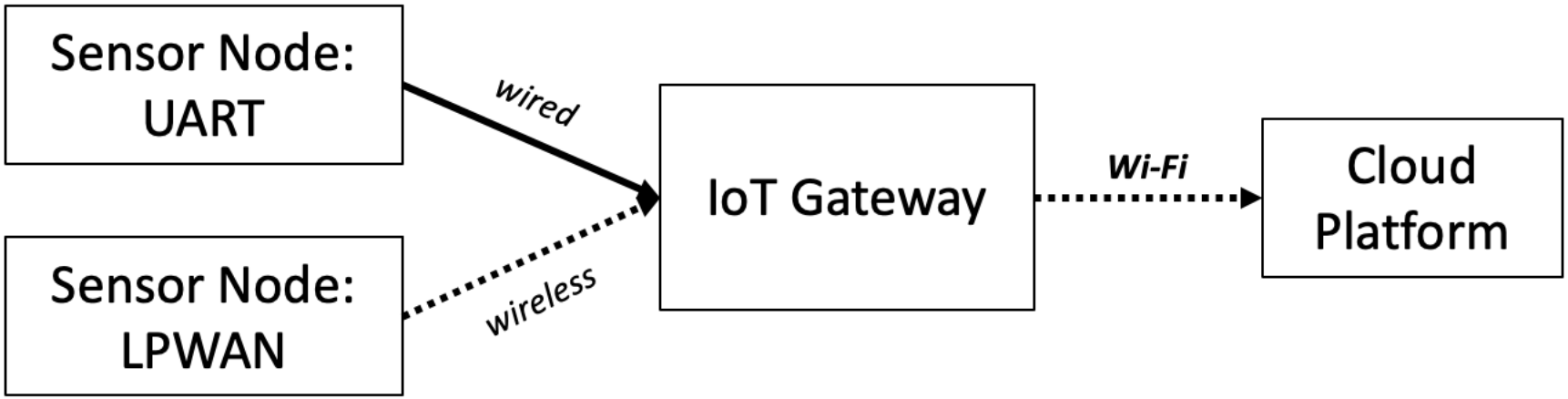
System Architecture



Sensor Nodes to Gateway

Set Up

Sensor Nodes: Arduino UNO (sensor nodes will be identified with numbers i.e., sensor node ID)
Gateway: Raspberry Pi

Communication Protocol

- Transferring of data will be done wirelessly and wired.
    - Wired: UART
    - Wireless: LPWAN
        - NB-IoT if low latency required and budget permits
        - LoRa if low latency is not required

Hardware

- Nodes connected via UART: Connect wires from Arduino UNO's TXD and RXD pins to Raspberry Pi's UART pins with a logic level converter

Figure 1 - Raspberry Pi UART Pins

- Nodes using LPWAN: Attach selected shields/hats onto Arduino UNOs and Raspberry Pi

Software: Receiving & Processing Data from Sensor Node

Format

Packet format:

- New packet starts with sensor node ID and '#'
- End packet with '\n'
- Each sensor value separated by ','

Receive sensor data as string as parse based on specified format.
All values will be stored as floats.
Drop packet if does not match required format (count the number of packets dropped).

Receiving & Processing

Data will be sent to cloud first before reading new packet from buffer.

Algorithm

Reading, processing and sending will be implemented in an infinite loop.
Starting algorithm: Alternate reading of serial buffer and buffer from LPWAN receivers (i.e., interleaving of packets).
Algorithm will need to be adapted with different ratios should there be more data being received via certain connections. For example, for every 2 packets read from UART connections, read 1 packet from wireless connections.

Machine learning algorithm should be implemented by predicting what ratio of reading should be done, based on the amount of data in the serial and LPWAN buffers.

Gateway to Cloud

Set Up

Cloud Platform: AWS/Azure

Software: Sending Data to Cloud

Readings are sent to cloud once processed.
Sensor readings and the sensor ID it belongs to will be formatted into the required format based on cloud platform. General packet format will be as follows:

Sensor ID	Sensor Readings

Timer

Start timer whenever program boots up and send health statistical data to the cloud every 10 minutes. Health data should include number of packets being dropped in that time period in case too much data is being corrupted and lost.
Implementation: At the end of each loop, check if timer is equal to 10 minutes. Send to cloud if equal.

Component Selection

LPWAN

LoRa	No need telecom provider	Cheaper	Higher latency	Less power intensive
NB-IoT	Need telecom provider	More expensive	Lower latency	More power intensive

Project Plan & Timeline

Wired: Set up wiring from sensor nodes to gateway.
Wireless: Attach hat/shields to sensor nodes and gateway.

Write script that receives from sensor nodes.

Implement algorithm to do packet interleaving from sensor nodes & analyse if algorithm is sufficient in fairly receiving from all sensor nodes.

Iteration of testing and analysing different ratios/algorithms to determine which allows for most fair implementation.

Write script that sends data from gateway to cloud.

Implement processing of data: parse data from sensor node and put in required format for cloud platform.

Integrate code that sends data to cloud platform and code that receives from sensor nodes.