Integrated Architecture from Sensor to Weapon


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Undersea Superiority – Realities, Challenges and Opportunities

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Commercial Adaptation Strategy

- Commercial Architectures with Respective Technical, Financial, Maturity, and Life-Cycle Constraints
  - SOA – Service Oriented Architecture
  - SCA – Service Component Architecture
  - EDA – Event Driven Architecture
  - EAI – Enterprise Application Integration
  - MDA – Model Driven Architecture
  - RDA – Responsibility Driven Architecture
- and Frameworks
  - AJAX, RMI, CORBA, DDS, ESB, …
- Technical Approach
  - Concept Focus not Implementation – e.g. Binary versus XML Mediation
- Goals and Objectives
  - Performance and Life-cycle (Maintenance and Tech Refresh)
  - Adapt without Compromising Requirements
Technology Maturity Plan

- **Limited Technology Experiments**
  - Joint ONR/IWS Combat System-to-Command and Control Integrated Architecture Experiments
    - 2010 – 2011 Period of Performance
    - ONR, IWS, NUWC, SPAWAR, BAA, USW-DSS …

- **USW-DSS B3 Integration**
  - Core and Integration Architecture

- **Industry Donations**
  - Provide back to Value Added Resellers
    - E.g. Red Hat
  - Participate in Industry Consortiums
    - E.g. OMG, W3C, OASIS
  - Collaborate with CANES and Other Services
    - System-of-systems Related Services

- **CV-TSC and others …**
System Integration Problems - Addressed

- Tightly coupled tactical subsystem interface changes require application updates that are cost prohibited due to development, integration and recertification issues.

- Tactical systems often have multiple interface dependencies that are highly integrated causing single interface changes to affect multiple systems

- Changes to data distribution protocol routing require application changes

- Commercial SOA solutions do not support messaging performance required by tactical systems

- Proprietary infrastructure promotes vendor lock in and often cost prohibitive

- Multiple infrastructure solutions incur redundant customer costs

- Communications across low bandwidth and ad-hoc networks impose challenging data sharing solutions

Navy Capabilities are Delayed Due to High Integration Cost & Multi-Year Schedules
Service Architecture Utilization Rational

- Program managers and system integrators recognize that current integration practices can be improved
  - Excessive integration costs and reduced budget available for advanced capabilities
  - Extended integration timelines delay capabilities for the warfighter

**TODAY**
System Integration Friction

- New application or system provider
- Re-architect integrated system
- Implement process randomly
- Integrated system change

**Desired**
System Integration Agility

- New application or system provider
- Leverage provider ramp process
- Integrate provider into SOA

**Fleet Requirement – Integration Speed and Flexibility**

Time and Cost Savings
Exemplary Commercial Mashup

- Rapid integration of new components is in our everyday life
- iPhone allows instant download & integration of hundreds of services
- Web browsers are customizable in seconds giving us personalized information instantly to keep us in touch with relevant information

Leveraging commercial integration style will improve costs and schedule baselines
System Integration Mashup Concept

- Integrated Architecture from Sensor and Weapon

- Find Service
- View Service Data
- Service Technical Model
- Integrate Service

Information discovery, mediation and visualization improvements
RT-Architecture Definition

- **SOA**
  - Centralized Messaging
    - JMS
  - XML Data Structures
    - XML-based Throughput and Loading
  - XML Mediation
    - XSLT, XQuery
  - XML-based Content Routing
    - XML Rules
  - Enterprise QoS
    - JMS Durability and Queuing

- **RT SOA - All SOA Features PLUS**
  - Peer-to-Peer Messaging
    - DDS
  - Binary Data Structures
    - Binary and XML Converted to Binary
  - Binary Mediation
    - Object. Memory
  - Binary-based Content Routing
    - DDS
  - Real Time QoS
    - DDS Latency, Reliability …
  - Real Time Workflow

**RT SOA Builds Upon SOA – XML/Enterprise Plus Real-Time**
RT-Architecture Operational View

RT SOA Deployment Target

- Organic Sensor backbone and integration
- Tactical Edge Communication that must handle Mobil Ad Hoc Networks and unreliable networks

RT SOA Benefits

- Low Cost Common System Infrastructure
- High Throughput, Low Latency
- Non Intrusive, Simplified System Integration
- Open Architecture & Open Standards
- ForceNet Integration

RT SOA Stack

- Core Services
  - Management Registry
  - Rules Workflow Data Mediation

- Service Definitions
  - Rule Set Execution Process
  - Service Set Execution Process

- Enterprise Service Bus
  - Web services, Social, OSI, CORBA, FTP, Email, File, Specialized

- Protocol Mediation
  - Pluggable Real-Time Messaging System (RT ESB)
  - OMG Data Distribution Service (DD) and future Advanced Message Queuing Protocol (AMQP)
RT-SOA Architecture

- Development/Integration Approach
  - JBoss ESB with Open DDS, Open Real Time ESB, and Protocol Mediation
  - JBoss SOA with Registry (Registration/Discovery), Data Mediation, Routing, and Workflow support
  - Value-Added Services – Q89 Data/Services (Tracks, Mission Planning Data)
  - System Applications – Track Display, Data Manager

![RT SOA Architecture Diagram]

- Integrated Architecture from Sensor and Weapon

OMG Data Distribution Service (DDS) and future Advanced Message Queuing Protocol (AMQP)
Objective Architecture Transition

RT SOA is part of the Objective Architecture Process
Objective Architecture Integration Vision

Integrated Architecture from Sensor and Weapon
Objective Architecture Integration Evaluation
Summary

- **Experiments**
  - Laboratory test event - LTE
  - Collaborative field events

- **Programs**
  - ARCI, AEGIS CG and DDG, Carrier (including CVN 78), large deck amphibious ships (LHA, LHD, and LPD 17), DDG 1000, LCS Flight 1, and CG(X) ship classes

- **Standardization**
  - World Wide Web (W3C)
    - Efficient XML
  - Object Management Group (OMG)
    - Data Distribution Services
    - Information Exchange Standard

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**Please Participate**

**While Standard Bodies Expend Participation costs, without a Standard there is None**
Backup
Abstract

- The Navy and other services have the need to connect systems across the Global Information Grid (GIG) for the realization of the military’s Net-Centric warfare vision, which focuses on getting the right information to the right person at the right time, on and beyond the battlefield. Yet, despite the desire and need for such capabilities, some great challenges remain. The dynamics of military information flow, and the network infrastructure that is relatively unreliable and time-varying in both location and topology, demand developments of new areas in network theory. While there are great motivators for wanting to use commercial enterprise architectures, protocols, standards, and products as much as possible for military applications, several fundamental differences between tactical military communications and the Internet limit their applicability. For example, simply adopting commercially-developed Service Oriented Architectures (SOA) is far from adequate, eXtensible Markup Language (XML) is verbose, and respective messaging protocols, message routing and data replication require reliable and high throughput networks. The predominant difference is the relative unreliable or temporal nature of network communication links in mobile military communications. These networks are not nearly as robust as wired networks in terms of link availability, quality (delay, throughput, and reliability), and durability. This presents a problem when the fundamental theory, protocols, Quality of Service (QoS) philosophy, and applications designed for the Internet, which assumes a highly predictable communication infrastructure at the physical layer. This assumption, while valid for the commercial Internet, has serious ramifications on network operation and reliability when applied to the fielded military systems with its constraints on bandwidth and stability. When moving from traditional “stovepipe” designs and pure commercial solutions, new network protocols and components must be specifically designed with this unreliability in mind.
Abstract (cont.)

• Recent initiatives such as Real-Time ESB (RT-ESB), Data Distribution Service (DDS), cloud computing, the Semantic Web and Efficient XML (EXI) for network-centric military applications demonstrate the complexity and emergence within this area and push decision makers and engineers alike to consider the unique operational requirements and technological needs of the military challenge.

• One technical approach is to provide real-time equivalence of these commercial enterprise architectures using real-time base technologies of binary structures and C/C++. For example, the adaptation is DDS instead of Java Message Service (JMS) and ontologies instead of The Extensible Stylesheet Language (XSLT)/XML Query (XQuery) for mediation. Another approach is the use of a tailored, commercially-available SOA framework and incorporating a DDS-based ESB within that framework. A demonstration of the later case will be given if time permits.

• Our effort includes working with industry consortiums such as the World Wide Web Consortium (W3C), Object Management Group (OMG) and Organization for the Advancement of Structured Information Standards (OASIS) to establish new standards as well as extend existing standards. In addition, the technology readiness approach includes using selected real-time technologies in the research and development stages of applicable programs and experimental activities.

• This effort is being performed in collaboration with NAVSEA PEO IWS Common Combat System Architecture initiative, Objective Architecture, and Command & Control systems, AN-UYQ100 Undersea Warfare Decision Support System (USW-DSS) and AN/SQQ-34C Aircraft Carrier Tactical Support Center (CV-TSC) in conjunction with SPAWAR and other agencies within the Information Management and Distributed Enterprise space.
Biographies

- **Gary Sikora** - Director of Information Systems at Progeny Systems with twenty years of experience adapting emerging information technologies to solve DoD Legacy Systems evolutionary and systems-of-systems integration needs. Current activities comprise Community of Interest (COI) data modeling, legacy system Enterprise Service Bus (ESB) integration, Real-Time Service Oriented Architecture (RT-SOA) development, and reliable messaging across the Global Information Grid (GIG), for various surface and subsurface Navy legacy systems. Industry participation includes Open Architecture with the Navy, the World Wide Web Consortium (W3C), and the Object Management Group (OMG). Gary received his BS in Electrical Engineering from Penn State University and his MS in Systems Engineering from Johns Hopkins University.

- **Matthew Fisher** - co-author of Semantic Web Programming, has over fifteen years in the fields of software and systems development. He has worked in a wide range of engineering environments, ranging from small technology startups and research and development companies to large Fortune 50 firms. He regularly contributes to the Semantic Report and has participated in conferences such as JavaOne, OWLED and ISWC. Matthew is a Principal Systems Engineer at Progeny Systems and holds a BS in Computer Science from Penn State University and a MS in Computer Science from George Mason University. He is a senior member of the IEEE.

- **Tom Burns** - has been leading software development efforts at Progeny Systems for several years, adopting commercial technologies for the military. He has developed solutions to problems of all sizes, from packet segmentation libraries to common operational pictures. Tom is an active member of the Object Management Group. He is currently working in effort to provide an information translation standard within the DDS framework. Tom holds a BS in Computer Science and is currently working towards an MS in Systems Engineering at George Mason University.