Chapter 13:

Data and Database Administration

Traditional Administration Definitions

- ***Data Administration*** A high-level function that is responsible for the overall management of data resources in an organization, including maintaining corporate-wide definitions and standards
- ***Database Administration*** A technical function that is responsible for physical database design and for dealing with technical issues such as security enforcement, database performance, and backup and recovery

Traditional Data Administration Functions

- Data policies, procedures, standards
- Planning
- Data conflict (ownership) resolution
- Managing the information repository
- Internal marketing of DA concepts

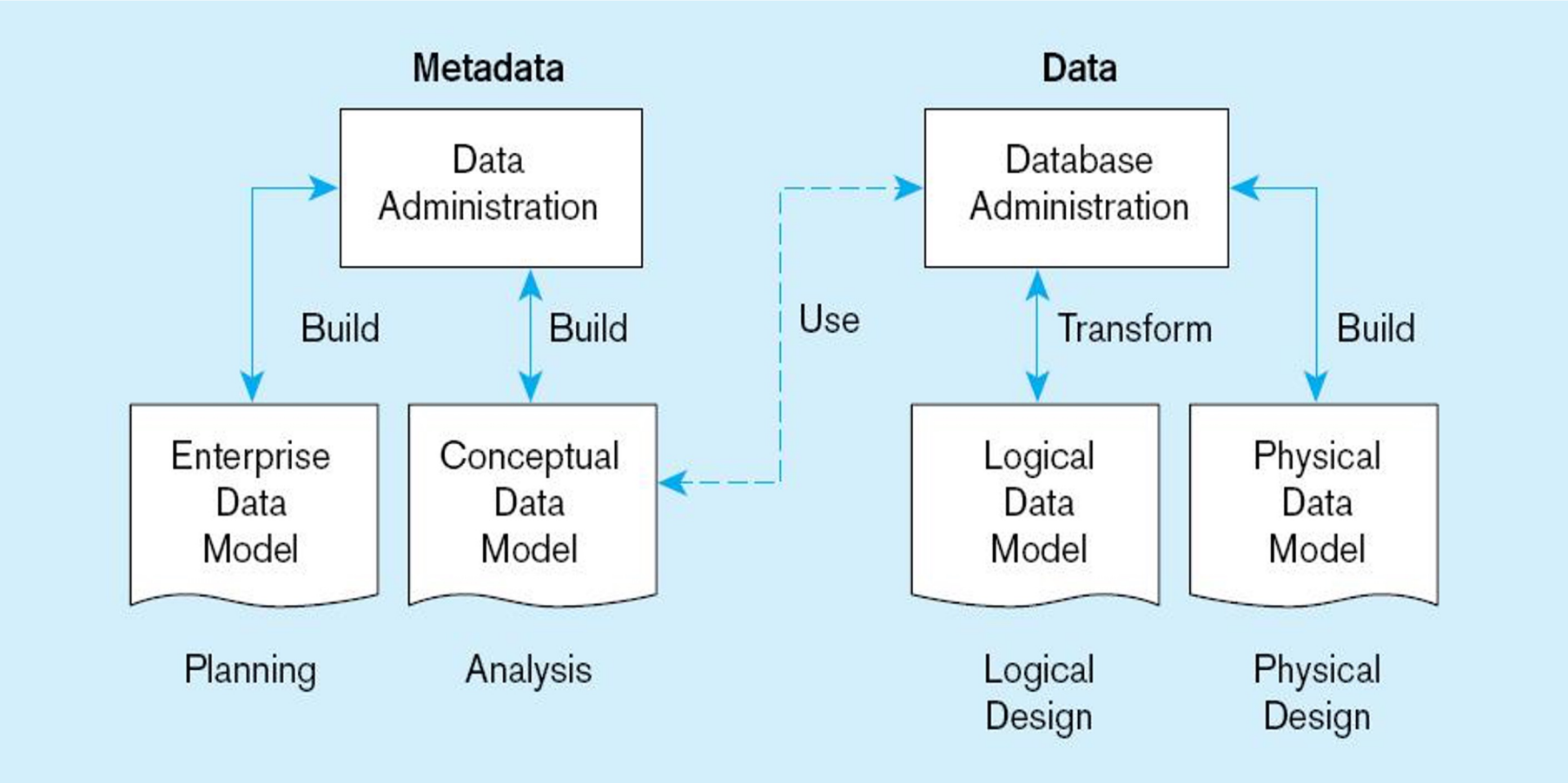
Traditional Database Administration Functions

- Selection of DBMS and software tools
- Installing/upgrading DBMS
- Tuning database performance
- Improving query processing performance
- Managing data security, privacy, and integrity
- Data backup and recovery

Data Warehouse Administration

- New role, coming with the growth in data warehouses
- Similar to DA/DBA roles
- Emphasis on integration and coordination of metadata/data across many data sources
- Specific roles:
  - Support DSS applications
  - Manage data warehouse growth
  - Establish service level agreements regarding data warehouses and data marts

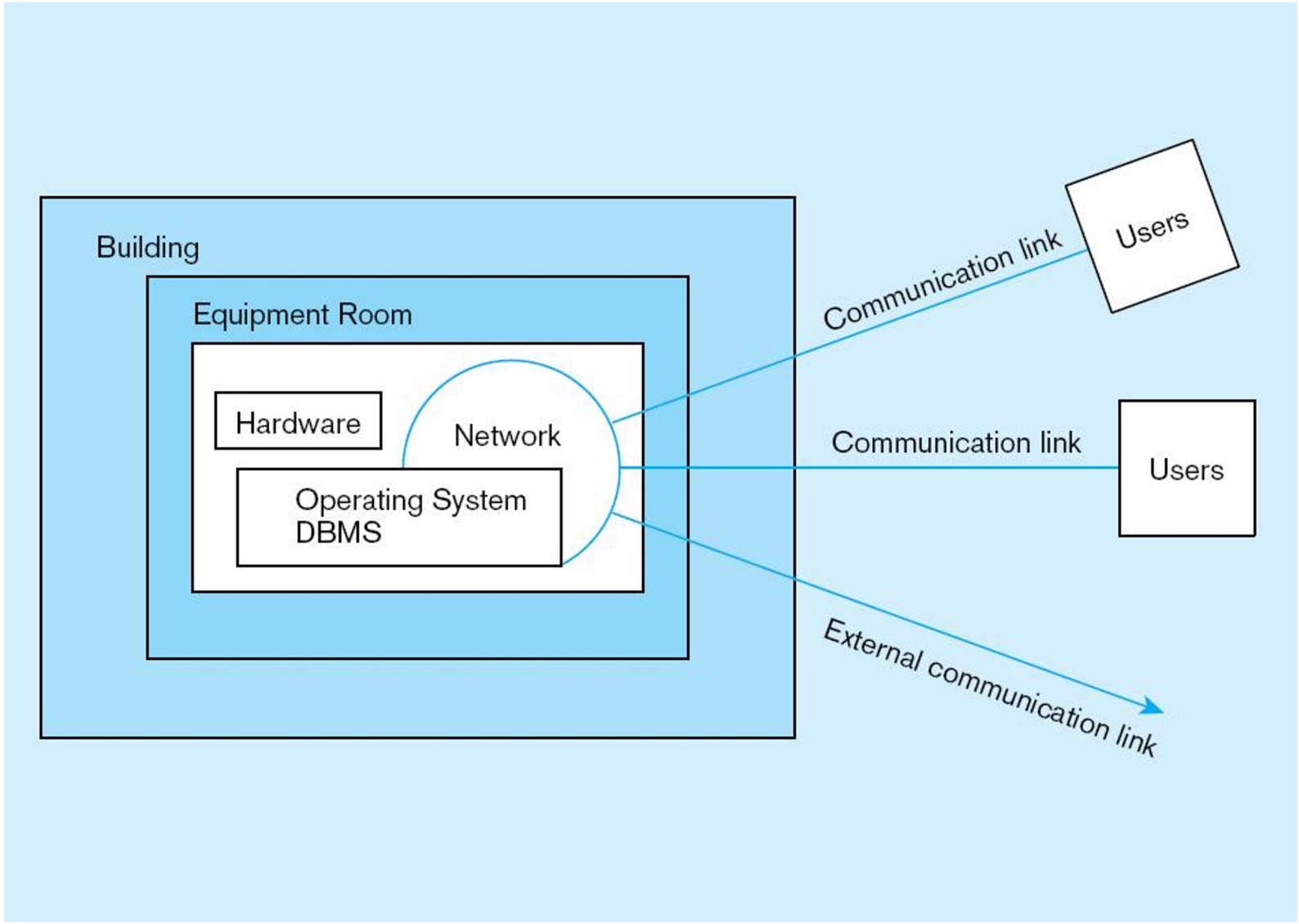
Figure 13-2 Data modeling responsibilities



Database Security

- **Database Security:** Protection of the data against accidental or intentional loss, destruction, or misuse
- Increased difficulty due to Internet access and client/server technologies

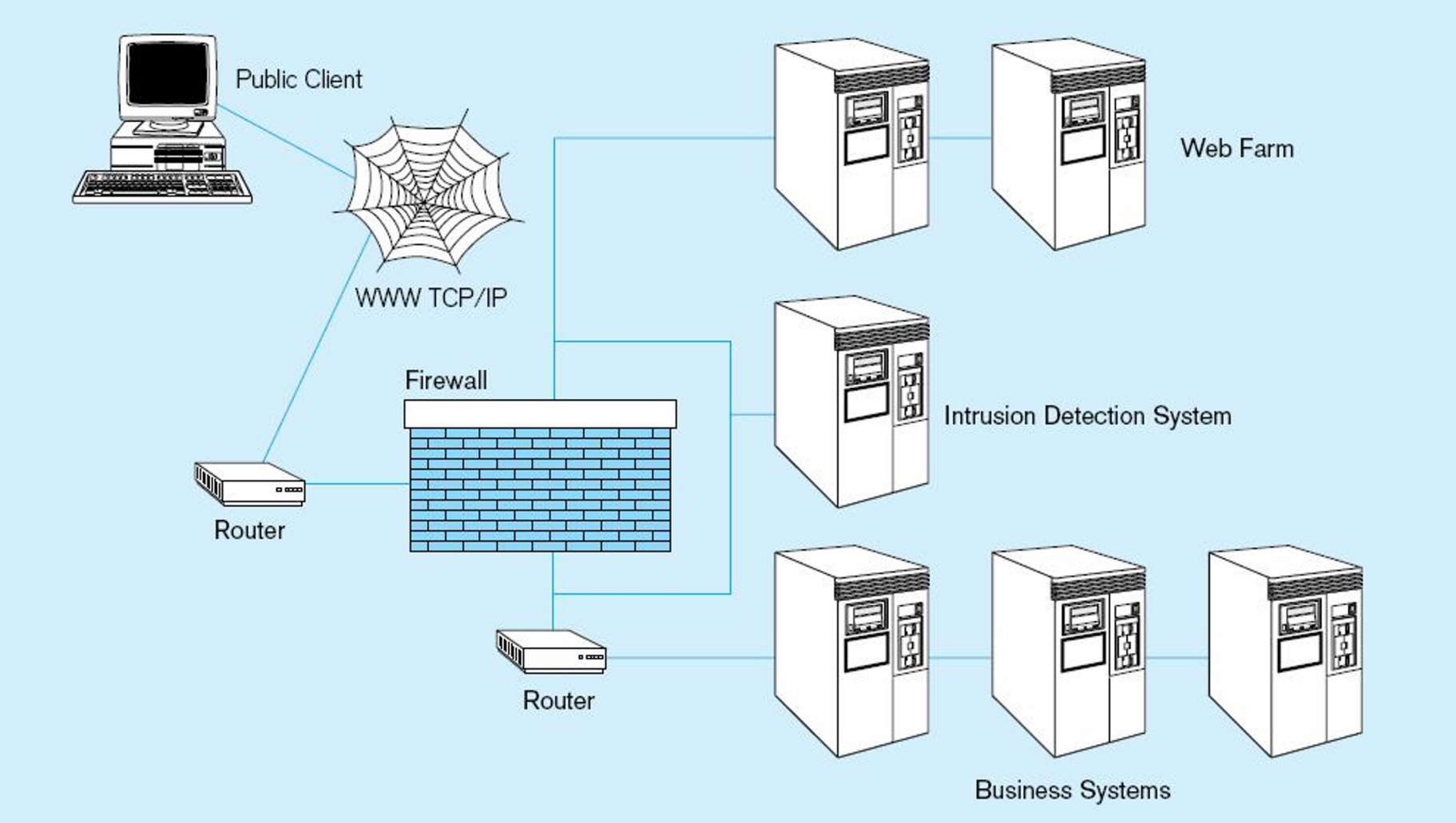
Figure 13-3 Possible locations of data security threats



Threats to Data Security

- Accidental losses attributable to:
  - Human error
  - Software failure
  - Hardware failure
- Theft and fraud
- Improper data access:
  - Loss of privacy (personal data)
  - Loss of confidentiality (corporate data)
- Loss of data integrity
- Loss of availability (through, e.g. sabotage)

Figure 13-4 Establishing Internet Security



Web Security

- Static HTML files are easy to secure
  - Standard database access controls
  - Place Web files in protected directories on server
- Dynamic pages are harder
  - User authentication
  - Session security
  - SSL for encryption
  - Restrict number of users and open ports
  - Remove unnecessary programs

W3C Web Privacy Standard

- Addresses the following:
  - Who collects data
  - What data is collected and for what purpose
  - Who is data shared with
  - Can users control access to their data
  - How are disputes resolved
  - Policies for retaining data
  - Where are policies kept and how can they be accessed

Database Software Security Features

- Views or subschemas
- Integrity controls
- Authorization rules
- User-defined procedures
- Encryption
- Authentication schemes

Views and Integrity Controls

- Views
  - Subset of the database that is presented to one or more users
  - User can be given access privilege to view without allowing access privilege to underlying tables
- Integrity Controls
  - Protect data from unauthorized use
  - Domains–set allowable values
  - Assertions–enforce database conditions

Authorization Rules

- Controls incorporated in the data management system
- Restrict:
  - access to data
  - actions that people can take on data
- Authorization matrix for:
  - Subjects
  - Objects
  - Actions
  - Constraints

Figure 13-5 Authorization matrix

Subject	Object	Action	Constraint
Sales Dept.	Customer record	Insert	Credit limit LE $5000
Order trans.	Customer record	Read	None
Terminal 12	Customer record	Modify	Balance due only
Acctg. Dept.	Order record	Delete	None
Ann Walker	Order record	Insert	Order aml LT $2000
Program AR4	Order record	Modify	None

Implementing authorization rules

	Customer records	Order records
Read	Y	Y
Insert	Y	Y
Modify	Y	N
Delete	N	N

Figure 13-6b Authorization table for objects (orders)

	Salespersons (password BATMAN)	Order entry (password JOKER)	Accounting (password TRACY)
Read	Y	Y	Y
Insert	N	Y	N
Modify	N	Y	Y
Delete	N	N	Y

Figure 13-7 Oracle privileges

Privilege	Capability
SELECT	Query the object.
INSERT	Insert records into the table/view. Can be given for specific columns.
UPDATE	Update records in table/view. Can be given for specific columns.
DELETE	Delete records from table/view.
ALTER	Alter the table.
INDEX	Create indexes on the table.
REFERENCES	Create foreign keys that reference the table.
EXECUTE	Execute the procedure, package, or function.

Some DBMSs also provide capabilities for ***user-defined procedures*** to customize the authorization process

Authentication Schemes

- Goal – obtain a *positive* identification of the user
- Passwords: First line of defense
  - Should be at least 8 characters long
  - Should combine alphabetic and numeric data
  - Should not be complete words or personal information
  - Should be changed frequently

Authentication Schemes (cont.)

- Strong Authentication
  - Passwords are flawed:
    - Users share them with each other
    - They get written down, could be copied
    - Automatic logon scripts remove need to explicitly type them in
    - Unencrypted passwords travel the Internet
- Possible solutions:
  - Two factor–e.g. smart card plus PIN
  - Three factor–e.g. smart card, biometric, PIN
  - Biometric devices–use of fingerprints, retinal scans, etc. for positive ID
  - Third-party mediated authentication–using secret keys, digital certificates

Security Policies and Procedures

- Personnel controls
  - Hiring practices, employee monitoring, security training
- Physical access controls
  - Equipment locking, check-out procedures, screen placement
- Maintenance controls
  - Maintenance agreements, access to source code, quality and availability standards
- Data privacy controls
  - Adherence to privacy legislation, access rules

Database Recovery

Mechanism for restoring a database quickly and accurately after loss or damage

Recovery facilities:

- Backup Facilities
- Journalizing Facilities
- Checkpoint Facility
- Recovery Manager

Back-up Facilities

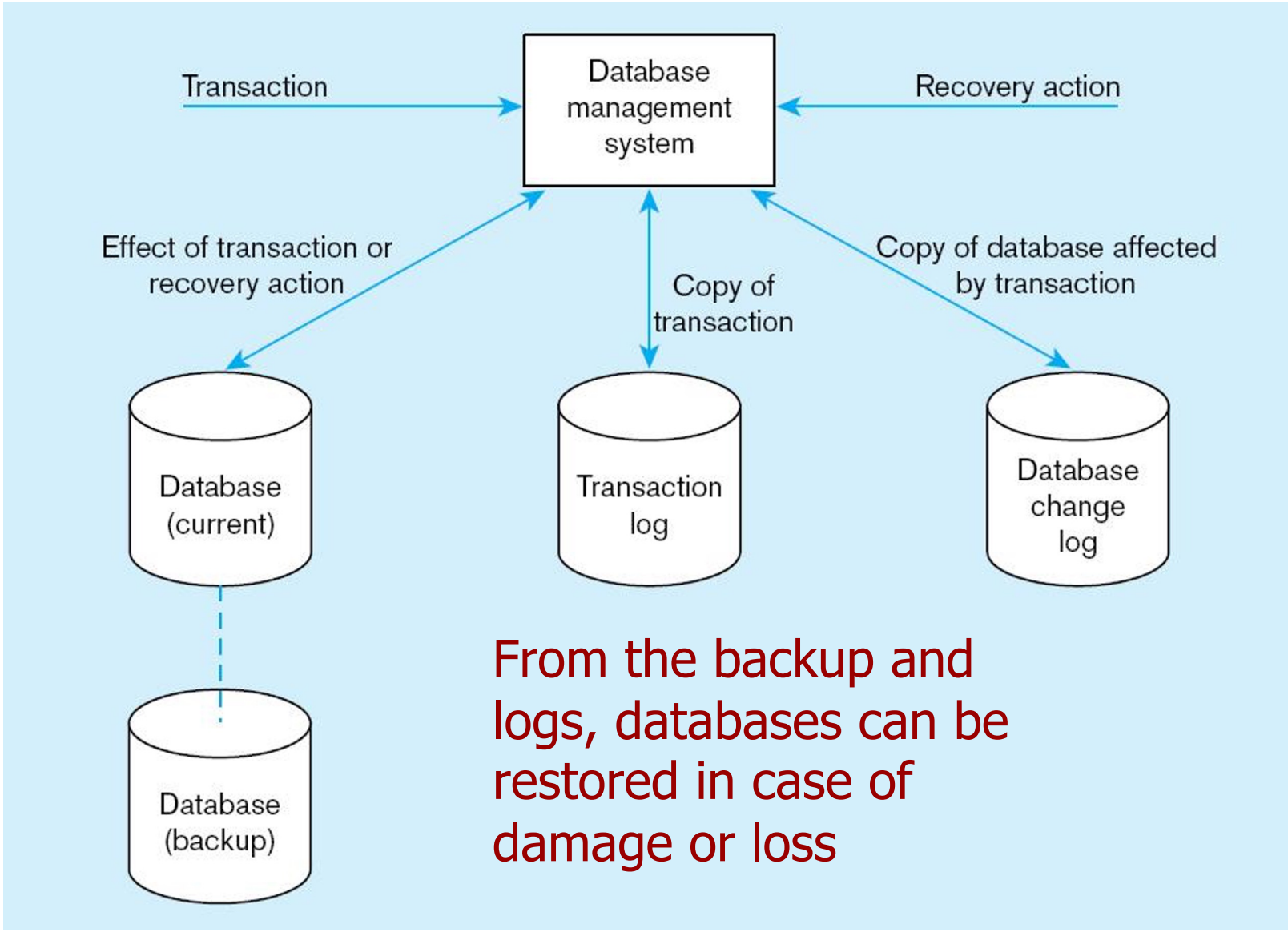
- Automatic dump facility that produces backup copy of the entire database
- Periodic backup (e.g. nightly, weekly)
- Cold backup–database is shut down during backup
- Hot backup–selected portion is shut down and backed up at a given time
- Backups stored in secure, off-site location

Journalizing Facilities

- Audit trail of transactions and database updates
- Transaction log–record of essential data for each transaction processed against the database
- Database change log–images of updated data
  - Before-image–copy before modification
  - After-image–copy after modification

Produces an ***audit trail***

Figure 13-9 Database audit trail



Checkpoint Facilities

- DBMS periodically refuses to accept new transactions
- □ system is in a *quiet* state
- Database and transaction logs are synchronized

This allows recovery manager to resume processing from short period, instead of repeating entire day

Recovery and Restart Procedures

- Disk Mirroring–switch between identical copies of databases
- Restore/Rerun–reprocess transactions against the backup
- Transaction Integrity–commit or abort all transaction changes
- Backward Recovery (Rollback)–apply before images
- Forward Recovery (Roll Forward)–apply after images (preferable to restore/rerun)

Transaction ACID Properties

- Atomic
  - Transaction cannot be subdivided
- Consistent
  - Constraints don’t change from before transaction to after transaction
- Isolated
  - Database changes not revealed to users until after transaction has completed
- Durable
  - Database changes are permanent

Figure 13-10 Basic recovery techniques

a) Rollback

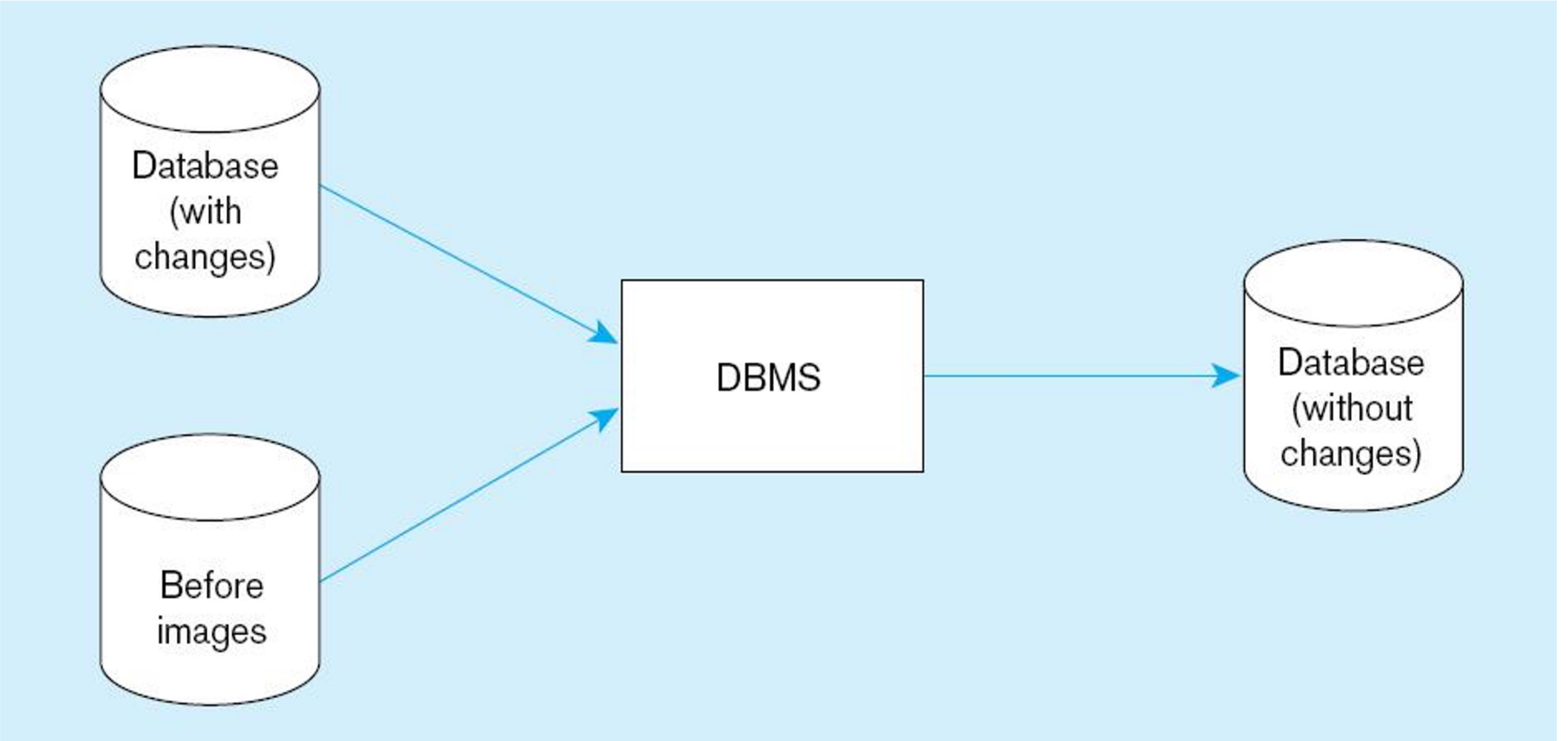
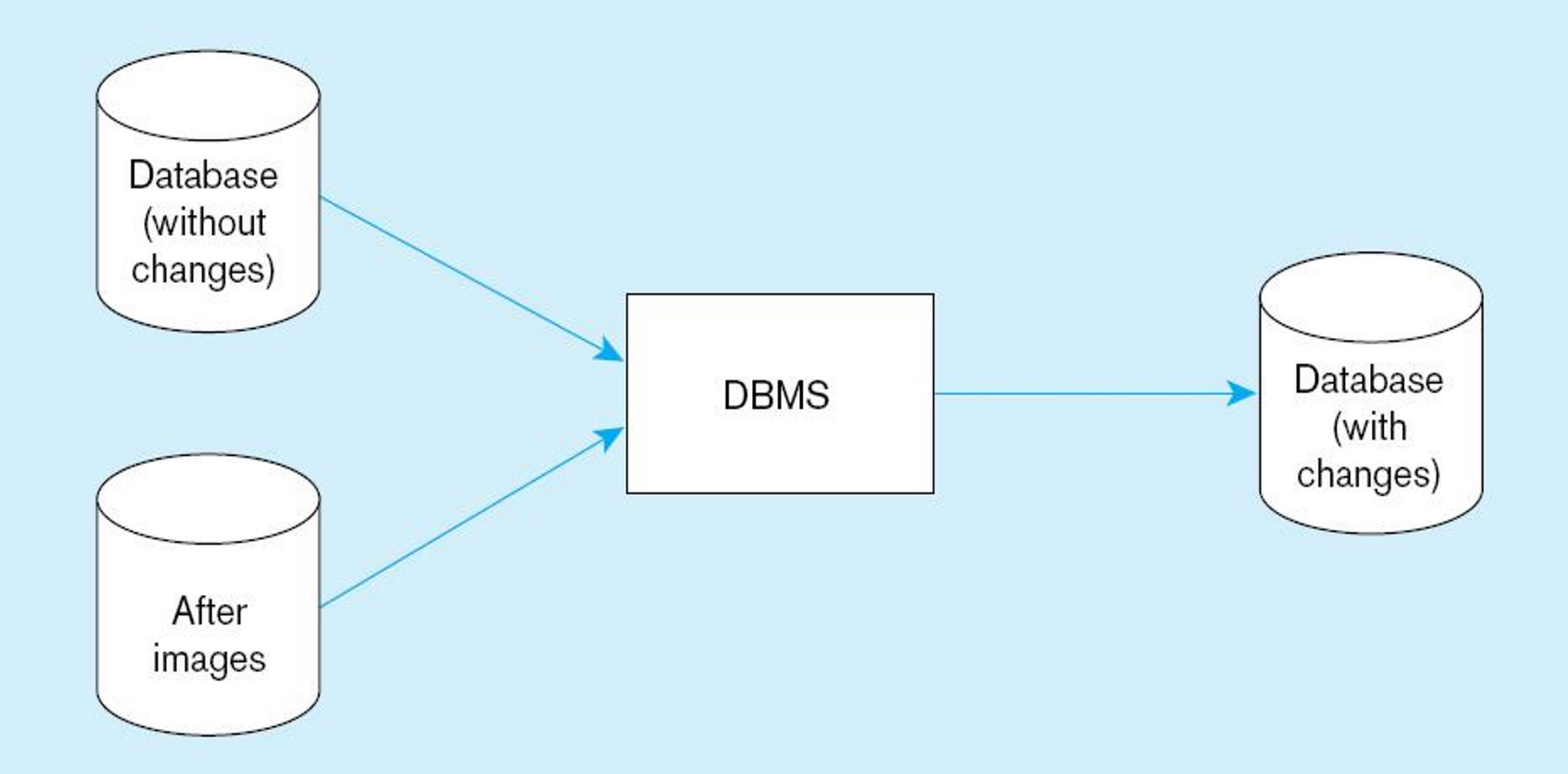


Figure 13-10 Basic recovery techniques (cont.)

b) Rollforward



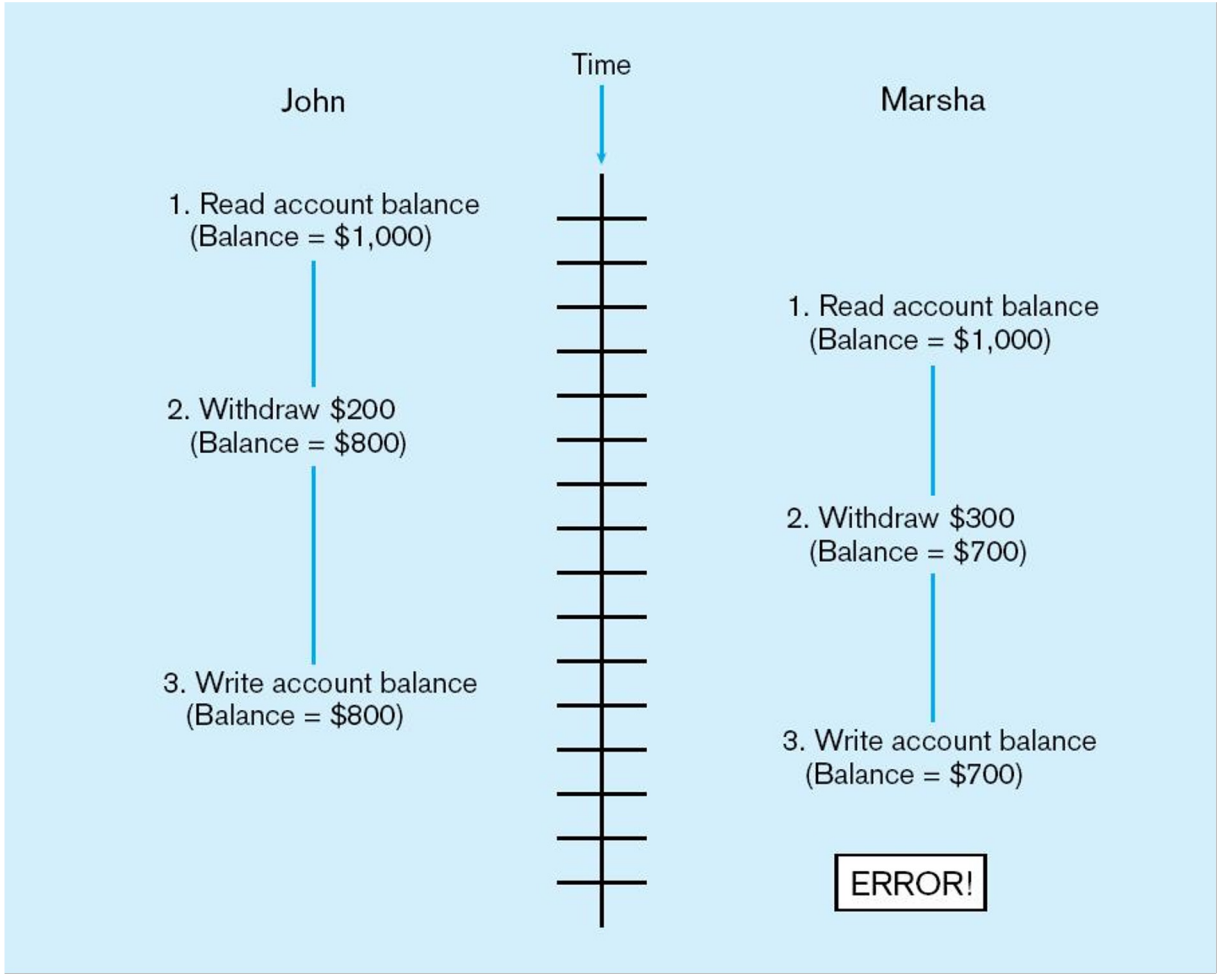
Database Failure Responses

- ***Aborted transactions***
  - Preferred recovery: rollback
  - Alternative: Rollforward to state just prior to abort
- ***Incorrect data***
  - Preferred recovery: rollback
  - Alternative 1: rerun transactions not including inaccurate data updates
  - Alternative 2: compensating transactions
- ***System failure (database intact)***
  - Preferred recovery: switch to duplicate database
  - Alternative 1: rollback
  - Alternative 2: restart from checkpoint
- ***Database destruction***
  - Preferred recovery: switch to duplicate database
  - Alternative 1: rollforward
  - Alternative 2: reprocess transactions

Concurrency Control

- *Problem*–in a multi-user environment, simultaneous access to data can result in interference and data loss
- ***Solution*–Concurrency Control**
  - The process of managing simultaneous operations against a database so that data integrity is maintained and the operations do not interfere with each other in a multi-user environment

Figure 13-11 Lost update (no concurrency control in effect)



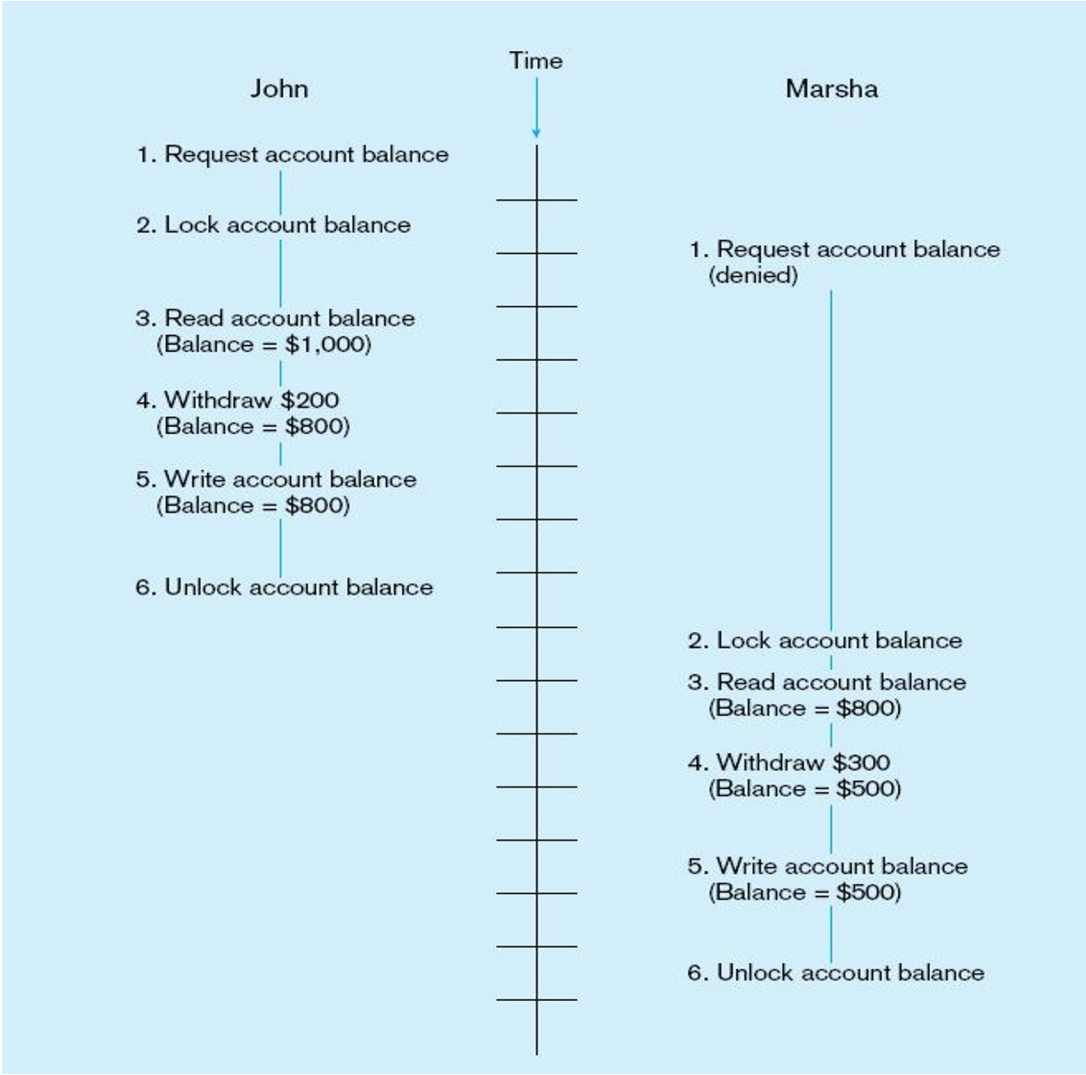
Simultaneous access causes updates to cancel each other

A similar problem is the **inconsistent read** problem

Concurrency Control Techniques

- Serializability
  - Finish one transaction before starting another
- Locking Mechanisms
  - The most common way of achieving serialization
  - Data that is retrieved for the purpose of updating is locked for the updater
  - No other user can perform update until unlocked

Figure 13-12: Updates with locking (concurrency control)



This prevents the lost update problem

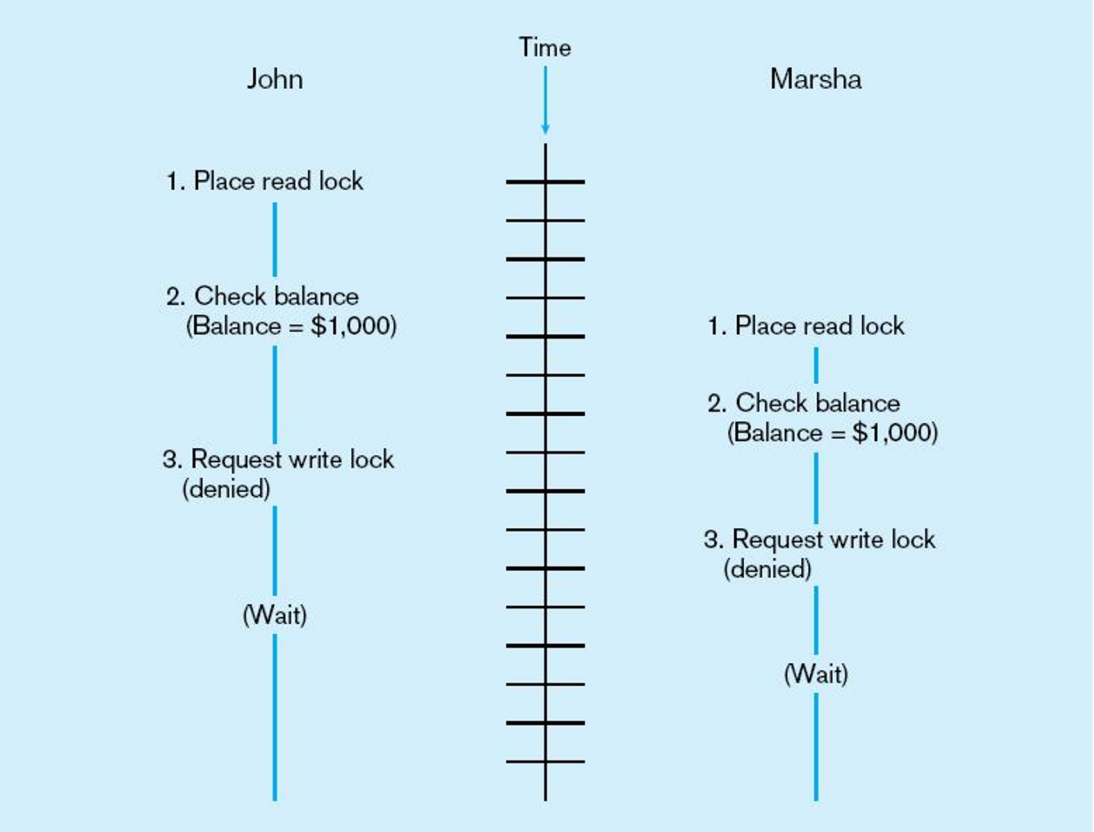
Locking Mechanisms

- Locking level:
  - Database–used during database updates
  - Table–used for bulk updates
  - Block or page–very commonly used
  - Record–only requested row; fairly commonly used
  - Field–requires significant overhead; impractical
- Types of locks:
  - Shared lock–Read but no update permitted. Used when just reading to prevent another user from placing an exclusive lock on the record
  - Exclusive lock–No access permitted. Used when preparing to update

Deadlock

- An impasse that results when two or more transactions have locked common resources, and each waits for the other to unlock their resources

Figure 13-13
The problem of deadlock



John and Marsha will wait forever for each other to release their locked resources!

Managing Deadlock

- Deadlock prevention:
  - Lock all records required at the beginning of a transaction
  - Two-phase locking protocol
    - Growing phase
    - Shrinking phase
  - May be difficult to determine all needed resources in advance
- Deadlock Resolution:
  - Allow deadlocks to occur
  - Mechanisms for detecting and breaking them
    - Resource usage matrix