Standards in reporting Software Flaws: SCAP, CVE and CWE

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Who am I ?

- **Job**
  - Assistant Professor of Information Assurance at IS&T since Fall 2008
- **Research highlights**
  - Regulatory Requirements driven Risk Assessment
    - Using the semantic web to bridge the gap from high-level regulations to low-level technical evidence (Domain: SCADA)
  - Software Assurance in the Development Lifecycle
    - Building semantic templates for the most egregious software flaws
  - Cyber attack modeling and forecasting (CyCast)
    - Exploring disturbances in the human network to predict cyber attacks
- **Teaching**
  - Software Assurance (seniors/grad) New !
  - Foundations of Information Assurance (seniors/grad)
  - Introduction to Information Assurance (Freshmen) New !
  - Introduction to Computer Science II (Freshmen/Sophomore)

A two part talk

- SCAP
  - What is it?
  - What does it do?
  - What will it take to realize its potential?
  - What do I need to do to start preparing for it?

- How can we better understand vulnerabilities
  - Research on semantic templates built from CWE and CVE enumerations

The Burning Issue

- It has been said that we have long known how to build secure systems
  - We simply don’t act on what we know
- For a fielded system the details are “enormous” to assess the security posture
  - Rich **abstractions** supported by **automation** is key to manage the complexity of current systems
  - If we are in a constant battle, then let’s get efficient about it

What is SCAP

- Pronounced S-CAP
- Security Content Automation Protocol
  - **NIST 800-126**
    - Technical specification
  - **NIST 800-117**
    - Guide for adoption
  - **NISTIR 7511 rev2**
    - Requirements for achieving SCAP validation
    - Demonstration of SCAP capabilities
- This presentation borrows heavily from these documents

Motivation for SCAP

- The number and variety of systems to secure
- The need to respond quickly to new threats
- Compliance often becomes a paperwork exercise
- Lack of standard expression of security content
  - Duplication across standards and baselines
  - Lack of interoperability among tools

Clearing SCAP Myths

- No, NIST and FFRDCs are not attempting to regulate the entire security industry
  - It is really a community effort that wants your participation to grow and mature
- The managed data streams do not limit personal/proprietary innovation
  - Community repositories can be enriched with locally developed content and contributed back to the public

SCAP v1.0

- SCAP has two major elements:
  - **Components:** 6 **open specifications** that standardize the **format** and **nomenclature** by which **security software** communicates information about **software flaws** and **security configurations**.
  - **Content:** Software flaw and security configuration standardized **reference data**

SCAP v1.0 Components

- **Expression and Checking Languages**
  1. Express what is to be evaluated and how to report results
     - e**X**tensible **C**onfiguration **C**hecklist **D**escription **F**ormat (**XCCDF**); **NSA** and **NIST**
  2. Check the corresponding low level system states
     - **O**pen **V**ulnerability **A**ssessment **L**anguage (**OVAL**); **MITRE**

SCAP v1.0 Components

- **Enumerations**
  - 3 **C**ommon **P**latform **E**numeration (**CPE**); MITRE
  - 4 **C**ommon **C**onfiguration **E**numeration (**CCE**); MITRE
  - 5 **C**ommon **V**ulnerabilities and **E**xposures (**CVE**); MITRE
- **Vulnerability measurement and scoring**
  - 6 **C**ommon **V**ulnerability **S**coring **S**ystem (**CVSS**); Forum of Incident Response and Security Team (FIRST)

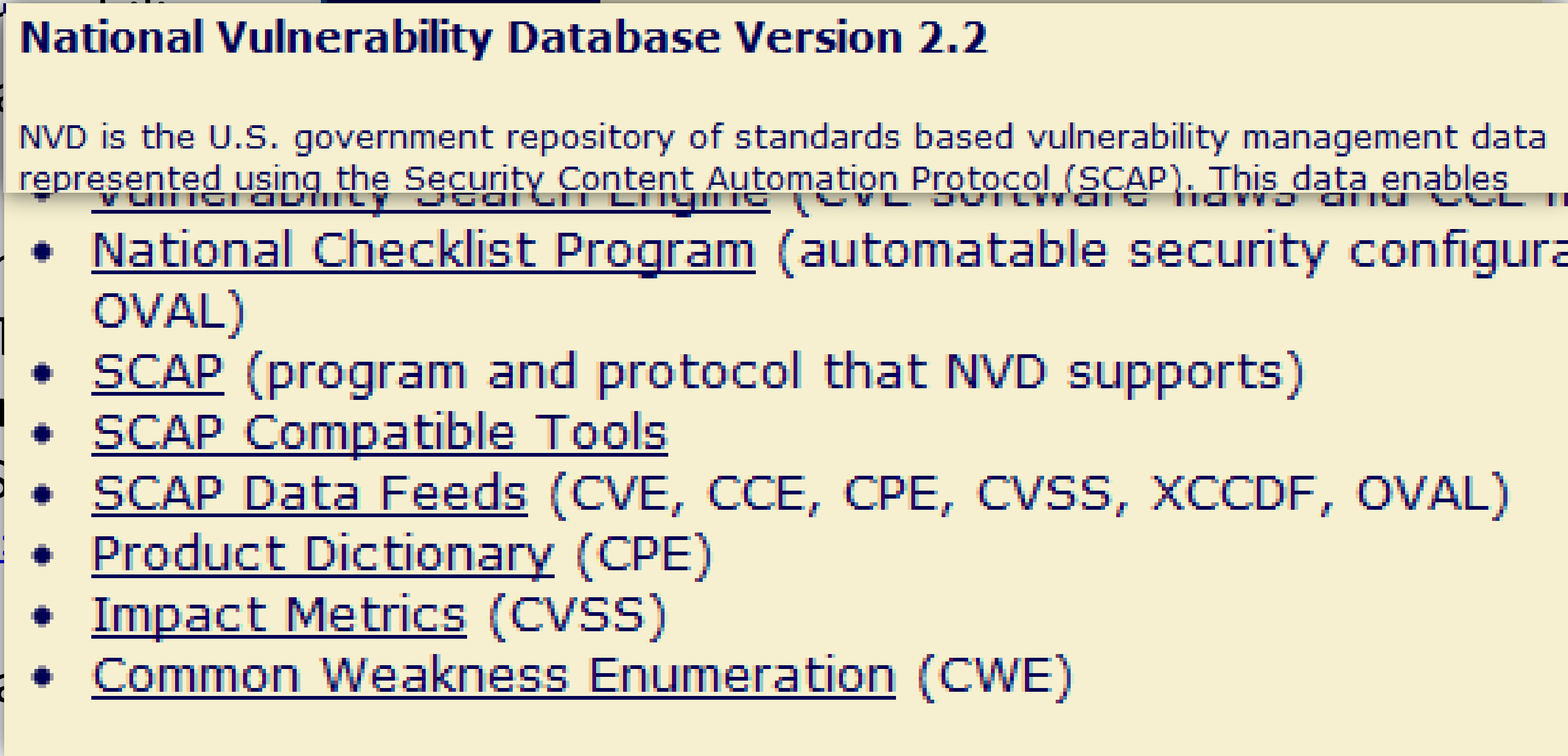
SCAP v1.0 Content

- Provided by the National Vul
Data

- Mar
NIST
spo
DHS
(http:

- Data

Sponsored by
DHS National Cyber Security Division/US-CERT
NIST
National Institute of Standards and Technology
National Vulnerability Database
automating vulnerability management, security measurement, and compliance checking
Vulnerabilities
Checklists
Product Dictionary
Impact Metrics
Data Feeds
Statistics
Home
SCAP
SCAP Validated Tools
SCAP Events
About
Contact
Vendor Comments



National Vulnerability Database Version 2.2

NVD is the U.S. government repository of standards based vulnerability management data represented using the Security Content Automation Protocol (SCAP). This data enables

- Vulnerability Search Engine (CVE software flaws and CCE m
- National Checklist Program (automatable security configura OVAL)
- SCAP (program and protocol that NVD supports)
- SCAP Compatible Tools
- SCAP Data Feeds (CVE, CCE, CPE, CVSS, XCCDF, OVAL)
- Product Dictionary (CPE)
- Impact Metrics (CVSS)
- Common Weakness Enumeration (CWE)

SCAP component specifications interoperation

- A checklist uses **XCCDF** to describe what to evaluate
  - **OVAL** to perform the tests on the target system
  - **CPE** to identify platforms for which the checklist is valid and on which the tests will run
  - **CCE** to identify security configuration settings to be addressed or assessed in the checklist
  - **CVE** to refer to known vulnerabilities
- **CVSS** to rank the vulnerabilities

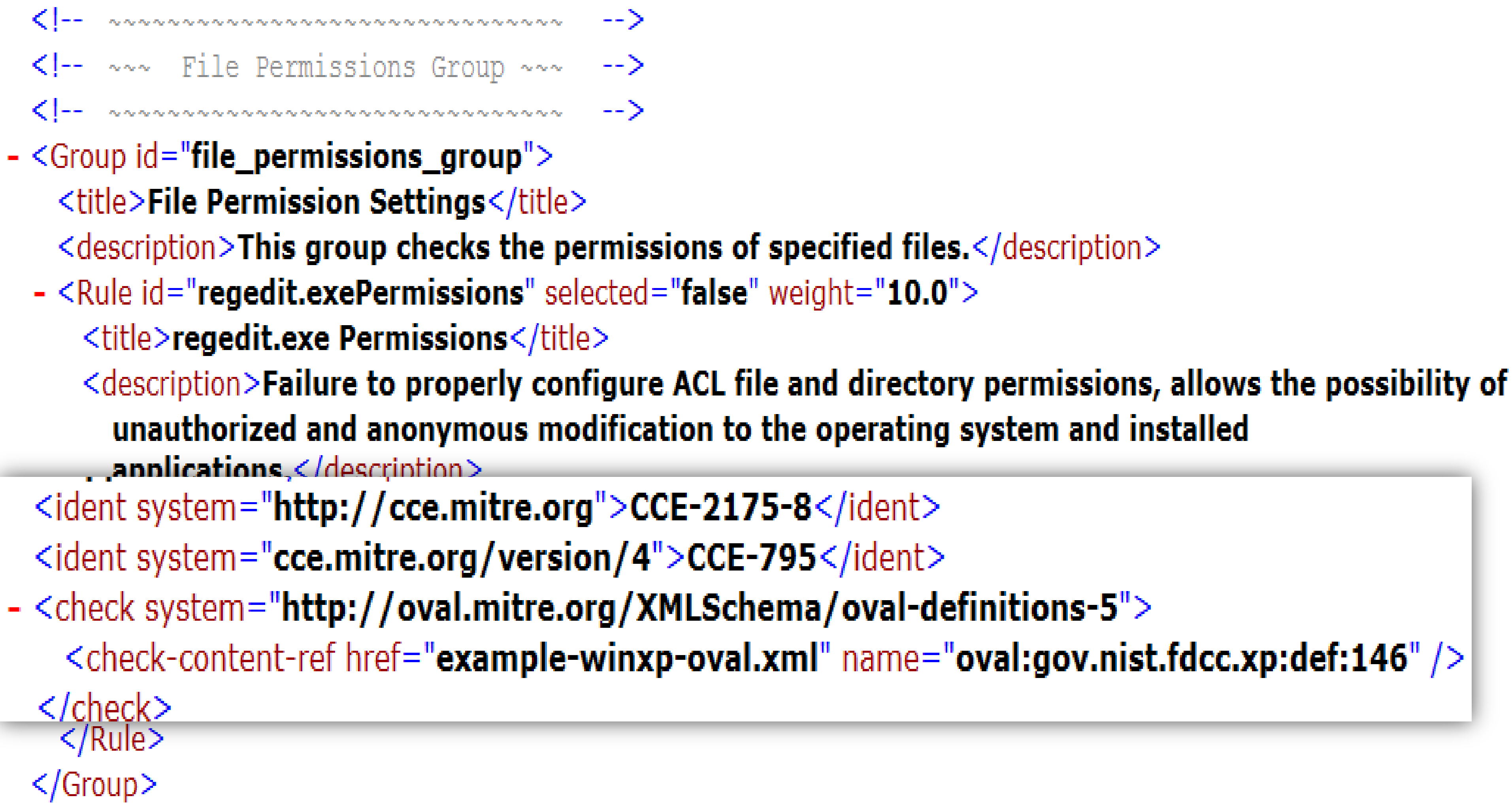
1

XCCDF

- A XCCDF documents consists of **`Rules`** to be evaluated
- **`Profiles`** can be used to bundle rules for particular types of systems
- **`Groups`** allow multiple rules to be enabled or disabled at once
- **`Values`** allow user-defined values for certain rules

1

XCCDF Sample



```
  <!--  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  -->
  <!--  ~~~  File Permissions Group ~~~   -->
  <!--  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  -->
- <Group id="file_permissions_group">
    <title>File Permission Settings</title>
    <description>This group checks the permissions of specified files.</description>
  - <Rule id="regedit.exePermissions" selected="false" weight="10.0">
      <title>regedit.exe Permissions</title>
      <description>Failure to properly configure ACL file and directory permissions, allows the possibility of
        unauthorized and anonymous modification to the operating system and installed
        applications.</description>
  <ident system="http://cce.mitre.org">CCE-2175-8</ident>
  <ident system="cce.mitre.org/version/4">CCE-795</ident>
- <check system="http://oval.mitre.org/XMLSchema/oval-definitions-5">
    <check-content-ref href="example-winxp-oval.xml" name="oval:gov.nist.fdcc.xp:def:146" />
  </check>
    </Rule>
  </Group>
```

Open Vulnerability Assessment Language (**OVAL**)

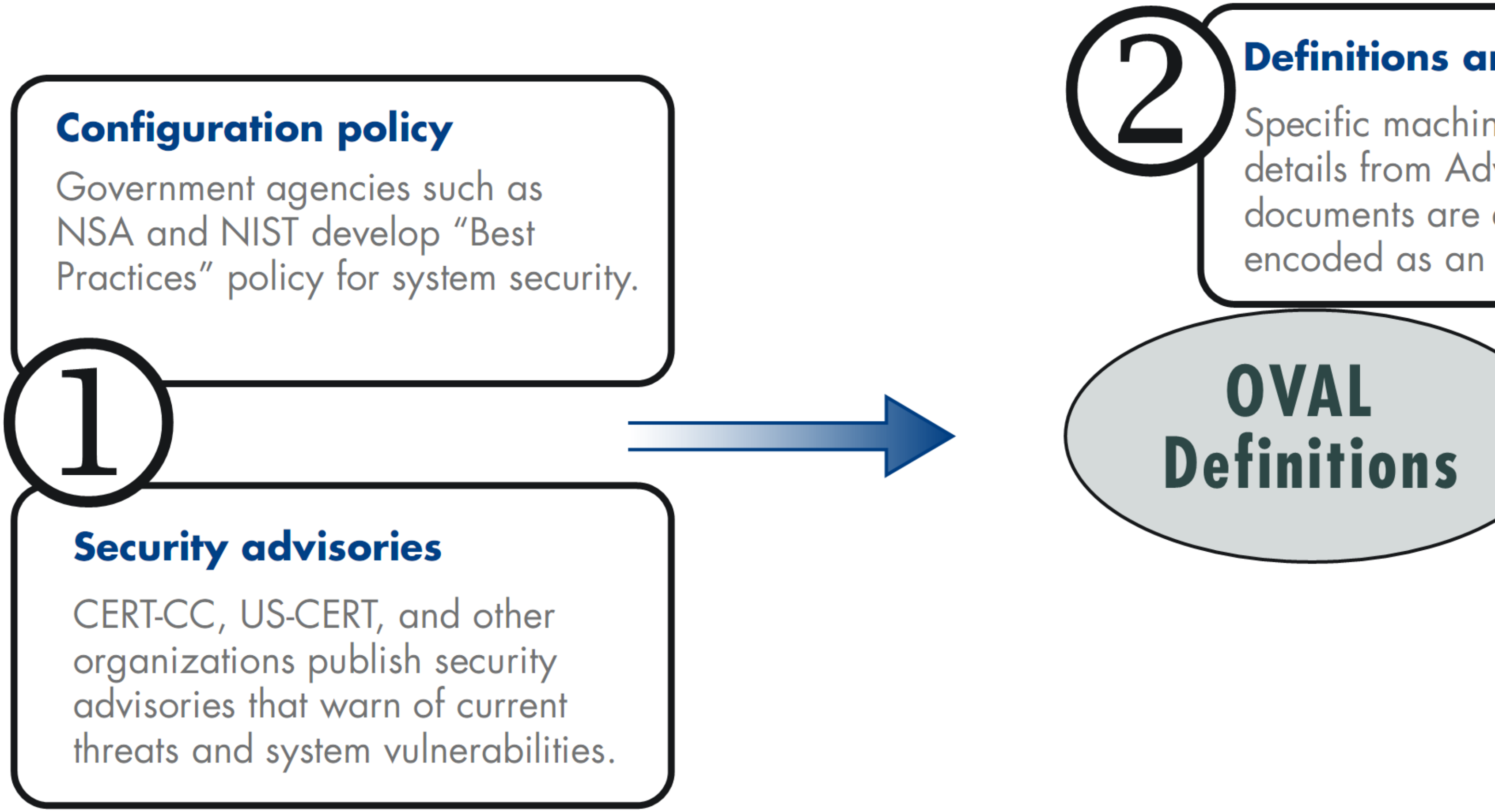
- For SCAP, OVAL is commonly used to check the presence of vulnerabilities and insecure configurations
  - A set of instructions used to check for a security problem, is known as a **`Definition`**

Oval Definitions

- **Vulnerability Definitions**
  - Is a specific vulnerability present?
- **Patch Definitions**
  - is a particular patch appropriate for a system?
- **Inventory Definitions**
  - is a specific piece of software installed on the system?
- **Compliance Definitions**
  - Do conditions exist on a system necessary for compliance with a specific policy or configuration statement?

2

How OVAL works?



1

Configuration policy

Government agencies such as NSA and NIST develop “Best Practices” policy for system security.

Security advisories

CERT-CC, US-CERT, and other organizations publish security advisories that warn of current threats and system vulnerabilities.

2

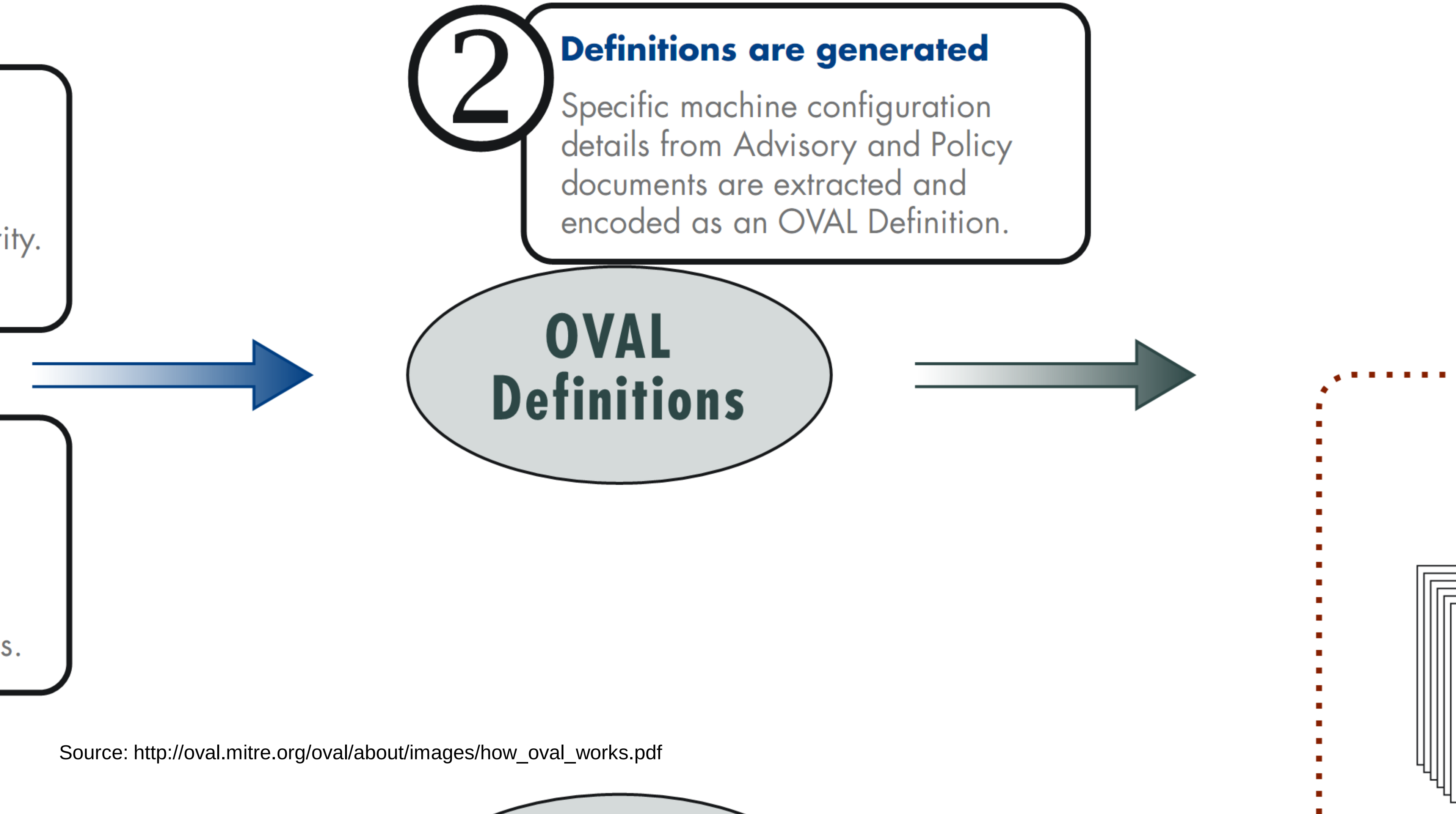
Definitions ar

Specific machin
details from Ad
documents are
encoded as an

Source: http://oval.mitre.org/oval/about/images/how_oval_works.pdf

How OVAL works?

2



2

Definitions are generated

Specific machine configuration details from Advisory and Policy documents are extracted and encoded as an OVAL Definition.

Source: http://oval.mitre.org/oval/about/images/how_oval_works.pdf

2

Security advisories

CERT-CC, US-CERT, and other organizations publish security advisories that warn of current threats and system vulnerabilities.

OVAL System Characteristics

Commercial Product

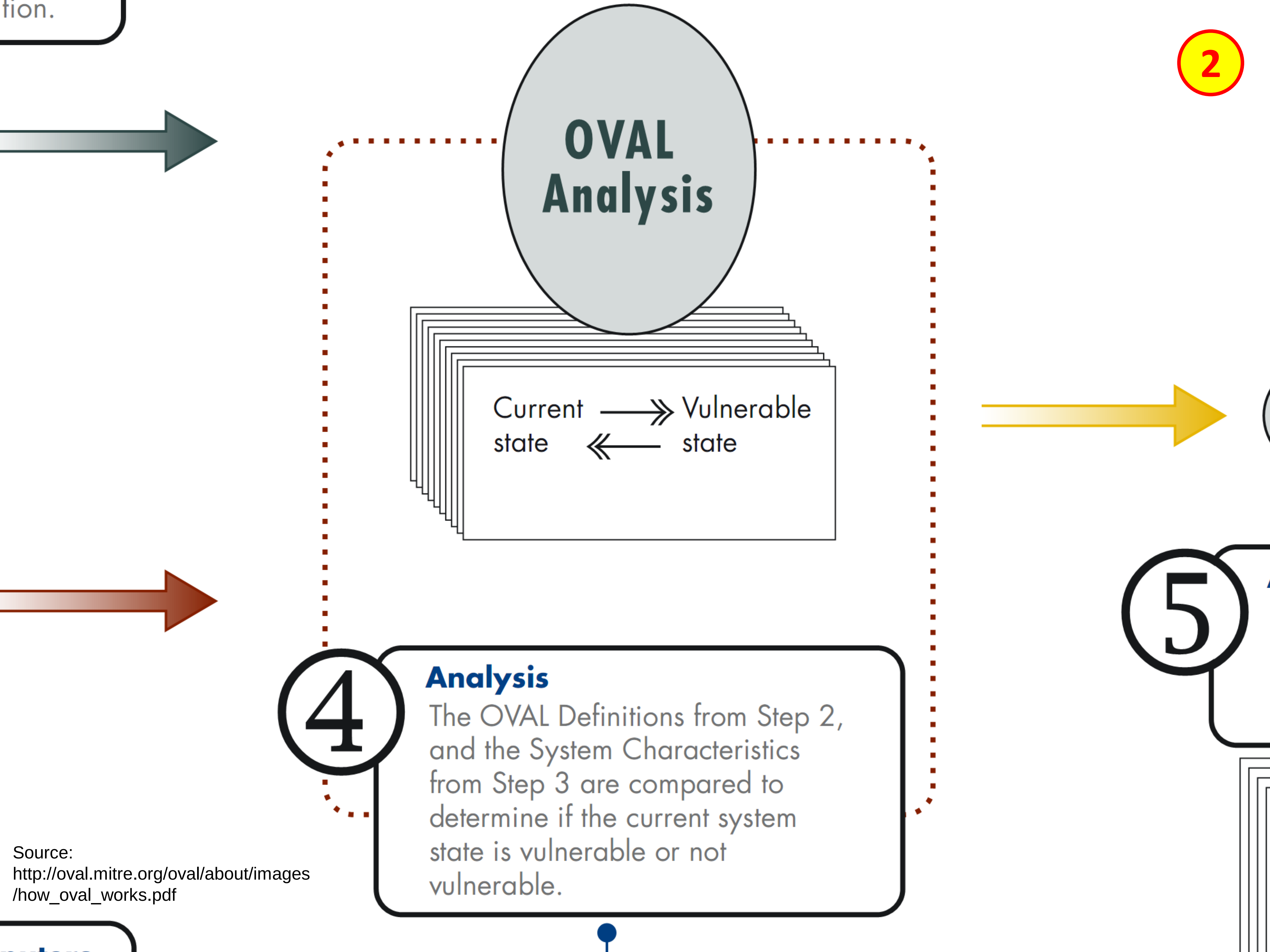
A commercial vulnerability scanner can read OVAL Definitions and use them to gather configuration information to generate a system characteristics file.

3

Data collected from computers

OVAL Definitions are structured to indicate what configuration information needs to be collected from an individual system.

Source: http://oval.mitre.org/oval/about/images/how_oval_works.pdf

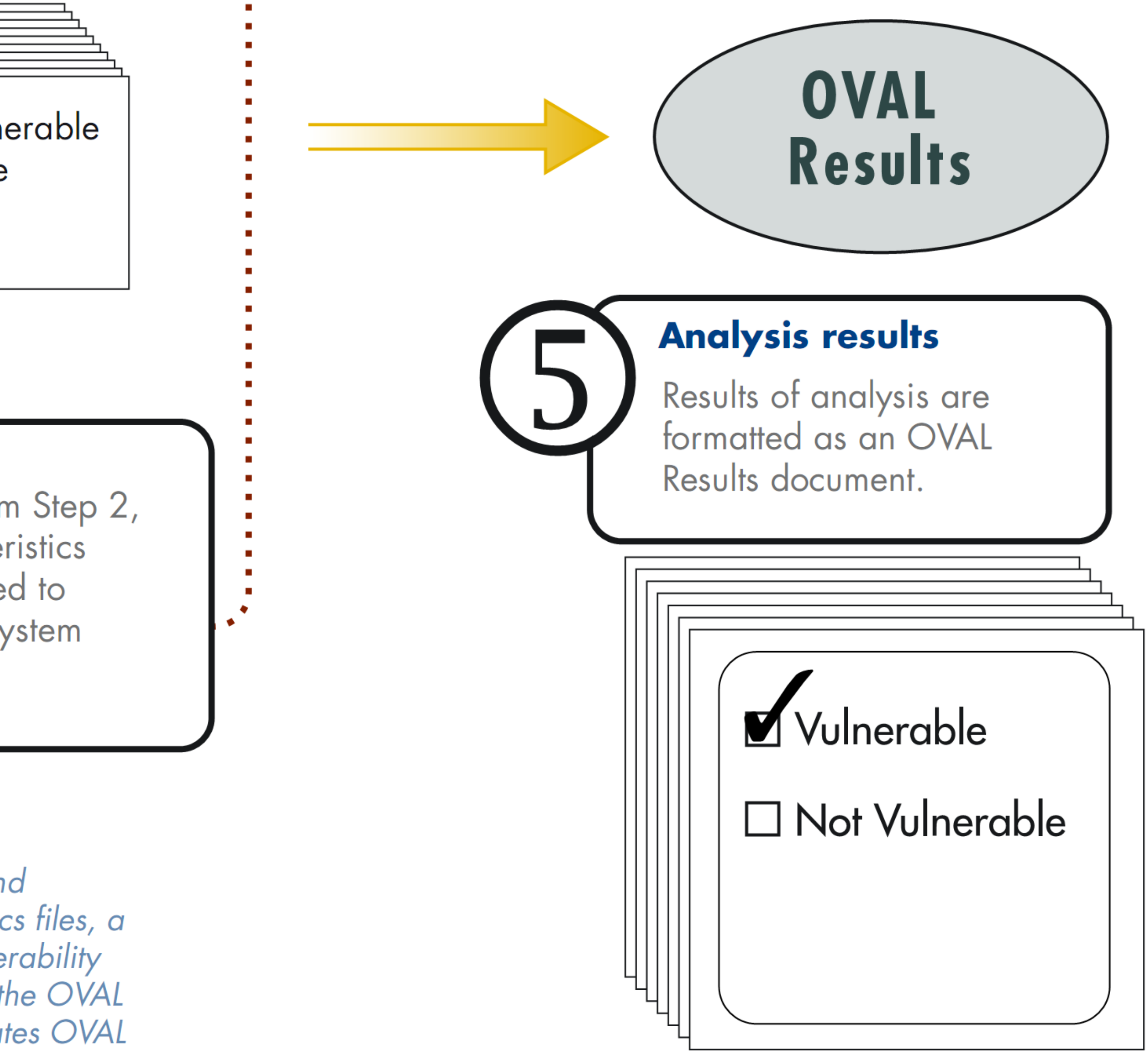


Analysis

The OVAL Definitions from Step 2, and the System Characteristics from Step 3 are compared to determine if the current system state is vulnerable or not vulnerable.

Source: http://oval.mitre.org/oval/about/images/how_oval_works.pdf

2



OVAL Results

5

Analysis results

Results of analysis are formatted as an OVAL Results document.

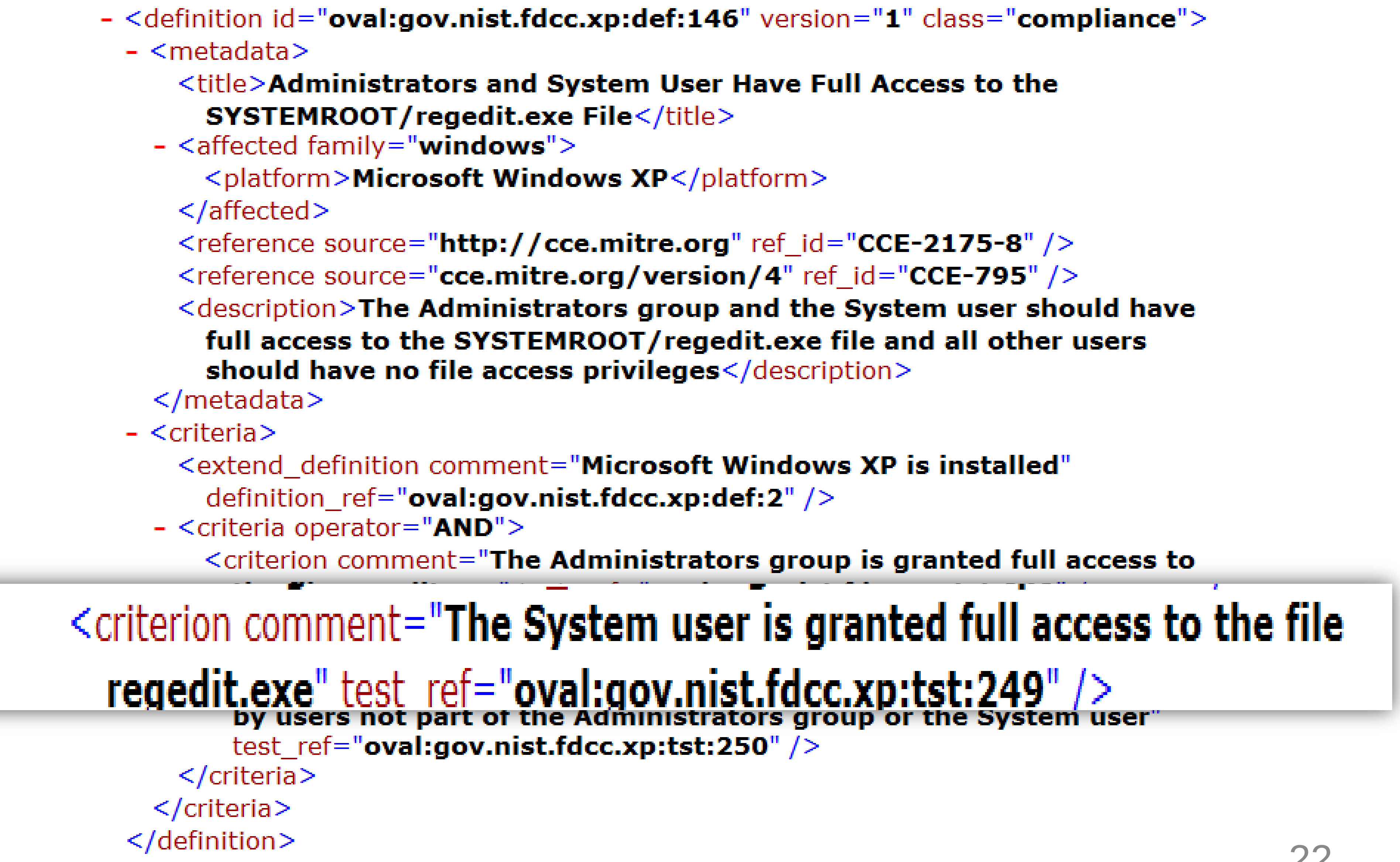
☑ Vulnerable

□ Not Vulnerable

Source: http://oval.mitre.org/oval/about/images/how_oval_works.pdf

Definition

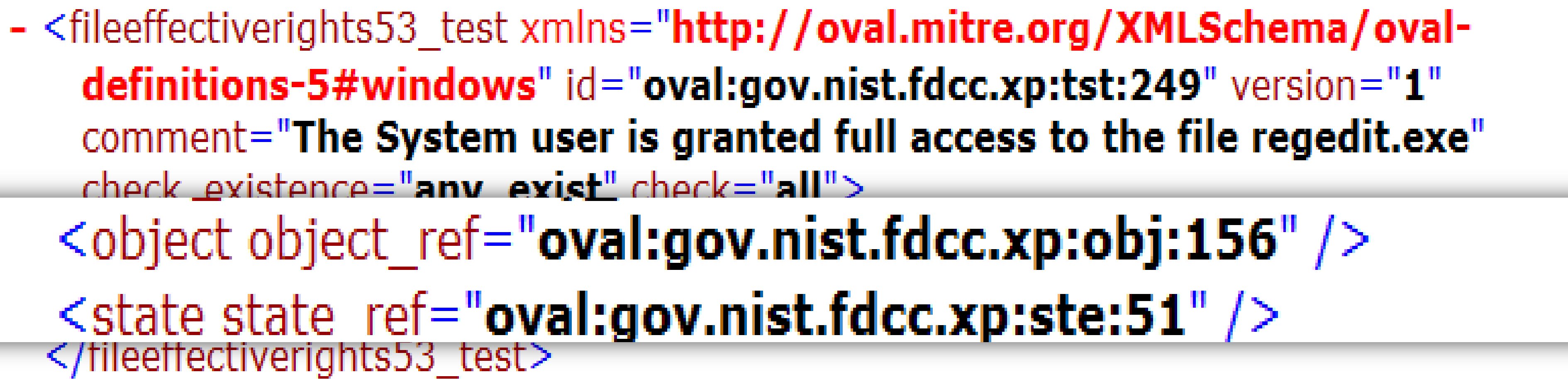
2



```
- <definition id="oval:gov.nist.fdcc.xp:def:146" version="1" class="compliance">
  - <metadata>
      <title>Administrators and System User Have Full Access to the
        SYSTEMROOT/regedit.exe File</title>
    - <affected family="windows">
        <platform>Microsoft Windows XP</platform>
      </affected>
      <reference source="http://cce.mitre.org" ref_id="CCE-2175-8" />
      <reference source="cce.mitre.org/version/4" ref_id="CCE-795" />
      <description>The Administrators group and the System user should have
        full access to the SYSTEMROOT/regedit.exe file and all other users
        should have no file access privileges</description>
    </metadata>
  - <criteria>
      <extend_definition comment="Microsoft Windows XP is installed"
        definition_ref="oval:gov.nist.fdcc.xp:def:2" />
    - <criteria operator="AND">
        <criterion comment="The Administrators group is granted full access to
          [illegible]
  <criterion comment="The System user is granted full access to the file
     regedit.exe" test_ref="oval:gov.nist.fdcc.xp:tst:249" />
          by users not part of the Administrators group or the System user"
          test_ref="oval:gov.nist.fdcc.xp:tst:250" />
      </criteria>
    </criteria>
  </definition>
```

2

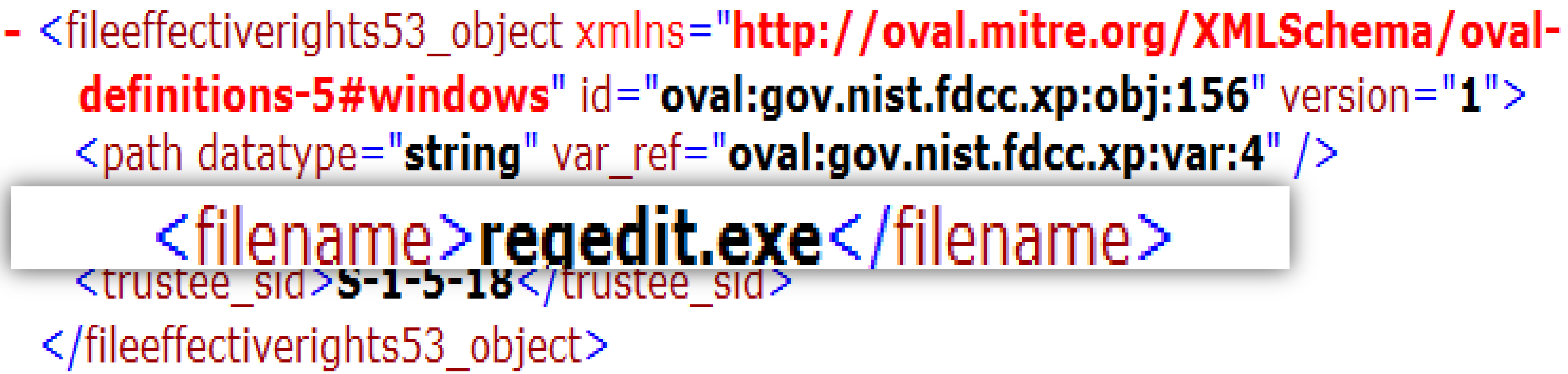
Tests



```
- <fileeffectiverights53_test xmlns="http://oval.mitre.org/XMLSchema/oval-
    definitions-5#windows" id="oval:gov.nist.fdcc.xp:tst:249" version="1"
    comment="The System user is granted full access to the file regedit.exe"
    check_existence="any_exist" check="all">
  <object object_ref="oval:gov.nist.fdcc.xp:obj:156" />
  <state state_ref="oval:gov.nist.fdcc.xp:ste:51" />
  </fileeffectiverights53_test>
```

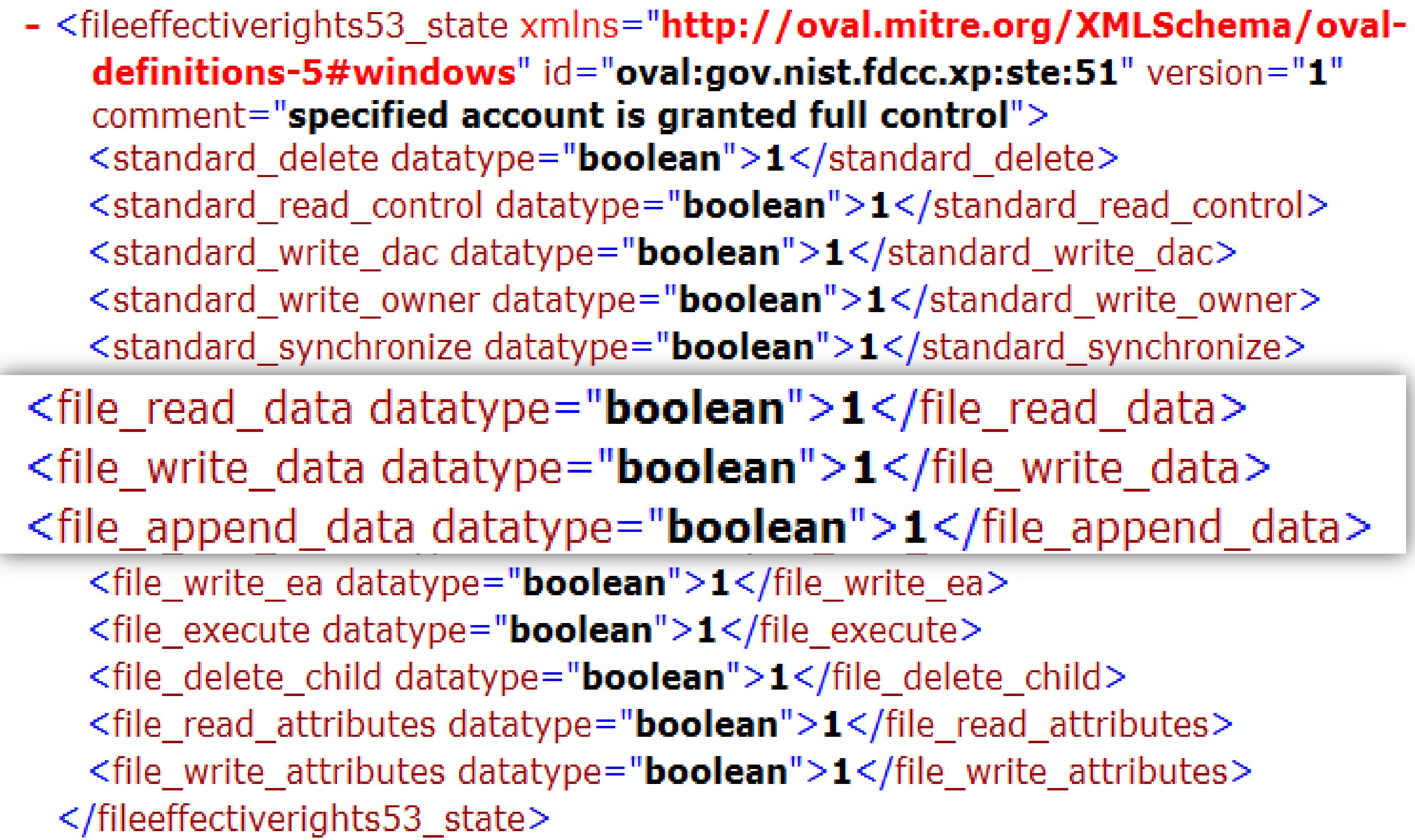
2

Object



```
- <fileeffectiverights53_object xmlns="http://oval.mitre.org/XMLSchema/oval-
    definitions-5#windows" id="oval:gov.nist.fdcc.xp:obj:156" version="1">
    <path datatype="string" var_ref="oval:gov.nist.fdcc.xp:var:4" />
        <filename>regedit.exe</filename>
    <trustee_sid>S-1-5-18</trustee_sid>
  </fileeffectiverights53_object>
```

State



```
- <fileeffectiverights53_state xmlns="http://oval.mitre.org/XMLSchema/oval-
    definitions-5#windows" id="oval:gov.nist.fdcc.xp:ste:51" version="1"
    comment="specified account is granted full control">
    <standard_delete datatype="boolean">1</standard_delete>
    <standard_read_control datatype="boolean">1</standard_read_control>
    <standard_write_dac datatype="boolean">1</standard_write_dac>
    <standard_write_owner datatype="boolean">1</standard_write_owner>
    <standard_synchronize datatype="boolean">1</standard_synchronize>
    <file_read_data datatype="boolean">1</file_read_data>
    <file_write_data datatype="boolean">1</file_write_data>
    <file_append_data datatype="boolean">1</file_append_data>
    <file_write_ea datatype="boolean">1</file_write_ea>
    <file_execute datatype="boolean">1</file_execute>
    <file_delete_child datatype="boolean">1</file_delete_child>
    <file_read_attributes datatype="boolean">1</file_read_attributes>
    <file_write_attributes datatype="boolean">1</file_write_attributes>
  </fileeffectiverights53_state>
```

3

Common Platform Enumeration (**CPE**)

- CPE is a naming format and dictionary of hardware, operating systems, and applications
  - Based upon the generic syntax for Uniform Resource Identifiers (URI)
  - CPE includes
    - A formal name format
    - A method for checking names against a system
    - A description format for binding text and tests to a name

CPE Name Structure

3

cpe:/ {part} : {vendor} : {product} : {version} : {update} : {edition} : {language}

cpe:/a:acme:wizbang:1.0:update2:pro:en-us

cpe:/o:microsoft:windows_xp:::pro

4

Standard Configurations

- For a large infrastructure, the lack of a standard configuration on each node often leads to a administration nightmare
- Deployment of new software applications is difficult and unpredictable on different configurations
- Vulnerability and patch management can be significantly difficult without a common baseline

Standard Configurations

- Mandated baselines, or minimum configuration of all systems in a critical infrastructure
  - DISA gold disk
  - Federal Desktop Core Configuration (FDCC)
  - DoD Security Technical Implementation Guides (STIGS)
  - NSA Security Guides
  - NIST SP 800-68: Guidance for Securing Microsoft Windows XP Systems for IT Professional
  - Center for Internet Security (CIS) baselines

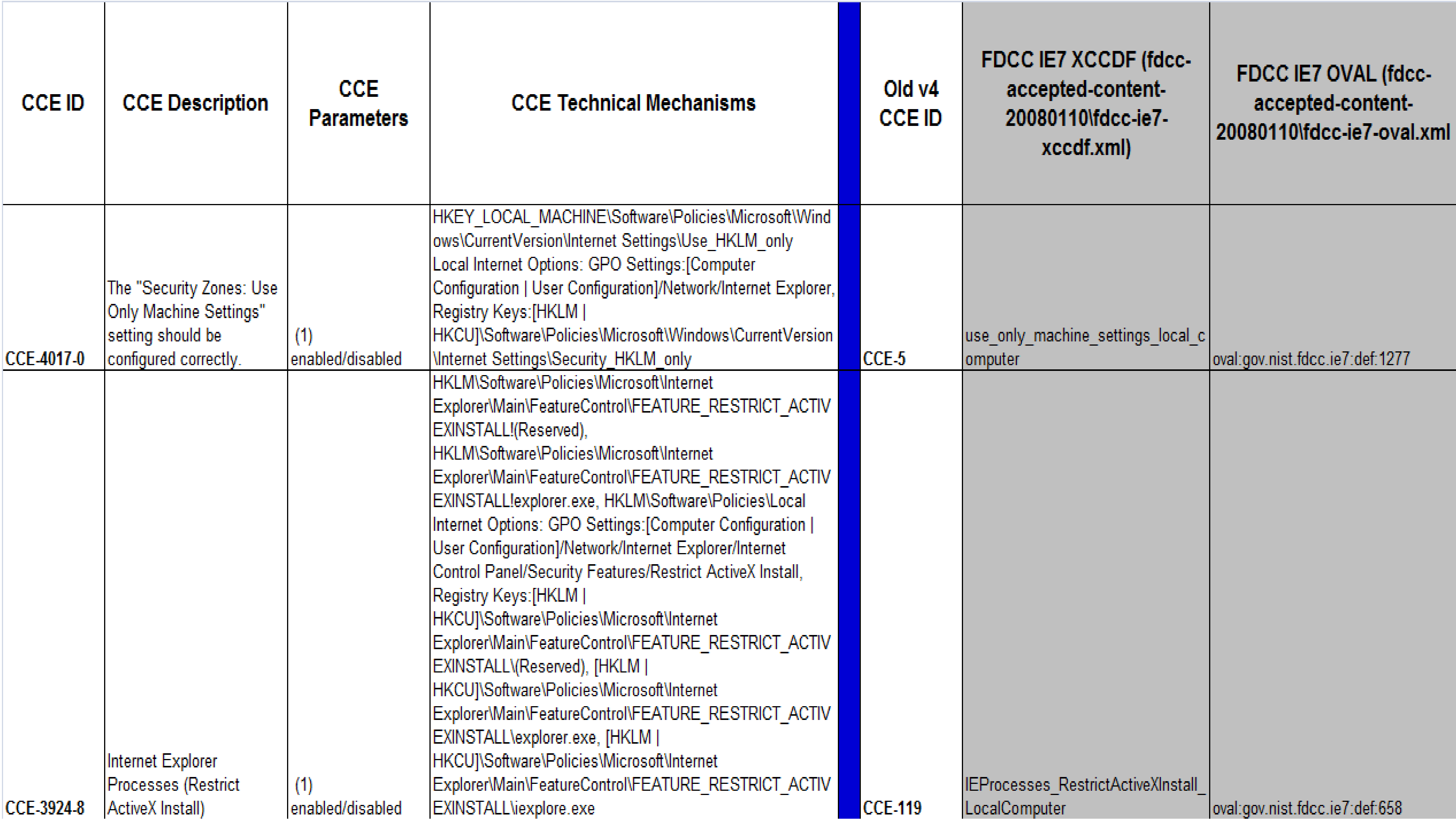
4

Common Configurations Enumeration (CCE)

- CCE a nomenclature and dictionary of security software configurations
  - CCE identifiers link natural language, prose-based configuration guidance documents and machine-readable or executable capabilities such as configuration audit tools
- Does not introduce new entries but maintains traceability to different standard configurations

4

CCE entries for IE7



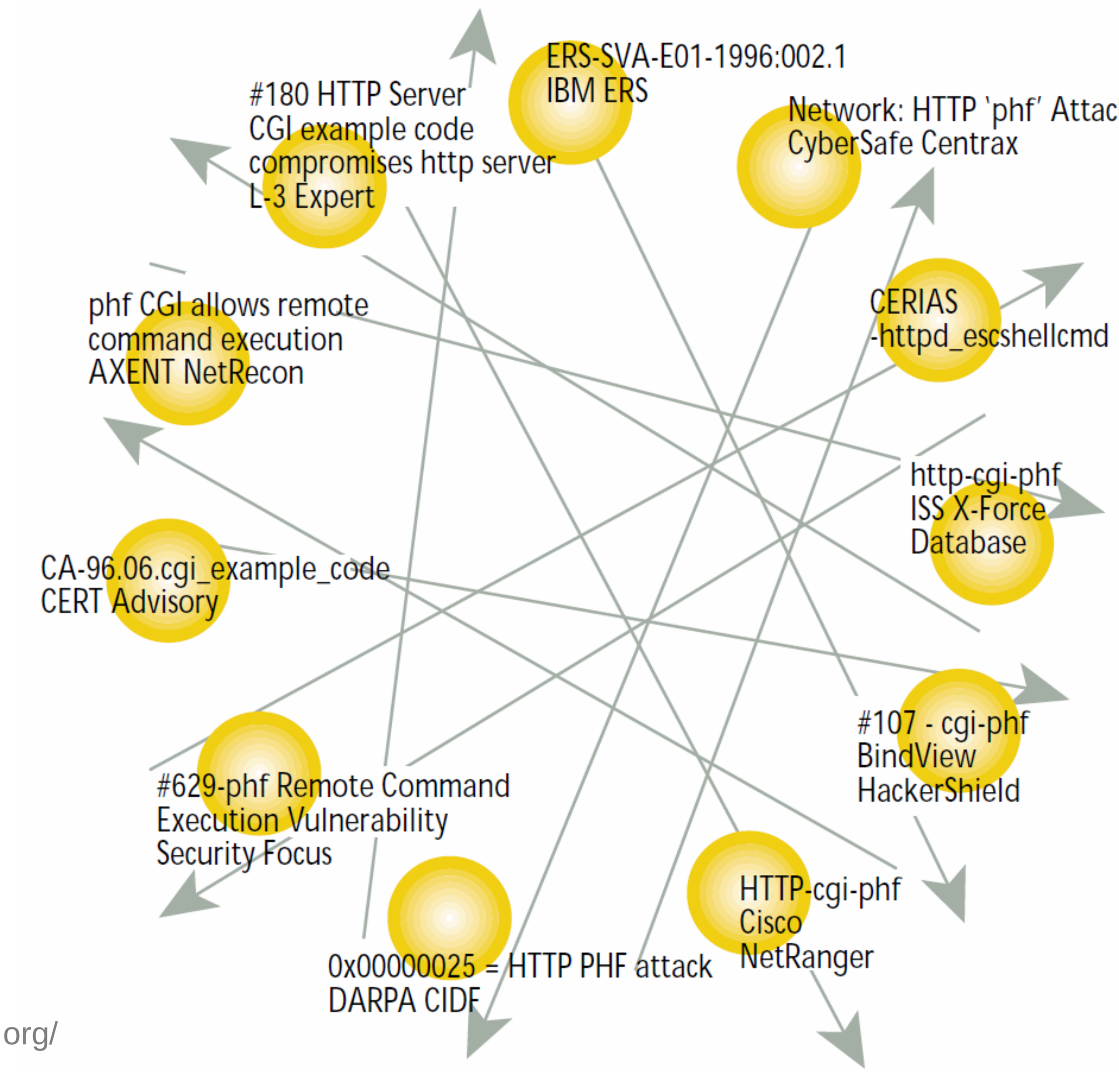
CCE ID	CCE Description	CCE Parameters	CCE Technical Mechanisms	Old v4 CCE ID	FDCC IE7 XCCDF (fdcc-accepted-content-20080110\fdcc-ie7-xccdf.xml)	FDCC IE7 OVAL (fdcc-accepted-content-20080110\fdcc-ie7-oval.xml
CCE-4017-0	The "Security Zones: Use Only Machine Settings" setting should be configured correctly.	(1) enabled/disabled	HKEY_LOCAL_MACHINE\Software\Policies\Microsoft\Windows\CurrentVersion\Internet Settings\Use_HKLM_only Local Internet Options: GPO Settings:[Computer Configuration | User Configuration]/Network/Internet Explorer, Registry Keys:[HKLM | HKCU]\Software\Policies\Microsoft\Windows\CurrentVersion\Internet Settings\Security_HKLM_only	CCE-5	use_only_machine_settings_local_computer	oval:gov.nist.fdcc.ie7:def:1277
CCE-3924-8	Internet Explorer Processes (Restrict ActiveX Install)	(1) enabled/disabled	HKLM\Software\Policies\Microsoft\Internet Explorer\Main\FeatureControl\FEATURE_RESTRICT_ACTIVEXINSTALL!(Reserved), HKLM\Software\Policies\Microsoft\Internet Explorer\Main\FeatureControl\FEATURE_RESTRICT_ACTIVEXINSTALL!explorer.exe, HKLM\Software\Policies\Local Internet Options: GPO Settings:[Computer Configuration | User Configuration]/Network/Internet Explorer/Internet Control Panel/Security Features/Restrict ActiveX Install, Registry Keys:[HKLM | HKCU]\Software\Policies\Microsoft\Internet Explorer\Main\FeatureControl\FEATURE_RESTRICT_ACTIVEXINSTALL\(Reserved), [HKLM | HKCU]\Software\Policies\Microsoft\Internet Explorer\Main\FeatureControl\FEATURE_RESTRICT_ACTIVEXINSTALL\explorer.exe, [HKLM | HKCU]\Software\Policies\Microsoft\Internet Explorer\Main\FeatureControl\FEATURE_RESTRICT_ACTIVEXINSTALL\iexplore.exe	CCE-119	IEProcesses_RestrictActiveXInstall_LocalComputer	oval:gov.nist.fdcc.ie7:def:658

Common Vulnerabilities and Exposures (**CVE**)

- One name for a vulnerability or exposure
- A dictionary rather than a database
- Common language to share tool reports and vulnerability information among different entities
  - TOTAL CVEs: 42100 and counting..
  - On average ~ 15 to 20 added every day

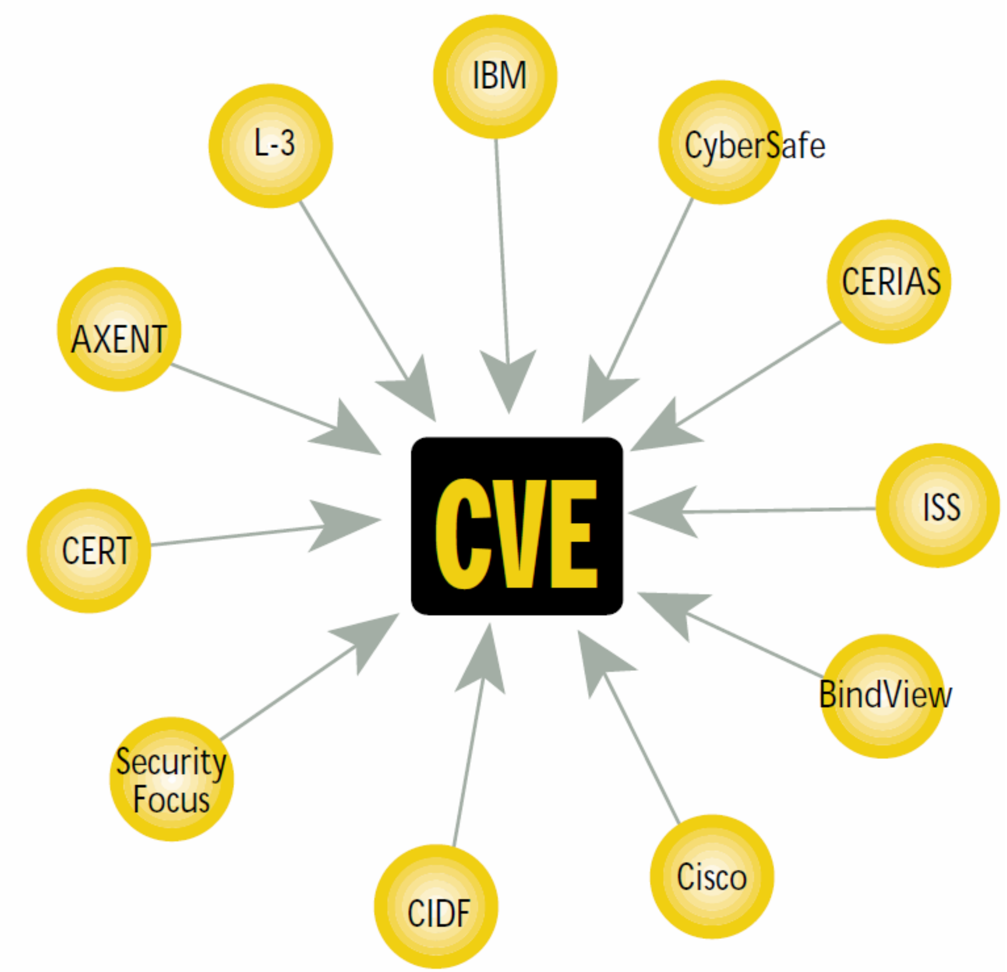
Trying to capture what went wrong….

5



Source: http://cve.mitre.org/

CVE



CVE-1999-0067
CGI phf program allows remote command execution through shell metacharacters.

Source: http://cve.mitre.org/

Common Vulnerability Scoring System (CVSS)

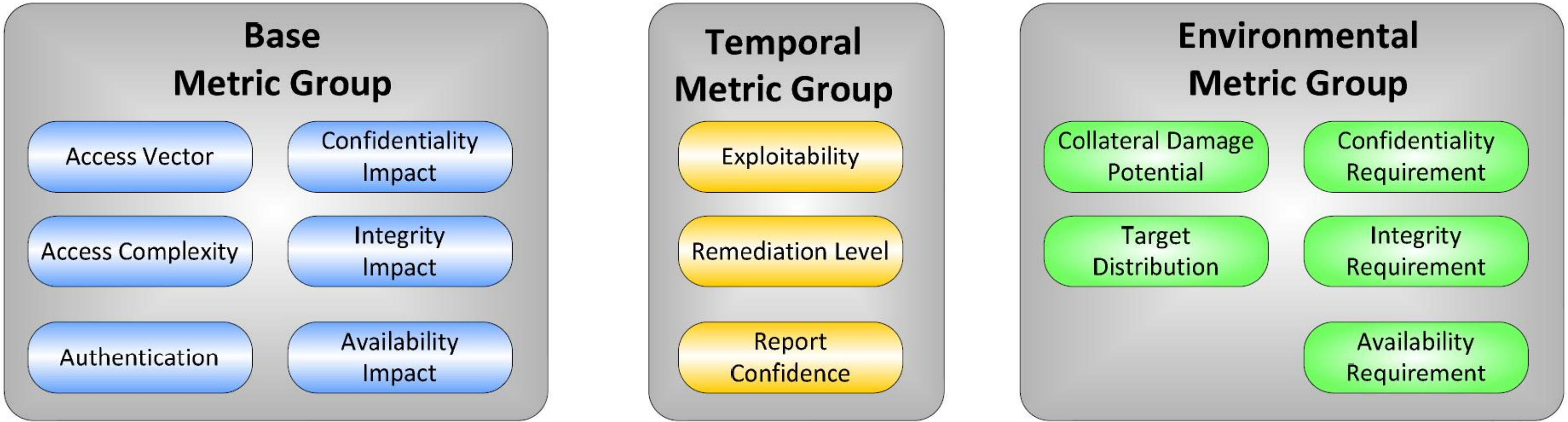
6

- Determining the severity of a vulnerability can be a highly subjective process

- Common Vulnerability Scoring System (CVSS) provides an open specification for measuring the relative severity of software vulnerabilities
  - Quantitative model
  - Repeatable measurement
  - Transparency of vulnerability characteristics that influence the computed scores

CVSS Calculator

- **Base:** the intrinsic and fundamental characteristics of a vulnerability that are constant over time and user environments.
- **Temporal:** Characteristics of a vulnerability that change over time but not among user environments
- **Environmental:** Characteristics of a vulnerability that are relevant and unique to a particular user's environment

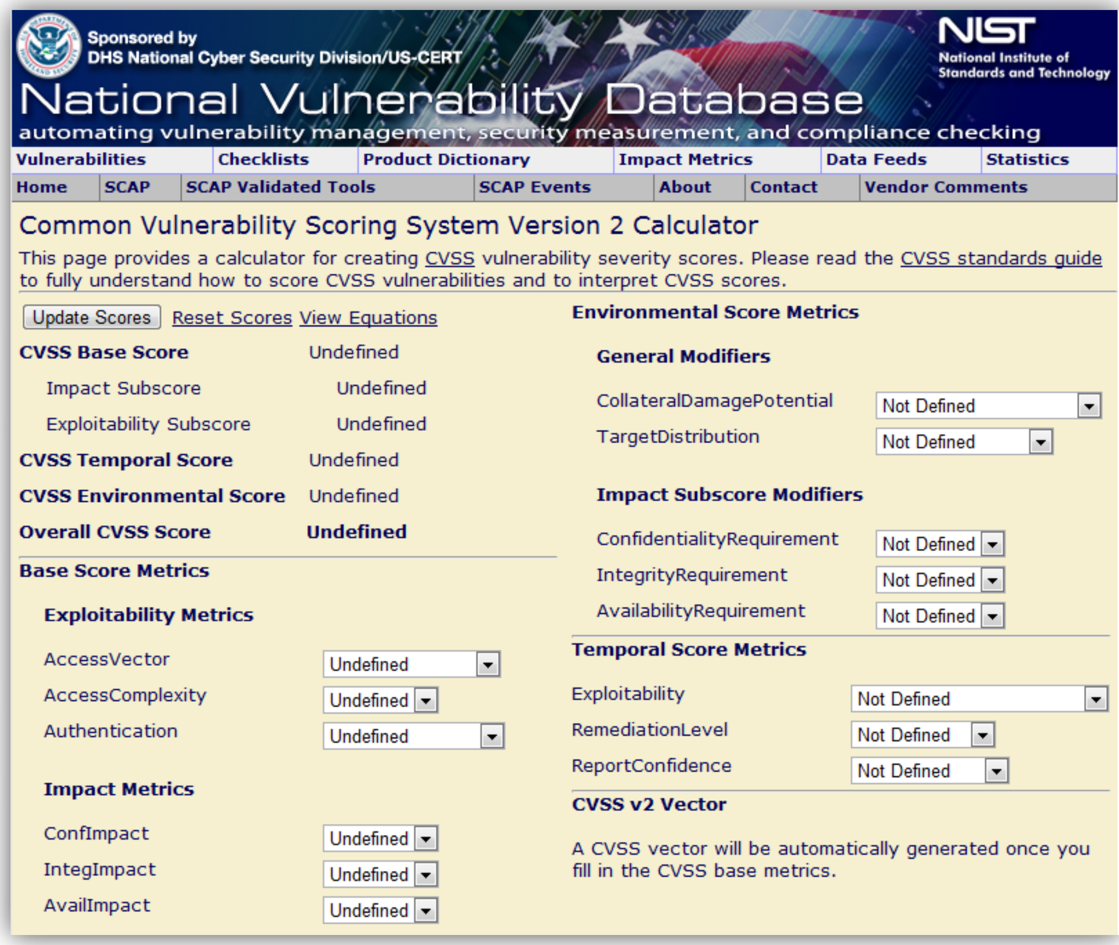


Source: http://nvd.nist.gov/cvss.cfm

6

CVSS computations

- CVSS Calculator
- Equations for the computations
  http://nvd.nist.gov/cvsseq2.htm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DHS National Cyber Security Division/US-CERT
NIST
National Institute of Standards and Technology
National Vulnerability Database
automating vulnerability management, security measurement, and compliance checking
Vulnerabilities
Checklists
Product Dictionary
Impact Metrics
Data Feeds
Statistics
Home
SCAP
SCAP Validated Tools
SCAP Events
About
Contact
Vendor Comments
Update Scores
Reset Scores
View Equations

Common Vulnerability Scoring System Version 2 Calculator

This page provides a calculator for creating CVSS vulnerability severity scores. Please read the CVSS standards guide to fully understand how to score CVSS vulnerabilities and to interpret CVSS scores.

CVSS Base Score	Undefined
Impact Subscore	Undefined
Exploitability Subscore	Undefined
CVSS Temporal Score	Undefined
CVSS Environmental Score	Undefined
Overall CVSS Score	**Undefined**

Base Score Metrics

Exploitability Metrics

AccessVector	Undefined
AccessComplexity	Undefined
Authentication	Undefined

Impact Metrics

ConfImpact	Undefined
IntegImpact	Undefined
AvailImpact	Undefined

Environmental Score Metrics

General Modifiers

CollateralDamagePotential	Not Defined
TargetDistribution	Not Defined

Impact Subscore Modifiers

ConfidentialityRequirement	Not Defined
IntegrityRequirement	Not Defined
AvailabilityRequirement	Not Defined

Temporal Score Metrics

Exploitability	Not Defined
RemediationLevel	Not Defined
ReportConfidence	Not Defined

CVSS v2 Vector

A CVSS vector will be automatically generated once you fill in the CVSS base metrics.

SCAP Usage Scenarios

- Automating checks for known vulnerabilities
- Automating the verification of security configuration settings
- Generating reports that link low-level settings to high-level requirements
- Vulnerability tracking and prioritization
- Scoring and Measurement
- Many others… (malware detection, remediation, etc..)

Implications for software vendors

- Register and use standardized identifiers
- Make the state of security settings available through APIs
  - Be very very careful!
- Develop security software with SCAP validation requirements in mind

Possible SCAP Roles

- Checklist Author (XCCDF)
- Definition Author (OVAL)
- Data Source Maintainer (XCCDF, OVAL,CVE, CCE, CPE)
  - Vulnerability, Patch, Compliance, Inventory enumerations
- Dispatcher (CVSS)
  - Prioritization of tasks based on a uniform vulnerability measuring instrument
- Assessor (Tool Execution and Reporting)

What about People and Process?

- We have automated technology assessment
  - ~60 % of NIST 800-53 controls cannot be automated

    Source: http://nvd.nist.gov/scap/docs/SCAP-webpp-10182006.ppt
  - What about people and process?
- SCAP 2.0 has OCIL in the works
  - The **O**pen **C**hecklist **I**nteractive **L**anguage (OCIL)
    - Expressing a set of questions to be presented to a user
    - Corresponding procedures to interpret responses to those questions
    - http://scap.nist.gov/specifications/ocil/

Should I pay attention to SCAP?

- *The U.S. Federal Government, in cooperation with academia and private industry, is adopting SCAP and encourages its use in support of security automation activities and initiatives*

- *….successfully manage systems in accordance with risk management frameworks such as*
  NIST Special Publication 800-53;
  Department of Defense (DoD) Instruction 8500.2; and the
  Payment Card Industry (PCI) framework

Source: NIST 800-126

Common Attack Pattern Enumeration and Classification (**CAPEC**)

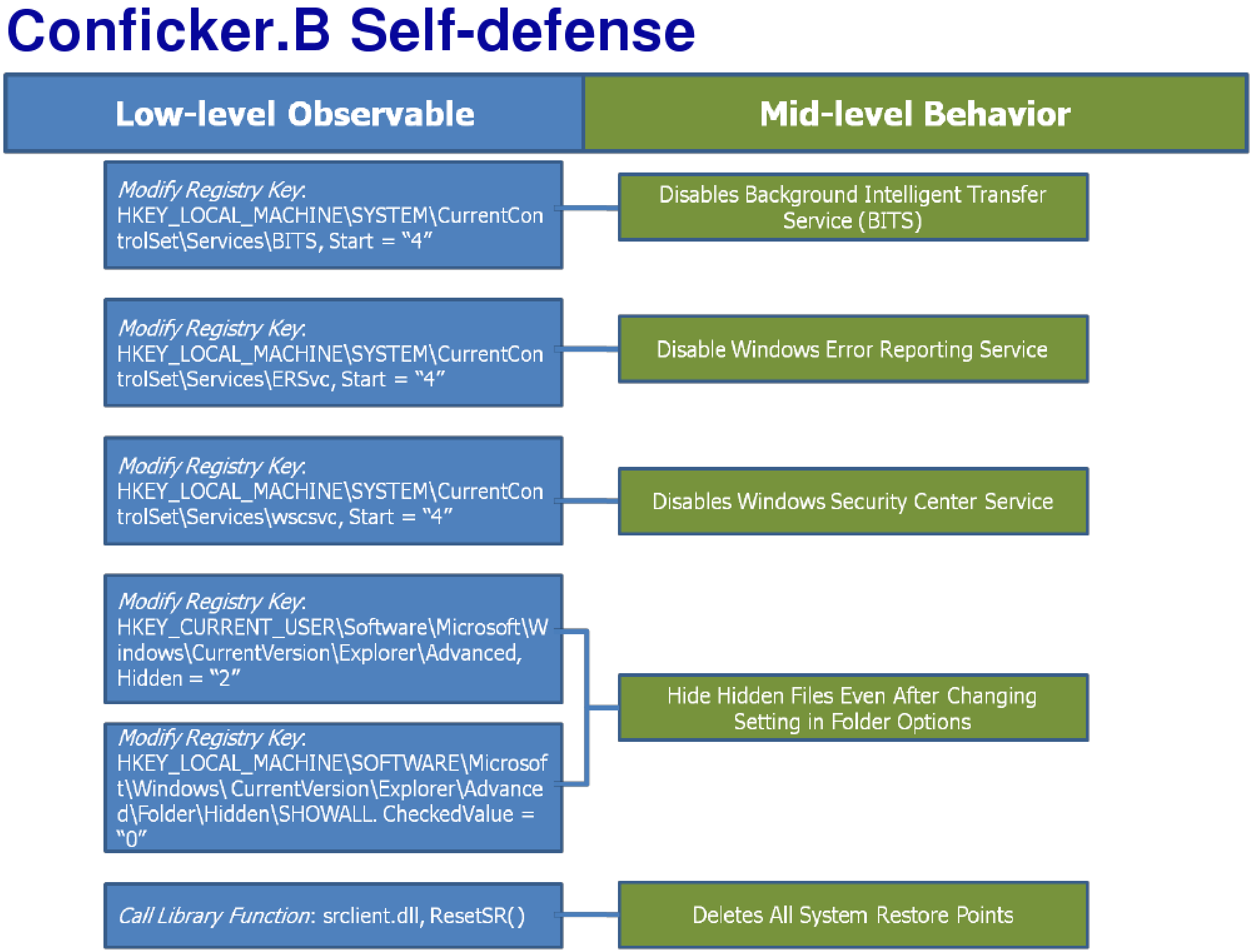
- A shared indexing standard for common attacks patterns used in exploits or malware
- Attack patterns
  - Capture and communicate an attackers perspective
    - Common vocabulary to express attack vectors
  - List of common methods to exploit vulnerabilities
  - A “destructive” way of thinking
    - Know your enemy. Defense alone is not enough.
- http://capec.mitre.org/

Malware Attribute Enumeration and Characterization (**MAEC**)

- A standardized language for encoding and communicating high-fidelity information about malware based upon attributes such as behaviors, artifacts, and attack patterns
- Eliminate the ambiguity and inaccuracy that currently exists in malware descriptions and by reducing reliance on signatures
- http://maec.mitre.org/

MAEC example

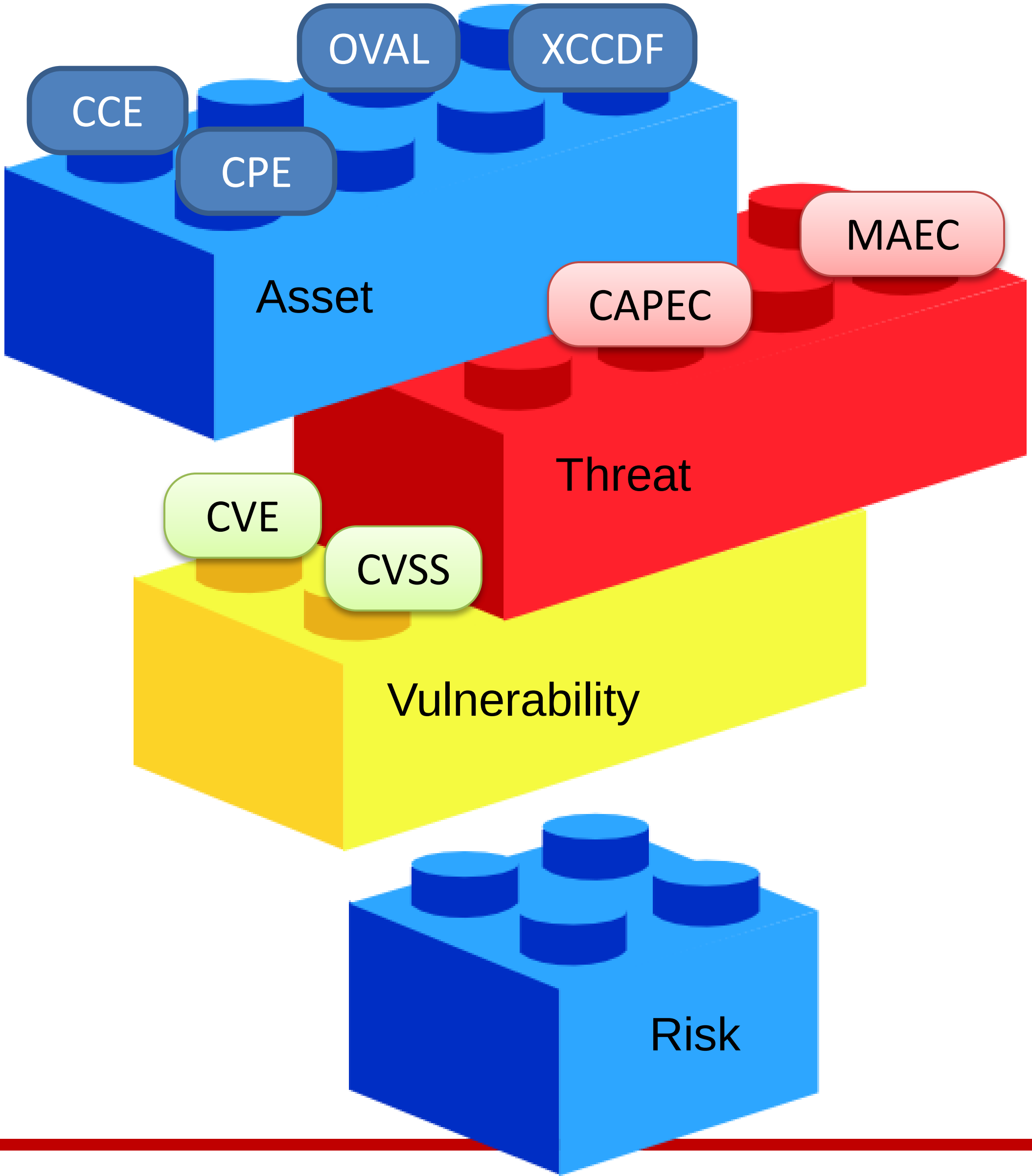
Source: http://maec.mitre.org/



Conficker.B Self-defense

Low-level Observable	Mid-level Behavior
Modify Registry Key: HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\BITS, Start = "4"	Disables Background Intelligent Transfer Service (BITS)
Modify Registry Key: HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\ERSvc, Start = "4"	Disable Windows Error Reporting Service
Modify Registry Key: HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\wscsvc, Start = "4"	Disables Windows Security Center Service
Modify Registry Key: HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Explorer\Advanced, Hidden = "2"	Hide Hidden Files Even After Changing Setting in Folder Options
Modify Registry Key: HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\ CurrentVersion\Explorer\Advanced\Folder\Hidden\SHOWALL. CheckedValue = "0"	
Call Library Function: srclient.dll, ResetSR()	Deletes All System Restore Points

Putting it all together



Thank you for your Attention