Developing Interdisciplinary Workforce to Meet Future Aerospace Challenges

Dr. Ajay Misra
Deputy Director, Research and Engineering
NASA Glenn Research Center

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Outline

- Definition and Drivers for interdisciplinary research
- Examples of interdisciplinary research
- Enablers for interdisciplinary research and implication for universities
- Concluding remarks

Multidisciplinary and Interdisciplinary Research - Definition

Multidisciplinary:

- Multiple disciplines coming together to study a complex problem, but each working primarily with their own framings and methods (interaction)

Interdisciplinary:

- Study of complex issue, problem, or question by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline

Drivers for Interdisciplinary Research

- Grand challenges that cannot be addressed by a single discipline
- Complex problems with interaction between multiple elements
- Scientific and engineering discovery at the interface between various disciplines

NASA Aeronautics Vision for Aviation in the 21st Century

3 Mega-Drivers

6 Strategic Thrusts

Safe, Efficient Growth in Global Operations
Enable full NextGen and develop technologies to substantially reduce aircraft safety risks

Innovation in Commercial Supersonic Aircraft
Achieve a low-boom standard

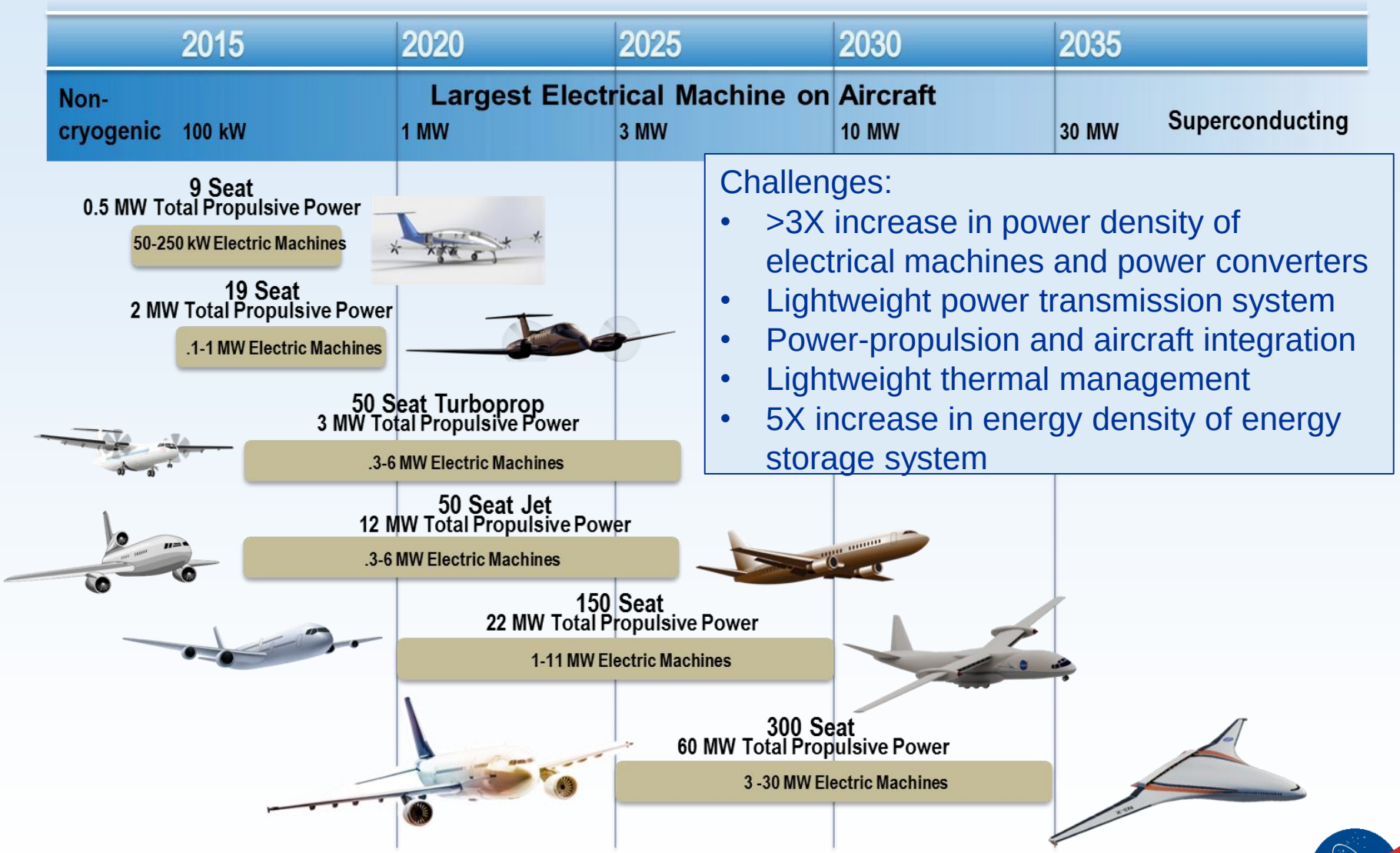
Ultra-Efficient Commercial Vehicles
Pioneer technologies for big leaps in efficiency and environmental performance

Transition to Low-Carbon Propulsion
Characterize drop-in alternative fuels and pioneer low-carbon propulsion technology

Real-Time System-Wide Safety Assurance
Develop an integrated prototype of a real-time safety monitoring and assurance system

Assured Autonomy for Aviation Transformation
Develop high impact aviation autonomy applications

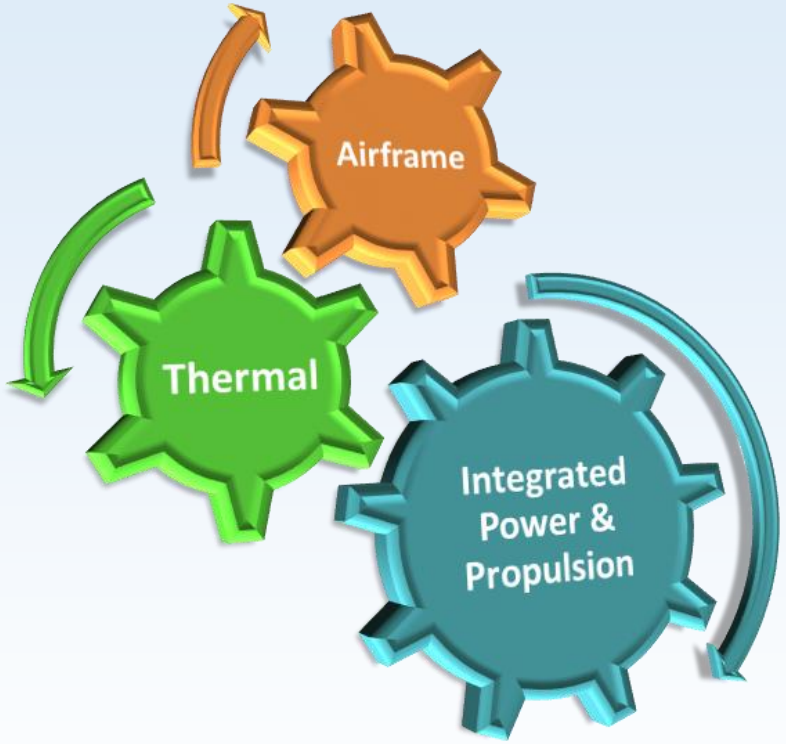
Electrified Aircraft Propulsion



Challenges:

- >3X increase in power density of electrical machines and power converters
- Lightweight power transmission system
- Power-propulsion and aircraft integration
- Lightweight thermal management
- 5X increase in energy density of energy storage system

Interdisciplinary Approach for Defining Architecture of Electrified Aircraft Propulsion

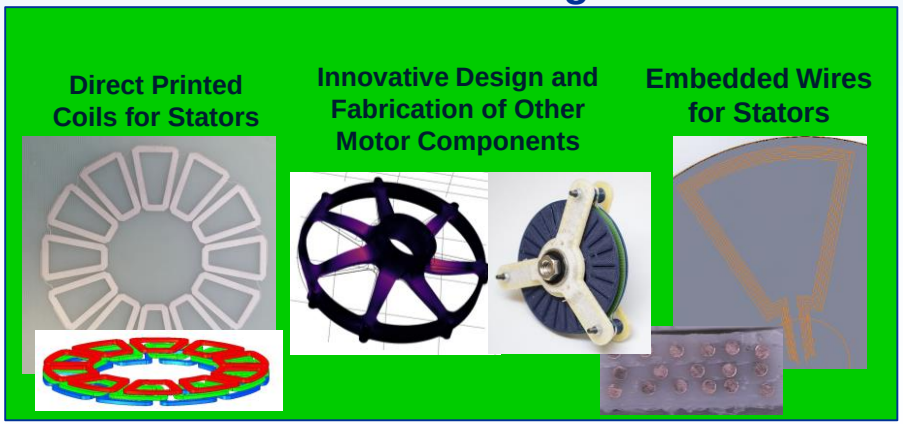


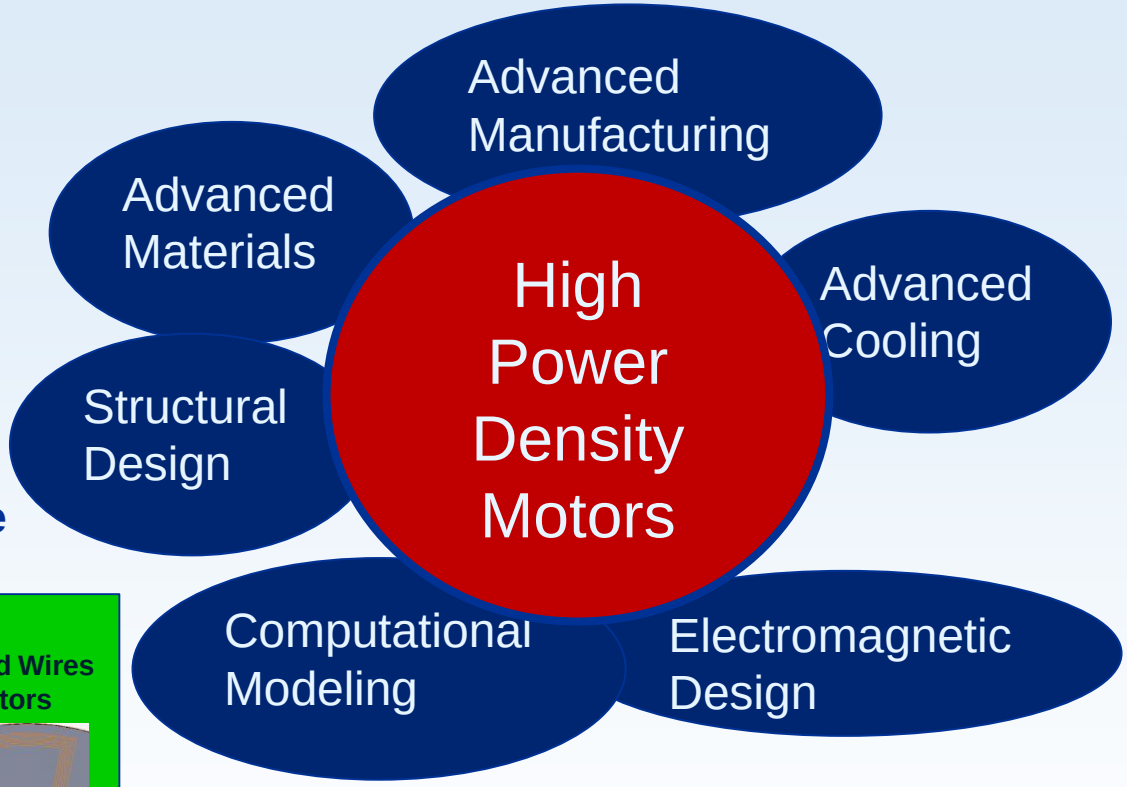
The solutions will be SYSTEMS-level

Interdisciplinary Approach for 3-5X Increase in Power Density of Electric Motors

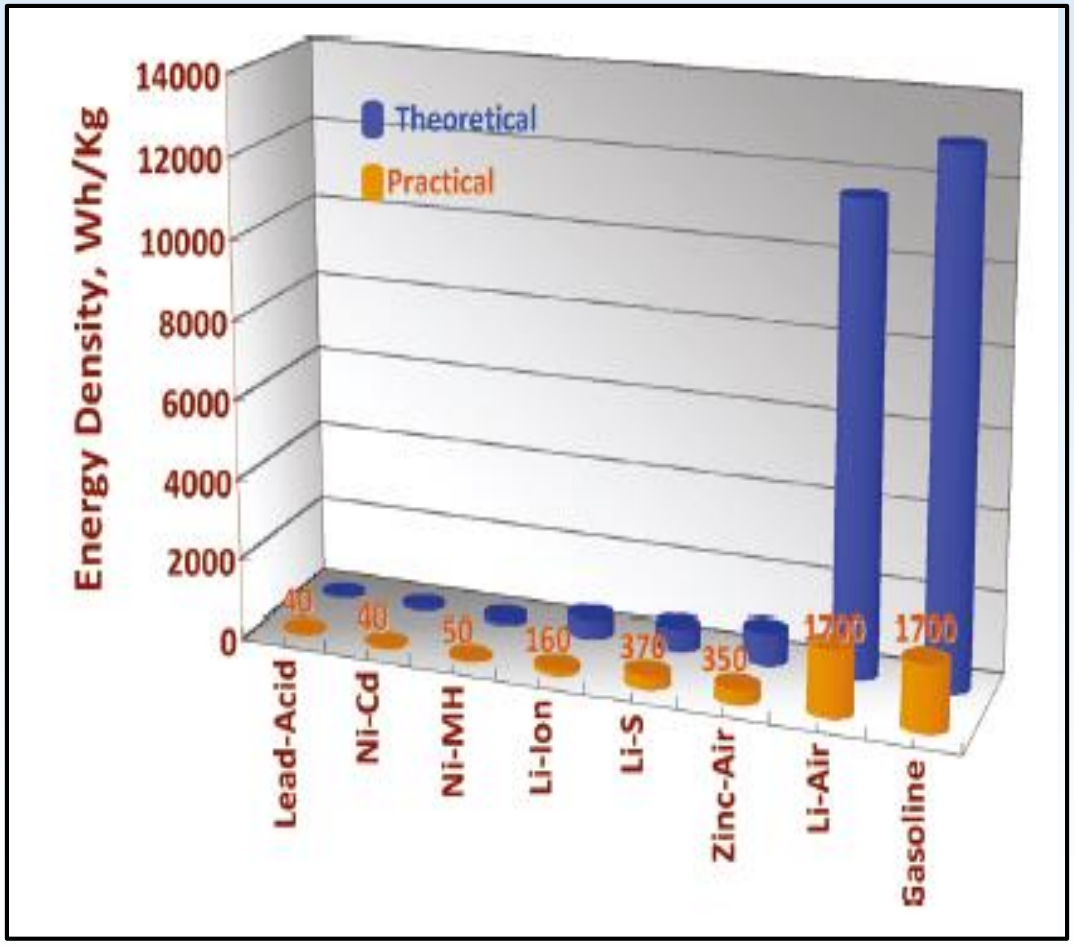
Conventional Design

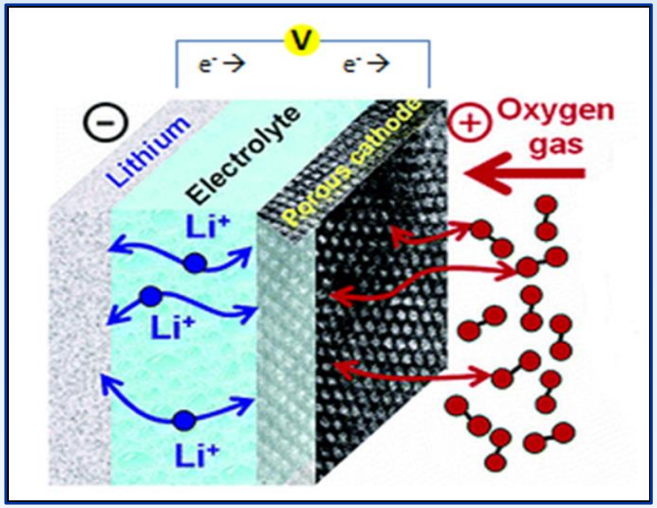
New Designs Enabled by Additive Manufacturing





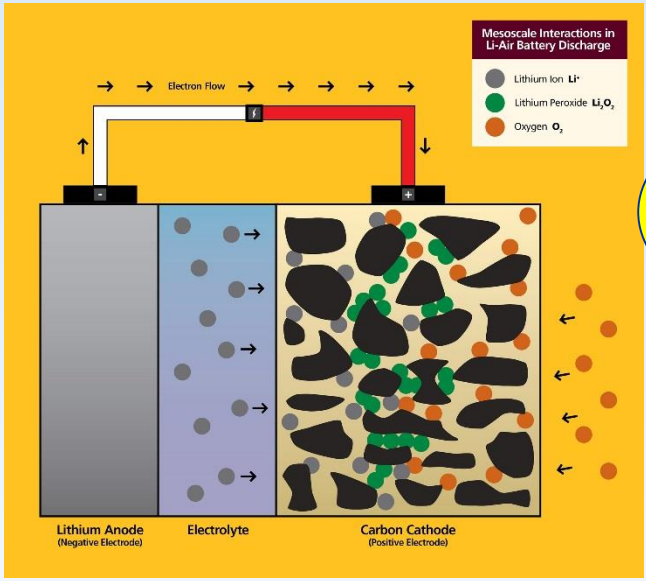
Li – Air Battery

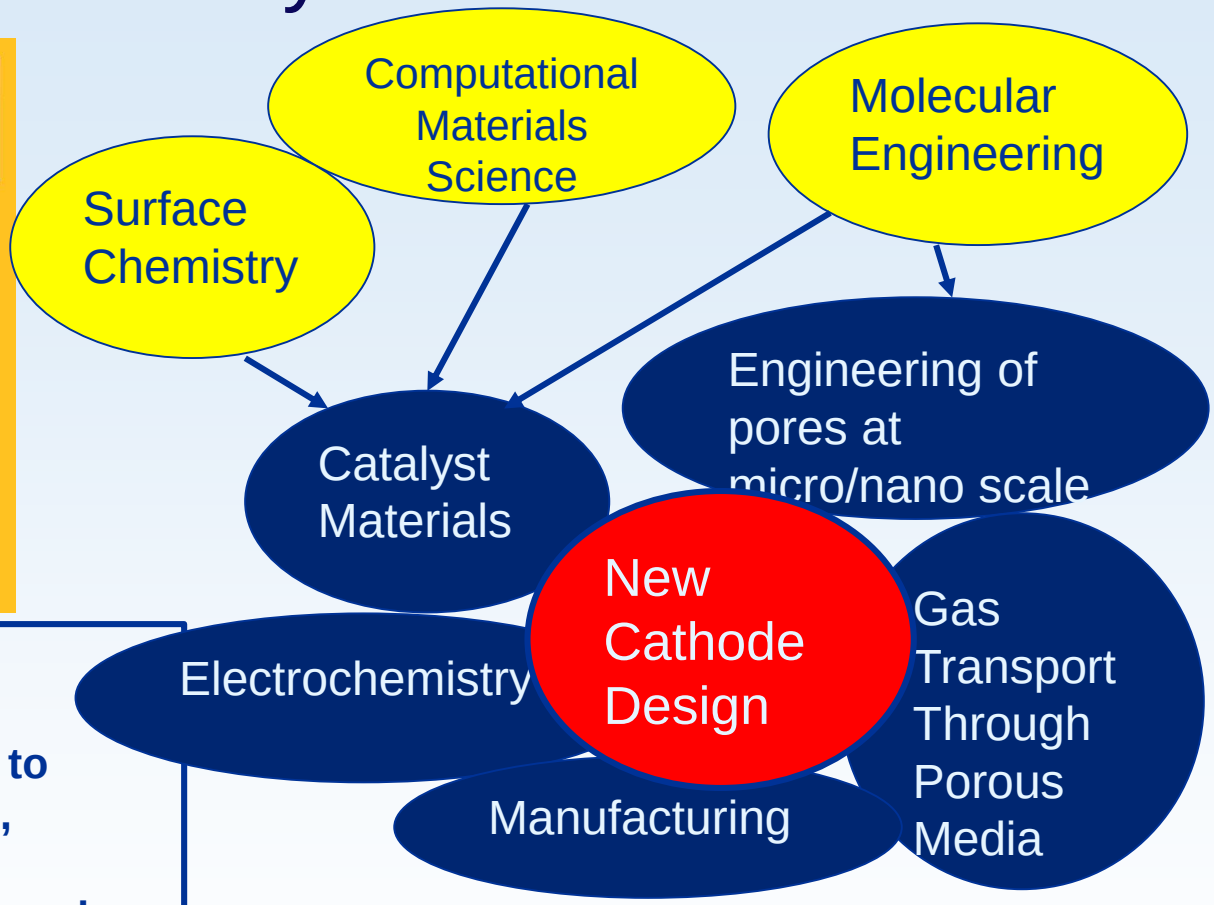




After many years of research, energy storage potential of Li-air battery has not been realized

Interdisciplinary Approach for Design of Li-Air Battery Cathode



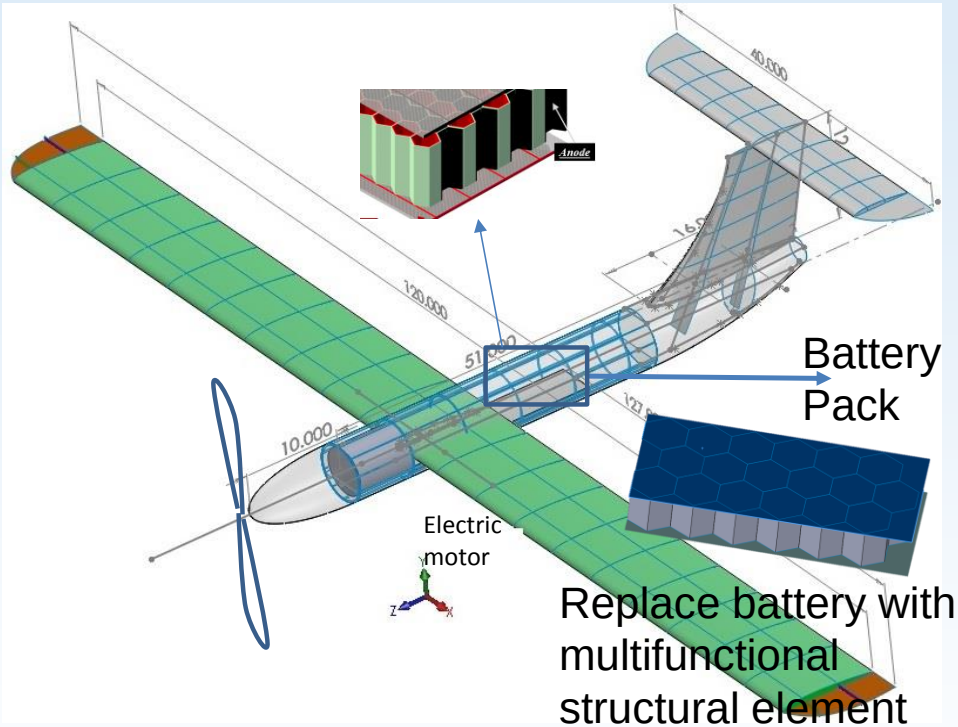


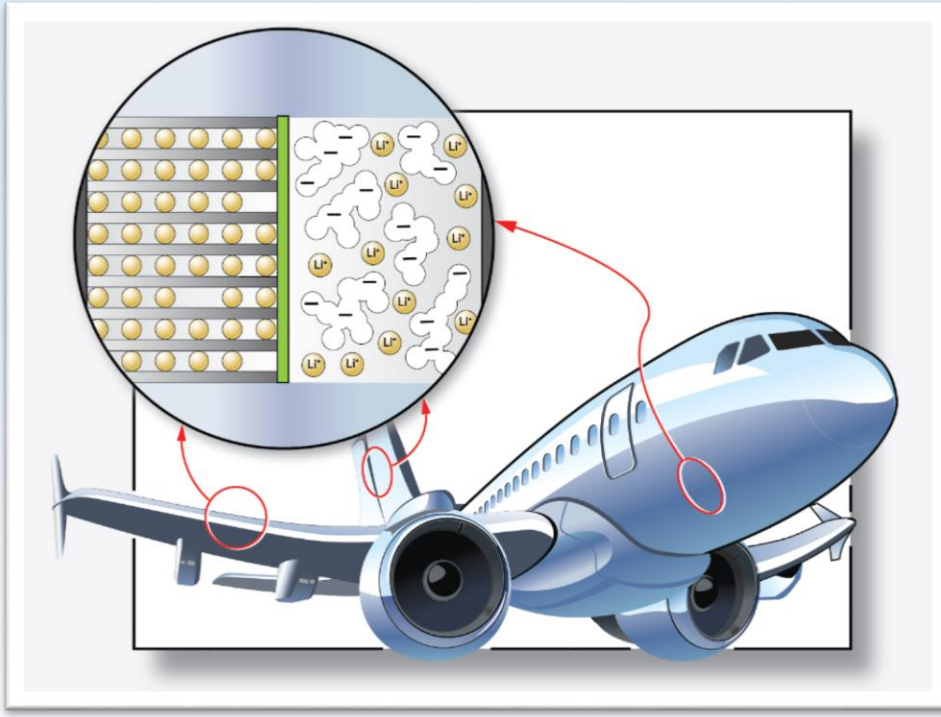
Need a combination of:

- **Large active surface area**
- **Micro/nano porous structure to optimize transport of oxygen, lithium ion**
- **Catalyst materials for charge and discharge**
- **Volume to store reaction products**
- **Affordable manufacturing process**

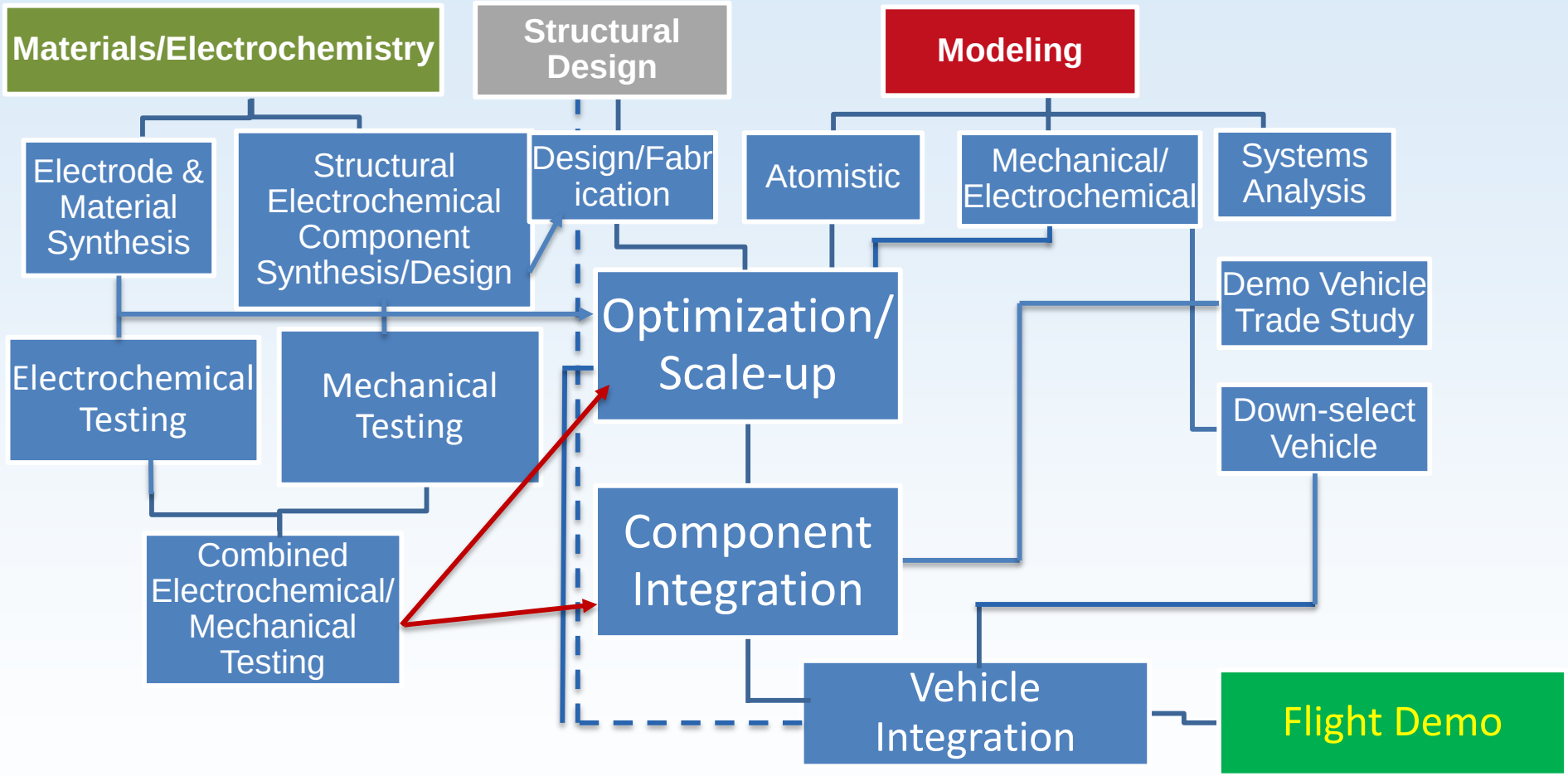
Need system thinking

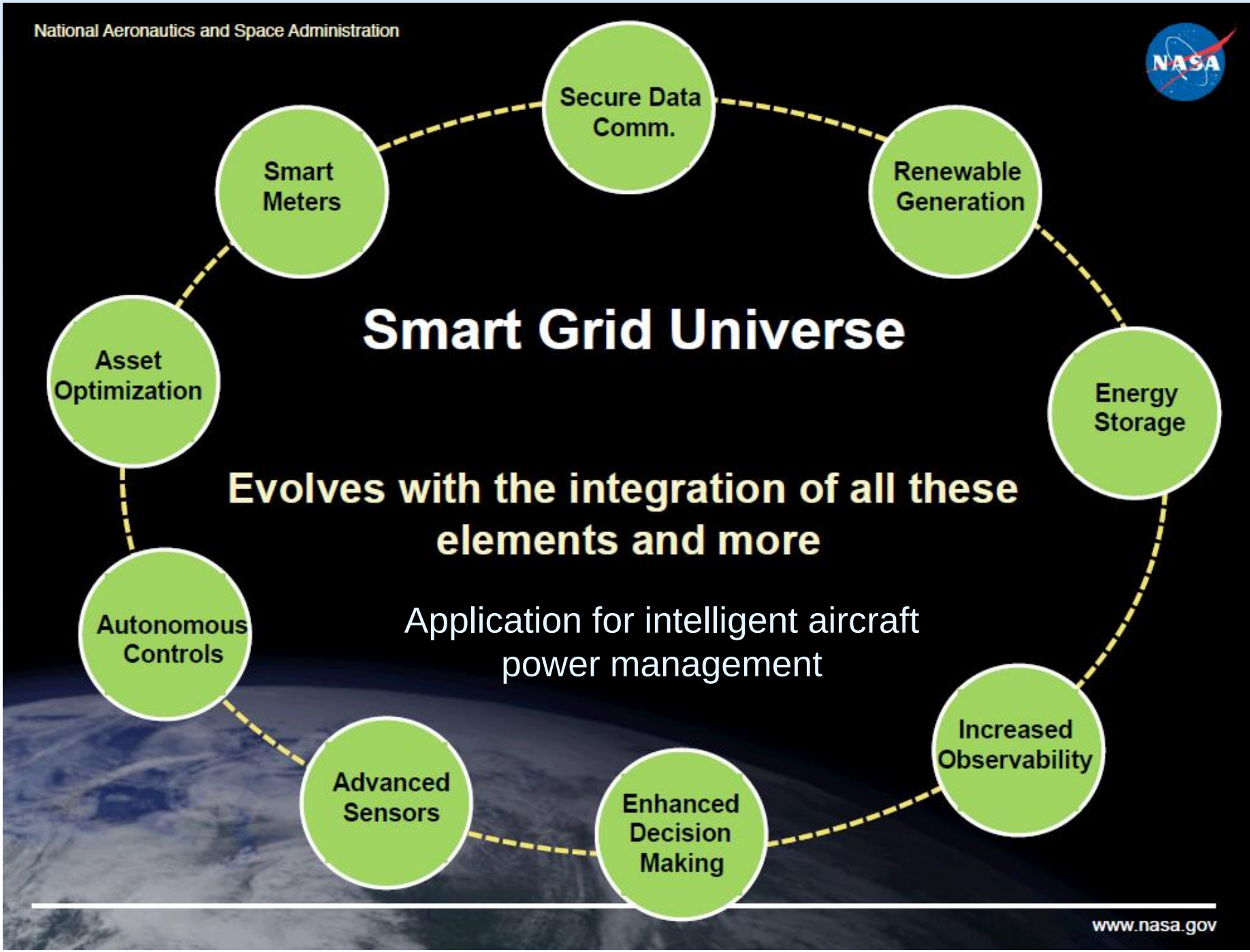
Multifunctional Structures for Lightweight Load-bearing Energy Storage



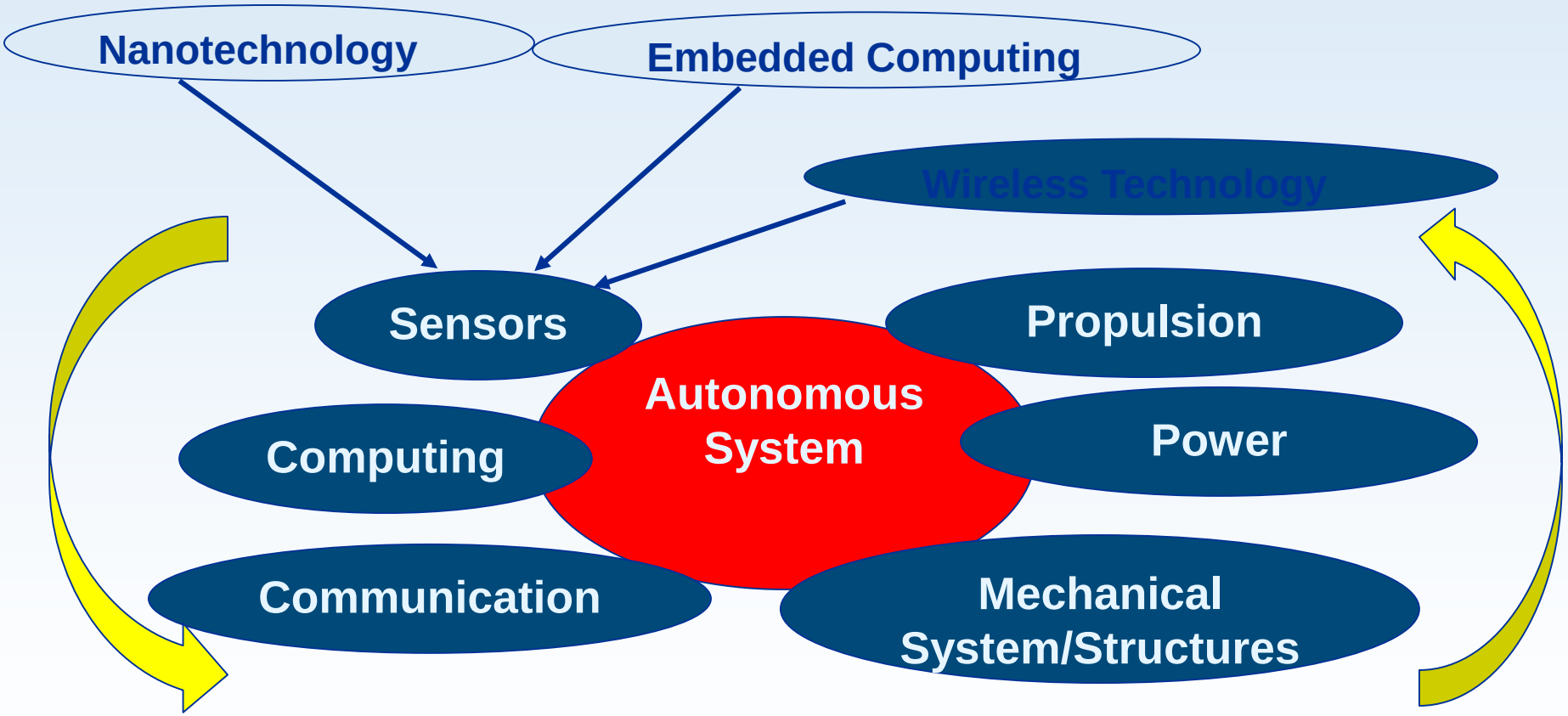


Interdisciplinary Research to Develop Multifunctional Structures With Energy Storage Capability




National Aeronautics and Space Administration
NASA
Secure Data Comm.
Smart Meters
Renewable Generation
Smart Grid Universe
Asset Optimization
Energy Storage
Evolves with the integration of all these elements and more
Autonomous Controls
Application for intelligent aircraft power management
Increased Observability
Advanced Sensors
Enhanced Decision Making
www.nasa.gov

Interdisciplinary Nature of Autonomous System Development



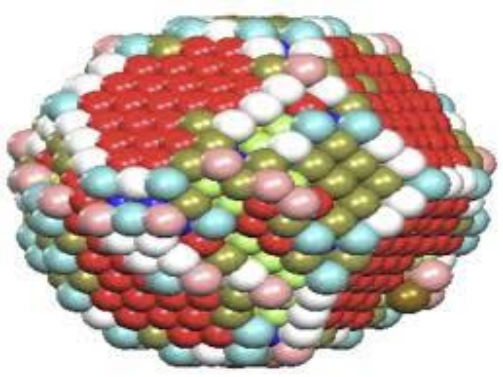
Integration of Computing Sciences With Engineering Disciplines

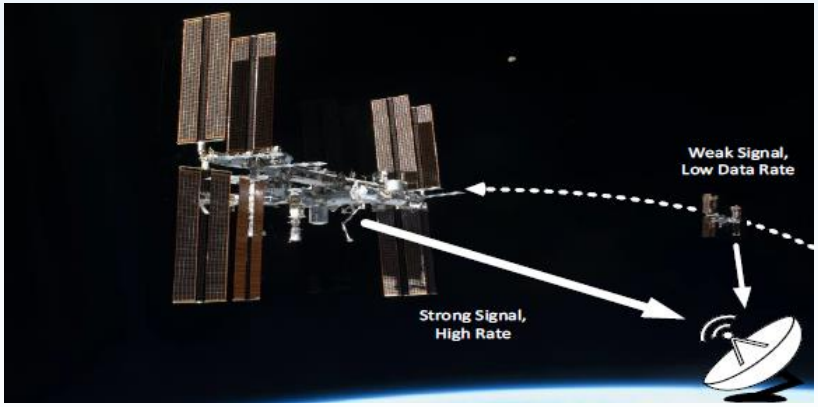
Machine Learning

Artificial Intelligence

Data Analytics

Discovery of New Material Chemistries





Cognitive Aerospace Communication

Enablers for Interdisciplinary Research

- Major challenge or grand challenge
- System level thinking
- Communication among team members from different disciplines
- Ability of team members to explain their discipline content in such a way that it can be clearly understood by other team members
- Prototypes to gain team experience
- Frequent experimental campaigns to quickly explore system alternatives
- Risk taking
- Strong leadership

Implications for Universities

- Early introduction of interdisciplinary thinking through coursework and various team projects
- Emphasis on system level thinking
- Coursework in multiple disciplines as part of curriculum
- Teambuilding and communication skills as part of the curriculum
- Recognition and reward system for faculty members engaged in interdisciplinary research

Interdisciplinary research is becoming the norm:

- To create new knowledge
- To develop advanced concepts
- To develop new products