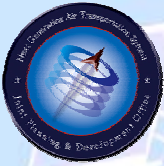


Transformation in Transportation Systems of the 21st Century

***Dr. Bruce J. Holmes, NASA / JPDO
International Council of Aeronautical Sciences
Yokohama, Japan
September 2, 2004***



JPDO Heritage



2001

President's Commission
on the Future
Of the
U.S. Aerospace Industry

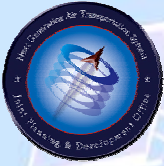
2002

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

2003

Integrated Plan for the
Next Generation
Air Transportation System

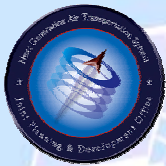
2004



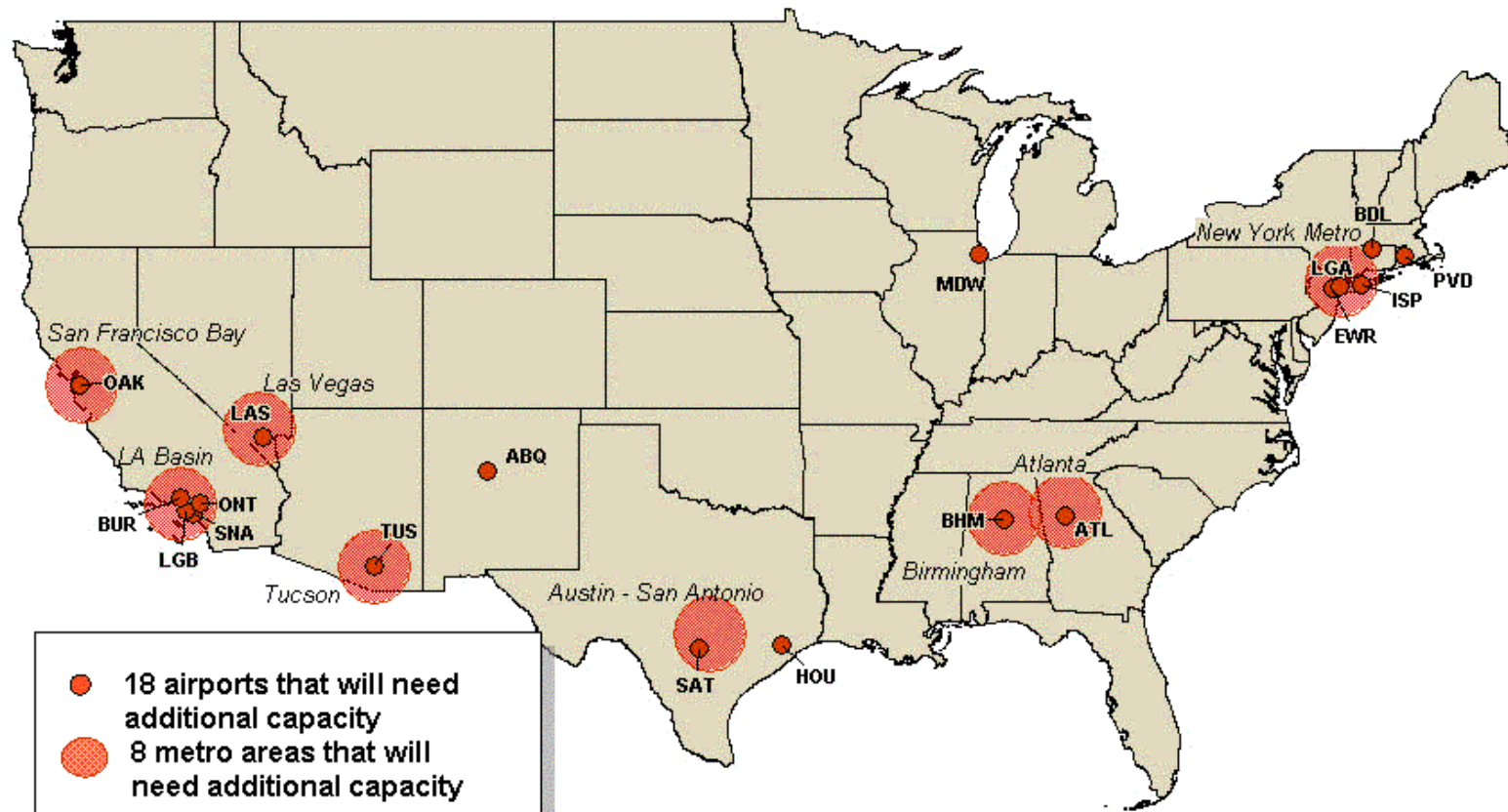
Outline

- 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





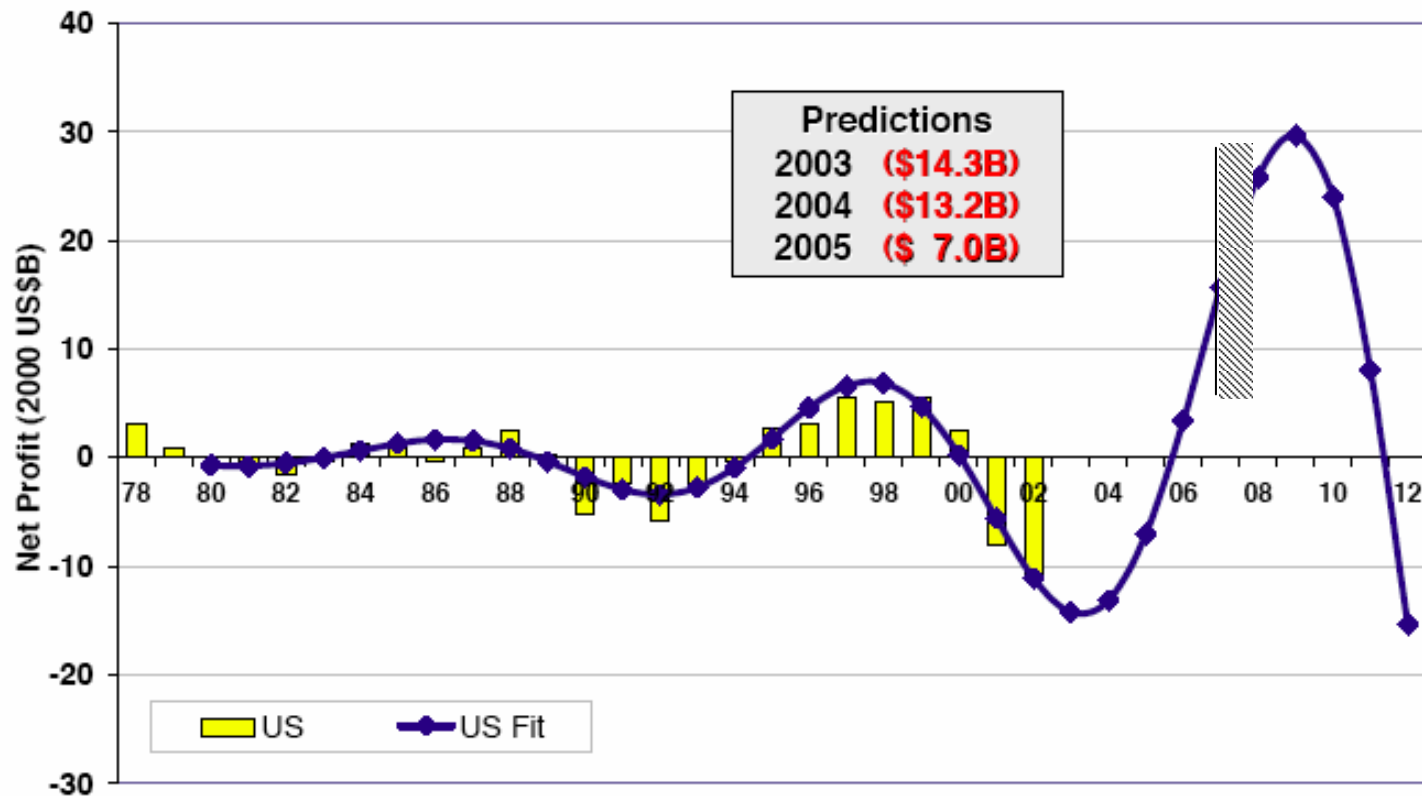
Whither or Wither?



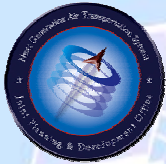
US Airlines Net Profit Model - 2002

Best Fit of Undamped Oscillation

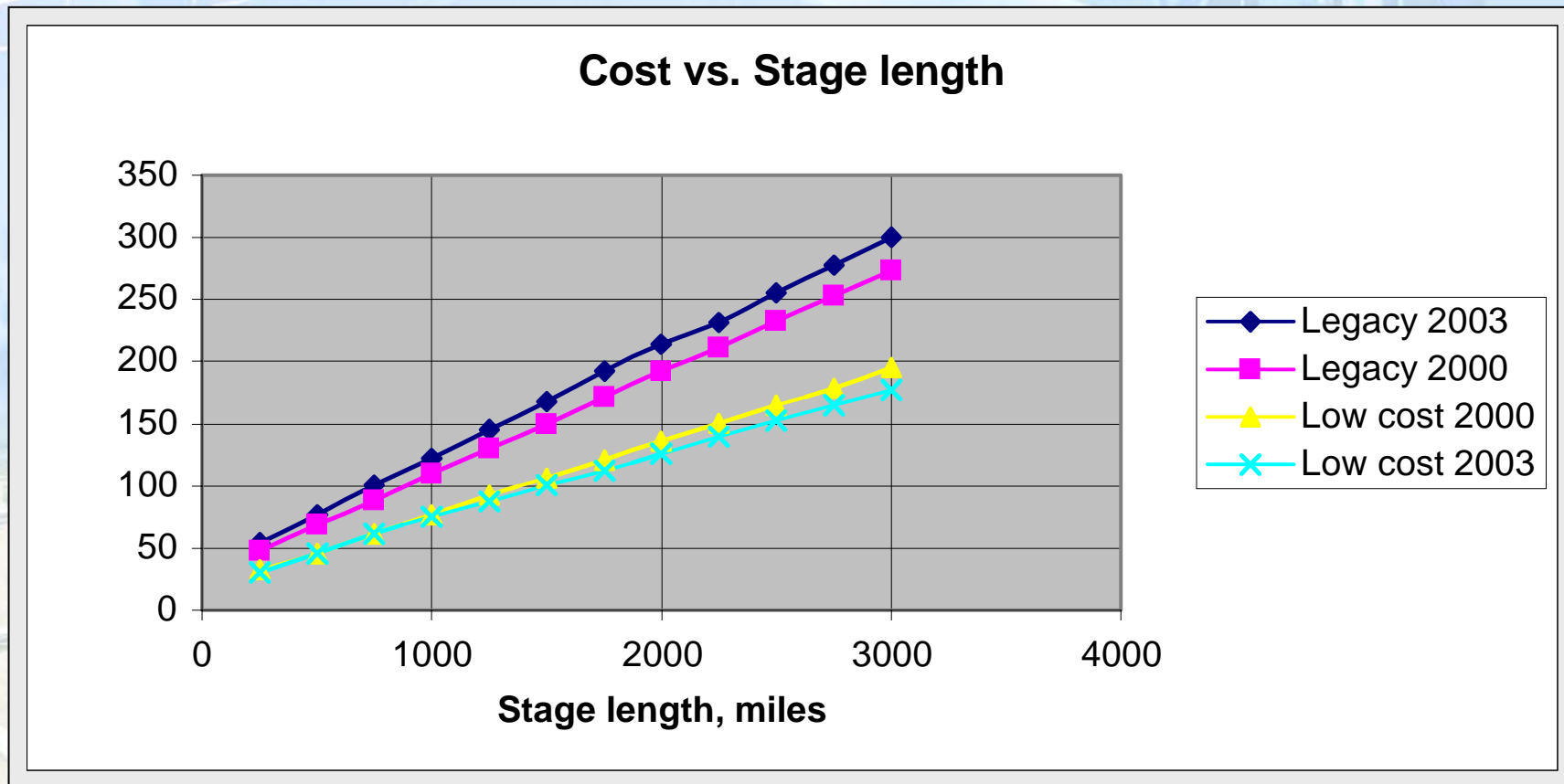
Cycle Period = 11.3 yr eFolding Time = 7.9 yr



NB: Predictions are in constant 2000 dollars.



The Widening Gap Between Legacy and Low Cost Carrier Operating Costs



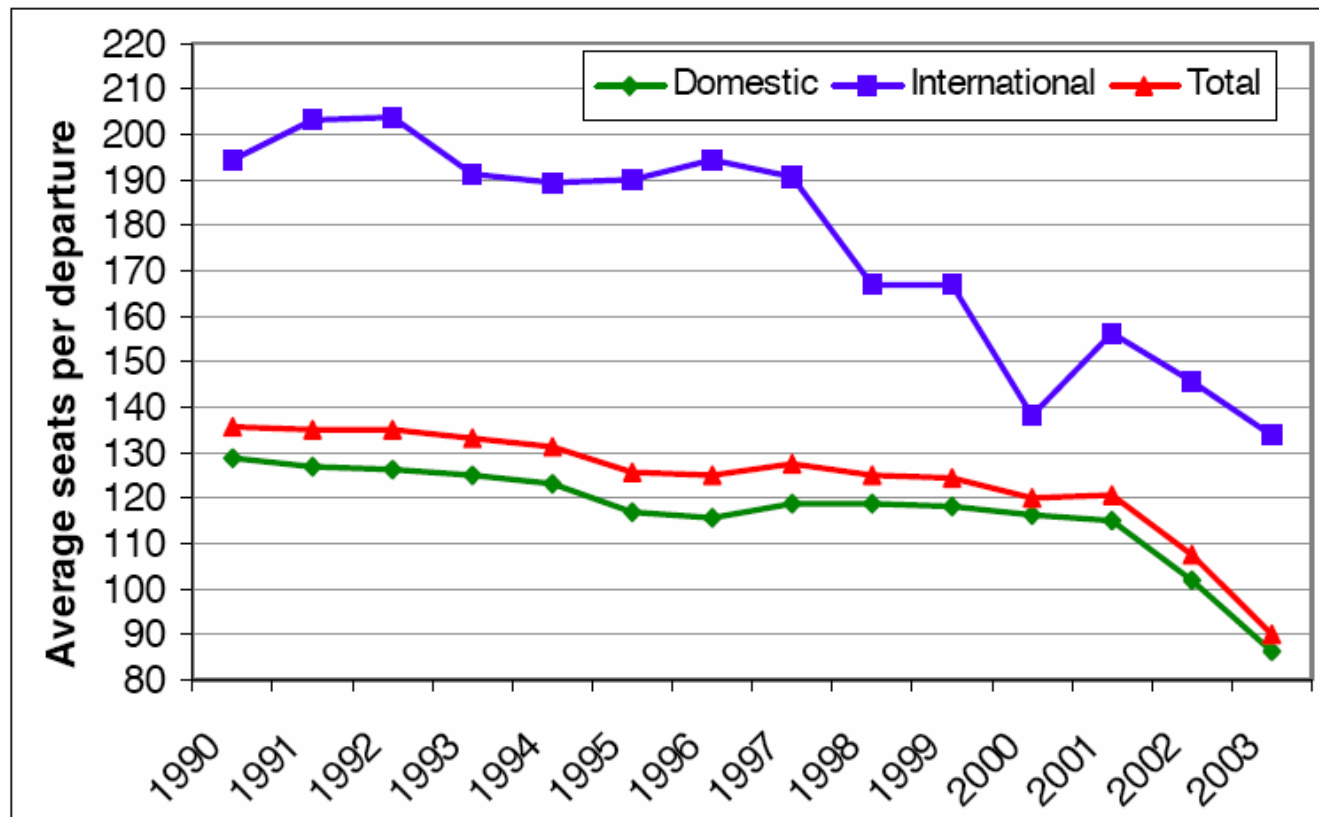
Based on data from U.S. Government Accountability Office Report GAO-04-836:
Commercial Aviation -- Legacy Carriers Must Further Reduce Costs to Restore Profitability.



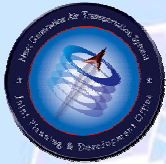
What's Really Happening Here?



Trends in Aircraft Size



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

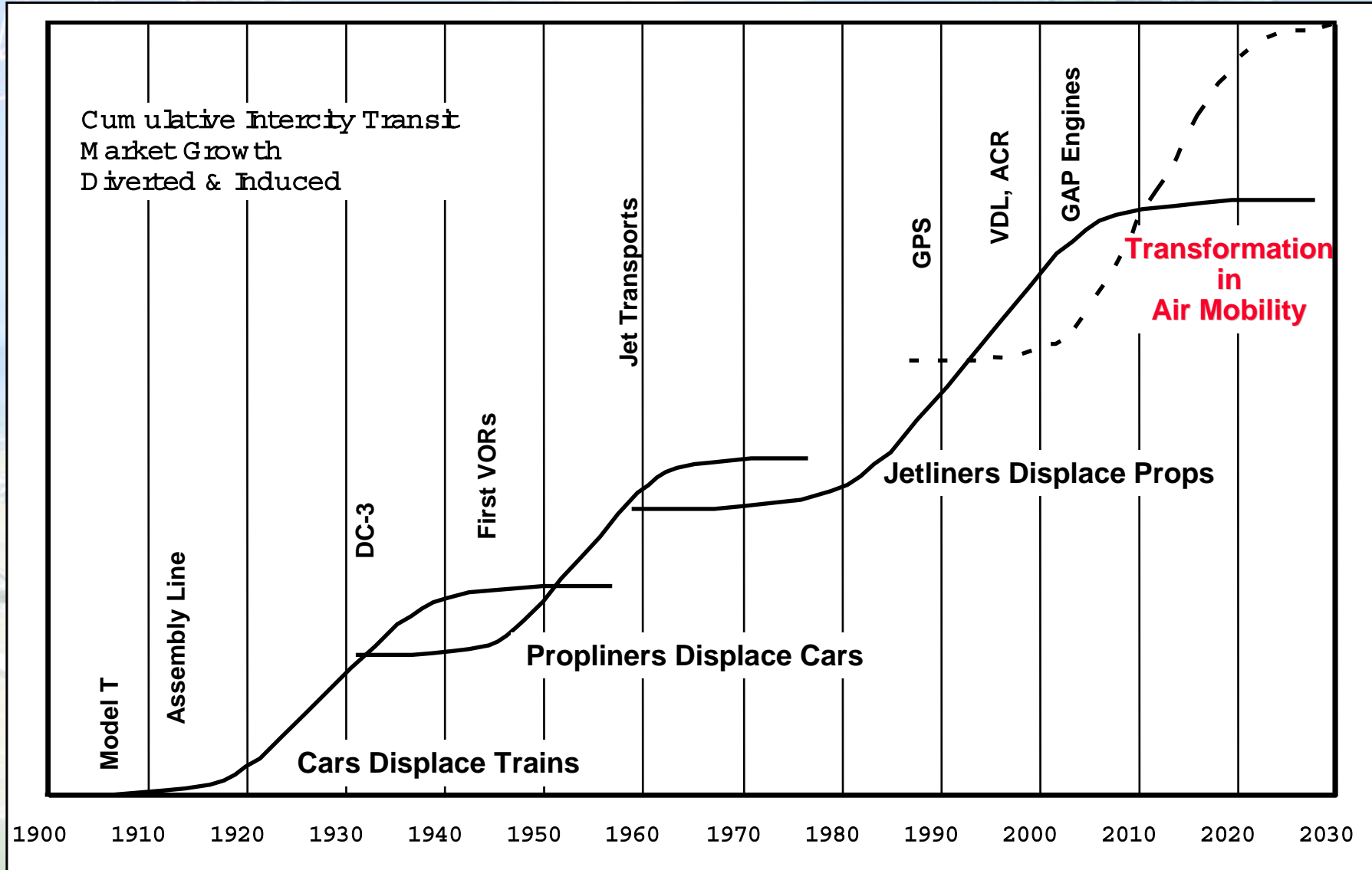


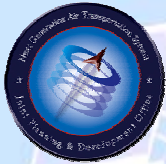
The Notional Life Cycle of The Innovation Called Airline Travel



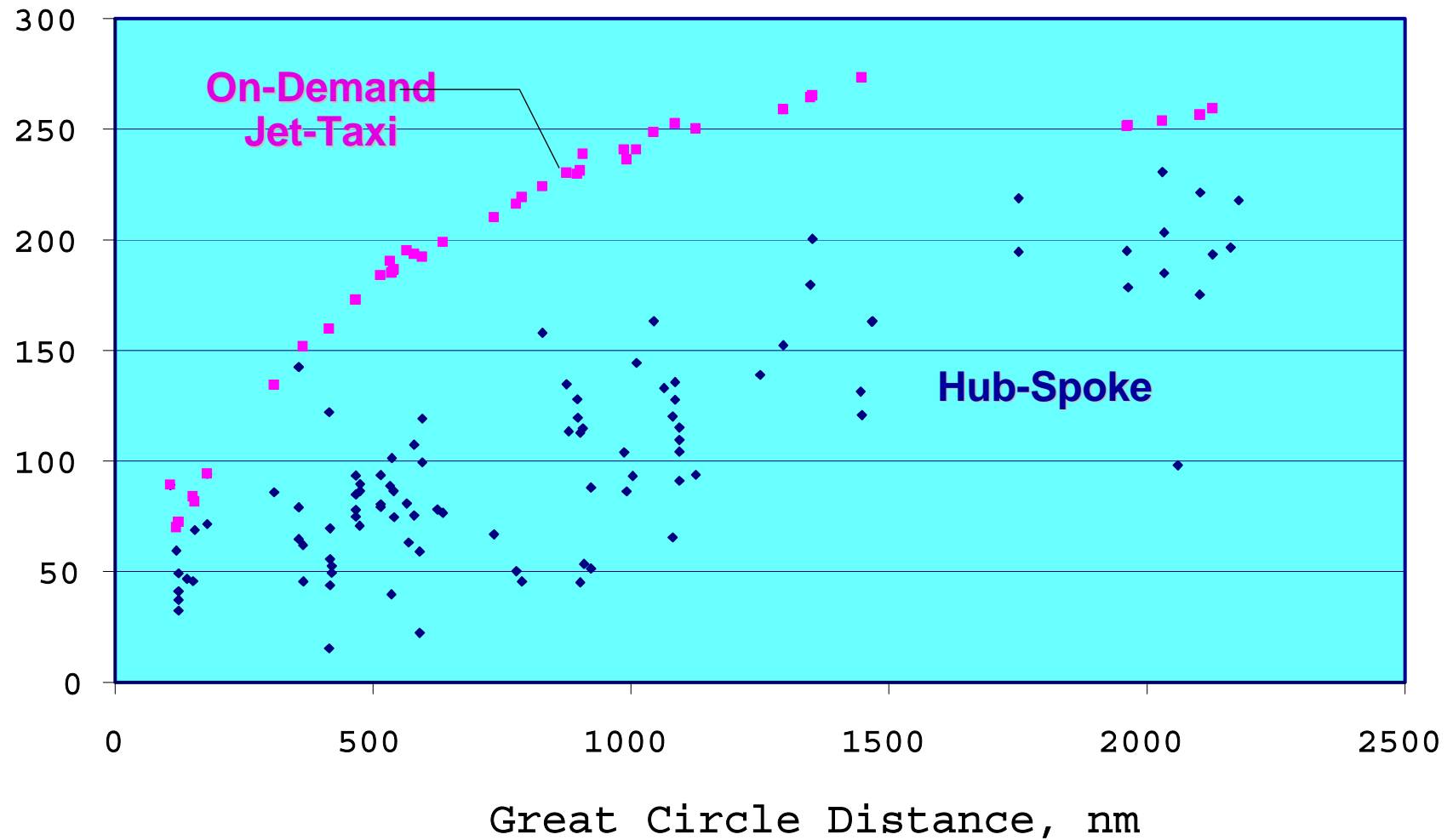


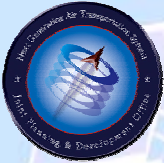
Notional Life Cycles in Transportation





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





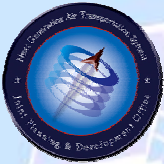
Rules of the Game Are Changing





Technological Underpinnings for Transformation

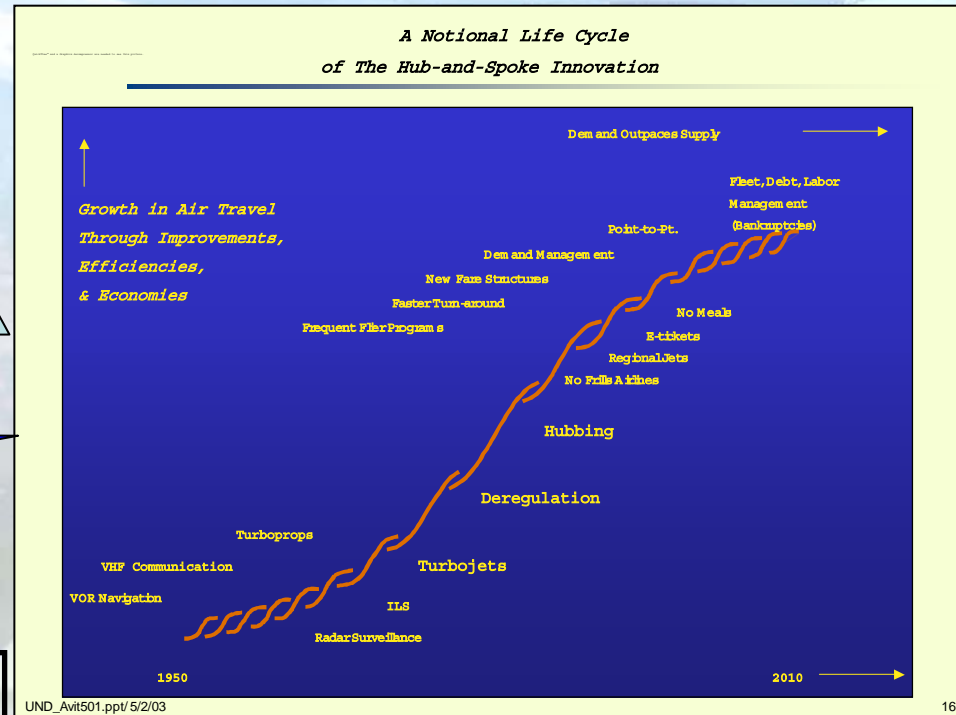
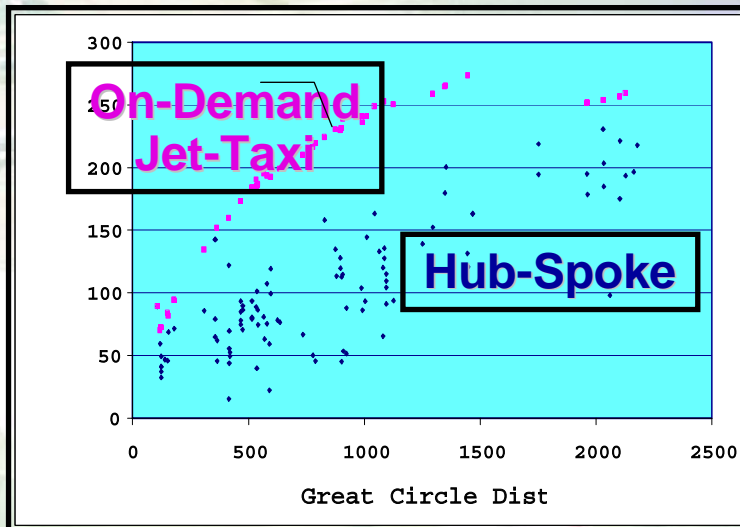
1. **Moore's Law**
on microprocessor
cost/performance
2. **Gilder's Law**
on bandwidth performance
3. **Metcalf's Law**
on network performance
4. **The unwritten law
of abundance**
5. **The unwritten rule
of gridlock**
6. **Kurzweil's Law
of Accelerating Returns**
7. **The Golden Rule
of the information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



A Perfect Storm

Delays
Congestion
Demand Management

Technologies



**SARS
Avian Flu**

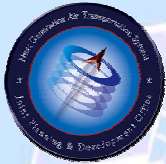
Security



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.

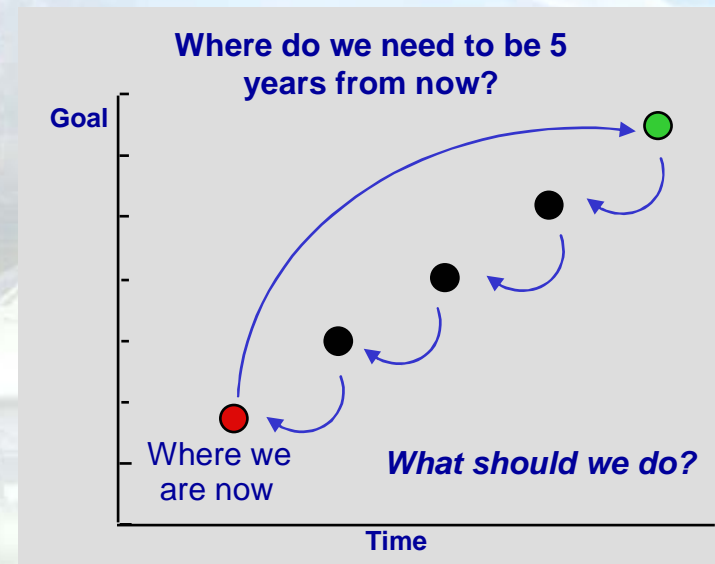
Incremental Execution

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

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

JPDO Futures Working Group Scenario Planning

U.S. Economy

Weak

Summary

The U.S. in the year 2025 is a terror, but it has been a proxy from other national problems inadequately funded entities across the country, average it work hard - sometimes at stagnation have taken a toll of global markets. China - and rapidly and developing into p It is there where many of our

JPDO Futures Working Group Scenario Planning

U.S. Economy

Weak

Summary

It seems that just about every health condition and painful are surfacing around the globe. Sea waters are rising with the species are migrating toward warmer areas. forest lands lost

In spite of the very real and pe regions with a slow and often damaging effects on the environment, aggressive international policy environment, and it will take a

Economic conditions are part companies have allowed for a Unfortunately no major success gotten so had that an interest addressing the current global Organization (IBO) is acting

JPDO Futures Working Group Scenario Planning

U.S. Economy

Strong

Summary

Nobody thought they'd be now today's breakthrough pace the new purchase whatever they want, Companies that were not able This former pace has helped spread increasingly in Asia as already deteriorating in many in Asia. Also, individuals are discarded when they can't. The never its back on the issues.

JPDO Futures Working Group Scenario Planning

U.S. Economy

Strong

Summary

To an historian of the post-W very significant differences in globalization" has resulted. By following a coup in South Africa return of state-sponsored terrorism obvious feature of the world's greater European Union that American Free Market Alliance (now and the Southern Drags). China are deeply engaged in space, an arms race, and high ways; however, governments

JPDO Futures Working Group Scenario Planning

U.S. Economy

Strong

Summary

In 2025, the world economy is struggling with the consequences of repeated terrorist attacks. The actions of the United States in defending its perceived legitimate interests have alienated a large segment of the world economy, and caused "the axis of evil" to be joined by a larger group of nations that are not actively opposed to the U.S., but are profoundly ambivalent about American power. The global economy has become far more regionalized, as security costs have dragged down global trade. The United States is not the only target of international terrorism, but it is the leading object of the hatred of Islamist groups. These are in turn not the only terrorist groups active in the world, but they are the most destructive and resist the highest profile.

The world transportation system has been similarly hamstrung by higher costs, security fears, and regionalization, and has been the target of more than one terrorist action. Terrorism has not been stopped, nor has it even been contained.

JPDO Futures Working Group Scenario Planning

U.S. Economy

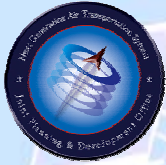
Strong

Summary

In 2025, the world economy is struggling with the consequences of repeated terrorist attacks. The actions of the United States in defending its perceived legitimate interests have alienated a large segment of the world economy, and caused "the axis of evil" to be joined by a larger group of nations that are not actively opposed to the U.S., but are profoundly ambivalent about American power. The global economy has become far more regionalized, as security costs have dragged down global trade. The United States is not the only target of international terrorism, but it is the leading object of the hatred of Islamist groups. These are in turn not the only terrorist groups active in the world, but they are the most destructive and resist the highest profile.

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Work as a set to define an environment for strategy synthesis

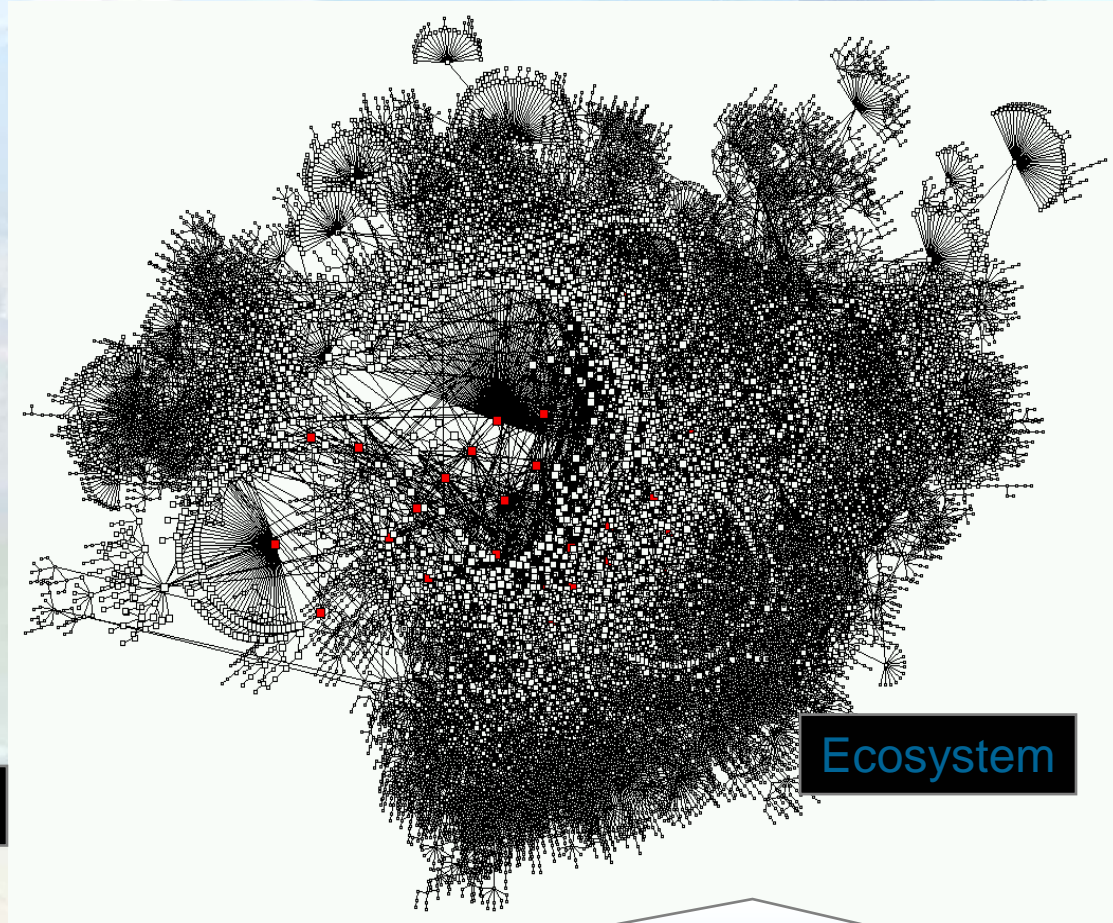
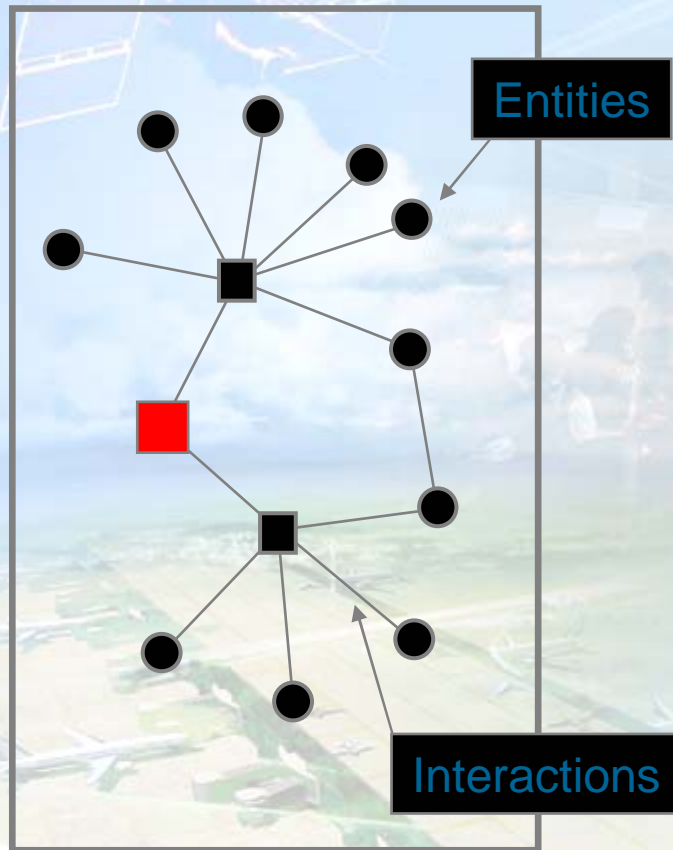


JPDO Strategies for Transformation

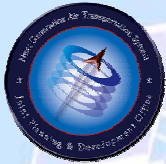
1. Harmonize Equipage and Operations Globally
2. Enable Innovative Airport Planning & Management
3. Integrate Air Transportation Security Activities
4. Develop Air Traffic Management that can Respond to Market Changes
5. Establish User-specific Situational Awareness
6. Establish a Comprehensive Proactive 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

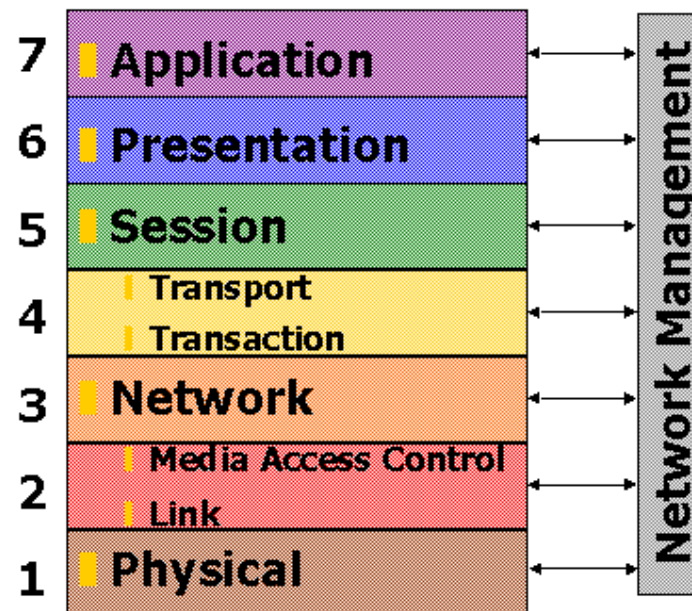


***“Laws of Form” lead to individual actions
that lead to the behavior of complex adaptive systems***



ISO (or OSI) Stack

LonTalk ISO-Model Protocol Stack



10

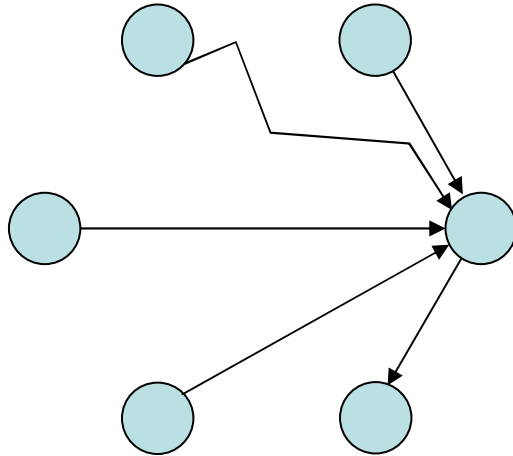
© TOSHIBA

As a metaphor for a transportation system topology



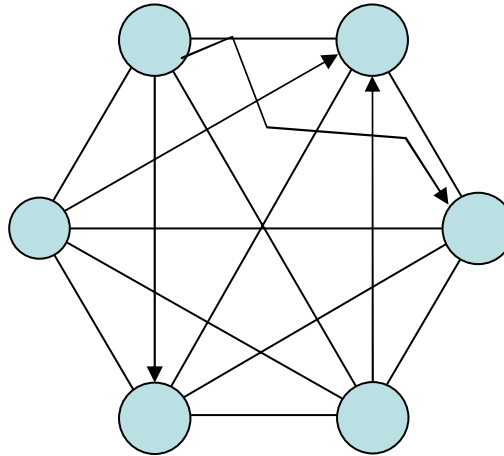
Physical Layer For Three Air Transportation Networks

A. Hub-and-Spoke
 Directed, Scheduled,
 Aggregated
 Jet Routes
 User-Determined
 Direct



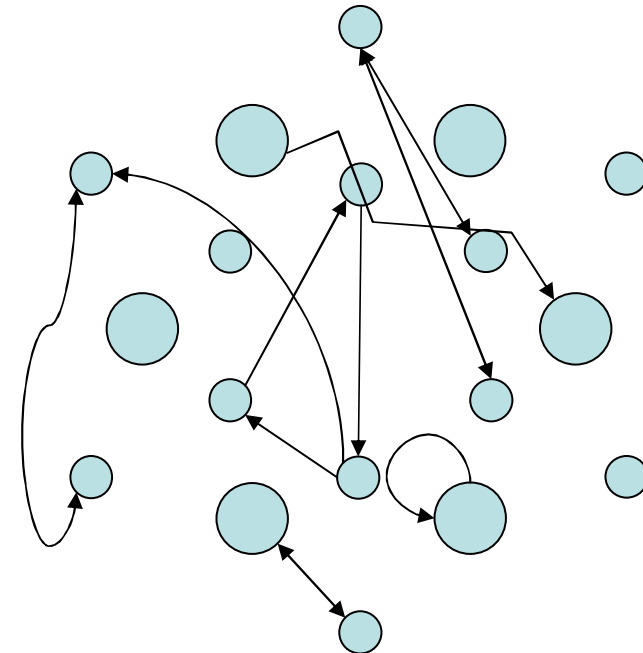
Legacy Carriers
Hub-and-Spoke
CFAR 25, 121, 139

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

Network Management

**Communication
Navigation
Surveillance**

**Airspace
Architecture**

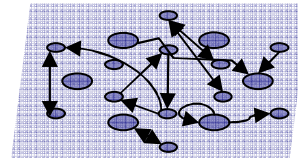
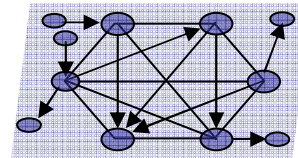
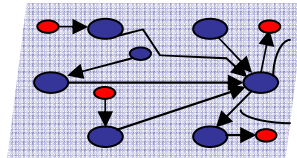
**Airspace Services
Airspace Procedures
Commercial Services**

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

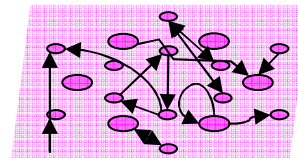
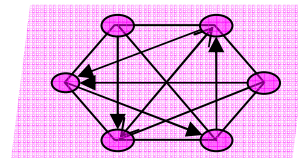
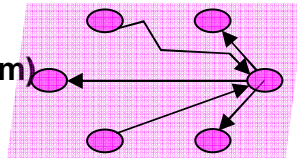
**B. Point-to-Point
Directed, Scheduled
Aggregated**

**C. Distributed
Undirected, On-Demand,
Disaggregated**

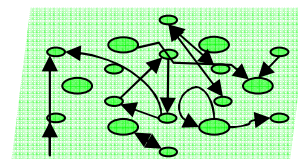
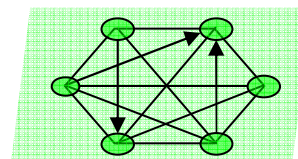
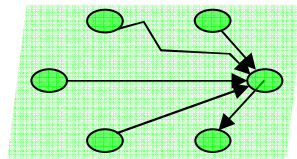
**Mobility Layer
(Passengers, Cargo/
Internet-Telcomm)**



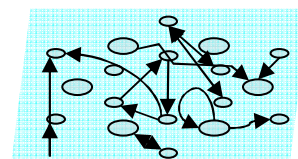
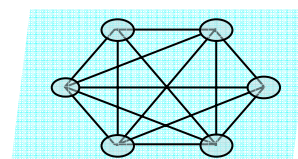
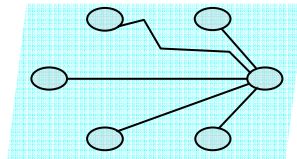
**Operator Layer
(Pilots-Crew/VHF Comm)**



**Transport Layer
(Aircraft/Radar)**



**Physical Layer
(Airports/Routes)**

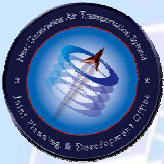


As a guide for HOW to think about transformation

Distributed (Scalable) Air Mobility

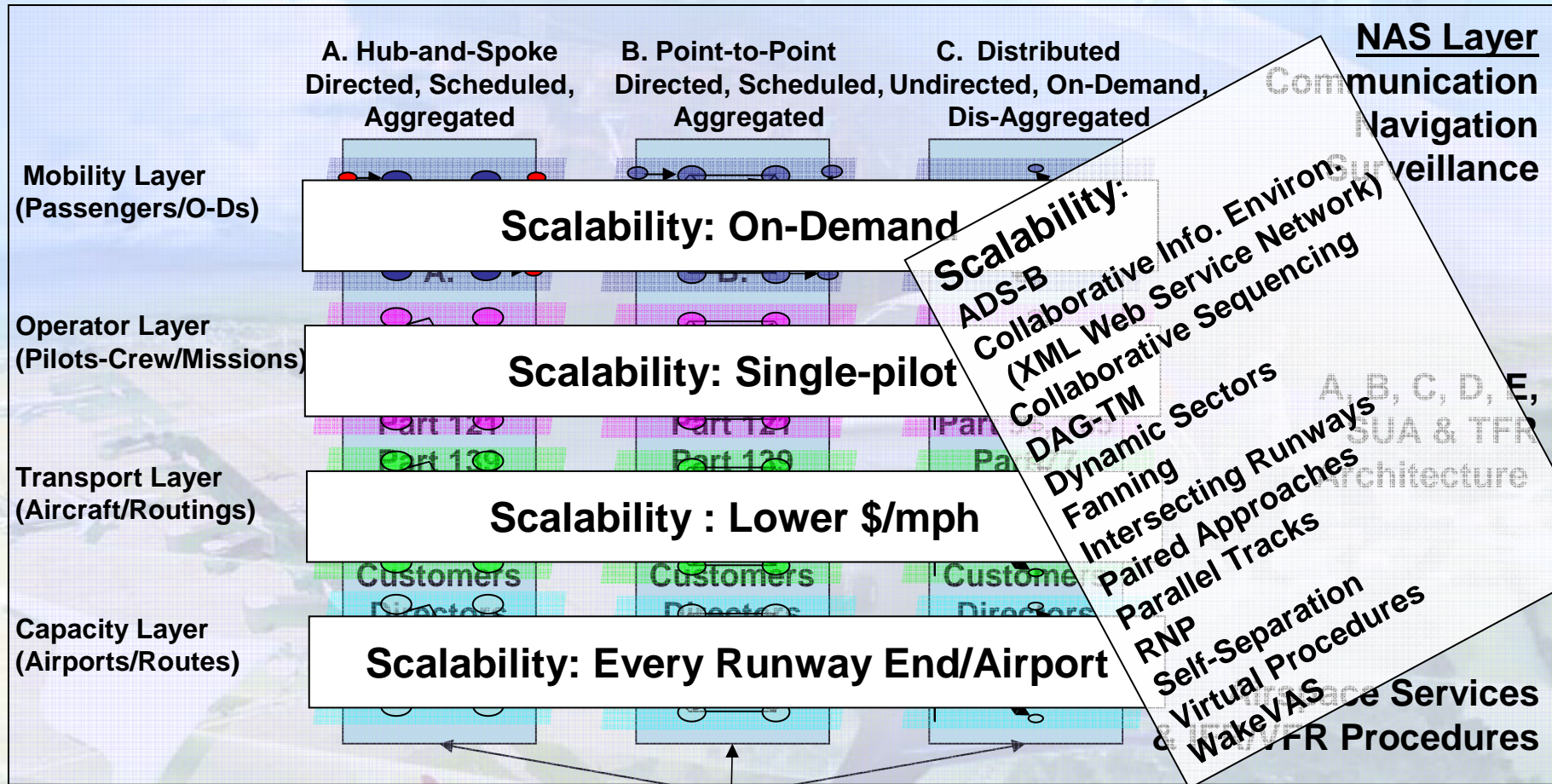
QuickTime™ and a Sorenson Video 3 decompressor are needed to see this picture.

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

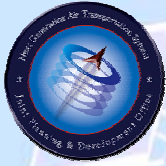


Scalability for Air Transportation Networks

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



Policy Changes Enable Scalability of Business Stacks



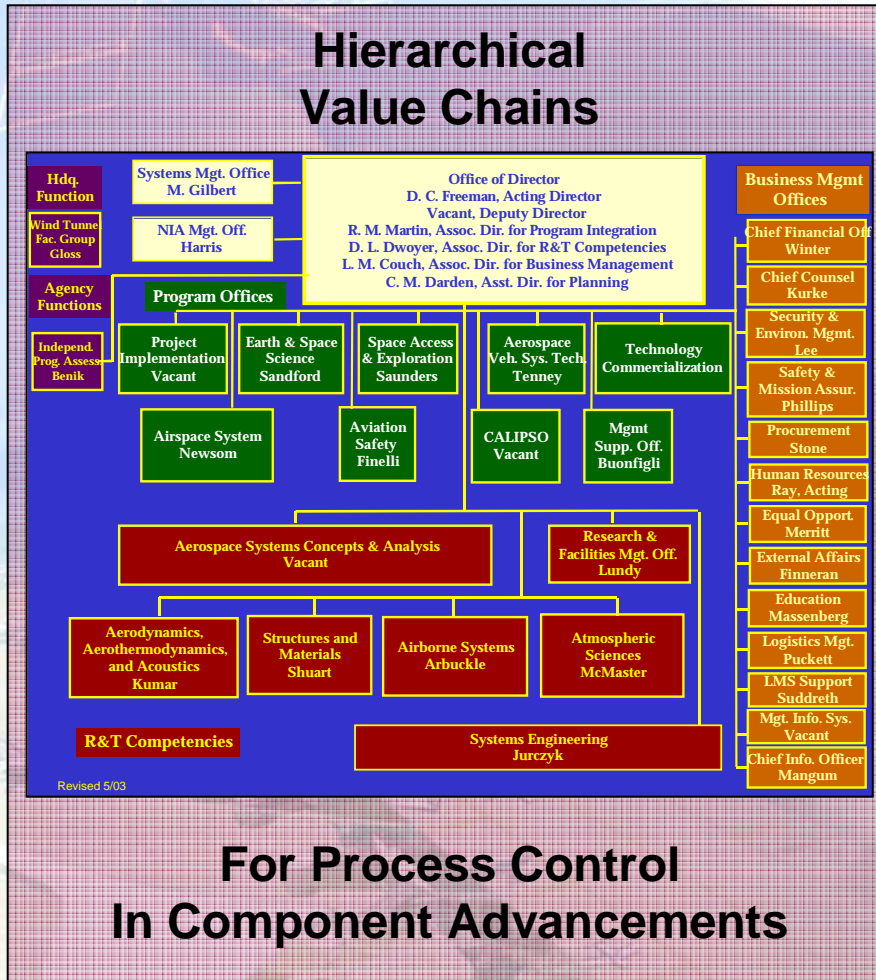
Transformation As a Campaign Against the 20th Century

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

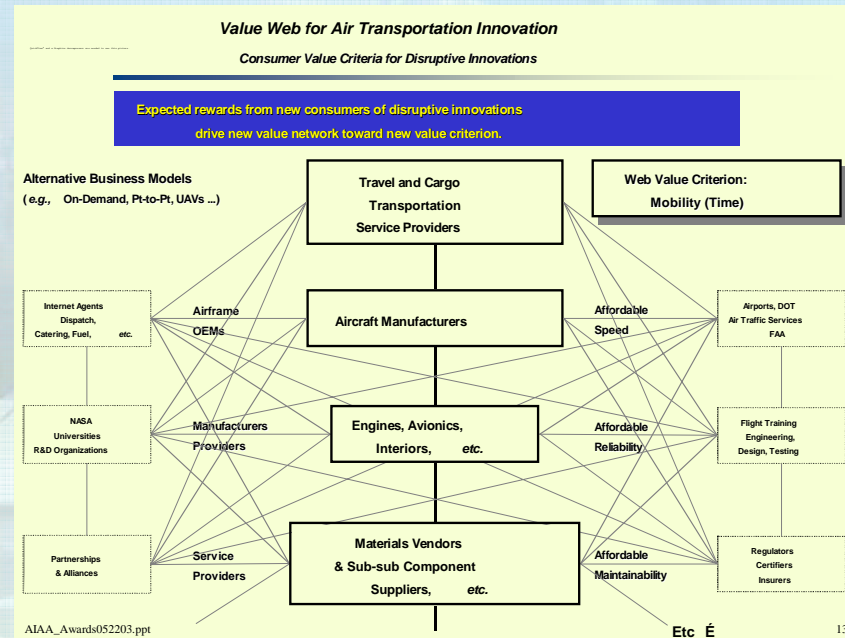
Hierarchical Value Chains



**For Process Control
In Component Advancements**

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

Multi-Scale Value Webs

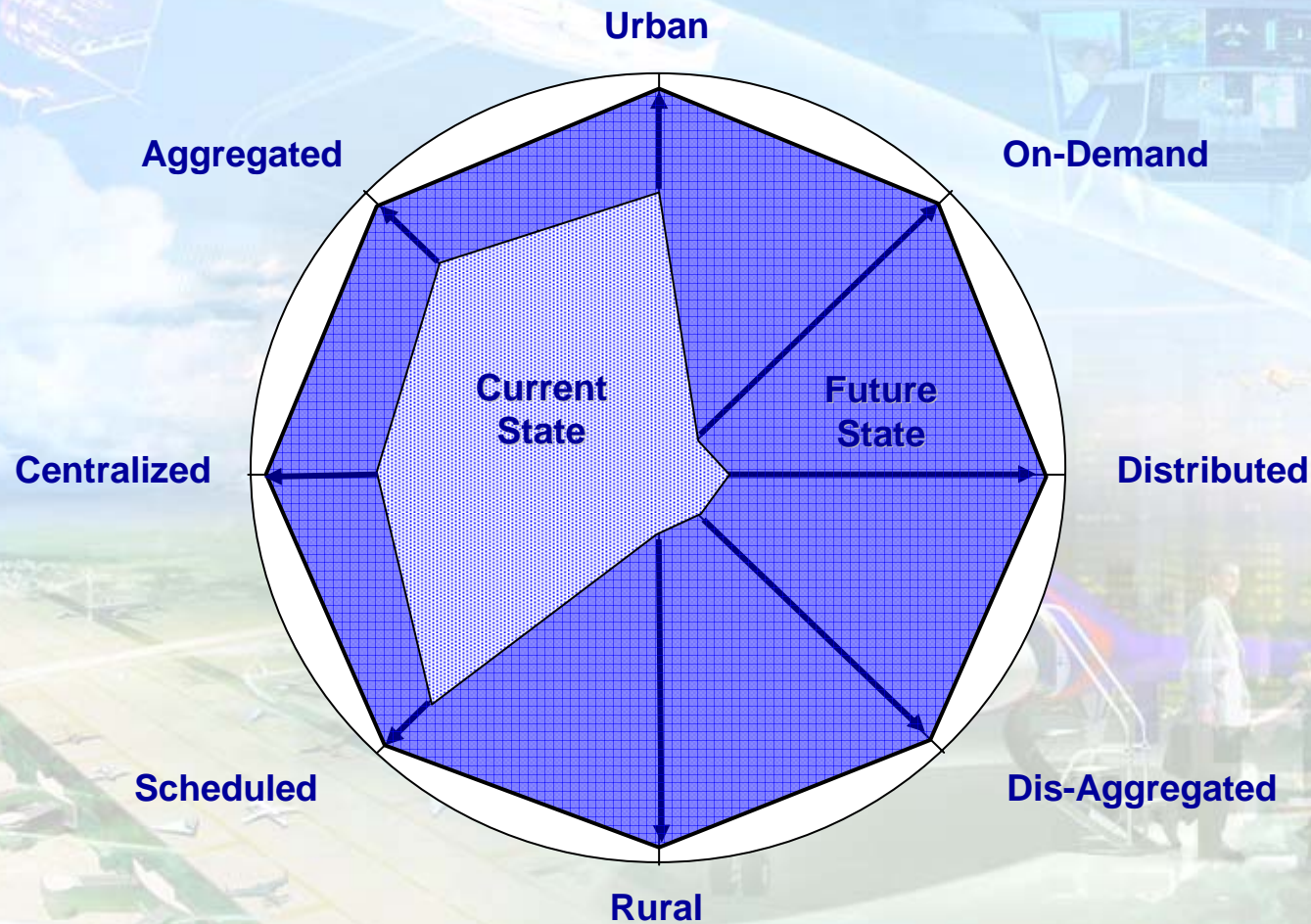


**For Influence
In System Advancements**

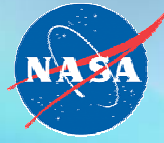
Multi-scale networks require "weak links" for high performance in conditions of ambiguity, uncertainty, disruption, and perform poorly in conditions of certainty and stability.



Notional Transformation Concept Space



The vision includes expanding scalability along all dimensions.



Integrated Plan for the Next Generation Air Transportation System

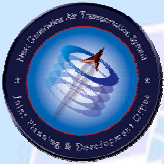
***For More Information:
<http://www.jpo.aero>***



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

