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The Center for Education and Research in Information Assurance and Security

Using Digital Twins as a Sandbox for the Evaluation of Cyber Attacks on Avionics Networks

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Problem Statement

- Conventional methods of the evaluation of cyber attacks on avionics networks do not meet the requirements of the ongoing Industry 4.0 (I4.0) revolution
- Digital twins have not been widely used in avionics networks in academia

Research Goals

- To increase the fidelity of the existing prototype of the Digital Twin (Kuleshov et al., 2024)
- To design an Avionics Networks Sandbox using the Digital Twin
- To demonstrate the feasibility and value of the Avionics Networks Sandbox for the emulation and evaluation of cyber attacks and defenses

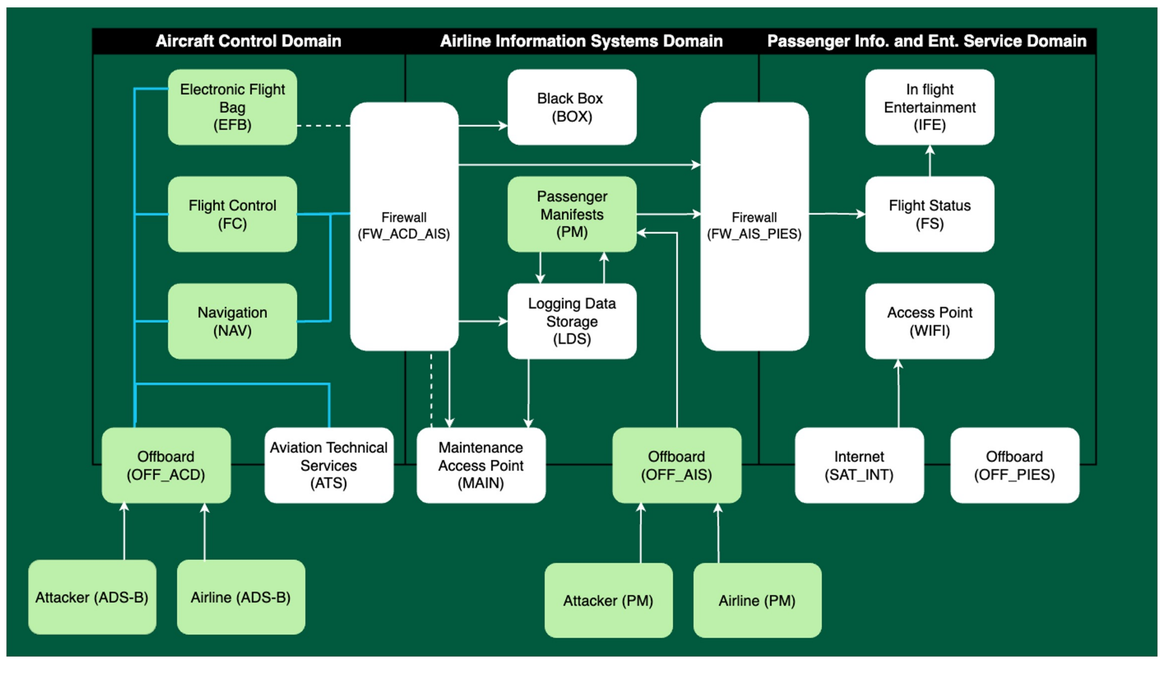
ADS-B ATTACK VECTOR

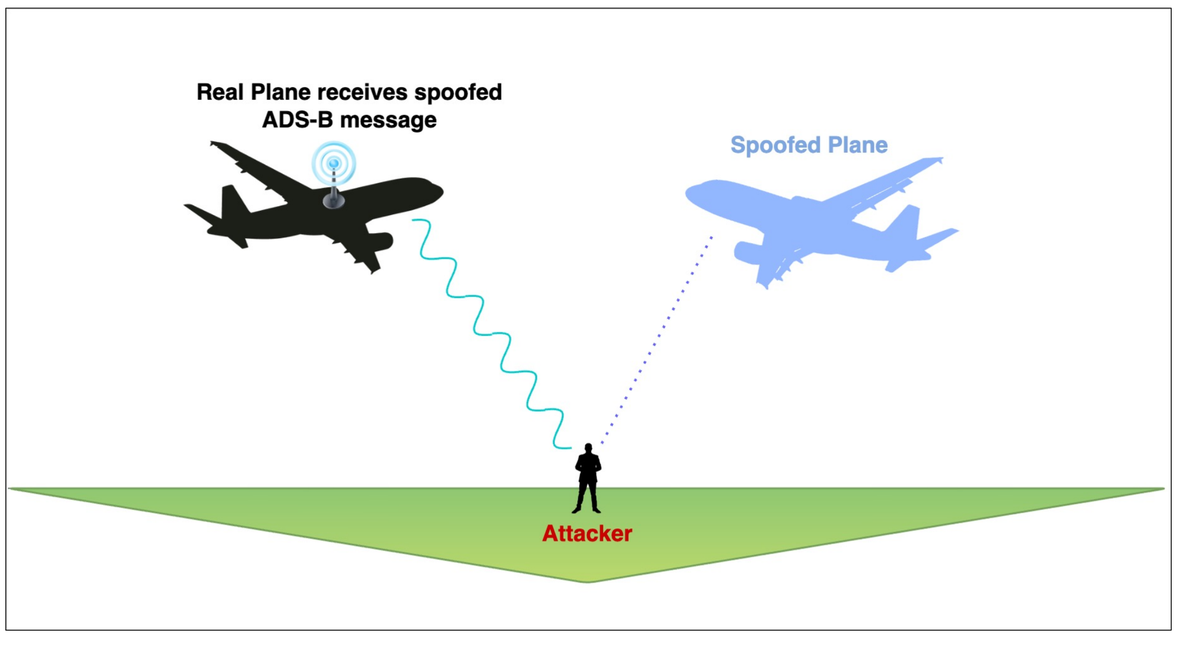
- Currently, the ADS-B lacks protection against spoofing attacks
- A fake message containing relative position data can disrupt aircraft trajectories
- Attack begins with a message being read at the Offboard ACD
- Data is sent to the Navigation system to be decoded and then to the Electronic Flight Bag to be displayed
- Pilot responds based on data displayed when it is read at the Flight Control system

ADS-B DEFENCE

- The distance to the signal origin is calculated using the RSSI
- This value is compared to the distance to the plane as inferred by GPS coordinates from the ADS-B messages
- Divergent values beyond a set threshold indicate a spoofed message

DIGITAL TWIN





IMPLEMENTATION OF MIL-STD 1553 DATA BUS

- Data bus standard in use in military aircraft avionics systems since the early 1970s
- All communication must be initiated by the bus controller
- One data bus system in the ACD: Flight Control acts as the bus controller while other systems act as remote terminals

CHALLENGES & LIMITATIONS

- Documents like ARINC 629, a standard used in aircraft systems, have limited availability to the public. Assumptions and abstractions were made to replicate MIL-STD 1553
- The digital twin uses publicly available repositories of real ADS-B messages for testing, though the repositories do not cover all cases, and do not include spoofed messages
- The plane receiving the ADS-B data follows a generated flight path rather than a publicly available one

Reference

Kuleshov, Y. A., Nagpal, K., Ucpinar, K., Gadaginmath, A., Gadaginmath, S., O'Daniel, K., Sun, D., Tan, L., Veatch, N., & Monangi, H. (2024). Cyber Attacks on Avionics Networks in Digital Twin Environment: Detection and Defense. In *AIAA SciTech 2024 Forum* (p. 0277). American Institute of Aeronautics and Astronautics. https://doi.org/10.2514/6.2024-0277

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