Database Security

COMP620

Database Value

- Database
  - Representing an essential corporate resource
  - Should be properly secured using appropriate controls
- Database Security
  - The mechanisms that protect the database against intentional or accidental threats
  - Protecting the database from
    - Unauthorized access
    - Modification
    - Destruction

Database Security: Before, Now, and Future

- A couple decades ago, databases were
  - Physically secure
  - Housed in central data centers – not distributed
  - External access mediated through customer service reps, purchasing managers, etc.
  - Security issues rarely reported
- Now increasingly DB's externally accessible
  - Suppliers directly connected
  - Customers directly connected
  - Customers and partners directly sharing
- Data is the most valuable resource in applications
- DB security a growing problem

Privacy and Database Design

- Privacy
  - The right of individuals to have some control over information about themselves
- Laws
  - Many countries have laws designed to protect privacy
  - Every organization that collects and stores information about individuals is legally obliged to adopt policies that conform to local privacy legislation
- Database designers have a responsibility to protect the privacy of individuals about whose data is kept

Legal Perspective

- "Database and Collections of the Information Misappropriation Act of 2003"
  - Limitation of Copyright laws
  - Protect Privacy
- "Sweat of the brow"
  - The effort expended in labor, and the value created thereby
  - Protecting large database from competitors

Accidental Security Threats

- The user may unintentionally request an object or an operation for which he should not be authorized
- A system error might connect a user to a session that belongs to another user with different access privileges
- The operating system might not erase files that should be destroyed

Deliberate Security Threats

- Impersonating an authorized user, or a user with greater access, by using his or her login and password
- Writing system programs with illegal code to bypass the database management system and its authorization mechanism
- Writing application programs to perform unauthorized operations
- Bribing, blackmailing, or influencing authorized users to obtain information from the database

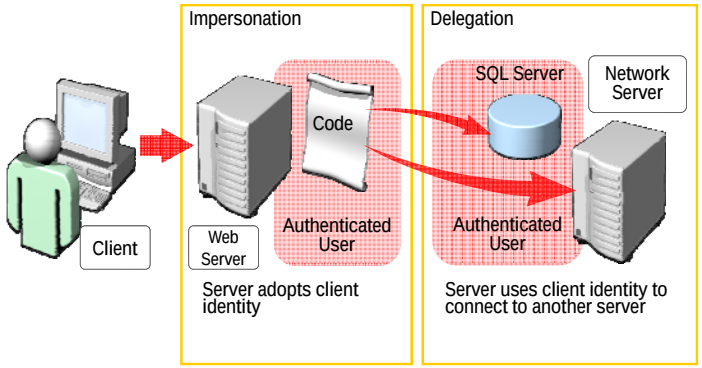
Database Application Questions

- Can the database be attacked through a web page?
- Can the data be tampered with?
- Are illegal operations traceable?
- Do error messages leak too much info?
- Can an attacker send script into your database?

Security Context

- A process or thread always executes in the context of an identity
  - May be the identity of the process itself
  - Or may be derived from user or client identity: impersonation (next slide)
  - And may flow between application or tiers: Delegation (next slide)

Impersonation and Delegation



Access Control

- Goal: make sure that data are accessed only in authorized ways
- Access Control Matrix
  - Specifying types of access permitted on a resource
- Responsibility of the DBA
  - Have a comprehensive view of users, roles, and resources
  - Design the access control matrix
  - Implement the access control matrix using the authorization language

Access Control Matrix

- A set of subjects S
- A set of objects O
- A set of privileges R
- One row for each subject
- One column for each object
- Elements are privileges of subject on an object

Example Access Control Matrix

Subject	Student (table)	StudentView (view)	Faculty (table)	Enrol (table)	Wrapup (procedure)	…
John (user)	read, update	read	Read			
Tom (user)	read	read				
Faculty (role)	read	read	read	Read, insert, update, delete	execute	

Privilege

- Privilege
  - A privilege is an action that a user is permitted to perform on database objects
    - Read
    - Update
    - Delete
    - Execute
    - Etc.
- Granting privileges
  - In standard SQL, the creator of an object (table, view, role, procedure, module, etc) is given all privileges in it
  - The creator can also pass these privileges on to others

SQL User Creation

- Create a user

create user *username* identified by *password*
default tablespace *tablespacename*
temporary tablespace *temptablespacename*

- Example

create user tom identified by tom
default tablespace comp620project
temporary tablespace temp;

Granting SQL Privileges

- Granting Privileges Statement

  GRANT {ALL_PRIVILEGES | privilege-list}
  ON {table-name | view-name}
  TO {PUBLIC | userlist | rolelist} [WITH GRANT OPTION];

- Examples
  - GRANT UPDATE ON branch TO tom;

    User Tom can update table branch.
  - GRANT UPDATE (assets) ON branch TO tom;

    User Tom can only update the asset column in the branch table.
  - GRANT UPDATE ON branch TO tom WITH GRANT OPTION;

    User Tom can update table branch and also grant it to other users

Revoking SQL Privileges

- Remove Privileges

  REVOKE {ALL PRIVILEGES | privilege-list}
  ON object-list FROM {PUBLIC | user-list|role-list}
  [CASCADE];
- CASCADE
  - If an individual has the grant option for a certain privilege and the privilege or the grant option on it is later revoked, all users who have received the privilege from that individual have their privilege revoked as well.
- Example

  REVOKE insert ON student FROM tom

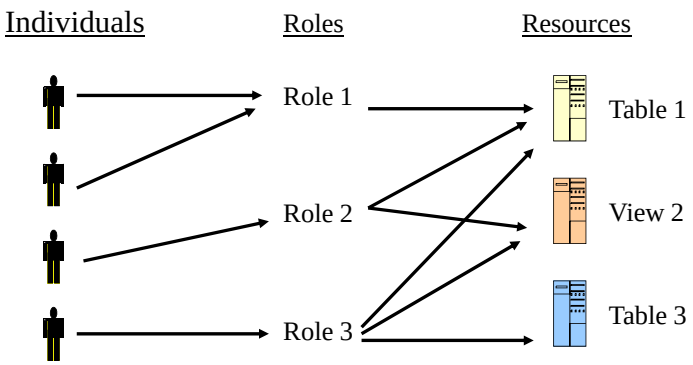
Using Views for Access Control

- View
  - A widely used method for implementing access control
    - Hiding structures and data that the user should not see
- Example

  GRANT SELECT on Student to Tom;
  - Tom is a student and he can read other student records
  - Protect the Privacy of the student table
  - Create a view for Tom for his record

  CREATE VIEW TomView AS
  SELECT * FROM student WHERE name='Tom';
  Grant SELECT on TomView to Tom;

Role-Based Access Control



User's change frequently, Roles don't

SQL Roles

- Role

  CREATE ROLE rolename;
  - Example

    CREATE ROLE AdvisorRole;
    CREATE ROLE FacultyRole;
- Grant Privileges to Role

  GRANT SELECT ON Student TO AdvisorRole
  GRANT UPDATE ON Enroll TO AdvisorRole
  GRANT SELECT ON Enroll TO FacultyRole
- Assign a Role to a User

  GRANT AdvisorRole to Jack

Excessive Privilege Abuse

- When users (or applications) are granted database access privileges that exceed the requirements of their job
- Query-Level access control can be used to limit what a user can access
  - limit the SQL operations (SELECT, UPDATE, etc.)
  - limit access to tables, rows and columns

Platform Vulnerabilities

- Unless properly secured, it may be possible for a user to access the database files without using the database system
- Files can be copied, inspected or changed
- A separate database can be created from copies of the original database

Audit Trails

- Databases provide the ability to keep track of who did what
  - Regulatory Requirement - Sarbanes-Oxley (SOX) and the Healthcare Information Portability and Accountability Act (HIPAA) have audit requirements
- Deterrence
- Problem detection
- Recovery

Audit Weaknesses

- Lack of User Accountability – some audit trails do not record the exact user
- Performance Degradation – maintaining the audit trail consumes resources
- Limited Granularity – the audit trail might not record enough information
- Separation of Duties – Can a privileged user turn off the audit trail?

Denial of Service

- A user may be able to make many resource intensive requests of the database which can significantly reduce performance
- Users should be given only the capabilities necessary for their job

Backup File Exposure

- Organizations need to backup their databases on a regular schedule
- The backup data needs to be secure
- All backups should be encrypted