CEP4Cloud - Complex Event Processing for Mastering the Elastic Cloud

Distributed Systems Group
Database Research Group
University of Marburg, Germany

Software AG - ProcessWorld 2011
Elastic Cloud Computing

• Gartner clients' No. 1 topic in 2010
  “A style of computing where scalable and elastic IT-enabled capabilities are delivered as a service to customers using Internet technologies”

• Five essential characteristics (NIST)
  – Resource Pooling
  – Rapid Elasticity
  – Measured Service

• The Challenge
  – Guarantee of Service Level Agreements in a Highly Dynamic World of Elastic IT-Resources and Services
CEP4Cloud

Sense Extensively

React in Time

Analyse Continuously
CEP4Cloud: Architecture

- Sensors running on different cloud layers
  - Application, Hardware, System (Linux, Windows)
- Easy activation/deactivation using a bundle framework
  - Sensors load dependencies automatically
  - Provides messaging infrastructure (JMS, AMQP)
- CEP engine queries the data streams
  - Continuously observation, filtering and combination of streams
  - Extraction of relevant information from input data
- Aris MashZone is used to show the results
- Action Framework executes custom actions
CEP4Cloud: Architecture
CEP4Cloud: CEP Engine

- New and powerful monitoring possibilities
- Multi-dimensional cross-layer analyses
- Queries are expressed declarative in SQL
- Pattern matching on single and combined streams
- Detection of trends, evolutions and abnormal situations
- Scalable
CEP4Cloud: Action Framework

- Listens on JMS bus for incoming events
- Executes actions on cloud instances
  - Custom JavaScript code
- Actions
  - Notify admin via email
  - Execute actions on system and application layer
- Has access to sensor's interfaces and data
Contact

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Team

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Hardware Layer
System Layer

```
SELECT *
FROM ProcessesStream, ImportanceTable
WHERE ProcessesStream.Command = ImportanceTable.Command
AND ProcessesStream.Command = /sbin/portmap
```

**Query Output (last 10 seconds)**

<table>
<thead>
<tr>
<th>Time</th>
<th>Process</th>
<th>CPU</th>
<th>Memory</th>
<th>Command</th>
<th>Priority</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>204494745</td>
<td>daemon</td>
<td>0.0</td>
<td>0.0</td>
<td>/sbin/portmap</td>
<td>low</td>
<td></td>
</tr>
<tr>
<td>204494747</td>
<td>daemon</td>
<td>0.0</td>
<td>0.0</td>
<td>/sbin/portmap</td>
<td>normal</td>
<td></td>
</tr>
<tr>
<td>204494749</td>
<td>daemon</td>
<td>0.0</td>
<td>0.0</td>
<td>/sbin/portmap</td>
<td>normal</td>
<td></td>
</tr>
<tr>
<td>204494751</td>
<td>daemon</td>
<td>0.0</td>
<td>0.0</td>
<td>/sbin/portmap</td>
<td>normal</td>
<td></td>
</tr>
<tr>
<td>204494753</td>
<td>daemon</td>
<td>0.0</td>
<td>0.0</td>
<td>/sbin/portmap</td>
<td>normal</td>
<td></td>
</tr>
<tr>
<td>204494755</td>
<td>daemon</td>
<td>0.0</td>
<td>0.0</td>
<td>/sbin/portmap</td>
<td>normal</td>
<td></td>
</tr>
</tbody>
</table>

**Action History**

<table>
<thead>
<tr>
<th>Time</th>
<th>ActionID</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>129439475</td>
<td>1</td>
<td>Set priorities because of high cpu usage</td>
</tr>
</tbody>
</table>
Application Layer

Heap Utilization

CPU Utilization

Thread Count

Live Threads

Loaded Classes

Query 1: Average difference of heap usage

```
SELECT avg(deltaHeapUsage) 
FROM HeapStream WINDOW(RANGE 10 SECONDS)
```

Query Output (last 10 seconds)

<table>
<thead>
<tr>
<th>Time</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1295394821</td>
<td>-2.1113948704140058</td>
</tr>
<tr>
<td>1295394822</td>
<td>-2.546062175573944</td>
</tr>
<tr>
<td>1295394823</td>
<td>-3.0786615560190503</td>
</tr>
<tr>
<td>1295394827</td>
<td>-3.8418883929629592</td>
</tr>
<tr>
<td>1295394828</td>
<td>-4.45564295303558</td>
</tr>
</tbody>
</table>

Action History

<table>
<thead>
<tr>
<th>Time</th>
<th>ActionID</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1295394737</td>
<td>4</td>
<td>Killed Thread-13 because of deadlock</td>
</tr>
<tr>
<td>1295394817</td>
<td>1</td>
<td>Started garbage collector because of high growth of heap</td>
</tr>
<tr>
<td>1295394823</td>
<td>2</td>
<td>Saved new GC Log: [1295394823, 6]</td>
</tr>
</tbody>
</table>