A Large Scale FDTD Analysis of Cross Polarization Characteristics for Wireless Link Design of 4.4 GHz-band WAIC Systems inside and outside Aircraft Cabin

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Wireless Avionics Intra-Communication (WAIC), which substitutes for wire harness communicating devices of improving safety performance such as emergency light and barometric pressure sensor has been proposed to reduce aircraft cabin operation cost. Aerospace Vehicle Systems Institute (AVSI) has been offered to use the frequency band from 4.2 GHz to 4.4 GHz for WAIC. In this paper, novel cross-polarization characteristic of RF propagation due to WAIC emitter inside and outside aircraft cabin is discussed. Numerical estimation on three-dimensional electromagnetic fields distribution of huge simulation space which includes an Airbus 320-200 aircraft model is examined using a large-scale FDTD analysis.

Figure 1 shows the numerical aircraft model based on structure and dimensional data of Airbus 320-200 which is the narrow body aircraft. The FDTD space are discretized with 5 mm cubic voxel. By using symmetry boundary condition, we can calculate half region of the problem space. Here, we used a λ/2 dipole antenna excited by sinusoidal waveform at 4.4 GHz as a transmitter of WAIC. The antenna polarization was vertical, and it was installed at 1.0 m above the floor in the aircraft.

As an example, we evaluated electromagnetic fields distribution of the plane passing through the installation height of the transmitter based upon the co-polarized wave component and the triaxial composite component of the fields. From the estimation results, the triaxial composite component of electric field intensity becomes larger at the backward area of the cabin compared to the co-polarized component. The difference is approximately 11 dB at the maximum. This is because the cross polarized wave component could be caused by reflection on the cylindrical shaped metallic surfaces of the aircraft. Thus, the cross-polarization component becomes larger depending upon propagation distance inside the cabin. Also, in the case of outside the cabin, the triaxial composite component of the fields becomes larger compared to the co-polarized component, and the difference is approximately 25 dB. The reason why the cross polarized component becomes larger at outside the cabin than inside is the outside fields mainly caused by RF wave leakage from windows of the aircraft and then added multiple reflected waves from the curve shaped metallic structures such as wings and engines. Newly obtained these results can contribute to design of experimental condition for on-site field measurements using actual aircraft planned in near future.

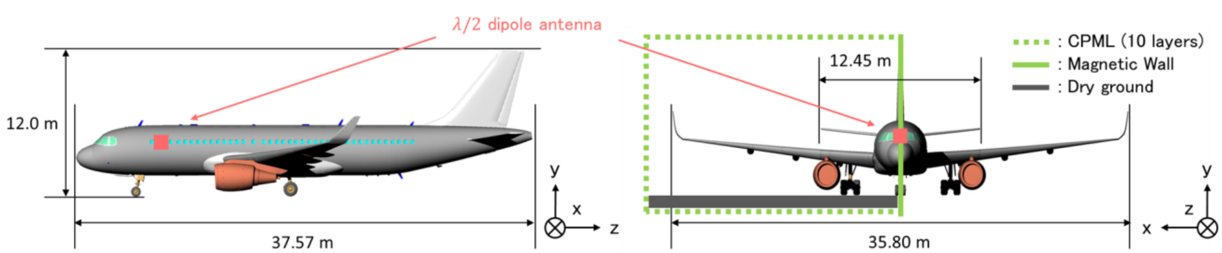

Figure 1. Aircraft cabin model and transmit antenna installation position