The Future of Safety Management

Boeing Aviation Safety Conference

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Abu Dhabi, UAE

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NASA System-Wide Safety

Innovating the Future of Aviation

Human-Centric Capabilities

Safety + Density
Human centered traffic &
Safety management

Digitally Transformed Infrastructure

Collaborative Environment
Service oriented architecture
for tailored mission services
+ Machine Learning
+ Internet of Things (IoT)

xTM
Provider of Services

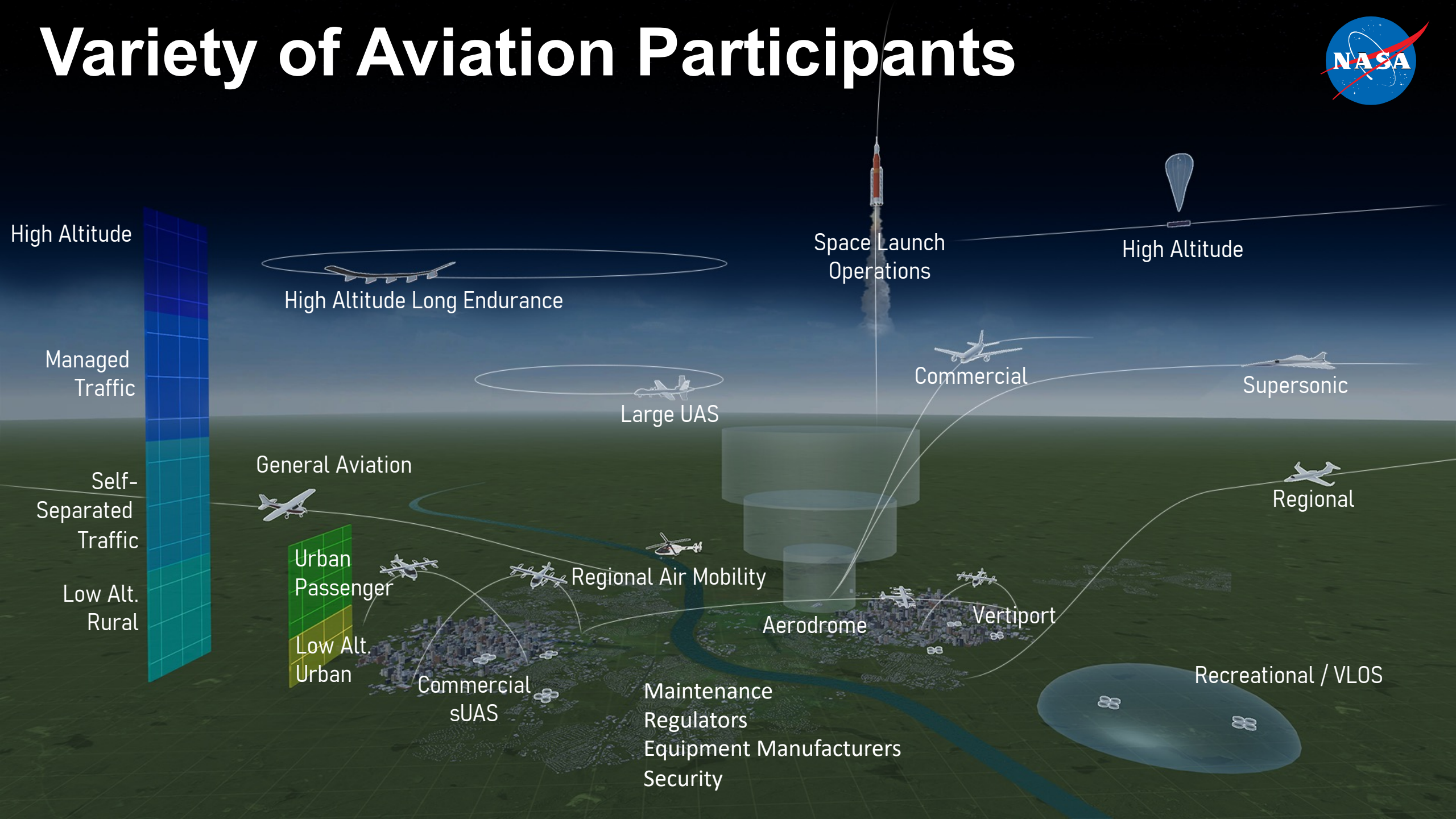
FAA
Industry Data Exchange

Automation-Enabled Diversity

Highly Automated
Complexity, scalability,
And dynamic adaptation
+ digital mesh
+ Artificial Intelligence
+ IoT

Evolution of Airspace Operations and Safety

Variety of Aviation Participants



Transformed Airspace
A Great Opportunity

Increased number of traditional commercial operations

Accessible to all with new aviation missions

Environmentally sustainable

Enablers

- **Digital Transformation –> InfoCentric Airspace**
- **AAM – New vehicle types and new operations**
- **Automation and Autonomy – Improve existing and enable new, scalable aviation missions**

System-Wide Safety

Transformed Airspace
A Complex Challenge

More Operations = Increased risk potential

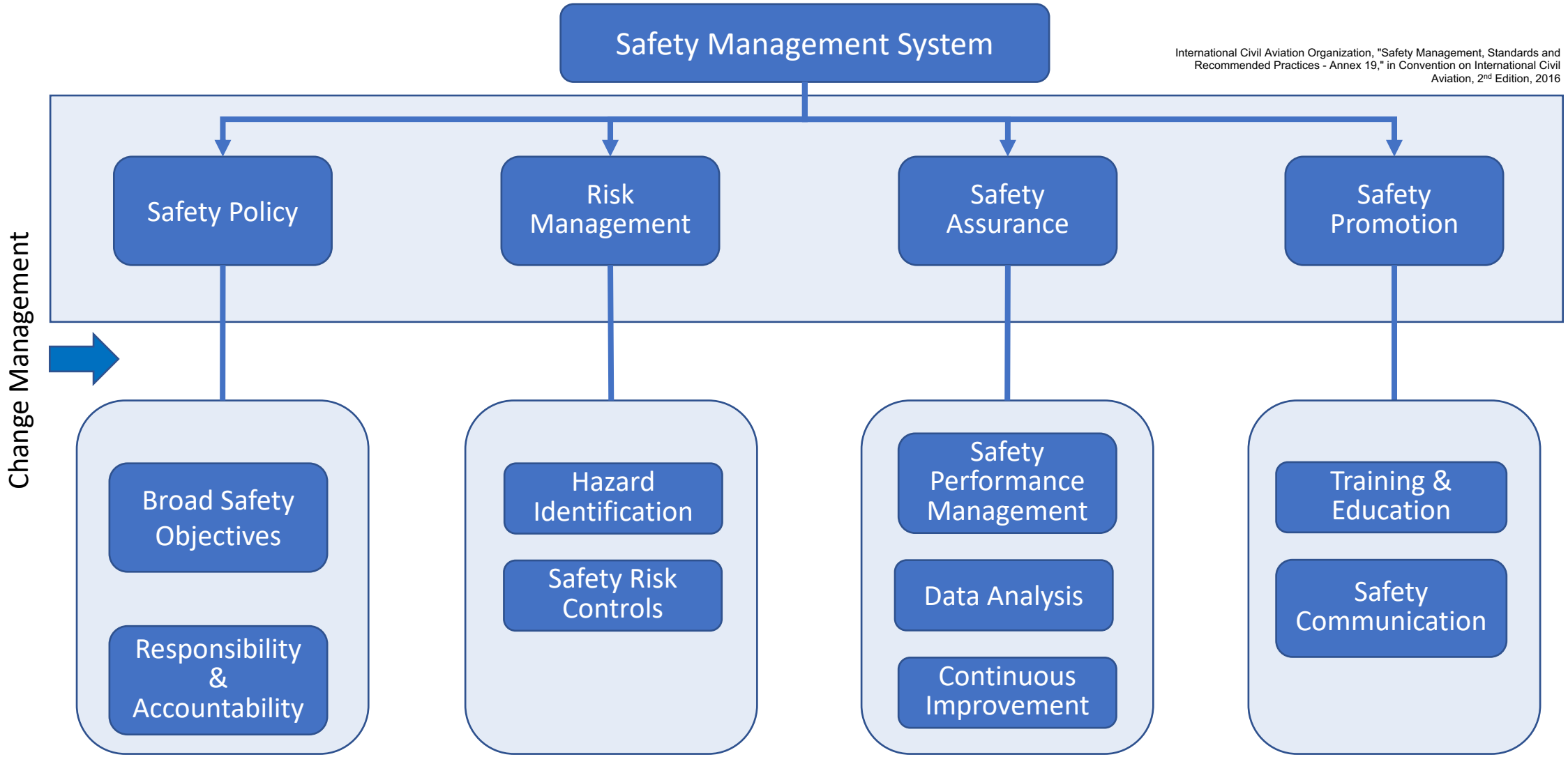
New Missions = Increased Integration Complexity

Sustainability = New Constraints

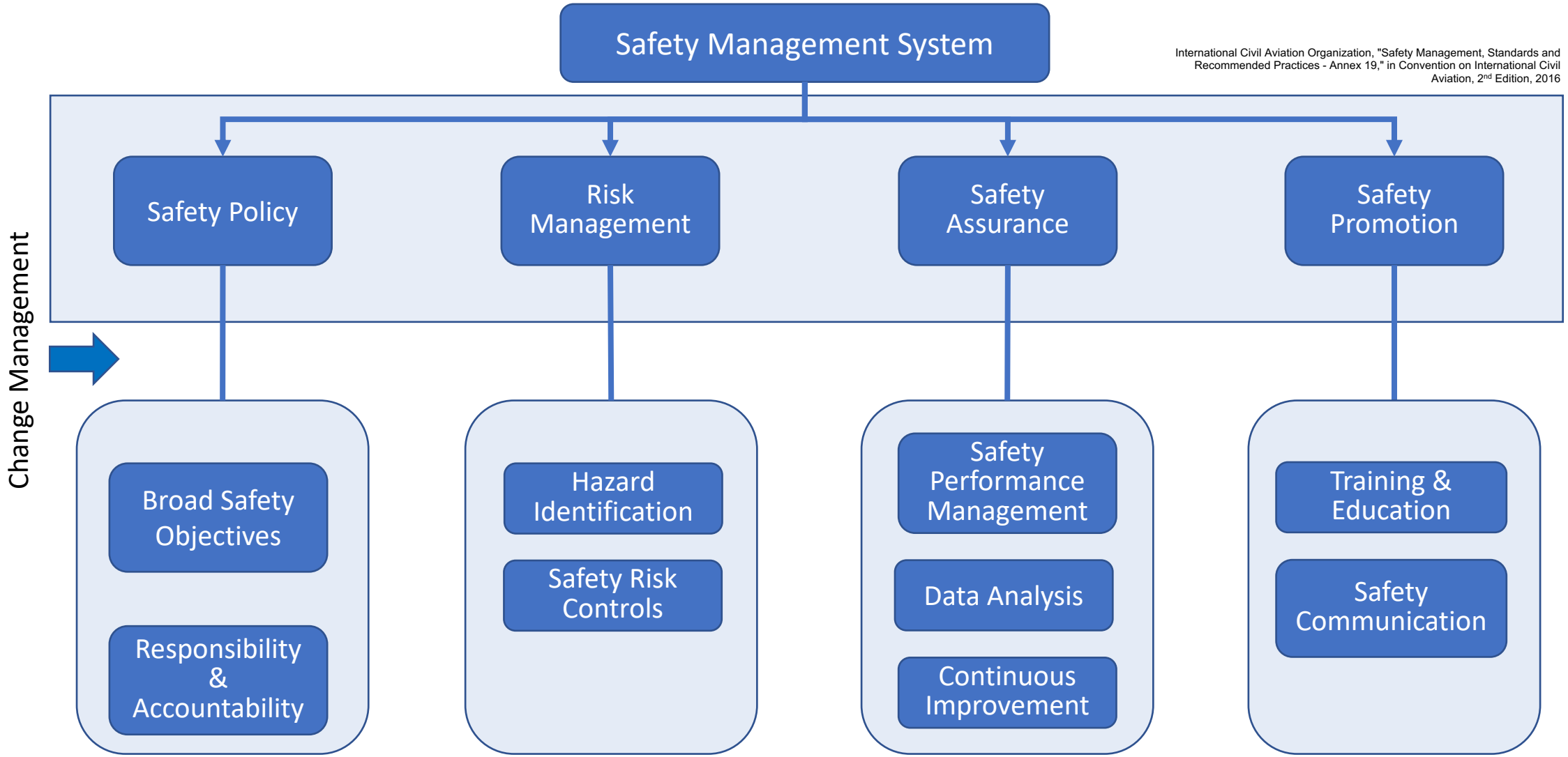
Notable Barriers

- **Digital Transformation – Changes to Existing Systems and Integration of New Systems is a Known Challenge**
- **AAM – Certification Paths Needed for both Airworthiness and Operations**
- **Automation and Autonomy – Means of Assuring Automated/Autonomous Systems Needed**

Achieving Aviation Safety Today



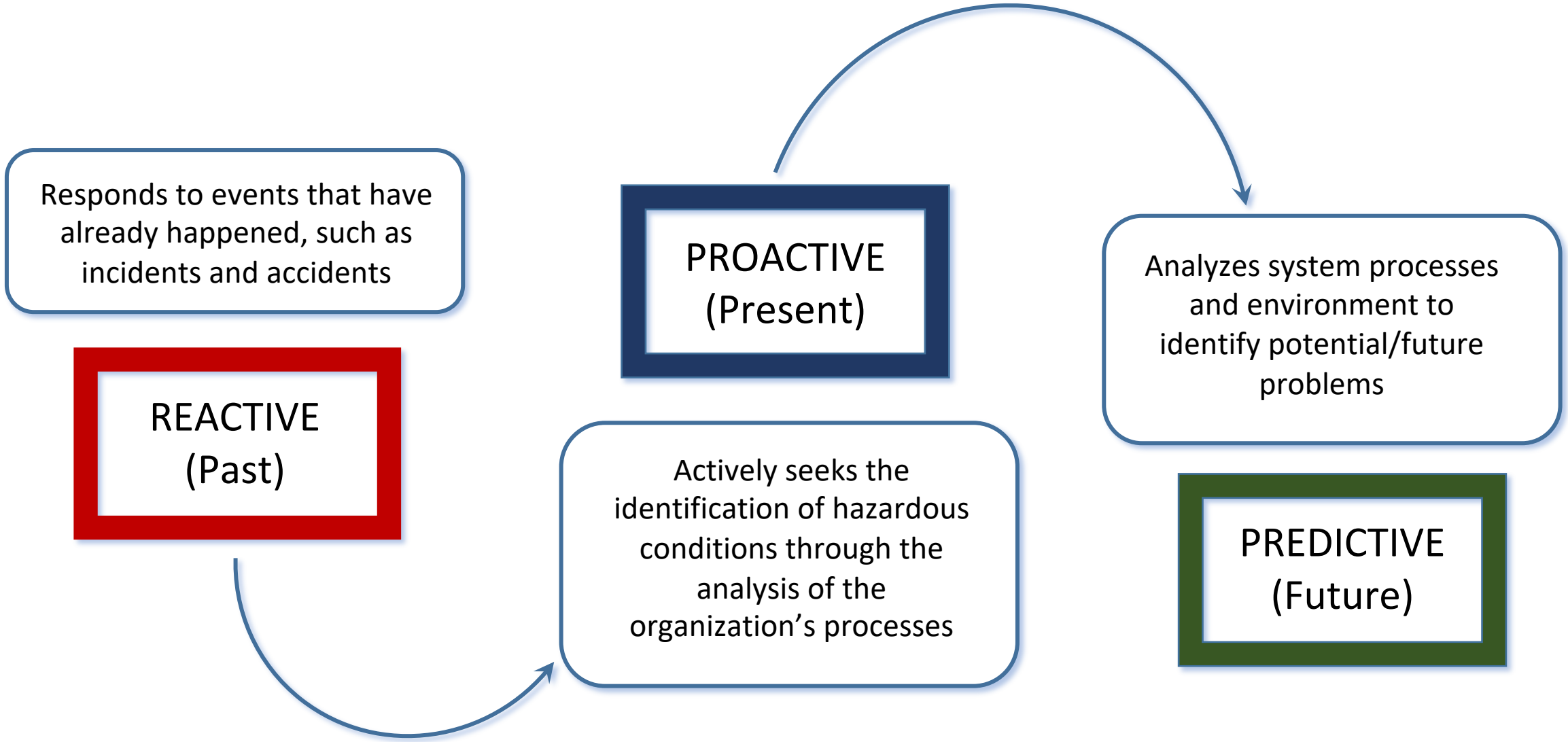
Achieving Aviation Safety Today



International Civil Aviation Organization, "Safety Management, Standards and Recommended Practices - Annex 19," in Convention on International Civil Aviation, 2nd Edition, 2016

Labor intensive
Limited ability to scale
Not fast enough

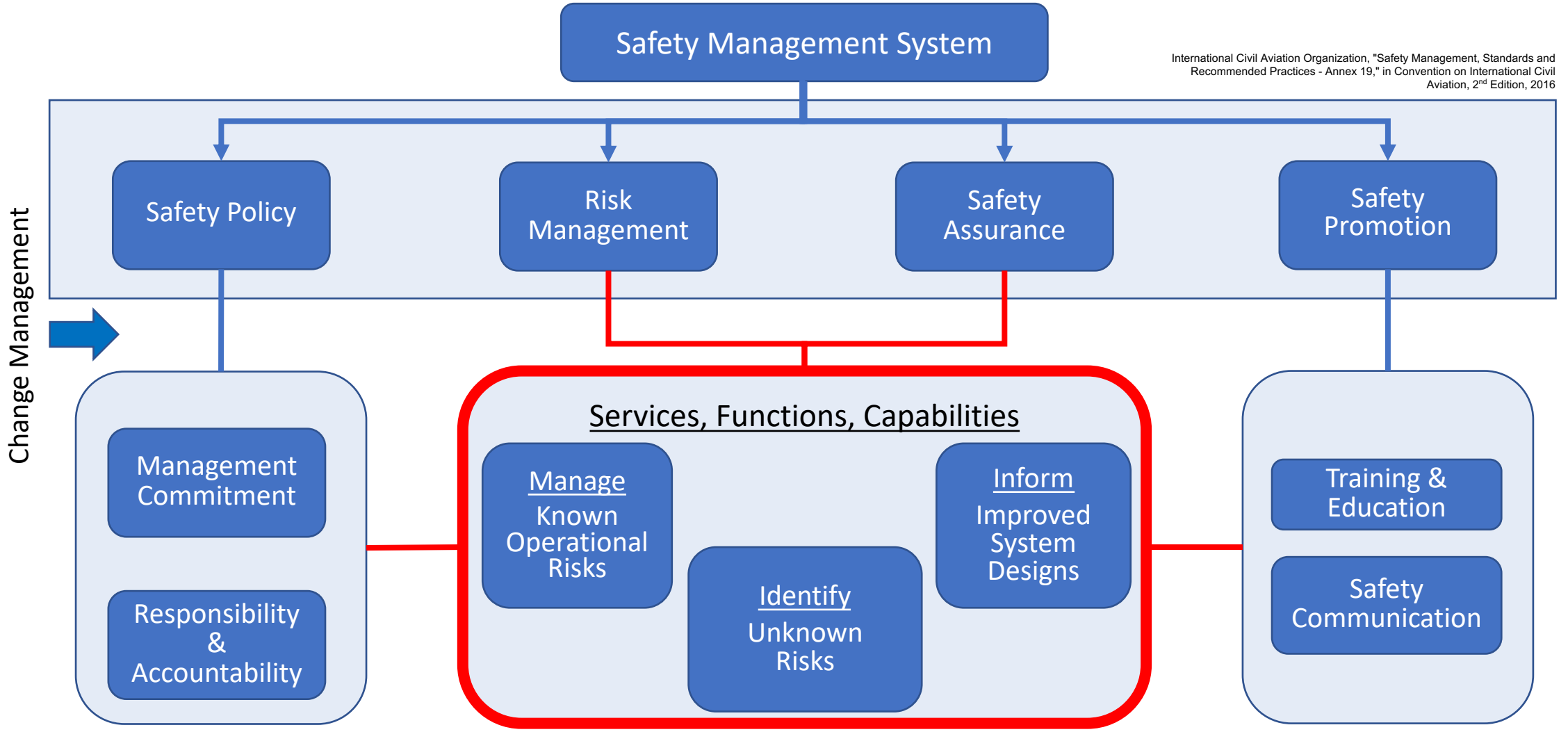
Safety Management & Safety Intelligence



[1] https://www.faa.gov/about/initiatives/sms/explained/basis/

Adapted FAA Graphic[1]

How We Achieve Aviation Safety Tomorrow

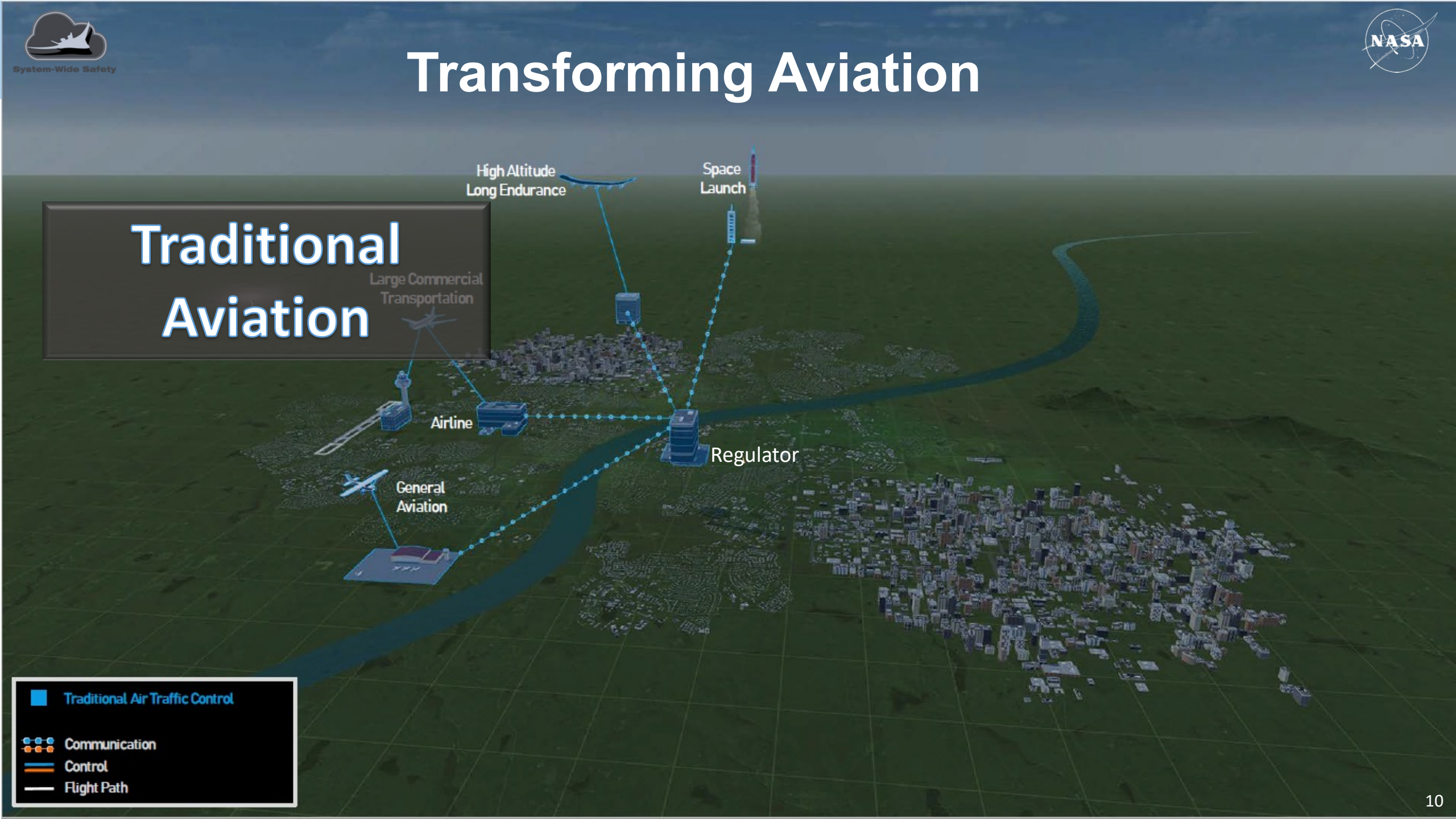


Quickly manage known operational risks at scale

Quickly identify previously unknown risks

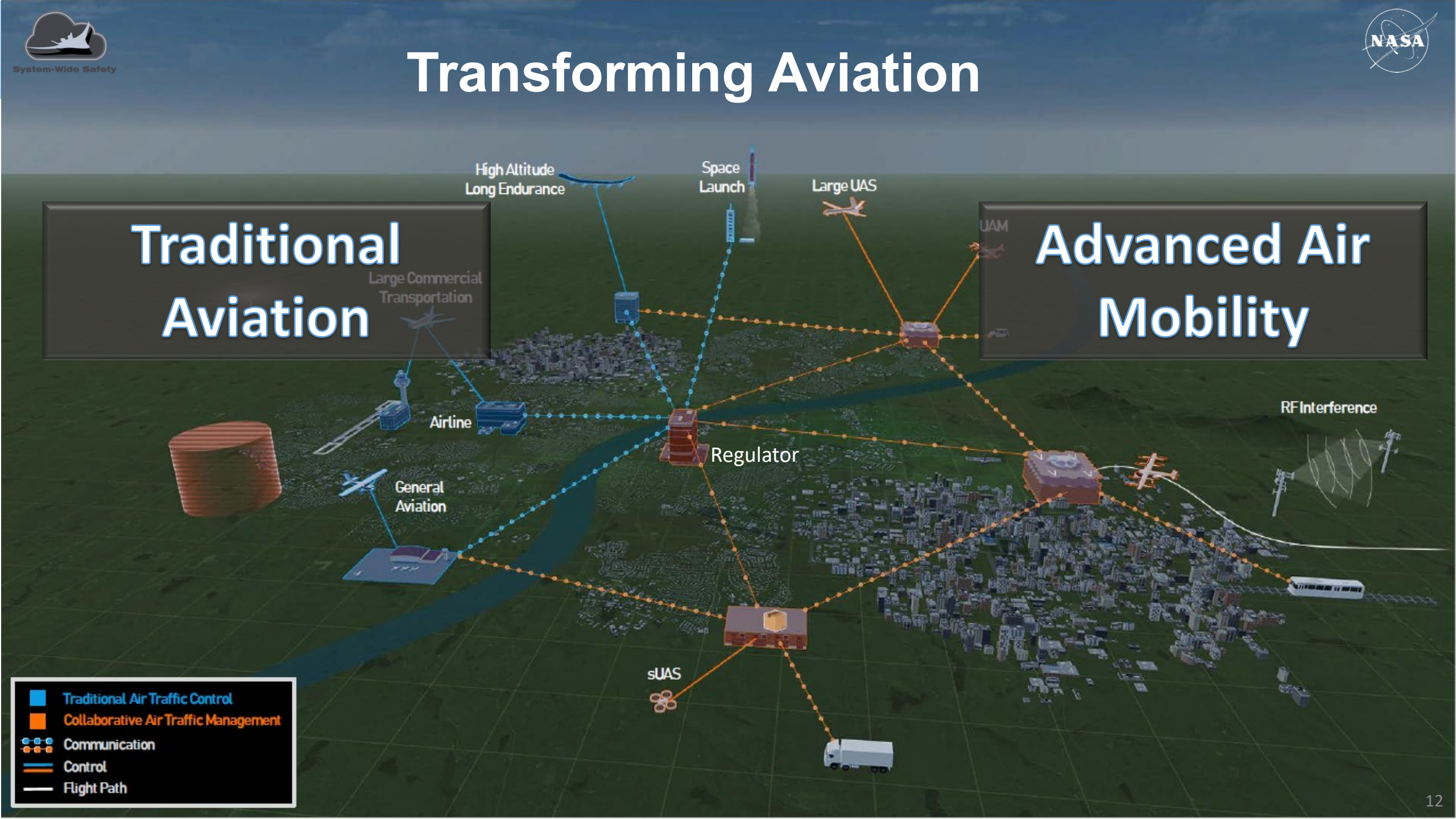
Quickly inform design

Transforming Aviation

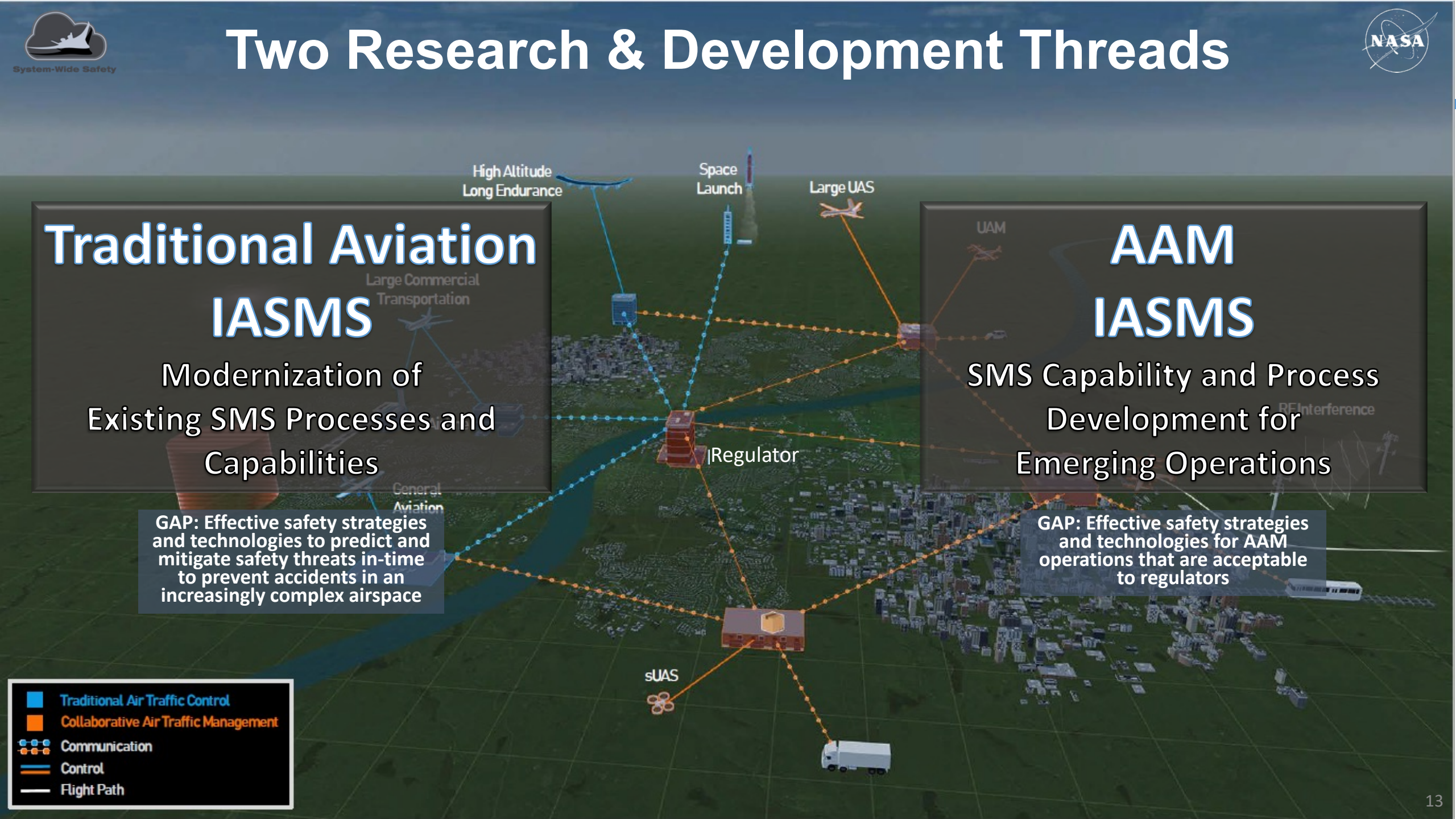


Transforming Aviation

Transforming Aviation



Two Research & Development Threads



Traditional Aviation IASMS

Modernization of Existing SMS Processes and Capabilities

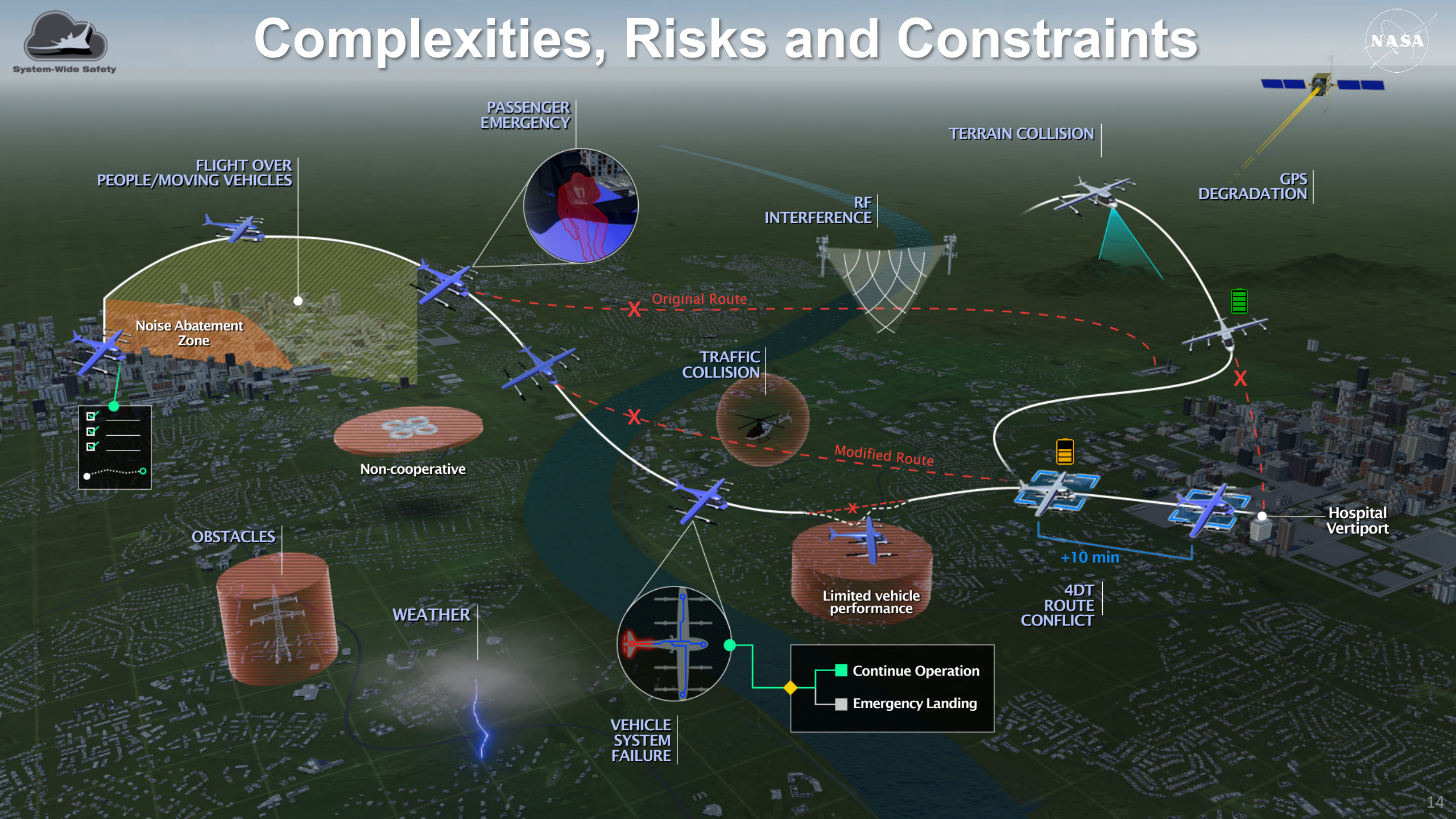
GAP: Effective safety strategies and technologies to predict and mitigate safety threats in-time to prevent accidents in an increasingly complex airspace

AAM IASMS

SMS Capability and Process Development for Emerging Operations

GAP: Effective safety strategies and technologies for AAM operations that are acceptable to regulators

Complexities, Risks and Constraints



In-Time Aviation Safety Management Systems

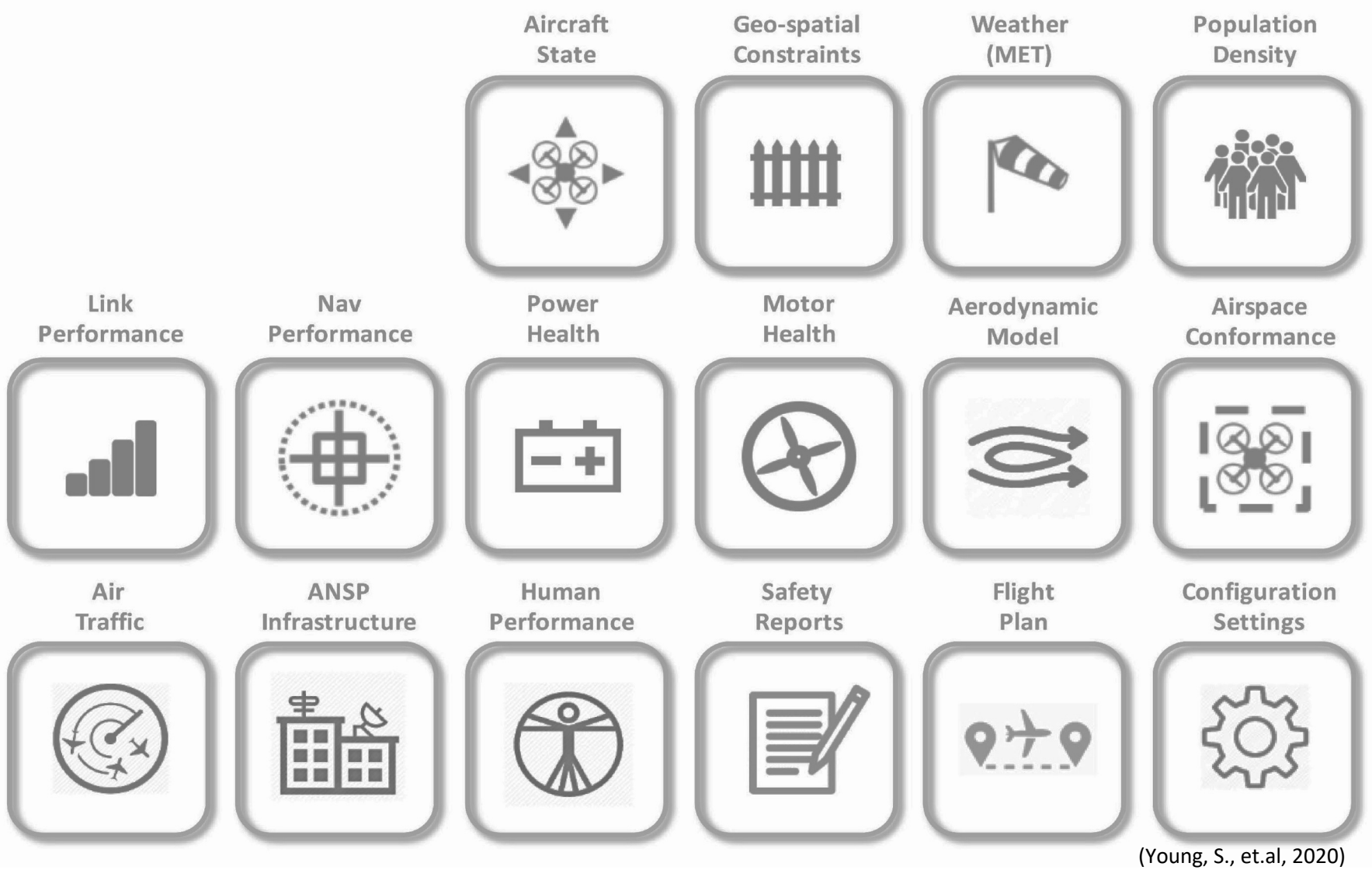
IASMS – Extensible & Tailorable Safety Management Framework

System-Wide Safety

It All Starts with Data…

Information classes useful to enable IASMS SFCs

- ANSP Sourced
- Operator Sourced
- Vehicle Sourced
- Supplemental Data Service Provider (SDSP) Sourced
- System Wide Information Management (SWIM) / Flight Information Management System (FIMS) Sourced
- Other Sources…



(Young, S., et.al, 2020)

Monitor • Assess • Mitigate

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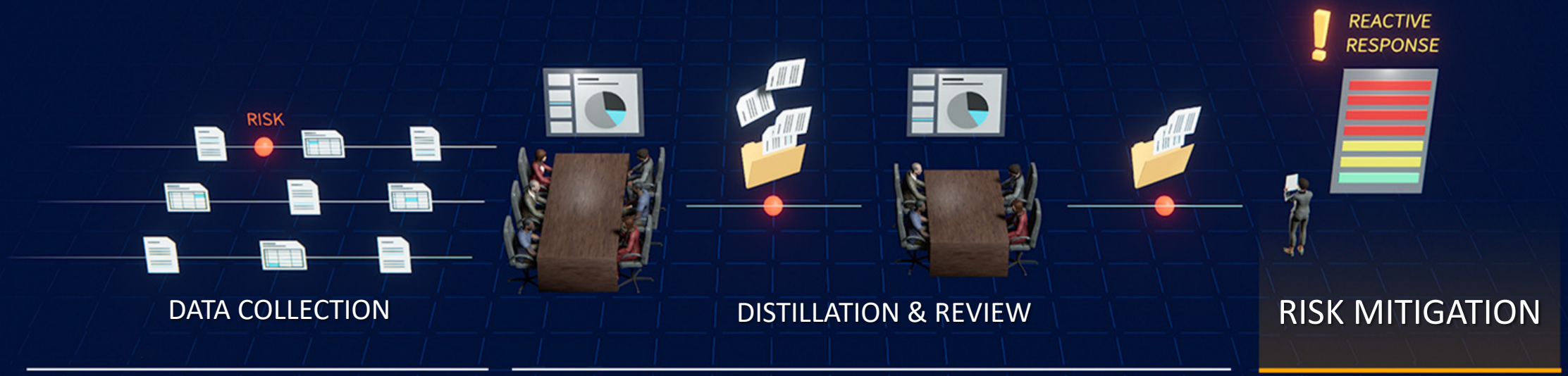
SMS



Credit: NASA

DATA COLLECTION & AGGREGATION

FUSION OF BIG DATA SETS

RISK MITIGATION

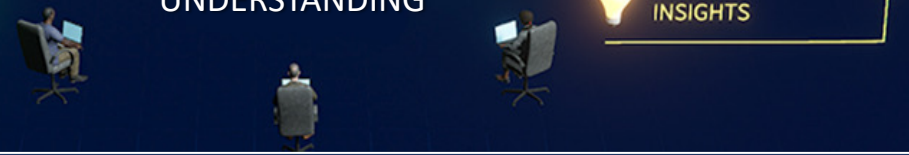
Safety Data

Safety Information

Actionable Safety Intelligence

IASMS

INTERPRETATION & UNDERSTANDING



Monitor • Assess • Mitigate

SMS

DATA COLLECTION

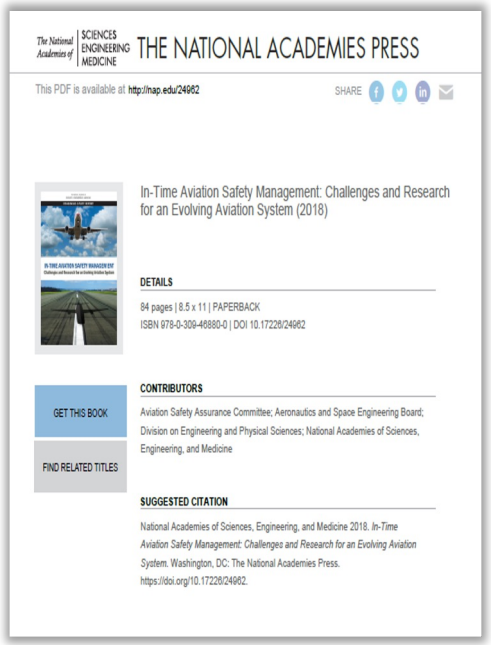
DISTILLATION & REVIEW

RISK MITIGATION

Credit: NASA

Progress Toward IASMS

National Academies Report

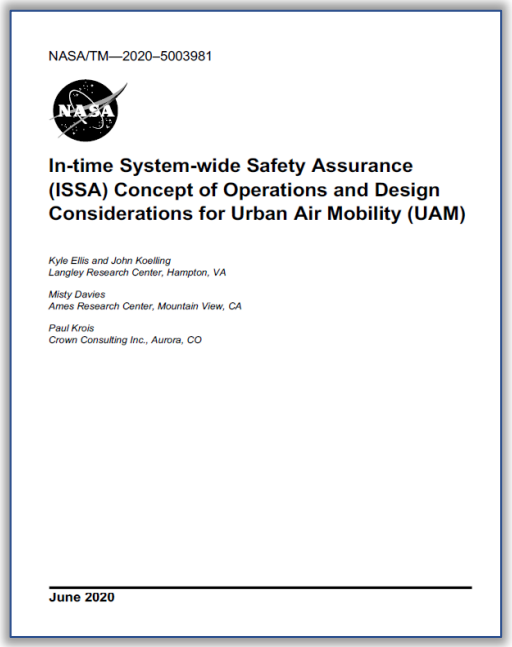


https://nap.nationalacademies.org/download/24962#

Identifies 4 Fundamental System Element Development Areas:

1. Concept of Operations and Risk Prioritization
2. System Monitoring
3. System Analytics
4. Mitigation and Implementation

IASMS ConOps

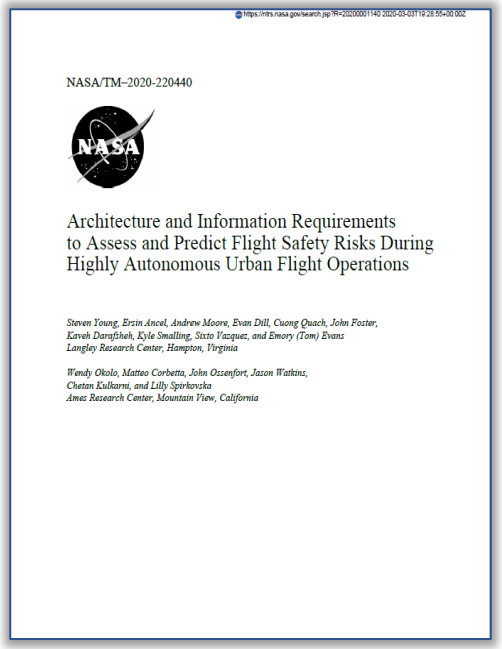


https://ntrs.nasa.gov/citations/20205003981

Outlines Scope, Functionality and Risk Priorities for IASMS

1. Drafted with Industry Input
2. V.1 of ConOps focused on UAM domain with relevant use cases. V.2 expanding across domains (in dev)
3. FAA-NASA RTT Near-Term ConOps (in dev)
4. Built upon service-oriented architecture of UTM

Architecture & Information Reqmts



https://ntrs.nasa.gov/citations/20200001140

Describes NASA approach to development of IASMS

1. Identifies Information Classes
2. Discussion of Initial IASMS SFC Developments
3. Design Considerations for IASMS
4. Reference architecture for autonomous urban flight operation


NASA
EXPLORE FLIGHT
WE'RE WITH YOU WHEN YOU FLY

Dr. Kyle Ellis

NASA

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Dr. Kyle Ellis is an aerospace research engineer at NASA Langley Research Center and currently manages research supporting NASA's Aeronautics Research Mission Directorate as the project manager for the System-Wide Safety Project under the Airspace Operations and Safety Program.

Kyle currently leads a team charged with developing a vision and Concept of Operations for In-Time Aviation Safety Management Systems (IASMS). The concept of an IASMS is envisioned to be an evolution of SMS, designed to safely integrate emerging aviation markets with those already in place and is being developed and demonstrated by leveraging strategic partnerships across industry, academia, and government. His work identifies, matures, and integrates methods and technologies in the areas of increasingly automated and autonomous systems, verification and validation methods for certification, and future-gen aircraft, airspace management and infrastructure concepts to transform the global aviation industry.

Kyle currently serves on multiple committees and working groups related to safety, technology, and policy for the aviation industry including the International Forum of Aviation Research (IFAR), the CAST Joint Implementation Measurement Data Analysis Team (JIMDAT), the Flight Safety Foundation Autonomous and Remotely Piloted Aviation Capabilities (ARPAC) safety working group, the AIAA Human-Machine Teaming Technical Committee and the ICAO Safety Management Panel and the Remotely Piloted and Autonomous Systems Panel as a technical advisor.