Joint-Multi-Role Technology Demonstrator (JMR TD) Overview

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6 Elements of the FVL Strategy

1. Decision Point - Based Plan of Execution
2. S&T Plan that Aligns Technology Development with Milestone Decision Options
3. Early Joint Requirements Development
4. Multi-Role Family of Aircraft
5. Common Systems and Open Architecture
6. Industry Partnership/Interaction (thru the VLC)

- Considers the vertical lift needs across the DoD
- Addresses the capability gaps identified in the Army Aviation Operations CBA, and the OSD-sponsored Future Vertical Lift CBA
Purpose:
Demonstrate transformational vertical lift capabilities to prepare the DoD for decisions regarding the replacement of the current vertical lift fleet.

Products:
- Technology maturation plans
- Foundation for cost analysis for future capabilities
- Two demonstrator test bed aircraft

Payoff:
- A refined set of technologically feasible and affordable capabilities that enable higher speed, better lift efficiency, lower drag (L/De), and improved Hover Out of Ground Effect (HOGE) at high/hot conditions (6K/95)
- Standards, architectures and tools that increase SW reuse and reduce SW costs
- Reduced risk for critical technologies
- Data readily available to support future DoD acquisitions
Schedule

Fort Rucker/FVL Study

<table>
<thead>
<tr>
<th>Phase I</th>
<th>Phase II</th>
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<tr>
<td>Model Performance Specification (MPS)</td>
<td>Scope: Design, fabricate and test 2 vehicles</td>
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<td>• Performance demonstration and verification</td>
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<td>• Technology characterization</td>
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<td>• Test predictions and correlation</td>
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<td>• Value and readiness assessments</td>
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Vehicle Config Trades

Air Vehicle Demonstration (AVD)

| BAA | Award | IDR | FDRR | 1st flight |

Scope:
- Trade space description
- Prioritize critical attributes/capabilities
- Establish success metrics
- Assess value and affordability

Air Vehicle Demonstration (AVD)
Mission Systems Architecture Demo (MSAD)

Joint Common Architecture (JCA) Development

- Incremental efforts designed to investigate specific concepts / technologies
- Demonstrate benefits of Model Based Approach & Open Systems Architecture
- High level of collaboration between Government and industry

JCA Demo

ACVIP Shadow

AIPD

MS AD Capstone Demo

Trades and Analyses
- Architectures
- Communications
- Survivability
- Cockpit HMI Technologies
- Sensors and Sensor Fusion
- Weapons
- Verify JCA Standard 0.X
- Utilize JCA / FACE Ecosystem
- Exercise Partial System Architecture Virtual Integration (SAVI) Process
- Demonstrate Software Portability and Interoperability

ACVIP – Architecture Centric Virtual Integration Process
AIPD – Architecture Implementation Process Demonstrations

UNCLASSIFIED
Air Vehicle Demo (AVD) Status

- Sep 2013 – Four (4) Technology Investment Agreements (TIAs) were awarded for initial design to AVX, Bell, Karem, and Sikorsky-Boeing
- Jun 2014 – Initial Design & Risk Reviews with each contractor
- Oct 2014 – Bell and Sikorsky-Boeing selected to proceed design, fabrication and flight test
- Apr 2015 – Subsystem CDRs in progress; system CDRs planned in 2015
- Apr 2015 – TIAs with Karem and AVX rescoped to demo key technologies (ground test)
Tech Demonstrator Aircraft

Bell Helicopter

- Low Disk Loading
- Superior Low-Speed Maneuverability
- Advanced Rotor and Drive System
- Non-Rotating Fixed Engines
- Large Side Door
- Large Cell Carbon Core Wing
- Advanced Composite Fuselage
- Cruises at 280 knots
- Fly-By-Wire

Demonstrating technologies that provide affordable tilt-rotor access to Army capability sets

- Full-authority digital fly-by-wire flight control system
- Flight envelope protection
  - Structural load limiting
  - Conversion corridor protection
- Designed for low-cost manufacturing
  - Broad goods skin lay-up
  - Large cell carbon core
  - Bonded skin assemblies
  - Broad goods yoke
- Performance
  - Designed to meet ADS-33 Level 1 yaw, pitch and roll quickness
  - Cruise at 280 kts

Sikorsky-Boeing

- X2™ Technology
- Advanced Rigid Rotor System
- Composite Fuselage
- Advanced Drive System
- Manual Blade Fold
- Active Vibration Control
- Pusher Prop with Clutch
- Lift Offset Co-Axial Rotor
- Retractable Gear
- Active Rudders and Elevators
- Fly-by-Wire Flight controls
- Cabin for 12 Combat equipped troops
- Crew of four

Demonstrating technologies that provide affordable coaxial, lift-offset compound access to Army capability sets

- Fly-by-wire flight controls
- Active vibration control
- Configuration
  - Lift Offset Coaxial Rotor
  - Pusher Prop
  - Variable RPM drive system
- Performance
  - 250 knots cruise
  - HOGE 6K95
  - Low & medium speed maneuverability
Technology Demonstrations

AVX

Demonstrate technologies that enable an innovative design solution to meet Army capability sets

- Configuration
  - Conventional coaxial compound
  - Ducted fans for auxiliary propulsion
  - Aft ramp
- Effort
  - Scaled wind tunnel testing and CFD
  - Develop and evaluate control laws to reduce rotor loads, vibration, and vertical spacing of rotors
- Aeromechanics Challenges:
  - High cruise efficiency
  - Favorable dynamic characteristics (vibration, rotor blade tip clearance)
  - Handling qualities

Karem Aircraft

Demonstrate technologies that enable an innovative design solution to meet Army capability sets

- Optimum Speed Tilt Rotor configuration
- Designed for
  - Speed > 300 kts
  - High cruise and hover efficiency
- Enabling technologies
  - Lightweight, stiff rotor design
  - Multi-speed transmission
  - Individual rotor blade control
  - Electromechanical actuation
- Effort: Integrated powered test of all the enabling technologies on a tower

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.
Mission Systems Architecture Challenges

- Increasing software (s/w) development costs:
  - Commercial aircraft s/w development cost ≥ $10B
  - >70% of new aircraft development cost is s/w
  - >70% of s/w development cost in rework and certification
  - S/W complexity increasing logarithmically

- Obsolescence driven by:
  - Rapid advancements in computing technology
  - Proliferation of sophisticated threat systems

- Increasing certification challenges:
  - Multi-core processors
  - Multi-level Security
  - Integrated Modular Avionics
  - Increasing complexity of Cyber Physical Systems

- Time to integrate and field new capabilities
- Emphasis on commonality across the fleet
- Re-use and portability of s/w between on-board and off-board systems
- Adequacy/maturity of architecturally centric model based system engineering tools and processes to address challenges
• Provide the guidance and infrastructure necessary for FVL to implement a mission systems architecture that enables the integration of capabilities that are affordable, timely, and effective.
  – Too early to design the FVL Mission Equipment Package (MEP) or architecture

• Perform a series of increasingly complex demonstrations directly relevant to FVL mission systems architecture implementation
  – Joint Common Architecture (JCA) Demonstration
    • JCA, FACE & ACVIP Proof of Concept, “Learn by doing”
  – Architecture Implementation Process Demonstrations (AIPDs)
    • Leverage existing components & architectures and industry investments
  – Mission Systems Architecture Capstone Demonstration (MSACD)
    • Large scale representative architecture demonstration

**MSAD focuses on concepts, standards, processes and tools not an objective design for an FVL MEP or architecture**
Purpose: Demonstrate analytical tools, methodologies and processes necessary for design and implementation of FVL mission system architecture

- 4th QTR FY13 - Mission Systems Effectiveness Trades and Analysis
  - Rockwell Collins, Boeing, Honeywell, Lockheed Martin, Sikorsky and SURVICE Engineering

Joint Common Architecture (JCA) Demonstration
- Validate JCA and Future Airborne Capability Environment (FACE™) concepts and explore Architecture Centric Virtual Integration Process (ACVIP)
- 3rd QTR FY14 - Two awards: Sikorsky/Boeing and Honeywell
- 3rd QTR FY15 - Scheduled completion; 3 AHS Papers Authored

Path forward
- Series of increasingly complex demonstrations directly relevant to FVL mission systems architecture implementation
  - Architecture Implementation Process Demonstrations (AIPD)
    - 4th QTR FY15 - BAA Release
    - 2nd QTR FY16 - Anticipate ~ 6 TIA awards: focused demonstrations of limited scope exploring JCA, FACE and ACVIP application to existing systems and architectures
  - FY19 – MSA Capstone Demonstrations: large scale demos of FVL relevant architecture implementations
Projected Road Ahead for FVL

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<th>Year</th>
<th>Pre-AoA Refinement</th>
<th>Material Solutions Analysis</th>
<th>Technology Development (TD)</th>
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Aug 2013
- Services Agreed to Analysis Plan

Oct 2016
- Materiel Development Decision

Jan 2019
- Milestone A

CEM Base Case Analysis

Pre-MDD/Pre-AoA Questions

AoA Execution

RFP Proposal and Approval Contract Award

CT&A
- Phase 1 Spec

JMR Technology Demonstrator
- Air Vehicle Demo
- Analytic Sweet Spot
- JCA Demo
- Mission Systems Architecture Demo

Flexibility of JMR TD effort based on available funding

Maturity of knowledge, tools, and technology
Key Take Aways

- JMR TD will fly technology demonstrator aircraft beginning in FY17 – demonstrator aircraft are not prototypes.

- JMR TD will perform a series of increasingly complex demonstrations directly relevant to FVL mission systems architecture implementation.

- JMR TD will prove advances in vertical lift technology and help refine FVL requirements.

- Rebuilding govt and industry competency in new design.

- Enhancing tools for better, more efficient early trades and affordability analysis and ultimately increased product performance.
QUESTIONS?