

## Chapter 6

### Security

#### **Introduction**

- Database security means the protection of data or information from accidental loss, unauthorized access, modification, destruction and unintended activities.
- In any organization, certain class of data is available only to those persons who are authorized to access it.
- So data stored in database need to be protected from un-authorized access and from any kind of intentional or accidental corruption.

#### **Needs of database security**

- Database security is needed for a database due to the following reasons.
  1. Unauthorized disclose of information.
  2. Unauthorized modification or destruction of valuable information.
  3. Unauthorized use of service.
  4. Denial of service to the authorized users.
- To protect database, we must make security measures at several levels.

#### **1. Physical Security**

- a) The room where the computer storing a database must be itself strong and secured.
- b) Unknown person must be restricted to enter into system room.
- c) Placing backup copies of database in a separate location so that they remain safe in case of any disaster in office area.
- d) It also includes protection of database against fire, earthquake.

#### **2. Human**

- The unauthorized access of data should be prevented.
- There are many measures to protect data from unauthorized access like as password system.
- Also the employee of a company should not leak valuable information about the organization to outsiders.

#### **3. Operating System**

- No matter how secure the database system is, weakness in OS security may serve as a means of unauthorized access to the database.

#### **4. Network**

- The database information must be protected from hackers and attack of viruses, leakages of data while being transferred from one computer to other in a network or internet.

#### **5. Database System**

- Database system users may be authorized to access only limited portion of the database.
- Here user may be allowed to issue queries without any modification.
- Also several views can be utilized as a form of security in the database because it can be used to suppress the confidential columns from viewing and manipulation.

#### **6. Administrative Controls**

- Administrative controls are the security and access control policy that determines what information will be accessible to what class of users.

#### **Authorization**

- Authorization is the process of giving someone permission to do or have something.
- In multi-user database systems, a system administrator defines for the system which users are allowed access to the system and what privileges of use.
- Authorization primarily includes two processes.
  - i. Permitting only certain user to access, process or alter data.
  - ii. Applying varying limitations on users access.
- Thus, authorization is sometimes seen as both the preliminary setting up of permissions by a system administrator and the actual checking of the permission values that have been set up when a user is getting access.
- GRANT and REVOKE command can be used to provide and restrict some form of authorization.
- A user may have several form of authorization on parts of database.
  - Read Authorization allows reading but not modification to database.
  - Insert Authorization allows insertion of new data but not modification of existing data.
  - Update Authorization allows modification of data not deletion of data.
  - Delete Authorization allows deletion of data.

- A database user may be assigned all, none, or combination of these types of authorization.
- In addition to these form of authorization for access to data, we may grant user authorization to modify the database schema.
- Index Authorization allows creation and deletion of indices.
- Resource Authorization allows the creation of new relations.
- Alteration Authorization allows the addition or deletions of attributes in relations.
- Drop Authorization allows the deletion of relations and attributes.

*Logically, authorization is preceded by authentication.*

## **Authentication**

- Authorization is the process to confirm what you are authorized to perform but Authentication confirms who you are.
- So the primary goal of authentication system is to allow access to the legal system users and deny access to unauthorized access.
- After authentication, authorization process limits the level of access and action performed on the given database.
- The most widely used authentication techniques are

### **1. Password Based Authentication:**

- A **password** is a secret word or string of characters used for user authentication to prove identity to a resource, which should be kept secret from those not allowed access.
- It is not much reliable than other authentication system because if a weak password is chosen then it can be easily guessed.
- Good criteria when choosing a password or setting up password guidelines includes the following:
  - Don't pick a password that someone can easily guess if they know who you are (for example, not your Social Security number, birthday, or maiden name)
  - Don't pick a word that can be found in the dictionary (since there are programs that can rapidly try every word in the dictionary!)
  - Don't pick a word that is currently newsworthy
  - Don't pick a password that is similar to your previous password
  - Do pick a mixture of letters and at least one number
  - Do pick a word that you can easily remember

### **2. Artifact Based Authentication:**

- It includes machine-readable batches and electronics cards.
- These cards consist of magnetic strip, which represents a unique identification number.
- Card reader may be installed in or near the terminal and users are required to supply the artifact for authentication.
- This form of authentication is common in ATMs in bank.
- Some companies also provide cards to their employee for authentication.

### **3. Biometric Technique:**

- In this technique, the major groups of authentication mechanism are based on the unique characteristic of each user.
- This falls into two basic categories.
  - a. Physiological Characteristics: Characteristics such as finger prints, facial characteristics, retina characteristics etc.
  - b. Behavioral Characteristics: Characteristics such as voice pattern, signature pattern etc.

## **Access Control**

- Access control mechanism enforces rules who can perform what operation or who can access which data.
- This access control mechanism must concern with three basic components.

### **1. Accessor (Subject):**

- A subject is an active element in the security mechanism that operates on the object.
- A subject is a user who is given some right to access a data object.
- A subject may be a class of users or even an application program.
- To provide security to object, identification and authentication of accessor is required.
- The process of identification may be performed with the help of password, finger print or voice pattern etc.

### **2. Object to be accessed:**

- An object is something that needs protection.
- A typical object in a database environment could be a unit of data that need to be protected.
- Object can be classified as
  - a. Data:** These are prime candidates for protection. Data object may be file, record, table etc.
  - b. Access Path:** Access path to be followed for accessing a particular data item or service is an important object by itself in any security mechanism.
  - c. Schema:** The database schema is another object for protection. Since schema declaration defines access right to different data object, anyone having access to schema declaration can eventually attain access right to different data items also. This is highest level of security.
  - d. Views:** The views may involve read only facility of the data items and no modification will be permitted for one class of users while other call of user might be able to update view also.
  - e. Communication Object:** In a distributed database environment, some communication protocols have to be maintained for reliable communication of environment. The communication protocol may include necessary information for the identification and authentication of the sender and receiver.

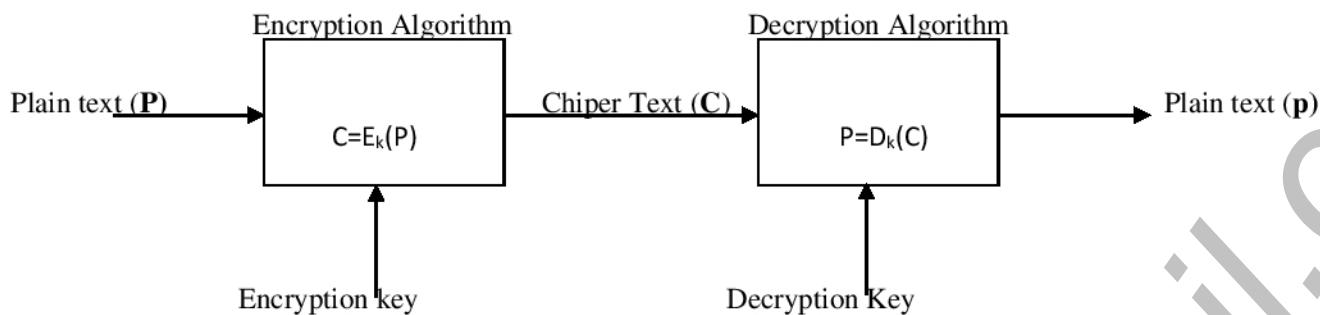
### **3. Types of Access Control:**

- Once an object is created, the owner may grant the following rights to object to the other authorized users.  
**Read, insert, delete, update, run, create, destroy**

## **Cryptography**

- Cryptography in Greek means “Secret Writing”
- Science and Art of transforming message to make them secure and immune to attack.
- Original message before transformation is called Plaintext.
- An Encryption algorithm transforms Plaintext to Cipher text.
- Decryption algorithm transforms Cipher text back to Plaintext
- Cryptography enables you to store sensitive information or transmit it across insecure networks (like the Internet) so that it cannot be read by anyone except the intended recipient.
- Cryptography is used to protect e-mail messages, credit card information, computer password, electronic commerce etc.
- Most practical cryptographic systems combine two elements:
  - A process or algorithm which is a set of rules that specify the mathematical steps needed to encipher or decipher data.
  - A cryptographic key (a string of numbers or characters), or keys. The algorithm uses the key to select one relationship between plaintext and cipher text out of the many possible relationships the algorithm provides. The selected relationship determines the composition of the algorithm's result.

- A general model of cryptography system is shown below.

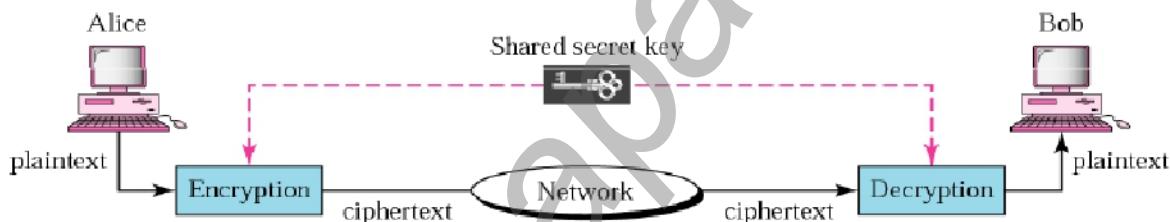


- **Encryption** means modifying the data such a way that it becomes useless or unidentifiable or unreadable to the intruder (Undesired person, program) but only the desired receiver can view the actual data.
- It can be encrypted using some encryption method parameterized by encryption key.
- The result is cipher text which is unreadable.
- The cipher text may be stored or transmitted over the secured communication medium.
- Now a plain text can be obtained by decrypting the cipher text using the decryption key.
- So use of key to reverse this encryption process and return the data to its original form is called **decryption**.

## Types of Cryptography

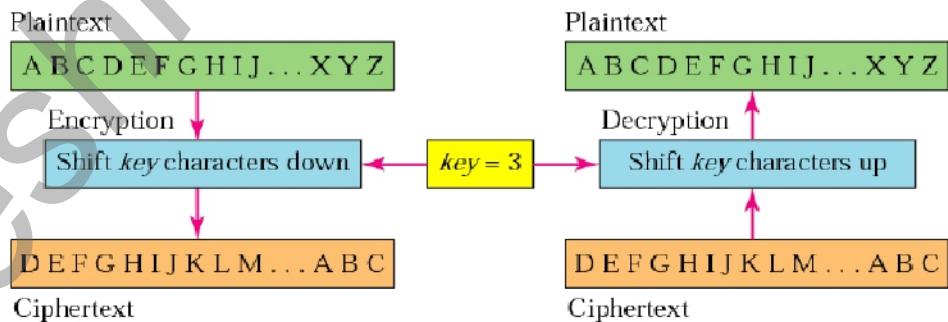
There are two types of cryptography.

1. Private Key Cryptography (Symmetric Cryptography)



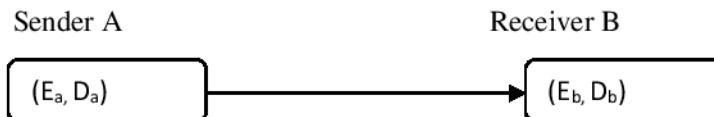
- A cryptography system that uses the same key for both encryption and decryption is called symmetric cryptography.
- The key used for encrypt and decrypt must only be known by the sender and receiver i.e. key must be private hence called as private key cryptography.
- The sender uses some key along with the encryption algorithm to encrypt the data, and the receiver uses the same key and decryption algorithm to decrypt the data.

Example:



## 2. Public Key Cryptography (Asymmetric Cryptography)

- The main disadvantage of private key cryptography is key management since it requires greater number of keys because each distinct pair of communicating parties has to share different key.
- A cryptography system that used different keys for encryption and decryption are known as public key cryptography.
- In this system every user has two keys known as public key and private key.
- It is also called as asymmetric cryptography because the two keys are not identical.
- The public key is open for all interested users and a particular user only knows the private key.
- In public key encryption, encryption uses public key and decryption is performed using private key.
- When two part A and B wish to communicate they proceed as follows.



- The sender A looks for the receiver's public key  $E_b$  and uses it to generate cipher text  $C=E_b(P)$  where  $P$  is the plain text.
- The receiver then receives the encrypted cipher text and decrypts the cipher text using his private key  $D_b$  as  $P=D_b(C)$  to get plain text  $P$ .

Example:

- If Alice wishes to send a private message to Bob, Alice encrypts the message using Bob's public key.
- When Bob receives the message, he decrypts it using his private key.
- No other recipient can decrypt

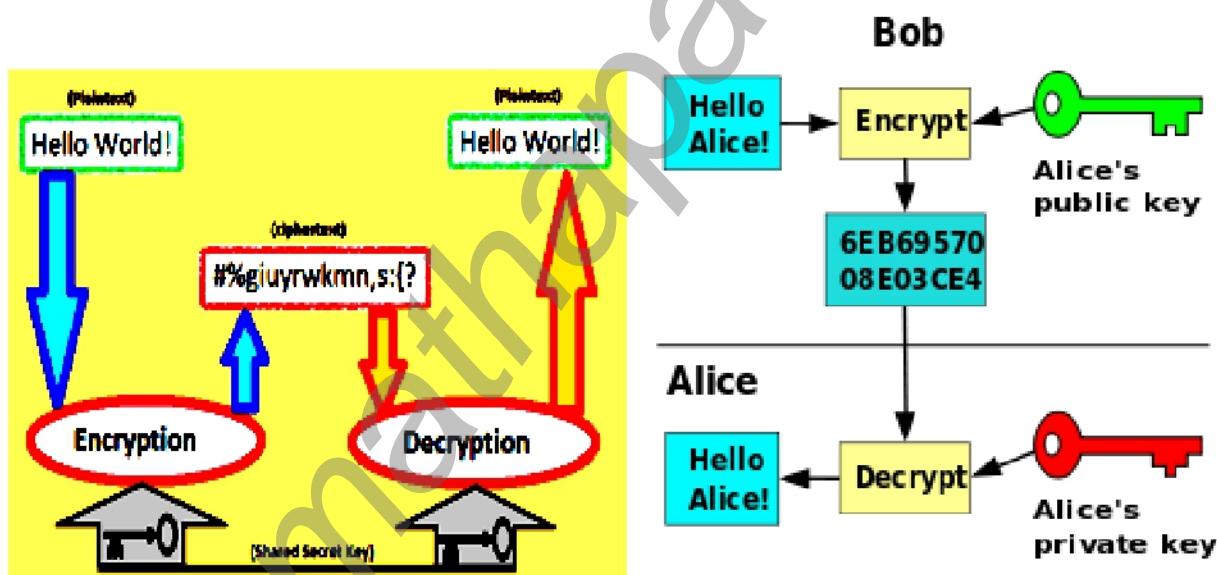
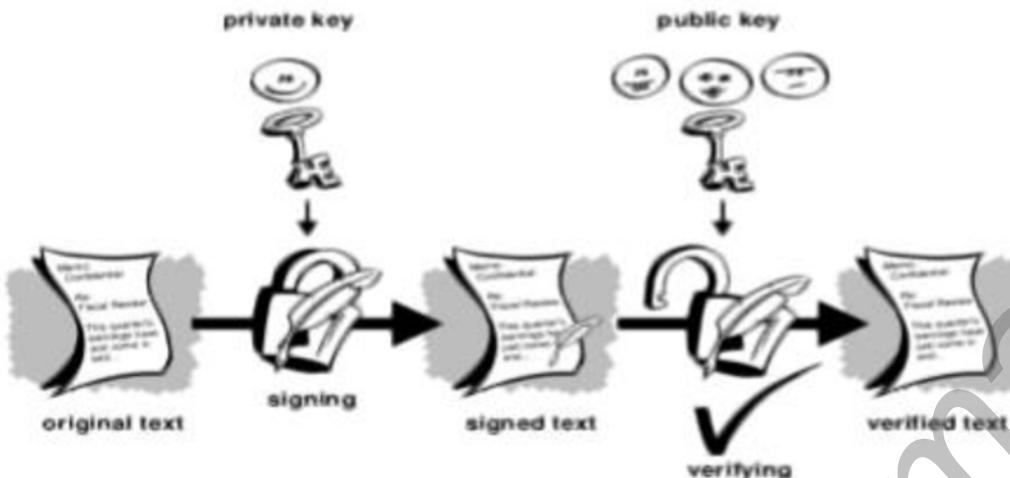


Fig : Private key Cryptography

Fig: Public Key Cryptography

## Digital Signature



- Public key cryptography systems are often used to generate and verify **digital signatures** on electronic documents.
- The sender uses his or her private key to generate the digital signature.
- The receiver then uses the sender's public key to verify the identity of the sender.
- On the emerging information highway, the digital signature replaces the handwritten signature as a legal proof of authenticity.

## Discretionary Access Control Vs Mandatory Access Control

- **In discretionary access control (DAC),** the owner of the object specifies which subjects can access the object.
- This model is called discretionary because the control of access is based on the discretion of the owner/admin.
- Most operating systems such as all Windows, Linux, and Macintosh and most flavors of Unix are based on DAC models.
- In these operating systems, when you create a file, you decide what access privileges you want to give to other users;
- When they access your file, the operating system will make the access control decision based on the access privileges you created.
  
- **In mandatory access control (MAC),** the system (and not the users) specifies which subjects can access specific data objects.
- The MAC model is based on security labels.
- Subjects are given a security clearance (secret, top secret, confidential, etc.), and data objects are given a security classification (secret, top secret, confidential, etc.).
- The clearance and classification data are stored in the security labels, which are bound to the specific subjects and objects.
- When the system is making an access control decision, it tries to match the clearance of the subject with the classification of the object.
- For example, if a user has a security clearance of secret, and he requests a data object with a security classification of top secret, then the user will be denied access because his clearance is lower than the classification of the object.