Rapid Prototyping: Leapfrogging into Military Utility

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Rapid Prototyping Needed

- Asymmetric threat has a very short timeline for change
  - COTS timeline available to threats
  - WWW used by threat
- DoD Acquisition has relatively long timeline
  - Limited access to COTS
  - Budget process is multi-year
- Complex systems stress definition of requirements/architecture
  - Requirement trade-offs delay system
  - Only as fast as slowest element
SAF/RCO Rapid Prototyping

Objectives

- Rapidly develop new capabilities to counter the increasing pace of threat evolution
- Improve acquisition process; facilitate faster transition of S&T to warfighter
- Realistic definition of requirements & architectures for complex problems; prototype to innovate

Enablers

- Mindset: acceptance of 80% solution
- Team: leadership support, warfighter involvement, “A-team” executing
- Investments for the future: open architectures, etc.
- Experience: practice to improve
“Rapid Prototyping” in Commercial Industry

A tool for rapid design & manufacturing …

A way to rapidly get products to market …

A way to innovate …

Not a new idea; approaches well established in commercial industry
Outline

- Motivation / Objectives
- Air Force Rapid Capabilities Office
- Rapid Prototyping
  - Rapid capability development examples
  - Enablers to rapid development
  - Prototyping to innovate
- Summary
Air Force Rapid Capabilities Office

- Established April 2003

- Mission: Expedite development and fielding of select DoD systems
  - Leveraging defense wide technology development efforts and existing operational capabilities

- Reports directly to Board of Directors
  - SecAF, CSAF, SAF/AQ, and USD(AT&L) chairs
  - Responds to Combat Air Force (CAF) and Combatant Command (COCOM) requirements

- Rapid Prototyping Example: National Capital Region (NCR) IADS
  - Enhanced Regional Situational Awareness (ERSA)
  - Norwegian Advanced SAM System (NASAMS)
National Capital Region Airspace

ADIZ – Air Defense Identification Zone
FRZ – Flight-Restricted Zone
IAD – Dulles International Airport
DCA – Reagan National Airport
ADW – Andrews Air Force Base
National Capital Region Airspace

1300 beacon tracks within ADIZ for one hour time period

ADIZ – Air Defense Identification Zone
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IAD – Dulles International Airport
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ADW – Andrews Air Force Base
RCO Rapid Developments

Enhanced Regional Situational Awareness (ERSA)

- Integrated air defense system for National Capital Region (NCR) in 2 years
- Operational for Jan 2005 Presidential Inauguration
- Developed and Fielded
  - Tower Mounted Radars
  - Aircraft ID
  - Visual Warning

Norwegian Advanced Surface to Air Missile System (NASAMS)

- Developed & integrated system into NCR IADS
- 9 months from Chairman JCS tasking to IOC
Rapid Prototyping

Visual Warning System (VWS)

Visual Warning System developed by rapidly integrating COTS to create a new capability
Visual Warning System (VWS)

- Provide visual warning to errant pilots entering NCR airspace
- Eye safe system at aperture and beyond
- Precision pointing at single aircraft
- Special Flight Advisory has been published on meaning of lights
- Operational on 21 May 2005

• Warning Sequence with translucent covers on

• Nighttime aircraft view from 3 nm, 28 Jan 05
A NORAD spokesman cites the use of the Visible Warning System.

A small plane penetrated restricted air space and flew within six miles of the U.S. Capitol yesterday before being intercepted without incident, officials said.

When air-traffic controllers couldn't reach the pilot by radio, military personnel on the ground aimed red and green warning lights at the cockpit, said Maj. Brian Martin, a spokesman for the North American Aerospace Defense Command, or NORAD. That prompted the pilot to veer west, Martin said.

Two F-16 jets from Andrews Air Force Base and a Coast Guard helicopter escorted the plane to Leesburg airport, where the pilot was questioned by the Secret Service and the FAA, officials said. He was not considered a threat, they said.
12 March 2008 Events

- A Cessna 177 crosses the Air Defense Identification Zone (ADIZ) in violation of airspace rules

- NORAD warns pilot using the Visible Warning System

- The Cessna is escorted to Leesburg Airport by F-16 interceptors
NASAMS Integration Timeline

<table>
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<td>A M J J A S O N D J F M</td>
<td>Chairman JCS Direction ▲&lt;br&gt;AT&amp;L funding ▲&lt;br&gt;Fire Control Cue Developed ▲&lt;br&gt;Integration with fire control unit ▲&lt;br&gt;Live Fire Tests ▲ ▲&lt;br&gt;NORAD Validation and Acceptance Testing ▲ ▲&lt;br&gt;NASAMS IOC in NRC ▲</td>
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NASAMS developed, deployed and operational in nine months
NCR IADS

Key Attributes for Rapid Fielding

- Clear Charter with Clear Priorities
  - Schedule was #1; field ERSA by inauguration day 2005 (18 months)

- Senior DoD, Joint Staff, US Air Force, & US Army leadership buy-in
  - Short chain of command facilitated quick decisions

- Small, Focused, Empowered Team; 5 – Program Office, 7 Contractor, plus key external POC’s
  - Experienced, solution oriented, A-team type personnel
  - QRC focus – Long hours, 6 & 7 days/week were routine

- Recognition of Need for After-Fielding Clean Up
  - Formalized needed leases and MOAs/MOUs
  - Minor safety adds to installed equipment
  - Long-term transition planning
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Enablers to Rapid Development

- Series of elements key to enabling rapid innovation, demonstration, prototyping, and fielding of critical military capabilities
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Open System Architecture

Advantages

- **Commonality allows lower cost ...**
  - Plug and play pieces reusable from system to system

- **Innovation enabler ...**
  - Allows entrance of “smaller” players, often with innovative ideas

- **Rapid development & rapid upgrades ...**
  - Open design allows replacement of individual components
  - Allows isolation of components that evolve technically at differing rates (e.g., rapid Moore’s Law advance in computing)
  - Upgrades vs. replace; more responsive to agile threats
Open Systems Support
“Leverage Adapt” Strategy

- Open Systems supports “leverage and adapt” strategy; allows DoD to leverage commercial industry’s investment
- Continuous upgrade/refresh possible to meet evolving threats and obsolescence

“Leverage & adapt”
- Good for rapidly changing technology
- Good for rapidly changing requirements
- Built-in refresh and improvements
- More difficult to manage

“Freeze & build”
- Freezes technology and builds to fixed design
- Acceptable for slow moving technologies
- Requires stable requirements throughout lifecycle
- Easier to manage with current acquisition strategy
Layered Open System Architecture Approach

- **OSA = Open System Architecture**
- **SOA = Service Oriented Architecture**
- **COI = Community Of Interest**

**OSA Sensor Control SOAs**
- **Open Radar Middleware**
  - AESA
  - RX/Exciter
  - Signal Processor
  - Control Processor
- **Open AMRAAM System**
- **Open EW Sensor System**

**Avionics SOAs**
- **Open Mission Computer**
- **Open System Mass Storage**
- **Comm Link (with Network Adapter)**
- **Open Display System**
- **Open Comm/Nav/ID**

**Multi-INT Centers Ground Station SOAs**
- **C2 Services**
- **Other Sensor Adapters**
- **Comm Link (bridge to GIG)**
- **ISR Tasking**

**Global Network COI User SOAs**
- **Global Information Grid (with NCES)**
  - Intel User
  - Intel Sensor Adapters
  - Exploitation App
  - Federated Search Service

- **Layered Open System Architecture Approach**
- **Extend SOA Concepts**
  - Change with technology and readily add new capabilities

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Prototyping Facilitates Innovation

“It is far easier for [users] to articulate what they want by playing with prototypes than by enumerating requirements.”†


- Key additional use of rapid prototyping is for innovation; “simulate to innovate” concept
Development Approaches

Linear / “Waterfall” Approach

Fixed Design

- Problem
- Design
- Build
- Use

- Assumes “design” can be accomplished apriori
- No developer / user co-design

Rapid Prototype Approach

Inherent Feedback

- Problem
- Use
- Prototype
- Design

- Build prototypes to explore “design” approach
- Iterate based on user feedback; design influenced by user response

- Get user feedback
- Define requirements through “play”
- Understand problem
- Generate idea
- Use prototype to understand better approach
Prototype to Innovate

**National Capital Region IADS**
- Integrated Air Defense for protection of the National Capital Region

**Touch Table**
- Vehicle for novel data extraction / representation and action

**X-37B Orbital Test Vehicle**
- Unmanned reusable vehicle test platform for new space technologies
Summary

- Rapid prototyping permits timely, cost effective military capability development
  - Strongly motivated by increasing pace of threat cycle

- Air Force Rapid Capabilities Office (SAF/RCO) established to expedite development of selected DoD systems
  - Number of successful projects (e.g., ERSA, NASAMS)

- Success of rapid developments dependent on variety of factors
  - 80% solution mindset, strong team, enabling investments (e.g., Open system architectures)

- Additional rapid prototyping role in innovating new military capabilities
  - Rapid prototyping cycle allows refinement of solution
Challenge to S&T Community

- Traditional “S&T Gap” still exists; greater warfighter interchange needed

- Apply rapid prototyping approach earlier in S&T development

  Early insertion of new technologies  
  Faster innovation  
  Discovery of new / advanced capabilities

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