

SSP Boardreader status for protoDUNE DAQ review

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Introduction

- Brief overview
- Interface of Boardreader to SSP
- Interface of Boardreader to DAQ
- Timing/triggering
- Implementation
- Testing
- Dates/risks
- Outlook

Overview

- The SSP (SiPM Signal Processor) is the readout hardware for the Photon Detector system in protoDUNE.
 - Amplify and digitize SiPM pulses, calculate pulse properties using Data Processors implemented on Artix FPGA.
 - Separate Zynq FPGA with embedded processor manages communication interfaces.
- The SSP Boardreader is the program responsible for interfacing the SSP hardware with ardaq. There is one Boardreader per SSP.
 - Configure the hardware from FHiCL on DAQ initialization.
 - Handle run start/stops.
 - Collect data from the SSP, package into fragments and send on to DAQ.
 - Do some data processing – keeping/discarding/reducing data based on trigger conditions.
- Boardreader was written for the 35t detector and used successfully. Hope to make evolutionary changes only for protoDUNE.

Interfaces – to SSP

- SSP has full TCP/IPoE support via CAT-5E port. Exposes separate logical ports for control/monitoring and data transmission.
 - Bandwidth on SSP side is 1000Mbps.
 - Connection to Boardreader PC via network switch, and optical links from detector to building ground.
- All configuration of SSP done via setting registers over control port. Run start/stop handled in this way as well.

Interfaces – to DAQ

- SSP Boardreader is a standard artdaq Boardreader program.
 - Class derived from CommandableFragmentGenerator implements SSP-specific code for run start/stop, initialization, retrieving data for transmission to Event Builder.
- Configuration for Boardreader and hardware retrieved from DAQ using parameters in FHiCL file.
- Minimal DAQ header added to raw SSP data to form event fragments – start/end time, packet length, number of packets.

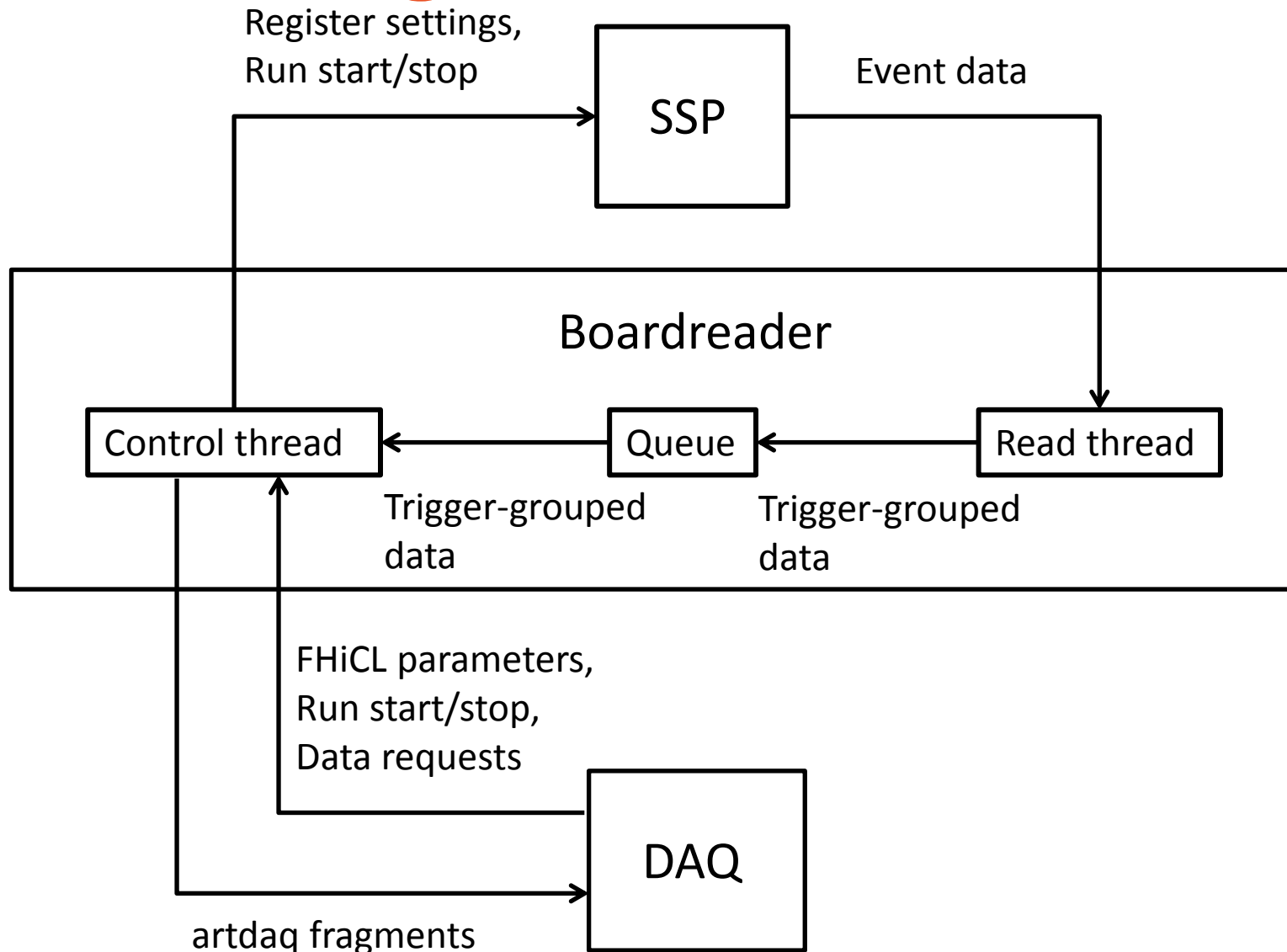
Timing/triggering

- SSP gives each packet a timestamp from the global timing system. This gives timing synchronisation between subsystems.
- In 35t each Boardreader sent one event fragment per fixed time period (“millislice”). ProtoDUNE will produce one event per trigger produced by the central trigger board.
 - Data packets from SSP will include trigger information - Boardreader will use this to correctly assign events to fragments.
- Can perform some sparsification at Boardreader stage.
 - Will use external trigger info from SSP to discard uninteresting packets.

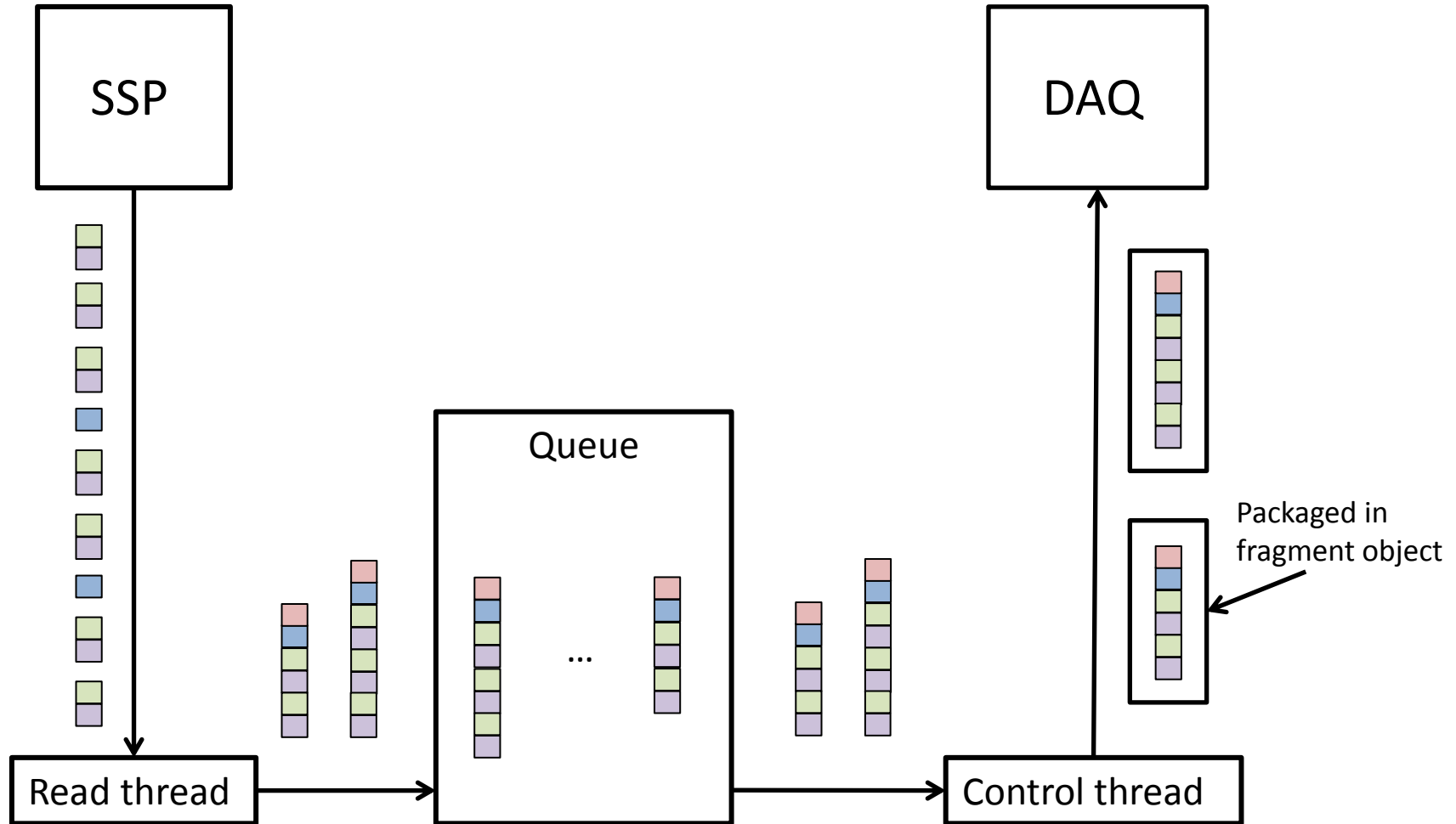
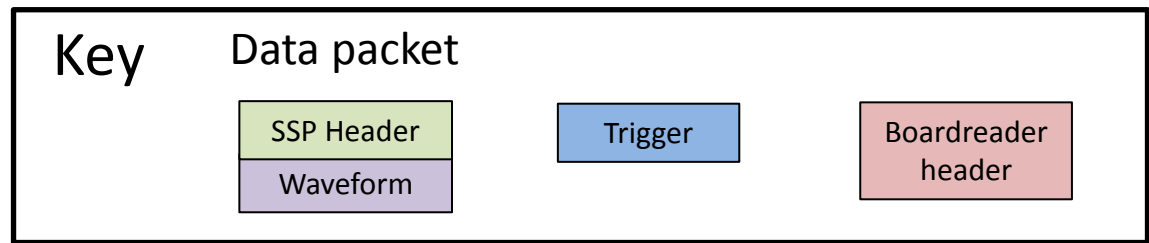
Implementation

- Self-contained library built as part of lbne-artdaq to handle all hardware interactions.
 - Uses boost::asio library for communication with SSP, for both control and data.
 - Supports USB and Ethernet interfaces, and can also be used for slow control of board only.
- During running, separate read thread is started to handle polling of port for data.
 - Get individual SSP packets from port as they arrive.
 - Combine packets into fragments which will be synchronous with rest of system.

Block diagram



Data flow



Numbers

- ProtoDUNE requirements:
 - For beam running most data is from TPC which dominates. SSP data in this mode is ~118Mbps for beam triggers @25Hz (full waveforms), 1106Mbps for cosmics (headers only).
 - May use up to 1Gbps per SSP (24Gbps total) for calibration data (maximum rate for SSP Ethernet connection). Need to test SSP-Boardreader processing at this rate, but bottleneck is almost certainly in network transmission.

Component testing

- Boardreader was tested thoroughly on 35t system with no problems identified.
- 1xSSP present on DAQ vertical slice test stand at Oxford.
 - Boardreader installed and tested on this system.
 - Use to test throughput, compatibility with new artdaq...
 - System will have protoDUNE timing unit when ready. Use this to test Boardreader with new timing system, triggering etc..
 - Test synchronisation of events between subsystems with new event definition.

Dates/Risks

- Dates:
 - By end 2016: Test of SSP system with new timing in UK.
 - Feb 2017: New Boardreader ready.
 - April 2017: Full test of SSP at CERN with new Boardreader.
 - May 2017: Integration of full system at CERN.
- Boardreader is pure software => no associated risks.
 - Risks associated with SSP come from hardware/infrastructure.

Conclusion

- SSP Boardreader program from 35t will be further developed to work for protoDUNE.
 - Main alteration is to change fragment format from fixed time period to per-trigger.
 - Implement logic to discard uninteresting data based on triggers received.
 - Compatibility with newer artdaq, minor changes to SSP data format.
- Changes will be tested on test stand at Oxford.
- Available time to make/test changes is sufficient assuming availability of hardware for timing/triggering system.