Architectural Design Patterns for SSO (Single Sign On) Design and Use Cases for Financial Web Applications

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Presentation outline

- The needs/challenges for securing SSO architectures in financial web applications
- Secure SSO design patterns
- Security consideration and risk for SSO design
- Secure architecture principles
- Architectural diagrams
- Data flow diagrams
- Sequence diagrams
- Threat models of SSO architectures
- Attack trees and misuse cases
- Security risk framework for secure design of SSO architectures

Single Sign On (SSO) needs for financial web systems

- Different systems serving different functions
  - ATM cash withdraw
  - Branch deposit
  - Monthly statements
  - Make a payment with a check
  - Wire transfer
- Different systems have different type of user's information
  - Personal and sensitive information
  - Financial transactions
  - Bank statements
- Different business features are available for each system
  - Saving/checking accounts
  - Credit card accounts
  - Mortgage applications or loans
  - Cash rewards
  - Mileage rewards

Requirements for SSO

- User friendly is the key
- Single view is the goal
- Eliminate additional sign on is the approach
- Security is the foundation

SSO Use Case

- User can sign on site A to do function B about product C
- User can sign on site X to do function Y about product Z.
- For users with both product C and Z, user should be able to sign on from Site A to access function B and function Y without additional authentication.
- Site X will not be sunset to support users with only product Z.

Design options for SSO

- Duplicate function Y on site A and access information on site X
  - Pros:
    - Make it possible to sunset site X
  - Cons:
    - Introduce duplicated function on two sites
    - Needs to maintain the function and processing rules on two sites.
- Build SSO for user to access function Y on site X
  - Pros:
    - No need to maintain two sets of function and processing rules on two sites
    - Enable the possibility to fully leverage functions on site X
  - Cons:
    - Make site A depends on site X
    - Introduce security complexity:
      - Authentication
      - Authorization
      - Session coordination
      - UI

SSO Design Patterns

- Ad-hoc Encrypted Token:

  Use symmetric and public key cryptography to encrypt the application data that used for SSO

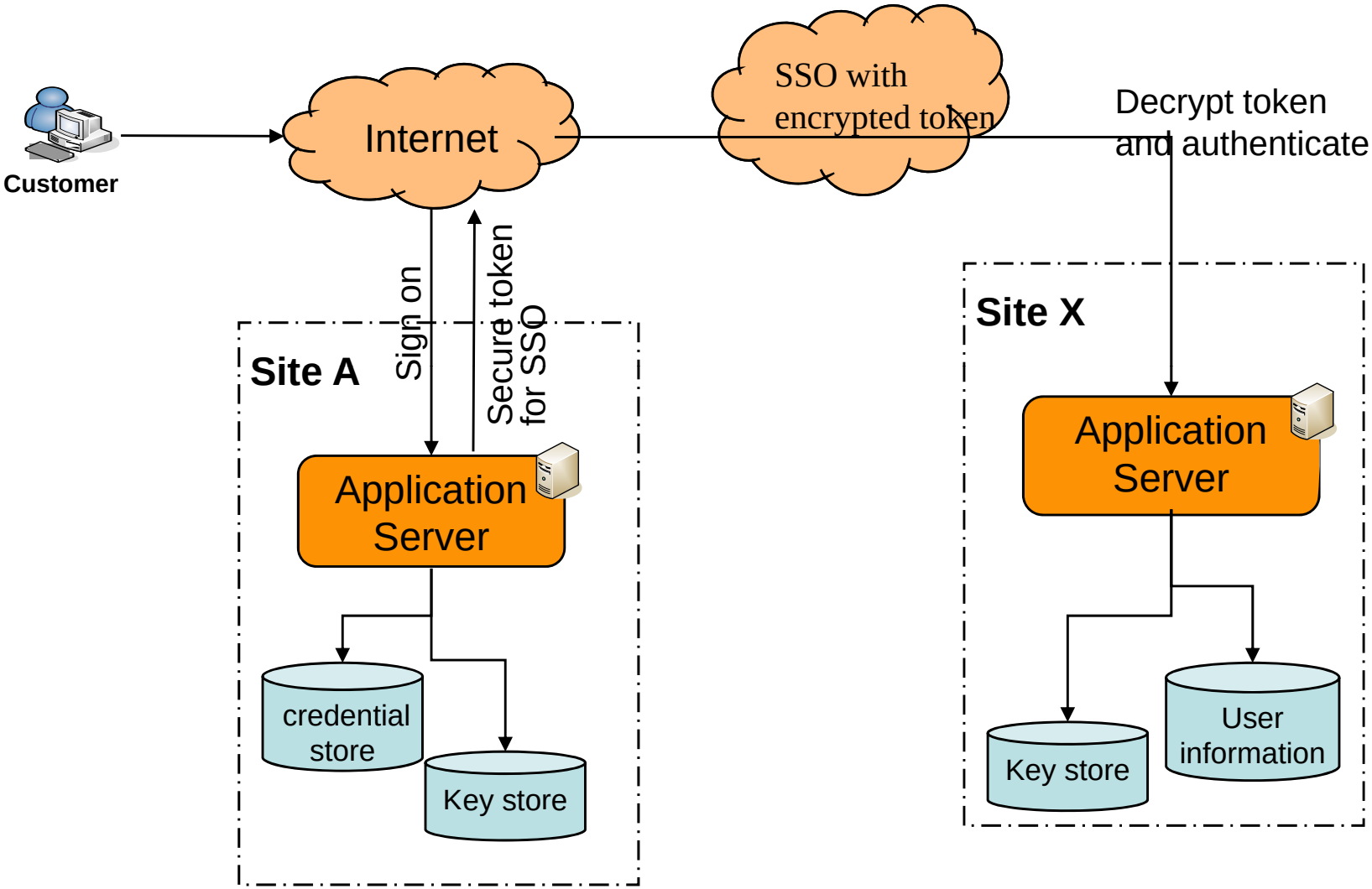
- Standard Secure Token Service (STS):

  Central Security Token Service to respond with standard SAML token that supports federation across different sites upon request.

SSO – Ad-Hoc Encrypted Token

- Pros:
  - Easy to set up and implement
  - Supports PKI and SAML
  - No dependency on other system.
- Cons:
  - Not a unified solution
  - Each federated site has to manage cryptographic key

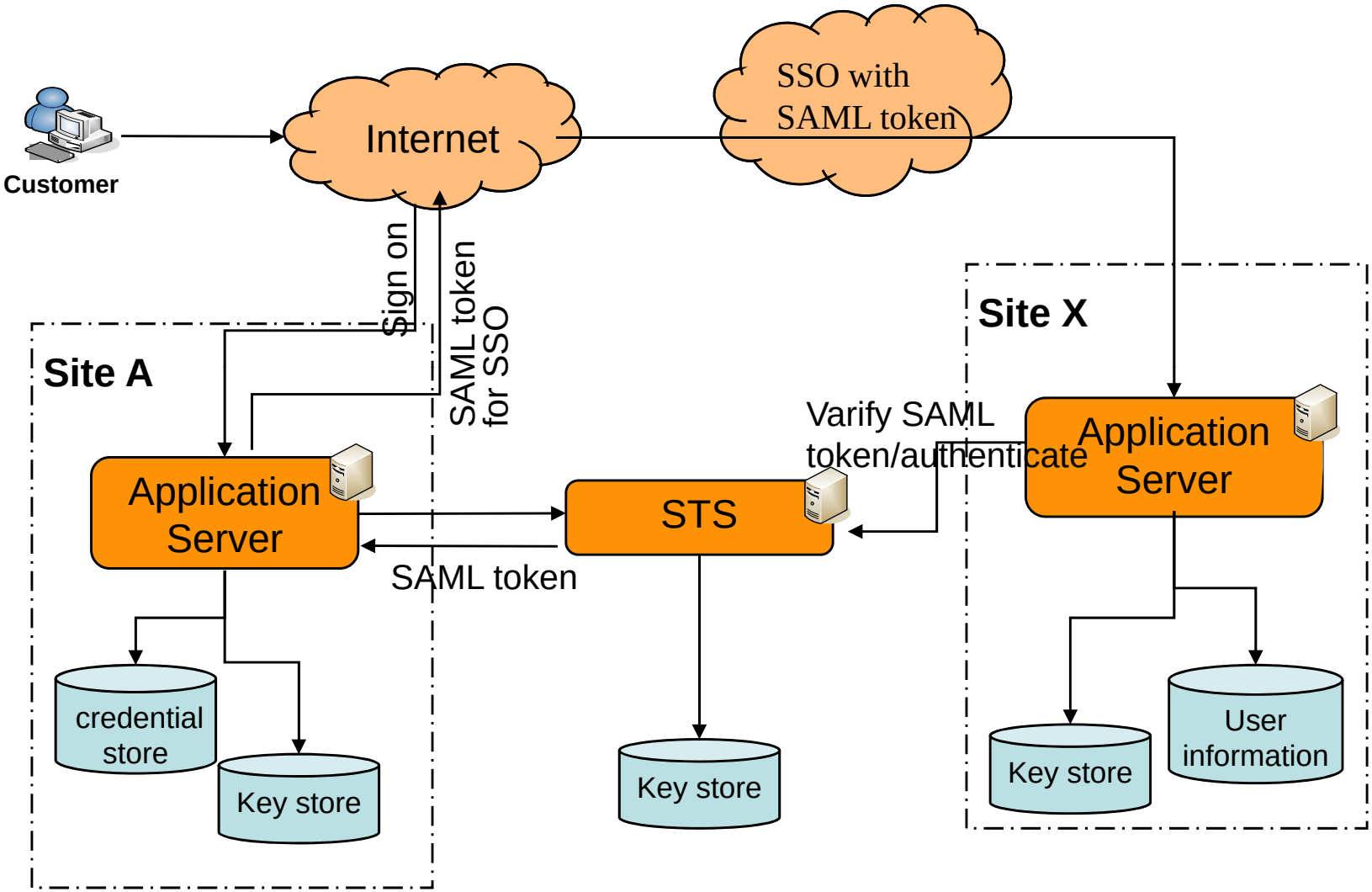
SSO – Ad-hoc encrypted token



SSO – STS

- Pros:
  - Drives to unified solution for both internal and external communication.
  - Centralized cryptographic key management approach.
  - Supports SAML and SOAP
- Cons:
  - Introduces dependences on STS for federated sites
  - Introduces additional internet hop for communication

SSO – STS


Customer
Internet
SSO with
SAML token
Sign on
SAML token
for SSO
Site A
Site X
Application
Server
STS
Varify SAML
token/authenticate
Application
Server
SAML token
credential
store
Key store
Key store
Key store
User
information

SSO design and security considerations

- Secure authentication and authorization
  - Ad-hoc encrypted token
  - STS
- Secure session management: one dies, both die
  - Session initiation
  - Session termination
  - Session recovery
  - Keep alive
- Secure web page wrapping: look and feel of the site
  - iFrames

Potential Security Issues with SSO Design

- In-Secure Session Management:
  - Sessions are not sync: one dies, one left open
  - Session Replay
  - Session Riding (CSRF)
  - Session hijacking
  - Sessions un-protected/in clear, cached, logged
- Malicious Data Injections:
  - XSS, SQL Injection
- Elevation of Privileges, Bypass of Authentication
  - Bypass authorizations
  - Forceful browsing

Secure Architecture Design

- General Security Design Principles
  1. Implement Authentication With Adequate Strength
  2. Enforce Least Privilege
  3. Protect Data In Storage, Transit And Display
  4. Enforce Minimal Trust
  5. Trace and Log User Actions And Security Events
  6. Fail Securely And Gracefully
  7. Apply Defense in Depth
  8. Apply Security By Default
  9. Design For Simplicity, KISS Principle
  10. Secure By Design, Development and Deployment
  11. Secure As The Weakest Link
  12. Avoid Security By Obscurity

Security Controls Design Guidelines: Authentication and Authorization

- Authentication, What, Where and How
  - Mandatory to restrict access to validated users
  - Strength depends on application risk/data classification
  - Compliant with regulations/standards
  - Provide for secure password and account management
  - Mitigates brute forcing and credentials harvesting
  - Mitigates Man In The Middle Attacks (MiTM)
  - Provides for user and host to host authentication
- Authorization Most Common Flaws
  - Flaws in Role Base Access Controls (RBAC)
  - Flaws allow for horizontal and vertical privilege escalation
  - Forceful browsing

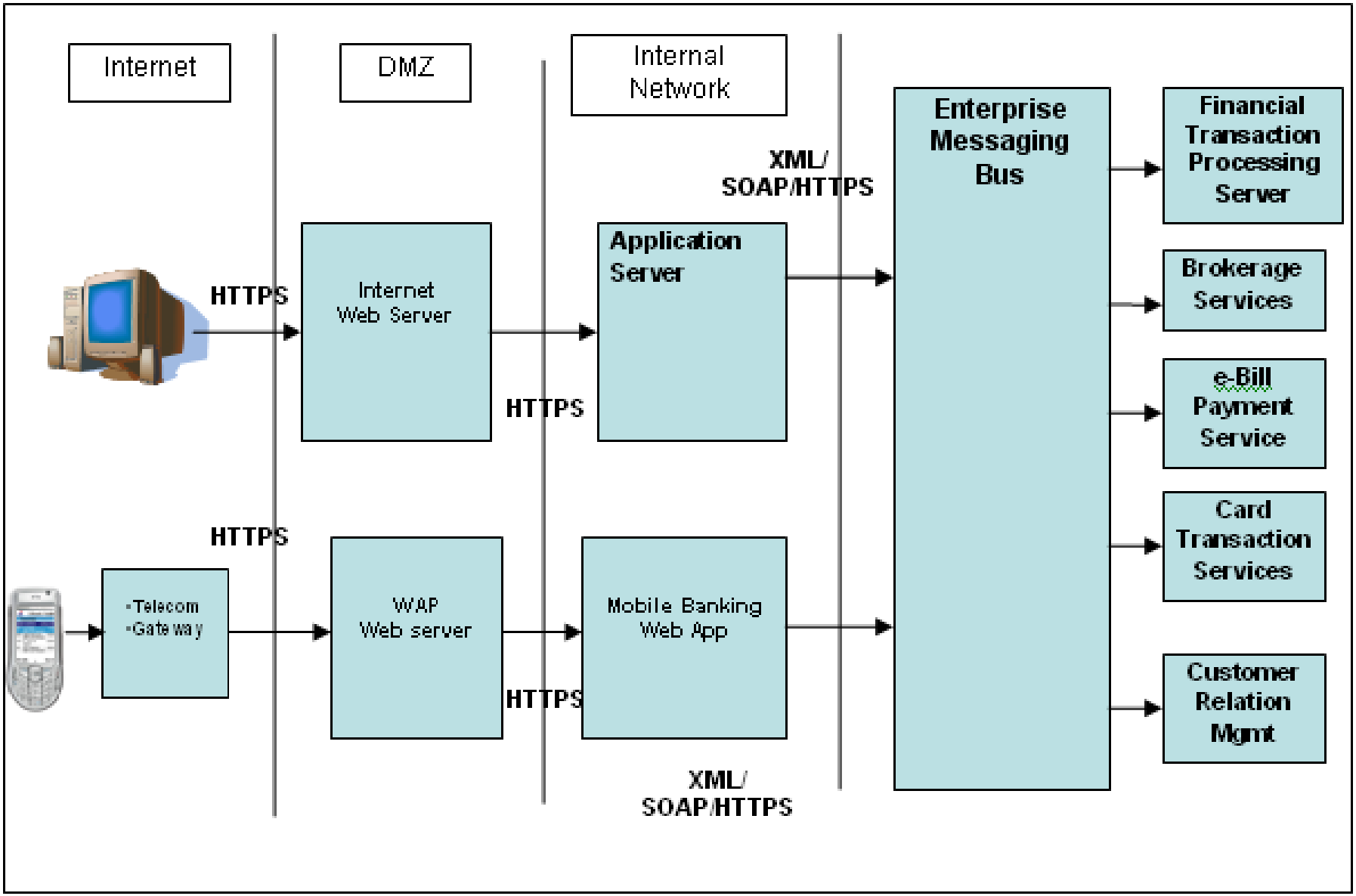
Security Controls Design Guidelines: Session Management

- Avoid common session management flaws:
  - Session cookies and authentication tokens unprotected (e.g. clear text) between client and server
  - Missing session invalidation at idle-time out and user logout
  - Missing re-issuance of new session token to prevent re-use for authentication
  - Un-secure storage in a session store in clear text
  - Lack of strong random generation of session cookies/identifiers (e.g. >128 bit)
  - Lack of coordinated session between application tiers

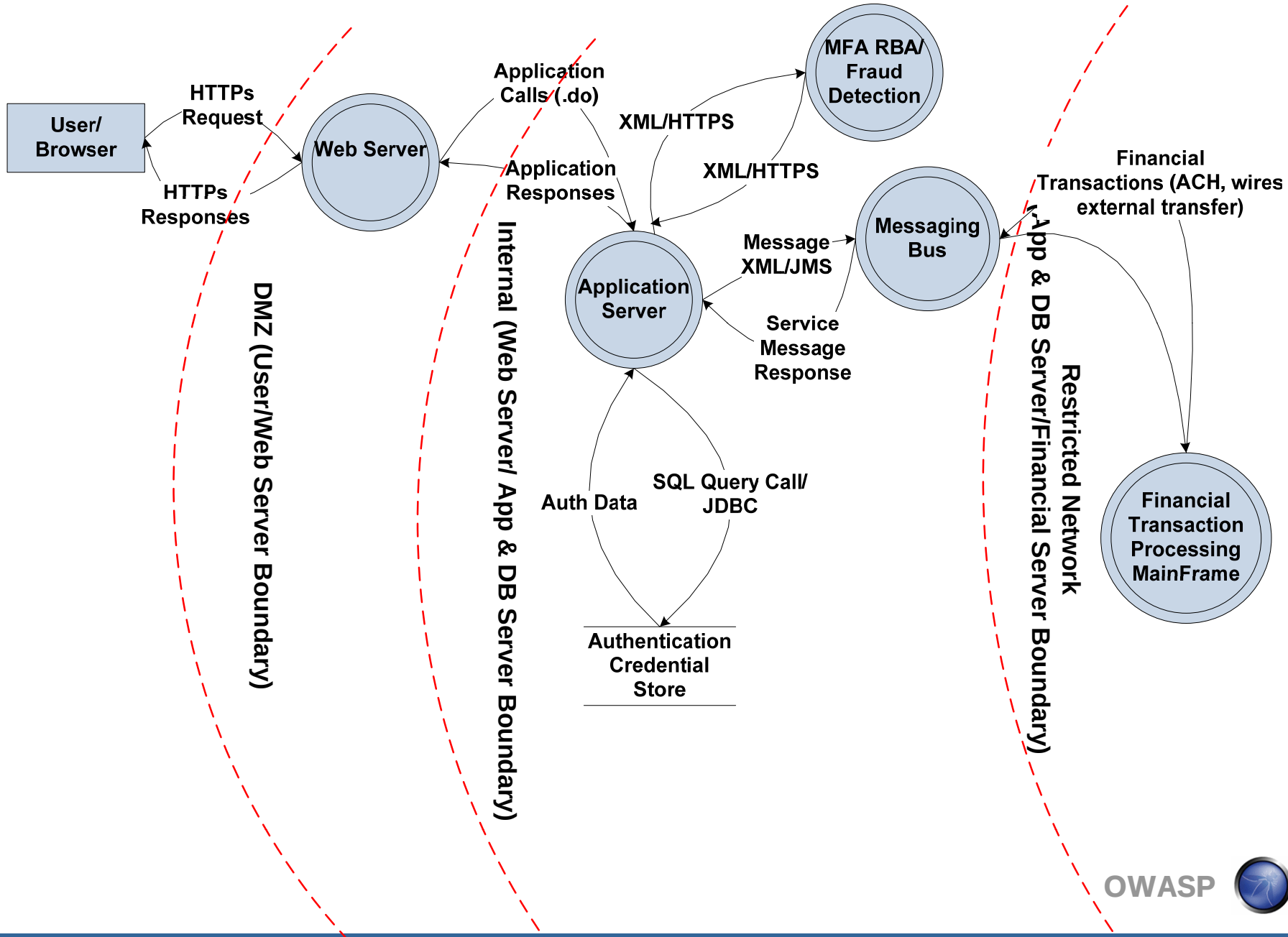
Security Controls Design Guidelines: Input Validation

- What and where to validate
  - Type, format, range and length of input data
  - Wherever data crosses system or trust boundaries
  - Input and output
  - Client validation vs. server validation
- How to validate
  - Constraint, Reject, Sanitize
  - Canonical Validation
  - Encoding
  - Integrity Checks

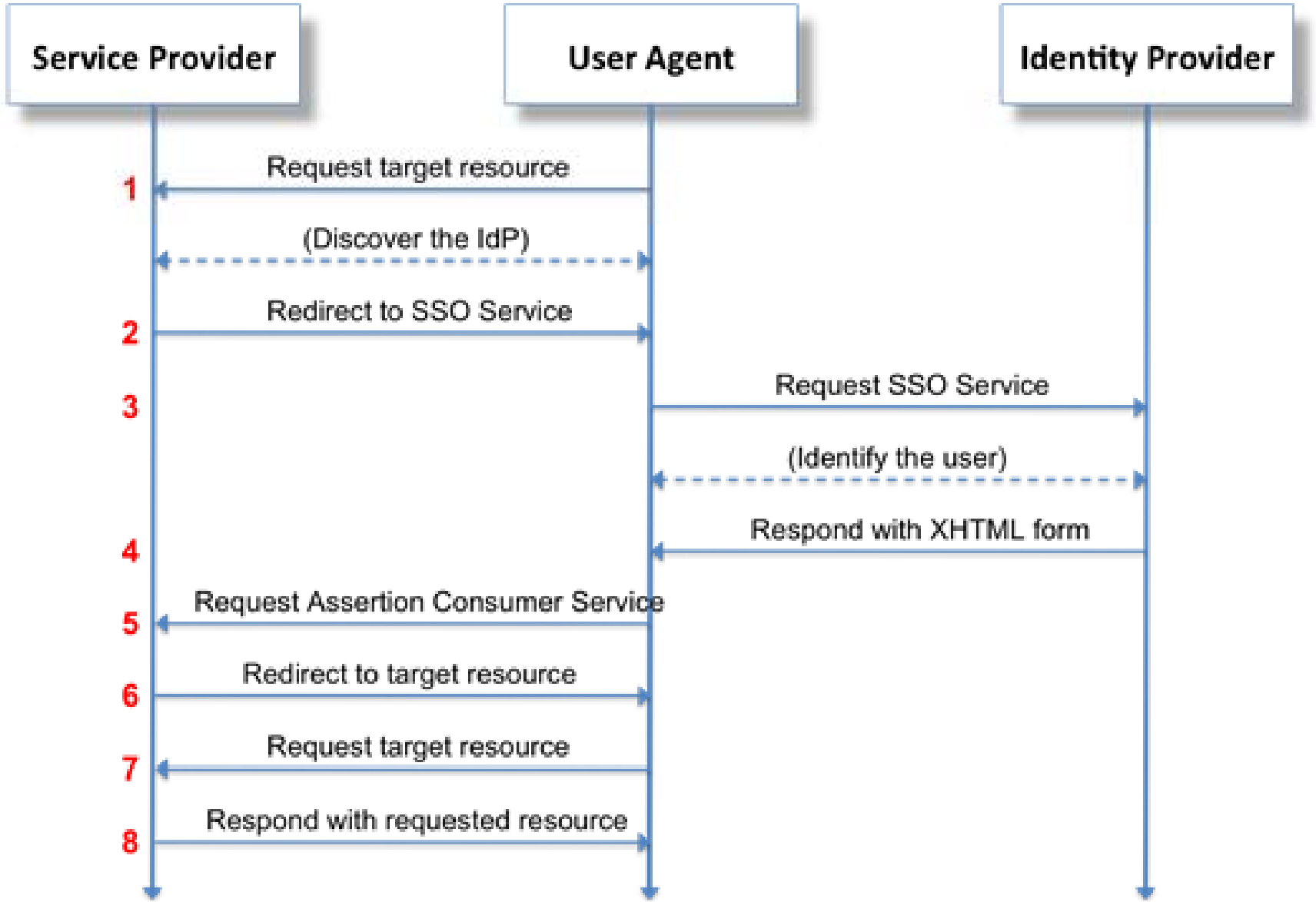
Architecture of Financial Web Applications



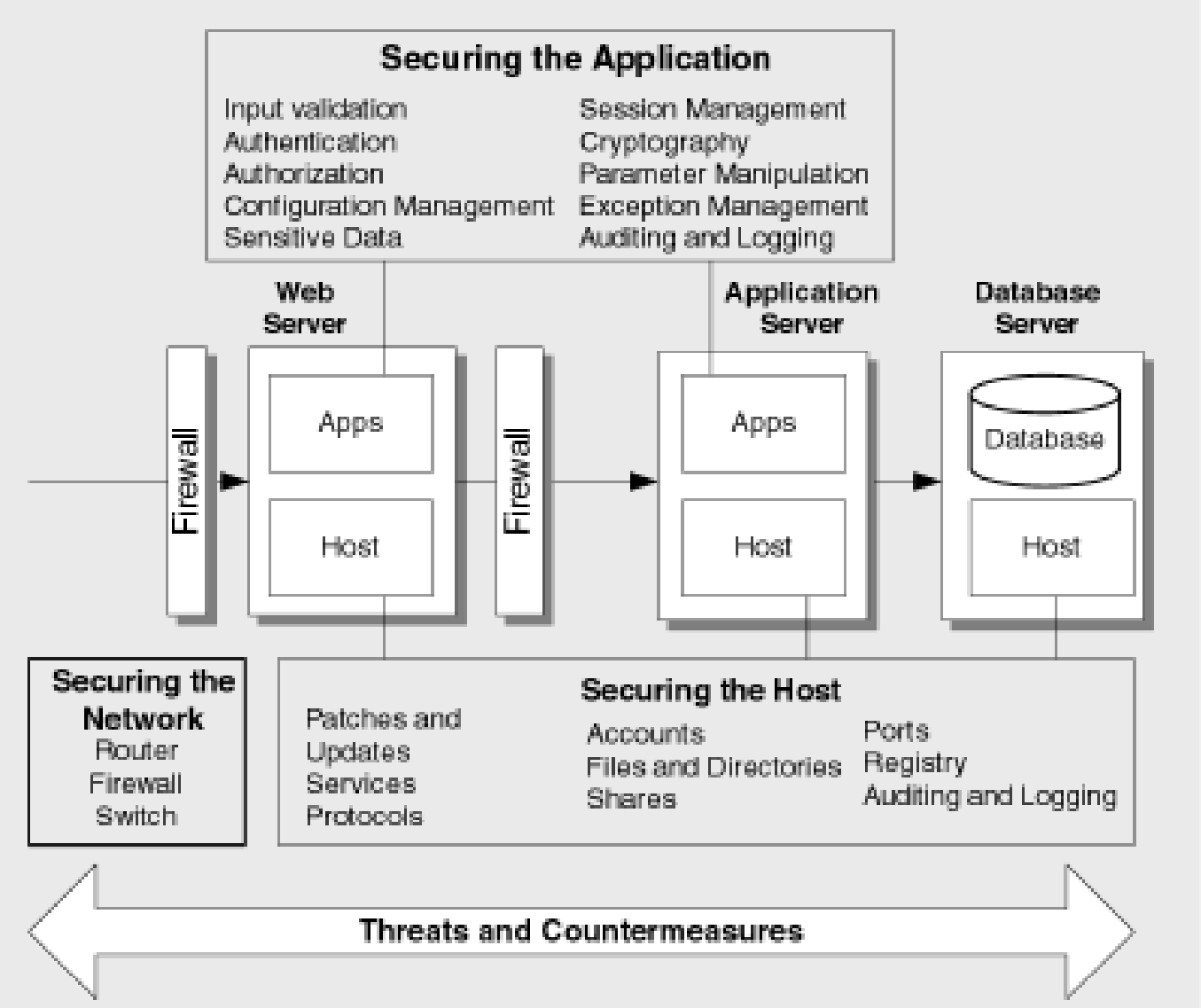
Data flow diagram-Online Banking Application



Sequence diagram of SAML SSO

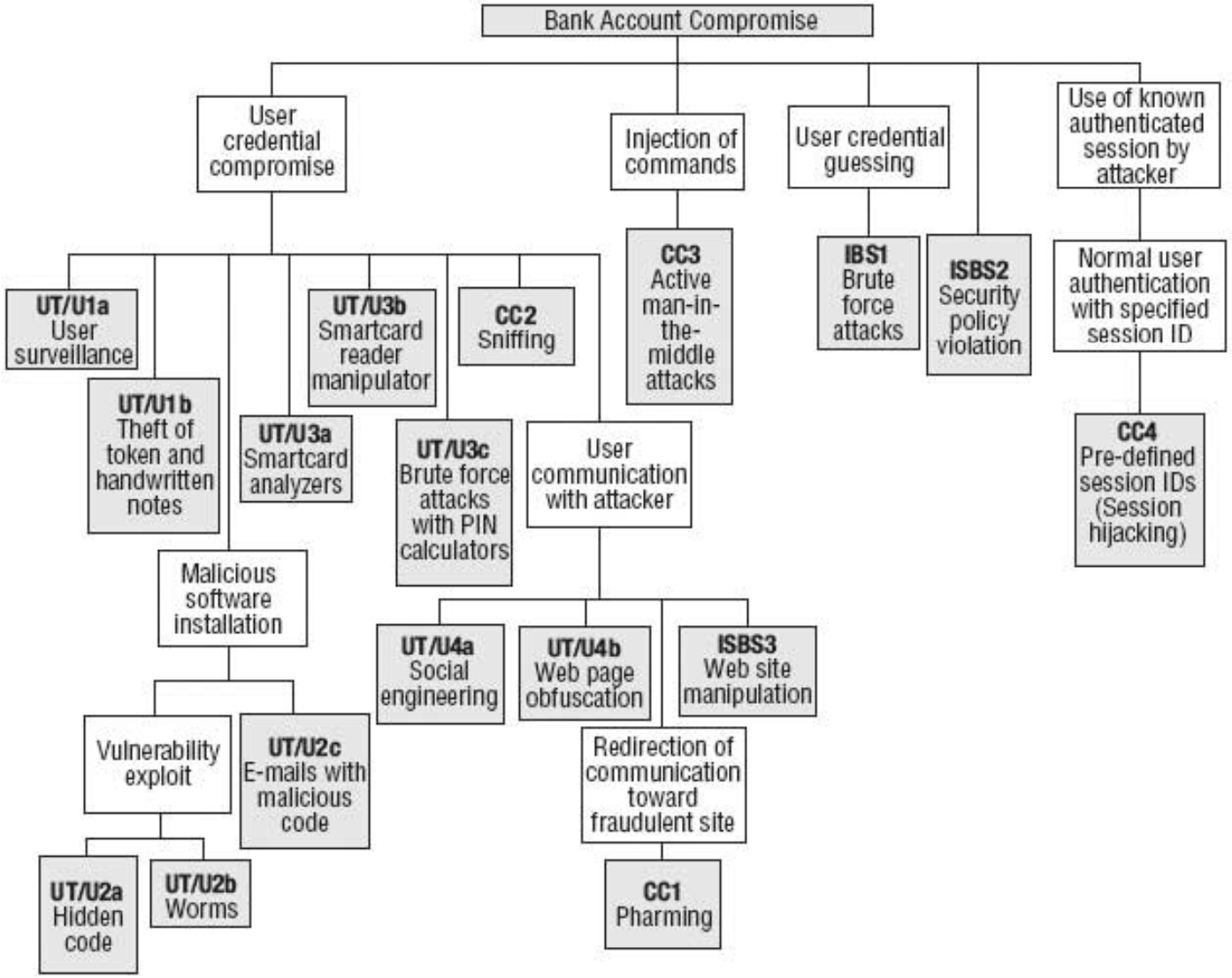


Threat Modeling Web Applications



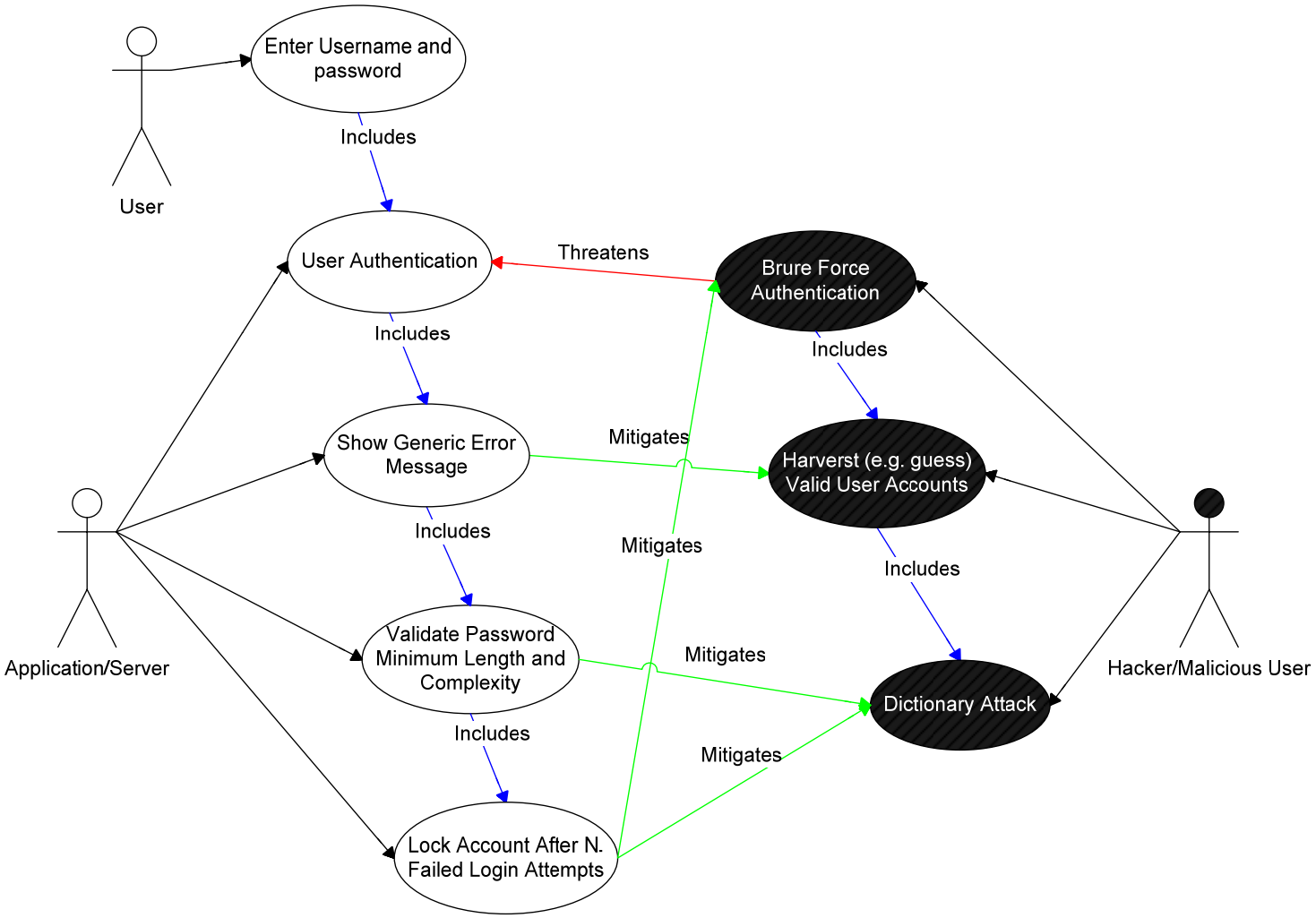
From Improving Web Application Security: Threats and Countermeasures http://msdn.microsoft.com/en-us/library/ms994921.aspx

Attack Trees-Online Banking Applications



Analyzing the Security of Internet Banking Authentication Mechanisms :
http://www.itgi.org/Template.cfm?Section=Home&CONTENTID=35743&TEMPLATE=/ContentManagement/ContentDisplay.cfm

Use and Misuse Case of Authentication



From OWASP Security Testing Guide
https://www.owasp.org/index.php/Testing_Guide_Introduction#Security_Requirements_Test_Derivation

Security risk framework for secure design of SSO architectures

Threat Agents	Misuses and Attack Vectors	Security Weaknesses	Security Controls/ Countermeasures	Technical Impacts	Business Impacts
Users, Customers/ Employees	User logs out from one application and forget to log out to another application that SSOs into it	Inherent weaknesses in synchronizing sessions among applications	Single Logout Among Applications, Keep-alives	Loss of sensitive/confidential data	Reputation loss. Unlawful compliance fines
Malicious Users, Fraudsters	Victim is targeted by phishing, download of malware	Social Engineering, Web Application Vulnerabilities, XSS	Consumer Education, Data Filtering, escape all un-trusted data based on HTML content	Execute JS on client, install malware	Fraud, financial losses, reputation loss/defacements
Malicious Users, Fraudsters	Attacker sends malicious data to the application	Input Validation Vulnerabilities: XSS, SQL Injection	Filtering, parameterized API, ESAPI filtering APIs, white-list validations	Loss of data, data alteration, denial of service/access	Public disclosure of vulnerability Reputation damage
Malicious Users, Fraudsters	Attacker target design flaws in the SSO/authentication or session management functions	Weak Auth and Session Mgmt Vulnerabilities	Follow Security Requirements For Secure Password Policies, Implement Account Locking, Disable “Auto-logons”	Unauthorized access to data, functions	Legal and financial implications
Fraudsters	Attacker creates forged HTTP requests and tricks a victim into submitting them	Cross Site Request Forgery Vulnerabilities	Include the unique token in a hidden field.	Can change data and functions on behalf of the user	Fraud, revenue loss because of denial of access
Automated Scripts/ Spam Bots	Attacker uses a bot/script to attack the application for denial of service and harvesting	Insufficient Anti-Automation protection	Include CAPTCHA, ESAPI intrusion detection APIs	Can overflow/deny service to process spam data, harvest accounts./data	Loss due to business Disruptions/losses, reputational damage

References

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  https://spaces.internet2.edu/display/OpenSAML/Home
- ESAPI:
  https://www.owasp.org/index.php/Category:OWASP_Enterprise_Security_API
- Improving Web Application Security: Threats and Countermeasures
  http://msdn.microsoft.com/en-us/library/ms994921.aspx
- Analyzing the Security of Internet Banking Authentication Mechanisms
  http://www.itgi.org/Template.cfm?Section=Home&CONTENTID=35743&TEMPLATE=/ContentManagement/ContentDisplay.cfm
- OWASP Security Testing Guide
  https://www.owasp.org/index.php/Testing_Guide_Introduction#Security_Requirements_Test_Derivation

THANK YOU!

- **Q&A**

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