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Department of Cyber Security

Subject:

Software Security

Class:

second

Lecturer:

Dr. Suha Alhussieny

Lecture: (2)

Isolation, Least Privilege ,Compartmentalization

Isolation

Isolation in software security refers to the practice of separating different components, processes, or data within a system to enhance security. By isolating these elements, potential security risks are contained, preventing them from spreading to other parts of the system. Isolation is a key strategy in reducing the attack surface and minimizing the impact of security breaches. Here's a Types **of Isolation** in software security:

1. **Process Isolation:** Ensuring that each process runs in its own memory space, separate from other processes. This prevents one process from accessing or interfering with the memory of another.
2. **Virtualization:** Each **Virtual Machines** VM runs its own operating system instance, isolated from other VMs on the same physical host. Hypervisors manage the isolation between VMs.
3. **Network Isolation:** Dividing a network into smaller, isolated segments or zones to control traffic flow and limit the spread of potential attacks. For example, isolating the internal network from the public-facing network.
4. **Privilege Isolation: Principle of Least Privilege (PoLP),** users and processes are granted the minimum level of access rights necessary to perform their tasks, ensuring that higher-privileged functions are isolated from lower-privileged ones.
5. **Database Isolation:** Ensuring that data from different users or tenants is kept separate, especially in multi-tenant environments like cloud services.

6.Code Isolation:

- **Module Isolation:** Structuring code into isolated modules or components with well-defined interfaces, limiting the impact of vulnerabilities within a single module.
- **Micro services:** A software architecture where applications are built as a collection of loosely coupled, independently deployable services, each running in its own isolated environment.
- **Benefits:** Enhances maintainability and security by containing vulnerabilities within specific components.

Least Privilege

The Principle of Least Privilege (PoLP) is a fundamental concept in software security that advocates for granting users, systems, and processes the minimum level of access or privileges necessary to perform their required tasks. By limiting access rights, the potential attack surface is reduced, minimizing the risk of accidental or intentional misuse of privileges.

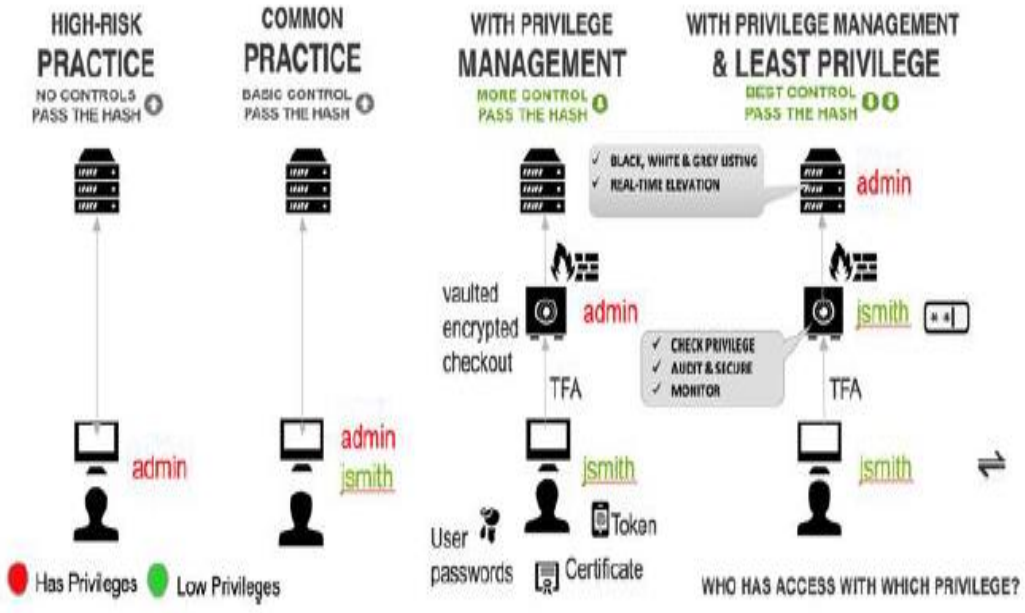
The goal is Least Privilege to reduce security risks by limiting the potential damage that could result from security breaches or errors. This minimizes the opportunities for malicious actors or malware to exploit elevated privileges.

Implementation Least Privilege in Different Contexts

- **User Accounts:**
  - ✓ Regular users should have access only to the files, applications, and systems needed for their job. Administrative privileges should be restricted to a few trusted individuals who need them to perform specific tasks.
- **System Processes:**

- ✓ System services and applications should run under dedicated service accounts with minimal privileges, rather than under accounts with full administrative rights.

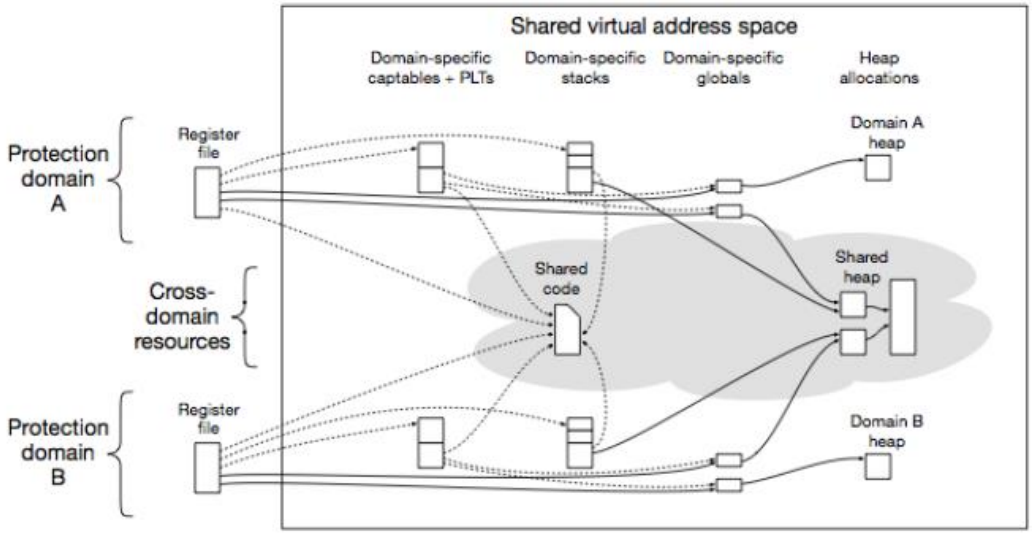
- **Applications:**
  - ✓ Applications should request only the permissions necessary to perform their functions. For example, a messaging app should not require access to the device's camera unless it supports video calling.
- **Network Access:**
  - ✓ Network resources should be segmented, and access should be restricted based on the principle of least privilege, ensuring that users or systems can only access the parts of the network they need.



Compartmentalization

Compartmentalization in software security refers to the practice of dividing a system into distinct, isolated sections or compartments, each with specific functions, data, and access controls. The purpose is to limit the impact of a security breach by ensuring that if one compartment is compromised, the others remain unaffected. This approach enhances security by reducing the attack surface and containing potential threats. **Examples of Compartmentalization in Practice**

- **Military and Government Systems:**
  - ✓ Sensitive information in military and government systems is often compartmentalized based on classification levels (e.g., Confidential, Secret, Top Secret), with strict access controls and isolation between compartments.
- **Cloud Environments:**
  - ✓ In cloud computing, multitenant architectures use compartmentalization to ensure that each tenant's data and applications are isolated from others, protecting against cross-tenant data breaches.
- **Web Applications:**
  - ✓ Web applications often compartmentalize user sessions, isolating them from each other to prevent session hijacking and cross-site attacks.



Threat Model

A Threat Model in software security is a structured approach used to identify, evaluate, and address potential threats that could harm a software system. The purpose of threat modeling is to understand the security risks to a system, prioritize those risks, and develop strategies to mitigate them. This process is crucial in building secure software, as it helps in anticipating and countering potential attacks before they occur.

Threat modeling is the process of systematically identifying security threats and vulnerabilities, assessing their potential impact, and planning mitigations to protect the system.

The primary goal is to improve the security posture of a system by proactively identifying and addressing potential threats, ensuring that security is integrated throughout the software development lifecycle. Key Components of Threat Modeling

- **Assets:** The valuable components of the system that need protection, such as data.
- **Threats:** Potential actions or events that could compromise the confidentiality, integrity, or availability of assets.
- **Vulnerabilities:** Weaknesses or flaws in the system that could be exploited by a threat to cause harm.
- **Attack Vectors:** The paths or methods that attackers use to exploit vulnerabilities and carry out threats.
- **Mitigations:** The security controls or countermeasures implemented to reduce or eliminate the risks posed by threats.

Bug versus Vulnerability

In software security, "bug" and "vulnerability" are terms that refer to different aspects of software flaws. While they are related, they have distinct meanings and implications.

1. Bug

- **Definition:** A bug is a flaw, mistake, or unintended behavior in the software's code that causes the software to operate incorrectly or produce unexpected results. Bugs can arise from errors in logic, incorrect assumptions, or programming mistakes.
- **Scope:** Bugs can affect the functionality, performance, or usability of software. They are not necessarily security-related and may not have any impact on the security of the system.

• **Examples:**

O A calculation error in a financial application that leads to incorrect results.

O A typo in a user interface string that displays incorrect information to the user.

O A crash in a software program due to improper memory management.

2. Vulnerability

• **Definition:** A vulnerability is a specific type of bug or flaw in software that can be exploited by an attacker to compromise the security of the system. Vulnerabilities create opportunities for unauthorized access, data breaches, or other malicious activities.

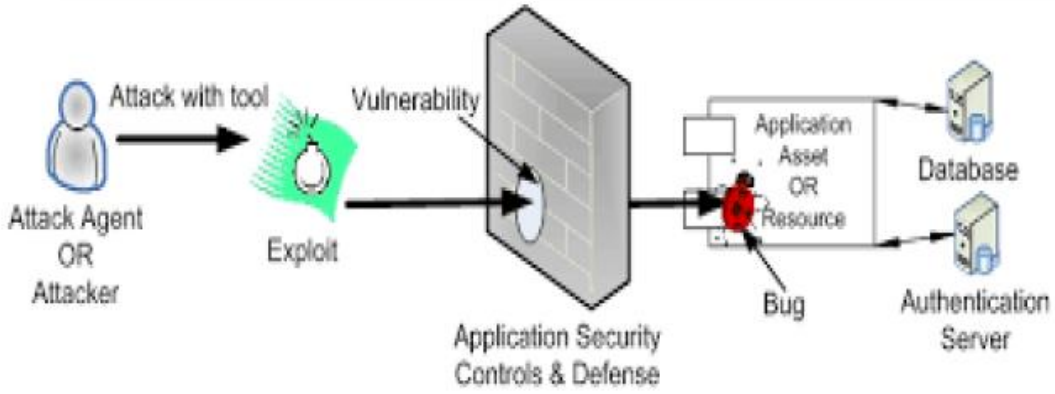
• **Scope:** Vulnerabilities directly impact the confidentiality, integrity, or availability of a system. They can be exploited to perform actions that should not be possible, such as gaining unauthorized access, executing arbitrary code, or causing a denial of service.

• **Examples:**

O A buffer overflow vulnerability that allows an attacker to execute arbitrary code on a system.

O An SQL injection vulnerability that enables an attacker to manipulate a database.

O An authentication bypass vulnerability that lets an attacker access a system without proper credentials.


Attack with tool
Vulnerability
Application
Asset
OR
Resource
Database
Attack Agent
OR
Attacker
Exploit
Bug
Authentication
Server
Application Security
Controls & Defense