Abstract

In this thesis, we have presented research work focused on the development of a wireless sensor network in avionics to ensure robust communication. We have presented a detailed report on the current state of WSN for intra-aircraft communication, opportunities, and challenges in meeting the performance requirements of complex safety critical applications in the operational life cycle of aviation. We have provided analysis of technologies reported in the literature on stringent performance requirements such as selection of robust network architecture, network protocols, and security algorithms to meet the quality of service parameters. We have presented a two-layered architecture for IAWSN, a pre-emptive queueing model for throughput enhancement for variable data type and variable data rates, and a CDMA based approach to mitigate the throughput challenges due to coexistence of multiple networks like Wi-Fi, Bluetooth in presence of various sources of emission and absorption. We have analysed the threat scenarios and presented a comprehensive security framework for IAWSN with lightweight cryptography algorithms, key generation and key management techniques to ensure optimised throughput and robust security in the given use case scenarios. We have discussed the implementation of all the above research outcomes / solutions in the aircraft environment, performance analysis both on simulation platforms and in the lab environment. We have discussed the revision of security algorithms to meet performance requirements. Performance analysis has confirmed that the results of the simulation and experimental studies are satisfactory. Finally, we have presented the use cases of Aircraft Health Management as an application of the proposed WSN that can be scaled up to WAIC band based on AVSI recommendations and ITU approvals. We have further presented a feasibility analysis of the potential use of the proposed IAWSN architecture for Wireless Power Transfer inside aircraft. We have discussed the future scope of this research on network architecture and protocols, detailed threat evaluation, and enhancement of security algorithms to scale up to the 4.2 GHz WAIC band.