Vulnerability Analysis and Mitigation of MIL-STD-1553 Communication Protocol

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Introduction

MIL-STD-1553 is a widely-used network protocol that was published by the United States Department of Defense in 1975. It was created for military avionics. The protocol is currently being used for many military and civilian applications because of its flexibility and easy adoption.

For many years this protocol has been reasonably secure from attacks because of its physical isolation from the external world. Due to technological advances in connectivity, it has become a priority that operators/pilots can detect and protect the subsystems within an aircraft using MIL-STD-1553.

Objectives

- Learn the history and details of MIL-STD-1553 and explore each part of the protocol, along with its function.
- Use/create a working simulation of the protocol and track the packets being sent to and from the classes in the simulation.
- Investigate potential attacks on the simulator to expose vulnerabilities within the protocol.
- Create ways to detect and protect the protocol using the information found during the attacks.
- Map the protocol and its vulnerabilities to other legacy protocols for future investigations.

Method

Programming Language

Python version 3.9.

IDE

PyCharm

Simulation Code

- The simulation code was acquired from GitHub and was thoroughly analyzed before using. The code was created by Shubhankar Kulkarni.

Related Work

Cybersecurity on Avionics (AIM)

- The company AIM has developed a suite of tools that will help analyze, attack, detect, and remove potential security vulnerabilities. Some security concerns were found considering that the data bus is an interaction of many subsystems.

Exploiting the MIL-STD-1553 (Science Direct)

- The multiplexing and scheduling scheme causes a single point of failure
- Attackers could learn the frame scheduling and execute malicious actions during convenient bus times.

Results

- During research, I have found that there are many vulnerabilities within MIL-STD-1553.
- Several papers I have read indicate that MIL-STD-1553 has little to no defense mechanisms against cyber attacks. Many also suggest that the protocol will have to detect an attack before it can protect it.
- We have found that the messages sent to and from other classes in the simulator are very simple. Which makes it easy for attackers to compromise the system. There is also no authentication measures in place.

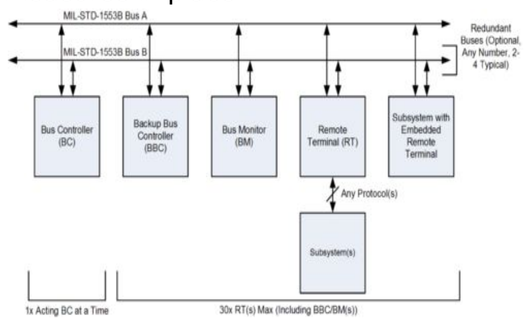
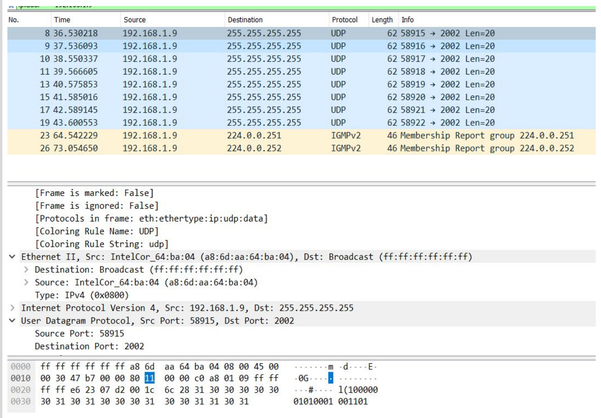


Diagram of MIL-STD-1553



Wireshark tool used to track packets

F-16 Fighting Falcon

Conclusions

In conclusion, there is more to be discovered with this research. I know there are many vulnerabilities within MIL-STD-1553 and once they are exploited, attackers may grab the control of flying objects. With there being no form of authentication methods in the simulator, encryption and decryption methods will have to be put in place. This will cause a delay in the simulator that will have an unknown effect of the protocol. Mitigation strategies must be properly designed and integrated into the system to protect the protocol and our pilots.

References

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