FERMILAB-POSTER-25-0083

Prototyping DAQ network functions on FABRIC

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Introduction & Goals

- This project is using advanced equipment on the FABRIC testbed to build prototypes for processing DAQ (Data Acquisition) streams.
- In particular, we are interested in processing DAQ streams that encode waveforms for the packet format used in modern LArTPC-based neutrino experiments.
- The equipment we are using on FABRIC provides a lot of network performance but requires a different programming paradigm compared to other computing platforms.
- Adapting DAQ techniques to this paradigm is part of the research being done in this effort.

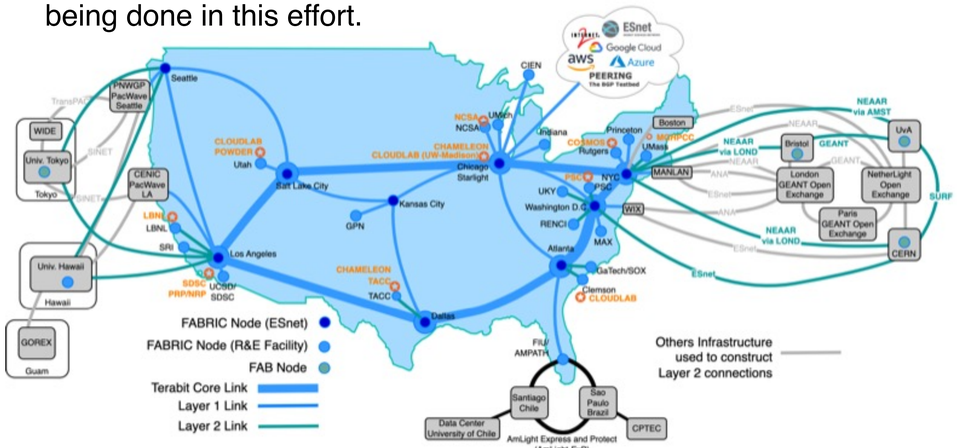

Fig 1. Topology of the FABRIC federated testbed. Credit: Tom Lehman.

What is FABRIC? (https://portal.fabric-testbed.net/)

- FABRIC is a state-of-the-art testbed for networking research.
- It is funded by the NSF and became operational in October 2023 after several years of development.
- The testbed consists of racks that are embedded in the networks of different institutions, including universities and Internet exchange points (IXPs).
- These racks provide a valuable array of resources to researchers, including access to specialized hardware.

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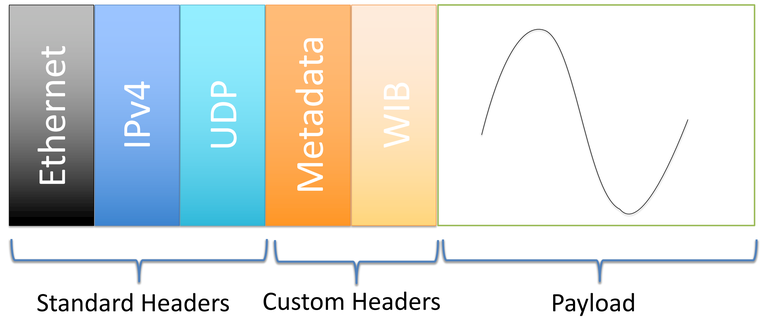

Fig 2. Structure of LArTPC packets. Packets contain important metadata and a digitized waveform.

Approach

LArTPC DAQ data is streamed by the detector in a custom packet format. This format is sketched in Fig 2. The custom headers contain important metadata that allow us to identify the part of the detector that produced the sampled waveform that is contained in each packet.

1. On FABRIC we are developing and testing a parser for the LArTPC's packet format. This parser is being run on specialized network hardware – a programmable network switch that can process data flowing through the network. (Usually data is processed only after it has crossed the network.)
2. Using FABRIC we obtain a "slice" – a collection of resources for our project. These include a Tofino programmable switch. These switches were made available on FABRIC from January 2025.
3. Implementing this parser requires the development of new techniques for processing data on a Tofino:
   a) The LArTPC custom headers and payload use "little endian" encoding. This requires extra steps to decode, compared to standard network header formats.
   b) The packet payload is large, requiring several iterations through the switch in order to digest it.

Status and Future Work

- The parser currently works for the LArTPC Jumbo Ethernet packets, approximately 7200KB in size.
- Currently it is being validated against an earlier prototype written in Python, to ensure that the Tofino implementation is behaving correctly.
- Future work includes porting an implementation of a Trigger Primitive algorithm that we developed in earlier work, to have that algorithm work in tandem with the parser and produce an integrated LArTPC DAQ parser and Trigger Primitive generator on a Tofino switch.

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