Supporting *Secure Software Operations*

Robert A. Martin
Sean Barnum

May 2011

UNCLASSIFIED

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
Supporting Secure Software Operations	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) **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)**	**32**	

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

Secure Software Operations

- Where secure development use cases required foundational knowledge and ways to package it and understand it within a static context, Secure Software Operations requires situational awareness & interpretation of foundational knowledge within a dynamic context
- Considering that secure operations is a key element of overall software assurance we need ways to:
  - Bridge the secure development and secure operations domains
  - Improve the analysis, characterization, collection, discovery & knowledge sharing of malware
  - Combine elements of the ecosystem as practical applications to support secure software operations
- This portion of the tutorial will focus on resources/efforts focused at addressing these three needs

Secure Software Operations

- **Bridge the secure development and secure operations domains**
- **Improve the analysis, characterization, collection, discovery & knowledge sharing of malware**
- **Combine elements of the ecosystem as practical applications to support secure software operations**

Cyber Observable eXpression (CybOX)

Malware Attribute Enumeration & Characterization (MAEC)

Security Content Automation Protocol (SCAP) and other Automation Protocols

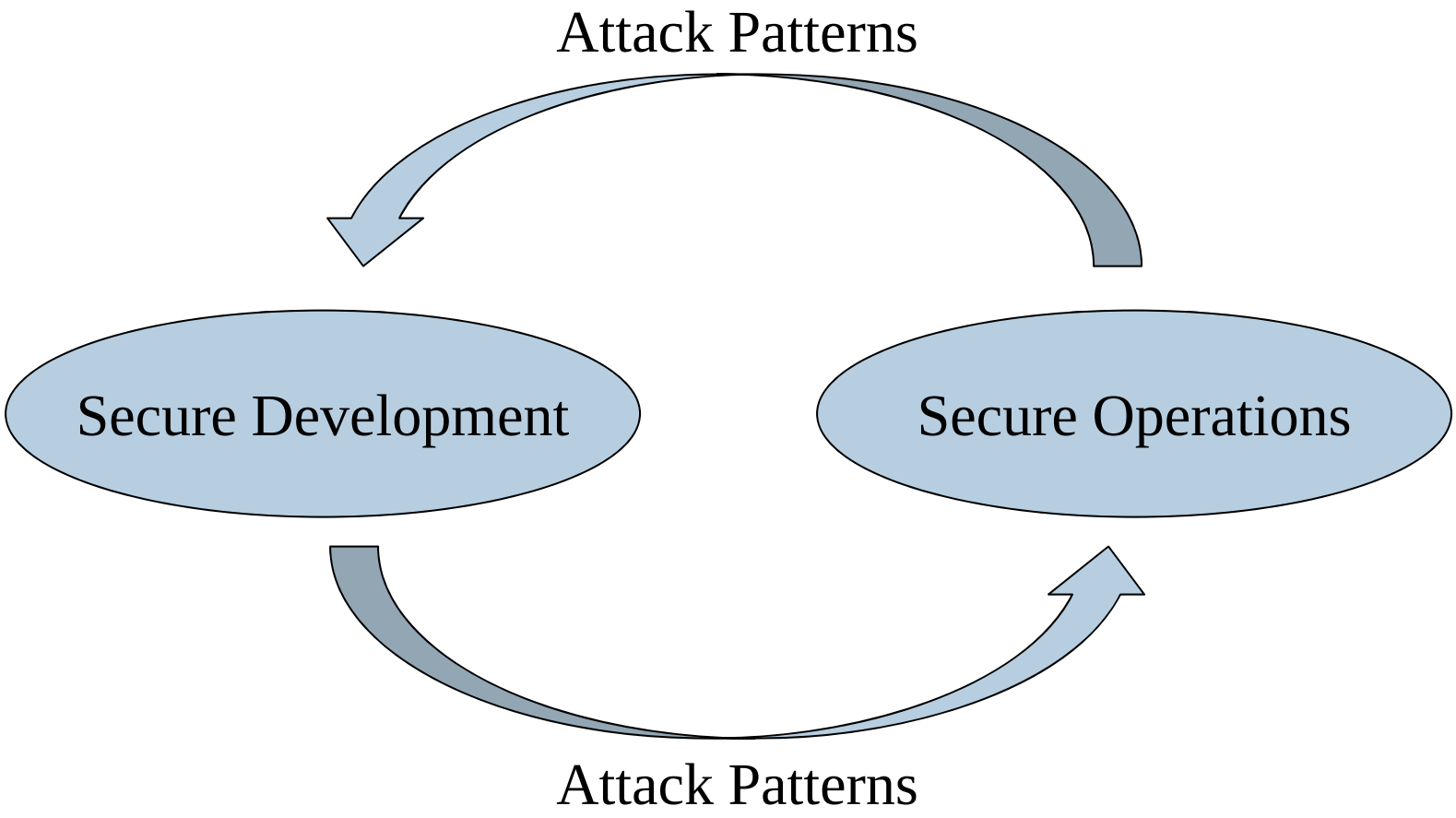
Bridge the secure development and secure operations domains

Cyber Observable eXpression (CybOX)

The topic and content covered in this presentation was published as an article in the Sep/Oct 2010 issue of CrossTalk: The Journal of Defense Software Engineering

MITRE

Attack Patterns Bridge Secure Development and Operations



Secure Operations Knowledge Offers Unique Value to Secure Development

- Using attack patterns makes it possible for the secure development domain to leverage significant value from secure operations knowledge, enabling them to:
  - Understand the real-world frequency and success of various types of attacks.
  - Identify and prioritize relevant attack patterns.
  - Identify and prioritize the most critical weaknesses to avoid.
  - Identify new patterns and variations of attack.

Secure Development Knowledge Offers Unique Value to Secure Operations

- Attack patterns enable those in the secure operations domain to provide appropriate context to the massive amounts of data analyzed to help answer the foundational secure operations questions.

So, this all sounds great but how do we map these high-level attack pattern abstractions to the low-level operational world?

Cyber Observables

The Secret Sauce for Bridging the Abstract to the Concrete

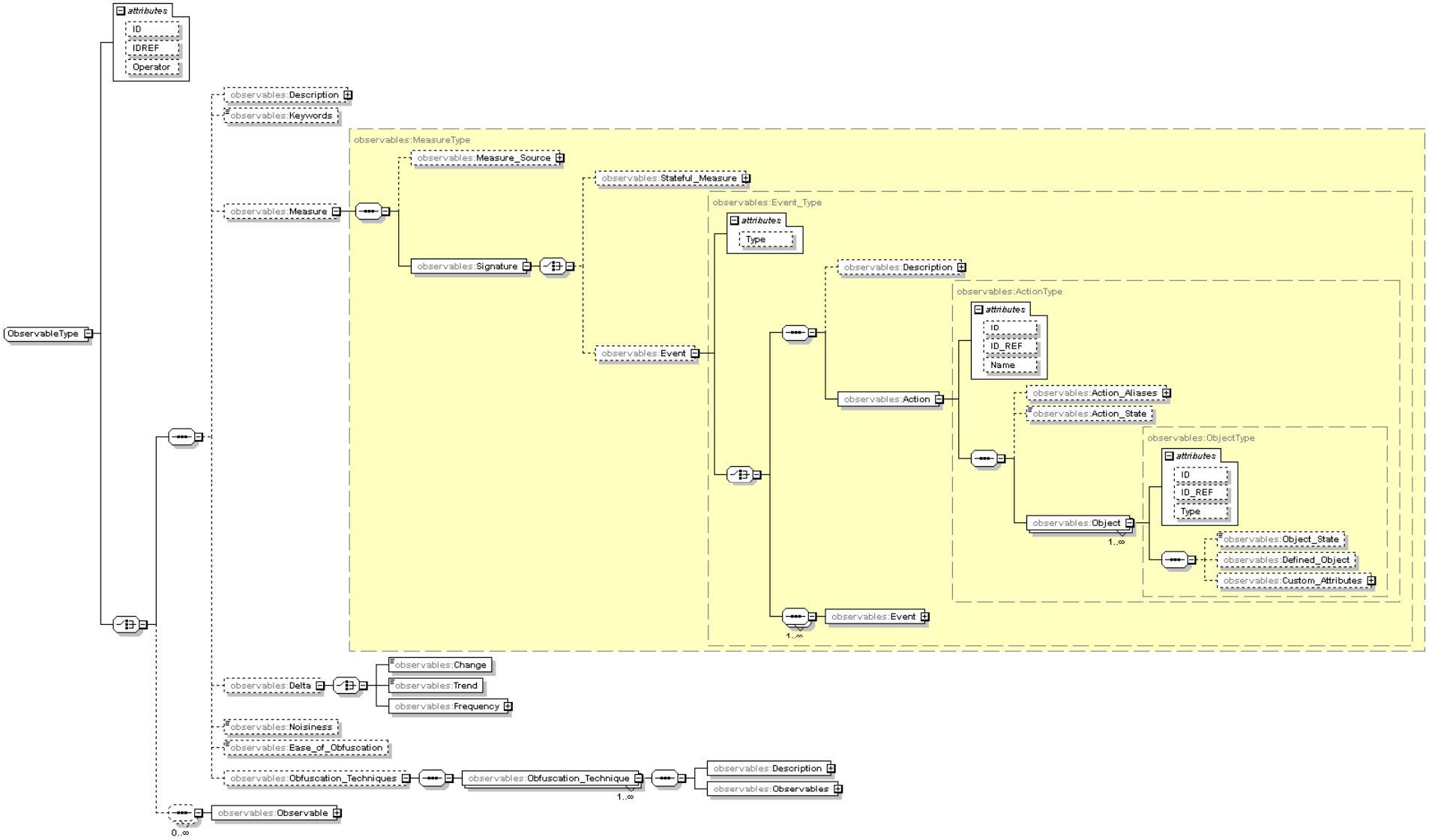
Cyber Observables Overview

- The Cyber Observables construct is intended to capture and characterize events or properties that are observable in the operational domain.
- These observable events or properties can be used to adorn the appropriate portions of the attack patterns in order to tie the logical pattern constructs to real-world evidence of their occurrence or presence.
- This construct has the potential for being the most important bridge between the two domains, as it enables the alignment of the low-level aggregate mapping of observables that occurs in the operations domain to the higher-level abstractions of attacker methodology, motivation, and capability that exist in the development domain.
- By capturing them in a structured fashion, the intent is to enable future potential for detailed automatable mapping and analysis heuristics.

A Brief History of Cyber Observables

- **September 2009: Concept introduced to CAPEC in Version 1.4 as future envisioned adornment to the structured Attack Execution Flow**
- **June 2010: Broader relevance to MSM recognized leading to CAPEC, MAEC & CEE teams collaborating to define one common structure to serve the common needs**
- **August 2010: Discussed with US-CERT at GFIRST 2010**
- **December 2010: Cyber Observables schema draft v0.4 completed**
- **December 2010: Discussions with Mandiant for collaboration and alignment between Cyber Observables and Mandiant OpenIOC**
- **January 2011: Discussed & briefed with MITRE CSOC**
- **February 2011: Discussed & briefed with NIST – EMAP and US-CERT who also have a need for this construct and had begun to work on parallel solutions**

Simplified Overview of Current Schema



Generated by XMLSpy www.altova.com

Cyber Observable Broader Use Cases

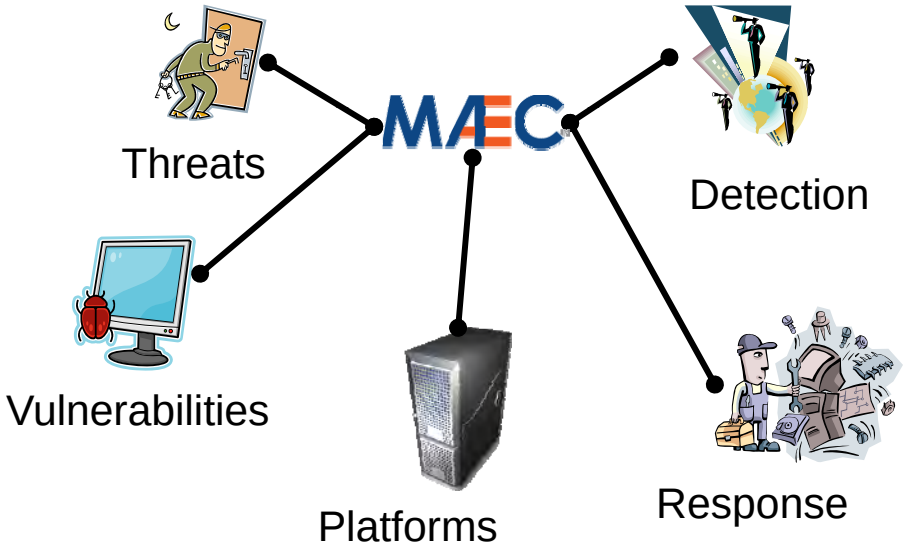
- Detect malicious activity from attack patterns
- Empower & guide incident management
- Identify new attack patterns
- Prioritize existing attack patterns based on tactical reality

- Potential ability to analyze data from all types of tools and all vendors
- Improved sharing among all cyber observable stakeholders
- Ability to metatag cyber observables for implicit sharing controls
- Enable automated signature rule generation
- Enable new levels of meta-analysis on operational cyber observables
- Potential ability to automatically apply mitigations specified in attack patterns
- Etc….

Improve the analysis, characterization, collection, discovery & knowledge sharing of malware

Malware Attribute Enumeration & Characterization (MAEC)

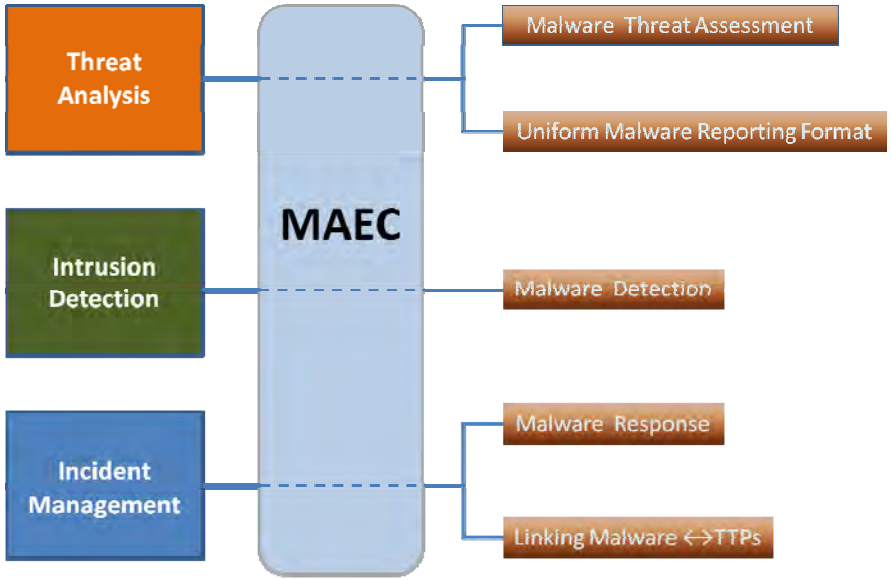
Malware Attribute Enumeration and Characterization (MAEC)



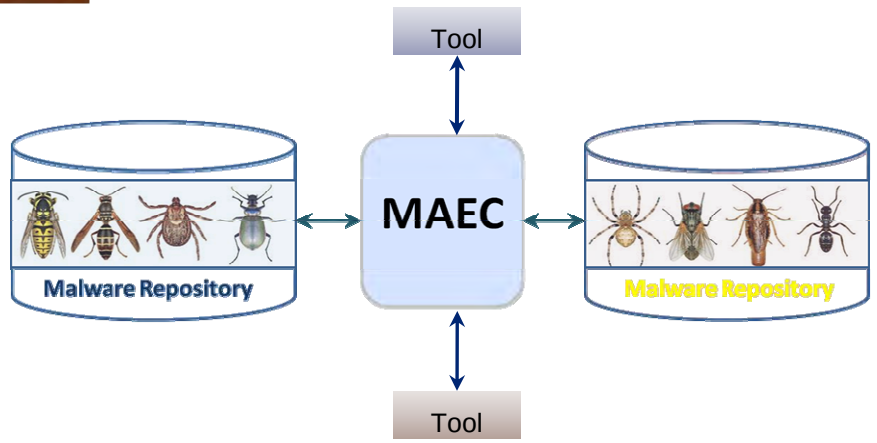
- **Language for sharing structured information about malware**
  - **Grammar (Schema)**
  - **Vocabulary (Enumerations)**
  - **Collection Format (Bundle)**
- **Focus on attributes and behaviors**
- **Enable correlation, integration, and automation**

MAEC Use Cases

- **Operational**



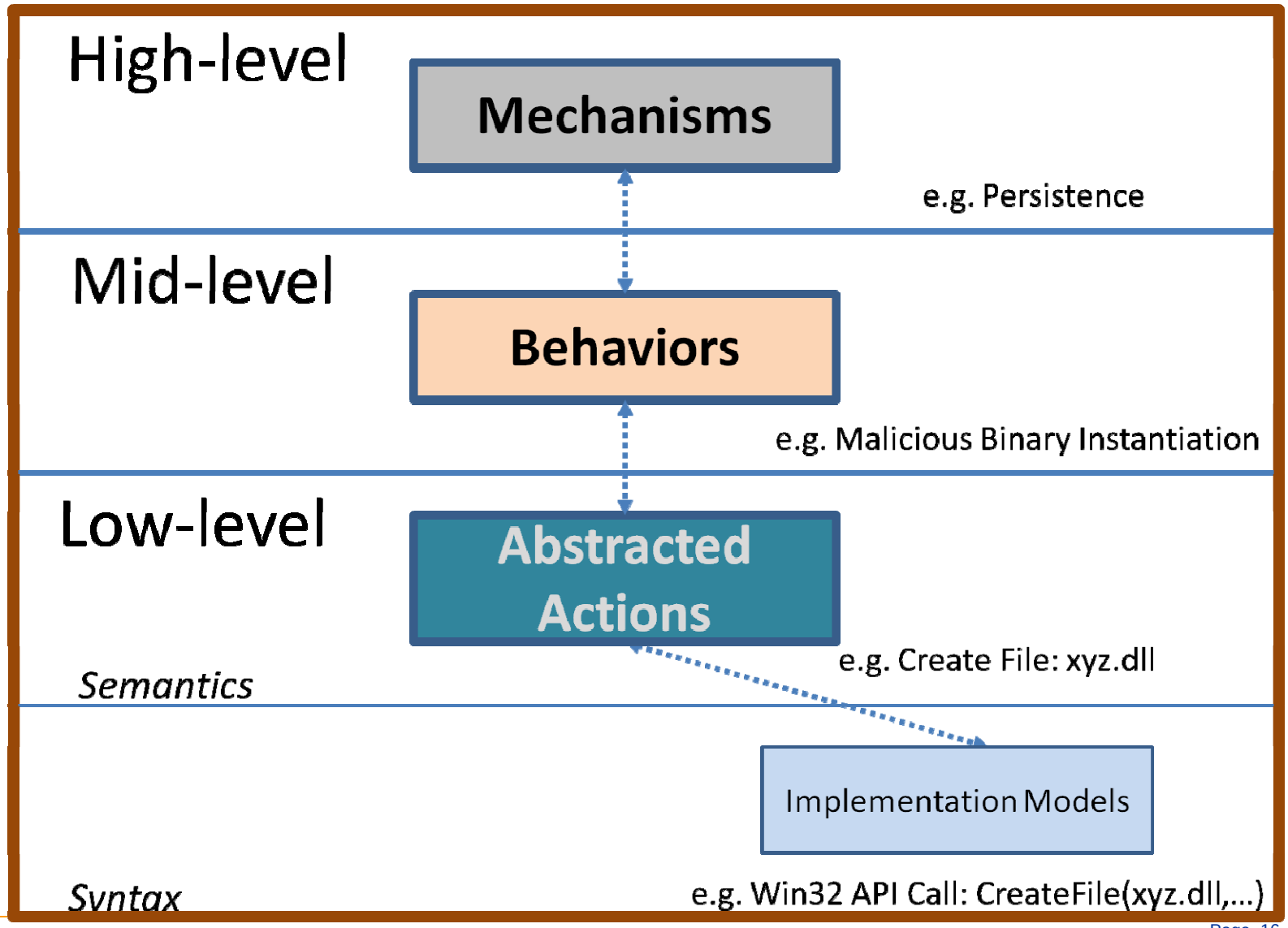
- **Analysis**
  - **Help Guide Analysis Process**
  - **Standardized Tool Output**
  - **Malware Repositories**



MITRE

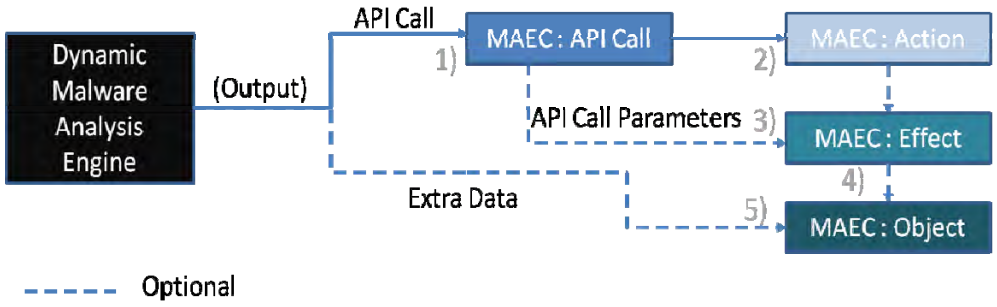
UNCLASSIFIED

MAEC Overview



MITRE

Dynamic Malware Analysis → MAEC



Process

1) An API call is captured by the analysis engine and mapped to MAEC's enumeration of API calls.
2) The MAEC enumerated call is mapped to its corresponding action.
3) The MAEC defined action is mapped to a corresponding MAEC effect (as necessary), which is populated by the parameters of the call.
4) The MAEC effect is linked to a MAEC object (as necessary).
5) Any extra data output (e.g. file attributes, network capture, etc.) from the analysis engine is mapped to its corresponding object (as necessary).

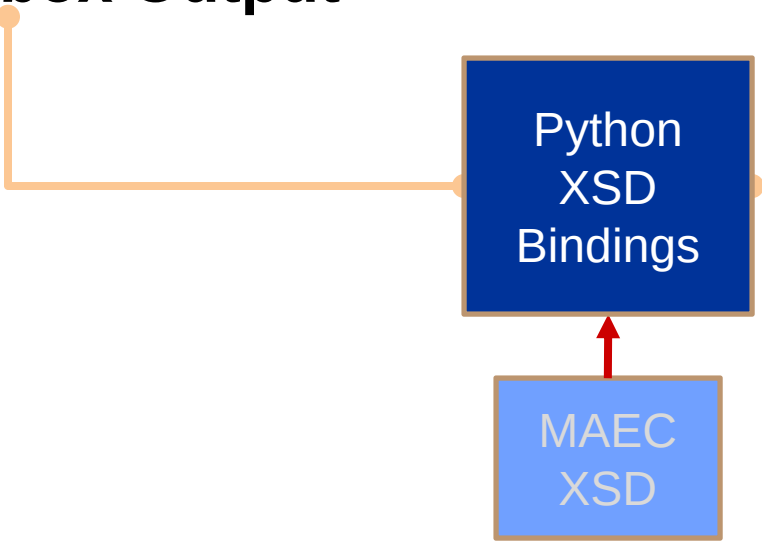
- **Demonstrate the ability to generate MAEC XML descriptions from dynamic analysis tools**
- **Developed proof-of-concept translators for:**
  - **CW Sandbox (Sunbelt)**
  - **ASAT (MITRE)**
  - **Anubis**
  - **ThreatExpert**

Test Case: CWSandbox Output -> MAEC

```
PID:1080,TID:1812,Caller:$00400000("KB823988.exe"),BEFORE,typFileSystem."FindFirstFile
PID:1080,TID:1812,Caller:$00400000("KB823988.exe"),BEFORE,typFileSystem."SetFileAttrib
PID:1080,TID:1812,Caller:$00400000("KB823988.exe"),BEFORE,typFileSystem."DeleteFileW" -
PID:1080,TID:1812,Caller:$77A80000("CRYPT32.dll"),AFTER,typRegistry."RegOpenKeyExA" - -
PID:1080,TID:1812,Caller:$77A80000("CRYPT32.dll"),AFTER,typRegistry."RegEnumKeyA" - <e
PID:1080,TID:1812,Caller:$77A80000("CRYPT32.dll"),AFTER,typRegistry."RegOpenKeyExA" - -
PID:1080,TID:1812,Caller:$77A80000("CRYPT32.dll"),AFTER,typRegistry."RegOpenKeyExA" - -
PID:1080,TID:1812,Caller:$77A80000("CRYPT32.dll"),AFTER,typRegistry."RegEnumKeyA" - <e
PID:1080,TID:1812,Caller:$77A80000("CRYPT32.dll"),AFTER,typRegistry."RegOpenKeyExA" - -
PID:1080,TID:1812,Caller:$77A80000("CRYPT32.dll"),AFTER,typRegistry."RegEnumValueW" - -
PID:1080,TID:1812,Caller:$77A80000("CRYPT32.dll"),AFTER,typRegistry."RegOpenKeyExA" - -
PID:1080,TID:1812,Caller:$77A80000("CRYPT32.dll"),AFTER,typRegistry."RegEnumValueW" - -
PID:1080,TID:1812,Caller:$77A80000("CRYPT32.dll"),AFTER,typRegistry."RegOpenKeyExA" - -
PID:1080,TID:1812,Caller:$77A80000("CRYPT32.dll"),AFTER,typRegistry."RegOpenKeyExA" - -
PID:1080,TID:1812,Caller:$77A80000("CRYPT32.dll"),AFTER,typRegistry."RegOpenKeyExW" - -
PID:1080,TID:1812,Caller:$77A80000("CRYPT32.dll"),AFTER,typRegistry."RegOpenKeyExW" - -
PID:1080,TID:1812,Caller:$77A80000("CRYPT32.dll"),AFTER,typRegistry."RegOpenKeyExW" - -
PID:1080,TID:1812,Caller:$77A80000("CRYPT32.dll"),AFTER,typRegistry."RegCreateKeyExW" -
```

Raw CWSandbox Output

```
<Action Successful="true" id="10" Action_Type="copy" Name="copy_file">
    <Description/>
    <Action_Initiator type="Process">
        <Initiator_Name>KB823988.exe</Initiator_Name>
        <Process_ID>1080</Process_ID>
        <Thread_ID>1812</Thread_ID>
    </Action_Initiator>
    <Action_Implementation>
        <API_Call>
            <Name>CopyFileW</Name>
            <API_Call_Parameter ordinal_position="1">
                <Name>filetype</Name>
                <Value>file</Value>
            </API_Call_Parameter>
            <API_Call_Parameter ordinal_position="2">
                <Name>srcfile</Name>
                <Value>c:\\KB823988.exe</Value>
            </API_Call_Parameter>
            <API_Call_Parameter ordinal_position="3">
                <Name>dstfile</Name>
                <Value>C:\\WINDOWS\\system32\\ntos.exe</Value>
            </API_Call_Parameter>
            <API_Call_Parameter ordinal_position="4">
                <Name>creationdistribution</Name>
                <Value>CREATE_ALWAYS</Value>
            </API_Call_Parameter>
            <API_Call_Parameter ordinal_position="5">
                <Name>desiredaccess</Name>
                <Value>FILE_ANY_ACCESS</Value>
            </API_Call_Parameter>
            <API_Call_Parameter ordinal_position="6">
                <Name>flags</Name>
                <Value>SECURITY_ANONYMOUS</Value>
            </API_Call_Parameter>
        </API_Call>
    </Action_Implementation>
```

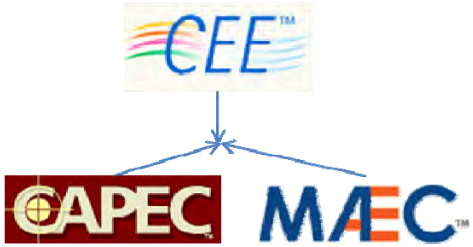


MAEC XML

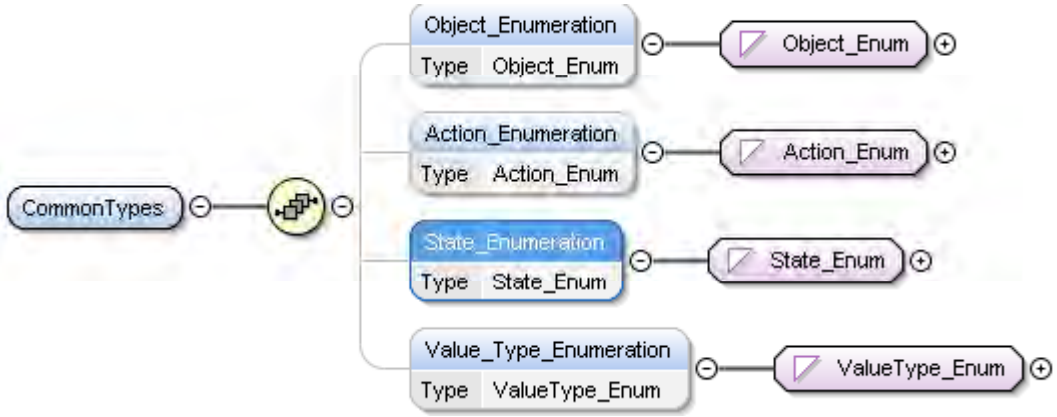
- MAEC Actions
- **MAEC Objects**
- MAEC Behaviors

MITRE

Collaboration

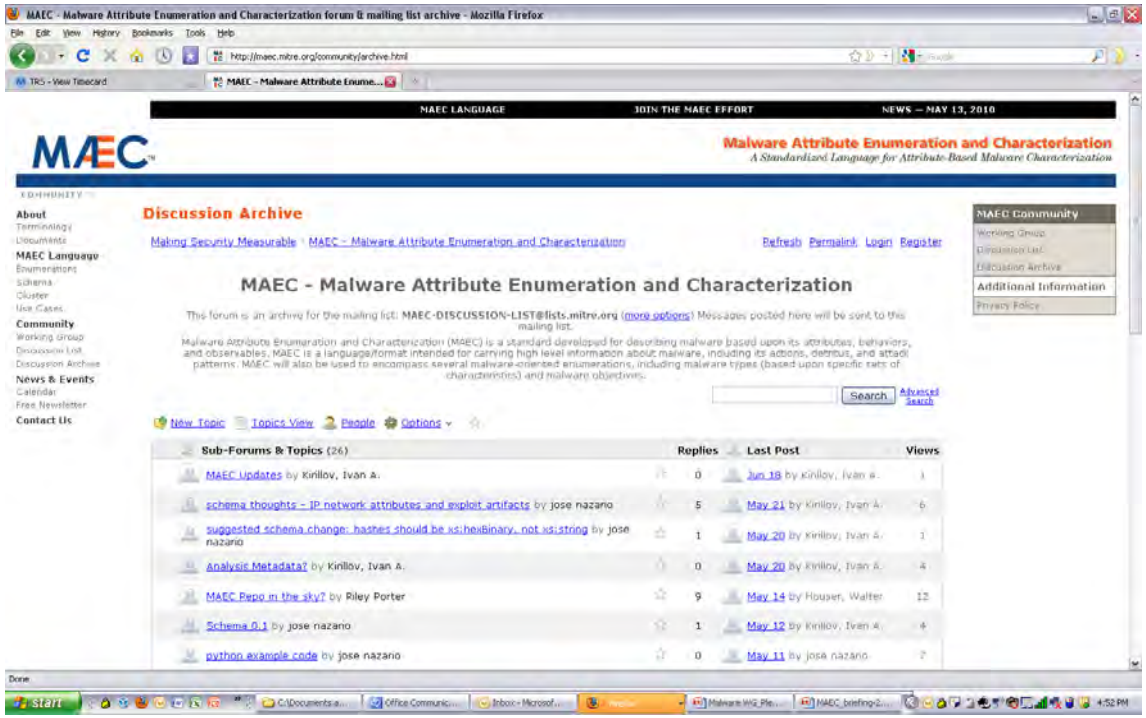


- **Related Making Security Measurable Efforts**
  - **There is significant overlap between MAEC, CAPEC, and CEE in describing observed actions, objects, and states.**
  - **As such, we're working on developing a common schematic structure of observables for use in these efforts:**

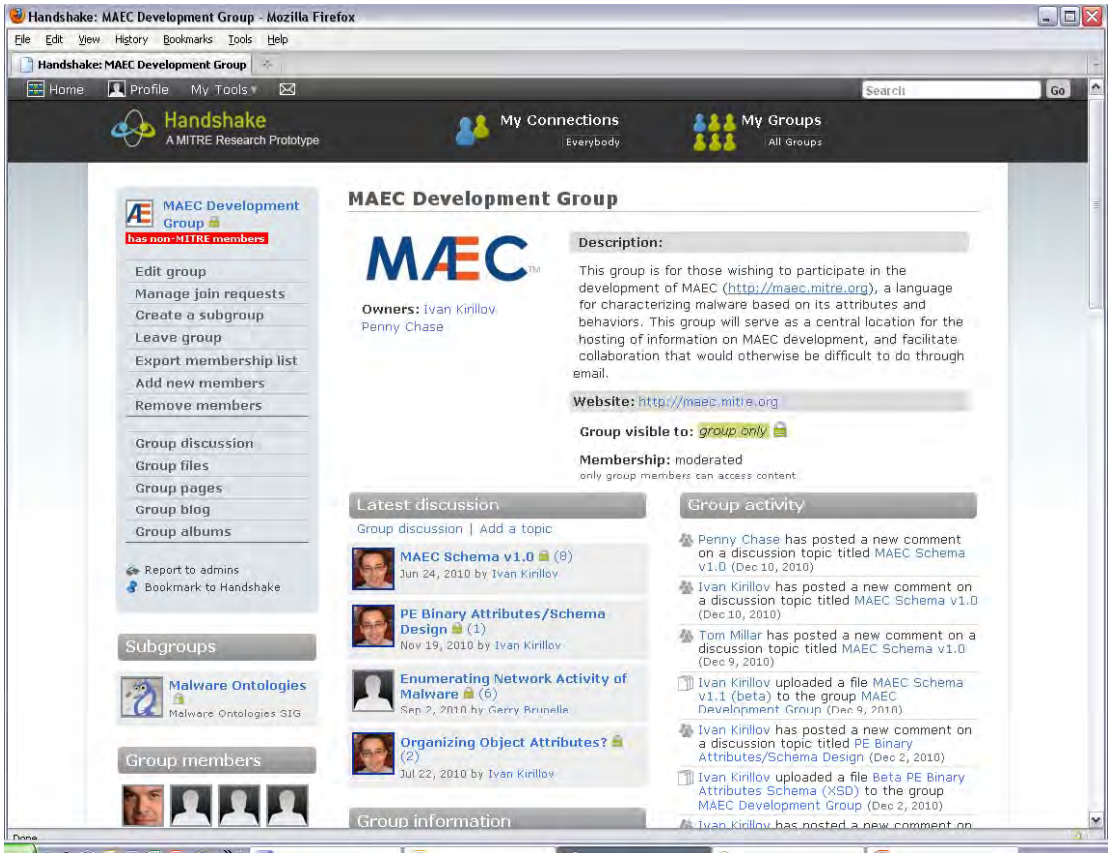


MAEC Community: Discussion List

- **Request to join:**
  http://maec.mitre.org/community/discussionlist.html
- **Archives available**



MAEC Community: MAEC Development Group on Handshake



- **MITRE hosts a social networking collaboration environment: https://handshake.mitre.org**
- **Supplement to mailing list to facilitate collaborative schema development**
- **Malware Ontologies SIG Subgroup**

Combine elements of the ecosystem as practical applications to support secure software operations

Security Content Automation Protocol (SCAP) and other Automation Protocols

MITRE

Remembering the Acronyms

What IT systems do I have in my enterprise?	• CPE (Platforms)
What vulnerabilities do I need to worry about?	• CVE (Vulnerabilities)
What vulnerabilities do I need to worry about RIGHT NOW?	• CVSS (Scoring System)
How can I configure my systems more securely?	• CCE (Configurations)
How do I define a policy of secure configurations?	• XCCDF (Configuration Checklists)
How can I be sure my systems conform to policy?	• OVAL (Assessment Language)
How can I be sure the operation of my systems conforms to policy?	• OCIL (Interactive Language)
What weaknesses in my software could be exploited?	• CWE (Weaknesses)
What attacks can exploit which weaknesses?	• CAPEC (Attack Patterns)
What should be logged, and how?	• CEE (Events)
How can I aggregate assessment results?	• ARF (Results)
How can we recognize malware?	• MAEC (Malware Attributes)

Standardization Efforts leveraged by the Security Content Automation Protocol (SCAP)

What IT systems do I have in my enterprise?	• CPE (Platforms)
What vulnerabilities do I need to worry about?	• CVE (Vulnerabilities)
What vulnerabilities do I need to worry about RIGHT NOW?	• CVSS (Scoring System)
How can I configure my systems more securely?	• CCE (Configurations)
How do I define a policy of secure configurations?	• XCCDF (Configuration Checklists)
How can I be sure my systems conform to policy?	• OVAL (Assessment Language)
How can I be sure the operation of my systems conforms to policy?	• OCIL (Interactive Language)
What weaknesses in my software could be exploited?	• CWE (Weaknesses)
What attacks can exploit which weaknesses?	• CAPEC (Attack Patterns)
What should be logged, and how?	• CEE (Events)
How can I aggregate assessment results?	• ARF (Results)
How can we recognize malware?	• MAEC (Malware Attributes)

SCAP – FDCC and USGCB

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

June 1, 2007

M-07-18

MEMORANDUM FOR

FROM:

SUBJECT:

The Office of M
"Implementation of Cor
Systems," which stated:
and/or plans to upgrade
configurations by Febru

This memorandu
solicitations to ensure n
information technology
configurations. Your ag

"a) The provide
and operate
Configuratio
Windows XI
see: http://cs
settings, see:

b) The standar
software sha
configuratio
Service for i
silently insta

c) Applications
without elev

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

August 11, 2008

M-08-22

MEMORANDUM FOR THE CHIEF INFORMATION OFFICERS

FROM: Karen S. Evans
Administrator
E-Government and Information Technology

SUBJECT: Guidance on the Federal Desktop Core Configuration (FDCC)

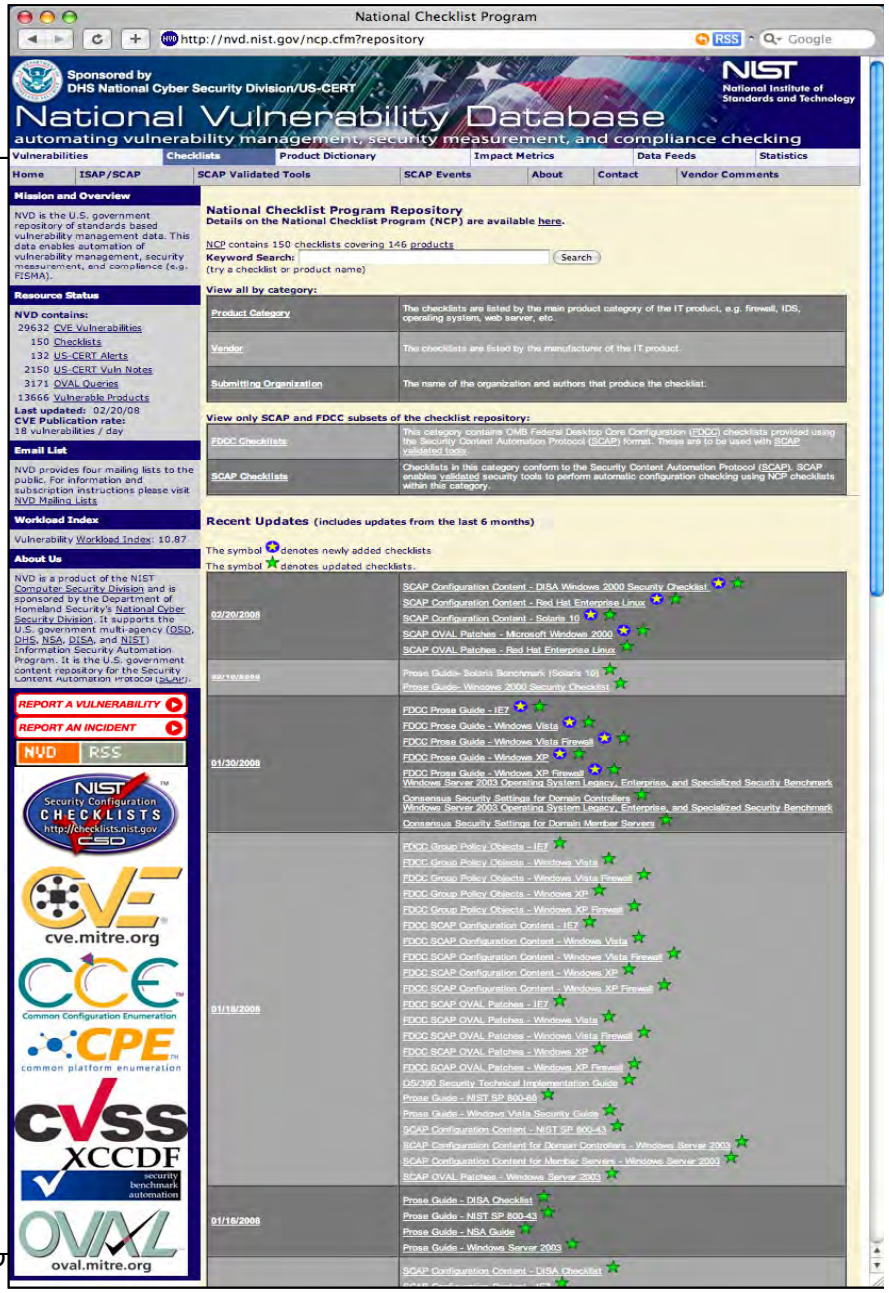
In March 2007, OMB Memorandum M-07-11 announced the "Implementation of Commonly Accepted Security Configurations for Windows Operating Systems," directing agencies with Windows XP ™ deployed and/or plan to upgrade to the Vista ™ operating system to adopt the Federal Desktop Core Configuration (FDCC) security configurations developed by the National Institute of Standards and Technology (NIST), the Department of Defense (DoD) and the Department of Homeland Security (DHS).

On June 20, 2008, NIST published the updated Federal Desktop Core Configuration Major Version 1.0 settings release. Relative to the previous version of FDCC which was originally posted in July 2007, 40 settings have changed. Changes were derived from public comment during the April and May 2008 public comment periods, analysis of the March 31, 2008, Agency FDCC reports and subject matter expertise. FDCC Major Version 1.0 settings are available at http://nvd.nist.gov/fdcc/download_fdcc.cfm.

Federal Desktop Core Configuration Major Version 1.0

FDCC Major Version 1.0 is based on Microsoft Windows XP Service Pack (SP) 2 and Microsoft Windows Vista SP 1. Although Security Content Automation Protocol (SCAP) Content has been engineered so that it will also operate on Windows XP SP3, near-term Windows XP patch checking will be oriented toward Windows XP SP2. It is understood that many managed environments throughout the Federal government implement service packs shortly after their release. While near-term Windows XP checking is based on Windows XP/SP2, we do not anticipate any significant measurement issues for Windows XP/SP3. NIST is currently working with IT product vendors to develop additional SCAP Content based on the FDCC settings for other platforms and applications.

To coincide with the release of FDCC Major Version 1.0, new SCAP Content has also been made available. This SCAP Content is inclusive of the 40 FDCC settings changes. At this time, the FDCC is comprised of settings located at http://fdcc.nist.gov that can be checked using the updated SCAP Content and SCAP-validated tools with FDCC Scanning capability as specified on the NIST website at http://nvd.nist.gov/scapproducts.cfm. Not all FDCC settings can be checked using automated scanning tools. NIST is coordinating the refinement of SCAP Content



SCAP-Based FDCC Guidance

Configuration Guidance

FDCC

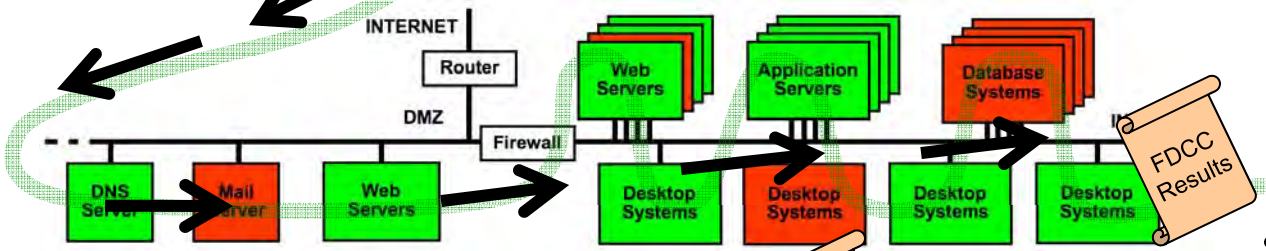
Configuration Guidance Analysis

Operations Security Management Processes

FDCC Compliant Tools

TENABLE Network Security
nCircle
ThreatGuard
netIQ
SignaCert
hp
symantec.
Telos
Lumension SECURITY
Shavlik
tripwire TAKE CONTROL.
LANDesk SOFTWARE
the CENTER for INTERNET SECURITY
ca
bmcsoftware
Atlantic Systems Group, Inc.
McAfee
BIGFIX
FORTINET
eEye Digital Security
QUALYS
GIDEON TECHNOLOGIES
PRISM MICROSYSTEMS
Triumfant
SPAWAR Systems Center ATLANTIC
Microsoft System Center Configuration Manager

Operational Enterprise Networks



FDCC Results

FDCC Results

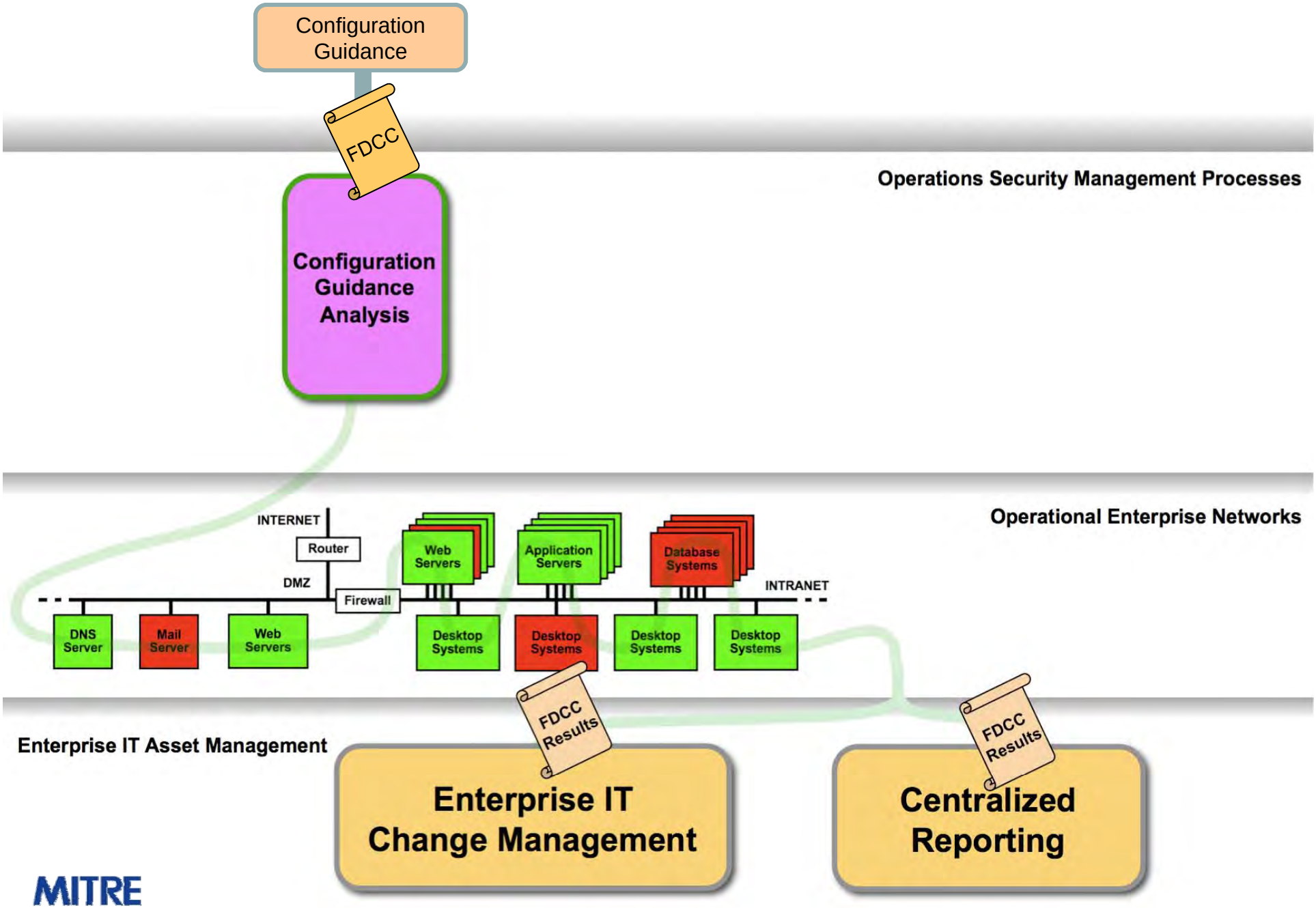
FDCC Results

Enterprise IT Asset Management

Enterprise IT Change Management

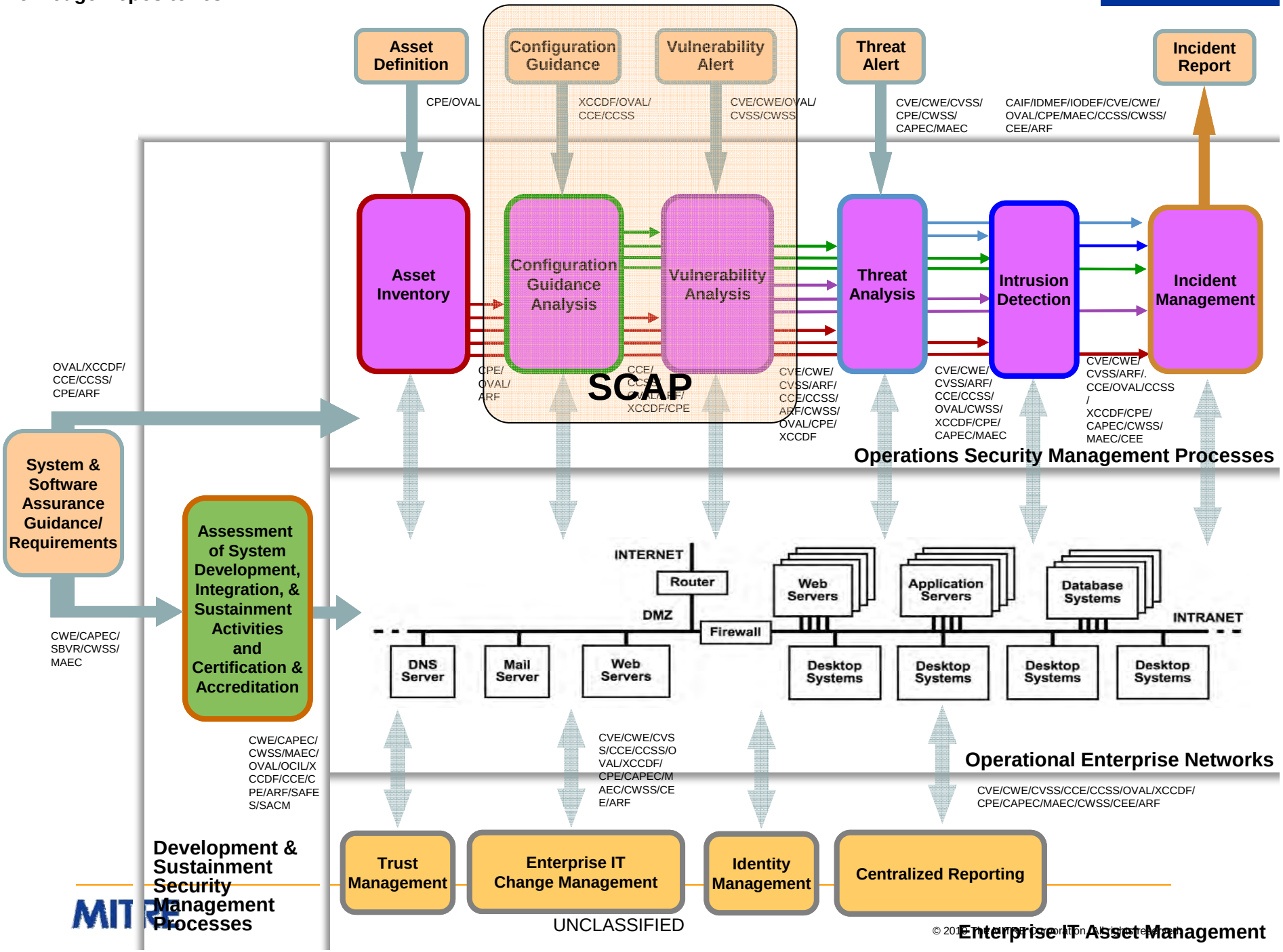
Centralized Reporting

SCAP-Based FDCC Reporting



MITRE

Knowledge Repositories



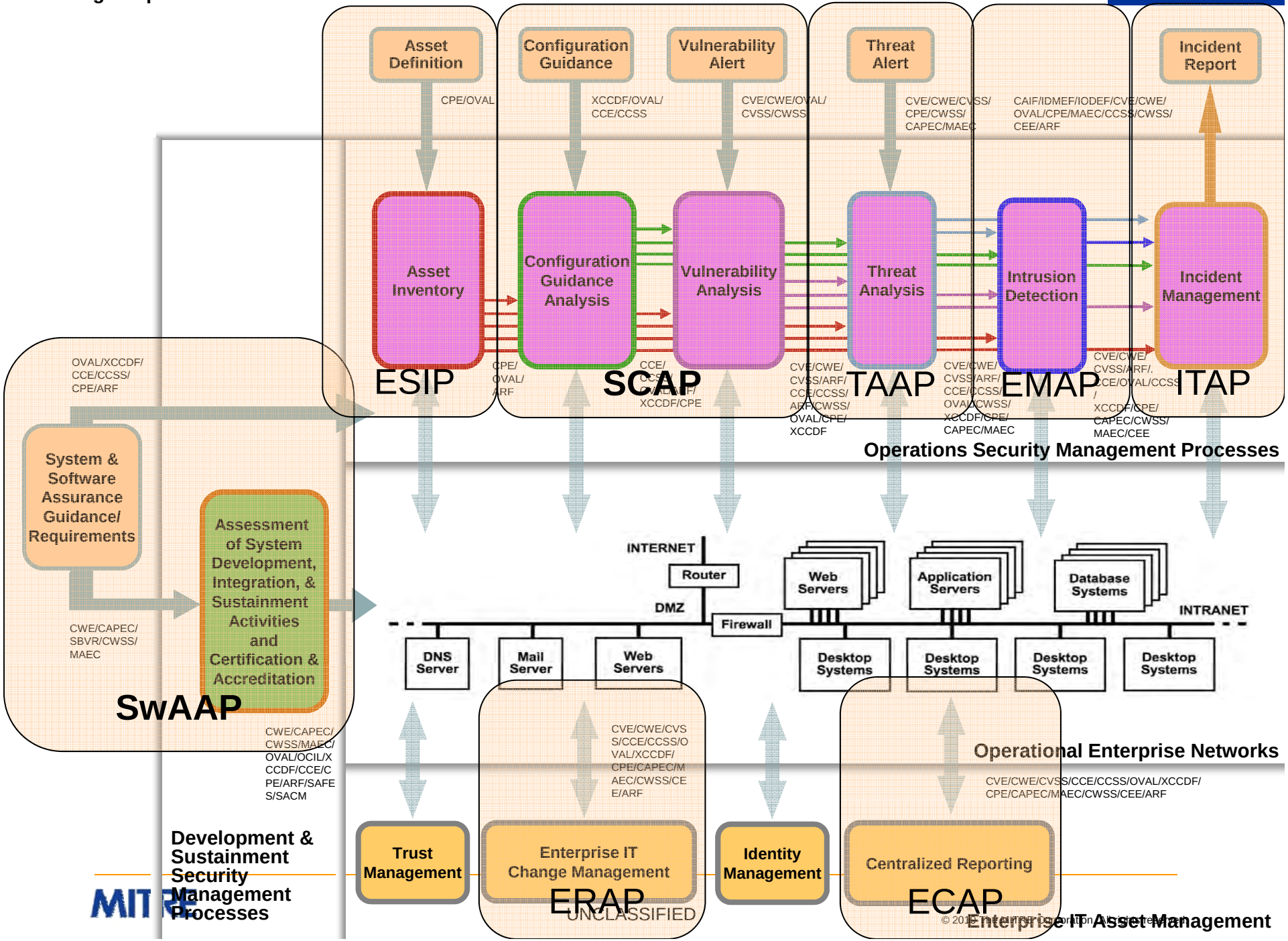
Other Automation Protocols Can Capture the Government Use Cases…

- **Enterprise System Information Protocol (ESIP)**
  - For reporting of asset inventory information. Common Platform Enumeration (CPE), etc.
- **Threat Analysis Automation Protocol (TAAP)**
  - For reporting and sharing structured threat information. Malware Attribute Enumeration & Characterization (MAEC), Common Attack Pattern Enumeration & Classification (CAPEC), Common Platform Enumeration (CPE), Common Weakness Enumeration (CWE), Open Vulnerability and Assessment Language (OVAL), Common Configuration Enumeration (CCE), and Common Vulnerabilities and Exposures (CVE).
- **Event Management Automation Protocol (EMAP)**
  - For reporting of security events. Common Event Expression (CEE), Malware Attribute Enumeration & Characterization (MAEC), and Common Attack Pattern Enumeration & Classification (CAPEC).

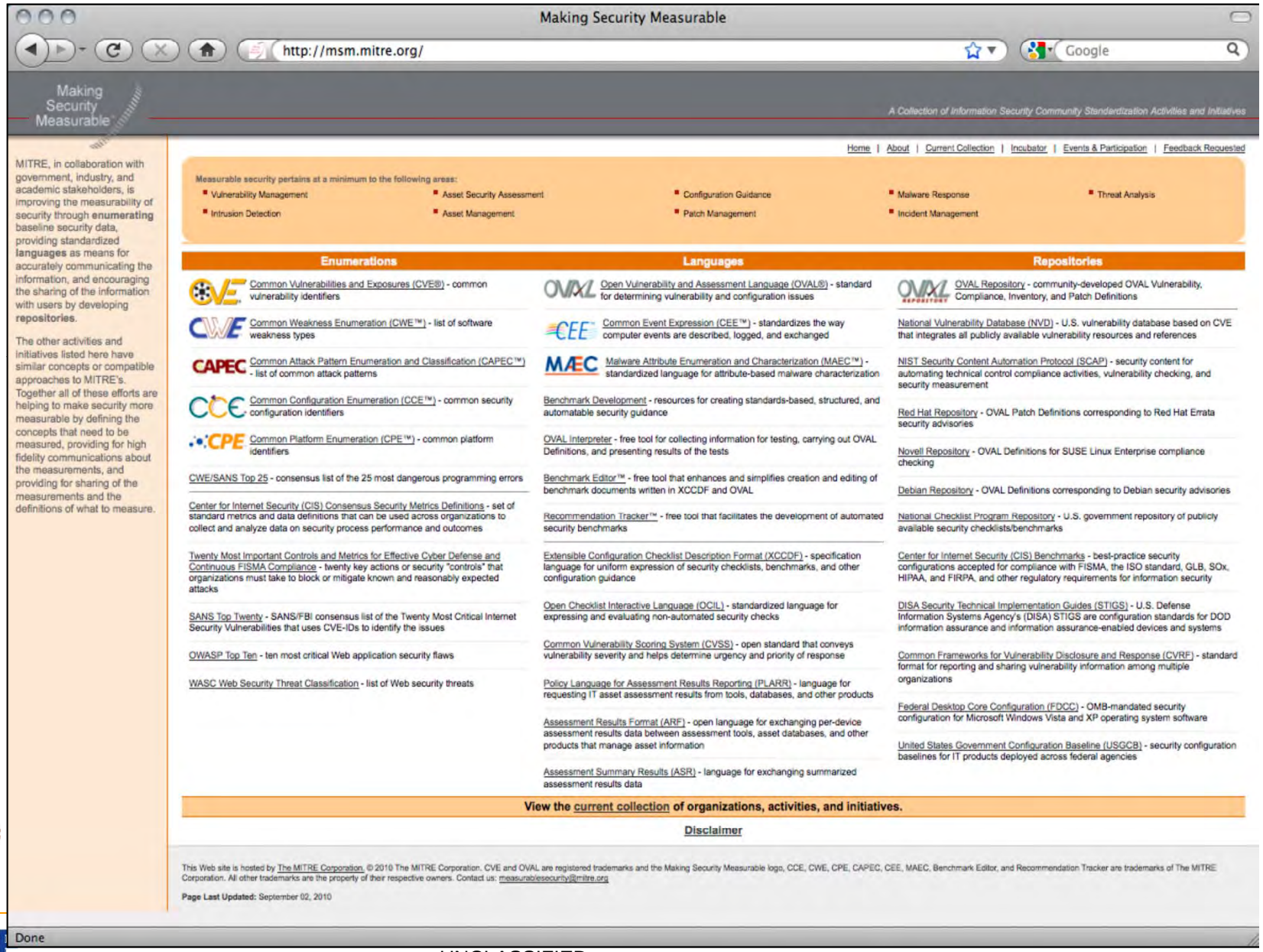
Other Automation Protocols Can Capture the Government Use Cases…(concluded)

- **Incident Tracking and Assessment Protocol (ITAP)**
  - For tracking, reporting, managing and sharing incident information. Open Vulnerability and Assessment Language (OVAL), Common Platform Enumeration (CPE), Common Configuration Enumeration (CCE), Common Vulnerabilities and Exposures (CVE), Common Vulnerability Scoring System (CVSS), Malware Attribute Enumeration & Characterization (MAEC), Common Attack Pattern Enumeration & Classification (CAPEC), Common Weakness Enumeration (CWE), Common Event Expression (CEE), Incident Object Description Exchange Format (IODEF), National Information Exchange Model (NIEM), and Cybersecurity Information Exchange Format (CYBEX).
- **Enterprise Remediation Automation Protocol (ERAP)**
  - For automated remediation of mis-configuration & missing patches. Common Remediation Enumeration (CRE), Extended Remediation Information (ERI), Open Vulnerability and Assessment Language (OVAL), Common Platform Enumeration (CPE), and Common Configuration Enumeration (CCE).
- **Enterprise Compliance Automation Protocol (ECAP)**
  - For reporting configuration compliance. Asset Reporting Format (ARF), Open Checklist Reporting Language (OCRL), etc.

Knowledge Repositories



[makingsecuritymeasurable.mitre.org]



Making Security Measurable™

MITRE