

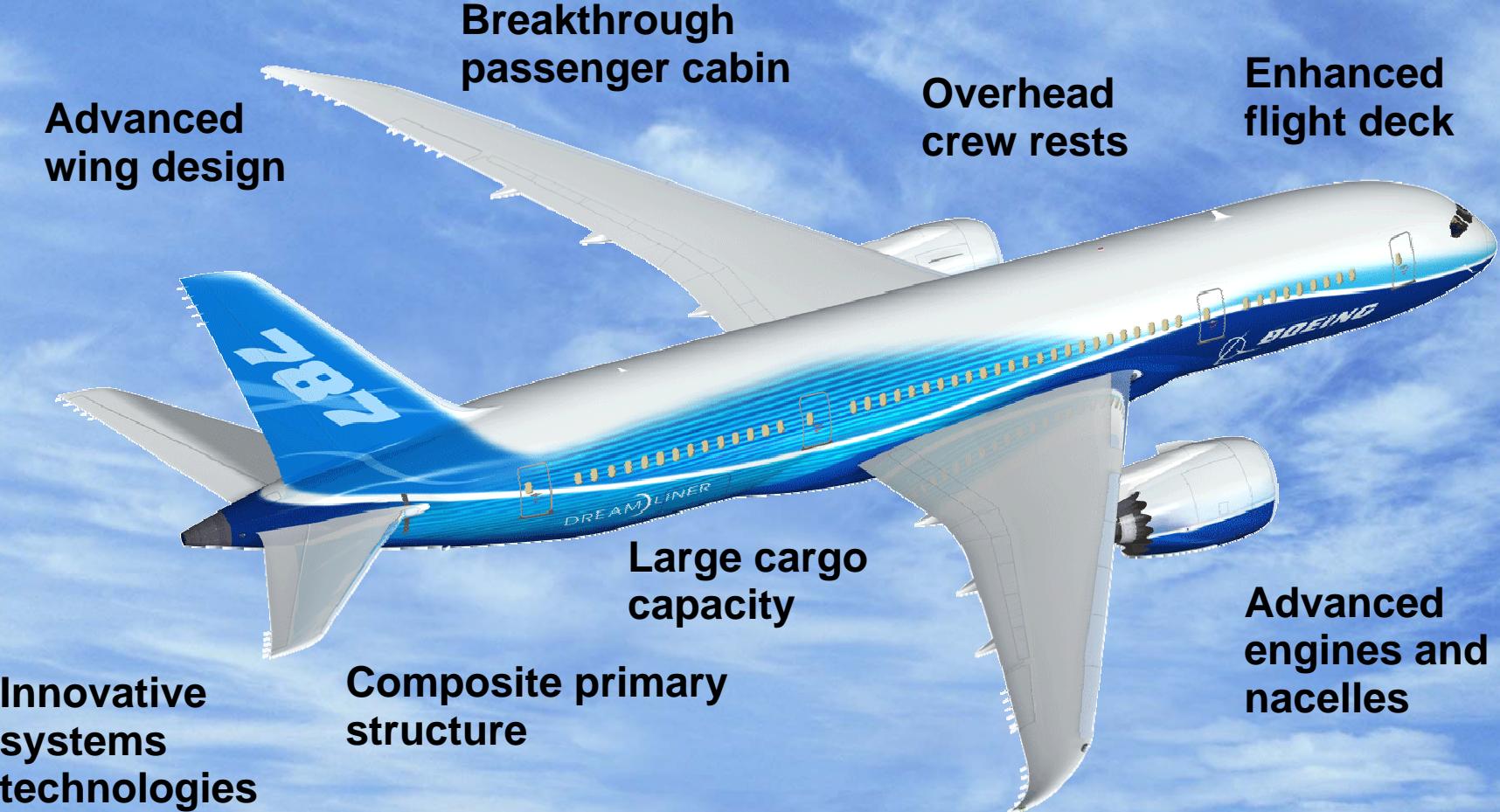


# 787 Systems and Performance

Tim Nelson  
Flight Operations Engineering  
Boeing Commercial Airplanes

# Configured for Success

## 787-8 Design Features



# The 787 Is a Complete, Flexible, Efficient Family



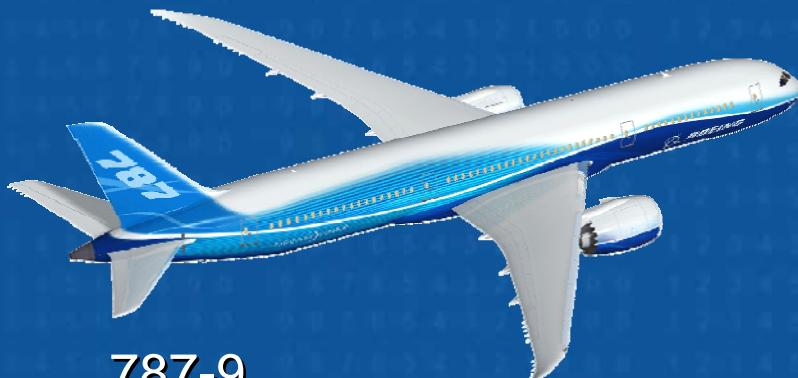
787-8

223 passengers (three-class)  
8,500 nmi / 15,700 km



787-3

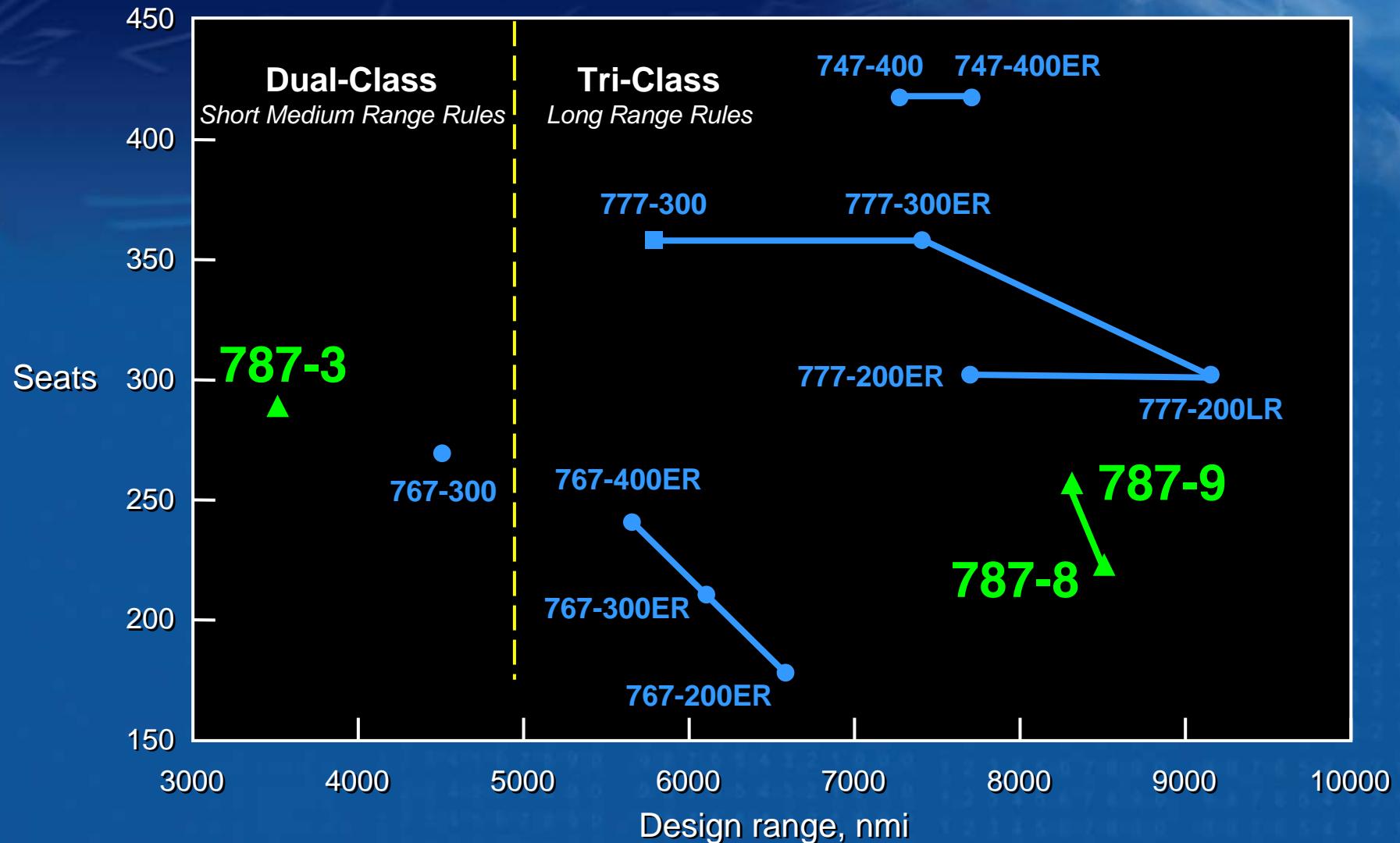
296 passengers (two-class)  
3,500 nmi / 6,500km



787-9

259 passengers (three-class)  
8,300 nmi / 15,400 km

# Efficiency for Medium — and Long-Haul Markets



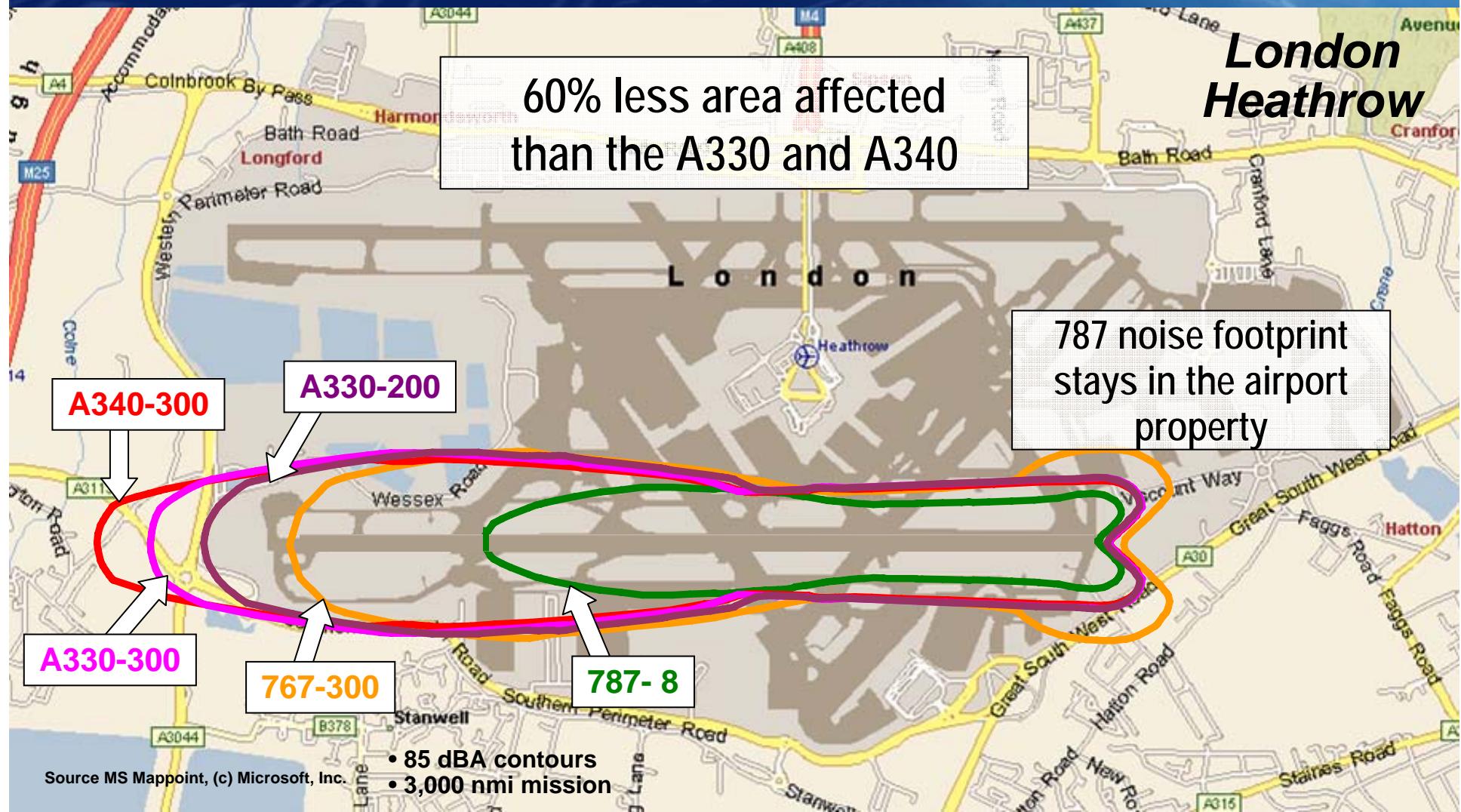
# Creating New Non-Stop Routes

The 787 can efficiently connect more than 450 new city pairs

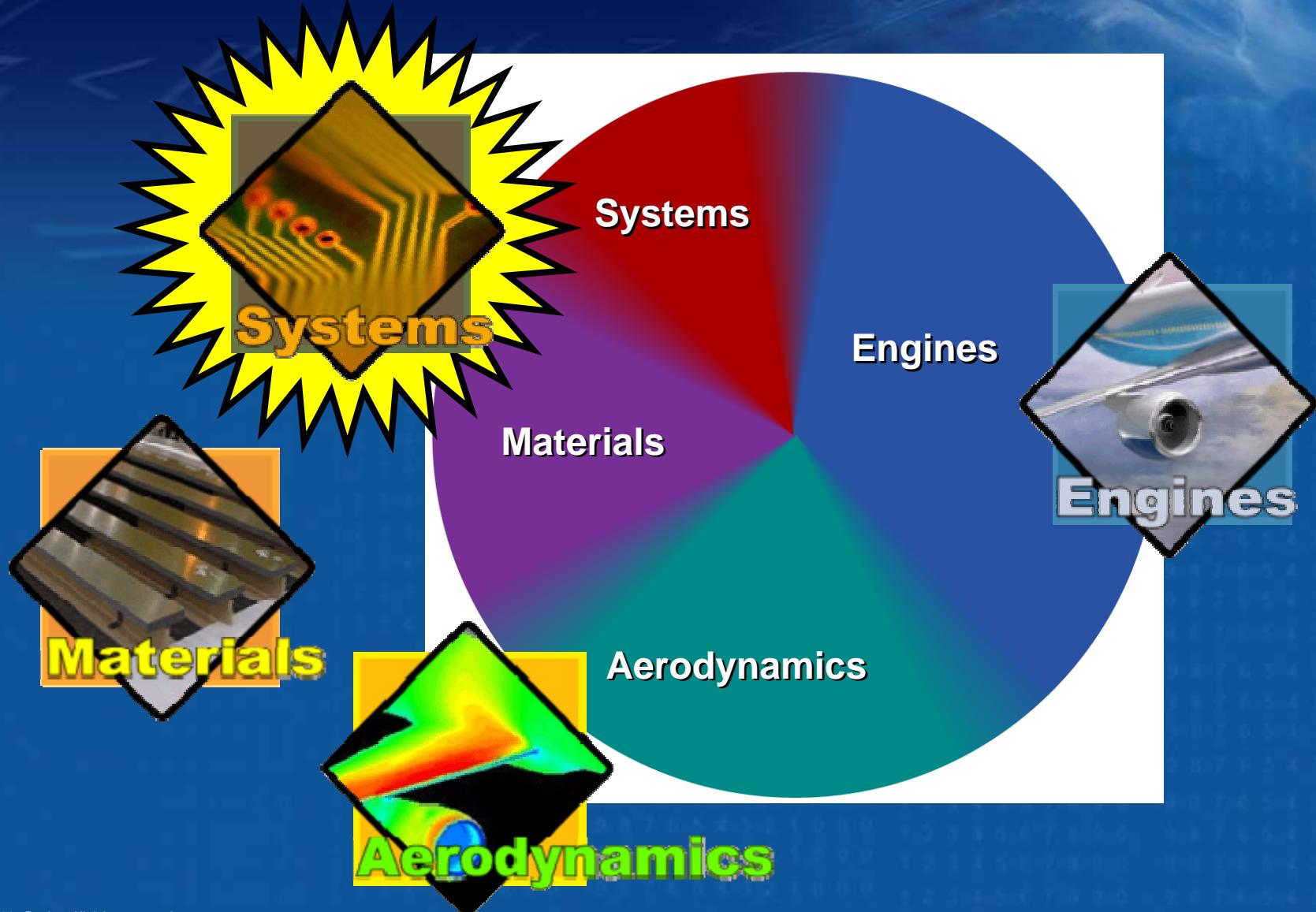


# Quiet for Airport Communities

## 85 dB Noise Contours at Heathrow



# Breakthrough Technologies Reduce Fuel Burn Per Seat by 20%



# Engine Technology Advancements

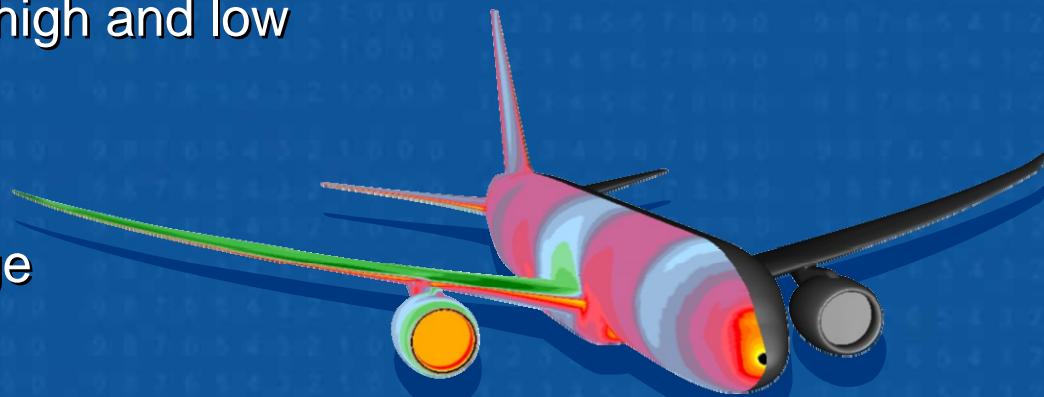


Engine and nacelle features  
(Common to RR and GE engines)

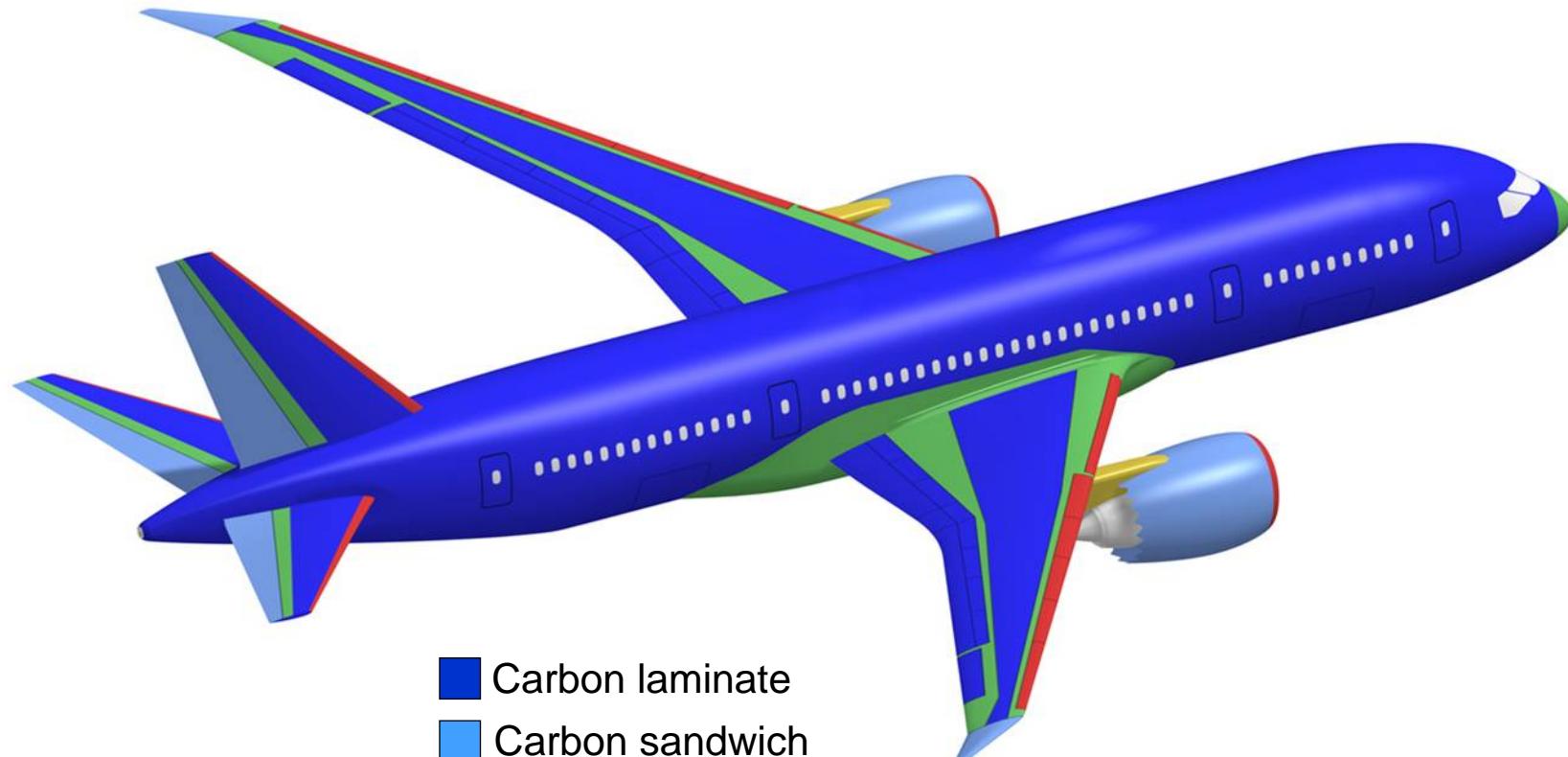
- Higher bypass ratio and higher pressure ratio compressor
- High-flow low-speed fan
- Advanced materials and coatings
- No-engine-bleed systems architecture
- Low-noise nacelles with chevrons
- Engine types are interchangeable at wing / pylon interface

# Advanced Aerodynamics

- State of the art 3-D aerodynamic analysis and design tools provide:
  - Advanced transonic wing design for improved speed and lift
  - High performance, but mechanically simplified high lift system for high reliability and reduced maintenance cost
  - Multi-disciplinary optimization for best combination of weight, drag and engine performance
- Tightly integrated packaging of systems to reduce the size of aerodynamic fairings for reduced weight and drag
- Advanced aerodynamic features validated through extensive wind tunnel test program at both high and low Reynolds number facilities
- Laminar flow nacelles
- Variable camber trailing edge



# Composite Solutions Applied Throughout the 787



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

# Starting the Second Century of Powered Flight



# 787 Advanced Systems

## Efficient Airplane Systems

- Advanced Energy Management – The More Electric Airplane
- Flight Controls – Variable Camber Trailing Edge and Drooped Spoilers

## Highly Integrated Avionics

- Common Core Systems open architecture
- Integrated Flight Controls Electronics
- Integrated Communication/Navigation/Surveillance equipment
- Integrated Airplane Systems control

## e-Enabled Airplane

- Broadband connectivity within airplane and with ground
  - Flight Deck
  - Crew Information System
  - Onboard Health Maintenance
  - Cabin systems

Trade Study decisions assume Life Cycle Costs of the airplane

# Advanced Energy Management

Generate, Distribute, and Consume energy in  
an effective and efficient manner.

Hybrid AC and DC Primary Distribution Systems  
(230 Vac, 115 Vac,  $\pm 270$  Vdc, 28 Vdc)

Elimination of Pneumatic  
Bleed System



Two 250 kVA Variable Frequency  
Starter/Generators per engine

Adjustable Electric Air  
Conditioning

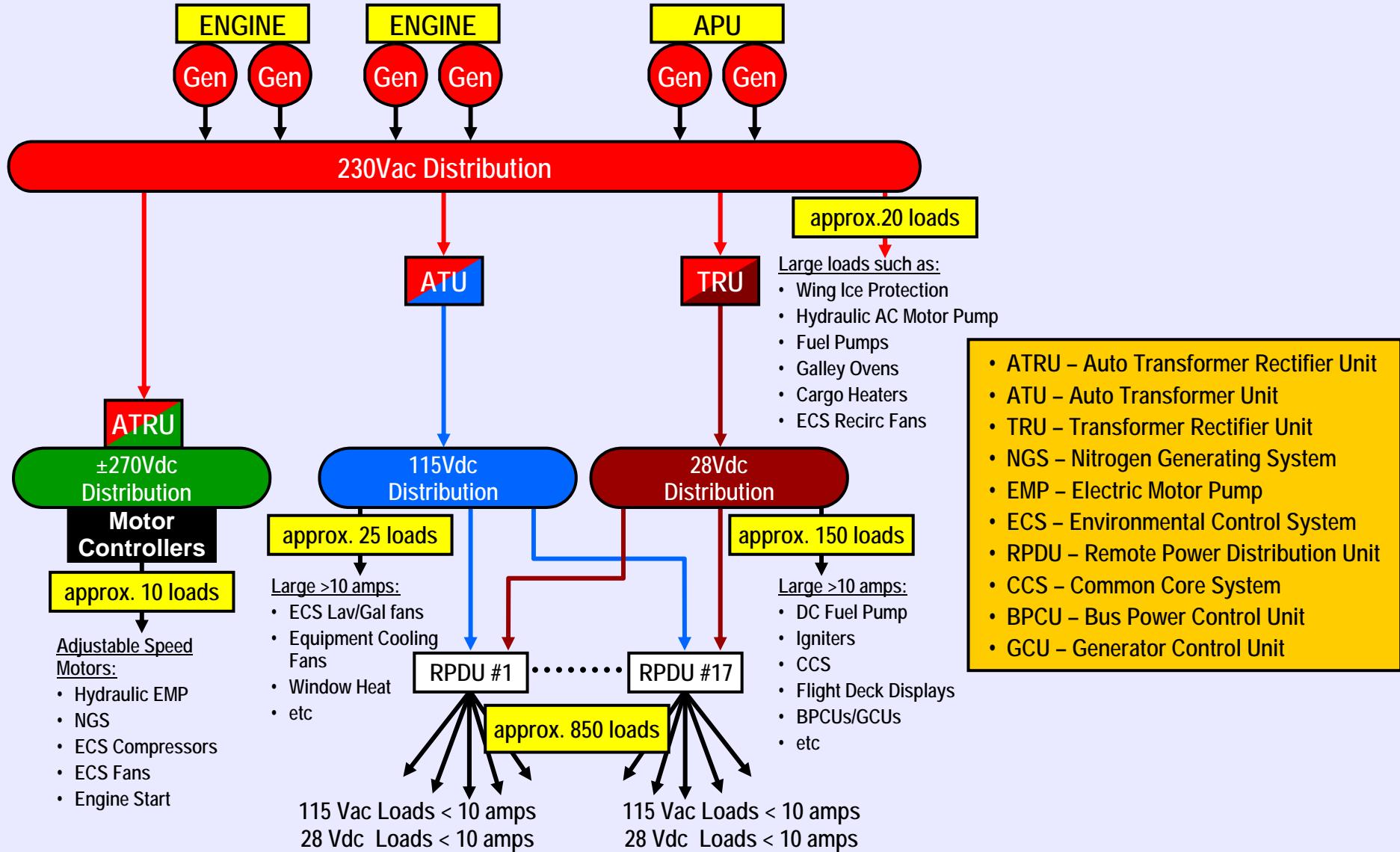
APU with Two 225 kVA  
Starter/Generators

Adjustable Speed Motors  
and Motor Controllers

Electric Wing  
Ice Protection

Liquid Cooled Power  
Electronics

# Electrical Systems Overview



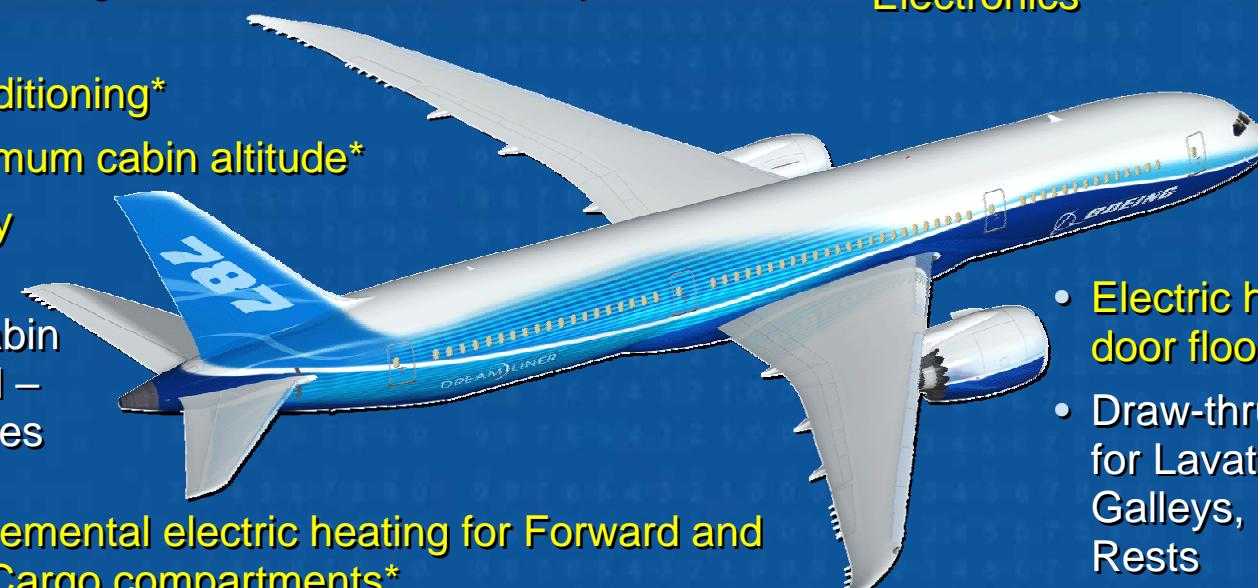
# Electronic Circuit Breakers

- Display-based control and indication of breaker state
- Accessible on Multi-Function Displays (MFDs) and maintenance access devices

SYS MENU	FLIGHT DECK CB	NON-NORMAL CB	CB BY STATE	CB SEARCH
CB BY ATA	CB BY BUS	CB BY LOCATION	RECENT USED CB	CB CUSTOM LIST
CE2100713 CIRCUIT BREAKER NAME 1		TRIPPED	DETAILS	CONTROL
CE2100714 CIRCUIT BREAKER NAME 2			DETAILS	CONTROL
CE2100715 CIRCUIT BREAKER NAME 3			DETAILS	CONTROL
CE2100701 CIRCUIT BREAKER NAME 4			DETAILS	CONTROL
CE2100702 CIRCUIT BREAKER NAME 5			DETAILS	CONTROL
CK2100780 CONTACTOR NAME 6		TRIPPED	DETAILS	CONTROL
CE2100716 CIRCUIT BREAKER NAME 7		UNK	DETAILS	CONTROL
CE2100717 CIRCUIT BREAKER NAME 8			DETAILS	CONTROL
CE2100718 CIRCUIT BREAKER NAME 9			DETAILS	CONTROL
CE2100719 CIRCUIT BREAKER NAME 10			DETAILS	CONTROL
CE2100703 CIRCUIT BREAKER NAME 11			DETAILS	CONTROL
CE2100721 CIRCUIT BREAKER NAME 12			DETAILS	CONTROL
CE2100722 CIRCUIT BREAKER NAME 13			DETAILS	CONTROL
CE2100723 CIRCUIT BREAKER NAME 14		UNK	DETAILS	CONTROL
CK2100724 CONTACTOR NAME 15			DETAILS	CONTROL
CE2100725 CIRCUIT BREAKER NAME 16			DETAILS	CONTROL

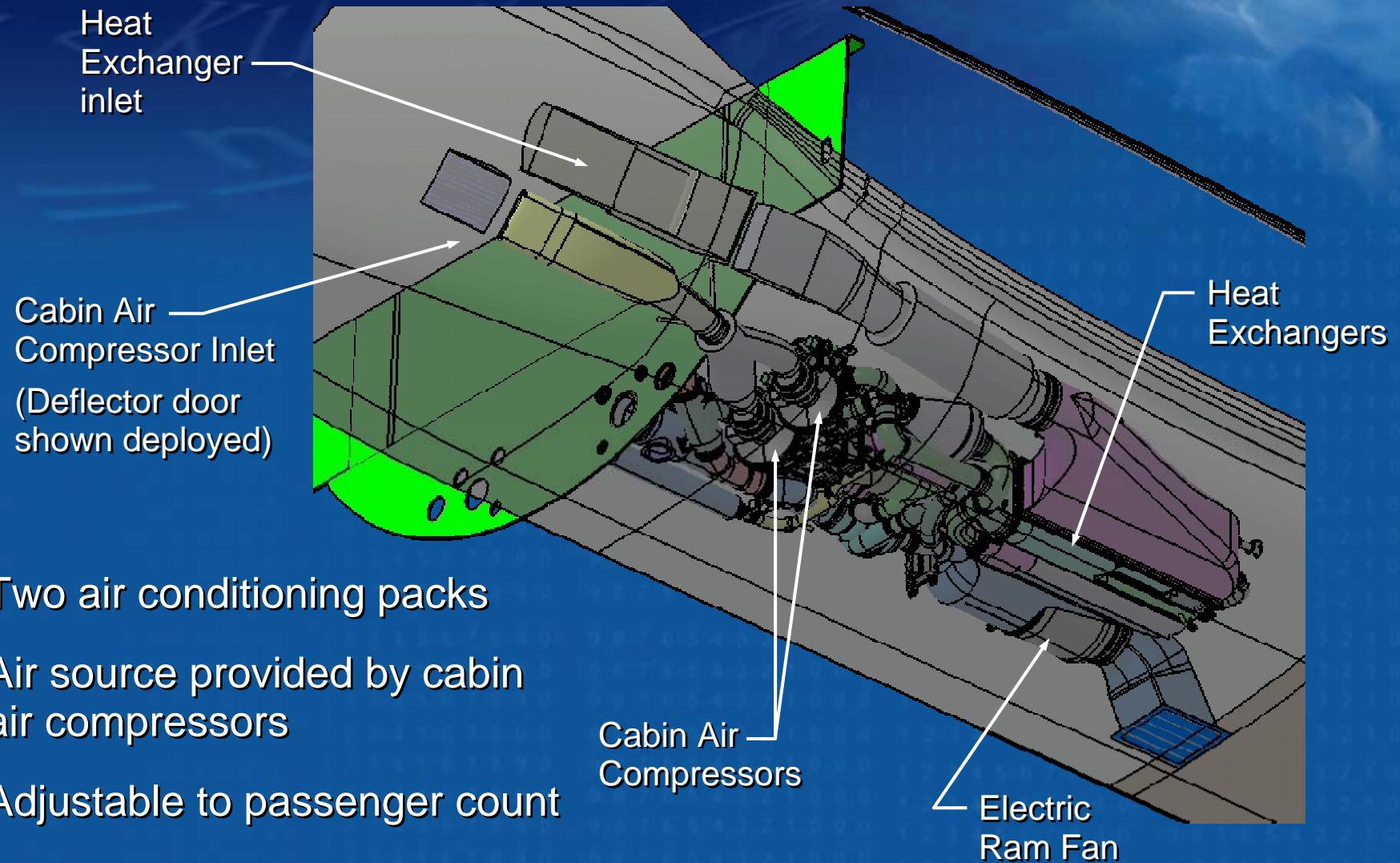
# Environmental Control Systems

- Overhead cabin air distribution
- Upper and lower air recirculation
- HEPA Filters and Gaseous Air Purification\* for recirculated air
- Personal Air Outlet (Gasper) System\* - Basic
- Optional Flight Deck Humidification System
- Electric Air Conditioning\*
- 6,000 foot maximum cabin altitude\*
- Integrated galley refrigeration\*
- Conventional cabin pressure control – two outflow valves
  - Supplemental electric heating for Forward and Bulk Cargo compartments\*
  - Forward\* and Bulk Cargo heating and ventilation for animal carriage
  - Optional Forward Cargo air conditioning
- Forced air cooling for essential E/E equipment
- Draw-thru cooling for minor E/E equipment
- Liquid cooling for Power Electronics\*
- Electric heating for door floor areas\*
- Draw-thru ventilation for Lavatories, Galleys, and Crew Rests

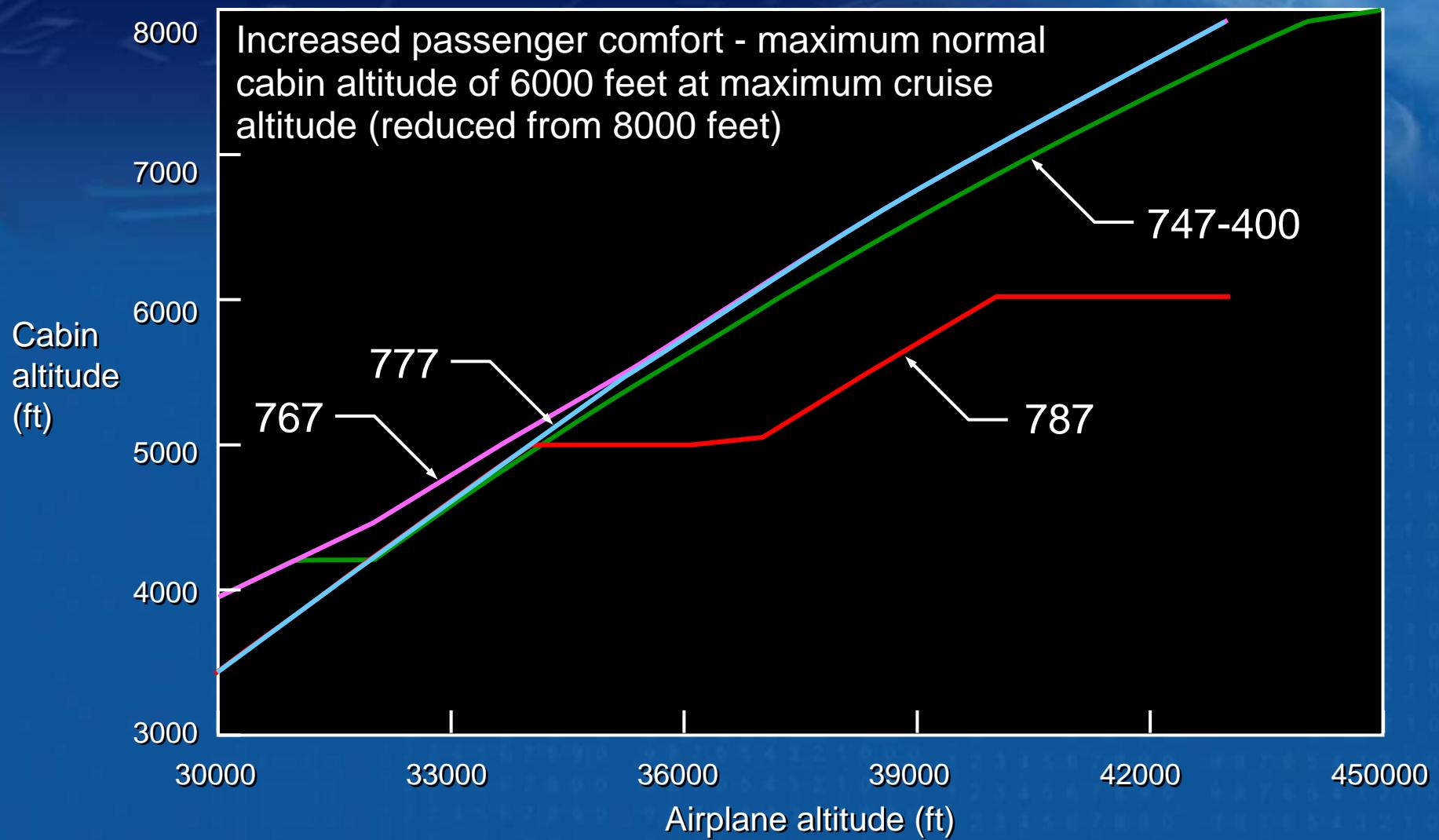


\* Different from 777

# Cabin Air Conditioning System

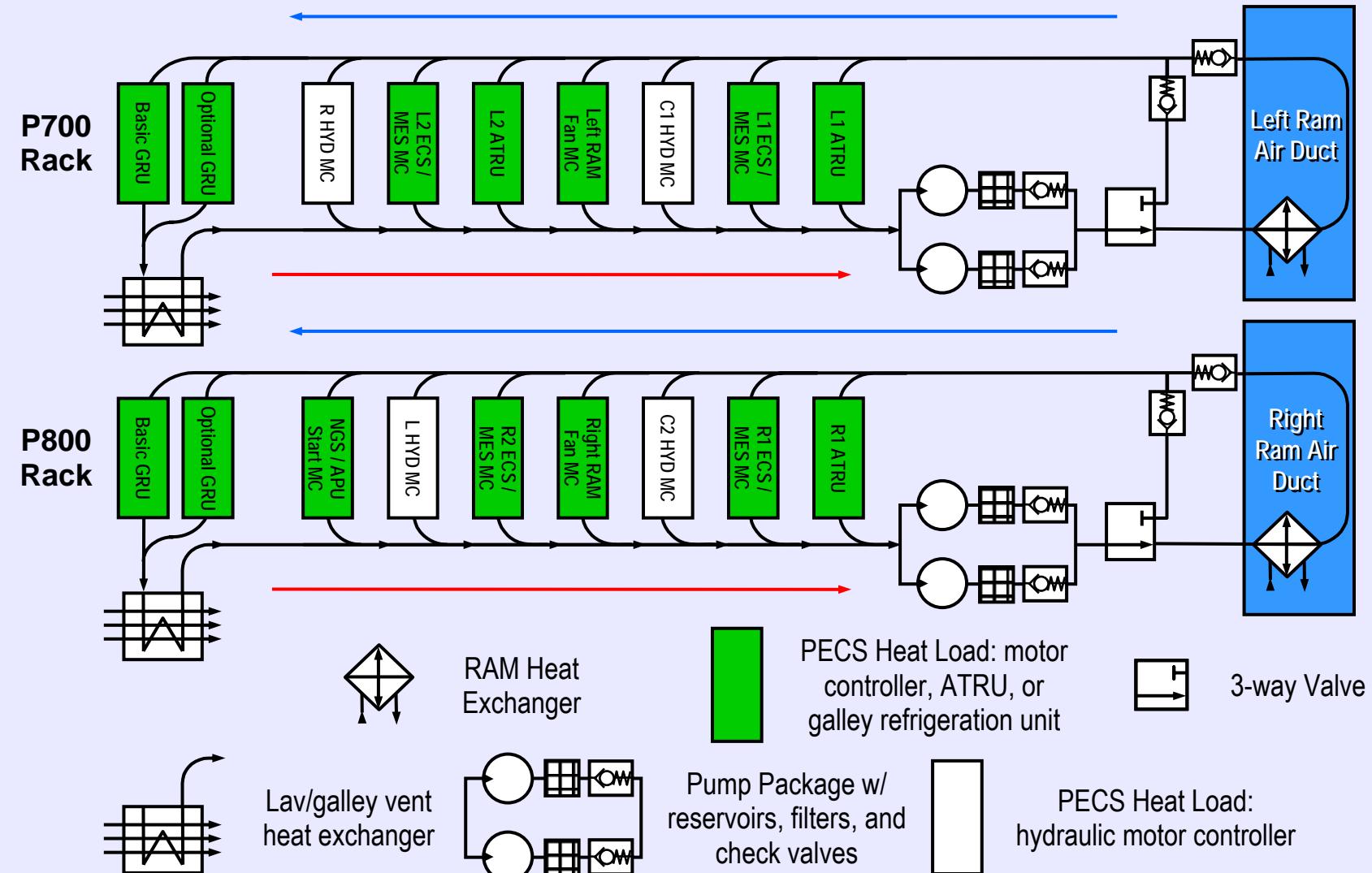


# Cabin Pressurization Schedule

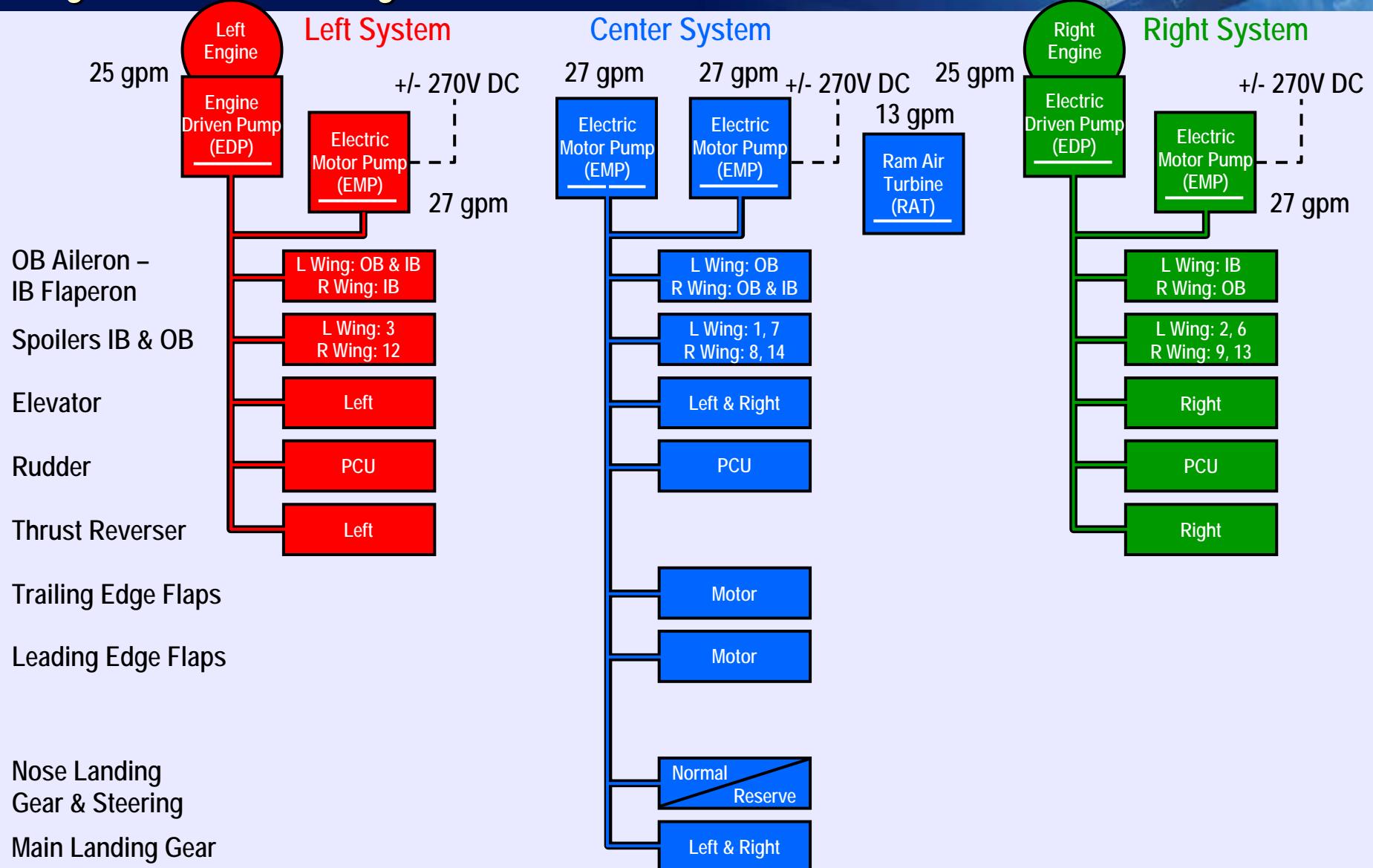


# Equipment Cooling System

## *Power Electronics Cooling System*



# Hydraulic System Architecture



**5000 psi systems with common pumps**

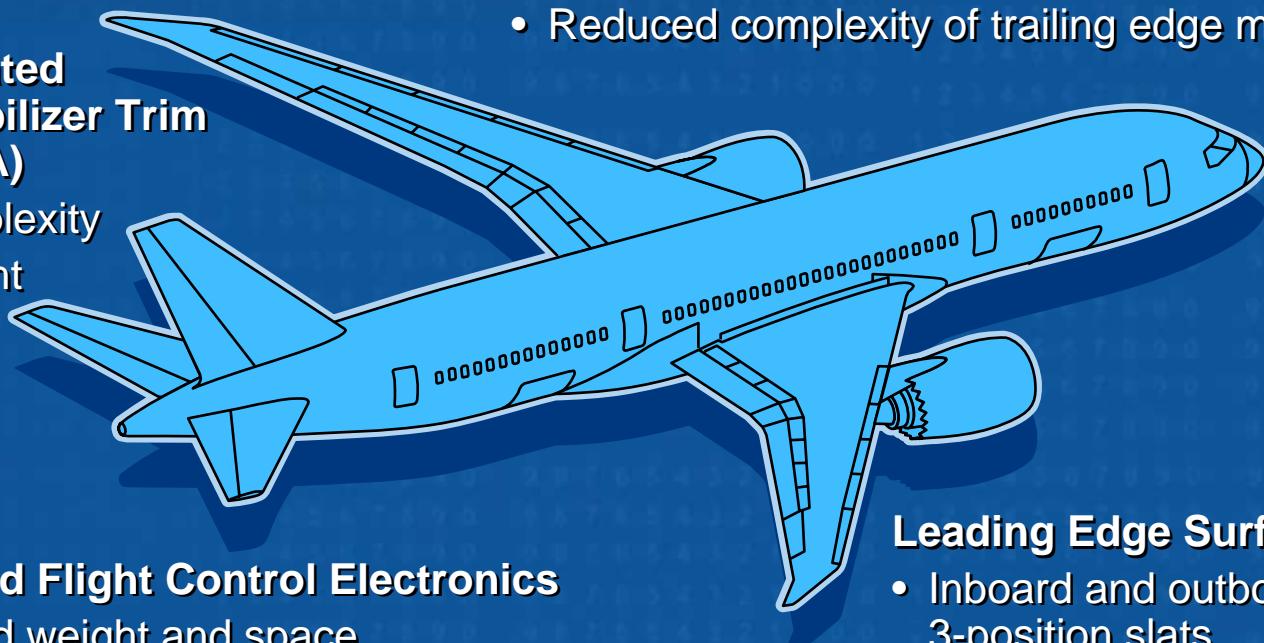
# 787 Fly-by-Wire Flight Controls

## All Surfaces Fly-By-Wire

- Eliminates cables
- Reduced weight
- Improved functionality

## Electric Integrated Horizontal Stabilizer Trim Actuator (HSTA)

- Reduced complexity
- Reduced weight



## Trailing Edge Surfaces

- Inboard and outboard single slotted flaps
- Single outboard ailerons
- Single flaperons
- Seven spoiler pairs with droop function
- Trailing Edge Variable Camber (TEVC)
- Reduced complexity of trailing edge mechanism

## Integrated Flight Control Electronics

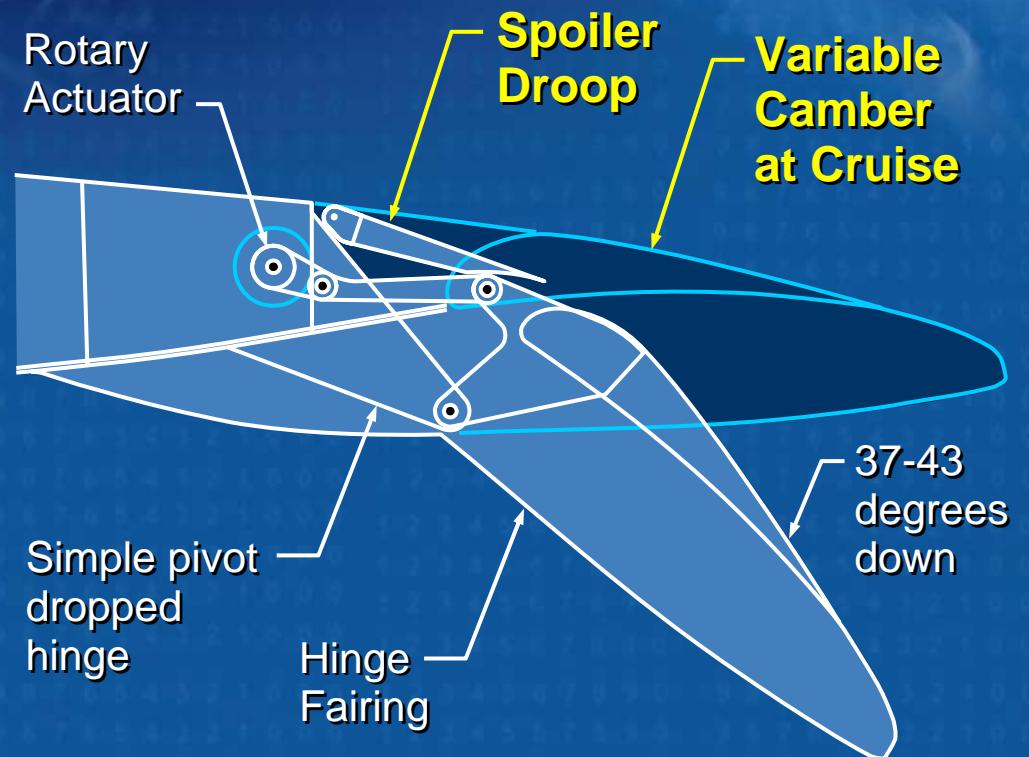
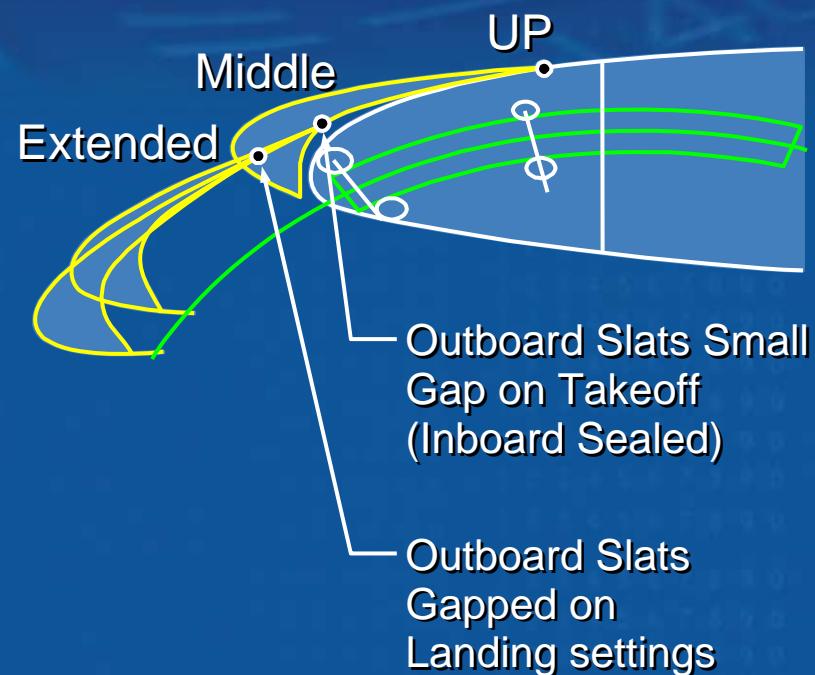
- Reduced weight and space

## Leading Edge Surfaces

- Inboard and outboard 3-position slats
- Sealing Krueger Flap at pylon

# High Lift Function

- Leading Edge and Trailing Edge Kinematic Motion



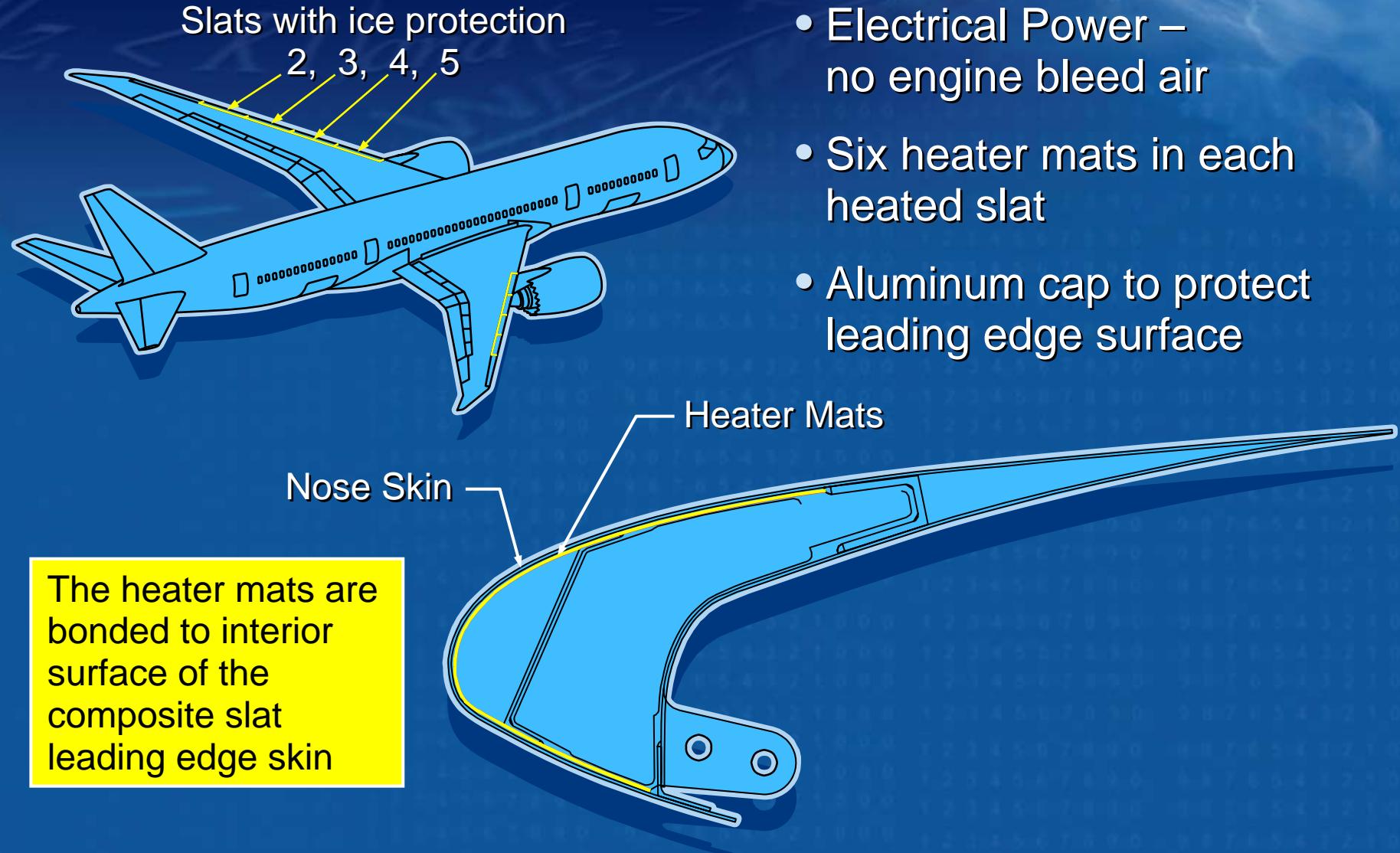
- Spoiler Droop functionality replaces fore flaps and maintains gap and overlap requirements.
- Spoilers driven down via fly-by-wire control.

# Landing Gear Systems New Control-by-Wire

- Landing Gear Actuation
  - Electronic control and sequencing of landing gear and doors
  - Dedicated proximity sensors to monitor gear and door position, and to control sequencing
  - Alternate landing gear extension electrically controlled and hydro-mechanically released
- Brake Control
  - Control-by-wire for brake, autobrake, and anti-skid functions
  - Electric Brake Actuators
- Steering Control
  - Control-by-wire rudder pedals and dual tillers
- Brake Temperature Monitoring System – baseline
- Tire Pressure Indication System – baseline



# Wing Anti-Ice System Overview



# Final Nose Configuration

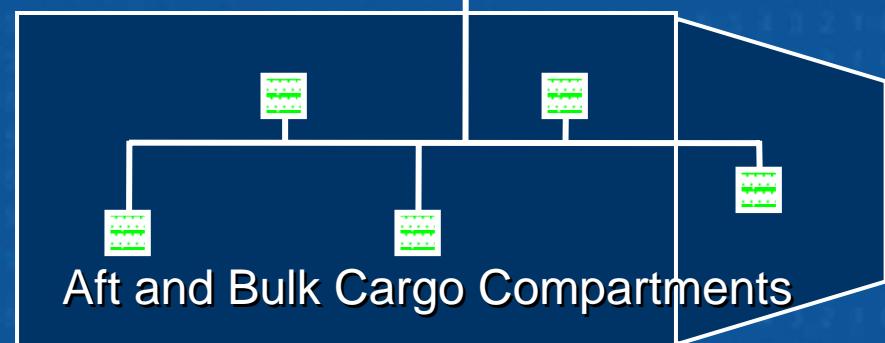
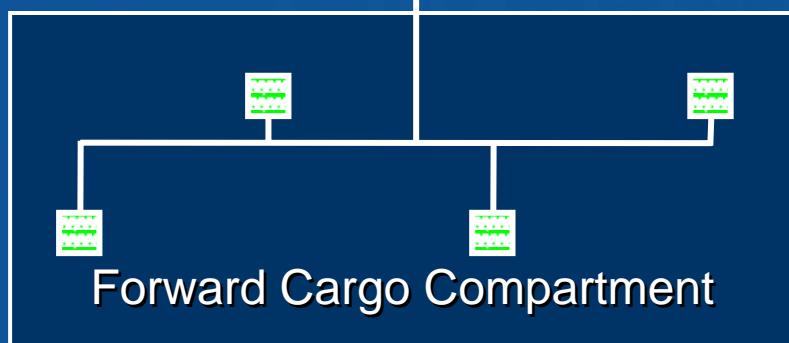
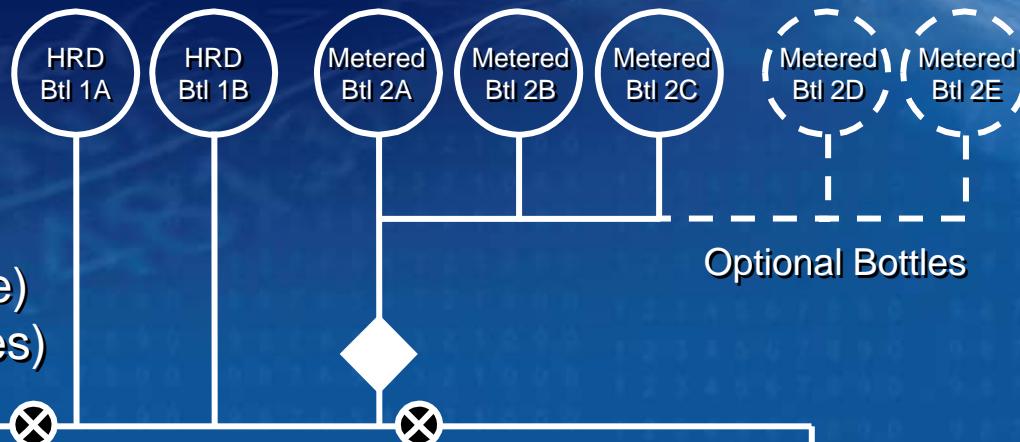
- Four windows, fewer posts
- Pilot vision similar to 777
- Non-opening windows
- Crew escape door
- Vertically stowed wipers
- Windshield washer



# Cargo Fire Protection

## ETOPS Capability:

- Basic - 180 minutes
- Options (-8 and -9):
  - 240 minutes (one bottle)
  - 330 minutes (two bottles)

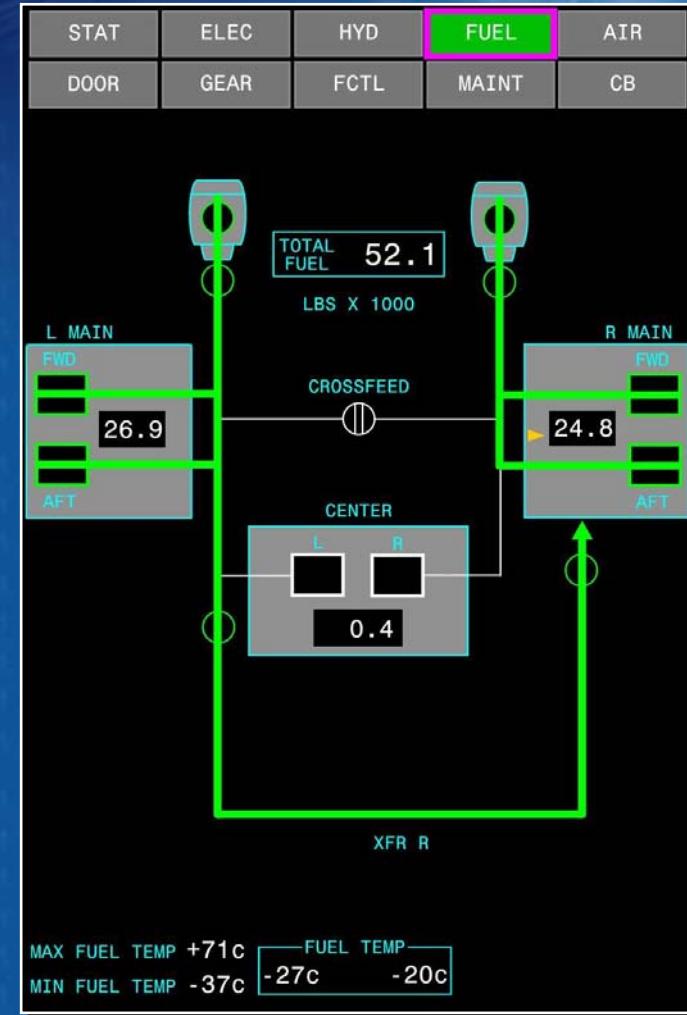


Cargo Fire Suppression System

Nozzles: Flow Valves:

# Fuel Systems Improvements

- Improved Fuel Quantity availability (measuring sticks removed)
- Highly capable center tank fuel scavenge system
- Improved lateral balance correction without need to turn off fuel pumps
- Redundant jettison path of main tank fuel
- Improved anti-ignition safety using all-tank Nitrogen inerting and compliance to latest ignition prevention regulations



# Common Core System Benefits

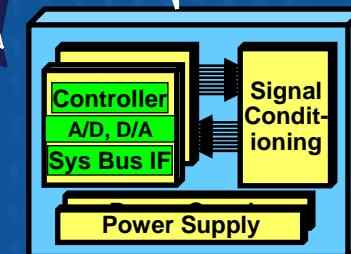
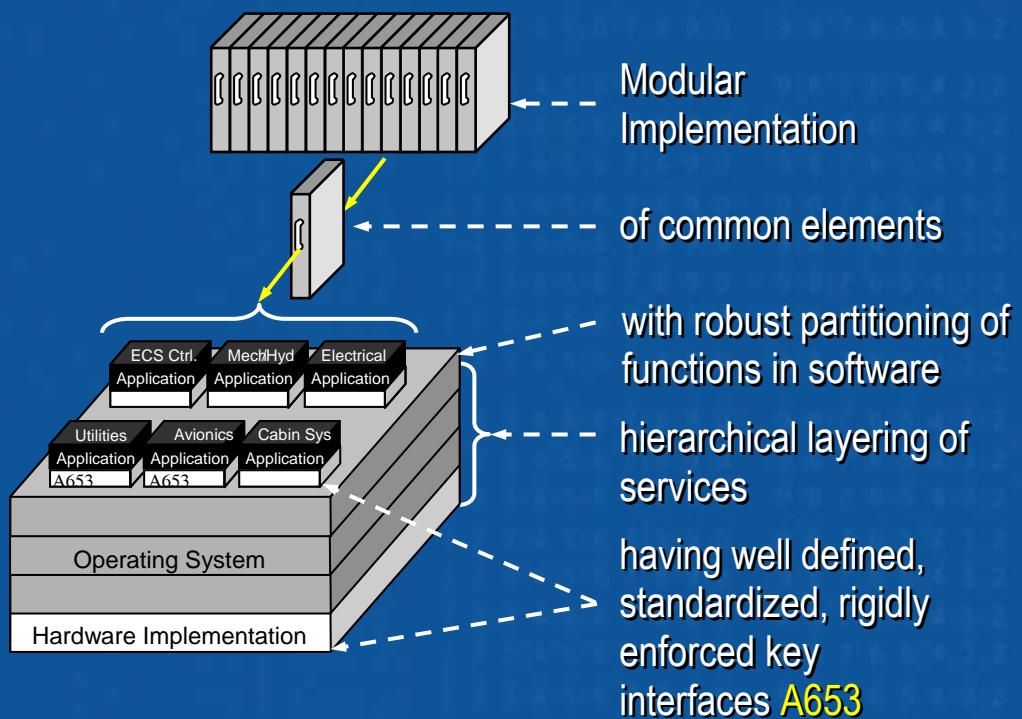
## Common Data Network

- Open industry standard interfaces A664
- Eliminate multiple standards & protocols
- Fiber Optic Network media



## Common Computing Resource

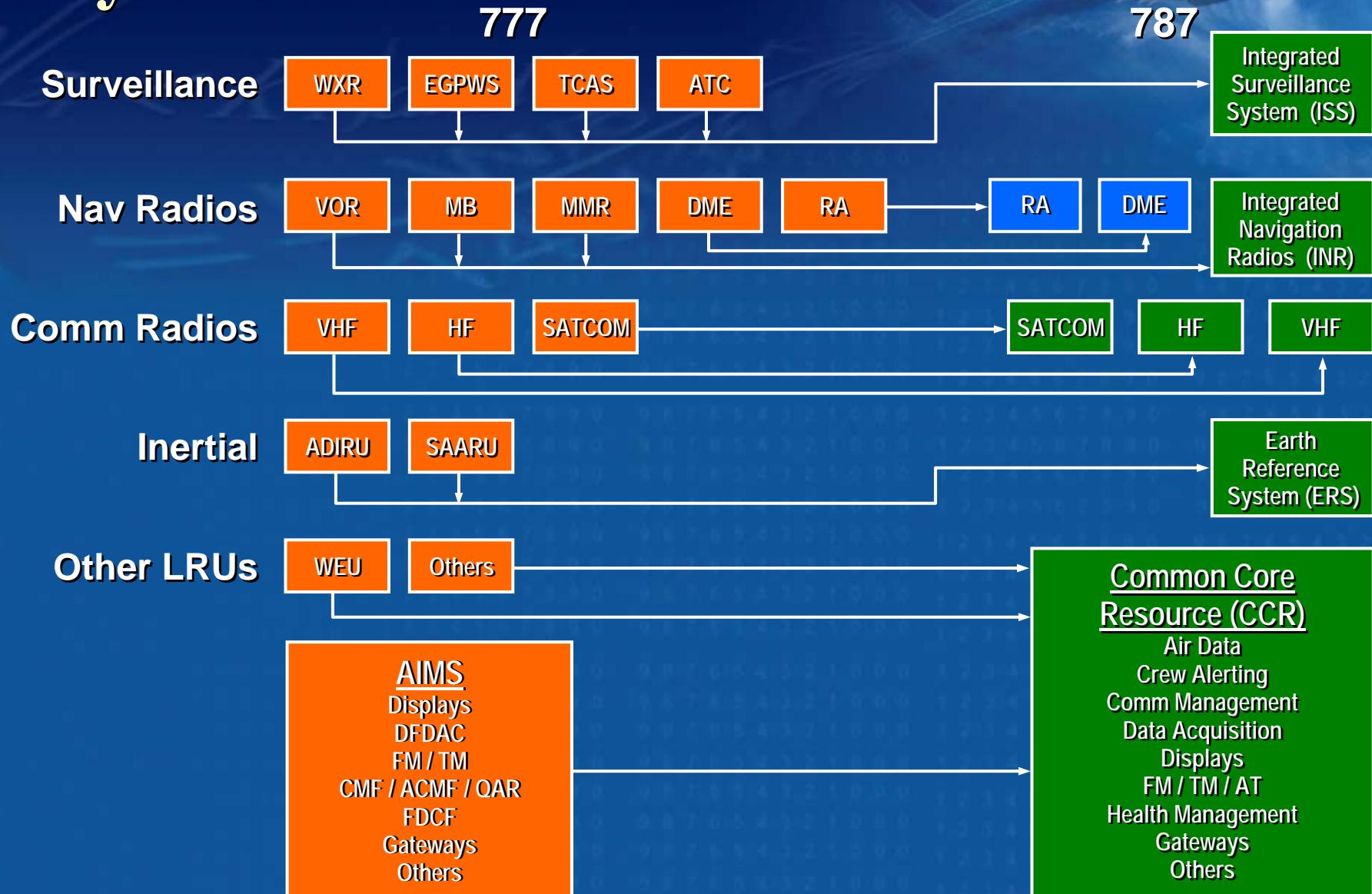
- Based on Open System Architecture Principles



## Remote Data Concentrators

- Reduces airplane wiring/weight,
- Ease of system upgrade/modification
- Highly reliable

# Avionics Integration Beyond 777



# Flight Deck



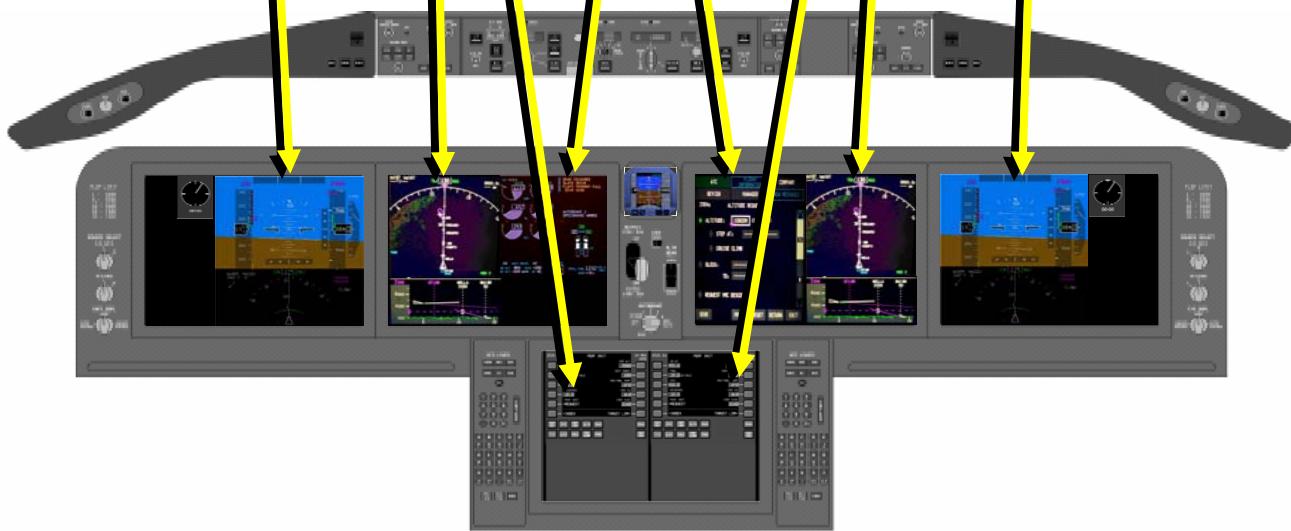
- Boeing look, feel and procedures flow
- Familiar Boeing controls
- Familiar display formats
- All 777 functions and features
- Large format displays

# Display Layout Comparison

777



787



# Class III EFB Overview

- One installed for each pilot – basic
- Avionics quality LCD
- Accessible via touchscreen, bezel keys, cursor control device and keyboard



- Interfaces to:
  - Other Avionics (e.g. Flight Management)
  - Communication systems
  - Flight Deck printer

# On-board Performance Tool



- Calculates limit weights, V speeds, thrust and more
- Performance optimization and flexibility
  - Optimum flap
  - Multiple intersections
  - Calculates assumed temperature thrust reduction
  - MEL and CDL item entry
  - Airport NOTAM entry
- Data from FMC
  - Origin airport, QNH, OAT
- Simplified weight and balance

# Crew Information System — Onboard Health Management

Objective: Reduce schedule interruptions and maintenance costs

Integrated data load and configuration reporting

Electronic Distribution of Software

Electronic link to maintenance manuals

Fault Prediction

Airplane level fault consolidation and correlation, and data collection

Media-less data transfer to/from ground stations

Coordinated airplane and ground processing approach

# 787 Program Schedule



# Thank You

