Industrial Application of Time Sensitive Networking

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Industrial System Overview

A rope is fixed between two industrial motors. When spinning at the right speeds the rope can form nodes, like a jump rope.

Motors that don't talk to each other lose sync and lose nodes. Could communicate over IP, but need TSN to guarantee communication and share a clock.
To add TSN, add control nodes (xMOS boards)
Control nodes bridge network communication to motor control. Add in control node with common industrial control algorithm for sync,, commands and feedback guaranteed communications with shared clock!

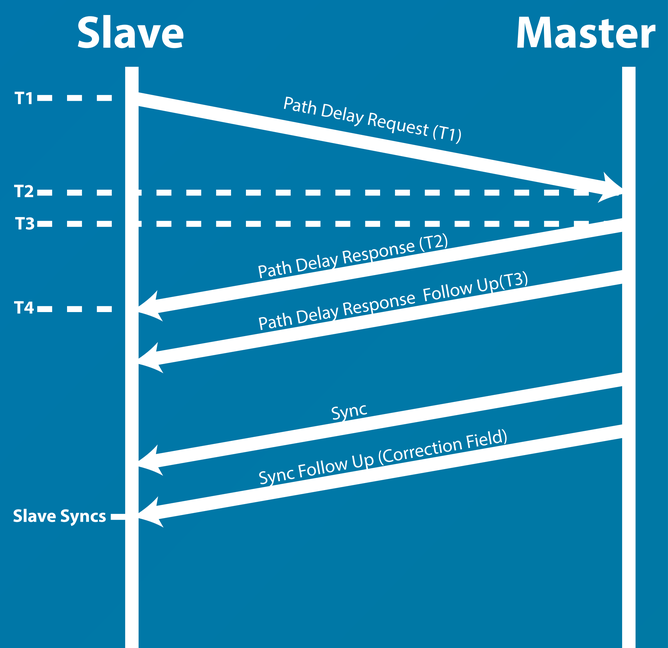
BACKGROUND

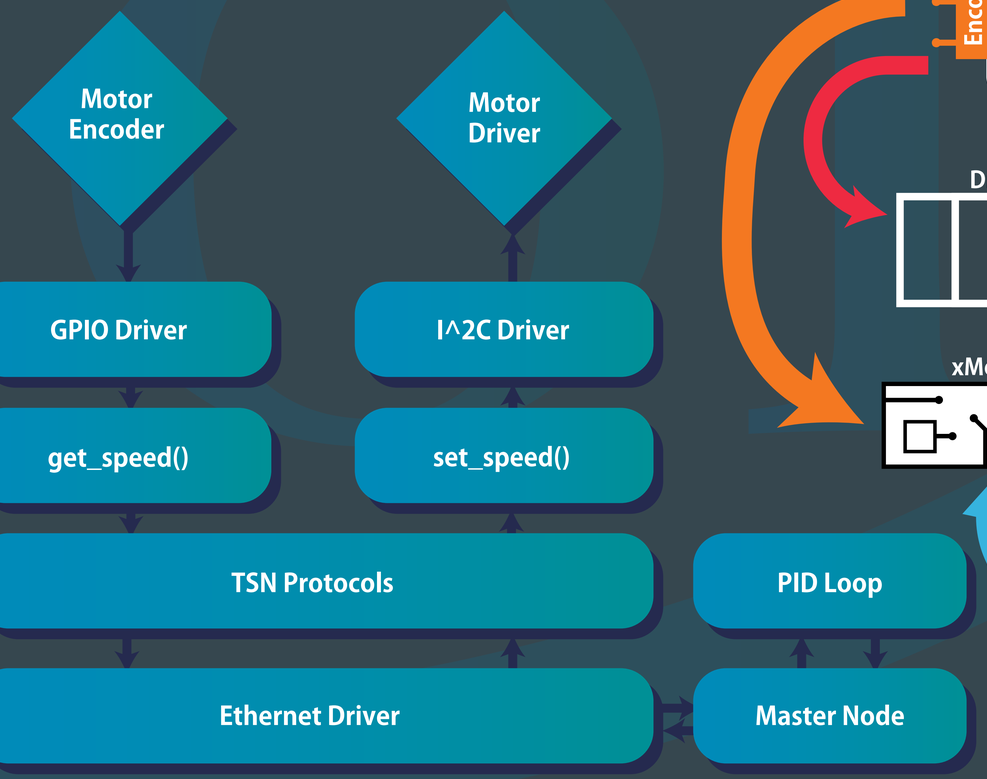
Regular computer networks can slow down unexpectedly, and this can cause issues for time sensitive applications. Time sensitive networking protocols serve to provide guaranteed throughput and latency over a regular Ethernet network, eliminating this problem.
An existing application of TSN can be found in the audio / visual industry. It is very important that the speakers at opposite ends of a concert hall play the correct sounds at the correct time. Even slight delays in the signal can reduce sound quality significantly. This project is a proof of concept application of existing TSN protocols to an industrial system, where sensor data must be communicated and reacted to in real time.

Software Overview

- Embedded Application
  - Written in XC
    - Functional C derivative
    - Hardware integration
  - Controllers
    - Communication with motors and master node
    - Synchronizes to grandmaster clock
  - Master Node
    - Reads data and calculates adjustments
    - Grandmaster clock

Timing Diagram



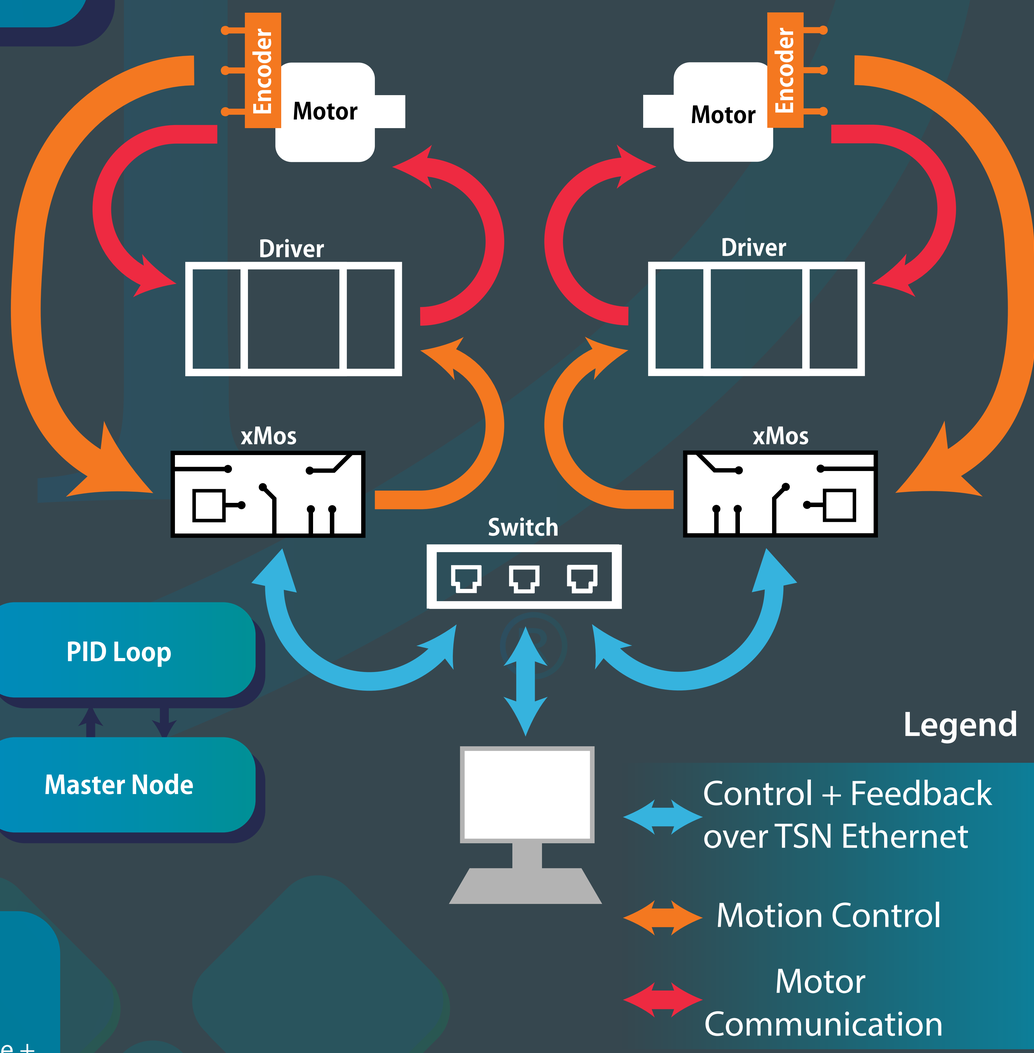


GPTP

Mean Propagation Delay = ((T2 - T1) - (T4 -T3))/2
- Used to find the amount of time a message takes to travel through the medium

Correction Field = PropDelay + ResidenceTime + TransmissionTime + Prior CorrectionField
- Used to help sync the time between the two different clocks

TimeSync = OriginTimeStamp + PropDelay + CorrectionField + transmissionTime



Conclusions

In conclusion, TSN protocols provide an efficient way for industrial systems to communicate. Our proof of concept application has shown that a physical system can relay and react to information quickly using a just partial TSN. In the future to build upon this project MSRP can be added in order to get full TSN functionality working.

Results

- We developed a set of embedded applications that use TSN protocols to manage an industrial system.
- Serves as a demonstration of TSN
- An example / starting point for "real" applications
- Can be extended in the future with additional TSN protocols
- You can learn more about TSN from the Avnu Alliance. This is the group that drafts the standards and develops open source implementations.

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