Online remote monitoring facilities for the ATLAS experiment

Serguei Kolos (University of California, Irvine)
Of behalf of the ATLAS remote monitoring team
Outline

• Introduction
  – ATLAS collaboration
  – Motivation for remote monitoring

• Remote monitoring requirements

• Remote monitoring services:
  – ATLAS online monitoring architecture
  – Remote monitoring services design and implementations
  – Experience of the exploitation

• Summary and conclusion
ATLAS collaboration

- ATLAS is one of the 4 major LHC experiments at CERN
- ATLAS detector and TDAQ system construction took about 15 years:
  - 140 000 000 channels
- Over 3000 people from:
  - 169 institutes
  - 38 counties
The motivation for remote monitoring

• After the first year of the ATLAS exploitation the DAQ efficiency for 7TeV data is about 93%

• Availability of expertise from the people who were participating in the ATLAS construction is the key point to the success:
  – Many experts are not permanently located at CERN
  – Coming to CERN is possible but not too often due to various reasons (other commitments, budget limitations, teaching duties, etc.)
  – Even those who are at CERN can not be present in the Control Room all day
ATLAS security restrictions

- ATLAS experiment has its private set of networks:
  - Data, Technical and Control
  - Connection from the CERN Global Public Network is provided via dedicated gateway server:
    - Closed during data taking
    - Experts can log-in only in case of serious issues after the approval of the ATLAS Shift Leader

- Even experts based at CERN don’t have direct access to the monitoring data, unless sitting in one of the control rooms
ATLAS Remote Monitoring Requirements

- Any member of the ATLAS collaboration shall be able to:
  - View overall high-level status of the currently ongoing data taking activities
  - Small amount of information is made available to everybody
  - Updated at fixed time intervals (every couple of minutes)

- ATLAS sub-system expert shall be able to:
  - Request and obtain an up-to-date value of a given monitoring information

- ATLAS sub-system shifter shall be able to:
  - Permanently monitor the status of the given sub-system in real-time while data are being taken
  - Reduces the burden on the sub-system experts, who are contacted only in case of problems
ATLAS Online Monitoring Architecture

- All monitoring information is kept in the Information Service:
  - It’s complete
  - It’s up-to-date
- IS provides read-write and subscribe-callback APIs:
  - Java
  - C++
  - Python
General public remote monitoring

- Very limited set of data
- Practically unlimited number of users
General public remote monitoring: Design

- Data Quality Monitoring Framework
- Visual Displays
- Information Service (IS)
- Event Analysis Frameworks
- Web Monitoring Interface (WMI)
- Web Server

- Status, counters, etc.
- Event samples
- Periodically regenerated static HTML pages

Histograms

DQ Status
General public remote monitoring: Implementation

- WMI is a C++ framework:
  - It is running in the ATLAS private network
  - It fires plug-ins execution at configurable time intervals
  - It provides data-out C++ API for the plug-ins
  - It converts monitoring data chosen by the plug-ins to HTML files
  - It copies those files to the ATLAS Web server

- WMI plug-ins:
  - Select information to be put to HTML files
## Partition ATLAS

Check today's program here! Data taking efficiency
Other active partitions can be seen here.

### Run Info

<table>
<thead>
<tr>
<th>Run Tag</th>
<th>Run Time</th>
<th>Master &amp; Prescale Keys</th>
<th>L1 Bunch Group</th>
<th>Beam Mode</th>
<th>Beam 1 Status</th>
<th>Beam 2 Status</th>
<th>Beam Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>data10_7Tev</td>
<td>11:54:57</td>
<td>920, 2284, 2281</td>
<td>100</td>
<td>INJECTION PROBE BEAM</td>
<td>Present &amp; Safe</td>
<td>Present &amp; Safe</td>
<td>450.12</td>
</tr>
</tbody>
</table>

### Run Statistics

<table>
<thead>
<tr>
<th>Luminosity Block</th>
<th>Average Event Size MB</th>
<th>Throughput to Disk MB/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>367</td>
<td>1.408</td>
<td>52.0425</td>
</tr>
</tbody>
</table>

### L1 Parameters

<table>
<thead>
<tr>
<th>L1 Parameter</th>
<th>IC</th>
<th>TP1</th>
<th>TP2</th>
<th>TL1</th>
<th>TL2</th>
</tr>
</thead>
<tbody>
<tr>
<td>VME</td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECR</td>
<td>0.041%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Veto 0</td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Veto 1</td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backplane</td>
<td>1.192%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Global Rates (Hz)

- L1 out (TPR)
- L2out (TPR)
- L2F out (TPR)
- EF out (TPR)
- L2AFout (TPR)
- L1_MDT2_1
WMI HTML pages usage statistics (first week of October)

<table>
<thead>
<tr>
<th>#</th>
<th>Hits</th>
<th>KBytes</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>196322</td>
<td>16144</td>
<td>/sysadmin/ldap_roles/scripts/ajax/ldap.py/getShiftLeaderBoxContent</td>
</tr>
<tr>
<td>2</td>
<td>113878</td>
<td>732569</td>
<td>/atlas-point1/wmi/current/Run Status_wmi/ATLAS.html</td>
</tr>
<tr>
<td>3</td>
<td>113467</td>
<td>93211</td>
<td>/atlas-point1/wmi/current/Data Quality Monitoring_wmi/ATLAS.html</td>
</tr>
<tr>
<td>4</td>
<td>88691</td>
<td>7121</td>
<td>/sysadmin/ldap_roles/scripts/ajax/rolesdb.py/showRolesInWaitingState</td>
</tr>
<tr>
<td>5</td>
<td>55252</td>
<td>8871</td>
<td>/atlas-point1/dcs/css/atldcs.css</td>
</tr>
<tr>
<td>6</td>
<td>53432</td>
<td>101594</td>
<td>/atlas-point1/script-new/jquery-1.2.1.min.js</td>
</tr>
<tr>
<td>7</td>
<td>53426</td>
<td>65026</td>
<td>/atlas-point1/script-new/jquery.js</td>
</tr>
<tr>
<td>8</td>
<td>53350</td>
<td>5798</td>
<td>/atlas-point1/script-new/collapDiv.js</td>
</tr>
<tr>
<td>9</td>
<td>53348</td>
<td>2767</td>
<td>/atlas-point1/script-new/menu.js</td>
</tr>
<tr>
<td>10</td>
<td>53304</td>
<td>60435</td>
<td>/atlas-point1/css-new/style.css</td>
</tr>
<tr>
<td>11</td>
<td>53224</td>
<td>1859</td>
<td>/atlas-point1/css-new/reset.css</td>
</tr>
<tr>
<td>12</td>
<td>42358</td>
<td>315423</td>
<td>/atlas-point1/dcs/dcs/process.php</td>
</tr>
</tbody>
</table>

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Expert mode remote monitoring

- Any monitoring information can be provided on request
- Overall request rate is limited
Expert mode remote-monitoring: Implementation

• Each object in IS has a unique URL:
  – https://atlasop.cern.ch/info/current/ATLAS/is/RunParams/RunParams.RunParams
  – One can type this URL in the Web browser to get the specific info

• WebIS – Python HTTP server:
  – Send back the content of IS objects with respect to given URLs
  – Apache cache is used to reduce the number of requests

• Generic facility which can be used to construct complex WEB based GUIs using:
  – CSS, JavaScript, Java applets, standalone Java applications
WebIS: Histogram presenter

https://atlasop.cern.ch/atlas-point1/tdaq/web_is/ohp/ATLAS.html
WebIS: L1 Calorimeter remote monitoring application (Java)

https://twiki.cern.ch/twiki/bin/view/Atlas/LevelOneCaloRemoteMonitoring
**Expert mode Web access statistics (first week of October)**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Accesses</th>
<th>Percent</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>28279</td>
<td>0.49%</td>
<td>/info/current/ATLAS/is/RunCtrl/RunCtrl.RootController</td>
</tr>
<tr>
<td>17</td>
<td>27562</td>
<td>0.48%</td>
<td>/info/current/ATLAS/is/RunCtrlStatistics/RunCtrlStatistics.L2PU-SUM</td>
</tr>
<tr>
<td>18</td>
<td>27434</td>
<td>0.48%</td>
<td>/info/current/ATLAS/is/RunCtrlStatistics/RunCtrlStatistics.L2SV-SUM</td>
</tr>
<tr>
<td>19</td>
<td>27386</td>
<td>0.48%</td>
<td>/info/current/ATLAS/is/RunCtrlStatistics/RunCtrlStatistics.SFI-SUM</td>
</tr>
<tr>
<td>20</td>
<td>27278</td>
<td>0.48%</td>
<td>/info/current/ATLAS/is/RunCtrlStatistics/RunCtrlStatistics.SFO-SUM</td>
</tr>
<tr>
<td>21</td>
<td>23572</td>
<td>0.41%</td>
<td>/atlas-point1/systems/qeninfo/sys.php</td>
</tr>
<tr>
<td>22</td>
<td>20558</td>
<td>0.36%</td>
<td>/atlas-point1/wmi/current/scripts/wtrp_scripts/attachmap.js</td>
</tr>
<tr>
<td>23</td>
<td>20414</td>
<td>0.36%</td>
<td>/atlas-point1/page1/index-1280.php</td>
</tr>
<tr>
<td>24</td>
<td>19579</td>
<td>0.34%</td>
<td>/atlas-point1/systems/qeninfo/css/page.css</td>
</tr>
<tr>
<td>25</td>
<td>19578</td>
<td>0.34%</td>
<td>/atlas-point1/systems/qeninfo/css/1dynamicMenu.css</td>
</tr>
<tr>
<td>26</td>
<td>19428</td>
<td>0.34%</td>
<td>/info/current/ATLAS/is/RunCtrlStatistics/RunCtrlStatistics.L2RH-SUM</td>
</tr>
<tr>
<td>27</td>
<td>19245</td>
<td>0.34%</td>
<td>/info/current/ATLAS/is/RunCtrlStatistics/RunCtrlStatistics.PT-SUM</td>
</tr>
<tr>
<td>28</td>
<td>19087</td>
<td>0.33%</td>
<td>/info/current/ATLAS/is/DF/DF.DFM-1</td>
</tr>
<tr>
<td>29</td>
<td>19062</td>
<td>0.33%</td>
<td>/info/current/ATLAS/is/RunParams/RunParams.TrigConfL1PsKey</td>
</tr>
<tr>
<td>30</td>
<td>19058</td>
<td>0.33%</td>
<td>/info/current/ATLAS/is/RunParams/RunParams.TrigConfHltPsKey</td>
</tr>
</tbody>
</table>
Shifter mode remote monitoring

- Provides the same desktop and GUI monitors as in the ATLAS Control Room
- Supports limited number of users
Shifter mode remote monitoring: Design

- Data Quality Monitoring Framework
- Visual Displays
- Information Service (IS)
- Event Analysis Frameworks
- IS Mirror

Status, counters, etc.
Event samples
IS Streaming makes full real-time copy of the Information in IS
**Shifter mode remote monitoring: Implementation**

- **Mirror IS nodes have 2 NICs:**
  - One can be connected only from Atlas Private Network
  - Another one is restricted to “Remote X session” nodes

- **Remote users:**
  - Open ssh-tunnel on a CERN public node
  - Open X (NX) session on one of the “Remote X session” nodes
  - Use the same GUI displays as in the ATLAS Control Room
**NX technology**

- Plain X11 is very slow over long distance connections
- Several technologies were evaluated:
  - VNC, Sun Secure Global Desktop, NX
- Finally NX technology has been chosen:
  - The fastest, the cheapest and with small CPU/Memory overhead
- What is NX:
  - Initially proposed and implemented by NoMachine company
  - Provides compression and caching over standard X11 protocol
  - We are using FreeNX server (GPL)
  - Clients can download NoMachine NX client:
    - It is free for non-commercial use
    - It is available on Linux, Windows, MacOS
Shifter mode remote monitoring: Scalability

- This approach is almost “infinitely” scalable:
  - The information in the “IS mirror” service can be streamed to the “Secondary IS mirror”, which in turn can stream to the “Tertiary IS mirror”, etc.
  - At every level the streaming delay is $O(1)$ ms
Shifter mode remote monitoring: The highlights

- Mirrors full status of the ATLAS data taking session in real-time:
  - Information transfer delay is at the order of a few milliseconds
- Provides the same GUI applications as being used in the ATLAS Control Room:
  - No additional learning curve involved
  - No overhead for the SW development and maintenance
- Current configuration:
  - Two “Remote X session nodes” handle now up to 20 concurrent remote users sessions
- With recurrent mirroring, any practical number of remote sessions can be easily handled:
  - It’s just a matter of available HW resources
Summary and conclusion

- Three types of services have been implemented to provide remote monitoring for ATLAS
  - Each service is oriented to a specific group of ATLAS collaboration members

- The information available via WEB covers most of the experts needs for the monitoring
  - The number of log-in requests to the ATLAS private network was drastically reduced when the services were put in place

- Remote NX sessions are working nicely for people logged in from USA, Japan, Russia and other long distance sites:
  - Remote shifts become regular for some ATLAS sub-systems