



SHAPING  
OUR  
FUTURE  
SKIES

[canso.org](https://canso.org)

CANSO ACADEMY:

# BUILDING AN AI FACTORY APPROACH TO INNOVATE AT SCALE

**Tuesday 19 July 2022**

15:00 – 16:30 CEST



## **Patrick Souchu**

Director of SESAR Programme / Chair of the Strategic Technology Workgroup

DSNA / CANSO

# STRATEGIC TECHNOLOGY WORKGROUP

## Objectives



31 members



26 organizations



3 deliverables

### Deliverable 1

Complete an overview of the current state of technology deployment and issues with implementation planning

### Deliverable 2

Conduct assessment of emerging technologies  
Focus on 7 key technologies

### Deliverable 3

Provide recommendations to ensure a coordinated approach to technology among CAN SO's work groups  
Look for ways to provide Member value in support of technology deployment and implementation planning

## Emerging technologies for future skies

- New technologies and innovation speed in ATM
- A real challenge to know what delivers the most benefit and where your focus should be
- How will they transform ATM business ?
- The CAN SO STWG has launched a series of white papers examining breakthrough technologies and the role they will play in the transformation of our industry.
- Developed through close cooperation with industry experts and innovators



Space-based CNS



Virtualisation



System wide information management (SWIM)



Blockchain



Airborne capabilities



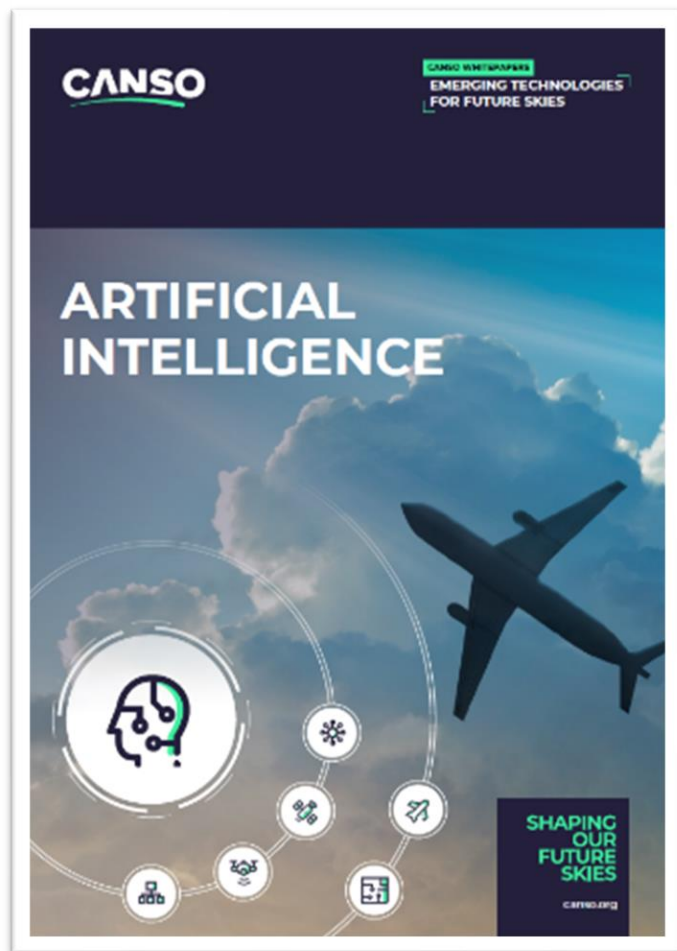
New concepts stemming from UTM



Artificial Intelligence



# OUTLINE OF THE AI WHITE PAPER



## Enablers

Infrastructures for Data

Explainability

Certification

Safety

Human Machine  
Collaboration

## Use Cases

Increasing Safety through AI

Conflict Resolution Advisories

Voice Recognition

Optimal sectorization, Demand  
prediction, Remote Towers, UTM, CDM,  
...

# AGENDA

- **CATS GC vision snapshot by CANSO :**
  - Eduardo Garcia Manager (European ATM Coordination and Safety – CANSO)
- **Presentations and panel discussions:**
  - Moderated by Mr. Raj Pai (NASA Ames Research Center)
  - Mr. Amit Ganjoo
  - Mr. Erick Corona
  - Mr. Alexis Brooker
  - Mr. Frank Zetsche



**Eduardo Garcia**

Manager European ATM Coordination and Safety

CANSO

# A roadmap to future skies

By the Complete Air Traffic System  
(CATS) Global Council



# The Complete Air Traffic System (CATS) Global Council



AIRBUS

ae AirEuropa



CHANG 中国东方航空



FREQUENTIS



Graham Aerospace International



indra



MITRE



NATS



openvia air



skyguide



Think



# The first ever cross-industry vision for our future skies

In October 2021 the Complete Air Traffic System (CATS) Global Council, a forum of industry aviation leaders, launched '[our shared vision for the skies of 2045](#)'



# 2045 Vision Statement

To create global airspace that is safe, fair, intelligent and interoperable, leveraging revolutionised design, technology and services to power sustainable global mobility and prosperity.

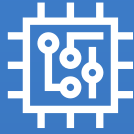


**Our Shared Vision for 2045**

# **2045 Vision Building Blocks**



**Services and Service Delivery**



**Technology and Digitisation**



**Safety and Regulation**



**Environmental Sustainability and Social Impact**



**Airspace Design and Classification**



**Data and Security**



**People, Organisation and Talent**

# CATS GC Vision Roadmap Structure

## VISION STATEMENT

A **future-facing** statement of what success looks like

## BUILDING BLOCKS

Key pillars that **underpin** the vision and will **enable** it to be achieved

## GOALS & MILESTONES

**Targets** linked to each building block and interim steps to get there

## ACTIONS

**Directives and initiatives** to help us reach the goals and overcome the challenges within each Building Block



<b>GOAL 1</b> Improved performance through automation	<b>GOAL 2</b> Harmonised service delivery	<b>GOAL 3</b> Integrated airspace	<b>GOAL 4</b> Harmonised, efficient and flexible systems
<b>GOAL 5</b> Digital Collaboration	<b>GOAL 6</b> Safety and Security by design	<b>GOAL 7</b> Predictive approach to risk management	<b>GOAL 8</b> Strong safety and quality culture
<b>GOAL 9</b> Towards reduced climate impact	<b>GOAL 10</b> Environmental sustainability and social impact management are broadly integrated into the air transport system	<b>GOAL 11</b> Integrated and connected multimodal transportation network and infrastructures	<b>GOAL 12</b> Data-powered ecosystem
<b>GOAL 13</b> Thriving airspace management community	<b>GOAL 14</b> High performing teams		

## LONG TERM GOALS (2045)

2025

2030

2035

## GOAL 1

### Improved performance through automation

Advancements in technology and digitisation have enabled higher levels of automation and fuelled the rise of new and improved user-centric services.

M1 New CONOPS

M4 Conceptual framework for cross border service delivery and management of sovereign airspace

M9 Technology roadmap

M18 Network of sandboxes

M68 New ANS financing mechanisms

M25 Agile regulatory practices

M31 Sustainable integration of new technologies

M34 Electric UAS and eVTOLS reduce emissions in urban areas

M72 Disruption management

M17 Autonomous and decentralised operation

M50 Digitally connected aviation

## GOAL DESCRIPTION



**THANK YOU**



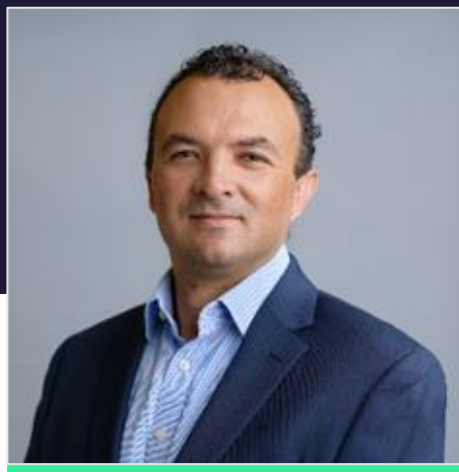
**Raj Pai**

Senior (Chief) Technologist, Aviation Systems Division  
NASA



**Amit Ganjoo**

Founder and CEO  
ANRA Technologies



**Erick Corona**

Director of Product  
Management and  
Unmanned Air System  
Operations  
Wisk Aero LLC



**Alexis Brooker**

VP of R&D  
Cirium



**Frank Zetsche**

Head of Simulation &  
Research  
Deutsche Flugsicherung  
GmbH



## **Amit Ganjoo**

Founder and CEO  
ANRA Technologies

# **Building an AI Factory Approach to Innovate at Scale**

*Amit Ganjoo, CEO*



VPA 1  
SLA 798  
13:25  
STATUS  
OPERATION SUBMITTED  
LISTENING.....

ANRA  
OPERATION  
SUBMITTED

**Airspace Management leveraging AI/ML for Uncrewed Traffic**



## Company Overview

We are a Technology company providing software solutions that enable complex operations for autonomous aircraft



Modular services evolve with standards and regulatory environment



Multimodal and Mission Management solutions with value-added services



Engaged with aviation authorities and regulators around the world



Aviation, communications and robotics experience



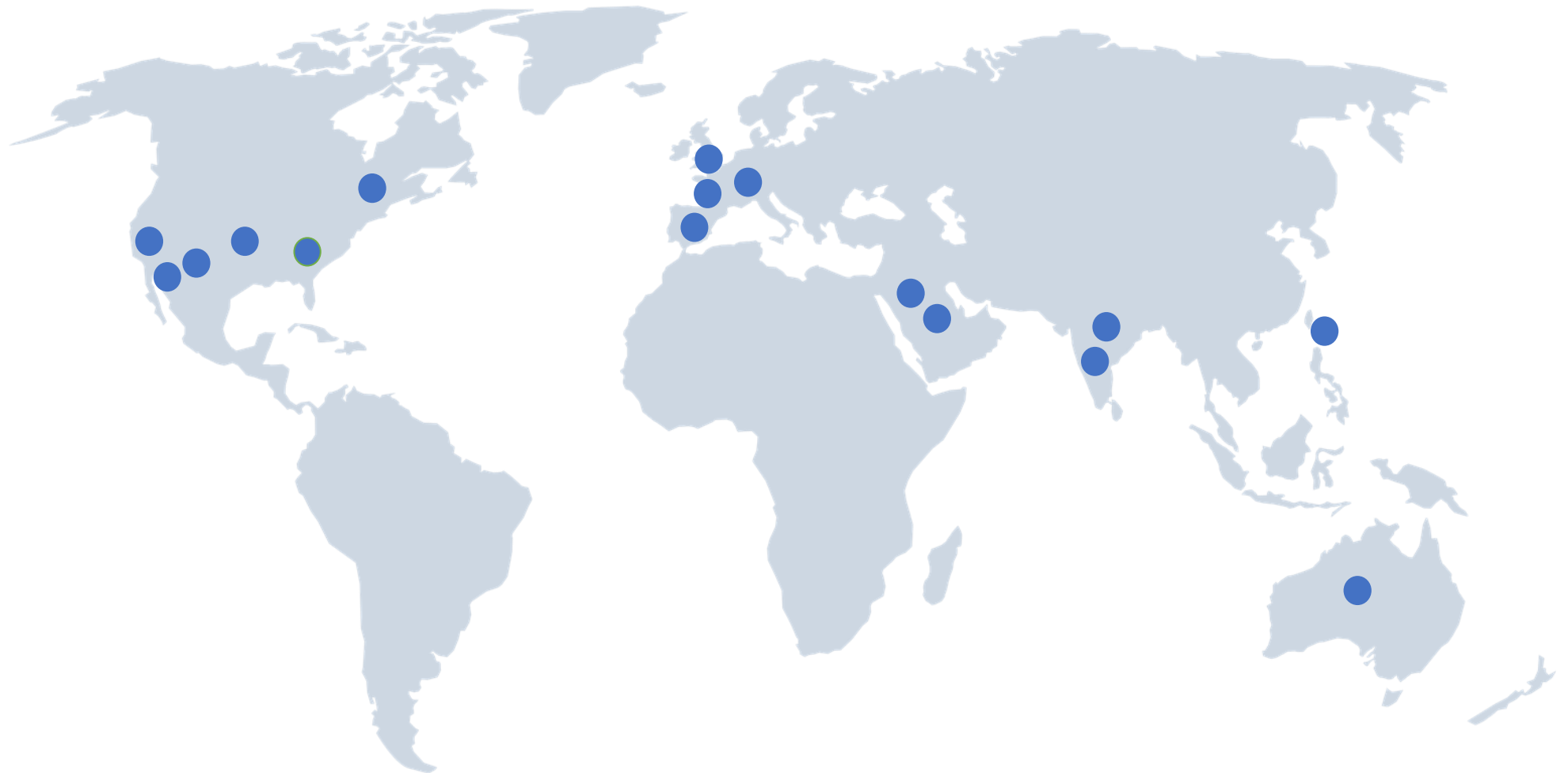
Collaborative Research with NASA, EASA-SESAR, UK-CPC, UK-DASA, EU Space Agency



ISO 27001 Certified for Information Security Management Systems



# ANRA Technologies Global Footprint



www.anratechnologies.com



# Machine Learning And Airspace Management



# Machine Learning And Airspace Management

## Operational Planning

- Dynamic trajectory planning in new situations
- Lack of prior information of paths, needed to classify
- Adjustment of paths as a function of UAV states
- Flight optimization on the fly

## Fault Detection and Recovery

- Failure detection (UAV, comm. network, ground users)
- Failure assessment and impacts classifications
- Failure recovery

## Situational Awareness

- Weather condition awareness and prediction
- Terrain awareness and assessment of communications and safety implications
- Obstacle awareness

## Traffic Flow Management

- Optimization of Traffic flow management
- Advanced dynamic rerouting,





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**Erick Corona**

Director of Product Management and Unmanned Air System Operations

Wisk Aero LLC

*wisk*

# Advanced Air Mobility in the Current Airspace and Beyond

Erick Corona - Director Product Management  
CANSO Academy: Building an AI Factory Approach to Innovate at Scale  
July 2022

INDUSTRY-LEADING PARTNERSHIPS

# Stronger Together

30 years of  
autonomous  
experience

Breadth & depth of  
technical leadership

Joint regulatory  
engagement

Dozens of  
aircraft FAA  
type certified

Access to  
ecosystem and  
technology  
investments

Global aerospace  
reach & scale

Stakeholder  
relationships

The Wisk logo is a stylized, lowercase, yellow script font with a thick, sweeping underline that extends to the right.

AIR NEW ZEALAND



BLADE

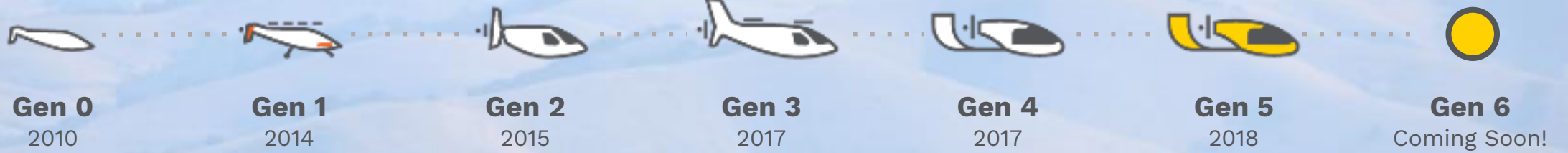


AVIAL

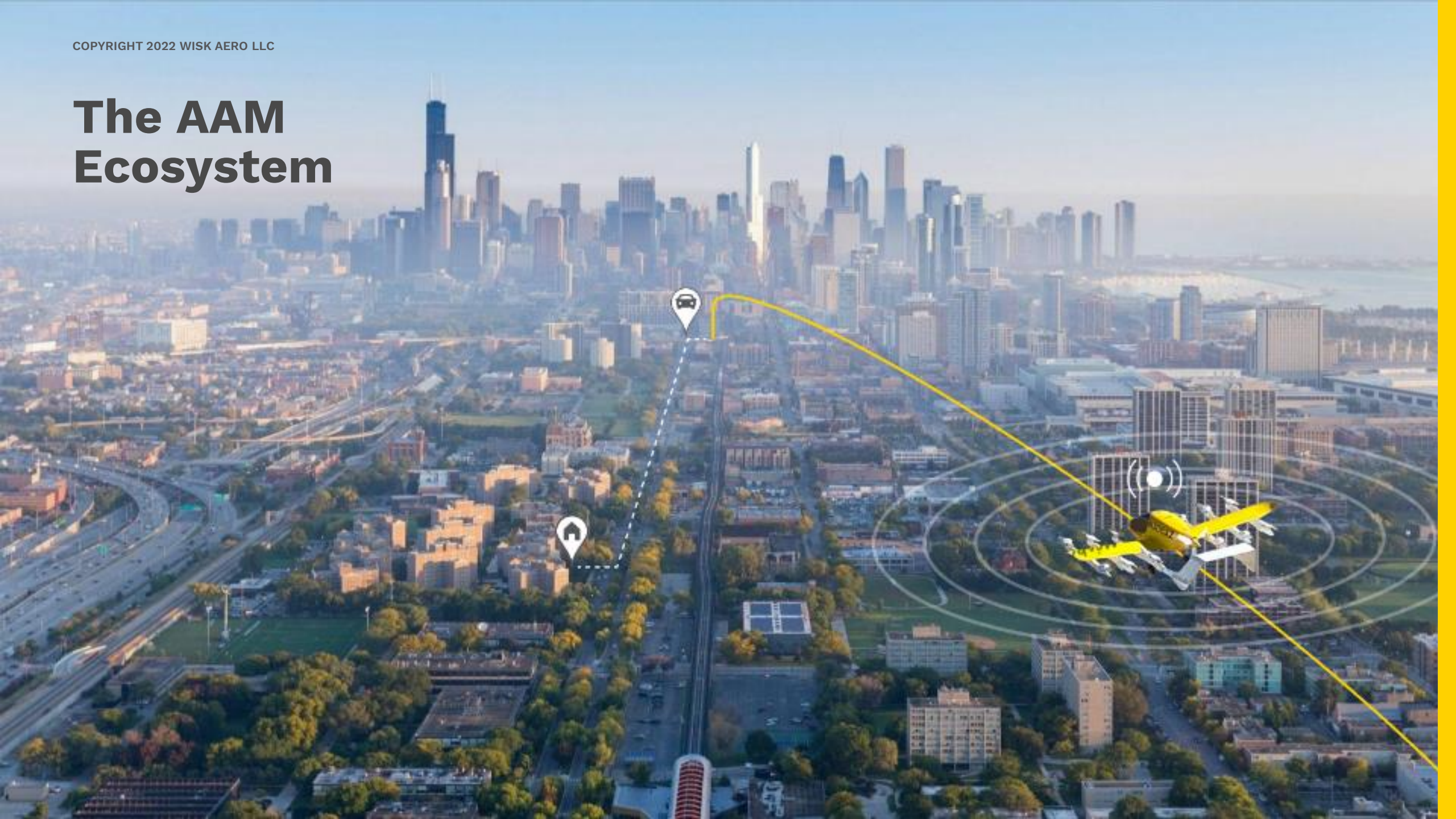
A BOEING COMPANY



# 10+ Years of Flight



# The AAM Ecosystem



# Why Now?

Convergence of Technology, Infrastructure, and Regulations are ready to deliver a new means of transportation.



Advanced Sensing &  
Automation



Electrification & Battery  
Technology



C2 Links & Data Infrastructure



Regulations/Standards

# Why Autonomous Self-flying?

## Safety

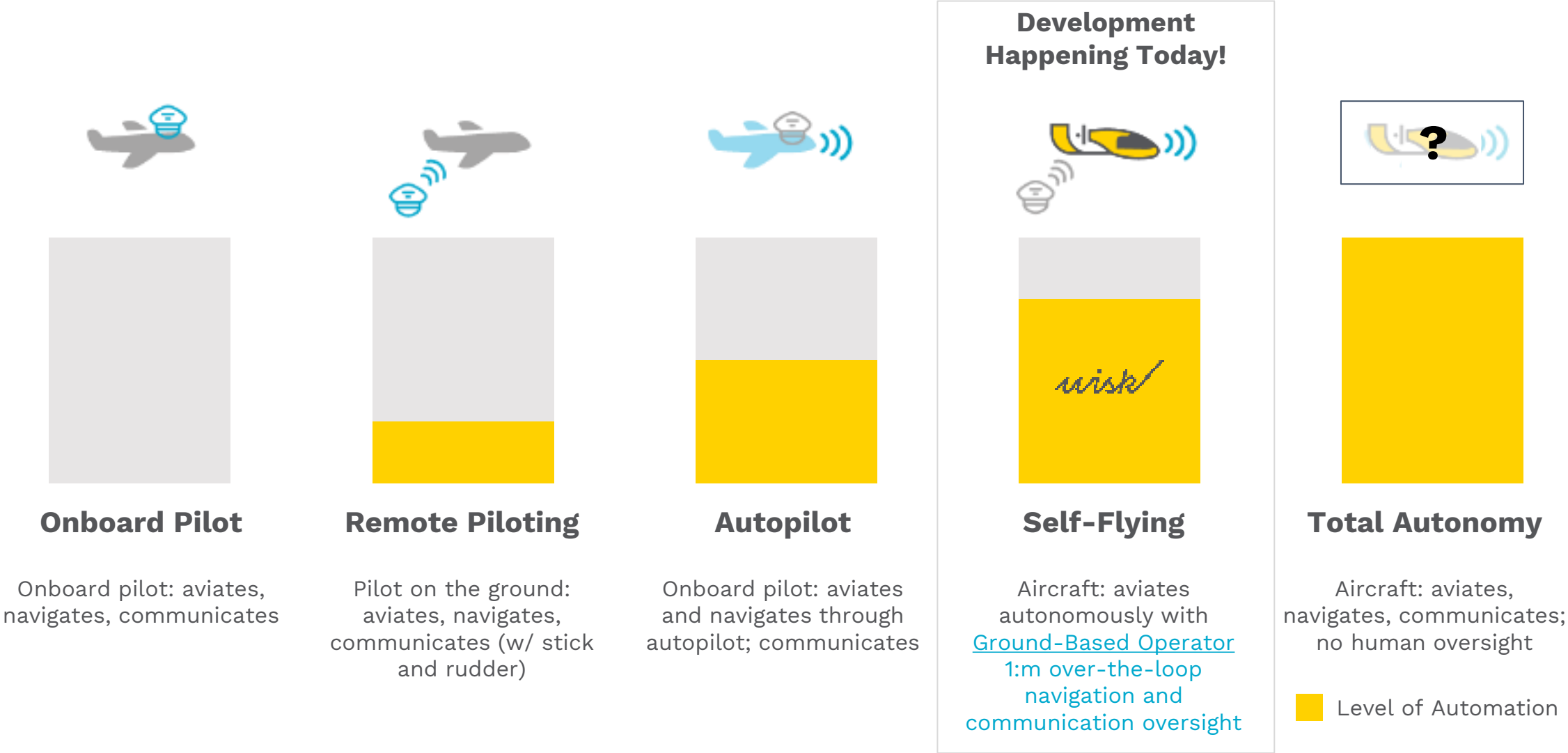
- Fully validated **Flight Control** technology provides full *stick & rudder* autonomy
- **Distributed Electric Propulsion** and state-of-the-art **Avionics** delivers the highest levels of safety
- Widespread **Information & Sensor Integration** offers unparalleled situational awareness

## Scalability

- Addresses envisioned AAM and aviation-wide **pilot shortage**
- Reduces at-scale **operating costs**



# What Do We Mean by Autonomous Self-Flying?



# AAM Operating Environment Actors

## Wisk Elements

Gen 6 Aircraft

Gen 6 Fleet Operations Center

Fleet Operations Manager

Multi-Vehicle Supervisor (MVS)

## Ecosystem

Airspace Classification and Rules

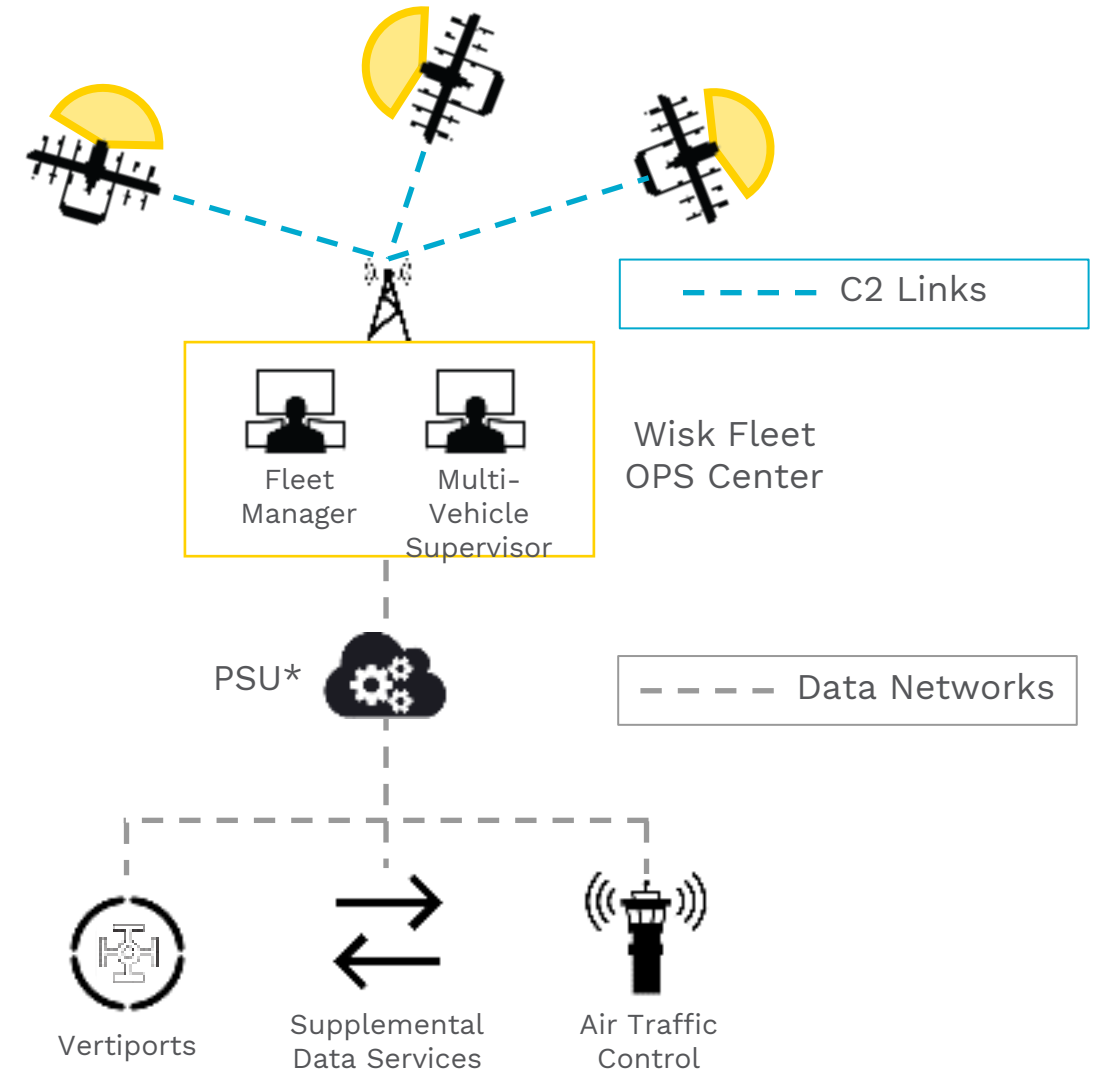
Air Navigation Service Provider (ANSP)

C2 Data Links and Comms Networks

Vertiport Surface/Airspace Mgt. Systems

Provider of Services for UAM (PSU)\*

Supplemental Data Services



*\*In the EU these services will be provided by U-Space Service Providers (USSPs)*

# UAS will Leverage AI/ML in Detect-and-Avoid (DAA) and Landing-Hazard-Avoidance (LHA) Systems

- High precision/recall interpretable AI/ML image recognition methods (e.g., Neural Networks) will support DAA/LHA systems
- Systems will leverage processed imagery alongside deterministic signals/systems (e.g., radar) as means of enhancing system performance
- Industry solutions will closely align with regulatory and industry efforts as those captured by EASA's CoDANN IPC Report (2020)



Detect-and Avoid (DAA) and  
Landing Hazard Avoidance (LHA)

# How May UAS Operations Further Leverage AI/ML?

- Highly interpretable AI/ML systems will support flight-planning (strategic deconfliction) - algorithms will include both airspace and vertiport resources
- Higher density UML/U-SPACE operations will leverage AI/ML recommendation engines to optimize flow management, provide separation services, and handle contingencies

FAA Charting Aviation's Future - Operations in an Info-Centric NAS (June 2022) on the Future on of Air Traffic Management:

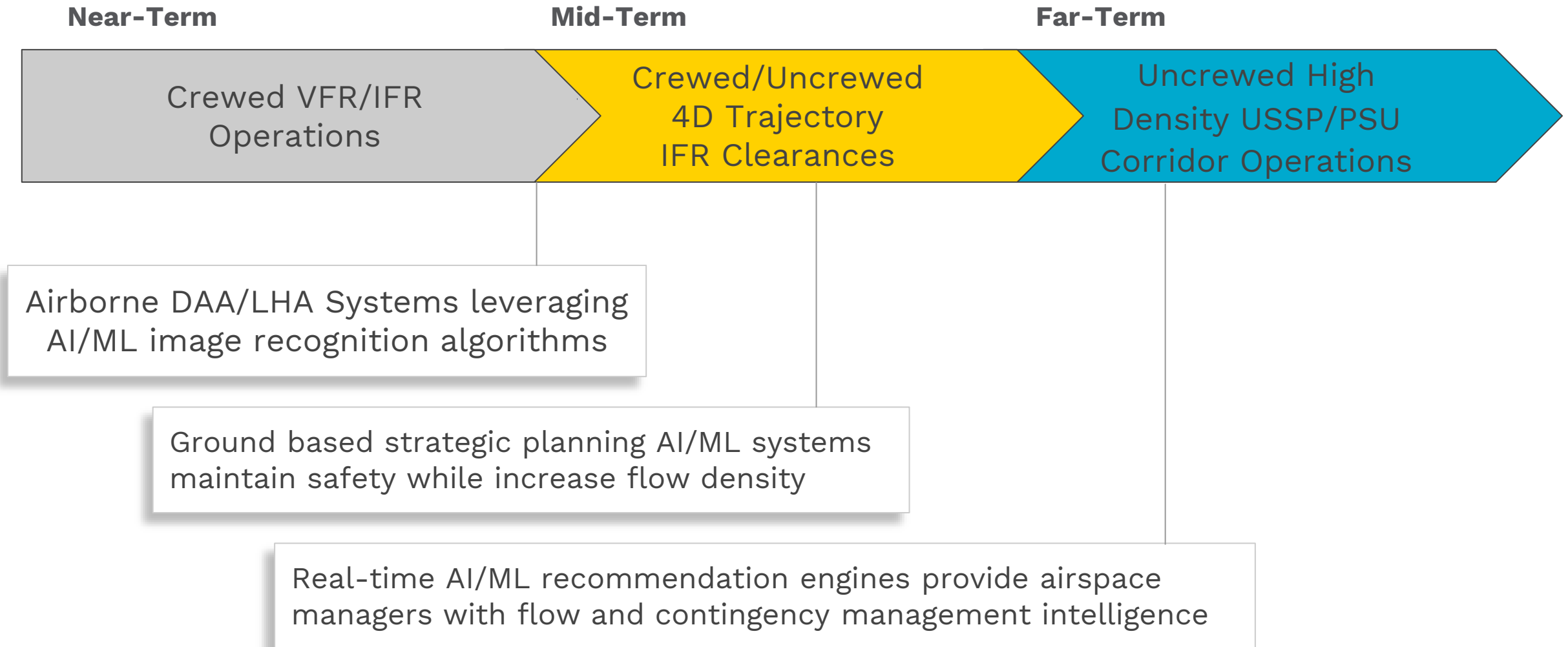
*"In such an environment, humans guide the objectives, while automation processes information and makes recommendations to assist in reaching solutions best meeting the objectives."*



## PSUs/USSPs

extend Airspace Operating Picture  
to AAM participants

# Advanced Air Mobility and AI/ML Support Systems







**Alexis Brooker**

VP of R&D

Cirium



# AI/ML Challenges to Innovation at Scale in Aviation

NASA CANSO Webinar

19<sup>th</sup> July 2022

# Cirium brings together powerful data and advanced analytics, it's in our DNA



Cirium is part of RELX, a global provider of information-based analytics and decision tools for professional and business customers. The shares of RELX PLC, are traded on the London Amsterdam and New York Stock Exchanges.

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Over **30,000 employees**

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Serving customers in over **180 countries** worldwide

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Market capitalization of **£52bn**



Cirium brings together **powerful data and analytics** to keep the world in motion

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Over **400** technologists, analysts, data scientists and market experts

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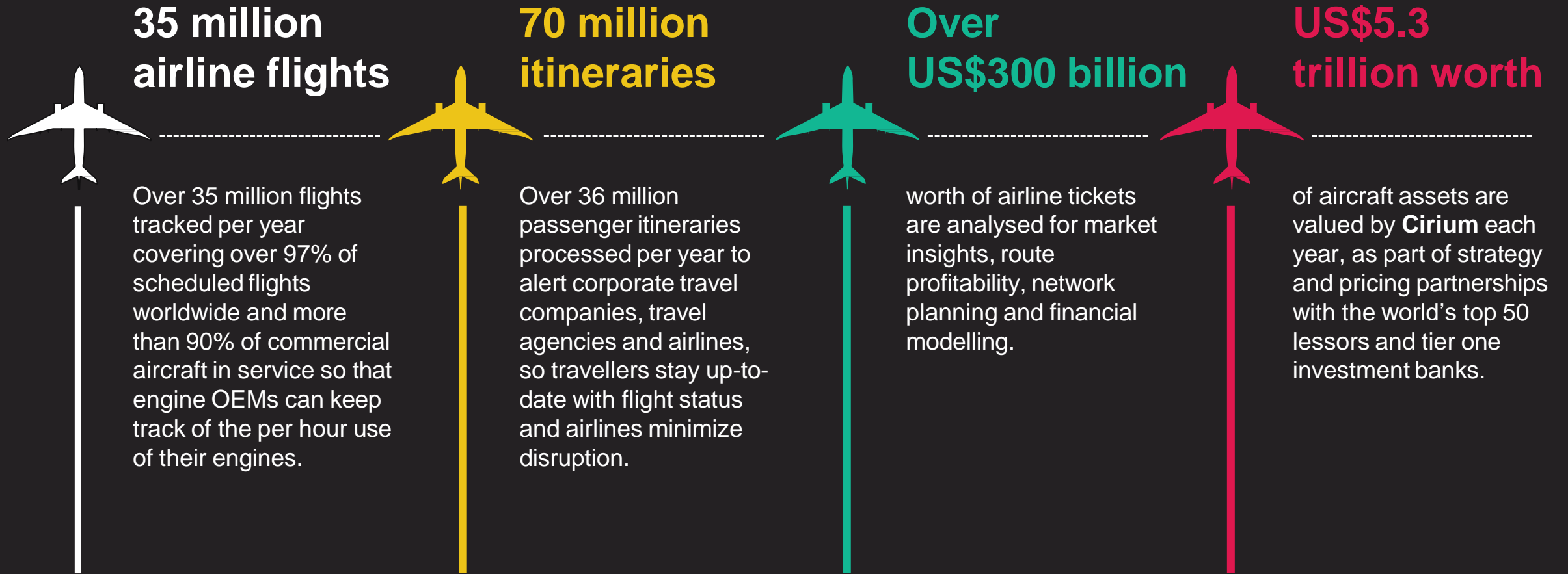
Offices worldwide in **UK, USA and Asia-Pacific**

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Our legal entity is **LNRS Data Services** (holding company)

Cirium is part RELX's Lexis Nexis Risk Solutions Group.

# Using our smart data and advanced analytics to improve the way we travel



# 5 Challenges to AI Innovation at Scale in Aviation



01

## ISSUES

- Humans trying to imagine every possibility in the environment
- Shutdown button problem – at scale does the AI know better than human?
- Unanticipated outcomes related to rewards & risk

## MITIGATIONS

1. Cooperative inverse Reinforcement Learning (watch the expert)
2. Rich(er) environments...

Environment



02

## ISSUES

- Unexpected but formally correct solutions
- Feedback loops and false optimisation
- Metrics, targets, adversarial rewards

## MITIGATIONS

1. Human labelling of rewards and a reward adversary agent
2. Multiple agents checking each other dynamically
3. Careful engineering / caps



03

## ISSUES

- Explainable results -> trust
- Cannot simply refer every decision to human review
- Complex environments will create unforeseen data and scenarios

## MITIGATIONS

1. Supervised reward learning – watch the expert
2. Real world physics, weather, domain expertise as constraints
3. Unsupervised model learning, with data uncertainty budgets

Human In The Loop



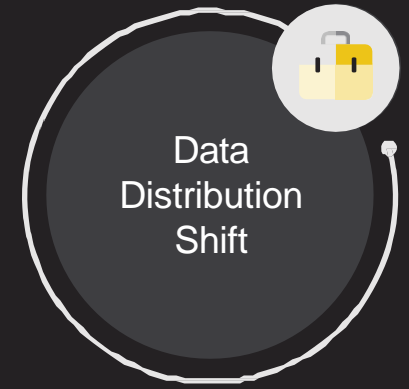
04

## ISSUES

- Must allow exploration to find positive irreversible scenarios
- Not possible to explore full problem space and all failure modes
- Risk models and uncertainty has not been researched in great depth

## MITIGATIONS

1. Simulate, digital twin, common models
2. Safety II, Supervision/Trust
3. Separate reward & risk expression functions (costs)



05

## ISSUES

- Test data can never\* match all real world possibilities
- Systemic drift in real world data with feedback loops
- False confidence in results presented by the AI

## MITIGATIONS

1. Data and Model Uncertainty research
2. Off nominal scenarios, data standards, imagenet, AI SafetyGym

Data

# THANK YOU

[Alex.Brooker@cirium.com](mailto:Alex.Brooker@cirium.com)



**Frank Zetsche**

Head of Simulation & Research  
Deutsche Flugsicherung GmbH

# Potential AI Solutions for Air Traffic Services

Frank Zetsche

Head of Simulation and Research

DFS, German Air Navigation Services

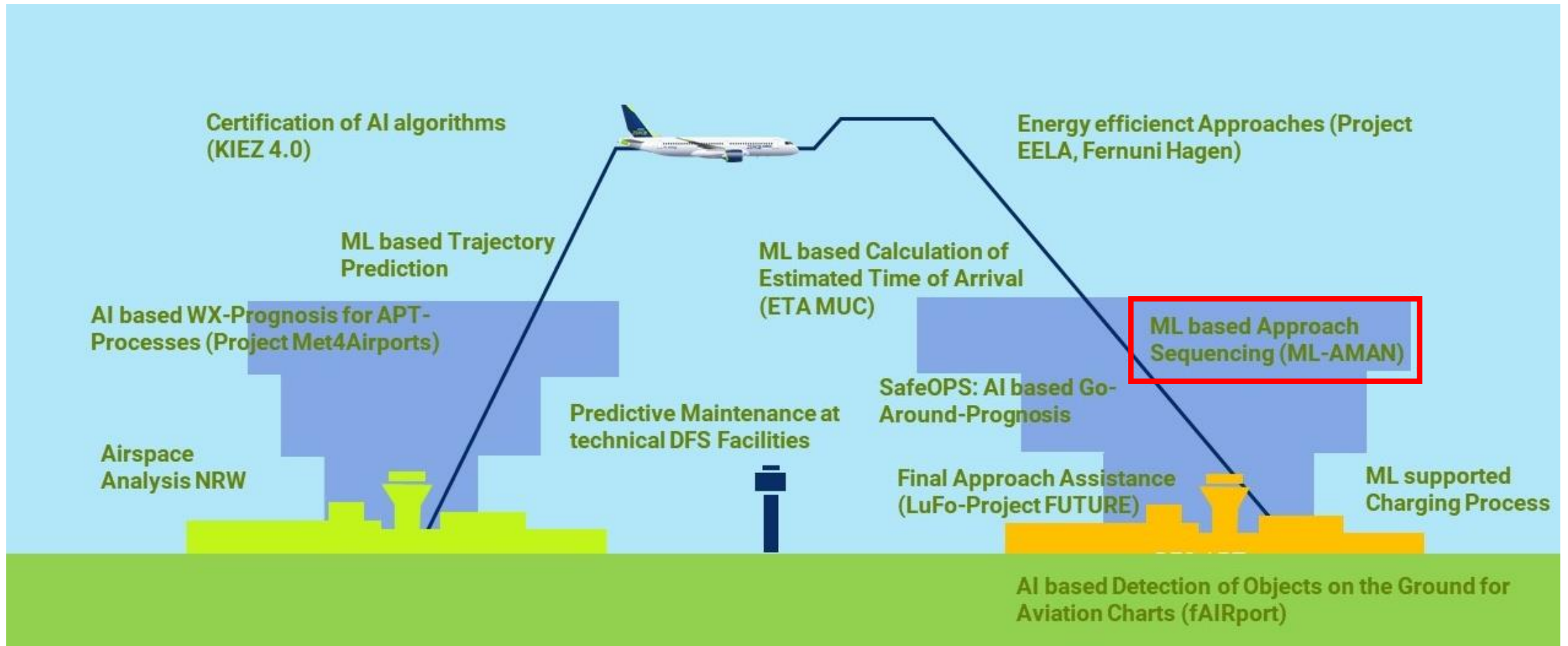
CANSO-NASA Seminar on AI

19.07.2022



**DFS** Deutsche Flugsicherung

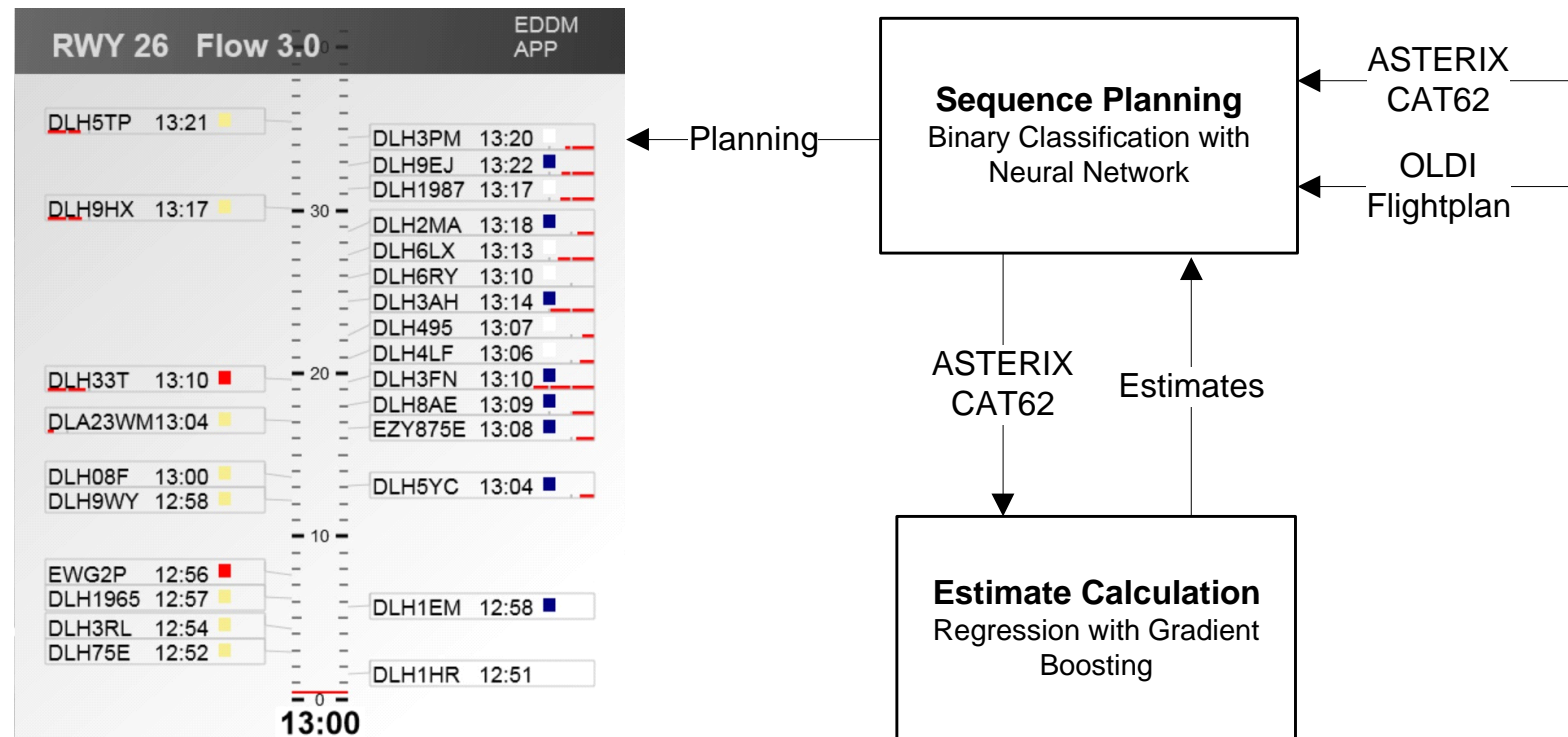
# Overview of AI Solutions für Air Traffic Services



# Example: ML Arrival Manager (ML-AMAN)

The Arrival Manager assists the Air Traffic Controller in arrival planning und execution. The AMAN main functions are realized with machine learning (ML) methods.

- Sequence calculation: Binary classification with a neural network
- Estimate calculation: Regression with a gradient boosting method



# Example: Key Findings for ML-AMAN

Compared to a conventionally rule-based developed AMAN System, the following benefits can be shown:

- Arrival planning quality equivalent or better
- Quality of arrival planning can be assessed with historical data → no or only little real time simulations with air traffic controllers are necessary
- No more ATC knowledge is needed for programming the AMAN → the knowledge is contained in the (test) data itself
- Amount of source code strongly reduced (less than 10 %)
- Adaptation to another airport within one day only by training new models → about 1 month of training data needed
- Simulation runs with Air Traffic controllers show good acceptance

# Benefits and Challenges for AI Applications for ATS

## Strategic Fit:

- AI Applications are on the strategic roadmap for many Air Navigation Service Providers

## Main Benefits:

- Developing new ATS applications and unlocking unexplored potentials (new data, e.g. voice)
- Improving existing ATS applications
- Reducing development efforts and costs for ATS applications

## Main Challenges:

- Data availability / accessibility
- AI/Data factory for continuous development/improvement
- AI acceptance and certification (Role of XAI?)
- Integration and deployment in ATS-System (Service-oriented framework)

# AI@DFS

# Tracking

## Sector limits

# Transfer Flight Levels

# Conflict Detection

# Route Networks

# Thank You!

Contact: [frank.zetsche@dfs.de](mailto:frank.zetsche@dfs.de)



**DFS Deutsche Flugsicherung**



# PANEL DISCUSSION



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**Raj Pai**

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# THANK YOU

