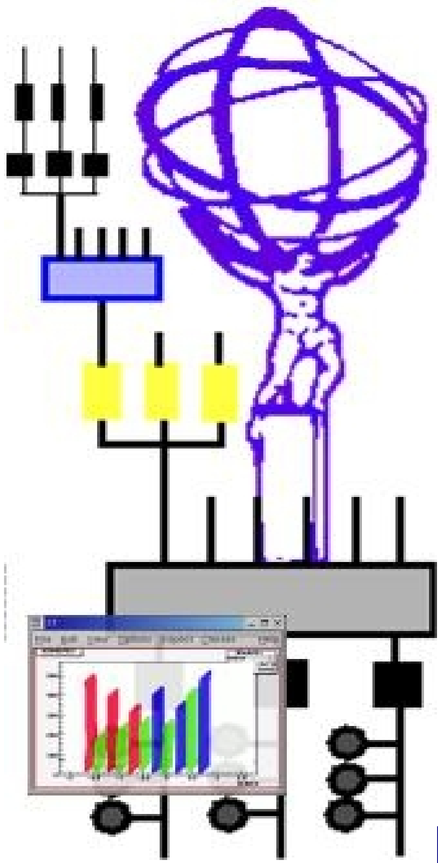
Strategies and Tools for the ATLAS On-line Monitoring



W.Vandelli (Univ. Pavia/INFN Pavia)
on behalf of the
ATLAS TDAQ Monitoring Working Group

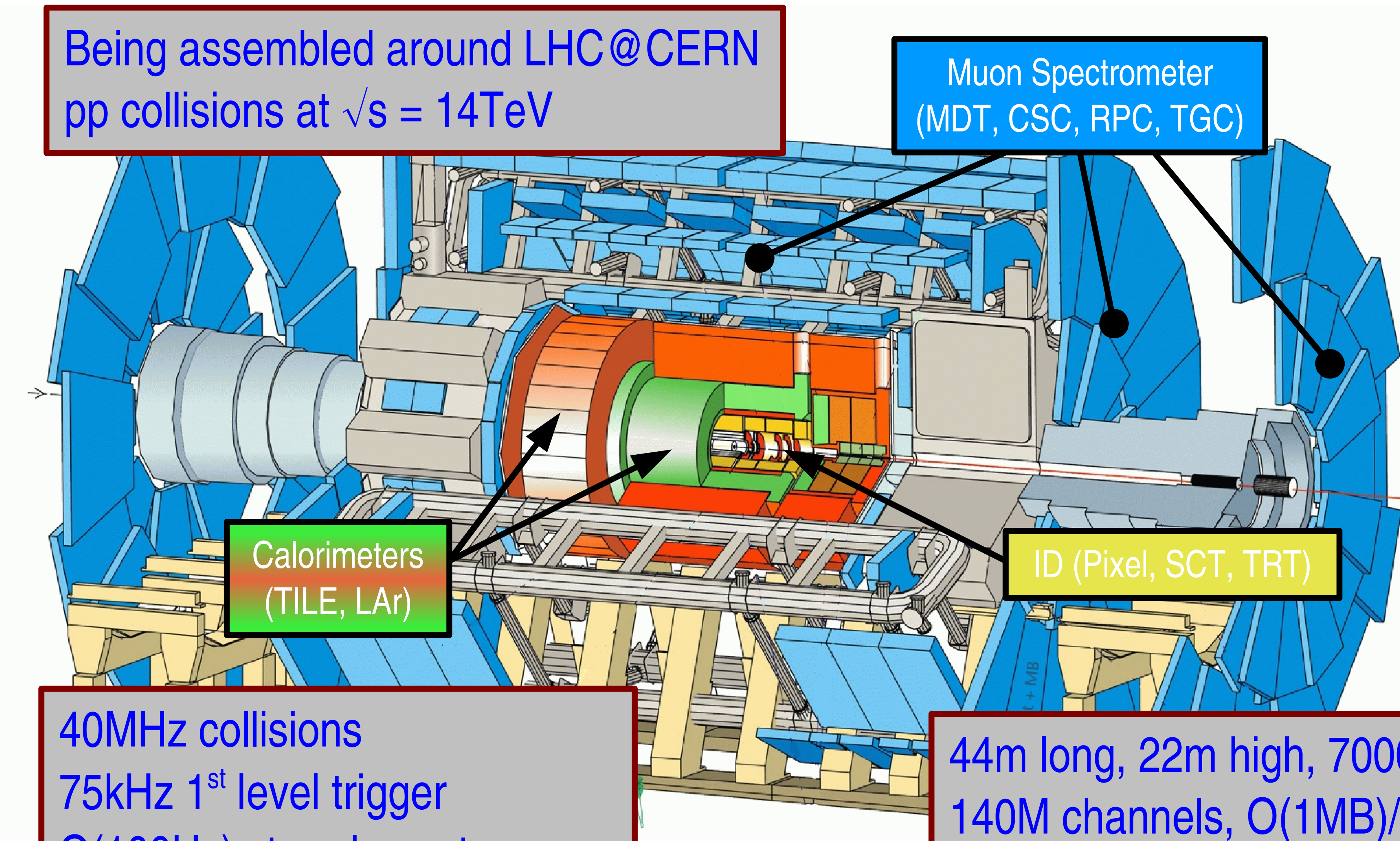
P. Adragna, M. Bosman, D. Burckhart, M. Caprini, M.J. Costa, M. Della Pietra, A. Dotti, I. Eschrich, R. Ferrari, M.L. Ferrer, G. Gaudio, H. Hadavand, M. Hauschild, S. Hillier, B. Kehoe, S. Kolos, K. Kordas, R. Mcpherson, M. Mineev, C. Padilla, T. Pauly, I. Riu, C. Roda, D. Salvatore, I. Scholtes, S. Sushkov, W. Vandelli, J. Von Der Schmitt, P.F. Zema

Outline

- ATLAS and ATLAS TDAQ
- Monitoring requirements
- Monitoring components
- Large Scale Test 2005

ATLAS Experiment

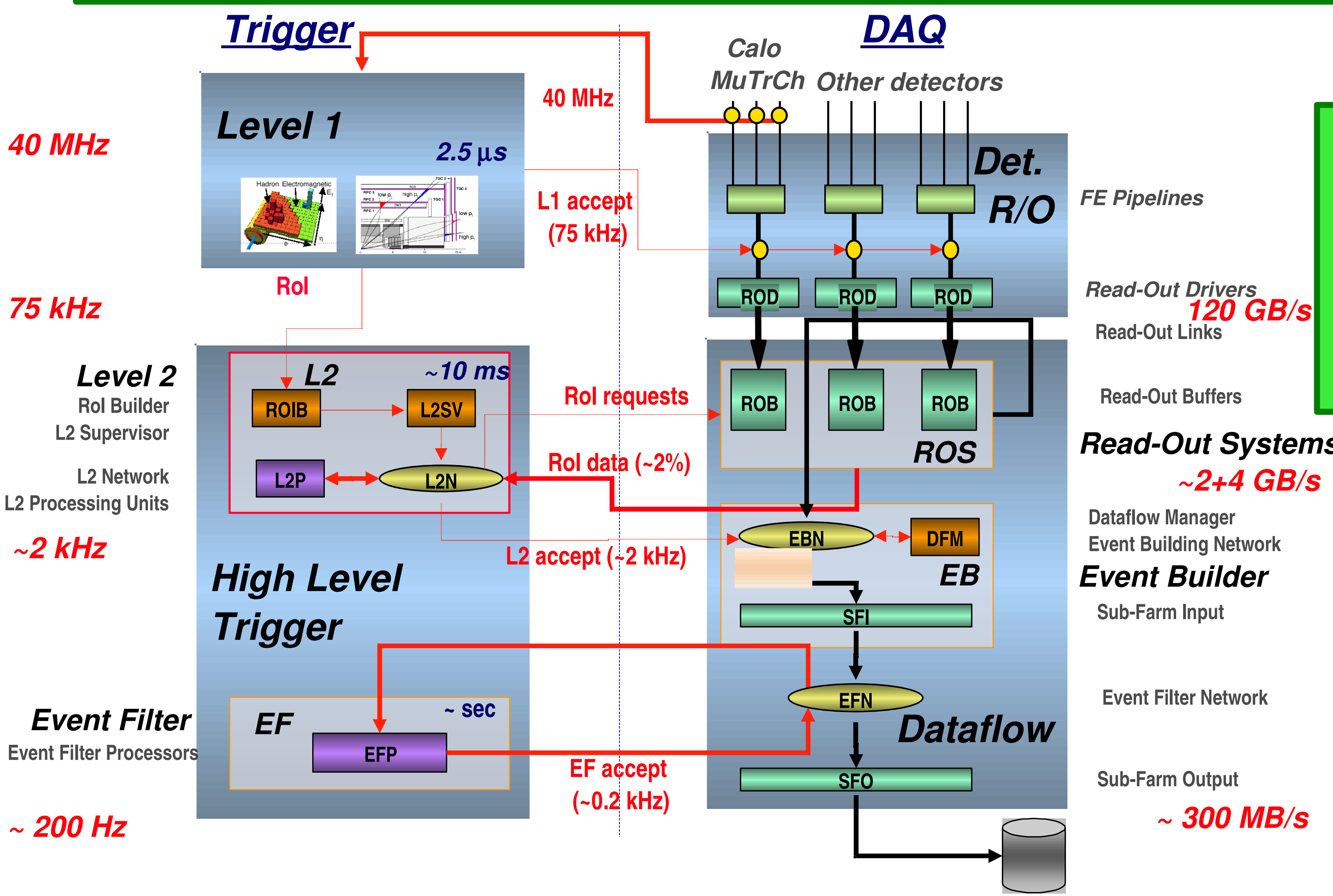
Being assembled around LHC@CERN
pp collisions at $\sqrt{s}$ = 14TeV



40MHz collisions
75kHz 1st level trigger
O(100Hz) stored events

44m long, 22m high, 7000 tons
140M channels, O(1MB)/event

ATLAS TDAQ System



Challenging experimental conditions and extreme detector complexity

Scalable and highly distributed TDAQ system

B. Gorini, "The ATLAS Data acquisition and High-Level Trigger: concept, design and status", OC-2

On-line Monitoring Requirements

- Provide a framework to constantly check:
  - the whole triggering system, in terms of functionality and physics performances
  - the DAQ system, in terms of hardware integrity and data integrity
  - the ATLAS sub-detectors
- Cope with the detector complexity being scalable and tunable to comply with all the different needs
- Support dynamic change of the monitoring parameters
- Provide flexible and configurable GUIs to show the status of monitored items
- Capable of performing automatic checking of the results including alarm generation and distribution

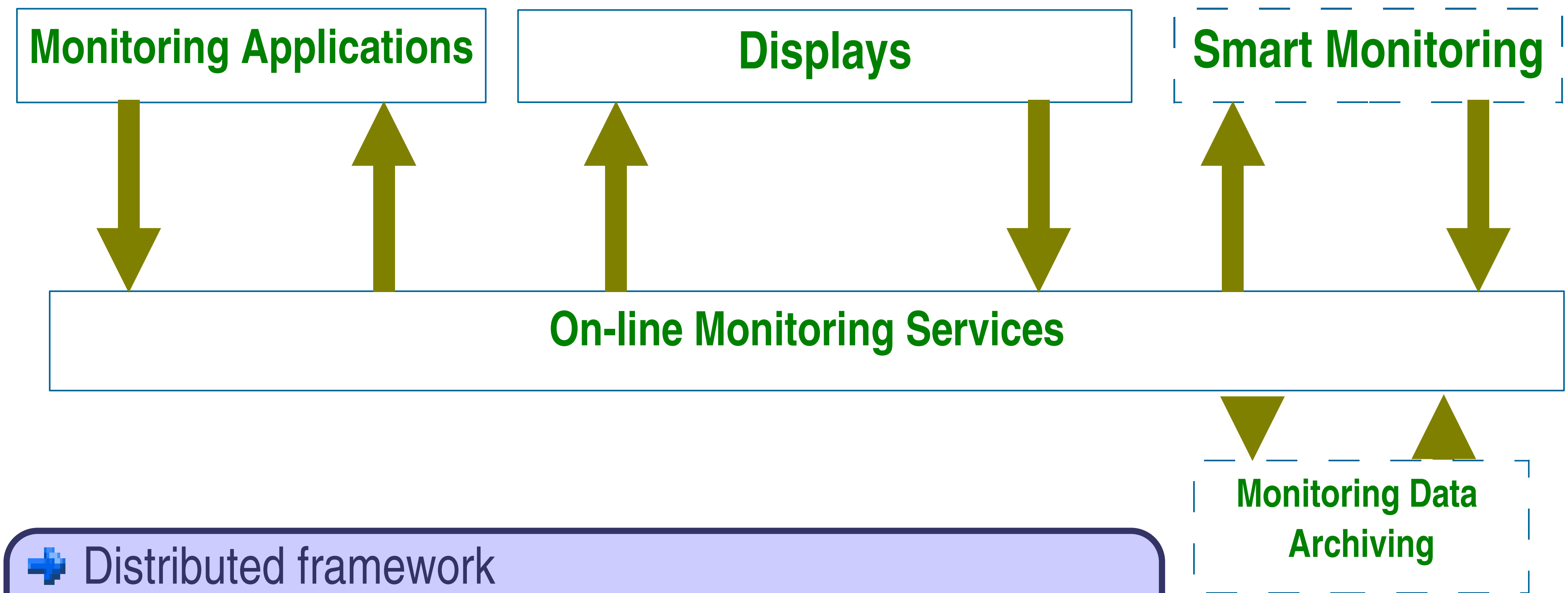
→ 15 sub-systems monitored in terms of functionality and results ←

→ 3000 sources of monitoring information ←

→ Up to 300 event sampling points ←

→ O(10GB)/run produced monitoring data ←

Monitoring Framework Structure

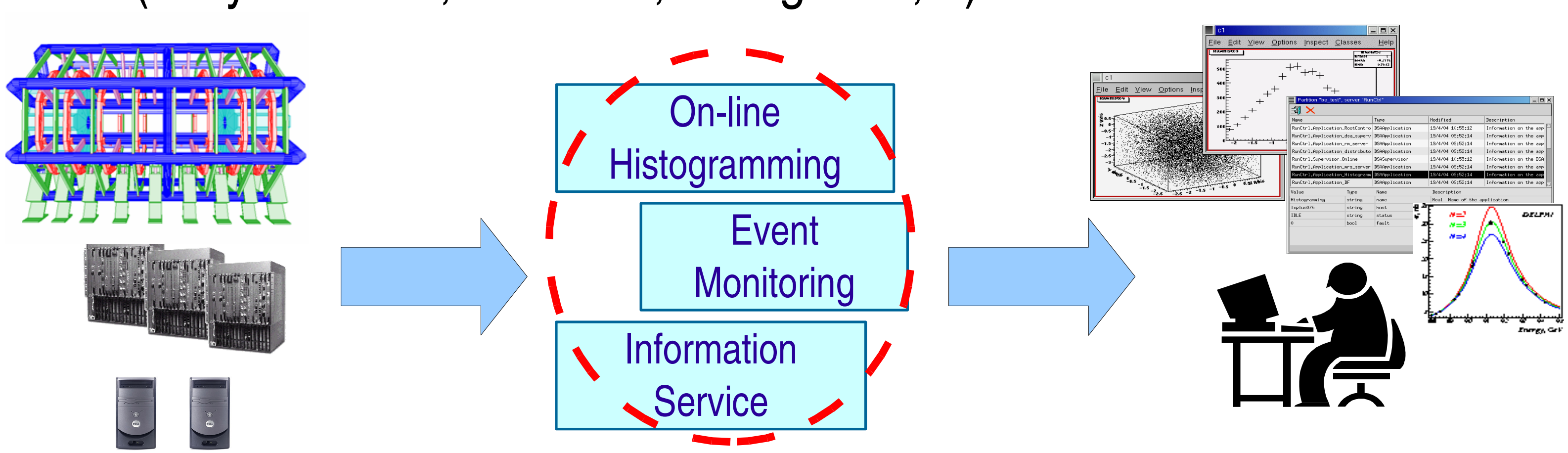


- Distributed framework
  - Isolate problems
  - Optimize applications for specific needs

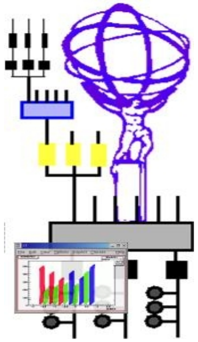
On-line Monitoring Services

AIM: provide different information-sharing channels abstracting the underlying complexity of the distributed environment

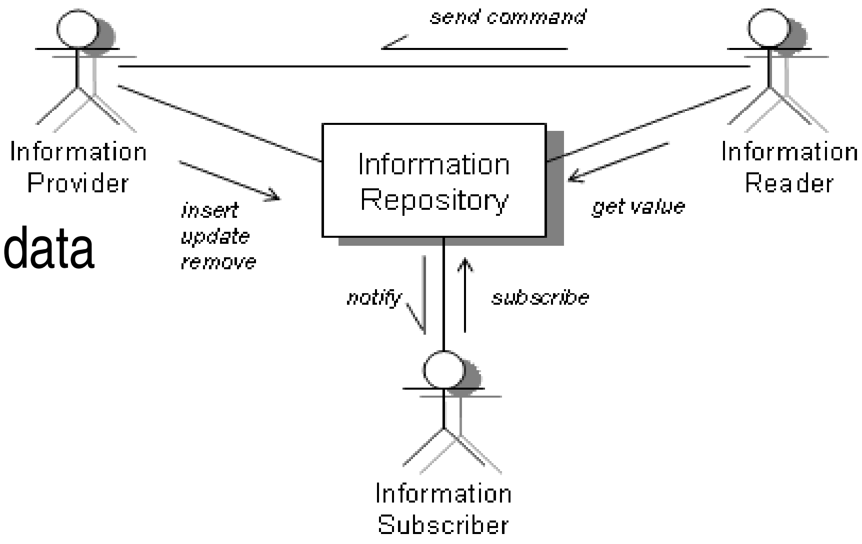
- Independent of the main data flow stream
- Transport requests and data between sources and destinations
- Adopt algorithms and mechanisms for the minimization of network and CPU loads
- Operational Monitoring: collection of many sorts of data produced by TDAQ components (busy statuses, data rate, histograms,...)



On-line Services: IS & OHS



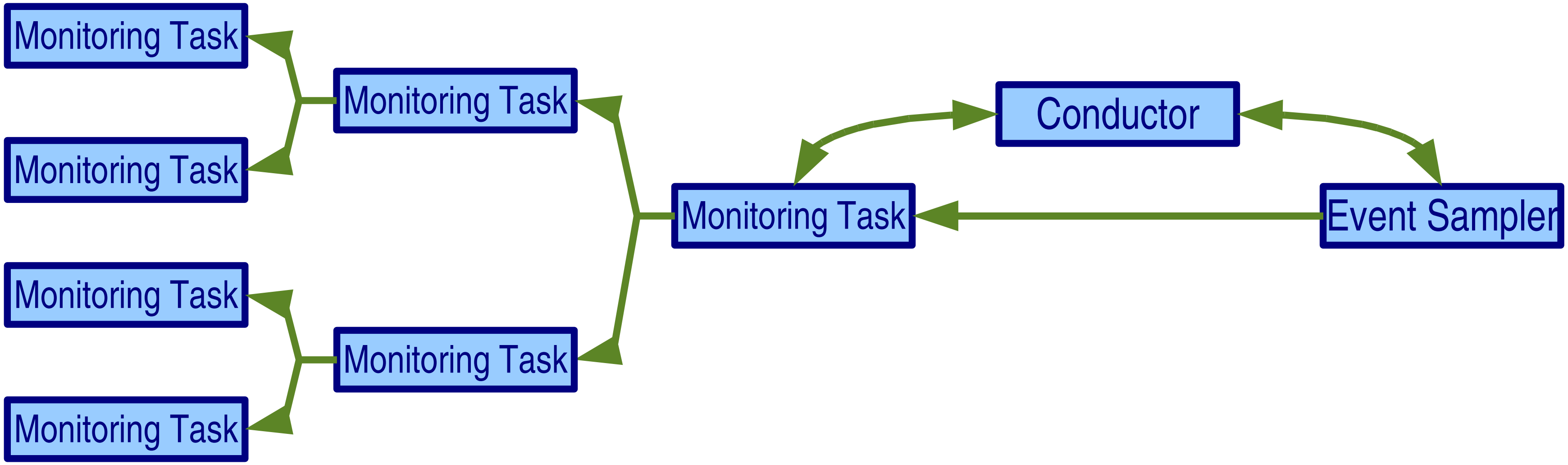
- Information Service (IS): enables software applications to share information
  - Insert, update, remove, read information
  - Copes with simple variables and user-defined data
  - Transport commands
  - Change notification



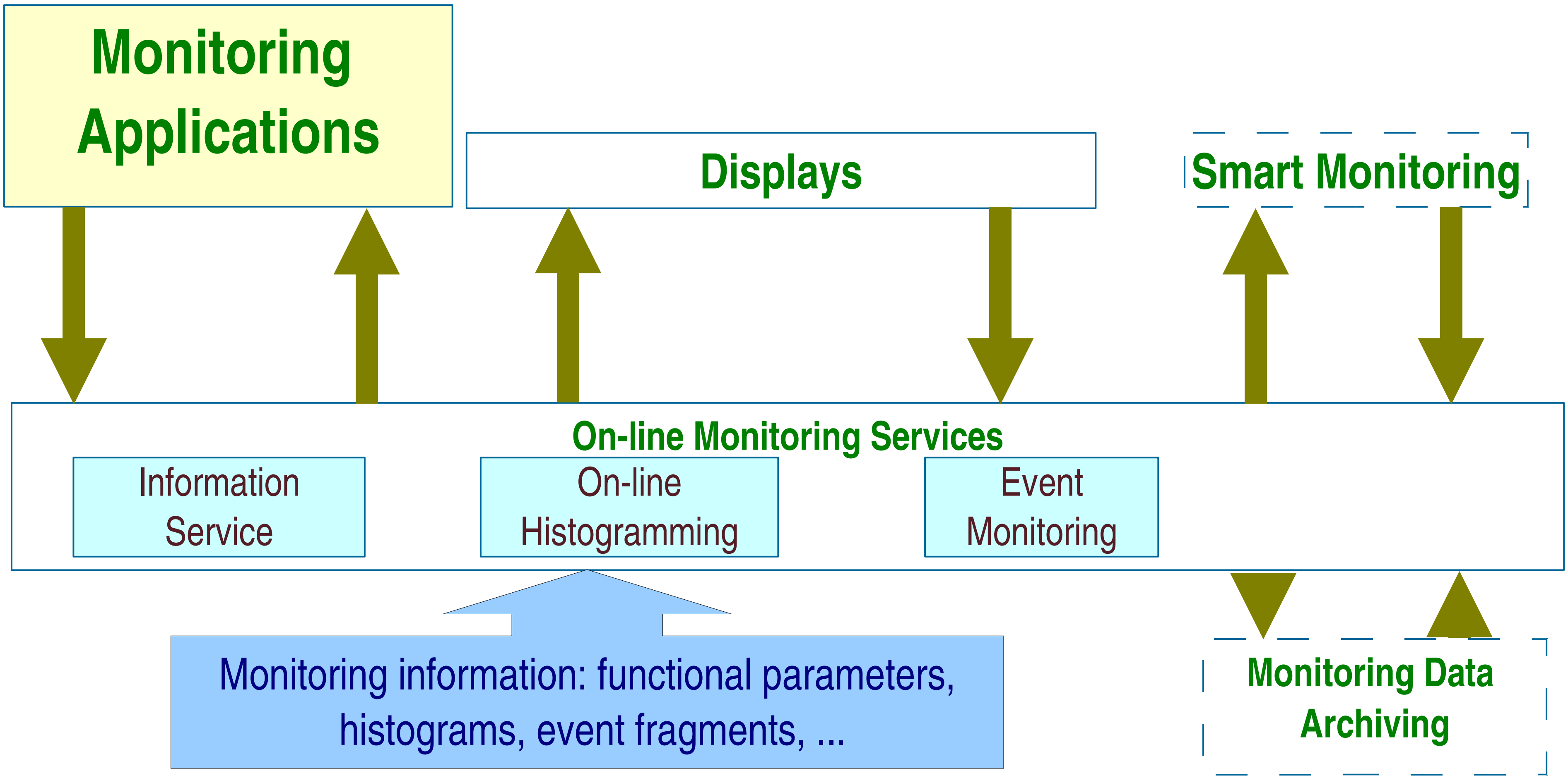
- On-line Histogramming Service (OHS): allows software applications to share histogram data
  - Based on IS
  - supports raw and ROOT histograms

On-line Services: Emon

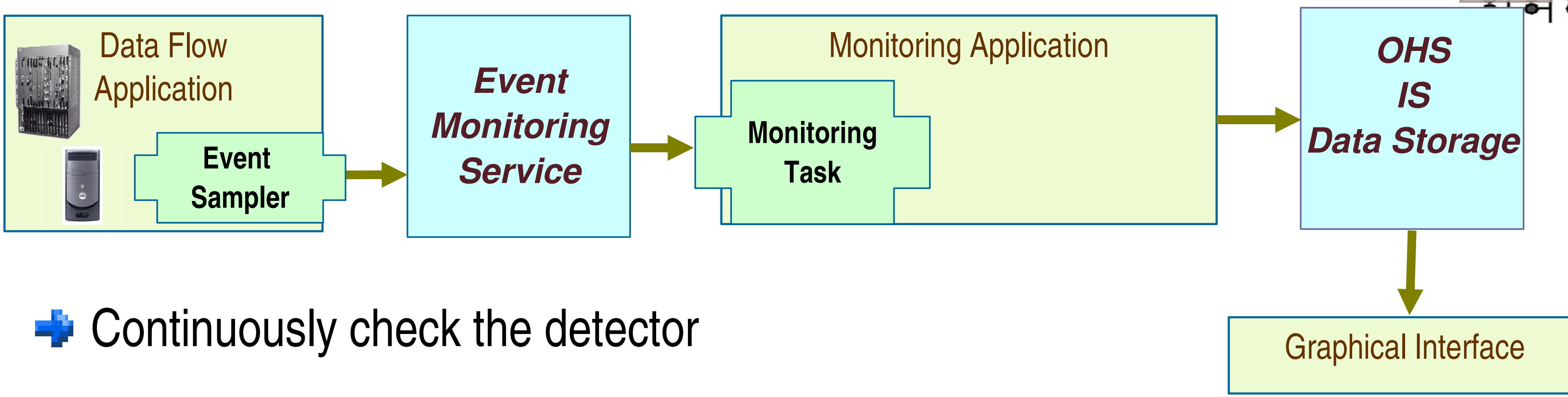
- Event Monitoring (Emon): provides on-line sample of events
  - Samples events or sub-fragments at any level of the data flow
  - Implements selection criteria based on trigger type and detector type
  - Load minimization thanks to a tree topology



Monitoring Framework



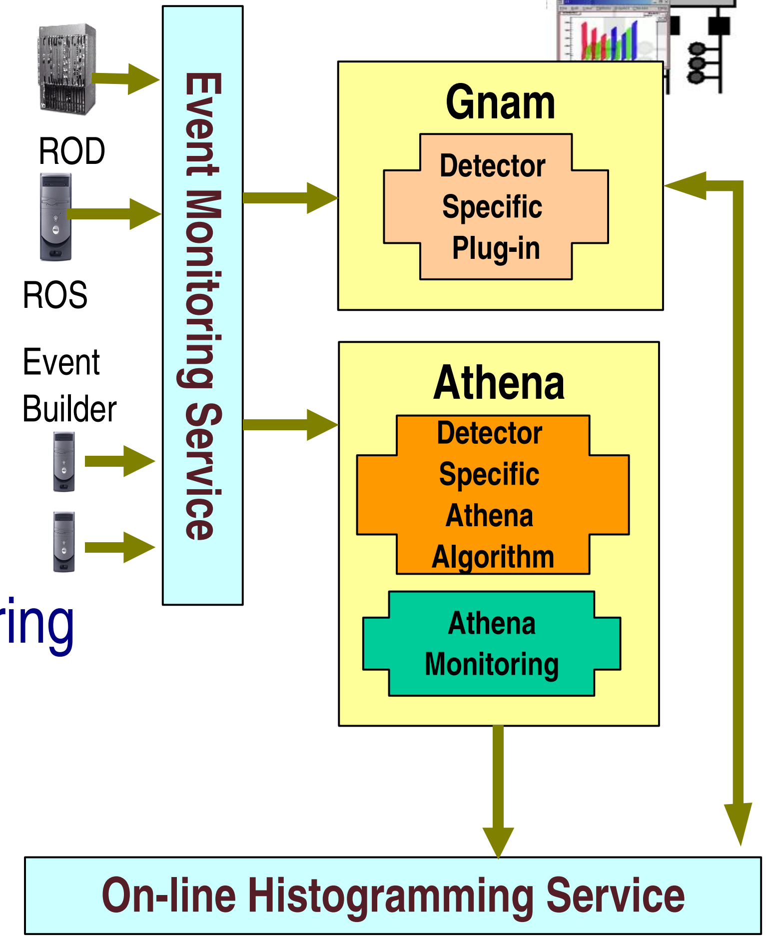
Data Monitoring



- Continuously check the detector
  - noisy and dead channels, calibration, ...
- Monitor HLT/DAQ sub-systems
  - track reconstruction, event types, ...
- Monitoring Applications provide a framework for the on-line analysis of the event fragments
- Exploit on-line services to retrieve events and publish results

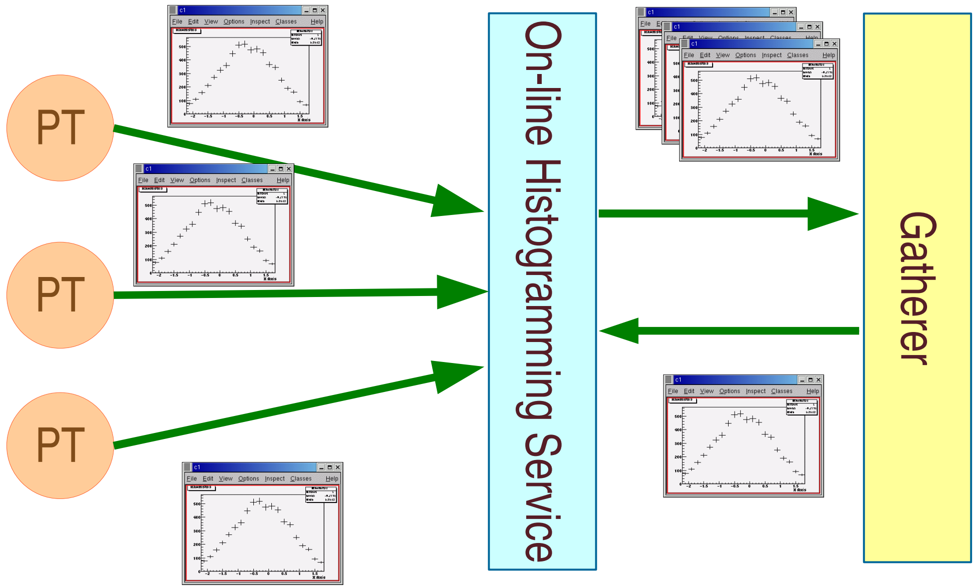
Monitoring Applications

- Athena Monitoring: physics monitoring
  - Based on the Event Filter processing task
  - Uses off-line analysis algorithms
  - High-level monitoring even before trigger filtering
- Gnam: lightweight hardware functionality monitoring
  - Analysis algorithms as plug-ins (dynamic loaded libraries)
  - Can run interactively or controlled by the TDAQ system
  - Can receive asynchronous commands



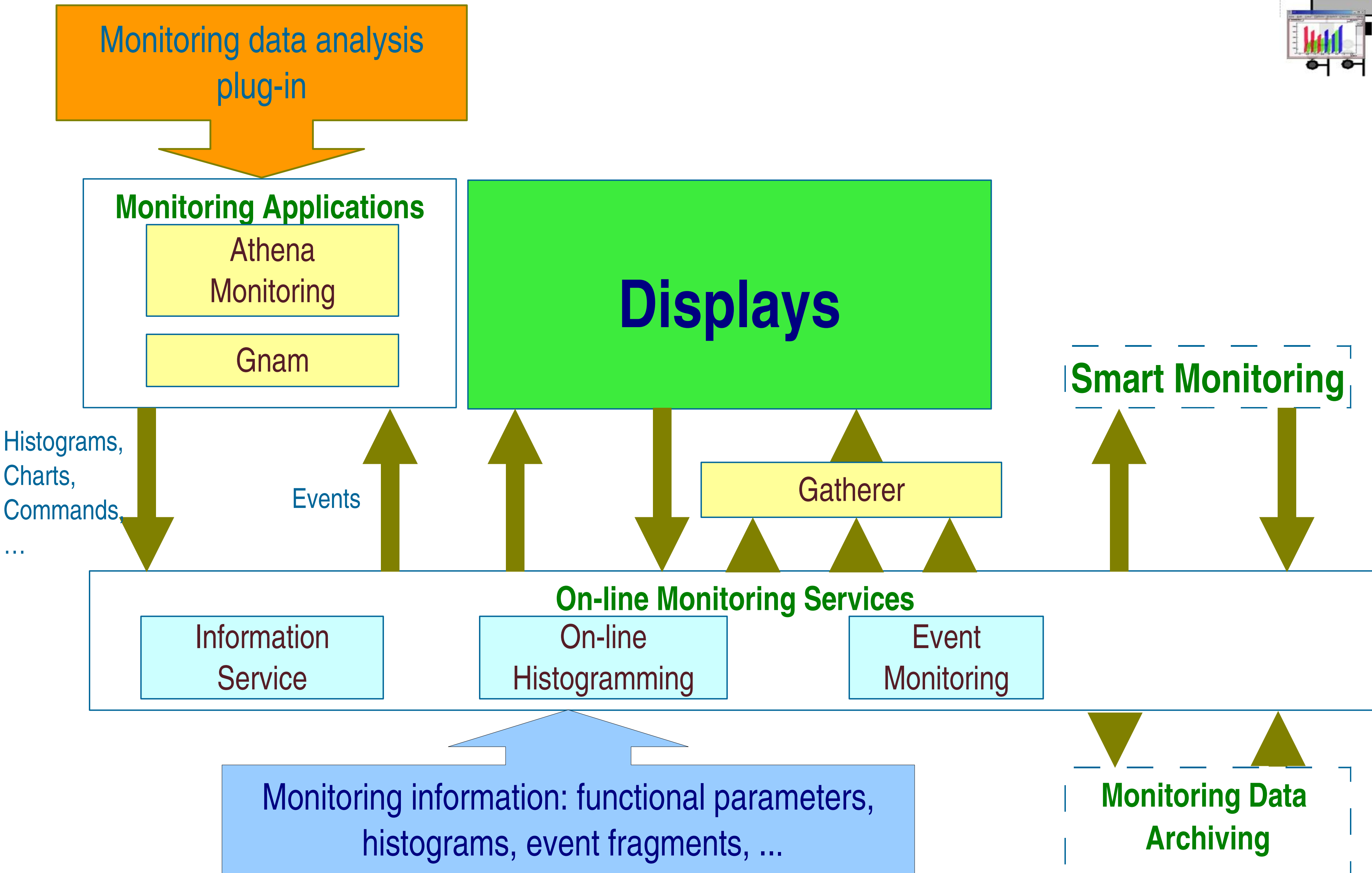
Gatherer

- EF & LVL2 processing tasks can run monitoring algorithms
  - functionality of HLT and DAQ sub-systems
- A lot of parallel processing task running the same algorithms

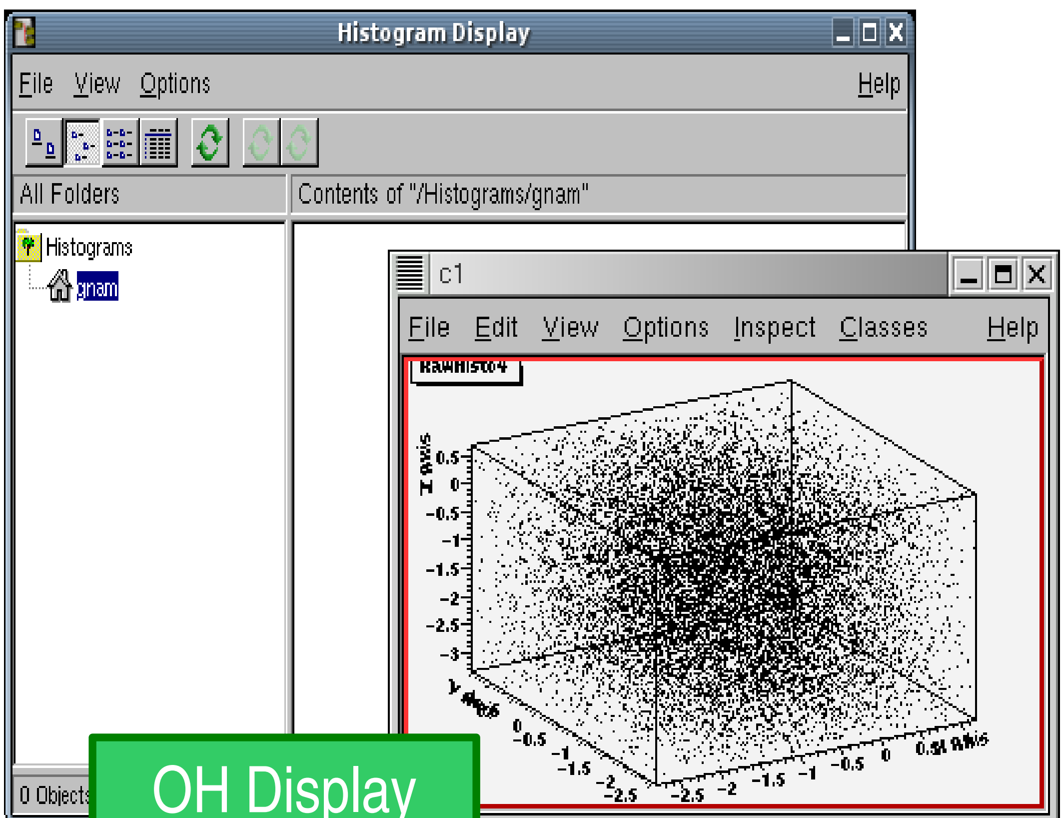


Gatherer
adds up histograms and publishes the summary

Monitoring Framework

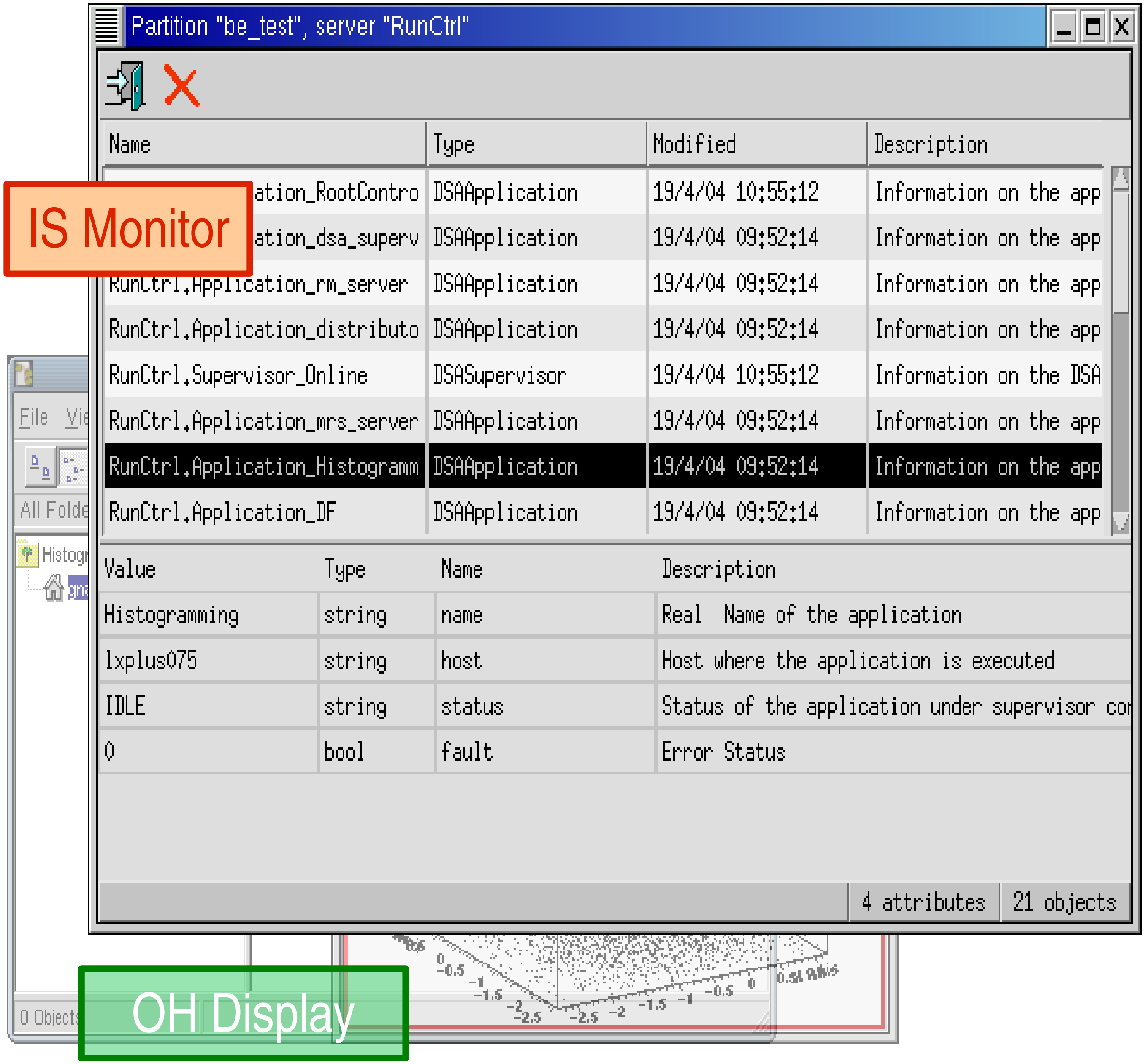


Graphical Interfaces

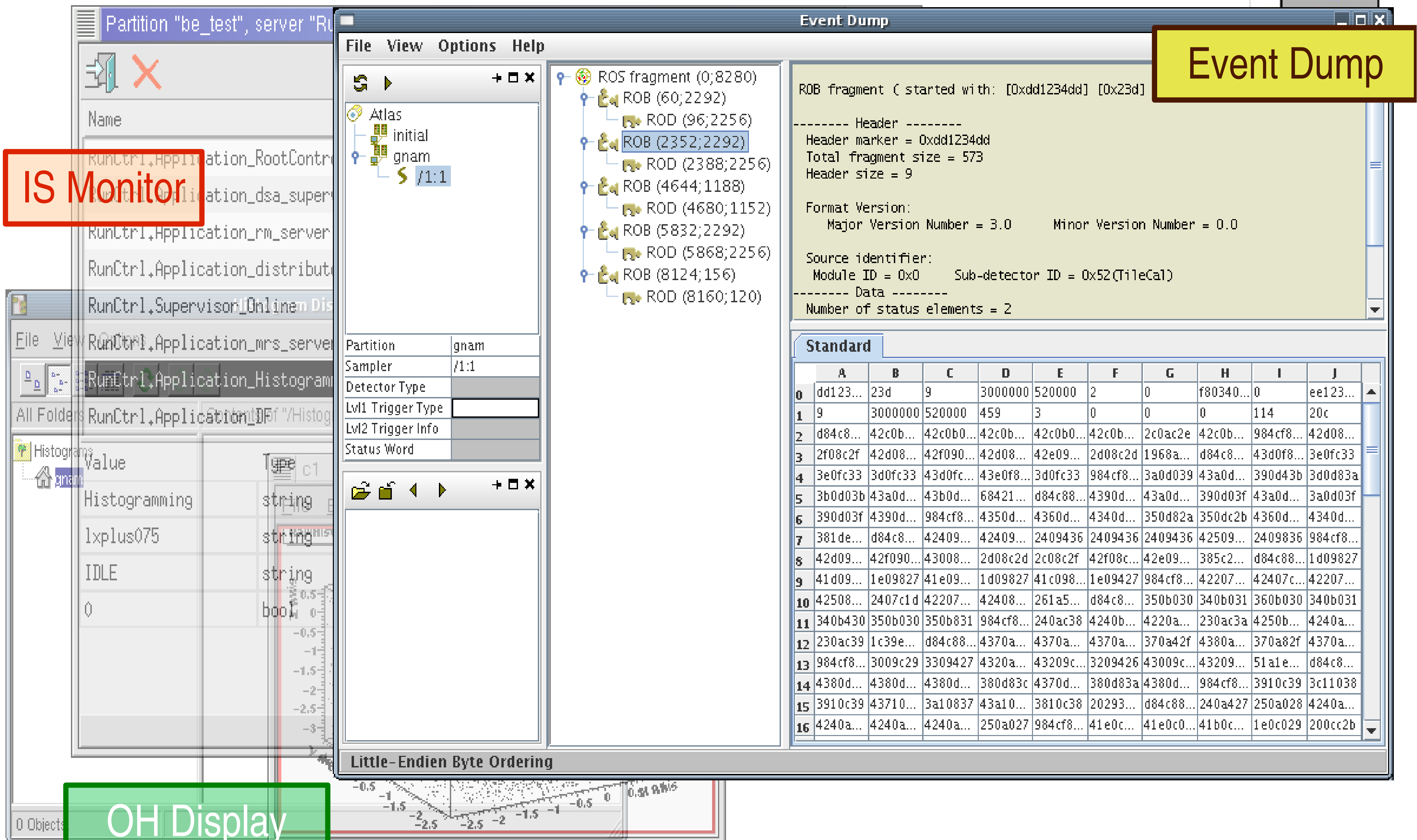


OH Display

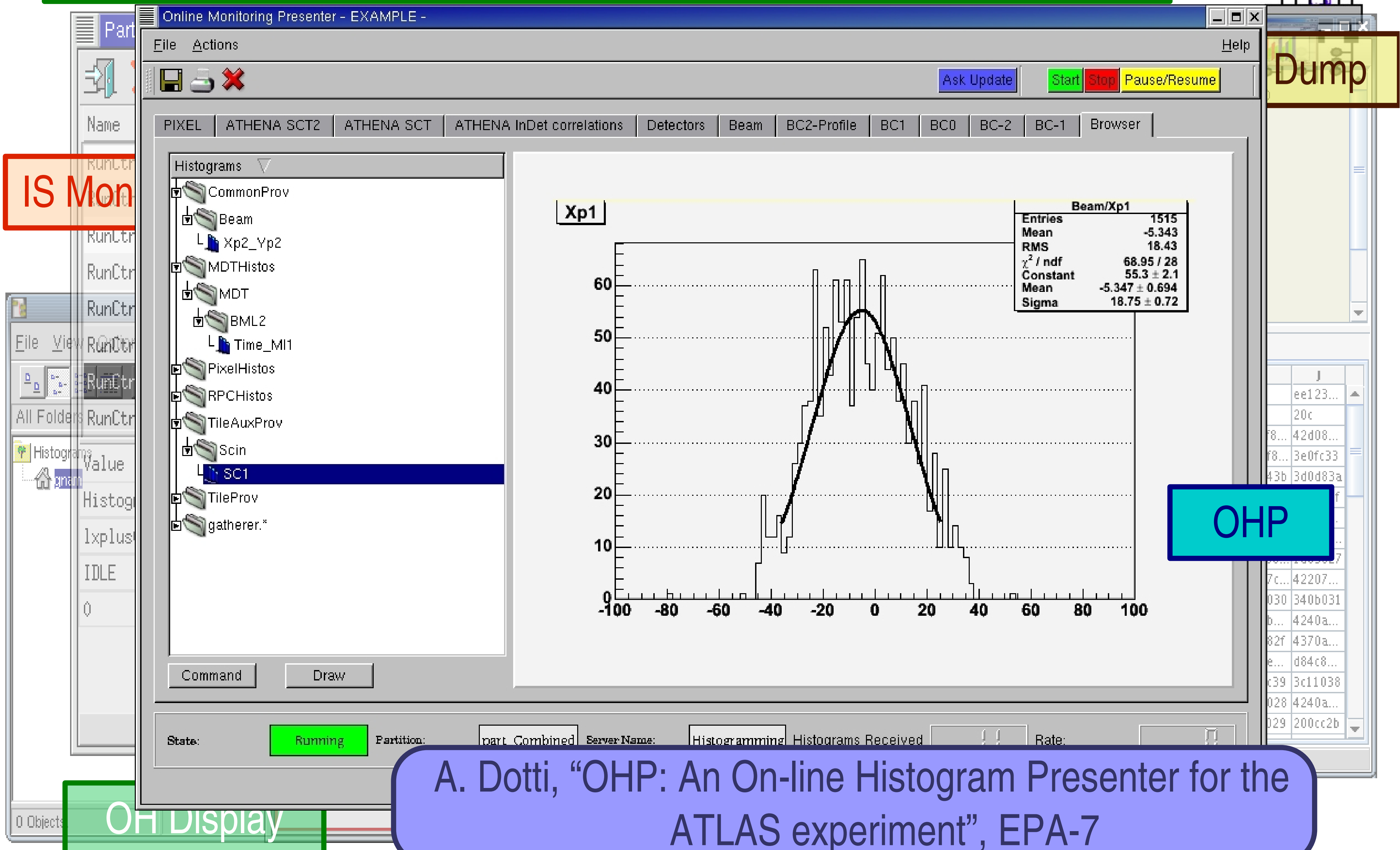
Graphical Interfaces



Graphical Interfaces

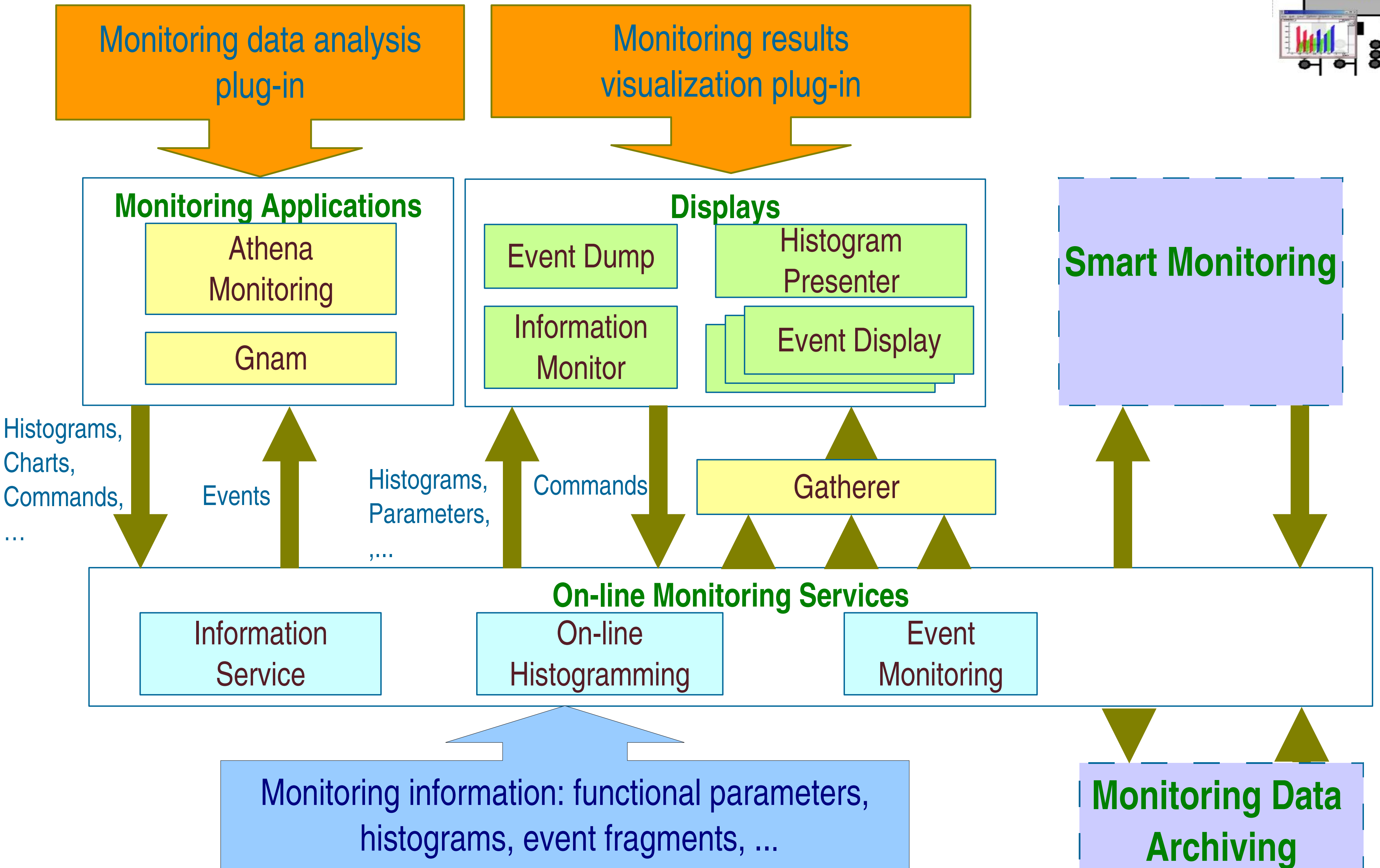


Graphical Interfaces



A. Dotti, "OHP: An On-line Histogram Presenter for the ATLAS experiment", EPA-7

Monitoring Framework



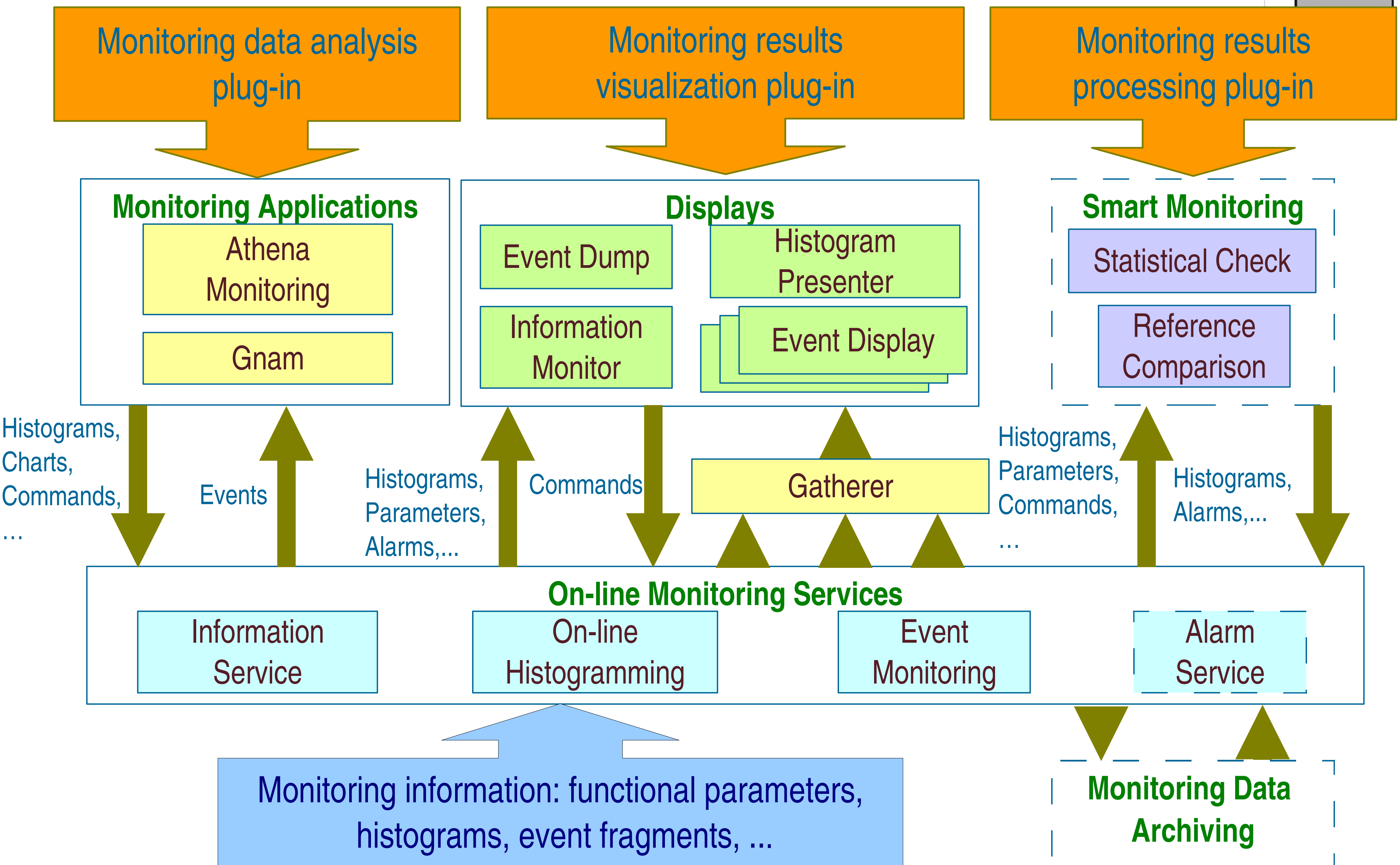
Further Developments

Collecting requirements, investigating experiences from HEP experiments, implementing prototype functionalities in the existing tools

- Smart monitoring: cope with the detector complexity
  - Automatic reference histogram comparison and statistical checks
  - Alarm generation, routing and reaction

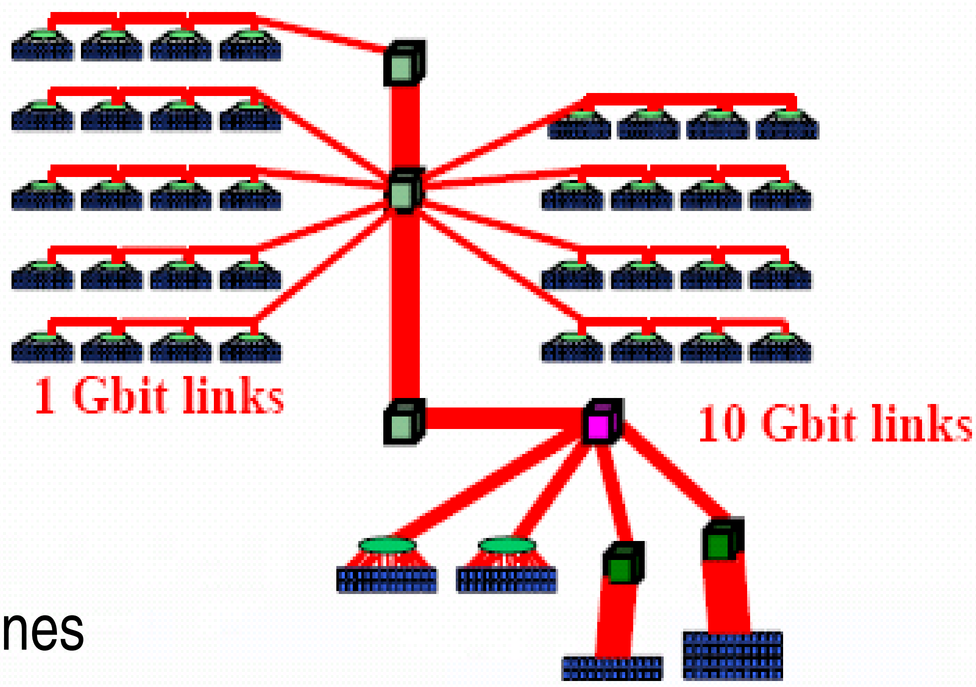
- Monitoring Data Archiving: store and make available data (when needed)
  - O(10GB)/run of monitoring results need to be stored (most of them not forever)
  - reference histograms available and linked with on-line histograms
  - Proposed architecture: local data cache, off-line archiver and database

Monitoring Framework



Large Scale Test 2005

- Infrastructure: up to 700 nodes of the LXBATCH cluster at CERN
- Scope:
  - functionality of the TDAQ system
  - access to the condition database
  - test of selected components
- Network performances less than final ones

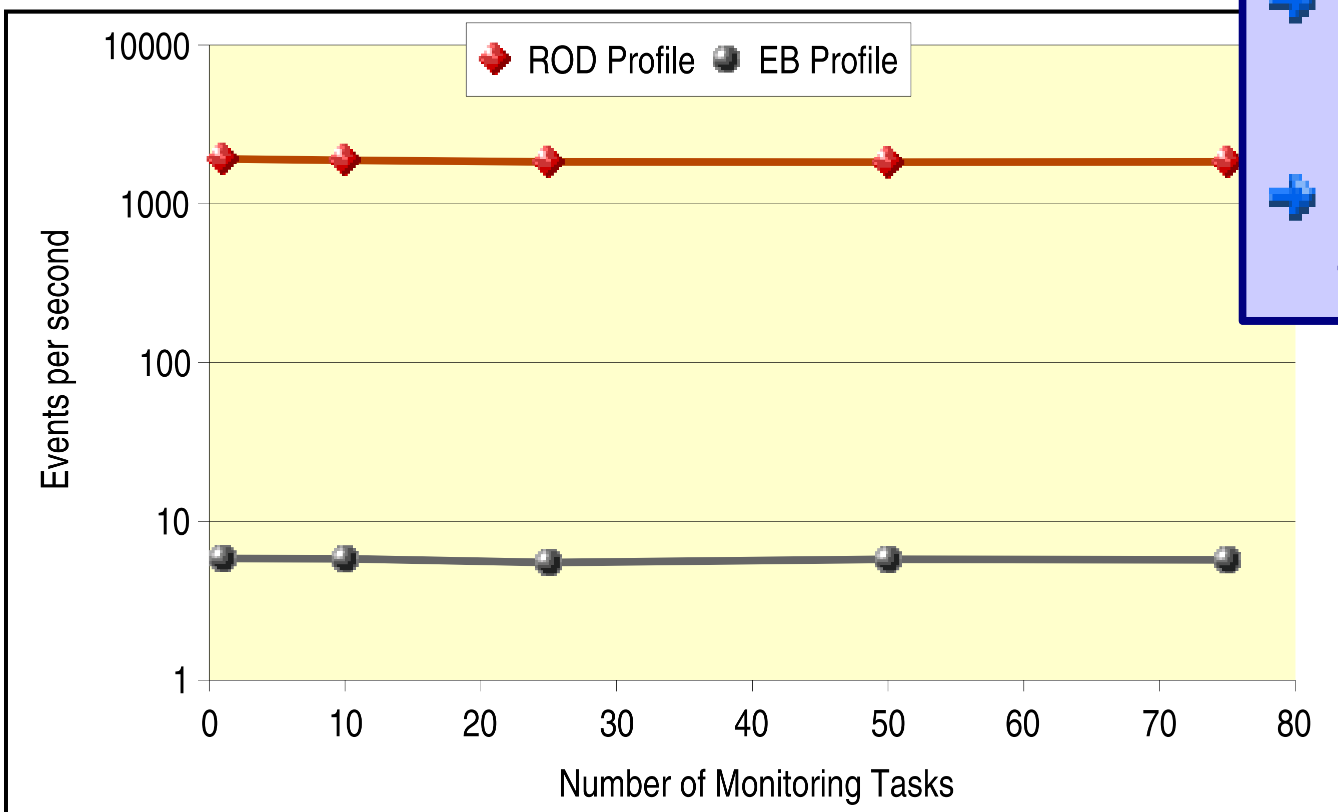


Comprehensive tests performed on: Emon, IS and OH

D. Burckhart, "Testing on a large scale: Running the ATLAS Data Acquisition and High Level Trigger software on 700 pc nodes", OC-5

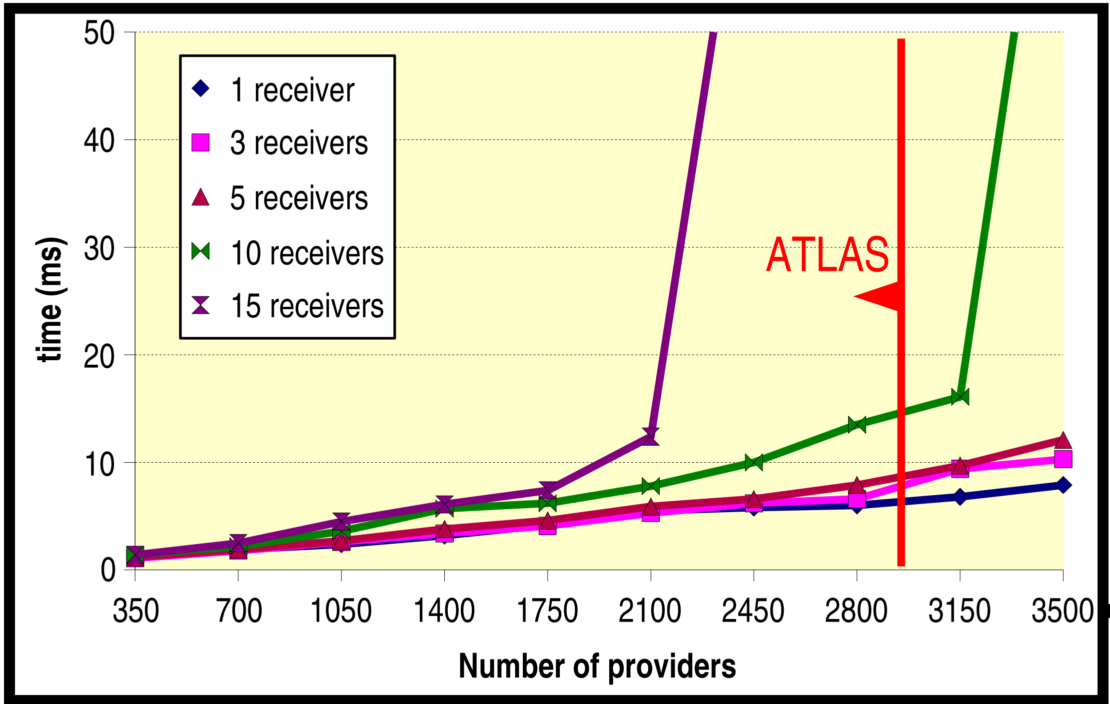
LST: Emon

- 1 sampler, N sampling channels
- ROD – 2kB/event
- EB - 2MB/event



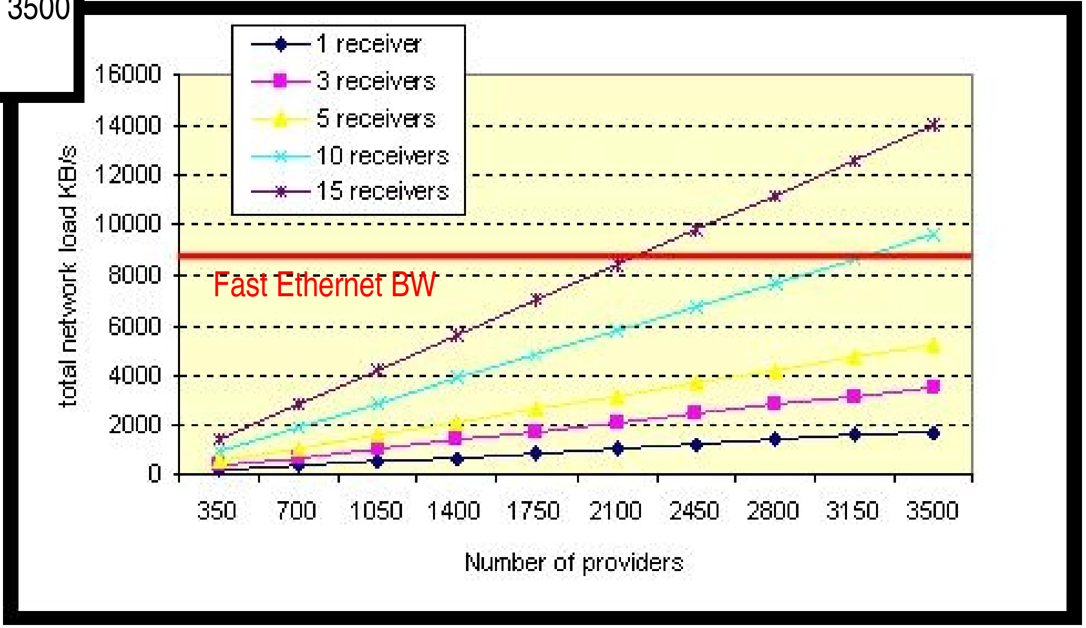
- No failures were observed
- Constant event rate in the ATLAS working range
- Negligible CPU utilization by the sampling thread
- No impact on the data flow rate for mild sampling rate (<1%)

LST: IS



- 350 nodes
- 1 to 10 providers per node publishing 250 bytes of data
- 1 to 15 receivers

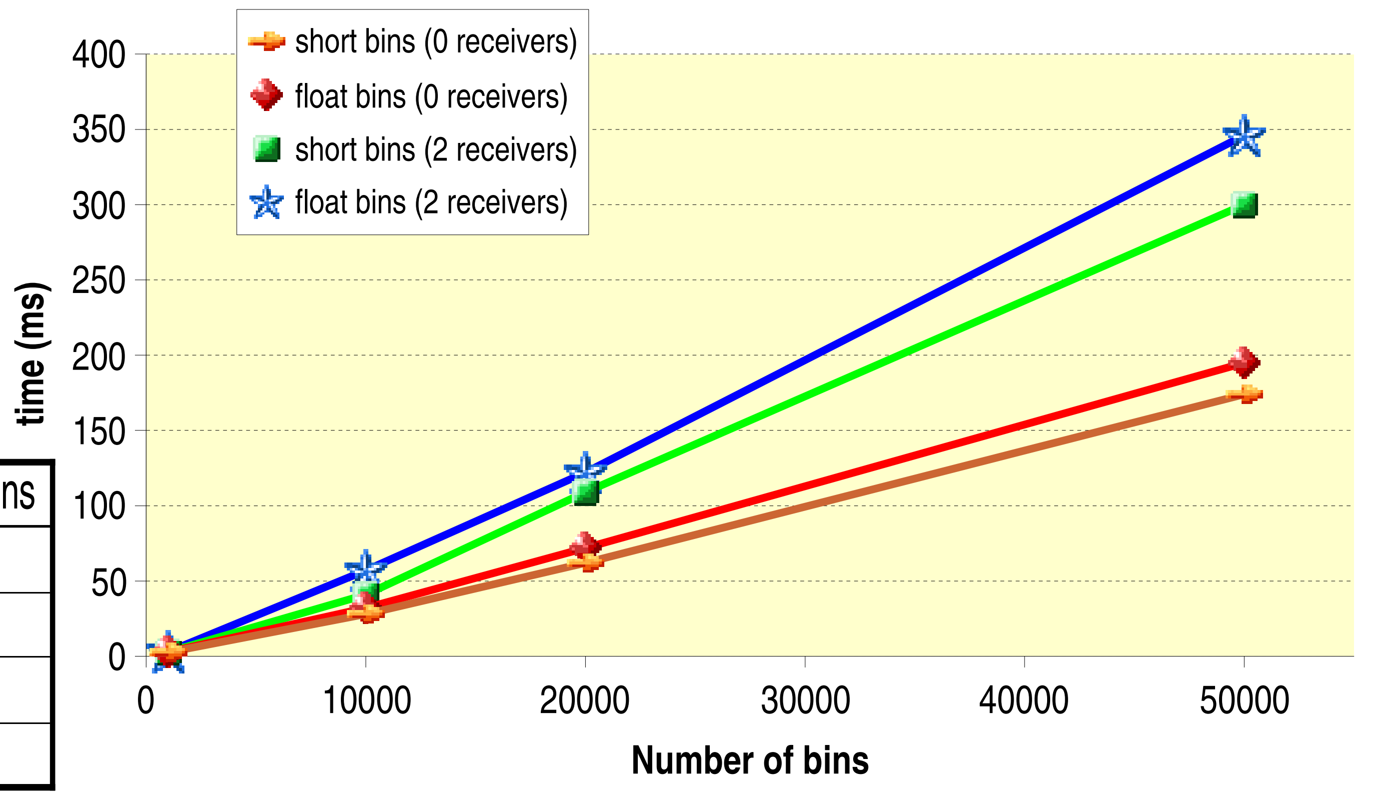
- No failures were observed
- Linear scaling in the publishing time
- Fast Ethernet is the bottleneck (not the ATLAS case)



LST: OH

- 650 nodes
- 1 provider per node
- Scenario 1:
  - No receivers
  - update every 10s
- Scenario 2:
  - 2 receivers
  - update every 30s

- No failures were observed
- Good performances for small histograms
- Improvements with 1GB network



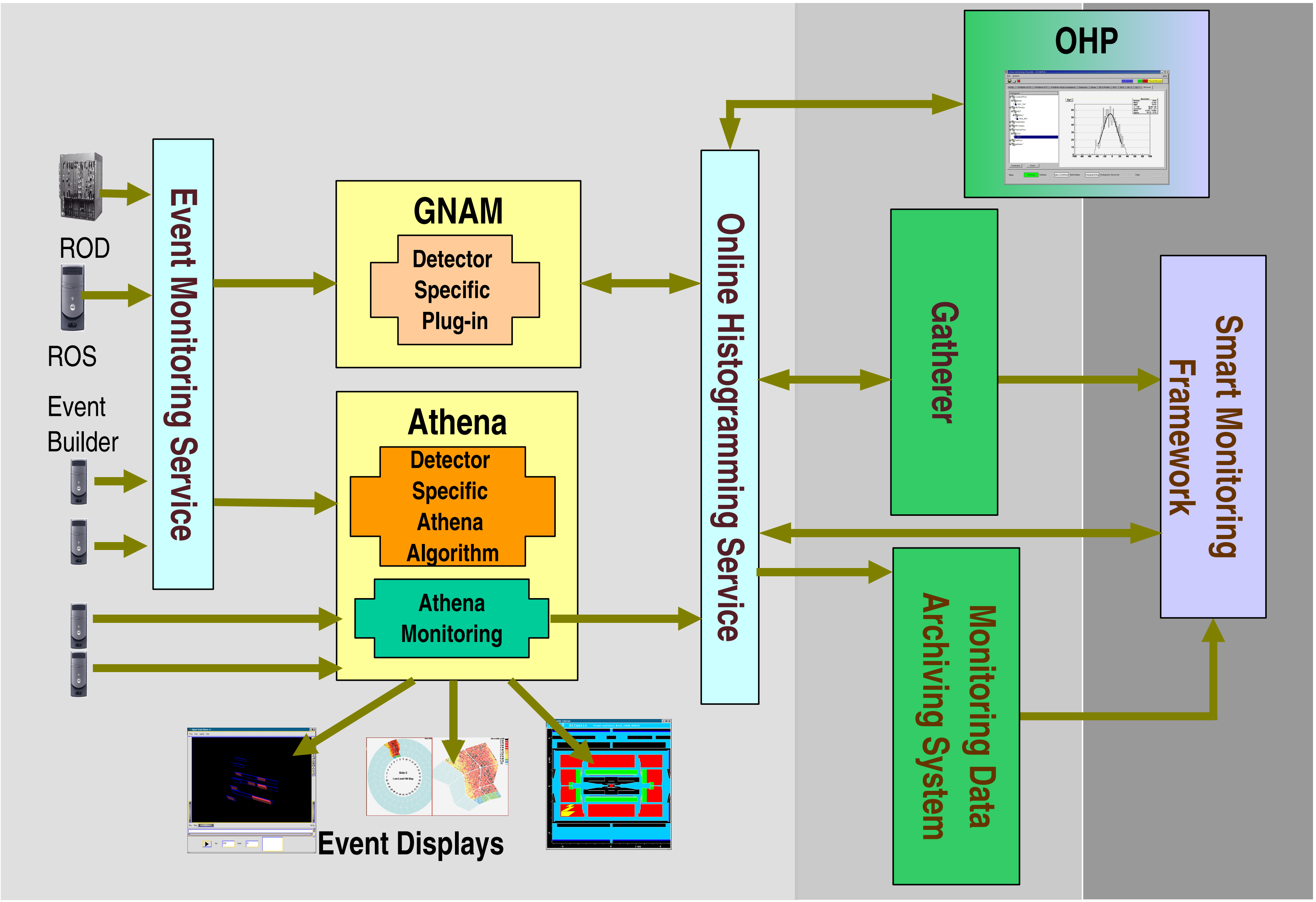
#bins	Size (kB) short bins	Size (kB) float bins
1000	18	20
10000	180	200
20000	360	400
50000	900	1000

Outlook

- A first implementation of the ATLAS monitoring framework is already present, from fundamental services to high-level applications
- Software applications have been tested during the past test beams and now are used by the sub-detectors in the commissioning sites
- Preliminary tests on a large distributed environment suggest that, at least for the fundamental services, the actual implementation is suitable for ATLAS
- The development is going ahead, improving the existing applications, thanks to the users' feedback, but also adding to the framework new functionalities and features
- A complete and functional monitoring system is requested to bring ATLAS to its maximum performances and exploit its discovery potential

Backup Material

Global Monitoring Framework



OH Test: Histogram sizes

- Short bin
  - value (2 bytes/bin) + errors (8 bytes/bin) + variable axis (8 bytes/bin)

- Float bin
  - value (4 bytes/bin) + errors (8 bytes/bin) + variable axis (8 bytes/bin)