Transformation in Transportation Systems of the 21st Century

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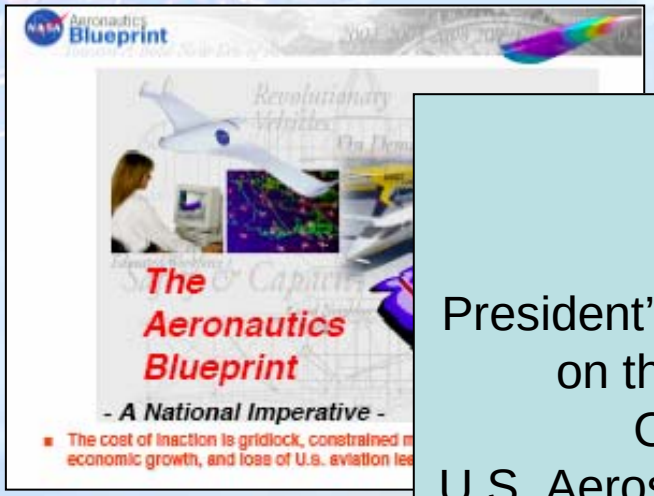
International Council of Aeronautical Sciences

Yokohama, Japan

September 2, 2004

JPDO Heritage



2001

President's Comm
on the Future
Of the
U.S. Aerospace In

2002

U.S. Public L
HR 2115
Section 709-7

2003

Integrated Plan for the
Next Generation
Air Transportation System

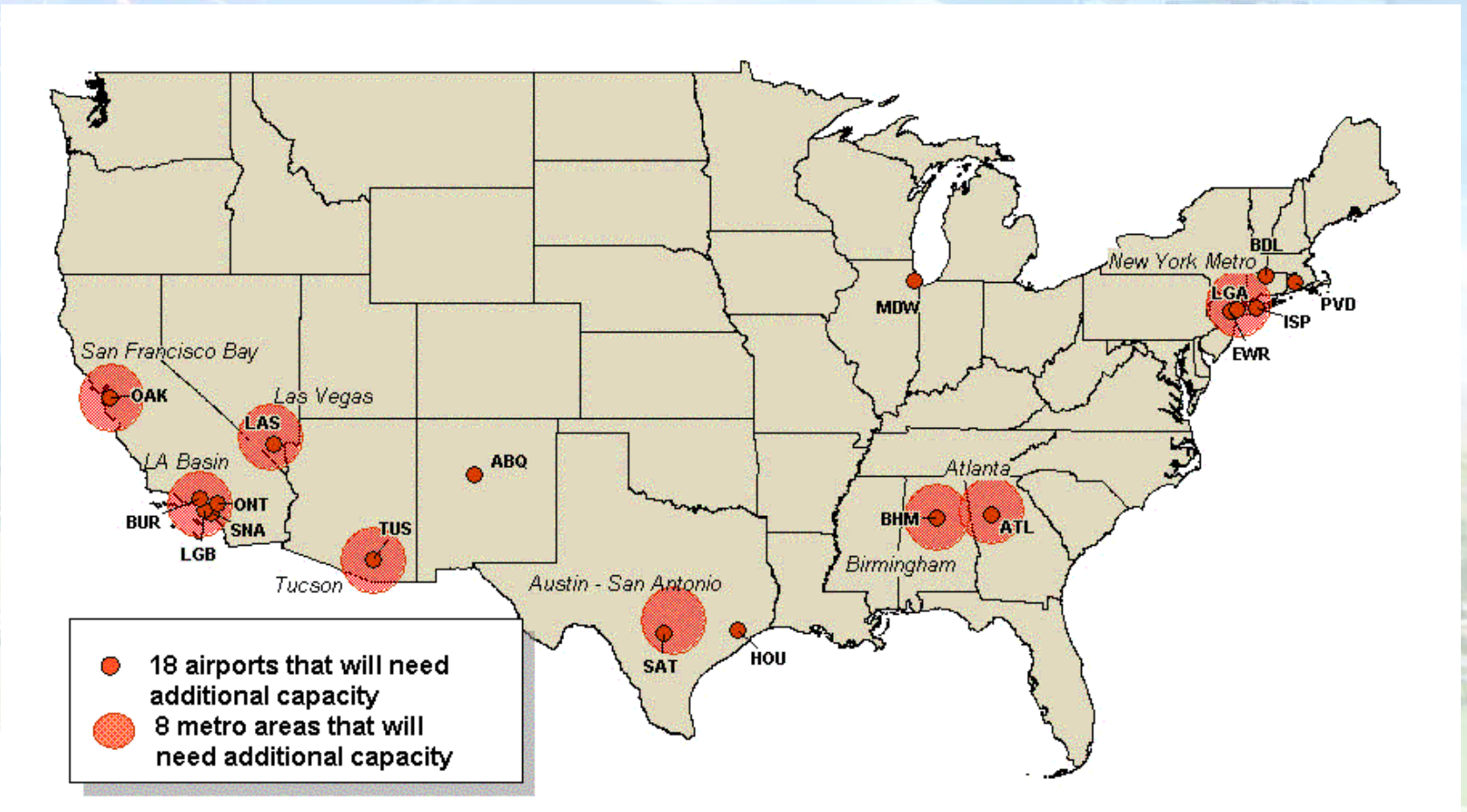
2004

Outline

1. **What is transformation?**
2. **How do we lead transformation?**
3. **How do we think about transformation?**

Network theory considerations offer additional understanding about strategic thinking for complex, adaptive systems, and their transformation

Anticipated Growth in Airport Congestion

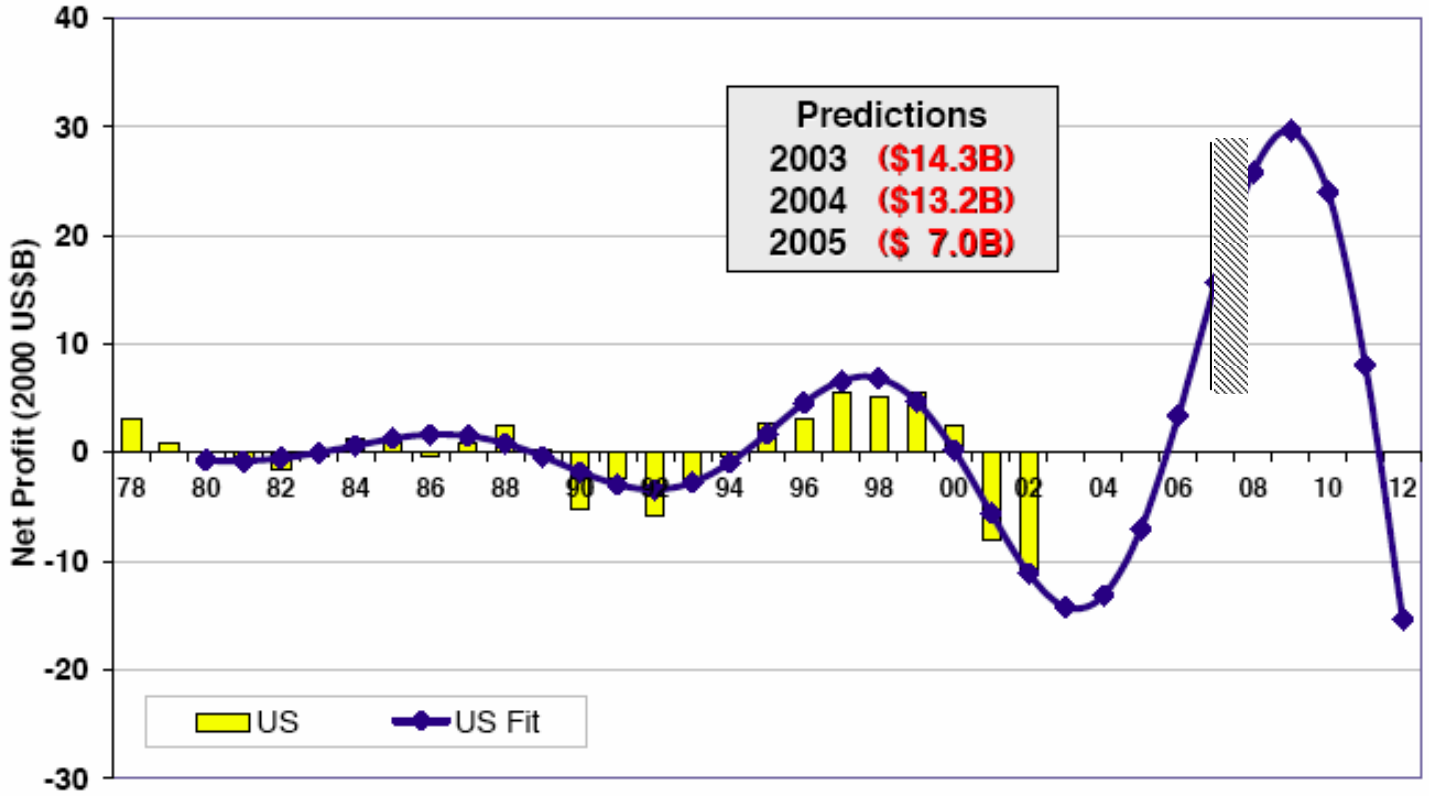


Whither or Wither?

US Airlines Net Profit Model - 2002

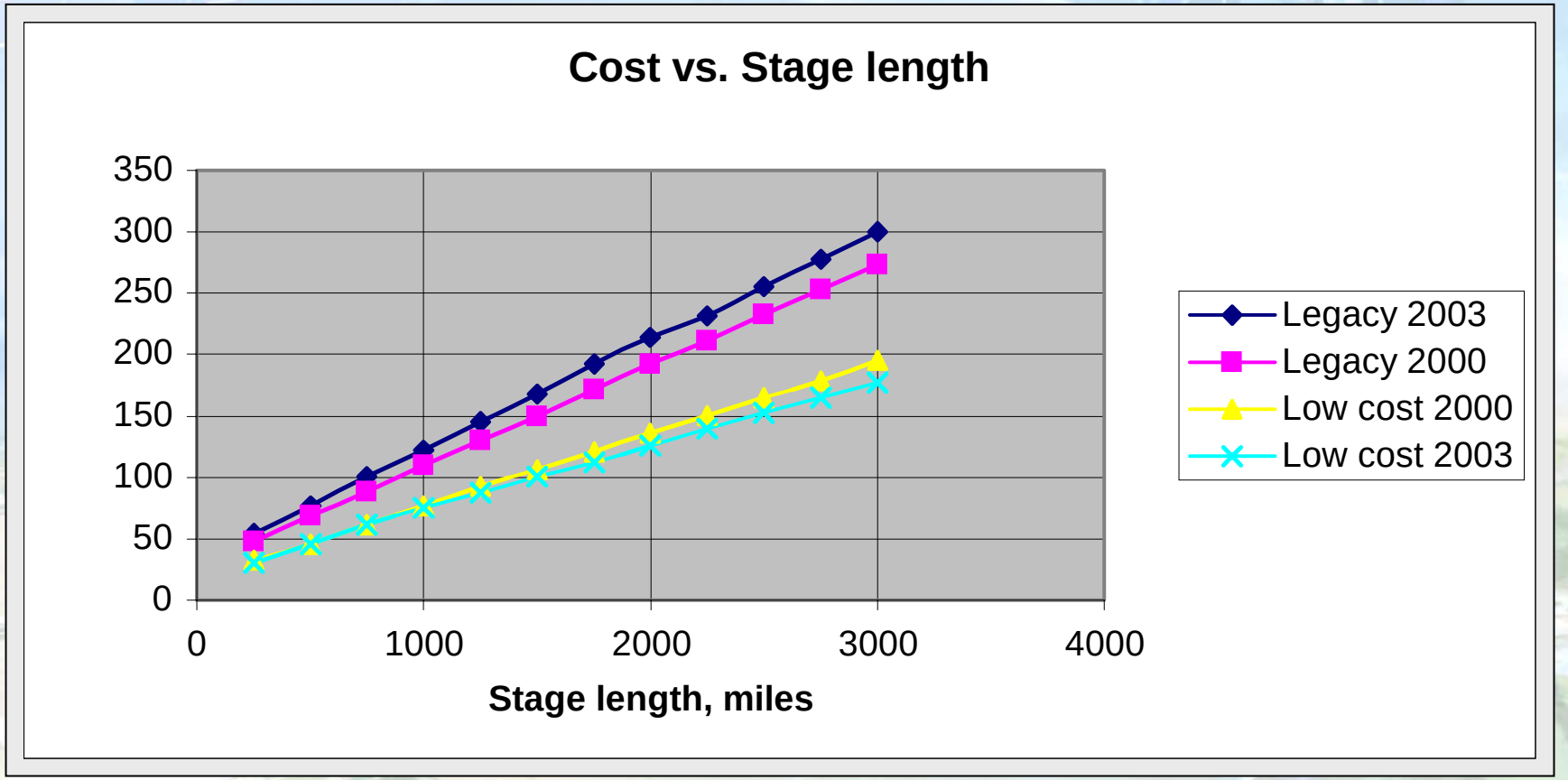
Best Fit of Undamped Oscillation

Cycle Period = 11.3 yr eFolding Time = 7.9 yr



NB: Predictions are in constant 2000 dollars.

The Widening Gap Between Legacy and Low Cost Carrier Operating Costs

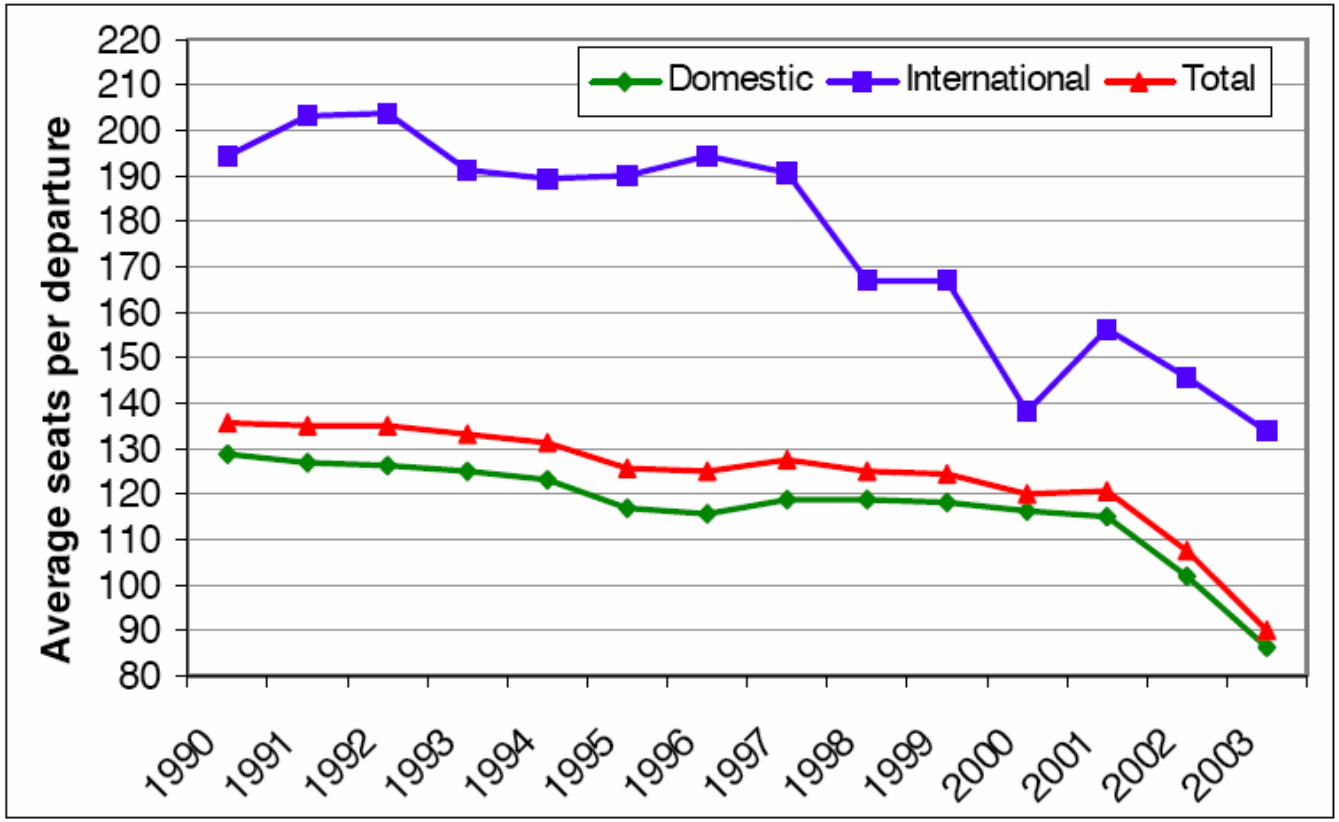


Based on data from U.S. Government Accountability Office Report GAO-04-836: Commercial Aviation -- Legacy Carriers Must Further Reduce Costs to Restore Profitability.

What's Really Happening Here?

MIT ICAT

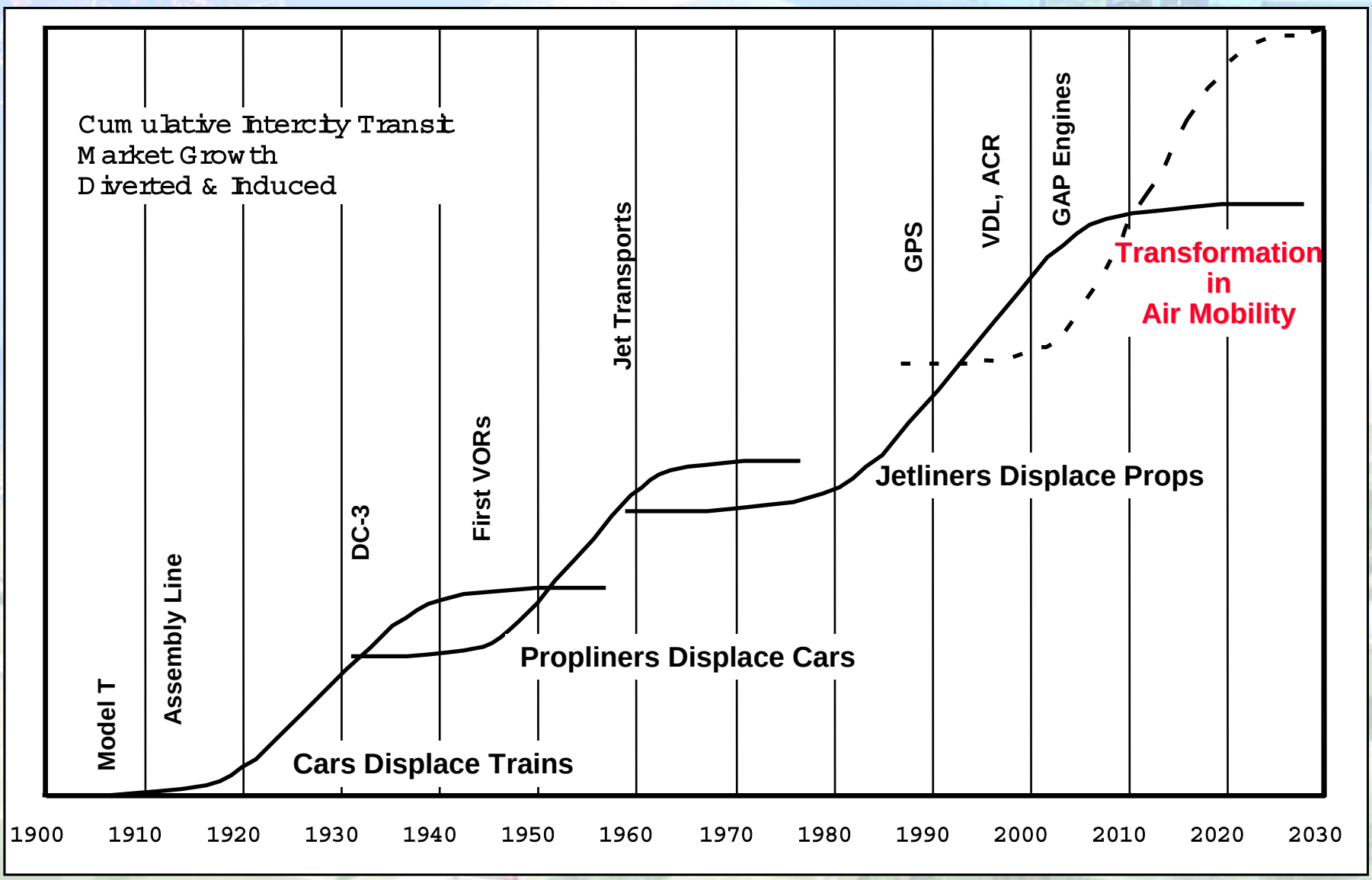
Trends in Aircraft Size



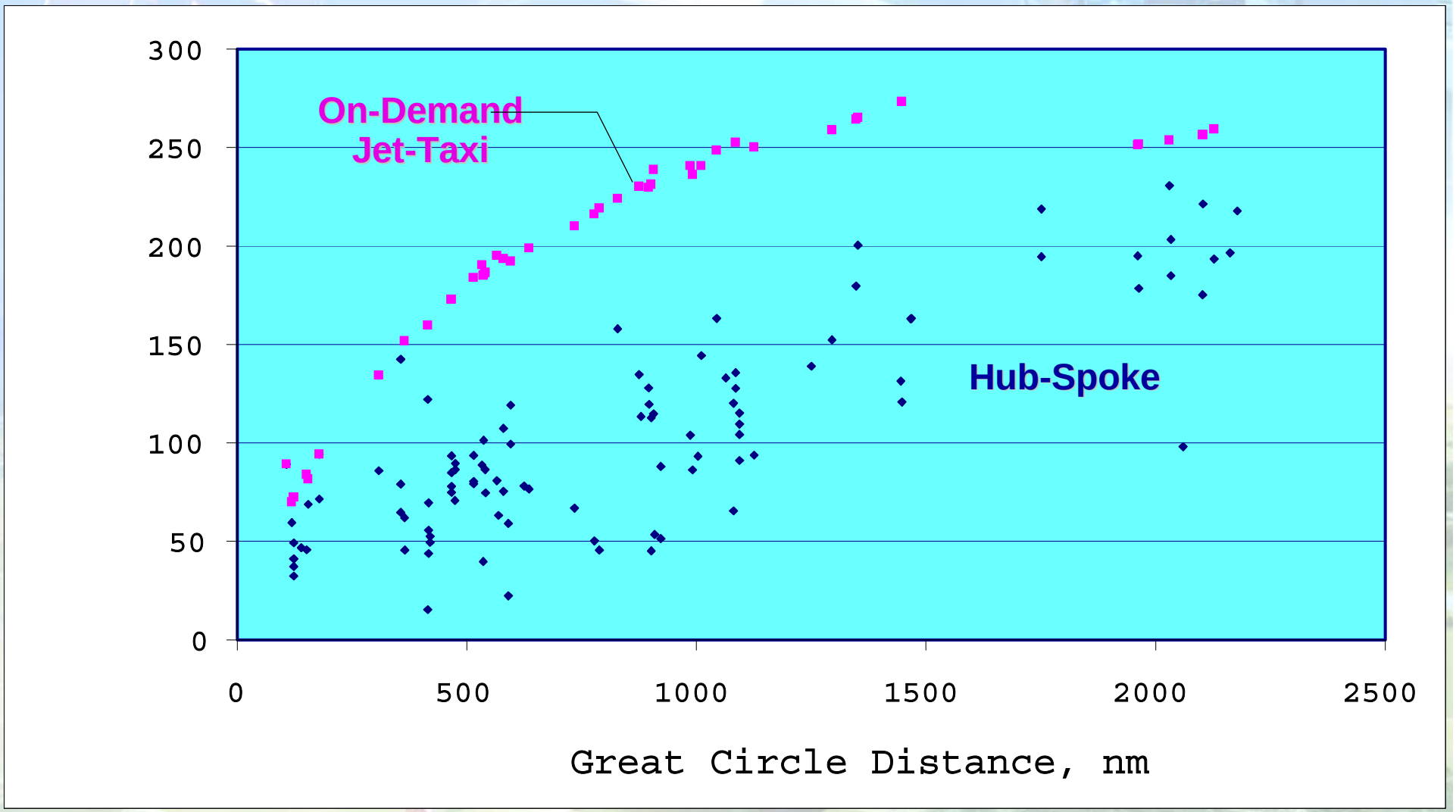
Data source: Form 41 Traffic data from Bureau of Transportation Statistics (includes Regional Jets and Turboprops)

The Notional Life Cycle of The Innovation Called Airline Travel

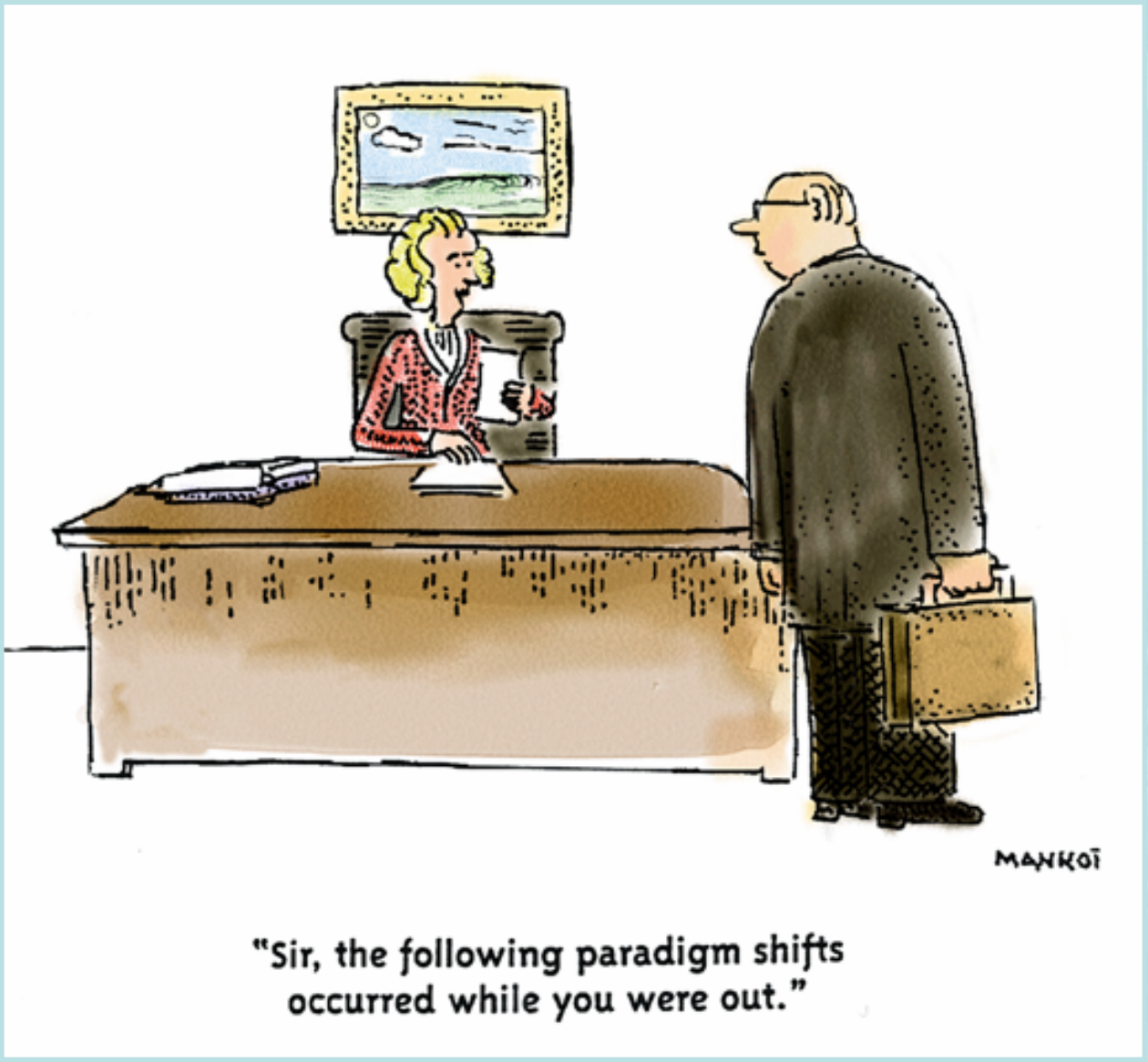
Notional Life Cycles in Transportation



Comparison of Actual and Theoretical Speed of Doorstep-to-Destination Travel



Rules of the Game Are Changing



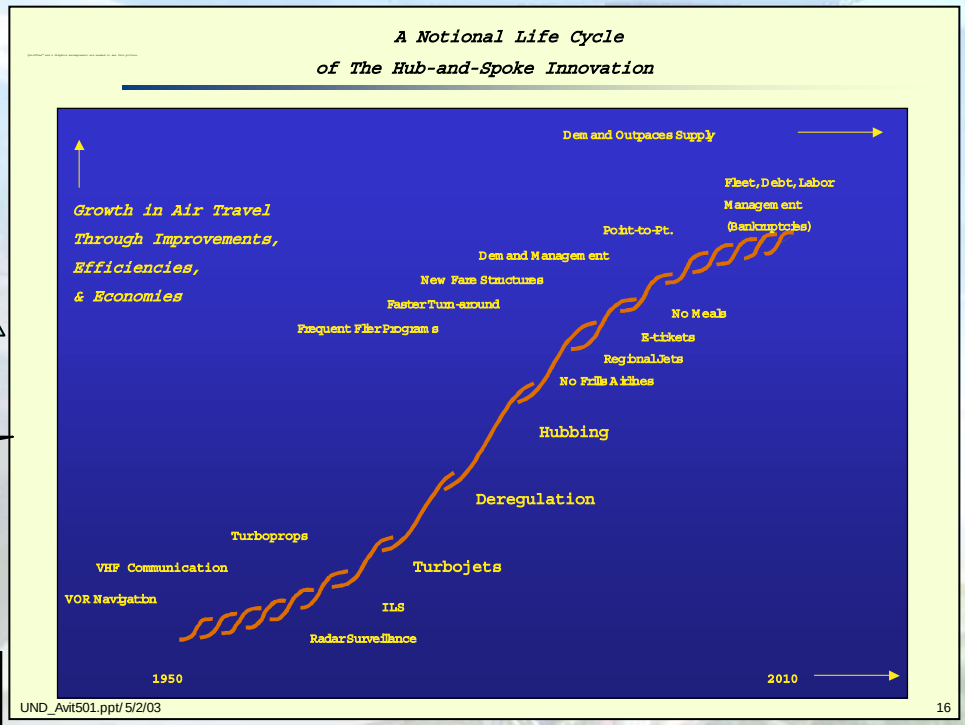
Technological Underpinnings for Transformation

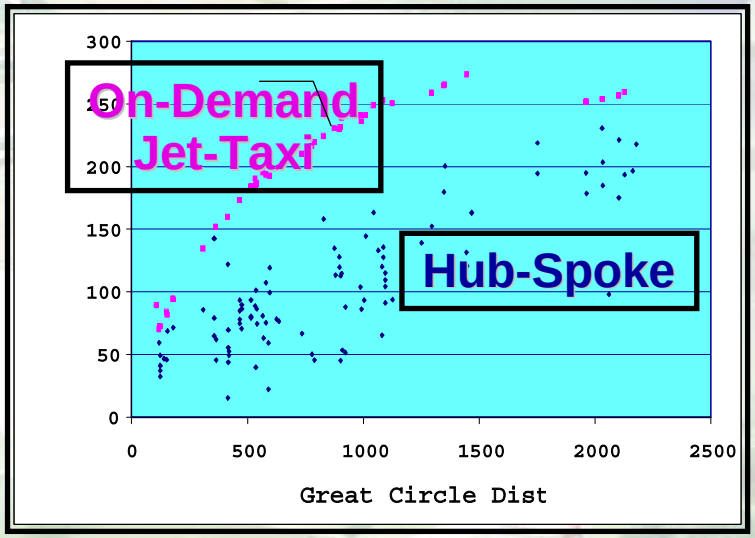
1. Moore's Law on microprocessor cost/performance
2. Gilder's Law on bandwidth performance
3. Metcalf's Law on network performance
4. The unwritten law of abundance
5. The unwritten rule of gridlock
6. Kurzweil's Law of Accelerating Returns
7. The Golden Rule of the information age

A Perfect Storm

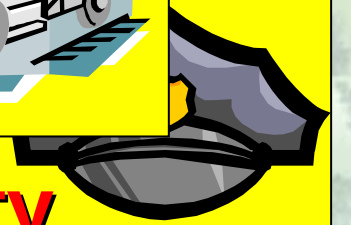
Delays
Congestion
Demand Management

Technologies





SARS
Avian Flu



Security

Why Transformation?

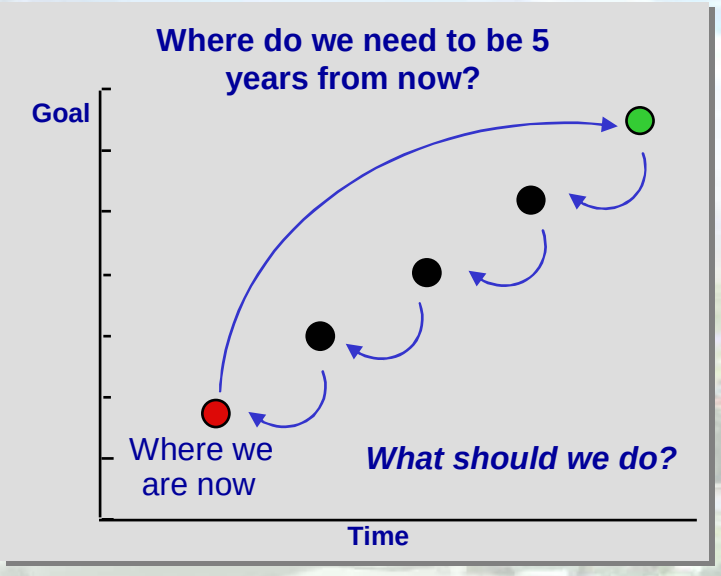
- The current aviation system does not scale to meet future needs related to*
  - Aircraft
  - Airports
  - Airspace
  - Commerce and Business models
  - Environmental considerations
  - Security and safety considerations
- Evolution and modernization plans do not lead us to the changes needed beyond 2015
- Transformation requires change across government agencies
- The results of transformation produce new business models, new regulatory models, and new uses of airspace, airports, and aircraft
- The outcome of transformation is to enable scalability to meet the nation's needs in commerce, mobility, security , and safety

*From NRC Report (2003) and the President's Commission Final Report (2002)

The pace of change in today's world demands context-derived strategic thinking.

Incremental Execution
- *Negotiation-Derived Strategies*

Strategic Thinking
- *Context-Derived Strategies*



Context-derived strategies create relentless execution toward a vision
And
Help avoid failures of imagination.

Building the JPDO Scenario Space

- **Drivers are coalesced into dimensions for plausible future worlds**

LIST OF DRIVERS

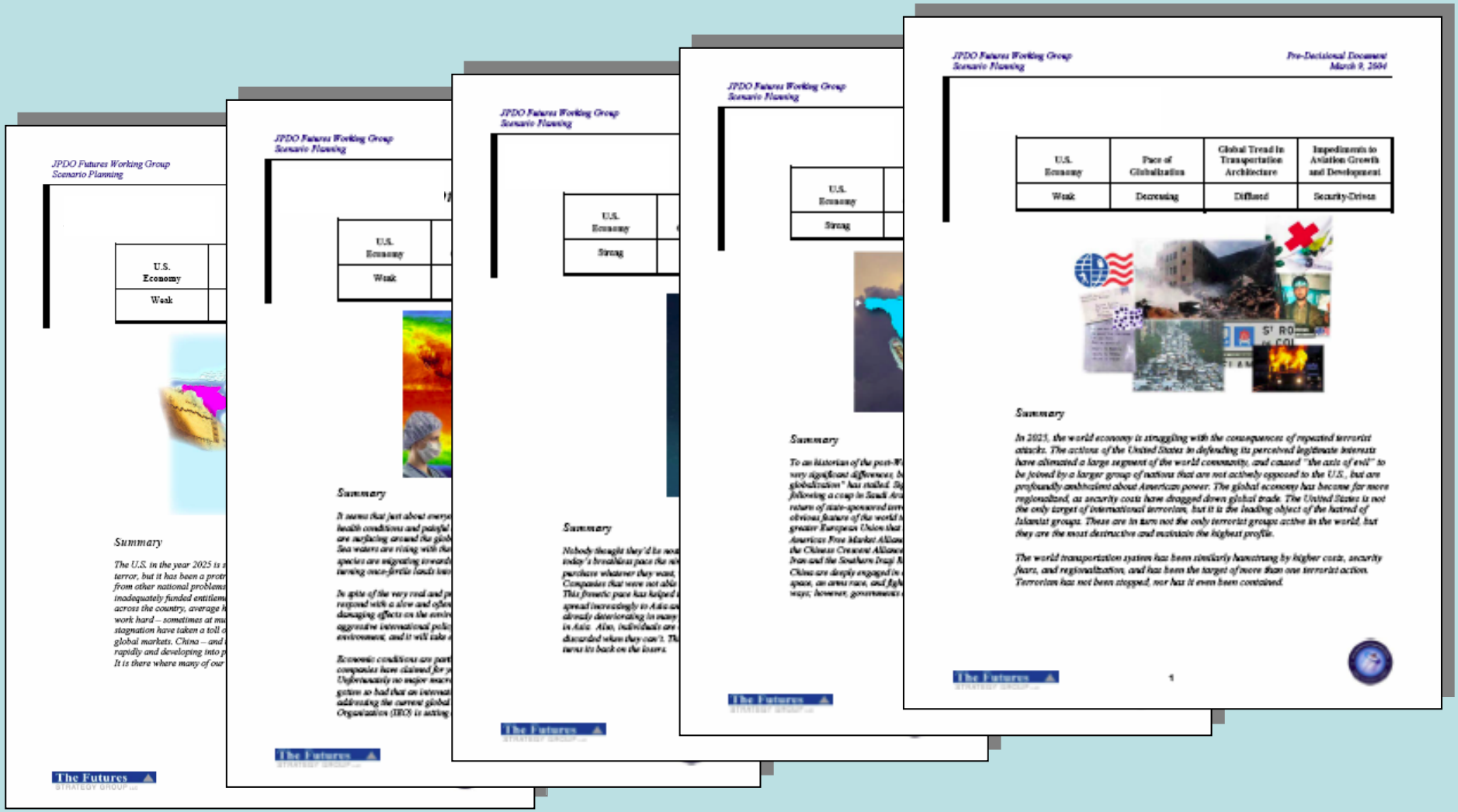
World Economy and Market Environment
Political Instability
International Trade Environment
Global Transportation Infrastructure
Global Distribution of Power & Technology
U.S. International Policies
Prevalence of Violence, Terrorism, and War
U. S. Military Posture
State of the Environment
US population growth rate
US migration patterns
US population distribution by age
US population distribution by urban/suburban/rural areas
US population distribution by geographic region
US population migration relative to hub-and-spoke locations
US population distribution by heritage and family origins (travel implications)
US population by distribution of knowledge-worker (value of time)
US population by distribution of leisure time (value of time)
Education trends
Congestion as a decision factor in quality of life
Family structure, dynamics, distance
Value of time
Urban, Suburban, Rural quality of life factors
Inequalities, inequities
US GDP growth rate
World GDP growth rate
International trade environment
Extent of 'globalization' of business and finance
Land use patterns, constraints, and competition
World Economy and market environment
Availability of & Climate for capital for innovation (Venture, Angel, Commercial)
Public investment in R&D
Equity in mobility by geography, by income
Transportation energy sources
Environment
Geopolitics
Technology
Aviation System Factors

Scenario Dimensions

- **U.S. Economy**
- **Pace of Globalization**
- **Global Trend in Transportation Architecture**
- **Impediments to Aviation Growth and Development**

Five Worlds of 2025

JPDO World Scenarios



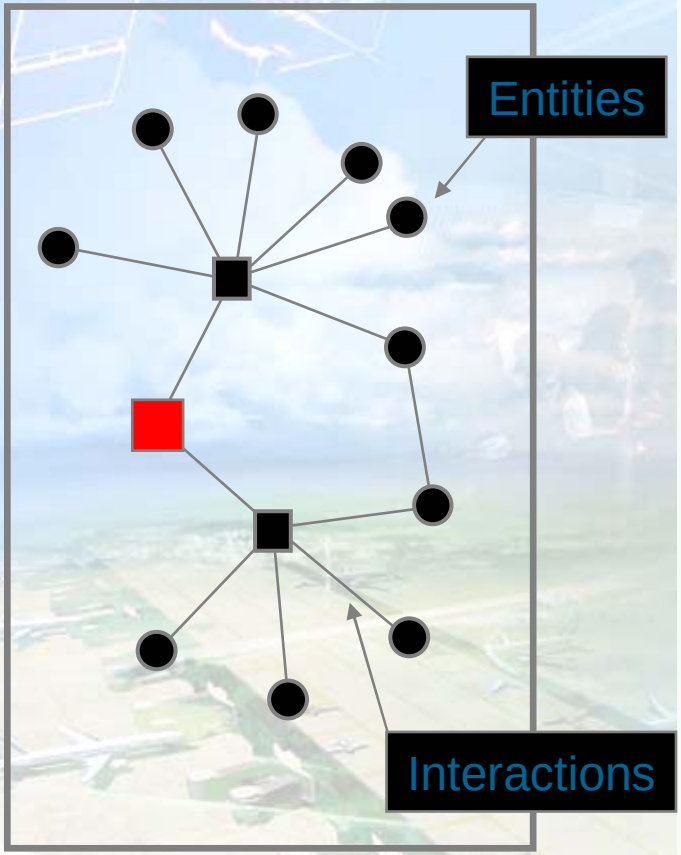
Work as a set to define an environment for strategy synthesis

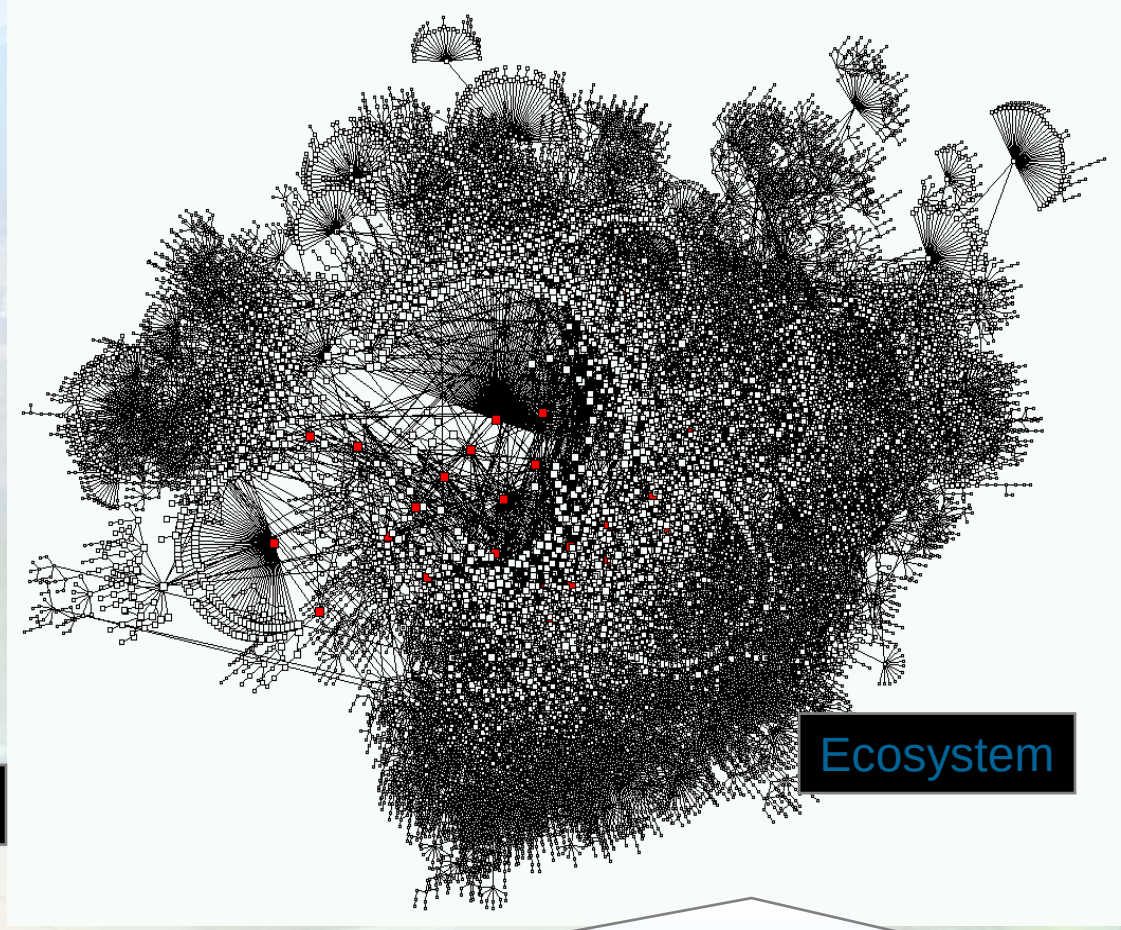
JPDO Strategies for Transformation

1. Harmonize Equipage and Operations Globally
2. Enable Innovative Airport Planning & Management
3. Integrate Air Transportation Security Activities
4. Develop Air Traffic Management that can Respond to Market Changes
5. Establish User-specific Situational Awareness
6. Establish a Comprehensive Proactive Safety Management Approach
7. Accelerate Adoption of New Operations and Technologies
8. Develop Environmentally Friendly & Sustainable Technology
9. Develop System-wide Capability to Reduce Weather Impacts

- Create a national enterprise architecture for transformation

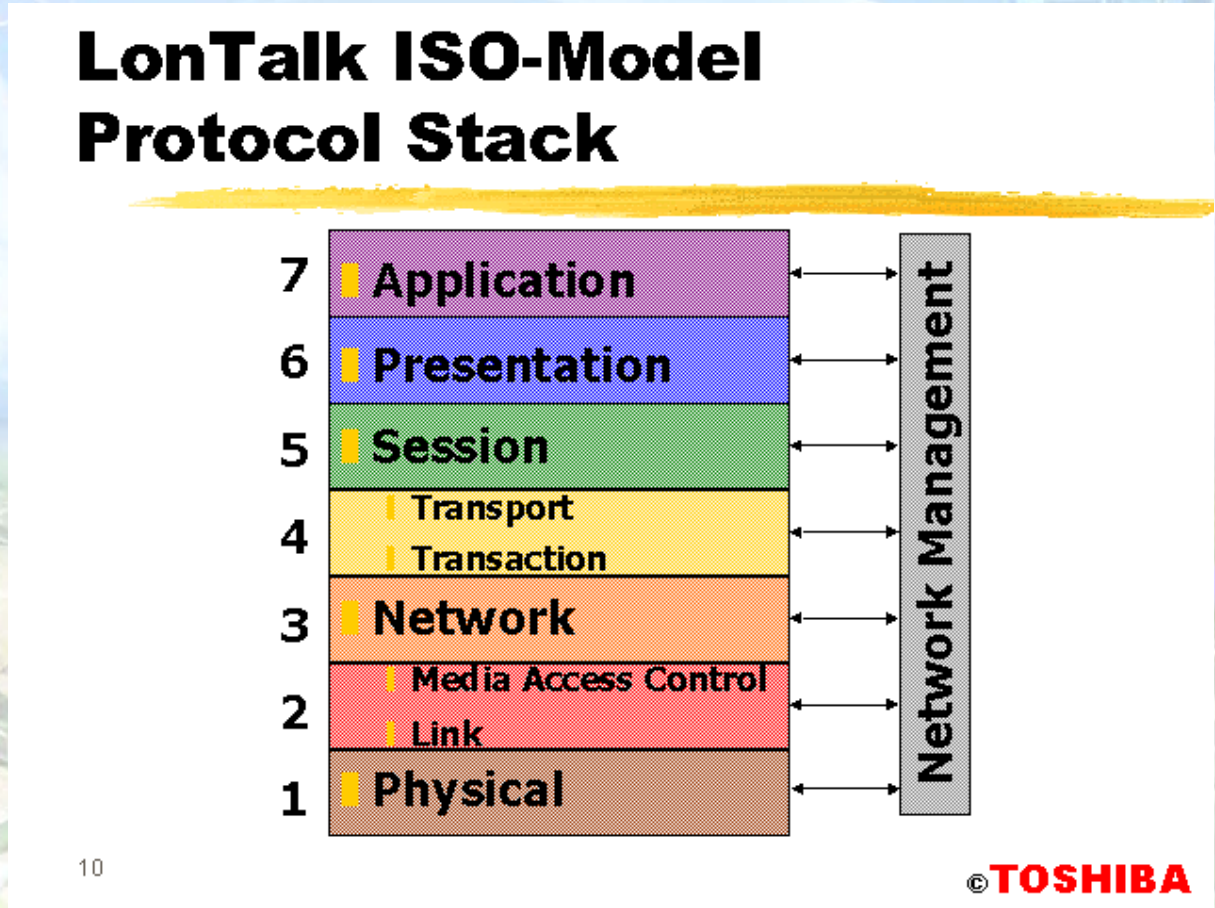
An Ecosystem Illustrates The Need for Topology





"Laws of Form" lead to individual actions that lead to the behavior of complex adaptive systems

ISO (or OSI) Stack



As a metaphor for a transportation system topology

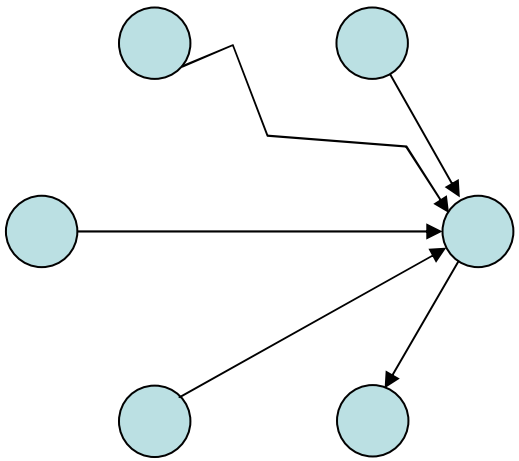
Physical Layer
For Three Air Transportation Networks

A. Hub-and-Spoke
Directed, Scheduled, Aggregated

Jet Routes

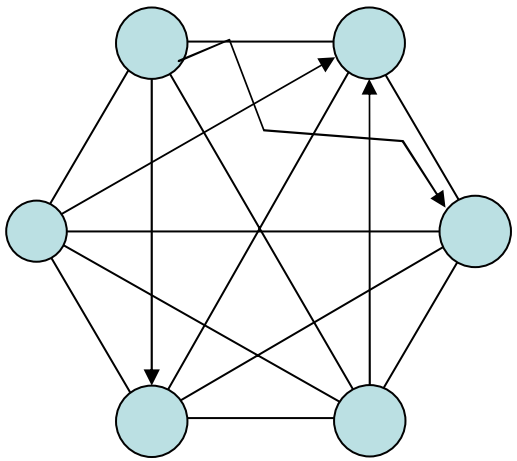
User-Determined

Direct



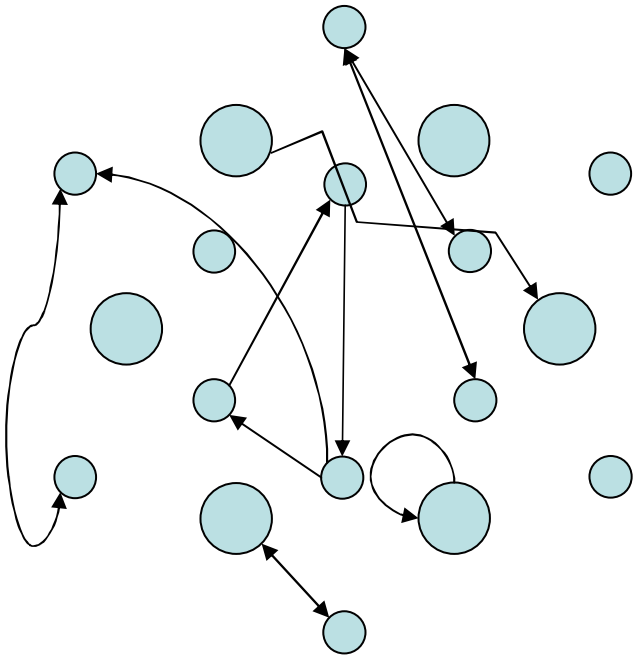
Legacy Carriers
Hub-and-Spoke
CFAR 25, 121, 139

B. Point-to-Point
Directed, Scheduled, Aggregated



Low-Cost Carriers
“Focus Cities”
CFAR 25, 121, 139

C. Distributed
Undirected, On-Demand Dis-Aggregated

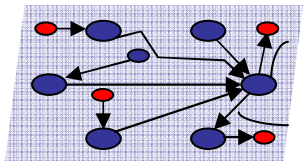
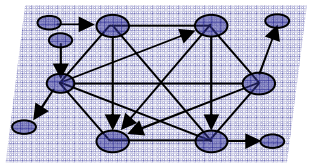
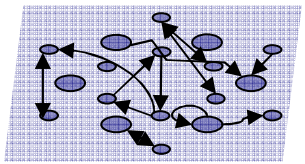
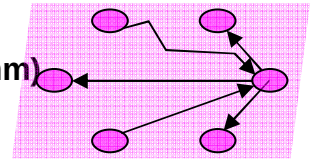
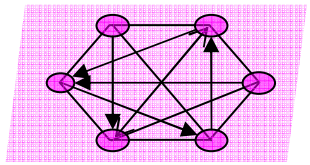
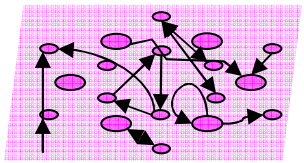
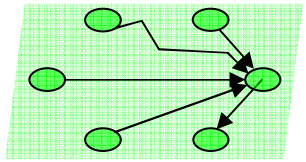
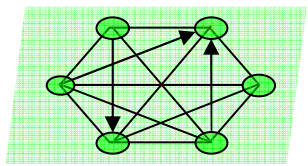
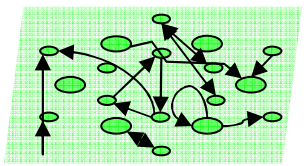
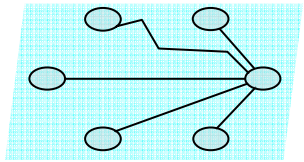
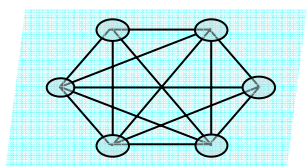
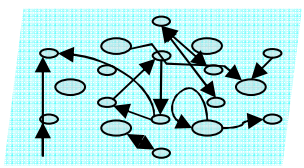


Un-piloted Air Vehicles
GA, Business, Corporate Fleets
New Very Light Jet Fleets
Runway Independent Aircraft
Supersonic Overland
Micro Air Vehicles

A Proposed Air Transportation Network Topology

Domain Layers

Business Model Stacks

	A. Hub-and-Spoke Directed, Scheduled, Aggregated	B. Point-to-Point Directed, Scheduled Aggregated	C. Distributed Undirected, On-Demand, Disaggregated
Mobility Layer (Passengers, Cargo/ Internet-Telcomm)			
Operator Layer (Pilots-Crew/VHF Comm)			
Transport Layer (Aircraft/Radar)			
Physical Layer (Airports/Routes)			

Network Management

Communication
Navigation
Surveillance

Airspace Architecture

Airspace Services
Airspace Procedures
Commercial Services

As a guide for HOW to think about transformation

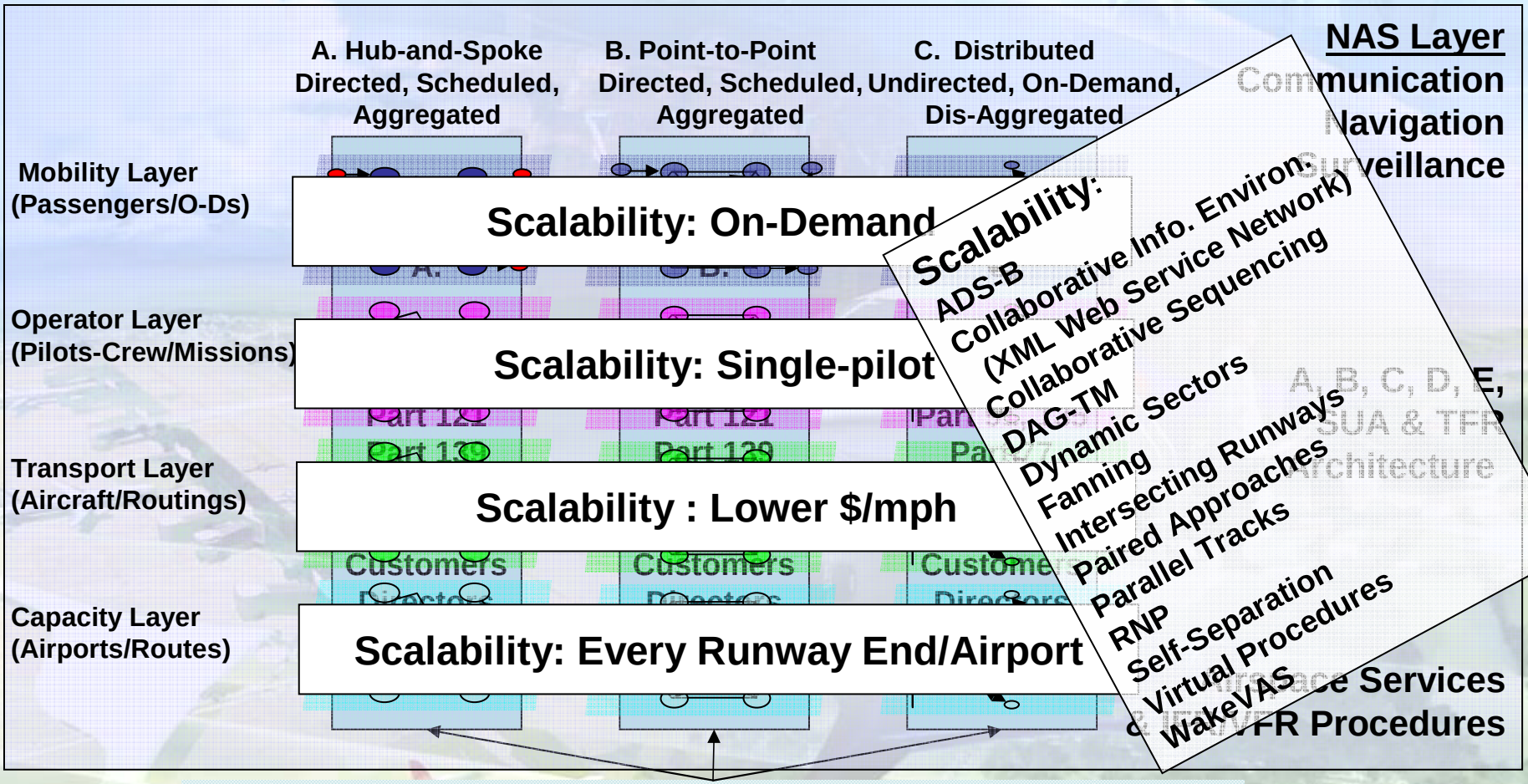
Distributed (Scalable)Air Mobility

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**

Scalability for Air Transportation Networks

Q: What policy and technology strategies reduce the friction, or improve the impedance matching between the layers?



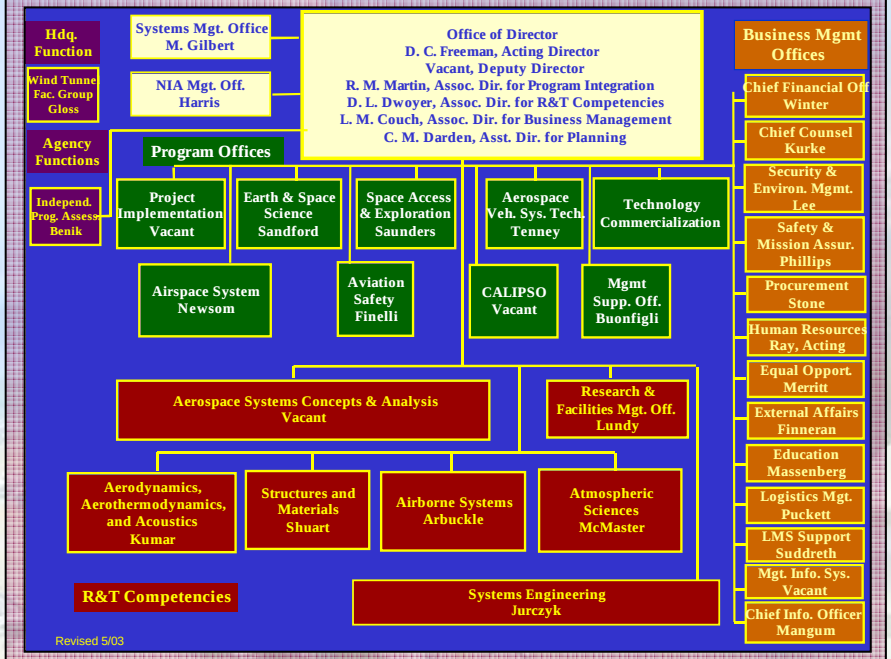
Policy Changes Enable Scalability of Business Stacks

Transformation
As a Campaign Against the 20th Century

System	20th Century	21st Century
Communication	Analog, Voice, Shared Frequencies	Digital, VXML, Addressable
Airport networks	Hub-and-Spoke	Widely Distributed
Air Traffic Services (Separation and Sequencing)	Ground-Centric	Airborne-Centric
Air Transportation Services	Scheduled	On-Demand
Air Crews	Two-Pilot	Single-Pilot Un-Piloted
Network Tools	Linear	Non-Linear
Cargo & Package Delivery	High-density markets, next-day service	Thin markets, same-day service
Economic Opportunity	Centralized	Diffused
System Responsiveness	Brittle	Resilient
System Growth	Constrained	Scalable (Up or Down)

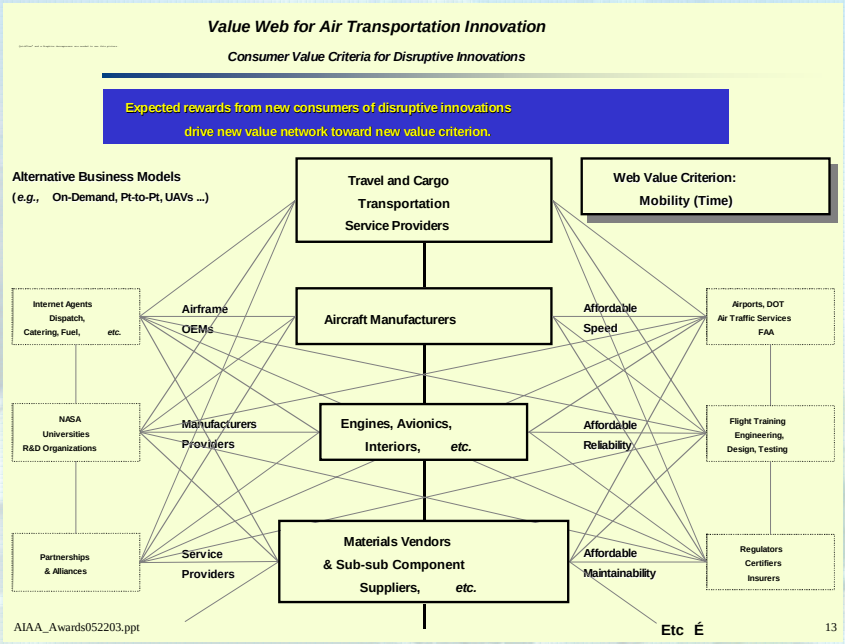
Organizational Architectures

Hierarchical Value Chains



For Process Control
In Component Advancements

Multi-Scale Value Webs

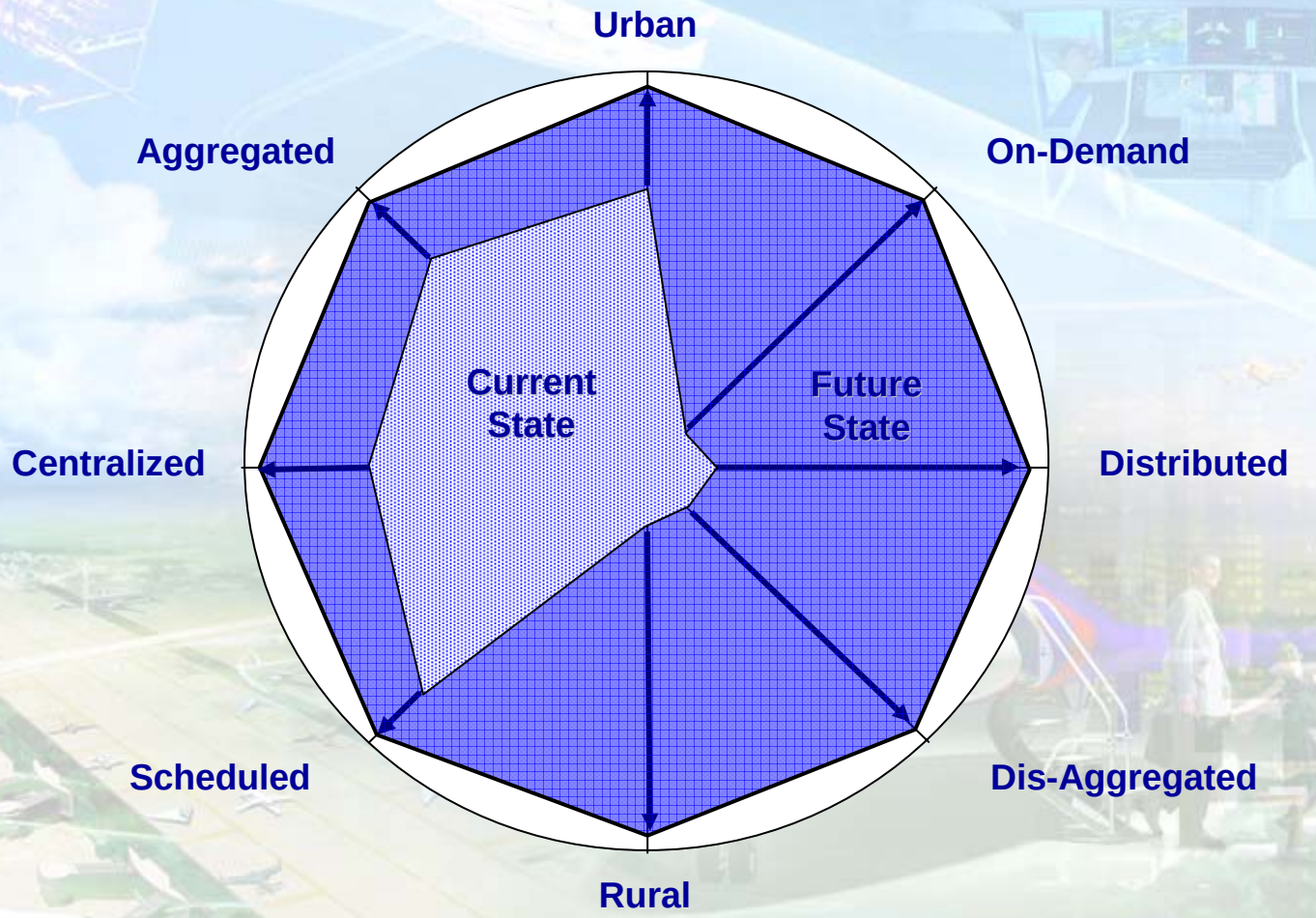


For Influence
In System Advancements

Hierarchical networks require strong links for high performance in conditions of certainty, and perform weakly in conditions of ambiguity, uncertainty, disruption.

Multi-scale networks require "weak links" for high performance in conditions of ambiguity, uncertainty,disruption, and perform poorly in conditions of certainty and stability.

Notional Transformation Concept Space



The vision includes expanding scalability along all dimensions.

Integrated Plan for the Next Generation Air Transportation System

For More Information: http://www.jpo.aero

Summary

1. **Context-Derived Strategies Provide Integrity, Accountability and Stability for Strategic Management**
2. **A Transportation Topology Serves as a Framework for Strategic Thinking**
3. **Strategies for Transformation Work as "Laws of Influence"**

Network theory considerations offer additional understanding about strategic thinking for complex, adaptive systems.

Thank You