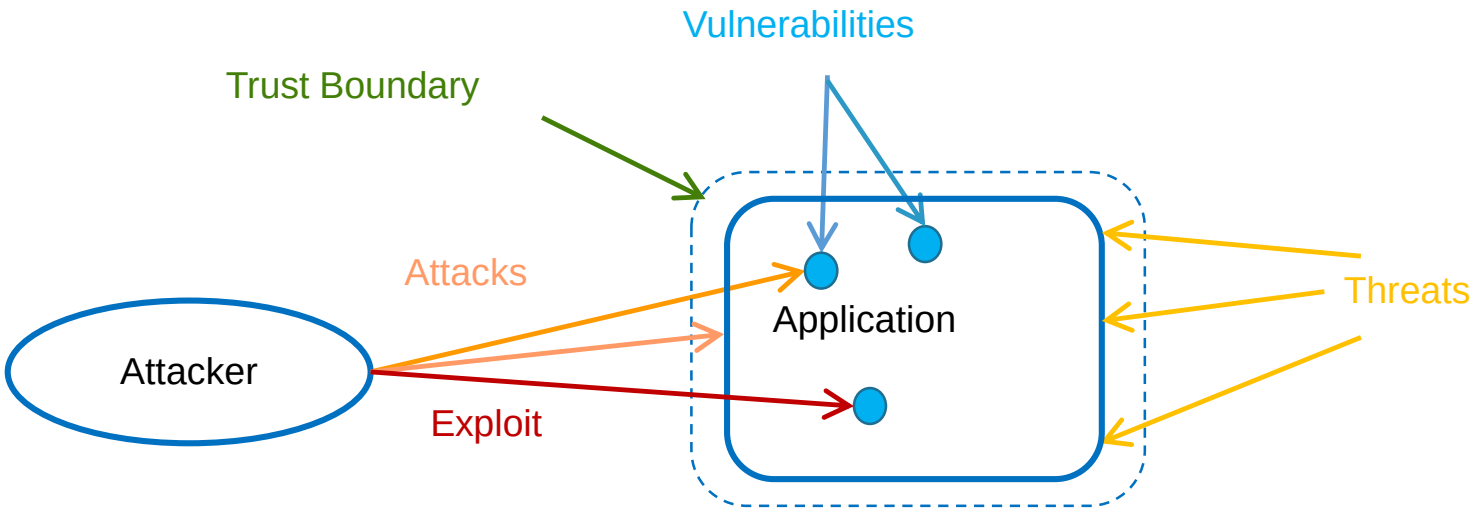
Threat Modeling

Threat Modeling Review



Vulnerability: a software defect with security consequences

Threat: a potential danger to the software

Attack: an attempt to damage or gain access to the system

Exploit: a successful attack

Trust Boundary: where the level of trust changes for data or code

Threat Modeling Review

- Threats represent a potential danger to the security of one or more assets or components
  - Threats could be malicious, accidental, due to a natural event, an insider, an outsider, …
  - A single software choice can result in many threats.
  - Threats exist even if there are no vulnerabilities
    - No relaxing
    - Threats change with system changes

How can a change in software result in either or fewer threats?

Threat Modeling Review

- Social threats: people are the primary attack vector
- Operational threats: failures of policy and procedure
- Technological threats: technical issues with the system
- Environmental threats: from natural or physical facility factors
- The threats themselves are the same, but this is a different view
  - Threats have certain sources (Social, Operational, Technical, Environments)
  - And certain security impacts (STRIDE)

Threat Modeling Overview

- Threat Modeling is a process that helps the architecture team:
  - Accurately determine the attack surface for the application
  - Assign risk to the various threats
  - Drive the vulnerability mitigation process
- It is widely considered to be the one best method of improving the security of software
- The Microsoft approach is cumbersome

Threat Modeling Overview

- The phases of the Threat Modeling process
  - Understand the security requirements
    - Use Scenarios – what are the boundaries of the security problem
    - Identify external dependencies – OS, web server, network, …
    - Define security assumptions – what can you expect with regard to security; will the DB encrypt columns? Is there a key manager? What are the limitations you are working with.
  - Create an activity matrix (actor-asset-action matrix)
    - Identify assets
    - Identify roles
    - Their interaction
  - Create Trust Boundaries

Threat Modeling
Overview

- Identify threats that put assets at risk
- Identify attacks that can be used to realize each threat
  - Threat Trees
  - Abuse Cases
- Determine the risk for each attack and prioritize (if needed)
- Define the conditions required for each attack to be successful

- Plan and implement your mitigations

Threat Modeling Example

- This is abstracted from the OWASP site so that you can look at it in greater detail
  - https://www.owasp.org/index.php/Application_Threat_Modeling
- Moo U University is installing a new website to provide online access to patrons (students, staff) and library personnel
- This starts with you determining the requirements
  - What needs to be secured and what are the security requirements
  - What are potential threats against the system
  - What are the limitations on building the system
  - …

Threat Modeling Example

1. Name: Library Online Access Site Threat Model
2. Version: 1.0
3. Document Owner: Joe Security
4. Description: <as above>
5. Participants: Joe S, Bob W, Amy C (DEV), Ron R(LIB), Abby T(IT)
6. Reviewers: CISO, CSO, DM, SECTEAM

Threat Modeling Example

7. External Dependencies
    - Server type will be Linux
    - Site will have to be off-campus accessible
    - MySQL database
    - Database server will be the existing library server
    - Private network between web server and db server
    - Both servers must be behind the campus firewall
    - All communications over TLS

Threat Modeling Example

8. Use Scenarios
   - Students can search the database(s)
   - Students can put holds on some items for checkout
   - Staff can search the database(s)
   - Staff can place some items on reserve for up to 15 weeks
   - Librarians can do anything students or staff can do
   - Librarians can place items on an invisible list
   - Librarians can access limited account information

Threat Modeling Example

9. Roles (deviation from OWASP)
   - Anonymous user – connected, but not yet authenticated
   - Invalid user – attempted to authenticate and failed
   - Student – authenticated student
   - Staff – authenticated staff
   - Librarian – authenticated librarian
   - Site admin – authenticated site administrator with configuration privileges
   - DB admin – authenticated database administrator with full db privileges
   - Web server user – user/process id of web server
   - Database read user – db user for accessing the database with read-only access
   - Database write user – db user for accessing te database with read-write access

Threat Modeling Example

10. Assets

- Library users and librarian
- User credentials
- Librarian credentials
- User personal information
- Web site system
- DB system
- Availability of the web server
- Availability of the DB server
- User code execution on web site
- User DB read access
- Librarian/Admin code execution on the web site
- Librarian/Admin DB read/write access
- Ability to create users
- Ability to audit system events

Threat Modeling Example

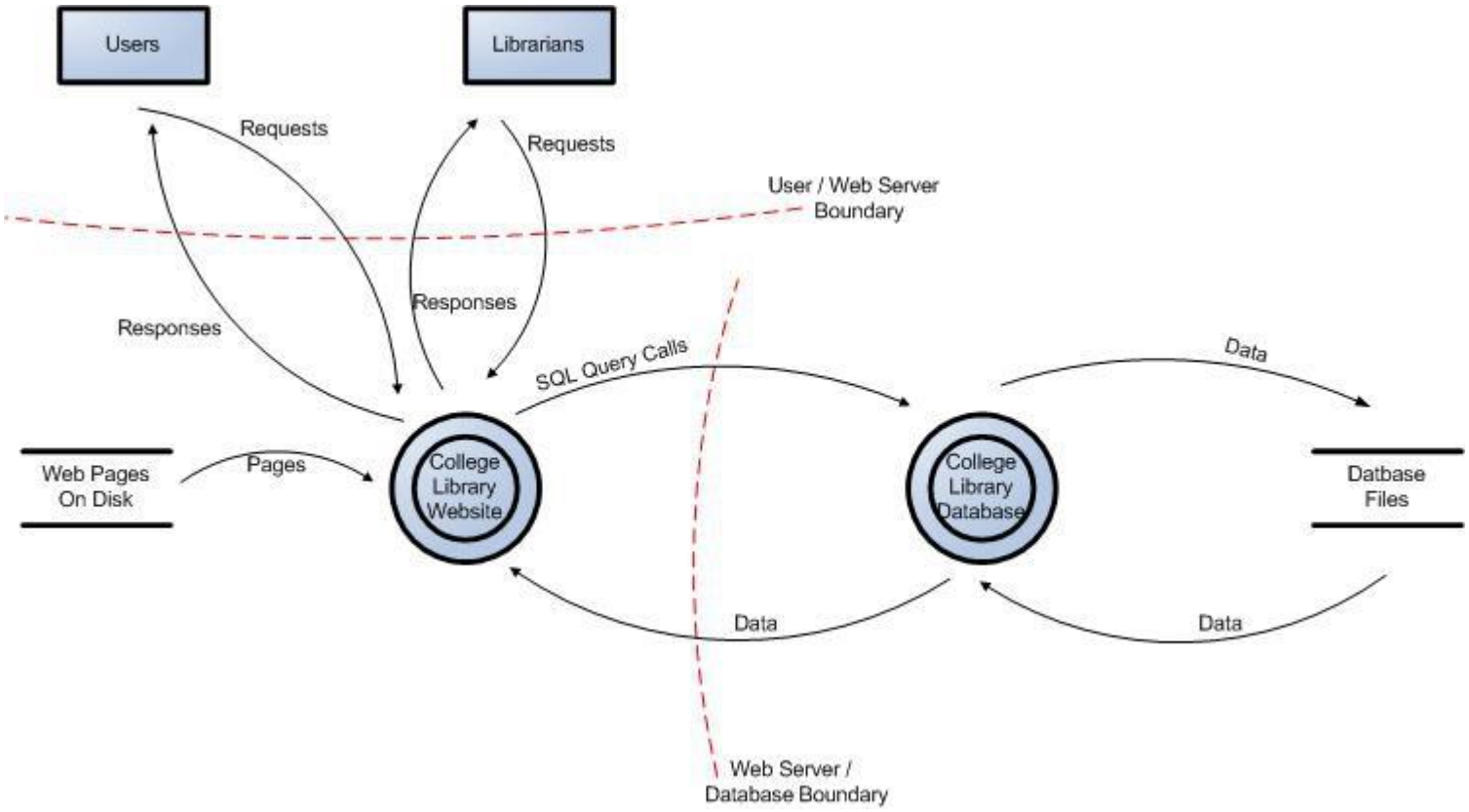
11. Activity Matrix

- This can be messy and it best done in a spreadsheet. The results are much the same as in the OWASP example, but easier to visualize

Asset/Role	Anonymous	Invalid	Student	Faculty	Librarian	Admin
	C R U D	C R U D	C R U D	C R U D	C R U D	C R U D
Users	A - - -	A - - -	- - - -	- - - -	X X X -	
Librarians	- - - -	- - - -	- - - -	- - - -	- - - -	
Personal info	- - - -	- - - -	B B B -	B B - -	- - - -	
Web site	- - - -	- - - -	- - - -	- - - -	- C - -	X X X X

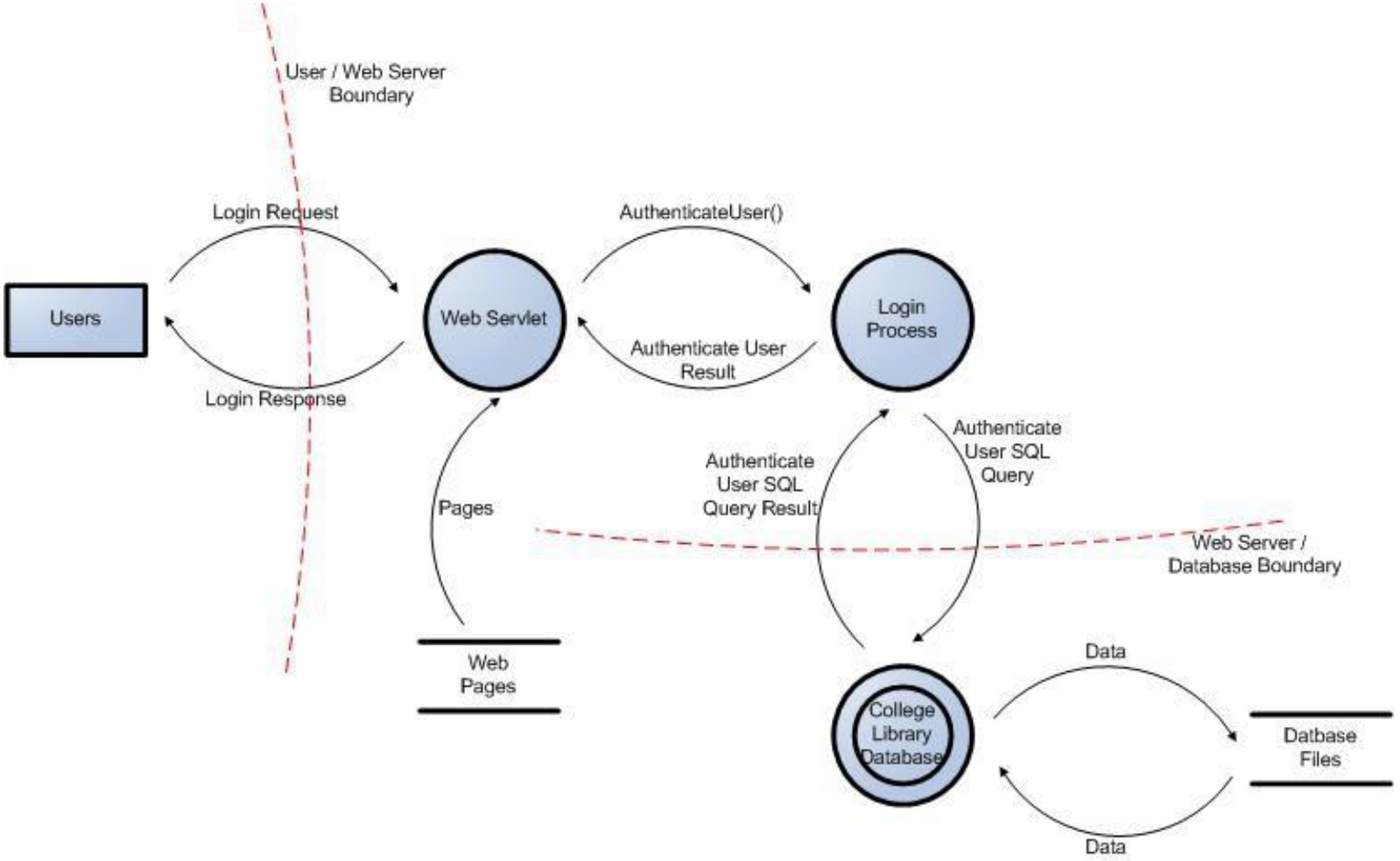
- A = Create if valid name, id, pin provided
- B = Only for their own profile information
- C = Must be limited to specific files, tables. No access to web site files.

12. Trust Boundaries



Threat Modeling Example

- Login DFD



Threat Modeling Example

13. Threats

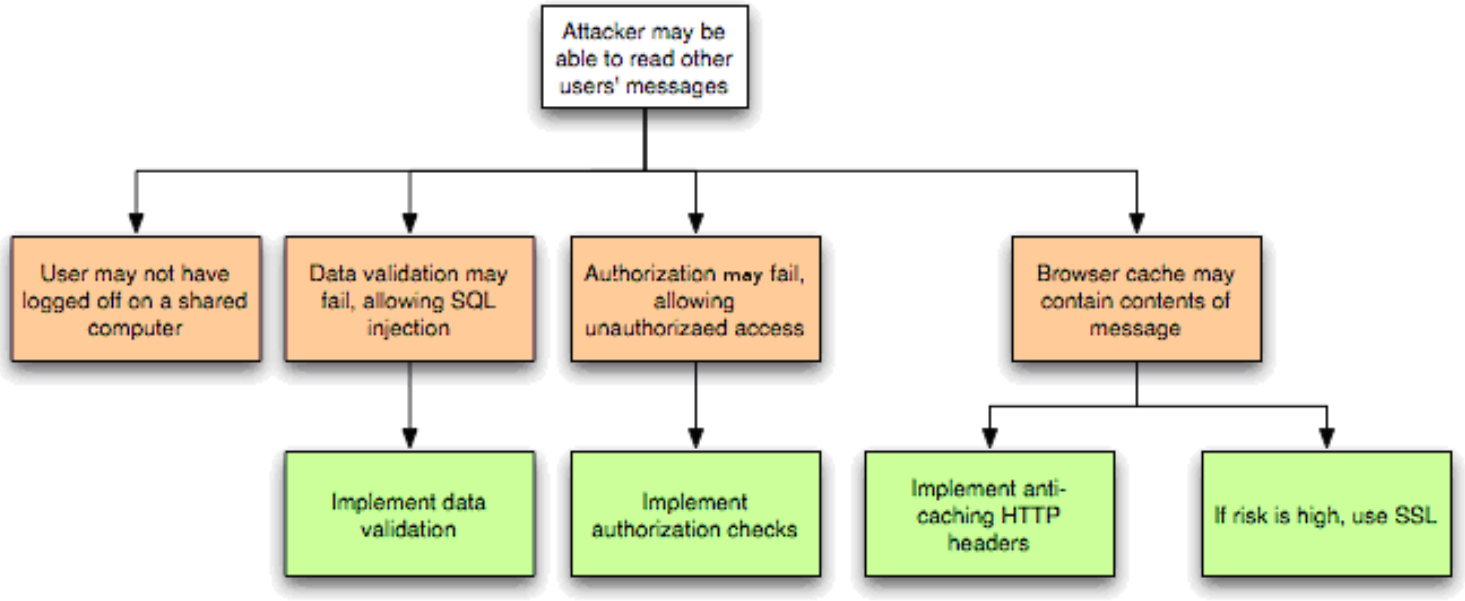
- Anonymous user evades the authentication system
- Anonymous user gathers information from the authentication system
- Anonymous user can forcefully browse to pages
- Librarian has access to web site pages on the server
- Student or Staff can modify privilege level
- Student or Staff can forcefully browse to restricted pages
- Any user can tamper with critical data on the client
- Student/Staff/Anonymous can inject SQL into the database
- Student/Staff/Anonymous can inject JavaScript into an HTML page
- SSL version is vulnerable or allows vulnerable algorithms
- …..

13. Threats – continued

- OWASP does this differently
  - First they talk about STRIDE, but they don't follow through with a list of threats
  - It is fine to use STRIDE and think about every place where Spoofing, Tampering, …. can be used
  - You need a very complete list, but you can combine threats that are common
- Understand the threats
  - There are tools to help: Threat Trees and Abuse Cases

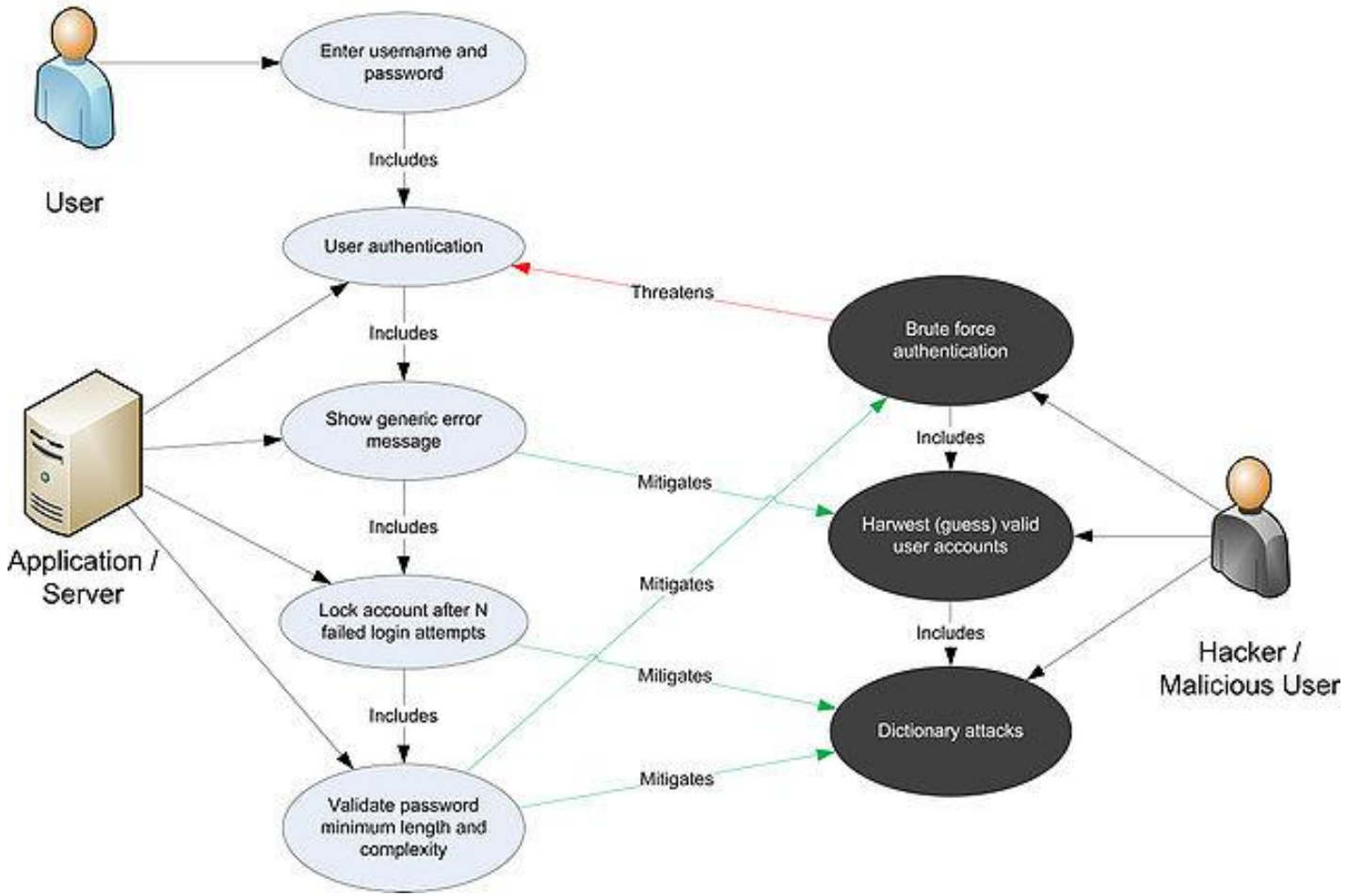
Threat Modeling Example

- Threat Tree



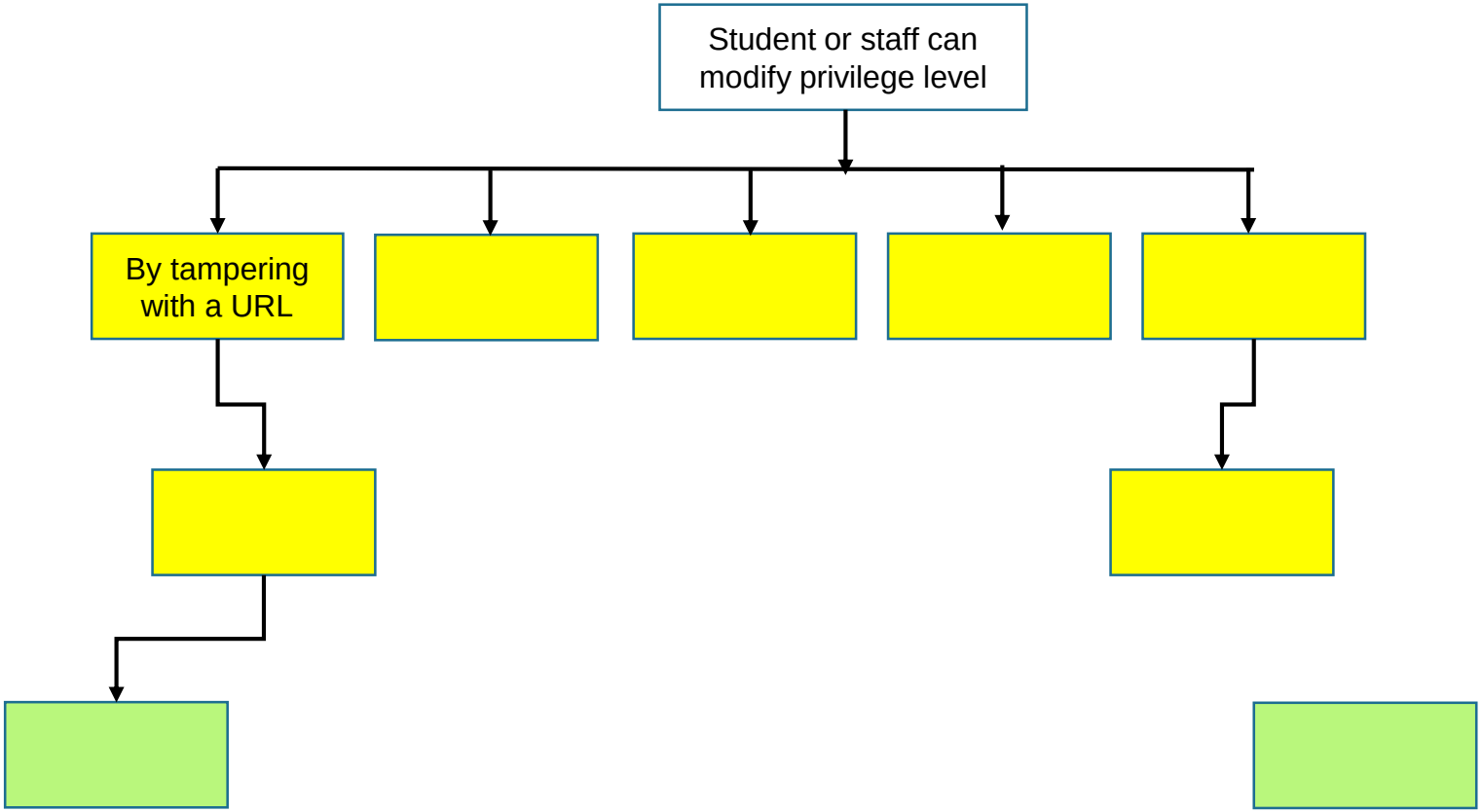
Threat Modeling Example

- Abuse Case



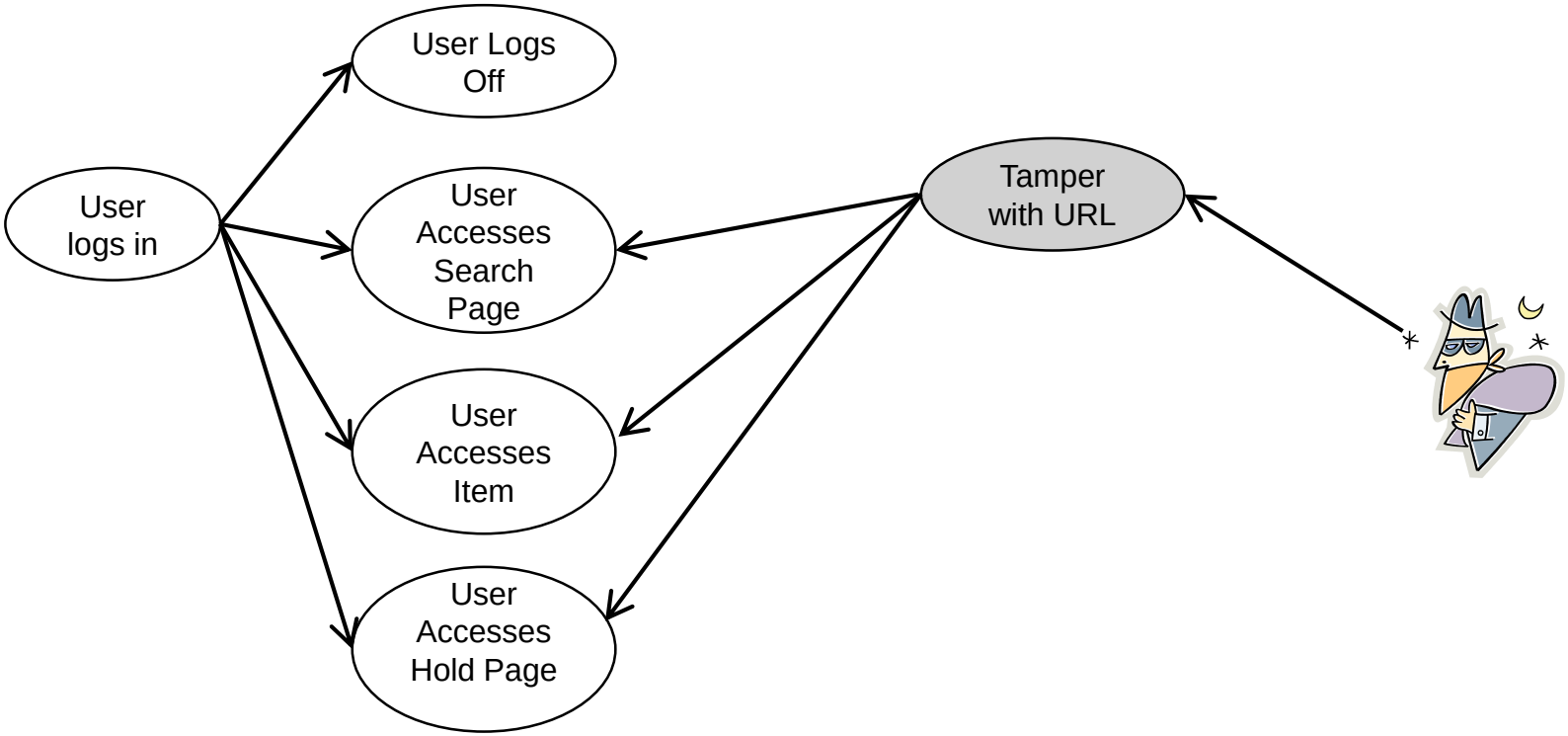
Threat Modeling Example

- Threat Tree



Threat Modeling Example

- Abuse Case: Student or staff can elevate privilege level



Threat Modeling Example

15. Plan your mitigations

- OWASP uses the following categories
  - Authentication
    - All credentialed users require user name and password required for authentication
    - All pages check authentication
    - All credentials communicated only with secure channel
    - No backdoor accounts or default accounts can be left available
  - Authorization
    - Use role-based authentication with unlimited levels, but including anonymous, user, staff, librarian, admin
    - All accesses will use least privilege and fail securely
  - Cookie Management
  - Data/Input Validation
  - Error Handling
  - Logging/Auditing
  - Cryptography
  - Secure Code Environment
  - Session Management

Threat Modeling Example

- Threat Modeling is over; continue with the remainder of the Design process