A Validation System for the Complex Event Processing Directives of the ATLAS Shifter Assistant Tool

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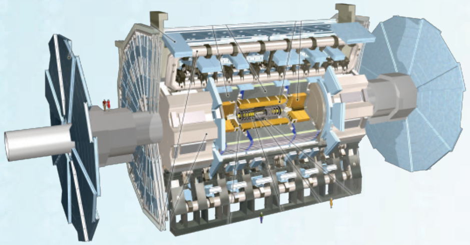
Outline

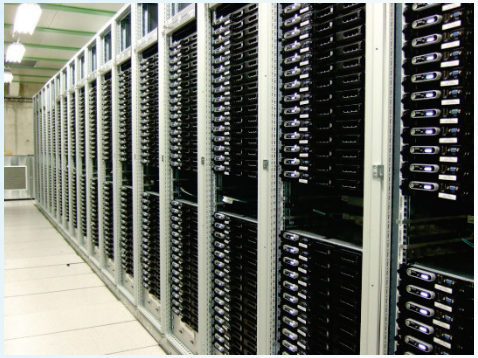
- **The ATLAS Trigger and Data Acquisition (TDAQ) system**
  - General schema
- **Complex Event Processing (CEP) in TDAQ**
  - Challenges
  - The Shifter Assistant (SA) tool
- **A validation tool for the SA**
  - General architecture
  - Web front-end
- **Conclusions**

Trigger and Data Acquisition System

See "The ATLAS Data Flow system for the second LHC run"
(R. Hauser - Track 1: Online Computing - 14/4)

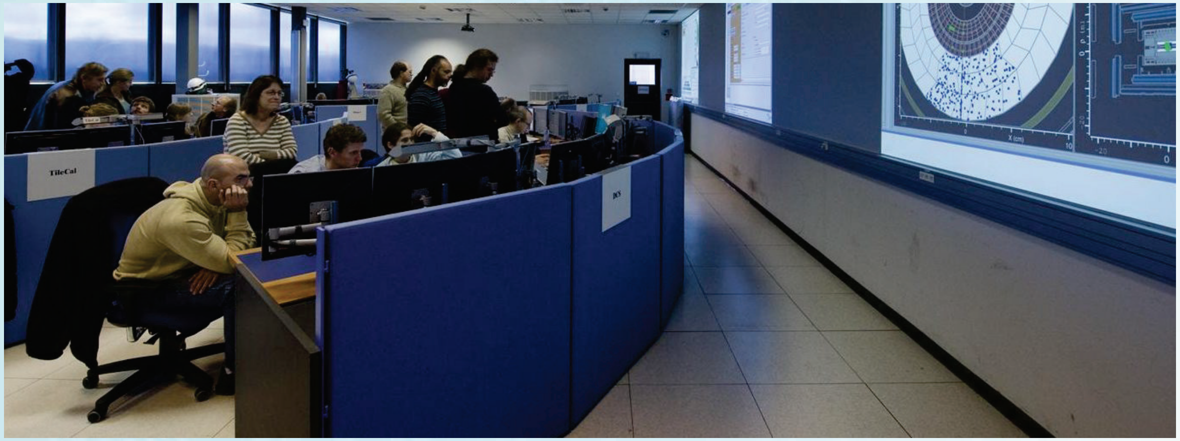
- The **Trigger and Data Acquisition** (TDAQ) system is responsible for filtering and transferring data from the detector to the mass storage
  - **40 millions** proton bunch interactions per second
  - Most of the generated events are **totally uninteresting**
    - A filter mechanism is needed in order to select and collect the more interesting ones
- More than **20k** applications running on **2k** hosts
- **1800** point-to-point connections from detectors to TDAQ





From detector to data storage

Challenges in TDAQ Operations



- **The main goal when operating the system is to maximize the data taking efficiency**
  - Dealing fast and effectively with errors and failures
- **The system is operated by a non-expert shift crew with support by experts (from various sub-systems) providing knowledge for specific components**
  - Inefficiency may come from human interventions
- **Automating error detection and diagnosis is a key feature**
  - Introduction of the Shifter Assistant

The Shifter Assistant

What

- A tool assisting the shifter in his/her daily work
  - **Diagnosing** problematic situations and **assisting** in problem solving
  - **Remind** the shifter to (not) take action

Why

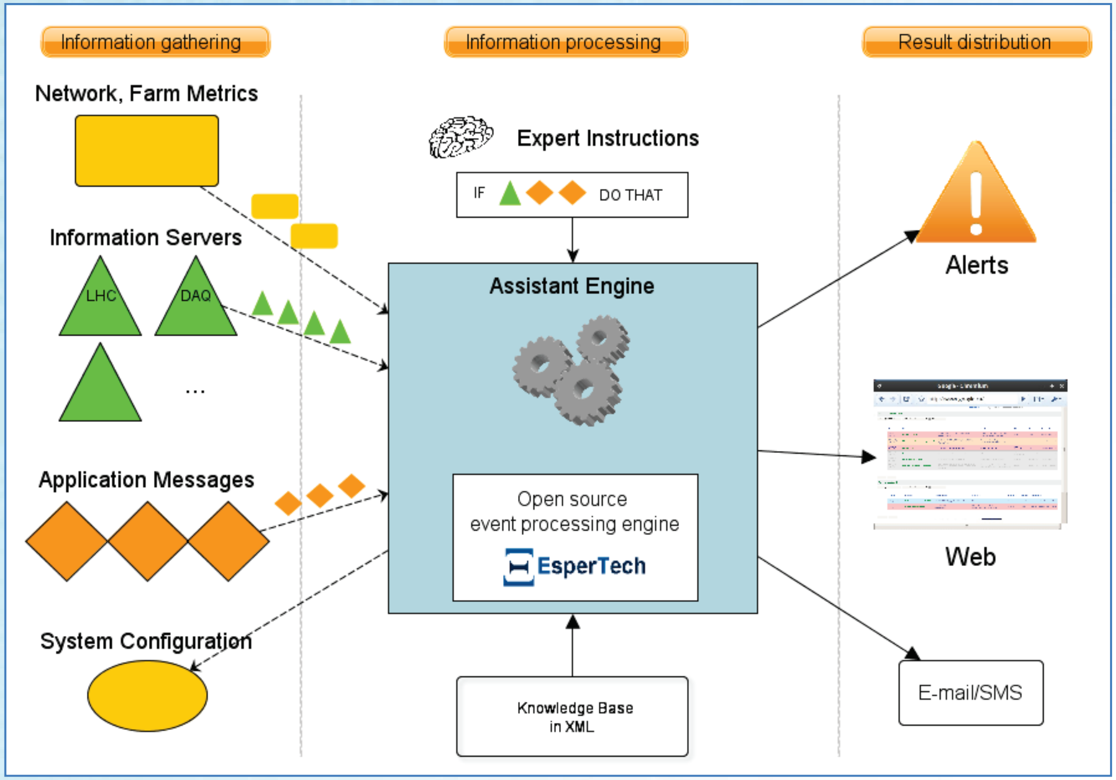
- **Reduce** and **simplify** shifter tasks
- Help shifters with more detailed and **pertinent** information
- Formalize **knowledge** from experts

How

- **Automate** checks and controls in real-time
- Process and analyze **heterogeneous** streams of information
- Provide **instructions** to the shifters on what to do and how to react
- **Promptly notify** shifters of problems and failures

The SA Architecture

- **Meant to deal effectively with problems requiring the human intervention**
- **Based on the ESPER Complex Event Processing (CEP) engine**
  - Continuous stream processing
  - Support for time/size windows, aggregation and grouping events
  - SQL-like pattern languages (EPL)



- **Directives**
  - Encode the knowledge from experts
  - XML structured KB
- **Alerts**
  - Effective and timeliness notification
  - Carry all the information needed for debug and fault diagnosis

A Validation Tool for the SA

Why

- **Maintenance** and **extendibility** of the knowledge base
- Spread **expertise** on CEP
- Writing **correct** directives is not trivial

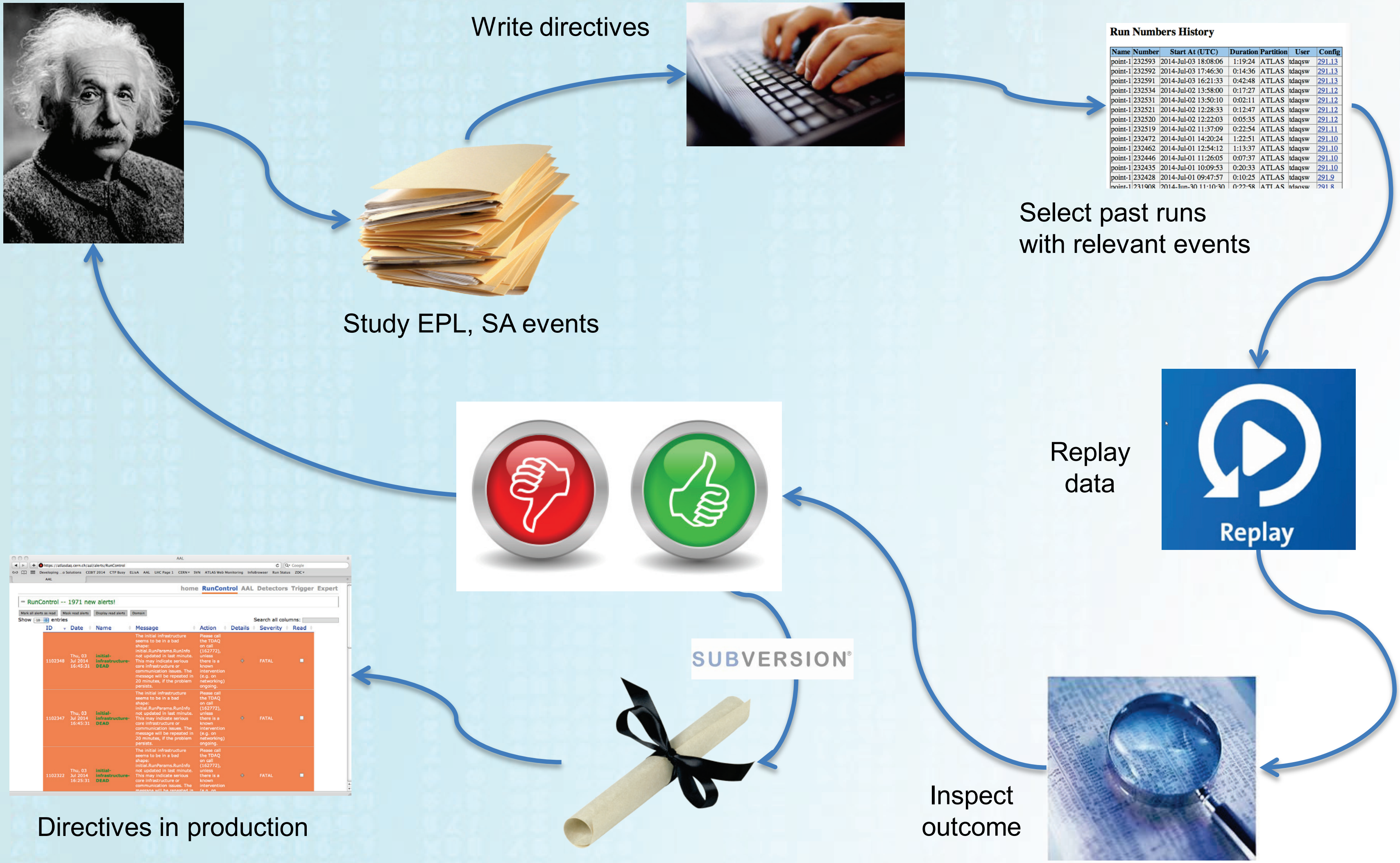
Requirements

- Directives shall be evaluated in an environment as close as possible to the **production system**
- Verify **syntactic correctness** of directives
- Verify correctness of “**condition matching**”
- Produce meaningful **diagnostic**
- **Easy** to use

How

- Exploit the **modular** “input” of the SA
- Inject into the SA **historical archived** “real” data
- Feed the SA with the **directives** to be tested

The Working Model



Run Numbers History

Name	Number	Start At (UTC)	Duration	Partition	User	Config
point-1	232593	2014-Jul-03 18:08:06	1:19:24	ATLAS	tdaqsw	291.13
point-1	232592	2014-Jul-03 17:46:30	0:14:36	ATLAS	tdaqsw	291.13
point-1	232591	2014-Jul-03 16:21:33	0:42:48	ATLAS	tdaqsw	291.13
point-1	232534	2014-Jul-02 13:58:00	0:17:27	ATLAS	tdaqsw	291.12
point-1	232531	2014-Jul-02 13:50:10	0:02:11	ATLAS	tdaqsw	291.12
point-1	232521	2014-Jul-02 12:28:33	0:12:47	ATLAS	tdaqsw	291.12
point-1	232520	2014-Jul-02 12:22:03	0:05:35	ATLAS	tdaqsw	291.12
point-1	232519	2014-Jul-02 11:37:09	0:22:54	ATLAS	tdaqsw	291.11
point-1	232472	2014-Jul-01 14:20:24	1:22:51	ATLAS	tdaqsw	291.10
point-1	232462	2014-Jul-01 12:54:12	1:13:37	ATLAS	tdaqsw	291.10
point-1	232446	2014-Jul-01 11:26:05	0:07:37	ATLAS	tdaqsw	291.10
point-1	232435	2014-Jul-01 10:09:53	0:20:33	ATLAS	tdaqsw	291.10
point-1	232428	2014-Jul-01 09:47:57	0:10:25	ATLAS	tdaqsw	291.9
point-1	231908	2014-Jun-30 11:10:30	0:22:58	ATLAS	tdaqsw	291.8

AAL

https://atlasdaq.cern.ch/aal/alerts/RunControl

RunControl -- 1971 new alerts!

Mark all alerts as read | Mask read alerts | Display read alerts | Domain

Show 10 entries

Search all columns:

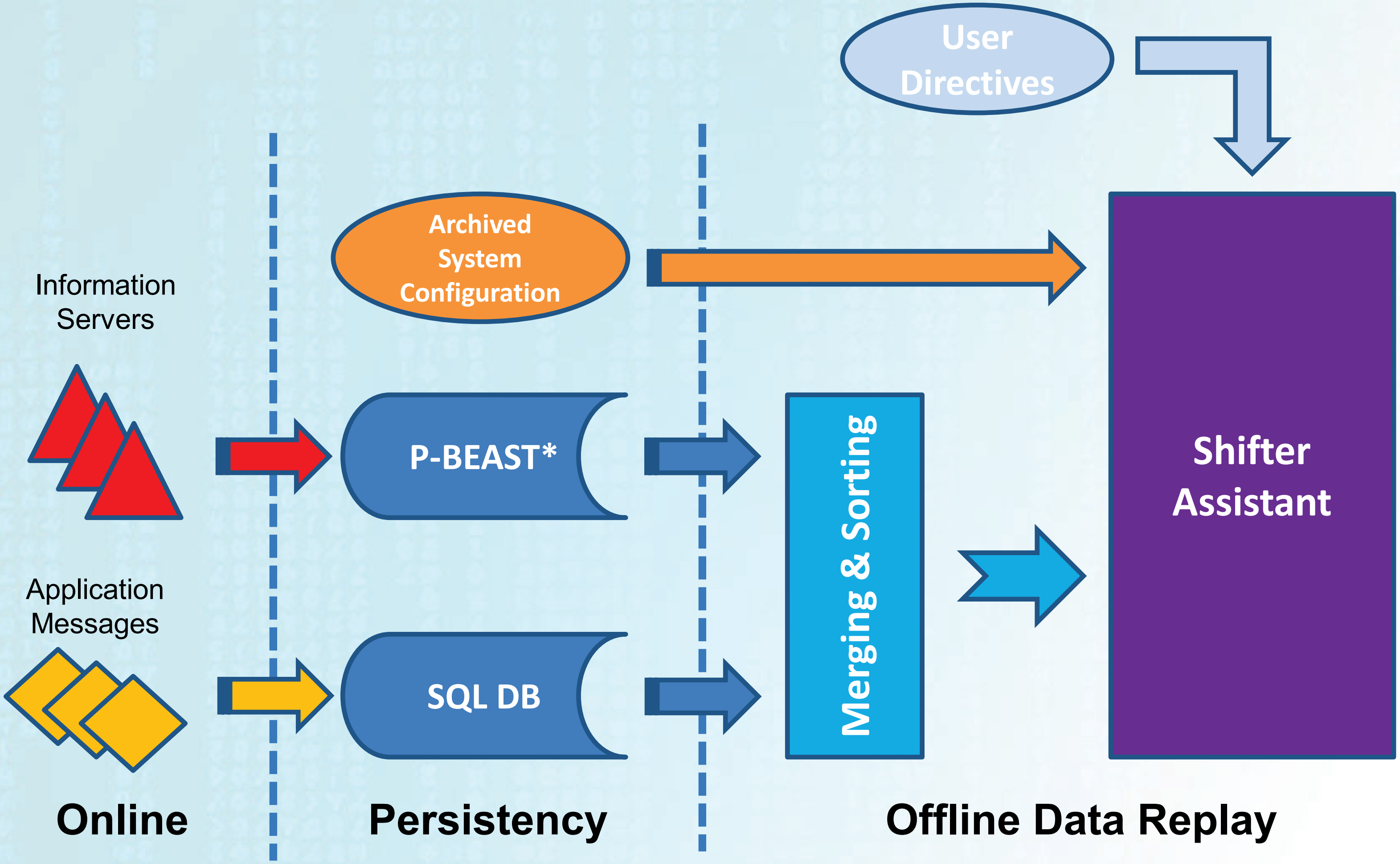
ID	Date	Name	Message	Action	Details	Severity	Read
1102348	Thu, 03 Jul 2014 16:45:31	initial-infrastructure-DEAD	The initial infrastructure seems to be in a bad shape: initial.RunParams.RunInfo not updated in last minute. This may indicate serious core infrastructure or communication issues. The message will be repeated in 20 minutes, if the problem persists.	Please call the TDAQ on call (162772), unless there is a known intervention (e.g. on networking) ongoing.	+	FATAL	□
1102347	Thu, 03 Jul 2014 16:45:31	initial-infrastructure-DEAD	The initial infrastructure seems to be in a bad shape: initial.RunParams.RunInfo not updated in last minute. This may indicate serious core infrastructure or communication issues. The message will be repeated in 20 minutes, if the problem persists.	Please call the TDAQ on call (162772), unless there is a known intervention (e.g. on networking) ongoing.	+	FATAL	□
1102322	Thu, 03 Jul 2014 16:25:31	initial-infrastructure-DEAD	The initial infrastructure seems to be in a bad shape: initial.RunParams.RunInfo not updated in last minute. This may indicate serious core infrastructure or communication issues. The	Please call the TDAQ on call (162772), unless there is a known intervention	+	FATAL	□

Challenges

- **Provide a proper controlled context for testing**
  - Sand-boxing the SA
- **Archive all the needed information**
  - Not archived means lost
- **Efficient data retrieval**
  - Often from custom database-like services
- **Reconstruct information that looks like the original one**
- **Merge and sort data in time**
  - Crucial for proper event correlation
- **Inject events into the SA with proper timing**

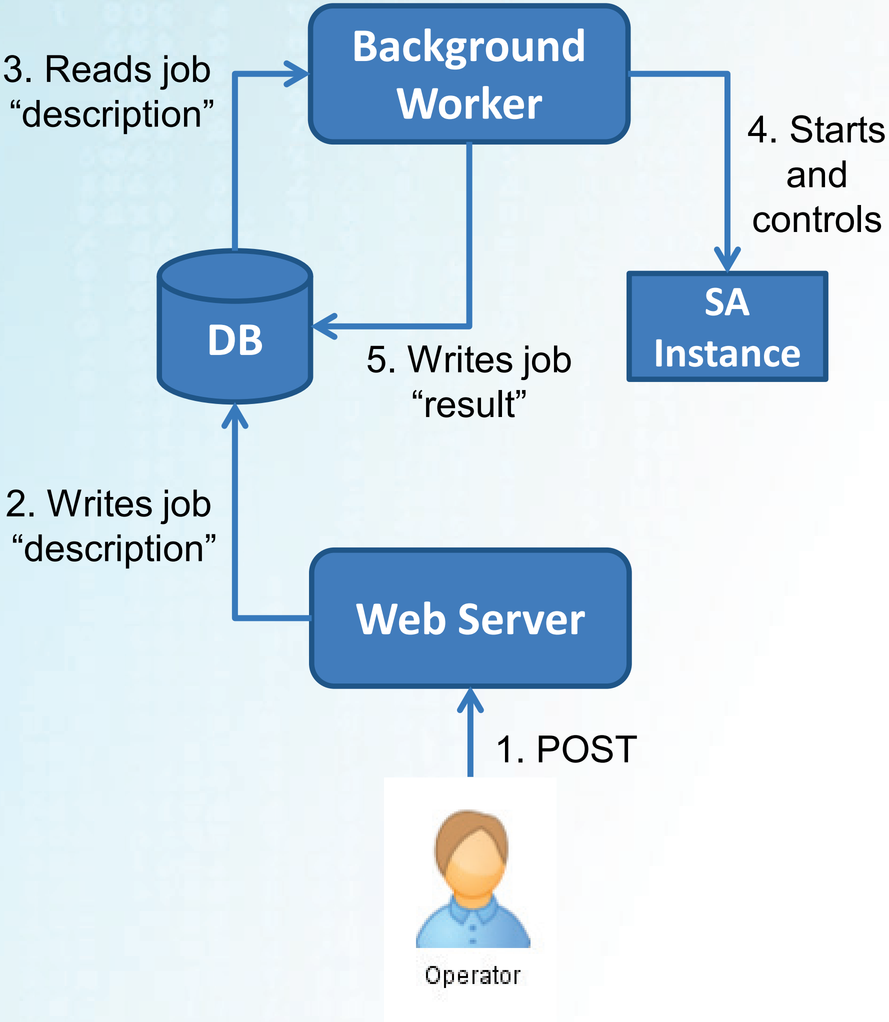
Architectural Overview

*Persistent Back-End for the Atlas Information System

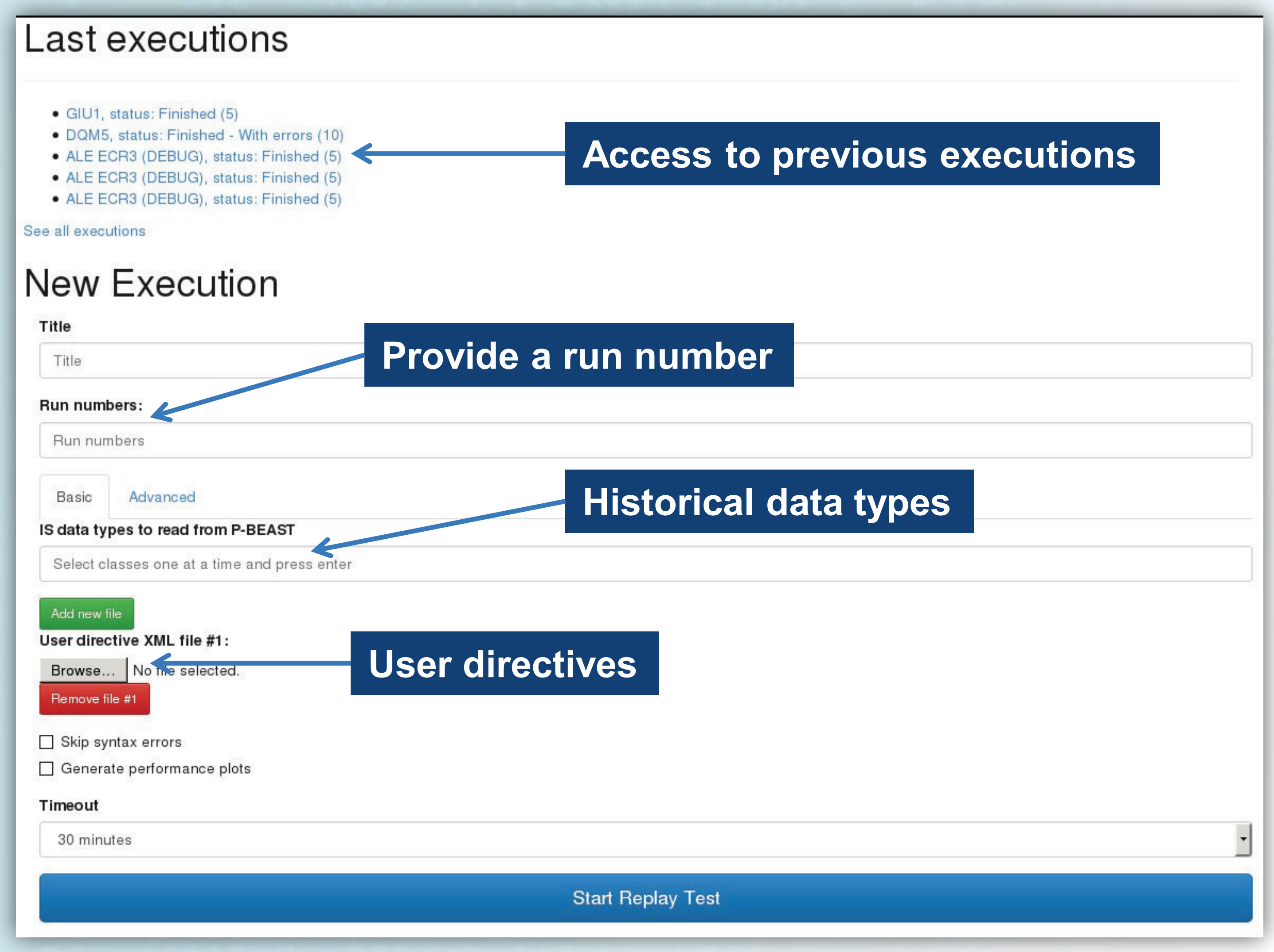


Web-Based Interface

- **The user is requested to provide**
  - The run number identifying historical data
  - The directives to be tested
  - Information type to play-back
- **A server-side application takes care of running a SA instance**
  - Proper environment
  - Process management
- **Results of the SA run available on-demand**
    - Detailed activity log



Web Interface



Last executions

- GIU1, status: Finished (5)
- DQM5, status: Finished - With errors (10)
- ALE ECR3 (DEBUG), status: Finished (5)
- ALE ECR3 (DEBUG), status: Finished (5)
- ALE ECR3 (DEBUG), status: Finished (5)

See all executions

New Execution

Title

Title

Run numbers:

Run numbers

IS data types to read from P-BEAST

Select classes one at a time and press enter

User directive XML file #1:

No file selected.

□ Skip syntax errors

□ Generate performance plots

Timeout

30 minutes

Access to previous executions

Provide a run number

Historical data types

User directives

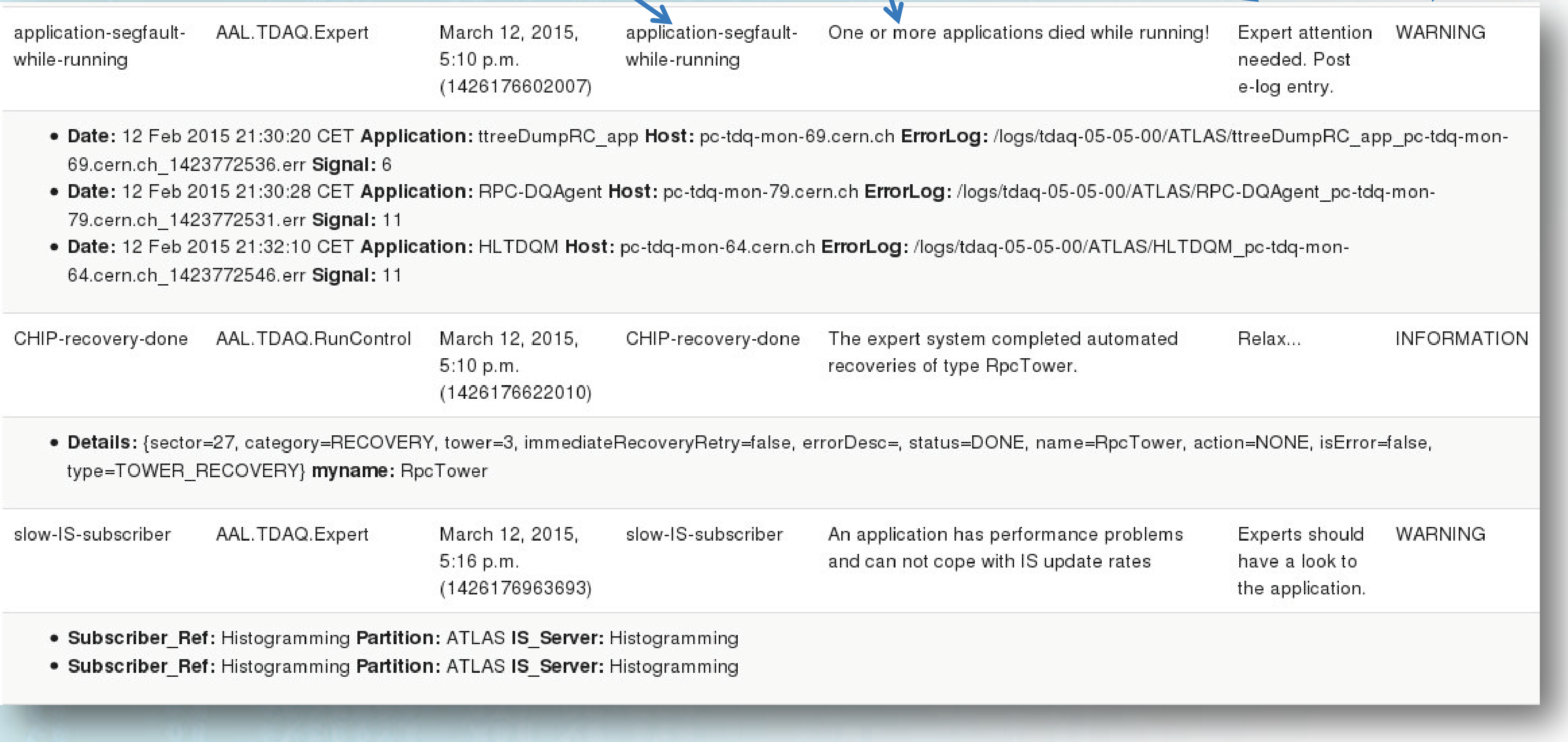
Results of a Validation Run

Directive

Message

Action

Severity



application-segfault-while-running	AAL.TDAQ.Expert	March 12, 2015, 5:10 p.m. (1426176602007)	application-segfault-while-running	One or more applications died while running!	Expert attention needed. Post e-log entry.	WARNING
• **Date:** 12 Feb 2015 21:30:20 CET **Application:** ttreeDumpRC_app **Host:** pc-tdq-mon-69.cern.ch **ErrorLog:** /logs/tdaq-05-05-00/ATLAS/ttreeDumpRC_app_pc-tdq-mon-69.cern.ch_1423772536.err **Signal:** 6 • **Date:** 12 Feb 2015 21:30:28 CET **Application:** RPC-DQAgent **Host:** pc-tdq-mon-79.cern.ch **ErrorLog:** /logs/tdaq-05-05-00/ATLAS/RPC-DQAgent_pc-tdq-mon-79.cern.ch_1423772531.err **Signal:** 11 • **Date:** 12 Feb 2015 21:32:10 CET **Application:** HLTDQM **Host:** pc-tdq-mon-64.cern.ch **ErrorLog:** /logs/tdaq-05-05-00/ATLAS/HLTDQM_pc-tdq-mon-64.cern.ch_1423772546.err **Signal:** 11						
CHIP-recovery-done	AAL.TDAQ.RunControl	March 12, 2015, 5:10 p.m. (1426176622010)	CHIP-recovery-done	The expert system completed automated recoveries of type RpcTower.	Relax...	INFORMATION
• **Details:** {sector=27, category=RECOVERY, tower=3, immediateRecoveryRetry=false, errorDesc=, status=DONE, name=RpcTower, action=NONE, isError=false, type=TOWER_RECOVERY} **myname:** RpcTower						
slow-IS-subscriber	AAL.TDAQ.Expert	March 12, 2015, 5:16 p.m. (1426176963693)	slow-IS-subscriber	An application has performance problems and can not cope with IS update rates	Experts should have a look to the application.	WARNING
• **Subscriber_Ref:** Histogramming **Partition:** ATLAS **IS_Server:** Histogramming • **Subscriber_Ref:** Histogramming **Partition:** ATLAS **IS_Server:** Histogramming						

Conclusions

- **The Shifter Assistant proved to be an essential tool for optimal DAQ operations during LHC Run I**
- **Having a solid and robust model for the maintenance and extension of the knowledge base is crucial**
- **The developed model allows to**
  - Validate directives in an easy and “controlled” way
  - Fully expose experts/developers to the alert system
    - Better understanding of the implications of bad directives
- **Greatly improving the quality of directives**
  - The “replay” sandbox allows to experiment directives writing, and agile iterations over different approaches
  - Independently of the working system infrastructure