Ogden Air Logistics Center

A-10 Avionics System Architecture Trade Analysis (AVSATA) Program

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Agenda

- A-10 Background
- Architecture & Requirements Overview
- A-10 Architecture Development
- Example
- Path Forward
- Results
A-10 BACKGROUND
A-10 designed as a tank buster, low-technology, easy to maintain ground attack fighter

- A-10 upgrades limited in scope and capability.
- Sustainment programs
  - Largely form/fit/function replacements.
- Lack of funding and a master plan (architecture roadmap) resulted in stovepipe sustainment/capabilities modifications without considerations for:
  - Systems Engineering
  - Distribution of functions
  - Growth of capabilities
  - Interoperability
Beyond Design Life

Baseline Graph extracted from USAF Viable Combat Avionics Initiative Implementation, Mr. Doug Ebersole; AFMC Aeronautical Enterprise Program Office; 22 Oct 02; pg 5
Precision Engagement
This Ain’t Your Daddy’s Hog

- Precision Engagement is the largest upgrade in the history of A-10
  - Significantly upgraded and changed the platform, providing an integrated avionics suite with a considerable number of functions moved into software
  - New aircraft baseline provides a point of departure for many new operational and sustainment capabilities
Future programs, post-PE, will be forced to be smaller, generally sustainment-based programs with a focus on form/fit/function replacement.

Enterprise architecture maximizes the bang for every dollar spent.
Avionics Sustainment Program (ASP) (Wish List)

- Digital Video and Data Recorder
- Engine Instruments
- Out of Cockpit systems
  - Stall Warning System
  - Embedded GPS/INS
  - Data Distribution
  - TEMS/ADR
  - Radar Altimeter
- Fuel Quantity ID
- Nav Mode Select Panel
- Caution Annunciator Panel
- Heading & Attitude Reference System
- Intercom Panel
- Data Transfer System
- Control Display Unit
- Digital Video and Data Recorder

Key:
- D – Diminishing Manufacturing Sources & Material Shortages Issues
- R – Reliability Issues
- M – Maintainability Issues
- O– Obsolescence issues
- P – Performance Issues (Operations)
- G – Growth Issues
- F – Function is duplicated elsewhere
- I – Not integrated

- Replace w/ MFCD
- Replace w/ upgraded RWR
- Replace w/ COTS B/U instrument
- Integrate with OFP
- Replace w/ software
- Upgrade/Consolidate

- Replace

Out of Cockpit systems:
- Embedded GPS/INS – R, M, O, P, G
- Data Distribution - none
- TEMS/ADR – P, G, F
- Radar Altimeter – R, M, O, P, G

Develop/Integrate

Upgrade/Integrate

Replace w/ software

Update
A-10 AVSATA Vision

A-10 Integrated Lifecycle Management Process
A-10 Weapon System Roadmap

Requirements
- 37s, 1067s, ASRRC, CDD: Connectivity, PUP, EW
- DMS & Spares Retention
- PMD, SEP, FVB Report
- SLAs with ALCs and DMS & Spares Retention
- RCM & RMS&S Program MECSIP, AVSIP, etc.
- Aircraft Structural Integrity Program (ASIP)
- IMP/IMS - LCMP

Obsolescence

Direction

Reliability

SLEP, Wing Replacement, PE, Suite Updates, Consolidated Mod, etc.

AVSATA FY07 – FY12-13: Avionics Architecture/Roadmap

Analysis >>> Multiple OAs >>> Permanent Mods >>> ASP

- 3400 POM
- 594, 592, 583, 540, MSD

- PEM POM
- 30XX 3600

Sustainment and Modernization Modifications

SLEP, Wing Replacement, PE, Suite Updates, Consolidated Mod, etc
A-10 Integrated Architecture

- AVSATA provides the framework to help make the most of the resource limited sustainment programs

- Integrated architecture provides a comprehensive plan for the operational and technical capabilities and interconnections required by the aircraft lifecycle sustainment
  - Defines a roadmap to show smaller programs how they can fit into the overall plan
  - Defines a way to leverage small sustainment investments into significant increased platform sustainment and capability

- **Path Finding** process applied to legacy sustainment
  - Keep A-10 relevant in our nations conflict and at the forefront of the force throughout its lifecycle.
ARCHITECTURE & REQUIREMENTS OVERVIEW
Integrated Architecture Overview

What is an architecture?
- “The structure of components, their relationships, and the principles and guidelines governing their design and evolution over time” – DoD Integrated Architecture Panel

What is an “integrated” architecture?
- Architecture is an integrated architecture when products and their constituent architecture data elements are developed such that architecture data elements defined in one view are the same (i.e., same names, definitions, and values) as architecture data elements referenced in another view.

What are the advantages of integrated architectures?
- Facilitate an organized and consistent standardized design process
- Facilitate the clear definition and implementation of new operational, system & technical requirements
- Promote interoperability
- Required by Joint Capabilities Integration & Development System (JCIDS)
- Provide for traceability of system requirements back to the originating joint concepts (facilitates successful POM inputs, i.e., getting program funding)
- Facilitate systems and systems sustainment engineering
Fundamental Linkages Between Views

Operational View
Identifies What Needs to be Accomplished and Who Does It

Technical Standards View
Prescribes Standards and Conventions

Technical Standards Criteria Governing Interoperable Implementation/Procurement of the Selected System Capabilities

Systems View
Relates Systems and Characteristics to Operational Needs

Specific System Capabilities Required to Satisfy Information Exchanges

Basic Technology Supportability
New Technical Capabilities
Operational Requirements & Capabilities

Systems that Support the Activities and Information Exchanges

What needs to be done
Who does it
Information Exchanges Required to Get it Done

KIHOMAC
System Acquisition Excellence
Traceability of Requirements from Users to Acquirers to Contractors

A-10 System Program Office

System Functional Architecture
Technical Requirements

Operational Requirements
System Physical Architecture
Design Requirements & Technical Specs

Operational Architecture

Requirements are tightly coupled to Architectures
A-10 ARCHITECTURE DEVELOPMENT
A-10 Architecture and External Docs

GIG MA* ICD
Joint Fires ICD
CAS MA* ICD
JCAS CONOPS
Crypto MA* ICD

A-10 Architecture

A-10 Connectivity CDD
A-10 EW CDD

PE Baseline (Documents)

CPD’s

* MA ICD’s were directed to be converted or they were rescinded effective June 2008
Architecture -Top-Level View

ICD’s & CONOPS (guidance) → CDD’s

Operational Architecture → Requirements → System Architecture

A-10 PE Baseline (A-10 WSS, A-10 PIDS) → CPD’s
Operational Architecture

ICD's, CONOPS, Etc. (guidance)

Capability Threads (OV-5)

Organizations (OV-4)

Operational Nodes (OV-2, OV-3)

Integrated Operational Architecture (OV-5, OV-6, OV-7, & MOE’s)

CDD's

PE Baseline (WSS, PIDS)

Requirements
System Architecture

PE Baseline (WSS, PIDS)

CDD's

CPD's

System Architecture

System Functional Design (SV-4's)

System Physical Design (SV-1, SV-2, SV-6, SV-7)
Architecture Layering

Operational Architecture

System Architecture

Increasing Detail

Level 0

Level 1

Level 2

Level 1

Level 0

Level 1

Level 2

Level 2

Level 2
EXAMPLE

From JCAS CONOPS:
- Establish & Maintain Battlespace Awareness
Joint level documents are imported into DOORS and any data deemed operationally significant to the A-10 is marked for inclusion into the Operational Architecture.
Operational Architectures are created in System Architect and linked both to the Joint Level capabilities and the A-10 specific system requirements.

This example shows the JCAS CONOPS ‘Battlespace Awareness’ capability decomposed into the components that provide the capability.
Operational Architecture Thread
- Establish & Maintain Battlespace Awareness

This view (OV-5) details the general data required to perform the operations spelled out in the JCAS CONOPS.
**Operational Requirements**

- Derived from Operational Architecture

A-10 documents such as the Connectivity CDD are linked to the Operational Views and specific system requirements.

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<table>
<thead>
<tr>
<th>Operational Requirements</th>
<th>Derived from Operational Architecture</th>
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<tbody>
<tr>
<td>A-10 documents such as the Connectivity CDD are linked to the Operational Views and specific system requirements.</td>
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14.1 Key System Attributes:

- Diagnostics and Prognostics: Collection, refinement, compilation, integration, and distribution of aircraft status elements into an overall support database are critical to successful AOA-10 employment throughout its entire operational spectrum. AOA-10 Connectivity will integrate applicable and effective on-board monitoring/recording devices and software, i.e., Built-in-Test (BIT), that provide enhanced capability for fault detection and isolation, monitor various components and indicate out-of-range conditions, imminent failure probability, and similar proactive maintenance optimization actions to optimize the time to repair of the Processor. Emphasis must also be on accuracy and minimization of false alarms. On-board collected data shall be provided so it facilitates the immediate start of ground servicing and other recovery actions as well as a more detailed and comprehensive analysis of in-flight failures and operational needs.

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KIHOMAC

System Acquisition Excellence
The A-10 system requirements are stored in DOORS and are traced to the Operational Views, System Views, as well as documents such as the Connectivity CDD and PIDS.

<table>
<thead>
<tr>
<th>ID</th>
<th>Comm 064</th>
<th>Comm</th>
<th>General Data Link</th>
<th>The A-10 shall support a selected DoD standard digital data link communication capability.</th>
<th>Same as Threshold.</th>
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</thead>
</table>
| 119 | COMM-003 | Comm | General Interoperability Platforms | The A-10 shall be capable of providing digital data and voice communications to the Tactical Air Control System (TACS) that include, but not be limited to: | - A-10
- F-35
- Joint Terminal Attack Controllers (JTAC)
- Tactical Air Control Points (TACPs)
- Air Support Operation Centers
- Air Operations Centers
- Forward Air Controller Airborne (FAC-A) aircraft
- Command and Control (C2) aircraft (e.g., B-3 AWACS, E-8 JSTARS). |
| 120 | COMM-004 | Comm | General Data Link | The A-10 data link system must fully support execution of joint critical operational activities identified in the applicable joint and system integrated architectures and the system must satisfy the technical requirements for transition to Net-Centric military operations to include: |

1. DISR mandated GIG IT standards and profiles identified in the AOA-10 Technical Standards View (TV-1).
2. DISR mandated GIG APIs identified in the Key Interface Profiles (KIP) declaration table.
4. Information assurance requirements including availability, integrity, authentication, confidentiality, and nonrepudiation, and issuance of an Interim Approval to Operate (IATO) by the Designated Approval Authority (DAA)
5. Operationally effective information exchanges; and mission critical performance and information assurance attributes, data correctness, data availability, and consistent data processing specified in the applicable joint and system integrated architecture views. |

The A-10 data link system should support execution of all operational activities identified in the applicable joint and system integrated architectures and the system must satisfy the technical requirements for Net-Centric military operations to include:

1. DISR mandated GIG IT standards and profiles identified in the TV-1.
2. DISR mandated GIG APIs identified in the KIP declaration table.
3. NCOW-RM Enterprise Services
4. Information assurance requirements including availability, integrity, authentication, confidentiality, and nonrepudiation, and issuance of an Interim Approval to Operate (IATO) by the Designated Approval Authority (DAA)
5. Operationally effective information exchanges; and mission critical performance and information assurance attributes, data correctness, data availability, and consistent data processing specified in the applicable joint and system integrated architecture views. |

| ID | Comm 005 | Comm | General Data Link | The A-10 data link system should fully support execution of all operational activities identified in the applicable joint and system integrated architectures and the system must satisfy the technical requirements for Net-Centric military operations to include: |

1. DISR mandated GIG IT standards and profiles identified in the TV-1.
2. DISR mandated GIG APIs identified in the KIP declaration table.
3. NCOW-RM Enterprise Services
4. Information assurance requirements including availability, integrity, authentication, confidentiality, and nonrepudiation, and issuance of an Interim Approval to Operate (IATO) by the Designated Approval Authority (DAA)
5. Operationally effective information exchanges; and mission critical performance and information assurance attributes, data correctness, data availability, and consistent data processing specified in the applicable joint and system integrated architecture views. |
The functions are traced from the system requirements which they fulfill as well as any associated Operational Views.
The functions are then linked to the actual systems in the physical architecture.
PATH FORWARD
Roadmap Process

Baseline Architecture → Assessment, Evaluation & Trade Studies → To-Be Architecture

- Sustainment Priorities
- Technology Changes
- ASRRC Inputs
- ICD Inputs

Sustainment & Modification Programs

Updates → Guidance

POM Inputs
POM Results

Guidance Updates
Systems/Services Evolution

- A-10 PVI CDD
- A-10 Connectivity CDD (Update)
- ASP + HMCS + LARS v12 + MSD Programs
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020
- 2021
- 2022
- 2023
- 2024
- 2025
- 2026
- 2027
- 2028

- A-10 Weapons CDD
- A-10 PVI CDD (Update)
- A-10 Connectivity CDD (Update)
- 1760 + UA + CSMU + JPALS
- 2023
- 2024
- 2025
- 2026
- 2027
- 2028

- Comm Integration + 3D Audio + Voice Recog + Next Gen Data Link + Video Data Link + MUOS SATCOM
- Sunset window
Technology Forecast

Increment 1
2010 Start
- ASP
- HMCS
- LARS v12 & CSEL
- MSD Programs

Increment 2
2014 Start
- 1760
- UAI
- CSMU
- JPALS

Increment 3
2018 Start
- 3D Audio
- Voice Recognition
- Next Gen Data Link
- Video Data Link
- MUOS SATCOM

Key
- Technical Maturity Level
  - Low
  - High

Sunset window
RESULTS
AVSATA Results

- AVSATA already resulted in integrated system on A-10
  - Distributed mass memory (greater map and data storage),
  - Helmet mounted cueing,
  - LARS V12, Integrated personnel recovery systems for use during CSAR,
  - Expanded bus infrastructure to support future high speed devices (12 Port 1GB Ethernet switch)
Tying Requirements to Funding Requests
(U) A-10 Avionics Sustainment Program (ASP)

BACKGROUND:
(U) A-10 avionics system has aging Line Replaceable Units (LRU) that have exceeded their design lives. The reliability, sustainment, and obsolescence issues are decreasing aircraft availability, increasing maintenance costs, and limiting growth, mission readiness and capability.

ADJUSTMENT:
(U) Develop, procure, and install 344 ASP kits on A-10 fleet (replace 26 aging LRU's including one displays, high maintenance drivers with obsolescence issues with 5 new LRU's per aircraft).

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IMPACTS:
- (U) RQMTs to ORD, Dec 04; A-10 EW CDD, A-10 Connectivity CDD, Mar 07, JCAS MA ICD, Jun 04, JCAS CONOPS, Jun 08, Joint Fires ICD, Nov 02, GIG MA Nov 02
- (U) If not funded, continued decrease in Aircraft Availability
- (U) If not funded, Grounding of aircraft due to unsupportable CDU, HARS, and displays in FY14-FY17
- (U) If not funded, Mission non capable - no (processing) growth path as processors are maxed out, FY17
- (U) If not funded, Projections lead to capability gaps, FY17 through FY28
Systems and Systems Sustaining Engineering

AvSATA Recommended System Architecture
**Biographies**

**Richard L. Sorensen** is a Staff Systems Engineer at KIHOMAC Inc. He has over twenty eight years experience in systems engineering and systems architecture in both military and civil applications.

**Adam Grimm** is Director for Strategic Programs at KIHOMAC Inc. He has over eight years working logistics, engineering and requirements for U.S. Air Force aircraft and net-centric and command and control systems.

**Jerry L. Coates**, M. E. E. E., is the A-10 OSS&E Integrator for the A-10 System Program Office (OO-ALC/ 538th ACSD/EN). He has 21 years of experience with the USAF at OO-ALC including 2 years as an AF Exchange Engineer in Manching, Germany at the German Airworthiness Certification Airbase WTD 61, and 11 years of experience in industry (Boeing, SSAI, Robert Bosch and as an independent consultant).