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Vulnerability Management

Introduction to Processes and Standards

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WP8-T1

Webinar, 27th of May 2021

Public

www.geant.org

The Road Ahead: Vulnerability Management

- Processes & Standards - 27th of May
  - Processes: ISO 29147 & 30111
  - Standards: CVE, CVSS & CPE
- Vulnerability Information Dissemination - 8th of June
  - How to get and distribute vulnerability information in your organization
- Patch Management - 11th of June
  - How to keep track and fix vulnerabilities

The Road Ahead: Finding Vulnerabilities I

- Local Vulnerability Scanning - 28th of June
  - Finding vulnerabilities from inside
- Network Vulnerability Scanning - 30th of June
  - How to plan and conduct network scans
  - Tools: Nmap, OpenVAS
- Penetration Tests - 5th of July
  - Why, when and how
  - Examples of pen-test tools: ZAP, Metasploit

The Road Ahead: Finding Vulnerabilities II

- Code Audits - 14th of July
    - How to increase the quality of your code
- Vulnerability Disclosure - 16th of July
    - How to properly deal with found vulnerabilities
- Breach and Attack Simulation - 19th of July
    - What would happen if vulnerabilities in your organization are exploited

What we will cover today

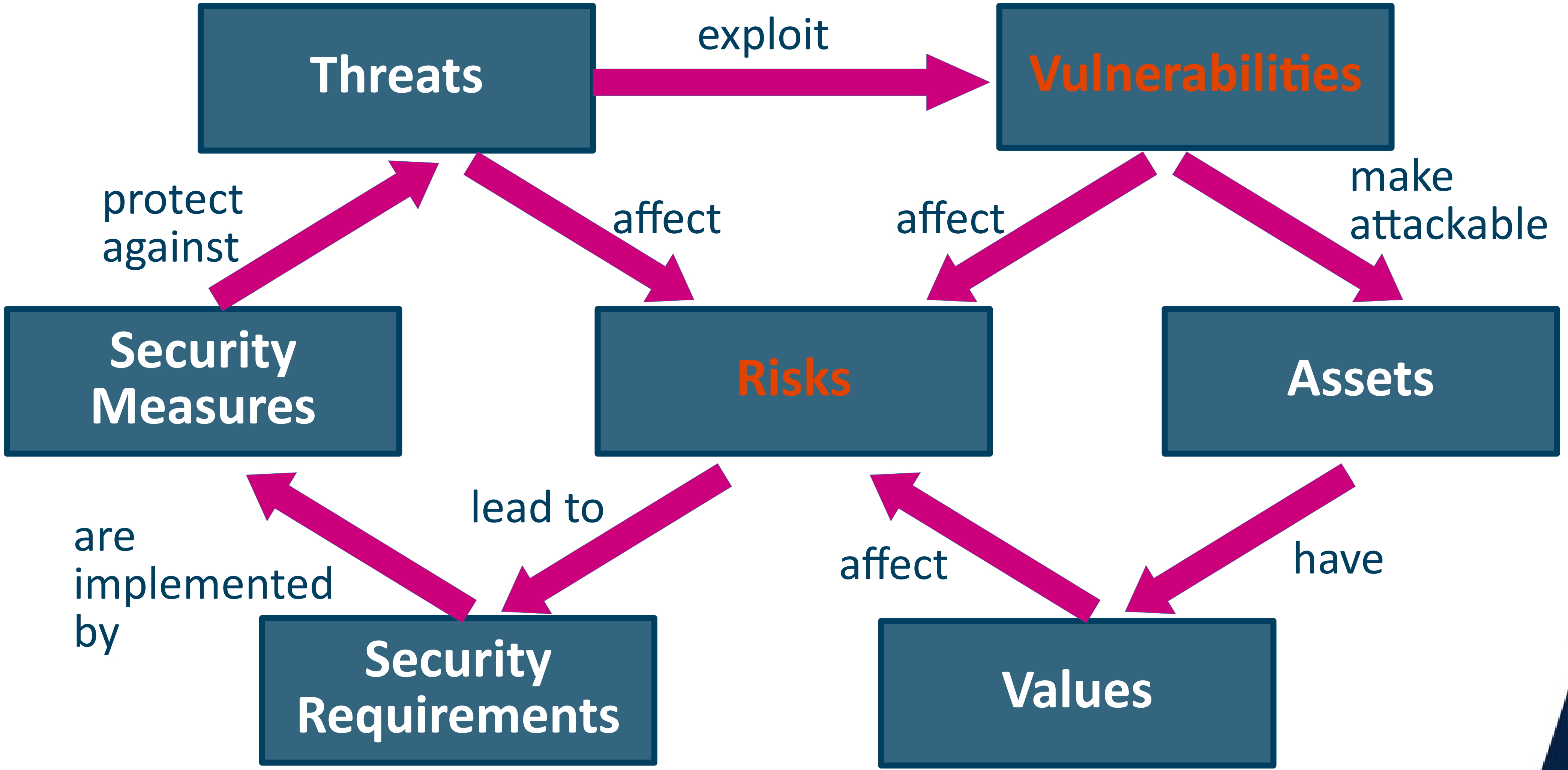
- What are vulnerabilities?
- Vulnerability management processes
  - ISO 29147:2018 - Vulnerability disclosure
  - ISO 30111:2019 - Vulnerability handling process
- Standards to assess vulnerabilities and their impacts
  - CVE
  - CVSS
  - CPE
  - Etc.

Source: MITRE

What is a Vulnerability?

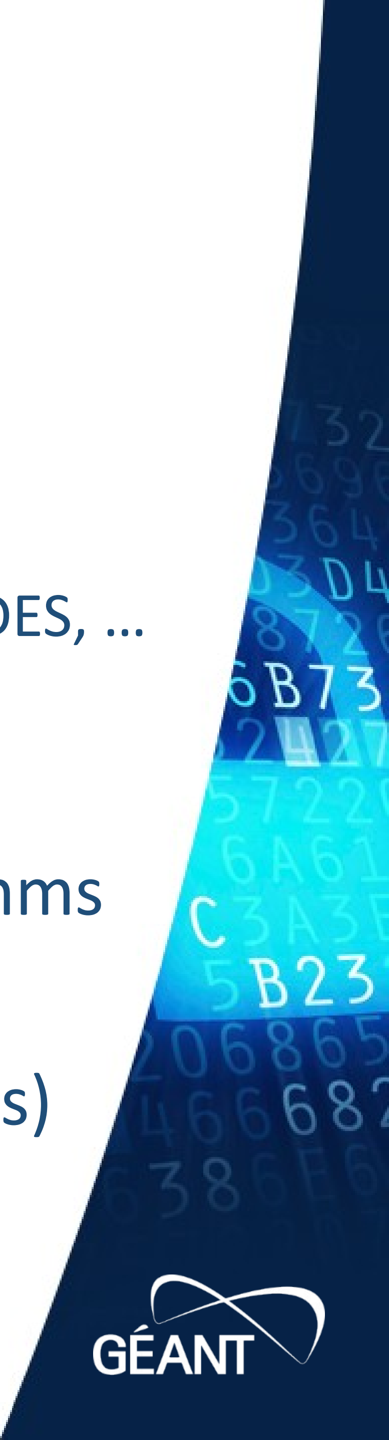
- ENISA: *“The existence of a* ***weakness****,* ***design****, or* ***implementation error*** *that can lead to an unexpected, undesirable event compromising the security of the computer system, network, application, or protocol involved.”*
- ISO/IEC 27005: *“A weakness of an* ***asset*** *or group of assets that can be* ***exploited*** *by one or more* ***threats****, where an asset is anything that has value to the organization, its business operations and their continuity, including information resources that support the organization's mission.”*
- IETF RFC 4949: *“A* ***flaw*** *or* ***weakness*** *in a system's* ***design****,* ***implementation****, or* ***operation and management*** *that could be exploited to violate the system's security policy.”*

Vulnerabilities & Risk



Design Error

- Fundamental flaws in protocols or software design
- Typical cases
  - Clear text authentication in protocols (telnet, ftp, …)
  - Weak or outdated encryption or hash algorithms: MD3/4/5, SHA-1, DES, …
  - Flawed authentication protocols: WEP, WPA-2/3
  - Reliance on IP addresses for authentication
- Most difficult to fix - requires re-design of protocols or algorithms
- Fix usually breaks compatibility
- Systems left vulnerable in transition period (downgrade attacks)



Implementation Error

- Developer has made an error in designing or programming the software
  - No input validation: Buffer overflows, Format string bugs, XSS, SQL-Injection etc.
  - Broken access control: Session fixation, running processes with wrong privileges, etc.
  - Improper error handling
  - Race conditions
  - And many more …
- Fixing requires analysis of the vulnerable code
- Requires testing of the corrected code
  - Open Source: Anybody can contribute (but who does?)
- Needs to be deployed in form of software upgrades (patches)
- To be conducted by developers (and system administrators)

Configuration Error (aka Weakness)

- A mistake in software configuration
  - By system administrator or user
- Like
  - Open accounts with no, known, or weak passwords
  - Active content enabled in web-browser or e-mail client
  - Unneeded network services: RPC interfaces, database mgmt., etc.
  - Disabled security functions: firewall, anti-virus scanner, auto-update, etc.
- Usually easy to fix by correcting the flawed configuration
  - Detection process somewhat different from other vulnerability types
- Can be done in the field, no outside dependency

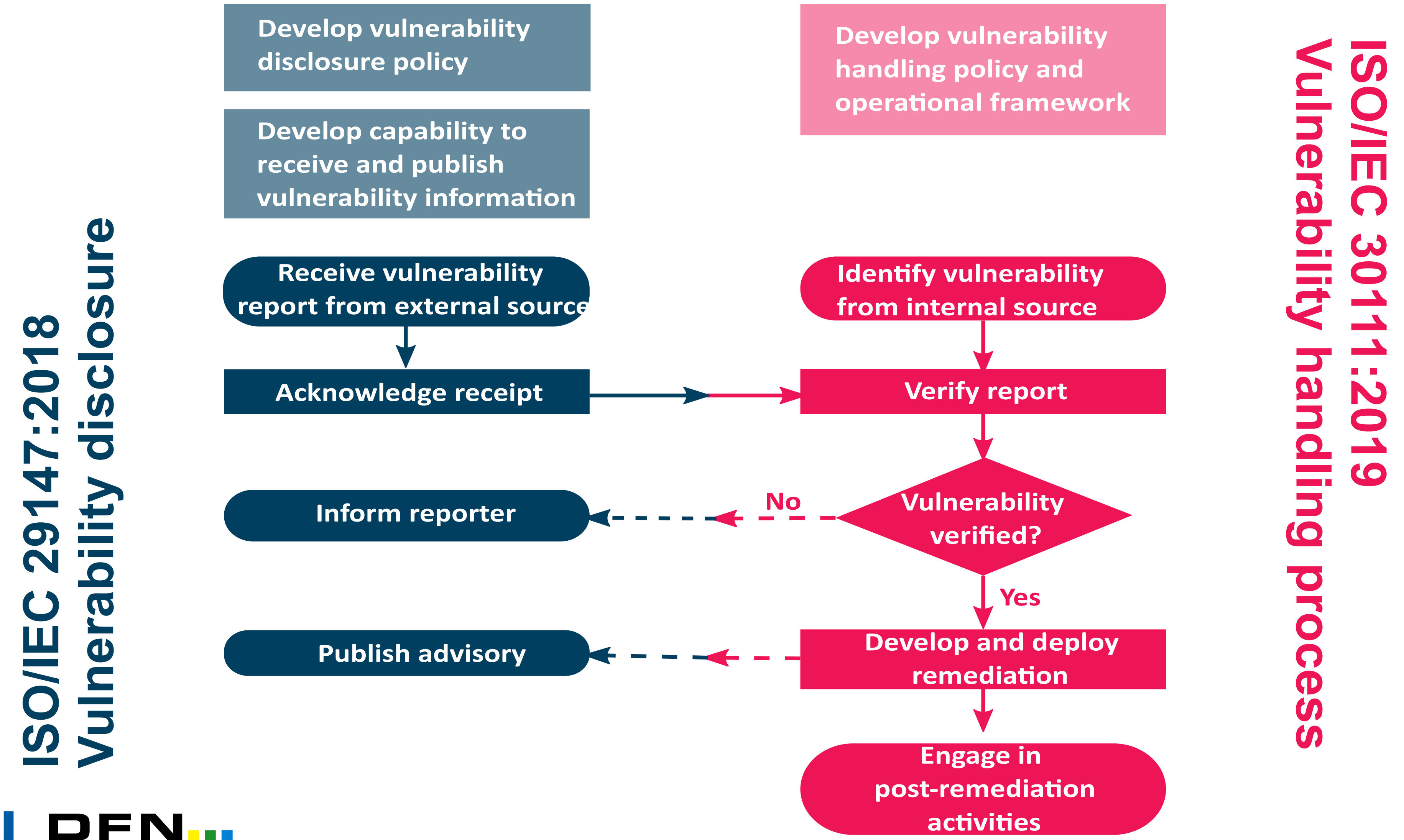
Hardware Error

- Special case - fix typically requires replacing the hardware
- Replacement problems
  - Devices at hard to reach places (field sensors, inside machines, etc.)
  - Costs to replace expensive hardware or large number of cheap devices
  - Time needed to replace large number of deployed devices
- Often errors in hardware design
  - Re-design needed before new hardware can be built
  - Hardware upgrade cycles are much longer than software (re-tooling)
- Software patches to hardware vulnerabilities are workarounds
  - Often with serious performance impact
  - Often no complete mitigation

Operational Errors

- Flaws in the way operations are organized or carried out
- Typical flaws:
  - Blindly trusting phone calls
  - Blindly trusting web-links in e-mails or messages
  - Unsupervised (external) personnel in security areas
  - Unauthorized personnel in security areas
- Typically exploited by social engineering
  - Sometimes without any attack on hard- or software
- Fixing can be difficult - changing human behavior is tricky

Vulnerability handling vs. disclosure



ISO/IEC 29147:2018 Vulnerability disclosure

Develop vulnerability disclosure policy

Develop capability to receive and publish vulnerability information

Receive vulnerability report from external source

Acknowledge receipt

Inform reporter

Publish advisory

ISO/IEC 30111:2019 Vulnerability handling process

Develop vulnerability handling policy and operational framework

Identify vulnerability from internal source

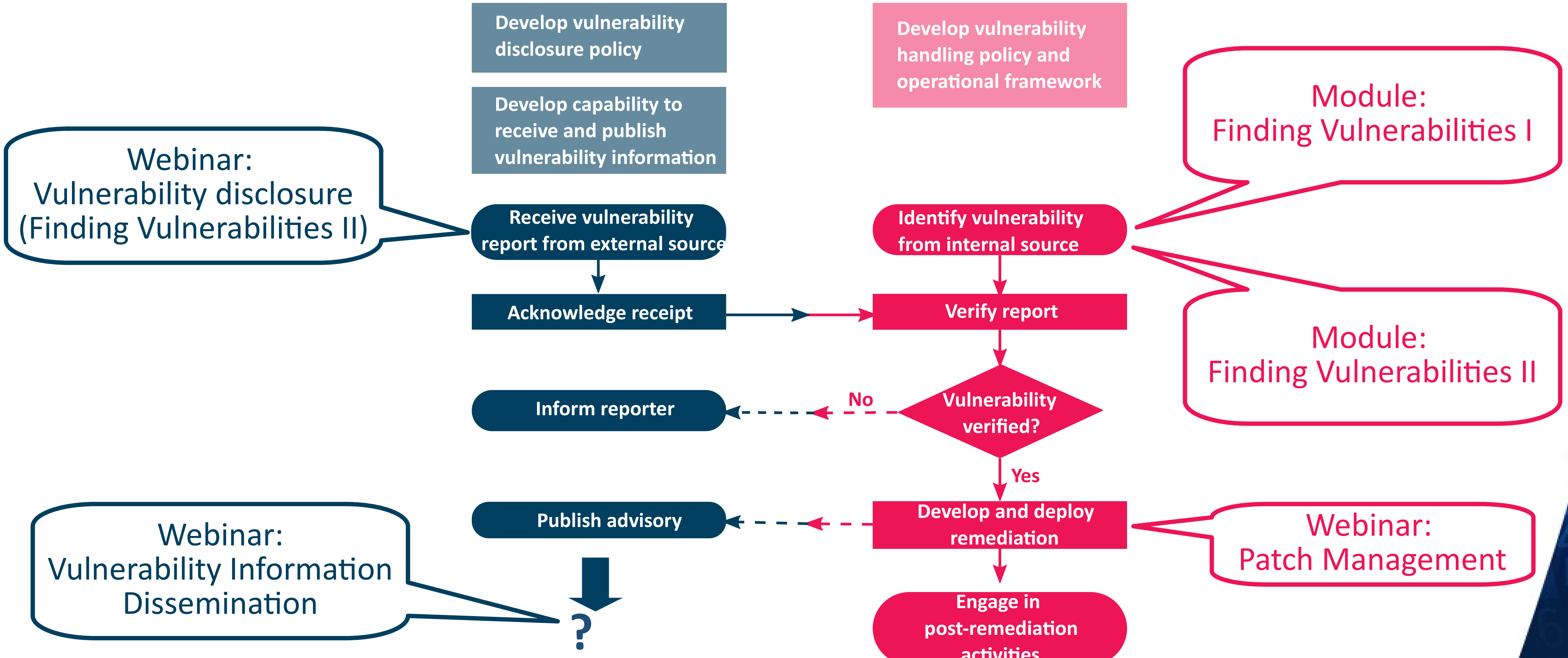
Verify report

Vulnerability verified?

Develop and deploy remediation

Engage in post-remediation activities

What will be covered in the course



Develop vulnerability disclosure policy

Develop capability to receive and publish vulnerability information

Develop vulnerability handling policy and operational framework

Webinar: Vulnerability disclosure (Finding Vulnerabilities II)

Receive vulnerability report from external source

Acknowledge receipt

Identify vulnerability from internal source

Verify report

Module: Finding Vulnerabilities I

Module: Finding Vulnerabilities II

Vulnerability verified?

No

Inform reporter

Yes

Develop and deploy remediation

Publish advisory

Webinar: Patch Management

Engage in post-remediation activities

Webinar: Vulnerability Information Dissemination

?

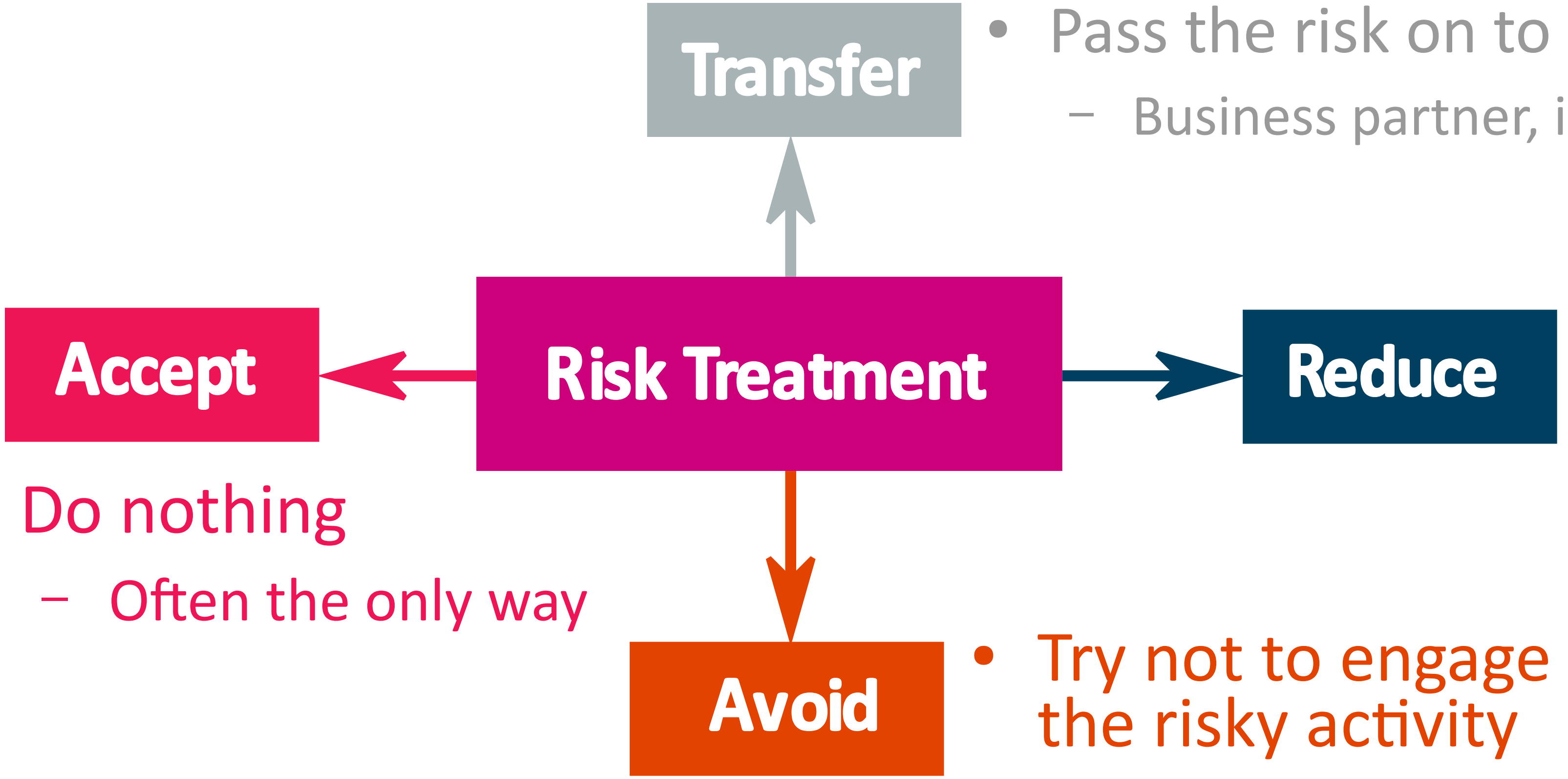
Vulnerability handling policy (ISO 30111)

- Define and clarify organizations intentions when investigating and remediating vulnerabilities
- Internal part
  - Who is responsible, safeguards against premature disclosure
- Public part
  - How the organization will interact with external vulnerability finders
- How to process and resolve potential vulnerabilities
  - Investigation - is the vulnerability real, what are the consequences, etc.
  - Triage - prioritize handling of vulnerabilities
  - Remediation - how to deal with the found & confirmed vulnerabilities

Operational framework (ISO 30111)

- Covers all operational aspects (besides engineering)
- Defines a role to decide on vulnerabilities internally
  - And who assumes that role
- Defines a point of contact to the outside
  - E-mail: security@… (typically)
- Remediation - how to address a vulnerability
  - Patch, fix, upgrade, configuration or documentation change
  - Compare TARA principle

Related Discussion: Risk Management Strategies - TARA



- Pass the risk on to somebody else
  - Business partner, insurer, etc.

- Mitigate or
- Share w/ partner

- Do nothing
  - Often the only way

- Try not to engage in the risky activity

- Measures can be combined

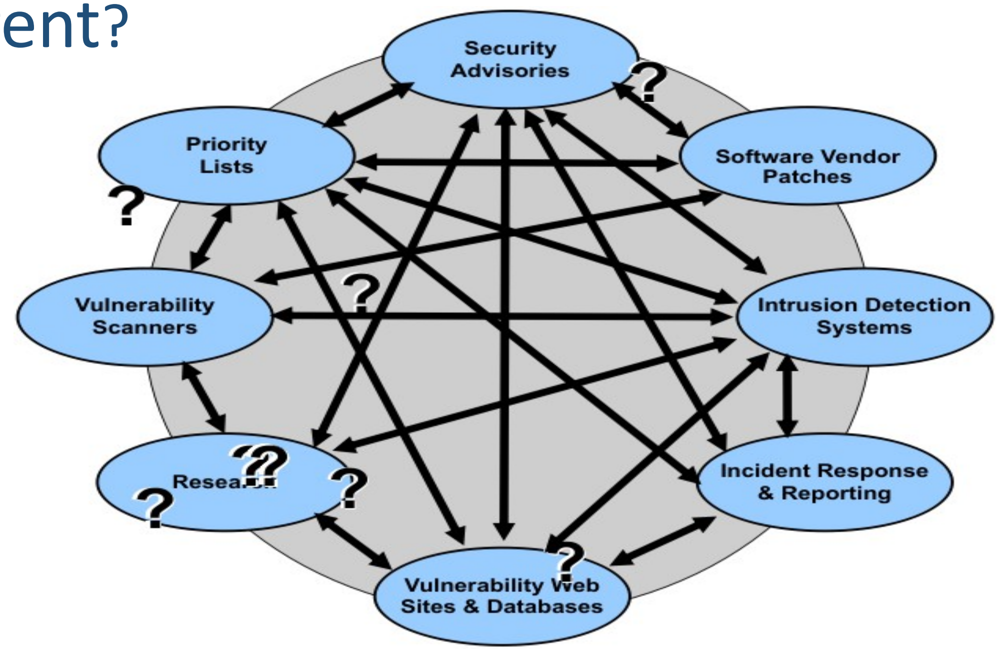
Typical Vulnerability Handling Timescale

Develop Remediation

- Verify Report: Days, given good quality initial report
  - Reproduce/understand bug, identify affected products
- Fix: Days, unless there’s a fundamental problem
  - Uses information from comprehensive evaluation
  - Look for workarounds as well as bugfixes
  - Check related code and design process for the same bug (ideally)
- Test: Weeks
  - Does it fix all problems, on all products?
    - Many different versions, plattforms, languages to check
  - Does it break anything else? Start again if so
- Release, dependent on schedule/urgency

The Problem with Vulnerability Naming

- Vulnerabilities are referenced in many different contexts/products
- Are they talking about the same vulnerability?
  - Is *“a vulnerability in the Linux x.y.z kernel network stack”* the same as in *“Linux kernel a.b network code problem”*?
  - Compare names given to malware by AV vendors
- Or are they different?

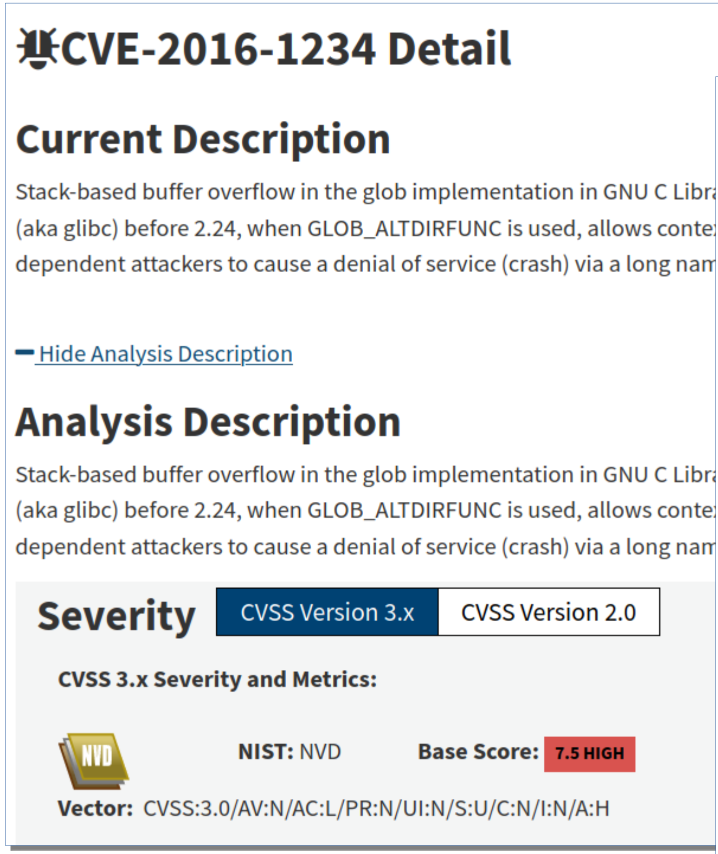

Security Advisories
Software Vendor Patches
Intrusion Detection Systems
Incident Response & Reporting
Vulnerability Web Sites & Databases
Resea...
Vulnerability Scanners
Priority Lists
?

DEUTSCHES FORSCHUNGSNETZ

Standards: Common Vulnerabilities and Exposures

- Idea: Give each vulnerability a unique identifier
- I.e. the CVE-Identifier: CVE-YYYY-NNNNN
  - Also called CVE-Name, CVE-Number, or CVE-ID
- Attached to the CVE-Identifier is additional information
  - (Technical) Details, References
  - Severity
  - Affected platforms
- All in one central repository
- CVE-IDs are assigned by CVE Numbering Authorities (CNAs)
  - If you find a vulnerability, ask your CSIRT or the vendor's PSIRT
  - More about this in another webinar

Example: CVE-2016-1234



CVE-2016-1234 Detail

Current Description

Stack-based buffer overflow in the glob implementation in GNU C Libra (aka glibc) before 2.24, when GLOB_ALTDIRFUNC is used, allows conte dependent attackers to cause a denial of service (crash) via a long nam

− Hide Analysis Description

Analysis Description

Stack-based buffer overflow in the glob implementation in GNU C Libra (aka glibc) before 2.24, when GLOB_ALTDIRFUNC is used, allows conte dependent attackers to cause a denial of service (crash) via a long nam

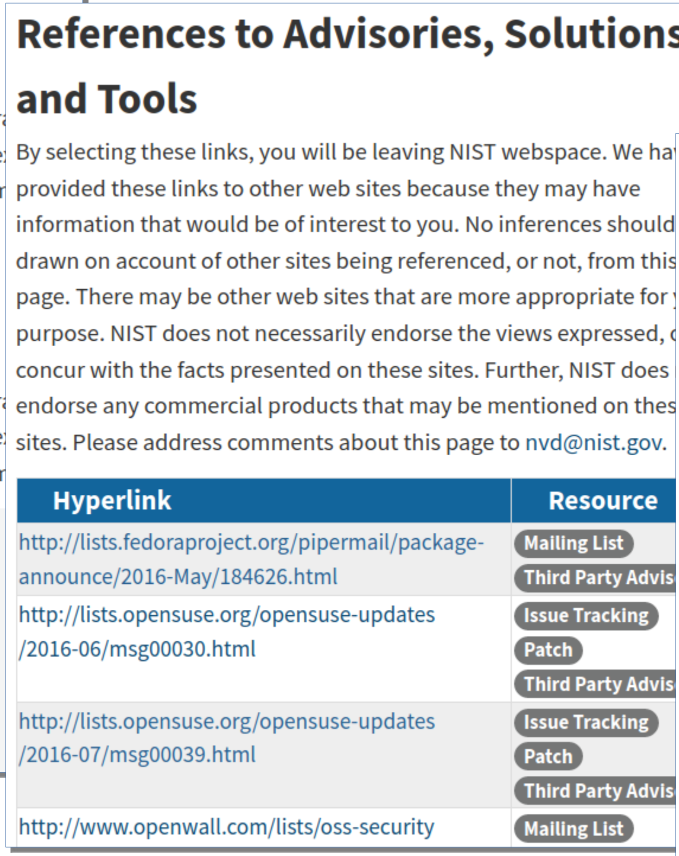
Severity

CVSS Version 3.x | CVSS Version 2.0

CVSS 3.x Severity and Metrics:

NVD **NIST:** NVD **Base Score:** 7.5 HIGH

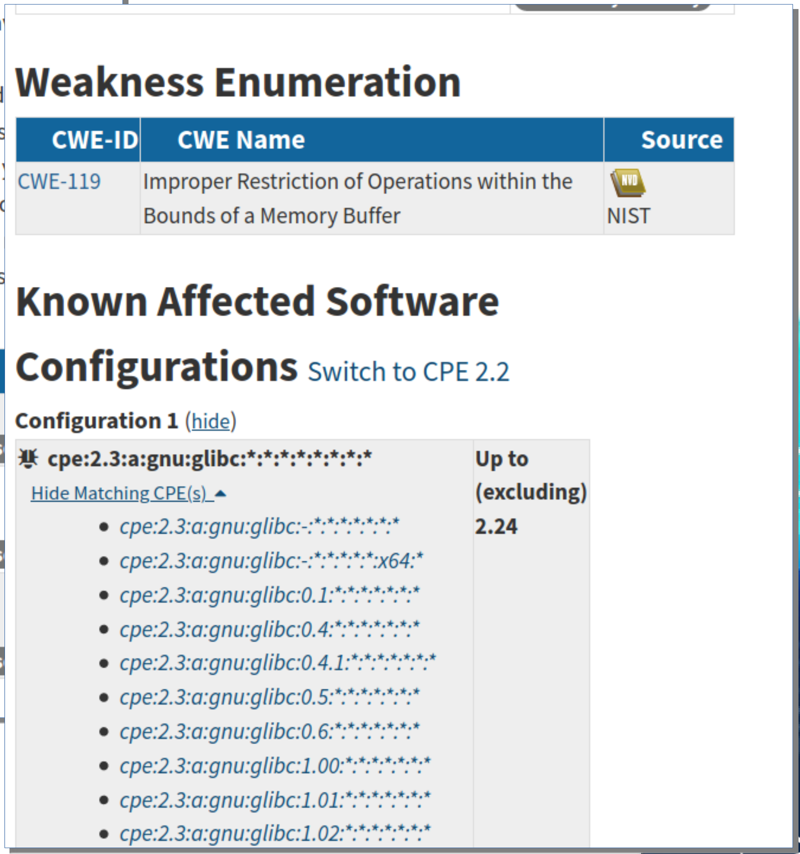
Vector: CVSS:3.0/AV:N/AC:L/PR:N/UI:N/S:U/C:N/I:N/A:H



References to Advisories, Solutions, and Tools

By selecting these links, you will be leaving NIST webspace. We ha provided these links to other web sites because they may have information that would be of interest to you. No inferences should drawn on account of other sites being referenced, or not, from this page. There may be other web sites that are more appropriate for y purpose. NIST does not necessarily endorse the views expressed, o concur with the facts presented on these sites. Further, NIST does endorse any commercial products that may be mentioned on thes sites. Please address comments about this page to nvd@nist.gov.

Hyperlink	Resource
http://lists.fedoraproject.org/pipermail/package-announce/2016-May/184626.html	Mailing List Third Party Advis
http://lists.opensuse.org/opensuse-updates/2016-06/msg00030.html	Issue Tracking Patch Third Party Advis
http://lists.opensuse.org/opensuse-updates/2016-07/msg00039.html	Issue Tracking Patch Third Party Advis
http://www.openwall.com/lists/oss-security	Mailing List



Weakness Enumeration

CWE-ID	CWE Name	Source
CWE-119	Improper Restriction of Operations within the Bounds of a Memory Buffer	NIST

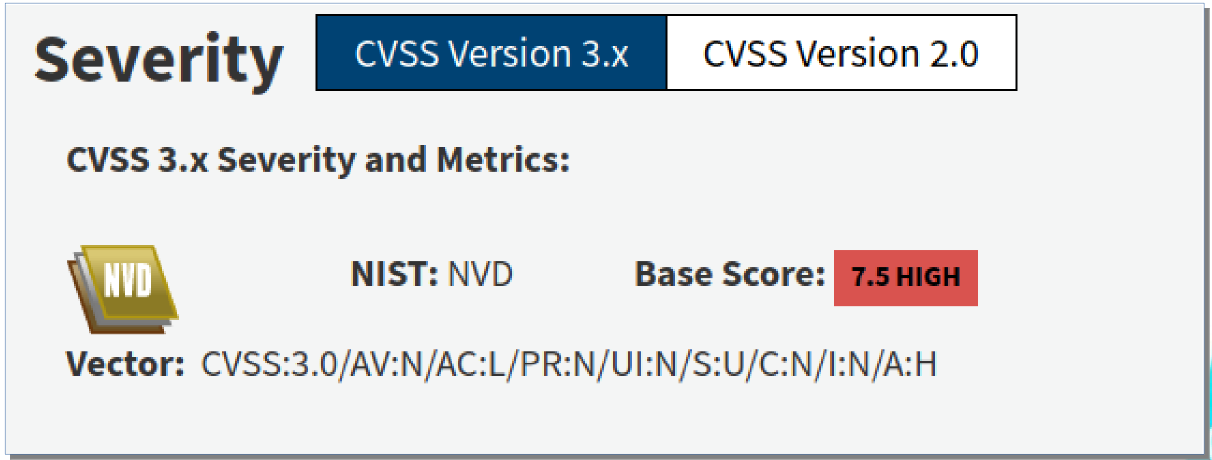
Known Affected Software Configurations Switch to CPE 2.2

Configuration 1 (hide)

cpe:2.3:a:gnu:glibc:*:*:*:*:*:*:*:* Hide Matching CPE(s) • cpe:2.3:a:gnu:glibc:-:*:*:*:*:*:*:* • cpe:2.3:a:gnu:glibc:-:*:*:*:*:*:x64:* • cpe:2.3:a:gnu:glibc:0.1:*:*:*:*:*:*:* • cpe:2.3:a:gnu:glibc:0.4:*:*:*:*:*:*:* • cpe:2.3:a:gnu:glibc:0.4.1:*:*:*:*:*:*:* • cpe:2.3:a:gnu:glibc:0.5:*:*:*:*:*:*:* • cpe:2.3:a:gnu:glibc:0.6:*:*:*:*:*:*:* • cpe:2.3:a:gnu:glibc:1.00:*:*:*:*:*:*:* • cpe:2.3:a:gnu:glibc:1.01:*:*:*:*:*:*:* • cpe:2.3:a:gnu:glibc:1.02:*:*:*:*:*:*:*	**Up to (excluding) 2.24**

Standards: Common Vulnerability Scoring System

- Measure for the severity of a vulnerability (Score)
  - 0 (None) - least severe
  - 0.1-3.9 (Low)
  - 4.0-6.9 (Medium)
  - 7.0-8.9 (High)
  - 9.0-10.0 (Critical) - most severe
- More precisely: Three scores
  - ***Base***
  - ***Temporal*** - changes over time
  - ***Environmental*** - depends on the organizations setup
- Plus context information about exploitability (***Vector***)



Severity CVSS Version 3.x | CVSS Version 2.0

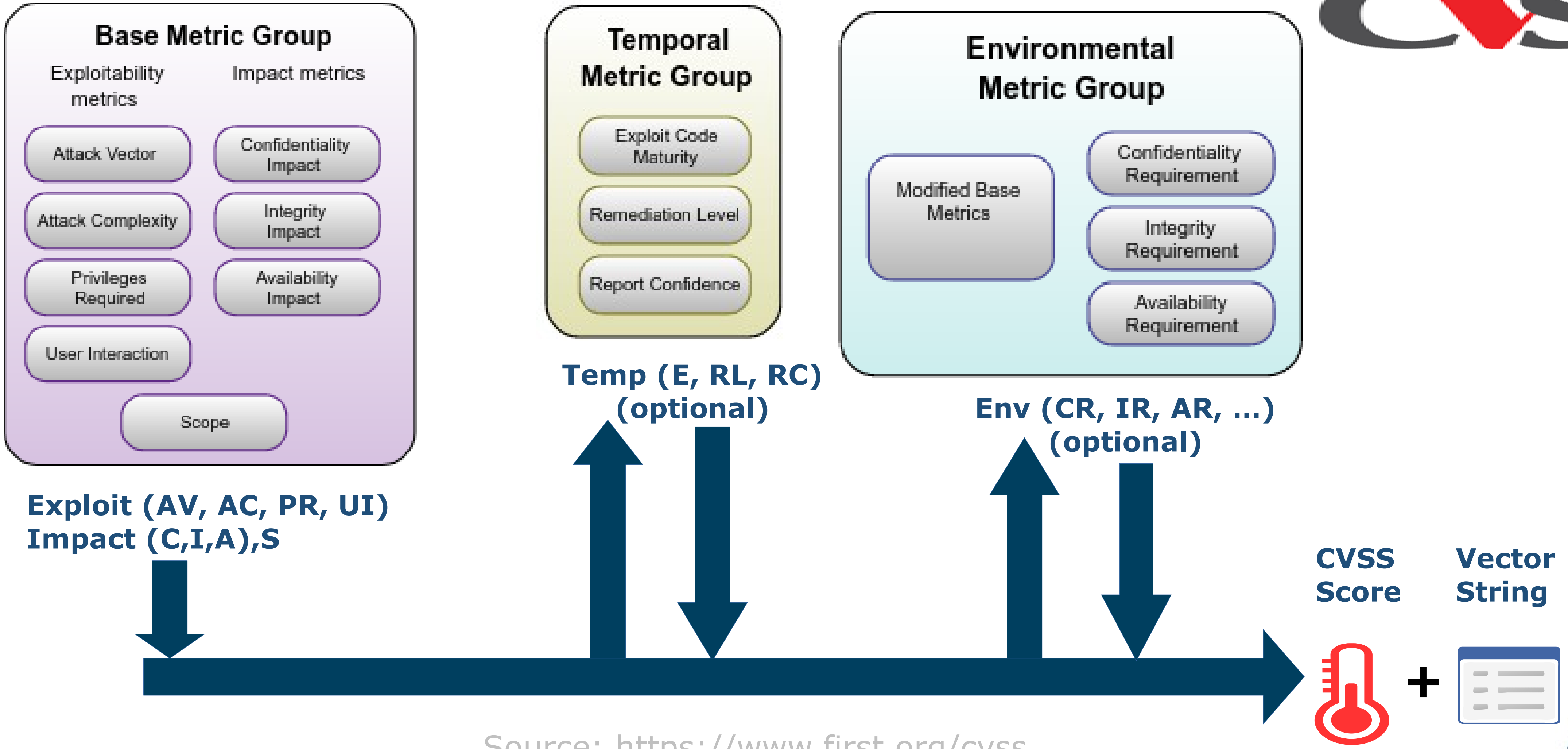
CVSS 3.x Severity and Metrics:

NIST: NVD **Base Score:** 7.5 HIGH

Vector: CVSS:3.0/AV:N/AC:L/PR:N/UI:N/S:U/C:N/I:N/A:H

Standards: Common Vulnerability Scoring System

CVSS



Base Metric Group

Exploitability metrics

- Attack Vector
- Attack Complexity
- Privileges Required
- User Interaction

Impact metrics

- Confidentiality Impact
- Integrity Impact
- Availability Impact

Scope

Temporal Metric Group

- Exploit Code Maturity
- Remediation Level
- Report Confidence

Environmental Metric Group

- Modified Base Metrics
- Confidentiality Requirement
- Integrity Requirement
- Availability Requirement

Exploit (AV, AC, PR, UI)
Impact (C,I,A),S

Temp (E, RL, RC)
(optional)

Env (CR, IR, AR, …)
(optional)

CVSS Score + **Vector String**

Source: https://www.first.org/cvss

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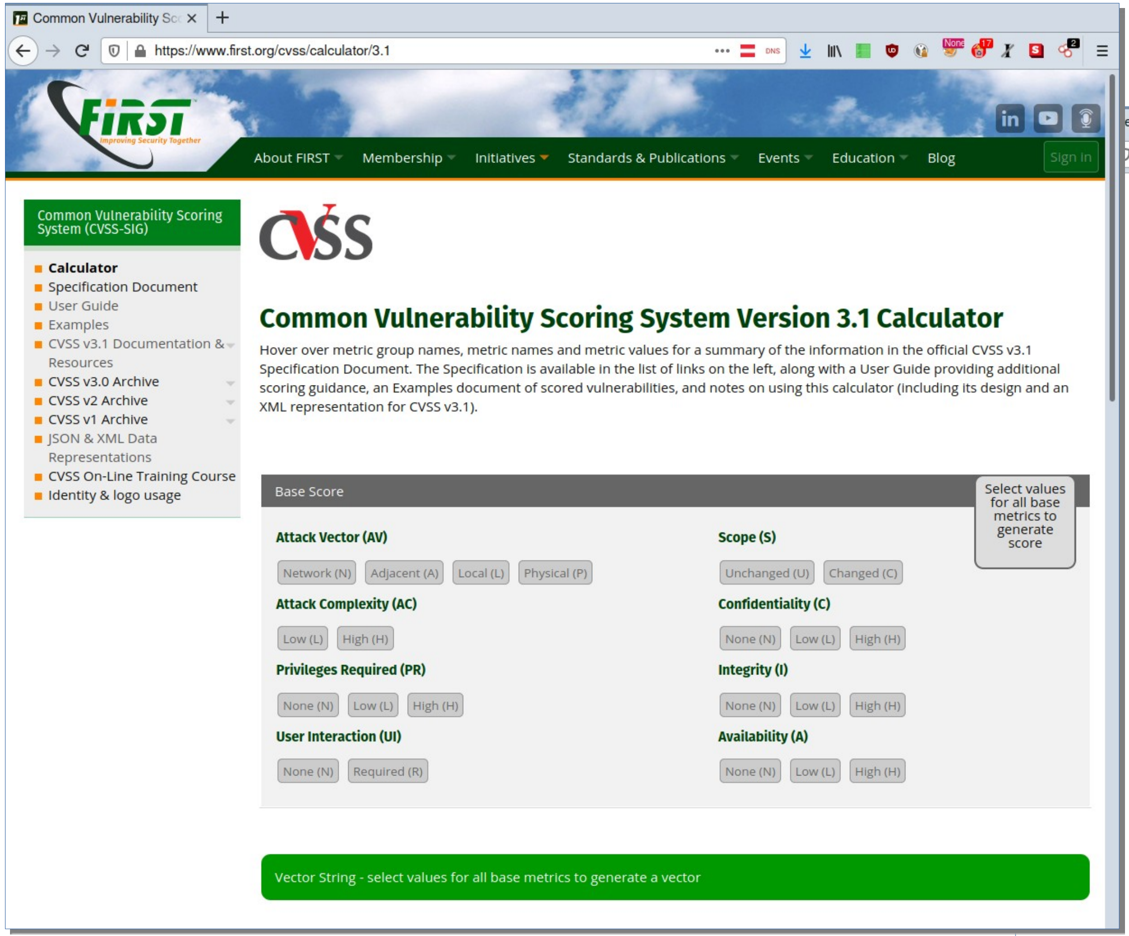
CVSS Demo



Common Vulnerability Sc ×
https://www.first.org/cvss/calculator/3.1
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Common Vulnerability Scoring System (CVSS-SIG)

- **Calculator**
- Specification Document
- User Guide
- Examples
- CVSS v3.1 Documentation & Resources
- CVSS v3.0 Archive
- CVSS v2 Archive
- CVSS v1 Archive
- JSON & XML Data Representations
- CVSS On-Line Training Course
- Identity & logo usage

Common Vulnerability Scoring System Version 3.1 Calculator

Hover over metric group names, metric names and metric values for a summary of the information in the official CVSS v3.1 Specification Document. The Specification is available in the list of links on the left, along with a User Guide providing additional scoring guidance, an Examples document of scored vulnerabilities, and notes on using this calculator (including its design and an XML representation for CVSS v3.1).

Base Score

Select values for all base metrics to generate score

Attack Vector (AV)

Network (N) | Adjacent (A) | Local (L) | Physical (P)

Attack Complexity (AC)

Low (L) | High (H)

Privileges Required (PR)

None (N) | Low (L) | High (H)

User Interaction (UI)

None (N) | Required (R)

Scope (S)

Unchanged (U) | Changed (C)

Confidentiality (C)

None (N) | Low (L) | High (H)

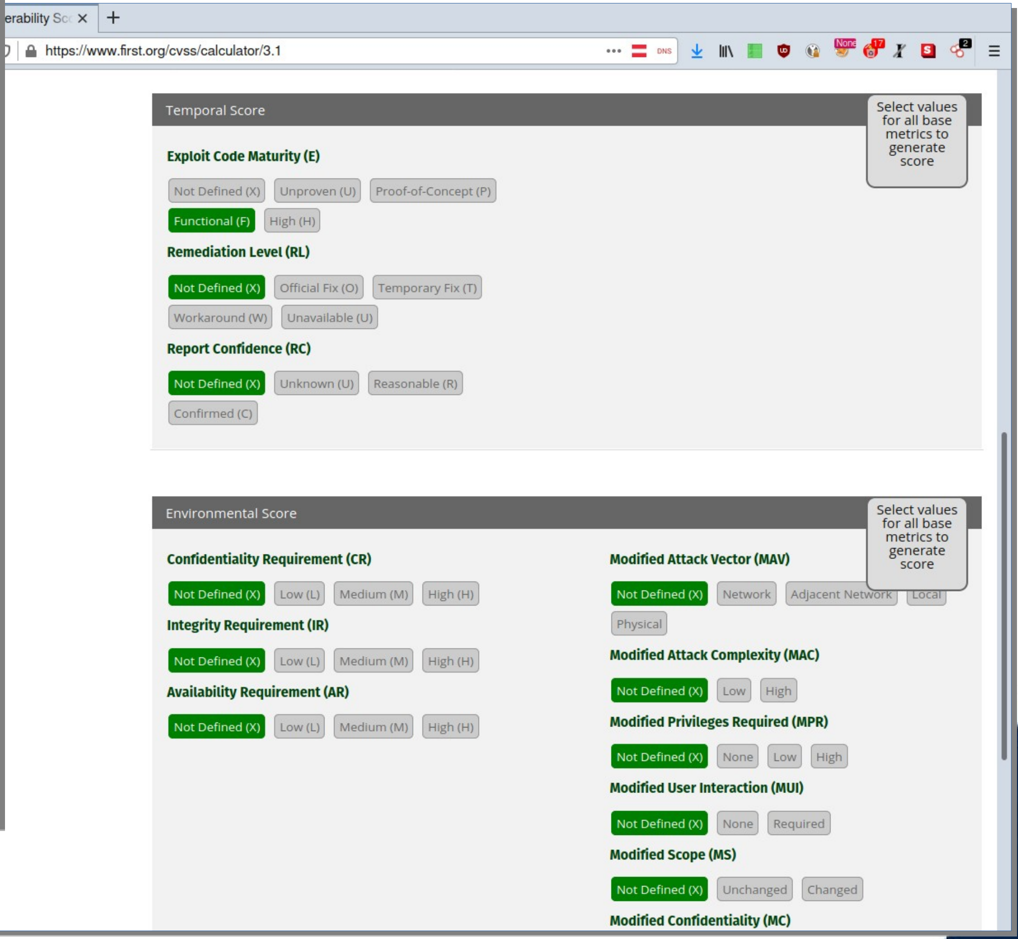
Integrity (I)

None (N) | Low (L) | High (H)

Availability (A)

None (N) | Low (L) | High (H)

Vector String - select values for all base metrics to generate a vector



Temporal Score

Select values for all base metrics to generate score

Exploit Code Maturity (E)

Not Defined (X) | Unproven (U) | Proof-of-Concept (P) | [✓ Functional (F)] | High (H)

Remediation Level (RL)

[✓ Not Defined (X)] | Official Fix (O) | Temporary Fix (T) | Workaround (W) | Unavailable (U)

Report Confidence (RC)

[✓ Not Defined (X)] | Unknown (U) | Reasonable (R) | Confirmed (C)

Environmental Score

Select values for all base metrics to generate score

Confidentiality Requirement (CR)

[✓ Not Defined (X)] | Low (L) | Medium (M) | High (H)

Integrity Requirement (IR)

[✓ Not Defined (X)] | Low (L) | Medium (M) | High (H)

Availability Requirement (AR)

[✓ Not Defined (X)] | Low (L) | Medium (M) | High (H)

Modified Attack Vector (MAV)

[✓ Not Defined (X)] | Network | Adjacent Network | Local | Physical

Modified Attack Complexity (MAC)

[✓ Not Defined (X)] | Low | High

Modified Privileges Required (MPR)

[✓ Not Defined (X)] | None | Low | High

Modified User Interaction (MUI)

[✓ Not Defined (X)] | None | Required

Modified Scope (MS)

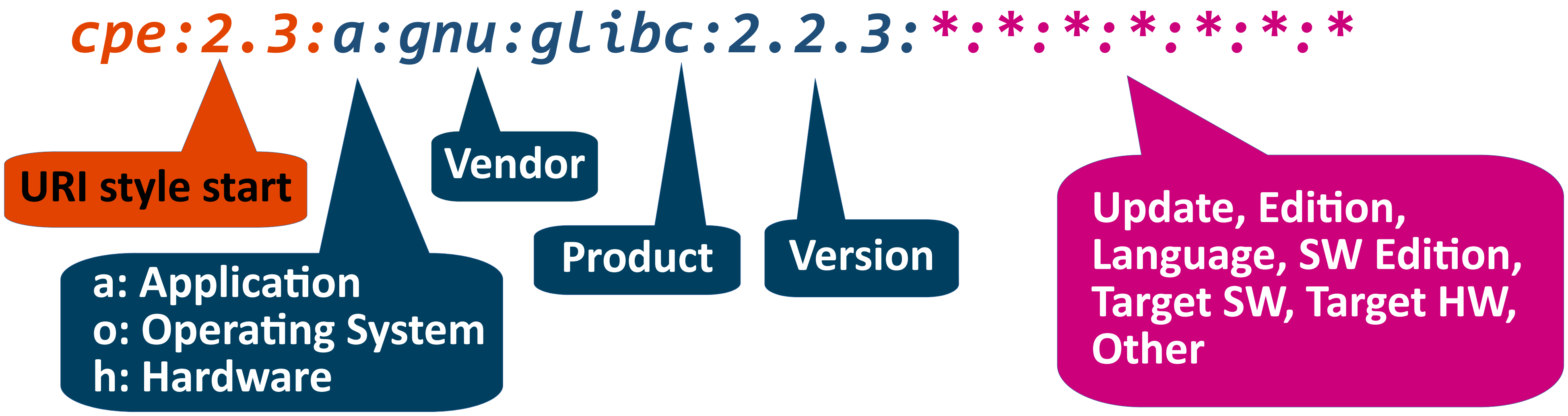
[✓ Not Defined (X)] | Unchanged | Changed

Modified Confidentiality (MC)

Standards: Common Platform Enumeration

- Question: What is affected by a vulnerability?
- To answer we need “*… a standardized method of describing and identifying classes of applications, operating systems, and hardware devices …“*
- A series of XML schemata that define
  - The structure of names for individual platforms (**Naming)**
    - “… the logical structure of Well-formed Names (WFNs)”
  - A standard to combine multiple WFNs with logical expressions (i. e. AND, OR, NOT) so that multiple products and platforms can be matches **(Applicability Language)**
  - Rules to parse and match (compare) WFNs **(Name Matching)**
  - A repository of registered names (**Dictionary)** each entry identifying a single class of IT product
- What if a vulnerability is found a product that doesn’t have a CPE (yet)?

CPE in Practice: GNU C Library



cpe:2.3:a:gnu:glibc:2.2.3::*:*:*:*:*:**

URI style start

a: Application
o: Operating System
h: Hardware

Vendor

Product

Version

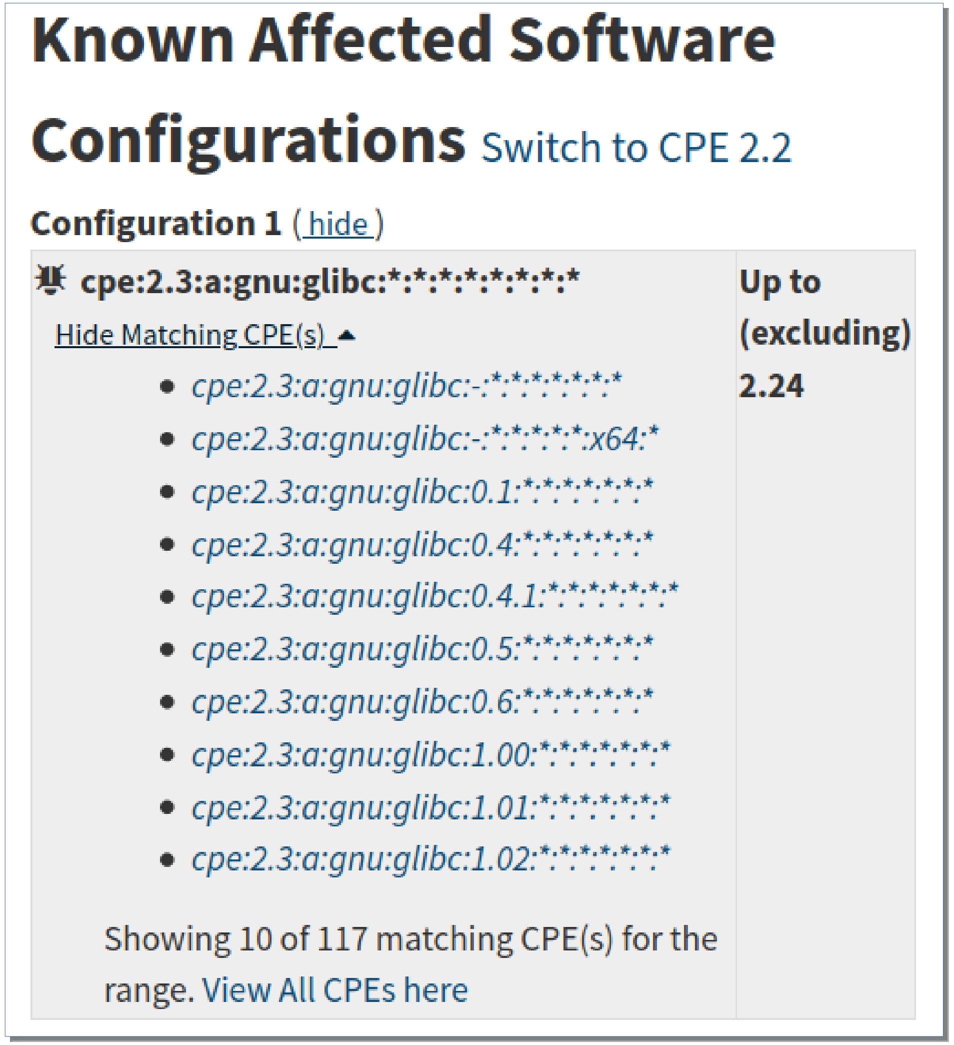
Update, Edition, Language, SW Edition, Target SW, Target HW, Other

Multiple WFNs are grouped with logical operators (i. e. “or”, “not”)

cpe:2.3:a:gnu:glibc:2.2.3::*:*:*:*:*:* **OR***

cpe:2.3:a:fedoraproject:fedora:23::*:*:*:*:*:**

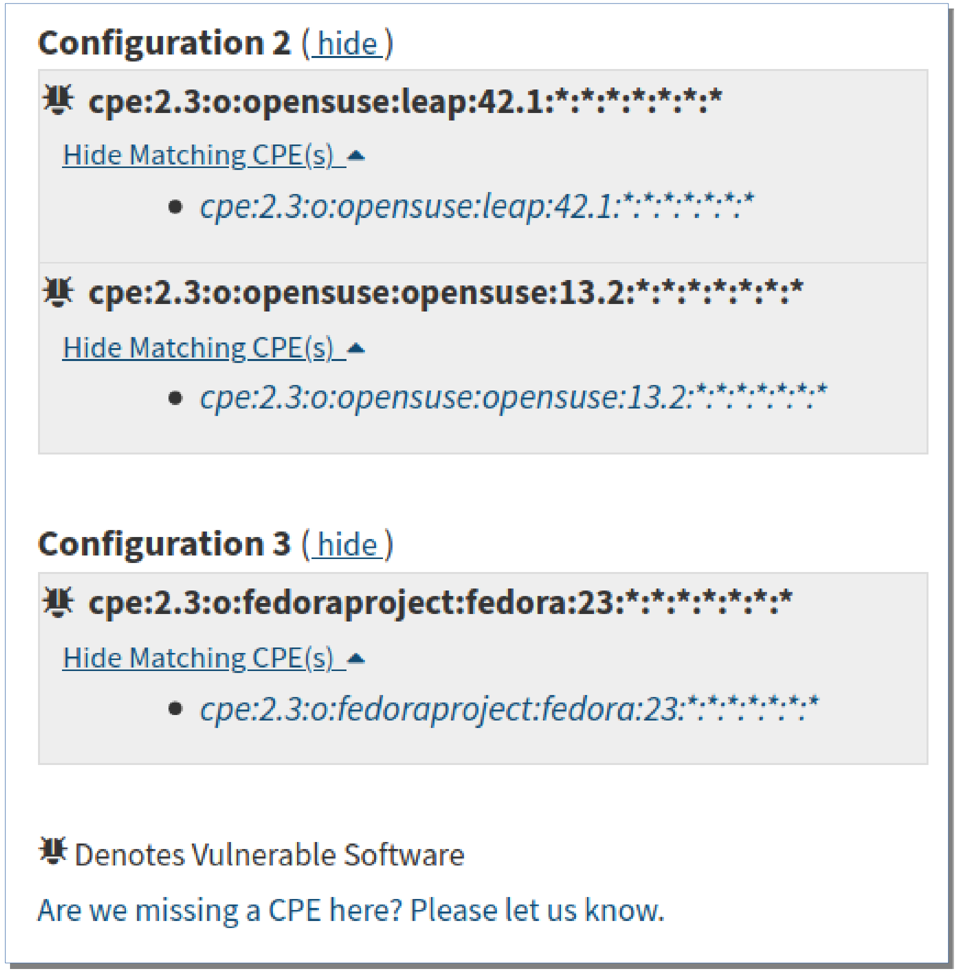
CPE Example: CVE-2016-1234



Known Affected Software Configurations Switch to CPE 2.2

Configuration 1 (hide)

🐞 **cpe:2.3:a:gnu:glibc:*:*:*:*:*:*:*:*** Hide Matching CPE(s) ▲ ● *cpe:2.3:a:gnu:glibc:-:*:*:*:*:*:*:** ● *cpe:2.3:a:gnu:glibc:-:*:*:*:*:*:x64:** ● *cpe:2.3:a:gnu:glibc:0.1:*:*:*:*:*:*:** ● *cpe:2.3:a:gnu:glibc:0.4:*:*:*:*:*:*:** ● *cpe:2.3:a:gnu:glibc:0.4.1:*:*:*:*:*:*:** ● *cpe:2.3:a:gnu:glibc:0.5:*:*:*:*:*:*:** ● *cpe:2.3:a:gnu:glibc:0.6:*:*:*:*:*:*:** ● *cpe:2.3:a:gnu:glibc:1.00:*:*:*:*:*:*:** ● *cpe:2.3:a:gnu:glibc:1.01:*:*:*:*:*:*:** ● *cpe:2.3:a:gnu:glibc:1.02:*:*:*:*:*:*:** Showing 10 of 117 matching CPE(s) for the range. View All CPEs here	**Up to (excluding) 2.24**



Configuration 2 (hide)

🐞 **cpe:2.3:o:opensuse:leap:42.1:*:*:*:*:*:*:***

Hide Matching CPE(s) ▲

- *cpe:2.3:o:opensuse:leap:42.1:*:*:*:*:*:*:**

🐞 **cpe:2.3:o:opensuse:opensuse:13.2:*:*:*:*:*:*:***

Hide Matching CPE(s) ▲

- *cpe:2.3:o:opensuse:opensuse:13.2:*:*:*:*:*:*:**

Configuration 3 (hide)

🐞 **cpe:2.3:o:fedoraproject:fedora:23:*:*:*:*:*:*:***

Hide Matching CPE(s) ▲

- *cpe:2.3:o:fedoraproject:fedora:23:*:*:*:*:*:*:**

🐞 Denotes Vulnerable Software

Are we missing a CPE here? Please let us know.

CPE Example: nmap & Linux

```
# nmap -O localhost
Starting Nmap 7.91 ( https://nmap.org ) at 2021-05-17 17:27 CEST
Nmap scan report for localhost (127.0.0.1)
Host is up (0.000030s latency).
Other addresses for localhost (not scanned): ::1
Not shown: 996 closed ports
PORT     STATE SERVICE
22/tcp   open  ssh
25/tcp   open  smtp
631/tcp  open  ipp
6667/tcp open  irc
Device type: general purpose
Running: Linux 2.6.X
OS CPE: cpe:/o:linux:linux_kernel:2.6.32
OS details: Linux 2.6.32
Network Distance: 0 hops

OS detection performed. Please report any incorr
https://nmap.org/submit/ .
Nmap done: 1 IP address (1 host up) scanned in 1
```

```
> cat /etc/os-release
NAME="openSUSE Leap"
VERSION="15.2"
ID="opensuse-leap"
ID_LIKE="suse opensuse"
VERSION_ID="15.2"
PRETTY_NAME="openSUSE Leap 15.2"
ANSI_COLOR="0;32"
CPE_NAME="cpe:/o:opensuse:leap:15.2"
BUG_REPORT_URL="https://bugs.opensuse.org"
HOME_URL="https://www.opensuse.org/"
```

More Standards

- Building open standards to automatically process incoming vulnerability information
  - According to your strategy/policy
- Goal: Systems are automatically (securely) configured and/or patched
  - Common Configuration Enumeration (CCE)
  - Common Weaknesses Enumeration (CWE)
  - **Security Content Automation Protocol (SCAP)**
  - Asset Identification, Asset Reporting Format (ARF)
  - **Open Vulnerability Assessment Language (OVAL)**
  - Open Checklist Interactive Language (OCIL)
  - Trust Model for Security Automation Data (TMSAD)
  - Extensible Configuration Checklist Description Format (XCCDF)
  - Software Identification (SWID)
  - Asset Summary Reporting (ASR)

What have you learned?

- Two main standards: ISO 29147 and ISO 30111
  - Vulnerability disclosure
  - Vulnerability handling
- Open standards making vulnerability information machine readable
  - CVE - Vulnerability identifier
  - CVSS - severity score
  - CPE - affected platform
- Next webinar: human readable vulnerability information - security advisories

Thank you

Any questions?

Next webinar: ***Vulnerability Information Dissemination,***

8th of June 2021

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the European Union's Horizon 2020 research and innovation
programme under Grant Agreement No. 731122 (GN4-2).

References:

- CVE Specification: `https://cve.mitre.org/`
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