UPDATES ON PRECISION TIME PROTOCOL IMPLEMENTATION IN ARA

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MAIN PHYSICS GOALS

- Clock synchronization will lead to more efficient time coincidence searches between IceCube and ARA.

- Potentially **synchronize** time clocks of IceCube & ARA to **nano-level** precision.

- Also achieve synchronization between ARA stations.

A ROADMAP TO THE IMPLEMENTATION OF PRECISION TIME PROTOCOL

- A temporary master clock has to be set up to send precision time protocol (PTP) messages to the microcontroller clock in the ARA DAQ.

- The microcontroller in the ARA DAQ should be programmed to recognize incoming PTP messages.

- The microcontroller should in turn be programmed to send PTP messages to the master clock.

- Firmware code should be written to implement synchronization between master clock and microcontroller clock.
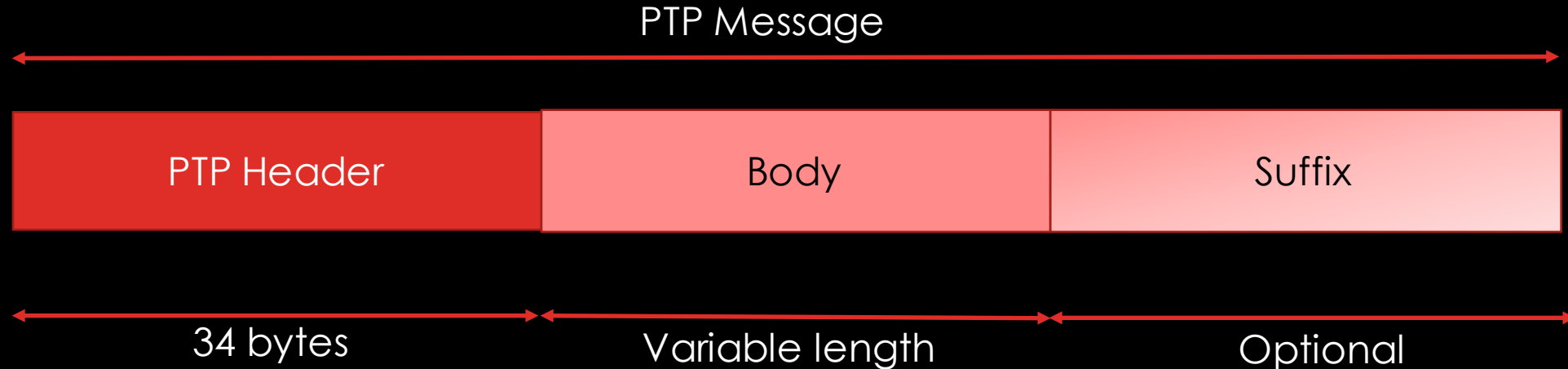
PROGRESS MADE SO FAR

- We have been successfully able to set up a local master clock which can send PTP sync messages to the microcontroller.
  - We can track these messages using an application called PTP Track Hound (http://ptptrackhound.com).
  - Can easily look up information about master clock details, message details including the bytes in the message.

- We have also started compiling code on GitHub which will be updated as we make progress. (Check out ArduinoPTP.cpp under the libraries folder in the 'ptp' branch. (https://github.com/ara-daq-hw/asps_daq_basic/tree/ptp/libraries/ArduinoPTP).

Note: To set up the software on your computer, follow the instructions here: https://github.com/ara-daq-hw/ara-smart-power-supply/blob/master/Documentation/Energia_Setup_Instructions.pdf
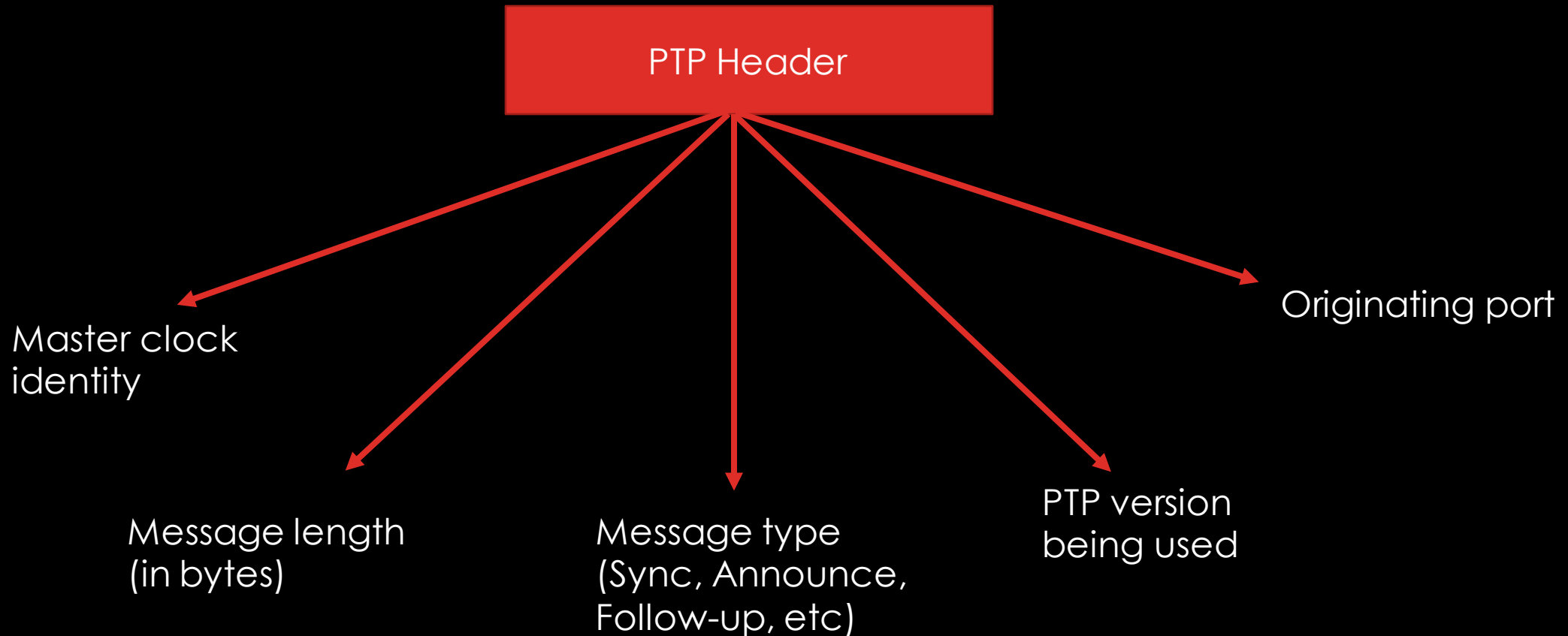
PROGRESS MADE SO FAR

- We have successfully been able to reprogram the microcontroller to recognize PTP messages and decode the sync, follow-up & announce messages.
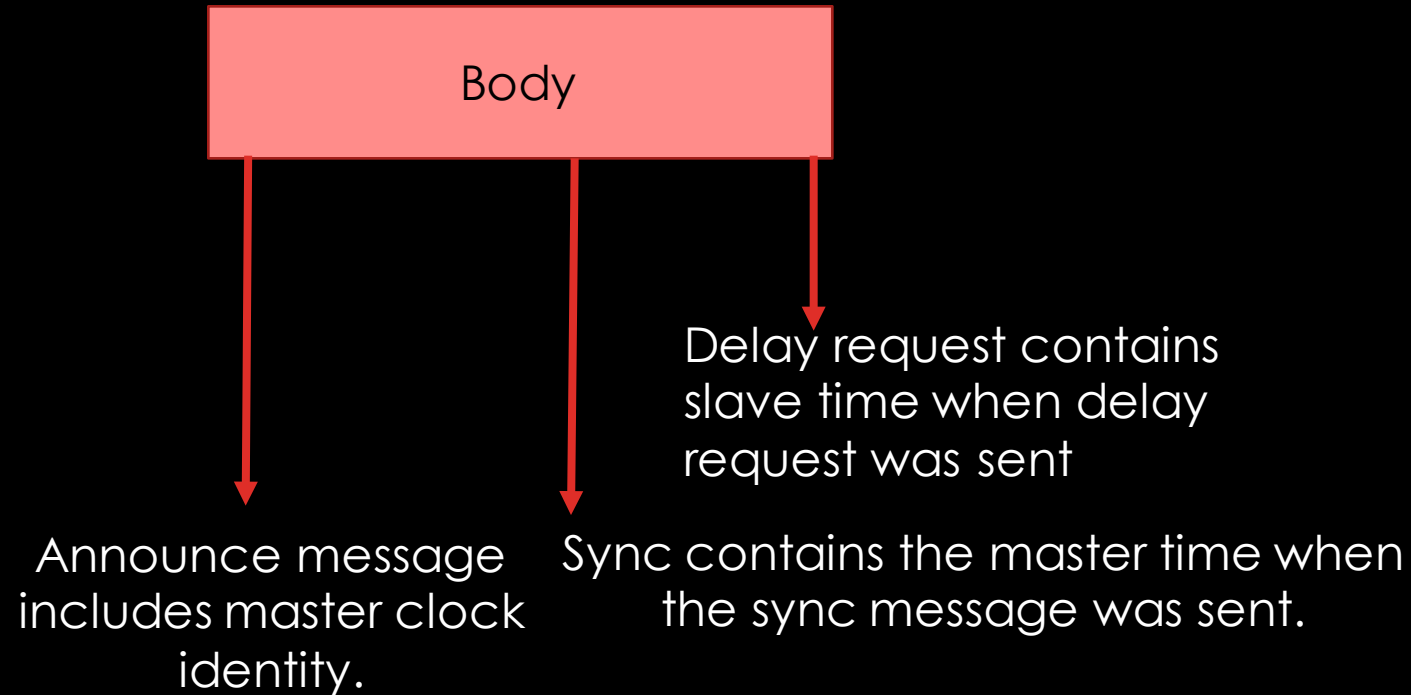
PTP Message

PTP Header	Body	Suffix
34 bytes	Variable length	Optional

http://www.chronos.co.uk/files/pdfs/cal/TechnicalBrief-IEEE1588v2PTP.pdf

PROGRESS MADE SO FAR

PTP Header

Master clock identity

Originating port

Message length (in bytes)

Message type (Sync, Announce, Follow-up, etc)

PTP version being used

- We have been able to successfully decode the PTP header message.

PROGRESS MADE SO FAR

- We have been able to decode the timestamps in the sync and follow-up messages.

- Timestamps follow epoch time with UTC reference.

- Timestamps show time in seconds and nanoseconds.

Body

Delay request contains slave time when delay request was sent

Announce message includes master clock identity.

Sync contains the master time when the sync message was sent.

SUMMARY

- Implementing the precision time protocol in will allow for nano-scale inter-station clock synchronization in ARA (also allowing for efficient time coincidence searches between IceCube and ARA.)

- We have made significant progress towards implementing PTP as of yet.

- In the future, we will need to reprogram the microcontroller on ARA DAQ to send PTP messages.

- In the future, we will need to write code to properly synchronize the local master clock and microcontroller clock. Possible source codes for this are available here: https://sourceforge.net/projects/ptpd/files/ptpd/

REFERENCES

- Correll, Kendall, Nick Barendt, and Michael Branicky. "Design considerations for software only implementations of the IEEE 1588 precision time protocol." *Conference on IEEE*. Vol. 1588. 2005.