
# NASA Aeronautics Research – Strategic Planning

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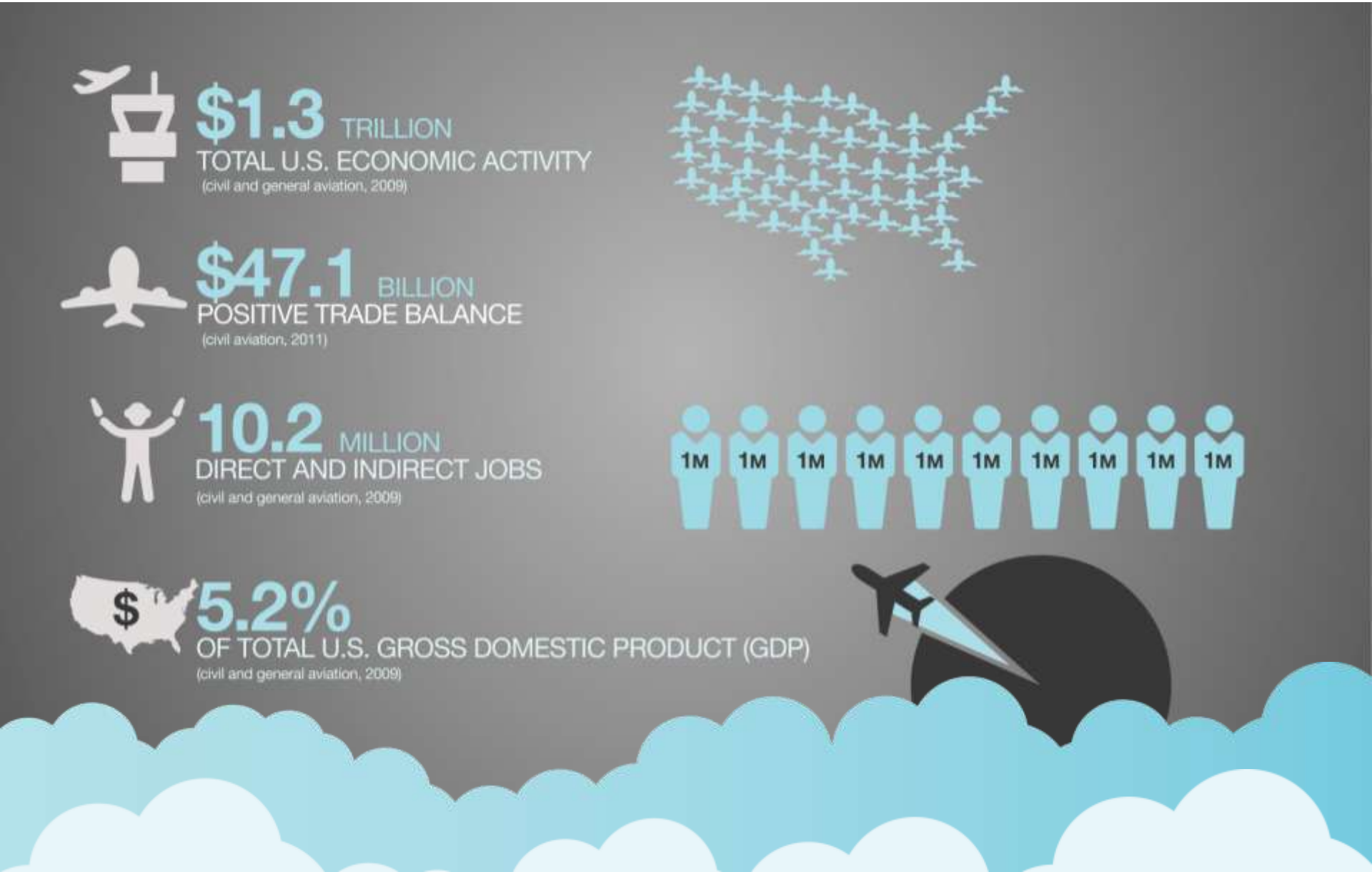
Aeronautics Research Mission Directorate

# Why is aviation so important?

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



# Why should I care?

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

# Aeronautics Research Supports High Quality Manufacturing Jobs

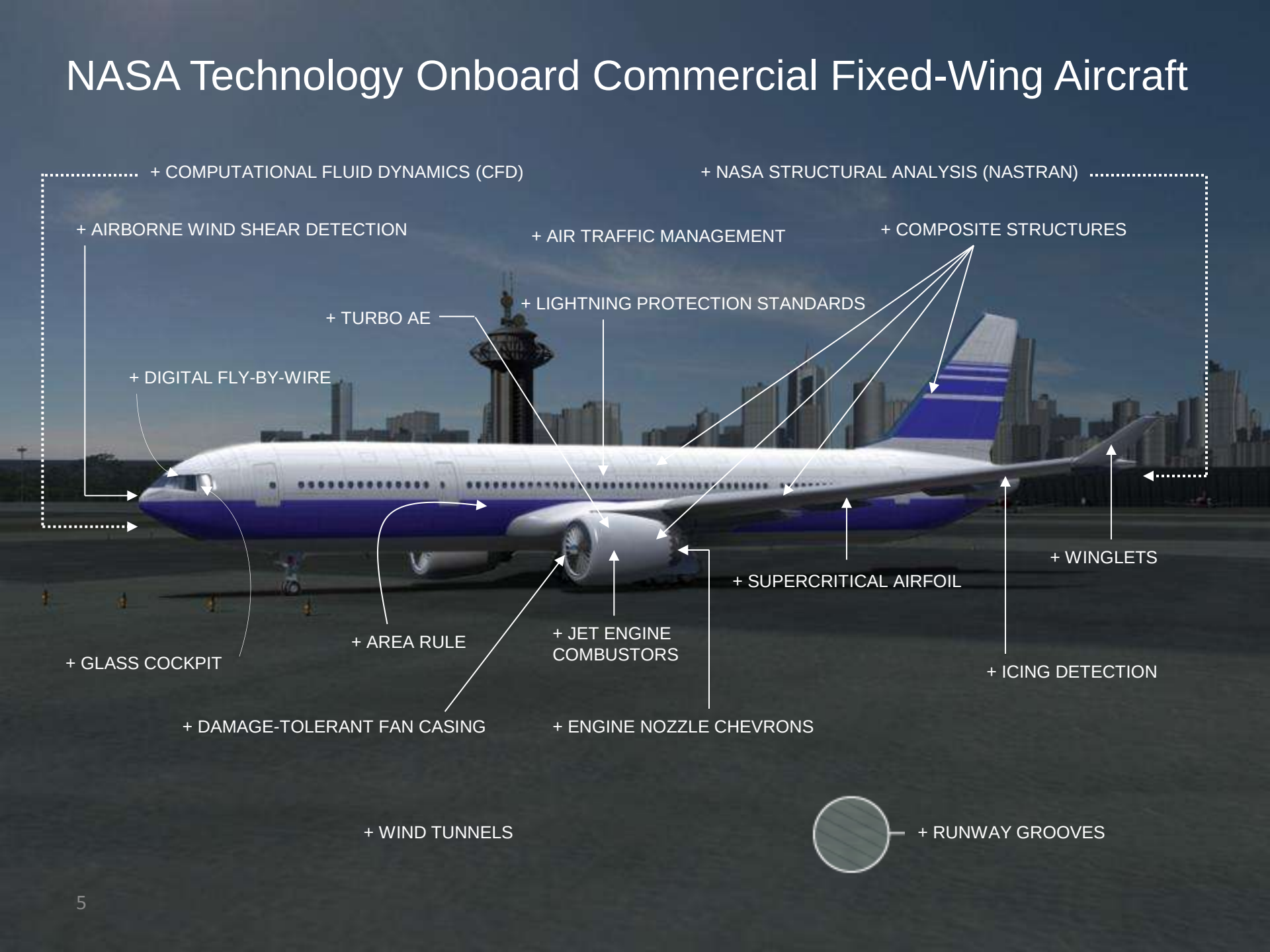

**Civil Aeronautics Manufacturing***

| | |
|---|---|
| 2008 | 1,096,000 jobs |
| 2009 | 1,112,000 jobs |

"Sales orders for all four versions of the GTF engine, which each have an estimated price of $12 million, have prompted Pratt to add nearly 500 engineers at its East Hartford, Conn., headquarters. "We haven't done this in some time," says Sue Gilbert, director of human resources…. Every business in the area, from real estate to dentists to pizzerias, could benefit." – **Time Magazine**

* FAA 2011

# NASA Technology Onboard Commercial Fixed-Wing Aircraft



# Where do we see NASA's benefits today?

NASA's fundamental research can be traced to ongoing innovation.

## Boeing 787

**NASA's work on these technologies**

- Advanced composite structures
- Chevrons
- Laminar flow aerodynamics
- Advanced CFD and numeric simulation tools
- Advanced ice protection system

**Was transferred for use here**

*824 confirmed orders through August 2012*

Boeing 787

**Benefits**

- 20% more fuel efficient/ reduced $CO_2$ emissions
- 28% lower $NO_x$ emissions
- 60% smaller noise footprint

Source: Boeing

## Boeing 747-8

**NASA's work on these technologies**

- Advanced composite structures
- Chevrons
- Laminar flow aerodynamics
- Advanced CFD and numeric simulation tools

**Was transferred for use here**

*106 confirmed orders through August 2012*

Boeing 747-8

**Benefits**

- 16% more fuel efficient/ reduced $CO_2$ emissions
- 30% lower $NO_x$ emissions
- 30% smaller noise footprint than 747-400

Source: Boeing

## P&W PurePower 1000G Geared Turbofan

**NASA's work on these technologies**

- Low $NO_x$ Talon combustor
- Fan Aerodynamic and Acoustic Measurements
- Low noise, high efficiency fan design
- Ultra High Bypass technology
- Acoustics Modeling and Simulation tools

**Was transferred for use here**

*Proposed for Airbus A320NEO, Bombardier C-Series, Mitsubishi Regional Jets*

P&W PurePower 1000G Geared Turbofan

**Benefits**

- 16% reduction in fuel burn/reduced $CO_2$ emissions
- 50% reduction in $No_x$
- 20dB noise reduction

Source: Pratt & Whitney

## CFM LEAP-1B

**NASA's work on these technologies**

- Compression system aerodynamic performance advances
- Low $NO_x$ TAPS II combustor
- Low pressure turbine blade materials
- High-pressure turbine shroud material
- Nickel-aluminide bond coat for the high pressure turbine thermal barrier coating

**Was transferred for use here**

*Proposed for Airbus A320NEO, Boeing 737MAX*

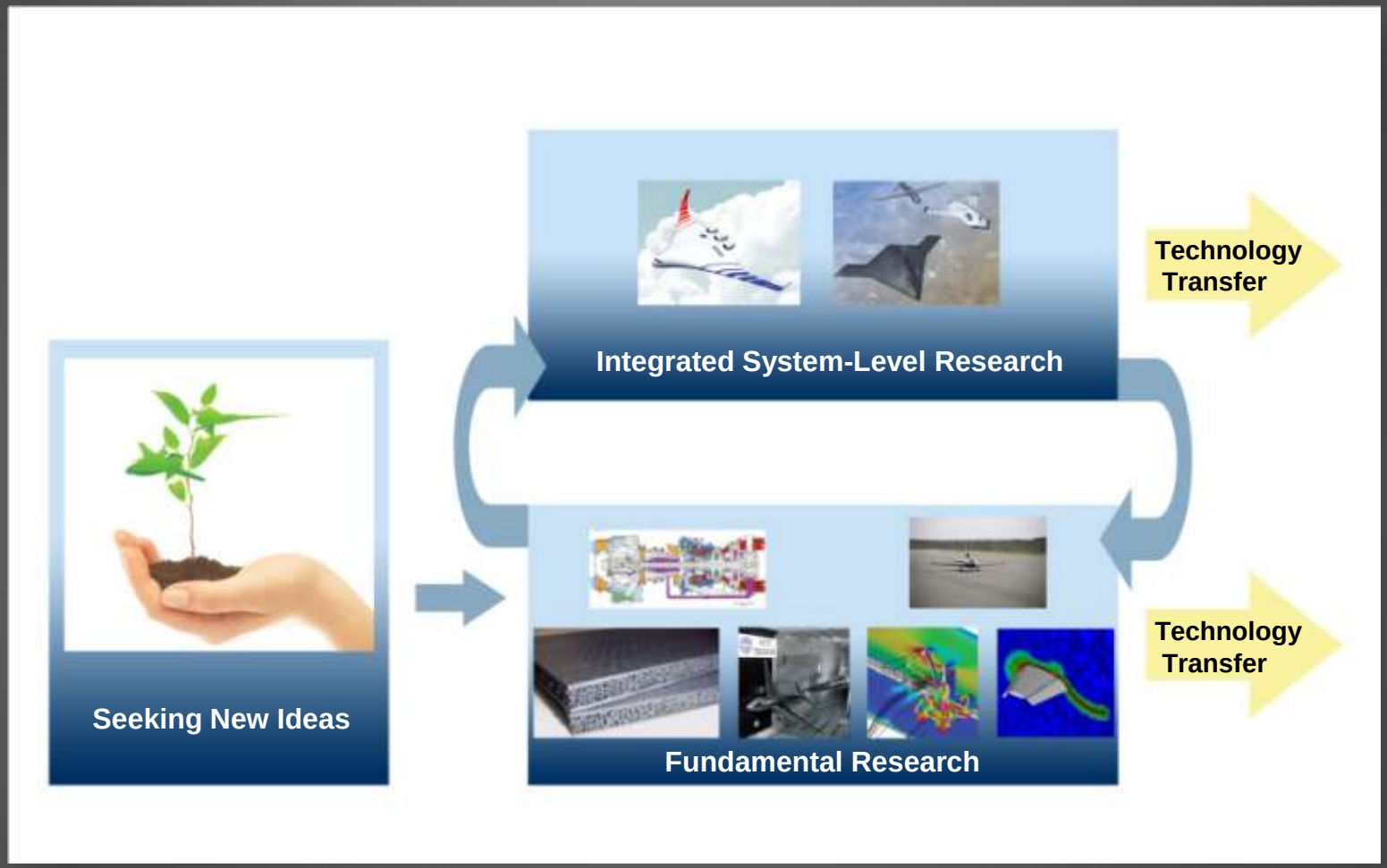
CFM LEAP-1B

**Benefits**

- 15% reduction in fuel burn/ reduced $CO_2$ emissions
- 50% less $NO_x$
- 15dB noise reduction

Source: CFM

# ARMD Investment Strategy




Enabling “Game Changing” concepts and technologies

# NASA Aeronautics Programs

## Fundamental Aeronautics Program

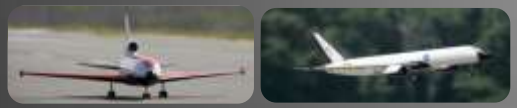
Conducts fundamental research to generate innovative concepts, tools, technologies and knowledge to enable revolutionary advances for a wide range of air vehicles.

## Integrated Systems Research Program

Conducts research at an integrated system-level on promising concepts and technologies and explore, assess and demonstrates the benefits in a relevant environment.

## Airspace Systems Program

Directly addresses the fundamental air traffic management research needs for NextGen by developing revolutionary concepts, capabilities, and technologies that will enable significant increases in the capacity, efficiency and flexibility of the NAS.



## Aviation Safety Program

Conducts cutting-edge research to produce innovative concepts, tools, and technologies to improve the intrinsic safety attributes of current and future aircraft and air traffic management systems.


## Aeronautics Test Program

Preserves and promotes the testing capabilities of one of the United States' largest, most versatile and comprehensive set of flight and ground-based research facilities.

# Collaboration with External Partners

## Other Government Agencies

U.S. ARMY

DARPA

## U.S. Industry

NORTHROP GRUMMAN

LOCKHEED MARTIN

Gulfstream

Raytheon

BOEING

United Technologies Research Center

## Academia

## International Organizations

JAXA

Japan Aerospace Exploration Agency

NRC·CNRC Canada

DLR

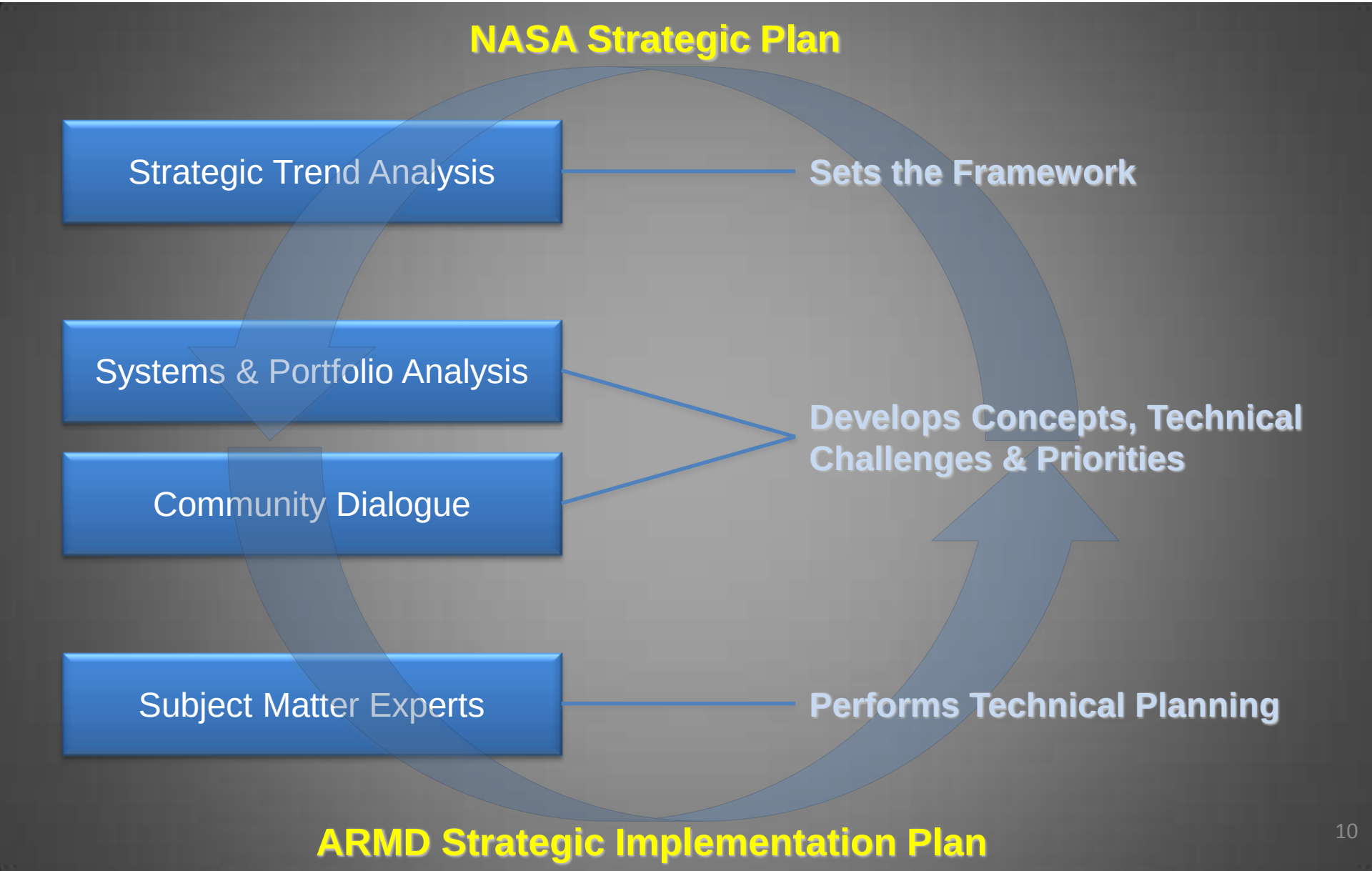
NLR

ONERA

THE FRENCH AEROSPACE LAB

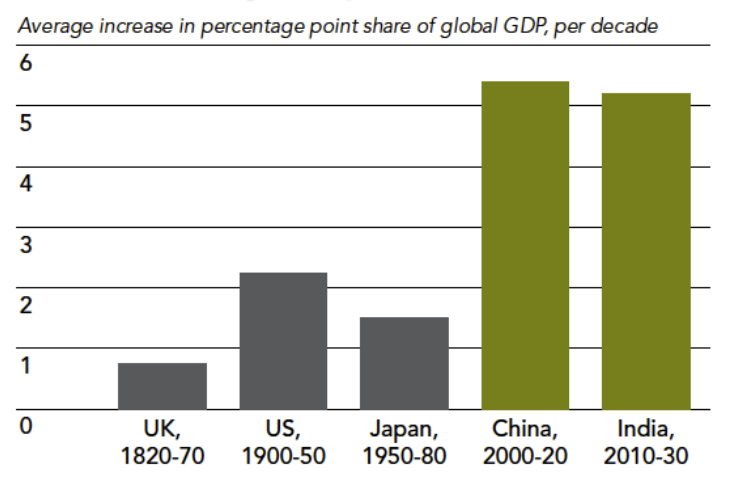
**Aeronautics**

# Approach to Planning

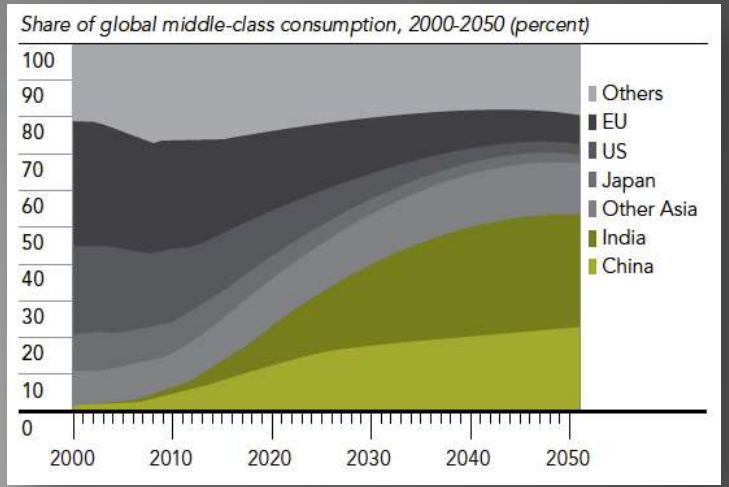


# Exploring Strategic Trends
## Challenges Traditional Approaches

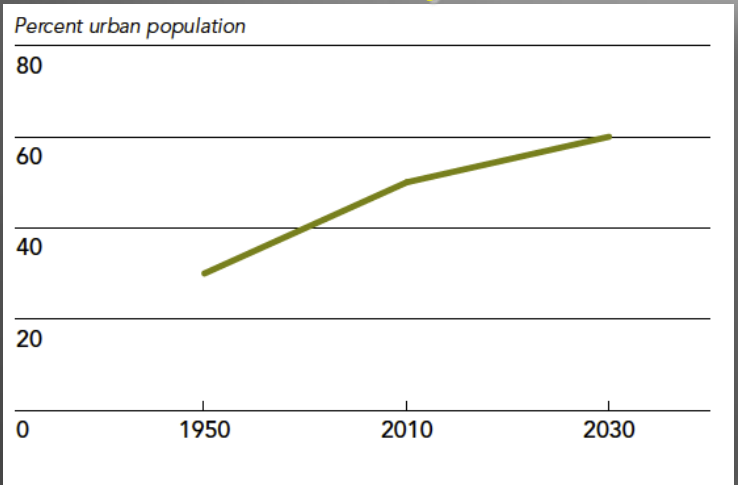
### China & India Growing Economically at Historically Unprecedented Rates



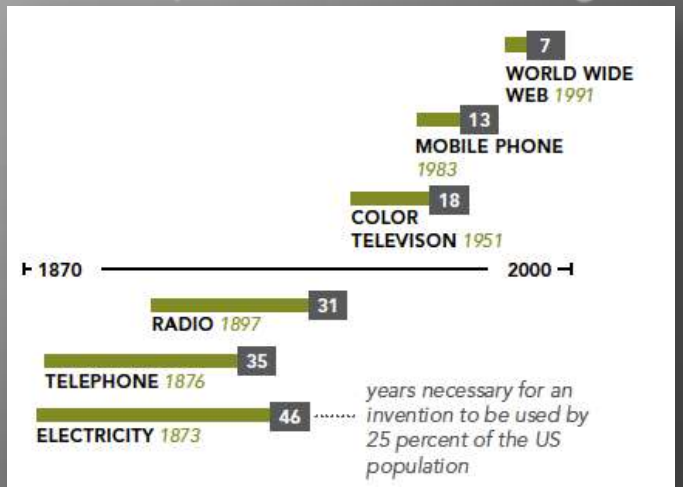

### They will have the Largest Middle-Class




### The World will be Predominantly Urban



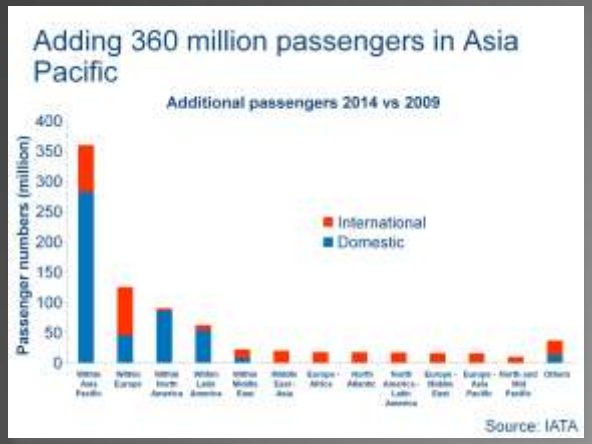

### Technology Development & Adoption is Accelerating



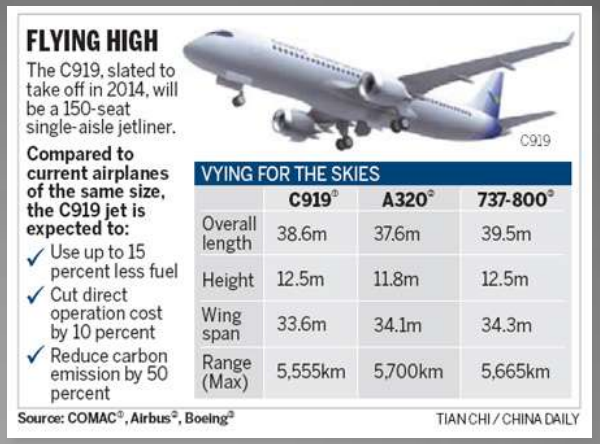

Source: National Intelligence Council

# Why are these trends important?

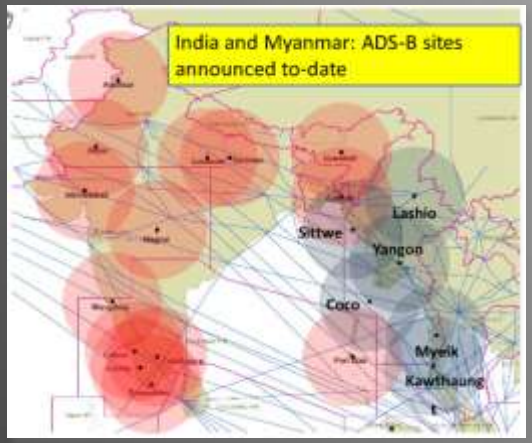
## Challenges are multiplying and accelerating – technology is a key lever!



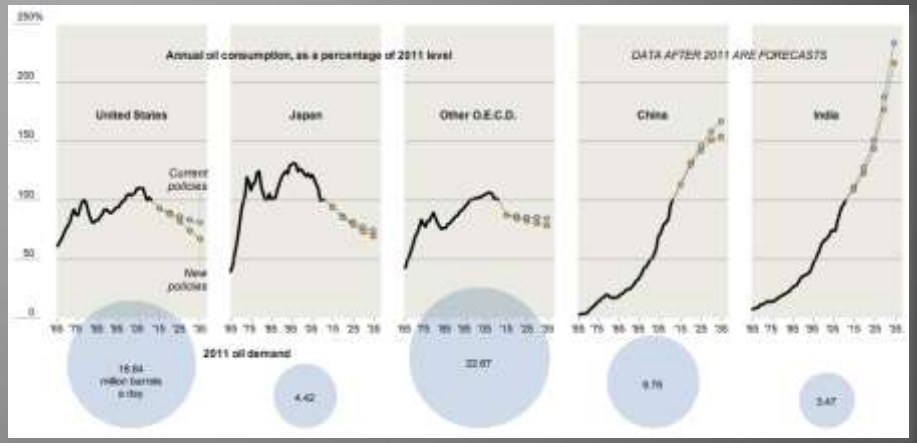

It drives global demand growth for air travel…




It drives expanding competition for high tech manufacturing…




It enables “leapfrog” adoption of new technology/infrastructure…

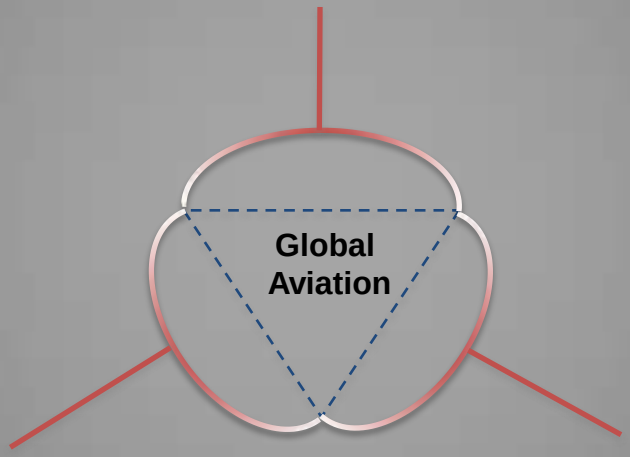



It drives resource use, costs, constraints and impacts…

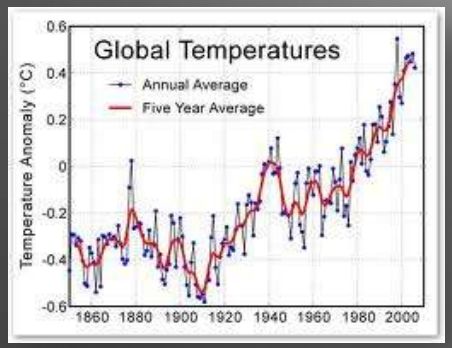
# These Trends Create Aviation Mega-Drivers

*Three critical vectors*

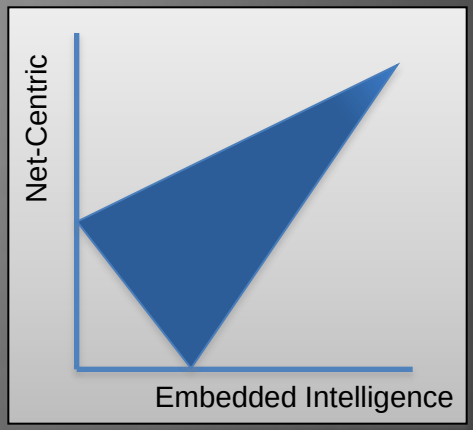
**Global Growth in Demand for High Speed Mobility**




**Global Climate Change, Sustainability, & Energy Transition**




**Technology Convergence**



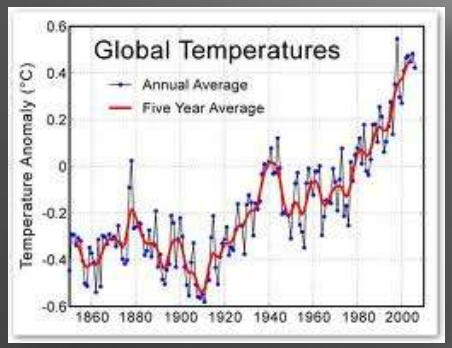
# Aviation Mega-Drivers

*Three critical vectors*

**Global Growth in Demand for High Speed Mobility**

**Global Aviation**

**Global Climate Change, Sustainability, & Energy Transition**

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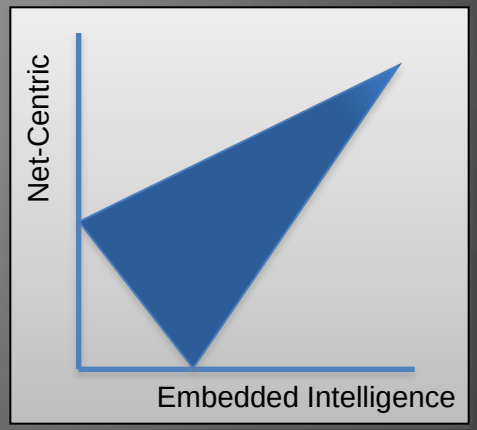
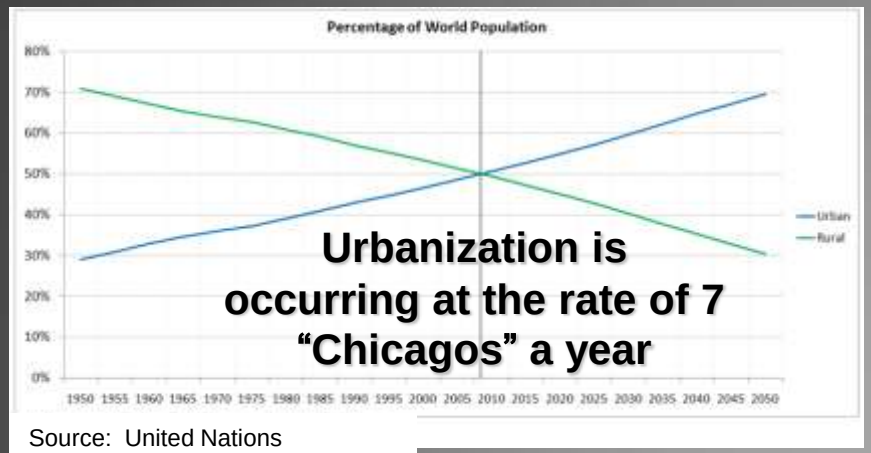
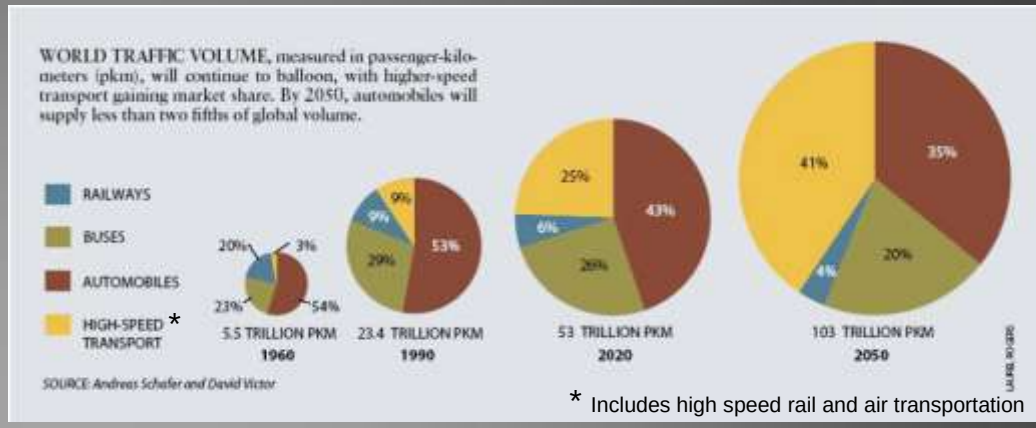


# Air Transportation - A Critical Global Capability

**Century long trend toward urbanization…**




Source: United Nations




* Includes high speed rail and air transportation

**Century long trend toward higher speed transport…**

## International Air Transport Association (IATA) – Vision 2050

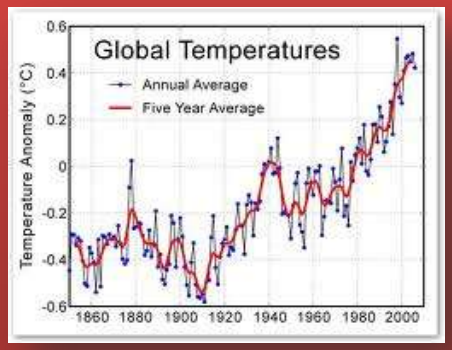
The world in 2050: "Traffic has grown from 2.4 billion to 16 billion passengers in the last 40 years…Technologically advanced aircraft operating on advanced renewable energy sources and capable of carrying anywhere from 2 to 2000 passengers connect intercontinental traffic through a dozen global gateways feeding them to 50-75 regional hubs which redistribute onwards to local airports."

# Aviation Mega-Drivers

*Three critical vectors*

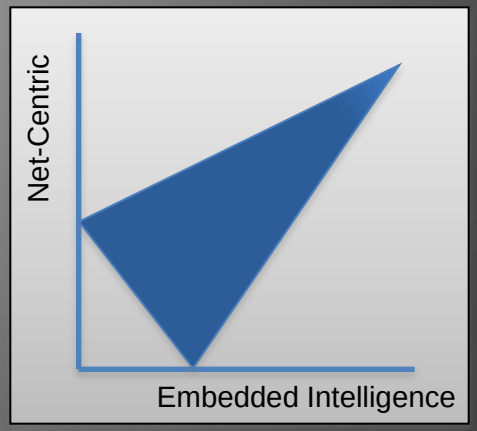
**Global Growth in Demand for High Speed Mobility**

**Global Climate Change, Sustainability, & Energy Transition**




**Global Aviation**

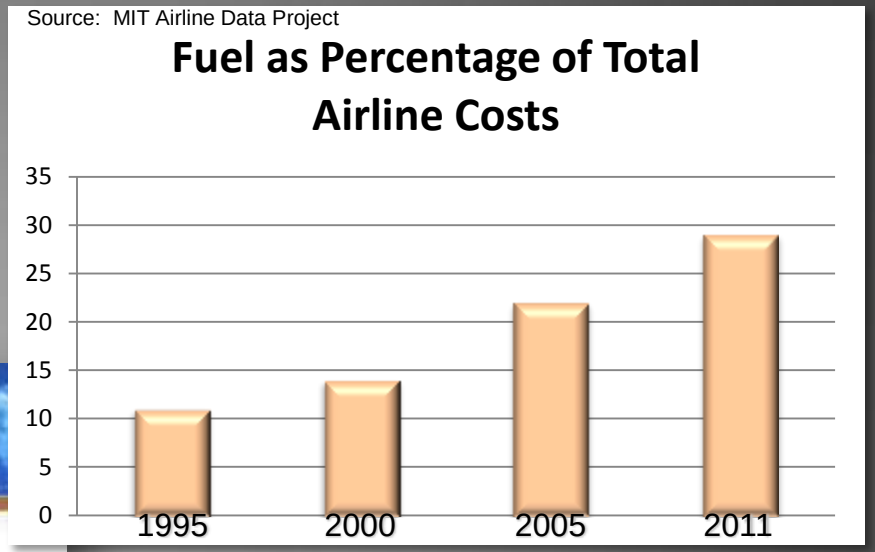
**Technology Convergence**



# Escalating Fuel Prices have a Large Aviation Impact

**"Fuel is the only major cost item that has become significantly larger over time"**
**IATA**

Source: MIT Airline Data Project





Source: A4A

# Aviation Mega-Drivers

*Three critical vectors*

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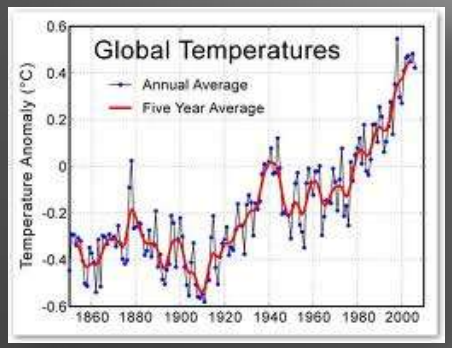
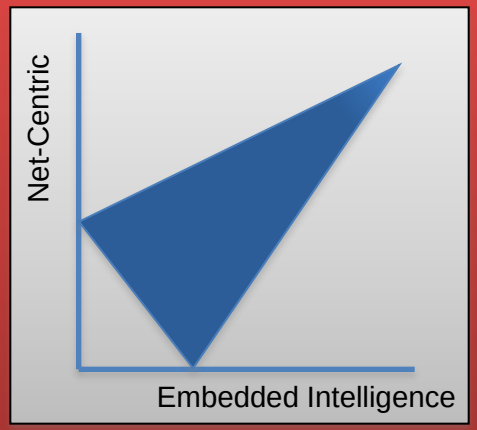



**Global Aviation**

**Technology Convergence**



# Technology Convergence

## Enabling Assured Autonomy for Safety Critical Systems

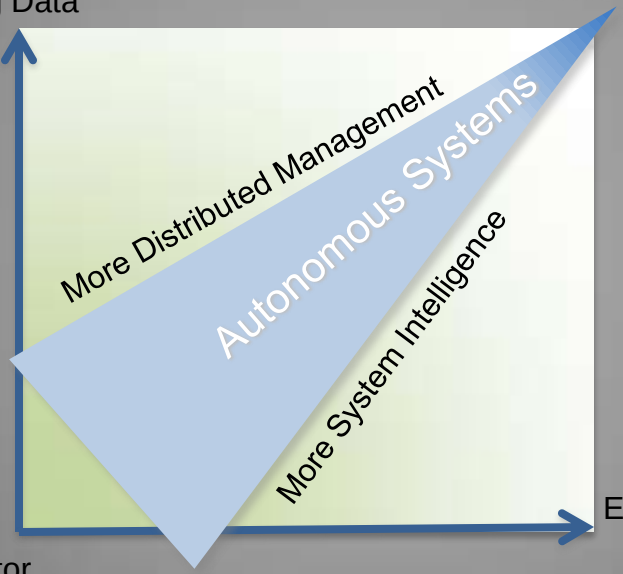
Net-Centric Information – Big Data

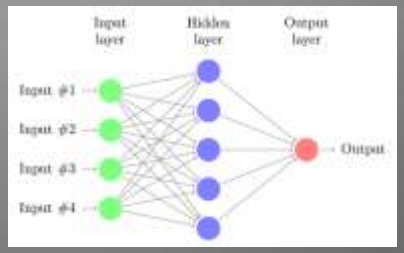
**Reduce Operations Costs**

**Improve Performance**

**Increase Safety**

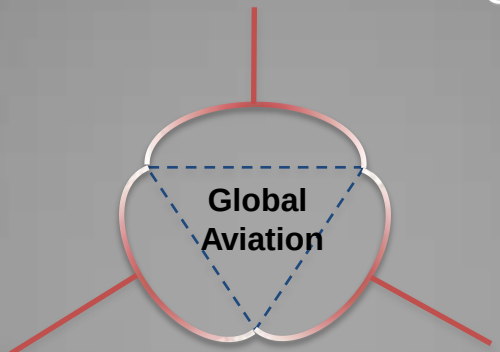
**Transform Mobility – On Demand Aviation**

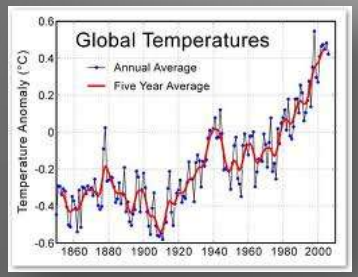


# Summary of Strategic Trends

Traditional measures of demand for mobility growing rapidly
- Rapid growth of developing economies
- Global urbanization



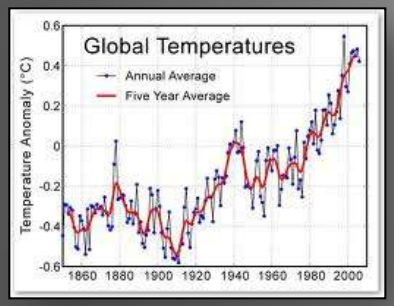



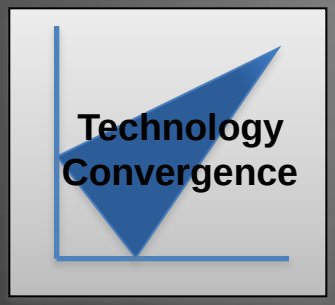

Severe energy and climate issues create enormous affordability and sustainability challenges


Revolution in automation, information and communication technologies enable opportunity for safety critical autonomous systems

# Strategic Response

## 3 Mega-Drivers




## 6 Strategic Research & Technology Thrusts

**Safe, Efficient Growth in Global Operations**

**Innovation in Commercial Supersonic Aircraft**

**Ultra-Efficient Commercial Transports**

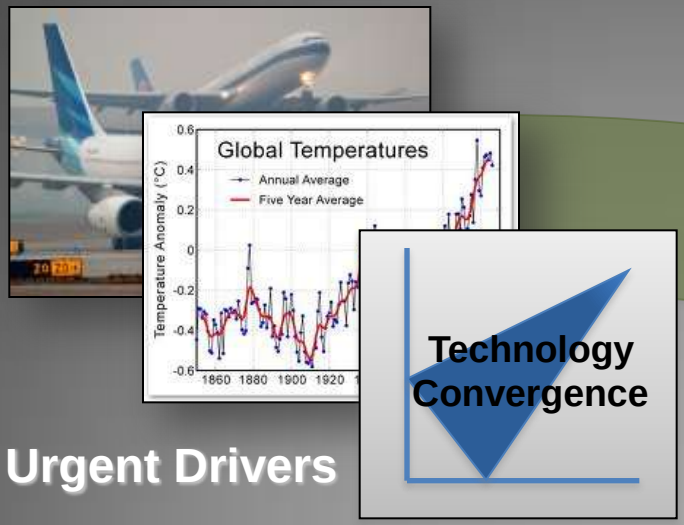
**Transition to Low-Carbon Propulsion**

**Real-Time System-Wide Safety Assurance**

**Assured Autonomy for Aviation Transformation**

# Vision: A Revolution in Sustainable, High Speed Global Mobility

# Summary




**Urgent Drivers**

**Innovative Solutions & High Payoff Technologies**

Economic Growth
High Quality Jobs
Revolutionary Mobility
Long-Term Sustainability