TRADOC Architecture Management Program (TAMP)

1 September 2003

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TRADOC ARCHITECTURE MANAGEMENT PROGRAM (TAMP)

EXECUTIVE SUMMARY

This document is written primarily for the TRADOC architecture community and answers four basic questions: Who develops architectures? When are they developed? What do they consist of? and How does the process work? For the senior leaders involved in "architecting," the TAMP is a great resource. The processes and procedures detailed in this document support the accomplishment of many core TRADOC missions, e.g. development of Initial Capabilities Documents (ICD) and Capability Development Documents (CDD) (formally Operational Requirements Documents (ORD), shaping, guiding and informing concept development of mission threads for analysis and mission/task/purpose decomposition. It also provides a ready reference of architecture roles and responsibilities, and serves as a reference in determining resource requirements. It is not, however, a resourcing document.

The complexity of transforming the Army in today's and future environments mandates the utilization of a structured, disciplined process. The TAMP details roles and responsibilities as well as processes and procedures. In the past, the Unit Set Fielding (USF) schedule was the primary document in determining what architectures would be developed. Over time, architecture development has evolved to support all Army transformation development requirements, not just USF, and architectural analysis is required to describe, integrate, and maintain force capabilities. Within this effort many organizations play key roles. There are Army functional area "Domain" leads that will take on an increasingly important role in organizational, systems and functional architecture development. In addition, there are two new HQDA organizations – the Army Architecture Integration Cell (AAIC) and the Army Enterprise Integration Oversight Office (AEIOO) that will coordinate and integrate Army-wide architecture development.

A useful framework to approach this document is to ask "What is the necessity for a TAMP?"

- The nature of architecting has changed. Today we are developing entirely new organizations (Objective Force), systems architectures (Medical Communications for Combat Casualty Care - MC4) and functional architectures (Medical, Training, MWR). We are converting units to new configurations (Stryker Brigades), and we will continue to modernize the force. We are developing System of System Architectures (SoSA) for Future Combat Systems (FCS) and Family of System Architectures (FoSA), for the Unit of Action (Maneuver) that is comprised of FCS and complementary systems to include imbedded training, personnel, medical and logistics systems. Today, no architecture can be developed without consideration of the requirement for Joint interoperability.
- Architectures themselves require collaborative development, cross-BOS/BFA (UJTL tactical constructs) as well as increasingly cross Service boundary vertical and horizontal integration.

- The focus of architectures is on the development of capabilities and architecture information that shapes and informs concept development and decision-making.
- Not only must architectures be integrated, so must the databases that contain the data upon which significant portions of the architecture are based. Army databases will be integrated into DoD level systems, thus the data must be in an all DoD Core Architecture Data Model (ALL_CADM) format – useable by all.
- The architecture implications of transformation are extensive. The Transformation Campaign Plan (TCP), combined with the requirements of Objective Force, has identified over 50 architectures to be prioritized and initiated over the next two years. These requirements mandate the development of DA and TRADOC annual architecture development programs.

The TAMP is a living document. Process and procedures, roles and responsibilities and the nature of Army and Joint, Inter-Agency, and Multi-National (JIM) requirements continue to evolve at ever-increasing speed. The TAMP establishes a framework for managing the effort to develop supporting systems, functions and organizations. Annex A is a list of emerging architecture development efforts projected for the next decade. Detailed architecture development work will be outlined in an annual architecture development plan. The plan will incorporate architecture development requirements from higher headquarters as well as those that are internally generated. Architects will need the full support of Directors of Combat Developments (DCDs), Battle Lab Directors, Domain leads, proponent senior leadership and the TRADOC staff. Each must be aware of the tremendous contributions of the architecture development process within their area of responsibility.

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Chapter 1: Introduction

1.0 General: The TRADOC Architecture Development Program (TAMP) is written for personnel in the TRADOC architecture community who are in the business of developing, validating and approving TRADOC architectures. It is also written for staffers and decision makers who need information that can be derived from operational architecture data and products. It is intended to be a valuable deskside companion because it is organized to answer the WHY, WHO, WHAT, HOW, WHEN and WHERE of architecture; It is a process document and NOT a resource document. The architecture development environment continues to evolve; therefore, the TAMP is a living document and will be updated on a regular basis. This version of the TAMP is based on current information; future versions will build upon this foundation.

1.1 Purpose and Applicability: This document provides definitive guidance to all TRADOC organizations and activities that are involved in the development, validation, integration, management, and use of architectures that are related to tactical and operational level warfighting concepts and capabilities.

1.2 Scope: The scope is to describe management and integration processes and procedures for all architecture activities within TRADOC as well as how they interact with external organizations' processes and procedures. This document is organized in the following manner:

- Chapter 1: Introduction. This chapter presents the purpose, applicability, and scope of the TRADOC Architecture Management Program. Also, it discusses architecture support of Army transformation, architecture challenges, and general operating concepts for architecture development.

- Chapter 2: Why We Develop Architectures. This chapter addresses the reason why we develop architectures from two perspectives. First, law and regulation to support the acquisition of systems mandate the development of architectures. Secondly, and more importantly, the architecture development process has value - translating concepts and capabilities into functions, systems and organizations.

- Chapter 3: Who Does the Architecting. This chapter addresses who does the architecting; their roles, responsibilities and relationships; and the customers and consumers of architecture information. It presents this information beginning with the Army staff and encompasses the key organizations and activities including DCDs and Battle Labs at proponents, centers and schools.

- Chapter 4: What Are the Architecture Components. This chapter provides information on the components of architecting – information sets/data, products, services, and how TRADOC initiates coordinated architecture development efforts.

- Chapter 5: How are Architectures Constructed (The Process). This chapter describes architecture from TRADOC's perspective and includes an overview of the development process. It addresses why architecture processes and strategies have changed and are changing. The role of architecture in support of analysis and experimentation is discussed. Lastly, the Army Architecture Repository and Management System (AARMS) capabilities and vision to support JIM and Army Enterprise Architecture (AEA) design and development is presented.

- Chapter 6: When/Where Integration, Validation, Approval, and Registration Occurs. This chapter discusses these important processes and procedures involved in architecture development for the transforming Army and how the architect participates.

- Key Annexes contain architecture production schedules and more detail on the architecture process, as well as analysis, and experimentation support:

  A Projected Architecture Development Work
  B Architecture Development Process
  C Analysis
  D Experimentation

1.3 Architecture Support for Army Transformation: The Army's transformation to the Objective Force is a comprehensive undertaking that impacts all aspects of the Army, from the operational Army to the institutional Army and the sustaining base. It is important to remember that the definition of Objective Force includes the Current Force as well as the Stryker Brigades (SBCT) and the Units of Action (UA)/Units of Employment (UE).

TRADOC, as the Army's Operational Architect, translates joint operating concepts into warfighting capabilities and is the lead agent for the transformation of the tactical and operational level forces.

TRADOC's architecture workforce includes proponents, centers and schools, battle labs, selected activities, and the headquarters, and provides the architectures that enable Doctrine, Organizations, Training, Materiel, Leadership and Education, Personnel and Facilities (DOTMLPF) processes. Architects develop architecture foundational data that informs and shapes concepts, capabilities documents, and analysis. They support the development of requirements that are traceable to warfighting concepts. More importantly, they structure the effort to develop a knowledge base, which can provide insightful, integrated information sets for senior decision makers.

Architecture development uses a disciplined, logical process to translate warfighting concepts and capabilities into understandable, actionable information sets. These information sets, composed of relational data pulled from AARMS, and other Defense

Architecture Repository System (DARS) databases will respond to questions posed by staffers and decision makers and provide a common understanding of the qualities and characteristics of desired capabilities.

> ***Information Sets****:*
> *Information sets are an extracted collection of relational data that describe the desired aspect of an architecture.* ***Information sets focus on what is needed to respond to the intended use of the architecture.*** *They are designed to contribute to a common understanding of required capabilities and provide useable, actionable information. Information sets include, but are not limited to the standard architecture products described within the DoD Architecture Framework.*
>
> *Examples include: Current and Stryker information sets provided to support Analysis of Alternatives for the FCS ORD; information sets developed for the FCS C4ISP; the set of information exchange requirements developed for WIN-T Analysis of Alternatives; and information provided to support JTRS analysis. (See Para 4.1.1 for more examples)*

In the institutional Army, the Business Management Modernization Program (BMMP) has been established to fulfill one principal agenda: Develop a DoD-wide enterprise architecture and transition plan designed to transform the Defense business operations and technical infrastructure. By documenting processes and modeling them according to DoD's Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) architecture standards, streamlining will begin. An evolving, graduated transition plan will move the Department from the "as-is" environment to the "to-be" of the DoD Business Enterprise Architecture (BEA).

The success of the Army transformation and the realization of the Objective Force will depend, in large measure, on the timeliness and quality of the architecture products, services, and information sets that TRADOC develops and validates. Architecture does not provide the solutions to all the challenges associated with developing the Objective Force, but it does provide structured information and data to meet the “customer’s need” in an understandable format, which leads to solutions and development.

1.4 The Architecture Challenge in a Changing Environment: The 2008 timeframe will be the most complex period in the Army’s recent history. The Army will field the first units of the Objective Force in 2008. Current Force units will have different baselines and at least four SBCTs will have been fielded. We must ensure, therefore, that warfighting capabilities are integrated vertically and horizontally from the tactical and operational levels to the strategic and national levels. The integration requirement includes integrating JIM architectures, as well as architectures under development by the Army staff for the sustaining base. TRADOC’s architecture workforce must sustain and continually update its skill sets and core competencies to meet these challenges.

TRADOC's architecture workforce has developed its skill sets and core competencies through the development of architecture products in support of Army modernization for the current and Stryker Forces as prescribed by G-8 in USF plans. They have also produced architecture products to support proponents' functional requirements, such as those produced by the Intelligence Center at Fort Huachuca in association with the Army Intelligence and Security Command (INSCOM) and national agencies. They have focused on developing operational architecture and conceptual systems architecture products in accordance with the DoD Architecture Framework guidance within a Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) framework. The skill sets and core competencies they have developed include the ability to:

- Translate land warfare warfighter operational concepts into useable, actionable information. TRADOC possesses the most proven architecture workforce within DoD with this skill set.
- Provide a source of analytical underpinnings for tracing warfighter capabilities and concepts.
- Integrate battlefield functional area tasks into a framework at the functional data point level of detail.
- Provide configuration management of data and information that builds architecture knowledge and its applications.
- Provide communications modeling & simulations (real traffic analysis that informs network performance, capacity and throughput).

As we move forward in transforming the Army to the Objective Force, these skill sets and core competencies will continue to serve the community well. Objective Force development in accordance with the USF model will remain a vital part of Army transformation. In addition, based on TRADOC's experience in partnering with industry's Lead Systems Integrator (LSI) in developing the SoSA for the FCS, a different paradigm is emerging for architecture development in support of new systems for Objective Force UA/UE, and their enabling systems. System of systems architectures will move us beyond a C4ISR focus to encompass other systems, including training, sustainment, platforms, and soldier systems.

The objective of LSI's SoSA is to provide information sets that inform the development of specifications for FCS systems. The distinctions between operational architecture and systems architecture have blurred. That is, operational and systems architectures are developed in a complementary, iterative manner. Systems engineers work in tandem with operational architects and warfighter representatives to ensure that systems solutions are traceable to warfighting capabilities. Also, operational and systems architectures both inform analysis and experimentation and are updated based on the resultant changes to operational capabilities or systems solutions.

The emerging paradigm requires an expansion of current architecture skill sets and core competencies. The following insights are from TRADOC's work with LSI, Defense Advanced Research Projects Agency (DARPA), and the Army staff in developing architectures in support of the FCS Operational Requirements Document (ORD) and Command, Control, Communications, Computers and Intelligence Support Plan (C4ISP). We must be able to:

- Establish partnering relationships that leverage architecture development and integration expertise within TRADOC, the Army, the Joint community, OSD, and industry.
- Ensure the AARMS repository can integrate externally produced architectures and can be expanded to capture new data to properly describe new warfighting capabilities.
- Provide the expertise to extract relational data in the form of understandable, actionable information sets.
- Expand architecture development to include non-C4ISR dimensions, such as those in Training, Personnel, and Sustainment processes.
- Develop tailored architectures in support of Army and joint analysis and experimentation communities.
- Provide the expertise to integrate system of systems capabilities into Objective Force architectures.

The management processes and procedures presented herein were developed with these emerging insights in mind. Our efforts to expand and improve our architecture skills and competencies will continue to be informed through on-going Objective Force development work.

1.5 Operating Concepts: Architectures must be developed and integrated in a collaborative environment to ensure a common understanding of how products are built, how they trace to operational concepts and the relationships between them. An example of this collaborative approach is to establish teaming relations among stakeholders to accomplish the work through integrated concept teams (ICT), integrated process teams (IPT), and working groups (WG). Another example is architects from different proponents, schools and centers working together on the same architecture using the same virtual toolset within AARMS. The purpose for using a collaborative approach is to avoid stovepiped development and facilitate integration and validation of architectures. Roles, responsibilities and relationships discussed in Chapter 3 emphasize this collaborative concept and provide more detail on the operating concepts for architecture development presented in the paragraphs below.

1.5.1 Development of Operational Architectures: Operational Architectures for the Current Force and SBCTs will be developed by proponents, centers and schools and the battle labs. TRADOC has designated six Enhanced Battle Labs to focus on future force development. Enhanced Battle Labs are:

- Commander, Combined Arms Command (CAC) is the Director of the Battle Command Battle Lab.
- Commander, Combined Arms Support Center (CASCOM) is the Director of the CSS Battle Lab.
- Commander, Maneuver Support Center is the Director of the MANSCEN Battle Lab.
- Commander, U.S. Army Field Artillery Center is Director of the Depth and Simultaneous Attack Battle Lab.
- Commander, U.S. Army Armor Center is the Director of the Unit of Action Maneuver Battle Lab.
- Commander, U.S. Army Infantry Center is the Director of the Dismounted Battle Space Battle Lab.

Enhanced Battle Labs, with support from the proponents as required, will develop operational architectures for the future force to include UA/UE and enabling systems, and integrate Current Force and SBCT architectures as appropriate.

1.5.2 Entry Point for Army Architectures: The Architecture Integration and Management Directorate (AIMD) under the Deputy Chief of Staff, Developments (DCSDEV) is designated TRADOC's executive agent for architecture development activities. AIMD is TRADOC's single entry point for Army architectures that require TRADOC validation. AIMD is responsible for the overall management, development, integration, validation, and configuration management of architectures that enable warfighting capabilities.

1.5.3 Collaboration with the Army Architecture Integration Cell: In collaboration with the Army Architecture Integration Cell (AAIC), TRADOC validates and integrates operational architectures from externally produced sources that enable warfighting capabilities. TRADOC works with AAIC to ensure proper integration of all appropriate operational architectures into the AEA. This includes architectures produced by HQDA Functional Domains, MACOMs, and the JIM community.

1.6 Summary: Management processes and procedures described within this document are designed to show how architects within TRADOC operationalize the architecture. Operationalizing the architecture is accomplished through developing mission, task, purpose linkages of desired warfighting capabilities from the soldier on point, horizontally and vertically, through tactical and operational level warfighting systems to the strategic – national levels and sustaining base: "space to mud; factory to foxhole." It is key to the enabling the Objective Force's ability to see first, understand first, and act first. Architectures thus play a pivotal role in informing senior decision makers.

Chapter 2: Why We Develop Architectures

2.0 General: Architectures are developed for two primary reasons. First, law and regulation mandate the development of architectures. Secondly, and more importantly, the architecture development process is the best way of informing and shaping concepts and translating those concepts into fieldable capabilities, such as systems, functions and organizations.

2.1 Requirements: Traditionally, architecture development has consisted of documenting operational facility rules (OPFAC) and associated information exchange requirements. As architecture development progressed, the processes and products began to include activity modeling, operational view (OV) and systems view (SV) products that were more than just briefing slides, but were actually drawn from databases. Today's and tomorrow's environment demands an even greater evolution of the process. The requirement now is for data, resident in integrated databases, e.g., JIM and DoD, that can be quickly accessed, configured and used to support TRADOC core competencies (mission/task decomposition, concept/JCIDS development, training, etc). Supporting Joint Operating Concepts (JOC) and Joint Functional Concepts (JFC) provide the foundation from which integrated architectures will be developed and refined. Today's integrated architecture information must inform concepts, compare alternatives, refine identified capabilities and requirements, shape acquisition strategies and provide the traceability from the warfighting requirement to the solution. Several key documents that describe architecting requirements are listed below. While all these documents are important because they define foundational building blocks, they are not all inclusive. Architecting is a process – a tool – to help answer questions, and it now, more than ever, encompasses other than traditional C4ISR issues. For example, we have training architectures and medical architectures that help define tasks and requirements. Architectures also support the development of Army training and readiness evaluations and foundational training and doctrinal manuals. The true power of architecting is its ability to inform and shape concept exploration. This power is based on the fact that the process imposes a discipline over detailing information requirements, exchanges and flows. Once detailed, systems can be determined that satisfy warfighting and warfighting support requirements.

2.1.1 Architecting - Moving Towards Tomorrow: Architecting, as we currently know it, was placed on the map by two legislative acts: The Government Performance Results Act and the IT Management Reform Act (now called The Clinger/Cohen Act of 1996). These acts deal with existing and planned information systems and provided the catalyst for integrating information systems. They remain valid as the Army moves towards Battle Command centric warfare - the integrated architecture that guides IT development in the Army transformation.

2.1.2 Changing from Army "Green" to Joint "Purple": Given the increasing importance of joint operations, there are also two key joint documents an architect

should be familiar with. The Chairman of the Joint Chiefs of Staff Instruction (CJCSI) 3170.01C implements the Joint Capability Integration and Development System (JCIDS), which replaces the Requirements Generation System (RGS). This system implements an integrated, collaborative capabilities development process based on top level, strategic direction. The system is focused on the integration of forces, is capabilities based, and is developed through integrated architectures. The CJCSI 6212.01B, Interoperability and Supportability of National Security Systems and IT Systems establishes policies and procedures for interoperability requirements for ICDs and CDDs. These documents are also required by CJCSI 3170.01C. These two instructions are the key documents required for system development and acquisition.

2.1.3 DoD Architecture Framework Guidance: DoD Architecture Framework Version 1.0 defines a common approach for architecture description, development, presentation and integration. It also defines the three views of architecture - Operational (OV), Systems (SV) and Technical (TV) and what the specific architecture products they entail. These are the products TRADOC architects have traditionally produced in our architecture development process – and will continue to produce. (See Chapter 5)

2.1.4 The Army CIO/G-6 Guidance: The Army CIO/G-6 developed the AEA Guidance Document (AEAGD), which supports the standardization of IT and C4I architecture development. Included in the AEAGD is the AEA Development Plan (AEADP) that details the development of specific architectures. It provides suspense dates, specifies what products must be developed and includes other architecture requirements.

2.1.5 The TRADOC Architect's Requirements Document: For the TRADOC architect, the most important document is the Army's Transformation Campaign Plan (TCP.) This document has been approved and signed by the Chief of Staff of the Army. The TCP establishes the CG, TRADOC as "Lead agent for the transformation of the operational force" – thus the title "Operational Architect of the Army." The TCP organizes all Army functions into functional domains (See Chapter 3, Who Does the Architecting, para 3.2.11) and assigns each domain a specific proponent on the DA Staff. The domain proponents are responsible for required enterprise architectures in their areas. TRADOC proponents will have linkages to DA level staff leads. The exact relationships are still emerging, however tasking will be through HQ TRADOC.

2.1.6 Army Transformation: As the Army transitions to the Objective Force (meaning the entire Army enterprise), there are several significant actions occurring simultaneously. New organizations are being created – the Unit of Action and the Unit of Employment – while the modernization of the current force continues. For the UA, TRADOC established a Unit of Action (Maneuver) Battle Lab and the Army has employed a Lead System Integrator to assist in developing one of the key components of this new organization – the Future Combat System. For the current force the USF process will continue to be utilized.

- Unit Set Fielding (USF): USF is a modernization strategy and process that modernizes the force through a system of systems (SOS) approach based on delivery of a total organizational warfighting capability rather than delivering individual, non-integrated systems to units (system fielding). The goal is to achieve a modernized organization in the shortest period of time. The development of Stryker brigades is an example of this process.
- USF Modernization Schedule (USFMS). To ensure fielding of unit packages of integrated capabilities, the Army G8 develops the USFMS (captured in the AEADP), which documents the modernization sequence of the Army. Based on the TCP, the USFMS for the Objective Force extends out to 2015. TRADOC AIMD uses the AEADP as a source document for the development of its annual architecture development schedule.

2.2 The Value of Architecture: The value of the architecture process is that it is a reasonable, logical and disciplined approach to translating concepts into something physical – an organization, a system or a function.

- Architectures assist in the management of complexity. They establish a common framework to describe missions, organizations and systems. They enable horizontal and vertical integration through task and information requirement analysis across battlefield functional areas (BFA) (UJTL Tactical Constructs) and battlefield operating systems (BOS). They facilitate coordination and synchronization among architecture developers.
- Architectures assist and guide concept development.
- Architectures assist in business process engineering, in that they facilitate the analysis of alternatives to accomplish warfighting tasks and system solutions.
- They provide a method of achieving joint interoperability by contributing to key performance parameter analysis utilizing the Universal Joint Task List (UJTL) and information requirements (IR).
- Architectures provide an audit trail/traceability, establishing the linkage between warfighting requirements and system solutions.
- They contribute to the development of a blueprint for transforming and modernizing forces.
- Architectures enable analysis of operational capabilities and identify gaps requiring system modifications.
- Architectures feed institutional Army processes:
    - War planning – a quick synthesis of “Go to War” requirements and capabilities.
    - Training – architecture development assists in the identification of missions and tasks that organizations must master, and that systems and functions must support. Training architecture development also assists in identifying Training Support Packages (TSP), Interactive Electronic Technical Manuals (IETM) and training management requirements.

- Joint Capabilities Integration and Development System (JCIDS) -identifies warfighting shortcomings and redundancies and supports determination of warfighting capabilities and requirements.
- Force Developments - OPFACs and organizational structures feed TOE, BOIP, TAADS and TAA development and support FDU actions.
- Acquisition - IERs, OPFACs, descriptions feed USF, Nodal descriptions feed BOIP and system engineering.
- Budget – systems requirements and force structure over time feed AAO, TAA, POM and DPG.
- Testing, Analysis and Simulation – provides MOE/MOP, quantifies performance requirements in detail.
- Doctrine – Architecture development assists in identification of missions, tasks, and functions that supports the development of doctrinal material.

2.2.1 Operationalizing the Architecture: Perhaps the greatest value of architectures is that they can be used to "operationalize" the process. "Operationalizing the architecture" is of key importance in determining system solutions to operational requirements – translating concepts into architectures. It establishes traceability of system solutions to warfighting requirements. The process is straight-forward.

- Assess the problem to be resolved - develop the mission requirement.
- Determine what tasks and functions are required to accomplish the mission.
- Determine the purpose for which the tasks are to be performed.
- Determine the information that is required to accomplish the purpose and tasks.
- Determine the nature of the information that must be exchanged (voice, data, video), who must exchange the information, how frequently, the sensitivity of the information, etc.
- Determine the processing and information management behaviors and functionality that are required – as well as systems that are required to enable the information exchange.
- Determine the organization(s), system (s) and function(s) required to accomplish the tasks.

Once the architecture has been developed, it needs to be integrated into supported and supporting architectures. For example, the architecture that is developed for a mechanized maneuver organization would need to be integrated with the supporting fires and sustainment architectures. Additionally, the beauty of this process is that the task decomposition leads to the identification of training requirements and contributes to the proponent task of Army Universal Task List (AUTL) as well as UJTL maintenance. This process can be used by any architect, for any architecture requirement – not just warfighting. See Chapter 5 for a Mission/Task/Purpose analysis of operationalizing the architecture.

2.2.2. Recent TRADOC Architecture Value Added: TRADOC's recent work for Stryker, Operation Enduring Freedom, Millennium Challenge '02 and the FCS C4ISP/SoSA have provided enormous insights on the value of architecture. Architecture efforts supported the Battle Command Interoperability Assessment in preparation for Operation Enduring Freedom and provided solutions to many problems prior to the operation. This effort utilized a detailed mission thread analysis and an examination of on the ground unit C4ISR systems to identify information exchange requirements and shortfalls. The resulting analysis led to the fielding of selected systems and the development of system work-arounds. Millennium Challenge '02 utilized mission thread analysis to identify information exchange requirements among the exercise participants, and also served to inform the joint community on C4 requirements. Finally, architecture efforts associated with the development of the FCS resulted in those efforts informing the requirements determination process and systems specifications.

2.3 Summary: The complexity of today's operational requirements and the costs associated with those requirements demands an improved, formalized and comprehensive approach to the development of systems, functions and organizations. At the same time, the process must be responsive to the needs of warfighters, staffs and decision-makers in an era where windows of opportunity are narrower and less frequent.

Chapter 3: Who Does The Architecting

3.0 General: This chapter addresses WHO does the architecting, WHAT are the relationships, roles and responsibilities, and WHO are the customers and consumers of the architecture information sets. The intent of this chapter is to be a one-stop source document for roles and responsibilities. Some of the information contained in this chapter is partially covered in other chapters.

- In the past, the "*WHO does the architecting* " consisted primarily of TRADOC Proponent School and Center architects that developed Unit Set Fielding architectures, and some limited functional architectures. The WHO has now changed. Functional domains (space, finance, personnel, medical, intel, etc) are developing comprehensive architectures, as well as other agencies, some outside of the Army. More importantly, *what we are architecting is* changing. Here are some examples:

- Mission threads that link Training Architectures from the Institutional Army to forward deployed operating forces.
- Logistics Common Operational Picture (LCOP) that links Army logistics systems with joint databases and joint logistics software over the Global Information Grid (GIG).
- Situational awareness enabled by various sets of architectures.
- Unit of Action Maneuver Battle Laboratory (UAMBL) collaborating with the Future Combat System (FCS) Lead Systems Integrator (LSI), supported by matrixed staff from AIMD.
- Rewrite 08JUL03Operation ENDURING FREEDOM architecture interoperability addressed by proponent staffs, functional Subject Matter Expert (SME), systems integrators and AIMD analysts.
- Military Health System's Enterprise Architecture that defines medical functions at all echelons in the 2015-2020 timeframe.

TRADOC's architecture role is focused on forging an operational warfighting force that supports joint capabilities within a joint architecture framework. This means that Army architectures must be linked not only to various integrated joint architectures, but also to the Global Information Grid as well as other agencies. This linkage mandates a look at broader warfighting communities, across all services and includes their supporting infrastructures and emerging joint concepts.

3.1 Relationships: Collaboration and matrixed support provides diverse skills, domain expertise, and new approaches to architecting requirements. Collaborative and coordinated working relationships are essential to achieve integrated, traceable architecture information sets that inform the senior leadership. This proven approach has helped shape architecture relationships, roles, and responsibilities.

TRADOC's role as the Operational Architect is also critically linked to the Army's institutional processes. Architectures and architecture information sets inform combat

development processes, experiments, unit set fielding, software blocking, force development, AOA, the Program Objective Memorandum (POM), the Programming, Planning, Budget, and Execution System (PPBES), the Army's Transformation Campaign Plan, and acquisition. Additionally, the Institutional Training Strategy informs the development of the FCS SoSA. The associated institutional processes have numerous players, supporting systems, and decision forums – all relying on architecture information sets and data. Thus the linkages are real, significant, and deserve special emphasis in understanding interrelationships.

3.2 Specific Roles, Responsibilities, and Relationships:

3.2.1 OSD/Joint Staff/JFCOM: These organization establish standards and joint operational capabilities requirements. The SECDEF has provided definitive DoD Transformation Guidance as part of the Quadrennial Defense Review, the Defense Planning Guidance (DPG), and various decision memoranda. DoD and Joint Transformation has focused on enhanced joint interoperability, joint battle management, Standing Joint Task Force Headquarters (SJTFHQs), accelerated joint experimentation evolving joint operational concepts, and Joint C2.

TRADOC's architecture relationship with OSD (C3I) is tied to DoD architecture standards articulated in the DoD Architecture Framework V1.0 document and guidance for the Defense Architecture Repository System (DARS).

TRADOC's architecture relationship with the Joint Staff is tied to the Joint Capabilities Integration and Development System (JCIDS), defined in CJCSI 3170.01C, the requirements stipulated within CJCSI 6212.01C (Draft), Joint Operational Concepts (V 4.8), various ORDs such as the JC2 that has major impact on joint architectures supporting battle command and the integration of functional operational concepts, and the Joint Technical Architecture.

TRADOC's relationship to JFCOM is evolving. Currently, TRADOC DCSDEV- JID (Joint Integration Directorate) operates inside the JFCOM HQs. TRADOC is providing architecture support to joint experiments and joint concept exploration through the JID and the TRADOC Joint and Army Experimentation Directorate (JAED).

3.2.2 DARPA: The Defense Advanced Research Projects Agency has been on the forefront in facilitating Army research into the manned and unmanned capabilities of the Future Combat Systems. The Army has partnered with DARPA and the LSI (Boeing/SAIC) to inform the transformation to the Objective Force with the concept exploration phase and appropriate technology demonstrations. These efforts help shape the development of TRADOC FCS concepts and requirements documents.

TRADOC's architecture role on the path towards FCS Milestone B has been to work with the LSI to produce and validate preliminary architecture products required by

CJCSI 3170.01C (DRAFT) and CJCSI 6212.01B. TRADOC validates and approves the SoSA developed by the LSI.

3.2.3 Department of the Army: Architecture roles and responsibilities for staff principals and staff organizations at the Department of the Army level are also evolving. Architecting within the Army Enterprise Architecture (AEA) context has resulted in designation of roles, establishing Domain architecture requirements and establishment of integration offices and cells. The charters for both the Army Architecture Integration Cell (AAIC) and the Army Enterprise Integration Oversight Office (AEIOO) are under development. This portion of the Chapter will be updated as new information becomes available. A preliminary chart highlighting the principal architects, organizations and their interrelationships is depicted below:

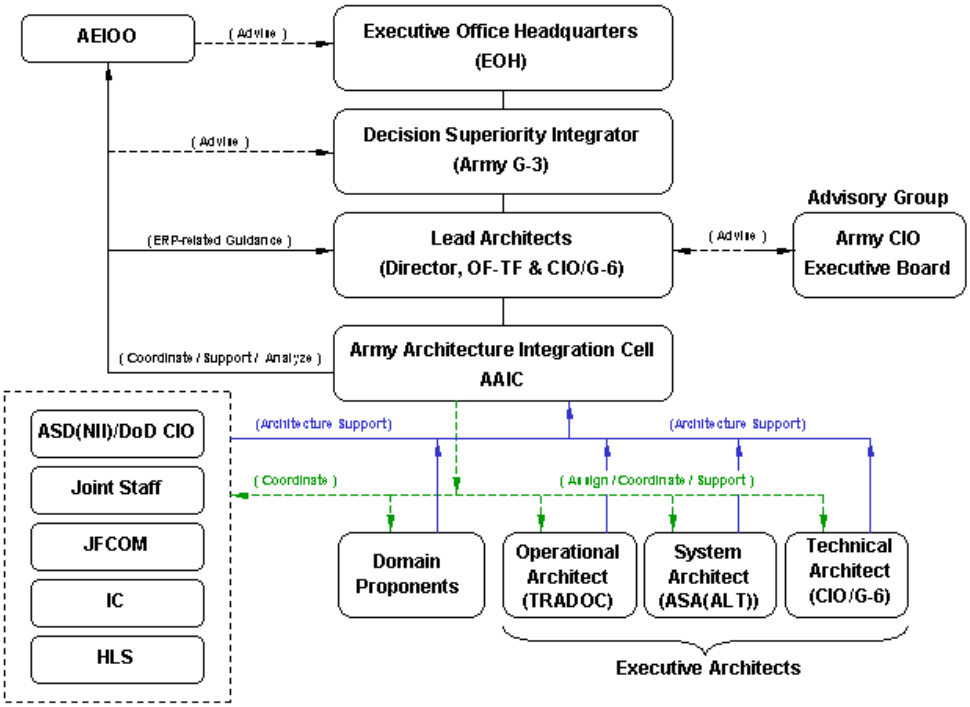

Figure 3.2.3 DA Architecture Principals and Architecture Integration Cells (As of 02 July 03)

Please note the positions and interrelationships of the following:

- **Executive Office Headquarters (EOH) –** Final approval authority of the Army Transformation Strategy
- **Army G-3** – Army Decision Superiority Integrator
- **Director of the OFTF and the CIO/G6** - Army Lead Architects
- **Army CIO/G-6** – Chief Integration Officer

- **AAIC** - Army Architecture Integration Cell – Manages, synchronizes and integrates architectural efforts across the Army and the DoD/Joint enterprise.
- **Army G8** – Army Principal Force Developer
- **AEIOO –** The Army Enterprise Integration Oversight Office

There are three **Executive Architects** for the Army:
- **TRADOC** – The Army 's Operational Architect
- **ASA (ALT)** – The Army Systems Architect
- **Army CIO/G-6** – The Army's Technical Architect

3.2.4 Army G-3: The G-3 identifies requirements and establishes priorities. In the role of Decision Superiority Integrator, G-3 uses the AOFA and other architectures (Joint, Federal, etc.) to ensure that Army command data, information and knowledge needs are met by authoritative sources through interoperable systems. In the DSI role he works in concert with the AAIC to synchronize the knowledge gained from architecture information sets and insures interoperability at the Army interfaces with Joint, Interagency and Multinational Forces. The G-3, as the DSI, will also integrate Domain Proponents operational architecture efforts to insure that decision superiority can be achieved as part of battle command.

TRADOC's relationship to G-3 is prioritization, and approval of architectures.

3.2.5 Director, Army Objective Force Task Force: Army Lead Architect (one of two with the CIO/G6). Serves as the single, overarching, integrating activity within the Department of the Army that provides the direction, means, and impetus for the Objective Force. As the Objective Force architect, he must provide management oversight for the development, synchronization, integration and alignment of all related OF architectures in support of the Army Transformation. He recommends to the appropriate agencies for incorporation into the TCP intermediate objectives, SA/CSA decisions, milestones, events and timelines required to achieve the Objective Force.

TRADOC's relationship to the Director, Objective Force Task Force is one of collaborative partnering in OF architecture working groups.

3.2.6 Army G-6: The G-6 is the Army CIO, Chief Information Officer, an Army Lead Architect, and the Army Technical Architect responsible for the development of the Joint Technical Architecture – Army (JTA-A). He undertakes the validation and integration of all Army Technical Architectures.

TRADOC's relationship to the CIO/G-6 is one where TRADOC develops the operational architecture and the Systems Conceptual architectures (SA-C) to the technical standards and mandates provided by the CIO/G-6 as the domain lead for AKE.

3.2.7 Army Architecture Integration Cell (AAIC): The AAIC is responsible for the management, synchronization, and integration of all Army Architecture efforts to achieve the Objective Force. It was established pursuant to the AKEA RRC briefing to the CSA on 2 January 2003 and supports the CSA's mandate of "One Network, One Database, One Enterprise." The AAIC reports to the Army Lead Architects, the Director of the Objective Force Task Force and the
G-6. Its current roles and responsibilities are:

- Manage the Army's architecture planning, programming, and budgeting; identify all Army architecture resource requirements; recommend apportioned funding levels and defend Army architecture resource requirements during the resource review process.
- Manage the integrated development of all Army architecture products.
- Shape architecture related policies, governance structures, supporting tools, repositories and partnering agreements.
- Develop the enterprise architecture views (all view, operational, system and technical views), as required.
- Synchronize and integrate the development of, analyze the interoperability between, and facilitate the approval of the Army architectural products by the Army Chief architect.
- Provide direct assistance to the Domain proponents by actively helping them develop and integrate their domain architectures.
- Assign, coordinate, and support the architectural tasks of the Army Executive Architects.

TRADOC partners with the AAIC. As one of three Executive Architects and the Army's Operational Architect, TRADOC collaborates with the AAIC to ensure integration of appropriate operational architecture products into the AKEA.

3.2.8 Army G-8: As the Army's principal force developer, the G-8 supports the DSI and the Executive Architects by ensuring architecture milestones are met, are consistent and relevant with Army modernization, recapitalization, and investment strategies. The G-8 focuses on meeting the architecture development milestones of the TCP and Software Blocking policies.

TRADOC's relationship to G-8 is meeting architecture development schedules that feed institutional processes (i.e., USF, TOE, MTOE requirements development, testing, fielding and support).

3.2.9 AEIOO: On behalf of the Secretary of the Army, the Army Enterprise Integration Oversight Office (AEIOO) provides top-level policy, guidance, and direction in the definition, design, implementation, and integration of enterprise solutions across the Army and between Department of Defense (DoD), the Army and other external organizations. The AEIOO has responsibility for the integration and coordination of all Army business systems efforts across all functional domains. The AEIOO will oversee

and synchronize Army functional and system architecture development efforts and activities within the Army and between OSD and the Federal government. The AEIOO partners with the AAIC in order to ensure that functional domain architectures, where relevant, meet the integrated Objective Force warfighting requirements.

TRADOC coordinates through the AAIC with the AEIOO as required.

3.2.10 Assistant Secretary of the Army for Acquisition, Logistics and Technology ASA (ALT): Is the Executive Architect for Army Systems architectures.

TRADOC's relationship to the ASA (ALT) is one of collaborative partner as OA architecture products/information sets are handed off to the Systems Architecture developers and traceable warfighting capabilities requirements are verified throughout the systems development process.

3.2.11 Domain Architects: Domain/Enterprise architects focus on either an enterprise mission or a function. The Domain/Enterprise Proponent is responsible for architecture development of respective domains to support the Army-wide Objective Force Architecture as part of the larger Army Knowledge Enterprise Architecture. The following Domains and Domain Proponents have been identified to date – and the list is evolving:

Domain	Domain Proponents
Manpower & Personnel	(G-1)
Intelligence (ISR)	(G-2)
Requirements	(G-3)
Programs	(G-8)
Operations and Plans	(G-3)
Readiness	(G-3)
Training	(G-3)
Battle Command,	(G-3/TRADOC)
Army Knowledge Enterprise (AKE)	(G-6)
Infostructure Components	
Communications	(CECOM)
Computing	(PEO EIS/PEO C3T)
Applications	(CECOM)
NETOPS	(NETCOM)
Systems and Network Management	
Information Assurance	
Information Dissemination Management	
Information Management	(G-6)
Logistics	(G-4)
Transportation	(G-4)
Installations	(ACSIM)

Finance	(ASA(FM))
Medical	(OTSG)
Acquisition	(ASA(ALT))
Legal	(TJAG)
Quality of Life/MWR	(ACSIM(CSFC))
Space	(SMDC)
Special Operations	(USASOC)

TRADOC will receive Domain Operational Architectures, validate warfighting tasks, and forward to the AAIC validated architecture information for higher-level integration and use at the Enterprise Architecture level. Detailed discussions of the Process Charts shown below are developed in Chapter 6. These Charts highlight the interactions and relationships between the Department of the Army Architects, OSD/Joint, and Executive Architects (TRADOC, ASA (ALT), and G-6) in order to meet the goals of the AEIOO and the AAIC.

An example of receiving and integrating a Domain Architecture is the medical domain architecture produced by the Office of the Surgeon General. Selected warfighting task and functions will be extracted, analyzed by the UAMBL and CAC for integration into the UA and the UE. Additionally, as the architectures for SBCT 5, and 6 are developed, the medical operations concepts, tasks, functions, IERs will be cross-walked and integrated by Ft. Benning, CASCOM, and MANSCEN architects. Subsequently, as the Stryker and UA/UE organization architectures mature, they will be brought forward for TRADOC level integration and validation.

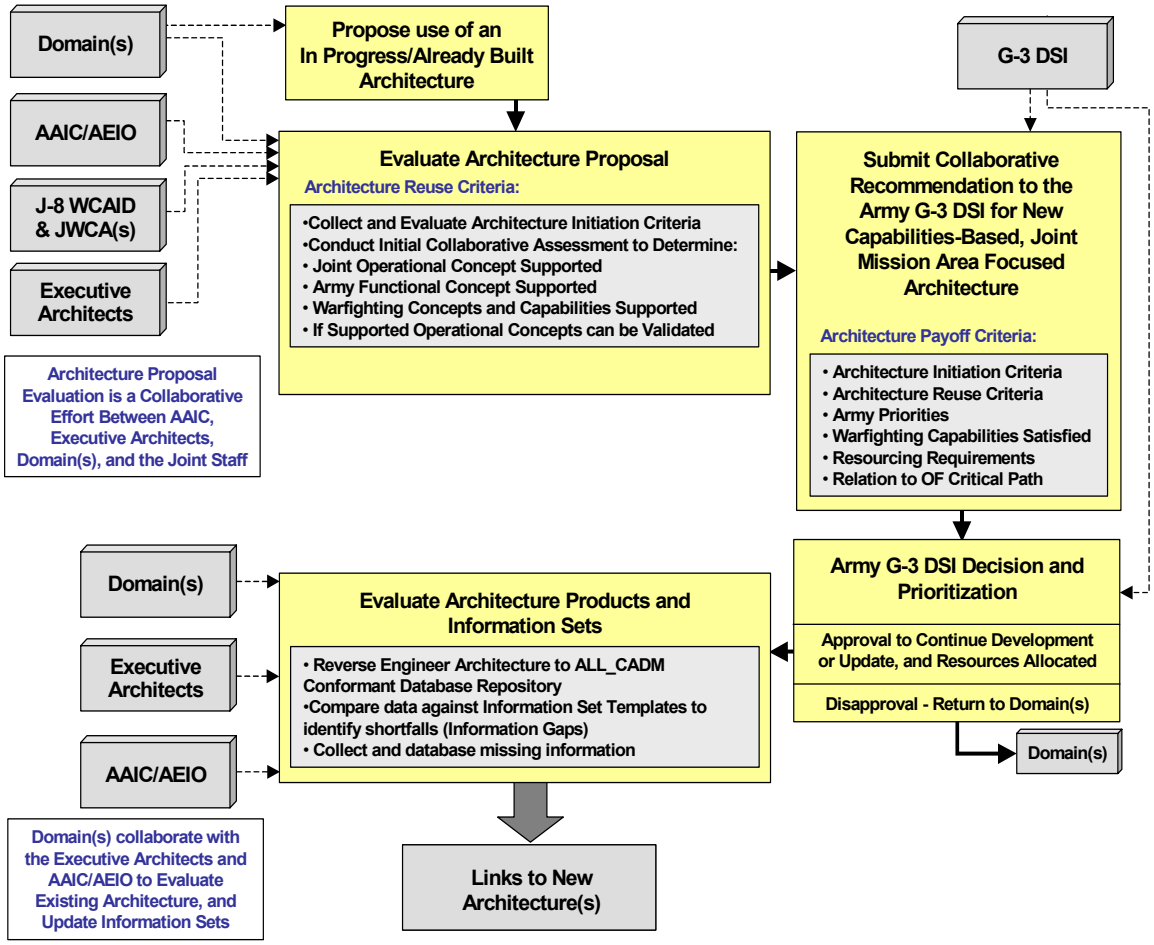

Figure 3.2.11-1 Assessment of In-Progress/Already Built Domain Architectures

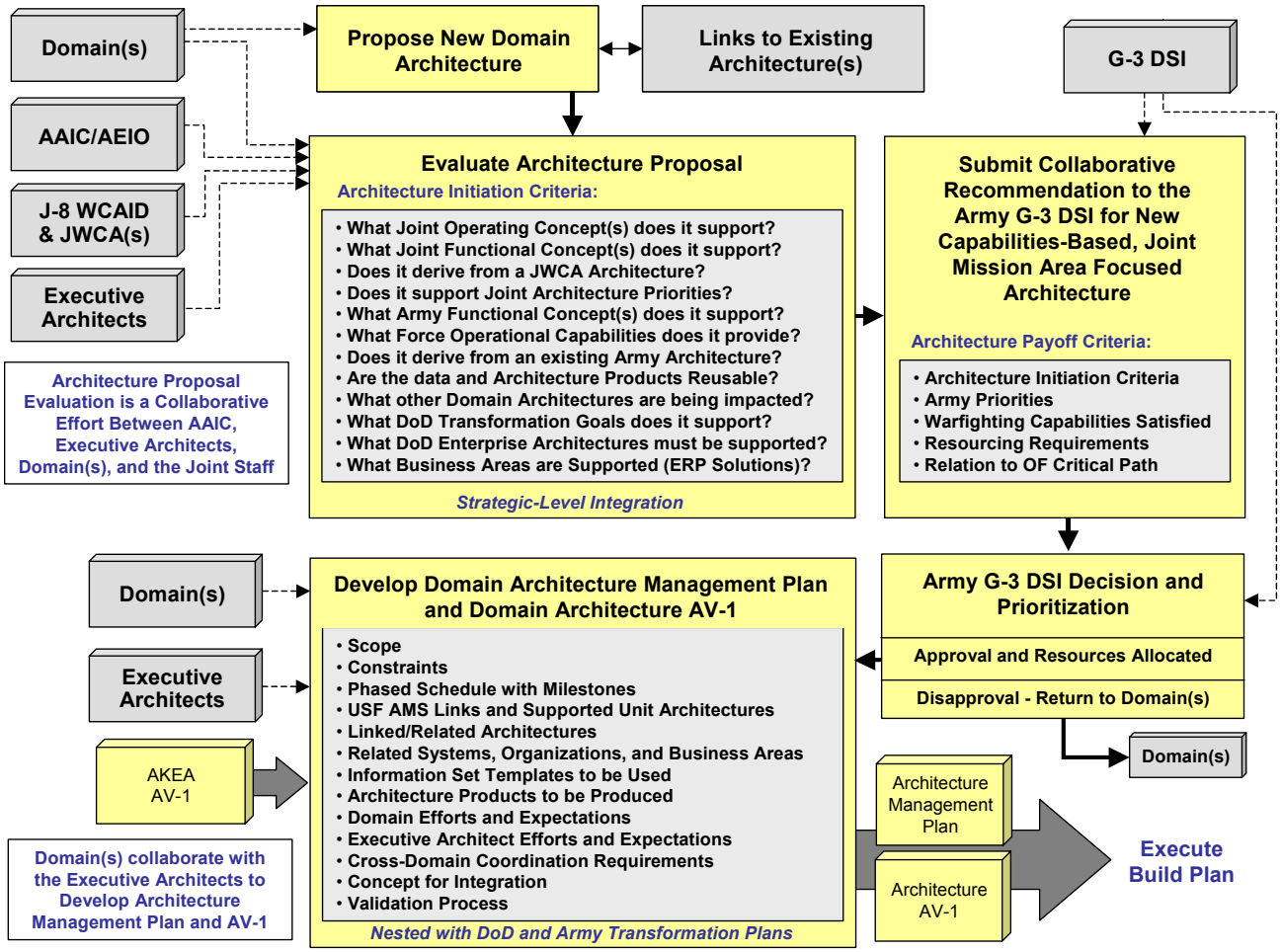

Figure 3.2.11-2 New Domain Architectures

3.2.12 TRADOC: The overall architect roles, responsibilities and relationships for TRADOC are summarized as follows:

TRADOC is the Executive Architect for Operational Architectures that impact on Current, Stryker and Objective Force tactical and operational forces. TRADOC is responsible for the development, validation, standardization, integration and traceability of all Operational Architectures that enable warfighting capabilities. In collaboration with the Army Architecture Integration Cell (AAIC), TRADOC reviews JIM, Army Domain, and MACOM architecture components that have warfighting implications for the US Army. TRADOC works with JFCOM to effectively integrate the transforming Army into joint operational capabilities and with the AAIC to ensure proper integration of all appropriate operational architecture products into the AEA.

The chart below highlights the external relationships described above and the internal relationships that will be discussed in follow-on paragraphs:

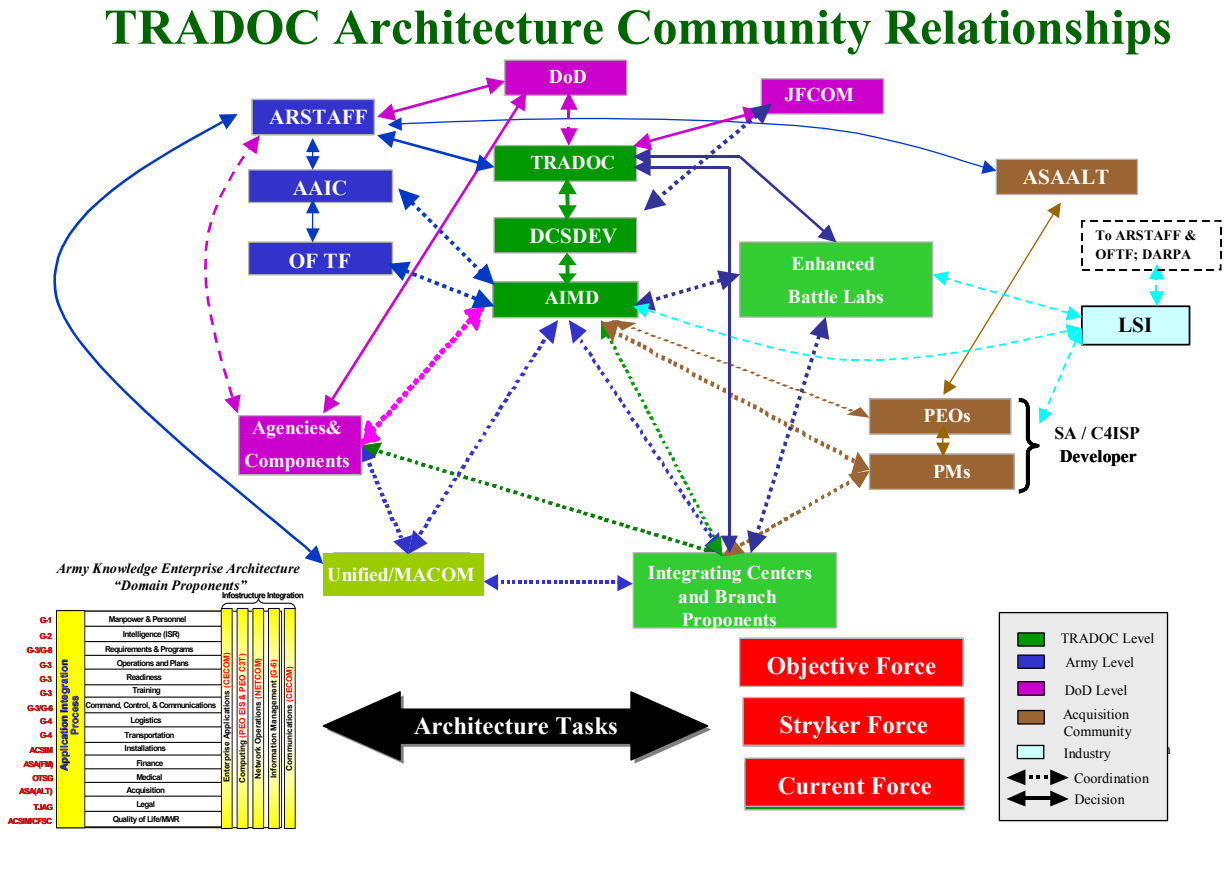

Figure 3.2.12 TRADOC Architecture Community Relationships

3.2.13 TRADOC DCSDEV: DCSDEV is the TRADOC lead for architecture development. It:

- Approves O&O concepts and plans, force design, studies, analytical results, and scenarios
- Serves as the HQ TRADOC Staff lead for all architecture development to include experimentation. (Commander, CAC, is responsible for Battle Command and C4ISR development).
- Frames architecture recommendations for Chief of Staff/CG approval.
- Submits validated operational architectures to DA/G3 for approval.
- Is the TRADOC Executive Agent for Battle Lab tasking, resourcing, prioritization, and integration.

3.2.14 Battle Labs: Six Enhanced Battle Labs have been established to accomplish specific tasks. There are also four additional battle labs, two of which have been

identified to support battle command development. In general, battle labs have definitive charters, integrate requirements, and leverage proponent expertise.

Six Enhanced Battle Labs are:
- Commander, Combined Arms Center is the Director of the Battle Command Battle Lab, and specified proponent for Battle Command and C4ISR.
- Commander, Combined Arms Support Center (CASCOM) is the Director of the CSS Battle Lab.
- Commander, Maneuver Support Center (MANSCEN) is the Director of the MANSCEN Battle Lab.
- Commander, U.S. Army Field Artillery Center is Director of the Depth and Simultaneous Attack Battle Lab.
- Commander, U.S. Army Armor Center is the Director of the Unit of Action Maneuver Battle Lab.
- Commander, U.S. Army Infantry Center is the Director of the Dismounted Battle Space Battle Lab.

Four Supporting Battle Labs are:
- Commander, U.S.Army Signal Center is the Director of the Battle Command Battle Lab (Gordon).
- Commander, U.S. Army Intelligence Center is the Director of the Battle Command Battle Lab (Huachuca).
- Commander, U.S. Army Aviation Center is the Director of the Experimentation Branch, Future Development Division.
- Commander, U.S. Army Medical Center is the Director of the Battle Lab Support Element.

The architecture roles and responsibilities of Battle Labs entail the following:

- Utilize architecture information to shape the development, refinement and integration of future operational capabilities in support of Joint and Army concepts.
- As OF requirements are developed across all DOTMLPF domains: doctrine, organizational designs, training strategies/products, and capabilities/requirements documents must be examined in a SoSA and FoSA context.
- Coordinate and integrate Current and Stryker capabilities with the Objective Force development and ensure that vertical and horizontal architecture integration is achieved.
- Develop operational architecture products and information sets that are ALL_CADM compliant and have traceable warfighting concepts.

AIMD will provide matrix support in the development of architecture products/information sets in coordination with DCSDEV-BLITD.

3.2.15 TRADOC DCSC4: Is the TRADOC CIO and performs CIO functions IAW 25-1.

AIMD collaborates with the DCS4 on CIO issues.

3.2.16 TRADOC DCSOPS&T and ATSC: Identifies and approves the functional requirements for the Training and Leader Development architectures and the Army Training Information Architecture (ATIA). Henceforth submits training and Leader Development architectures for validation and approval to AIMD and:

- Coordinates architecture development, integration, and configuration management procedures with AIMD.
- Ensures all architecture data is ALL_CADM compliant.
- Coordinates for matrix support requirements with AIMD as required.

AIMD will address Training and Leader Development architectures from a collaborative partnering approach, and when appropriate, treat Training Domain architectures with the same conceptual approach as the Medical Domain architecture cited in paragraph 3.2.11.

3.2.17 TRADOC DCSINT: AIMD collaborates with DCSINT on ISR architectures, ISR concepts, and ISR integration issues, across DOTMLPF.

AIMD utilizes the TRADOC DCSINT as a collaborative partner in influencing space to mud ISR architectures that are outside the scope of TRADOC and the Army.

3.2.18 TRADOC AIMD: Is the TRADOC POC for architectures. AIMD's roles and responsibilities are as follows:

- Serve as TRADOC's single entry point for Army and Army component pieces to Joint, Interagency and Coalition architectures.
- Prioritize, coordinate, manage and standardize the development of Operational Architecture (OA) products and information sets IAW Joint and Army Staff development plans across TRADOC staff elements, Battle Labs, Schools and Proponents per the JCIDS/RGS Process, TCP Taskers, AEADP guidance, and AAIC MU 17 Funded efforts.
- Ensure all architecture data is ALL_CADM compliant.
- Integrate and validate architecture products and information sets for the Current, Stryker, Objective Force, and Joint/Army warfighting experiments prior to release to DA/OSD, Joint communities.
- Develop, document, and maintain the SA-C in support of Unit Set Fielding, the Army Transformation Campaign Plan, and other technology investments as appropriate.
- Provide Configuration Management and Quality Control
- Provide performance analysis of communications networks and automation systems in support of TRADOC, HQDA, and other agencies
- Prioritize and provide matrix, analytical, and modeling and simulation support to the TRADOC Architecture Communities.

- Enhance TRADOC's automated tool set and ALL_CADM compliant architecture data repository into a networked Decisions Support System as part of DARS.
- Integrate, distribute, and store architecture products, information sets, and analytic results of products developed by proponent, non-proponent activities and agencies.
- IAW contractual agreements, establish both informal and formal relationships with the LSI to support architecture development, validation, and approval activities for the Future Combat Systems (FCS) equipped Unit of Action (UA) Maneuver (M).
- Establish a collaborative working relationship with the AAIC, ASA (ALT), G-3, G-6 and G-8; Coordinate and liaison with ARSTAFF, MACOMs, OSD, Joint Staff, and JFCOM as required.
- Work collaboratively with AAIC to validate those aspects of domain functional architectures that impact on warfighting concepts and capabilities.
- Conduct architecture training.
- Collaborate with Proponents, Schools, and Centers to support the accomplishment of their architecture efforts.

AIMD has collaborative relationships across the TRADOC Headquarters staff, with the AAIC, G-3/G-6/G-8, the ASA (ALT) communities, and OSD C3I. AIMD works closely with the LSI/DARPA, UAMBL, the Battle Command Battle Lab, and with JFCOM. AIMD in its capacity of developing and framing the TRADOC Architecture Management Program specifies directed matrix teams and task organizes when special challenges arise.

3.2.19 Lead System Integrator (LSI): The LSI has selected architecture responsibilities to the Army in general, and to TRADOC AIMD specifically. The nature of the relationship has been framed through interpretation of the Statement of Work, collaborative ICT/IPT matrix team efforts, and tough lessons learned.

AIMD approves SoSA architectures produced by LSI. It collaborates with AAIC, along with ASA (ALT) and G-6 within their portions of the SoSA approval processes. AIMD is also TRADOC's senior architecture representative to the LSI including having the lead role on LSI's AWG and ASG. AIMD sets TRADOC architecture priorities and in that capacity, through DCSDEV, it tasks appropriate TRADOC organizations to provide support to LSI.

3.2.20 TRAC: TRAC is an architecture customer/user and ensures architectures are properly represented within their models. TRAC coordinates with TRADOC AIMD for architecture information sets required for AOA, experiments, and other analytical efforts. Sample products used include the OV-1, High Level Operational Concept Description, OV-3, Operational Information Exchange Matrix, OV-6, Operational Event Trace Description, and the SV-1, System Interface Description. AIMD's modeling and simulations support, such as connected traffic analysis, has fed TRAC Force on Force models.

AIMD provides customer support to TRAC through analysis and modeling and simulation.

3.2.21 TRADOC Systems Managers (TSM):

- Ensure materiel developers are using the appropriate versioned architecture products to develop systems solutions to warfighter requirements.
- Coordinate individual systems changes with DCDs and Operational Architects to insure warfighter requirements traceability is maintained.
- Use architecture information to support requirements determination, acquisition objectives, procurement objectives and fielding plans adjustments - BOIPs and MTOEs.
- Participate in the architecture validation process, as required.

AIMD coordinates with TSMs when adding systems under their purview that support organizational architectures. AIMD also collaborates with TSMs in the shaping of CDDs/CPDs to include top-level exchange requirements.

3.2.22 Proponents, Schools, and Centers: The architecture development roles and responsibilities are as follows:

- Develop Operational Architectures (OA) and products per the guidance provided in the AIMD Tasking Letter and AV-1.
- Ensure that all TRADOC architects that are supporting the schools and centers in developing architecture products and information sets are formally trained in the architecture development process and AARMS.
- Develop, store and maintain all architecture products/information sets in the ALL_CADM compliant AARMS repository.
- Utilize architecture information to shape, inform, and guide concept development, doctrine, and capabilities/requirements documents (ICD, CDD, CPD, CRD, O&Os, URS, and TOEs).
- Assist the DCD in reconciling TOE C4I equipment change requests (DART, DIWG, SACP), and coordinate with TSMs and Branch-unique Program Managers to ensure that platform/system C4I resources are adequately defined (as ASIOE or Component [non-LIN equipment]).
- Coordinate with United State Army Force Management Support Agency (USAFMSA) on the development of Table of Organization and Equipment (TOE) and applicability of BOIPs.
- Ensure that OA products are utilized in the development of TTP training documentation and doctrine development.
- Coordinate action officer level proponent specific issues with MACOM/Unified/Joint and USARC functional counterparts.
- Manage, in collaboration with AIMD, workload to ensure accomplishment of prioritized, architecture development requirements.

3.3 Architecture Customers and Consumers: The customers of the architecture information sets and products are the institutional Army (e.g. TSMs, PEOs, PMs), the operational Army, and outside the Army (OSD, JIM). It is the soldier on the ground, walking point that is the ultimate beneficiary of sound architecting efforts. He is the ultimate consumer. Architecting the information flow from the soldier, equipped with Land Warrior, to his Sergeant on an FCS that is linked to the Joint fires network is no simple task. Collaboration to achieve the linkages of architecture information sets that support institutional processes – and the nesting to attain joint operational capabilities – entails taking care of both our Title 10 customers and the warfighting commanders. Network centric architecting requires extensive vertical and horizontal integration. Our integration and validation efforts must not only focus on the operational unit, but also linkages to the joint level, and sustaining base/institutional architectures. Proponents, schools, centers and battle lab architects thus have a vital role. No easy task – but it is the soldier walking point that benefits from this comprehensive, integrated architecture.

Chapter 4: What are the Architecture Components

4.0 General: This chapter addresses the components of architecting and when those components are prepared.

4.1 Components of Architecting: Architectures are framed and produced through a collaborative approach. Not all architecture requirements are the same. There are various sources of architecture requirements. The requirement will define the specific components required for that architecture. The foundational basis for the architecting components is a disciplined, tailorable, traceable and reusable process, using published standards – such that all architecture data is captured in an ALL_CADM format, the sole standard for DoD and the Army. The components of architecting are developed and comprised of information sets, products, data and services.

4.1.1 Information Sets/Data: Information sets are groupings of data designed to answer specific questions. These questions may be simple – such as how many FBCB2s are in the heavy division; what TOEs are associated with III Corps; how much does an FBCB2 cost? It may also be much more complex. For example, information requirements that provide for improvements in sensor-shooter networks to shape a joint capabilities experiment may require some front-end analysis and the need for information sets where the data has not yet been developed. Another example: FCS development has identified gaps in systems specification data entities that are not resident in any database.

Information sets can also be derived from different databases, and grouped together to guide, shape and inform decision-making. If the question was posed: How much does an entire unit cost, the architect could go to many databases and pull that information into logical and presentable information sets and answer the question. Some of these databases could include the Logistics Integrated Database (Equipment cost, BOIP Feeder Data), SB-700-20 (LINs, equip nomenclatures), Standard Army Manpower Allocation System (force structure), The Army Authorization Document System (MTOE data, UIC) and the US Army Force Management Support Agency Requirements Documentation System (TOE data).

The value of architecting is the availability of usable, accessible data, resident in powerful, flexible, interchangeable and scalable databases that can be configured and adapted to customer needs. The challenge is ensuring that the identified data fields are the correct ones and will provide useful information sets for the questions to be answered. Data, mined from various architecture databases, can be utilized to support institutional processes, decision making across the Army, and various analysis and studies, to include modeling and simulation.

4.1.2 Products: Currently the DoD Architecture Framework V 1.0, CJCSI 3170.01C, CJCSI 6212.01B and the AEADP continue to specify required OA, SA, and TA products. (See Chapter 5 for more detailed discussions of the various products).

However, traditional TRADOC architecture products are being redefined as we approach the era of systems of systems and family of systems. The accelerated development of FCS and UA architecture information underscores the need for linkages to JIM, the Sustaining Base, and the institutional army architectures. As we further develop the SoSA and FoSA, there will be new approaches to formatting, capturing and displaying these complex information sets that link foxhole to factory and space to mud.

4.1.3 Services: Selected services are performed for multiple customers across TRADOC and the larger architecture community. These services range from architecting data analysis to modeling and simulations, to an AARMS repository that is quickly evolving into a service focused decision support system. The selected services are integrated within the architecture development process and are also on demand to support concept exploration, experimentation, warfighting capabilities analysis, and DA level integration/validation requirements. (Note: a more detailed discussion of various services is in Chapter 5)

4.2 When are Architectures Prepared: There are three primary drivers as to when formal architectures are prepared: The Army Transformation Campaign Plan, the AEADP, and the Annual TRADOC Architecture Development Plan.

4.2.1 Architecture Prioritization: The Army Transformation Campaign Plan (TCP), maintained by the G-3, is the overarching Headquarters Department of the Army (HQDA) strategy document from which architecture priorities are drawn. The inclusion of the individual architecture production milestones on the TCP synchronization matrix ensures architecture coordination and integration across HQDA. The TCP Prioritization List establishes the modernization priorities for the Army during transformation. This document when used in conjunction with the Army Modernization Schedule (AMS) outlines the overall modernization path for The Army.

4.2.2 AEADP-PD Guidance: The Army Enterprise Architecture Development Plan (AEADP) Process Document (PD) provides the Army's architecture community with ***detailed guidance*** required for the production of consistent and comparable Architectures to support the Army Transformation. This guidance is comprehensive, ranging from initial gleaning of requirements through the fielding of the operational unit. The AEADP PD provides detailed architecture development process direction, specifies the mandatory and suggested set of AEA products to be developed (the product sets), and specifies the associated management processes. The AEADP PD is primarily focused on unit architectures (tactical units from the Army TCP as well as units specified in the AMS, which represent the entire Army Enterprise). Currently, the AEADP PD also covers non-unit specific functional architectures that support specific mission areas such as Intelligence, Personnel, Logistics, Space, Sustaining Base interfaces and other Functional Domains. In the future we can expect this document to incorporate the requirements emanating from CJCSI 3170.01C – the focus on JCIDS and the capabilities of Joint, Interagency, Multi-National units. The AEADP PD Annexes address the requirements for specific architectures and provide integrated production

schedules. Completion of the AEADP Annex is the starting point for identifying architecture's scope and purpose, customer(s), precise product set, development milestones, and corresponding production schedules in Annex A. These schedules are principally tied to the G-8's AMS, and the HQDA Command Plan.

4.2.3 TRADOC Architecture Development Plan: The TRADOC Architecture Development Plan will be developed on an annual basis. It will incorporate DA's stipulated architecture development requirements. This plan will represent a collaborative effort among the DA AAIC, DA Domain Proponents and TRADOC to insure the full range of architecture development requirements are addressed, prioritized, resourced and critical development sequences are fully synchronized.

The AIMD Tasking Letter – A companion to the Annual TRADOC Architecture Development Plan is the architecture tasking letter with an AV-1. These documents initiate the TRADOC architecture development efforts. It depicts milestones for the required architecture products and information sets. It will specify products/information sets to be produced by whom and when. The AV-1 will provide specific planning information such as purpose, scope, responsibilities, concept for integration, viewpoints, context, standards and tools to be used. The AV-1 may mandate selected studies, analysis, and modeling and simulation associated with a specific project and may not be structured into traditional operational and systems views. All requirements will be articulated in the AV-1.

4.3 Architecture Requirements to Support the Capabilities Integration and Development System (CIDS) Process: As described in CJCSI 3170.01C and CJCSM 3170.01, Joint CIDS (JCIDS) is an enhanced methodology utilizing joint concepts that will identify and describe existing or future shortcomings and redundancies in warfighting capabilities, describe the attributes of effective solutions and identify the most effective approach or combination of approaches to resolve these shortcomings. Army CIDS, as described in TRADOC Reg 71-9 (DRAFT), supports the JCIDS process. The CIDS process begins during development of warfighting concepts and adds front-loaded analytic rigor to requirements determination and refinement. Properly applied, CIDS produces an integrated set of requirements for DOTMLPF requirements that collectively constitute required capabilities. CIDS provides traceability of all system and non-system requirements back to the overarching strategic guidance.

Architecture plays a key supporting role throughout the CIDS process. Concepts and O&O plans initially frame capability requirements and form the basis for development of Operational Architectures that inform institutional decision-making (prioritization, funding, acquisition and authorization processes). Concepts provide an operational and organizational logic for how the future force might accomplish its tasks. Approved concepts are authoritative; they define how the force functions (operational concept), the environments it must be able to operate in, its physical and organizational characteristics (design parameters), and what it must be able to do (required capabilities) in terms of performing missions or producing effects. The aim of CIDS is to

develop and integrate into a given force the means of performing all tasks required of it, in all of the environments where it operates, in the manner described and within the force design limitations prescribed in the concept. Approved concepts are rendered in architectural views that developers use to understand the missions and tasks that must be performed for what purposes (operational view), the nodes and systems that support the missions and tasks and how the nodes communicate and interact to produce the desired effects (systems view). Architectures form the basis for decision makers by reflecting an analytical basis for disciplined analysis throughout the DOTMLPF domains – thus they are both inputs and products of the analysis process.

As shown in Figure 4.3 below, integrated architectures, refined or developed as necessary, are integral to the up front CIDS analysis phase (Functional Area Analysis (FAA), Functional Needs Analysis (FNA), and Functional Solutions Analysis (FSA)). In addition, architecture information sets/data are provided to support the Analysis of Alternatives that is required prior to Milestone A, as well as to support experimentation throughout the development cycle. In addition, specific architecture products must be included in the following CIDS documents. The key word within these documents is CAPABILITIES. (See Table 5.3.1, Chapter 5 for explanation of architecture products listed below.)

- Initial Capabilities Document (ICD) (replaces MNS at Milestone A)

Describes desired capability. Evaluates multiple materiel approaches. Recommends a materiel approach. Architecture products required: Operational View (OV) – 1. Other views may be included as desired.

- Capability Development Document (CDD) (replaces ORD at Milestone B)

Describes the SDD effort and provides KPPs for the increment. Describes program to get to complete solution. Architecture products required:

  - Operational process synchronization products: OV-1, OV-2, OV-5
  - System synchronization products for systems with top-level IERs: OV-3, SV-1, SV-6, SV-2
  - These views will continue to evolve throughout the System Development and Demonstration (SDD) phase

- Capability Production Document (CPD) (replaces ORD at Milestone C)

Describes the SDD effort to produce materiel solution for the increment and provides KPPs for the production increment. Architecture products required:

- Operational process synchronization products: OV-1, OV-2, OV-5
- System synchronization products for systems with top-level IERs: OV-3, OV-6c, SV-1, SV-2, SV-6, TV-1
- Optional: OV-6b, SV-10c

Requirements and Acquisition Processes

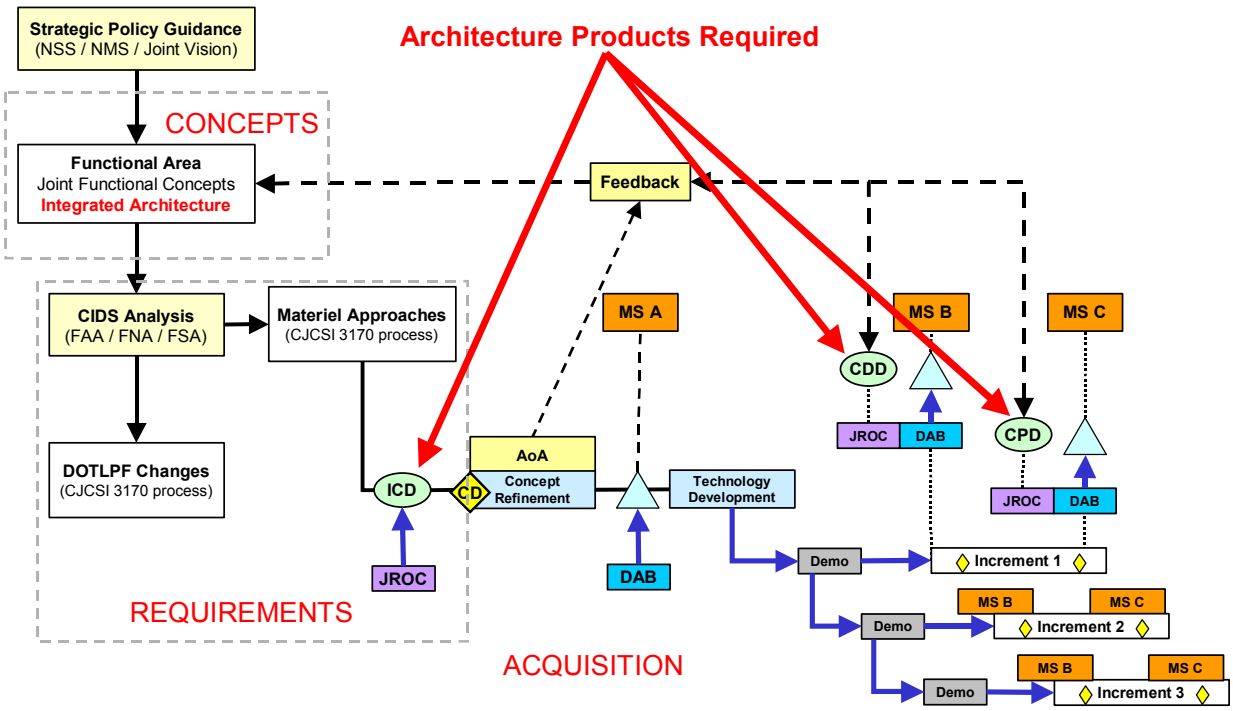

Figure 4.3 Requirements and Acquisition Process

4.4 Architecture Requirements to Support Unit Set Fielding Timelines: Using backward planning from the milestones found in the USF Directive, the architecture development, integration and validation processes can be mapped against a generic timeline, shown in Figure 4-4. Each specific unit and other types of architectures timelines are modified to account for existing constraints, such as shortened fielding schedules, available lead-time, resource constraints and purpose/scope. A Tasking Letter with an AV-1 will identify the specific timelines associated with the specific architecture development requirement. AIMD will work collaboratively with the appropriate schools and centers to ensure timelines identified are realistic and sufficient.

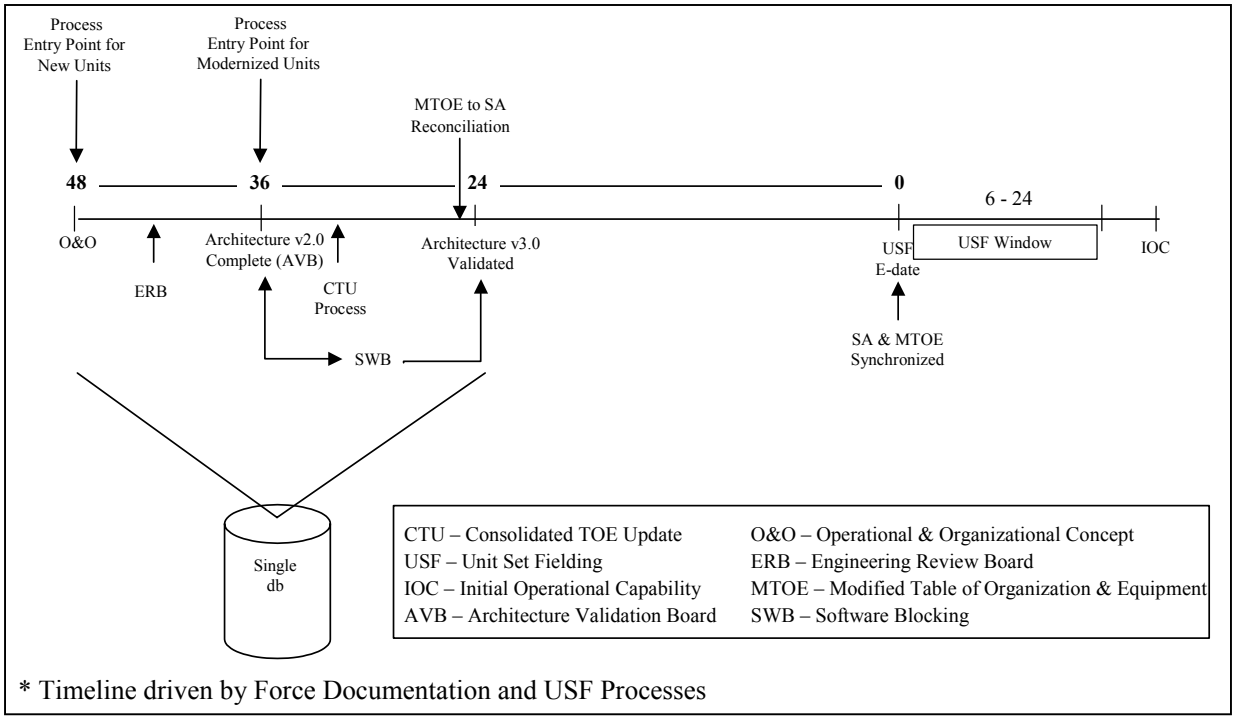

Figure 4-4 AEADP Generic Development Timeline by month – New Force Capability

4.5 Summary: In summary, this chapter explained the three components of architecting and provided a review of the three primary drivers that specify formal architectures. The details of architecting and what is to be architected are addressed in the following chapters and in Annexes. The next chapter, How are Architectures Constructed (the Process), defines the core architecting process. It will also give some insights into the basics of architecting and the tools architects use.

Chapter 5: How are Architectures Constructed (The Process)

5.0 General: This chapter addresses "How are architectures constructed?" and describes the architecture process from TRADOC's perspective. It includes an overview of the development process, and it addresses why architecture processes and strategies have changed and are changing. The role of architecture in support of analysis and experimentation is discussed. Lastly, AARMS capabilities and vision to support AEA and JIM architecture development is presented.

5.1 What is Architecture from TRADOC's perspective: Architecture from TRADOC's perspective is the structure of components *(organizations, systems, and functions)*, their relationships, and the principles and guidelines governing their design *(concepts, capabilities, requirements, mission, task, purpose)* and their evolution over time to enable warfighters to successfully execute their mission. Architectures inform concept development and serve as powerful tools for describing the qualities and characteristics of desired capabilities. Development and use of architectures is essential when required capabilities are ill defined and the likely design will be unprecedented and complex. Architecture products do not exist independently of each other. They must be integrated to demonstrate relationships and to facilitate coordination and synchronization with related architectures within a nested environment. Therefore, within the context of representing the Warfighter, TRADOC architectures:

- Inform Concepts
- Refine Capabilities and Requirements
- Shape Acquisition
- Establish and Audit Traceability
- Inform Institutional Processes

Architecting is not just about developing products and views. It is a process that can assist a multitude of customers in accomplishing various missions. Activity modeling enables the mission/task/purpose (MTP) decomposition that leads to information exchange requirements (IERs), but it can also be used to support development of training requirements. The architecture community and the training community must work together to ensure this information can be imported into appropriate databases, such as the Automated Systems Approach to Training (ASAT), in a usable format. Activity modeling can also support doctrine writing in the delineation of tasks and functions. Developing architectures in AARMS contributes to the development of an integrated database that, as it grows, becomes more useful in supporting analysis and determining system fielding questions. Architecting helps to define concepts and capabilities to inform ICD/CDD development. Architecting also is valuable in shaping experimentation frameworks to gain greater insights on underlying warfighting concepts.

5.2 Mission, Task, and Purpose Analysis: TRADOC's institutional Operational Architecture knowledge is ***foundational,*** grounded in warfighter concepts derived from

Joint Operating Concepts. *Participation in Joint and Army concepts development provides the foundation that architects require in order to perform their developmental duties alongside warfighters and force developers.* Integrated architectures support the refinement of warfighting concepts that constitute the front end of JCIDS. Warfighter operational capabilities defined through mission, task, and purpose analysis (Figure 5.2), facilitates a common understanding of the central concept(s), and:

- Determine functions to achieve capabilities
- Define tasks to accomplish functions
- Frame system(s) requirements
- Drive a capabilities empowered force structure

The starting points for warfighter tasks from which activities can be derived are the AUTL and UJTL. These universal reference resources provide documentation concerning common terms, pick-lists, and structures.

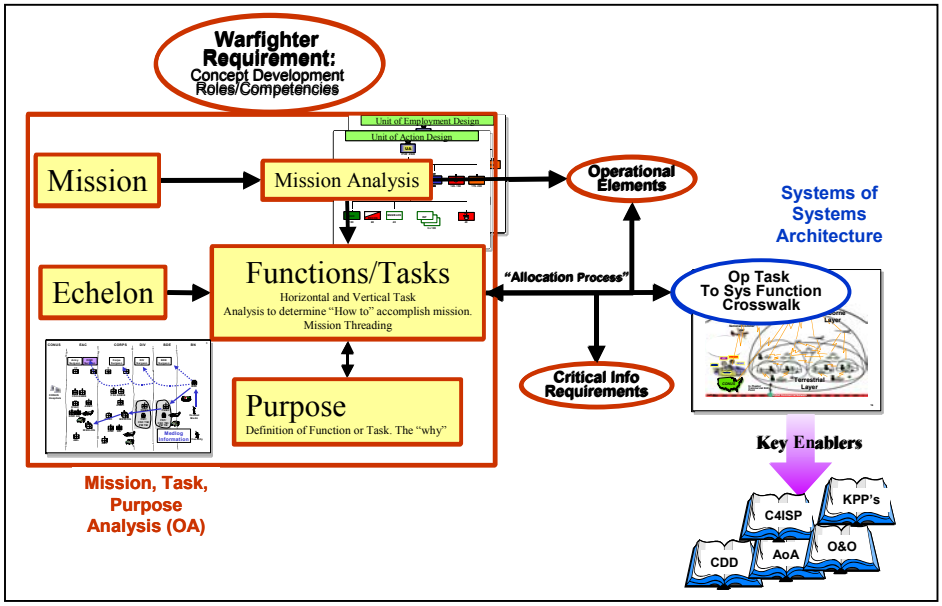

Figure 5.2 Mission, Task, Purpose Analysis

Proponent mastery of its MTP, as well as those of the forces it supports, is critical. This mastery extends to the requirement to update the AUTL for which it has proponency, and the ability to crosswalk the AUTL with UJTL. This capability is required for the development of integrated architectures, as it enables the various proponents to plug into structures under development.

5.3 Architecture Development: The DoD Architecture Framework is the primary source document for architecture development. It describes the three architecture views (OV, SV, and TV), provides development guidance, and detailed descriptions of architecture products.

The overlapping circles in Fig 5.3 emphasize the fact that architecture views must form an integrated whole. Operational Views establish the foundation for operational capability requirements. Systems solutions and technical standards must be traceable to and support operational capability requirements.

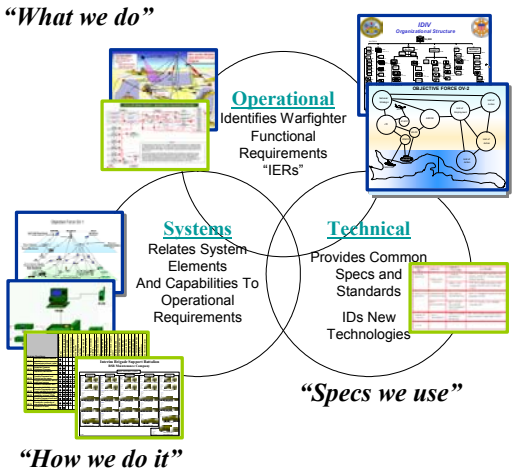

Figure 5.3 Architecture Views

Operational Views (OV) provide descriptions of the total aggregation of missions, functions, and tasks. They provide a detailed process description, identify operational nodes and develop organizational relationships. Within TRADOC, battle labs and proponents play critical roles in the development of OVs – translating concept capability requirements into MTP. In effect, MTP determination is a functional decomposition – the "What we do" to satisfy the concept. Within TRADOC, these views are driven by warfighter documented concepts.

Systems Views (SV) provide descriptions of the physical implementation of the OVs, the layout and relationships of systems – the "How we do it." They provide data on system performance within the process identified in the operational views. Specifically, system views catalog system capability descriptions, system-to-function mapping and identification of system-to-system interfaces. Although TRADOC produces conceptual systems views, called Systems Architecture – Conceptual (SA-C), to support maturation of the operational architecture, the acquisition community under the Assistant Secretary of the Army (Acquisition, Logistics, and Technology) (ASA (ALT)) is primarily responsible for developing SVs since they focus on system performance details.

Technical Views (TV) provide a collection of technical standards, conventions, rules and criteria that govern systems design – the "Building Codes." They are the catalog of design standards and interface protocols sorted by functions identified in the operational view. The CIO/G-6 is responsible for TVs, and CECOM Army System Engineering Office (ASEO) has responsibility to provide technical support to the CIO/G-6. Architecture development work at proponent schools and centers is focused on producing DoD Architecture Framework OV products for the Current Force, SBCTs and Objective Force. . Architecture work is organizationally and functionally based and includes Operational Facility (OPFAC) rule development, the Systems Architecture Change Proposal (SACP) process, the Documentation Assistance and Review Team

(DART) process, Force Design Update (FDU) actions, and Documentation Integration Working Group (DIWG) updates.

Currently, AIMD works in collaboration with the proponents to develop SA-C and integrate it with the operational architecture. Following analysis, validation, and approval, the outcome becomes an architecture version 2.0, which is released to HQDA for further development and use. The SA-C (Version 2.0) is delivered to the AAIC then to the PEOC3T who uses the SA-C as the basis for developing the SA-D (System Architecture Detailed). To ensure the SA-D is consistent with requirements, AIMD actively participates in SA/MTOE scrubs, the Configuration Management Board Process and the material/review boards. With the creation of the AAIC and the establishment of the ASA-ALT Army's system architect, the current relationships and processes may evolve or change. The TAMP will be updated as these events occur.

5.3.1 The Product Table: The following table presents products that are normally developed as an integral part of an architecture:

APPLICABLE VIEW	PRODUCT REFERENCE	ARCHITECTURE PRODUCT	GENERAL DESCRIPTION
All Views (Context)	AV-1	Overview and Summary Information	Scope, purpose, intended users, environment depicted, analytical findings, if applicable
All Views (Terms)	AV-2	Integrated Dictionary	Definitions of all terms used in the products
Operational	OV-1	High-level Operational Concept Graphic	High-level graphical/textual description of operational concept (high-level organizations, missions, geographic configurations, connectivity…)
Operational	OV-2	Operational Node Connectivity Description	Operational nodes, activities performed at each node, connectivities, & information flow between nodes
Operational	OV-3	Operational Information Exchange Matrix	Information exchanged between nodes and the relevant attributes of that exchange such as media, quality, quantity, and the level of interoperability required

Operational	OV-4	Organizational Relationships Chart	Command, control, coordination, other relationships among organizations
Operational	OV-5	Operational Activity Model	Activities, relationships among activities, inputs and outputs. Overlays can show cost, performing nodes, or other pertinent information
Operational	OV-6a	Operational Rules Model	One of the three products used to describe operational activity sequence and timing – identifies business rules that constrain operation
Operational	OV-6b	Operational State Transition Description	One of the three products used to describe operational activity sequence and timing – identifies business process responses to events
Operational	OV-6c	Operational Event-Trace Description	One of the three products used to describe operational activity sequence and timing – traces actions in a scenario or sequence of events
Systems	SV-1	Systems Interface Description	Identification of systems and system components and their interconnections within and between nodes
Systems	SV-2	Systems Communications Description	System nodes and their related communications lay downs
Systems	SV-3	Systems-Systems Matrix	Relationships among systems in a given architecture, can be designed to show relationships of interest, e.g., system-type interfaces, planned and existing interfaces, etc.
Systems	SV-4	Systems Functionality Description	Functions performed by systems and the information flow among system functions
Systems	SV-5	Operational Activity to Systems Function Traceability Matrix	Mapping of system functions back to operational activities
Systems	SV-6	Systems Data Exchange Matrix	Extends the operational Information Exchange Matrix (OV-3) to show source and destination systems and details of data being exchanged

Table 5.3.1 Typical Architecture Products

There are other products that may be needed for a particular architecture product set, such as Technical View products. Sets are determined based on the intended use of the architecture. (Refer to the DoD Architecture Framework for more details.) The following paragraphs present a general overview of architecture product development

based on these views (see Annex B, Architecture Development Process, for a more complete description of the development process):

5.3.2 Universal Guidance: The DoD Architecture Framework provides only high-level, Universal Guidance and a set of architecture products for representing architectures. It does not identify a process for developing specific architecture views and associated products. Instead, six high level steps are defined for the development of an architecture. (Figure 5.3.3-1) These are fundamental steps and it is the responsibility of the architect that they be followed in every architecture development effort.

1 The first step reinforces the idea that architectures must be designed for a purpose, to address a particular set of problems. This purpose and the associated problems must be articulated before the development of the architecture and the production of products begins.

2 The next step is the determination of the scope of the architecture. The scope of the architecture will determine the complexity of the follow-on steps. In systems engineering terms, this corresponds to determining the system boundary, i.e., determining which elements are going to be considered within the architecture and which will be considered as part of the environment.

3 The third step is closely related to the first one: the choice of data attributes that are to be included is directly dependent on the questions to be answered.

4 At this point, the architect is ready to determine which set of supporting products are needed. Note that the first four stages require the involvement of few people – the architect, the users, and a small staff that supports the architect.

5 The fifth step is the labor intensive one in which the architecture is designed and the products developed. This step is guided by the previous four steps; failure to do them may easily result in a set of products that will be unable to address the last, and most critical step.

6 Use the architecture for the intended purpose, i.e., to provide answers to the original questions.

5.3.3 The Phased Approach: TRADOC AIMD has taken the Universal Guidance provided by the Framework and broken it down into three phases for managing architecture development: (Figure 5.3.3-1)

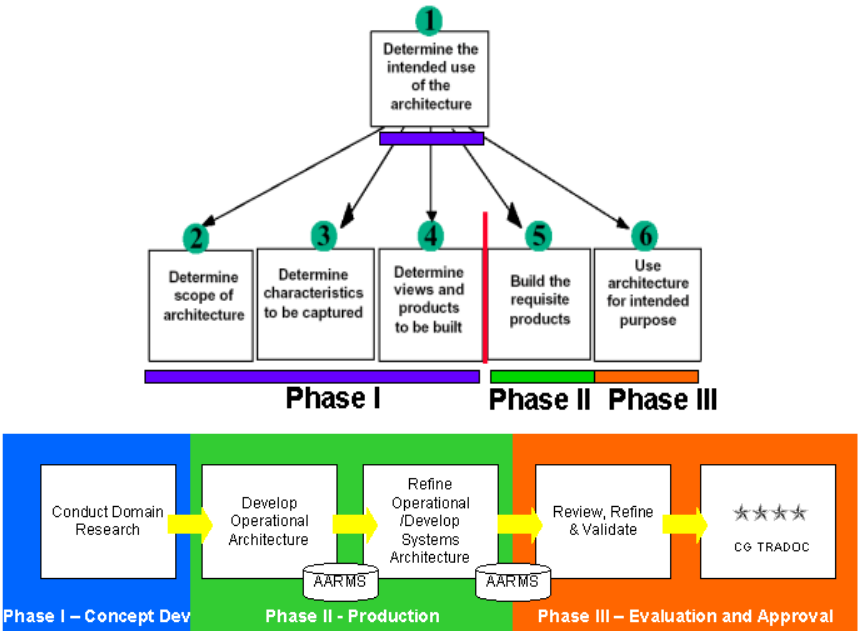

Figure 5.3.3-1 Phased Approach to the Universal Guidance

Phase I, Conduct Domain Research: (Figure 5.3.3-2) The first phase of architecture development captures decisions made in steps 1 – 4 of the Framework's Universal Guidance. The Overview and Summary Information (AV-1) product serves as the planning guide during the initial phases of architecture development. The AV-1 is a living document collaboratively developed with the proponents. During architecture development, it is used to document lessons learned. The completed AV-1 provides summary textual information concerning the "who, what, when, why and how" of the architecture and will be maintained throughout the useful life of the architecture. An Integrated Dictionary (AV-2) is produced to serve as a central source for definitions and metadata associated with the graphical representations of an architecture product. MTP analysis begins here.

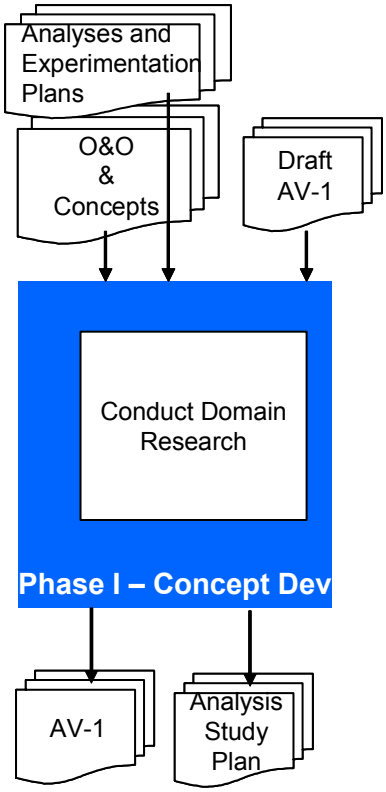

Figure 5.3.3-2 Conduct Domain Research

- **Phase II, Production**: (Figure 5.3.3-3) Architects "operationalize the architecture" by developing a representation of the warfighter's concepts and required capabilities by showing, through a series of diagrams and views, what activities and information sets will accomplish the operational concept, and which organizations and systems will perform those activities. Product views are merely graphical and textual representations of the architecture data that is stored in detail in the AARMS/CADM database. This is an iterative rather than sequential process. The OA and SA-C cannot be developed independently from each other. Warfighter input is critical in the initial stages of Phase II in order to obtain the warfighter's acceptance of the architecture products to support his concepts. The Production Phase (Step 5 of the Universal Guidance) is the most complex portion of architecture

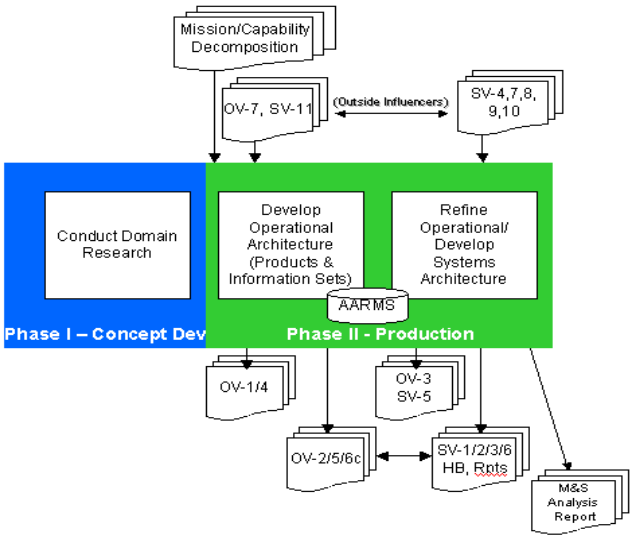

Figure 5.3.3-3 Production

development. This phase has been broken down into Six Stages (Figure 5.3.3-4). The Production Phase and its Six Stage process described herein is one approach to developing the architecture products specified by the DoD Architecture Framework and supported by the CADM. Alternative approaches are possible, but this process serves as a template to ensure that the alternative approaches cover all needed steps and produce a complete architecture description. Irrespective of the process used, the basic Universal Guidance process requires concurrent, coordinated activities to take place, and the role of architects is to plan and direct these activities. The Data Flow Diagram of the Six Stage process shown is further defined in Annex B, Architecture Development Process. What follows is a brief description of the diagram and each stage of the Production Phase.

Stage 0 - The Production Phase starts with the needed inputs (terminator/sources) on the left and are usually compiled during Phase I, Concept Development. The relationships between key entities are addressed within this process and adhere to CADM standards. Not all the products developed in a stage are actually produced for an architecture project. The AV1 will specify which products, or information sets, are required for an architecture.

Stage 1 - Operational Concept and Required Capabilities: Once the basic information has been assembled in Stage 0, the process starts by converting the operational concept that implies or includes organizations and actions or tasks into the operational concept graphic (OV-1) with a textual description.

Stage 2 - Functions and Organizations: The organizations identified for the given concept have assets that are the basis for systems in the physical architecture and operational nodes and elements. This organizational laydown helps to capture the long-haul communications requirements for the systems views. The actions or tasks help in the selection of activities from the UJTL or the AUTL to perform functional decomposition. Functional decomposition must be couched in terms of mission, required capability, task, and purpose. The AUTL and UJTL are often the start point for functional decomposition. Their subtasks (user defined tasks) that must be accomplished to completely define the AUTL and UJTL are usually decomposed in the Activity Model.

Stage 3 - Activity Model, Logical Data Model, Needlines, System Nodes, System Elements and Functions, and Task Allocation: A full functional architecture with activity model, data model, and rule model is created along with a dynamics model. Concurrently the initial physical architecture is defined using systems, elements, components, and links derived from the OA. The activities are allocated to both organizational elements and to system functions.

Stage 4 - Operational Information Elements and Exchanges, System Functionality Description, Physical Data Model: Based on the analysis of the functional architecture models, the Operational Node Connectivity Description and the Operational

Information Exchange Matrix are finalized. The implementation of the functional architecture is formulated and evaluated by creating the Systems Functionality Description and supporting Physical Data Model.

Stage 5 – System Information Elements and Exchanges, LAN/WANs, system Interface Descriptions, System Performance: From the previous analysis, the System Information Elements and the LAN/WANs are specified. The remaining products of the Systems Architecture view are created including the System Information Exchange Matrix, the System Communication Description, the System Interface Description, and the System Evolution Description.

In sum, architecture products group systems and functions into capability nodes that form the basis for interoperability requirements and provide traceability between the warfighter's capabilities-based requirements and system solutions. The Operational Node Connectivity (OV-2) and its related System Interface Description (SV-1) are good examples. While these products address connectivity between nodes, the Systems Communication Description (SV-2) describes the specific systems that connect with other systems within nodes. Finally, the System Information Exchange Matrix (SV-6) describes, in tabular format, information exchanges between systems within a node and between systems in differing nodes.

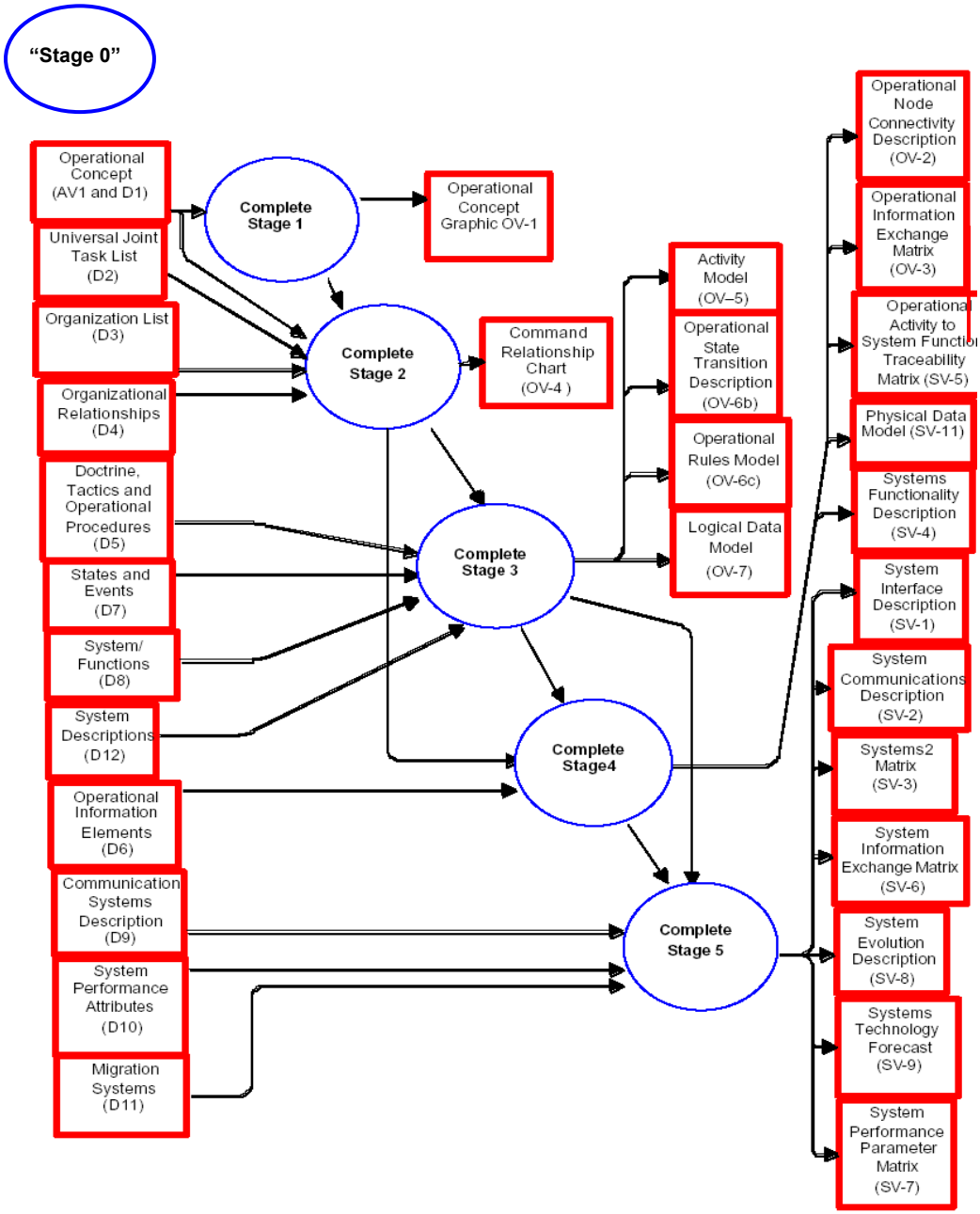

Figure 5.3.3-4 Phase II: Production
The Six Stage Product Development Process
(GMU, Levis/Wagenhals)

- **Phase III, Evaluation and Approval**: The Evaluation and Approval Phase (Step 5 of the Universal Guidance) (Fig 5.3.3-5) examines the products and information sets created in the Production Phase and determines if the architecture meets the intended purpose laid out in the AV-1 at the conclusion of Phase I. Verification and validation of

the architecture data is usually conducted at each level of validation within TRADOC through the use of executable models (See paragraph 5.5, Experimentation and Analysis for more information on Executable Models). Results of the verification and validation of the architecture information are posted to the AV-1 as architecture findings. The remainder of this phase focuses on the configuration management of the architecture products and the steps necessary to gain approval for the architecture. (See Chapter 6 and Annex B for more details.)

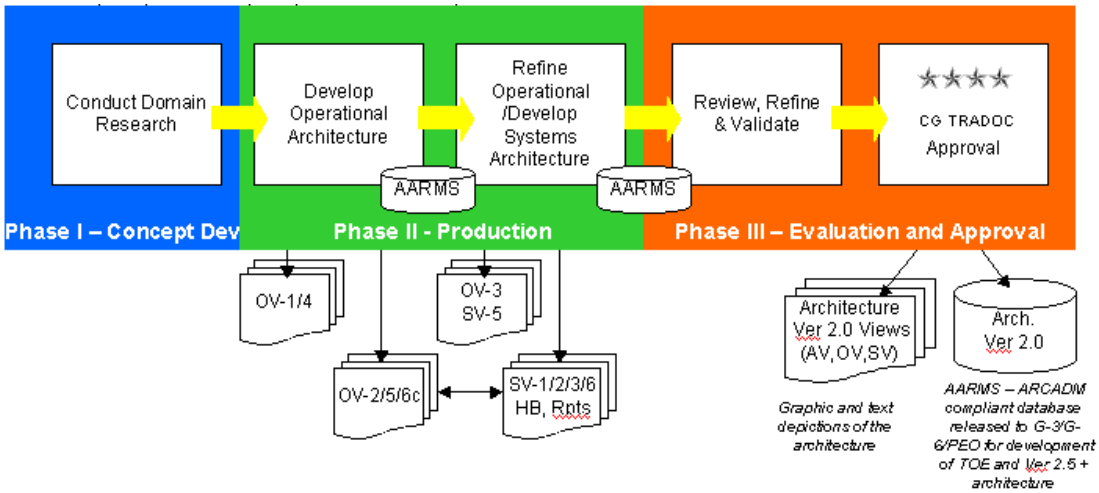

Figure 5.3.3-5 Approval

5.4 Architecture Development in a Changing Environment: Typical architecture development by proponents and AIMD as described above will continue to be driven by the Army modernization schedule. As we focus on the development of Objective Force architecture information we recognize that the scope and complexity of architecting is increasing. This has an impact on roles and responsibilities and on integration and validation approaches. Some of the key dynamics of OF architecture development are:

- Architectures to support acquisition will be top-down driven based on joint operating concepts and how the warfighter folds into joint operations (per CJCSI 3170.01C). Integrated architectures are to be developed and utilized within a System of Systems (SoS) or Family of Systems (FoS) approach. Acquisition documents (ICD, CDD, CPD) within the Joint Capabilities Integration and Development System (JCIDS) must include selected architecture information/product sets. For example, ICDs must have an appendix that includes mandatory Architecture Framework documents, which include: OV-1, OV-2, OV-5, SV-1, SV-5, and others as appropriate.
- The scope of UA/UE architecting has become more than C4ISR; it has broadened to include training, personnel, sustainment, platforms and other domain/enterprise architectures. It places a premium on integration.
- UA/UE OF development work will principally be through the six enhanced battle labs and their supporting proponents and, in some cases, in partnership with a Lead Systems Integrator (e.g., FCS).

- We are moving away from producing mandatory "products" (except when directed by higher headquarters, regulations, or instructions) to focus more on what is needed in the way of information sets (which may include standard products) to respond to the intended use of the architecture (For example, the objective of LSI SoSA is to provide information sets that inform the development of specifications for FCS systems).
- A fundamental shift in the paradigm from product/process centric to data centric architecture tools and repositories is captured in the AARMS concept (paragraph 5.6.1). AARMS will interface directly with the DoD Repository System (DARS) to facilitate not only the integration of existing Army architectures with emerging designs, but with the rest of the JIM community as well.

5.4.1 Architecture SoS/FoS Focus: Up to this point in time, architecture developments have focused primarily on existing organizations, functions and systems and have been done in a relatively stand-alone manner. Architecture development for the FCS equipped UA (Maneuver), UE and its enablers, as well as some Current and Stryker units, must be developed in a SoS and FoS construct. SoS architectures represent the horizontal and vertical integration of multiple capabilities (e.g., functions, tasks, processes, information flows, networks, etc.). Architecting will facilitate identification of interdependencies and capabilities gaps and DOTMLPF analysis of multiple domains (C4ISR, Training, Sustainment, Transportation, and other domains).

- **System of Systems** – A set or arrangement of systems that are related or connected to provide a given capability. The loss of any part of the system will degrade the performance or capability of the whole.

- **Family of Systems** – A set or arrangement of independent systems that can be arranged or interconnected in various ways to provide different capabilities. The mix of systems can be tailored to provide desired capabilities dependent on the situation.

CJCSI 3170 Definitions of System of Systems and Family of Systems

5.4.2 Emerging Army Objective Force Architecture (AOFA) Methodology: The emerging Army Objective Force Architecture (AOFA) methodology, currently being developed by the AAIC in collaboration with the Executive Architects, provides the guiding principles for developing an integrated, capabilities-based architecture that delivers the desired effects to the 2015 force. This methodology leverages, and is directly linked to the architecture requirements advocated by the Joint Staff in CJCSI 3170.01C. To the maximum extent possible, information sets, architecture products, and development approaches will remain consistent with the DoD Architecture Framework Version 1.0. The AOFA methodology is intended to ensure that all Army architecture descriptions can be compared and related across organizational boundaries, including JIM boundaries. The mechanism for capturing these descriptions is via the use of standard information sets that focus domain efforts on their respective

operational, systems, and technical capabilities required to satisfy Army and Joint operating concepts, vision statements, and the National Military Strategy. The methodology will support capability-based analysis & assessments that in turn will provide decision support for institutional processes. It also supports Domain unique, sub-enterprise level information gathering and architecture product development, so that a Domain can articulate its internal capabilities and requirements in supporting an operating concept.

The TAMP will be updated to reflect this emerging methodology as it matures. A proof-of-principle integrated architecture development effort for a Precision Engagement (PE) architecture is currently underway. The first incremental build of the Army PE Architecture is to demonstrate that the Army can develop cross-domain, conceptual capabilities architecture. Further, it will support evaluation of the Army's architecture validation and approval process and proposed capabilities-based architecture development methodology.

5.5 Architecture Role in Support of Experimentation and Analysis: Phase III of our Architecture Development Process determines if the architecture meets the intended purpose laid out in the AV-1 at the conclusion of Phase I. As mentioned earlier, this evaluation of the data can be conducted through the use of Executable Models. Executable Models provide Measures of Performance (MOPs) and Measures of Effectiveness (MOEs). A key use of the executable model is to allow the architect to shift the locus of discourse with the warfighter or user from the architecture views and information sets to the behavior and performance that the architecture enables. This concept is shown in figure 5.5. Results of the analysis then feed back into the AV-1 and operational concepts.

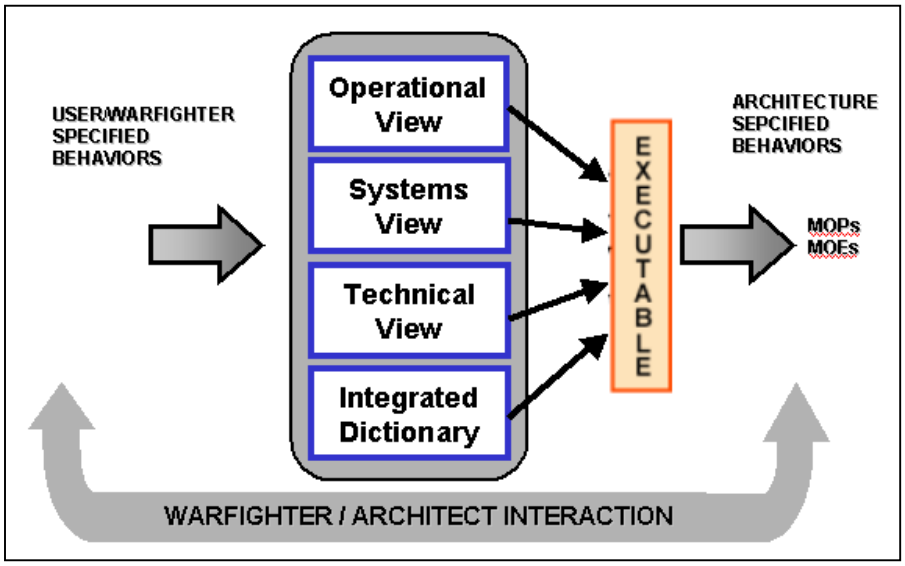

Figure 5.5 Role of the Executable Model

Analysis and experimentation will form an important component of the development strategy for the FCS, UA, UE, OF, and Joint initiatives. These complementary efforts will focus on issues at system, unit, and force levels across the spectrum of operations from peacekeeping to major regional conflict. Throughout the analysis and experimentation process, modeling and simulation will provide critical analysis support capabilities. (For more details on analysis see Annex C; for experimentation, see Annex D.)

5.5.1 Experimentation: Experimentation is one of the many tools that the Army will use to design, shape and validate the Objective Force. It will be the mechanism by which new and emerging operational concepts are tested and converted into definitive capabilities and requirements prior to system acquisition. The Army will conduct its concept development and experimentation across a series of processes that will cover exploratory concepts, developmental concepts, integrating concepts and service/joint experimentation. Architectures will play a crucial role during the concept development and experimentation process.

Experimentation architectures will be closely modeled along the architecture development guidelines addressed in paragraph 5.3 above. These experimentation architectures will help focus and define the experimental objectives and will integrate operational concepts, capabilities, and force design. These architecture information sets will cover all of the DOTMLPF domains. Additionally, experimental architecture information sets must include and ensure joint interoperability and connectivity. Experimental architectures will be developed to inform not only concept development,

but also capabilities documents (e.g., O&O, ICD, CDD, etc.) that will provide the overarching framework for the Army's SoS and FoS developments. Warfighter capabilities based operational architecture views and information sets will articulate the concepts that will be tested.

All experimental architecture products or information sets must conform to the DoD Architecture Framework and must be ALL_CADM compliant. This includes the information sets from Army/Joint major experiments, enhanced battle lab integrating experiments, LSI demonstrations and all other CD & E efforts. Architecture data from these events will be captured and stored in the AARMS where it can be reconfigured, reformatted and reused to inform other experiments and demonstrations.

Experimentation makes heavy use of modeling to simulate various aspects of the future environment to facilitate understanding and knowledge of what is feasible. Models are a critical component of any experiment and are used to represent most functional aspects of the experimental environment. The value of the information garnered from an experiment is directly proportional to the fidelity of the experimental design and the fidelity of the model. To achieve the best possible analytical results, AIMD will provide well designed, warfighter validated, operational architecture information sets to inform the science and technology community. The analytical community will use these operational architecture information sets to feed the experimental models and to help shape and properly analyze the concepts. The information sets will also provide the required audit traceability back to the warfighter. TRADOC architects and analysts will participate in all stages (planning/design, execution, and after-action) of an experiment to ensure the experiment design effectively applies the correct simulation requirements and ensures the analytical efforts support the concept being explored.

5.5.2 Analysis: Legislation requires that all system acquisition claims and requirements be supported by credible analysis. A component of this requirement is to justify proposed and existing system investments by quantifying the improvements in measures of performance to be gained. The DoD Architecture Framework is designed to help organizations meet these requirements by providing uniform methods for describing systems and their performance in context with mission and functional effectiveness. The Framework provides the rules, guidance, and product descriptions for developing and presenting architecture descriptions that ensure a common denominator for understanding, comparing, and integrating architectures. The goal is to enable the acquisition and fielding of mission effective, cost effective and interoperable military capabilities.

As the Army transforms over the next 15 years, the operational capabilities requirements, solutions and development environment will be incredibly complex. Development and decision cycles will be shortened. Operational risk of failure will increase. The dependence on C4ISR and technology will increase. The operational environment and system solutions will become more integrated and complex. All of

these features and changes impact the TRADOC architecture process making the task of analysis equally difficult.

Analysis Division functions and capabilities encompass a wide range of architecture related topics, most often set 5 to 15 years in the future. Is the “system” or “system of systems” functionally responsive and traceable to the Warfighter capabilities? How do we evaluate such performance? Do we have the tools to do so? What are the alternative options? Do we change the performance requirements and, if so, to what? How does changes in deployment of system architecture affect performance? What are the potential risks and rewards of a planned course of action? Analysis Division analyses directly support the development of future concepts and architectures that will transform the Army.

5.6 Architecture Tools and Repositories: Architecture is data that is developed as sets of graphical, tabular, or textual information. Products and information sets are mechanisms for visualizing, understanding, and assimilating the broad scope and complexities of the data and data relationships that comprise an architecture. Architecture tools extract and format data from one or more databases and format it to build architecture information sets that present the desired point of view and scope. Data can be shared among databases that implement the same logical data model and physical schema. The CADM provides a standard logical data model for storing Objective Force and Current/SBCT architecture data. The current version of the CADM is the ALL_CADM. The ALL_CADM provides the logical basis for moving architectures from compendiums of documents, spreadsheets, and graphics to data that can be stored in architecture data repositories and manipulated with automated tools. The DARS is the common repository at OSD level for architecture descriptions for the department. Multiple government off-the-shelf (GOTS) and commercial off-the-shelf (COTS) tools may be used to manipulate the architecture data and generate products.

5.6.1 The Army Architecture Repository Management System: TRADOC developed the Army Architecture Repository Management System as a GOTS tool to support its roles and responsibilities as the Army’s Operational Architect. AARMS fully supports capabilities-based architectures and is both a flexible decision support system and a CADM compliant data repository for architecture products and information. ***All TRADOC/DA directed architecture development must use the AARMS repository.***

- AARMS supports the JCIDS process.
- AARMS is both a flexible decision support system and an ALL_CADM compliant data repository for architecture products and information sets.
- AARMS fully supports a capabilities-based architecture development process and supports the DARS vision.
- AARMS allows architects across proponents and domains to produce consistent products/views by performing cross product checking in a virtual, collaborative environment.

- The requirement to provide traceability from joint capabilities to Land Warfare architectures warrants Joint/DoD partnerships to enhance integrated OA and SA products within AARMS.
- An AARMS - DARS partnership will support Joint experimentation and architecture data sharing with JIM partners as envisioned by SECDEF/CJCS.
- AARMS supports development of Mission Capability Packages (MCP) as an approach for using architectures to achieve a rationalized and interoperable family of systems providing required levels of mission capabilities.
- AARMS can change quickly to meet new requirements at minimal cost by incorporating GOTS tools to stay ahead of JIM requirements.

The AARMS vision is to support AEA and JIM architecture design and development. It will also serve as a repository for land warfare architecture information, and facilitate the validation, approval, analysis and distribution of information sets within a joint context. AARMS provides a controlled collaborative framework for architecture product/information set development using a distributed CADM compliant database. As an architecture tool and repository, AARMS supports Current, Stryker, and Objective Force architecture development, to include the Battle Command and UA/UE architectures.

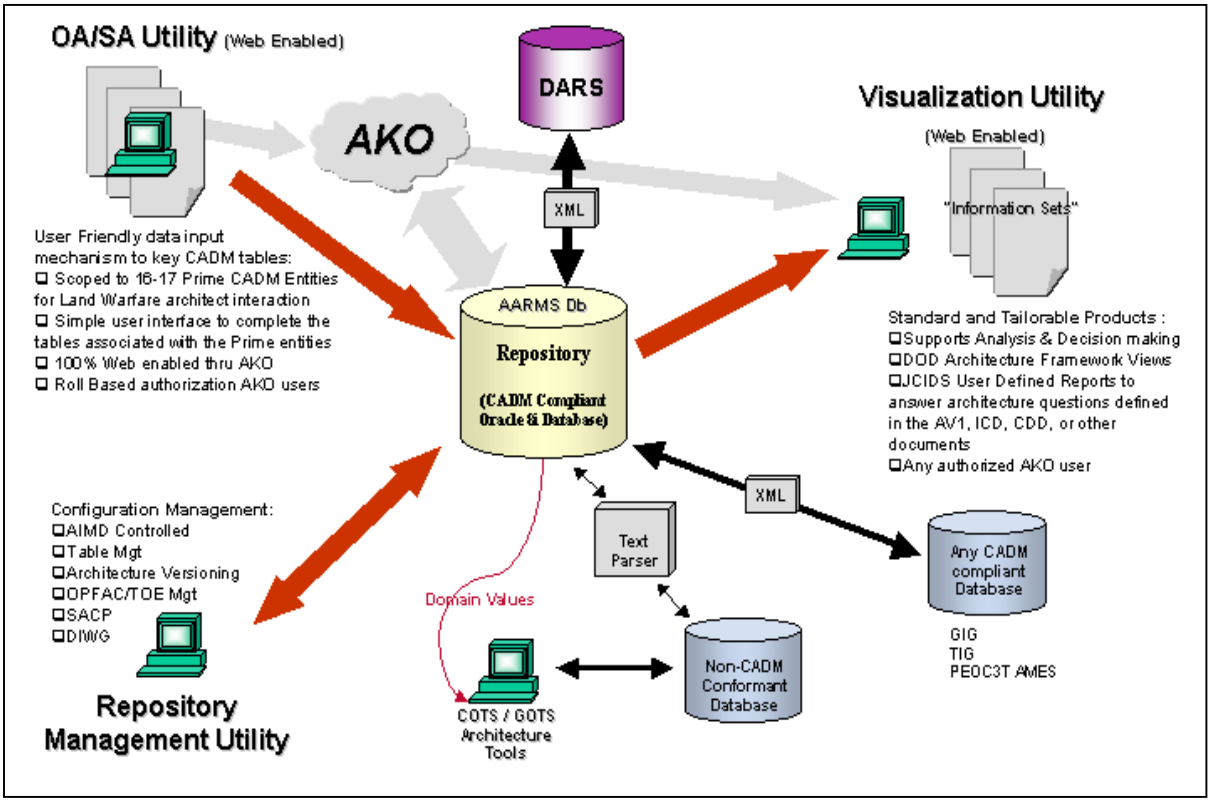

Figure 5.6.1 AARMS Vision

5.6.2 The AARMS Paradigm: The AARMS paradigm (Figure 5. 6.2) centers on data points within the CADM construct. By breaking down the large and complex CADM data model into 16 key entities and their relationships (see Annex B, Architecture Development Process, for more details) and applied against the three Phased Architecture Process discussed in paragraph 5.3, the architect can populate the key data points that make up the product views and assemble the piece parts into information sets to build the knowledge necessary to support decision making.

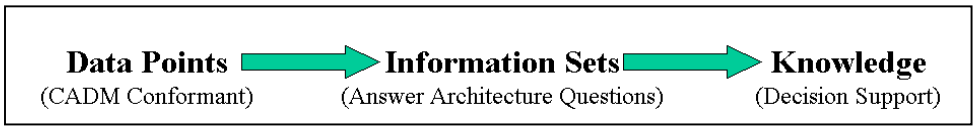

Figure 5.6.2 AARMS Paradigm

Each Framework product was perceived as an entity containing data, and a formal data model (The CADM) was derived showing the relationships among the various entities. The relationships among the entities induced a partial ordering of the entities, which led to the series of six stages in Phase II for their production.

AARMS focuses on the key entities and provides data manipulation and visualization tools for architects and integrators. AARMS also provides data and architecture management tools in support of data management.

5.7 Summary: This chapter has focused on the creation of architectures and the creation of products and information sets associated with the DoD Architecture Framework. The Phased approach to the architecture process demonstrates the steps necessary to develop architecture descriptions that conform to the Framework. Furthermore, the process incorporates the derivation of an executable model that can reveal the logical, behavioral and performance characteristics of the architecture. This is largely an iterative process and not a sequential one due to the interrelationships between the key entities of the data that make up the products. Phase I concepts and AV1 documentation is revised throughout the process based on knowledge produced by the information sets created in Phase II and the evaluation of the architecture in Phase III.

Chapter 6: When/Where Integration, Validation, Approval And Registration Occurs

6.0 General: Architectures have taken on a tremendous importance over the last several years as technology has improved, the requirement for Army/JIM integration increased, costs have increased and the nature of warfare has changed. Architectures now must be nested vertically across DoD, from platform to the National Command Authority, and horizontally, across organizations, systems and functions. These facts will continue to shape not only how architectures are prepared, but how they are integrated across all Army and JIM domains. The processes of development, integration, validation, and approval, however, will still depend on the skills of the individual architect. There are significant risks in not integrating architectures. One of the more significant risks of integration is the cost of not properly integrating architectures and their components. If the architect does not employ the appropriate tools, standards and integration techniques from the very beginning of the development effort to the end, it will be costly. The cost is directly proportional to the complexity of the architecture and the delay in the integration effort. Architectures must link to Joint functional concepts to ensure that the work the Army is doing will be synchronized with the direction the Joint Staff and the other services are moving. During the process of architecture development, gaps and overlaps in existing and developing capabilities will be identified – both of which have associated costs. Additionally, the data entered by proponent architects into integrated databases in the process of developing architectures, will serve as the foundation for the development of an integrated database system at the DoD level and the Defense Architecture Repository System (DARS). This system will become a powerful tool and transform the nature of architecting and support joint capabilities analysis

6.1 Integration – Definition: Integration is the process of ensuring that all required components of a system, function/mission, organization, system of systems or family of systems come together and begin to behave as one to achieve a desired outcome. It means that architecture components resident in the architecture are linked (both vertically and horizontally), are totally compatible and are relevant to all associated architectures. This “linkage” is usually among systems, organizations and functions. Integrated systems result when information flows among them as if they were a single system – even if it is only a temporary arrangement designed to achieve a single capability. Organizations are integrated when their tasks, missions and capabilities are complementary and achieve synergy – without being hindered by organizational boundaries. Functions are integrated when their associated accomplishments support the systems or organizations as intended and that they can be traced seamlessly through organization and system boundaries. It is of the utmost importance that architectures, as the blueprint that ties systems, organizations and functions together, be integrated from initial concepts to data. The requirement in the Army of today and tomorrow is for physical integration – the ability of systems (to include databases), functions and organizations to operate together and intellectual integration – the ability of soldiers to appropriately leverage those capabilities.

The four critical aspects of integrating architectures include: Adherence to the framework – a common approach in the development of architectures; consistency within the GIG architecture; data compliance with the CADM; and use of a common taxonomy for architecture data element values. This chapter addresses how, in the pursuit of capabilities, architectures are integrated, validated, approved and, as required, registered. Four additional aspects include, but are not limited to: Identify key linkages and seams between process and domains; Identify transitions between entities, systems and domains; Identify thoroughness of process to capability; validate traceability to mission, vision, and performance measures.

6.1.1 Physical Integration: An example of physical integration is the linkages required by a mechanized battalion. It is vertically linked to the next lower level, its companies, and next higher, a brigade. Horizontally, it is linked to units on its left and right (may be from a different brigade, division or country), as well as its supporting organizations, such as field artillery, MI, signal, aviation (Army and Air Force/Navy/Marines), and combat service support. This battalion can exchange information with these other organizations (compatible communications systems) and perhaps see them. They can comprehend both the affect of their relationship (e.g. supplies and fire support), and the reciprocal impacts on how well they perform their missions. Systems must be integrated with other systems, e.g. firing platforms linked to communications systems. Likewise, functions are also integrated. For example, the MEDEVAC function is enabled by communications systems, and these contribute to the accomplishment of the medical mission. Organizations employ systems and perform functions to create capabilities that enable mission accomplishment. Another aspect of physical integration is the linkage of the development of functional training requirements to the tasks and missions that result from operationalizing of the architecture.

6.1.1.1 Levels of Integration: Integration is also required at the systems of systems level. A system of systems, as discussed in Chapter 5, is a relationship and level of interoperability developed between systems of differing capability brought together to achieve a single, higher level capability. An example of this can be found through inspection of the Joint concept of Effects Based Operations (EBO). In order to achieve EBO, the Army has developed a concept for networked fires that requires sensors, shooters and information systems that provide battle commanders with the understanding and decision support necessary to satisfy the capabilities required. Traditionally, the Army had treated each of the four areas described: sensors, shooters, fire control systems and command and control systems as separate, stove-piped systems. The diagram below depicts the concept of a systems of systems approach to achieving capabilities:

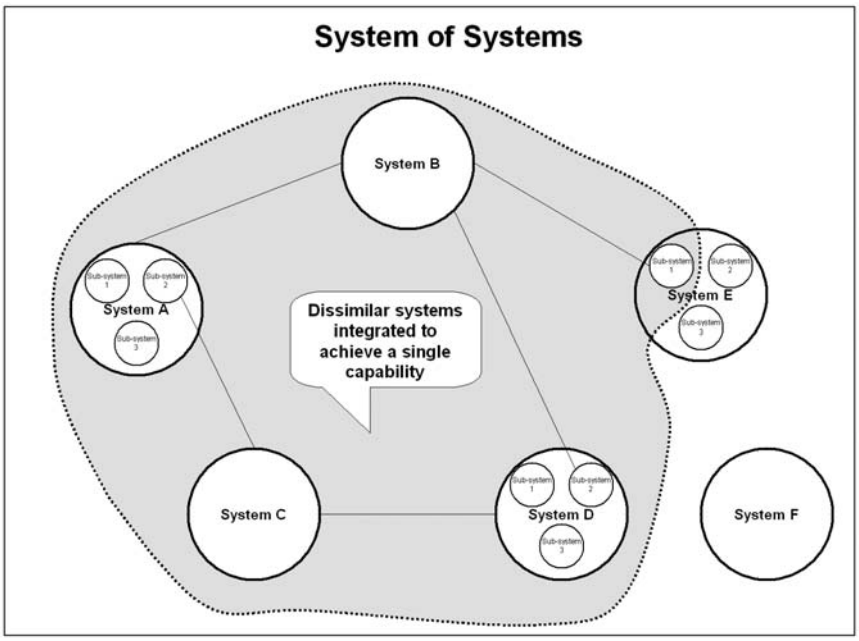

Figure 6.1.1.1-1 Systems of Systems

A system of systems context sometimes depends on the scope and level of the desired capability. An example of a system of systems is Comanche – it is a platform that contains multiple systems - fire control, weapons and communications systems. Additionally, in the example above, to a achieve a capability that is less broad, such as only fire control, then System D with its three subsystems could be considered a system of systems. A family of systems level of integration is similar to the notion of system of systems, however it requires integration of multiple systems to achieve multiple capabilities as depicted in the figure below.

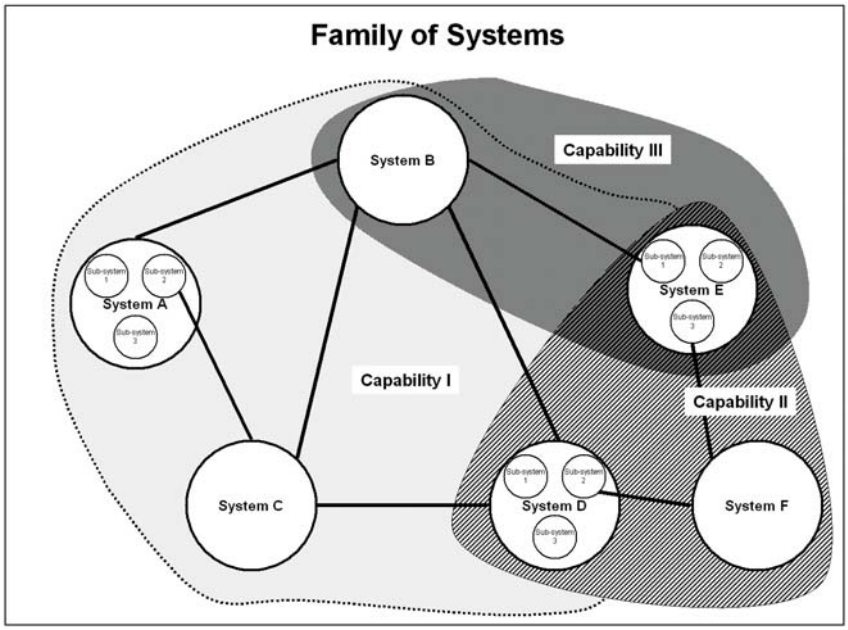

Figure 6.1.1.1-2 Family of Systems

An example of a family of systems is the Future Combat System. FCS is a family of systems integrated to achieve battle command, sustainment, networked fires, etc. The FCS FoS includes a variety of FCS platforms (e.g. cannon, gun, command and control, medical). The architectures that depict system of systems will identify and isolate these capabilities independent of platform, traditional stove-pipes, and physical boundaries.

Integration of SoS and FoS in an architecture is particularly challenging because of the increased level of interoperability required and the need to break down traditional system, program, budgetary and other “rice-bowls”. A SoS architecture Systems of Systems Architecture (SoSA) or FoS Architecture (FoSA) assembles components, perhaps optimized for other purposes, into a single interoperable system to achieve desired capabilities. The key to achieving true SoSA/FoSA integration is to establish a tight linkage among three steps: the ability among the component systems to exchange information, the linkage of functions among components as identified by mission analysis and mission thread decomposition and a demonstration that the component operational concepts and capabilities are interoperable at the requisite level. This integration, within the umbrella of a domain architecture nested within Army and Joint architectures, will also be captured in a database with a common format so that ultimately the higher level purpose is served.

6.2 Integration – The Process

6.2.1 Integration first occurs at the proponent level: The proponent must:

- Identify joint capabilities and required integrating concepts. An example of this would be the Joint Capability required for a unit that deploys as part of a Joint Task Force to be capable of Rapid, Decisive Operations (RDO). Army required integrated concepts would include Battle Command, Enroute Mission Planning and Battle Command on-the-move.
- Perform analysis of core competencies for each architecture. Core competencies for an ARFOR might include:
  - C2 Army Forces
  - Develop the situation
  - Synchronize Maneuver
  - Set conditions for Deep Ops/Fires
  - Army Force Title X
  - Counter enemy efforts on anti-access (terrorist/insurgency)
  - Maintain information networks
  - Deploy forces into theater by land, air and sea. Direct Reception, Staging, Onward-movement & Integration (RSOI)
- Form an IPT or working group to address and decompose these competencies across the appropriate BOS/BFA if necessary. A working group between Armor, Infantry, Intel and Aviation to work through ISR for a Stryker Brigade would be such an example.
- If mission thread development/decomposition is utilized for a particular architecture, it also must be synthesized across the BOS/BFA.
- Builds and enters data into AARMS, the tool itself will perform data level integration, especially at the IER level.
- Ensures that the architecture development process is linked to training requirements.

6.2.2 Integrating Centers and Battle Labs:
Architecture products/information sets from proponents are checked and validated against emerging warfighting concepts that the Integrating Centers and/or Battle Labs are responsible for. Battle Labs perform experimentation and analysis that provide warfighter underpinnings that will be captured and described in the architectures/information sets. As part of experimentation, Battle Labs combine promising independent initiatives into relevant, integrated warfighter capabilities and assess their value/potential to Warfighters.

Battle Labs may be directed to produce operational architectures. The Unit of Action Maneuver Battle Lab (UAMBL) is developing the UA and Future Combat System (FCS) architecture products that are being used for the initial UA architecture and to render high level architecture products supporting the FCS Operational Requirements

Document (ORD) and Command, Control, Communications, Computers, and Intelligence Support Plan (C4SIP).
If the battle lab is designated as "Lead Architect", then the integration responsibilities for the battle lab are the same as the proponent.

To ensure thorough integration, proponents and their supporting battle labs will form teams and partnerships with other battle labs, appropriate branch proponents and agencies within TRADOC to inform their work (See TRADOC Transformation O&O Plan).

6.2.3 AIMD: AIMD is responsible for integration at the TRADOC level. To accomplish This AIMD must:

- Integrate architecture components into a single, cohesive, linked architecture that can be used to describe organizational, functional and systems components, their relationships and interdependencies.
- Develop integration roles, procedures and responsibilities and publish them in each architecture Overview and Summary (AV-1).
- Confirm integration at proponent seams through analysis, modeling and simulation.
- Design and maintain AARMS so that it provides an automated force, concept and data-level integration capability facilitating integration of collaborative architecture development.
- Conduct mission analysis across system of systems and family of systems architectures; linking through SA-C as required.
- Manage the development process to ensure that architectures are collaboratively developed among required proponents – Army and JIM.
- Integrate non-TRADOC developed operational architectures with TRADOC developed architectures.
- Ensure SA-C is traceable back to warfighter requirements and is underpinned by analysis and experimentation.
- Resolve integration conflicts as required.

6.2.4 AAIC: The AAIC performs key integration functions. As domains deliver architecture requirements, the AAIC must assess the nature of the requirement and ensure it is tasked to the appropriate agencies. Upon receipt of an architecture approved for release from TRADOC, the AAIC coordinates with the two other Executive Architects – the ASA (ALT) and CIO/G6 – to ensure the architecture is integrated prior to submission to the G3 for final approval. The AAIC ensures the architecture is integrated into the Army Knowledge Enterprise Architecture (AKEA), supports integration of Army Functional Concepts and Domain architectures in JWCA Joint Architectures and ensures the architecture is integrated with the AEIOO/Sustaining Base.

6.2.5 Concept of Domain Architectures: The concept of "Domain" architectures is relatively new. The Transformation Campaign Plan established the domain proponents.

One of their primary responsibilities is to establish enterprise-level domain architectures that encompass ALL aspects of Army operations within their functional area. This overarching architecture must be integrated and assimilated into the Army Enterprise Architecture, which in turn is nested within the Joint and OSD enterprise architectures

NOTE: The following discussion of domain architecture integration process is based on preliminary working group recommendations. The process is in its infancy and has a long way to go before it matures into an approved process. The issue is domain initiated architectures versus UA/UE/USFMS initiated architectures.

6.2.5.1 Domain Architecture Integration Process: The AAIC has developed a methodology for Army Domain Proponents and Major Commands (MACOM) to use in the development of their functional architectures that will be integrated into the Army Objective Force Architecture (AOFA)/Army Knowledge Enterprise Architecture (AKEA). It provides the guiding principles for developing an integrated, capabilities-based architecture that delivers the desired effects to the 2015 force. This methodology leverages, and is directly linked to the architecture development approach advocated by the Joint Staff in CJCSI 3170.01C. TRADOC is a participant in this process by its responsibility as the developer, validator, and integrator of the warfighting aspects of all Operational Architectures. It is generally the same process as with any other architecture.

6.2.5.1.1 New Domain Architecture. The methodology for integrating new domain architecture is depicted in the figure below.

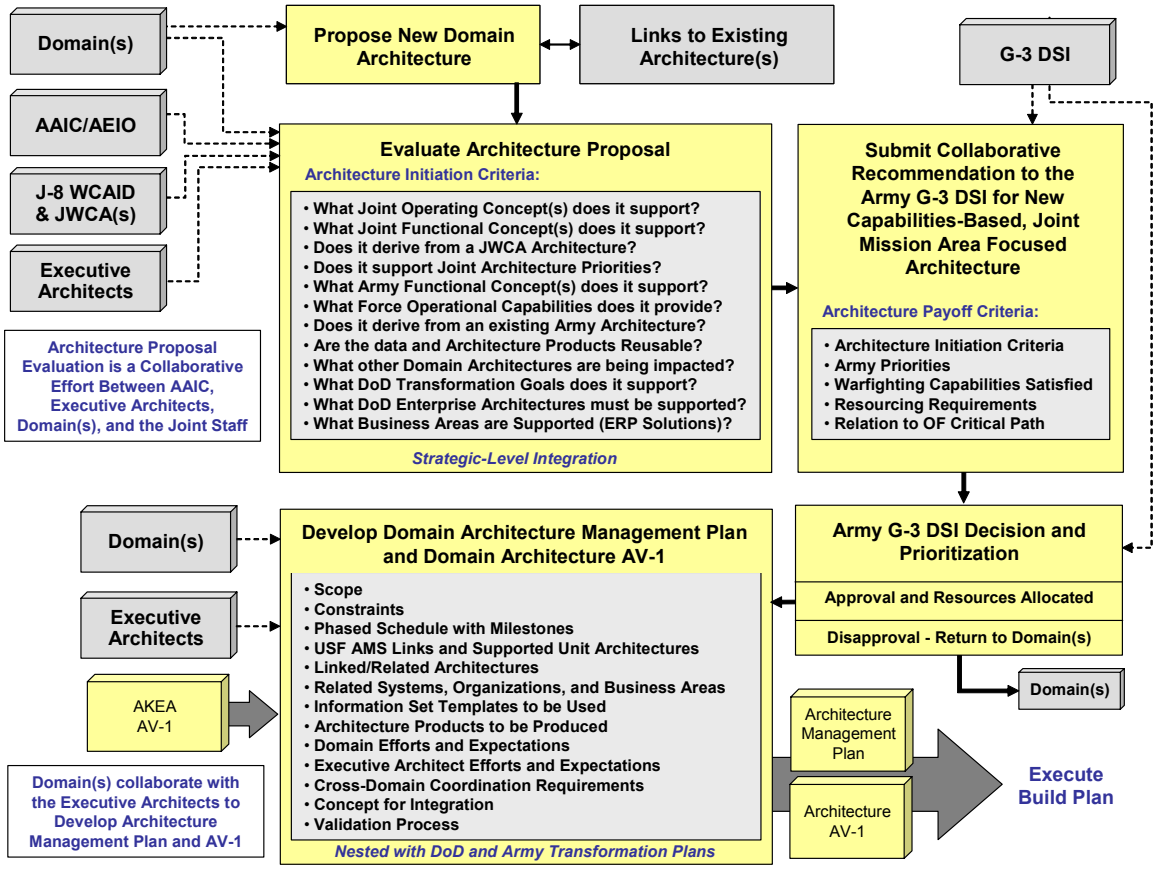

Figure 6.2.5.1.1 New Domain Architecture

- The process begins when an Army Domain or MACOM (hereinafter referred to as domain) submits a new architecture development requirement to the AAIC. The AAIC in collaboration with the domain, the AEIOO, Joint Staff, and the Executive Architects evaluates the architecture proposal using the architecture initiation criteria listed in Figure 6.2.5.1.1.
- Recommendations resulting from this collaborative effort are submitted to the Army's Decision Superiority Integrator, the G-3. Recommendations will be framed based on the following payoff criteria:
  - Architecture initiation criteria evaluation
  - Army priorities
  - Warfighting capabilities considered
  - Resourcing Requirements
  - Relation to Objective Force critical path
- If the G-3 disapproves the proposed architecture work, the proposal is returned to the domain for follow-up action, if any.
- If the G-3 approves the proposed architecture work, priorities are established and resources are allocated for follow-on development.

- Following approval, the AAIC will facilitate a collaborative effort with the domain and the Executive Architects to develop/update the domain's Architecture Management Plan and develop the AV-1 for the architecture. The DoD and Army Transformation Plans, AKEA AV-1 and DoD Architecture Framework will guide this collaborative effort. The resulting AV-1 must address the topics listed in Figure 6.2.5.1.1.
- Following AAIC approval of the Architecture Management Plan and AV-1, the domain will execute the build plan. Should the architecture involve TRADOC, the AV-1 will be sent to TRADOC whose participation in the process includes the same requirements for development, integration, validation, and approval as all other architectures. TRADOC will review all architectures that may have warfighting implications, such as sustaining base and enterprise/business architectures.

6.2.5.1.2 In-Progress/Previously Developed Army Domain Architecture: The methodology for integrating domain architectures that are in-progress or have been previously developed is depicted in Figure 6.2.5.1.2, below.

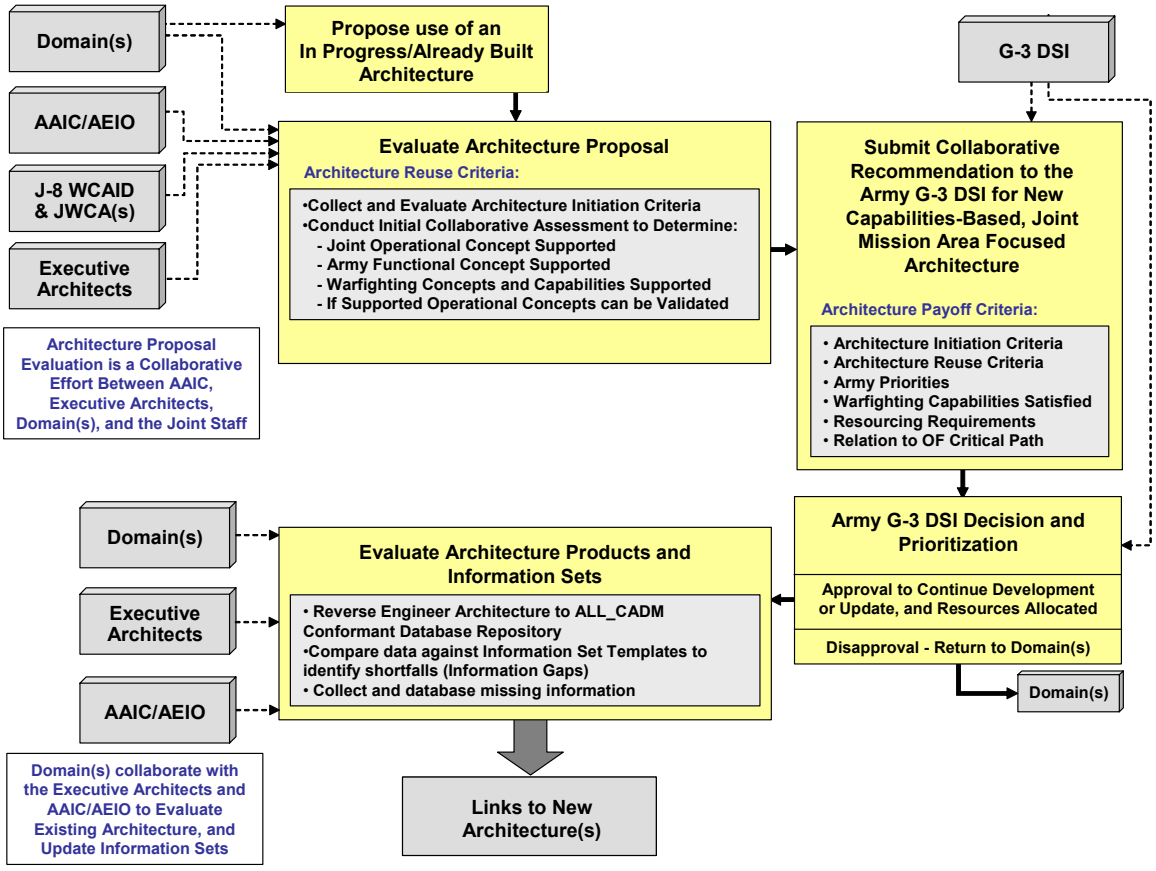

Figure 6.2.5.1.2 In-Progress/Previously Developed Army Domain Architecture

The process begins when a domain submits an architecture to the AAIC that is in-progress or has been previously developed. The AAIC in collaboration with the domain, the AEIO, Joint Staff, and the Executive Architects evaluates the architecture to determine if continued development/update is warranted using the architecture reuse criteria listed in Figure 6.2.5.1.2 in combination with the initiation criteria listed in Figure 6.2.5.1.1.

- Recommendations resulting from this collaborative effort are submitted to the Army's Decision Superiority Integrator, the G-3. Recommendations will be framed based on the following payoff criteria:
  - Architecture initiation criteria evaluation
  - Architecture reuse criteria evaluation
  - Army priorities
  - Warfighting capabilities considered
  - Resourcing Requirements
  - Relation to Objective Force critical path
- If the G-3 disapproves the proposed architecture work, the proposal is returned to the domain for follow-up action, if any.
- If the G-3 approves continued development or update, priorities are established and resources are allocated for follow-on work.
- Following approval, the AAIC will facilitate a collaborative effort with the domain and the Executive Architects to evaluate existing architecture products and information sets. This may involve reverse engineering of the architecture into an ALL_CADM conformant database repository. Data will be compared against Information Set Templates to identify shortfalls (information gaps).
- Following this evaluation, the AAIC will facilitate a collaborative effort with the domain and the Executive Architects to develop/update the domain's Architecture Management Plan and update the AV-1 for the architecture. The DoD and Army Transformation Plans, AKEA AV-1 and DoD Architecture Framework will guide this collaborative effort. The resulting AV-1 must address the topics listed in Figure 6.2.5.1.1.
- Following AAIC approval of the Architecture Management Plan and AV-1, the domain will execute the plan to continue development/update the architecture. As with new Domain architectures, TRADOC will participate in the process if the architecture involves warfighting aspects.

6.3 Validation: Operational Architectures, as well as their associated Systems Architectures (Conceptual) are validated to ensure they meet the warfigher's capability requirements and are technically supportable. The process also ensures that the capabilities expressed in the architectures meet Army and Joint concepts and capability requirements as expressed in such documents as the C4ISP, ICD, CDD, CRD, Doctrine, and Organization and Operations (O&O) documents. Architectures must be doctrinally correct and consistent with operational concepts, fielding plans and Army and Joint Vision documentation. A sub-set of Integration, the validation process unfolds primarily during architecture development.

6.3.1. Architecture Validation Criteria:

- Complete – required products produced and entered into the appropriate database in the appropriate format. Required internal and external linkages are present.
- Accurate – the content is factually correct, faithfully representing supporting information.
- Prepared in Standard Format – contents meet the required standards as specified in the architecture initiation tasking document.
- Consistent – the content is in conformance with current or emerging doctrine, concepts, systems capabilities and fielding/development plans. Products are developed from the same viewpoint, integrated across the entire architecture, and are based on traceable supporting data.
- Relevant – the architecture has answered the questions posed in the requirement, is framed in the appropriate Army/Joint context, and is provided in a timely manner. If the purpose of the architecture was to inform the POM cycle, and if the architecture is delivered after the fact, then the principal purpose of the architecture has not been served.

6.3.2 Validation occurs at every level of review:

- Tier 1. Branch and Specified Proponent DCD/equivalent, and Battle Lab Directors ensure, from their perspective, that the architecture meets the five criteria specified in 6.3.1, above. Every proponent DCD/equivalent and battle lab director will establish procedures for validating architectures.
- Tier 2. Once validated at the Tier 1 level, architectures are provided to the Director, AIMD. The AIMD can validate minor architecture development utilizing the five criteria listed above, where consensus within the architecture community already exists. As a caveat, however, this validation may occur only when:
    - Operational systems are mature
    - Systems are applied in a manner consistent with TRADOC approved requirements documentation (ORD/CDD, BOIP, AAO, etc.) or business rules previously validated and approved by a TRADOC Council of Colonels.
    - Systems are used for their intended purpose.
    - Disagreement within the architecture community is of a limited, technical nature and does not question the warfighter underpinnings upon which the architecture was based.
    - Analytical assessment via modeling and simulation indicates limited or negligible feasibility/performance risk.
- Tier 3. TRADOC Council of Colonels Architecture Validation Board (AVB). This level of validation is utilized when:
    - Operational concepts are developing, the architecture deviates from what is considered mature, or if the purpose of the architecture is to vet operational concepts.
    - The architecture represents a new Army mission.
    - The architecture applies new, unproven or complex systems of systems.

- Mature systems are not used for their intended purpose (e.g. EPLRS first used in the lower tactical internet.)
- The architecture is of a special nature or is intended for high level/Joint decision-makers.
- Analytical assessment via modeling and simulation indicates a high level of feasibility/performance risk.

The members and procedures of the AVB are as follows:

a. Voting Board Membership:
   - HQ TRADOC (Director, AIMD) will Chair the board.
   - CAC (TPIO-ABCS), CASCOM, MANSCEN, Directors of Combat Developments/Equivalents of Branch Proponents.
   - TRADOC DCSOPS&T (for training architectures)

b. Board Participation (as invited to address specific validation issues)
   - Other TRADOC organizations – TRADOC DCSOPS&T, TSMs, Battle Lab Directors, TRAC, etc.
   - PEOs and PMs for selected systems.
   - DA Staff (G3, G8, AAIC, ASA (ALT)/Domain Leads
   - United States Army Force Management Support Agency (USAFMSA)
   - AKEA GOSC designees.

c. Validation Board Procedure.
   - The Board will be empowered to direct actions to resolve proponent architecture issues.
   - The Board will be conducted when required. Special meetings of the Board may be convened by the chairman, in addition to regular meetings, to resolve time-critical issues.
   - A voting Board member may delegate its vote to any other voting member.
   - A simple majority of voting members is required to reach a decision.
   - Personnel from the AIMD will serve as the secretariat.
   - The chairman will only vote in case of a tie.
   - The Architecture Development Division (ADD), AIMD, will conduct a technical review of all products and architectures and issue packages to be considered at the Board, and will provide results to Board members prior to each meeting.
   - Proponents/architecture developers may recommend issues for consideration at the next Board meeting to ADD NLT 45 days prior to the next scheduled meeting.
   - The ADD will notify proponents/architecture developers of the architecture products and issues to be reviewed at the meeting at least 30 days in advance.
   - The Director, AIMD, will publish the official minutes of each Board meeting NLT 15 calendar days after the meeting.

6.3.3 Number of Tools Available: There are a number of tools to assist in this effort above and beyond the use of manuals, AARMS and many phone calls. Two frequently utilized tools include:

- Integrated Process Teams (IPT). The complexity of the architecture may require the assembly of a number of experts from associated disciplines to develop architecture fundamentals as well as conduct extensive efforts within their realms of responsibility.
- Mission Threads. Mission Threads (OV-6c) are examinations of aspects of architectures. The thread traces a representative aspect of an architecture across system, function and organizational boundaries. It demonstrates, among other things, how information is exchanged among specific communication systems. Using a series of mission threads that cover the area the architect is exploring, the architect can perform a quicker, albeit limited, analysis.

6.4 Approval: Architectures are approved at succeedingly higher levels of the development process, similar to validation, beginning at the Proponent level. The final level of approval is based on the relative importance of the architecture, with the level of final approval specified in the Tasking Letter that initiates most architecture development. Should a Branch Proponent develop an architecture for internal use, approval is at whatever level it desires. The requirement for a senior leader to approve serves as the indicator that the architecture accurately reflects that the purpose of the architecture has been met, and that the proponent solution is in accordance with the direction the Army is moving – transformation to the Objective Force. Progressive levels of approval ensure a valid, synchronized product is presented at each succeeding level. The approval level will be specified in the Tasking Letter.

6.4.1 Architecture Approval Prior to Submission to TRADOC AIMD: For TRADOC directed architecture development, prior to submission to the AIMD; the architecture will be approved at the DCD/equivalent level at a minimum. Approval at this level signifies that all appropriate coordination has been accomplished and the architecture appropriately entered into the AARMS database. The architecture has been vetted with the other proponents who are impacted and any Joint linkages have been researched and included. If it is a Current Force architecture, the supporting Battle Lab has reviewed it to ensure the transitional linkages to OF are addressed. If not signed by the proponent CG, the DCD is signing for him/her. If the developing proponent is subordinate to a Specified Proponent, the approved architecture is sent to that proponent for review and approval prior to it being sent to AIMD. The Specified Proponent ensures it has been validated, conducts whatever approval process it deems appropriate, then is signed by the CG, DCG or DCD, as determined internally, and forwarded to the Director, AIMD.

6.4.2 AIMD Architecture Receipt: Upon receipt at AIMD, the architecture may be scheduled for an AVB. At a minimum, it will be staffed with the appropriate TRADOC staff elements. Determining factors will be complexity of the architecture and the existence of any disagreements with content. Through an iterative process and once validated, the architecture will be approved at HQ, TRADOC by either the DCSDEV,

acting for the CG, or by the CG, again determined by the nature of the architecture. The Director, AIMD, will determine the appropriate level of approval, and present it to the approver at the completion of the staffing process. Architectures with low risk and low cost can be approved by the DCSDEV. Approval at the CG, TRADOC level means that the architecture is of critical importance to the Army. Architectures approved at the TRADOC level are forwarded to the Army Architecture Integration Cell (AAIC) at HQ DA for review. Once the architecture is integrated and validated by the AAIC, it is forwarded to the DA G3 for final approval.

6.4.3 AAIC Architecture Receipt: The AAIC ensures that the architecture has been properly integrated across the Army Domain and JIM communities, and coordinates for the development of the Systems and Technical Architectures. Any issues with the Operational Architecture are resolved with the AIMD. Once the architecture is complete, it is sent to the Army G3 for approval. Once approved by the G3, funding, personnel, acquisition, doctrine, training and documentation actions begin.

6.4.4 External Architectures: Many non-traditional architectures will be completed. Functional and Systems architectures will be initiated, like MEDEVAC and MC4, and some will be a combination – like FCS. We will have UA and UE architectures. Training architectures will be developed that are increasingly complex, and tie directly into platforms – such as embedded training in FCS. We will contribute to the development of architectures initiated by non-TRADOC proponents, such as Space and Missile Defense Command, SOCOM and The Surgeon General – architectures that have warfighting implications. There will be others that have warfighting implications – such as Home Station Operation Centers, a component of Reach operations. Finally, we will be involved in the development and approval of JIM architectures – such as Standing Joint Task Forces, Homeland Defense, and JIM experiments and testing. Many TRADOC proponents will participate in the approval process of non-TRADOC architectures, and these events will be coordinated by the AIMD. Proponents receiving requests to participate in non-TRADOC directed architecture development activities will refer the requesting agency to the Program Management Office, AIMD.

6.5 Registration: Registration is the inclusion of non-standard architectures in the AARMS database. These may include commercially produced architectures that are not CADM compliant. The purpose of registering an architecture is to provide access to information that can be used to support development or refinement of a TRADOC architecture. For example, a training architecture will contain components that have C4 implications, but will not have information exchange requirements. The training architecture will also have components that will have information exchange requirements, such as the requirements for the training embedded in the FCS. Morale, Welfare and Recreation has developed an architecture which may be registered, is of interest to warfighters, but does not have direct warfighting implications. This architecture could be registered. Architectures that are developed by TRADOC directive are produced in the AARMS database, are CADM conforming, and do not require registration.

6.6 Summary: We can already see how architecting is evolving. We are seeing the development of interactive, integrated databases. We are seeing the growing importance of the development of JIM architectures. The development of integrated architectures is a process that extends from the proponent to the Joint Staff and OSD. Not only does the process assist in developing data that can be reused to create hybrid architectures in a short period of time, but also it assists in developing the training and doctrine required of the Objective Force.

Annex A

Projected Architecture Development Work

TBP

Annex B

Architecture Development Process

1. Introduction:

1.1 This Annex describes a process for creating the products of the DoD Architecture Framework Version 1.0 and user defined Information Sets to answer key questions about the purpose of the architecture. The Framework has a Structured Analysis bias in its representation of the products that represent the three views of an architecture (Operational, Systems, Technical). It does not provide or recommend a process for creating these products, but only some universal guidance. In this annex, we will show, using Structured Analysis, a process that generates these products and in addition provides the necessary information for the derivation of information sets and an executable model to analyze the data.

1.2 The annex consists of information that is derived from three components: The Process; An extract of the OA SOP; and the AARMS Users' Guide, which can be found on the AIMD website www.aimd.gordon.army.mil in the Policy, Plans and Programs Division documents section.

1.2.1 The Process. This document is an expanded discussion of Chapter 5 and goes into a greater detail on the various steps, phases, and stages of the physical building of architecture products and the associated database. The basis for this component comes from research conducted and published in a series of three white papers by the creators of the original DoD C4ISR Architecture Framework, Alexander H. Levis and Lee W. Wagenhals (C4ISR Architectures I, II, III; revised JAN 02). It is highly recommended all Army architects read these white papers in addition to the Framework Document itself. TRADOC AIMD endorses the processes presented here and where appropriate, specific AIMD terms and procedures have been injected into the standards set forth by Dr. Levis and Dr. Wagenhals.

1.2.2 OA SOP Extract. This document provides a more detailed explanation of the nature of the OA products that proponents are required to be constructed in support of architecture development. It describes the requirement to prepare product in the AARMS database, as well as the requirement to prepare selected products in PowerPoint for board presentation purposes. It is the goal of the AARMS branch to be able to produce board presentation quality products from the AARMS database in the near future, but that capability does not yet exist.

1.2.3 The AARMS Users' Guide. This document details how architects utilize the AARMS database for entering data, storing and extracting data, and producing required architecture products.

2. Developing a process for creating the framework products

2.1 As described in the TAMP, Chapter 5, paragraph 5.2.1, the only guidance provided by the Framework document is shown in Figure 1. The following paragraphs discuss ways to apply the Framework in building and integrating architecture descriptions. A high-level, six-step process has been developed to provide some universal guidance to the architect and to emphasize the guiding principles. This generic process should be tailored to specific organizations and purposes; the AIMD's approach is discussed in paragraph 3. The Framework does not endorse any specific process; it only serves as a basic outline for DoD organizations to follow when establishing their own process.

2.1.1 The Universal Guidance Six-Step Architecture Description Process

The following steps are fundamental to describing an architecture in accordance with the Framework and appear in the general sequence in which they often will be performed. Figure 1 depicts this six-step process. For simplification, feedback loops have been largely eliminated. It should be understood, however, that many such iterations are likely to be encountered.

Step 1: **Determine the intended use of the architecture description**. Descriptions should be built with a specific purpose, whether the intent is support to investment decisions, requirements identification, system acquisition, interoperability evaluation, operations assessment, or any other intent. Before beginning to describe an architecture, an organization must determine as specifically as possible the issue(s) the description is intended to explore, the questions it is expected to help answer, and the interests and perspectives of the audience and users. In addition, the types of analysis that are expected to be performed must be considered; for example, knowing that the architecture may be used as input to specific models or simulations can affect what should be included and how the products should be structured. This focusing will make the architecture description effort more efficient and the resulting architecture more appropriately balanced and useful.

Step 2: **Determine the architecture description's scope, context, environment, and any other assumptions to be considered**. Once the purpose or use has been decided, the prospective content of the architecture description can be determined. Items to be considered include, but are not limited to, the scope (activities, functions, organizations, timeframes, etc.); the appropriate level of detail to be captured; the architecture effort's context within the "bigger picture"; operational scenarios, situations, and geographical areas to be considered; the projected economic situation; and the projected availability and capabilities of specific technologies during the timeframe to be depicted. Project management factors that contribute to the above determinations include the resources available for describing the architecture, the resources and level of expertise available for analyzing the architecture, and availability of the necessary architecture data.

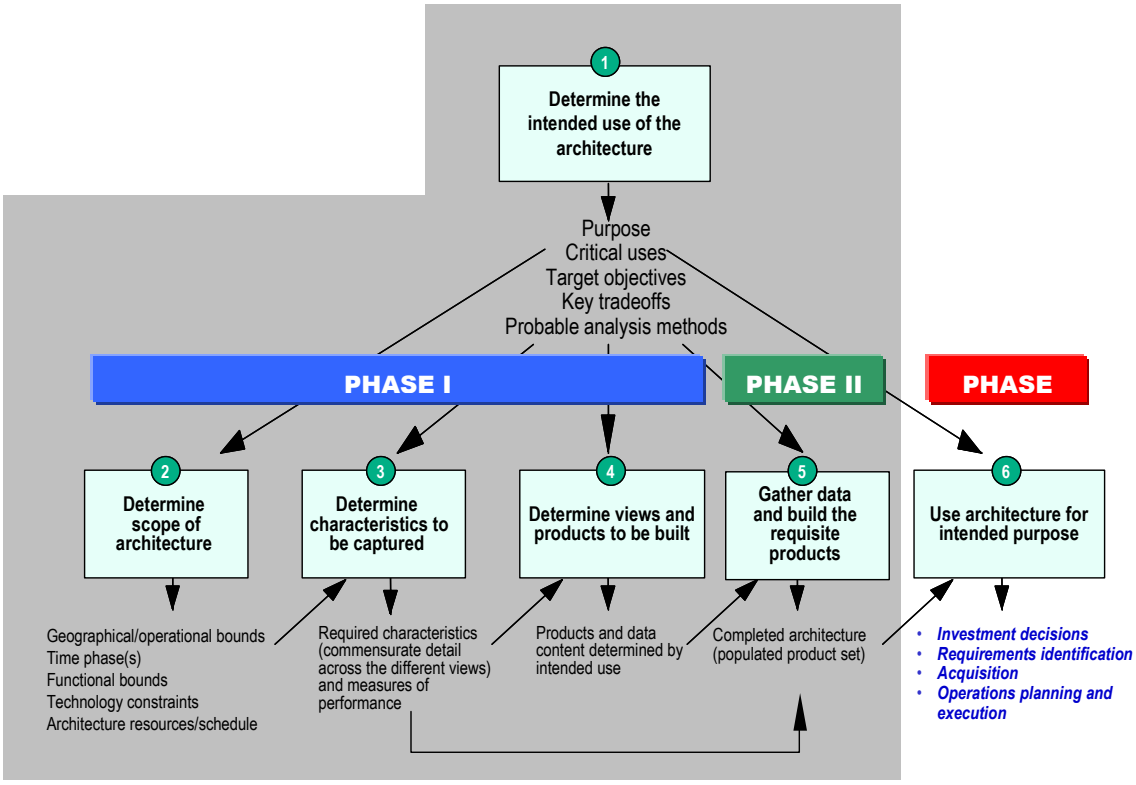

Figure. 1: The Six-Step Universal Guidance of Building an Architecture Description

Step 3: Based on the intended use and the scope, determine what information the architecture description needs to capture. Care should be taken to determine which architecture information will need to be described to satisfy the purpose. If pertinent information is omitted, the architecture description may not be useful; if unnecessary information is included, the architecture effort may prove infeasible given the time and resources available, or the description may be confusing and/or cluttered with details that are superfluous to the issues at hand. Care should be taken as well to predict the future uses of the architecture description so that, within resource limitations, it can be structured to accommodate future tailoring, extension, or reuse.

Architecture measures are a critical aspect of an integrated architecture description and should be considered at this early step in the architecture development effort. The developer wants to ensure each view (operational, systems, and technical standards) has measures identified in order to correctly determine what products need to be built, the level of detail in the products, and the attributes to be captured in the products. Measures may be both quantifiable and qualitative. If the developer is unable

to determine measures, then the end result will have less meaning to senior decision makers.

Step 4: **Determine products to be built**. Based on the understanding gained in Steps 1 through 3, determine which products to build and what data must be gathered to build the products. The DoD Architecture Framework Deskbook contains supplementary material in using products to support certain types of analysis and may also be of assistance in determining which products to build.

Step 5: **Gather the data and build the requisite products**. The next step is to collect, correlate, and compose the necessary data that will form the basis for the products. This marks the beginning of the AIMD's Phase II to the architecture process. Volume II of the DoD Architecture Framework defines the data elements associated with each product definition.

To facilitate integration with other architectures, architectures should be developed such that they are consistent with the Core Architecture Data Model (CADM) and include relationships with applicable Joint, Inter-agency, and Multinational (JIM) components. If the architecture description needs some re-tailoring to serve its purpose, that tailoring should be done as efficiently as possible. It may be useful, resources permitting, to conduct some proof-of-principle analysis at various stages, i.e., make trial runs of step six using carefully selected subsets of the areas to be analyzed. Care should be taken to ensure that the products built are consistent and properly integrated. Use of automated tools and a CADM-compliant data repository such as the AARMS can facilitate the architecture development process, assist in the use of common terms/definition, and facilitate consistency with the DoD Architecture Repository System.

Step 6: **Use the architecture description for its intended purpose**. The architecture description will have been built with a particular purpose in mind. As stated in the discussion of step one, the ultimate purpose may be to support investment decisions, requirements identification, system acquisition, interoperability evaluation, operations assessment, or some other purpose. The architecture description facilitates and enables these purposes but does not itself provide conclusions or answers. For that, human and possibly automated analysis must be applied. The Framework does not attempt to dictate how this analysis should be performed; rather, the Framework intends to promote architecture descriptions that are sufficiently complete, understandable, and integratable to serve as one basis for such analysis.

2.2 The AIMD's Architecture Development Phase II and III described in Chapter 5 of the TAMP that are addressed in this annex are step 5 and part of step 6 above.

2.3 In order to produce the products and information sets in Phase II, each one of the Framework products was considered a data entity composed of other data entities in accordance with the CADM and a formal IDEF1x data model of the set products was created. This model contained over 100 entities. Of those 100 entities, 16 were identified a key entities that are necessary to understand the mapping between the

Structured Analysis products and the Framework products. These entities and their relationships are shown in Figure 2 in the form of an Entity-Relationship diagram.

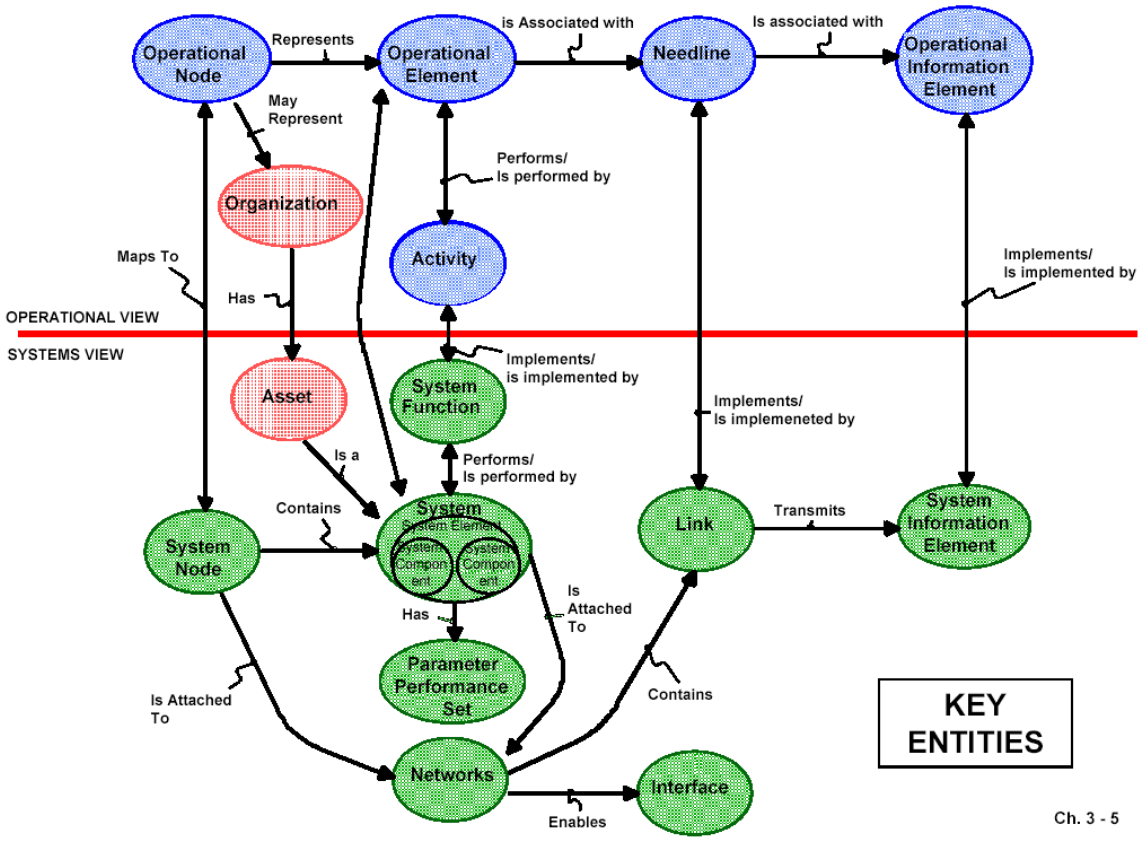

Figure 2: Key Data Entities for Architecture Product Development
(GMU, Levis/Wagenhals)

2.3.1 In this Entity Relationship diagram, the entities are partitioned into two categories: entities associated with the operational architecture view and entities associated with the systems architecture view. This partition is indicated by the horizontal line in Figure 2.

2.3.2 Starting with the operational view, the key entities are the *operational nodes* and *operational element*s. The operational nodes are the graphic constructs that appear in the Operational Node Connectivity Description (OV-2). The operational elements are specified in the Operational Information Exchange Matrix (OV-3). Each graphical operational node in OV-2 represents one or more operational elements, and, therefore, can contain one or more operational elements.

2.3.3 These nodes and the elements they represent do not have to be real physical facilities. Instead they can represent notional or “virtual” nodes and elements based on the operators’ view of operational roles. These roles are normally associated with *organizations* that have *assets* that comprise the *systems* that ultimately perform the

activities of the architecture. Thus each operational node represents or contains operational elements that perform activities and receive and produce *operation information elements*. The Operational Node Connectivity Description also has directed arcs between the operational nodes that are called *needlines*. The needlines indicate the need for connectivity between operational nodes. The need for the connectivity is based on the operational information elements that must flow between the activities that are performed at the operational nodes.

2.3.4 There are several mappings between key entities of the Operational Architecture View and Systems Architecture View. The operational nodes map to systems nodes that are graphical constructs in the System Interface Description (SV-1) and the Systems Communications Description (SV-2). Each system node represents or contains systems. Systems, in turn are composed of system components that are in turn composed of system elements. These are also part of SV-1 and SV-2. These systems, components and elements perform system functions that are the physical implementation of the activities described in the operational architecture view. Because they represent real physical entities, each system, component, and element has performance parameters associated with it. The systems, components and elements are connected together via communications assets such as Local Area Networks (LANs) and Wide Area Networks (WANs). These networks provide interfaces between the systems, components, and elements. These networks provide communications links between the systems that implement the needlines of the Operational Architecture View. System information elements, which are the physical implementation of the operational information elements flow over the links between the systems, component, and elements as the system functions are performed.

2.3.5 Together, these key entities support the creation of most of the Framework products. For the operational architecture view, in addition to OV-2 and OV-3, the organizations are represented in the Organizational Relationship Chart (OV-4), the activities and their relationships are specified in the Activity Model (OV-5), and the Operational Information Elements are described in the Logical Data Model (OV-7). For the Systems Architecture View, in addition to SV-1 and SV-2, the system functions and their relationships are expressed in the System Functionality Matrix (SV-3), the allocation of the activities to system functions is defined in the Operational Activity to System Functions Traceability Matrix (SV-4), the characteristics of the system information elements are described in the Physical Data Model (SV-11), the relationship between system information elements and system functions are specified in the System Information Exchange Matrix (SV-6), and the system performance parameters are described in the System Performance Parameter Matrix (SV-7). Description (SV-4), the relationship between system functions are described in the System2

2.4 Given the understanding of the key entities of the Framework products and the formal procedure for creating an architecture using Structured Analysis, it is possible to show the relationship between the elements of the Structured Analysis descriptions of

the architecture and the Framework products. **It is also possible to create Information Sets required for an architecture outside the realm of the Framework based on these same key entities.** Recall that the structure analysis process begins with the description of the operational concept for accomplishing a mission that is used to guide the development of both the functional architecture and the physical (system) architecture views. The latter also includes organizational models. Throughout the Structured Analysis process, the functional and physical architecture views are balanced.

2.5 Figure 3 depicts the part of the process in which the static representations of the Functional and Physical (Systems) Architecture views are obtained using operational concepts and Mission, Task, Purpose Analysis as described in Chapter 5 of the TAMP to drive the process. This is commonly referred to as the three types of architectures (Functional, Physical (Systems), and Organizational). Figure 4 shows the three types of architectures overlaid on the model of the Key Entities. The process begins with the creation of the operational concept. Note that this can be defined in the Operational Concept Graphic (OV-1). The operational concept guides the development of the functional decomposition, the physical architecture composed of system nodes and links, and the organization model. It also guides the selection of the operational nodes.

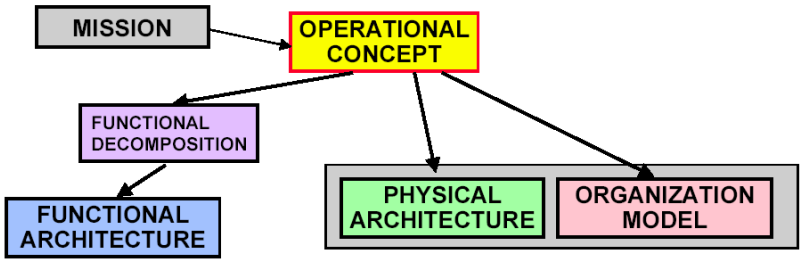

Figure 3: The Three Types of Architectures

2.5.1 The functional decomposition contains the Functions and Tasks identified by the warfighter to accomplish the mission and is used to guide the development of the Functional Architecture. This is composed of the activity model, that is OV-5, the Logical Data Model, OV-7, and the rule model, OV-6a. The dynamics model (OV-6b) is created in the form of a State Transitions Diagram. The arrows between these models reflect the need to ensure concordance between the models. Implied, but not shown is the Integrated Dictionary, AV-2. Figure 4 also depicts the Physical Architecture view as the system nodes with systems, system elements, and system components, and the links that connect them.

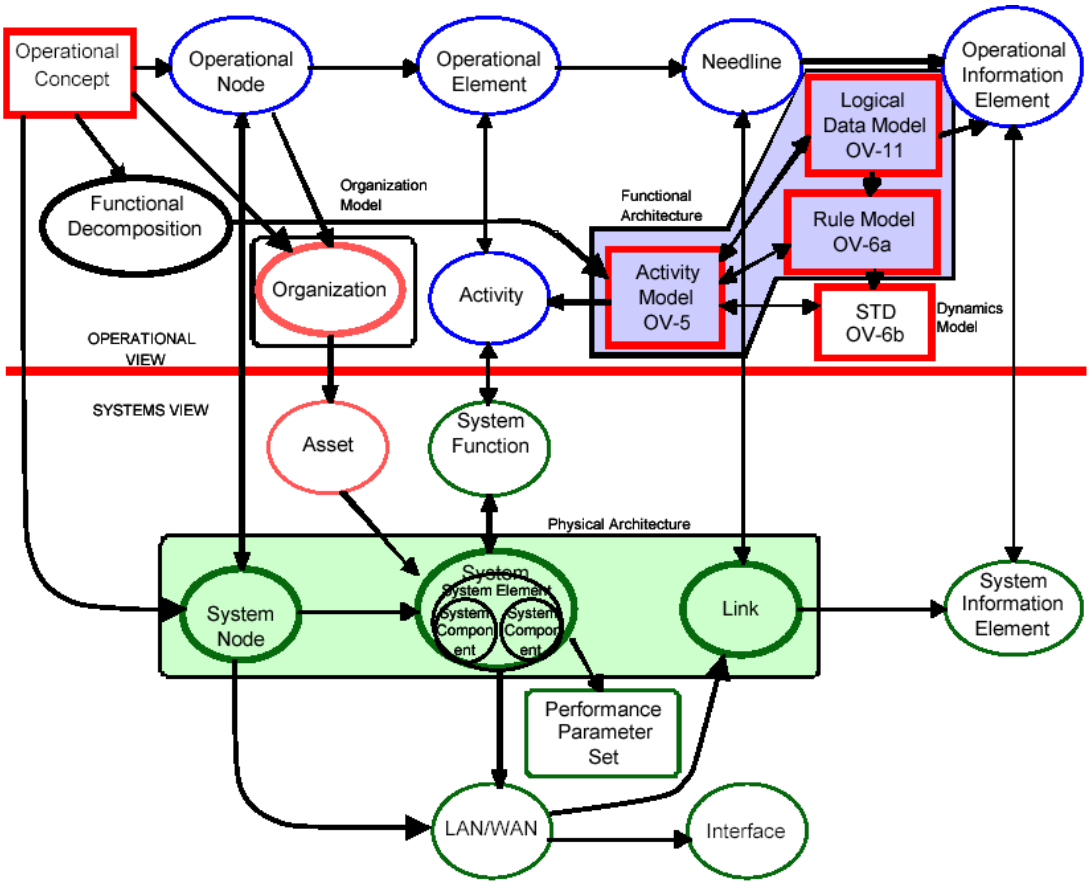

Figure. 4: Relationship Between Analysis Phase and Framework Key

2.5.2 These fundamental relationships among the key entities induce a partial ordering of them and of the Framework products. This partial order forms the basis for a process for creating the architecture. The process can be based either on Structured Analysis constructs, as is done here, or on Object-Oriented ones [Bienvenu et al., 00]

3. Developing architecture product views and information sets using a structured analysis based process

3.1 The AIMD's Architecture Development Phase II, Production (Figure 5), marks the beginning of the Structured Analysis process. The architect develops a representation of the architecture by showing, through a series of diagrams and views, what activities and information flows will accomplish the warfighter's operational concept, and which organizations and systems will perform those activities. Product Views are merely graphical and textual representations of the architecture data that is stored in detail in the AARMS/CADM database. This is an iterative rather than sequential process.

The Operational and Systems views cannot be developed independently from each other.

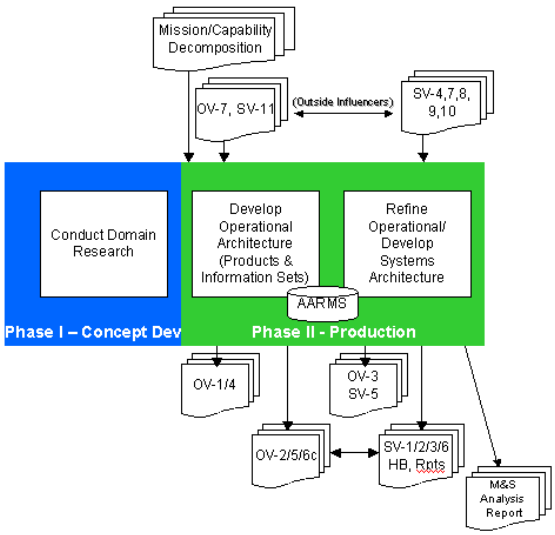

Figure 5: Phase II, Production

3.2 The Structured Analysis process has been divided into six steps or stages, the first stage being Stage 0. Each stage generates one or more of the Framework products. This allows for continuous review and evaluation of the architecture design.

3.2.1 The first step in any architectural effort involves the collection of domain information. This is designated as Stage 0 in the Structured Analysis process. In the DoD Architecture context, 12 types of documents and information have been identified as candidates for this effort and they are listed in Table 1. Once they are gathered, they form the input to the process and are represented as Terminators in the Data Flow Diagram description of the process. Much of this domain information is stored in the AARMS repository as standardized entity data for use with the AARMS architecture tool.

(AV1)	Purpose, Viewpoint (Problem Definition)
D1	Operational Concept Narrative
D2	Universal Joint Task List (UJTL)
D3	Current DOD Organization charts/ Joint, Services, Agencies
D4	Description of Organizational Relationships
D5	Textual description of Doctrine, Tactics and Operational Procedures
D6	List of Operational Information Elements
D7	Definitions of States and Events
D8	Description of System Functions
D9	Communication Systems Description
D10	Performance Attributes of Systems
D11	Migration Plans for Systems
D12	Description of Systems

Table 1: Inputs to the Process Collected in Stage 0

3.2.2 This gathering of domain information is analogous to an architect eliciting requirements and desires from a client who wants the architect to design a new home. In the DoD Architecture context, this requirements elicitation process can be a little more formal. The Warfighters (the operators) and the Program Managers (the acquisition executives) have a wealth of information about how the DoD does business, including formal documents that define doctrine and tactics, formal organizational structures, and descriptions and specifications of existing systems that may be incorporated in the design of the architecture.

3.2.3 The list of source documents in Table 1 represents typical classes of information. As was described in Levis and Wagenhals [00], the architecting process must start with a clear purpose and viewpoint and an operational concept must be provided. Sources for these items may include mission needs analyses, and operational requirements documents (ORDs) as well as discussions with operators of the systems that are similar to the ones that will be defined in the architecture. These documents and elicitations are listed as Purpose and Viewpoint, part of the All Views Overview and Summary Information (AV-1) product and D1, Operational Concept Narrative, in Table 1.

3.2.4 DoD has published the Universal Joint Task List (UJTL) that appears as D2. The Army also has the Army Universal Task List (AUTL) that supports Army specific tasks and are traceable to the UJTL. These lists are high-level functional decompositions of standard tasks and functions that are performed by DoD and Army organizations during military operations. The Army and its components also have standardized organizational structures and relationships. They are described in standard command relationship charts and standing operational plans and operational orders. These also are important references to the architect and are listed as D3 and D4. As the architect delves more deeply into the background domain information he/she can make use of DoD documents that describe doctrine and tactics, techniques, and procedures (D5). In

some cases, the architect may be able to access studies about systems that reveal typical operational or system information elements. Many previous architectural efforts contain this type of information. Furthermore, documents describing standard message types also may be useful. These items are listed as D6, List of Operational Information Elements.

3.2.5 As the architect elicits material, Warfighters often describe their vision of the architecture in terms of events that the system must react to and various high level states that the system will be in. Examples include readiness states and the events or conditions that can occur that should cause the system to change states. These descriptions, listed as D7, are important to the architectural design and may offer high level descriptions of desired behavior.

3.2.6 As the architect creates the system architecture views, information about potential systems (D12) and their functions (D8) will be useful. A variety of documents provide technical descriptions of current and future systems that can serve this purpose and provide performance parameters of those systems (D10). In addition to the systems, descriptions of existing and planned communications networks and links also are available to the architect (D9). Finally, the architect may refer to documents that describe the planned evolution or migration of the system. DoD planning guidance and defense plans are good sources for this information (D12).

3.3 The remaining five stages of the process are shown in the Data Flow Diagram of Figure 6. The diagram also shows the input terminators as described in the TAMP, Chapter 5, on pages 5-9 and 5-10.

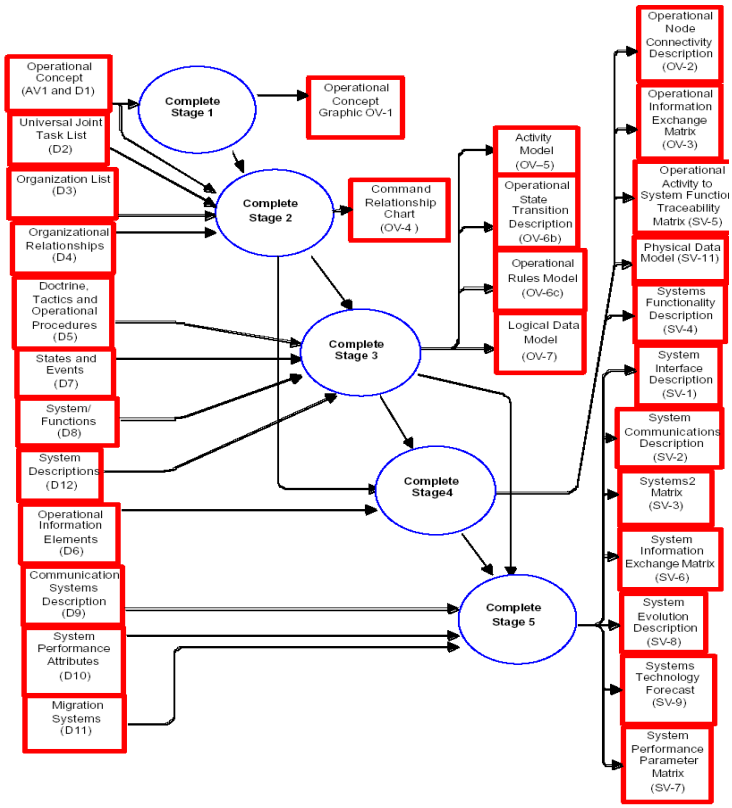

Figure 6: The Six Stage Process

3.3.1 Stage 1 - Operational Concept and Required Capabilities: Once the basic information has been assembled in Stage 0, the process starts by converting the operational concept that implies or includes organizations and actions or tasks into the operational concept graphic (OV-1) with a textual description.

Stage 1 is shown in Figure 7. While this is a very simple diagram, it represents a critical step in the architecting process because it is the operational concept that guides the remaining stages of the process, thus it is passed to the second stage as indicated by the “2” in the oval. The OV-1 product, the High Level Operational Concept Graphic, is produced in this stage. Also note the influence of the O&O Plan for the project. PowerPoint or other COTS programs offer very good “free flow diagram” capabilities called for in the Framework. The AARMS repository can store these diagrams.

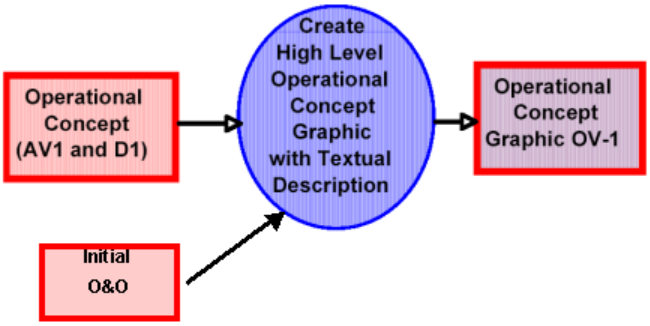

Figure. 7: Process model of Stage 1: Develop the Operational Concept

3.3.2 Stage 2 - Functions and Organizations: The organizations implied in the operational concept have assets that are the basis for systems in the physical architecture and operational nodes and elements. The relationships between organizations imply communications requirements. The actions or tasks help in the selection of activities from the UJTL or the AUTL to perform functional decomposition. **Functional decomposition must be couched in terms of mission, required capability, task, and purpose (Mission, Task, Purpose Analysis)**. The AUTL and UJTL are often the start point for functional decomposition. Their subtasks (user defined tasks) that must be accomplished to completely define the AUTL and UJTL are usually decomposed in the Activity Model.

Stage 2 is shown in Figure 8. It has four terminators that provide inputs and one terminator that is the output of the stage, the Command Relationship Chart (OV-4). In this stage, the architect uses the Joint Universal Task List and the Operational Concept (as shown by the "2" in the oval) to determine the functions that need to be performed to carry out the operational concept and organizes them in a functional decomposition. The architect also uses the operational concept, the list of potential organizations, and the organizational relationships to determine which organizations to include in the architecture and the command relationships that will exist between those organizations. These command relationship are documented in the Command Relationship Chart, OV-4. These organizations have assets that are the systems that will support the activities. The traditional or logical grouping of the organizations and their assets are used to define operational elements and aggregate them into the operational nodes that will be depicted in the operational node connectivity diagram. Some key points to note:

- The Operational Concept, which is supported by the OV1 diagram, now drives both the Functional AND Organizational path.
- The D3, Organizational List, is generally considered the TOE list for the architecture.
- The Operational Concept supplies the mission; the UJTL and AUTL's supply the standard "approved" operational tasks to support the mission. User Defined

Tasks (UDT) are permitted, but must be managed to maintain consistency in standards.
• Task analysis through some form of functional decomposition is key to this phase even if formal Activity Modeling is not required for a given project.
• Notice how the OV4 is a by-product of the "select organizations" to Define Operational Nodes thread. Even if the OV4 itself is not required by the AV1, the entities still need to be entered into the database.

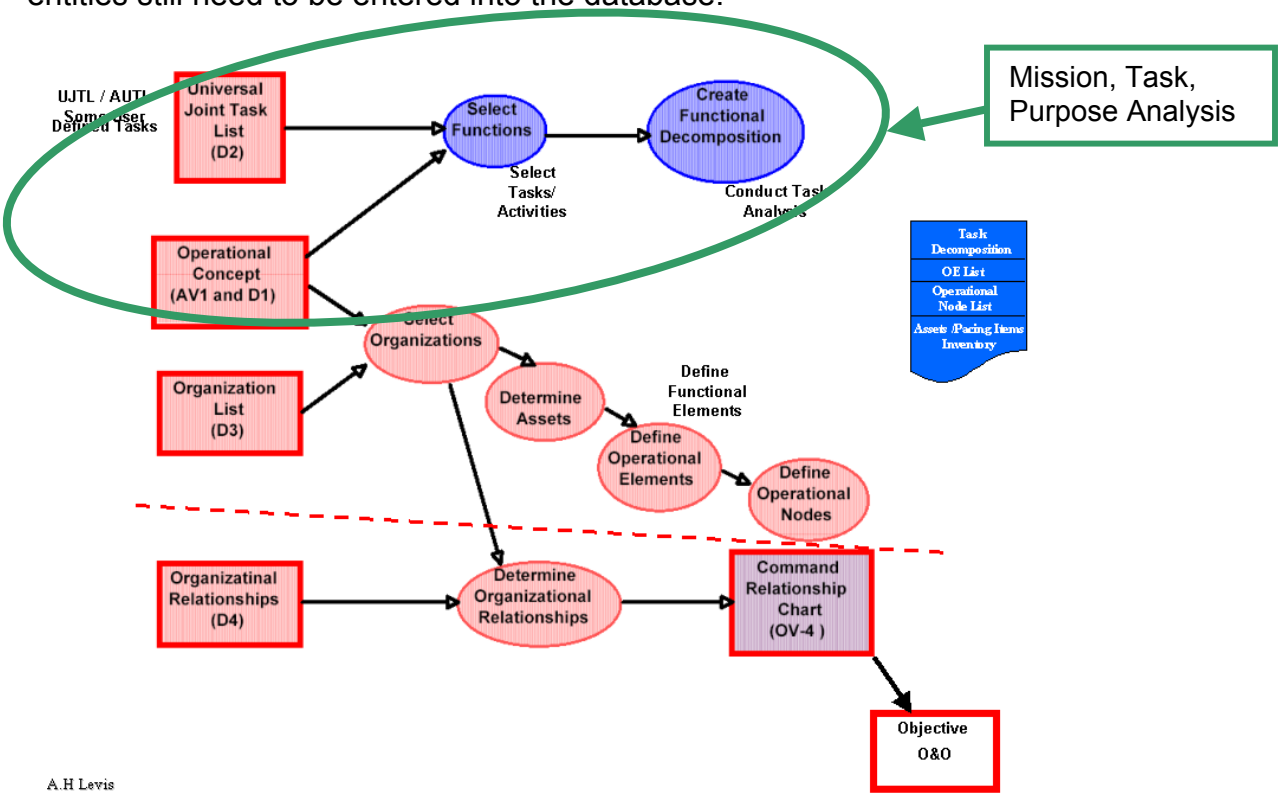

Figure. 8: Process Model of Stage 2

3.3.3 Stage 3 - Activity Model, Logical Data Model, Needlines, System Nodes, System Elements and Functions, and Task Allocation: A full functional architecture with activity model, data model, and rule model is created along with a dynamics model. Concurrently the initial physical architecture is defined using systems, elements, components, and links derived from the OA. The activities are allocated to both organizational elements and to system functions.

Stage 3, is composed of two main parts. The architect is engaged in three major efforts. First, the functional architecture (Figure 9a), composed of the activity model (If required by the AV1), the logical data model, and the rule model are created based on the functional decomposition. The desired behavior of the architecture is captured in the state transitions diagram. The concordance process ensures consistency and completeness of all of these products.

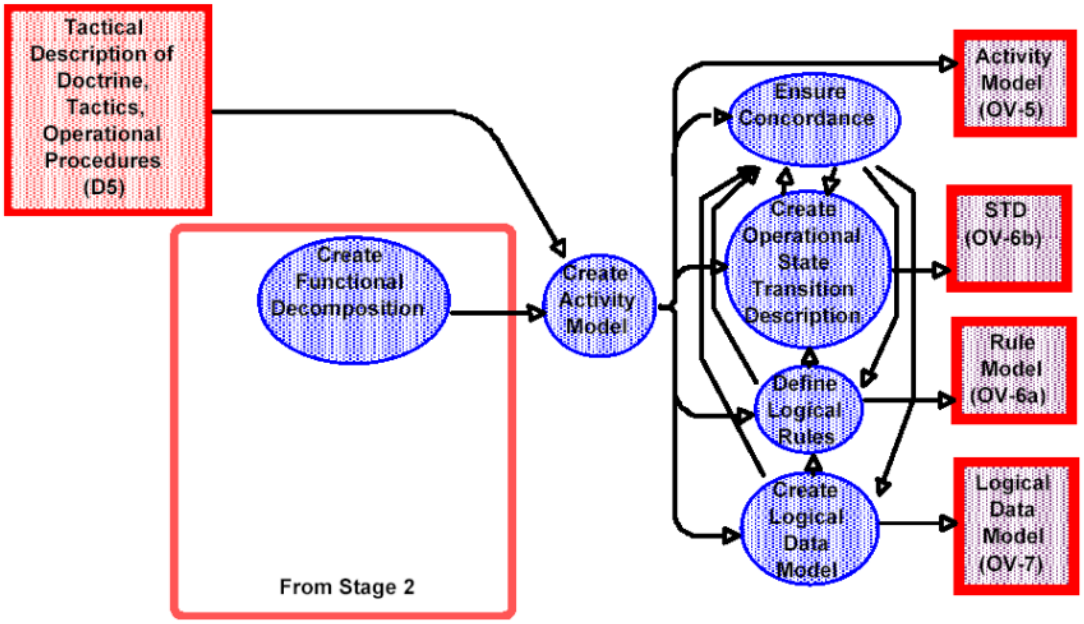

Figure 9a: Process Model of Stage 3a

Secondly, the architect creates the initial physical architecture composed of system nodes that contain systems, system components, and system elements (Figure 9b). Consistency and balance is maintained between the physical and functional architecture views through two allocation processes, the third main activity of Stage 3. In the allocation process, the architect evaluates the assets to be associated with the operational elements. These assets are systems that perform system functions. The architect decides which system functions should perform the operational activities. This in turn allocates the activities in the activity model to those operational elements that own these systems. The activities are also allocated to the functions those systems perform. This is the key step that marries the operational and system architecture views together. This is the “so what” of activity modeling or any method used by the architect in attributing activites to Operational Elements or Functional Elements in AARMS. All of the activities in stage 3 are highly coupled and an iterative process is used during this stage. Other key notes about stage 3:

- The System Node is the same thing as the Operational Network Node (ONN) and the Operational Facility (OPFAC) in AARMS Terms.
- The assets inventory from stage 2 helps in Determining Systems availability for the architecture’s time frame. It’s also a consideration when reusing existing “OPFAC’s” as templates for future Operational and System Nodes.
- M&S has a key role of providing feedback to the systems architects on capabilities. M&S is the AIMD’s in-house executive agent for the Executable Model in the process.

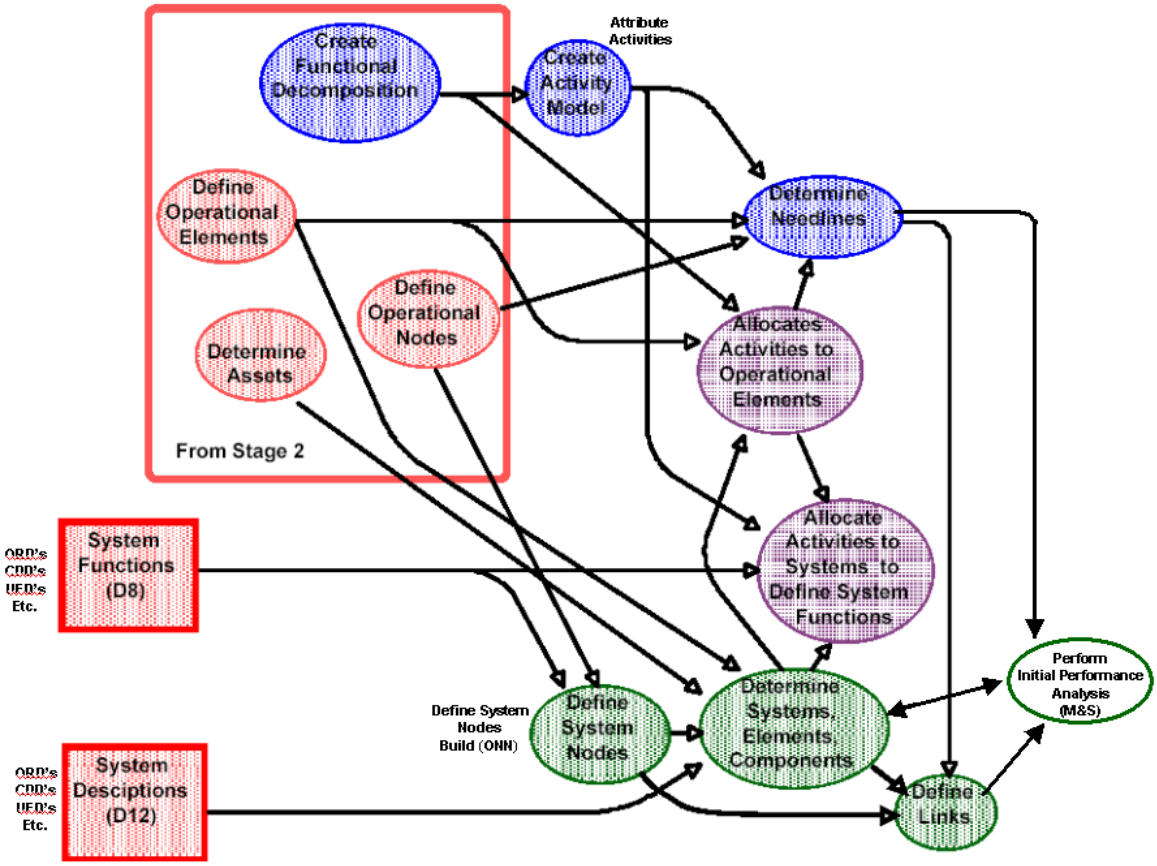

Figure 9b: Process Model of Stage 3b

3.3.4 Stage 4 - Operational Information Elements and Exchanges, System Functionality Description, Physical Data Model: Based on the analysis of the functional architecture models, the Operational Node Connectivity Description and the Operational Information Exchange Matrix are finalized. The implementation of the functional architecture is formulated and evaluated by creating the Systems Functionality Description and supporting Physical Data Model.

Stage 4, shown in Figure 10, the architect creates the remaining Operational Architecture View products using the information and models created in Stage 3. Key parts of the analysis needed to create the System Architecture View products are also done.

The Logical Data Model and the Needlines define the Operational Information Elements. The allocation process assigned activities to operational elements and nodes. The activity model contains the information flows between activities and, by the allocation process, between operational nodes. Thus, the Operational Node Connectivity Description (OV-2) and the Operational Information Exchange Matrix (OV-

3) can be extracted from the combination of activity model and allocation. The allocation of activities to system functions is documented in the Operational Activity to System Function Traceability Matrix (SV-5). Using this allocation and the activity model, the architect creates the System Functionality Description (SV-4), which is a process model that uses the system functions as the processes or transformations. SV-4 and the Logical Data Model (OV-7) can be used to create the Physical Data Model, SV-11.

- The operational Information Elements are considered the standardized IR tables in AARMS (The Message Data Table)
- The SV4 and SV5 are very important. The SV5 bridges the OA and SA Functional Architectures. In most cases, the SV4 will come from the material developers (CECOM, PEO, Etc)

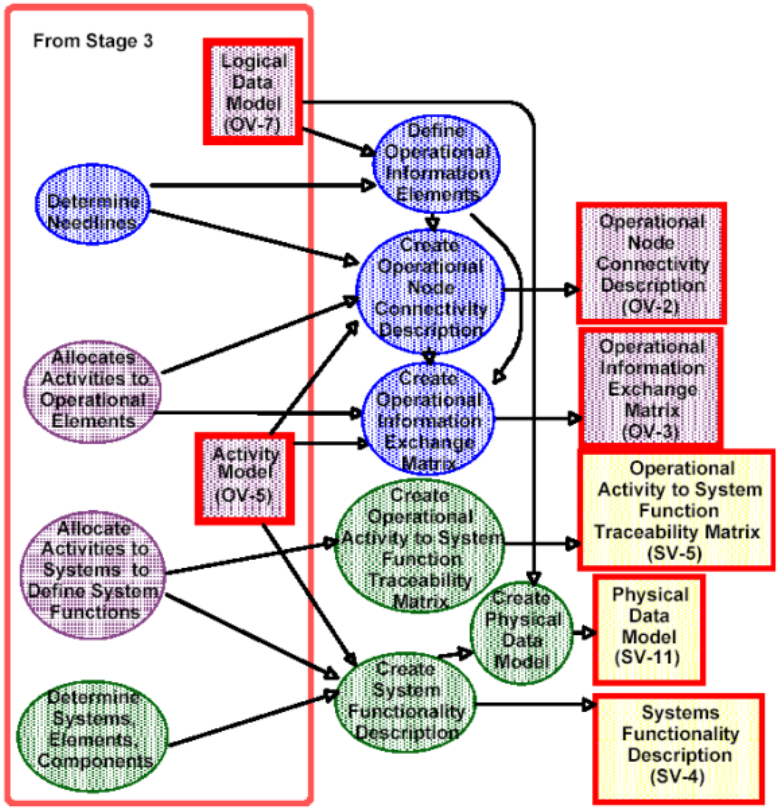

Figure 10: Process Model of Stage 4

3.3.5 <u>Stage 5</u> – <u>System Information Elements and Exchanges, LAN/WANs, system Interface Descriptions, System Performance</u>: From the previous analysis, the System Information Elements and the LAN/WANs are specified. The remaining products of the Systems Architecture view are created including the System Information Exchange Matrix, the System Communication Description, the System Interface Description, and the System Evolution Description.

Stage 5 is dedicated to completing the System Architecture View Products. As shown in Figure 11, it requires inputs from both Stages 3 and 4. The System Information Elements are the physical manifestation of the Operational Information Elements that were defined in Stage 4. They can be defined from a combination of the Physical Data Model (SV-11) and the System Activity Description (Data Flow Diagram of system functions). The allocation and initial physical architecture allows the definition of the system nodes that the system information elements flow between. Once the System Information Elements have been specified, the System Information Exchange Matrix (SV-6) can be created. The characteristics of the System Information Elements and Exchanges are used to guide the selection of the Communications System including the LANs and WANs that will be included in the architecture. The architect uses the Systems Communications Description (SV-4) that was obtained in Stage 0. Once the LANs and WANs have been identified, the architect can create the System Interface Description.

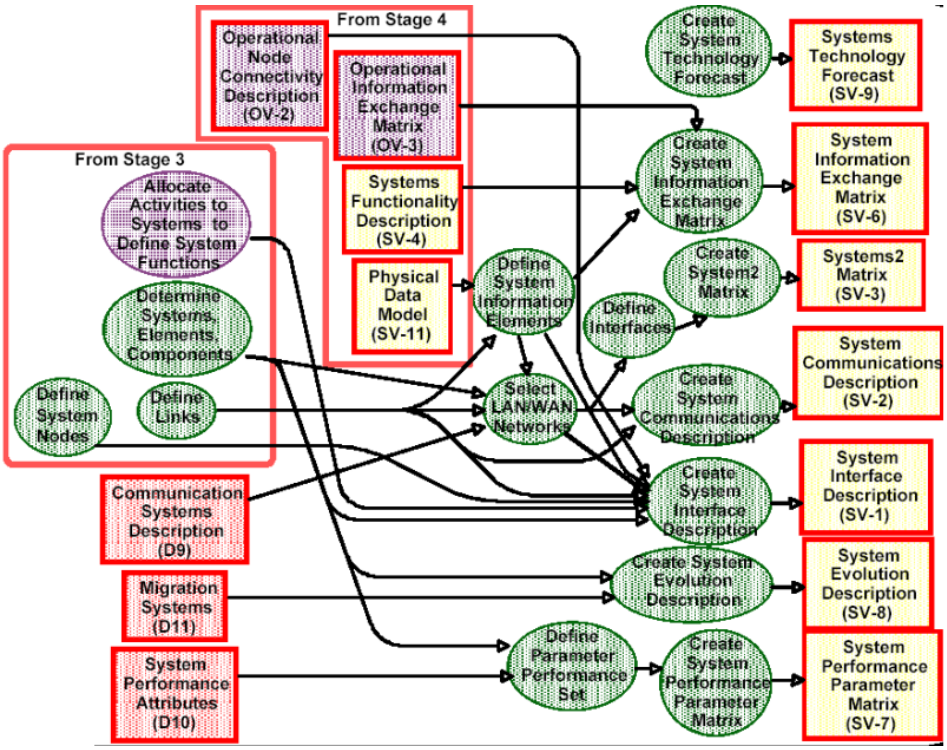

Figure 11: Process Model of Stage 5

The System Interface Description (SV-1) describes the physical manifestation of the Operational Node Connectivity Description (OV-2). It is based on the Initial Physical Architecture that was developed in Stage 3. The Systems Communications Description (SV-2) can be created using the LAN and WAN selections. It should also be coordinated with the System Interface Description because it is a more detailed view of the Systems Architecture. The LANs and WANs define the interfaces between the systems, system

elements, and system components. Once the interfaces have been defined, the System Matrix (SV-3) can be created. Finally, the architect can create the System Evolution Description (SV-8), System Performance Parameter Matrix (SV-7) and the System Technology Forecast (SV-9) using the Initial Physical Architecture and the Migration Systems (D11) and System Performance Attributes (D10) information that were developed in Stage 0. Clearly, there is a great deal of redundancy in the System Architecture View. The architect must maintain consistency (concordance) between these products.

4. Summary

4.1 This Annex has discussed the creation of information architectures in general and a process for creating the products associated with the DoD Architecture Framework and Information Sets outside the scope of the Framework, but within the bounds of the Core Architecture Data Model (CADM). The CADM was based on the Framework, which, by its depictions of example products, has a Structured Analysis bias. The TRADOC AIMD sponsored AARMS program was developed along the lines of the Structured Analysis approach and how the architect can use the tools and techniques of Structured Analysis to produce a coherent set of products for the Operational and Systems views . The approach provides the necessary and sufficient set of information for creating executable models of the architecture that can reveal its logical, behavioral, and performance characteristics.

4.2 The Framework describes a set of products or views of the architecture. It does not provide or recommend a process for creating these products. Instead, it offers universal guidance and a logic sequence of events as a guideline. TRADOC AIMD has adopted a phased approach using the strawman process developed by AH Levis and LW Wagenhals of George Mason University. This approach is based on the interrelationship of the products through the common data elements they contain.

4.3 Information Sets and Framework products can be derived from the information contained in the Structured Analysis constructs of the CADM. Of course, executable models can also be created and used as a focus of discourse with the customers of the architecture (discussed in Chapter 5 of the TAMP), even though the Framework does not require these.

4.4 Another approach alluded to earlier was that of Object-Oriented using Unified Modeling Language (UML). This approach may have several advantages over Structured Analysis for developing architectures. Many commercial users including the Lead System Integrator for the Army's Objective Force Unit of Action are currently using this approach. The approach is a current area of research for the AIMD as the AARMS program moves forward to support new and emerging architecture techniques.

Annex C

Analysis Division Modeling and Simulation Branch Management Plan

Background

The Army visualizes fighting in the future operational environment as part of the nation's joint military forces. To maintain supremacy in this future environment, the Army must be more strategically responsive, deployable, agile, versatile, lethal, survivable and sustainable across the full spectrum of conflict. These seven characteristics, outlined in the Army Vision, are the foundation for the development and evolution of Army organizations, their operational concepts, required capabilities and missions.

The Army leadership has converged on a vision and concept for an Objective Force (OF) and is committed to a path toward transformation that includes maintaining the current force, fielding the Stryker Brigade Combat Team (SBCT) and achieving OF capability. It includes fundamental realignment of roles and functions, reengineering of organizational structures, rethinking of relationships and reengineering of processes and procedures. Current experiences in the Global War on Terrorism and Homeland Security, coupled with our responsibility to be prepared to decisively win in major contingency operations, serve to illuminate just how critical transformation is to both in terms of capability of the force and in timeliness to transform.

The Army is transforming to the OF; multiple national, DoD and Army policy and guidance documents describe not only why the Army is transforming but into what the Army (and Joint forces) should transform. This process broadly involves the development of ideas for future warfare that are matured into operational warfighting concepts. These concepts then form the basis for generating required capabilities for all aspects of warfighting – Doctrine, Organization, Training, Materiel, Leader Development, Personnel, and Facilities (DOTMLPF) – which are then prioritized and implemented through various acquisition processes.

Architecture Development

Prior to the Information Technology Management Reform Act (ITMRA), also known as the Clinger-Cohen Act of 1996, many federal and DoD acquisition programs were presented to Congress with insufficient detail to support the request. The ITMRA requires Government organizations to measure or otherwise provide credible analysis to support acquisition claims and requirements. A component of this requirement is to justify proposed and existing system investments by reporting the improvements in measures of performance to be gained. The DoD Architecture Framework is designed to help organizations meet these requirements by providing uniform methods for describing systems and their performance in context with mission and functional effectiveness. The Framework provides the rules, guidance, and product descriptions for developing and presenting architecture descriptions that ensure a common

denominator for understanding, comparing, and integrating architectures. The goal is to enable the acquisition and fielding of mission effective, cost effective and interoperable military capabilities.

An architecture is a representation, as of a current or future point in time, of a defined domain in terms of its component parts, what these parts do, how the parts relate to each other, and the rules and constraints under which the parts function. The architecture becomes the "analytical basis" for higher-level decision makers! It provides a mechanism for understanding and managing complexity. Architectures form the basis for decision-makers by reflecting an analytic base for disciplined analysis of alternative concepts, procedures, systems, etc. throughout the DOTMLPF domains – thus they are both inputs and products for the analysis process.

The type of analysis or assessments that must be made by the architecture user drives the degree of granularity or detail in a view. The operational, systems, and technical views and their interrelationships provide the basis for deriving measures such as interoperability or performance and also provide the basis for measuring the impact of the values of these metrics on operational mission and task effectiveness. Integration of these views is critical if the architecture description is to be useful as an analytical tool.

TRADOC is the Warfighter's Operational Architect and the integrator of related capabilities. CG TRADOC is the Army's Architect of the Future. The DCSDEV Architecture Integration and Management Directorate (AIMD) is the TRADOC single point of entry for all architectures. The AIMD Analysis Division (AIMD – AD), Modeling and Simulation (M&S) Branch provides analysis services in support of the AIMD mission and selected analytical services in support of other TRADOC, DA, OSD, and Joint decision makers.

Role of Analysis Division

Analysis Division provides relevant and credible analysis to inform and focus decision making within the Army architecture development process by providing analytical underpinnings for concepts, requirements, and systems in support of architecture development and Army transformation.

Analysis Division functions and capabilities encompass a wide range of architecture related topics, most often set 5 to 15 years in the future. Is the "system" or "system of systems" functionally responsive and traceable to the Warfighter requirements? How do we evaluate such performance? Do we have the tools to do so? What are the alternative options? Do we change the performance requirements and, if so, to what? How do changes in deployment or system architecture affect performance? What are the potential risks and rewards of a planned course of action? Analysis Division analyses directly support the development of future concepts and architectures that will transform the Army.

The Analysis Division is supporting Army Transformation, to include development of the Stryker (IAV), Stryker Brigade, Future Combat System (FCS), and the OF. Analysis and experimentation will form an important component of the development strategy for the FCS, Unit of Action (UA), Unit of Employment (UE), OF, and Joint initiatives. These complementary efforts will focus on issues at system, unit, and force levels across the spectrum of operations from peacekeeping to major regional conflict. Throughout the analysis and experimentation process, modeling and simulation will provide critical analysis support capabilities.

As the Army transforms over the next 15 years, the operational requirements, solutions and development environment will be incredibly complex. Development and decision cycles will be shortened. Operational risk of failure will increase. The dependence on C4ISR and technology will increase. The operational environment and system solutions will become more integrated and complex. It will be necessary for the Analysis Division to constantly evolve in terms of analysis capability and related tools if it is to remain a relevant source of analysis. The primary analysis tools include subject matter experts, models and databases. These capabilities will be constantly evaluated and adjusted based on future transformation analysis requirements.

Key Roles and Responsibilities

- AIMD - AD, M&S Branch will provide product oriented validation and verification (V&V) and quality control for all aspects of new architecture projects to include:
  - Operational Architecture products,
  - Systems Fielding Strategies,
  - Force Design Documents,
  - System Allocations, and
  - Information Exchange Requirements.

The objectives of this effort are to develop a baseline understanding of the objective architecture and related operational environment to include any risks or impediments to the development of a responsive and effective architecture. A major goal of this effort is to identify architecture related issues that will require detailed analysis support. The result is the development and delivery of an “Analysis Study Plan” that details the analysis tasks, schedules and deliverables for the balance of the architecture development. This plan will become the basis for all follow-on analysis of the target architecture.

- AIMD - AD, M&S Branch will provide product oriented V&V and quality control of the following Version .5 Architecture products:
  - Task Organization Design
  - Network Node Design,
  - TOC/CP Structure Design,
  - Radio Nets Design,

- LAN/WAN Structure Design, and the
- Information Assurance Structure Design.

The goal of this review is to begin the architecture quality control and verification process. The results of the review will be documented, shared with Architecture Development Division (ADD), and archived as a permanent component of analysis relating to the subject architecture. This work will also become the basis for all follow-on analysis. Preparation for any required simulation will begin at this point.

▪ AIMD - AD, M&S Branch will provide product oriented V&V and quality control of the following system oriented Version 1.0 Architecture products:

- Organizational Structure,
- Network Nodes,
- Platform Connectivity, and
- TOC/CP Structure.

The results of the review will be documented, shared with ADD, and archived as a permanent part of analysis relating to the subject architecture. This work will also become the basis for all follow-on analysis. Preparation for any required simulation will continue.

▪ AIMD - AD, M&S Branch will provide product oriented V&V and quality control of the following system oriented Version 1.5 Architecture products from a network performance perspective:

- TOC/CP Structure,
- System Configuration,
- Network Configuration,
- Information Assurance Structure, and
- Overall Systems Integration.

The results of the review will be documented, shared with ADD, and archived as a permanent part of analysis relating to the subject architecture. This work will also become the final basis for all follow-on analysis and related simulation to be accomplished prior to the TRADOC Architecture Validation Board.

▪ AIMD - AD, M&S Branch will finalize, prepare, and deliver the final Architecture Analysis Report in accordance with the Study Plan developed at the beginning of the project. The package will include the results of all earlier analysis as well as final results, conclusions and recommendations. This report will normally be completed and available for use during the proponent review period.

▪ AIMD - AD, M&S Branch will develop and archive other model inputs, such as loading data (traffic), that may be required to support model based simulation and analysis.

▪ AIMD - AD, M&S Branch will plan for, develop and maintain models, system software, databases, and other tools that may be required to support the required

analysis mission. This may include the development and maintenance of tools for other parts of the AIMD as well as outside organizations.

- AIMD - AD, M&S Branch will plan for, recruit, and maintain an appropriately sized team of subject matter experts and technical personnel to support assigned analysis and development tasks.

- AIMD - AD, M&S Branch will represent AIMD interests, as required, with established working groups, standards bodies and other organizations / commands within TRADOC, the Army, and DoD that are concerned with analysis and / or modeling and simulation.

- AIMD - AD, M&S Branch will develop Information Exchange Requirements (IER) and connected traffic, as required, to support architecture simulation and analysis. M&S Branch may also be required to develop such data sets for external organizations.

- AIMD - AD, M&S Branch will collaborate with and support the Experimentation Branch with respect to analysis and validation architectures in support of the Army and Joint Experimentation Programs.

AIMD Analysis Division Key Relationships

The AIMD - AD, M&S Branch is the single source of TRADOC architecture analysis.

- **DoD:**

Joint Forces Command (JFCOM) – Support all Army related M&S based analysis being done by JFCOM. Validate Army tactical, operational, and sustaining base architectures and provide / validate loading data for them.

Network Warfare Simulation (NETWARS) – Represent the Army in all aspects of NETWARS development. Use NETWARS as an M&S tool, to the extent that it can support our requirements. Apply NETWARS to JFCOM requirements where appropriate.

Defense Modeling and Simulation Office (DMSO) – Participate in DMSO work groups and standards bodies to the extent that it is applicable.

- **Army:**

Army Modeling and Simulation Office (AMSO) – Participate in all Army M&S Standards Working Groups. Contribute models and studies for other Army use as may be appropriate. Act as Standards Category Coordinator for communications systems.

- **TRADOC:**

DCSSA – Partner with DCSSA in efforts to develop TRADOC M&S policy and procedures, integrate M&S requirements and support cross-domain and joint initiatives related to architecture development. Participate in the TRADOC M&S Advisory Council and Board.

TRAC – Continue to support TRAC analysis activities by supplying architecture information sets and related communications traffic (IERs) to support communications modeling within TRAC Force on Force modeling.

Battle Labs – Support the Battle Labs with validated experimentation architectures, system loading data and related parameters.

Integration Centers - Support the Integration Centers with validated C4ISR architectures, system loading data and related parameters, and modeling / simulation support as required.

Proponent Schools and Centers – Provide analysis and simulation services, as required, to support development of architecture products at proponent schools and centers. Provide other system-oriented analysis as required.

PEO – Simulations, Training and Instrumentation (STRI) – Battle Command (BC)/C4ISR Battle Lab collaboration with PEO-STRI.

LSI – Support the M&S IPT as it relates to the development of OF and FCS architecture products. Provide performance oriented analysis and validation of LSI produced architectures.

Analysis Calendar

The Analysis Division, M&S Branch architecture analysis schedule is dictated by the AIMD architecture development schedule. Scheduling for other outside projects is driven by project requirements and resource availability. AIMD schedules and requirements take priority over other non-AIMD tasks and projects.

Annex D

Experimentation Operational Architecture Development

Army transformation has been organized along three interdependent coordinated axes titled Training a Ready Army; Transforming our Operational Army; and Transforming the institutional Army. The Army is implementing a transformation plan that will include changing the form, or structure of our forces; adapting the training and doctrine supporting those forces; and the streamlining our warfighting functions to more effectively meet the complexities of the new threats to our nation and our world.

To execute this transformation, the Army has begun to develop a new type force and capability that allows for adapting rapidly to new challenges and unexpected scenarios. This new force will progress from our current forces to interim forces and ultimately to the objective force. To assist us in this transformation, we will use a validated tool that has a long tradition among our military services, Experimentation. Through the use of experimentation and exercises we will be able to ensure we provide soldiers and leaders with the skills, abilities, characteristics, and the enhanced technological organizational structure that will meet the 21st century strategic requirements.

The Army Transformation Concept Development and Experimentation Campaign Plan (AT-CDEP) outlines the processes, responsibilities and procedures to implement aggressive concept development and experimentation to support Army Transformation. This support will be provided through a series of concept development and experimentation (CD&E) processes executed along four broad avenues: exploratory, developmental, service/joint engagement and integrating experiments. A key means of reducing experimentation/process uncertainties while capturing warfighter requirements as well as ensuring interoperability is through the development of comprehensive architecture products and information sets. These products and/or architecture information sets will provide analysis mechanisms for understanding and managing the complexity of the experiments as well as providing a traceability means back to the warfighter requirements. A well-designed Experimentation Operational Architecture is one of the experimental tools that will greatly enhance the UA/UE organization design/redesign, the required node connectivity determination, the development and validation of models and simulations and the planning and training for system tests.

Army experimentation is an ongoing process that improves our capabilities, evaluates and ensures both inter and intra service interoperability and allows more effective use of our resources. Experimentation Operational Architecture development and methodologies help translate operational concepts into information sets for fieldable capabilities. These include not only the operational requirements of C4ISR, but also the requirements across all aspects of warfighting - DOTMLPF (Doctrine, Organization, Training, Material, Leader Development, Personnel and Facilities. The DOTMLPF architecture requirements will greatly enhance the experiments ability to develop capability requirements. Architectures inform experiments through several venues but

the primary purpose of an experimental architecture is to ensure the warfighter has the connectivity and interoperability necessary to satisfy the Joint and Army experimental objectives. A proven process is through the use of a mission thread type analysis. In this process the Experimentation Operational Architecture identifies warfigher functional requirements or operational concepts. These requirements/concepts are reviewed and validated by the warfighter. This documents the operational requirements for system development and integration. Additionally, Experimentation Operational Architecture information sets provide an integration tool for joint interconnectivity and interoperability while at the same time providing real traffic data that is used by both the system trainers and the modeling and simulation community. Architecture information sets are the desired results of a careful translation of the Army Strategic Context into Operational Concepts, which are further translated into Operational Requirements. These resultant architecture information sets lead to successful acquisition of combat capabilities. Recent successes in Army and Joint experimentation have proven the values are well worth our efforts. Despite the successes of past experimentation efforts it is imperative that we now evolve from our traditional architecture processes and procedures. We can no longer afford to develop individual stand-alone architectures from scratch for each and every experiment or exercise; nor can we continue to be only “Army”. We must think in terms of interchangeable, reusable, configurable data sets that can be applied to any operational contingency, which are “joint” in nature and execution and transferable among experiments.

The TRADOC DCSDEV Joint and Army Experimentation Directorate (JAED) has the responsibility of ensuring that the AT-CDEP integrates Army CD&E in a coherent Service / Joint context to ensure the Army provides Combatant Commanders with sustained land combat capabilities that are an indispensable combat multiplier for the Joint force. TRADOC DCSDEV Architecture Integration and Management Directorate (AIMD) has been designated by CG, TRADOC, as the single point of entry for Army and Army Component operational architectures and as such provides support to DSCDEV JAED in experimental army/joint architecture development, integration, prioritization, synchronization, validation and approval.

Role of AIMD

The AIMD, Experimentation Branch, has the responsibility to ensure experimental and developmental architecture initiatives are developed within the framework of the Army Knowledge Enterprise Architecture guidelines and are ALL_CADM compliant. Architectures developed to support AT-CDEP must be designed to obtain the most useful results in the least amount of time. Reuse of information between experiments will enable the experimentation community to apply known results from previous architecture development/analysis efforts. This will assist in reducing the amount of time, money, and resources required for experimentation/exercise objectives. Architecture becomes the tool to provide decision maker with the information sets and or products required for resolving issues and answering the “hard” questions. Architecture designs must be modular and reusable and provide actionable

recommendations from experimentation results to senior leaders to inform options for future force investments.

Experiments are normally designed to investigate specific questions or risk relative to the concept being explored. The value of the resulting data or information derived from an experiment is directly related to how well the experiment was designed and executed. Architecture is a major contributor to the success of the experimental process. On the planning side of an experiment, the role of AIMD-EB is to bring focus to the experiment from an architectural perspective. The goal is to focus the experiment in such a way so that the maximum benefits can be derived from the resulting architecture information sets. The information sets derived from the experiment can then be applied to the development of the formal objective architectures as well as additional experiments. The experimental based information sets as well as those currently in the architecture repository will be vital to informing the Science and Technology community as they create and shape follow on tests and experiments.

Experimentation makes heavy use of modeling to simulate various aspects of the tested concepts and future environment to facilitate understanding and knowledge as to what is feasible. Models are used to represent most functional aspects of the experimental environment and are a critical component of any experiment. Therefore, the value of the data and or knowledge produced by an experiment is directly related to the fidelity of the overall experiment design, particularly the models. AIMD-EB will work closely with its own Analysis Division (AIMD-AD) and TRAC to provide the required key documentation and Experimentation Operational Architecture information sets to feed and help shape the experimental models. By participating in and understanding how the models are designed and how they are actually used AIMD-EB will be able to provide more meaningful architecture information sets for future architecture designs.

Relationship to Objective Force - Architecture products will be developed to inform concept development, the Organizational and Operational Plans, the Operational Requirements Documents and Capabilities Development Documents for both the Unit of Action and the Unit of Employment as well as the FCS System of Systems and other operational requirements. These products and/or information sets will capture the warfighting concepts and requirements and will be developed to support combat developers, the warfighters, the material developers, the force developers and the decisions makers (Milestone B, C etc). The products and/or information sets will represent the operational, system and technical architectural views and will inform the Functional, Systems and Organizational architectures of the Objective Force. These architectures will be used as a part of a disciplined process to guide the system of system and family of system development enabling these organizations. As the operational requirements become clearer, selected missions and processes can be selected to evaluate the level of maturity of technology using the experimentation process.

Through active participation in ATWGs (Army Transformation War Games), ATExs

(Army Transformation Experiments), the JFCOM experimentation series, selected Army integrating experiments, selected Advanced Concept Technology Demonstrations, selected UA LSI concept demonstrations, selected CEPs (Concept Evaluation Plan), Joint Mission Area Analyses, the Distributed Continuous Experimental Environment (DCEE), selected concept design and critical demonstrations and selected Joint Warfighter Interoperability demonstrations the AIMD- Experimental Branch will fulfill the below listed key roles and responsibilities.

Key roles and Responsibilities

- Serves the Joint/Army Experimentation/Exercise community as the TRADOC single point of entry for architecture development, integration, prioritization, synchronization, validation, and approval.

- Collaborates with the warfighter and concept developers to provide, apply and document the analytical underpinnings for tracing warfighter requirements and concepts to the experimental objectives and goals.

- Provides the TRADOC Joint Army Experimentation/Exercise community with configuration management of data and information sets that builds architecture knowledge and its applications.

- Translates operational and experimental concepts into information sets for fielding capabilities.

- Partners with the Joint and Army Experiment Directorate, the Battle Labs, the Proponent Schools and Centers, the TRADOC staff, TRAC, TEC, NCS, CALL, USAWC, AMSAA, the PMs and the PEO to leverage knowledge packets and domain expertise.

- Delivers to the Experimental/Exercise community meaningful, relevant, and timely information sets.

- Sets Experimentation Operational Architecture policy and manage resourcing for Experimentation Operational Architecture objectives. Coordinate development, review, revision and integration of joint, Army and multi-service Experimentation Operational Architecture efforts.

- Conducts Liaison with JFCOM in Experimentation Operational Architecture development. Assist DCSDEV in integrating Army and TRADOC support to and participation in joint Experimentation Operational Architecture development.

- Acts as the DCSDEV lead agent for Experimentation Operational Architecture development that may include battle lab missioning, resourcing, prioritization and integration, ICW DCSDCS, integrates the preparation and execution of JFCOM-sponsored joint experimentation.

- Integrates operational concepts, capabilities, force design and architecture for current and future forces experimentation initiatives.

- Provides recommendations for Validation and approval on experimentation scenarios, O&O concepts and plans, force designs, experimentation plans, study and analysis plans, studies and analytical results.

- Through experimentation - Assists in identifying, exploring and assessing new concepts in order to provide future force commanders with significant warfighting improvements and capabilities

AIMD-EB Key Relationships

- Provides TRADOC DSCDEV JAED with Experimentation Operational Architecture policy, management, coordination, integration, synchronization and development.

- Liaisons with JFCOM J6/J9 on all TRADOC experimental architecture efforts.
- Coordinates with TRADOC JID (Joint Integration Directorate) on all Joint architecture policies and issues.

- Partners, Coordinates and integrates all TRADOC architecture issues with CALL, TRAC, CECOM, TPIO ABCS, PEO, NCS, FOAs, PMs, TEC, AMSAA, Battle Labs, Battle Lab Collaborative Simulation Environment (BLCSE) and other DA/DoD organizations and agencies.

- Supports the Proponent Schools and Centers and the TRADOC Integrating Centers with identification of DOTMLPF experimental architecture requirements.

- Coordinates through TRADOC DSCDEV JAED with TRADOC DCSDCS on the integration of Army Operational Concepts and Doctrine.

Experimental Architecture Opportunities Calendar

FY 03

O & O UA & UE
Selected LSI Concept Demonstrations
Selected Exploratory CD & E
Pinnacle Impact 03
ATWG 03

Selected Operational Concepts (10 for FY 03)
- Objective Force
- Unit of Employment

- Aviation
- Battle Command/C4ISR
- Maneuver Support
- Maneuver Sustainment
- Homeland Operations
- Space Operations
- Soldier as a System
- Engineer Operations
- Maintenance Operations
- Supply and Service Operations
- Air and Missile Defense

FY 04

Selected Exploratory CD & E
ATEx 04
ABCA
Joint Global Wargame
USJFCOM SJFHQ efforts
Selected Operational Concepts (10 for FY 04)
- Force Protection
- Special Operations Forces
- Information Operations
- Fires and Effects
- NBC Defensive Operations
- Transportation and Distribution Operations
- Medical Protection
- Engineer Operations
- Maintenance Operations
- Supply and Service Operations

FY 05

Selected Exploratory CD & E
ATEx 05
JFCOM Unified Endeavor
ATEx07 (Planning)

Selected Operational Concepts (4 for FY 05)
- Military Police Operations
- Non-lethal Operations
- Soldier Support
- EOD Operations

FY 06

Selected Exploratory CD & E
ATWG 06
ATEx 06
ATEx 07 (Planning)

FY 07

Selected Exploratory CD & E
ATEx 07 (Execution)

Annex E

Abbreviations/Acronyms

A

AAIC	Army Architecture Integration Cell
AAO	Army Acquisition Objective
AARMS	Army Architecture Repository Management System
ABCS	Army Battle Command System
ACIDS	Army Capabilities Integration and Development System
ACSIM	Assistant Chief of Staff for Installation Management
ACSIM (CSFC)	Assistant Chief of Staff for Installation Management (CSFC)
ADD	Authorization Documentation Directorate
AEA	Army Enterprise Architecture
AEADP	Army Enterprise Architecture Development Plan
AEADP PD	Army Enterprise Architecture Development Plan Process Document
AEAGD	Army Enterprise Architecture Guidance Document
AEIOO	Army Enterprise Integration Oversight Office
AIMD	Architecture Integration Management Directorate
AIMD-AD	AIMD Analysis Division
AIMD-EB	AIMD Experimentation Branch
AKE	Army Knowledge Enterprise
AKEA	Army Knowledge Enterprise Architecture
AKO	Army Knowledge On-Line
ALL_CADM	ALL_Core Architecture Data Model
AMS	Army Modernization Schedule
AMSAA	Army Material Systems Analysis Activity
AMSO	Army Modeling and Simulation Office
AoA	Analysis of Alternatives
AOA	Army Operational Architecture
AOE	Army of Excellence
AOFA	Army Objective Force Architecture
AR	Army Regulation
ARFOR	Arm Force
ARSOF	Arm Forces Special Operation Command
ARSTAFF	Army Staff
ASA	Army Systems Architecture
ASA (ALT)	Assistant Secretary of the Army for Acquisition, Logistics and Technology
ASA (FM)	Assistant Secretary of the Army for FM
ASEO	Army System Engineering Office
ASG	Architecture Steering Groups
ASIOE	Associated Support Items of Equipment

ASAT	Automated System Approach of Training
ATEx	Army Transformation Experiments
AT-CDEP	Army Transformation Concept Development and Experimentation Campaign Plan
ATIA	Army Training Information Architecture
ATSC	Army Training Support Center
ATWG	Army Transformation War Games
AUTL	Army Universal Task List
AV	All (Architecture) View
AV-1	Overview and Summary Information
AV-2	Integrated Dictionary
AV-3	Capability Maturity Profile
AVB	Architecture Validation Board
AWG	Architecture Working Groups

B

BC	Battle Command
BCOM	Battle Command on-the-Move
BDE	Brigade
BFA	Battlefield Function Area
BLCSE	Battle Lab Collaborative Simulation Environment
BLITD	Battle Labs Integration Technology Director
BMC2	Battlefield Management Command and Control
BMMP	Business Management Modernization Program
BOIP	Basis of Issue Plan
BOS	Battlefield Operations System
BOS/BFA	Battlefield Operations System/Battlefield Functional Area
BTOE	Base Table of Organization and Equipment

C

C2	Command and Control
C3I	Command, Control,Communications and Intelligence
C4	Command, Control, Communications, and Computers
C4/IT	Command, Control, Communications, and Computers/Information Technology
C4I	Command, Control, Communications, Computers, and Intelligence
C4RDP	Command, Control, Communications, Computers, Requirements, Documentations and Publications
C4ISP	Command, Control, Communications, Computers, and Intelligence Support Plan
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
CAC	Combined Arms Command
CAC (TPIO-ABCS)	Combined Arms Command (TPIO-ABCS)
CADM	Core Architecture Data Model

CALL	Center for Army Lessons Learned
CASCEN	Combined Arms Support Center
CASCOM	Combined Arms Support Command
CBRS	Concept Based Requirements System
CD&E	Concept Development and Experimentation
CD	Cavalry Division
CDD	Capability Development Document
CECOM	Communications Electronic Command
CEP	Concept Evaluation Plan
CG	Commanding General
CIDS	Capabilities Integration and Development System
CIO	Chief Information Officer
CIO/G-6	Chief Information Officer/G-6
CJCS	Chairman of the Joint Chiefs of Staff
CJCSI	Chairman of the Joint Chiefs of Staff Instruction
CM	Configuration Management
CMB	Configuration Management Board
COE	Common Operating Environment
COP	Common Operational Picture
COTS	Commercial-Off-The-Self
CPD	Capability Production Document
CPG	Contingency Plan Guidance
CR	Cavalry Regiment
CRD	Capstone Requirements Document
CSA	Chief of Staff of the Army
CSS	Combat Service Support
CTC	Combat Training Center
CTU	Consolidated Table of Organization and Equipment Update

D

DA	Department of the Army
Db	Database
DAMO-RQ	Requirements Directorate, HQDA G3
DARPA	Defense Advanced Research Procurement Agency
DARS	Defense Architecture Repository System
DART	Documentation Assistance and Review Team
DCD	Director of Combat Development
DCEE	Distributed Continuous Experimental Environment
DCG	Deputy Commanding General
DCSDCS	Deputy Chief of Staff for Doctrine, Concepts and Strategy
DCSDEV	Deputy Chief of Staff for Development
DCSINT	Deputy Chief of Staff for Intelligence
DCSOPS&T	Deputy Chief of Staff for Operations and Training
DCSSA	Deputy Chief of Staff for Simulations and Analysis
DII	Defense Information Infrastructure

DISA	Defense Information Systems Agency
DISC4	Directorate of Information Systems for C4
DIWG	Documentation Integration Working Group
DMSO	Defense Modeling and Simulation Office
DoD	Department of Defense
DoDD	Department of Defense Directive
DOTMLPF	Doctrine, Organization, Training, Material, Leadership, People and Facilities
DPG	Defense Planning Guidance
DSI	Decision Superiority Integrator

E

EBO	Effects Based Operations
EOH	Executive Office Headquarter
EPLRS	Enhanced Position Location Reporting System
ERB	Engineer Review Board
ERP	Enterprise Resource Planning

F

FAA	Functional Area Analysis
FBCB2	Force XXI Battle Command Brigade and Below
FCS	Future Combat Systems
FD	Force Development
FDU	Force Development Update
FISO	Force Integration Staff Officer
FMMP	Financial Management Modernization Program (Renamed to BMMP (Business Management Modernization Program)
FNA	Functional Needs Analysis
FOA	Field Operating Agency
FoS	Family of Systems
FoSA	Family of Systems Architecture
FSB	Forward Support Battalion
FY	Fiscal Year

G

GIG	Global Information Grid
GMU	George Mason University
GOSC	General Officers Steering Committee
GOTS	Government Off-The-Shelf

H

HB	Horseblanket
HSOC	Home Station Operation Center
HQ	Headquarters
HQDA	Headquarters Department of the Army

I

I3A	Information infrastructure Architecture
I&RTS	Integration and Runtime Specification
IAV	Interim Armored Vehicle
IAW	In Accordance With
ICD	Initial Capabilities Document
ICP	Interim Change Proposal
ICT	Integrated Concept Team
ICW	In Collaboration With
ID	Infantry Division or Identification
IER	Information Exchange Requirement
IETM	Interactive Electronic Technical Manual
INSCOM	Intelligence Security Command
IOC	Initial Operational Capability
IPT	Integrated Process Team
IR	Information Requirement
ISR	Intelligence, Surveillance, Reconnaissance
IT	Information Technology
ITMRA	Information Technology Management Reform Act
ITOE	Intermediate Table of Organization and Equipment

J

JAED	Joint and Army Experimentation Directorate
JC2	Joint Command and Control
JCD&E	Joint Concept Development and Experimentation
JCIDS	Joint Capabilities Integration and Development System
JFC	Joint Functional Concepts
JFCOM	Joint Forces Command
JID	Joint Integration Directorate
JIM	Joint, Inter-Agency and Multi-National
JOC	Joint Operating Concepts
JTA-A	Joint Technical Architecture-Army
JTRS	Joint Tactical Radio System
JWCA	Joint Warfare Capability Assessment

K

KPP	Key Performance Parameters

L

LAN	Local Area Network
LIN	Line Item Number
LO	Line of Operation
LOA	Letter of Authorization
LSI	Lead Systems Integrator

LW	Land Warrior

M

M	Maneuver
MANSCEN	Maneuver Support Center
M&S	Modeling and Simulation
MACOM	Major Command
MATDEV	Material Developer
MC02	Millennium Challenge 02
MC4	Medical Communications for Combat Casualty Care
MCP	Mission Capability Packages
MEDEVAC	Medical Evacuation
MI	Military Intelligence
MNS	Mission Needs Statement
MOE	Measures of Effectiveness
MOP	Measures of Performance
MP	Military Police
MTOE	Modified Table of Organization and Equipment
MTP	Mission, Task, Purpose
MWR	Morale, Welfare and Recreation

N

NETCOM	Network Command
NETOPS	Network Operations
NETWARS	Network Warfare Simulation
NLT	Not Later Than
NSC	National Simulation Center
NCW	Network-Centric Warfare

O

O&O	Operational and Organizational Concept
OA	Operational Architecture
OEF	Operating Enduring Freedom
OF	Objective Force
OFTF	Objective Force Task Force
OPFAC	Operational Facility
OPNET	Operational Network
ORD	Operational Requirement Document
OSD	Office of the Secretary of the Defense
OTSG	Office of the Surgeon General
OV	Operational (Architecture) View
OV-1	High-Level Operational Concept Diagram
OV-2	Operational Node Connectivity Description
OV-3	Operational information Exchange Matrix
OV-4	Organizational Relationship Chart

OV-5	Operational Activity Model
OV-6a	Operational Rules Model
OV-6b	Operational State Transition Description
OV-6c	Operational Event Trace Description
OV-7	Logical Data Model

P

PCS	Permanent Change of Station
PEO	Program Executive Office
PEO-EIS	Program Executive Office- EIS
PEO/PM	Program Executive Office/ Program Manager
PEO-C3T	Program Executive Office-Command Control and Communications Tactical
PEO-STRI	Program Executive Office – Simulations, Training and Instrumentation
PM	Program Manager
POC	Point of Contact
POM	Program Objective Memorandum
PP	Publish/Process
PPBES	Programming, Planning, Budget, and Execution System

R

RDO	Rapid, Decisive Operations
RGRS	Rangers
RGS	Requirements Generation Systems
RRC	Requirements Review Committee

S

SA	Systems Architecture or Secretary of the Army
SA/CSA	Secretary of the Army/ Chief of Staff of the Army
SAALT	Secretary of the Army for Acquisition, Logistics, and Technology
SA-C	Systems Architecture-Conceptual
SA-D	Systems Architecture-Detailed
SACP	Systems Architecture Change Proposal
SB	Supply Bulletin
SBCT	Stryker Brigade Combat Team
SDD	System Development and Demonstration
SECDEF	Secretary of the Defense
SJTFHQS	Standing Joint Task Force Headquarters
SME	Subject Matter Expert
SOC	Special Operation Command
SOP	Standard Operating Procedure
SoS	Systems of Systems
SoSA	Systems of Systems Architecture
SRC	Standard Requirements Code

SJTF	Standing Joint Task Forces
STRICOM	Simulation, Training, and Instrumentation Command
SV	Systems (Architecture) View
SV-1	Systems Interface Description
SV-2	Systems Communication Description
SV-3	Systems to Systems Matrix
SV-4	Systems Functionality Description
SV-5	Operational Activity to System Function Traceability Matrix
SV-6	System Information Exchange Matrix
SV-7	System Performance Parameters Matrix
SV-8	System Evolution Description
SV-9	System Technology Forecast
SV-10a	Systems Rules Model
SV-10b	Systems State Transition Description
SV-10c	Systems Event/Trace Description
SV-11	Physical Data Model
SWB	Software blocking
SWG	Seminar Work Group

T

TA	Technical Architecture
TAA	Total Army Authorization
TAADS	The Army Authorization Document System
TAMP	TRADOC Architecture Management Program
TBD	To Be Determined
TBP	To Be Published
TCP	Transformation Campaign Plan
TDY	Temporary Duty
TEC	Test and Evaluation Command
TJAG	The Judge Advocate General
TOC/CP	Tactical Operations Center/Command Post
TOE	Table of Organization and Equipment
TP	TRADOC Pamphlet
TPFD	Time-Phased Force Deployment
TPIO	TRADOC Program Integration Office
TRAC	TRADOC Analysis Center
TRADOC	Training and Doctrine Command
TSM	TRADOC Systems Managers
TSP	Training Support Package
TV	Technical (Architecture) View
TV-1	Technical Architecture Profile
TV-2	Standards Technology Forecast

U

UA	Unit of Action

UAMBL	Unit of Action Maneuver Battle Laboratory
UDT	User Defined Tasks
UE	Unit of Employment
UIC	Unit Identification Code
UJTL	Universal Joint Task List
UML	Unified Modeling Language
URS	Unit Reference Sheet
US	United States
USA	United States of America or Under Secretary of the Army
USAFMSA	U. S. Army Force Management Support Agency
USAFMSA-ADD	U. S. Army Force Management Support Agency-Authorization Documentation Directorate
USAFMSA-RDD	U. S. Army Force Management Support Agency-Requirements Documentation Directorate
USAWC	U. S. Army War College
USF	Unit Set Fielding
USFMS	Unit Set Fielding Modernization Schedule

V

V	Version or Validation
VCSA	Vice Chief of Staff of the Army

W

WAN	Wide Area Network
WG	Working Group
WIN-T	Warfighters Information Network-Tactical

Annex F

Definitions

Architecture – the structure of components, their relationships, and the principles and guidelines governing their design and evolution over time. Architecture provides an integrated planning tool during force development and serves as an implementation document during force fielding and sustainment.

DoD Integrated Architecture Panel,
1995, based on IEEE STD 610.12, 1990[1]

Army Knowledge Enterprise Architecture (AKEA)
A disciplined, structured, comprehensive, and integrated methodology and framework that encompasses all Army information requirements, technical standards, and systems descriptions regardless of the information system's use. The AKEA transforms operational visions and associated required capabilities of the warfighters into a blueprint for an integrated and interoperable set of information systems that implements horizontal Information technology insertion, cutting across the functional stovepipes and Service boundaries. The AKEA is the combined total of all the Army's operational, technical, and system architectures.

Army Knowledge Management
The Army-wide effort to transform the Army into a network-centric self-learning organization that will improve operational and mission performance.

Architecture "types" – include the same products (Views) and types of information - the primary difference between them is in how the products are organized and the information is presented. The three primary architecture types are: operational, systems, technical.

Battle Command (BC) – the art and science of applying leadership and decision making to achieve mission success. [TRADOC draft Battle Command (C4ISR) Concept]

Capability – a measurable capacity to perform a function or set of functions. It will include the systems, knowledge and skill sets to accomplish a function.

Collective Training – instruction and applied exercises that prepare an organizational team (such as a squad, aircrew, battalion, or multi-service task force) to accomplish military tasks as a unit. (DoDD 1322, Military Training)

Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) – an integrated system of systems that enables situational understanding and decision superiority. The systems include both C4 systems and ISR

systems. This system of systems better allows a commander to command and control his organization. (Draft DCSDCS definition)

Doctrine – fundamental principles by which the military forces or elements thereof guide their actions in support of national objectives. It is authoritative but requires judgment in application. (Joint Pub 1-02)

Family of Systems Architecture (FoSA) – a set or arrangement of independent systems that can be arranged or interconnected in various ways to provide different capabilities. The mix of systems can be tailored to provide desired capabilities dependent on the situation. (CJCSI 3170.01C)

Function – a unit of work that totally is defined by its inputs and outputs. As applied here refers to the activities or operations expected of a domain.

Inform – to impart information or knowledge. To give information.

Information Sets – for the purposes of this discussion, Information Sets are an extracted collection of predetermined relational data depicting a perspective- oriented view.

The Information Sets will provide the framework for guiding requirements for specific architecture products. Below is the initial group of Information Sets to be used in driving AOFA efforts.

- The set of Army Objective Force related and associated concepts. (accurate collection, categorization and decomposition of all area of interest/influence operational concepts)
- The set of Army Objective Force required capabilities. (decomposition by echelon and force construct)
- The set of approved functions (services) provided by each domain that will enable the OF required capabilities
- The set of relational Crosswalk products that measures the feasibility of domain approved functions as it correlates to and enables associated OF required capabilities.
- The set of layouts (by echelon and units) that depicts the view of the physical relationship between alike systems, view of the family of primary systems that enables each specific capability, and a view of the aggregation of all systems.
- Depict system schematics for each individual (autonomous) system.
- The set of Organizational products depicting the organizational structure and its command relationships (internal and external perspective).

- A set of products that provides cost layout of capabilities, systems, functions, requirements and/or echelons (unit/agency).

Army Objective Force Architecture—2015, Overview and Summary Information (AV-1), Army Architecture Integration Cell, Draft V 0.1, as of 31 Jan 03

Integrated Architecture – an architecture consisting of multiple views (operational, systems, and technical standards) that facilitate integration and promote interoperability across family-of-systems (FoS)/system-of-systems (SoS) and compatibility among related mission area architectures.
DoDD 4630.5, "Interoperability and Supportability of Information Technology and National Security Systems." January 11, 2002

Four critical aspects of being able to integrate architectures are adherence to the Framework, consistency with the GIG Architecture, compliance with the CADM, and use of a common taxonomy for architecture data element values (such as names of nodes).

A single integrated architecture includes three views (OV, SV, and TV) of the Framework that defined work processes and supporting information technology (IT). The logical linkages among the views serve to ensure that the single architecture so described can actually be developed and operated. In particular, these linkages ensure that the architecture views remain mutually consistent. The linkages provide traceability from view to view, and from product to product within a view and across views, that ensures:

- Integration of systems within a system-of-systems
- Alignment of IT functionality to mission and operational needs

DoD Architecture Framework Version 1.0, Volume I: Definitions and Guidelines, 15 January 2003

Integration – the result of an effort that joins two or more similar products, such as individual system elements, components, modules, processes, databases, or other entities and results in a new product that functions as a whole to provide a capability that cannot be met by any of its components acting alone.

Interoperability – the ability of two or more systems, units, forces, or physical components to exchange and use information. The conditions achieved among communications-electronics systems or items of communications-electronics equipment when information or services can be exchanged directly and satisfactorily between them and/or their users.

Operational Architecture (OA) – a description (often graphical) of the operational elements, assigned tasks, and information flows required to accomplish or support a warfighting function. It defines the type of information, the frequency of exchange, and what tasks are supported by these information exchanges. (AR 25-1)

OA is the sum total of all Operational Views (OV). OA is presented from the viewpoint of the warfighter by:

- Analyzing operational concepts to frame requirements (mission, task, purpose)
- Continually refining requirements for DOTLM-PF analysis
- Producing standard products based on type of architecture
- Using common formats for integration, interoperability
- Describing the who, what, why, when, and how often

Operational Control (OPCON) – the authority to perform those functions of command over other activities involving assigning tasks, designating objectives, and giving authority direction necessary to accomplish the mission. (Joint Pub 1-02) Per FM 3-0, Operations, the inherent responsibilities are:

- Has command relationship with gaining command
- May be tasked by gaining command
- As required by gaining command, provides liaison to and maintains communications with gaining command
- Has priorities established by gaining command

Product Sets – the set of architecture deliverables for an individual architecture, specified in the AEADP-PD Annex, are evaluated and updated throughout the development process. They provide input to the Army TCP, the PPBES, and the POM. The precise makeup of each AEADP-PD Product Set depends on several factors, including, but not limited to, the following (see also Section 2.6 in the AEADP-PD document):

- Describing the who, what, why, when, and how often
- Architecture Purpose
- Customer Requirements
- Available production time

Proponent – the army organization or staff element that has primary responsibility for material or subject matter expertise in its area of interest or charged with accomplishment of one or more functions. (AR 5-22, The Army Proponent System)

Systems Architecture (SA) – a description, including graphics, of systems and interconnections providing for or supporting warfighting functions. It defines the physical connection, location, and identification of key nodes, circuits, networks, and warfighting platforms and specifies system and component performance parameters. SA is the sum total of all systems views (SV). SA provides descriptions of the physical implementation of the OVs, the layout and relationship of systems by associating physical resources and their performance attributes to the operational view and its requirements

System of Systems Architecture (SoSA) – a set or arrangement of systems that are related or connected to provide a given capability. The loss of any part of the system will degrade the performance or capability of the whole. It represents the horizontal/vertical integration of multiple architectures (e.g. tasks, functions, elements, information flows, and networks) to identify interdependencies, optimize warfighter requirements, and facilitate DOTLM-PF analysis of systems, organizations, functions, and capabilities. (CJCSI 3170.01B)

Technical Architecture (TA) – a minimal set of rules governing the arrangement, interaction, and interdependence of the parts or elements whose purpose is to ensure that a conformant system satisfies a specified set of requirements. It identifies the services, interfaces, standards, and their relationships. It provides the technical guidelines for implementation of systems on which engineering specifications are based, common building blocks are built, and product lines are developed. TA is the sum total of all technical views (TV). TVs include a collection of the technical standards, conventions, rules and criteria organized into profile(s) that govern system services, interfaces, and relationships for particular systems architecture views and that relate to particular operational views.

Transition Plan – a document or series of related documents describing the strategy and establishing the timelines for changing the enterprise from the "*current"* to the "*future"* architecture.

Annex G

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