


Johnson Space Center Engineering Directorate

L-8: Modeling the integration of hardware and software systems of spacecraft using SysML

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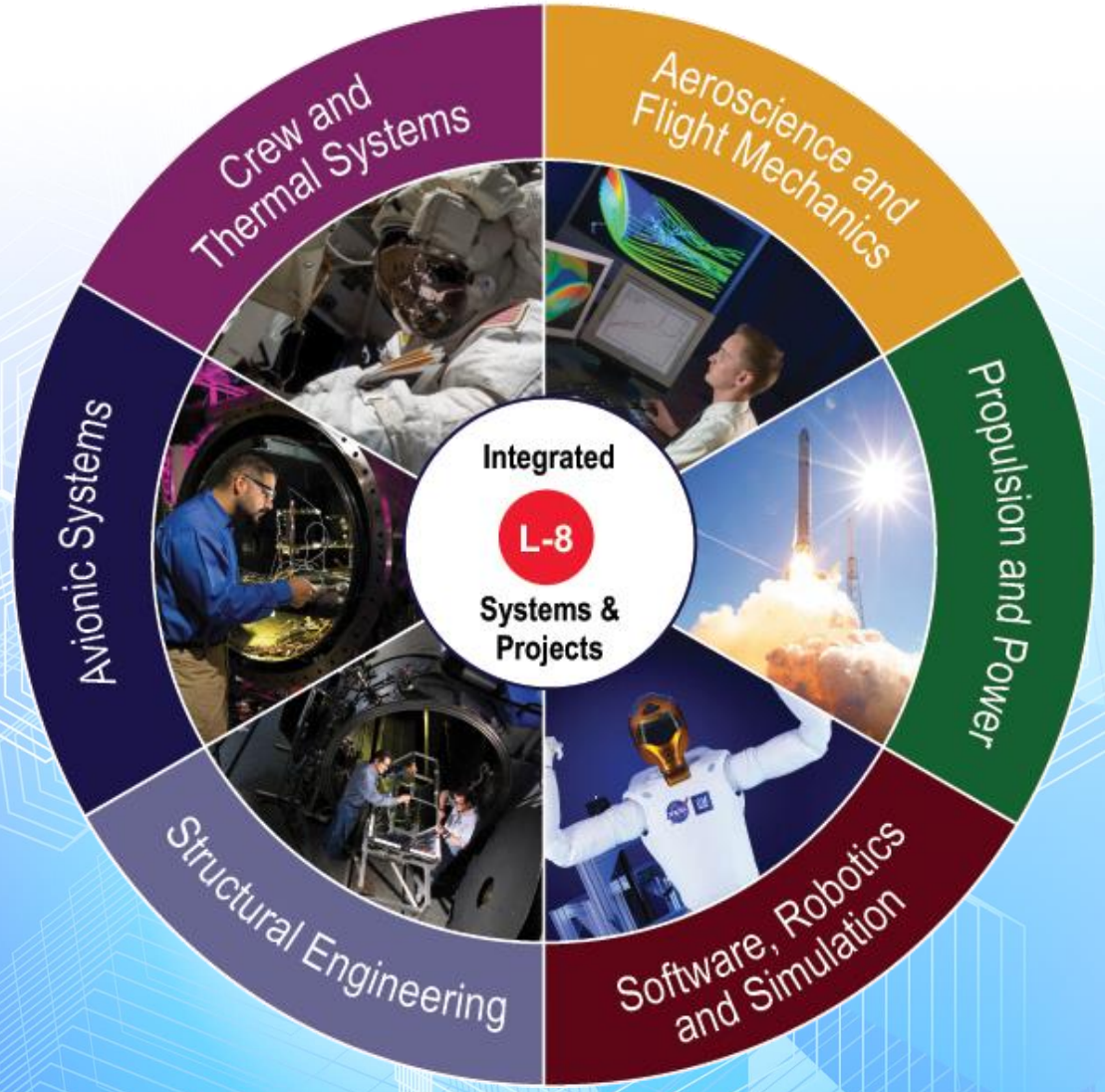
JSC Engineering: HSF Exploration Systems Development



- We are sharpening our focus on Human Space Flight (HSF) Exploration Beyond Low Earth Orbit
- We want to ensure that HSF technologies are ready to take Humans to Mars in the 2030s.
  - Various Roadmaps define the needed technologies
  - We are attempting to define our activities and dependencies
- Our Goal: Get within 8 years of launching humans to Mars (L-8) by 2025
  - Develop and mature the technologies and systems needed
  - Develop and mature the personnel needed
- This is one of a number of specific partnership opportunities that you might be interested in to discuss during SpaceCom 2016.

EA Domain Implementation Plan Overview

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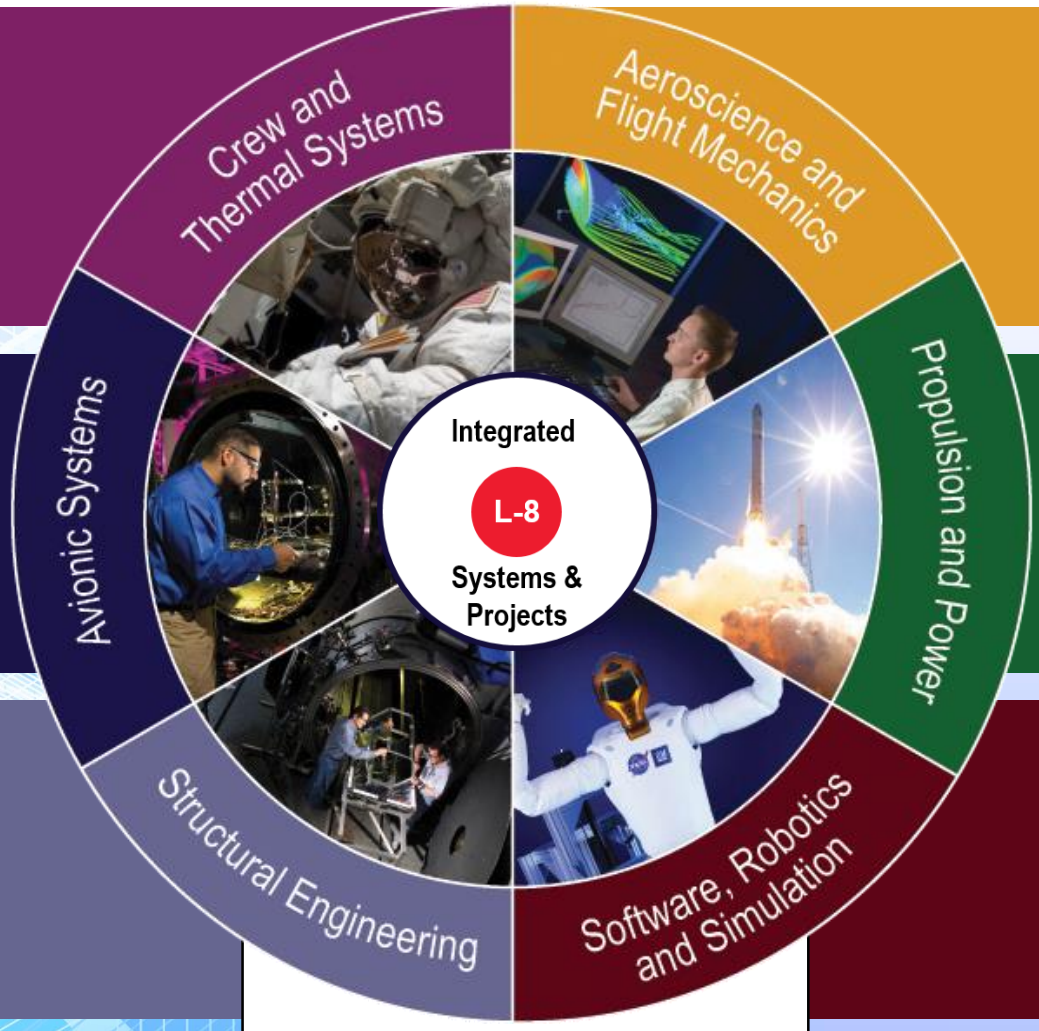
- Life Support
- Active Thermal Control
- EVA
- Habitation Systems

- Human System Interfaces
- Wireless & Communication Systems
- Command & Data Handling
- Radiation & EEE Parts

- Lightweight Habitable Spacecraft
- Entry, Descent, & Landing
- Autonomous Rendezvous & Docking
- Vehicle Environments



AA-2 | iPAS | HESTIA | Morpheus

- Entry, Descent, & Landing
- Autonomous Rendezvous & Docking
- Deep Space GN&C

- Reliable Pyrotechnics
- Integrated Propulsion, Power, & ISRU
- Energy Storage & Distribution
- Breakthrough Power & Propulsion

- Crew Exercise
- Simulation
- Autonomy
- Software
- Robotics

Integrated Systems and Projects Challenge

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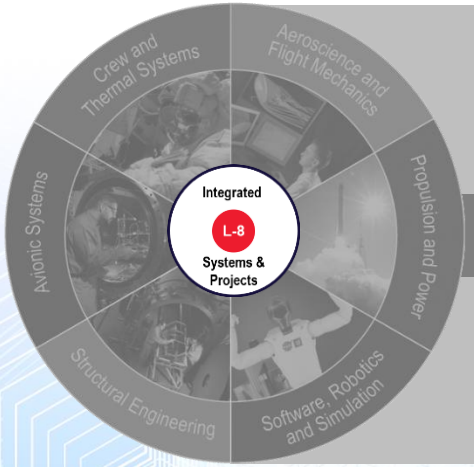


- Integrated Test & Verification
- System Modeling
- System Engineering & Integration

The Problem

- Space systems are becoming increasingly complex
- Space systems are becoming increasingly intelligent
- Space systems are becoming increasingly autonomous

- Interactions among intelligent systems is not consistent and is incomplete

- Can NASA learn from other industry experience?

Modeling the integration of hardware and software systems of spacecraft using SysML

The Effort being proposed

- We are implementing the use of a standard system modeling language (SysML) to describe space systems and their interactions

The Idea we have

- Each system can be represented at a high level and a detailed level. Any level of abstraction can be leveraged to demonstrate interfaces, activities, and states between systems

Why is collaboration a good idea?

- Complex and intelligent yet otherwise independent systems that require unattended intercommunication is common among many industries

The kind of Collaboration we envision

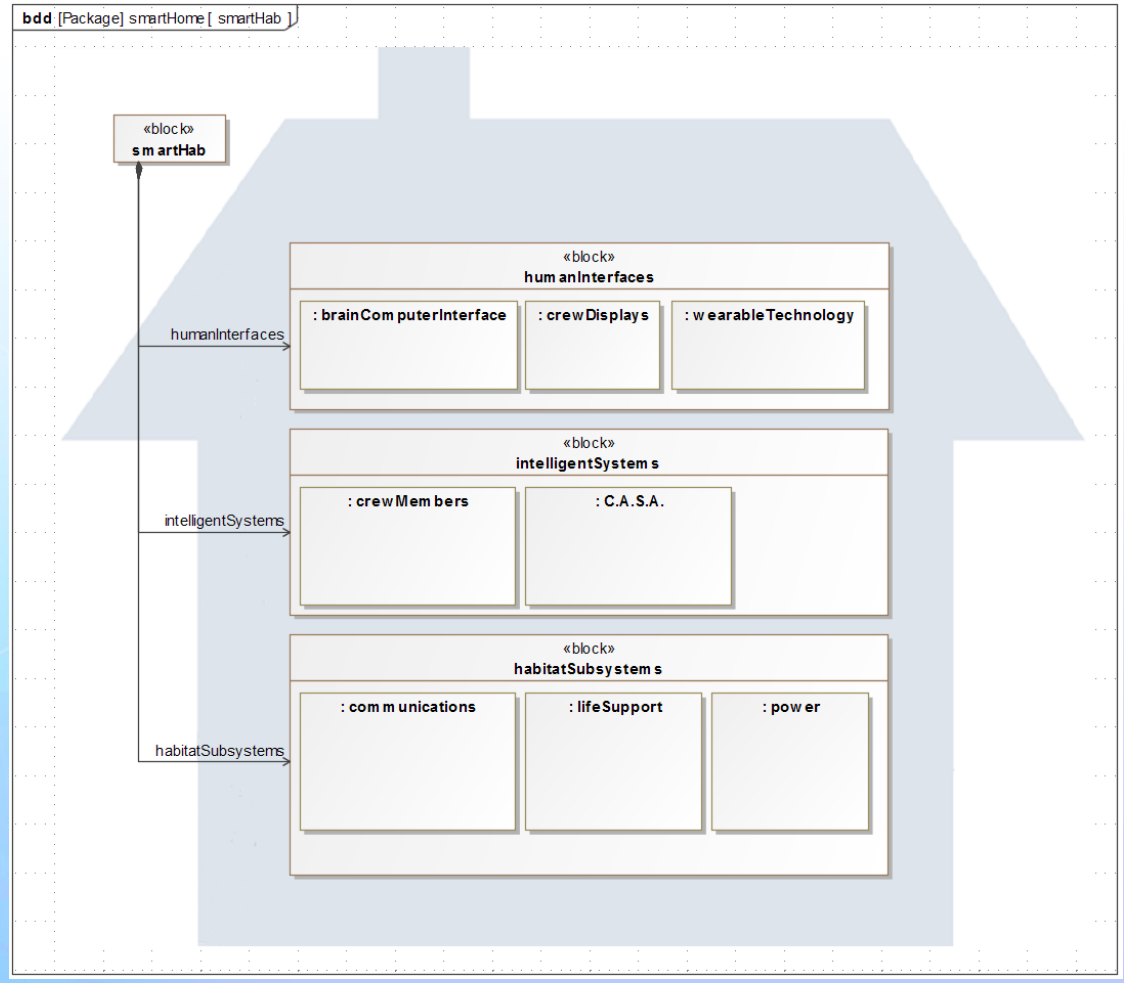
- Modeling methodologies, product evaluations, success criteria

The kind of partner we expect

- Provider of systems analogous to space systems (smart home, manufacturing, self-driving cars, remote systems, Internet of Things)

Modeling the integration of space craft systems

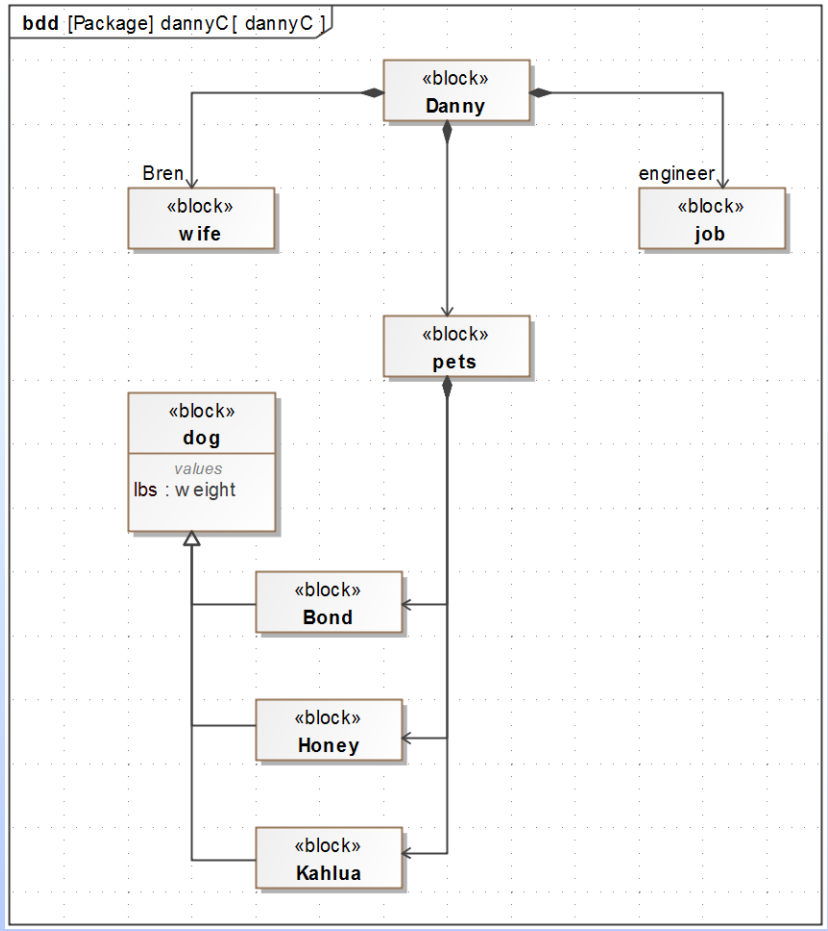
- Space systems are now smart connected systems
  - Avionics
    - Physical – sensors and actuators
    - Smart – embedded processing
    - Connectivity – wired or wireless
  - Behavior
    - Monitoring – conditions, operation
    - Control – functions, behavior
    - Autonomy - independence
- System modeling is needed to understand interactions
  - Common language for representing typically independent systems
  - Interface Description
  - Failure modes



"Smart" Habitat for Deep Space Exploration

The benefits of SysML

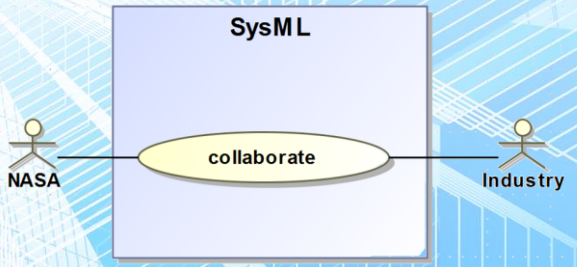
- What is SysML
  - OMG standard - System Modeling Language
  - General purpose graphical modeling language
- Abstraction and detail together
  - Blocks with embedded attributes
  - Complex systems simplified
- Hardware and Software description
  - Extension of UML
  - Co-location of hardware and software
- SysML can be used to describe technologies considered different from one another AND their interactions

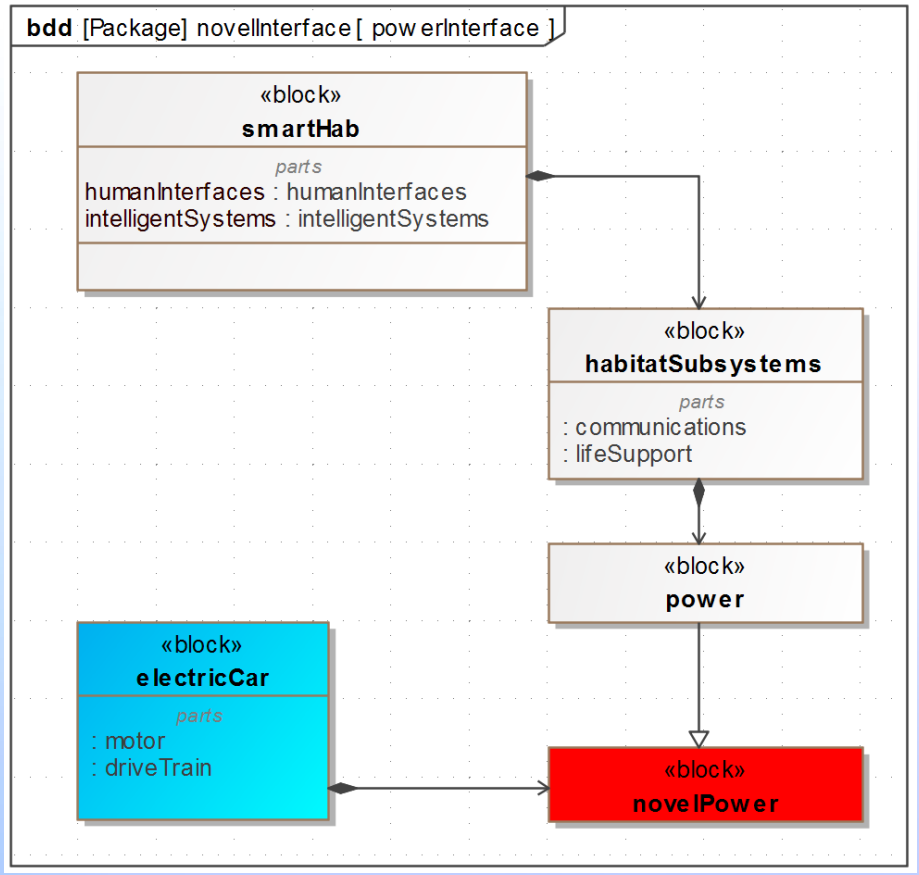


Model of complex system (family)

How we can work together

- 1 - Share models
  - Is the language really standard?
  - Does the architecting tool matter?
  - How can model libraries help?
- 2 - Start a model together
  - Choose a diverse and integrated scenario
  - Model independently yet cooperatively





Model of system shared
from one industry to another

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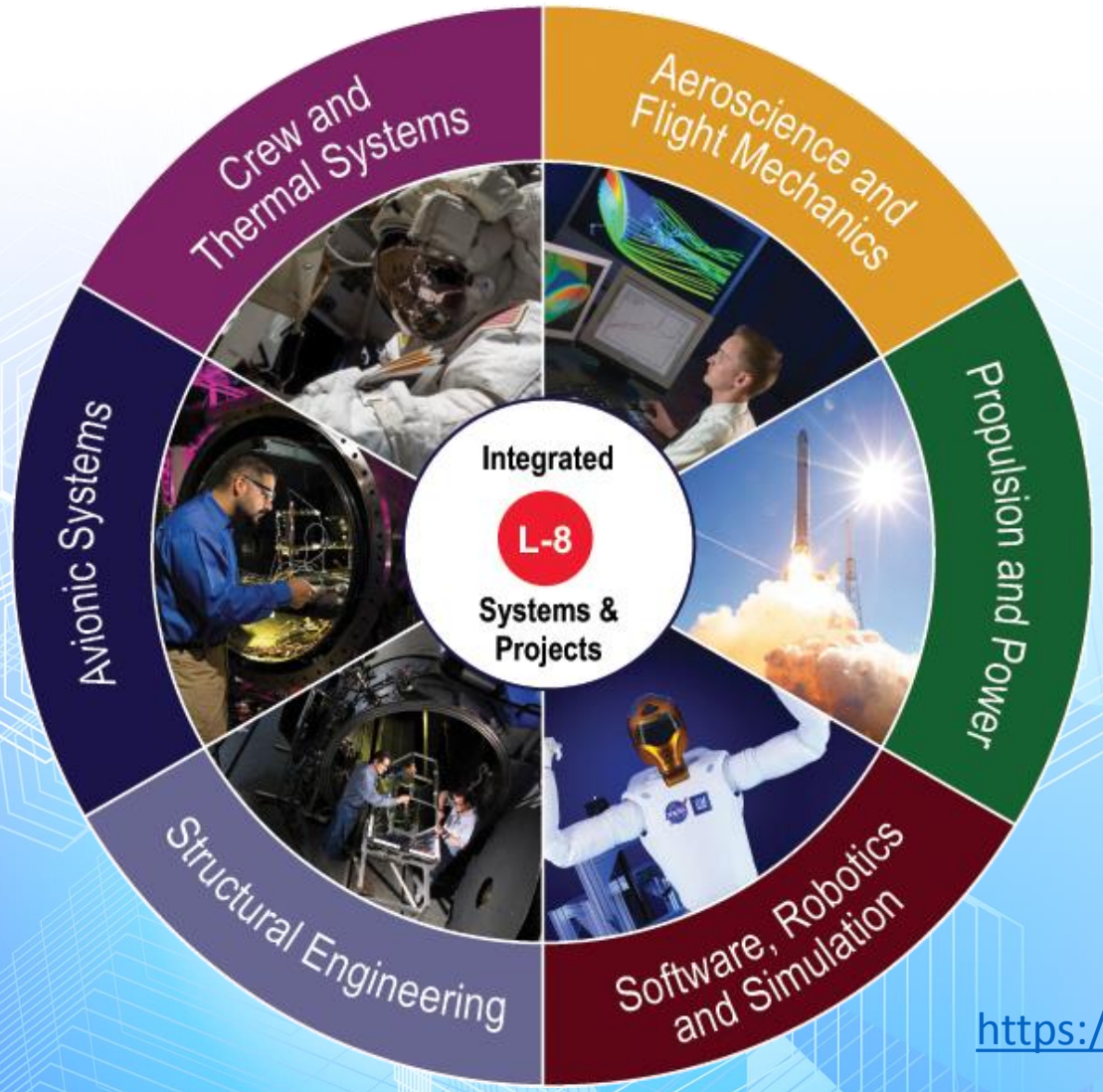

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- If you're interested in one of these, or you have other ideas, let us know at:

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