Investigating LoRa for use in a Cattle Tracking and Monitoring System

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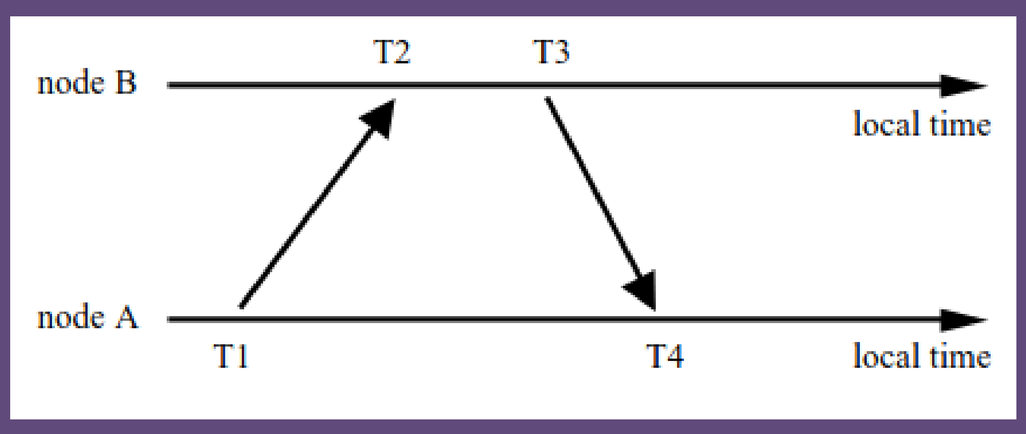
Introduction and Background

- This project Aims to develop a Cattle Tracking and monitoring system based on LoRa technology.
- Preventing cattle theft or loss is the main objective, however acquiring sensory data is also a target.
- Sensor tracking is achieved by localization, which is a method of calculating the physical location of sensors.
- The method of use in this project is Time of Arrival, which as a result requires accurate timing.
- Sensor clocks therefore need to be synchronized, have minimal error and minimal clock drift.
- Due to limitations, the main focus of this project was to obtain the accurate timings that could be used to implement a full system.

Methodology

- Sensor clocks were set up, and clock drift was attempted to be mitigated.
- A timing Synchronization protocol was implemented in order to synchronize the two clocks.

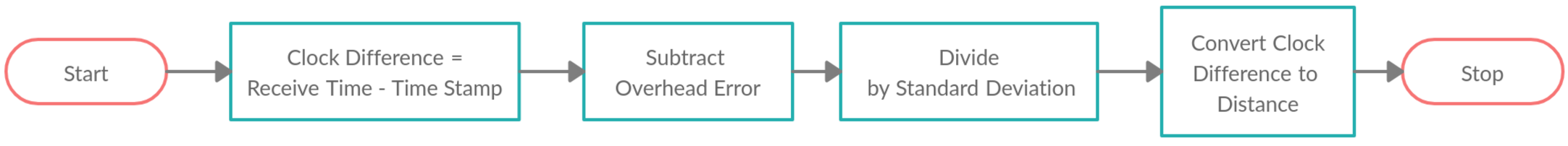


Timing Synch Protocol for Sensor Networks [1]

- Calculating clock Offsets and errors in message sending:

$$\text{Clock Offset} = \frac{(T2 - T1) - (T4 - T3)}{2} \qquad Message\ Errors = \frac{(T2 - T1) + (T4 - T3)}{2}$$

- Distance between sensor nodes were calculated using time of flight and speed of light.
- After synchronizing the sensor clocks, time of flight is found by the difference in clock times. That is, difference between transmitted time and received time.
- Sensor clocks contain uncertainties and so they need to be mitigated with. Uncertainties stem from varying lengths of clock cycles to complete operations.
- The method of obtaining distance is shown below:



Results

- After synchronization, clocks achieved accuracy of 1.57ms.
- After statistical analysis, the system was narrowed to show changes if there is a clock difference of 95µs.
- Maximum accuracy achieved, due to microcontroller chosen, is 37.5m.
- Distance measurement results are shown:

Conclusion

- Due to the limitations of hardware chosen, the theoretical accuracy was 37.5m.
- In experimentation, the clocks offered a variation in ticks which made the achieved accuracy vary by a few thousand meters, which needed to be dealt with.
- The resulting distance measurement varies too wildly, which is not desirable. A microcontroller with higher clock speed is required.

Technology Used

LoRa™

Adafruit Feather 32u4

Reference

[1] S. Ganeriwal, R. Kumar, and M. B. Srivastava, "Timing-sync protocol for sensor networks," The First ACM Conference on Embedded Networked Sensor Systems (SenSys), pp. 138–139, 2004.