Air Platforms COI

NDIA 17th Annual S&ET Conference

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OASD(R&E)/Research/Weapons Systems

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Current Major DoD Air Platforms



















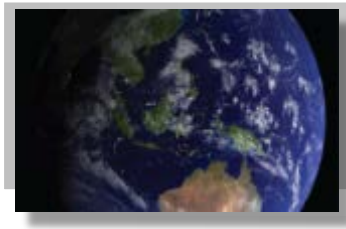

Air Force	Navy
F-35A	F-35C
F-22	F-18
KC-46/X	P-3X
LRS-B	P-8A
MQ-1	E-2C
RQ-4	SH-60
MQ-9	MH53-H
B-2	

ARMY	Marines
AH-64E	F-35B
UH-60M	MV-22B
MQ-1	UH-1Y
RQ-7	AH-1Z
CH-47F	CH-53E
	KC-130J
	RQ-7B

Strategic Context

"…But today that [U.S.] superiority is being challenged in unprecedented ways."


Secretary Carter



- **Limited budgets**
- **Increasing global R&D competition**

- **Cyberspace threats**
- **Electromagnetic spectrum competition**

- **Less freedom of movement in space**

- **Growing sophistication in A2/AD threats**

AF S&T Priorities

Push Innovation

- Integrate existing technologies
- Create disruptive capabilities
- Strategic agility

Cost Imposing Strategy

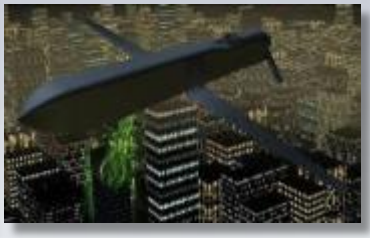
- Force costly adversary response
- $1 US → 10x adversary investment

Affordability

- "Baked in"
- Open architectures
- Adaptable & flexible
- Rate independent production cost

More Advanced Technology Demos

- Reduce acquisition risk
- Energize tech base
- Show warfighter impact
- Motivate S&Es



Engagement & Partnership

- Maintain global awareness
- Shape domestic tech base
- Leverage the best S&T

CSAF Call to the Future Game Changers

Hypersonics

Directed Energy

Autonomy

Unmanned Systems

Nano Technology

Technology to make and keep the fight unfair - Game Changers

Army S&T Priorities

Extension of Range and Endurance

- Fly faster and farther
- Support all FVL initiative capabilities
- Carry more payload
- Demonstrate transformational vertical lift capabilities

Operations in Degraded Visual Environments (DVE)

- Operate in complex environments
  - Pilotage in all DVE's
  - 360° situational awareness (SA)
  - Multi-functionality
  - Multi-spectral

Sustainability, Maintainability, Reduced Logistics Footprint

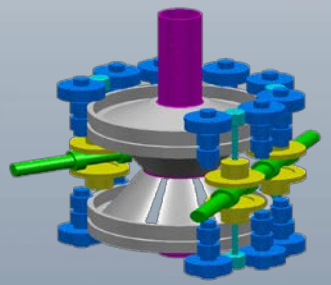
- Ultra-reliable designs
- Zero maintenance concept
- Reduced Maintenance burden

Future Family of UAS Demo

- Mature autonomous capabilities
- Refine the interface between pilot and aircraft
- Advanced UAS engine concepts

Advance Engine and Drive Technologies

- Multi-speed transmission
- Move beyond traditional turbo-shaft engine architecture

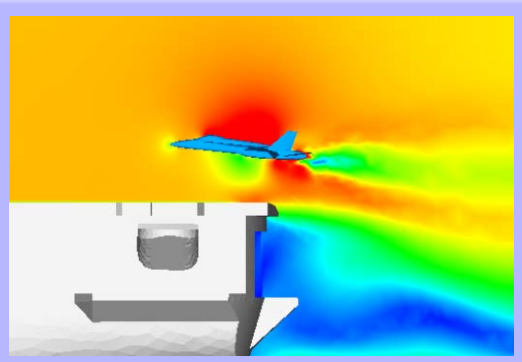


Army Aviation S&T Perspective

- **From the Aviation Science & Technology Strategic Plan (ASSP) 2014:**
  - Fly faster and farther while carrying more: fully support all FVL initiative capabilities
  - Operate in complex environments
  - Develop the next generation of UAS
  - Demonstrate mature autonomous decision-making capabilities
  - Refine the interface between pilot and aircraft
  - Support ultra-reliable designs for no maintenance
  - Advance engine and drive configuration technologies that move beyond traditional turbo-shaft engine and power transmission architectures
  - Reduce fielding timelines and improve transition time from S&T to the field
  - Enhance in-house capabilities: sculpt the government workforce, facilities and equipment to develop diverse in-house capabilities

Legacy fleet sustainment while leading future rotorcraft development!

Naval Air Platforms S&T Priorities
Basic and Applied Research



Virtual Dynamic Interface

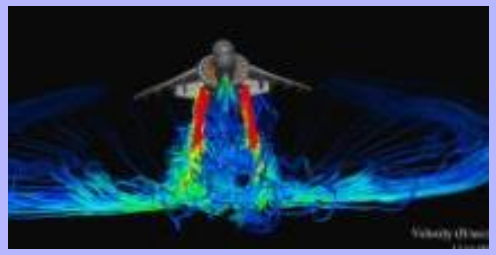
Advanced Handling Qualities

Improved Fixed-Wing High-Lift

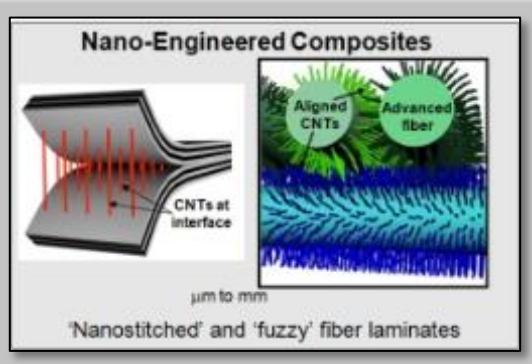
Enhanced Fixed-Wing V/STOL Ops

Autonomous Deck Operation

Advanced Concepts, e.g. Flow Control



Aircraft



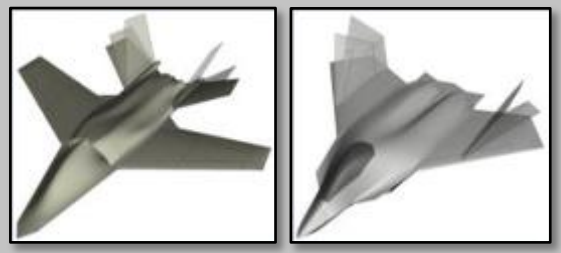
Structural Mode Characterization

High-Loading, Lightweight Structural Materials

Advanced Structural Concepts

Materials Degradation/Corrosion

Structural Protection/Maintenance



Structures

Advanced Propulsion Cycles/Systems

Component Interactions

Engine-Airframe Integration

Turbomachinery and Drive Systems

Jet Noise Reduction for TACAIR

Hot-Section Materials and Coatings

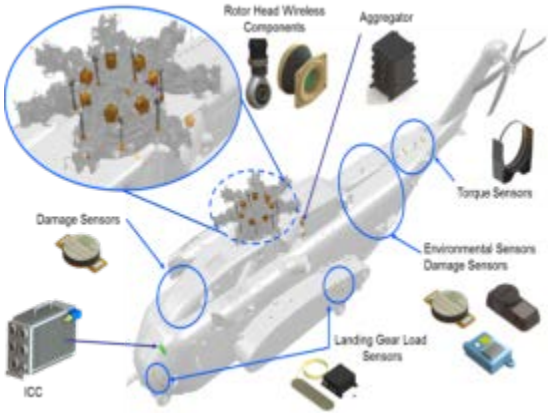
Small UAV Propulsion

Propulsion

Naval S&T Priorities
Advanced Technology Development

- Advanced Technology Development (6.3) projects are competitive across all ONR areas.
- Future Naval Capabilities (FNCs), Innovative Naval Prototypes (INPs), and Leap-Aheads have lead times of 2+ years.
- We seek demonstrators that show Navy unique or driven capabilities

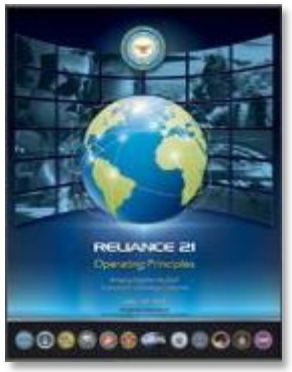
AACUS – INP
Platform independent autonomous landing capability



Integrated Hybrid Structural Management System (IHSMS) FNC

Tern (joint with DARPA)
VTOL with long endurance and range, compatible with small deck ships

Air Platforms Community of Interest (COI)



Air Platforms Vision

Provide innovative air platform technology and technology integration for *survivable*, *affordable*, *effective* and *agile* capability for legacy and future aircraft

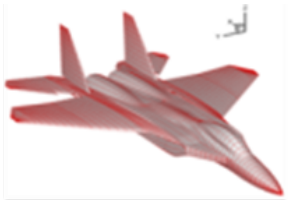
Effectiveness

- Increased range and speed
- Increased time-on-station
- Survivability against advanced threats
- Improved sensor / weapons integration
- Increased availability / msn capable rate

Affordability

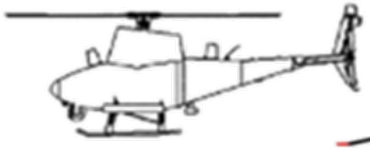
- Shortening development timelines
- Applying advanced manufacturing
- Reducing sustainment demands
- Improving logistics
- Pursuing energy efficiencies

Air Platforms COI Sub Areas

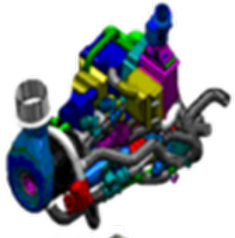

Fixed Wing Vehicle


Artist's Concepts



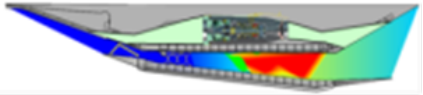
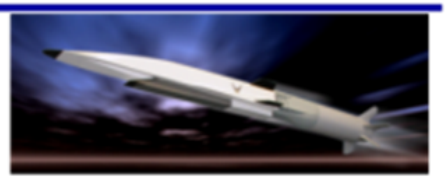
Rotary Wing Vehicle


Artist's Concepts

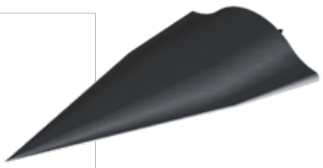



Aircraft Propulsion, Power & Thermal

Artist's Concepts

High-Speed/Hypersonics

Artist's Concepts

Air Platforms COI
Capability Challenge Areas

Air Platforms COI Leadership

* COI Lead
** COI Deputy

Dr. Siva Banda*

Dr. Bill Lewis

Dr. Tom Beutner

Dr. Spiro Lekoudis
Dr. Joe Doychak**

Dr. Brad Tousley

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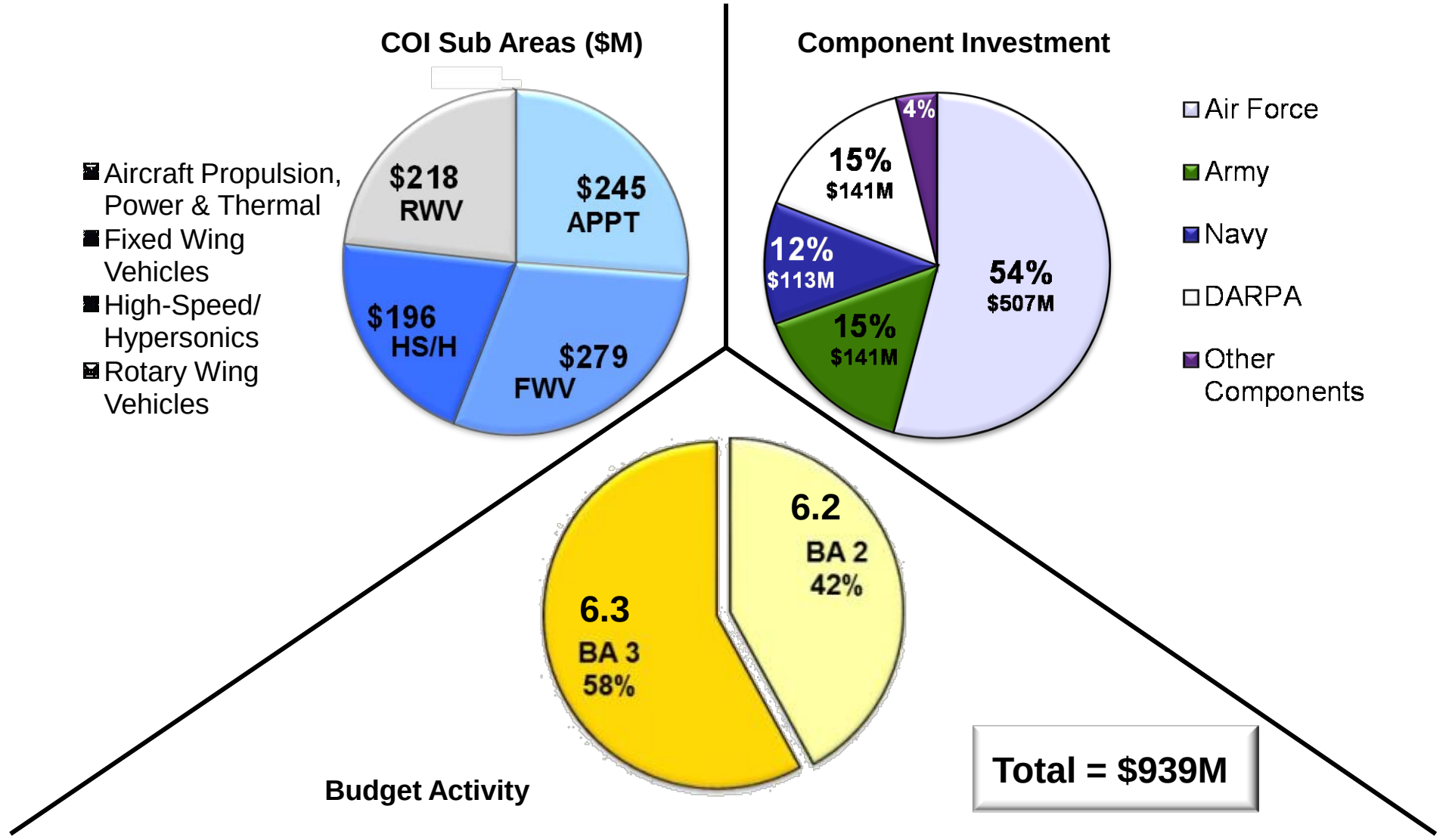
Air Platforms COI Funding FY16 PB16



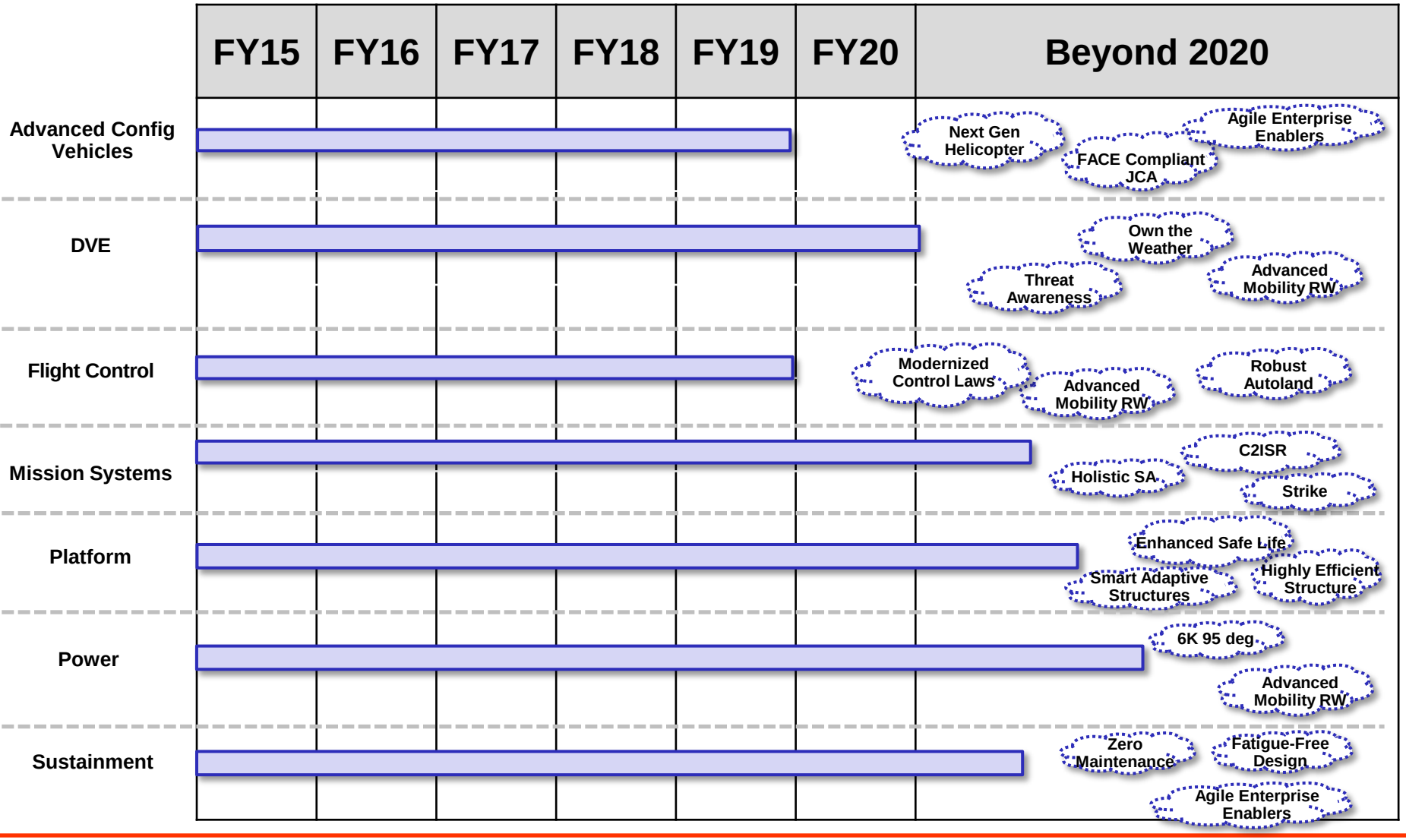
Rotary Wing Vehicle

- **Vision**
  - Over the next 40 years, the DoD will transform the Department-wide vertical lift fleet through the development and fielding of families of next generation, Joint, vertical lift aircraft that provide the advanced capabilities to the Joint force required to meet future operational requirements across the spectrum of conflict.

- **Objectives**
  - Fly faster and farther while carrying more
  - Expand operations in complex environments, including sea bases
  - Develop the next generation of UAS
  - Demonstrate mature autonomous decision-making capabilities
  - Refine the interface between pilot and aircraft
  - Support ultra-reliable designs for no maintenance
  - Advance engine and drive configuration technologies that move beyond traditional turbo-shaft engine and power transmission architectures
  - Reduce fielding timelines and improve transition time from S&T to the field

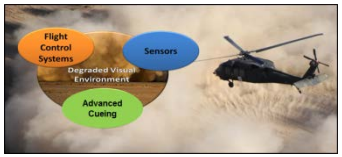
- **Technology Challenges:**
  - Zero Maintenance
  - Interactional aerodynamics, including multi-rotor
  - Multi-disciplinary design analysis and optimization and development of new tools
  - Balanced Integrated Survivability
  - Efficient and effective cueing for safe pilotage in complex environments
  - Higher performing, lighter weight platform technologies of the future
  - Autonomous control of multiple UAVs/twin lift
  - Autonomous algorithms for obstacle field navigation and safe landing area determination
  - Hybrid engine and two-speed transmission
  - Multi-axis flight control of traditional and compound configurations

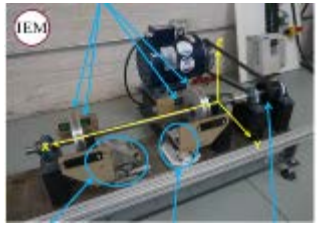
Rotary Wing Vehicle



RWV Significant Accomplishments

- **Joint Multi-Role Technology Demonstration (JMR TD)**
  - Agreements in place for flight demos, GFE engines delivered, Architecture Centric Virtual Integration Process (ACVIP) analysis completed
- **Degraded Visual Environment (DVE)**
  - DVE-M Program Ground Test successfully executed at Yuma Proving Grounds, AZ
- **Autonomous Aerial Cargo / Utility System (AACUS)**
  - Commenced development of UH-1H testbed for AACUS aircraft-portability demonstration
- **Sea-based Automated Landing Recovery System (SALRS)**
  - Completed data collection flights of non-GPS sensors against ship deck platform over water (Lake Erie)
- **Integrated Hybrid Structural Management System (IHSMS)**
  - Completed bench test of tail rotor drive shaft torque sensor prototype
- **TERN**
  - DARPA Phase 3 award to Northrop Grumman to build full-scale demo system. Initial ground-based testing, if successful, would lead to at-sea demonstration
- **Ship-launched Electronic Warfare Extended Endurance Decoy (SEWEED)**
  - Program award to Naval Research Laboratory, completed conceptual design
- **Advanced Rotor Blade**
  - Completed flight testing or blade coatings in sand / dust environment





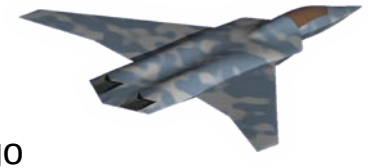
Fixed Wing Vehicle

- **Vision**

  Restricted airspace and limited basing drive the need for significant increase in range and access for tactical and mobility aircraft – while sustainment needs continue to increase.

  The Fixed Wing Vehicle Sub Area will:

  – Enable air superiority platforms with longer range, supercruise, greater payload, and more survivability
  – Enable future mobility aircraft that allow people and cargo to get to the fight and provide support in restricted areas
  – Clearing House for Sea-based Aircraft Launch and Recovery Technology
  – Enable more affordable and autonomous unmanned vehicles; and manned and unmanned teaming operations
  – Keep legacy fleet safe, affordable, available, and capable

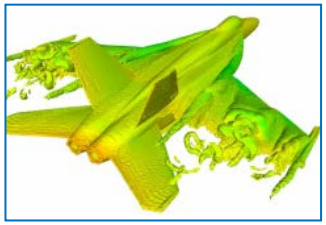


- **Objectives**

  – Air vehicle range, payload, control, speed, and cost
  – Access, interoperability, and expanded operating envelopes
  – Operational safety, efficiency, and reduced pilot training

- **Technology Challenge Areas**

  – Propulsion Integration
  – Aerodynamics and Control
  – Advanced Weapons Integration
  – UAS Integration and Autonomy
  – Advanced Structures and Sustainment
  – Design and Analysis (Faster, more robust analyses,
  – trade studies, flight simulations)



Fixed Wing Vehicle

Air Force Funded

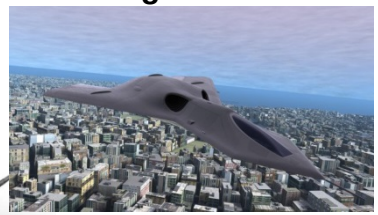
NASA / Navy Component

	FY15	FY16	FY17	FY18	FY19	FY20	FY21 +
Propulsion Integration	Mobility						Next Gen Mobility
	Next Gen Air Dominance						NGAD
Aerodynamics & Control	Drag Reduction						Legacy and Next Gen Mobility
	Advanced Aero and Control						NGAD and Next Gen UAS
Advanced Weapons Integration							NGAD
Structures, Control, and Integration							NGAD
							UAS Spirals
Advanced Structures							Next Gen Aircraft
Sustainment							Legacy Fleet
Design and Analysis							Next Gen Aircraft

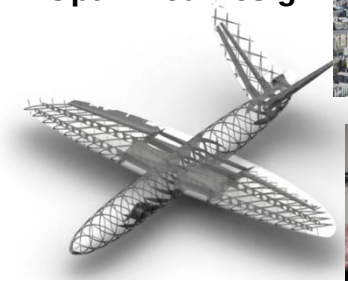
FWV Significant Accomplishments

- **For Sustainment…**
  - Metals Affordability Initiative (MAI) Bulkhead tested
  - Exhaust Washed Structure Modeling, Simulation, V&V – completed Phase 1 testing on aluminum mock panels
- **For Mobility…**
  - Hybrid Wing Body (HWB) – completed transonic cruise validation testing in the NASA NTF
  - KC-135 Compliant Flap Tab – initiated following successful NASA Adaptive Compliant Trailing Edge testing as part of the ERA Program
  - (Higher Bypass Ratio Inlet Development) Inlet Integration Demonstration (HIID) – working with NASA towards full propulsion flowpath demonstration with representative inlet, engine and exhaust systems
- **For Air Superiority…**
  - Advanced Control and Displays for Future Carrier Aircraft Approach and Recovery – CVN and fleet testing in 2016
  - Weapons-cavity Acoustics Store Separation Pod (WASSP) – obtained the first ever measurements of unsteady loads on a small store in a weapons bay during flight
- **For ISR…**
  - Low-Cost Attritable Aircraft Technology (LCAAT) – completed CONOPS, trade-space exploration and manufacturing risk reduction, determined low cost design/acquisition methods, fast-track demo planning, flight vehicle prototype conceptual design

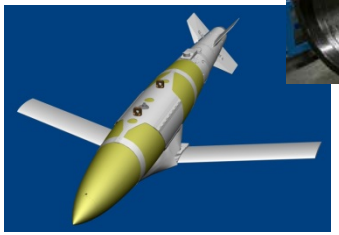
Flight Test



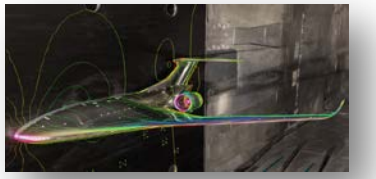
Optimized Design



Cost Imposing Manufacturing



Capable Vehicles



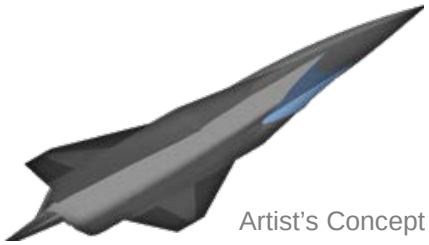
High-Speed/Hypersonics (HS/H)

Vision, Objectives, Major Research Areas

- **Vision**
  - Advance weapon systems into the hypersonic regime to enable transformational strike and intelligence, surveillance and reconnaissance (ISR) capabilities

- **Objectives**
  - By 2020, develop robust, comprehensive technology options for responsive, long-range strike
  - By 2030, develop robust, comprehensive technology options for penetrating regional platform

- **Major Research Areas**
  - Scramjet propulsion and integration
  - Rocket booster propulsion
  - Advanced materials, structures and manufacturing
  - Vehicle aeromechanics
  - Adaptive flight control
  - *High-speed Turbine Engines (leveraging Aircraft Propulsion, Power and Thermal Sub Area)*

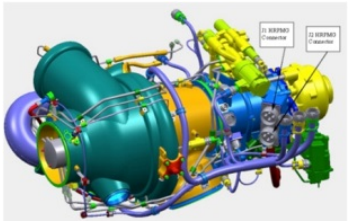


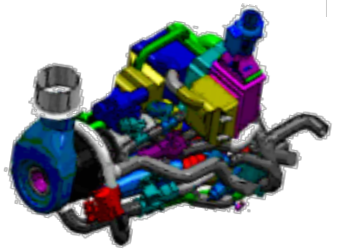
HS/H Significant Accomplishments

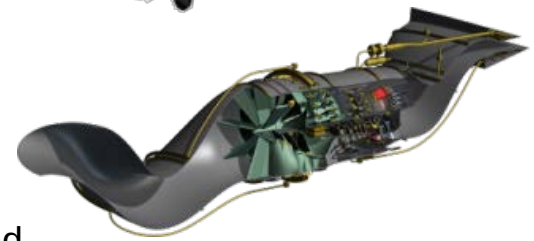
- **Tactical Boost Glide (TBG)**
  - Completed objective system trade studies and conceptual design definition
  - Derived hypersonic boost glide demonstration system design from the objective system
  - Conducting preliminary design of TBG missile demonstration system
  - Initiated development and testing of enabling subsystem technologies
  - Developing flight test plans
- **Hypersonic Air-breathing Weapon Concept (HAWC)**
  - Completed objective system trade studies and conceptual design definition
  - Derived hypersonic air-breathing missile demonstration system design from the objective system
  - Conducted preliminary design of HAWC missile demonstration system
  - Conducting risk reduction testing of enabling subsystem technologies
  - Developing flight testing plans for the hypersonic air-breathing missile demonstrator
- **High Speed Strike Weapon (HSSW) Technology Maturation**
  - Focusing on longer-term enabling/enhancing technologies
  - Developing technologies to expand the trade space in hypersonics
  - Technology maturation areas include guidance, navigation, control (GNC), ordnance, solid rocket motors, and materials and manufacturing

Aircraft Propulsion, Power & Thermal (APPT)

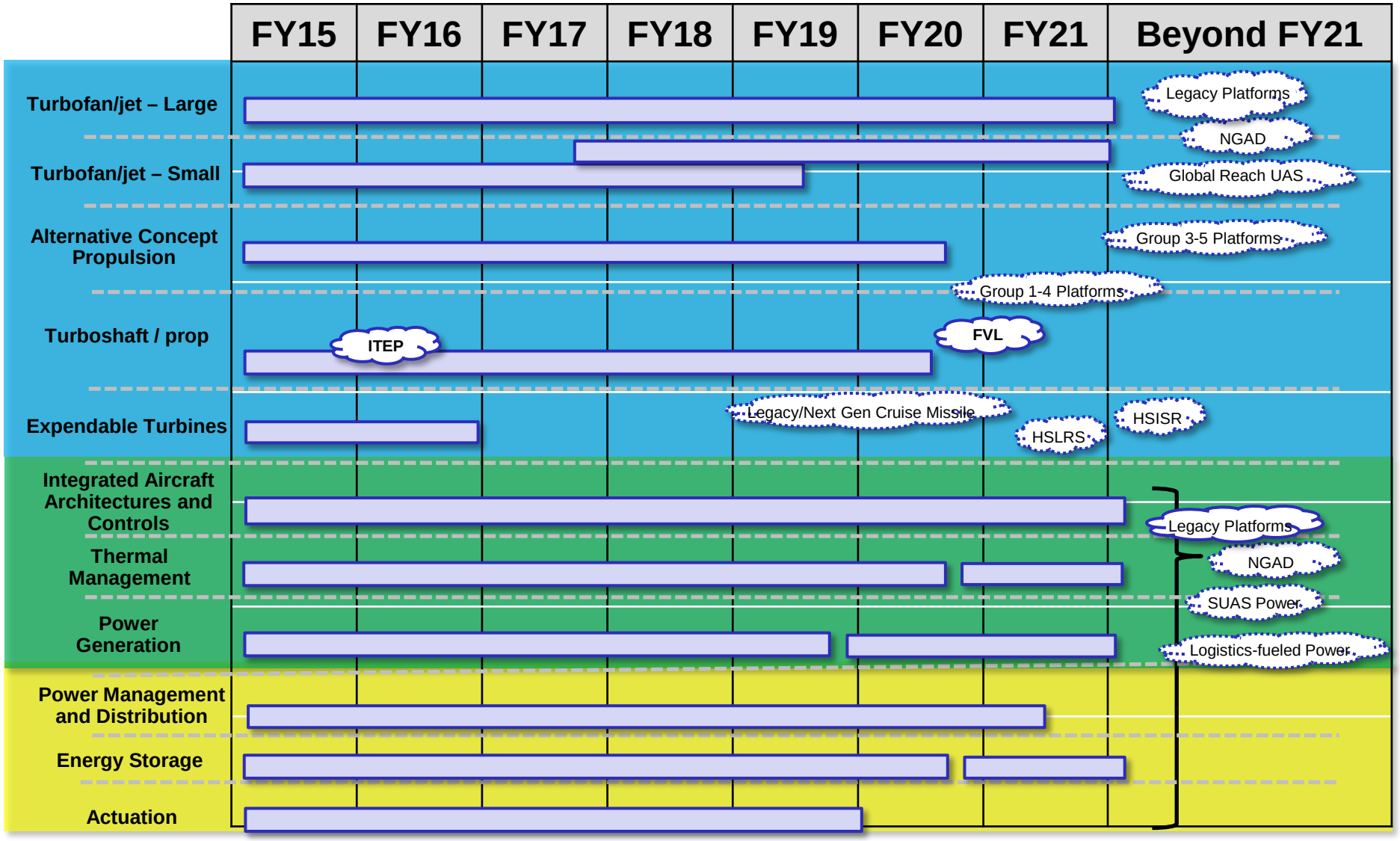
- **Vision**
  - Enhanced air platform capabilities addressing current/future threats and sustainment challenges are enabled by the Aircraft Propulsion, Power & Thermal (APPT) Sub Area's technology products
  - Coordination within APPT energizes a strong technology and Industry base maintaining U.S. leadership and superiority in aircraft propulsion, power and thermal management
- **Objectives**
  - Develop efficient, high-performing, light-weight, reliable, maintainable and affordable aircraft propulsion systems
  - Develop electrical power and thermal management technologies and subsystems to enable airborne mission capabilities
  - Develop an integrated architecture of engine, power and thermal technology for cost effective aircraft infrastructure capability demonstrations
- **Technology Challenges**
  - Robust integrated propulsion, power and thermal architectures
  - Model-based design for reduced design cycles
  - Large power extraction over a wide engine operating range
  - Balanced power and thermal systems without thermal restrictions and compromising engine operation





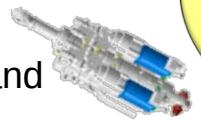


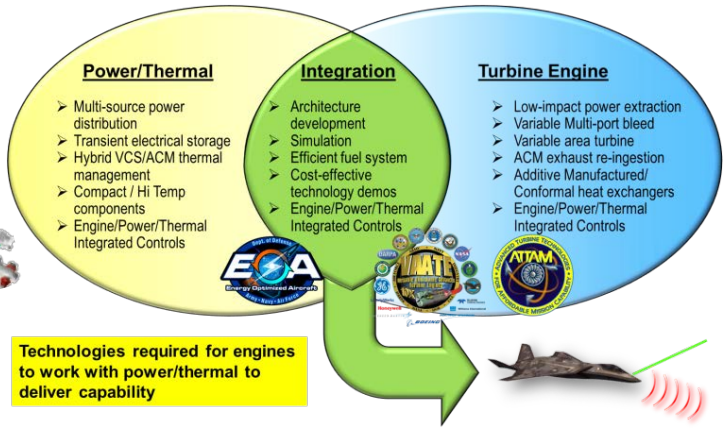
Aircraft Propulsion, Power & Thermal

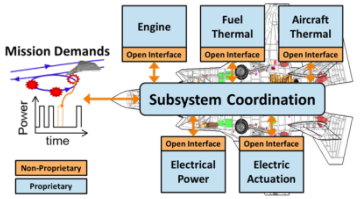


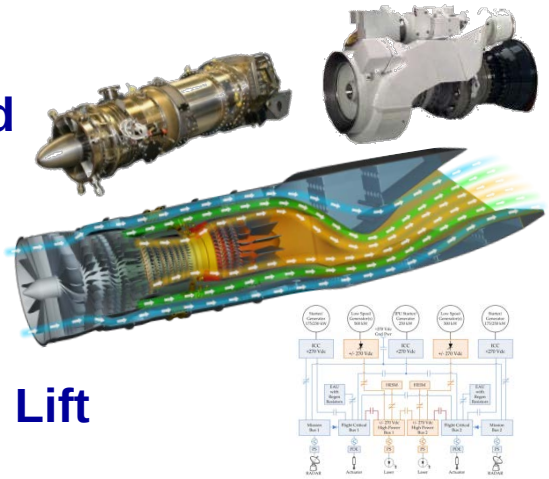
APPT Significant Accomplishments

- **Setting APPT foundation to develop engine, electrical power and thermal management integrated systems delivering air platform capabilities**
  - AEDC investigating upgrades to include power and thermal capabilities
  - Architectures and controls brainstorming
- **New planning construct for Beyond VAATE**
  - ATTAM – Advanced Turbine Technologies for Affordable Mission Capability
- **Develop a true integrated program with Energy Optimized Aircraft (EOA) and VAATE/ATTAM**
  - Recently awarded $5M on evaluating Future Air Dominance propulsion, power and thermal systems via Integrated Propulsion, Power and Thermal (INPPAT)
  - INPPAT will leverage MegaWatt Tactical Aircraft Initiative
- **Variable Cycle Advanced Technology (VCAT) – Initiated Phase II efforts for 2020 technology suite for variable cycle engine**
- **INtegrated Vehicle ENergy Technology (INVENT) Subsystem Demonstration Testing underway**
- **Army leverage of APPT for Aeronautics/Future Vertical Lift planning**









Air Platforms COI
Concluding Remarks

- **High-level, enduring coordination within the AP COI**
  - Cross-Service/Agency leadership and working-level coordination
  - Well-established Industry constituency
  - National-level forums
- **AP COI expanding interactions with other COIs**
  - Address integration holistically
  - Communicate better with Stakeholders, Industry, etc.
- **International activities aligned with Service strategies**

Providing innovative air platform technology and technology integration for *survivable*, *affordable*, *effective* and *agile* capability for legacy and future aircraft