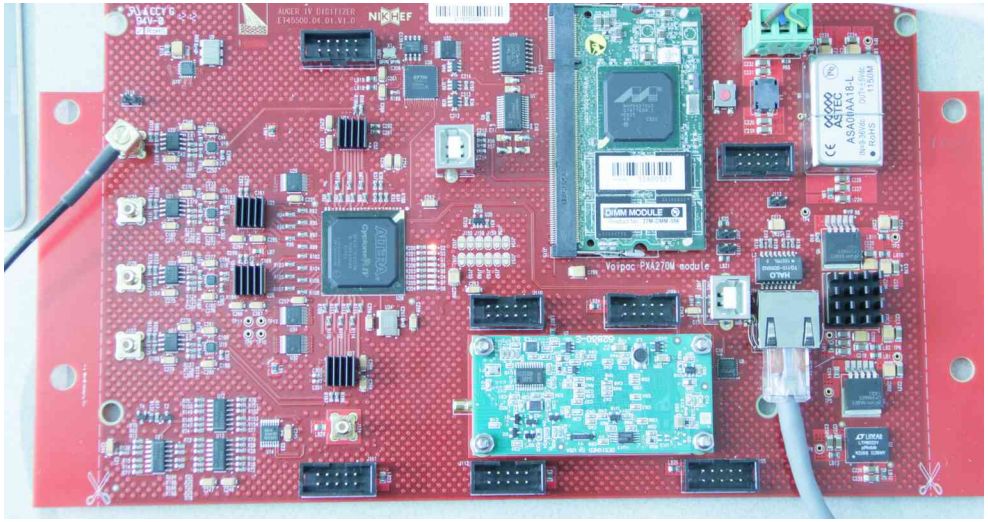
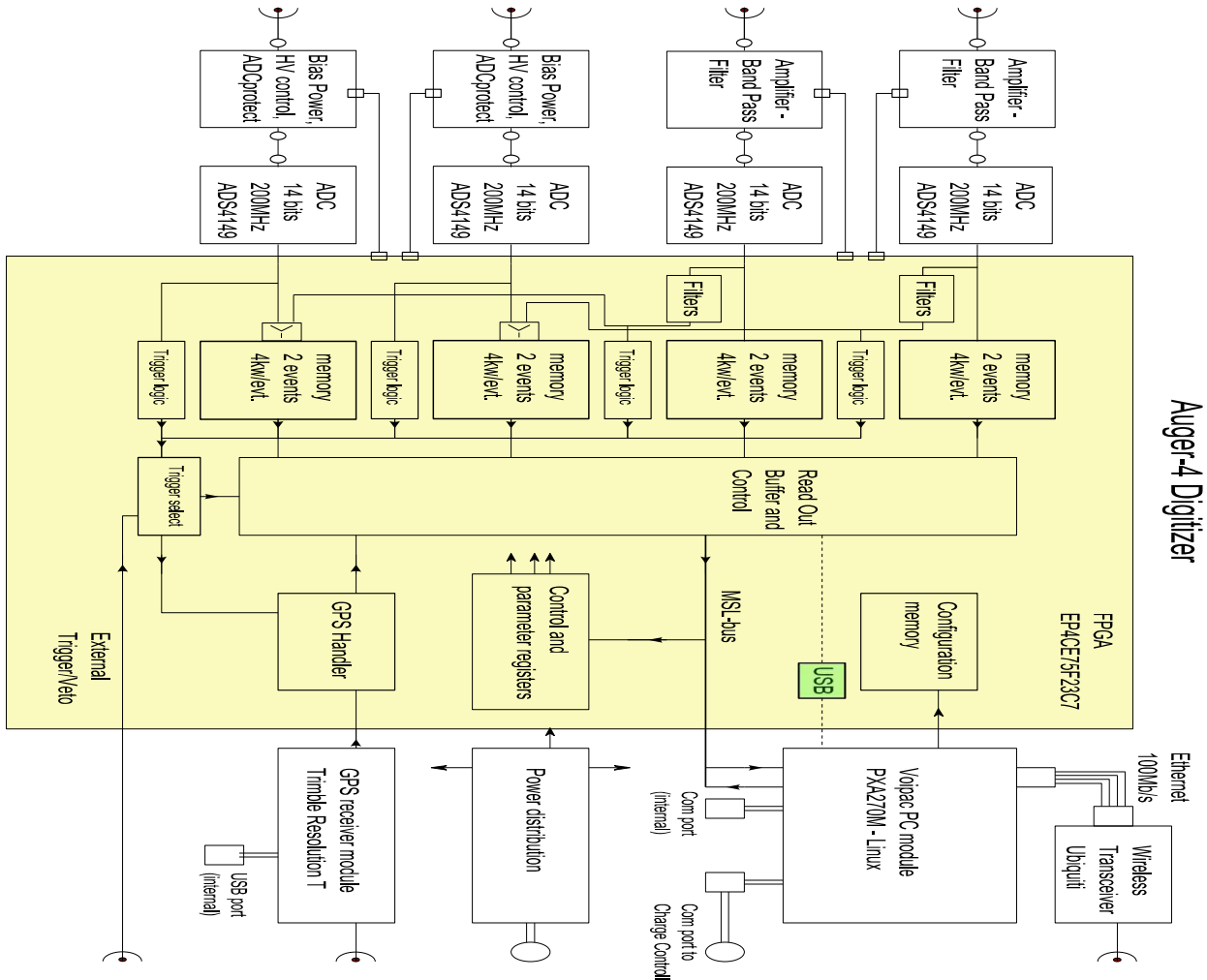
Data Acquisition/comms/online

Front-end hardware –Engineering emphasis differences



- ARM-CPU (self trigger, storing triggered events)
- Filter designed to reduce dispersion (maintain signal)
- Power efficient FPGA (noise reduction/trigger)

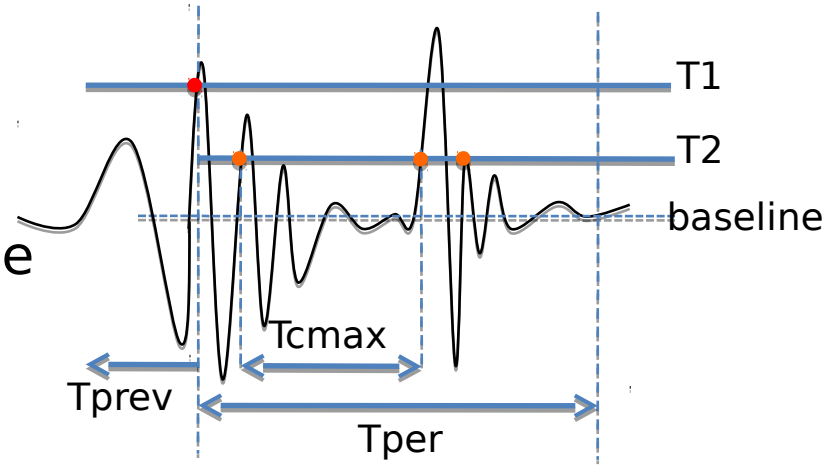
Schematics Dutch AERA board



Implemented self trigger

Now based upon:

- Rejection of multi-pulsed signal
- Removal of single-frequency noise
- Selection on pulse width



An additional selection based upon polarization and LDF could be added when direction and core position are known.
Requires reconstruction in the field

5 GHz Commercial Wireless COMMS

dBi 90° sector antenna +
biquity 5 GHz Rocket M access point

Stations: 30 dBi parabolic dish antenna +
Ubiquity 5 GHz Bullet M subscriber unit

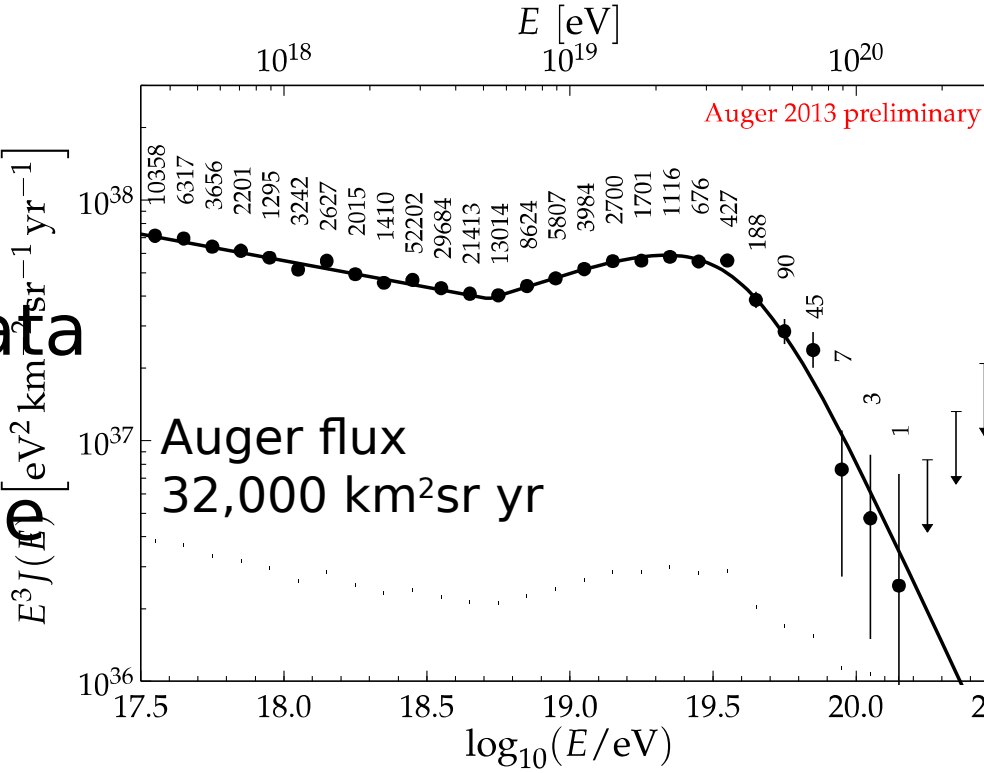
subscribers: two 40 MHz channels in 5 GHz band gives 2 Mbps per station,
required ~0.5 Mbps

Event Volume

- Say 6 channels/station
- Sampling frequency 200 MHz
- Pulse width ~ 300 ns
- Say tracelength 5 musec
  - 1000 samples/trace times 2 bytes
  - 12 kB/station for 1 event
  - Overhead ⎵ 15 kB/station

Data Volume

- Cosmic rays/gamma rays:
  - 71,000 km²sr ~350,000 evts/yr above $10^{18.5}$ eV
  - Above $10^{17.5}$ ~ 35 10^{6} events/yr
  - 100000 events/day
- Assumption
  - ~10 stations/event
- 1 station sends CR data every 5 hours
- Throughput: negligible
- Storage: 15 GB/day



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  - ev
- Throug ble
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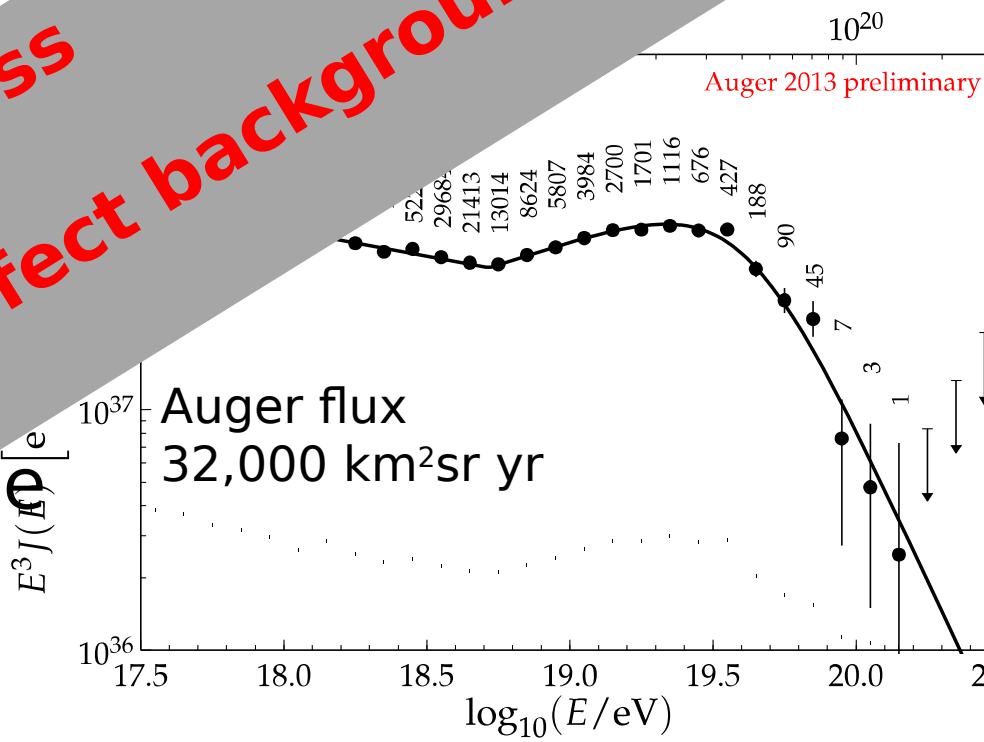
neutrinos far less

Assumes perfect background rejection



Data Volume

- Astronomy
  - FFT option:
    - 8000 values/channel (2 channels) every 10 ms ⎵ 3.2 MB/s data sent per station
    - Data storage: 280 GB/day
  - Summing option
    - 2000 values/channel every 10 sec ⎵ 0.8 kB/s station
    - Data storage: 14 TB/day (saving all stations)

Data Volume

- Monitoring
  - System health, say 1 event/minute
  - Throuhput 250 bytes/sec
  - Storage: 4.3 TB/day

Triggering

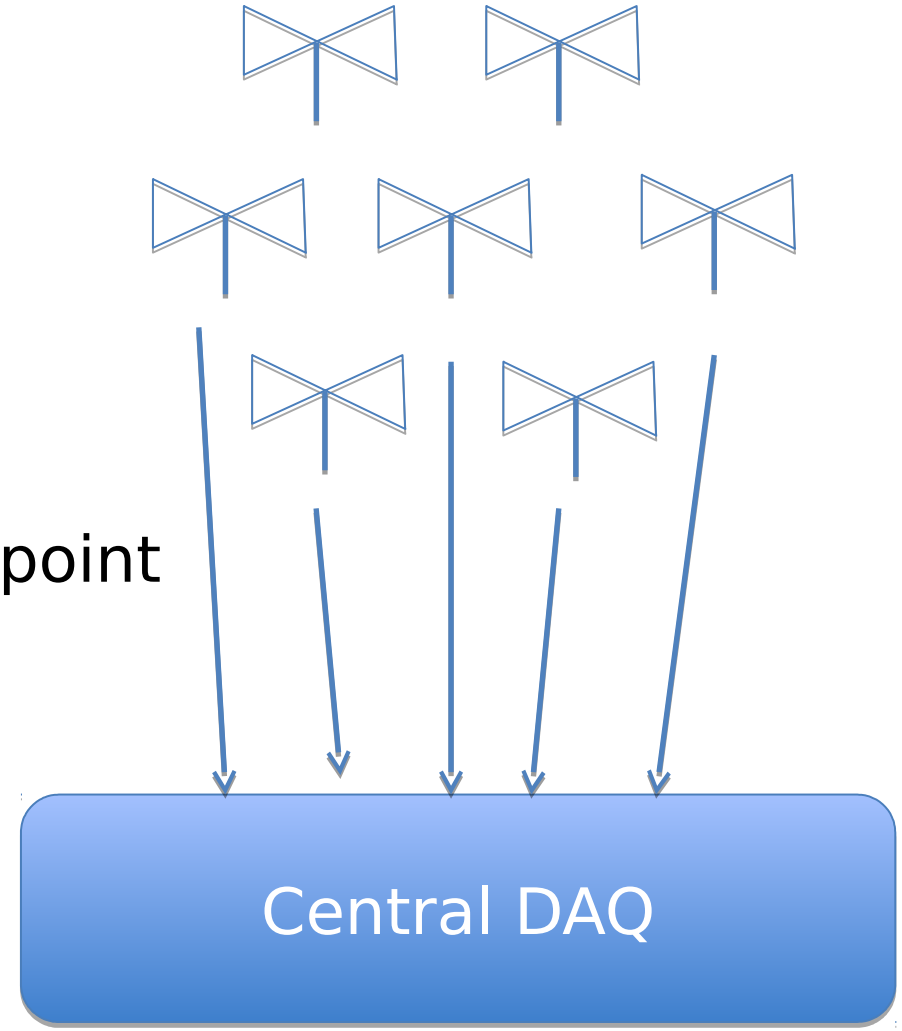
- Trigger created from timestamps radio detector
- Assumption: 100 Hz/station, 2 bytes/timestamp = 0.2 kB/sec

Total requirement:

- Throughput: 4 MB/sec
- Datavolume: 5 TB/day

DAQ implementation

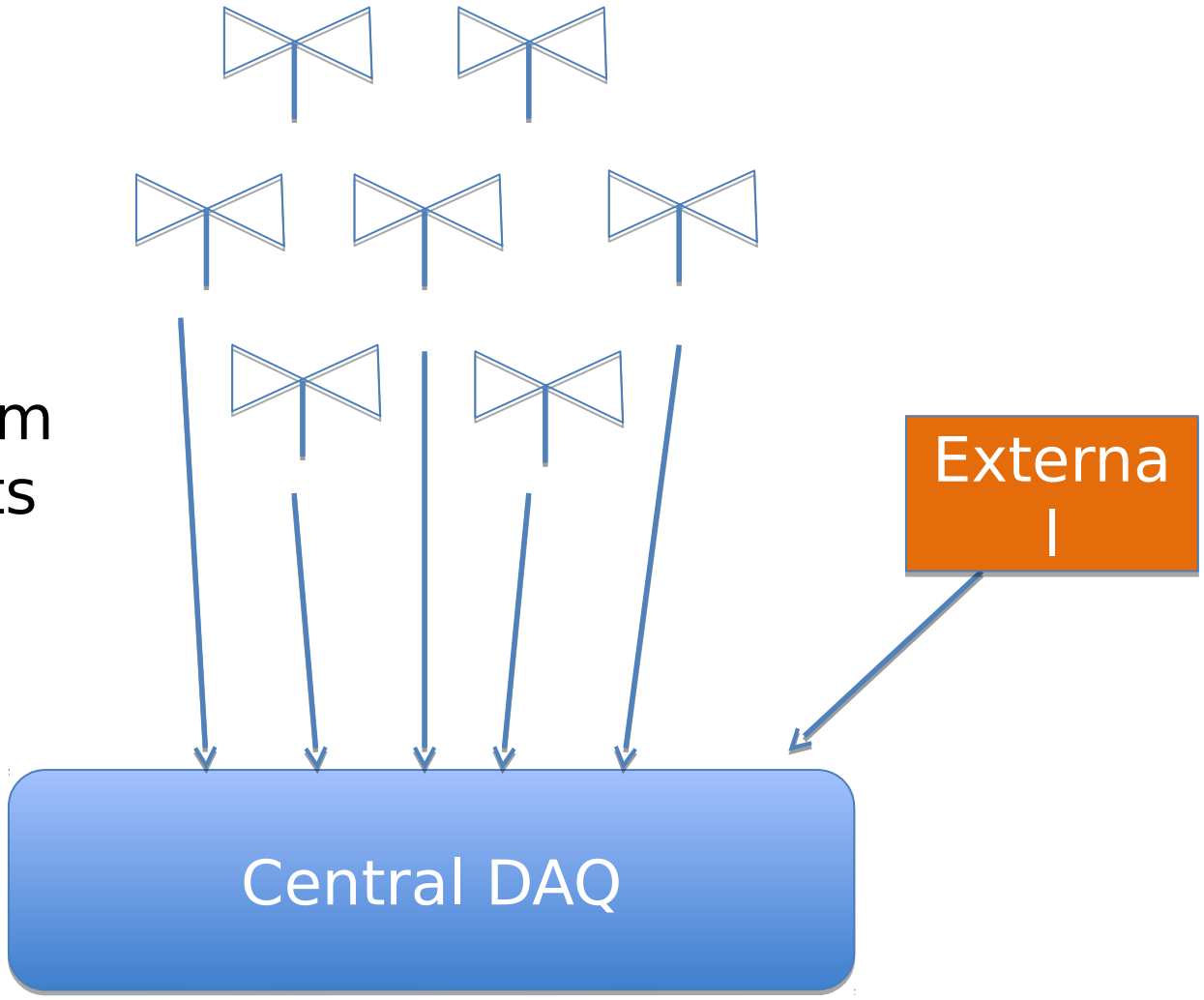
Point to multipoint



DAQ implementation

1a) Send timestamps from triggered events

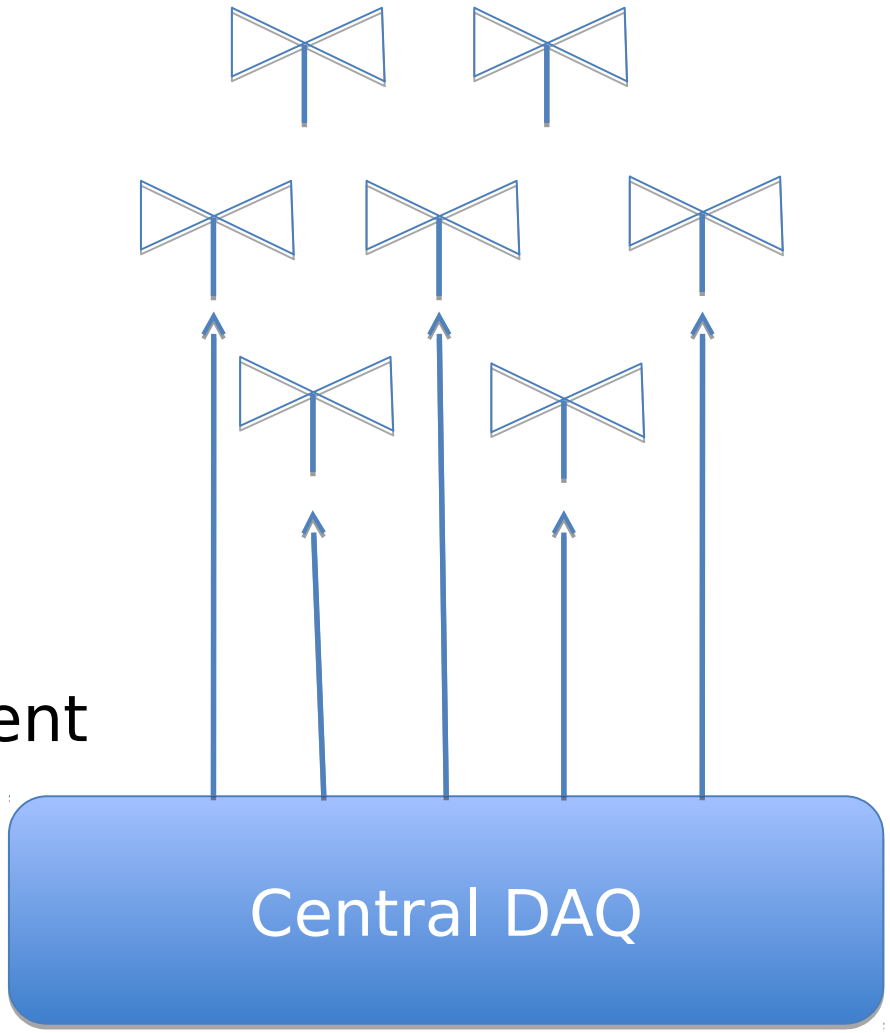
1b) Receive external timestamps



DAQ implementation

2) Create high level trigger

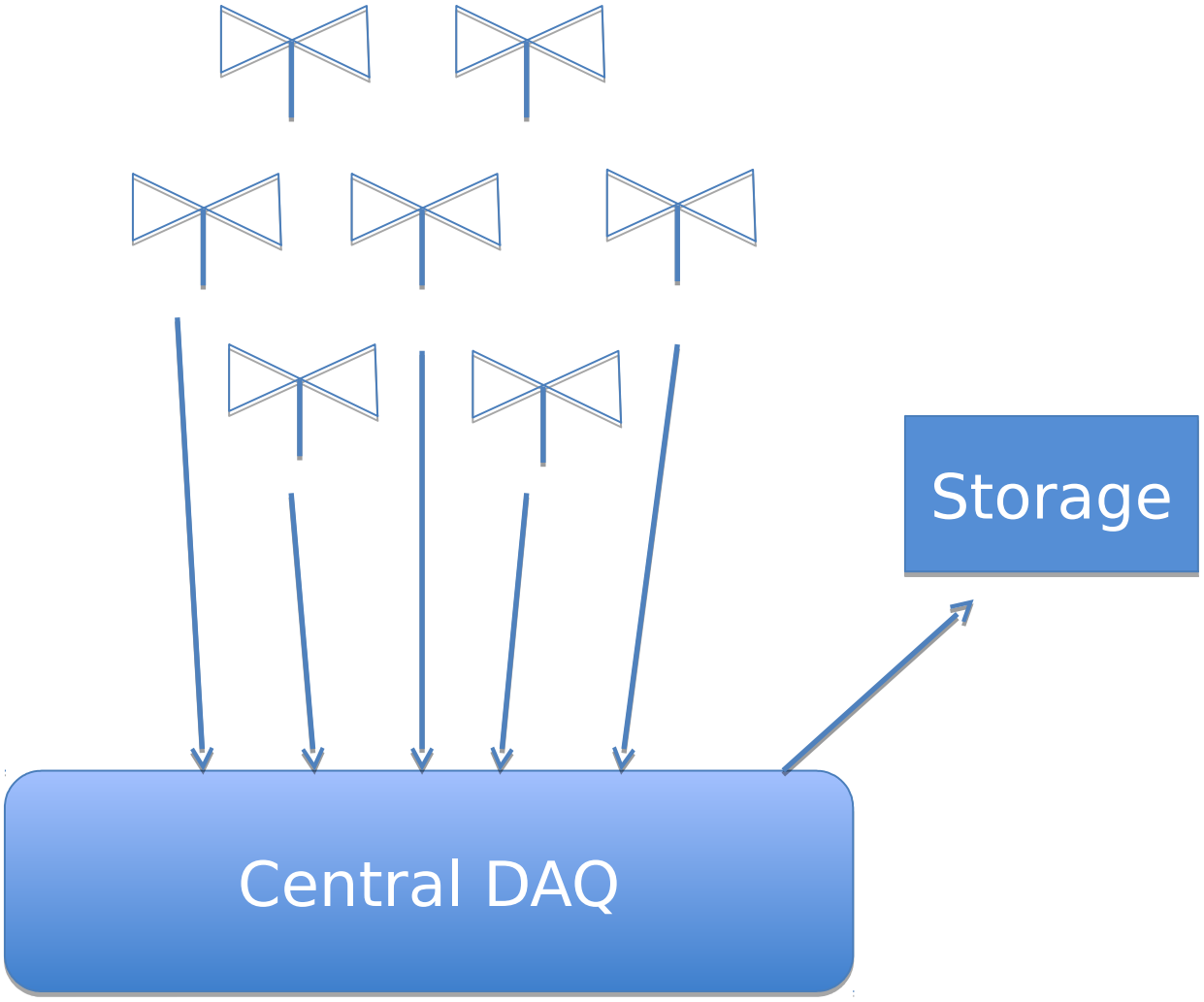
3) Request event fragments



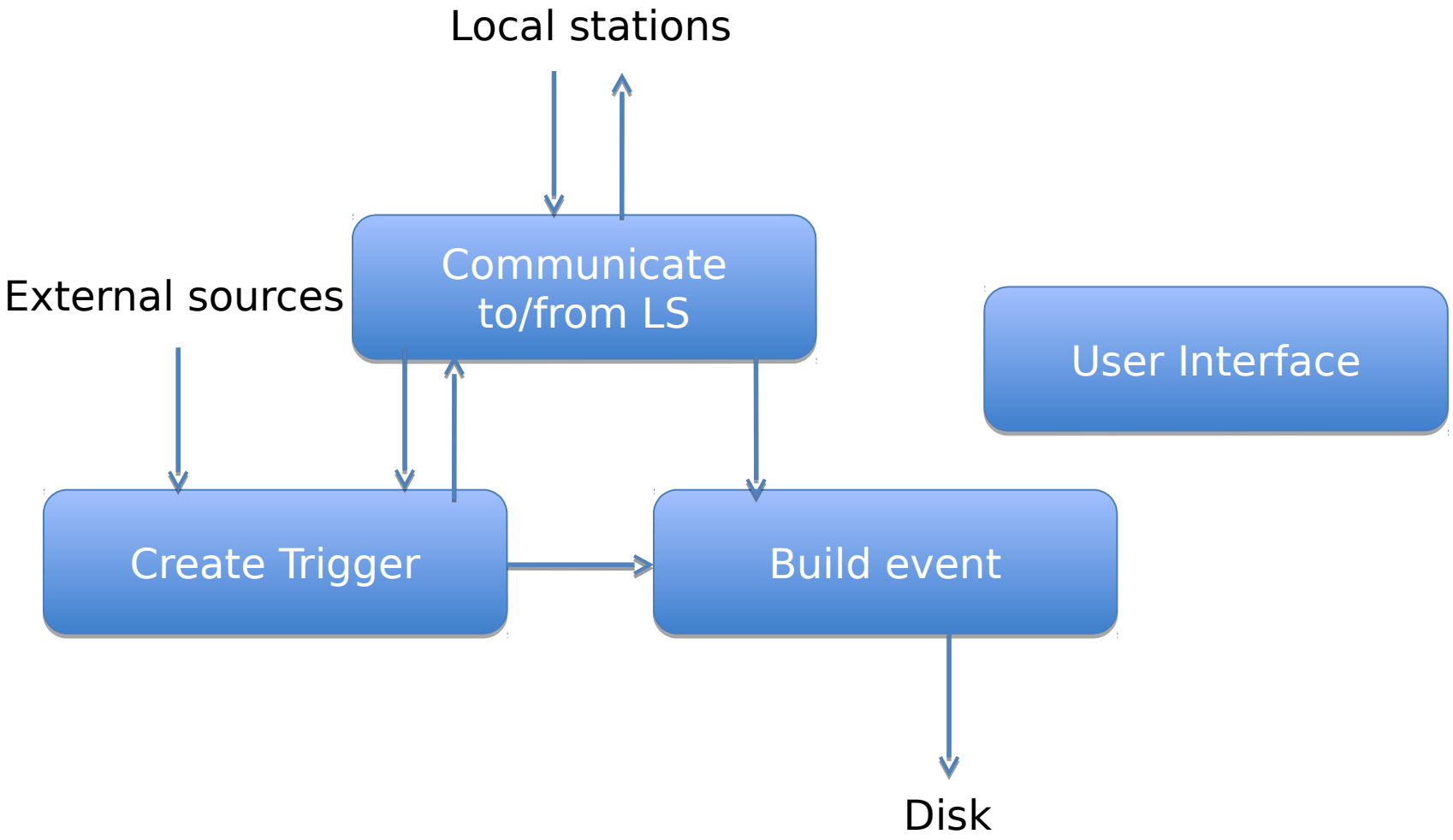
DAQ implementation

4) Build event

5) Write event



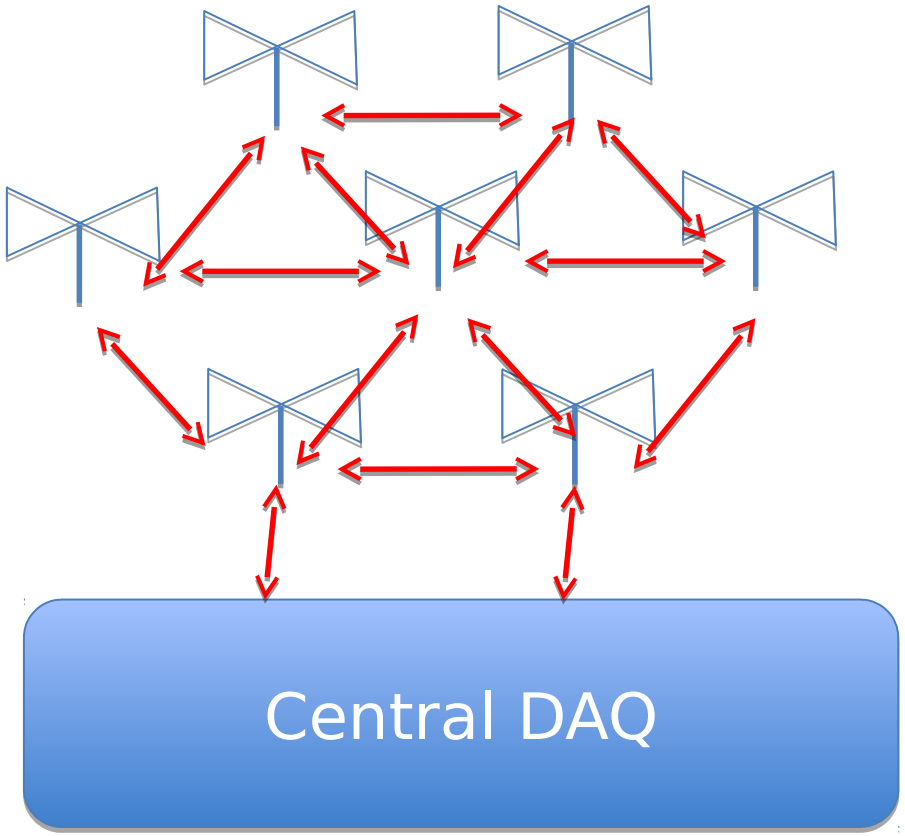
Core DAQ Software



Scalability Mesh-like structure

Every station communicates to nearest neighbors.

Provide many paths and short distance communications



Higher level triggering could be done in the field.

Central DAQ only needs to build event and perform monitoring tasks

Compromise between extremes