



787 Design for Maintainability

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Presented to:



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Building the Dream

787 DREAMLINER™

Agenda

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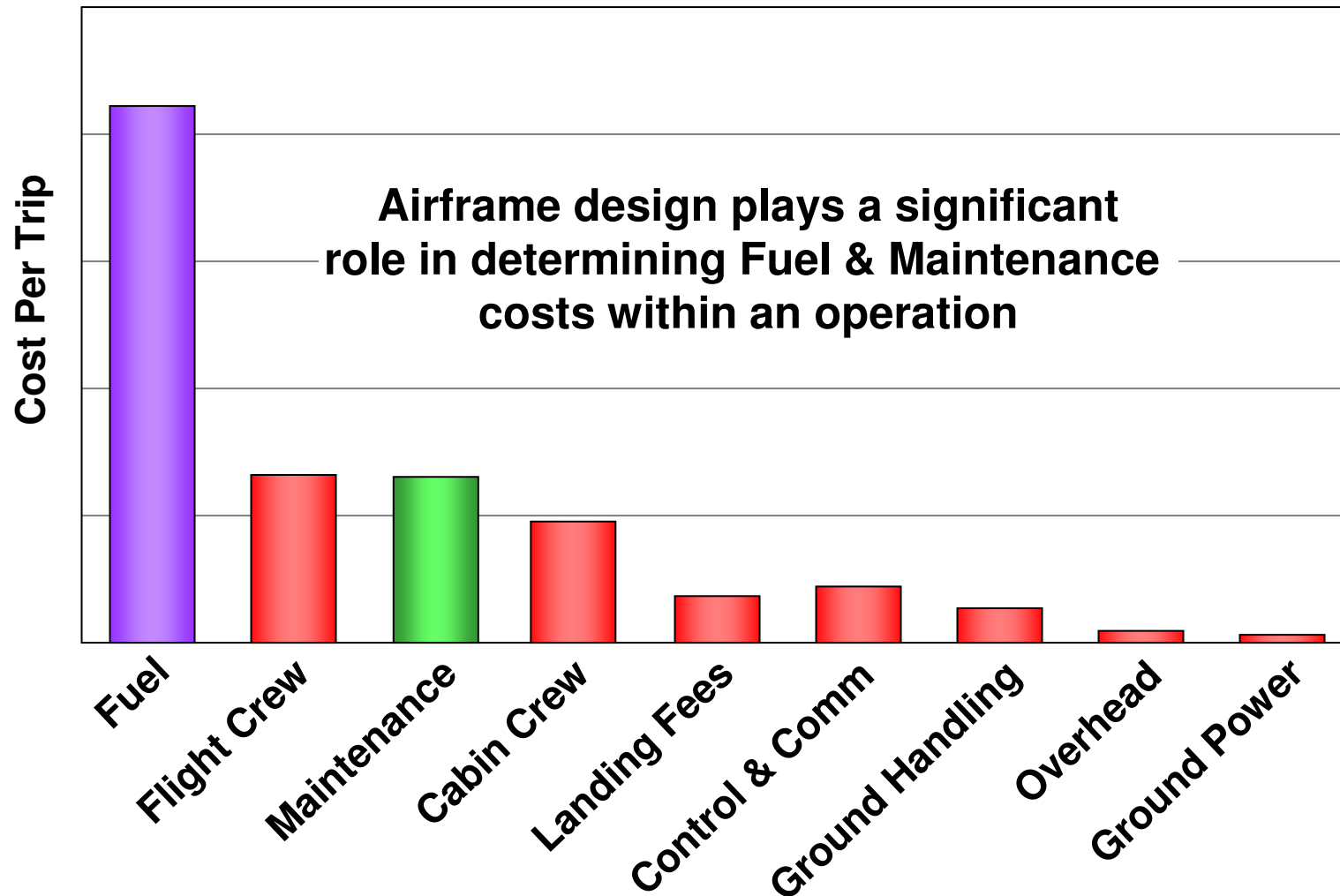


- Role of maintenance in operating costs
- Measuring the value of a design
- Designing for maintainability

Direct operating costs (CAROC)

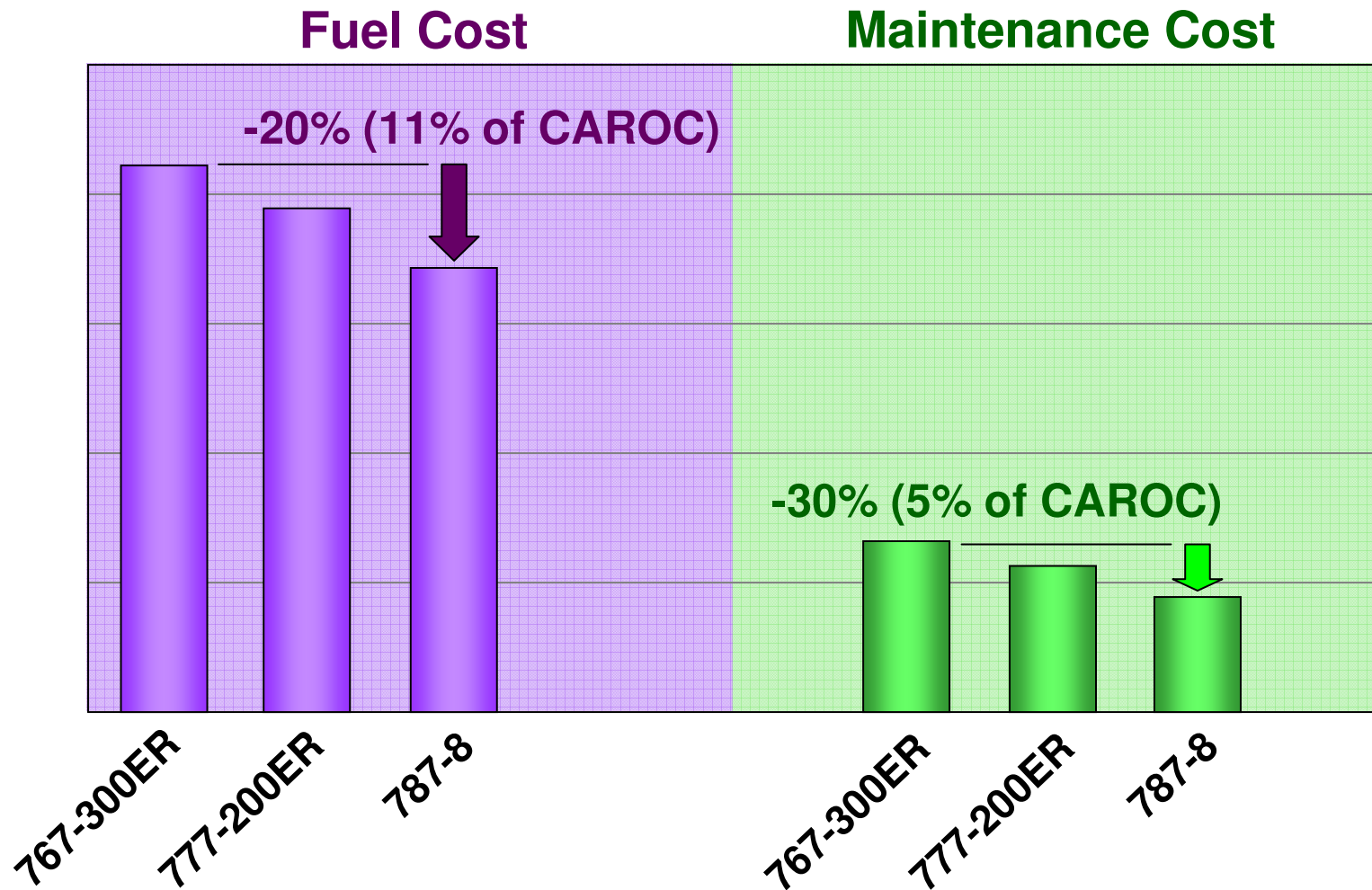
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767-300ER – US International Rules



Direct operating costs (CAROC)

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Agenda

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- Role of maintenance in operating costs
- Measuring the true value of a design
- Designing for maintainability

Measuring design performance

Traditional design measures

Life-Cycle Cost design approach

- Drag
- Weight
- Schedule reliability
- Community / Cabin noise
- Development cost
- Build cost

- Certification risk
- Safety
- Maintenance cost
- Airplane availability
- Training cost
- Standard airplane impact
- Cruise HP extraction
- Factory flow

The 787 program uses these and more than 70 other performance measures to evaluate each design option

Agenda

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- Role of maintenance in operating costs
- Measuring the value of a design
- Designing for maintainability

787 structures

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Why composites?

- Lighter weight
- New design possibilities
- New manufacturing processes
- Better suited for many aircraft loads
- More durable
- Insensitive to fatigue
- No corrosion

**Reduced scheduled
maintenance burden**

Reduced scheduled maintenance

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767 Aluminum Tail



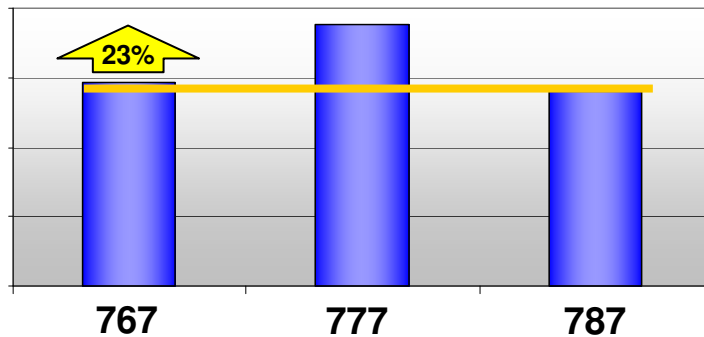
777 Carbon Tail



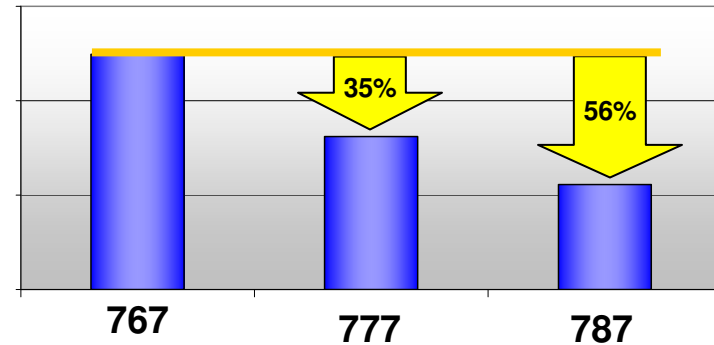
787 Advanced Carbon Tail



Tail Size Comparison (wet area)



Scheduled Labor Hours Comparison



Reduced non-routine maintenance

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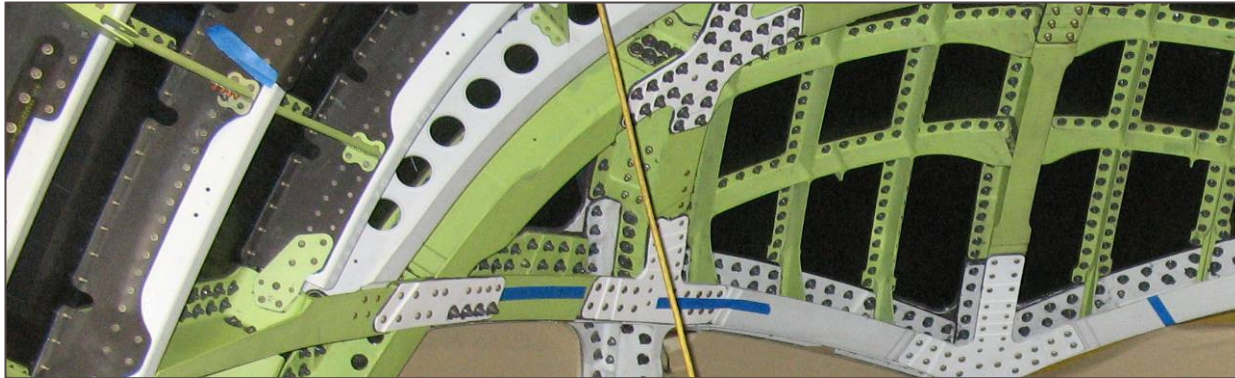


787 Carbon Fiber Floor Beams

- **Boeing in-service experience with carbon fiber floor structure in the 777 demonstrates the non-routine maintenance advantage**
- **The 777 fleet history reveals ZERO non-routine labor hours for the composite floor beams**
- **Boeing has never sold a replacement composite floor beam for the 777**

Why not 100% composite?

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787 Aluminum Flight Deck sub-Structure



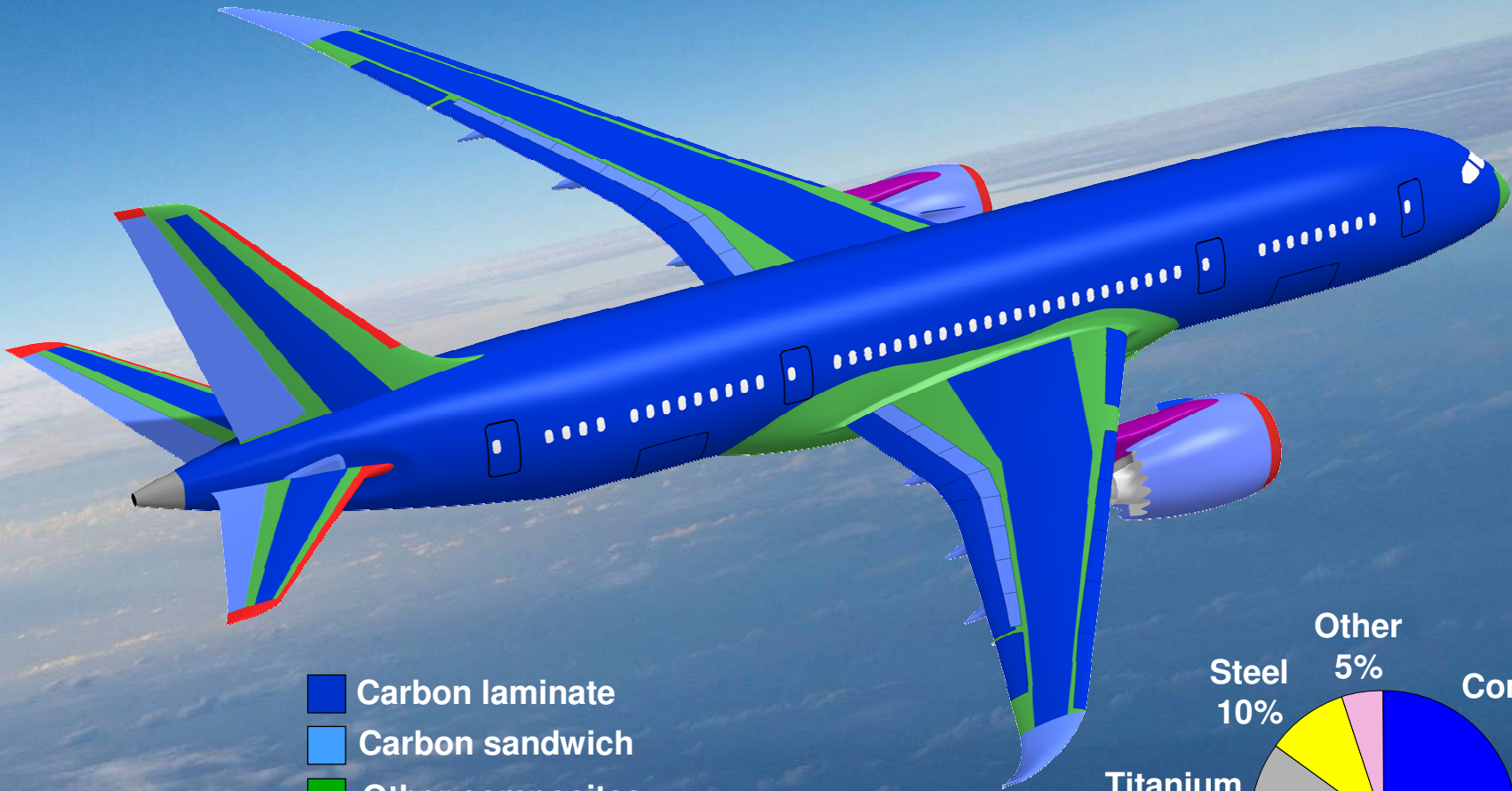
787 Titanium Keel Beam Extensions



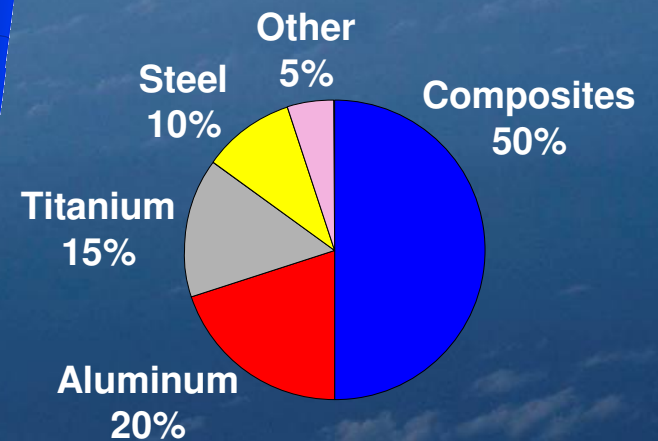
787 Titanium Frame & Fuselage Splice

787 Materials Overview

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- Carbon laminate
- Carbon sandwich
- Other composites
- Aluminum
- Titanium
- Titanium/steel/aluminum



Structures maintenance intervals

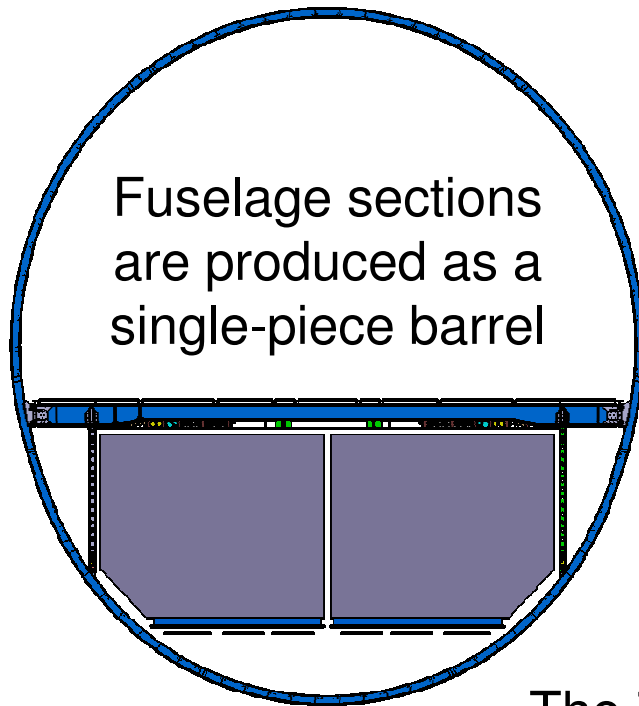
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- The 787 structure is optimized for reduced scheduled maintenance burden
- All routine inspections of structure are visual, with no NDI or special inspection equipment or skills required

	767 current intervals	777 current intervals	787 intervals at EIS
External (2C check) No inspection behind panels, no interior removal, etc.	36 months	48 months	72 months
Internal (4C check) Typical D-check or heavy check - significant access required	6 yrs	8 yrs	12 yrs
Landing Gear Restoration	9 yrs	10 yrs	12 yrs

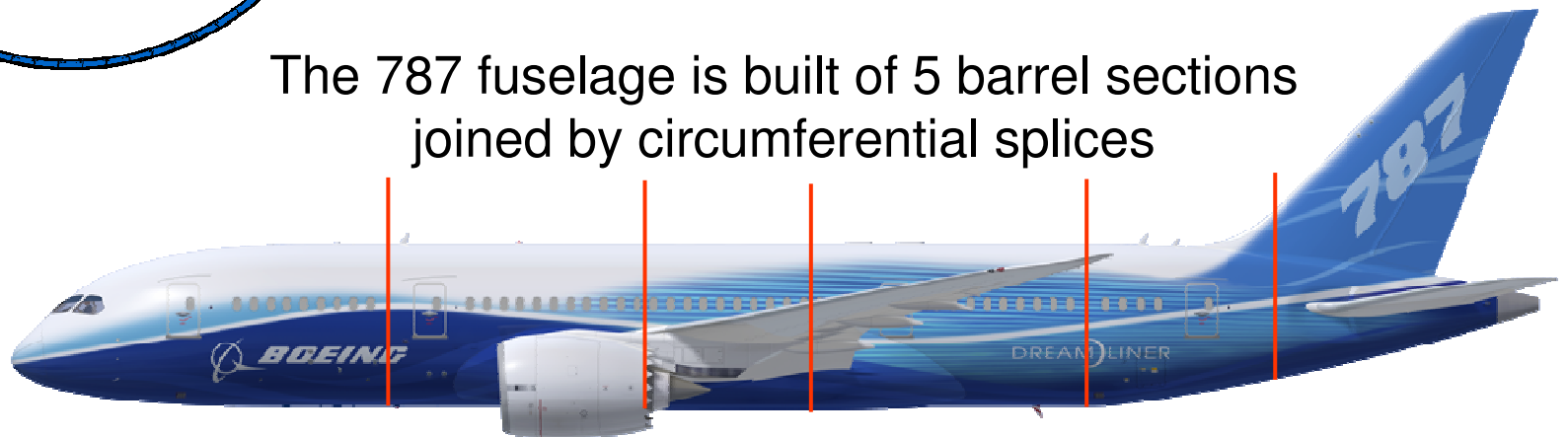
Fuselage Construction

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- **787 design approach minimizes overall fuselage joints**
 - **Eliminates all longitudinal lap-joints**
 - **Reduces weight & drag**
 - **Lowest structural maintenance burden**

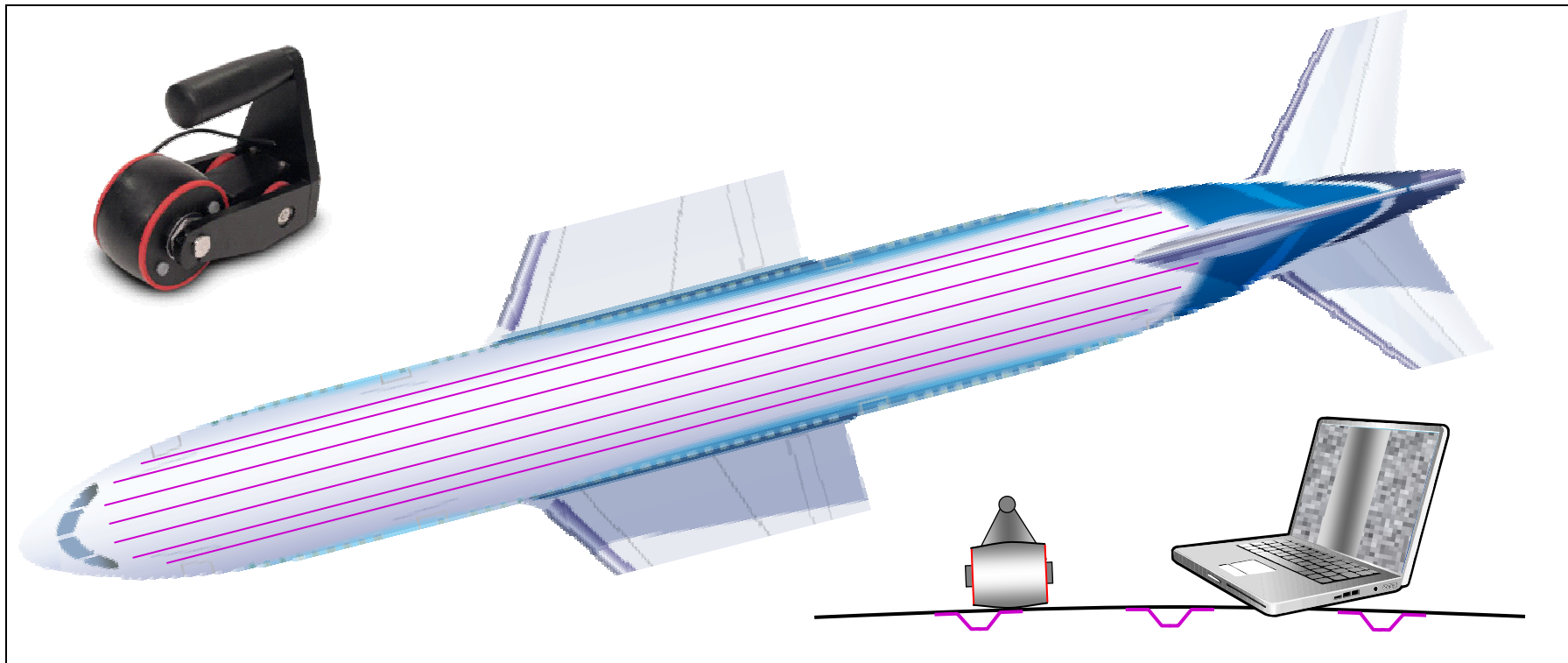
The 787 fuselage is built of 5 barrel sections joined by circumferential splices



Scheduled maintenance

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■ Reduced inspection intensity

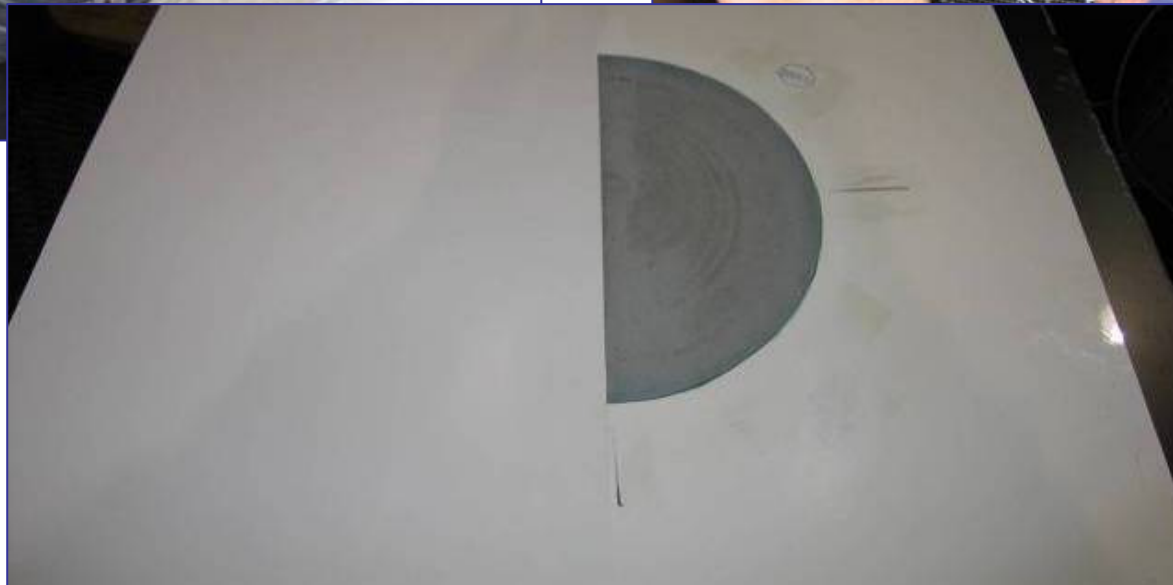


787 fuselage architecture enables non-invasive structural crown inspections without systems and insulation removal

Bonded & hybrid repair development

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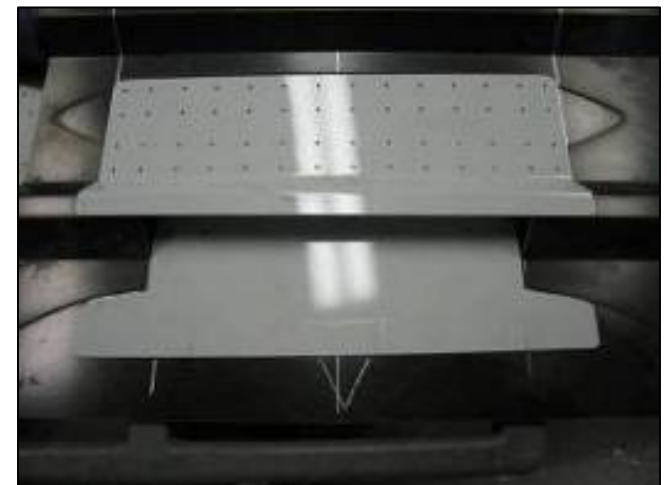
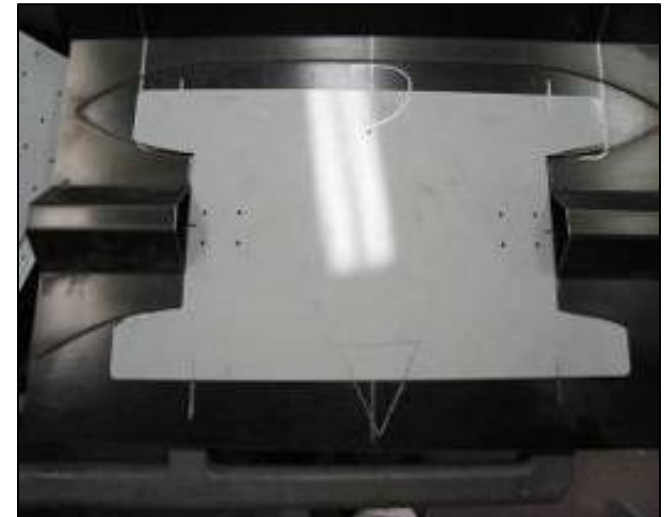
Bonded and hybrid (bonded with bolted sub-structure) repairs are certified for all major areas of structure (fuselage, wing, tail, etc.)



Bolted repair development

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Bolted repair options are certified for all major areas of structure (fuselage, wing, tail, etc.)



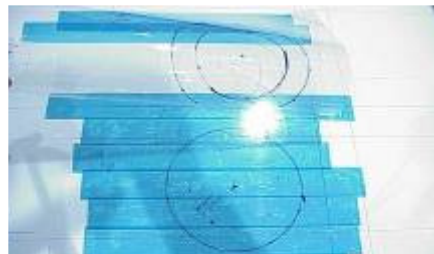
Quick composite repair

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- “QCR” is temporary composite repair which takes 1-hour to install and which can remain on the airplane for up to 24 months.



Area Identified



Coating Removed



Patch Cut



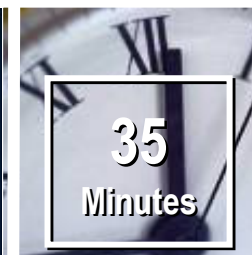
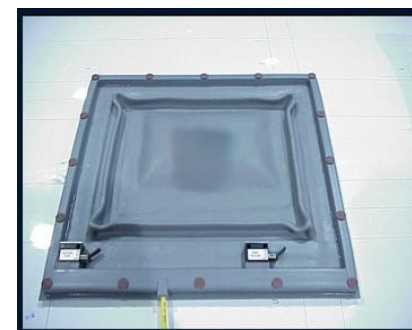
Adhesive



Patch Applied



Heat Pad



Cure



Installed Patch



Surface Covering



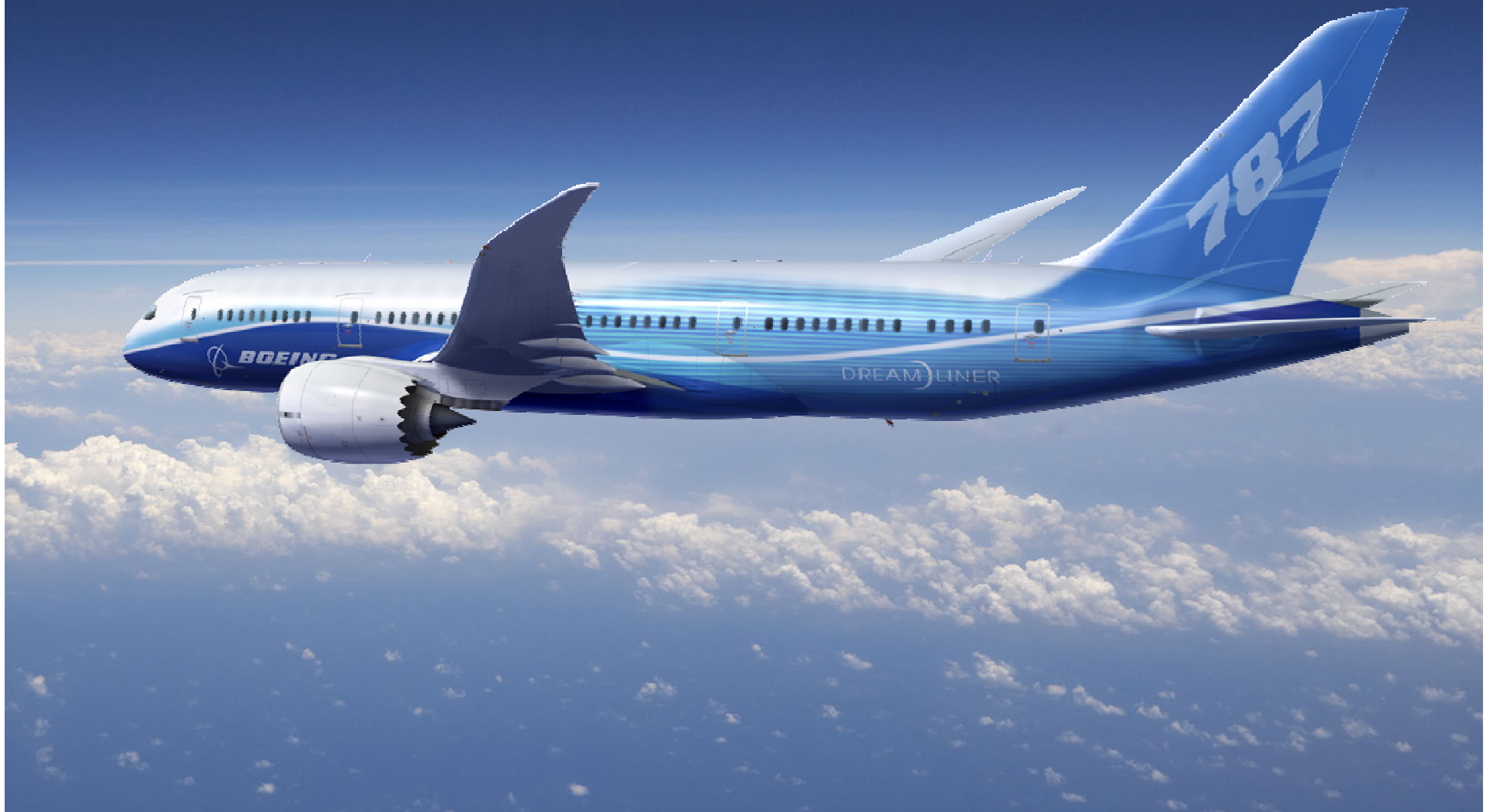
Finished Repair

0:59

Time

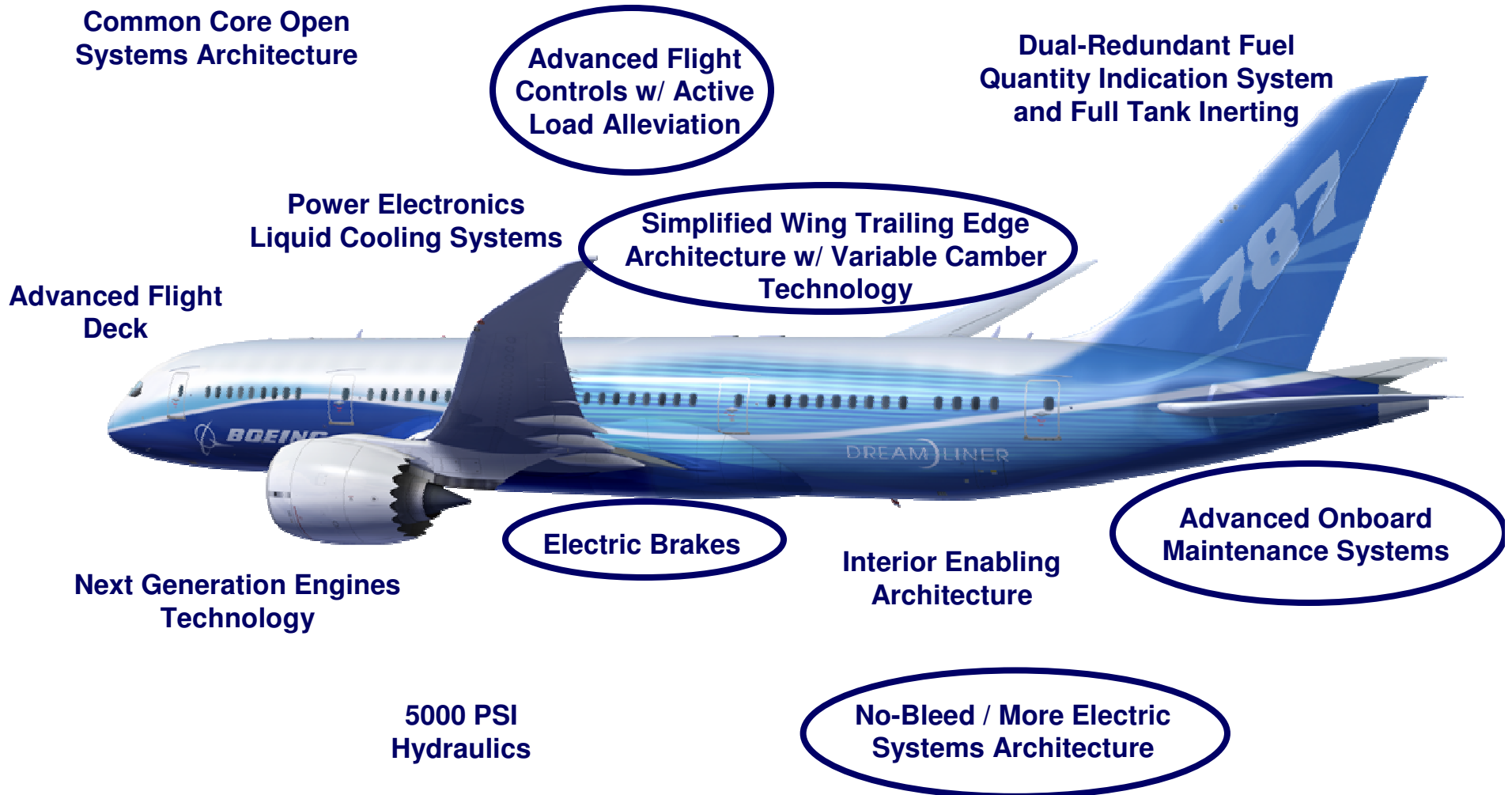
787 Systems

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Key 787 systems technologies

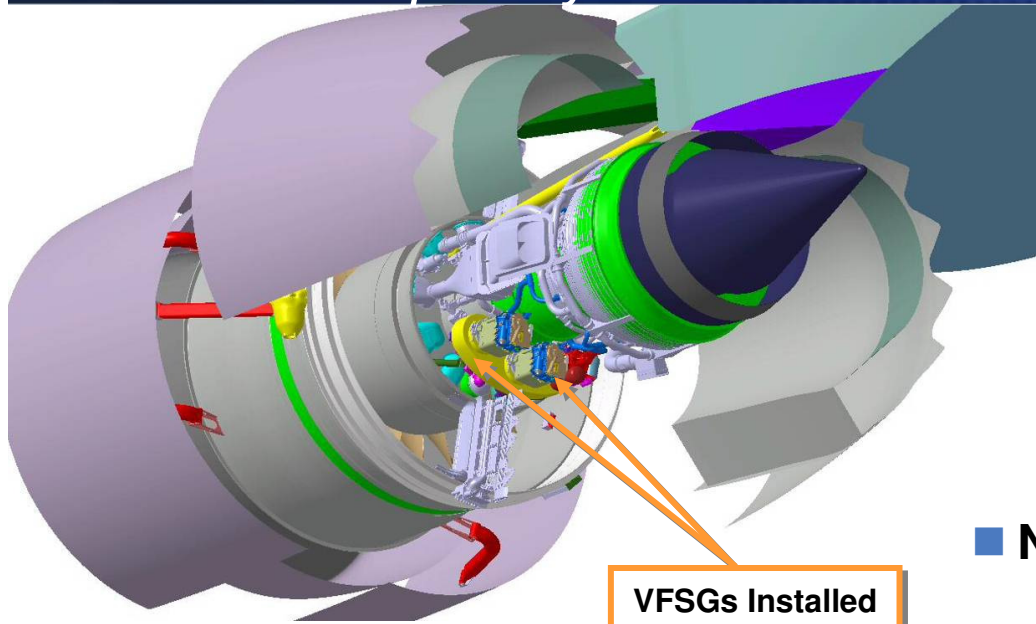
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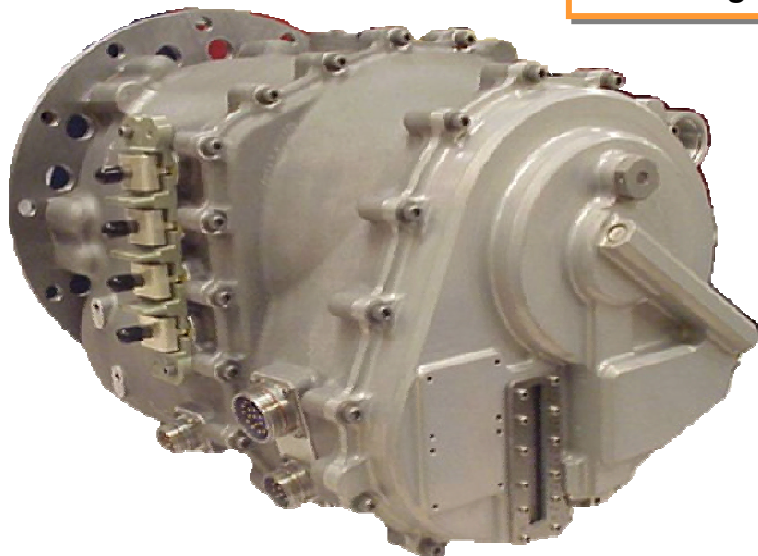
Electrical Power Generation

Variable Frequency Starter/Generator (VFSG)

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VFSGs Installed
On Engine



- No Constant Speed Drive
- No frequency conversion at engine
- Eliminates Pneumatic Start Motor
- Reliability improvement vs IDG

No-bleed/more electric architecture

APU maintenance & reliability

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HS APS 5000 APU



- All pneumatic elements eliminated
 - No Load Compressor
 - No Inlet Guide Vane or IGV Actuator
 - No Pneumatic Ducts or Sensors
- No Frequency Converter
- Improved MTBF
- Greater hours between overhaul

Maintainability R&I Testing – San Diego, CA



Line maintenance

787 Electric brakes

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GOODRICH

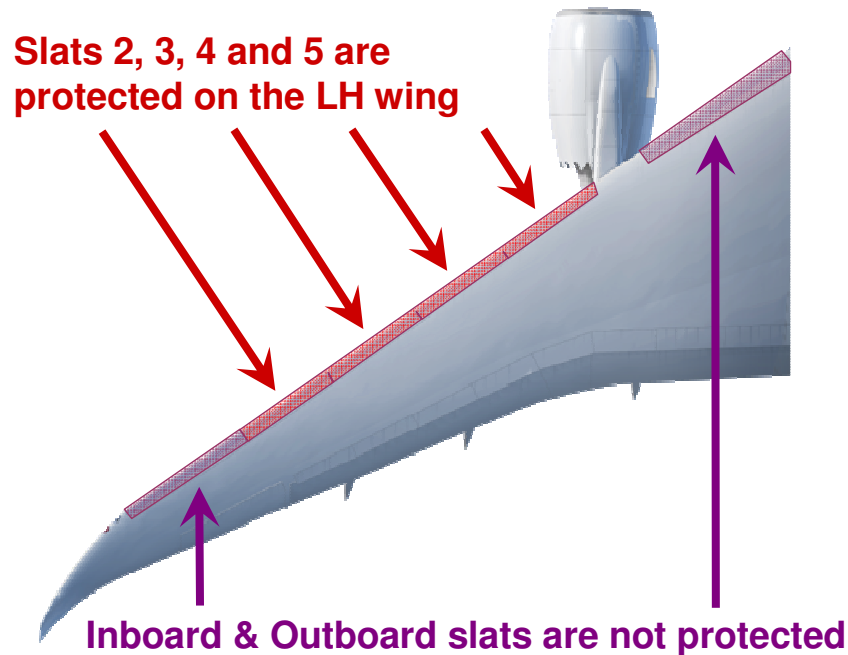


Messier-Bugatti

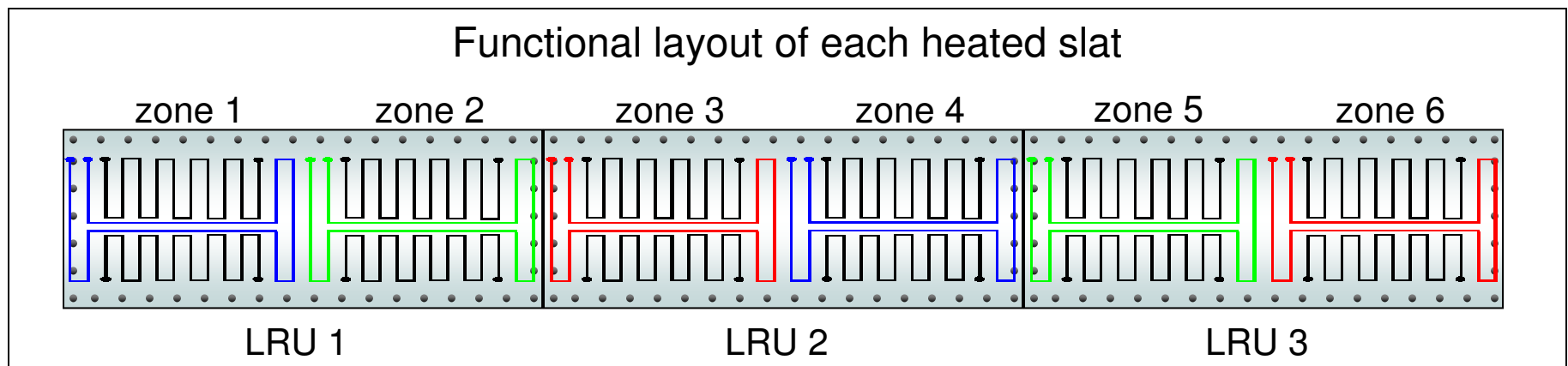


No-bleed/more electric architecture *wing ice protection*

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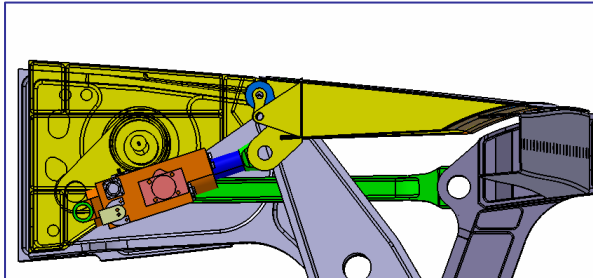
- Ice protection is provided by electrically heated leading edge
- Heated portion of slat is line replaceable
- Aircraft is dispatchable into icing conditions with any two-zone LRU inoperative
- More reliable and more dispatchable than pneumatic anti-ice system



Simplified trailing edge

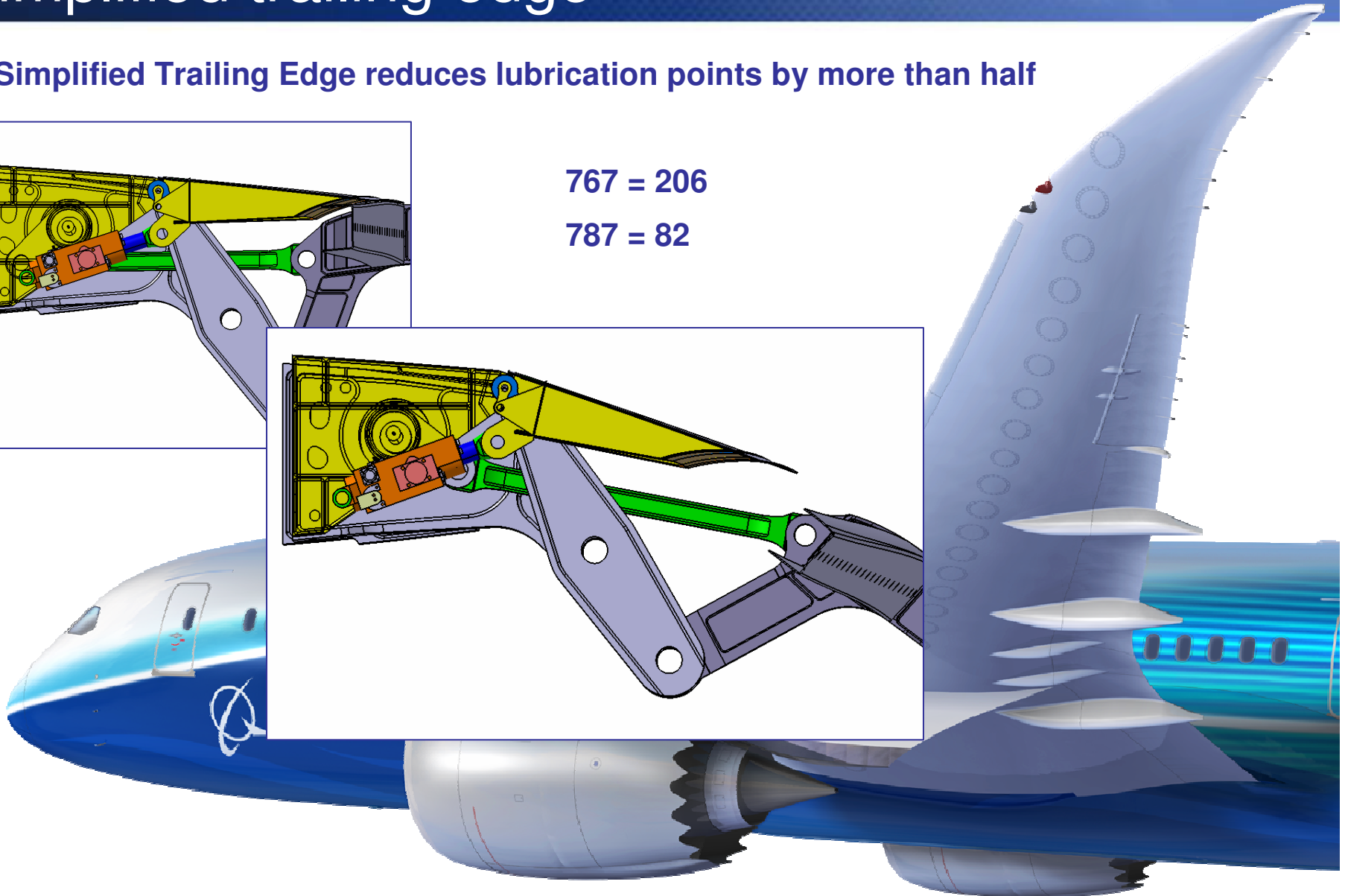
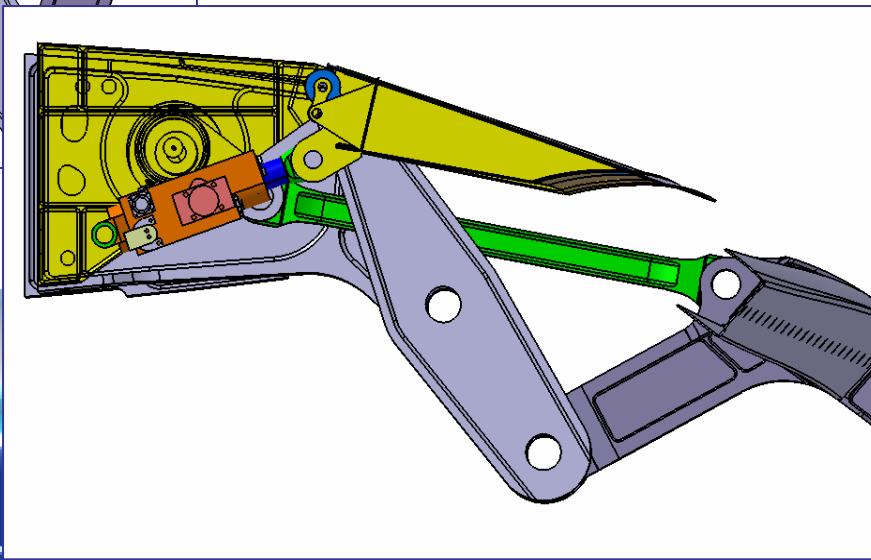
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Simplified Trailing Edge reduces lubrication points by more than half



767 = 206

787 = 82



Scheduled maintenance intervals

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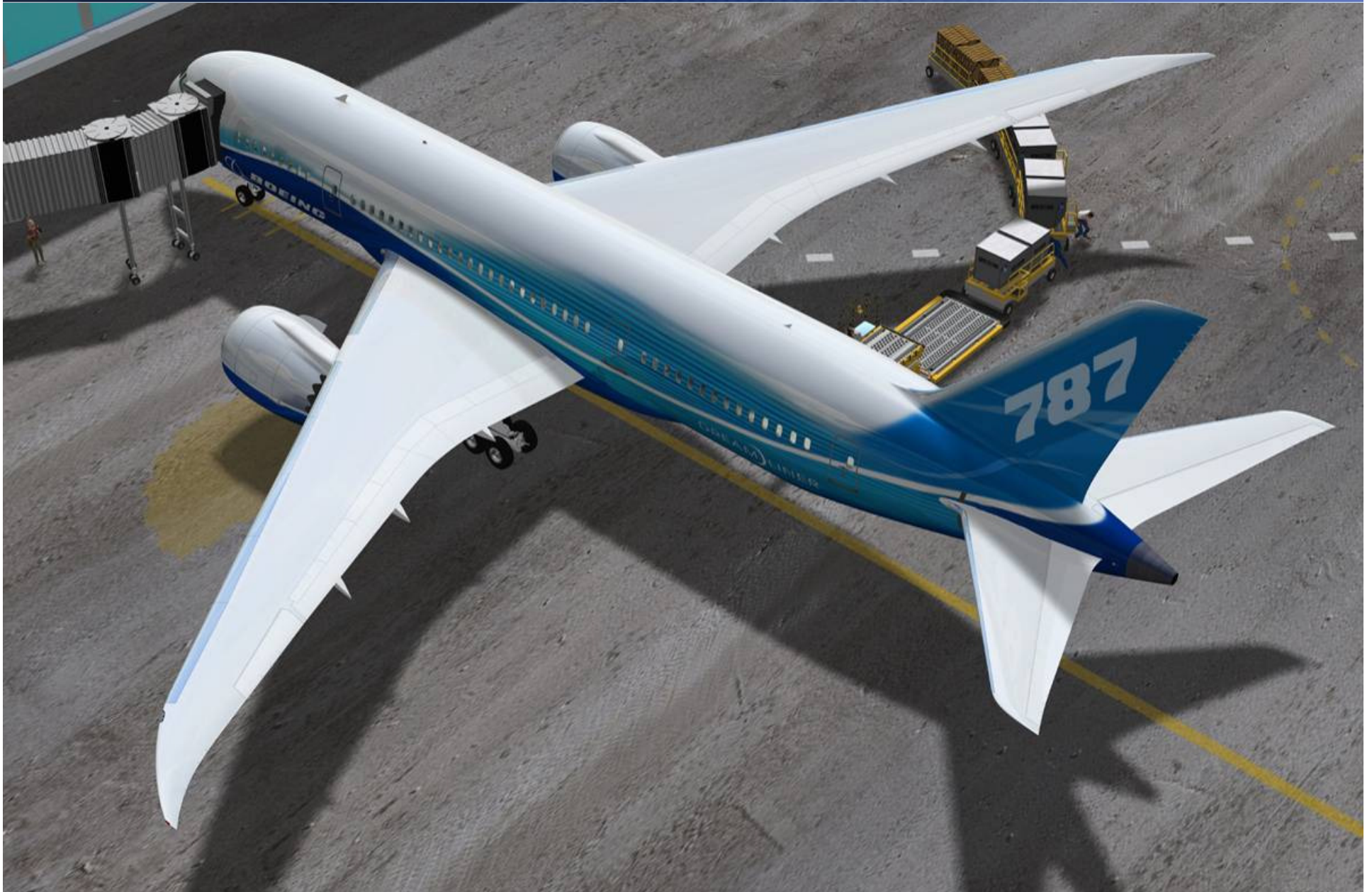
- 787 systems are optimized to reduce scheduled maintenance

	767 current intervals	777 current intervals	787 intervals at EIS
Line (A check) Light duty airframe and powerplant systems checks.	500 flight hours	650 flight hours	1000 flight hours
Base (C check) Systems servicing and checks	18 months	37 months	36 months

- The 787 has no transit or daily maintenance tasks

Onboard maintenance systems

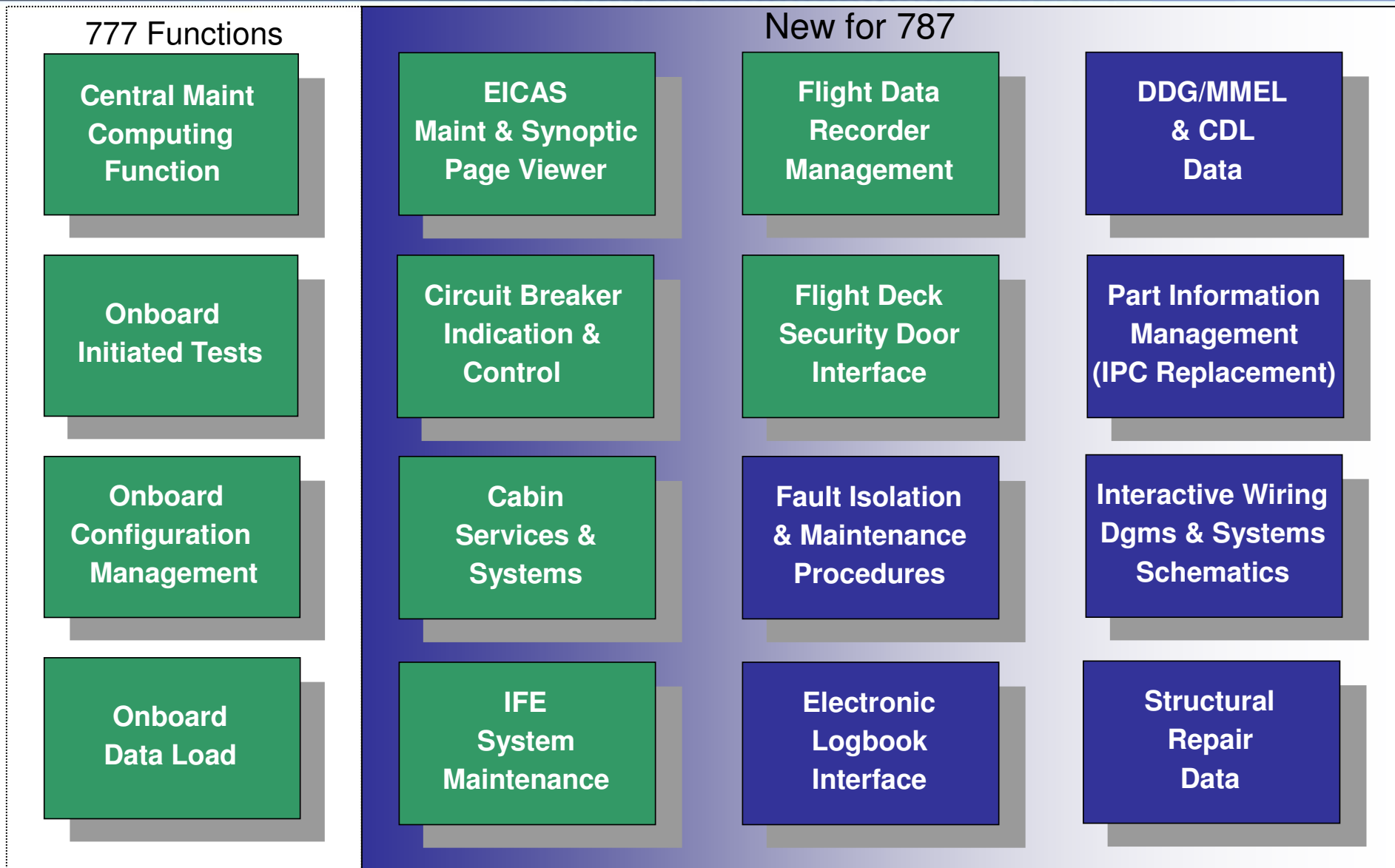
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Onboard maintenance systems

Expanded scope

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Onboard maintenance systems

Expanded availability

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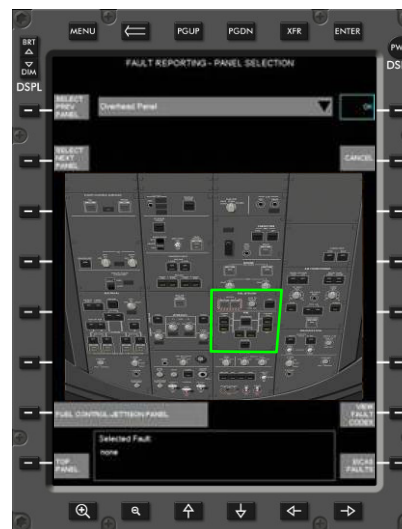


Flight Deck MFDs



EFBs

Maintenance Laptops
(wired or wireless)

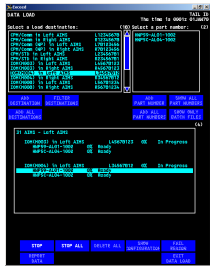


Onboard maintenance systems

centralized, integrated & linked maintenance functions

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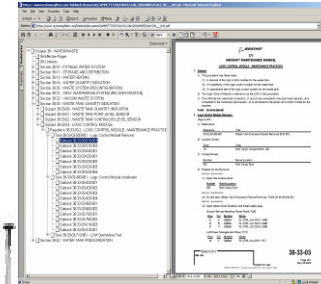
Dataload



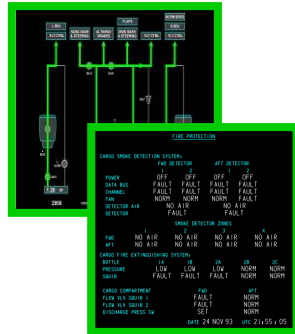
Circuit Breaker Control



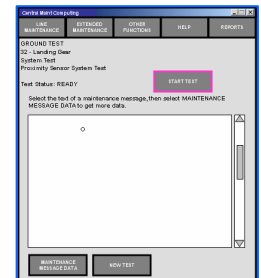
Maintenance Procedure



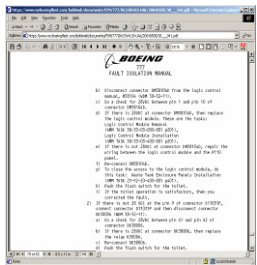
Airplane Systems Info



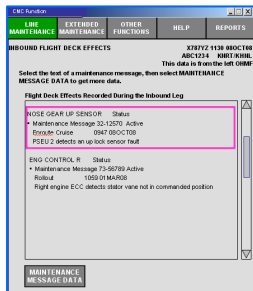
System Test



FIM Procedure



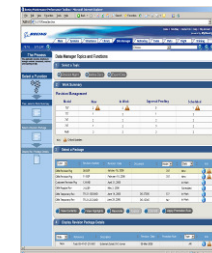
Airplane Fault Data



Pilot Report

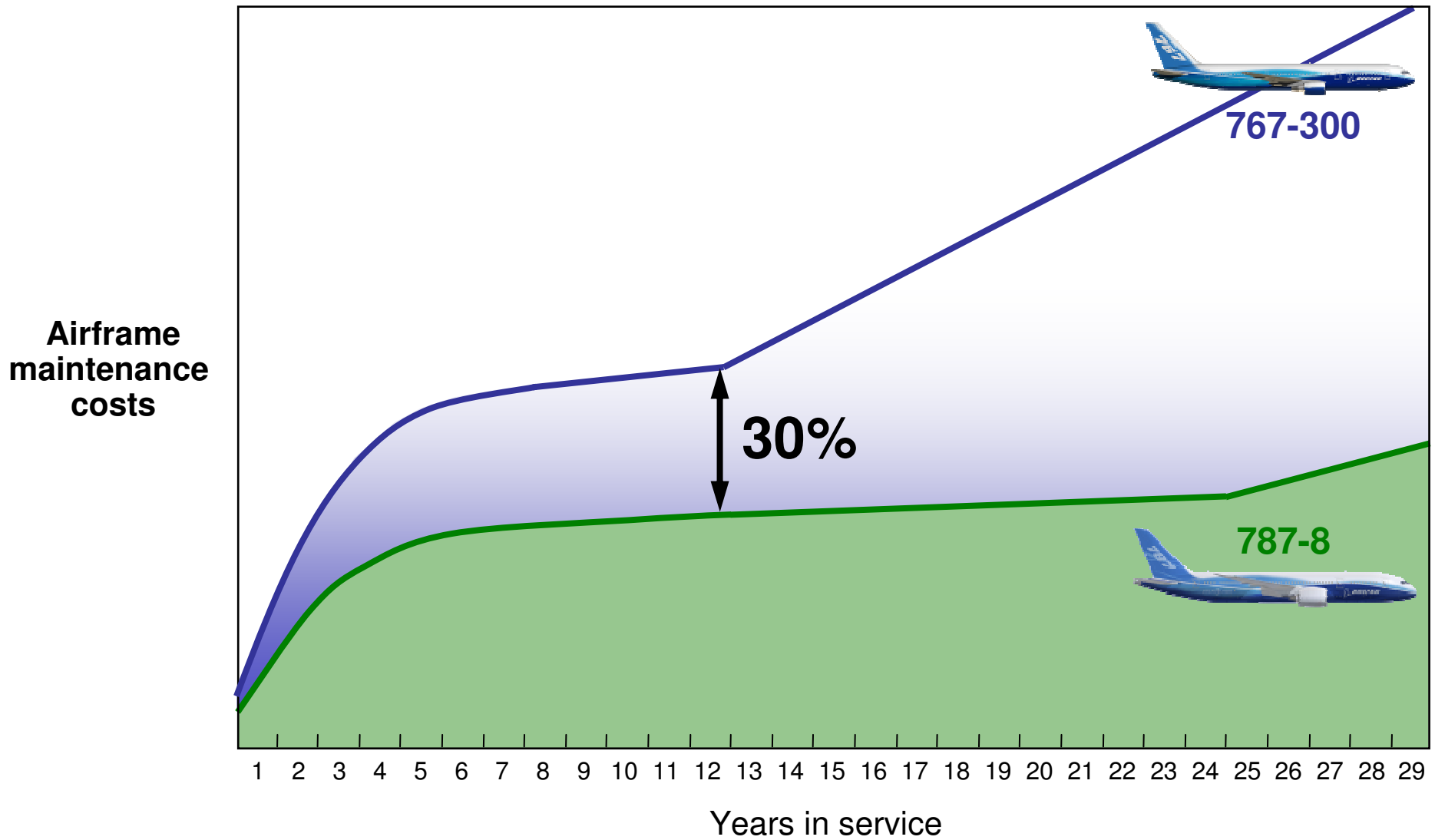


Maint. Log



A guaranteed advantage

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Thank You!

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BAE

