

LANDING SYSTEMS



OPPORTUNITIES FOR WIRELESS TECHNOLOGY IN THE FIELD OF AIRCRAFT LANDING GEAR SYSTEMS

October 12, 2017



Applications for wireless technology in landing gear systems?

- **Description of the landing gear system**
- **Lifecycle of the equipment**
- **Opportunities: In-Service**
- **Opportunities: Maintenance and Certification**
- **Opportunities: Design and Manufacture**
- **Conclusion**

Landing gear system – Safran Landing Systems scope



Fully dressed Landing Gear

Complete with hydraulic and electrical installations



Landing gear extension /retraction system

- System control unit
- Uplocks
- Hydraulic manifolds
- Electro-hydraulic valves
- Electric or hydraulic actuators
- Sensors
- Emergency Extension System



Monitoring systems

- Tire Pressure Monitoring
- Brake Temperature Monitoring
- Position Monitoring
- Oleo Monitoring



Steering System

- Steering control units
- Hydraulics manifolds
- Electro-hydraulic valves
- Sensors



Braking System

- Braking control units
- Hydraulic manifolds
- Electro-hydraulic valves
- Sensors (hydraulics and pedals)
- Back-up hydraulic supply (accumulators / moto-pumps)



Wheels and Brakes

- Carbon disks
- Electric or hydraulic brakes
- Wheels

Landing gear system

■ Primary equipment

- > Main and nose landing gear
- > Actuators for gears, doors and steering
- > Locking mechanisms for gears and doors
- > Wheels, tires and brakes
- > Electronics to control steering, retraction/extension and braking
- > Sensors to detect WOW, gear and door positioning, steering angle, wheel speeds, brake temperature, tire pressure
- > Hydraulic lines and electrical wiring

Landing gear system

■ Main Functions

- > Absorption of Landing Energy
- > Support aircraft during movement on ground
- > Gear retraction and extension
- > Steering
- > Braking



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Video

<https://www.safran-landing-systems.com/video/536?shadowbox=1>

Lifecycle of the Landing Gear System

■ Design/Analysis

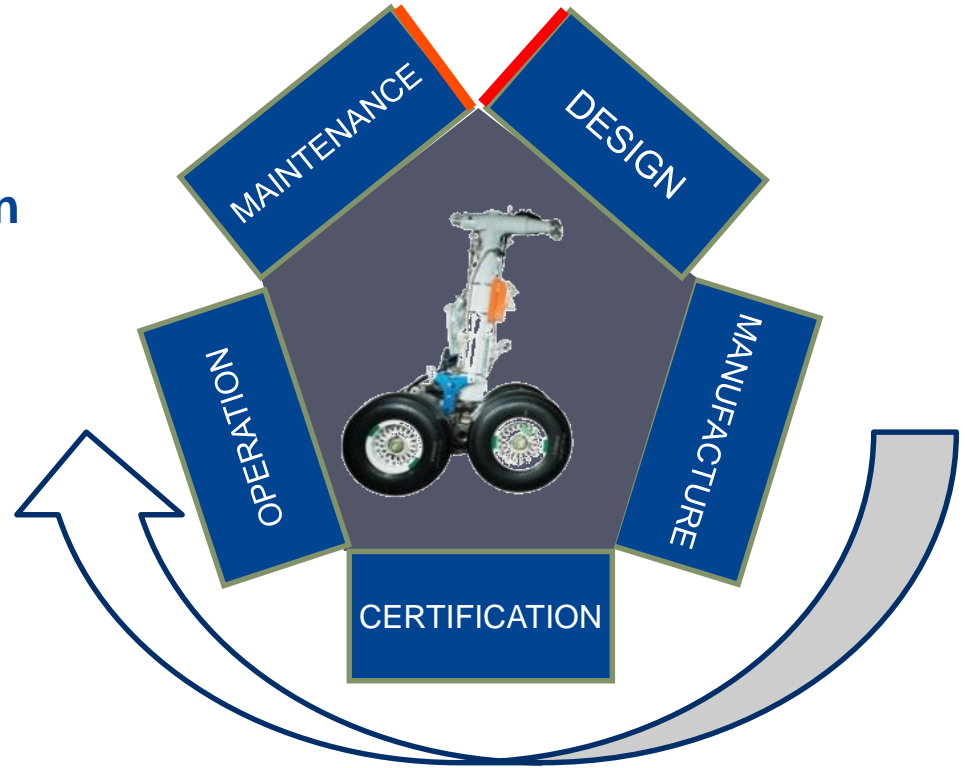
■ Manufacture/Assembly/Inspection

■ Certification Testing

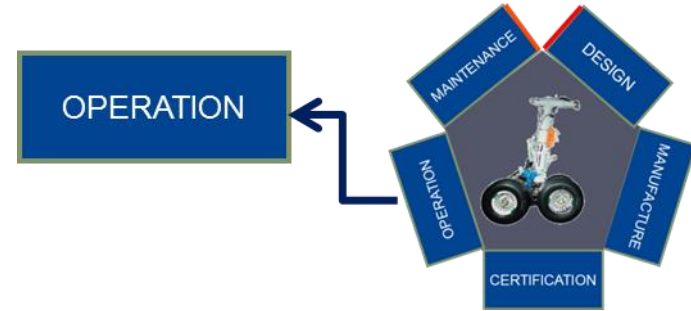
- Laboratory
- Flight

■ In-service Operation

■ Maintenance



In-Service Operation - Environmental Conditions



■ Temperature

> Gear equipment (ie. -55 °C to +115 °C)

■ Fluid Susceptibility

> (ie. Skydrol, de-icers, etc)

■ Shock/vibration

■ Altitude/Humidity

■ HIRF/EMI/Lightning

■ Sand/Dust/Hail

■ Waterproofness/Salt spray

■ FOD/debris



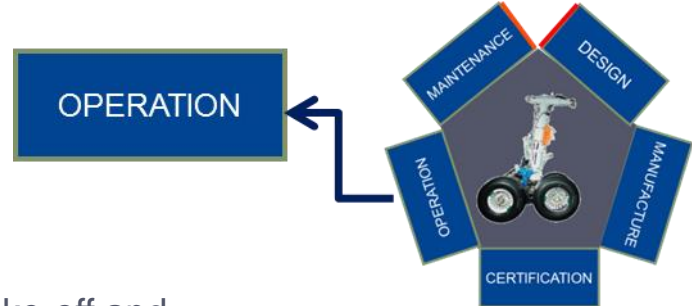
In-Service Operation - Requirements

■ Regulatory – Safety focused

- Linked to the high speed and energy associated with landing, take-off and braking
- Electronic equipment reliability linked to consequence of failure
 - ◆ (Reliability of equipment = $1 \cdot 10^{-9}$, DO-178)
- Principal Structural Elements
 - ◆ Required to maintain integrity and load carrying capability
- Cyber security (new requirements)

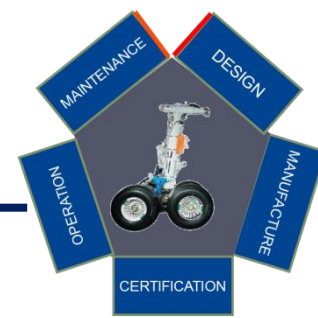
■ Customer - Ease of operation focused

- Minimize downtime of aircraft ('eliminate unscheduled removals')
- Minimize turn-around time of aircraft (limited inspections)
- Maximum robustness and reliability of equipment
- No nuisance messages to pilot or maintenance crews
- Ease of Maintenance and Low maintenance costs
- Long life requirements (ie. A320 60K and 30+ years)



Opportunities for Wireless

OPERATION



■ Where do we currently use wiring

- Sensors- WOW, locking, brake temp, tire pressure, wheel speed
- Electric brakes
- Emergency extension/unlock actuation

■ In-flight Health and Usage Monitoring opportunities

- Shock absorber condition
- Monitoring of loads/overloads
- Strain

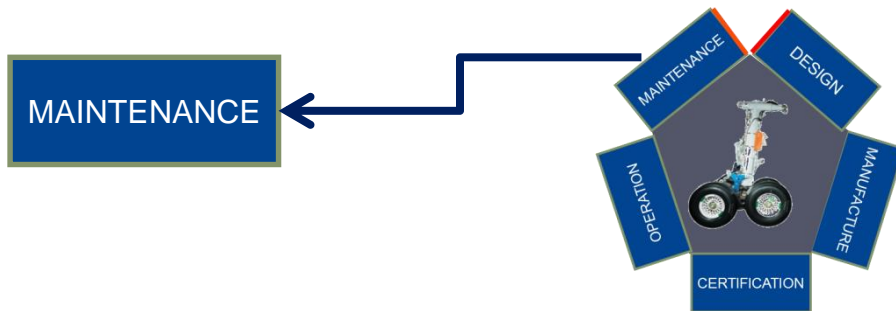
■ More Electric Aircraft

- Electric actuation – gears, doors and locks
- Steering



Safety Critical and Harsh environment

Opportunities for Wireless



■ Ground Inspection

- > Tire pressure – existing technologies/activity
 - ◆ Excellent presentation by Andrew Bill of Airbus at WiSEE2015 Workshop
 - ◆ **'PresSense'** – collaboration between Michelin and SAFRAN of embedded sensor
 - ◆ SAE (AIR4830) Aircraft Tire Pressure Monitoring Systems
- > Shock absorber condition (oil /nitrogen)
- > Monitoring of gear loads/overloads
- > Aircraft weight

■ Diagnostics

- > Landing gear, steering and brake control units
- > Other stored data



Improved working environment
Inspections still fulfilling critical conditions (ie.
return to service), Rapid Turn-Around

Opportunities for Wireless

CERTIFICATION

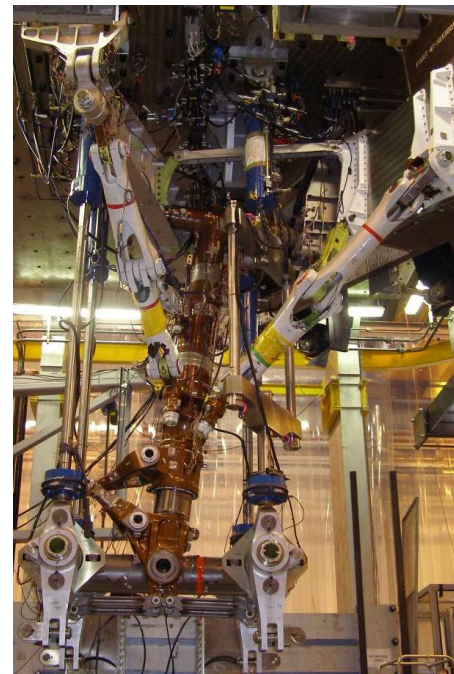


■ Laboratory

- Multiple tests – strength, fatigue, drop, environmental
- Massive data collection (strain data/deflection data)
- Recent benefits seen in using photogrammetry for dynamic deflection measurement

■ Flight

- Flight Test Instrumented landing gear equipment
- Connected to aircraft monitoring systems



Controlled testing environment
Required durability of testing equipment is limited
to protection of test article and flight test aircraft

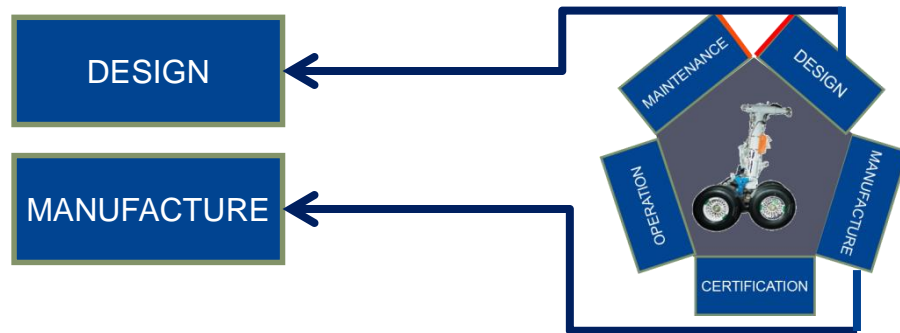
Opportunities for Wireless

■ Manufacture/Assembly/Inspection

- > Improved quality
- > Ease of manufacture and assembly
- > Tooling and part monitoring
- > Some harsh environments
- > Factory of the future

■ Design/Analysis

- > Safety and reliability analysis of equipment for in-service and FTI proposals
- > Improved methods through correlation with testing results



Open to new or proven opportunities

Conclusion - Opportunities for Wireless

- Needs of landing gear differ throughout the life-cycle
- Varying levels of criticality for safety and reliability
- Significant variation in operational environment

Safran LS welcomes ideas for the application of wireless technology

