Spring Batch Workshop

Arnaud Cogoluègnes

Consultant with Zenika, Co-author Spring Batch in Action

May 24, 2011

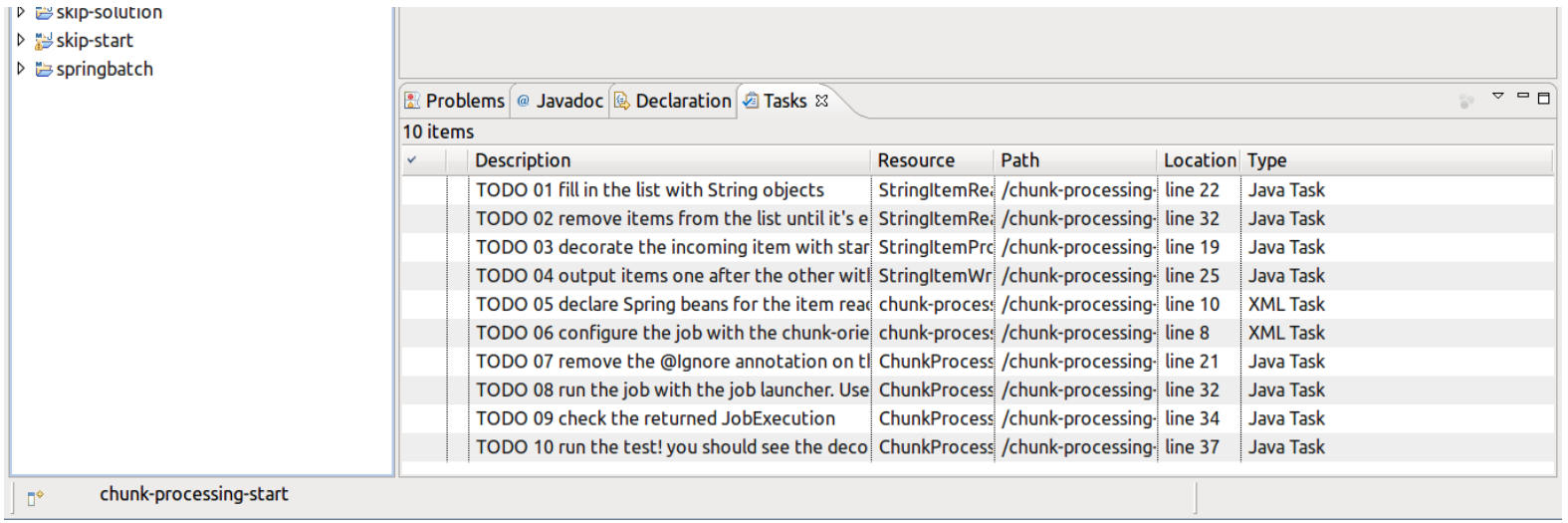
Overview

- This workshop highlights Spring Batch features
- Problem/solution approach
  - A few slides to cover the feature
  - A project to start from, just follow the TODOs
- Prerequisites
  - Basics about Java and Java EE
  - Spring: dependency injection, enterprise support
- https://github.com/acogoluegnes/Spring-Batch-Workshop

License

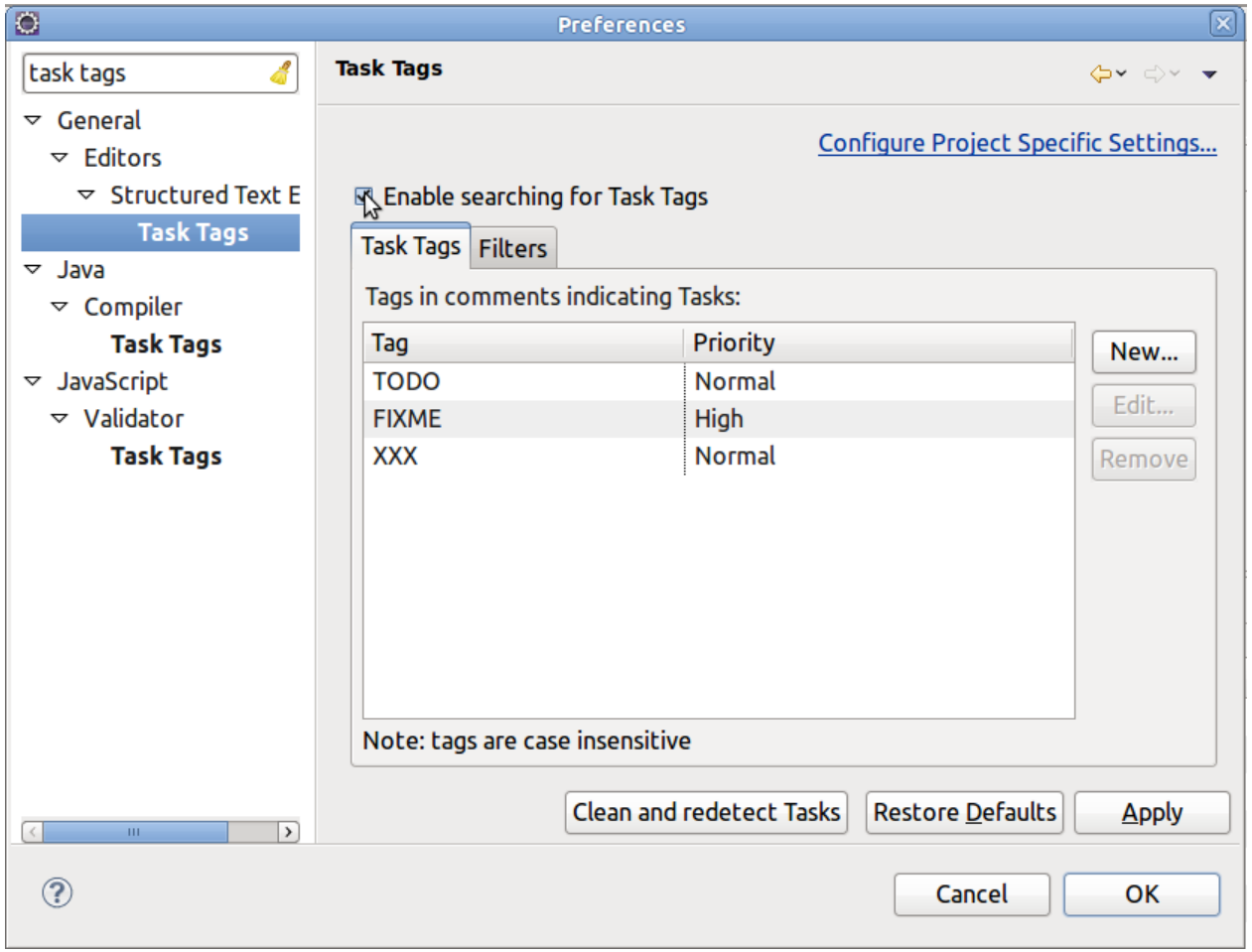
Follow the TODOs

- Track the TODO in the *-start projects!
- It's easier with support from the IDE



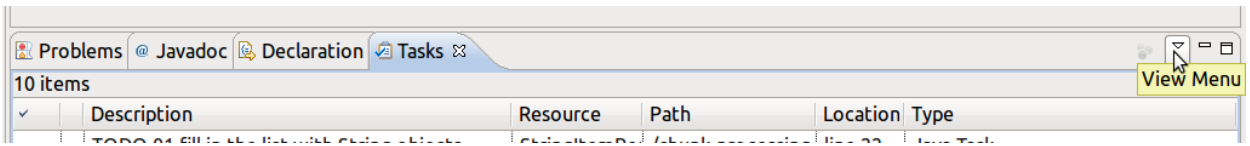
TODO with Eclipse

- Window > Preferences > “tasks tag” in filter



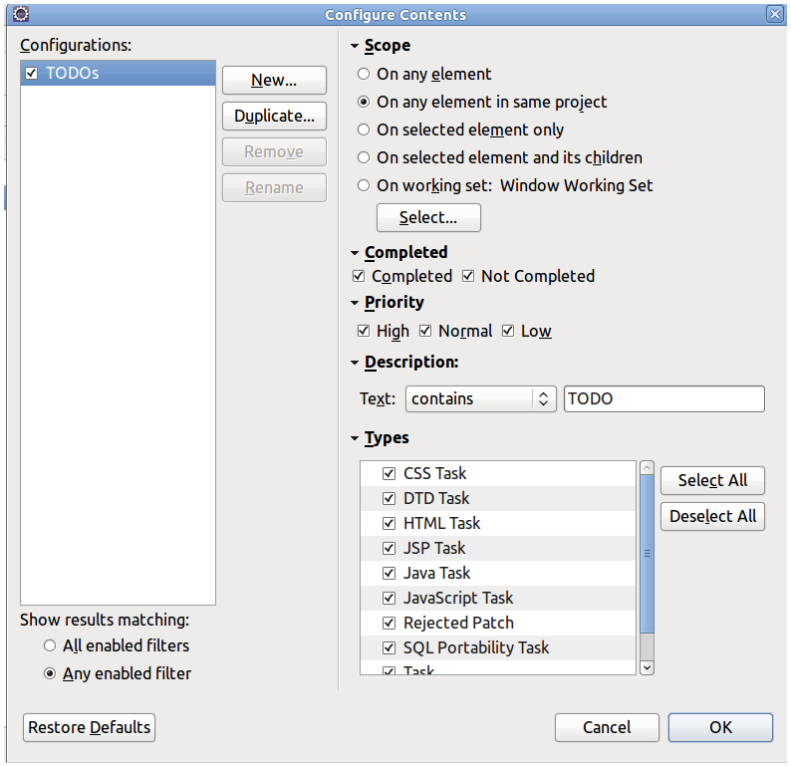
TODO with Eclipse

- Open the “Tasks” view
- click on the down arrow on the right
- “configure contents”



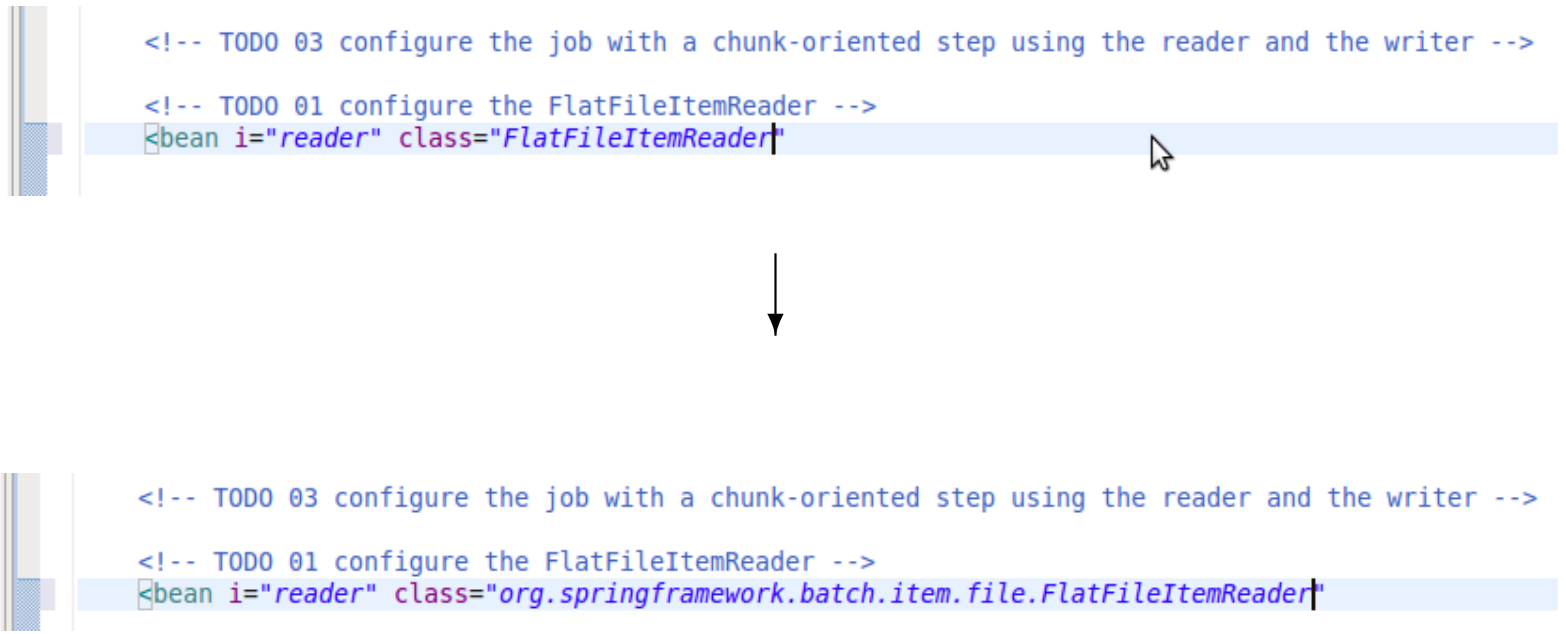
TODO with Eclipse

- Check “TODOs” on the left
- Check “On any element in the same project” on the right (scope)



Spring support in IDE is a +

- e.g. code completion in SpringSource Tool Suite



Basic features for batch applications

- Read – process – write large amounts of data, efficiently
- Ready-to-use components to read from/write to
  - Flat/XML files
  - Databases (JDBC, Hibernate, JPA, iBatis)
  - JMS queues
  - Emails
- Numerous extension points/hooks

Advanced features for batch applications

- Configuration to skip/retry items
- Execution metadata
  - Monitoring
  - Restart after failure
- Scaling strategies
  - Local/remote
  - Partitioning, remote processing

- Problem: getting started with Spring Batch
- Solution: writing a simple “Hello World” job

Structure of a job

- A Spring Batch job is made of steps
- The Hello World job has one step
- The processing is implemented in a `Tasklet`

The Hello World Tasklet

```
public class HelloWorldTasklet implements Tasklet {

  @Override
  public RepeatStatus execute(
      StepContribution contribution,
      ChunkContext chunkContext) throws Exception {
    System.out.println("Hello world!");
    return RepeatStatus.FINISHED;
  }

}
```

The configuration of the Hello World job [1]

```
<batch:job id="helloWorldJob">
  <batch:step id="helloWorldStep">
    <batch:tasklet>
      <bean class="com.zenika.workshop.springbatch.HelloWorldTasklet" />
    </batch:tasklet>
  </batch:step>
</batch:job>
```

[1] Notice the `batch` namespace

Spring Batch needs some infrastructure beans

- Let's use the typical test configuration

```
<bean id="transactionManager"
      class="o.s.b.support.transaction.ResourcelessTransactionManager" />

<bean id="jobRepository"
      class="o.s.b.core.repository.support.MapJobRepositoryFactoryBean" />

<bean id="jobLauncher"
      class="o.s.b.core.launch.support.SimpleJobLauncher">
  <property name="jobRepository" ref="jobRepository" />
</bean>
```

Running the test in a JUnit test

```
@RunWith(SpringJUnit4ClassRunner.class)
@ContextConfiguration("/hello-world-job.xml")
public class HelloWorldJobTest {

  @Autowired
  private Job job;

  @Autowired
  private JobLauncher jobLauncher;

  @Test public void helloWorld() throws Exception {
    JobExecution execution = jobLauncher.run(job, new JobParameters());
    assertEquals(ExitStatus.COMPLETED, execution.getExitStatus());
  }
}
```

- Problem: processing large amounts of data efficiently
- Solution: using chunk processing

What is chunk processing?

- Batch jobs often read, process, and write items
- e.g.
  - Reading items from a file
  - Then processing (converting) items
  - Writing items to a database
- Spring Batch calls this “chunk processing”
- a chunk = a set of items

Chunk processing with Spring Batch

- Spring Batch
  - handles the iteration logic
  - uses a transaction for each chunk
  - lets you choose the chunk size
  - defines interfaces for each part of the processing

The reading phase

- Spring Batch creates chunks of items by calling `read()`
- Reading ends when `read()` returns `null`

```
public interface ItemReader<T> {

  T read() throws Exception, UnexpectedInputException,
                  ParseException, NonTransientResourceException;

}
```

The processing phase

- Once a chunk is created, items are sent to the processor
- Optional

```
public interface ItemProcessor<I, O> {

  O process(I item) throws Exception;

}
```

The writing phase

- Receives all the items of the chunk
- Allows for batch update (more efficient)

```
public interface ItemWriter<T> {

  void write(List<? extends T> items) throws Exception;

}
```

An example

- Let's implement a (too?) simple chunk-oriented step!

The ItemReader

```
public class StringItemReader implements ItemReader<String> {

  private List<String> list;

  public StringItemReader() {
    this.list = new ArrayList<String>(Arrays.asList(
      "1","2","3","4","5","6","7")
    );
  }

  @Override
  public String read() throws Exception, UnexpectedInputException,
                              ParseException, NonTransientResourceException {
    return !list.isEmpty() ? list.remove(0) : null;
  }
}
```

The ItemProcessor

```
public class StringItemProcessor implements ItemProcessor<String, String> {

  @Override
  public String process(String item) throws Exception {
    return "*** "+item+" ***";
  }

}
```

The ItemWriter

```
public class StringItemWriter implements ItemWriter<String> {

  private static final Logger LOGGER =
    LoggerFactory.getLogger(StringItemWriter.class);

  @Override
  public void write(List<? extends String> items) throws Exception {
    for(String item : items) {
      LOGGER.info("writing "+item);
    }
  }

}
```

Configuring the job

```
<batch:job id="chunkProcessingJob">
  <batch:step id="chunkProcessingStep">
    <batch:tasklet>
      <batch:chunk reader="reader" processor="processor" writer="writer"
                   commit-interval="3"
       />
    </batch:tasklet>
  </batch:step>
</batch:job>

<bean id="reader" class="com.zenika.workshop.springbatch.StringItemReader" />

<bean id="processor"
      class="com.zenika.workshop.springbatch.StringItemProcessor" />

<bean id="writer" class="com.zenika.workshop.springbatch.StringItemWriter" />
```

Considerations

- Do I always need to write my `ItemReader`/`Processor`/`Writer`?
- No, Spring Batch provides ready-to-use components for common datastores
  - Flat/XML files, databases, JMS, etc.
- As an application developer, you
  - Configure these components
  - Provides some logic (e.g. mapping a line with a domain object)

Going further...

- Reader/writer implementation for flat/XML files, database, JMS
- Skipping items when something goes wrong
- Listeners to react to the chunk processing

- Problem: reading lines from a flat file and sending them to another source (e.g. database)
- Solution: using the FlatFileItemReader

Spring Batch's support for flat file reading

- Spring Batch has built-in support for flat files
  - Through the `FlatFileItemReader` for reading
- The `FlatFileItemReader` handles I/O
- 2 main steps:
  - Configuring the `FlatFileItemReader`
  - Providing a line-to-object mapping strategy

The usual suspects

```
Susy,Hauerstock,2010-03-04
De Anna,Raghunath,2010-03-04
Kiam,Whitehurst,2010-03-04
Alecia,Van Holst,2010-03-04
Hing,Senecal,2010-03-04
```

```
public class Contact {

  private Long id;
  private String firstname,lastname;
  private Date birth;

  (...)
}
```

What do we need to read a flat file?

- How to tokenize a line
- How to map the line with a Java object
- Where to find the file to read

The FlatFileItemReader configuration

```
<bean id="reader"
      class="org.springframework.batch.item.file.FlatFileItemReader">
  <property name="lineMapper">
    <bean class="org.springframework.batch.item.file.mapping.DefaultLineMapper">
      <property name="lineTokenizer">
        <bean
   class="org.springframework.batch.item.file.transform.DelimitedLineTokenizer">
          <property name="names" value="firstname,lastname,birth" />
        </bean>
      </property>
      <property name="fieldSetMapper">
        <bean class="com.zenika.workshop.springbatch.ContactFieldSetMapper" />
      </property>
    </bean>
  </property>
  <property name="resource" value="classpath:contacts.txt" />
</bean>
```

The line-to-object mapping strategy

- A `FieldSetMapper` to map a line with an object
- More about business logic, so typically implemented by developer
- Spring Batch provides straightforward implementations

Custom `FieldSetMapper` implementation

```
package com.zenika.workshop.springbatch;

import org.springframework.batch.item.file.mapping.FieldSetMapper;
import org.springframework.batch.item.file.transform.FieldSet;
import org.springframework.validation.BindException;

public class ContactFieldSetMapper implements FieldSetMapper<Contact> {

  @Override
  public Contact mapFieldSet(FieldSet fieldSet) throws BindException {
    return new Contact(
      fieldSet.readString("firstname"),
      fieldSet.readString("lastname"),
      fieldSet.readDate("birth","yyyy-MM-dd")
    );
  }
}
```

Going further...

- `FlatFileItemWriter` to write flat file
- Fixed-length format (different tokenizer)
- Skipping badly formatted lines

- Problem: my job fails miserably because of a tiny error in my input file
- Solution: skipping lines without failing the whole execution

A CSV file with a badly formatted line

```
Susy , Hauerstock ,2010-03-04
De-Anna , Raghunath ,2010-03-04
Kiam , Whitehurst ,2010-03-04
Alecia , Van  Holst , 09-23-2010
Hing , Senecal ,2010-03-04
Kannan , Pirkle ,2010-03-04
Row, Maudrie ,2010-03-04
Voort , Philbeck ,2010-03-04
```

Skip configuration

- Choose the exceptions to skip
- Set the max number of items to skip

```
<batch:job id="skipJob">
  <batch:step id="skipStep">
    <batch:tasklet>
      <batch:chunk reader="reader" writer="writer" commit-interval="3"
                   skip-limit="10">
        <batch:skippable-exception-classes>
          <batch:include
           class="org.springframework.batch.item.file.FlatFileParseException"/>
        </batch:skippable-exception-classes>
      </batch:chunk>
    </batch:tasklet>
  </batch:step>
</batch:job>
```

Going further...

- Logging skipped items with a `SkipListener`
- Setting a custom `SkipPolicy`

- Problem: passing values to the configuration when launching a job
- Solution: using job parameters and late binding

Use case: providing a input file dynamically to the item reader

```
JobParameters jobParameters = new JobParametersBuilder()
  .addString("input.file", "file:./input/contacts-01.txt")
  .toJobParameters();
JobExecution execution = jobLauncher.run(job, jobParameters);
```

```
<bean id="reader"
      class="org.springframework.batch.item.file.FlatFileItemReader"
      scope="step">
  <property name="resource value="#{jobParameters['input.file']}" />
  (...)
</bean>
```

Going further...

- Spring Expression Language (SpEL)
- Step scope for partitioning

- Problem: reading large result sets from the database with a stable memory footprint
- Solution: using the `JdbcPagingItemReader`, which uses paging to handle large result sets

JdbcPagingItemReader configuration

```
<bean id="reader"
      class="org.springframework.batch.item.database.JdbcPagingItemReader">
  <property name="dataSource" ref="dataSource" />
  <property name="pageSize" value="10" />
  <property name="queryProvider">
    <bean class="o.s.b.item.database.support.SqlPagingQueryProviderFactoryBean">
      <property name="dataSource" ref="dataSource" />
      <property name="selectClause"
                value="select id,firstname,lastname,birth" />
      <property name="fromClause" value="from contact" />
      <property name="sortKey" value="id" />
    </bean>
  </property>
  <property name="rowMapper">
    <bean class="com.zenika.workshop.springbatch.ContactRowMapper" />
  </property>
</bean>
```

Paging or cursors?

- By paging, you send multiple queries to the database
- Alternative: cursor-based item reader
  - Spring Batch "streams" the result set from the DB
  - Only one query
- Paging always works, cursor-based reader depends on driver implementation and database

Going further...

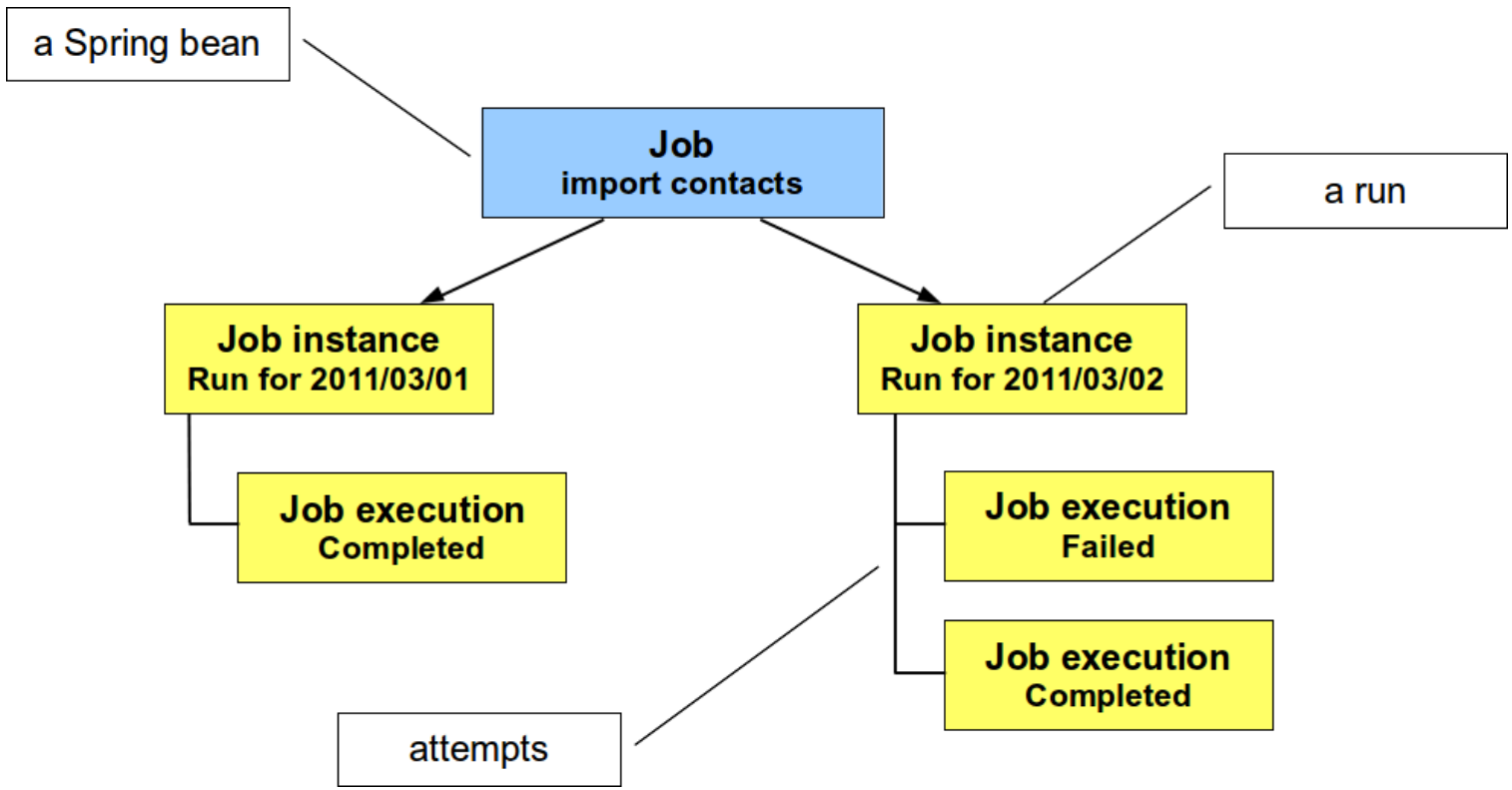
- Paging readers for Hibernate, JPA, iBatis
- Cursor-based readers

- Problem: monitoring the execution of batch jobs
- Solution: letting Spring Batch storing execution metadata in a database

Why storing execution metadata?

- Spring Batch keeps track of batch execution
- Enables:
  - Monitoring by querying metadata tables
  - Restarting after a failure

Job, job instance, and job execution



Job instance

- How to define a job instance?
- Thanks to job parameters
- Job parameters define the identity of the job instance

The reading phase

- Metadata are stored in a database
  - In-memory implementation for test/development
- Monitoring tools can query metadata tables

Going further...

- Spring Batch Admin, the web console for Spring Batch
- `JobExplorer` and `JobOperator` interfaces
- Spring JMX support

- Problem: scheduling a job to execute periodically
- Solution: using the scheduling support in Spring

A class to launch the job

```
public class ImportLauncher {

  public void launch() throws Exception {
    JobExecution exec = jobLauncher.run(
      job,
      new JobParametersBuilder()
        .addLong("time", System.currentTimeMillis())
        .toJobParameters()
    );
  }
}
```

Spring scheduling configuration

```
<bean id="importLauncher"
      class="com.zenika.workshop.springbatch.ImportLauncher" />

<task:scheduled-tasks>
  <task:scheduled ref="importLauncher" method="launch"
                  fixed-delay="1000" />
</task:scheduled-tasks>
```

- `cron` attribute available

Going further...

- Threading settings in Spring Scheduler
- Spring support for Quartz

- Problem: I want to add some business logic before writing the items I just read
- Solution: use an `ItemProcessor` to process/convert read items before sending them to the `ItemWriter`

Use case

- Reading contacts from a flat file
- Registering them into the system
  - This is the *business logic*
- Writing the registration confirmations to the database

The ItemProcessor interface

```
public interface ItemProcessor<I, O> {

  O process(I item) throws Exception;

}
```

How to implement an `ItemProcessor`

- An `ItemProcessor` usually delegates to existing business code

```
public class ContactItemProcessor implements
             ItemProcessor<Contact, RegistrationConfirmation> {

  private RegistrationService registrationService;

  @Override
  public RegistrationConfirmation process(Contact item)
       throws Exception {
     return registrationService.process(item);
  }

}
```

Registering the ItemProcessor

```
<batch:job id="itemProcessorJob">
  <batch:step id="itemProcessorStep">
    <batch:tasklet>
      <batch:chunk reader="reader" processor="processor"
                   writer="writer" commit-interval="3"/>
    </batch:tasklet>
  </batch:step>
</batch:job>

<bean id="registrationService"
      class="com.zenika.workshop.springbatch.RegistrationService" />

<bean id="processor"
      class="com.zenika.workshop.springbatch.ContactItemProcessor">
  <property name="registrationService" ref="registrationService" />
</bean>
```

Going further...

- Available `ItemProcessor` implementations
  - Adapter, validator
- The `ItemProcessor` can filter items

- Problem: logging skipped items
- Solution: using a `SkipListener`

2 steps to log skipped items

- Writing the `SkipListener` (and the logging code)
- Registering the listener on the step

Writing the SkipListener

```
package com.zenika.workshop.springbatch;

import org.slf4j.Logger;
import org.slf4j.LoggerFactory;
import org.springframework.batch.core.listener.SkipListenerSupport;

public class Slf4jSkipListener<T,S> extends SkipListenerSupport<T, S> {

  private static final Logger LOG = LoggerFactory.getLogger(
      Slf4jSkipListener.class);

  @Override
  public void onSkipInRead(Throwable t) {
    LOG.warn("skipped item: {}",t.toString());
  }

}
```

Registering the SkipListener

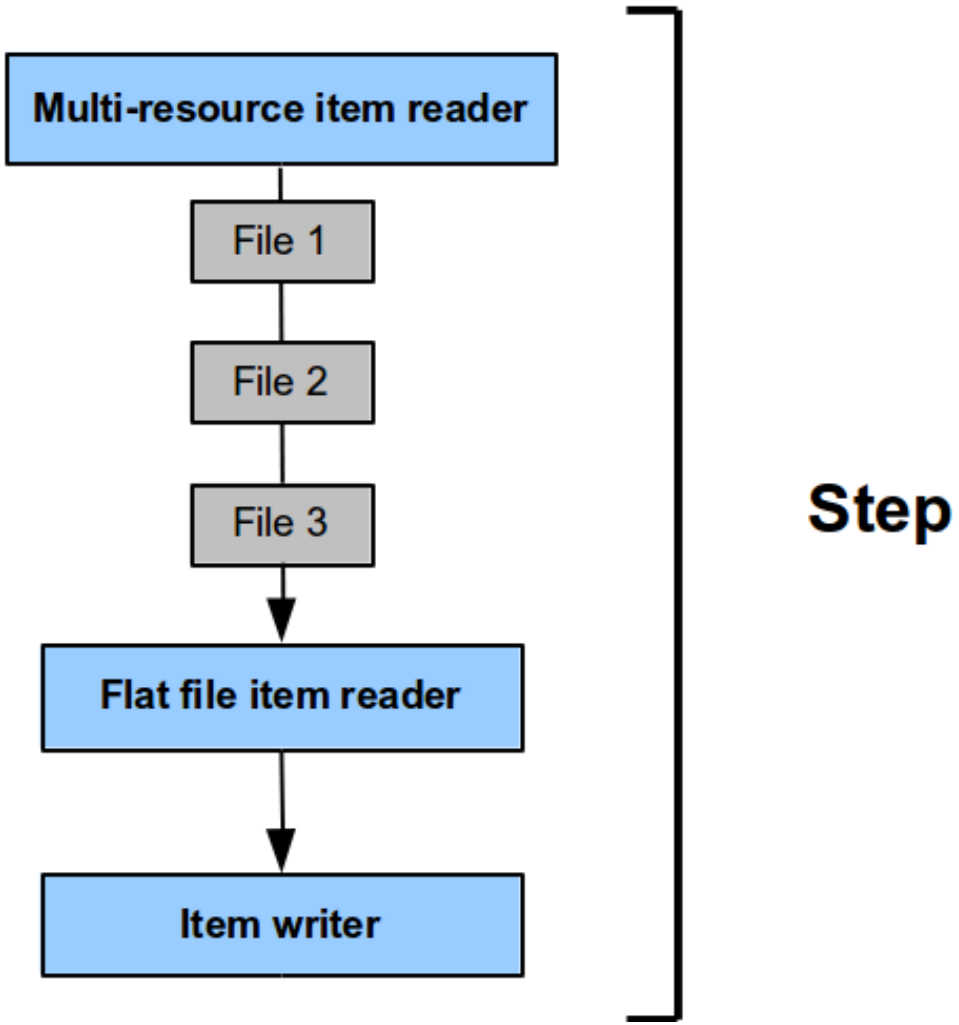
```
<batch:job id="loggingSkippedItemsJob">
  <batch:step id="loggingSkippedItemsStep">
    <batch:tasklet>
      <batch:chunk reader="reader" writer="writer" commit-interval="3"
                   skip-limit="10">
        <batch:skippable-exception-classes>
          <batch:include
            class="org.springframework.batch.item.file.FlatFileParseException"/>
        </batch:skippable-exception-classes>
      </batch:chunk>
      <batch:listeners>
        <batch:listener ref="skipListener" />
      </batch:listeners>
    </batch:tasklet>
  </batch:step>
</batch:job>

<bean id="skipListener" class="com.zenika.workshop.springbatch.Slf4jSkipListener" />
```

Going further...

- Other listeners in Spring Batch
  - `ChunkListener`, `Item(Read/Process/Write)Listener`, `ItemStream`, `StepExecutionListener`, `JobExecutionListener`

- Problem: I have multiple input files and I want to process them in parallel
- Solution: use partitioning to parallelize the processing on multiple threads

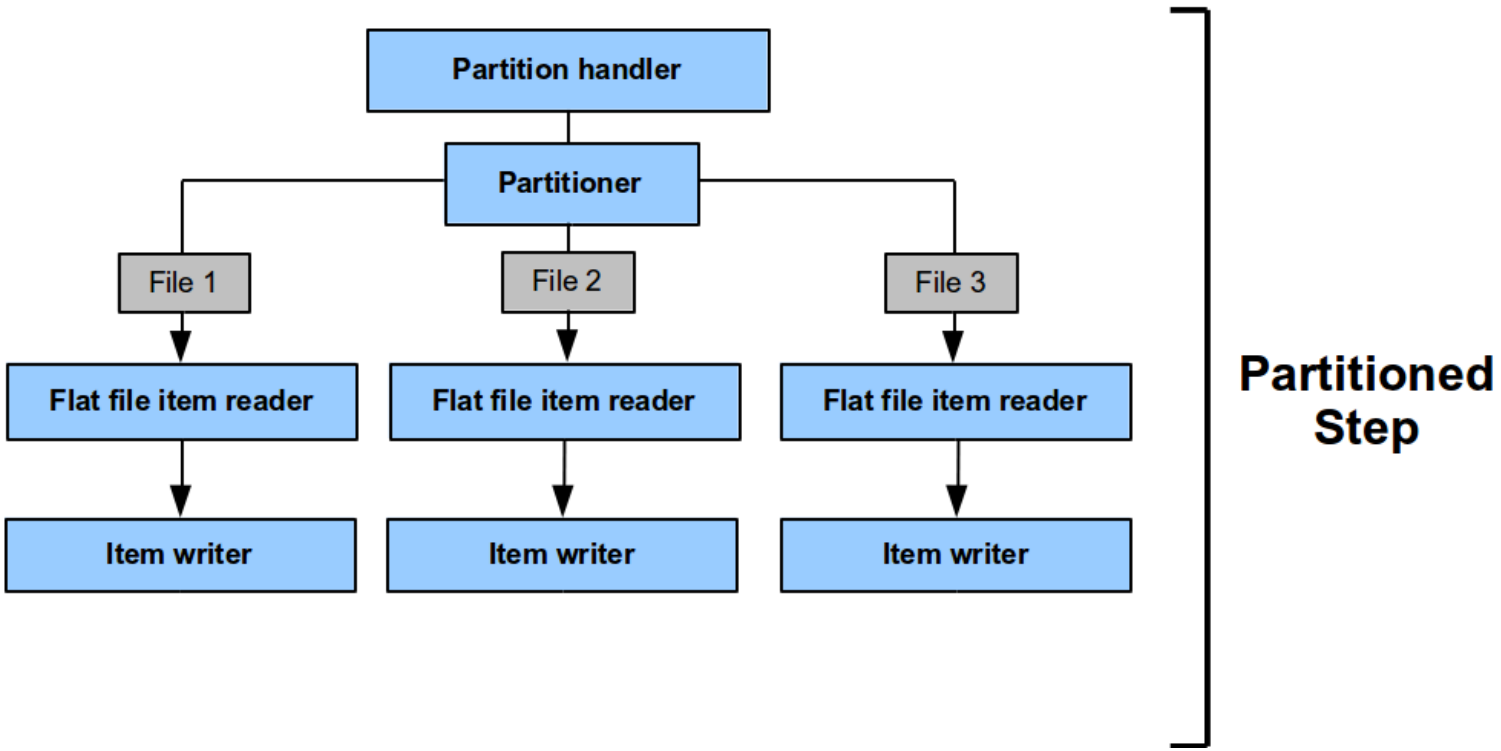
Serial processing



Partitioning in Spring Batch

- Partition the input data
  - e.g. one input file = one partition
  - partition processed in a dedicated step execution
- Partitioning is easy to set up but need some knowledge about the data
- Partition handler implementation
  - Multi-threaded
  - Spring Integration

Multi-threaded partitioning



Partitioner for input files

```
<bean id="partitioner"
      class="o.s.b.core.partition.support.MultiResourcePartitioner">
  <property name="resources"
            value="file:./src/main/resources/input/*.txt" />
</bean>
```

The partitioner sets a context for the components

```
<bean id="reader"
      class="org.springframework.batch.item.file.FlatFileItemReader"
      scope="step">
  (...)
  <property name="resource" value="#{stepExecutionContext['fileName']}" />
</bean>
```

Using the multi-threaded partition handler

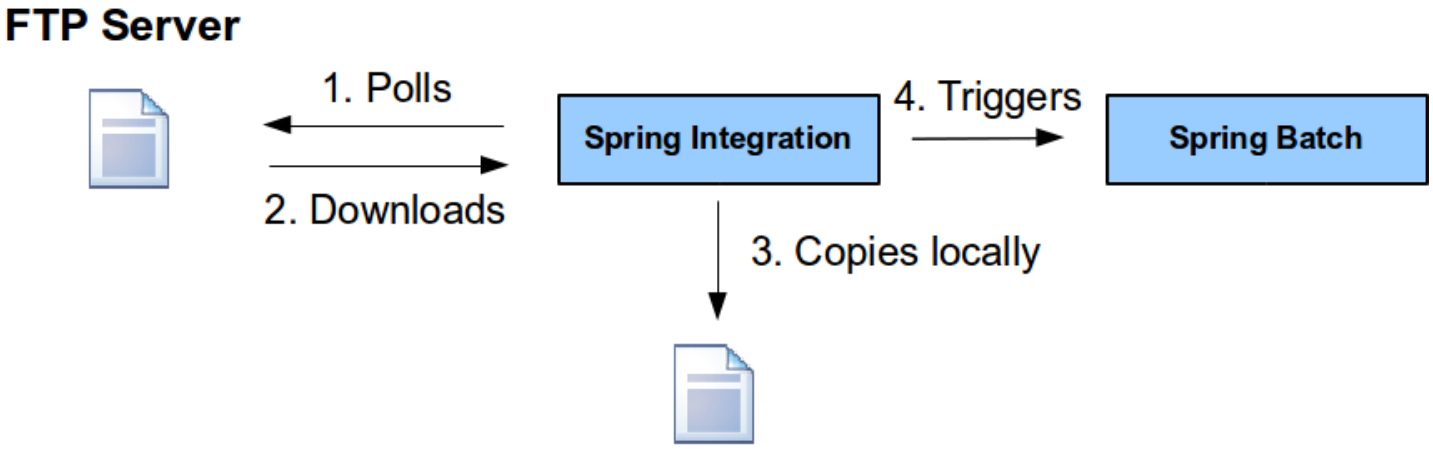
```
<batch:job id="fileReadingPartitioningJob">
  <batch:step id="partitionedStep" >
    <batch:partition step="readWriteContactsPartitionedStep"
                     partitioner="partitioner">
      <batch:handler task-executor="taskExecutor" />
    </batch:partition>
  </batch:step>
</batch:job>

<batch:step id="readWriteContactsPartitionedStep">
  <batch:tasklet>
    <batch:chunk reader="reader" writer="writer" commit-interval="10" />
  </batch:tasklet>
</batch:step>
```

Going further...

- Spring Integration partition handler implementation
- Other scaling approaches
  - parallel steps, remote chunking, multi-threaded step)

- Problem: downloading files from a FTP server and processing them with Spring Batch
- Solution: use Spring Integration to poll the FTP server and trigger Spring Batch accordingly

Using Spring Integration for transfer and triggering



The launching code

```
public class FileContactJobLauncher {

  public void launch(File file) throws Exception {
      JobExecution exec = jobLauncher.run(
        job,
        new JobParametersBuilder()
          .addString("input.file", "file:"+file.getAbsolutePath())
          .toJobParameters()
      );
  }

}
```

- The `File` is the local copy

Listening to the FTP server

```
<int:channel id="fileIn" />

<int-ftp:inbound-channel-adapter local-directory="file:./input"
    channel="fileIn" session-factory="ftpClientFactory"
    remote-directory="/" auto-create-local-directory="true">
  <int:poller fixed-rate="1000" />
</int-ftp:inbound-channel-adapter>

<bean id="ftpClientFactory"
      class="com.zenika.workshop.springbatch.integration.DefaultFtpSessionFactory">
  <property name="host" value="localhost"/>
  <property name="port" value="2222"/>
  <property name="username" value="admin"/>
  <property name="password" value="admin"/>
</bean>
```

Calling the launcher on an inbound message

```
<int:channel id="fileIn" />

<int:service-activator input-channel="fileIn">
  <bean
     class="com.zenika.workshop.springbatch.integration.FileContactJobLauncher">
    <property name="job" ref="fileDroppingLaunchingJob" />
    <property name="jobLauncher" ref="jobLauncher" />
  </bean>
</int:service-activator>
```

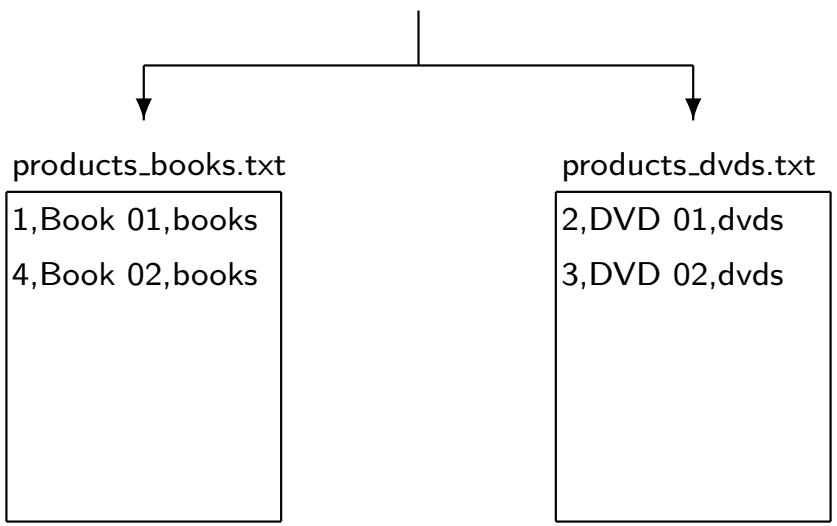
Going further...

- Checking Spring Integration connectors
  - Local file system, FTPS, SFTP, HTTP, JMS, etc.
- Checking operations on messages
  - Filtering, transforming, routing, etc.

- Problem: I want to export items from different categories from a database to files
- Solution: provide a partition strategy and use partitioning

The use case

ID	name	category
1	Book 01	books
2	DVD 01	dvds
3	DVD 02	dvds
4	Book 02	books



Partitioning based on categories

- 2 partitions in this case

ID	name	category
1	Book 01	books
2	DVD 01	dvds
3	DVD 02	dvds
4	Book 02	books

Partitioning logic with the `Partitioner` interface

```
public class ProductCategoryPartitioner implements Partitioner {
  (...)

  @Override
  public Map<String, ExecutionContext> partition(int gridSize) {
    List<String> categories = jdbcTemplate.queryForList(
      "select distinct(category) from product",
      String.class
    );
    Map<String, ExecutionContext> results =
      new LinkedHashMap<String, ExecutionContext>();
    for(String category : categories) {
      ExecutionContext context = new ExecutionContext();
      context.put("category", category);
      results.put("partition."+category, context);
    }
    return results;
  }
}
```

Components can refer to partition parameters

- They need to use the step scope

```
<bean id="reader"
      class="org.springframework.batch.item.database.JdbcCursorItemReader"
      scope="step">
  <property name="sql"
            value="select id,name,category from product where category = ?" />
  <property name="preparedStatementSetter">
    <bean class="org.springframework.jdbc.core.ArgPreparedStatementSetter">
      <constructor-arg value="#{stepExecutionContext['category']}]" />
    </bean>
  </property>
</bean>

<bean id="writer"
      class="org.springframework.batch.item.file.FlatFileItemWriter"
      scope="step">
  <property name="resource"
     value="file:./target/products_#{stepExecutionContext['category']}.txt" />

  (...)
</bean>
```

Configure the partitioned step

- The default implementation is multi-threaded

```
<batch:job id="databaseReadingPartitioningJob">
  <batch:step id="partitionedStep" >
    <batch:partition step="readWriteProductsPartitionedStep"
                     partitioner="partitioner">
      <batch:handler task-executor="taskExecutor" />
    </batch:partition>
  </batch:step>
</batch:job>

<batch:step id="readWriteProductsPartitionedStep">
  <batch:tasklet>
    <batch:chunk reader="reader" writer="writer" commit-interval="10" />
  </batch:tasklet>
</batch:step>
```

Going further...

- Check existing partitioner implementations
- Check other partition handler implementations
- Check other scaling strategies