# Agenda

**July 27, 2021**  
*1:30pm - 3:00pm ET*

<table>
<thead>
<tr>
<th>Time (ET)</th>
<th>Topic</th>
<th>Speaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:30PM – 1:35PM</td>
<td>Welcome</td>
<td>Kyle Ellis, NASA</td>
</tr>
<tr>
<td>1:35PM – 1:45PM</td>
<td>Evolution of IASMS SFCs in Transitions of Increasing Autonomy</td>
<td>Kyle Ellis, NASA</td>
</tr>
<tr>
<td>1:45PM – 1:55PM</td>
<td>Evolution of AAM Using S-Curves</td>
<td>Parimal Kopardekar, NASA</td>
</tr>
<tr>
<td>2:35PM – 2:55PM</td>
<td>Discussion with the Audience, including:</td>
<td>All the Above</td>
</tr>
<tr>
<td>2:55PM – 3:00PM</td>
<td>Closing Remarks</td>
<td>Misty Davies, NASA</td>
</tr>
</tbody>
</table>
Platforms and Discussion

• Active Participants
  – Platform: MS Teams
  – Discussion: MS Teams microphone, chat, and “Raise your hand” functions
    • Leave your cameras/webcams off to preserve WiFi bandwidth
    • Use your mute/unmute button (e.g., remain on mute unless you are speaking)
    • Enter comments/questions in the chat
    • Click the “Raise your hand” button if you wish to speak
    • Say your name and affiliation before you begin speaking

• Listen Only Participants
  – Platform: YouTube Live Stream
    • Go to https://nari.arc.nasa.gov/aam-portal/ for the link
  – Discussion: Conferences.io
    • Enter https://arc.cnf.io/sessions/hrhw/#!/dashboard into your browser
    • Questions will be addressed if times permits or at the facilitator’s discretion
A Safe Future National Airspace System

The Problem:

Safety Assurance and Accessibility for integrating emerging domains into the NAS. The public has a low tolerance for risk in aviation and the current NAS is labor-intensive with limited ability to scale up for new entrants.

Possible Solution:

Collaboratively define a Concept of Operations for scalable In-time Aviation Safety Management Systems (IASMS) with a service-oriented architecture to better focus safety investments in technological solutions that overcome barriers to future envisioned operations in the NAS (2045+).

Industry Collaboration:

Consensus on desirable system traits based on relevant Use Cases to show integration of data and leveraging of automated/autonomous systems that can identify anomalies, precursors, and trends to more proactively manage operational risks.
Achieving Aviation Safety Today

Air Transportation Safety

Overall Safety Management System

Safety Policy
- Broad Safety Objectives
- Responsibility & Accountability

Risk Management
- Hazard Identification
- RM Controls
- Safety Performance

Safety Assurance
- Data Collection
- Data Analysis
- Resource Prioritization

Safety Promotion
- Safety Training
- Dissemination of Information
- Safety Culture

Labor intensive
Limited ability to scale
Not fast enough
How We Achieve Aviation Safety Tomorrow

Air Transportation Safety

In-Time System-Wide Safety Assurance (ISSA)

In-Time Aviation Safety Management System (IASMS)

Services, Functions, Capabilities

Monitor
Assess
Mitigate

Hazard Identification
RM Controls
Safety Performance

Data Collection
Data Analysis
Resource Prioritization

Safety Policy

Safety Promotion

Broad Safety Objectives
Responsibility & Accountability

Safety Training
Dissemination of Information
Safety Culture


Services, Functions, and Capabilities Execute Risk Management and Safety Assurance Actions
How We Achieve Aviation Safety Tomorrow

- Safety Policy
- Broad Safety Objectives
- Responsibility & Accountability
- Safety Promotion
- Safety Training
- Dissemination of Information
- Safety Culture

In-Time System-Wide Safety Assurance (ISSA)

- In-Time Aviation Safety Management System (IASMS)

- Services, Functions, Capabilities
  - Manage Known Operational Risks
  - Identify Unknown Risks
  - Inform Improved System Designs

Quickly manage known operational risks at scale
Quickly identify unknown risks
Quickly inform design

Service-Oriented Architecture

Vehicle ISSA SFCs
- Communication/C2
- Remote ID
- Many Others
- Conflict Advisory/Alert
- UAS System Monitoring

Information Classes
- Link Performance
- Aircraft State
- Monitor Health
- Nav Performance
- Power Health
- Configuration Settings

ISSA SFCs
Monitors data, makes assessments, and performs or informs a safety assurance action

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

Airspace ISSA SFCs
- USS Network Discovery
- Airspace Authorizations
- Many Others
- Constraint Management
- Conformance Monitoring
- USS System Monitoring

Information Classes
- Airspace Conformance
- Geo-spatial Constraints
- Human Performance
- Air Traffic
- Flight Plan
- Configuration Settings

Information Classes
- Human Performance
- Air Traffic
- Flight Plan
- Configuration Settings

SDSP ISSA SFCs
- Weather
- Surveillance
- Many Others
- uFOQA
- Operator Messaging
- 3rd Party Risk Tool

Information Classes
- Weather (MET)
- ANSP Infrastructure
- Population Density
- Configuration Settings
- Safety Reports
- Human Performance

Information Classes
- Aerodynamic Model
- Human Performance
- Configuration Settings
SFCs to Address Risks

**Risks**

- **Flight outside of approved airspace**
- **Unsafe proximity** to air traffic, people on the ground, terrain or property
- **Critical system failures** (including loss of link, loss or degraded positioning system performance, loss of power, flight control failure and engine failure)
- **Loss-of-Control** (i.e., envelope excursions)
- **Physical/Environment Related Risks**
  - Weather encounters (including wind gusts)
  - Threat by person—malicious
- **Cyber-security** related risks
- Those our predictive and prognostic SFCs have **not identified yet**...
In-Time Aviation Safety Management System (IASMS)

Pre-flight Safety
- 3rd Party Risk Modeling
- Noise Abatement Zone

Obstacle Avoidance
- Enhanced Obstacle Database/Detection

WEATHER
- Advanced Weather Models

Vehicle System Failure
- Vehicle Health Monitors

RF Interference
- RF Interference Models

Traffic Collision Avoidance
- DAA Safety Monitor

DAA
- Traffic Collision Avoidance

Route Conflicts
- 4DT Route Sequencing

Traffic Management
- ATM-X Sequencing

Emergency Landing
- Post-flight Safety

Safety Monitor
- Safety Monitor

In-flight Safety
- In-flight Safety

Vehicle Performance
- Limited vehicle performance

Post-flight Safety
- Post-flight Safety

Noise Abatement
- Noise Abatement Zone

Pre-flight Safety
- Pre-flight Safety

System-Wide Safety
- System-Wide Safety

IASMS—Extensible & Assured Safety Framework for Fast, Repeatable Access to the NAS
SFC Maturity for IASMS Evolution

Evolution of Airspace Operations and Safety

**Epoch 1**
- Procedural
  - Estimate the current and planned a/c positions
- Safety

**Epoch 2**
- Radar
  - Know the current and estimate planned a/c positions
- +Density

**Epoch 3**
- Trajectory
  - Know & exchange current and planned a/c positions
- + Efficiency and proactive planning
- Collaborative
  - Connected, performance-based, collaborative ATM
  - Introduces 3rd-party service providers
- + Service oriented architecture for tailored mission oriented services

**Epoch 4 (~2035)**
- Highly-Automated
  - ML/AI – based dynamic, robust performance and safety
  - Machine-to-machine interactions and humans collaborate
- + Complexity, scalability, and dynamic adaptation

**Epoch 5 (~2045)**
- Digital Transformation of ATM
  - Automated in-time safety monitoring and alerting services
  - Integrated predictive risk mitigation across domains
  - Automatically-assured adaptive in-time safety threat management
SFC Maturity for IASMS Evolution

Level 1: Alerting Function for Human
- Monitor 1*; Assess 1, Mitigate 0

Level 2: Automated Function with Human Fallback
- Monitor 2, Assess 2, Mitigate 1

Level 3: Autonomous Functionality with Human-Over-the-Loop
- Monitor 3, Assess 3, Mitigate 2

Level 4: Fully Autonomous Functionality
- Monitor 3, Assess 3, Mitigate 3

*The Monitor-Assess-Mitigate numbers signify increases in capability

In-Time
Adaptive
Increasingly Scalable
Decreasingly Labor-Intensive

12
EVOLUTION OF ADVANCED AIR MOBILITY USING S-CURVES

PARIMAL KOPARDEKAR, PHD
DIRECTOR, NASA AERONAUTICS RESEARCH INSTITUTE (NARI)
SENIOR TECHNOLOGIST, AIR TRANSPORTATION SYSTEM

PARIMAL.H.KOPARDEKAR@NASA.GOV
Advanced Air Mobility/Urban Air Mobility

Note: managed vs. supervised denotes different levels of responsibility and decision making, with supervision at a higher level than management; supervision is like a dispatch role.
Small Unmanned Aircraft Systems

- **Epoch 1**: Remotely operated, pilot-in-command, and human-in-the-loop
- **Epoch 2**: Remotely managed, pilot-in-command with software, and human-on-the-loop
- **Epoch 3**: 1:1 Autonomously managed and human-on-the-loop supervision with ability to step in (control by exception)
- **Epoch 4**: m:n Autonomously managed and human steps in for goal-setting only—not for execution (dispatch role)
Evolution of Airspace Operations and Safety

Epoch 1
- Procedural
- Estimate the current and planned a/c positions
- Human-centered safety monitoring, assessment and mitigation

Epoch 2
- Radar
- Know the current and estimate planned a/c positions

Epoch 3
- Trajectory
  - Know & exchange current and planned a/c positions
  - Efficiency and proactive planning

Epoch 4 (~2035)
- Collaborative
  - Connected, performance-based, collaborative ATM
  - Introduces 3rd-party service providers
  - Automated in-time safety monitoring and alerting services

Epoch 5 (~2045)
- Highly-Automated
  - ML/AI-based dynamic, robust performance and safety
  - Machine-to-machine interactions and humans collaborate
  - Integrated predictive risk mitigation across domains
  - Automatically-assured adaptive in-time safety threat management

Digital Transformation of ATM
QUESTIONS?

PARIMAL KOPARDEKAR, PHD
DIRECTOR, NASA AERONAUTICS RESEARCH INSTITUTE (NARI)
SENIOR TECHNOLOGIST, AIR TRANSPORTATION SYSTEM

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Panelist Discussion
The Crosscutting Working Group’s meeting dates and times vary depending on the needs of the AAM community.

- Aug. 31, 2021  Topic: MBSE Implementation Lessons Learned
Upcoming AAM Working Group Meetings

• Aircraft Working Group: The Pilot’s Perspective on UAM
  – **DATE:** Thursday, July 29, 2021
  – **TIME:** 3:00PM – 4:30PM ET (12:00PM – 1:30PM PT)

• Community Integration Working Group: Roles & Responsibilities
  – **DATE:** Thursday, August 5, 2021
  – **TIME:** 3:30PM – 5:00PM ET (12:30PM – 2:00PM PT)
Crosscutting Working Group POCs

• Technical Lead:
  – Dr. Misty Davies (misty.d.davies@nasa.gov)

• Coordinator:
  – Anna Cavolowsky (anna.e.cavolowsky@nasa.gov)

Comments, questions, suggestions for future topics, and other workgroup information:

• Email us at: arc-cal-nari@mail.nasa.gov; or
• Visit the new AEWG Portal: https://nari.arc.nasa.gov/aam-portal/.
Panelist Biographies
Parimal Kopardekar (PK) serves as the Director of NASA Aeronautics Research Institute (NARI). In that capacity, he is responsible for exploring new trends, collaborations and partnerships needs related to aviation enterprise. He also serves as NASA's senior technologist for Air Transportation Systems and principal investigator for the Unmanned Aircraft Systems Traffic Management (UTM) project. He is the recipient of many awards such as NASA Federal Invention of the Year Award, Exceptional Technology Achievement Medal, Outstanding Leadership Award, and Engineer of the Year Award; Samuel J Heyman Service to America’s Promising Innovation Award; and was named among 25 most influential people in drone industry. He is Co-Editor-in-Chief of Journal of Aerospace Operations and fellow of American Aeronautics and Astronautics. He also serves as an adjunct faculty and teaches undergraduate and graduate courses related to operations management and supply chain management.
Jon is the Founder & CEO of Aloft, the market leader in drone airspace systems & UTM technologies. Kittyhawk’s patented technology is used in today’s leading recreational and enterprise drone applications.

Jon is a certified commercial drone pilot as part of FAA Part 107 and is an active member of industry groups including, NBAA Emerging Tech, GUTMA, Drone Advisory Committee (DAC) working groups, and is a founding member and data working group chair of the FAA UAS Safety Team. He’s a self-taught iOS developer, writes about drone topics for technology news outlets including VentureBeat, TechCrunch, and Forbes, and regularly speaks at industry events such as Commercial UAV Expo, 2B Ahead Future Congress, and DJI AirWorks. Jon graduated from TCU with a major in finance and received his MBA from Thunderbird Global School of Management (ASU).
Eric J Bergesen is the Director of Operations for UPS Flight Forward Inc. Eric led the operations team through the Part 135 Certification effort, resulting in the FAA awarding UPSFF with the first Standard Part 135 Air Carrier Operating Certificate for Unmanned Aircraft Operations. His current role follows 5 years as a Flight Qualified Management Pilot for UPS Airlines. During that time he served as an A300 Captain, Check Airman, and FAA Aircrew Program Designee for both the simulator and aircraft. Eric also served most recently in UPS’ Global Operations Center, in support of daily worldwide airline functions.

Eric started his aviation career over 30 years ago as an instructor for FlightSafety, accumulating the flight time and experience to enter the Part 135 and 121 airline environment. Eric spent 18 years with DHL Airways/ASTAR Air Cargo, where he held various leadership positions including Check Airman, Fleet Manager, Training and Standards Manager, and Director of Operations. Following a brief period as Manager of Alaska Airlines’ Advanced Qualification Training Program, he assumed responsibility as the Director of Operations for World Airways. This role expanded to Senior Vice President and Chief Operating Officer. Following this opportunity, Eric joined UPS in 2014.
IASMS Capability Levels – SFC Development

IASMS

Key SFCs IASMS to Mitigate Risks

- Integrated Risk Tool
- Human Automation Teaming Assistant
- Power Systems Failure (Battery Health Tool)
- C2 Link System Failure (RF Interference Tool)
- Unsafe Proximity to Terrain (ProxThreat)
- Unsafe Proximity to Traffic (ICAROUS Traffic Deconfliction Module)
- Unsafe Proximity to People (NPCRA Tool)
- Flight Outside of Approved Airspace (SAFEGUARD 2.0)

Note: Proposed SFCs and ICLs to enable safe operations are still being analyzed with our operational and regulatory partners.
IASMS Capability Levels – SFC Maturation

Proposed SFCs To Mitigate Hazards

ConOps (e.g., Wildfire Fighting)

Roles and Responsibilities

Maturity Level

SFC Maturity
Services – Functions – Capabilities

Level 1:
Alerting Function for Human
Monitor 1*; Assess 1, Mitigate 0

Level 2:
Automated Function with Human Fallback
Monitor 1, Assess 1, Mitigate 1

Level 3:
Autonomous Functionality with Human-Over-the-Loop
Monitor 1, Assess 1, Mitigate 2

Level 4:
Fully Autonomous Functionality
Monitor 2, Assess 2, Mitigate 3

Note: Proposed SFCs and ICLs to enable safe operations are still being analyzed with our operational and regulatory partners.

The ConOps defines maturation needs for each SFC.

SFCs can be integrated with varying degrees of maturity depending on mission roles and responsibilities.
Note: Proposed SFCs and ICLs to enable safe operations are still being analyzed with our operational and regulatory partners.