**Project Title: Securing MAVLink Communications for Drone Operations**

**Introduction:**

MAVLink (Micro Air Vehicle Link) is a protocol for communicating with small unmanned vehicles, widely used in the drone industry. This project focuses on enhancing the security of MAVLink communications between a Raspberry Pi and a drone, ensuring that commands sent (such as flight commands) are encrypted and protected against potential cyber attacks.

**Overview:** MAVLink is a lightweight, header-only message marshalling library for micro air vehicles. It's designed as a protocol for communicating with small unmanned vehicles, which is why it's extensively used in the drone community, particularly with flight controllers like Pixhawk.

**How It Works:** MAVLink sends messages in a binary format over serial or UDP (User Datagram Protocol) and is designed to be as bandwidth-efficient as possible, which is essential for real-time control. It defines a set of messages and commands that control vehicle behavior and transmit real-time data about vehicle status.

**Project Goals:**

1. **Understand the MAVLink Protocol:** Study the fundamentals and operational mechanisms of MAVLink to identify potential security vulnerabilities.
2. **Implement Encryption:** Develop and implement an encryption mechanism to secure command transmissions between the Raspberry Pi and the drone.
3. **Evaluate Security Measures:** Test and evaluate the effectiveness of the implemented security measures under various scenarios.

**Week-by-Week Plan:**

**Week 1: Project Orientation and Initial Research**

* **Objective:** Understand the project scope and begin researching MAVLink.
* **Tasks:**
  + Research MAVLink protocol specifications.
  + Compile a list of common vulnerabilities associated with MAVLink.

**Week 2: Deep Dive into MAVLink and Security Threats**

* **Objective:** Gain a deeper understanding of MAVLink and identify specific security threats.
* **Tasks:**
  + Study the MAVLink message structure, command types, and communication flow.
  + Identify and document potential points of attack in the communication process.
  + Start learning about cryptographic techniques suitable for embedded systems and drones.

**Week 3: Designing the Encryption Scheme**

* **Objective:** Design an encryption mechanism tailored for MAVLink commands.
* **Tasks:**
  + Select encryption algorithms suitable for the hardware limitations of Raspberry Pi and drones.
  + Design the encryption and decryption process.
  + Prepare a simulation environment for testing.

**Week 4 and 5: Implementation of Encryption in Simulation**

* **Objective:** Implement the encryption mechanism in a controlled environment.
* **Tasks:**
  + Code the encryption module for the Raspberry Pi.
  + Integrate encryption into the MAVLink communication process.
  + Perform initial tests in simulation to ensure stability and functionality.

**Week 6: Evaluation and Documentation**

* **Objective:** Final evaluation and preparation of project documentation.
* **Tasks:**
  + Finalize testing and refine the encryption module as necessary.
  + Prepare a comprehensive project report detailing the development process, challenges, solutions, and results.
  + Present the project.

**Next step: Real-world Testing and Optimization**

* **Objective:** Test the encryption on actual drone hardware and optimize.
* **Tasks:**
  + Deploy the encryption mechanism on the Raspberry Pi connected to the drone.
  + Conduct field tests to evaluate the effectiveness of encryption.
  + Optimize the system based on test results and performance feedback.

**Possible Applications:**

* **Military Drones:** Secure communications for military drones operating in hostile environments.
* **Commercial Delivery Drones:** Protection of flight paths and payloads in commercial drone delivery services.
* **Environmental Monitoring:** Ensuring the integrity of data collected from drones used in environmental monitoring.

**Suggested Readings and Resources:**

1. **MAVLink Developer Guide** - Detailed documentation and guidelines provided by the official MAVLink organization.

https://mavlink.io/en/

1. **"Practical Cryptography for Developers"** by Svetlin Nakov - A guide to implementing encryption effectively, with examples suitable for embedded systems.

https://github.com/nakov/Practical-Cryptography-for-Developers-Book/tree/master

1. **Research papers on securing UAV communications** - Explore current academic research focusing on drone communication security.
2. **Simulation:**

Pymavlink:

<https://www.youtube.com/watch?v=kecnaxlUiTY&list=PLy9nLDKxDN68cwdt5EznyAul6R8mUSNou>

<https://mavlink.io/en/mavgen_python/>