Distributed Resilience in High-Energy Physics DAQs

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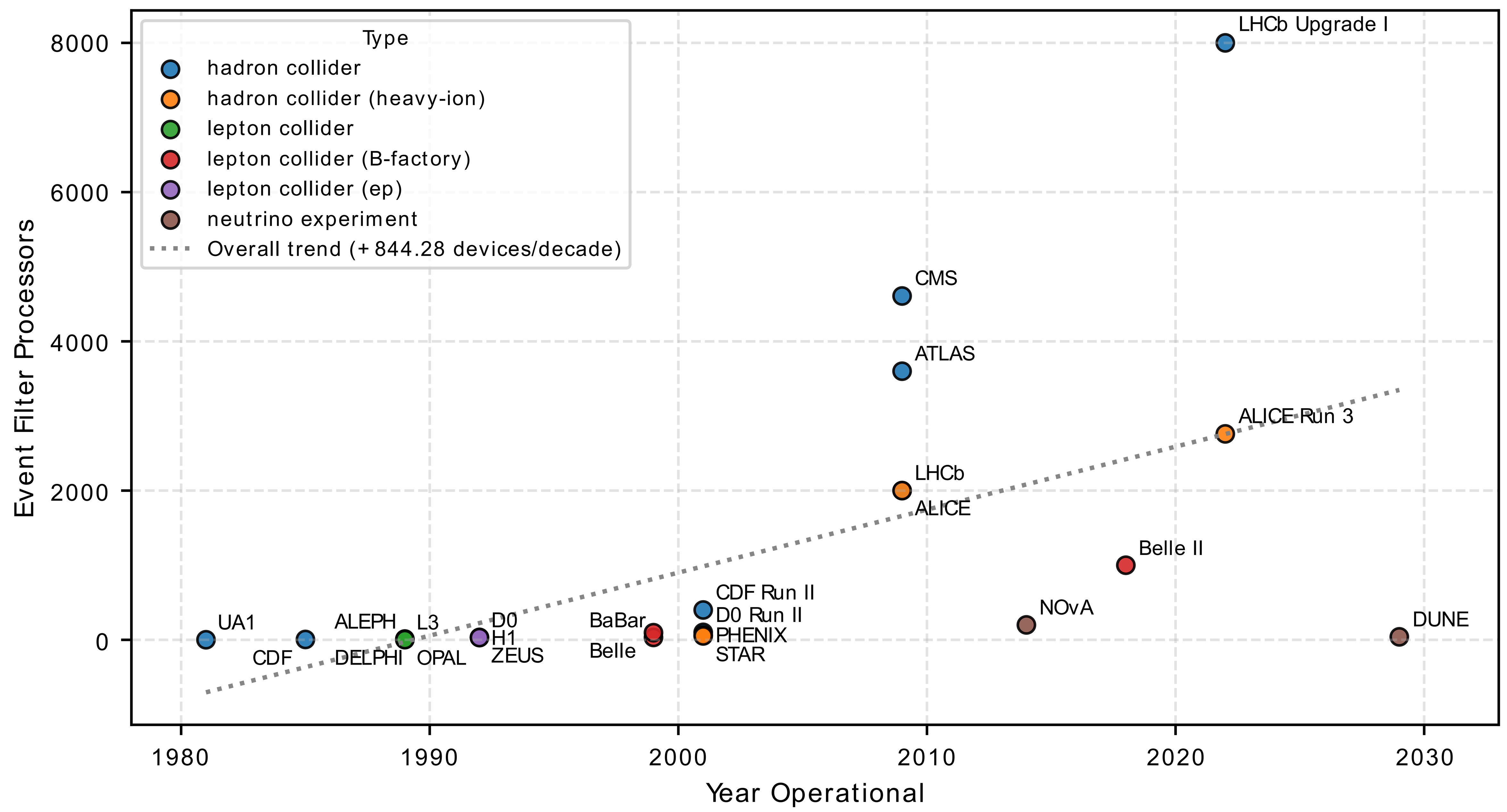
DiDAQt: A general system for failure resolution in HEP DAQs

High-Energy Physics (HEP) Data AcQuisition (DAQ) networks are growing over time, and seek even rarer data, such as DUNE's goal to capture data from core-collapse supernovae. Currently, these DAQs handle failures by tolerating degradation until a manual fix is enacted. Using the supernovae data as an example (100s event, 750 TB, *a few times per century*), a switch failure can cause up to 22.5 TB of data loss. Thus, automatic failure resolution is necessary. We design and evaluate DiDAQT to demonstrate such a system, which can be integrated with existing and future HEP DAQs.

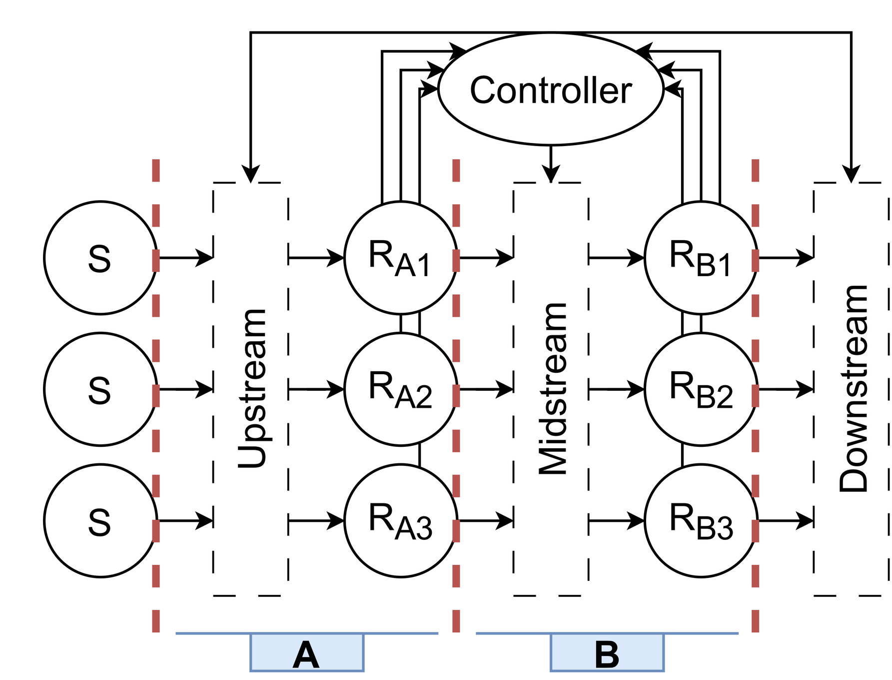


Growth in HEP DAQs over time

A survey of major HEP experiments since UA1 at CERN in 1981 reveals an exponential growth in both network capacity (x22.17 in bandwidth/decade) and in number of processing devices (above). By experience with other HPC systems, we can recognize that this growth will coincide with increased failures. When failures go from rare occurrences to normal, the current practice of manual failure resolution becomes infeasible.

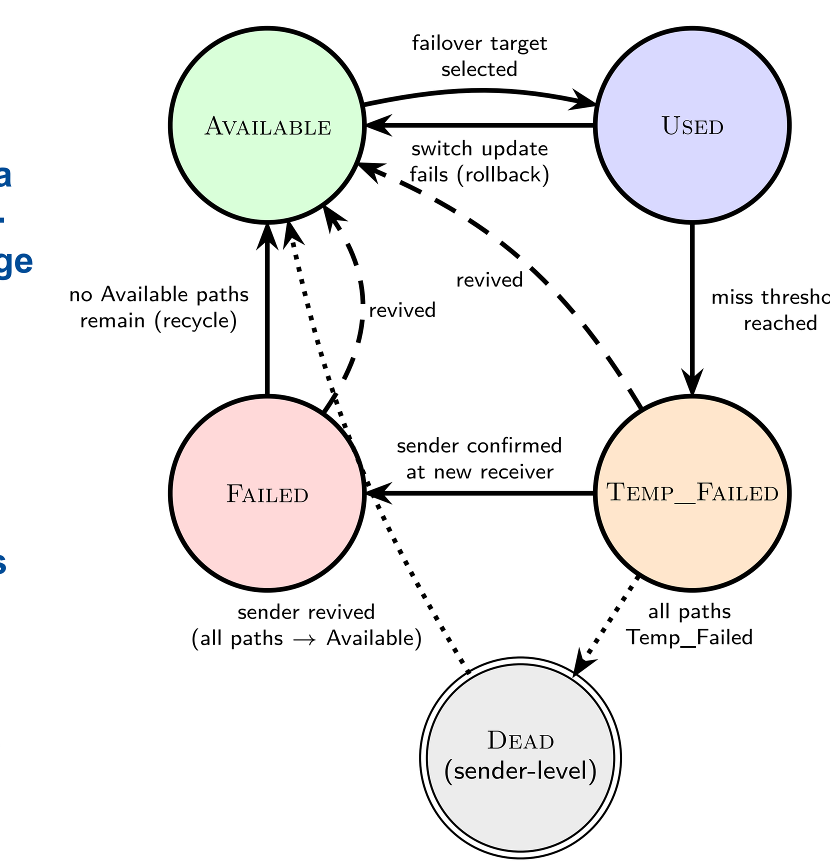
DiDAQt Design

DiDAQt provides an API designed to integrate with DAQ workloads and controllers. It provides operators an ability to specify what "correct" traffic looks like, and how a controller can change network paths on detecting "incorrect" traffic to enact fail-overs.



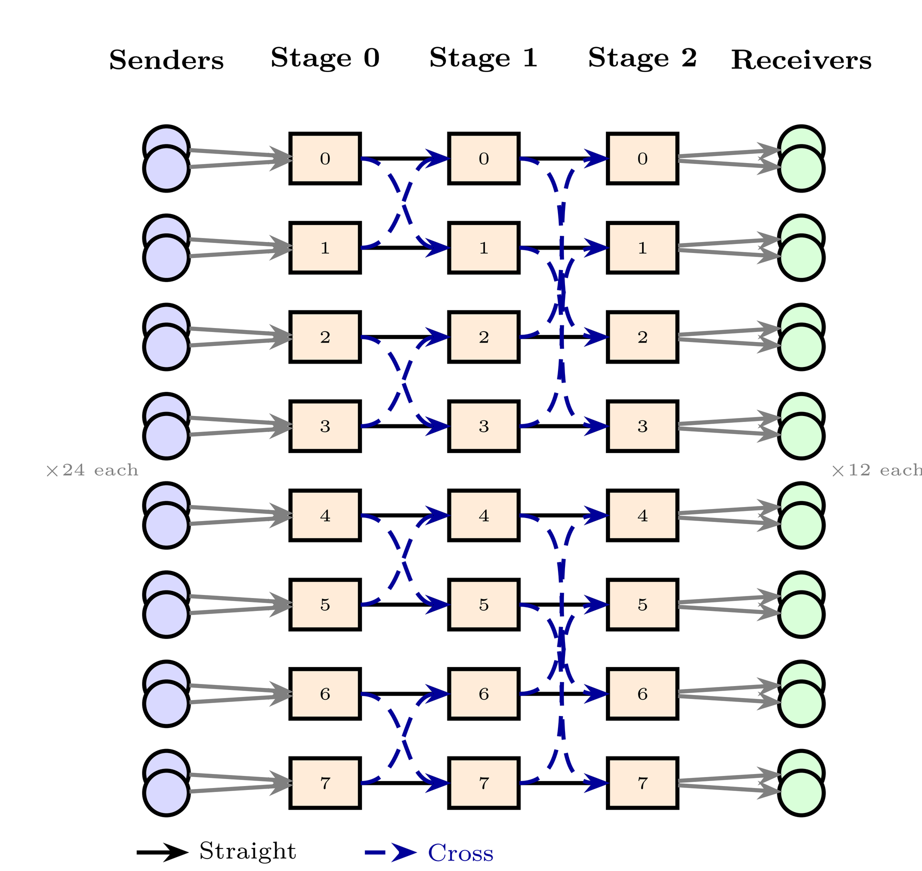
Left: A high-level view of the DiDAQt design placed in an abstract but typical topology. Receivers (R) are connected to a network controller via an out-of-band control network. Each Stage A receiver (R_A) monitors for network problems along paths between connected senders (S) and themselves. Each Stage B receiver (R_B) monitors for problems on paths between connected the Stage A receivers and themselves.

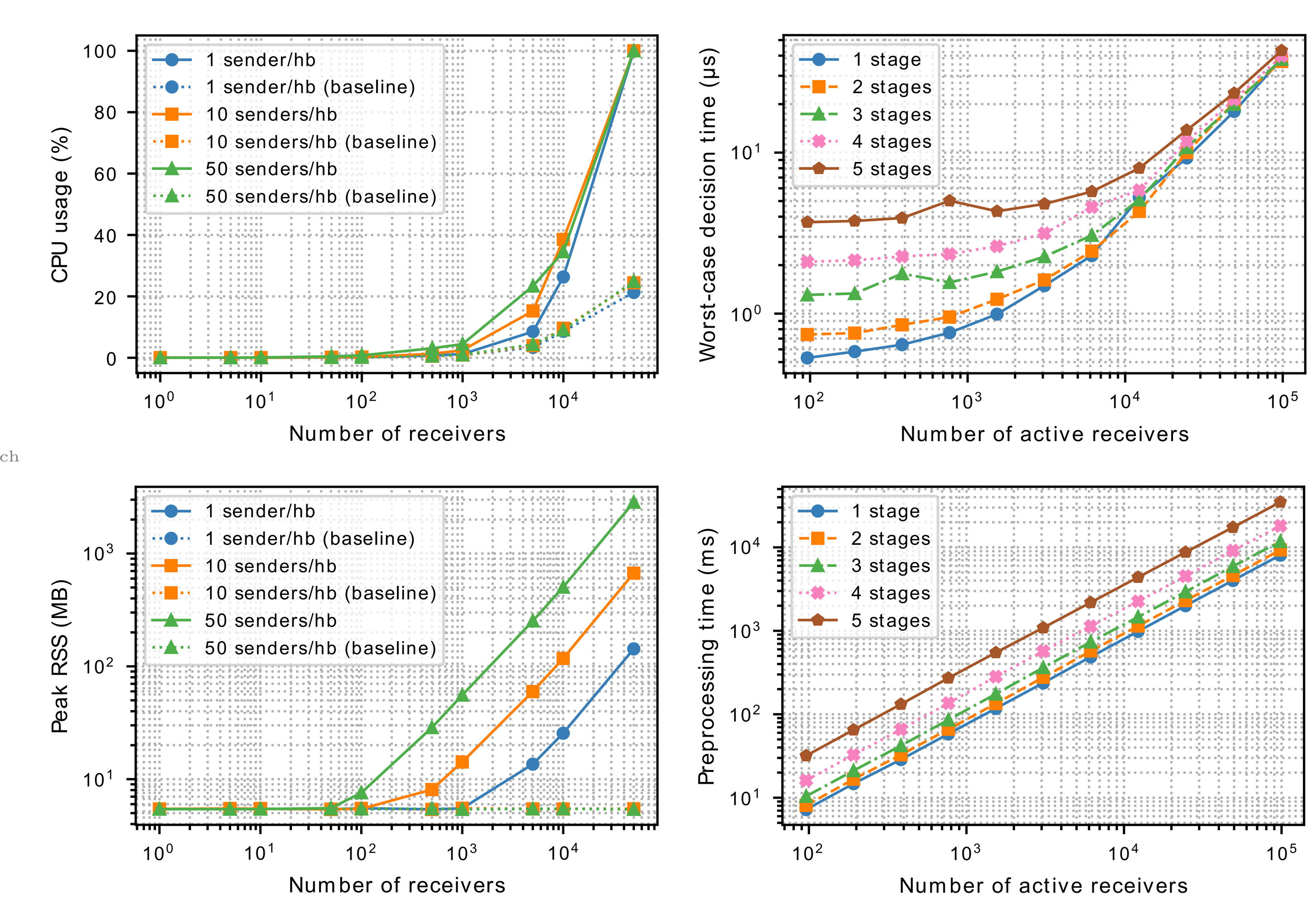
Right: State diagram depicting the management of ablatives by the controller.



DiDAQt Evaluation

We demonstrate DiDAQt using simulated and real evaluations on the FABRIC national testbed. For simulated evaluations, we use a staged butterfly topology pictured below (left). The time for the system to decide on a fail-over path (top-right of quad) measures in <100 µs, well below the time for a Tofino2 switch to update its rules (avg. 699 µs). The time to process the topology scales linearly (bot-right of quad). The resource usage on the controller (left of the quad) is practical for current and proposed HEP DAQ sizes.





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