SolarMetric

Kodo™ JDO

The Future of Object Persistence

St Louis JUG

13 January 2005

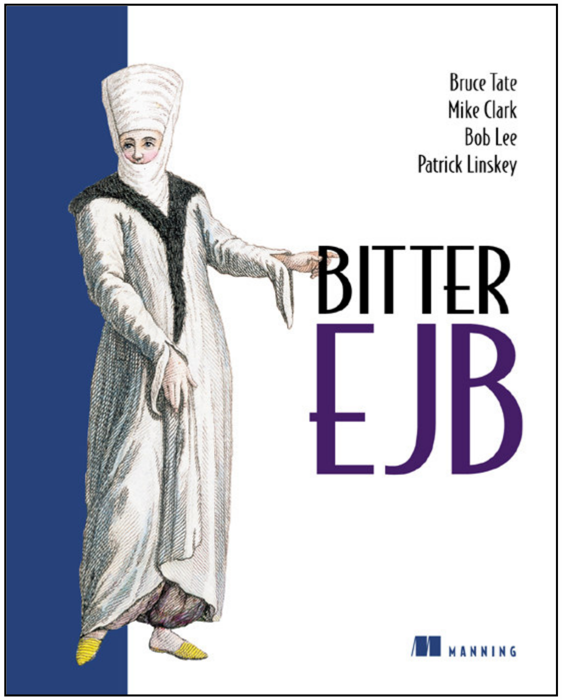
Patrick Linskey
pcl@solarmetric.com

About Me

SolarMetric

Patrick Linskey

- CTO at SolarMetric
- Involved in object/relational mapping and EJB since 1999
- Frequent JDO presenter at JUGs, Java conventions and seminars
- Member, JDO Expert Group
- Member, EJB Expert Group
- Luminary, JDOcentral
- Co-author of *Bitter EJB* along with Bruce Tate, Mike Clark, and Bob Lee



Corporate Profile

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- International Company Based in Austin, TX
  - Offices in London, California, Massachusetts
  - Through partners, reach is worldwide
- Founded in 2001 by MIT alums.
  - Core team has been together since 1997.
- Frustrated with trying to do Java object persistence with:
  - Proprietary Tools – Vendor Lock-in
  - Entity beans – difficult, slow, impose undesirable constraints on object model and development patterns
- Committed to Technical Quality and Innovation, Customer Support
- Leading JDO implementation
- Client base is diverse, both in terms of industry and size
  - 300+ customers
- Regular JDO Training courses throughout the world

SolarMetric's Role

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JSR 220 (EJB 3)

- Actively contributing member
- Actively developing preview version of the EJB 3 specification

JSR 243 (JDO 2)

- Will continue active role on the development and release of JDO 2
- Will continue active development of Kodo's JDO bindings, for JDO 2 and for future JDO versions

Object / Relational Mapping

Object / Relational Mapping

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- Object-oriented programming languages are vastly different than relational data languages.
- Object / relational “impedance mismatch” has plagued enterprise programmers for years.
  - Mapping
  - Remoteness of data
- Proprietary O/R mapping products exist for a variety of languages: Smalltalk, C++, Java, others.
- JDO and EJB3
  - designed for object/relational mapping and
  - designed to work inside and outside a container

Why not just JDBC?

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- JDBC misses the “O” part of O/R mapping
  - Interface is not at an object level but rather at SQL (row and column) level
  - Not Java
  - Creates complexity especially when leveraging OO concepts e.g., inheritance, polymorphism
- JDBC is a low level API
  - Used as a building block by most O/R mapping tools
- Sadly, SQL is not portable
  - Many different dialects

Goals of an O/R specification

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- Abstract API for object persistence
- No need to write persistence infrastructure
- Standard means of persisting objects. Low risk of vendor lock-in
- Portability between data stores

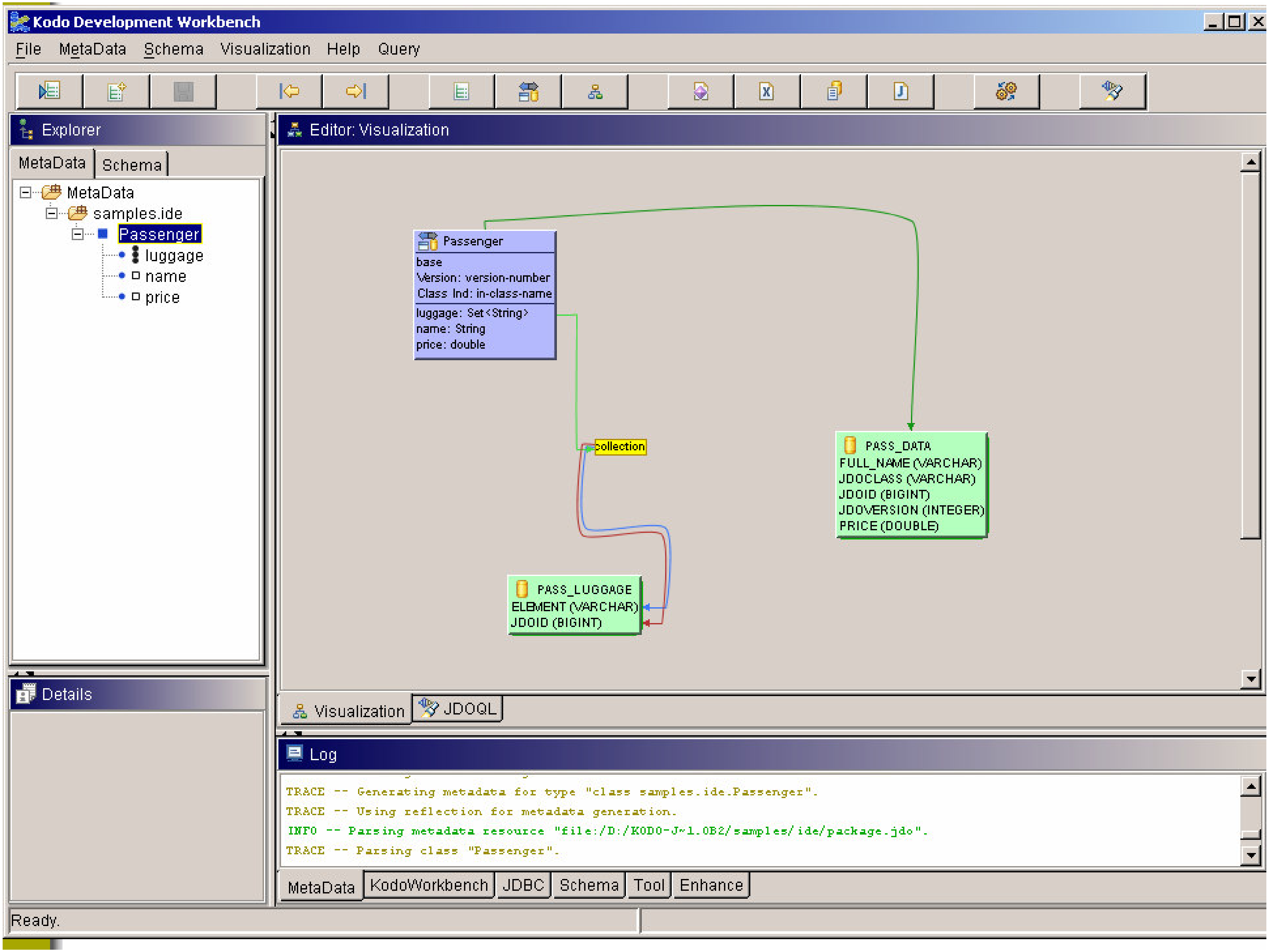
Requirements of an O/R Specification

- Persist objects whether simple or complex mapping is required
- Query those persisted objects
- Minimize visibility of O/R mapping APIs
- Connection management
- Transaction management
- Allow object model and data model to be optimized independently

Mapping Objects to RDBMS

- Many ways to “map” (describe the relationship) between an object model and a schema
  - Map directly to a column
  - Relationships between objects can be mimicked with foreign key relationships in schema
  - Collections of objects can be:
    - One-to-many
    - Many-to-many with a join table
- Schema and classes are not tied together

Most good O/R Solutions Have Tools To Help with Mappings



```
TRACE -- Generating metadata for type "class samples.ide.Passenger".
TRACE -- Using reflection for metadata generation.
INFO -- Parsing metadata resource "file:/D:/KODO-J~1.0B2/samples/ide/package.jdo".
TRACE -- Parsing class "Passenger".
```

Benefits of these specs

There are already a number of persistence solutions out there. What does JDO and EJB3 UPS bring to the table?

- Defer decisions
- Focus on core competencies
- Use Java to its fullest
- Project maintainability

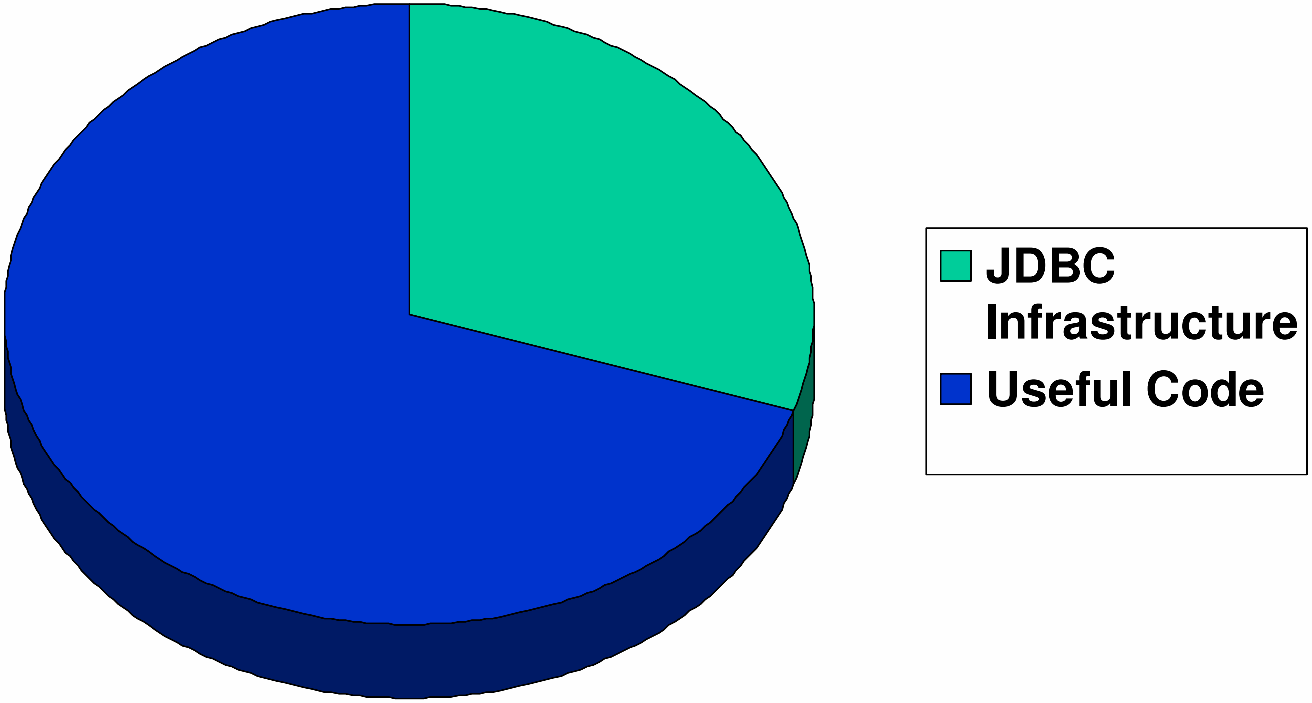
Defer data store decisions

- Choice of persistence technology should not require any other architecture decisions

- Entity beans prior to EJB3: require the use of a container
- JDBC and proprietary object-relational mapping: require a relational database
  - often, results in dependencies to a particular SQL variant
- Changes to schema would cause pain and large amounts of code rewriting

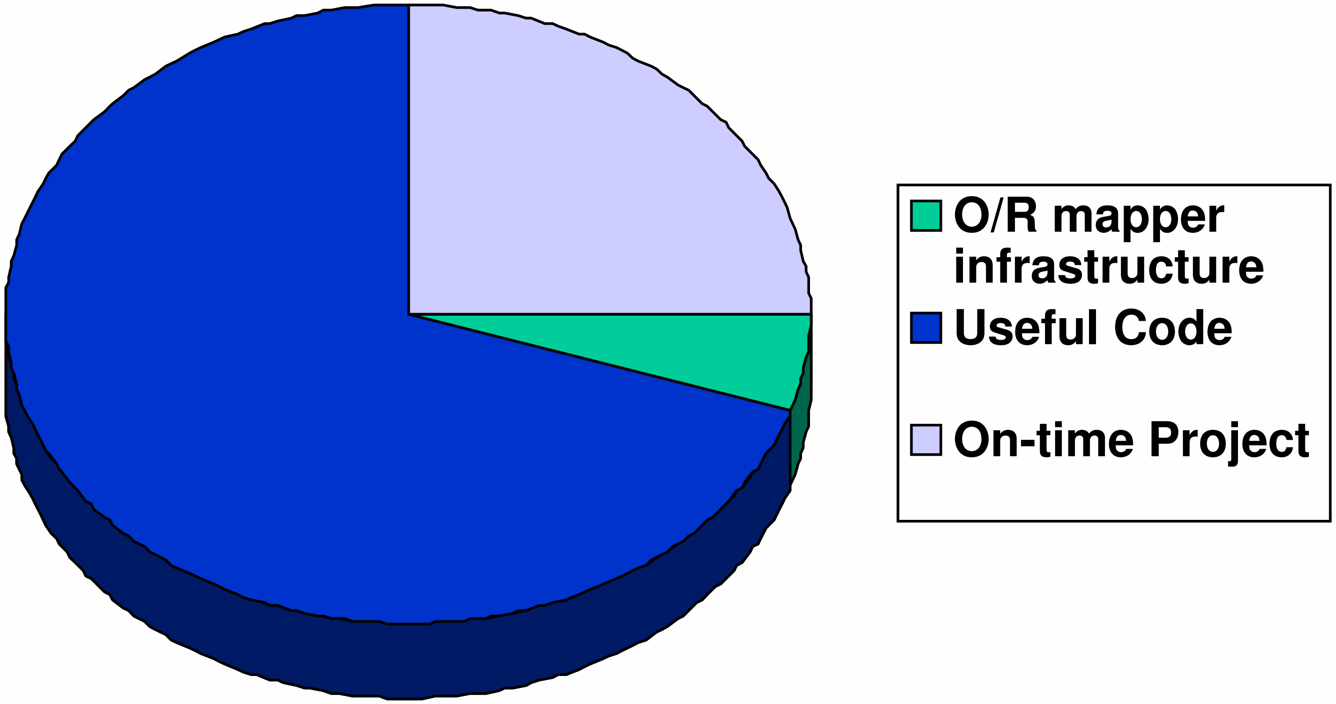
- JDO and EJB3: seamlessly work with J2EE, but do not require it. Can be used with all sorts of data stores (relational, legacy EISs, J2ME devices, ...)

Focus on core competencies



- 20% to 40% of typical JDBC projects is persistence infrastructure
- JDBC code is repetitive and difficult, and therefore prone to errors

Focus on core competencies



- O/R mapper’s infrastructure is typically closer to 5%
- No boilerplate code, so less room for cut-and-paste errors

Use Java to its fullest

O/R mapping is designed to integrate seamlessly with Java

- Polymorphism, both in queries and relations
  - Show me all the Vehicles in the warehouse
- Data encapsulation supported

Developers need not re-learn new rules and limitations. Regular Java concepts behave exactly as expected.

Maintenance over time

- Most interaction happens through object model
- Direct use of APIs is minimal, so is readily understandable
  - query for objects
  - transaction demarcation (when used outside a JTA environment)
  - adding objects to database

Why O/R mapping?

To sum up, an O/R mapping framework enables you to:

- Make architecture and data store decisions as needed
- Do more "real work" in a given amount of time
- Do the same amount of "real work" in less time
- Write regular Java, without learning all sorts of restrictions
- More easily maintain your code base through its lifecycle

JDO 2 Status / Schedule

JDO 2 is an Evolution from JDO 1, Not a Revolution

- Maintain Java Data Objects 1.0 Compatibility
- Standardize Mapping to Relational DB
  - SQL as a supported query language
- Multi-tier Development Improvements
  - Disconnected Object Graphs
- Usability Improvements
- Better Object Modelling
- Richer Queries
  - Single-line format
  - Projections
  - Aggregates
  - Paging Query Results
- More Vendor Support
  - Remove PersistenceCapable requirement

JDO 2.0 schedule

- Public Draft currently available
- TCK, RI being developed in the Apache project
- JDO2 jars should be available in the next few weeks
- Final JDO2 specification (including TCK and RI) in four to eight months

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Unnamed Persistence Specification (UPS) Status

Enterprise Java Beans 3

The Announcement

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- http://java.sun.com/j2ee/letter/persistence.html

Historical background

- Core of EJB and JDO specs have included persistence
- Data persistence models have differed
- Sun is leading a community effort to have a single POJO persistence model

The Announcement

- http://java.sun.com/j2ee/letter/persistence.html

Summary of announcement

- Added 6 JDO members to JSR-220 (EJB3 Spec Team)
- All current JDO experts are listeners on JSR-220 list
- Work will start under JSR-220 but independent of EJB3
- Goal: Single O/R Mapping Framework for J2EE, J2SE
- Timeframe: J2EE 5.0 (January 2006 currently)

EJB 3

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- Unnamed Persistence Specification (UPS) is part of EJB3
- Work in progress on a second Early Release Draft
- Heavy utilization of annotations
- Lots of mis-information out there
  - No existing product is UPS

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Criteria to Consider When Choosing a Persistence Solution

Looking for a Persistence Solution? (1 of 3)

<u>Criteria to Consider</u>

- Standards based vs. Proprietary
  - Portability – avoid vendor lock-in
  - Specification created by experienced community members vs. 1 individual or 1 company with other goals
- Which standard?
  - JDO (27+ implementations)
  - EJB3
  - Both
- Total Cost of Ownership
  - Upfront Costs vs. Runtime Costs
  - Support Costs
  - Maintenance Costs
  - Training Costs

Looking for a Persistence Solution? (2 of 3)

Criteria to Consider

- Ease of Use
  - Tooling
- Ability to Optimize Scalability & Performance Trade-Offs
- Supported Mappings
  - Custom Mappings Available?
- Extensibility
- Datastore Flexibility
  - Relational
  - Non-relational (legacy, hierarchical, object, etc.)
- Architecture flexibility
  - In container – session beans, CMP, BMP
  - Outside container – servlets, Spring, JSP, client-server

Looking for a Persistence Solution? (3 of 3)

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Criteria to Consider

- Performance and Scalability Issues
  - Lazy Loading
  - Dirty Field Tracking
  - Caching (pluggable caching with variety of invalidation strategies)
  - Minimize Round-Tripping
- Legacy Database Support
  - Stored Procedure Support
  - SQL Support
- Supporting Organization
  - Tied to another product?
  - Organization’s thought leadership
  - Support response times
- Legal Issues
  - Indemnification

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Kodo Product Suite

Kodo Roadmap

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- Continue to build an underlying engine that promotes:
  - Performance
  - Scalability
  - Flexibility
  - Ease of Use
- Will offer multiple bindings to the underlying Kodo engine
  - Kodo JDO – JDO bindings
  - Kodo “UPS” – “UPS” (Unnamed Persistence Spec) bindings
- Interoperability between Kodo JDO and Kodo “UPS”
  - Will be possible to simultaneously use both APIs with same domain model

Current Situation – Kodo JDO

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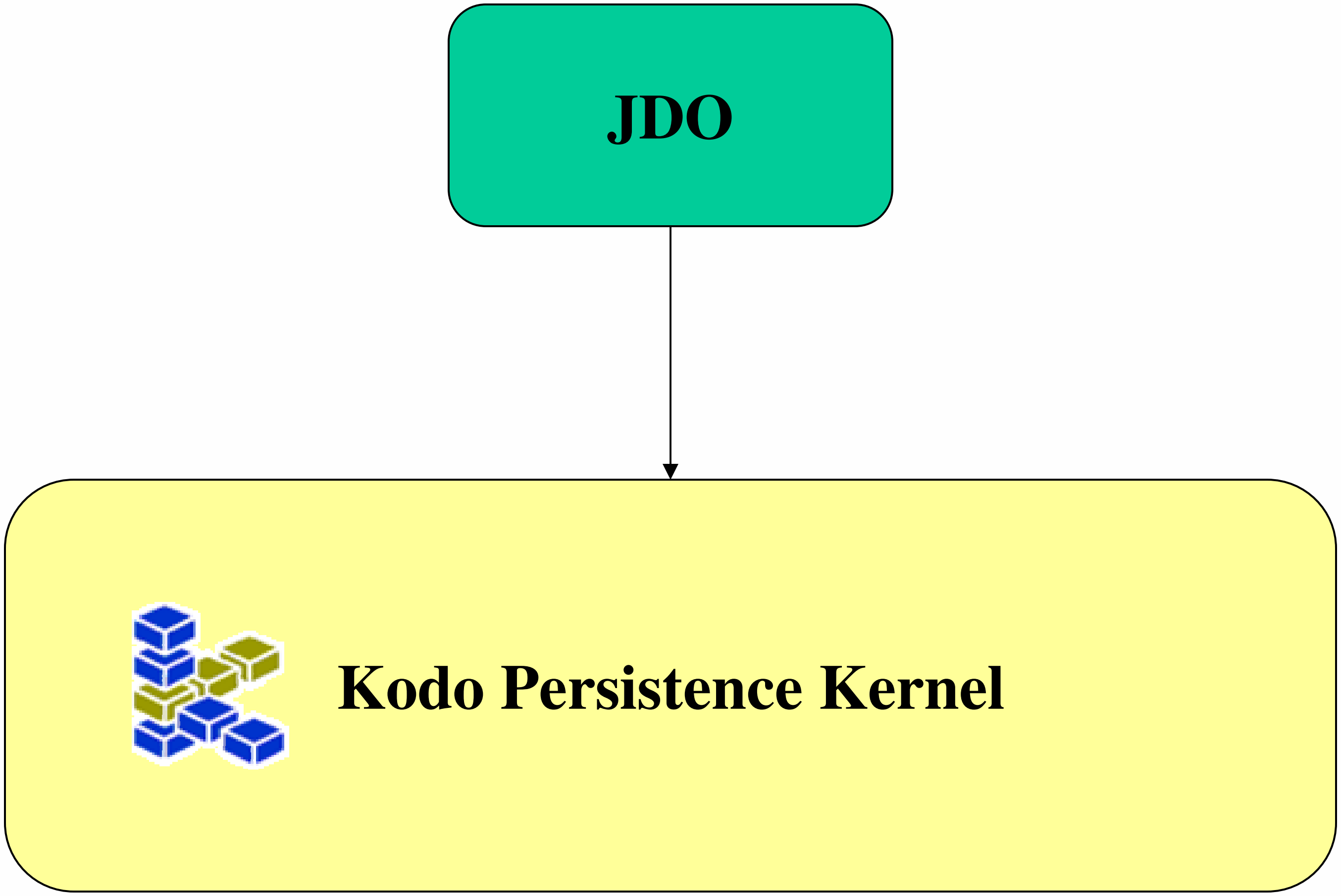
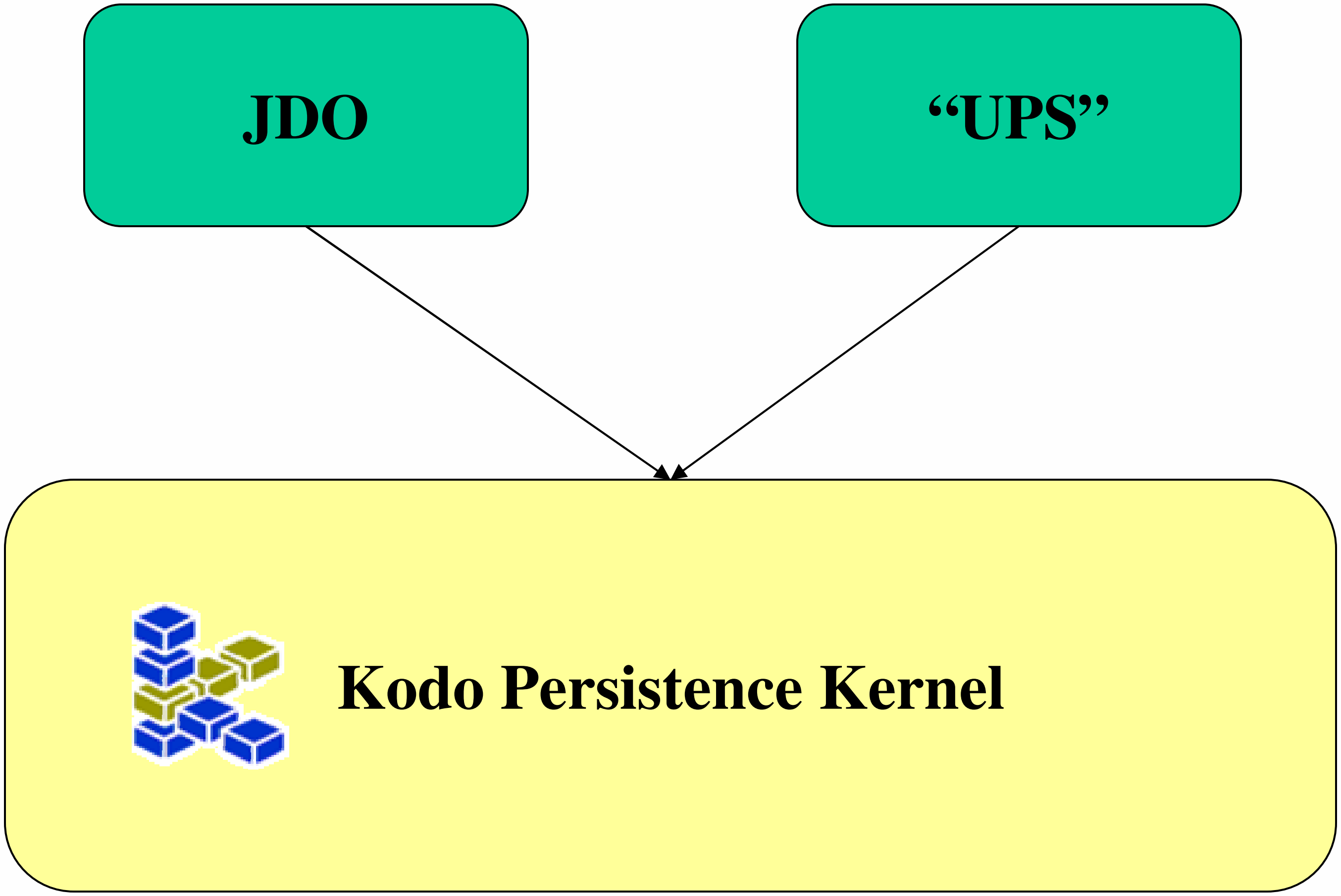


Future Situation – Kodo JDO and Kodo "UPS"



Kodo JDO 3.2

- Significant support for JDO 2 including:
  - JDO 2 Queries (single string JDOQL queries, implicit parameters / variables, named query support, subqueries)
  - More flexibility with detachment APIs, including automatic detachment on PM close
- Improvements to Kodo Development Workbench, Management Console, and Profiler
- Reverse Mapping Tool is accessible via a guided wizard
- Improved eager fetching
- Support for managed inverses
- Intersystems Caché database support

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- Tools – Workbench and Management Console
- High-performance database cache
- Prepared statements, statement caching, statement batching
- Intelligent handling of large result sets
- SQL as query language
- flat, vertical, horizontal inheritance mappings
- Extensible architecture
- Reverse and forward engineering of database schema
- Schema evolution

Kodo Development Workbench

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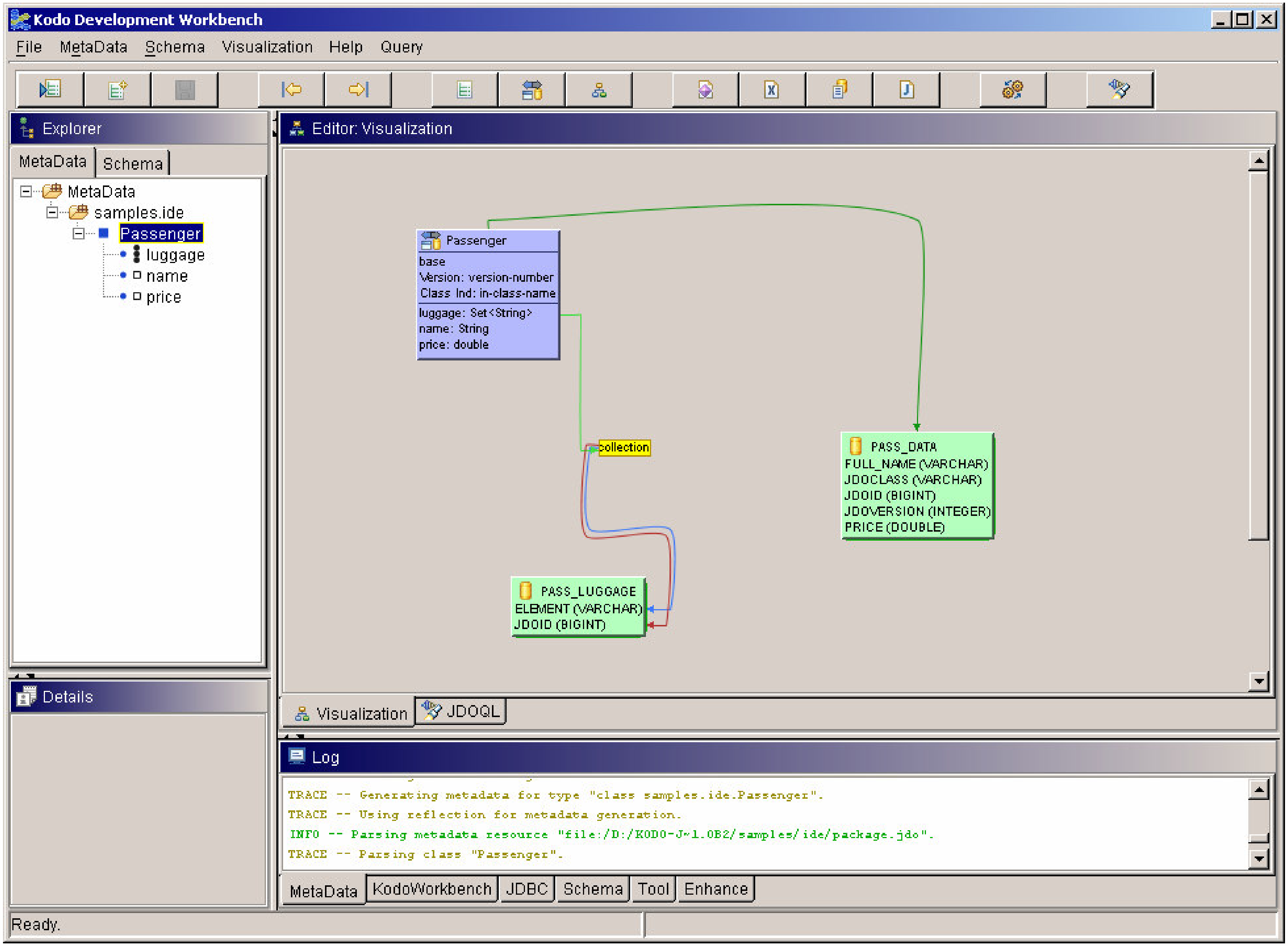

Passenger
base
Version: version-number
Class Ind: in-class-name
luggage: Set<String>
name: String
price: double

PASS_DATA
FULL_NAME (VARCHAR)
JDOCLASS (VARCHAR)
JDOID (BIGINT)
JDOVERSION (INTEGER)
PRICE (DOUBLE)

PASS_LUGGAGE
ELEMENT (VARCHAR)
JDOID (BIGINT)

```
TRACE -- Generating metadata for type "class samples.ide.Passenger".
TRACE -- Using reflection for metadata generation.
INFO -- Parsing metadata resource "file:/D:/KODO-J~1.0B2/samples/ide/package.jdo".
TRACE -- Parsing class "Passenger".
```

Kodo JDOQL Editor

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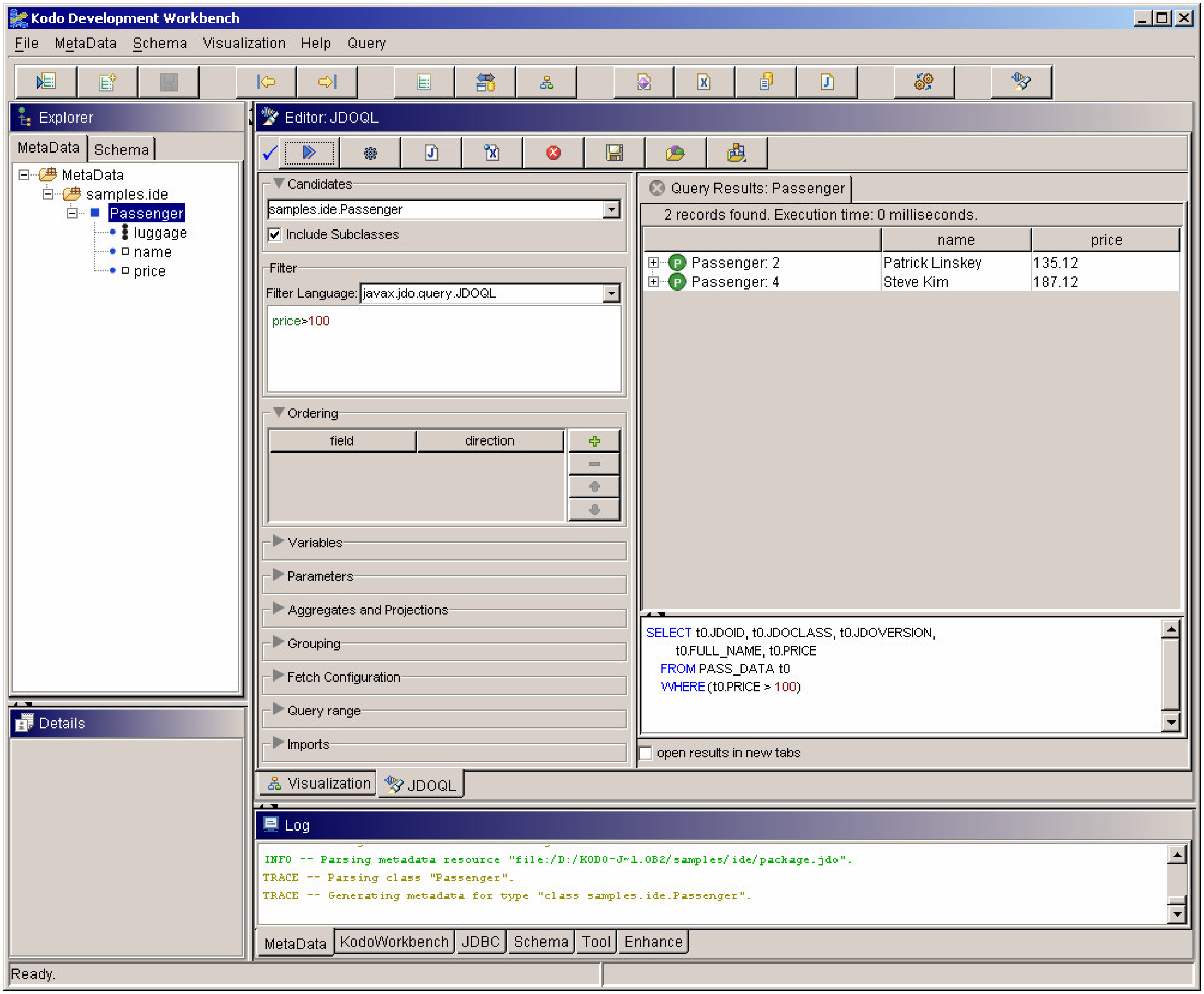

Candidates: samples.ide.Passenger

☑ Include Subclasses

Filter Language: javax.jdo.query.JDOQL

```
price>100
```

Query Results: Passenger

2 records found. Execution time: 0 milliseconds.

	name	price
⊞ Passenger: 2	Patrick Linskey	135.12
⊞ Passenger: 4	Steve Kim	187.12

```
SELECT t0.JDOID, t0.JDOCLASS, t0.JDOVERSION,
    t0.FULL_NAME, t0.PRICE
  FROM PASS_DATA t0
  WHERE (t0.PRICE > 100)
```

□ open results in new tabs

```
INFO -- Parsing metadata resource "file:/D:/KODO-J~1.0B2/samples/ide/package.jdo".
TRACE -- Parsing class "Passenger".
TRACE -- Generating metadata for type "class samples.ide.Passenger".
```

Management Console (JMX)

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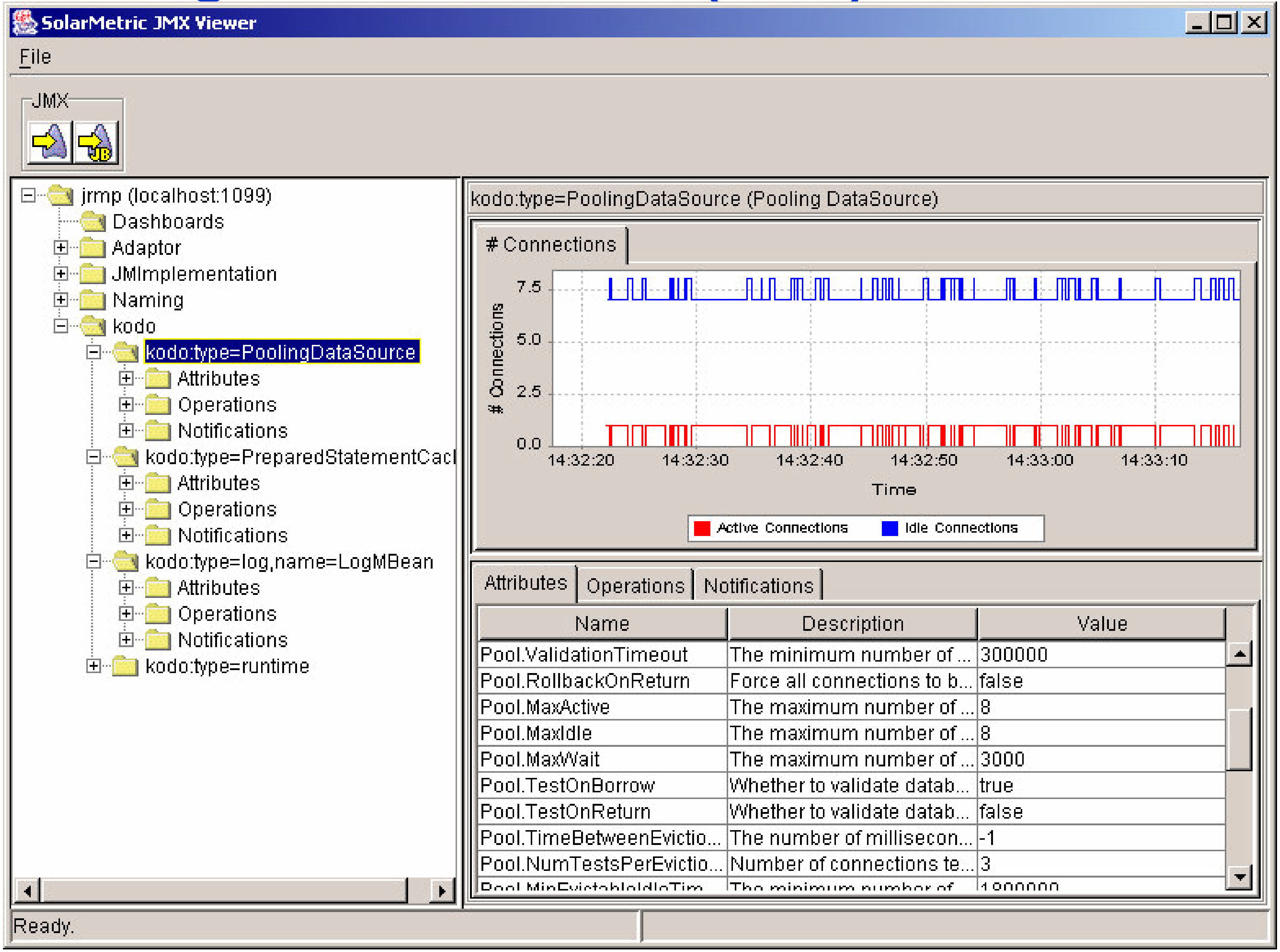


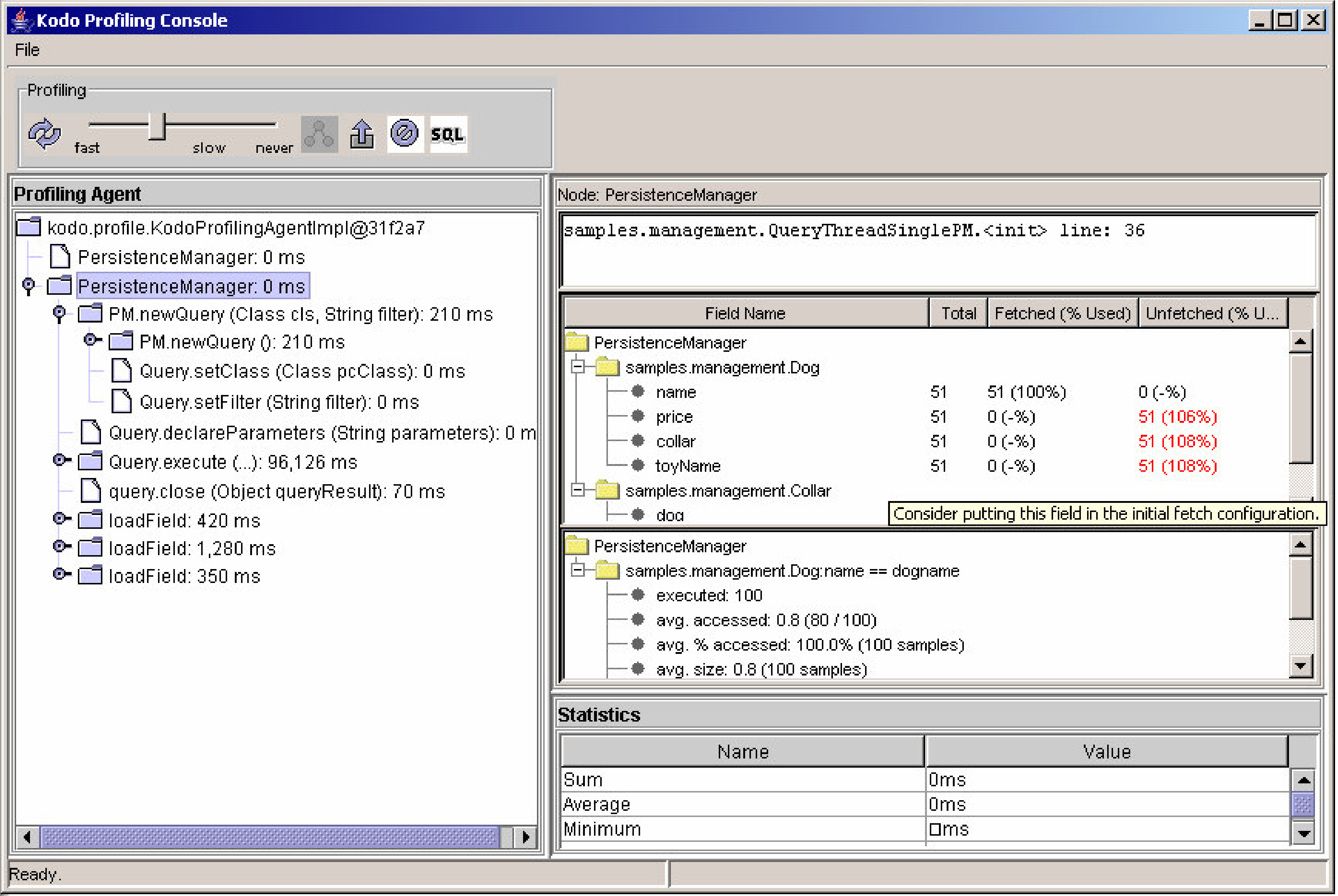
- jrmp (localhost:1099)
  - Dashboards
  - Adaptor
  - JMImplementation
  - Naming
  - kodo
    - kodo:type=PoolingDataSource
      - Attributes
      - Operations
      - Notifications
    - kodo:type=PreparedStatementCacl
      - Attributes
      - Operations
      - Notifications
    - kodo:type=log,name=LogMBean
      - Attributes
      - Operations
      - Notifications
    - kodo:type=runtime

kodo:type=PoolingDataSource (Pooling DataSource)

Name	Description	Value
Pool.ValidationTimeout	The minimum number of ...	300000
Pool.RollbackOnReturn	Force all connections to b...	false
Pool.MaxActive	The maximum number of ...	8
Pool.MaxIdle	The maximum number of ...	8
Pool.MaxWait	The maximum number of ...	3000
Pool.TestOnBorrow	Whether to validate datab...	true
Pool.TestOnReturn	Whether to validate datab...	false
Pool.TimeBetweenEvictio...	The number of millisecon...	-1
Pool.NumTestsPerEvictio...	Number of connections te...	3
Pool.MinEvictableIdleTim	The minimum number of	1800000

Ready.

Profiler



Profiling Agent

```
kodo.profile.KodoProfilingAgentImpl@31f2a7
  PersistenceManager: 0 ms
  PersistenceManager: 0 ms
    PM.newQuery (Class cls, String filter): 210 ms
      PM.newQuery (): 210 ms
      Query.setClass (Class pcClass): 0 ms
      Query.setFilter (String filter): 0 ms
    Query.declareParameters (String parameters): 0 m
    Query.execute (...): 96,126 ms
    query.close (Object queryResult): 70 ms
    loadField: 420 ms
    loadField: 1,280 ms
    loadField: 350 ms
```

Node: PersistenceManager

```
samples.management.QueryThreadSinglePM.<init> line: 36
```

Field Name	Total	Fetched (% Used)	Unfetched (% U...
PersistenceManager			
samples.management.Dog			
name	51	51 (100%)	0 (-%)
price	51	0 (-%)	51 (106%)
collar	51	0 (-%)	51 (108%)
toyName	51	0 (-%)	51 (108%)
samples.management.Collar			
dog			

Consider putting this field in the initial fetch configuration.

```
PersistenceManager
  samples.management.Dog:name == dogname
    executed: 100
    avg. accessed: 0.8 (80 / 100)
    avg. % accessed: 100.0% (100 samples)
    avg. size: 0.8 (100 samples)
```

Statistics

Name	Value
Sum	0ms
Average	0ms
Minimum	□ms

Ready.

Supported Databases

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Relational:

- Oracle 8i/9i/10
- Microsoft SQL Server
- IBM DB2
- Sybase Adaptive Server Enterprise
- Informix IDS
- MySQL
- PostgreSQL
- Firebird
- Interbase
- Hypersonic SQL
- JDataStore
- FoxPro
- MS Access
- Pointbase
- Cloudscape
- InstantDB
- Empress
- **Extensible database support**

Non-Relational:

- Legacy EIS (CICS, Unisys, others) (ask for details)
- LDAP (coming soon)
- BerkeleyDB (coming soon)
- InterSystems Caché

Kodo JDO IDE Support

- All IDEs with Ant Support
- Tight integration with:
  - Borland JBuilder 7 or newer
  - Sun One Studio / NetBeans
  - Eclipse / WSAD / WSED
- Standalone Development Workbench

Kodo JDO Supported App Servers

- WebLogic 6.2 – 8.1
- WebSphere 5
- JBoss 3.0 – 3.2
- SunONE
- Trifork
- JRun 4
- Borland Enterprise Server

More Info

- Web site: http://www.solarmetric.com
- On-site and off-site Kodo JDO training available
- Professional Services available
- Email contact: info@solarmetric.com
- Speaker

  Patrick Linskey: pcl@solarmetric.com

- Advanced Webinar – December 9 – 10:00 AM Pacific
  - Covers Performance and Scalability
  - Using JDO with J2EE
  - Other Advanced Topics
  - Register at http://www.solarmetric.com

Backup Slides

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What’s New In JDO 2?

Goals for Java Data Objects 2.0

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- Maintain JDO 1.0 Compatibility
- Standardize Mapping to Relational DB
  - SQL as a supported query language
- Multi-tier Development Improvements
  - Disconnected Object Graphs
- Usability Improvements
- Better Object Modelling
- Richer Queries
  - Single-line format
  - Projections
  - Aggregates
  - Paging Query Results
- More Vendor Support
  - Remove PersistenceCapable requirement

Standardize Mapping to RDBMS

- Simple Mapping
  - Class ⇔ Table
  - Field ⇔ Column
  - 1-1 relationship ⇔ unique foreign key
  - 1-many relationship ⇔ foreign key
  - many-many relationship ⇔ join table
- Complex Mapping
  - Inheritance strategies
  - Multiple tables per class
  - List, Map, Embedded

Multi-tier Development

- Disconnected Object Graphs
  - Disconnect objects from PersistenceManager
  - Close PersistenceManager
  - Modify disconnected objects
    - send to different tier, or
    - apply changes directly to objects
  - Begin new transaction
  - Reconnect objects to PersistenceManager
  - Commit transaction (applies changes)
- Disconnected Objects keep original identity and version

Usability (Bootstrap)

- How do you find a PersistenceManagerFactory?
- Java Data Objects 1.0 Properties:

```
javax.jdo.PersistenceManagerFactoryClass:\
  com.sun.jdori.fostore.FOStorePMF
   javax.jdo.option.ConnectionURL:\
  fostore:/shared/databases/jdo/dbdir
   javax.jdo.option.ConnectionUserName:craig
   javax.jdo.option.ConnectionPassword:faster
   javax.jdo.option.Optimistic:true
javax.jdo.option.RetainValues:true
javax.jdo.option.NontransactionalRead:true
```

Bootstrap

- JDO 1.0 Properties instance:
    - getPersistenceManagerFactory (Properties props)
- JDO 2.0 Properties loaded from:
    - stream
        - getPersistenceManagerFactory (InputStream props)
    - File (use to get a stream)
        - getPersistenceManagerFactory (File propsFile)
    - resource name (use to get a stream)
        - getPersistenceManagerFactory (String propsResource)
- JDO 2.0 JNDI lookup
    - getPersistenceManagerFactory (String name, Context c)

Usability

- JDO 2.0 Transaction adds:
  - boolean getRollbackOnly();
  - void setRollbackOnly();
- JDO 2.0 Query can be defined in metadata and accessed by name

Usability

- ThreadLocal JDOHelper methods
    - getThreadLocalPersistenceManager
    - setThreadLocalPersistenceManager
    - getThreadLocalPersistenceManagerFactory
    - SetThreadLocalPersistenceManagerFactory
- Allows business delegates to be independent of their environment
    - Web server
    - App server
    - Two tier

Better Object Modeling

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- Persistent Abstract Class Support
  - map abstract classes to tables
  - map properties, fields to columns
  - create new implementation instances
- Persistent Interface Support
  - map interfaces to tables
  - map properties to columns
  - create new implementation instances
  - use interfaces in queries

Richer Queries

- Projections
- Aggregates
- More String expressions
- More numeric, Map functions
- Paging query results
- Native SQL
- User-defined Result Class

Preserve Expressability in SQL

Projections

- JDO 1.0: query results are a subset of instances in the candidate collection
- JDO 2.0: query results can be projections of:
  - candidate collection instances;
  - variable instances;
  - fields;
  - parameters;
  - combinations of the above.

Projections: Example

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```
Query q = pm.newQuery (Employee.class,
   "dept.name.startsWith(deptName)");
q.declareParameters ("String deptName");
q.setResult("name, salary, boss");
Collection names = (Collection)
q.execute("R&D");
```

```
Bill Jones          12546  Employee@18d8788
Sam Adams           15948  Employee@18d8788
Will Clinton        50453  Employee@1867480
Westlake Clerk      18737  Employee@18720
Harvey Dean         14657  Employee@18720
Ed Muskrat          13009  Employee@18720
```

Aggregates

- Query Results can be aggregates
- Aggregates have standard semantics
  - min
  - max
  - avg
  - sum
  - count
- Group by projected fields
- “Having” allows conditional filtering

Aggregates: Example

```
Query q = pm.newQuery (Employee.class,
   "dept.name.startsWith(deptName)");
q.declareParameters ("String deptName");
q.setResult("dept.name, min(salary), max(salary)");
q.setGrouping("dept.name having count(dept.name) > 1");
Collection names = (Collection) q.execute("R&D");
for (Object[ ] i : (Collection<Object[ ]>) results) {
   println(i[0], i[1], i[2]);
}
```

```
R&D Santa Clara     12546 15948
R&D Burlington      13009 18737
```

String Expressions

- toLowerCase(), toUpperCase()
- indexOf(String), indexOf(String, int)
- matches(String pattern)
  - pattern is a subset of regular expressions:
    - (?i) global case-insensitive
    - . match any one character
    - .* match any number (0 to n) of characters
    - pattern is literal or parameter only
- substring(int), substring(int, int)

Other Query Filter Methods

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- Math.abs(numeric expression)
- Math.sqrt(numeric expression)
- Map.containsKey(Object)
- Map.containsValue(Object)

Paging Query Results

- Improves performance for some applications
  - Skips already-returned results
  - Limits number of results
- Query.setRange (int fromIncl, int toExcl);
- default
  - fromIncl = 0
  - toExcl = Integer.MAX_VALUE

User-Defined Result Class

- JDO 1.0 query results are of type Collection
- JDO 2.0 allows user to specify result class:
  - Primitive wrapper (unique results)
  - Collection<Primitive wrapper>
  - Object[] (projected or aggregate unique results)
  - Collection<Object[]>
  - User-defined Class (unique results)
  - Collection<User-defined Class>

ResultClass: Example

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```
class Info {
    public String name;
    public Float salary;
    public Employee reportsTo;
}
```

```
class Employee {
    private String name;
    private float salary;
    private Department dept;
    private Employee boss;
}
```

```
Query q = pm.newQuery (Employee.class,
    "dept.name == deptName");
q.declareParameters ("String deptName");
q.setResult("name, salary, boss as reportsTo");
q.setResultClass(Info.class);
Collection results = (Collection)
q.execute("R&D");
for (Info i : (Collection<Info>) results) {
    println(i.name, i.salary, i.reportsTo.name);
}
```

JDO Code Examples

Employee.java

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```
package kodo.example;

import java.util.*;

public class Employee extends Person
{
  private float salary;
  private Company company;
  private Set projects = new HashSet();

  public Employee (String firstName,
    String lastName) {
      super (firstName, lastName);
  }

  public void giveRaise (float percent) {
    salary *= 1 + percent;
  }

  public Collection getProjects () {
    return projects;
  }
}
```

```
<?xml version="1.0" encoding="UTF-8"?>
<jdo>
 <package name=”kodo.example">
  <class name=”Employee”
   persistence-capable-superclass=“Person”>

   <field name=”projects">
    <collection element-type=”Project" />
   </field>

  </class>
 </package>
</jdo>
```

JDO Usage Example

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```
import javax.jdo.*;

public class MyPersistenceCode
{
  public static void main (String[] args)
  {
    // configure system
    PersistenceManagerFactory pmf =
        JDOHelper.getPersistenceManagerFactory (System.getProperties());
    PersistenceManager pm = pmf.getPersistenceManager();

    // business code
    Employee emp = new Employee (“Marc”, “Prud’hommeaux”);
    emp.setCompany (new Company (“SolarMetric, Inc.”));
    emp.getProjects ().add (new Project (“Kodo”));
    emp.giveRaise (.10F);

    // persistence code
    pm.currentTransaction().begin();
    pm.makePersistent (emp);
    pm.currentTransaction ().commit ();
    pm.close ();
    pmf.close ();
  }
}
```

JDOQL Examples

- Basic Query:

```
String filter = "salary > 30000";
Query q = pm.newQuery (Employee.class, filter);
Collection emps = (Collection) q.execute ();
```

- Basic Query with Ordering:

```
String filter = "salary > 30000";
Query q = pm.newQuery (Employee.class, filter);
q.setOrdering ("salary ascending");
Collection emps = (Collection) q.execute ();
```

JDOQL Examples

SolarMetric

- Query with Relation Navigation and Parameters:

```
String params = “float min, float max”;
String filter = ”company.revenue > min”
 + “ && company.revenue <= max";
Query q = pm.newQuery (Employee.class, filter);
q.declareParameters (params);
Collection emps = (Collection) q.execute
   (new Float (500000F), new Float (1000000F));
```

JDOQL Examples

- Query with Multi-value Navigation:

```
String vars = “Project p”;
String filter = ”projects.contains (p)”
    + “ && p.name == \”Kodo\”";
Query q = pm.newQuery (Employee.class, filter);
q.declareVariables (vars);
Collection emps = (Collection) q.execute ();
```

Native SQL

- JDO 1.0 does not recognize SQL
- JDO 2.0 supports:
  - obtaining java.sql.Connection from PersistenceManager
  - defining SQL queries
    - may improve performance (good)
    - makes query non-portable (bad)
    - may support SQL-specific constructs (?)
    - may allow SQL DBA more control (!)

More Vendor Support

SolarMetric

- Remove PersistenceCapable requirement
  - Remove pre-processor, post-processor requirement
  - Allow non-enhancer versions of JDO implementation
  - All other compliance requirements remain