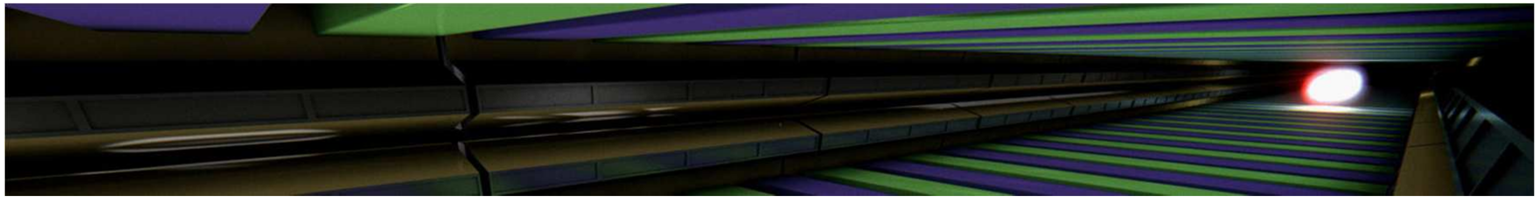

Overview of PBS system architecture

1st Meeting of the European XFEL Accelerator Consortium

17.4.2012

C.Youngman for WP76

Aim of talk

- Give the ACC an overview of the PBS control system and set the scene for the following talks:
  - Control, scientific computing and data management s/w (Burkhard Heisen)
    - → *Development of a homogeneous software framework*
  - Visualization tool development (Kerstin Weger)
    - → *GUI and visualization developments*
  - Integration of Beckhoff control systems (Nicola Coppola)
    - → *Describes integration of “slow” control h/w devices*
  - Integration of Experiments and Diagnostics (Chris Youngman)
    - → *Describes integration of “expt and diag” h/w devices*
- Talks concentrate on control and acquisition, data management and offline scientific computing analysis descriptions are brief.
- Electronics, FPGA… developments are described in parallel session.

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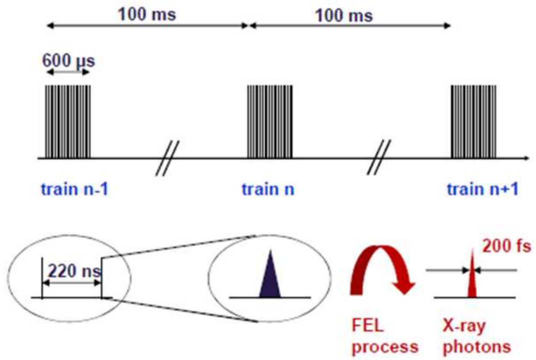
Beam time structure drive DAQ and control

- Readout rate driven by bunch structure
  - 10 Hz train of pulses
  - 4.51 MHz pulses in train
- Data volume driven by detector type and use of data



Detector type	Sampling	Data/pulse	Data/train	XFEL/sec	LCLS/sec
1 Mpxl 2D camera	4.5 MHz	~ 2 MB	~ 1 GB	~ 10 GB	~ 300 MB
1 channel digitizer	5 GS/s	~ 2 kB	~ 6 MB	~ 60 MB	~ 0.2 MB
Low latency feedback	5 GS/s	~ 2 B	~ 4 KB	~ 40 KB	~ 200 B
Screen camera	10 Hz	~ 2 MB	~ 2 MB	~ 20 MB	~ 200 MB

- **Experiment detectors are characterized by large data sizes (PBS)**
  - Need to acquire, long term storage required, offline analysis, multi-user full AAA s/w framework
- **Feedback systems are characterized by low data rates and low send latency (machine+PBS)**
  - Use on-the-fly, no need to store, trigger level with limited analysis, single user
- **Diagnostic devices are characterized by low data sizes (machine+PBS)**
  - Use on-the-fly, possibly short term storage, on-the-fly analysis, single user

Differences between handling of different detector type data is apparent

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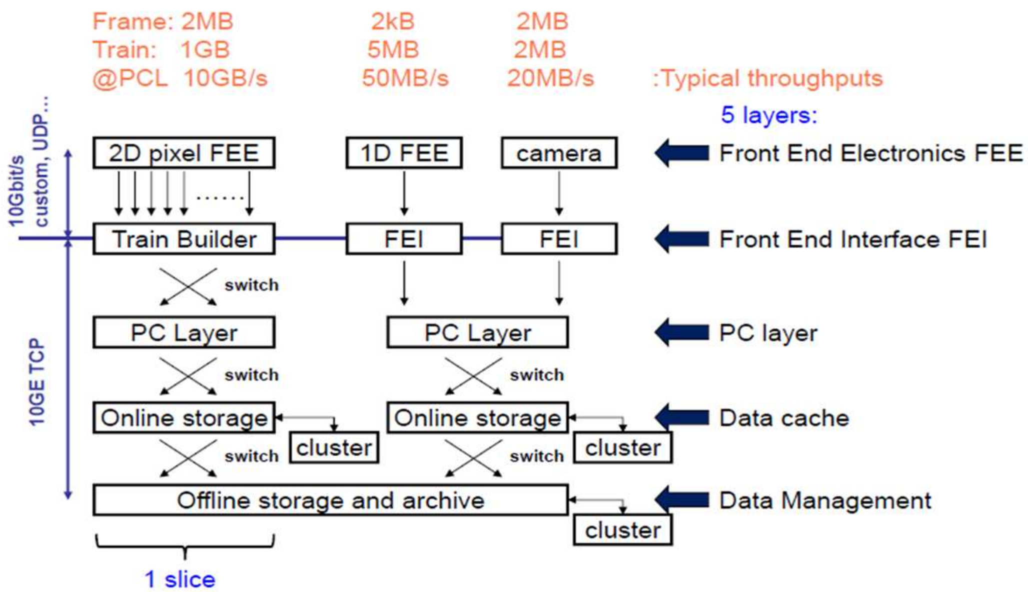
DAQ, control and Data Management architecture

The architecture chosen to bring all of these under one hat is:

Architecture chosen



- Multiple layers with well defined APIs
  - to allow insertion of new technology layers
- Multiple slices for partitioning and scaling
  - camera sizes will increase and slice replication will be one solution
- Allow full speed write through to online storage, but discourage usage
  - sometimes this capability is needed to understand measurement
- Enforce data reduction and rejection in all layers
  - early data size reductions and data rejection are needed to reduce storage resources

Large data volumes, their acquisition, storage and analysis and changing configurations are issue the PBS system architecture is trying to solve

Standards and policies (1/3)

The following standards and policies are being followed to build the photon system

DAQ

- Data transfer links are 10 Gbps with SFP+ (fibre or twinax links)
- TCP protocol is used for data transfer downstream of FEI (UDP initially)
- Data blocks transferred are complete trains of pulse ordered frames
- Data is tagged with the unique train number (and pulse number)
- FEIs must implement the VETO interface (low latency trigger)
- All layers must implement data rejection and reduction methods
- Use e-machine crate standards (MTCA.4 and ATCA)
- Define and use a small set of standard electronics components (digitizers, fast ADCs…)

Control

- Control interface to FEIs is via 1 or 10Gbps TCP
- Time synchronization is performed using the XFEL timing system (DESY-MCS4)
- Control of pumps, valves, gauges, motors, etc. is via a commercial distributed EtherCAT control system based on Beckhoff terminals and PLCs
- Control s/w must implement the device interface of the homogeneous s/w framework
- Interface (gateway) devices are used to connect other control systems

Standards and policies (2/3)

- **Data Management**
  - The initial size of the data storage system will be 10PB, scalable to 100PB
    - ➔ Implementation of 10PB storage system is agreed
    - ➔ Expanding the system beyond 10PB requires additional funding
  - Store second copy of data files in archive
  - Data will be archived for at least one year before deletion
  - A reasonable amount of computing power on site will be provided to scientists for data analysis
  - Use DESY IT infrastructure and basic services for implementation of XFEL.EU data management system
  - Record and maintain data and metadata needed for complete analysis
  - Define logical and physical model for data and metadata using HDF5
  - Provide support and infrastructure for online and offline data reduction and analysis on site
  - Efficient data transfer between different component of architecture layers
  - Small scale data export service
  - Coherent user identity management, authentication and authorization scheme for all services

Standards and policies (3/3)

- **Software**
  - Provide homogeneous software framework needed for DAQ, control, DM and SC
  - Core functionality implementation using C++/Boost
  - Python interfaces for non computing experts
  - Main platform is Linux (cross platform GUIs)
  - Pluggable software architecture
  - Software repositories, building and deployment system

- **Scientific Computing (analysis)**
  - Provide a analysis pipeline framework
  - Work with experts to insert user analysis s/w packages into the framework

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Reuse an existing control system

Can we reuse an existing system ?

Had a round trip (SLAC, ESRF, ALBA, Diamond/RAL, Petra3) looked at software, talked to experts.

Control Systems: EPICS, TANGO, GDA (software for science), DOOCS

DAQ: **Mostly in-house solutions + some commercial products (firmware etc.)**

Data Management: **Mostly in-house solutions** The HDF Group + lustre

Scientific Computing: **Mainly user driven – not a facility service** python

Common statements:

"It would be nice to have only one system serving all needs."

"Python as a language is very mighty and brings a lot of useful tools/libraries with it."

We can build a modern up-to-date technology system which will be out-of-date later ☺

Regions of interest = mandates

- Experiments
  - Provide DAQ, control, DM and SC system
- Optics
  - Provide Control f/w and s/w
  - Provide Required DM sub-systems
- Diagnostics
  - Provide DAQ and Control f/w and s/w
  - Provide Required DM and Scientific Computing sub-systems
- Machine
  - Provide our side machine interfaces
- Undulators
  - Provide our side undulator interface

Conclusion

- Message you should take home with you after the session
  - There is a reason for having a homogeneous system
  - There is a need for system separate from the e-machine control system
  - There is a need to exchange information between the two systems
  - There is a need to share control of some devices
  - Progress is being made