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Understanding How They Attack Your Weaknesses: CAPEC

Robert A. Martin
Sean Barnum

May 2011

Homeland Security

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
MAY 2011		**00-00-2011 to 00-00-2011**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Understanding How They Attack Your Weaknesses: CAPEC	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **The MITRE Corporation,202 Burlington Road,Bedford,MA,01730-1420**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
Presented at the 23rd Systems and Software Technology Conference (SSTC), 16-19 May 2011, Salt Lake City, UT. Sponsored in part by the USAF. U.S. Government or Federal Rights License

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**21**	

Agenda

8:00-8:45am	Software Security Knowledge about Applications Weaknesses
9:00-9:45am	Software Security Knowledge about Attack Patterns Against Applications
	Training in Software Security
10:15-11:00am	Software Security Practice
11:15-12:00am	Supporting Capabilities
	Assurance Cases
	Secure Development & Secure Operations

The Long-established Principal of "Know Your Enemy"

- "One who knows the enemy and knows himself will not be endangered in a hundred engagements. One who does not know the enemy but knows himself will sometimes be victorious. Sometimes meet with defeat. One who knows neither the enemy nor himself will invariably be defeated in every engagement."

- Chapter 3: "Planning the Attack"
  - The Art of War, Sun Tzu

The Importance of Knowing Your Enemy

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- **An appropriate defense can only be established if you know how it will be attacked**

- **Remember!**
  - Software Assurance must assume motivated attackers and not simply passive quality issues
  - Attackers are very creative and have powerful tools at their disposal
  - Exploring the attacker's perspective helps to identify and qualify the risk profile of the software

What are Attack Patterns?

- **Blueprint for creating a specific type of attack**
- **Abstracted common attack approaches from the set of known exploits**
- **Capture the attacker's perspective to aid software developers, acquirers and operators in improving the assurance profile of their software**

Leveraging Attack Patterns Throughout the Software Lifecycle

- Guide definition of appropriate policies
- Guide creation of appropriate security requirements (positive and negative)
- Provide context for architectural risk analysis
- Guide risk-driven secure code review
- Provide context for appropriate security testing
- Provide a bridge between secure development and secure operations

Common Attack Pattern Enumeration and Classification (CAPEC)

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- **Community effort targeted at:**
  - Standardizing the capture and description of attack patterns
  - Collecting known attack patterns into an integrated enumeration that can be consistently and effectively leveraged by the community
  - Gives you an attacker's perspective you may not have on your own

- **Excellent resource for many key activities**
  - Abuse Case development
  - Architecture attack resistance analysis
  - Risk-based security/Red team penetration testing
  - Whitebox and Blackbox testing correlation
  - Operational observation and correlation

- **Where is CAPEC today?**
  - http://capec.mitre.org
  - Currently 386 patterns, stubs, named attacks


CAPEC – Common Attack Pattern Enumeration and Classification (CAPEC)
http://capec.mitre.org/
Google
CAPEC Common Attack Pattern Enumeration and Classification
A Community Knowledge Resource for Building Secure Software
Search by ID:
Go
CAPEC List
Full CAPEC Dictionary
Methods of Attack View
Reports
About CAPEC
Documents
Resources
Community
Related Activities
Collaboration List
News & Events
Calendar
Free Newsletter
Contact Us
Search the Site
Building software with an adequate level of security assurance for its mission becomes more and more challenging every day as the size, complexity, and tempo of software creation increases and the number and the skill level of attackers continues to grow. These factors each exacerbate the issue that, to build secure software, builders must ensure that they have protected every relevant potential vulnerability; yet, to attack software, attackers often have to find and exploit only a single exposed vulnerability. To identify and mitigate relevant vulnerabilities in software, the development community needs more than just good software engineering and analytical practices, a solid grasp of software security features, and a powerful set of tools. All of these things are necessary but not sufficient. To be effective, the community needs to think outside of the box and to have a firm grasp of the attacker's perspective and the approaches used to exploit software.
Attack patterns are a powerful mechanism to capture and communicate the attacker's perspective. They are descriptions of common methods for exploiting software. They derive from the concept of design patterns applied in a destructive rather than constructive context and are generated from in-depth analysis of specific real-world exploit examples.
To assist in enhancing security throughout the software development lifecycle, and to support the needs of developers, testers and educators, the Common Attack Pattern Enumeration and Classification (CAPEC) is sponsored by the Department of Homeland Security as part of the Software Assurance strategic initiative of the National Cyber Security Division. The objective of this effort is to provide a publicly available catalog of attack patterns along with a comprehensive schema and classification taxonomy. This site now contains the initial set of content and will continue to evolve with public participation and contributions to form a standard mechanism for identifying, collecting, refining, and sharing attack patterns among the software community.
Release 1.6 Available
Page Last Updated: February 07, 2011
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What do Attack Patterns Look Like?

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- **Primary Schema Elements**
  - Identifying Information
    - Attack Pattern ID
    - Attack Pattern Name
  - Describing Information
    - Description
    - Related Weaknesses
    - Related Vulnerabilities
    - Method of Attack
    - Examples-Instances
    - References
  - Prescribing Information
    - Solutions and Mitigations
  - Scoping and Delimiting Information
    - Typical Severity
    - Typical Likelihood of Exploit
    - Attack Prerequisites
    - Attacker Skill or Knowledge Required
    - Resources Required
    - Attack Motivation-Consequences
    - Context Description

- **Supporting Schema Elements**
  - **Describing Information**
    - Injection Vector
    - Payload
    - Activation Zone
    - Payload Activation Impact
  - **Diagnosing Information**
    - Probing Techniques
    - Indicators-Warnings of Attack
    - Obfuscation Techniques
  - **Enhancing Information**
    - Related Attack Patterns
    - Relevant Security Requirements
    - Relevant Design Patterns
    - Relevant Security Patterns

Attack Pattern Description Schema Formalization

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Description

- **Summary**
- **Attack_Execution_Flow**
  - Attack_Phase[1..3] (Name(Explore, Experiment, Exploit))
    - **Attack_Step[1..*]**
      - **Attack_Step_Title**
      - **Attack_Step_Description**
      - **Attack_Step_Technique [0..*]**
        - **Attack_Step_Technique_Description**
        - **Leveraged_Attack_Patterns**
        - **Relevant_Attack_Surface_Elements**
        - **Observables[0..*]**
        - **Environments**
      - **Indicator[0..*] (ID, Type(Positive, Failure, Inconclusive))**
        - **Indicator_Description**
        - **Relevant_Attack_Surface_Elements**
        - **Environments**
      - **Outcome[0..*] (ID, Type(Success, Failure, Inconclusive))**
        - **Outcome_Description**
        - **Relevant_Attack_Surface_Elements**
        - **Observables[0..*]**
        - **Environments**
      - **Security Control[0..*] (ID, Type(Detective, Corrective, Preventative))**
        - **Security_Control_Description**
        - **Relevant_Attack_Surface_Elements**
        - **Observables[0..*]**
        - **Environments**
      - **Observables[0..*]**

Individual CAPEC Dictionary Definition (Release 1.2)

Blind SQL Injection

Attack Pattern ID 7

Pattern Abstraction: Detailed

Typical Severity High

Description

Summary

Blind SQL Injection results from an insufficient mitigation for SQL Injection. Although suppressing database error messages are considered best practice, the suppression alone is not sufficient to prevent SQL Injection. Blind SQL Injection is a form of SQL Injection that overcomes the lack of error messages. Without the error messages that facilitate SQL Injection, the attacker constructs input strings that probe the target through simple Boolean SQL expressions. The attacker can determine if the syntax and structure of the injection was successful based on whether the query was executed or not. Applied iteratively, the attacker determines how and where the target is vulnerable to SQL Injection.

In order to achieve this using Blind SQL Injection, an attacker:

For example, an attacker may try entering something like "username' AND 1=1; --" in an input field. If the result is the same as when the attacker entered "username" in the field, then the attacker knows that the application is vulnerable to SQL Injection. The attacker can then ask yes/no questions from the database server to extract information from it. For example, the attacker can extract table names from a database using the following types of queries:

"username' AND ascii(lower(substring((SELECT TOP 1 name FROM sysobjects WHERE xtype='U'), 1, 1))) > 108".

If the above query executes properly, then the attacker knows that the first character in a table name in the database is a letter between m and z. If it doesn't, then the attacker knows that the character must be between a and l (assuming of course that table names only contain alphabetic characters). By performing a binary search on all character positions, the attacker can determine all table names in the database. Subsequently, the attacker may execute an actual attack and send something like:

"username'; DROP TABLE trades; --

Complete CAPEC Entry Information

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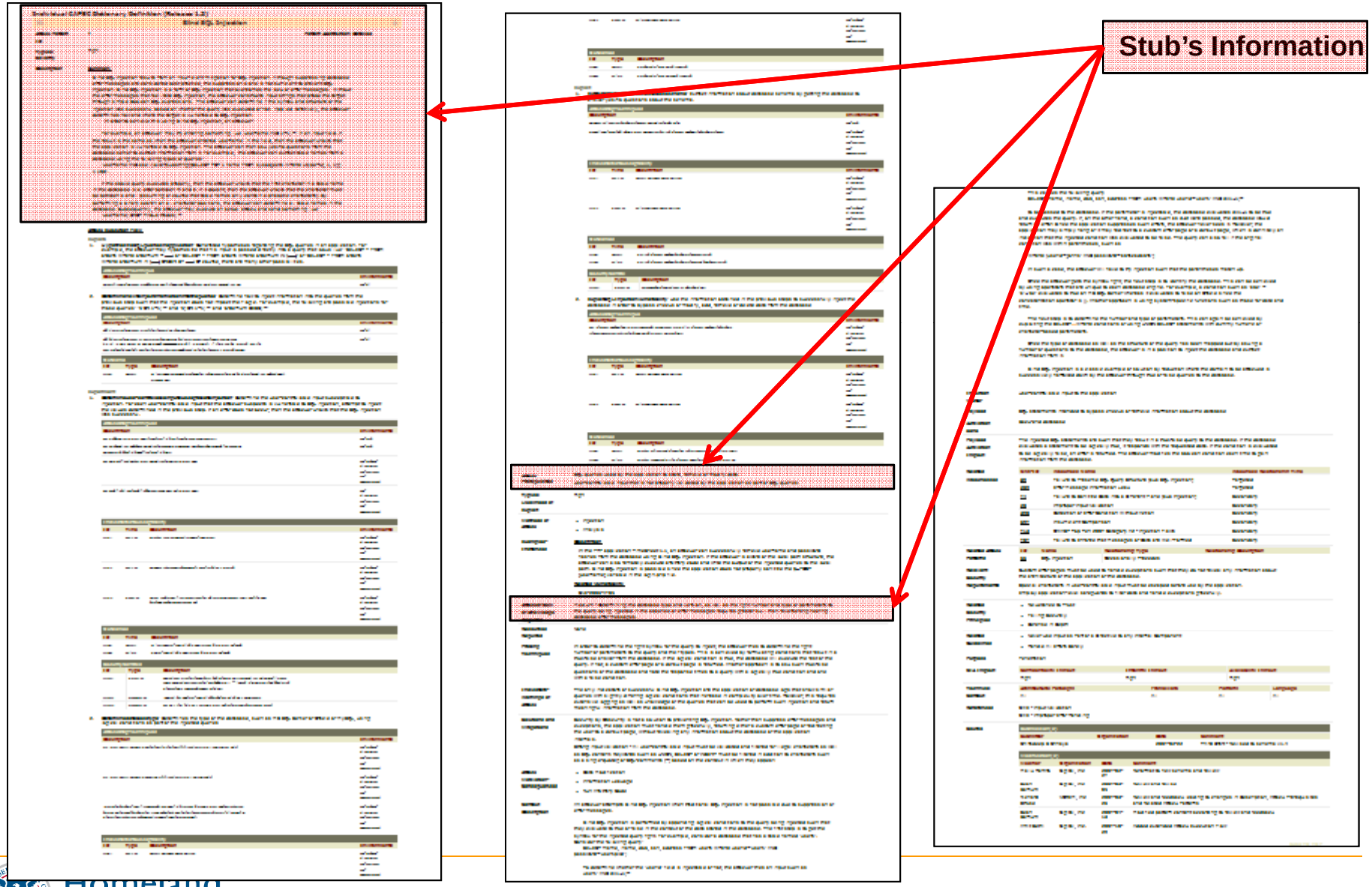

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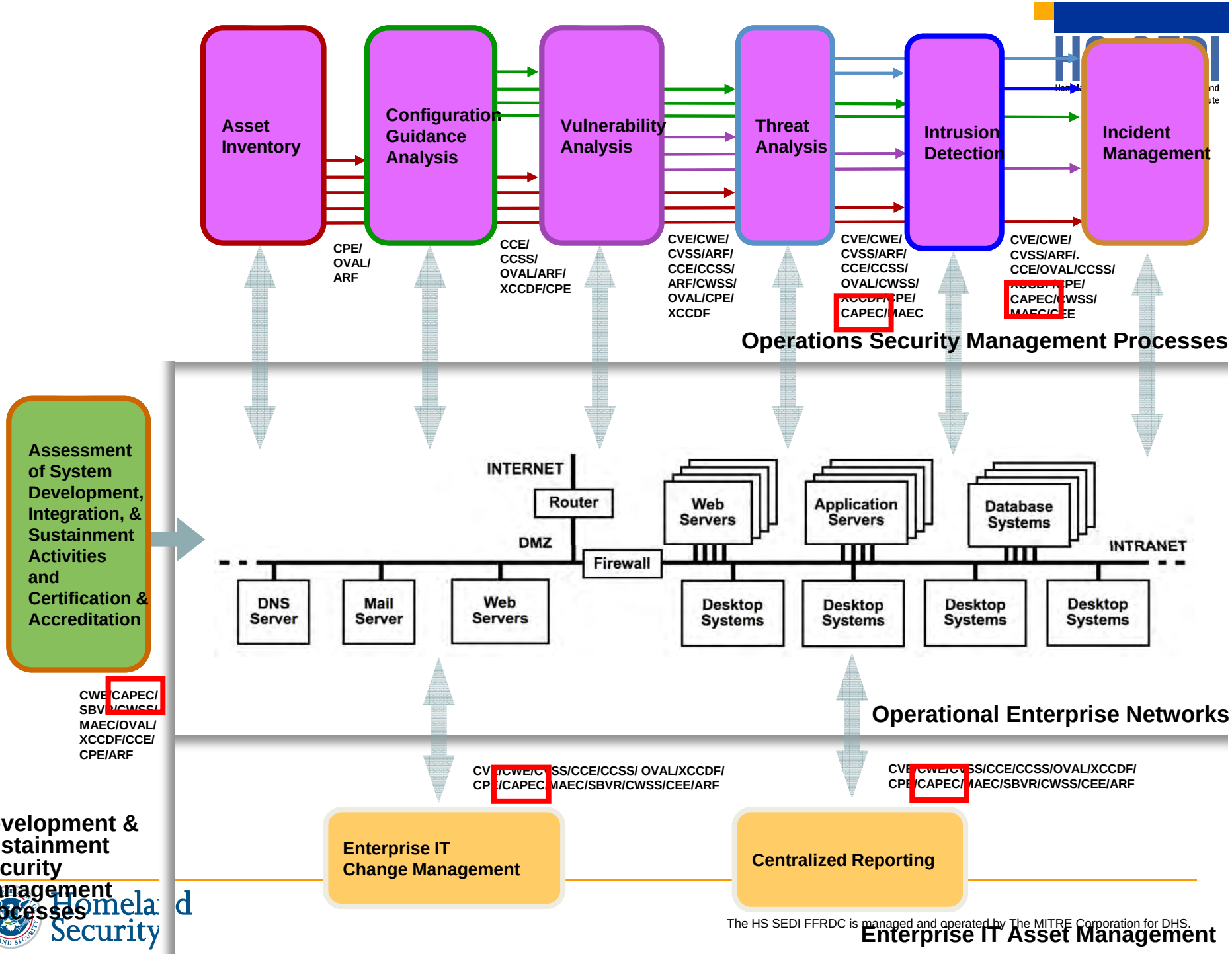
A Few Key Use Cases for CAPEC in Support of SwA

- Help developers understand weaknesses in their real-world context (how they will be attacked)
- Objectively identify specific attacks under which software must demonstrate resistance, tolerance and resilience for a given level of assurance
- Indirectly scope which weaknesses are relevant for a given threat environment
- Identify relevant mitigations that should be applied as part of policy, requirements, A&D, implementation, test, deployment and operations
- Identify and characterize patterns of attacks for security test case generation
- Identify and characterize threat TTPs for red teaming
- Identify relevant issues for automated tool selection
- Identify and characterize issues for automated tool results analysis


Asset Inventory
Configuration Guidance Analysis
Vulnerability Analysis
Threat Analysis
Intrusion Detection
Incident Management
CPE/ OVAL/ ARF
CCE/ CCSS/ OVAL/ARF/ XCCDF/CPE
CVE/CWE/ CVSS/ARF/ CCE/CCSS/ ARF/CWSS/ OVAL/CPE/ XCCDF
CVE/CWE/ CVSS/ARF/ CCE/CCSS/ OVAL/CWSS/ XCCDF/CPE/ CAPEC/MAEC
CVE/CWE/ CVSS/ARF/. CCE/OVAL/CCSS/ XCCDF/CPE/ CAPEC/CWSS/ MAEC/CEE
Operations Security Management Processes
Assessment of System Development, Integration, & Sustainment Activities and Certification & Accreditation
INTERNET
Router
DMZ
Firewall
Web Servers
Application Servers
Database Systems
INTRANET
DNS Server
Mail Server
Web Servers
Desktop Systems
Desktop Systems
Desktop Systems
Desktop Systems
CWE/CAPEC/ SBVR/CWSS/ MAEC/OVAL/ XCCDF/CCE/ CPE/ARF
Operational Enterprise Networks
CVE/CWE/CCSS/CCE/CCSS/ OVAL/XCCDF/ CPE/CAPEC/MAEC/SBVR/CWSS/CEE/ARF
CVE/CWE/CCSS/CCE/CCSS/OVAL/XCCDF/ CPE/CAPEC/MAEC/SBVR/CWSS/CEE/ARF
Development & Sustainment Security Management Processes
Enterprise IT Change Management
Centralized Reporting
Enterprise IT Asset Management

CAPEC Status

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Where is CAPEC today?

- **V1.4**
  - Massive schema changes
    - Including addition of Observables structure
  - Some new content
  - Added initial set of network attack patterns
- **V1.5**
  - Added ~25 new network attack patterns
  - Added enhanced material to ~35 patterns
  - New View added for WASC Threat Taxonomy 2.0
  - Added ~65 mappings to CWE and several within CAPEC
- **V1.6**
  - Added 7 new application framework attack patterns as well as 68 new attack patterns in three new attack pattern categories: Physical Security Attacks, Social Engineering Attacks & Supply Chain Attacks
  - Added ~35 mappings to CWE and several within CAPEC

Currently 386 patterns, stubs, named attacks; 68 categories and 6 views

CAPEC Current Content
(15 Major Categories)

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1000 - Mechanism of Attack

- **Data Leakage Attacks - (118)**
- **Resource Depletion - (119)**
- **Injection (Injecting Control Plane content through the Data Plane) - (152)**
- **Spoofing - (156)**
- **Time and State Attacks - (172)**
- **Abuse of Functionality - (210)**
- **Exploitation of Authentication - (225)**
- **Probabilistic Techniques - (223)**
- **Exploitation of Privilege/Trust - (232)**
- **Data Structure Attacks - (255)**
- **Resource Manipulation - (262)**
- **Physical Security Attacks (436)**
- **Network Reconnaissance - *(286)***
- **Social Engineering Attacks (403)**
- **Supply Chain Attacks (437)**

CAPEC Current Content (Which Expand to…)

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- 1000 - Mechanism of Attack
  - Data Leakage Attacks - (118)
    - Data Excavation Attacks - (116)
    - Data Interception Attacks - (117)
  - Resource Depletion - (119)
    - Violating Implicit Assumptions Regarding XML Content (aka XML Denial of Service (XDoS)) - (82)
    - Resource Depletion through Flooding - (125)
    - Resource Depletion through Allocation - (130)
    - Resource Depletion through Leak - (131)
    - Denial of Service through Resource Depletion - (227)
  - Injection (Injecting Control Plane content through the Data Plane) - (152)
    - Remote Code Inclusion - (253)
    - Analog In-band Switching Signals (aka Blue Boxing) - (5)
    - SQL Injection - (66)
    - Email Injection - (134)
    - Format String Injection - (135)
    - LDAP Injection - (136)
    - Parameter Injection - (137)
    - Reflection Injection - (138)
    - Code Inclusion - (175)
    - Resource Injection - (240)
    - Script Injection - (242)
    - Command Injection - (248)
    - Character Injection - (249)
    - XML Injection - (250)
    - DTD Injection in a SOAP Message - (254)
  - Spoofing - (156)
    - Content Spoofing - (148)
    - Identity Spoofing (Impersonation) - (151)
    - Action Spoofing - (173)
  - Time and State Attacks - (172)
    - Forced Deadlock - (25)
    - Leveraging Race Conditions - (26)
    - Leveraging Time-of-Check and Time-of-Use (TOCTOU) Race Conditions - (29)
    - Manipulating User State - (74)
  - Abuse of Functionality - (210)
    - Functionality Misuse - (212)
    - Abuse of Communication Channels - (216)
    - Forceful Browsing - (87)
    - Passing Local Filenames to Functions That Expect a URL - (48)
    - Probing an Application Through Targeting its Error Reporting - (54)
    - WSDL Scanning - (95)
    - API Abuse/Misuse - (113)
    - Try All Common Application Switches and Options - (133)
    - Cache Poisoning - (141)
    - Software Integrity Attacks - (184)
    - Directory Traversal - (213)
    - Analytic Attacks - (281)
  - Probabilistic Techniques - (223)
    - Fuzzing - (28)
    - Manipulating Opaque Client-based Data Tokens - (39)
    - Brute Force - (112)
    - Screen Temporary Files for Sensitive Information - (155)
  - Exploitation of Authentication - (225)
    - Exploitation of Session Variables, Resource IDs and other Trusted Credentials - (21)
    - Authentication Abuse - (114)
    - Authentication Bypass - (115)
  - Exploitation of Privilege/Trust - (232)
    - Privilege Escalation - (233)
    - Exploiting Trust in Client (aka Make the Client Invisible) - (22)
    - Hijacking a Privileged Thread of Execution - (30)
    - Subvert Code-signing Facilities - (68)
    - Target Programs with Elevated Privileges - (69)
    - Exploitation of Authorization - (122)
    - Hijacking a privileged process - (234)
  - Data Structure Attacks - (255)
    - Accessing/Intercepting/Modifying HTTP Cookies - (31)
    - Buffer Attacks - (123)
    - Attack through Shared Data - (124)
    - Integer Attacks - (128)
    - Pointer Attack - (129)
  - Resource Manipulation - (262)
    - Accessing/Intercepting/Modifying HTTP Cookies - (31)
    - Input Data Manipulation - (153)
    - Resource Location Attacks - (154)
    - Infrastructure Manipulation - (161)
    - File Manipulation - (165)
    - Variable Manipulation - (171)
    - Configuration/Environment manipulation - (176)
    - Abuse of transaction data strutcture - (257)
    - Registry Manipulation - (269)
    - Schema Poisoning - (271)
    - Protocol Manipulation - (272)
  - Network Reconnaissance - (286)
    - ICMP Echo Request Ping - (285)
    - TCP SYN Scan - (287)
    - ICMP Echo Request Ping - (288)
    - Infrastructure-based footprinting - (289)
    - Enumerate Mail Exchange (MX) Records - (290)
    - DNS Zone Transfers - (291)
    - Host Discovery - (292)
    - Traceroute Route Enumeration - (293)
    - ICMP Address Mask Request - (294)
    - ICMP Timestamp Request - (295)
    - ICMP Information Request - (296)
    - TCP ACK Ping - (297)
    - UDP Ping - (298)
    - TCP SYN Ping - (299)
    - Port Scanning - (300)
    - TCP Connect Scan - (301)
    - TCP FIN scan - (302)
    - TCP Xmas Scan - (303)
    - TCP Null Scan - (304)
    - TCP ACK Scan - (305)
    - TCP Window Scan - (306)
    - TCP RPC Scan - (307)
    - UDP Scan - (308)

CAPEC Current Content (386 Attacks…)

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Current Maturation Paths

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- Extend coverage of CAPEC
- Improve quality of CAPEC
- Expand the scope of CAPEC
- Bridge secure development with secure operations
- Improve integration with other standards (MAEC, CEE, etc.)
- Expand use of CAPEC

CAPEC Future Plans

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- **V1.7 (within the next month or two)**
  - **Will flesh out ~30-40 stub patterns to full patterns**
  - **Will include existing content that has been refined for quality & consistency**
  - **Will incorporate initial use of the Observables sub-schema**

- **Strategic focus for the near to mid-term will be on utilizing CAPEC as a bridge between secure development and secure operations**

- **Continue expanding and refining content**

- **Continue expanding outreach and supporting CAPEC use**

- **Establish initial compatibility program**

Questions?

sbarnum@mitre.org