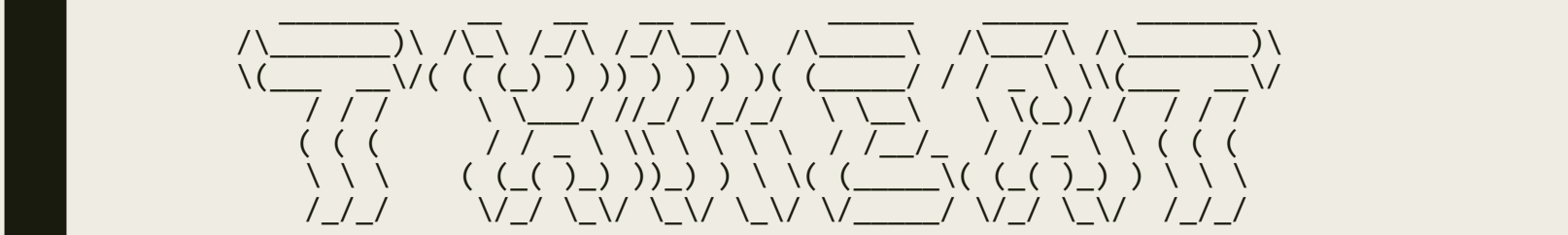

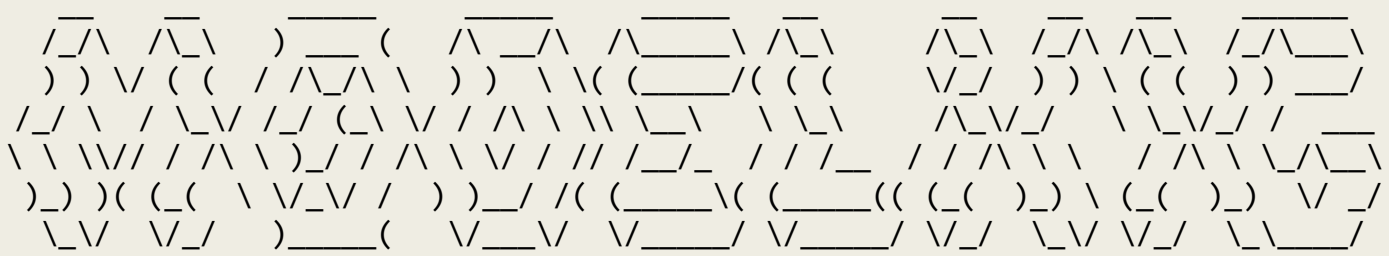

and a typical pentest

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 that guides this process

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 alcohol
- 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 five main sources of background information:
  - *Specifications*
  - *Implementation Assumptions*
  - *External Dependencies*
  - *Internal and External Security Notes*
  - *People*

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 (System Under Test)
- 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 taken against them
- Are used to capture the security assumptions from an architectural point of view
- Help to make the threat model clearer
- 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: People

- Find out what is really happening
- Pinpoint areas of concern
- Compare assumptions of developers, QA, PMs, etc. against assumptions in the design documentation
- Fill in gaps from missing, incomplete, or immature paper documentation

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, DoB, and credit card information*
  - *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 in defining 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 PII data*
  - *Checkout cart*
  - *Merchandise*
  - *Inventory*
  - *The recommendations algorithm*
  - *User purchase history*
  - *Uptime*

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:
  - *Customer*
  - *3rd-party payment processing system*
  - *Customer service representative*
  - *QA*
  - *Developers*
  - *Ops*

Threat Based Testing – Threat Modeling

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

- Identifying roles in our online store application:
  - *HTML and CSS components*
  - *Database framework*
  - *Load balancer*
  - *Edge router*
  - *Developer's computer*
  - *Ops scripts*

Threat Based Testing – Threat Modeling

- Threat Modeling Process
  - *Collecting Information*
  - *Decomposing the Application*
    - Identifying Entry Points
    - Identifying Assets
    - Identifying Roles
    - Identifying Components
  - ➢ *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 – 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 PII Data	Merchandise	[…]
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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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 a component or through an entry point to gain access to an asset*
  - *Threats spring out of the "sometimes" and "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 [component/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*
  - *Threat #2: Attacker connects to merchandise database to delete merchandise and cause denial of service*
  - *Threat #3: Attacker can run arbitrary server commands*

Threat Based Testing – Threat Modeling

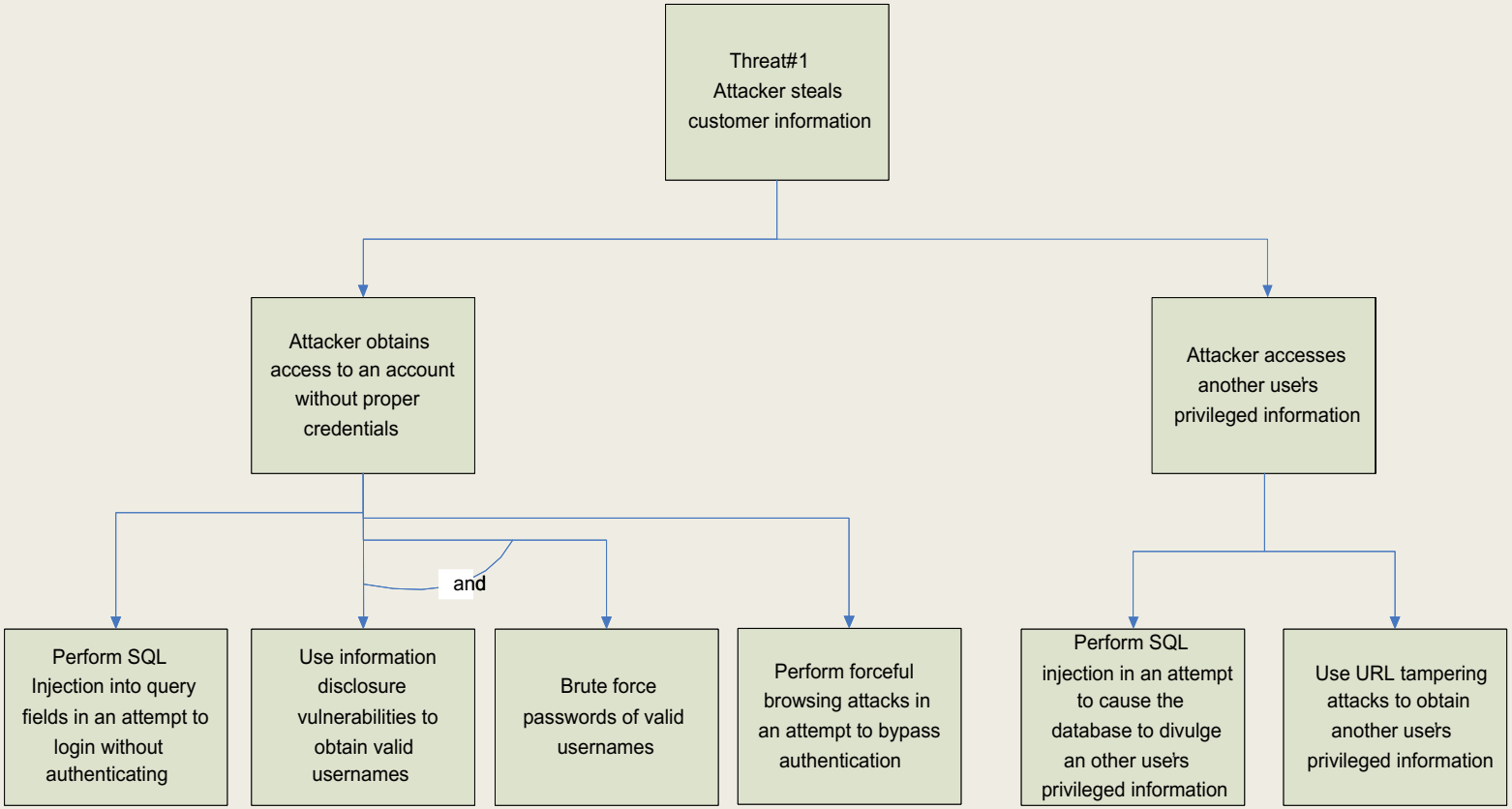
The Threat Modeling Process – Building the Threat Profile: Building Threat Trees

- 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 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*
    - Information 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*

Threat Based Testing – Threat Modeling

- Threat Modeling Process
  - *Collecting Information*
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  - *Analyzing Risks*

Threat Based Testing – Analyzing Risks

The Threat Modeling Process – Analyzing Risks

- Mitigations aren't free
  - *Time*
  - *Money*
  - *Personnel*
  - *Cheap, secure, usable (pick 2)*
- Risks are not all the same
  - *How does a remote command injection compare to a verbose error message?*
- Risks need to be ranked and prioritized, then a mitigation plan can be developed
- A realistic list and a wish list need to be created – one helps focus, the other helps vision

If time, DREAD v2

- Defense in Depth
- Directly Exploitable