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Recent Advances in Electrical Landing Gear Systems

1. Historic Landing Gear Systems - *fully Hydraulic*

From Second World War to early 21st century, the Landing gear systems (Extension/Retraction, Steering, and Braking) have always been powered by a centralized hydraulic power source.

The benefits foreseen at aircraft level for switching from hydraulic to electric power have greatly increased the R&T activity in this domain in the recent years.

2. Electrical Landing Gear R&T permitted introduction of Electrical power technology on commercial Aircrafts in the 00's

R&T activities started in the 80's on electro-hydrostatic actuation permitted introduction in service of electrical power for Landing Gear back-up systems (Steering & Braking). But at the moment this is only limited to back-up systems with low usage occurrence.

3. Latest research & technology projects - toward all electrical Landing Gear Systems

3.1 Nose Landing Gear EHA (Electro-Hydrostatic Actuator) demonstration - *from technological bricks to integrated demonstration*

From the technological bricks developed in the 00's (hydraulic pump, wet electric motor, …), a demonstration has been made on real Landing Gear covering the full Nose Landing Gear systems (combining steering and extension/retraction). This demonstration proved the capability to suppress the need to bring A/C hydraulic power at the front of the A/C which is a first step towards complete removal of centralized hydraulic systems.

3.2 EHA key components life potential increase - *EHA candidate for front line usage*

In order to envisage EHA as the primary mode for LG Systems and no more as back-up, the life potential of the pump which is the key EHA component needed to be increased. Extensive test has been performed, and study on different materials / treatments, and geometries to prove that this technology was robust enough to be selected for a full life aircraft application.

3.3 Main Landing Gear Electrical Actuation – *The challenge of the size*

The most challenging landing gear system for use of Electrical Power is the Main Landing Gear Retraction due to its high Load and Dimension. After demonstration of feasibility for

the other LG functions, recent focus has been put on definition of an EHA solution that could compete with the long optimized hydraulic solutions.

3.4 Electro-Mechanical Actuator (EMA) for braking systems– *A pioneer for in service Landing Gear electrification*

Braking is the first Landing Gear system to have proven sufficient maturity to bring the technology onboard a commercial aircraft.
The first generation of braking EMA is now in service and providing a good operational feed-back. The research activity on the braking EMA has now entered in the optimization phase to get the best of this technology, with improvement already foreseen both in terms of weight, cost and reliability.

3.5 Electro-Mechanical Actuator (EMA) for retraction systems– *A challenger for the future*

EHA technology has the drawback of keeping an interim mean of power transmission between the electrical power source and the mechanical output, which adds complexity (therefore cost and unreliability) compared to EMA which is direct transformation from electrical to mechanical.
For retraction system the challenge is to always permit LG going back to the safe down-lock position, even in case of failure.
Innovative actuator architecture concepts have been studied and tested which permit a 30 to 40% weight improvement compared to first generation of EMA for the same function.
Even if maturity of EMA need to be progressed at the same level as EHA, those actuators can already compete in terms of weight, cost and reliability with their EHA equivalent.

3.6 Electro-Mechanical Actuator (EMA) for steering systems– *Removing the show stoppers*

EMA technology for steering systems still has some show stoppers compared to the other hydraulic or EHA technologies.
The progress made during the recent projects has permitted to improve a lot the EMA solutions for this system (innovative concept for weight optimization), but the reversibility and compatibility to shimmy phenomenon on a compact EMA solution are still to be proven. Activity is now focused on overpassing those last blockers.

3.7 Electrical Green Taxiing System– electrical technology brings *a new A/C function with major environmental and economic impact*

The progress made in the recent years on the different EMA components in terms of power to weight ratio permitted some time ago to envisage the possibility to shut down the A/C engines on ground and mover the aircraft from EMA connected to the main landing gear wheels (powered by the APU energy). This permit to save a great amount of fuel burn during the taxi phase for short range A/C. Research projects have demonstrated that this concept was fully operational, and development is now underway to bring this technology onboard a commercial aircraft.