Implementation

The team “Helios” proposes with the technologies previously mentioned and the implementation in aircrafts supported, which could be in different ways, so it is only proposed two ways of demonstrating that the usage of wireless networks is practical, one of them is the implementation on flight systems more indispensable of a trainer aircraft and the other theoretical way on a commercial aircraft; for the trainer aircraft it doesn’t have problem of information stealing since being an exclusive use aircraft in military zones is possible to modify systems even more specifics without compromising the security, saving a big number of wiring kilograms. The aircraft that was used is the trainer aircraft PC-7, which is an aircraft given by the Mexican Air Force as a learning method.

For the PC-7 aircraft it was partially disassembled to check in which parts the cables were located, doing this the team identified the parts that could be replaced, this aircraft has a lot of cables with a wide area, which are potentially replaceable like the ones that are connected to LEDS, radio systems, etc, this systems are going to be replaced by ZigBee sensors. PC-7 vibrations are always there, therefore the objective is to place the piezoelectrics near to the seat by the sides or in the floor. This because the seat needs to have a parachute in, the parachute acts like a seat and needs to have an easy access that also do not obstruct the piezoelectrics.

For the wing tip lights the piezoelectrics could be located inside the wings, in this aircraft the fuel tanks are inside the wing but only in the wing root, having a hollow wing tip, therefore placing there the piezoelectric won’t be a problem. The weight aspect isn’t a problem either because the weight of the cables is being reduced. This plane’s lights are incandescent and are going to be replaced by LEDs consuming less energy, doing this the weight is reduced and the battery efficiency is increasing.

To get concrete numbers and validate the percent of cables in an aircraft, the PC-7 wire system was used as a reference. A wire system in a PC-7 weighs 51.651 kg, this data is known because of a field research. Taking into consideration that the most of wires have a 2mm diameter and the most of wire systems are distributed by the floor at both sides of the plane the following calculations were made.

Each cable area.

$$A = (3.141592)(.1)^2$$
$$A = 0.03141592\ cm^2$$

To power the LEDs that goes to the wing tip 12 cables are used for each semi-wing. The length of the wires coming out of the battery to the controls is 350cm, from the controls the wires return 320cm to pass through the perforation and finally reaching the wing tip 588cm away from the perforation. This for each wing tip light.

$$A = (0.031415926cm^2)(12) = 0.37699cm^2$$
$$V = (0.37699cm^2)(895cm) = 337.407cm^3$$

To power the LEDs that go to the landing gear (left side and right side) 6 on each side, in the same way, cables come from the battery to the flight deck where the length is of 350 cm, then they go back from the controllers until the perforations where the length is 320 cm, and from there, the cables go to the landing gear where the distance is 225 cm. Adding everything it has a total length of 895 cm per cable.

$$A=(0.031415926cm^2)(12)= 0.37699cm^2$$
$$V=(0.37699cm^2)(895cm)=337.407cm^3$$

To power the LEDs that are at the end of the tail are needed 8 cables. Cables come from the battery, then to the flight deck, and then they go to the tail covering a length of 1130 cm.

$$A=(0.031415926cm^2)(8)=0.251327cm^2$$
$$V=(0.251327cm^2)(1130cm)=283.999cm^3$$

Headlights have a cable of 2m long and a thickness of 4mm each, an area of $0.1256cm^2$, therefore a volume of $25.1327cm^3$, the aircraft has 2 headlights so the total volume is $50.26548cm^3$

Adding all the volumes of the cables it gives a total of

$$V=1620.1714cm^3$$

Copper's density is 8.96 g/cm^3, with the formula of the density we can obtain the total weight of the wires

$$\rho=m/v$$

$$\rho v=m$$

$$(8.96\ g/cm^3)(1620.1714cm^3)=14{,}516.73\ g$$

$$14{,}516.73\ g=14.51673\ kg$$

Making a relation between the total weight of wires and the weight of the wires that are going to be quit it was obtained that:

$$((14.51673\ kg)/(57.346\ kg))(100\%)=25.3142\%$$

Just with this part of the wiring it was reduced a 25.3142% of the total weight of wiring present in the aircraft.

In total the PC-7 has 778 cables according to the field research and everyone of this has 3 connectors, therefore it has a total of 2,334 of which 44 cables were reduced making a total of 132 connectors, this represents a total of 5.6555% of the connectors. For the control of this it will be used the protocol ZIGBEE with a receptor and a transmitter. Also, it was reduced both perforations that go to the wing tip and another one that goes to the tail.
In total the empty weight of the aircraft is 1330kg of which the 4.3117% is the total of the wiring, it was reduced 14.51673kg, this represents a total of 1.09% of the total empty weight of the aircraft

The implementation of the piezoelectrics will be located in the wing tips and in the floor of the aircraft, depending of the demand of the LEDs it will have different layers, either in series or in parallel depending on the necessities of the system. Furthermore piezoelectrics layers will be implemented