Component Selection

1. Sipeed Maixduino RISC V Microcontroller board-

The Sipeed Maixduino RISC-V Kit is an excellent choice for your Edge AI-powered surveillance project due to its specialized features and capabilities, which align well with the objectives of the proposed real-time threat detection and response system:

- **RISC-V Architecture for Efficient AI Processing:**
  i) **Open-Source and Customizable Architecture:**
  RISC-V is an open-source instruction set architecture (ISA), meaning developers can customize it for specific applications like AI. The Maixduino's K210 processor running at 400 MHz, based on RISC-V, includes custom extensions optimized for machine learning tasks. This makes it highly efficient for running AI models, such as TensorFlow Lite, on a microcontroller without unnecessary overhead.
  ii) **Low Power Consumption**:
  RISC-V processors are known for their energy efficiency. The lightweight nature of the instruction set allows for simpler designs, reducing the power required to execute tasks.
  iii) **Parallel Processing Capabilities**
  RISC-V allows for parallel processing, which is essential for handling AI workloads efficiently. The dual-core design in the K210 processor enables it to handle multiple tasks simultaneously—such as processing camera input, running AI inference, and handling data transmission via LoRa and Wi-Fi—without overwhelming the system.
- **Integrated Camera Support and LCD support**:
  The board contains 24P 0.5mm FPC connector allowing us to easily integrate camera modules to monitor live video feed for weapon detection. Similar 24P 0.5mm FPC connector is present for supporting LCD interfacing using SPI.
- **TensorFlow Lite Compatibility**:
  It supports TensorFlow Lite, allowing us to deploy lightweight deep learning models for weapon detection on the microcontroller itself. This enables efficient real-time inference on the device.
- **Integrated Wi-Fi and Bluetooth:**
  The Maixduino supports Wi-Fi (2.4 GHz, 802.11 b/g/n) and Bluetooth 4.2, enabling wireless communication for data transmission and remote access. This is crucial for connecting surveillance nodes to central systems or cloud platforms without the need for physical cables, enhancing deployment flexibility in different environments. Wi-Fi allows utilization of MQTT protocol to connect to a remote Node-RED dashboard.
- **SPI and UART Functionality** :

The LoRa SX1278 module communicates using SPI, enabling long-range, low-power communication between devices. The Maixduino's SPI interface allows seamless integration of the LoRa module for transmitting threat data from edge devices to a central gateway or cloud-based platform. The SPI interface also enables the use of an SD card for local data storage. This allows the system to retrieve the threat detection model stored on SD card, allowing creation and dynamic linking of modular micropython files. Also the UART interface allows for easy debugging of code and real-time monitoring of the system's operation.
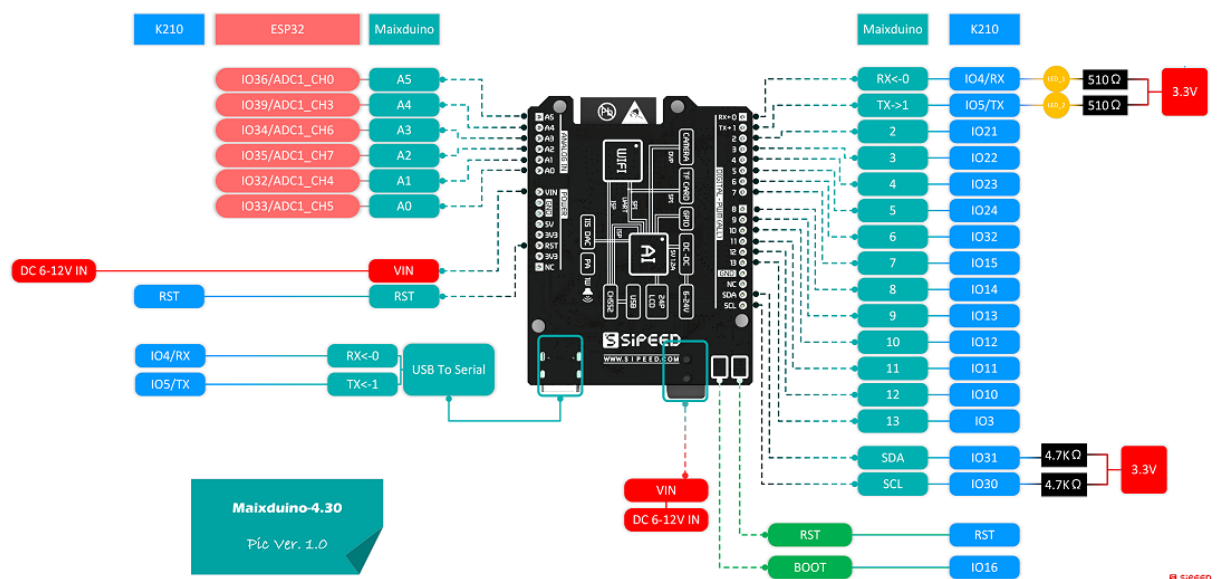
2. LoRa SX1278 XL-

The LoRa SX1278 module despite being the cheapest LoRa module perfectly fits for the project due to its robust features, high compatibility and capabilities that align with the project goals.

- **Long-Range Communication:**
  The SX1278 operates using LoRa (Long Range) modulation, enabling reliable communication over several kilometres (up to 8-10km in open environments). This is crucial for a distributed surveillance system where edge nodes (like cameras and sensors) might be deployed far from the central control system.

- **Robust and Secure Data Transmission:**
  The LoRa SX1278 offers secure and interference-resistant data transmission. It uses spread spectrum technology, which provides better immunity to interference, noise, and multipath fading.

- **Supports Point-to-Multipoint Communication:**
  The SX1278 allows for point-to-multipoint communication, which is especially advantageous in this project, where multiple edge nodes (such as cameras and sensors) need to transmit data to a number of mobile devices carried by policemen.

- **License-Free ISM Band Operation:**
  The SX1278 operates in the license-free ISM band (typically 433 MHz or 915 MHz), which makes it cost-effective for deployment.
- **High Sensitivity and Penetration:**
  With a high sensitivity of -148 dBm and +20 dBm power amplifier, the SX1278 can send and detect weak signals among distant nodes, ensuring reliable communication even in challenging conditions (e.g., behind walls, in basements, or across large areas).
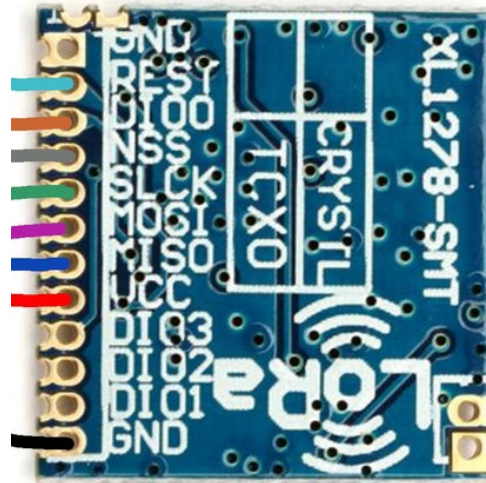
3. Micro-SDXC 128GB

- **High Storage Capacity:**
  With 128GB of storage, the Micro-SDXC card can hold a significant amount of data, including high-resolution images and video footage if needed in future. This allows large size modular micropython code files which would be dynamically linked upon program execution.
- **Compatibility:**
  Micro-SDXC cards are compatible with a wide range of devices, including cameras, drones, and microcontroller boards.
- **Low Power Consumption:**
  Micro-SDXC cards consume relatively low power compared to traditional storage solutions.
- **Durability and Reliability:**
  Many Micro-SDXC cards are designed to be shockproof, temperature-proof, waterproof, and X-ray-proof. **:** In a surveillance environment, the card must withstand varying conditions, such as outdoor usage or exposure to potential physical impacts

4. Arduino Uno for Gateway Node-

- **Microcontroller Capability:**

  The Arduino Uno is equipped with a microcontroller (ATmega328P) that can handle basic processing tasks and control operations in your surveillance system. These operations may include retrieving Node-ID and location of the threat detecting sensor node.

- **LoRa Integration:**

  Readily available LoRa libraries could be used enable long-range, low-power communication between devices, which is crucial for remote surveillance applications.

- **Cost-Effective Solution:**

  Costing at just ₹ 200 the Arduino Uno is an affordable microcontroller platform, making it accessible for cheap monitoring solution when equipped with LoRa. This allows creation of a great monitoring device which could be utilized in developing mobile solutions for police and defence personnel.