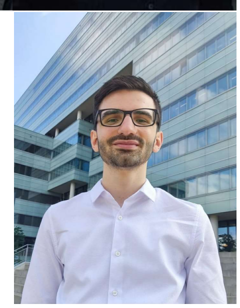
# ADENEAS Newsletter 8

## Wireless avionics networks ground based demonstrator


Hello there! We are Nestor Edgar Sandoval Alaguna and Asterios Souftas, Research engineers at Fokker Elmo (FE) Research and Technology Department and Blendi Ahmeti and Youri Smolders BSc students at Eindhoven University of Technology (TU/e). Within the ADENEAS project, Nestor is leading the Fokker wireless measurement and testbench laboratory and Asterios is coordinating the Fokker research on network architecture and reliability. Blendi and Youri are developing reliable wireless techniques for avionics intra communications.



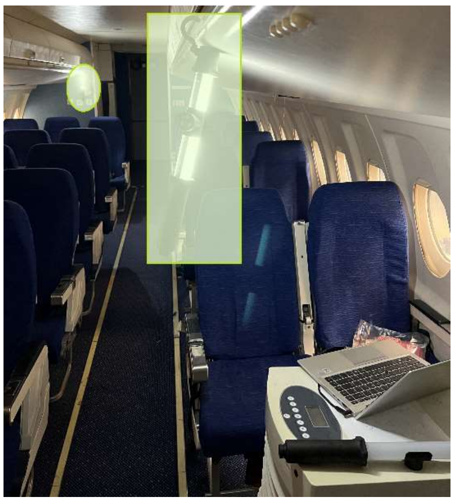
Part of our assignment in ADENEAS is to develop technologies to minimize the impact of the aircraft data network. We are targeting a weight reduction and a decrease in design lead time. We expect that wireless technologies can play an important role in the aircraft data networks of tomorrow. The weight decrease due to wire replacement can translate up to 200 kg of weight savings in regional commuter aircrafts, which will decrease fuel consumption and thus make for greener aviation.

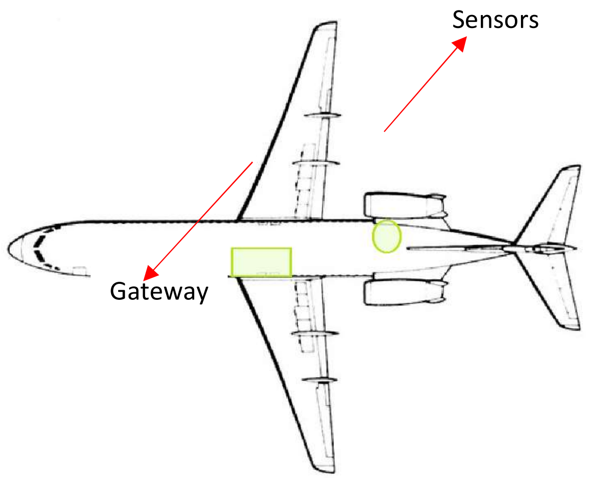
However, we need to make sure that wireless technologies are as reliable as their wired counterparts. To evaluate the achievable reliability of wireless networks, a wireless Ground Based Demonstrator (GBD) was developed in ADENEAS WP6.

Designing wireless networks that can meet the requirements of avionics applications is challenging. The main objective of aircraft systems is safety. This means that aircraft system intra-communication has to be adequately reliable and predictable. Data packets containing critical information should arrive at its destination within a bounded time limit. Wireless communication is instead inherently unpredictable and dependent on external factors such as the environment.

Novel techniques are developed to meet the stringent reliability requirements of avionics networks. In collaboration with the Eindhoven University of Technology (TU/e), an improved version of the Internet of Things (IoT) wireless protocol IEEE 802.15.4 was designed to be used in the GBD. The reliability solutions were based on the concepts of scheduling and multicast. The former means sequencing the exchange of data packets to avoid collisions and the latter means taking advantage of multiple receiving nodes to achieve enhanced reliability.

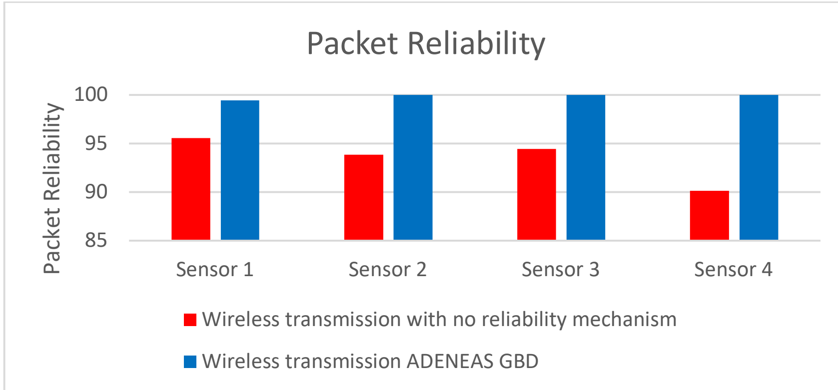
To evaluate the performance of the developed technologies, FE worked to capture relevant requirements. These requirements were determined based on the communication specifications of an emulated aircraft system. The system was emulated using software for IoT technologies. Once there was enough understanding of the system, IoT devices were deployed to create a network using the identified reliability protocols and mechanisms. All these nodes send information that is received at a central information reception point (gateway). The system reliability requirement is $10^{-5}$ failure probability per flight hour and the maximum acceptable delay per packet is 250 milliseconds. The quality of transmission was measured with a limit of 5 consecutive failures before counting packet reception as failed. Also, the time at which the packet is sent from the node, as well as its reception time at the gateway were measured to calculate the packet delay in the network. These tests were carried out in a Fokker 100 aircraft for greater credibility. The square areas indicate gateway placement and circular areas indicate IoT node placement.






Tests were performed in the F100 aircraft mainly inside the cabin. Other configurations were also explored to evaluate the impact of node placement on the performance of the network. The distance between the gateway and the sensors varies within the range of 3 to 5 meters. It is necessary to have some standard values and results of the network to see how the proposed reliability mechanism can improve the performance. These benchmark values for comparison are obtained with the deployment of simpler wireless technologies with limited reliability methods (Carrier Sense Multiple Access - CSMA).

When the wireless network was tested in a similar environment to the intended avionics system, all requirements were achieved. The signal reliability reached 99,7% for the test with the most representative conditions. To determine the limitations of the technology used in this demonstrator, different settings were tested. The tests include line of sight scenario as well as various distances between the gateway and the nodes. Even for tests with long distance (around 5 meters) and with obstruction to the line of sight, the system performed well and met all the requirements with exception of the maximum delivery time of the packets. Preliminary results show that it is possible to meet medium avionic requirements with commercial of the shelf devices in ranges within 5 meters.




Based on the experience of the GBD we have effectively established a framework to evaluate the suitability of wireless technologies in aerospace applications. We plan to use this knowledge for further tests. We are interested in identifying the limits of the IoT technology used in the GBD with respect to the limit of simultaneously connected devices and interference. In future projects, we aim to test the performance of other technologies (like 5G/6G and Wi-Fi) and integrate our GBD to real aircraft systems to verify our conclusions.