Object – Oriented Design with UML and Java

Part XVII - (Enterprise) Java Beans

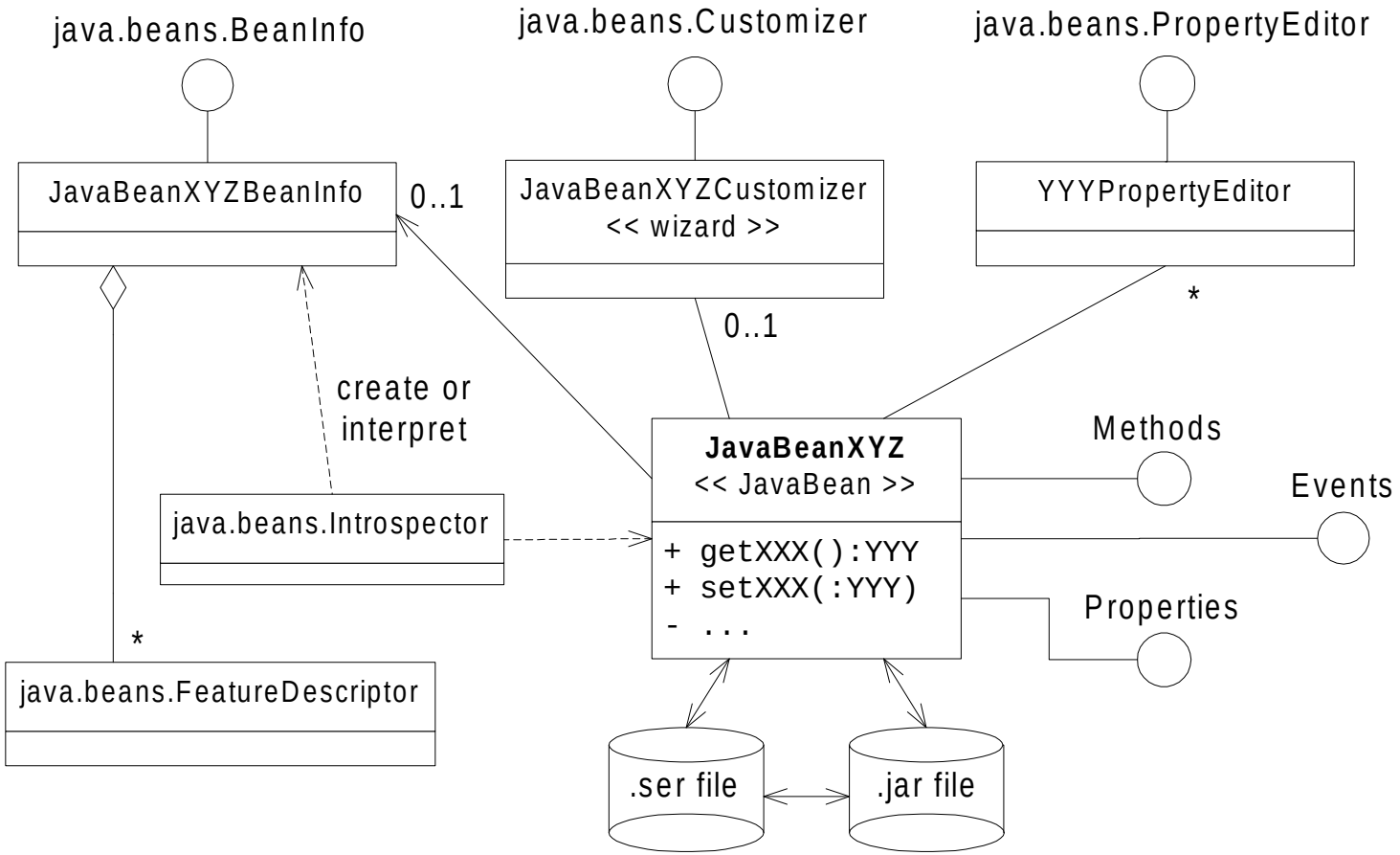
Version 2023

JavaBeans

A *JavaBean* (pre-*Enterprise*) is a reusable component bundled with supporting files (in a `.jar` file) that adheres to the *JavaBean* standard.

- Note the word "*JavaBean*" has two meanings.
- The official definition from Sun Microsystems: "A Java Bean is a reusable software component that can be manipulated visually in a builder tool."
- JavaBeans are used primarily on the client side of a distributed application. They are often visual components, like, say, for a Spreadsheet or Calendar widget. But they can be "invisible" and still be quite useful, like, say a proxy for a legacy system, or a PGP Bean, providing encryption services.
- Reflection allows the Bean's properties to be determined at "customization time" (design time) by a tool.

JavaBeans


java.beans.BeanInfo
java.beans.Customizer
java.beans.PropertyEditor
JavaBeanXYZBeanInfo
0..1
JavaBeanXYZCustomizer
<< wizard >>
YYYPropertyEditor
0..1
*
create or
interpret
JavaBeanXYZ
<< JavaBean >>
Methods
Events
java.beans.Introspector
+ getXXX():YYY
+ setXXX(:YYY)
- ...
Properties
*
java.beans.FeatureDescriptor
.ser file
.jar file

The JavaBean Standard

In order for a Java object to be a JavaBean:

- The Bean's configurable properties have public "getter and setter" methods. For example, the property "String foo" must have the methods getFoo() and setFoo(). (This naming convention is referred to as "design patterns").
- This Bean's companion ***Introspector*** determines the configurable properties using Java's Reflection API. The Introspector constructs a ***property sheet*** for the Bean, which can be edited using visual tools at design time.
- The Bean might have a companion ***BeanInfo*** object that describes the Bean's configurable properties; if a BeanInfo object exists, the Introspector will use it instead of using reflection.
- The Bean might have a companion ***Customizer*** object, which is Java code (adhering to a standard interface) designed to assist the user with Bean customization at design time. Within the Bean Box tool, the Customizer acts like a "wizard" to guide the bean configuration use case and/or constrain the range of possible values for the Bean's properties.

JavaBeans

- The fact that the Bean can be customized at design /deployment time implies that the Bean must have a means to “remember” the values for all of the customizable properties. This is accomplished using *Serialization*. A persistent Bean is saved to a `.ser` (Serialized) file, deployed with the Bean inside of a `.jar` (Java Archive) file. This is an example of the *Memento* design pattern.
- Individual Bean properties can have their own custom PropertyEditors. For example, a Color object is often described by three integers representing red, blue, and green; a visual ColorEditor can be provided.
- Bean properties may be “indexed”, “bound” or “constrained”… *Indexed* properties have array values, and it is expected that the Bean provides methods to get and set individual elements of the array. *Bound* properties, when updated, will cause the appropriate Bean *Observers* to get notified. These observers have the right to “veto” proposed updates of *constrained* properties.

JavaBeans

To summarize, JavaBeans have the following core features:

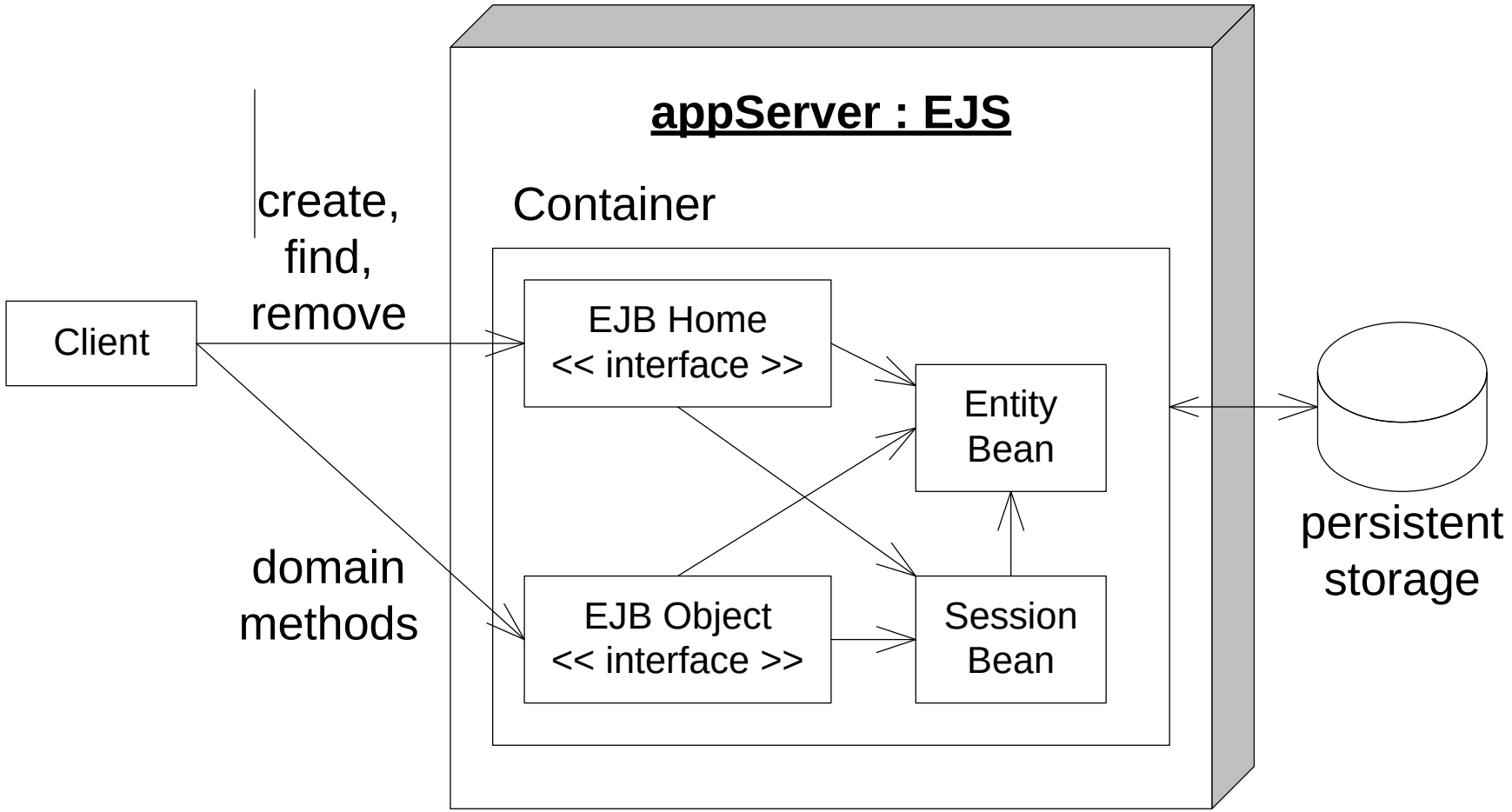
- Ability to be manipulated visually in a builder tool.
- Introspection, to allow the Bean's properties to be determined by the tool.
- Customization, of both appearance and behavior.
- Event handling, using the *Observer* design pattern (listener model).
- Properties, for customization and other programmatic uses.
- Persistence, allowing the Bean's state to be stored for later retrieval.

Design-time customization code is NOT deployed with a run-time Bean.

Enterprise Java Beans (EJB)

- Powerful ***Framework*** for building fast, scalable, and secure servers.
- Configured with an XML deployment descriptors, or ***annotations***.
- Part of the **Java *Enterprise Edition***, along with
  - Java Server Pages (JSP) / Java Server Faces (JSF2)
  - Container-Managed Persistence (CMP)
  - Servlets , Portlets, and more…
  - Java Naming and Directory Interface (JNDI)
  - Java Management Extensions (JMX) Managed Beans (MBeans)
  - Java Message Service (JMS)
  - Other API specifications: JDBC, RMI, XML, Web Services, …
- EJB 1.0 was klunky and not well liked.
- EJB 2.0 was klunky but significantly better.
- EJB 3.0 is good ☺

EJB2 Architecture



EJB3 Framework

- Good for creating server-side applications that are:
  - Secure
  - Scalable
  - Persistent
  - Distributed
  - Configurable
  - Transactional

EJB3 provides a consistent component architecture for creating distributed middleware and applications, with minimal dependencies in your code to the framework.

Much of your code can be implemented as ***POJOs***.

The revolutionary feature in Java that enabled EJB3 is the ***annotation***.

There are 3 types of EJBs

Session - web-site user session

Entity - persistent business entity

Message-driven - intra-enterprise message

Session Beans

- Beans that represent *mediators*, *commands*, or *controllers*
- Define the scope of transactions involving multiple entity beans
- Two basic types:
  - **Stateless**
    - » Have no internal state
    - » Because of the fact that they are stateless, they can be pooled to service multiple clients
  - **Stateful**
    - » Possess internal states
    - » There can be only one **Stateful Session Bean** per EJB Client
    - » Must be thread safe or thread isolated.
    - » Frameworks can manage ***session-scoped*** variables, handy for stateful web-site user sessions (often mapping to a session-id in a browser cookie).

Entity Beans

- Entity Beans are business domain objects
- Can be a POJO (Plain Old Java Object) ***annotated*** with `@Entity`
- Stateful
- Persistent
  - can survive system shutdowns
  - can be shared by multiple EJB Clients
- There are two types of entity bean persistence
  - Container-Managed Persistence (CMP)
  - Bean-managed persistence – the Bean has code to map itself to some persistent storage, usually using JDBC.

`javax.persistence.EntityManager` has an interface to find, create and remove entity beans from the data store.

Message-Driven Beans

Ala the **Java Message Server** (JMS) standard.

The most useful tool for **Enterprise Application Integration**?

Commercial **Message Queues** are good.

Beyond the basic idea of messages on message queues, there are patterns:

- Producer – Consumer
- Publish – Subscribe
- Delivery Channels
- Persistent SOAP

Container-Managed Persistence (CMP)

The EJB container is responsible for saving the Bean's state.

- The container generates all the database calls (or however it chooses to manage the bean’s persistence).
- The implementation is independent of the data source.

- The EJB 3.0 CMP implementation is nearly identical to work done on the ***Hibernate*** project. See also the ***Spring*** framework.
- May be configured using XML or annotations (see chapter XVIII).
- CMP using annotations is a huge leap forward in simplifying the code required to implement object-to-relational mapping.

The Spring Framework

The **Spring Framework** provides sub-frameworks:

1. **Inversion of Control** (IoC) – Configure components using **dependency injection**. Manage the lifecycles of EJBs.
2. **Aspect-oriented programming** (AOP) – for cross-cutting concerns such as exception handling, distributed transactions, logging, and security.
3. Support for **object-relational mapping** (with annotations).
4. Support for enterprise queuing using **Java Message Service** (JMS).
5. **Java Server Faces** (JSF2) can be the View technology for **Spring MVC** (a quality web-application framework).
6. Spring makes it easier to test your code.

Further discussion of ***Java Enterprise Edition*** is out of scope for this course.

Enterprise Architecture

EJB3 technology is powerful, but it is not the only tool in your toolkit.

- Commercial middleware ***components*** are configurable.
- Free and Open Source Software (FOSS) has come of age.
- ***Python*** is a better language for many tasks related to production deployment, scripting, and small jobs that need to be done quickly.
- The key is to ***design*** an elegant solution using “best fit” technologies.
- Keep it simple, and use the right tool for the right job.