



Presented to:

**American Helicopter Society,
Forum 71**

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



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**U.S. Army Aviation and Missile Research,
Development, and Engineering Center**

May 7, 2015

Transition to Future Vertical Lift (FVL)

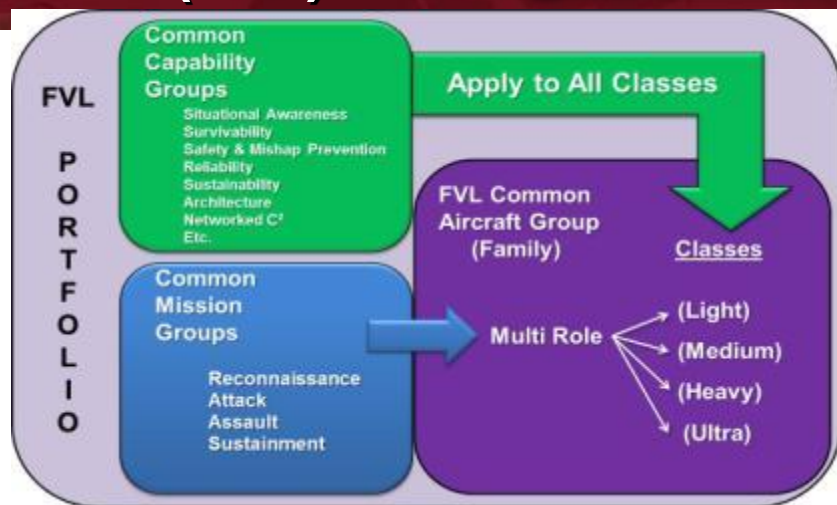
Defining the future of vertical lift

21 May 08 Secretary Gates: "I have directed the Joint Advanced Concepts Directorate... to lead the development of a CBA that will outline a joint approach to the future development of vertical lift aircraft for all the Military Services"

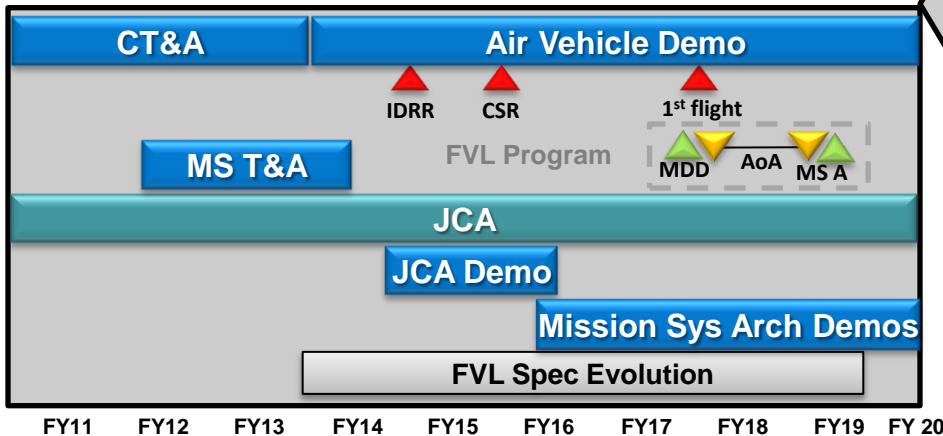
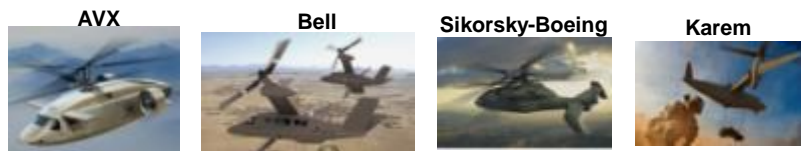
A joint collaborative environment for future capability discussions

S. 3001
AN ACT

•Escalating Ops and Sustainment Cost
•Unacceptable Number of Vertical Lift Losses
•Vertical Lift Fleet Accelerated Aging Due to OPTEMPO
•Capability Gaps (2008 CBA – 55 gaps)
•Decaying US Vertical Lift Industrial Base



JMR TD Program



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

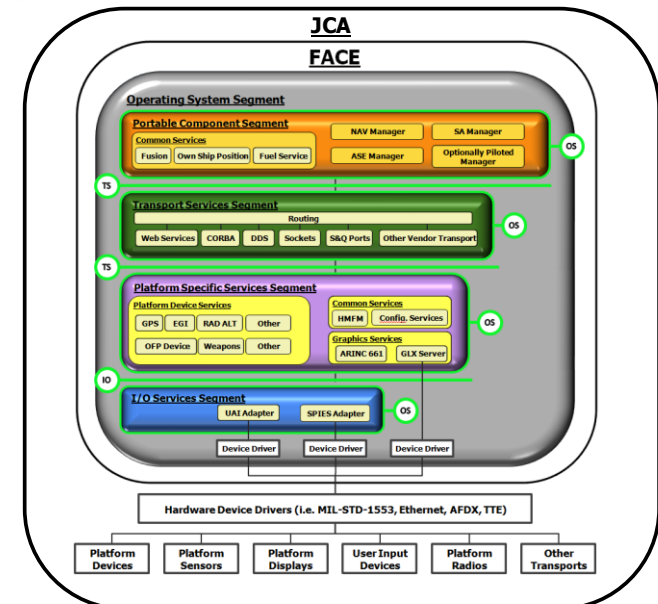
Payoff:

- 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

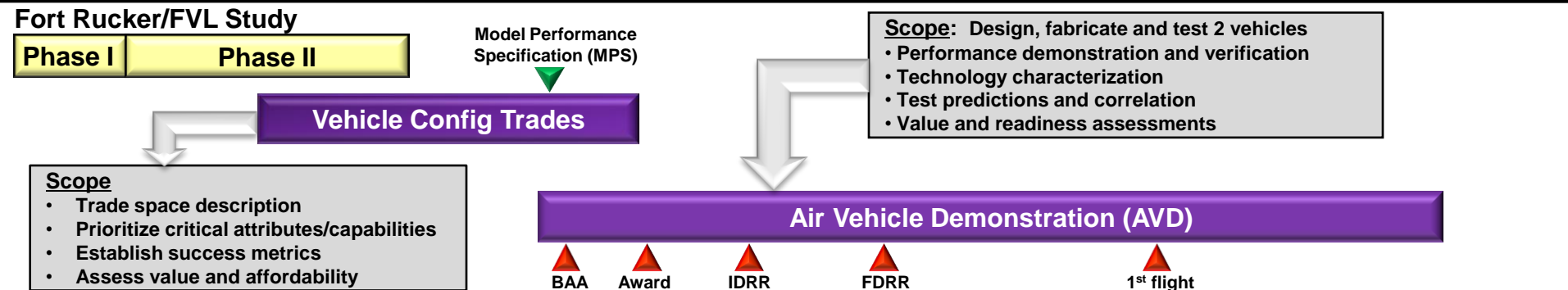
Air Vehicle Demo (AVD)



Mission Systems Architecture Demo (MSAD)

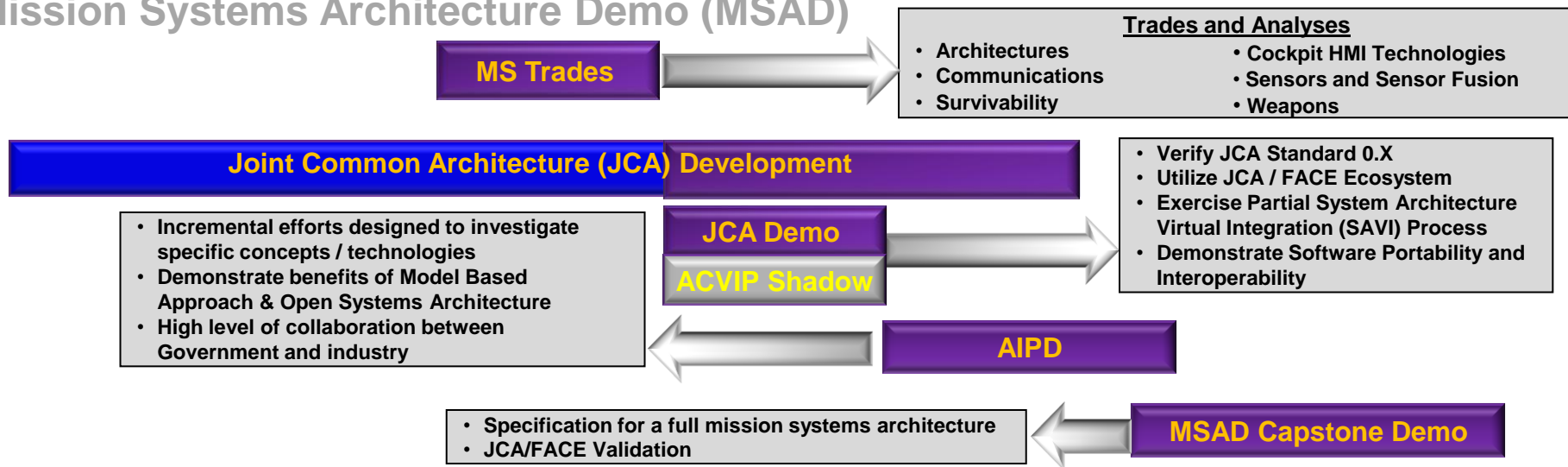


FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20
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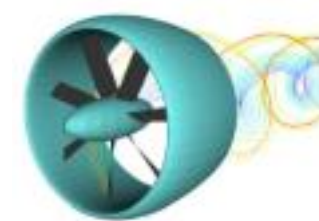
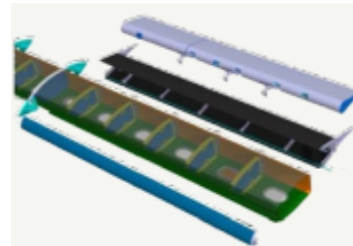
Air Vehicle Demonstration (AVD)

Mission Systems Architecture Demo (MSAD)

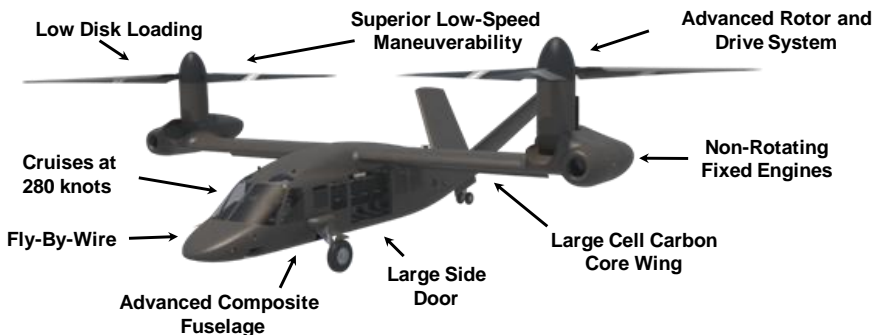


Air Vehicle Demo (AVD) Status

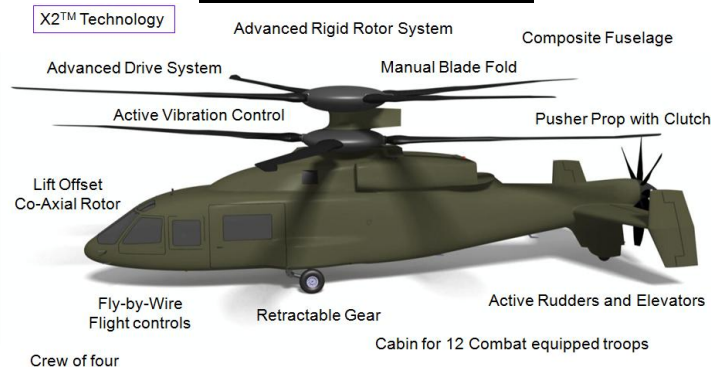
- Sep 2013 – Four (4) Technology Investment Agreements (TIAs) were awarded for initial design to AVX, Bell, Karem, and Sikorsky-Boeing
- Jun 2014 – Initial Design & Risk Reviews with each contractor
- Oct 2014 – Bell and Sikorsky-Boeing selected to proceed design, fabrication and flight test
- Apr 2015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



Bell Helicopter



Sikorsky-Boeing



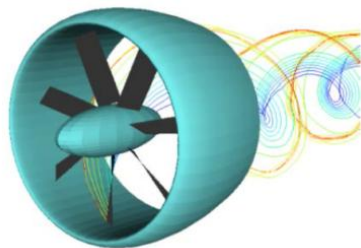
Demonstrating technologies that provide affordable tilt-rotor access to Army capability sets

Demonstrating technologies that provide affordable coaxial, lift-offset compound 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

- 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

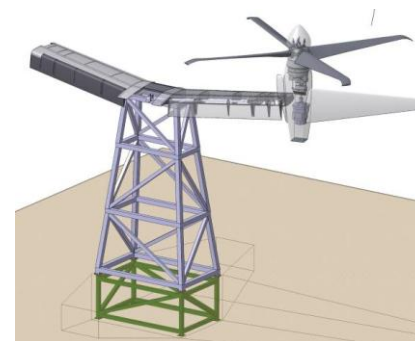
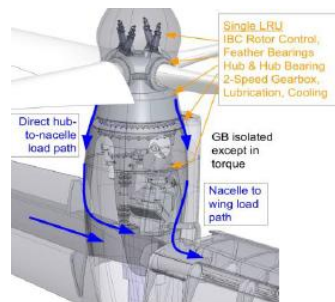
AVX



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

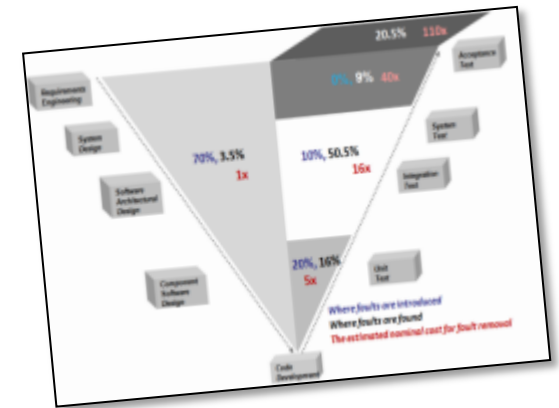
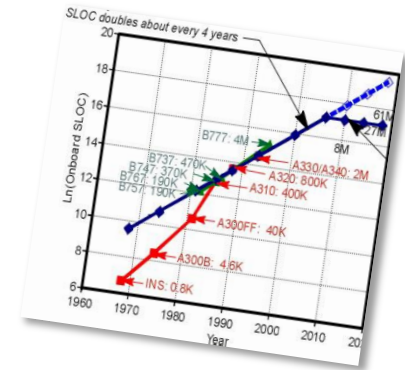
Karem Aircraft



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

- **Increasing software (s/w) development costs:**
 - Commercial aircraft s/w development cost \geq \$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**

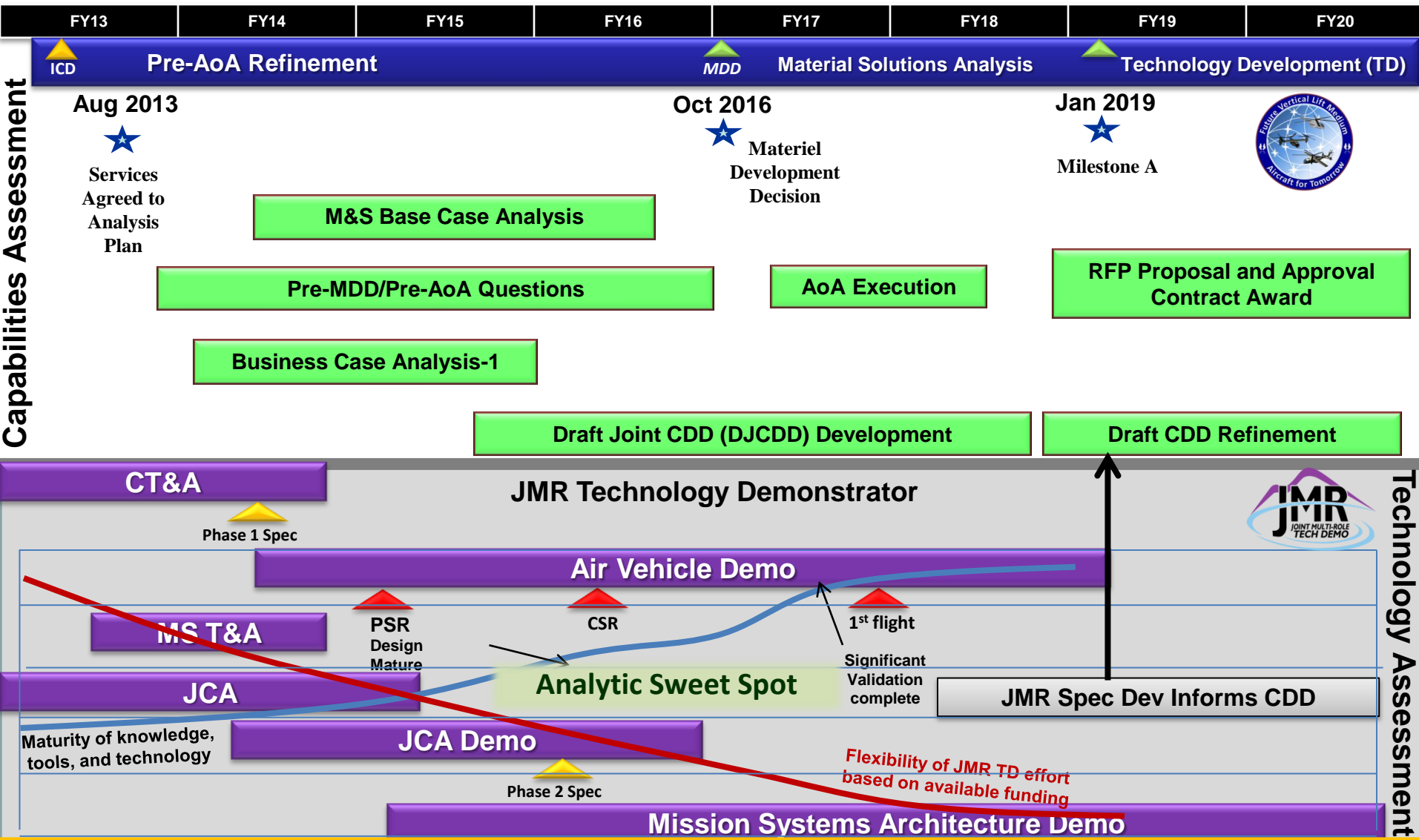


- Provide the guidance and infrastructure necessary for FVL to implement a mission systems architecture that enables the integration of capabilities that are **affordable**, **timely**, and **effective**.
 - Too early to design the FVL Mission Equipment Package (MEP) or architecture
- Perform a series 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*



Projected Road Ahead for FVL





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?

