

# NASA's Air Traffic Management Research

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SMART-NAS for Safe TBO Project Manager

# Why is aviation so important?

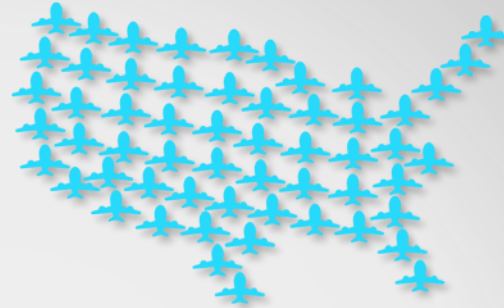


The air transportation system is critical to U.S. economic vitality.



**\$1.5** TRILLION

TOTAL U.S. ECONOMIC ACTIVITY  
(civil aviation-related goods and services, 2012)



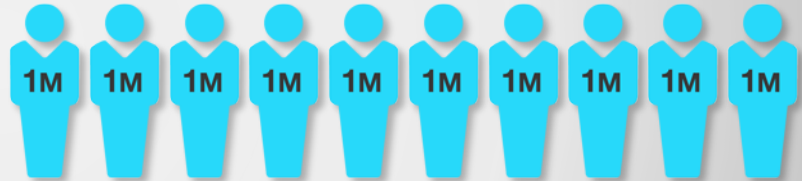
**\$75.1** BILLION

POSITIVE TRADE BALANCE  
(aerospace industry, 2013)



**11.8** MILLION

DIRECT AND INDIRECT JOBS  
(civil and general aviation, 2012)



**5.4%** (\$847.1 BILLION)

OF TOTAL U.S. GROSS DOMESTIC PRODUCT (GDP)  
(civil and general aviation, 2012)



# Why should I care?

Take the system view. You may not have flown today but something you needed did.



**17.7** BILLION

TONS OF FREIGHT TRANSPORTED BY AIR

(all U.S. carriers, 2013)



**\$670.8** BILLION

SPENT BY AIR TRAVELERS IN U.S. ECONOMY

(domestic and foreign travelers, 2012)



**741** MILLION

PASSENGERS ON U.S. CARRIERS

(domestic and foreign, 2013)

# What are the challenges?



Challenges are driven by emerging global trends.



**16** BILLION

GALLONS OF JET FUEL BURNED IN 2013  
(U.S. airlines)



**\$8.1** BILLION

COST OF DELAYS TO U.S. AIRLINES IN 2013



**\$9.3** BILLION

SPENT BY AIRPORTS ON NOISE ABATEMENT SINCE 1982



**3%**

AND

**5%**

OF GLOBAL CO<sub>2</sub>

PROJECTED WARMING EFFECTS FROM AVIATION BY  
2050



**360** MILLION

PASSENGERS BEING ADDED IN ASIA PACIFIC FROM 2009 TO 2014  
(market is growing and moving East)

# What is NASA Aeronautics working on?



Our research continues to show how we're with you when you fly.

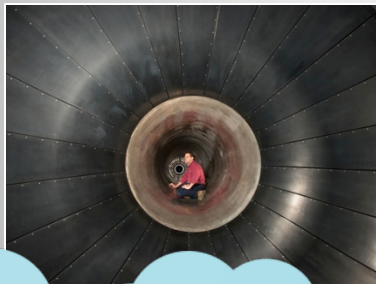
Air traffic management tools that reduce delays and save fuel

Aircraft shapes that reduce aviation's impact on the environment

Data that reveals the impacts of alternative jet fuels on emissions

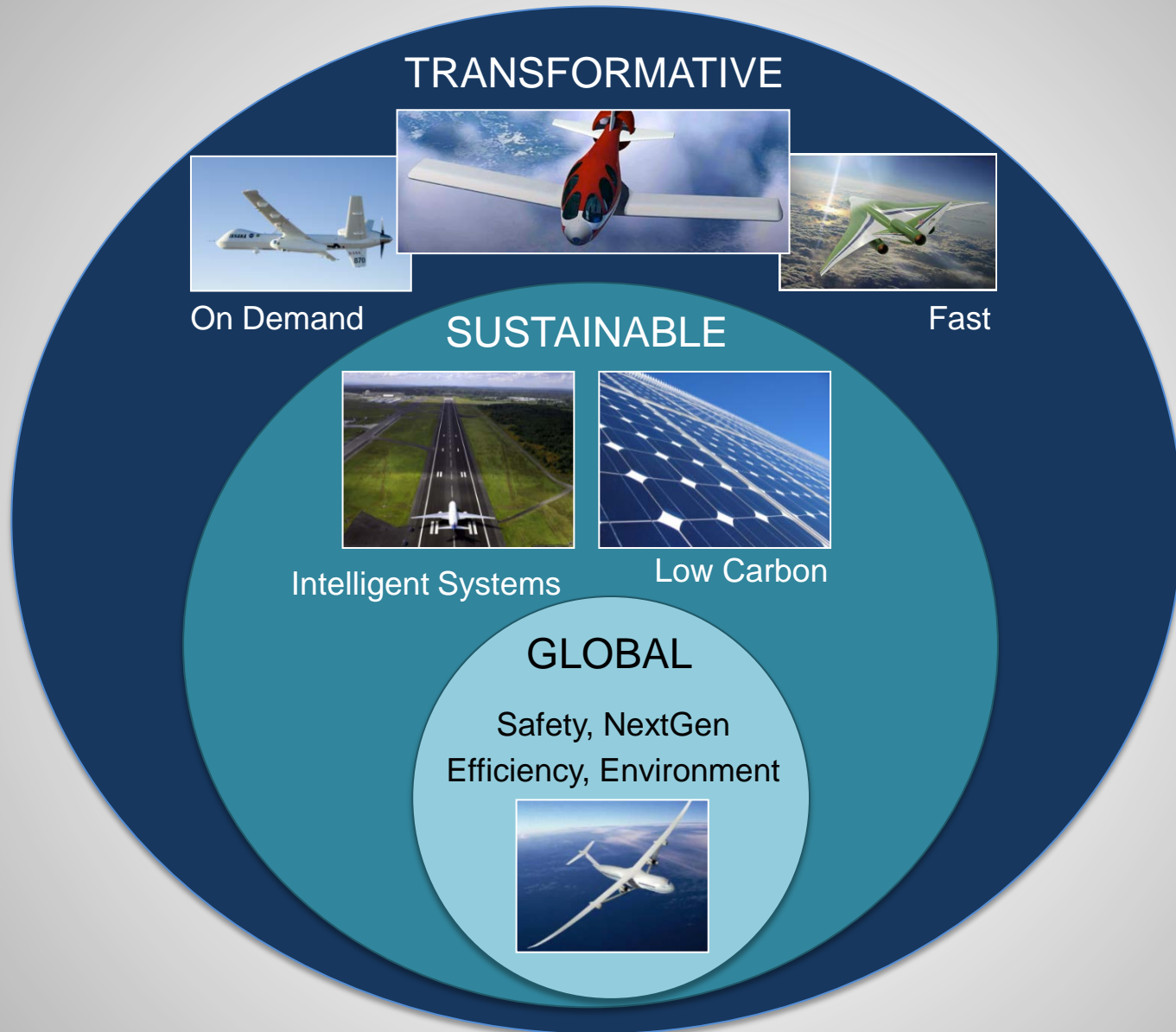
Tests of new technologies that increase autonomy in the aviation system

Technologies that lower the volume on sonic booms



# What vision has NASA set for aviation?

A revolution in sustainable global air mobility.



# How is NASA improving aviation today?

We are meeting global aviation challenges by using six research thrust areas to organize our research.



## Safe, Efficient Growth in Global Operations

- Enable full NextGen and develop technologies to substantially reduce aircraft safety risks



## Innovation in Commercial Supersonic Aircraft

- Achieve a low-boom standard



## Ultra-Efficient Commercial Vehicles

- Pioneer technologies for big leaps in efficiency and environmental performance



## Transition to Low-Carbon Propulsion

- Characterize drop-in alternative fuels and pioneer low-carbon propulsion technology



## Real-Time System-Wide Safety Assurance

- Develop an integrated prototype of a real-time safety monitoring and assurance system



## Assured Autonomy for Aviation Transformation

- Develop high-impact aviation autonomy applications



# Where does NASA ATM Research fit in?

ATM Research is conducted in the new Airspace Operations and Safety Program.



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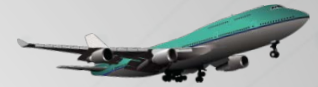
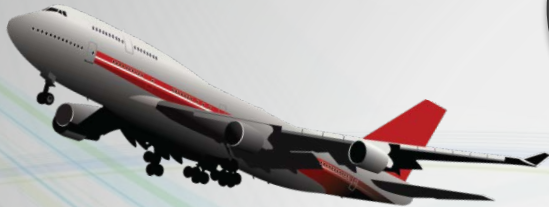
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# NASA's ATM research is conducted in the Airspace Operations and Safety Program



Airspace  
Operations  
and Safety  
Program

Develops and explores fundamental concepts, algorithms, and technologies to increase throughput and efficiency of the National Airspace System safely.

Provides knowledge, concepts, and methods to the aviation community to manage increasing complexity in the design and operation of vehicles and the air transportation system.

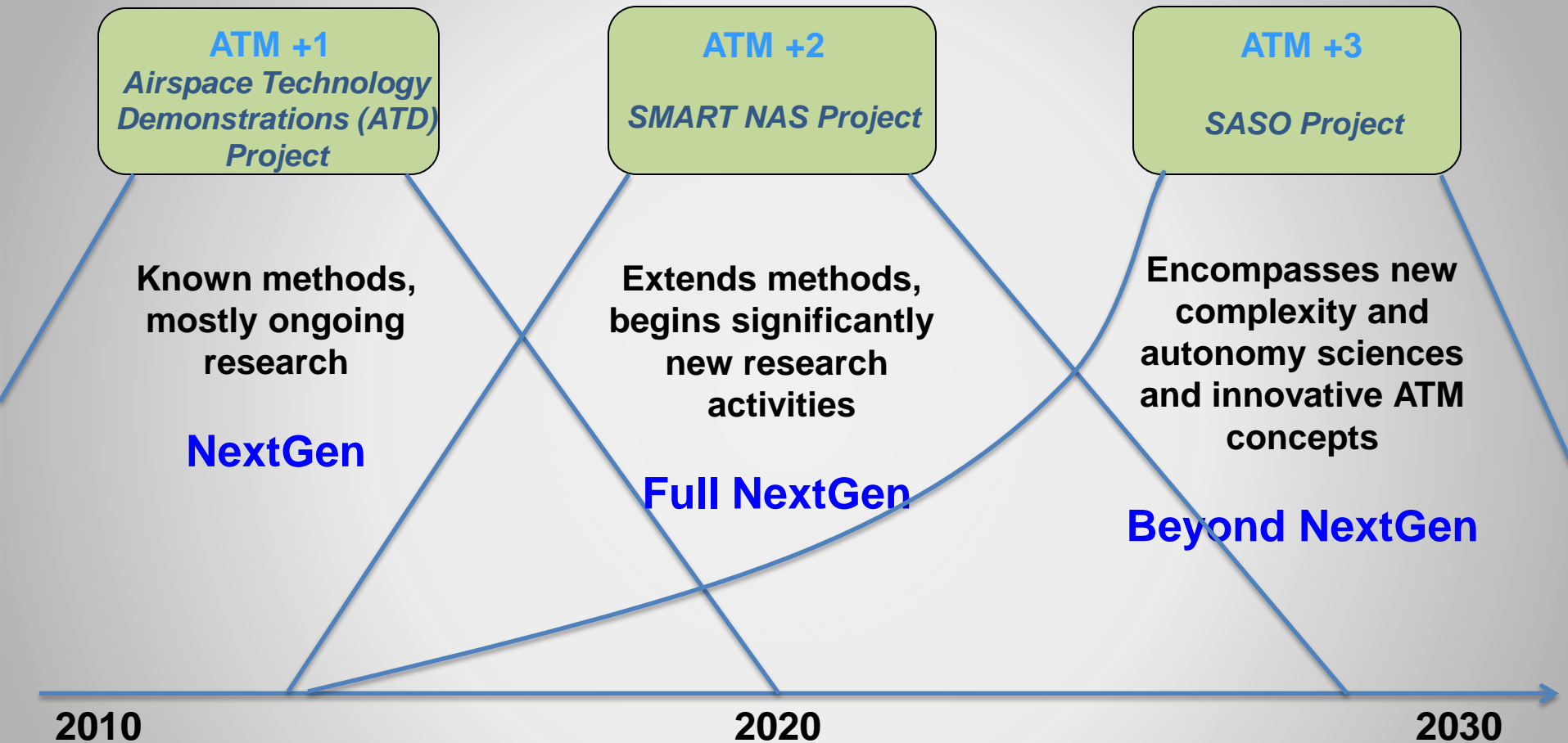
Continues Airspace Systems Program research, and the aircraft state awareness research and system wide safety research that was previously conducted within the Aviation Safety Program.

## Projects

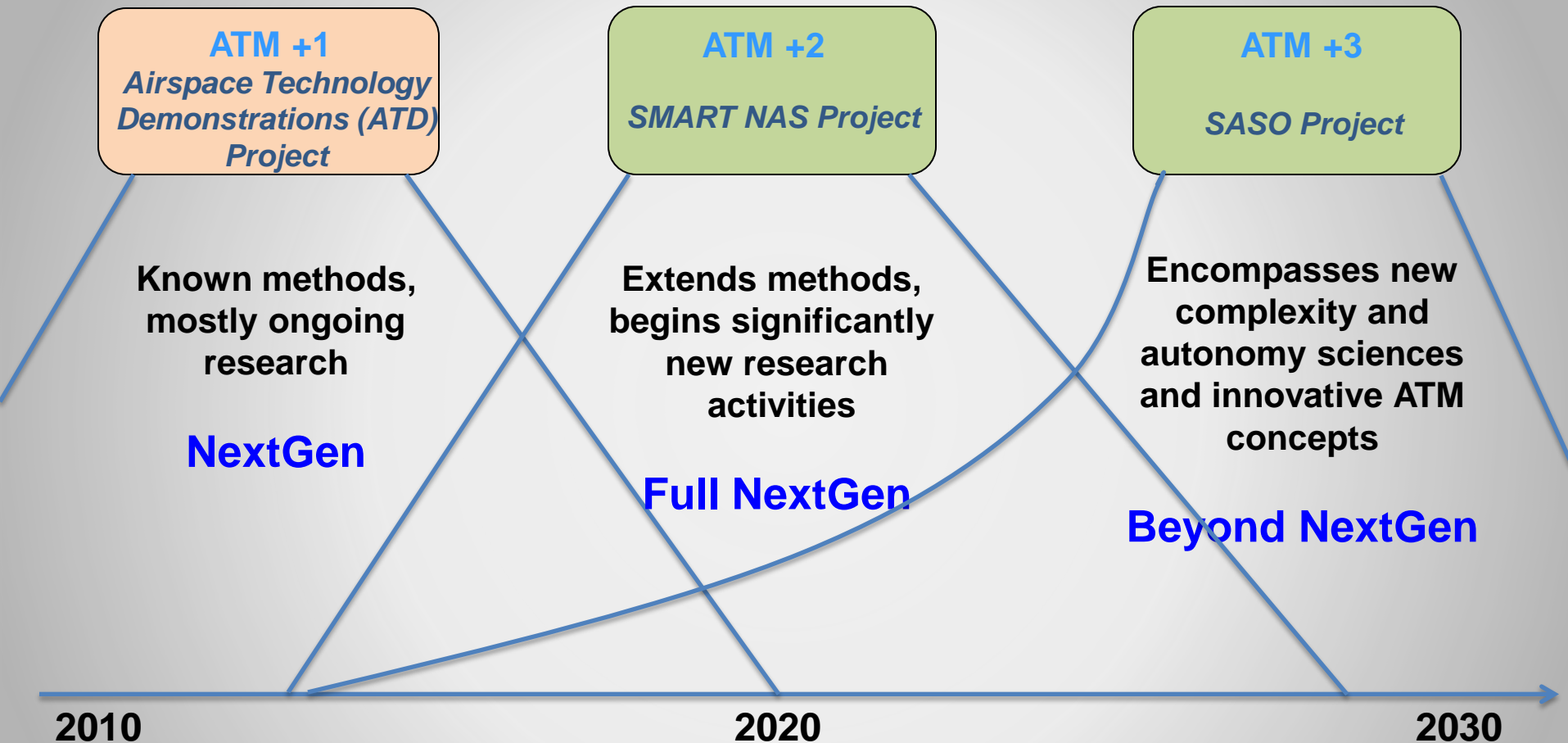
- Airspace Technology Demonstrations (ATD)
- SMART NAS for Safe Trajectory-Based Operations
- Safe Autonomous System Operations (SASO)



# ATM Generations Timeline



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# ATM Technology Demonstration-1



**ATD-1:** Improve arrival operations efficiency while increasing arrival throughput using integrated aircraft-based and ground-based automation technologies

**Flight Deck Interval Management (FIM) for Arrival Operations**



**Utilizes:**

- ADS-B Out/In
- RNAV arrivals
- Optimum profile descents (OPDs)

**Controller-Managed Spacing (CMS) in Terminal Airspace**



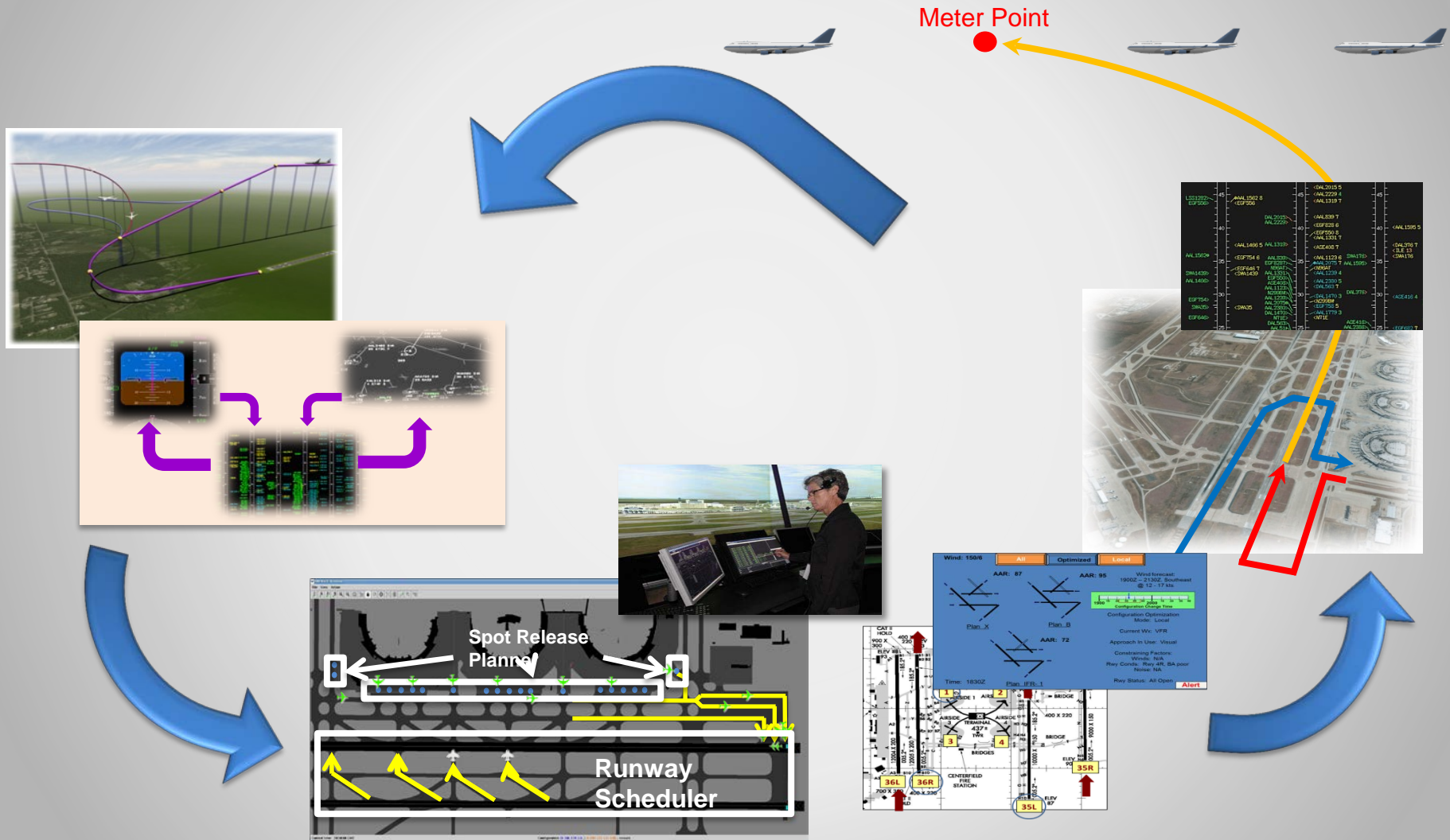
**Traffic Management Advisor with Terminal Metering (TMA-TM)**

**FAA's Terminal Sequencing & Spacing (TSS)**

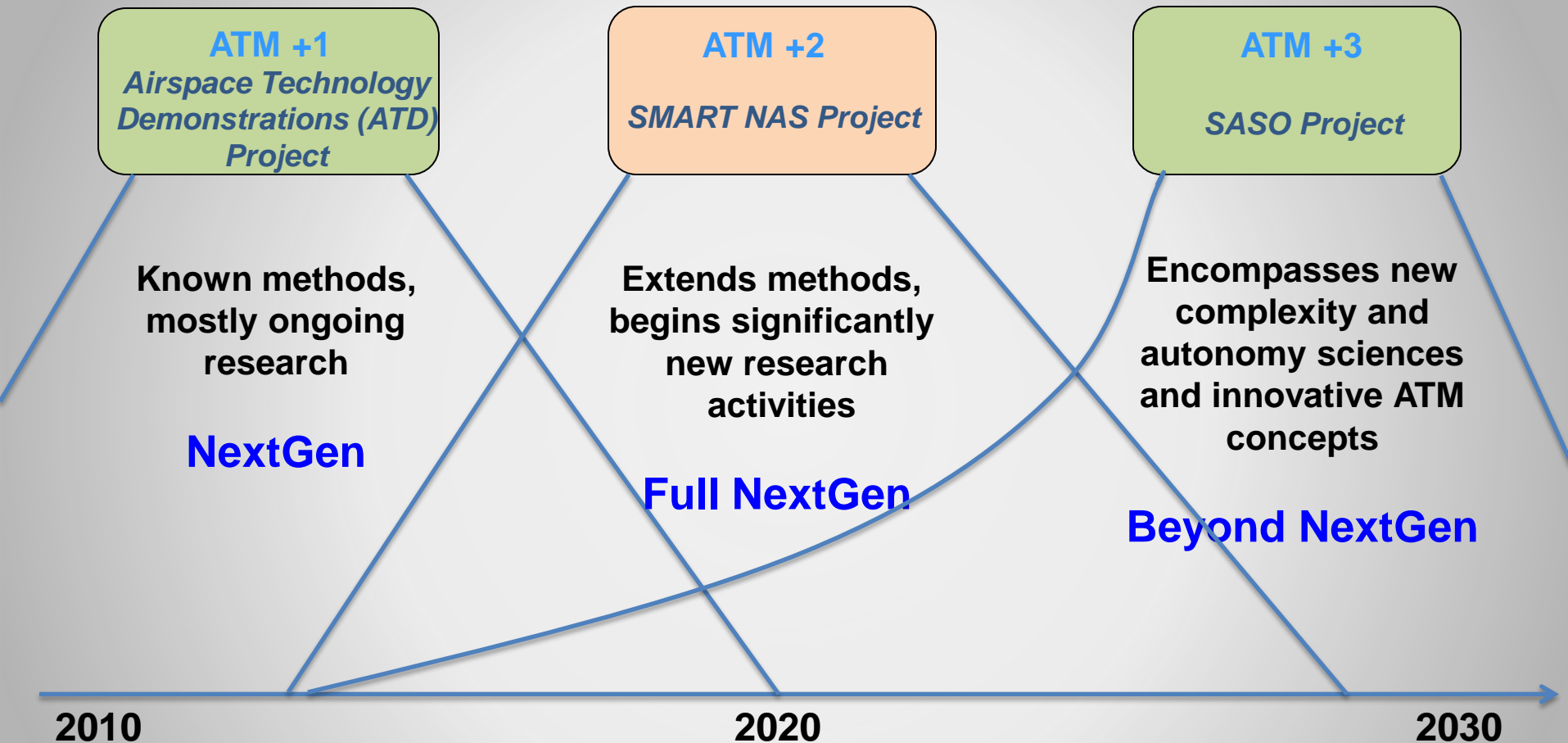
# Integrated Arrival/Departure/Surface Operations



**Integrated Arrival/Departure/Surface Operations (IADS):** Simultaneously increase arrivals, departures, and surface operations efficiency while increasing overall throughput



# ATM Generations Timeline



# SMART NAS for Safe Trajectory Based Operations (TBO) Project

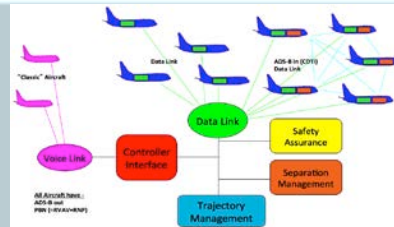
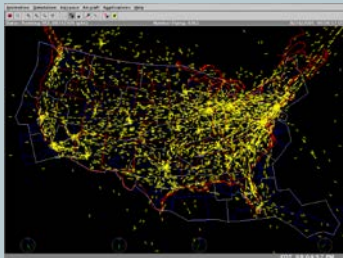


Explore and Develop Concepts, Technologies and a Test Bed for Safe, Global, Gate-to-Gate Trajectory Based Operations in the 2025-2035 time horizon



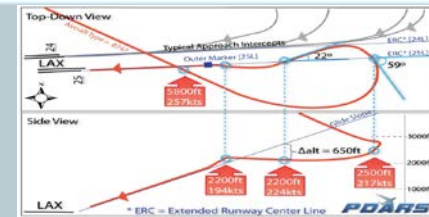
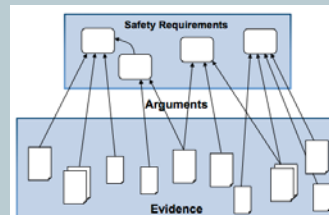
Trajectory Based Operations (TBO)

SMART NAS Test-bed



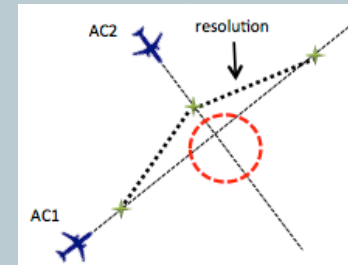
Network-enabled ATM

Verification and Validation



Data Mining and Prognostics

Function Allocation of Separation Assurance



# Conceptual SMART NAS Test-bed Architecture

## SMART NAS Test-bed Core Distributed Infrastructure



Test-bed Physical Cloud Layer



NAS Weather



ATC / SWIM Live  
Data

Test-bed Core Services Layer

NASA, FAA,  
Industry  
ATM  
Technology  
Applications  
/ Algorithms



Test-bed Application Layer  
Repository and Services

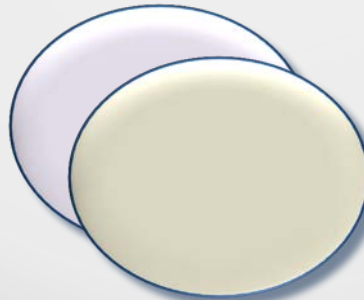
## Alternative Future #1



## Alternative Future #2



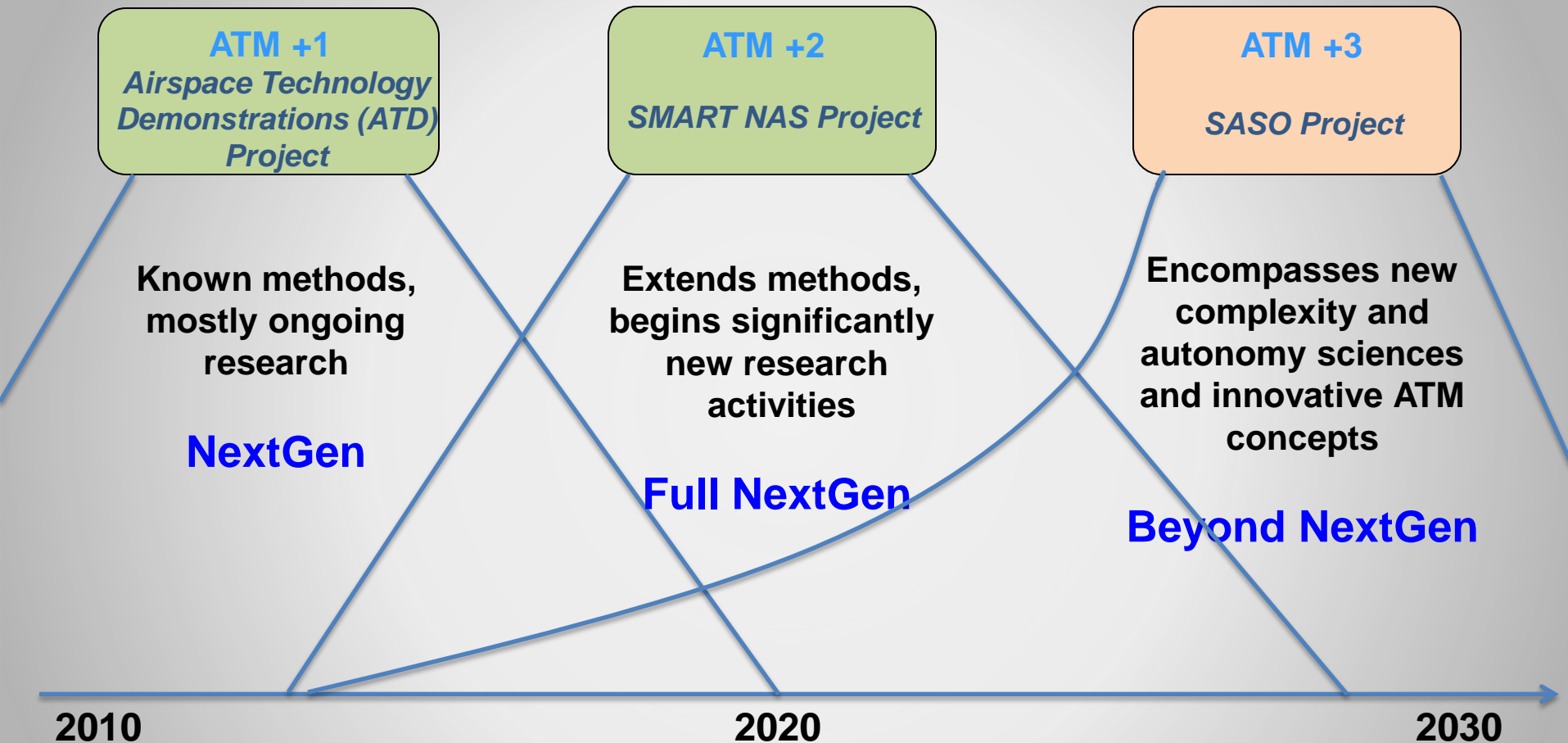
## Alternative Future #3, 4 ...



Seeking Members for the Test-bed Core User Group



# ATM Generations Timeline

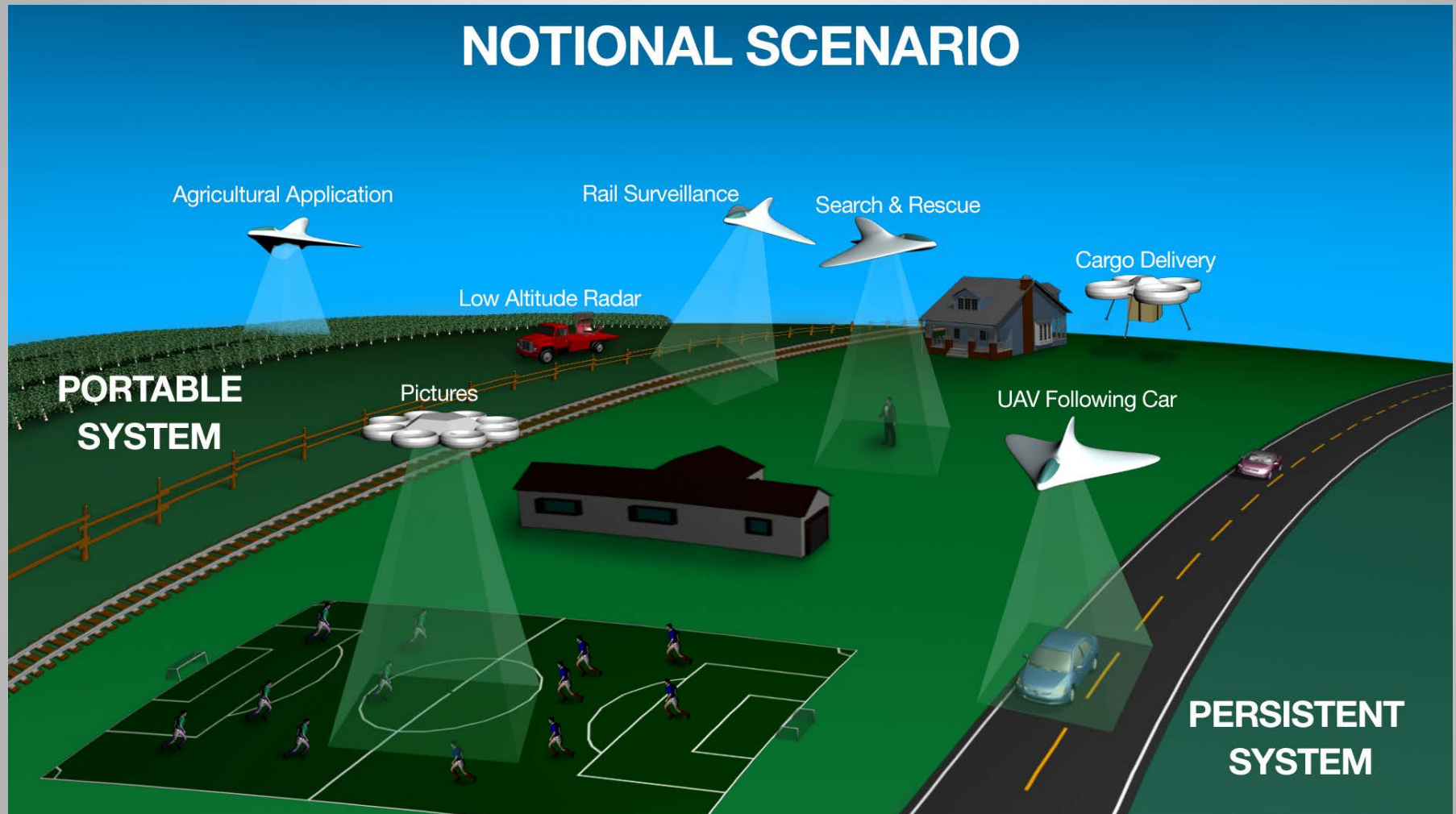


# Unmanned Aerial Systems Traffic Management (UTM)

- Many civilian applications of Unmanned Aerial System (UAS) are being considered
  - Humanitarian
  - Goods delivery
  - Agricultural services
  - Strategic assets surveillance (e.g., pipelines)
- Many UAS will operate at lower altitude (Class G, 2000 Feet)
- No infrastructure to safely support these operations is available
- Global interest (e.g., Australia, Japan, France, United Kingdom, Europe)
- Need to have a system for civilian low-altitude airspace and UAS operations

UTM will enable low-altitude airspace operations

# UTM Supported Applications



# Summary

