Bird Strike Committee USA

Panel No. 2: Advanced Air Mobility (AAM)

Introduction

Lisa Harmon, Moderator
Mead & Hunt, Inc.
Chair, BSC USA Communications Committee

Bird Strike Committee USA

Mead&Hunt

NARI NASA AERONAUTICS RESEARCH INSTITUTE

ALAKA'I TECHNOLOGIES

skai

August 17, 2021

Bird Strike Committee USA

Advanced Air Mobility (AAM) Network,
Mead & Hunt, Inc.

DREAM IT, DO IT, POSITION YOURSELF FOR THE NEXT TRANSPORTATION REVOLUTION – ADVANCED AIR MOBILITY (AAM)!

AAM is closer to reality every day!

This next transportation revolution will include the use of electric Vertical Takeoff and Landing (eVTOL) technology.

New eVTOL aircraft will fly at low altitudes, use new flightpaths, and use new infrastructure both at airports and at locations not traditionally associated with aviation.

This session provides a description of AAM and the potential interaction of eVTOL aircraft with birds. We'll discuss what we know about bird strikes and how we can apply those lessons to emerging AAM technology.

Speakers

Moderator

Lisa Harmon

Mead & Hunt, Inc.

Presenter

Parimal Kopardekar

NASA Aeronautical Research Institute (NARI)

Presenter

Roger Nicholson

Alaka'i Technologies | Skai

Presenter

Craig Quick

GE Aviation

Agenda

- Advanced Air Mobility
  - Parimal Kopardekar | NARI
- AAM Design and Operation – an OEM Perspective
  - Roger Nicholson | Alakai'i, Skai
- AAM and Emerging Technologies – The Role of BSC USA
  - Craig Quick | GE Aviation

Advanced Air Mobility

Parimal Kopardekar

NASA Aeronautical Research Institute (NARI)

Advanced Air Mobility

Parimal Kopardekar, Director, NASA Aeronautics Research Institute

August 17, 2021

AAM Mission Critical Commitment

Vehicle Development and Operations Develop concepts and technologies to define requirements and standards addressing key challenges such as safety, affordability, passenger acceptability, noise, automation, etc.

Airspace Design and Operations Develop UTM-inspired concepts and technologies to define requirements and standards addressing key challenges such as safety, access, scalability, efficiency, predictability, etc.

Community Integration Create robust implementation strategies that provide significant public benefits and catalyze public acceptance, local regulation, infrastructure development, insurance and legal frameworks, etc.

Critical Commitment:

Based on validated operational concepts, simulations, analyses, and results from National Campaign demonstrations, the AAM Mission will deliver aircraft, airspace, and infrastructure system and architecture requirements to enable sustainable and scalable medium density advanced air mobility operations

Achieving "systems and architecture requirements" will require *enabling activities* such as 1) the AAM National Campaign Series 2) a robust Ecosystem Partnership model and 3) NASA ARMD Portfolio Execution.

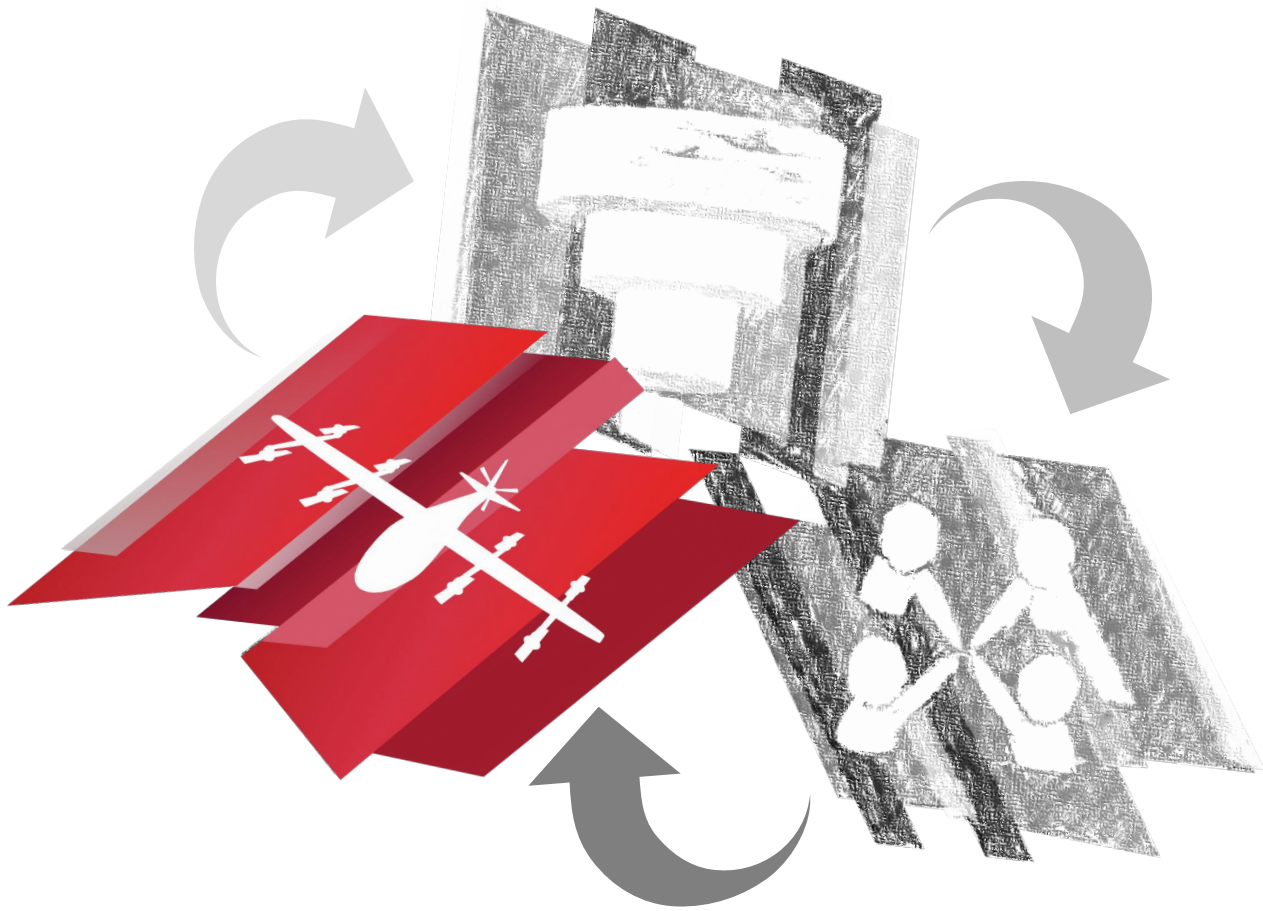
Aircraft

Vehicle Development & Production

- Design, manufacture, and system readiness of AAM vehicles

Individual Vehicle Management & Operations

- Operations and maintenance of a single AAM vehicle, independent of sharing of airspace or other system resources



Aircraft

- At least 18 companies are developing electric vertical takeoff and landing (eVTOL) aircraft
- Generally, have a range of 100+ miles on one battery charge
- Will fly below 5,000 ft at up to 200 mph top speed
- Carry ~4 passengers and one pilot
- Most have wings that are used in forward flight

Joby Aviation

Strong Domestic (e)VTOL Industry Base

- Alaka'i

- Beta [Flown]

- Bell

- Elroy Air [Flown]

- Joby [Flown]

- Jaunt Air Mobility

- Kitty Hawk [Flown]

- Wisk [Flown]

- Workhorse/Moog [Flown]

Airspace

Airspace System Design & Implementation

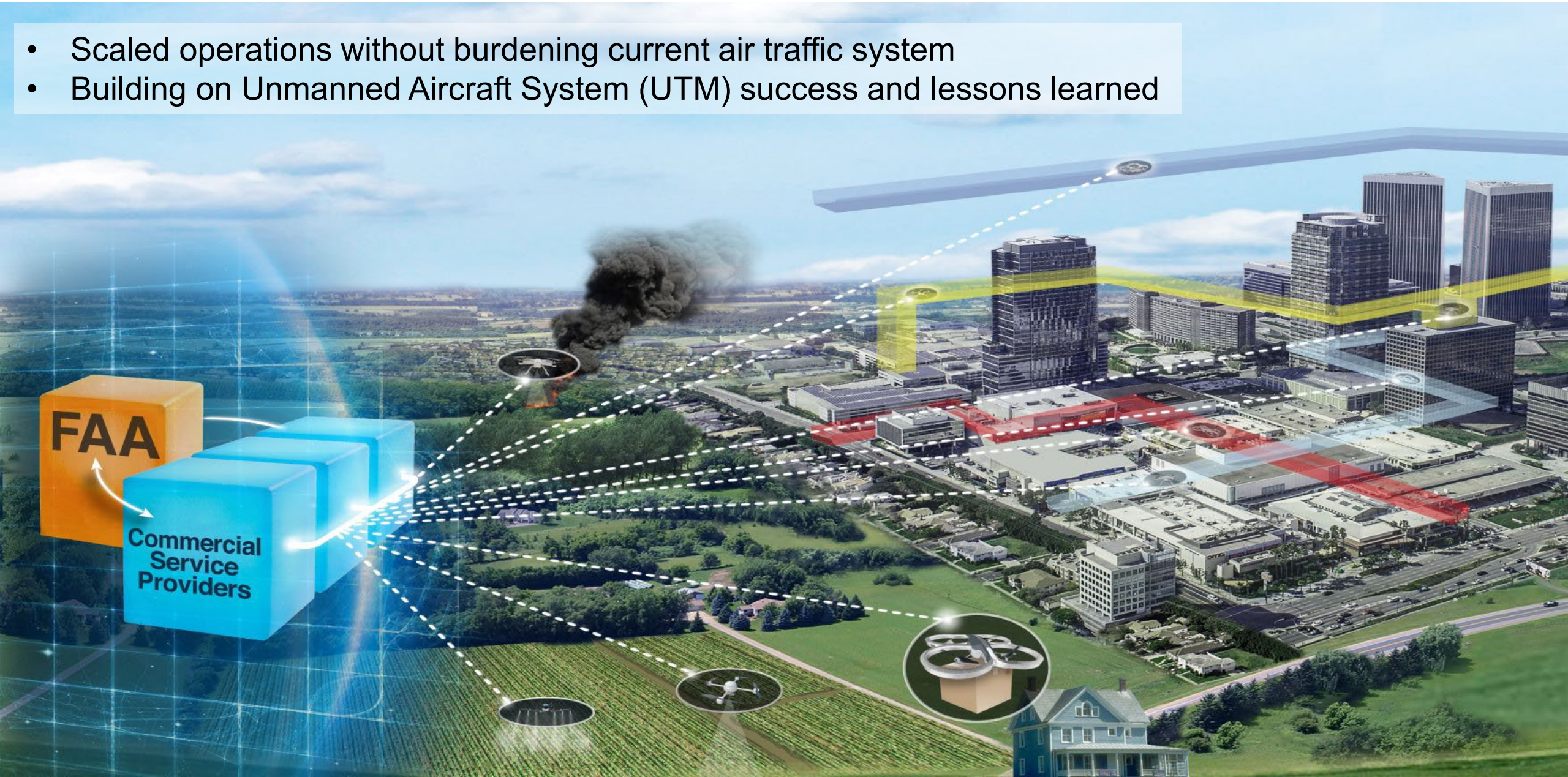
- Design, development, and implementation of infrastructure to enable safe and efficient multi-vehicle AAM Operations

Airspace & Fleet Operations Management

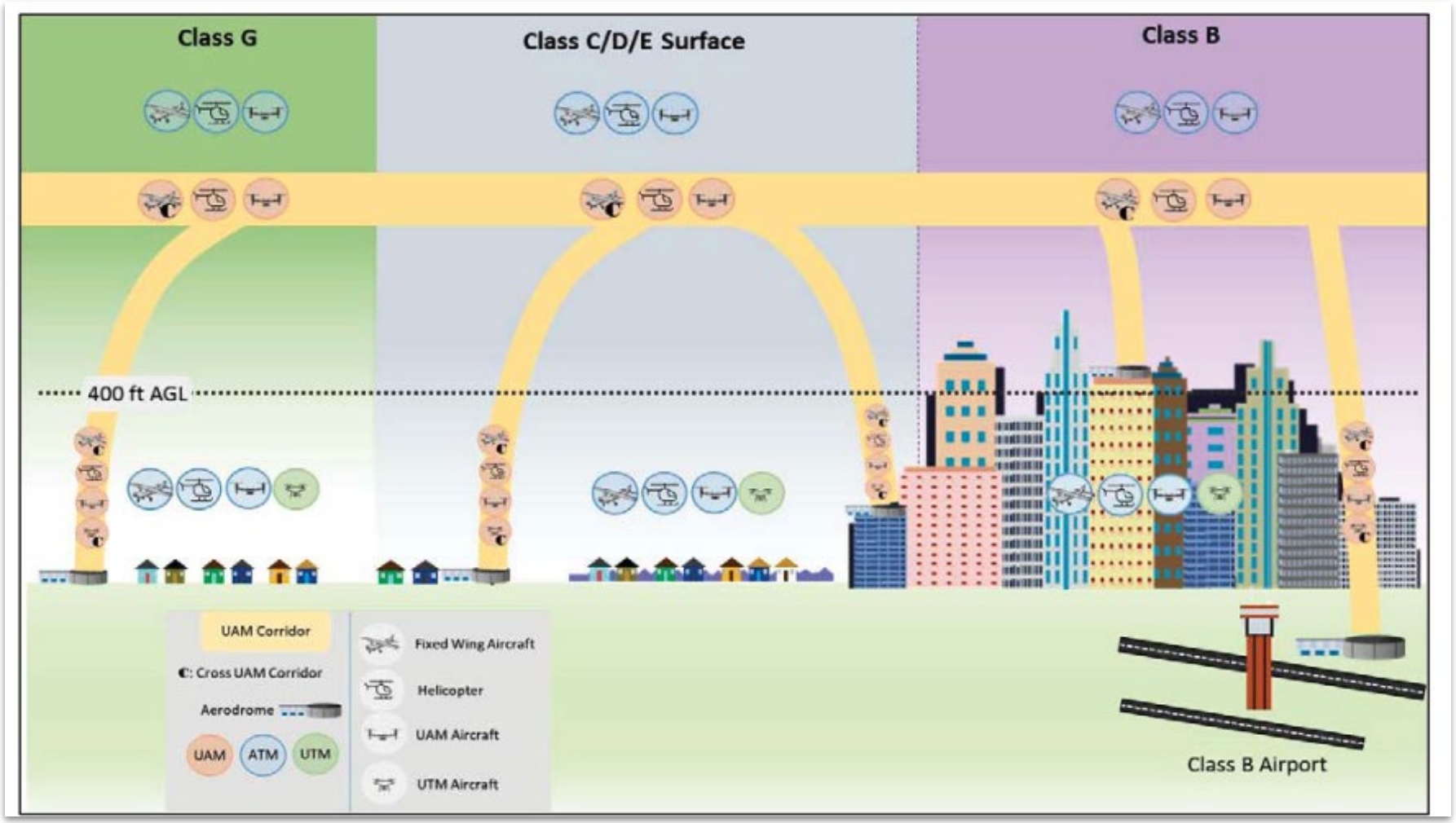
- Operations and management of multiple vehicles within an AAM system that enable safe and efficient sharing of airspace and other system resources

Airspace Considerations

- Scaled operations without burdening current air traffic system
- Building on Unmanned Aircraft System (UTM) success and lessons learned



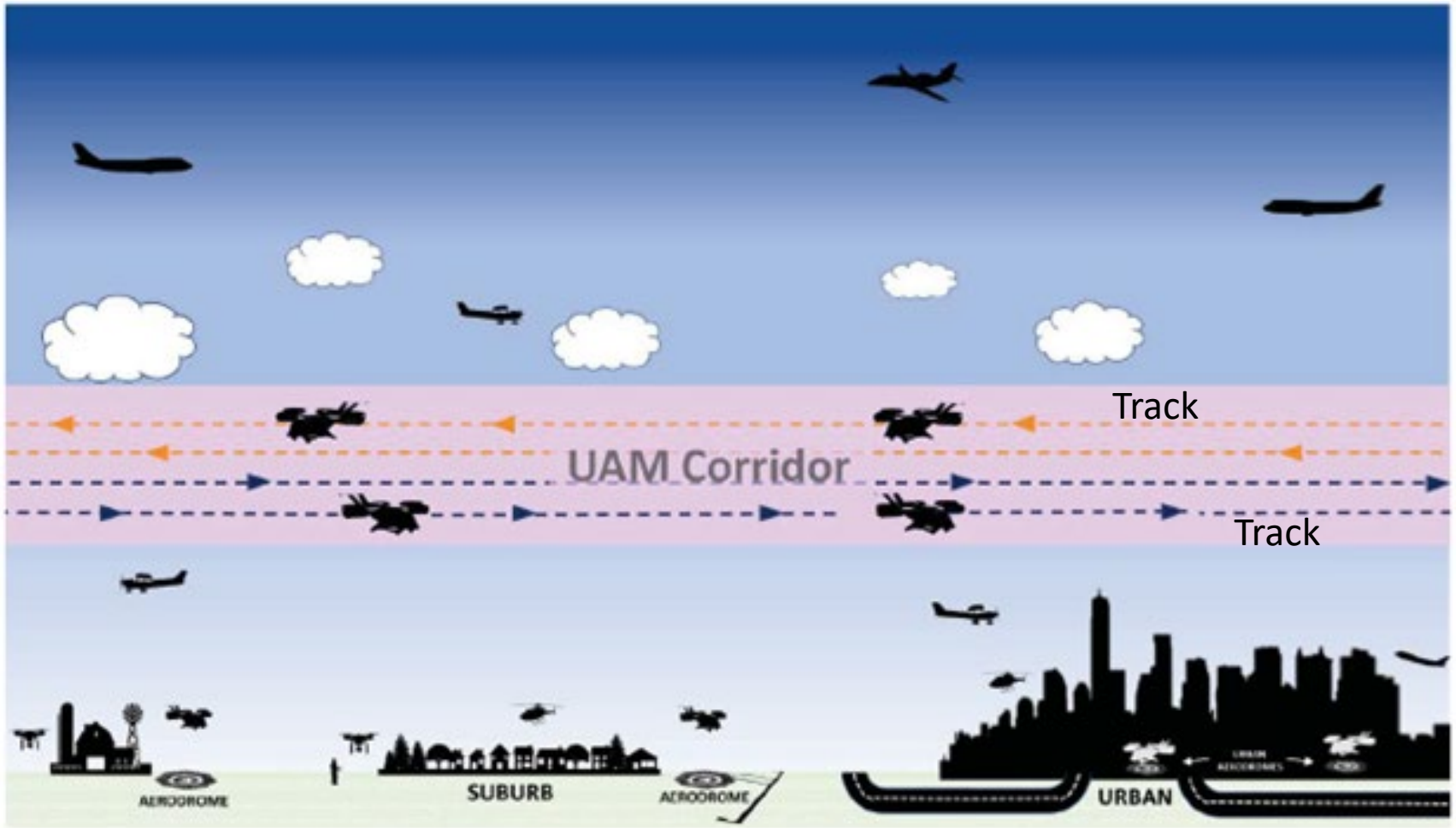
Airspace Structure and Procedures



Corridors

UAM corridors are performance-based airspaces of defined dimensions in which aircraft abide by UAM-specific rules, procedures, and performance requirements

Airspace Structure and Procedures



Tracks

Additional structure within the UAM Corridor to help organize UAM traffic at higher operational tempo (Derived from FAA NextGen UAM ConOps v1.0)

Routes

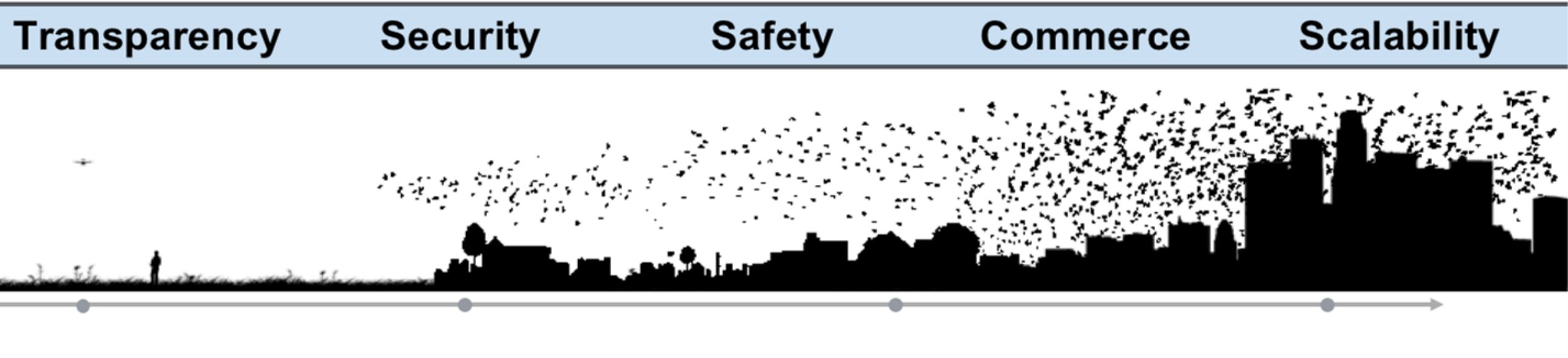
Concatenation of tracks, corridors, and terminal procedures that defines the operation from origin to destination

What is Unmanned Aircraft System Traffic Management?

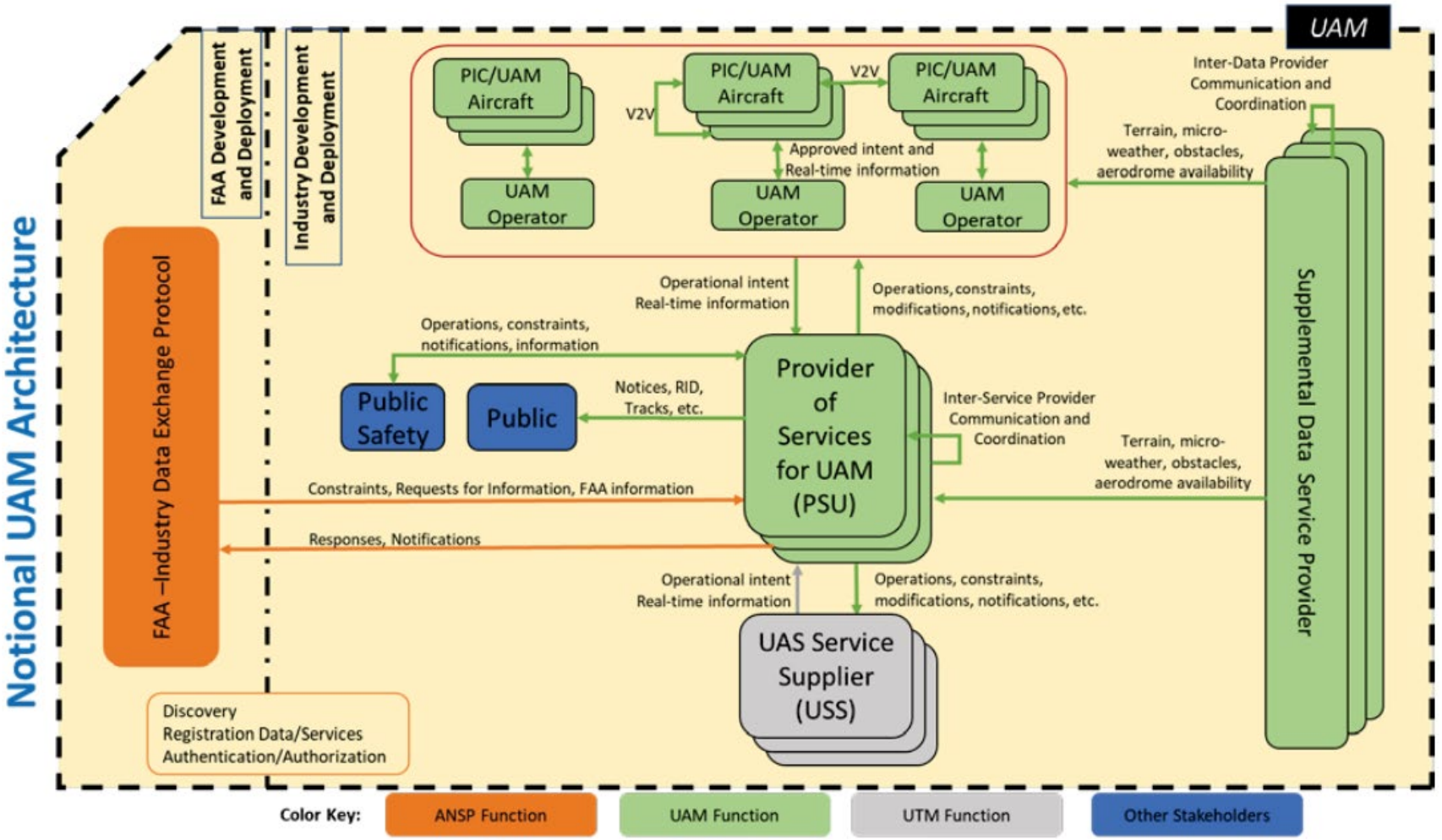
UTM is an "air traffic management" ecosystem for small UAS in low altitude airspace

UTM utilizes industry's ability to supply services under FAA's regulatory authority where these services do not exist.

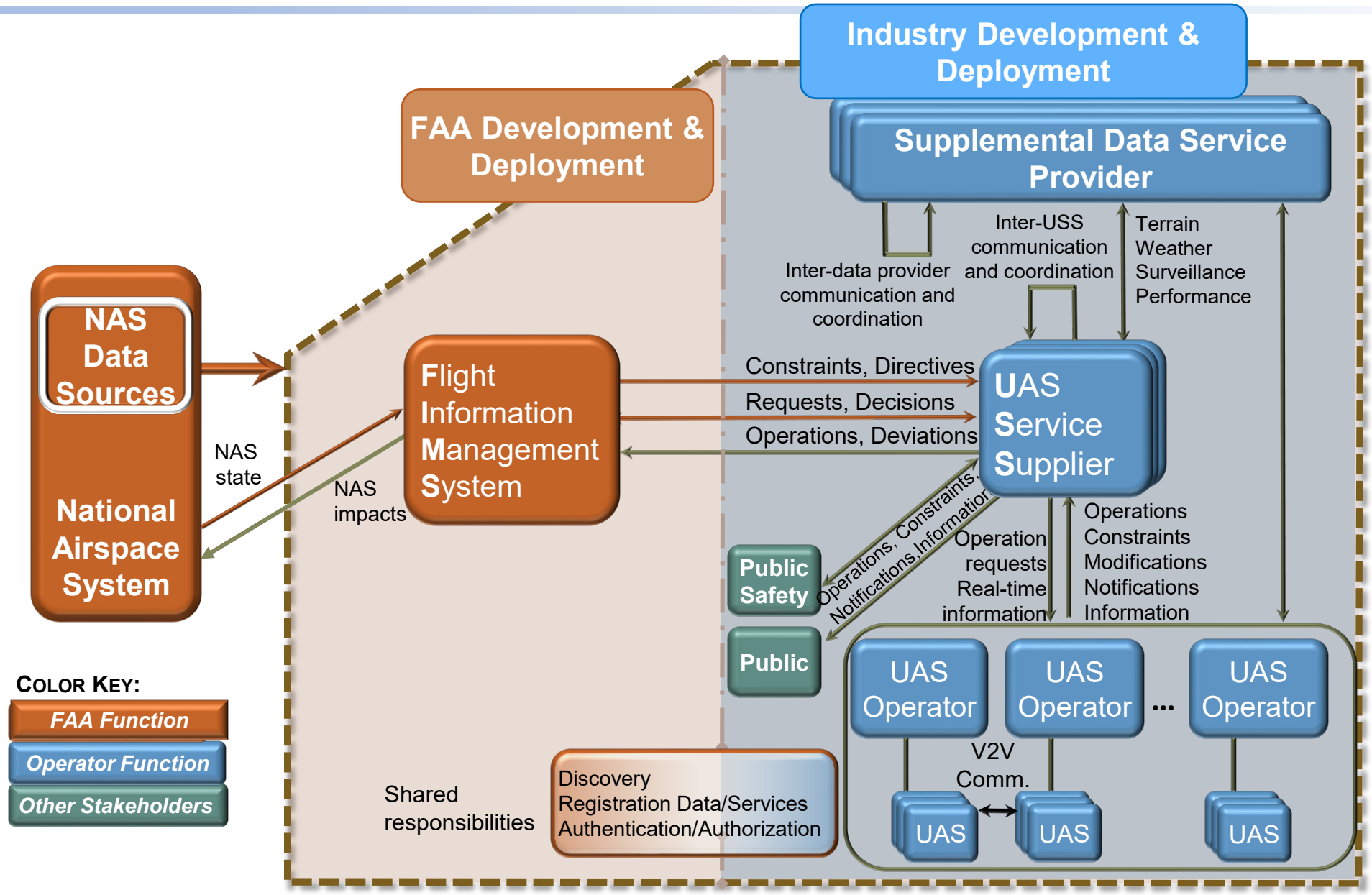
UTM development will ultimately identify services, roles/responsibilities, information architecture, data exchange protocols, software functions, infrastructure, and performance requirements to enable the management of low-altitude UAS operations.



Notional UAM Architecture



UTM Service-Based Architecture



Flight Information Management System

- → Enables airspace controls
- → Facilitates requests
- → Supports response in emergencies impacting NAS

UAS Service Supplier

- → Federated Structure
- → Cloud-based system
- → Automated System
- → Supports UAS with services (e.g. separation, weather, flight planning, contingency management, etc.)

Supplemental Data Service Provider

- → Supplies supplemental data to USS and UAS Operator to support operations

UAS / UAS Operator

- → Individual Operator
- → Fleet Management
- → On-board capabilities to support safe operations

Community Integration

Community Integration

- Societal integration and acceptance of AAM Operations

AAM-related Social Concerns

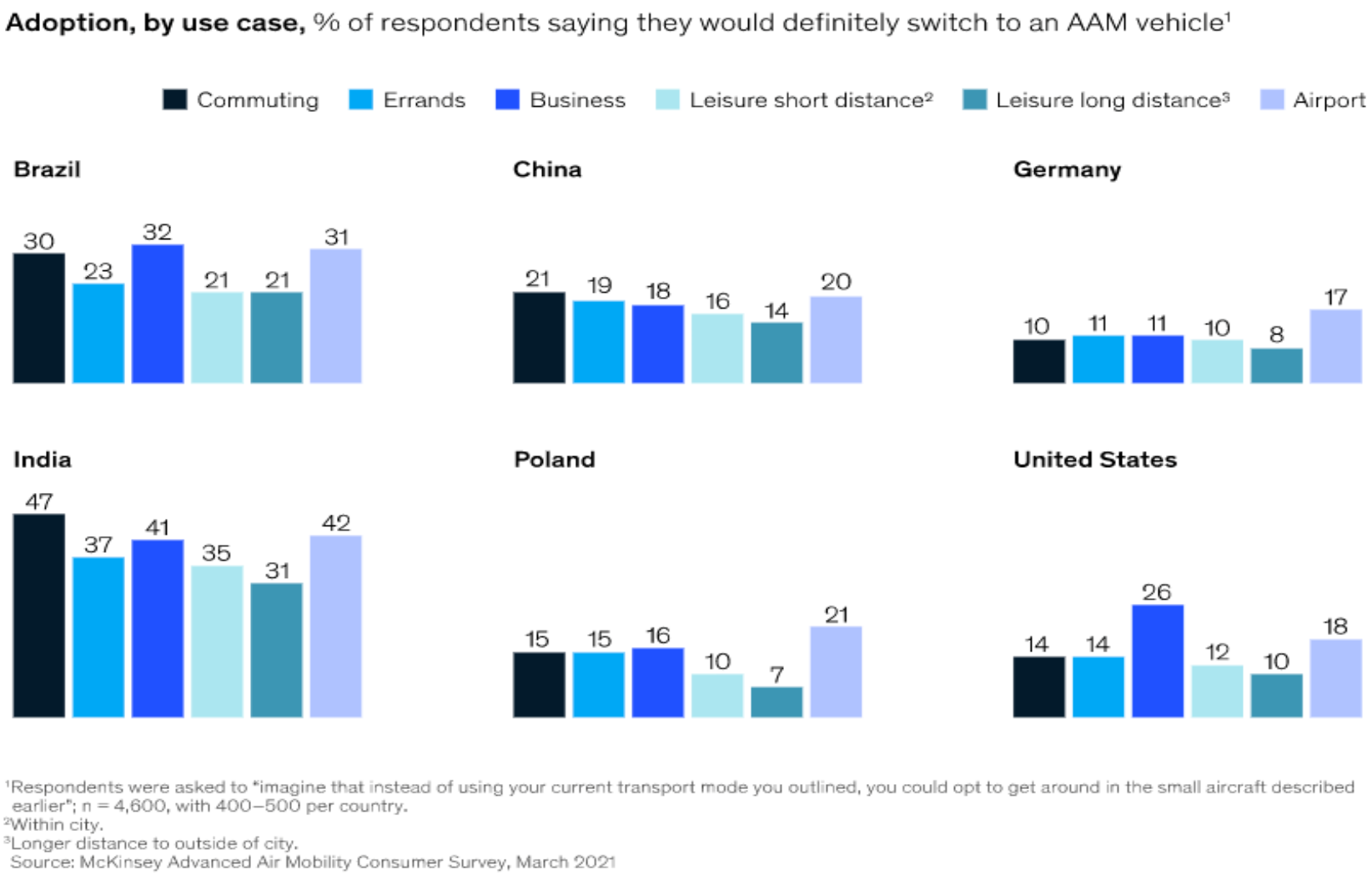
- Affordability
- Noise
- Privacy
- Legality

Urban Environment

- Off-airport takeoffs and landings will likely occur in confined, intra-city helipad/vertiport locations and on top of high-rise buildings
- Performing emergency procedures in these environments is a high-risk operation
- Pilots will need to make judgement calls on the safest alternative course or landing site, considering the busy air space, the battery life, and aircraft limitations
- Must allow for local urban and microclimate weather conditions and communication-blackout zones

From CAE Training White Paper

Willingness to adopt AAM services varies



[1]Respondents were asked to "imagine that instead of using your current transport mode you outlined, you could opt to get around in the small aircraft described earlier"; n = 4,600, with 400–500 per country.
[2]Within city.
[3]Longer distance to outside of city.
Source: McKinsey Advanced Air Mobility Consumer Survey, March 2021

McKinsey & Company

https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/up-in-the-air-how-do-consumers-view-advanced-air-mobility

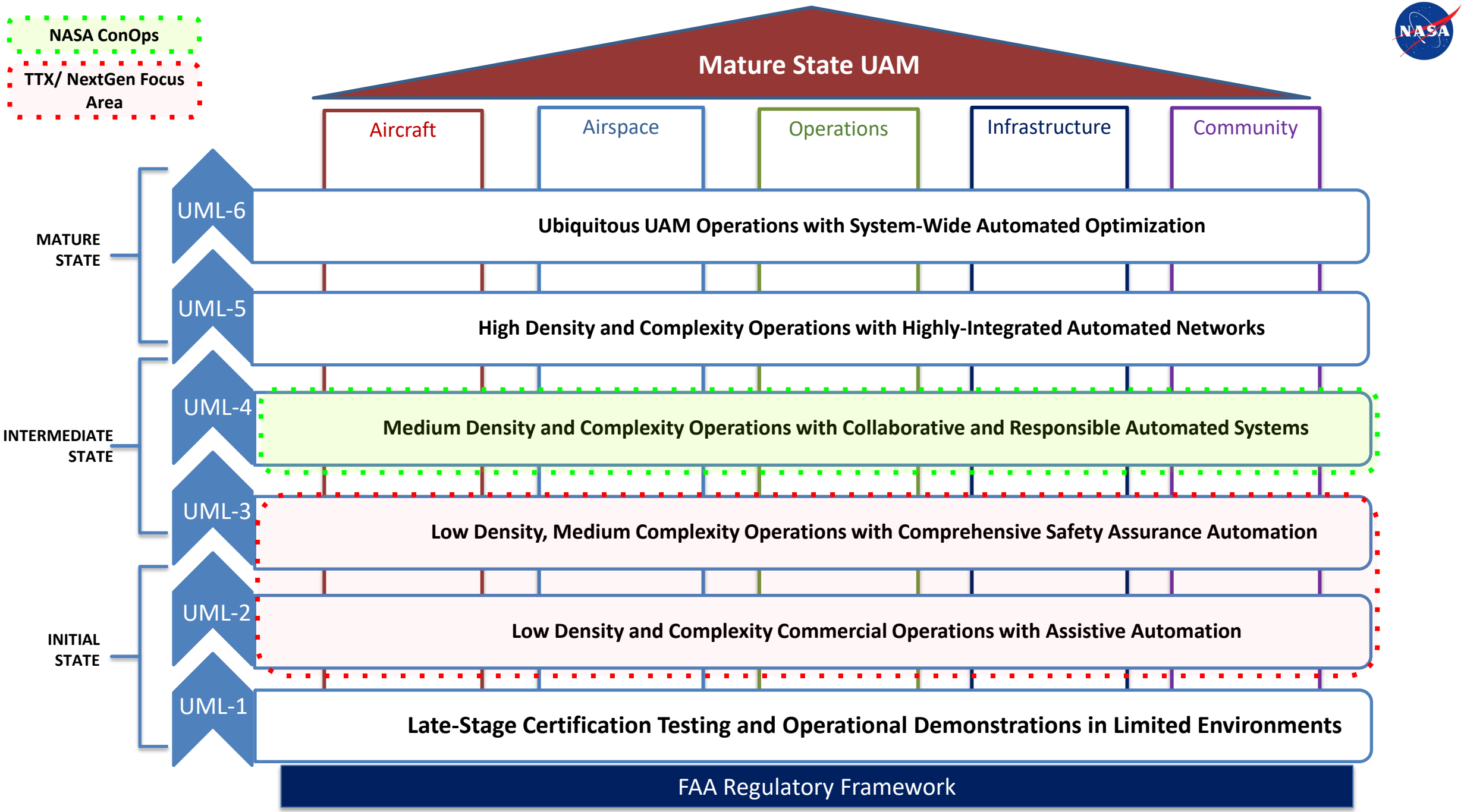
Crosscutting

Key elements that pertain to the entire AAM ecosystem - Aircraft, Airspace, and Community Integration

- Safety
- Security
- Autonomy

NASA's efforts that feed into the AAM Mission's Critical Commitment

- National Campaign
- Urban Air Mobility (UAM) Vision Concept of Operations (ConOps) Urban Maturity Level (UML) 4
- System & Architecture Requirements (Model-based Systems Engineering (MBSE))


NASA ConOps
TTX/ NextGen Focus Area
Mature State UAM
Aircraft
Airspace
Operations
Infrastructure
Community
MATURE STATE
INTERMEDIATE STATE
INITIAL STATE
UML-6
Ubiquitous UAM Operations with System-Wide Automated Optimization
UML-5
High Density and Complexity Operations with Highly-Integrated Automated Networks
UML-4
Medium Density and Complexity Operations with Collaborative and Responsible Automated Systems
UML-3
Low Density, Medium Complexity Operations with Comprehensive Safety Assurance Automation
UML-2
Low Density and Complexity Commercial Operations with Assistive Automation
UML-1
Late-Stage Certification Testing and Operational Demonstrations in Limited Environments
FAA Regulatory Framework

Innovating in aviation while respecting its safety tradition.

Contact: parimal.h.kopardekar@nasa.gov

AAM Design and Operation: An OEM Perspective

Roger Nicholson, Ph.D
Alaka'i Technologies / Skai

Overview

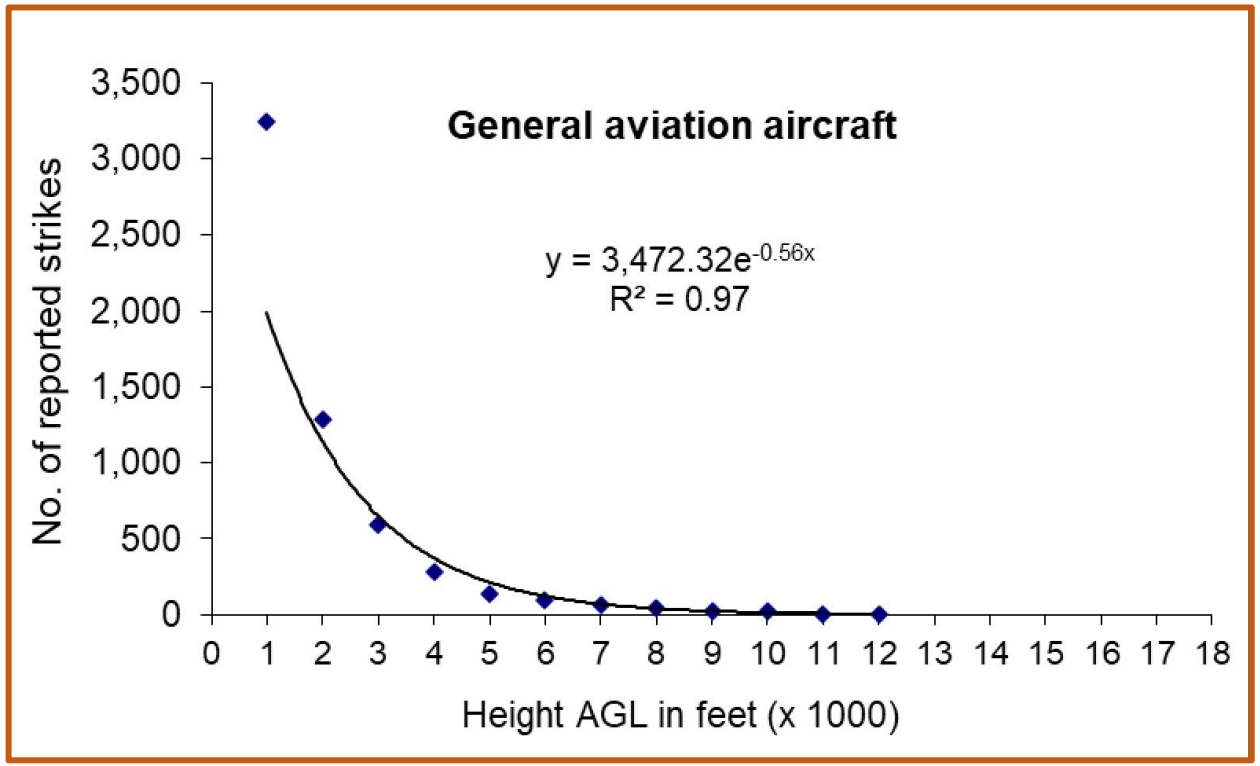
Overview

- What We Know
  - Wildlife Strikes
  - Rotorcraft and Wildlife Strike Events
  - Research and Agency Recommendations
- Application to AAM
- What OEMs can do
  - Design and Operational Considerations
- Conclusions and Recommendations

What we know…

Wildlife Strikes

- Wildlife strikes are increasing
  - Increased aircraft operations
  - Increased populations of large birds
- Strikes occur at low altitudes
  - Near Airports (97% <3,500 feet AGL)
  - 71% <500 feet AGL
  - 87% ,1,500 feet AGL
  - 94%<2,500 feet AGL



Reported Strikes with GA Aircraft by 1,000-foot height intervals.

Source: *Wildlife Strikes to Civil Aircraft in the U.S. 1990-2020*

What we know…Strikes with Rotorcraft

Case Study:

- PHI Sikorsky S-76C++, N748P, Terrebonne Parish, LA, January 4, 2009
  - NTSB report CEN09MA117
  - 850 feet mean sea level, 135 kt indicated airspeed
  - Single red-tailed hawk (2.2 lb) - windshield penetration
  - Sudden dual engine power loss, departure from controlled flight
  - Probable flight crew disorientation
  - Eight of nine occupants fatally injured
  - Aircraft destroyed on impact

What we know…

Case Study:

- USAF Pave Hawk Sikorsky HH-60G (2014) | Cley next the Sea, UK
  - 110 ft AGL, 110 kts IAS
  - Geese weights from 6 to 12 pounds
  - Multiple goose strikes (3 birds) to windshield
  - Both pilots incapacitated (rendered unconscious)
  - Disabled Trim and Flight Path Stabilization systems
  - Aircraft departed controlled flight, crashed 3 seconds after strikes
  - Four crew members perished
  - Aircraft destroyed on ground impact

What we know…Strikes with Rotorcraft

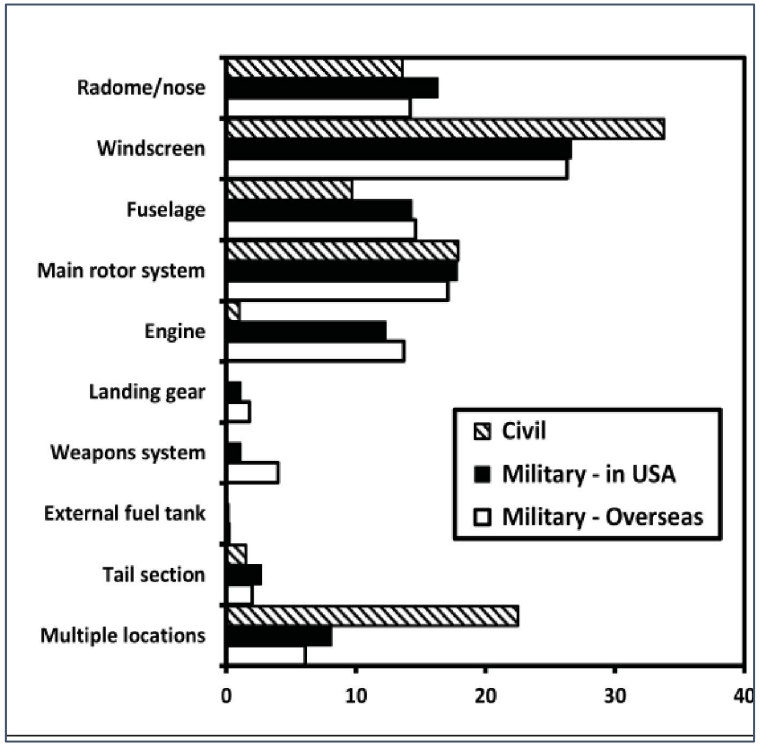
Wildlife Strikes to Rotorcraft

- Strikes have caused injuries and fatalities
- Hazardous species:
  - Raptors (eagles, vultures)
  - Waterfowl (geese)
  - Shorebirds
- Multiple agencies have identified Risks to Rotorcraft (FAA, USDA, NTSB, EASA, AAIB)
- Comparatively little data compared to fixed wing!

What we know…Strikes with Rotorcraft

Impact Locations and Damage to Civil and Military Rotary-wing aircraft from Wildlife Strikes (Washburn, Cisar, and Devault, 2017)

- 35% of reported strikes to civil helicopters resulted in damage (1990-2011)*
- Birds (93%) and mammals only (7% bats)
- Impact Location on civil aircraft:
  - Strikes impacted all parts of aircraft
  - Highest proportion of strikes impacted the windscreen
- Most strikes occurred off the airfield



Proportion of Reported Wildlife Strikes by Impact Location in U.S. for Civil Helicopters (1990-2011)

What we know…Strikes with Rotorcraft

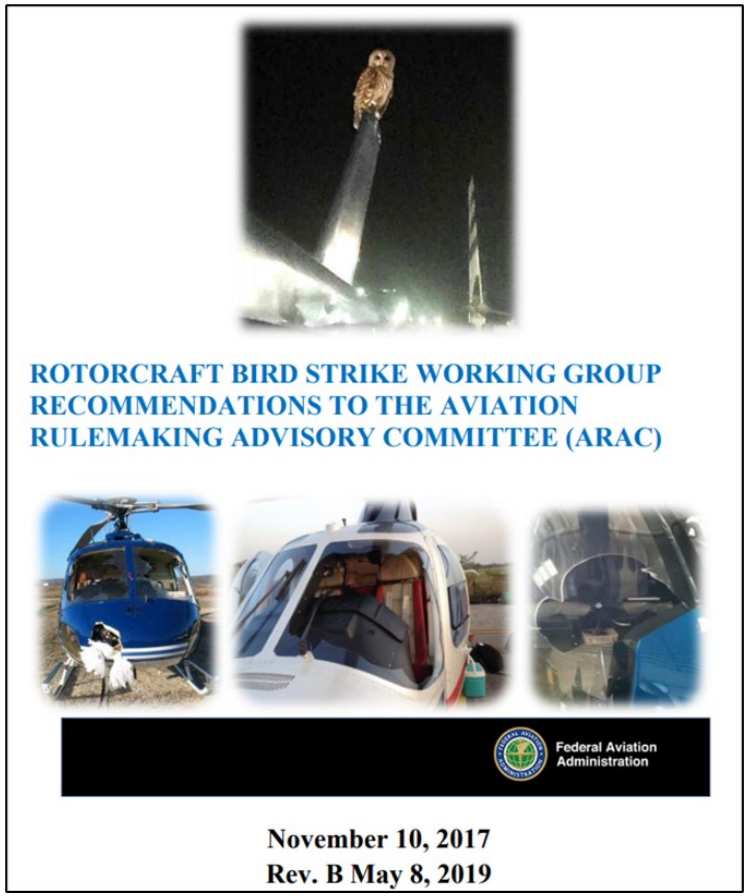
Impact Locations and Damage to Civil and Military Rotary-wing aircraft from Wildlife Strikes (Washburn, Cisar, and Devault, 2017)

- Discussion Recommendations
  - Wildlife strikes with rotorcraft pose a safety concern worldwide
  - Damage to rotary aircraft occurs frequently; the potential for human injuries and fatalities is notable (more frequently than fixed wing)
  - Most strikes occur outside the airport environment
  - Integrated wildlife management programs at airports remain important.
  - Manufacturers/maintenance personnel should consider reinforcing critical areas, such as windscreens and main rotor systems to reduce damage.

Agency Research and Guidance for Rotorcraft Safety

Rotorcraft Bird Strike Working Group (BSWG) Recommendations to the Aviation Rulemaking Advisory Committee (ARAC) – FAA 2019

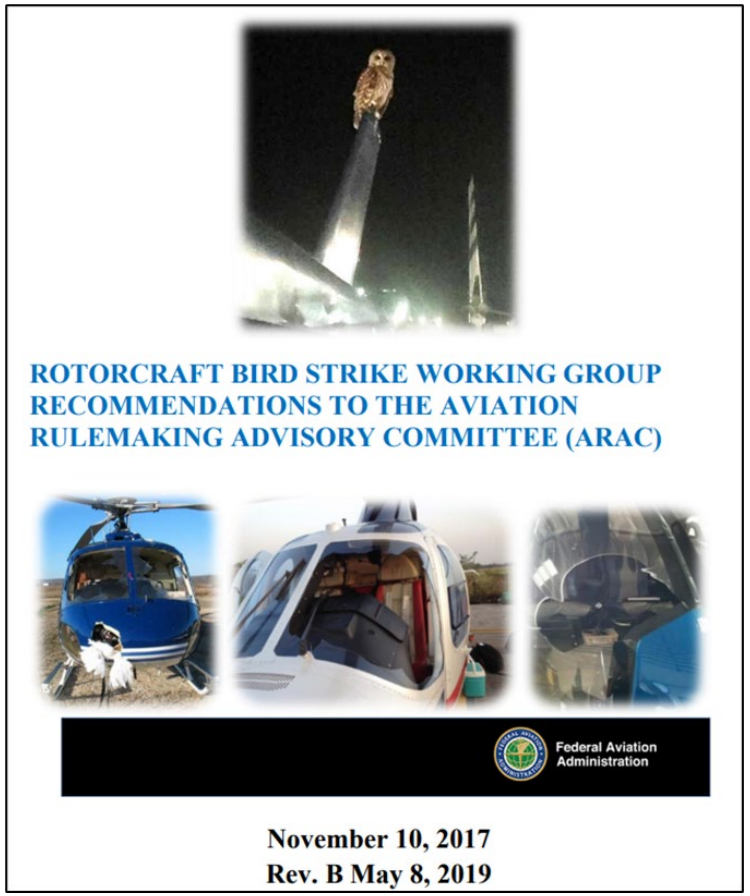
- Bird Strike Safety Procedures
  - Reduce airspeed when practical
  - Increase altitude as quickly and practically as possible
  - Consider Personal Protective Equipment (helmet and visor) use when practical
  - Use taxi and/or landing lights in a continuous mode



Agency Research and Guidance on Rotorcraft Safety

Rotorcraft Bird Strike Working Group (RBSWG) Recommendations to the Aviation Rulemaking Advisory Committee (ARAC) – FAA 2019

- Policy and Guidance
  - Maintain guidance that no windshield penetration is permitted for the required bird regulation
  - Pursue guidance for the temperature range required for windshields undergoing bird strike tests
  - Pursue guidance for induced effects of proximate bird strikes
  - Pursue guidelines on analytical substantiation techniques to show compliance to the bird-strike requirement.



Agency Research and Guidance on Rotorcraft Safety

European Union Aviation Safety Agency (EASA) – Proposed Amendment

- Rotorcraft Occupant Safety in the Event of a Bird Strike 2021
  - Purpose:
    - Pilot and Operator Guidance
  - Recommendations to manage risk:
    - Have design and testing of aircraft driven by certification specifications
    - Apply operational mitigating recommendations
    - To a limited extent, reduce bird populations near operational sites

European Union Aviation Safety Agency

Notice of Proposed Amendment 2021-02

in accordance with
Articles 6(3), 7 and 8 (Standard procedure: public consultation) of MB Decision No 18-2015

Rotorcraft occupant safety in the event of a bird strike

RMT.0726 — SUBTASK 1

EXECUTIVE SUMMARY

The objective of this Notice of Proposed Amendment (NPA) is to improve rotorcraft occupant safety in the event of a bird strike.

This NPA proposes to introduce a new risk-based certification specification to prevent windshield penetration on small rotorcraft (CS-27) with higher passenger capacities.

The new proposed CS.27.631 is similar to CS 29.631 on safe landing, but is only applicable to the windshield.

The proposed amendments are expected to increase the safety of rotorcraft operations.

Action area:	Design and production		
Related rules:	CS-27, CS-29		
Affected stakeholders:	Design organisation approval (DOA) holders		
Driver:	Safety	**Rulemaking group:**	No
Impact assessment:	Yes	**Rulemaking Procedure:**	Standard

Other OEM Pilot and Operator Guidance

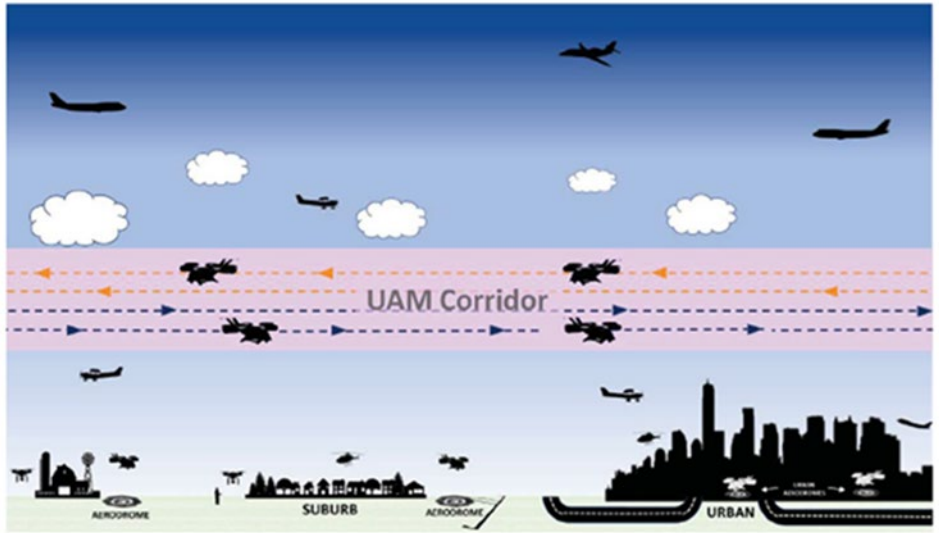
Boeing Aero Magazine 2011

- Strategies for Prevention of Bird-Strike Events
  - Purpose
    - Flight Crew wildlife strike awareness and response
    - “Pilots and operators should be knowledgeable about the hazard, and flight crews should use facts, and standard operating procedures to reduce the potential for and consequences of a bird strike.”
      By: Roger Nicholson and William Reed, Boeing

AAM and Wildlife Management

Emerging AAM Technology and Wildlife Management

- Emerging market - characteristics
  - **Diverse Designs:** At least 18 companies are developing electric vertical takeoff and landing (eVTOL) aircraft
  - **Low-Altitude Flight:** Aircraft will fly at altitudes below 5,000 feet and at top speeds of 200 mph
  - **Point-to-point operations:** not all flights will include airports
  - **Non-traditional flight paths:** urban and remote areas, over water bodies, etc.
  - **Single-Pilot Crews:** AAM will carry passengers and one pilot



Source: NASA

AAM and Wildlife Management

Emerging AAM Technology and Wildlife Management

- Challenges: Aircraft Certification
  - Numerous, non-traditional aircraft manufacturers
  - Certification requirements for AAM are evolving from
    - 14 CFR Part 23 Normal Category Airplanes
    - 14 CFR Part 27 Normal Category Rotorcraft
    - 14 CFR Part 25 Transport Category Airplanes
    - 14 CFR Part 29 Transport Category Rotorcraft
    - Part 27 Safety Continuum, different rotorcraft classes, and movement away from prescriptive regulations to performance-based requirements

Source: NASA

AAM and Wildlife Management

Emerging AAM Technology and Wildlife Management

- Challenges: Flight within the “Strike Zone”
  - Aircraft will fly at altitudes below 5,000 feet
  - Some aircraft will fly in Class E airspace/helicopters (750 feet AGL)
  - Vertiports (not just airports!)
    - Existing heliports
    - Garages
    - Remote areas
    - Areas not previously identified or managed for aviation or wildlife hazards

Source: NASA

AAM and Wildlife Management

OEM and Risk Management Design Measures

- Apply lessons learned from airplane and rotorcraft wildlife strikes by providing:
  - Structure reinforcements - windshield penetrations
  - Structural protection - flight controls, powerplant controls, displays, and critical equipment
  - Bird strike shock pulse effects - on switches, controls, head-up displays, etc.
  - System separation - power, data wiring, control elements
  - Critical System redundancy
  - Aircraft lighting to increase conspicuity

AAM and Wildlife Management

OEM and Risk Management

- Promote Bird Strike Hazard Awareness:
  - Pilot Education and Training
  - Consider PPE for pilots (helmet/visor)
  - Flight Planning and Procedures – consider wildlife hazard management
  - Institute reporting policy for bird strikes and near misses

AAM and Emerging Technologies

The Role of Bird Strike Committee USA

Craig Quick, GE Aviation
Vice Chair, BSC USA

BSC Mission and Objectives

Mission

"BSC USA is dedicated to providing leadership in managing wildlife hazards to aviation."

Five Objectives

- Facilitate the exchange of information regarding the characteristics and management of wildlife hazards and risk to aviation safety
- Promote the collection and analysis of accurate wildlife strike data
- Promote research and development of effective procedures, methods, and technologies for reducing aviation wildlife hazards and risks to aviation safety
- Promote professionalism in wildlife hazard management
- Serve as the national expert body and liaison to the FAA, other bird strike committees, and other organizations involved in aviation wildlife hazards.

BSC Research and Development Committee

Committee Structure

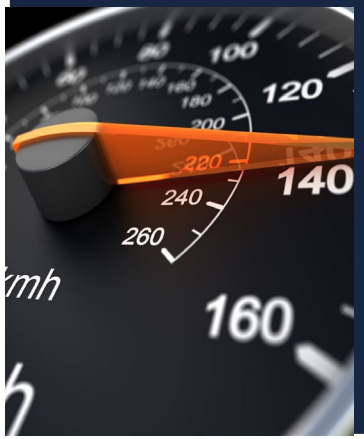
- One of six standing committees
- Chair and minimum of three members

Executive committee

Chair (Nick Atwell)

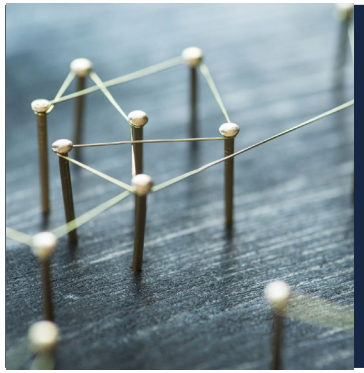
Vice Chair (Craig Quick)

Past Chair (John Weller)



Steering Committee

Aerospace	Airlines
Airports	U.S. Department of Defense (DOD)
FAA	U.S. Department of Agriculture (USDA)
Private Sector	General



Standing Committee

Membership	Annual Conference
Communications	Operations and Policy

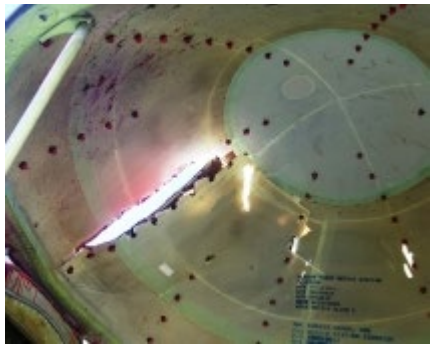
Research and Development

Education and Outreach

BSC Research and Development Committee

Research and Development Committee Charge (BSC Bylaws)

- Identify R & D needs
- Provide existing and new R & D material for BSC website, communications, and publications
- Identify and prioritize BSC USA committee R & D needs
- Work with the BSC Steering Committee to identify funding or entities to further committee R & D projects



BSC Research and Development Committee

Join Us!

Contact: birdstrike.usa@gmail.com

Questions?

Bird Strike Committee USA

Lisa Harmon
Mead & Hunt, Inc.
lisa.harmon@meadhunt.com

Roger Nicholson
Alakai'i | Skai
rnicholson@skai.co

Parimal Kopardekar
NASA Aeronautical Research Institute (NARI)
parimal.h.kopardekar@nasa.gov

Craig Quick
GE Aviation
Birdstrike.usa@gmail.com

Thank You!