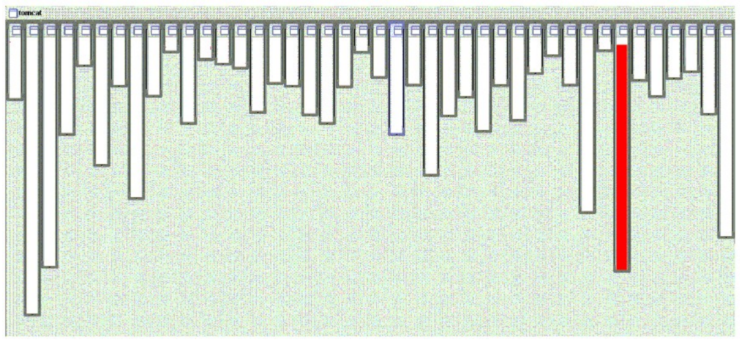
JAVA

Aspects (AOP)
AspectJ

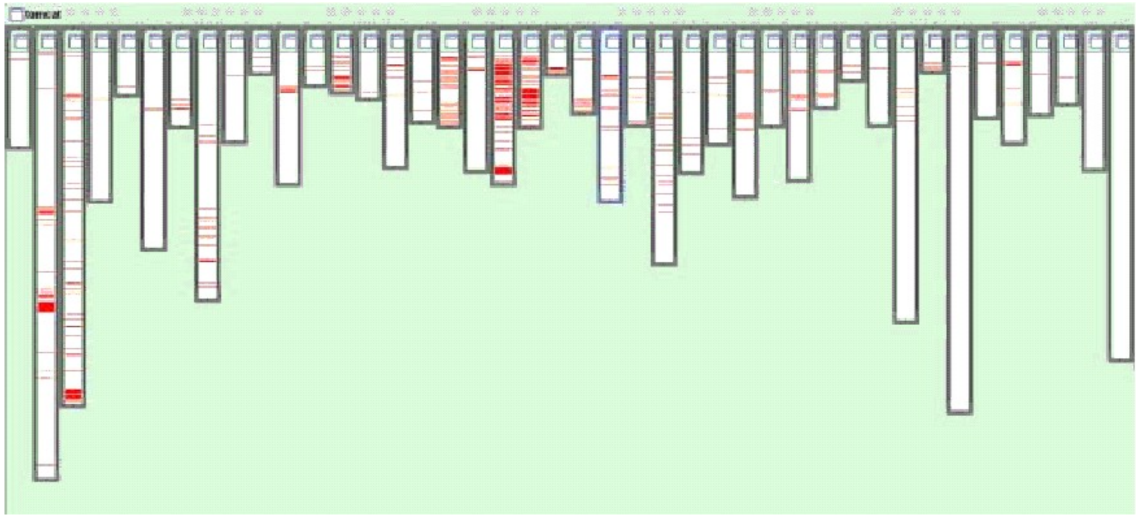
AOP

- Aspect-oriented programming
- „separation of concerns“
  - concern ~ a part of program code related to a particular functionality
- typically understood as an extension of OOP
- solves the problem that it is not always possible to put a code for a single functionality to a single (or several) classes
  - contrary, code is through the all application

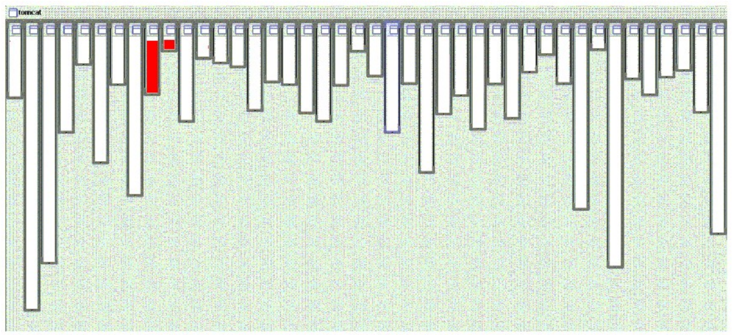
Application modularity



XML parsing in Tomcat



logging



URL manipulating in Tomcat

AspectJ

- http://www.eclipse.org/aspectj/
- a Java extension
  - 1 concept – **joinpoint**
    - a place in a program for adding code
  - several constructs
    - **pointcut**
      - definition of joinpoint(s)
    - **advice**
      - code to be added
    - **inter-type declaration**
      - extending a class declaration
    - **aspect**
      - a “class” that can contain the above mentioned constructs

Pointcut

- call(void Point.setX(int))
- call(void Point.setX(int)) ||
  call(void Point.setY(int))
- call(void FigureElement.setXY(int,int)) ||
  call(void Point.setX(int)) || call(void Point.setY(int)) ||
  call(void Line.setP1(Point)) ||
  call(void Line.setP2(Point))
- pointcut move():
  call(void FigureElement.setXY(int,int)) ||
  call(void Point.setX(int)) || call(void Point.setY(int)) ||
  call(void Line.setP1(Point)) ||
  call(void Line.setP2(Point));
- call(public * Figure.* (..))

Advice

-
  ```
  before(): move() {
      System.out.println("about to move");
  }
  ```

-
  ```
  after() returning: move() {
      System.out.println("just successfully moved");
  }
  ```

Inter-type declaration

- aspect PointObserving {
    private Vector Point.observers = new Vector();
    ...
  }

Aspect

```
aspect PointObserving {
    private Vector Point.observers = new Vector();
    public static void addObserver(Point p, Screen s) {
        p.observers.add(s);
    }
    public static void removeObserver(Point p, Screen s) {
        p.observers.remove(s);
    }
    pointcut changes(Point p): target(p) && call(void Point.set*(int));
    after(Point p): changes(p) {
        Iterator iter = p.observers.iterator();
        while ( iter.hasNext() ) {
            updateObserver(p, (Screen)iter.next());
        }
    }

    static void updateObserver(Point p, Screen s) {
        s.display(p);
    }
}
```

Aspect

-
  ```
  aspect SimpleTracing {
      pointcut tracedCall():
          call(void FigureElement.draw(GraphicsContext));

      before(): tracedCall() {
          System.out.println("Entering: " + thisJoinPoint);
      }
  }
  ```

-
  ```
  aspect SetsInRotateCounting {
      int rotateCount = 0;
      int setCount = 0;

      before(): call(void Line.rotate(double)) {
          rotateCount++;
      }

      before(): call(void Point.set*(int))
              && cflow(call(void Line.rotate(double))) {
          setCount++;
      }
  }
  ```

AspectJ

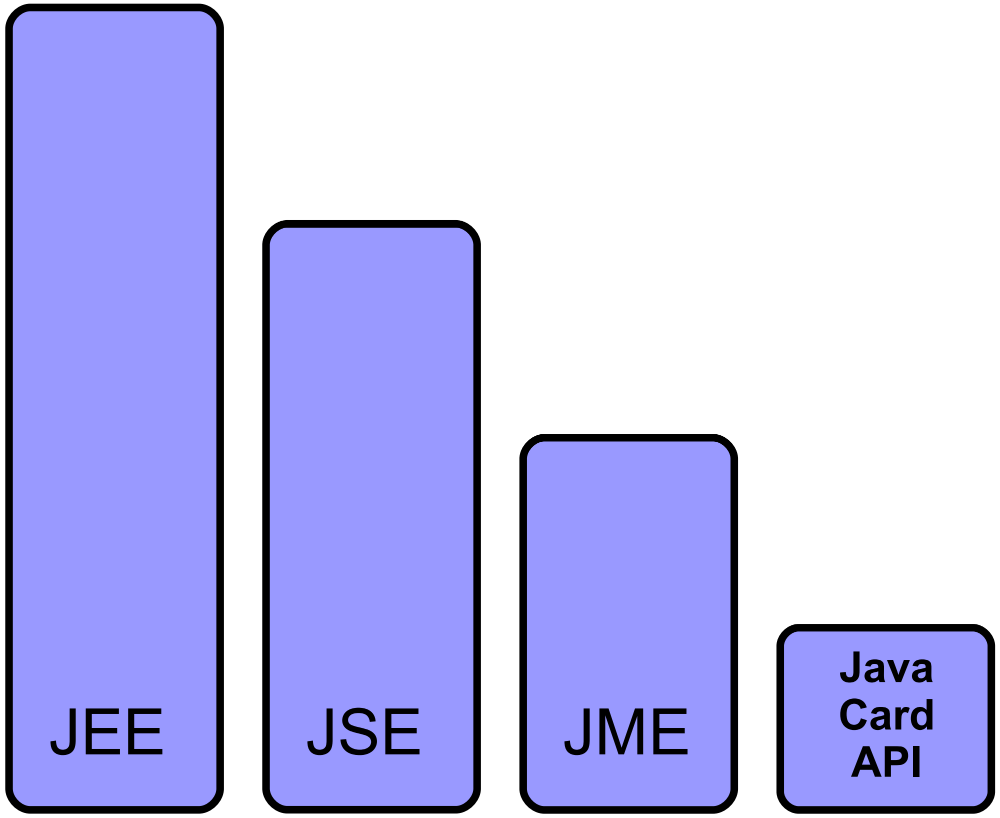
- aspects can be defined directly in Java
  - via annotations

```
@Aspect
public class Foo {

  @Pointcut("call(* *.*(..))")
  void anyCall() {}

  @Before("call(* org.aspectprogrammer..*(..))
                                  && this(Foo)")
  public void callFromFoo() {
  }

}
```

JAVA

JEE
Java Enterprise Edition

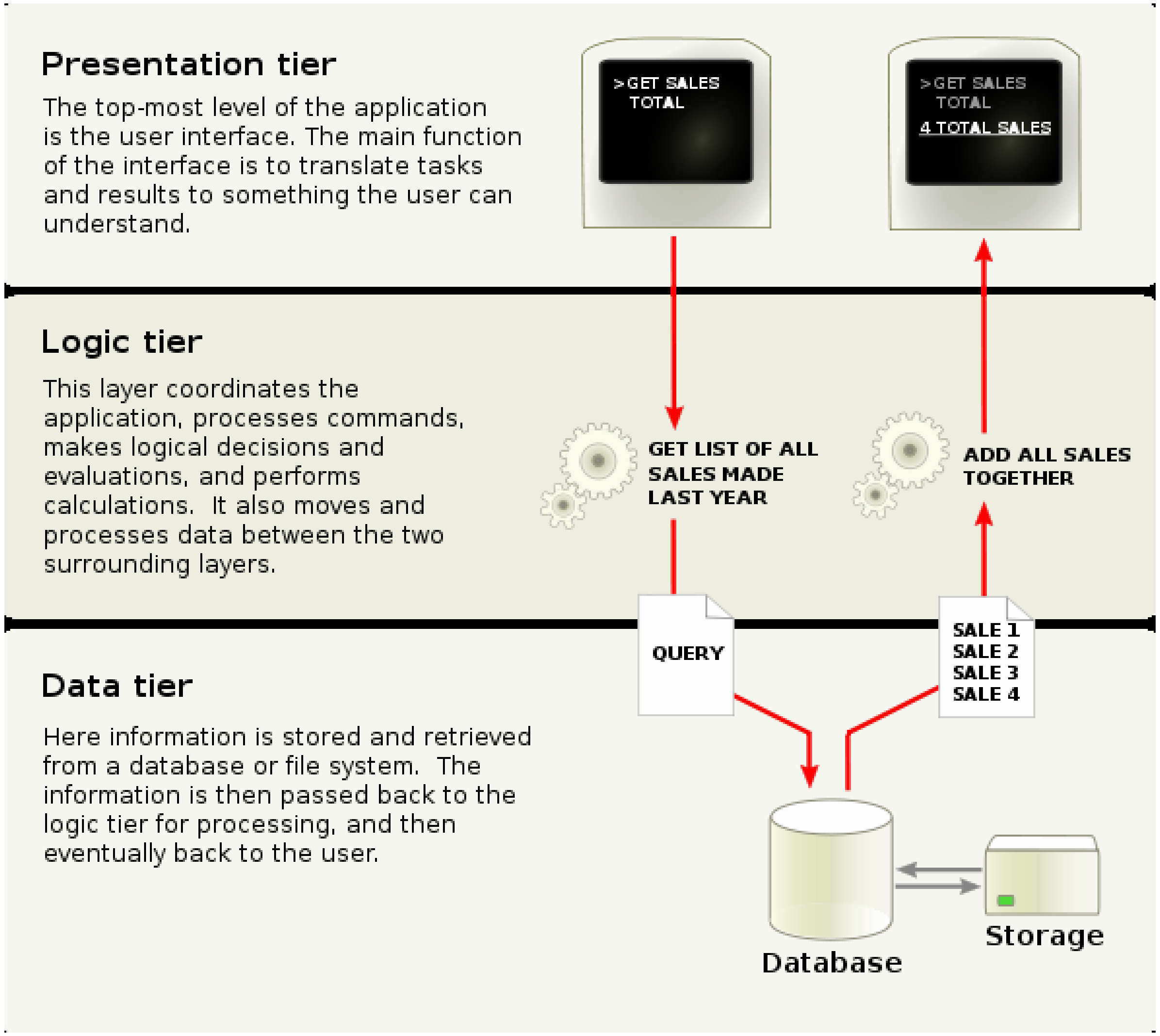
Overview



“Enterprise” applications

- “big enterprise” applications
- required features
  - re-usability
  - loosely coupled
  - transactions
  - declarative interface
  - persistence
  - security
  - distributed applications
  - ...

3-tier architecture



Presentation tier

The top-most level of the application is the user interface. The main function of the interface is to translate tasks and results to something the user can understand.

Logic tier

This layer coordinates the application, processes commands, makes logical decisions and evaluations, and performs calculations. It also moves and processes data between the two surrounding layers.

Data tier

Here information is stored and retrieved from a database or file system. The information is then passed back to the logic tier for processing, and then eventually back to the user.

image source: http://en.wikipedia.org/wiki/File:Overview_of_a_three-tier_application_vectorVersion.svg

JAVA

EJB
(first, briefly EJB 2, i.e. old EJB)

Overview

- Enterprise Java Beans
- components
- runs in a server
  - an EJB container
- local and remote access
- the container offers many services
  - persistence
  - security
  - transactions
  - scalability
  - concurrency

EJB

- kinds of beans
  - session beans – implement business logic (logic tier), not persistent
    - stateless – no state kept
    - statefull – a state is kept
  - message-driven beans
    - implements prescribed interface
      - MessageListener – onMessage()
  - entity beans – persistent data
    - persistence
      - container managed
      - bean managed
- deployment descriptor
- EAR

EJB

- many issues
  - necessity to create several interfaces and classes
    - classes had to have the same methods but had not implement the interfaces
    - EJB container "ties" the interface and implementation
      - generates stubs and skeletons
  - necessity to creates multiple descriptors
  - ...

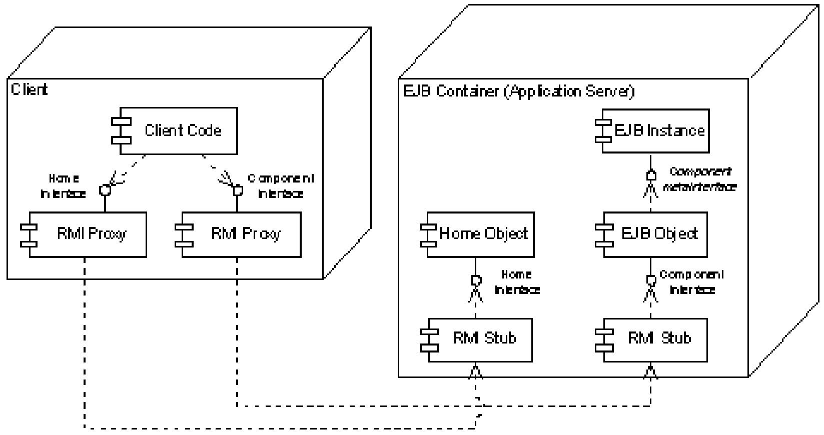


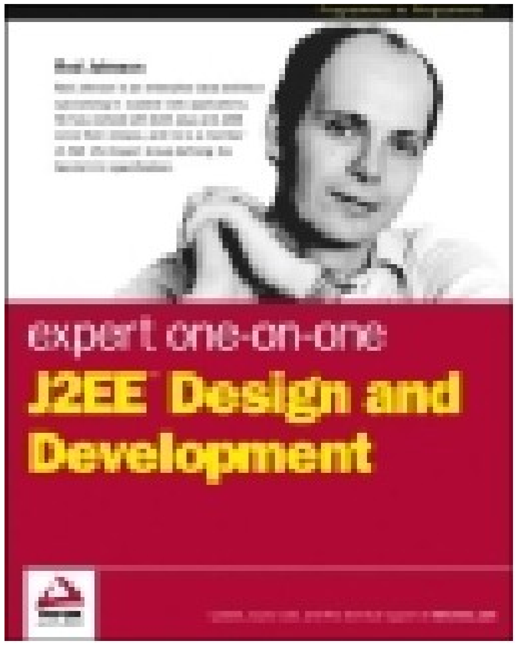
image source: B.Eckel: Thinking in Enterprise Java

JAVA

Spring

Overview

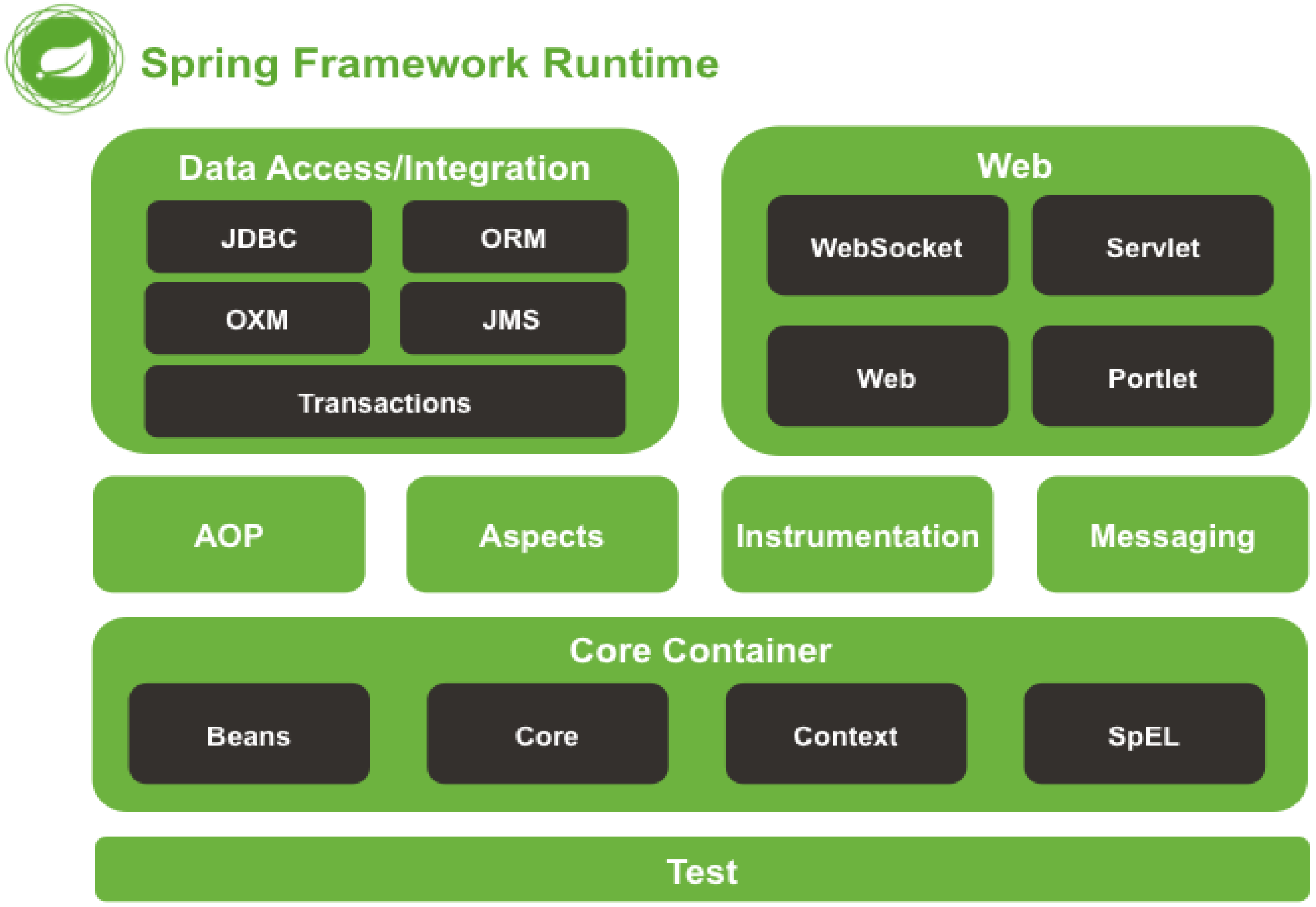
- 2002
- critique of EJB
  - to complex
  - hard to be used
  - hard to be tested
  - RemoteException everywhere
  - …
- Rod Johnson: Expert One-on-One J2EE Design and Development
  - critique of EJB +
    proposal of a better architecture
    - Spring foundations



Overview

- Spring
  - http://www.spring.io/
  - based on POJO
    - plain old Java objects
    - but can be integrated with EJB
  - “lightweight” solution
    - the smallest possible dependency of application code on Spring
    - no server necessary
      - suitable for any type of application
  - effort for integration with other frameworks
    - not to “reinvent the wheel”
    - to use proven existing solutions

Architecture



Spring core

- the org.springframework.beans package
- an “inversion of control” container
  - Dependency Injection
  - Hollywood Principle: "Don't call me, I'll call you."

- objects are not interconnected in code but in a configuration file
- an object is not responsible for searching its dependencies
- dependencies are declared
  - a container “provides” them – sets them via setters
    - common naming conventions setXxx()
    - or via parameters of constructors
- no special requirements on objects

Spring core

- objects created via a “factory”
  - the interface org.springframework.beans.factory.BeanFactory
  - the most used factories
    - DefaultListableBeanFactory

Spring core – example

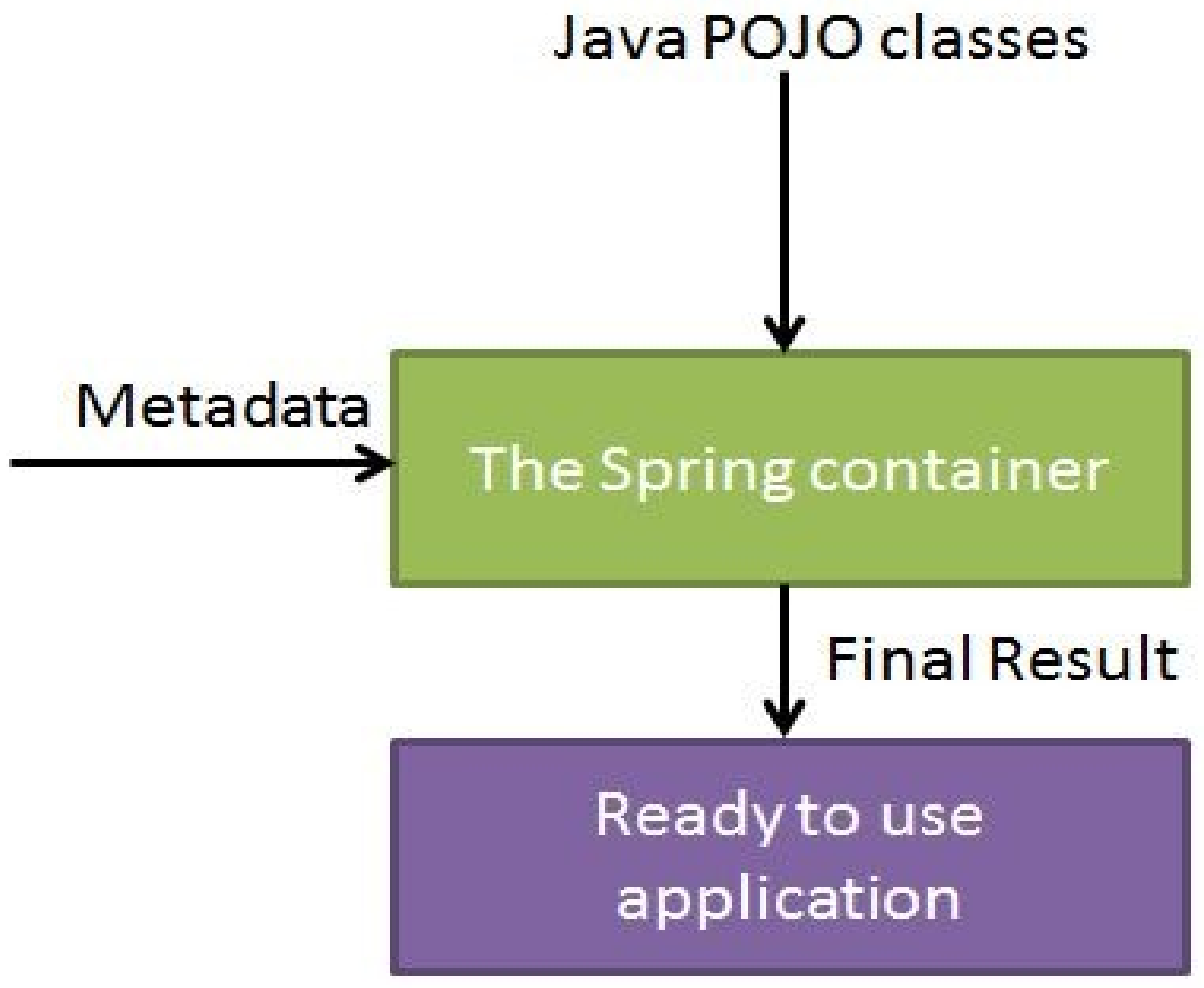
```
public class nameBean {
    String name;

    public void setName(String a) {
        name = a;
    }

    public String getName() {
        return name;
    }
}
```

```
<bean id="bean1" class="nameBean">
   <property name="name" >
       <value>Tom</value>
   </property>
</bean>
```

- interconnecting objects

```
<bean id="bean" class="beanImpl">
   <property name="conn">
       <ref bean="bean2"/>
   </property>
</bean>

<bean id="bean2" class="bean2impl"/>
```

Spring core


Java POJO classes
Metadata
The Spring container
Final Result
Ready to use application

Spring and data tier

- anything can be used
  - JDBC
  - ORM
    - Hibernate
    - ...
- can be used separately
  - simplified DB usage
  - unified exceptions
  - ...

Spring and data tier

-
  ```
  JdbcTemplate template = new JdbcTemplate(dataSource);
  List names = template.query("SELECT USER.NAME FROM USER",
    new RowMapper() {
      public Object mapRow(ResultSet rs, int rowNum) throws SQLException {
        return rs.getString(1);
      }
   });
  ```

-
  ```
  int youngUserCount = template.queryForInt("SELECT COUNT(0) FROM USER WHERE
  USER.AGE < ?", new Object[] { new Integer(25) });
  ```

-
  ```
  class UserQuery extends MappingSqlQuery {
     public UserQuery(DataSource datasource) {
       super(datasource, "SELECT * FROM PUB_USER_ADDRESS
              WHERE USER_ID = ?");
       declareParameter(new SqlParameter(Types.NUMERIC));
       compile();
     }
    protected Object mapRow(ResultSet rs, int rownum) throws SQLException{
       User user = new User();
       user.setId(rs.getLong("USER_ID"));  user.setForename(rs.getString("FORENAME"));
       return user; }
    public User findUser(long id) { return (User) findObject(id); }
  }
  User user = userQuery.findUser(25);
  ```

Spring AOP

- implemented in plain Java
  - can be integrate with AspectJ
- intended for functionality for which aspects are ideal
  - originally for adding JEE services to Spring

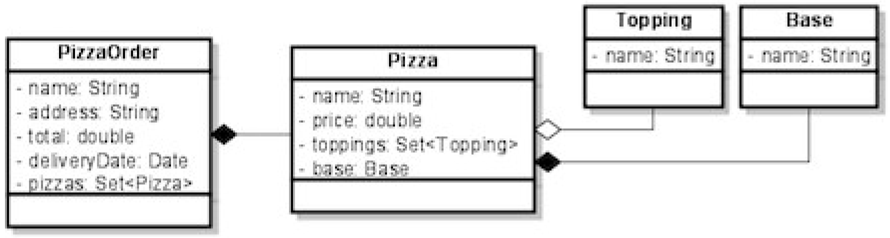
  - transactions
  - logging
  - ...

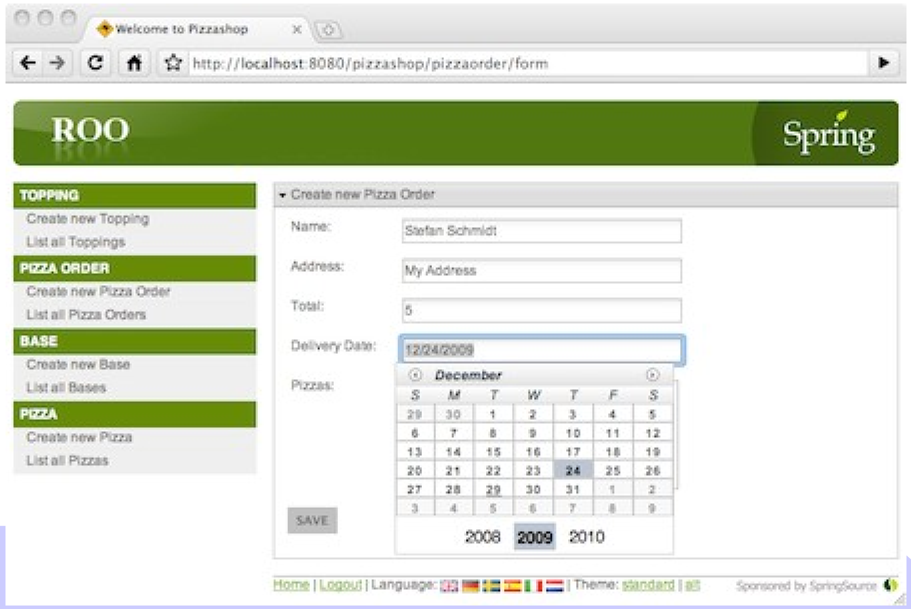
Other Spring parts

- Spring MVC
  - a web MVC framework
  - inspired by the Struts framework
  - does not prescribe what should be used for generating pages
    - JSP
    - template systems (Velocity,...)
    - ...
- EJB
  - instead of POJO, EJBs can be used
- ...

Spring Roo

- framework easy generation of enterprise applications
  - roughly
    creation of an application using a “wizard” in several steps




Welcome to Pizzashop

http://localhost:8080/pizzashop/pizzaorder/form

Create new Pizza Order

Name: Stefan Schmidt

Address: My Address

Total: 5

Delivery Date: 12/24/2009

Pizzas:

December
2008 2009 2010
SAVE
Home | Logout | Language: | Theme: standard | alt
Sponsored by SpringSource

JAVA

EJB 3

Overview

- inspired by Spring
- instead of implementing interfaces, annotations are used
- using “dependency injection”
- no need to use descriptors
- …
- entity beans replaced by Java Persistence API
  - “mapping” classes to tables in relational database
  - JPQL query language
    - “SQL over objects”

Session bean – example

```
@Remote
public interface Converter {
  public BigDecimal dollarToYen(BigDecimal dollars);
}

@Stateless
public class ConverterBean implements converter.ejb.Converter {
  private BigDecimal euroRate = new BigDecimal("0.0070");

  public BigDecimal dollarToYen(BigDecimal dollars) {
    BigDecimal result = dollars.multiply(yenRate);
    return result.setScale(2, BigDecimal.ROUND_UP);
  }
}
```

Message-driven bean – example

```
@MessageDriven(mappedName="MDBQueue")
public class MDB implements MessageListener {
  public void onMessage(Message msg) {
    System.out.println("Got message!");
  }
}
```

Entity – example

```
@Entity
@Table(name = "phonebook")
public class PhoneBook implements Serializable {
  @Column(name="number") private String number;
  @Column(name="name") private String name;

  public PhoneBook() {}

  public PhoneBook(String name, String number) {
    this.name = name;
    this.number = number;
  }

  @Id public String getName() { return name; }
  public void setName(String name) { this.name = name; }
  public String getNumber() { return number; }
  public void setNumber(String number) { this.number = number; }
}
```

JPQL

- inspired by HQL
  - a subset of HQL

- SELECT ... FROM ...
  [WHERE ...]
  [GROUP BY ... [HAVING ...]]
  [ORDER BY …]
- DELETE FROM ... [WHERE ...]
- UPDATE ... SET ... [WHERE …]

- SELECT a FROM Author a ORDER BY a.firstName, a.lastName
- SELECT DISTINCT a FROM Author a INNER JOIN a.books b WHERE b.publisher.name = 'MatfyzPress'

Hibernate

Architecture

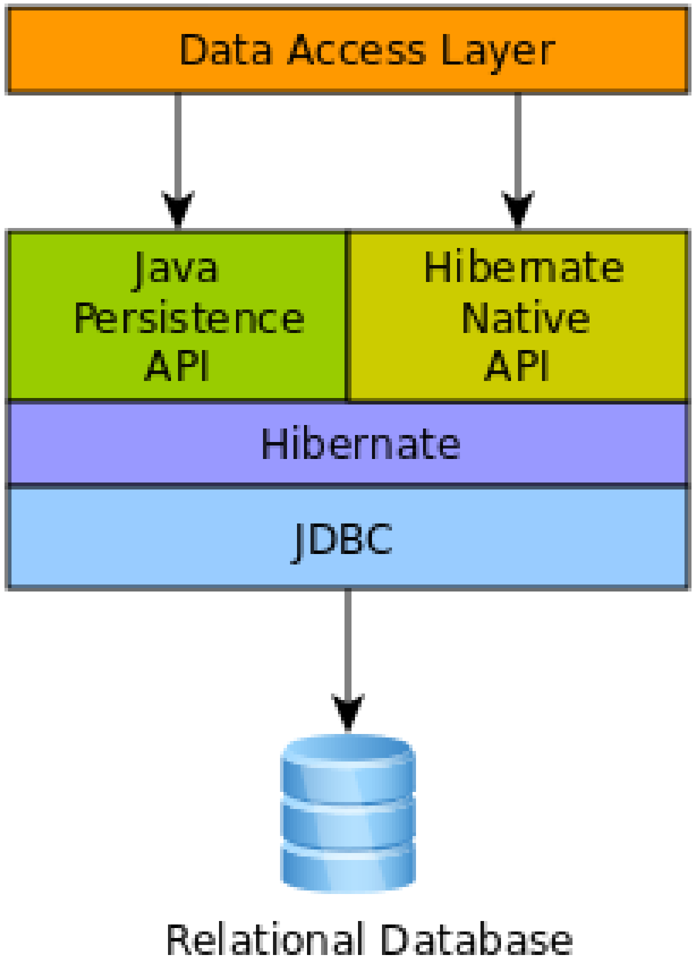


image source: http://docs.jboss.org/hibernate/orm/5.4/userguide/html_single/Hibernate_User_Guide.html

Core API

- Session
  - interconnection between DB and application
  - keeps inside a connection to DB
    - a JDBC connection
  - manages objects
    - contains a cache of objects
- SessionFactory
  - a session creator
  - contains mapping between objects and DB
  - can containa a cache of objects
- persistent objects
  - POJOs
  - should follow JavaBeans rules
    - but it is not necessary

Usage

- roughly
  - creating a configuration
    - XML
  - creating classes
    - Java
  - creating a mapping
    - XML, or
    - Java annotations

Configuration

- an XML file
- defines
  - a DB connection
  - a type of DB (dialect)
  - a mapping reference
  - ...

```
<hibernate-configuration>
    <session-factory>
        <property name="connection.driver_class">org.h2.Driver</property>
        <property name="connection.url">jdbc:h2:mem:db1;DB_CLOSE_DELAY=-1;MVCC=TRUE</property>
        <property name="connection.username">sa</property>
        <property name="connection.password"/>

        <property name="connection.pool_size">1</property>

        <property name="dialect">org.hibernate.dialect.H2Dialect</property>

        <property name="cache.provider_class">org.hibernate.cache.NoCacheProvider</property>

        <property name="show_sql">true</property>

        <property name="hbm2ddl.auto">create</property>

        <mapping resource="org/hibernate/tutorial/hbm/Event.hbm.xml"/>
    </session-factory>
</hibernate-configuration>
```

Classes for persistent data

- POJO
- should follow JavaBeans rules for naming
  - it is not necessary
- a constructor without parameters is necessary
  - its visibility is not important

```
public class Event {
  private Long id;
  private String title;
  private Date date;

  public Event() {}

  public Event(String title, Date date) {
    this.title = title;
    this.date = date;
  }

  public Long getId() { return id; }
  private void setId(Long id) {  this.id = id;  }

  public Date getDate() {  return date;  }
  public void setDate(Date date) {  this.date = date;  }

  public String getTitle() {  return title;  }
  public void setTitle(String title) {  this.title = title; }
}
```

Mapping

- an XML file
- mapping class attributes and columns
- defines
  - name
  - type
    - not necessary if it is “obvious”
    - Hibernate types
      - nor Java nor SQL types
      - they are “converters” between Java and SQL types
  - column
    - not necessary if it is the same as the name

```
<hibernate-mapping package="org.hibernate.tutorial.hbm">
    <class name="Event" table="EVENTS">
        <id name="id" column="EVENT_ID">
            <generator class="increment"/>
        </id>
        <property name="date" type="timestamp" column="EVENT_DATE"/>
        <property name="title"/>
    </class>
</hibernate-mapping>
```

Mapping

```
@Entity
@Table( name = "EVENTS" )
public class Event {
  private Long id;
  private String title;
  private Date date;

  public Event() { }

  public Event(String title, Date date) {
    this.title = title;
    this.date = date;
  }

  @Id
  @GeneratedValue(generator="increment")
  @GenericGenerator(name="increment", strategy = "increment")
  public Long getId() {  return id;  }

  private void setId(Long id) {  this.id = id; }

  @Temporal(TemporalType.TIMESTAMP)
  @Column(name = "EVENT_DATE")
  public Date getDate() { return date; }

  public void setDate(Date date) {  this.date = date; }

  public String getTitle() { return title; }
  public void setTitle(String title) { this.title = title; }
}
```

- mapping can be defined using annotations
- in the configuration, the class is referenced

Usage

-
  ```
  SessionFactory sessionFactory =
          new Configuration().configure().buildSessionFactory();
  ```

-
  ```
  Session session = sessionFactory.openSession();
  session.beginTransaction();
  session.save(new Event("Our very first event!", new Date()));
  session.save(new Event("A follow up event", new Date()));
  session.getTransaction().commit();
  session.close();
  ```

-
  ```
  List result = session.createQuery( "from Event" ).list();
  ```

States of objects

- Transient
  - created object (new)
  - not yet associated with a Hibernate session
- Persistent
  - the object is associated with a session
    - created and then saved or loaded
- Detached
  - a persistent object but its session was terminated
  - can be associated with a new session

Using objects

- loading
  - sess.load(Event.class, new Long(id));
    - an exception is thrown if the object does not exist
    - may not immediately access DB
  - sess.get(Event.class, new Long(id));
    - returns null if the object does not exist
- querying
  - sess.createQuery(...).list()
- changing objects
  - Event e = sess.load(Event.class, new Long(69));
    e.set...
    sess.flush();

Using objects

- modifying detached objects
  - Event e = sess.load(Event.class, new Long(69));
    e.set...
    ...
    secondSess.update(e);
- deleting objects
  - sess.delete(e);

Querying

- HQL – Hibernate query language
  - similar to SQL

```
select foo
from Foo foo, Bar bar
where foo.startDate = bar.date
```

- native SQL can be used too

```
sess.createSQLQuery("SELECT * FROM CATS").list();
```

Hibernate...

- other parts
  - creating classes from tables
  - support for full-text searching
  - object versioning
  - object validation
  - support of JPA (Java Persistence API)
  - ...