Transaction Definition

- **Unit of work that accesses one or more shared resources (usually databases)**
  - **Set of one or more activities related to each other**
  - **Must be completed together or not at all**
  - **Cohesion of unit is normally mission critical**
  - **Examples**
    - ATM
      - Withdraw from one source, deposit to another
    - **Order System (e.g. online book store)**
      - **Locate item, charge account, schedule shipment**
    - **Medical System**
      - **Identify medical state, dispense prescription**

Transaction Properties (ACID)

- **Atomic**
  - Transaction must execute completely or not at all
- **Consistent**
  - Data in database is always in a consistent state (data integrity makes sense)
  - A transactional system fulfills its responsibility for consistency by ensuring that a transaction is atomic, isolated and durable
  - Application developer must ensure that database has appropriate constraints (primary keys, referential integrity, etc.) and that unit-of work doesn't result in inconsistent data
- **Isolated**
  - Transaction executes without interference
- **Durable**
  - Changes are not lost if the system crashes

EJB Transaction Support

- EJB is designed to support transactions automatically.
- Declarative (CMT)
  - Easy
  - Transaction management controlled through deployment descriptor (transaction attributes for individual enterprise bean methods)
- Programmatic (BMT)
  - Complex
  - Explicit transaction demarcation
  - Direct programming calls to Java Transaction Service (JTS) API
  - Transaction management code mixed with business code (change in transactional behavior requires change in business code)

Transaction Scope

- One or more tasks that operate as a unit of work; succeed or be rolled back together
- Tasks
  - EJB methods
- Unit of Work
  - Each bean visited by the methods during a thread of execution depending on bean transaction attributes
  - Ends when thread of execution
    - Completes normally
    - An exception is thrown (type)
    - Transaction is rolled back

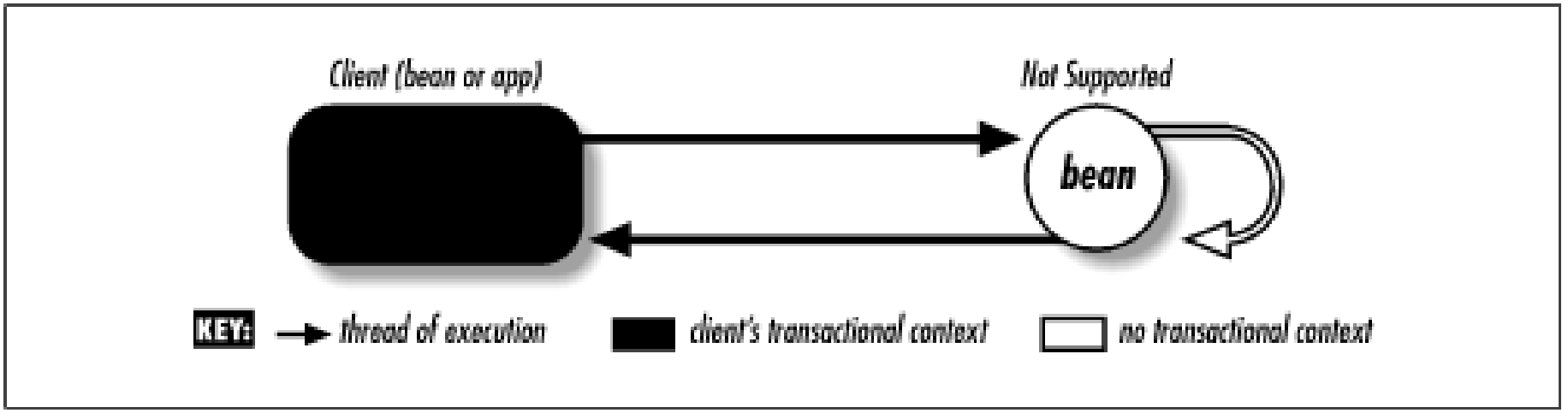
Transaction Attributes

- EJB servers can manage transactions implicitly, based on the transaction attributes established at deployment time.
- Supports Transactions
  - Supports
  - Required
  - RequiresNew
  - Mandatory
- Transactions not Supported
  - NotSupported
  - Never
- Set a transaction attribute for the entire EJB or for individual methods (flexibility)

Setting a Transaction Attribute

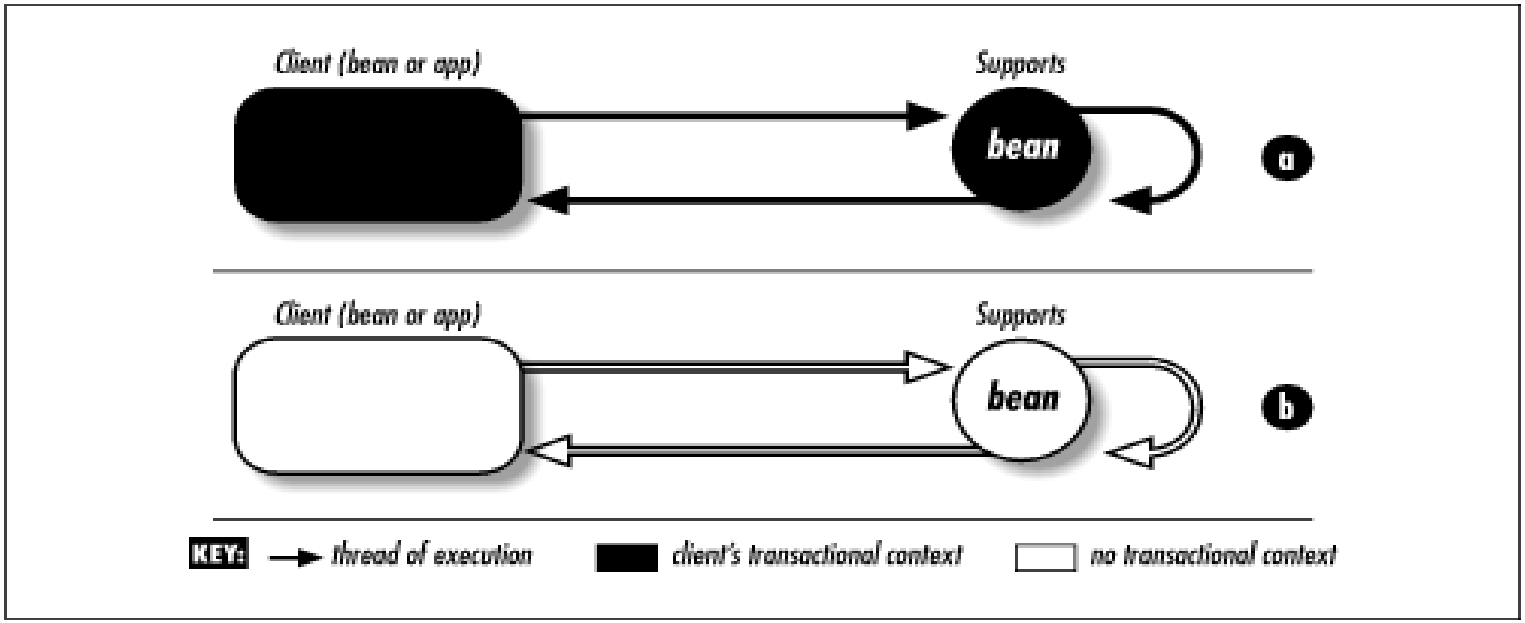
```
<ejb-jar>
...
   <assembly-descriptor>
        <container-transaction>
              <method>
                 <ejb-name>MyEJB</ejb-name>
                 <method-name>*</method-name>
              </method>
            <trans-attribute>Required</trans-attribute>
       </container-transaction>
</assembly-descriptor>
</ejb-jar>
```

Not Supported



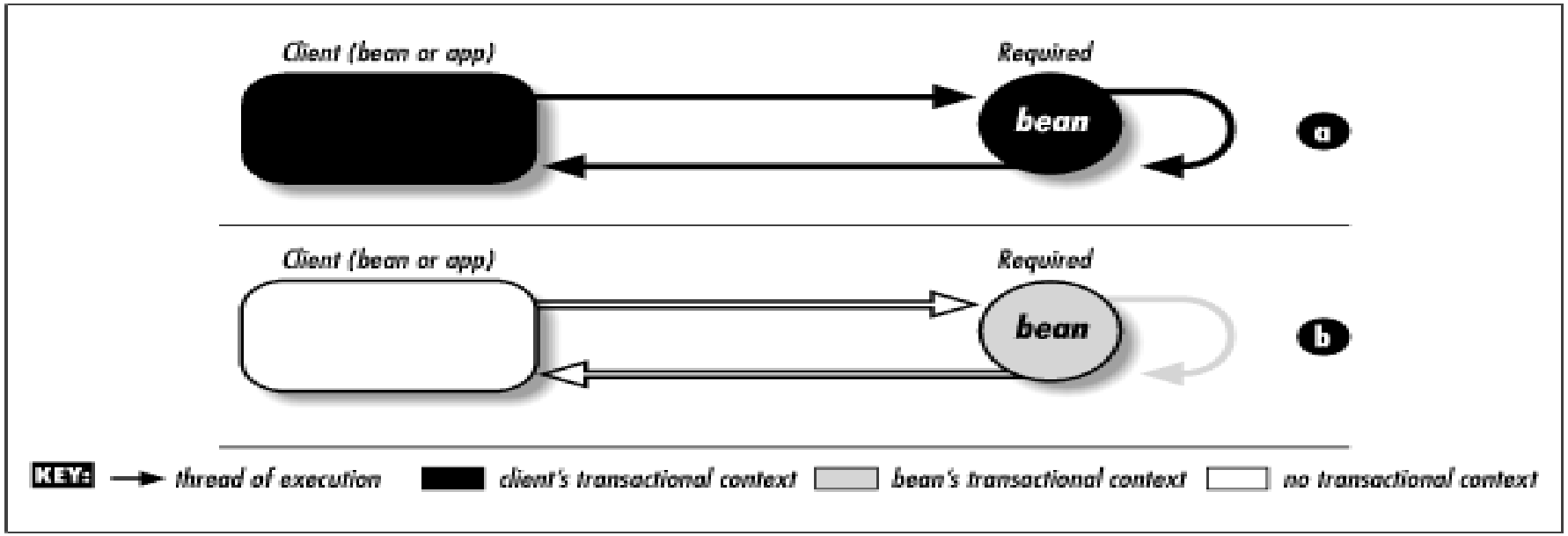
- Transaction is suspended during the method of the invoked Bean;
- Resumes when method complete
- Transaction scope is not propagated to invoked EJB or anything it invokes

Supports



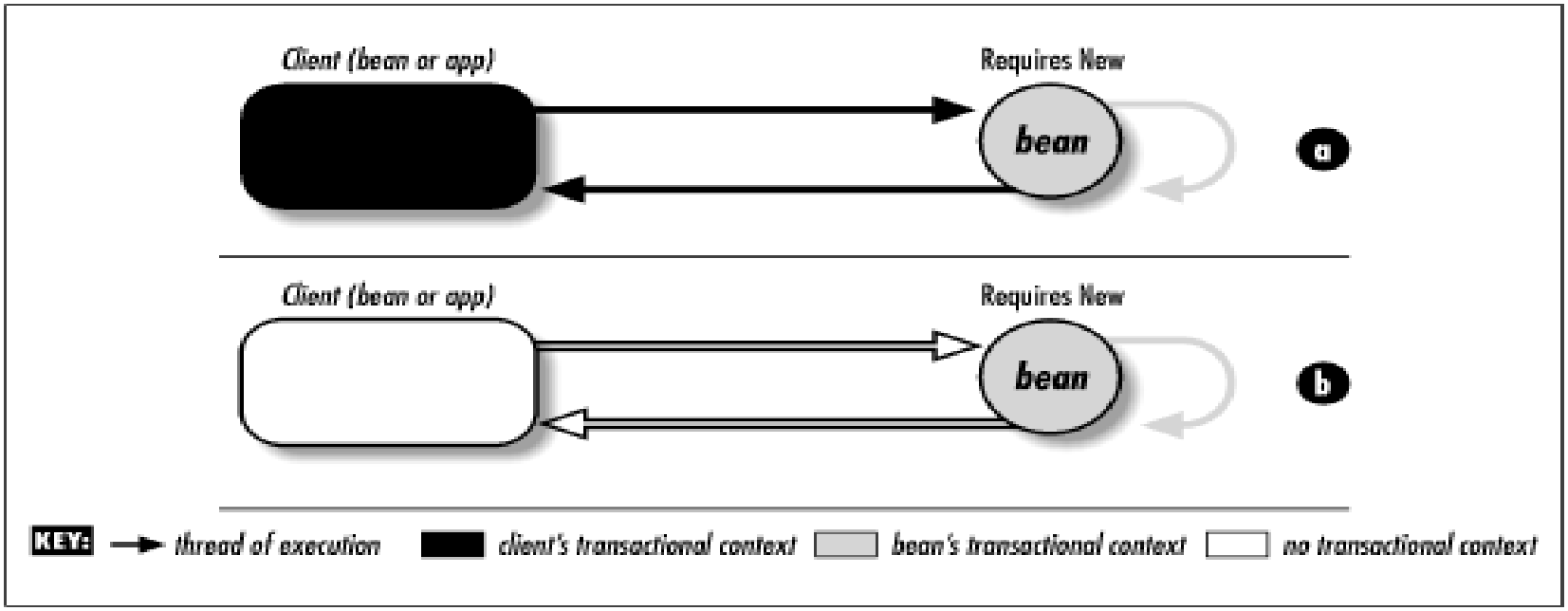
- Joins the transaction context if invoked as part of a transaction (A)
- Does not require a transaction; can be invoked outside of a transaction context (B)

Required



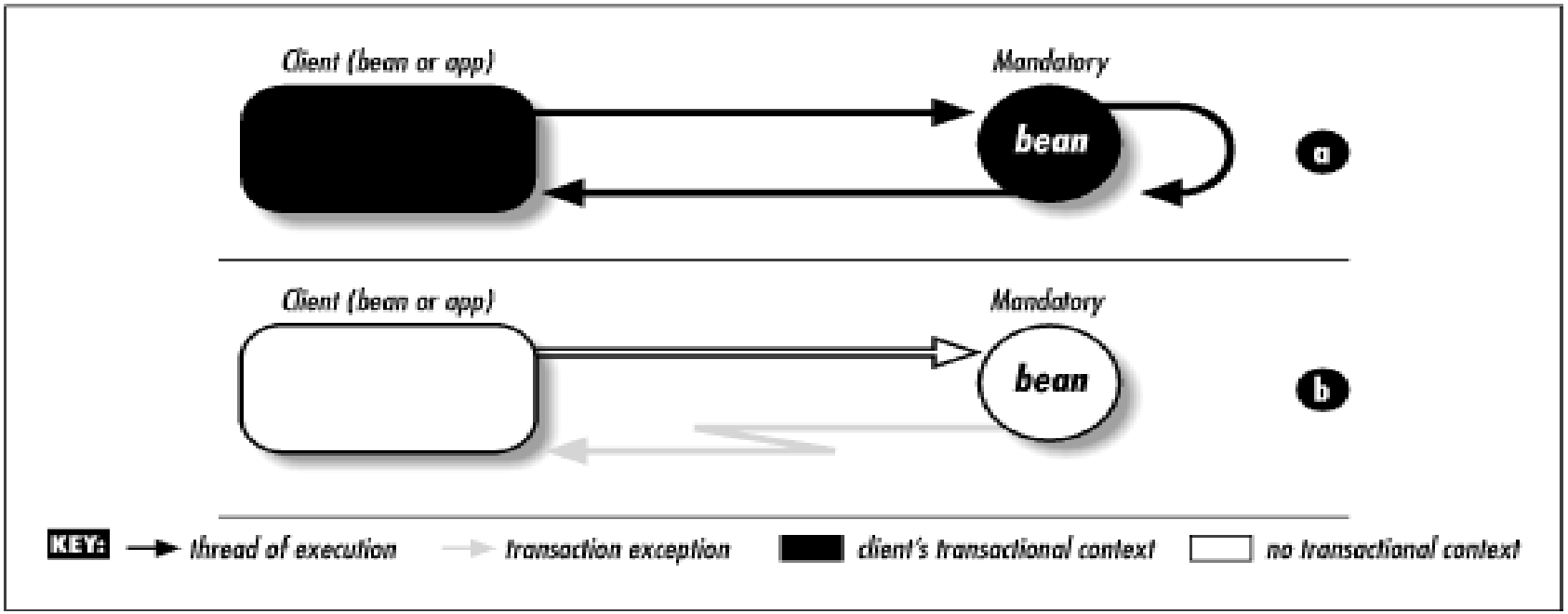
- Enterprise bean method must be invoked within the scope of a TX
- Joins the transaction context if invoked as part of a transaction (A)
- Initiates its own transaction context if invoked outside of a transaction(B)

RequiresNew



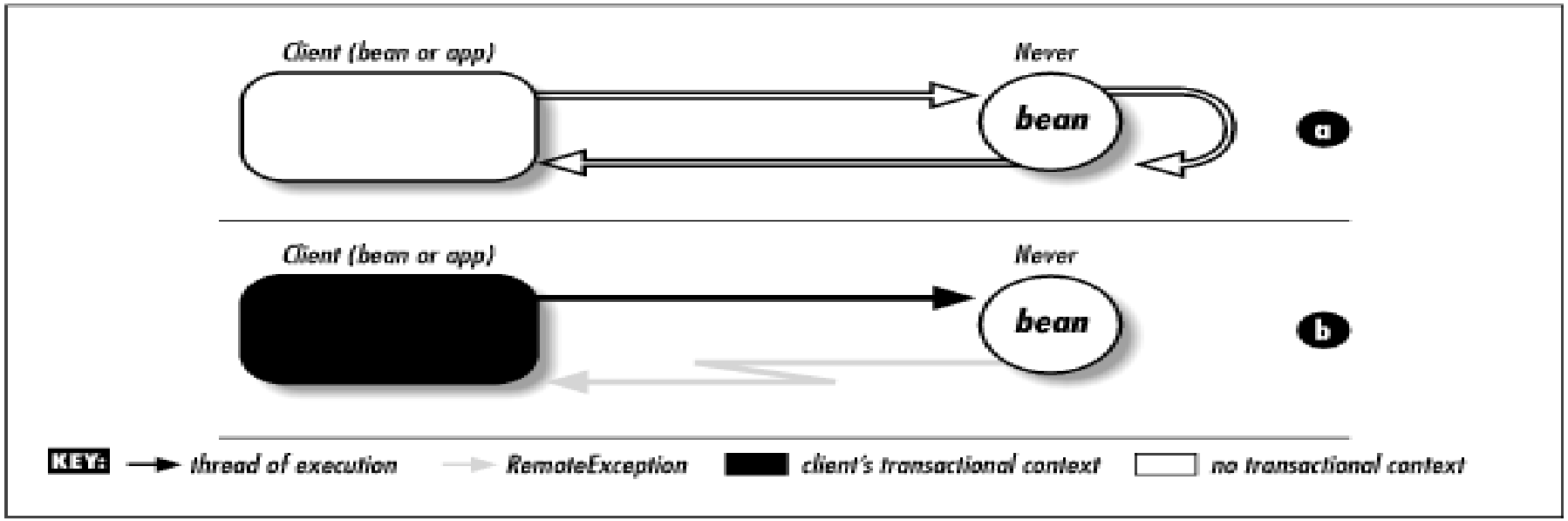
- A new transaction is always started.
- Initiates its own transaction context whether called within an existing transaction context (A) or outside of a transaction context (B)
- Initiated transaction completes prior to returning to caller

Mandatory



- Joins the transaction context if invoked as part of a transaction (A)
- Throws a Transaction Exception if not called within a transaction context (B) (TransactionRequiredException for Remote Clients; TransactionRequiredLocalException for Local Clients)

Never



- Bean method must not be invoked within the scope of a transaction Throws a Transaction Exception if called within a transaction context
- (A) (RemoteException to Remote Clients; EJBException to Local Clients)
- Must be invoked outside of a transaction context (B)

Isolation and Database Locking

- **What happens when two or more transactions attempt to access the same Data:**
  - **Dirty Reads**
    - First transaction reads uncommitted changes from a second transaction that may eventually be rolled back
  - **Repeatable Reads**
    - **Data guaranteed to be the same if read multiple times during the same transaction; implemented with locks or snapshots**
    - Opposite: nonrepeatable read
  - **Phantom Reads**
    - **First transaction sees new rows added by second transaction after beginning of the first transaction**

Database Locks

- How to prevent overlapping transactions from viewing the other's data?
  - Read Lock
    - Data is prevented from changing while transaction is in progress
    - Current transaction is prohibited from making changes
  - Write Lock
    - Prevents other transactions from modifying the data
    - Permits dirty reads by other transactions (and by the current TX itself)
  - Exclusive Write Lock
    - Prevents other transactions from reading and modifying data
    - Prevents dirty reads
  - Snapshots - frozen view of data
    - Every transaction gets its own snapshot of the data

Transaction Isolation Levels

- Defined in terms of the isolation conditions (dirty reads, repeatable reads, and phantom reads)
- Used in DBS to describe how locking is applied to data within a transaction:

– Read Uncommitted
  - Can read data being modified by another transaction
  - Allows dirty, non-repeatable, and phantom reads

– Read Committed
  - Cannot read data being modified by another transaction
  - Allows non-repeatable and phantom reads; prevents dirty reads

– Repeatable Read
  - Cannot change data being read by another transaction
  - Allows phantom reads; prevents dirty and non-repeatable reads

– Serializable
  - Transaction has exclusive read/write privileges to data
  - Different transactions can neither read or write same data

Specifying Isolation Level

- **EJB deployer sets transaction isolation levels in a vendor specific way if the container manages the transaction**

```
<weblogic-ejb-jar>
<transaction-isolation>
        <!-- TRANSACTION_SERIALIZABLE
        TRANSACTION_READ_COMMITTED
        TRANSACTION_READ_UNCOMMITTED
        TRANSACTION_REPEATABLE_READ
        -->
<isolation-level>TRANSACTION_READ_COMMITTED</isolation-level>
    <method>
        <ejb-name>Account</ejb-name>
        <method-name>*</method-name>
    <method>
</transaction-isolation>
```

Message Driven Bean Transactions

- **Valid Values**
  - ***NotSupported***
  - ***Required***
- **Client transaction context not propagated to MDB**
  - ***Supports, RequiresNew, Mandatory*, and *Never* are relative to client**

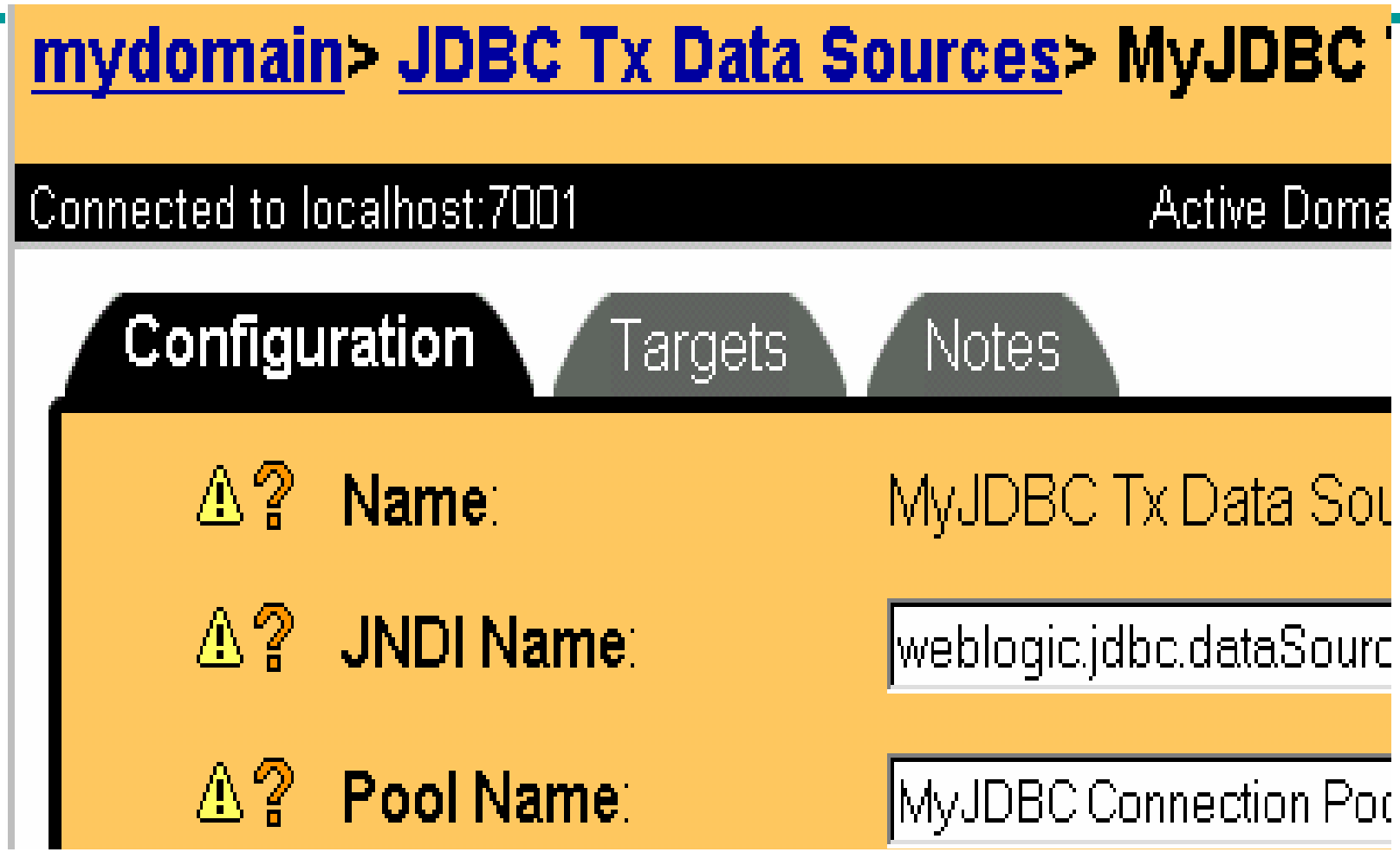
Exceptions within Transactions

- System Exceptions (e.g. NullPointerException, EJBException)
  - Container automatically rolls back transaction
  - Bean instance is discarded
- ApplicationException (e.g. AccountOverdrawException)
  - Container does not automatically rollback transaction
  - Exception delivered to client
  - Client optionally signals rollback
    - EJBContext.setRollbackOnly()

Distributed Transaction

- In addition to managing transactions in its own environment, an EJB server can coordinate with other transactional systems
  - ❖E.g. EJBs on different EJB servers
- EJB server would cooperate to manage the transaction as one unit-of-work
- Two-phase commit (2-PC) is required

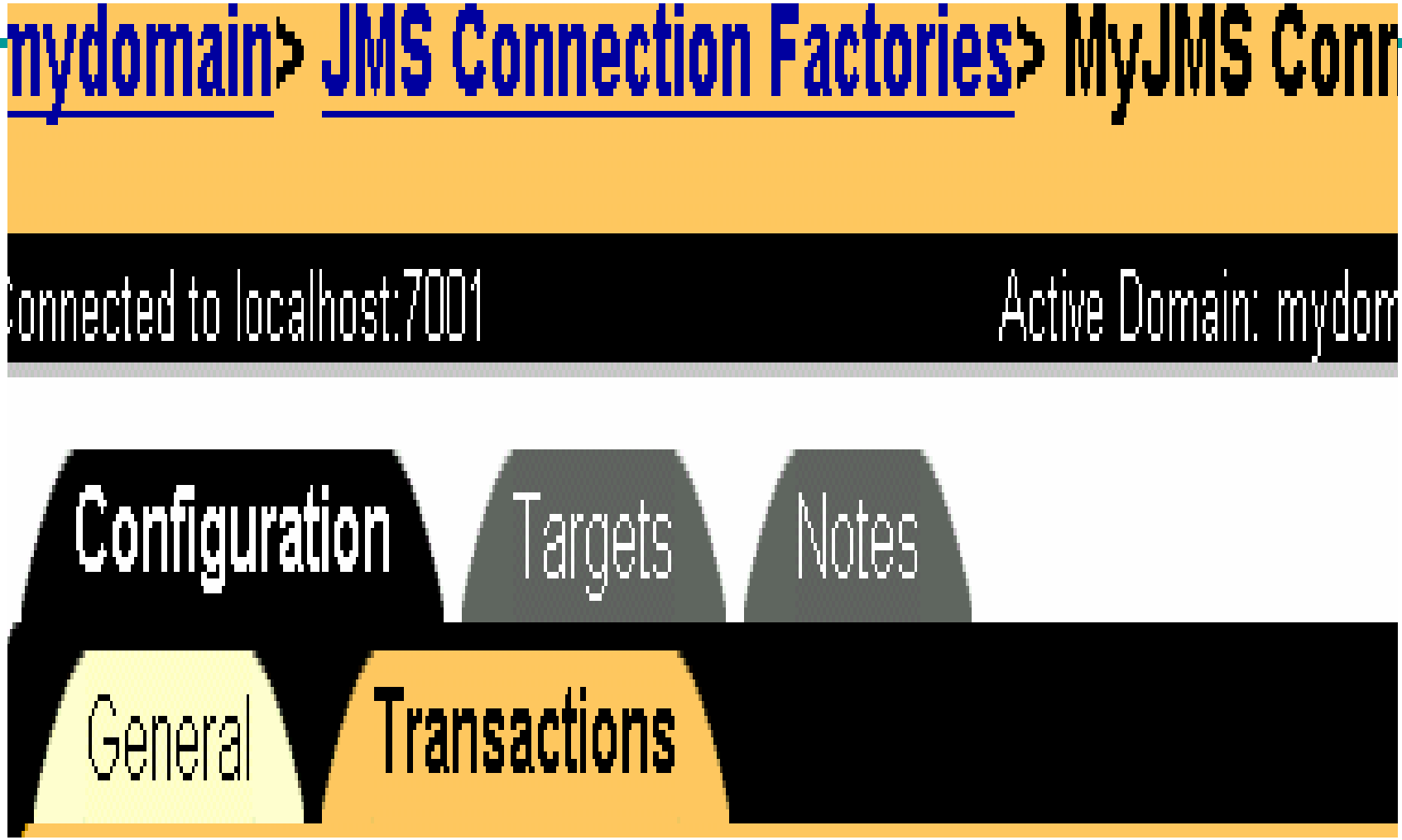
Enable JTS Transactions for Connection Pool



Enable JTS Transactions in Entity Bean

```
<weblogic-rdbms-jar>
   <weblogic-rdbms-bean>
        <ejb-name>Account</ejb-name>
        <data-source-name>java.jdbc.txDataSource
        </data-source-name>
        <table-name>Account</table-name>
```

Enable JTS Transactions for JMS



Bean Types and Transactions

- Entity
  - In EJB 1.1 must be container managed
  - May force a rollback with setRollbackOnly()
- Stateless Session
  - Transactions simple. Abort by throwing EJBException
- Stateful Session
  - E.g. shopping cart (Caching)
  - What about the conversational state?
  - Have to respond to transaction aborts to keep conversational state consistent

Stateful Session Bean and Transactions

- **Can implement** SessionSynchronization **interface**
  - afterBegin(), beforeCompletion(), afterCompletion(boolean)
- **If afterCompletion is false, you can roll back the conversational state**
- **SessionSynchronization can not be implemented with vbean-managed TX**

Programmatic Transactions

- **Bean programmer is responsible for issuing** begin()**,** commit()**, and** abort() **calls in application code**
- **Discouraged**
  - Why not let the container do it?
  - Flexibility and fine grained control
- **Use Java Transaction API (JTA)**

– Simple layer over Java Transaction Service (JTS) which is an implementation of the CORBA Object Transaction Service (OTS)

User Transaction

- **Required EJB Transaction interface (**javax.transaction.UserTransaction**)**
- **Set transaction-type on bean-managed transaction (BMT) in deployment descriptor**
- **Provides access to transaction service**
  - **– Can start and commit**
  - **– Can mark that transaction must be rolled back**
- **Client and server components can use**
- **Container/Server does not have to expose JTS API to the bean**

Code Example

```
public void transfer(AccountRemote from,AccountRemote to, float
    amount ) throws AccountException {
    UserTransaction tx = null;
    try {
    tx = ctx.getUserTransaction();
    tx.begin();
    // perform JDBC operations and transfer the money
    tx.commit();
    }
 catch (Exception ex) {
    tx.setRollbackOnly();
    throw new AccountException();
    }
}
```

Programmatic Transactions in EJB

- **Allowed in Session Beans**

<session>

...

<transaction-type>Bean</transaction-type>

– Stateless Session Beans must begin/end in same method

– Stateful Session Beans may begin/end in separate methods (although not advised)

- **EJB 1.1 disallows this for Entity Beans**
- **MDB - TX scope must begin and end within the** onMessage() **method**
- **Bean controls transactions programmatically**

Transactional Clients

- **End user can also control transactions**

```
UserTransaction ut = (UserTransaction);
jndiContext.lookup(“javax.transaction.UserTransaction”);
ut.begin();
// perform multiple operations on beans
account1.deposit( 34 );
account2.withdraw( 34 );
ut.commit();
```

Client Issues

- Lots of network traffic required when client manages transactions
- More complicated
- Should have asked a session bean to perform the set of operations over on the server
- Transactions should be short

Performance Implications

- Avoid distributed transactions across multiple resource managers and/or multiple transaction managers
  - Consider JMS synchronization
- Avoid client control of transaction boundaries
  - Try to encapsulate transactional business operations in session beans

EJB Transaction Summary

- **Supports EJB goal of removing middleware programming burden from bean programmer**
- **Declare transactional requirements in deployment descriptor**
- **• Transactions have performance implications**
  - **– Limit client control, distributed transactions**
  - **– Can control frequency of** ejbLoad() **and** ejbStore()