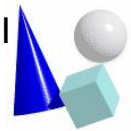
Department of Information Systems III
University of Mannheim
Germany



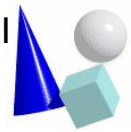
UNIVERSITY OF MANNHEIM

JDOSecure: A Security Architecture for the Java Data Objects-Specification

15th International Conference on

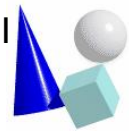
Software Engineering and Data Engineering (SEDE-2006)

Los Angeles, USA, 2006, 6.-8. July



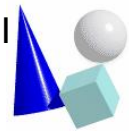
Agenda

1. Motivation
2. The Java Data Objects-Specification
3. Related Work: Persistence Solutions and Security
4. JDOSecure: A Security Architecture for the JDO-Specification
5. Conclusion



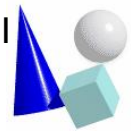
Motivation

- Object-Persistence is one key aspect when developing distributed multitiered enterprise applications
- Numerous requirements, e.g. performance, concurrency, transactions, interoperability, maintainability, etc.
- Different persistence solutions for Java e.g. Enterprise JavaBeans, O/R mapping tools (Hibernate, TopLink), OODMBS
- Provide an adequate mapping between the object-oriented application layer and the conceptually different data stores
- But proprietary or platform-dependent solutions often locks developers and limit application portability



Motivation

- Java Data Objects (JDO), a standardized persistence abstraction layer, wants to improve this situation
- JDO provides a data store independent abstraction layer and enables the mapping of domain object architectures to any type of data store (RDBMS, OODBMS, file system)
- Even JDO provides a promising framework for object persistence, it does not cover role-based security
- Consequently, when a JDO database connection is established, every user has full access privileges to the persistence instances of the data store



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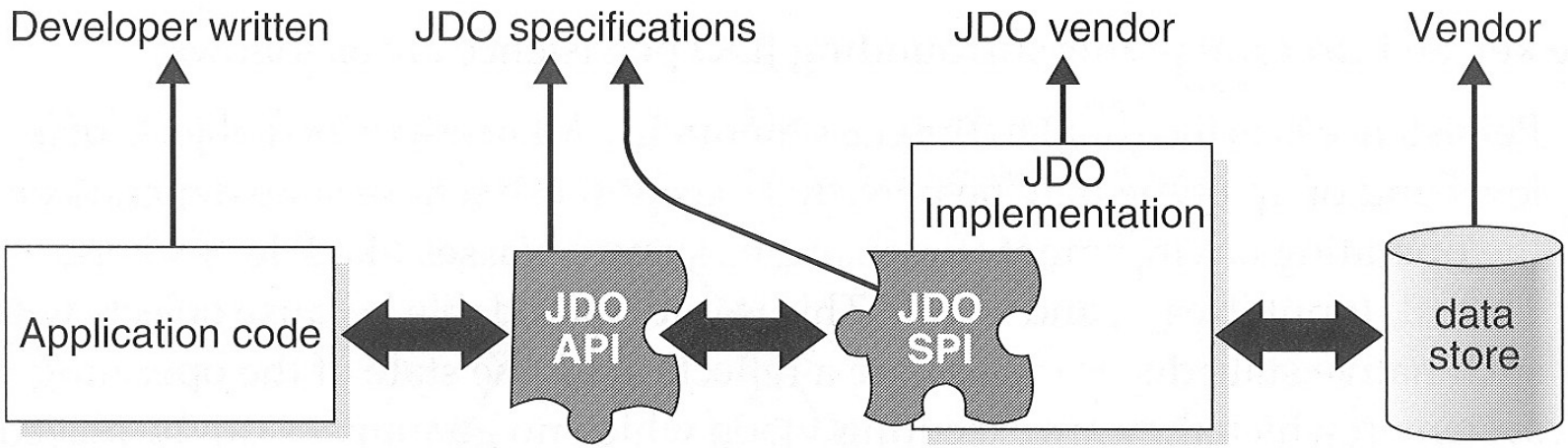
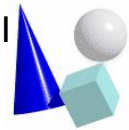
The Java Data Objects-Specification

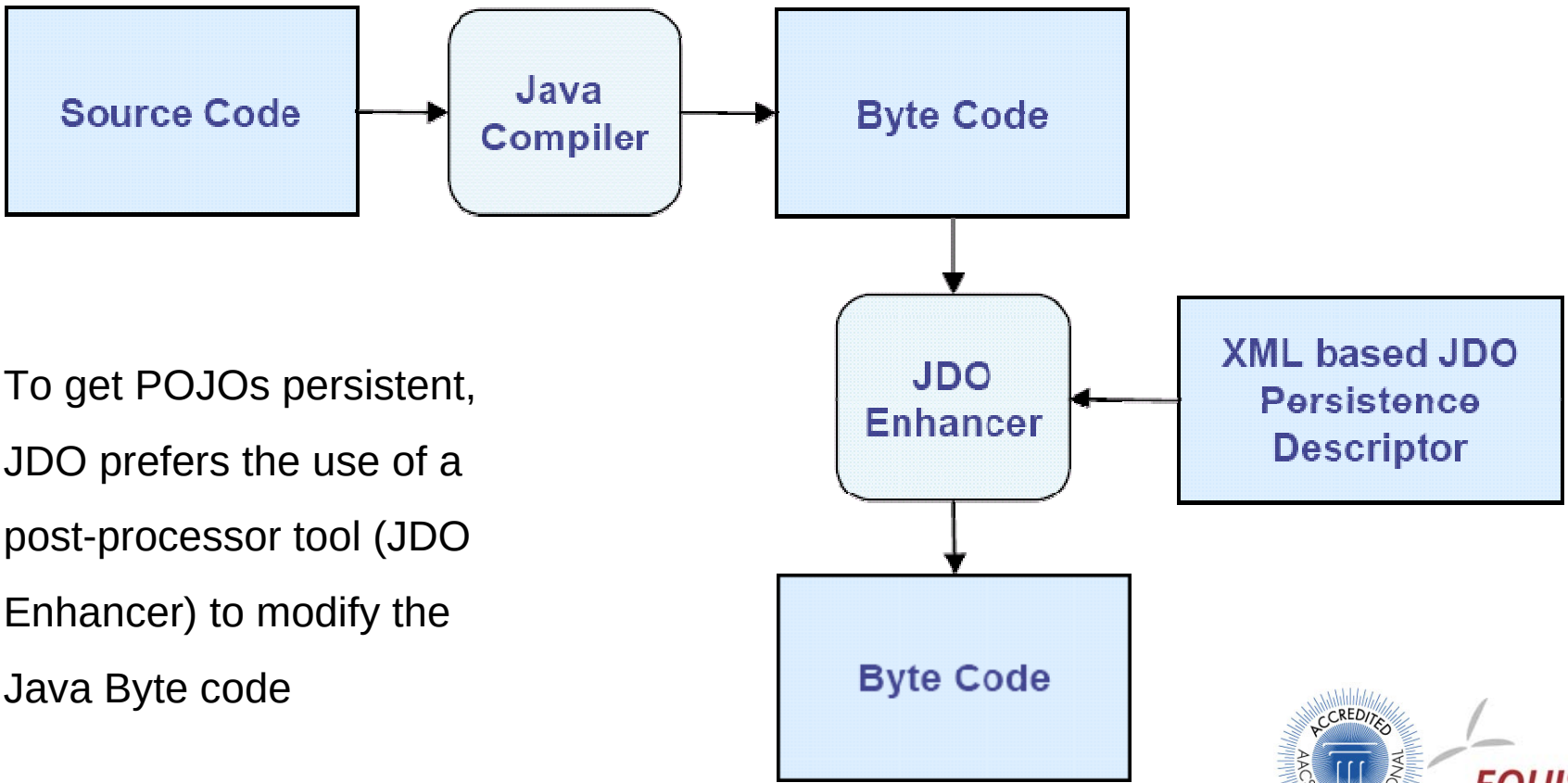
- The JDO specification includes two Interfaces:
  - JDO Application Programming Interface (JDO API)
  - JDO Service Provider Interface (JDO SPI)



Source: Core Java Data Objects

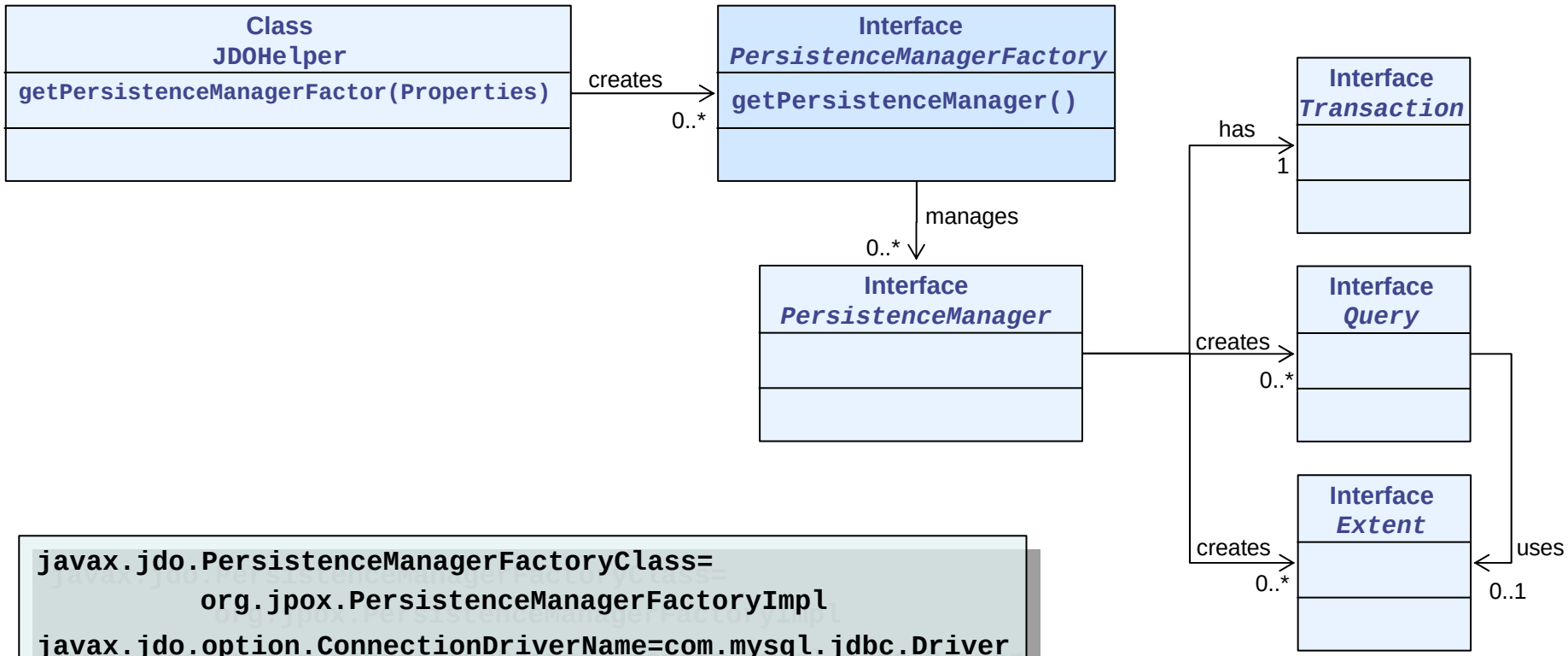


The Java Data Objects-Specification

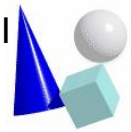


To get POJOs persistent, JDO prefers the use of a post-processor tool (JDO Enhancer) to modify the Java Byte code

The Java Data Objects-Specification




```
javax.jdo.PersistenceManagerFactoryClass=
          org.jpox.PersistenceManagerFactoryImpl
javax.jdo.option.ConnectionDriverName=com.mysql.jdbc.Driver
javax.jdo.option.ConnectionURL=jdbc:mysql://localhost/jpox
javax.jdo.option.ConnectionUserName=merz
javax.jdo.option.ConnectionPassword=********
```



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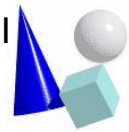
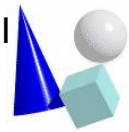


Related Work: Persistence Solutions and Security

Hibernate:

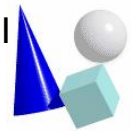
- A popular object/relational persistence and query service
- Originally it does not provide an access control mechanism
- At first, the Hibernate community proposes the usage of a declarative permissions approach using JAAS and the Interceptor interface
  (= allows the registration of a custom object that gets called by Hibernate)
- The recent version (Hibernate3) provides
  - User's authentication via JAAS
  - Permissions for CRUD operations for entities, based on the Java Authorization Contract for Containers (JACC)



Related Work: Persistence Solutions and Security

Enterprise JavaBeans (EJB):

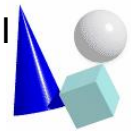
- Server-side component architecture for the J2EE platform
- Frees developers from having to deal with code that handles transactional behavior, security, connection pooling, threading, or even persistence
- Entity beans represent persistent data that can be shared across multiple simultaneous remote and local clients
- EJB distinguishes between programmatic and declarative authorization:
  - Programmatic authorization: Security checks have to be implemented by an entity bean provider using specific methods
  - Declarative authorization: Access permissions for EJB methods and security roles can be set-up in the deployment descriptor



Related Work: Persistence Solutions and Security

Provisional Result:

- Hibernate and EJB provide sufficient authentication and authorization capabilities
- In contrast, JDO does not provide an access control mechanism in order to restrict the access to the persistent objects
- As long as security gets more and more important when developing distributed multitiered enterprise applications, a widespread use of JDO is doubtful
- Thus, we have implemented an access control mechanism for JDO to significantly reduce the security specific barriers and to increase the security of JDO based architectures in future



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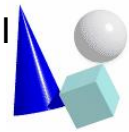


JDOSecure: A Security Architecture for the JDO-Specification

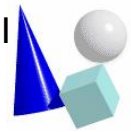
Challenges for developing JDOSecure:

Providing sufficient access-privileges with regard to

- Users and their roles
- Specific packages, classes and objects
- CRUD-Operations (Create, Retrieve, Update, Delete)

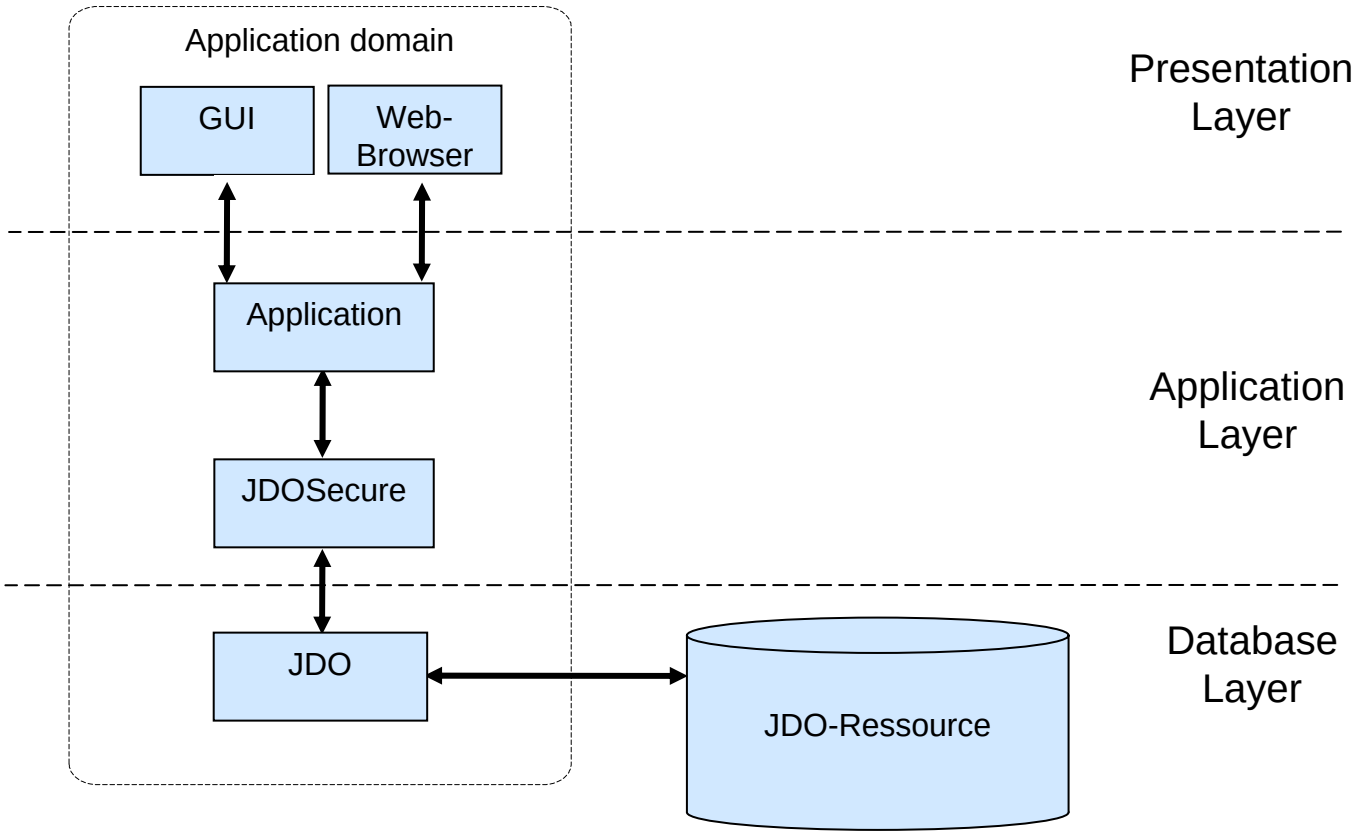
Additional requirements:

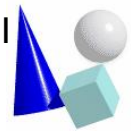
- Keep the solution JDO compatible
- Independency from a concrete JDO implementation
- No "work around" to compromise the security approach



JDOSecure: A Security Architecture for the JDO-Specification

Interposing Access Control between an Application and a JDO-Implementation

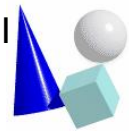




JDOSecure: A Security Architecture for the JDO-Specification

How to create an entry point for applications?

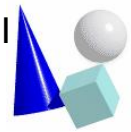
- A **`JDOSecureHelper`** class, derived from the original **`JDOHelper`**, overrides the **`getPersistenceManagerFactory()`** method
- It returns a dynamic proxy instance instead the real **`PersistenceManager`**
- This allows to introduce access-control capabilities in the associated **`PMInvocationHandler`**
- The dynamic proxy approach enables the collaboration with any JDO implementation, without source code modification



JDOSecure: A Security Architecture for the JDO-Specification

Dynamic Proxy

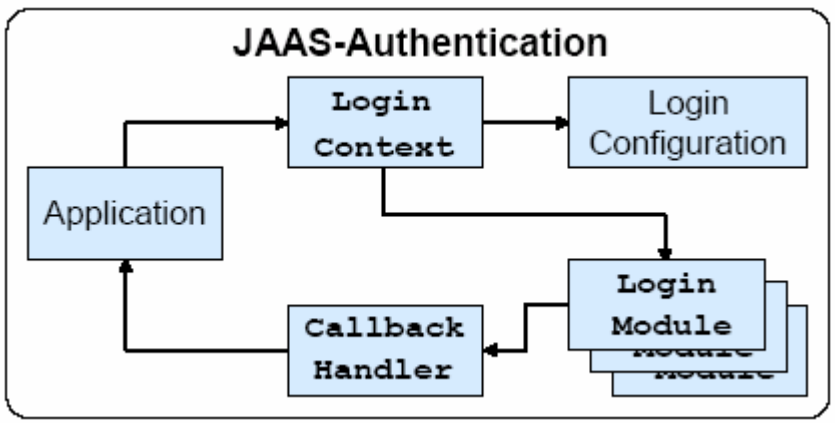
- A proxy provides "a placeholder for another object to control access to it"
- This allows to control the access to the real object
- One disadvantage of static proxies is the set-up at compile time
- The dynamic proxy approach allows the construction of a proxy instance dynamically at runtime
- It can be constructed at runtime only for a set of interfaces
- A dynamic proxy instance is always associated with an **`InvocationHandler`**
- Every call to the proxy is automatically redirected this instance
- The **`InvocationHandler`** allows to intercept method calls before they are forwarded to the real object

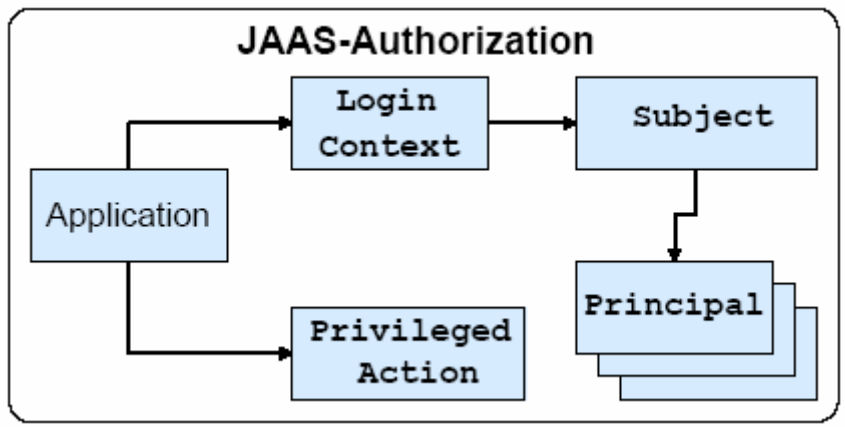


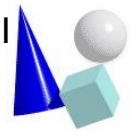
JDOSecure: A Security Architecture for the JDO-Specification

How to implement access-control?

- Java Authentication and Authorization Service (JAAS) allows to restrict the access to resources depending on the currently logged on user



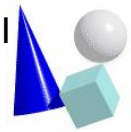




JDOSecure: A Security Architecture for the JDO-Specification

Authentication

- The **`Properties`** object passed to the **`JDOHelper`** class contains amongst others user ID and password to access a JDO resource
- The **`JDOSecureHelper`** class uses this information to authenticate the user
- If successful, the user ID and the password are replaced before the database connection is established
- The replacement is necessary to prevent a direct user connection to the database



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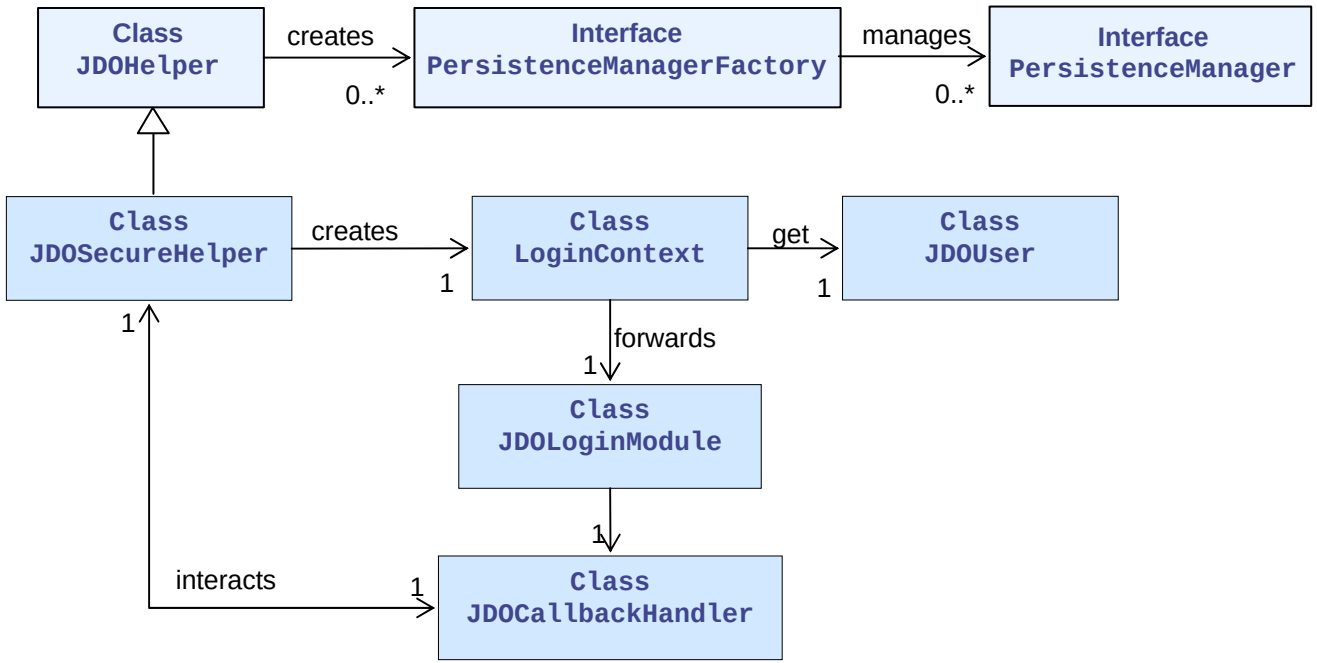
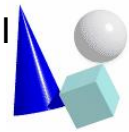


Context between JAAS-Authentication and JDOSecure



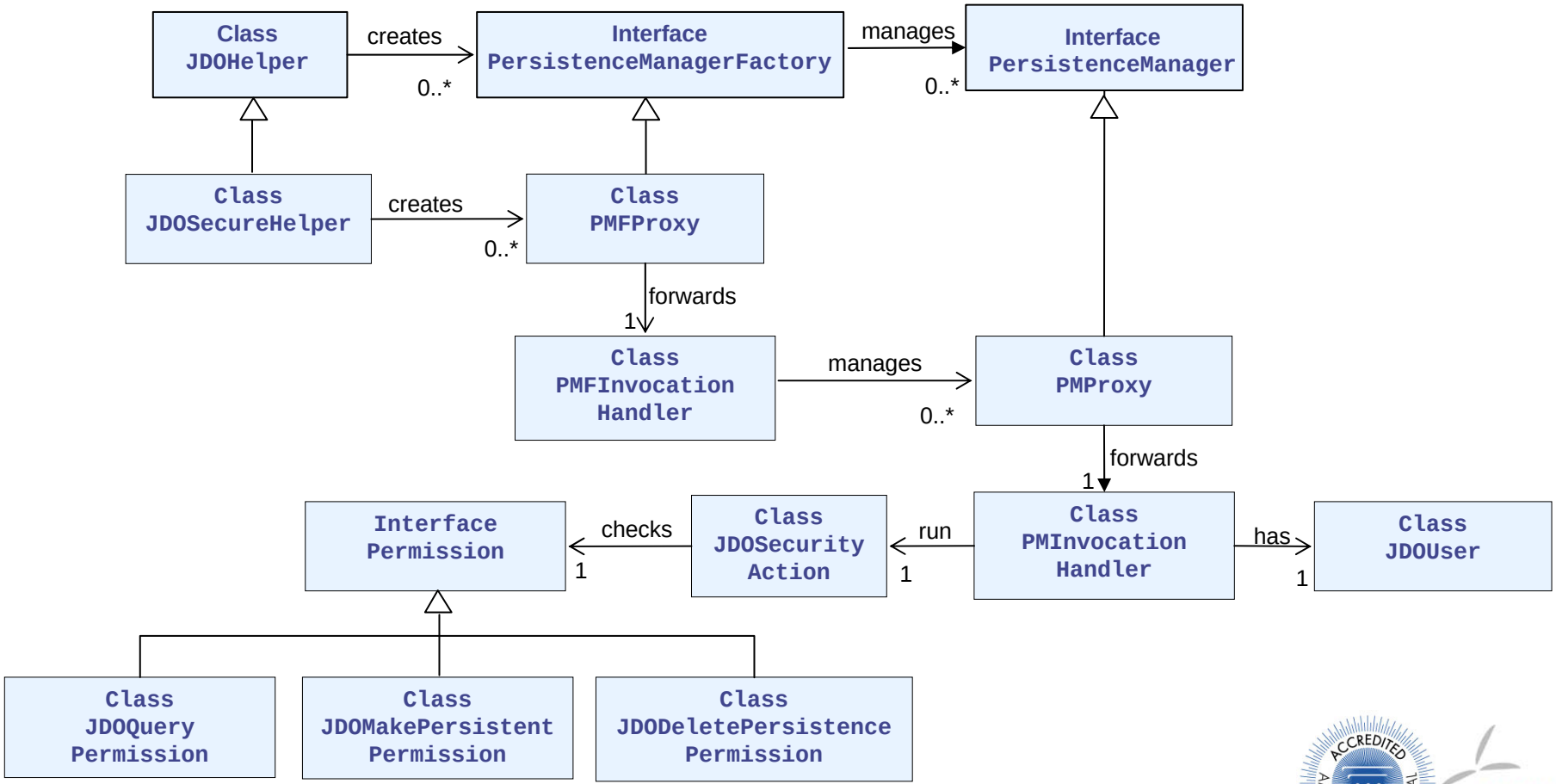
JDOSecure: A Security Architecture for the JDO-Specification

Authorization

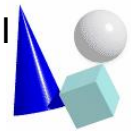
- Calls to the **`PersistenceManager`** proxy are only delegated, if the authenticated user has appropriate permissions
- Inside the **`PMInvocationHandler`**, the access-control is delegated to Java **`AccessController`** as part of JAAS
- E.g. the permission to invoke **`makePersistent()`** for objects of the package "org.sample" and a user ”sample” could be defined in a JAAS policy file:

```
grant Principal JDOUser "sample"{
    permission JDOMakePersistentPermission "org.sample.*";
}
```

JDOSecure: A Security Architecture for the JDO-Specification



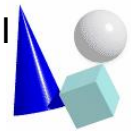
Context between JAAS-Authorization and JDOSecure



JDOSecure: A Security Architecture for the JDO-Specification

Update of object attributes:

- JDO doesn’t provide any methods to update object attributes or flushing instances after an update to the data store ("transparent persistence")
- Within the JDO Enhancement process every persistence capable instance is assigned with **`StateManager`**
- This instance is responsible for flushing changes to the data store
- To enable JDOSecure to permit or disallow the update process in regard with the permissions auf a user, the **`StateManager`** is also replaced by a dynamic proxy instance



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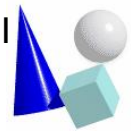
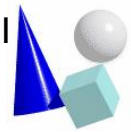


Conclusion

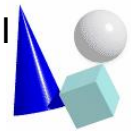
- As it turns out, other persistence solutions like Hibernate and EJB provide sufficient authentication and authorization capabilities
- In contrast, JDO does not provide an access control mechanism
- JDOSecure has been developed to significantly reduce the security specific barriers within the JDO specification and to increase the security of JDO based architectures
- It and allows to define role-based permissions that can be defined individually
  - for every user/role
  - with regards to certain operations (create, delete, update, or query)
  - and for a specific object, class, or package



Conclusion

Future Work:

- Defining appropriate permissions JAAS policy-files becomes more and more complex with an increasing number of different users and roles
- To reduce possible inconsistency and potential typos, we are developing a management solution for users, roles, and permissions
- This management solution should enable to store the authentication and authorization information in any arbitrary JDO resource
- An administration utility with a graphical user interface should also simplifies the maintenance of security privileges and permissions.



Conclusion

Thank you for your attention!

More information can be found at

`http://projekt-jdo.uni-mannheim.de/JDOSecure`