ICAO SMP

In-Time Aviation Safety Management Systems (IASMS)

presented by
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ICAO HQ
Montreal, Canada

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
+ ML
+ IoT

xTM
Provider of Services

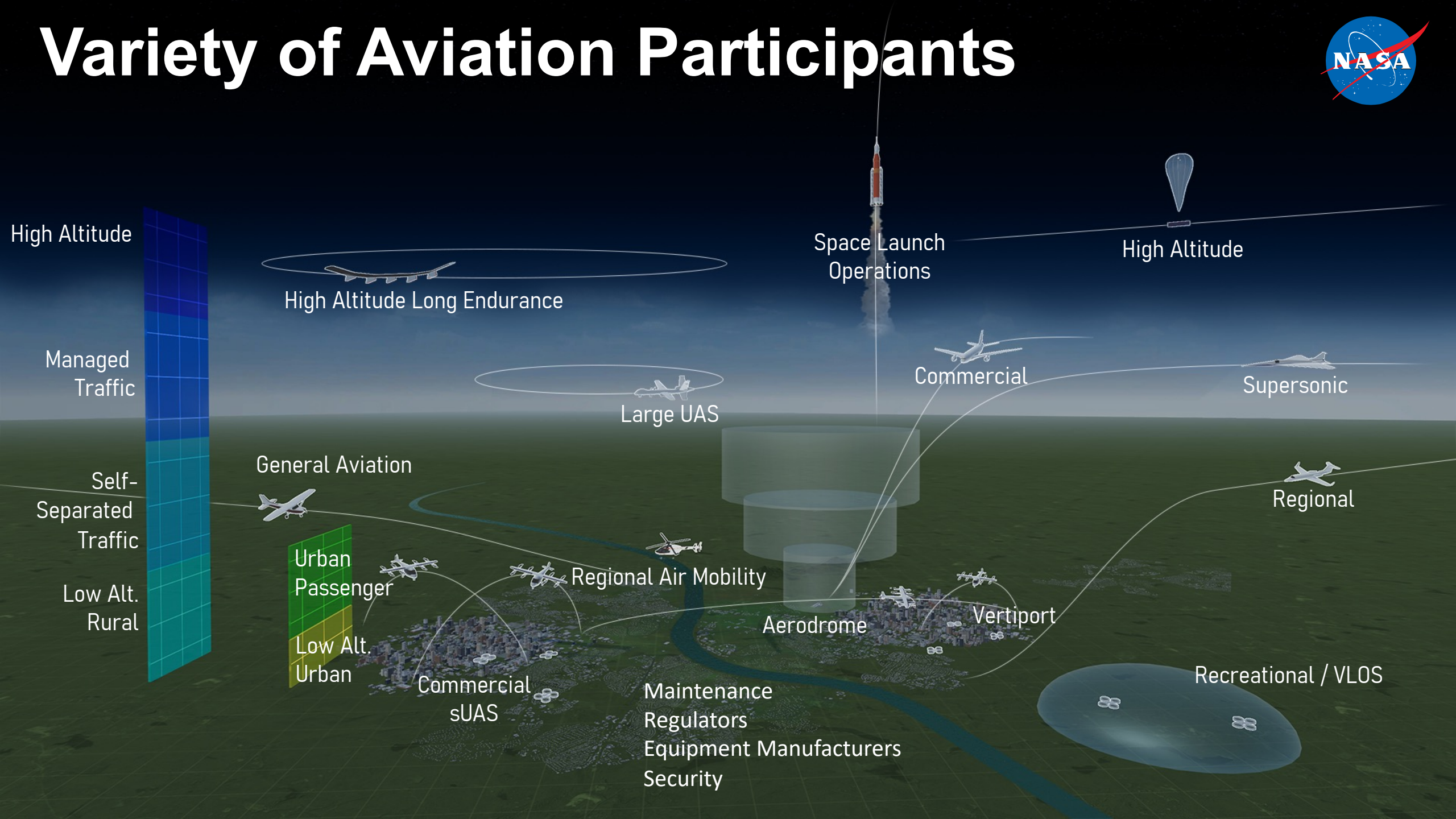
FAA
Industry Data Exchange

Automation-Enabled Diversity

Highly Automated
Complexity, scalability,
And dynamic adaptation
+ digital mesh
+ AI
+ 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

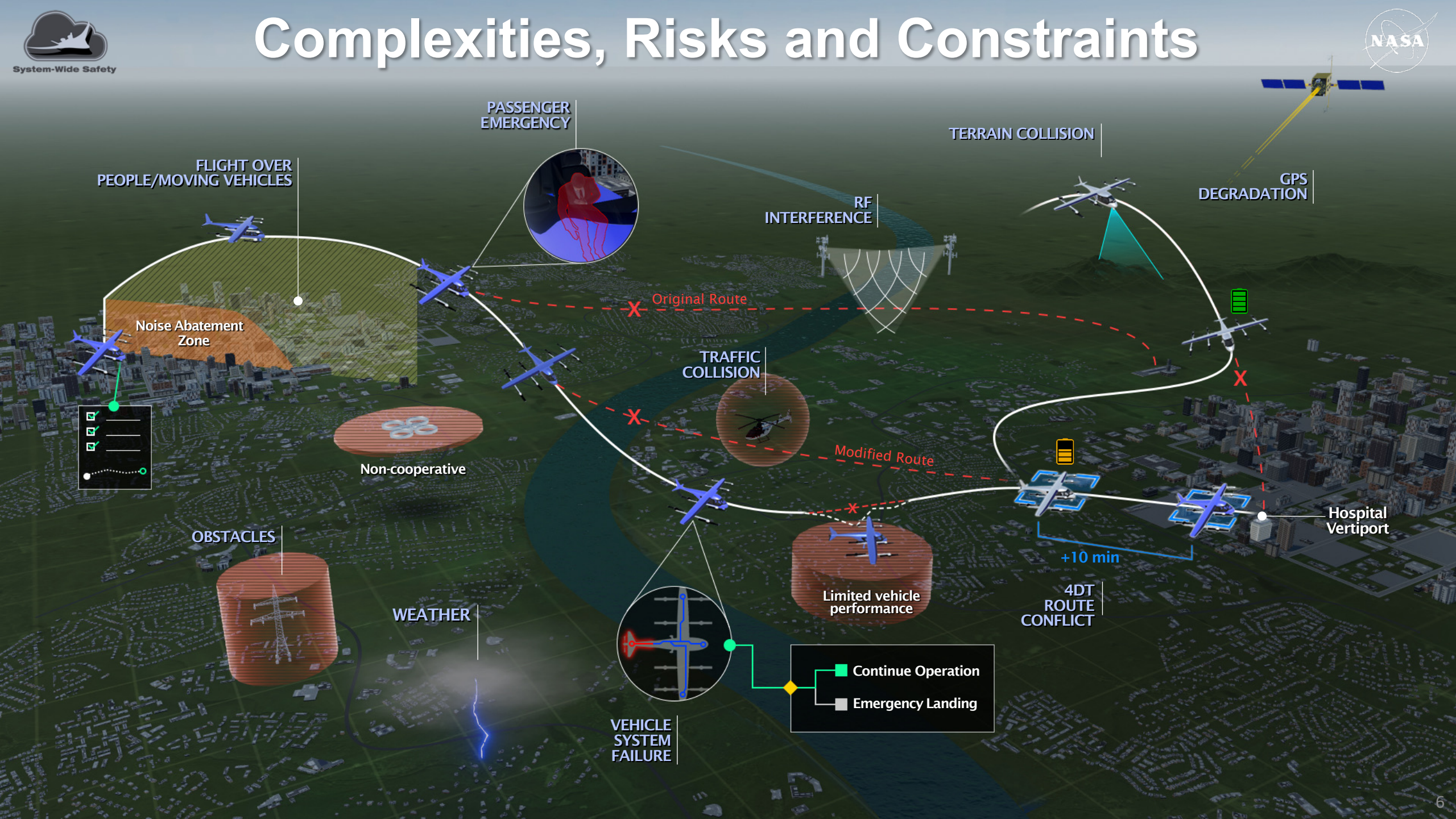
New Missions = Increased Integration Complexity

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**

Complexities, Risks and Constraints

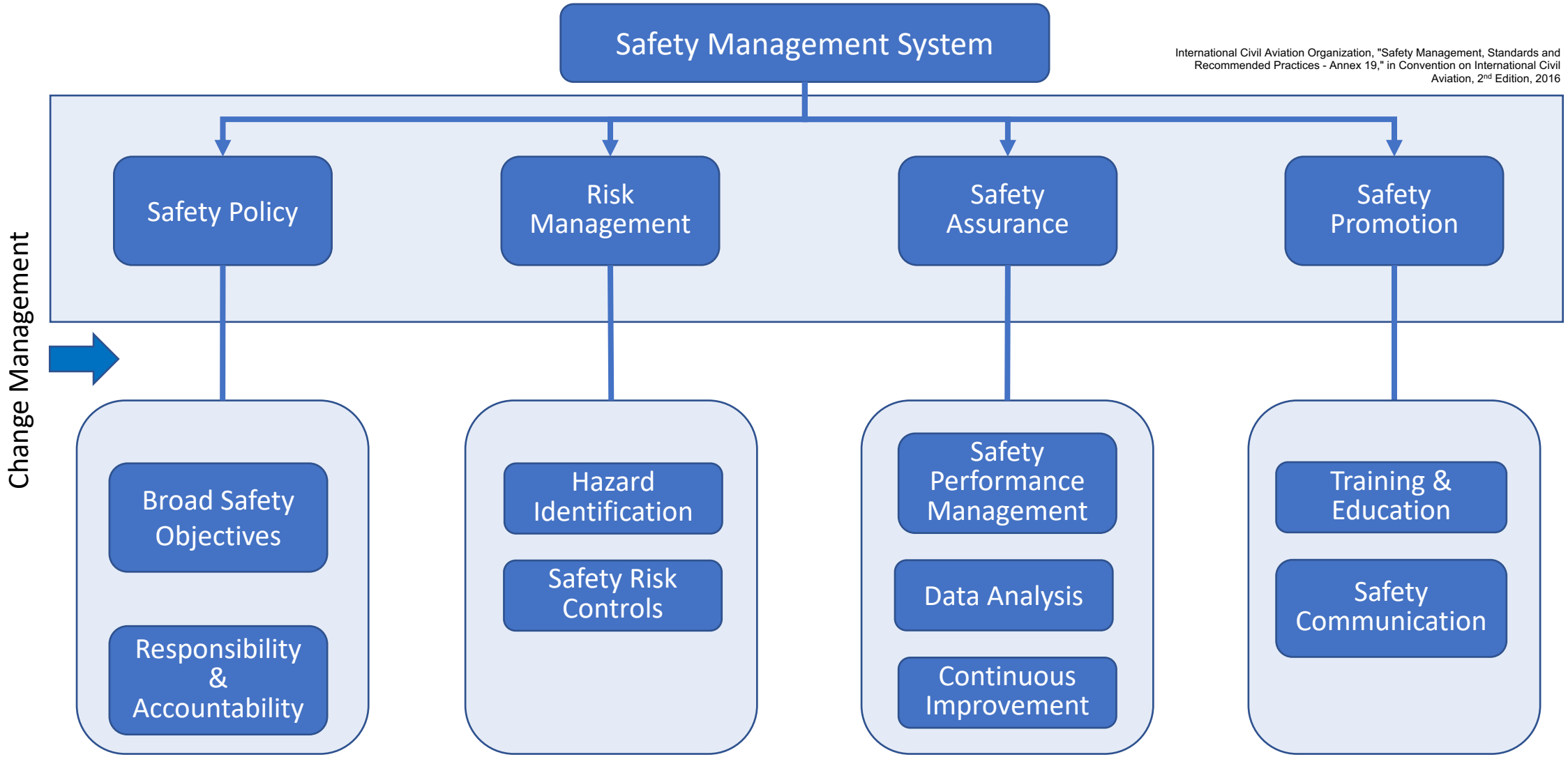


System-Wide Safety Project Goals

*To **explore, discover, and understand** the **impact** on **safety** of **growing complexity** introduced by modernization aimed at improving the **efficiency of flight**, the **access to airspace**, and/or the **expansion of services provided by air vehicles**.*

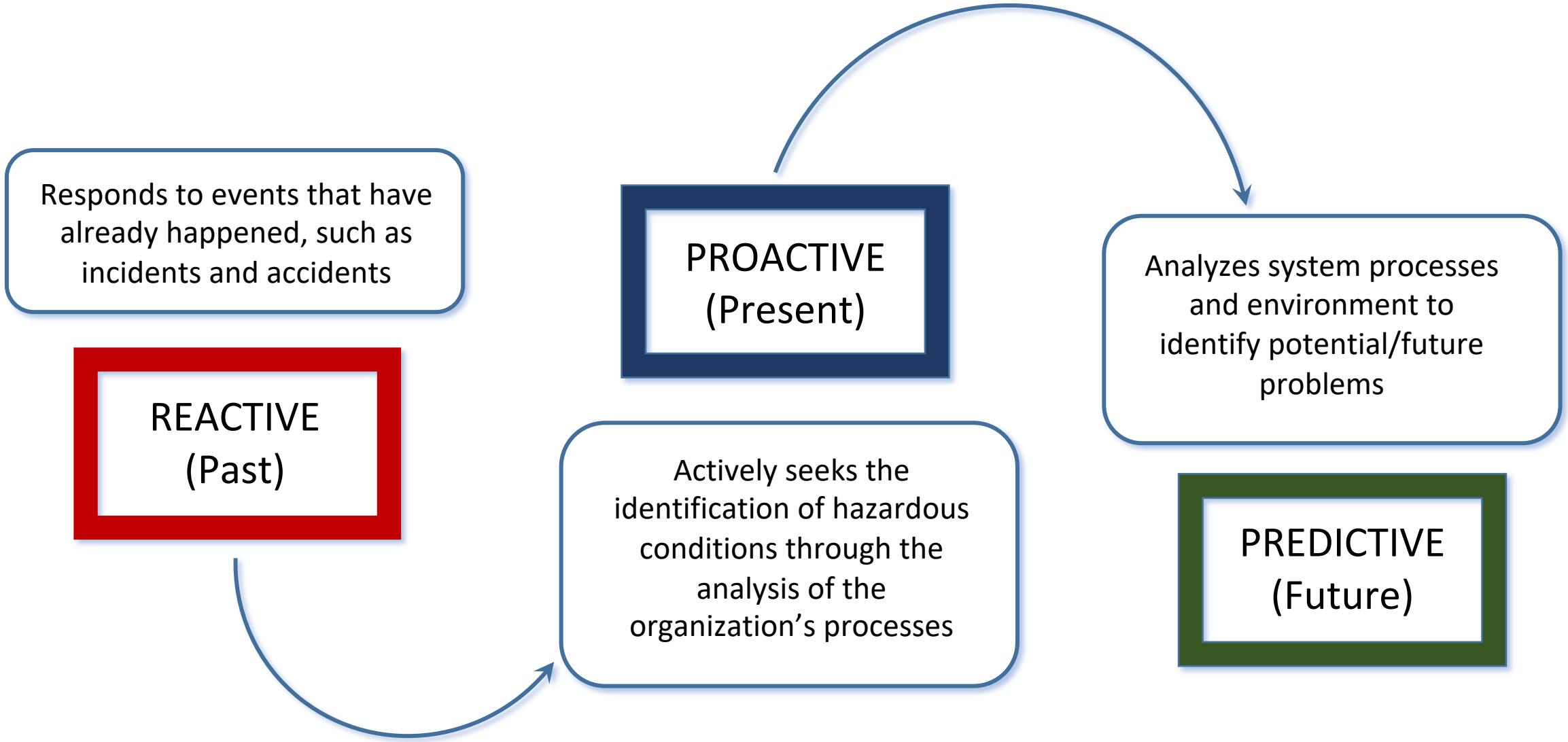
*To **develop** and **demonstrate innovative solutions** that **enable** this **modernization and the aviation transformation** envisioned for the **global airspace system** through **proactive mitigation of risks** in accordance with **target levels of safety.***

Achieving Aviation Safety Today



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]

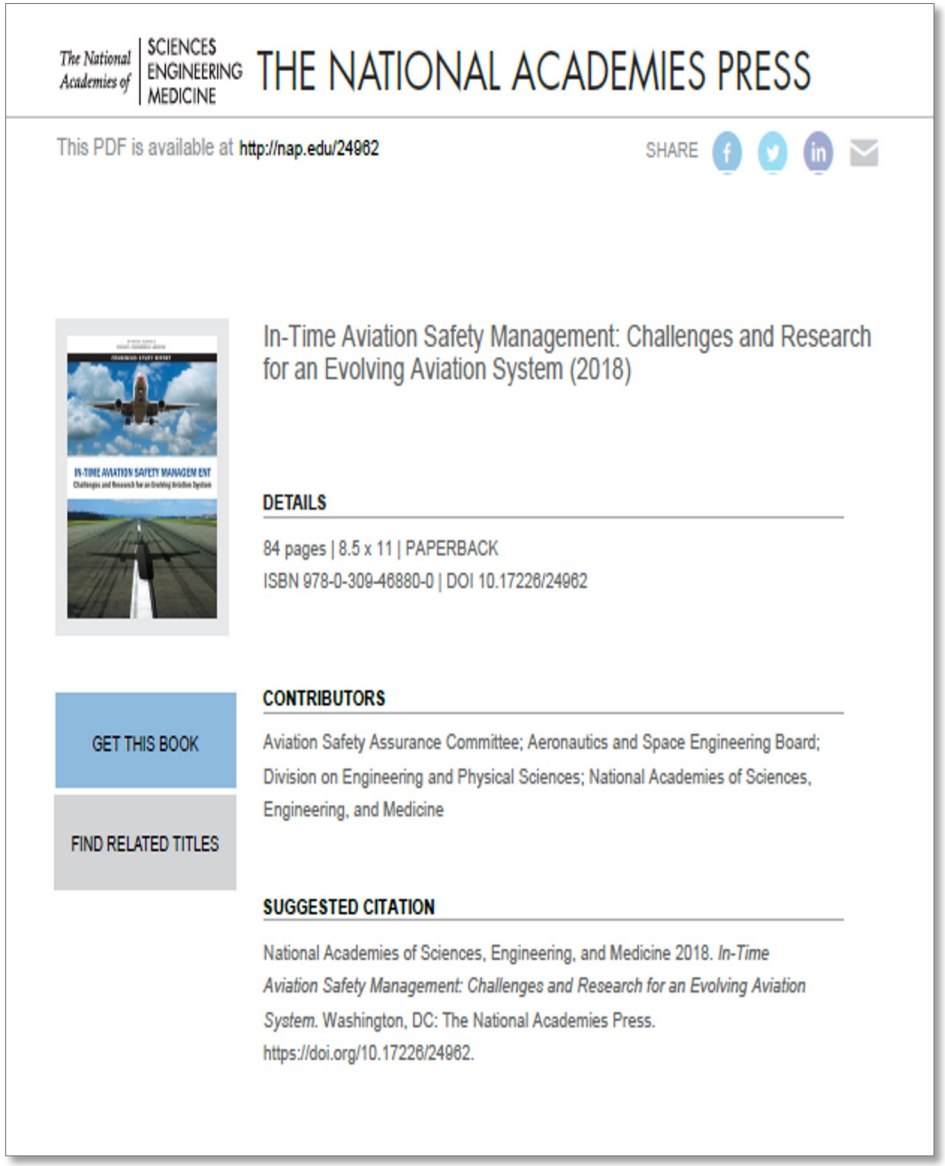
National Academies — IASMS

Outlines need for evolution of the existing Safety Management System

In-Time Aviation Safety Management System (IASMS)

Identifies 4 Fundamental System Element Development Areas:

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



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In-Time Aviation Safety Management: Challenges and Research for an Evolving Aviation System (2018)

DETAILS

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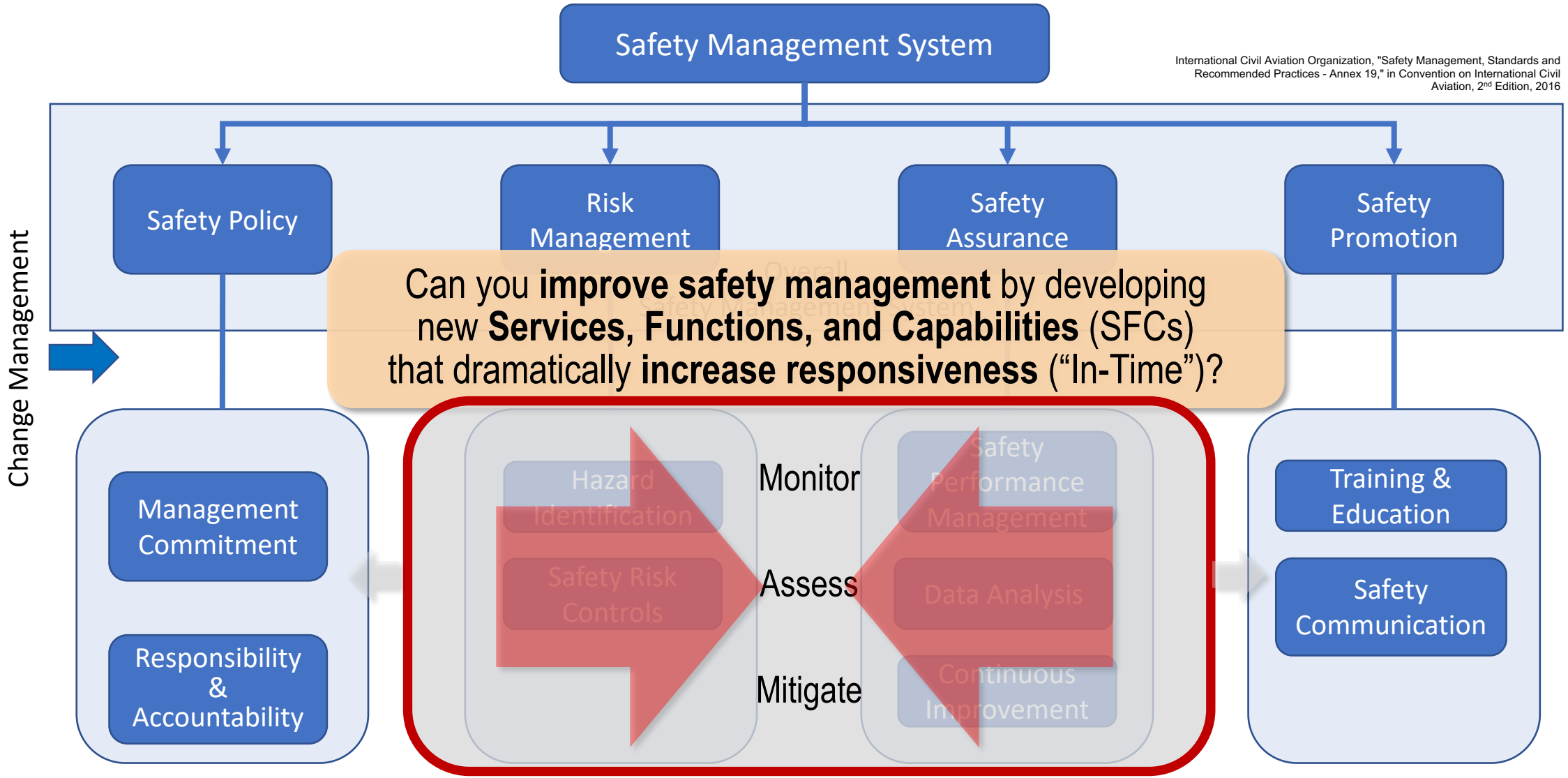
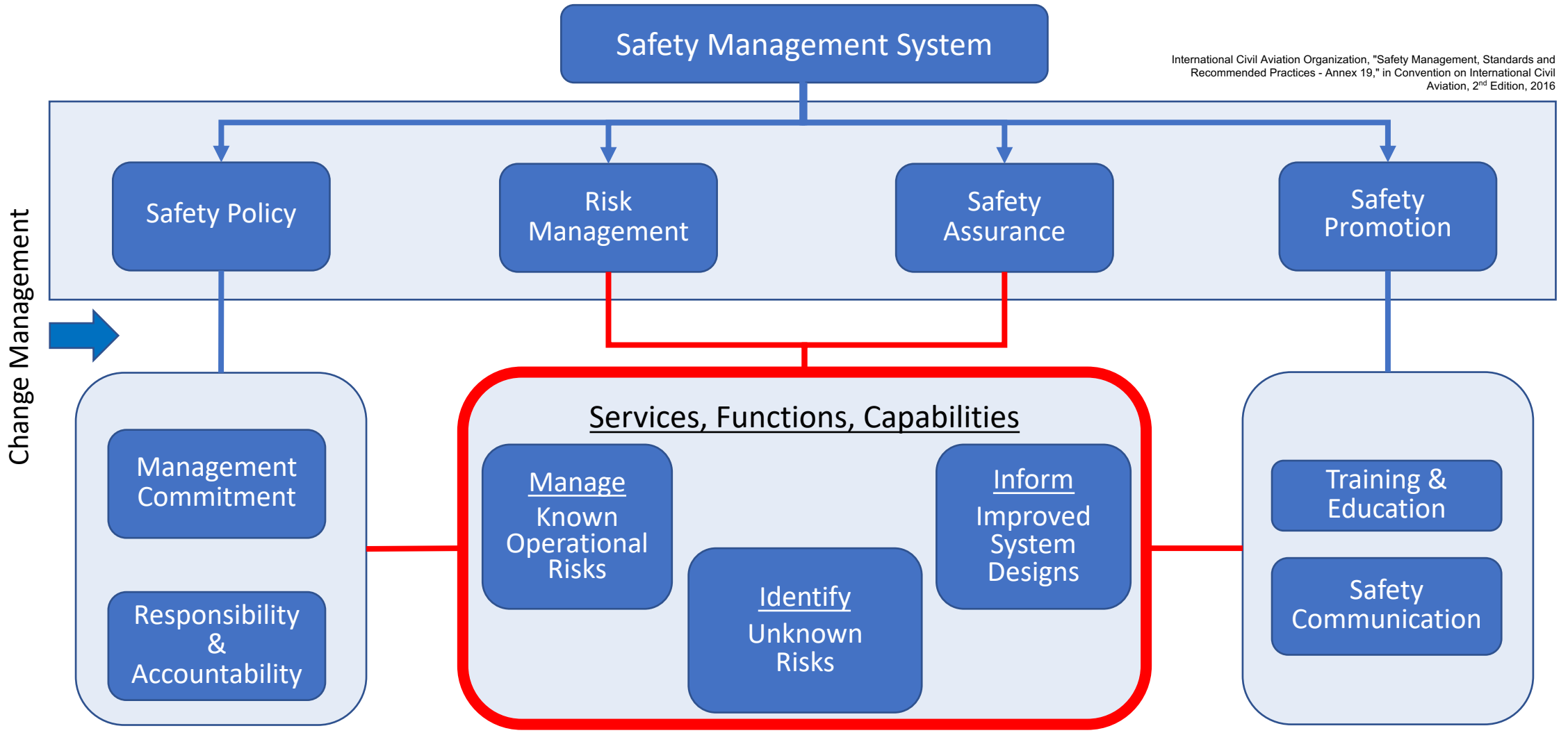
Safety Management System Evolution



Ref: National Academies, In-Time Aviation Safety Management: Challenges and Research for an Evolving Aviation System, 2018.

How We Achieve Aviation Safety Tomorrow



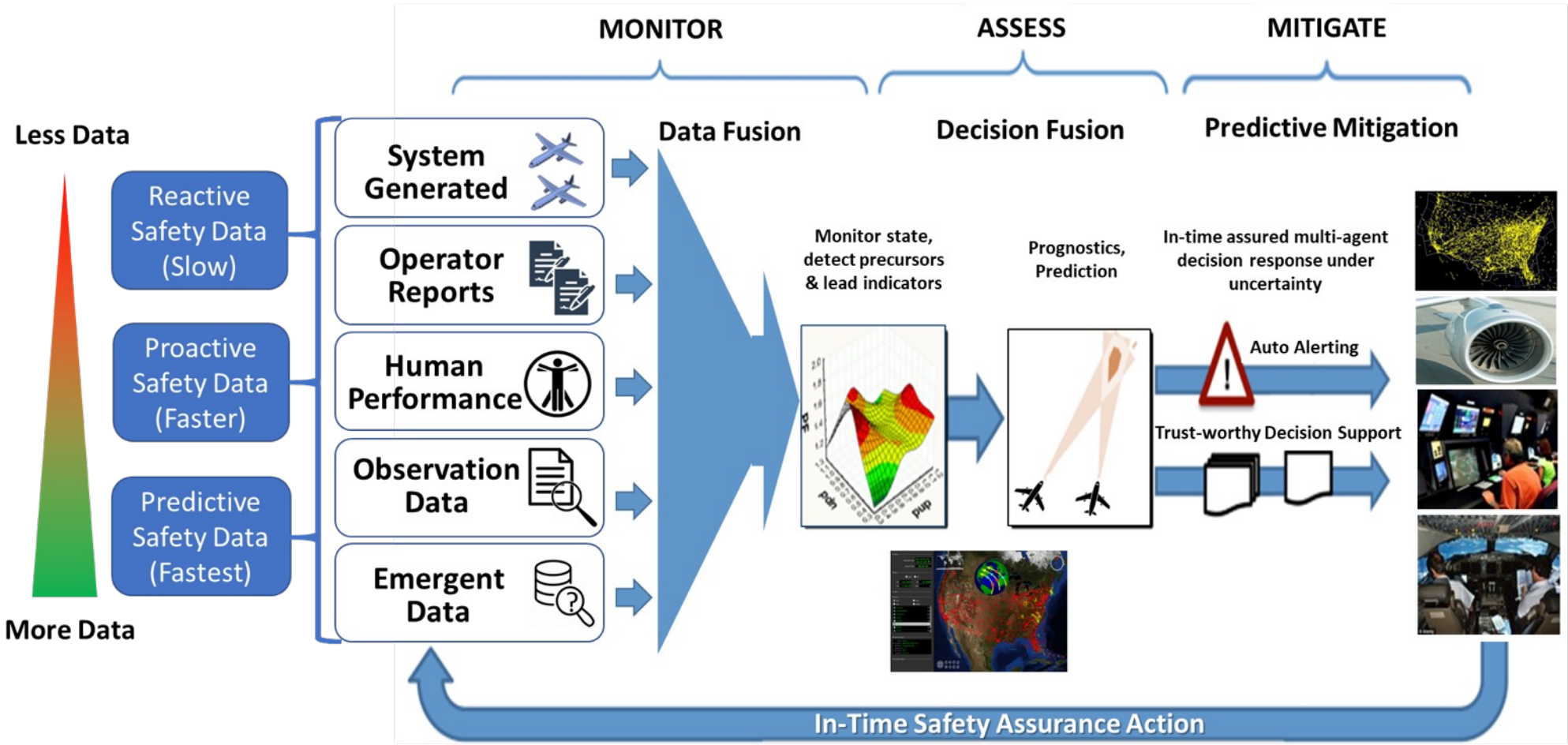
Quickly manage known operational risks at scale

Quickly identify unknown risks

Quickly inform design

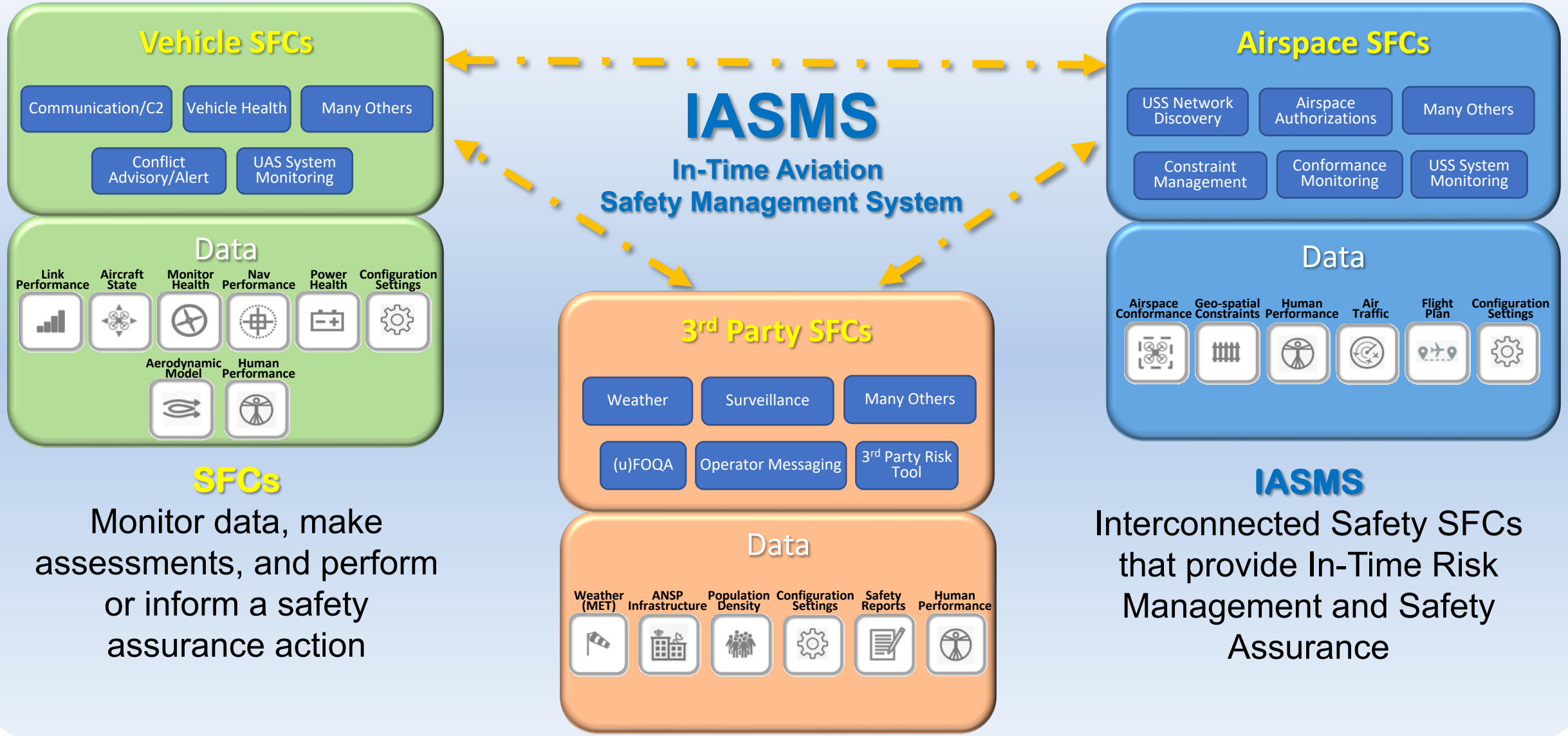
Increasingly In-Time Safety Assurance

Operational Needs	Improve in-time safety	Improve scalability	Improve accessibility	Increase participation
Transformation Goals	In-time Safety Assurance	Tailored Safety	Interoperability	



Credit: NASA

Distributed Digital Systems Architecture



SFCs

Monitor data, make assessments, and perform or inform a safety assurance action

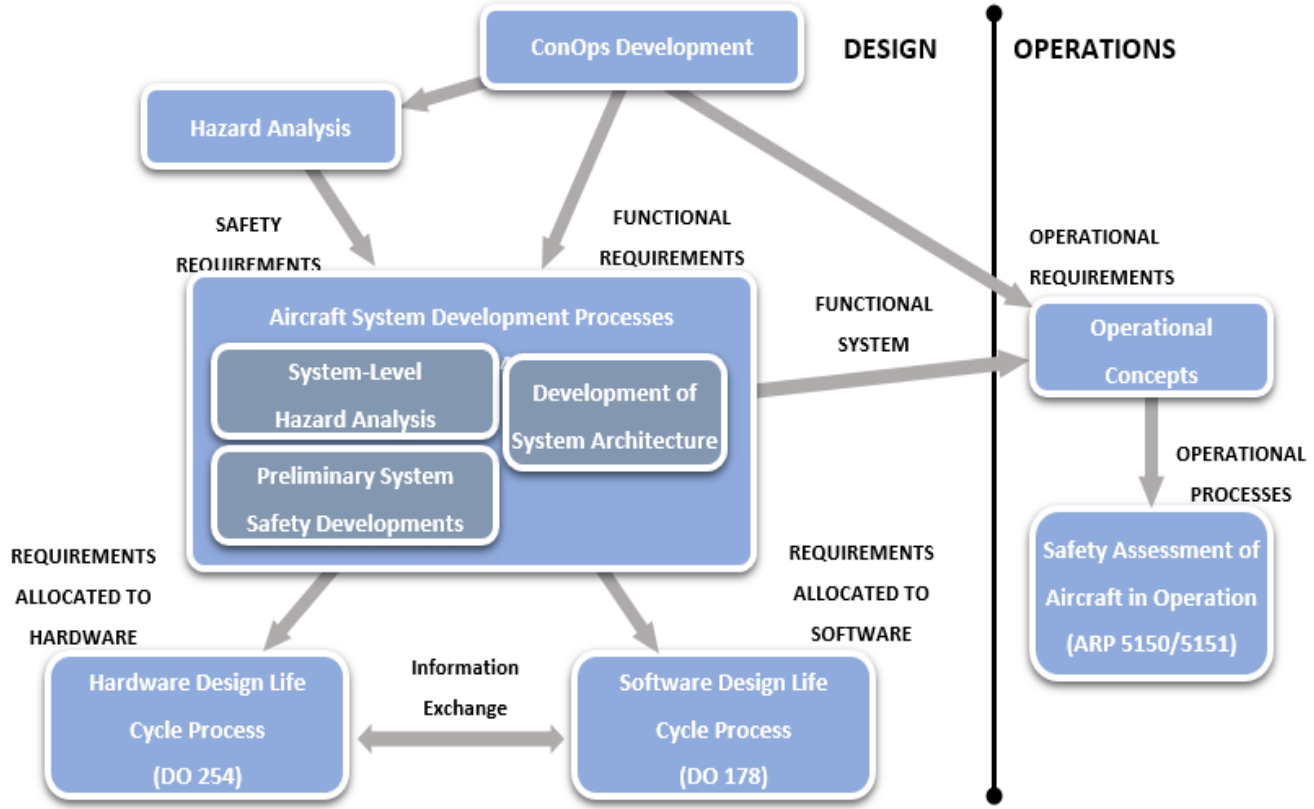
IASMS

Interconnected Safety SFCs that provide In-Time Risk Management and Safety Assurance

SFC Assurance of Functionality

Assure Design

- **Assurance requirements are specific to flight rules, operation complexity and risk criticality**
- **SFCs must be assured to an appropriate level via an acceptable process**



Building Confidence

SFCs that

Manage Operational Risks:

Must mitigate risks with an acceptable level of certainty

SFCs that

Identify Unknown Risks:

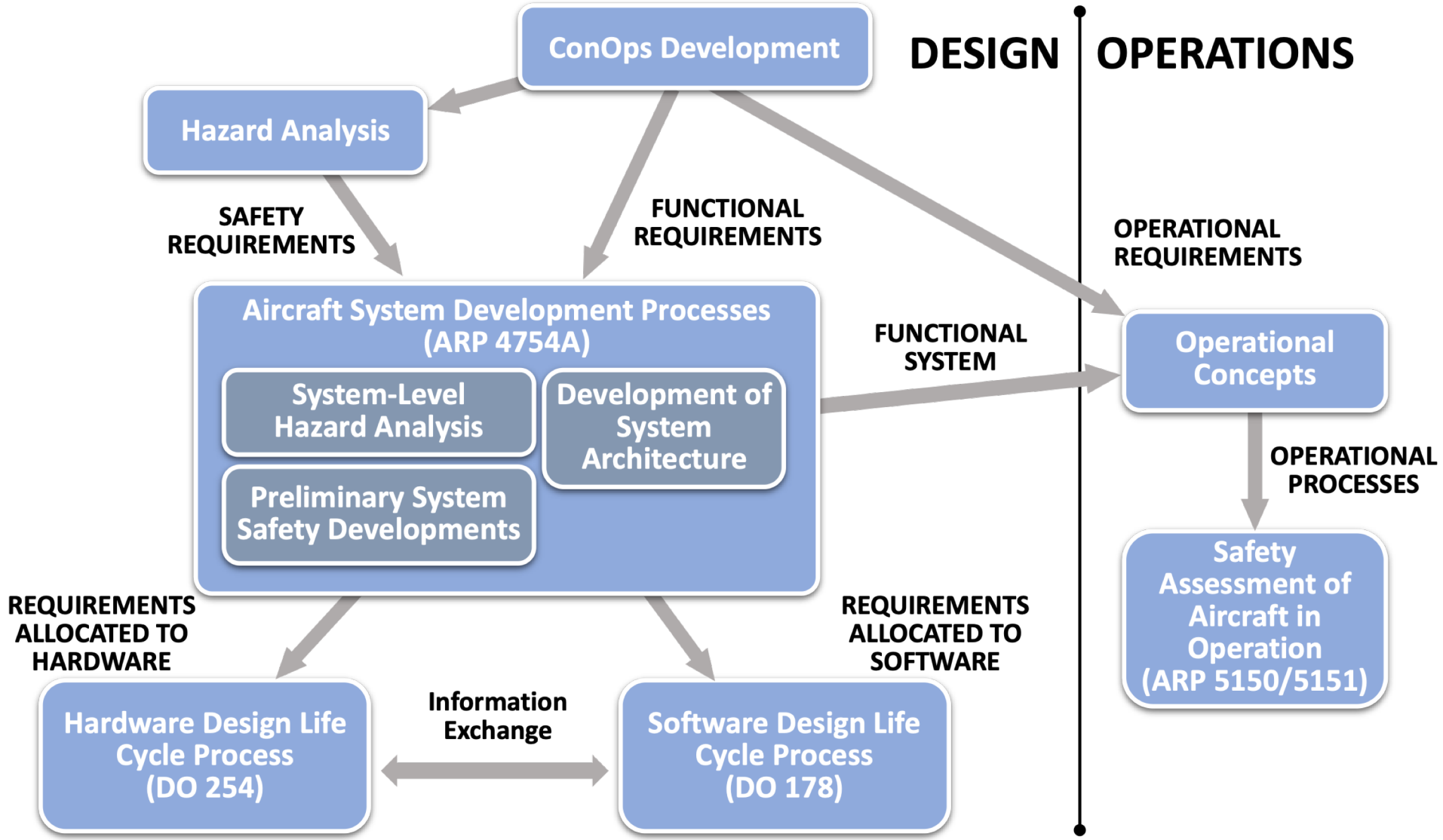
Must correctly identify unknown anomalies and hazards in the system

SFCs that

Inform System Designs:

Must correctly assess performance and deficiencies of the existing design

Design Safety vs. Operational Safety



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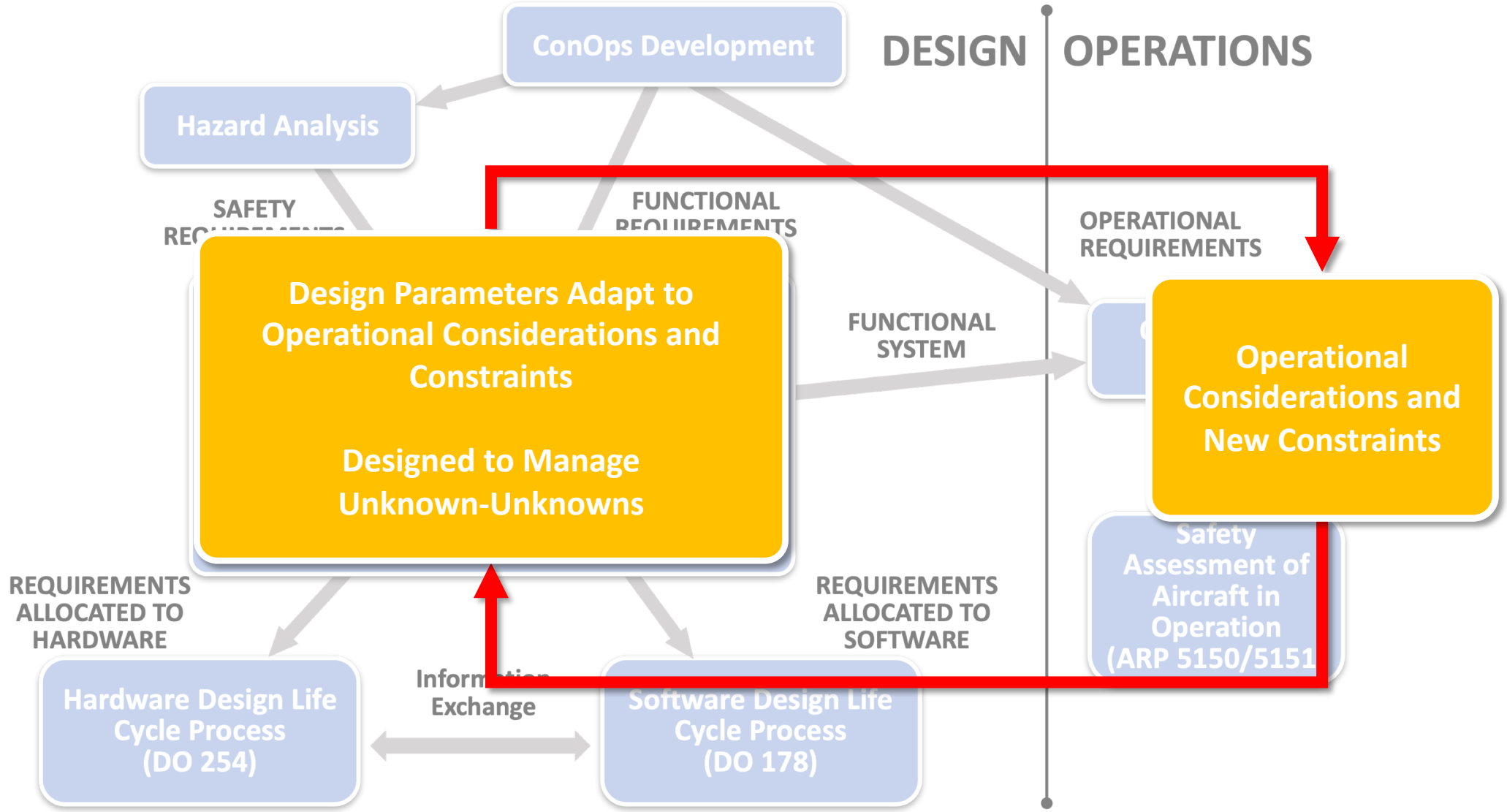
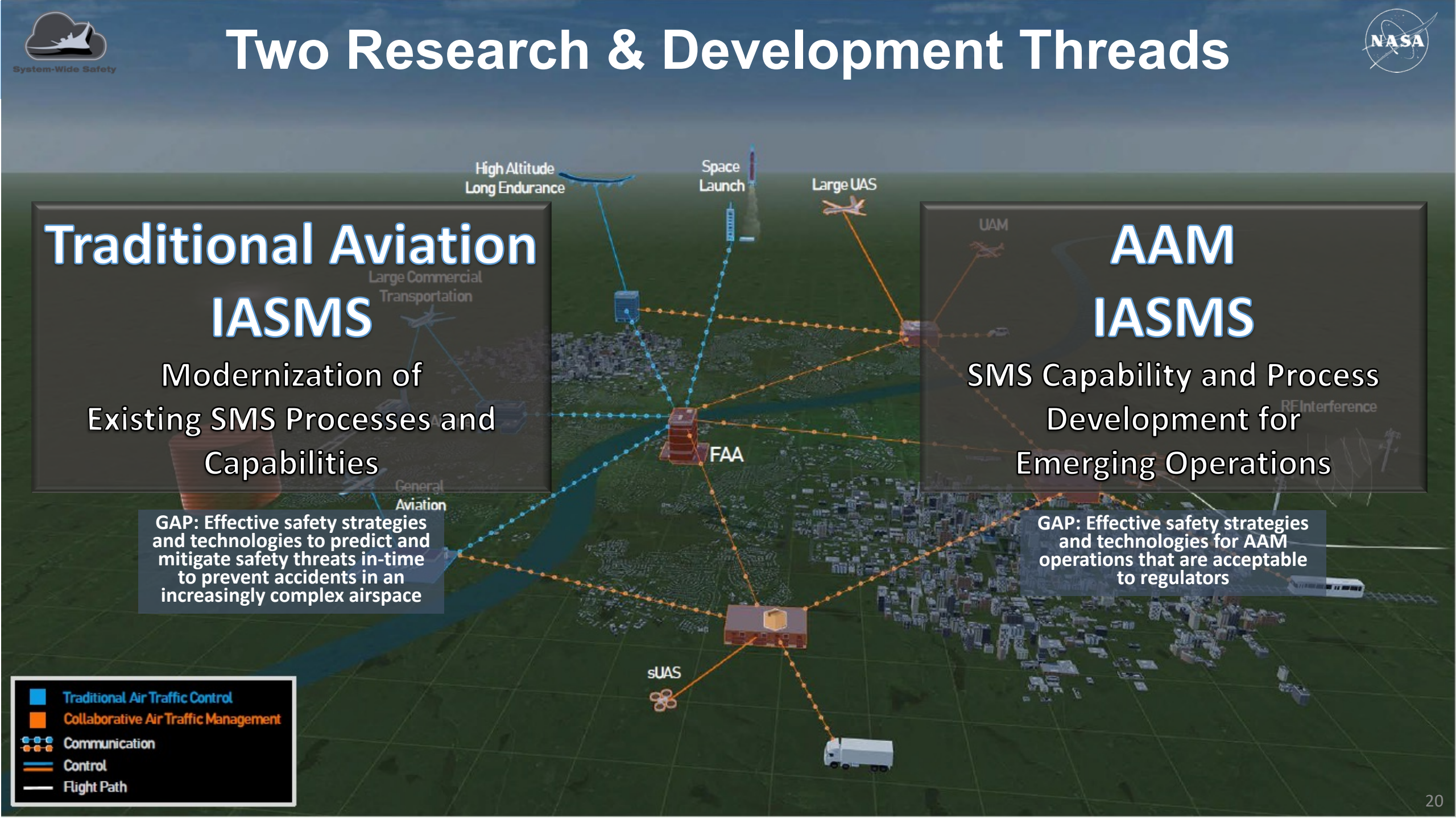


Transforming Aviation

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

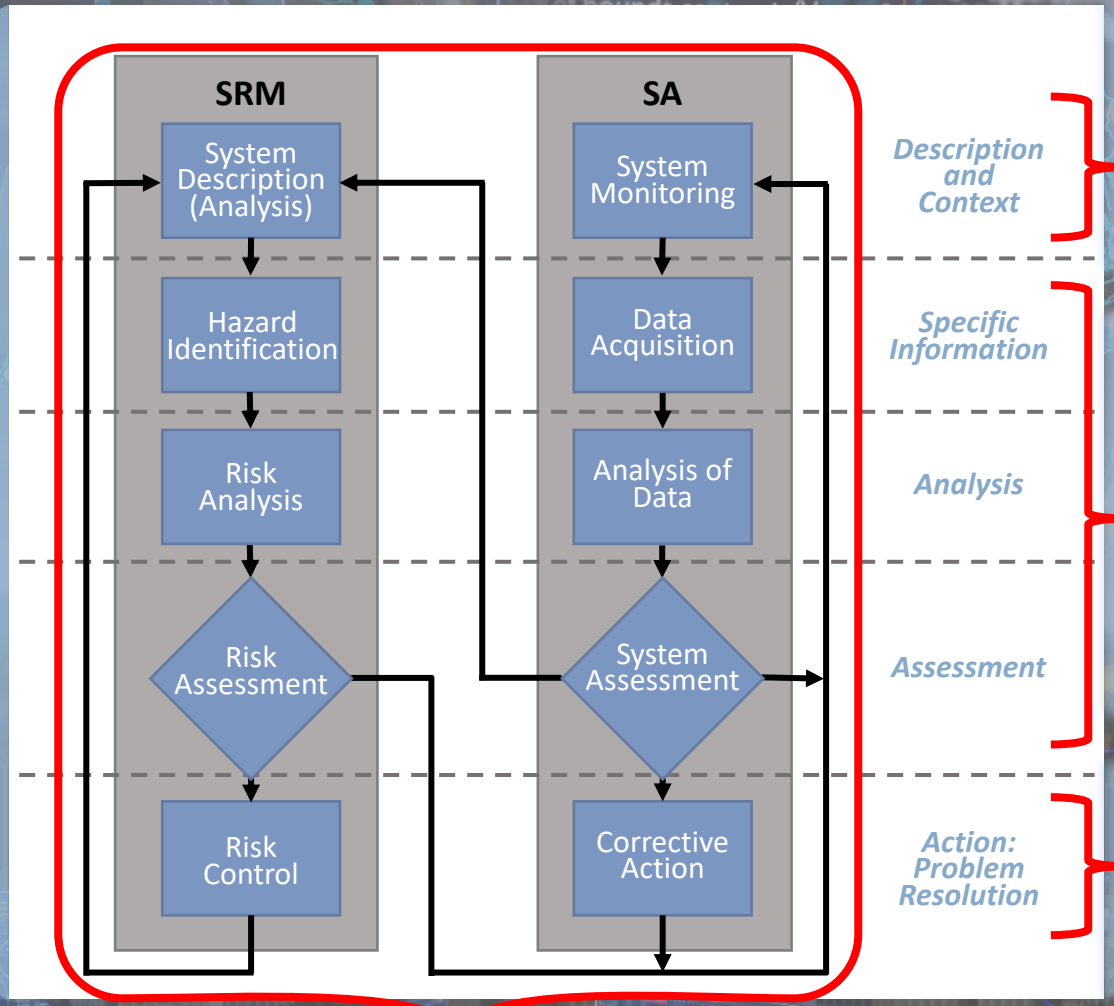
SMS Capability and Process Development for Emerging Operations

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

In-Time Aviation Safety Management Systems

Needs

- In-Time Safety Risk Mitigation
- Proactive -> Predictive Safety Management Systems
- Adopt ML/AI for predictive analysis and advanced data mining
- Build upon existing IT architectures for increased access to data and tools
- Improve system agility and responsiveness



R&D Required:

- New Safety Databases
- Non-traditional data
- Data Fusion w/existing services
- Required vs. Voluntary Data
- Synthetic Data Generation

- ML/AI Anomaly Detection
- Predictive Risk Assessment
- Multi-Risk Safety Prognostics
- Integrated Risk Assessments
- Digital Twin Assessments
- Data Exchange Architecture
- Digital Information Service Integration

- Pre-Flight Mitigation
- In-Flight Mitigation
- Post-Flight Mitigation
- Re-Design Consideration

Figure from FAA AC No: 120-92B, Safety Management Systems for Aviation Service Providers

In-Time Aviation Safety Management Systems


NASA
EXPLORE FLIGHT
WE'RE WITH YOU WHEN YOU FLY

Questions?

Dr. Kyle Ellis

NASA

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 deputy 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 and airspace management 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 as a technical advisor.