Name: Yang Hao Mao

CP: 10705881

Q11: You opt to use LoRa, using an open-source gateway close by (e.g., provided by the Things Network). However, your transmission are not successfull. What are the possible causes, and what kind of solutions could be adopted?

R:----------

Main possible issues:

Signal interference: LoRa can operate in unauthorized spectrum, so other wireless devices or electromagnetic interference may affect the transmission of LoRa signals, this interference may come from other devices in the same frequency band or from external electromagnetic sources.

Distance or obstacles: LoRa's long range characteristics allow it to penetrate obstacles, but if the distance is too far or there are many obstacles in the way, the signal strength may be reduced, resulting in transmission failure LoRa is a low-power, long-distance transmission technology.
(*Solution*: Optimize the layout and location of LoRa devices, try to use LoRa in wide, less obstructed areas, and ensure that the distance between the device and the gateway is within the range of reliable communication)

Data encryption and authentication: LoRa operating in unauthorized spectrum without proper encryption and authentication mechanisms may be vulnerable to malicious attacks or data theft. Lack of encryption may lead to data leakage loss.
(*Solution:* Use secure encryption algorithms like AES algorithm; strengthen key management, regularly update, and rotate keys to enhance system security; choose reliable spectrum for operation)

Aloha collision: the Media Access Control protocol used by LoRa for communication is similar to Aloha, i.e., there is no coordination mechanism before sending data, and thus it may lead to collision, i.e., multiple devices send data at the same time, resulting in data loss.
(*Solution*: Try to use it in places with low device density to avoid the collision rate of Aloha, or introduce collision detection and retransmission mechanisms, e.g., using the CSMA/CA protocol, which detects if the channel is free before sending data, to reduce the occurrence of collisions)

Data Loss: At low transmission rates, data packets are continuously sent for a longer period of time, thus requiring higher signal quality. If the signal strength is insufficient or interfered, the receiver may not be able to decode the packet correctly, resulting in loss of data.
(*Solution*: use Forward Error Correction codes, by introducing FEC codes at the sending end, the redundancy of packets can be increased, thus improving the receiving end's ability to correct packet errors and reducing data loss; add retransmission mechanism: in the event of a packet loss, the sending end can re-send the lost packet through the retransmission mechanism to ensure that the receiving end successfully receives the data)

Other possible issues:

- Network congestion: If there are many devices or data traffic on the network, it may lead to LoRa network congestion, which may affect the communication quality.
- Weather conditions: Adverse weather conditions such as thunderstorms, heavy rain, etc. may affect the

transmission quality of LoRa signals.

- Power problems: unstable or insufficient power supply may cause LoRa devices to fail to work properly, thus affecting communication.