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and a typical pentest

Threat Modeling

- Step 1: Read all documentation
- Step 2: Use the application to perform basic tasks
- Step 3: Watch how data moves
- Step 4: Define user roles
- Step 5: Define assets
- Step 6: Define components
- Step 7: Access matrix
- Step 8: Component diagram
- Step 9: Threat tree

Threat Based Testing – Threat Modeling

Introduction to Threat Modeling – What is Threat Modeling

- Software development is about creating applications that enable users to perform some tasks
- Secure development requires determining what a user shouldn't do and ensuring that the code properly restricts users to authorized actions.
- Threat modeling is a design activity to do just that

Threat Based Testing – Threat Modeling

Introduction to Threat Modeling – How Threat Modeling Helps

- **Threat Modeling enables you to:**
  - Identify threats
  - Identify vulnerabilities
  - Identify mitigating factors
  - Perform risk analysis
  - Prioritize security fixes
  - Derive security test cases

Threat Based Testing –Threat Modeling

Introduction to Threat Modeling – Threat Modeling Walkthrough

- For our threat modeling walkthrough, we will have an example in which we model a simple online store application that allows users to buy sport equipment
- We will apply the process step-by-step to our example

Threat Based Testing – Threat Modeling

The Threat Modeling Process

- **Threat Modeling Process**
  - Collecting Information
  - Decomposing the Application
    - Identifying Entry Points
    - Identifying Assets
    - Identifying Roles
  - Building the Activity Matrix
  - Building the Threat Profile
    - Identifying Threats
    - Classifying Threats
    - Building Threat Trees
    - Identifying Vulnerabilities
  - Analyzing Risks

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Collecting Information

- **Background information:**
  - Can be collected relatively fast
  - Is crucial for a good start of a threat model
  - Helps to understand the application and its basic purposes
  - Provides better understanding of threat mitigations
  - Can be used throughout the entire iterative threat modeling process

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Collecting Information

- There are four main sources of background information:
  - Specifications
  - Implementation Assumptions
  - External Dependencies
  - Internal and External Security Notes

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Collecting Information: Specifications

- **Usually include:**
  - Customer requirements
  - Intended purposes
  - Use cases
- **Define the primary functionality of the system**
- **Scope the threat model by providing common and uncommon uses of the System Under Test (SUT)**
- **Can be used later to analyze the threats that emerge depending on the specific use case**

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Collecting Information: Implementation Assumptions

- Decisions made before developing or during architectural or project revisions
- Capture basic architectural and design assumptions that may raise security issues
- List features that may increase the attack surface of the SUT
- Help in defining mitigations to specific threats.

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Collecting Information: External Dependencies

- List the software components which the SUT relies to function properly
- Can be used to construct dependency contracts to capture third-party security concerns

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Collecting Information: Security Notes

- Internal and external security notes
- Hidden security concerns and steps that were take against them
- Are used to capture the security assumptions from an architectural point of view
- Help to make the threat model more clear
- Aid in defining mitigations for threats discovered during step 4 (Building the Threat Profile)

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Collecting Information: Example

- **High-level information for our online store application:**
  - The application stores customer data such as shipping and billing addresses, and credit card numbers
  - The application interfaces with a 3rd party payment processing system
  - The application interfaces with a separate inventory system to manage stock and re-orders

Threat Based Testing – Threat Modeling

The Threat Modeling Process

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Threat Based Testing – Threat Modeling

The Threat Modeling Process – Decomposing the Application

- **Decomposing the application…**
  - Is key to define the main elements of a threat model
  - Provides a more structured and formal approach to threat modeling
  - Is a great exercise to understand the inner workings of the software being modeled
  - Helps to find threats during threat discovery phase

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Decomposing the Application

- **Decomposing the application consists of three steps:**
  - Identifying Entry Points
  - Identifying Assets
  - Identifying Roles

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Decomposing the Application: Identifying Entry Points

- Find the sources of input to your application. List all the points in which your system receives data from outside
- List all components that receive hidden sources of input such as components that interact with the file system, registry, RPC/DCOM, memory, etc.
- Collect entry points by looking at background information (use cases or external dependencies will reveal entry points for a threat model)

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Decomposing the Application: Identifying Entry Points Example

- **Identifying entry points in our online store application:**
  - Front-end Web server
  - Merchandise database
  - Interface with 3rd-party credit card processing system
  - Interface with inventory system

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Decomposing the Application: Identifying Assets

- To find assets one needs to think about what the attacker will target
- When enumerating threats during the next step, you will see that most threats relate to an attacker exploiting or stealing an asset
- While doing this exercise you might start encountering threats. Note them down for later use.

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Decomposing the Application: Identifying Assets Example

- **Identifying assets in our online store application:**
  - Customer data
  - Checkout cart
  - Merchandise
  - Inventory system
  - The Web application

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Decomposing the Application: Identifying Roles

- Roles reflect the different privileges included in your application
- They are nouns that usually translate to the different users of the system (user, admin/root, guest, wheel, etc), but can also can refer to different privilege levels such as user mode vs. kernel mode
- Each entry point and asset will have an associated list of roles
- Noting down the roles per entry point or asset might reveal escalation of privilege or information disclosure threats

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Decomposing the Application: Identifying Roles Example

- Identifying roles in our online store application:
  - Web customer
  - 3rd-party payment processing system

Threat Based Testing – Threat Modeling

- **Threat Modeling Process**
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Threat Based Testing – Threat Modeling

The Threat Modeling Process – Building the Activity Matrix

- The activity matrix is a set of explicit mappings between roles and asset
- Each <role, asset> pair lists the access types granted to a role for the asset
- The activity matrix is used in later steps to derive threats to the system based on improper asset access

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Building the Activity Matrix: Example

- Building the activity matrix for our online store application:

	Customer Data	Merchandise	[…]

Web Customer	Read:
	Own = always
	Other = never
	Modify:
	Own = always
	Other = never
		Read: always
		Modify: never	

[…]			

Threat Based Testing – Threat Modeling

- **Threat Modeling Process**
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  - Analyzing Risks

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Building the Threat Profile

- **A Threat Profile is:**
  - A list of threats
  - A threat tree for each of the discovered threats
  - A description of mitigations
  - A list of vulnerabilities

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Building the Threat Profile

- **This step uses all the information collected to this point from the previous steps:**
  - Use cases serve to identify threats in specific scenarios
  - Security notes, external dependencies, and implementation assumptions imply where to look and narrow the scope
  - Data Flow Diagrams are great resources to understand the attack surface of your application
  - Assets are target of threats
  - Entry points give context, help to identify attacks
  - Roles affect threat mitigations

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Building the Threat Profile

- **Building the Threat Profile is achieved with the following four steps:**
  - Identifying Threats
  - Classifying Threats
  - Building Threat Trees
  - Identifying Vulnerabilities

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Building the Threat Profile: Identifying Threats

- **Threats are possible attacks**
  - A threat is what an attacker might try to do to an asset or through an entry point
  - Threats spring out of the “never” entries in the activity matrix
- **Threats have the following characteristics:**
  - They are usually expressed as verbs (actions)
  - They involve at least one entry point or one asset
  - They are written in the following form:
    - Attacker verb to\from\with\etc asset (for goal)

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Building the Threat Profile: Identifying Threats Example

- **Threat examples from our online store activity matrix:**
  - Threat #1: Attacker steals customer information
  - Threat #2: Attacker connects to merchandise database to delete merchandise thus causing a denial of service

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Building the Threat Profile: Classifying Threats

- **STRIDE**
  - **S**poofing
  - **T**ampering with Data
  - **R**epudiation
  - **I**nformation Disclosure
  - **D**enial Of Service
  - **E**scalation of privilege

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Building the Threat Profile: Classifying Threats Example

- **Classifying our online store threats:**
  - Threat #1: Attacker steals customer information
    - **I**nformation Disclosure
  - Threat #2: Attacker connects to merchandise database to delete merchandise and cause denial of service
    - **D**enial of Service

Threat Based Testing – Threat Modeling

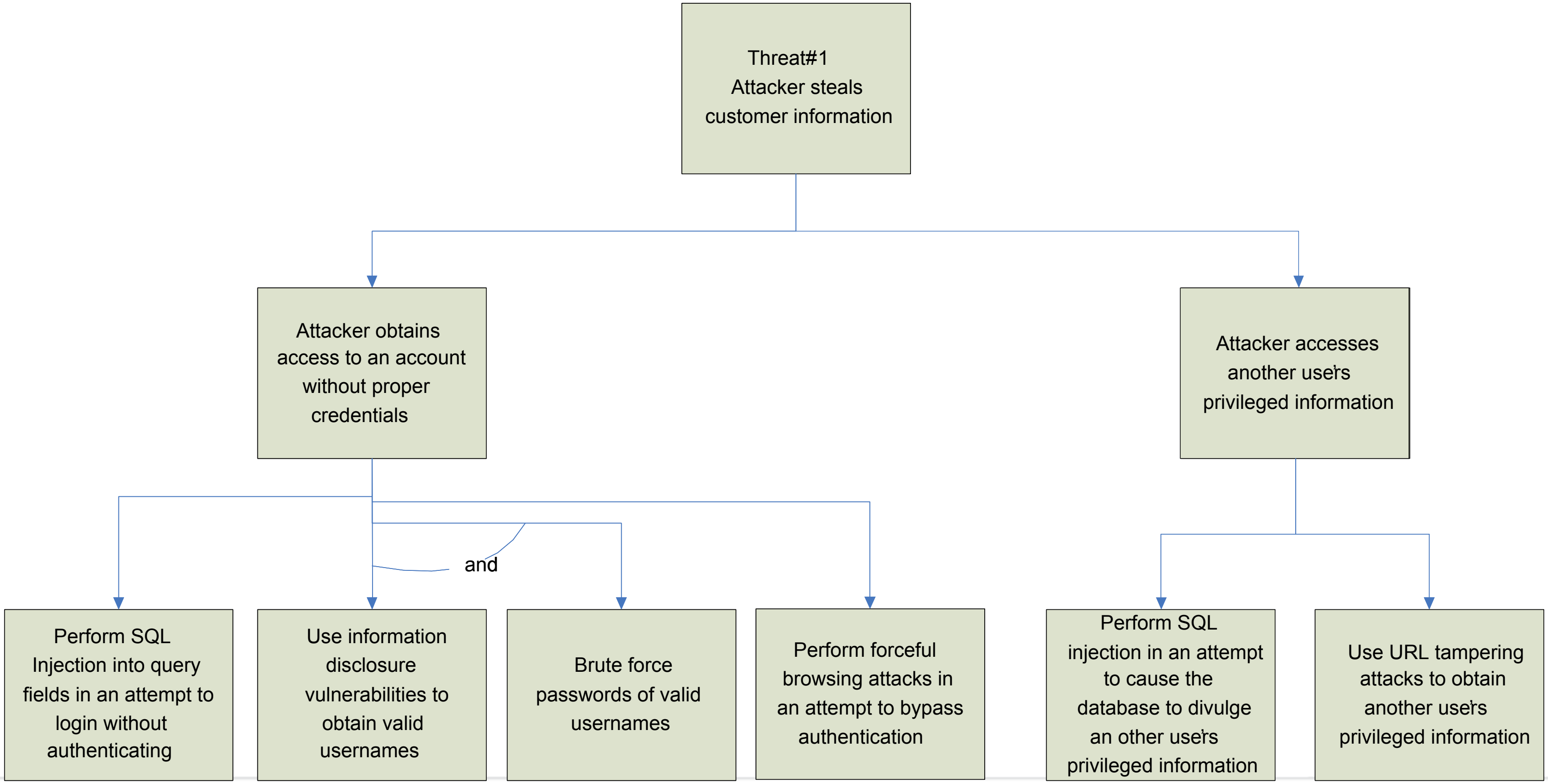
The Threat Modeling Process – Building the Threat Profile: Building Threat Trees

- **Threat trees provide comprehensive details about a threat, describing the conditions required to realize it:**
  - The root node is the threat
  - Child nodes are the conditions necessary for the threat to realize
- **Threat trees are used during penetration testing to construct test cases from the condition nodes**

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Building the Threat Profile: Building Threat Trees Example

- **Threat tree example from our online store:**
  - Threat #1: Attacker steals customer information



Threat#1
Attacker steals
customer information

Attacker obtains access to an account without proper credentials

Attacker accesses another user's privileged information

and

Perform SQL Injection into query fields in an attempt to login without authenticating

Use information disclosure vulnerabilities to obtain valid usernames

Brute force passwords of valid usernames

Perform forceful browsing attacks in an attempt to bypass authentication

Perform SQL injection in an attempt to cause the database to divulge an other user's privileged information

Use URL tampering attacks to obtain another user's privileged information

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Building the Threat Profile: Identifying Vulnerabilities

- Threats and conditions can be mitigated or unmitigated
- Attack paths can be built by identifying unmitigated routes from the leaf conditions to the root threat
- Unmitigated attack paths yield vulnerabilities
- Vulnerabilities inherit the root threats’ STRIDE classifications

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Building the Threat Profile: Identifying Vulnerabilities Example

- **Vulnerability from our online store threat tree:**
  - A SQL injection vulnerability in the query fields allows an attacker to obtain access to an account without proper credentials
    - **I**nformation Disclosure

Threat Based Testing – Threat Modeling

The Threat Modeling Process – Building the Threat Profile

- **Suggestions for building the threat profile:**
  - Arrange a meeting to brainstorm on threats
  - Don’t think too much into solutions or mitigations
  - Identify each threat with a proper ID