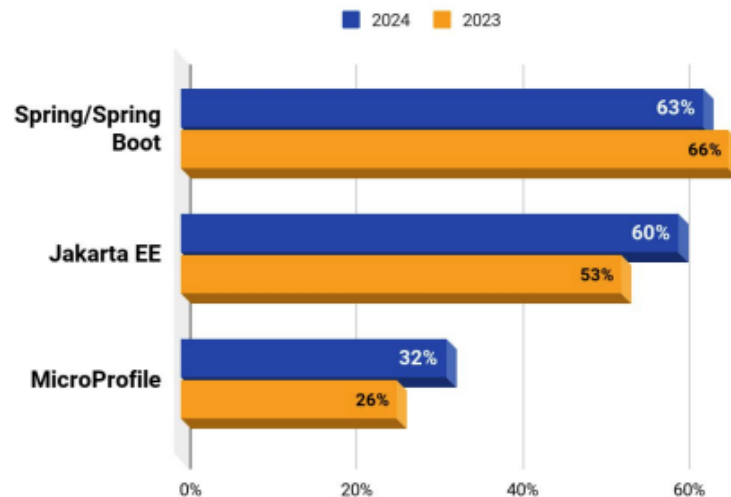


# 1 Business Logic

## Spring and Jakarta EE

### 2024 Jakarta EE Developer Survey Report



#### Spring Framework Highlights

pros

**Dependency Injection**

**Convention over Configuration**

**Many Components** for desktop/web/enterprise application development

**Modular** , i.e., individual Spring components can be used and combined with other frameworks

**Open-Source, POJO-Based**

cons

**Not part of the Jakarta EE stack**

#### Examples

Examples from this lecture can be found at <https://gitlab.fel.cvut.cz/ear/spring-example>.

## Spring and EJB

- Both technologies provide enterprise container with DI, IoC, transactions and other relevant features
- EJB is a part of Jakarta EE stack, it is a standard, supporting high-availability, clustering
- Spring is a feature-rich alternative to EJB with many extensions cf. EJB, e.g. @Configurable
- A comparison is at <https://dzone.com/articles/spring-boot-or-jakarta-ee-whats-better>

## 2 Dependency Injection

### Dependency Injection Reminder

```
package cz.cvut.kbss.ear.spring_example;
import ...

public class SchoolInformationSystem {

    private CourseRepository repository
        = new InMemoryCourseRepository();

    public static void main(String[] args) {
        SchoolInformationSystem main = new SchoolInformationSystem();
        System.out.println(main.repository.getName());
    }
}
```

The client code (SchoolInformationSystem) itself decides which repository implementation to use

- change in **implementation** requires *client code* change.
- change in **configuration** requires *client code* change.

### DI using XML

SchoolInformationSystem.java

```
package cz.cvut.kbss.ear.spring_example;
import ...

public class SchoolInformationSystem {
    private CourseRepository repository;
}
```

CourseRepository.java

```
package cz.cvut.kbss.ear.spring_example;
public interface CourseRepository {
    public String getName() { return name; }
}
```

InMemoryCourseRepository.java

```
package cz.cvut.kbss.ear.spring_example;
import ...

public class InMemoryCourseRepository implements CourseRepository {
    public String getName() { return "In-memory course repository"; }
}
```

application-config.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<beans ...>
    <bean id="SchoolInformationSystem"
        class="cz.cvut.kbss.ear.spring_example.SchoolInformationSystem"
        scope="singleton">
        <property name="repository" ref="CourseRepository"/>
    </bean>
    <bean id="CourseRepository"
        class="cz.cvut.kbss.ear.spring_example.InMemoryCourseRepository">
    </bean>
</beans>
```

## DI using Annotations

SchoolInformationSystem.java

```
package cz.cvut.kbss.ear.spring_example;
import ...

@Component
public class SchoolInformationSystem {
    @Autowired
    private CourseRepository repository;
}
```

CourseRepository.java

```
package cz.cvut.kbss.ear.spring_example;
public interface CourseRepository {
    public String getName() { return name; }
}
```

InMemoryCourseRepository.java

```
package cz.cvut.kbss.ear.spring_example;
import ...

@Component
public class InMemoryCourseRepository implements CourseRepository {
    public String getName() { return "In-memory course repository"; }
}
```

## Dependency Injection (DI) and Inversion of Control (IoC)

### Dependency Injection

Component lifecycle is controlled by the *container* which is responsible for delivering correct implementation of the given bean.

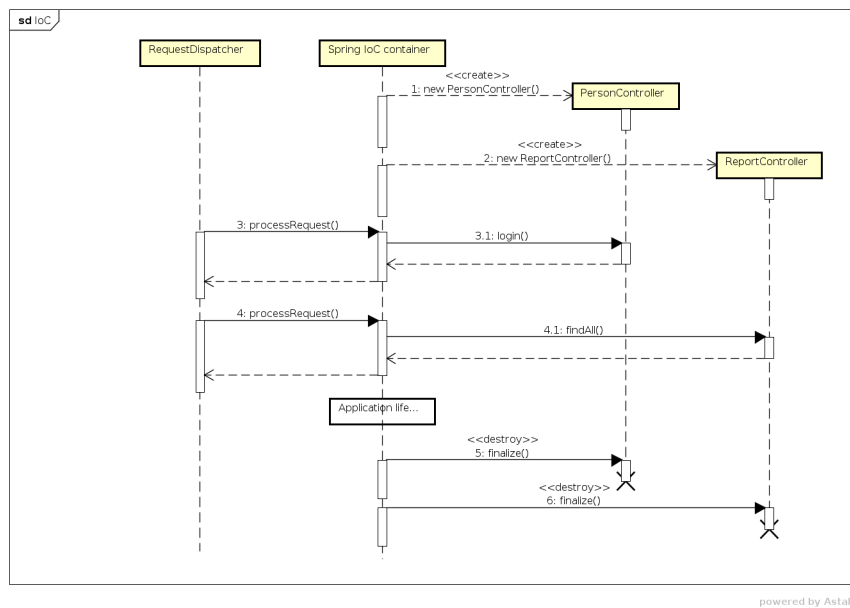
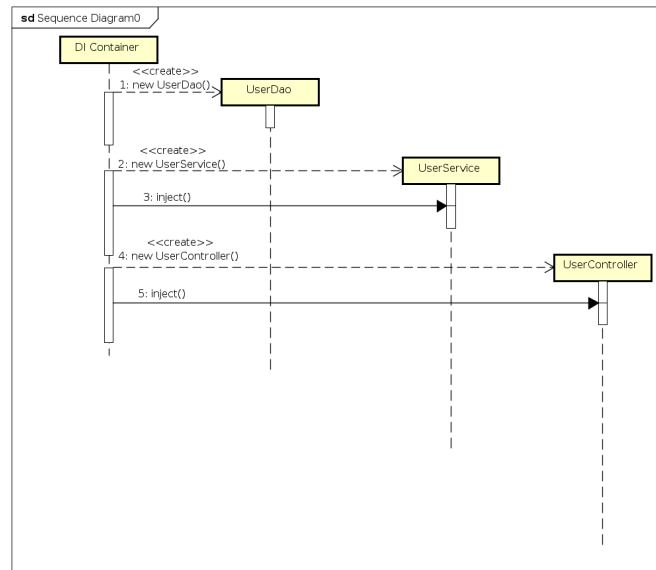
### Inversion of Control

The programmed application is a “library” for the generic framework that controls the application lifecycle.

### Hollywood Principle

*Don't call us, we'll call you.*

### Dependency Injection



## Inversion of Control

### Related Dependency Technologies

#### Dependency Injection for Java (JSR 330)

- Dependency mechanism
  - (partially) implemented in Spring
- ∈ Jakarta EE Web Profile

#### Context Dependency Injection (CDI) (JSR 299)

- Definition of bean scopes
  - Not implemented in Spring
- ∈ Jakarta EE Web Profile

### DI with JSR 330 annotations and bean disambiguation

#### JSR 330: Dependency Injection for Java

is a part of Jakarta EE Web Profile. Spring supports JSR 330 annotations.

SchoolInformationSystem.java

```
package cz.cvut.kbss.ear.spring_example;
import ...

@Named
public class SchoolInformationSystem {
    @Inject
    private CourseRepository repository;

    ...
}
```

CourseRepository.java

```
package cz.cvut.kbss.ear.spring_example;
public interface CourseRepository {
    public String getName() { return name; }
}
```

InMemoryCourseRepository.java

```
package cz.cvut.kbss.ear.spring_example;
import ...

@Named
public class InMemoryCourseRepository implements CourseRepository {
    public String getName() { return "In-memory course repository"; }
}
```

AnotherInMemoryCourseRepository.java

```
package cz.cvut.kbss.ear.spring_example;
import ...

@Named("repository")
public class AnotherInMemoryCourseRepository implements CourseRepository {
    public String getName() { return "Another In-memory course repository"; }
}
```

## Spring Bean Scopes

**singleton** a single bean instance per Spring IoC container

**prototype** a new bean instance each time when requested

**request** a single bean instance per HTTP request

**session** a single bean instance per HTTP session

**globalSession** a single bean instance per global HTTP session

### global HTTP session

A session shared accross multiple portlets in a portlet application.

Spring allows custom scope definition (e.g. JSF 2 Flash scope)

## Spring Bean Scopes – Prototype

SchoolInformationSystem.java

```
package cz.cvut.kbss.ear.spring_example;
import ...

@Component
@Scope("singleton")
public class SchoolInformationSystem {
    @Autowired
    private CourseRepository repository;

    @Autowired
    private CourseRepository secondRepository;
    ...

    public static void main(String[] args) {
        ...
        // injected SchoolInformationSystem s;
        System.out.println(
            s.repository == s.secondRepository
        );
    }
}
```

CourseRepository.java

```
package cz.cvut.kbss.ear.spring_example;
public interface CourseRepository {
    public String getName() { return name; }
}
```

AnotherInMemoryCourseRepository.java

```
package cz.cvut.kbss.ear.spring_example;
import ...

@Component("repository")
@Scope("prototype")
public class AnotherInMemoryCourseRepository implements CourseRepository {
    public String getName() { return "Another In-memory course repository"; }
}
```

prints “false”

## Spring Bean Scopes – Singleton

SchoolInformationSystem.java

```
package cz.cvut.kbss.ear.spring_example;
import ...

@Component
@Scope("singleton")
public class SchoolInformationSystem {
    @Autowired
    private CourseRepository repository;

    @Autowired
    private CourseRepository secondRepository;
    ...

    public static void main(String[] args) {
        ...
        // injected SchoolInformationSystem s;
        System.out.println(
            s.repository == s.secondRepository
        );
    }
}
```

CourseRepository.java

```
package cz.cvut.kbss.ear.spring_example;
public interface CourseRepository {
    public String getName() { return name; }
}
```

AnotherInMemoryCourseRepository.java

```
package cz.cvut.kbss.ear.spring_example;
import ...

@Component("repository")
@Scope("singleton")
public class AnotherInMemoryCourseRepository implements CourseRepository {
    public String getName() { return "Another In-memory course repository"; }
}
```

prints “true”

## Dependency Injection Mechanisms

Constructor injection

```
package cz.cvut.kbss.ear.spring_example;
import ...

@Component
public class SchoolInformationSystem {

    private CourseRepository repository;

    @Autowired
    public SchoolInformationSystem(CourseRepository repository) {
        this.repository = repository;
    }
}
```

Field injection

```
package cz.cvut.kbss.ear.spring_example;
import ...

@Component
public class SchoolInformationSystem {

    @Autowired
    private CourseRepository repository;
}
```

Setter injection

```

package cz.cvut.kbss.ear.spring_example;
import ...

@Component
public class SchoolInformationSystem {

    private CourseRepository repository;

    @Autowired
    public void setRepository(CourseRepository repository) {
        this.repository = repository;
    }
}

```

## Dependency management for non-Spring objects

- Sometimes Spring cannot manage bean lifecycle, but needs to inject into it
  - Objects of other frameworks need not be ready for being managed by Spring
  - JPA entities – based on OO paradigm, objects should encapsulate both state and operations
- Annotation `@Configurable` denotes classes, objects of which are not managed by Spring, yet can inject Spring-managed objects
  - Byte-code instrumentation (aspect weaving)
    - \* Load-time weaving (java agent)
    - \* Compile-time weaving (aspect compiler)
  - Same mechanism used for declarative transactions (see later)

## `@Configurable` – Example

```

@Configurable
@Entity
public class User {

    @Column(length=40, nullable=false)
    private String password;

    @Column(length=40, nullable=false)
    private String salt;

    @Autowired
    private transient HashProvider provider;
    ...
    public void setPassword(String password) {
        this.password = provider.computeHash(
            password + salt + "/* long string */");
    }
}

```

## 3 Spring Container Features

### Declarative Transactions

```
@Component
public class UserService {

    @Autowired
    private UserDao userDao;

    @Transactional(readOnly=true)
    public List<UserDTO> findAll() {
        // implementation
    }

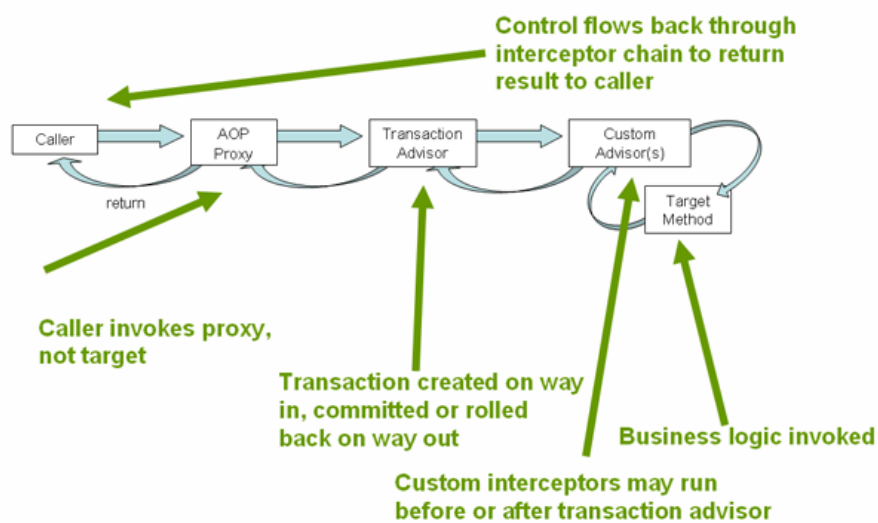
    @Transactional
    public UserDTO persist(UserDTO user, String password) {
        // implementation
    }

    @Transactional(readOnly=true)
    public UserDTO findByUsername(String name) {
        // implementation
    }

    // Other methods
}
```

- Transactions configurable through XML/annotations
- Global/local transactions
- Wraps multiple transaction APIs – JDBC, JTA, JPA, ...

### Transaction Flow



Source:

[docs.spring.io/spring-framework/docs/4.2.x/spring-framework-reference/html/transaction.html](https://docs.spring.io/spring-framework/docs/4.2.x/spring-framework-reference/html/transaction.html)

### Transaction Propagation

We can control, whether and how the transactional execution of the method should be supported

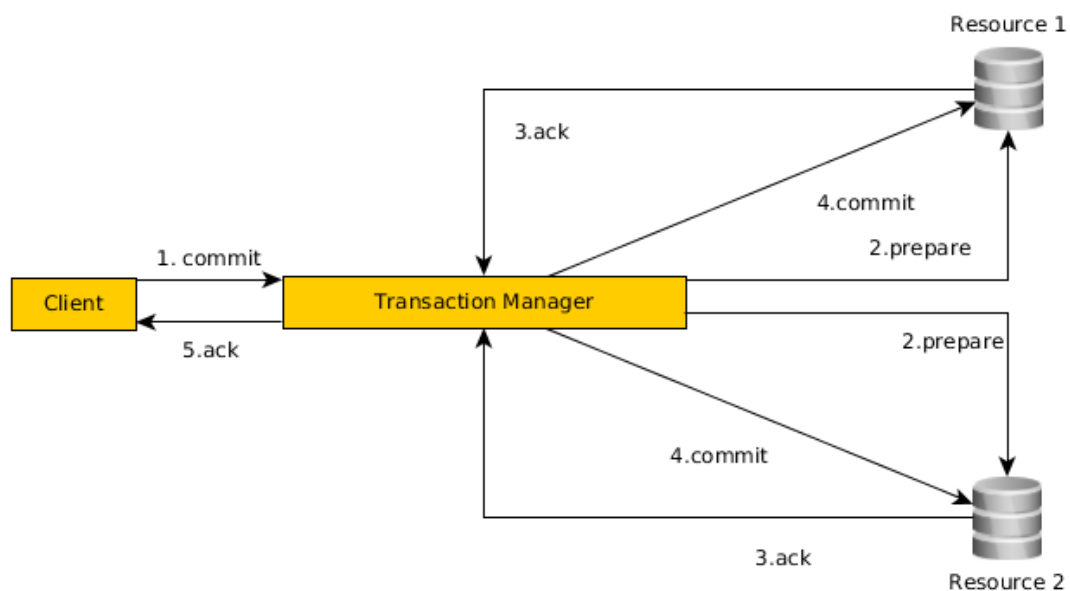
@Transactional(propagation=...

- MANDATORY
- NESTED
- NEVER
- NOT\_SUPPORTED
- REQUIRED – default
- REQUIRES\_NEW
- SUPPORTS

### Other Transaction Attributes

- isolation – transaction isolation level
- rollbackFor (and other similar) – which exception hierarchies cause rollback (RuntimeException and Error by default)
- readOnly – true/false – readonly transactions can be optimized in runtime
- timeout
- transactionManager

### Distributed Transactions



## Spring and Persistence

1. Use standard JPA configuration through `persistence.xml` and load it by Spring
  - Reuse of existing configuration
  - Two XML configuration types
2. Configure JPA using Spring
  - One type of XML configuration/annotations
  - One more dependency on Spring...

## JPA Configuration

```
@Configuration
@PropertySources({@PropertySource("classpath:jpa.properties"), @PropertySource("classpath:jdbc.properties")})
@ComponentScan(basePackages = "cz.cvut.kbss.ear.eshop.dao")
public class PersistenceConfig {
    @Autowired
    private final Environment environment;

    @Bean
    public DataSource dataSource() {
        final BoneCPDataSource ds = new BoneCPDataSource();
        ds.setDriverClass(environment.getRequiredProperty("jdbc.driverClassName"));
        ds.setJdbcUrl(environment.getRequiredProperty("jdbc.url"));
        ds.setUsername(environment.getRequiredProperty("jdbc.username"));
        ds.setPassword(environment.getRequiredProperty("jdbc.password"));
        return ds;
    }

    @Bean
    public LocalContainerEntityManagerFactoryBean entityManagerFactory(DataSource ds) {
        final LocalContainerEntityManagerFactoryBean emf = new LocalContainerEntityManagerFactoryBean();
        emf.setDataSource(ds);
        emf.setJpaVendorAdapter(new EclipseLinkJpaVendorAdapter());
        emf.setPackagesToScan("cz.cvut.kbss.ear.eshop.model");

        final Properties props = new Properties();
        props.setProperty("databasePlatform", environment.getRequiredProperty("jpa.platform"));
        emf.setJpaProperties(props);
        return emf;
    }

    @Bean(name = "txManager")
    JpaTransactionManager transactionManager(EntityManagerFactory entityManagerFactory) {
        JpaTransactionManager transactionManager = new JpaTransactionManager();
        transactionManager.setEntityManagerFactory(entityManagerFactory);
        return transactionManager;
    }
}
```

## Security

```
@Transactional
public class UserService {

    @Autowired
    private UserDao dao;

    @Secured("ROLE_ADMIN")
    public void persist(UserDto user, String password, Boolean isAdmin) {
        // Implementation
    }

    @Secured("ROLE_ADMIN")
    public void removeById(Long id) {
        // Implementation
    }
}
```

- Method access control using annotations
- More on this in weeks 7 and 10

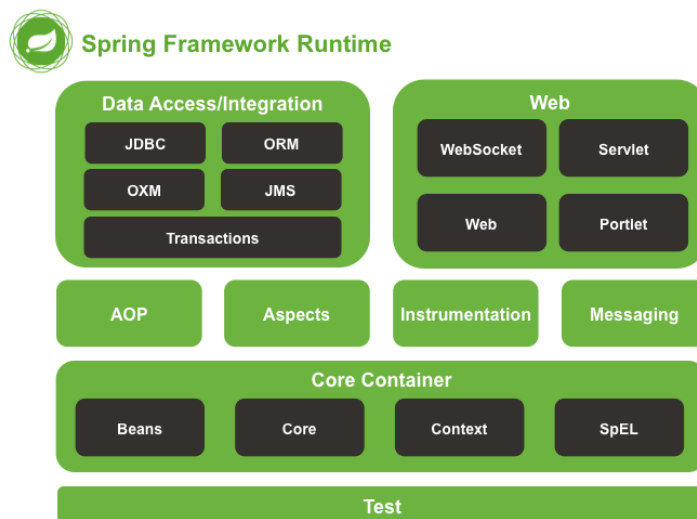
## 4 Spring 5

### Spring 5 Features

- Built on Java SE 8, Jakarta EE 7
- `@Nullable` and `@NotNull` – compile time validation of null values
- Kotlin support – functional programming (web endpoints/bean registration).
- Reactive programming – “async logic without callbacks” (WebFlux)

## 5 Spring Modules

### Spring Landscape



source: Spring documentation, [docs.spring.io/spring/docs/current/spring-framework-reference/html/overview.html](https://docs.spring.io/spring/docs/current/spring-framework-reference/html/overview.html)

### Selected Spring Modules

**Spring Core** framework core

**Spring ORM** JPA integration and ORM

**Spring MVC** MVC web framework, REST controllers

**Spring Test** testing support

**Spring Security** application security support

**Spring Data** access to data – paging, filtering, map-reduce

**Spring Integration** enterprise integration patterns – gateways, channels, adapters

**Spring Boot**

## 6 Spring Boot

### Spring Boot

- Spring module for rapid standalone application development
- Greatly simplifies configuration and deployment
- Taking convention over configuration to the next level
  - Composed annotations group common annotations
  - Sensible configuration defaults
  - Automatic classpath scan for beans
  - Package as jar for simple startup – embedded application server (Tomcat or Jetty) for web applications
- Externalized configuration – `application.properties`

### Spring Boot II

- To simplify configuration even more, starter projects containing common dependencies are provided
  - *spring-boot-starter-parent* – parent Maven project
  - *spring-boot-starter-data-jpa*
  - *spring-boot-starter-web*
  - *spring-boot-starter-security*
  - ...
- Test extensions allowing to isolate tested components
  - `@DataJpaTest`, `@SpringBootTest`
- Automatic creation of default beans
  - `@ConditionalOnMissingBean`
  - `ObjectMapper`, `DataSource`, `TransactionManager`
  - `TestRestTemplate` for tests

## Resources

- Spring home <https://spring.io/>
- Spring Framework – Documentation <https://docs.spring.io/spring/docs/current/spring-framework-reference/index.html>
- Spring Boot – Documentation <https://docs.spring.io/spring-boot/docs/current/reference/html/>
- Spring (WPA lecture) [https://cw.fel.cvut.cz/wiki/\\_media/courses/a7b39wpa/spring1.pdf](https://cw.fel.cvut.cz/wiki/_media/courses/a7b39wpa/spring1.pdf)