CS-475 Checksum via LoRa 32

By: Kacey La & Jonas Ling

Objective

- Using two LoRa 32 devices we will do checksum by sending message packets between the two devices using the LoRa protocols(LPWAN)
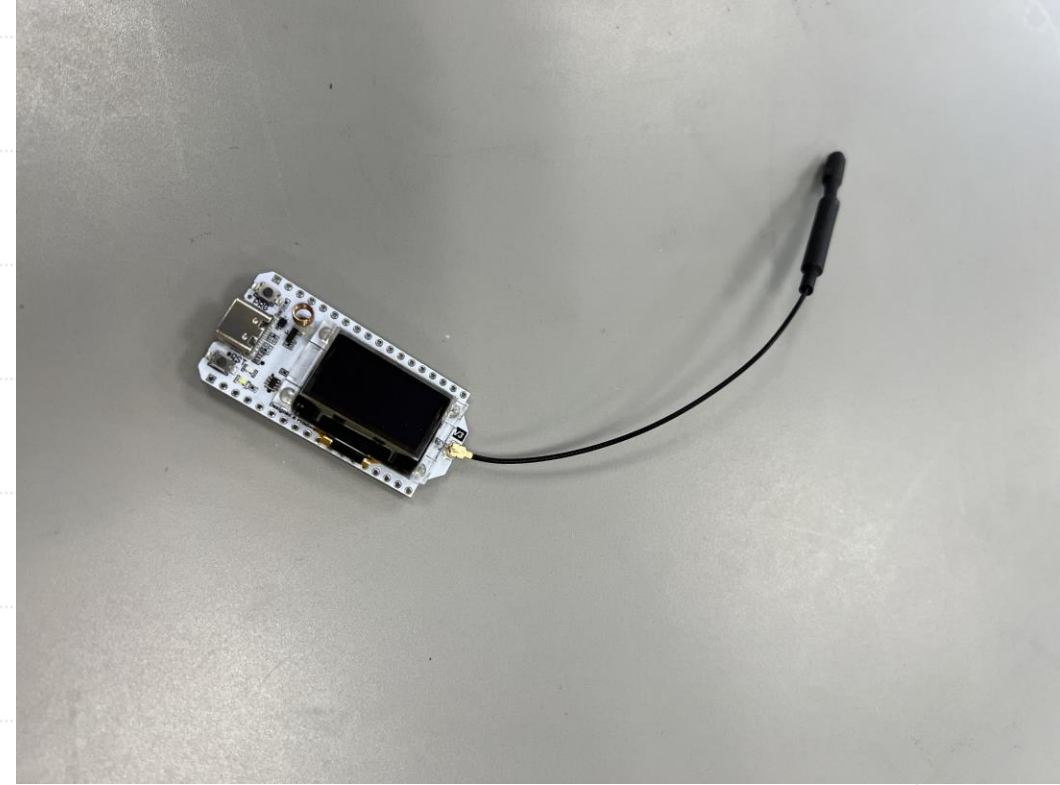
Background (LoRa 32)

- This modulation technique allows for long-range wireless communication using low power.
- LoRa 32 can talk to each other using RF (Radio Frequency) which is point-to-point/LPWAN tech, or simply use to build a network using LoRaWan (Low Power Wide Area Network) which allows for sending and receiving data between IoT devices or gateways.
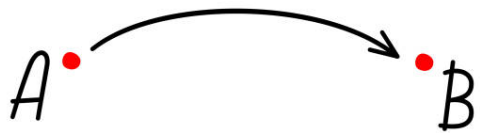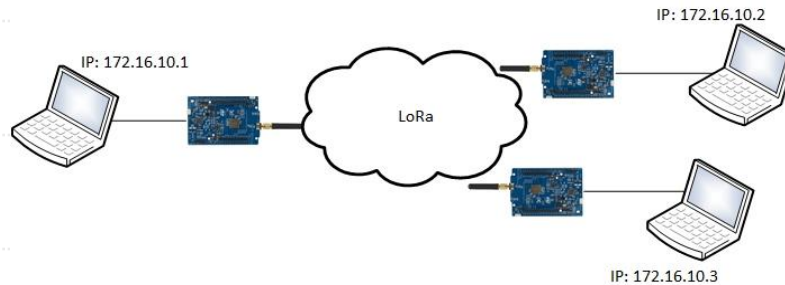
(Heltec LoRa 32 (V3))

A development board that uses radio modulation technique generated by Semtech LoRa transceiver chips

Point-to-Point

IP: 172.16.10.1
IP: 172.16.10.2
LoRa
IP: 172.16.10.3

LoRaWan Network

Background (Checksum)

An error detection method that is used to prevent corrupted data from entering to protect data integrity.

How it works: Sender gives checksum value to the data which then gets transmitted together to receiver. The Receiver then calculates the value too and compares it to the value that got sent over and if it doesn't match then an error.

-Checksum algorithms often use parity bits(even or odd), CRC (cyclic redundancy checks) or Hash functions (map data to fixed values)
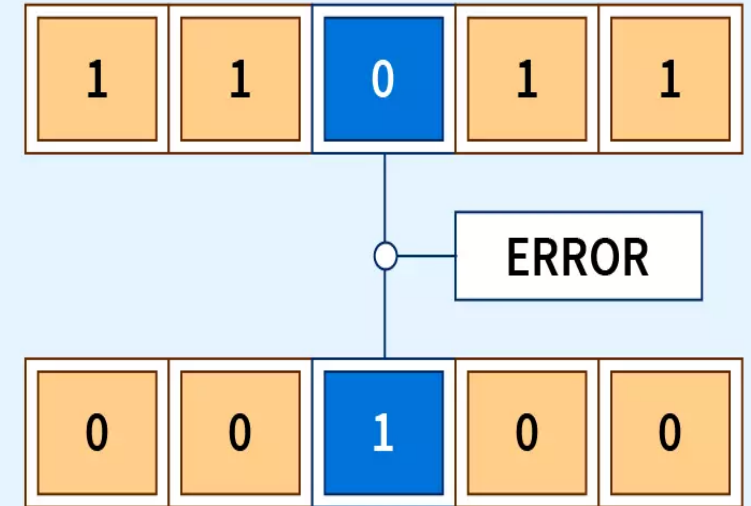
(Checksum)

Difficulties

- Getting the LoRa radios to work properly with code upload.
  - Equipment: We didn't realize that you needed to connect the LoRas to our laptop with a USB cable when trying to upload code with the Arduino IDE.
    - Installed the drivers from https://www.silabs.com/developers/usb-to-uart-bridge-vcp-drivers?tab=downloads allowed the USB ports to work.
    - Installed the LoRa Library by Sandeep Mistry was the library, which was compatible with our LoRas.
  - There were many different ports and libraries for LoRa, but those were for specifically V2 versions. We had the V3 version, which was not backwards compatible with the V2 libraries.
  - "*Hard resetting* via *RTS pin*..."
    - This message always appeared in our output console and was always stuck.
    - Turns out, everything the LoRa printed was outputted to the Serial Monitor and you needed to set the baud rate to 115200.
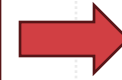
Progression

Creation of Final Project Idea, and reading up on LoRa tech & Arduino

Install Arduino and set up LoRa 32 board & port library and drivers.

Using Heltec Automation Ping Pong communication test example to understand how LoRa Programming works!

Understanding how LoRa Programming works. Created a skeleton code that implements LoRaWAN protocol. Test send a message back and forth.
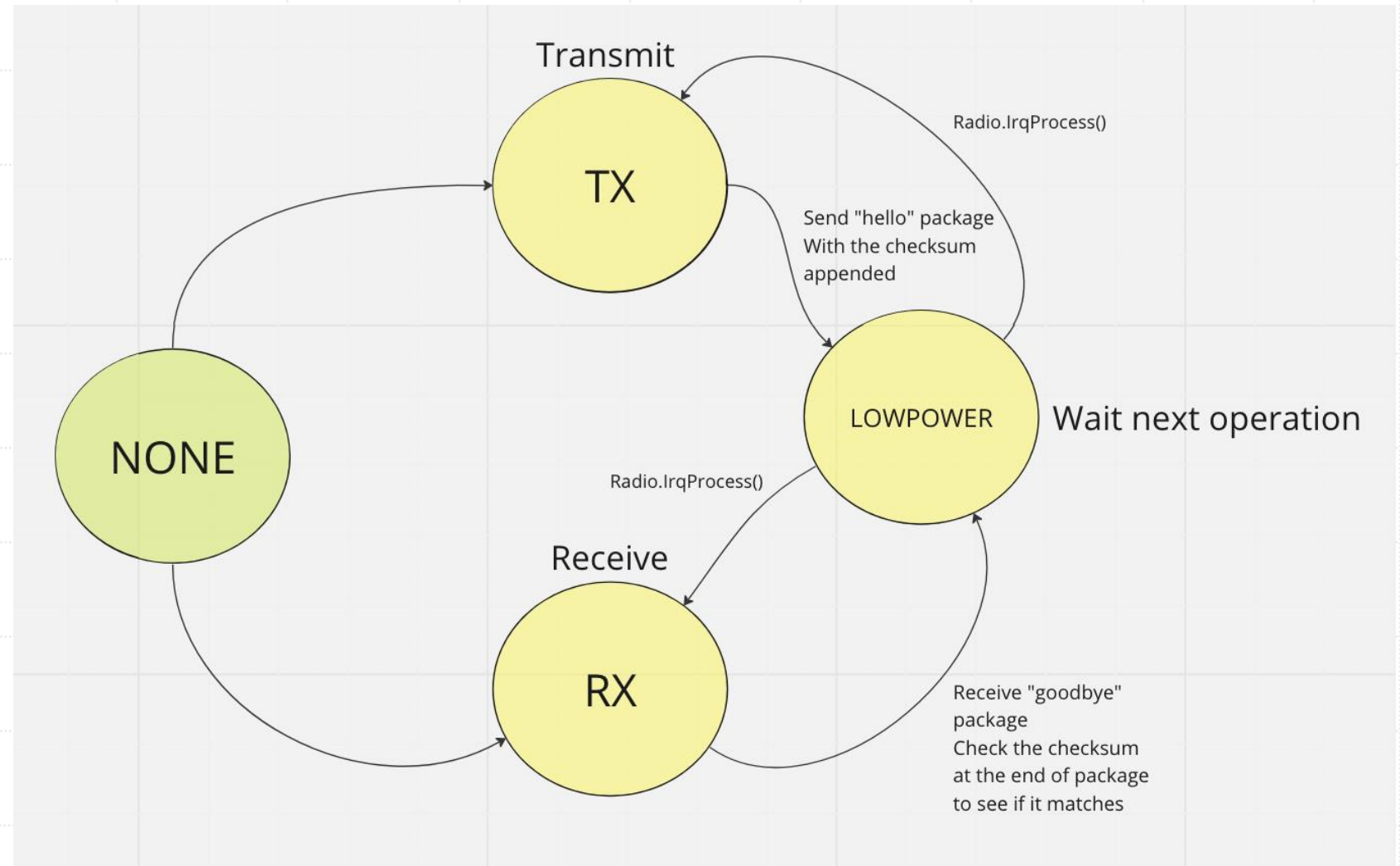
Realized that it worked. Built upon that skeleton code by adding on XOR checksum. Tested it by send packets with sequences + checksum every 5 seconds to see if checksum passes

Final test on code to ensure XOR checksum works + protocol works, and lastly cleaning up the code and documentation.

State Machine

Algorithm of calculated checksum

Given a packet, let the checksum = 0

```
int16_t xo = 0;
```

For each character in the packet, XOR each character with the checksum

```
for (uint16_t i = 0; i < size; i++) { xo = xo ^ (int) packet[i]; } return xo; }
```

The result is appended to the end of the packet message.

```
sprintf(txpacket,"hello-%d.%d",txNumber, checksum);
```

Code Demo Result!

Hello Sender

```
Calculated checksum: 6
Package checksum: 6
Checksums are equal!

sending packet "hello-2.21" , length 10
TX done......into RX mode

received packet "goodbye-2.5" with Rssi -35, length 11
Calculated checksum: 5
Package checksum: 5
Checksums are equal!

sending packet "hello-3.20" , length 10
TX done......into RX mode
```

Goodbye Sender

```
received packet "hello-1.22" with Rssi -40, length 10
Calculated checksum: 22
Package checksum: 22
Checksums are equal!

sending packet "goodbye-2.5" , length 11
TX done......into RX mode
```

Conclusion

- We learned what and how LPWAN, LoRa 32 works.

- Proved and showcased point-to-point communication between the two devices using LPWAN protocol.

- Showed XOR checksum error detection was viable using the devices.

- Uploading the code to the LoRa 32 with the packet message (hello) for one and the other device (Goodbye) will ping-pong back and forth with the checksum succeeding.

- (Manual error check) Can be done by XORing each bit in the character.

Source Code

- https://github.com/ItsJonasL/LoraTest

Acknowledgement

- **Images (listed are the sites that house the image)**

- https://www.cyber.airbus.com/ip2lora-a-diverted-use-of-lora-to-build-your-wireless-ip-link-over-kilometers/

- https://www.istockphoto.com/vector/the-route-from-point-a-to-point-b-line-with-arrow-tip-from-a-to-b-solution-problem-gm1355106123-429680513

- https://www.scaler.com/topics/computer-network/checksum/\

- **References + (library & drivers)**

- https://raw.githubusercontent.com/Heltec-Aaron-Lee/WiFi_Kit_series/master/esp32/libraries/Heltec-Example/examples/LoRaBasic/pingpong/pingpong.ino

- https://www.silabs.com/developers/usb-to-uart-bridge-vcp-drivers?tab=download

- https://dl.espressif.com/dl/package_esp32_index.json

- *Cryptography hash functions*. Tutorials Point. (n.d.). Retrieved May 5, 2023, from https://www.tutorialspoint.com/cryptography/cryptography_hash_functions.htm

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