Hochschule für Angewandte Wissenschaften
Hamburg

Aircraft and Technology Drivers for 21st Century Air Transportation Systems

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Berlin, Germany

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Otto Lilienthal (ca. 1894)

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Agenda

- **Boeing Today**
- **787 Dreamliner**
- **21st Century Geopolitical/Environment Drivers**
- **21st Century Owners**
- **21st Century Operators**
- **21st Century Customers**

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- Commercial Aircraft
- Aviation Services
- Defense Systems
- Network Systems
- Satellites and Launch Vehicles
- Financial Services
- Technology

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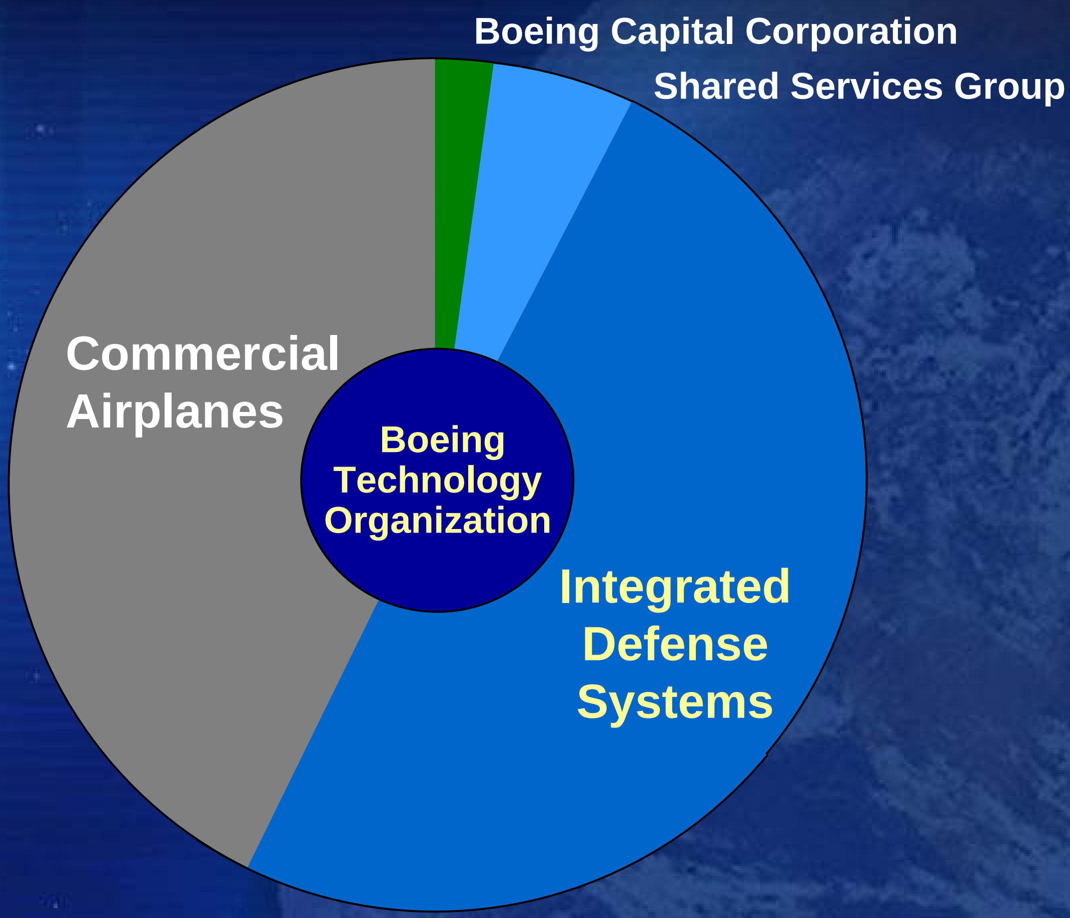
Major Business Units



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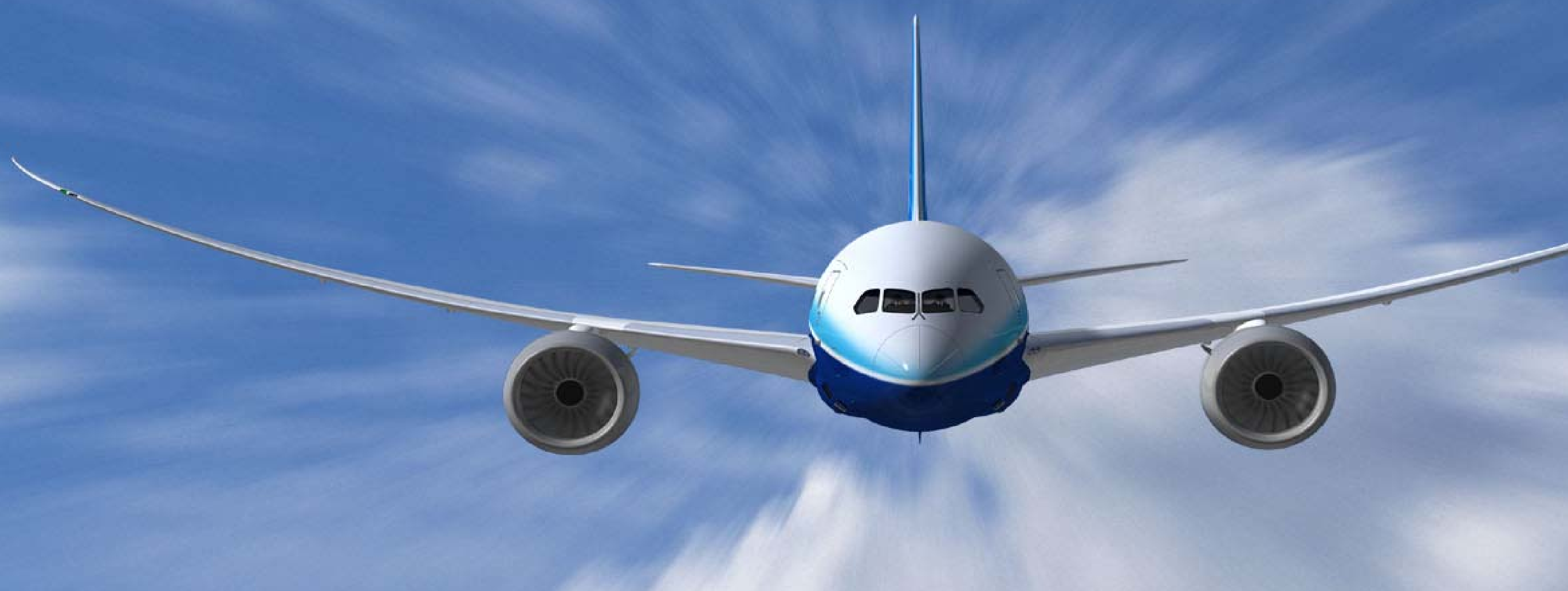
The Boeing 787 Dreamliner

- **787 Overview**
- **Market Drivers**
- **Technology Summary**
- **Program Status**



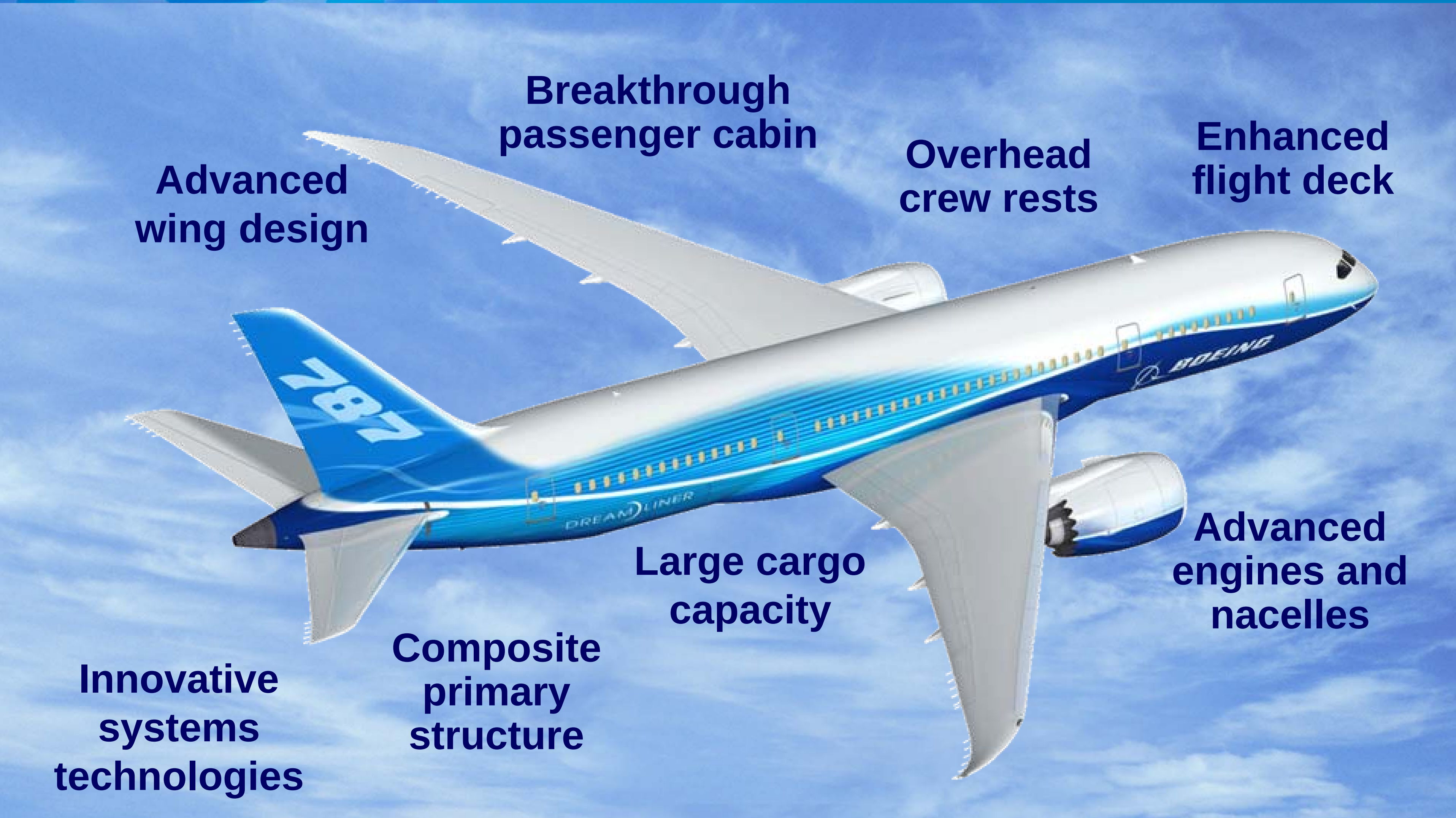
The 787 Is a Complete, Flexible, Efficient Family

787-8
210-250 passengers (three-class)
8,000 – 8,500 nmi | 14,800 – 15,700 km

787-3
290-330 passengers (two-class)
3,000 – 3,500 nmi | 5,500 – 6,500 km

787-9
250-290 passengers (three-class)
8,600 – 8,800 nmi | 15,700 - 16,300 km

Configured for Success
787-8 Design Features



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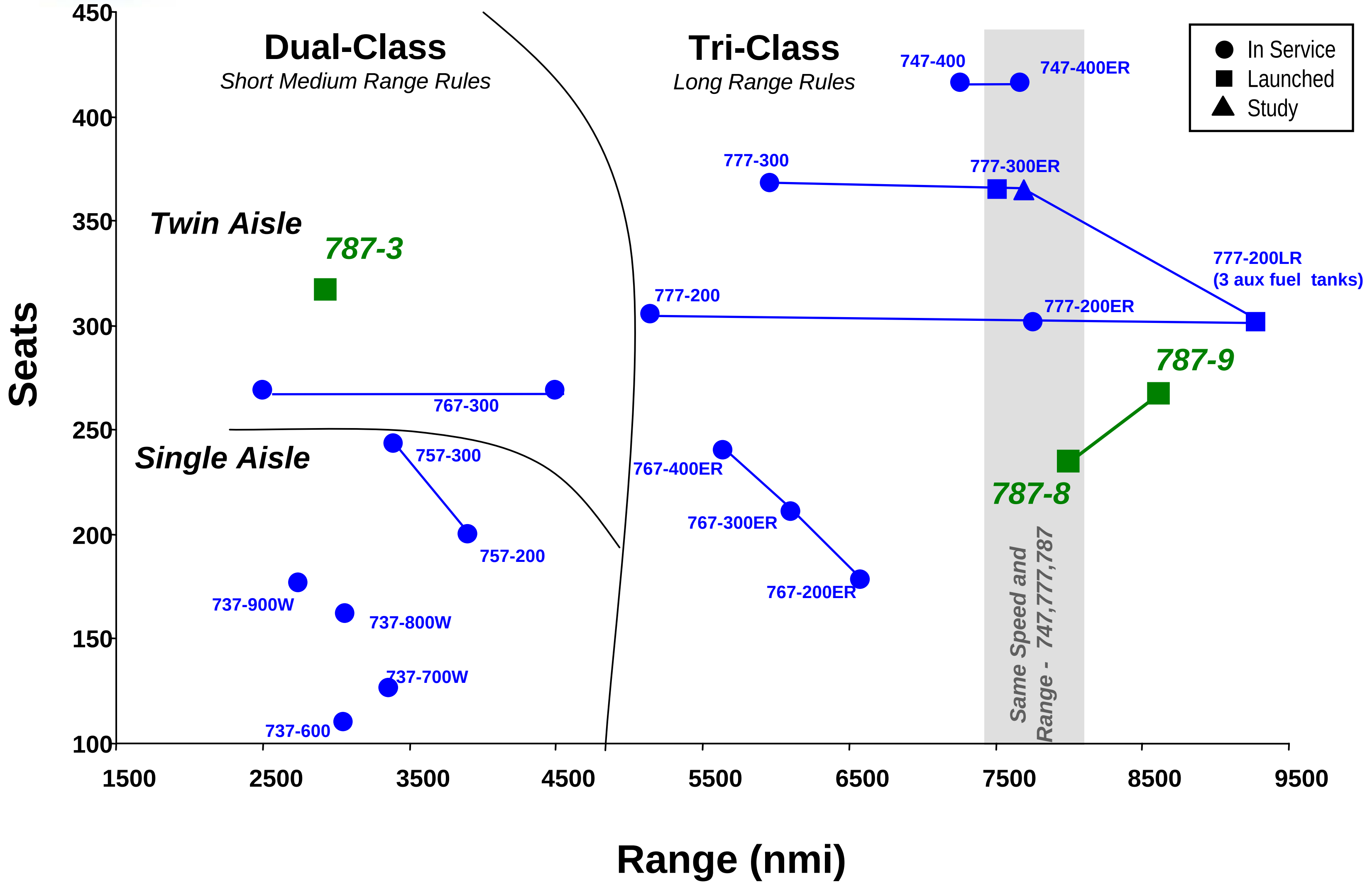
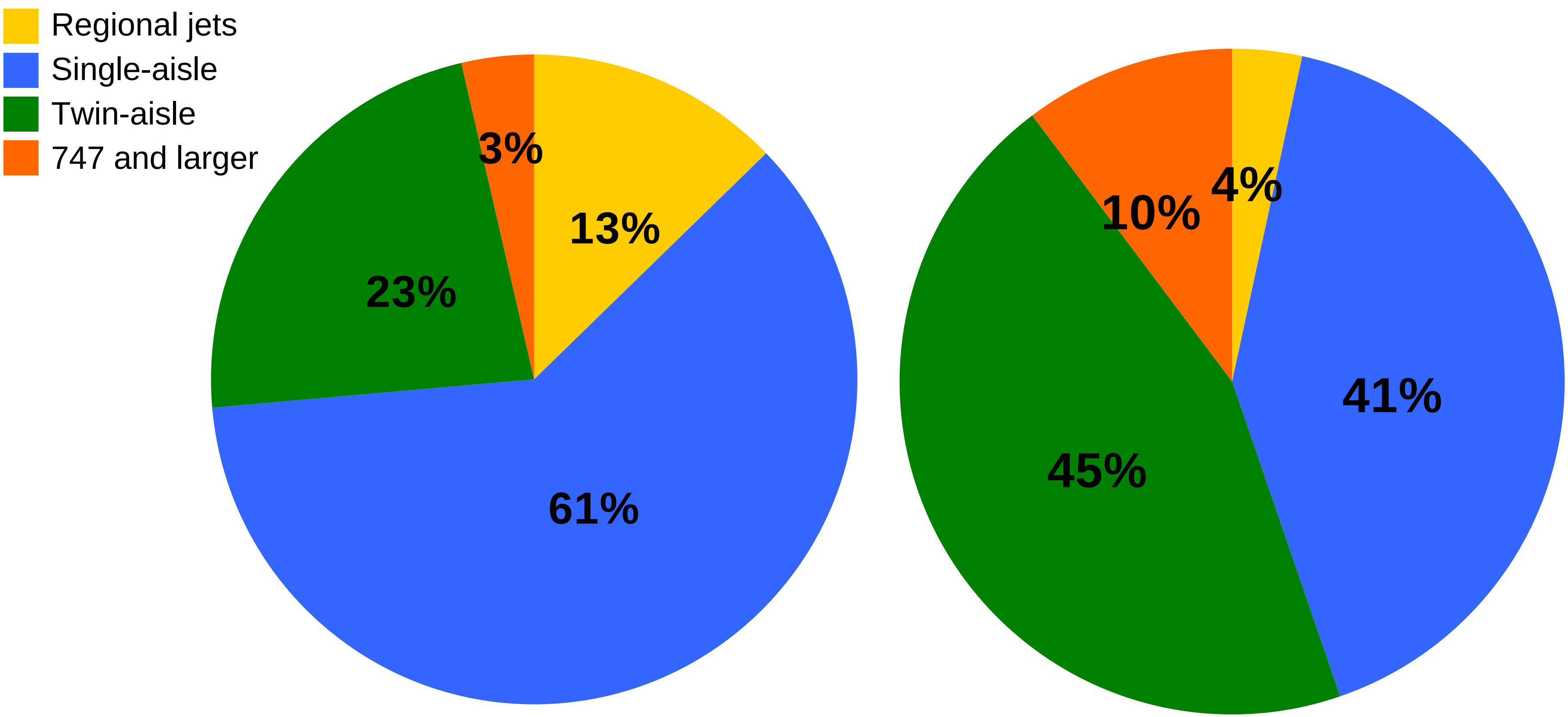
Efficiency for Medium- and Long-Haul Markets



Addressing the Market's Needs (2006-2025)

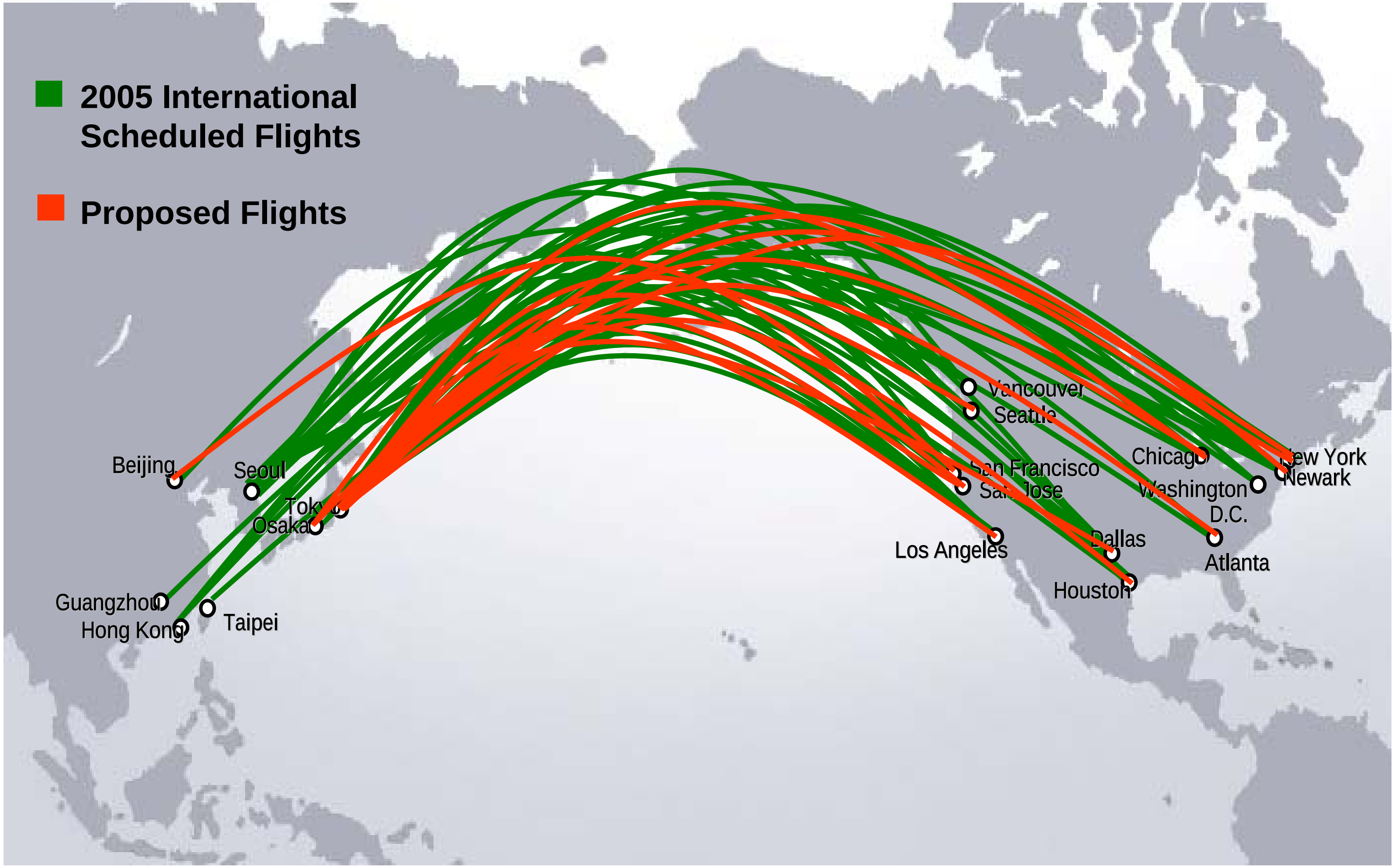


27,200
airplanes

2.6 trillion
delivery dollars*

*In year 2005 dollars

Fragmentation Is Happening



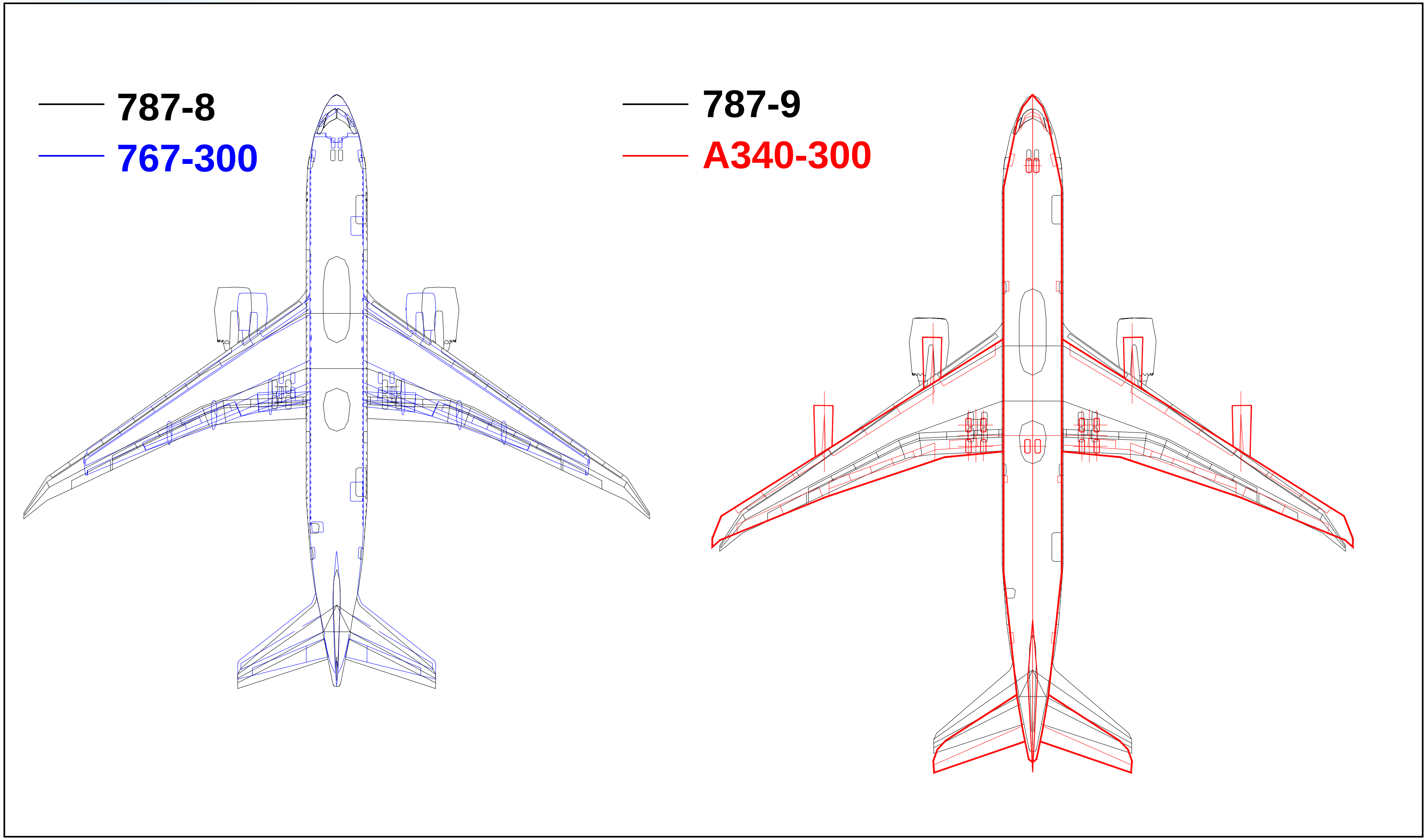
Creating New Non-Stop Routes

The 787 can efficiently connect more than 450 new city pairs

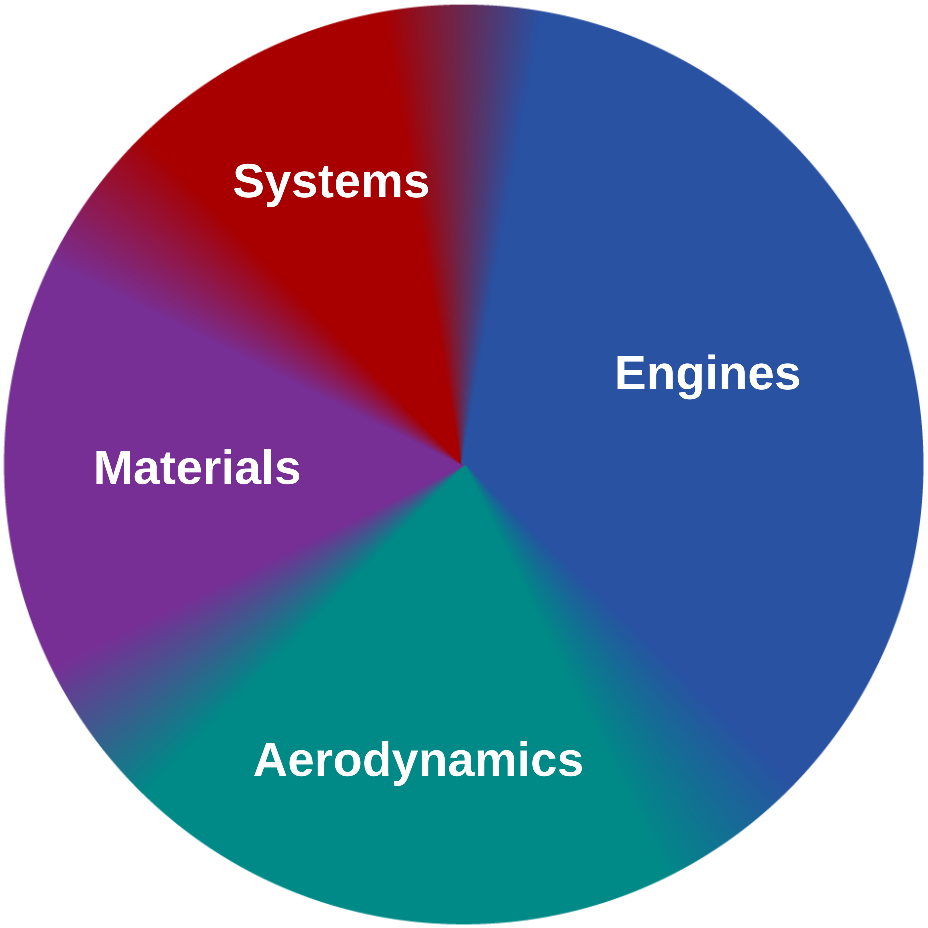
Possible New Airport Pairs

Vancouver	-	Sao Paulo	Munich	-	Nairobi
Seattle	-	Shanghai	Geneva	-	Singapore
San Francisco	-	Manchester	Dubai	-	Taipei
Boston	-	Athens	Madrid	-	Manila
Tel Aviv	-	Montreal	Auckland	-	Beijing

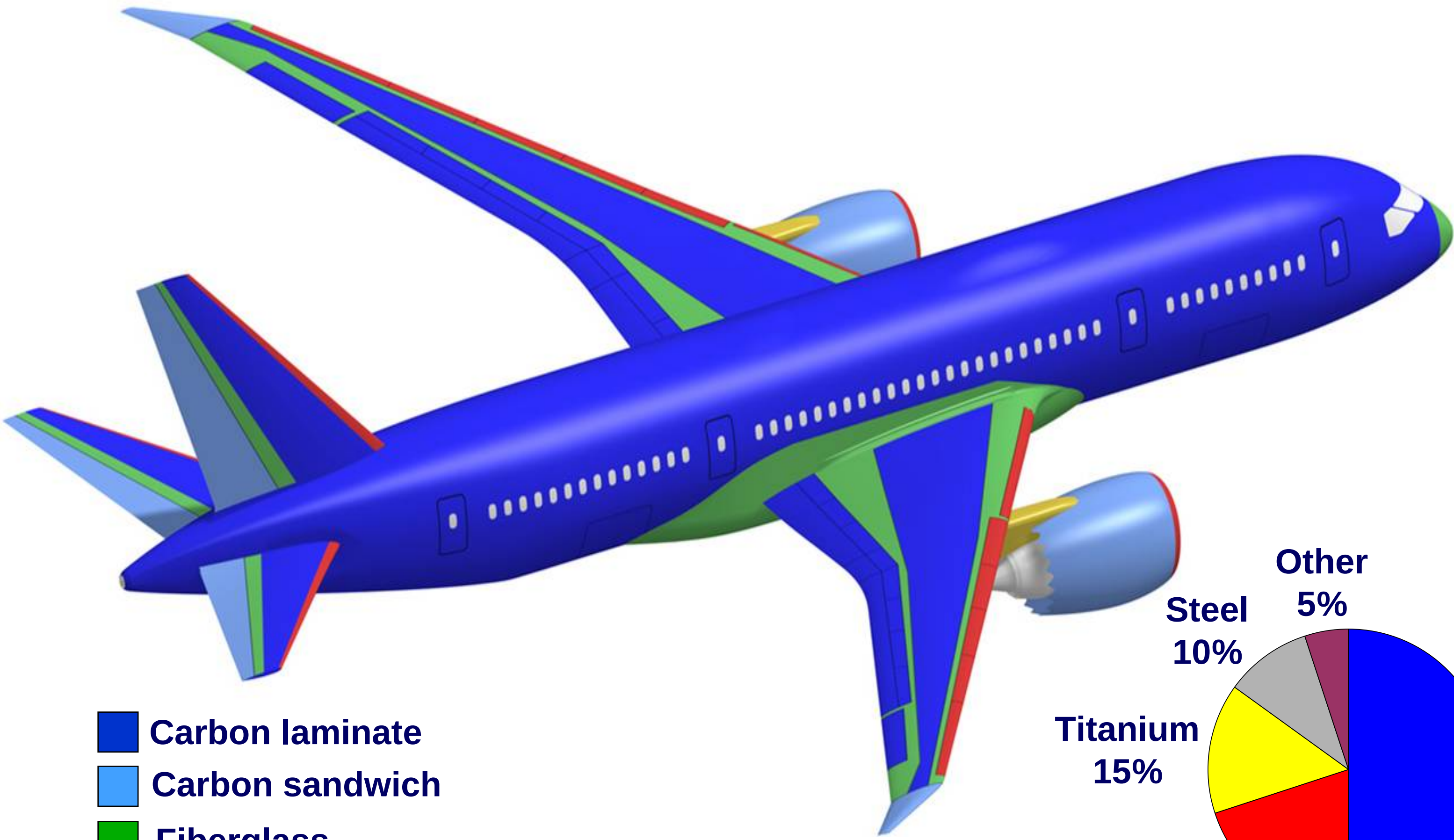
Compatible with Today's Infrastructure



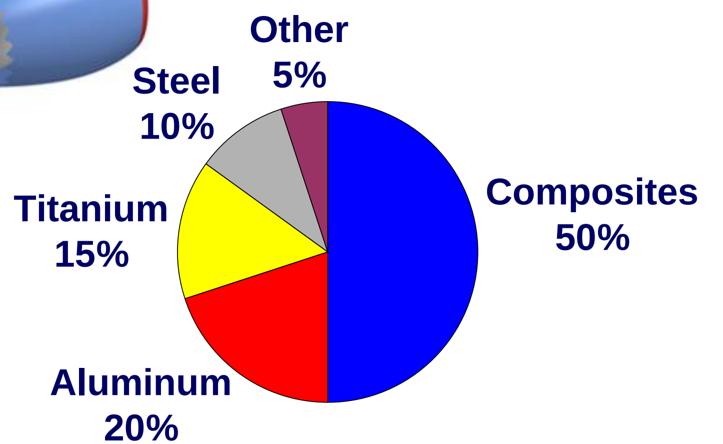
Advanced Technology Contributions to 787 Efficiencies



Composite Solutions Applied Throughout the 787



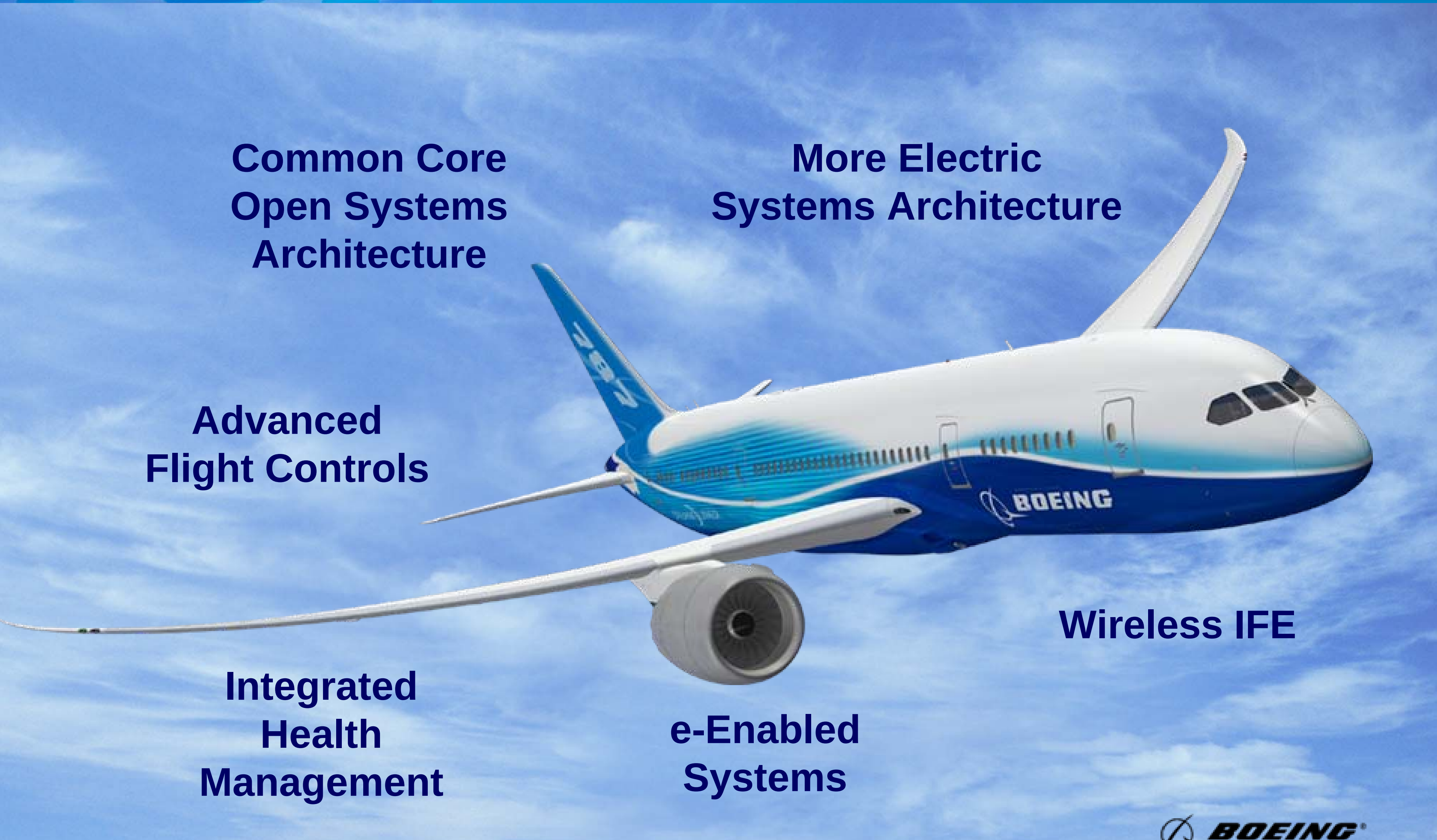
- Carbon laminate
- Carbon sandwich
- Fiberglass
- Aluminum
- Aluminum/steel/titanium pylons



Propulsion Systems Feature Key Technologies

- Higher bypass ratio
- No-engine-bleed systems architecture
- Low-noise nacelles with chevrons
- Laminar flow nacelles
- Interchangeable (at the wing)

Advanced Systems Technologies Provide Value



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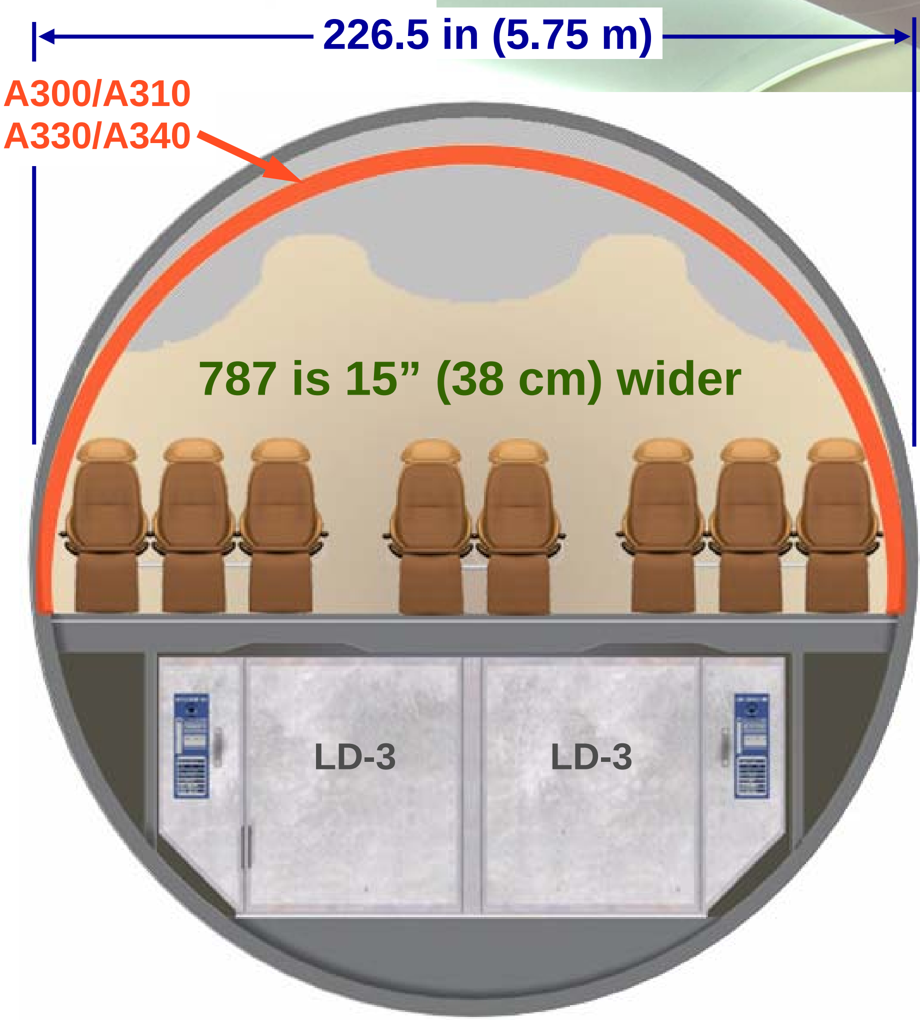
Improving the Flying Experience



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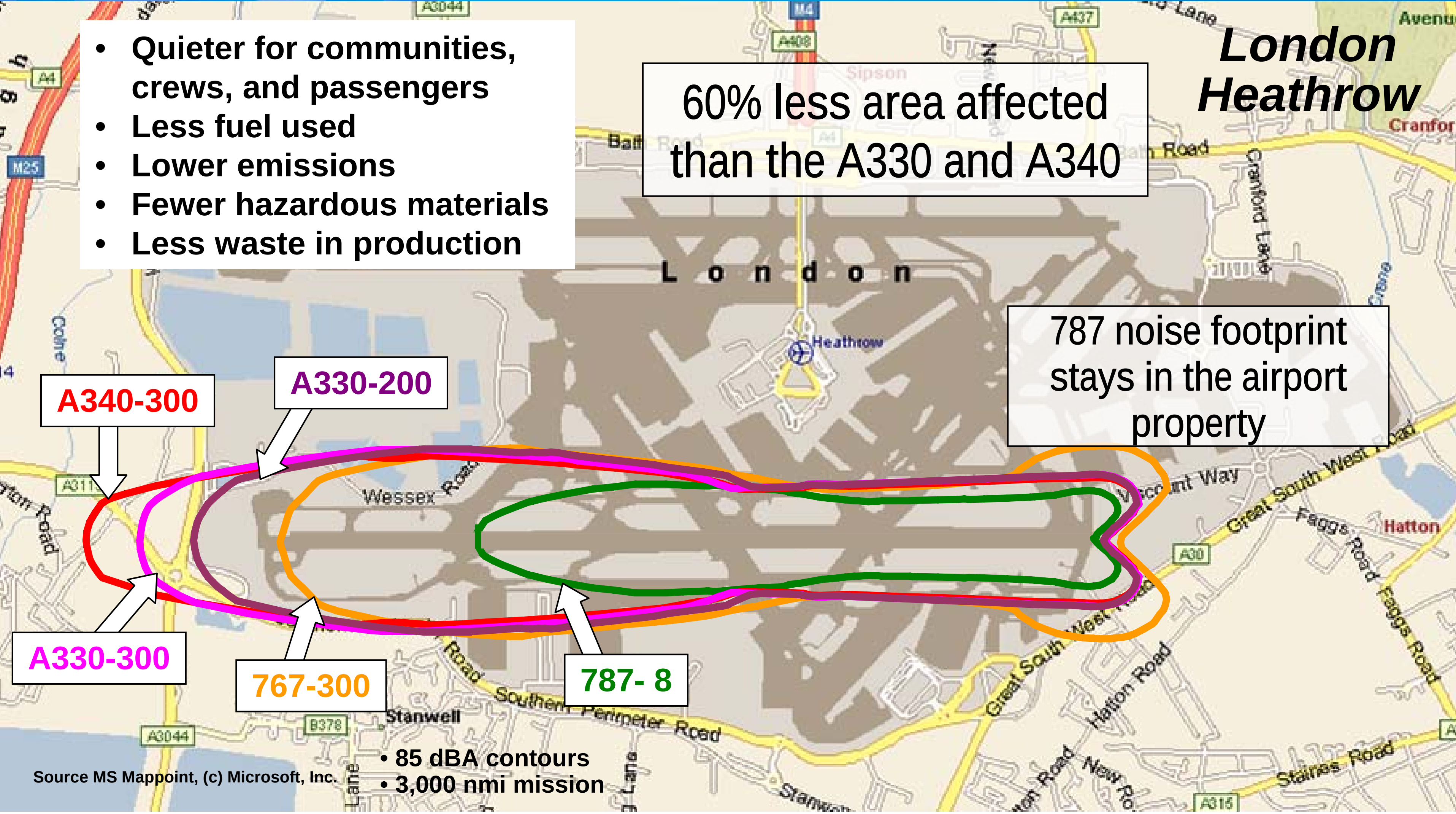
Quiet for Airport Communities

- Quieter for communities, crews, and passengers
- Less fuel used
- Lower emissions
- Fewer hazardous materials
- Less waste in production



Source MS Mappoint, (c) Microsoft, Inc.

Structures Progress

LCF Progress

Large Cargo Freighter First Flight

Progressing on Schedule

Worldwide Market Interest Strong

36 customers, 455 announced orders and commitments. 432 Firm orders. (October 11, 2006)

787 DREAMLINER

ANA

AIR CANADA

中富航空 CR AIRWAYS

QANTAS

ILFC

POLISH AIRLINES LOT

AIR CHINA

Continental Airlines

Ethiopian

JAL

nwa NORTHWEST AIRLINES

Blue Panorama airlines *

First Choice

Jet

AIR INDIA

SINGAPORE AIRLINES

Kenya Airways The Pride of Africa

Garuda Indonesia

中國東方航空 CHINA EASTERN

AIR NEW ZEALAND

AIR PACIFIC

中国南方航空 CHINA SOUTHERN

KOREAN AIR

royal air maroc

Air Seychelles

Monarch

LCAL

SHANGHAI AIRLINES

Hainan Airlines

BOEING BUSINESS JETS Boeing & General Electric

Pegasus

flyglobespan *

Vietnam Airlines

ICELANDAIR

AEROMEXICO *

UNIDENTIFIED

* Leasing Operator

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Geopolitical and Environmental Drivers

Urban congestion and population growth

- drive transportation integration and new modes of travel

Globalization and leisure travel growth require safety and efficiency

- Breakthroughs in speed, range, and comfort
- New passenger convenience
- Safe and affordable

Hydrogen Fuel Airplane

Dwindling natural resources and environmental concerns

- Cleaner alternative fuels
- Reduced emissions

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  – New Missions and Configurations
  – Enabling Technologies
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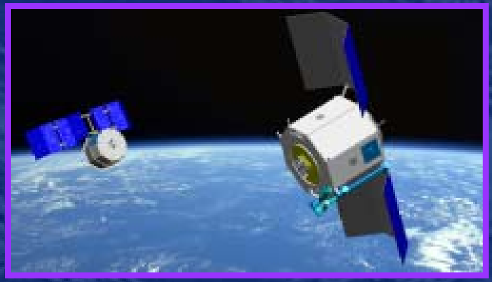
Future Missions in the Next 20+ Years

- Super/hypersonic airplanes flying on the edge of space to meet the needs of intercontinental business travelers

- Ultra-quiet VTOL air taxis will move people from local parking lots to urban multi-modal transportation centers

- Personal air vehicles capable of landing on the owner’s driveway could emerge over the next 100 years

- Autonomous systems will enable new defense missions and commercial services such as satellite repair



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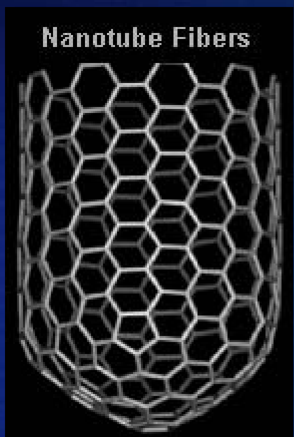
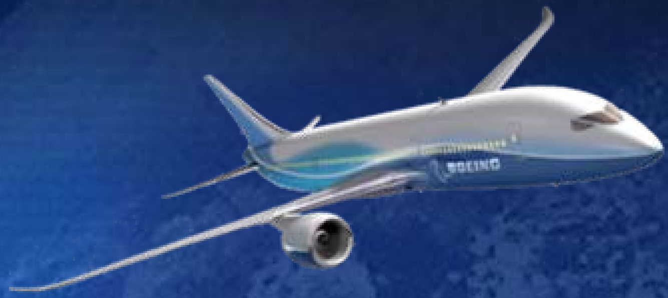
Super-Efficient Platform Technologies

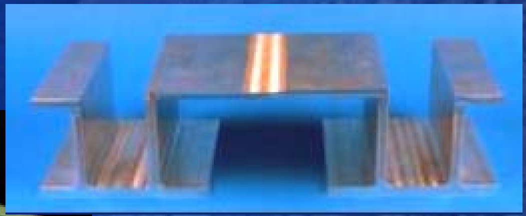
Technologies being developed today for the aircraft of tomorrow



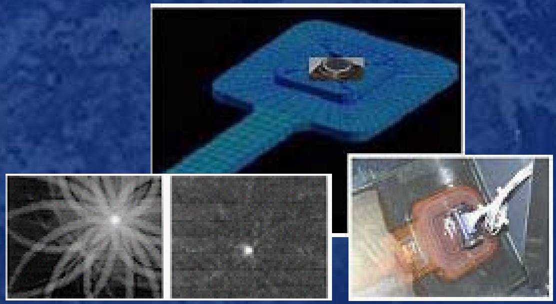
Nanotech materials

Integrally stiffened composite panels

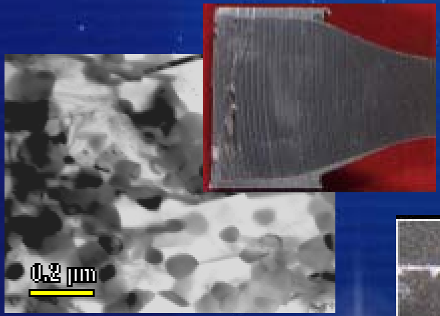




Joining processes that eliminate fasteners

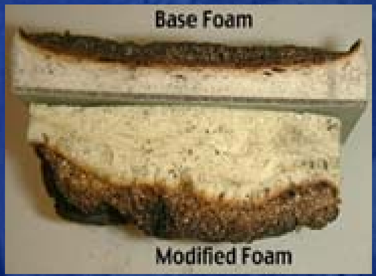


Multifunctional structures with embedded systems

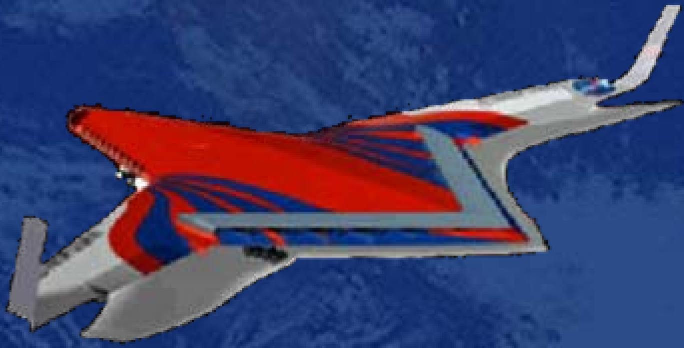


New metallic alloys

Smart coatings



Fire retardant foam w/Nano-composites



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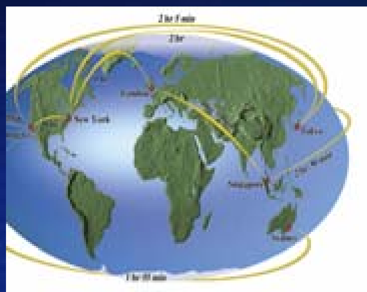
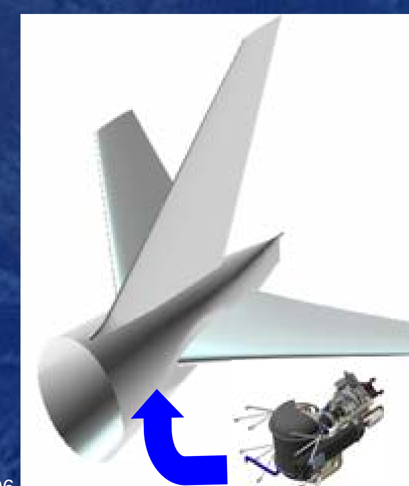
Clean Platform Enabled Future Operational Environment



Clean/Safe Multi-modal Transportation Systems

- **More Electric Technologies support no-bleed engines power; ultra-capacitors, Li-Ion Batteries**

- **Photonics - Control/Power By Light**
- **Component Cooling by electron tunneling devices**
- **Fuel Cell Auxiliary Power Unit (APU)**



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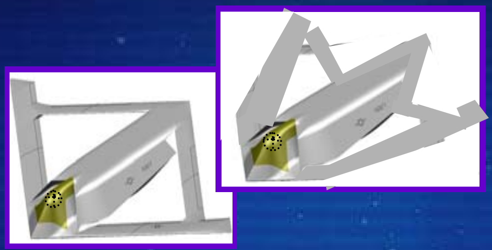
Technologies Required to Realize the Morphing Aircraft of the Future

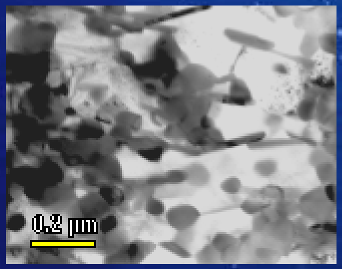


Advanced Structures

Active Aeroelastic Wing Research

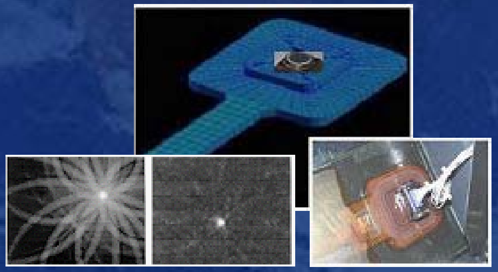
Nastic Structures

Real-time Flight Control Systems



New metallic alloys and flexible skins

Small, Low Cost Actuators



Imbedded Actuation and Thermal Control

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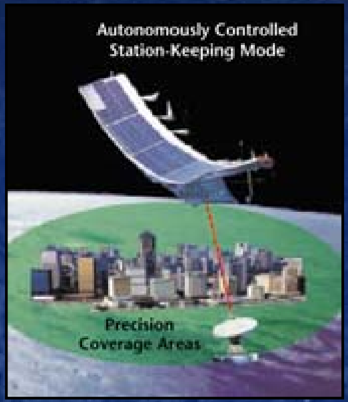
Mission Adaptive, Multi-ship Flight Control

Intelligent and "learning" flight control systems will ensure safe and reliable aircraft



- **Provide optimal use of all flight controls and effectors**
- **Optimize performance and trajectory, for normal or abnormal conditions**
- **Key enabler for autonomous flight in national airspace systems**

Piloted and autonomous air vehicles operate together in common controlled airspace

- **Heterogeneous vehicle operations**
- **Autonomous deconfliction**
- **Managed formations of multiple aircraft – vortex drag reduction, air refueling, etc.**
- **Autonomous comm/surveillance platforms in near-term. Autonomous cargo in 10-20 years**

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- 21st Century Operators
  - Super-Efficient Flight Crews
  - Integrated Vehicle, Fleet and System Health Management
- 21st Century Customers

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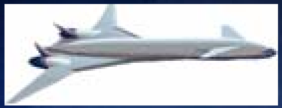
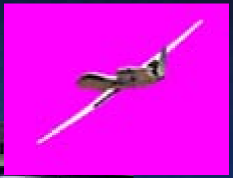
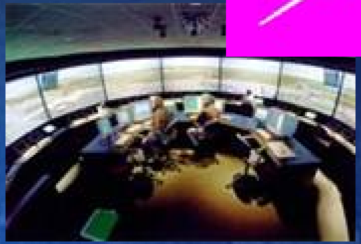
Super-Efficient Flight Crews

Key Operational Challenges

- Demand for increased capacity & efficiency
- Need for improved system safety and security
- Need to minimize operations & support costs
- Integration of manned & unmanned vehicles



Enabling Technologies



Advanced vision & visualization devices

- Synthetic/enhanced vision
- Holographic/immersive interfaces
- Seamless real-time collaboration

Multi modality interfaces

- Robust head and eye tracking devices
- Touch sensitive/responsive interfaces
- Spatial auditory cueing/discrimination
- Speech synthesis/recognition



Advanced automation and decision support

- Intelligent/adaptive flight controls
- Dynamic human-machine task allocation
- Predictive models of human performance

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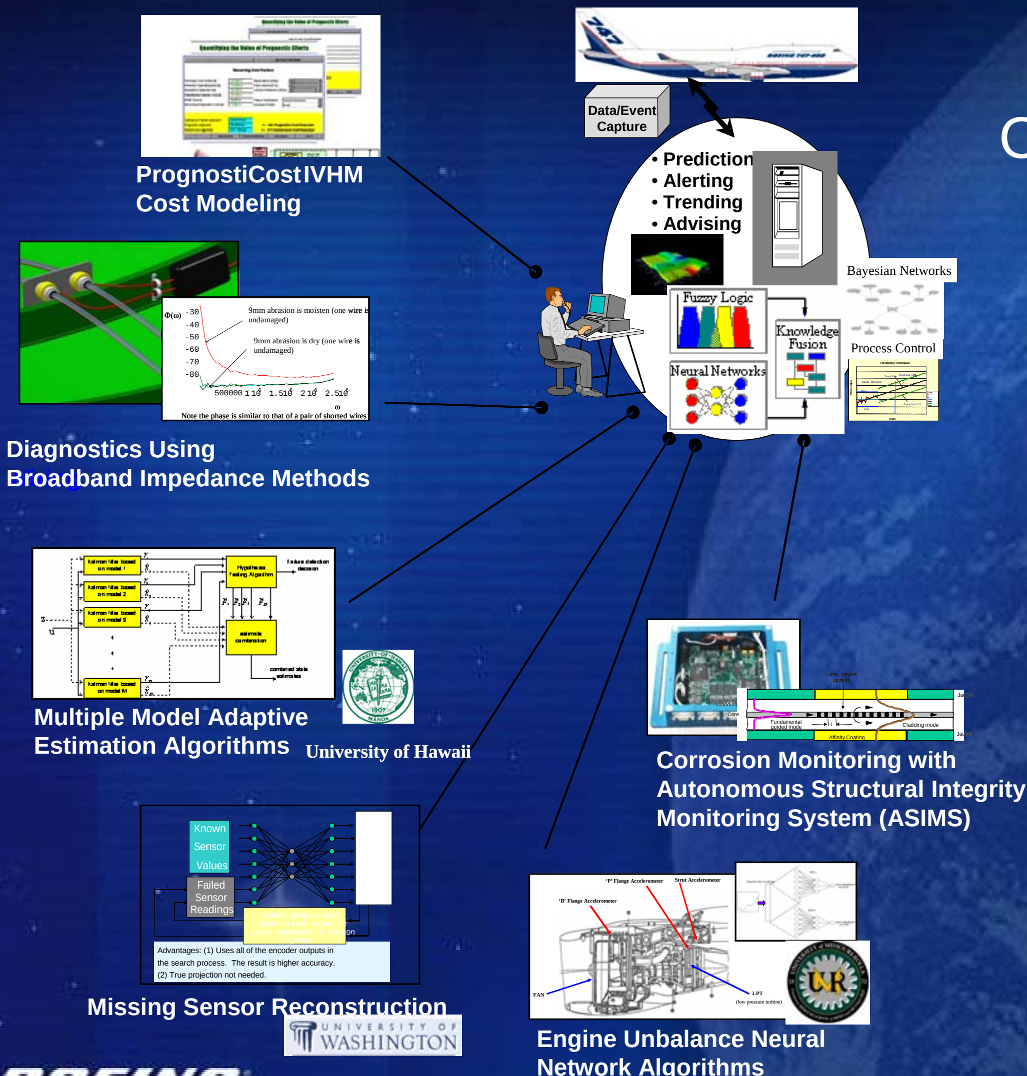
Integrated Vehicle, Fleet and System Health Management



On and off board predictive health management

Integrated system architecture

Ubiquitous sensing

Self-awareness

Network centric system health and maintenance services

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Passenger Flow Services

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THE FUTURE IS CLOSE

Creating the Future of Aerospace

Questions?

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Forever New Frontiers

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