HAT Tricks: Understanding Human Autonomy Teaming through Applications

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What is a "Hat Trick" ?

Achieving a positive feat three times in a game

Effective Human-Autonomy Teaming in three critical functions:

MONITOR → **ASSESS** → **DECIDE**

Safe and Efficient Crew-Autonomy Teaming/Technologies (SECAT) Sub-project

Goal:

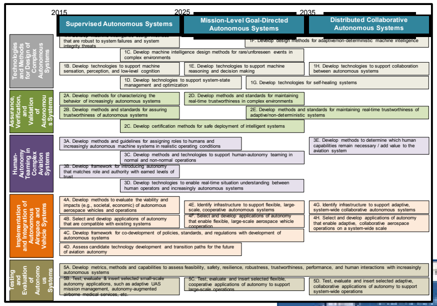
Develop and demonstrate the feasibility of using autonomous systems concepts, technologies, and procedures to improve aviation safety and efficiency during nominal and off-nominal operations.

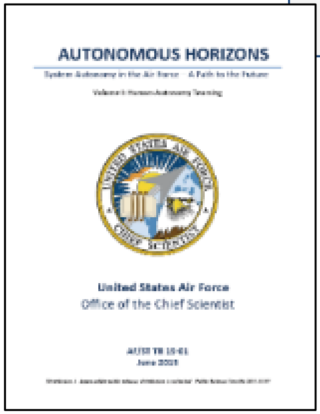
Benefits:

- Provide autonomy-based technologies that collaborate with the human crew to monitor and mitigate risk in flight.
- Develop crew-autonomy teaming strategies and techniques that will enhance trust in autonomy in the cockpit.

Addressing Autonomous Systems Research Needs

- SECAT addresses the research themes identified by the ***ARMD Strategic Thrust 6 Roadmap***, primarily:
  - Human-Autonomy Teaming in Complex Aviation Systems
  - Technologies and Methods for Design of Complex Autonomous Systems
- SECAT addresses the emerging White House AI policy
  - Identifying benefits and risks of Artificial Intelligence (AI)
- SECAT addresses USAF Autonomous Systems Research Needs
  - Goal: “the best benefits of autonomous software working synergistically with the innovation of empowered airmen”

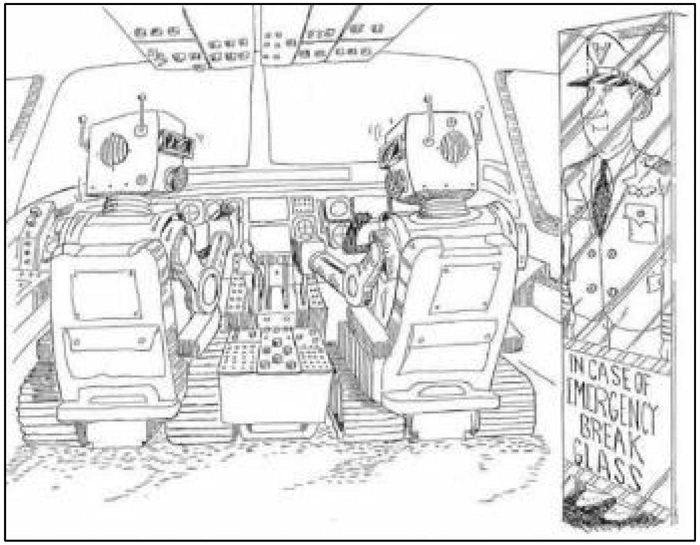




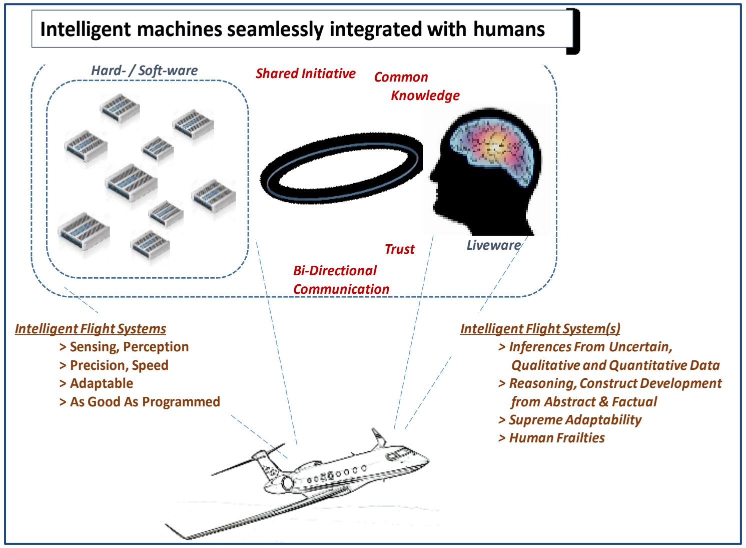
Technical Background - Increasingly Autonomous Systems

PRESENT → **FUTURE**

Increasingly Automated Systems



Increasingly Autonomous System



Performance and safety of combined system is greater than either component alone.

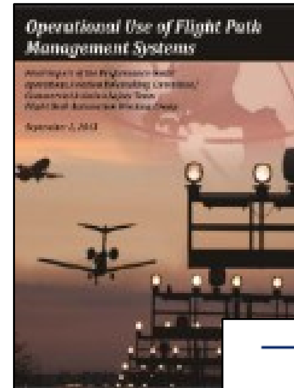
Levels of Automation (SAE International)

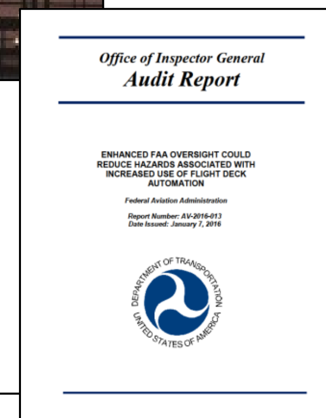
	Human Driver Monitors Environment			System Monitors Environment		
	0 No Automation	**1** Driver Assistance	**2** Partial Automation	**3** Conditional Automation	**4** High Automation	**5** Full Automation
	The absence of any assistive features such as adaptive cruise control.	Systems that help drivers maintain speed or stay in lane but leave the driver in control.	The combination of automatic speed and steering control—for example, cruise control and lane keeping.	Automated systems that drive and monitor the environment but rely on a human driver for backup.	Automated systems that do everything—no human backup required—but only in limited circumstances.	The true electronic chauffeur: retains full vehicle control, needs no human backup and drives in all conditions.
Who steers, accelerates and decelerates	Human driver	Human driver and system	System	System	System	System
Who monitors the driving environment	Human driver	Human driver	Human driver	System	System	System
Who takes control when something goes wrong	Human driver	Human driver	Human driver	Human driver	System	System
How much driving, overall, is assisted or automated	None	Some driving modes	Some driving modes	Some driving modes	Some driving modes	All driving modes

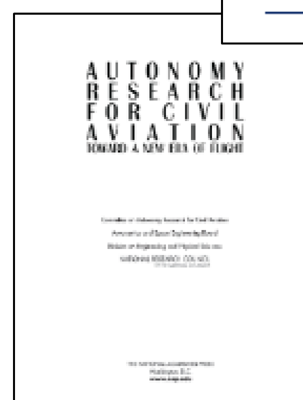
Credit: Scientific American, June 2016

Current Flight Safety Challenges with Automation

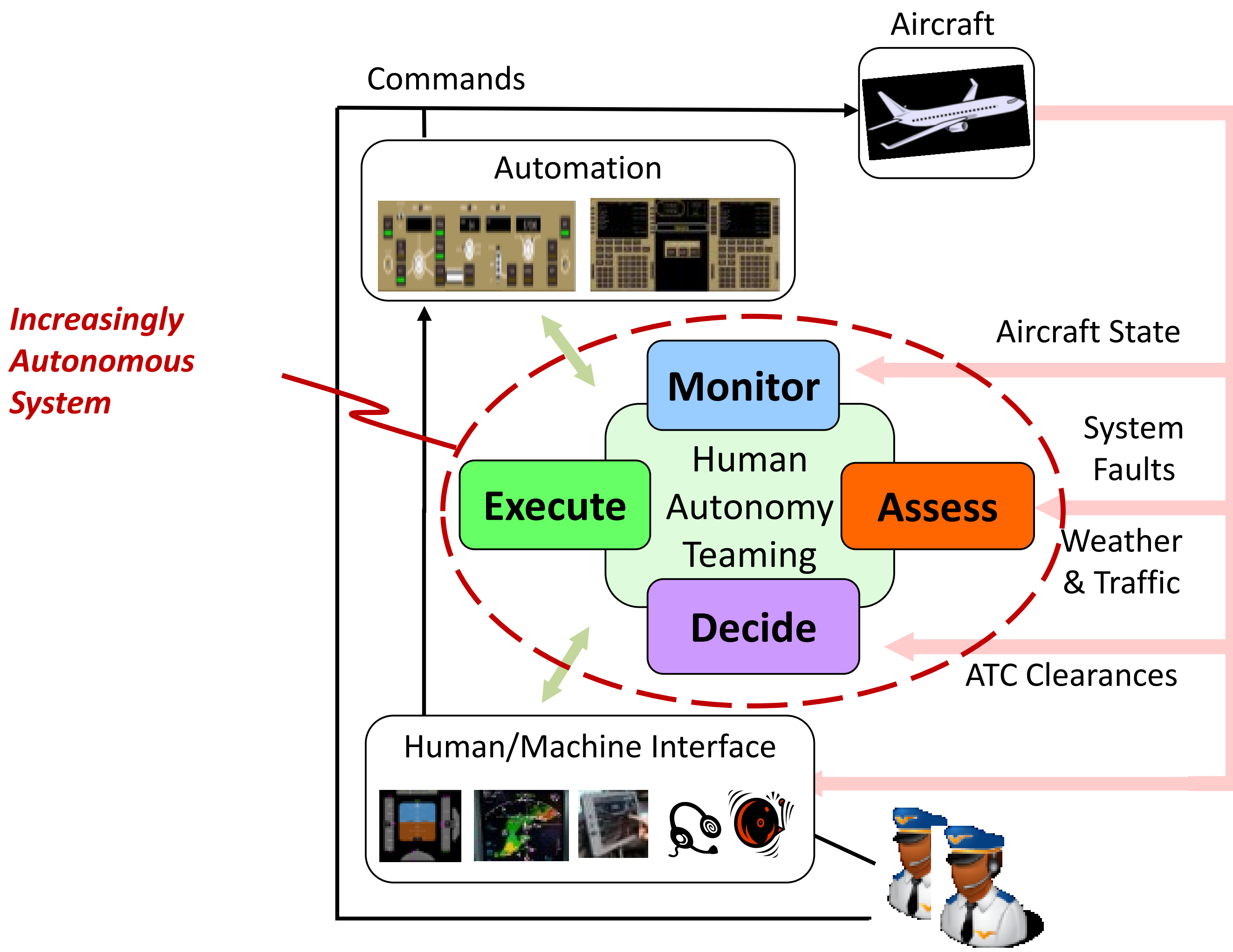
- *FAA PARC/CAST Flight Deck Automation Working Group Final Report, 2013*
  - Pilots frequently mitigate safety and operational risks – the aviation system is designed to rely on that mitigation
  - Insufficient depth of system knowledge or understanding of aircraft
- *"Enhanced FAA Oversight Could Reduce Hazards Associated With Increased Use of Flight Deck Automation," DOT OIG Report, 2016:*
  - Relying too heavily on automation systems may hinder a pilot's ability to manually fly the aircraft during unexpected events
- From "Autonomy Research for Civil Aviation: Toward a New Era of Flight," *National Research Council*, 2014
  - *Stakeholder/Public/Flight Crew perception* - autonomy "trust" and "social issues"



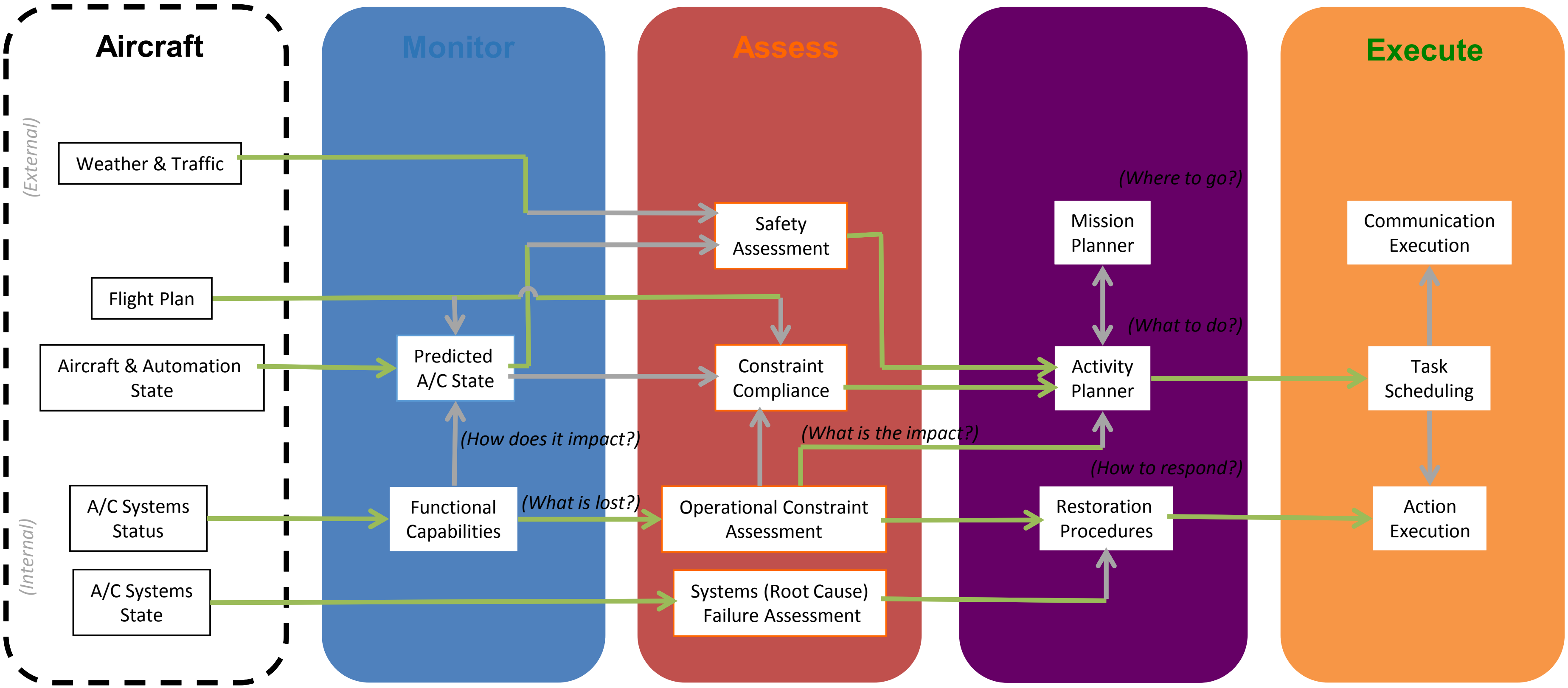




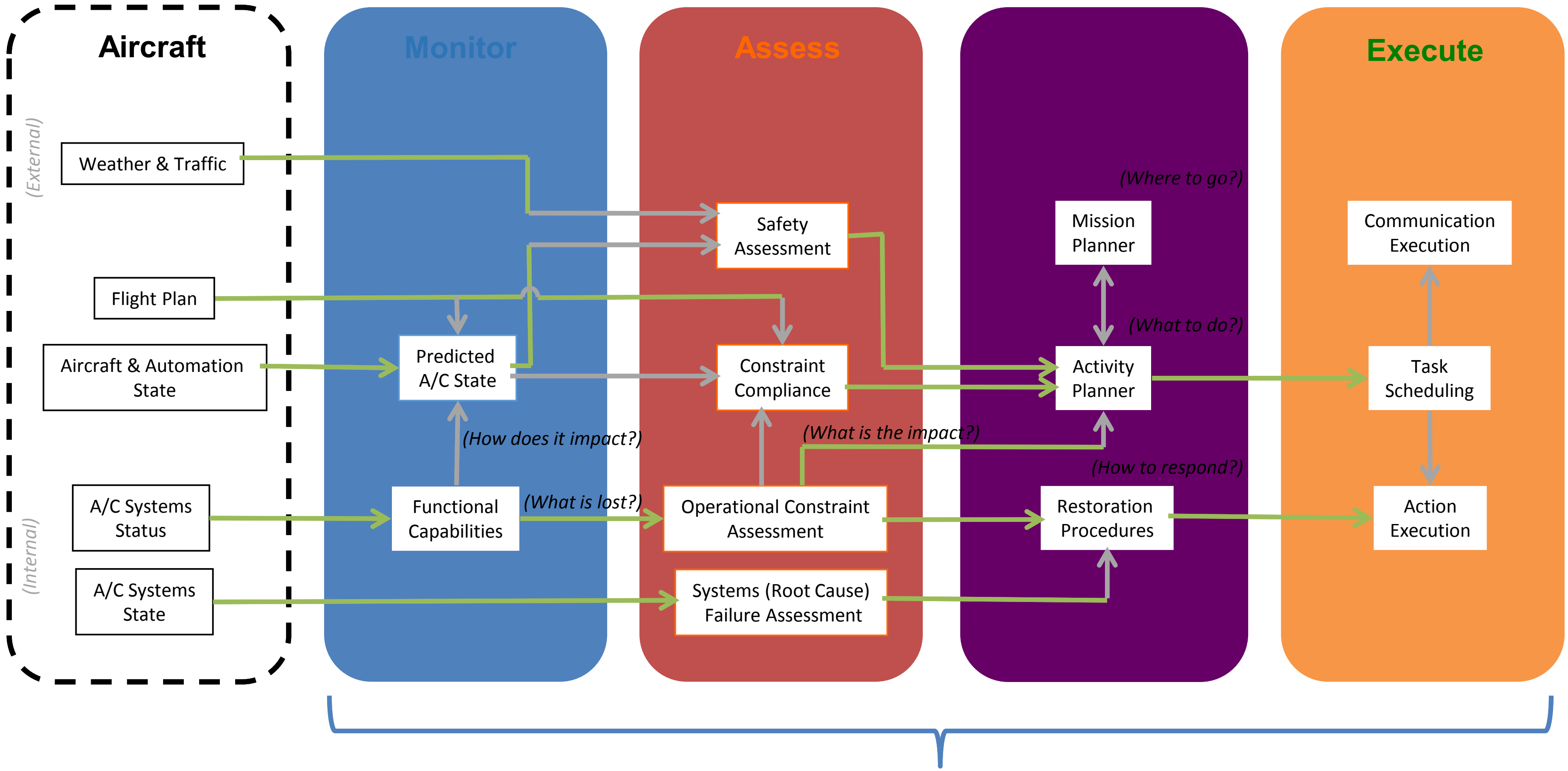
Technical Approach



Technical Approach

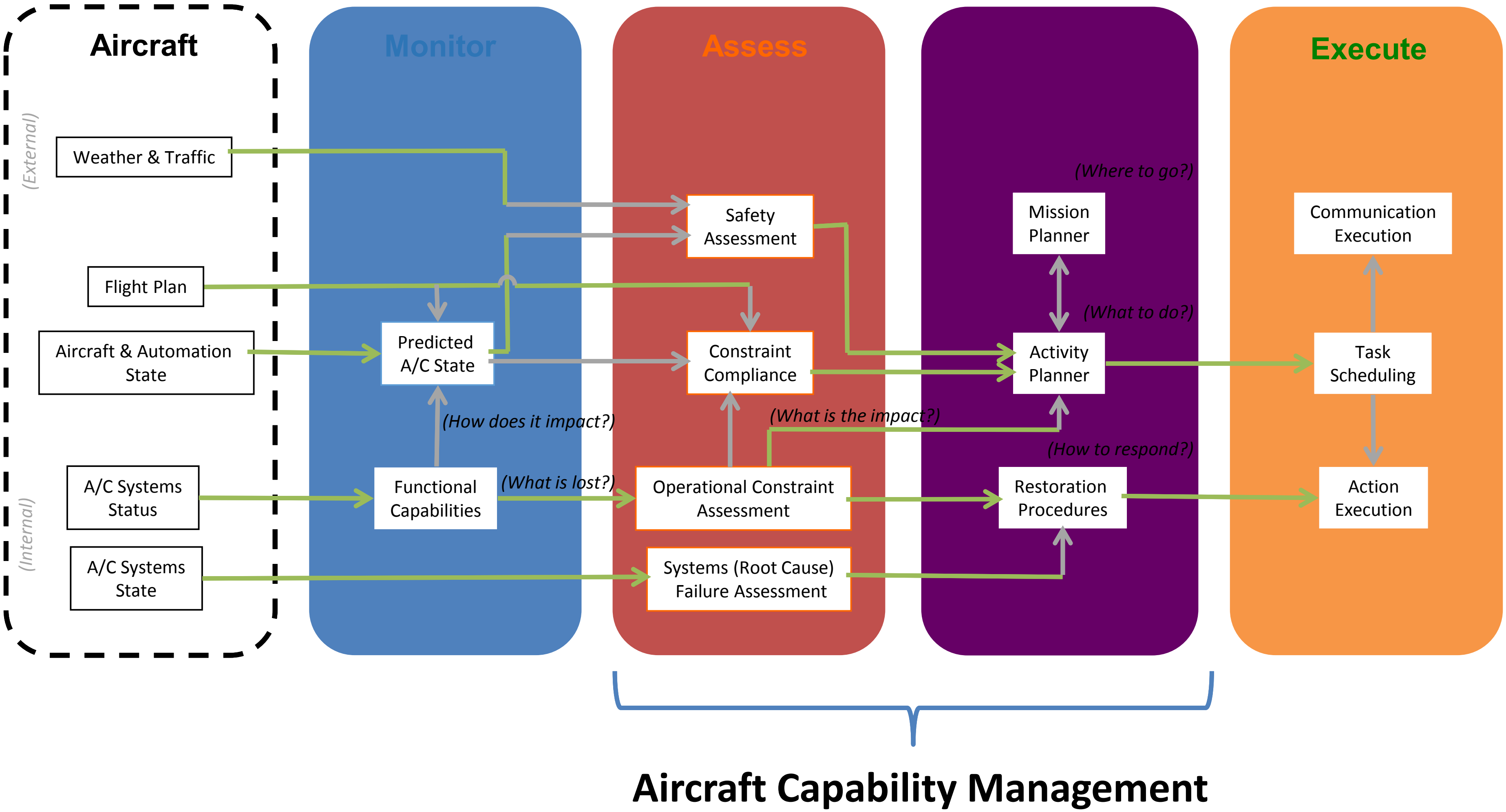


SECAT Technical Objectives



General Framework for Human Autonomy Teaming

SECAT Technical Objectives



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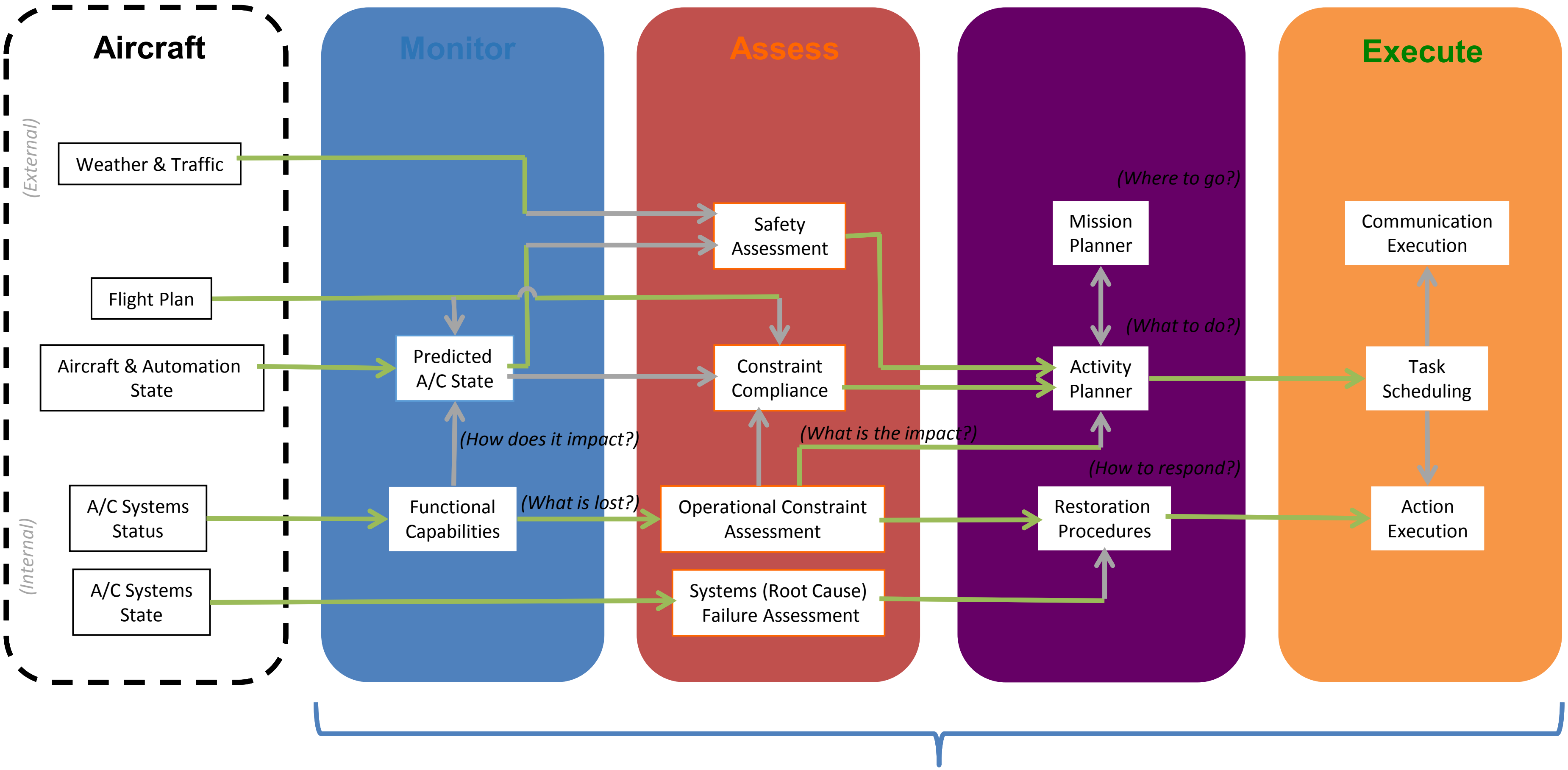

Cockpit Hierarchical Activity Planning and Execution