UNIT 3:
Integrity and Security

Audit Trail

Audit trail keeps track of different actions that took place for an activity in a chronological order, these activities may be scientific, financial transaction or communication by individual people, system or other entities.

As per the definition of the National Institute of Standards and Technology (NIST), an audit trail is: *"A set of records that collectively provide documentary evidence of processing used to aid in tracing from original transactions forward to related records and reports, and/or backward from records and reports to their component source transactions."*
Therefore, the audit trail records:

- **Who:** User or the application program and a transaction number.
- **When:** Date and time
- **Where:** Location of user or terminal
- **What:** Data that is being worked upon or is modified.

Example: When checkout from the counter of a market after shopping, the receipt (bill) that we get is a type of audit trail, we (Who/customer) can find all the necessary information on it like the date and time (when) of checkout, location of the mall and counter number (Where), and the items purchased (What/data).

Why Audit Trail?

Audit trails are one of the most essential things for any company or organization, they keep track of all the things and activities that the organization is up to and due to this any chaos or irregularities in the future can be rectified. It helps the organization to keep track of the internal records and the growth of the organization. It most importantly enhances the security of the organization.

Audit trails also makes the organization trustworthy when it comes to collaboration with other organizations, also all publicly-traded companies require active audit trails, because — by law — they must be audited once a year at minimum by independent, third-party companies.

Industries/organizations such as financial and accounting, manufacturing and product design, health and medical information, clinical research data, IT tracking and data, digital content management systems, e-commerce sales records and similar makes it mandatory to maintain an audit trail as they deal with sensitive information and data.

Types of Audit Trails:

There are three types of audit trails:

1. **External Audits**: An external audit is an independent examination of the financial statements prepared by the organization. External audits are performed by CPA (independent certified public accountants) firms hired by a business to ensure the correctness and accuracy of the accounting records maintained by a company.
2. **Internal Audits:** An Internal audit is performed within the company/organization, one department of an organization can perform audit verification for some other department. This helps an organization look at its growth and take actions for further growth and steps the avoid the upcoming risks that might become evident while the internal audit.
3. **Internal Revenue Service (IRS) Audit:** The IRS audit is performed to avoid any tax violations, it is a type of external audit that is performed on organizations that are accused guilty of providing wrong tax data.

Audit Trail in DBMS

When we talk about audit trail, it usually maintains the history (mainly) of transactions stored in the database, when we retrieve this information or modify it, auditing helps the database administrator (DBA) to keep track of the database resources and authority from the DBMS. Whenever an action is performed on the database resources an audit trail of information including what database object was impacted, who performed the operation, and when is generated, if the DBMS supports a very high level of auditing, a record of what actually changed might also be maintained. It is really important to maintain the record of “who” made the changes in order to avoid security threats because it is easier for an internal entity to have access to the system as compared to an outsider.

There are certain functions and variables that keep track of a successful or unsuccessful transaction, these are:

- **start_transaction(T)**: keeps a record of the start of transaction
- **commit (T)**: when the transaction is successful and changes must be saved in the DBMS also.
- **abort (T)**: keeps a record that the transaction has terminated unsuccessfully or aborted.

Advantages of Audit trail

1. **Fraud prevention:** Fraud is easily prevented by maintaining an audit trail, if any irregularities occur within the system, they can be easily recovered, also the employees won't dare to do any scam as they know that the audit trail will make things clear. External frauds can be averted if the security is made tight and hard to break in.
2. **Easy verification:** It has been compulsory by the government especially for large businesses to perform an audit at least once a year by an independent third party, if an audit trail is already maintained, it will reduce the job of the external auditor to just verify if all the transactions mentioned on the audit trail are valid or not. This reduces the time and money spent by the organization on external audits while making the job of the auditor less tiresome.
3. **Maintaining financial history:** If an organization maintains a proper audit trail, it makes it easier for an investor to decide whether or not to invest in that organization. Any other activity that requires verification of finances will be made easy.
4. **Easy recovery:** In case of any disaster, all the necessary information can be backed up with the help of audit trails.

Disadvantages of Audit trail

1. **Maintenance cost:** The main disadvantage of audit trail is the extra maintenance that it requires, the hiring of a charted accountant, the cost of memory and other similar requirements.
2. **Security threats:** Though audit trails are protected and their security is taken care of but if fall in the hands of a perpetuator/attacker, then he/she has entire access to the system and organizations history, especially the financial ones, which is a serious threat as they can modify, delete the data and also use them for awful purposes.

What is Data Encryption?

Data Encryption is a method of preserving data confidentiality by transforming it into ciphertext, which can only be decoded using a unique decryption key produced at the time of the encryption or prior to it.

Data encryption converts data into a different form (code) that can only be accessed by people who have a secret key (formally known as a decryption key) or password. Data that has not been encrypted is referred to as plaintext, and data that has been encrypted is referred to as ciphertext. Encryption is one of the most widely used and successful data protection technologies in today's corporate world.

Encryption is a critical tool for maintaining data integrity, and its importance cannot be overstated. Almost everything on the internet has been encrypted at some point.

Importance of Data Encryption:

The significance of encryption cannot be overstated in any way. Even though your data is stored in a standard infrastructure, it is still possible for it to be hacked. There's always the chance that data will be compromised, but with data encryption, your information will be much more secure.

Consider it this way for a moment. If your data is stored in a secure system, encrypting it before sending it out will keep it safe. Sanctioned systems do not provide the same level of protection.

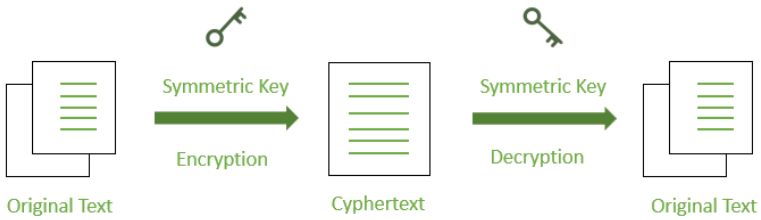
So, how do you think this would play out in real life? Consider the case of a user of a company's data who has access to sensitive information while at work. The user may put the information on a portable disc and move it anywhere they choose without any encryption. If the encryptions are set in place ahead of time, the user can still copy the information, but the data will be unintelligible when they try to see it someplace else. These are the benefits of data encryption that demonstrate its genuine value.

Types of Data Encryption:

1. Symmetric Encryption
2. Asymmetric Encryption

Encryption is frequently used in one of two ways i.e. with a symmetric key or with an asymmetric key.

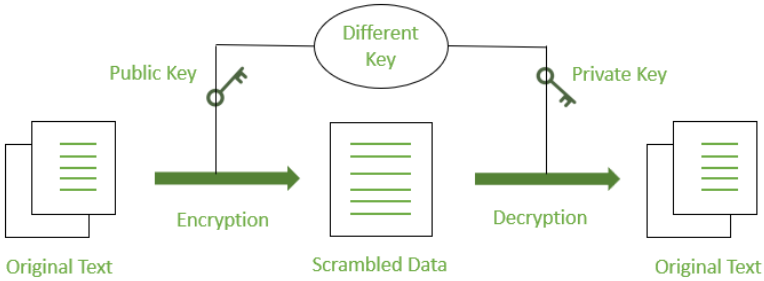
Symmetric Key Encryption:



Symmetric Encryption

There are a few strategies used in cryptography algorithms. For encryption and decryption processes, some algorithms employ a unique key. In such operations, the unique key must be secured since the system or person who knows the key has complete authentication to decode the message for reading. This approach is known as "**symmetric encryption**" in the field of network encryption.

Asymmetric Key Encryption:



Asymmetric Encryption

Some cryptography methods employ one key for data encryption and another key for data decryption. As a result, anyone who has access to such a public communication will be unable to decode or read it. This type of cryptography, known as "**public-key**" encryption, is used in the majority of internet security protocols. The term "**asymmetric encryption**" is used to describe this type of encryption.

States of Data Encryption:

Data, whether it's being transferred between users or stored on a server, is valuable and must be protected at all times.

Data encryption in transit: Information that is actively traveling from one point to another, such as via the internet or over a private network, is referred to as data in transit. Data is deemed less safe when in transit due to the weaknesses of transfer techniques. End-to-end encryption encrypts data throughout transmission, guaranteeing that it remains private even if intercepted.
Encryption of data at rest: Data at rest refers to information that is not actively moving from one device to another or from one network to another, such as information stored on a hard drive, laptop, flash drive, or archived/stored in another way. Due to device security features restricting access, data at rest is often less vulnerable than data in transit, but it is still vulnerable. It also contains more valuable information, making it a more appealing target for criminals.
Data encryption at rest reduces the risk of data theft caused by lost or stolen devices, inadvertent password sharing, or accidental permission granting by increasing the time it takes to access information and providing the time required to discover data loss, ransomware attacks, remotely erased data, or changed credentials.

How the Data Encryption takes place?

Assume a person possesses a box containing a few documents. The individual looks after the box and secures it with a lock. The individual sends this box of paperwork to his or her pal after a few days. The key is also kept by a buddy. This signifies that both the sender and the recipient have the same key. The buddy has now been given permission to open the box and see the document. The encryption method is the same as we mentioned in the sample. Encryption is performed on digital communications, though. This technological procedure is designed to prevent a third party from deciphering the signal's secret content.

Consumers conduct transactions for goods purchases over the internet. There are millions of web services that can help various trained employees do their responsibilities. Furthermore, to utilize these services that demand personal information, most websites require substantial identification. One of the most common ways, known as "encryption," is to keep such information safe and secure.

Encryption Process

The security of networks is intimately related to encryption. Encryption is useful for concealing data, information, and things that are incomprehensible to a normal human. Because both encryption and decryption are effective ways of cryptography, which is a scientific procedure for performing secure communication, the encrypted information may be transformed back to its original condition following the decryption process. There are a variety of algorithms for data encryption and decryption. However, “keys” can also be utilized to obtain high-level data security.

Uses of Data Encryption:

Using digital signatures, Encryption is used to prove the integrity and authenticity of the information. Digital-rights management and copy protection both require encryption.

Encryption can be used to erase data. But since data recovery tools can sometimes recover deleted data, if you encrypt the data first and then throw away the key, the only thing anyone can recover is the ciphertext, not the original data.

Data Migration is used when transferring data over a network to ensure that no one else on the network can read it.
VPNs (Virtual Private Networks) uses encryption, and you should encrypt everything you store in the cloud. This can encrypt the entire hard drive as well as voice calls.
Given the importance of data security, many organizations, governments, and businesses require data to be encrypted in order to protect the company or user data. Employees will not have unauthorized access to user data as a result of this.

Advantages of Data Encryption:

1. Encryption is a low-cost solution.
2. Data encryption keeps information distinct from the security of the device on which it is stored. Encryption provides security by allowing administrators to store and send data via insecure channels.
3. Regulatory Fines Can Be Avoided With Encryption
4. Remote Workers Can Benefit from Encryption
5. If the password or key is lost, the user will be unable to open the encrypted file. Using simpler keys in data encryption, on the other hand, makes the data insecure, and anybody may access it at any time.
6. Encryption improves the security of our information.
7. Consumer Trust Can Be Boosted by Encryption

Disadvantages of Data Encryption:

1. If the password or key is lost, the user will be unable to open the encrypted file. Using simpler keys in data encryption, on the other hand, makes the data insecure, and anybody may access it at any time.
2. Data encryption is a valuable data security approach that necessitates a lot of resources, such as data processing, time consumption, and the use of numerous encryption and decryption algorithms. As a result, it is a somewhat costly approach.
3. Data protection solutions might be difficult to utilize when the user layers them for contemporary systems and applications. This might have a negative influence on the device's normal operations.
4. If a company fails to realize any of the restrictions imposed by encryption techniques, it is possible to set arbitrary expectations and requirements that might undermine data encryption protection.

Examples of Data Encryption algorithms:

Depending on the use case, there are a variety of data encryption algorithms to choose from, but the following are the most commonly used:

- **DES (Data Encryption Standard)** is an old symmetric encryption algorithm that is no longer considered suitable for modern applications. As a result, DES has been superseded by other encryption algorithms.
- **Triple DES (3DES or TDES)**: Encrypts, decrypts, and encrypts again to create a longer key length by running the DES algorithm three times. It may be run with a single key, two keys, or three separate keys to increase security. 3DES is vulnerable to attacks such as block collisions since it uses a block cipher.
- **RSA** is a one-way asymmetric encryption algorithm that was one of the first public-key algorithms. Because of its long key length, RSA is popular and widely used on the Internet. It is used by browsers to create secure connections over insecure networks and is part of many security protocols such as SSH, OpenPGP, S/MIME, and SSL/TLS.
- **Twofish** is one of the fastest algorithms, with sizes of 128, 196, and 256 bits and a complex key structure for added security. It is available for free and is included in some of the best free software, including VeraCrypt, PeaZip, and KeePass, as well as the OpenPGP standard.
- **Elliptic Curve Cryptography (ECC)** was created as an upgrade to RSA and offers better security with significantly shorter key lengths. In the SSL/TLS protocol, ECC is an asymmetric method.
- **The Advanced Encryption Standard (AES)** is the encryption standard used by the US government. The AES algorithm is a symmetric-key algorithm that employs block

cipher methods. It comes in sizes of 128, 192, and 256 bits, with the number of rounds of encryption increasing as the size increases. It was designed to be simple to implement in both hardware and software.

Difference between Grant and Revoke

Data Controlling Language (DCL) helps users to retrieve and modify the data stored in the database with some specified queries. Grant and Revoke belong to these types of commands of the Data controlling Language. DCL is a component of SQL commands.

1. Grant :

SQL Grant command is specifically used to provide privileges to database objects for a user. This command also allows users to grant permissions to other users too.

Syntax:

```
grant privilege_name on object_name

to {user_name | public | role_name}
```

Here privilege_name is which permission has to be granted, object_name is the name of the database object, user_name is the user to which access should be provided, the public is used to permit access to all the users.

2. Revoke :

Revoke command withdraw user privileges on database objects if any granted. It does operations opposite to the Grant command. When a privilege is revoked from a particular user U, then the privileges granted to all other users by user U will be revoked.

Syntax:

```
revoke privilege_name on object_name

from {user_name | public | role_name}
```

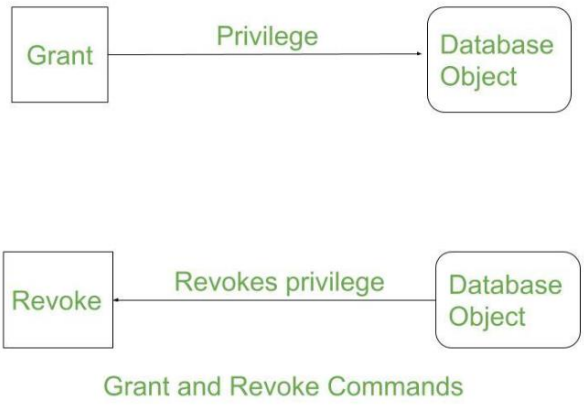
Example:

```
grant insert,

select on accounts to Ram
```

By the above command user ram has granted permissions on accounts database object like he can query or insert into accounts.

```
revoke insert,

select on accounts from Ram
```

By the above command user ram's permissions like query or insert on accounts database object has been removed.



Grant and Revoke Commands

Differences between Grant and Revoke commands:

S.NO	Grant	Revoke
1	This DCL command grants permissions to the user on the database objects.	This DCL command removes permissions if any granted to the users on database objects.
2	It assigns access rights to users.	It revokes the useraccess rights of users.
3	For each user you need to specify the permissions.	If access for one user is removed; all the particular permissions provided by that users to others will be removed.
4	When the access is decentralized granting permissions will be easy.	If decentralized access removing the granted permissions is difficult.