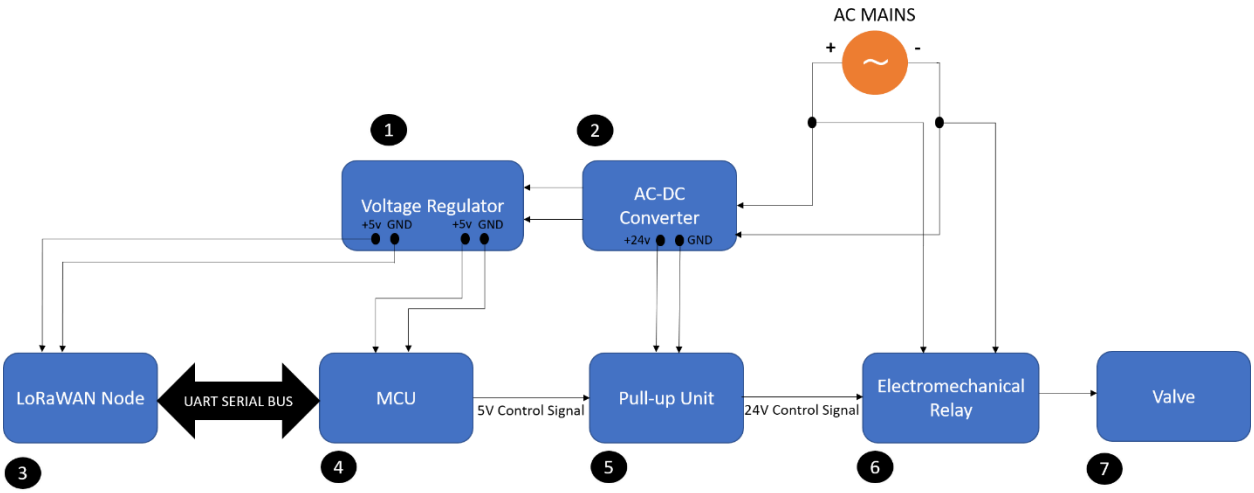
SYSTEM OVERVIEW



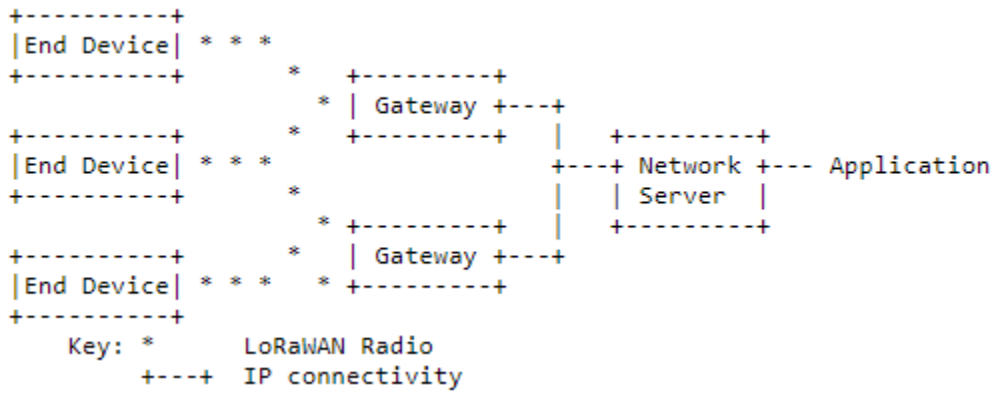
The final deployment system would be a custom designed PCB having the capability of leveraging a dedicated LoRa wireless link for downlink and uplink communication for enabling the end user to control the operation of valves remotely thereby overcoming the problem of laying down control signal cable network for the same. The system proposed used a cost effective LoRa enabled IoT node that is effectively a transceiver device capable of receiving and transmitting wireless packets for controlling and monitoring purpose. The LoRa node is connected to a Microcontroller unit (MCU) with i/o capability that shall output a control signal based on the reception of an ON/OFF signal by the LoRa from the remote-control station. The LoRa node shall be connected to MCU through a serial UART bus and the exchange of baseband data shall be undertaken through the bus. A pull up circuit with optocoupler isolation shall be used for converting the voltage level from 5V to 24V dc and the same shall be provided to the Electromechanical relay for switching/controlling the valve. For powering up the devices and for voltage pull up an AC-DC converter shall be used that shall convert the AC mains to 24V and the 24V shall be routed to the Voltage regulator and the pull-up unit for deriving a 5V supply and providing the bias voltage respectively.

Bill of Material

1. Voltage regulator: Infineon's TLS850C2TEV50
2. AC-DC converter: VER24US240-JA
3. LoRa Node: TarangMini SM20LR03
4. MCU: STM32F103C8T6
5. Pull up Unit: Custom designed with PC817XxNSZ1B series optocoupler
6. Electromechanical relay: Phoenix Contact 2942111

7. Valve : from Inoviea
8. IP67 housing (dimension and material to be provided later)
9. LoRaWAN Gateway: Advantech WISE-6610

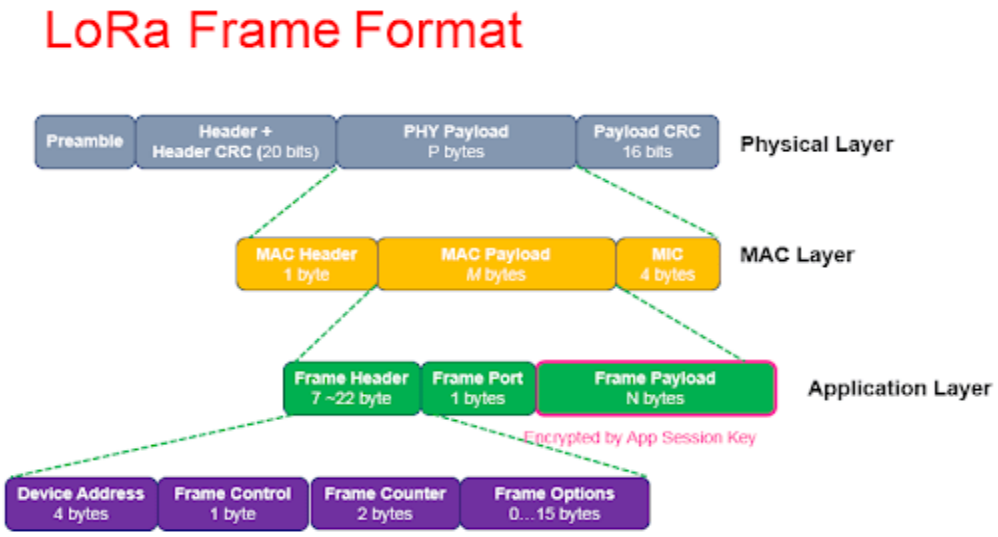
LoRaWAN General Network Overview



LoRaWAN networks are typically organized in a star-of-stars topology in which Gateways relay messages between end devices (you can consider them to be sensors and actuators connected to the Gateway) and a central "network server" in the backend. Gateways are connected to the network server via **IP links** while end devices use single-hop LoRaWAN communication that can be received at one or more Gateways. Communication is generally bidirectional;

uplink communication --end devices to the network server
downlink communication—- network server to end devices

LoRaWAN packet structure



In our scenario, for most operational purposes we shall keep the payloads at their default state wherein we shall change the PHY data payload which shall essentially consist of two messages

ON: 11110000
OFF: 00001111

The PHY Payload shall be 1 byte long and the requirement of any other data to be included in the Payload shall be investigated at the time of the development. Altogether excluding the packet overhead there shall be 41 bytes of data free in the payload to be sent and received.

Development Environment

Open-source C++/embedded C shall be used for LoRa node and MCU programming. Python shall be used for any algorithmic development and for integration with webservice platforms. Nodejs shall be used for a web-based User Interface. The device shall be programmed for a standalone mode and firmware upgradation shall be done in a bi-yearly basis. A local/cloud database shall be designed for storing the data and report generation shall be configured on an auto-generated/manual mode.

The User Interface

- Control Buttons for switching valves
- Status of the valves (to be discussed)
- GPS coordinate of the valves (have to check on the GIS compatibility with LoRa nodes)

Feedback System Discussion

For getting status of the valves, a flow meter can be used. However, the usage of the flowmeter has to be investigated as it need to be installed in the pipeline and hence does not follow the retrofitting approach. It also shall add up to the cost which might increase the CAPEX and OPEX of the project. Secondly, there are certain valves that gives a digital high or low on ON/OFF condition and the valve currently in use need to be checked for the same. Whatever the feedback be, the same need to be provided in the analog input/DIO of the MCU module. The LoRa module has a dedicated uplink for it to transmit data from the edge (remote location) to the gateway.