Convergent Aeronautics Solutions (CAS) Project Overview

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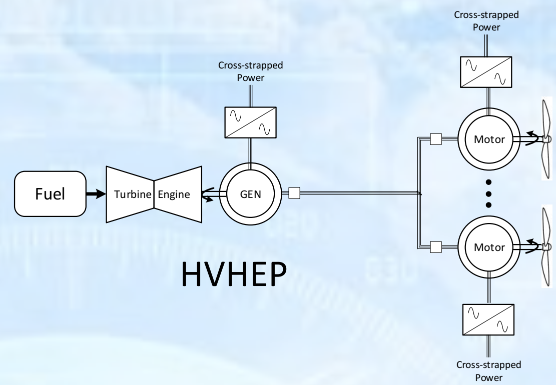
CAS PROJECT

DELIVER

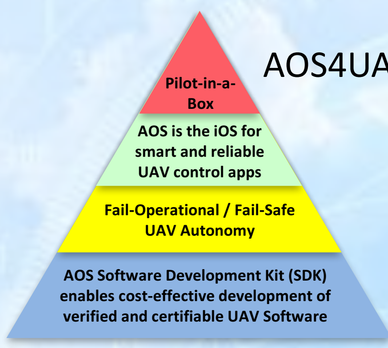
Learn to Fly

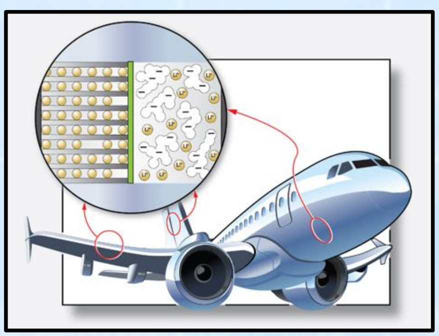
Digital Twin



HVHEP

AOS4UAV





M-SHELLS

MADCAT

AATC

Aeronautics Autonomy Testbed Capability

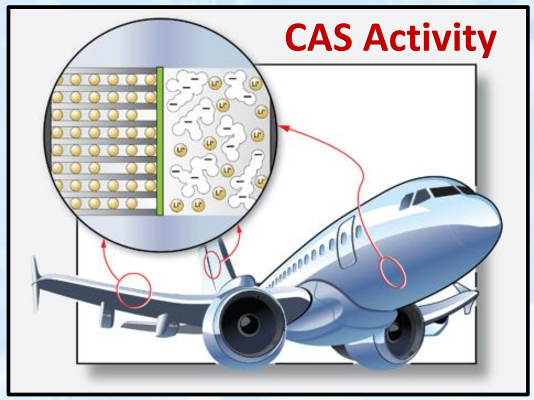
The CAS Vision: Transformative Concepts that are –

Feasibility Assessment Focused

… Technology Evaluation

Targeted

Rapidly Executed



Convergent

– Cross-Discipline, Cross-Center, Diverse Sources

Transformative

- Competitively Selected
- Light Project Management

CAS is Focused on Rapid Feasibility Assessment

What's a Feasibility Assessment and how is it different than a technology demonstration effort?

- **Feasibility Assessment is Technology Evaluation**
  based on extensive investigation and research to support the process of decision making.
  Short Term (0.5-2.5 yrs), rapid "build-measure-learn" - assess feasibility and move on

  – Understand where the concept works and where it does not

  – Understand the concept's broader applicability

  – Push the boundaries of concept effectiveness (even taking the concept to failure)
  Such as determine: When, How, and To What Extent, … to Use the Concept

  – Consider important real-world "ilities" – e.g. Maintainability, Community Acceptability, Fly-ability, Cost, Interoperability, etc.

  – Not to suggest that all "ilities" will be considered, but identify the most important challenges and have them inform the feasibility approach

- **A successful feasibility assessment may determine that the concept doesn't work**

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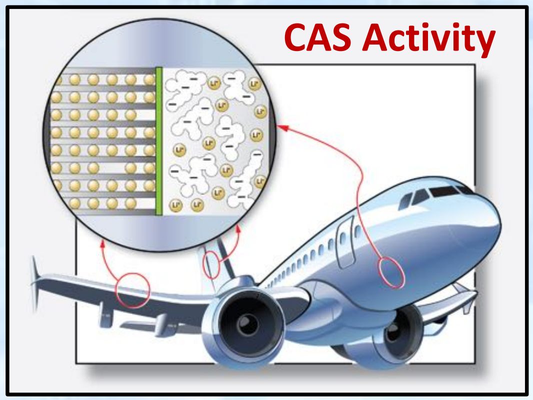

Convergent

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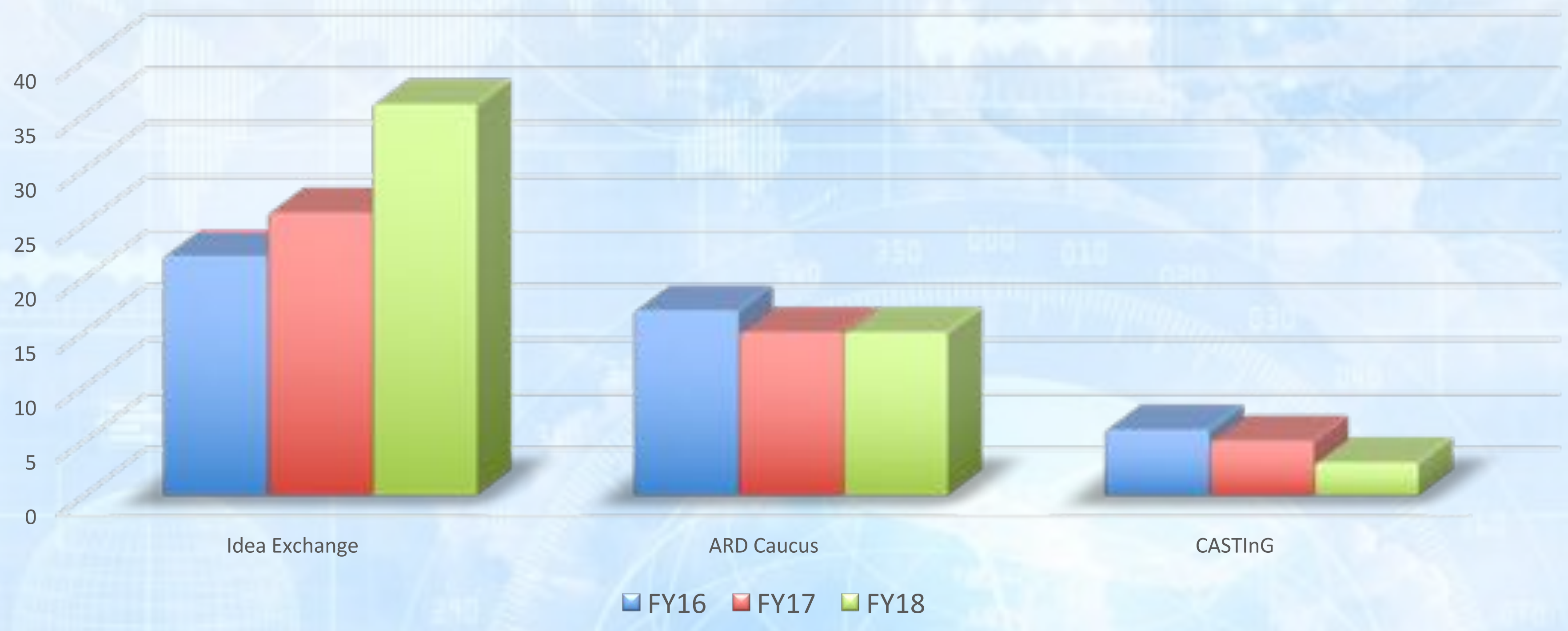
Transformative

FY comparison of CAS proposals



Projected CAS FY18 Project Portfolio

	Quarters in Execution																Thrusts/Outcomes						Participating Centers			
	FY17 Q1	FY17 Q2	FY17 Q3	FY17 Q4	FY18 Q1	FY18 Q2	FY18 Q3	FY18 Q4	FY19 Q1	FY19 Q2	FY19 Q3	FY19 Q4	FY20 Q1	FY20 Q2	FY20 Q3	FY20 Q4	1	2	3	4	5	6	ARC	AFRC	GRC	LARC
FY18 (Round 3) New Start Sub-Projects																										
ATTRACTOR																	F				F	**M,F**	x	x		X
AAAVA																					**N,F**	N,F			x	X
QT																	**M**				M	M	X		x	
FY17 (Round2) Sub-Projects																										
LION																			A	**A**			X	x	x	
SAW																		A	**A**					X	x	x
FUELEAP																			A	**A**				x	x	X
CAMIEM																			A	**M, F**				x	X	x
CLAS-ACT																	**M, F**		M,F			F	x	x	X	x
FY16 (Round1) Sub-Projects																										
Learn2Fly																	**F**		F			F	x	x		X
Digital Twin																			M		**N,M**		x			X
MADCAT																			**F**				X			x
AOS4UAV																						**F**	X			x
M-SHELLS																			M,F	**M,F**			x		X	x
HVHEP																			M,F	**M,F**			x		X	x
Pre-Selected (Round0) Sub-Projects																										
DELIVER																			**N**	M			X		x	x
																							10	7	9	12

quarters in execution — quarters in transition/closeout — transition from CAS to Mission Projects

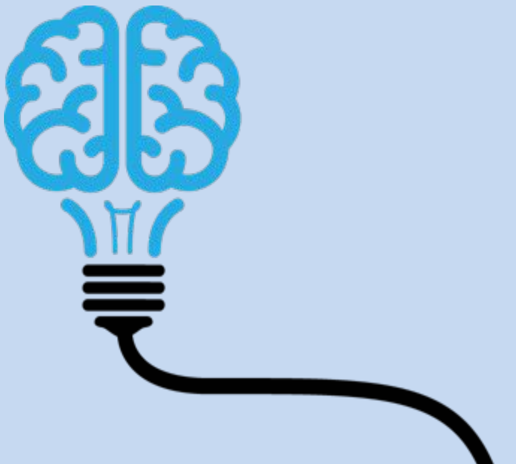
P Primary Thrust
S Secondary Thrust

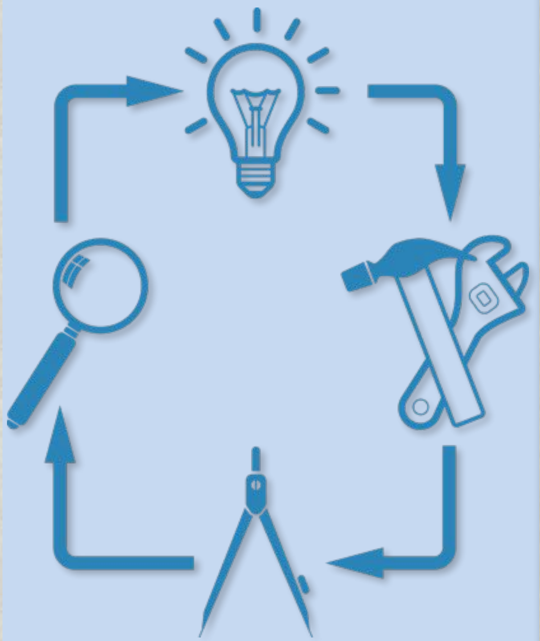
Outcomes
N: Near Term (2015-2025) M: Mid-Term (2025-2035)
F: Far-Term (>2035) A: All Outcomes

X Home Center of Principal Innovator
x Partnering Center

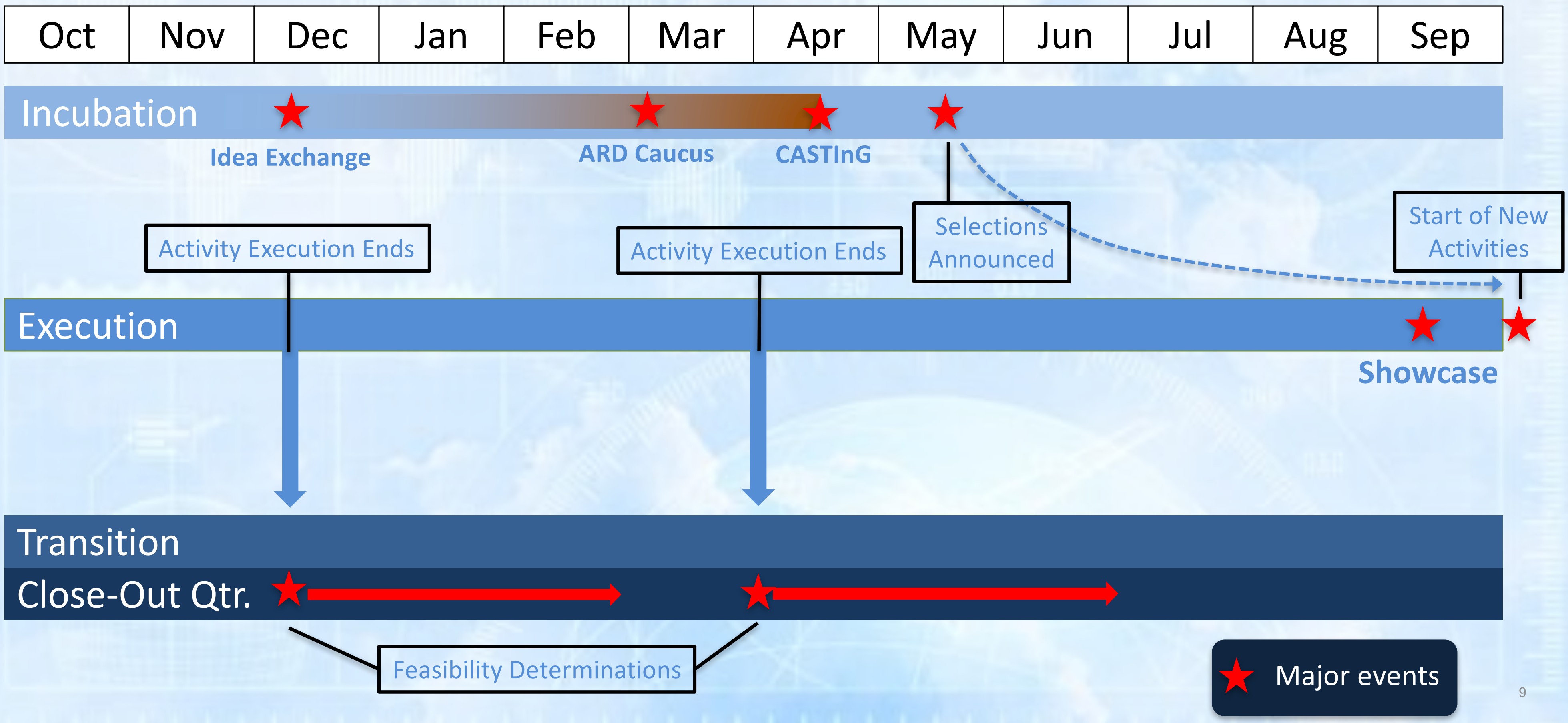
Managed by Phases

Incubation	ARMD Decision Gate: CAS Teams Investment Gateway (CASTInG)	Execution	Feasibility Determination and Assessment	Transition & Closeout	CAS Sponsorship Ends





Notional CAS Year



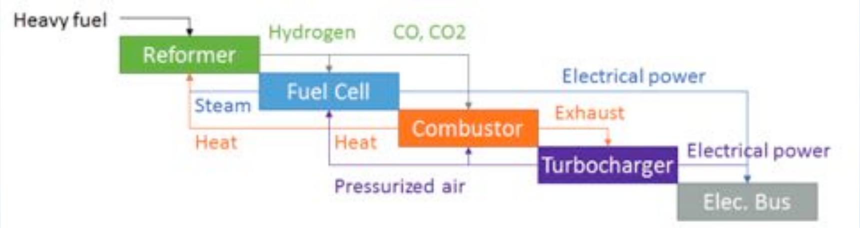
CAS Activities coming after this presentation

	Activity
Round 1 (2016)	Digital Twin
Round 1 (2016)	Learn to Fly (L2F)
Round 1 (2016)	Autonomy Operating System for UAVs (AOS4UAV)
Round 1 (2016)	High Voltage Hybrid Electric Propulsion (HVHEP)
Round 1 (2016)	Multifunctional Structures for High Energy Lightweight Load-bearing Storage (M-SHELLS)
Round 1 (2016)	Mission Adaptive Digital Composite Aerostructure Technologies (MADCAT)

CAS Activities

DELIVER – Design Environment for Novel Vertical Lift Vehicles, PI: Colin Theodore (ARC): The key focus of DELIVER is to demonstrate the feasibility of applying current conceptual design tools to small and novel vertical lift vehicle configurations, and to augment these tools with the most compelling technologies for usability, operability, and community acceptance of these novel vehicles. The compelling technologies examined in DELIVER are noise, autonomy/automation, and hybrid-electric propulsion systems.

CAS Activities (continued)



FUELEAP – (Fostering Ultra Efficient Low- Emitting Aviation Power), PI: Nicholas Borer (LaRC): This concept leverages technology convergence in high-efficiency Solid Oxide Fuel Cells (SOFC), high- yield fuel reformers, and hybrid-electric aircraft architectures to develop tightly integrated power system that produces electricity from traditional hydrocarbon fuels at ~2x typical combustion efficiencies. The ability to use existing infrastructure, along with compelling performance, will enable near-term adoption of electric propulsion for aircraft. This project is to establish the feasibility of an integrated heavy fuel hybrid-electric SOFC power system through safety-focused design and selected component technology maturation, using the X-57 "Maxwell" Mod 2 and Mod 4 configurations as integration baselines.

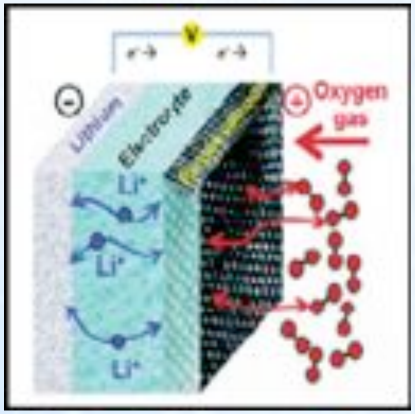
SAW – (Spanwise Adaptive Wing) PI: Matthew Moholt (AFRC) and Co-PI: Dr. Othmane Benafan (GRC): Enabling reconfigurable aircraft through The Spanwise Adaptive Wing (SAW) Concept. Increasing aircraft efficiency by reducing the rudder through the incorporation of SAW. Articulating the outboard portions of the wing via Shape Memory actuation. Lateral-directional stability and control augmentation. Supersonic - Increased compression lift and reduced wave drag for supersonic flying wing design.

CAS Activities (continued)

CAMIEM – (Compact Additively Manufactured Innovative Electric Motor), Michael C. Halbig (PI GRC), Peter Kascak (Co-PI GRC): New manufacturing method are needed to obtain innovative electric motor designs that have much higher power densities and/or efficiencies compared to the current state-of- the-art. Additive manufacturing offers the potential to radically change the motor designs so that they have compact designs, multi-material components, innovative cooling, and optimally designed and manufactured components. A new motor, which utilizes additive manufacturing will be built and tested and performance gains will be evaluated.

CLAS-ACT – (Conformal Lightweight Antenna Structures for Aeronautical Communication Tech- nologies), PI: Mary Ann Meador (GRC) and Robert Kerczewski (Co-Pi): Develop lightweight conformal antennas which enable beyond line of sight (BLOS) command and control for UAVs and other vehicles. Antennas will be made using polyimide aerogels as the low dielectric substrate to reduce weight and improved performance, will take advantage of newly assigned provisional Ku-bands to enable UAV communication and use unique antenna designs to avoid interference with ground.

CAS Activities (continued)



LION – (Integrated Computational-Experimental Development of Lithium-Air Batteries for Electric Aircraft) PI: John Lawson (ARC), and PI: Vadim Lvovich (GRC): The primary obstacle to enable NASA's vision of Green Aviation is the extraordinary energy storage requirements for electric aircraft. Lithium-Air batteries have the highest theoretical energy storage capacity of any battery technology and if realized will transform the global transportation system. Lithium-Air batteries are effectively "breathing batteries". During discharge, Oxygen is pulled into the battery to react with Lithium ions and when the battery is charged, Oxygen is expelled from the battery. A significant problem for current Lithium-Air batteries is large scale decomposition of the battery electrolyte during operation leading to battery failure after a handful of charge/discharge cycles. Therefore, development of large scale, ultra-high energy, recharge- able, and safe Lithium-Air batteries require highly stable electrolytes that are resistant to decom- position under operating conditions. A NASA led "dream team" of high-powered experts from NASA, academia, the Department of Energy and industry will integrate supercomputer modeling, fundamental chemistry analysis, advanced material science, and battery cell development to tackle this very challenging, multidisciplinary problem. The ultimate goal for the team is to discover the "design rules" for ultra-stable electrolytes for Lithium-Air batteries. The developed Lithium-Air battery will be demonstrated in an UAV flight. These high energy batteries have the potential to meet the energy storage challenges of current and future NASA aeronautics and space missions in addition to many terrestrial transportation applications.

CAS Project Organization [FY17]

PROJECT LEVEL

PM: Isaac López
DPM: Marty Waszak

Center Liaisons: Starr Ginn (AFRC), Dr. Greg Dorais (ARC), Dr. Jerry Welch (GRC), Dr. Pete Lillehei (LaRC)

Execution Manager: Debbie Martínez
Transition Manager: Peggy Cornell
Business Lead: Christina Morris
Scheduler: Donna Gilchrist

Manager	Center Liaisons	Execution Manager	Transition Manager
Phase	Incubation	Execution	Transition & Close Out

Incubation

- **Next FY18 Concepts**

Execution

Round 1 (FY16-18)

- AOS4UAV*
- HVHEP
- DELIVER*
- MADCAT*
- Digital Twin*
- M-SHELLS
- L2F*

Round 2 (FY17-19)

- FUELEAP
- LION
- CAMEIM
- SAW
- CLAS-ACT

** Execution activities ending 4QFY17*

Transition & Close Out

- AATC
- SCEPTOR
- X-Plane