Aviation Opportunities

Parimal Kopardekar, PhD (PK)

University of Cincinnati

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Background

1991, University of Cincinnati, Industrial Engineering → 1991-93, Lived in Scioto Hall → 1993, 11th Annual International System Safety Conference in Cincinnati (July)

1993, An internship at the FAA Tech Center (December) → 1993-2002, FAA contractor → 1996-2002, Adjunct faculty: Rutgers University, Drexel University, and Atlantic City Community College

2002, FAA civil servant → 2004-current, NASA civil servant → 2018- current, Adjunct faculty: Colorado State University, and Northeastern University

Rewarding career to date at NASA: 50+ papers, 2 patents, many awards and recognitions, and various leadership roles → Connect with me on LinkedIn

Outline

- Importance of aviation
- Needs and opportunities
- My passions
- Personal reflections
- Summary

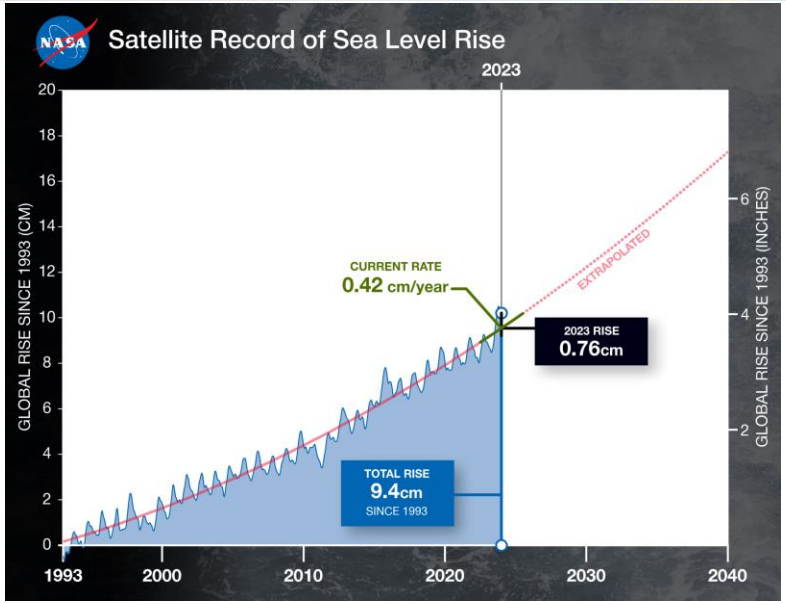
Aviation is Vital to our Nation's Economy

- $1.25 trillion economic impact from commercial aviation in 2022
- $77.3 billion positive manufacturing trade balance in 2022
- 8.97 million flights by U.S. carriers worldwide in 2022
- 24 million tons of freight transported by U.S. airlines in 2022
- 2.2 million aerospace/defense jobs; 603,000 in aeronautics/aircraft in 2022

Needs and Opportunities

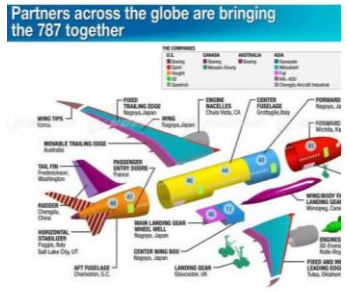
- Climate neutral (sustainable)
- Equity
- High scale
- Increased diversity
- Faster flight
- Safer
- Societal good
- Resiliency
- Systems thinking

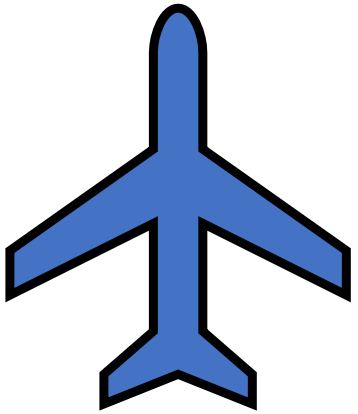
Climate Impact Neutral



Autonomy

NASA Worthy Autonomy Related Challenges and Research – Autonomous Aircraft	Access	Continuity	Scalability
ATC interactions and interoperability (ability to respond to voice instructions)	X	X	X
Surface movement at airports and/or vertiports	X	X	X
Automated/autonomous take-off (safety pilot to fully autonomous)		X	X
Automated/autonomous landing without decision height (CAT I/II/III) (safety pilot to fully autonomous)		X	X
Hazard avoidance and perception including Detect and Avoid	X	X	X
Separation algorithms for cooperative and uncooperative aircraft	X	X	X
Collision avoidance: ACAS-X (and extensions)		X	X
Spacing and merging to vertiports and/or airports		X	X
Scheduling algorithms to vertiport and/or airports		X	X
Flow management			X
V2V and V2X			X
CNS requirements (e.g., GPS outage or degradation)	X	X	X
Cyber security	X	X	X
Assurance (design, sub systems, and integrated system of system)	X	X	X
Update current or new flight rules			X
Off-nominal, contingencies, emergencies: bird strike, missed approach, go around, energy depletion, GPS outage, comm link failure, weather related disruptions, etc.	X	X	X





High Scale (Supply Chain)

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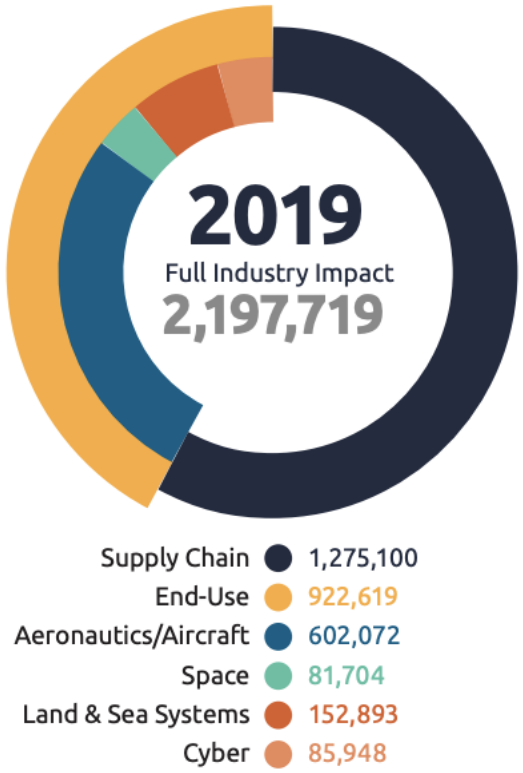
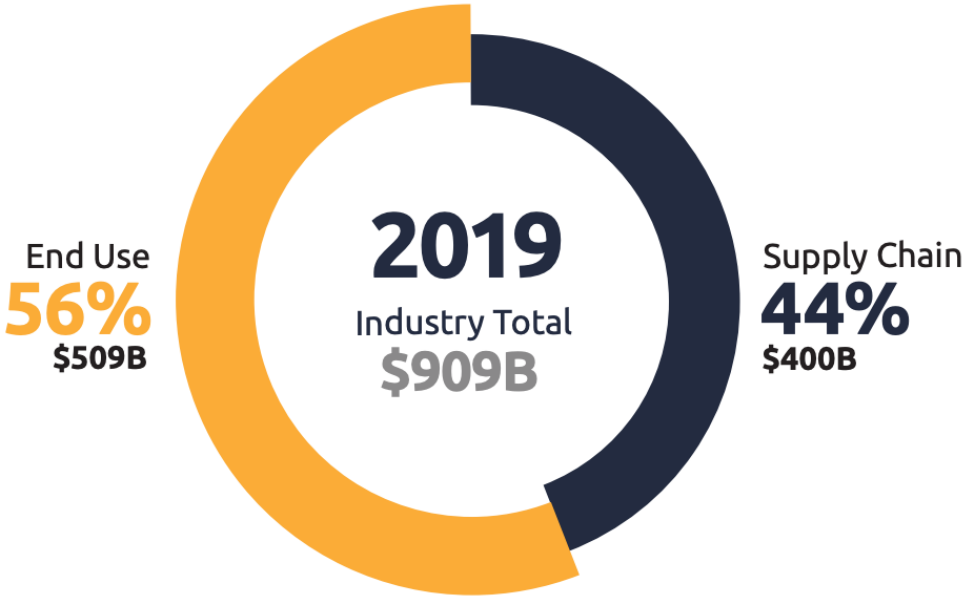
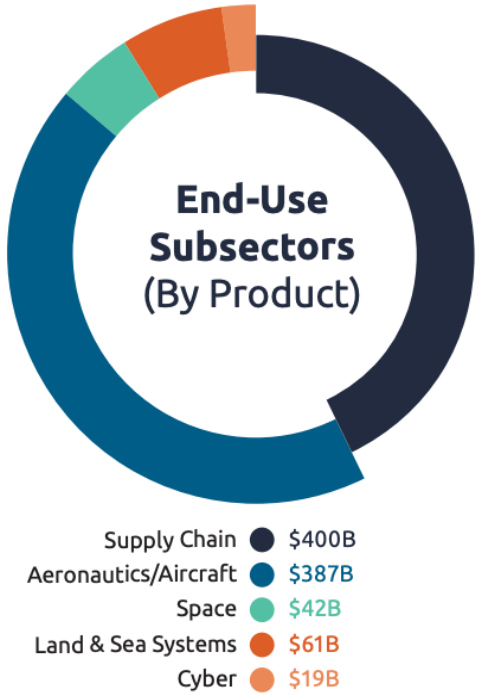
Importance

- $909B Revenue, $148B exports, and $77.6B trade difference
- $400B contributed by supply chain (44%)

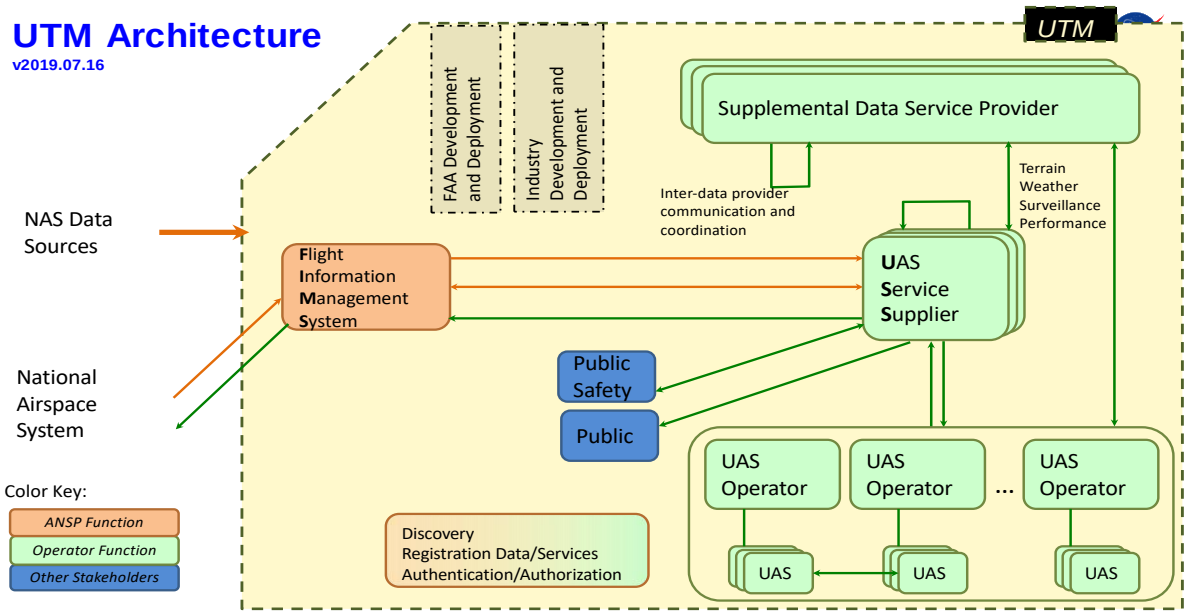
Employment





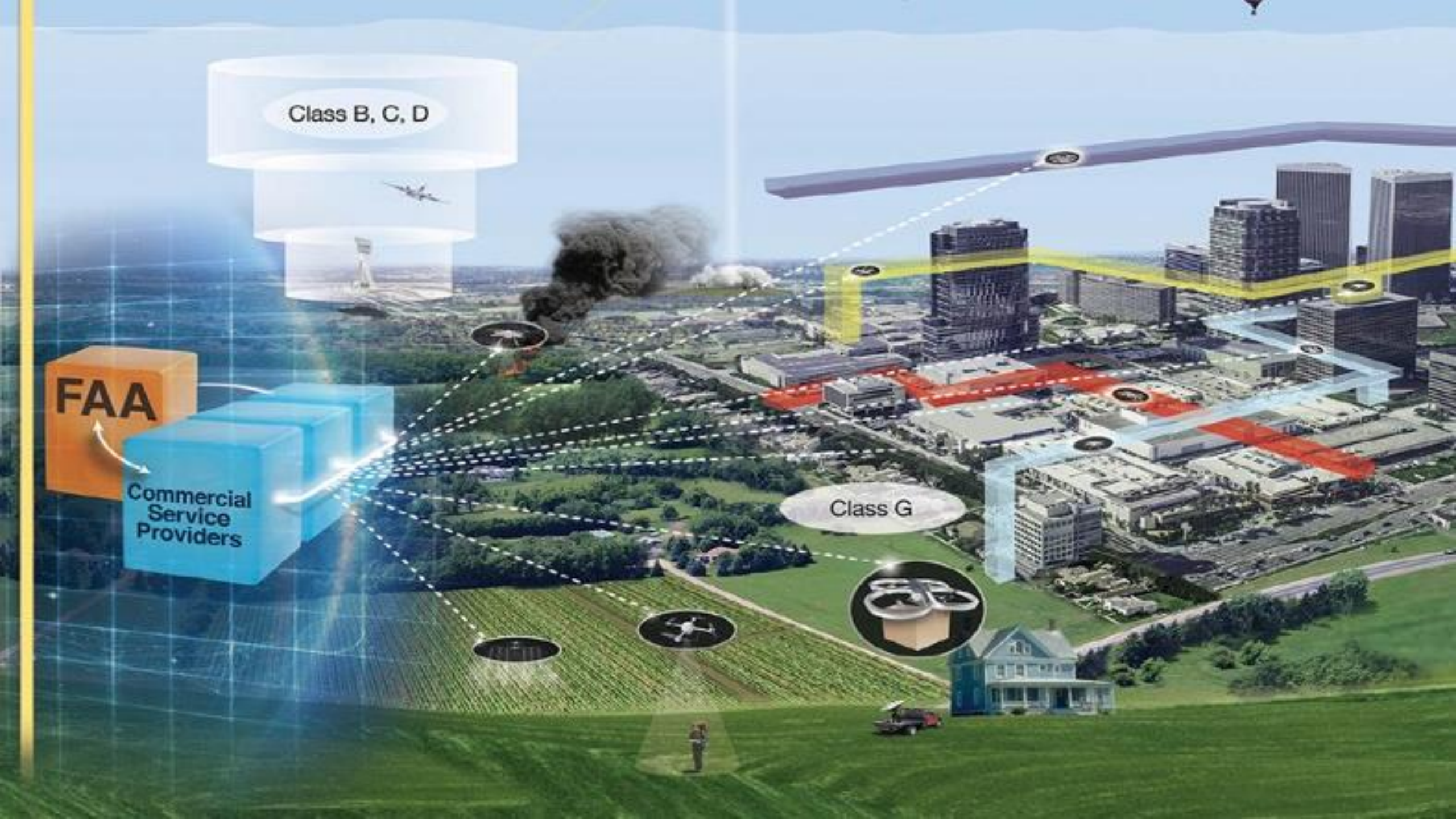


Reference: AIA 2020 Industry Outlook



Lessons Learned from Successful Unmanned Aircraft System Traffic Management

- Cooperative (share and care)
- Intent-sharing
- Digital: data exchanges among operators
- Standardized application protocol interfaces
- Air/ground integrated
- Service-oriented architecture
- Role for third-parties
- Management by exception


Class B, C, D
FAA
Commercial Service Providers
Class G

High Scale: Evolution of Airspace Operations and Safety

S-curves

Safety

Procedural

Estimate the current and planned a/c positions

+Density

Radar

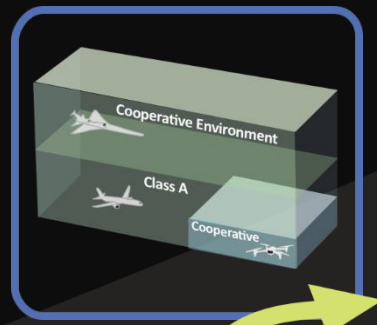
Know the current and **estimate** planned a/c positions

+ Efficiency and proactive planning

Trajectory

Know & exchange current and planned a/c positions

+ Service oriented architecture for tailored mission oriented services



Collaborative

Connected, performance-based, collaborative ATM

Introduces 3rd-party service providers

+ Complexity, scalability, and dynamic adaptation

Highly-Automated

ML/AI – based dynamic, robust performance and safety

Machine-to-machine interactions and humans collaborate

Digital Transformation of ATM

Human-centered safety monitoring, assessment and mitigation

Automated in-time safety monitoring and alerting services

Integrated predictive risk mitigation across domains

Automatically-assured adaptive in-time safety threat management

Epoch 1

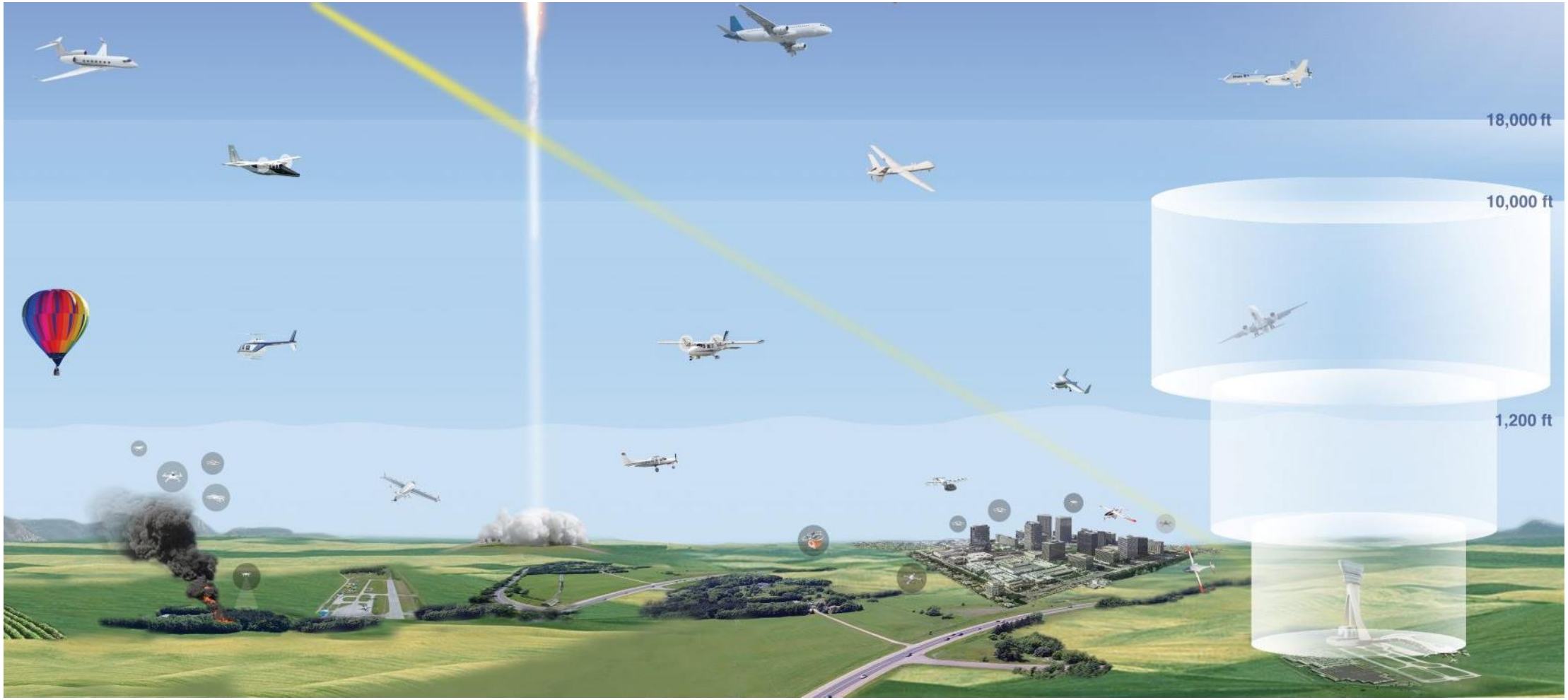
Epoch 2

Epoch 3

Epoch 4 (~2035)

Epoch 5 (~2045)

Opportunities: Increased Diversity of Operations



Transition to UTM-inspired Airspace Traffic Management

Current ATM	UTM-inspired-ATM
All services are provided by FAA	Services are provided FAA and third-parties
Human address off-nominal situations and contingencies to ensure safety	Automation addressed off-nominal situations and contingencies to ensure scalability while maintaining
Very little interaction among users and third parties	Users collaborate/cooperate for efficiency, preferences for flights into constraints resources
• Human at the epi-center of information integration • Every data for every vehicle moves through FAA systems • Management by clearances • Each change is focused on domain-specific FAA	• Automation at the epi-center of information integration • New paradigm: Digital, connected ecosystems, outside applications • Movement towards management by exceptions • Each change is focused on trajectory optimization

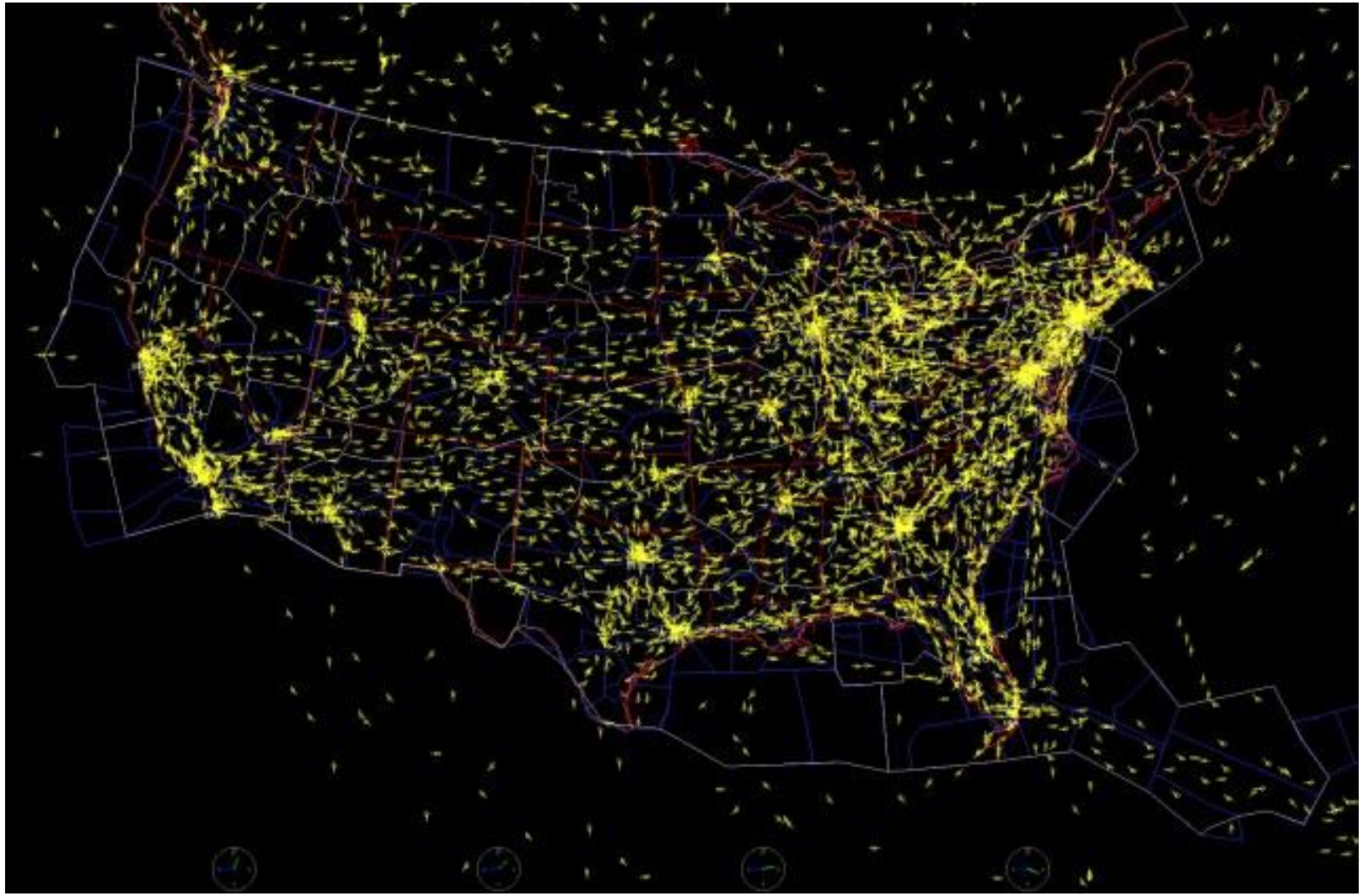
Research Needed: Architecture, data exchanges, service allocation/roles/responsibilities, rules of engagement, performance requirements for aircraft and airspace system technologies, automation for contingency management and disruption handling, machine learning environment and algorithms for continuous improvement, safety assurance/certification/acceptance approaches, and technology transfers.

Faster

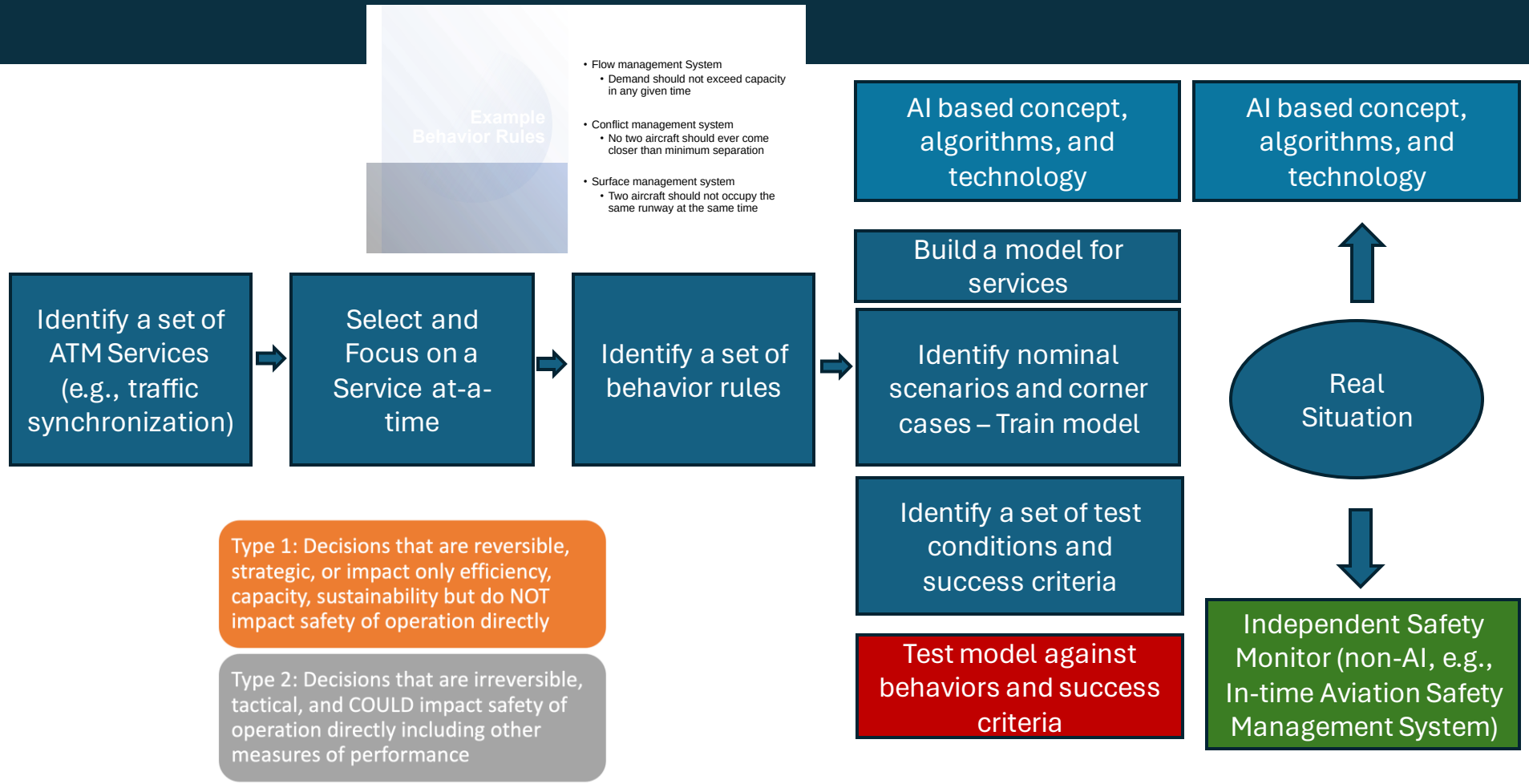
Safety

Societal Good – Wildfire Management

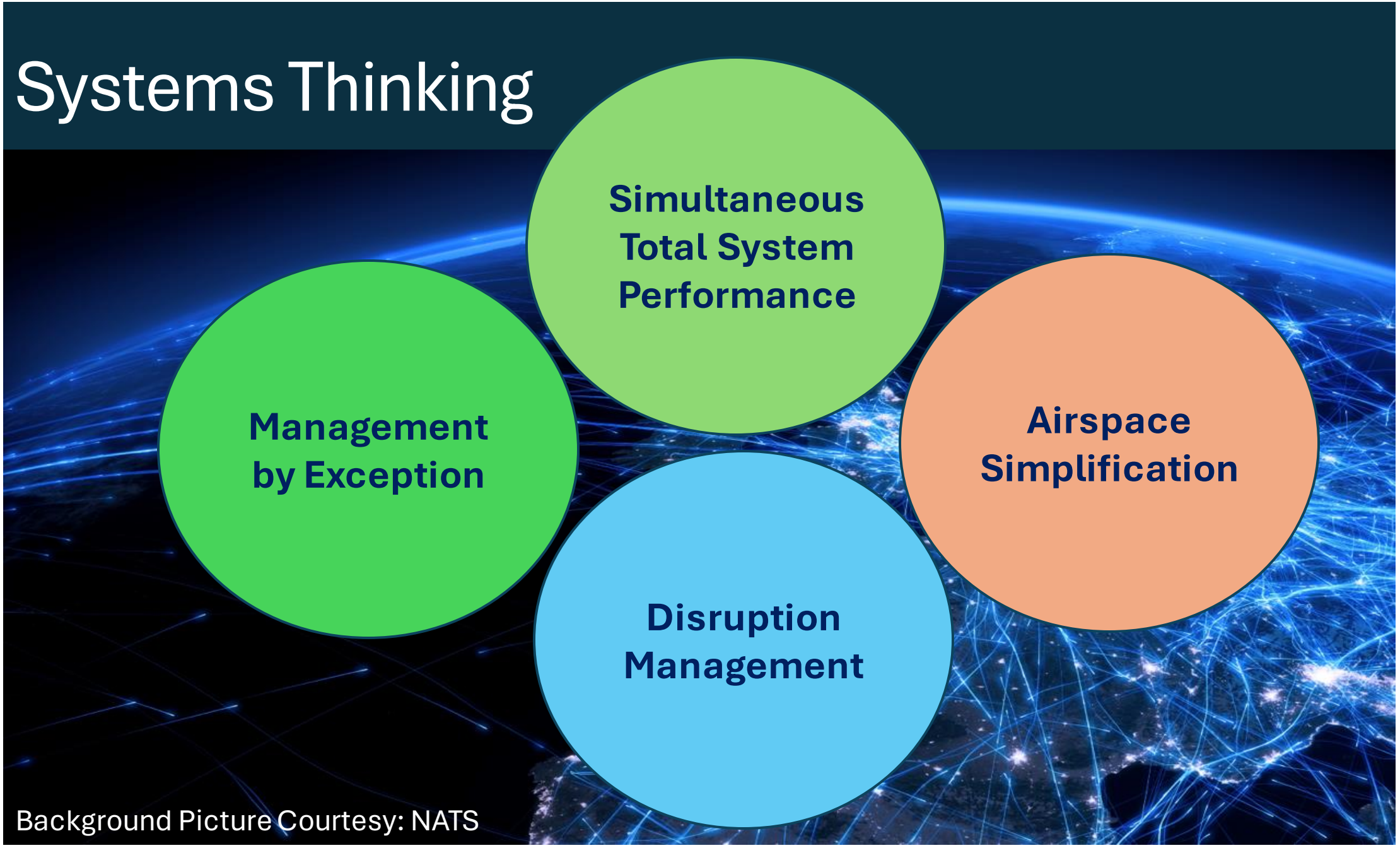
Resiliency



Responsible AI/ML in Aviation



Systems Thinking



Background Picture Courtesy: NATS

I am excited about…

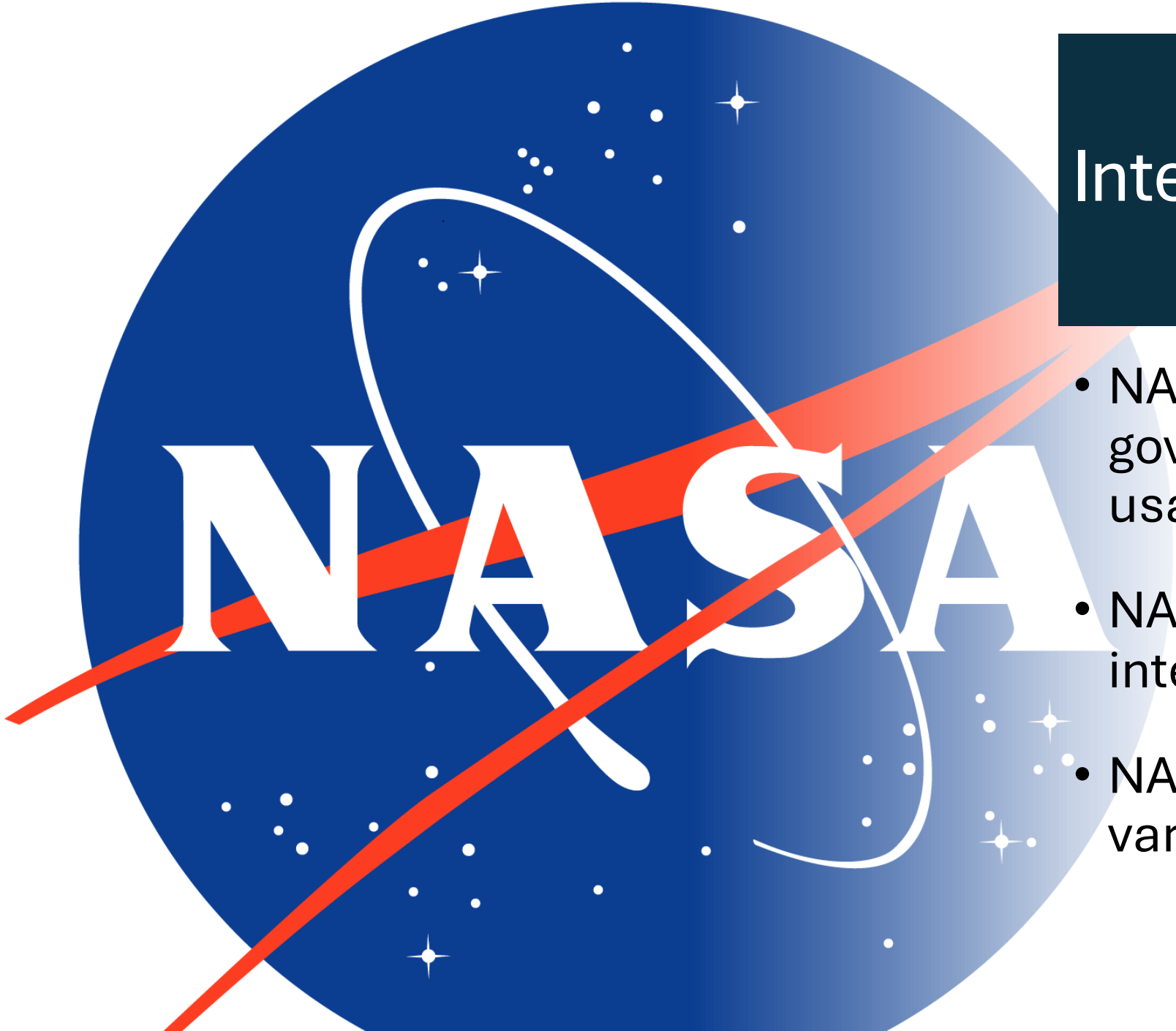
- Advanced Air Mobility
- Artificial Intelligence/Machine Learning – Responsible AI/ML in aviation
- Increasingly autonomous operations
- Wildfire management
- Supply chain management
- Concepts and technologies to enable future airspace operations
- Managing NASA Aeronautics Research Institute

Innovation in aviation while respecting its safety tradition

Personal Reflections….

- Soft skills make a significant difference in your career: most problems in aviation are complex and require team work
- Understand your personality well (e.g., introvert vs extrovert)
- Discipline expert, generalist, early conceptual stage, late deployment stage, transitions, etc.
- You have to know you, and keep improving yourself
- Focusing on satisfaction will lead you to fulfilled career and life – only you can decide what makes you satisfied
- Career Stages: Learning (10+ years), leading (15+ years), and mentoring others (15+years)
- Money matters, savings matter (mortgage, college, retirement), but not be the only thing
- Find a good mentor(s) throughout the career

Am I satisfied?



Interested?

- NASA, FAA, and other government jobs: usajobs.com
- NASA internships: intern.nasa.gov
- NASA contractor jobs: various sites

Embracing Innovation in Aviation while Respecting its Safety Tradition

Parimal.H.Kopardekar@nasa.gov