Component and Inheritance Mapping

Originals of Slides and Source Code for Examples:
http://courses.coreservlets.com/Course-Materials/hibernate.html

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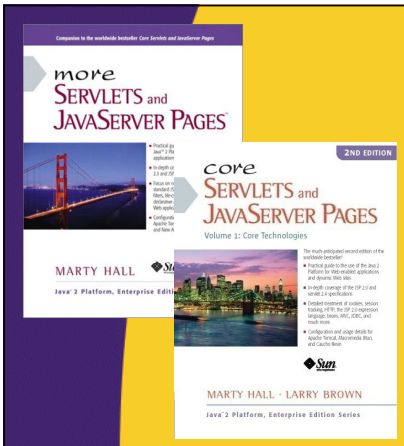


Topics in This Section

- Understand the difference between Components and Entities
- Walk through some uses of Components, and their mapping
- Look at different strategies and implementations for realizing inheritance

Component

- Refers to the UML modeling term of composition
- Does not exist on its own; dependent on a parent object
  - Does not have a table or identifier in the database
  - Only associated to a single parent class
- Commonly referred to as a "*has a*" relationship
  - An **AccountOwner** *has an* **Address**

Entity

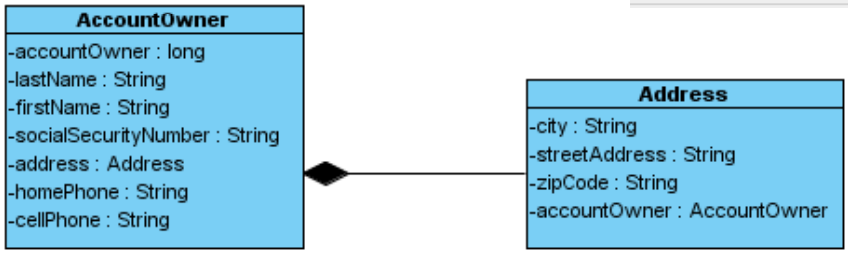
- 1st class citizen -- lives on its own
- Has its own table and identifier
- Can be made up of multiple components
- Can be related/associated to other entities

Entity/Component Example

- 'AccountOwner' is an Entity
  - Can lives on its own
  - Has its own id
- 'Address' is a component of 'AccountOwner'
  - Non-existent without AccountOwner
  - No id of its own.

ACCOUNT_OWNER

Column Name	Data Type	Nullable
ACCOUNT_OWNER_ID	NUMBER	No
LAST_NAME	VARCHAR2(50)	No
FIRST_NAME	VARCHAR2(50)	No
SOCIAL_SECURITY_NUMBER	VARCHAR2(50)	No
STREET_ADDRESS	VARCHAR2(50)	No
CITY	VARCHAR2(50)	No
STATE	VARCHAR2(50)	No
ZIP_CODE	VARCHAR2(10)	No
HOME_PHONE	VARCHAR2(20)	Yes
CELL_PHONE	VARCHAR2(20)	Yes



Using Components

1. **Determine your domain model**
   - Which objects are best suited to be a component?
2. **Create your database tables**
   - Model your components accordingly within entity tables
3. **Create your Java classes**
   - One for each entity, and one for each component
   - Setup your components within the entity classes
4. **Write the Hibernate mapping file for the entity, using the embedded component tag within it to identify the component class.**

Mapping a Component

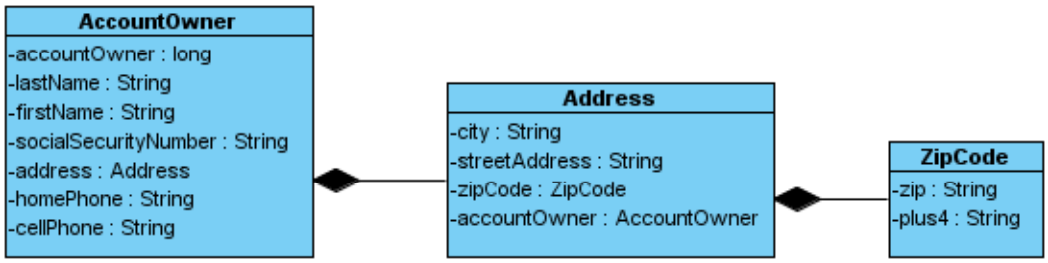
```
<class name="courses.hibernate.vo.AccountOwner"
       table="ACCOUNT_OWNER">
  <id name="accountOwnerId" column="ACCOUNT_OWNER_ID">
    <generator class="native" />
  </id>
  <property name="lastName" column="LAST_NAME" type="string" />
  <property name="firstName" column="FIRST_NAME" type="string" />
  <property name="socialSecurityNumber"
            column="SOCIAL_SECURITY_NUMBER" type="string" />
  <component name="address" class="courses.hibernate.vo.Address">
    <parent name="accountOwner"/>
    <property name="streetAddress" column="STREET_ADDRESS"
              type="string" />
    <property name="city" column="CITY" type="string" />
    <property name="state" column="STATE" type="string" />
    <property name="zipCode" column="ZIP_CODE" type="string" />
  </component>
  <property name="homePhone" column="HOME_PHONE" type="string" />
  <property name="cellPhone" column="CELL_PHONE" type="string" />
</class>
```

Nested Components

- **Component 'Address' has *nested* component 'ZipCode'**
  - Example: 12222-1234

ACCOUNT_OWNER

Column Name	Data Type	Nullable
ACCOUNT_OWNER_ID	NUMBER	No
LAST_NAME	VARCHAR2(50)	No
FIRST_NAME	VARCHAR2(50)	No
SOCIAL_SECURITY_NUMBER	VARCHAR2(50)	No
STREET_ADDRESS	VARCHAR2(50)	No
CITY	VARCHAR2(50)	No
STATE	VARCHAR2(50)	No
ZIP_CODE	VARCHAR2(5)	No
ZIP_PLUS_FOUR	VARCHAR2(4)	Yes
HOME_PHONE	VARCHAR2(50)	Yes
CELL_PHONE	VARCHAR2(50)	Yes



Mapping Nested Components

```
<class name="courses.hibernate.vo.AccountOwner"
       table="ACCOUNT_OWNER">
  ...

  <component name="address" class="courses.hibernate.vo.Address">
    <parent name="accountOwner"/>
      <property name="streetAddress" column="STREET_ADDRESS"
                type="string" />
      <property name="city" column="CITY" type="string" />
      <property name="state" column="STATE" type="string" />
      <component name="zipCode"
                 class="courses.hibernate.vo.ZipCode">
        <property name="zip" column="ZIP_CODE" type="string" />
        <property name="plus4" column="ZIP_PLUS_FOUR"
                  type="string" />
      </component>
   </component>

  ...
   </class>
```

Collection of Components

```
<class name="courses.hibernate.vo.Account" table="ACCOUNT">
   ...
  <set name="accountOwnerAddresses" table="ACCOUNT_ACCOUNT_OWNER">
    <key column="ACCOUNT_ID" />
    <composite-element class="courses.hibernate.vo.Address">
      <property name="streetAddress" type="string"
        formula="(SELECT AO.STREET_ADDRESS FROM ACCOUNT_OWNER AO
                  WHERE AO.ACCOUNT_OWNER_ID = ACCOUNT_OWNER_ID)"/>

      <property name="city" type="string"
          formula="(SELECT AO.CITY FROM ACCOUNT_OWNER AO WHERE
                    AO.ACCOUNT_OWNER_ID = ACCOUNT_OWNER_ID)" />

      <property name="state" type="string"
          formula="(SELECT AO.STATE FROM ACCOUNT_OWNER AO WHERE
                    AO.ACCOUNT_OWNER_ID = ACCOUNT_OWNER_ID)" />
    </composite-element>
  </set>
  ...
</class>
```

Component as Entity ID

- **Done with or without a separate Java class**
  - If using Java class
    - Must implement Comparable and Serializable
    - Must define 'class' attribute in mapping file
- **If composite key contains identifiers from associations:**
  - Set the id value when you set the corresponding association on the main object
  - Set insert='false' and update='false' on the association on the main object

Component as Entity ID

- **Example: EBill uses EBillId component as primary key**
  - EBillId component class contains attributes required to uniquely identiry the EBill

EBillId Class

```
public class EBillId implements
  Comparable<EBillId>, Serializable {
  private long accountId;
  private long ebillerId;
  private Date dueDate;
  ...
  // getters and setters
  ...
}
```

Component as Entity ID

- **Example: EBill uses EBillId component as primary key**
  - In EBill entity class, EBillId values are set as appropriate setters are called.

EBill Class

```
public class EBill {
  private EBillId ebillId = new EBillId();
  private EBiller ebiller;
       ...
  protected void setEbiller(EBiller ebiller) {
    this.ebiller = ebiller;
    ebillId.setEbillerId(ebiller.getEbillerId());
    ...
  }
  ...
}
```

Component as Entity ID

- **Example: EBill uses EBillId component as primary key**

EBill Mapping File

```
<class name="courses.hibernate.vo.EBill" table="EBILL">
  <composite-id name="ebillId"
                class="courses.hibernate.vo.EBillId">
    <key-property name="accountId" column="ACCOUNT_ID"
                  type="long"/>
    <key-property name="ebillerId" column="EBILLER_ID"
                  type="long"/>
    <key-property name="dueDate" column="DUE_DATE"
                  type="timestamp"/>
  </composite-id>
  ...
  <!-- Must have insert="false" update="false" because ids for the objects are
   part of the composite key. The relationships are managed via the composite
   key elements rather than the M:1 relationship. -->
  <many-to-one name="ebiller" column="EBILLER_ID"
          class="courses.hibernate.vo.EBiller" access="field"
          insert="false" update="false" />
  ...
</class>
```

Component as Entity ID Caveat

- **Using a Component as an Entity ID and not using a separate class to represent it can be troublesome**
- **You can *not* simply pass in the attributes which make up the key into a session.get () method**
  - **`session.get(EBill.class, int x, int y)`**
  - No such api on Session object
- **Need to write a separate Hibernate query to bring back the object**

Inheritance

Inheritance

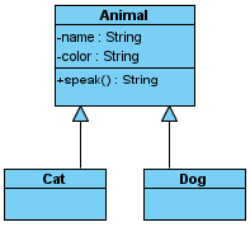
- **Allows for logical affiliation of classes with common state and/or behavior**
- **Commonly referred to as an "*is a*" relationship**
  - A **Cat** *is a* **Animal**
  - A **Dog** *is a* **Animal**
- **Polymorphism**
  - Dynamic realization of subclass behavior while treating the object as an instance of its superclass

Polymorphism

```
public class Animal {
  public String speak() {
    return "Generic Hello";
  }
}

public class Cat extends Anima
  public String speak() {
    return "Meow";
  }
}

public class Dog extends Animal {
  public String speak() {
    return "Woof";
  }
}
```



Polymorphism

```
public class Farm {
  List<Animals> animals =
  someDAO.getAnimals();
    for (int index=0; index < animals.size();
         index++) {
      Animal someAnimal = animals.get(index);
      System.out.println(someAnimal.speak());
    }
}
```

Even though the variable type in our List is 'Animal'...

Assuming the list of animals returned included (in order) a cat, then a dog, the output would be:

... polymorphism allows each instance to make use of it's own implementation

Meow

Woof

Inheritance Realization

- **Easy to do in an object oriented language**
  - Java: Use ‘extends’ or ‘implements’ keyword
- **Not so easy to do in a relational database**
  - Tables do not ‘extend’ from each other
  - Part of the ‘impedance mismatch’ problem
- **How do we get around this?**
  - Four approaches through Hibernate
    - Hibernate implicit polymorphism
    - Table-per-concrete class
    - Table-per-class-hierarchy
    - Table-per-subclass

Modeling Inheritance

1. **Determine your domain model**
   - What objects have hierarchical relationships?
2. **Choose your inheritance strategy**
   - Hibernate implicit polymorphism
   - Table-per-concrete class
   - Table-per-class-hierarchy
   - Table-per-subclass
3. **Create your database tables based on the chosen strategy**
4. **Code your Java objects, using ‘extends’ or ‘implements’**
5. **Write your Hibernate mapping file using the appropriate subclass tags**

Implicit Polymorphism

- **Database**
  - *One* database table *per* concrete class
- **Hibernate Mapping Files**
  - *Separate mapping files for each inherited class*
    - Like normal, including any inherited properties
- **Default Behavior**
  - Out of the box Hibernate will automatically recognize any Java inheritance associations

Implicit Polymorphism

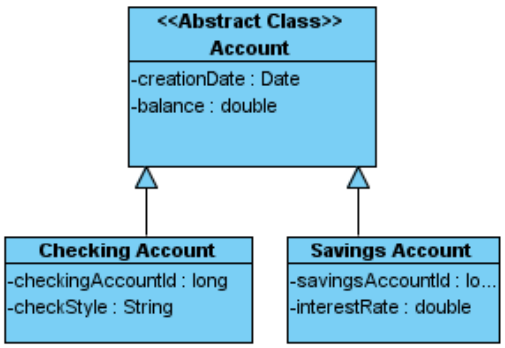
- **One table per concrete class**

CHECKING_ACCOUNT

Column Name	Data Type	Nullable
CHECKING_ACCOUNT_ID	NUMBER	No
CREATION_DATE	TIMESTAMP(6)	No
BALANCE	NUMBER(10,2)	No
CHECK_STYLE	VARCHAR2(50)	No

SAVINGS_ACCOUNT

Column Name	Data Type	Nullable
SAVINGS_ACCOUNT_ID	NUMBER	No
CREATION_DATE	TIMESTAMP(6)	No
BALANCE	NUMBER(10,2)	No
INTEREST_RATE	NUMBER(10,2)	No



Implicit Polymorphism

- CheckingAccount mapping file

```
<class name="courses.hibernate.vo.CheckingAccount"
       table="CHECKING_ACCOUNT">

  <id name="checkingAccountId" column="CHECKING_ACCOUNT_ID">
    <generator class="native"/>
  </id>

  <property name="creationDate" column="CREATION_DATE"
            type="timestamp"    update="false"/>

  <property name="balance" column="BALANCE" type="double"/>

  <property name="checkStyle" column="CHECK_STYLE"
            type="string"/>
</class>
```

Implicit Polymorphism

- SavingsAccount mapping file

```
<class name="courses.hibernate.vo.SavingsAccount"
       table="SAVINGS_ACCOUNT">

  <id name="savingsAccountId" column="SAVINGS_ACCOUNT_ID">
    <generator class="native"/>
  </id>

  <property name="creationDate" column="CREATION_DATE"
            type="timestamp"    update="false"/>

  <property name="balance" column="BALANCE" type="double"/>

  <property name="interestRate" column="INTEREST_RATE"
            type="double"/>
</class>
```

Implicit Polymorphism

- **Advantages**
  - Get it for free. Hibernate automatically scans classes on startup (including inheritance); No additional configuration/mapping needed
  - Not a lot of nullable columns *(good for integrity)*
  - Queries against individual types are fast and simple

Implicit Polymorphism

- **Disadvantages**
  - Makes handling relationships difficult
    - One-to-many relationships typically require a foreign key, but inherited associations can't key to both tables; Databases don't support it (Example: AccountOwner:Account)
  - Polymorphic queries are process intensive
    - For queries against the superclass, Hibernate executes multiple queries
      - `SELECT * FROM CHECKING_ACCOUNT WHERE ACCOUNT_OWNER_ID=?`
      - `SELECT * FROM SAVINGS_ACCOUNT WHERE ACCOUNT_OWNER_ID=?`
  - Database schema evolution more complex
    - Need to add the same column to multiple tables
    - Integrity constraints might have to span multiple tables

Table-per-concrete class

- **Database**
  - *One* database table *per* concrete class
- **Hibernate Mapping**
  - *Single mapping file*
    - Based on superclass
    - Includes 'union-subclass' definitions for inherited classes

Table-per-concrete class

- **One table per concrete class**

CHECKING_ACCOUNT

Column Name	Data Type	Nullable
ACCOUNT_ID	NUMBER	No
CREATION_DATE	TIMESTAMP(6)	No
BALANCE	NUMBER(10,2)	No
CHECK_STYLE	VARCHAR2(50)	No

SAVINGS_ACCOUNT

Column Name	Data Type	Nullable
ACCOUNT_ID	NUMBER	No
CREATION_DATE	TIMESTAMP(6)	No
BALANCE	NUMBER(10,2)	No
INTEREST_RATE	NUMBER(10,2)	No

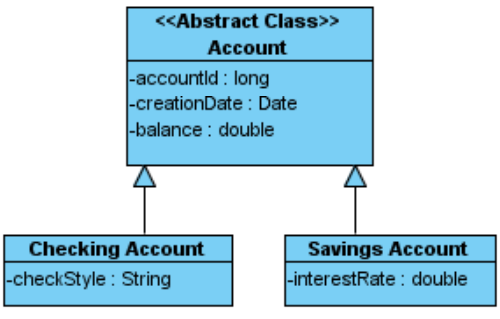


Table-per-concrete class

- **Account Mapping File**

```
<class name="Account" abstract="true">
  <id name="accountId" column="ACCOUNT_ID" type="long">
    <generator class="native"/>
  </id>

  <property name="creationDate" column="CREATION_DATE"
            type="timestamp"/>
  <property name="balance" column="BALANCE"
            type="double"/>

  <union-subclass name="courses.hibernate.vo.SavingsAccount"
                  table="SAVINGS_ACCOUNT">
    <property name="interestRate"
              column="INTEREST_RATE" type="double"/>
  </union-subclass>
  <union-subclass name="courses.hibernate.vo.CheckingAccount"
                  table="CHECKING_ACCOUNT">
    <property name="checkStyle" column="CHECK_STYLE"
              type="string"/>
  </union-subclass>
</class>
```

Table-per-concrete class

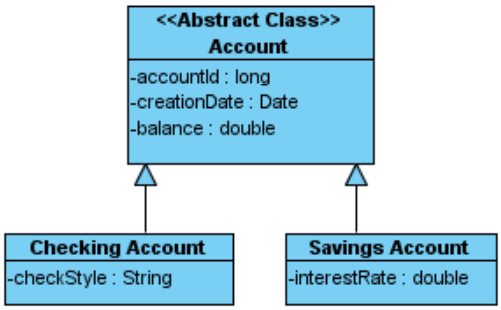
- **Advantages**
  - Shared mapping of common elements
    - Shared database id
  - Not a lot of nullable columns *(good for integrity)*
  - Queries against individual types are fast and simple
  - Less SQL statements generated with use of 'Union' for polymorphic queries
- **Disadvantages**
  - Still have difficulty with relationships
    - Foreign keying to two tables not possible
  - Database schema evolution still more complex
    - Need to add the same column to multiple tables
    - Integrity constraints might have to span multiple tables

Table-per-class-hierarchy

- **Database**
  - *One* database table for *all* subclasses
  - Denormalized table has columns for all attributes
- **Hibernate Mapping**
  - *Single mapping file* still based on superclass
  - Includes 'subclass' definitions for inherited classes
  - Use 'discriminator' column/field to identity concrete type

Table-per-class-hierarchy

- **One table for all inherited classes**



ACCOUNT

Column Name	Data Type	Nullable
ACCOUNT_ID	NUMBER	No
CREATION_DATE	TIMESTAMP(6)	No
BALANCE	NUMBER(10,2)	No
ACCOUNT_TYPE	VARCHAR2(1)	No
CHECK_STYLE	VARCHAR2(50)	Yes
INTEREST_RATE	NUMBER(10,2)	Yes

ACCOUNT_ID	CREATION_DATE	BALANCE	ACCOUNT_TYPE	CHECK_STYLE	INTEREST_RATE
1	17-AUG-08 06.03.27.000000 PM	1000	C	Sea Creatures	-
2	09-AUG-08 06.03.45.000000 PM	6000	C	Angels	-
3	09-SEP-08 06.04.24.000000 PM	12000	S	-	.25
4	09-SEP-08 06.04.53.000000 PM	8000	S	-	4.2

Table-per-class-hierarchy

- Account Mapping File

```
<class name="Account" table="ACCOUNT" abstract="true">
  <id name="accountId" column="ACCOUNT_ID" type="long"
    <generator="native"/>
  </id>
  <discriminator column="ACCOUNT_TYPE" type="string"/>
  <property name="creationDate" column="CREATION_DATE"
            type="timestamp"/>
  <property name="balance" column="BALANCE" type="double"/>

  <subclass name="courses.hibernate.vo.SavingsAccount"
            discriminator-value="S">
    <property name="interestRate" column="INTEREST_RATE"/>
  </subclass>

  <subclass name="courses.hibernate.vo.CheckingAccount"
            discriminator-value="C">
    <property name="checkStyle" column="CHECK_STYLE"/>
  </subclass>
</class>
```

Table-per-class-hierarchy

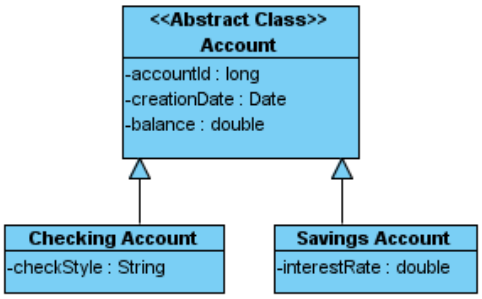
- **Advantages**
  - Simple
  - Fast reads/writes, even across types
- **Disadvantages**
  - Lots of nullable columns
    - Possible data integrity concern
  - Denormalized table generally considered bad database design

Table-per-subclass

- **Database**
  - *One* database table for the superclass ***AND*** one *per* subclass
    - Shared columns in superclass table
    - Subclass tables have their object-specific columns
- **Hibernate Mapping File**
  - *Single mapping file* based on the superclass
  - Includes 'joined-subclass' definitions for inherited classes

Table-per-subclass

- **Every class that has persistent properties has its own table**
  - Each table contains a primary key, and non-inherited properties
  - Inheritance is realized through foreign keys



Column Name	Data Type	Nullable
ACCOUNT_ID	NUMBER	No
CREATION_DATE	TIMESTAMP(6)	No
BALANCE	NUMBER(10,2)	No

Column Name	Data Type	Nullable
CHECKING_ACCOUNT_ID	NUMBER	No
CHECK_STYLE	VARCHAR2(50)	No

Column Name	Data Type	Nullable
SAVINGS_ACCOUNT_ID	NUMBER	No
INTEREST_RATE	NUMBER(10,2)	No

Table-per-subclass

- **Account Mapping File**

```
<class name="Account" table="ACCOUNT" abstract="true">
  <id name="accountId" column="ACCOUNT_ID" type="long">
    <generator class="native"/>
  </id>
  <property name="creationDate" column="CREATION_DATE"
            type="timestamp"/>
  <property name="balance" column="BALANCE"
            type="double"/>
  <joined-subclass name="courses.hibernate.vo.SavingsAccount"
                   table="SAVINGS_ACCOUNT">
    <key column="SAVINGS_ACCOUNT_ID"/>
    <property name="interestRate" column="INTEREST_RATE"
              type="double"/>
  </joined-subclass>
  <joined-subclass name="courses.hibernate.vo.CheckingAccount"
                   table="CHECKING_ACCOUNT">
    <key column="CHECKING_ACCOUNT_ID"/>
    <property name="checkStyle" column="CHECK_STYLE"
              type="string"/>
  </joined-subclass>
</class>
```

Table-per-subclass

- **Advantages**
  - Normalized schema
    - Schema evolution and integrity are straight forward
  - Reduced number of SQL statements produced
    - Hibernate uses inner joins for subclass queries, outer joins for polymorphic ones
- **Disadvantages**
  - Can have poor performance for complex systems
    - Requires many joins or sequential reads for queries

When to use Which

- Leave implicit polymorphism for queries against interfaces *(based on behavior, not different attributes)*
- If you rarely require polymorphic queries, lean towards table-per-concrete-class.
- If polymorphic behavior is required, AND subclasses have only a few distinct properties, try table-per-class-hierarchy
- If polymorphic AND many distinct properties, look at table-per-subclass or table-per-concrete-class, weighing the cost of joins versus unions.

Wrap-up

Summary

- **In this lecture, we:**
  - Saw how Components are different from Entities
    - Enties have their own IDs
    - Component are dependant on Entities
  - Learned how to use Components and Entities to represent
    - Subsets of logical data,
    - Identifiers for Entities,
  - Talked about the different methods of modeling inheritance relationships through Java/Database/Hibernate, and where each one is best suited.
    - Hibernate implicit polymorphism
    - Table-per-concrete class
    - Table-per-class-hierarchy
    - Table-per-subclass

Preview of Next Sections

- **Stages of an object's lifecycle within Hibernate**
- **Closer look at the Hibernate persistence process**
- **Session Management**

Questions?