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Process Flow Modeling for an In-Time Aviation Safety Management System

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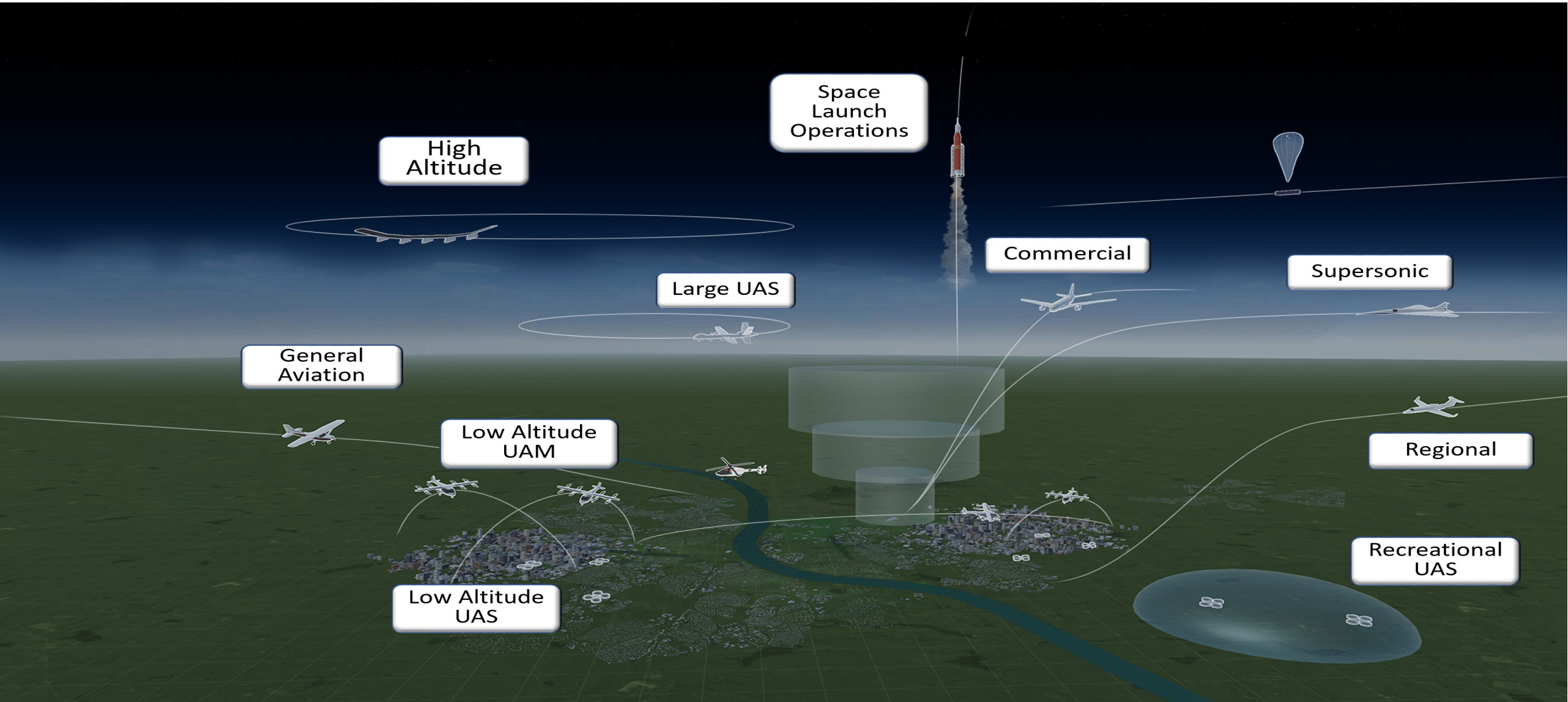
Future of the National Airspace System



Motivation

- The Federal Aviation Administration requires all Part 121 air carriers to have a SMS in place
- As a result of that, commercial air transportation is the safest means of transportation with a fatality rate of 1 per 10^9 flight hours
- Due to its higher risk environment, wildfire management efforts still face a significant number of aviation-related incidents
- NASA, the FAA and industry are collaborating to alleviate those aviation-related incidents

Goals

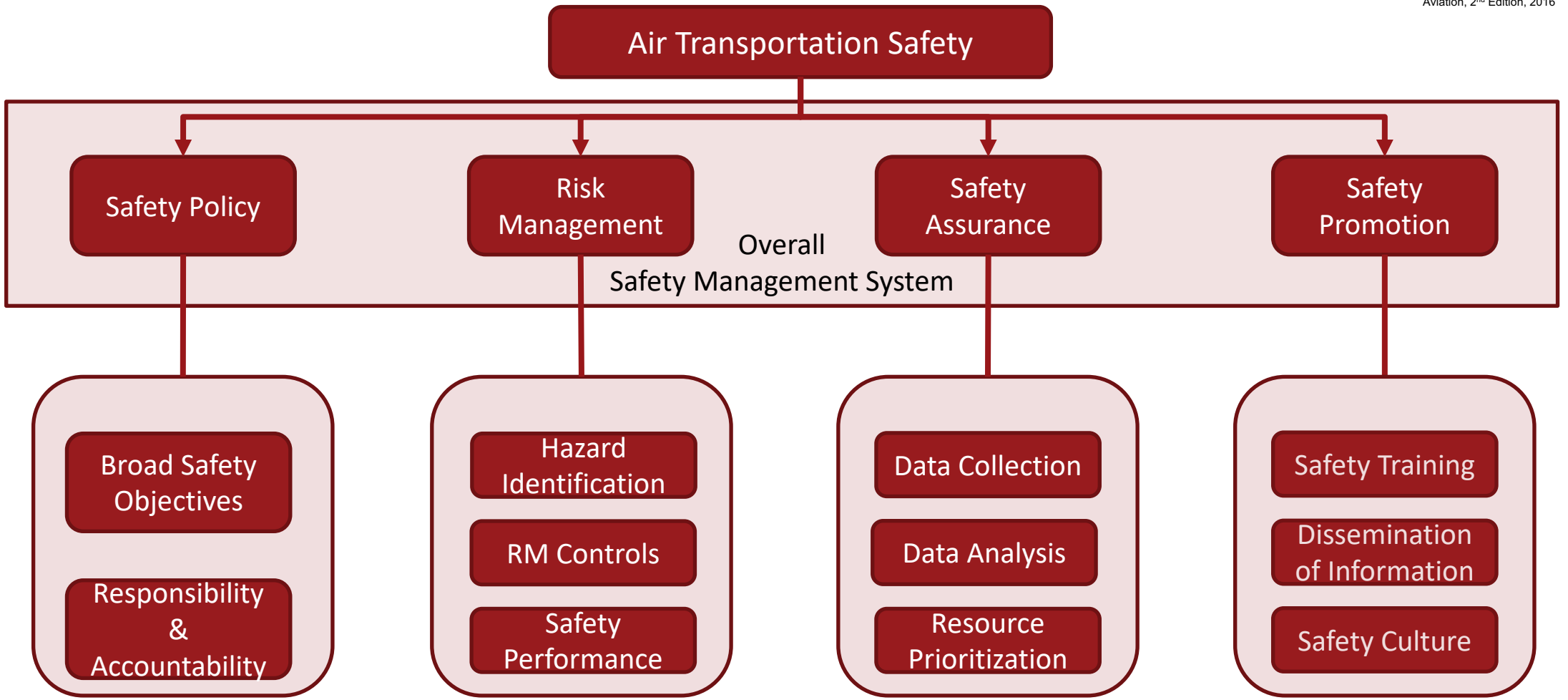
- Show how safety management is done today
- Show why it does not scale to the changes the national airspace system will undergo
- Demonstrate the need for an IASMS
- Show existing gaps

Approach

- Detail the safety management system according to ICAO
- Highlight Federal Aviation Administration's guidance
- Abstract current-day SMS process flow
- Use that process flow as a baseline to transition to an IASMS

ICAO's Guidance for Safety Management System

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



Safety Management System for Part 121 Carriers

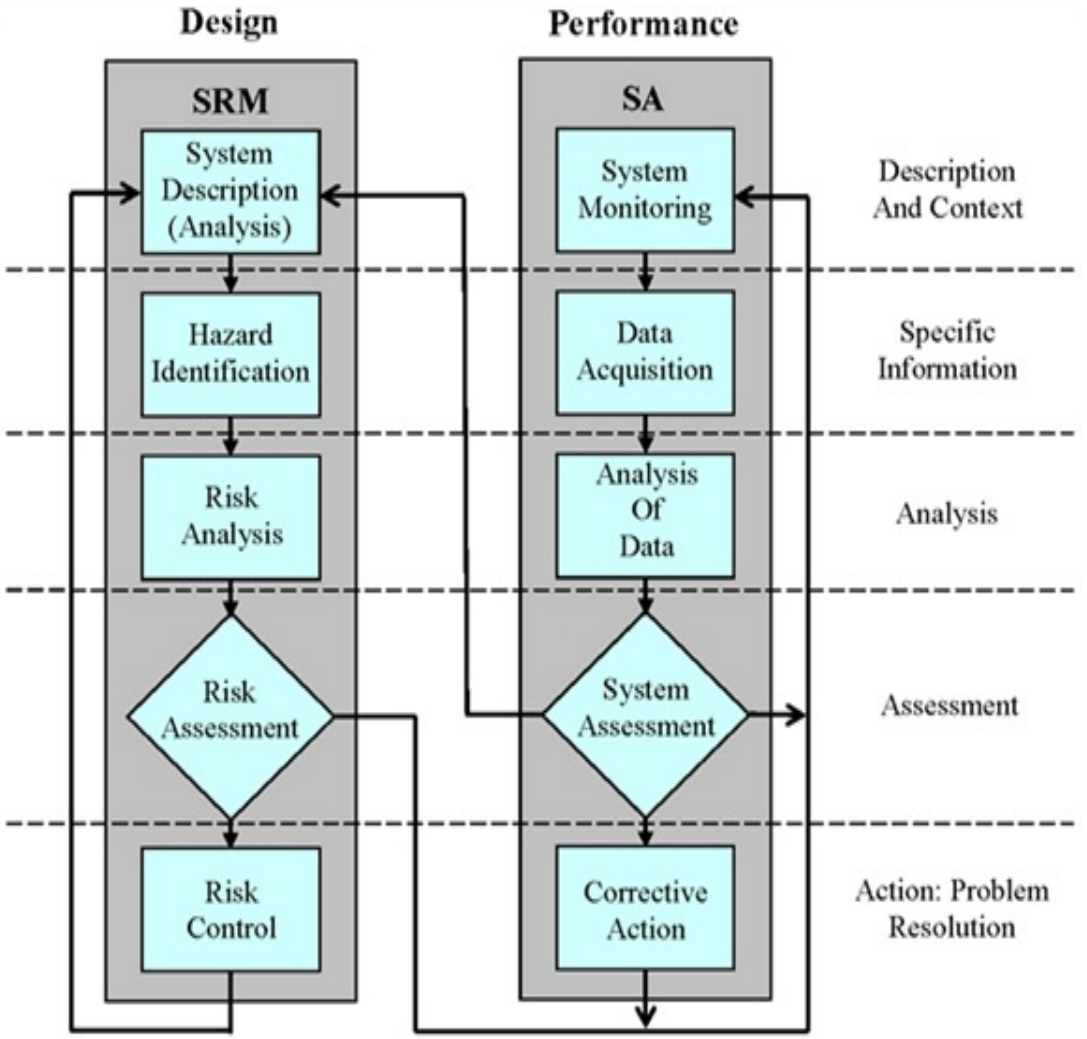
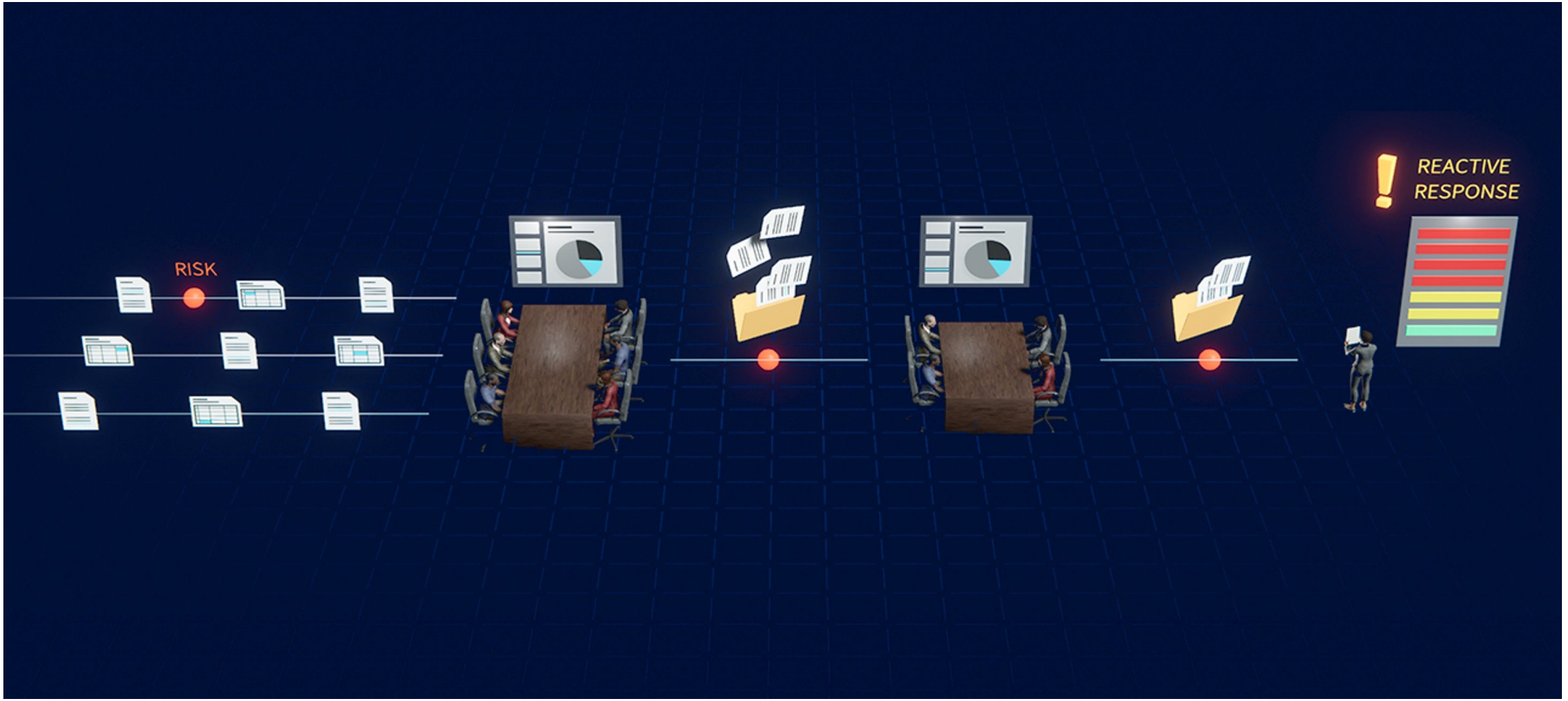
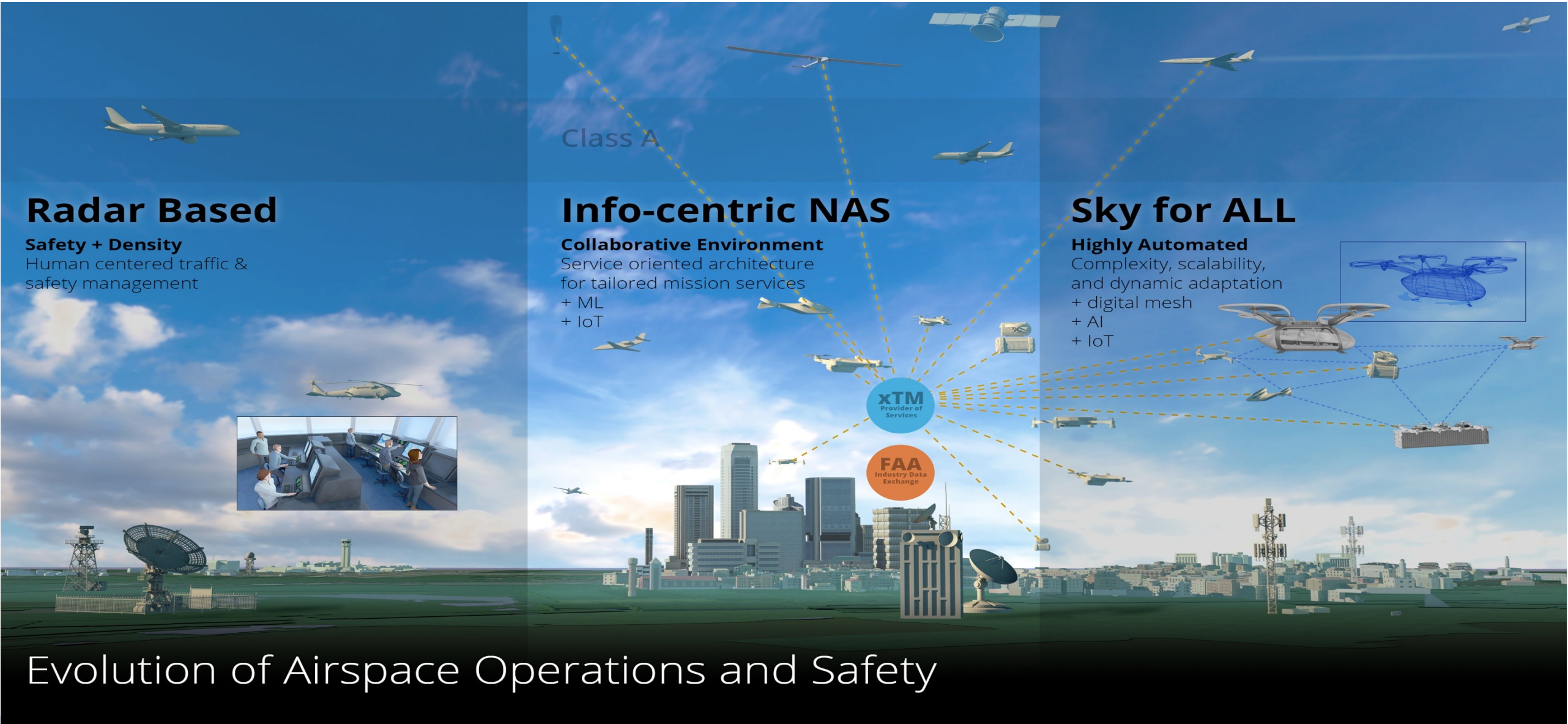


Figure from FAA AC No: 120-92B, Safety Management Systems for Aviation Service Providers

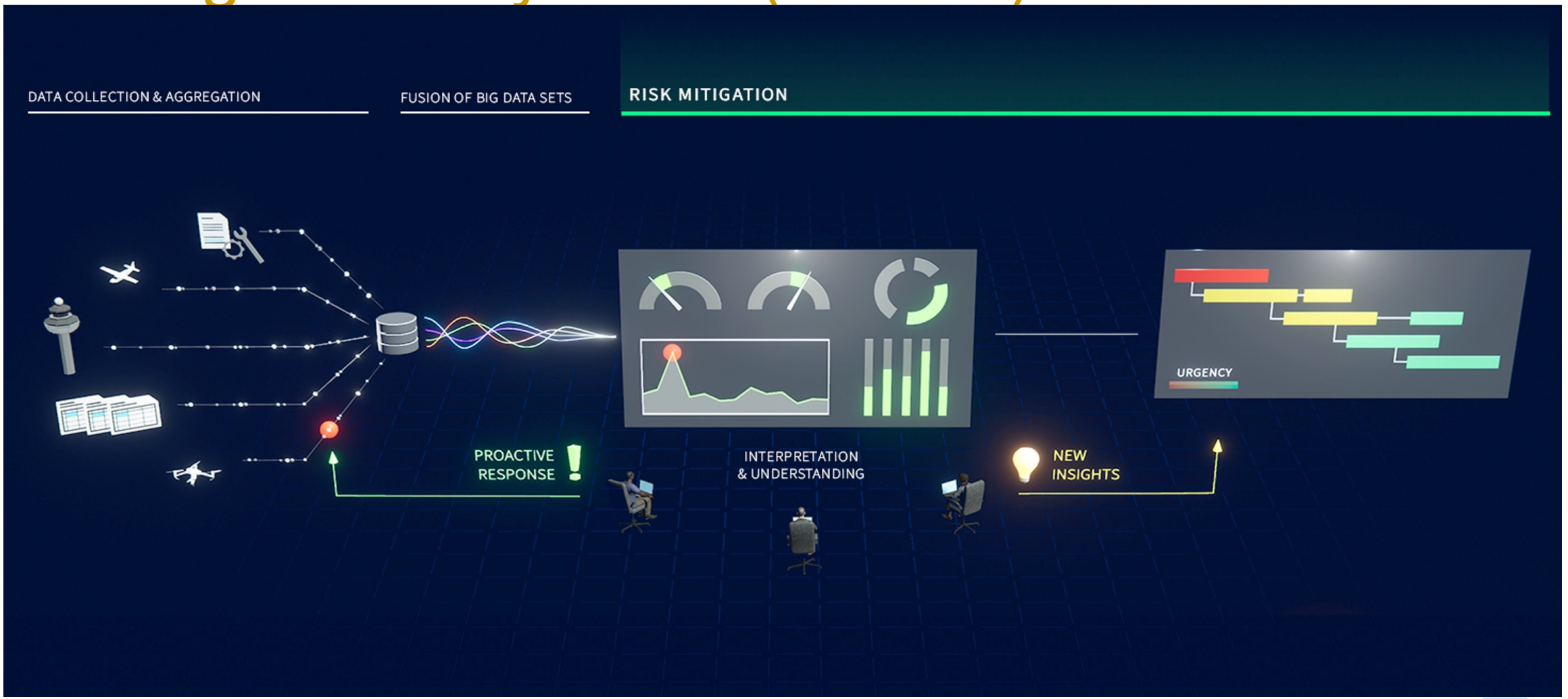
Current-Day Safety Management System Process



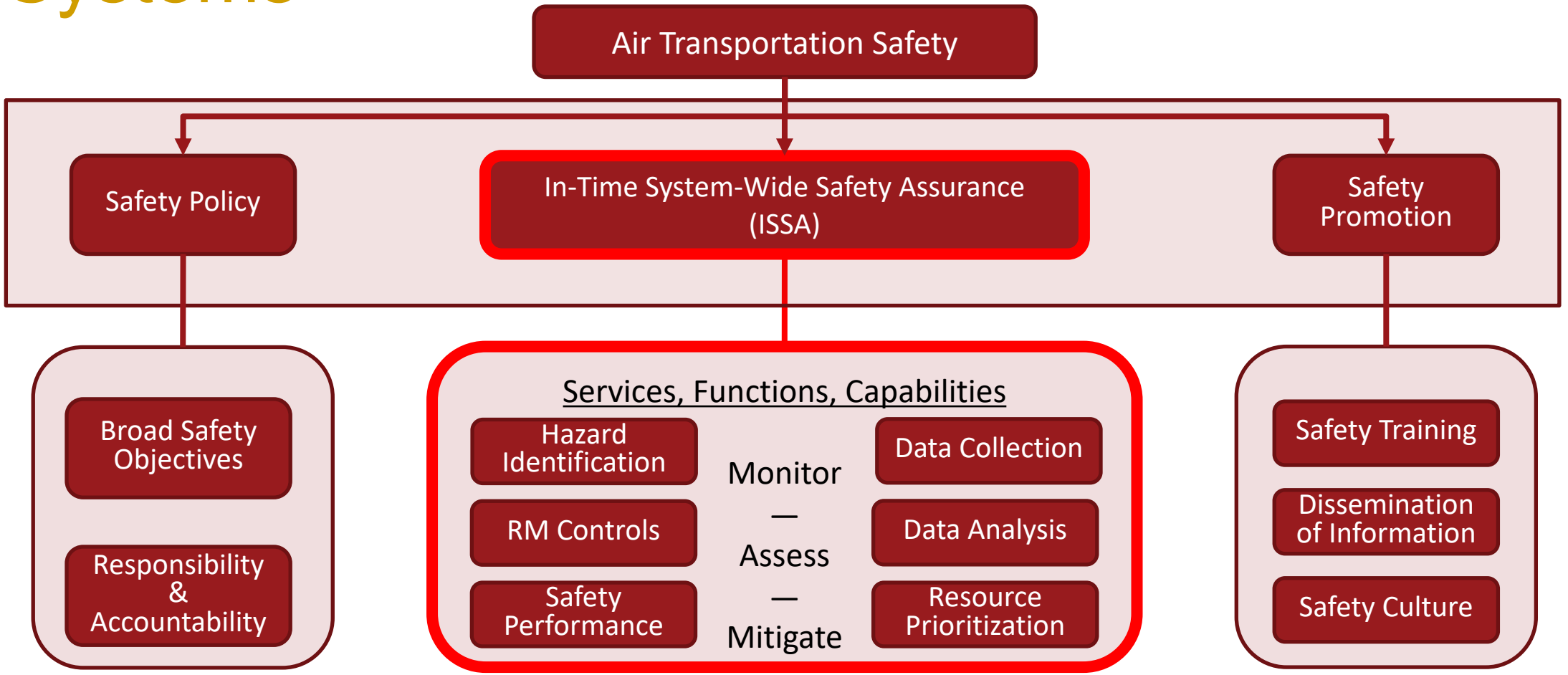
Evolution of Airspace Operations



Vision for the Future: In-Time Aviation Safety Management Systems (IASMS)



In-Time Aviation Safety Management Systems

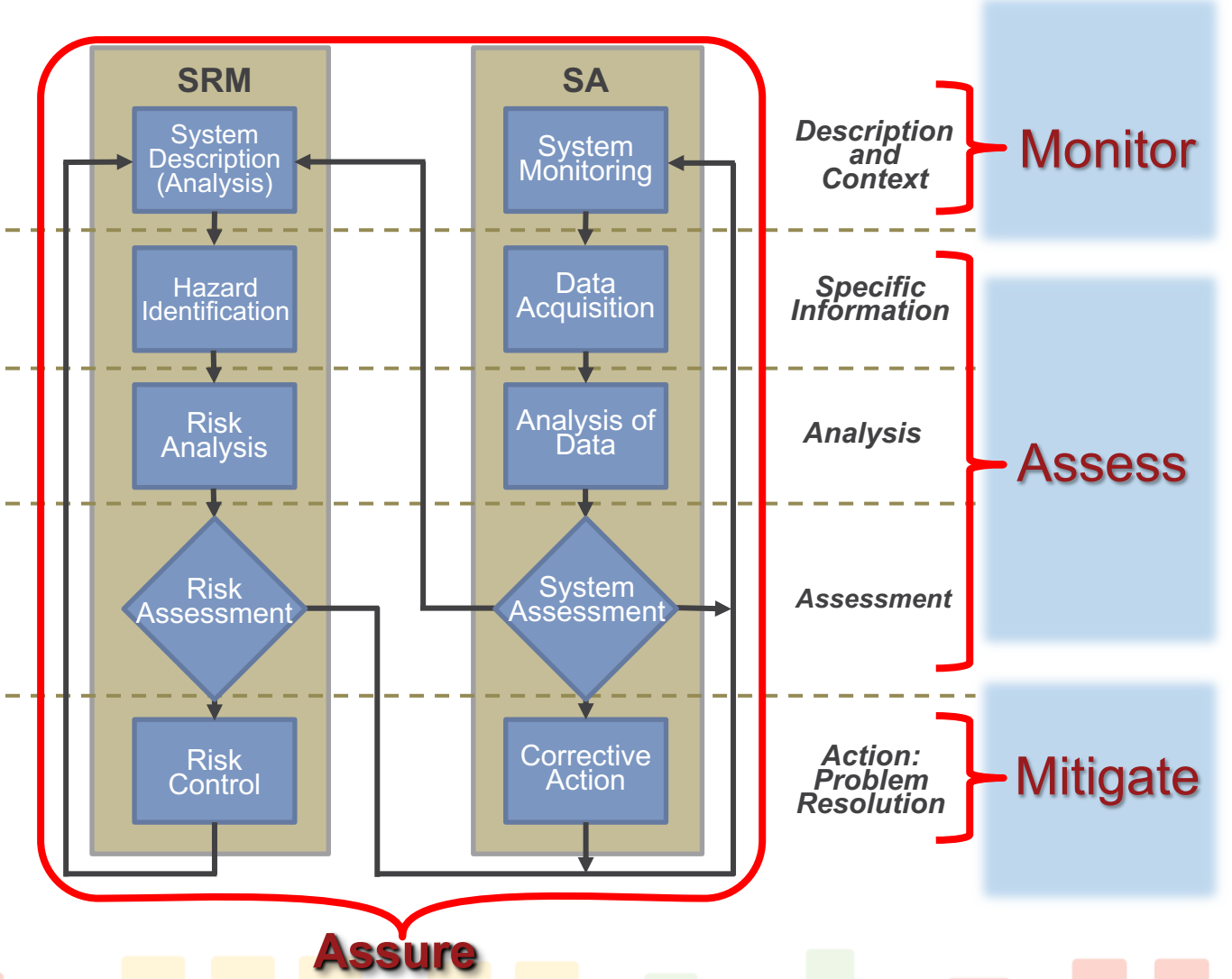


In-Time Aviation Safety Management Systems

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**

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



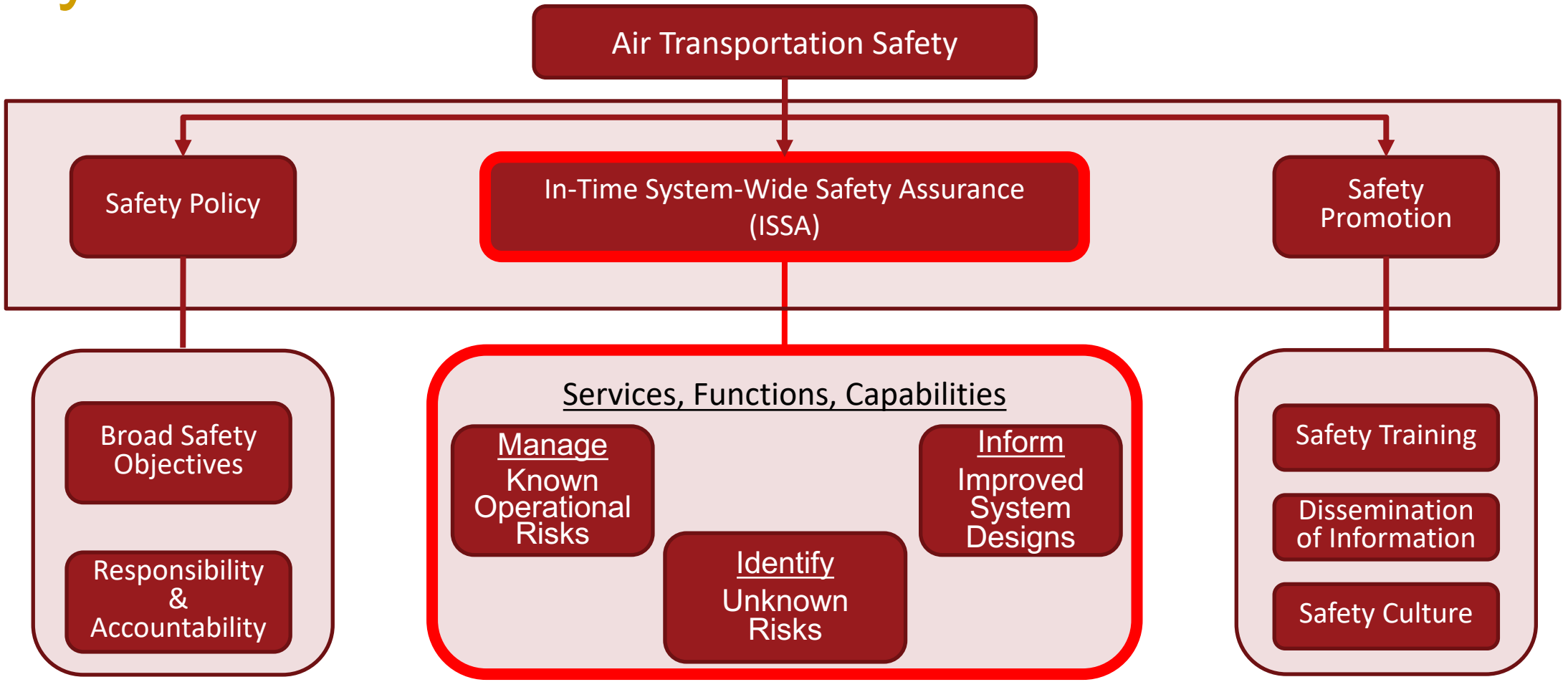
R&D Required:

- 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

In-Time Aviation Safety Management Systems



Research Questions (RQ)

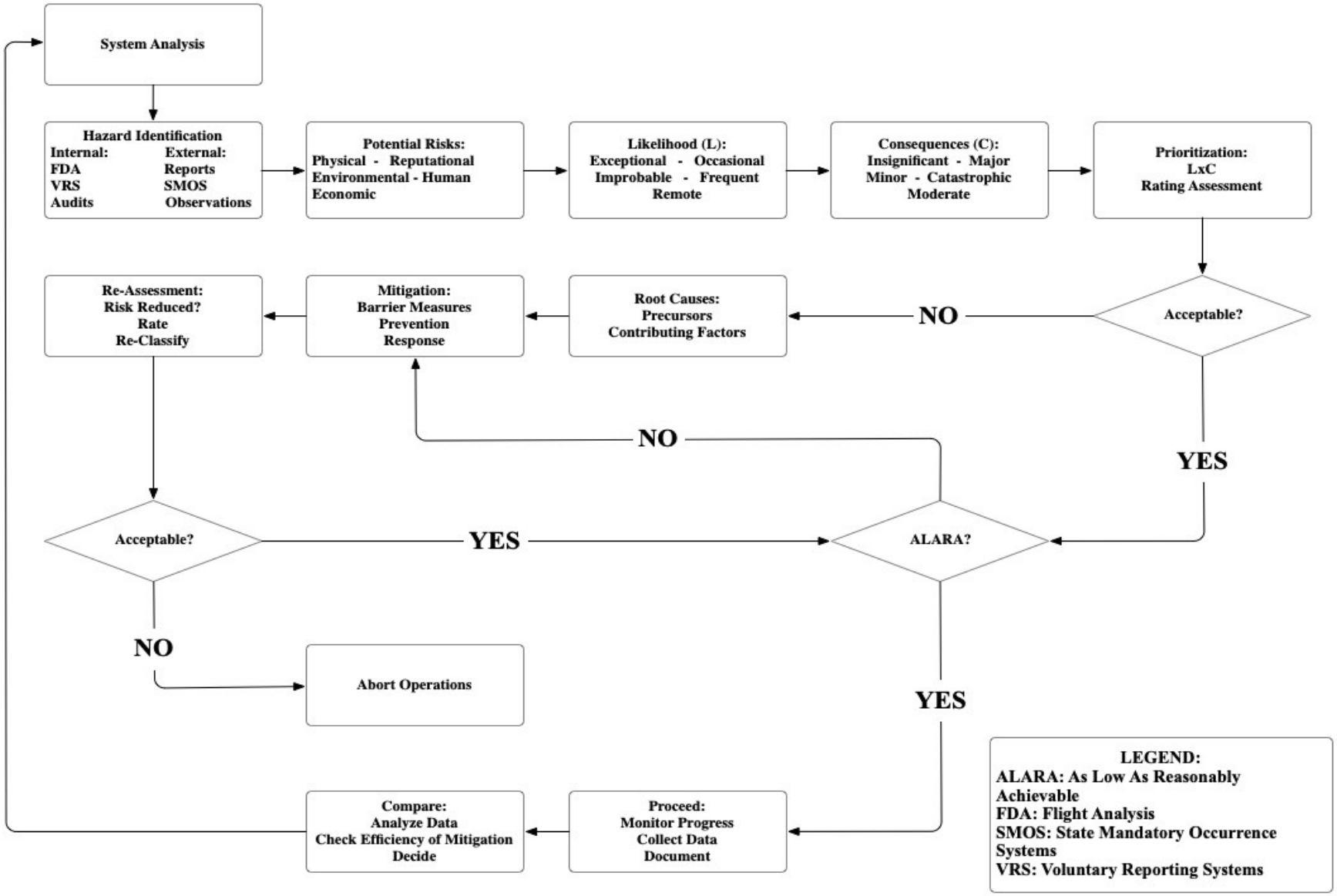
RQ1

- Can we abstract current-day SMS guidance in a way that does not proscribe operators beyond current-day requirements but does elucidate the parts of the process that will change as we shift from SMS to IASMS?

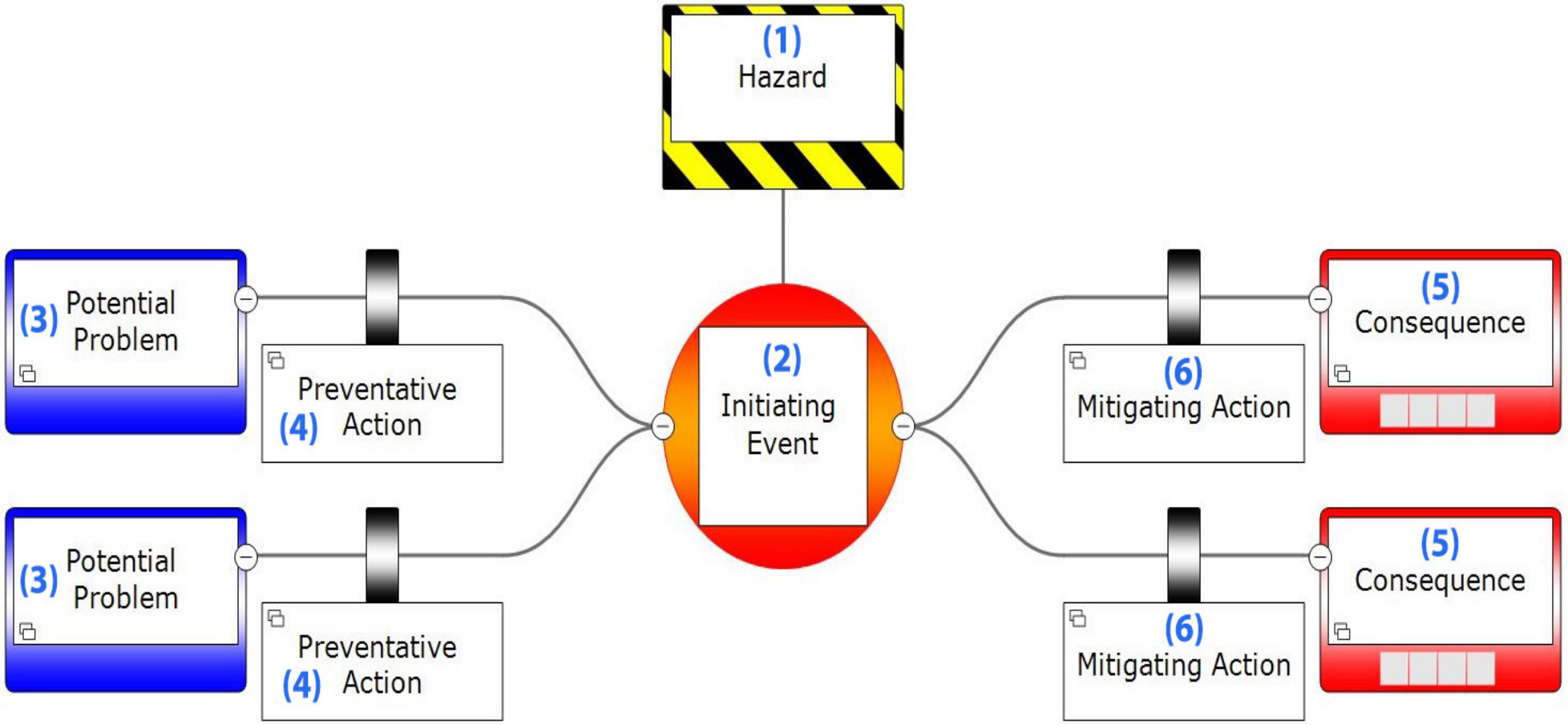
RQ2

- As a method of validating research question 1, can we use specific Disaster Management & First Responder use cases to concretize the gaps that will need to be filled by the shift to an IASMS?

Current-Day SMS Process Flow

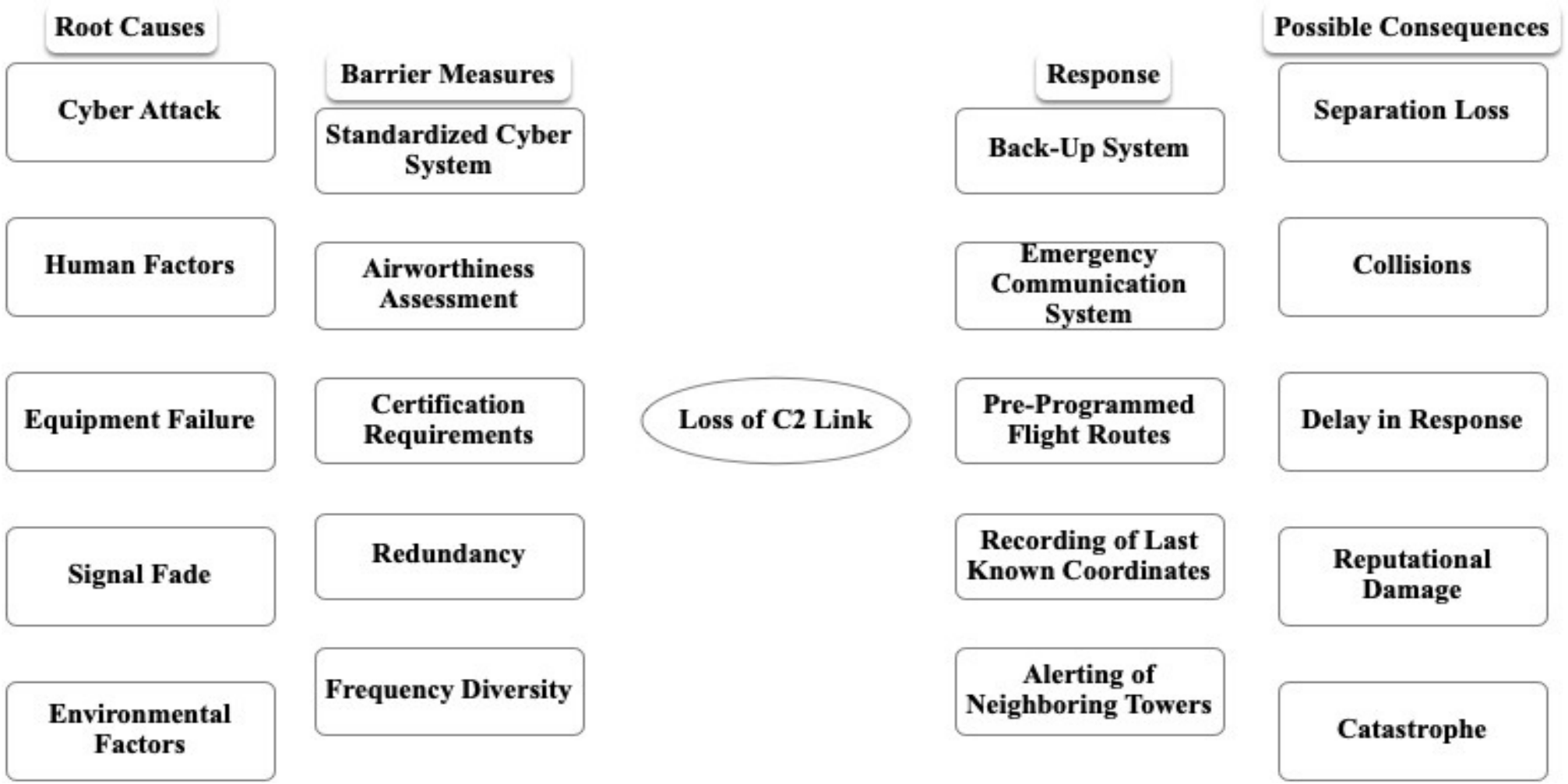


Safety Analysis: Bowtie Diagrams

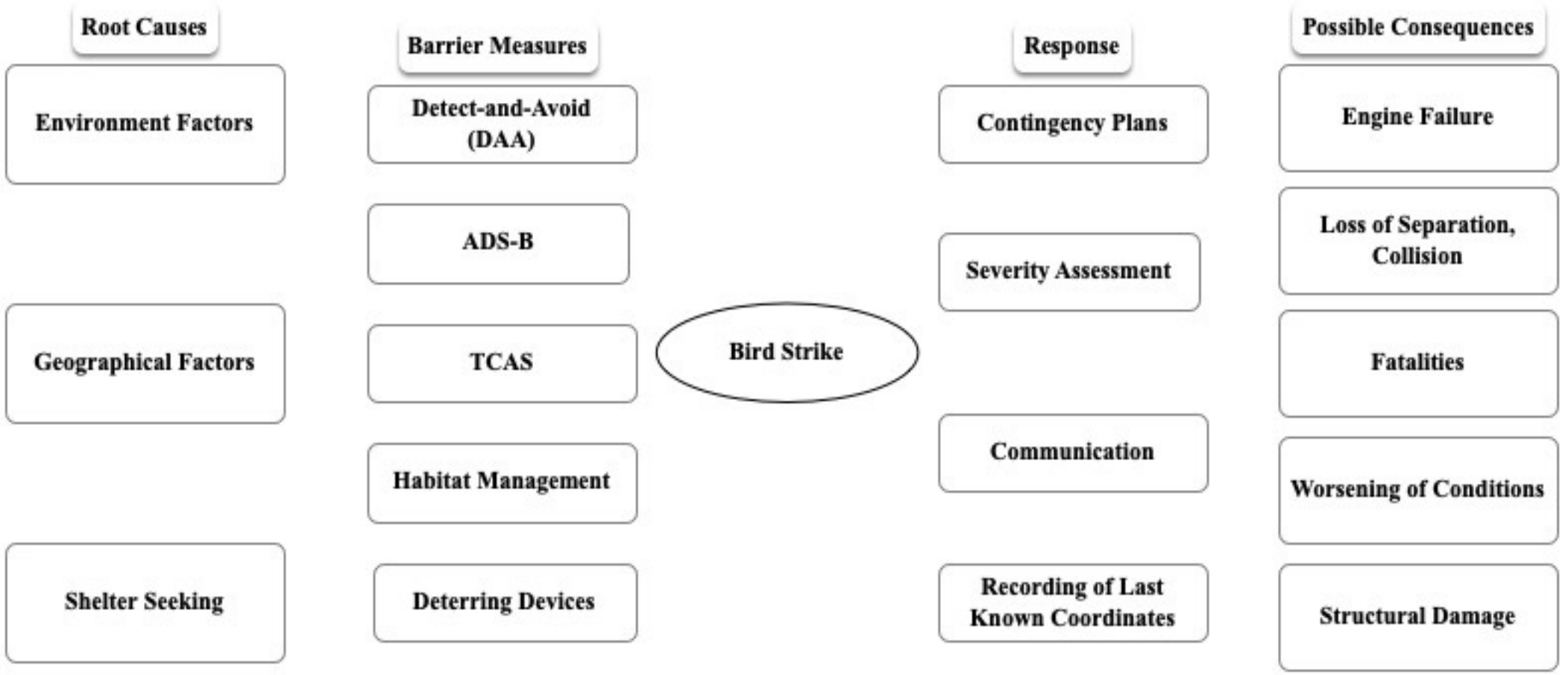


Credit image: University of Michigan

Bowtie Diagram: Command and Control Link Loss



Bowtie Diagram: Bird Strike



Discussion

- Today's SMS framework guidance relies on Annex 19 and AC 120-92B
- That guidance is not proscriptive:
  - Different organizations have different acceptable levels of risk
- The goal is to maintain that freedom while assuring safety

- Data collection and analysis are still labor intensive
  - Reports, for example, need de-identification before they can be used
  - Post incidents, it can take a while to recover flight data; this prevents us from using the data 'in-time' to prevent future negative outcomes
- These limitations motivate the need for an IASMS

Discussion (Contd.)

- SMS implementation affects Service Providers' competitive performance
- Providing proper guidance for an IASMS is of essence:
  - Enough details for organizations to understand requirements
  - But leaves enough room for innovation
- Today's guidance lacks that level of abstraction
  - Does not detail what changes in the transition from SMS to IASMS

Future Work

- Use of SysML to model the developed process flow to evaluate the evolution from SMS to IASMS
- Development of a survey to get insight from first responders on use of UASs in wildfire response
- Expand safety analysis on other FSF-identified hazards
- Continuous collaboration between NASA, FAA and industry partners to define IASMS requirements

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