An In-time Aviation Safety Management System Concept of Operations and Modernization of the National Airspace System

https://www.nasa.gov/directorates/armd/aosp/sws/

SCITECH FORUM

AIAA SCITECH 2025

DA-03: Digital Avionics II
January 10

CROWN
AIR MOBILITY. ADVANCED.

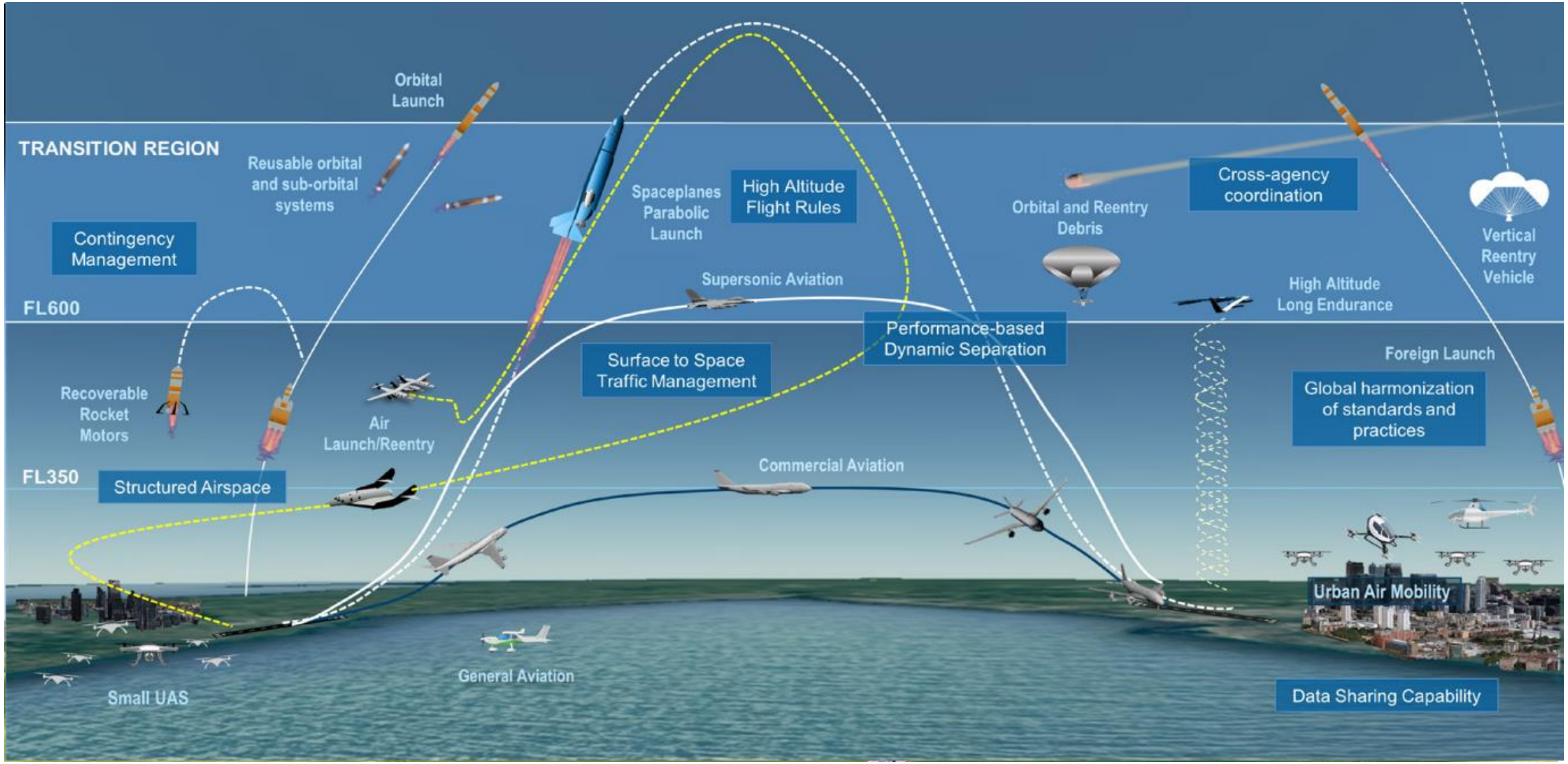
NASA

Paul Krois, Ph.D
Senior Technical Consultant – Aviation Safety

System-Wide Safety Project
Airspace Operations and Safety Program

Future Air Transportation System

System Wide Safety



Credit: FAA

Future Concepts[1]

System Wide Safety

FAA

NASA

2025 2040 2050

https://www.faa.gov/sites/faa.gov/files/Charting-Aviations-Future-Operations-in-ICN_0.pdf
https://skyforall.directus.app/assets/0b3957f5-e224-44a5-922b-f688fc0ba8a1.pdf

[1] U.S. Future Visions shown.
Not shown - International future air transportation system documents

Visions of Future Transformational National Airspace System

System Wide Safety

NextGEN

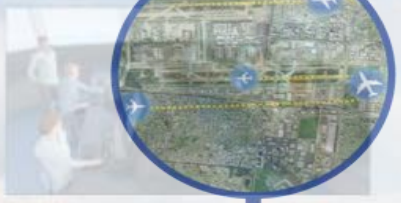
Airspace Modernization

SKY for ALL

+ Efficiency and proactive planning

+ Service oriented architecture for tailored missions-oriented services

+ Complexity, scalability, and dynamic adaption



Diversity, Density, Scalability, and Complexity

TRAJECTORY

Automated in-time safety monitoring and alerting services

COLLABORATIVE

Integrated predictive risk mitigation across domains

HIGHLY-AUTOMATED

Digital Transformation of ATM

Assured adaptive in-time safety management

Today

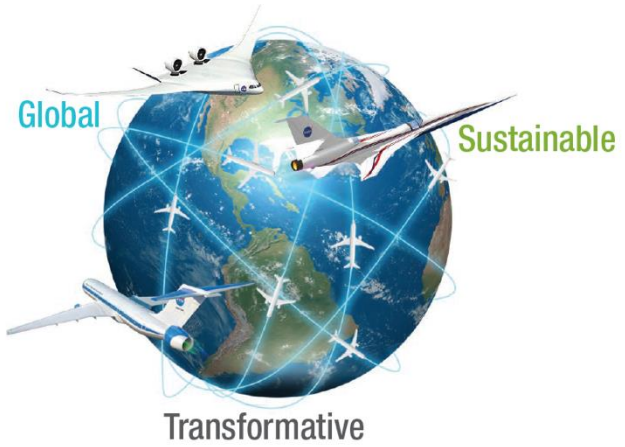
circa 2040

circa 2050

ARMD Strategic Thrust Alignment

System Wide Safety

https://www.nasa.gov/aeroresearch/strategy

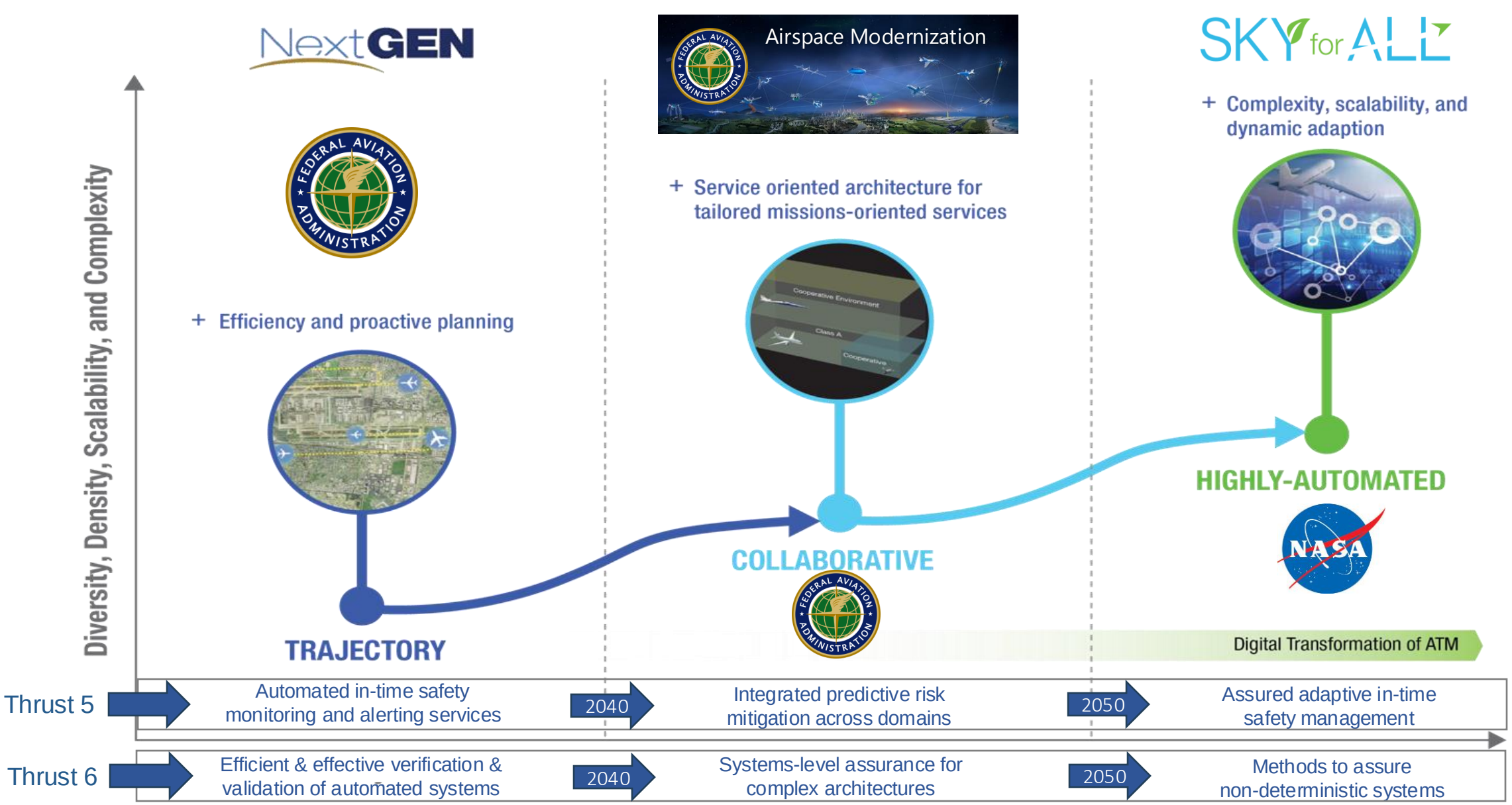


- Safe, Efficient Growth in Global Operations
- Safe, Quiet, and Affordable Vertical Lift Air Vehicles
- Innovation in Commercial Supersonic Aircraft
- In-Time System-Wide Safety Assurance
- Ultra-Efficient Subsonic Transports
- Assured Autonomy for Aviation Transformation

https://nap.nationalacademies.org/catalog/24962/

Future Airspace and Safety

System Wide Safety



FAA Representative Transformations of the NAS[1]

System Wide Safety

Operations	Infrastructure	Integrated Safety Management
Collaboration Among Diverse Service Providers	Ubiquitous Services	Tailored Safety Processes
Fully Integrated Information Environment	System Resiliency	Interoperability
Agile Systems and Services	System Evolves On-Pace with Technology	In-Time Safety Assurance

NASA and collaborative partnerships are helping to enable each of these transformations

[1] Federal Aviation Administration, "Charting Aviation's Future: Operations in an Info-Centric National Airspace System," 2021.

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Standards, flight rules, and services tailored to meet the needs of diverse operations in all airspace.

Diverse services will interoperate safely.

Continuous modeling, monitoring, and verification will provide in-time safety assurance and alerting.

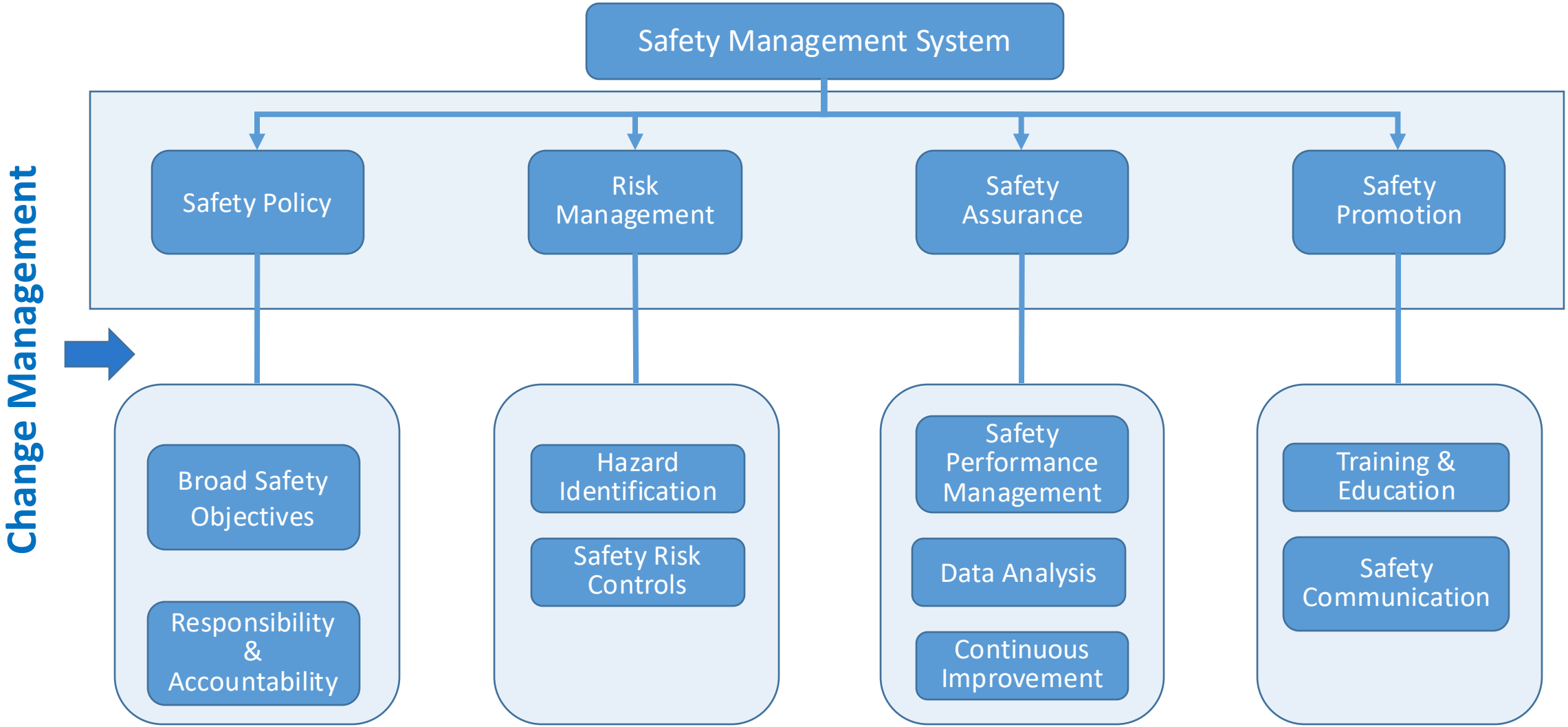
NASA and collaborative partnerships are helping to enable each of these transformations

[1] Federal Aviation Administration, "Charting Aviation's Future: Operations in an Info-Centric National Airspace System," 2021.

ICAO – Safety Management System

System Wide Safety

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



FAA Policy for Safety Risk Management and Safety Assurance

System Wide Safety

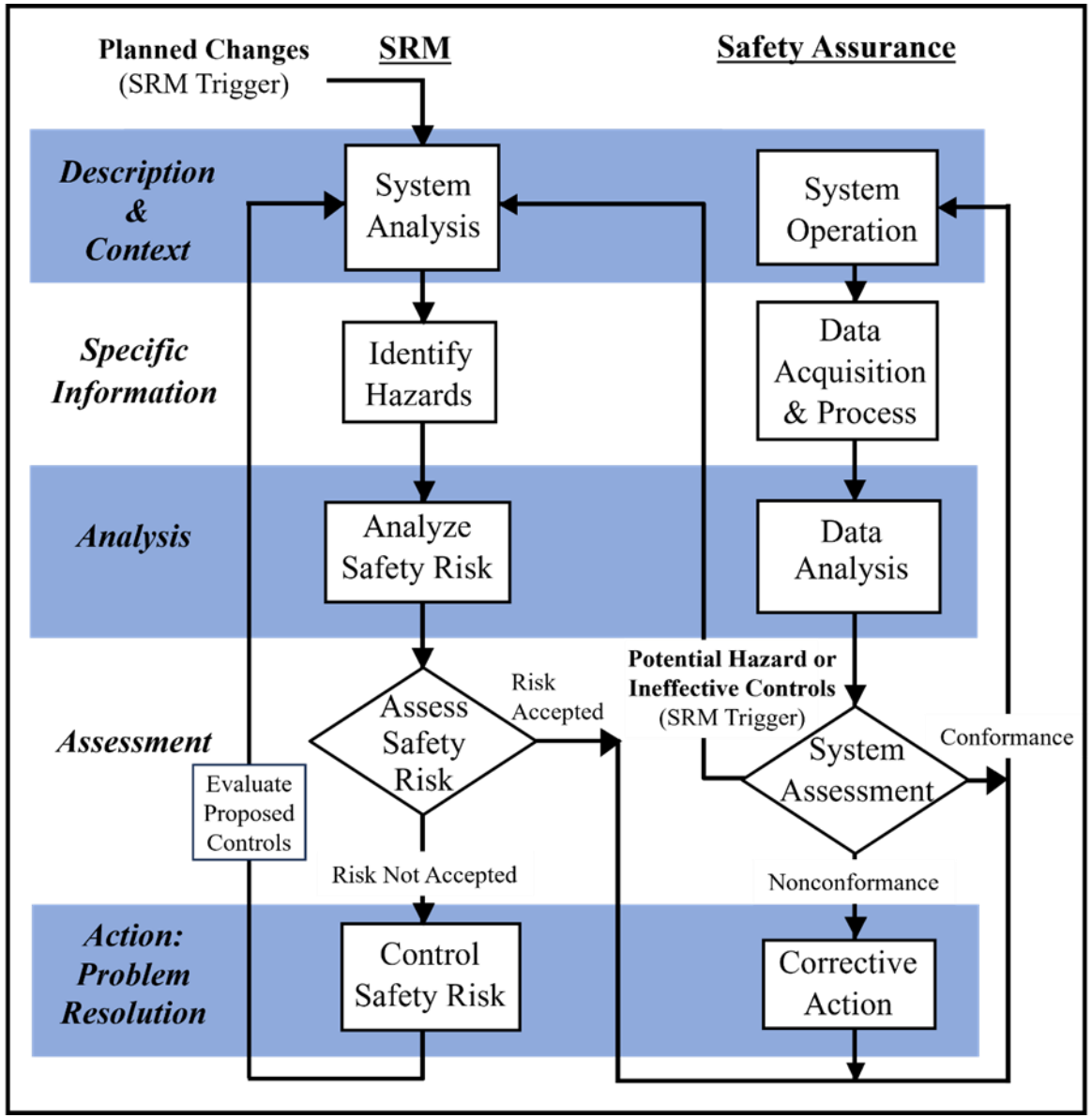
Safety Risk Management

System Analysis

Hazard Identification

Risk Assessment

Development of Risk Controls



Safety Assurance

Ensure Effectiveness of Controls

Ensure Safety Data Meet Organization Objectives

Progression of Safety Intelligence

System Wide Safety

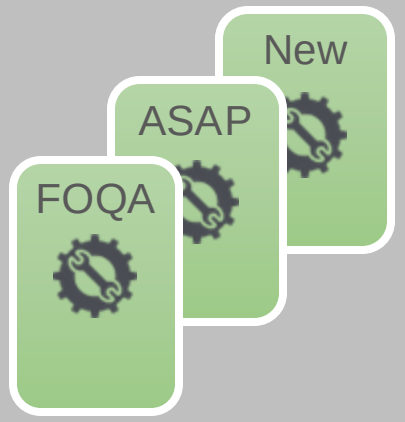
Unknown Risk

Reactive Safety

Safety Reports

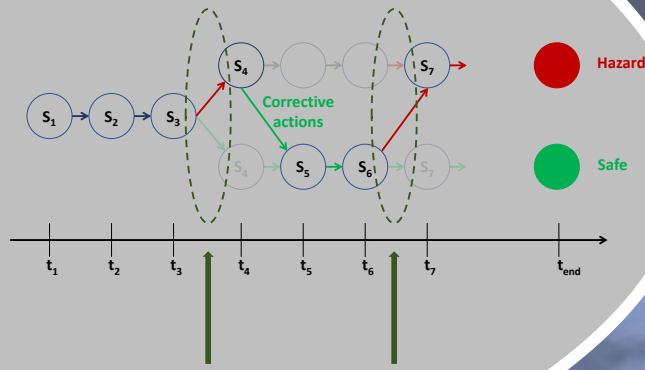
Causal Factors

Proactive Safety



Precursors, Anomalies, & Trends

Predictive Safety



Leading Indicators, Weak Signals

LESS DATA → MORE DATA[1]

[1]More data volume, complexity, and types

Credit: NASA

In-time Aviation Safety Management System (IASMS)

System Wide Safety

- In-time
- Effective
- Tailorable
- Interoperable
- Scalable
- Assured
- Teaming
- Value

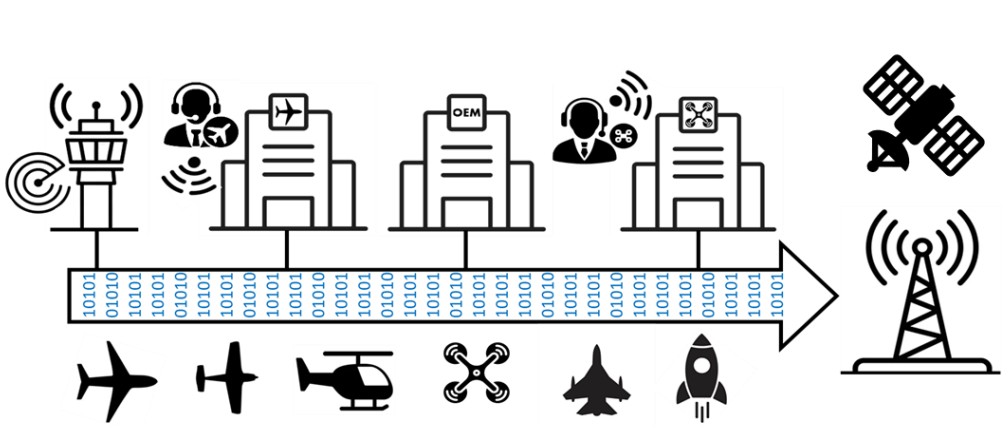
IASMS Objectives for *Integrated Safety Management*

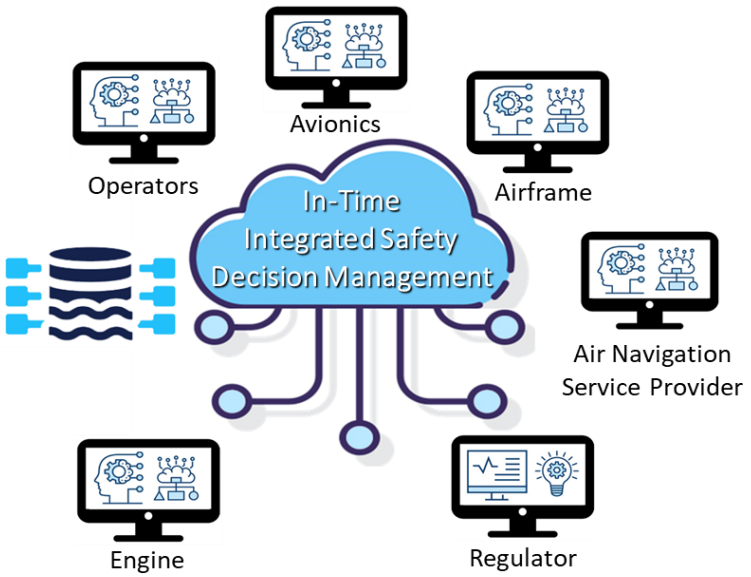
To *Monitor, Assess, Mitigate* for *in-time* risk management and *Assure* safety

Enabled by *Services, Functions, Capabilities* and *tailored safety processes*

For *proactive* & *predictive safety intelligence* for *operational* and *design safety*

Implementable through *Scalable* and *Interoperable System-Wide* Architectures





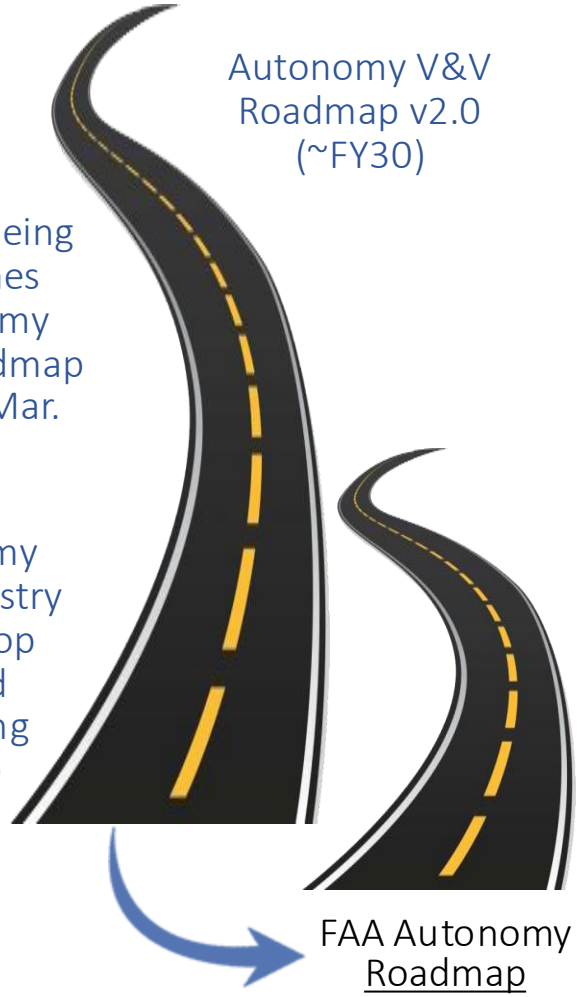
Credit: NASA (adapted FAA graphic)

Design and Operational Safety – Identifying R&D Needs

System Wide Safety

DESIGN SAFETY

Autonomy V&V Roadmap

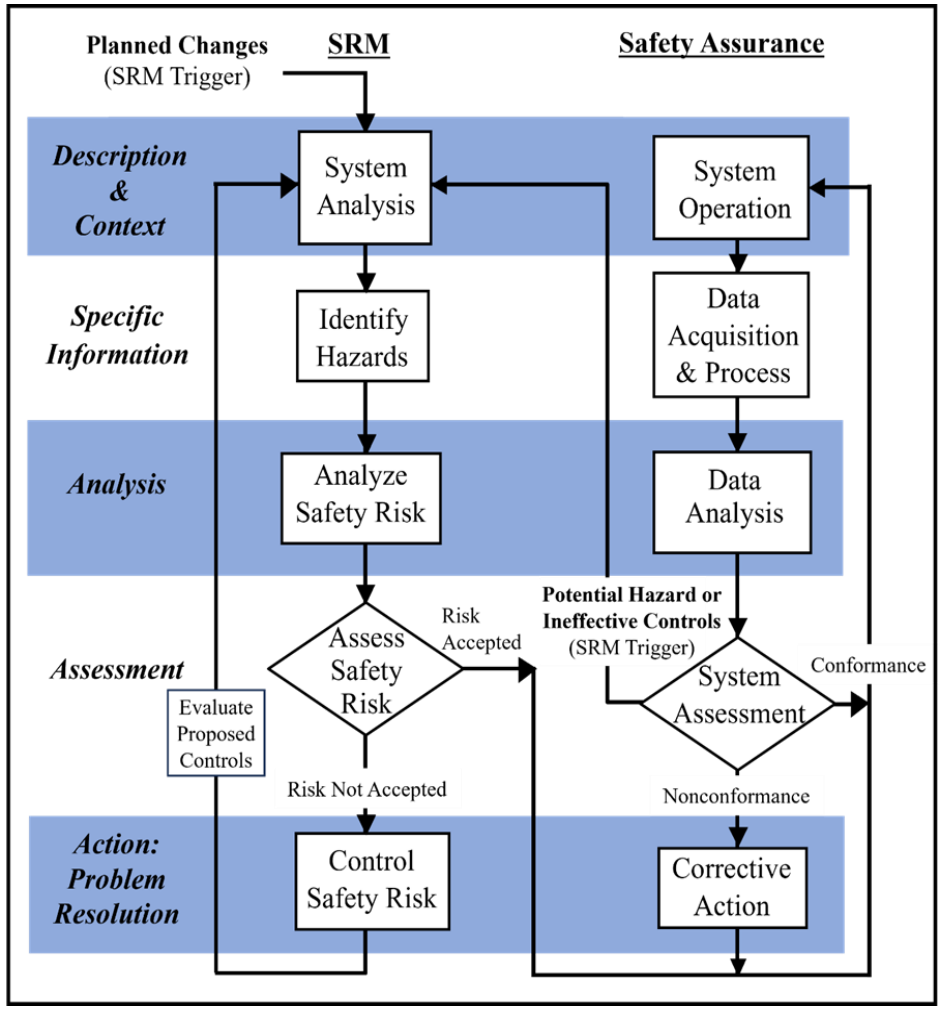


Autonomy V&V Roadmap v2.0 (~FY30)

NASA/Boeing Publishes Autonomy V&V Roadmap v1.0 (Mar. ’23)

Autonomy V&V Industry Workshop hosted at Boeing (FY22)

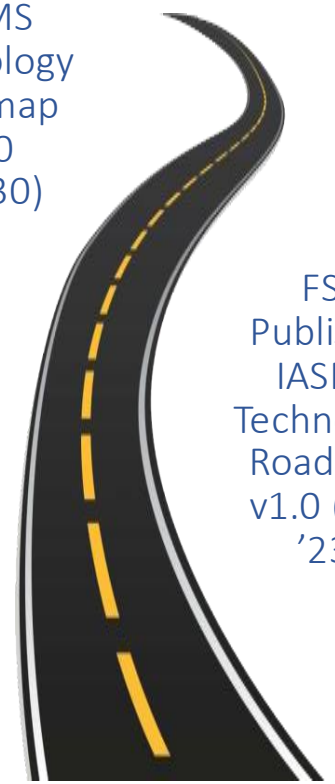
FAA Autonomy Roadmap



OPERATIONAL SAFETY

IASMS Roadmap

IASMS Technology Roadmap v2.0 (~FY30)



FSF Publishes IASMS Technology Roadmap v1.0 (Apr. ’23)

FSF IASMS Industry Workshop hosted at NASA (Jan. ’23)

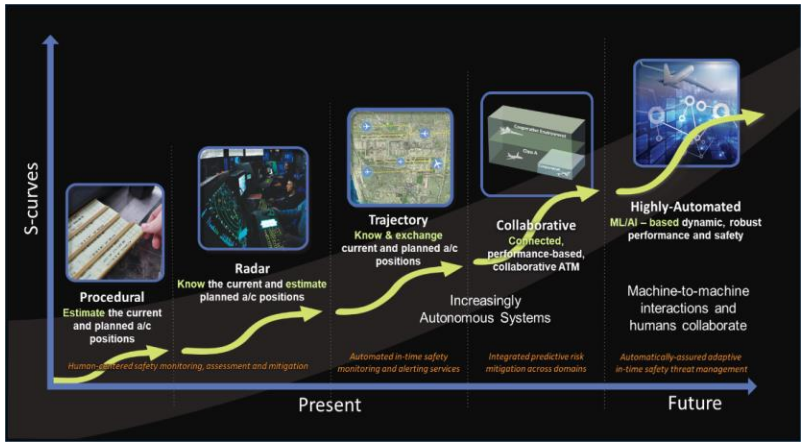
FAA, “National Policy: Safety Risk Management Policy, Order 8040.4C,” 2023.

New Challenges, New Research Opportunities

System Wide Safety

Legacy Aviation IASMS

Modernization of Existing SMS Processes and Capabilities



Future NAS IASMS

Development of new SMS Capabilities and Processes for Emerging Operations

Helping Transform the Future of Air Transportation System ... Safely

- Interoperability and other challenges of legacy operations (today) integrated with new and emergent operations (future),
- Complex automated (today) and increasingly autonomous, collaborative (future) aircraft and traffic management systems,
- Developing SFCs and advance how safety management and assurance is done (today) for safety intelligence including anticipated/forecasted advancements in AI-based data analytics (future)

Credit: NASA

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