



# DAQ Trigger framework and appfwk

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#### Introduction



- Some of this is already outdated (discussions on Friday)
- Did the simplest thing I could think of:
  - Define trigger "objects":
    - TriggerPrimitive
    - TriggerCandidate
    - TriggerDecision
      - Missing "TriggerCluster" or whatever we decide to call it
    - Define algorithms:
      - Maker class for each of the object
    - Created an interface with appfwk
      - Each algorithm is it's own DAQProcess
      - Defined queues etc

DuneTriggerAlgs

NEUTRINO EXPERIMENT



## Trigger Primitive



#pragma once
#include <cstdint>

```
namespace DuneTriggerAlgs {
  struct TriggerPrimitive {
    int64 t time start
                                 = \{0\};
    int64 t time peak
                                 = \{0\};
    int32 t time over threshold = {0};
    uint32 t channel
                                 = \{0\};
    uint16 t adc integral = {0};
    uint16 t adc peak
                               = \{0\};
    uint32 t detid
                                 = \{0\};
    uint32 t flag
                                 = \{0\};
 };
}
```

- Very similar (identical?) to what is in PTMP.
- Hopefully that can accommodate for optical TPs?



### Trigger Candidate



#pragma once
#include <cstdint>

```
namespace DuneTriggerAlgs {
   struct TriggerCandidate {
      int64_t time_start = {0};
      int64_t time_end = {0};
      int64_t time_peak = {0};
      uint32_t ntps = {0};
      uint32_t channel_start = {0};
      uint32_t channel_end = {0};
      uint32_t channel_peak = {0};
      uint32_t channel_peak = {0};
      uint16_t adc_integral = {0};
      uint32_t detid = {0};
      uint32_t flags = {0};
   };
}
```



### Trigger Decision



#pragma once
#include <cstdint>

```
namespace DuneTriggerAlgs {
   struct TriggerDecision {
      int64_t time_start = {0};
      int64_t time_end = {0};
      int64_t time_triggered = {0};
      uint32_t detid = {0};
      uint32_t flag = {0};
   };
}
```



#### Algorithm "Maker"



- }
- One for each object (TriggerPrimitiveMaker, TriggerCandidateMaker, TriggerDecisionMaker)
- operator() pure virtual function  $\rightarrow$  that's where all the algorithmic part happens
- flush is maybe not needed...
  - At the end of the run, maybe somebody is interested in ill-formed clusters which had to be truncated?



### Appfwk interface



- Where the DAQProcesses are implemented and calling these operator() functions
- Example class: class DAQTriggerCandidateMaker: public dunedaq::appfwk::DAQModule, DuneTriggerAlgs::TriggerCandidateMakerSupernova
- Fills and consumes queues of Trigger objects
  - Simplest thing I could think of (most of it is just copy-paste from listrev)
  - Obviously, all of this has to run on the same host since there isn't any message protocol implemented in the appfwk (or at least I didn't know about it)
- Holds and parses all the configurations of the algorithms previously defined.
  - For example, in case of Supernova trigger decision maker, we might change the threshold in number of clusters at which the SN trigger is emitted
  - Implemented as simple std::atomic<int> in TriggerCandidateMaker, the DAQProcess is in charge to update it (i.e. reconfiguration can happen without a "stop and start" sequence)
    - Didn't quite make it happen for this talk



#### simplest\_trigger.json



```
"queues"
    "TPsQueue" {
        'capacity"
        "kind" "FollyMPMCQueue"
    'TCsQueue"
        "capacity"
        "kind" "FollyMPMCQueue"
    'TDsQueue"
        "capacity"
        "kind" "FollyMPMCQueue"
"modules"
    "TPsGenerator"
                            "TriggerPrimitiveRadiological"
        "user module type"
        "output" "TPsQueue"
    'TPsGenerator2"
        "user module type"
                            "TriggerPrimitiveSupernova"
        "output" "TPsQueue"
    "TCsGenerator"
                            "DAQTriggerCandidateMaker"
        "user module type"
        "input" "TPsQueue"
        "output" "TCsQueue"
     TDsGenerator"
                             "DAQTriggerDecisionMaker"
        "user module type"
        "input" "TCsQueue"
        "output" "TDsOueue"
"commands"
    "start'
               "TDsGenerator"
                                "TCsGenerator"
                                                 "TPsGenerator"
                                                                 "TPsGenerator2"
    "stop'
               "TPsGenerator"
                                "TPsGenerator2"
                                                 "TCsGenerator"
                                                                  "TDsGenerator"]
    "configure threshold"
                           [ "TDsGenerator" ]
```

- Stores everything in MPMCQueues (probably not the best choice...)
- Generators:
  - TCsGenerator consumes TPs
  - TDsGenerator consumes TCs
  - TPsGenerator should consumes something representative of the raw data
    - Right now, just generates random TPs (Argon 39 and Supernova)
- Of course this is cheating
  - Although there are 2 threads generating TPs, they are nicely "time ordered", there are some assumptions during the formation of TCs would make it break if that wasn't the case
- Would need equivalent of a ptmp's "TPwindow" to make it more realistic

## Running it



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nd of while loop					Leaend
2020-Aug-18 07:33:35,713 DEB	BUG_0 [dunedaq::trigg	er::DAQTriggerDecisionMaker::	do_work() at /dune/app/users/	/plasorak/appfwk/DAQDune	
e: TDsGenerator					Yellow-ish: Ar39 IPs generator
2020-Aug-18 07:33:36,706 DEB	006_0 [dunedad::toy_0 10dule: TPsGenerator?	enerator:::riggerPrimitiveSup	ernova::do_work() at /dune/ap	op/users/plasorak/apptw	
tp.time start : 146837934044	1814 tp.channel: 40	19			Red: SN IPs generator
tp.time_start : 146837934046	5216 tp.channel : 41				
2020-Aug-18 07:33:36,713 DEB	BUG_0 [dunedaq::toy_g	enerator::TriggerPrimitiveRad	iological::do_work() at /dune	e/app/users/plasorak/app	Blue: ICs generator
Argon 39 TPs #51 last TPs pa	acket has size 2 DAQM	lodule: TPsGenerator			
2020-Aug-18 07:33:36,713 DEB	SUG_0 [dunedad::trigg	er::DAQIriggerCandidateMaker:	do_work() at /dune/app/users	s/plasorak/apptwk/DAQDu	Pink: IDs generator
tc.time_start : 146837884023		t : 1848 -> tc.channel_end :	1849 tc.ntps : 2 2020-Aug-18 07	7:33:36,713 DEBUG_0 [du	<pre>nedag::toy_generator::TriggerPrimitiveRadiological::do_work() at /dune</pre>
/app/users/plasorak/appfwk/D	)AQDuneTriggers/src/T	 riggerPrimitiveRadiological.c	op:191] Sent generated Argon 39	hits # 53 DAQModule: Th	PsGenerator
2020-Aug-18 07:33:36,713 DEB	BUG_0 [dunedaq::trigg	er::DAQTriggerCandidateMaker:	do_work() at /dune/app/users	s/plasorak/appfwk/DAQDu	neTriggers/src/DAQTriggerCandidateMaker.cpp:121] Clustered prim #88 DAQMo
dule: TCsGenerator				(-)	Tripper (DAOT ripper Desision Males, and 120] Cand ressined #20 DAOMadul
2020-Aug-18 07:33:30,713 DEB e: TDsGenerator	SUG_0 [dunedad::trigg	er::DAUIriggerDecisionMaker::0	do_work() at /dune/app/users/	plasorak/apptwk/DAQDun	erriggers/src/DAQTriggerDecisionMaker.cpp:128] Cand received #30 DAQModul
2020-Aug-18 07:33:36,713 L0G	G [dunedaq::toy_gener	ator::TriggerPrimitiveRadiolo	gical::do_work() at /dune/app	o/users/plasorak/appfwk,	/DAQDuneTriggers/src/TriggerPrimitiveRadiological.cpp:193] TPsGenerator e
nd of while loop					
2020-Aug-18 07:33:37,706 DEB	BUG_0 [dunedaq::toy_g	enerator::TriggerPrimitiveSup	ernova::do_work() at /dune/ap	op/users/plasorak/appfw	k/DAQDuneTriggers/src/TriggerPrimitiveSupernova.cpp:172] Last TPs packet
has size 0, continuing! DAQM	lodule: TPsGenerator2				
tp.time_start : 146837984069	1359 Tp.Channel : 11 1765 tp.channel : 11	60 66			
2020-Aug-18 07:33:37,713 DEB	BUG 0 [dunedag::toy c	enerator::TriggerPrimitiveRad	iological::do work() at /dune	e/app/users/plasorak/app	pfwk/DAQDuneTriggers/src/TriggerPrimitiveRadiological.cpp:163] Generated
Argon 39 TPs #53 last TPs pa	acket has size 2 DAQM	lodule: TPsGenerator			
2020-Aug-18 07:33:37,713 DEB	BUG_0 [dunedaq::trigg	er::DAQTriggerCandidateMaker:	do_work() at /dune/app/users	s/plasorak/appfwk/DAQDu	<pre>neTriggers/src/DAQTriggerCandidateMaker.cpp:121] Clustered prim #89 DAQMo</pre>
dule: TCsGenerator		t 100 to to shore l and t	110 to star + 2 2020 Ave 10 07.5		desister secondor. Trizza Drimitic Dadialazia luda cark() at (dura (s
np/users/plasorak/annfwk/DA0	DuneTriggers/src/Tri	<pre>deerPrimitiveRadiological.com</pre>	191] Sent generated Argon 39 h	its # 55 DAOModule: TPs	Generator
2020-Aug-18 07:33:37,713 DEB	BUG_0 [dunedaq::trigg	er::DAQTriggerCandidateMaker:	:do_work() at /dune/app/users	s/plasorak/appfwk/DAQDu	neTriggers/src/DAQTriggerCandidateMaker.cpp:121] Clustered prim #90 DAQMo
dule: TCsGenerator					
2020-Aug-18 07:33:37,713 DEB	BUG_0 [dunedaq::trigg	er::DAQTriggerDecisionMaker::	do_work() at /dune/app/users/	/plasorak/appfwk/DAQDun	eTriggers/src/DAQTriggerDecisionMaker.cpp:128] Cand received #31 DAQModul
e: TDsGenerator	dupodogutov gopor		ricolude vert() ) of $dupe (or$	/uconc/nlaconak/annfuk	(DAODunaTriagans (are (TriaganDrimitiveDadia)agical annu102] TheConorator a
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SUPERNOVAAAAAA!					
n_evt : 8					
<pre>tp.time_start : 146838033732</pre>	2154 tp.channel : 19	87			
tp.time_start : 146838033732	2874 tp.channel : 19	88			
tp.time_start : 140838033733	376 tn.channel: 19	99			
tp.time_start : 146838033733	3549 tp.channel : 19	91			
2020-Aug-18 07:33:38,707 DEB	BUG_0 [dunedaq::toy_g	enerator::TriggerPrimitiveSup	ernova::do_work() at /dune/ap	op/users/plasorak/appfwl	<pre>k/DAQDuneTriggers/src/TriggerPrimitiveSupernova.cpp:177] Generated Supern</pre>
ova TPs #35 last TPs packet	has size 5 DAQModule	: TPsGenerator2			
2020-Aug-18 07:33:38,707 DEB	3UG_0 [dunedaq::toy_g . TPsCenerator?	enerator::IriggerPrimitiveSup	ernova::do_work() at /dune/ap	op/users/plasorak/apptwl	<pre>k/DAQDuneTriggers/src/TriggerPrimitiveSupernova.cpp:205] Sent generated S</pre>
2020-Aug-18 07:33:38,707 DEB	BUG_0 [dunedag::trigg	er::DAQTriggerCandidateMaker:	do_work() at /dune/app/users	s/plasorak/appfwk/DAODu	neTriggers/src/DAQTriggerCandidateMaker.cpp:121] Clustered prim #91 DAOMo
dule: TCsGenerator					
<pre>tc.time_start : 2020-Aug-18</pre>	07:33:38,70714683798	4069359 tc.channel_start :	1165 -> tc.channel_end : 1166 t	tc.ntps : 2LOG [ duneda	<pre>q::toy_generator::TriggerPrimitiveSupernova::do_work() at /dune/app/us</pre>
ers/plasorak/appfwk/DAQDuneT	riggers/src/TriggerF	'rimitiveSupernova.cpp:207] TP:	sGenerator2 end of while loop		Hdunobuilda2 fp2] gov# 07,40, 10 Aug 20
[0] 0.bash— I.[thiùX]↑					uunebuitubz.fhat.gov 07:46 18-Aug-20

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#### ... and a bit further



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tp.time_start : 146838133761116	5 tp.channel : 1795				Legend
tp.time_start : 146838133761321	tp.channel : 1796				
tp.time_start : 146838133761534	tp.cnannel : 1/9/				Yellow-Isn: Ar39 IPS generator
tp.time_start : 146838133761907	tp.channel: 1790				
tp.time_start : 146838133762101	tp.channel : 1800				<b>Red:</b> SN IPS generator
2020-Aug-18 07:33:40,707 DEBUG_	_0 [dunedaq::toy_gener	ator::TriggerPrimitiveSupern	ova::do_work() at /dune,	/app/users/plasorak/appfwł	
ova TPs #48 last TPs packet has	s size 9 DAQModule: TP	sGenerator2			Blue: ICs generator
2020-Aug-18 07:33:40,707 DEBUG_	_0 [dunedaq::toy_gener	ator::TriggerPrimitiveSupern	ova::do_work() at /dune,	/app/users/plasorak/appfwł	
2020_Aug_18 07:33:40 707 DEBUG	PSGeneratorz	AOTriggerCandidateMaker.do	work() at /dune/ann/us	ers/nlasorak/annfwk/DAODur	Pink: IDs generator
odule: TCsGenerator				21 37 p (d 301 dk) dpp i wk/ bhqbdi	
tc.time_start : 146838083745404	2020-Aug-18 07:33:4	0,707 tc.channel_start : LOG	[2299 -> tc.channel_end	: 2306 tc.ntps : 8 dunedad	<pre>g::toy_generator::TriggerPrimitiveSupernova::do_work() at /dune/app/us</pre>
ers/plasorak/appfwk/DAQDuneTrig	gers/src/TriggerPrimi	tiveSupernova.cpp:207] TPsGe	nerator2 end of while loop		
2020-Aug-18 07:33:40,707 DEBUG_	_0 [dunedaq::trigger::	DAQTriggerCandidateMaker::do	_work() at /dune/app/use	ers/plasorak/appfwk/DAQDun	<pre>neTriggers/src/DAQTriggerCandidateMaker.cpp:121] Clustered prim #105 DAQM</pre>
odule: ICsGenerator	A [dupodogutriggoru]	AOTriggor(andidateMakor, do	work()) at (duna(ann/us)	are (nlacorak (annfuk (DAODur	potriggors (srs (DAOTriggorCondidateMaker cons121) (lustered prim #106 DAOM
odule: TCsGenerator	_o [dunedaqiiiggei			ers/plasurak/apprikk/bAQbui	len iggers/sic/baginiggercandidatenaker.cpp.izij clustered prim #100 bagn
2020-Aug-18 07:33:40,707 DEBUG_	_0 [dunedaq::trigger::	DAQTriggerCandidateMaker::do	_work() at /dune/app/use	ers/plasorak/appfwk/DAQDun	neTriggers/src/DAQTriggerCandidateMaker.cpp:121] Clustered prim #107 DAQM
odule: TCsGenerator					
2020-Aug-18 07:33:40,707 DEBUG_	_0 [dunedaq::trigger::	DAQTriggerCandidateMaker::do	_work() at /dune/app/use	ers/plasorak/appfwk/DAQDun	<pre>neTriggers/src/DAQTriggerCandidateMaker.cpp:121] Clustered prim #108 DAQM</pre>
odule: TCsGenerator					Think we (and (DAOThink we can did the Malan and 1911) Clustered and #100 DAOM
2020-Aug-18 07:33:40,707 DEBUG_	_U [dunedaq::trigger::	DAQI riggercandidatemaker::do	_work() at /dune/app/use	ers/plasorak/apptwk/DAQDUn	leiriggers/src/DAQIriggerCandidateMaker.cpp:121] clustered prim #109 DAQM
2020-Aug-18 07:33:40.707 DEBUG	0 [dunedag::trigger::	DAOTriggerCandidateMaker::do	work() at /dune/app/use	ers/plasorak/appfwk/DAODun	neTriggers/src/DAOTriggerCandidateMaker.cpp:121] Clustered prim #110 DAOM
odule: TCsGenerator					
2020-Aug-18 07:33:40,707 DEBUG_	_0 [dunedaq::trigger::	DAQTriggerCandidateMaker::do	_work() at /dune/app/use	ers/plasorak/appfwk/DAQDun	<pre>neTriggers/src/DAQTriggerCandidateMaker.cpp:121] Clustered prim #111 DAQM</pre>
odule: TCsGenerator					
2020-Aug-18 0/:33:40,/0/ DEBUG_	_0 [dunedaq::trigger::	DAQIriggerDecisionMaker::do_	work() at /dune/app/use	rs/plasorak/appfwk/DAQDune	elriggers/src/DAQlriggerDecisionMaker.cpp:128] Cand received #34 DAQModul
2020-Aug-18 07:33:40.708 DEBUG	0 [dunedag::trigger::	DAOTriggerCandidateMaker::do	work() at /dune/app/use	ers/plasorak/appfwk/DAODun	neTriggers/src/DAOTriggerCandidateMaker.cpp:121] Clustered prim #112 DAOM
odule: TCsGenerator	_o [aanoaaq.i.c. 1990.i.i				
td.time_start : 146837583745404	td.time_end : 14683	8083747443			
tp.time_start : 146838134118930	) tp.channel : 8				
2020-Aug-18 07:33:40,714 DEBUG_	_0 [dunedaq::toy_gener	ator::TriggerPrimitiveRadiol	ogical::do_work() at /d	une/app/users/plasorak/app	ofwk/DAQDuneTriggers/src/TriggerPrimitiveRadiological.cpp:163] Generated
2020-4ug-18 07:33:40 714 DEBUG	0 [dunedag::trigger::	2: TPSGenerator DAOTriggerCandidateMaker:do	work() at /dune/ann/us	ers/nlasorak/annfwk/DAODun	peTriggers/src/DAOTriggerCandidateMaker con:121] Clustered prim #113 DAOM
odule: TCsGenerator					
tc.time_start : 146838133759913	B tc.channel_start :	1792 -> tc.channel_end : 18	00 tc.ntps : 9 2020-Aug-18	07:33:40,714 DEBUG_0 [dun	<pre>nedaq::toy_generator::TriggerPrimitiveRadiological::do_work() at /dune</pre>
/app/users/plasorak/appfwk/DAQD	DuneTriggers/src/Trigg	erPrimitiveRadiological.cpp:	191] Sent generated Argon 3	39 hits # 56 DAQModule: TP	PsGenerator
2020-Aug-18 07:33:40,714 DEBUG_	_0 [dunedaq::trigger::	DAQTriggerDecisionMaker::do_	work() at /dune/app/use	rs/plasorak/appfwk/DAQDune	<pre>PTriggers/src/DAQTriggerDecisionMaker.cpp:128] Cand received #35 DAQModul</pre>
e: IDsGenerator	lunedaatov generator		al. do work( ) at (dune/	ann/ucerc/nlacorak/annfuk/	/DAODupeTriggers/src/TriggerPrimitivePadiological_cop:103] TDsCenerator_e
nd of while loop	iuneuaqtoy_generator			app/users/plasorak/apprwk/	DAQDuneringgers/sic/iniggerrinmitiveRadiotogicat.cpp.1953 inscenerator e
tp.time_start : 146838183773081	tp.channel : 2386				
tp.time_start : 146838183773877	tp.channel : 2387				
tp.time_start : 146838183774146	tp.channel: 2388				
tp.time_start : 146838183774365	tp.channel : 2389				
2020-Aug-18 07:33:41 707 DEBUG	0 [dunedag::tov gener	ator::TriggerPrimitiveSupern	ova::do work() at /dune	/ann/users/nlasorak/annfwk	(/DAODuneTriggers/src/TriggerPrimitiveSupernova.cop.177] Generated Supern
[0] 0:bash- 1:[tmux]*	_o _uuncaaq.i.coy_gener				"dunebuild02.fnal.gov" 07:53 18-Aug-20

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#### Conclusion



- Basic SN triggering scheme implemented in the appfwk
- Quite a bit of bricks are missing to make it usable in the real system, here are the one I can think of:
  - Messaging system in appfwk
  - TP window
  - This intermediate state between TCs and TDs
  - A better idea how to implement TP generator from raw data (no input queue for the TPs in my example)
- Where to go from here?
  - <u>https://github.com/plasorak/DAQDuneTriggers</u>
  - <u>https://github.com/plasorak/DuneTriggerAlgs</u>