Panel 3: Open Architecture Going DoD-Wide

Moderator:
Nickolas Guertin, Director for Transformation, Deputy Assistant Secretary of the Navy for Research, Development, Test and Evaluation

Speakers:
Mr. Rich M. Ernst, Interoperability Lead, Office of the Secretary of Defense for Acquisition, Technology, and Logistics, Unmanned Warfare

Dan Gahafer, Forge.mil Program Manager, Defense Information Systems Agency (DISA)

Dr. Douglas C. Schmidt, Professor of Computer Science, Vanderbilt University

Robert Sweeney, Future Airborne Capability Environment Lead Engineer, Air Combat Electronics, PMA-209
Unmanned Aircraft
Ground Control Stations (UCS)

Open Architecture Summit - 2012
Rich Ernst
OUSD S&TS/ Interoperability Lead
OSD ADM
‘Common DoD Architecture’

Acquisition Problem

Open System Interconnection (OSI), but not Open Architecture (OA)

Standards-based Interconnection, but...

Closed (Stove-piped) Architectures and Business Models
(Silos of excellence)

OA Acquisition Objectives

To remove the traditional barriers to Effective Competition in the UAS Control Segment and provide market access to a broad, heterogeneous industrial base of software providers in an agile acquisition and integration environment.
Open GCS Architecture for UAS
Joint HMI Style Guide for GCSs

2.1 Architecture Model

DoD Open App Store Marketplace
30+ PoR ready Apps & Demos
PoR: TCS, Block 50, and Global Hawk
Potential PoR: OSRVT

DoD Contract Guidebook & IP Rights
Open Business Model for UAS GCSs
RFP Language for UAS GCSs

Existing UCS ADMs: OSD, Army, Navy, Air Force
UCS ADMs: GSRA

UNCLASSIFIED - Public Release 12-S-2677
OSD UCS Working Group
Our Product is Stakeholder Consensus

• Technical Society
• Chartered by Joint UAS Task Force Interoperability IPT
• Program of Work and Operating Rules defined in DoDAF AV-1
• Operating Rules per Public Law 104-113 (NTTAA) and OMB Circular A-119
• Private collaboration site for Working Group members
• Visit public site at http://www.ucsarchitecture.org (video demos included)
• OUSD UCS architecture documents consist of:

<table>
<thead>
<tr>
<th>Architecture Description</th>
<th>Deployment Architecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program of Work</td>
<td>Platform Guidance for Safety and Information Assurance</td>
</tr>
<tr>
<td>Governance</td>
<td>System Safety and Airworthiness Case</td>
</tr>
<tr>
<td>Style Guide</td>
<td>Information Assurance Case</td>
</tr>
<tr>
<td>Conformance Specification</td>
<td>Architecture Description</td>
</tr>
<tr>
<td>System Safety and Airworthiness Management Plan</td>
<td>Model Driven Architecture (MDA) Transform Reference</td>
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<tr>
<td>Information Assurance Management Plan</td>
<td>Interface Control Document (ICD)</td>
</tr>
<tr>
<td>Core Application Program Interface Standards</td>
<td>Platform Independent Model (PIM): Application</td>
</tr>
<tr>
<td>Platform Independent Model (PIM): Application</td>
<td>Platform Independent Model (PIM): Refined PIM</td>
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<tr>
<td>Platform Independent Model (PIM): Infrastructure</td>
<td>Interface Control Document: Data Distribution Service (DDS)</td>
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<td>Platform Independent Model (PIM): IA and Security Mgmt</td>
<td>Interface Control Document: Java Messaging Service (JMS)</td>
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<tr>
<td>Platform Independent Model (PIM): Deployment Architecture</td>
<td>List of UCS Architecture Validation Experiments 1.0</td>
</tr>
<tr>
<td>System Implementations: Deployment Architecture</td>
<td>ToolTrade</td>
</tr>
<tr>
<td>System Implementations: Mobile Deployment Architecture</td>
<td>Development Tool Trade Study</td>
</tr>
<tr>
<td>System Implementations: Fixed Facility</td>
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</tbody>
</table>
An open business model will promote competition and innovation while reducing costs

The Ground Control Station Open Business Model is an approach for doing business in a transparent way that leverages the collaborative innovation of numerous participants across the enterprise permitting shared risk, maximized asset reuse, and reduced total ownership costs.

OBM is designed to:
1. Target affordability
2. Incentivize productivity and innovation
3. Promote real competition
OSD has developed a common architecture and designed an open business model to meet its objectives.
# Reusable Code Cost Savings

## UCS Services

<table>
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<td>$ 18,640</td>
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<td>Total:</td>
<td>112,688</td>
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</table>

**Cost Savings Assumptions (Minimal):** Based on all code, 30 LOC produced per day, $100/hr billing rate

**Cost Savings Assumptions (Industry Average):** Based on autogenerated code, 10 LOC produced per day, $230/hr billing rate

---

A ~450K code base translates to at least $10M in cost savings and as much as $72M
UCS 2.1+ App Store Products

TCS Products

Primary Mission Control
- Vehicle Flight Status
- Vehicle Interface
- Vehicle Subsystem Ctrl/Status
- Vehicle Flight Ctrl

System Support
- Manage UAV Health
- Manage WCAs
- EMC
- Vehicle Messenger

Additional – UCS Services

Dynamic Airspace
- SA (Combined Forces)
- Annotation (White Boarding)
- Google Earth
- World Wind

Dynamic Airspace cont’d
- White Boarding

System Support
- Chat

BDRVT – UCS Services

Primary Mission Control
- Vehicle Flight Status
- Vehicle Config. Data
- Flight Ctrl
- Vehicle Handover

Sensor Mgmt
- EO/IR Sensor Search
- Sensor Pedestal
- Sensor Plan Manager

Planning
- Mission Mgmt Planning
- Generate Route Planning
- EO/IR Sensor Planning
- Airspace Restrictions

UCS-WG As of Jan 2012
200+ Organizations
640+ Documented Members
25+ Funded Companies
Summary

• **V2.1 completed in May 2012 (first baseline finished specification)**
  - Included final open architecture specification for the following PoRs:
    - Global Hawk, BAMS, Gray Eagle, Predator/Reaper, and Fire Scout

• **V2.2 will be completed end of November 2012** (completing the core architecture services)

• Supported by Government and Industry stakeholders

• Technical Society is the right business model for Gov to benefit from

• **Responsive to acquisition priorities**
  - Effective Competition  •  Continued Innovation  •  Interoperability
  - Reusability  •  Acquisition Efficiency  •  Rapid Capability to Warfighter

• **Demonstrations**
  - Rover  •  CDL - Integration of six (6) previously stand-alone services
  - MAESTRO  •  Bidirectional Remote Video Terminal (BDRVT) – PoR
  - App Store Environment  •  Successfully completed demonstrations across: Army, Navy, & USAF

• **Reach Out**
  - Publications
    - UAS Digest (June 2011), Unmanned Vehicles (UK) (February 2012)
  - Conferences
      • PEO U&W PMA 281, DPM PM UAS,
      • Lead Engineer, Global Hawk Capabilities Branch
      • UCS-WG Industry Members
Questions?
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Open System Architecture (OSA): Challenges & Success Drivers

Douglas C. Schmidt
d.schmidt@vanderbilt.edu

Professor of Computer Science
Institute for Software Integrated Systems
Vanderbilt University

Visiting Scientist
Software Engineering Institute
Carnegie Mellon

OA Summit, October 18th, 2012
# Evolution of DoD Combat Systems

<table>
<thead>
<tr>
<th>Traditional Stovepipe</th>
<th>Early OSA with COTS</th>
<th>OSA with Domain Reuse</th>
<th>OSA with Product Lines</th>
<th>OSA with SOA</th>
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<tbody>
<tr>
<td>Comms</td>
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<td>Other</td>
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</tbody>
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## Key Questions

- When has OSA been successful thus far?
- Why hasn’t OSA succeeded further?
- How can OSA be more successful in the future?
When Has OSA Been Successful Thus Far?

Alignment between business incentives, technical maturity, & managers perceptions of risk prudence

Provide mechanisms to manage endsystem resources, e.g., CPU scheduling, memory management, file systems & IPC
When Has OSA Been Successful Thus Far?

Alignment between business incentives, technical maturity, & managers perceptions of risk prudence

Domain-independent commonality

Encapsulates & enhances native OS mechanisms to create reusable network programming components
When Has OSA Been Successful Thus Far?

Alignment between business incentives, technical maturity, & managers perceptions of risk prudence

Common Middleware Services
Distribution Middleware
Host Infrastructure Middleware
Operating Systems & Protocols

Domain-independent commonality

Defines distributed programming components & APIs that automate & extend OS mechanisms

DDS
SOAP
Apache "Web Services" Project
Domain-independent commonality

Defines reusable domain-independent services that simplify distributed computing

Alignment between business incentives, technical maturity, & managers perceptions of risk prudence

When Has OSA Been Successful Thus Far?
Domain-Specific Services

Tailored to requirements of specific warfighter domains, e.g., C4ISR, avionics, air defense, etc.

Alignment between business incentives, technical maturity, & managers perceptions of risk prudence

When Has OSA Been Successful Thus Far?

Domain-specific commonality

AIR
C4I
MARINES
SPACE
SUBS
SURFACE
Despite substantial technical advances during the past decade, affordable & dependable OSA-based solutions remain elusive.

Serialized phasing of OSA infrastructure & application development postpones identifying design flaws that degrade system QoS until late in the lifecycle, i.e., during system integration.
Glacially slow contracting processes don’t support timely delivery of OSA capabilities to meet mission needs.
Why Hasn’t OSA Succeeded Further?

Despite substantial technical advances during the past decade, affordable & dependable OSA-based solutions remain elusive.

Contracting models that assume OSA requirements can be fully defined up front are expensive when inevitable changes occur.
Quality-of-service (QoS) suffers when OSA initiatives use COTS products that are not suited for mission-critical DoD combat systems.
Despite substantial technical advances during the past decade, affordable & dependable OSA-based solutions remain elusive.

Rigid adherence to ossified standards & reference architectures impedes OSA technology refresh & limits application capabilities.
At the heart of these problems is the lack of an holistic approach that aligns & balances key business, management, & technical drivers *at scale*.
Why Hasn’t OSA Succeeded Further?

Joint Tactical Radio System (JTRS) is a poster child for lack of alignment between business, management, & technical drivers

Some key problems

- Business model disincentivized completion of design phase
- The Software Communication Architecture was a poorly specified standard, which impeded portability & interoperability
- “Tragedy of the Commons” complicated effective program management & acquisition strategy encouraged “requirements creep”
How Can OSA Be More Successful in the Future?

Successful OSA initiatives need aligned multi-dimensional approaches

**Technical Drivers**
- Foundations of OSA development
  - Agile Architecture Expertise
  - Systematic Reuse Expertise
  - Managed Industry/Government Consortia
  - Data Rights & Effective Licensing Model
  - Agile Contracting Model
  - Automated Conformance & Regression Test suites
  - Strong S&T Connections to Reduce Risk
  - Mastery of Agile Lifecycle Methods

**Management Drivers**
- Ensuring effective leadership & guidance of OSA initiatives
- Achieving effective governance & broad acceptance of OSA economic aspects

**Business Drivers**
- Systematic Reuse Expertise
- Managed Industry/Government Consortia
- Agile Contracting Model
- Automated Conformance & Regression Test suites
- Strong S&T Connections to Reduce Risk
- Mastery of Agile Lifecycle Methods

How Can OSA Be More Successful in the Future?
Successful OSA initiatives need aligned multi-dimensional approaches
How Can OSA Be More Successful in the Future?

Effective open competition requires economic & value-based OSAs

Key attributes

- Crisply defined software & system technical architecture
  - Enable focused competition at component, subsystem, & system levels
- Modular innovation potential
  - New economically-guided criterion for decomposing OSAs into modules
- Competitive evolutionary procurement processes
  - Generate a sequence of evolutionary improvements over DoD program lifecycles, instead of just point solutions
Concluding Remarks

- OSA initiatives for defense systems need a holistic strategy.
- OSAs are achievable & valuable, though not easy to develop & sustain.
- Alignment in business, management, & technical dimensions is essential.

"Big breakthroughs often happen when what is suddenly possible meets what is desperately necessary" – Thomas Friedman
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Transforming Defense Through the Use of Open Architecture

Robert Sweeney
Naval Air Systems Command
FACE TWG Chair

NAVAIR Public Release
12-1141 (prior versions
11-1134, 11-1510, and 12-524)
Distribution Statement A
"Approved for public release
distribution is unlimited"

18 October 2012
Agenda

• The Problem
• The Solution: FACE
• Why FACE?
• Summary
The Problem: Barriers to Portability

- Truly portable applications require common open standards at multiple layers in the architectures to prevent lock-in and improve competition throughout supply chain.

- Uniform application of common open standards across DoD aviation needed to break “Cylinders of Excellence”.

http://www.opengroup.org/face
Important Differences Between COE Domains

• Competition must exist throughout layers and segments of embedded systems

• Defense embedded systems have stringent requirements for Robustness, Security, and Determinism

• Defense hardware must withstand extreme environmental conditions
  – Results in a “disadvantaged” operating environment for software

• System life spans are many years
  – Architecture must support technology refresh

http://www.opengroup.org/face
The Solution: FACE

- FACE is Future Airborne Capability Environment
- FACE is an open COE enabling:
  - Defense product line architectures
  - A flexible and modular software architecture
- FACE includes:
  - Technical Standard and support documentation
    - Reference Implementation Guide
    - Verification Matrix
    - Data Model
  - Business Guide and support documentation
    - Contracting Guide
    - Conformance Program
    - Library Registry and Repositories for FACE-conformant products
Why FACE? Technical Benefits

• Reduces the time to field new capabilities
• Provides for portability of software components across embedded defense systems
• Enables interoperable software components across multiple operating environments
• Reduces integration effort
• Provides a software standard and reference architecture to enable truly open software components in existing and future embedded systems
FACE Architectural Segments

- FACE Portable Components Segment
  - Portable Applications
  - Portable Common Services
- Transport Services Segment
- Platform Specific Services Segment
  - Platform Device Services
  - Platform Common Services
  - Graphics Services
- I/O Services Segment
- Drivers
- Operating System Segment

http://www.opengroup.org/face
FACE Consortium Publications

• FACE Business Guide
  – Version 1.1 published September 2011 and available at the following link on The Open Group's Bookstore:
    – http://www.opengroup.org/bookstore/catalog/g115.htm

• FACE Technical Standard
  – Edition 1.0 published January 2012 and available at the following link on The Open Group's Bookstore:
    – http://www.opengroup.org/bookstore/catalog/c122.htm
Summary

• FACE enables getting capabilities to the Warfighter faster and at an affordable cost

• FACE is addressing the business concerns that have hampered other OA initiatives

• FACE has established a Common Operating Environment

• FACE is being designed through industry and government collaboration

• FACE and its model for public-private partnership are relevant to many domains
  - UCS, Army COE, others…

• FACE Standard is creating a new Defense marketplace for embedded software
Questions?
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Questions?
Panel 4: Perspectives from Industry

Moderator: Judy Cerenzia, Director, Collaboration Services, The Open Group

Speakers:
Patrick M. Antkowiak, Vice President and General Manager, Advanced Concepts & Technologies Division, Electronic Systems Sector, Northrop Grumman Corporation
Jamie G. Durbin, Technical Director, Product Line Architecture, Lockheed Martin
Gordon Hunt, Chief Applications Engineer, RTI
Thomas J. Laliberty, Director, Integrated Combat Systems, Raytheon Integrated Defense Systems
Affordability, Agility and Open Innovation for AESA Systems

October 18, 2012

Pat Antkowiak
Vice President and General Manager
Advanced Concepts and Technologies Division
So What’s the Big Deal with AESAs?

- Efficient effective radiated power generation
- Fast, inertialess, high-gain beam agility
- High reliability with graceful degradation
- Wider operating and instantaneous bandwidths

- Modular scalable architectures
- Reducing risks and costs

Proven and affordable AESA solutions
AESA Technology Trends

**Scalable, Lower SWAP:** Thin, Lightweight, Fewer parts, LRUs, LRM, better power added efficiency

**More Bandwidth:** wider operating and instantaneous bandwidth

**Digital Beamforming:** backend receiver and processor architecture evolution

**Multi-Function & Sensor Exploitation:** Radar, Comms, Electronic Warfare, ISR, Passive Sensing, ATR, Data Fusion

**Lower Cost of Ownership**

**More Open:** Modular Open System Architectures allow for “best-of-breed” technologies
• Modular Open Systems Architectures (MOSA) penetrating DoD
• Software and hardware being driven to open standards and sourcing
• Major change in defense electronics business model
• Open innovation and an open business model are a “must”
A Shift Towards Capabilities Based Systems Development & OA/Open Innovation …

- Existing Capabilities and “Re-usable” Components … *Producible, Open Innovation*
- Modeling/Simulation Explore Mission Performance … *Collaborative Development*
- Cost and Risk Constrained … *Requirements Iterated Around Constraints*

“Open” as A Foundation for Affordability
Open Architecture … Revolutionizing New and Legacy Platforms

- Open Architecture
- Scalability
- Tech Insertion for Affordability

“Open” as a Foundation

Leveraging Capability Investment

Open Architecture Applies to Both
Bottom Line

- Proven and affordable AESA solutions

- Technology engine continuing to rapidly evolve AESA radar capability

- Bringing open systems architecture back to legacy platforms
THE VALUE OF PERFORMANCE.

NORTHROP GRUMMAN
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www.OpenArchitectureSummit.com #OA2012
The Benefits of Open Architecture: A Practitioner’s View

Open Architecture Summit
18 October 2012

Jamie G. Durbin
Technical Director, Navy OA
Lockheed Martin MS2
AEGIS Open Architecture Evolution

Phase 1: Commercial Technology…

- Commercial / Open Standards
- Commodity Products
- Separation of Application/Infrastructure
- Planned Refresh Cycles

Focus: Leverage the Commercial Marketplace – Exploit Continuous Increases in Performance

Mid 1990s

- COTS Display and Network Distribution (B/L 6)
- Complete COTS Weapon System Infrastruct. (B/L 7)
- Through B/L 9:
  - 6th Generation Networks
  - 4th Generation Display/Processors
  - 1st Generation Signal Processing
AEGIS Open Architecture Evolution
Phase 2: Componentized Software…

Mid 2000s

- Component-Based Designs
- Distributed Processing
- Message-Passing Architectures
- Modern Development Technologies

• C2 Component Architecture (B/L 7)
• AEGIS Open Architecture Model-Based Design (B/L 8)
• Through B/L 9:
  • Merge of AAW and BMD Baselines into Single Component Architecture
  • Model-Based Architecture Document Describes Key Interfaces

Focus: Decrease Development Time – Reduce Cost
AEGIS Open Architecture Evolution

Phase 3: Open Business Model…

• Open Disclosure / Collaboration
• Peer Reviews and Independent Assessments
• Contract Guidebook
• SHARE / CAL Repositories
• Open System Management Plans

Focus: Increase Number of Players/Opportunities – Improve Transition of S&T Into Fleet

• Established Technology Collaboration Centers
• Migrated Core Track Management using 3rd Party STM/TS (B/L 9)
• Through B/L 9:
  • Numerous 3rd Party Developers (Commercial and Non-Commercial)
  • Plethora of Licensed Products

Today
Key Benefit of OA Approach

REUSE within contractor configurations…

**Common Source Library**

Key Elements of Common Development:
• Single Set of Specifications
• Common Program Plans
• Single Set of Processes & Metrics
• Integrated Team Structure
• Enterprise Products

“Fix it Once”

• Open Standards-based Designs
• Componentized Architecture
• Well-Defined Interfaces
• Clear Separation of Application and Infrastructure

Common Development and Variation Techniques Enable Life Cycle / Total Ownership Cost Savings
Key Benefit of OA Approach

REUSE across multiple stakeholders, contracts, configurations…

Objective Architecture Provides “Architectural Context” for Product/Capability Development

- Consistent Domains / Boundaries
- Common Precepts and Methods
- Common Functional Allocation
- Common Data Model
- Core Common Components
Government / Industry Collaboration

SBIR Example…

Combat System Requirements
- Technology/ Capability Roadmaps
- Architecture Models

System Development
- Component-based Architectures
- Standards-based Designs
- Well-Defined Interfaces

System Integration and Test

System Certification and Deployment

Combat System Development

Minimal Transition into Fleet Today

S&T Development

SBIR Pipeline
- Existing Topics
- New Topics

SBIR Phase I / Phase II
- Small Business Mentorship
- Technical Guidance During Development

Need to Increase Integration of Collaboration/ Planning Between Development Communities
Government / Industry Collaboration

SBIR Example…

Collaborate Early and Often … from Gap Analysis Through Transition
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Engagement in OA Continuum

- **Standards**
  - Open Architecture Computing Environment (OACE)
  - Joint Technical Architecture (JTA)
  - DoD Information Technology Standards and Profile Registry (DISR)

- **Assessments and Policy**
  - Open Architecture Assessment Tool (OAAT)
  - Modular Open System Assessment (MOSA)
  - DoD Open Systems Architecture Contract Guidebook for Program Managers

- **Reuse and Architecture**
  - Software Hardware Asset Reuse Enterprise (SHARE) Repository, Common Asset Library (CAL), Forge.mil
  - Tri-Program Initiative → Surface Navy Standard Command & Control (SNSC2)
  - PEO IWS Product Line Architecture (PLA)
  - PLA Components: Common Display System, Common Processing System, System Track Manager/Track Server
Software Modularity through Variability Dimensions

PEO IWS Product Line Architecture supports Managed Variability

### Variability Dimension

<table>
<thead>
<tr>
<th>Description</th>
<th>From the IWS Product Line Architecture ADD:</th>
</tr>
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<tbody>
<tr>
<td>Mission Area</td>
<td>Components include or exclude support for specific mission areas</td>
</tr>
<tr>
<td>Mission Capability</td>
<td>Components include or exclude support for various capabilities within a mission area</td>
</tr>
<tr>
<td>Sensors and Weapons</td>
<td>Components include or exclude support for specific types of sensors/weapons</td>
</tr>
<tr>
<td>Foreign Military Sales (FMS)</td>
<td>Components replace sensitive algorithms with approved replacements for FMS</td>
</tr>
<tr>
<td>Restrictive Data Rights</td>
<td>Components enable late binding of code protected by restricted data rights</td>
</tr>
</tbody>
</table>

PEO IWS Product Line Architecture supports Managed Variability
Implementing Variability Dimensions & Maintaining Single/Common Source Library

SSDS implementation of Managed Variability and SSL/CSL

Six ship classes and 44 platforms
Perspective on Intellectual Property

- Need to balance the overall interests and preserve incentives for non-Government investments and commercial market participation

- How to ensure the Government can establish competition for interchangeable components and their support
  - Form, fit, function and interface data
  - Should not require detailed design or manufacturing process

- Small business impact of use of any Government development funding?
Panel 4: Perspectives from Industry

Moderator:
Judy Cerenzia, Director, Collaboration Services, The Open Group

Speakers:
Patrick M. Antkowiak, Vice President and General Manager, Advanced Concepts & Technologies Division, Electronic Systems Sector, Northrop Grumman Corporation
Jamie G. Durbin, Technical Director, Product Line Architecture, Lockheed Martin
Mr. Gordon Hunt, Chief Applications Engineer, RTI
Thomas J. Laliberty, Director, Integrated Combat Systems, Raytheon Integrated Defense Systems
Questions?
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