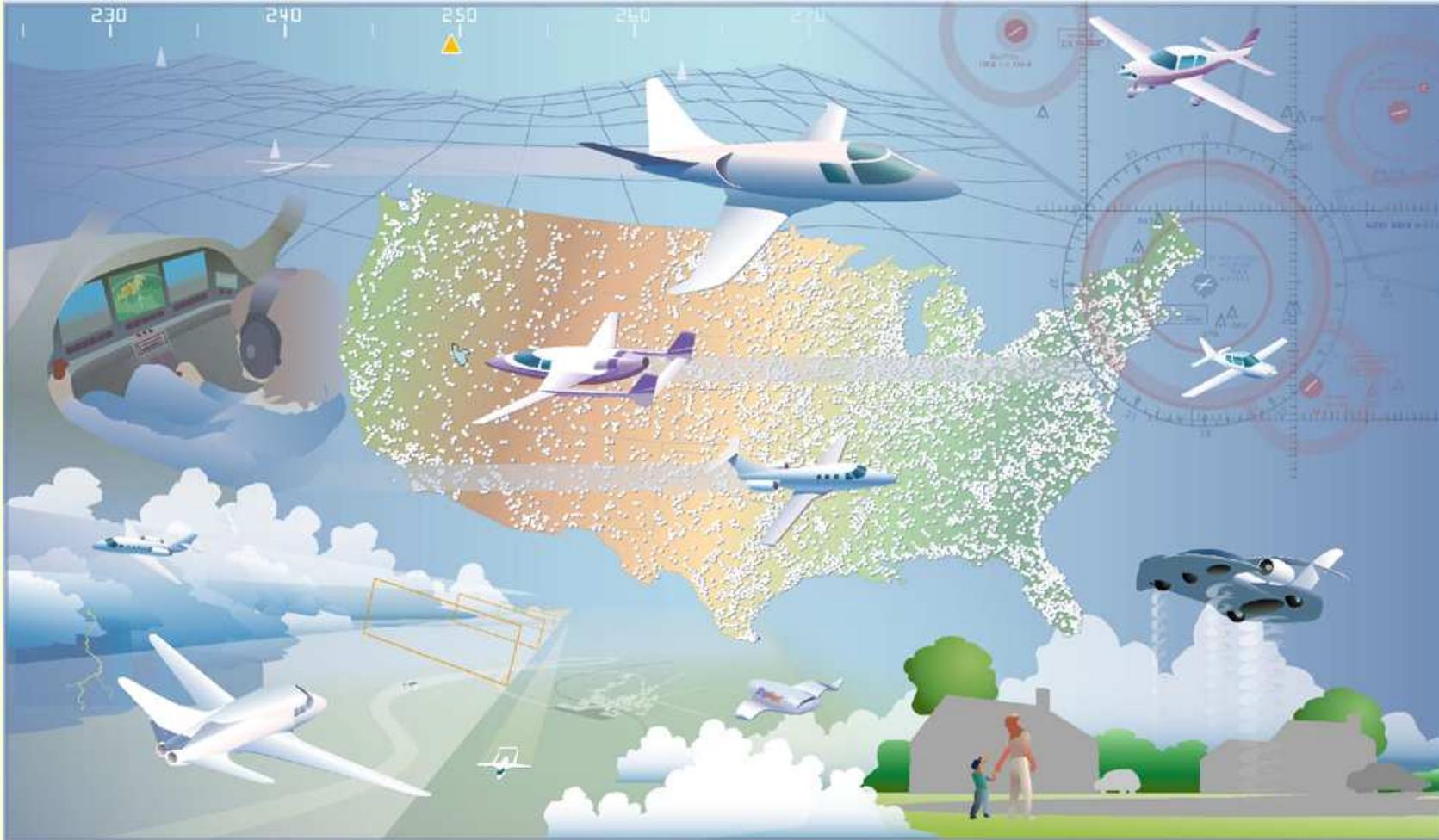




# ***Alternatives for Air Mobility***

## ***SAE World Aviation Congress***

### ***Plenary Session***



**BRUCE J. HOLMES**  
**NASA LANGLEY RESEARCH CENTER**  
**November 10, 2002**



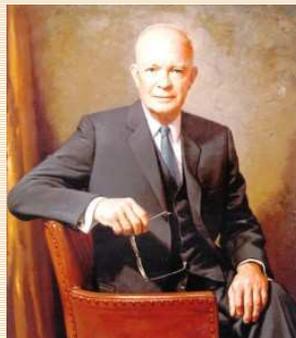
# ***Two Centuries of Historical Context for Disruptive Innovation in Transportation Systems***



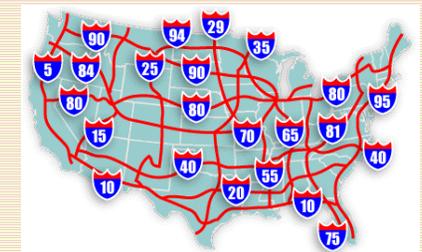
**Jefferson sends  
Lewis and Clark  
to search for a path  
for commerce**



**The Transcontinental  
Railroad connects  
east and west**



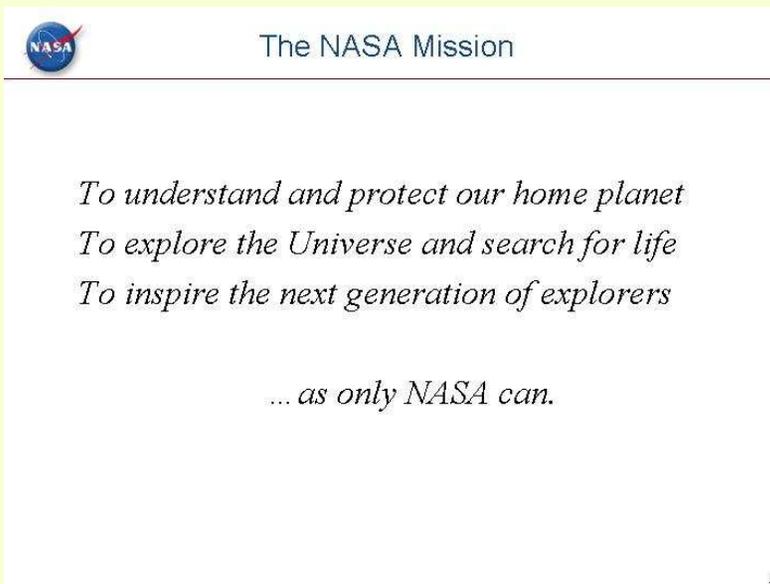
**The Interstate Highway  
system connects  
the nation's cities**





# Technical Context for Mobility Alternatives

1. Moore's Law on microprocessor performance
2. Gilder's Law on bandwidth performance
3. Metcalf's Law on network performance
4. The unwritten law of abundance
5. The unwritten rule of gridlock
6. Kurzweil's Law of Accelerating Returns
7. The Golden Rule of the information age



The NASA Mission

*To understand and protect our home planet  
To explore the Universe and search for life  
To inspire the next generation of explorers*

*... as only NASA can.*

5



Aeronautics  
**Blueprint**  
*toward A Bold New Era of Aviation*

2002 2003 2008 2019 2022

Revolutionary Vehicles  
On Demand Mobility

Educated Workforce  
National Security

**The Aeronautics Blueprint**

- A National Imperative -

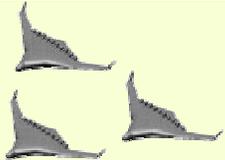
■ The cost of inaction is gridlock, constrained mobility, unrealized economic growth, and loss of U.S. aviation leadership.

Figure 3



# Integrated Advancements In Airspace and Aircraft

## Airspace Capability



- Ubiquitous Airspace Accessibility
- Automated Airspace Procedures
- Dynamic Airspace Procedures
- Aircraft Autonomy
- Systemic (Flocking, Networked) Operations
- Airborne Mobile Internet-based CNS
- Distributed Air-Ground Procedures
- Non-towered, Non-radar Airspace Use
- NAS Evolution

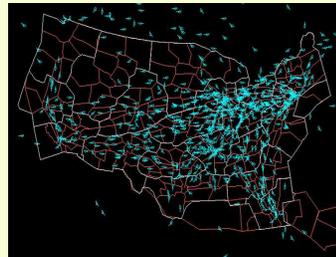


## Future State

Dual-State:  
On-Demand, Point-  
to-point  
& Hub Systems

## Current State

Hub & Spoke  
Long-Haul  
GA



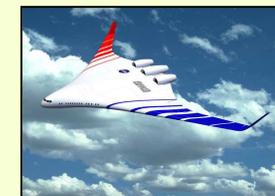
Point-to-Point



UAV's



Green  
Aircraft



Aircraft  
Utility

Cost  
Environment  
Safety/Security



## ***The Difficulty About Predictions...***

- 1. “The telephone has too many shortcomings to be seriously considered as a means of communication.”**  
– Western Union executive, 1876
- 2. “The problem with television is that the people must sit and keep their eyes glued on a screen; the average American family hasn’t time for it.”**  
– NY Times, 1939 (World’s Fair)
- 3. “I think there is a world market for maybe five computers.”**  
– IBM Chairman Thomas Watson, 1943
- 4. “Computers in the future may weigh no more than 1.5 tons.”**  
– Popular Mechanics, 1949
- 5. “There is no reason for individuals to have a computer in their home.”**  
- DEC Chairman Ken Olson (DEC), 1977
- 6. “640,000 bytes of memory ought to be enough for anybody.”**  
– Microsoft Chief Software Architect Bill Gates, 1981

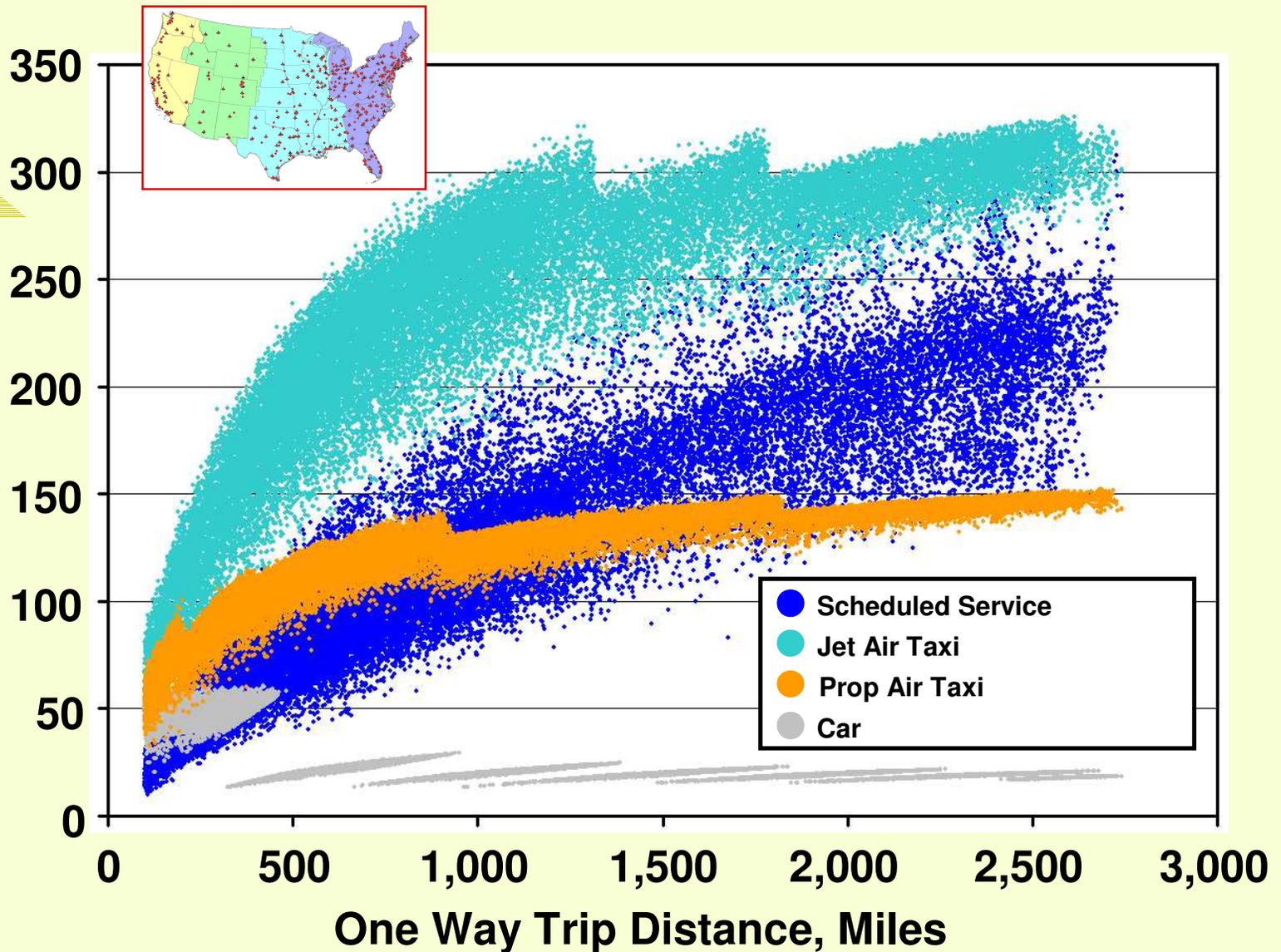


# If Time is Gold

Then Door-to-Door Speed is the Coin of the Realm



Door to Door  
Trip Speed,  
MPH



# ***Equitable, On-Demand, Distributed Air Mobility***

QuickTime™ and a Sorenson Video 3 decompressor are needed to see this picture.

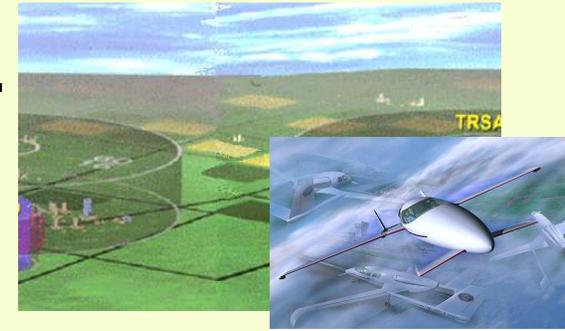
- **93% of population within 30 minutes of SATS-type airport**
- **22% within 30 minutes of major/hub airport**
- **~700 airports with Instrument Landing Systems**



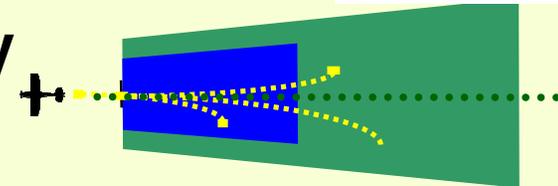
# ***Small Aircraft Transportation System Project***

## ***Operating Capabilities for Access to All Communities/***

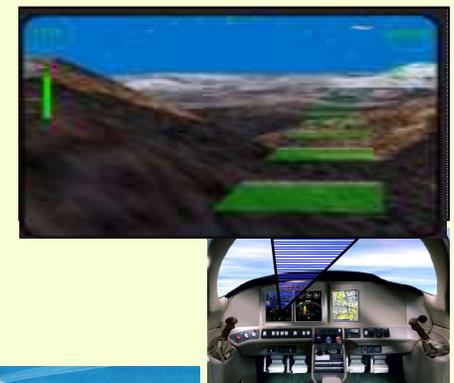
**Higher Volume Operations in Non-Radar  
Airspace and at Non-Towered Airports**



**Lower Landing Minimums at Minimally  
Equipped Landing Facilities**



**Increase Single-Pilot Crew Safety &  
Mission Reliability**

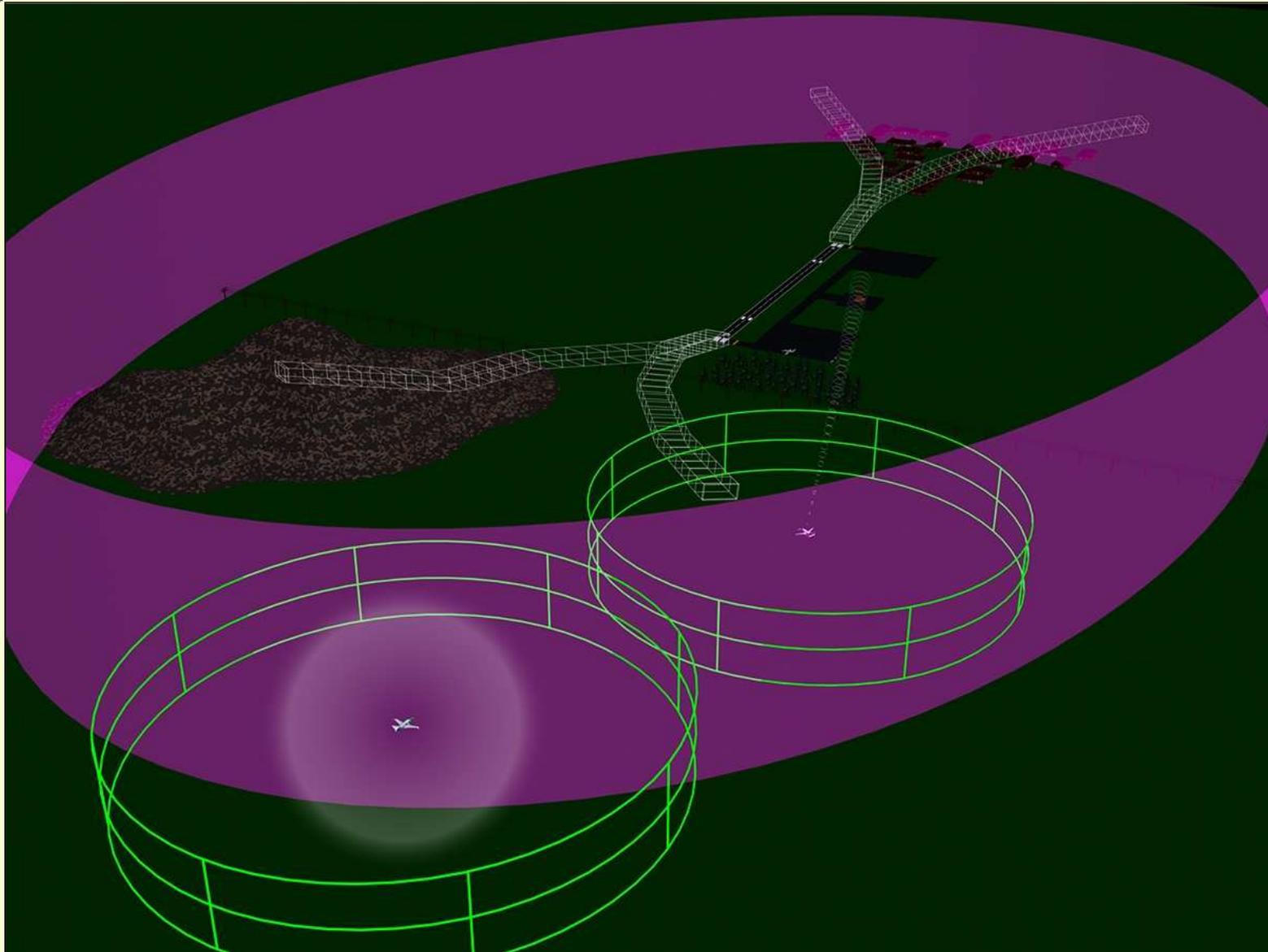


**En Route Procedures & Systems for  
Integrated Fleet Operations**





# *SATS Operating Capabilities*



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# A Revolution in the Cost of Speed

Toyota



Honda

Safirre



Adam Aircraft



Eclipse





# What Challenges Lie Ahead?

**Vehicle Systems:** A further revolution in the cost of vehicle speed is needed for:

- Shorter range, intra-urban, multi-point distributed mission (<100 miles)
- Mid-range, inter-city point-to-point missions (100-1,000 miles)
- Longer range (>2000 mile) high-speed point-to-point missions

**Airspace Systems:** A further revolution in airborne and airspace technologies and procedures automation to any runway end or helipad is needed for reliable ubiquitous accessibility:

- Cockpit system display/control/automation architectures
- Airspace system architectures and procedures automation

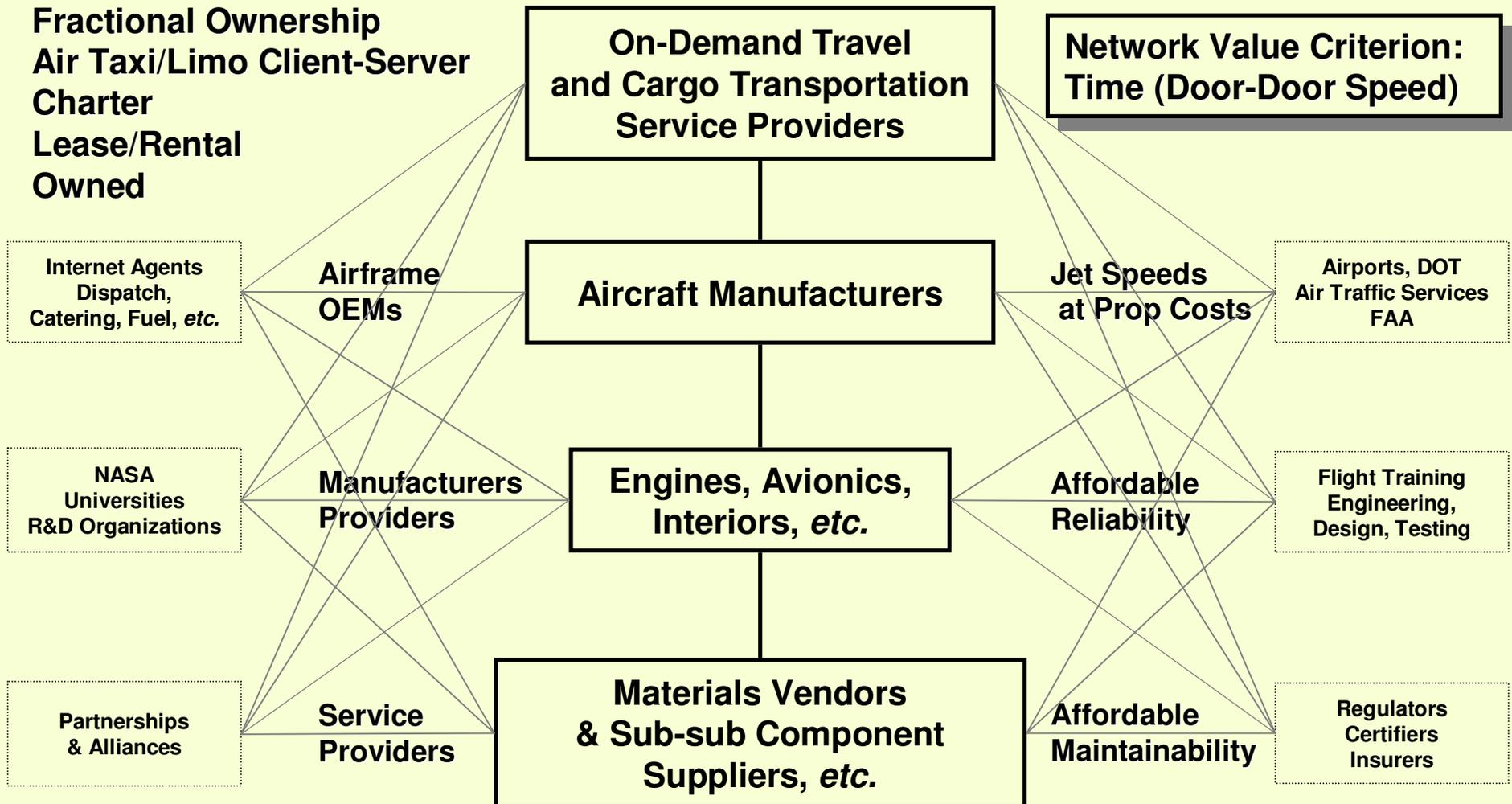




# New Value Network for Air Mobility

## Consumer Value Criteria for Disruptive Innovations

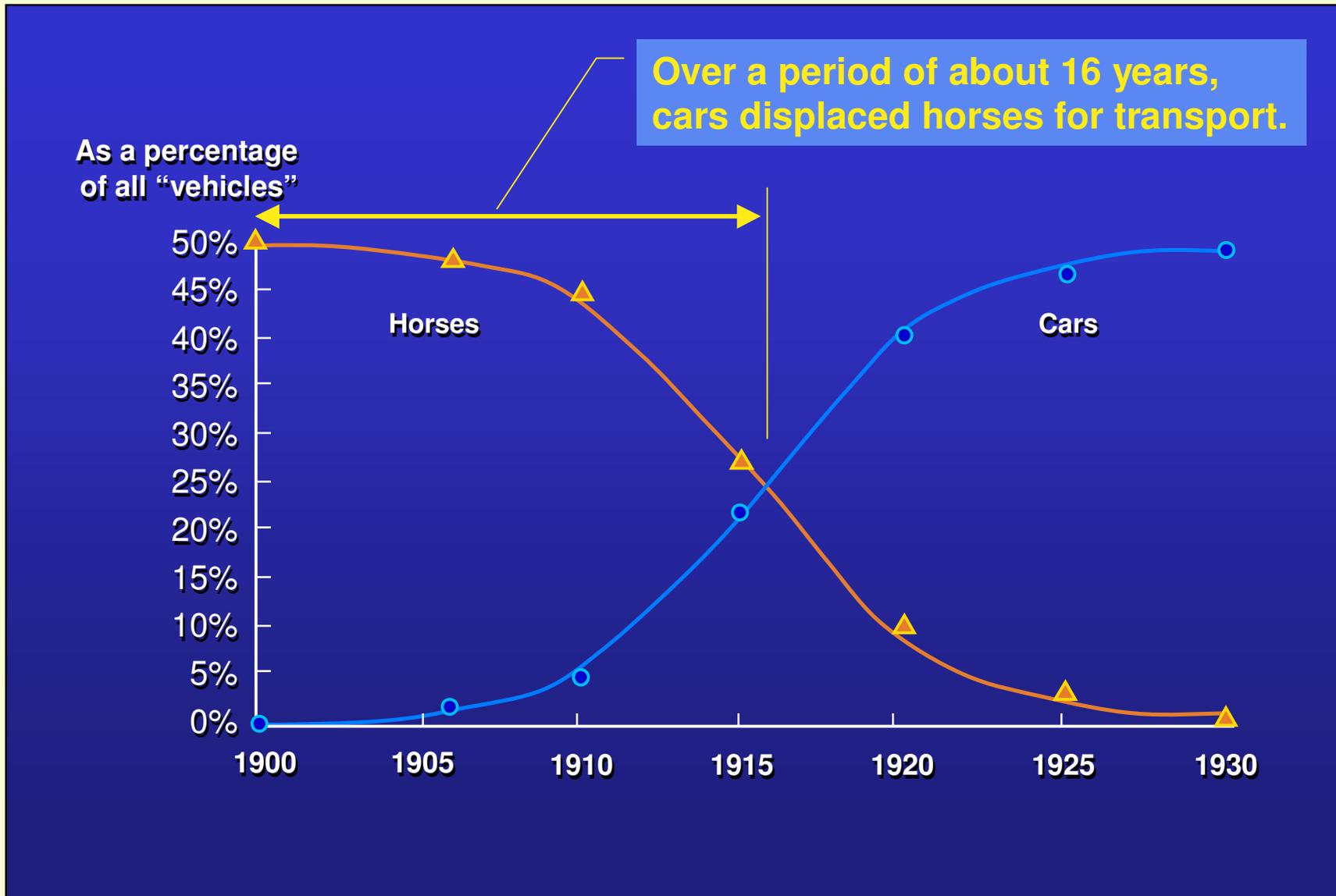
Expected rewards from new consumers of disruptive innovations drive new value network toward new value criterion.





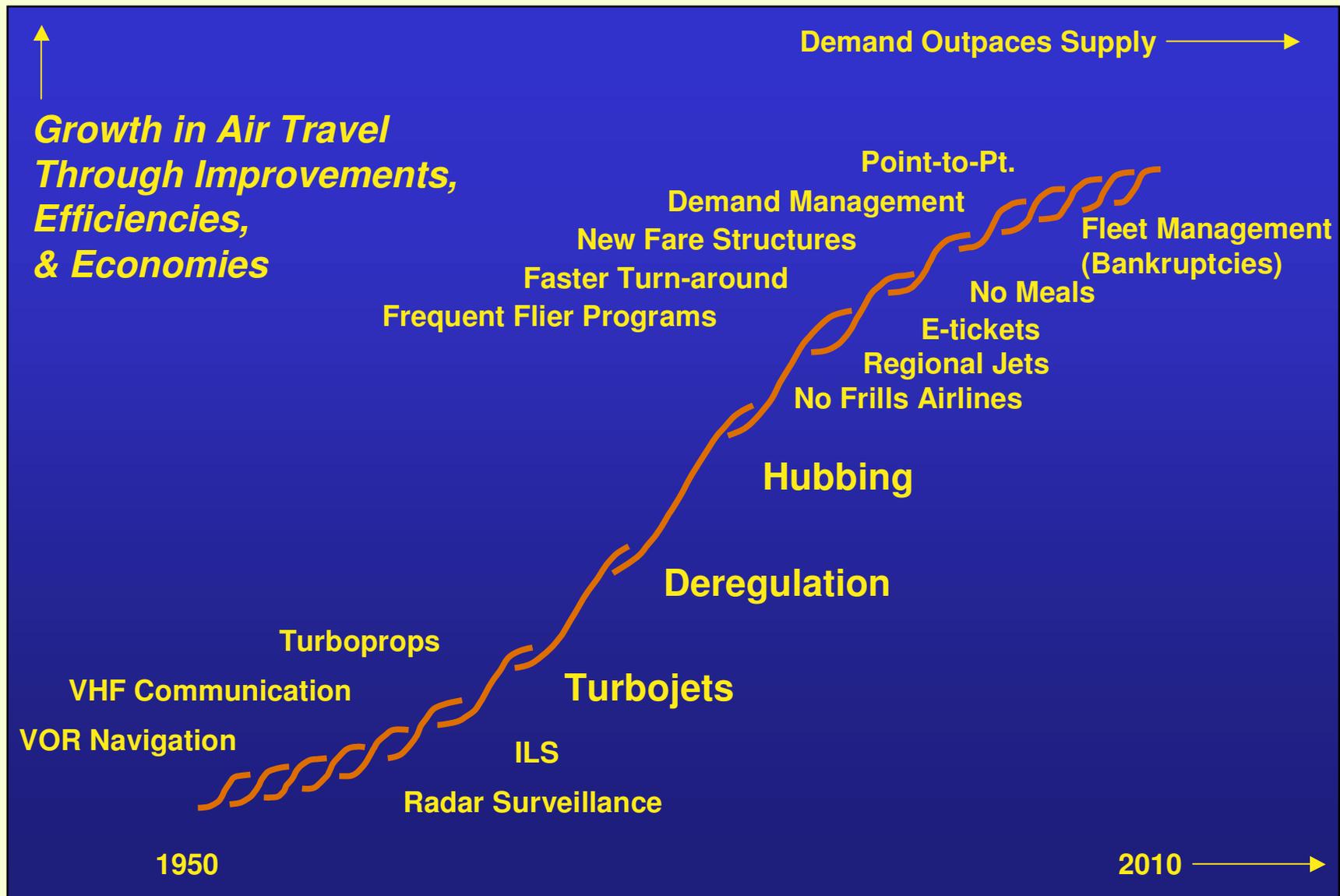
# The Substitution of Cars for Horses

N. Nakicenovic (1986)



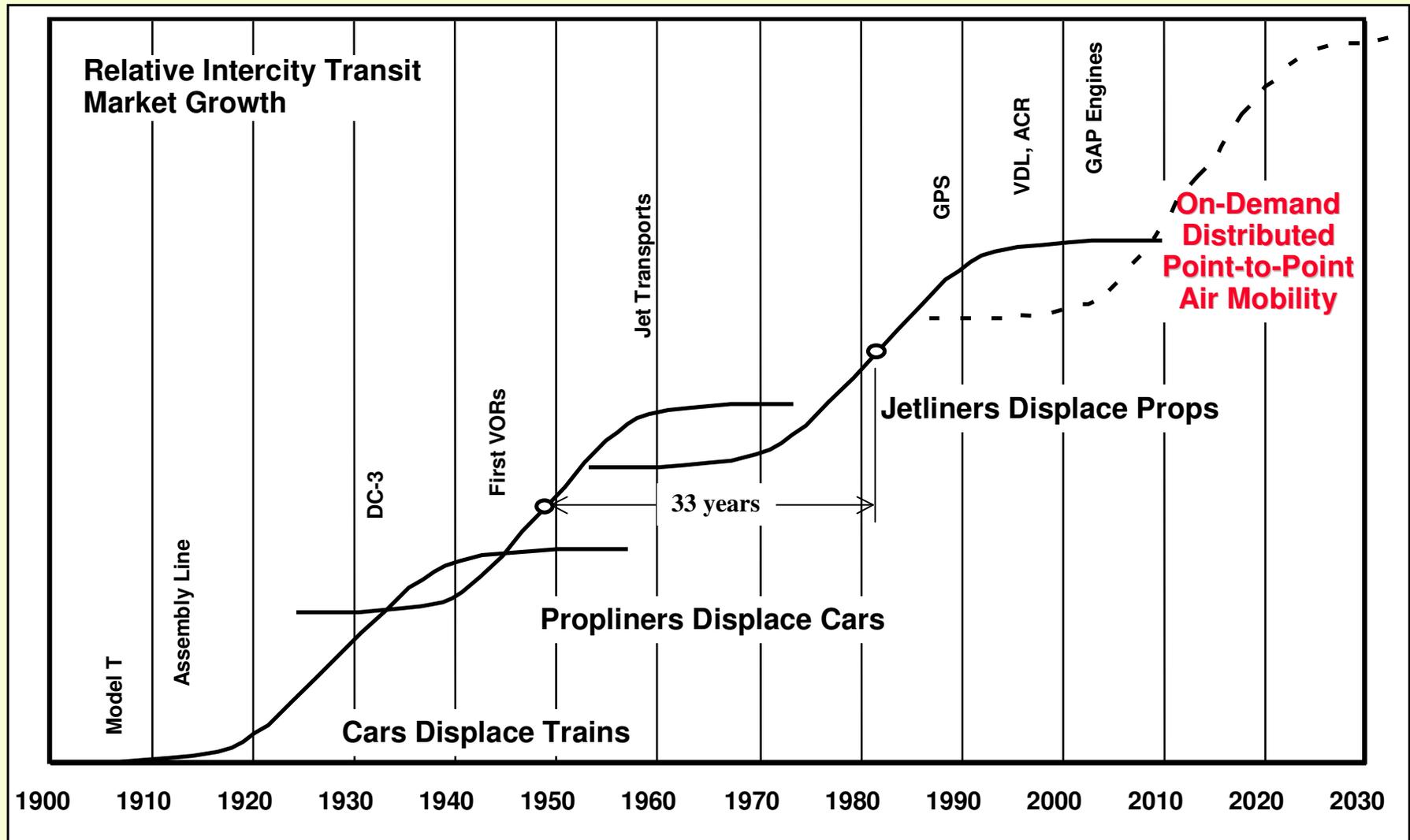


# A Notional Life Cycle of The Hub-and-Spoke Innovation





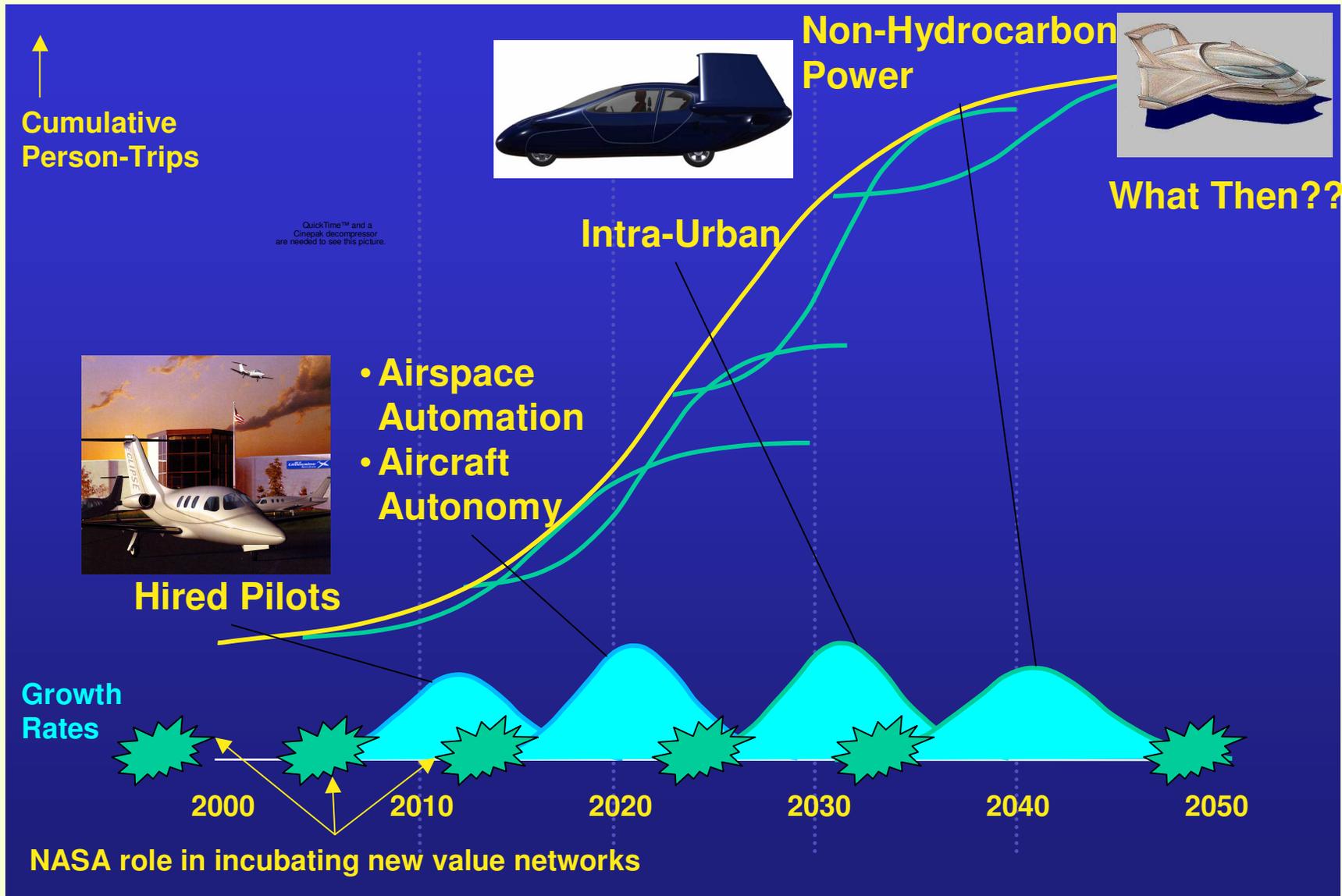
# Disruptive Innovations Re-Define the Market





# A Notional Life Cycle

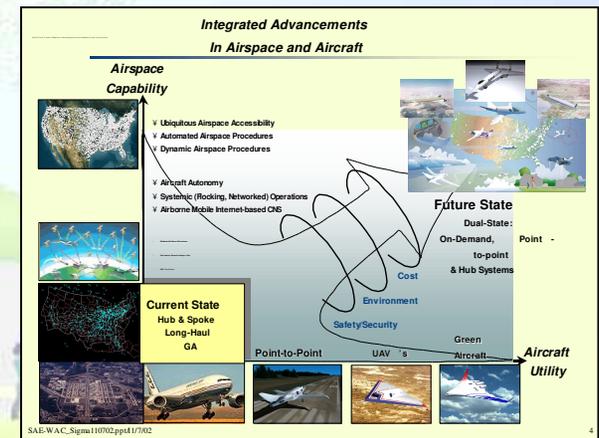
## For an Innovation in On-Demand, Distributed Air Mobility





# Summary

- The vision for alternatives in air mobility represents a logical step in a natural progression in the nation's history of disruptive transportation system innovations.
- While we cannot know what form the vision will ultimately take, the historical nature of transportation system innovations, along with the enabling technologies from AGATE, GAP, SATS, PAVE, NAST, VSP, AvSP, NAS OEP, *et.al.* suggest that ubiquitous and equitable personal air mobility could be a logical 21st century evolution.
- The role for NASA in this part of our portfolio is to host the incubation of new value networks for disruptive technology innovations.



# From Wheels on America to Wings on America



Equitable  
On-Demand  
Widely Distributed  
Point-to-Any Point  
21st Century Air Mobility