Data & Reasoning Fabric Overview

September 2020

NASA Aeronautics Research Mission Directorate (ARMD)
Transformative Aeronautics Concepts Program (TACP)
Convergent Aeronautics Solutions (CAS) Project
Data and Reasoning Fabric Team

MOBILITY CHALLENGES

- Transportation shapes society, enabling economic and social interactions
- The quality of life is impacted by ever growing commute time.
- Transportation is increasingly driven by door-to-door challenges.

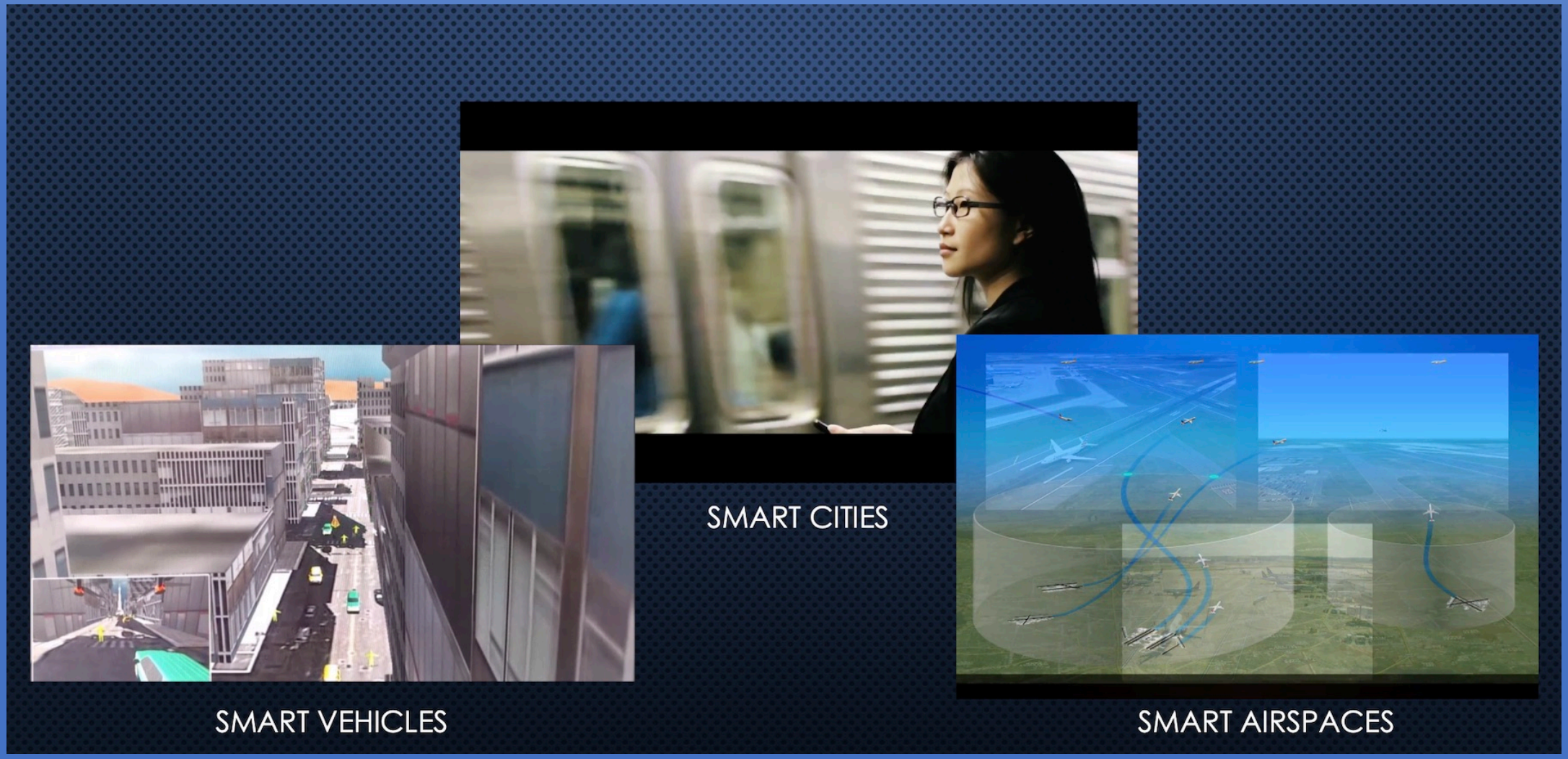
Air Mobility can convert our 2D mobility system to a 3D mobility system, increasing mobility options for both people and goods.

AIR MOBILITY DATA AND REASONING CHALLENGES

- Urban air operations require decisions based on diverse and dynamic data, including at least vehicle, airspace, weather, infrastructure, payload, and customer data.
- Decisions need to be made where the data exist and, increasingly, data may be too large or dynamic to centralize.
- The envisioned density of operations will only be achieved if decision processes continue to move from purely human decisions, to machine-intelligence based decisions with human oversight.
- Machine-intelligence generally requires greater volumes of digital data of explicitly known applicability, quality, and many other “ilities.”

Air Mobility Data Sources

Data will arise from Smart Vehicles operating in Smart Airspaces, within Smart Cities:

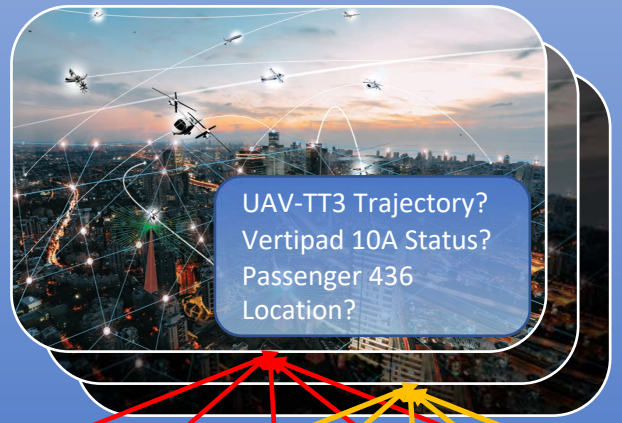


Air Mobility Planning, Operations, and Performance
- Current Trajectory -

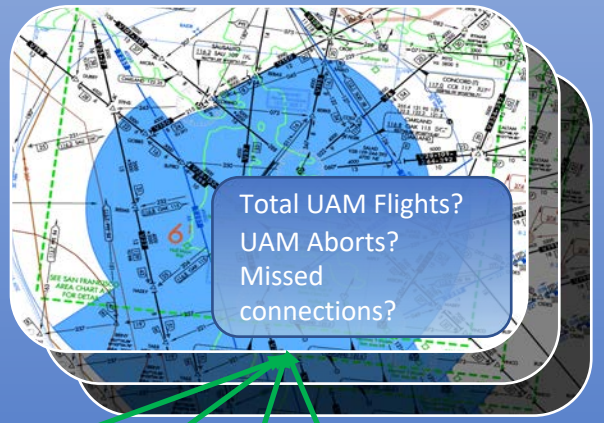
APPLICATION ENGINES

PLANNING

OPERATIONS



PERFORMANCE



CASE-BY-CASE DATA
- DISCOVERY
- AGGREGRATION
- VETTING
- DATA/$ TRANSACTIONS

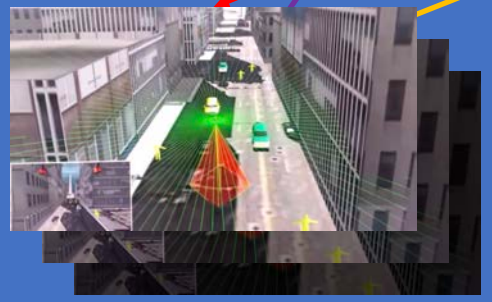
City "A" Planner

Package-As-Service Provider "A"

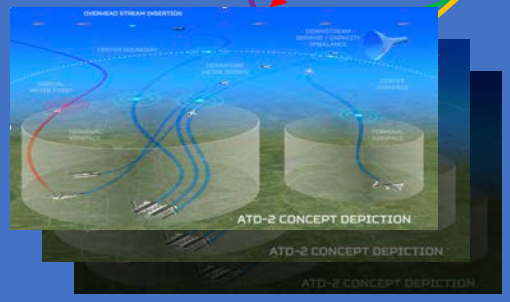
City "L" Planner

Mobility-As-Service Provider "U"

CONCERNS
- COST
- SAFETY
- SECURITY
- "MONO" ECOSYSTEMS



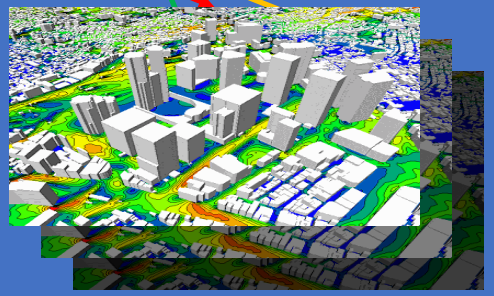
SMART VEHICLES



SMART AIRSPACES

SMART CITIES

REGULATORY



MICRO-WEATHER

DATA Producers & Consumers

Data & Reasoning Fabric Marketplace

DRF is envisioned to provide the data and reasoning marketplace to support:

- High-density air transportation, even in complex urban environments
- Transportation of people and cargo to places previously not served or underserved by aviation
- Efficient and user-friendly integration of emerging and evolving traditional air transportation capabilities

How:

- DRF will allow 1000s of small and large enterprises with different assets to create a data and reasoning marketplace
- More choice, better prices, and a secure buying experience for the consumers.
- DRF will make it easier to add new data, reasoning and other services

Allow air transportation systems to be aware of and adapt to all available data, from evolving user intent to real-time environmental, infrastructure, and ground/water transportation systems status

Air Mobility Planning, Operations, and Performance

- DRF Trajectory -

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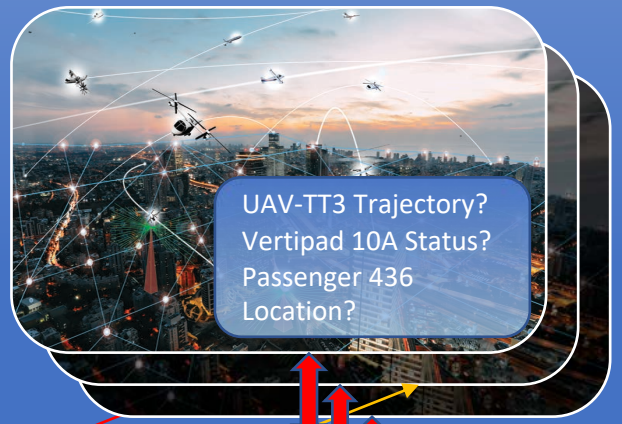

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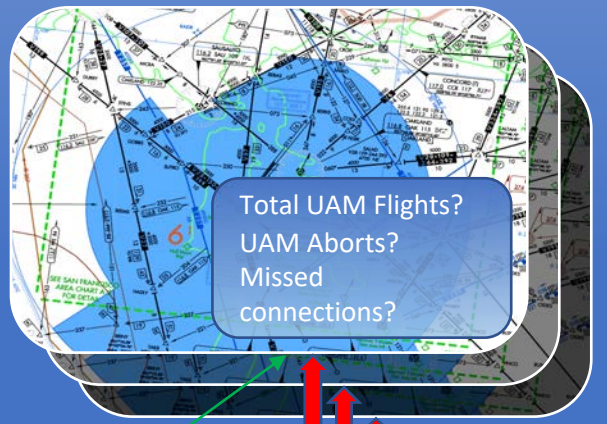
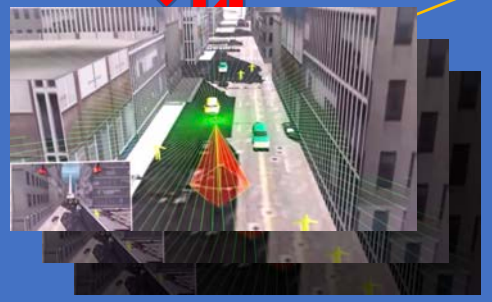


DATA & REASONING FABRIC

A set of secured software infrastructure, tools, protocols, governance and policies to implement, administer, manage and operate data sharing and reasoning services across the entire span of air mobility and other "smart" edge nodes.

- ENABLE EFFICIENT AND PERVASIVE DATA DISCOVERY, AGGREGRATION, VETTING, AND DATA/$ TRANSCATIONS –



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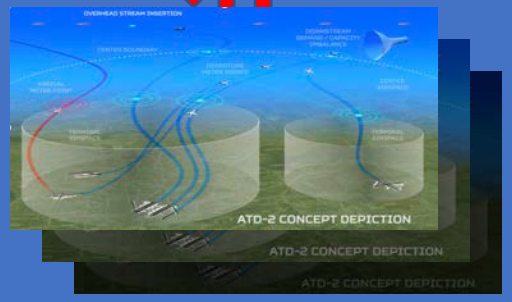

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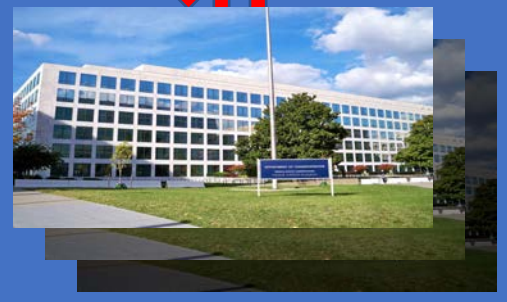

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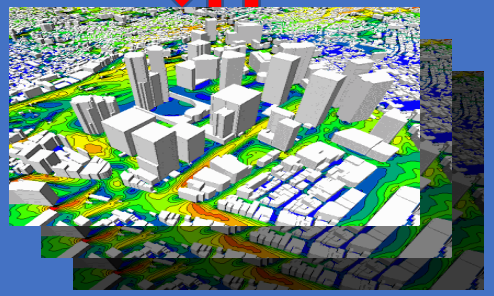


MICRO-WEATHER

DATA Producers & Consumers

Data & Reasoning Ecosystem For Traditional and Emerging Airspace Systems

- For traditional and emerging airspace systems, DRF will enable data and reasoning services across the entire span of air mobility
  - The DRF will enable ubiquitous urban air mobility operations with system-wide automated optimization, enabling multitudes of simultaneous flights in a metropolitan area
  - The DRF will help emerging aviation markets to safely develop an air transportation system that moves people and cargo between places previously not served or underserved by aviation – local, regional, intraregional and urban.
  - As technology, societal and environmental factors evolve, the DRF will help the traditional future NAS meet operational requirements that enable increased density, efficiency and diverse operations

In support of future NAS requirements, the DRF enables an efficient and pervasive data discovery, aggregated and vetting marketplace

Data & Reasoning Framework Strawman – Hypothetical Scope to Explore

A DRF Should:

- Support discovery of data sources and elements across the system
- Support standard definition or format of common data types required by the NAS
- Support data access rights/policies
- Implement security at the data level
- Support defined service levels for data exchange, such as those tied to safety
- Support capture and exchange of system state and data quality (i.e. metadata)
- Support common core elements related to National Airspace (NAS) safety

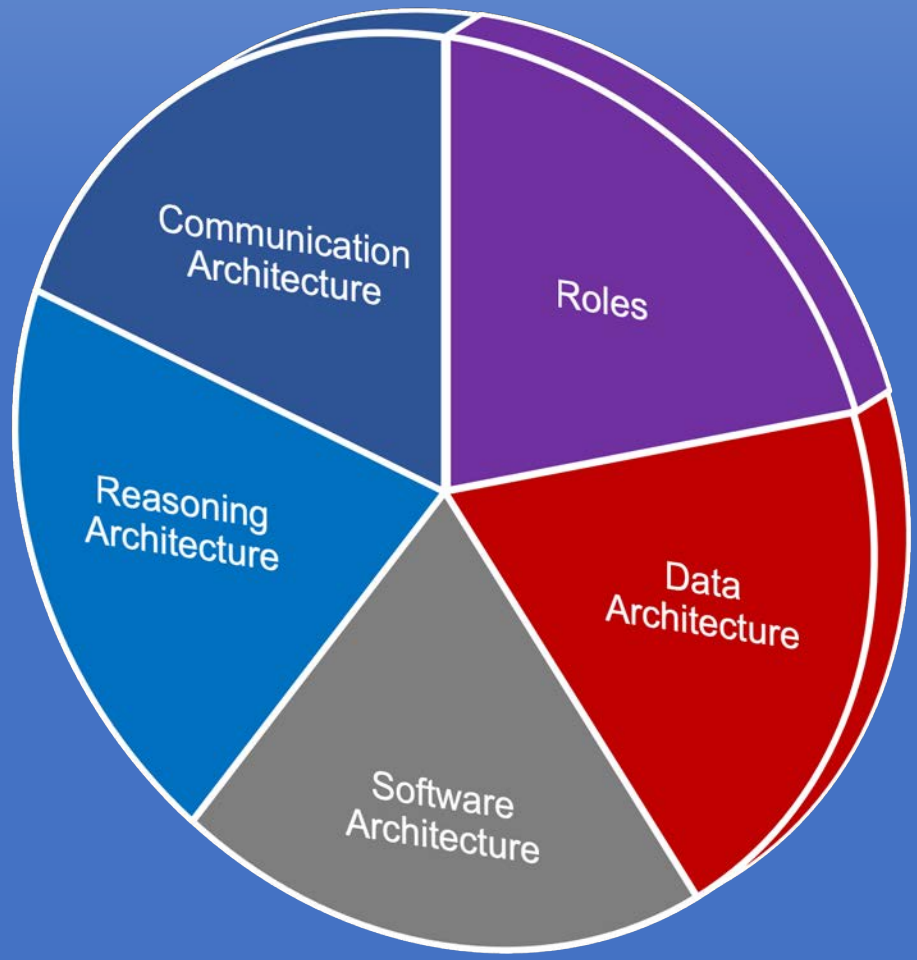
A DRF Should be Agnostic to:

- End-application or type of flight operations
- Application-level data that is exchanged
- Technologies used for implementation
- Policies/Rules (present and future) for the NAS

Play an enabling role, reduce complexity by encapsulating common elements
Avoid being prescriptive

Data & Reasoning Fabric Teams

- Data & Reasoning Fabric has five teams working together to:
  - Gain understanding of current state of the art, future needs of human machine teaming and identify gaps that will need to be addressed
  - Identify successful market identification and servicing strategies in other industries that can be adopted or leveraged by DRF
  - Assess public-private working groups/partnerships to facilitate constructive requirements definitions
  - Identify critical prototyping activities required to mature the DRF vision and technical approach
  - Seamlessly integrate with existing NAS systems



DRF Tenets of Operations (WHY-WHAT-HOW)

[WHY]

DRF IS FOUNDATIONAL LEVERAGE FOR THE SYSTEMS THAT SUPPORT COMPLEX AND UBIQUITOUS Advanced Air Mobility (AAM) OPERATIONS . DRF will be for AAM what HTTP, HTML, and XML were for the Web.

[WHAT]

DRF IS A SOURCE OF DATA AND REASONING SERVICES FOR ALL AAM STAKEHOLDERS. With a foundational layer such as DRF, these capabilities can be implemented with more consistent quality, more robust real-world performance, better interoperability, better security, and greater future extensibility.

DRF INCLUDES AND SUPPORTS A TRUSTED MARKETPLACE: DRF succeeds if it supports a vibrant business ecosystem with foundational support for the economically viable participation of all relevant industry sectors, as well as the minimal appropriate participation by government to assure the equitable, safe, and secure operation of the national airspace and supporting infrastructure. To the extent possible, academia should be allowed far reaching access to DRF to support their research in the effective operation of the national airspace.

[HOW]

DRF IS FLEXIBLE AND APPLICATION/MISSION-AGNOSTIC, BUILT ON THE SHOULDERS OF CURRENT AIRSPACE CAPABILITIES: It must have a generalized framework, be inherently extensible, and enable appropriate adoption and plug-in interoperability across open standards and technologies. DRF must be backward-compatible with existing airspace systems and infrastructure, as well as extensible to other modes of transportation.

Factors in Successfully Introducing DRF Capabilities

Involvement from the Public Sector	• The public sector, as regulator, plays a necessary role in defining requirements from the perspective of safety and other factors that are in the public interest.
The Role of the Private Sector	• Clarity on requirements combined with economic incentive can cause the private sector to deliver the desired innovation and ultimately to push capabilities beyond initially envisioned goals.
Systems Engineering – System of Smart Systems capable of Safety Critical Operations	• Automation and data for time-critical and safety-related operations across nominal and contingency situations.
Requirements – Enabling vs. Prescriptive	• The ultimate requirements are complex and cannot be fully known at the outset. Future technologies are sure to bring change. • A foundational layer built around data can reduce complexity while encapsulating core common capabilities and providing inherent flexibility for evolving requirements, future operating policies, and future unanticipated end-applications for the airspace system

A Data & Reasoning Framework Could Contribute to End Goals

Reduce Complexity	Reduce complexity of system-level engineering challenges for the traditional and emerging airspace system
Provide Clarity	Provide baseline requirements and architecture clarity to all stakeholders, including the private sector
Provide Incentive	Provide core elements of a framework supporting marketplace functions for data, operations and policies that provides a clarifying economic incentive to the private sector to bring the relevant innovations, products and services to market
Provide Flexibility	Build in the flexibility and extensibility of the data systems supporting the National Airspace System to give all stakeholders confidence in a path to continued innovation and increased capability in the traditional and emerging airspace system