JobScheduler Events

Definition and Processing

Reference

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We would appreciate any feedback you have, or suggestions for changes and improvements; please forward your comments to info@sos-berlin.com.

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1 Introduction

In its standard configuration, the JobScheduler can process job chains that start jobs in a predictable order, this serialization of jobs being suitable for many applications and situations. However, job chains are not able to represent the dynamic dependencies that occur, for example, when jobs are dependent on several other jobs or are to be started either by external events or by jobs that are started by other JobSchedulers.

A solution for this problem is available for the JobScheduler, in which centrally processed events can be triggered. This makes it possible to evaluate events originating in different sources and to initiate job starts or orders depending on these events.

The JobScheduler can use events to control the progress of jobs and orders in job chains: jobs and job chains being started when one or more particular events occur. Events are particularly suited for the implementation of procedures in which there are several followers and/or several forerunners.

Three different methods are available for handling events:

1. Processing in event handlers: this solution offers the greatest freedom in formulating complex conditions. See --> XML Event Handlers (page 25)

2. Monitoring of events and appropriate handling using shell scripts: this method allows individual shell scripts and events to be generated and the existence of events tested. See --> Script-Based Event Handlers (page 22)

3. Job chain synchronization using the Synchronizer Job: this method allows the processing of a number of job chains to be synchronized with a minimum of configuration. See --> Job Chain Synchronization (page 19)

Example application:

Consider the situation with two job chains: job chain A is used to process file orders and job chain B writes data to a database. Data for job chain B is written by a persistent order which is started at daily at 15.00. However, database entries can only be made once a particular file for job chain A has been received. On the other hand, it should be possible for the steps in both job chains up to the synchronization point to be carried out in any order and in parallel.

Terminology note: "Supervisor JobScheduler"

The use of events is described in this document for a number of job scheduling scenarios in which more than one JobSchedulers are used and one of these JobSchedulers takes on a supervisory role. It is, however, also possible to use events with a single JobScheduler. In this case the JobScheduler handling the event will check whether a supervisor JobScheuler has been configured. If this is not the case and the JobScheduler will forward the event to the JobScheduler that generated the event, which in a single JobScheduler scenario would be itself.

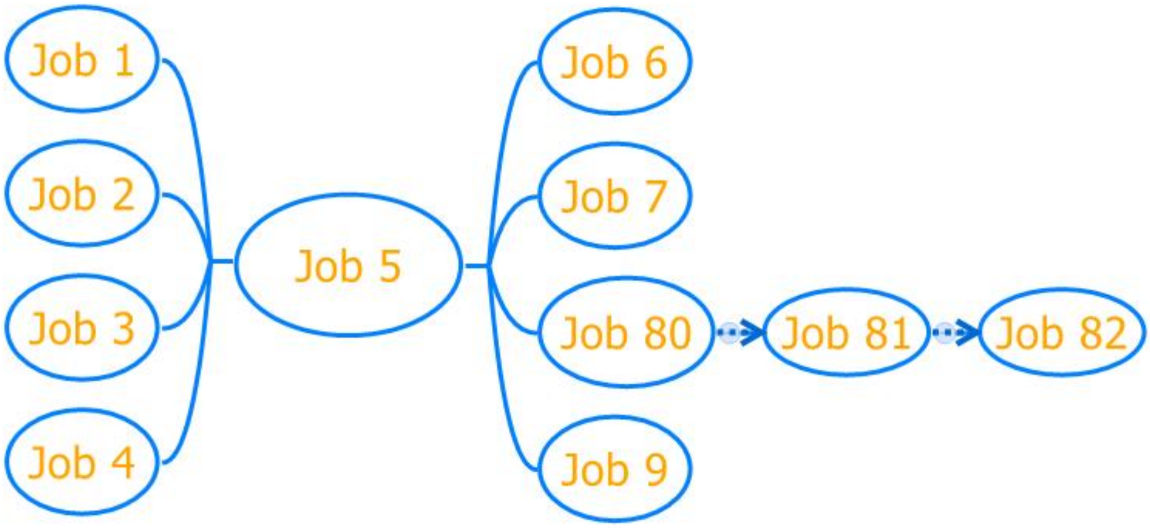
In a single JobScheduler scenario, parameters described in the example scripts for the supervisor JobScheduler, such as host name and port number would then be set to the those of the single JobScheduler.

1.1 Examples

1.1.1 A Merge and Split series:

The following example shows a Merge and Split series: The architecture shown in this example could be used, for example, when processing time-intensive jobs that can run in parallel. Parallel processing of jobs is often used to speed processing as a whole, with different jobs possibly being run on different JobSchedulers.

A further reason for such a processing architecture is to allow for delays to events: when jobs are serialized in job chains a delay in one event means that the whole chain would be delayed.

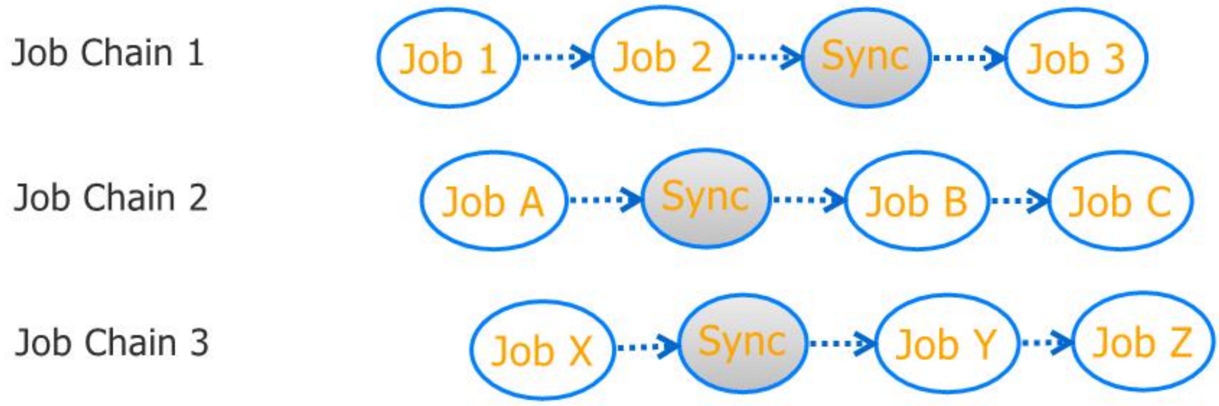


- In this example, jobs "Job 1", "Job 2", "Job 3" and "Job 4" run at different times.
- However, "Job 5" will only be started when these four jobs have all been successfully completed.
- Finally, "Job 6", "Job 7", "Job 9" and the job chain comprising "Job 80", "Job 81" and "Job 82" will be started.

Note that this process architecture will be used in the course of this documentation to illustrate the use of event processing.

1.1.2 Job Chain Synchronization

Consider a number of job chains, which are to be synchronized at a particular point in each chain. In other words, the orders in a job chain will only be processed beyond the synchronization point once all the orders in the other job chains have been processed up to the synchronization point.



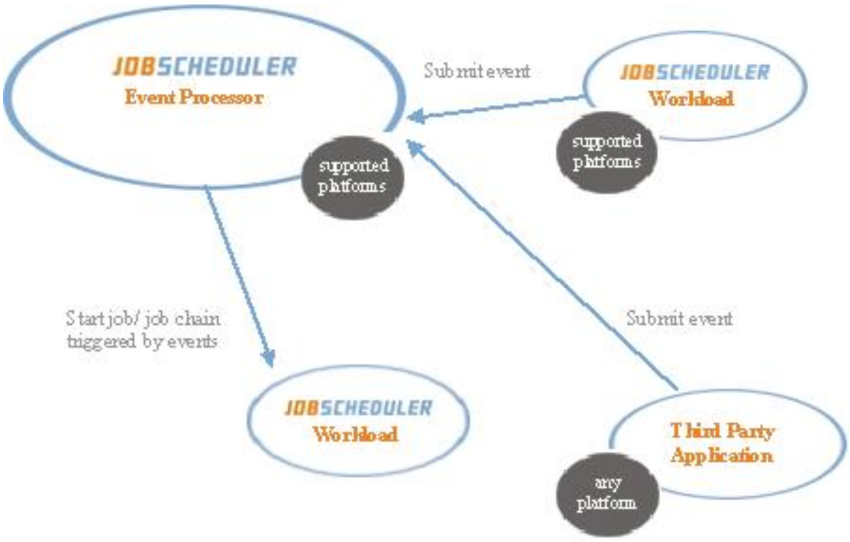
In the diagram, orders for job chains 1 and 2 will wait at the synchronization point until all job chains have an order and are processed up to the synchronization point. This means that job chains 1 and 2 will not be processed as long as job chain 3 does not have an order.

2 Event Processing

The expressions:

1. event generator,
2. event processor and
3. event handler

will be explained in this chapter.



2.1 Event Generators

Events need to be created before they can be processed by the JobScheduler. This can be carried out by one of a number of possible event sources (event generators):

- job monitors (Pre- and post-processing) in a job chain,
- standalone jobs that generate:
  - events
  - scripts or
  - event handling routines.

All event generators share the principle that they send an order to the JobScheduler event processor via TCP/IP. This processor then makes an entry for each order in the event database table as well as holding them in a global JobScheduler variable. The Event Generator Order contains a description of the event as well as specifying the action to be carried out. The add action is used to insert events in the database table and remove is used to remove all the events possessing a particular attribute (e.g. all events belonging to a particular class).

In principle, any software could be used to generate events, what is important is that the order is correctly generated and send to the relevant supervising JobScheduler.

Events possess the following attributes:

event-id
Must only be unique in conjunction with the event-class

exit-code
The current exit code of the job script running
Default: the script exit code

event-class
Results in a unique identifier when used together with the event-id. Can, for example, be used to remove events (remove all events of a particular class)

job-name
The name of the job currently running
Default: the current job name

job-chain
The name of the current job chain
Default: the current job chain

order-id
The identifier of the current order
Default: the current order identifier (order id)

name
The event name

creation-date
The timestamp from the moment at which the event was generated
Default: now

expiry-date
The timestamp for the moment when the event expires. If this attribute is not set, then the event lifetime is set according to the value set in the Event Processor (default=24h).
Default: 00.00 on the following day

The event class must be specified when an event is generated, all other attributes are optional.

2.1.1 Event Generator Jobs

The standard JobSchedulerSubmitEventJob job can be used to set off an event. An event generated by this job will be forwarded to a Supervisor JobScheduler. If a Supervisor has not been configured then the event will be forwarded to the JobScheduler that ran the event processor job. Both the order and job parameters of this generating job can be used to configure the event. This generating job can either be run in a job chain or stand-alone.

See the job documentation in `./jobs/JobSchedulerSubmitEventJob.xml`

The following job generates an event with the myClass class and myId ID.

```
<job name="JobSchedulerSubmitEventJob" title="Submit Events" order="yes">

    <description>
        <include file="jobs/JobSchedulerSubmitEventJob.xml" />
    </description>

    <params>
        <param name="scheduler_event_class" value="myClass" />
        <param name="scheduler_event_id" value="myId" />
    </params>

    <script language="java" java_class="sos.scheduler.job.JobSchedulerSubmitEventJob" />
</job>
```

Example: An job generating an event with the myClass class and myId ID.

Example: consider an event causing "It is now 17:00" to be printed. This is done by configuring a job that has 17.00 as its starting time.

```
<job name="sample" title="Submit Event &quot;17:00 Uhr&quot;">
    <description>
        <include file="jobs/JobSchedulerSubmitEventJob.xml" />
    </description>
    <params>
        <param name="scheduler_event_class" value="myClass" />
        <param name="scheduler_event_id" value="myId1" />
    </params>
    <script language="java" java_class="sos.scheduler.job.JobSchedulerSubmitEventJob" />
    <run_time>
        <period single_start="17:00" />
    </run_time>
</job>
```

Example: An event causing "It is now 17:00" to be printed.

This job can, for example, be configured as a step in a job chain in order to use the event to document the progress of an order. This use of an event is illustrated in the following example, which is based on a job chain consisting of three steps. The event is to be generated once step "100" has been completed.

```
<job_chain name="job_chain1"
           orders_recoverable="yes"
           visible="yes">
    <job_chain_node state="100"
                    job="anyJob"
                    next_state="200"
                    error_state="error"/>
    <job_chain_node state="200"
                    job="firstStepIsReady"
                    next_state="300"
                    error_state="error"/>
    <job_chain_node state="300"
                    job="anyOtherJob"
                    next_state="success"
                    error_state="error"/>
    <job_chain_node state="error"/>
    <job_chain_node state="success"/>
</job_chain>

<job name="firstStepIsReady"
     title="Submit Event &quot;Step 100 is ready&quot;"
     order="yes">
    <description>
        <include file="jobs/JobSchedulerSubmitEventJob.xml"/>
    </description>
    <params>
        <param name="scheduler_event_class"
               value="myClass"/>

        <param name="scheduler_event_id"
               value="myId2"/>
    </params>
    <script language="java"
            java_class="sos.scheduler.job.JobSchedulerSubmitEventJob"/>
    <run_time/>
</job>
```

Example: Event generator job in a job chain

2.1.2 Event Generator Monitors

A monitor has the same functions as a job, but its implementation as a monitor allows its use with any other job. See the job documentation in `./jobs/JobSchedulerSubmitEventJob.xml`.

```
<job title="Generate an Event with a Monitor"
     name="job2_event_by_monitoring">
    <params>
        <param name="scheduler_event_id"
               value="2"/>

        <param name="scheduler_event_class"
               value="monitorEvent"/>
    </params>
    <script language="javascript">
function spooler_process(){
  spooler.log.info("Here is a event coming from a monitor");
  return false;
}
    </script>
    <monitor name="create_event"
             ordering="0">
        <script java_class="sos.scheduler.job.JobSchedulerSubmitEventMonitor"
                language="java"/>
    </monitor>
    <run_time/>
</job>
```

Example: Job that generates an event with a monitor

2.1.3 Event Generator Scripts

The `jobscheduler_event.sh` and `jobscheduler_event.cmd` scripts are provided for use on Unix® and Microsoft® Windows® systems respectively. Calling either of these scripts causes an event to be generated. These scripts can, for example, be incorporated in existing shell scripts; called either as a separate step in a job chain or called as standalone jobs.

The following example is for a shell job that generates an event with the class example:

```
     <job order="yes"
        name="file_job">
         <script language="shell">
          @echo off
          @rem submit event to Supervisor &js;
          %SCHEDULER_HOME%/bin/jobscheduler_event.cmd -x %ERRORLEVEL% -e example
    </script>
    <run_time/>
</job>
```

The following parameters can be specified in these scripts:

jobscheduler_event.sh - submit event to JobScheduler

-x

exit-code
Use $? to specify the exit code of a previous Unix command.

-e

event-class
Specifies a common name for a set of events that enabling event handlers to process multiple events of the same class. For example, "daily_closing" could be an event class for jobs that should start once day-time business processes have drawn to a close.

-i

event-id
An identifier for an event. Allows event handlers to react to events having a particular ID. The ID is unique for an event class.

-c

job-chain
The name of the job chain. If empty, the name of the current job chain is used.

-o

order-id
If the current job is executed within a job chain then its Order ID can be used to identify the event. By default, the SCHEDULER_ORDER_ID environment variable is set by the Job Scheduler if this option is not specified.

-j

job-name
The name of the current job. By default, the SCHEDULER_ORDER_ID environment variable is set. This environment variable is automatically set by the Job Scheduler

-h

workload-job-scheduler-host
Specifies the local Job Scheduler Workload instance host name. The SCHEDULER_HOST environment variable is used by default.

-p

workload-job-scheduler-port
Specifies the local Job Scheduler Workload instance host name. The SCHEDULER_TCP_PORT environment variable is used per default.

-s

supervisor-job-scheduler-host
Specifies the Job Scheduler Supervisor instance host name. The SCHEULER_SUPERVISOR_HOST environment variable is used by default. Workload Job Scheduler instances automatically register at a Supervisor in order to synchronize job configurations. The Supervisor instance receives events, executes the event handler and starts jobs and job chains.

-r

supervisor-job-scheduler-port
Specifies the port number on which the Job Scheduler Supervisor instance is operating. By default the SCHEDULER_SUPERVISOR_PORT environment variable is used.

-v

supervisor-job-chain
Specifies the name of the job chain in the Job Scheduler Supervisor instance that implements the event processor. The default value is scheduler_event_service.

-w

what
Events can be added (add), deleted (remove) and checked (check). Die Default-Aktion ist add. check is used to determine whether one or more particular events are present. Here at least one of the options -i -e -x or -a must be specified, in order to determine the event being sought after.

-t

expiration-date

Specifies the point in time at which an event automatically expires: this parameter being implemented by the Event Processor. A specific point in time can be specified in the ISO date format, i.e. yyyy-MM-dd hh:mm:ss. The value never ensures that the event does not ever expire. The options expiration-date, -cycle and -period may not be used at the same time.

-tc

expiration-cycle
Specifies a time of the current or the next day at which the event expires. The cycle is specified in the format hh:mm[:ss]. May not be used together with expiration date or period.

-tp

expiration-period
Specifies a period after which the event expires. The period is specified in the format hh:mm[:ss]. May not be used together with expiration date or cycle.

-d

name=value
Allows additional parameters for event handlers to be specified. Parameters are created using name-value pairs, separated by an equals sign. Parameter names can be freely chosen and event handlers configured to take account of values handed over. This option can be specified as often as required, allowing the definition of any number of parameters.

-a

xpath-expression
All events corresponding to the XPath expression specified when this parameter is set. Complex expressions are possible and all the attributes of an event can be considered. This parameter allows complex queries to be made, that would not be possible with the -e -i and -x options.

allowed-exit-code

...
Enables the specification of a list of exit codes that mean that a job should be considered as having run successfully. This is useful if job scripts provide return values in the form of exit codes and these codes should not be considered as errors.

The `jobscheduler_event.sh` script forwards events to the event processor in the JobScheduler Supervisor instance. These events are then processed by event handlers in the event processor and are then used to trigger jobs and job chains depending on the parameters in the script. Suitably configured, event handlers are able to take account of situations that require multiple events to be fired in order to trigger a job start.

Should a JobScheduler Supervisor not be accessible then the event data will be stored in a local file: `./logs/scheduler.events` . These events will be dequeued by the scheduler_dequeue_events job, which is one of the standard automation jobs provided with the JobScheduler distribution, as soon as the Supervisor JobScheduler is available again.

2.1.3.1 Examples

Create an event with the minimum parameters required for an event class (event id and job name):

```
./jobscheduler_event.sh -x $? -e daily_closing -i my_id -j my_job
```

Specify a different host name and port for the JobScheduler Supervisor and define a parameter proc1 with the value 42:

```
./jobscheduler_event.sh -x $? -e daily_closing -i my_id -j my_job -s master -r 4444 -d proc1=42
```

2.1.3.2 Environment

SCHEDULER_HOME
Installation directory of the Job Scheduler Workload instance.

SCHEDULER_HOST
Host name of the Job Scheduler Workload instance.

SCHEDULER_TCP_PORT
Port number of the Job Scheduler Workload instance.

SCHEDULER_JOB_CHAIN
Name of the job chain currently being executed, should the current job be part of a job chain.

SCHEDULER_ORDER_ID
Id of the order currently being executed, should the current job be part of a job chain.

SCHEDULER_SUPERVISOR_HOST
Hostname of the Job Scheduler Supervisor instance.

SCHEDULER_SUPERVISOR_PORT
Port number on which the Job Scheduler Supervisor instance operates.

2.1.3.3 Diagnostics

The following error messages may be written to stderr:

ERROR-001: no host has been specified
The host name for the Job Scheduler Supervisor instance has not been specified.

ERROR-001: no port has been specified
The port number for the Job Scheduler Supervisor instance has not been specified.

ERROR-010: could not connect to host
The specified host name or IP address is invalid or no Job Scheduler is running via the specified port.

2.1.4 Event Generator Event Handler

See also Testing for events in a job chain (page 18)

New events can be generated by event handlers. To do this the event handler executes the <add_event> element.

```
<commands>
    <add_event>
        <event event_id="7" event_class="sample" event_title="Neues Ereignis" />
    </add_event>
</commands>
```

2.2 Event Processors

Event Processors carry out two tasks:

1. Recording the event and saving it in the database as well as in a Job Scheduler variable;
2. Execution of event handling routines (Event Handlers) and the evaluation of conditions.

2.2.1 Event handlers

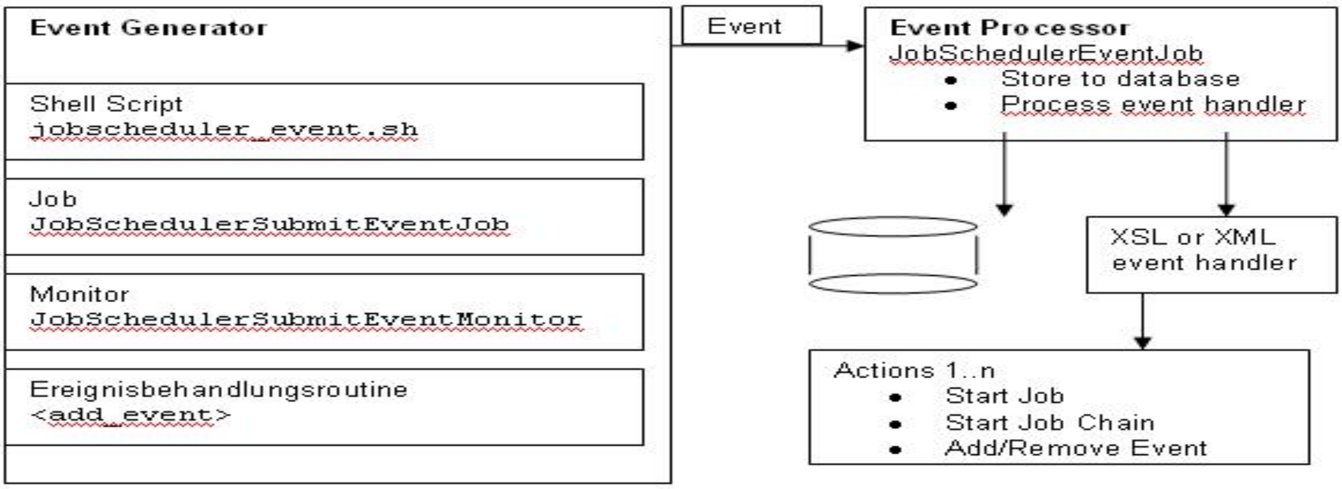
Event handlers consist of:

- A set of rules, to test whether an event has occurred and
- a list of actions that are to be carried out when the event conditions are met. The following actions are possible:
  - starting a job,
  - starting a job chain,
  - generating a new event,
  - deleting events.

Event handlers can either be in XML format or in XSL in the form of stylesheets. Event handling routines in XML format are supported by the Job Scheduler Job Editor, which can be used to write and edit routines. See also Testing for events in a job chain (page 18)

2.2.2 Event generators

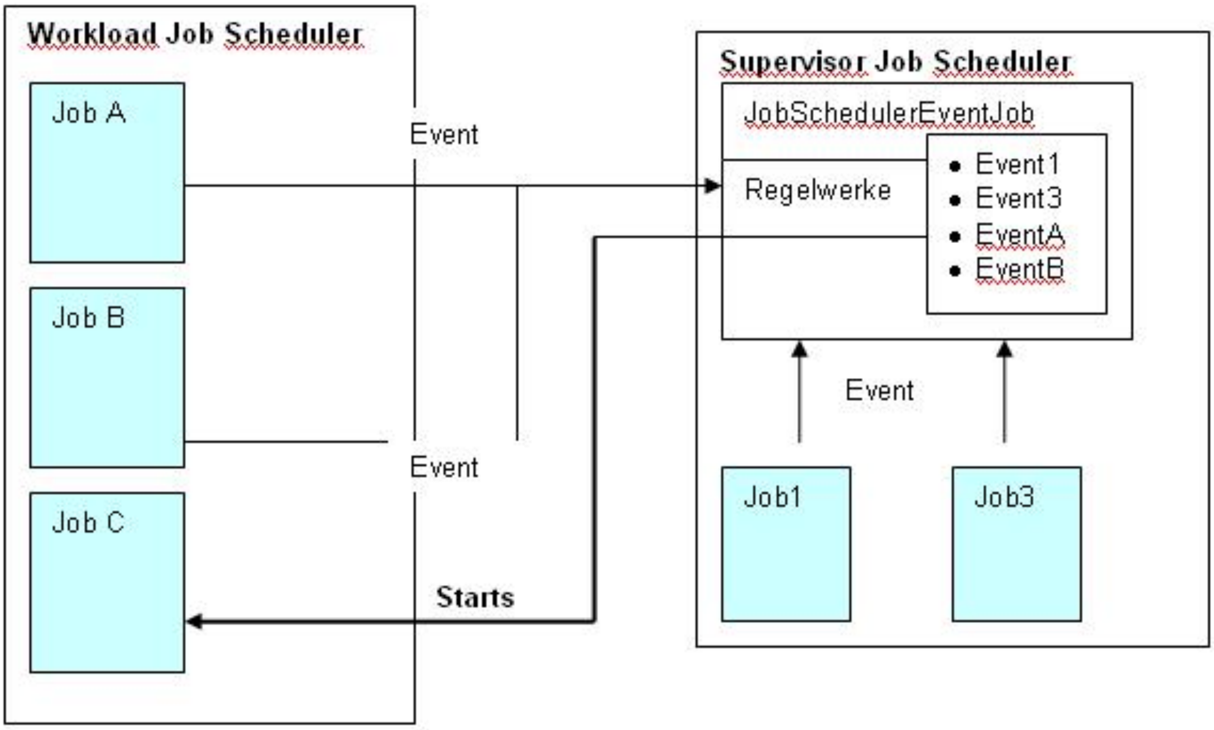
Event generators can also generate events. These are collected in the Event Processor and one or more event handlers will be executed by the Event Processor each time an event occurs. The conditions used to determine whether one or more events have taken place are tested whilst the Event Handler is being executed. The actions specified for the event will be carried out if these tests are positive.



2.2.3 Event processors

The Event Processor consists of a job chain made up of the scheduler_event_service job and the scheduler_event_service job chain. The event processor definition can be found in the `./config/scheduler_event.xml` file.

The job chain contains the scheduler_event job. The parameterization of this job is described in the `scheduler/jobs/JobSchedulerEventJob.xml` documentation.



Summary: example system architecture with two Job Schedulers

In this example, Jobs A and B are started on a Workload Job Scheduler, with each of these jobs causing an event. These events are processed by the Supervisor Job Scheduler Event Processor. Within the Event Processor, the event processing Rules Set is processed by the Event Handler. Jobs 1 and 3 are run by the Supervisor Job Scheduler and also cause events. The event processor would then start, for example, Job C when a rule set returns TRUE.

Events have a limited lifetime, which can be set when they are generated: the default setting is that events expire at 00:00 i.e. at midnight. As long as an event has not expired, it is possible for it to be explicitly deleted by an event handling routine. All events are saved in a database and remain available after the Job Scheduler has been restarted.

2.3 Testing for events in a job chain

Sometimes it is necessary to test within a job chain for the presence of one or more events and to make further processing of the chain dependent on the results of these tests. The JobSchedulerExistsEventJob job is provided for this purpose.

This job tests whether particular events exist. It does this by processing orders that contain specification(s) of the event(s). Depending on whether or not the events exist, the order will either be set to the next_state or to the error_state.

The specification of the events to be tested is saved in the scheduler_event_spec parameter. This parameter contains an XPath expression, which will be applied to the XMLrepresentation of the events. If the XPath expression returns a result, then the order will be set to the next_state. If the XPath expression does not return a result, then the order will be set to the error_state.

An example for the use of this job can be found in the Appendix.

The documentation for this job can be found in the Job Scheduler installation directory under `./jobs/JobSchedulerExistsEventJob.xml` .

2.3.1 Example event tests

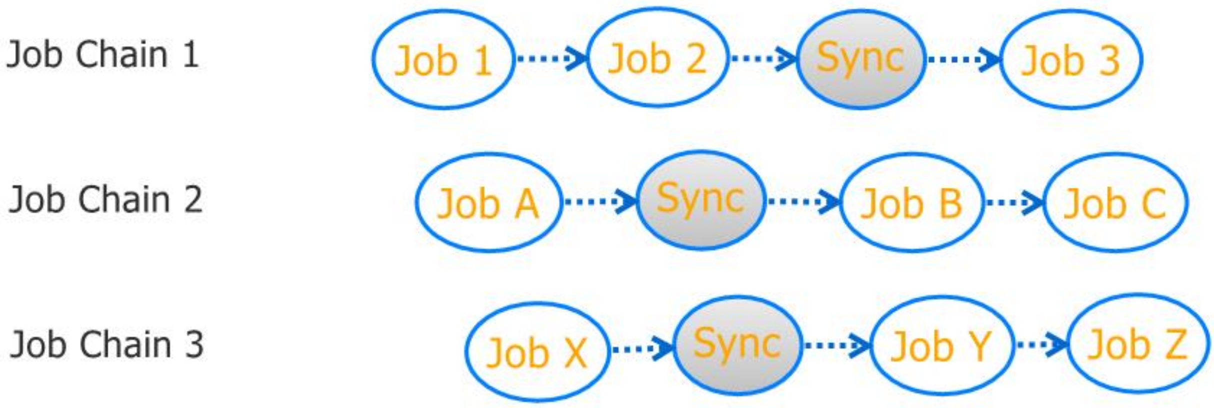
```
//event[@event_class='foo']
Successful, if an event with the "foo" event class is found

//events[event[@event_class='foo'] and events[event[@event_class='bar']]
Successful, if an event with the "foo" event class is found along with one with the "bar" class

//events[not(event[@event_class='foo'])]
Successful, if no event with the "foo" event class is found
```

Example: Event tests

3 Synchronization of Job Chains

The synchronization of job chains is a standard task that in a simplified form can be configured without the use of events:

Consider a number of job chains, that are to be synchronized at a particular point in each chain. In other words, the orders in a job chain will only be processed beyond the synchronization point once all the orders in the other job chains have been processed up to the synchronization point.



Both orders will wait at the synchronization point until all job chains have an order. This means that job chains 1 and 2 will not be processed as long as job chain 3 has not received an order.

The number of orders that are synchronized is specified in the Sync-Job (default=1). This means that, for example, if a new order arrives in Job Chain 2 (meaning that there are now two orders in this job chain), and then an order in Job Chain 3, then only one order will be processed in each job chain. In this case, the first order in Job Chain 2 will be processed along with the order in Job Chain 3. The second order in Job Chain 2 will remain at the synchronization point until a further order arrives in Job Chain 3.

More information about this procedure can be read in our How can job chains be synchronized? article on our web-site.

Configuration of the Sync-Job:

```
<job order="yes"
     stop_on_error="no">
    <!--
    <params>
        <param name="ChainA_required_orders"
               value="2"/>


        <param name="ChainB_required_orders"
               value="3"/>
    </params>
    -->
    <script java_class="sos.scheduler.job.JobSchedulerSynchronizeJobChains"
            language="java"/>
    <delay_order_after_setback setback_count="1"
                               is_maximum="no"
                               delay="00:02"/>
    <delay_order_after_setback setback_count="200"
                               is_maximum="yes"
                               delay="00:02"/>
    <run_time/>
</job>
```

Example: Configuration of the job chain synchronisation job

4 Event Handlers

All event handlers basically function by searching for and determining whether or not events exist. All existing events are held in a global JobScheduler variable. The content of the JobScheduler variables can be found in the event processor log file. In this case the list of the events currently existing.

Further information can be written in the `scheduler/logs/task.scheduler_event_service.log` file when the debug-level in the `./config/factory.ini` file is set to a value > 2. This is done in the [spooler] section of the file and a typical value would be debug3. Settings made in this section of the `scheduler/config/factory.ini` file are applicable to all jobs. When, however, the debug level is set in the [scheduler_event_service] section, the settings made will only apply to jobs being run by the Event Processor.

With a debug3 level, the current task XML structure will be written in the event processor log file (`scheduler/logs/task.scheduler_event_service.log`). A typical XML structure would be:

```
<events current_date="2008-05-16 11:14:01" expiration_date="2008-05-16 23:14:01">
    <event created="2008-05-16 11:13:29"
        event_class="example"
        event_id="0"
        exit_code="0"
        expires="2008-05-16 23:13:30"
        job_chain=""
        job_name="simple_shell_job"
        order_id=""
        remote_scheduler_host="wilma"
        remote_scheduler_port="4444"
        scheduler_id="scheduler.supervisor"/>

    <event created="2008-05-16 11:14:01"
        event_class="example"
        event_id="0"
        exit_code="0"
        expires="2008-05-16 23:14:01"
        job_chain="txt_chain"
        job_name="file_job"
        order_id="files/in/sample2.txt"
        remote_scheduler_host="wilma"
        remote_scheduler_port="4444" scheduler_id="scheduler.supervisor"/>
</events>
```

Example: Structure of a typical XML event handler

The Event Processor first of all determines and executes all the event handlers. It recognizes two types of event handlers:

- XML Event Handlers
- XSL Event Handlers

XML event handlers are written and modified using the JOE and define the event processing rules and the corresponding actions.

XSL event handlers are processed using an XSLT style sheet transformation. This transformation results in commands for one or more JobSchedulers.

All event handlers are stored in a central directory, the name of which is stored in the event processor event_handler_filepath job parameter.

4.1 Script-Based Event Handlers

Events can be monitored using shell scripts. This means that it is possible to implement checks in shell scripts and use the possibilities provided by shell scripts to handle the events. In this case, the event processor is only used to record and save the events. Either the jobscheduler_event.cmd or the jobscheduler_event.sh shell scripts are used to determine whether or not a particular event is present. In this case there are two possible ways of checking whether the event exists:

1.

2.

The -w option is set to check. In addition, the attributes that are to be sought for can be set. The script writes the number of events found to stdout. In addition, the %JOB_SCHEDULER_COUNT_EVENTS% environment variable is set on Windows systems.

4.1.1 Example queries:

```
call c:\scheduler\bin\jobscheduler_event.cmd -h localhost -p 4454 -w check -e foo


call ./bin/jobscheduler_event.cmd -h localhost -p 4454 -w check -e foo
```

How many "foo" class events have occurred?

The script calls the JobScheduler at port 4454 on localhost and asks for the number of occurences for the event named "foo".

```
How many foo class events have occurred (with XPath)?
call c:\scheduler\bin\jobscheduler_event.cmd h localhost p 4454 w check
a //events/event[@event_class='foo']

Has an event occurred with both the foo and the bar classes?
call c:\scheduler\bin\jobscheduler_event.cmd h localhost p 4454 w check
a //events[event/@event_class='foo' and event/@event_class='bar']

Has no foo class event occurred?
call c:\scheduler\bin\jobscheduler_event.cmd h localhost p 4454 w check
a //events[not(event/@event_class='foo')]
```

How many foo class events have occurred (with XPath)?

4.1.2 An example split and merge script

In this example, one script is used to start three further scripts in parallel (split). It is only after all three scripts have been completed that processing will be continued (merge). The three scripts running in parallel each signal their completion by generating an event.

4.1.2.1 The main script

The implementation of the main script is defined in a job. The scripts called by this script do not have to be present on the Job Scheduler as jobs.

```
@echo off
@echo This is Script A.
@rem ---------- Begin split
@echo Split is now taking place.
start b.cmd
start c.cmd
start d.cmd
@rem ---------- End split

@rem ---------- Begin merge
:merge
call c:\scheduler\bin\jobscheduler_event.cmd -h localhost -p 4444 -w check -e test >nul
@echo ++%JOB_SCHEDULER_COUNT_EVENTS%++ class test events found.
@rem Sleep 10 seconds
ping -n 11 localhost > nul
@rem Number of events present determined
if %JOB_SCHEDULER_COUNT_EVENTS% lss 3 goto merge

@rem ---------- End merge

@echo Merge has been completed.
@rem Delete events
call c:\scheduler\bin\jobscheduler_event.cmd -h localhost -p 4444 -w remove -e test
```

Example: The main script specifying the split and merge operations

4.1.2.2 Script B (similar to scripts C and D)

```
@echo off
@echo This is Script B.
... (processing)
@rem Generate result
call c:\scheduler\bin\jobscheduler_event.cmd -h localhost -p 4444 -w add -i B -e test
```

Example: One of the secondary scripts being split and merged

The same example could also, for example, have been configured for 4 jobs A, B, C and D instead of the scripts described above. All scripts are defined as jobs. In this case the implementation of Job A would look like:

```
                    <job>
                    <script language="shell">
  @echo off
  @echo This is Script A.
  @rem ---------- Begin split
  @echo Split is now taking place.
  call c:\sos\scheduler\bin\jobscheduler.cmd command "<start_job job='test/jobB'/>
  call c:\sos\scheduler\bin\jobscheduler.cmd command "<start_job job='test/jobC'/>
  call c:\sos\scheduler\bin\jobscheduler.cmd command "<start_job job='test/jobD'/>
  @rem ----------  End split

  @rem ----------  Begin merge
  :merge
  call c:\scheduler\bin\jobscheduler_event.cmd  -w check -e test > nul
  @echo ++%JOB_SCHEDULER_COUNT_EVENTS%++ class test events found.
  ping -n 11 localhost > nul
  if %JOB_SCHEDULER_COUNT_EVENTS% lss 3 goto merge

  @rem ----------  End merge
  @echo Merge has been completed.
  call c:\scheduler\bin\jobscheduler_event.cmd -w remove -e test
</script>
                    <run_time />
                </job>
```

Example: The job containing the main script specifying the split and merge operations

The implementation of Job B and correspondingly Jobs C and D would look like:

```
                <job>
                    <script language="shell">
  @echo off
  @echo This is Script B.
  call c:\scheduler\bin\jobscheduler_event.cmd -w add -i B -e test
</script>
                    <run_time />
                </job>
```

Example: A job containing one of the secondary scripts being split and merged

4.2 XSL Event Handlers

Event handlers will be executed when their names correspond with the regular expression defined in the event_handler_filespec job parameter.

In addition, the Event Processor job processes job stylesheets for particular jobs, job chains or event classes according to the following name convention:

[job_name].*.job.xsl

Is executed for events belonging to the [job_name] job;

[job_chain_name].*.job_chain.xsl

Is executed for events belonging to a job in the [job_chain_name] job chain;

[event_class].*.event_class.xsl

Is executed for events belonging to the [event_class] class.

XSL event handlers must be manually written using a text editor. The event handler in the example below executes the list of all known events (see above).

The following example shows an event handler that searches for three events: an event from the simple_shell_job job and an event from each of the two job chains listed.

```
<xsl:template match="events[
 event[@job_name='simple_shell_job'] and
 event[@job_chain='txt_chain'] and
 event[@job_chain='pdf_chain']  ]">
```

Example: An XSL event handler that waits for three events

Once these events have been found, two commands are sent to the Supervisor Job Scheduler. The first command starts the samples/events/done_job job in the Workload Job Scheduler:

```
<xsl:call-template name="run_job">
    <xsl:with-param name="job">samples/events/done_job</xsl:with-param>
    <xsl:with-param name="host">localhost</xsl:with-param>
    <xsl:with-param name="port">4444</xsl:with-param>
</xsl:call-template>
```

Example: The first command, which starts the "done_job" job

The second command deletes the events, in order to ensure that they are not processed a second time.

```
<remove_event><event event_class="example"/></remove_event>
```

Example: The second command, which deletes the events

4.3 XML Event Handlers

The Event Handler directory is searched for events in the following order:

[job_name].*.job.actions.xml
Is executed for events belonging to the [job_name] job;

[job_chain_name].*.job_chain.actions.xml
Is executed for events belonging to a job in the [job_chain_name] job chain;

[event_class].*.event_class.actions.xml
Is executed for events belonging to the [event_class] class

[name].actions.xml
Is executed for all events.

If an event is created by the job1 job and a file with the name `job1.job.actions.xml` exists, then this file will be executed.

XML event handling routines can be written and modified using the Job Scheduler Job Editor. In order to create new event handling routines, click on the New menu item and on Event Handler.

XML event handling routines consist of a rule set and a list of commands. The commands will be executed once the rule set is evaluated as being TRUE. Commands for the each Job Scheduler instance can be brought together in groups.

4.3.1 Example: Event handling commands and groups

```
<commands>
  <command name="command_1" scheduler_host="localhost" scheduler_port="4454">
    <start_job job="job0" at="now" />
    <add_order job_chain="job_chain1" replace="yes" />
  </command>
  <command name="command_2" scheduler_host="server" scheduler_port="4444">
    <start_job job="job33" at="now" />
  </command>
</commands>
```

Example: Event handling commands grouped together

In this example, two command groups are described:

- in the first group, two commands are defined for the localhost:4454 Job Scheduler and;
- in the second group one command for the server:4444 Job Scheduler.

4.3.2 Rule Sets

The rule set consists of one or more event groups. An event group consists of a list of events combined together with a Boolean expression. The event groups are evaluated individually and the results of the evaluation combined using the Boolean expression. This determines whether or not the commands will be executed.

Shortened notation:

When all the elements of a group are to be combined using OR or AND operators, then it is sufficient when the logic parameter is set to or or and as shown in the example below. This also applies for combination of groups.

4.3.2.1 Example 1: Using XML event handler rule sets

Group 1: Event A and Event B Logic of group Test is A OR B

Group 2: Event C and Event D Logic of group Sample is C AND D

The groups are linked together using Test AND Sample

This means that, for example, when A is present, B missing and both C and D present, then the commands will be executed.

```
       <events logic=Test and Sample>
  <event_group group="Test" logic="or">
    <event event_id="A"
    event_class="sample"
    event_title="Job1 ist gelaufen"
    job_name="job1" />
    <event event_id="B"
    event_class="sample"
    event_title="Job2 ist gelaufen"
    job_name="job2" />
  </event_group>
  <event_group group="Sample">
     <event event_id="C"
    event_class="sample"
    event_title="Job3 ist gelaufen"
    job_name="job3" />
     <event event_id="D"
    event_class="sample"
    event_title="Job4 ist gelaufen"
    job_name="job4" />
  </event_group>
</events>
```

Example: Using XML event handler rule sets

In this example, two command groups are described: in the first group, two commands for the localhost:4454 Job Scheduler are defined and; in the second group one command for the server:4444 Job Scheduler.

4.3.2.2 Example 2: Combined event and run time rules and actions

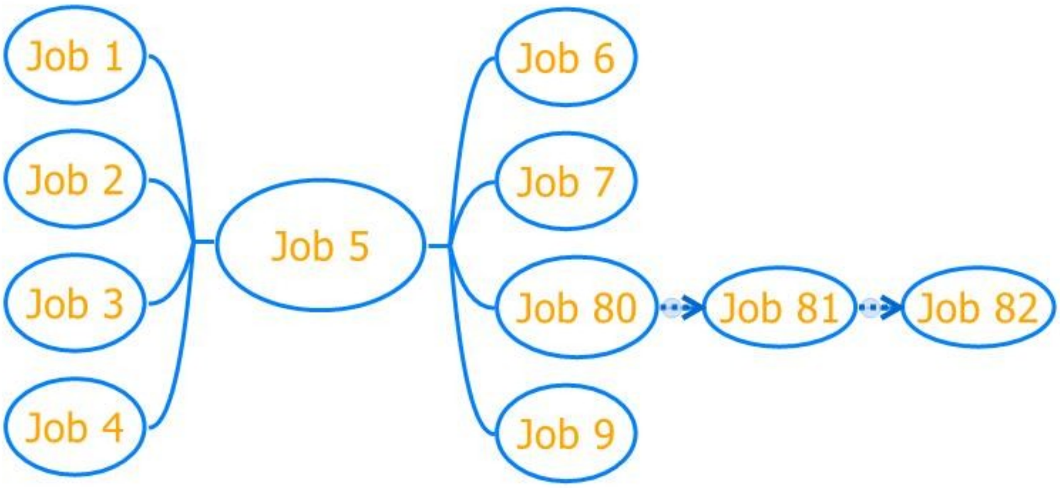
Note that the configuration of the event generator for this example was described in Section 2.1

```
       <?xml version="1.0" encoding="UTF-8"?>
<actions>
  <action name="SampleAction">
    <events>
      <event_group group="beforePrinting" logic="and">
        <event event_id="myId1" event_class="myClass" event_title="17:00 reached" />
        <event event_id="myId2" event_class="myClass" event_title="Step100 is ready" />
      </event_group>
    </events>
    <commands>
      <command name="command_1" scheduler_host="localhost" scheduler_port="4444">
        <start_job job="dailyPrint" />
      </command>
    </commands>
  </action>
</actions>
```

Example: Combining event and run time rules

If the time is 17:00 or later and a particular step in a job chain has been completed, then the dailyPrint job should be started.

4.3.2.3 Example 3: The "Merge and Split" scenario described previously



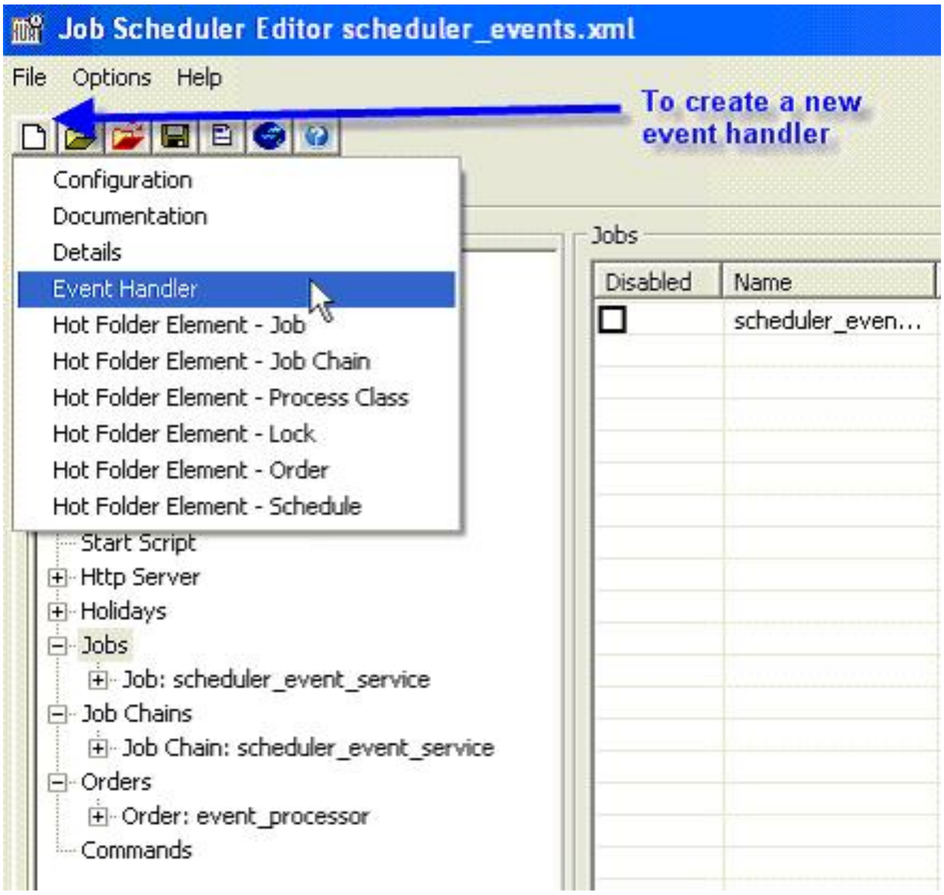
Note that this scenario was described in Chapter 1.

```
       <?xml version="1.0" encoding="UTF-8"?>
<actions>
  <action name="BeforeJob5">
    <events logic="and">
      <event_group group="pre" logic="and" event_class="pre">
        <event event_id="1" event_title="Job 1 is ready" job_name="job1" />
        <event event_id="2" event_title="Job 2 is ready" job_name="job2" />
        <event event_id="3" event_title="Job 3 is ready" job_name="job3" />
        <event event_id="4" event_title="Job 4 is ready" job_name="job4" />
      </event_group>
    </events>
    <commands>
      <command name="command_1" scheduler_host="localhost" scheduler_port="4444">
        <start_job job="job5" />
      </command>
    </commands>
  </action>
  <action name="AfterJob5">
    <events>
      <event_group group="post" event_class="post" logic="and">
        <event event_id="5" event_title="Job5 is ready" job_name="job5" />
      </event_group>
    </events>
    <commands>
      <command name="Start Job6" scheduler_host="localhost" scheduler_port="4444">
        <start_job job="job6" />
      </command>
      <command name="Start Job7" scheduler_host="localhost" scheduler_port="4444">
        <start_job job="job7" />
      </command>
      <command name="Start Job9" scheduler_host="localhost" scheduler_port="4444">
        <start_job job="job9" />
      </command>
      <command name="Start Jobchain" scheduler_host="localhost" scheduler_port="4444">
        <add_order job_chain="job_chain_sample" replace="yes" id="4711" />
      </command>
    </commands>
  </action>
</actions>
```

Example: "Merge and Split"

In this example Job 1 , Job 2, Job 3 and Job 4 run at different times. However, Job 5 will only be started when all four have been successfully completed. Finally, Job 6, Job 7, Job 9 and the job chain comprising Job 80, Job 81 and Job 82 will be started.

4.3.3 Creating XML rule sets with the JobScheduler Job Editor

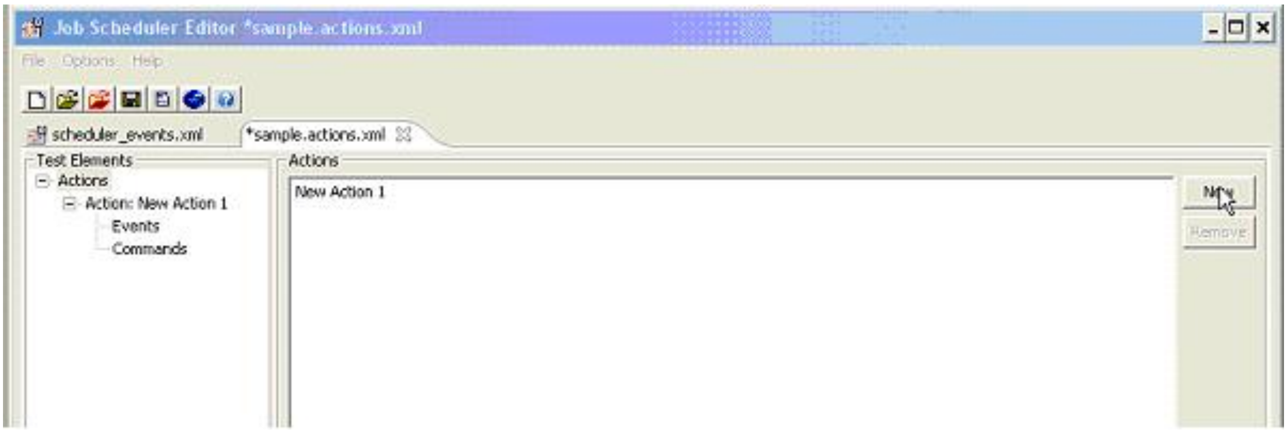

Job Scheduler Editor scheduler_events.xml
File Options Help
To create a new event handler
Configuration
Documentation
Details
Event Handler
Hot Folder Element - Job
Hot Folder Element - Job Chain
Hot Folder Element - Process Class
Hot Folder Element - Lock
Hot Folder Element - Order
Hot Folder Element - Schedule
Start Script
Http Server
Holidays
Jobs
Job: scheduler_event_service
Job Chains
Job Chain: scheduler_event_service
Orders
Order: event_processor
Commands
Jobs
Disabled
Name
scheduler_even...

Event handling routines are made up of one or more actions. Actions, in turn, are made up from event groups and commands with the event groups being evaluated according to the (event logic) conditions specified. Similarly, groups will be evaluated according to the corresponding group logic conditions. If all groups evaluate to TRUE, then the relevant commands will be executed. If only one group has been specified, then this must evaluate TRUE. If only no condition has been specified, then one of the groups must evaluate TRUE (default or).

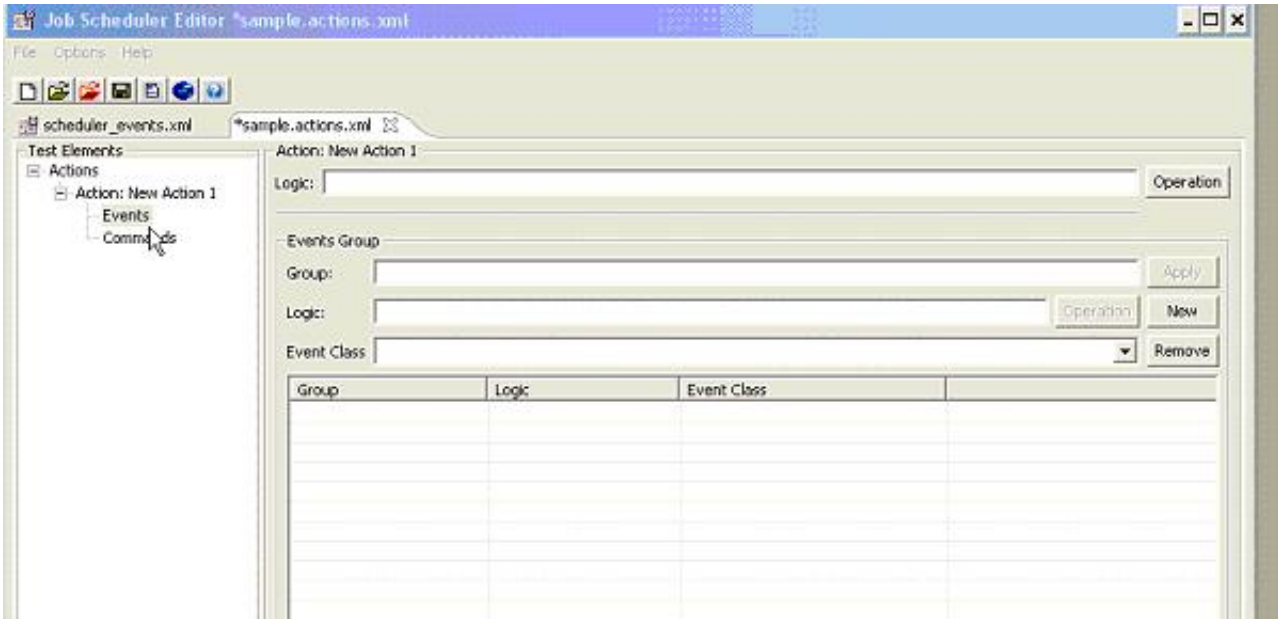
4.3.3.1 Example: one group and two events

When event 1 or event 2 is present then the commands will be executed.

4.3.3.1.1 Step 1: add a new action



4.3.3.1.2 Step 2: add a new event group

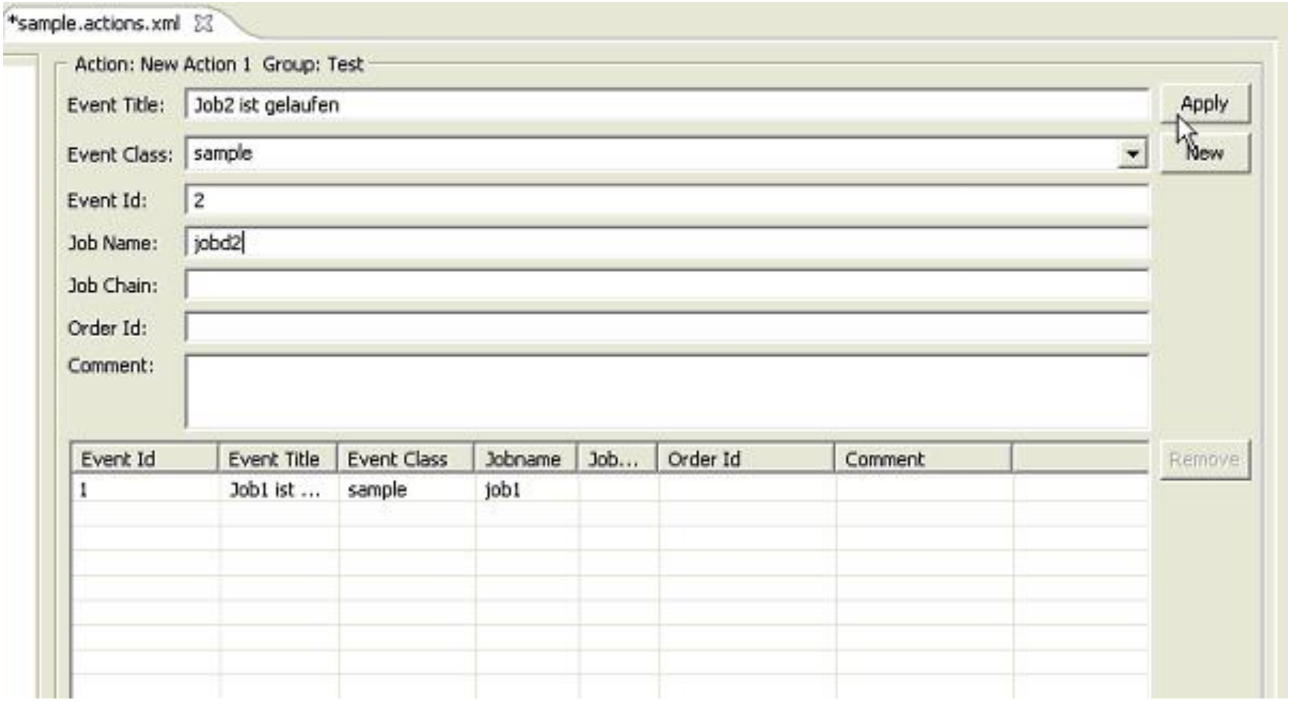


A group has a name and a logic parameter and comprises one or more events. An event class can be specified for all the events of a group. The default logic operator is OR. The logical operators possible are:

- OR: one of the events must be present
- AND: all events must be present
- conditions that combine the results of a group. For example: event1 and not event2

Within the logic parameter, events are referenced by their names. If the name of an event is empty, a name will be generated for it by the Event Processor using `<class>.<id>` .

4.3.3.1.3 Step 3: specify events



Action: New Action 1 Group: Test

Event Title: Job2 ist gelaufen

Event Class: sample

Event Id: 2

Job Name: jobd2

Job Chain:

Order Id:

Comment:

Event Id	Event Title	Event Class	Jobname	Job...	Order Id	Comment
1	Job1 ist ...	sample	job1			

An event has the following parameters:

Title:

Is shown in the console event monitor.

Name:

Is used to address the event in the logic (e.g. event1 and not event2). If only or or and are specified in the logic, then it is not necessary to specify a name. However, it is recommended that a name is defined as, for example, this will be shown in the console event monitor.

Class:

Is used to test whether an event is to be found in the list of current events. Can be used if the name of an event is empty and an internal name is generated using class.id.

ID:

Used to test whether an event is to be found in the list of current events. Can be used if the name of an event is empty and an internal name is generated using class.id.

Job name:

Is used to test whether an event is to be found in the list of current events.

Job chain name:

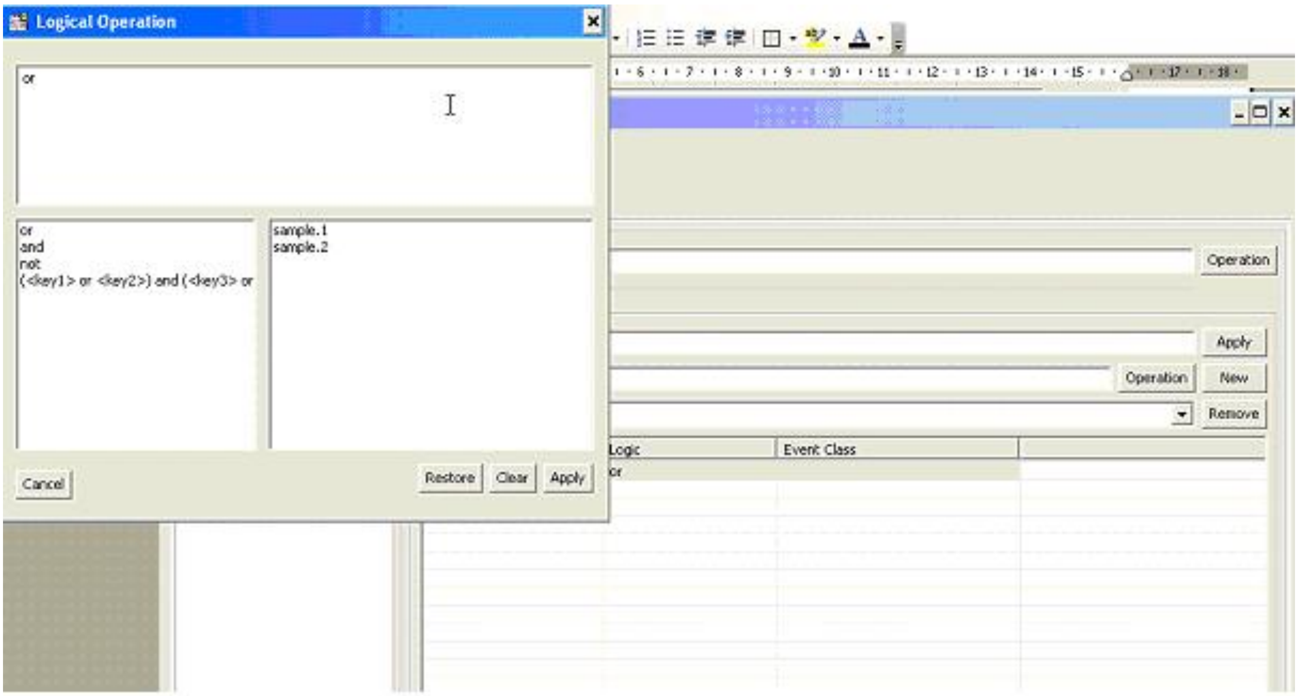
Used to test whether an event is to be found in the list of current events.

Current order identifier:

The current order identifier (order id) is used to test whether an event is to be found in the list of current events.

4.3.3.1.4 Step 4: specify logic

The logic can either be specified using a wizard or directly entered in the input field. In the screen shot below "or" has been selected from the list of possible operators

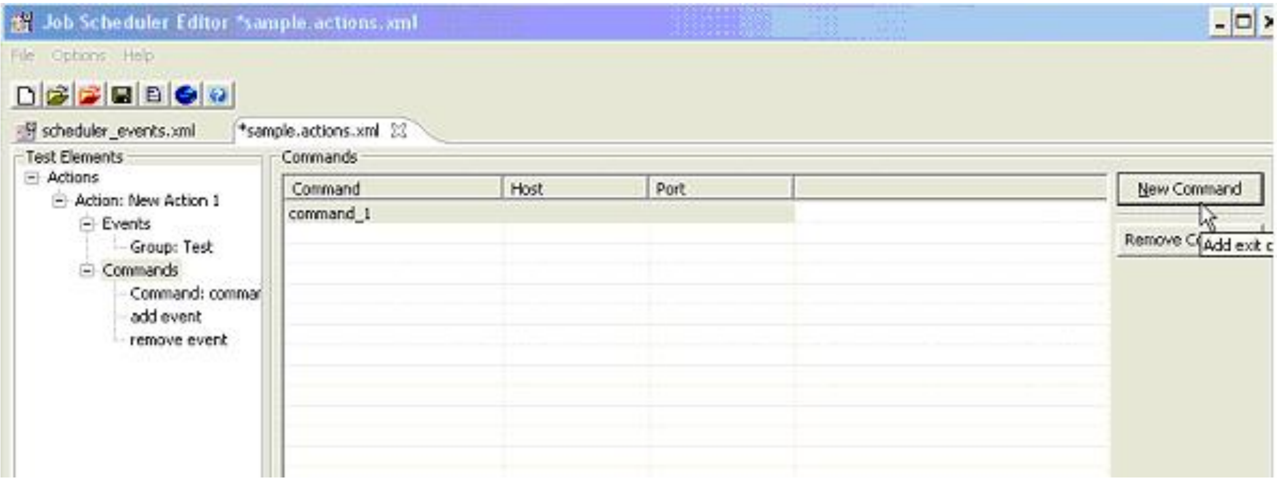


Logic	Event Class
or	

4.3.3.1.5 Step 5: add any additional groups

More groups can be included using the Group Logic Field. The default logic operator for groups is "OR".

4.3.3.1.6 Step 6: add commands



Command	Host	Port
command_1		

A host and a port need to be specified for all commands within a block. The commands are then sent to this Job Scheduler.

Commands are added using "New Command". The following commands are available:

start job:

Starts a job. The start time is to be specified.

order:

Starts a job chain,

job chain:

The job chain for the order

order ID:

A unique ID for the order

start time:

Orders can be given delayed starts

priority:

The order priority

title:

Free text

status:

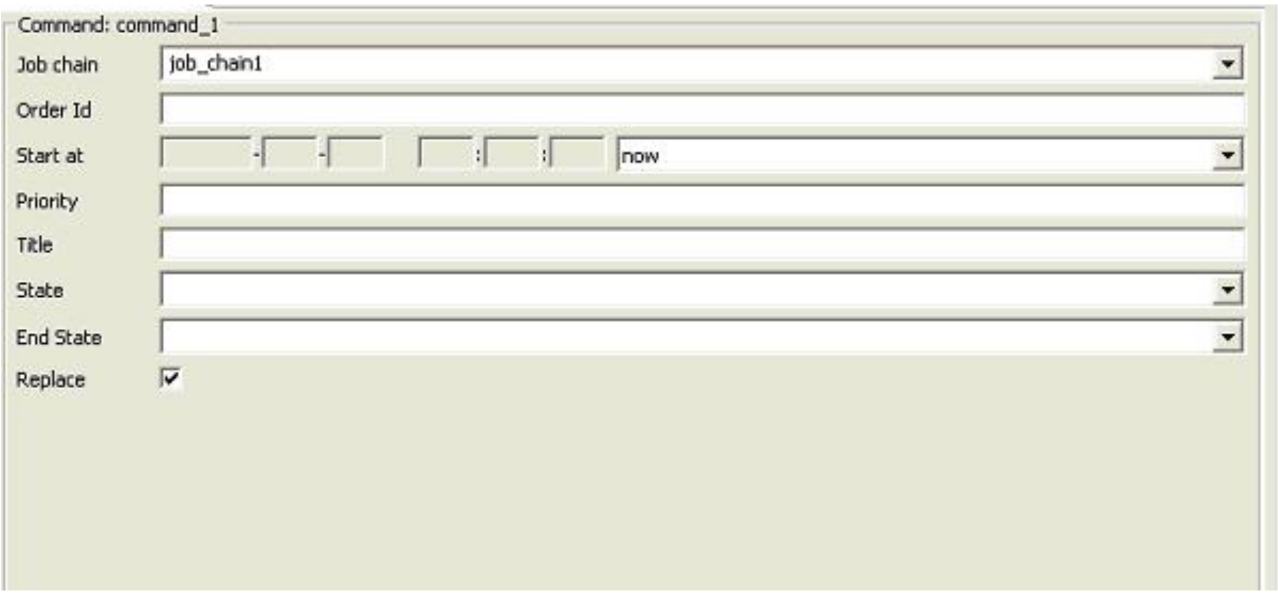
The state with which the order should start in the job chain.

end state:

The job chain state which the order should run to.

replace:

Should the order overwrite an existing order of the same ID?



Command: command_1

Job chain	job_chain1
Order Id	
Start at	now
Priority	
Title	
State	
End State	
Replace	☑

start job:

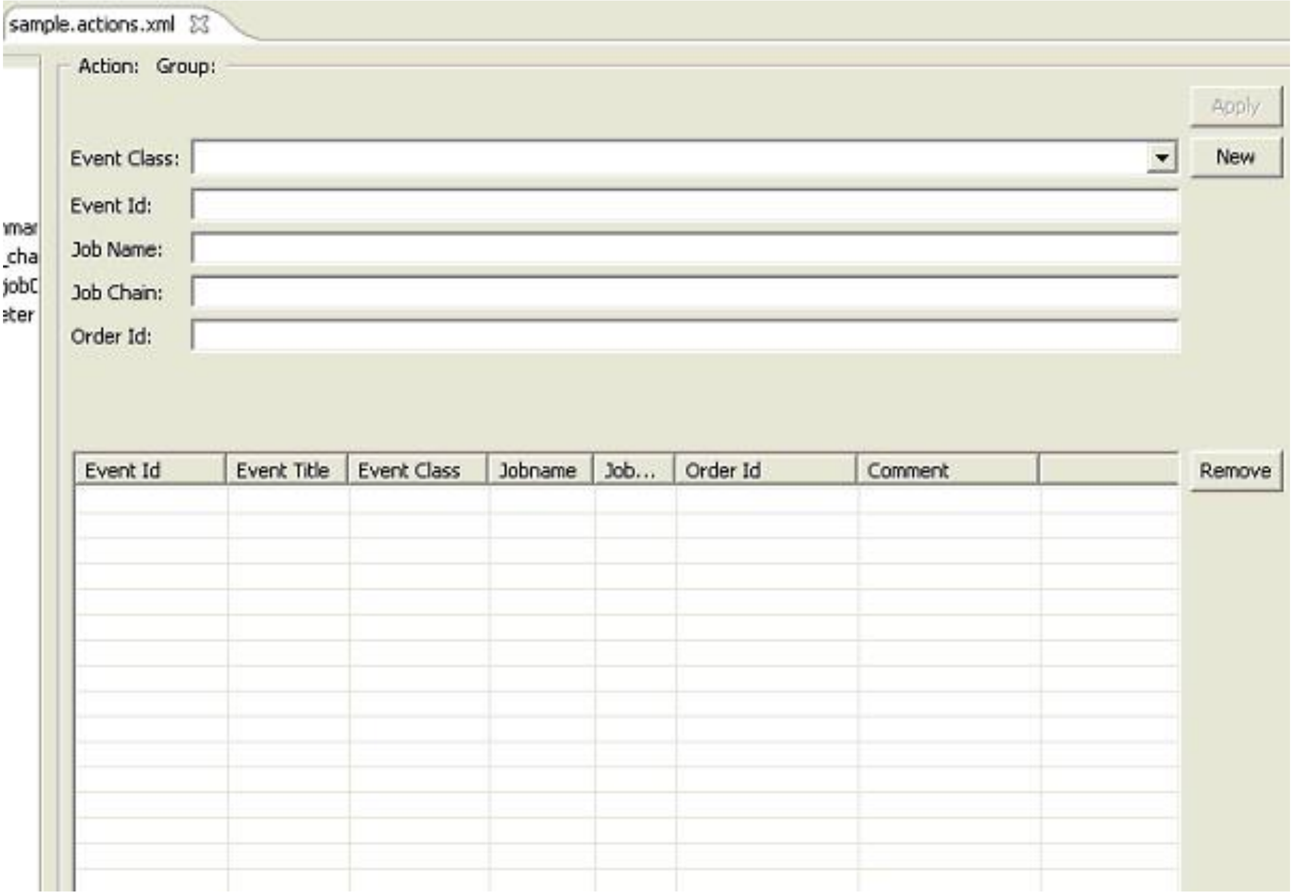
Starts a job. The start time is to be specified.

add event:

Creates a new event

remove event:

Deletes events. For example, all the events belonging to a class or job could be deleted.



The event handler is saved as an XML file:

```
                 <?xml version="1.0" encoding="UTF-8"?>
        <actions>
          <action name="New Action 1">
            <events>

              <event_group group="Test" logic="or">
                <event event_id="1"
                event_class="sample"
                event_title="Job1 has been completed"
                job_name="job1" />
                <event event_id="2"
                event_class="sample"
                event_title="Job2 has been completed"
                job_name="jobd2" />
              </event_group>

            </events>

            <commands>
              <command name="command_1" scheduler_host="localhost" scheduler_port="4454">
                <start_job job="job0" at="now" />
                <add_order job_chain="job_chain1" replace="yes" />
              </command>
            </commands>
          </action>
        </actions>
```

Example: A typical event handler as an XML file

4.3.4 Evaluation of the rule set

Evaluation of the rule set tests whether the events specified in the logic of an event group can be found in the list of currently existing events. The TRUE / FALSE values determined are then combined using the group Boolean operators.

An event is seen as being present in the events list once the attributes specified in the event handler have been tested. Note, however, that the title, expires and creation attributes are not considered here.

4.3.4.1 Example: Rule set evaluation

This event group evaluates to TRUE when event1 is present and event2 not present.

- event1 is present, when an event with event_class="sample", event_id="1" and job_name="job1" is found
- event2 is present, when an event with event_id="2" is found.

```
<event_group group="Test" logic="event1 and not event2">
        <event event_id="1"
               event_name="event1"
          event_class="sample"
          event_title="Job1 has been completed"
          job_name="job1" />
        <event event_id="2"
               event_name="event2"
          event_title="Job2 has been completed"/>
      </event_group>
```

Example: A typical XML rule set

5 Event Processing Configuration

5.1 Event Processor Installation

The Event Processor must be installed on a Supervisor Job Scheduler.

The `scheduler_event_service` file can be found in the config directory of the Job Scheduler installation and defines scheduler_event_service job chain. This job chain implements the Event Processor.

The configuration should be defined as a <base file="..."/> so that it is made known to the Supervisor Job Scheduler.

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<config>
    <!--  -->
    <base file="scheduler_events.xml"/>
    <process_classes>
        <process_class max_processes="10"/>
    </process_classes>
</config>
```

Example: Configuration of the Event Processor with the scheduler_event_service file

Use the following link to download the Event Processor as a file.

5.1.1 Configuration:

The expiration_period parameter should be set to the standard expiry time required for all events: e.g.

```
<param name="expiration_period"      value="00:00"/>
```

Example: Setting the Event Processor expiration_period parameter

5.2 Define at least one event handler

Event handlers are written and modified using the Job Scheduler Job Editor. The default directory for saving Event Handlers is scheduler/config/events. Note that this directory can be changed by modifying the following parameter in the Event Processor:

```
        <param name="event_handler_filespec"    value="scheduler_events.xsl"/>
```

Example: Setting the default directory for saving Event Handlers

The following example illustrates a very simple Event Handler, in which Job B starts after Job A has been completed:

```
<?xml version="1.0" encoding="UTF-8"?>
<actions>
  <action name="sample">
    <events>
      <event_group group="Main">
        <event event_id="0" event_title="Job A" job_name="job_a" />
      </event_group>
    </events>
    <commands>
      <command name="start_Job_B" scheduler_host="localhost" scheduler_port="4444">
        <start_job job="job_b" />
      </command>
    </commands>
  </action>
</actions>
```

Example: A simple XML event handler

5.3 Configure an event generator for every event listed in the event handler

There are several possible methods to generate a "Job A is running" event:

- if it is a shell job then the jobscheduler_event.cmd shell script can be called;
- if it is a Java job then the monitor can be used.

Example showing the use of a shell script:

```
<job>
    <script language="shell">
        <![CDATA[
          # any commands
          # submit event to Supervisor Job Scheduler
          ${SCHEDULER_HOME}/bin/jobscheduler_event.sh -x $? -e "sample"
        ]]
    </script>
    <run_time/>
</job>
```

Example: A shell script based event generator that generates the events listed in the event handler

6 Event Handling Routine Examples

6.1 Example: Split and Merge

```
   <actions>
  <action name="Split">
    <events>
      <event_group group="A">
        <event event_class="example_split" event_id="0"
               event_title="Job A" job_name="job_A"/>
      </event_group>
    </events>

    <commands>
      <command name="Start B1" scheduler_host="localhost" scheduler_port="4474">
        <start_job job="samples/splitAndMerge/job_B_1"/>
      </command>

      <command name="Start B2" scheduler_host="localhost" scheduler_port="4474">
        <start_job job="samples/splitAndMerge/job_B_2"/>
      </command>
      <remove_event debug="example_split">
        <event event_class="example_split" event_id="0"  job_name="job_A"/>
      </remove_event>
    </commands>
  </action>

  <action name="And Merge">
    <events>
      <event_group logic="and" group="A">
        <event event_class="example_andmerge" event_id="0"
               event_title="Job B_1" job_name="job_B_1"/>
        <event event_class="example_andmerge" event_id="0"
               event_title="Job B_2" job_name="job_B_2"
               comment="Call 01728388383 if not active before 18:00"/>
        <event event_class="example_andmerge" event_id="0" event_title="Job B_4"
               job_name="job_B_4" comment="Is started manually"/>
      </event_roup>
    </events>

    <commands>
      <command name="Start C" scheduler_host="localhost" scheduler_port="4474">
        <start_job job="samples/splitAndMerge/job_C"/>
      </command>
      <remove_event debug="example_andmerge">
        <event event_class="example_andmerge" event_id="0"/>
      </remove_event>
    </commands>
  </action>
</actions>
```

Example: Handling split and merge

This example consists of two actions: the "split" action, which is followed by the "merge" action.

The "split" action starts job_B_1 and job_B_2 once job_A has been completed. In addition, the event will be deleted after it has been processed.

The "merge" action waits on the job_B_1 completed and job_B_2 completed events as well as the conditions for job_B_4, which is manually started. The action then starts job_C and removes the events involved.

6.2 Example: Job synchronisation on different JobSchedulers

```
        <actions>
  <action name="New Action 1">
    <events>
      <event_group group="Main">
        <event event_id="1" event_class="sample" event_title="Job A" job_name="job_A" />
        <event event_id="2" event_class="sample" event_title="Job B" job_name="job_B" />
      </event_group>
    </events>
    <commands>
      <command name="command_1" scheduler_host="Scheduler2" scheduler_port="4444">
        <start_job job="job_C" />
      </command>
    </commands>
  </action>
</actions>
```

Example: Job A and Job B on Job Scheduler 1, then Job C on Job Scheduler 2

Job A and job B run on Job Scheduler 1 and each generates an event. Once both events are present, Job_C is started on Job Scheduler 2.

6.3 Example: Job has not run before a specified time

```
<actions>
  <action name="Missing File">
    <events logic="A">
      <event_group logic="example_missing.time and Not example_missing.file" group="A">
        <event   event_class="example_missing" event_id="file"
                 event_title="File is detected" job_name="job_A" />
        <event   event_class="example_missing" event_id="time"
                 event_title="Its Teatime now"  job_name="job_1700" />
      </event_group>
    </events>
    <commands>
      <command name="Start B1" scheduler_host="localhost" scheduler_port="4474">
        <start_job job="job_B1" />
      </command>
      <remove_event>
        <event event_class="example_missing" event_id="0" />
      </remove_event>
    </commands>
  </action>
</actions>
```

Example: Job A has not run by 5 o'clock

In this example, the situation where job_A monitors a directory is considered: The function of job_1700 is exclusively that of running at 17:00 and sending an event.

Job_B is started, when job_1700 has run and job_A has not been completed:

6.4 Example: Notification when a file has not arrived before 17:00

```
<?xml version="1.0" encoding="UTF-8859"?>
<job name="sample" title="Submit &quot;17:00&quot Event;">
    <description>
        <include file="jobs/JobSchedulerSubmitEventJob.xml"/>
    </description>
    <params>
        <param name="scheduler_event_class" value="file_arrived"/>
        <param name="scheduler_event_id"    value="1"/>
    </params>
    <script language="java"
            java_class="sos.scheduler.job.JobSchedulerSubmitEventJob"/>
    <run_time>
        <period single_start="17:00"/>
    </run_time>
</job>
```

Example: Step 1 - Generate the "It is 17:00" event

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<job name="sample" title="Submit Event &quot;File has arrived&quot;">
    <description>
        <include file="jobs/JobSchedulerSubmitEventJob.xml"/>
    </description>
    <params>
        <param name="scheduler_event_class" value="file_arrived"/>
        <param name="scheduler_event_id"    value="2"/>
    </params>
    <script language="java"
            java_class="sos.scheduler.job.JobSchedulerSubmitEventJob"/>
</job>
```

Example: Step 2 - Generate the "Generate the file has arrived" event

```
<?xml version="1.0" encoding="UTF-8"?>
<actions>
  <action name="FileIsMissing">
    <events>
      <event_group group="File Missing" logic="Its17_00 and not File"
                   event_class="file_arrived">
        <event event_name="File" event_class="file_arrived"
               event_title="File has arrived" event_id="2" />
        <event event_name="Its17_00"
               event_title="A specific time has been reached" event_id="1" />
      </event_group>
    </events>
    <commands>
      <command name="notify" scheduler_host="localhost" scheduler_port="4444">
        <start_job job="job_notify">
          <params>
            <param name="to" value="admin@host.de" />
            <param name="subject" value="File is missing" />
          </params>
        </start_job>
      </command>
      <remove_event>
        <event event_class="file_arrived" />
      </remove_event>
    </commands>
  </action>
</actions>
```

Example: Step 3 - The event handler

7 Appendix

7.1 Event Processor configuration

The job chain contains the scheduler_event job. The parameterization of this job is described in the scheduler/jobs/JobSchedulerEventJob.xml documentation.

```
<config>
    <jobs>

        <job name="scheduler_event_service"
             title="Process Events"
             order="yes"
             stop_on_error="no"
             timeout="120">
            <description>
                <include file="jobs/JobSchedulerEventJob.xml"/>
            </description>

            <params>
                <param name="event_handler_filepath"
                       value="./config/events"/>
                <param name="event_handler_filespec"
                       value="scheduler_events.xsl"/>
                <param name="expiration_period"
                       value="12:00"/>
            </params>

            <script java_class="sos.scheduler.job.JobSchedulerEventJob"
                    language="java"/>

            <run_time/>
        </job>
    </jobs>
    <job_chains>
        <job_chain name="scheduler_event_service"
                   orders_recoverable="no"
                   visible="yes">
            <job_chain_node state="start"
                            job="scheduler_event_service"
                            next_state="end"
                            error_state="error"/>

            <job_chain_node state="end"/>

            <job_chain_node state="error"/>
        </job_chain>
    </job_chains>
    <commands>
        <add_order id="event_processor"
                   job_chain="scheduler_event_service">
            <params>
                <param name="action"
                       value="process"/>
                <param name="event_handler_filespec"
                       value="\.xsl$"/>
            </params>

            <run_time let_run="yes"
                      repeat="300"/>
        </add_order>
    </commands>
</config>
```

Example: Event processor configuration