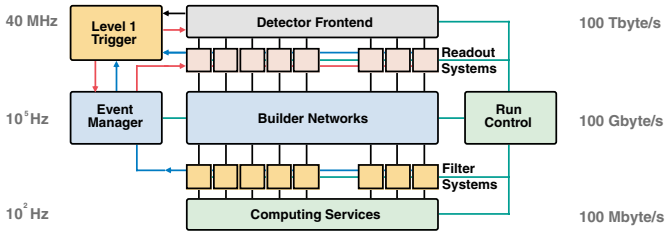
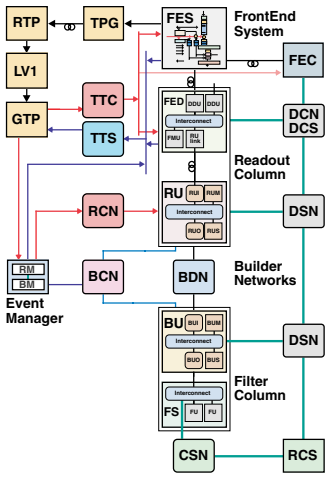
Trigger and data acquisition

Data Acquisition Main Parameters		
Collision rate		40 MHz
Level-1 Maximum trigger rate		100 kHz
Average event size	=	1 Mbyte
No. of electronics boards	=	10000
No. of readout crates	=	250
No. of In-Out units (200-5000 byte/event)	=	1000
Event builder (1000 port switch) bandwidth		1 Terabit/s
Event filter computing power	=	5 10^7 MIPS
Data production	=	Tbyte/day



Trigger and Data Acquisition baseline structure

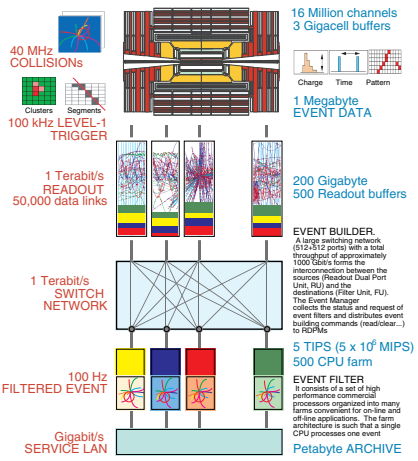


FLT	**FIRST LEVEL TRIGGER**
TPG	Trigger Primitive Generator
TDL	Trigger Data Link
RTP	Regional Trigger Processor
LV1	Calo & μ Trigger Processors
GTP	Global Trigger Processor
TTC	Timing, Trigger & Control
TTS	Trigger & Throttle System
EVB	**EVENT BUILDER**
BN	Builder Networks
BDN	Builder Data Network
RCN	Readout Control Network
BCN	Builder Control Network
EVM	Event Manager
RM	Readout Manager
BM	Builder Manager
FES	Front End System
DDL	Detector Data Link
RC	Readout Column
FED	FrontEnd Driver
FMU	Fast Monitoring Unit
DDU	Detector Dependent Unit
RDL	Readout Data Link
RU	Readout Unit
RUI	Readout Unit Input
RUM	Readout Unit Memory
RUO	Readout Unit Output
RUS	Readout Unit Supervisor
FC	Filter Column
BU	Builder Unit
BUI	Builder Unit Input
BUM	Builder Unit Memory
BUO	Builder Unit Output
BUS	Builder Unit Supervisor
FS	Filter Subfarm
FU	Filter Unit
HLT	High Level Trigger
RCS	**RUN CONTROL SYSTEM**
DCN	DAQ operation control and monitor
DDB	DAQ data bases
DCS	Detector Control System
DCN	Detector Control Network
FEC	FrontEnd Control
CDL	Control Data Link
CS	**COMPUTING SERVICES**
CSN	Computing and Services Network
DSN	DAQ Services Network
DA	Data archives

Computing and Communication main subsystems

At the LHC, the proton beams cross each other 40,000,000 times each second. At the highest LHC beam intensities, there will be roughly 25 proton-proton collisions for each crossing. Recording all the information from these collisions in the CMS experiment, requires, for every second of operation, the equivalent of 10,000 Encyclopaedia Britannica

The task of the Trigger and Data Acquisition System is to select, out of these millions of events, the most interesting 100 or so per second, and then store them for further analysis. An event has to pass two independent sets of tests, or Trigger Levels, in order to pass the TriDAS examination. The tests range from simple and of short duration (Level-1) to sophisticated ones requiring significantly more time to run (High Levels 2, 3, ...)

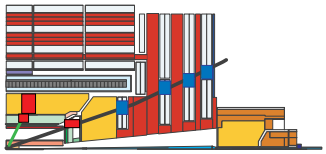


At Level-1 (LV1), the selection is carried out by special hardware processors seeking simple signs of an interesting event, e.g. a group of calorimeter cells with a lot of energy in them or muon chamber hits lying on given paths. The LV1 Trigger is very fast: it runs for less than one millionth of a second and selects the best 100,000 events each second. After Level-1 accepts an event, the data for that event is stored in 500 independent memories (RDPMs), each one connected to a different part of the CMS detector

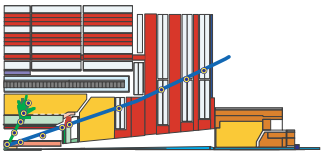
The next test, "Level-2" uses information from more than one piece of the detector. The next step is therefore to assemble the data corresponding to the various pieces of the CMS detector in a single location, a task referred to as "event building". In CMS, there will be a large switch that will connect all 500 RDPMs to a farm of computers. The latter are ready to accept data and run the Level-2 and Level-3 tests

Level-2, running on commercial processors, has more time and information to make a decision: it can take roughly thousandths of a second to decide, and the detector information available is more detailed

Finally, at Level-3, the full event has been assembled, and one can run very sophisticated physics algorithms looking for complex signatures. This is where particle tracks are matched to hits in the muon chambers, and where a photon is identified as a cell with high electromagnetic energy and no track pointing to it! Throughout this process, the DAQ system monitors the CMS detector and corrects for any malfunction



Level-1 trigger. 40 MHz input :
- Specialized processors (25 ns pipelined, latency < 1μs
- Local pattern recognition and energy evaluation on prompt macro-granular information from calorimeter and muon detectors
- Particle identification: high p_t electron, photon, muon, jets, missing E,



High trigger levels (>1). 100 kHz input :
- Large network of processor farms
- Clean particle signature. All detector data
- Finer granularity precise measurement
- Effective mass cuts and event topology
- Track reconstruction and detector matching
- Event reconstruction and analysis