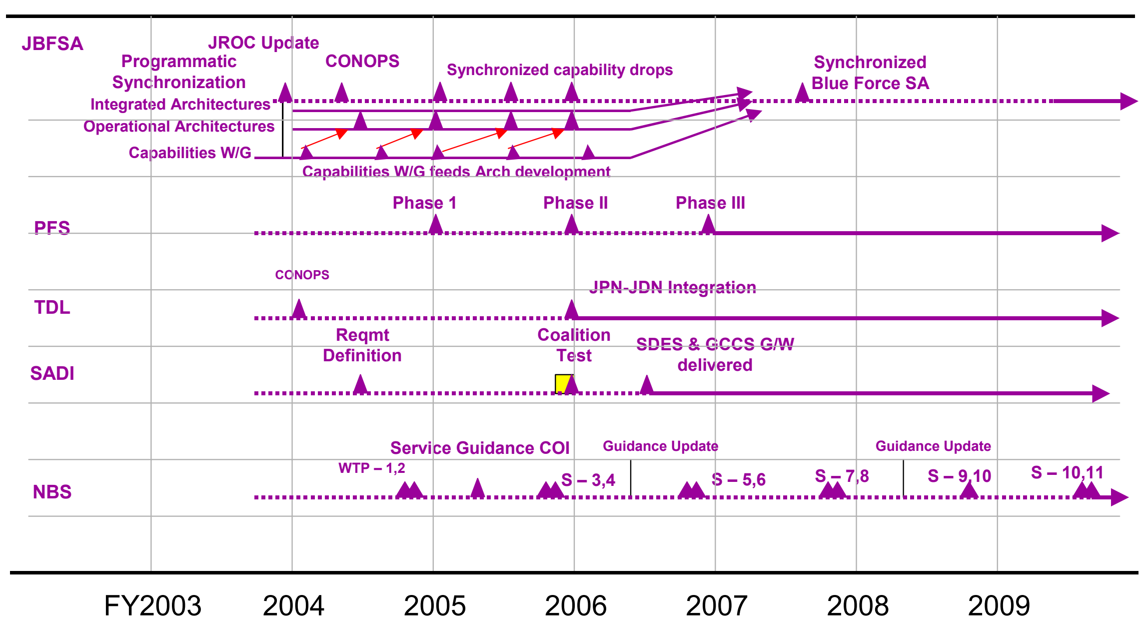
2.6.1, METOC Services. Create information service that pulls weather information from a number of sources and provides it to all weather information users. Target SORs: GCCS FoS, all operational or tactical system creating or displaying environmental situational awareness. Additional comments: Technical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

Schedule

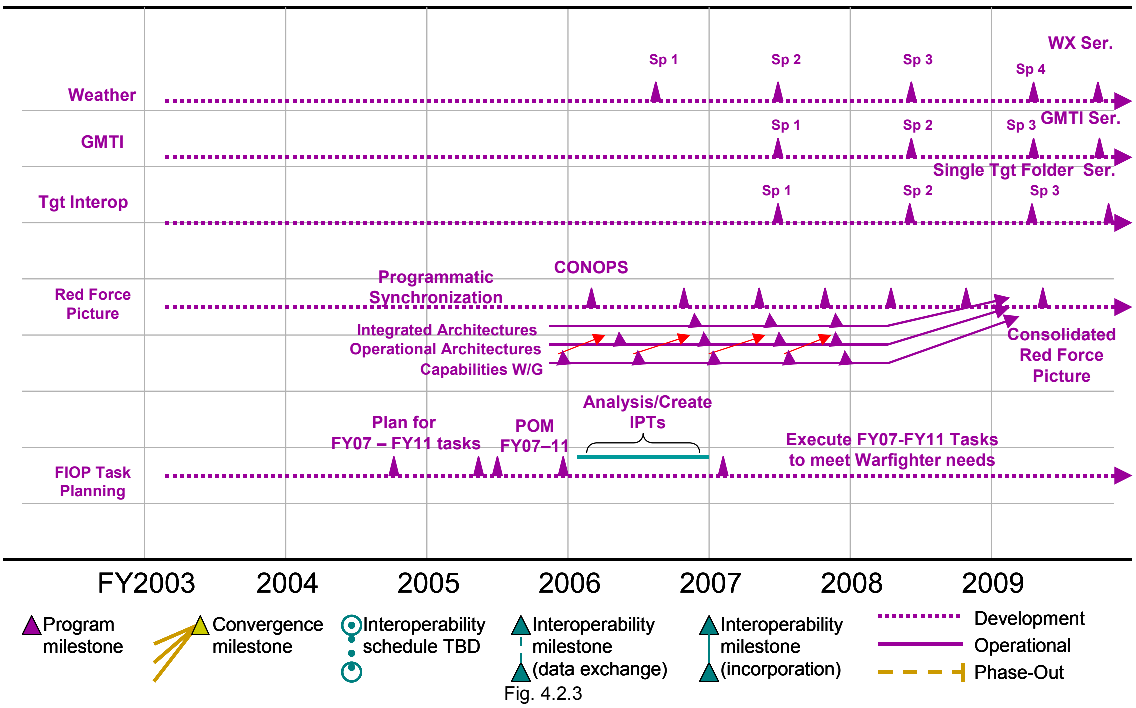
Figures 4.1–4.3 shows the current schedule of tasks for FIOP.



SEWG/JFCOM
Engineering Plan
Converged JBMC2
Pictures
JBMC2 Picture coordination
Architectural guidance
6 Month Updates
A/UD1
A/UD2
A/UD3
A/UD4
A/UD5
D/UD1
D/UD2
D/UD3
D/UD4
Data Strategy Updates
6 Mo IMS Updates
Integrated Master Schedule
WEEMC Prototype
Inc 1
Inc 2-JFI
Final delivery to SoRs
WEEMC
Fielded to Beta
Sites
Fielded to SORs
Integration/sustainment
C2PC v5.9
Tactical COP Workstation
C2PC v6.0
Fielded
Integration/Fielding
End-to-End Test
JSID Db
VMF/COP Interoperability
Multiple Segment drops
Delivered to SORs
FIOP
General Tasks:
ID & address SOR interoperability shortfalls
Coordinate across picture/JBMC2 efforts
Provide engineering guidance
FY2003
2004
2005
2006
2007
2008
2009



JBFSA
JROC Update
Programmatic
Synchronization
CONOPS
Synchronized capability drops
Synchronized
Blue Force SA
Integrated Architectures
Operational Architectures
Capabilities W/G
Capabilities W/G feeds Arch development
Phase 1
Phase II
Phase III
PFS
CONOPS
JPN-JDN Integration
TDL
Reqmt
Definition
Coalition
Test
SDES & GCCS G/W
delivered
SADI
Service Guidance COI
Guidance Update
Guidance Update
WTP – 1,2
S – 3,4
S – 5,6
S – 7,8
S – 9,10
S – 10,11
NBS
FY2003
2004
2005
2006
2007
2008
2009



Figures 4.1–4.3—Current Schedule of Tasks for FIOP

4.4 Single Integrated Air Picture (SIAP)

4.4.1 Background

The Department of Defense has substantial evidence that significant warfighting capability shortfalls exist in joint theater air and missile defense. Lessons learned from military operations, training exercises, and evaluations point to specific issues that must be addressed to meet the requirements for the SIAP and for combat identification (CID) (henceforth referred to collectively as SIAP) articulated in the Theater Air and Missile Defense (TAMD) and CID Capstone Requirements Documents (CRDs) and other relevant operational requirements documentation. The JROC recommended a lead system engineering organization be established to facilitate the transition of the SIAP requirements from concept to a fielded joint capability.

The SIAP Systems Engineering Task Force (TF) was chartered on October 26, 2000, to institute a disciplined joint system engineering process to address and resolve interoperability problems in the implementation of the joint data network (JDN) and development of the SIAP Integrated Architecture. Because of the long-term nature of these objectives and the need to stabilize this effort, the JROC and the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) decided to transition the TF into a Joint SIAP System Engineering Organization (JSSEO) to simplify oversight, establish clear funding lines within each Service, and dedicate sufficient resources to support the initiative. Management Initiative Decision (MID) 912, "Joint Battle Management Command and Control (JBMC2)," dated January 7, 2003, directed USJFCOM, in coordination with the Army, to execute oversight and directive authorities for joint integration and interoperability of the JSSEO starting in FY 2003.

Today, the JSSEO functions as a collaborative organization, in which the JSSEO provides a relatively small core engineering and management team augmented with technical expertise from industry and the academic community. The Services contribute by providing subject-matter experts (SMEs) in a "virtual staff" to participate in the engineering process. The Director, JSSEO, participates in the Joint Theater Air and Missile Defense (JTAMD) process through the JSSEO-chaired SIAP Block working integrated product team (WIPT) and the SIAP Architecture WIPT—two of the topical WIPTs reporting to the Joint Council of Captains and Colonels (JCoCaC)—and in membership in other standing WIPTs, the JCoCaC, and the IPT.

4.4.2 SIAP Block Approach

The JSSEO was initially assigned the responsibility to develop the system and technical views of the SIAP component of the TAMD Integrated Architecture (IA). The JSSEO has adopted an incremental approach to resolve the interoperability problems that constrain joint and coalition operations.

- *Block 0.* This approach started with the definition of the Block 0 upgrades, which included three approved tactical data link interface change proposals (ICPs). The Block 0 effort also included a fourth issue—formation tracking—that required additional engineering work before implementation. The three Block 0 ICPs were approved for implementation in August 2001 (JROCM 164-01).

- *Block 1.* The Block 1 system engineering effort consisted of 13 block issues (some with deferred start dates) that encompassed the next round of SIAP capability fixes and the baseline SIAP IA. In the first quarter of FY 2003, the task force began to make the transition to a business model for implementing SIAP capabilities through the concept of building a behavior model. This business model replaced the previous block upgrade process with an evolutionary series of reference implementation baselines developed using an agile, model-driven architecture approach.

- *Block 2.* The Block 2 engineering effort is currently in the initial planning stages. Block 2 engineering will focus on the following themes:
    - Host implementation consistency

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

4.4.2.1 SIAP Block 0

To identify root cause problems, the Joint IADS (JIADS) Interoperability Working Group (IWG) analyzed ASCIET 99 and ASCIET 00 data. More than 30 items were identified as significant issues that needed to be addressed. Four of the items were selected and endorsed by the JROC as the initial demonstration of the SIAP system engineering process. These four issues formed the basis of the Block 0 upgrades (three ICPs and formation tracking).

4.4.2.1.1 Block 0 Issues

The four Block 0 items were selected because of their impact on the JDN, their applicability across all four Services, and the opportunity to demonstrate the broad set of SIAP system engineering processes that were developed and used to address them. Details of the four Block 0 items are discussed in the following paragraphs:

- Correlation/Decorrelation (ICP TM98-035 Ch 11). This ICP standardized the correlation/decorrelation processing for applicable, primarilyC2, systems participating on Link 16 by prescribing the method by which the correlation "window" will be computed as well as providing details on the use of kinematics, identification (ID), and Identification, Friend or Foe (IFF)/Selective Identification Feature (SIF) data in the correlation/decorrelation process. This ICP was selected because it had great promise to reduce the incidence of dual tracks and it was already approved by the Services for allied coordination through the JINTACCS process.

- Identification (ID) Taxonomy and Symbology Display. Link 16 provides seven ID values (Pending, Unknown, Suspect, Assumed Friend, Neutral, Friend, Hostile). Currently, some systems have only implemented a subset of these seven values for display to the operator. This leads to confusion and loss of previously derived data following a reporting responsibility shift to these systems that have not implemented all seven values. The ID Taxonomy Display problem was selected because it was the one issue that commander of USJFCOM wanted resolved because of the impact of symbology mismatch on the operational forces.

- ID Conflict Resolution Matrix (ICP TM94-005 Ch 10). This ICP established the standardized way to process the resolution of ID differences between units. The ICP stipulated the conditions under which a track's ID, received from another unit and different from the locally held ID, would be automatically accepted, automatically rejected, or subject to operator review. This ICP was selected because it has been approved for implementation and it too had great promise to reduce operator workload and distraction.

- Formation Tracking/Assessment. This was not an ICP but a problem statement. The problem arose from a difference in how Services handle "formation" tracks—one Link 16 track employed to represent more than one object. The formation tracking provides 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 systems.

4.4.2.1.2 Block 0 Recommended Weapon Systems

The Services were asked to nominate C2 and weapon systems to implement these four JDN fixes from 92 systems utilizing Link 16. A core set of systems was initially selected for implementation, stemming in large part from their plans to participate in JCIET 2002. This exercise would have provided an opportunity for JSSEO and the joint community to assess the impact of the fixes in an operational environment. Additionally, as part of the Block 0 effort, the Block 0 team and Service representatives recommended that other systems consider implementing the Block 0 fixes to improve joint warfighting capability. Of the other remaining 92 Link 16 systems, the Block 0 team used a down-select process to define a manageable set of systems and configurations to perform an optimized acquisition analysis. These systems meet several common criteria:

- Support air and/or cruise missile defense.

- Established IOC before or during FY 2006 with deployment through the POM 2004 FYDP.

- Contribute to the SIAP.

Table 4.1—Block 0 Recommended Weapon Systems

Army	**PATRIOT ICC** **FAADC2** AMDPCS PATRIOT BCP RAH-66	**USAF**	**E-3 Block 30/35** **F-15 A/B/C/D Suite 5M** **MCE, v.111** **RIVET JOINT** F-15E Suite 5E

	ADAM Cell		F-16 Blk 40 F-16 Blk 50 F-22 B-2 TACP-M
Navy	**ACDS Blk 0** **ACDS Blk 1** **AEGIS B/L 5.3** **AEGIS B/L 6.1** **E-2C Group II, IIN, MCU, & CEC** **F/A-18C/D & E/F** AEGIS B/L 6.3 AEGIS B/L 7PH1 SSDS MK 2	**USMC**	**TAOM**

Note: **Bold** indicates Block 0 "Core" Systems

As a pathfinder, Block 0 delivered the first increment of processes and JDN fixes required to achieve an objective SIAP. Figure 4.4 depicts the timelines for the systems implementing SIAP Block 0.

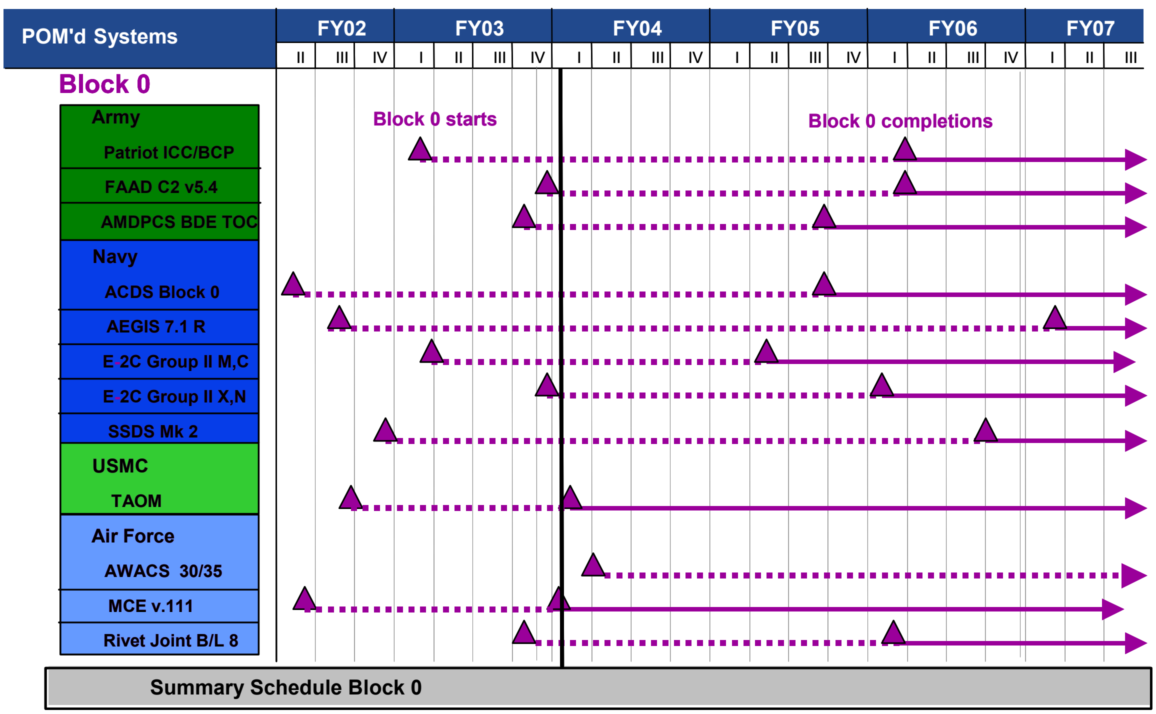


Figure 4.4—SIAP Block 0 Systems' Timelines

4.4.2.2 SIAP Block 1

The Director, JSSEO, chartered the Block 1 WIPT to lead the system engineering efforts necessary to develop engineering recommendations, with supporting rationale that address the USJFCOM-endorsed Block 1 issues. Specific objectives of the Block 1 WIPT are to:

- Produce decision-quality engineering recommendations for JROC decisions.
- Produce implementation-quality engineering recommendations for program manager decisions.
- Establish and maintain a collaborative system engineering team.
- Establish, maintain, and refine the system engineering process (in accordance with the IEEE Std 1220-1998-based System Engineering Master Plan).

The JSSEO uses the IPT approach for its block process. The Block 1 Manager assigns a lead for each Block 1 issue. Each issue lead employs the services of the Engineering Architecture, Analysis, and the Acquisition Roadmapping Divisions as required in an effort to develop a set of engineering recommendations that will feed the Integrated Architecture Behavior Model (IABM) and are fully traceable to the SIAP IA component of the JTAMD IA.

4.4.2.2.1 Block 1 Issues

The JSSEO convened a body of Service and Agency SMEs to discuss and document known IADS performance deficiencies. The candidate Block 1 Issues List was developed and forwarded to and endorsed by USJFCOM and JTAMDO.

The Block 1 issues were grouped into the following four themes:

- *Further Reduce Dual Tracks (and operator confusion).* The underlying issues are common time reference, data registration, precise participant location identification (PPLI), track quality (TQ), consistency of distributed track databases, and tracking/track management.
- *Improve CID Capabilities.* The underlying issues are CID and IFF/SIF-related.
- *Improve TBMD Performance.* The underlying issues, being addressed in partnership with MDA are TBM reporting, TBM data association/correlation, and TBM early warning impact point prediction (IPP).
- *Improve Data-Sharing/Networking Capabilities.* The underlying issues are Link 16 throughput and multilink translation and forwarding.

4.4.2.2.2 Block 1 Systems Identification

The Block 1 WIPT developed criteria to identify and select the Services' systems that would be considered for SIAP Block 1 upgrades. Using these criteria, the Services selected a cross section of candidate systems, which included 23 systems from the Army, 8 systems (with variants) from the Navy, 4 systems (with variants) from the Marine Corps, 6 systems (with variants) from the Air Force, and 7 systems from MDA. This systems list was further pared down to a 10-system list because of the Services' cost and schedule concerns about systems modifications. The remaining 10 systems are: Army (3 systems)—PATRIOT, FAAD C2, and Brigade TOC (AMDPCS); Navy (3 systems)—AEGIS, SSDS MK2, and E-2C; Air Force (3 systems)—AWACS, RC-135 (Rivet Joint), and MCE; and USMC (1 system)—TAOC. Subsequent to selection of the above 10 systems, two systems have been replaced (because of modernization). The TAOM (of which the TAOC is a subset) system has been replaced by the CAC2S, and the MCE system has been replaced by the BCS. Additional information can be found in the Candidate Block 1 Systems Technical Report (2002-006), published in June 2002 and available on the unclassified DTIC website (http://www.dtic.mil) under accession number ADA403896.

4.4.2.2.3 Block 1 Systems Engineering Effort

The Block 1 system engineering effort is based upon the model found in the industry standard IEEE 1220-1998 and tailored for use within the JSSEO. The process focuses on identification and analysis of requirements, identification and analysis of functions, identification of system interfaces (e.g., system's SV1/SV2 architectural drawings), synthesis, identification of "common" processing techniques (e.g., algorithms), and recommendations. The products of the engineering effort are coupled closely with the products of the SIAP Architecture WIPT. Many of the products are specific architecture products consistent with the Defense Department's C4ISR Architecture Framework Version 2.0. These architecture products are traceable to JTAMD architecture products (e.g., 2010 TAMD Operational Concept and TAMD/CID CRDs). In turn, these architecture products form the context for the analysis of specific Block 1 issues and the formulation of recommendations.

- Requirements analysis and verification focused on identification of the system requirements. Identification of the system issues and candidate Block 1 systems is part of this process. Requirements from the TAMD CRD, CID CRD, GIG CRD, and other JROC-validated requirements found in CJCSIs and Office of Secretary of Defense (OSD) documents, as well as MIL-STD-6016, were identified and traced to the individual Block 1 issues and finally to individual existing, applicable, Service system ORDs and specifications.

- Functional analysis and verification focused on the functional architecture. The functional architecture describes functions performed, the flow of data among system functions, and the relationships between systems or system functions. The primary products of this phase are system views consistent with the architecture framework—specifically, SV-4a, SV-4b, and SV-6.

- Systems analysis is the “engine” that develops and delivers the products from requirements and functional analysis, as well as provides the alternatives for consideration during the synthesis phase. The SIAP Analysis Team (SAT) conducted empirical and perturbation analysis of numerous SIAP Block 1 issues using data from such exercises as All-Services Combat Identification Evaluation Team (ASCIET) 00, Roving Sands 01, and Joint Combat Identification Evaluation Team (JCIET) 02, and the Joint Combat Identification Exercise (JCIDEX) 03. The products from the systems analysis are synthesized, results verified, and recommendations developed for SIAP Block 1 Systems upgrades.

4.4.2.3 SIAP Block 2

The primary focus for Block 2 engineering will be in the areas of distributed resource management and network management to support robust peer-to-peer networking. Block 2 focus will be to ensure that data management protocols provide sufficient capabilities over existing TADIL links and robust capabilities over IP-based networks, to work on data dissemination rules and network scheduling, and to develop Network Management capability (network switching, transmission, information services, and computing resources). The target for implementation of much of this specific Block 2 functionally is Configuration 07. If possible or practical, some Block 2 functionality may be realized in Configuration 05. Some examples may be: agreement and development of a common object model with the Future Combat Systems to provide robust SIAP interface with ground systems.”

4.4.3 SIAP Business Model

In December 2002, the Joint Staff, the (then) Assistant Secretary of Defense for Command, Control, Communications and Intelligence (ASD(C3I)), and the USD(AT&L) endorsed a funding option that required significant convergence for developing and fielding the SIAP capability. The JSSEO developed a business strategy using a consortium of industry partners, along with the JSSEO and other government organizations, to develop a single, generic behavior model referred to as a platform independent model (PIM). From the PIM, platform-specific models (PSMs) and their associated reference implementations will be developed, all of which will be subjected to joint independent verification and validation as both a single and distributed system using the JDEP Technical Framework before being integrated into specified combat system. SIAP implementation is depicted in Figure 4.5. A completely engineered PIM and PSM is essentially a computer program. The new business model also required adjustments to the JSSEO cost-estimating process. Instead of estimating costs based on individual ICPs, the new methodology is based on the JSSEO-led development of the PIM and the resulting IABM and the Services’ integration of this IABM (via implementations of a PSM), with some JSSEO support and within specified cost constraints using a "design-to-cost" approach.

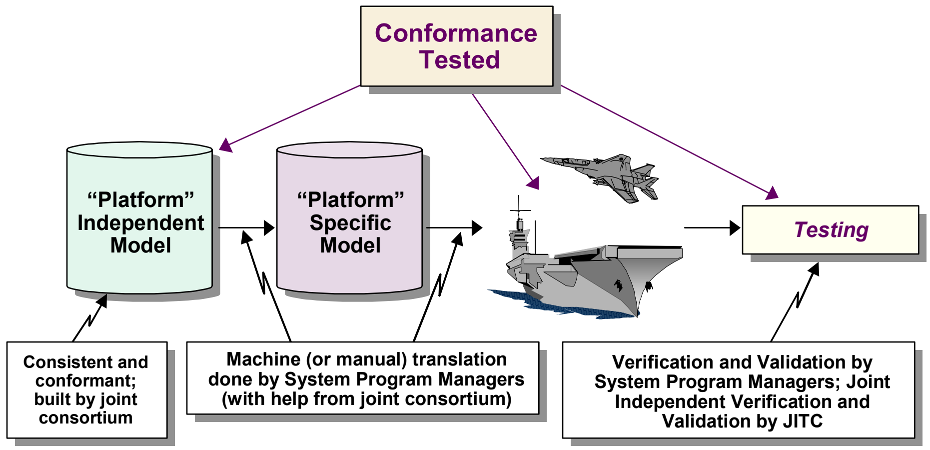


Figure 4.5—Implementation in Tactical Systems

4.4.3.1 SIAP Architecture WIPT

The SIAP Architecture WIPT was established by, and within, the JSSEO in March 2002. Effective July 3, 2002, the SIAP Architecture WIPT was formally integrated into the JTAMD process as a topical WIPT, with no change in charter or purpose, which is to guide and coordinate collaborative activities related to the chartered responsibility of the JSSEO to produce the SIAPIA, a component of the TAMD integrated architecture. The SIAP IA was to describe and prescribe the objective SIAP capability, including its integral CID (air) component. Subsequently, with establishment of the JSSEO and directed expansion of its mission to encompass such advanced concepts as integrated fire control (IFC) and associated automated battle management aids (ABMA), the SIAP IA is now the JSSEO IA and encompasses all architectural aspects of the JSSEO system engineering mission. The JSSEO Architecture WIPT is chaired by the JSSEO and includes representatives of the Services, JTAMDO, MDA, and, for CID matters, the J8/CID Assessment Branch. All SIAP architecture processes and formal products are developed by and/or vetted through the JSSEO Architecture WIPT and, subsequently, the JTAMD Process.

4.4.3.2 SIAP Products

The focus of the JSSEO Architecture effort in 2003 was in five areas: continued establishment of a suitable operational framework for the JSSEO IA and related system engineering activities; establishment of collaborative architectural processes, consistent with guidance provided in the DoD Architecture Framework Version 1 tailored for JSSEO applications, suitable to guide collaborative development of the JSSEO IA, including those architectural products necessary to guide block engineering and support development of an IABM; production of functional architecture products (largely, draft operational views that are subsequently integrated into the TAMD IA); development of physical architecture products; and collaborative development with the Services, agencies, and industries of the IABM, the initial configuration of which will be delivered to the Services in late 2005. Each of these areas, together with draft or baseline products produced during CY 2003, is discussed briefly in the paragraphs that follow.

- *JSSEO Operational Framework.* Analysis of applicable requirements is the initial step in the formal system engineering process. For SIAP (and its included CID element), the primary applicable requirements are those in the 2010 JTAMD Operational Concept and the TAMD, CID, and GIG CRDs. SIAP requirements analysis conducted through early 2002 concluded that the existing requirements were not an adequate operational framework to guide system engineering of the objective SIAP capability. Generally, the requirements documentation was too ambiguous, too incomplete, and to a large degree, implied expectations for SIAP (or relationships to other objective TAMD enabling capabilities) that were not supported by specific or sufficiently detailed requirements. Consequently, the JSSEO, in coordination with the Services and JTAMDO, derived an operational framework for SIAP from these validated requirements suitable to continue architectural definition and related system engineering of the objective SIAP capability. This derived operational framework was vetted with the Services in the formal JTAMD Process and the OV-1, and assumptions were incorporated into the JTAMD Operational Architecture. The framework continues to be refined through periodic updates and provides the basis for further operational detailing of SIAP in a series of draft SIAP Operational Views and derived operational requirements and, wherefrom, a requirements trace of operational activities to specified and implied capstone requirements.

- *JSSEO Architectural Process.* The overview and summary of the SIAP architectural efforts and process is described in the SIAP AV-1 (Overview and Summary Information). This product is updated quarterly and configuration controlled. The AV-1, together with the SIAP System Engineering Management Plan (SEMP), describes the interrelationships between architectural and system engineering activities. Architectural activities are also integrated fully in the SIAP Integrated Master Schedule and the JSSEO Capstone Test and Evaluation Master Plan. The Engineering Architecture Division employs the DoD Integrated Product and Process Development scheme for management oversight, using a disciplined system engineering approach modeled after the industry standard established in IEEE 1220-1998 for architecture product development.

This approach and the processes that support this method are documented in the JSSEO SEMP. The JSSEO IA effort has evolved to align with the direction generated from changes in the new CJCSI 3170.01C, CJCSI 6212.01C, and the DoD 5000-series directives and instructions. These changes drive a new vision for defining requirements by the use of integrated mission area requirements, which will be analyzed through a capability-based warfighting perspective. JSSEO has leveraged its existing requirements trace and architecture development to respond to this shift and the JSSEO IA is using these integrated mission area architectures to align the SIAP-derived requirements. This will occur by embedding the derived operational requirements in the operational views of the IA, thus capturing the warfighter's vision of how to fight and win future wars. The system views (SVs) of the architecture will define the trade-space within which the engineers can respond to that vision. This is a critical step in prioritizing what needs to be bought or improved first, based on its impact on warfighting capability. The Roadmap that describes the acquisition plan to field the FoS that will bring that vision to reality is being built into a capability-based document, the first artifact of which is the extended SV-8, the capability evolution description (CED). The CED presents the alignment, based on architectural analysis, of the engineering changes and new system fielding to operational capability objectives for Block 2 and beyond, as well as an IABM that embeds objective capabilities in an executable model that is the basis for common implementation of SIAP capabilities in designated Services' host systems.

- *Functional Architecture Products.* Collectively, the functional products provide a bridge between the structured analysis of the JSSEO IA operational views and the object-oriented methodology used to develop the IABM. Primary focus in 2003 was on continued refinement and detailing of the draft SIAP OV-5 (Activity Model), a SIAP capability functional description that includes operator activities through a mission threads process, completion and refinement of key OV products, and development of a comprehensive set of derived operational requirements based on the CRDs' requirements trace undertaken in 2002.

    - *Mission Threads.* In late 2002, 10 SIAP mission threads were identified that offered sufficient diversity in terms of theater-wide users and user needs supported by SIAP to capture all essential SIAP functionality and connectivity requirements. These threads validate and refine SIAP Operational Views, with particular emphasis on the OV-5 activity model and the OV-3 information exchange matrix. Threads are also a basis to link the JSSEO IA to mission activities in the parent JTAMD 2010 OA. The nodes, activities, and detailed data exchanges in the threads provide an essential starting point to develop the SIAP logical and physical data models. In addition, because the threads encompass SIAP support to warfighting activities theater-wide, both within and outside the TAMD mission area, the threads also provide a means to identify critical linkages with the SIGP and, subsequently, the SIMP and the common tactical picture. By refining and detailing the activities and information exchanges applicable to acquiring, processing, distributing, and applying information within the SIAP process and its users' communities, the threads lead to development of an executable model and the related development of the JSSEO IA system views. In addition, by involving the Services' user communities in the threads' development process, the threads provide valuable insights into both the objective SIAP *system* and derived operational requirements traceable to applicable capstone requirements and joint concepts. Six threads (i.e., Combat ID, Integrated Fire Control, Passive Defense/Early Warning, Integrated Combat Airspace C2, Targeting, and Track Management) were matured in 2003. In late 2003, it was determined that operator support, automated management aids, and collaborative planning—originally intended as separate threads—would instead be examined within the operational context of the other threads. To this end, a generic collaborative planning thread was also completed in 2003. This effort was deferred to early 2004, as was the start of the Distributed, Collaborative Battle Management Thread (originally known as the P_n Thread). Each thread was worked within an operational context specified for the thread mission or subject area by working groups of SMEs from the Services and agencies that operate under the auspices of the Architecture WIPT. These threads are a means to refine the SIAP OV-5 and the top-level IERs described as a result of the OV-5 development process. These threads, together with the derived operational framework, provided the basis for further and continued operational detailing of SIAP in a series of draft JSSEO IA Operational Views, which were updated in JSSEO IA versions 1.1 and 1.2 (August and October 2003, respectively).

- *Derived Operational Requirements.* In the absence of a specific SIAP requirements document or concept of operations, the Engineering Architecture Division developed a SIAP operational framework consistent with the overarching JTAMD 2010 Operational Concept, as noted earlier, and began deriving an overarching set of SIAP requirements from the TAMD, CID, and GIG CRDs and the JICO Support System ORD. Few specified requirements exist for SIAP. Rather, most of the requirements for SIAP are implicit in that many of the CRDs' requirements either are dependent on, or affect, the objective SIAP capability and thus affect the development and implementation of the SIAP architecture. The resultant derived operational requirements, along with the mission-oriented threads to be developed during FY 2003–2004, will help form the operational framework needed to further develop the required architecture products.

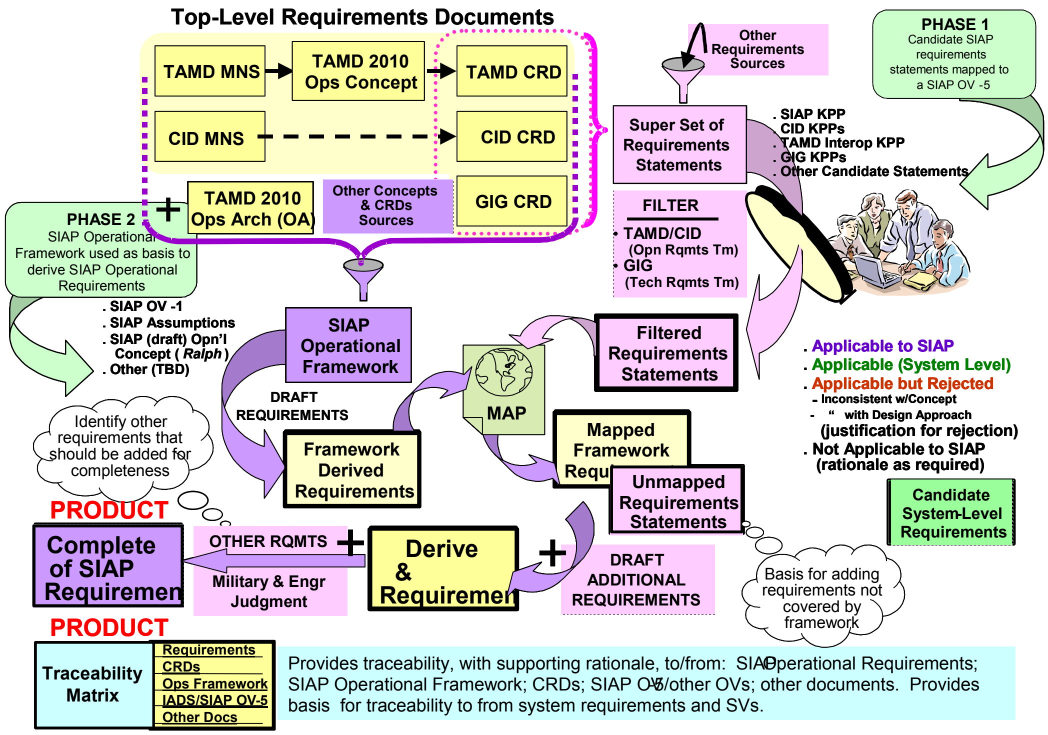


Figure 4.6—SIAP Operational Requirements Development and Traceability

- *Physical Architecture Products.* Collectively, the functional products provide a bridge between the structured analysis of the JSSEO IA operational views and the object-oriented methodology used to develop the IABM (as illustrated in Figure 4.7). Physical architecture products provide the SVs applicable to the TAMD FoS that implement the operational intent and requirements described in the OVs. In 2003, the Architecture WIPT focused on collecting baseline data, specifically, the System Interface Description (SV-1) and the System Communications Description (SV-2) for a select set of systems for which SIAP Block 1 fixes and enhancements are being addressed in the JSSEO system engineering process as well as the development of the initial SV-8 (Capability Evolution Description) based on information provided by the Services.

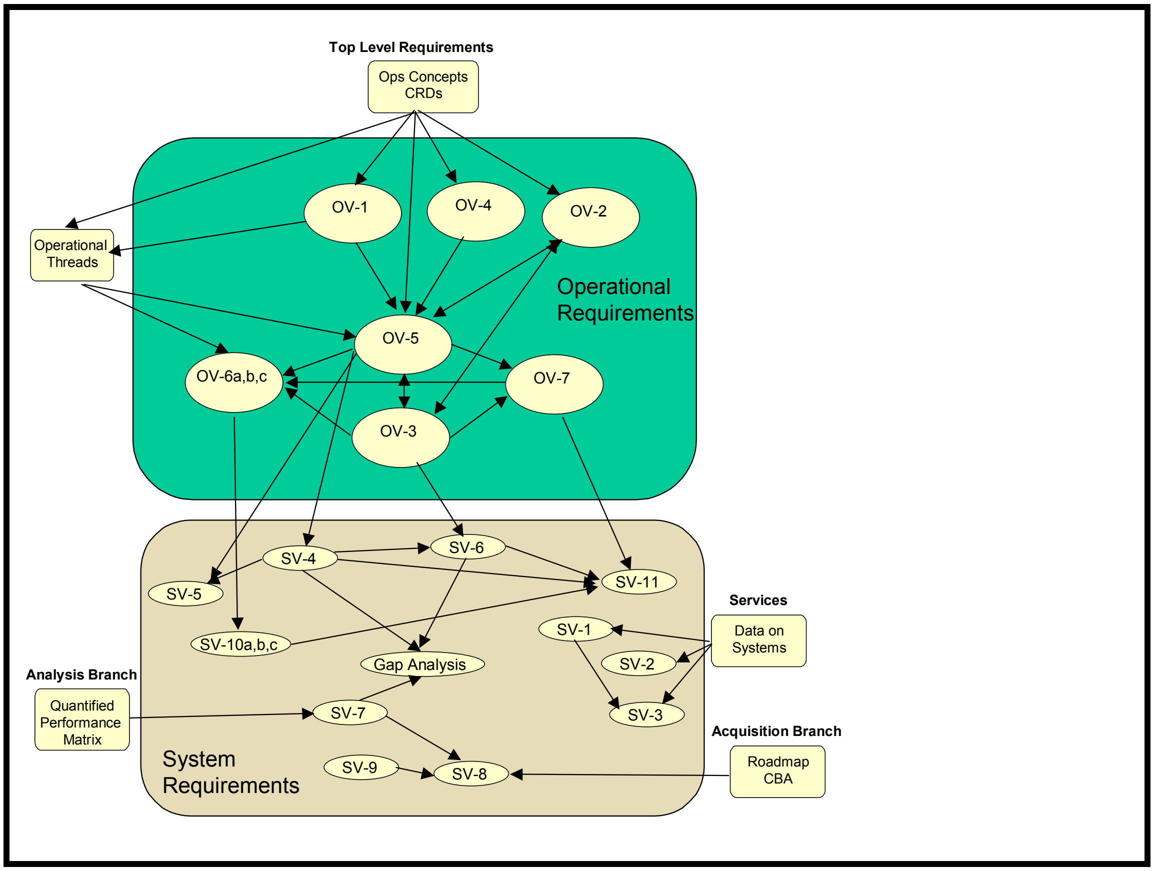


Figure 4.7—JSSEO Architecture Products Relationship

- *Integrated Architecture Behavior Model.* JSSEO is developing a behavior model of the tactical BMC2 functionality needed to meet JROC-validated Capstone Requirements for TAMD, CID, and the GIG. This IABM will be translated into a constructive model that will evaluate the correctness of the integrated architecture and protocols. The first formal delivery of the IABM to the Services for implementation into selected Service systems is scheduled for September 2005 and is known as "Configuration '05." Configuration '05 will be applied to a select set of Services' systems. Subsequent configurations will expand and refine the functionalities included and be implemented into more types of host systems. JSSEO anticipates that several (at least two) subsequent IABM deliveries on two-year cycles will be necessary to evolve to the objective SIAP capability. This objective capability is described by the integrated architecture and an operational framework that consists of SIAP OV-1 with associated assumptions, a derived operational concept, and a set of derived operational requirements. IABM deliveries are depicted in Figure 4.8.

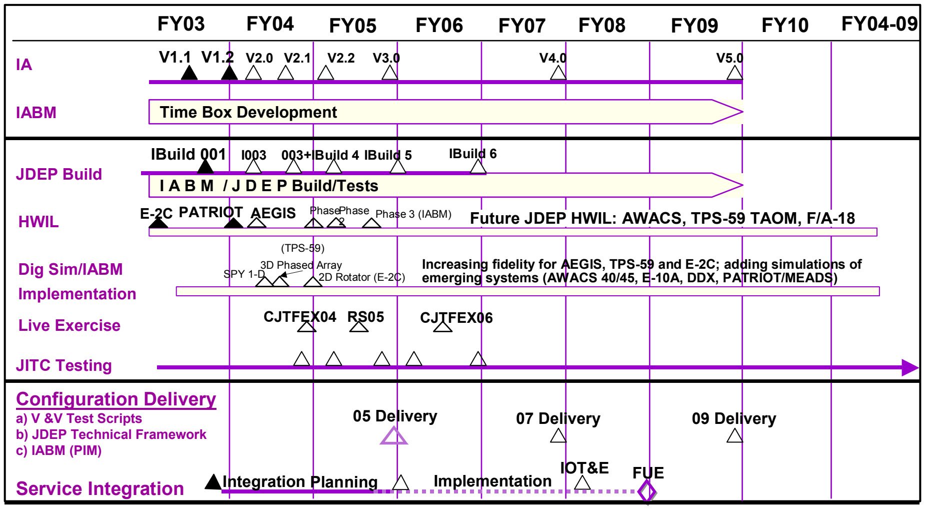


Figure 4.8—SIAP Products Delivery Schedule

IABM implementations will generate and maintain a single, consistent aerospace "picture" on all IABM Implementation-equipped units. To achieve this goal, the IABM provides all the processing functionality that is responsible for:

- Receiving local sensor measurement data and remote associated measurement reports (AMRs).
- Distribution of AMRs from local sensors to all IABM peers via a peer-to-peer network.
- Processing the local and received sensor data received from TDLs and other remote sources to develop the single, integrated air track picture. This includes the management of track-associated data such as Combat ID.
- Distributing the resulting track information to the various users of the track information.

4.4.4 Road Ahead

Architecture efforts in 2004 will focus on

- Continued development of the IABM for the *Configuration '05* delivery;
- Completion and formal staffing of the full set of derived SIAP operational requirements;

- Initiation and completion of the DCBM thread and examination of OS, CP, and AMA aspects of the threads completed in 2003;
- Further refinement, detailing, and expansion of the set of OVs as a result of the aforementioned thread work; and
- Development of detailed system and technical requirements for the IABM based on the operational products. The SVs and TVs of the JSSEO IA (e.g., SV-4, SV-5, SV-7, SV-11, and TV-1) will be derived in the process of development of the system and technical requirements for the IABM and delivered as IA Version 2.2 in December 2004.

JSSEO plans to participate fully in the transition of JSSEO IA products and the TAMD OA into an Integrated Air and Missile Defense (IAMD) IA. Phase 1 of this effort is expected to begin in early 2004 and transition to Phase 2 by year's end. A critical early element of this transition to an IAMD IA is the full integration of the JSSEO IA with the TAMD OA.

The JSSEO Architecture WIPT is expected to make the transition from a JSSEO-chaired topical WIPT to a standing WIPT, co-chaired by the JSSEO and JTAMDO, in early 2004. A standing WIPT is more appropriate because of the extended timeframe to mature the JSSEO IA and DoD's new thrust to use integrated architectures as the requirements bridge between mission area concepts and implementing Capability Description Documents (CDDs). Additional information on JSSEO's Architecture effort may be found at the JSSEO web site, http://siap.navsea.navy.mil and the JSSEO Worksite (https://server2.csci-va.com/siap/siap.nsf). Access to these sites requires registration and assignment of a user ID and password.

4.5 Single Integrated Ground Picture (SIGP)

The SIGP provides a coordinated battlespace situational awareness to the warfighter through the use of advanced integrated sensors, innovative information transport technologies and 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 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:

- DOTMLPF 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 USJFCOM-led DOTMLPF 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 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 and knowledge requirements are met. SIGP's System to Human Interface adapts to the commanders' needs, leading to decisive optimal decisions. SIGP cuts across the six JWCA functional areas (see Figure 4.9).

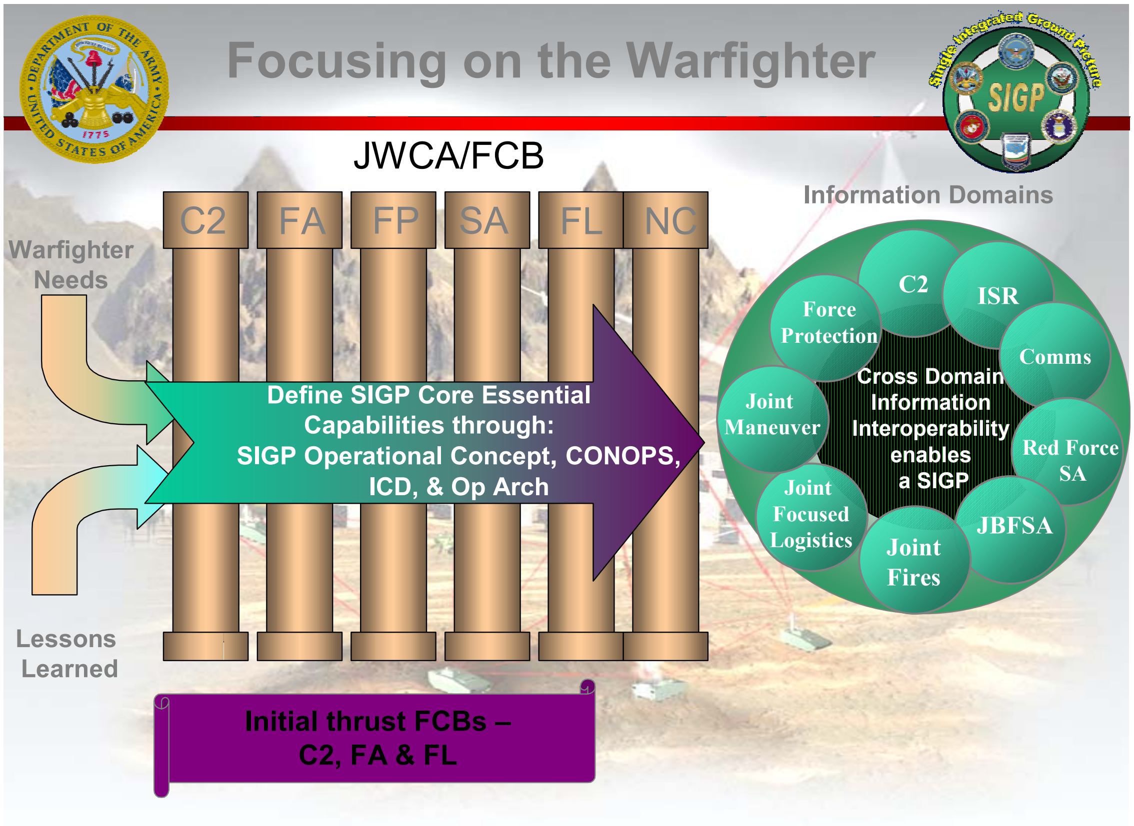


Figure 4.9—SIGP Mission Threads

SIGP is a new initiative that began in FY 2004, and its planned long-term activities/strategies are preliminary and are currently being refined and developed. As a result, it does not have a detailed, multiyear schedule comparable to such more established programs as the SIAP. 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 USJFCOM-led DOTMLPF operational products (e.g., Operational Concept and CONOPS)

To meet the joint interoperability testing timelines recommended earlier in the Roadmap, an initial set of SIGP JBFSA products should 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).

4.6 FORCEnet Maritime Picture (FnMP)

PLACEHOLDER. The summer 2004 edition of the Roadmap will include a description of the FORCEnet Maritime Picture.

4.7 Single Integrated Space Picture (SISP)

PLACEHOLDER. The summer 2004 edition of the Roadmap will include a description of the SISP as it relates to JBMC2.

4.8 Single Integrated Special Forces Picture (SOFP)

PLACEHOLDER. The summer 2004 edition of the Roadmap will include a description of the SOFP as it relates to JBMC2.

5.0 Joint Battle Management Command and Control (JBMC2) Capability Development and Integration Management

5.1 Overview

Clusters of JBMC2 systems and integrated JBMC2 capabilities will be determined by Joint Mission Thread (JMT) –based analysis and related analyses. These JBMC2 capability integration analyses and the organizations responsible for their completion will be described later in this section. The integration strategy for each JMT program cluster will be approved by USD(AT&L) based on the outcome of the USJFCOM JMT analysis and other DOTMLPF programmatic and architectural input. USD (AT&L) will be the milestone decision authority for JBMC2 program clusters. USD (AT&L) will convene Capability Area Defense Acquisition Boards (DABs) as required to assess progress in developing integrated JBMC2 capabilities for specific joint mission threads and associated program clusters. Capability Area DABs for JBMC2 programs will be chaired by USD(AT&L).

5.2 Background

In the past, many C2 capabilities were developed independently by each of the Services and in some cases have not been effectively integrated together. Recent changes to the defense acquisition process (DoD Instruction 5000.2), the joint requirements generation process (the Joint Capabilities Integration and Development System as defined in CJCS 3170), the Unified Command Plan (UCP) and Management Initiative Decision (MID) 912 have led to new management structures and new integration processes.

The Joint Requirements Oversight Council (JROC) has addressed numerous interoperability problems encountered in recent operations, exercises, and developmental and operational tests. These shortfalls and needs are recognized as joint requirements and appropriate decisions are codified in JROC Memoranda (JROCMs) as indicated in figure 5.1. In these JROCMs a number of initiatives, later categorized as JBMC2 initiatives, were established, e.g., the Single Integrated Air Picture (SIAP), Family of Interoperable Operational Pictures (FIOP), Joint Blue Force Situational Awareness (JBFSA) and Blue Force Tracking (BFT). These JBMC2 initiatives are highlighted in Yellow in the figure. Also shown in Figure 5.1 is JROCM 134-01, which authorized the development of the Global Information Grid (GIG). The program elements of the GIG are described in Section 7. JROCM 134-01 assigns ASD(NII) oversight responsibility for developing the GIG and associated technical architecture products and interface standards.

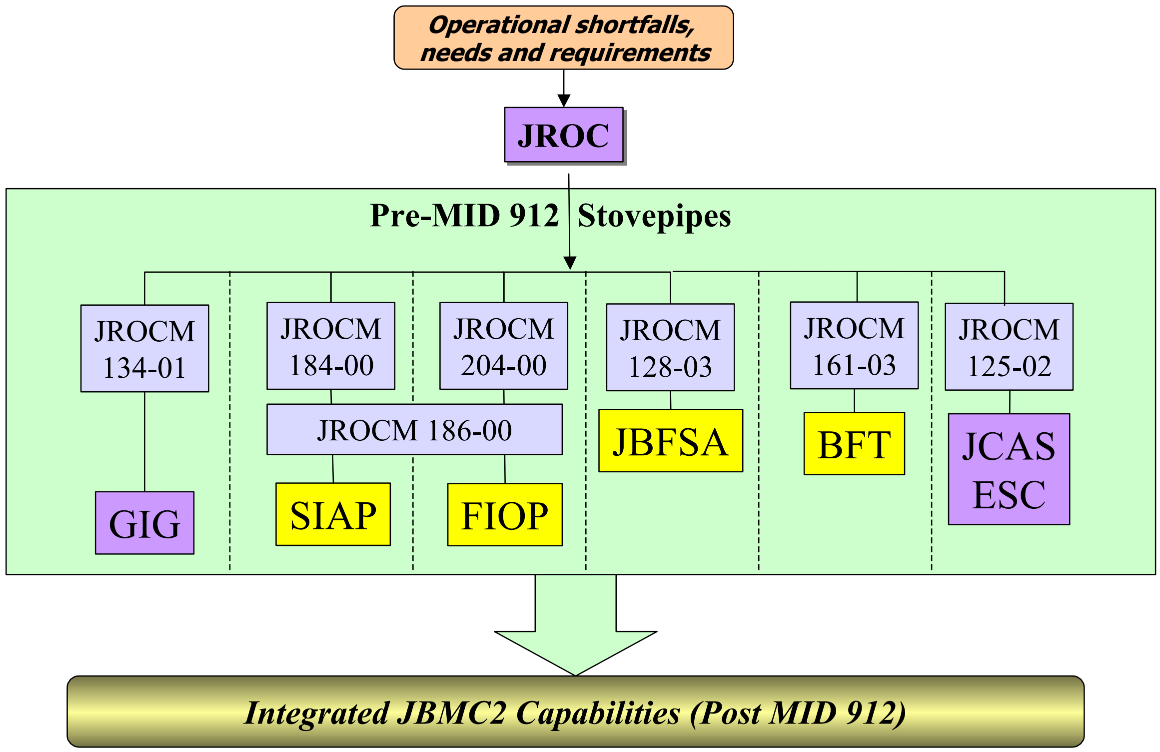


Figure 5.1—Evolution of JBMC2 Capability Integration

Another important JROCM concerns the Joint Close Air Support (JCAS) mission. Problems encountered in Kosovo, during Operation Enduring Freedom, and during Operation Anaconda indicated that more attention was needed to solve interoperability problems between U.S. ground and air forces. Consequently, the JROC assigned USJFCOM the chairmanship of the JCAS executive steering committee (ESC).

Figure 5.1 illustrates the growing number of interoperability solution initiatives that were established by the JROC prior to MID 912. Many of these initiatives are led by different organizations; for example, the Air Force leads the FIOP initiative, while the Army leads the JBFSA IPT under FIOP. Prior to the introduction of MID 912 it became increasingly evident that the growing portfolio of JBMC2 interoperability initiatives and programs were not necessarily well coordinated or integrated. This state of affairs and growing concern over interoperability problems encountered by U.S. forces in recent operations in Kosovo, Afghanistan, and Iraq led to the introduction of MID 912 in January 2003. MID 912 seeks to establish stronger coordination of the department's JBMC2 efforts. It expands the oversight and directive authority of USJFCOM over JBMC2 capability development and integration efforts in order to improve the department's ability to organize, train, and equip joint forces and to provide well integrated system of systems capabilities to joint warfighters.

All major elements shown in Figure 5.1 are important elements of the JBMC2 Roadmap.

5.3 Defense Acquisition Management Process for JBMC2 Programs

The defense acquisition management process defines a set of program phases and specific entrance criteria for those phases for individual programs. The milestone decision authority may authorize the entry of a particular program into the acquisition system at any point consistent with these criteria and statutory requirements. This Roadmap defines an extension of the defense acquisition management process consistent with the DOD Instruction 5000.2 that applies to clusters of JBMC2 programs where membership to a specific JBMC2 program cluster is determined by the JMT analysis described in Section 2. This JBMC2 cluster acquisition management process is designed to integrate clusters of JBMC2 systems and enable effective development of integrated JBMC2 capabilities. The process considers all programs in a JBMC2 program cluster as an appropriately integrated set of systems and is specifically focused on the integration and interoperability linkages between members of the program cluster. This acquisition management process also will examine potential redundancies and gaps in the JBMC2 system capabilities that are needed to effectively execute the relevant joint mission threads.

Each JBMC2 program cluster will be anchored by the set of ACAT-I JBMC2 Pathfinder programs relevant to a specific JMT. The program cluster will also include ACAT level II and III programs that are essential to the end-to-end execution of the relevant joint mission thread. JBMC2 program cluster composition will be determined by AT&L. The JBMC2 capability integration strategy and interoperability test plan for the JBMC2 program cluster will be reviewed by a Capability Area DAB convened by the USD(AT&L). The USD(AT&L) will be the milestone decision authority for determining whether and how each JBMC2 program cluster is integrated and modified, and how specific JBMC2 program plans are modified to achieve the objectives of the overall JBMC2 capability integration strategy for the cluster. Per the responsibilities granted to USJFCOM by MID 912 by the Deputy Secretary of Defense, USJFCOM will review the program integration strategy for JBMC2 program clusters based on JBMC2 integration and interoperability requirements provided in existing requirements documents, joint lessons learned from recent operations, and based on results of JBMC2 capability needs, gaps, or solution assessments of relevant joint mission threads.

The composition of the Capability Area DAB is shown in Figure 5.2. It should be noted that JBMC2 Capability Area DAB membership may be modified to include top leadership of the DoD.

DAB Principals	DAB Advisors
• USD(AT&L)	• DUSD(L&MR)
• JCS	• D, DR&E
• Sec of the Army	• Navy AE
• Sec of the Navy	• Army AE
• Sec of the Air Force	• Air Force AE
• USD(P)	• DUSD(IP)
• USD(C)	• D, DS
• USD(P&R)	• PD, C3S&ITP
• USD(I)	• PEO
• ASD(NII)	• PM's
• D,OT&E	• D, Innovision, NGS
• D,PA&E	• D, DP&AP
• D,AR&A	• Chairman, OSD CAIG
	• DGC(A&L)
	• D, IC
	• OASD(LA)
	• DT&E

Figure 5.2—Capability Area DAB Membership

5.4 Roles, Responsibilities and Authorities

The JBMC2 Roadmap is a planning document called for in DoD Instruction 5000.2.[25] The supporting JBMC2 management structure leverages the roles and responsibilities of various DoD organizations for developing and integrating JBMC2 capabilities and is based on and fully consistent with authorities provided in applicable DoD documents.

5.4.1 Under Secretary of Defense (Acquisition, Technology, and Logistics) (USD(AT&L))

DoD Instruction 5000.2,"Operation of the Defense Acquisition System," requires Under Secretary of Defense (Acquisition, Technology, and Logistics) (USD(AT&L)), to work collaboratively with the Assistant Secretary of Defense Networks and Information

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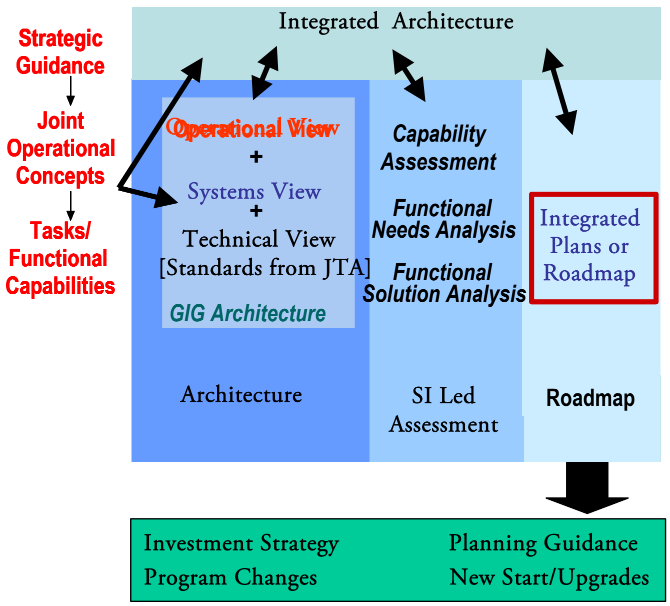
[25] *Joint Battle Management Command and Control (BMC2) Roadmap*, Memorandum from the Under Secretary of Defense for Acquisition, Technology, and Logistics, June 9, 2003. See Appendix C.

Integration (ASD(NII)), the Joint Staff, the Military Departments, the Defense Agencies, Combatant Commanders, and other appropriate DoD Components to develop joint integrated architectures for capability areas as agreed to by the Joint Staff. These integrated architectures are an important element of DoD Instruction 5000.2, the JBMC2 MID 912, and the JCIDS processes. The elements of an integrated architecture are indicated in Figure 5.3 (some of the mechanisms for development of integrated architectures are discussed in Section 2.2). Many of the integrated architecture elements intended for systems of systems analysis and capability integration will be the product of a collaborative process between DOD organizations.



DoD shall use these roadmaps to:

1. Conduct capability assessments
2. Guide systems and systems architecture development
3. Define investment plans as the basis for aligning resources
4. Provide input to the Strategic Planning Guidance, Program Objective Memorandum development, and Program and Budget Reviews.

Figure 5.3—DoD Instruction 5000.2 – Genesis of the JBMC2 Roadmap

Each integrated architecture has three views: operational, systems, and technical, as defined in the current DoD Architectural Framework guidance and has direct relationships to DoD Component-developed functional area integrated architectures. DoD Instruction (DoDI) 5000.2 specifies that the Joint Staff lead development of the operational view, in collaboration with the Services, Agencies, and Combatant Commanders, to describe the joint capabilities that the user seeks and how to employ them. In addition, MID 912, which post-dates DoDI 5000.2, assigns USJFCOM the responsibility of developing integrated JBMC2 architectures. This roadmap, in seeking to be consistent with DoDI 5000.2 and MID 912, indicates that USJFCOM and the Joint Staff will work collaboratively to develop integrated JBMC2 architecture products, and that both joint organizations will integrate relevant operational architecture products of the Services and relevant defense agencies. Integrated JBMC2 operational architecture products will be approved by the JBMC2 Board of

Directors and the Commander of USJFCOM. These integrated JBMC2 operational architecture products will be coordinated with the Joint Staff as specified in Section 5.2.2.

USD (AT&L) leads development of the systems view, in collaboration with the Services, Agencies, and Combatant Commanders, to characterize available technology and systems functionality. The systems view identifies the kinds of systems and integration needed to achieve the desired operational capability.

The DoD Chief Information Officer (CIO) leads the development and facilitates the implementation of the Global Information Grid Integrated Architecture, which underpins all mission area and capability architectures. ASD(NII) also leads the development of architecture technical views and network-centric program review criteria.

The Military Departments and Defense Agencies participate in the identification of the appropriate technical views consisting of standards that define and clarify the individual systems technology and integration requirements. The standards used to form the Technical Views of integrated architectures are selected from those contained in the current approved version of the Joint Technical Architecture.

Those architecture efforts that are relevant to the development of integrated JBMC2 capabilities will be coordinated by USJFCOM, when such coordination is consistent with USJFCOM's responsibility to develop a joint integrated architecture for JBMC2 programs, as specified in MID 912.

5.4.2 Commander U.S. Joint Forces Command (CDRUSJFCOM)

USJFCOM and USD(AT&L) have partnered in the development of the JBMC2 Roadmap. Together they will determine JBMC2 capability integration requirements and assist in making systems acquisition related decisions in coordination with Services, Combatant Commands, Agencies, and the Joint Staff (interfaces between the JBMC2 MID 912 and JCIDS processes are described in Section 5.5.2).

The Unified Command Plan requires Commander USJFCOM to serve as the lead joint force integrator, responsible for combining Service and Defense agency capabilities to enhance interoperability and joint and combined capabilities by recommending changes in doctrine, organization, training, materiel, leadership and education, personnel and facilities. The UCP also requires Commander USJFCOM to support the development and integration of fully interoperable systems and capabilities, including command, control, communications, computers and intelligence, surveillance and reconnaissance (C4ISR), for joint warfighting.

Further authorities amplified in DoD Directive 4630.5 and DoD Instruction 4630.8, assign Commander USJFCOM the responsibility to provide operationally prioritized and programmatically synchronized materiel and non-materiel recommendations for resolving Department of Defense interoperability issues.

MID 912 builds on the UCP and the aforementioned DoD directives, expanding the oversight and directive authority of USJFCOM over JBMC2. This expanded authority includes capability developments, integrated JBMC2 architecture development, and integration efforts needed to improve the department's ability to organize, train, and equip joint forces and to provide well integrated system of systems capabilities to joint warfighters.

MID 912 further assigns Commander USJFCOM responsibility for developing JBMC2-related operational capabilities based on the inputs from the combat commanders. It also assigns Commander USJFCOM oversight and directive authority over the DJC2 program, the SIAP and FIOP initiatives with future expansion to include the single integrated ground picture (SIGP) and the FORCEnet Maritime Picture.

A key element in the Deputy Secretary of Defense direction contained in MID 912, was the requirement for Commander USJFCOM in coordination with CJCS to lead the Combatant Commanders, Services and the Joint Staff in the development of JBMC2 capabilities to strengthen the organization, training, and equipping of Joint Battle Management Command and Control capabilities. This function is accomplished through the Joint Battle Management Command and Control (JBMC2) Board of Directors (BOD).

5.4.3 The Joint Battle Management Command and Control Board of Directors

The Joint Battle Management Command and Control Board of Directors focuses on the following objectives in providing a forum for Combatant Commanders, Services and the Joint Staff (JS) to seek consensus:

- Developing consensus on Desired Operational Capabilities (DOC) that influence operational concepts, doctrine and requirement needs for future and near term Joint Battle Management Command and Control capabilities.

- Implementing and overseeing Joint Operational Concept and Joint Integrated Architectures associated with Joint Battle Management Command and Control

- Consolidating, validating, prioritizing, and synchronizing current and future operational capability needs from Combatant Commanders for Joint Battle Management Command and Control to support joint warfighting.

In seeking coordinated positions on JBMC2 requirements, it is recognized that unanimity will not always be achievable and is recognized. If the JBMC2 BOD cannot achieve consensus, the BOD Chairman (Deputy Commander, USJFCOM) will forward relevant documentation to Commander, USJFCOM. The Commander, USJFCOM will adjudicate any critical dissenting opinions raised by Component Commanders during the deliberations of the JBMC2 BOD, and may seek the advice of the Secretary of Defense and Chairman, Joint Chiefs of Staff on other issues. Membership on the JBMC2 BOD is as follows:

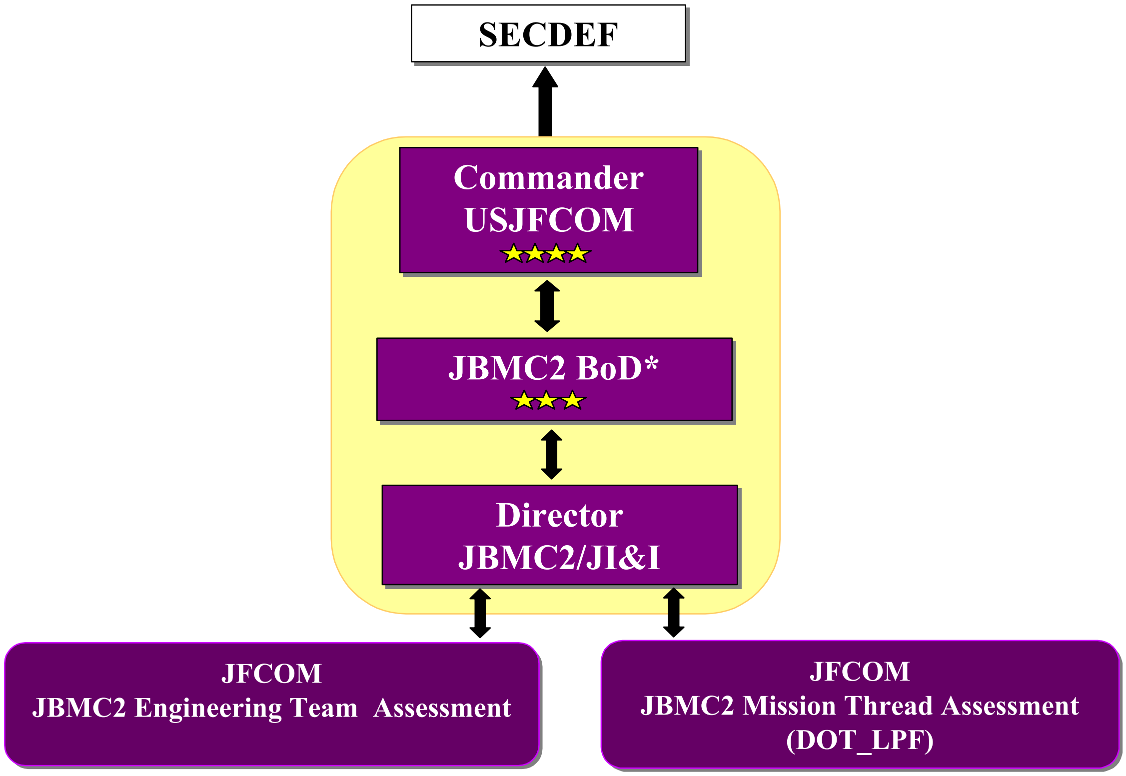
a. Primary Members: The Joint Battle Management Command and Control Board of Directors consists of Flag Officer/General Officer/Senior Executive Service

(FO/GO/SES) members from Combatant Commands, typically the Director of Operations or Requirements, responsible for the Commands position on JBMC2 issues or agenda items, as required. Each Service is represented by a Flag/General Officer, typically from the Service operational requirements or combat development organization. The Service representative is responsible to provide Service perspective on JBMC2 issues or provide agenda items, as required. The Joint Staff (JS) is represented by a Flag/General Officer, currently from the J6 organization who provides Joint Staff perspective and input on JBMC2 issues.

b. <u>Advisory Members (Optional)</u>: Advisory members consist of FO/GO/SES-level representatives from the Office of the Assistant Secretary of Defense for Networks and Information Integration, the Office of the Secretary of Defense for Acquisition, Technology and Logistics, the Office of the Undersecretary of Defense for Intelligence, Service/agency program sponsors/executive agents and selected Defense Agencies and United States Coast Guard, as required.

c. USJFCOM JBMC2 Organization: Commander, United States Joint Forces Command has designated the Director for Requirements and Integration (J8), responsible to develop and maintain associated operational concepts, doctrine, integrated architectures, and capability-based requirements for the Board of Directors. This provides a direct coupling of the JCIDS C2 FCB chaired by USJFCOM J8 with the JBMC2 organization and BOD. Allied representatives shall be considered on a case-by-case basis as required.

5.4.4 USJFCOM JBMC2 Capability Management Structure



*Primary: Combatant Commands, Services, Joint Staff
Advisory Members: OUSD/AT&L, OUSD(I), OASD/NII (service/agency program sponsors and selected defense agencies and US Coast Guard as appropriate)

Figure 5.4—USJFCOM JBMC2 Capability Management Structure

The USJFCOM management structure for JBMC2 capability development and integration is illustrated in Figure 5.4. A key necessary component for JBMC2 capability development and integration are joint mission threads to determine JBMC2 capability and system integration needs and priorities. USJFCOM will lead the development of joint mission threads (JMTs) in collaboration with Joint Staff, Services, Combatant Command and Agencies. Joint mission threads will be developed collaboratively with the Services using relevant lesson learned from recent operations, existing requirements documents, and by integrating the new operational concepts developed by COCOMs, the Joint Staff, and the Services. All joint requirements derived from these JMTs will be reviewed by the JBMC2 BoD and will coordinated with the Joint Staff in the JCIDS process as described in Section 5.5.2.

A second essential element of JBMC2 capability management and integration are system integration and interoperability assessments, i.e., whether a particular system is essential for the conduct of a JMT, is already effectively integrated with the other systems essential for the conduct of the JMT (the JMT program cluster), is not effectively integrated, or whether it is cost-effective and mission essential to integrate the system in question into the JMT system cluster or phase it out. The USJFCOM JBMC2 Engineering Team Assessment (JET) will examine these system integration and interoperability assessment issues. The JET and the Joint Staff will use the USD(AT&L) legacy system interoperability or phase-out methodology to conduct these assessments.[26] The JET will conduct these systems integration analyses in coordination with the JCIDS process as described in Section 5.5.2 and will collaborate in these analyses with the FCBs designated for this purpose by the JCIDS process Gatekeeper, the Vice Director, J8, JCS.

5.5 Interfaces to the Joint Capability Integration and Development System (JCIDS) Process

The JCIDS process seeks to develop and employ an enhanced capabilities-based methodology to identify, describe, and resolve capability gaps. The JCIDS process will be used to review joint force capability proposals. One or more Functional Capability Boards (FCBs) will perform these reviews, depending upon the capability issue at hand. FCB's for Command and Control, Logistics, Force Protection, Force Application, Battlespace Awareness, and Network-Centric Infrastructure have been established.

5.5.1 JCIDS Management Structure

The JCIDS management structure is illustrated in Figure 5.5. The JCIDS process supports the acquisition process defined in the new 5000 series of instructions by supporting the development of key capability-based needs documents, such as Initial Capabilities Document (ICDs), Capability Development Document (CDD), and Capability Production Document (CPD) along with the essential JCIDS analysis.

[26] "*Request for Assessment of Legacy Systems*," Memorandum for vice director, J8 (Gatekeeper) BGEN Hunzeker, from Robin L. Quinlan, Deputy Director, Joint Forces Integration, OUSD(AT&L), 31 March 2004.

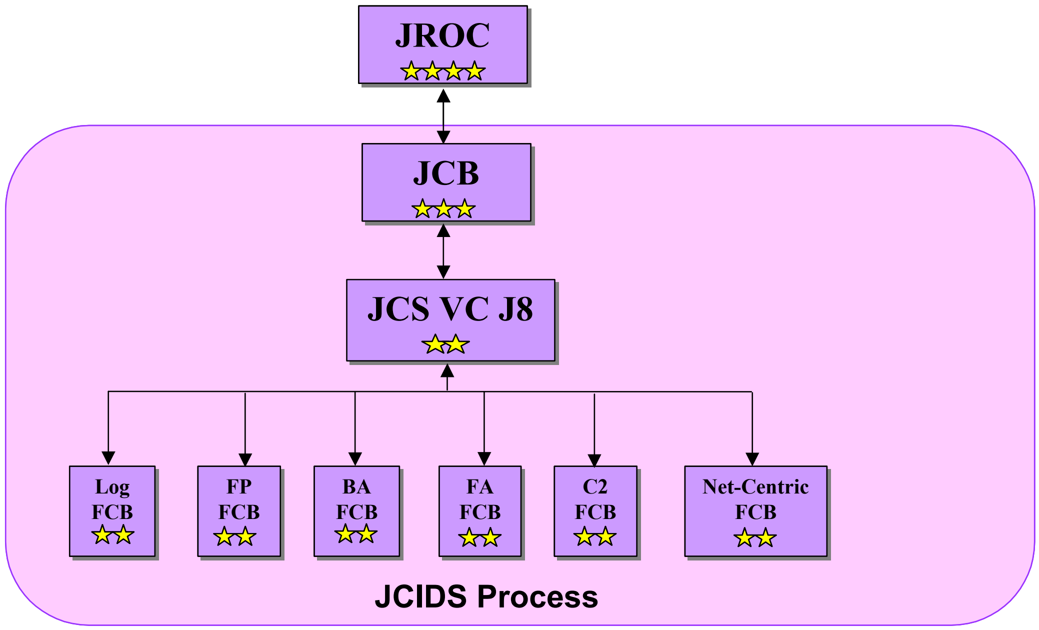


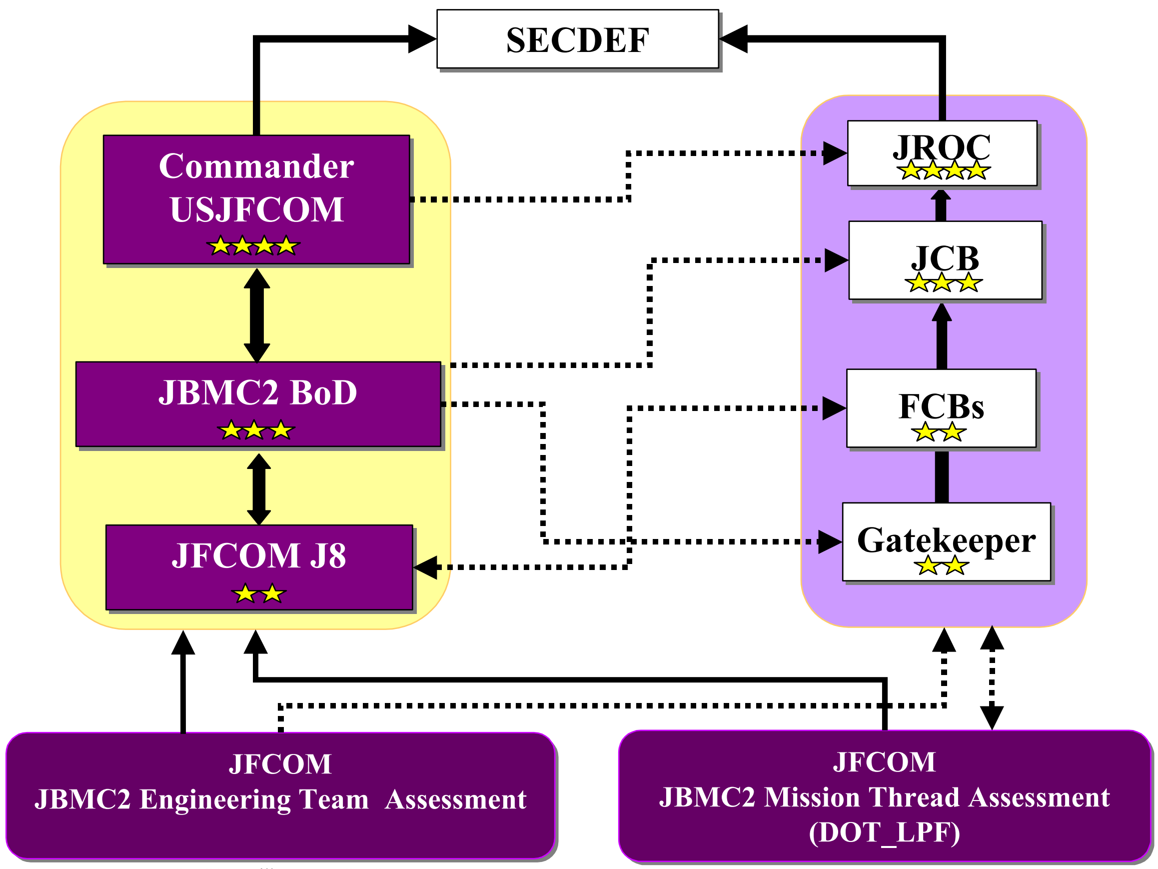
Figure 5.5—JCIDS Management Structure

FCB's recommend capability gap solutions to the JROC, but not directly. Such recommendations are forwarded to the Joint Capabilities Board (JCB). The Vice Director, JCS J8, performs two key roles in the JCIDS process: one, gatekeeper to control and review general types of submissions made by external organizations to the JROC: and two, the integrating function which assigns issues to the FCB's, and in turn, may assign leading or supporting FCB roles for a particular analysis, and which may de-conflict the analysis undertaken by individual FCB's. Submission of a document to the Knowledge Management/Decision Support (KM/DS) tool will trigger the gatekeeper process to determine whether the document has joint implications or is Component unique. The Gatekeeper will evaluate all JCIDS documents and the Gatekeeper will assign a JPD. Once the JPD has been assigned, the document will move into the staffing and approval process.

5.5.2 JBMC2 Interfaces to the JCIDS Process

Key interfaces between the JBMC2 capability development and integration processes and the JCIDS process are illustrated in Figure 5.6. The C2 FCB is led by USJFCOM and provides a key linkage between JBMC2 integrated capability management and JCIDS processes (USJFCOM J8 is also the chairman of the C2 FCB). As described in Section 1 of this Roadmap, the scope of JBMC2 crosses over multiple FCBs. Therefore it is appropriate that the USJFCOM J8 also interface with other FCBs, as directed by the JCIDS process Gatekeeper. Depending upon the JMT and the JBMC2 systems under consideration it may be appropriate to establish linkages to the FA FCB for example to accomplish the assessment of specific integration and interoperability issues or to update JBMC2 capability requirements for specific weapons systems.

In consultation with Commander USJFCOM, the JBMC2 BOD will determine JMT assessment and JBMC2 integration priorities. These integration priorities will be communicated to the JCIDS process as indicated in Figure 5.6. The JBMC2 BOD will inform the Gatekeeper of the JCIDS process of JBMC2 integration priorities. The JCIDS Gatekeeper can then elect to direct specific FCBs to assist in the assessment of specific JBMC2 integration and system interoperability or phase-out analyses.



- USJFCOM will pass to JCIDS:
  - Future JBMC2 Programmatic Requirements
  - Current JBMC2 Interoperability and Integration requirements (shortfalls) in need of Service lead assignment

Figure 5.6—JBMC2 and JCIDS Process Interfaces

Once one or more FCBs may be assigned by the Gatekeeper to assist in the conduct of these analyses. Those FCBs that are so designated, and other relevant Joint Staff organizations that contribute to the JCIDS process will coordinate their activities with the USJFCOM JET and the JBMC2 Mission Thread Assessment team. Likewise, the USJFCOM JET and the JBMC2 Mission Thread Assessment Team (JMTAT) will coordinate their activities with the FCBs assigned by the JCIDS Gatekeeper. Relevant FCBs, the JET, and the JMTAT may choose to work collaboratively and combine their efforts, or they may choose to conduct parallel assessments. However, it is required that the JET and

JMTAT report the results of their assessments to USJFCOM J8 and the JBMC2 BOD. If parallel FCB assessments are conducted, the JET and JMTAT are required to also forward the results of the FCB assessments to USJFCOM J8 and the JBMC2 BOD.

The Chairman of the JBMC2 BOD may choose to communicate the results of JBMC2 integration, interoperability, and phase-out assessments directly to the JCB as indicated in the figure. The chairman of the JBMC2 BOD may also choose to communicate JMT developments, JBMC2 interoperability shortfalls, related capability gaps, and proposed JBMC2 capability solutions to the JCB, including proposed changes to interoperability Key Performance Parameters.

An additional JBMC2 and JCIDS interface exists between Commander USJFCOM and the JROC, as indicated by the dashed line in Figure 5.6. Commander USJFCOM in coordination with CJCS will review desired operational capabilities, concepts, doctrine, requirements, and integrated architectures based on Combatant Command operational needs, prior to forwarding to the Joint Requirements Oversight Council (JROC) process for coordination. The JROC will ensure USJFCOM's JBMC2 mission/capability area requirements and system-of-systems capability requirements are synchronized with other FCBs. The JROC will also ensure Service and agency JBMC2 efforts are aligned, integrated, and coordinated with the USJFCOM JMBC2 operational architectures and requirements.

Additional interfaces between processes that are not shown in Figure 5.6 include Joint Staff support for JBMC2 requirements definition, which will be accomplished by Joint Staff participation in the JBMC2 BOD. In addition, the Joint Staff will perform JBMC2 capability reviews that take place within the new JBMC2 acquisition process as described in Section 6.3.

5.6 JBMC2 Capability Area Acquisition Process

The objective of the JBMC2 capability integration process is to develop integrated JBMC2 clusters of systems and to phase out legacy systems that cannot be integrated effectively by 2008 in a cost-effective manner.[27] JBMC2 system clusters to be integrated, and the manner in which they will be integrated, will be determined using the JMTs described in Section 2 of the roadmap. The JMT analysis approach for JBMC2 capability integration and legacy system phase-out assessment is described in Section 4. The JBMC2 system clusters determined from these JMT-based analyses shall be called JBMC2 program clusters.

Select key ACAT I programs for particular mission threads form the core of such a JBMC2 program cluster. These programs are designated pathfinder programs and anchor each program cluster. The Pathfinder set of programs is listed in Section 3 of the roadmap.

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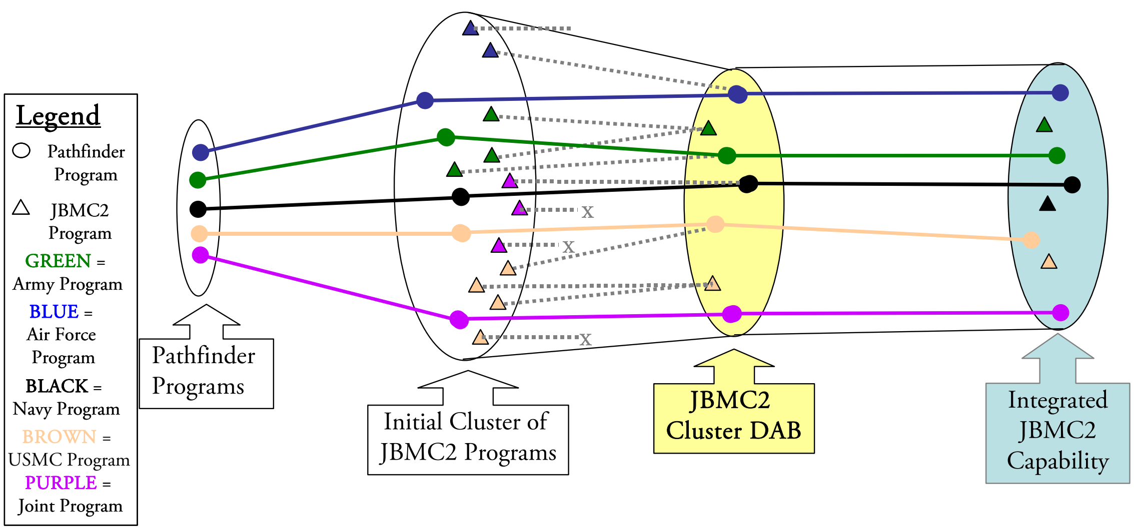
[27] In this roadmap we designate a cluster of systems to include both systems of systems (SoSs) if the requirement exists for these systems to be tightly integrated and Families of Systems (FoSs) if they can be effectively integrated in a more loosely coupled collection of systems.

Initially, interoperability and integration needs are developed for the core of Pathfinder programs based upon the mission, task, and purpose of the particular JMT.

5.6.1 JBMC2 Program Capability Area DAB Process

The USD(AT&L) chairs JBMC2 program Capability Area DABs. Capability Area DABs will be convened to assess progress in developing integrated JBMC2 capabilities for specific joint mission threads and capability areas. The Capability Area DAB will review and approve the composition of the JBMC2 program cluster, the overall strategy proposed for achieving JBMC2 capability integration and system interoperability within the program cluster, the specific data standardization and mediation approaches proposed for the program cluster, and the interoperability test strategy for incrementally improving program cluster interoperability performance.[28] This overall JBMC2 integration and interoperability strategy will apply to the entire cluster of JBMC2 programs, and to the JBMC2 integration initiatives that are relevant to the underlying JMT.



- Cluster of JBMC2 programs determined to be essential to the end-to-end performance of a specific joint mission thread
- Anchored by JBMC2 Pathfinder programs, but also including all ACAT II/III JBMC2 mission programs essential for end-to-end conduct of joint mission thread
- Cluster DABs will be convened to assess progress in developing integrated JBMC2 capabilities for specific joint mission threads and program clusters
- Legacy program phase out and convergence plan approved at the JBMC2 Cluster DAB

Figure 5.7—JBMC2 Capability Area DAB Process

[28] The specific data standardization and mediation approach proposed for a specific JMT and program cluster will be consistent with the ASD(NII) and JBMC2 data strategies as described in Sections 6 and 7 of this roadmap.

Key products that will be reviewed and approved at the Capability Area DABs will be synchronized test and experimentation schedules for the cluster of programs associated with the JMT for the Capability Area under review. JBMC2 Capability Area interoperability tests will demonstrate the ability of JBMC2 programs in a particular cluster to share situation awareness, battle management, and other information within the requirements specified for effective execution of the overall end-to-end joint mission thread.

Several features of the JBMC2 Capability Area DAB process are illustrated in Figure 5.7. JMT program clusters will be anchored by a core set of Pathfinder programs. As the joint mission thread becomes better defined, additional programs may be added to the cluster, including ACAT level II and III programs. Prior to the Capability Area DAB comprehensive JMT analysis and JBMC2 legacy program phase-out assessments will be conducted to identify relevant JBMC2 programs that will be selected as candidates for the program cluster. USD(AT&L) or USJFCOM may request an assessment be performed to determine whether all legacy programs should be included in the program cluster and whether any legacy programs should be phased out or converged. At the Capability Area DAB legacy phase out and convergence assessments will be reviewed and the composition of the program cluster determined and approved by USD(AT&L). This is illustrated in Figure 5.7 by the smaller number of programs shown at the conclusion of the Capability Area DAB. In addition, at the JBMC2 Capability Area DAB, the JBMC2 program cluster integration and test strategy will be reviewed and approved by USD(AT&L). The conclusion of capability integration process and interoperability test processes should be an integrated JBMC2 capability as illustrated in Figure 5.7.

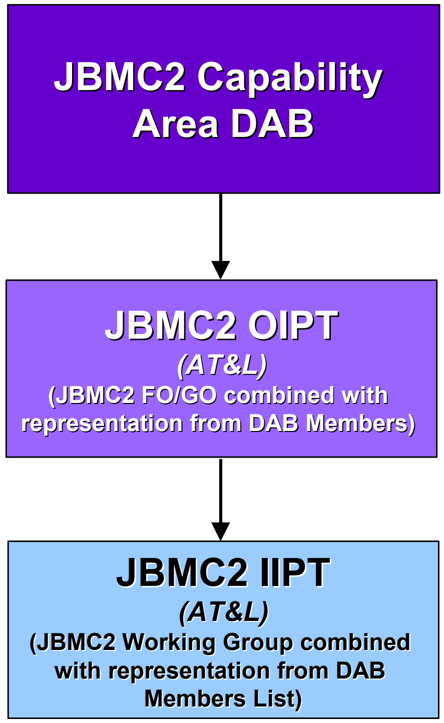


Figure 5.8—JBMC2 Capability Area Integrated Product Teams

The integrated product team structure that will be formed to support capability area DAB is shown in Figure 5.8. Initial JBMC2 JMT and system cluster interoperability and integration assessments, to include legacy system phase-out assessments, will be considered by the JBMC2 integrating integrated product team (IIPT). The IIPT will be co-chaired by OUSD(AT&L) and USJFCOM, as indicated in the figure. The IIPT will feed the results of their analyses and decisions to the JBMC2 overarching integrated product team (OIPT). Further assessments will be conducted by the OIPT as required. The OIPT will develop the JBMC2 capability integration and system cluster interoperability test strategy for the JMT under consideration for the capability area DAB. The membership of these two integrated product team's are shown in the figure and will be taken from by their predecessor organizations which have helped develop the JBMC2 roadmap as indicated in Figure 5.8.

The relationship of the requirements and acquisition processes is shown in Figure 5.9. As described above the requirements process provides a joint mission thread assessment that is approved by Commander USJFCOM. The mission thread assessment is forwarded to USJFCOM J8. This joint mission thread assessment includes the complete DOTMLPF mission capability package mission package necessary to execute the mission thread.

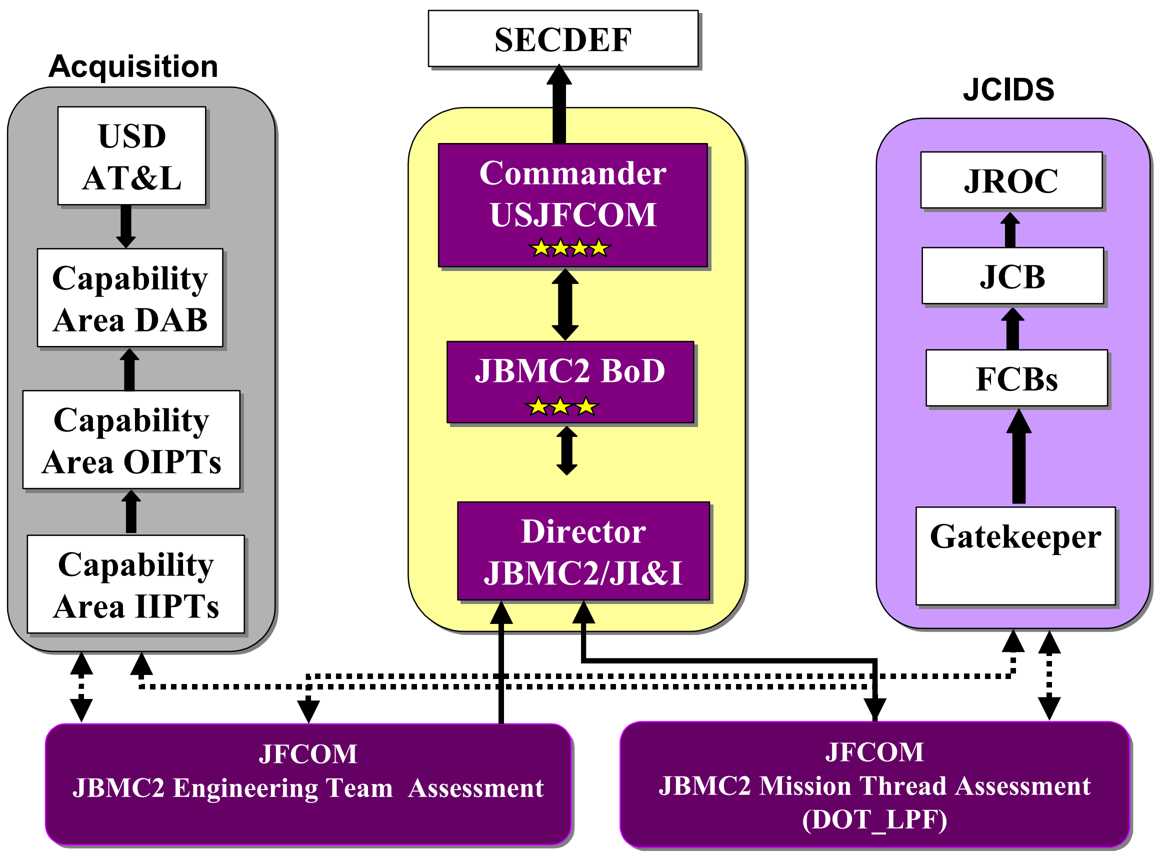


Figure 5.9—Relationship Between JBMC2 Requirements and Acquisition Processes

The USJFCOM J8 then forwards the joint mission thread assessment to the JBMC2 Cluster Overarching Integrated Product Team (OIPT). The USJFCOM J8 may also forward the mission thread assessment to the JCS VC J8 if a legacy system phase out assessment is requested for legacy systems contained in a particular mission thread program cluster. The methodology established in this Roadmap will be utilized to conduct the legacy system phase out assessment to ensure this assessment, and future assessments are transparent and repeatable, regardless of who conducts the assessment. The assessment will be conducted in accordance with the JCIDS process and will provide an opportunity for input on legacy phase out options. If such an assessment is determined to be necessary, the JCS VC J8 will select lead and supporting FCBs to conduct the assessment, ensuring that the methodology prescribed in this Roadmap is utilized. The recommendations from this assessment will be forwarded to the Cluster OIPT and the Capability Area DAB.

The outcome of the Capability Area DAB will be an Acquisition Decision Memorandum (ADM) to the Service Secretaries describing necessary steps to effectively integrate the JBMC2 program cluster together. This ADM may direct the Services to; align selected functionalities of specific JBMC2 systems; to conduct specific types of interoperability tests (e.g., JDEP-based testing); and may direct the Services to align data standards or translation approaches to achieve the JBMC2 capability integration goals established in the USJFCOM joint mission thread assessment.

5.7 Interfaces to the Planning, Programming, Budgeting, and Execution Process (PPBE)

In May of 2003, the DEPSECDEF implemented a 2-Year Planning, Programming, Budgeting, and Execution Process (PPBE). The DoD has evolved from an annual Program Objective Memorandum (POM)/Budget Estimate Submission (BES) cycle to a biennial (2-year) cycle starting with an abbreviated review and amendment cycle for FY 2005. The Department will formulate 2-year budgets and use the off year to focus on budget execution and program performance. A combined program and budget review will continue.

The 2-year cycle will guide the Department's strategy development, identification of needs for military capabilities, program planning, resource estimation and allocation, acquisition, and other decision processes. The first full-blown 2-year program/budget submission will be due in the fall of calendar year 2004. It will address funding requirements for FYs 2006 and 2007 as the budget years and FYs 2006-2011 as the Future Years Defense Program (FYDP) years.

In the budget review, the USD(C) will use the metrics that the Components submit as part of the budget estimate submission to make informed resource allocation decisions. The intent is for the Department to shift its focus to program performance and results, and then use that assessment in making budget decisions.

In October of 2003, the SECDEF signed a memorandum entitled, "Initiation of a Joint Capabilities Development Process" which mandates a greater participation by all of the stakeholders. The goal is a streamlined and collaborative, yet competitive, process that produces fully integrated joint warfighting capabilities. The Strategic Planning Guidance (SPG) was issued on March 15, 2004. It replaces the policy/strategy sections of the Defense Planning Guidance (DPG). An enhanced, collaborative joint planning process (EPP) will formulate and assess major issues and present them for SECDEF decision. In the spring of 2004, the SECDEF will issue the fiscally constrained Joint Programming Guidance (JPG) that will record the decisions reached in the EPP. This document will replace the programmatic elements of the DPG.

The results of assessments made as part of the JBMC2 Roadmap processes will be used to inform the language of the SPG, provide direction, as appropriate, in the JPG, and, if necessary, used as the basis for Program Change Proposals (PCPs) during the Program Review process. The Roadmap's assessments will allow for planning that accounts for entire JBMC2 capabilities enabling key warfighting capabilities (as specified by the JMTs), and the detailed needs for those capabilities. The PPBE process will then be able to address the portfolios of programs – and subsequent program changes – needed to improve JBMC2 capabilities systemically, as opposed to attempting to improve JBMC2 capabilities based on piecewise program analysis.

For the FY2006 – FY2011 budget preparation it is anticipated that the results of the JBMC2 Roadmap process will not be accomplished in sufficient time to affect the SPG and the JPG.

6.0 JBMC2 Data Strategy

6.1. Introduction to the JBMC2 Data Strategy

The Joint Battle Management Command and Control (JBMC2) Data Strategy specifies a method and process for creating data interoperability solutions that support JBMC2 capabilities. The JBMC2 Data Strategy applies the Department of Defense Net-Centric Data Strategy to the JBMC2 arena[29] and supports that strategy's major goals to:

- Make Data Visible
- Make Data Accessible
- Enable Data to be Understandable
- Enable Data to be Trusted
- Enable Data Interoperability.

The JBMC2 Data Strategy describes how *communities of interest* (COIs) support the development of Joint Mission Threads (JMTs) by specifying how systems share data, both to predefined JBMC2 users and to authorized users outside the JBMC2 domain. The JBMC2 Data Strategy also describes how the COIs support systems engineering and testing, through inclusion of requirements for incorporating the data interoperability specifications, as well as corresponding implementation, testing, and certification processes.

The JBMC2 Data Strategy is intended to support several objectives in addition to the goals of the DoD Net-Centric Data Strategy. First and foremost, it enables the development of warfighting capability, as specified by the JMTs.

Second, it supports the tenets of net centricity, moving away from traditional point-to-point connections between systems (with N^2 complexity) to *common interfaces.* The JBMC2 Data Strategy describes how common interfaces are developed, extended, and integrated. These are agreements, comprising comprehensive, flexible sets of specifications, that define how large families of systems will share a range of information correctly and consistently, including:[30]

[29] "DoD Net-Centric Data Strategy," Memorandum from DoD Chief Information Officer John Stenbit, May 9, 2003. A description of how the JBMC2 Data Strategy is consistent with the DoD Net-Centric Data Strategy is given in section 6.5.

[30] Section 1.5 introduced common interfaces; section 6.6 details the elements of a common interface.

- Essential elements of information (EEIs) to be shared, and data models that describe how data is utilized in EEIs.

- Metadata descriptions for referencing and cataloging the data (for both structured and unstructured data).

- Rules for using and managing the data, to include rules describing when and how data should be posted to shared spaces and made accessible across both local and DoD enterprise networks.

- Technical specifications for the physical exchange of data, including standards for importing and exporting data to and from applications, communications protocols, and rules of use for communications systems and waveforms.

- Procedures for migrating the interface toward *uniqueness* and *strict inheritance*. The uniqueness property implies that every JBMC2 EEI will have a core data interoperability definition in exactly one common interface. The strict inheritance property allows for extensions of the EEI definition to be applied to different JMTs and specific systems as needed, as long as the extensions are strictly consistent with the core definition. Establishing these properties are important goals to bring about seamless information sharing in support of JBMC2. Initially, developers will work toward a weaker property, *mediation*, which permits correct translation between disjoint EEI definitions. The disjoint definitions will then be converged, contributing to the stronger properties.

Third, the JBMC2 Data Strategy supports flexibility in implementing the data interoperability solutions; it provides a management process for tailoring implementations, as appropriate, for warfighter needs, systems development, and technology realities. The same management processes also support the evolution of data interoperability solutions over time.

The JBMC2 Data Strategy makes several key assumptions. The first is that the net-centric underpinnings and technologies described in Section 7 (notably NCES, GIG-BE, JTRS, TSAT, Horizontal Fusion) will be largely available by the 2008–2009 time frame to the planned levels of capability. It is assumed that COIs will be able to develop solutions that rely on these underpinnings, especially for far-term cluster development and testing (FY 2010–2012).

The second assumption is the expectation that incorporating these underpinnings, and progressing to full net-centric capability, will be an incremental process. Early increments will focus on fixing existing interoperability problems and providing initial joint warfighting capability that does not depend on the net-centric underpinnings.

The third assumption is that the organizations and management structures specified by this Data Strategy will be consistent with, and partially rely on, the DoD governance structure for the Global Information Grid (GIG) Warfighter Domains. In particular, it is assumed that USJFCOM will serve as Joint Force Integrator in the DoD data environment and management forums, and will lead development of the JBMC2 common interfaces in coordination with the Warfighting IT Capabilities Integrator (the JCS J6). It is also assumed that USJFCOM will be the owner of the Warfighter IT Domain for C2.

6.2 JBMC2 Community of Interest

To support USJFCOM in its MID 912 responsibility to "lead Combatant Commanders in the development of joint doctrine, concepts, requirements and integrated architectures for BMC2 interoperability and connectivity," the JBMC2 Community of Interest will be established as an institutional COI, within the JBMC2 office structure being established by the USJFCOM J8. The JBMC2 COI has the general responsibility to provide data interoperability solutions for JBMC2 in support of JMT requirements for shared information. As such, it has responsibility for leading and managing the development of JBMC2 common interfaces. The JBMC2 COI will be established as a permanent, institutional COI; the COI's recommendations will be subject to review and approval by the USJFCOM J8 and the JBMC2 BoD. The JBMC2 COI will follow the engineering process described below.

Identification of Needs. The first step of the process is to identify the need for a data interoperability solution that will share a particular range of information in a JBMC2 context. The JBMC2 COI will identify these needs from the information-sharing requirements developed by the individual JMTs, as well as other information-sharing requirements common across the JMTs.

Identification of Form and Source of Solution. The second step of the process is to identify the form of the data solution most appropriate for sharing the range of information and a source to create and manage the data interoperability solution. The form of the solution may be the creation of an entirely new interface, an addition to an existing interface, or the integration of pieces of existing interfaces, as appropriate.

The form of the solution guides the JBMC2 COI in sourcing a COI (henceforth referred to as a *source COI*) to develop the data interoperability solution itself. The JBMC2 COI may task an existing group to develop the solution. This is appropriate when the tasked group is already managing data interoperability products in the desired area, such that the products can form the basis of a common interface. For example, it is envisioned that many of the existing COIs will be tasked to develop interface elements. To avoid duplication of effort and conflicts, the JBMC2 COI will maintain a list of existing organizations suitable for developing JBMC2 data interoperability products.

When no existing organization is available, the JBMC2 COI will recommend the creation of a new source COI, under the direction and oversight of the JBMC2 COI. The Roadmap recognizes three major types of new source COIs. The first two are primarily responsible for integration rather than original development of data interoperability products; the third is responsible for limited, ad hoc development.

The first type, *mission thread COIs*, will work with other source COIs to integrate across existing interface elements to create a coherent set of data interoperability requirements and processes for their corresponding JMT. For example, there will be a Joint Close Air Support (JCAS) ad hoc COI. As such, they will report to their corresponding JMT development groups and cluster systems engineering group in addition to the JBMC2 COI.

The second type, *battlespace picture COIs*, will work with other source COIs to integrate across existing interface elements to create a coherent set of data interoperability requirements and processes for information to be shared across the JMTs. For example, there will be a COI providing core requirements for common objects, attributes, graphics, and overlays. As such, they will report to the development group responsible for integrating the JMTs and the systems engineering group responsible for JBMC2 integration across the program clusters. The mission thread COIs will ensure that their thread-specific solutions incorporate the common battlespace picture solutions.

The third type, *ad hoc COIs*, will develop interface elements for JMT information requirements not already treated by an existing group. For example, there might be some information elements highly specific to JCAS that have not been treated by the existing DoD Namespace COIs. As the name implies, these COIs will be temporary, lasting through the creation of the interface elements.

Figure 6.1 shows the proposed organization of COIs supporting the JBMC2 Data Strategy, describing both the new COIs under the direction and oversight of the JBMC2 COI and existing COIs being tasked to develop data interoperability products in support of the JMTs. Figure 6.1 also shows how the JBMC2 COI reports to the USJFCOM J8 via the J8's JBMC2 Office and then to the JBMC2 BoD.

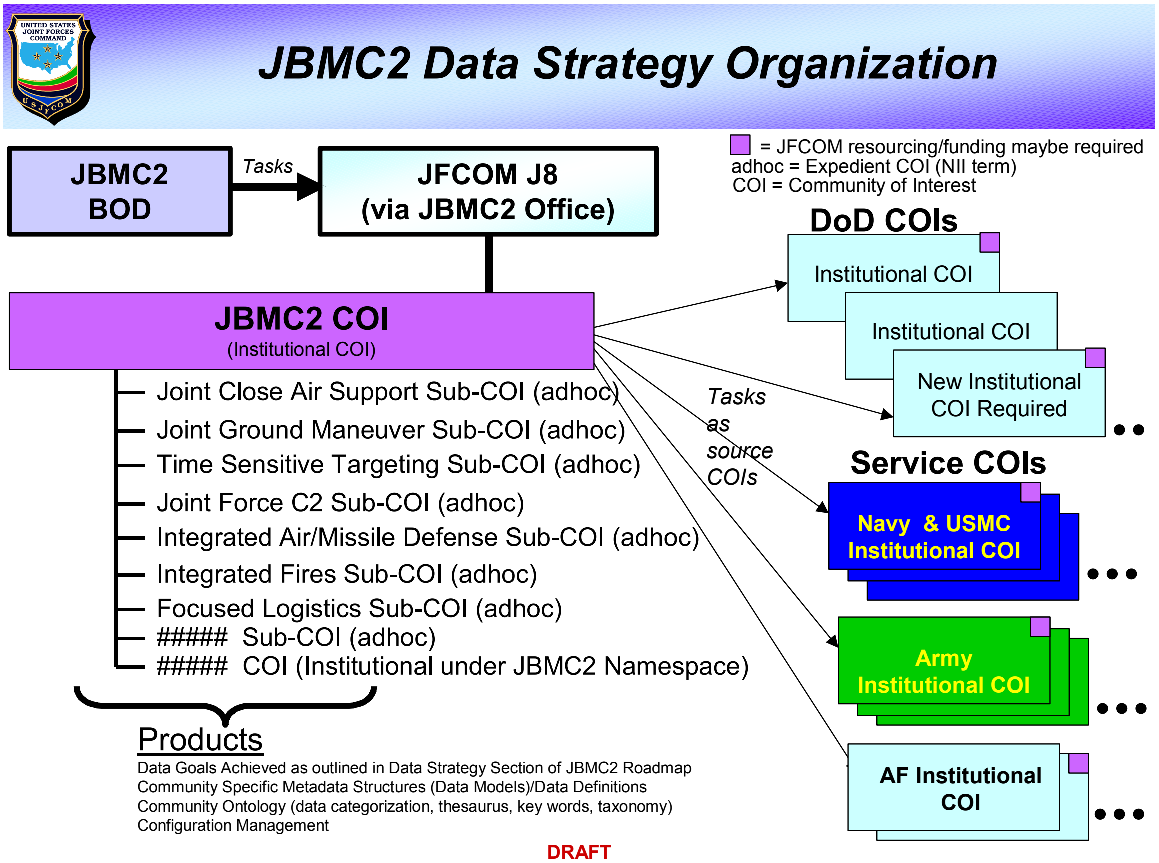


Figure 6.1—JBMC2 Data Strategy Organization

Provision of Guidance. In the third step of the process, the JBMC2 COI will disseminate its decisions (as reviewed and approved) to all involved parties and provide guidance as to the expected deliverables of the source COIs.

Synchronization and Management Across COIs. In the fourth step of the process, the JBMC2 COI will provide top-level management for, and synchronization of, the individual COIs relating to data interoperability solutions for JMTs. The JBMC2 Data Strategy does not require that all systems (or even all interfaces) use technically identical representations of an element of information (i.e., it does not require that all systems use the exact same messaging format and communications waveform); it does require that all the representations be identified, be consistent with the data model and business rules for that element, and be translatable from one representation to another. The JBMC2 COI will ensure such consistency and synchronization by doing the following:

- Providing requirements and timelines to the source COIs.

- Managing the transfer of common interface products from source COIs to their users. Notably, the JBMC2 COI will manage transfers from ad hoc COIs that will not persist once they complete their data interoperability products.

- Deconflicting the common interface products the COIs produce for JBMC2 and registering consistent products in the DoD Metadata Registry as standards of reference. The JBMC2 COI will maintain a hierarchy of recognized JBMC2 information elements, their core data models and business rules, their corresponding specific data representations (made consistent with the core models and rules), and supported translations between representations.

- Identifying authoritative sources for data interoperability solutions for particular ranges of information in support for JMT elements, and the key relationships between the sources. As an example of the latter, the JBMC2 COI will specify rules for building extensions from existing elements when creating new interface products.

- Resolving conflicts between source COIs over what elements should go into JBMC2 common interfaces, including the adjudication of disputes over how to model elements of information referenced by two or more COIs.

Review and Recommendation of Requirements. Finally, the JBMC2 COI will review the common interface elements created by the source COIs. As the JBMC2 COI approves the interface elements, it will recommend the creation formal requirements on their use. Consistent with the management processes in Section 5, these recommendations will be coordinated and reviewed by USJFCOM's JBMC2 organization, as appropriate, and forwarded to the JCIDS process for review and approval.

6.3 Roles and Responsibilities for COIs Serving as Data Interoperability Sources

Source COIs' roles and responsibilities will generally adhere to the following set of requirements. The particular roles and responsibilities assigned to a given COI will be developed by the JBMC2 COI, based on their understanding of expected data interoperability requirements. When roles and responsibilities have been approved, the JBMC2 COI will have continuing oversight and directive authority over the source COIs' JBMC2-related activities.

- **Engineering of Common Interfaces.** Developing, documenting, and managing a JBMC2 common interface, or extensions to an interface.

- **Integration of Common Interfaces.** Integrating across common interfaces to provide a data interoperability solution of reference for a JMT. The solution will be forwarded to systems engineers for program clusters for use in establishing program cluster requirements.

- **Development of Test Procedures.** Developing generic test criteria and procedures to ensure that the interface has been installed properly. The source COI will forward these generic criteria and procedures to system program managers and the systems engineers developing requirements for program cluster tests.

- **Mentoring Processes.** Developing *a mentoring process* for that interface. Through these mentoring processes, the source COI will send representatives to work with systems engineers and systems developers to implement the interface correctly, in a manner appropriate for that system.

- **Installation Testing.** Reviewing the systems' test procedures for compliance with the criteria developed above. As systems' testing occurs, COI representatives will verify that the interface has been installed properly, a requirement for systems prior to entering cluster testing.

6.4 Additional Roles and Responsibilities for Data Interoperability

USJFCOM J8. USJFCOM J8 will manage the JBMC2 COI and the source COIs' JBMC2-related activities, through the established JBMC2 Office structure. USJFCOM J8 also provides resources to support COI activities, including a common data engineering environment based on adopted open industry standards that can be used to develop and deconflict the elements of the common interfaces.

JMT Development Groups. JMT Development Groups will create and maintain a working relationship with their corresponding mission thread COIs to develop architectural views describing the essential elements of information that need to be shared across operational nodes and used as inputs and outputs to JMT activities.

Systems Engineers for Program Clusters. Cluster Systems Engineers will work with the corresponding source COIs to incorporate the appropriate common interfaces into their systems views for the cluster, and corresponding requirements for programs, to include providing their requirements and timetables. Using reports from the source COIs, they will certify that programs have installed the needed interfaces in their systems prior to the systems undergoing full-scale cluster testing.

Managers and Evaluators for Cluster Tests. Cluster Test Managers will work with the corresponding source COIs to incorporate the test procedures for the appropriate common interfaces into their test plans. Test evaluators will examine the success of the cluster systems in sharing the interfaces' information elements as part of their analyses.

Acquisition Decisionmakers. Acquisition decisionmakers (notably, the Cluster DABs and subsidiary OIPTs and IIPTs) will require that compliance with the JBMC2 Data Strategy, as measured by successful installation and testing of the appropriate common interfaces, be placed on the critical path of program success. The USJFCOM J8 will have the authority to certify a program as compliant with the JBMC2 Data Strategy, acting on the recommendations of the JBMC2 COI and the appropriate source COIs.

Warfighting IT Capabilities Integrator. The Warfighting IT Capabilities Integrator (JCS J6), supported by NII and DISA, will work with the JBMC2 COI and the source COIs to ensure that the common interfaces' rules for use of the net-centric technologies and standards are consistent and correct.

Joint Staff. Consistent with the JBMC2 management processes in Section 5, Joint Staff, through the JCIDS process, will review and validate proposed requirements proposed by USJFCOM on the use of common interfaces.

JBMC2 Program Managers. Program managers are responsible for ensuring that they incorporate the appropriate common interfaces in their systems as part of the larger cluster systems engineering process, including the appropriate data models, rules for making data visible and accessible, and rules for data utilization. As described above, the corresponding source COIs will provide mentoring on the use of their interfaces. Program managers will sponsor participation of systems developers in the mentoring process who will incorporate the interface into the system.

6.5 Consistency of the JBMC2 Data Strategy with the DoD Net-Centric Data Strategy

Table 6.1 describes the major tenets of the DoD Net-Centric Data Strategy and how the JBMC2 Data Strategy implements the tenets.

Table 6.1—Implementation of DoD Net-Centric Data Strategy Tenets

DoD Net-Centric Data Strategy Tenet	JBMC2 Data Strategy Implementation
Make Data Visible, through posting data to shared spaces, and referencing and cataloging the data through the use of metadata.	• JBMC2 COI and source COIs will develop rules for posting and retrieving data to shared spaces as part of common interface development. • Source COIs will develop metadata for the common interfaces, to include both registry metadata and catalog metadata. JBMC2 COI will ensure consistency of registry metadata and post the registry metadata to the DoD Metadata Registry.

DoD Net-Centric Data Strategy Tenet	JBMC2 Data Strategy Implementation
Make Data Accessible, through creating shared spaces and data access services and tagging data with security-related metadata.	• JBMC2 COI and source COIs will develop rules for posting and retrieving data to shared spaces as part of common interface development. (Designation of nodes hosting shared spaces and/or access services is part of JMT architectural development.) • Source COIs will develop metadata for the common interfaces; JBMC2 COI will ensure consistency of metadata and post the metadata to the DoD Metadata Registry. • As part of metadata development, source COIs will define security tagging-rules consistent with DoD standards.
Institutionalize Data Management, through net-centric governance and education processes, and the use of performance metrics.	• JBMC2 COI and source COIs are responsible for educating and mentoring JMT developers and systems developers about the proper use of the interfaces, and net-centric concepts in general. • Governance structure for JBMC2 COI and source COIs are similar to, and consistent with, existing COI governance structures. • Source COIs are responsible for development of appropriate MOEs and MOPs for their interface elements.
Enable Data to be Understandable, through the use of COIs developing specific ontologies for data and metadata.	• JBMC2 COI and source COIs are responsible for developing such ontologies as part of the common interfaces (ontologies are a core component of the data models).
Enable Data to Be Trusted, through the use of pedigrees and security metadata and authoritative sources.	• Source COIs will develop metadata tags for pedigrees, security, and authoritative sources consistent with the DoD Discovery Metadata Standard. (Designation of nodes as authoritative sources for certain classes of information is part of JMT architectural development.)
Support Data Interoperability; through the use of metadata-driven discovery and mediation services, and net-centric interfaces.	• Source COIs will provide rules for using these services as part of interface development.
Be Responsive to Use Needs, by involving users in the COIs and enabling user feedback.	• JBMC2 COI and source COIs will allow for open participation, similar to existing COIs. • JBMC2 COI and source COIs will have cross-participation with JMT developers, systems engineers, test managers, and program developers, allowing for extensive user feedback.

6.6 Elements of a Common Interface

Figure 6.2 shows the layers comprising a common interface.

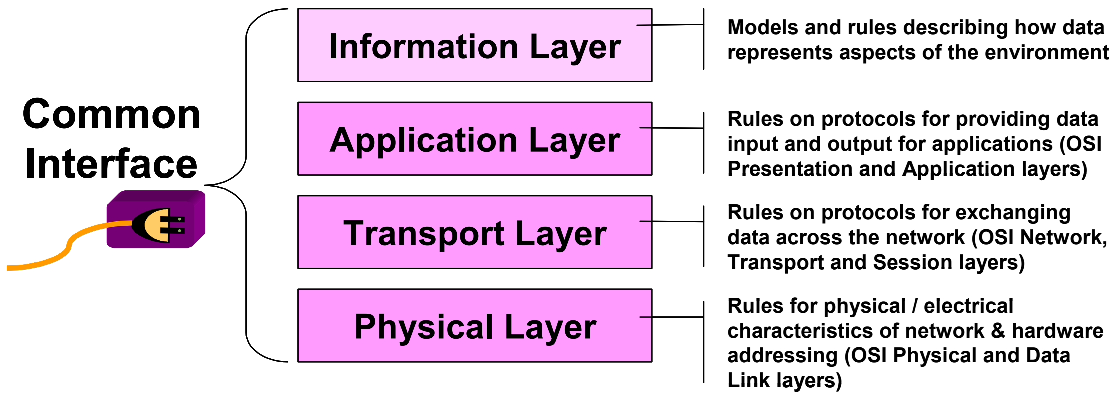


Figure 6.2—Layers of a Common Interface

The key interface elements for each layer follow.

Information Layer. The major interface element for this layer is the *data model*, which provides formal specifications for:

- A set of information elements that will be shared across multiple mission applications (usually based on subject area).
- One or more data-element representations for the information elements, to include specific fields and codes.
- The integrated metadata describing the data representations, including descriptive tags, ownership and pedigree tags, and security tags. The metadata descriptions will include both registry metadata, which describes the use and cataloging of the data representations, and catalog metadata, which indexes each specific data instance (e.g., a file) , to support users in finding the data instances.
- Business rules describing how the data representations will be used to correctly create information and knowledge, including
    - *Use cases*: rules that fully specify how to act on the data in the data models and, as appropriate, in different applications.
    - *Cross-functional checks*: rules that specify the system-independent processes to ensure that cross-system data use is consistent.

- *Consistency and synchronization*: rules to ensure that similar data requests to the force network will return consistent results, such as procedures and standards for keeping replicated data synchronized and procedures for reconciling data elements reporting on the same feature of the battlespace.

- *Posting and retrieval*: rules describing when and how sets of data elements should be posted and made accessible to larger networks (ranging in size from local joint force networks to the DoD enterprise networks), and when and how those elements should be retrieved.

In addition to the data model itself, other key elements are the organizational structures and business processes that specify the data model and educate program developers on the proper use of the data model.

Application, Transport, and Physical Layers. The major interface elements for these layers are a set of data exchange specifications describing the application of the net-centric standards and technologies.

- At the application layer, these specifications describe the accepted methods for importing and exporting data to and from applications. Examples here are rules for using particular messaging formats (XML, TADIL-J, etc.), file formats (Word, JPEG, etc.), and application access standards (Simple Object Access Protocol [SOAP], etc.) to transmit particular data elements.

- At the transport layer, these specifications describe the accepted communications protocols for transmitting data elements under different conditions, such as when it is appropriate to use particular versions of IP/TCP or Link 16.

- At the physical layer, these specifications describe the accepted physical systems and waveforms for transmitting data elements under different conditions, such as JTRS, JTIDS, or EPLRS.

6.7 Descriptions of As-Is Service and Picture Initiative Data Strategies

The following descriptions have been provided directly by the Services and Battlespace Picture Initiatives to describe their as-is data interoperability initiatives; no analysis has been performed on these descriptions. In upcoming versions of the Roadmap, these initiatives will be analyzed and synchronized with the JBMC2 Data Strategy.

6.7.1 Air Force Information and Data Management Strategy

The Air Force Information and Data Management Strategy (I&DMS) describes steps the Air Force will take to implement the Air Force Information Strategy and the DoD Net-Centric Data Strategy. Both strategies aspire to supply users and applications with on-demand access to authoritative, relevant, and sufficient data to perform their tasks efficiently and effectively. To accomplish this, we must ensure that the right data exists, is accessible, and is understood and discoverable. The first and most important step is to ensure that data are accessible—that is, made available by those who have the data and deliverable to those who need them. The next step is to make the right data discoverable and understandable. Individuals and organizations must be able to obtain all the data they need, but to avoid the problem of data overload, it must be possible for them to receive only the data they need. Finally, we must take steps to ensure that the right data will exist. We need to use our knowledge of current and anticipated information needs to drive the development and operation of our data resources so that the data needed by a decider will be collected and made available somewhere in the enterprise. Agility and flexibility are essential aspects of both machine-to-human and machine-to-machine data exchange: we want ad hoc user-directed queries answered in minutes and hours, not hours and days; we want new automated information flows implemented in hours and days, not months and years.

The I&DMS policy memorandum establishes the responsibilities of information owners in the Air Force. It directs Air Force data producers, the MAJCOMs and Functional Community leads, to execute these responsibilities, coordinating through Air Force Communities of Interest. Data producers are those organizations responsible for the creation, collection, storage, release, and disposition of the data that comprise their information holdings. Data producers make data available by posting them in shared information spaces, and they make data discoverable and accessible by providing descriptive metadata. Data producers participate in COIs to create the common vocabularies needed to carry out these responsibilities.

Each COI is a collaborative group of people who must exchange information in pursuit of their shared goals, interests, missions, or business processes, and who therefore must have shared definitions for the information they exchange (reference b). Air Force COIs are established by the Air Force Enterprise Architecture Council. Each Air Force COI is the collection of architects, builders, operators, and all other individuals and organizations concerned with the exchange of information in some subject area. COIs always contain both information producers and consumers. COI memberships always cross information system boundaries and organizational boundaries. They sometimes cross functional boundaries (e.g., combat ops, personnel, medical) as well.

The first purpose of a COI is to create a shared understanding of the terms used to describe information and define data. This common vocabulary for the COI subject area is used by architects who are describing information requirements in operational and system architectures. It is used by system developers who are implementing machine-to-machine data exchanges. It is also used by operators who are describing the “profile” of the information they need. Each COI will have a data panel responsible for creating and maintaining the COI vocabulary. The second purpose of a COI is to identify the authoritative sources of data and to eliminate duplicative data.

COIs and COI subject areas will always overlap to some degree, since individuals or information systems are frequently part of two or more COIs. Further, two or more COIs are often interested in the same kind of information. Overlaps will usually be handled by negotiation between the COIs involved. A separate COI may be created when the overlap is large and important.

Subordinate COIs may be created when a part of the COI needs a specialized vocabulary for a subset of the COI subject area. This is only done when the effort saved is greater than the overhead cost of the sub-COI.

Participation in Air Force COIs will not be limited to the Air Force. Interested parties from the rest of DoD, other government agencies, allied and coalition partners, and commercial industry will be encouraged to participate. Air Force COIs will coordinate with applicable external COIs (e.g., joint, allied, government).

Every Air Force COI has a MAJCOM or Functional OPR (and one or more OCRs) responsible for its operation. Every Air Force COI is also associated with a Domain Architecture Council. The COI's data panel will define the vocabulary based on the use within the domain, and those definitions will be used by the domain architects in their operational and system architecture products. This connection ensures that the definitions produced by the COI data panel and used by data owners will stay aligned with the architects' domain knowledge.

6.7.2 Army Net Centric Data Management Program

Overarching Mission Statement. The overall mission of the Army Net Centric Data Management (ANCDM) program is to manage and leverage information across the Army and, as appropriate, within DoD.

This access to information is also a vital part of the DoD transformation to Net-Centric Operations and Warfare (NCOW). The DoD Net-Centric Data Strategy describes the DoD vision for managing data in the NCOW environment. Part of the new strategy is management of data first within Army communities of interest, and then as appropriate jointly across the entire DoD. COIs are collaborative groups of people who must exchange information in pursuit of their shared goals, interests, missions, or business processes, and who therefore must have a shared vocabulary for the information they exchange.

To implement the ANCDM program and the DoD Net-Centric Data Strategy, the Army will form a number of institutional COIs, which will generally relate to enterprise architectures as the common foundation for integrating combat operations, combat support, and business elements within the Army. Architects within the COIs require a shared vocabulary to describe operational activities, information requirements, and enabling system functionality. Therefore, COIs within the Army will be directly related to the mission area operational architectures being developed by MACOMs and headquarters functionals, and to the system/technical architectures being developed by the acquisition community. The ANCDM work products created by the Army COIs are harmonized jointly as appropriate.

The Army Chief Information Officer (CIO/G6) is responsible for establishing Army information and data management policies. Establishment of Army COIs is delegated to the CIO of the Army.

Army Net Centric Data Management Program Architecture. The overall architecture of the ANCDM program is based on a top-down and bottom-up approach, wherein the top-down components provide guidance and facilitation and the bottom-up components are empowered and ultimately assert ownership of their data management products. These data management products reside within COIs and are manifest in a federated metadata environment, called the data performance planning system (DPPS). The data management products across Army COIs are then harmonization. These Army data management work products are then contributed, as appropriate, to the DoD metadata registry, and harmonization across DoD is achieved.

Governance. The governance of the ANCDM is through policy, guidance, and COIs. Supporting the guidance are a myriad of workshops, white papers, seminars, and software tool sets. The DPPS collectively assists Army staff as they develop, publish, integrate, and maintain all ANCDM work products within and across COIs.

Components. The ANCDM program consists of the following components:

- Process
- Standards
- Metrics
- Project Management
- Technology Components
- Data Performance Planning System (DPPS)
- Training and Awareness.

The process component contains the fundamental processes that necessarily must exist within ANCDM efforts. Included are prototypical techniques, processes, and products needed to achieve the goals and full compliance with all of the guidance provided at the DoD-level. It includes a description of the process required to develop, validate, and institutionalize the ANCDM concepts in a cohesive manner. The process addresses data problems and issues that require strategic development, such as architecture, that must be planned and built well in advance of deployment of systems with their associated data, as well as specific issues that can be addressed after the systems are deployed.

The process ensures that the policy for the ANCDM ensures that the requisite governance, support, resources, and tools are provided across the Army Enterprise, such that data are structured, documented, and managed to support information exchange within and across all commands and among data producers and consumers within the Total Army environment.

The standards components are those de jure standards critical to the execution of the ANCDM effort. Included in this standards set are SQL, ISO Standard 11179 for data element metadata, and XML for technology independent data transport.

The metrics components are measures that are captured, methods of capture, and analyses that will be undertaken to present valid conclusions from the metrics. Key classes of metrics include increasing quality, increasing productivity, decreasing risk, and decreasing cost.

The project management component addresses the classes of projects that are most common within the ANCDM effort. Project management provides the specifications of the project deliverables, unit effort estimates, work breakdown structures, required work environment factors, and characteristics of the staff that should be assigned to accomplish project work. Project management also supports the process of project management—that is, the creation of ANCDM projects, the determination of deliverable quantities, the allocation of proper work environment factors, and the identification and allocation of proper staff. Finally, project management includes the ability to monitor ANCDM projects and the capability to collect key metrics through which the ANCDM program can be evaluated.

The technology components of the ANCDM program include

- Standard Data Elements
- Standard Data Structures
- Enterprise Identifiers
- Authoritative Data Sources
- Information Exchange Standards Specifications
- Technology Independent Data Transport (e.g., XML).

The DPPS component is the ANCDM work product creation and/or capturing, publishing, interrelating, and evolution environment. The DPPS is a database system supported by report writers that enable DPPS users the ability to create, report, and evolve the complete set of ANCDM work products. The ANCDM work products are those that are already required by the DoDAF. The power of the DPPS is that these work products reside in a completely integrated database. The DPPS exists in a federated environment in which there is an instance within at least every COI and within the CIO-G6. The DPPS is supported by import and export mechanisms, supports the production of DoDAF products, and supports the creation of data management work products for the DoD metadata registry.

The training and awareness component includes the courses, seminars, workshops, white papers, books, and Web sites of information that supports the creation, accomplishment, and evolution of various training and awareness programs dealing with the ANCDM effort.

6.7.3 Marine Corps

[The Marine Corps did not submit a report for this edition of the Roadmap.]

6.7.4 Navy

Navy Data Management Strategy:

The Navy's Data Management Strategy is aligned with the Department of Navy's Data Management and Interoperability Strategic Plan and the Department's XML Policy. The Data Management SECNAV Instructions 5000.36 established Functional Area Managers (FAMs) and Functional Data Managers (FDMs). Functional Namespace Coordinators (FNCs) were established by the Department of Navy XML Policy.

Data Management and Interoperability Approach:

DMI aligns the key data management roles to Resource Sponsors and Functional Data Managers who work with system developers. The Department of Navy Applications and Database Management System (DADMS) is the authoritative source for system and database registration in the Navy. Functional Data Managers will eventually use this tool to register authoritative data sources and metadata.

Department of Navy Approach to XML:

Functional Namespace Coordinators and XML developers are directed to follow a standards hierarchy for development:

First use:	Voluntary Consensus Standards
Second:	Federal Standards
Third:	DoD Standards
Fourth:	Department of Navy Enterprise Standards.

Department of Navy COIs:

SECNAV Instruction 5000.36 established 22 Functional Areas for the Navy and Marine Corps, shown in the following table. These Functional Areas act as the Navy's Communities of Interest. Not all 22 are present for the Marine Corps.

Functional Area
Acquisition
Finance

Civilian Personnel
Administration
Manpower and Personnel
Intelligence and Cryptology
Logistics
Readiness
Command, Control, and Communication
Information Warfare
Modeling and Simulation
Weapons Planning and Control
Training
Resources, Requirements, and Assessments
Scientific and Technical
Test and Evaluation
Medical
Naval Reserve
Meteorology, Oceanography, GI&S
Precise Time and Astrometry
Religious Ministries
Naval Nuclear Propulsion

Implementation of DoD Net-Centric Data Strategy:
[placeholder]

References:
Data Management and Interoperability
SECNAV Instruction 5000.36
1 NOV 2001
http://www.doncio.navy.mil/PolicyMatrix/Uploads/1002CAZ28647.pdf

Department of Navy XML Policy
13 DEC 2002
http://www.doncio.navy.mil/PolicyMatrix/Uploads/0106UTQ59315.pdf

Additional Data Management references may be found at
http://www.doncio.navy.mil
Project Teams - tab at top
Enterprise Architecture, Standards and Interoperability
Library.

DADMS
https://www.dadms.navy.mil

6.7.5 Family of Interoperable Operating Pictures

The FIOP data strategy work is sponsored under the FIOP Systems Engineering Working Group (SEWG) activity, which provides technical oversight of FIOP activities to ensure that engineering solutions will be developed in accordance with the principles stated in the FIOP FY04 Management Plan (updated annually). For FY04, those activities include technical coordination and oversight of FIOP Multi-Service Management Team (MSMT) chartered integrated product teams (IPTs), providing a systems engineering coordination function to improve joint integration, interoperability, and synchronization of Single Integrated Air Picture, Single Integrated Ground Picture, Single Integrated Maritime Picture, and Single Integrated Space Picture activities (cross-picture coordination per FIOP/USJFCOM MOU, 14 April 2003), and working closely with USJFCOM to assist in the engineering level execution of their MID 912 responsibilities.

Therefore, the FIOP data strategy supports several related elements:

- Assists with providing consistent guidance across FIOP multi-service IPTs
- Supports FIOP in executing cross-picture systems engineering coordination function with a focus on data/information exchange
- Provides a contribution to development of consistent guidance in the JBMC2 Roadmap.

Across FIOP IPTs, the SEWG Data Team will provide general engineering guidance consistent with DoD Net-Centric Data Strategy:

- Focus on process guidance to IPTs on XML Registration/Subscription
    - Consistent with initial phase of DoD Metadata Asset Visibility Objectives (MID-905)
    - Modeled from similar work done for Army SWB PMs/PEOs
- Include recent guidance/activities from ASD NII
    - DoD Discovery Metadata Standard
    - DoD Metadata Registry Working Group
        - Metadata COI Managers

- Develop consistent Terms of Reference so that we all use common terms for communication

- Create a hierarchy that relates the various data models in use by FIOP IPTs

- Develop long-term guidance and compliance criteria.

- Across picture efforts, FIOP strategy is consistent with Section 4.1, Battlespace Picture Integration (Cross-Picture Coordination), and Section 5, JBMC2 Data Strategy.

6.7.6 FORCEnet Maritime Picture

[The Navy did not submit a report for this edition of the Roadmap.]

6.7.7 Single Integrated Air Picture

Introduction

The purpose of the overall joint data strategy is to assure reliable interoperability across heterogeneous systems, supporting efficient and reliable engineering processes across multiple systems and programs. Experience has shown that simple exchanges of data models is often not sufficient and can cause failures either in the misinterpretation of the meaning of the data or in expected behavior on one side or the other of the exchange.

JSSEO Approach

The JSSEO approach, being rooted in the object-oriented paradigm, is based on a two-pronged effort: (1) specify the Object Model used for object instances (messages) crossing the Integrated Architecture Behavior Model (IABM) interfaces, and (2) specify the Interaction Model, the underlying behavior expected across multiple systems.

The first effort involves the specification of essential a "Federated Object Model" to use the terminology from the HLA community. This specifies the object classes involved in the external interfaces of the system of concern—in our case, the external interfaces of the IABM Implementation.

The second effort involves the underlying processes and mechanisms that control how information will be disseminated, and this includes the structure and behavior underlying the publish/subscribe mechanisms, consistent with those required in the Global Information Grid Capstone Requirements Document (GIG CRD). The Interaction Model includes such things as the client-server, publish-subscriber, or other interaction paradigms that are planned and necessary for carrying out distributed capabilities.

SIAP and GIG Requirements

SIAP Data Strategy shall conform to applicable required capabilities as defined in the GIG CRD for Information Dissemination Management (IDM), as detailed below.

An IABM is an information consumer, processor, and producer, and, as such, is part of the GIG. IABM peers, defined as hosts running the IABM, shall conform to GIG CRD requirements to the extent that the SIAP mission is not compromised.

Some GIG CRD IDM requirements are core functions in the IABM and IABM peer-to-peer networks. These are identified below.

Information exchange with external systems shall be facilitated through a capable IABM peer. This peer shall be cognizant of all data elements in the IABM peer-to-peer network and shall subscribe for data collection to satisfy requests from external systems. Similarly this peer shall inject relevant information into the IABM peer-to-peer network as requested by external systems. All external information exchange shall proceed in a manner consistent with policy established by the commander and security procedures.

In general, SIAP can provide the following types of information:

Health and status of reporting systems
Command and Control, specific to systems active in the network
Object Track Information
Mission Planning.

The following paragraphs address specific capabilities described in the GIG CRD for IDM.

Requirements Identification

SIAP shall publish data descriptions for identification by COIs. The descriptions shall include information attributes so that information consumers can readily identify the meaning and quality of the data.

Search Driven Information

Search queries received from COIs shall be serviced commensurate with the priority of the request and factored by communications conditions and current mission situation.

Information Advertisement
Quality of Advertisement
Product Descriptions

The designated IABM peer, capable of external system data exchange, shall post data and metadata to the server for examination by the user population. Lacking specific subscription requests, data will be posted based on information provided to all IABM peers (e.g., general health and status) and metadata associated with identifiable characteristics of IABM peer-to-peer network participants. Posting of metadata associated with specific network participants will allow users to formulate queries that have a higher probability of fulfillment. Subscribing to all information solely for the purpose of replicating the data without a COI could introduce unusual stress on communications paths that are often challenged by the dynamics of the network and its operating environment.

Profile Management
Profile Driven Information
Collection Request
Dynamic Profiling
Directory Services

External Users can build profiles, describing information of interest, based on SIAP object models posted in the registry. External servers and designated, capable IABM peers may store user profiles to expedite subscription generation. The availability of any information in an IABM peer-to-peer network at any time shall be determined by advertisement of data descriptions (i.e., metadata) in a dynamic portion of the server registry. The delivery of subscribed information shall be automatic and dependent on its availability in the network.

Filtering of Multiple Sources
Geographic Areas
Allied Access
Information Retrieval
Survival Information Dissemination
Correlation

These functions are core to the IABM, its internal data dissemination processes, and network management functions.

Dissemination Policy Generation
Information Flow Awareness
Policy Management

Dissemination policy is a core function in the network management capability of IABM peer-to-peer network. Information flow shall be managed automatically, based on the dissemination policy. Network dynamics require automated control for proper operation.

Status
Resource Monitor
Controlled Access
Notification

IABM peers, designated as information portals to external systems, shall support the tracking of COI request status and general SIAP information resources. These functions are internal to the designated peer but external to the IABM peer-to-peer network, so that network resources are not burdened with this accounting function. The designated peers shall be identifiable in the network as external ports, just as any IABM peer shall identify itself. Based on the commander's information management (IM) policies, these peers shall be assigned access levels that will control their ability to report network information to external systems.

Information Description

IABM peers advertise their information production capability in the network, based on their host system type, status, and function. An IABM peer, designated as an exchange point to external systems, will do the same, consistent with the commander's IM policies and operational constraints. Other IABM peers may form subscription policies to extract external data via the designated peer, based on the advertised production capability.

Delivery Plan

Delivery Management

The designated IABM peer or dependent data server shall form the delivery plan for transmittal of user requested information. The IABM peer-to-peer network shall not be burdened with this function.

Flexibility

The IABM peer-to-peer network is designed for tactical applications but does not preclude strategic uses. The extent of support for strategic functions is to be determined (TBD).

Scalability

Scalability, in the sense of information delivery inside the IABM peer-to-peer network, is based on the availability of communications methods and the operating environment, and the peers' ability to utilize all available host communications methods. The scalability of external system data exchange is based on the configuration of designated IABM peers. Nothing in the design of the IABM precludes participation of additional designated peers for the purpose of external system data exchange.

6.7.8 Single Integrated Ground Picture

Purpose:

The purpose of this section is to outline the Joint Single Integrated Ground Picture's Data Strategy.

Background:

SIGP is the ground component of JBMC2. Its mission is to maximize the effectiveness of mission execution and significantly enhance the warfighting capabilities for

U.S., Allied, and Coalition Ground Forces by providing an integrated ground-based battlespace situational awareness to the warfighter based upon USJFCOM-led Joint SIGP Operational Concept, CONOPS, Operational Architecture, and Requirements. SIGP will provide the enabling Joint processes, methods, architectures, standards, and Operational Concepts & CONOPS that provide the Warfighter with enhanced situational awareness of the battlespace, enabling the warfighter to more precisely and decisively command and control that battlespace.

Problem Statement:

There are many systems within the SIGP "domain." These systems belong to various Services and Agencies, with many of them having their own message formats and communication protocols. As the need for Joint interoperability has increased, several communities have proposed their own data strategies to include MIP, SIAP, SADI and NCES. Each community's proposed data model handles a unique group of systems and passes unique data tailored to their own areas of interest. In addition, not all data models have been identified at this time, such as ISR.

Data Standardization Strategy:

A capabilities-based DOTML-PF approach will be utilized to guide the Joint SIGP data strategy. Based on the Joint SIGP Integrated Architecture, a standard for communication protocols, data types, and information exchanges will be determined. These standard communication protocols, data types, and information exchanges need to be agreed upon by stakeholders and enforced to enable seamless communication exchanges between all communities within and outside the SIGP domain.

The C2IEDM/GH6, SIAP, SADI, NCES, and other data models will be investigated to get a full understanding of their capabilities and limitations in support of the Joint SIGP Integrated Architecture. The SIGP multi-service Systems Engineering Workgroup will investigate these models and their ability to be expanded to encompass all the essential elements of information within the SIGP domain. This study will determine whether one or more of these standards, a modification of existing standard(s), or even a new standard would best satisfy the SIGP needs. But collaboration with the Services and the JBMC2 community is necessary. This decision will be made through a sound Systems Engineering approach taking many factors into consideration to include feasibility, scalability, time, effort, and cost. This engineering analysis coupled with a business analysis will aid the SIGP in determining which standards to adopt.

Current Initiatives:

SIGP is currently considering various data model/strategy interoperability initiatives.

The first initiative is the Multilateral Interoperability Program (MIP) and C2 Information Exchange Data Model (C2IEDM), which has been the basis for multiple coalition interoperability initiatives. An example of its application is a recent USMC effort to increase interoperability with coalition forces in response to an MARFOREUR Urgent Need Statement. A prototype capability is planned for demonstration at the EUCOM-sponsored Combined Endeavor 2004 exercise. In this demonstration, the goal is for USMC ground forces to share ground tracks with coalition forces through the USMC Command and Control PC (C2PC) and coalition partner National C2 systems. This effort is being coordinated and developed under the already-established MIP guidelines. MIP specifies common interface and exchange mechanisms to exchange information between co-operating but diverse C2 systems. The common interface is the C2 Information Exchange Data Model (C2IEDM). These guidelines are the initial framework for interoperability with coalition countries. This particular effort is utilizing the MIP Injector initially developed for the U.S. Army Maneuver Control System (MCS). The MIP Injector utilizes the C2IEDM data model.

Another initiative is the Shared Tactical Ground Picture (STGP), an OSD AT&L-sponsored, NATO-supported coalition program to explore commercial standards, practices, methodology, and tools. The STGP has developed and demonstrated a platform-independent tactical data exchange mechanism. The STGP information architecture is based on a Services Oriented Architecture methodology, which stresses the use of commercial standards and tools. This effort leverages a DARPA investment in Service Oriented Architectures aligned with the NCES Core Enterprise Services. STGP's Tactical Services Integration Framework provides a set of core services that are capable of being used by any COI on the network. The COI services developed to date include a tactical MTI service, tactical Fusion service, and tactical C2 service. STGP will also leverage MIP/C2IEDM.

7.0 Net-Centric Underpinnings to JBMC2

The vision for transformation of the information environment in the Department of Defense (DoD), calls for a move from the centralized thinking and planning currently reflected in the Task, Process, Exploit, Disseminate paradigm, to an edge-centered Task, Post, Process, Use (TPPU) approach to information sharing and availability. The envisioned changes in enabled by a shift to a service-oriented paradigm that requires the support of an available, secure and reliable network. "Net-centricity" 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.

Robust Global Information Grid (GIG) enterprise services (GES) will provide visibility of and access to data, enabling the end user to execute an intelligent pull of mission-tailored information from anywhere within the network environment. Users will see a collection of networked capabilities organized as Core Enterprise Services (CES) and Community of Interest (COI) services.

A new program called Net-Centric Enterprise Services (NCES) has begun to provide the core enterprise services and capabilities that are key to enabling the strategy and provide the ubiquitous access to reliable decision-quality information. NCES will provide the basic ability to search the DoD enterprise for desired information and services, and then establish a connection to the desired service/data.

7.1 Net-Centric Underpinnings

- GIG requires a common set of information services to provide the awareness, access and delivery of information.
- GIG Enterprise Services (GES) is a collection of networked capabilities organized as Core Enterprise Services (CES) and Community-of-Interest (COI) services.
- CES, generic information services that apply to any COI, provide the basic ability to search the enterprise for desired information and then establish a connection to the desired service.
- COI's are organized around DoD, IC, and dynamically created communities that have similar information requirements

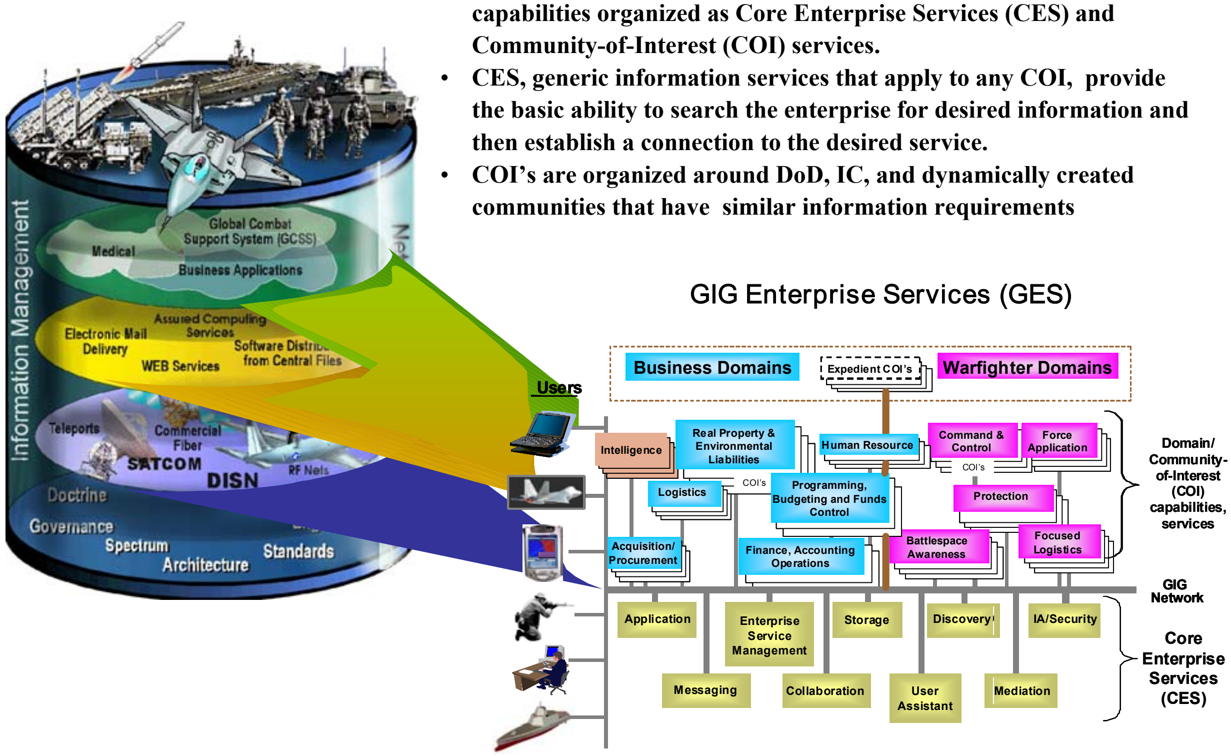


Figure 7.1—GIG and its Net-Centric Underpinnings

Department of Defense information 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 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 metadata registration tools and guidance 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 providing guidance to transform applications to 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 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 section. All of these initiatives are elements of the GIG.

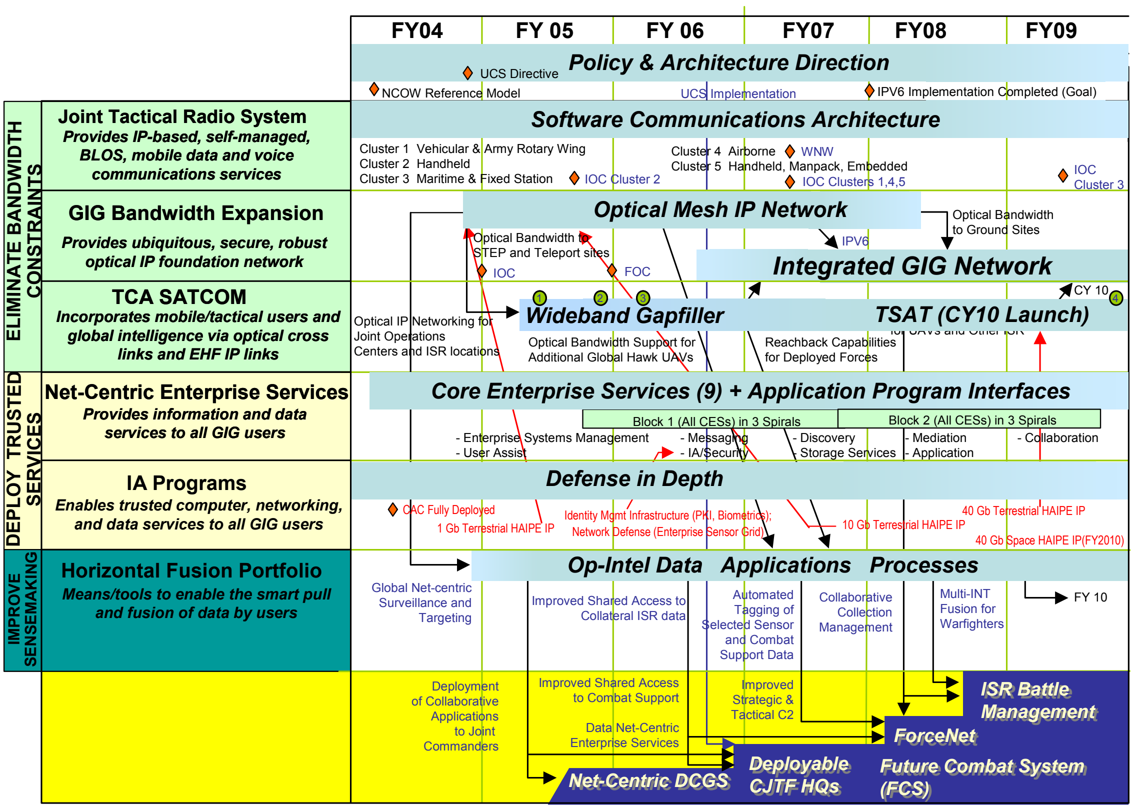


Figure 7.2—Key Net-Centric Initiatives

7.3 Joint Tactical Radio System (JTRS)

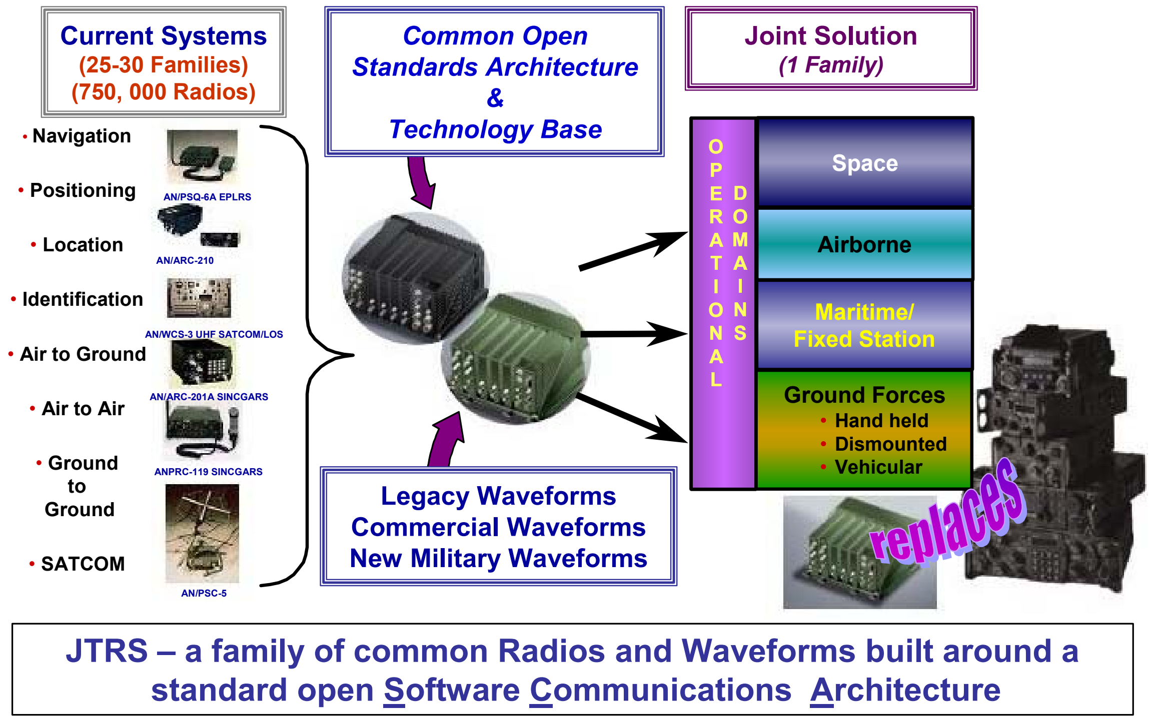


Figure 7.3—Joint Tactical Radio System (JTRS)

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.

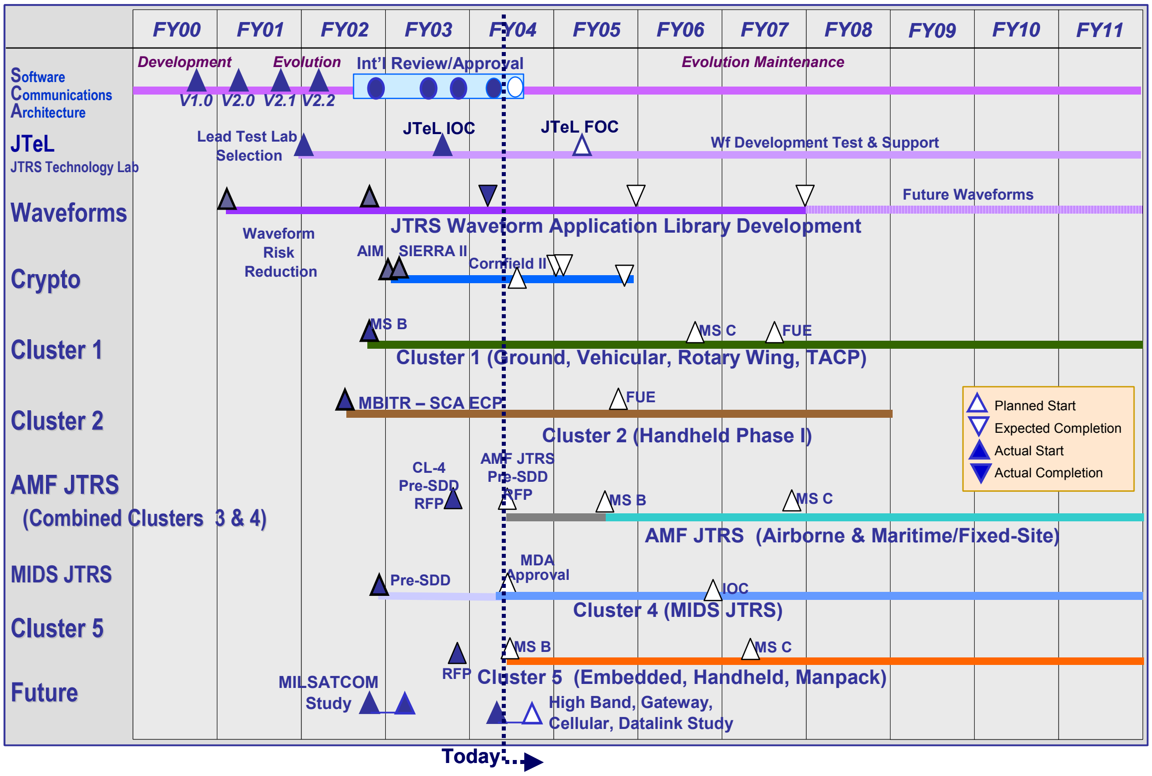


Figure 7.4—JTRS Program Schedule

Figure 7.4 provides a top-level schedule for each of the JTRS cluster programs, showing major program milestones. 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. 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 provides a schedule for the development of the JTRS waveforms (notably, the JTRS Wideband Network Waveform) and incorporation of current waveforms into the JTRS radios.

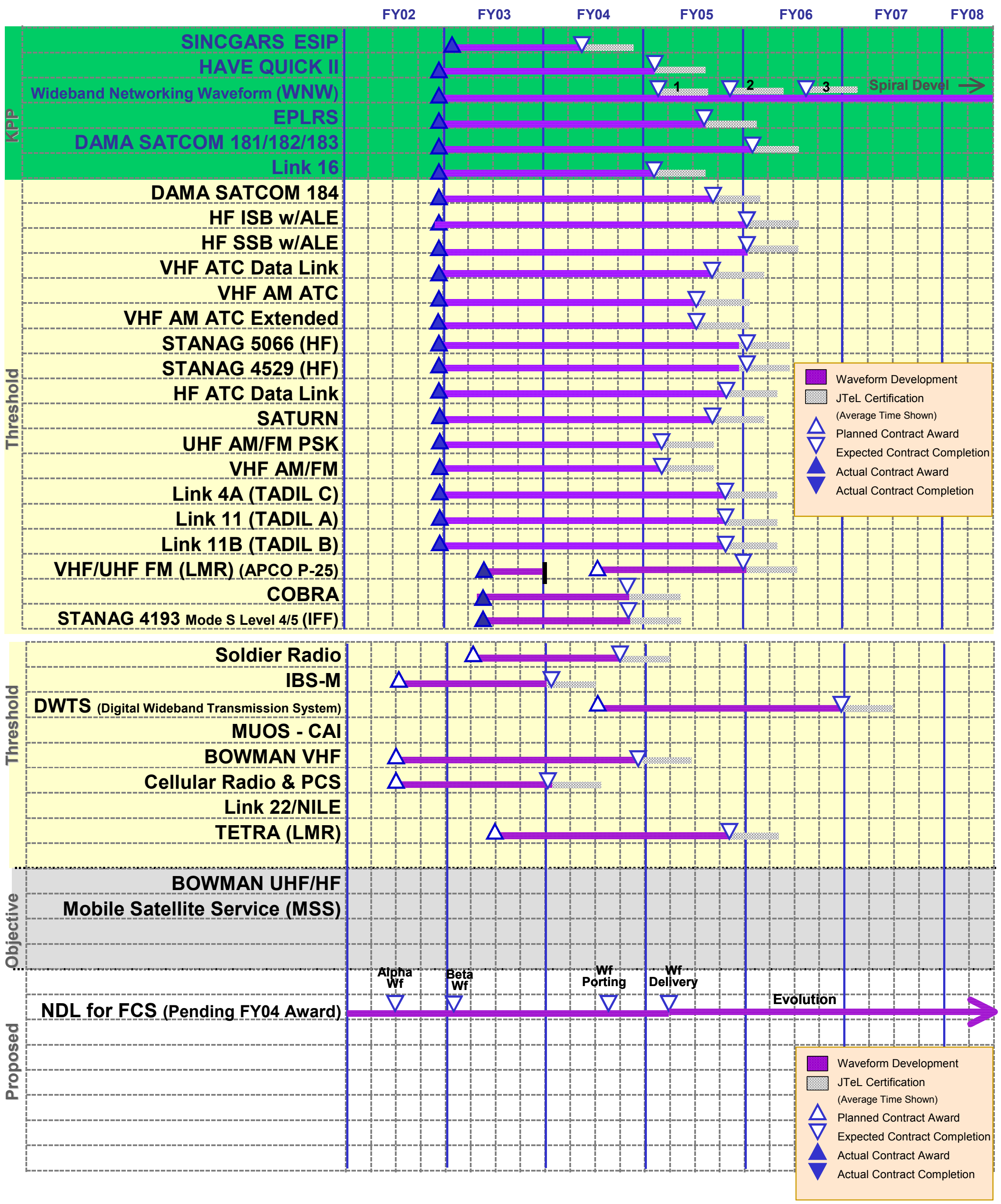
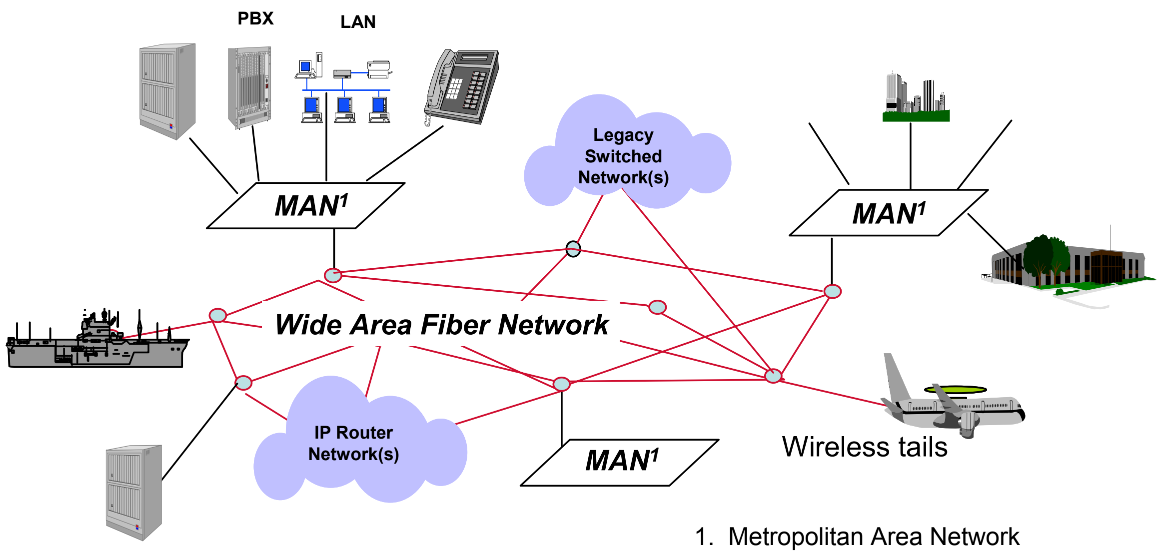


Figure 7.5—JTRS Waveform Schedule

7.4 Global Information Grid Bandwidth Expansion



Provides 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).

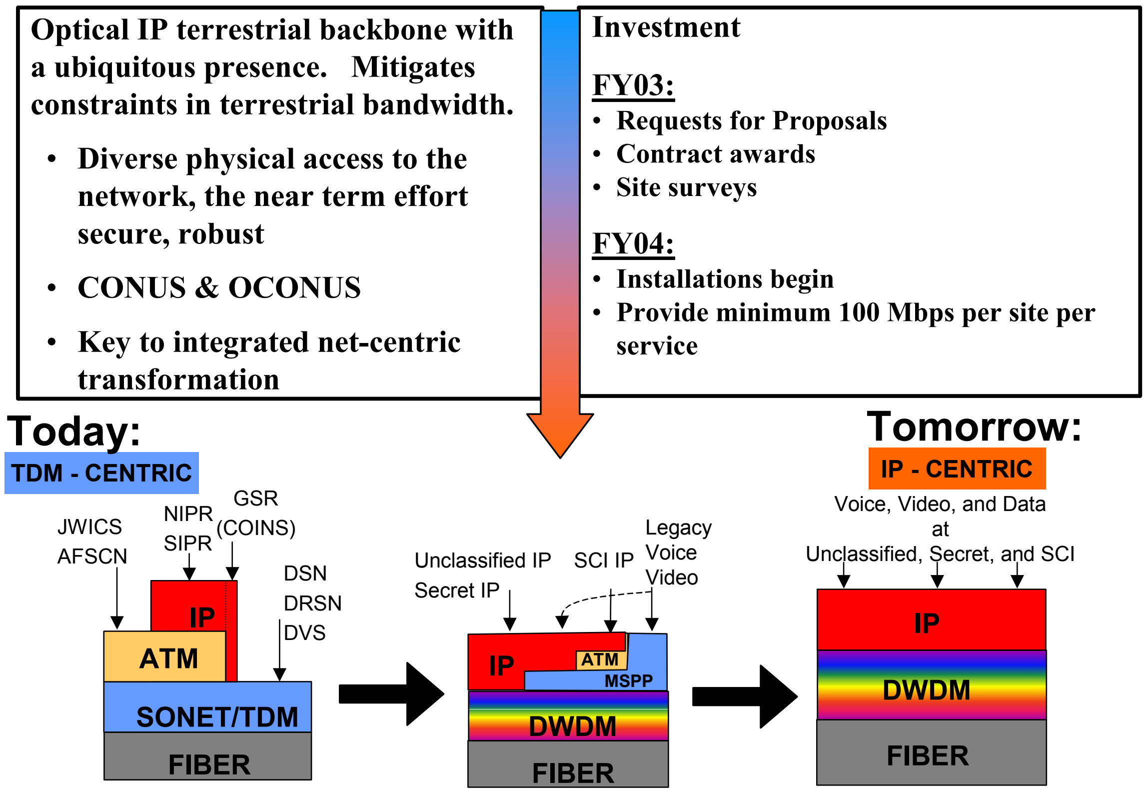


Figure 7.7—GIG Internet Protocol (IP) Convergence

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 the key milestones for the GIG Bandwidth Expansion Program.

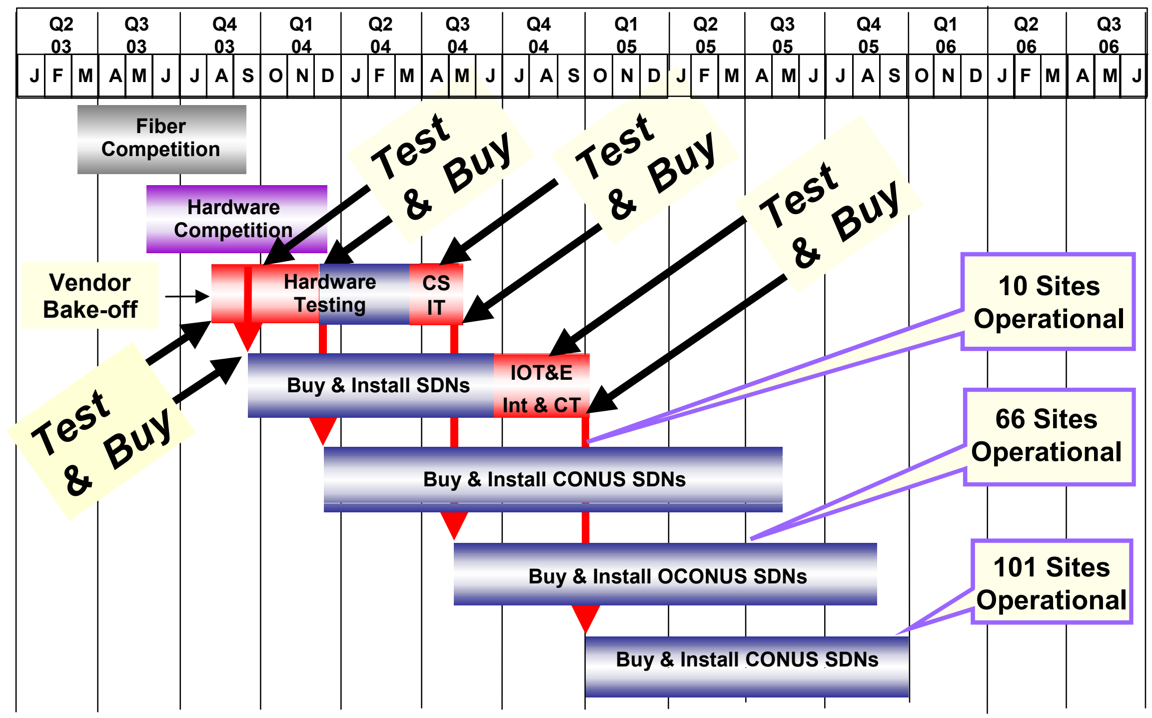


Figure 7.8—GIG Bandwidth Expansion Schedule

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.

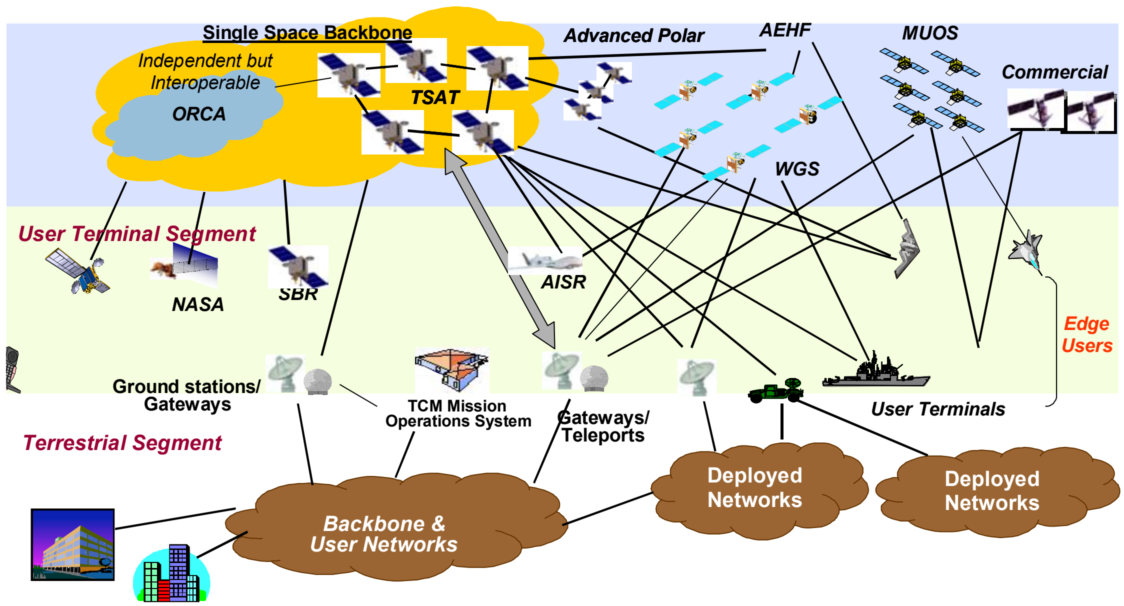


Figure 7.9—TCM (TSAT/APS) Architecture (2015)

This figure 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.

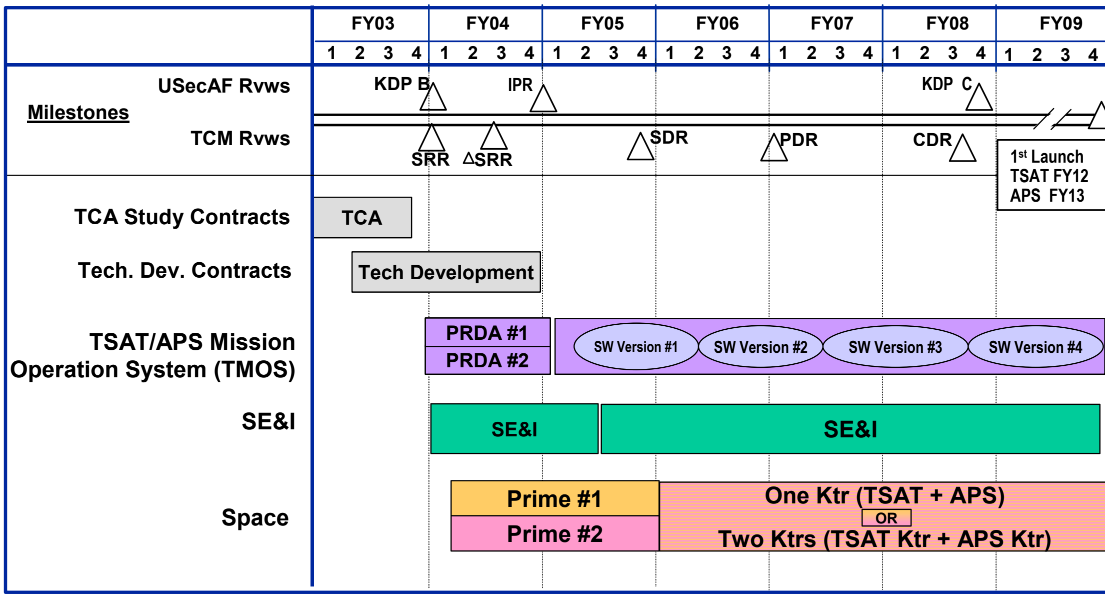


Figure 7.10—TCM (TSAT/APS) Acquisition Schedule

Under the current schedule, the first TSAT will be launched in the fall of 2011 (FY 2012) with the first Advanced Polar Satellite launch scheduled for FY 2013. 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 FY 2004. 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, FY 2009 & FY 2010
- Mobile User Objective System – FY 2009, FY 2010, FY 2011, FY 2012, & FY 2013.

7.6 Net-Centric Enterprise Services (NCES)

The NCES Program will 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 (see figure 6.12). The CESs will enable information providers to post any information they create, enable edge users to rapidly and precisely discover and pull information resources, and to allow groups to dynamically collaborate 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 can integrate NCES capabilities into their mission specific capabilities and services. The NCES Program will field these capabilities in three increments.

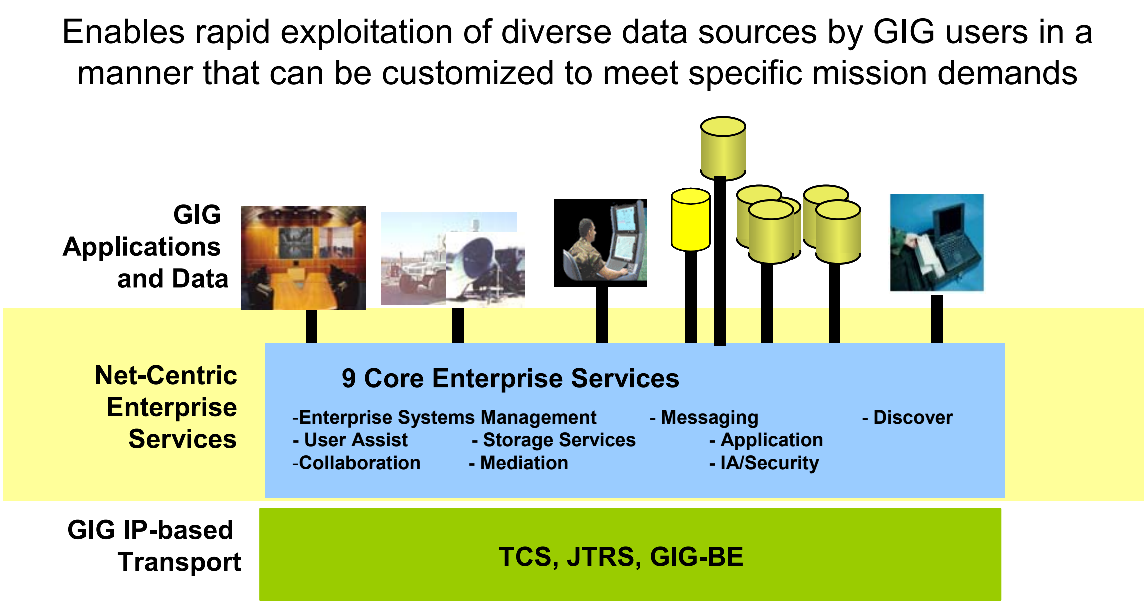


Figure 7.11—Net-Centric Enterprise Services (NCES)

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.

NCES will enable both service and data providers on the "net," by providing and managing the underlying capabilities to deliver content and value to end-users. The core enterprise services have to support a broad array of mission services and be open to allow the introduction of new classes of services. NCES will be able to support new requirements and CoI needs without re-engineering and re-implementation. To enable the support of NCW, the CESs must support the rapid development and deployment of services in order to respond promptly to user and CoI needs. NCES will provide information services necessary for all echelons to better utilize the network for the rapid decision processing necessary to support operations anywhere, anytime, by any user with privileges on the DoD network. NCES will change the way warfighters receive and process information. The user will be able to rapidly leverage CoI data producers and their release of real time data to a global data repository for general consumption and decision-making. This availability of information will enable more effective and rapid execution of command and control within a given theater of operations.

Increment one of NCES will be hosted at the DISA computing centers (NIPRNET, SIPRNET, and GIG-BE (IPV6)) and be available in FY 2005- FY 2007. Increment two will extend to tactical users by hosting on tactical networks (e.g., WIN-T, maritime platforms) supporting tactical GIG users with intermittent connectivity and be available in FY 2007- FY 2009. Increment three will provide additional capabilities and functionality as well as scale to the DOD Enterprise. Increment three will be available in FY 2009- FY 2011.

7.7 Net-Centric Data Strategy

History has shown that individual pieces of data, inconsequential by themselves, assembled together can create a robust and otherwise unobtainable amount of information. The Net-Centric Data Strategy (signed May 9, 2003) outlines the vision and plan for creating a robust data environment in order to support the various Department of Defense missions and ultimately achieve the goal of Information Superiority.

The Net-Centric Data Strategy recognizes the value of tightly engineered, predefined systems across well-defined interfaces. There is a clear need for certain systems to be highly coupled in support of their mission goals. However, the Data Strategy also recognizes the value of the data in these systems and where possible, emphasizes the need for these systems to share that data with the Enterprise.

There are three major challenges for users attempting to use data: “they don’t know the data exists,” “they know it exists, but cannot access it” and “they have access to a data asset, but cannot understand it”. The Data Strategy addresses these challenges through the goals of visibility, accessibility and understandability.

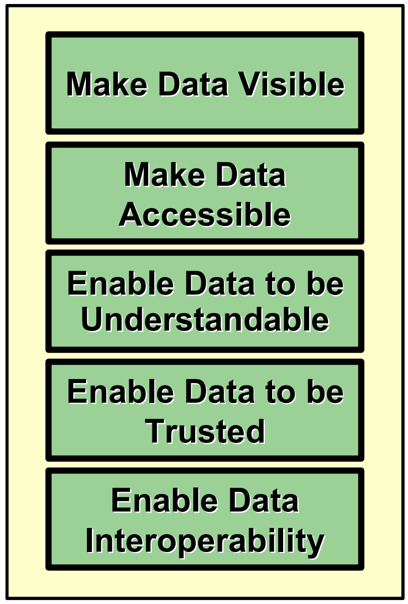


Figure 7.12—Key Net-Centric Data Strategy Goals

To assist users to know that data exists, the Data Strategy encourages the activities of "tagging data assets" and "posting to metadata catalogs". Tagging data assets with metadata (data about data) provides descriptive information (author, security level, asset description, etc), which facilitates discovery of data assets. Metadata catalogs provide a centralized repository of metadata for users to discover specific assets. Metadata catalogs can be created throughout the Department of Defense and federated via a single Enterprise wide search. Together, "tagging data assets" and "posting to metadata catalogs" provide visibility to data, across the Enterprise, for edge users.

"Shared space" is introduced in the Net-Centric Data Strategy as a method to ensure that known data assets can be accessed when needed. In this context, "shared space" refers to a shared location that can be accessed by users on the GIG. However, in the context of "Accessibility of Data Assets" any type of service that provides access (e.g. a data web service) to known data assets facilitates the core concept of accessibility.

Data assets that are discovered and accessed need to be understandable. There are two common examples at the heart of understandability:

In one example, a warfighter discovers information related to "enemy aircraft identification." However, the warfighter does not understand the terminology. In other words, the warfighter does not understand the meaning, or semantics, of the information.

In the second example, a developer who wishes to integrate information about "red force locations" determines that the needed data is stored in a database, but has no information about how to parse the data in order to process it. In other words, he/she does not understand the structure of the data.

Metadata registries, as described in the Net-Centric Data Strategy, provide the ability for data producers to describe both structural and semantic metadata related to data assets. This metadata can then be used to understand both how to electronically read and parse the data, as well as how to make semantic sense of the data.

The Net-Centric Data Strategy outlines a concept for operations (see figure 6.13) for creating a data rich environment, which enables users to access the most relevant information in supporting their mission and objectives. Information providers are not always aware of the value their data outside of their current mission. Information Superiority is about assembling pieces of data, from all locations, in new and meaningful ways, which provide a greater ability for decision-making and improved warfighting.

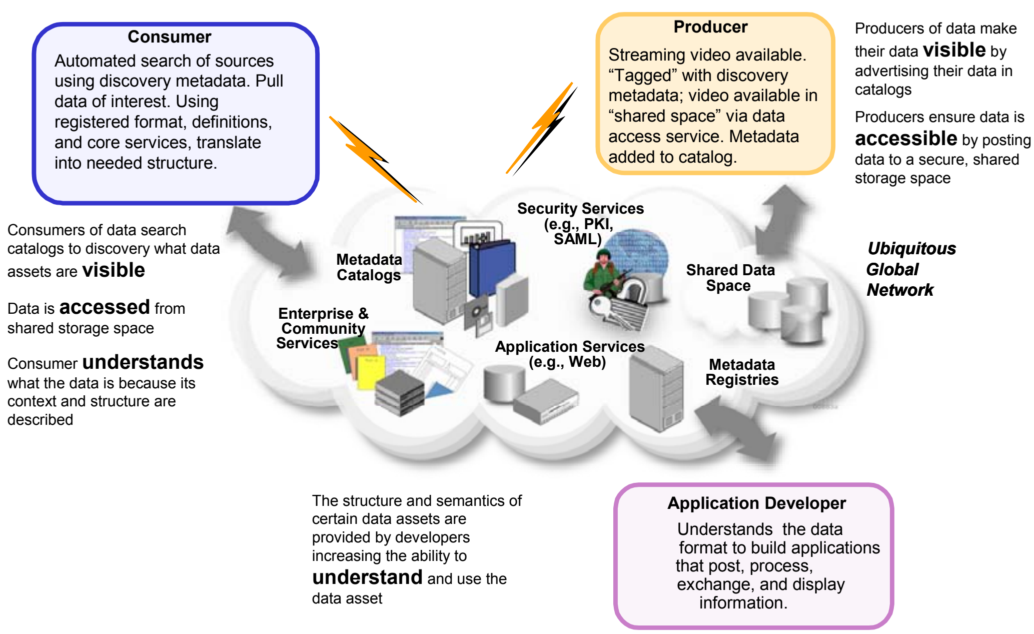
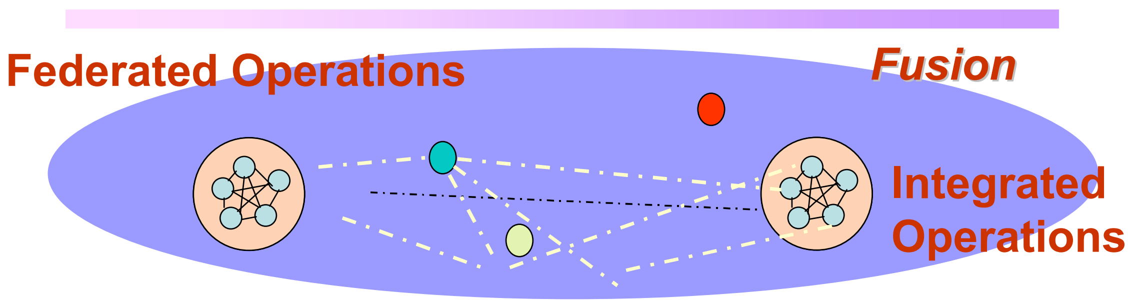


Figure 7.13— Net-Centric Data Strategy High-level CONOPs

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



Horizontal Fusion is net-centric capability with

- A focus on data and cross functional posting
- Ad Hoc access to and fusion of data that is created by operations which are both integrated and federated
- A focus on making 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 battlespace. 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.

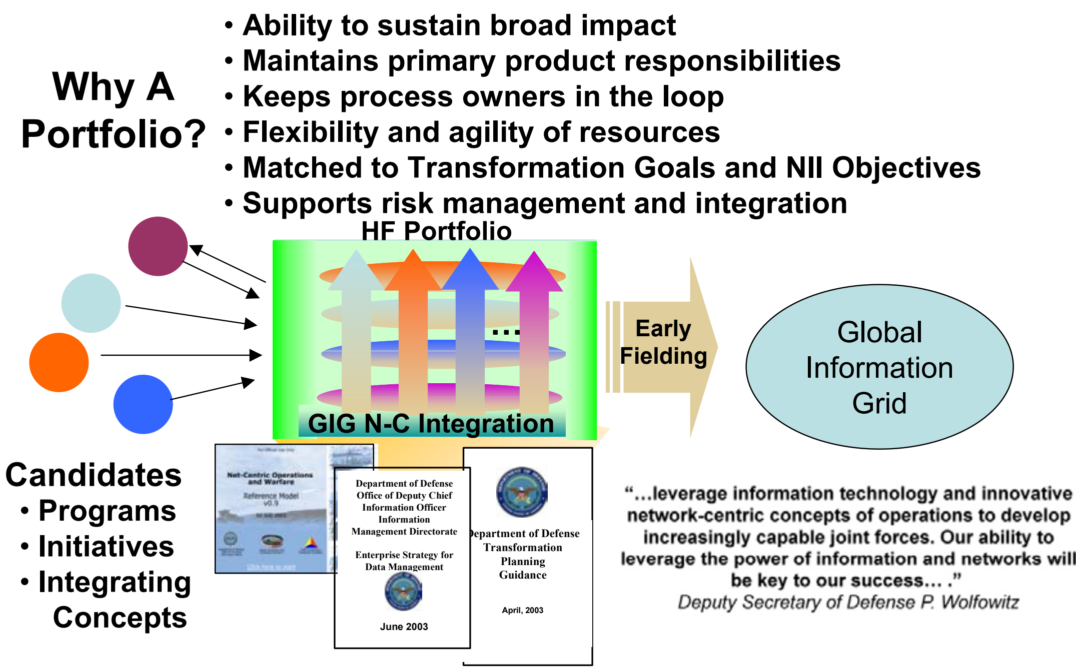


Figure 7.15—Horizontal Fusion's Portfolio Concept

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.

7.9 GIG Information Assurance

7.9.1 IA Importance and Key Characteristics

Information Assurance (IA) capabilities and components that support the net-centric GIG vision are DoD imperatives. The IA objectives in support of the GIG architectures are:

- To develop common unifying approaches for DoD components and the intelligence community, and
- To apply these approaches in the development and acquisition of systems incorporating IA and IA-enabled products and services.

The essential element is that IA be an embedded feature, designed into every system, holistically, within the family of systems that comprise the GIG. This requires a shift from today's model consisting predominantly of link encryption and boundary protection between multiple discrete networks, to an end-to-end, seamlessly interconnected information environment using "Defense-in-Depth." DoD policy (DODD 8500.1, DODI 8500.2, and DODD 5200.40) establishes authorities and assigns responsibilities with respect to these IA objectives.

7.9.2 IA Defense-in-Depth Implementation

To ensure a consistent "Defense-in-Depth" implementation across component systems of the GIG, IA architectural concepts must ultimately be translated into specific architecture guidance, IA standards and protocols, technical requirements, and policy. This applies to existing, emerging, and future system development efforts such as the Joint

Tactical Radio System (JTRS), Warfighter Information Network-Tactical (WIN-T), GIG Bandwidth Expansion (GIG-BE), Intelligence Community System for Information Sharing (ICSIS), Transformational Communications (TC), and other programs supporting the GIG vision.

The implementation must allow both human users of the GIG, and automated services acting on behalf of GIG users, to access information and services ubiquitously, based on need and capability. Information must be labeled and also cataloged using metadata allowing users to search and retrieve the information required fulfilling their mission under a "smart-pull" and information management model. This requires the GIG to know where the information is posted and to recognize who you are, regardless of location.

System access will be available regardless of location. However, access to information will be restricted based on the threat inherent to that location. IA will enforce user privileges and access to the information in addition to providing mechanisms so that the information can be trusted as coming from its claimed source. These mechanisms will also ensure that information is unaltered during processing, storage, and transport.

Ultimately, the GIG must enhance the capability to collect, process, and disseminate an uninterrupted flow of information-a Net-Centric approach-while inhibiting or denying an adversary's ability to do the same.

Figure 7.16 shows key milestones for the GIG Information Assurance Portfolio (GIAP), while Figure 7.17 describes the objectives of GIAP programs and initiatives.

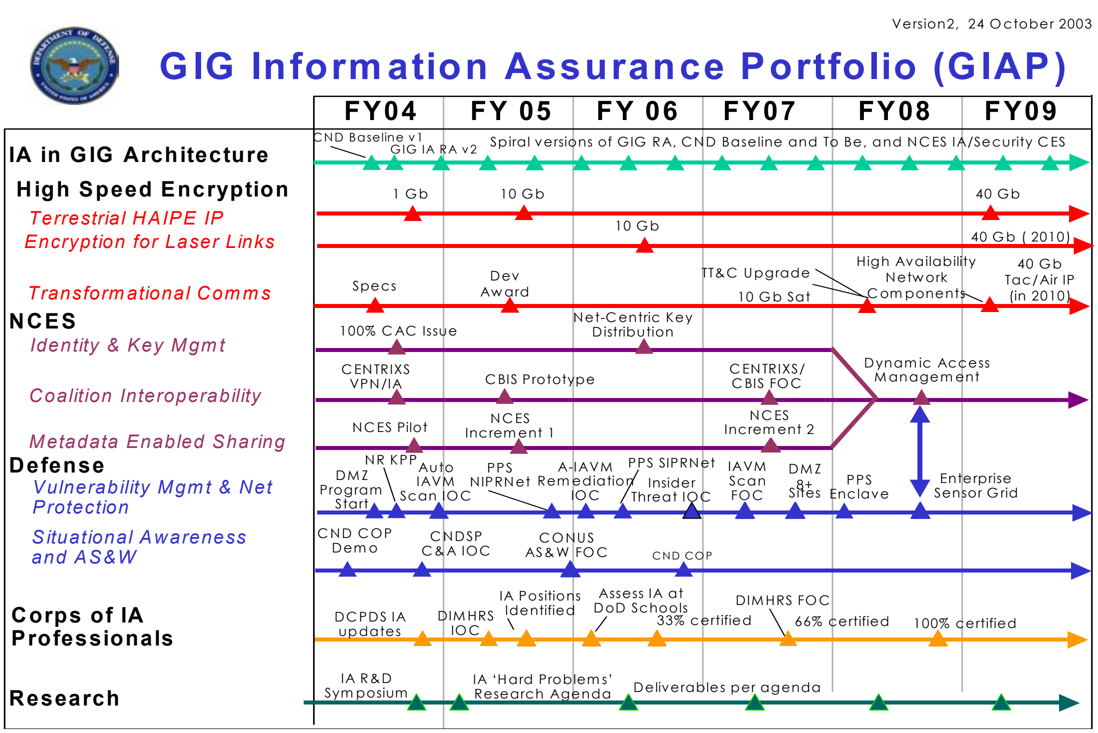


Figure 7.16—GIG IA Schedule

Table 7.1—GIG IA Objectives

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.

8.0 DOTMLPF Strategy for JBMC2

The vision of Joint Battle Management Command and Control (JBMC2) is the exercise of authority and direction by a properly designated joint force commander or component commander over assigned and attached forces in the accomplishment of missions at the operational and tactical levels of command, including interface with the strategic level, in joint, allied/coalition, or interagency operations. C2 functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in the planning, directing, coordinating, and controlling of forces and operations in the accomplishment of the mission.

Since the U.S. military fights as a joint team, dynamically reconfigurable to meet the demands of a wide spectrum of missions and unpredictable threats, all C2 capabilities are inherently joint. Therefore the development of Joint Mission Threads (JMTs) and the associated DOTLPF management functions extends to all Service, Agency, and SOCOM C2 capabilities and programs. The JMTs then support the vision of JBMC2 to provide a fully integrated capability to exercise operational- and tactical-level C2 that

- Ensures common shared situational awareness
- Ensures decision superiority through speed of command and self-synchronization of lower echelon forces when appropriate
- Supports coherent distributed and dispersed operations, including forced entry into antiaccess or area-denial environments
- Enables more agile and lethal joint operations with lower risk to friendly forces.

The JBMC2 Roadmap DOTMLPF (doctrine, organization, training, materiel, leadership, personnel, and facilities) approach will be the mechanism by which USJFCOM manages and coordinates with the FCBs, AT&L, the Joint Staff, Services, and Agencies.

The approach outlines the evolution, guides the conduct of capability assessments, and provides structure for systems development and the information required for development of trade space assessments. These assessments are necessary for senior leaders to make decisions requiring the alignment of investment plans and resources as directed in both MID 912 and the USD AT&L JBMC2 Roadmap Memorandum dated 09 June 2003. USJFCOM and USD(AT&L) will coordinate to define DOTMLPF objectives and develop an actionable, mission thread–based strategy

8.1 Scope

The DOTMLPF approach will, through the use of JMTs (as defined in Section 2), identify common processes and procedures for the execution of capabilities required as defined by the Combatant Commanders via the Joint Capabilities Integration and Development System (JCIDS). The DOTMLPF construct consists of certain products and services:

- *Doctrine* products include doctrine publications; tactics, techniques, and procedures (TTPs); operating procedures; regulations; checklists; or policy that governs or guides the way the military conducts business.

- *Organization* products and services include actual organizations needed to conduct an operation or business, the visual representation of those organizations, organizational characteristics, and opportunities and challenges in utilizing them to perform an operation or conduct business.

- *Training* products and services include training content and all methods of delivering that content to its intended audience, which enables performance and support of the mission.

- *Material* products traditionally have been associated with the defense acquisition process and include weapons, platforms, communication equipment, medical equipment, transportation, and training software. Even though materiel may be used to directly perform a mission, it may also support another DOTLPF component that supports the mission—especially facilities and training.

- From a requirements perspective, *leadership* deals with management and implementation of change across the DOTMLPF spectrum.

- The *personnel* component of DOTMLPF primarily ensures that qualified personnel are there to support a capability. This includes identification of the knowledge, skills, abilities, and competencies needed to perform a position, job, or task. It involves creation of new occupational specialties to support new missions, threats, and technologies and revision of those specialties over a period of time.

- Facilities products and services include supplies, engineering support, and much of what is currently associated with logistics, including buildings, roads, runways, and infrastructure and the activities it takes to build and maintain them to support performance of operations.

An important catalyst for transforming military capability is the development of joint concepts and supporting experimentation that accounts not only for materiel solutions but treats DOTMLPF considerations as well. As the JBMC2 operational concept, architecture and JMTs are developed, consideration will be given to the impact of JBMC2 across the spectrum of DOTMLPF. An assessment of the required changes to TTP, doctrine, training and training pipelines, manning, and organization to support the JMTs 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 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 programs of record? What programs of record should the functionalities be transitioned to?
    - 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?

8.2 Purpose

The DOTMLPF approach will employ concept-driven, capability-based assessments to de-conflict current and prospective JBMC2 capabilities and initiatives. It will identify milestones for CONOPS development for JBMC2, identify gaps and shortfalls in the current architecture based on OIF Lessons Learned, assign actions to synchronize divergent solutions, and, where possible, introduce solutions into the JBMC2 strategy. The DOTMLPF approach will also address the integrated architecture development process, implementation of "Net-Centricity," execution of key JBMC2 initiatives in MID 912, migration of key programs to JBMC2, and phasing out select legacy systems by 2008. The approach will be developed incrementally to encompass the following JMTs:

- Joint Task Force Command and Control
- Joint Close Air Support
- Time-Sensitive Targeting
- Integrated Air and Missile Defense
- Integrated Fire Control
- Joint Ground Maneuver
- Focused Logistics.

The DOTMLPF approach will synchronize and align existing DoD-wide JBMC2 community objectives, including

- Office of Force Transformation vision
- Operation Iraqi Freedom Lessons Learned
- USJFCOM vision
- USD AT&L vision
- JCS J2/J6 vision
- ASD(NII) vision
- Service and Agency vision and investment strategies.

8.3 Approach

Specific analysis and assessment techniques and procedures will be described in more detail in the associated annex.

8.3.1 JBMC2 Capability Definition

Joint Mission Threads are being developed to describe the warfighting processes that the Joint Commander will execute as part of operations in his AOR. These threads detail the specific capabilities and TTP for each of the various missions. The JMTs are derived from the Joint Functional Concepts and carry the attributes dictated by those concepts. They will be developed by a team consisting of Service and COCOM Subject Matter Experts, with coordinating members from USJFCOM, USD AT&L, and the appropriate FCB. The threads, however, are designed to describe in greater detail the specific goals of high priority, stressing missions within the Functional Concepts that will allow specific conditions, standards, and procedures to be described. Where possible, these Threads will inherit the MOEs and MOPs developed in the Enhanced Planning Process studies, as well as Capability Needs described in the RCC's OPLANs.

To allow comparison across the JMTs, a common lexicon for defining the top-level tasks within the threads will be adopted. As assessments are conducted against each thread, the resulting recommendations and findings will be binned under these top-level tasks to allow comparison to recommendations from other JMTs. Prior to finalizing any recommendations, a trade space assessment of each top-level activity will be completed to ensure that the recommendations across the JMTs are consistent and complimentary. Examples of these are structures are below. The actual binning structure used will be coordinated with the JCIDS process:

- Monitor, Assess, Plan, Execute, Sustain (MAPES)

- Observe, Orient, Decide, Act (OODA).

To provide the warfighter with an understanding of the impact of changes proposed in the JMTs, an operational context will be selected. Selection of the scenarios and operational themes against which the JMTs will be assessed will be aligned with the studies being conducted in the JCIDS process. For FY 2004, Joint Forcible Entry Operations (JFEO) will provide the backdrop. The military utility of the changes recommended will be described in terms of the impact on JFEO. Where Net-Centric concepts have not yet been developed, recommendations will include assessments on the benefits of changes to the broader concepts that would be realized from achieving Net-Centricity.

8.3.2 DOTLPF and Engineering Assessments

Three coordinated teams will develop the Roadmap and associated assessments:

- JBMC2 Roadmap Sustainment Team (USD AT&L/USJFCOM)
- JBMC2 Engineering Team (USJFCOM w/ FIOP Core)
- Joint DOTLPF Assessment Team (USJFCOM).

The teams will be:

- *JBMC2 Roadmap Sustainment Team*: Responsible for incorporating assessments into Roadmap revisions. The team will align the language and findings across the assessments and develop the overall strategy and program scope.

- *JBMC2 Engineering Team*: Responsible for Picture coordination and integration, overseeing accomplishment of joint interoperability requirements, and material and systems engineering assessments of JBMC2 programs in support of Joint Mission Thread Capability Area Defense Acquisition Boards (DABs).

- *Joint DOTLPF Assessment Team*: Responsible for assessing the DOTLPF impacts associated with changes to JBMC2 family of systems in the context of the Joint Mission Threads. The team will develop, monitor, and assess mission thread product requirements and timelines; describe Joint Capability Objectives; perform gap analysis; make recommendations on appropriate adjustments to sustain timely implementation of mission thread evolution; and maintain the current status of the threads in a web-based Roadmap management tool.

As the three teams are stood up, they will develop detailed descriptions of the processes, tools, and approaches that will be taken to support the assessments. The approaches will be coordinated across the teams, with USJFCOM providing the interface.

Each thread will be assigned to a directorate within USJFCOM, with cross-thread coordination being the responsibility of USJFCOM J8. The coordination will be done formally at the beginning of each assessment period by determining areas of focus and assigning a coordination lead through whom all draft recommendations will be routed. The coordination lead will identify any activities in which overlapping recommendations are being developed and direct that the teams developing the recommendations synchronize their course of action development. In cases in which the teams are unable to come to agreement, USJFCOM J8 will determine which course of actions will be taken forward.

Assessments will be ongoing, and each JMT will be supported by a Thread Management Team (TMT) consisting of appropriate members of each team along with C/S/A representatives as assigned by their respective organizations. The TMT will be responsible for focusing the assessments on those activities that address the highest priority operational concerns of the RCCs based on Lessons Learned and direct C/S/A input. This focus is necessary to ensure that assessment resources, and senior leadership decision space is concentrated on gaps and overlaps where the greatest impact to the warfighter will be realized.

8.3.3 Course of Action Approval

As each JMT assessment is completed, a set of draft recommendations will be developed. These recommendations will be synchronized across the material and nonmaterial spectrum by the USJFCOM Directorate responsible for the thread. The combined set of recommendations will then be scheduled for briefing to the JBMC2 Mini-BoD for initial vetting. The Mini-BoD will review and nominate courses of action to the JBMC2 BoD. The recommendations will also be informally vetted through the appropriate FCB by the JCS representative who participated in the development of the recommendations. The JBMC2 BoD will review inputs from the Mini-BoD and the FCB in order to approve a JMT assessment to move forward to the Capability Area DAB.

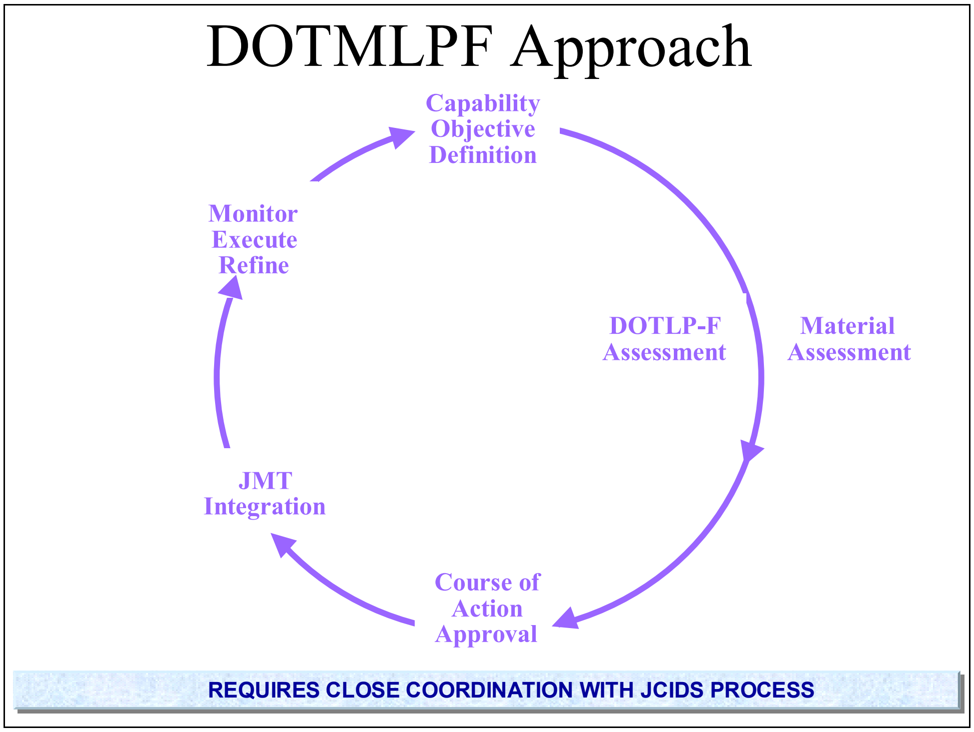


Figure 8.1—DOTMLPF Approach

8.3.4 JMT Integration

As described above, the completed JMT assessments will be integrated and synchronized prior to final determination at the CA CDAB. This integration is the responsibility of USJFCOM J8 and will be accomplished by means of Quarterly Integration Boards (QIBs). A team at USJFCOM will be assigned to prepare decision briefings for any course of action recommendations that require synchronization. Members from the appropriate assessment team will participate in the QIB to brief the reasoning behind the specific recommendation, and the QIB members will determine any changes to the recommendations that are needed to synchronize the JMTs. The results of the QIB will be briefed at the JBMC2 BoD and CA CDAB to allow Senior Leadership visibility into any cross JMT issues that may require suboptimization in a given thread in order to achieve overarching Integration and Interoperability goals.

8.3.5 Ongoing Assessment

As initial assessments are completed, the DOTLPF Team and JBMC2ET will identify exercise, experimentation, and operational venues from which data can be gathered to assist with monitoring the progress toward achieving the Capability Objectives as the Roadmap plan is executed. The data gathered will be used to inform and shape the ongoing assessments and to refine and adjust the Capability Objectives and JMTs to reflect changes in the Department's mission. Further, the information, along with status of actions that are assigned in the Roadmap, will be posted weekly to the Roadmap Management Tool so that the community of interest associated with each thread can collaboratively participate in the management of the JMTs. As an example, the fishbone chart for JCAS, the first mission thread that will go before a Capability Area DAB, is represented below (figure is notional). The process for developing and maturing the mission threads continues. The next joint mission thread to be developed is Joint Task Force Command and Control (JTFC2). The DOTMLPF functions as described above populate the ribs of a fishbone chart and provide the information required to manage multiple threads simultaneously and integrate functions across capabilities.

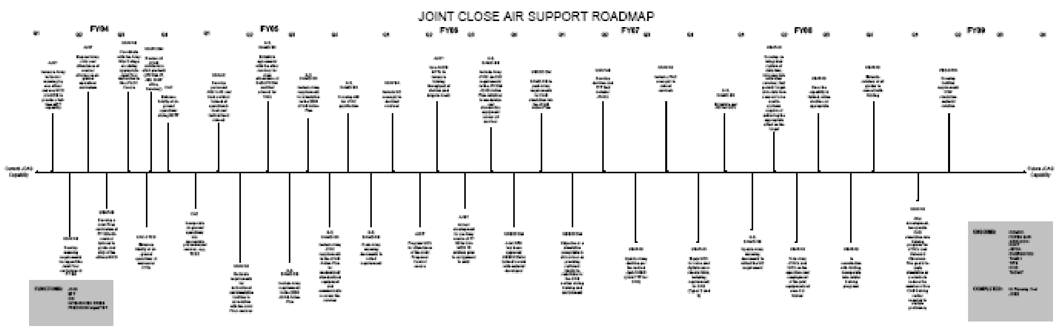


Figure 8.2—Fishbone Chart for JCAS (Notional)

Joint Forces Command anticipates this thread will be developed, staffed, and assessed for incorporation into the next version of the Roadmap, with other threads being developed as quickly as possible.

9.0 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 FCBs to identify areas where ACTDs could lead to potentially important new JBMC2 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 FY 2005 start is depicted in Figure 9.1.

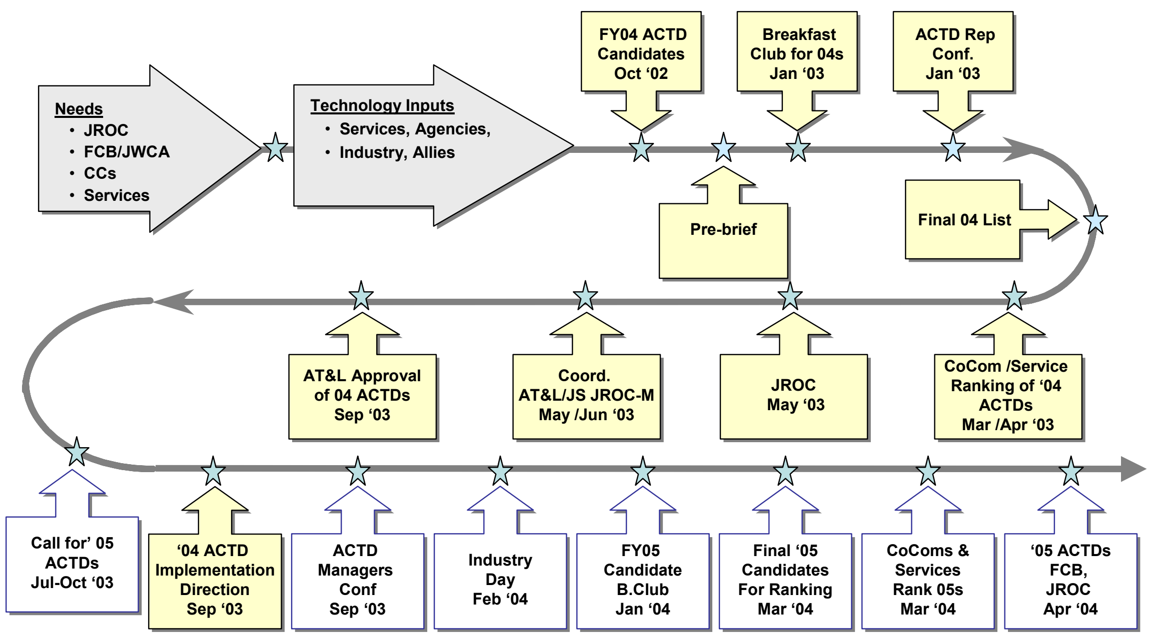


Figure 9.1—ACTD Selection Process and Timeline

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

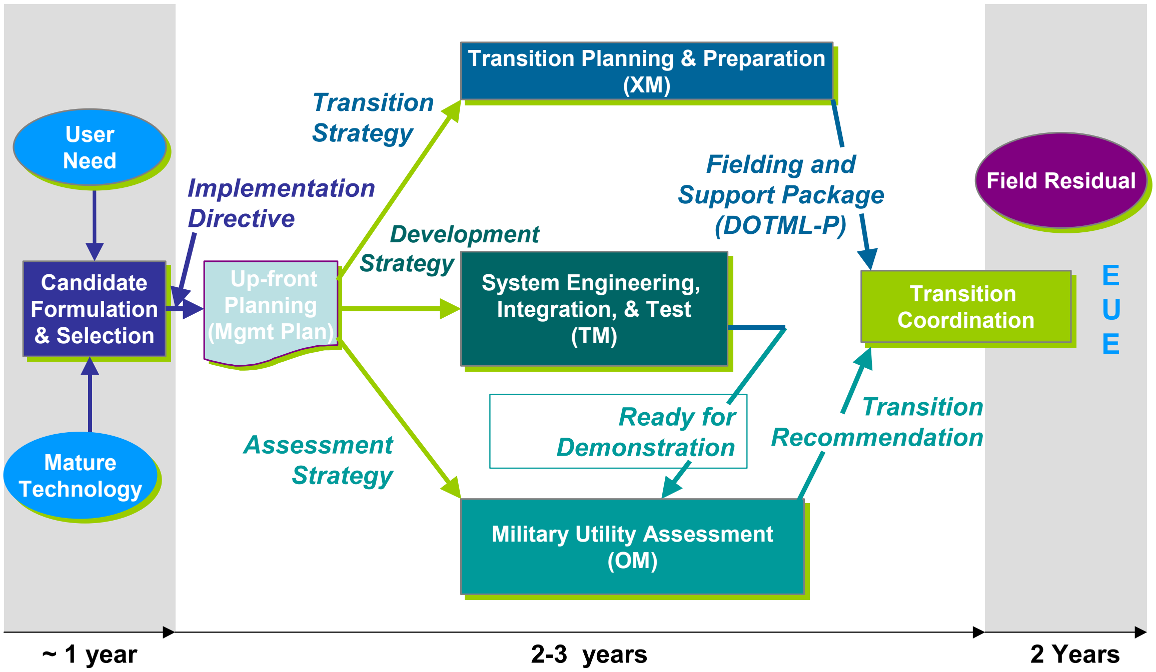


Figure 9.2—ACTD Process

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. 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. USJFCOM 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 9.3 shows the ACTDs ongoing or recently completed as of October 2003, 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."

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

USJFCOM has developed a new joint training strategy to address joint interoperability training. In response to DoD tasking, USJFCOM proposed the concept of the Joint National Training Capability (JNTC). The JNTC achieved initial operational capability in FY 2004 and expects full operational capability by FY 2009. The 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 1) a globally networked training environment, seamlessly linking ranges and simulation centers, 2) an adaptive and credible opposing force and a JTF functional headquarters, 3) ability to continuously assess interoperability performance in the field for common ground truth, and 4) ability to accommodate interagency and coalition requirements, the JNTC underpins a global, information age joint national training capability that advances DoD transformation efforts. The 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 USJFCOM-assigned forces, including USJFCOM 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. The plan has a fourfold purpose: 1) to field the SJFHQ, 2) deliver rapid prototyping of capabilities to improve joint warfighting now, 3) provide actionable recommendations based on the results of experiments to facilitate informed choices on future investments, and 4) and include Combatant Commands, Services, defense agencies and multinational partners in the experimentation process. To execute this plan USJFCOM will follow two paths; the joint prototype path and the joint concept path. The joint prototype path is designed to improve current warfighting capabilities while the joint concept development path pursues new concepts for improving future military operations. Products include prototype capabilities, joint concepts, and actionable recommendations for further joint experimentation and a description of how USJFCOM develops concepts assigned by the Chairman, Joint Chiefs of Staff to include the Joint Operations Concepts, Joint Operating Concepts, and functional and enabling concepts.

To improve near-term warfighting capabilities, the campaign pursues a strategy of rapid prototyping. This strategy takes new ideas or concepts that originate from joint concept development and converts them into physical form, as prototypes. From there, these prototypes are put into the hands of those who execute military operations as quickly as possible. Current approved prototypes include:

- Standing Joint Force HQ: A standing joint command and control element.
- Collaborative Information Environment: A tool and process that provides common situation awareness, understanding, and collaborative workspace for decision makers and staffs without today's time and space limitations.
- Operational Net Assessment: A product, process, and organization all focused upon understanding the operational environment as well as the effects of friendly actions.
- Effects-based Operations: A method of planning, preparing, and executing operations in which the focus is on achieving common effects on adversaries.
- Joint Interagency Coordination Group: An advisory element on the Commander's staff that facilitates information sharing and coordinated action across the interagency community.
- Joint fires Initiative: Processes and tools that improve the Joint Force's capability to apply fires from any force in support of any other.
- Joint Logistics (Common Relevant Operating Picture): A tool that addresses the deployment, employment, and sustainment for a coherently joint and multinational force.

Concepts are generated through a series of wargames and experiments in collaboration with the Services, Combatant Commanders, Joint Staff, defense agencies and multinational peers. As new ideas or concepts emerge, they are refined through an experimentation process that begins by testing hypotheses and ends with a demonstrated capability. Joint concept experimentation uses four common scenarios that reflect current and future threats based on geopolitical and military realities: 1) Major Combat Operations against an adversary with a global WMD threat and robust regional anti-access capability, 2) joint operations in urban environment, 3) operations against a non-state actor with significant regional combat capability, access to WME, and ties to global terrorist organizations, and 4) operations in a faltering or failing state that has regional WMD/WME capability. These scenarios encompass most of the range of military operations and contain a variety of adversaries from conventional enemies to adversaries who operate in the cusp between military combat and criminal activity. They are specifically designed to maintain consistency and correlation with defense planning scenarios, observe classification guidance, yet permit multi-national participation in experimentation. These approved scenarios are conditions in which major military challenges are investigated with the following experimental focus:

- Achieving decision superiority: generating and sustaining high-quality, shared situation understanding

- Creating coherent effects (lethal and nonlethal, kinetic and nonkinetic): harmonizing military (conventional and special operations), interagency, and multinational activities at the strategic, operational and tactical levels against any type of adversary

- Conducting and supporting distributed operations: planning, preparing, and executing (deploy, fight, command and control, and sustain) simultaneously in multiple theaters and widely distributed points of action within each theater

The Joint Operations Concepts and its associated family of concepts is a main output of concept development experimentation. Based on how these concepts perform, recommendations are provided as input to decisions on how to invest military resources. Concepts that meet certain requirements are eventually handed off to teams of specialists who convert them to prototypes. The concept development path creates a set of venues in which those concepts can be explored, examined, and refined.

A representative list of Joint Concept Development and Experimentation Campaign Plan events for JBMC2 activities are shown in Figure 9.4.

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). Subsequent versions of this Roadmap will discuss methods and timely decision points for identifying successful prototypes and planning transition to PORs.

9.4 Modular Open Systems Approach

A Modular Open Systems Approach (MOSA) is an integrated business and technical strategy that employs a modular design and, where appropriate, defines key interfaces using widely supported, consensus-based standards that are published and maintained by a recognized industrial standards organization. MOSA is an effective means toward providing joint combat capabilities required for 21st century warfare, and supporting these evolving capabilities over their total life-cycle. MOSA is both a business and technical strategy for developing a new system or modernizing an existing one. As a business strategy, it enables program teams to build, upgrade and support systems more quickly and affordably. These benefits may be realized by leveraging the commercial sector investment in new technology through the use of corresponding commercial products available from multiple sources. As a technical strategy, MOSA is focused on a system design that is modular, has well defined interfaces, is designed for change and, to the extent possible, utilizes widely supported industry standards for key interfaces.

The JBMC2 capabilities are among the specific acquisition objectives, operational capabilities, and performance requirements that lend themselves to the use of MOSA. The

JBMC2 System Engineering Advisory and Working Groups should oversee the MOSA implementation in various JBMC2 programs. The program offices should establish a tailored strategy for implementing MOSA, identify specific JBMC2 acquisition objectives and operational capabilities that lend themselves to the use of open systems, gather and analyze lessons learned by other programs, and analyze market research findings to evaluate commercial sector solutions and availability of standards needed for information exchange and integration of JBMC2 capabilities.

MOSA is an effective enabler for developing affordable and sustainable JBMC2 capabilities. The following JBMC2 characteristics make MOSA a suitable strategy for developing and sustaining JBMC2 capabilities:

1. The JBMC2 capabilities and requirements are specified in an incremental manner over time and must follow evolutionary acquisition and spiral development strategies that are enabled by MOSA.
2. The JBMC2 requirements place great emphasis on affordability, adaptability, and long-term sustainment that necessitate MOSA implementation.
3. Effective JBMC2 is dependent upon the ability to constitute and readily integrate functionally compatible forces and systems that require modular and flexible architectures.
4. Seamless, high speed, and digital information exchange among diverse pictures and systems comprising JBMC2 capabilities are effectively enabled by use of MOSA. The heavy reliance of the JBMC2 capability on digitized battlefield conditions, and ability to receive and disseminate command and control data in real time demands robust and open architectures.
5. Reprogramming of JBMC2 software modules and communication networks demand commonality of hardware and emphasis on software reuse that are effectively enabled by modular open systems.
6. Fulfillment of the growing JBMC2 capabilities and performance characteristics will be highly dependent on continuous use of emerging technologies such as computer, communication, surveillance, and navigation technologies. It also demands the application of an integrated approach for adding and incorporating future capabilities and advanced technologies with minimum impact on existing systems. MOSA can effectively facilitate the fulfillment of these requirements.
7. Continuing sustainment of the JBMC2 capabilities requires mitigation of the risks associated with being captive to specific products or sources. Such risks are effectively managed by MOSA.
8. The JBMC2 capabilities are interoperable joint solutions that necessitate development of integrated architectures that must comply with open standards across different platforms and Services.

9. Real-time shared situational awareness at the tactical level and common shared situational awareness at the operational level demand standardization of interfaces, data, and metadata formats.

The realization of MOSA benefits is dependent on adherence to three major principles, namely; employment of modular design, designation of key interfaces, and use of open standards for key interfaces, where appropriate. These principles lay the foundation for identification of a set of indicators that could be used by acquisition executives and program managers to assess the progress of implementing MOSA in JBMC2 programs.

Principle 1: Employ Modular Design

Partitioning the JBMC2 systems appropriately during the design process to isolate functionality makes the systems easier to develop, maintain, and modify or upgrade. It also allows for expansion of capability and functional reconfiguration of JBMC2 systems through the incorporation of replaceable modules. Moreover, the JBMC2 systems must be designed for modularity so that functions that change rapidly or evolve over time can be upgraded and changed with minor impact to the remainder components of the systems. This capability is realized when the overall JBMC2 design process starts with modularity and future evolution as an objective.

The JBMC2 System Engineering Advisory and Working Groups should place adequate emphasis on modularity principles (maximal cohesiveness of the functions and minimal coupling among elements) to convert functional architectures to design architectures, and the design architectures into an integrated network of open architectures. They need to group and regroup systems and components that perform a single independent JBMC2 function or single logical task into modules. They must then use desirable attributes such as low coupling, high binding (cohesion), and low connectivity to do the grouping required for modularity. Decoupling modules eases JBMC2 development risks and makes future modifications easier. High binding (similarity of tasks performed within the modules) allows for use of identical or like components or for use of a single component to perform multiple JBMC2 functions. Low connectivity (relationship among internal elements of one module to those of another module) is desirable because it reduces JBMC2 design and test complexity.

Modular design of JBMC2 should be characterized by the following:

- JBMC2 system of systems should be functionally partitioned into discrete scalable, reusable modules consisting of isolated, self-contained functional systems. The process then proceeds to decomposing higher-level JBMC2 functions (e.g., real-time shared situational awareness) into lower-level functions, identifying interfaces (e.g., internal and external), and finally to allocating performance from higher to lower-level functions. This process is repeated to define successively lower level JBMC2 functional and performance requirements, thus defining JBMC2 network of modular architectures at ever-increasing levels of detail.

- Modular interfaces and object oriented descriptions of JBMC2 modules' functionality should be rigorously defined so that designers of individual modules can do their work independently. Under the ideal situation, multiple product choices may become available that can be inserted with minimal integration complexity.

- JBMC2 systems should be decoupled and encapsulated for ease of change to achieve technology transparency and, to the largest extent possible, make use of commonly used industry standards for key interfaces. Such standards enable access to multiple sources of supply for commercially available software and hardware products needed for development of JBMC2 capabilities.

Principle 2: Designate Key interfaces

MOSA manages the interfaces by grouping them into key and non-key interfaces. Key interfaces are interfaces for which the preferred implementation uses an open standard to design the system for affordable change, ease of integration, interoperability, commonality, reuse or other essential considerations such as criticality of function. Such discrimination distinguishes among interfaces that are between technologically stable and volatile modules, between highly reliable and more frequently failing modules, and between modules with least interoperability impact and those that pass vital interoperability information.

The JBMC2 System Engineering Advisory and Working Groups should oversee the evaluation of the JBMC2 system modules using the characteristics listed above to designate an interface as a key interface. They should ensure that the program offices recursively apply the evaluation characteristics to the top-level design components/modules and their sub-modules until all key interfaces are designated. The Advisory and Working Groups should also determine the level of implementation (e.g., subsystem, system, system-of-systems) at and above which they aspire to maintain control over the key JBMC2 interfaces and would like these interfaces to be defined by widely supported and consensus based standards. To establish the desired level of control, they must review the results of market analysis on the availability of open standards for selected key interfaces and assess the impact of a chosen level of control on long-term viability and affordability of the JBMC2 system. Defining the level of interface control too low may limit efficient technology insertion, while defining the level too high may lead to the use of proprietary interfaces for major system components resulting in limited supplier support.

The JBMC2 System Engineering Advisory and Working Groups should also oversee the JBMC2 programs use of business case analysis models to justify the use of open standards for key interfaces at desired levels of implementation. Program offices may use Work Breakdown Structures developed from the design architecture or a reference model to designate key interfaces. Reference models provide a high-level view of the system modularity and the interfaces between those modules, and as such are perhaps the best means for designating key interfaces. They provide a high level, generalized view of a system, FoS or SoS and establish a context for understanding how disparate technologies and standards relate to each other. They also embody the earliest set of design decisions about the system. These program decisions are the most difficult to get right, the hardest ones to change and have the most far-reaching effects on downstream JBMC2 capabilities.

Principle 3: Use Open Standards

Interface standards specify the physical, functional, and operational relationships between the various systems or elements (hardware and software) of JBMC2 system of systems. They permit interchangeability, interconnection, compatibility and/or communication, and improve logistics support for the overall JBMC2 system of systems. The selection of the appropriate standards for key interfaces used in the JBMC2 system of systems should be based on sound market research of available standards and the application of a disciplined and standardized systems engineering processes. To take full advantage of modularity in design, interface standards must be well defined, mature, widely used, and readily available. In general, popular open standards yield the most benefit to the JBMC2 SoS in terms of ease of future changes to the comprising systems and should be the standards of choice. However, there are situations where proprietary standards are the correct choice.

JBMC2 standards should be selected based on maturity, market acceptance, and allowance for future technology insertion. As a general rule, preference is given to the use of open interface standards first, the de facto interface standards second, and finally government and proprietary interface standards. Open standards allow JBMC2 programs to leverage commercially funded or developed technologies and to take advantage of increased competition. They also allow faster upgrade of systems with less complexity and cost.

For legacy systems, the focus will be on gathering information on the existing or as-built designs, and performing the essential modular partitioning and mapping of services and interfaces to known functions and capabilities. To assess the appropriateness of a modular standards-based architecture, several items such as design specifications, interface control documents, functional specifications, and known standards profiles for an existing system may be reviewed. Knowledge of the respective battlespace views, and the Net-Centric Underpinnings to JBMC2 systems that must be interfaced are among the other essential information that can be derived from existing requirement or capability development documents. The JBMC2 System Engineering Advisory and Working Groups should also oversee the prototyping of the JBMC2 systems, subsystems, and components to demonstrate the integration of the systems using the proposed modular decomposition. They should also oversee the use prototypes to demonstrate standards and standards-compliant products to demonstrate that potential interface standards and specifications will achieve the required JBMC2 capabilities.

10.0 Joint System-of-Systems Development Testing and Operational Testing and Evaluation

10.1 Overview

This section addresses both joint Development Testing and Evaluation (DT&E) and joint Operational Testing and Evaluation (OT&E) of JBMC2 systems in support of Joint Mission Threads (JMTs). The section defines a high-level joint DT&E/OT&E schedule of incremental capabilities-based system-of-systems interoperability and net-centricity testing, answering questions such as "Can this set of interoperating systems perform a specified joint mission, meeting specific measure of effectiveness (MOE)/measure of performance (MOP) criteria?" Previous sections of the JBMC2 Roadmap have identified joint mission threads (JMTs) and essential JMT data interoperability. Figure 10.1 illustrates the relationship between the previous sections and this section. This section identifies venues that can expose and identify interoperability, net-centricity, and capability shortfalls in the JBMC2 systems enabling JMTs, as well as quantify improvements as JBMC2 systems evolve. The JBMC2 joint DT&E/OT&E processes are consistent with, and have clear links to, established methods of defining and improving systems performance and interoperability, namely the Joint Capabilities Integration and Development System (JCIDS); the Planning, Programming, Budgeting, and Execution (PPBE) process; and the Defense Acquisition System. JBMC2 Roadmap joint DT&E/OT&E is consistent with Strategic Planning Guidance (SPG) 2003 transformation of test and evaluation and other jointness initiatives and interoperability goals. The organization roles and responsibilities necessary to manage and execute JBMC2 systems joint DT&E/OT&E are identified.

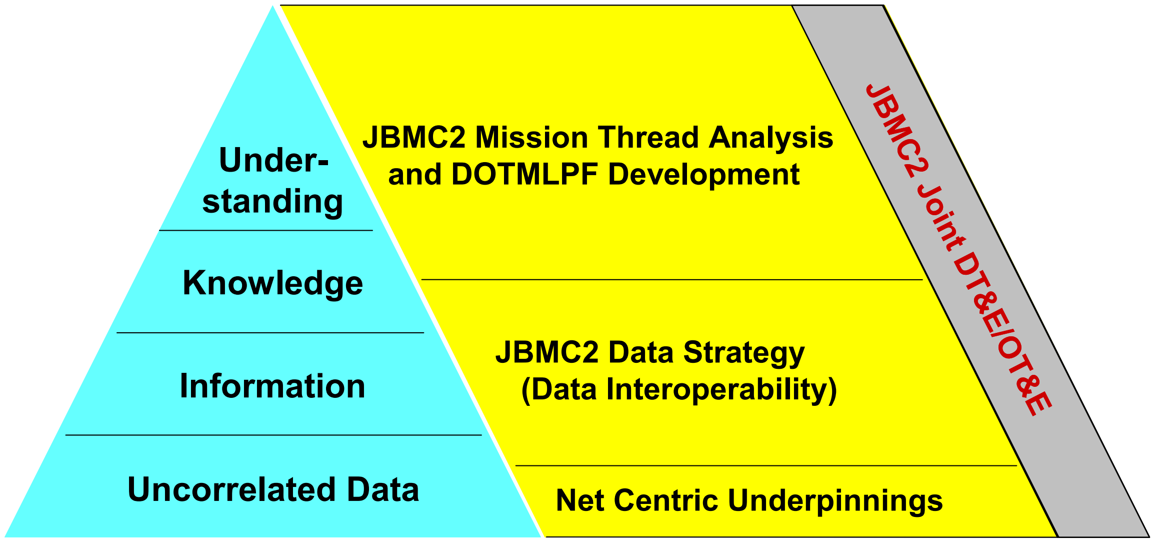


Figure 10.1—JBMC2 T&E in the Context of Other JBMC2 Roadmap Areas

A few words about terminology are essential at the start of this section. Hereafter, the phrase "JBMC2 T&E" will mean "JBMC2 Roadmap joint DT&E/OT&E". A system of systems (SoS) is a group of individual systems designed and developed to be interoperable and execute specified functions on a continuing basis. That is, some functions may not be executable without all members of the SoS. A family of systems (FoS) is defined as a set of individual but related systems that execute a common, required capability. An FoS is more loosely coupled than an SoS and, if not well managed, may exhibit only partial interoperability. On the other hand, the required capability can be sufficiently executable with a subset of the FoS. A SoS may be included in an FoS for specific purposes in the JBMC2 environment. A subset of JBMC2 systems contributing to a specific JMT will be called a *test cluster*. A test cluster may consist of FoS only, SoS only, or a mixture of both.

10.2 JBMC2 T&E Strategy

The five core elements of the JBMC2 T&E strategy are presented below.

JBMC2 T&E Joint Testing Environment.JBMC2 T&E will facilitate assessment of materiel and nonmateriel aspects of FoS/SoS integration, interoperability, and information assurance using a *joint testing environment* comprising the Joint Distributed Engineering Plant (JDEP), Joint National Training Capability (JNTC), Distributed Continuous Experimentation Environment (DCEE), Interoperability Technology

Demonstration Center (ITDC), and other venues.[31] Through development of testing assets and processes as described in this section, the joint test environment will provide for adequate, realistic test and evaluation conducted in an environment appropriate to the maturity of the test clusters involved. The joint testing environment will be an appropriate mix of live, virtual, and constructive (LVC) assets assembled to demonstrate cluster performance within the context of mission accomplishment, using codified mission essential tasks and designed functionality. Testing in a joint environment is not unique to a single service and does not preclude single-Service T&E. Joint testing must evaluate system performance in the joint environment, system contribution to the JMT, and overall effectiveness of the JMT (i.e., MOEs and MOPs for JMT).

Range of Interoperability Issues for T&E. JBMC2 T&E will address currently identified, and future potential, interoperability issues. These include addressing and ameliorating the following common barriers to interoperability:

- Low priority for joint and combined interoperability
- Poor implementation synchronization across programs
- Ambiguous or loose military standards (message formats, etc.)
- Incompatible technical approaches or data
- Cultural or process obstacles (e.g., sharing classified information in coalition)
- Subsequent system upgrades applied in uncoordinated, stovepiped fashion
- Lack of a joint system-of systems engineering & integration (SE&I) function.

Relationship of T&E to JBMC2 Systems Engineering. JBMC2 T&E will be conducted in the context of an overarching JBMC2 system engineering methodology. Thus, T&E is based on the rigorous development of JMTs, supporting architectural products, and supporting databases. The JMTs and architectural products define the JMBC2 capabilities and objectives to be tested, thus enabling the critical assessment of performance drivers, integration issues, and interoperability touch points.

JBMC2 T&E is also based on the use of rigorous design of test and test results analyses. Cluster test plans will incorporate statistically designed sets of experiments. Supporting modeling and simulation (M&S) provide the analytical assessments for the expected outcomes of the cluster test experiments, and the understanding as to the expected

[31] Department of Defense, Integrated Interoperability Plan, USJFCOM, 01 OCT 2003, p. ii.

variability in the expected outcomes. Detailed post-test analyses will diagnose how well the cluster meets warfighting capability objectives (as measured in areas such as quality of service and quality of situational awareness information). Further the results of post-test analyses will guide subsequent rounds of experiments – the cluster test plans will be responsive to test results, as opposed to being fixed.

Tools and Technologies Contributing to T&E. JBMC2 interoperability testing will require a number of contributing tools and technologies. Development of these tools and technologies will be based on the priorities identified through the rigorous systems engineering efforts. These efforts will define the processes that need to be in place to construct the combinations of systems, system and battlespace environment simulators, and other tools and technologies needed to carry out cluster interoperability tests. The utilization of JDEP-like assets only supports limited testing.

Evolution of the Joint Testing Environment. The assets of the joint testing environment will need to evolve significantly to support the needed cluster tests. JDEP and similar assets currently support limited testing across a few systems only. The advent of the Global Information Grid (GIG) and common enterprise services makes cluster testing even more complicated when the success will be based on the ensemble of large numbers of systems and networking components at any particular event. Thus, the development and testing of the joint test environment will be as critical as many of the same tests required for DT and OT assessments of JBMC2 programs. To respond to this need, the JBMC2 Roadmap calls for a subsidiary effort to migrate the "as-is" joint testing infrastructure to a new, significantly more capable Joint Testing and M&S Environment. This effort will need to provide testing environment capabilities that will be implemented, tested, and ready to go when full-scale cluster testing begins.

10.3 JBMC2 T&E Goals

The first set of JBMC2 T&E goals are to quantify or otherwise measure the *operational capabilities* and *interoperability* of test clusters. Test clusters—those JBMC2 systems needed to support execution of each of the seven JBMC2 Joint Mission Threads—were discussed in Section 3 of this JBMC2 Roadmap. JBMC2 testing should baseline the ability of each test cluster to support a given mission thread and then conduct periodic re-testing to measure incremental improvements in capability and interoperability. It is important to note that interoperability shortfalls will be highlighted as they contribute to shortfalls in operational capability; interoperability is important only as it improves operational capability, and is not an end in itself (this may change as DoD moves to a net-centric operations and warfare [NCOW] environment, but it is an important resource management principle in today's point-to-point environment).

The second set of JBMC2 T&E goals are to provide for the certification of JBMC2 program clusters as "interoperable" with respect to enabling critical warfighting capabilities (as specified in the JMTs). The resulting certification processes will be much more net-centric and capabilities-focused then current program certification processes.

Current practices are often focused on testing components within a system and between specific communicating systems (point-to-point testing). As an example, Figure 10.2[32] illustrates the Joint Interoperability Test Center (JITC) interoperability certification evaluation plan (ICEP) required for a complex system or FoS/SoS, multiple evaluation events, and/or significant reliance on non-JITC tests.

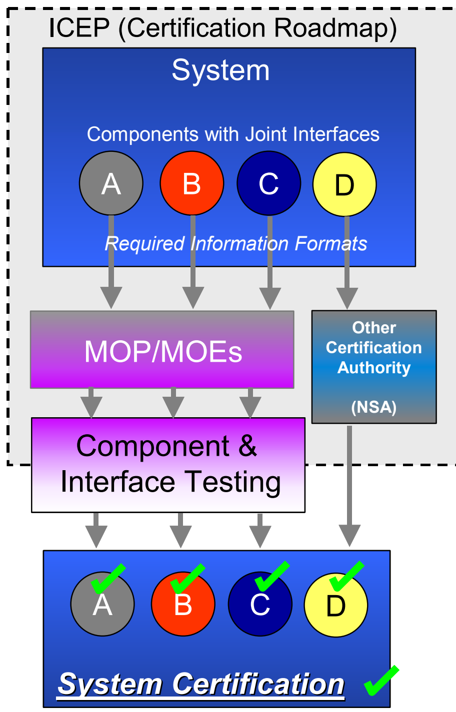


Figure 10.2—JITC ICEP

The ICEP provides an overview of system architecture and supporting information exchange requirements (IERs). It identifies previously certified subsystems and provides an interoperability testing plan to support the system-specific acquisition model. It establishes a data collection and analysis plan to support interoperability testing requirements. The ICEP documents MOEs/MOPs to support testing of IERs (e.g., timeliness, completeness, accuracy) and lists the test events where data can be collected. JBMC2 T&E must utilize similar process steps but do so for systems publishing/discovering/subscribing to data over a

[32] JITC Interoperability Certification Process briefing, Plans and Policies Branch, JITC, July 17, 2003.

distributed communication transport mechanism. Figure 10.3 illustrates one possible interpretation of modifying JITC's ICEP for net-centric systems interoperability testing.

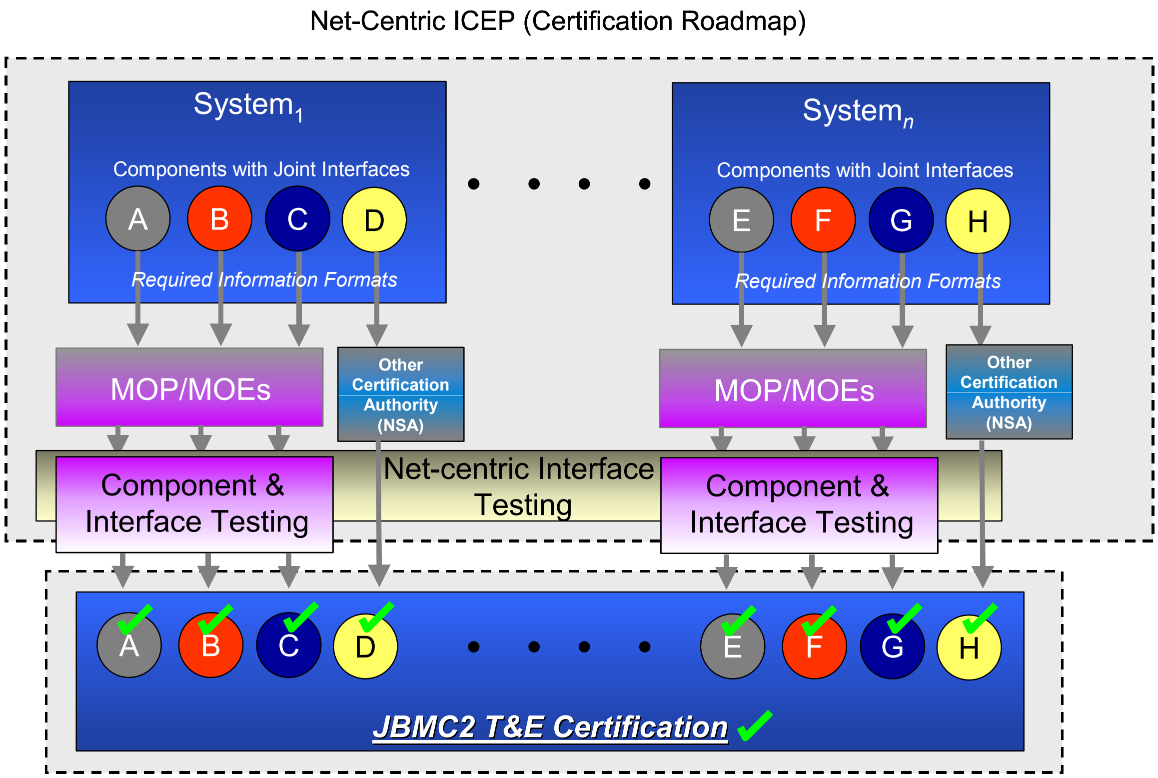


Figure 10.3—A Possible Net-Centric JITC ICEP Interpretation

In Figure 10.3, systems are specifically tested as before and have additional tests for their net readiness KPPs and net-centric interfaces with respect to publish/discover/subscribe against specific MOPs/MOEs for the particular JMT being tested. Note that the result is not specific systems certification but rather capability to support the JMT certification of a test cluster. The remainder of this section will describe details associated with enabling and executing tests that move from a point-to-point to a net-centric test focus.

10.4 JBMC2 T&E Methodology

JBMC2 T&E must be flexible, affordable, and plug-and-play. It should minimize disruption to program schedules. JBMC2 T&E must evolve to a capability that allows insight to performance of individual systems and their contributions to a JMT while they are in development (i.e., prior to Milestone C). These principles point to certain features that will drive JBMC2 T&E execution. JBMC2 T&E must

- Support end-to-end testing of a JBMC2 test clusters (i.e., specific cluster of systems supporting particular JMT operational capabilities)

- Permit systems under test to participate from distributed locations (e.g., contractor facilities, Service test facilities, development facilities)

- Facilitate the capability to test systems in their fielded configuration, linked into an operationally realistic SoS/FoS, and evolve into a capability to include software-based models of systems in development

- Utilize instrumentation adequate to trace capability and interoperability shortfalls to root causes at the individual system level

- Support early testing of groups and subgroups of systems that allows concentrated work on identified problems without involving the entire FoS

- Include live tests of JBMC2 test clusters in joint exercise and JNTC events.

The JBMC2 T&E high-level methodology meets these criteria and allows test and evaluations to “bootstrap.” “Bootstrapping” here means that capabilities-based assessments of JBMC2 test clusters can occur even if there are incomplete or not-yet-certified interoperability key performance parameters (KPPs) and IERs for systems in the JBMC2 test cluster. It is important to note that many of the JBMC2 Pathfinder Programs (those programs most central to providing JBMC2 capabilities across the JMTs) do not, as of this Roadmap version, have certified KPP/IERs (see subsections 10.12 through 10.14 for system details as of March 9, 2004). Figure 10.4 illustrates the DoDI 5000.2 requirements and acquisition process, with which the JBMC2 T&E high-level methodology is consistent.

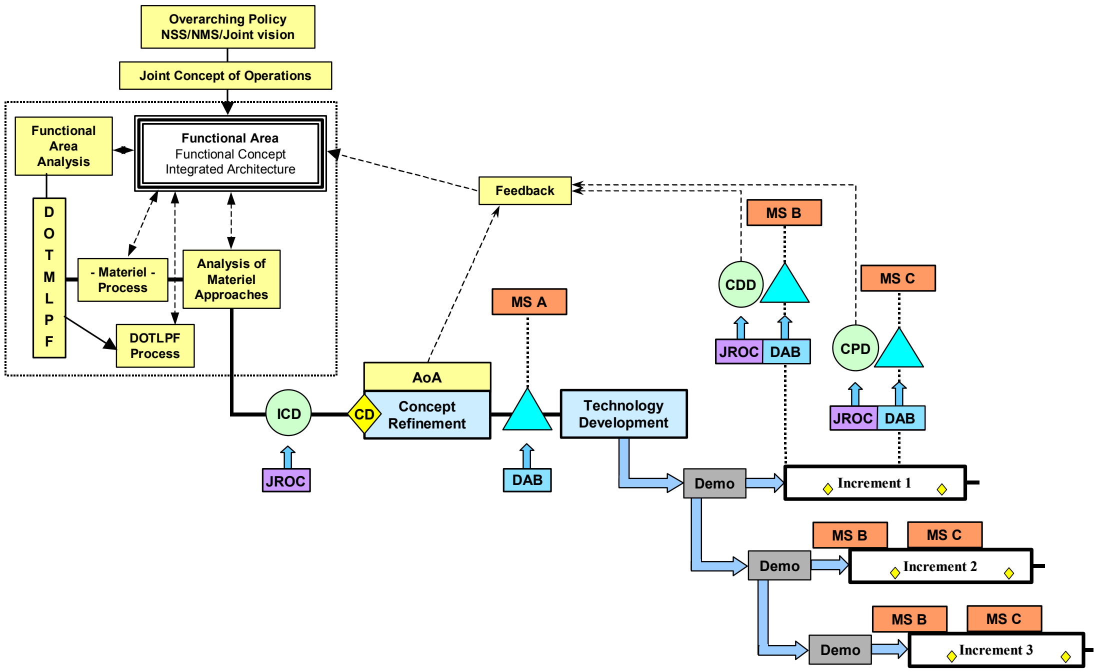


Figure 10.4—DoDI 5000.2 Requirements and Acquisition Process

Detailed JBMC2 T&E methodology must conform to JCIDS and Defense Acquisition Process policy and guidance. For example, each test and evaluation iteration must have detailed specifications, developed by the JMT member systems, defining the T&E environment; user involvement; test events; test plan; requirements for developer test reports; security events and requirements; T&E approval authority; requirements for M&S; and configuration management (CM) requirements for systems, data, tests, and results[33]. These detailed JBMC2 T&E methodology elements are not addressed in this section; they will be defined by JFCOM as part of JMT development.

10.4.1 Initial Test Cluster High-Level Methodology

1. Test Readiness Conditions

- CONOPS and TTPs for a given JMT must be understood by the operational members of the test team.
- Documented requirements for joint interoperability and net-centricity testing may or may not exist.
- Realistic SoS laydown must be known and replicated in the test environment.

[33] DISA Net-Centric Enterprise Services, Test and Evaluation Strategy, (Version: 3.9), NCES Program Management Office, 15 March 2004, Section 2.0 Test Strategy.

2. Test Event

    - Objective: Determine the level of overall mission effectiveness at which the cluster currently supports the JMT through interpretation of test findings and evaluation by the test operators and subject-matter experts; "user involvement is essential in interpreting test findings and determining overall mission effectiveness."[34]

3. Test Results Analysis

    - Substantial analysis and evaluation to quantify the level of success, key points of failure, and expected future improvements.

    - Second order analysis to prioritize improvements based on criticality, effectiveness, and cost.

    - Proposed implementation plan for next level improvements of various members of the cluster.

4. Test Analysis Report

    - Test reports and other documentation will feed USJFCOM JMT assessment and JBMC2 Legacy System phase out and convergence assessment processes leading to a single set of capabilities assessments for the entire JBMC2 program cluster. These assessments will describe and prioritize the improvements and programming decisions necessary to achieve the required capability. These assessments will be forwarded first to the JBMC2 Capability Area Overarching Integrated Product Team (OIPT) and then with specific recommendations to the capability DAB.

    - Use analyses of alternatives (AoA) help to scope capability requirements and identify particular incremental improvements for the systems in the cluster.

    - Program offices for individual JBMC2 systems to acquire funding and prioritization, through the PPBE process, for incremental improvements to their systems.

[34] Performance Test and Evaluation in the New Acquisition Environment, Col Victoria A. Valez, USAF, Commander, JITC, Ft. Huachuca, JITC Interoperability Conference 2004.

- Program offices execute individual system upgrades identified in the previous step, preferably through spiral development or incremental development in accordance with DoDI 5000.2.

10.4.2 Second and Subsequent Test Cluster High-Level Methodology

1. Test Readiness Conditions

    - Same as those in first iteration with improved/refined/established documented requirements for joint interoperability and net-centricity testing, based on results of prior iteration(s).

2. Test Even

    - Objective: measure how well repaired capabilities and additional capabilities since last iteration improved the test cluster's capabilities to execute the end-to-end JMT; periodic JBMC2 T&E measures the cumulative effect of the many individual system upgrades as overall increases in operational capability and interoperability occur.

3. Test Results Analysis

    - Same as those in the first iteration.

4. Test Analysis Report

    - Same activities as those in the first iteration.

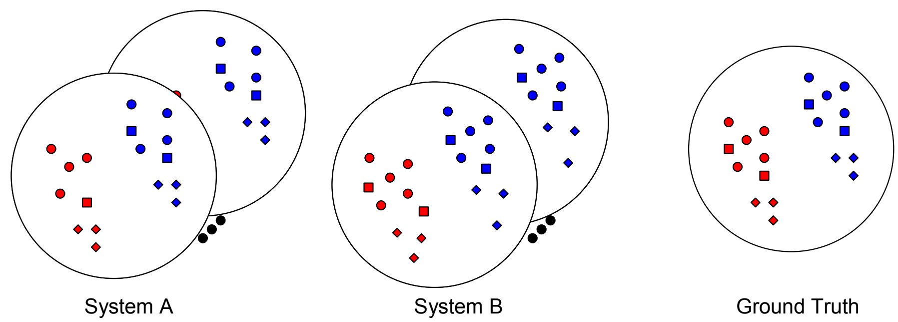
10.5 JBMC2 T&E Measure of Effectiveness/Measures of Performance

JBMC2 T&E must ensure that the JMT can be accomplished. In general, measures of performance can be categorized as in Table 10.1.

Table 10.1—Some Network and Application MOPs

	Interoperability	Net-Centricity
People	language, measurement system	richness, reach
Other Systems	# transactions/time, real-time parameters	timeliness, accuracy
Processes	workflow, task synchronization	distributed processing
Data	encoding, format	standard encoding, standard blocking
Hardware: Transmission Bearer Medium	signal characteristics, channel characteristics	reliability, BER
Hardware: Intermediate Message Processor (IMP)	routing, message handling	address format, flow and congestion control
Hardware: Data Storage	record media	caching of info in the network
Hardware: Processors	word-size, instruction set, cache size	DMA, specialized message processor capability
Software: Operating Systems	interrupt, error handling	protocol stack
Software: Applications	query language, standards compliance	dynamic binding

Service-specific system MOPs are the basis for JBMC2 T&E MOPs. Based on reviews of current Services' MOPs, only those MOPs needed to assess joint operations need to be defined. These additional MOP are related to shared awareness and situational awareness. Shared awareness measures of effectiveness and MOPs are specifically associated with reducing fratricide while enabling, notably in the case of some JBMC2 Pathfinder systems, joint operational mission planning and execution. Some key MOEs/MOPs for shared awareness and interoperability are illustrated in Figure 10.5.



- Are all Blue entities accounted for in both systems?
- Are all Red entities accounted for in both systems?
- Are the representations of Red and Blue entities in Systems A and B the same, and sufficiently accurate to support JMT accomplishment?

Figure 10.5—Shared Awareness and Interoperability

Enabling assessment of situational awareness requires real-time data collection and authentication, real-time monitoring of test execution across geographically distributed test nodes, and near-real-time data reduction and causality analysis. Some situational awareness elements from the Office of Force Transformation (OFT) / ASD(NII) Network Centric Warfare Conceptual Framework appear in Table 10.2.

Table 10.2—Situational Awareness Quality Measures

Attribute	Definition
Objective Attributes	Measures quality in reference to criteria that are independent of the situation
Correctness	Extent to which *entities* are consistent with ground truth
Consistency	Extent to which *entities* are consistent with related items (prior items or items held by other force members
Currency	Age of the *entities*
Precision	Level of measurement detail of *entity*
Fitness for Use Attributes	Measures quality in reference to criteria that are detarmined by the situation
Completeness	Extent to which the *entities* relevant to ground truth are collected or obtained
Accuracy	Appropriateness of the precision of the *entities* for a particular use
Relevance	Proportion of *entities* collected that are related to task at hand
Timeliness	Extent to which currency of the *entities* are suitable to their use

Entities are what is being measured – might be information elements, understandings, decisions, etc., depending on the key measure

The JBMC2 T&E does not define or impose specific MOEs/MOPs on specific JMT test clusters. It does require that MOEs/MOPs selected during the development of detailed

JBMC2 T&E plans include MOEs/MOPs for shared awareness and situational awareness assessment during the test results analysis step of the JBMC2 T&E high-level methodology.

10.6 JBMC2 T&E Supporting Tools

JBMC2 T&E must have available for use tools for data capture and analysis sufficient for determining the root cause(s) of interoperability and/or net-centricity failures during test cluster testing and evaluation. The percentage of instrumentation and data collection capabilities that are compatible between various service test and training ranges, development labs/testbeds, and experimentation facilities has been assessed at about 50 percent.[35] The same assessment estimates only 75 percent compatibility in FY 2008. Moreover, the time to analyze the test data and provide assessment of tasks and capabilities associated with the mission areas Immediate Joint Close Air Support, and Air Tasking Order development has been estimated at three to five months today and about one to three months in FY 2008.[36]

Recognizing that capabilities-based test and evaluation requires even more data collection (e.g., surveys and questionnaires of operational personnel participating in test events) and greater emphasis on collecting the right data from the right systems and users, it is imperative that JBMC2 T&E planning allow for additional, more accurate, and more efficient test support tools. Current Service-specific data collection and test analysis support tools are collections of commercial off-the-shelf (COTS) products, custom generated tools, and ad hoc tools created by testers themselves. The use of reusable tools across the Services is one of the JDEP objectives. Additional effort to support data collection and test result analysis tools beyond that in Service-specific or JDEP-like environments is essential to JBMC2 T&E success. This effort must proceed at a pace coordinated with the JBMC2 T&E high-level schedule.

10.7 JBMC2 T&E High-Level Schedule

The JBMC2 T&E high-level schedule, depicted in Figure 10.6, provides overall direction for near-tem JBMC2 cluster testing, focusing on the JBMC2 Pathfinder systems that will be part of multiple JMT test clusters. This direction provides testing and scheduling guidance for the later development of detailed test plans. The JBMC2 T&E high-level schedule is based on current JBMC2 Pathfinder systems' major program milestones and JBMC2 assessment of and suggestions for essential improvements to the JDEP infrastructure. Section 10.9 contains an extended discussion and assessment of JDEP and its current and future roles in supporting JBMC2 T&E.

[35] Enhanced Planning Process (EPP), Task #1: Netting the Force, Issue Team Meeting, March 12, 2004

[36] Ibid.

JBMC2 T&E is incremental with respect to the systems under test as well as the resources and facilities supporting tests. With respect to the systems under test, this schedule prescribes a series of testing opportunities to evaluate initial interoperability, mission thread capability, and net-centricity success/failure discovery through demonstrations and operational assessments with follow-ups on improvements/repairs to systems previously tested and culminating with a capstone certification test of a system's abilities to execute joint mission threads. JITC experimentation, assessments, testing, and demonstrations should identify the shortfalls in systems and clusters, for appropriate action. With respect to the resources and facilities used during tests, this schedule prescribes essential incremental improvements in the testing infrastructure. Initially, the infrastructure predominately supports test of actual fielded systems, (i.e., hardware-in-the-loop (HWIL) tests), and utilizes asynchronous transfer mode (ATM) telecommunications capabilities to link test facilities and enable distributed testing of groups of systems. Subsequently, the infrastructure must enable both HWIL and software-based emulations of systems in development—(i.e., software-in-the-loop (SWIL) tests), and utilize Internet Protocol (IP) communications capabilities. JBMC2 test events assess MOEs and MOPs defined within the context of a system's interoperability and net-centricity in support of one or more JBMC2 joint mission thread capabilities. JBMC2 test processes and tools can also simultaneously support assessment of MOEs and MOPs that are not operationally derived (e.g., compliance with NII Net-Centricity Checklist).

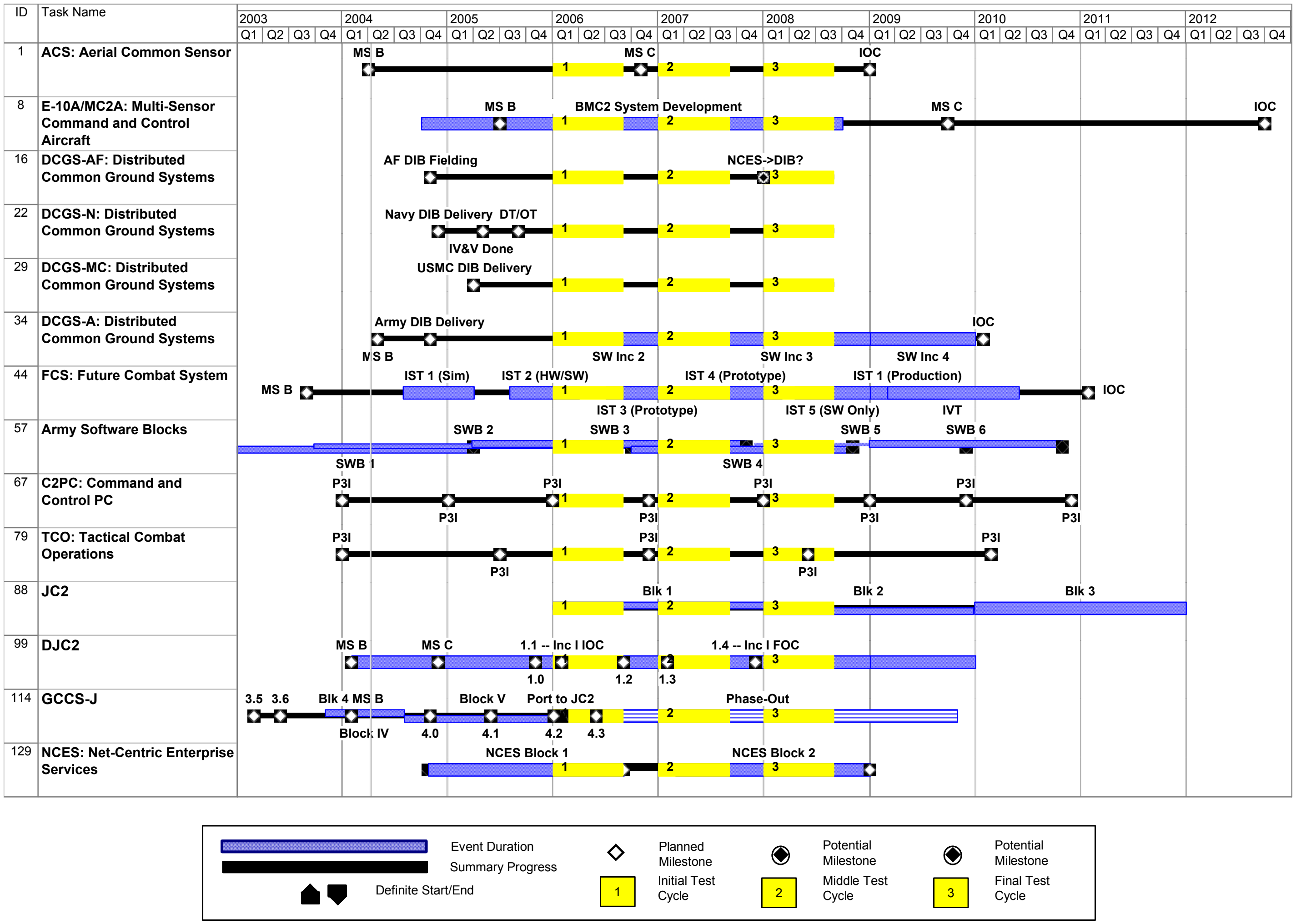


Figure 10.6—JBMC2 T&E High-Level Schedule

The three test cycles illustrated in Figure 10.6 are those tests essential to demonstrate an achievable level of interoperability by end of FY 2008. A variety of specific test events for the JMTs will be scheduled during each cycle, with the precise schedule to be derived from detailed systems engineering needs, as they become known. These tests focus primarily on interoperability, but do provide an interim yet significantly improved instrument to measure JBMC2 capability. Each of these tests follows the JBMC2 T&E test cluster high-level methodology defined previously in sections 10.4.1 and 10.4.2. These tests also assess current systems and systems under development. Systems under development are tested to improve the likelihood of achieving desired interoperability levels with other systems in an operational JBMC2 JMT cluster. It is expected that these tests will generally utilize enhancements to the JDEP-like infrastructure defined in section 10.9. JBMC2 T&E utilizing JDEP can begin as soon as the following conditions are met:

- A specific Joint Mission Thread has been defined to the degree that an enabling system test cluster can be identified, and realistic and representative operational scenarios are constructed based on the JMT.

- Each system in the test cluster has a currently fielded version and / or a digital representation configuration that can access the JDEP network via a contractor or program facility.

Tests scheduled beyond end FY 2008 represent those essential to assessing net-centric capability improvements in systems once future C2 systems and net-centric underpinnings become operational (e.g., Joint Tactical Radio System (JTRS), Net-Centric Enterprise Services (NCES), Transformational Satellite (TSAT)). Figure 10.6 does not have any specific test cycles scheduled between FY 2009 and FY 2012, but it is important to discuss what the tests during this period would address. These tests also test current systems and systems under development. The test objective during this period is to ensure that JBMC2 JMT cluster capabilities are sustained and/or improved as current systems are phased out and new systems are phased in to the operational FoS. Identification as a member of the JBMC2 FoS carries a requirement to develop and keep current a software-based model or emulation of the system. The Capability Area DAB will be the authoritative body for directing Programs of Record (PORs) to pay for software-based models or emulations of their system. Far-term testing can begin as soon as the following conditions are met:

- Programs responsible for operationally fielded systems must develop and maintain their digital representation and HWIL models representative of currently fielded capabilities.

- Programs responsible for systems that are in development, i.e., pre-Milestone C, must develop and maintain digital representations of the intended capability(ies).

- Programs must practice agile and adaptive acquisition methods that allow prompt and low-cost modifications to system design and development if and when periodic JDEP testing reveals interoperability and capability shortfalls.

- The previous requirement also applies to programs responsible for operationally fielded systems that are under spiral or incremental development.

The current JDEP Technical Framework is unable to fully support the JBMC2 Roadmap objective of demonstrating interoperability and net-centricity capabilities necessary to meet JMT MOEs and MOPs by end FY 2008. An accelerated program of JDEP Technical Framework evolution is essential to achieving JBMC2 Roadmap interoperability and net-centricity test objectives. Section 10.9 of this Roadmap provides specific recommendations with respect to this accelerated program. The recommended accelerated schedule shifts JDEP's ability to meet the requirement for full-scale JMT cluster test support from the current projected date of end FY 2008 to end FY 2006, a significant shift in current JDEP plans and expectations. Figure 10.7 depicts major categories of JDEP-based test events corresponding to the JBMC2 T&E high-level schedule depicted in Figure 10.6.

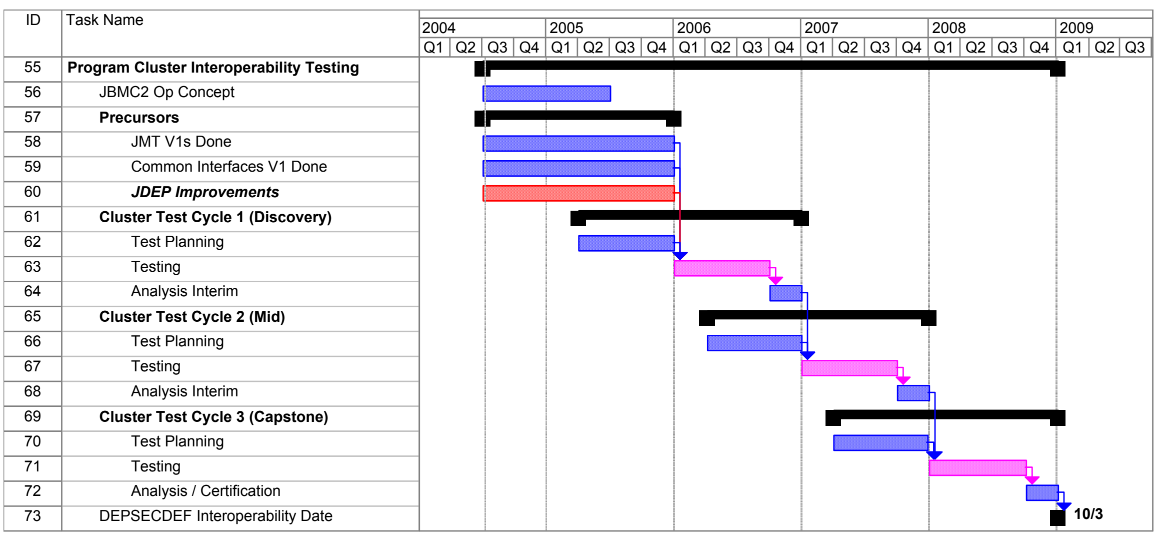


Figure 10.7—JDEP-Based Test Events Given Accelerated JDEP Technical Framework Evolution

10.8 JBMC2 T&E Roles and Responsibilities

It is not the intention of the JBMC2 Roadmap to reestablish organization roles and responsibilities already documented in JCIDS and Defense Acquisition Process policy and guidelines. Rather, it is important to specifically focus on roles and responsibilities critical to both the success of JBMC2 T&E and extension and enhancement of test support infrastructure and tools, two items already highlighted as critical to success of JBMC2 T&E in previous subsections of this JBMC2 Roadmap section. The exact nature of the roles and responsibilities for JBMC2 T&E has not yet been established as of this edition of the Roadmap; these will be detailed in the fall 2004 update of the Roadmap. A summary of the discussion to date follows.

JBMC2 T&E requires a more comprehensive approach to T&E than may be the case with more traditional systems. Single system, and some SoS development, is accepting of 'final testing' before operational fielding. The cluster concept changes that paradigm significantly. Testing in the cluster paradigm requires that the T&E program be an integral part of the overall development process and that well-constructed periodic testing play a key role in ensuring that cluster SoS/FOS meet and exceed the requirements of the JMT for which they are being developed.

JITC is currently assigned most of the operational roles and responsibilities specific to JBMC2 T&E success. JITC's responsibility for certification is important, but it occurs primarily at the end of the development process. An argument could be made that problems (such as sub-optimization or failure to achieve critical requirements in interoperability) are built into the process if the organization responsible for certifying interoperability has no role until the end. While impartiality is important in a testing environment, the lack of understanding and insight into problems arising in a particular technical approach and the trades that went into selecting that approach, can do significant damage to the overall evaluation. Impartiality can still be adequately maintained through application of objective and rigorous test/evaluation procedures by an organization that has involvement in all phases of development. Ultimately, the end customer needs to be involved in the certification process—and his or her criteria are simpler: "Can I perform the mission better with this new thing, or not as well?"

JBMC2 T&E requires a central lead that reflects joint warfighter needs, is not disposed to favor any Service or Agency at the joint warfighter's expense, and is unequivocally and unquestionably impartial. JITC may well be the best available extant organization to meet these needs—but might require rechartering or other changes to enhance its ability to execute these responsibilities

But certification is, again, only one step in JBMC2 T&E and is the last part of the process. Other steps, also as important, must be considered before assigning responsibilities. These are:

- Baselining: What is the current capability of the system or family of systems? Is this good enough or not? If not, how close or far is it from good enough?

- Progress measurement: Has the system or family of systems improved since the last test event? Is it good enough yet, or is more work needed? More succinctly, is the incremental performance improvement good enough to warrant fielding?

Four scenarios for future JITC responsibilities, in light of the above considerations, can be postulated:

- JITC is responsible for JBMC2 T&E and is chartered to expand its responsibilities to include baselining and progress measurement of JMT cluster systems' capabilities. JITC is formally recognized as the JBMC2 responsible test organization (RTO).

- JITC is designated the JBMC2 T&E Test Manager, and is chartered to expand its responsibilities to develop test plans; work with designated Service and (eventually) Joint Test Facilities who could be designated the RTO for specific test opportunities; and providing the post-test analysis and certification services.

- JITC preserves its certification responsibilities, and a new joint testing organization is established with responsibilities for baselining and progress measurement JMT cluster systems' capabilities. This new joint testing organization might be formally recognized as the JBMC2 RTO.

- JITC preserves its certification responsibilities, and a new cross-service (vice joint) testing organization is established with responsibilities for baselining and progress measurement of JMT cluster systems' capabilities. This new cross-service testing organization might be formally recognized as the JBMC2 RTO.

As currently established, JITC (or this new joint or cross-service testing organization) needs will report to the Defense Information System Agency (DISA).

For benchmarking, JITC's current roles and responsibilities with respect to JBMC2 T&E are enumerated in the next subsection. Additional JBMC2 T&E roles and responsibilities assigned to other organizations are then enumerated in the subsequent subsection.

10.8.1 Current JITC JBMC2 T&E Roles and Responsibilities

Note: JITC is responsible for interoperability certification of U.S. Services systems only—JITC cannot certify non-U.S. systems for interoperability. JITC may certify conformance to standards for systems (IT/NSS or non-U.S.) that implement standards that can possibly impact interoperability. JITC may also evaluate conformance to NATO Standardization Agreements (STANAGs) and issue a standards conformance certification.

1. Responsible Test Organization (RTO) for JBMC2 Events

- Support JBMC2 System Engineering and Functional Control Board assessment processes.
- Coordinate planning, conduct, and analysis of JBMC2 engineering and test and evaluation events with Service and Agency participants.
- Coordinate with Service and Agency participants to report results of JBMC2 events to USJFCOM.
- Establish methodology and resources to track status of JBMC2 cluster systems to include identification of deficiencies and status of fix implementation.

2. JDEP Technical Coordinator for JBMC2 Events

- Employ JDEP infrastructure and methodology to enable JBMC2 distributed HWIL and SWIL engineering and test and evaluation events.
- Identify JDEP infrastructure enhancements and resources required to support high-fidelity JBMC2 standalone and distributed engineering and test and evaluation events.

3. Joint and Combined Interoperability Test Certification of JBMC2 Systems and Capabilities

- Leverage JBMC2 events throughout engineering and test and evaluation phases to support joint interoperability certification as annotated in CJCSI 6212.01C.
- Certify the extent that JBMC2 systems/capabilities meet interoperability aspects of their Net-Ready KPP.
- Gain compliance with the NCOW Reference Model (RM).
- Gain compliance with applicable GIG Key Interface Profiles (KIP).
- Gain compliance with integrated architecture products.
- Track joint interoperability certification status of JBMC2 systems and capabilities.

10.8.2 Other Organizations' JBMC2 T&E Roles and Responsibilities

The following roles and responsibilities were identified in Department of Defense Integrated Interoperability Plan (DoD IIP), USJFCOM, Final 01 Oct 2003, section 1.5, and are repeated here for specific inclusion in the JBMC2 T&E roles and responsibilities.

Assistant Secretary of Defense for Networks and Information Integration (ASD(NII))/DoD CIO is responsible under Title 10 of the U.S. Code to ensure the interoperability of IT and NSS throughout the DoD and ensure that IT and NSS standards that will apply throughout DoD are prescribed. Under the Clinger Cohen Act, the DoD CIO shall be responsible for developing, maintaining and facilitating the implementation of a sound and integrated IT architecture for the DoD.

Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) is responsible for leading the development of the systems view (SV) of integrated architectures, for leading the development of integrated plans or roadmaps to be used to conduct capability assessments, and for ensuring that weapon systems and platform information standards and architectures are compliant with the standards and architectures promulgated by ASD(NII).

Under Secretary of Defense for Intelligence (USD(I)) is responsible for developing DoD intelligence policy and standards and for overseeing development of integrated intelligence architectures. USD(I) shall ensure that intelligence information standards and architectures are compliant with the standards and architectures promulgated by ASD(NII). This responsibility shall be executed in coordination with USD(AT&L), ASD(NII), the Joint Staff, Combatant Commanders and other Federal and allied organizations and agencies.

The Chairman of the Joint Chiefs of Staff (CJCS) is responsible for developing the joint operational concepts, joint operating concepts, joint functional concepts, integrated architectures, and doctrine in coordination with OSD, the Services, Defense Agencies, and Combatant Commanders. CJCS is also responsible for managing the development of Joint Mission Essential Task Lists (JMETLs), Universal Joint Task Lists (UJTLs), and functional capability needs, which are instrumental in the definition of interoperability requirements. In addition to the proposed net-ready key performance parameter (KPP), interoperability requirements are defined in terms of the information sharing and collaboration needed to support required functional capabilities such as dynamic planning and time sensitive targeting. CJCS, through the Joint Staff J6, is responsible for certifying interoperability requirements and C4ISR system supportability.

CDR USJFCOM is responsible for Joint Force requirements, concept development, experimentation, interoperability, and training, under the Unified Command Plan. Under MID 912, USJFCOM is responsible to improve the Department's ability to organize, train, and equip Joint Forces for JBMC2 capabilities. MID 912 assigns USJFCOM directive/oversight authority over the Deployable Joint C2 (DJC2) program and the Single Integrated Air Picture (SIAP) programs starting in FY03, and over the Family of Interoperable Operational Pictures (FIOP) starting in FY04. These programs and initiatives collectively are referred to as the USJFCOM MID 912 "portfolio." USJFCOM is directed by the MID to make recommendations to the Secretary of Defense for expanding the portfolio.

USJFCOM also serves as the DoD Executive Agent to the CJCS for Joint warfighting capability requirements and Joint experimentation. USJFCOM is assisted in these areas by the Joint Battle Center (JBC) and its associated Interoperability Technology Demonstration Center (ITDC).

Additionally, MID 906, Training Transformation, assigns USJFCOM responsibility for development of the Joint National Training Capability (JNTC). The JNTC goals include knowledge superiority across DoD, an adaptable mission rehearsal capability, joint force interoperability with interagency multinational and intergovernmental partners and systematic training in network centric warfare.

Under the Unified Command Plan, Commander U.S. Strategic Command (STRATCOM) is responsible for developing and advocating aspects of global C4ISR policy, concepts, doctrine, architectures and capabilities to include: providing global C2 services; planning, integrating and coordinating ISR in support of strategic and global operations; centralized planning, coordination and integration of missile defense command, control battle management communications; computer network attack and computer network defense, and execution of GIG network operations and defense.

DoD components are responsible for ensuring that their respective Service equipment, doctrine, organization, and training are developed in compliance with the GIG architecture and standards and other joint standards as promulgated by the DoD CIO. DoD components are also responsible for implementing internal FoS acquisition processes, and participating in similar joint processes, to promote system interoperability.

10.9 JDEP Technical Framework Evolution

This section addresses the utilization of JDEP as a facilitating infrastructure for JBMC2 T&E.

10.9.1 Background

It is important to note that, although there are physical entities that comprise JDEP (e.g., JDEP nodes), JDEP testing is considered a general activity rather than the use of a specific system. It is also important to note that JDEP currently supports a point-to-point test model (i.e., system-to-system interaction rather than publish/discover/subscribe model required in true net-centricity). Currently, JDEP is most closely supporting the Integrated Architectural Behavior Model (IABM) scenario test environment for the Single Integrated Air Picture (SIAP). Extension of JDEP to meet the needs of other test communities and JBMC2 T&E may be assigned another name (i.e., JDEP may one day refer to the prototype currently supporting IABM scenario testing). In this subsection, JDEP is used generically to describe the current JDEP IABM scenario prototype infrastructure and process as well as future JDEP-like extensions to the current JDEP IABM scenario prototype necessary for JBMC2 T&E.

What JBMC2 T&E and other joint interoperability and net-centricity testers need (and where JDEP is heading) is a capability to do joint, distributed engineering, not a fixed facility or “plant”—so the name “Joint Distributed Engineering Plant” is a bit misleading. The early conception of JDEP was based on linked HWIL facilities where the mission computers of multiple systems could be linked via landlines to test their ability to exchange messages and identify interoperability problems. These initial HWIL tests identified necessary extensions and methods to achieve them in JDEP. The next step is to extend JDEP to support investigation of alternative system concepts and developments. This requires digital systems representations, which are modified as necessary based on the results of testing. This approach also allows problem identification early in the development vice after the computer program is fielded. Obviously, this approach is less expensive than what it would cost to modify operational software.

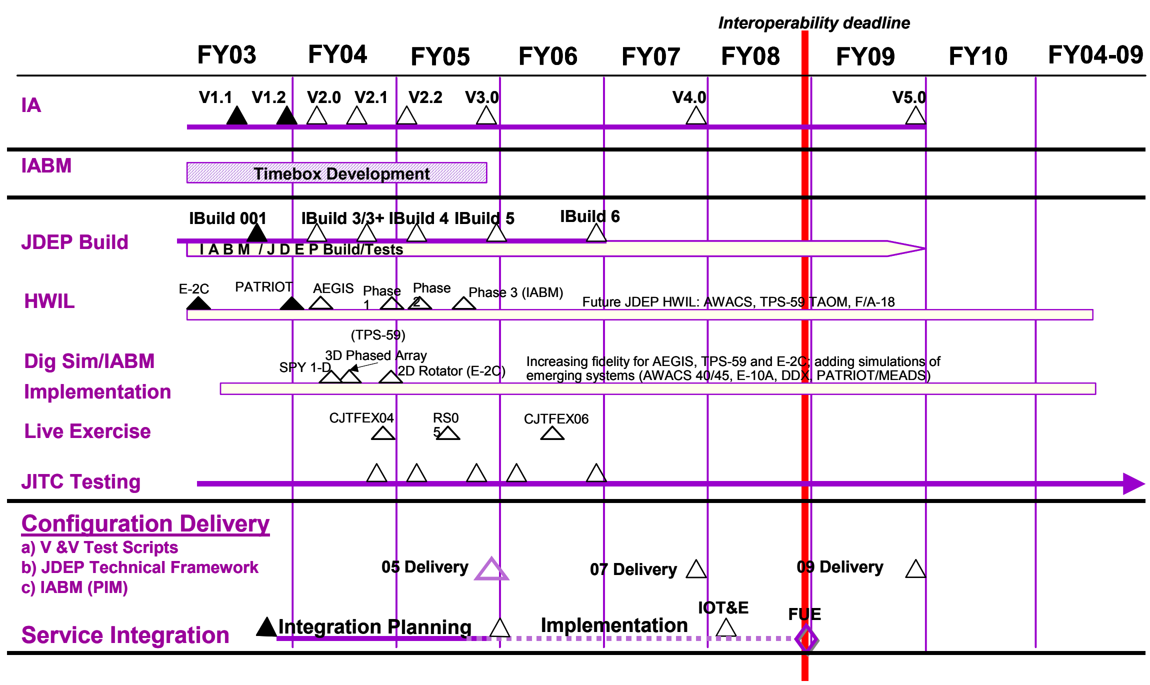
The JDEP Technical Framework currently defines the components that comprise a JDEP federation, interfaces (specifications) for the way the components interact, and guidance on how to configure and apply the components to the users needs. This JDEP framework can virtually be put on a handful of CDs. Thus, JDEP (the activity) can be conducted anywhere.

The T&E vision being used to conduct JDEP end-to-end testing is as follows: first, conduct assessments using distributed digital simulations; then, once you are confident that digital simulation tests have been successful, conduct HWILs. Once HWIL tests have been successful, live-events (graduation exercises) are conducted.

10.9.2 JBMC2 T&E and JDEP Linkage

Enabling the JBMC2 T&E methodology requires evolution of a distributed testing capability that can accommodate both fielded, real-world systems and software-based models or emulations of systems under development. This need forces two realizations: that JBMC2 T&E needs the JDEP, and that the current JDEP capability is not adequate to meet the need. Accordingly, both the JBMC2 test process and JDEP need to co-evolve, such that JDEP can support limited but increasingly capable JBMC2 testing as it evolves and that an accelerated plan for JDEP evolution is essential for successful and timely completion of JBMC2 Roadmap test requirements.

The current core capability within the JDEP-capable group of systems is the set of integrated air battle management systems. This raises significant concerns on JDEP evolution and the context within which planning for that evolution is proceeding. The JBMC2 Roadmap greatly extends the JDEP-capable family of systems. The GIG End-to-End Evaluation Facility plan extends through FY 2011, with the majority of improvements scheduled FY 2004 through FY 2007. The current JDEP Joint Theater Air and Missile Defense (JTAMD) Long Range Plan (LRP) covers FY 2004 through FY 2009; the next plan will cover FY 2005 through FY 2010 (see Figure 10.3).[37] The JBMC2 Roadmap interoperability deadline at the end FY 2008 has been overlaid on the JTAMD LRP.



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37 JTAMD JDEP Long Range Plan, Presentation to the JDEP Technical Working Group (JTWG-02), February 18, 2004, Mr. Mark Falkey, JDEP Missile Defense Application Area Manager Liaison.

Figure 10.8—JTAMD LRP Schedule

With these facts in mind, the following subsections will address current JDEP capabilities, required end-state JDEP capabilities, and recommendations for providing required end-state JDEP capabilities in sufficient time to execute JBMC2 T&E high-level schedule, depicted in Figure 10.6.

10.9.3 JDEP v0: Current Capability

Distributed Testing Sites

A number of Service and contractor test and development facilities can be linked together via DISN-LES ATM communications. Note that Bedford and Ft. Bliss are connected to JDEP via a backside T1 connection. Systems at these facilities can be linked together as systems, systems of systems, or families of systems, stimulated by modeling and simulation to behave in a realistic fashion in a synthetic, yet operationally realistic, environment. M&S communications are effected through either high-level architecture (HLA) or distributed interactive simulation (DIS) protocols. Instrumentation exists at some facilities to capture system behavior at sufficient levels of detail to isolate root causes of interoperability or net-centricity capability shortfalls, but there is currently no broad standard or common level of instrumentation. One notable standard of network performance monitoring for JDEP is implemented by the Advanced Information Technology Services (AITS) and JITC.

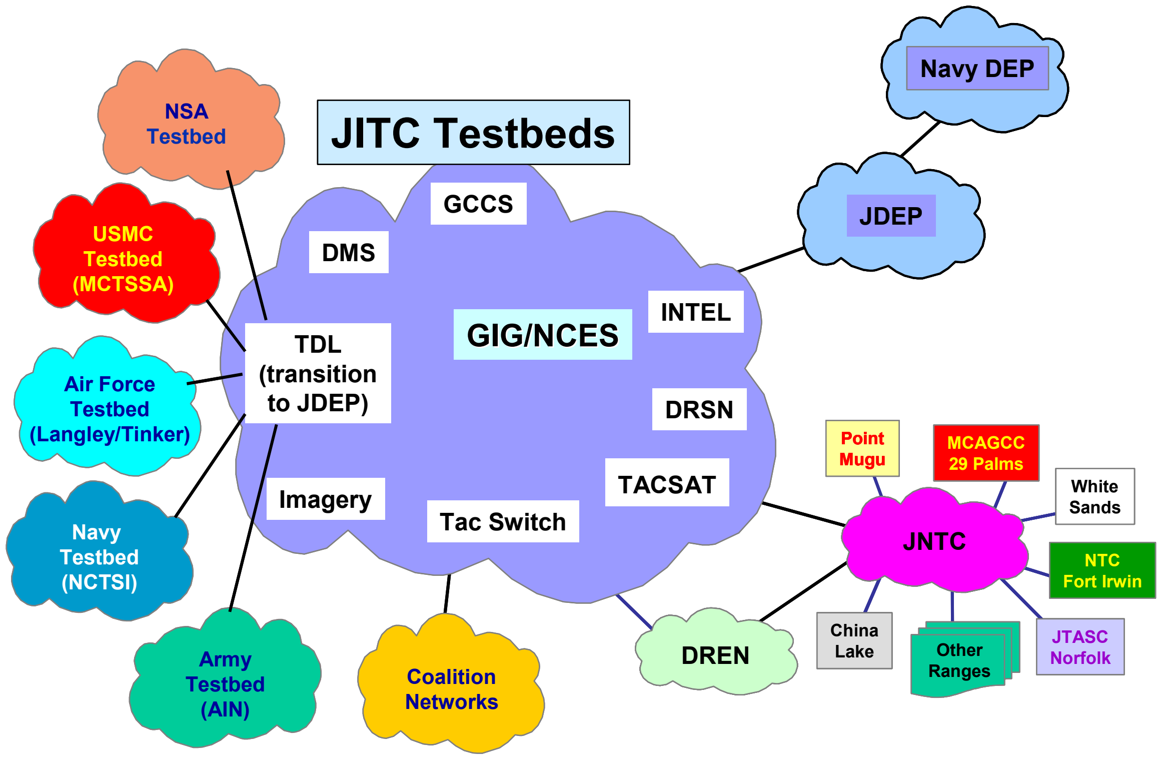

Figure 10.9—Current JITC Distributed Testing Environment

Figure 10.9[38] illustrates JITC's current mapping of key test facilities and the telecommunications infrastructures connecting them. The JDEP and Navy DEP elements in figure 10.9 have enough facility detail that an additional figure is required to illustrate their relationship to each other and to the overall view of distributed testing environment.

[38] Based on JBMC2 Systems Interoperability, Mr. Steve Bridges, Joint Interoperability Test Command, January 21, 2004

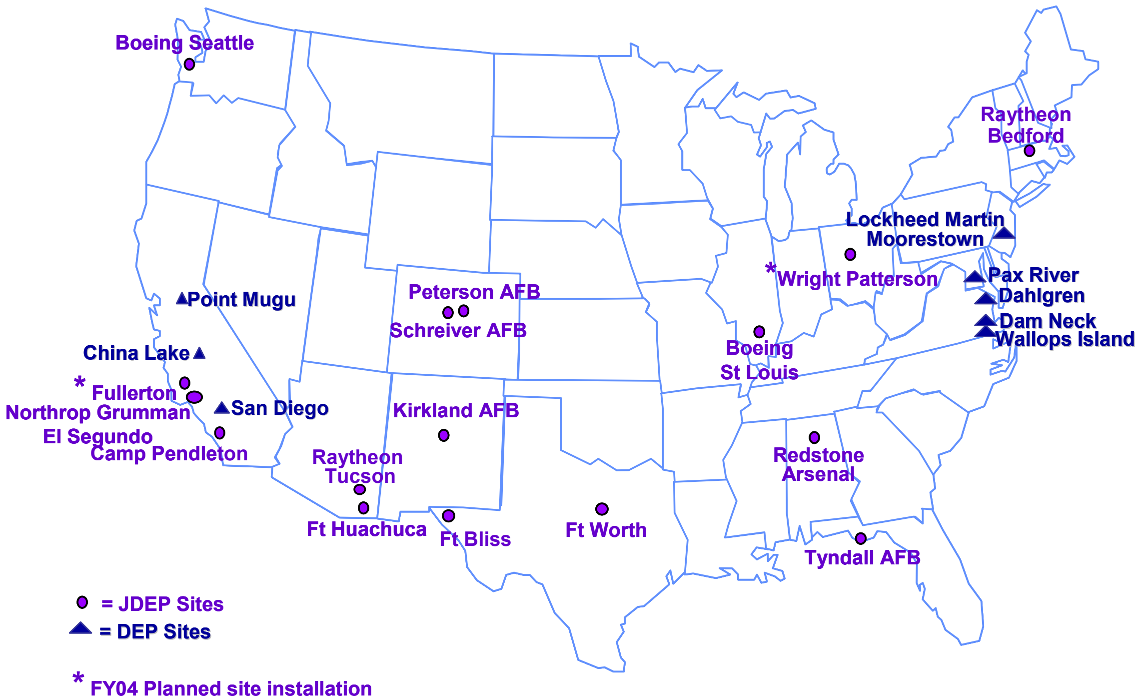

Figure 10.10—Current JDEP and Navy DEP Distributed Testing Environment

Current JDEP and Navy DEP sites are illustrated in Figure 10.10.[39] Although the communications infrastructure between sites is not illustrated in the figure, they are indeed connected. Virtual local area networks (VLANs) are established via ATM connections between sites. All sites illustrated in Figures 10.9 and 10.10 also utilize voice and video conferencing telecommunication links in addition to the data transport links illustrated in Figure 10.9.

The JDEP Technical Working Group (TWG) recently identified other potential collaborating DoD entities and key facilities and environments:

- U.S. Joint Forces Command (USJFCOM)
    - Joint National Training Capability (JNTC)
    - Joint Assessment and Enabling Capability (JAEC)
    - Joint Battle Center (JBC)
- Director, Operational Test & Evaluation (DOT&E)

[39] JDEP Technical Working Group Overview, George Rumford, JDEP Program Office, February 19, 2004.

    - Central Test & Evaluation Investment Program (CTEIP)
    - Strategic Planning Guidance (SPG) "Testing in a Joint Environment"
- Networks and Information Integration (NII)
    - Global Information Grid (GIG) End-to-End (E2E) Evaluation Facility
    - Net-Centric Enterprise Services (NCES)
- Army
    - Modeling Architecture for Technology, Research and EXperimentation (MATREX)
    - Virtual Proving Ground (VPG)
    - Future Combat System (FCS) System of Systems Integration Laboratory (SoSIL)
- Navy
- Distributed Engineering Plant (DEP)
    - ForceNET
    - Composable Network Environment (CNE)
- Air Force
    - Center for Domain Integration (CDI)
    - Distributed Mission Operations (DMO)
    - Joint Synthetic Battlespace (JSB)

The JDEP TWG defined multiple levels of collaboration between JDEP and these other DoD entities to

- Better communicate to what extent JDEP is collaborating with various other DoD activities

- Facilitate discussion of JDEP in other DoD efforts and programs (if not at least relative to other DoD efforts and programs).

Collaboration levels were initially defined as:

- Partnership—Tightly coupled with and/or dependent on the activities of the other DoD effort. Roles and responsibilities should be documented (MOA, TOR, etc.) between the JDEP program and the other DoD effort.

- Coordination—Strongly interested and/or aligning to the activities of the other DoD effort. JDEP Team members should be attending and participating in various meetings with the other DoD effort and vice versa.

- Awareness—Loosely interested or benefits of collaboration not yet well defined in the other DoD effort. JDEP Team members will review high-level materials and have telecons with the other DoD effort to determine whether a higher level of collaboration is warranted

Current JBMC2 T&E Model

Figure 10.11 illustrates the current methodology for JBMC2 testing, as constrained by current JDEP-like capabilities. The JDEP-like environment can support cluster testing of systems in their real-world, fielded configurations. As noted in the figure, only operational versions of systems participate in tests. Digital representations for some current HWIL nodes are being developed for use in the JDEP-like environment. Most systems currently being considered for addition to this Roadmap do not have digital representations compatible with JDEP-like environment.

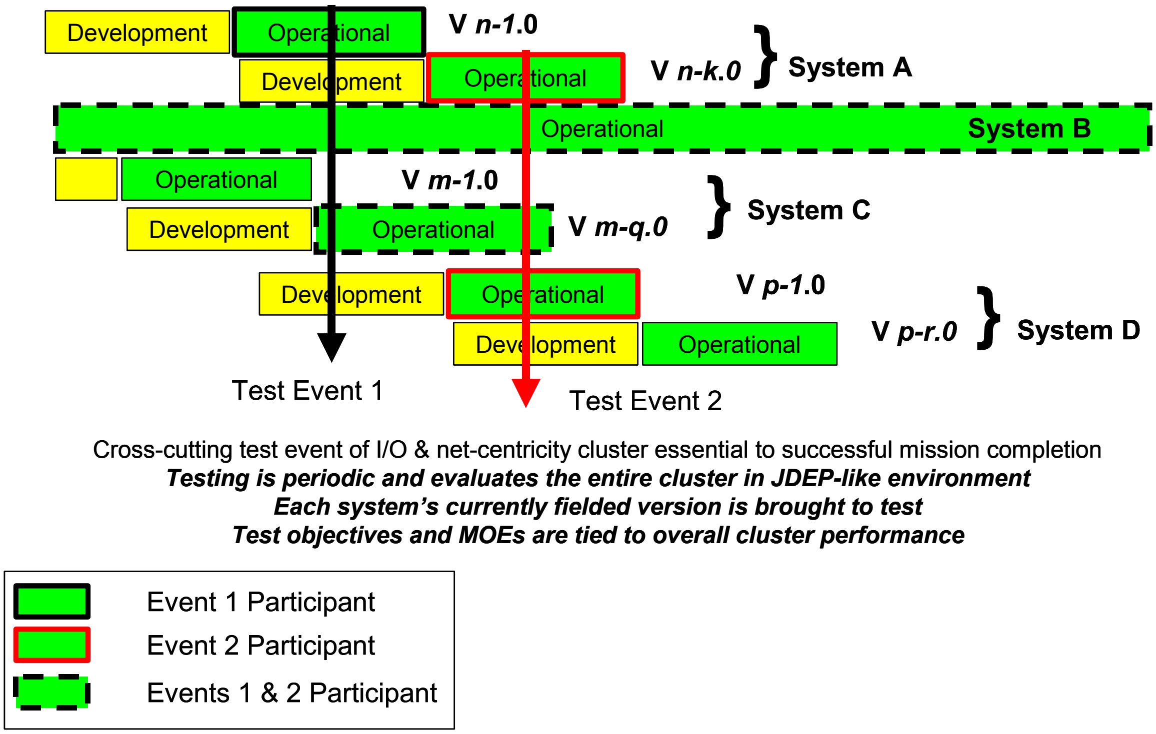

Figure 10.11—Current JBMC2 T&E Model (JDEP-like v0, FY 2004)

In Test Event 1, a cluster of operational systems within a JBMC2 JMT is baselined to capture their current contributions to the operational MOEs and MOPs of the JMT. Evaluations, assessments, and analyses identify (with varying levels of certainty) individual systems that contribute to any shortfalls. The JCIDS and acquisition processes use these findings to prioritize and advocate specific system improvements that provide the greatest improvement in overall joint capability within reasonable cost parameters. Services and Agencies owning these systems use the PPBE process to allocate funding for the required upgrades. Progress in improving end-to-end joint operational capability will be measured at periodic retests of the cluster through JDEP-like test activities, such as that illustrated by Test Event 2 in Figure 10.11.

10.9.4 Critical Assessment of Current JDEP Capabilities

The National Defense Industrial Association (NDIA) M&S Committee Report to USD(AT&L) noted in Finding 16 that "a promising example of [distributed simulation as a cost-effective way to integrate and test systems of systems] is the Joint Distributed Engineering Plant (JDEP), but it is currently under-resourced. A non-proprietary, tailorable, reasonably-available family of such federations (one or more per Functional Capabilities

Board (FCB)) would go a long way toward providing the 'standard' environments needed to explore the time-coordinated, dynamic interactions of a SoS."[40]

Although JDEP is currently unable to fully support the JBMC2 Roadmap objective, there is value to its use in near-term testing. JBMC2 systems currently configured to use DIS must be converted or augmented to use HLA, though. It should be clear that only currently operational systems can participate in JBMC2 testing using the current instantiation of JDEP. Programs still in development that have not yet reached Milestone C will not be able to participate until improvements to JDEP have been developed and implemented, due to current limited availability of system and environment digital representations. An important feature of end-to-end capability testing is that it allows operational doctrine, plans, and tactics, techniques, and procedures (TTP), as well as system performance, to be evaluated. JDEP will need accurate human-machine interfaces (HMI) to verify TTP. It should be obvious that evaluation and assessment across the DOTMLPF spectrum could be a significant contributor to the evolution of JBMC2 capabilities.

JDEP scheduling is also a concern. JDEP event planning occurs between January and October of each fiscal year for tests the following year; at this time, the earliest JDEP test events that could be scheduled would occur at the start of FY 2006. JDEP was unable to support the number of tests requested in FY 2003, and the number of tests expected during FY 2005 is about double that of FY 2003. Whether JDEP as currently configured and managed could efficiently and effectively support JBMC2 Roadmap testing is a concern. Owing to the varying amount of instrumentation currently available at JDEP facilities, it is not certain that capability and interoperability shortfalls can be traced to root causes in individual systems. The inability to identify the root causes of interoperability problems may be the biggest shortfall with current JDEP capability.

Alternatively, it may be possible to define the JDEP environment and resource requirements as a single, replicable package. It would then be possible to provide multiple JDEP packages to existing testing centers, such at JITC, allowing for multiple instances of "JDEP" testing JBMC2 systems simultaneously. Use of JDEP-defined families of systems and supporting resources would enhance evaluation of results across several testing opportunities. While each test opportunity is unique and requires meticulous, detailed planning, the use of JDEP-defined testing environments as the basis would provide a "standard" approach that may prove useful over the life of the testing requirements in any system(s) development. This could feasibly be done utilizing the JDEP Infrastructure Build

[40] M&S Support to the New DoD Acquisition Process, NDIA M&S Committee Report to PD USD(AT&L) Defense Systems, February 18, 2004, p. 10.

(I-Build) exportable, stand-alone environment package presently under development by the JDEP Program Office.

10.9.5 JDEP v*N*: Objective JDEP-like Capabilities

Objective JDEP consists of participating JDEP-like nodes linked via TCP/UDP transport layer protocols instead of the current ATM transport layer protocol. JBMC2 programs develop software-based models and emulations of their systems and keep them current and faithful to existing and developing performance. HLA-based modeling and simulation permits cluster testing of real-world, fielded systems, models and emulations of systems (whether fielded or still in development), or any combination thereof. Model-driven architecture (MDA) and Test Enabling Architecture (TENA) processes and tools contribute to ever more efficient and effective test planning, execution, and analysis. Instrumentation improvements have been made that allow root cause identification of early interoperability and net-centricity failures and clearly indicate areas of success that can be exported to other systems in the cluster. Standard or common levels of instrumentation exist for all systems in the test cluster. Note that Objective JDEP must support a publish-subscribe model of system interaction to support net-centricity testing.

Figure 10.12 illustrates objective JDEP-like capabilities with respect to JBMC2 objectives. Objective JDEP can support cluster testing of systems in their real-world, fielded configurations, as well as cluster/subcluster testing of systems under development interacting with fielded configurations. Digital representations of systems under development exist and are accessible on demand (24x7) over the supporting GIG infrastructure for use in developer test events (such as D1 in Figure 10.12). HWIL nodes exist for all operational systems in the test cluster. Digital representations of operational systems are available for SWIL tests prior to major test events. Test events 1 and 2 illustrated in Figure 10.12 now include both operational systems and current digital representations of systems under development, improving the chances of early identification of interoperability/net-centricity failures and successes.

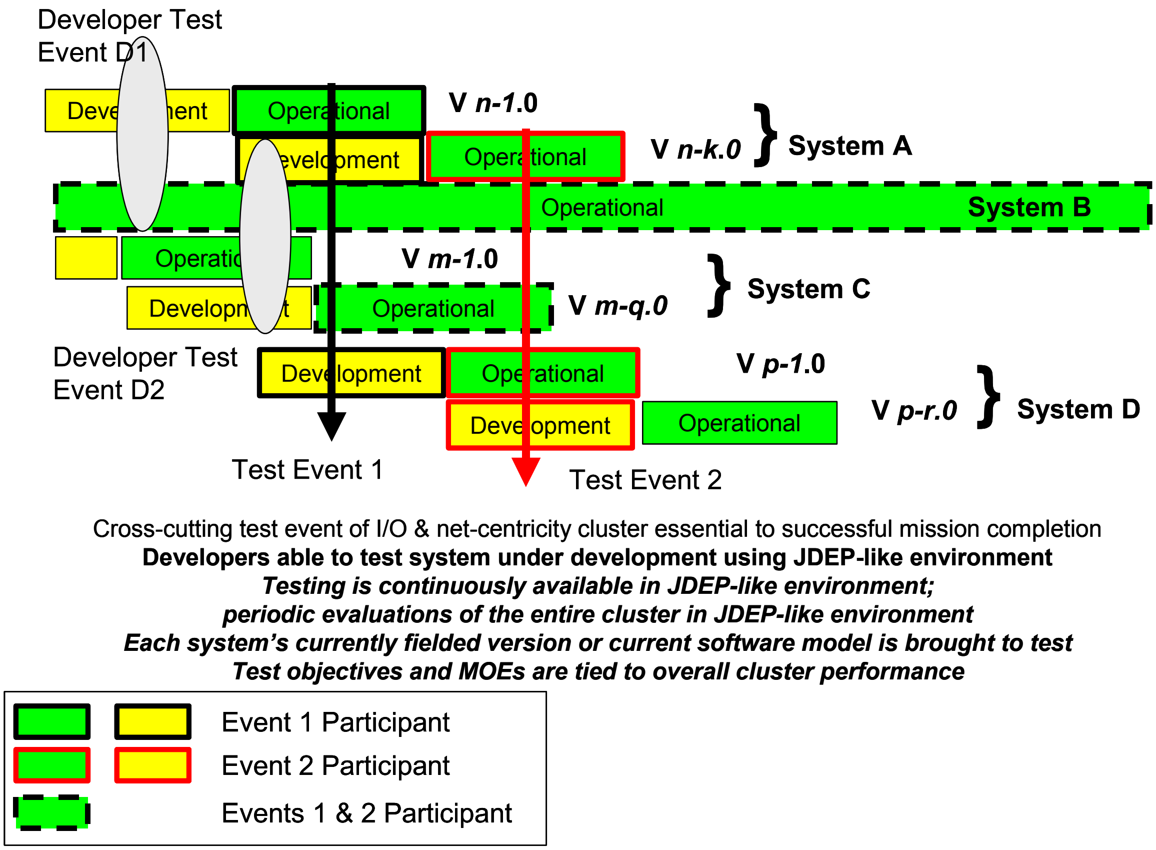

Figure 10.12—Objective JBMC2 T&E Model (JDEP-like v*N*, FY 2006)

Adding the ability to assess programs still in development should speed up the cycle time between finding capability shortfalls and fielding improvements to them. Test outcomes should affect contracts, schedules, and documented capability needs (e.g., Capability Requirements Documents (CRDs) and Capability Production Documents (CPDs)). The PPBE process must allow changes in funding to occur quickly enough to enact changes by the next scheduled JBMC2 test event.

10.9.6 Synchronizing JBMC2 T&E and JDEP-like Evolution

The needs for JBMC2 systems in development to have software-based models and for JDEP to be able to support testing with them are obviously mutually dependent. With OIPTs on the acquisition side, it may be necessary for a JDEP or JBMC2 OIPT to ensure that JDEP and JBMC2 program schedules both move in the right direction and result in integrated test capability improvements delivered at the right times.

An aggressive acceleration of the currently planned JDEP-like technical framework and I-Build is necessary to meet the end of FY 2008 interoperability deadline for JBMC2 systems. Current long-range plans define JDEP-like upgrades scheduled at the start of FY

2008 (perhaps by the middle of FY 2007 as an optimistic assessment). This essential schedule acceleration requires significant resources to be directed to JDEP and test development, execution, and analysis. The schedule also implies that a JDEP Joint Program Office with stable funding and management may need to be established in the near term to replace or formalize the presently existing DISA office. A formal JDEP initiative should be a management alternative for enabling JDEP evolution. JDEP will also need to be upgraded to allow for on-line connections such as Internet Protocol (IP), beyond the currently supported ATM protocol to support full-scale cluster interoperability testing. This approach anticipates the need to test each cluster of merging JBMC2 FOS about once a year. Test planning and management of JBMC2 tests and JDEP-like test cycles must be synchronized. Current JDEP-like test cycles occur at approximately one-year intervals (six to nine months event planning; about three months to run the event; and six to nine months for analysis and resulting improvements, with the planning and analysis periods able to overlap). With the currently planned JDEP-like evolution schedule, JBMC2 systems will only have time for one set of full-scale cluster tests. Under the aggressive accelerated schedule recommended in this Roadmap, each JMT cluster can undergo discovery, midpoint, and capstone testing in time for problem resolution and certification by end of FY 2008. The recommended plan for the JBMC2 and JDEP-like evolution synchronization process is as follows:

- Phase 1: Development and Implementation (now to 10/1/2006).
    - Planning for initial JDEP-like events, for one to two program clusters (1/1/2005–10/1/2005).
    - JBMC2 Operational Concept, JMT analysis v.1, Common Interfaces v.1 all done (10/1/2005).
    - Incorporation of v.1 JMT requirements and common interfaces; initial JDEP testing and analysis (10/1/2005–10/1/2006).
- Phase 2: First major round of JDEP-like testing and initial exercises, for all JBMC2 near-term clusters (10/1/2006–10/1/2007).
- Phase 3: Second major round of JDEP-like testing and capstone exercises for all JBMC2 near-term clusters (10/1/2007–10/1/2008).
- Interoperability for near term clusters achieved (10/1/2008).
- Interoperability for far term clusters achieved (10/1/2012).

Of special consideration during the JBMC2 and JDEP-like evolution synchronization process is the insertion of a test of the JDEP-like infrastructure itself. The JBMC2

Roadmap's recommendation is to test a system –of systems that has shown interoperability success in other test venues (e.g., Navy DEP, joint exercises and experiments). A candidate for the initial test of JDEP-like infrastructure is the General Command and Control System (GCCS).

10.10 JBMC2 T&E Risks

Three key risk associated with JBMC2 T&E have been identified as of this version of the JBMC2 Roadmap. Development of a complete risk identification, mitigation, monitoring, and management plan for JBMC2 T&E is beyond the scope of the current JBMC2 Roadmap charter but must be developed and executed upon acceptance of the JBMC2 Roadmap.

10.10.1 Codependence on Proposed JDEP-like Evolution

The JBMC2 T&E high-level schedule illustrated in Figure 10.6 and aggressive acceleration of the currently planned JDEP-like technical framework described in section 10.9.6 are codependent. The JBMC2 T&E methodology does include LVC tests, including joint exercises, and is not solely reliant on JDEP-like evolution. JDEP-like evolution is critical to enabling distributed tests for SWIL tests. Scheduling, development, cycle time for availability, and the need for greatly enhanced instrumentation have created a large risk for the JBMC2 programs. The co-evolution strategy with risk mitigation strategies needs to be developed. The entire JBMC2 T&E strategy relies on this capability unless the alternatives are properly developed.

10.10.2 Demand for Digital Representations

Existing programs may not have current funding nor may they be required to develop and support digital representations of their systems and appropriate simulations. In some cases, these simulations may require as much time to develop as the system itself. Funding for these efforts should be identified as a risk. There is concern that the models, emulations, and simulation that are not current requirements will be a financial drain on a system in which dollars need to be spent fixing known interoperability problems rather than writing simulations that model non-interoperable systems.

10.10.3 Need for Accelerated PPBE Process

The process as described depends upon changing the PPBE process to provide rapid access and funding. Given the need for testing, infrastructure, and tools to execute JBMC2 T&E through FY 2008 and the current PPBE Program Objective Memorandum (POM) FY 2006 planning, accelerated funding is at risk, as well as changes to the PPBE process in time to affect JBMC2 T&E. These PPBE process and funding risks are addressed elsewhere in policy and guidance and are recognized in this section as risks, but mitigation and management responses are not herein recommended.

10.11 JBMC2 T&E Conclusions and Recommendations

First, as a result of considering the JBMC2 T&E strategy, methodologies, roles and responsibilities, a key question, currently unanswered, arises. If incremental development and incremental capability improvement are the overriding paradigms for managing a family of net-enabled, software-intensive systems that individually are capable of periodic version upgrades, is “certification” feasible and cost-effective? If we are testing to measure the effect of incremental improvements to close capability gaps, vice testing to satisfaction of documented requirements, is it not true that any certification must have an extremely temporary period of effectiveness before something changes and renders the terms of the certification moot? If so, what is the cost of certification compared with the extremely limited period of utility of the certification?

JBMC2 T&E must be an effective tool to measure the progress of JBMC2 systems in achieving JMT capability, interoperability, and net-centricity requirements. This requires distributed HWIL and SWIL testing of JBMC2 systems, primarily using JDEP as its enabling infrastructure. Live testing utilizing the JNTC, for example, is also essential to JBMC2 T&E. However, current JDEP capabilities, development schedules, and resources are not adequate to meet required JBMC2 test capabilities and dates, and live testing cannot fully substitute for required JBMC2 T&E events. An aggressive accelerated schedule for JDEP-like evolution has been defined that supports JBMC2 test objectives. To ensure a robust JDEP-like capability supporting meaningful and adequate JBMC2 testing, the following steps are required:

- JDEP-like evolution should be adequately resourced and centrally managed, e.g., via a joint program office or initiative.
- JBMC2 test planning, events, and findings must be integrated with JBMC2 system development schedules.
- Clear and robust links must be established between JBMC2 testing, JCIDS, PPBE, and Defense Acquisition Process such that JBMC2 test results drive identification of interoperability and capability shortfalls, the allocation of resources to correct them, and the development and fielding of those fixes.
- Capabilities currently operational or expected to be operational in the near term must be available for HWIL testing in the JDEP-like environment.
- Digital representations of systems under development must be developed in synch with the proposed test schedule.

- Service-specific Program Manager champions should be selected to use JDEP-like environment for JBMC2 T&E. These Service-specific Program Managers champions would serve as a management hedge, "shaking out" and solving issues in the infrastructure or methodology vice distracting focus from JBMC2 test execution.

10.12 JBMC2 Pathfinders V2.0 Major C2 Systems & Platforms

Data as of March 9, 2004. Source: DISA, JITC.

Table 10.3—Major C2 Systems & Platforms

SYSTEM	CERTIFIED ORD/CDD/CPD	CERTIFIED IKPP/IERS	TEST CERTIFICATION STATUS	SCHEDULED TEST EVENT/REMARK
Air Force				
GCCS-AF	NO	NO	NONE	DCAPES, MAY 04
TBMCS	9 JUL 01 (ORD)	YES	SPEC INT	DT MAY/JUN 04; OT AUG 04
Army				
AFATDS	NO	NO	NONE	ABCS SW BLK 1, VER 6.4 JUN 04
FAADC2I	NO	NO	SCT	TDL JIT 04-03 (LINK 16), TDL JIT 04-05 (LINK 11B), ABCS SW BLK 1, VER 6.4 JUN 04
FBCB2	15 FEB 02(ORD)	YES	NONE	ABCS SW BLK 1, VER 6.4 JUN 04
GCCS-A	3 AUG 00 (ORD)	YES	SPEC INT	OT MAY 04, ABCS SW BLK 1, VER 6.4 JUN 04
MCS	3 SEP 02 (ORD)	YES	SPEC INT	ABCS SW BLK 1, VER 6.4 JUN 04, OT EARLY 2005
FCS	14 MAR 03 (ORD)	YES	COORINATING W/PM	ABCS SW BLK 1, VER 6.4 JUN 04
Navy				
GCCS-M	NO	YES(NC)	ICTO	COORDINATING W/PM
Joint				
GCCS-J	7 JUL 02 (ORD)(NC)	YES	SPEC INT	OT(A) MAY 2004 (JOPES); OT(B) TBD (COP)
JC2	19 FEB 03(ORD)	YES	NONE	NONE (2010)

PLATFORM	CERTIFIED ORD/CDD/CPD	CERTIFIED IKPP/IERS	TEST CERTIFICATION STATUS	SCHEDULED TEST EVENT/REMARK
Air Force				
AWACS(30/35)	NO	NO	SCT	TDL JIT 04-03 (CONCURRENT OPS)
AWACS(40/45)	6 MAY 03 (ORD)	YES	COORDINATING W/PM	FY 05/06
JSTARS(BLK 10)	18 OCT 00(ORD)(NC)	YES	SPEC INT	NONE
JSTARS(BLK 20)	30 JUN 03(ORD)(NC)	YES	SPEC INT	TDL JIT 04-06 (LINK 16), COMMON GROUND STATION CERT 2002
MC2A	12/1/03(CDD)(NC)	NO	COORDINATING W/PM	NONE
Navy				
AEGIS	1 JUL 98 (CRD)	NO	NONE	TDL JIT 04-04 (LINK 16 VER 6.3.2)
E-2C	22 JUL 02 (ORD)(NC)	YES	SPEC INT	NONE
USMC				
C2PC	NO	NO	NONE	NONE
TCO	2 AUG 95(ORD)	NO	SPEC INT (MCS->TCO)	NONE
Joint				
DJC2	22 JUL 03 (ORD)	YES	COORDINATING W/PM	NONE
JSF	31 MAR 03(ORD)	YES	COORDINATING W/PM	2008-2012

* System level program established with JITC POC

SPEC INT	SPECIFIED INTERFACE
SCT	STANDARDS CONFORMANCE TEST
NC	NON-CONCUR FROM JOINT STAFF

Green	JOINT CERTIFIED
Yellow	PROGRESSING TOWARD CERTIFICATON
Red	NOT CERTIFIED

10.13 JBMC2 Pathfinders V2.0 Major ISR Systems & Platforms

Data as of March 9, 2004. Source: DISA, JITC.

Table 10.4—Major ISR Systems & Platforms

SYSTEM	CERTIFIED ORD/CDD/CPD	CERTIFIED IKPP/IERS	TEST CERTIFICATION STATUS	SCHEDULED TEST EVENT/REMARK
Air Force				
DCGS-AF	16 NOV 00 (ORD)	YES	COORDINATING W/PM	APR-SEP 04
DIB	N/A	N/A	N/A	DCGS INTEGRATION BACKBONE
JSTARS(BLK 10)	18 OCT 00(ORD)(NC)	YES	SPEC INT	NONE
JSTARS(BLK 20)	30 JUN 03(ORD)(NC)	YES	SPEC INT	TDL JIT 04-06 (LINK 16)
Raindrop	NO	NO	NONE	NONE
MC2A	12/1/03(CDD)(NC)	NO	COORDINATING W/PM	NONE
Army				
ABCS/ASAS	NO	NO	NONE	ABCS SW BLK 1, VER 6.4 JUN 04
DCGS-A	2 DEC 03(ORD)(NC)	YES	SPEC INT	APR 04 - JAN 05
Navy				
DCGS-N	NO	NO	SPEC INT	JUNE 04 - DEC 04
USMC				
DCGS-MC	NO	NO	COORDINATING W/PM	JUNE 04 - NOV 04

PLATFORM	CERTIFIED ORD/CDD/CPD	CERTIFIED IKPP/IERS	TEST CERTIFICATION STATUS	SCHEDULED TEST EVENT/REMARK
Air Force				
GH (Global Hawk)	3 SEP 02(ORD)	YES	SCT	SEP 2005
MP-RTIP	29 MAY 03(ORD)	YES	NONE	NONE/RECOMMEND REMOVE
Army				
ACS	4 JUN 03 (ORD)(NC)	YES	NONE	NONE
Navy				
AESA(F/A-18)	27 OCT 03 (ORD)	YES	NONE	NONE
MMA	20 OCT 03(ORD)	YES	COORDINATING WITH PM	

* System level program established with JITC POC

SPEC INT	SPECIFIED INTERFACE
SCT	STANDARDS CONFORMANCE TEST
NC	NON-CONCUR FROM JOINT STAFF

(green)	JOINT CERTIFIED
(yellow)	PROGRESSING TOWARD CERTIFICATON
(red)	NOT CERTIFIED

10.14 JBMC2 Pathfinders V2.0 Joint Force Networking

Data as of March 9, 2004. Source: DISA, JITC.

Table 10.5—Joint Force Networking

SYSTEM	CERTIFIED ORD/CDD/CPD	CERTIFIED IKPP/IERS	TEST CERTIFICATION STATUS	SCHEDULED TEST EVENT/REMARK
Air Force				
AEHF	6 SEP 00 (ORD)	YES	NONE	MOT&E TESTING PLANNED ONCE SATELLITE IS IN ORBIT, 2006 TIMEFRAME
Army				
WIN-T	10 FEB 03 (ORD)	YES	COORDINATING W/PM	CONTINUOUS TESTING
Navy				
ATDLS	NOT IN STP/JCPAT			NONE
CEC	6 NOV 01 (ORD)	YES	NONE	NONE
JTIDS	NO	NO	NONE	EXPIRED CERTIFICATION
MIDS	15 JUL 03 (ORD)	YES	SPEC INT	CONTINUOUS TESTING
Joint				
GIG-BE	8 DEC 03(ICD)	NO	COORDINATING W/PM	17 JUN - 24 JUL 04, 13 AUG - 13 SEP 04
JTRS	20 FEB 03 (ORD)	YES	COORDINATING W/PM	STARTS FY05 THEN ONGOING
NCES	NOT IN STP/JCPAT		COORDINATING W/PM	
DoDT(Teleport)	25 MAR 03(ORD)	YES	COORDINATING W/PM	GENERATION 1, IOC 2, AUGUST 04
TSAT	NO	NO	NONE	TESTING PLANNED ONCE SATELLITE IS IN ORBIT, 2011 TIMEFRAME

* System level program established with JITC POC

SPEC INT	SPECIFIED INTERFACE
SCT	STANDARDS CONFORMANCE TEST
NC	NON-CONCUR FROM JOINT STAFF

Green	JOINT CERTIFIED
Yellow	PROGRESSING TOWARD CERTIFICATON
Red	NOT CERTIFIED

11.0 Summary and Conclusions

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[41] 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*
- *Responsive and precise targeting information for integrated real-time offensive and defensive fires*
- *The ability to conduct coherent distributed and dispersed operations, including forced entry into anti-access or area-denial environments.*

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 theater-wide Blue Force Tracking (BFT) capabilities and other JBMC2 capabilities, such as the Automated Deep Operations Coordination System (ADOCS), 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 ASD(NII)'s ambitious plans for increasing the capabilities of operational- and tactical-level communications networks, and information management and discovery capabilities.

[41] *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).

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, JBMC2 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.

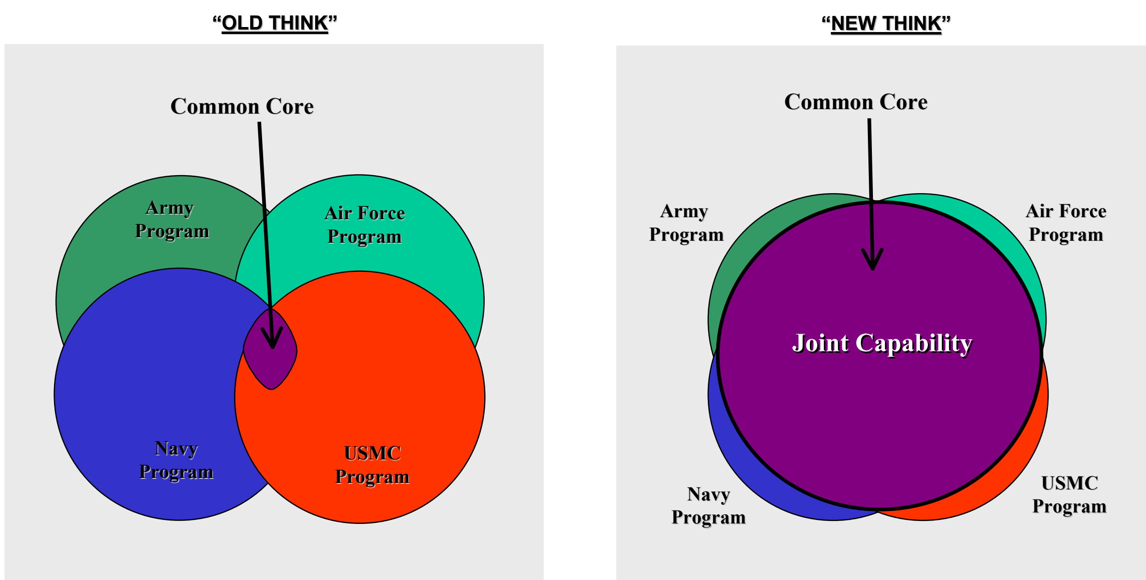

Figure 11.1—DoD's Philosophical Shift

11.2 JBMC2 Capability Integration Strategy

This roadmap will be the vehicle for prioritizing, aligning, and synchronizing Service JBMC2 architectural and acquisition efforts. Where policy and other acquisition initiatives are defined to drive JBMC2 developments and related activities, the specific means of application to JBMC2 will be via updates to this roadmap and decisions made by the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) and U.S. Joint Forces Command (USJFCOM) to ensure overall harmonization across affected efforts and programs. This roadmap provides a strategy with three major parts for integrating current and planned JBMC2 capabilities. These are described below.

JBMC2 Capabilities Development and Implementation. The first part of the strategy will focus on the development, implementation, and testing of the elements needed to provide enhanced JBMC2 capabilities for the warfighter. Figure 11.2 shows major milestones for the components of this part of the strategy.

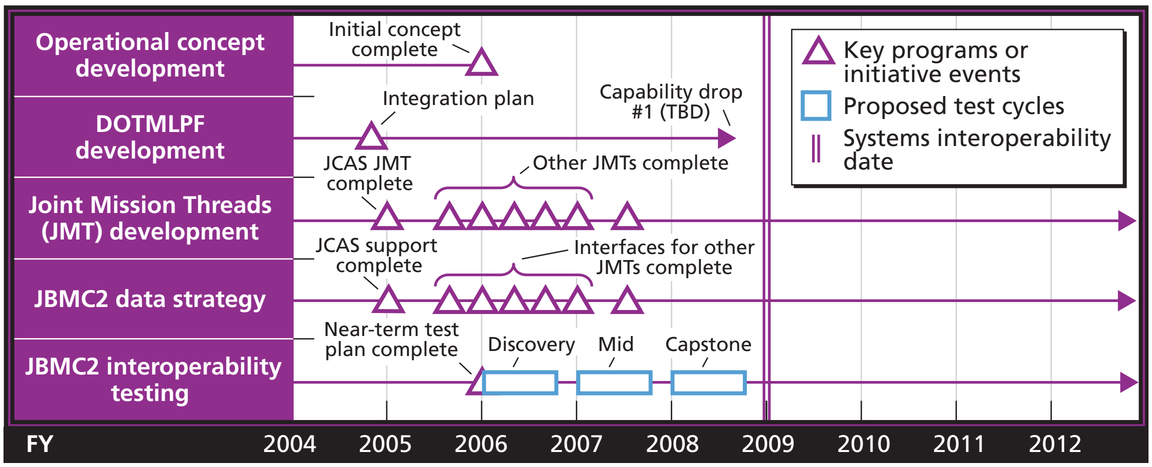

Figure 11.2—JBMC2 Capabilities Development and Implementation

USJFCOM will devise a plan for developing an overarching JBMC2 operations concept that will guide integration of Service JBMC2-related Concepts of Operations. A comprehensive plan to develop this operations concept will be completed by the end of Fiscal Year (FY) 2004. The operational concept will be completed by the start of FY 2006.

USJFCOM will develop a comprehensive, overarching outline in FY 2004 for the joint approach to provide nonmateriel parts of integrated JBMC2 capability solutions to the warfighter.

In collaboration with the Services, USJFCOM will lead the development of JBMC2 Joint Mission Threads (JMTs), which are comprehensive descriptions of architectural elements (including associated operational requirements and the system of systems engineering approach), of how the joint force will execute seven key warfighting capabilities using major JBMC2 capabilities. The seven JBMC2 JMTs are:

- Joint Close Air Support (JCAS)
- Joint Ground Maneuver
- Time-Sensitive Targeting
- Joint Force Command and Control

- Integrated Air/Missile Defense
- Integrated Fires
- Focused Logistics.

A comprehensive approach for integrating the JMTs will be developed that will ensure that the situational awareness and collaboration capabilities defined in the JMTs are common across JMTs and therefore will be common across the joint force.

Figure S.1 identifies when the analyses for each JMT will be completed (the first JCAS JMT analysis will be completed by the end of FY 2004). All JMT analyses will be completed by FY 2007 to allow approximately two years for JBMC2 integration and interoperability testing prior to FY 2009, the deadline the Deputy Secretary of Defense has established for the integration or phase-out of legacy JBMC2 systems.[42] Evolutionary development of the JMTs will continue past FY 2006 to respond to lessons learned from capabilities testing. JMT development past the FY 2009 interoperability deadline will capitalize on the Global Information Grid (GIG) net-centric infrastructure improvements that will be available in FY 2009 and beyond.

In conjunction with JMT development, the JBMC2 Data Strategy defines how JBMC2 systems will interact with the network infrastructure (both current and future net-centric infrastructure) to share information. Key to this data strategy are *JBMC2 common interfaces,* which are comprehensive descriptions for how a set of information will be shared in common across JBMC2 systems, ranging from high-level models and rules for representing information to technical specifications for using the network infrastructure. The interfaces supporting the JCAS JMT will be completed by the end of FY 2004, in parallel with JCAS JMT development; the interfaces supporting other JMTs (different from those developed for JCAS) will be developed by the end of FY 2006. Evolution of the interfaces will continue after FY 2006 to respond to lessons learned from capabilities testing. As with the JMTs, USJFCOM will lead development of the common interfaces.

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 incorporates a series of joint interoperability tests that demonstrate how well planned improvements in JBMC2 capabilities are being implemented. Test plans will be developed for ensuring that JBMC2 systems are interoperable by or shortly after the start of FY 2009. Figure 11.2 shows the major testing milestones and proposed test cycles between now and FY 2009. Each cycle will comprise a number of test events, to be determined in accordance with systems engineering needs. The first cycle, to be held in FY 2006, is intended to discover interoperability problems in providing JBMC2 capabilities. The second cycle, in FY 2007, is intended to evaluate progress in providing the capabilities. The final cycle, in FY

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

2008, is the only traditional capstone "test" series, intended to certify whether systems are providing the needed capabilities.

Interoperability test events within each cycle will examine the ability of each JBMC2 program cluster to jointly provide an end-to-end JBMC2 capability. The program clusters will parallel the seven JMTs described above. The cornerstone of the program clusters will be a set of JBMC2 Pathfinder Programs described later in this roadmap, which correspond to those major programs providing critical JBMC2 functionality across the JMTs. Each JBMC2 program cluster will undergo testing in each of the three cycles scheduled prior to FY 2009, as described above.

Where possible, these joint interoperability tests will employ hardware-in-the-loop and software models of JBMC2 systems using Joint Distributed Engineering Plant (JDEP)-like capabilities so that interoperability problems can be caught early and corrected before more expensive full-scale operational testing is done. In order to meet the ambitious test schedule presented in this roadmap, the JDEP-like capabilities of the DoD test community have to be expanded significantly. A plan for doing this is laid out in this roadmap.

Plans to Make Interoperable or Converge JBMC2 Programs. The second part of the JBMC2 integration strategy provides plans to make interoperable or converge JBMC2 programs, as shown in Figure 11.3.

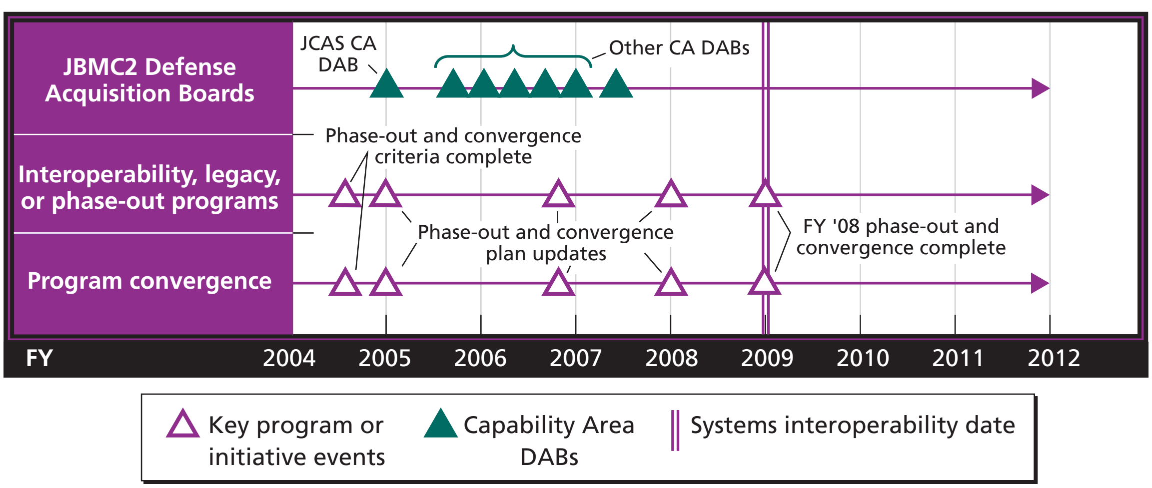

Figure 11.3—Plans to Make Interoperable or Converge JBMC2 Programs

The integration strategy for JBMC2 program clusters defined by the USJFCOM JMT analysis will be approved by USD(AT&L). USD(AT&L) will be the Milestone Decision Authority for JBMC2 program clusters. The USD(AT&L) will convene Capability Area Defense Acquisition Boards (DABs) as required to assess progress in developing integrated JBMC2 capabilities for JBMC2 program clusters. The first DAB, for the JCAS JMT Program Cluster, will be conducted at the end of FY 2004, in conjunction with the completion of the JCAS JMT and supporting common interfaces. DABs for the remaining JMT program clusters will be held by the end of FY 2006.

The second row of Figure 11.3 shows how JBMC2 system interoperability and legacy phase-out criteria will be developed and applied to designated 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). Objective and transparent criteria for identifying interoperable and legacy systems are presented in this first-order roadmap. Comprehensive system interoperability and legacy phase-out processes (that factor in potential value of JBMC2 initiatives) will be in place by the end of FY 2004. Legacy systems will be identified with the objective of making the majority of them interoperable or completing their phase-out by FY 2009. JBMC2 program convergence and phase-out plans will be updated as required to support JBMC2 Capability Area DABs. The third row of Figure 11.3 shows that a program convergence process will be in place by the end of FY 2004, with the objective of converging selected programs into a smaller set of interoperable programs by the start of FY 2009.

JBMC2 Initiatives. The third part of the strategy addresses the battlespace picture initiatives and net-centric underpinnings, which are key to providing integrated JBMC2 capabilities. The key milestones for these initiatives are shown in Figure 11.4.

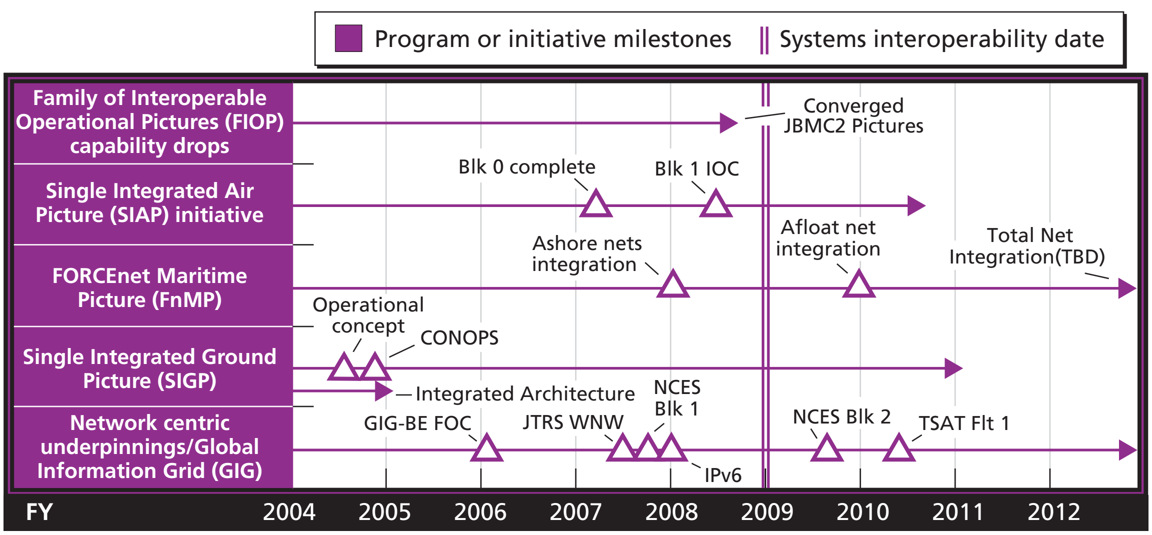

Figure 11.4—JBMC2 Initiatives

In accordance with Management Initiative Decision (MID) 912,[43] the joint battlespace picture initiatives have been placed or will fall under the oversight and directive

[43] *Joint Battle Management Command and Control*, Management Initiative Decision 912, January 7, 2003.

authority of USJFCOM. These key elements include USJFCOM's Family of Interoperable Operational Pictures (FIOP) and 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.

FIOP is developing a range of applications and services for insertion into programs of record, which can be used to integrate JBMC2 systems. These FIOP capability drops are not shown explicitly in Figure 11.4 but are discussed in detail in this roadmap. These will facilitate the ability to generate battlespace pictures relevant to the joint warfighter by FY 2008.

SIAP 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 milestones for the Navy's FnMP are shown in Figure 11.4. These milestones ensure that FORCEnet ashore communications networks can be integrated into the GIG and that afloat communications networks can rapidly assimilate SIAP and FIOP capability drops. The integration of Joint Command and Control (JC2) into the FORCEnet afloat JBMC2 architecture is recommended to occur by FY 2009.

SIGP was initiated in FY 2004 and will fall under USJFCOM MID 912 oversight in the future. SIGP will develop Doctrine, Organization, Training, Materiel, Leadership, Personnel, and Facilities (DOTMLPF) operational products under the leadership of USJFCOM; in FY 2004 and FY 2005, 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 11.4. 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 makes the transition 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.

JBMC2 Capability Development and Integration Management

USD(AT&L) leads the development of the JBMC2 Roadmap, in partnership with USJFCOM, and with the participation of the Joint Staff, Joint Requirements Oversight Council (JROC) (or FCBs on behalf of the JROC), Program Analysis & Evaluation, Services, and Agencies. In accordance with DoD 5000.2, Operation of the Defense Acquisition System, the DoD will use this roadmap to conduct capability assessments, guide systems development, and define the associated investment plans as the basis for aligning resources and as an input to Strategic Planning Guidance, Program Objective Memorandum development, and program and budget reviews.

USD(AT&L) also will review and approve the integration strategy for each JMT program cluster, and will be the milestone decision authority for JBMC2 program clusters. USD (AT&L) will convene Capability Area DABs as required to assess progress in developing integrated JBMC2 capabilities for specific JMTs and associated program clusters. JBMC2 Capability Area DABs will be chaired by USD(AT&L).

USJFCOM will lead development of JBMC2 capabilities, including the development of JMTs, and the integrated JBMC2 architectures that are based on approved operational systems. It will also present technical architecture views developed in accordance with DoDI 5000.2. and MID 912, which states that "USJFCOM, in coordination with the Chairman, Joint Chiefs of Staff, will lead Combatant Commanders in the development of joint doctrine, concepts, requirements, and integrated architectures for BMC2 interoperability and connectivity." The JBMC2 Board of Directors, chaired by the USJFCOM Deputy Commander, will be the principal forum for leading JBMC2 capabilities development and reviewing subsequent requirements.

The Joint Staff (or Principal Staff Assistant [PSA] for business areas) and the Joint Requirements Oversight Council (JROC) (or Functional Capabilities Boards (FCBs) on behalf of the JROC) will review and approve requirements associated with JBMC2 programs and will participate in the JMT development efforts described above, in accordance with the Joint Capabilities Integration and Development System (JCIDS) process (CJCSI 3170.01D). The Joint Staff and JROC will also review and approve requirements proposed by the USJFCOM-led JBMC2 development and engineering efforts as needed to bring about integrated JBMC2 capabilities.

Additional Future Steps

USD(AT&L) and USJFCOM are jointly developing, for inclusion into the next update of the JBMC2 Roadmap, a systems engineering approach linking the operational and tactical capabilities defined in the JMTs with the procurement and development expertise of the Services and agencies to ensure integrated JBMC2 capabilities result from the development and testing process defined herein.

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 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 USJFCOM.
- 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.

Data Interoperability. The ability to exchange data across system or organization boundaries and to have that data correctly interpreted by all parties. (Joint Publications 1-02, January 2003).

FIOP. A multi-Service effort under USJFCOM 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 USJFCOM J8 in determining the best approach to ensure coherence, synergy and interoperability across the other picture efforts.

Integrated Architecture. An architecture description is defined to be an integrated architecture when products and their constituent architecture data elements are developed such that architecture data elements defined in one view are the same (i.e., same names, definitions, and values) as architecture data elements referenced in another view. The term integrated architecture refers to an architecture description that has integrated Operational, Systems, and Technical Standards Views. That is, there are common points of reference linking the OV and the SV and also linking the SV and the TV. For example, SV-5 relates operational activities from OV-5 to system functions from SV-4; the SV-4 system functions are related to systems in SV-1, thus bridging the Operational and Systems Views. Integrated architectures with Doctrine, Organization, Training, Materiel, Leadership & education, Personnel, and Facilities (DOTMLPF) information provide important tools to facilitate coordination between requirements document developers, planners, programmers, budgeters, system acquirers and developers, and interoperability enforcers. These architectures clarify roles, boundaries, and interfaces between components of large systems of systems and influence participants in requirements generation, acquisition, resource allocation, interoperability enforcement, and waiver processes. Integrated architectures are the primary tool for enterprise-level systems integration. An integrated architecture as referenced in DoDI 5000.2, DoDI 4630.8, CJCSI 3170.01, and CJCSI 6212.01 consists of AV-1, AV-2, OV-2, OV-3, OV-5, SV-1, and TV-1, at a minimum. Additional products should be developed for a given architecture description depending on the architecture's intended use.

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 allows 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 (Joint Publications 1-02, January 2003).

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, decision-makers, 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: Multi-Service 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.

Semantics. Refers to some kind of meaning (of something that is written) and is thus usually opposed to syntax, which refers to the formal way in which something is written.

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 decision-making. (MIL-STD-499B)

Vocabulary. Denotes a range of artifacts that convey meaning: ontologies, taxonomies, symbology, data models and standard data elements, reference data, interface specifications transformation mappings, and so on. All of these are a way to document semantics which, when agreed, permit people and their information systems to communicate.

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
CENTCOM	Central Command
CES	Core Enterprise Services
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/Surface Systems—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, Training, Materiel, Leadership, Personnel, and Facilities

DPG	Defense Planning Guidance
DT	Development Test
DTSS	Digital Topographic Support System
DU	Deployed Unit
DWCF	Defense Working Capital Fund
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
USJFCOM	U.S. Joint Forces Command
JFN	Joint Fires Network
JITC	Joint Interoperability Test Command
JLENS	Joint Land-Attack Cruise Missile Defense Elevated Netted Sensor
JMT	Joint Mission Thread
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	Network 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
P3I	Pre-Planned Product Improvement
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

TACP	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—Navy
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 Structure
UE	Unit of Employment
USA	U.S. Army
USAF	U.S. Air Force
USD AT&L	Under Secretary 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

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.
- CJSCM 3500.04C: Universal Joint Task List (UJTL), 1 July 2002
- JP 1-02: DOD Dictionary of Military and Associated Terms, 12 April 2001, as Amended through 17 December 2003
- JP 3-60: Joint Doctrine for Targeting, 17 January 2002
- MID 912: Joint Battle Management Command and Control, 7 January 2003
- DoD Architecture Working Group: DoD Architecture Framework (DODAF) Version 1.0, 30 August 2003

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

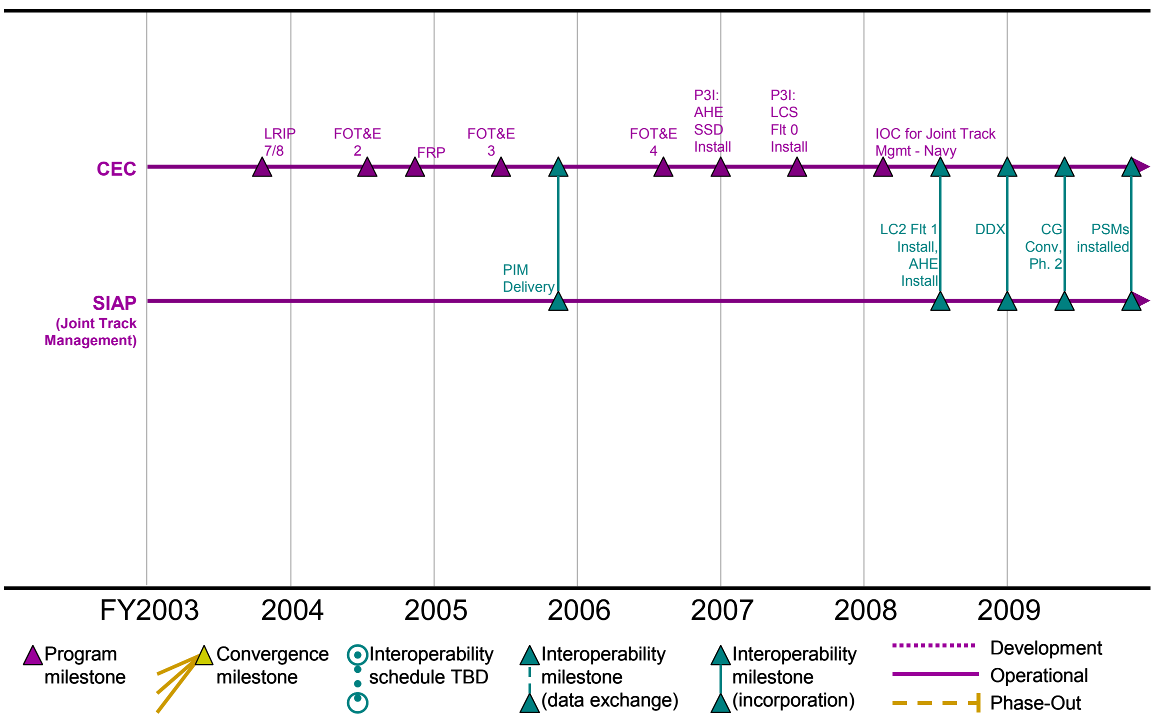

Figure D.1—CEC

D.2 MC2A

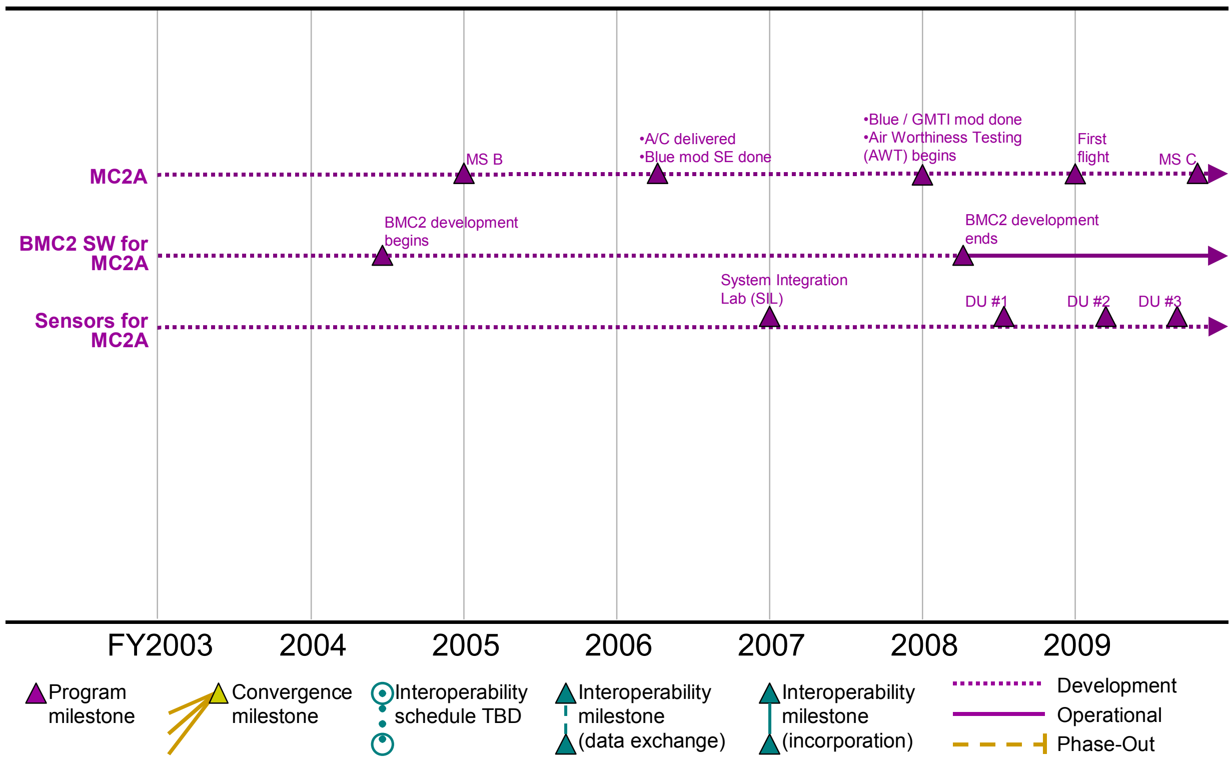

Figure D.2—MC2A Timelines

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.

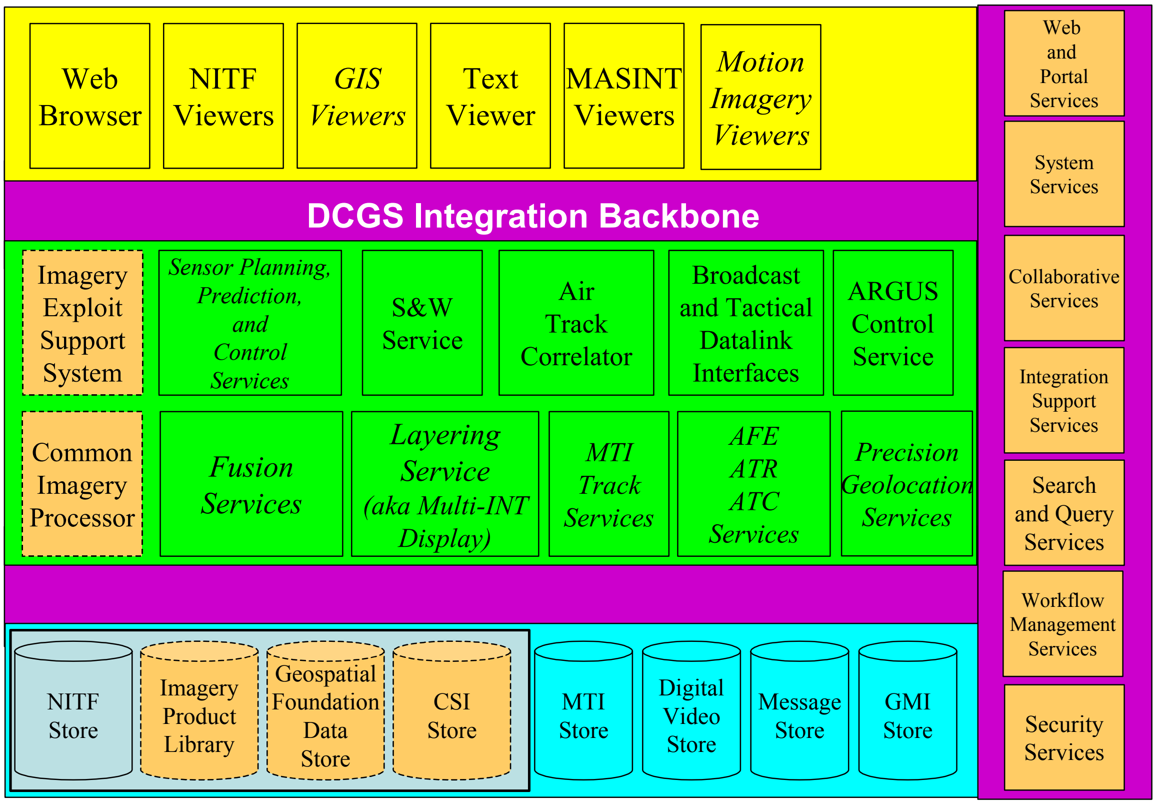

Figure D.3—Services Migrating to the DIB

E. JCAS Mission Cluster Programs

Acronym	Sponsor	Program Name	Category	Time Frame	ACAT Level
ITS	USAF	Interim Targeting Solution	Mission	C	
FALCONVIEW	USAF		Mission	C	
TAIS	USAF	Tactical Airspace Integration System	Mission	C	
TUAV	Army	Tactical UAV	Mission	C	
MTIX	USAF	Moving Target Information Exploitation	Mission	C	
IMTDS	Navy	Improved Multi-TDL Translating and Display System	Mission	C	
TACP Mod	USAF	Tactical Air Control Party Modification program	Mission	C	
THS-X	USMC	Target Hand-off System Experimental	Mission	C	
AFSOC BAO	ARMY	Battlefield Air Operations Kit	Mission	C	
DCS	NAVY	F/A-18 Digital Comms System	Mission	C	
MTS	USMC	AV-8 Marine Tactical System	Mission	C	
IDM	AF	Improved Data Modem (F-16 Block 40)	Mission	C	
IDM	AF	Improved Data Modem (B-52)	Mission	C	
IDM	AF	Improved Data Modem (AC-130)	Mission	C	
SADL	AF	Situation Awareness Data Link (Airborne EPLRS)	Mission	C	
EPLRS	ARMY	Enhanced Precision Location System	Mission	C	
Raindrop	USAF	DCGS-AF / Raindrop	Pathfinder 1	C	
ABCS-AFATDS	ARMY	ABCS / Advanced Field Artillery Tactical Data System	Pathfinder 1	C	
ABCS-FBCB2	ARMY	ABCS / Force XXI Battle Command Brigade and Below	Pathfinder 1	C	ACAT-1D
TBMCS	USAF	Theater Battle Management Core Systems	Pathfinder 1	C	
TCO	USMC	Tactical Combat Operations System	Pathfinder 1	C	
C2PC	USMC	Command and Control PC	Pathfinder 1	C	
MIDS	NAVY	Multi-function Information Distribution System	Pathfinder 1	C	ACAT-1C
JTIDS	NAVY	Joint Tactical Information Distribution System	Pathfinder 1	C	
FCS	ARMY	Future Combat System	Pathfinder 1	F	ACAT-1D
MC2A	USAF	Multi-Mission Command & Control Aircraft	Pathfinder 1	F	
JC2	DISA	Joint Command and Control	Pathfinder 1	F	
NCES	DISA	Net-Centric Enterprise Services	Pathfinder 1	F	
JTRS	Services / NII	Joint Tactical Radio System (all clusters)	Pathfinder 1	F	ACAT-ID
JSTARS	USAF	Joint Surveillance Target Attack Radar System	Pathfinder 2	C	ACAT-1C
AWACS	USAF	Airborne Warning and Control System (Mods and Upgrades)	Pathfinder 2	C	
ATDLS	Navy	Advanced Tactical Data Links (Link 11, Link 16, Link 22)	Pathfinder 2	C	
WIN-T	ARMY	Warfighter Information Network Tactical	Pathfinder 2	C	
JSF	AF/Navy	Joint Strike Fighter	Pathfinder 2	F	ACAT-1C
E-2C	Navy	Early Warning C2 Aircraft	Pathfinder 2	C	ACAT-1C
USMC H-1	Navy	AH-1W Attack Helo	Pathfinder 2	C	ACAT-1D
F/A-18E/F	Navy	Attack Aircraft	Pathfinder 2	C	ACAT-1C
WEEMC	USAF	Web-Enabled Execution Management Capability	FIOP	C	
BFT	SOF	Systems to be determined	Mission	C	
GB-BFT		Grenadier BRAT-BFT	Mission	C	
MTX-BFT		Miniature Transmitter-BFT	Mission	C	
LEOPARD	Army	BFT	Mission	C	
FBCB2/OmniTRACS	Army	Bosnia FBCB2/OmniTRACS-BFT	Mission	C	
MTS	Army	MTS Architecture-BFT	Mission	C	
COBRA	Army/NRO	COBRA-BFT	Mission	C	
LYNX	Navy	LYNX-BFT	Mission	C	
Nugget	NRO	Nugget-BFT-	Mission	C	
CSEL	AF	CSEL-BFT	Mission	C	

Figure E.1—JCAS Mission Cluster Programs

Shown in Figure E.1 is the complete list of JBMC2 programs for the JCAS Mission Thread. Both current and future programs are shown and the list is color coded according to the type of program. Pathfinder increment one and two programs are shown in purple and green respectively. Mission programs are shown in white and the JBFSA collection of programs is shown in yellow. A subset of these programs, as defined in Section 2.4, will form the cluster of JBMC2 programs for the JCAS Mission Thread.

F. Systems With Which FCS Is To Be Interoperable

Advanced Aviation Forward Area Refueling System (AAFARS)
Advanced Field Artillery Tactical Data System (AFATDS)
Air and Missile Defense Workstation (AMDWS)
Air Defense System Integrator (ADSI)
Airborne Standoff Minefield Detection System (ASTAMIDS)
All Source Analysis System (ASAS)
Army Airborne Command and Control System (A2C2S)
Army Command Training Information Architecture (ATIA)
Army Constructive Training Federation (ACTF)
Automated Deep Operations Coordination System (ADOCS)
Aviation Combined Arms Tactical Trainer (AVCATT)
Aviation Mission Planning System (AMPS)
Battle Command Sustainment System (BCS3)
Battlefield Video Telecon (BVTC)
Blue Force Tracking (BFT)
Bridge Site Mobility (BSM)
C-130 Hercules
C-17 Globemaster
C-5 Galaxy
Chemical Biological Nuclear Reconnaissance System (CBNRS)
Chinook CH-47
Class 4A SIGINT Payload (Tactical SIGINT Payload)
Class IV EO/IR (aka Adv EO/IR, ASTAMIDS
Class IV SAR/'MTI
Close Combat Tactical Trainer (CCTT)
Comanche RAH-66
Common Embedded Diagnostics (CED)
Common Training Instrumentation Architecture (CTIA)
Corps Battle Simulation RDTE (CBS)
Defense Collaboration Tool Suite (DCTS)
Defense Message System Army (DMS-A)
Digital Topographic Support System (DTSS)
Distributed Common Ground/Surface Systems (DCGS-A)
Distributed Learning System (DLS)
DoD Public Key Infrastructure (DoD PKI)
Electronic Time Fuse
Engineer Vehicle - Gap Crossing (EV-GC)

Engineer Vehicle - Physical Obstacle Detection/Neutralization (EV-PODN)
Excalibur (XM982) (Family of precision 155mm projectiles)
F-22 Raptor
Family of Interoperable Operational Pictures (FIOP)
Family of Medium Tactical Vehicles (FMTV)
Firefinder Radar Q36
Firefinder Radar Q37
Firefinder Radar Q47 (Phoenix Battlefield Sensor System)
Force XXI Battle Command Brigade and Below (FBCB2)
Forward Area Air Defense Command and Control (FAAD C3I)
Forward Repair System (FRS)
Global Broadcast System (GBS)
Global Combat Support System-Army (GCSS-A)
Global Command and Control System-Army (GCCS-A)
Global Positioning System (GPS)
Ground Standoff Minefield Detection System (GSTAMIDS)
Handheld Standoff Mine Detection System (HSTMIDS)
Heavy Expanded Mobility Tactical Truck - Load Handling System (HEMTT-LHS)
Heavy Expanded Mobility Tactical Truck - Tanker (HEMTT-TANKER)
Heavy Expanded Mobility Tactical Truck - Wrecker (HEMTT-WRECKER)
High Mobility Artillery Rocket System (HIMARS)
High Mobility Engineer Excavator (HMEE)
High Mobility Multipurpose Wheeled Vehicle (HMMWV)
HTI-2d GEN FLIR EO
IEW Tactical Proficiency Trainer (IEW TPT)
Improved Data Modem (IDM)
Integrated Broadcast System (IBS)
Integrated Meteorological System (IMETS)
Intelligent Munition System (IMS)
JAVELIN P3I
Joint Mission Planning System (JMPS)
Joint Tactical Ground Station (JTAGS)
Joint Tactical Radio Systems (JTRS 1)
Joint Tactical Radio Systems (JTRS 5)
Joint Warning and Reporting Network (JWARN)
Land Warrior II
Land Warrior III
Lightweight 120mm Cannon for Mounted Combat System
Lightweight Laser Designator Rangefinder (LLDR)
Lightweight Water Purifier (LWP)
Load Handling System Water Tank Rack (HIPPO)

Low Handling System Modular Fuel Farm (LHS MFF)
M1114 Up-Armored High Mobility Multipurpose Wheeled Vehicle (HMMVW)
Maneuver Control System (MCS)
Marine Corps Target Identification System (MCTIS)
Mark 7 Laser Target Locator (Mk VII)
Medium Range / Extended Range Munition (MRM/ERM)
Military Operations on Urbanized Terrain Objective Instrumentation System (MOUT-OIS)
Mongoose
Mortar Fire Control System (MFCS)
Movement Tracking System (MTS)
Multi-Option Fuze for Artillery (MOFA)
Multiple Integrated Laser Engagement System (MILES XXI)
Naval Fire Control System (NFCS)
New Generation Army Targetry Control System (NGATS)
Non-Lethal 155mm Cannon Munition (NL 155mm)
Non-Line-of-Sight Launch System (NLOS-LS)
One Semi-Automated Force (OneSAF)
ONE Tactical Engagement Simulation System (One TESS)
Palletized Loading System (PLS)
Palletized Loading System (PLS) Trailer
Precision Attack Missile (PAM)
Precision Guided Mortar Munition (PGMM)
Profiler (Meteorological Measuring Set) (MMS-P)
Radiac Set AN (UDR-13)
Rapidly Emplaced Bridge System (REBS)
Secure En Route Communications Package - Improved (SECOMP-I)
Soldier Combined Arms Tactical Trainer (Soldier-CATT)
Synthetic Environment Core (SE-CE)
Tactical Airspace Integration System (TAIS)
Tactical Combat Operations Systems (Marines C2) (TCO)
Tactical Electric Power (TEP)
Tactical Simulation (TACSIM) Constructive Simulation
Theater Battle Management Core System (TBMCS)
Theater Support Vessel (TSV)
Training Unique Ammo
UAV Class IV-b ILO (in lieu of)
Unit Water Pod System (Camel)
War Simulation (WARSIM)
Warfighter Information Network-Tactical (WIN-T)
XM307/XM312 Advanced Crew Served Weapon (Common Close Support Weapon)