Manufacturer's Perspective for *Environmental Performance*

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July 28, 2009

2009 EWG OPS SC Face-to-Face Workshop

NASA Ames Research Center, Moffett Field, CA

Key Elements of Successful Environmental Strategy

1 Focusing on a Clear Vision

- Technology unlocks the future
- CO_2 (fuel) and Noise are the priority
- System efficiency is essential
- A global approach involves and benefits everyone

2 Achieving Specific Metrics and Milestones

- Pioneer new technologies
- Relentlessly pursue manufacturing and life cycle improvements
- Create progressive new products and services
- Improve performance of worldwide fleet operations

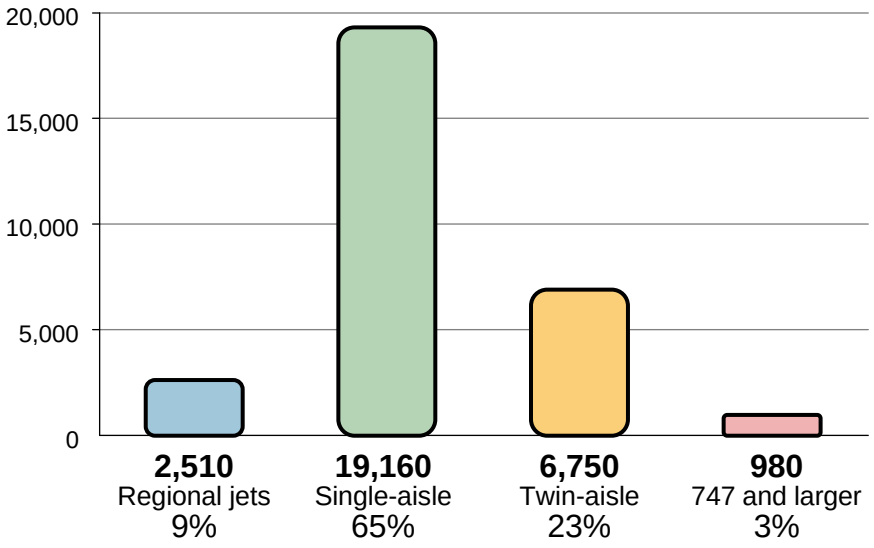
3 Delivering Global Aviation Industry Leadership

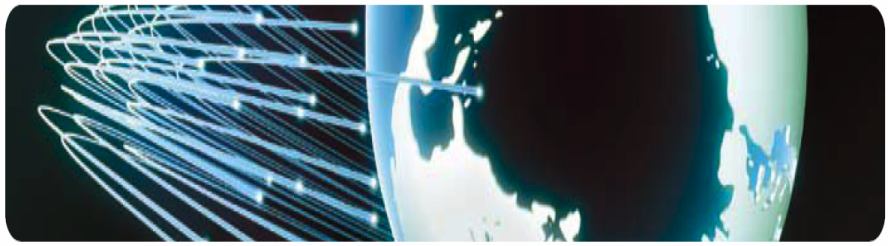
- Continually work together with the industry to promote effective global public policies and best practices – for a better future

Airlines will need more than 29,400 new airplanes valued at $3.2 trillion

29,400 New Airplane Deliveries

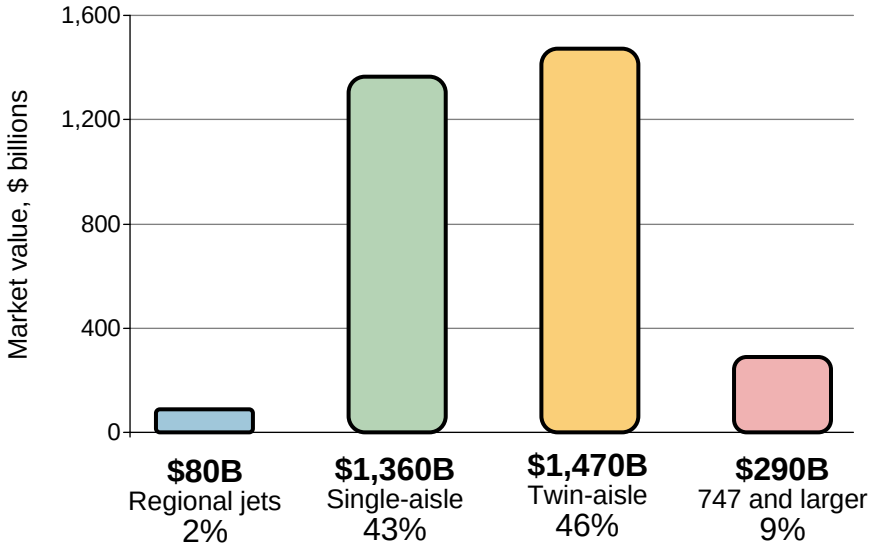
2008 to 2027





$3.2 Trillion Market Value

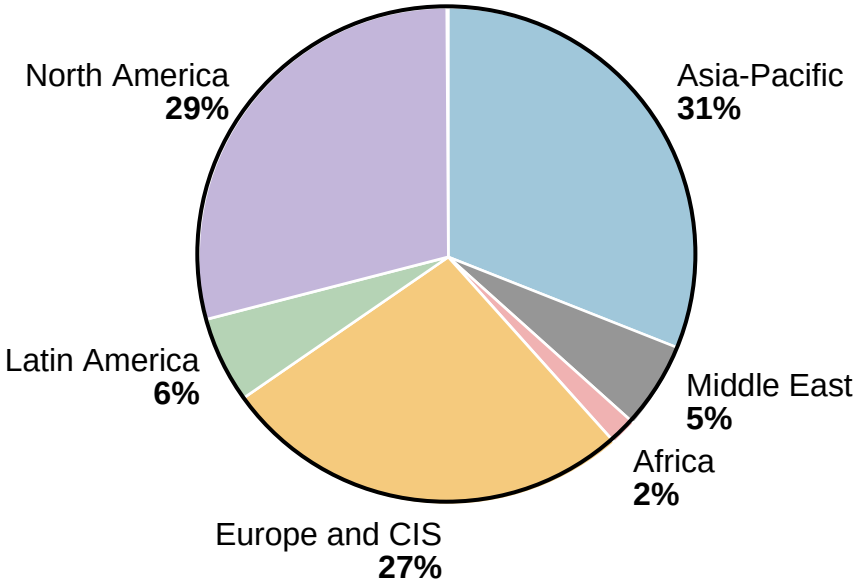
2008 to 2027



Market for new airplanes set to become considerably more geographically balanced

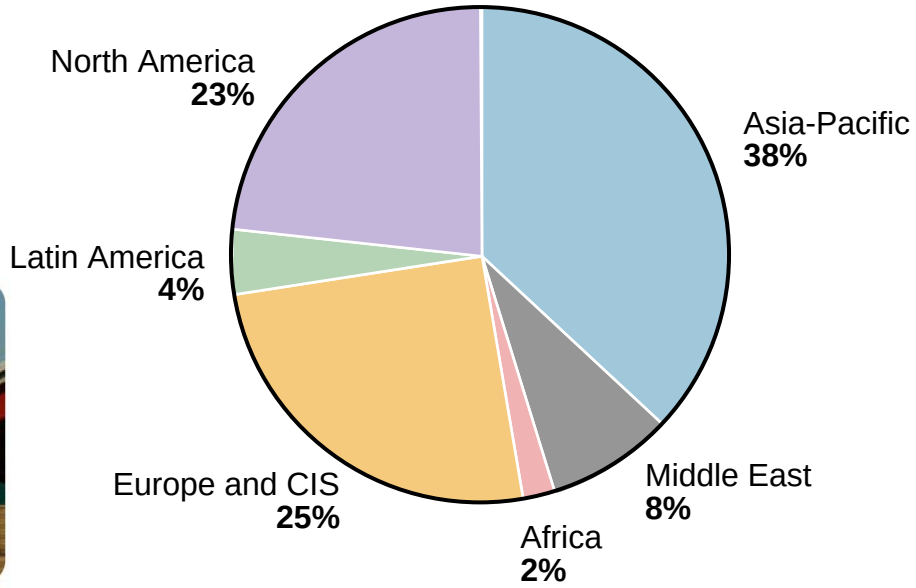
Deliveries by Region

2008 to 2027



Market Value by Region

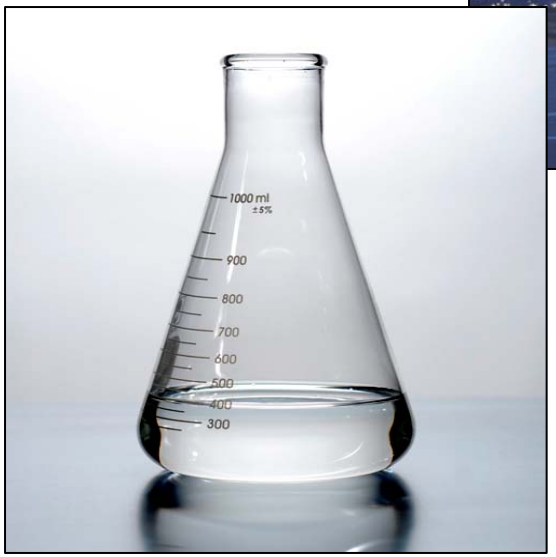
2008 to 2027



Technical solutions are being developed

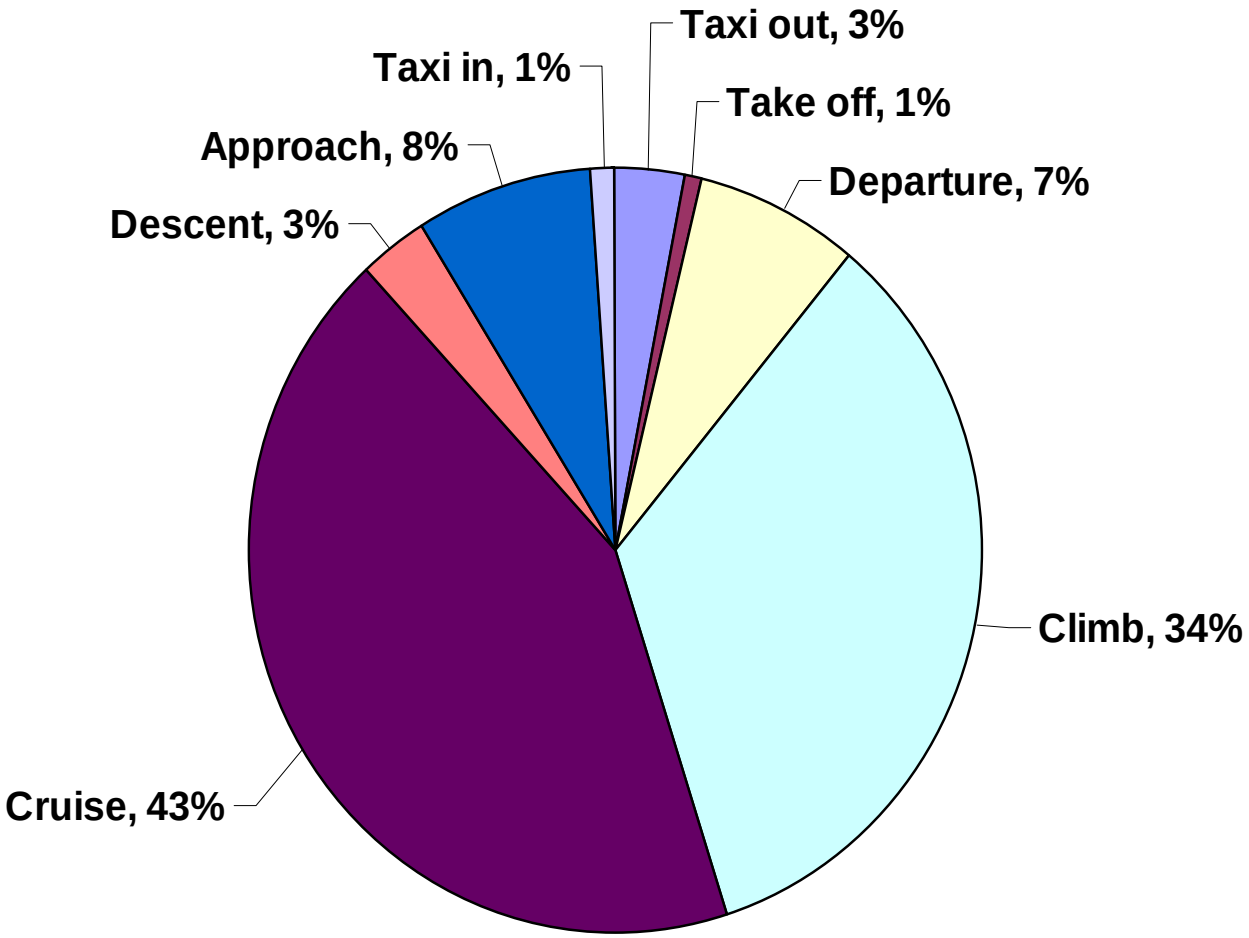
Efficient Aircraft

Environmentally Preferred Operational Procedures



Exploration of alternative fuels and technologies such as fuel cell

Fuel Burn/Emissions by Phase of Flight
For nominal 500 nm flight by a single aisle airplane



Efficient operating practices improve fuel and CO_2 efficiency

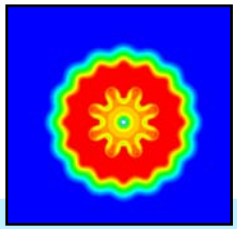
Target Opportunities	*Sample CO_2 Savings:*	
Reduce Aircraft Weight	■ Catering weight program	2 – 3 Million lbs
	■ Aircraft servicing	(0.9 – 1.4 Million kgs)
Plan More Efficient Flights	■ Flight plans	14 – 21 Million lbs
	■ Speed schedule	(6.4 – 9.5 Million kgs)
	■ Aircraft loading	
Fly More Efficient Flights	■ Reserve fuels	14 – 21 Million lbs
	■ Idle reverse	(6.4 – 9.5 Million kgs)
	■ Efficient routings	
	Total CO_2 Annual Savings:	**30 – 45 Million lbs (14 – 20 Million kgs)**

Reduced CO_2 Emissions

It is not one thing, it is everything

Source: Boeing analysis for a 115 narrow body airplane operation (22B ASMs)

Technology Programs for Quiet Airplanes
Quiet Technology Demonstrator (QTD)



Analytical studies

Wind-tunnel tests

Static engine tests

2001 QTD 1
Boeing
Rolls-Royce
American Airlines

2005 QTD 2
Boeing
General Electric
Goodrich
NASA
All Nippon Airlines

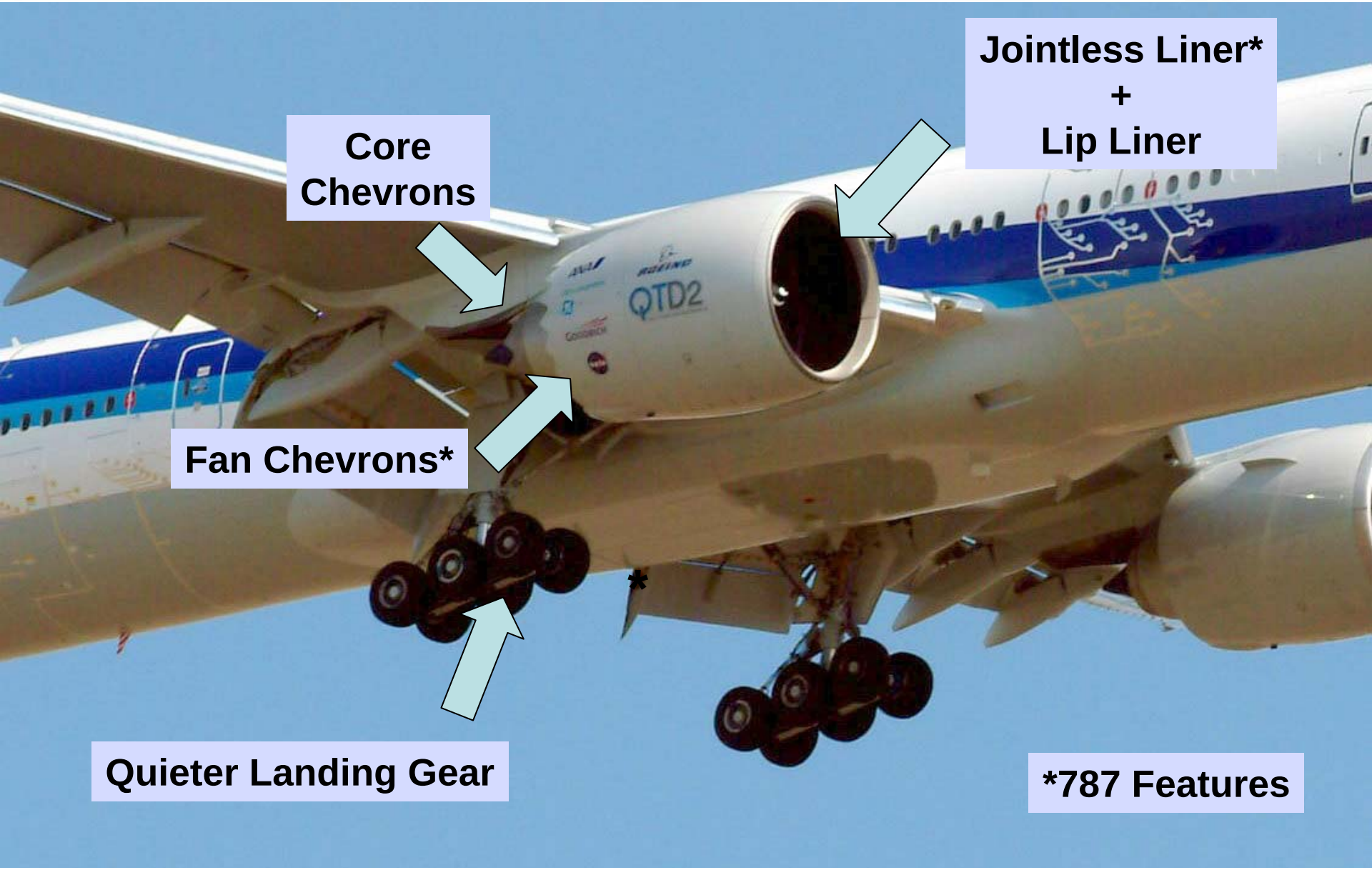
747-8
QTD 2 Technology Applied

787
QTD 2 Technology Applied

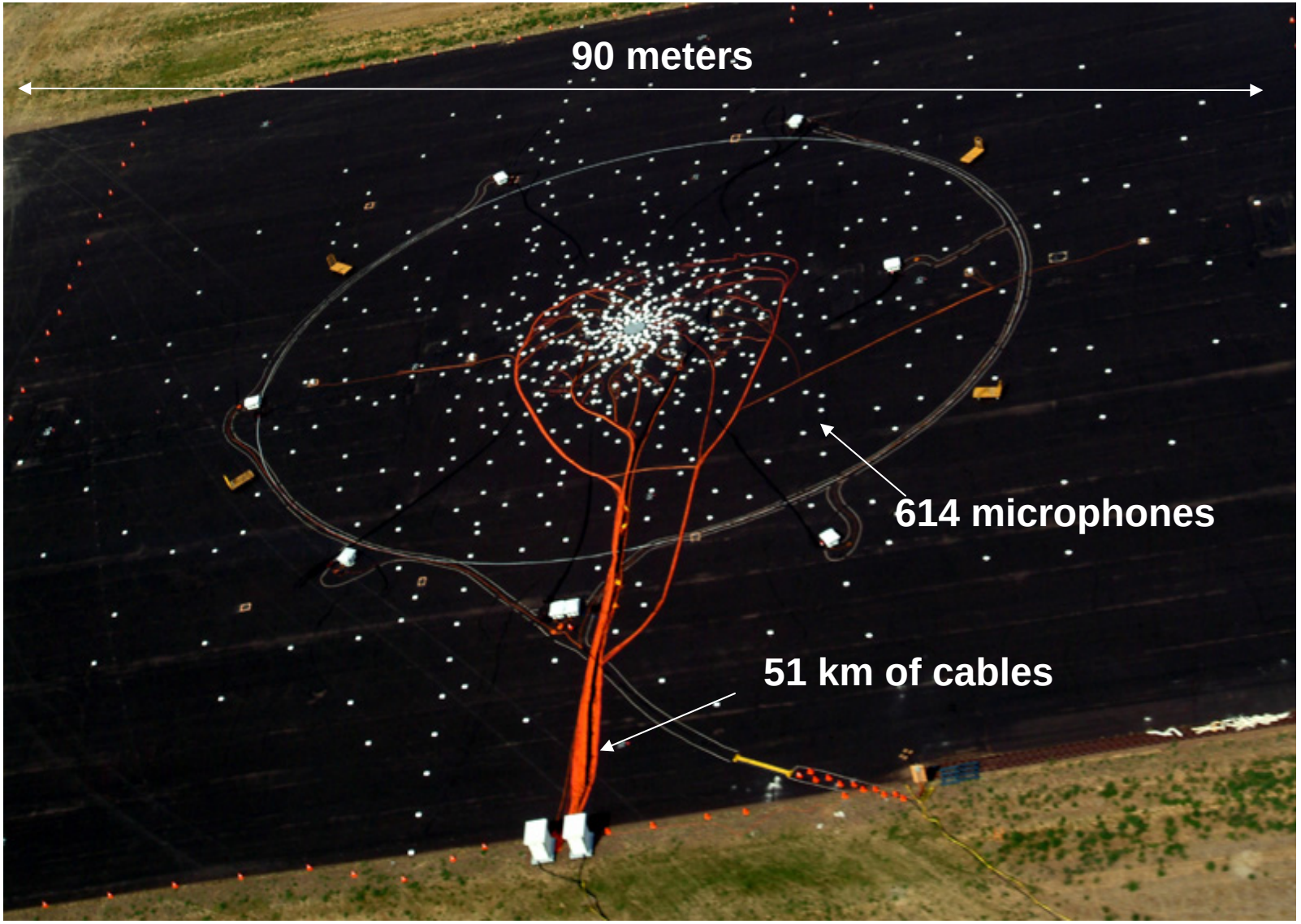
777
QTD 1 Technology Applied
QTD 2 Technology Application In Study

QTD 2
Multiple Organization Working Together

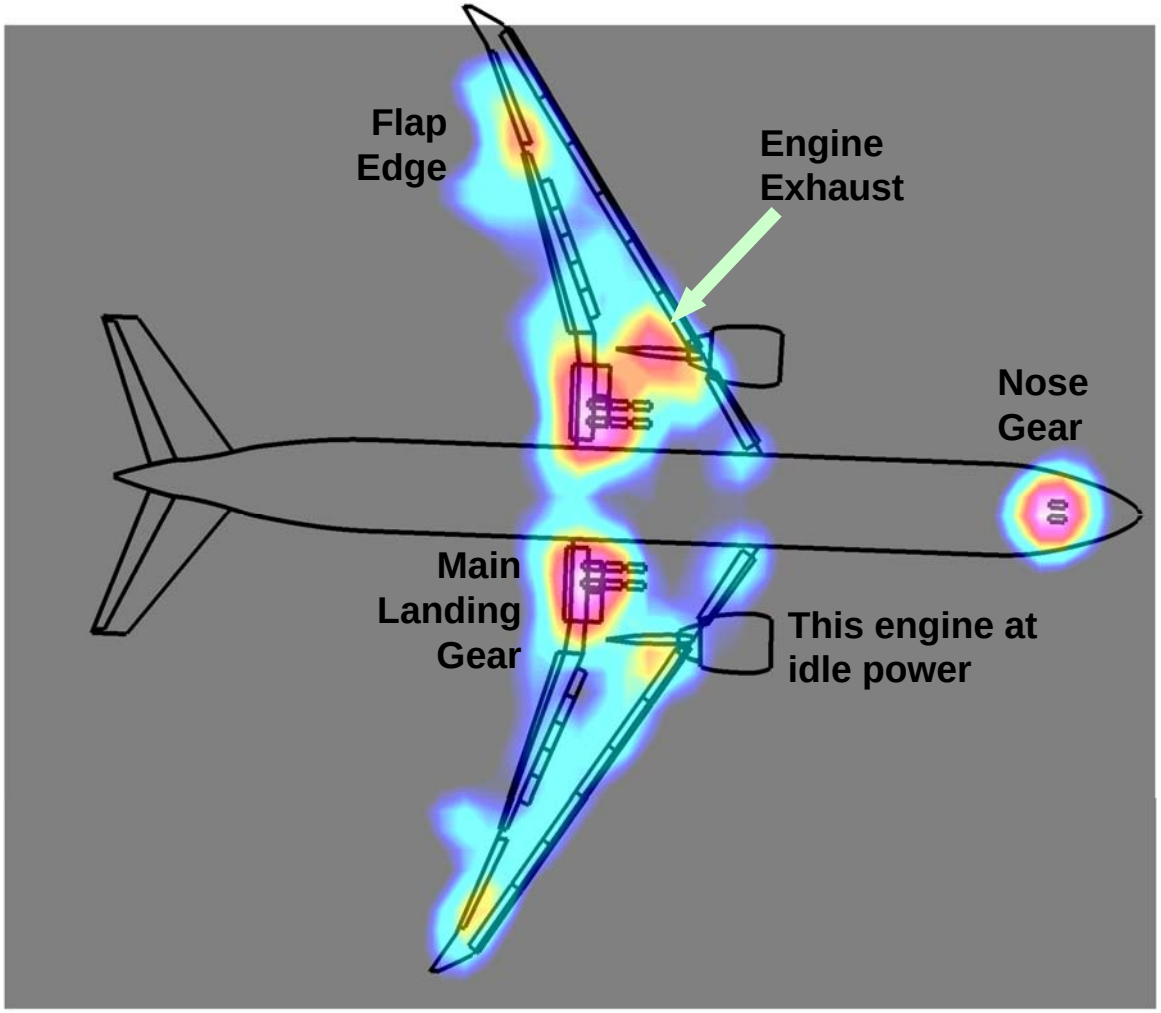
Reducing Noise for Communities and Passengers



Acoustic Camera Microphones



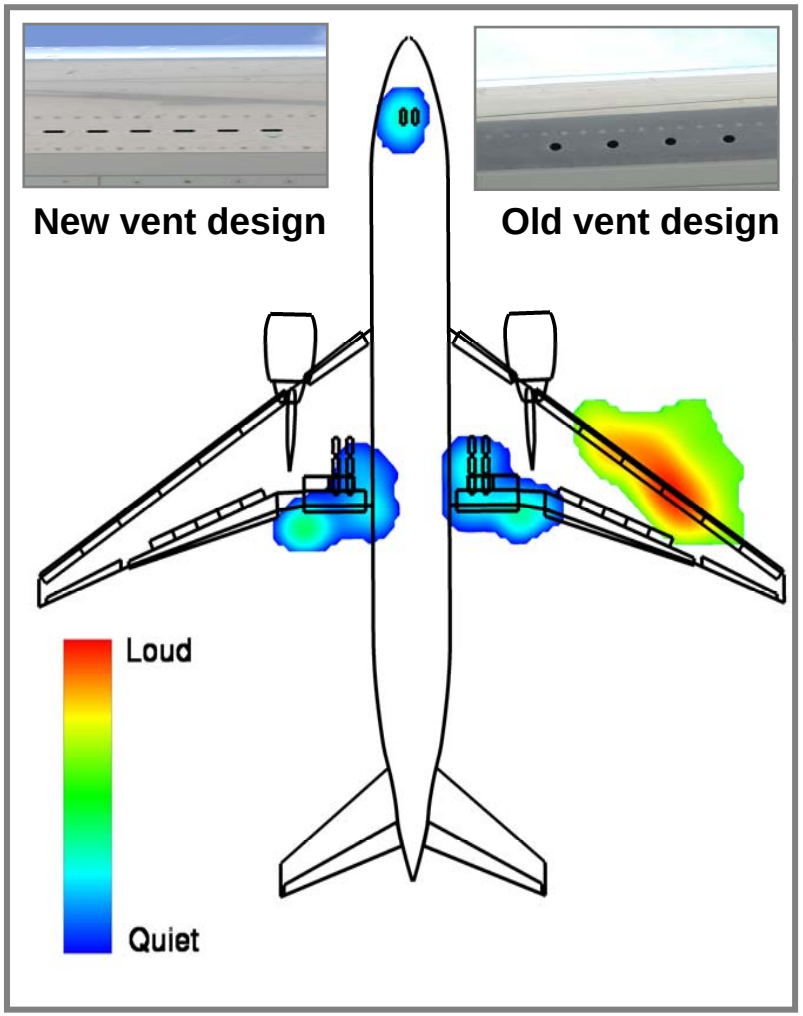
Acoustic Camera Pin-points Noise Sources



Acoustic Camera Enables Flyover Noise Mapping

Identify opportunities for source noise reduction

Distinguishes between engine and airframe sources



The 787 Dreamliner is cleaner, quieter and more efficient

The 787 Dreamliner delivers:

- **20%* Reduction in fuel and CO_2**
- **28% Below 2008 industry limits for NOx**
- **60%* Smaller noise footprint**

Advanced Wing Design

Innovative Systems Technologies

Enhanced Flight Deck

Composite Primary Structure

Advanced Engines and Nacelles

*Relative to the 767

The 747-8 is cleaner, quieter and more efficient

The 747-8 delivers:

- **16%*** **Reduction in fuel and CO_2**
- **28%** **Below 2008 industry limits for NO_x**
- **30%*** **Smaller noise footprint**

*Relative to the 747-400

Hydrogen fuel cell powered airplane takes flight

- **Fuel cell creates electricity**
- **No emissions**

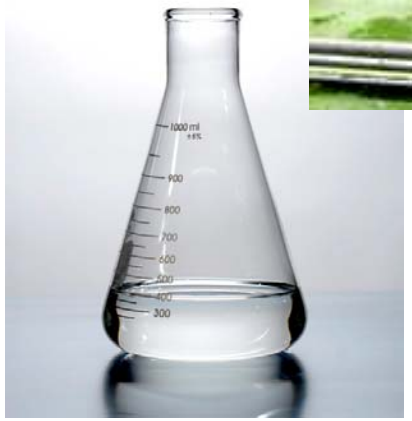
Priority technology research for sustainable next-generation biofuels

Demonstrating alternative, low-carbon life cycle fuels

Conducted the first biofuel demonstration on a commercial airplane

Researching potential of future environmentally progressive fuels

Plants, including algae, could supply fuel for the world's airplane fleet while absorbing CO_2 from the atmosphere



Accelerating deployment of viable sustainable low carbon life cycle fuels

Initiated industry working group to facilitate alternative fuel research

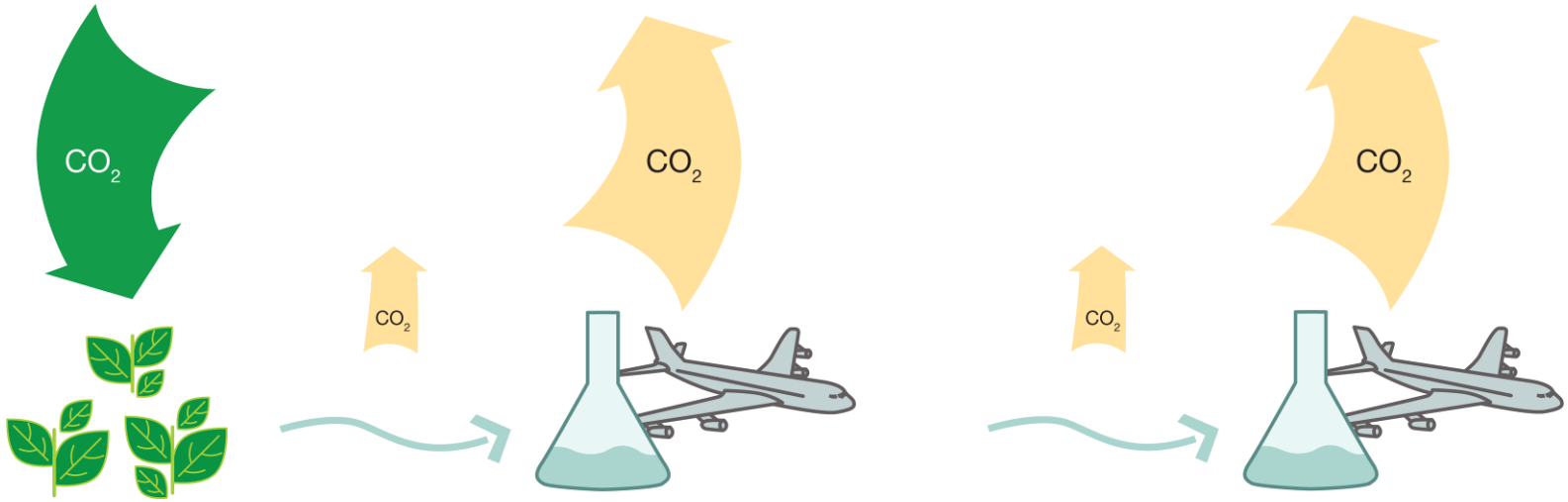
Plant-based feedstocks naturally remove CO_2 from the atmosphere

Plant-based fuel

Plant-based feedstocks absorb CO_2 emissions as the feedstocks grow.

Petroleum-based fuel

CO_2 emissions from petroleum-based fuel are sourced from fossil material.



Second-generation biofuels are efficient and sustainable

First-generation biofuels

- Inefficient and unsustainable sources of energy
- Require large landmasses and mostly grown for human consumption

Examples:
Ethanol produced from corn and soybean feedstocks

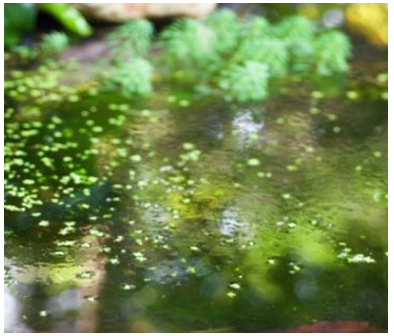
Soybean

Second-generation biofuels

- Derived from *non-food crops* utilizing *new biomass-to-fuel-conversion technologies*
- Exponentially more efficient and sustainable sources of energy
- Require small landmasses and proportionately less fertilizer and water

Examples:
New fuels from algae, babassu, switchgrass and jatropha

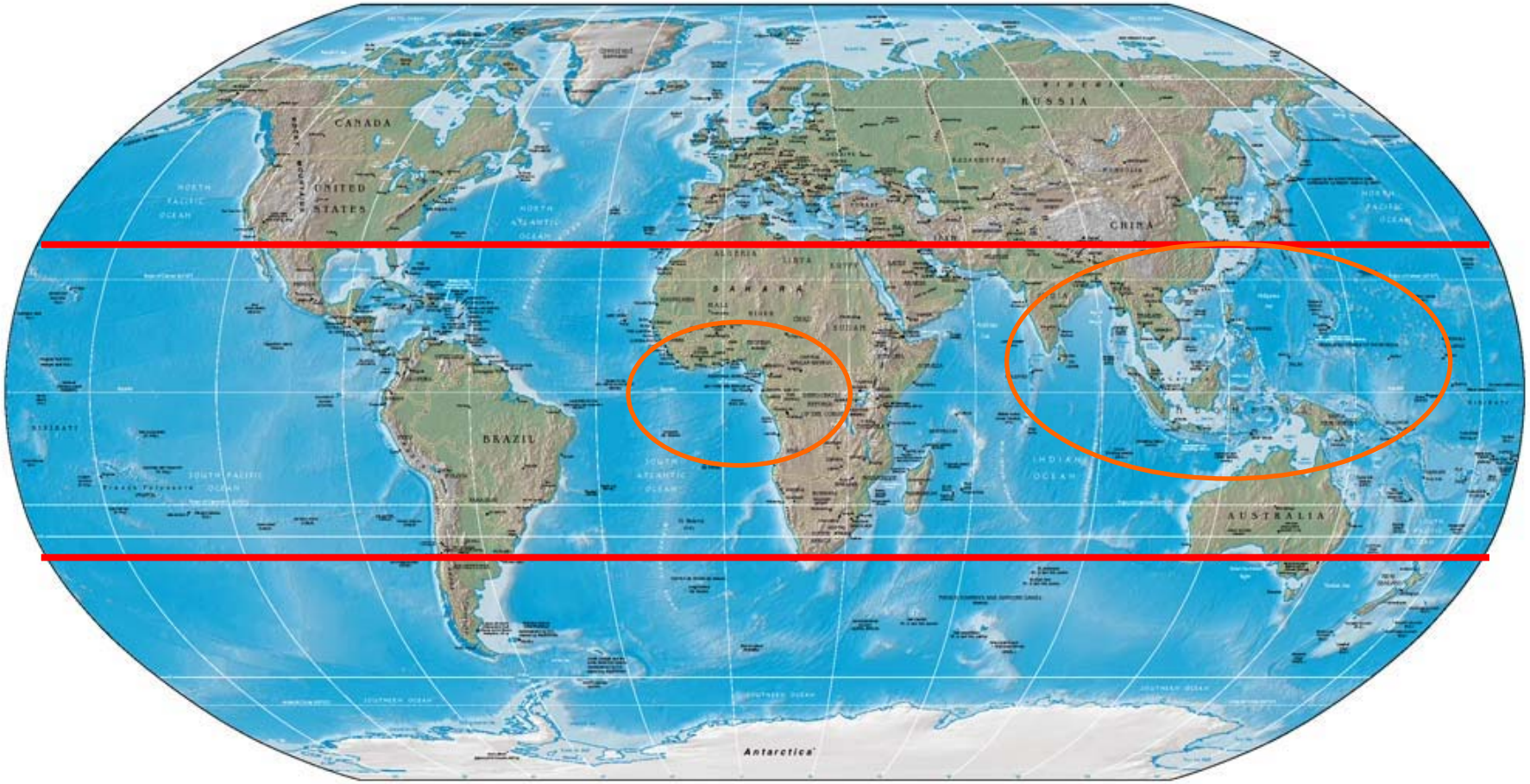
Babassu



Algae

What is the global potential for Jatropha?

- More than 800 million hectares of sustainable, non-forested, non-food land are suitable for jatropha.



Successful flight test program demonstrated sustainable biofuel viability

- Identified sustainable biofuel sources
- Demonstrated technical feasibility on various engine / airframe combinations
- Promoted development of viable commercial markets

BOEING

UOP A Honeywell Company

Virgin atlantic

GE

Imperium renewables

20% Coconut & Babassu

Feb 2008

AIR NEW ZEALAND

Rolls-Royce

terasol ENERGY

50% Jatropha

Dec 2008

Continental Airlines

cfm

Sapphire Energy

50% Algae & Jatropha

Jan 2009

JAL

Pratt & Whitney A United Technologies Company

Sustainable Oils Your trusted energy growth partner.

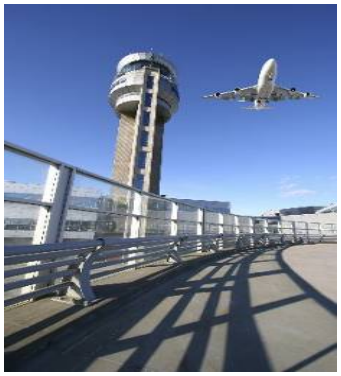
50% Camelina, Jatropha & Algae

Jan 2009

Increasing level of test objectives

Environmental solutions – we need to actively pursue all viable solutions

More efficient airplanes
- **Airplane programs**
- **Airline programs**



Efficient flight operations
- **Ground movement and handling (departure and arrival)**
- **Takeoff and climb**
- **Cruise**
- **Descent, approach, landing**

Newer solutions and alternatives
- **Sustainable biofuels**

Environmental solutions are being developed by Working Together Globally

Efficient Operations

Advanced Technology Airplanes

Alternative Fuels

Recycling