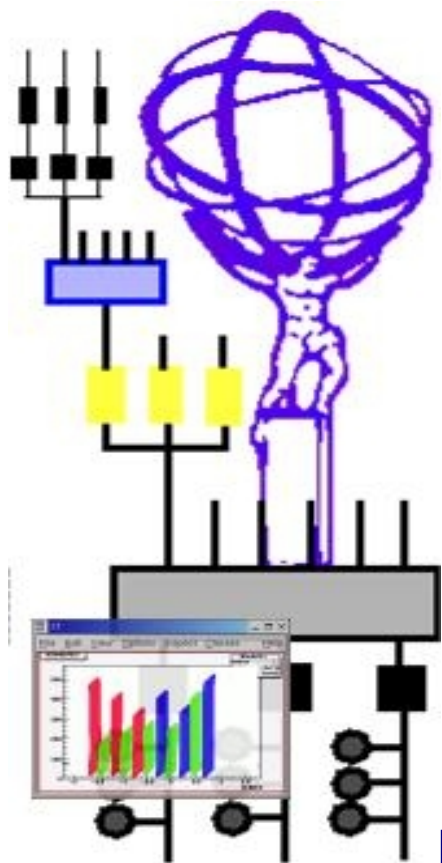


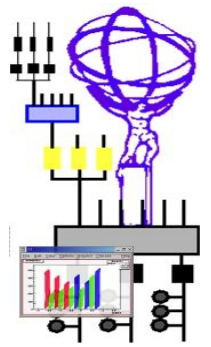
Strategies and Tools for the ATLAS On-line Monitoring



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

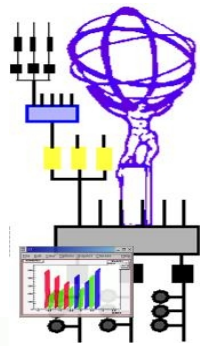
P. Adragna, M. Bosman, D. Burckhart, M. Caprini, M.J. Costa,
M. Della Pietra, A. Dotti, I. Eschrich, R. Ferrari, M.L. Ferrer, G. Gaudio,
H. Hadavand, M. Hauschild, S. Hillier, B. Kehoe, S. Kolos, K. Kordas,
R. Mcpherson, M. Mineev, C. Padilla, T. Pauly, I. Riu, C. Roda, D. Salvatore,
I. Scholtes, S.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

Outline



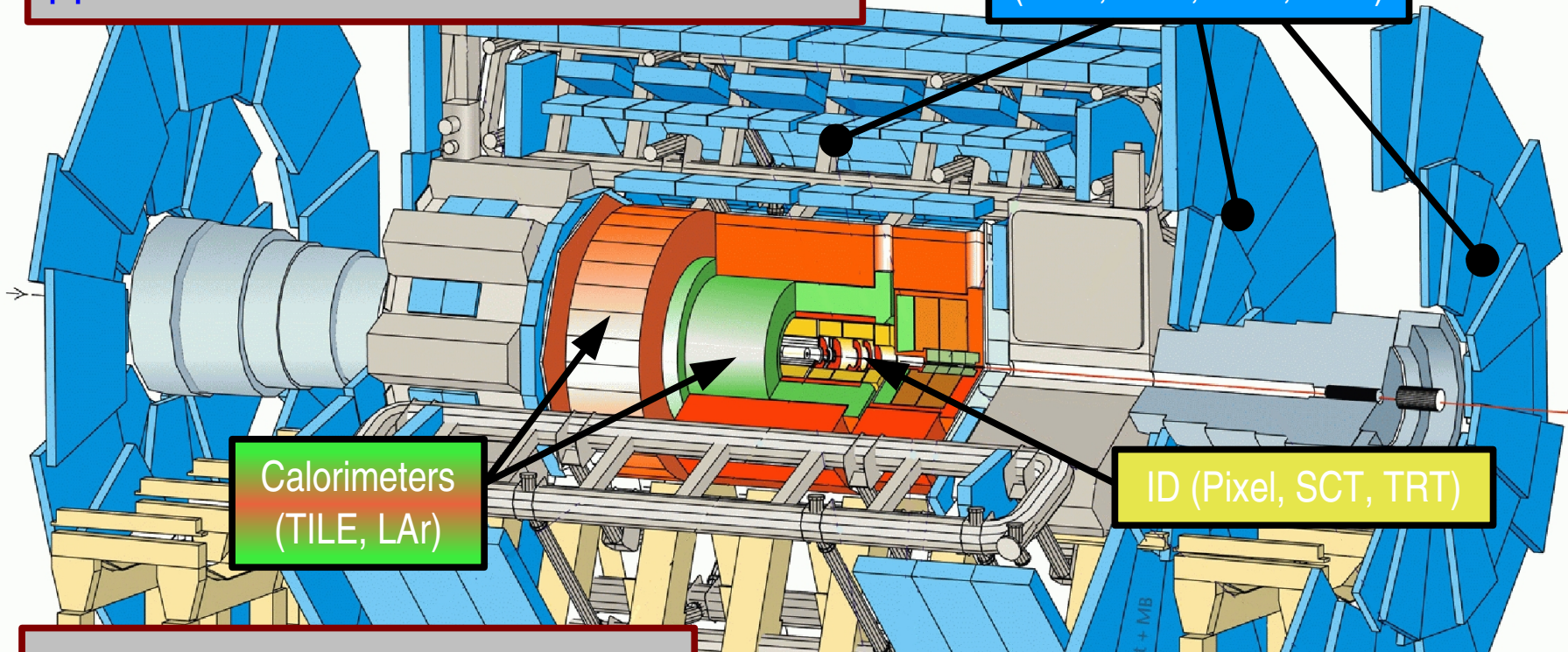
- ATLAS and ATLAS TDAQ
- Monitoring requirements
- Monitoring components
- Large Scale Test 2005

ATLAS Experiment



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

Muon Spectrometer
(MDT, CSC, RPC, TGC)



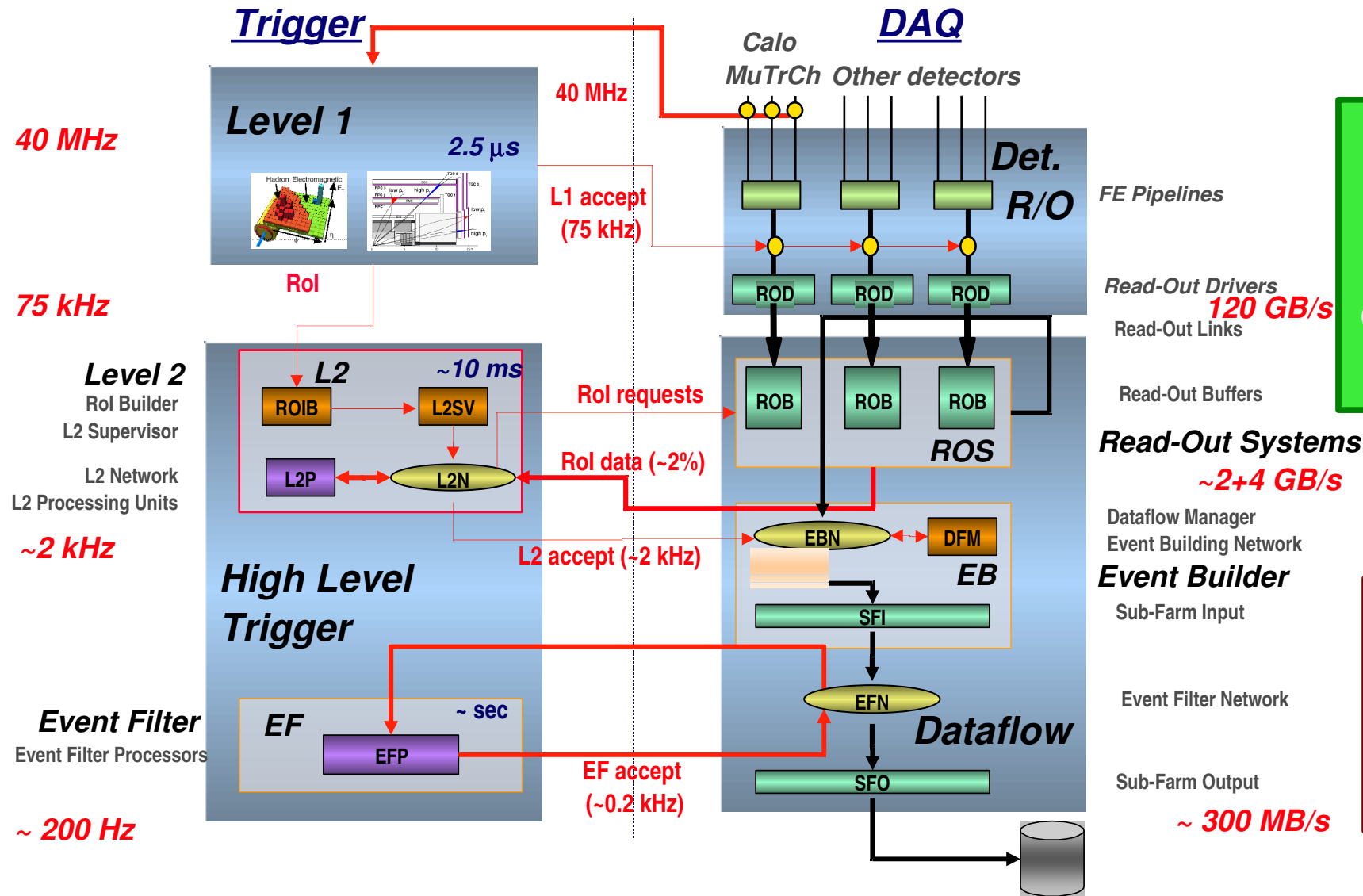
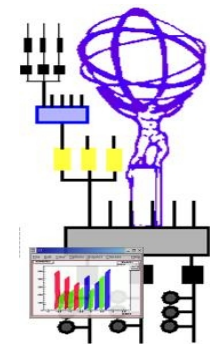
Calorimeters
(TILE, LAr)

ID (Pixel, SCT, TRT)

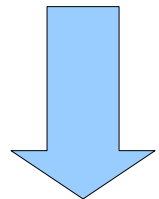
40MHz collisions
75kHz 1st level trigger
O(100Hz) stored events

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

ATLAS TDAQ System



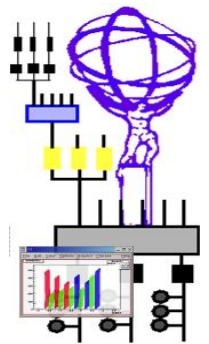
Challenging experimental conditions and extreme detector complexity



Scalable and highly distributed TDAQ system

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

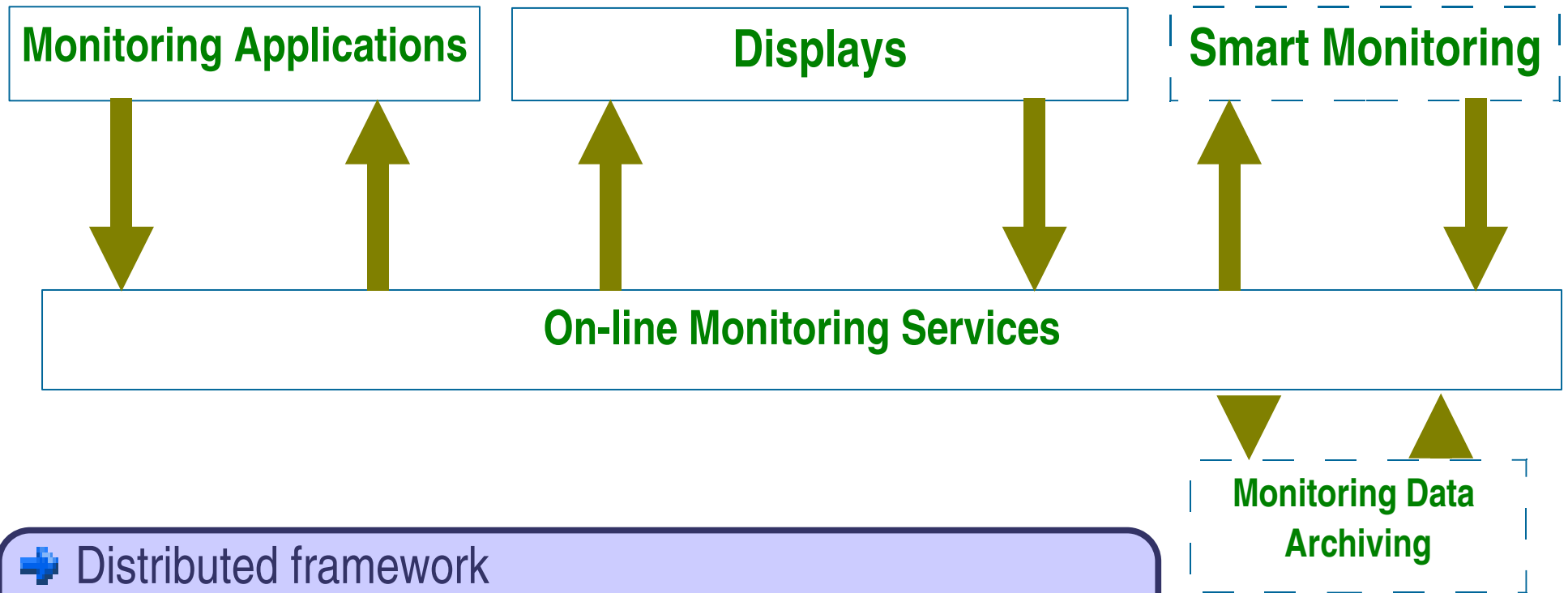
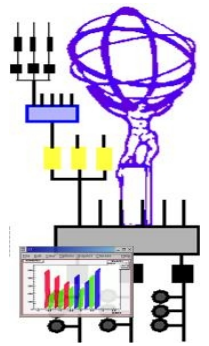
On-line Monitoring Requirements



- 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

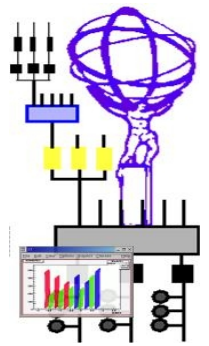
- 15 sub-systems monitored in terms of functionality and results ←
 - 3000 sources of monitoring information ←
 - Up to 300 event sampling points ←
 - O(10GB)/run produced monitoring data ←

Monitoring Framework Structure



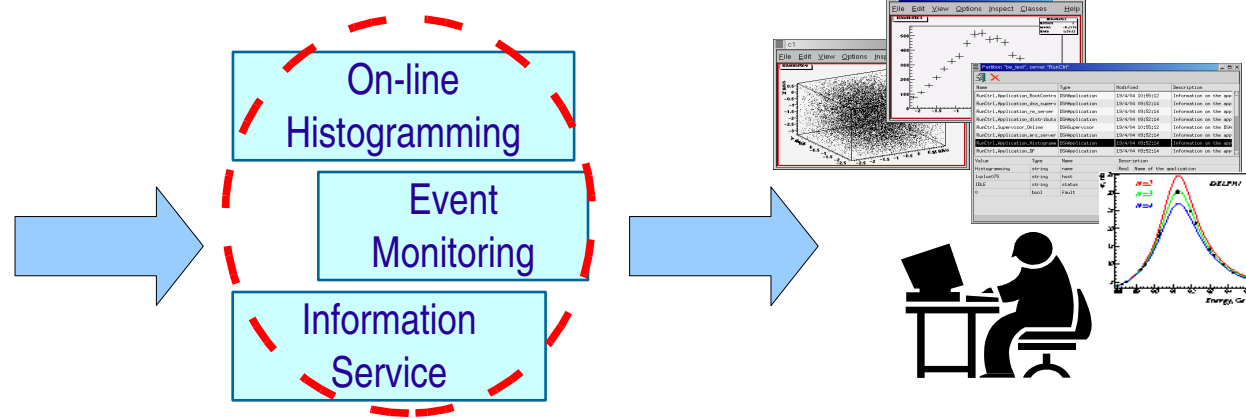
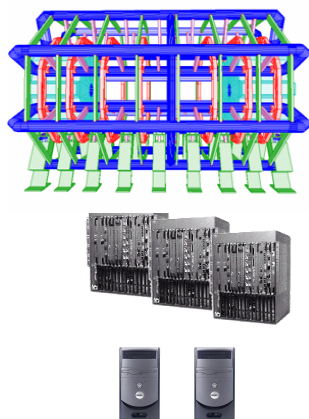
- + Distributed framework
 - Isolate problems
 - Optimize applications for specific needs

On-line Monitoring Services

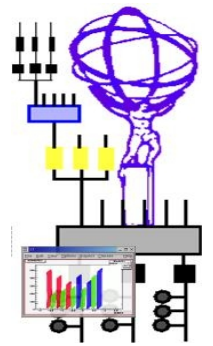


AIM: provide different information-sharing channels abstracting the underlying complexity of the distributed environment

- 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,...)

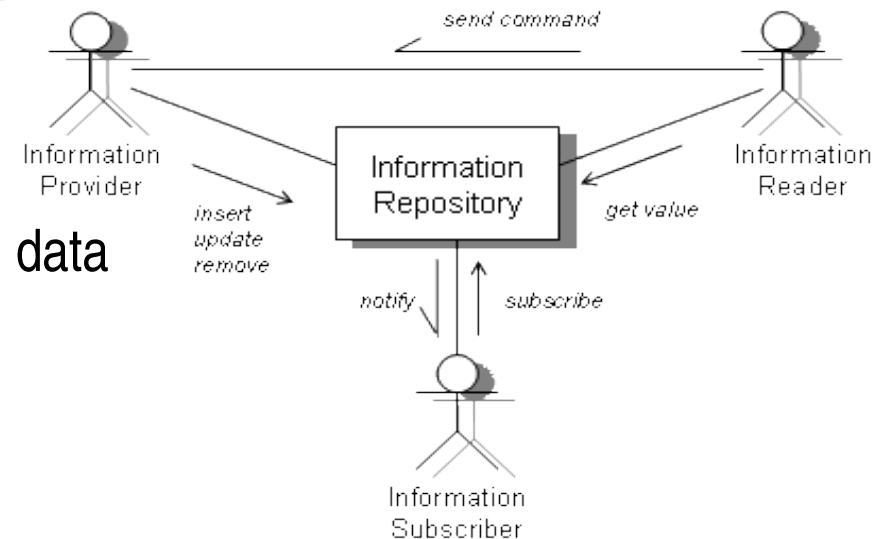


On-line Services: IS & OHS



+ Information Service (IS): enables software applications to share information

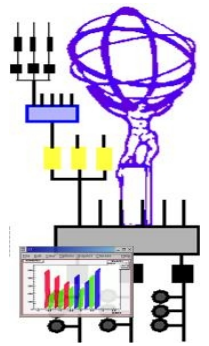
- Insert, update, remove, read information
- Copes with simple variables and user-defined data
- Transport commands
- Change notification



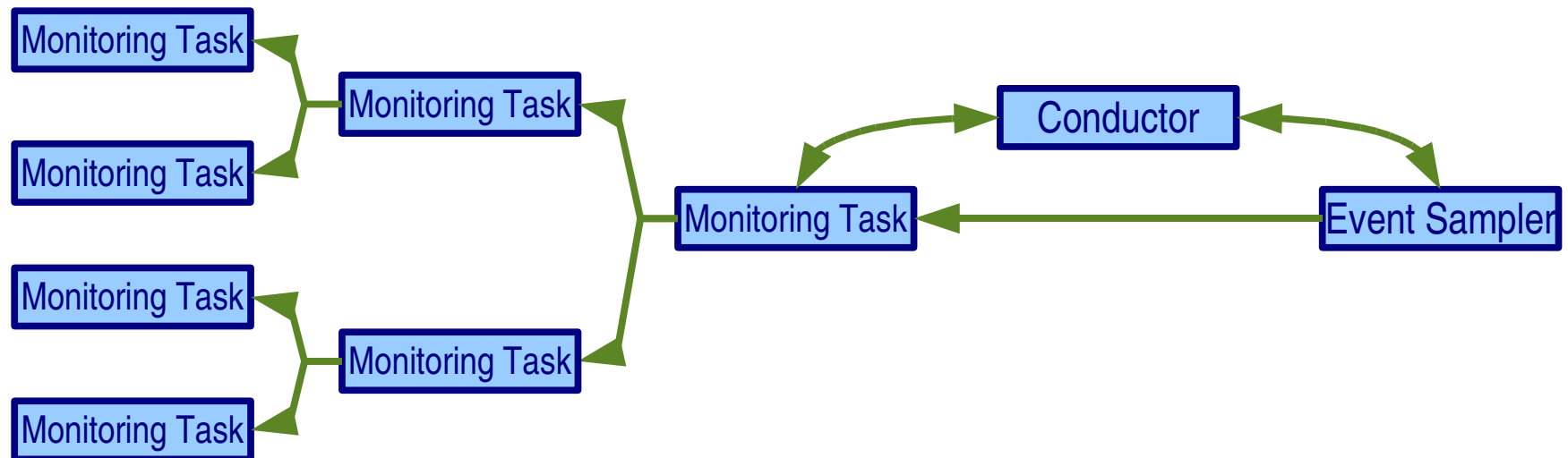
+ On-line Histogramming Service (OHS): allows software applications to share histogram data

- Based on IS
- supports raw and ROOT histograms

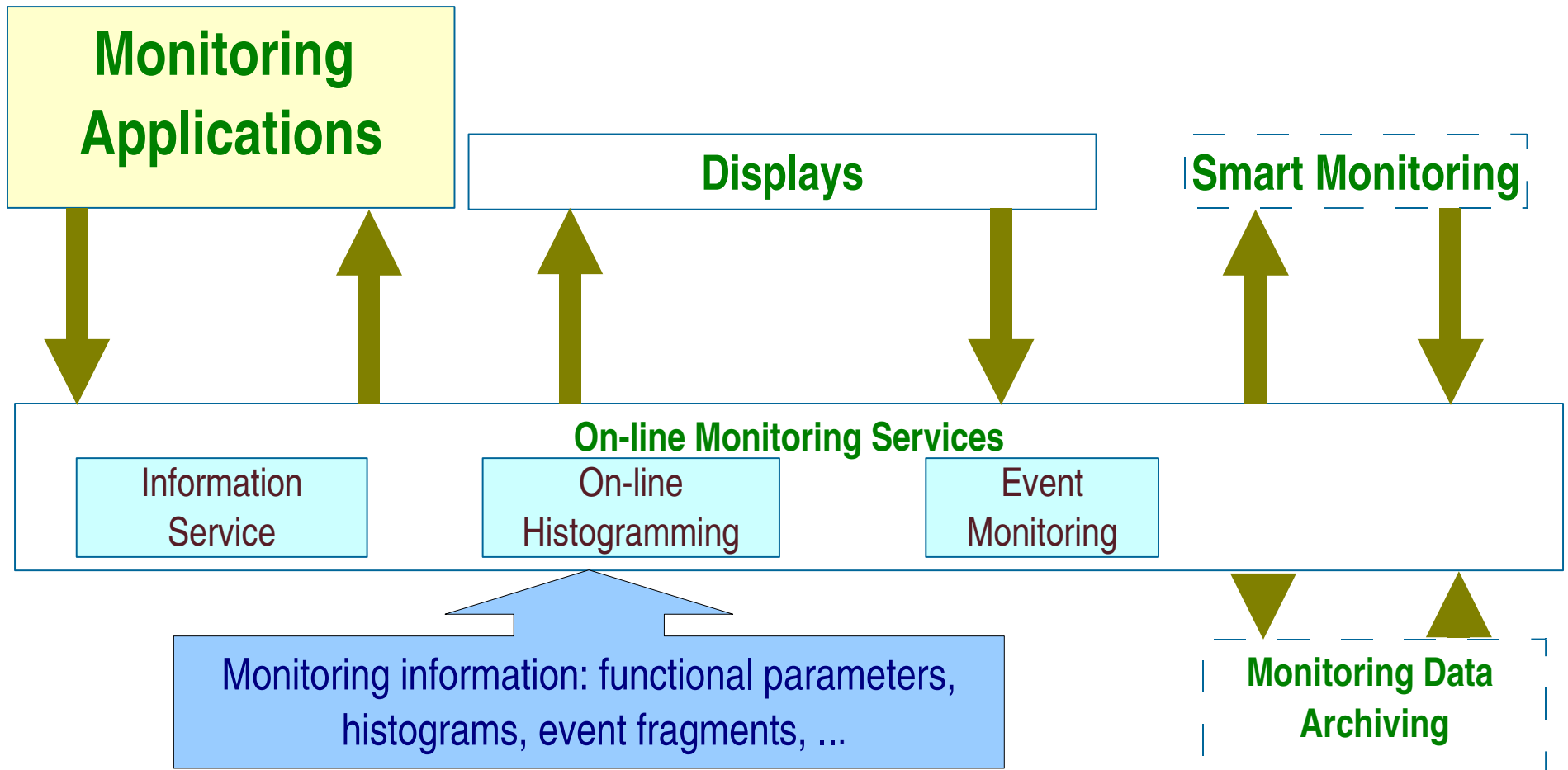
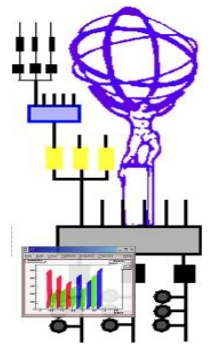
On-line Services: Emon



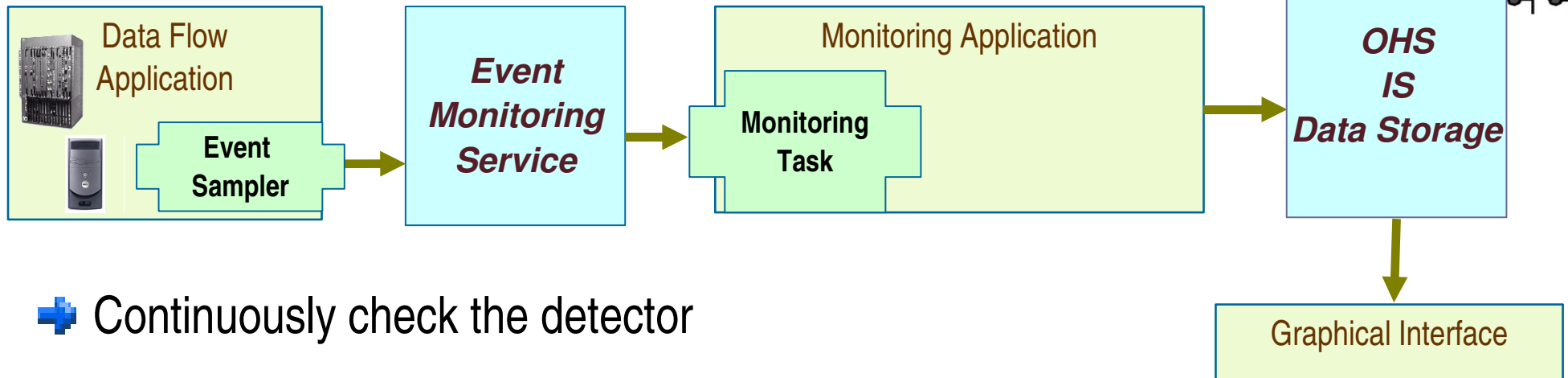
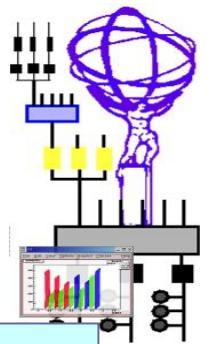
- **Event Monitoring (Emon):** provides on-line sample of events
 - Samples events or sub-fragments at any level of the data flow
 - Implements selection criteria based on trigger type and detector type
 - Load minimization thanks to a tree topology



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

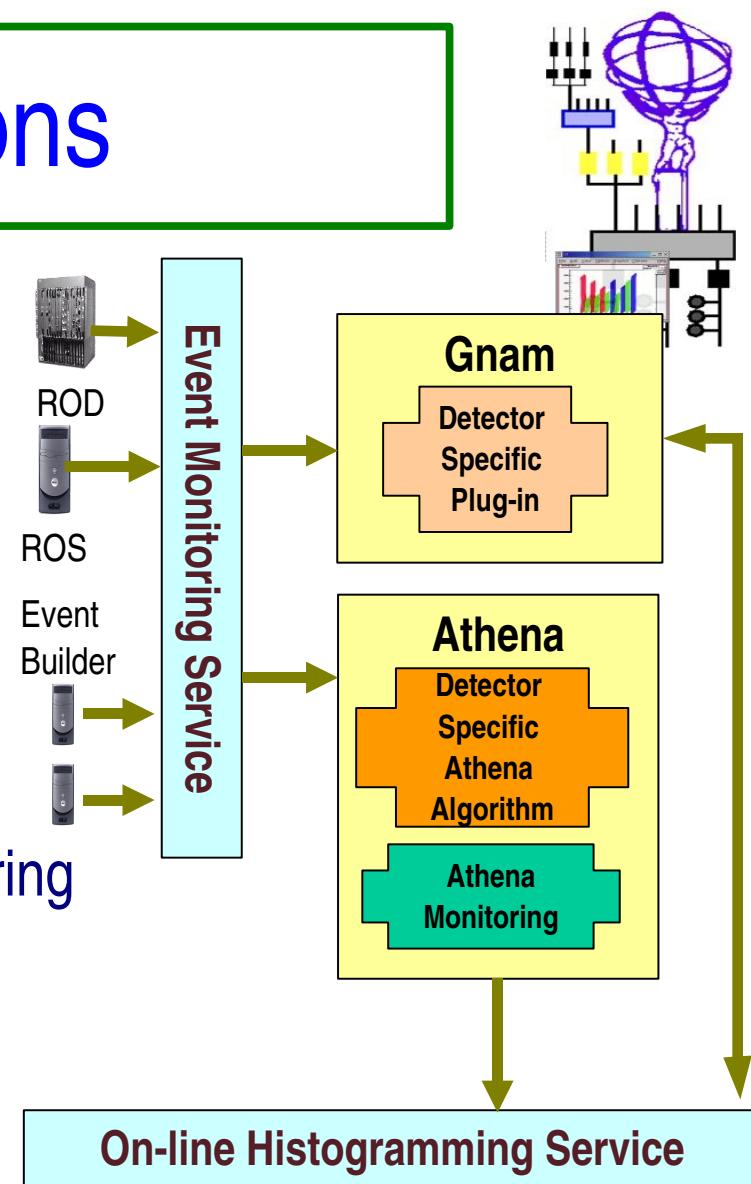
Monitoring Applications

+ Athena Monitoring: physics monitoring

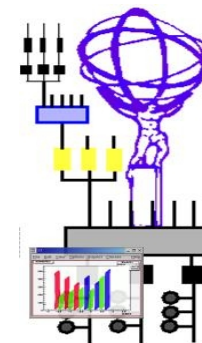
- Based on the Event Filter processing task
- Uses off-line analysis algorithms
- High-level monitoring even before trigger filtering

+ Gnam: lightweight hardware functionality monitoring

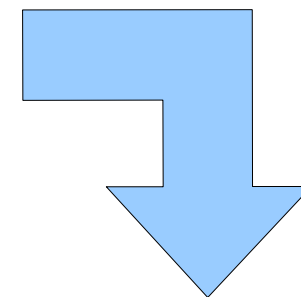
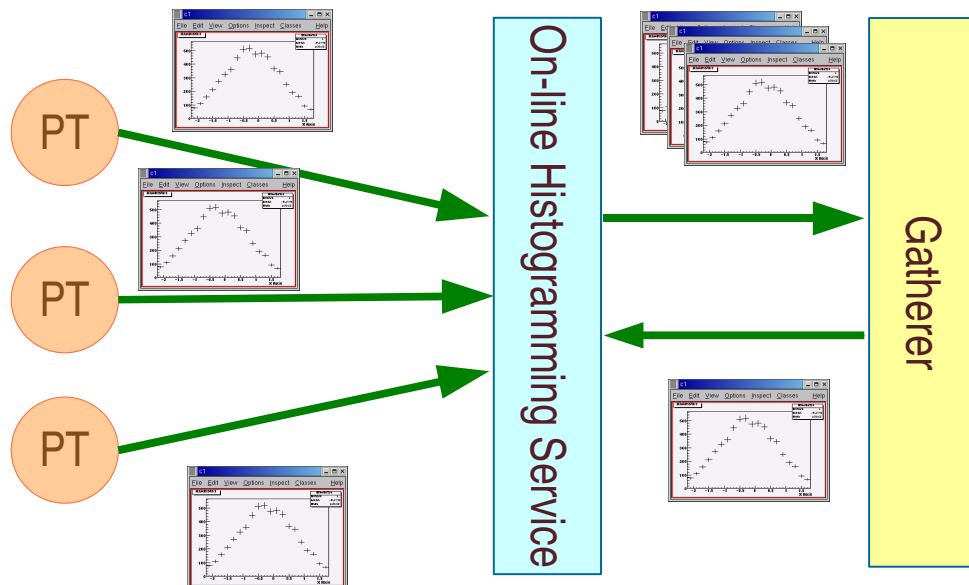
- Analysis algorithms as plug-ins (dynamic loaded libraries)
- Can run interactively or controlled by the TDAQ system
- Can receive asynchronous commands



Gatherer

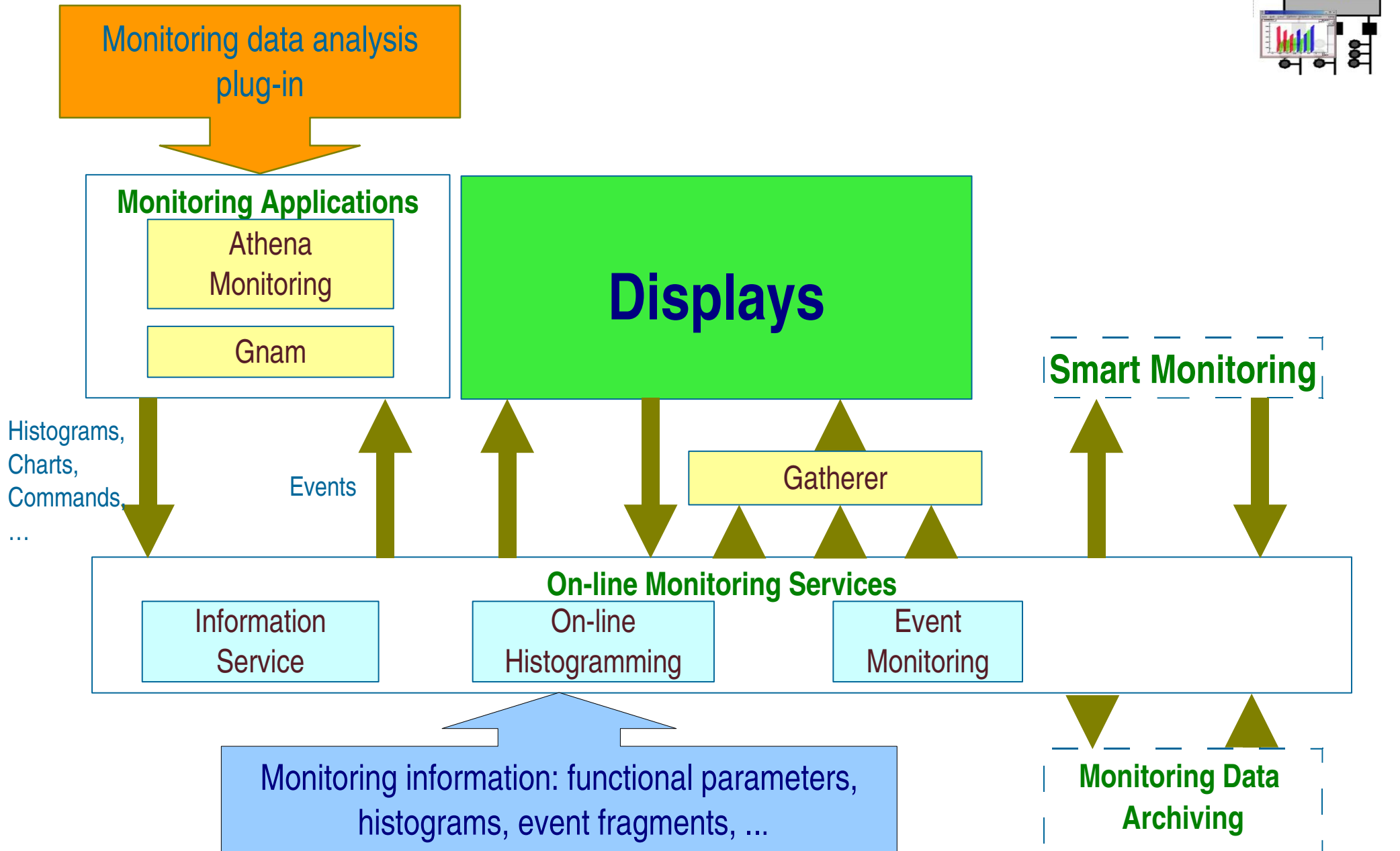
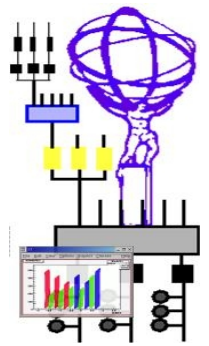


- ✚ EF & LVL2 processing tasks can run monitoring algorithms
 - functionality of HLT and DAQ sub-systems
- ✚ A lot of parallel processing task running the same algorithms

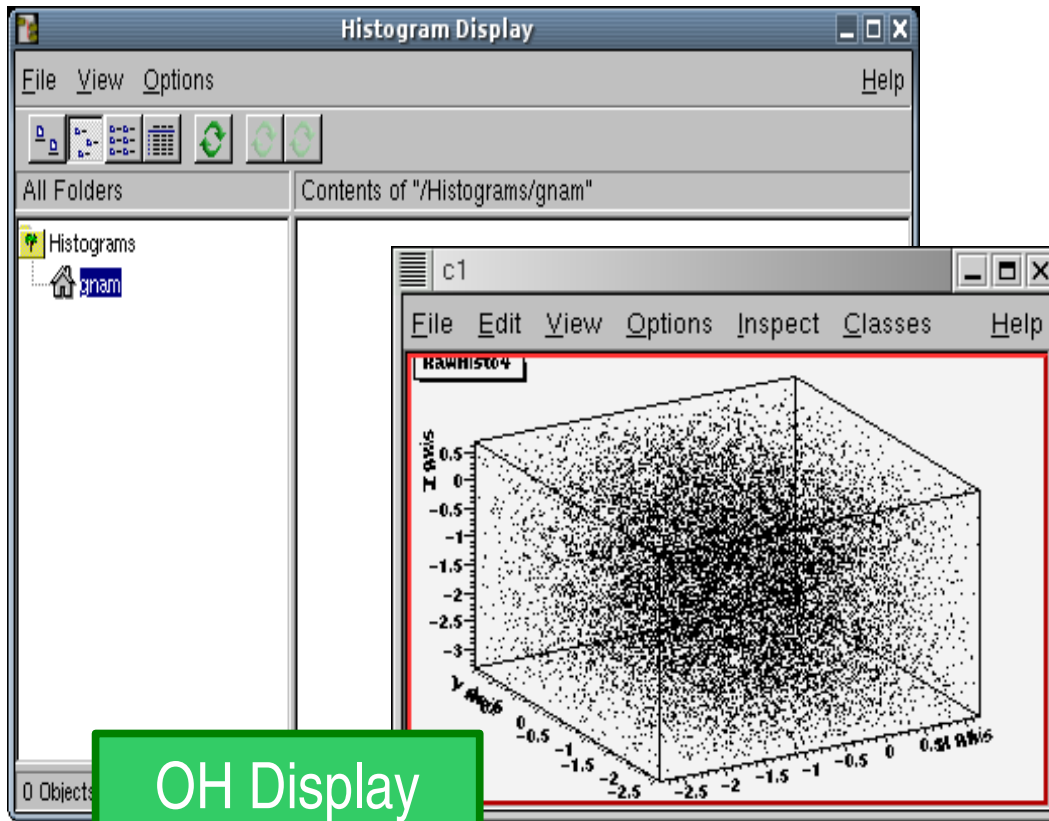
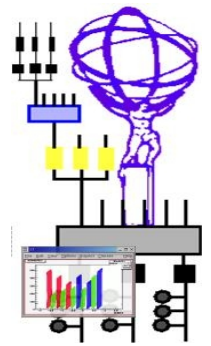


Gatherer
adds up histograms and
publishes the summary

Monitoring Framework

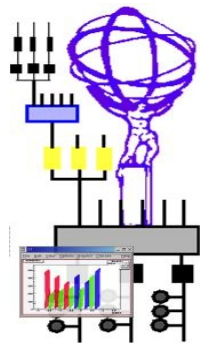


Graphical Interfaces



OH Display

Graphical Interfaces



IS Monitor

Partition "be_test", server "RunCtrl"

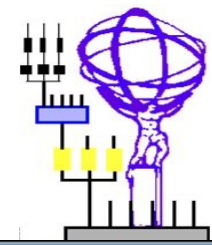
Name	Type	Modified	Description
ation_RootContro	DSAAApplication	19/4/04 10:55:12	Information on the app
ation_dsa_superv	DSAAApplication	19/4/04 09:52:14	Information on the app
RunCtrl.Application_rm_server	DSAAApplication	19/4/04 09:52:14	Information on the app
RunCtrl.Application_distributo	DSAAApplication	19/4/04 09:52:14	Information on the app
RunCtrl.Supervisor_Online	DSASupervisor	19/4/04 10:55:12	Information on the DSA
RunCtrl.Application_mrs_server	DSAAApplication	19/4/04 09:52:14	Information on the app
RunCtrl.Application_Histogramm	DSAAApplication	19/4/04 09:52:14	Information on the app
RunCtrl.Application_DF	DSAAApplication	19/4/04 09:52:14	Information on the app

Value	Type	Name	Description
Histogramming	string	name	Real Name of the application
lplus075	string	host	Host where the application is executed
IDLE	string	status	Status of the application under supervisor con
0	bool	fault	Error Status

4 attributes 21 objects

OH Display

Graphical Interfaces



IS Monitor

OH Display

Value	Type
Histogramming	string
lplusplus75	string
IDLE	string
0	boolean

Event Dump

File View Options Help

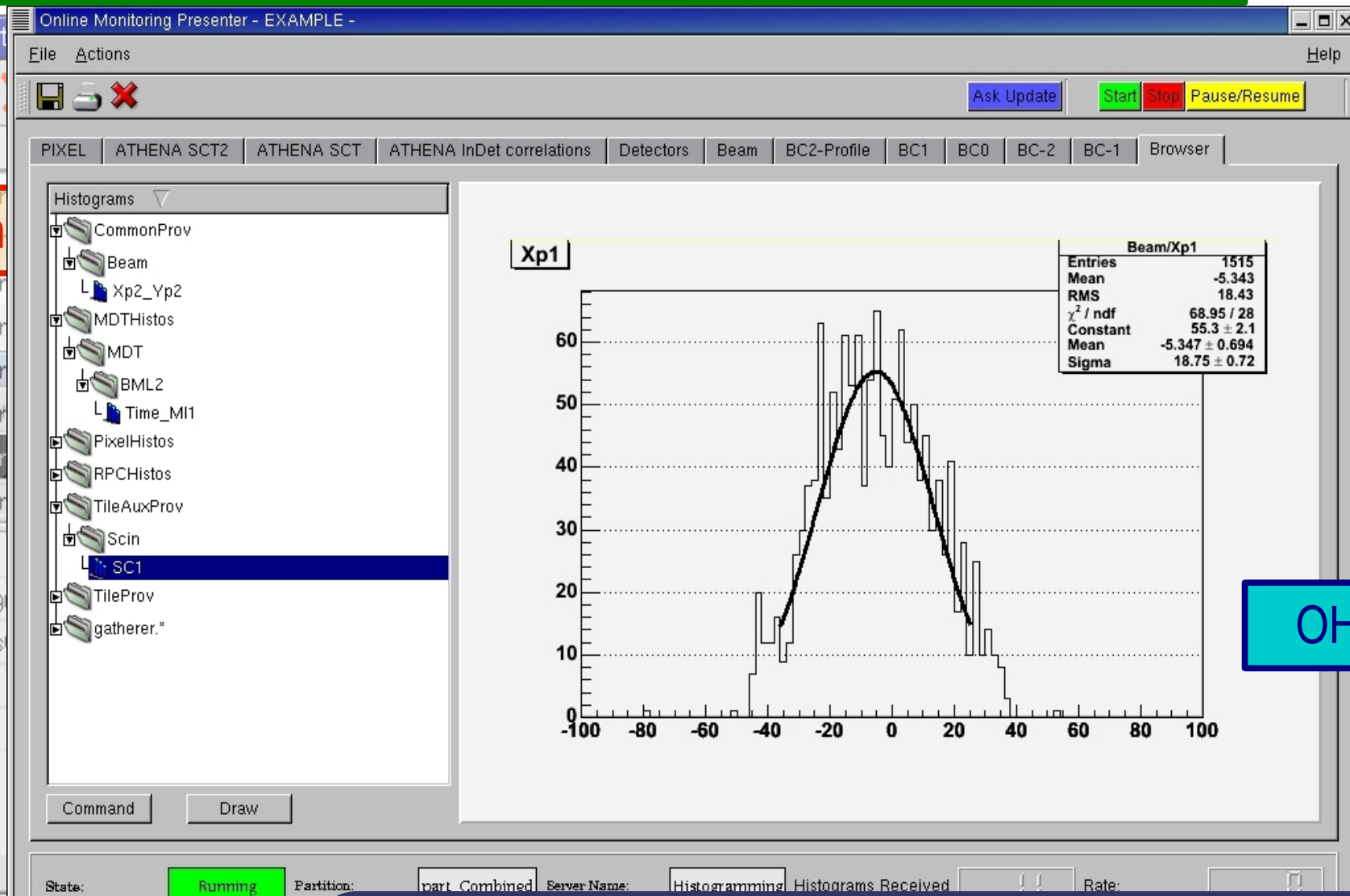
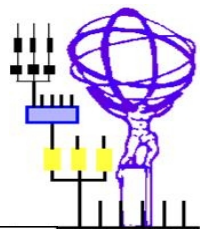
- Atlas
 - initial
 - gnam /1:1
- ROS fragment (0;8280)
 - ROB (60;2292)
 - ROD (96;2256)
 - ROB (2352;2292)
 - ROD (2388;2256)
 - ROB (4644;1188)
 - ROD (4680;1152)
 - ROB (5832;2292)
 - ROD (5868;2256)
 - ROB (8124;156)
 - ROD (8160;120)

Partition	gnam
Sampler	/1:1
Detector Type	
Lvl1 Trigger Type	
Lvl2 Trigger Info	
Status Word	

Little-Endian Byte Ordering

	A	B	C	D	E	F	G	H	I	J
0	dd123...	23d	9	3000000	520000	2	0	f80340...	0	ee123...
1	9	3000000	520000	459	3	0	0	0	114	20c
2	d84c8...	42c0b...	42c0b0...	42c0b...	42c0b0...	42c0b...	2c0ac2e	42c0b...	984cf8...	42d08...
3	2f08c2f	42d08...	42f090...	42d08...	42e09...	2d08c2d	1968a...	d84c8...	43d0f8...	3e0fc33
4	3e0fc33	3d0fc33	43d0fc...	43e0f8...	3d0fc33	984cf8...	3a0d039	43a0d...	390d43b	3d0d83a
5	3b0d03b	43a0d...	43b0d...	68421...	d84c88...	4390d...	43a0d...	390d03f	43a0d...	3a0d03f
6	390d03f	4390d...	984cf8...	4350d...	4360d...	4340d...	350d82a	350dc2b	4360d...	4340d...
7	381de...	d84c8...	42409...	42409...	2409436	2409436	2409436	42509...	2409836	984cf8...
8	42d09...	42f090...	43008...	2d08c2d	2c08c2f	42f08c...	42e09...	385c2...	d84c88...	1d09827
9	41d09...	1e09827	41e09...	1d09827	41c098...	1e09427	984cf8...	42207...	42407c...	42207...
10	42508...	2407c1d	42207...	42408...	261a5...	d84c8...	350b030	340b031	360b030	340b031
11	340b430	350b030	350b831	984cf8...	240ac38	4240b...	4220a...	230ac3a	4250b...	4240a...
12	230ac39	1c39e...	d84c88...	4370a...	4370a...	4370a...	370a42f	4380a...	370a82f	4370a...
13	984cf8...	3009c29	3309427	4320a...	43209c...	3209426	43009c...	43209...	51a1e...	d84c8...
14	4380d...	4380d...	4380d...	380d83c	4370d...	380d83a	4380d...	984cf8...	3910c39	3c11038
15	3910c39	43710...	3a10837	43a10...	3810c38	20293...	d84c88...	240a427	250a028	4240a...
16	4240a...	4240a...	4240a...	250a027	984cf8...	41e0c...	41e0c0...	41b0c...	1e0c029	200cc2b

Graphical Interfaces



IS Mon

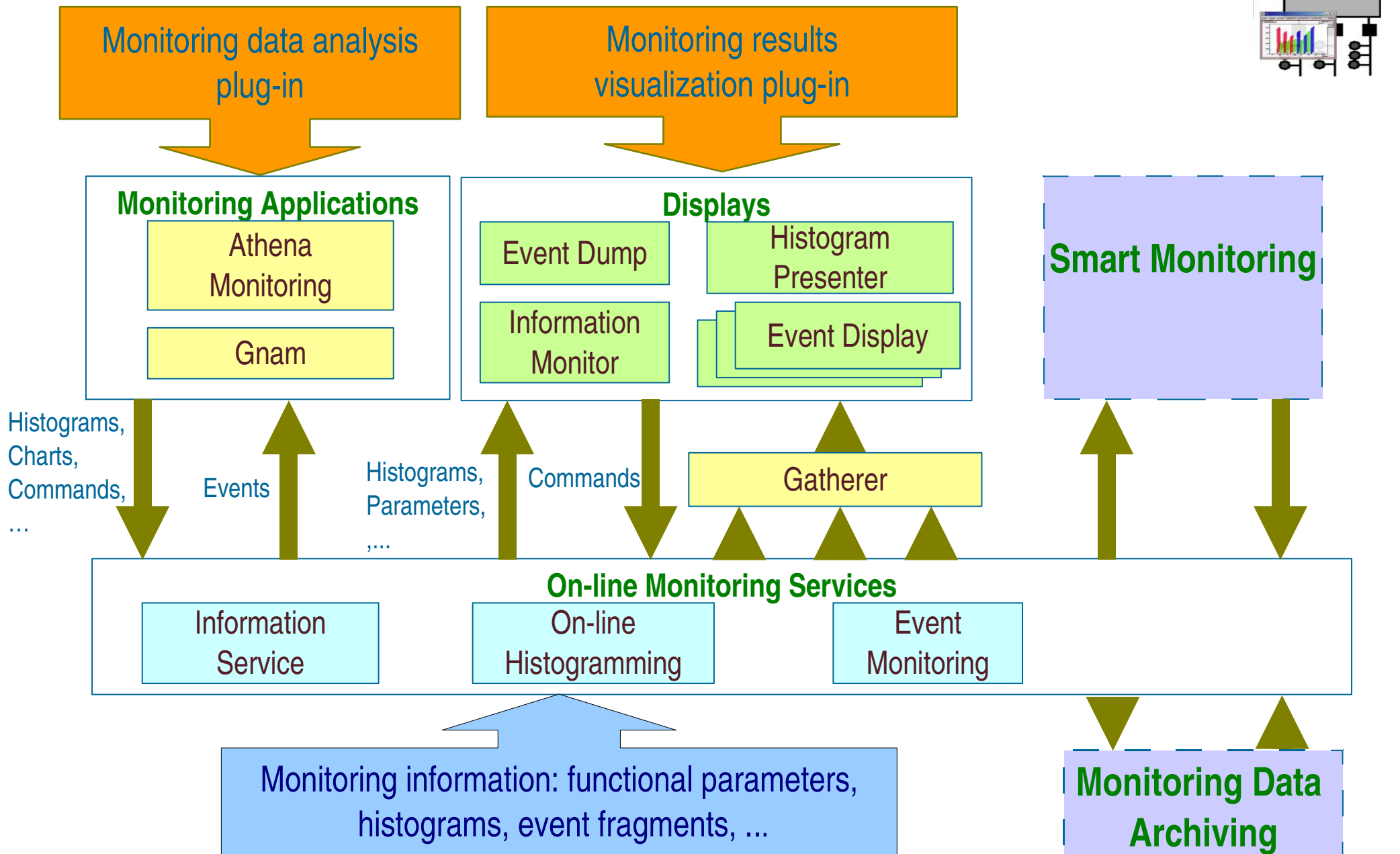
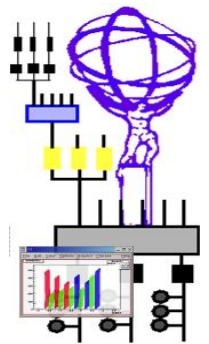
Dump

OHP

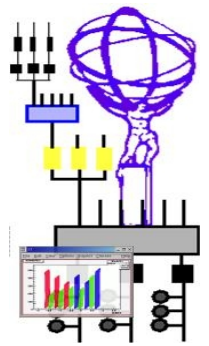
A. Dotti, "OHP: An On-line Histogram Presenter for the ATLAS experiment", EPA-7

OH Display

Monitoring Framework



Further Developments



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

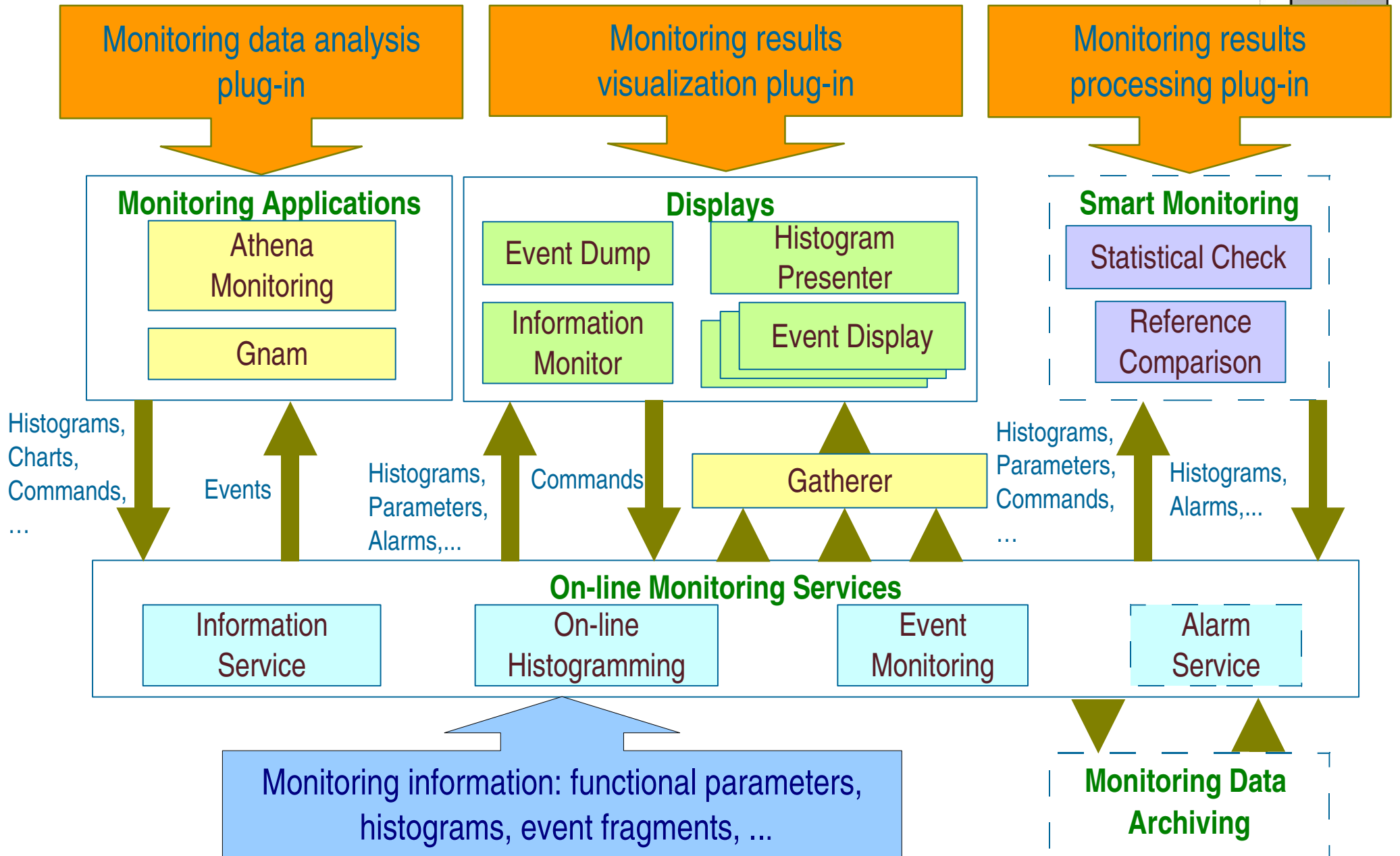
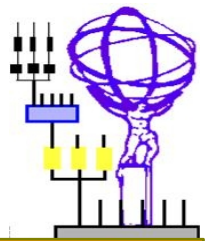
+ Smart monitoring: cope with the detector complexity

- Automatic reference histogram comparison and statistical checks
- Alarm generation, routing and reaction

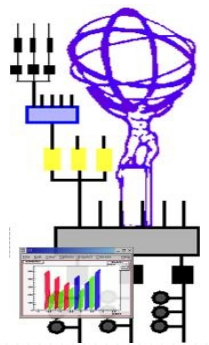
+ Monitoring Data Archiving: store and make available data (when needed)

- $O(10\text{GB})$ /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

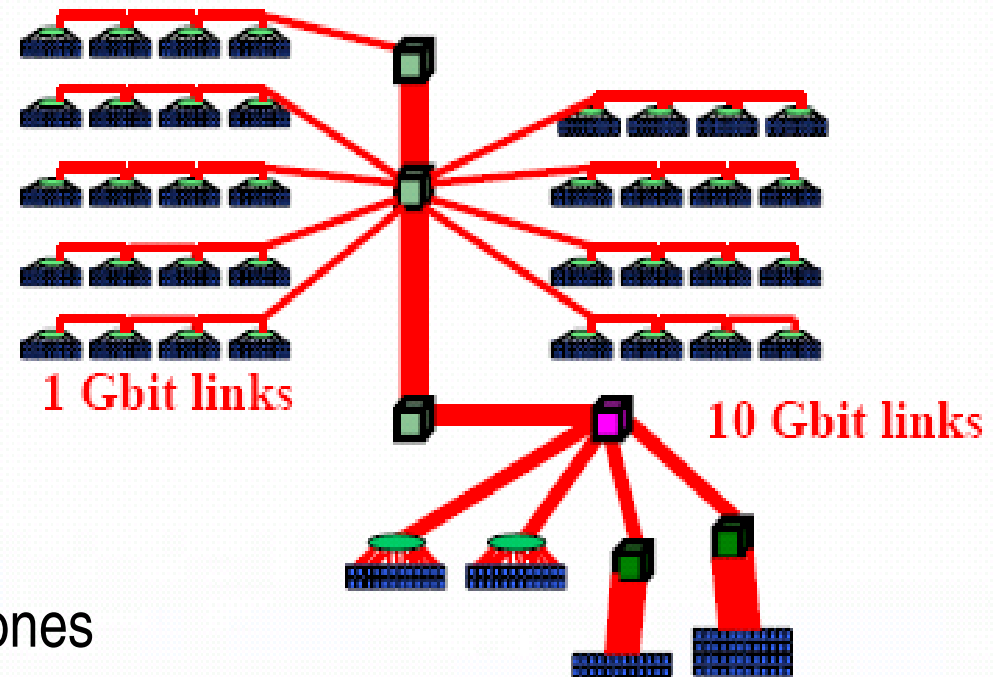
Monitoring Framework



Large Scale Test 2005



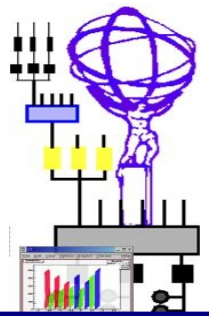
- Infrastructure: up to 700 nodes of the LXBATCH cluster at CERN
- Scope:
 - functionality of the TDAQ system
 - access to the condition database
 - test of selected components
- Network performances less than final ones



Comprehensive tests performed on: Emon, IS and OH

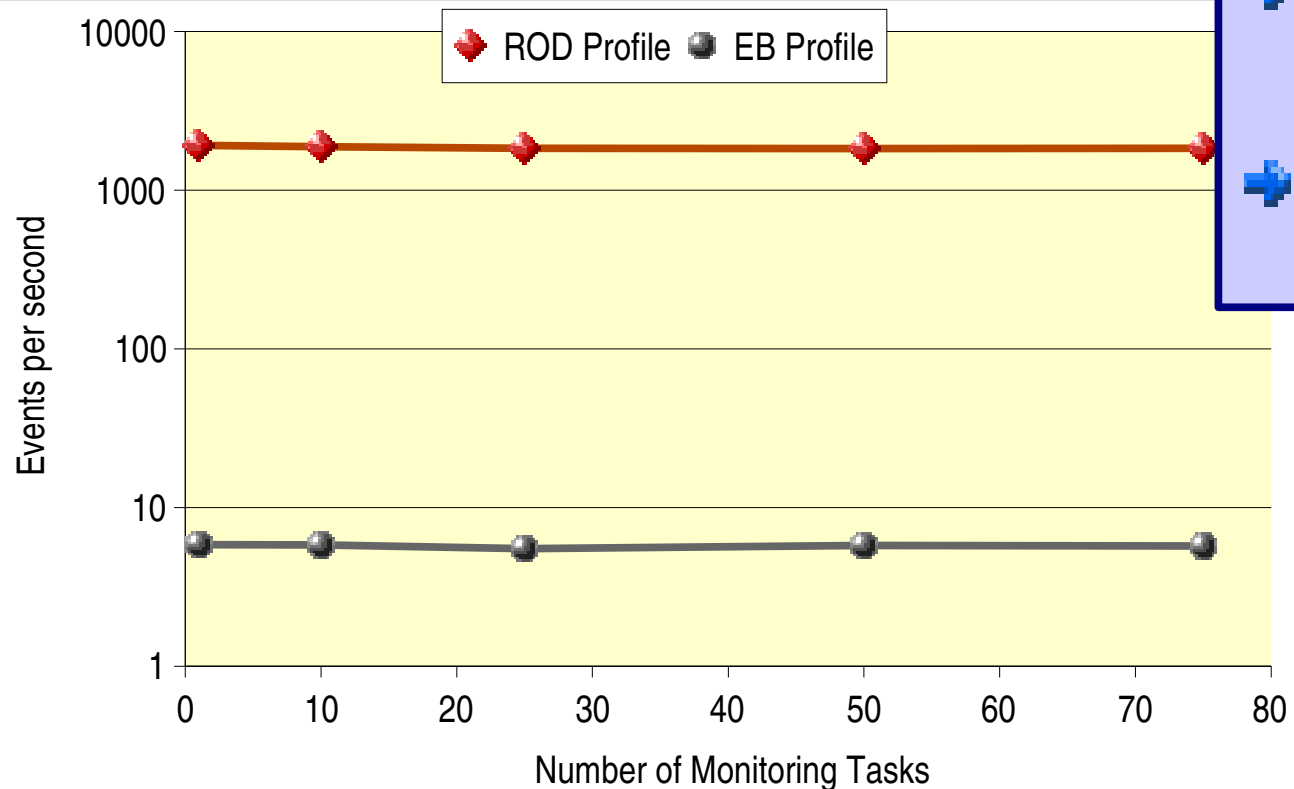
D. Burckhart, "Testing on a large scale: Running the ATLAS Data Acquisition and High Level Trigger software on 700 pc nodes", OC-5

LST: Emon

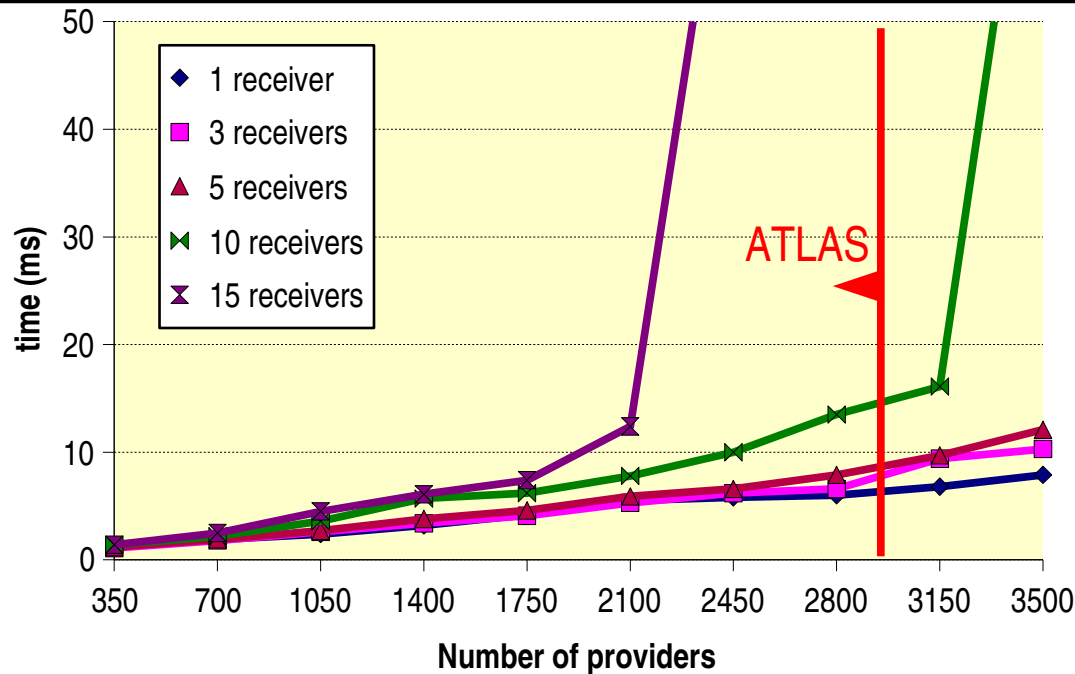
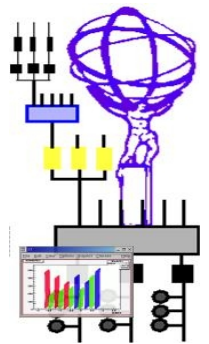


- 1 sampler, N sampling channels
- ROD – 2kB/event
- EB - 2MB/event

- 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%)

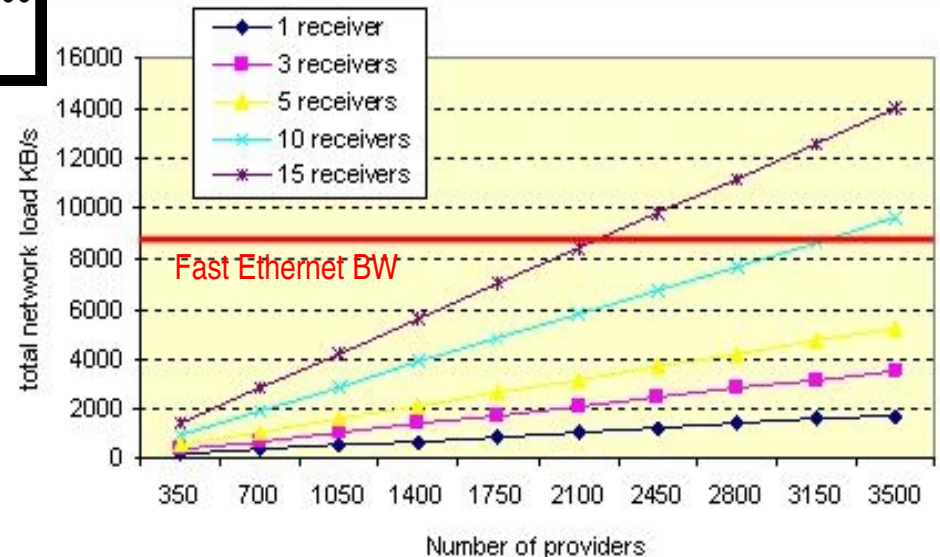


LST: IS

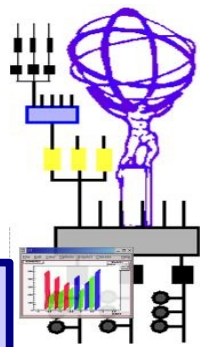


- 350 nodes
- 1 to 10 providers per node publishing 250 bytes of data
- 1 to 15 receivers

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

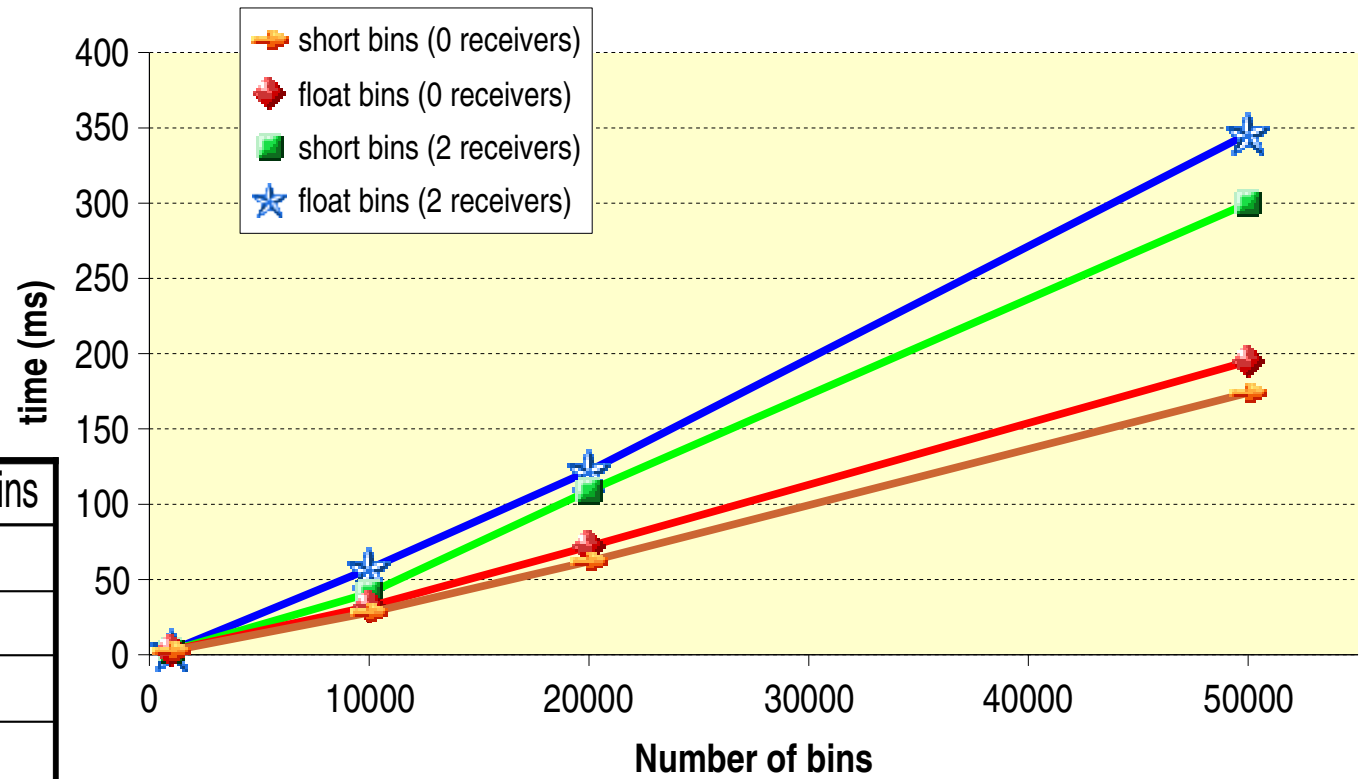


LST: OH



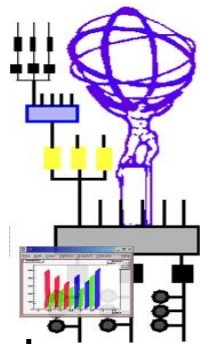
- 650 nodes
- 1 provider per node
- Scenario 1:
 - No receivers
 - update every 10s
- Scenario 2:
 - 2 receivers
 - update every 30s

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



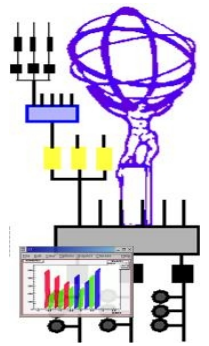
#bins	Size (kB) short bins	Size (kB) float bins
1000	18	20
10000	180	200
20000	360	400
50000	900	1000

Outlook

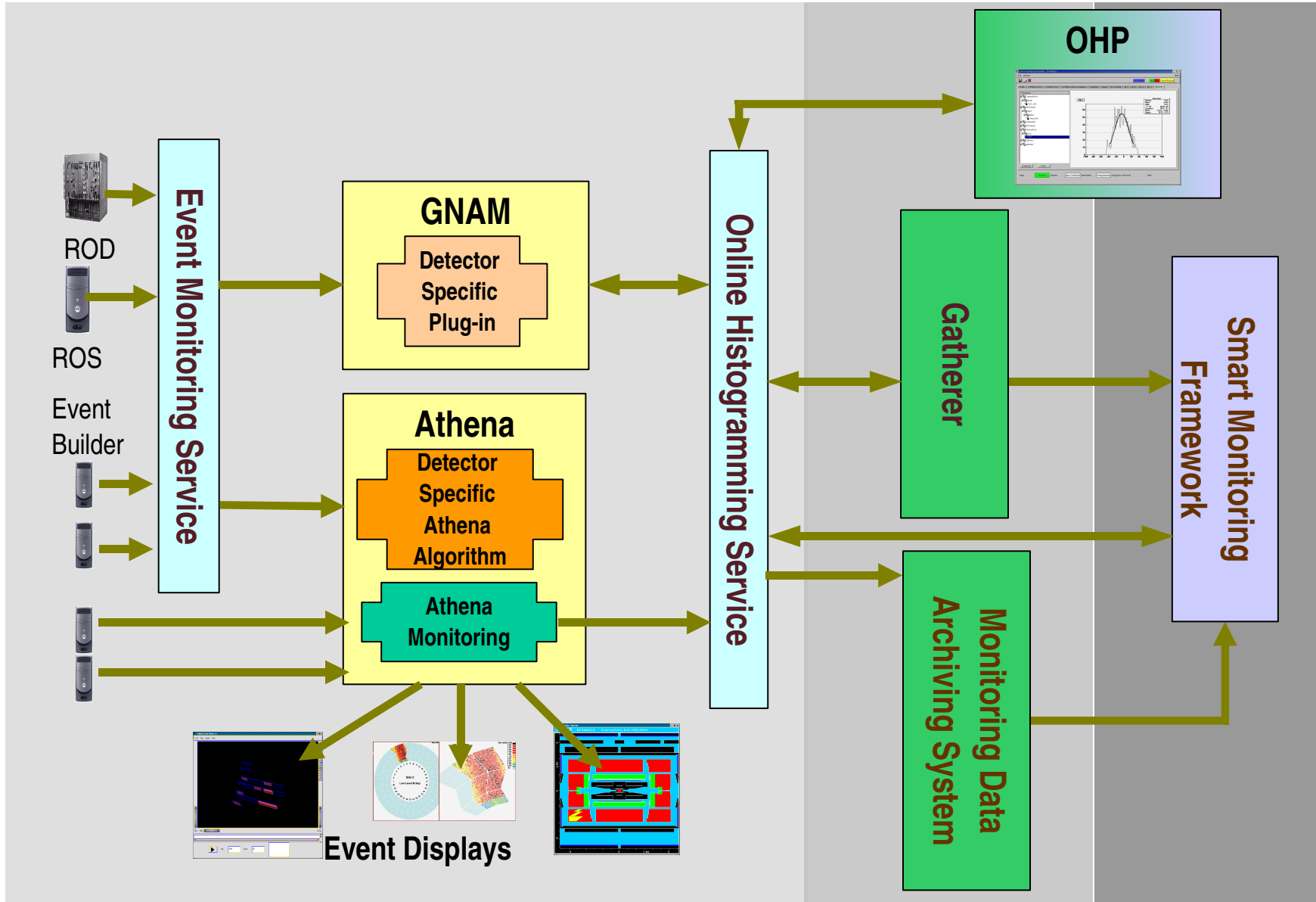
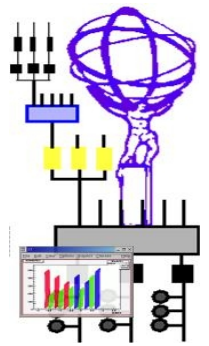


- A first implementation of the ATLAS monitoring framework is already present, from fundamental services to high-level applications
- Software applications have been tested during the past test beams and now are used by the sub-detectors in the commissioning sites
- Preliminary tests on a large distributed 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

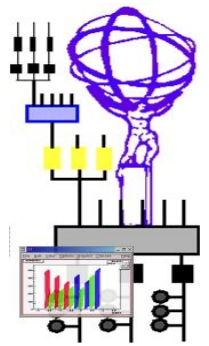
Backup Material



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)