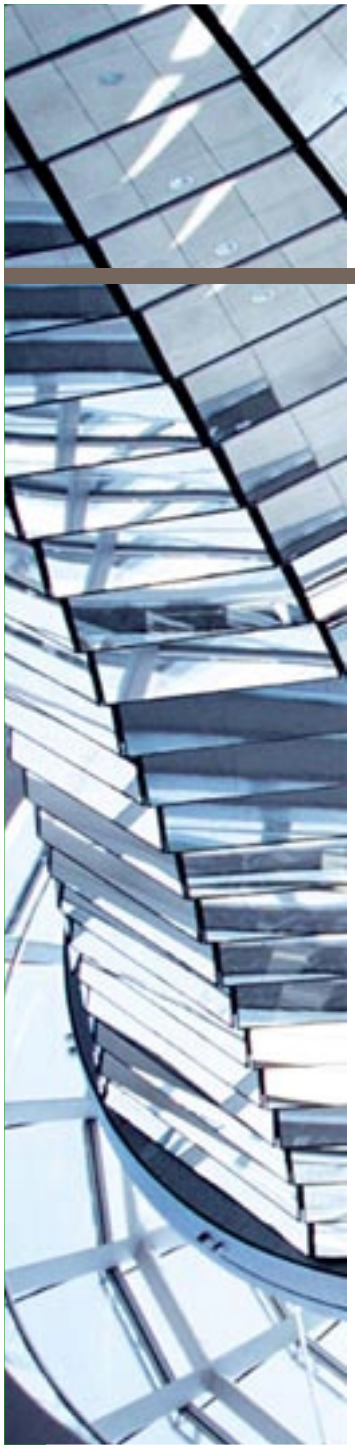

3. Application Kernel
Reference Architectures and Patterns

Winter Semester 2008 / 2009
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Department of Computer Science

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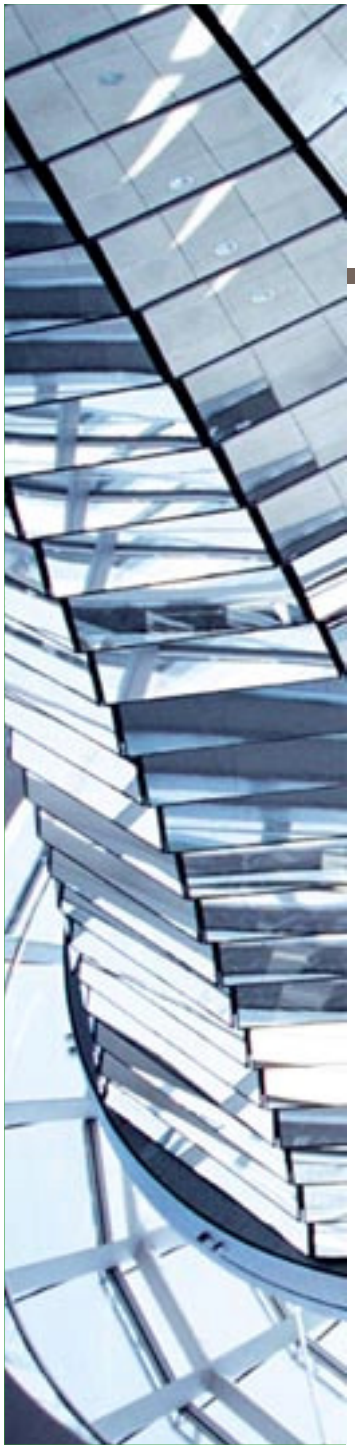
UNIVERSITY OF APPLIED SCIENCES

The lecture in the context of the entire course

1. Introduction
2. A reference architecture for business information systems
3. Application kernel
4. Persistence and transaction
5. Authorization
6. Client architecture
7. Other reference architectures: SOA, BI, systems integration, …



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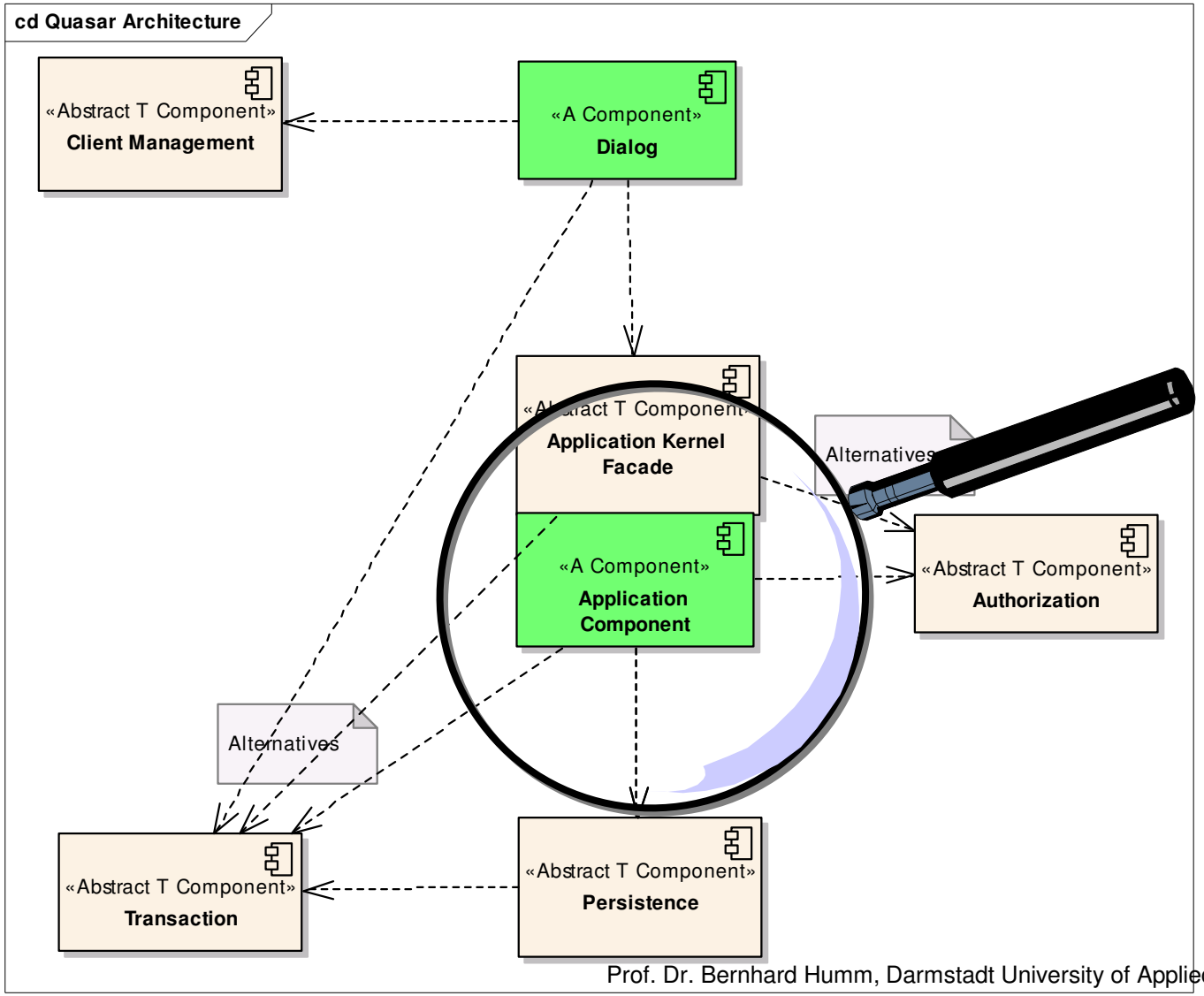
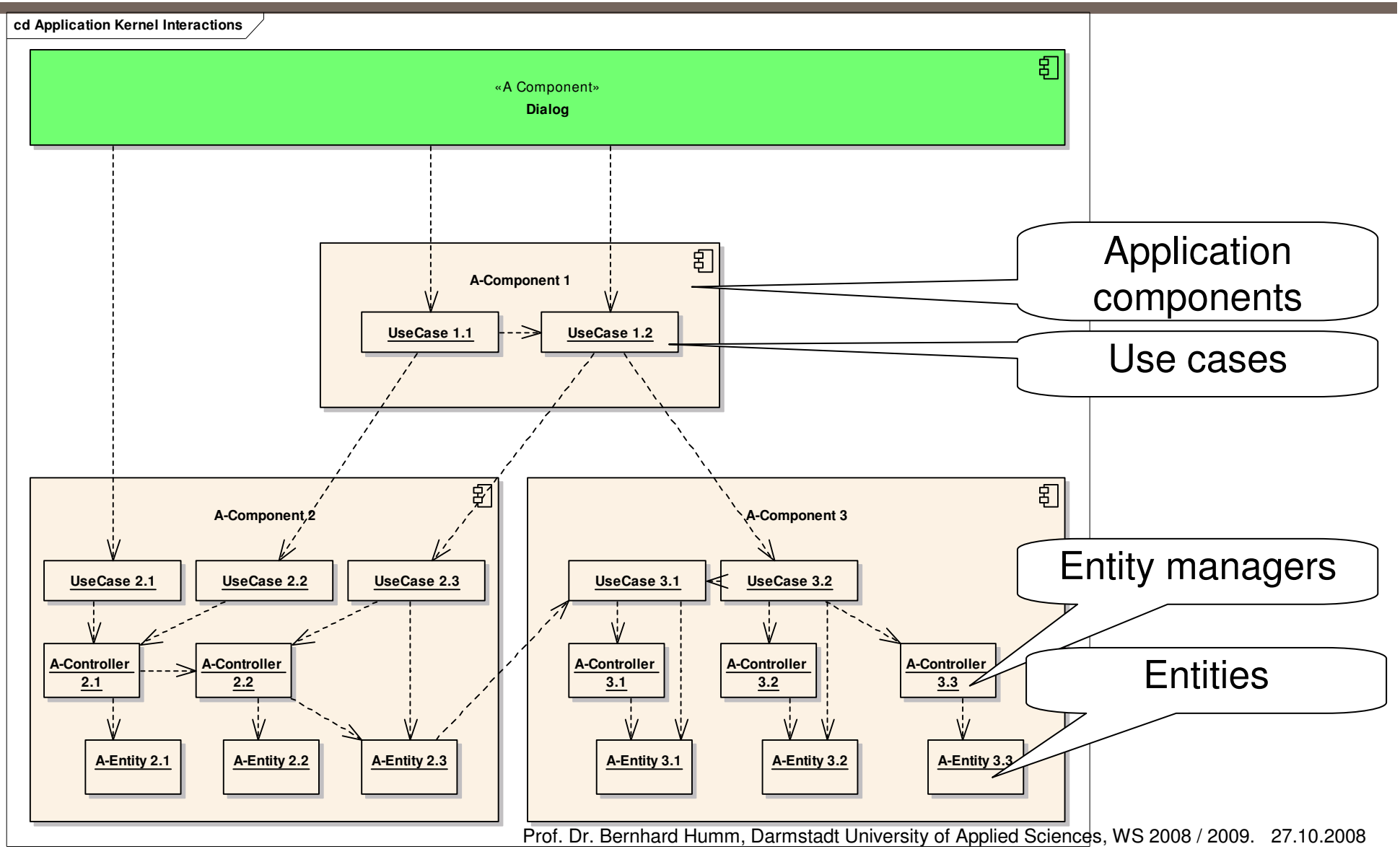
References

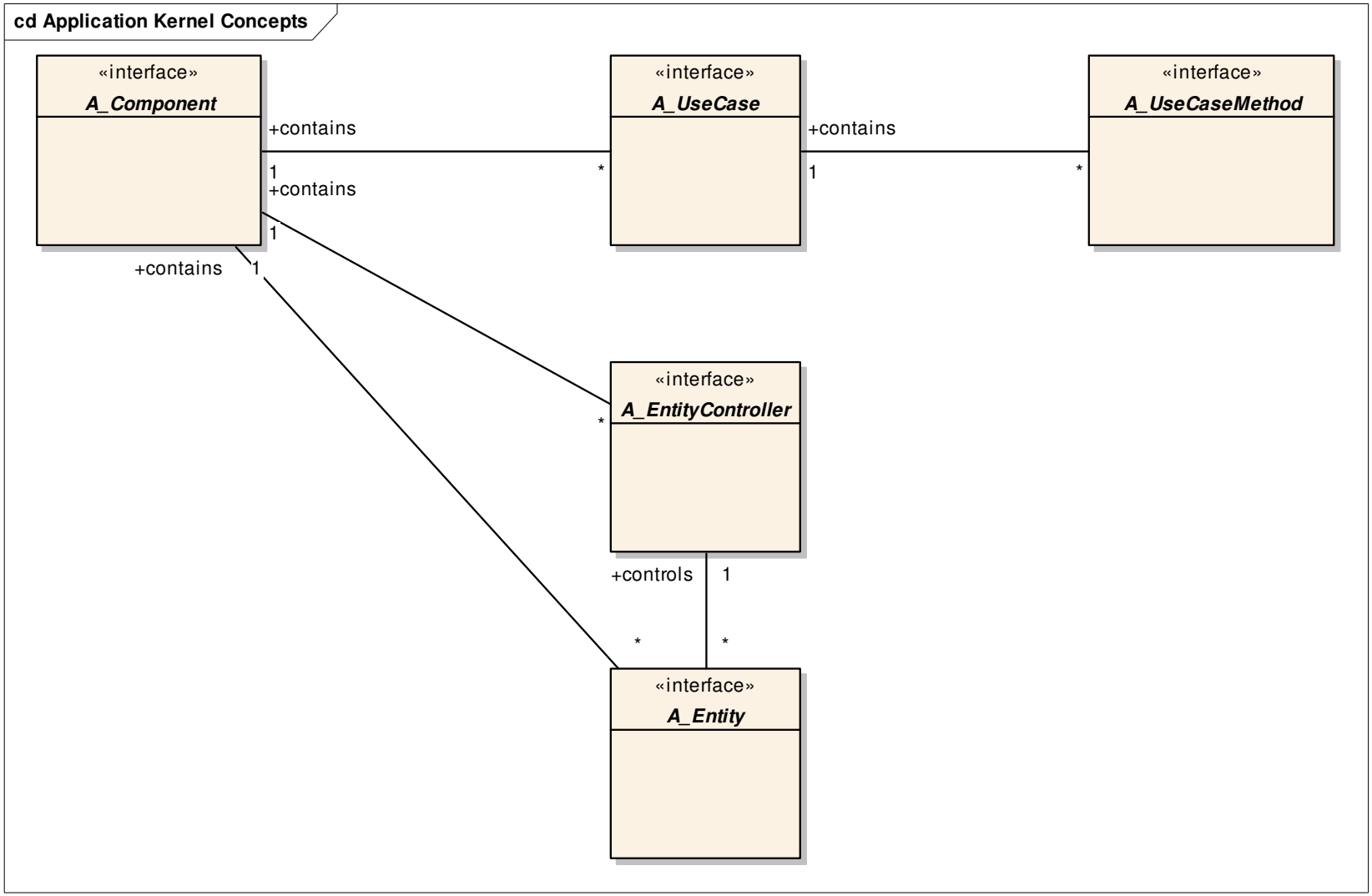
Reference architecture for business information systems Quasar (Quality Software Architecture)

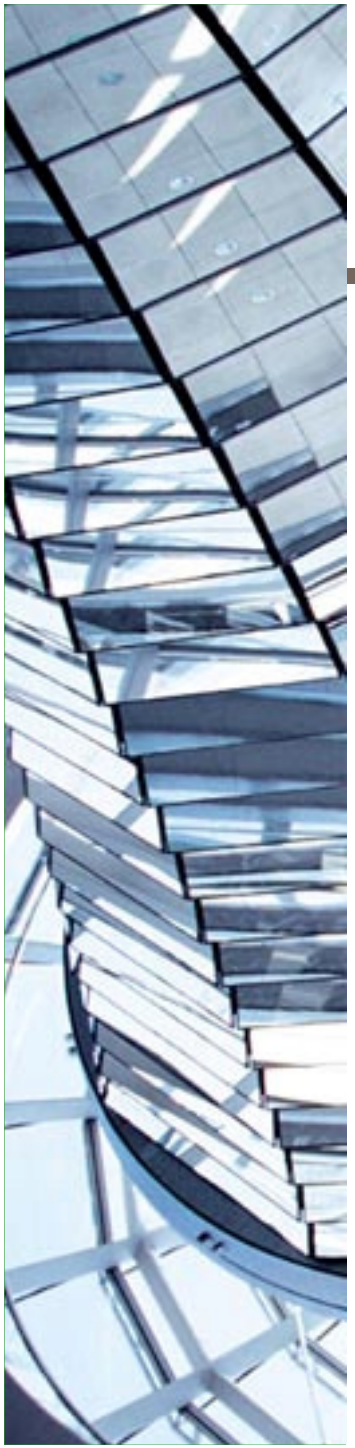


Reference architecture application kernel



Metamodel application kernel





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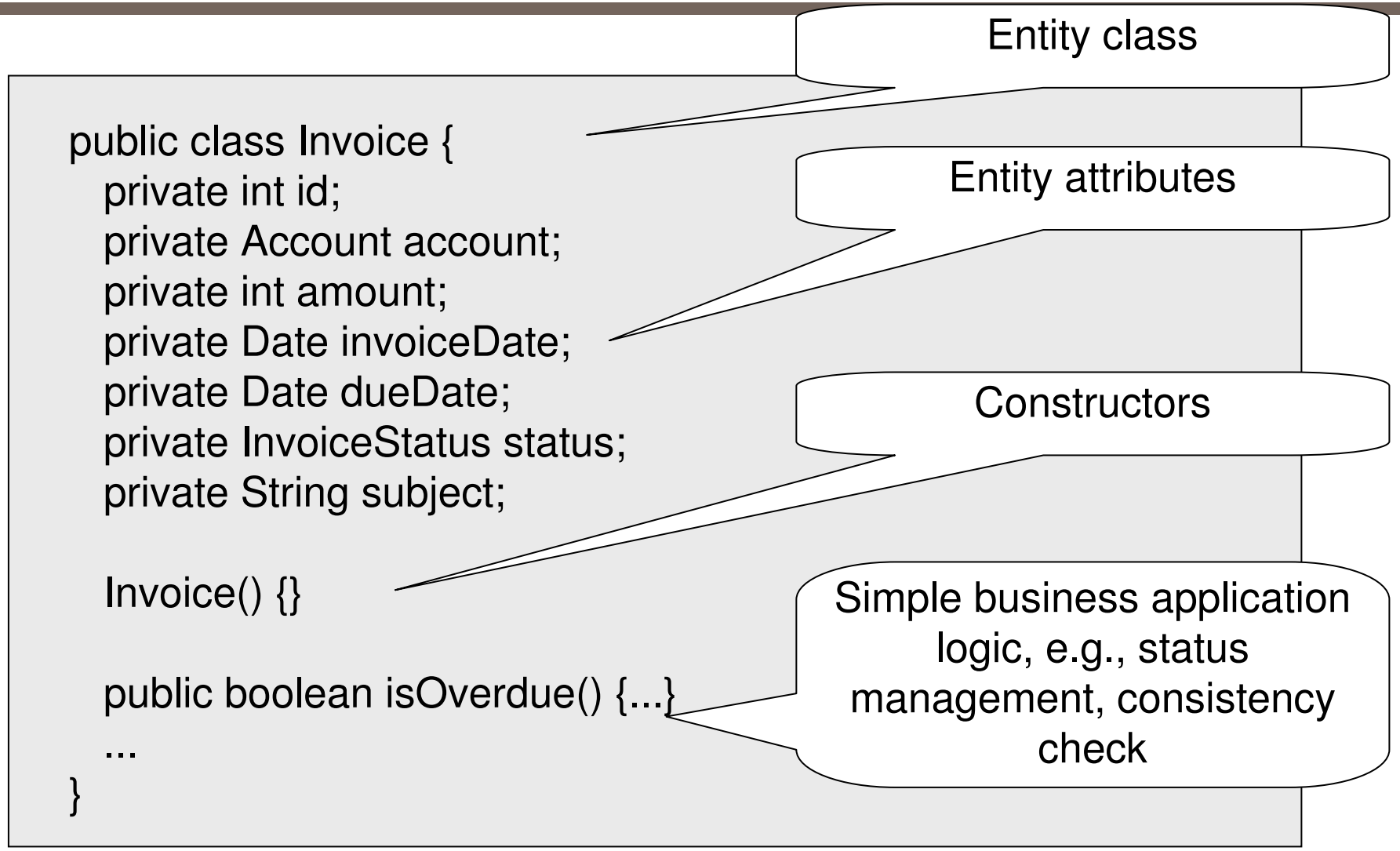
Entities represent real-world items

- Main objects of the information system
- Represent real-world items
- Contain persistent data
- Only little functionality, e.g., consistency checks
- Usually autonomous
  → unique identifier
- Distinguish between entity types (classes) and entity objects (instances)
- Examples: Customer, Product, Order, Invoice, …

Example for entity: Invoice



Associations (1/3)

Implementation alternatives:

1. Customer doesn‘t know about Orders and vice versa. Order contains customer id. Client software interprets customer id.

2. Order references unique customer

3. Customer references set of orders

4. (2) und (3): bidirectional reference; transparent navigation by client software possible

Associations (2/3)

Alternative 1:

```
class Customer {

    // not aware of orders



}
```

```
class Order {
  …
  private String CustomerId;

  public String getCustomerId() {
      return customerId;
  }
}
```

- Client software accesses customer id via get-method
- Can subsequently access customer object via id
- Represents a business application foreign key

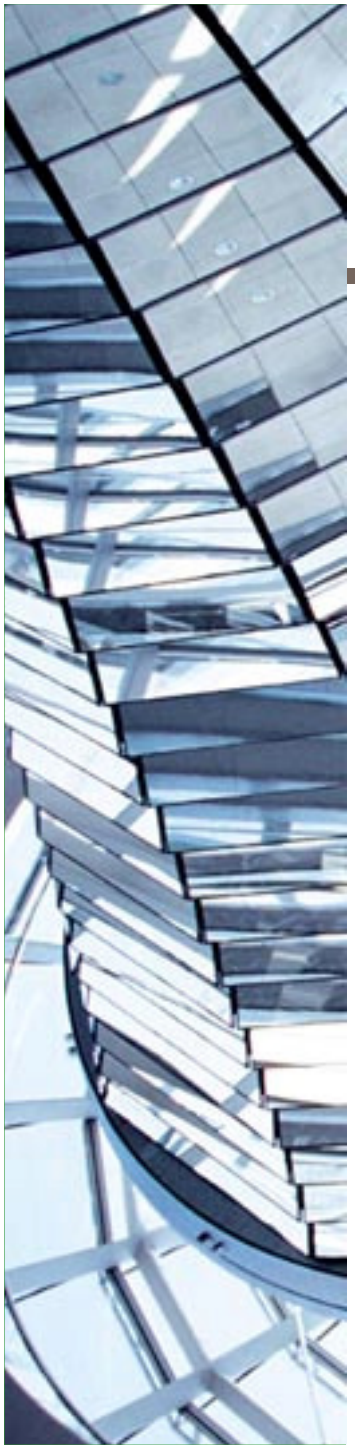
Associations (3/3)

Alternative 4:

```
class Customer {

   private List orders;

  public List getOrders()  {
       return orders.clone();
  }
}
```

```
class Order {
   private Customer customer;

  public Kunde getCustomer() {
      return customer;
  }
}
```

- Alternatives 2-4 couple tightly
- 10 tightly coupled classes are acceptable – 100 tightly coupled classes are a catastrophe!
- Don‘t couple classes tightly between components
- Avoid cyclic dependencies



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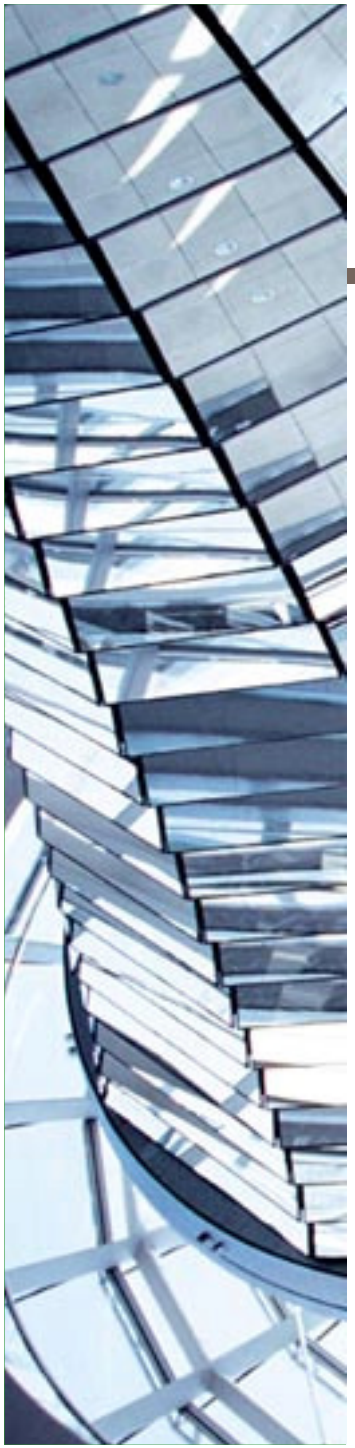
Application data types

- Finest-grained units of information in a business information system
- Specified by data range (including validity check) and simple transformation logic (e.g., toString)
- Used as values of entity attributes only
  → not autonomous
  → no unique identification
- Types:
  - Scalar, e.g., CustomerNumber, ISBN (needs validity check)
  - Compound, e.g., Address = street + number + ZIP code + city + country
  - Enumeration, e.g., CustomerType = {private, corporate}
- Remark: technical data types are provided by the programming language, e.g., String, Integer in Java



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Entity managers

- Manage one or more entity classes
- Implement functionality that cannot be assigned a single entity instance, particularly life cycle methods: create, read, update delete (CRUD)
- Also called Data Access Objects (DAO)
- Examples: CustomerManager, OrderManager, ProductManager, …

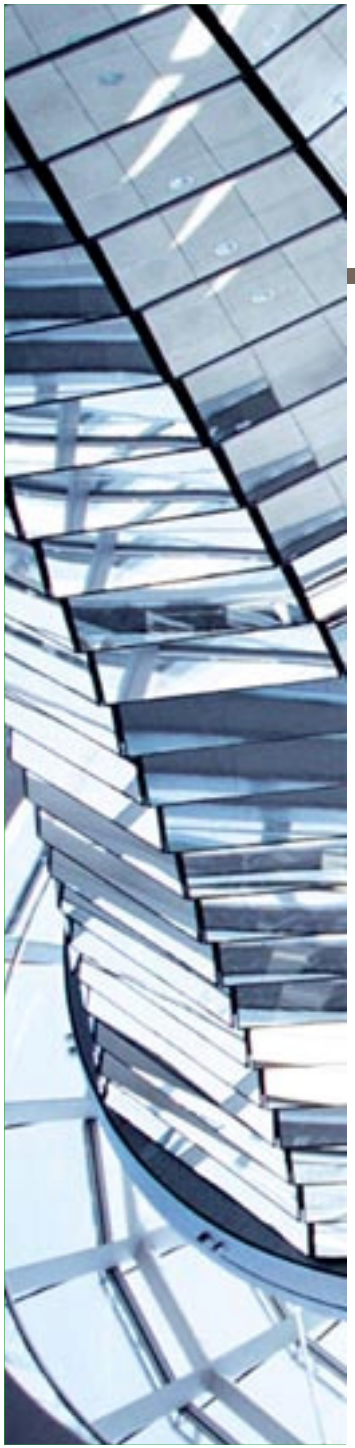
Example for entity manager class: CustomerManager

```
public class CustomerManager {

 public Customer newCustomer() {...}
 public Customer newCustomer(String name, String address) {...}

 public Collection<Customer> findCustomerById(int id) {...}
 public Collection<Customer> findCustomerByName(String name) {...}
 public Collection<Customer> findCustomerByAddress(String address) {...}

}
```

Entity manager class

Constructors

Search functionality



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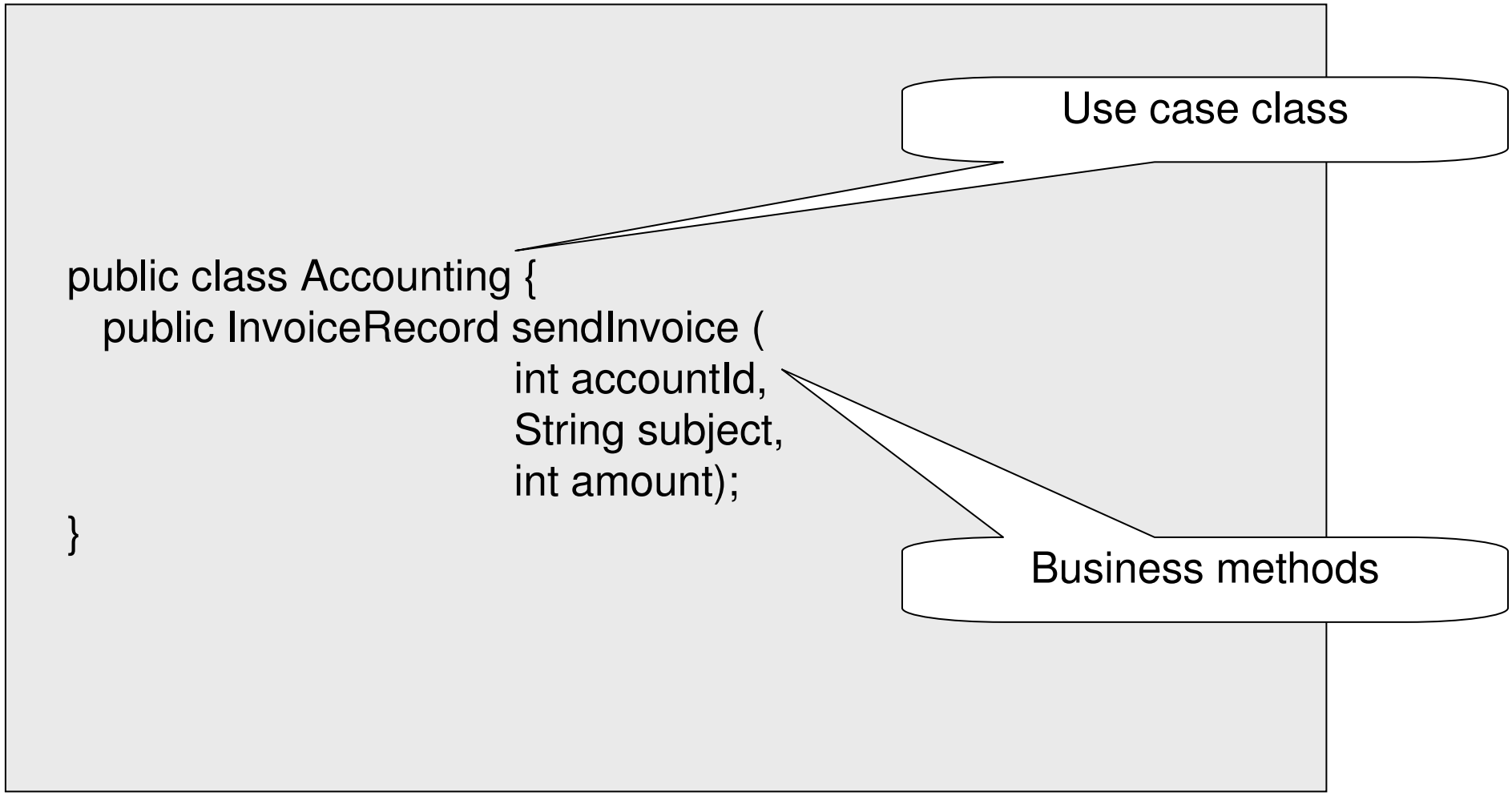
Use case objects

- Implement business logic
- Contain use case methods
- Form the application programmers' interface (API) of the application components
- Use entities and entity managers in their implementation
- Present technical or business application data types or transfer objects only to the outside (i.e., hide entities and implementation details)
- Also called service objects
- Examples: Accounting, Invoicing, Reminding, …

Example of use case object: Accounting



Transfer objects

- Primitive data containers
- No business functionality except transformation (e.g., to / from xml)
- Can be generated automatically from entities
- Transfer objects enforce call-by-value semantics instead of call-by-reference semantics
- Examples: CustomerRecord, ProductRecord, OrderRecord, InvoiceRecord, …

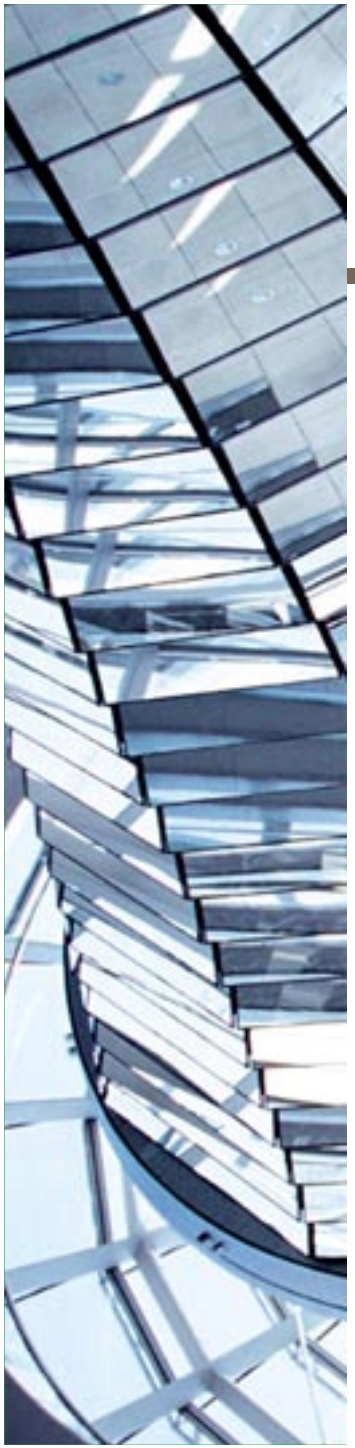
Example of transfer object: InvoiceRecord

```
public class InvoiceRecord {
   private int id;
   private int accountId;
   private int amount;
   private Date invoiceDate;
   private Date dueDate;
   private String invoiceStatus;
   private String subject;
}
```

Transfer object class

No references to entities

Technical data types



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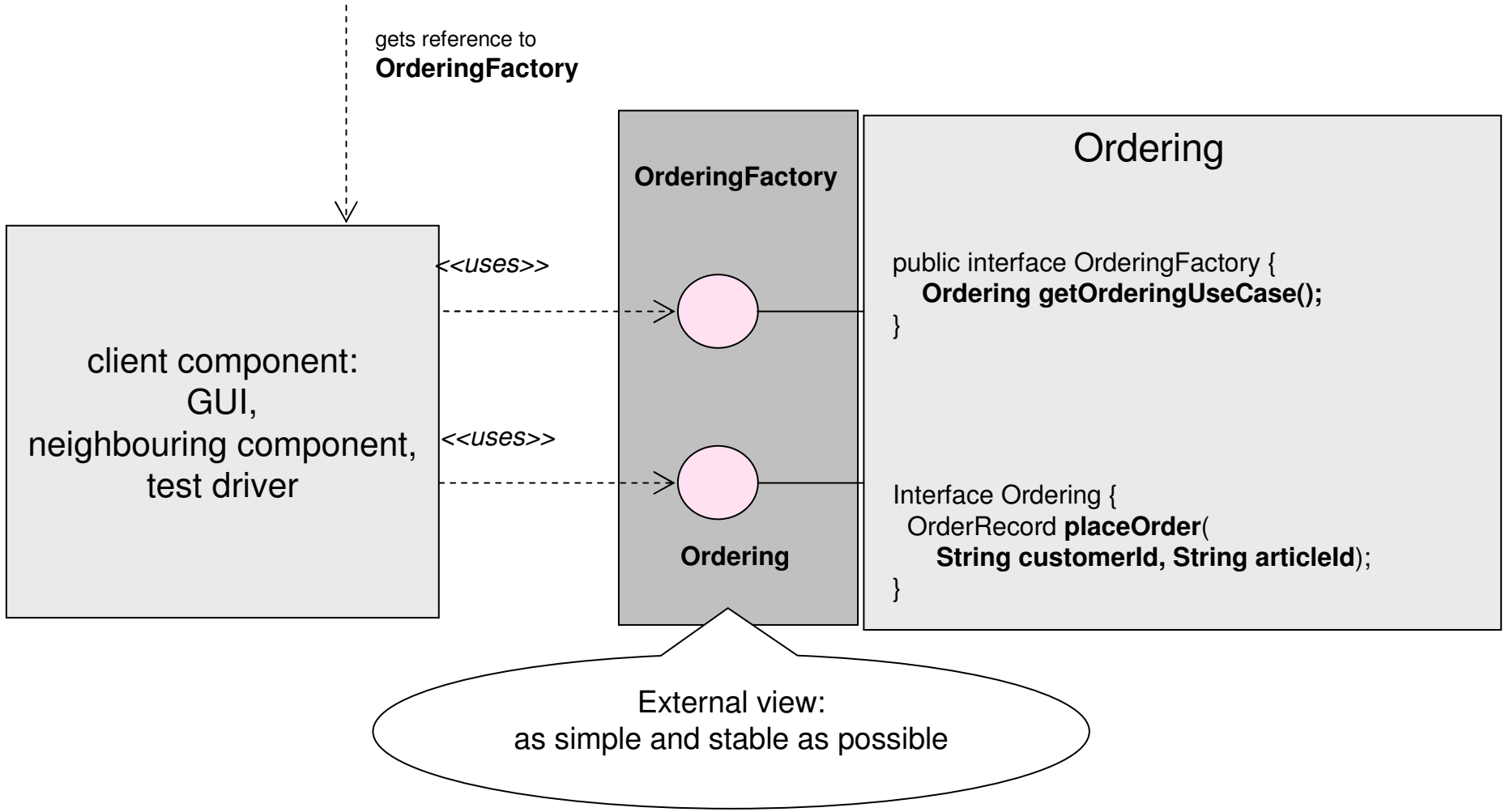
Application components

- Contain use cases, entities and entity managers
- Present use cases as interfaces for client software

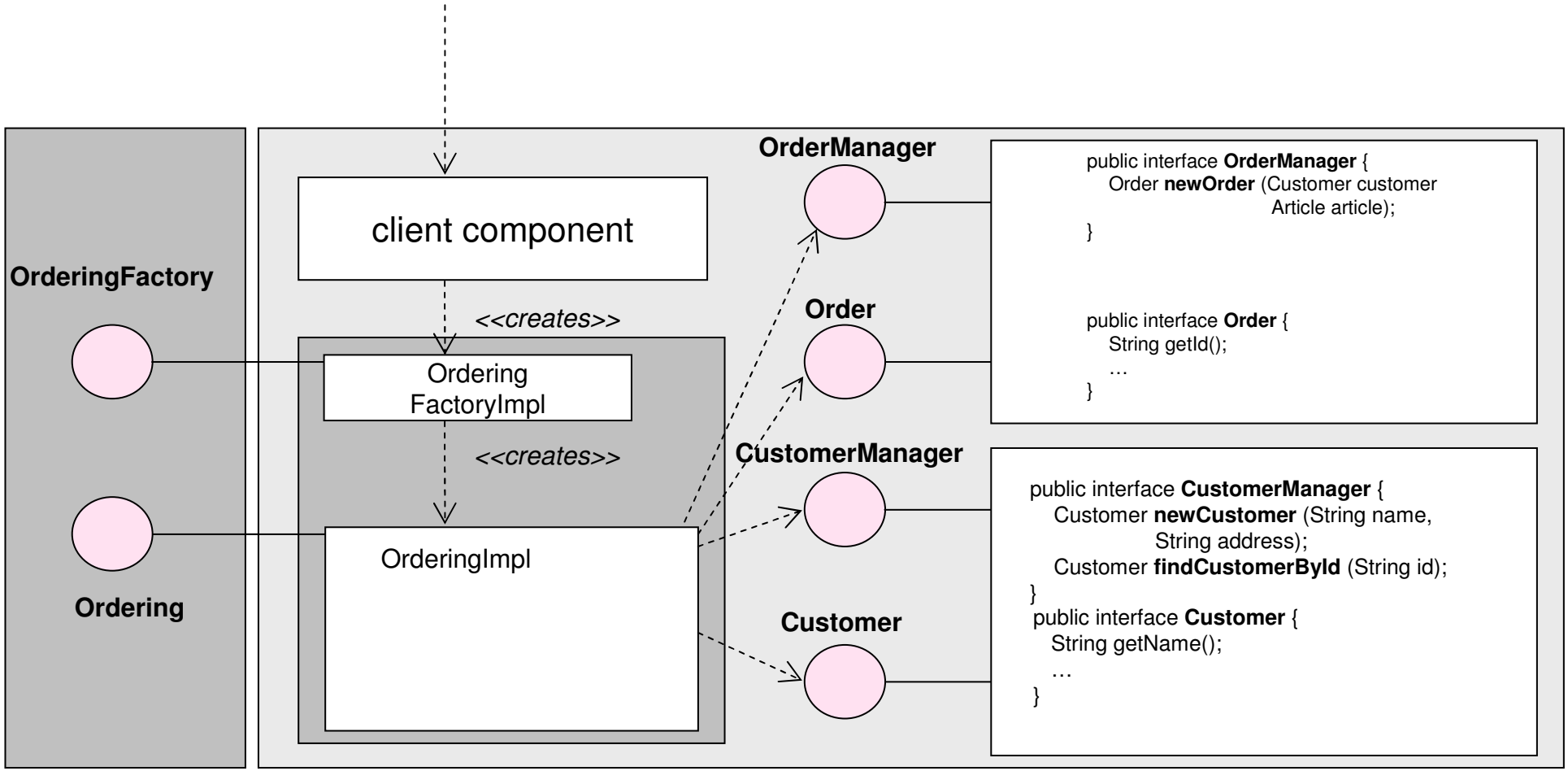
Component from the users' point of view

(i.e, application programmers who implement client components that use the component)

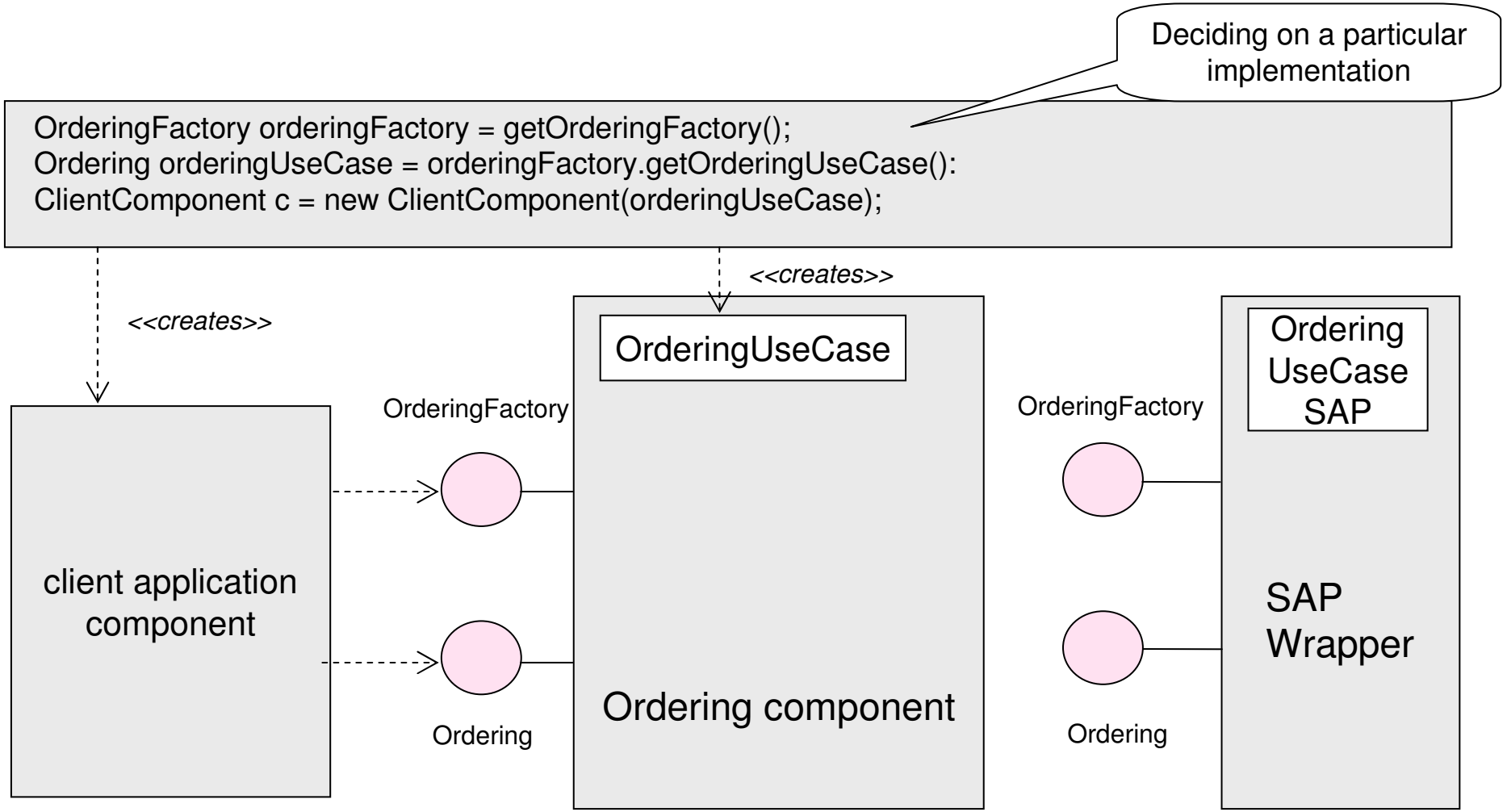


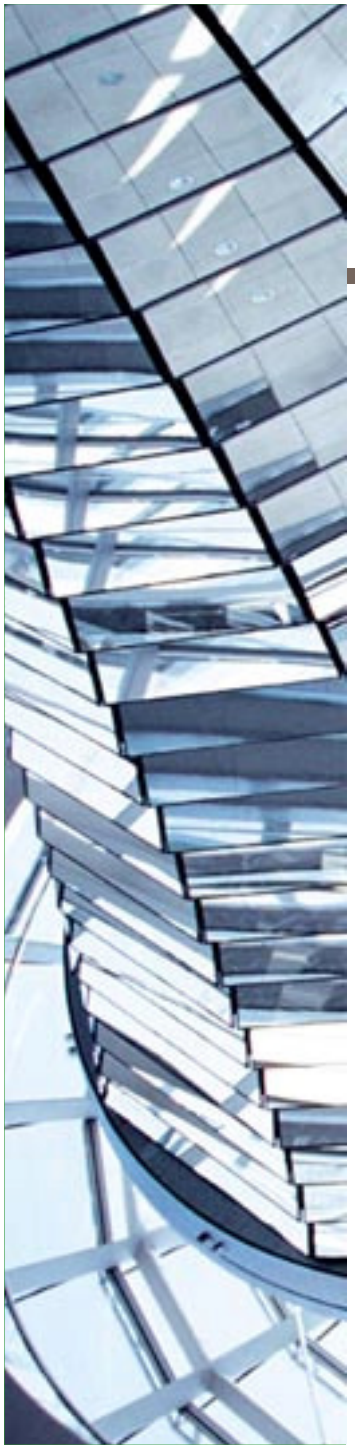
Component from the implementors' point of view

(i.e., application programmers who implement the ordering component)



Component from the integrator's point of view





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➔ **Realization with JEE**

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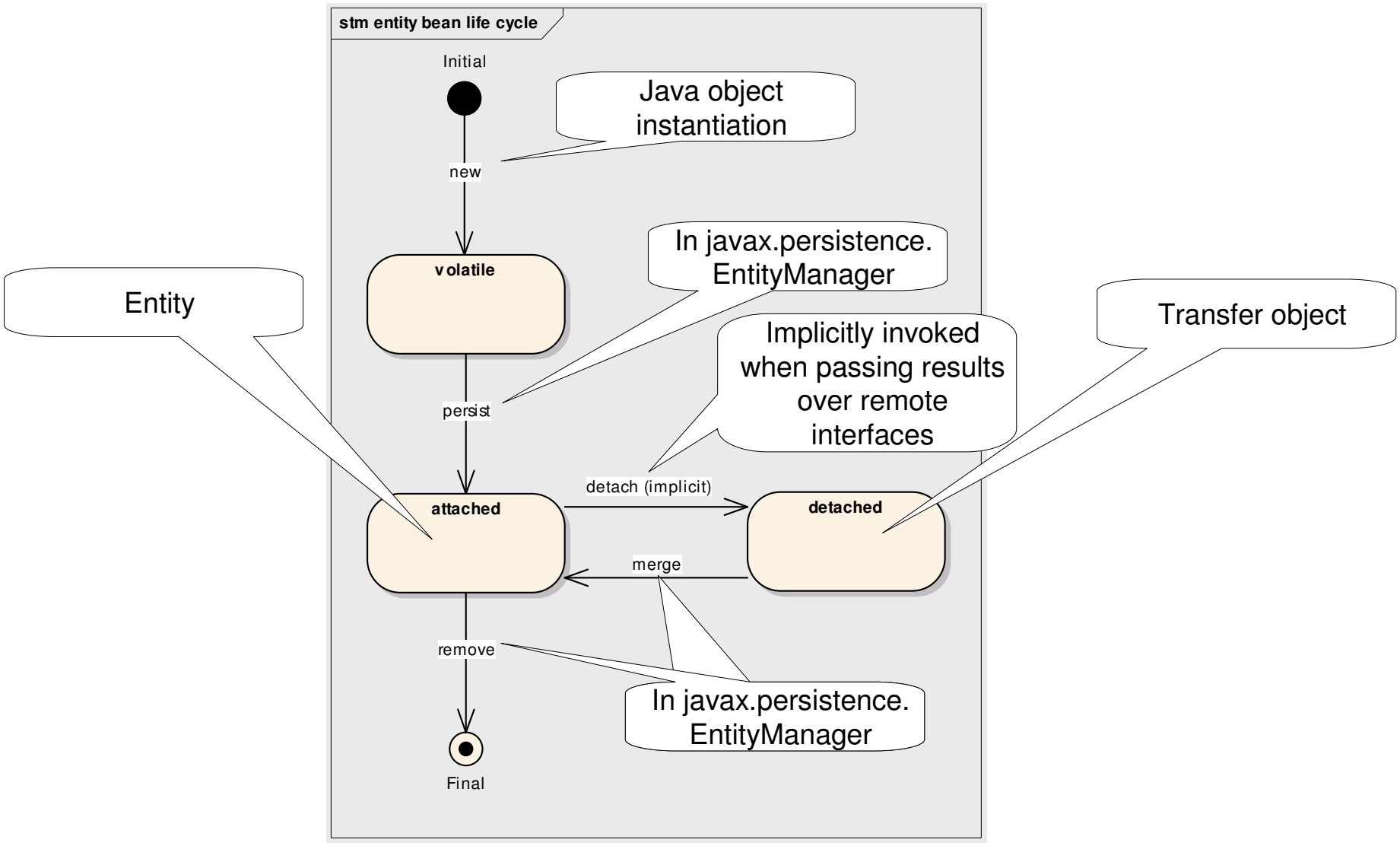
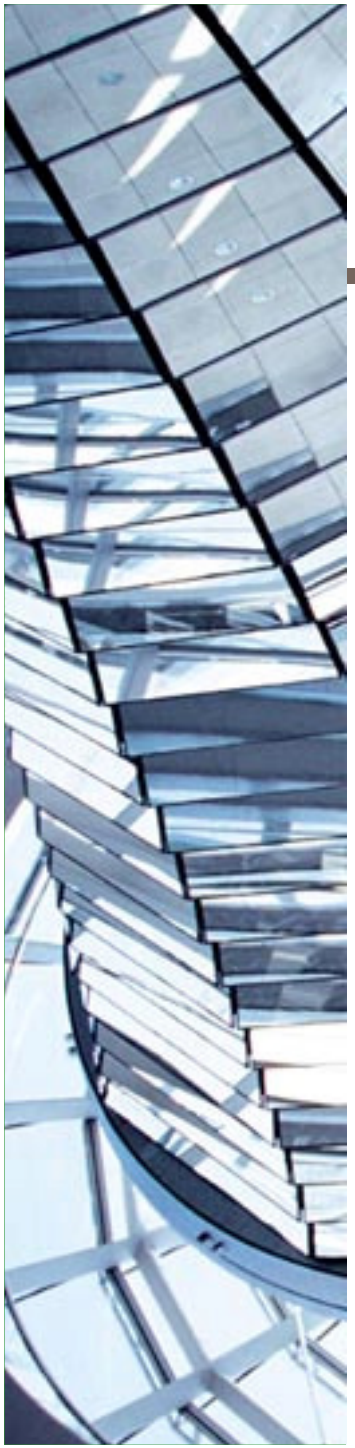
Realization of application kernel concepts with JEE / EJB

Concept	JEE / EJB Construct	Sample
Entity	Entity Bean	@Entity class Customer
Application data type	Java class that implements serializable	enum CustomerType
Entity manager	Stateless Session Bean + local interface	@Stateless class CustomerManagerImpl
Use case	Stateless Session Bean + remote interface	@Stateless class AccountingImpl
Transfer object	Detached Entity Bean	@Entity class Customer
Application component	Java package	package de.h_da.library.accounting

Life cycle of Entity Beans in EJB 3.0





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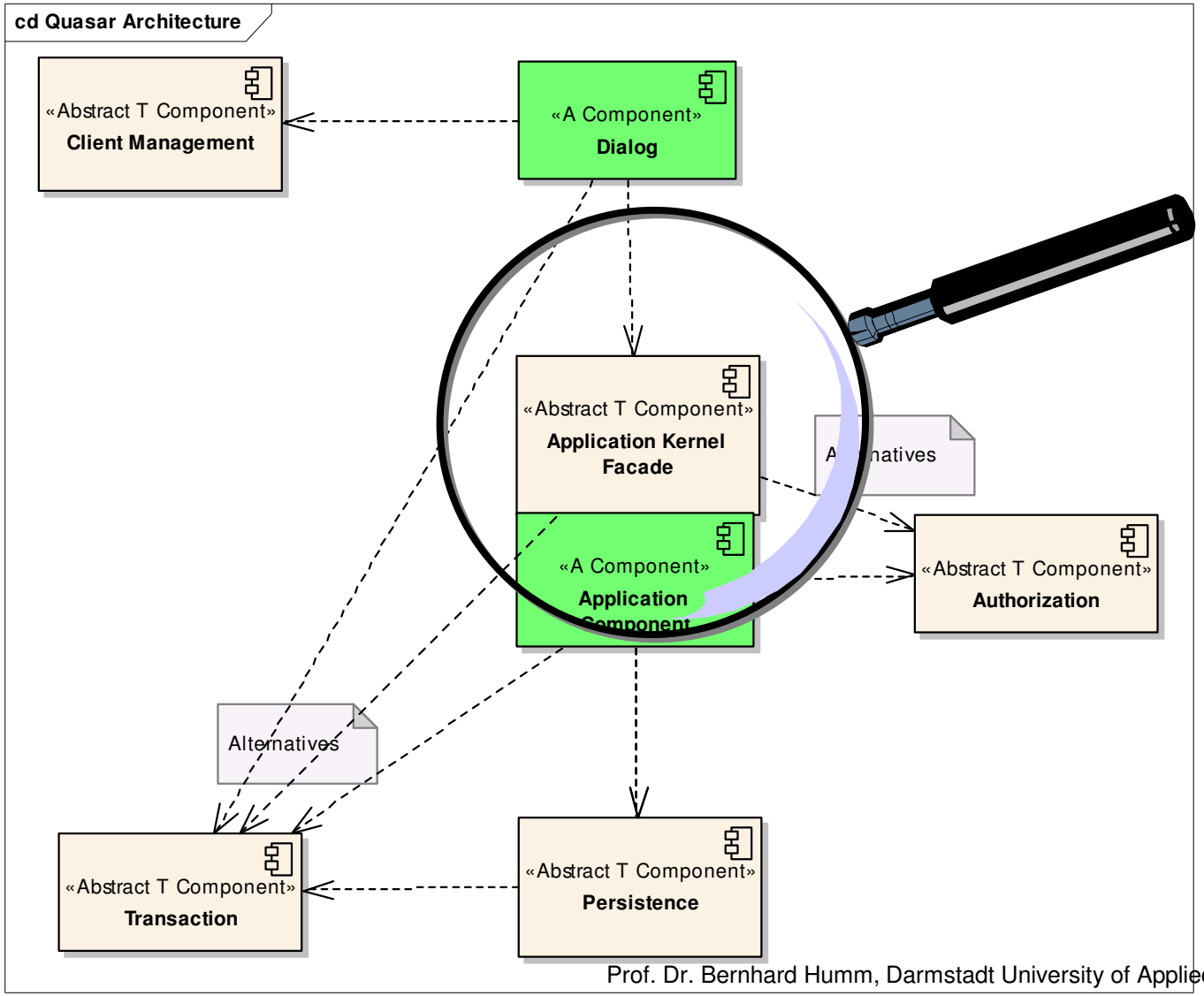
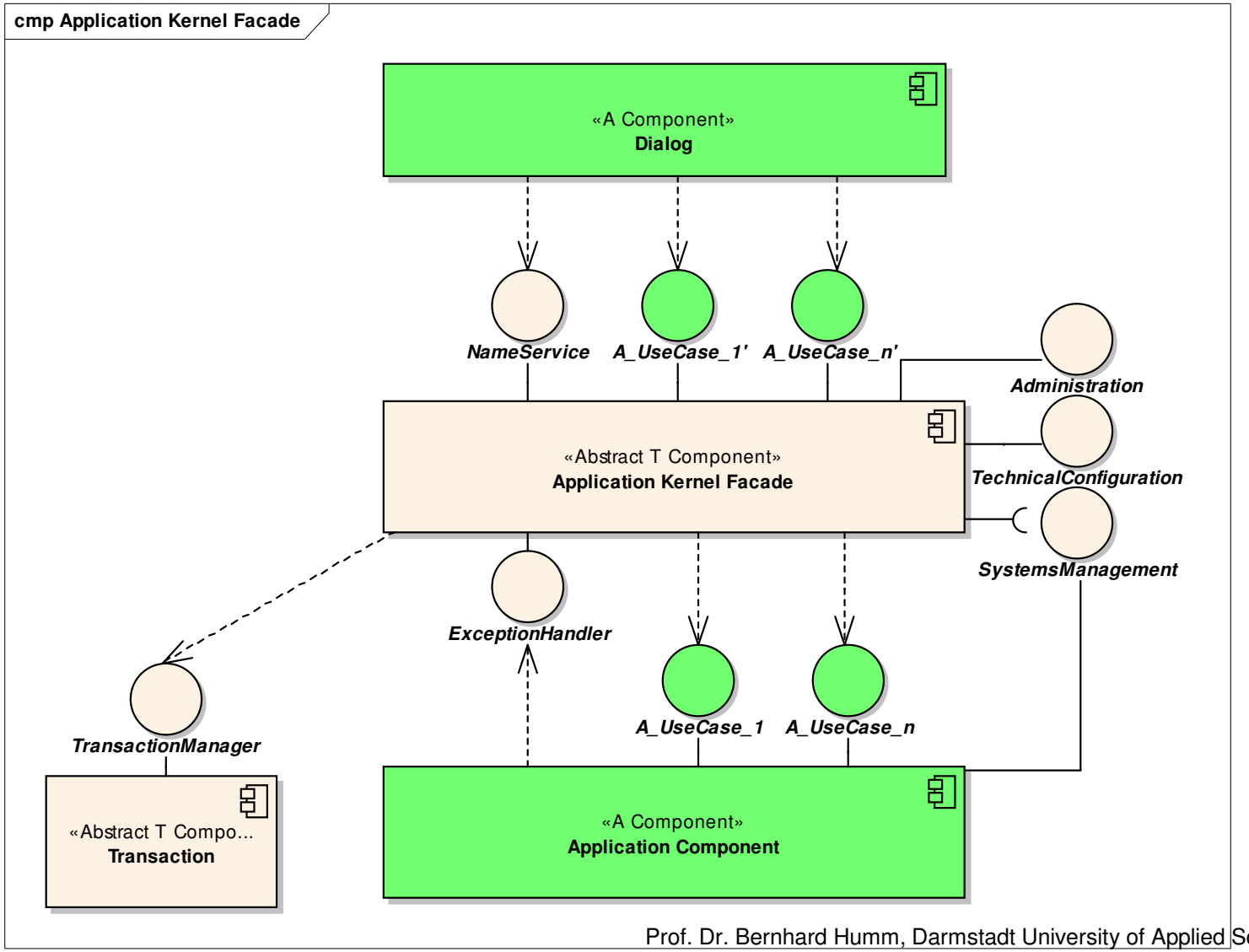


Application kernel facade



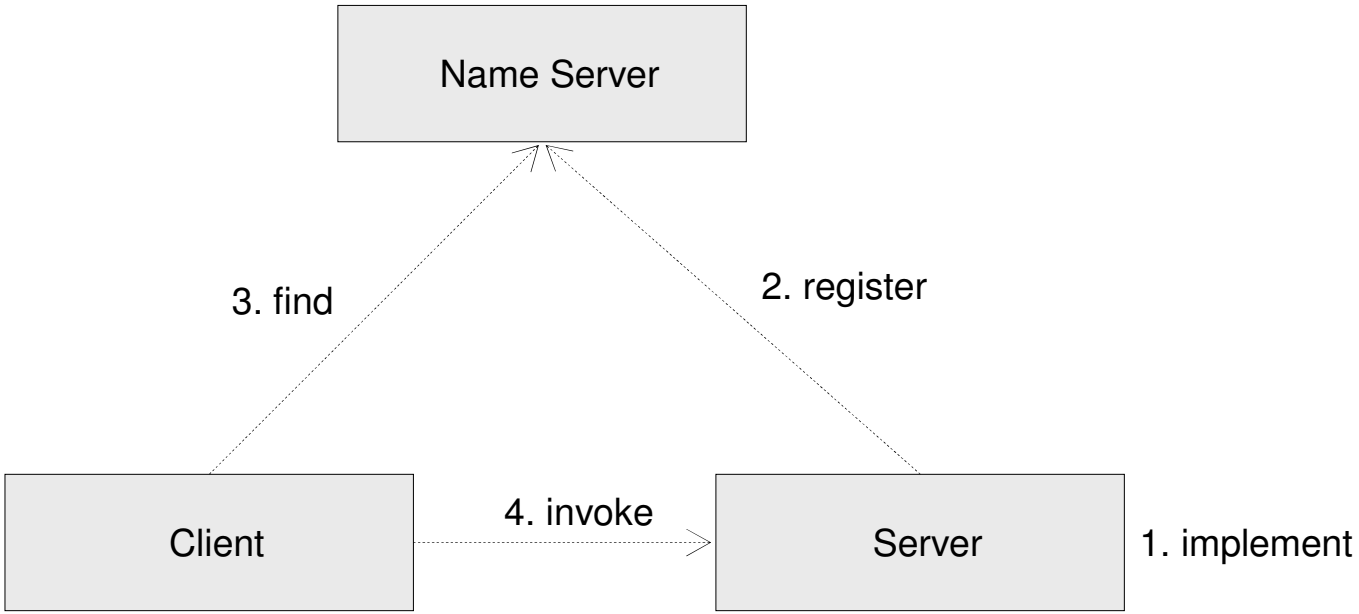
Added value:

- Location transparency
- Transactional behaviour
- Authorization
- Error Handling
- …

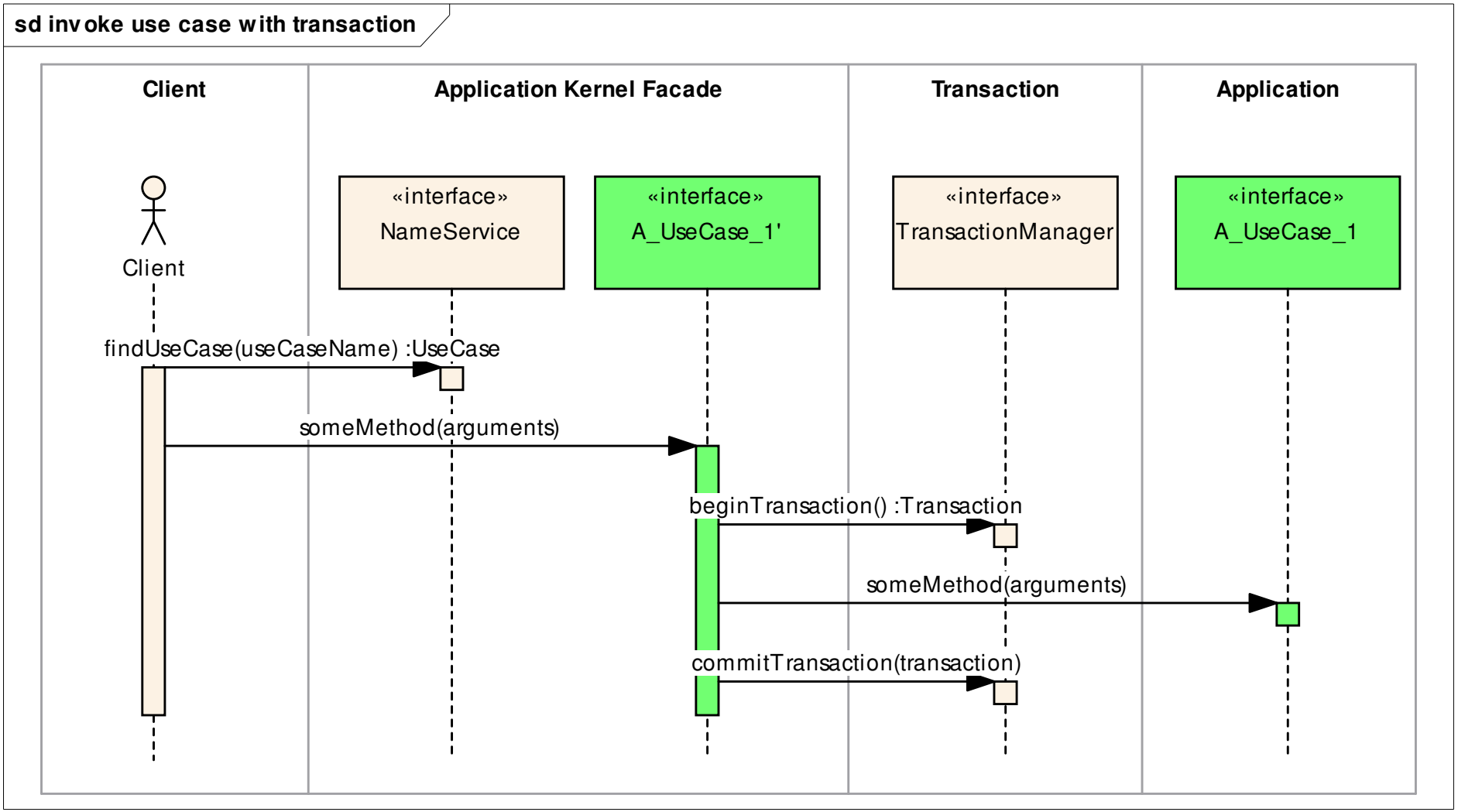
Realization of application kernel facade with JEE / EJB

Concept	JEE / EJB Construct	Sample
Location transparency (remote access)	JNDI (Java Naming and Directory Interface)	@Remote interface Accounting
Transactions	JTA (Java Transaction API) and EJB	@Transaction(REQUIRES_NEW) class AccountingImpl
Authentication and Authorization	JAAS (Java Authentication and Authorization Service) and EJB	@DeclareRoles({“Librarians“, “Customers“}) … @RolesAllowed({“Librarians“})
Systems Management	JMX (Java Management Extension)	

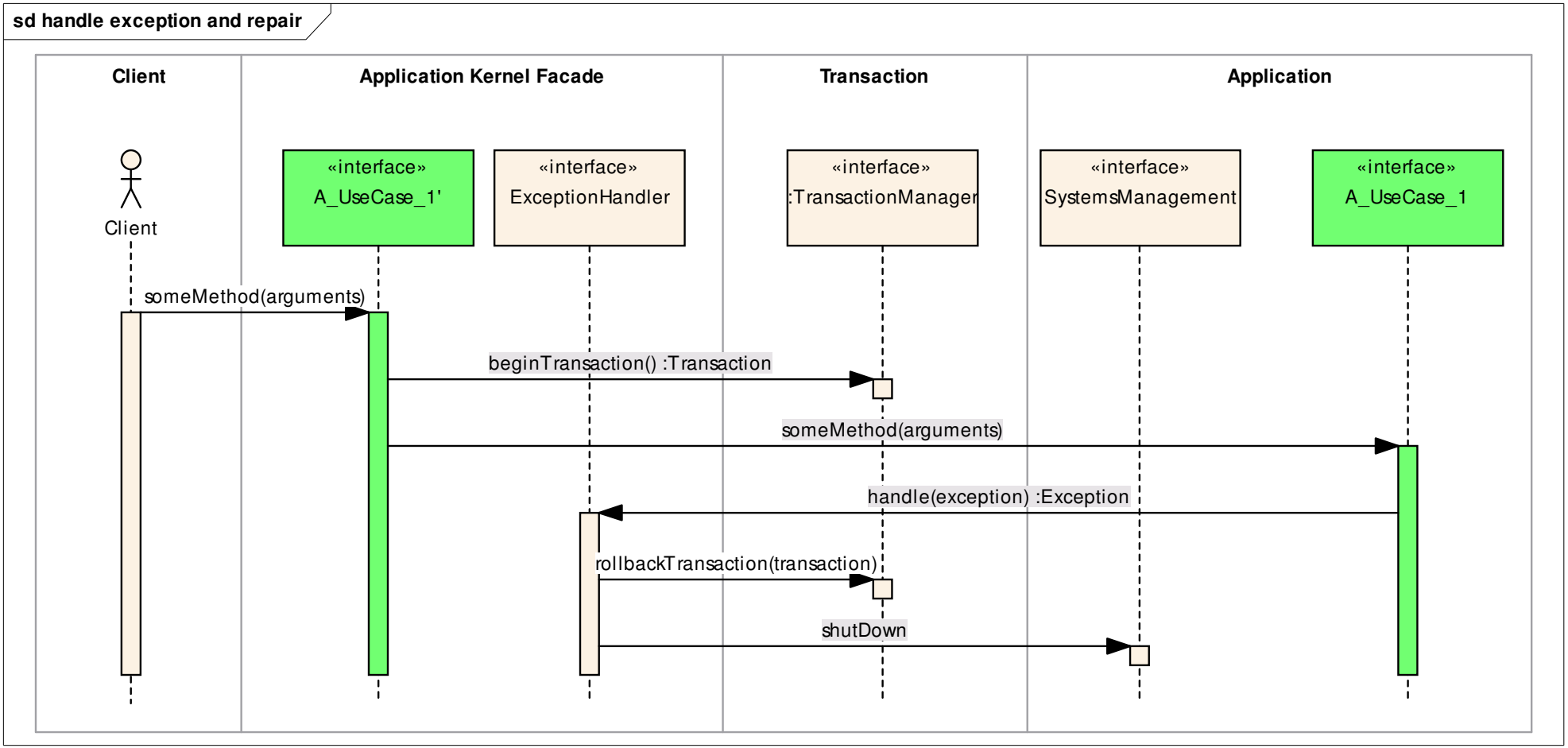
Name Service

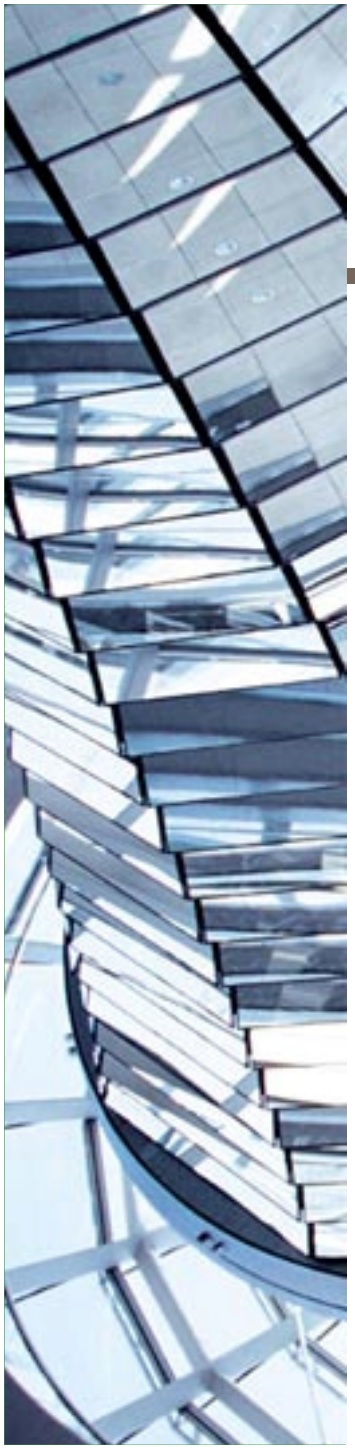


Sequence:
Invoke use case with transaction



Sequence: handle exception





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References for this lecture

Sections of „Teil 1“ dealing with today‘s lecture:

- 4. Standardarchitektur des Anwendungskerns