JPA

The New Enterprise Persistence Standard

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About Me

- Co-spec Lead of EJB 3.0 (JSR 220)
- Java EE 5 (JSR 244) expert group member
- Co-author “Pro EJB 3: Java Persistence API”
- Persistence/Container Architect for Oracle
- 15+ years experience in distributed, server-side and persistence implementations
- Presenter at numerous conferences and events

About You

- How many people have already used EJB 3.0 Java Persistence API (JPA)?
- How many people are using proprietary persistence APIs?
- How many people are interested in moving to a standard persistence API?

About JPA

- Persistence API for operating on POJO entities
- Merger of expertise from TopLink, Hibernate, JDO, EJB vendors and individuals
- Created as part of EJB 3.0 within JSR 220
- Released May 2006 as part of Java EE 5
- Integration with Java EE web and EJB containers provides enterprise “ease of use” features
- “Bootstrap API” can also be used in Java SE
- Pluggable Container-Provider SPI

Reference Implementation

- Part of "Glassfish" project on java.net
  - RI for entire Java EE platform
- Sun and Oracle partnership
  - Sun Application Server + Oracle persistence
- JPA impl called "TopLink Essentials"
  - Derived from and donated by Oracle TopLink
- All open source (under CDDL license)
  - Anyone can download/use source code or binary code in development or production

Anatomy of an Entity

- Abstract or concrete top level Java class
  - Non-`final` fields/properties, no-arg constructor
- No required interfaces
  - No required business or callback interfaces (but you may use them if you want to)
- Direct field or property-based access
  - Getter/setter can contain logic (e.g. for validation)
- May be Serializable, but not required
  - Only needed if passed by value (in a remote call)

The Minimal Entity

- Must be indicated as an Entity

1. @Entity annotation on the class

```
@Entity
public class Employee { … }
```

2. Entity entry in XML mapping file

```
<entity class="com.acme.Employee"/>
```

The Minimal Entity

- Must have a persistent identifier (primary key)

```
@Entity
public class Employee {
    @Id int id;

    public int getId() { return id; }
    public void setId(int id) { this.id = id; }
}
```

Persistent Identity

- Identifier (id) in entity, primary key in database
- Uniquely identifies entity in memory and in db

1. Simple id – single field/property

```
@Id int id;
```

Uses PK class

2. Compound id – multiple fields/properties

```
@Id int id;
@Id String name;
```

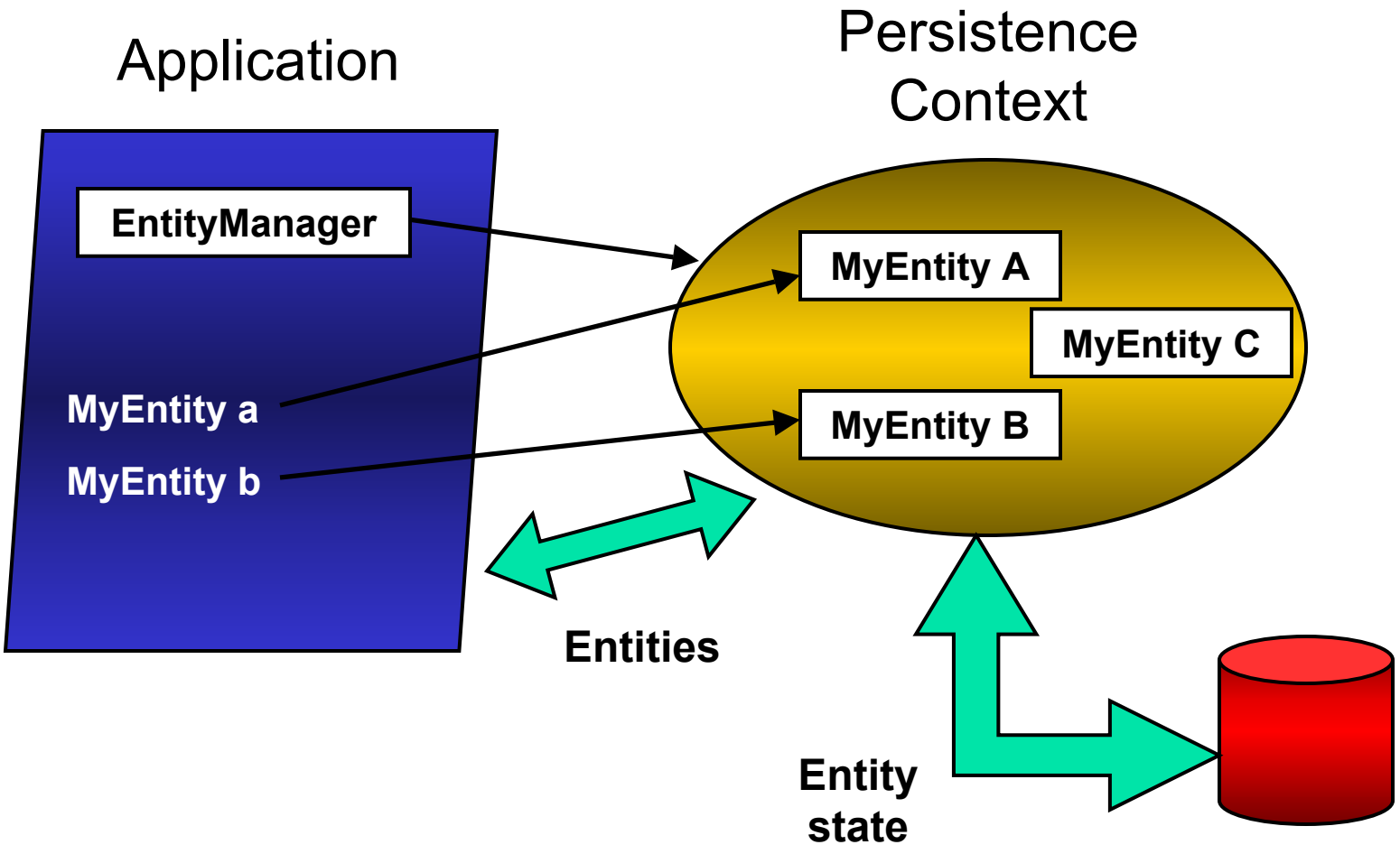
3. Embedded id – single field of PK class type

```
@EmbeddedId EmployeePK id;
```

Persistence Context

- Abstraction representing a set of "managed" entity instances
  - Entities keyed by their persistent identity
  - Only one entity with a given persistent identity may exist in the PC
  - Entities are added to the PC, but are not individually removable
- Controlled and managed by EntityManager
  - Contents of PC change as a result of operations on EntityManager API

Persistence Context



Entity Manager

- Client-visible artifact for operating on entities
  - API for all the basic persistence operations
- Can think of it as a proxy to a persistence context
  - May access multiple different persistence contexts throughout its lifetime
- Multi-dimensionality leads to different aspects of EntityManager (and persistence context) naming
  - Transaction type, life cycle

Operations on Entities

- EntityManager API
  - `persist()` - Insert the state of an entity into the db
  - `remove()` - Delete the entity state from the db
  - `refresh()` - Reload the entity state from the db
  - `merge()` - Synchronize the state of detached entity with the pc
  - `find()` - Execute a simple PK query
  - `createQuery()` – Create query instance using dynamic JP QL
  - `createNamedQuery()` – Create instance for a predefined query
  - `createNativeQuery()` – Create instance for an SQL query
  - `contains()` – Determine if entity is managed by pc
  - `flush()` – Force synchronization of pc to database

persist()

- Insert a new entity instance into the database
- Save the persistent state of the entity and any owned relationship references
- Entity instance becomes managed

```
public Customer createCustomer(int id, String name) {
    Customer cust = new Customer(id, name);
    entityManager.persist(cust);
    return cust;
}
```

find() and remove()

- find()
  - Obtain a managed entity instance with a given persistent identity – return null if not found
- remove()
  - Delete a managed entity with the given persistent identity from the database

```
public void removeCustomer(Long custId) {
    Customer cust =
        entityManager.find(Customer.class, custId);
    entityManager.remove(cust);
}
```

merge()

- State of detached entity gets merged into a managed copy of the detached entity
- Managed entity that is returned has a different Java identity than the detached entity

```
public Customer storeUpdatedCustomer(Customer cust) {
    return entityManager.merge(cust);
}
```

Queries

- Dynamic or statically defined (named queries)
- Criteria using JP QL (extension of EJB QL)
- Native SQL support (when required)
- Named parameters bound at execution time
- Pagination and ability to restrict size of result
- Single/multiple-entity results, data projections
- Bulk update and delete operation on an entity
- Standard hooks for vendor-specific hints

Queries

- Query instances are obtained from factory methods on EntityManager
- Query API:

`getResultList()` – execute query returning multiple results

`getSingleResult()` – execute query returning single result

`executeUpdate()` – execute bulk update or delete

`setFirstResult()` – set the first result to retrieve

`setMaxResults()` – set the maximum number of results to retrieve

setParameter() – bind a value to a named or positional parameter

`setHint()` – apply a vendor-specific hint to the query

`setFlushMode()` – apply a flush mode to the query when it gets run

Dynamic Queries

- Use createQuery() factory method at runtime and pass in the JP QL query string
- Use correct execution method
  - getResultList(), getSingleResult(), executeUpdate()
- Query may be compiled/checked at creation time or when executed
- Maximal flexibility for query definition and execution

Dynamic Queries

```
public List findAll(String entityName){
     return entityManager.createQuery(
       "select e from " + entityName + " e")
         .setMaxResults(100)
         .getResultList();
  }
```

- Return all instances of the given entity type
- JP QL string composed from entity type. For example, if "Account" was passed in then JP QL string would be: "**select e from Account e**"

Named Queries

- Use createNamedQuery() factory method at runtime and pass in the query name
- Query must have already been statically defined either in an annotation or XML
- Query names are “globally” scoped
- Provider has opportunity to precompile the queries and return errors at deployment time
- Can include parameters and hints in static query definition

Named Queries

```
@NamedQuery(name="Sale.findByCustId",
     query="select s from Sale s
            where s.customer.id = :custId
            order by s.salesDate")
public List findSalesByCustomer(Customer cust) {
  return
    entityManager.createNamedQuery(
                              "Sale.findByCustId")
          .setParameter("custId", cust.getId())
          .getResultList();
}
```

- Return all sales for a given customer
- Use a named parameter to specify customer id

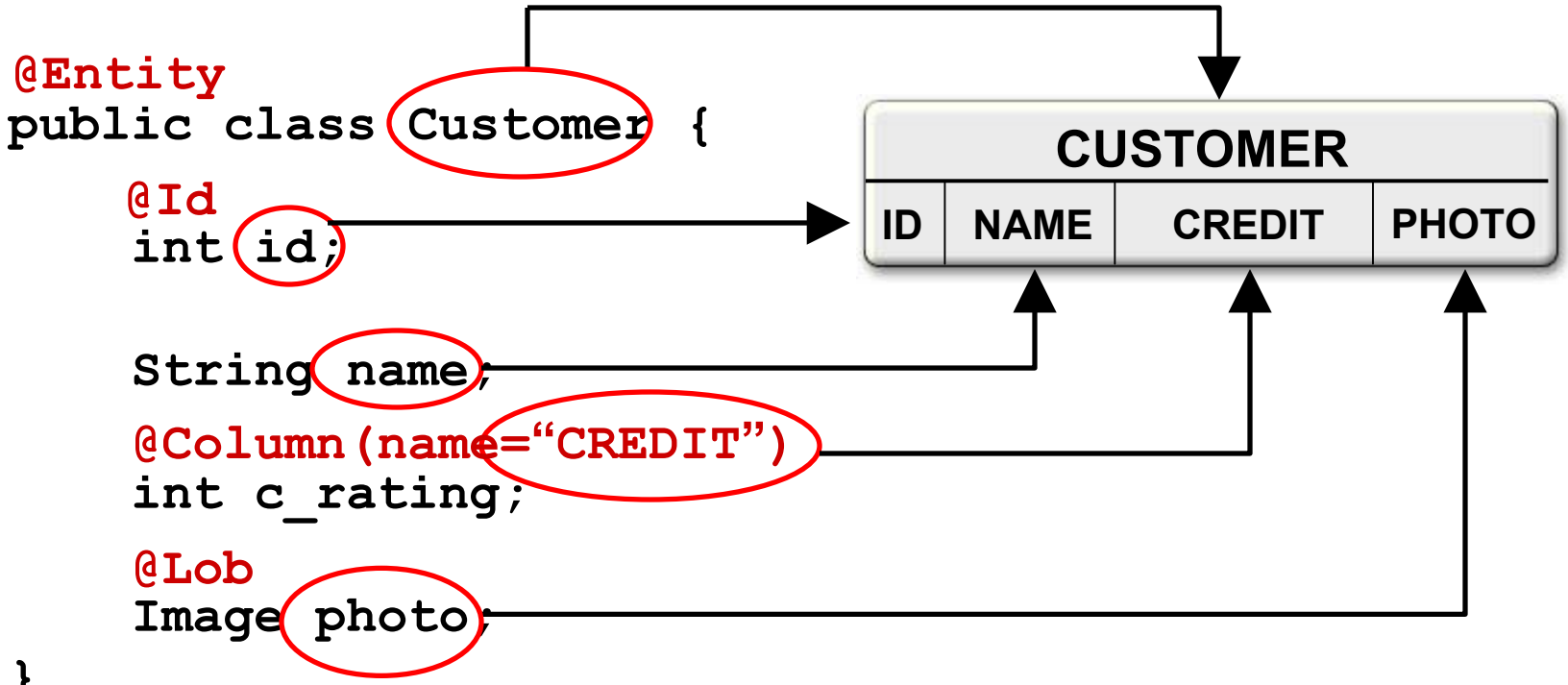
Object/Relational Mapping

- Map persistent object state to relational database
- Map relationships to other entities
- Metadata may be annotations or XML (or both)
- Annotations
  - Logical—object model (e.g. @OneToMany)
  - Physical—DB tables and columns (e.g. @Table)
- XML
  - Can additionally specify scoped settings or defaults
- Standard rules for default db table/column names

Simple Mappings

- Direct mappings of fields/properties to columns
  - @Basic - optional annotation to indicate simple mapped attribute
- Maps any of the common simple Java types
  - Primitives, wrappers, enumerated, serializable, etc.
- Used in conjunction with @Column
- Defaults to the type deemed most appropriate if no mapping annotation is present
- Can override any of the defaults

Simple Mappings



Simple Mappings

```
<entity class="com.acme.Customer">
  <attributes>
    <id name="id"/>
    <basic name="c_rating">
      <column name="CREDIT"/>
    </basic>
    <basic name="photo"><lob/></basic>
  </attributes>
</entity>
```

Relationship Mappings

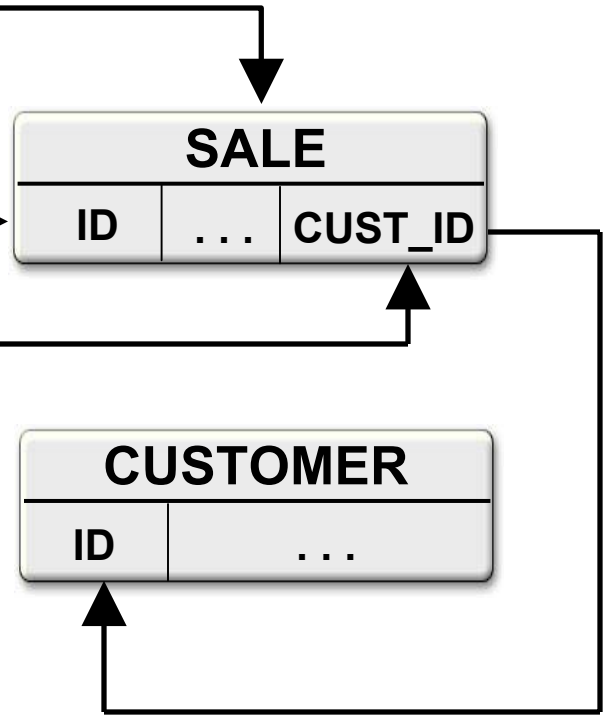
- Common relationship mappings supported
  - @ManyToOne, @OneToOne—single entity
  - @OneToMany, @ManyToMany—collection of entities
- Unidirectional or bidirectional
- Owning and inverse sides of every bidirectional relationship
- Owning side specifies the physical mapping
  - @JoinColumn to specify foreign key column
  - @JoinTable decouples physical relationship mappings from entity tables

ManyToOne Mapping

```
@Entity
public class Sale {
    @Id
    int id;

    ...

    @ManyToOne
    Customer cust;
}
```

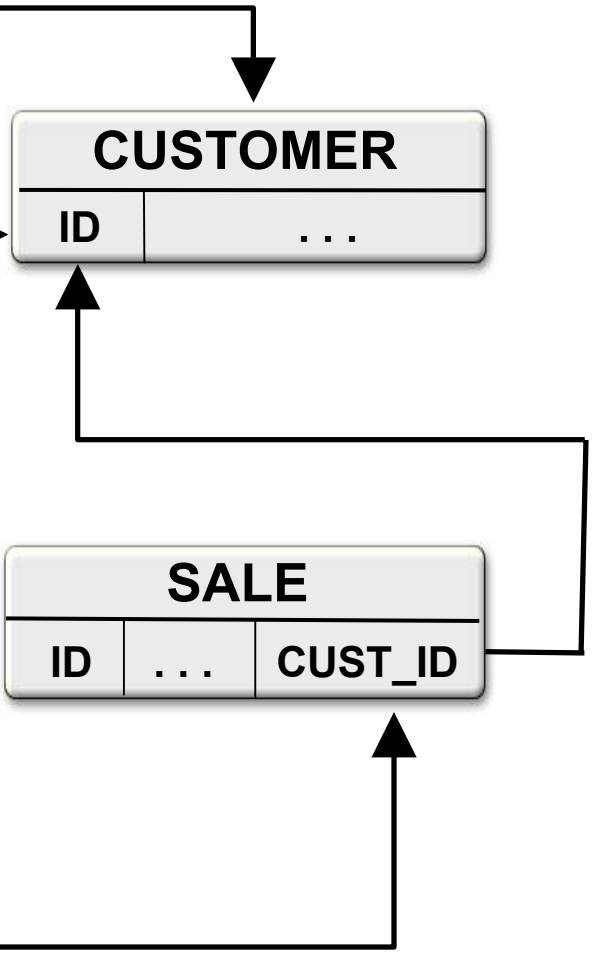


ManyToOne Mapping

```
<entity class="com.acme.Sale">
  <attributes>
    <id name="id"/>
    ...
    <many-to-one name="cust"/>
  </attributes>
</entity>
```

OneToMany Mapping

```
@Entity
public class Customer {
   @Id
   int id;
   ...
   @OneToMany(mappedBy="cust")
   Set<Sale> sales;
}
@Entity
public class Sale {
   @Id
   int id;
   ...
   @ManyToOne
   Customer cust;
}
```



OneToMany Mapping

```
<entity class="com.acme.Customer">
  <attributes>
    <id name="id"/>
      ...
    <one-to-many name="sales" mapped-by="cust"/>
  </attributes>
</entity>
```

Persistence in Java SE

- No deployment phase
  - Application must use a "Bootstrap API" to obtain an EntityManagerFactory
- Resource-local EntityManagers
  - Application uses a local EntityTransaction obtained from the EntityManager
- New application-managed persistence context for each and every EntityManager
  - No propagation of persistence contexts

Entity Transactions

- Only used by Resource-local EntityManagers
- Isolated from transactions in other EntityManagers
- Transaction demarcation under explicit application control using EntityTransaction API
  - begin(), commit(), rollback(), isActive()
- Underlying (JDBC) resources allocated by EntityManager as required

Bootstrap Classes

`javax.persistence.Persistence`

- Root class for bootstrapping an EntityManager
- Locates provider service for a named persistence unit
- Invokes on the provider to obtain an EntityManagerFactory

`javax.persistence.EntityManagerFactory`

- Creates EntityManagers for a named persistence unit or configuration

Example

```
public class PersistenceProgram {
  public static void main(String[] args) {
    EntityManagerFactory emf = Persistence
        .createEntityManagerFactory("SomePUnit");
    EntityManager em = emf.createEntityManager();
    em.getTransaction().begin();
    // Perform finds, execute queries,
    // update entities, etc.
    em.getTransaction().commit();
    em.close();
    emf.close();
  }
}
```

IDE Support

- Eclipse “Dali” project (**http://www.eclipse.org/dali**)
  - JPA support
  - Oracle (project lead), BEA, JBoss, Versant
- NetBeans (**http://community.java.net/netbeans**)
  - EJB 3.0 support including JPA (Beta 2)
  - Sun
- JDeveloper (**http://otn.oracle.com/jdev**)
  - EJB 3.0 support including JPA (10.1.3.1)
  - Oracle
- All 3 were developed against the JPA RI

Summary

- ✓ JPA emerged from best practices of existing best of breed ORM products
- ✓ Lightweight persistent POJOs, no extra baggage
- ✓ Simple, compact and powerful API
- ✓ Standardized object-relational mapping metadata specified using annotations or XML
- ✓ Feature-rich query language
- ✓ Java EE integration, additional API for Java SE
- ✓ “Industrial strength” Reference Implementation

Summary

Broad persistence standardization, mass vendor adoption and sweeping community acceptance show that we finally have an enterprise persistence standard in the Java Persistence API

Links and Resources

- JPA RI (TopLink Essentials) on Glassfish
  http://glassfish.dev.java.net/javaee5/persistence
- JPA white papers, tutorials and resources
  http://otn.oracle.com/jpa
- Pro EJB 3: Java Persistence API

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  (Apress)