DAQ: Event Model Interfaces, Goals and Deliverables

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DAQ Interfaces

- Refer to DAQ Design and Overview presentation, by Brett V., which specifies
  - DAQ, as data producer for offline, provides trigger records (active detector data) and DAQ (including DAQ subsystem) conditions data
  - Expected trigger record rates and trigger record sizes, assuming no compression

Goals and Deliverables I

Goals for this workshop, related to DAQ interface with Offline:

1. Agree on trigger record structure, and propose format
2. Agree on interface with Offline databases
3. Specify "gatekeeper" for shipping data (from DAQ and other FD systems) to offline

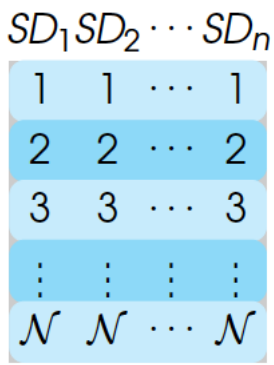
Goals and Deliverables II

4. Itemize and finalize information to be included as part of DAQ trigger records: What information must be contained in the data, including metadata, sufficient for offline processing
5. Itemize and finalize information to be included in DAQ conditions database

Before next workshop:
Formalize as appendix in data model document
https://docs.google.com/document/d/1j4gsYgYP9TwIuIf4H1IPxC9pECHgdFWWBCsU4J8-q28/edit?usp=sharing

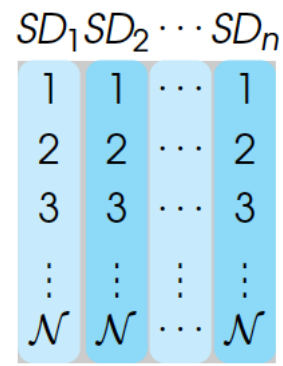
1. Trigger record structure

How do we package data, for N trigger records?



Per module

vs.



Per sub-detector

This is the chosen approach

- **Q to offline**: Does each SD include TPC and (local) PDS data, or exclusively either TPC or PDS? If the latter, is PDS all grouped into a single SD?
- Consider also SNB trigger records (100s or 100/0.0054 = ~20k times longer readout windows)

(Not actual file format!)

What does a trigger record include:

Trigger Number	Trigger Time	RO Window Start	RO Window Length	Trigger Type	Trigger Bits	Run #	Subrun #	Trigger Record Header
Module ID	Partition/Run Type	Wordcount (record)	Checksum (record)	Compression ID (record)	Format Version	Active subdetectors	RO subdetectors	
SD ID	TP_0	…	TP_n					Trigger Primitive Data
…								
TC_0	…	TC_m						Trigger Candidate Data
…								
TD_0	…	TD_k						Trigger Decision Data
HLF								HLF Info

SD ID	Compression ID (SD data)	Wordcount (SD data)	Checksum (SD data)					SD Header
SD Data	Compression ID	Reference Time						SD Data
Channel Data	…							
Channel ID	Compression ID	Reference Time						
Channel Data	…							

SD ID	Compression ID	Wordcount (SD data)	Checksum (SD data)					SD Header
Channel ID	Compression ID							SD Data

Trigger decision: requested data readout over a set of time and channel
Trigger record: the raw data acquired over that set and its metadata

What does a trigger record include:

Trigger Record Header

1. **Trigger Number:** Trigger record identifier; unique, increments within a run monotonically
2. **Trigger Time**: Time of trigger, reported by the Data Selection system, in absolute detector clock time (64bit number), not reset-able at run start; can be translated into global GPS time
3. **Readout Window Start**: In absolute detector clock time
4. **Readout Window Length**: In absolute detector clock time
5. **Trigger Type***: Trigger types are uniquely defined in terms of IDs, which correspond to (e.g.) SNB, high-energy off-beam, beam+PDS, beam+TPC, beam, etc. This is the trigger type of the accepted trigger which was responsible for the request for data readout.
6. **Trigger Bits**: A multi-bit word, each bit representing a uniquely defined trigger type, which allows for multiple triggers to be recorded if satisfied during the readout window. Trigger priority should be such that it's identifiable which one was accepted.
7. **Run Number**: Which run this set of data belongs to (see Data Model Task Force doc)
8. **Subrun Number**: Which run this set of data belongs to (see DMTF doc)

*Redundant, but maybe useful.

What does a trigger record include:

Trigger Record Header (continued)

9. **Module ID:** 10kton detector module ID (1-4)
10. **Partition/Run Type***: We anticipate different partitions servicing physics data taking vs. calibration vs. debugging, and so this identifier can be provided to indicate whether a particular trigger record corresponds to a physics data taking partition or otherwise. This should also be retrievable based on run number using the DAQ config database.
11. **Wordcount**: Number of words in record (compression dependent) which may be useful for unpacking
12. **Checksum**: For all words in record
13. **Compression ID**: Type of compression for record (applied prior to shipping to offline)
14. **Format version**: SD data format version number (associated decoders will be provided)
15. **Active subdetectors***: Number of subdetectors informing trigger decision (within subrun)
16. **Readout subdetectors*:** Number of subdetectors being read out

*Redundant, but maybe useful.

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Channel Data	…							
Channel ID	Compression ID	Reference Time						
Channel Data	…							

SD ID	Compression ID	Wordcount (SD data)	Checksum (SD data)					SD Header
Channel ID	Compression ID							SD Data

What does a trigger record include:

Trigger Info

For all active SDs, all generated

- **Trigger Primitives**
- **Trigger Candidates**
- **Trigger Decision(s)**

over the duration of the trigger record (readout window) is also recorded, as well as

- **High Level Filter**

information (e.g., which sub-detectors were dropped at HLF stage, or what topology classification each SD data might meet, etc., TBD)

This is written out once per trigger record, regardless of whether SD data is included as part of the trigger record or not.

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Channel Data	…							

SD ID	Compression ID	Wordcount (SD data)	Checksum (SD data)					SD Header
Channel ID	Compression ID							SD Data

What does a trigger record include:

SD Data (PDS or TPC)

1. **SD header info including:**
   SD ID (unique, and accommodates both PDS or TPC)
   Compression ID
   Checksum
   Wordcount
2. **SD data**
   For example, including:
   1. **Channel header info including**:
      Channel ID
      Compression ID
      Channel wordcount
      …
      Reference time (if not fixed relative to readout window start time)
   2. **Channel data** (ADC values)

Note: TPC ADC data may not be arranged in time order, but in channel order. **This is to be determined**. Example channel order in next slide…

What does a trigger record include:

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SD ID	Compression ID (SD data)	Wordcount (SD data)	Checksum (SD data)					SD Header
Channel ID	Compression ID	Reference Time	Wordcount (channel)					Channel Header
Channel Data	…							Channel Data
Channel ID	Compression ID	Reference Time						Channel Header
Channel Data	…							Channel Data

SD ID	Compression ID	Wordcount (SD data)	Checksum (SD data)					SD Header
Channel ID	Compression ID	Reference Time	Wordcount (channel)					Channel Header

2. DAQ Conditions: for Offline Conditions Database

- Module ID
- Partition number
- Run number
- Run begin time
- Run end time
- Subrun number
- Subrun begin time
- Subrun end time
- List of active sub-detectors
- Data selection configuration (trigger priority, active triggers, trigger prescales, thresholds and multiplicities, ...)
- Front-end configuration (gain, shaping time settings)
- Compression configuration
- Channel masking
- Trigger condition* (which DAQ elements were active, and thus informing trigger decision)
- Quality metrics*: TP/TC/TD losses due to backpressure from downstream

*changes during and outside of run/subrun boundaries

3. Outside of DAQ scope, also to be defined

Between offline and other detector subsystems:

Conditions data from other detector systems, and additional information so that the data/information can be correlated with trigger records, e.g.

- Laser calib system (laser configuration, laser data)
  - Is it multiple fires per trigger record, or one fire per trigger record?
- Front-end electronics gain, shaping time calibration
- PDS gain calibration
- Detector configuration for HV, bias voltage, ...
- Slow controls data

"Gatekeeping":
What is the gatekeeper entity (to offline)?
What is the priority, between DAQ vs. other subsystems, and within DAQ for trigger records of different types? E.g., are we guaranteed a maximum bandwidth for all other (non-DAQ) data producers?