A Systems Thinking Approach to Building and Updating C4ISR Architecture Views

William B. Carter

29 January 2003
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Standard Form 298 (Rev. 8-98)  
Prepared by ANSI Std Z39-18
C4ISR Architecture View Update Process

PURPOSE

- Describe the outcomes of a systems thinking analysis to understand the dynamics of building and updating C4ISR architecture views
- Present a process model and checklist for required key information at each step in the model
- Identify critical success factors for life cycle architecture update mechanisms
### Benefits of C4ISR System Architectures

- Picture of SPO’s program objectives
- Program architecture integration and transition tool
- Support of DoD Acquisition Over Site
- Source of system requirements specification
- Source of system design specification
- Execution model for system architecture
Rationale for Documenting the Investigations in the Paper

- C4ISR architecture views provide a method for IT programs to communicate
  - Who they are, what they do, and
  - How, in general, SPOs want to be viewed by other organizations
- High-level architectures support enterprise decision makers who might be unfamiliar with the technical details of a system
  - Understanding commonalities and inconsistencies between (a) merging systems, (b) systems on a collision course, and (c) major transitional stages in a single system’s evolution
- Low-level architecture views, on the other hand, allow IT experts to identify, analyze, and specify potential and real integration issues
  - Provides comparable detailed structured archives that they can manipulate to characterize specific current architectural conflicts
- Within the limitations of time, funding, and political will, analyzing architecture views can identify future integration issues by executing detailed systematic comparative analyses
- Keeping C4ISR architecture views updated—and therefore an accurate living representations of a system architecture—is the name of the game
Examples of GCSS-AF SPO Usage of High Level Architecture Views

- Executive level programmatic and technical interchanges
- Program funding negotiations
- Customer OutReach: over 600 programs and customer organizations
- DoD Acquisition Oversight
  - Clinger-Cohen Act Compliance
  - C4ISP Approvals
  - Certificate of Networthiness
# C4ISR Architecture Products Required for Acquisition

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<th>Architecture Products</th>
<th>Domain</th>
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- AC2ISRC Responsibility, COAC Develop
- AC2ISRC Initial, COAC Further Development
- Combat Operations Architecture Council Responsibility
- Program Responsibility
- Mandated Product
- Optional
- C4ISR Arch Framework Version 2.1
- AFI 33-124 Required for Air Force Architectures
- Combat Operations Architecture Council Sponsoring Programs

*AFI* - AFI 33-124 Required for Air Force Architectures

*COAC* - Combat Operations Architecture Council Sponsoring Programs
### C4ISR Architecture Products Required for Acquisition (concluded)

#### Architectures Products (concluded)

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#### Technical Architecture

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- **A**: AC2ISRC Responsibility, COAC Develop
- **A**: AC2ISRC Initial, COAC
- **C**: Combat Operations Architecture Council Responsibility
- **P**: Program Responsibility
- **O**: Optional
- **V**: Mandated Product
- **V**: C4ISR Arch Framework Version 2.1
- **AFI**: AFI 33-124 Required for Air Force Architectures
- **COAC**: Combat Operations Architecture Council Sponsoring Programs
Creating and Updating C4ISR Diagrams

Key to the Process: Architecture documentation is valid only if it kept up to date on the shelf

- Re-use of work by Ellen Conway and the MITRE COAC on dynamic interoperability assessments of architectures
- Two stages
- Three step Stage 1 to assess completeness of architecture
- Added interrelationships of architecture views and data collection requirements for selected views
- Developed a static update process flow for Stage 1
A Rapid Jog Through Some High Level GCSS-AF Architecture Examples

HIGH LEVEL EXECUTIVE VIEWS

- GCSS-AF High-Level Operational Concept Description (Operational View-1)
- GCSS-AF System Interface Description (System View-1)
- GCSS-AF System Communications Description (SV-2)
- GCSS-AF Systems Functionality Description (SV-4)
- GCSS-AF Operational Node Connectivity Description (OV-2)
- GCSS-AF Operational Node Connectivity Description (OV-2)
- GCSS-AF Systems$^2$ Matrix (SV-3)

DETAILED LEVEL IMPLEMENTER VIEW

- Overview of GCSS-AF System Data Exchange Matrix (SV-6)
“Provide access and connectivity to any authorized user on any box (within security parameters) at any location.”

“Provide modernized and integrated AISs through cross-functional business process reengineering.”

“Provide modernized and integrated AISs through cross-functional business process reengineering.”

“Provide cross-functional decision support tools.”

“Provide real-time and accurate data from authoritative data sources.”

“Provide cross-functional decision support tools.”

Source: ORD, 12/01; SPO
GCSS-AF System Interface Description (SV-1)
GCSS-AF System Comm Description
(SV-2, NIPRNET to SIPRNET Connectivity)

Source: GCSS-AF ORD, S PO

Integrity Service Excellence
GCSS-AF Systems Functionality Description (SV-4)

- ACS C2 Execution
  - Forces Beddown
  - Warfighter Requirements Coordination
  - Sortie Generation

- ACS C2 Dynamic Planning

- AEF ACS C2

- Theater ACS C2

- Integration Framework (IF) and Air Force Portal (AFP)

- Enterprise Systems Management (ESM)

- Enterprise Data Warehouse (EDW)

- Creation/Maintenance of Accurate Functional Data

- System Security

- GCSS-AF Subsystem Information Flows (Documented by GCSS-AF SPO)

- Warfighter ACS Systems Nodes

- Supporting Warfighter ACS Systems Nodes

- GCSS-AF Integration Infosphere

Source: ORD, 12/01
**GCSS-AF Operational Node Connectivity**

**Description (OV-2, ACS Warfighter)**

*All GCSS-AF Warfighter ACS nodes are functionally identical, independent, and supported by the same set of Integration infosphere functions.*

### Functions Within Warfighter Nodes
- ACS C2 Execution Functions
  - Forces Beddown
  - Warfighter Requirements Coordination
  - Sortie Generation
- ACS C2 Reachback Functions
- ACS C2 Dynamic Planning Functions
- Theater ACS C2 Functions
- AEF ACS C2 Functions
- Creation/Maintenance of accurate functional data

### Operational Nodes for ACS Information Use

- **JTF Ops Nodes**
- **Services Organizations Ops Nodes**
- **GCSS-AF Functional Pillars Ops Nodes**

Source: SPO
Integrity Service Excellence

GCSS-AF Operational Node Connectivity Description (OV-2, IntegrationInfosphere)

Air Force Portal Service Node

GCSS-AF Integration Infosphere Architecture Service Node

Integration Service Node for Functional Mission Applications

Cross-Functional Mission Applications and Decision Support Tools Service Node

Trusted Air Force Data Service Node

OLAP Service Node for OLTP Data, Database Updates, and Warehoused Data
## GCSS-AF Systems² Matrix (SV-3)

### High-Level GCSS-AF Integration Infosphere System Components Matrix

<table>
<thead>
<tr>
<th>High-Level System Component</th>
<th>Integration Framework (IF) and AFP</th>
<th>System Security</th>
<th>Enterprise Systems Management (ESM)</th>
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**GCSS-AF Warfighter Operational Activity to System Function Mappings**

(To be documented by AIS SPOs)

Source: SPO
GCSS-AF System Data Exchange Matrix (SV-6, Integration Infosphere)

Mapping of Underlying Detailed System Data to the SV-6 Architecture View

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Source: DoD Arch Framework v2.1
Objectives of the C4ISR Architecture View Update Process

- Maintain a clean requirements specification (System Data Exchange Product View)
  - Describes, in tabular format, system functional data exchanges between systems within a node and across nodes
  - Keys system functional data exchanges back to the operational activity information exchange it helps to satisfy (i.e., system functions \( \rightarrow \) an operational activity)
- Need to support many-to-many linkages in both directions (i.e., ops activities \( \rightarrow \) system functions)
Sources of the Impact and Change on a System Architecture

- Immaturity of the system architecture
- Generating the first instance (AV needed; high level data for OVs, SVs, and TVs to get started)
- Adding, deleting, swapping out technologies
- Adding, deleting, swapping out major system functions
- Adding, deleting, swapping out major operational activities
- Adding, deleting, swapping out both major operational activities and major system function at the same time
Simplified C4ISR Architecture View

Update Process

Step 1

Operational Activity Relationships and Information Flows

Step 2

Operational Nodes/Elements and Summary Ops Info Exchanges

Step 3

Ops Scenarios or Sequence of Critical Events

System Functions by Ops Activities

System Info Exchange Details

Performance Parameter Matrix
Insights on the Dynamics of the Update Process

- Critical Success Factors Identified by the Systems Thinking Analyses
  - Thick lines identify critical dynamic linkages
  - Maturity of the general system architecture
  - Maturity of your architectural data and data collection process
  - Volatility of the As-Is or To-Be architecture
  - Completeness of your implementation plan for lifecycle updates

- Eager to hear reviews of my paper at wbc@mitre.org