



ICAO

INTERNATIONAL CIVIL AVIATION ORGANIZATION

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Safety Intelligence and Safety Performance Management Workshop

ICAO Asia and Pacific (APAC) Regional Office

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Module 5

Safety Intelligence

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Module Overview



Safety Management Systems (SMS)



Safety Intelligence



Safety Management Systems (SMS)

Evolution of Airspace Operations and Safety

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+ Efficiency and proactive planning



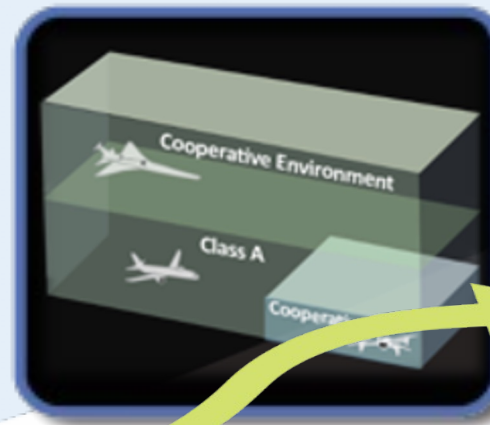
Trajectory

Know and exchange
current and planned aircrafts
positions

*Automated in-time safety
Monitoring and alerting services*

Today

+ Service-oriented architecture for
tailored mission-oriented services



Collaborative

Connected,
performance-based,
collaborative ATM

Introduces 3rd-party
service providers

*Integrated predictive risk
mitigation across domains*

~2035+

+ Complexity, scalability,
and dynamic adaptation



Highly-Automated

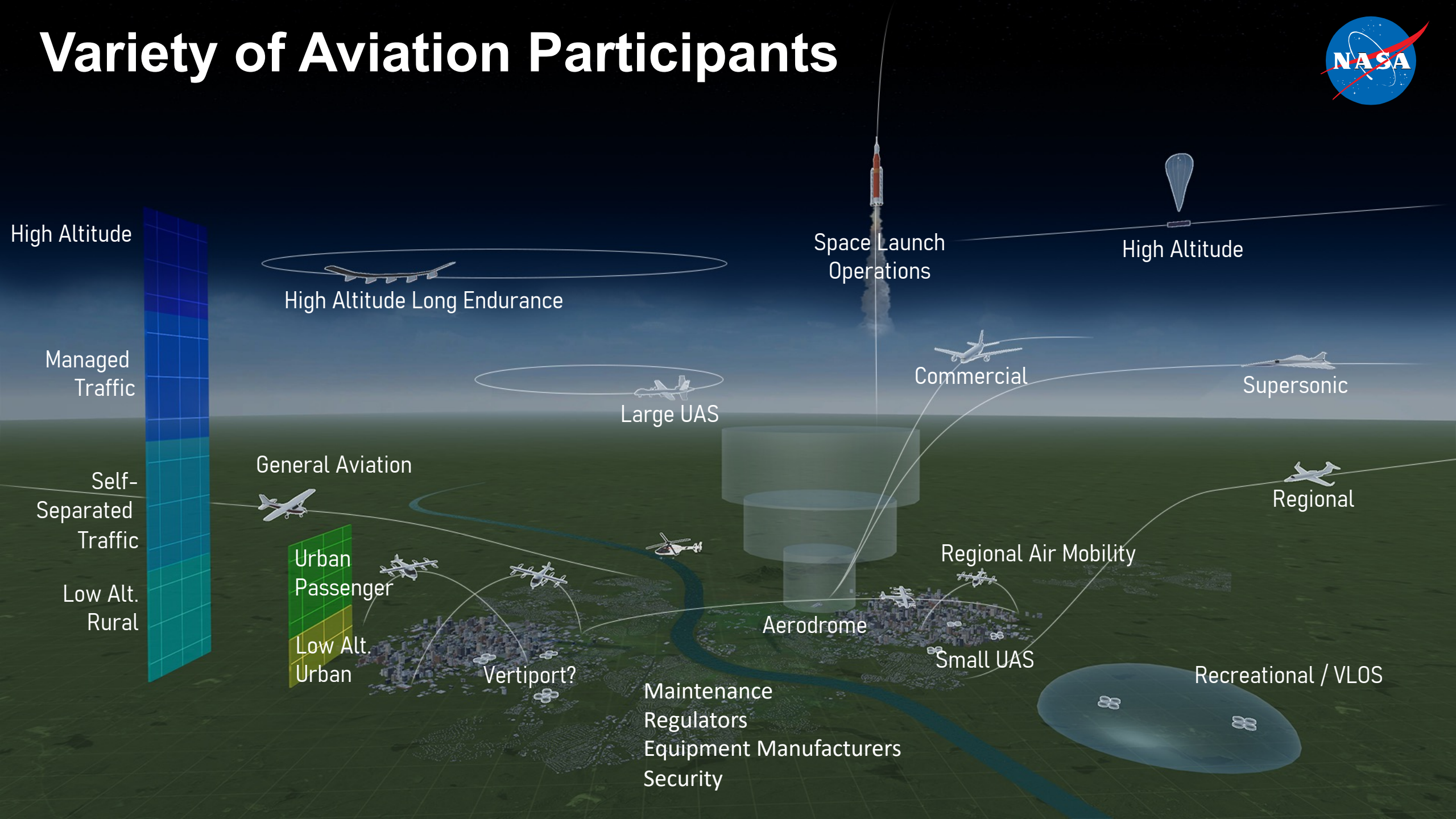
Machine Learning/Artificial Intelligence – based
dynamic, robust
performance and safety
Machine-to-machine
interactions and humans collaborate

Digital Transformation of ATM

*Automatically-assured adaptive
in-time safety threat management*

~2045+

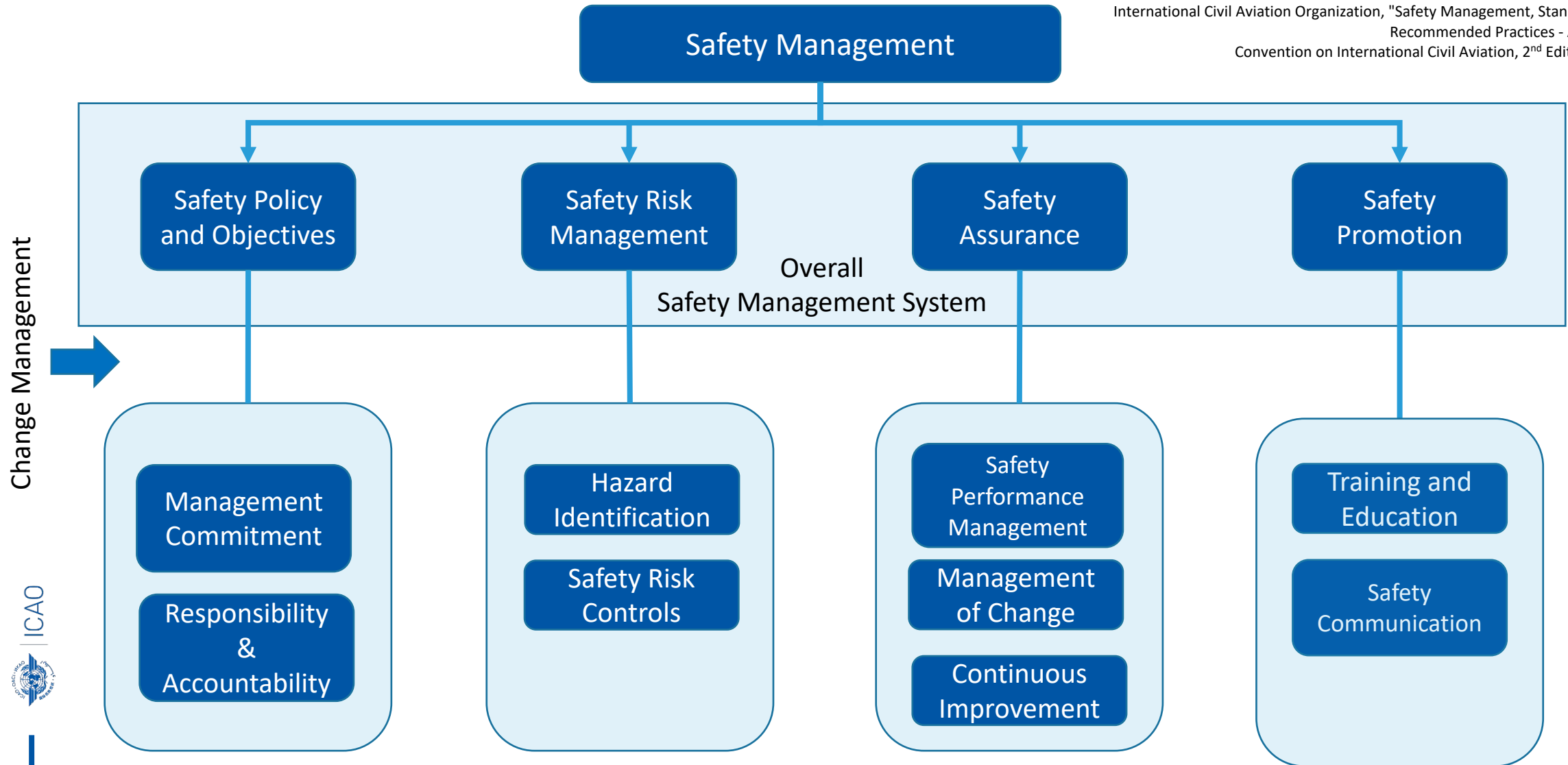
Variety of Aviation Participants



How We Achieve Aviation Safety Today

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



Current-Day Safety Management Systems



Current-day SMSs are primarily reactive—analysis based on data collected over a period of time

Data-Analysis Groups

Data Collection and Analysis: Audits, ASIAs, FMEA, Root Cause Analysis, FOQA, LOSA, Maintenance Records, Weight & Balance, Interviews, etc.

Flight
Ops

Ground
Ops

Tech
Ops

Airport
Ops

Security
Ops

....

Data

Information

Data-Analysis Boards

Flight
Board

Ground
Board

Tech
Board

Airport
Board

Security
Board

....

Intelligence

Company-Wide Data Analysis Board

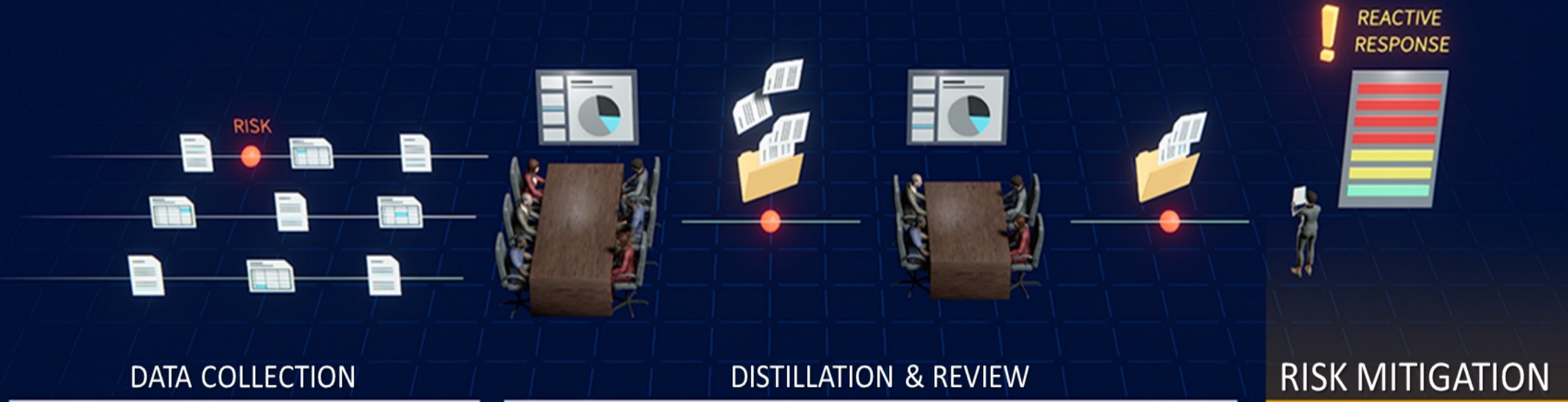
Company-Wide Boards filter input from Data-Analysis Boards to implement change, develop policies, or create operational standards

Company-Wide System-Safety Review Board (SSRB)

Company-Wide Operations/Standards/Policy Board

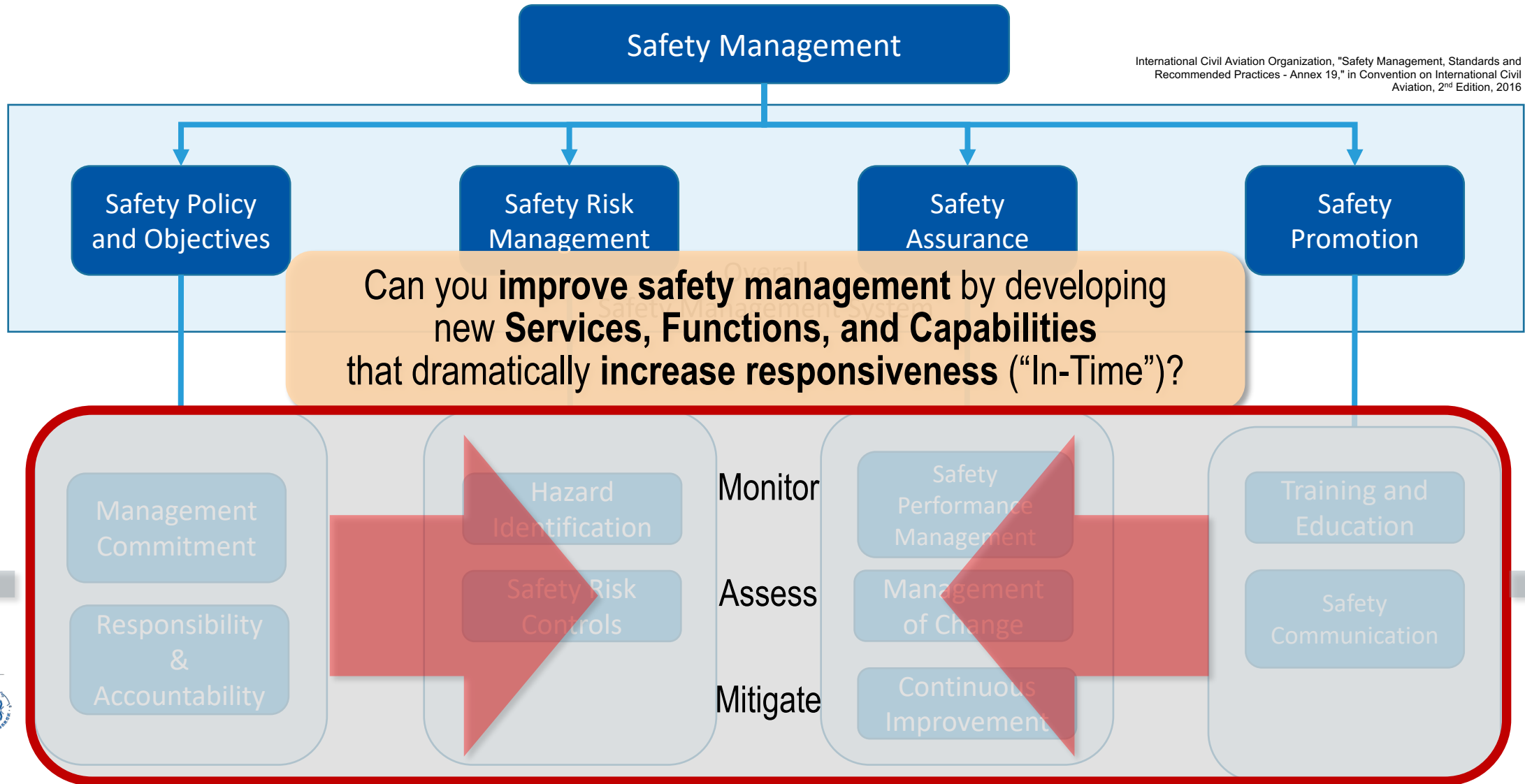
Current SMS for Air Carrier Operations

SMS



Safety Management System Evolution

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



SMS Evolution Example: Aviation Safety Information Analysis and Sharing (ASIAS)

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ASIAS 1.0

ASIAS 2.0

ASIAS 3.0

Characteristics of the Program:

- Data silos
- Distributed architecture
- Manual data-fusion process
- Sharing of aggregated, de-identified results via web portal
- Baseline governance, roles, and responsibilities
- Commercial and general aviation communities

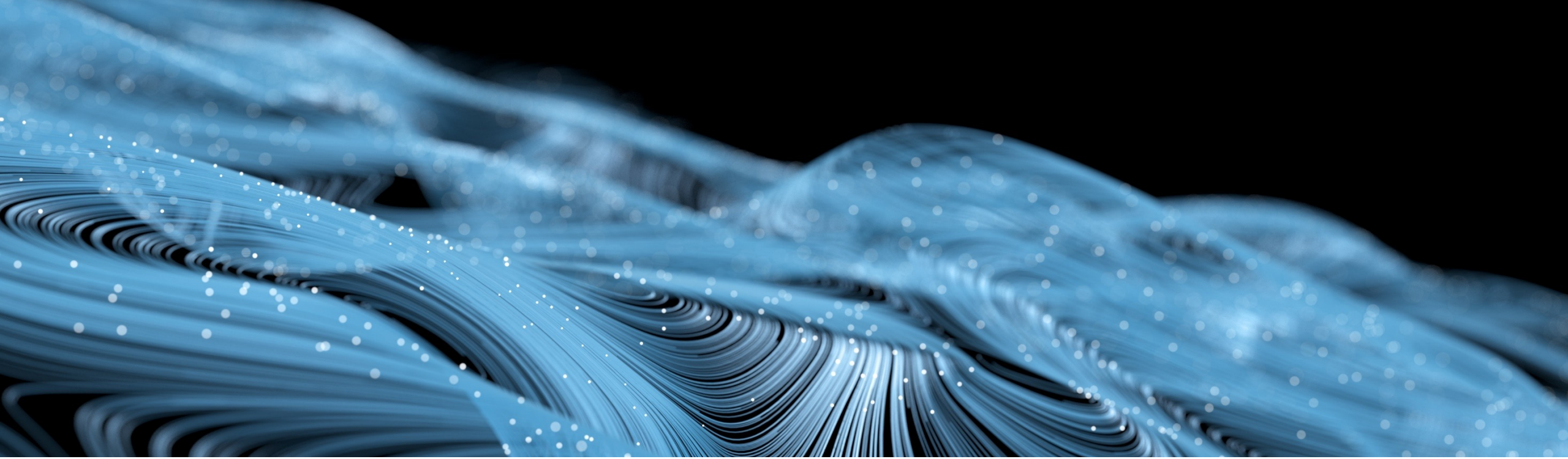
Key Changes:

- Integrated production system to support analytic processing requirements
- Higher volumes of data and processing speeds
- Automated capabilities to fuse disparate data sources
- Expanded fusion governance model

Key Changes:

- Predictive analytics and advanced tools to identify emerging risks
- Expansion – new communities, additional data, improved operating processes
- Transformed collaboration – more agile, innovative interactions
- Enhanced access to data by partners, to conduct specific analysis in controlled environments
- Application of fused data to improve quality of analysis

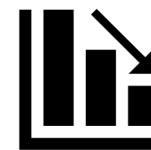
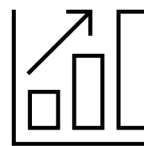
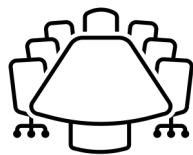
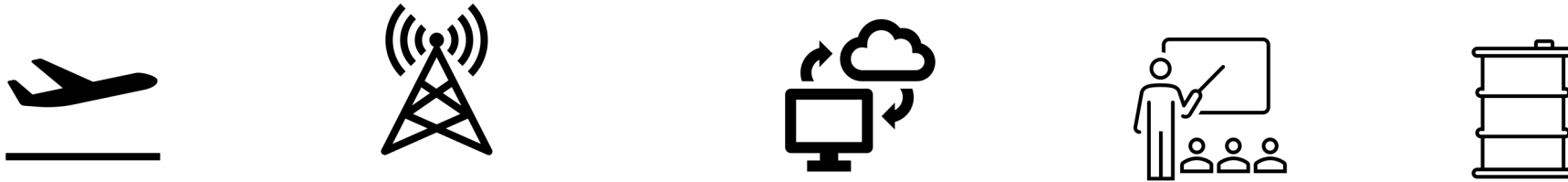




Safety Intelligence

Discussion Question

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How can your organization benefit from safety intelligence?

Proposed Safety Intelligence Definition

Annex 19 Amendment 2

An outcome of the process of analysing safety data and safety information to support decision-making

Near-Term Needs and Impact of Safety Intelligence

Need: Wide variation of operator size and complexity of operations necessitates the development of tools and processes to quickly mitigate risks and hazards effectively and economically.

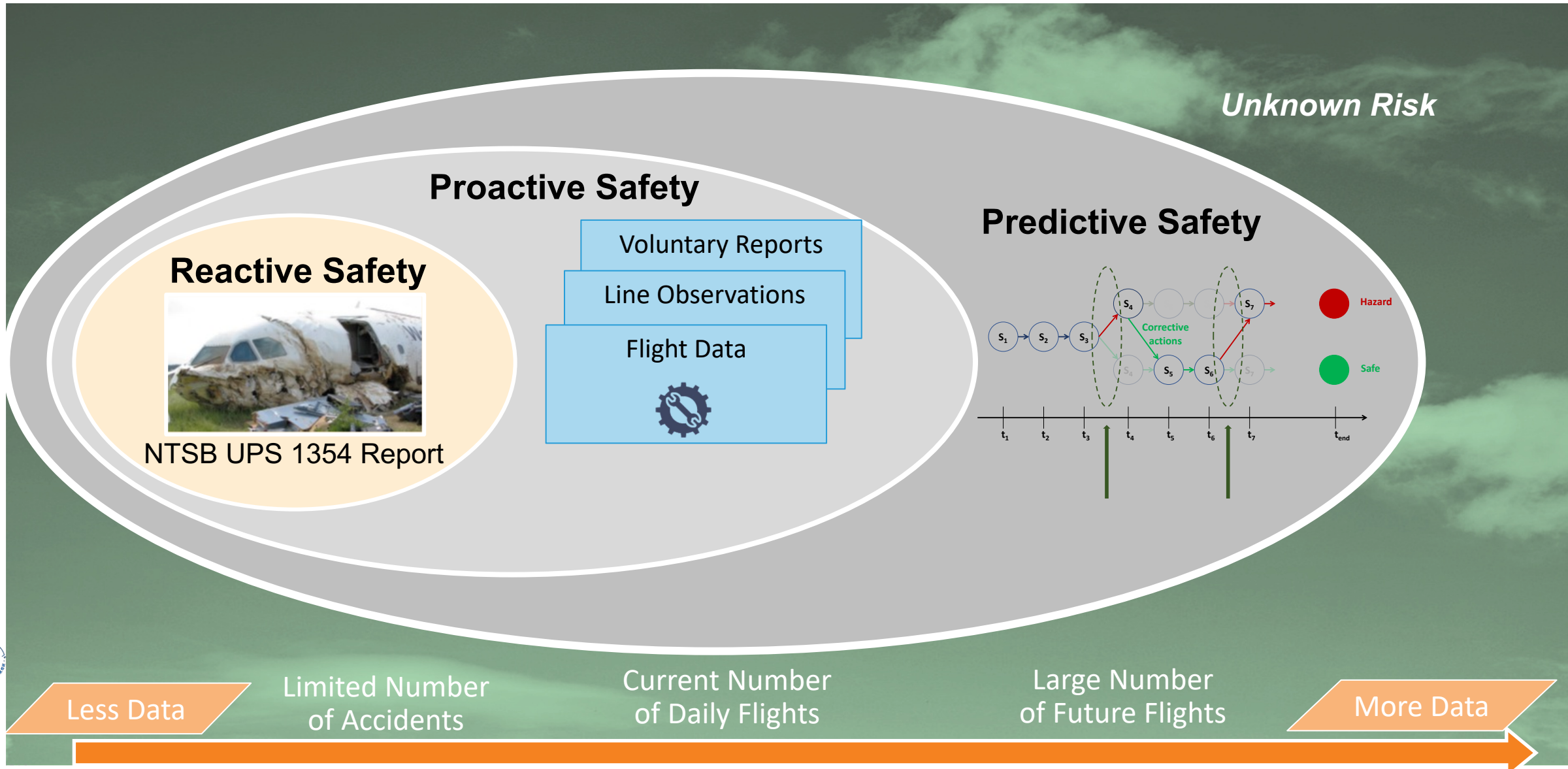
Objective: Improve safety intelligence. Rapidly evaluate existing data patterns and discover new patterns that lead to the next safety event.

Impact: Improved speed and characterization of system-wide risk identification to augment existing SMS processes supporting risk management and safety assurance.

Progression of Safety Intelligence



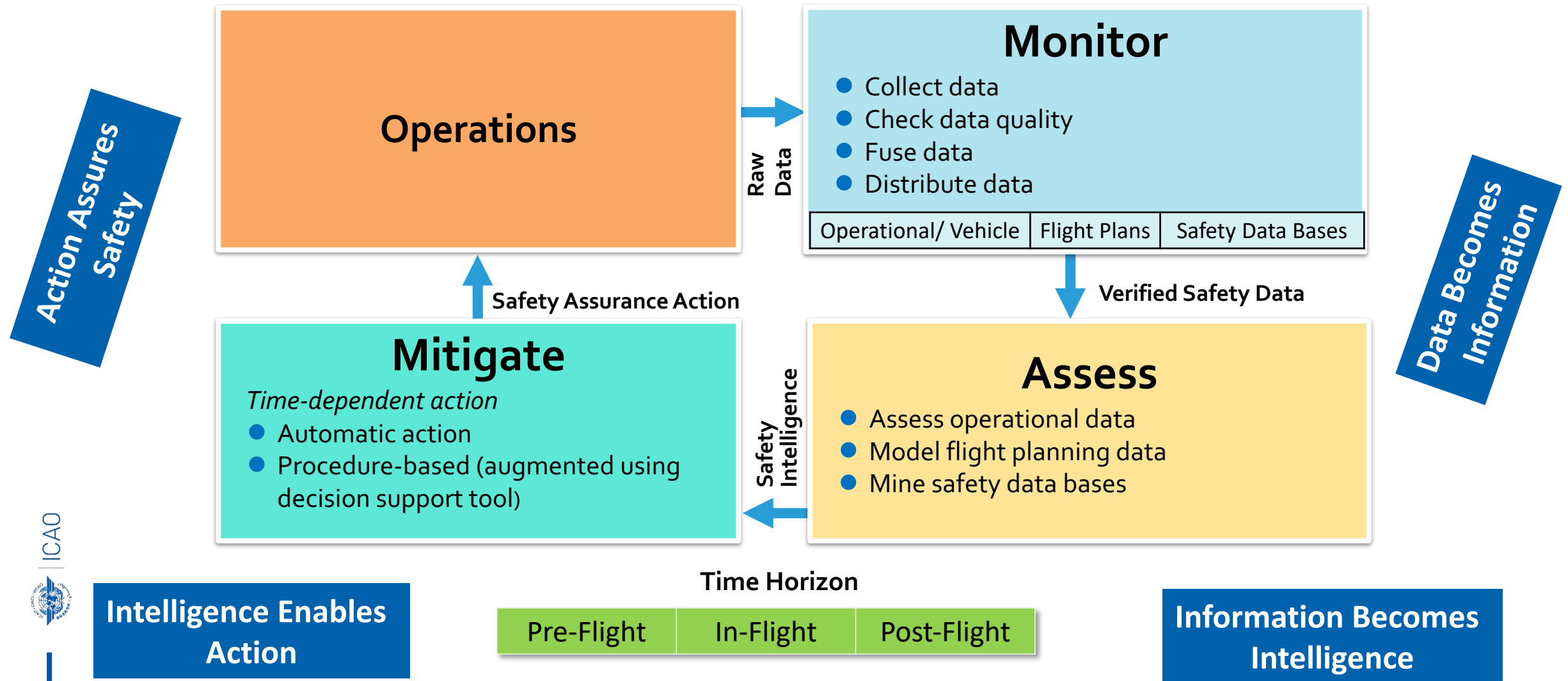
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Safety Intelligence, Risk Management and Safety Assurance



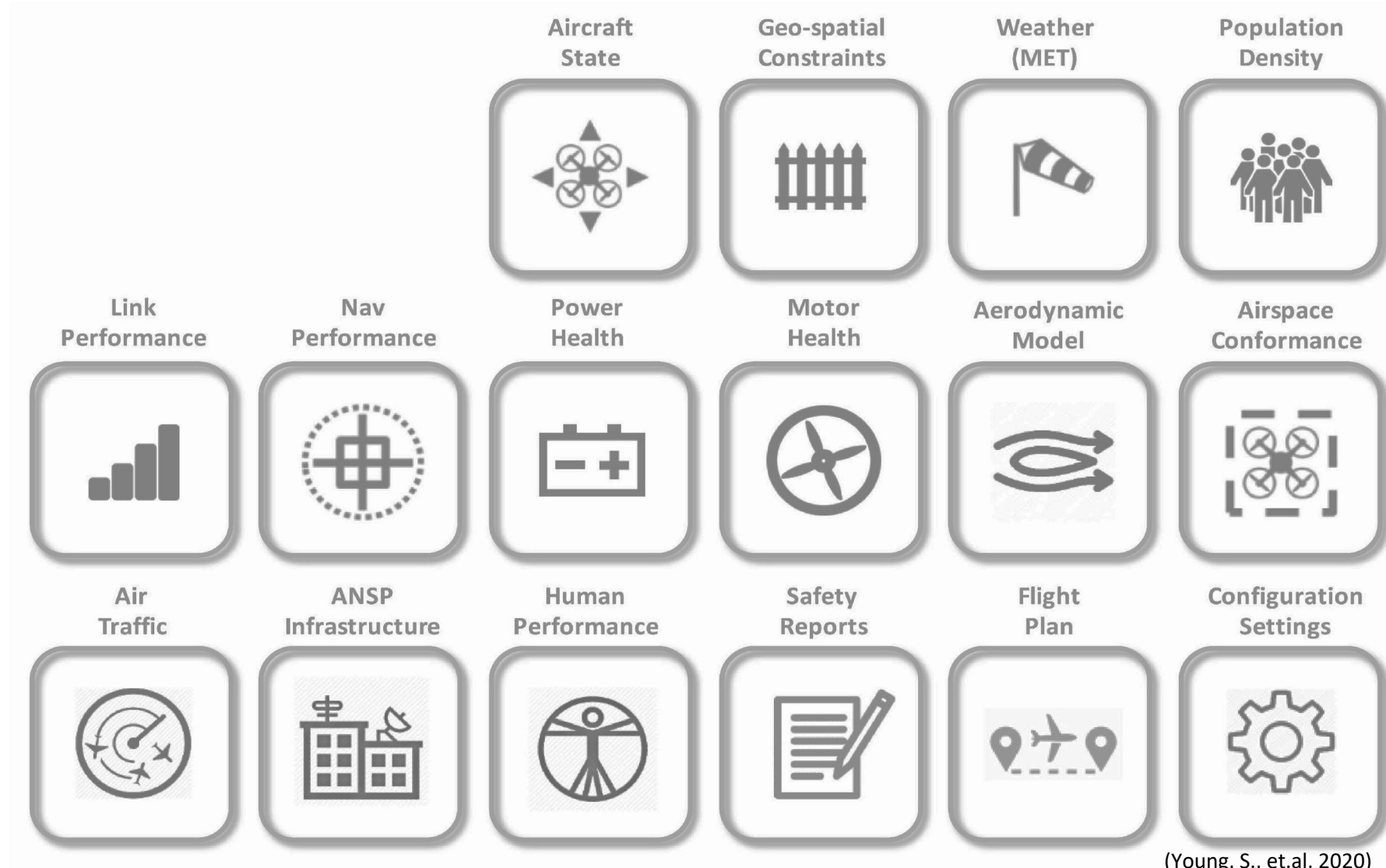
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It Begins with Data...

Information classes useful to enable SMS

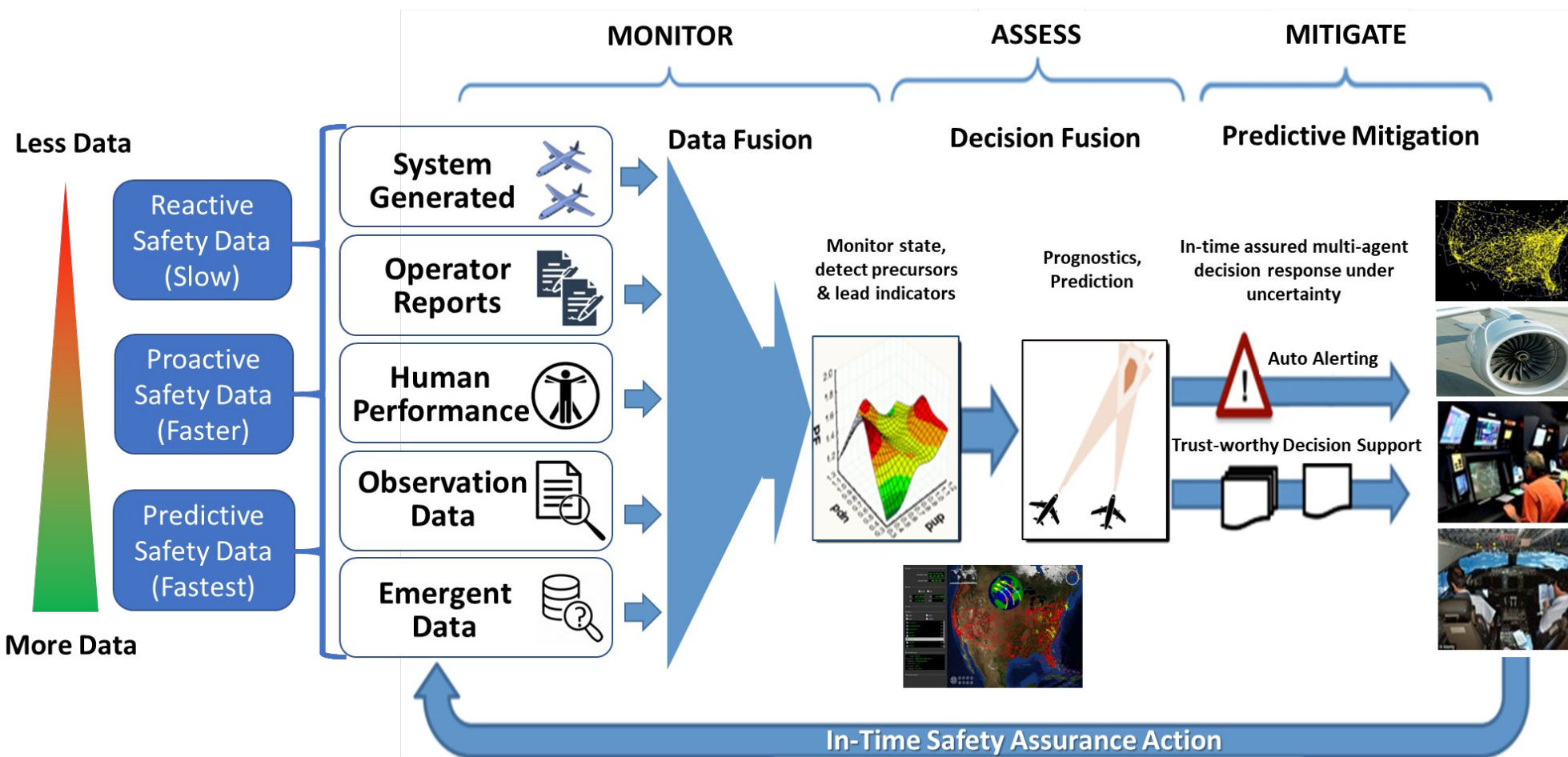
- Airspace Sourced
- Vehicle Sourced
- 3rd Party Data Service Provider
- System Wide Information Management (SWIM) / Flight Information Management System (FIMS) Sourced
- Other Sources...



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

Increasingly In-Time Safety

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



Data Challenges: The Four V's



Data

Data

➤ Volume:

- Radar Tracks: 47 facilities (1 year) ~423 GB (Compressed), ~3.2 TB (CSV)
- Weather and Forecast (Entire NAS): CIWS ~2.8 TB

➤ Velocity

- Radar Tracks: 47 Facilities
 - ~35 GB/month (compressed).
 - ~268 GB/month (uncompressed)
- Weather and Forecast (Entire NAS): CIWS ~233 GB/month

➤ Veracity

- Data drop outs
- Duplicate tracks
- Track ending in mid air
- Reused flight identifiers

➤ Variety

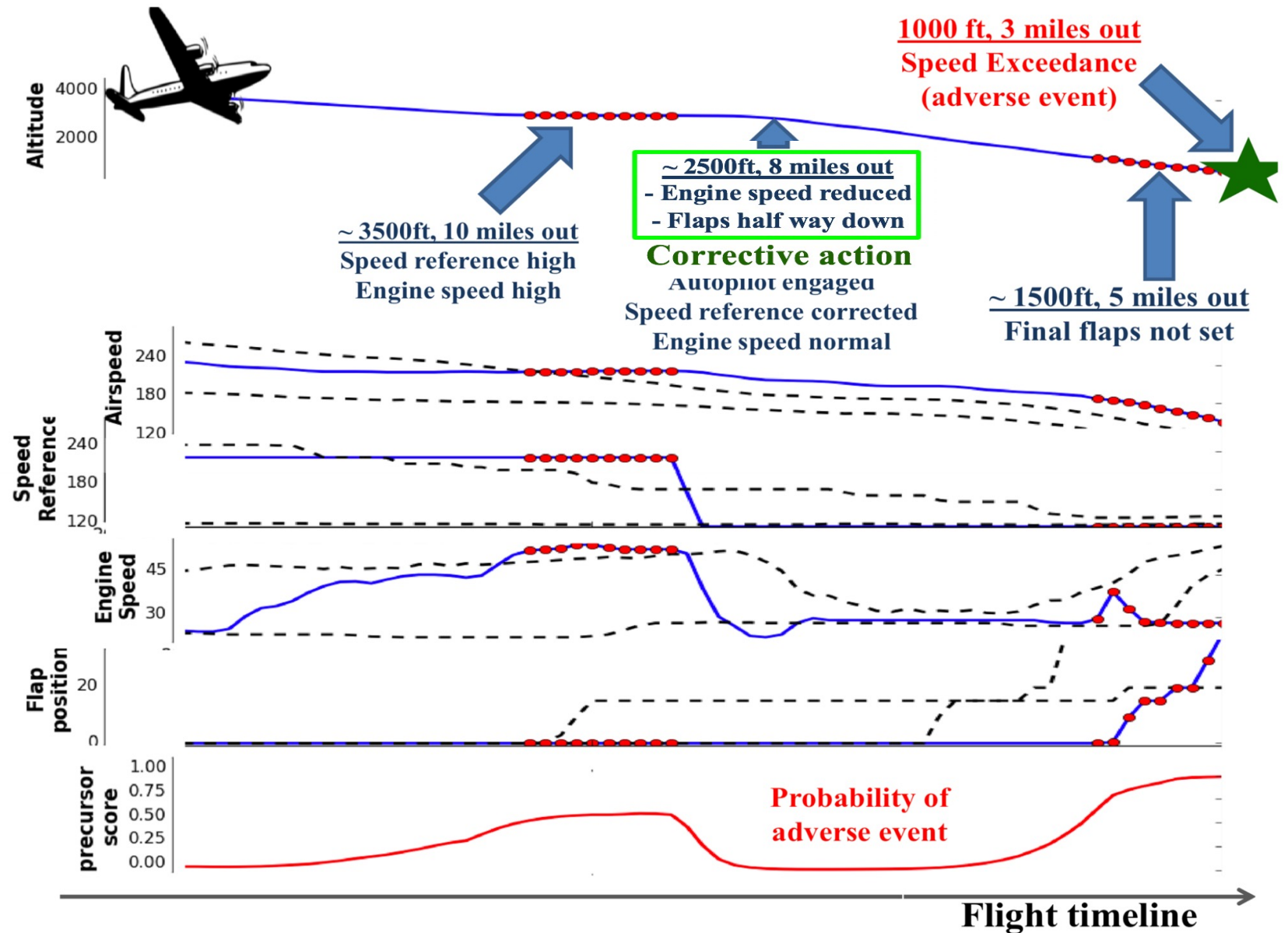
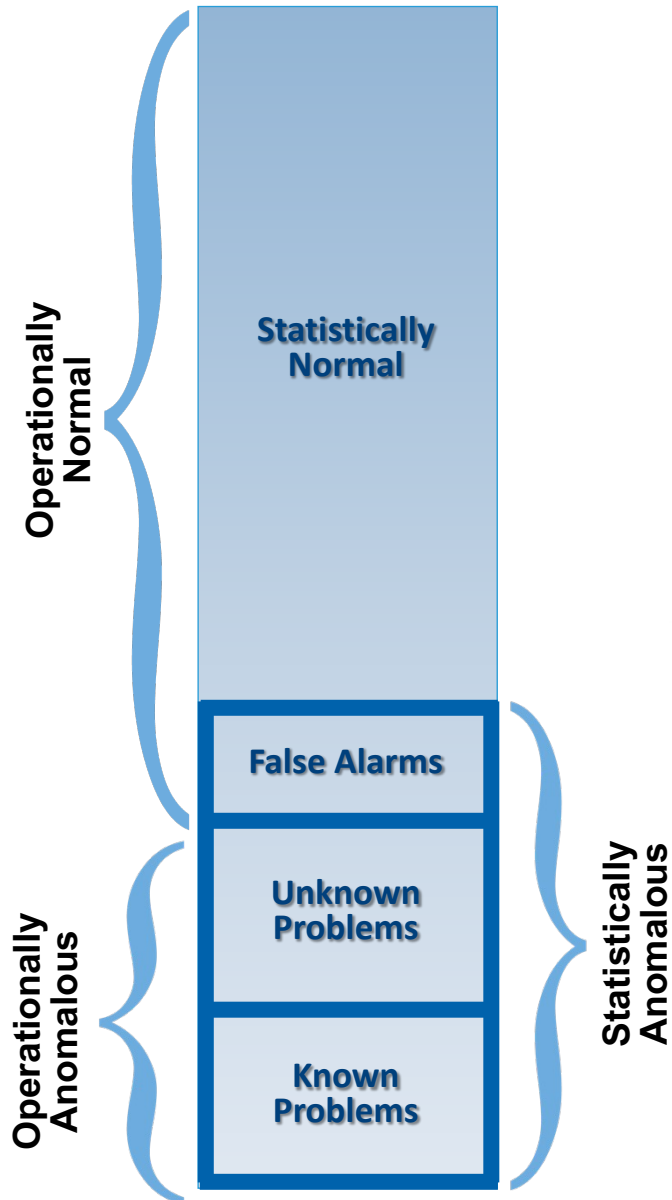
- Numerical (continuous/binary)
- Weather (forecast/actual)
- Radar/Airport meta data
- ATC Voice
- ASRS text reports (Pilot/Controller)

Amazing Algorithm

Safety Information

Intelligent Reports

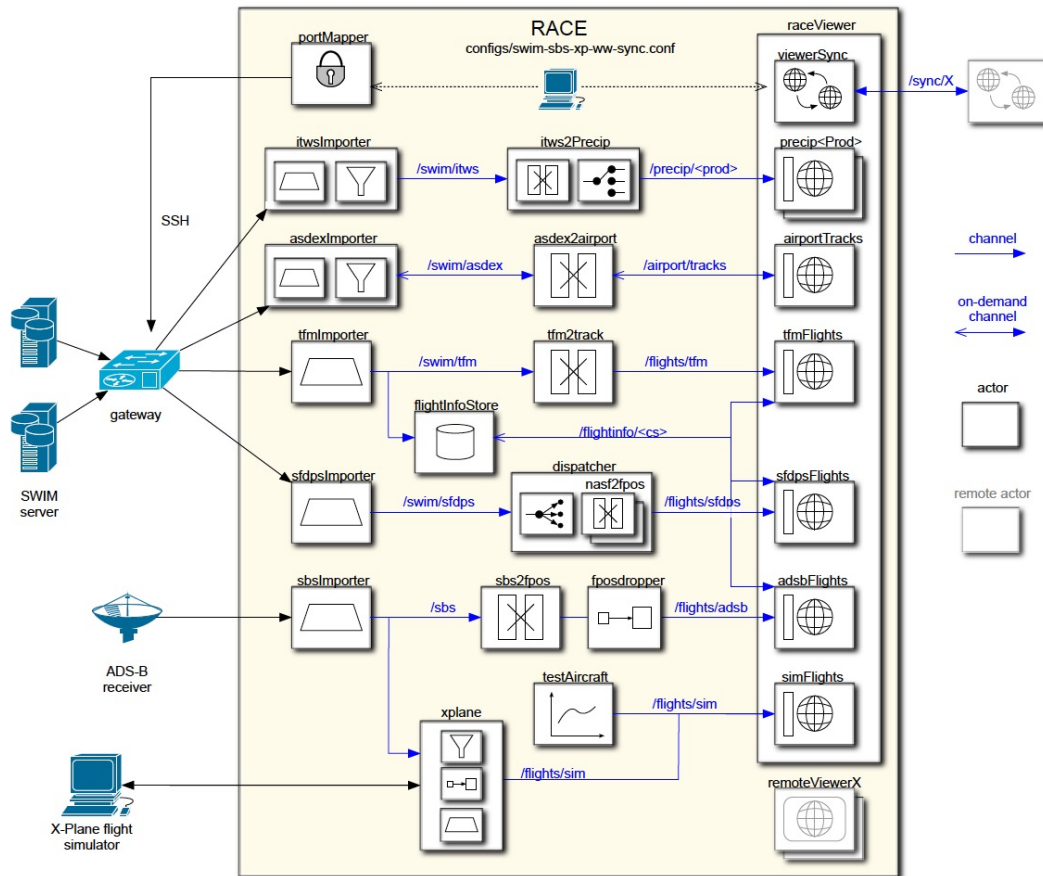
Discovery of Precursors in Time Series Data



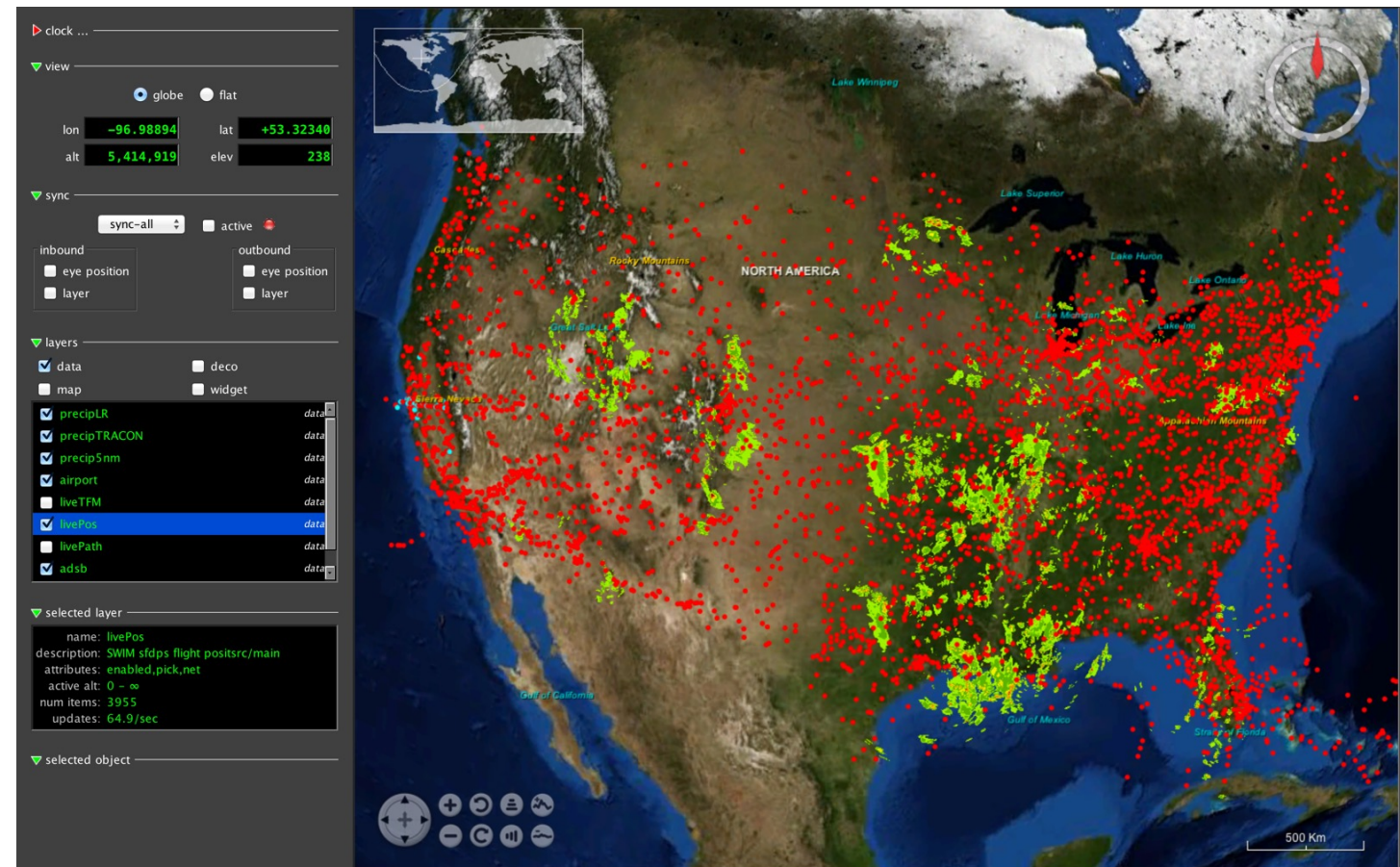
Data Diversity, Volume, and Visualization

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Imports Data (1000 msgq/sec)



4,500 Simultaneous Flights

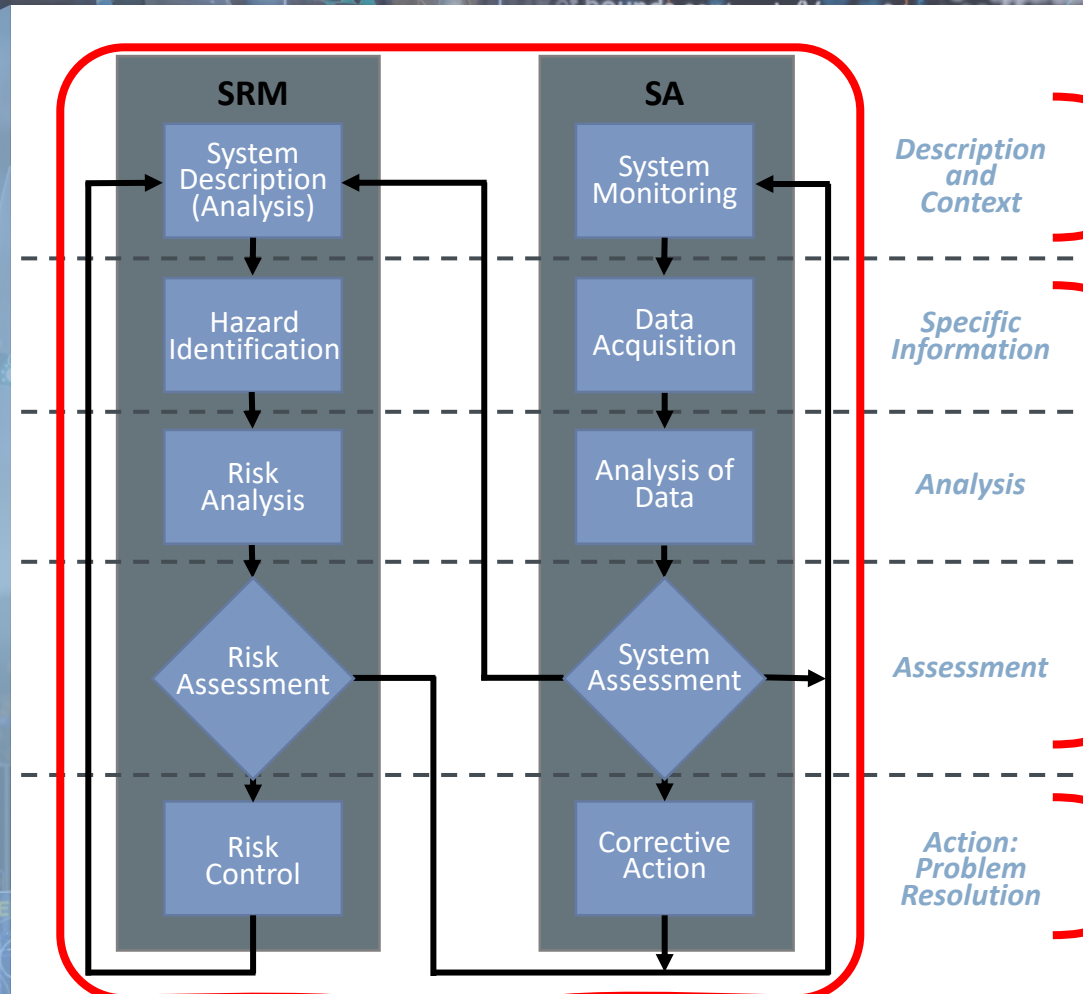


Credit: NASA

Advanced Safety Management Systems Enabled by Safety Intelligence

Needs

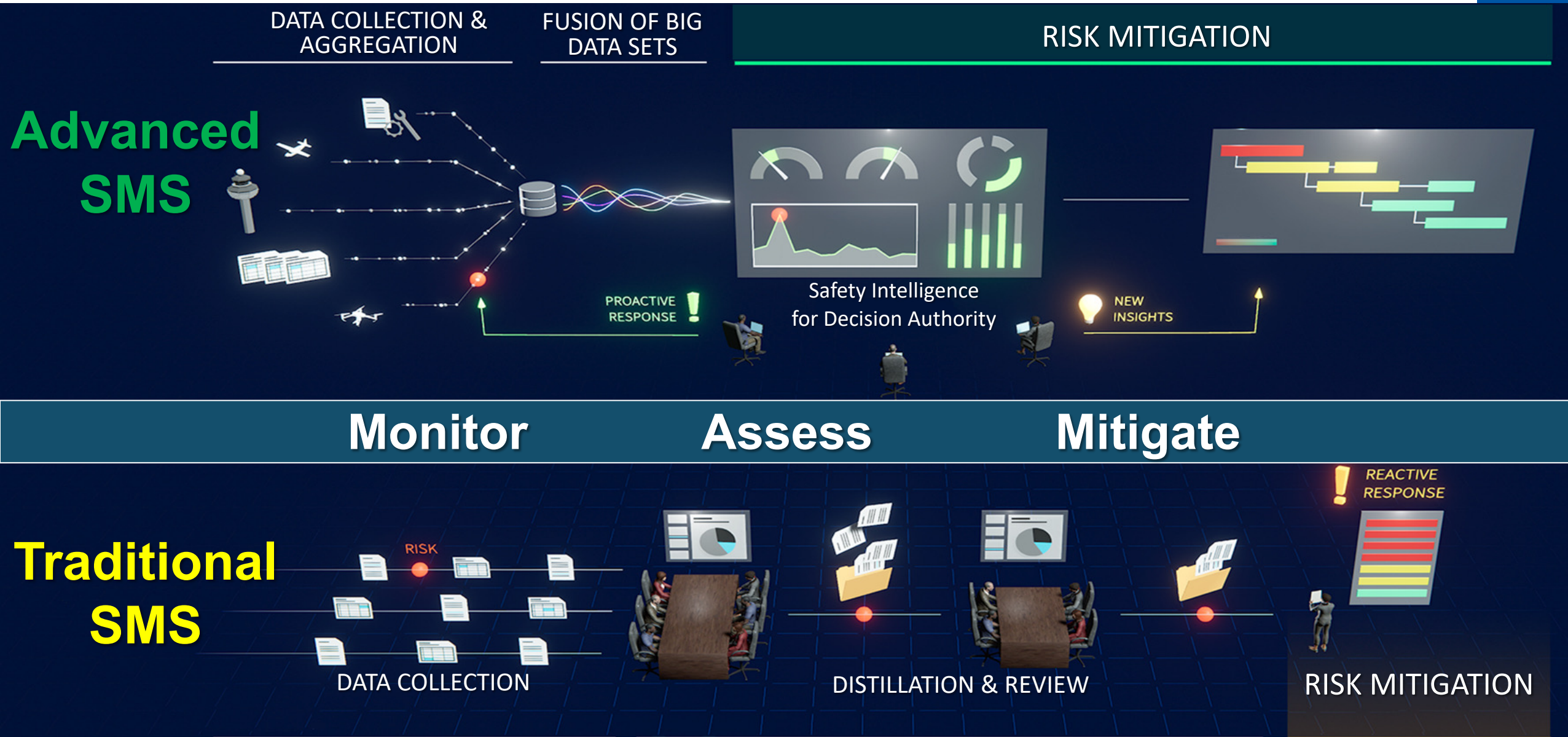
- Timely Safety Risk Mitigation
- Proactive -> Predictive Safety Management Systems
- Adopt ML/AI for predictive analysis and advanced data mining
- Build upon existing IT architectures for increased access to data and tools
- Improve system agility and responsiveness



R&D Required:

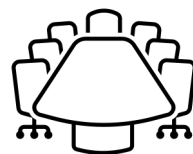
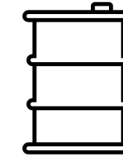
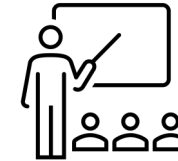
- New Safety Databases
- Non-traditional data
- Data Fusion w/existing services
- Required vs. Voluntary Data
- Synthetic Data Generation
- ML/AI Anomaly Detection
- Predictive Risk Assessment
- Multi-Risk Safety Prognostics
- Integrated Risk Assessments
- Digital Twin Assessments
- Data Exchange Architecture
- Digital Information Service Integration
- Pre-Flight Mitigation
- In-Flight Mitigation
- Post-Flight Mitigation
- Re-Design Consideration

Modernization of SMS



Discussion Question

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How else can your organization benefit from safety intelligence?

Exercise: Discussion

Your State is in the process of approving a foreign air operator for a Foreign Air Operator Certificate to conduct scheduled flights to your State. To support your approval process, risk assessments and surveillance activities, identify data needs and the challenges related to collecting/processing/analyzing the data.

- 1) List data to be collected for your approval process, risk assessment, and surveillance.
- 2) List possible challenges with the collection, processing and analysis of this data.



Thank You!