WebLogic JDBC monitor

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WebLogic provides rich JDBC monitoring and diagnostics capabilities (debug, WLDF), however does not provide lightweight facility to report executed SQL statements lasting longer than predefined time. Available out of the box subsystems (debug, WLDF) are little too heavy, in area of configuration and generate too much information. Practical use case is to be informed only about SQL executions which consumed too much time. Presented solution delivers such lightweight SQL monitoring functionality.

Note that it's an early version of the software. I've made a lot of work to tune and ensure that software is free of problems, but it's only software. Use it with caution.

JDBC monitor

Missing capability of WebLogic is filled with JDBC monitor utilizing interceptor interface exposed by WLS JDBC layer. The JDBC monitor traces all JDBC executions to extract SQL, related variables, and final execution time. In case of execution longer than predefined threshold, all information related to such execution are logged in alert log. Additionally JDBC monitor is shipped with user interface presenting real time SQL information and latest alerts.

Alert log

All executions lasting more that defined threshold are reported to ODL log file. ODL log files are located in server's log directory. SQL alert file is sufficed by "-sql.log".

```
$DOMAIN_HOME/servers/$SERVER_NAME/logs/$SERVER_NAME-sql.log
```

Alert with too long SQL statement execution contains all standard ODL information plus JDBC interceptor alert information. Alert is logged on Warning level.

```
[2015-03-24T08:50:44.017-07:00] [SOA_Server1] [WARNING] [] [weblogic.jdbc.debug] [tid: Workmanager: ,
Version: 0, Scheduled=false, Started=false, Wait time: 0 ms\n] [userId: <anonymous>] [ecid:
cd7222d84368db0c:41d95b8a:14c4c1494db:-8000-0000000000000217,0] [APP: soa-infra] SQL execution lasted more
than expected.[[
|------lasted [ms]:1
|------SQL:SELECT t1.ID, t1.SHORT_EXCEPTION_MSG, t1.PROPERTIES, t1.RECOVERABLE, t1.EXCEPTION_TYPE,
t1.CREATED_TIME, t1.CALLBACK_OPERATION, t1.CONTAINER_ID, t1.TARGET_ACTION_NAME, t1.FAULT_OBJ,
t1.TARGET_REFERENCE, t1.STEP, t1.TARGET_TYPE, t1.RETRY_INTERVAL, t1.CASE_NAME, t1.EXCEPTION_MSG,
t1.SYSTEM, t1.LOCK_TIME, t1.CONVERSATION_ID, t1.FAULT_NAME, t1.DEF_MESSAGE_ID, t1.EXCEPTION_TRACE,
t1.INSTANCE_ID, t1.STATUS, t1.TENANT_ID, t1.MI_PARTITION_DATE, t1.RETRY_COUNT, t1.SOURCE_URI, t0.CASE_ID,
t0.CONTAINER_ID, t0.DUMMY1, t0.MSG_ID, t0.COMPONENT_DN, t0.OPERATION, t0.CREATION_DATE, t0.PRIORITY,
t0.COMPONENT_STATUS, t0.QNAME_LOCAL_PART, t0.CASE_INFO, t0.QNAME_NAMESPACE, t0.LOCK_TIME, t0.SOURCE_URI,
t0.TENANT_ID, t0.INSTANCE_CREATED, t0.IS_EVENT, t0.STATUS FROM MEDIATOR_DEFERRED_MESSAGE t0,
MEDIATOR_CASE_INSTANCE t1 WHERE ((((t1.STATUS = ?) AND (t1.LOCK_TIME = ?)) AND (t1.CONTAINER_ID = ?)) AND
(t0.CASE_ID = t1.DEF_MESSAGE_ID))
|------with following modifiers:
       \------0: [name=setPoolable, parameters=[true]]
       \------1: [name=setObject, parameters=[1, locked]]
       \------2: [name=setObject, parameters=[2, 2015-03-24 08:50:44.013]]
       \------3: [name=setObject, parameters=[3, 221D7810D22F11E4BF91DF392C48EAB9]]
       \------4: [name=executeQuery, parameters=[]]
```

```
]]
```

Next to execution time, and SQL statement, all prepared statement's variables are presented.

JDBC monitor is shipped with one main interceptor, and five inherited classes using names suffixed by number 1..5. Such solution provides ability to configure different interceptors for different data sources, with separated log file for each data source. Not only different log files are maintained, but user interface presents interceptor class name next to SQL, what gives indirect information about associated data source.

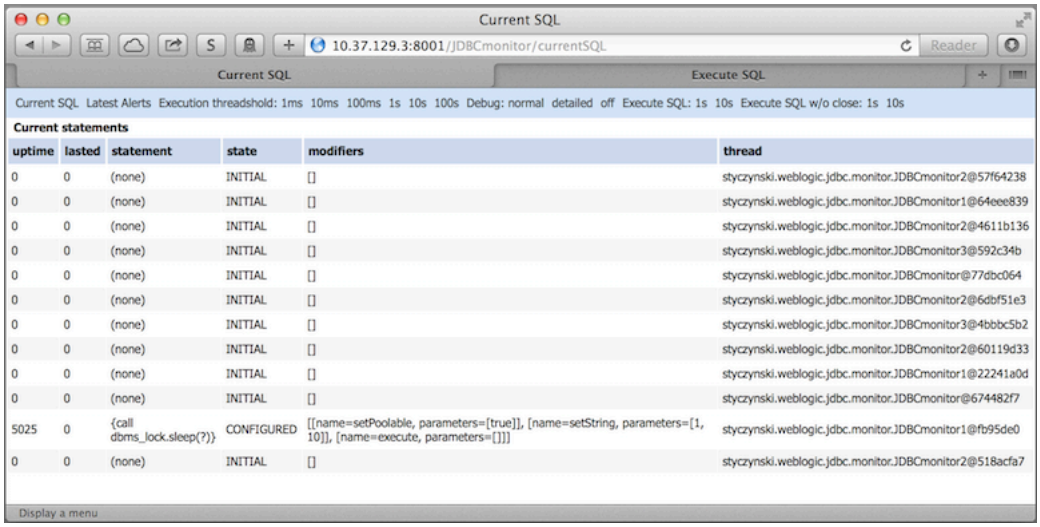
All interceptors are sharing single debug log file. Apart of debug information you will find content from sql[12345]*.log files in debug log.

User interface

User interface provides two functions: (1) view on currently active SQL statements, and (2) view on latest alerts.

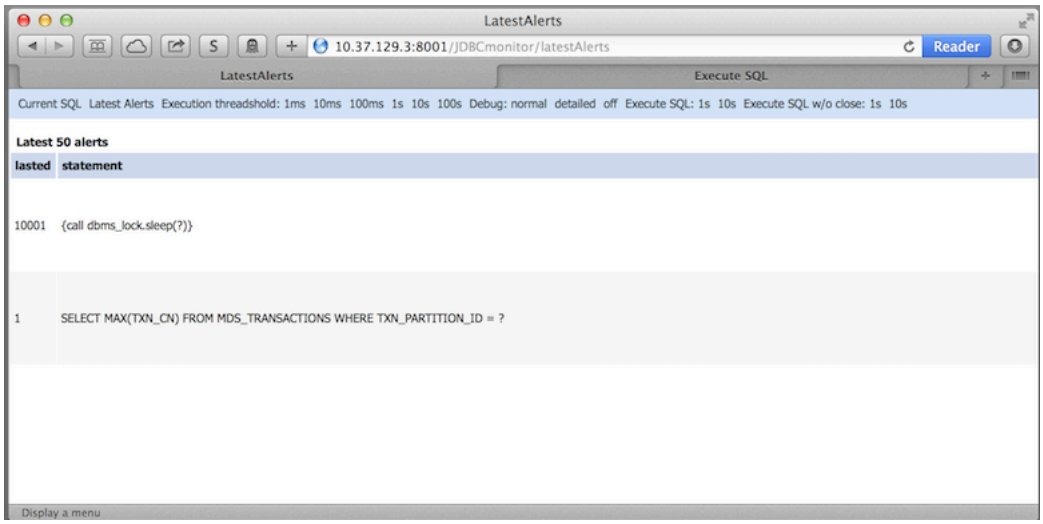
View on active SQL is available under

`http://<host>:<port>/JDBCmonitor/currentSQL`



View on latest alerts is available under

http://<host>:<port>/JDBCmonitor
or
http://<host>:<port>/JDBCmonitor/latestAlerts



Provided menu makes it easy to quickly switch between both views.

Next to standard options, menu contains possibility to configure sensitivity, and debug level. Use detailed debugging with caution, as amount of logged information is quite big, slowing down server JDBC operations.

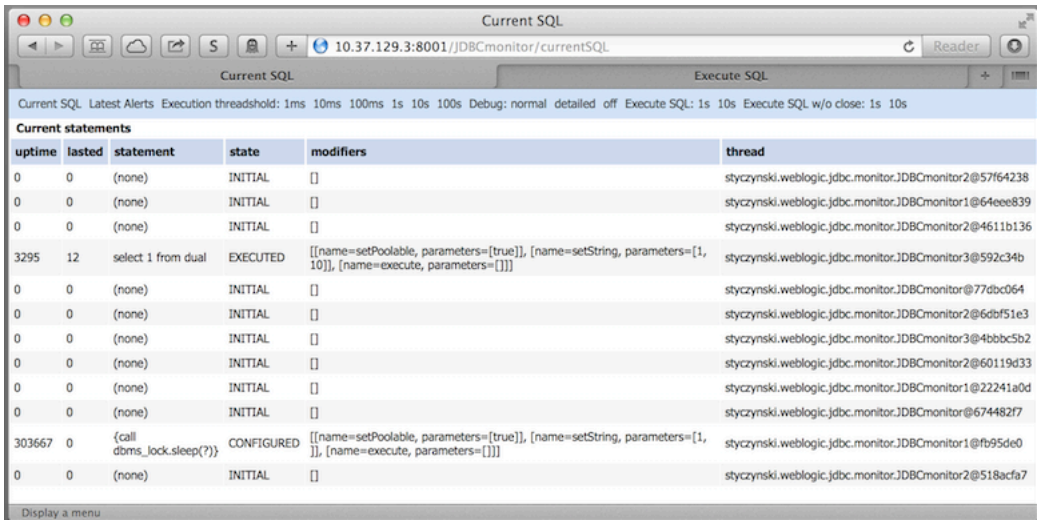
Menu provides ability to execute exemplary slow SQL statement (`{call dbms_lock.sleep(?)}`). This feature is used to verify proper work of JDBC monitor. Execution of dbs_lock may be parametrized by providing (a) sleep time, (b) datasource, (c) sleep in Java code between JDBC operations, and (d) information to finalize sql interaction w/o close. It's possible to specify own SQL command. Blow URL shows sample calls:

1. sleep for 1s on jdbc/SOADataSource
`http://10.37.129.3:8001/JDBCmonitor/executesql?param1=1&datasource=jdbc%2FSOADataSource`

2. sleep for 10s on jdbc/SOADataSource. Delay by 5 seconds each JDBC operation at client side.
`http://10.37.129.3:8001/JDBCmonitor/executesql?param1=10&datasource=jdbc%2FSOADataSource&param2=5`

3. execution of provided SQL with missing ps.close operation
`http://10.37.129.3:8001/JDBCmonitor/executesql?sqlCmd=select%201%20from%20dual&noClose`

Note that in case of executing SQL statements in improper way, JDBC monitor console presents counting up "uptime" with static "lasted". The former informs about total time consumed by statement handling, and the former one about time of "execute" command.



Another case on above screenshot shows broken execution of dbms_lock. In this situation statement was created and abandoned, due to Java exception. Both connections were forcibly closed by WebLogic once thread finished processing request. To simulate such situation trigger the following:

```
http://10.37.129.3:8001/JDBCmonitor/executesql?param1=XXX
```

To change sensitivity of JDBC interceptor click on menu "`Execution threshold: 1ms 10ms 100ms 1s 10s 100s`". the same may be achieved invoking URL with execution threshold defined by sqlMaxExecutionTime. Providing value of 0 will trace all SQL executions. Note that sensitivity is shared among all JDBCmonitor classes, thus sensitivity change will influence all data sources.

```
http://10.37.129.3:8001/JDBCmonitor/setparameters?sqlMaxExecutionTime=1
```

Configuration

Current version of JDBC interceptor is shipped w/o persistent configuration. Default SQL execution threshold is set to 1s, and number of in-memory collected alerts to 50. It's possible to change standard configuration by provided menu, and a servlet behind it. Note that size of alert array is fixed. Potential change requires modification of JDBCmonitor.topAlertsToStore variable and recompilation.

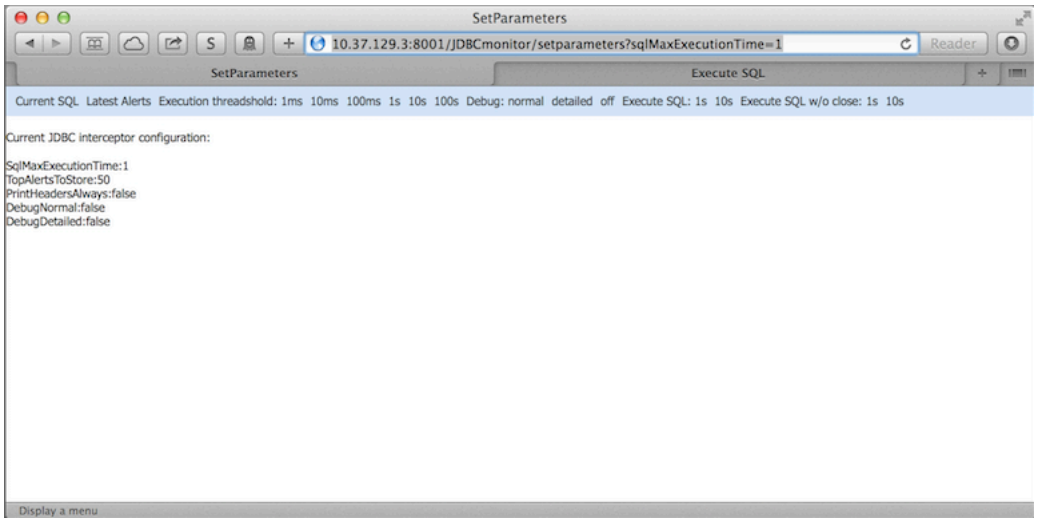
Runtime reconfiguration of monitor sensitivity and debug level are possible by using provided user interface menu, and internal servlet. Servlet's parameters with its default values are presented below:

SqlMaxExecutionTime	1000
PrintHeadersAlways	false
DebugNormal	false
DebugDetailed	false

Exemplary servlet use:

```
http://10.37.129.3:8001/JDBCmonitor/setparameters?
printHeadersAlways=false&debugNormal=false&debugDetailed=false
```

After invocation of configuration servlet monitor shows page with current value of parameters.



Installation

Installation of JDBC interceptor consist of five steps: (1) placing wlsJDBCmonitor.jar file in WLS file space, (2) adding wlsJDBCmonitor.jar to WLS system class path, (3) configuring ODL logging subsystem, (4) configuring domain data sources, and (5) optional deployment of web interface (wlsJDBCmonitorConsole.war).

Ad.1 Placing jar file in WLS file space

To make use of JDBC interceptor you must place showJDBCcalls.jar in directory available for WebLogic process. Good place is a domain lib directory.

```
DOMAIN_HOME=/home/oracle/Oracle/Middleware/user_projects/domains/
SOA_domain
SSH_USER=oracle
SSH_HOST=10.37.129.3
scp wlsJDBCmonitor.jar $SSH_USER@$SSH_HOST:$WLS_DOMAIN/lib
```

Ad.2 Add showJDBCcalls.jar to WLS system class path.

Update domain startup script by adding following shell variable.

```
export POST_CLASSPATH=$DOMAIN_HOME/lib/wlsJDBCmonitor.jar
```

Note that JDBC interceptor class must be added to system class path. Variable DOMAIN_HOME is available in configured (by setDomainEnv.sh) WLS environment.

Ad.3 Configuring ODL logging subsystem

JDBC interceptor uses ODL logger. Proper configuration, directs SQL execution alerts and potential debug information is different log files. In non configured system, generated information is placed in standard out.

To configure ODL, edit two files:
1. template to be used when configuration of new servers is prepared:
`$ORACLE_DOMAIN_CONFIG_DIR/logging-template.xml`

2. configuration if currently started servers:
`$ORACLE_DOMAIN_CONFIG_DIR/servers/<server_name>/logging.xml`

In both files, put (copy/paste should work) the following:

In section <log_handlers>:

```
<log_handler name='sql-debug-handler' class='oracle.core.ojdl.logging.ODLHandlerFactory' level='TRACE:32'>
   <property name='path' value='${domain.home}/servers/${weblogic.Name}/logs/${weblogic.Name}-sql-
debug.log'/>
   <property name='maxFileSize' value='104857600'/>
   <property name='maxLogSize'  value='524288000'/>
   <property name='encoding' value='UTF-8'/>
   <property name='useThreadName' value='true'/>
</log_handler>

<log_handler name='sql-handler' class='oracle.core.ojdl.logging.ODLHandlerFactory' level='WARNING'>
   <property name='path' value='${domain.home}/servers/${weblogic.Name}/logs/${weblogic.Name}-sql.log'/>
   <property name='maxFileSize' value='10485760'/>
   <property name='maxLogSize' value='104857600'/>
   <property name='encoding' value='UTF-8'/>
   <property name='useThreadName' value='true'/>
</log_handler>

<log_handler name='sql1-handler' class='oracle.core.ojdl.logging.ODLHandlerFactory' level='WARNING'>
   <property name='path' value='${domain.home}/servers/${weblogic.Name}/logs/${weblogic.Name}-sql1.log'/>
   <property name='maxFileSize' value='10485760'/>
   <property name='maxLogSize' value='104857600'/>
   <property name='encoding' value='UTF-8'/>
   <property name='useThreadName' value='true'/>
</log_handler>

<log_handler name='sql2-handler' class='oracle.core.ojdl.logging.ODLHandlerFactory' level='WARNING'>
   <property name='path' value='${domain.home}/servers/${weblogic.Name}/logs/${weblogic.Name}-sql2.log'/>
   <property name='maxFileSize' value='10485760'/>
   <property name='maxLogSize' value='104857600'/>
   <property name='encoding' value='UTF-8'/>
   <property name='useThreadName' value='true'/>
</log_handler>

<log_handler name='sql3-handler' class='oracle.core.ojdl.logging.ODLHandlerFactory' level='WARNING'>
   <property name='path' value='${domain.home}/servers/${weblogic.Name}/logs/${weblogic.Name}-sql3.log'/>
   <property name='maxFileSize' value='10485760'/>
   <property name='maxLogSize' value='104857600'/>
   <property name='encoding' value='UTF-8'/>
   <property name='useThreadName' value='true'/>
</log_handler>

<log_handler name='sql4-handler' class='oracle.core.ojdl.logging.ODLHandlerFactory' level='WARNING'>
   <property name='path' value='${domain.home}/servers/${weblogic.Name}/logs/${weblogic.Name}-sql4.log'/>
   <property name='maxFileSize' value='10485760'/>
   <property name='maxLogSize' value='104857600'/>
   <property name='encoding' value='UTF-8'/>
   <property name='useThreadName' value='true'/>
</log_handler>

<log_handler name='sql5-handler' class='oracle.core.ojdl.logging.ODLHandlerFactory' level='WARNING'>
   <property name='path' value='${domain.home}/servers/${weblogic.Name}/logs/${weblogic.Name}-sql5.log'/>
   <property name='maxFileSize' value='10485760'/>
   <property name='maxLogSize' value='104857600'/>
   <property name='encoding' value='UTF-8'/>
   <property name='useThreadName' value='true'/>
</log_handler>
```

In section <loggers>:

```
  <logger name='styczynski.weblogic.jdbc' level='TRACE:32' useParentHandlers='false'>
   <handler name='sql-debug-handler'/>
  </logger>
```

```
<logger name='styczynski.weblogic.jdbc.monitor.JDBCmonitor' level='TRACE:32' useParentHandlers='true'>
 <handler name='sql-handler'/>
</logger>
<logger name='styczynski.weblogic.jdbc.monitor.JDBCmonitor1' level='TRACE:32' useParentHandlers='true'>
 <handler name='sql1-handler'/>
</logger>
<logger name='styczynski.weblogic.jdbc.monitor.JDBCmonitor2' level='TRACE:32' useParentHandlers='true'>
 <handler name='sql2-handler'/>
</logger>
<logger name='styczynski.weblogic.jdbc.monitor.JDBCmonitor3' level='TRACE:32' useParentHandlers='true'>
 <handler name='sql3-handler'/>
</logger>
<logger name='styczynski.weblogic.jdbc.monitor.JDBCmonitor4' level='TRACE:32' useParentHandlers='true'>
 <handler name='sql4-handler'/>
</logger>
<logger name='styczynski.weblogic.jdbc.monitor.JDBCmonitor5' level='TRACE:32' useParentHandlers='true'>
 <handler name='sql5-handler'/>
</logger>
```

Ad.4. Configure Data Sources

Data source configuration may be done using one of three methods: (1) manual interaction with console, (2) use of WLST, and (3) edit of config.xml. The last option is typically not recommended as may lead to corruption of config.xml.

To configure Data Source manually go to data source configurable: `Diagnostics/ Driver Interceptor`, and provide interceptor class name: `styczynski.weblogic.jdbc.monitor.JDBCmonitor`.

WLST snippet looks the following. Replace <ds_name> with your data source name.

```
startEdit()
cd('/JDBCSystemResources/<ds_name>/JDBCResource/<ds_name>/JDBCConnectionPoolParams/<ds_name>')
cmo.setDriverInterceptor('styczynski.weblogic.jdbc.monitor.JDBCmonitor')
```

To configure system editing config.xml put following line in data source definition file above </jdbc-connection-pool-params> tag:

```
    <driver-interceptor>styczynski.weblogic.jdbc.monitor.JDBCmonitor</driver-interceptor>
```

Note that to utilize multiple log files, you should use different monitor classes from 6 available: JDBCmonitor, JDBCmonitor1, JDBCmonitor2, ..., JDBCmonitor5.

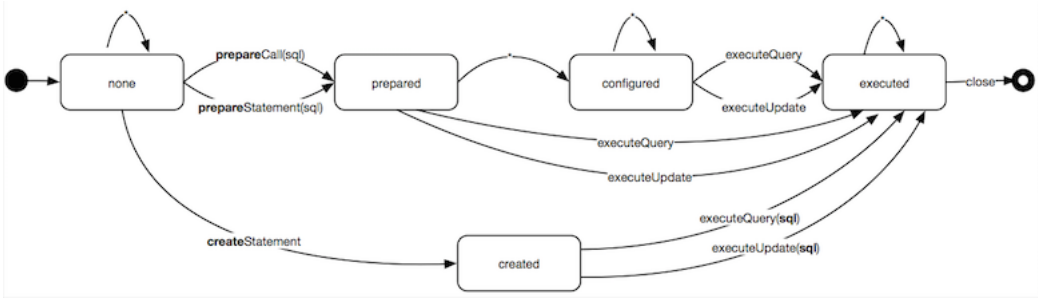
System must be restarted to activate JDBC interceptor.

Ad.5. Deployment of web interface

Deploy wlsJDBCmonitorConsole.war to each host.

Implementation

WebLogic provides possibility to configure JDBC interceptor - custom code implementing weblogic.jdbc.extensions.DriverInterceptor interface, which is called by each invocation of JDBC layer methods. Provided interceptor is based on this standard WebLogic interface. Internally code is based on a state machine., what guarantees complete and error free handling of defined flows. Below diagram presents state machine representing SQL execution of both statements and prepared statements.



Picture 1. SQL execution state machine

Interception supports both prepared and normal statements executed on XA and non-XA connections. Each call is traced using state machine logic from its creation, trough configuration, up to statement execution. Executed statements are verified against configured maximum execution time threshold, to be reported in case of too long time spent at database side. Execution alert is reported as a SQL, execution time, and all setters used to configure prepared statement.

Using different logger names JDBC monitor directs SQL alerts coming from different Data Sources into separated log file. Another file is used to keep all information on debug level.

JDBC monitor is shipped with real time monitoring capabilities based on web interface. This part is a WAR module providing two pages: (1) view on SQL statements currently being executed, and (2) view on latest alerts. Apart of this console may be used to change configuration and trigger long SQL executions.

Threading and synchronization

Internally all processing is single threaded w/o any synchronization points during normal processing. Whole JDBC interceptor execution is performed on threads executing JDBC calls, what is guaranteed by WebLogic, which physically calls interceptor, before, and after JDBC method invocation. All state information is stored in local variables, making each interceptor independent instance from each other. Note that initial version of interceptor was using ThreadLocal, but due to the nature of JDBC such technique was wrong. Simple and standard local variable is the working solution. There is no need to share state between separated executions, as due to JDBC conversation nature, all analyzed events are captured in the same object associated with JDBC connection.

The only synchronized operation is done during real time view on the system. To make it possible interceptor class exposes static object (ConcurrentHashMap jdbcGlobalState), being an interface between interceptor and user interface layer. Global state is updated when new connection is created. This point of synchronized access to ConcurrentHashMap.put operation is perceived as a lightweight operation, which does not limit system performance

in multithreaded environment. Moreover connection creation should be very rear operation in running system.

Another potential synchronization point is inside of a web page presenting global state (CurrentSQL). Rendering procedure enumerates jdbcGlobalState variable exposed by interceptor class. This operation is not synchronized by additional means, using only internal ConcurrentHashMap synchronization. Due to lack of this synchronization, page refresh may sometimes report ConcurrentModificationException as backing data structure is continuously updated. This unhanded exception is left in such condition by intension.

Exposing alerts on a user interface is implemented in synchronization free way. All alerts are stored in an array local variable in each interceptor instance. In case of page render, all instances are enumerated to gather arrays' content. Collected data is stored in single local list structure, and sorted by alert timestamp. Finally page rendering logic gets top N alerts. Note that each interceptor instance stores up to configured number of alerts. Array is a fixed length structure, thus potential change of number of captured/presented alerts requires WebLogic restart. Below table shows how alert store array works to implement sliding windows over produced alerts.

value added	counter	location in array	0	1	2	3	4
1	**1**	1	null	1	null	null	null
2	**2**	2	null	1	2	null	null
3	**3**	3	null	1	2	3	
4	**4**	4	null	1	2	3	4
5	**5**	0	5	1	2	3	4
6	**1**	1	5	6	2	3	4
7	**2**	2	5	6	7	3	4
8	**3**	3	5	6	7	8	4
9	**4**	4	5	6	7	8	9
10	**5**	0	10	6	7	8	9

Memory considerations

Global state is indexed by JDBCmonitor.getClass(). Number of instances is limited by number of connections. Global state does not remove objects. It's assumed in normal WLS environment connections are not recreated constantly. Such thing as connection pool shrinking may create potential memory leak situation.

Alerts are stored in a bounded array structure, guaranteeing that only configured number of alerts is stored by each interceptor instance. In case of putting new alert object, oldest one is removed, if structure already reached maximum allowed size.

Limitations

Current release of the software comes with number of limitations:

- lack of persistent configuration. JDBC interceptor comes with default values, which may be changed by configuration servlet.
- user interface provides no other that viewing features. It's not possible to drill down, sort, filter, etc.
- user interface works only locally - does not provide global view on whole cluster.
- interceptor does not mask sensitive information thus things like passwords will be visible in logs and web interface.

Known problems

Current release of the software comes with number of known problems:

- real time reporting of SQL commands and alerts is based on unbounded structure, which grows in case of opening new connections. As I do not know how to detect data source shrinking, I'm not able to remove objects associated with removed connections. Workaround of this is to set Data Source Maximum Capacity, and Minimum Capacity to the same value, it will guarantee that connections will not be removed.

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