# Digital Flight

**A New Cooperative Operating Mode to Complement VFR and IFR**

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EAA AirVenture 2022

# 20th Century Evolution of Operations

**Origins of Visual Flight Rules (VFR)**

See and Avoid

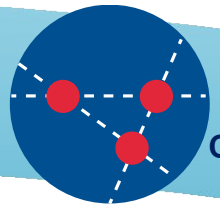
**Visual Separation**

Flexibility ✓
Access ✗

Radio Navigation

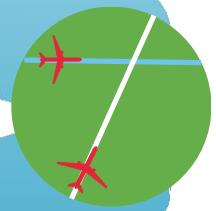
**Origins of Instrument Flight Rules (IFR)**

"Airways"



Increased Collision Risk

Flexibility ✗
Access ✓



"Airway" Traffic Control (ATC)

**Procedural Separation**

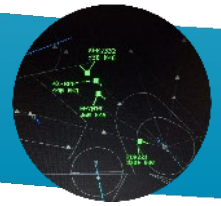
Voice Communications

Radar Surveillance

**Radar Separation**

Global Precision Navigation

Advanced Avionics



Traffic Management Automation

Data Communications

**Initial Trajectory-Based Operations**

Capacity ↑
Flexibility ✗
Access ✓

**CAUTION!**
**The Future of Aviation Mobility is:**

Capacity ✓
Flexibility ✓
Access ✓

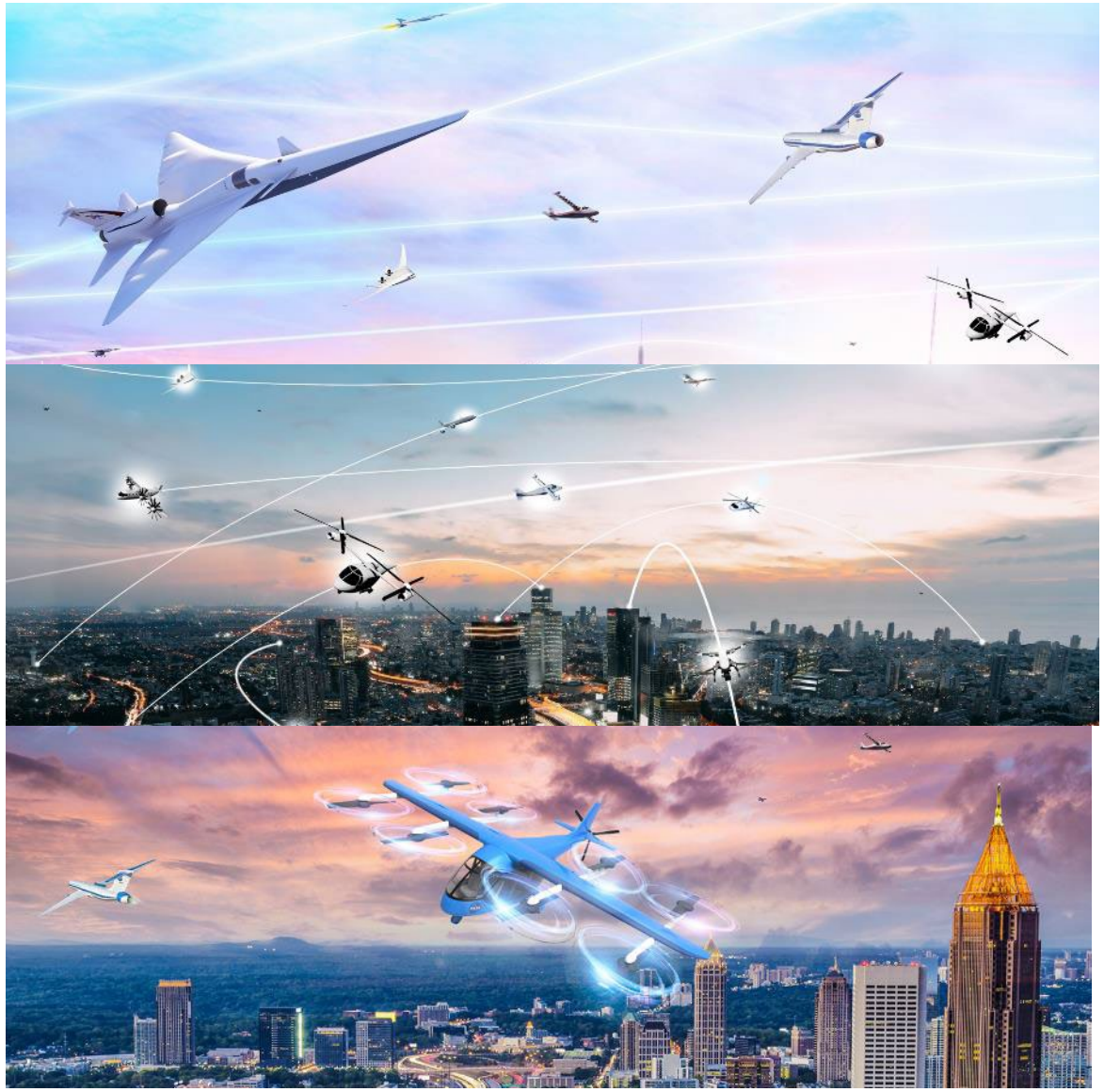
# Limitations of Current Operating Modes

VFR and IFR:

- Not adaptable to greater flight diversity
- Not scalable to high tempos & density
- Not suited to self-piloted aircraft
- Not ensuring operational predictability
- Not conducive to regional growth

***"New and adapted flight rules and procedures*** *will be required to efficiently manage these increasingly dynamic operations of differing priority and types."*

**Airbus and Boeing, 2020**



# Introducing “Digital Flight”

## Digital Flight (DF):

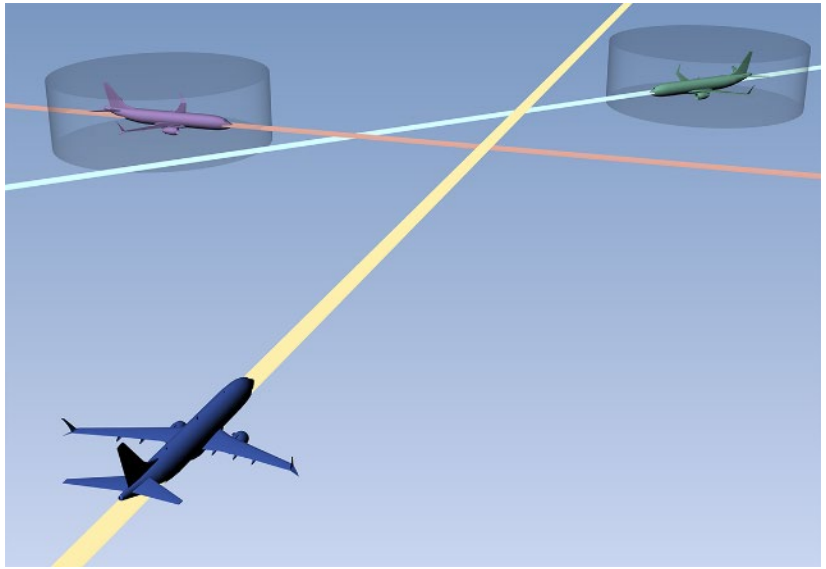
**A proposed cooperative operating mode**

in which the operator ensures flight-path safety

by applying cooperative practices and automated separation

enabled by connected digital technologies and information

in lieu of VFR’s visual procedures and IFR’s ATC separation services



## Digital Flight Rules (DFR):

**Regulations governing sustained Digital Flight operations**

authorizing airspace access and operational flexibility in all airspace classes and visibility conditions

# Problem: Patchwork of Emerging Operating Modes and Underlying Rules

**Approach**: Common New Operating Mode

**Harmonization through Digital Flight**
- **Common operating mode**
- **Serving unique market needs**

**UTM w/ DFR**
Small UAS
"Beyond visual line of sight"

**VFR + IFR + DFR**
General Aviation
"Simplified Vehicle Operations"

**VFR + IFR + DFR**
Emergency Air Svcs
"All Weather Safe Response"

**ETM w/ DFR**
High Altitude Ops
"Cooperative separation"

**VFR + IFR + DFR**
Regional Air Mobility
"Community-friendly regional travel"

**UML 4+ w/ DFR**
Urban Air Mobility
"Dense / complex urban ops"

**IFR + DFR**
Larger UAS
"Seamless integration in the NAS"

**IFR + DFR**
Airline / Bus. Aviation
"Reduced operating costs"

**Digital Flight Rules (DFR) & Digital Information Ecosystem**

**Transformation Accumulation**
Evolution of proven capability
Maturity to serve needs & risk targets


**Sky for All**
**Mid-21st Century Vision**

Achieve Scalable Secure Digital Aviation System

Assure Safety as Operations Diversify & Grow

Design for Sustainability & Resiliency

Enable Equitable Access for Diverse Ops

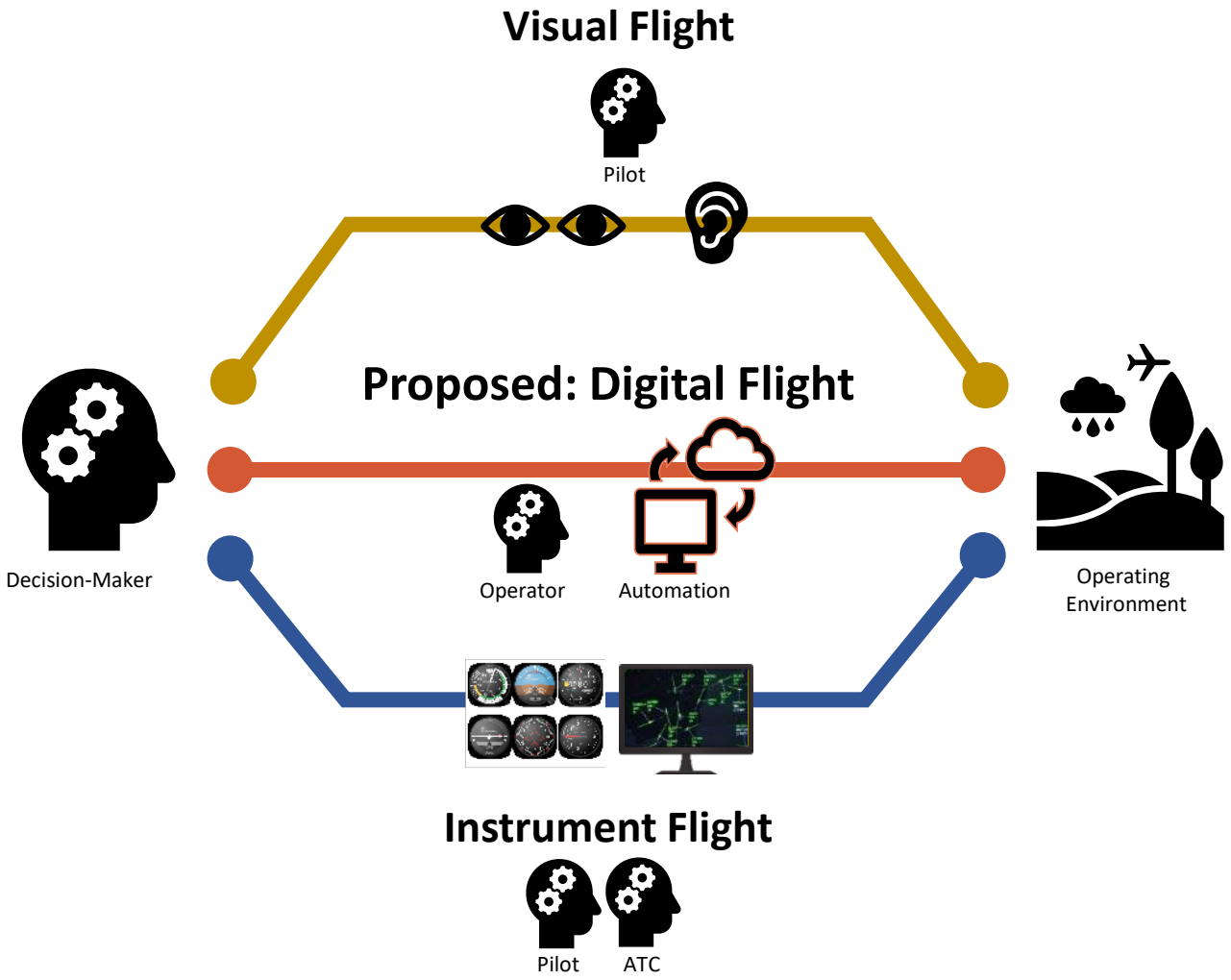
Enhance Quality of Life

Promote and Empower Operator Mobility

Transform Existing Aviation Ecosystem

UAS: Unmanned Aircraft System UTM: UAS Traffic Management ETM: Upper Class E Traffic Management UML: UAM Maturity Level

# A Third Operating Mode




## Pilot sees and avoids

(relying upon visual detection)

- Distributed decision-making
- No centralized coordination
- No intent sharing required
- Cooperative procedures and rules
- Limited to no dependence on technology or ATC

***Flexible***
***Scalable***

## Operator is the separator

(relying upon digital automation and services)

- Distributed decision-making
- No centralized coordination
- Required intent sharing
- Encoded cooperative practices
- Technology-dependent separation
- Cooperative with Air Traffic Management

***Flexible***
***Scalable***
***Predictable***
***Accessible***

## ATC is the separator

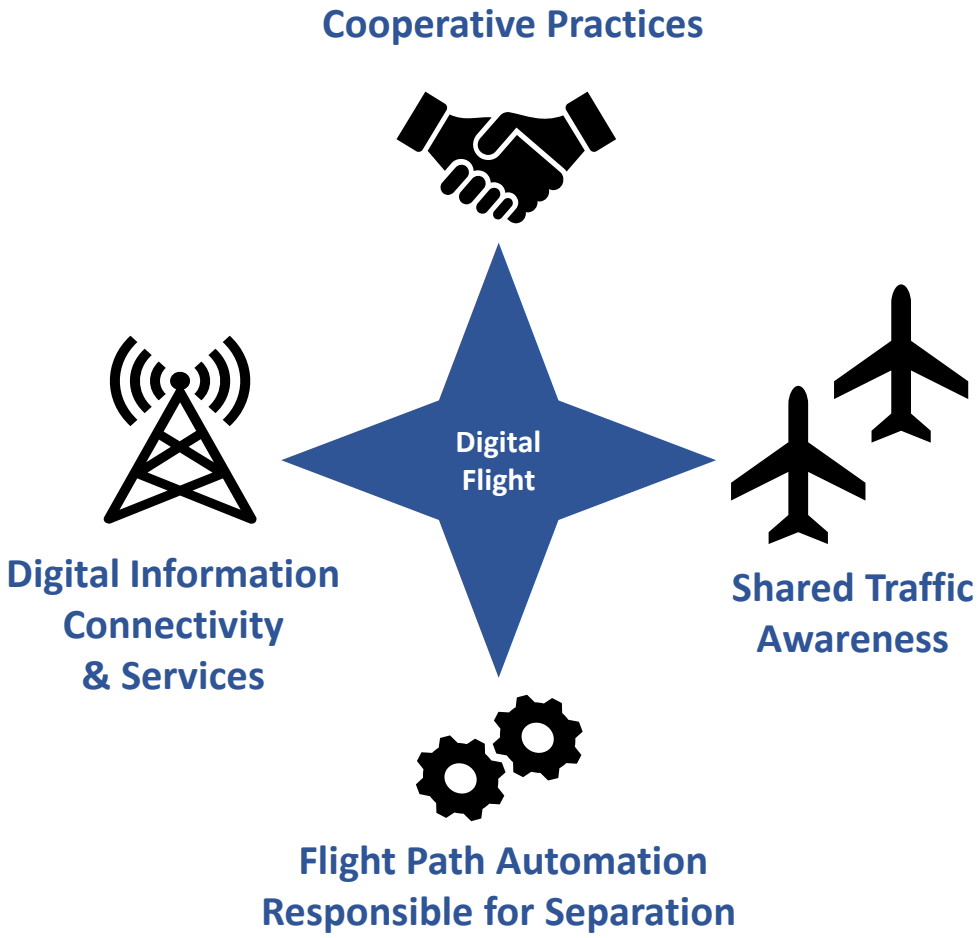
(relying upon radar and air/ground communications)

- Federated/centralized decision-making
- Centrally managed conflict management
- Intent sharing with ATC
- Limited dependence on technology
- ATC approval required

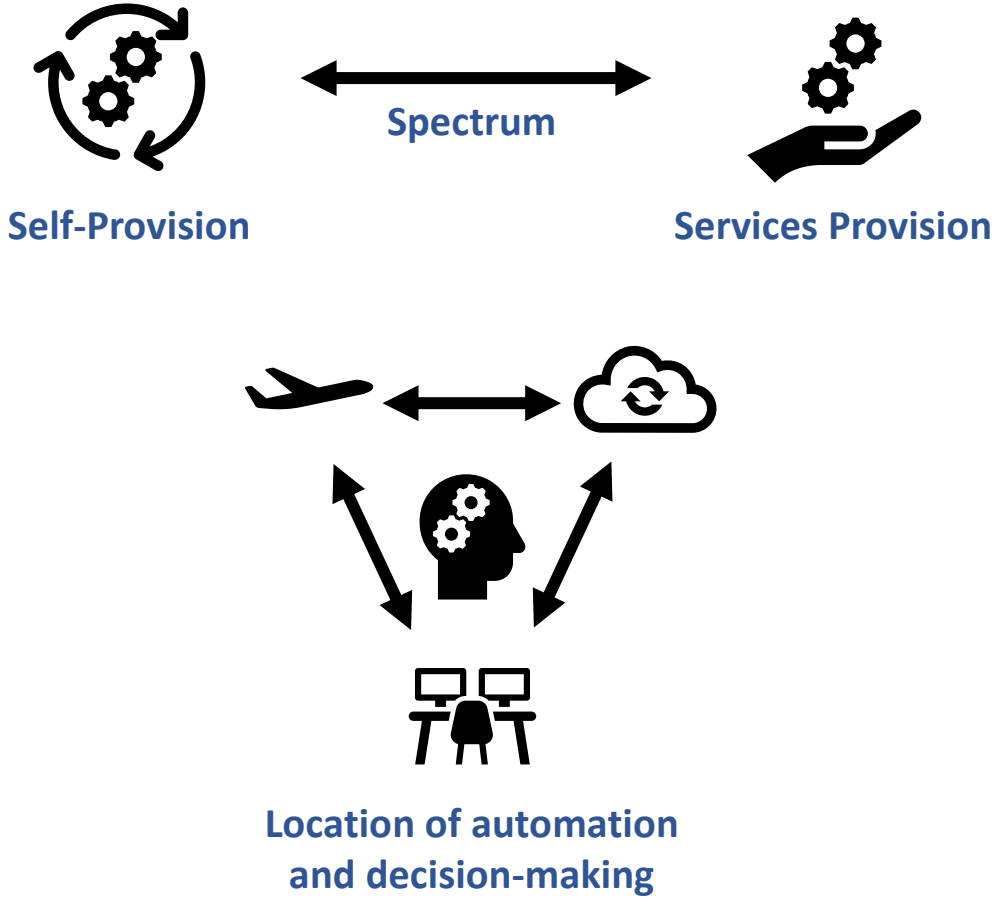
***Predictable***
***Accessible***

# Digital Flight Elements and Architecture

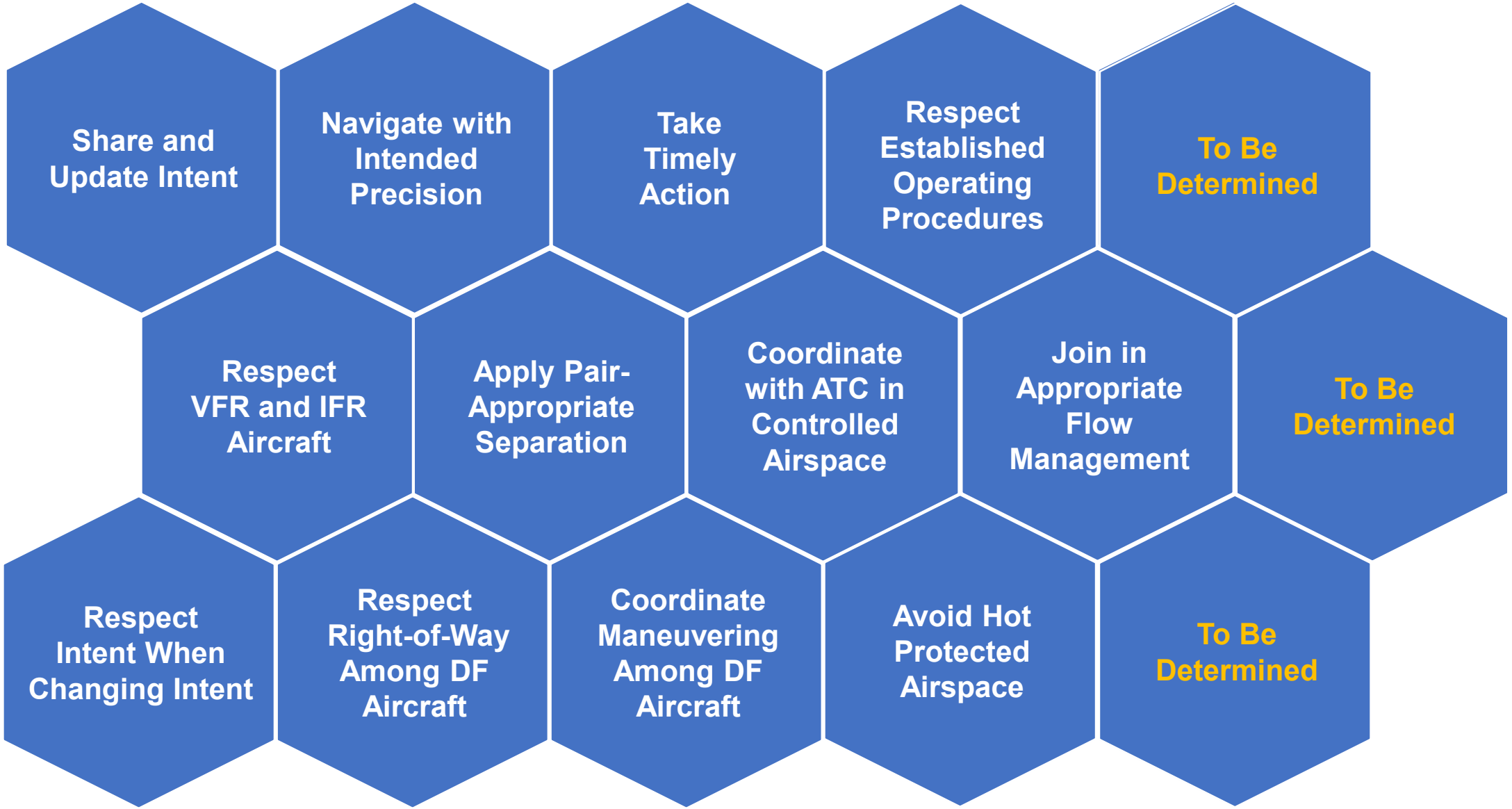
## Essential Elements




## Architectural Flexibility



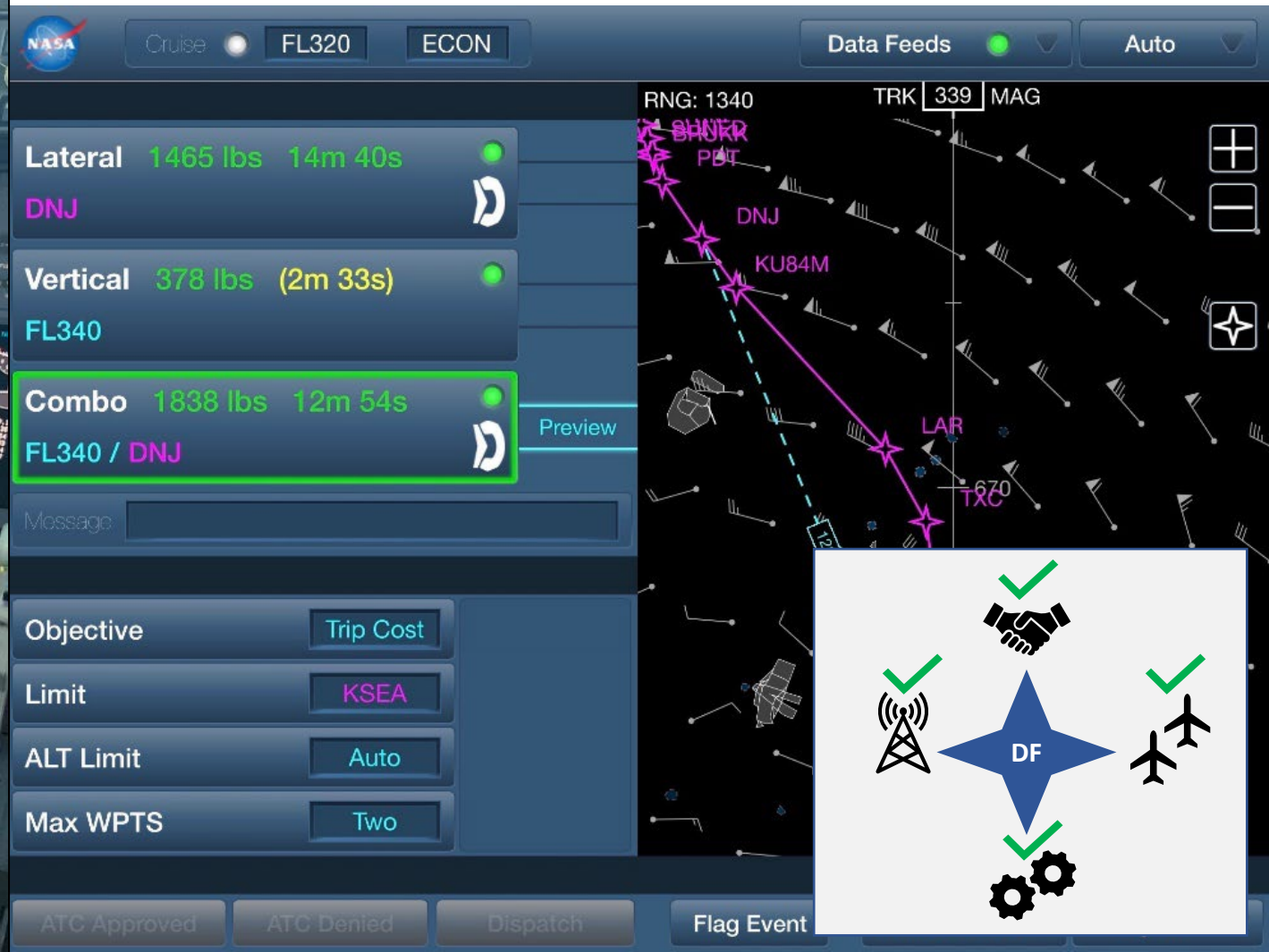
# Digital Flight Cooperative Practices



# NASA Tech is Already Building Toward Digital Flight

## TASAR: Traffic Aware Strategic Aircrew Requests

- NASA technology for flight optimization
- Validated in airline operations
- Now commercially available



# Community Engagement

## Industry Workshops Identified Critical Barriers…


## … and Paths Forward / "Chisels"

### Concept Communication

Describe the DF concept in greater detail to reduce identified uncertainties

### Stakeholder Engagement

Engage with key stakeholders to communicate concept and get input on desired DF policy

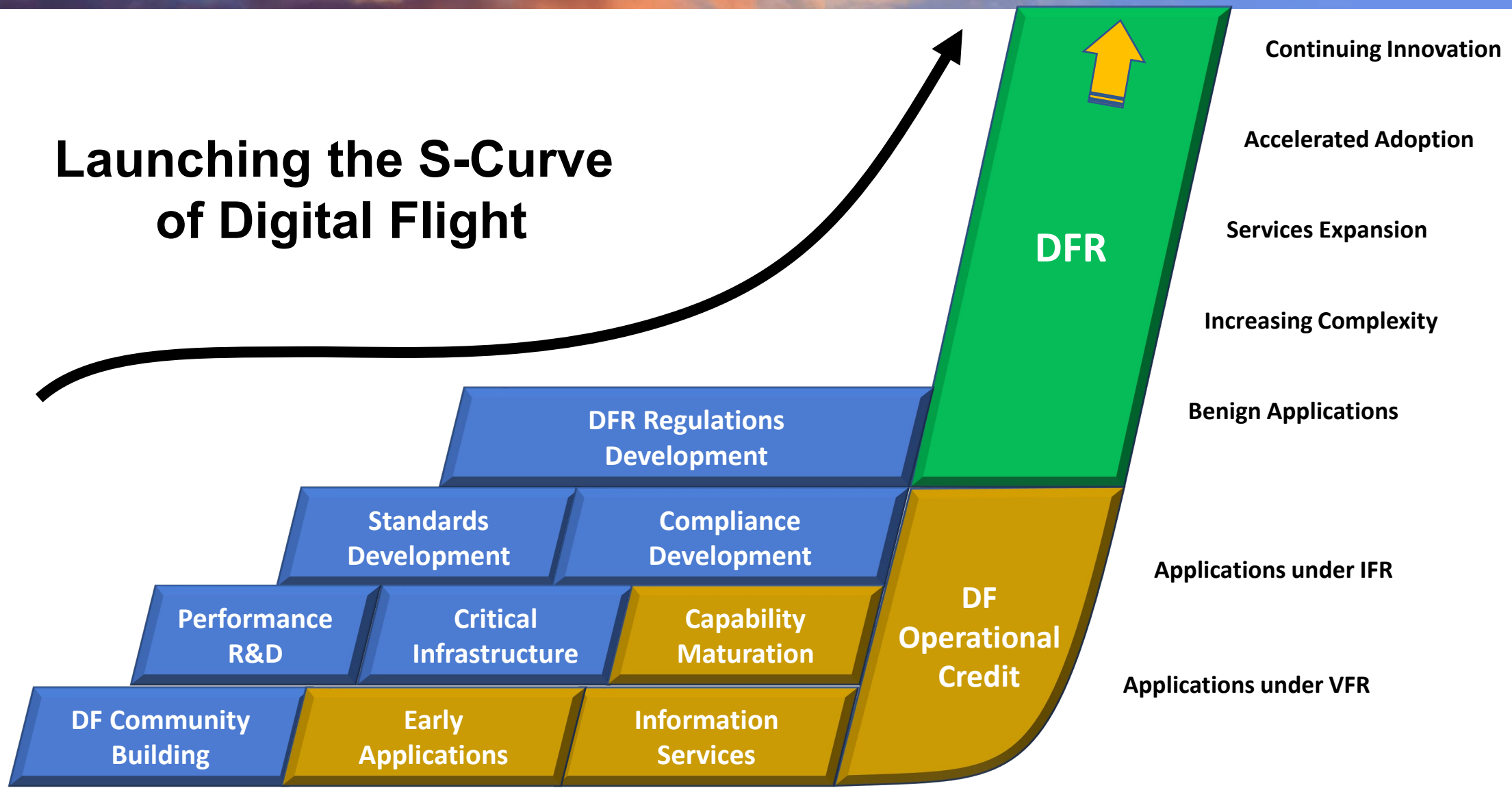
### Modelling and Simulation

Conduct studies to quantify performance and safety impacts resulting from DF

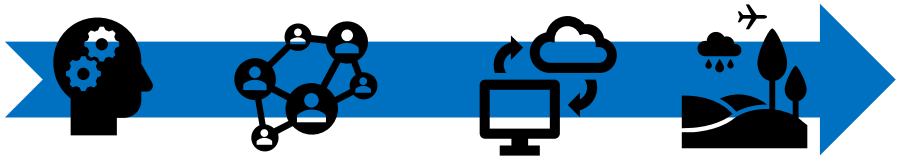
### Technology Demonstration

Define and conduct real-world demonstrations of DF capabilities

# Digital Flight: A Path Forward



# Digital Flight: A Moonshot for Aviation




**"We set sail on this new sea…
for the progress of all people."**

John F. Kennedy
Sept. 12, 1962

# Thank You!

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