Transforming War Fighting through the use of Service Based Architecture (SBA) Technology

Bernardo Perez & Randy Bell

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Agenda

- Introduction
  - Objectives of this Briefing
  - The Team
  - What is a Service Based Architecture
- SBA Evolution and Enabled Systems
- Battlefield Intelligence Systems Today
  - Information Sharing & the “Stovepipe” Problem
- The SEC Service Based Architecture
  - A High-Level Look at a Software Solution
Objectives

• Discuss the implementation of SBA technology and how it facilitated the distribution of Signals Intelligence, Radar Moving Target Indicator (MTI), Red/Blue Force, and Unmanned Aerial Vehicle (UAV) data to the warfighter.

• Describe how the use of Service Based Architecture (SBA) technology can rapidly implement Future Force capabilities into Current Force systems, helping accelerate fielding efforts of vital capabilities to our warfighters.

• Explore the potential applications of SBA technology and other tools of U.S. Army Communications and Electronics Life Cycle Management Command (CE-LCMC) Software Engineering Center (SEC) to receive and disseminate “actionable intelligence” to the warfighter.
The Team

- **Program Manager Distributed Common Ground System – Army**
  - Life Cycle PM for CGS

- **Communications Electronics LifeCycle Management Command Software Engineering Center (SEC)**
  - Responsible for Common Ground Station (CGS)/Joint Services WorkStation (JSWS) Common Software Baseline (CSB) Post Production Software Support (PPSS)

- **L-3 Communications ILEX Systems**
  - Prime Contractor for CGS/JSWS PPSS

- **General Dynamics C4 Systems**
  - PPSS Subcontractor & CGS/JSWS Prime Systems Developer
What is a Service Based or Service Oriented Architecture?

- An SBA is an architecture based on:
  - Service Consumer
  - Service Provider
  - Service Broker (Registry)

- A Service Provider will *dynamically* publish services, for execution, to a Service Broker that is *dynamically* used by a Service Consumer to obtain appropriate services.

- CGS SBA technology can disseminate information to other systems without altering their baseline software, display the information on their native graphical user interfaces along with consumer system data, and provides the warfighter additional intelligence data to significantly enhance their situational awareness.
Service Enabled Capability Example

Service Based Framework

COTS/GOTS Visualization Package

Targeting Interface Provided by AFATDS

UAV Viewing App Provided by CGS
SBA-Enabled Services Provided

UAV Video & Telemetry Service Capabilities
- Disseminates near-real-time video & telemetry to users on network using standard web-based protocols
- Provides web-based access to archived video files

MTI & Target Tracks Service Capabilities
- Disseminates near-real-time MTI and Target Tracks to users on network based on consumer specified geographic filter

IBS SIGINT Service Capabilities
- Disseminates near-real-time IBS SIGINT data to users on network based on consumer specified geographic filter

Red/Blue Force Service Capabilities
- CGS Disseminates Red/Blue Force data received from ASAS and MCS

Fire Detection
- Disseminates near-real-time enemy indirect fires to users on network
SBA Enabled Systems

CGS

PTDS

CPoF

MCS-L

AFATDS-EMT

JSWS
SEC CGS SBA Evolution

- Operation Iraqi Freedom Urgent Need (2003):
  - 3rd ID CGS disseminates Secret/Collateral SIGINT to ASAS RWS
- CGS CSB incorporation of services (2004):
  - MTI (JSTARS, ARL, U2)
  - UAV Video/Telemetry (Hunter, Predator, Shadow)
  - SIGINT (IBS Collateral)
  - Ground Target Tracks
- CGS CSB incorporation of additional services for PTDS (2004):
  - Fire Detection
  - Red & Blue Force
  - Video/Telemetry Service enhancement to allow automatic and manual aerostat mounted sensor tasking
SEC CGS SBA Evolution

• AFATDS EMT utilizes CGS SBA (2004/5)
  – MTI (JSTARS)
  – UAV Video/Telemetry (Hunter, Predator, Shadow)
  – SIGINT (IBS Collateral)
  – Ground Target Tracks
  – Fire Detection
  – Red & Blue Force
• MCS-L utilizes CGS SBA (2005)
  – UAV Video/Telemetry
• CPoF utilizes CGS SBA (2006)
  – UAV Video/Telemetry
• CGS ABCS PASS adaptation (2005/6):
  – SBA acts as a bridge, subscribing to & disseminating ABCS data to non-ABCS systems, and publishing above service data to ABCS systems
Information Sharing Among Battlefield Intelligence Systems Today

• Nature of Systems
  – Each system has its sensor input(s) and a unique visual display
  – Commander must visually/mentally correlate the disparate information in order to make decisions

• Traditional “Stovepipe” ICD Method for Information/Data Sharing
  – Generally Standards based (e.g. VMF, USMTF, GMTIF)
  – ICD changes require sender & receiver software updates
Old Stovepipe Approach
Addition of New Interface or Capability

- Significant changes in software to add new interfaces

Server

Must have agreement on Protocol, message sets, data elements & physical interface

ABCS type of network

Client

Old Stovepipe Approach
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Server

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ABCS type of network

Client
"Net-Centric" Architectures are maturing

E.G. Publish & Subscribe

- Service provider publishes data (e.g. XML)
- Data availability is announced via registry
- But, service consumers must each write applications to exploit the data
- ICD problem remains (when data schema changes)
“Net-Centric” Architecture Approach
Addition of New Interface or Capability

- Minimal or no effort to add new interfaces or change existing ones

Network

Provider

Consumer

Must have agreement on Service discovery mechanism (advertised) & software interface

Transparent Protocol

Agreed upon Service interface

Provider

Consumer

GUI

Driver

App SW
Advantages of SBA Software Approach

- Minimal or no effort to add new interfaces or change existing ones
- Dynamic self-configuration – reduces System and LAN administration time
- Systems dynamically join or leave networks transparently
- Systems dynamically discover, request and access data
- Dynamic self-healing to maximize overall availability

Warfighter Gets the Right Information When Needed
The CGS/JSWS SBA Approach
For “Current” Systems

• Discovery based, Peer-to-peer Architecture
  – Service availability is announced via distributed registry
  – Encapsulation: Service provider shares data and capability to use the data
  – 2-ended ICD problem is solved (changes require only service provider to update software)
CGS’ Service Based Architecture Characteristics

- Discovery based & peer-to-peer
- Executes on a IP LAN
  ...although a bridge element exists for WAN use
- Services distribute machine independent data and applications to peer systems
- Systems execute the SBA Core software
- The peer systems need no a priori knowledge of services being provided by other systems
- Alternatively, systems without the SBA Core can access a web applet to discover the services and interoperate with them
CGS SBA Architecture
Provider & Consumer Element Views

Service Implementation Layer (Providers)
- Application Services (MTI, UAV, SIGINT, etc.)
  - GIS Plugin
  - Database Plugin
  - Config Plugin
  - Alert Plugin
  - Message Plugin

Controllers and Adaptors Implementation Layer (Consumers)
- GIS Plugin Controller
- Database Plugin Controller
- Configuration Plugin Controller
- Alert Plugin Controller
- Message Plugin Controller

Domain Interface Layer
- GIS Plugin Controller
- Database Plugin Controller
- Configuration Plugin Controller
- Alert Framework
- Message Framework

Service-Based Layer
- Jini Plug-in
- GIS Plugin Controller
- Database Plugin Controller
- Configuration Plugin Controller
- Alert Framework
- Message Framework

Platform/Network Layer
- Java Virtual Machine, Operating System, Hardware Platform, Network
- Discovery Services
- GIS Plugin Controller
- Database Plugin Controller
- Configuration Plugin Controller
- Alert Framework
- Message Framework

SBA Core
Service Blueprint

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SBA Connector data path to plugins executing on a client system

------------- Service data path internal to the service provider system
Visualization Framework

Visualization adapters implement the APIs to the specific tools, allowing the same plug-in to be used regardless of visualization tool.
The Configuration framework allows for user preference settings.

Configuration Framework

Provider System

SBA Service (UAV Video example)

Configuration Plugin

Consumer System

Configuration

Plugin

System Configuration Controller

File

Configuration Plugins

UAV

Video Display

UAV Video Configuration

Video Mode: No Mode

Video Source: No Source

Working Tool

UAV Video Configuration

Enable Video

Disable Video

Frames/Second (1-30): 30 fps

Quality (50%-100%): 50%

Resolution:

Large

Medium

Small

OK

Apply

Cancel
OpenMap Screenshot
Service Based Architecture Benefits

• Layered Abstraction
  – Run-time reuse means the majority of the software for a new service already exists (controllers, adapters, service blueprint), thus new service development time is very short.
  – Implementations on multiple pub/sub architectures – ABCS PASS, RAIF, DIB, TCP/IP Sockets

• Enhanced Collaboration
  – Actionable data ("drill-down" capability)
  – Near Real Time updates
  – Historical playback through provider Database
Service Based Architecture Benefits

- Simplified Interoperability
  - Network Centric Architecture – SBA provides a path for current systems to easily interoperate with other systems
  - Platform Independent Data and Applications – Software code is Java
  - Simplified Integration – Because a new service or an update to an existing service is distributed from a single point (provider), no software update is required on the peer consumer/subscriber systems
  - Native Visualization tools reuse – Any subscriber system with network connectivity may visualize using Webtool (OpenMap variant) or JMTK (currently developing C/JMTK adapter)
  - Universal web browser based solution - users without the SBA Core may use WebTool applet through a browser
Key Points

- Makes current and future force systems collaboration possible
- Each Service can be turned on / off independently of other Services
- High Level of Reuse
- Platform Independent
- Visualization support (Webtool (generic), JMTK, C/JMTK (under development)
- Dynamic discovery of services across multiple systems
- Multiple platforms, operating systems and visualization tools can present a common operating picture (COP)
Key Points

- Actionable battle space objects on a common operating picture (COP)
- Addition of SBA to a system does not perturb baseline software, it is independent and easily integrated
- CGS/JSWS has implemented SBA interoperability with AFATDS-EMT, MCS-L, CPOF & PTDS, and has conducted demonstrations with other systems
- Implementation to disseminate data up security levels and/or Wide-Area Networks using Data Forwarding
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>ABCS</td>
<td>Army Battle Command System</td>
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<tr>
<td>AFATDS-EMT</td>
<td>Advanced Field Artillery Tactical Data System –</td>
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<td></td>
<td>Effects Management Tool</td>
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<td>APIs</td>
<td>Application Programming Interface</td>
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<td>ARL</td>
<td>Airborne Reconnaissance Low</td>
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<td>ASAS</td>
<td>All Source Analysis System</td>
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<td>CE LCMC</td>
<td>Communications Electronics</td>
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<td>LifeCycle Management Command</td>
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<td>CGS</td>
<td>Common Ground Station</td>
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<tr>
<td>C/JMTK</td>
<td>Commercial/Joint Mapping Tool Kit</td>
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<td>COP</td>
<td>Common Operating Picture</td>
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<td>CPOF</td>
<td>Command Post of the Future</td>
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<td>CSB</td>
<td>Common Software Baseline</td>
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<td>DCGS</td>
<td>Distributed Common Ground System</td>
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<tr>
<td>Acronym</td>
<td>Definition</td>
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<td>DIB</td>
<td>DCGS Integrated Backbone</td>
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<tr>
<td>GIS</td>
<td>Geographical Information System</td>
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<td>GMTIF</td>
<td>Ground Moving Target Indicator Format</td>
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<td>IBS</td>
<td>Intelligence Broadcast Service</td>
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<td>ICD</td>
<td>Interface Control Document</td>
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<td>IP LAN</td>
<td>Internet Protocol Local Area Network</td>
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<td>Jini</td>
<td>Jini network technology is an open architecture that enables developers to create network-centric services</td>
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<td>JMTK</td>
<td>Joint Mapping Tool Kit</td>
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<td>JSTARS</td>
<td>Joint Surveillance Target Attack Radar System (USAF Aircraft)</td>
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<td>JSWS</td>
<td>Joint Services WorkStation</td>
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<td>MCS-L</td>
<td>Maneuver Control System-Light</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>MTI</td>
<td>Moving Target Indicator</td>
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<td>PASS</td>
<td>Publish and Subscribe Services</td>
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<td>PTDS</td>
<td>Persistent Threat Detection System</td>
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<td>RAIF</td>
<td>Resource Adaptor InterFace</td>
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<td>RWS</td>
<td>Remote Work Station</td>
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<td>SBA</td>
<td>Service Based Architecture</td>
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<td>SEC</td>
<td>Software Engineering Center</td>
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<td>SIGINT</td>
<td>Signals Intelligence</td>
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<td>U2</td>
<td>the Airplane</td>
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<tr>
<td>UAV</td>
<td>Unmanned Aerial Vehicle</td>
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<td>USMTF</td>
<td>United States Message Text Format</td>
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<td>VMF</td>
<td>Variable Message Format</td>
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<td>WAN</td>
<td>Wide Area Network</td>
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<td>XML</td>
<td>Extensible Markup Language</td>
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BACKUP SLIDES
Example of sharing resources

Diagram Key
- Unmodified Software / HW
- Unmodified CGS CSB 1.8 SW
- New GD-developed SW
- Delivered Proxies
- Locally Loaded Adapter

Code
Adapters
- Message: 400 SLOC
- Visualization: 1200 SLOC
- Database: 2000 SLOC

Code
Plugins
- Message: 1100 SLOC
- Visualization: 920 SLOC
- Database: 2000 SLOC
- Data Interfaces: 1690 SLOC
- SIGINT Service: 4800 SLOC

Installed Software
- Any OS
- SBA Layer
- Framework Layer
- Java

Current Code remains unchanged

Adapters have to be created for each unique current system

1.8 Million SLOC
Current Code remains unchanged

MTI Service
- Event Service
- UAS Service
- XXX Service

MTI Adapter
- MSG Adapter
- MSG Adapter
- MSG Adapter
- MSG Adapter

Vis Adapter
- Vis Adapter
- Vis Adapter
- Vis Adapter

DB Adapter
- DB Adapter
- DB Adapter
- DB Adapter

Web Browser
- Sendmail
- Current Vis
- Current DB

Network

CGS

Any Current System