CSE- 321
Software Engineering

Lecture :17
Software Maintenance and Security

Fahad Ahmed
Lecturer, Dept. of CSE
E-mail: fahadahmed@uap-bd.edu

Software Maintenance

Software Maintenance

Software Maintenance is the process of **modifying a software product after it has been delivered** to the customer.

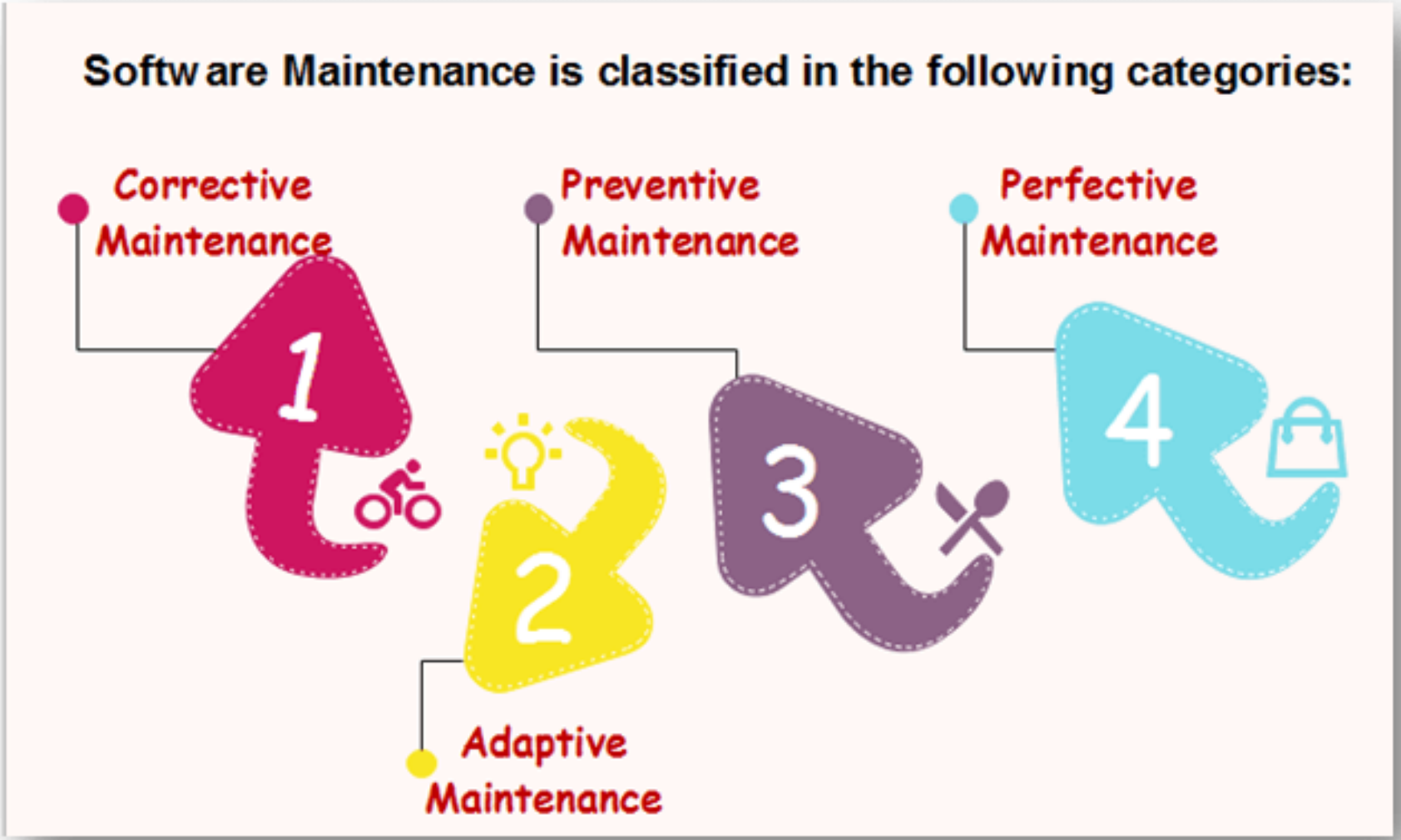
The main purpose of software maintenance is to **modify and update software application** after delivery to correct faults and to improve performance.

Need for Maintenance

Software Maintenance is required to ensure that the system continues to satisfy user requirements:-

- Correct errors
- Change in user requirement with time
- Changing hardware/software requirements
- To improve system efficiency
- To optimize the code to run faster
- To modify the components
- To reduce any unwanted side effects.

Types of Software Maintenance



Types of Software Maintenance

Maintenance can be divided into the following:

1.Corrective maintenance:

Corrective maintenance of a software product may be essential either to **rectify some bugs observed** while the system is in use, or to enhance the performance of the system.

2.Adaptive maintenance:

This includes modifications and updates when the customers need the product to run on **new platforms, on new operating systems**, or when they need the product to interface with new hardware and software.

3.Perfective maintenance:

A software product needs maintenance to **support the new features** that the users want or to change different types of functionalities of the system according to the customer demands.

4.Preventive maintenance:

This type of maintenance includes modifications and updates **to prevent future problems** of the software. It goals to attend problems, **which are not significant at this moment but may cause serious issues in future.**

Causes of Software Maintenance Problems

Following are the major causes of software maintenance problems:

Causes of Software Maintenance Problems

Lack of Traceability

- Codes are rarely traceable to the requirements and design specifications.
- It makes it **very difficult for a programmer to detect and correct a critical defect affecting customer operations**.
- Like a detective, the programmer pores over the program looking for clues.
- Life Cycle documents are not always produced even as part of a development project.

Lack of Code Comments

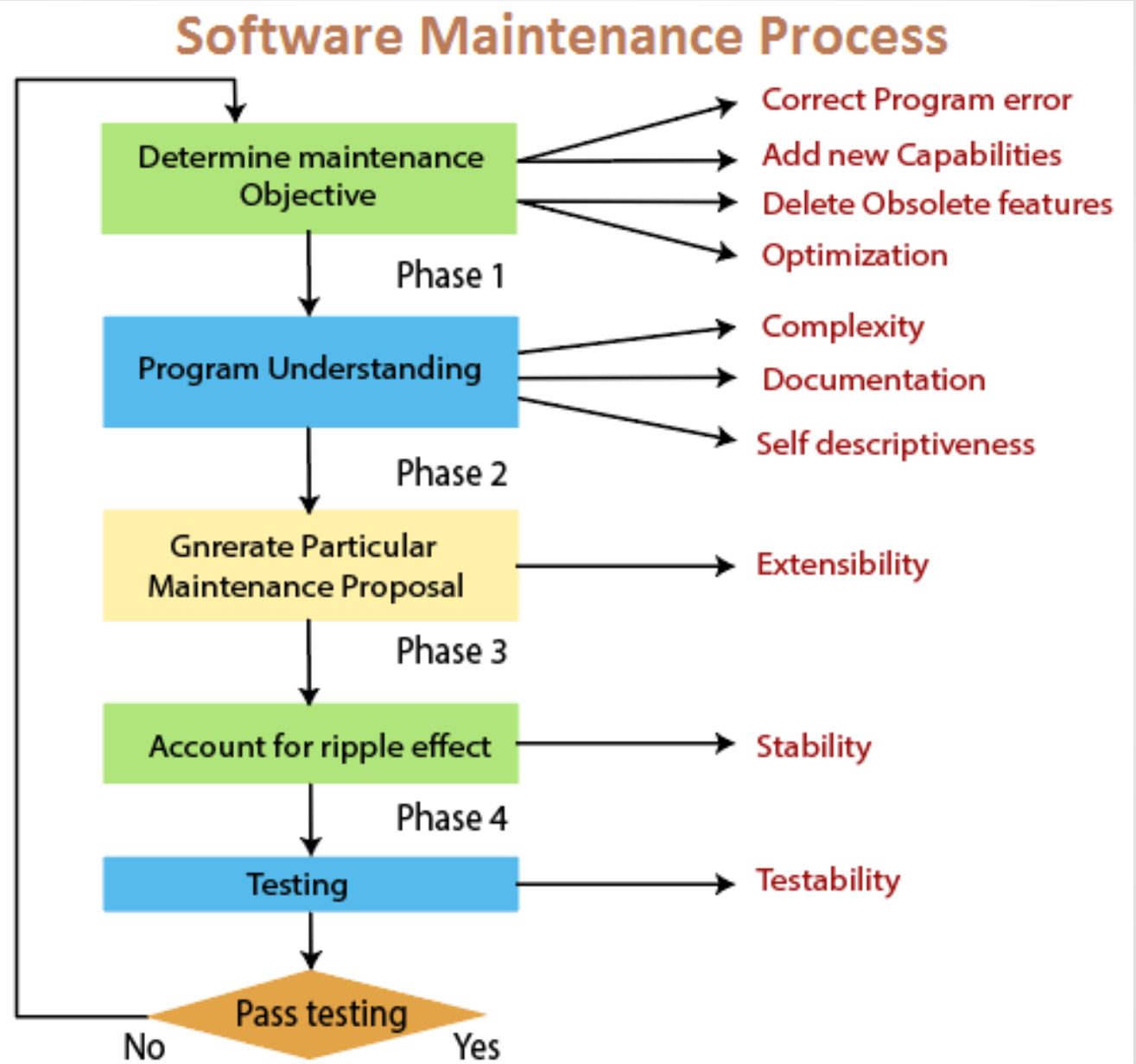
- Most of the software system codes lack adequate comments. Lesser comments may not be helpful in certain situations.

Causes of Software Maintenance Problems

Obsolete Legacy Systems

- In most of the countries worldwide, the legacy system that provides the backbone of the nation's critical industries, e.g., telecommunications, medical, transportation utility services, were not designed with maintenance in mind.
- They were not expected to last for a quarter of a century or more.
- As a consequence, the code supporting these systems is devoid of traceability to the requirements, compliance to design and programming standards and often includes dead, extra and uncommented code, which all make the maintenance task next to the impossible.

Causes of Software Maintenance Problems



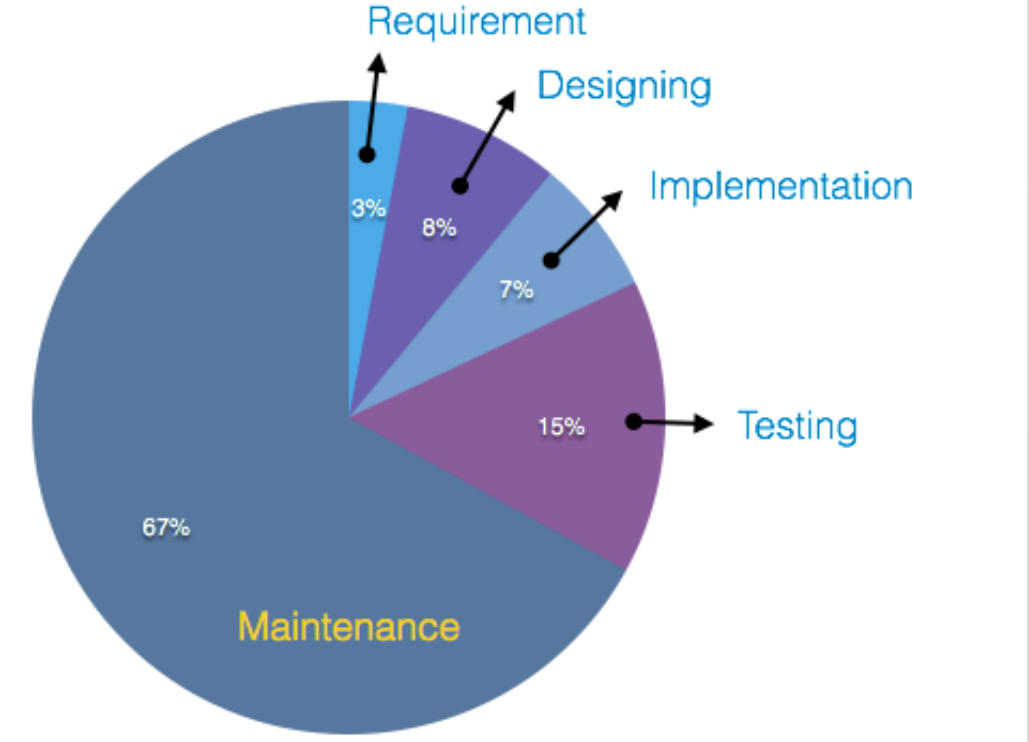
Software Maintenance Cost Factors

A study on estimating software maintenance found that the cost of maintenance is as high as **67% of the cost of entire software process cycle**.

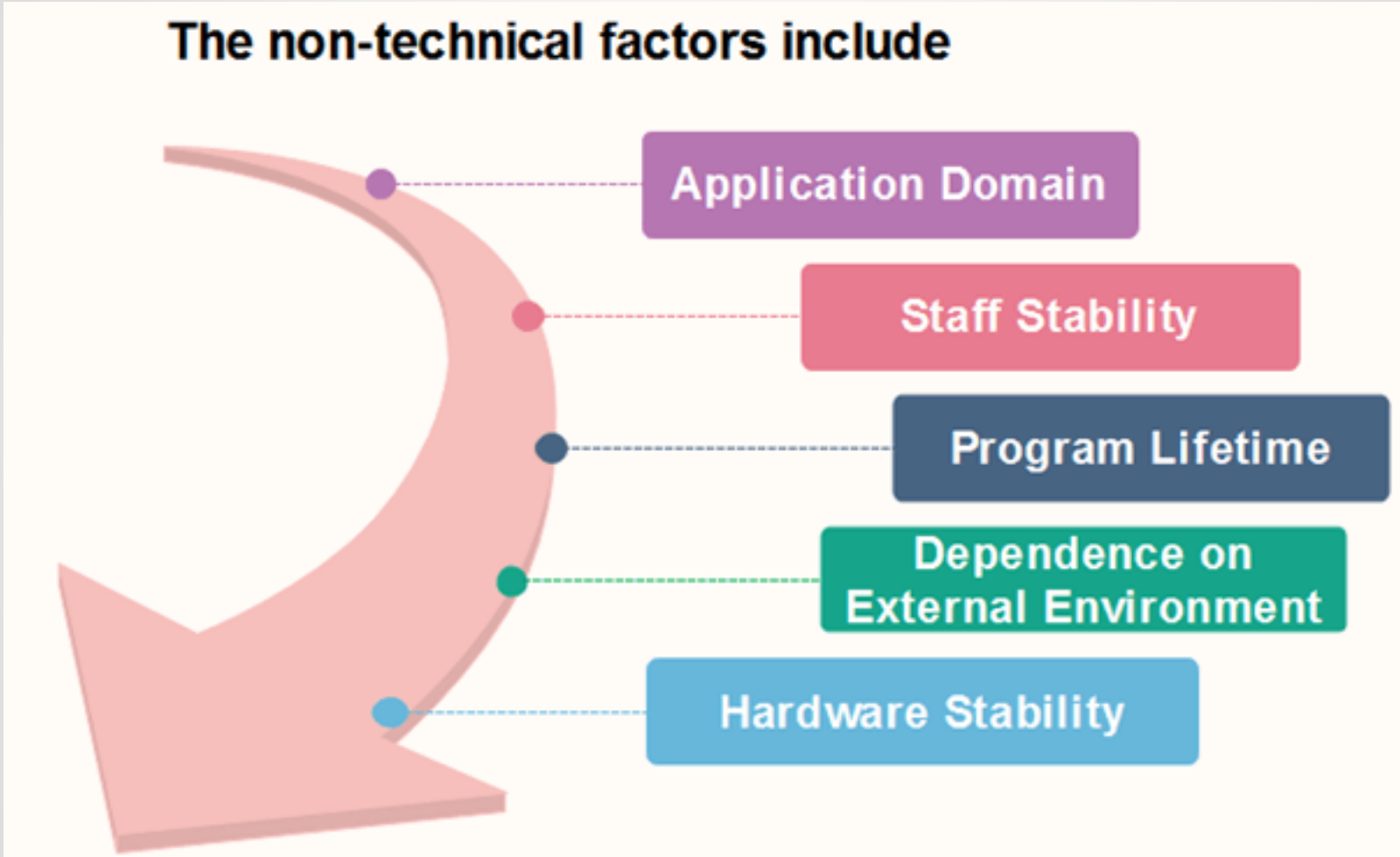
There are two types of cost factors involved in software maintenance.

These are

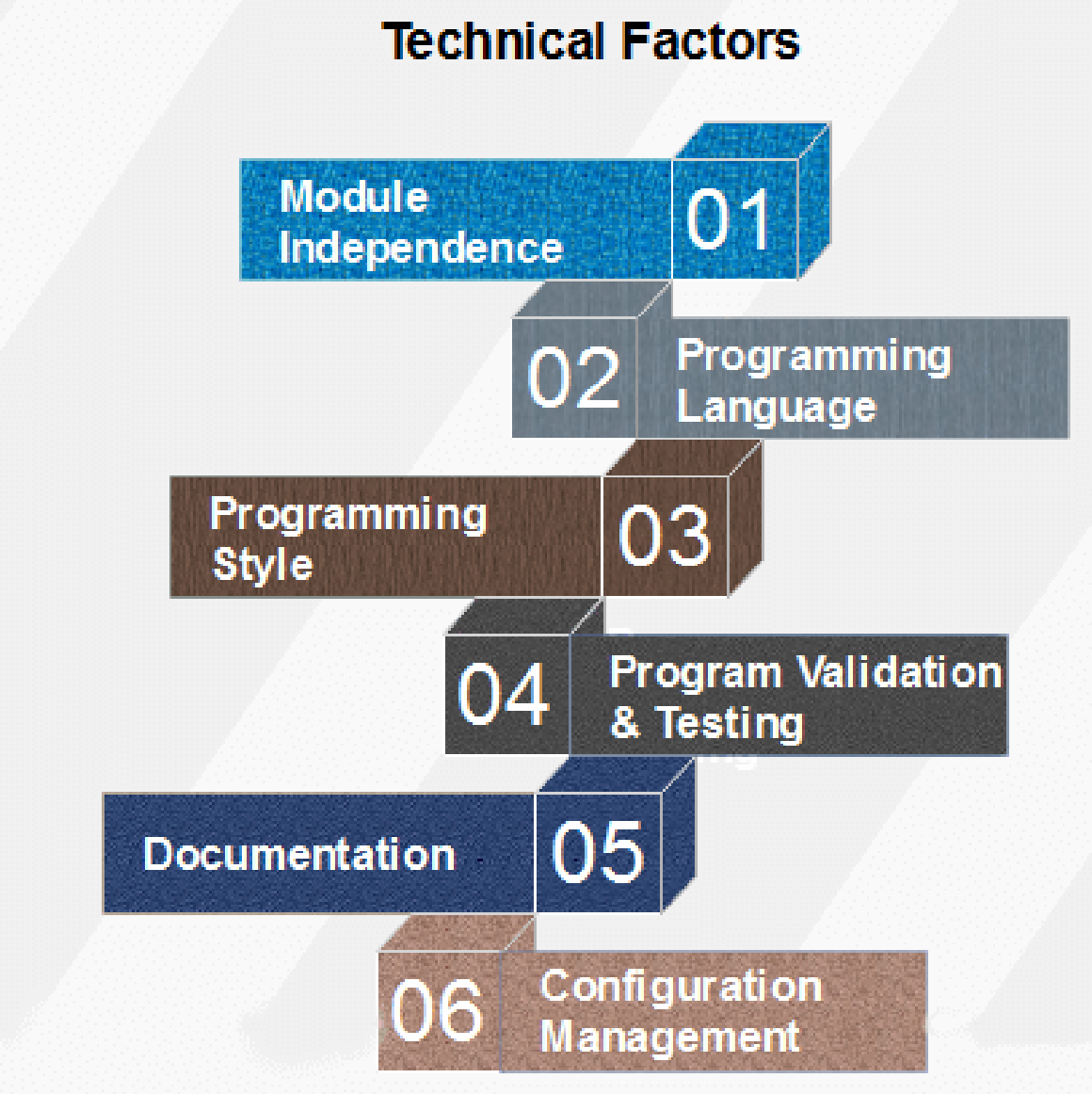
- Non-Technical Factors
- Technical Factors



Software Maintenance Cost Factors



Software Maintenance Cost Factors

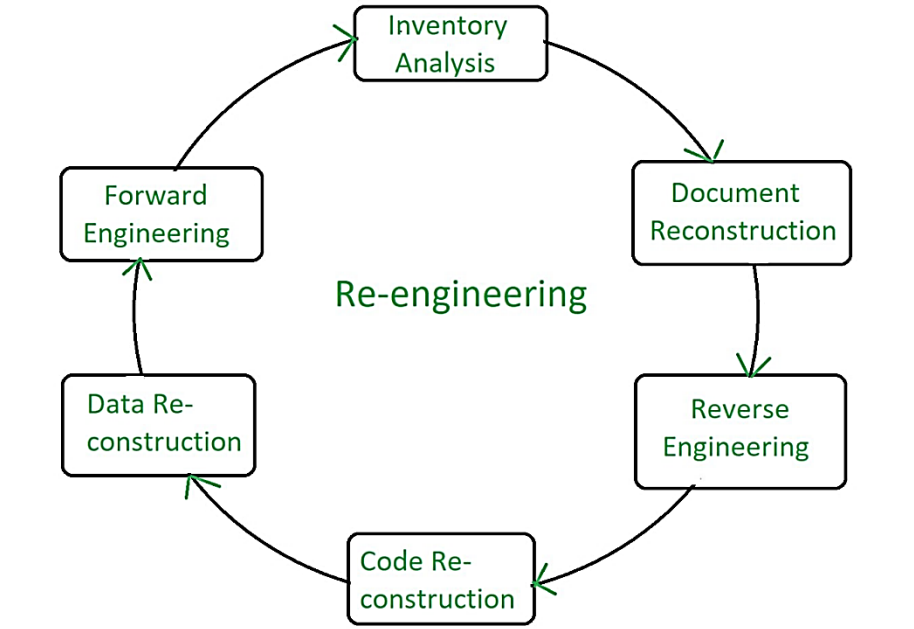


Software Re-engineering

Software reengineering involves **the use of existing software and documentation to specify. requirements, design, documentation, and to produce software for a target platform**.

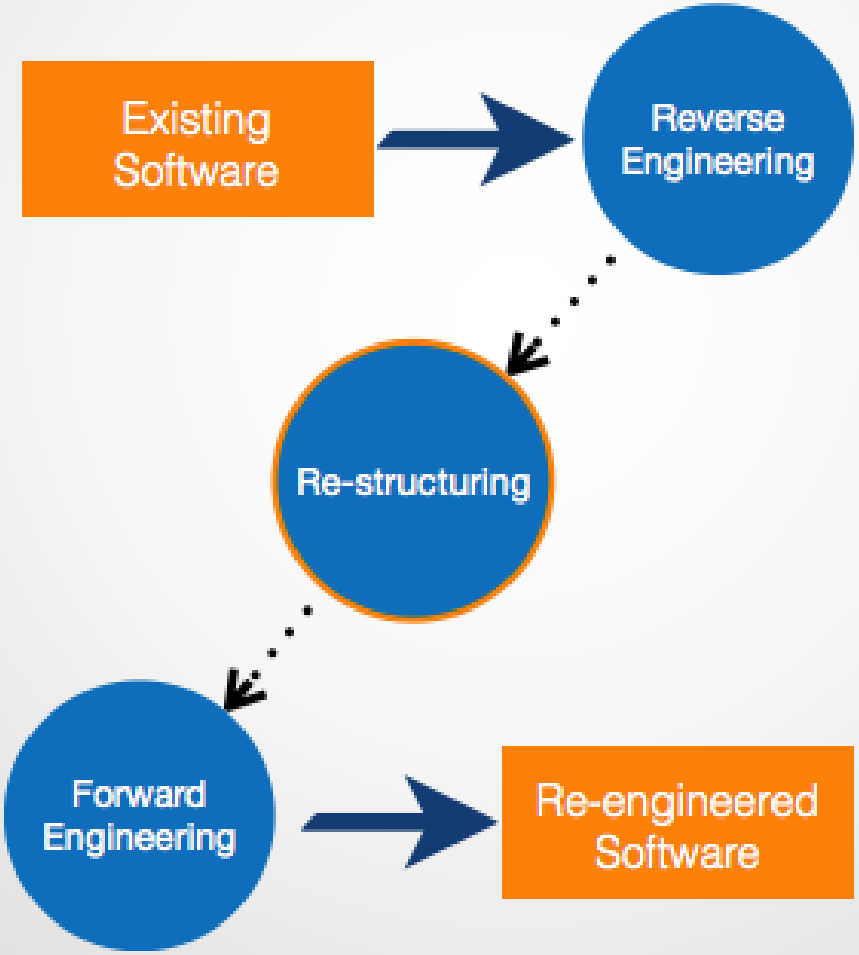
Steps involved in Re-engineering:

- Inventory Analysis
- Document Reconstruction
- Reverse Engineering
- Code Reconstruction
- Data Reconstruction
- Forward Engineering



Software Re-engineering

When we need to update the software to keep it to the current market, without impacting its functionality, it is called software re-engineering. It is a thorough process where the design of software is changed and programs are re-written.



Software Re-engineering

Software Re-Engineering Activities:

1. Inventory Analysis:

Inventory can be nothing more than a spreadsheet model containing information that provides a detailed description of every active application.

- By sorting this information according to business criticality, longevity, current maintainability and other local important criteria, candidates for re-engineering appear.
- The resource can then be allocated to a candidate application for re-engineering work.

2. Document reconstructing:

Documentation of a system either explains how it operates or how to use it.

Documentation must be updated.

- It may not be necessary to fully document an application.
- The system is business-critical and must be fully re-documented.

3. Reverse Engineering:

Reverse engineering is a process of design recovery. Reverse engineering tools extract data, architectural and procedural design information from an existing program.

Software Re-engineering

Software Re-Engineering Activities:

4. Code Reconstructing:

To accomplish code reconstructing, the source code is analysed using a reconstructing tool. Violations of structured programming construct are noted and code is then reconstructed.

•The resultant restructured code is reviewed and tested to ensure that no anomalies have been introduced.

5. Data Restructuring:

Data restructuring begins with a reverse engineering activity.

•Current data architecture is dissected, and the necessary data models are defined.

•Data objects and attributes are identified, and existing data structure are reviewed for quality.

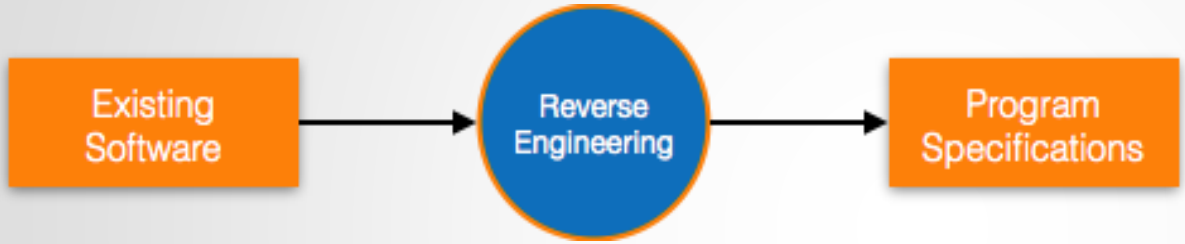
6. Forward Engineering:

Forward Engineering also called as renovation or reclamation not only for recovers design information from existing software but uses this information to alter or reconstitute the existing system in an effort to improve its overall quality.

Re-Engineering Process

Reverse Engineering

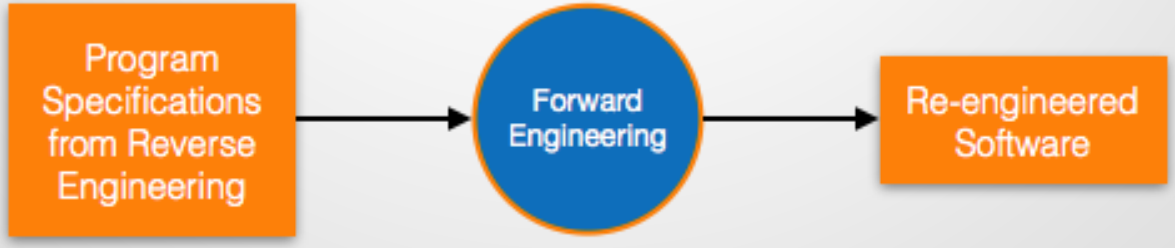
Reverse Engineering is processes of extracting knowledge or design information from anything man-made and reproducing it based on extracted information. It is also called back Engineering.



Reverse engineering is breaking down a completed product to create the equivalent of the original design. That design can then be use to recreate copies of the product. Engineering turns a design into a product, reverse engineering turns a product into a design.

Forward Engineering

Forward engineering is a process of obtaining desired software from the specifications in hand which were brought down by means of reverse engineering. It assumes that there was some software engineering already done in the past.



Re-Engineering Process

S.N.	Forward engineering	Reverse engineering
1.	Applications are developed with given requirements	Information for the system are collected from the given application
2.	It's flow is model => System	It's flow is System => model
3.	Takes more time for development	Takes less time for development
4.	Prescriptive, Developers are told how to work.	Adaptive, Engineer must find out what actually the developer did
5.	Production is started with given requirements.	Production is started by taking existing product.
6.	It requires high proficiency skills	It may not require high proficiency skills
7.	For example:- Developing a new software from scratch	For example:- Cloning Facebook, Instagram, Paypal

Re-Engineering Process

Why Reverse Engineering?

- Providing proper system documentation.
- Recovery of lost information.
- Assisting with maintenance.
- Facility of software reuse.
- Discovering unexpected flaws or faults
- To examine the working of a product.
- To update the digital version.
- Acquiring sensitive data.
- Military or commercial espionage.

Used of Software Reverse Engineering –

- Software Reverse Engineering is used in software design, reverse engineering enables the developer or programmer to add new features to the existing software with or without knowing the source code.

- Reverse engineering is also useful in software testing, it helps the testers to study the virus and other malware code .

Reverse Engineering :Legal Issues

Legal Issues

- Reverse engineering is a controversial subject. While the companies performing it may be at a distinct advantage, saving both time and money, the original creator of the design may be severely affected by the increased competition.
- Although design patents can protect an engineer or company from this kind of activity, the security this can offer is limited. By reverse engineering a product, you can discover original ideas that are not protected; in doing so, you can infringe another's intellectual property rights.
- It is therefore important that designs are not disclosed to competitors and protection is in place to prevent fraudulent activity.

Re-engineering

Re-Engineering :

Restructuring or rewriting part or all of a system without changing its functionality

Applicable when some (but not all) subsystems of a larger system require frequent maintenance

Reengineering involves putting in the effort to make it easier to maintain

The reengineered system may also be restructured and should be re-documented

When do you decide to reengineer?

- When system changes **are confined to one subsystem**, the subsystem needs to be reengineered
- When hardware or software support becomes obsolete
- When tools to support restructuring are readily available

Re-engineering

Economics of Reengineering:

Cost of maintenance = cost annual of operation and maintenance over application lifetime

Cost of reengineering = predicted return on investment reduced by cost of implementing changes and engineering risk factors

Cost benefit = Cost of reengineering - Cost of maintenance

Re-engineering advantages:

Reduced risk

There is a high risk in new software development. There may be development problems, staffing problems and specification problems

Reduced cost

The cost of re-engineering is often significantly less than the costs of developing new software

Reverse engineering vs Re-engineering

Reverse engineering is about uncovering the secrets behind the product so that you may change it according to your needs.

Reengineering is the process of amending the product to some new form.

Data re-engineering

- Involves analysing and reorganising the data structures (and sometimes the data values) in a program
- May be part of the process of migrating from a file-based system to a DBMS-based system or changing from one DBMS to another
- Objective is to create a managed data environment
- Data reengineering extends the life of existing systems by standardizing data definitions and facilitating source code simplification.
- It can also provide an accurate data model for use as a starting point in data modeling and database technology migration and as a preparation step for reverse engineering.

Sample question

1. How does software re-engineering fit into the agile development cycle?

2. How do we combine the re-engineering process model and the agile process model?

3. **Under what circumstances do you think that software be re-engineered rather than re-written? Give an example.**

Software Security

Software Security

What does Software Security mean?

In the general sense, security is “the state of being free from danger or threat”. The security of software systems in particular is a vast topic.

Software security is the application of techniques that assess, mitigate, and protect software systems from vulnerabilities.

These techniques ensure that software continues to function and are safe from attacks. Developing secure software involves considering security at every stage of the life cycle.

Software security isn’t the same thing as security software.

Software Security

What does Software Security mean?

Security testing takes the following six measures to provide a secured environment

1. **Confidentiality** − It protects against disclosure of information to unintended recipients.
2. **Integrity** − It allows transferring accurate and correct desired information from senders to intended receivers.
3. **Availability** − It ensures readiness of the information on requirement.
4. **Non-repudiation** − It ensures there is no denial from the sender or the receiver for having sent or received the message.
5. **Authentication** − It verifies and confirms the identity of the user.
6. **Authorization** − It specifies access rights to the users and resources.

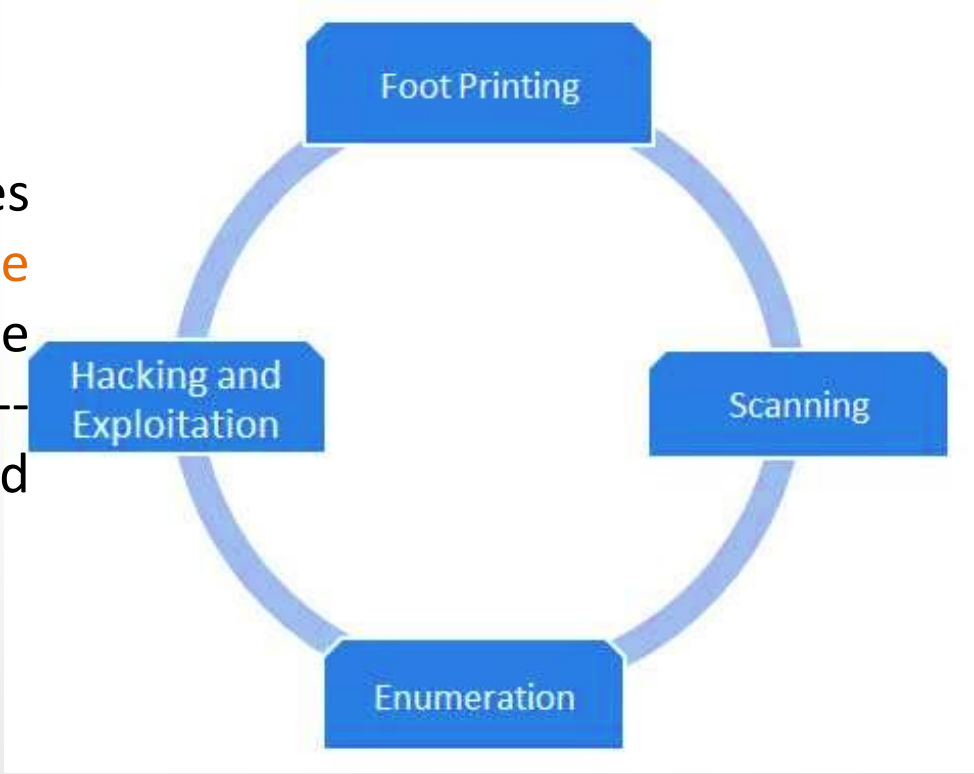
Software Security

Pen testing or **ethical hacking**, is the practice of testing a computer system, network or web application to find security vulnerabilities that an attacker could exploit.

The main objective of pen testing is to identify security weaknesses.

Pen testing can be automated with software applications or performed manually.

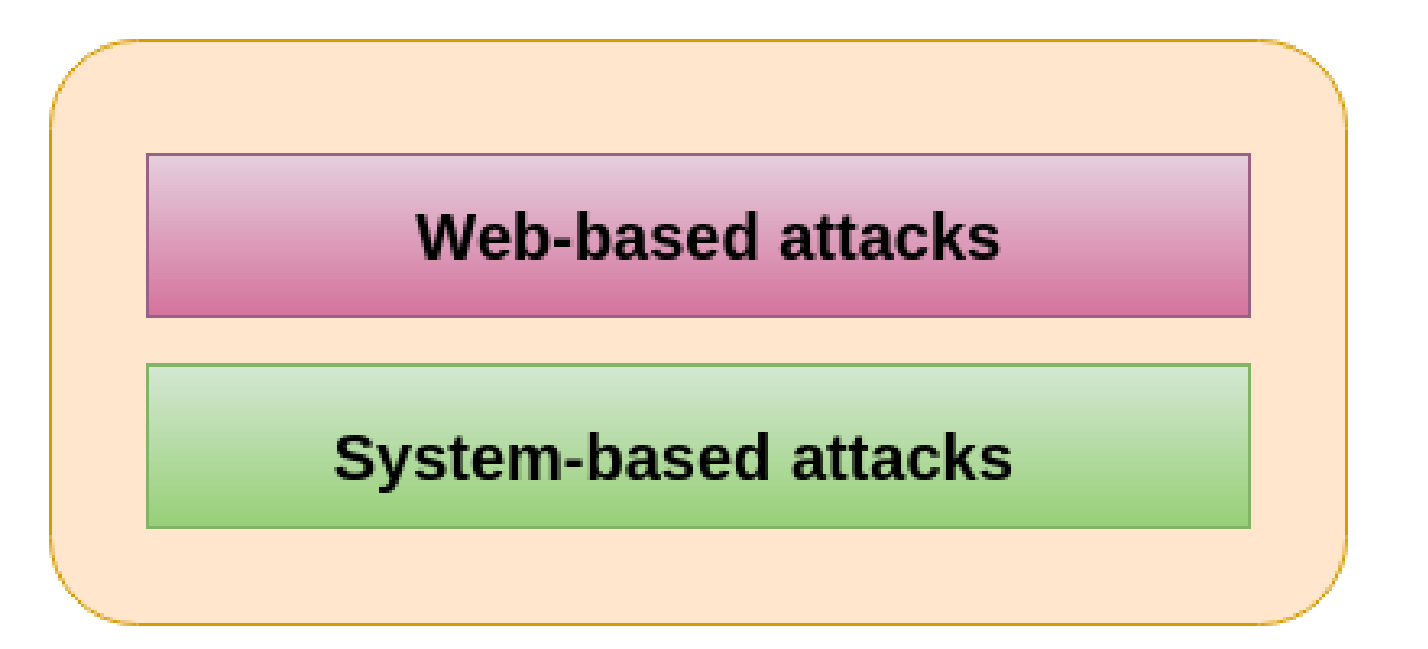
Either way, the process involves gathering information about the target before identifying possible entry points, attempting to break in -- either virtually or for real -- and reporting back the findings.



Malicious software (malware)

Malicious software (malware) is any software that gives partial to full control of the system to the attacker/malware creator**.**

Types of Attacks



Web-based attacks

These are the attacks which occur on a website or web applications. Some of the important web-based attacks are as follows-

Injection attacks

It is the attack in which some data will be injected into a web application to manipulate the application and fetch the required information.

Example- SQL Injection, code Injection, log Injection, XML Injection etc.

DNS Spoofing

DNS Spoofing is a type of computer security hacking. Whereby a data is introduced into a DNS resolver's cache causing the name server to return an incorrect IP address, diverting traffic to the attacker's computer or any other computer. The DNS spoofing attacks can go on for a long period of time without being detected and can cause serious security issues.

Session Hijacking

It is a security attack on a user session over a protected network. Web applications create cookies to store the state and user sessions. By stealing the cookies, an attacker can have access to all of the user data.

Web-based attacks

Phishing

Phishing is a type of attack which attempts to steal sensitive information like user login credentials and credit card number. It occurs when an attacker is masquerading as a trustworthy entity in electronic communication.

Brute force

It is a type of attack which uses a trial and error method. This attack generates a large number of guesses and validates them to obtain actual data like user password and personal identification number. This attack may be used by criminals to crack encrypted data, or by security, analysts to test an organization's network security.

Web-based attacks

Denial of Service (DOS)

It is an attack which meant to make a server or network resource unavailable to the users. It accomplishes this by flooding the target with traffic or sending it information that triggers a crash. It uses the single system and single internet connection to attack a server. It can be classified into the following-

Volume-based attacks- Its goal is to saturate the bandwidth of the attacked site, and is measured in bit per second.

Protocol attacks- It consumes actual server resources, and is measured in a packet.

Application layer attacks- Its goal is to crash the web server and is measured in request per second.

Web-based attacks

Dictionary attacks

This type of attack stored the list of a commonly used password and validated them to get original password.

URL Interpretation

It is a type of attack where we can change the certain parts of a URL, and one can make a web server to deliver web pages for which he is not authorized to browse.

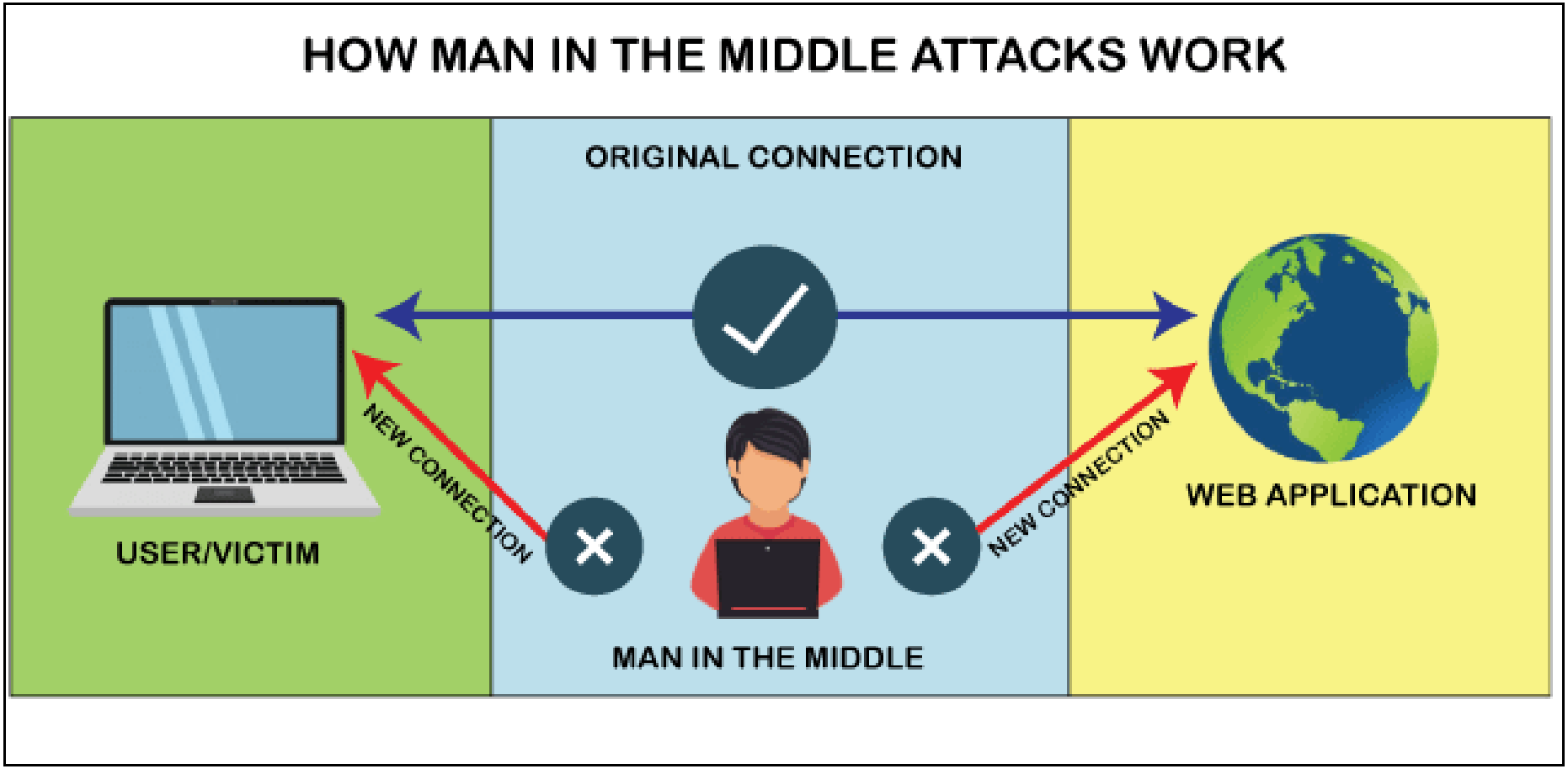
File Inclusion attacks

It is a type of attack that allows an attacker to access unauthorized or essential files which is available on the web server or to execute malicious files on the web server by making use of the include functionality.

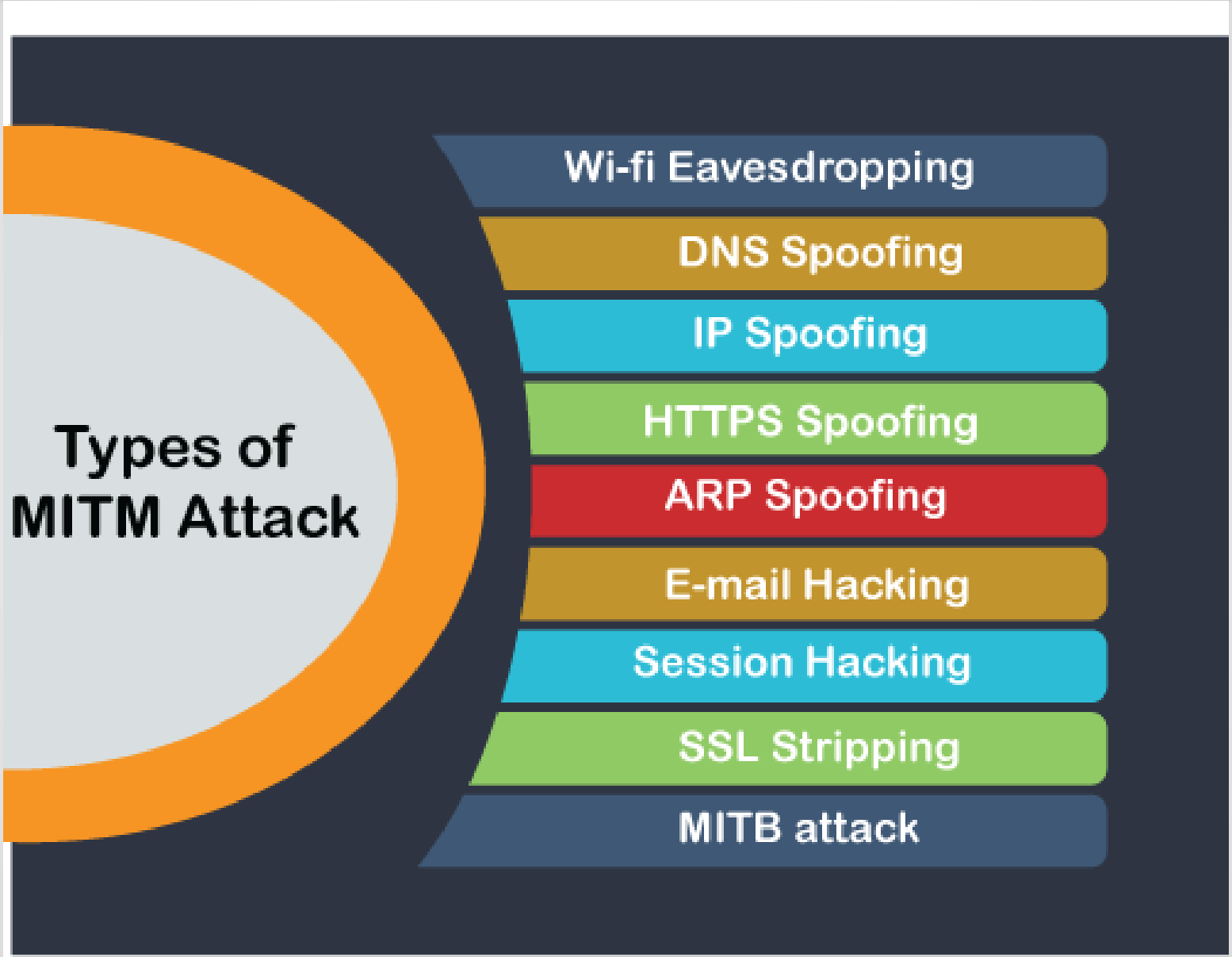
Man in the middle attacks(MITM)

It is a type of attack that allows an attacker to intercepts the connection between client and server and acts as a bridge between them. Due to this, an attacker will be able to read, insert and modify the data in the intercepted connection.

MIMT


HOW MAN IN THE MIDDLE ATTACKS WORK
ORIGINAL CONNECTION
NEW CONNECTION
NEW CONNECTION
USER/VICTIM
MAN IN THE MIDDLE
WEB APPLICATION

MIMT



https://www.javatpoint.com/cyber-security-mitm-attacks

System-based attacks

These are the attacks which are intended to compromise a computer or a computer network. Some of the important system-based attacks are as follows-

Virus

It is a type of malicious software program that spread throughout the computer files without the knowledge of a user. It is a self-replicating malicious computer program that replicates by inserting copies of itself into other computer programs when executed. It can also execute instructions that cause harm to the system.

Worm

It is a type of malware whose primary function is to replicate itself to spread to uninfected computers. It works same as the computer virus. Worms often originate from email attachments that appear to be from trusted senders.

Web-based attacks

Adware − Adware, also known as freeware or pitchware, is a free computer software that contains commercial advertisements of games, desktop toolbars, and utilities. It is a web-based application and it collects web browser data to target advertisements, especially pop-ups.

Spyware − Spyware is infiltration software that anonymously monitors users which enables a hacker to obtain sensitive information from the user's computer. Spyware exploits users and application vulnerabilities that is quite often attached to free online software downloads or to links that are clicked by users.

Ransomware - is a type of malware from cryptovirology that threatens to publish the victim's data or perpetually block access to it unless a ransom is paid. While some simple ransomware may lock the system so that it is not difficult for a knowledgeable person to reverse, more advanced malware uses a technique called cryptoviral extortion. It encrypts the victim's files, making them inaccessible, and demands a ransom payment to decrypt them

Web-based attacks

Trojan horse

It is a malicious program that occurs unexpected changes to computer setting and unusual activity, even when the computer should be idle. It misleads the user of its true intent. It appears to be a normal application but when opened/executed some malicious code will run in the background.

Backdoors

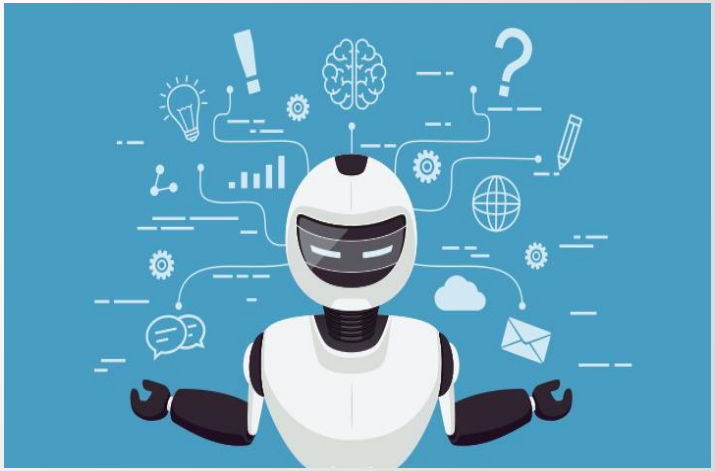
It is a method that **bypasses the normal authentication process**. A developer may create a backdoor so that an application or operating system can be accessed for troubleshooting or other purposes.

Web-based attacks

Rootkit − A rootkit is a software used by a hacker to gain admin level access to a computer/network which is installed through a stolen password or by exploiting a system vulnerability without the victim's knowledge.

Bots

A bot (short for "robot") is an automated process that interacts with other network services. Some bots program run automatically, while others only execute commands when they receive specific input. Common examples of bots program are the crawler, chatroom bots, and malicious bots.



Web-based attacks

KeyLoggers:
Traditionally, Keyloggers are software that monitor user activity such as keys typed using keyboard.

Modern keyloggers can,
- Record keystrokes on keyboard
- Record mouse movement and clicks
- Record menus that are invoked
- Take screenshots of the desktop at predefined intervals

Security Technologies

1.Firewalls

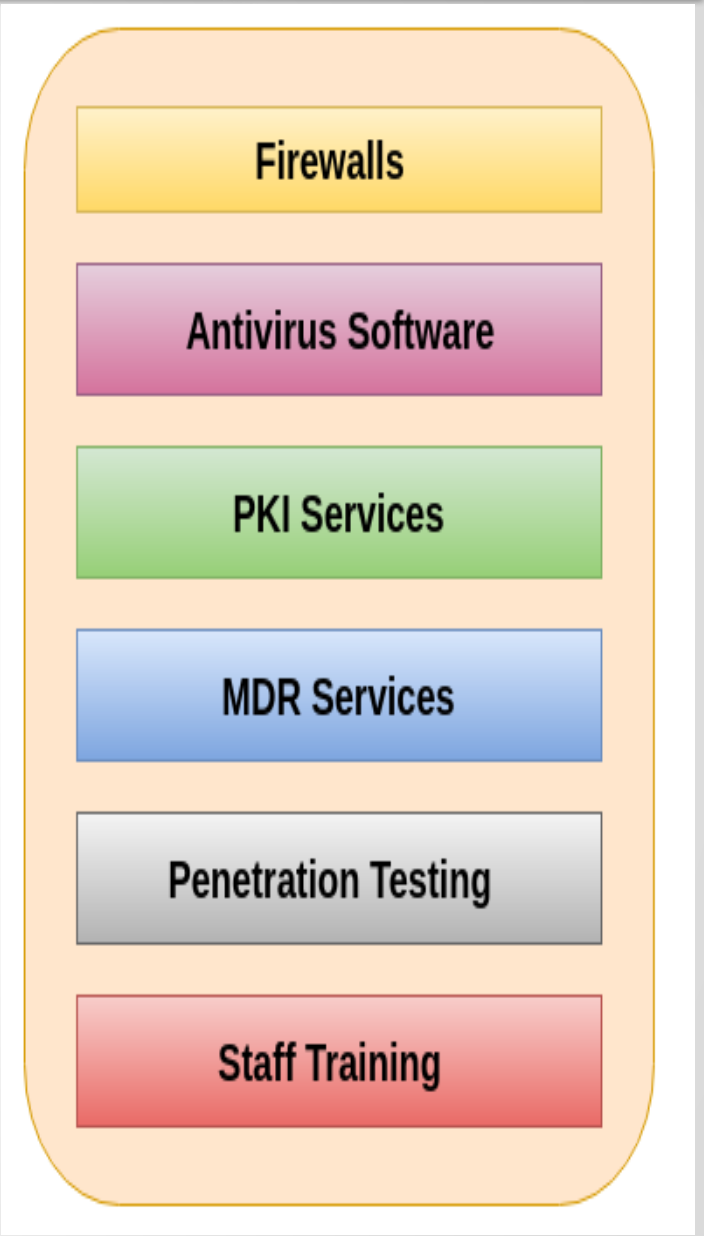
2. Antivirus Software

3. PKI Services (Public Key Infrastructure)

4. Managed Detection and Response Service (MDR)

5. Pen Testing

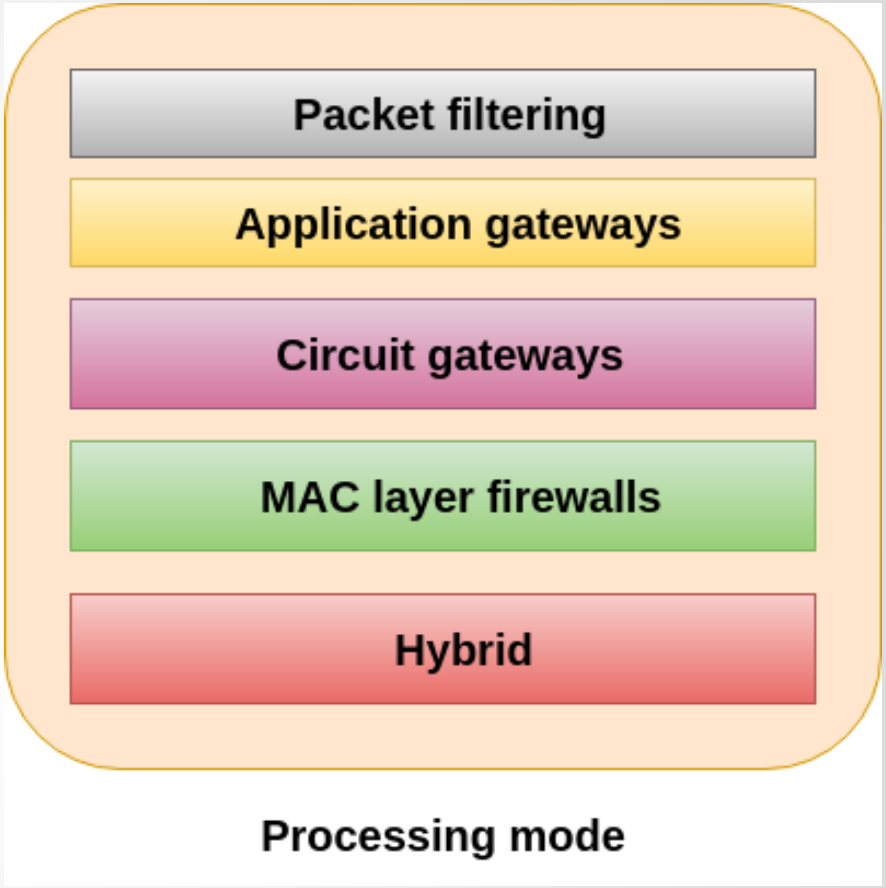
6. Staff Training



Security Technologies

Firewall

Firewall is a computer network security system designed to prevent unauthorized access to or from a private network. It can be implemented as hardware, software, or a combination of both. Firewalls are used to prevent unauthorized Internet users from accessing private networks connected to the Internet. All messages are entering or leaving the intranet pass through the firewall. The firewall examines each message and blocks those that do not meet the specified security criteria.



Intrusion Detection System (IDS)

An IDS is a security system which monitors the computer systems and network traffic.

It analyses that traffic for possible hostile attacks originating from the outsider and also for system misuse or attacks originating from the insider.

A firewall does a job of filtering the incoming traffic from the internet, the IDS in a similar way compliments the firewall security. Like, the firewall protects an organization sensitive data from malicious attacks over the Internet, the Intrusion detection system alerts the system administrator in the case when someone tries to break in the firewall security and tries to have access on any network in the trusted side.

Security Technologies

Access Control

Access control is a process of selecting restrictive access to a system. It is a concept in security to minimize the risk of unauthorized access to the business or organization.

In this, users are granted access permission and certain privileges to a system and resources. Here, users must provide the credential to be granted access to a system. These credentials come in many forms such as password, keycard, the biometric reading, etc. Access control ensures security technology and access control policies to protect confidential information like customer data.

The access control can be categories into two types-

- Physical access control
- Logical access control

Security Technologies

Encoding and Decoding

Encoding is the process of putting a sequence of characters such as letters, numbers and other special characters into a specialized format for efficient transmission.

Decoding is the process of converting an encoded format back into the original sequence of characters. It is completely different from Encryption which we usually misinterpret.

Encoding should NOT be used for transporting sensitive information.

Cryptography is useful tool for securing data, communications, and code globs, but it's no silver bullet.

Steganography

Steganography is the practice of hiding a secret message inside of (or even on top of) something that is not secret.

Security Technologies

Steganography is a method of hiding secret data, by embedding it into an audio, video, image, or text file. It is one of the methods employed to protect secret or sensitive data from malicious attacks.

a) b)

Fig. 1. a) An image without any modification. b) An image after embedding a list of names, emails and cellphone numbers.

Steganalysis is the art of analyzing files for the presence of data hidden by steganography and potentially recovering that data.

Security Technologies

Security orchestration, automation and response (SOAR) software solutions combine the functionality of security tools and add intelligent automation functionality to improve a security operations team's ability to tackle threats in real time with minimal manual labour.

User and entity behaviour analytics (UEBA) software and zero trust networking solutions are designed to detect threats in real time. These tools all use behaviour-based analytics to identify strange behaviours and misuse within a network.

Digital Signature

A digital signature is a **mathematical technique** which validates the authenticity and integrity of a message, software or digital documents. It allows us to verify the author name, date and time of signatures, and authenticate the message contents. The digital signature offers far more inherent security and intended to solve the problem of tampering and impersonation (Intentionally copy another person's characteristics) in digital communications.

Security Technologies

Algorithms in Digital Signature

A digital signature consists of three algorithms:

1. Key generation algorithm

The key generation algorithm selects private key randomly from a set of possible private keys. This algorithm provides the private key and its corresponding public key.

2. Signing algorithm

A signing algorithm produces a signature for the document.

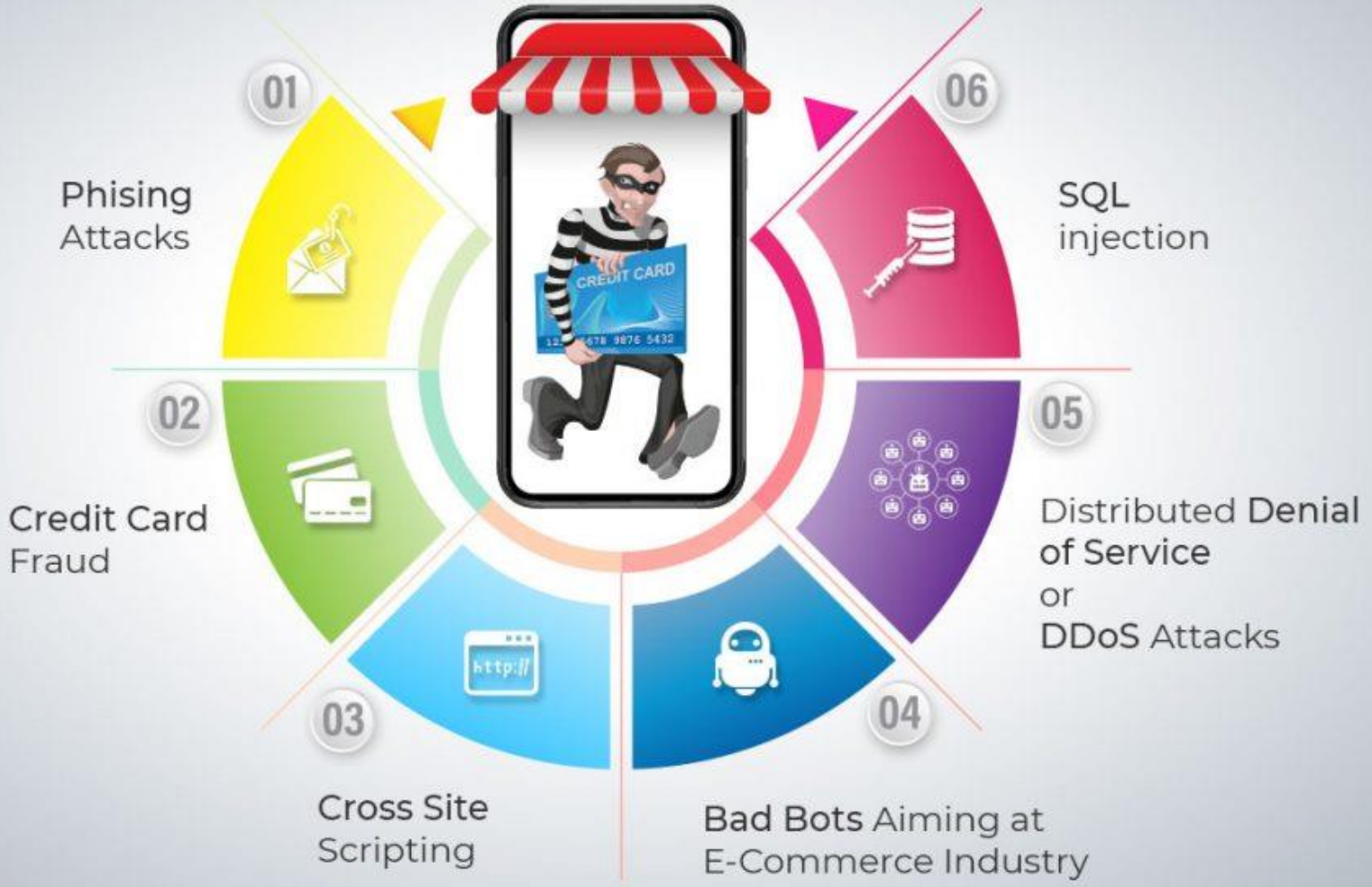
3. Signature verifying algorithm

A signature verifying algorithm either accepts or rejects the document's authenticity.

How do digital signatures secure e-commerce transactions ??

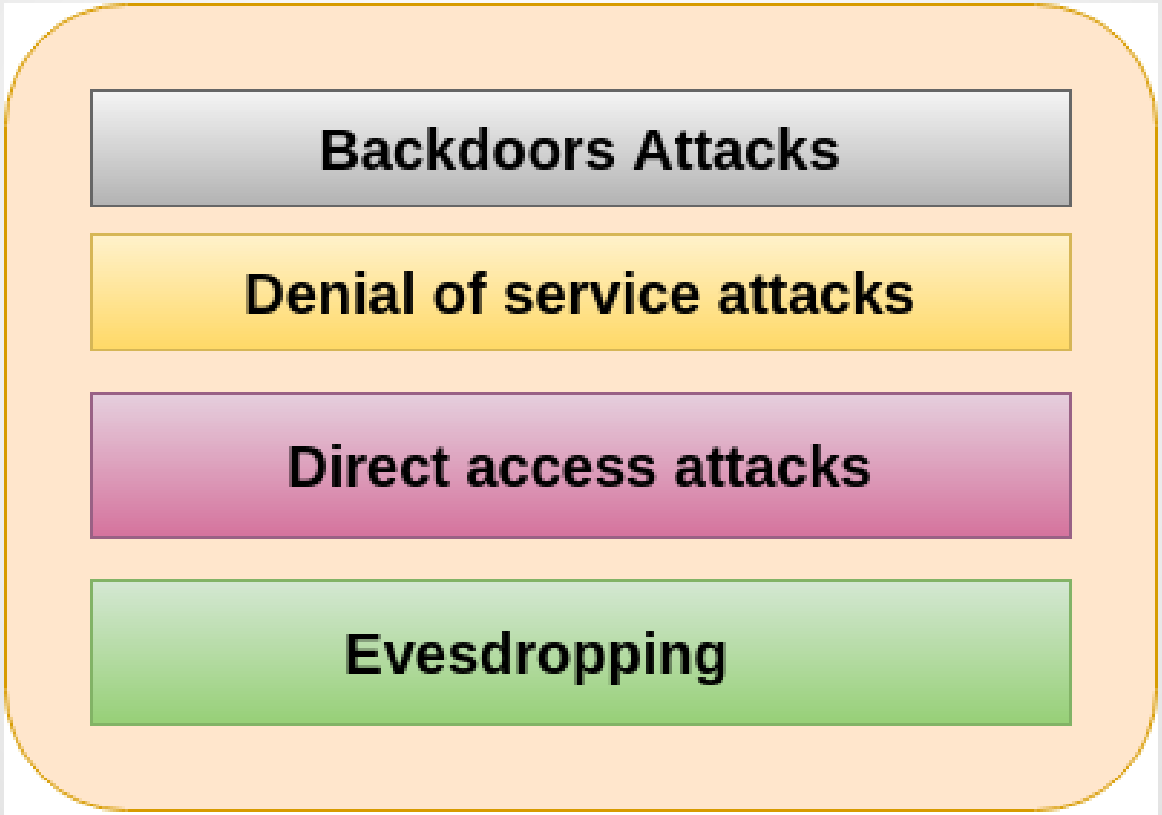
Link: https://www.linkedin.com/pulse/digital-signature-e-commerce-security-adeife-adeoye

Threat to E-Commerce



Threat to E-Commerce

In **e-cash**, we stored financial information on the electronic device or on the internet which is vulnerable to the hackers. Some of the major threats related to e-cash system are-



E-cash Threats

Threat to E-Commerce

Backdoors Attacks

It is a type of attacks which gives an attacker to unauthorized access to a system by bypasses the normal authentication mechanisms. It works in the background and hides itself from the user that makes it difficult to detect and remove.

Denial of service attacks

A denial-of-service attack (DoS attack) is a security attack in which the attacker takes action that prevents the legitimate (correct) users from accessing the electronic devices. It makes a network resource unavailable to its intended users by temporarily disrupting services of a host connected to the Internet.

Direct Access Attacks

Direct access attack is an attack in which an intruder gains physical access to the computer to perform an unauthorized activity and installing various types of software to compromise security. These types of software loaded with worms and download a huge amount of sensitive data from the target victims.

Threat to E-Commerce

Eavesdropping

This is an unauthorized way of listening to private communication over the network. It does not interfere with the normal operations of the targeting system so that the sender and the recipient of the messages are not aware that their conversation is tracking.

Credit/Debit card fraud

A credit card allows us to borrow money from a recipient bank to make purchases. The issuer of the credit card has the condition that the cardholder will pay back the borrowed money with an additional agreed-upon charge.

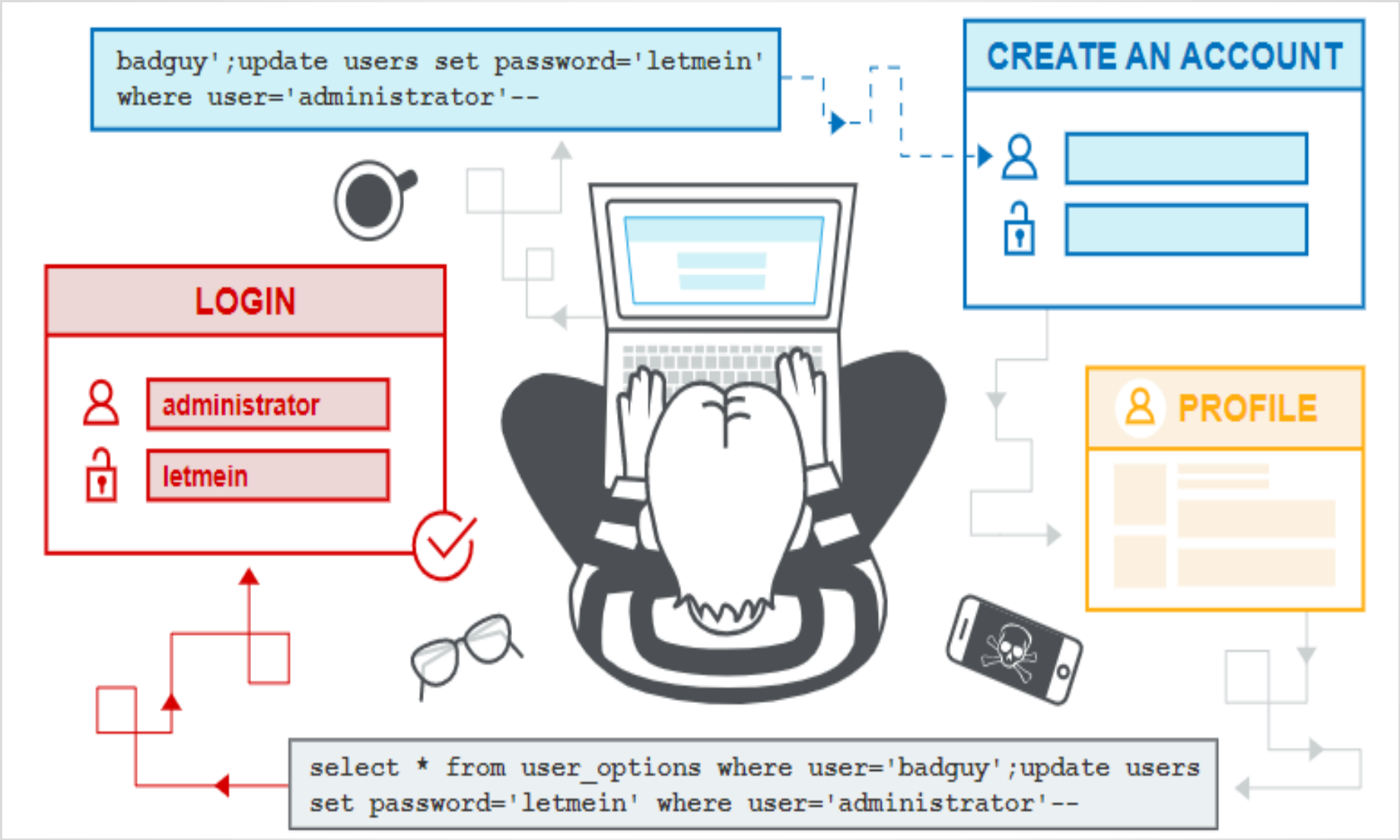
Web Application - Injection

Injection technique consists of **injecting a SQL query** or a command using the input fields of the application.

A successful SQL injection can read, modify sensitive data from the database, and can also delete data from a database. It also enables the hacker to perform administrative operations on the database such as shutdown the DBMS/dropping databases.

Blind SQL injection is a type of SQL Injection attack that asks the database true or false questions and determines the answer based on the applications response. This attack is often used when the web application is configured to show generic error messages, but has not mitigated the code that is vulnerable to SQL injection.

Web Application - Injection



Web Application - Injection

```
String query = "SELECT * FROM EMP WHERE EMPID = '" + request.getParameter("id") + "'";
```

Step 1 − Navigate to the SQL Injection area of the application.

Step 2 − Here, we use String SQL Injection to bypass authentication. Use SQL injection to log in as the boss ('Neville') without using the correct password. Verify that Neville's profile can be viewed and that all functions are available (including Search, Create, and Delete).

Step 3 − We will Inject a SQL such that we are able to bypass the password by sending the parameter as 'a' = 'a' or 1 = 1. The SQL above is valid and will return ALL rows from the “EMP" table, since OR 1=1 is always TRUE.

Step 4 − Post Exploitation, we are able to login as Neville who is the Admin

Web Application - Injection

Preventing SQL Injection
There are plenty of ways to prevent SQL injection.

When developers write the code, they should ensure that they handle special characters accordingly. There are cheat sheets/prevention techniques available from OWASP(Open Web Application Security Project) which is definitely a guide for developers.

- Using Parameterized Queries
- Escaping all User Supplied Input
- Enable Least Privilege for the database for the end users

Source Code Analyzers

Free Source Code Analysers

- OWASP Orizon
- OWASP O2
- SearchDiggity
- FXCOP
- Splint
- Boon
- W3af
- FlawFinder

Commercial Source Code Analysers

- Parasoft C/C++ test
- HP Fortify
- Appscan
- Armorize CodeSecure
- GrammaTech

Are you a software Engineer ?

Thanks to All