ADENEAS Newsletter #2

Wireless propagation measurement campaign

Hi! My name is Jesper Lansink Rotgerink, and I am a research and development engineer within the “Electromagnetic and Technology” team at the Royal Netherlands Aerospace Centre (NLR). Within the ADENEAS consortium I am the project lead for NLR. In this second newsletter, I will discuss the measurement campaign on a Fokker100 aircraft that was done early 2022 as part of our Work Package 2 (WP2) “Wireless Technologies”.

ADENEAS develops technology enablers to pave the way for a safe, light, self-configuring, autonomous and modular power and data distribution network that is scalable to all aircraft sizes. For the data distribution network this implies that ADENEAS is researching a hybrid network combining wired, wireless and power line communication. A strong collaboration between Technical University of Eindhoven (TU/e), GKN Fokker Elmo and NLR within WP2 focusses on the development of technologies for Wireless Aircraft Intra Communication (WAIC). One of the most pressing challenges is the reliability of the communication channel, which should be high to support avionics functions. Moreover, the introduced wireless technologies should not disturb (or be disturbed by) any other on-board equipment. Since a specific allocated frequency band for WAIC coincides with the operational band of the (safety critical) radio altimeter, this system is especially of concern. This is one of the topics EUROCAE WG-96 on WAIC, in which the ADENEAS project is involved, is actively working on.

As part of WP2 a measurement campaign has been performed in a Fokker100 aircraft at the Aircraft Maintenance & Training School (AM&TS) in Hoogerheide, the Netherlands (see Figure 1). The goal of this measurement campaign was to get data on the behavior of wireless propagation in an actual aircraft environment.

Figure 1: Fokker100 aircraft at the Aircraft Maintenance & Training School

To reach this goal, four types of measurements were performed (see Figure 2 for photos of the various measurements):

- Measurements of the propagation in various parts of the aircraft fuselage.
    - A dedicated positioner made by TU/e ensured measurements with a transmitter on a grid of closely placed points and in various polarizations. This will help characterizing the propagation channels on-board aircraft.
- Measurements of the shielding characteristics of the aircraft fuselage.
    - Part of the mitigations to prevent interference from WAIC to the radio altimeter (possibly of other nearby aircraft) is to put specific limits on the allowed Equivalent Isotropically Radiated Power (EIRP) of WAIC transmitters. Attenuation provided by the aircraft fuselage might alleviate corresponding requirements on in-cabin transmit powers.
- Measurements of shielding between various compartments in the aircraft.
    - Various compartments considered are illustrated in Figure 3.
- Measurements of the coupling between radio altimeter and transmitters at various locations in the aircraft.
    - Coupling between WAIC on one aircraft and radio altimeter of other aircraft might be even more interesting, but such a measurement was impossible at the given site.

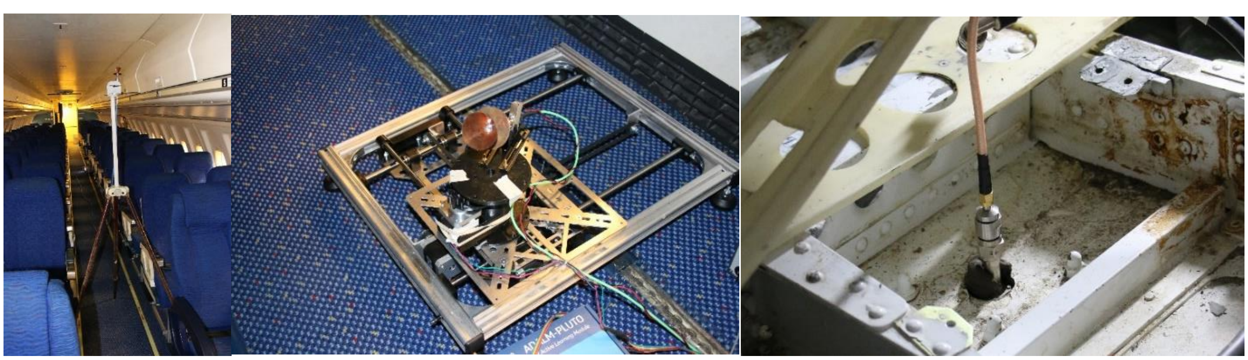

Figure 2: Photos of three different measurements: (1) transmitter used for measurement of aircraft shielding, (2) transmitter on positioner used for propagation measurements, and (3) receive equipment is attached to radio altimeter

Figure 3: Compartmentation of the aircraft, where NLG and MLG stand for Nose/Main Landing Gear

In a week's time a large variety of measurements have been performed. Specific broad-band omnidirectional antennas (see Figure 2), small enough to fit in small areas in the fuselage, were designed by TU/e. In short, some conclusions that could be derived from the obtained data are:

- The propagation channels on-board aircraft show strong multipath propagation. Signal separation performance using conventional beamforming is hampered.
    - More sophisticated beamforming solutions may aid in improving transceiver performance under these challenging propagation conditions.
- For Fokker100 type of aircraft, the attenuation provided by the fuselage varies between 0 and 30 dB, depending on the placement of transmit and receive antennas. Worst case is line-of-sight through the windows, in which case practically no shielding can be assumed.
    - Future aircraft (and modern examples, such as Boeing 787) may have shielded windows, which will likely imply a rough 25 dB extra shielding. This yields opportunities in terms of an increase in the potential transmit power for WAIC transmitters inside the fuselage.
- Isolation between compartments can roughly be subdivided in two categories: once the compartments are within the pressurized area isolation is generally low, while isolation between two compartments such as main landing gear and cabin are considered high.
- Worst-case attenuation between WAIC transmitter in various compartment and the radio altimeter on the same aircraft were measured to be above 50 dB.