Make Reflection Practical to Use

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Transaction Framework

- Goal: a transactional architecture with
  - high transparency to application developers
  - high performance
  - flexibility and scaleablility
  - fast application development
- Approach
  - three-tier architecture
  - component technology
  - reflection and introspection

Deliverables & Current Status

- A visual component builder tool (beta) ---> (1.0) ---> (2.0)
- A compiler for generating reflection class (beta) --->(1.0) ---> (2.0)
- A system component container (alpha)--->(beta) --->(1.0) --->(2.0)
- A set of concurrency control metaobjects (TPL)
- An object transaction service (75%)--->(beta) --->(1.0b) --->(2.0b)
- A demonstration example ( )--->(alpha) --->(1.0a) --->(2.0a)
- An architecture report (beta)
- Integration with FlexiNet --->(alpha)
- Packaging to EJB Jar --->(1.0b) --->(2.0b)
- Programming guide

Problem

Reflection

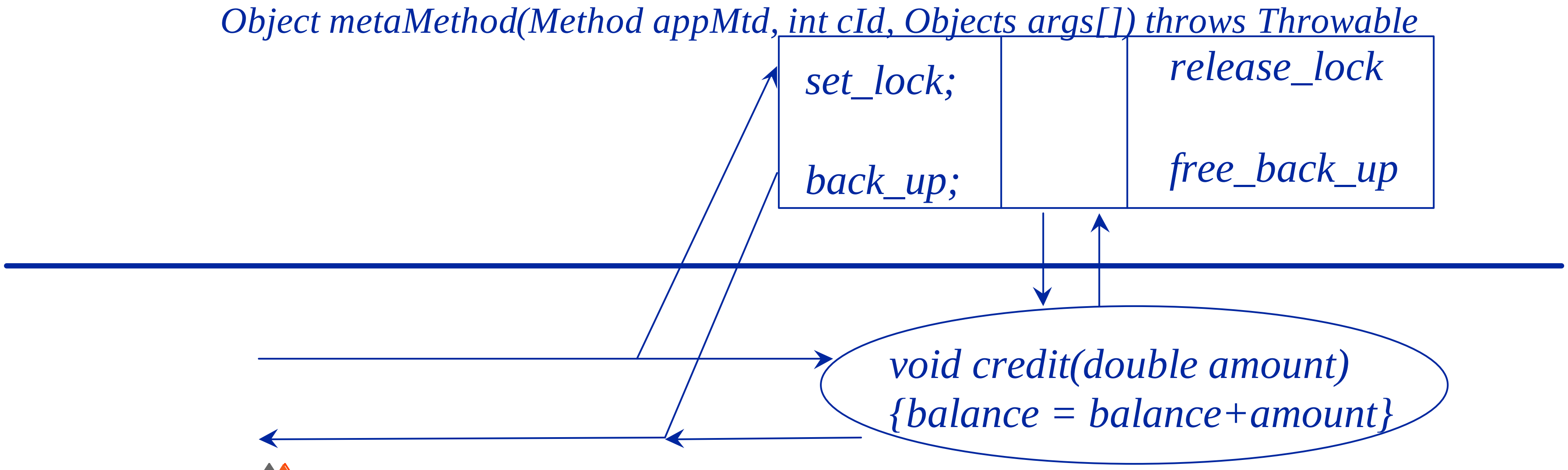
is a powerful tool for providing system flexibility and adaptability

however

some practical issues make it *difficult* to use

Behavioural Reflection

- The behaviour of method invocation can be customised by programmers via metaobjects
  - method invocation is intercepted by a metaobject
  - extra processing can be done before and after method execution
  - meta information for classes, objects, and parameters is accessible
  - values of parameters can be manipulated at meta level



Object metaMethod(Method appMtd, int cId, Objects args[]) throws Throwable

set_lock;

back_up;

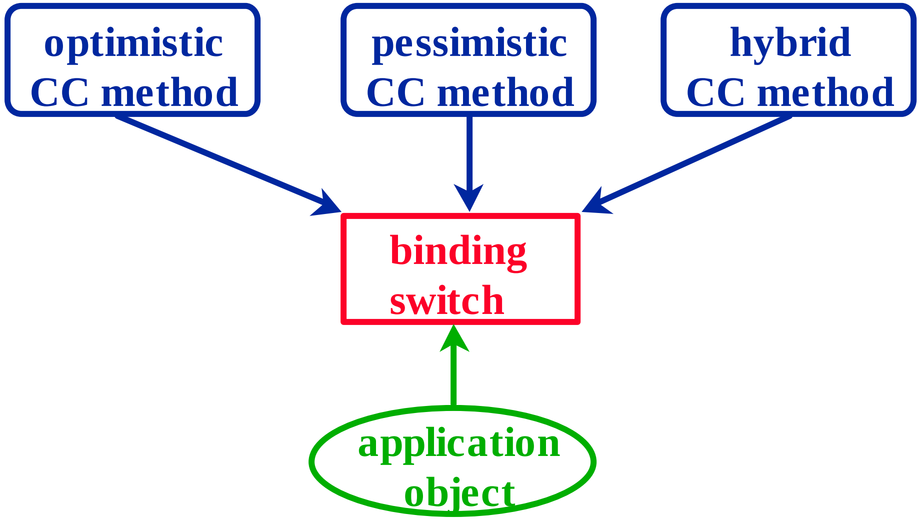
release_lock

free_back_up

void credit(double amount)
{balance = balance+amount}

Add System Capability via Reflection

- Business logic is implemented in application objects
- System capabilities are implemented in meta objects
- Integration through metaobject binding (static or dynamic)
- New strategy can be applied through changing metaobject binding

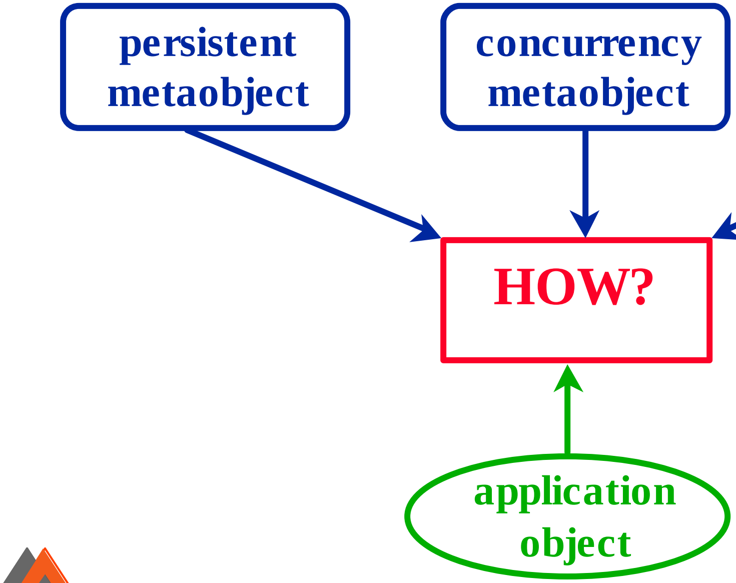


Challenges in Programming Metaobjects

- Generic programming
- Obscure way for accessing meta information
- Difficult to provide multiple capabilities
- Hard for metaobject reuse
- Impossible to use third-party products
- Consistency concerns for dynamic binding
  - between old and new metaobjects
  - system states

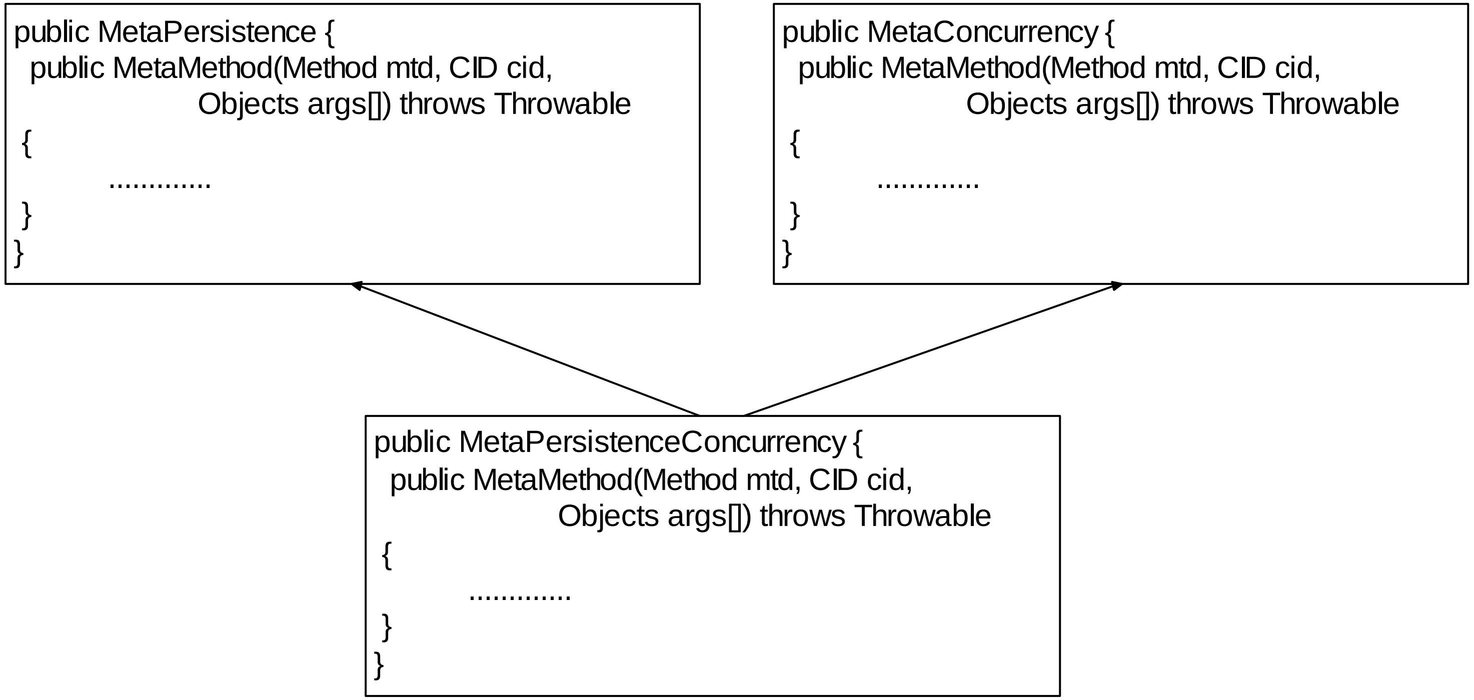
Provide Multiple Capabilities

- Multiple inheritance
- Multiple binding
- Multilevel reflection
- Metaobject chain
- Construct a new metaobject



Multiple Inheritance

- Name collision
- Multiple inheritance not supported in Java



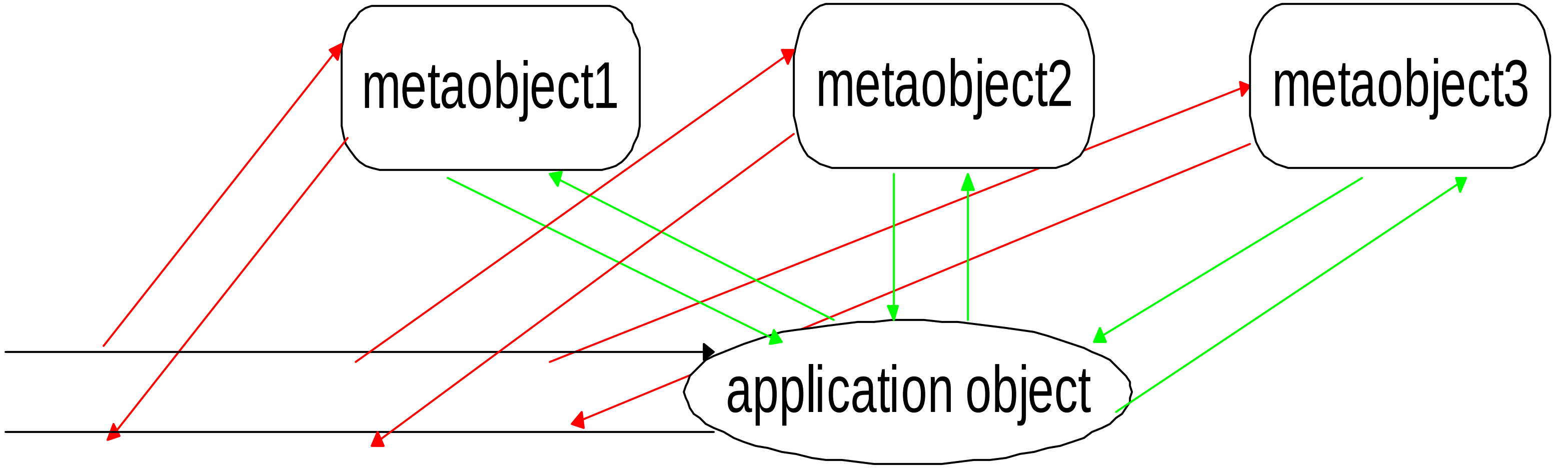
```
public MetaPersistence {
  public MetaMethod(Method mtd, CID cid,
                      Objects args[]) throws Throwable
 {
           .............
 }
}
```

```
public MetaConcurrency {
  public MetaMethod(Method mtd, CID cid,
                      Objects args[]) throws Throwable
 {
           .............
 }
}
```

```
public MetaPersistenceConcurrency {
  public MetaMethod(Method mtd, CID cid,
                      Objects args[]) throws Throwable
 {
           .............
 }
}
```

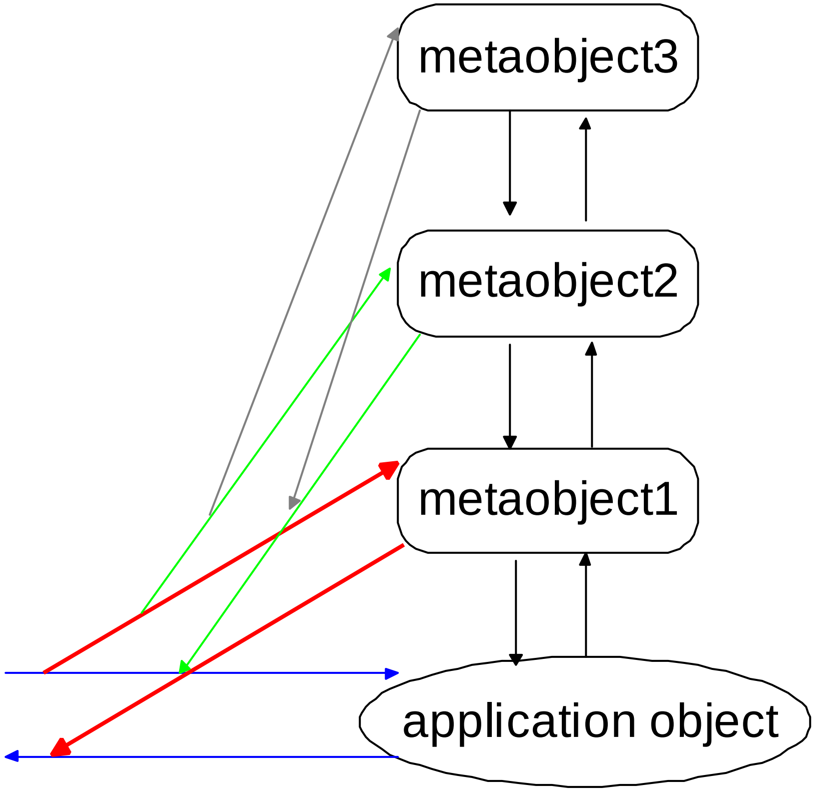
Multiple Metaobject Binding

- The application objects will be called multiple times
  - cannot ensure the correct functionality of the application object



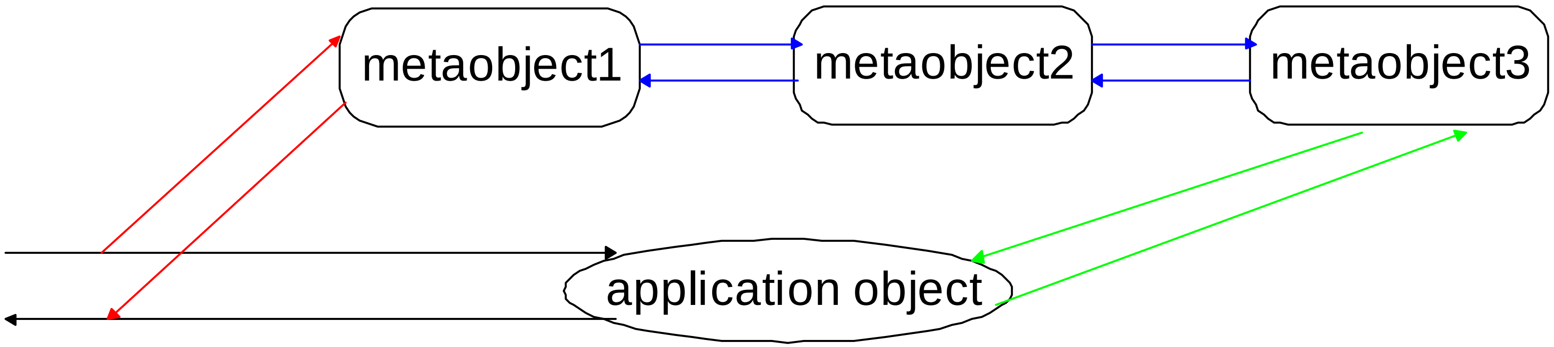
Multilevel Reflection

- Each level shifts an invocation to a higher level
- Poor performance
  - multiple packaging and unpackaging
  - multiple interceptions
- Order
  - in which order
- Integration is more complex than stacking
- Semantics



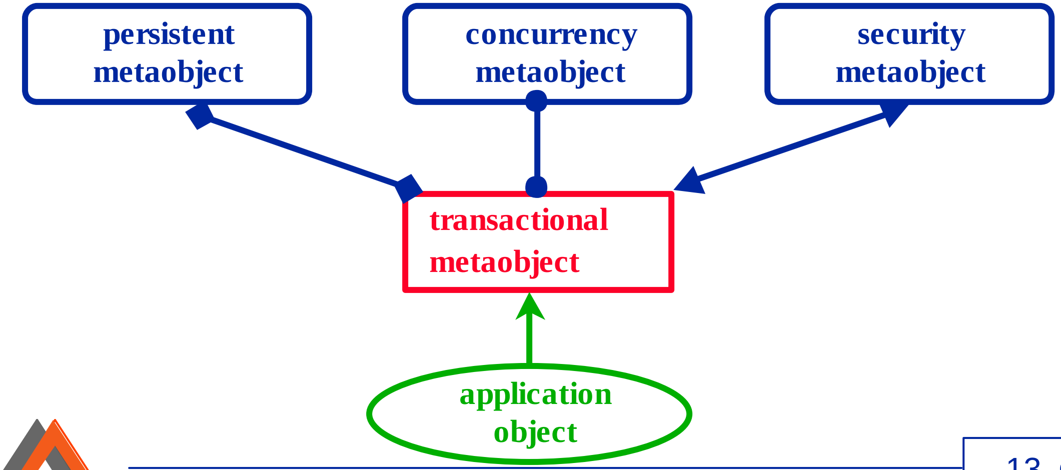
Metaobject Chain

- Performance: better than multilevel reflection
- Need to make changes to some metaobjects
- Order problem
- Integration is more complex than stacking

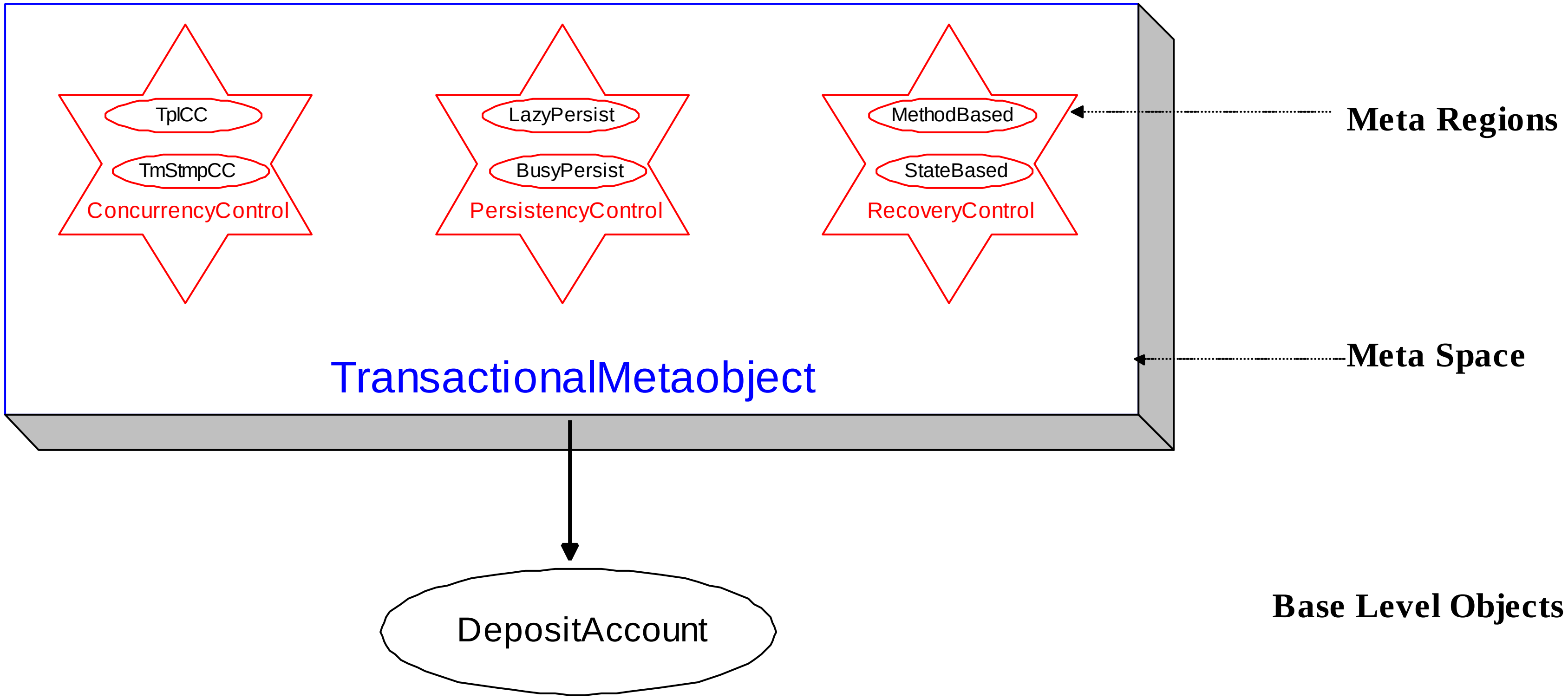


A Two-Layer Approach

- Separate composition and control from functionality implementation
- First-layer metaobject:
  - interception method invocation
  - coordinate second-layer metaobjects
- Second-layer metaobjects:
  - provide a particular capability
- Contract interface between first and second layer metaobjects
  - ensure a second layer metaobject reusable
  - ensure consistency between new and old metaobject



Metaobject Structure

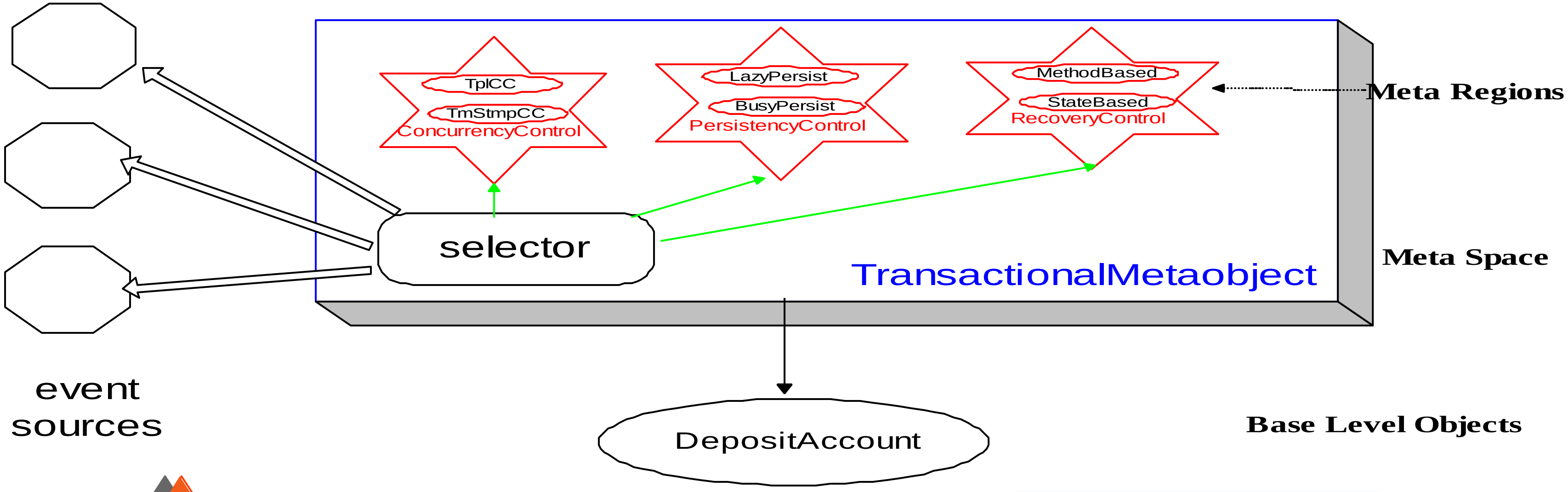


Dynamic Binding

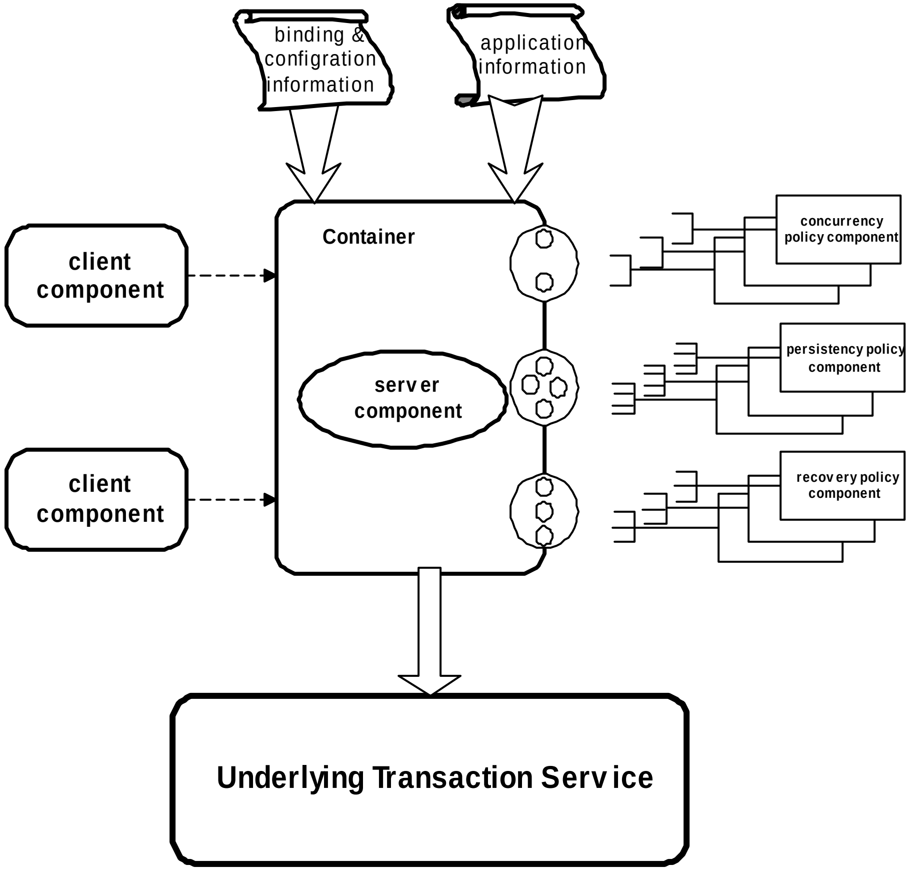
- Change metaobject binding at runtime
  - to cater for environment changes
  - to improve performance by making use runtime information
- When to make change
  - the rules
  - how to ensure the rules
- How to ensure consistency
  - new and old metaobject
  - system states

Selector

- A dedicated active object within a first-layer metaobject
- Define the rules for changing metaobjects
- Register to relevant events
- Make decision on when to change metaobject binding
- Perform binding changes if required
- Events
  - environment events, user interception events, runtime statistics events



A Reflective Transaction Architecture



- Container provides a first layer metaobject: *transactionalMetaobejct*
- Three second-layer metaobject interfaces: *persistency*, *concurrency*, *recovery*
- Each interface may have multiple implementations
- Application deployer choose metaobjects for a application
- “Off-the-shelf” metaobjects can be used

Summary of the Two-Layer Approach

- Separate composition, interception and control from implementations of subtasks
  - enable easy integration of multiple metaobjects
  - make second-layer metaobject much easier to implement
  - enable metaobject reuse
  - the contract interface ensures compatibility between metaobjects
- First-layer metaobject is responsible for composition, interception and control
- Construct first-layer metaobjects as components
  - easy composition
  - easy customisation