Vulnerabilities

JOÃO PAULO BARRACA

Vulnerabilities

Is a weakness in a system (software, hardware…)

- It’s a broad concept as a vulnerability can derive from many things

A vulnerability allows an attacker to violate a reasonable security policy for that system

- Policies define how a system should behave.
- Examples:
  - Wheels will turn left only when steering wheel turns left
  - Phones will only allow access to its owner
  - Programs will only run code inserted by its original developer

Vulnerability number always increases as software grows

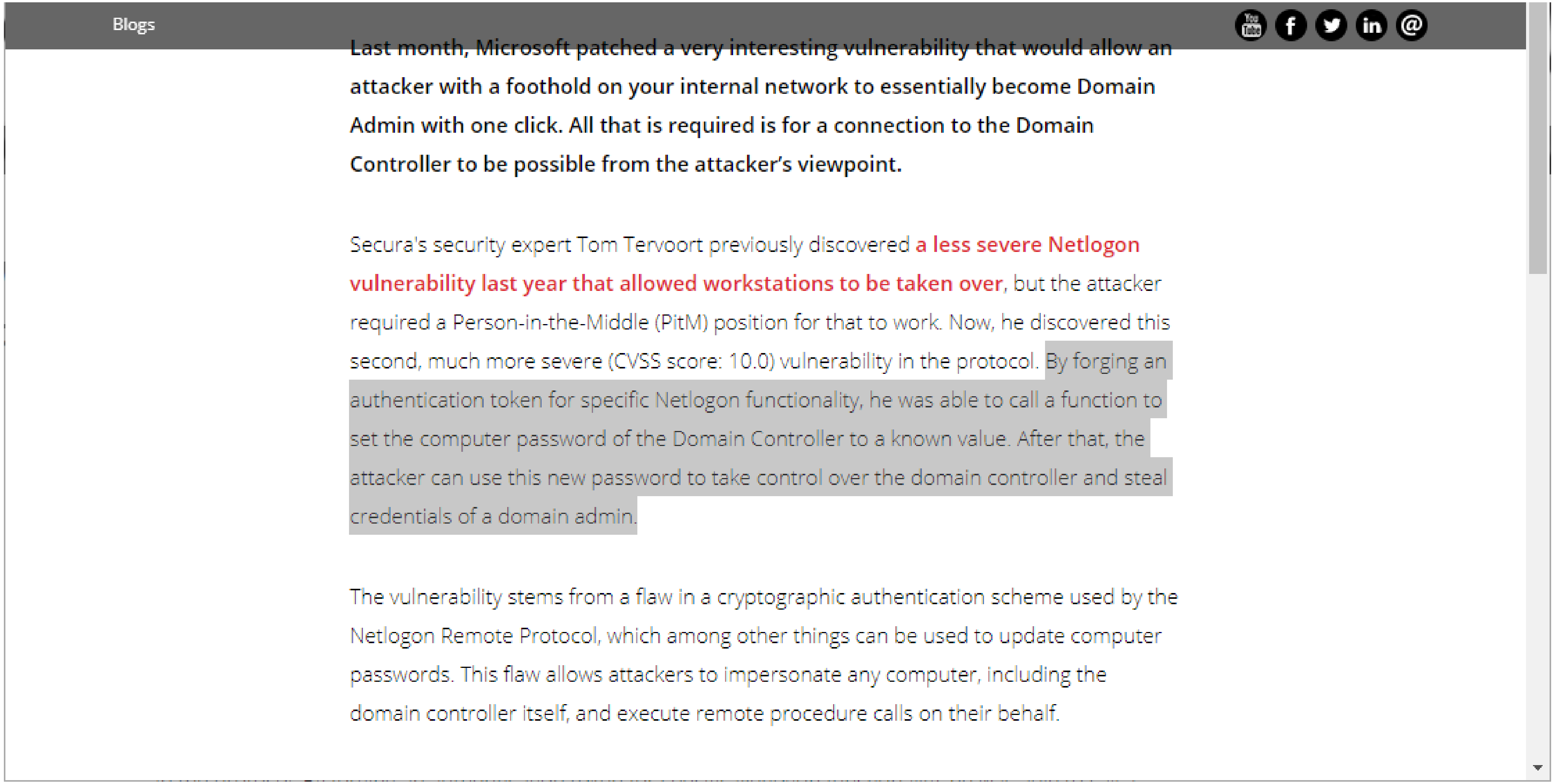
- It’s inherent to the increased complexity, interactions, development process
- Also, they do not disappear
- Software is updated with fixes, but older software is still vulnerable

Vulnerabilities

Vulnerabilities are states in a computing system that either allows an attacker to:

- execute commands as another user
- access data that is contrary to the specified access restrictions for that data
- pose as another entity
- conduct a denial of service (DoS) (affect availability)

A simple vulnerability - secura.com



Last month, Microsoft patched a very interesting vulnerability that would allow an attacker with a foothold on your internal network to essentially become Domain Admin with one click. All that is required is for a connection to the Domain Controller to be possible from the attacker's viewpoint.

Secura's security expert Tom Tervoort previously discovered **a less severe Netlogon vulnerability last year that allowed workstations to be taken over**, but the attacker required a Person-in-the-Middle (PitM) position for that to work. Now, he discovered this second, much more severe (CVSS score: 10.0) vulnerability in the protocol. By forging an authentication token for specific Netlogon functionality, he was able to call a function to set the computer password of the Domain Controller to a known value. After that, the attacker can use this new password to take control over the domain controller and steal credentials of a domain admin.

The vulnerability stems from a flaw in a cryptographic authentication scheme used by the Netlogon Remote Protocol, which among other things can be used to update computer passwords. This flaw allows attackers to impersonate any computer, including the domain controller itself, and execute remote procedure calls on their behalf.

CIA triad

Confidentiality

- Whether information is disclosed to others

Integrity

- Whether data contents and formats are kept safe from modifications

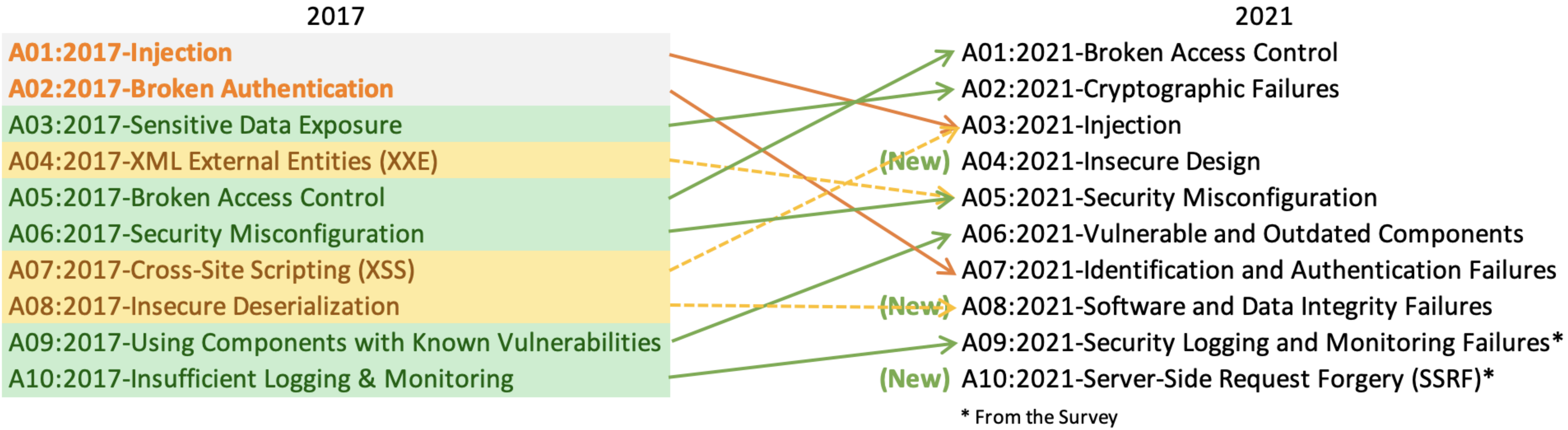
Availability

- Whether system performance is degraded

Vulnerability sources – OWASP Top 10 (Web)

1. **Injection**
2. **Broken Authentication**
3. Sensitive Data Exposure
4. **XML External Entities (XXE)**
5. **Broken Access control**
6. Security misconfigurations
7. **Cross Site Scripting (XSS)**
8. **Insecure Deserialization**
9. Using Components with known vulns.
10. **Insufficient logging and monitoring**

Vulnerability sources – OWASP Top 10 (Web)



2017

A01:2017-Injection
A02:2017-Broken Authentication
A03:2017-Sensitive Data Exposure
A04:2017-XML External Entities (XXE)
A05:2017-Broken Access Control
A06:2017-Security Misconfiguration
A07:2017-Cross-Site Scripting (XSS)
A08:2017-Insecure Deserialization
A09:2017-Using Components with Known Vulnerabilities
A10:2017-Insufficient Logging & Monitoring

2021

A01:2021-Broken Access Control
A02:2021-Cryptographic Failures
A03:2021-Injection
(New) A04:2021-Insecure Design
A05:2021-Security Misconfiguration
A06:2021-Vulnerable and Outdated Components
A07:2021-Identification and Authentication Failures
(New) A08:2021-Software and Data Integrity Failures
A09:2021-Security Logging and Monitoring Failures*
(New) A10:2021-Server-Side Request Forgery (SSRF)*

* From the Survey

Vulnerability sources – 7 Pernicious Kingdoms

1. **Input Validation and Representation**
2. **API Abuse**
3. **Security Features**
4. **Time and State**
5. **Errors**
6. **Code Quality**
7. **Encapsulation**

***. Environment**

K. Tsipenyuk, B. Chess and G. McGraw, "Seven pernicious kingdoms: a taxonomy of software security errors," in IEEE Security & Privacy, vol. 3, no. 6, pp. 81-84, Nov.-Dec. 2005, doi: 10.1109/MSP.2005.159.

Vulnerability sources - CWE

Vulnerabilities may exist due to Bugs or Faults

- Bug is an error in the implementation of a software
- Fault is a design or architectural error

CWE - Common Weaknesses Enumeration

- Extensive (891) list of anti-patterns that may lead to insecure systems
- Arranged in a tree, with examples in multiple languages

CWE-348: Use of Less Trusted Source

The software has two different sources of the same data or information, but it uses the source that has less support for verification, is less trusted, or is less resistant to attack.

Details at: https://cwe.mitre.org/data/definitions/348.html

- Describes pattern, provides examples, provides list of related CVEs

CWE-348: Use of Less Trusted Source

```php
$requestingIP = '0.0.0.0';
if (array_key_exists('HTTP_X_FORWARDED_FOR', $_SERVER)) {
        $requestingIP = $_SERVER['HTTP_X_FORWARDED_FOR'];
else{
        $requestingIP = $_SERVER['REMOTE_ADDR'];
}

if(in_array($requestingIP,$ipAllowlist)){
        generatePage();
        return;
}
else{
        echo "You are not authorized to view this page";
        return;
}
```

Set by Web Server or Client

Set by Web Server

Vulnerability Tracking by vendors

During the development cycle, vulnerabilities are handled as bugs

- May have a dedicated security team or not

When software is available, vulnerabilities are also tracked globally

- For every system and software publicly available

Public tracking helps…

- focusing the discussion around the same issue
  - Ex: a library that is used in multiple applications, distributions
- defenders to easily test their systems, enhancing the security
- attackers to easily know what vulnerability can be used

Vulnerability Tracking

Vulnerabilities are privately tracked

- Constitute an arsenal for future attacks against targets
- Exploits are weapons

Knowledge about vulnerabilities and exploits is publicly traded

- From 0 to 2-3M€ (more?) through direct markets, or acquisition programs
- Up to 2.5M€ for bug hunting programs or direct acquisition (Google, Zerodium)
  - 2.5M€: 1 click Android exploit
  - 2M€: 1 click iPhone exploit
  - 1.5M€: WhatsApp or iMessage exploit
  - ~2K for a XSS at HackerOne (although there are records of $1M payouts)

…and privately traded at unknown prices

- Private Companies, Organized Crime, APTs

Vulnerability Tracking

Most well-known trackers systems: CVE and NVD

- CVE: Common Vulnerabilities and Exposures, managed by MITRE
- NVD: National Vulnerability Database, managed by NIST
  - Fed by CVE@MITRE but provides enhanced information

Others

- CERT Vulnerability Notes Database (VNDB)
  - Maintained by CERTs, may provide additional information regarding a CVE
- VulnDB
  - Focus on APIs and providing information to companies
- DISA IAVA and STIGS
  - Information Assurance Vulnerability Alerts: includes MIL and GOV systems
  - Security Technical Implementation Guides
- Industry Sharing and Analysis Centers (ISAC)
  - Industry driven, thematic (AUTO, FINANTIAL, IT, etc… groups)

CVE: Common Vulnerabilities and Exposures

Dictionary of publicly known information security vulnerabilities and exposures

- For vulnerability management
- For patch management
- For vulnerability alerting
- For intrusion detection

Uses common identifiers for the same CVE's

- Enable data exchange between security products
- Provide a baseline index point for evaluating coverage of tools and services.

Details about a vulnerability can be kept private

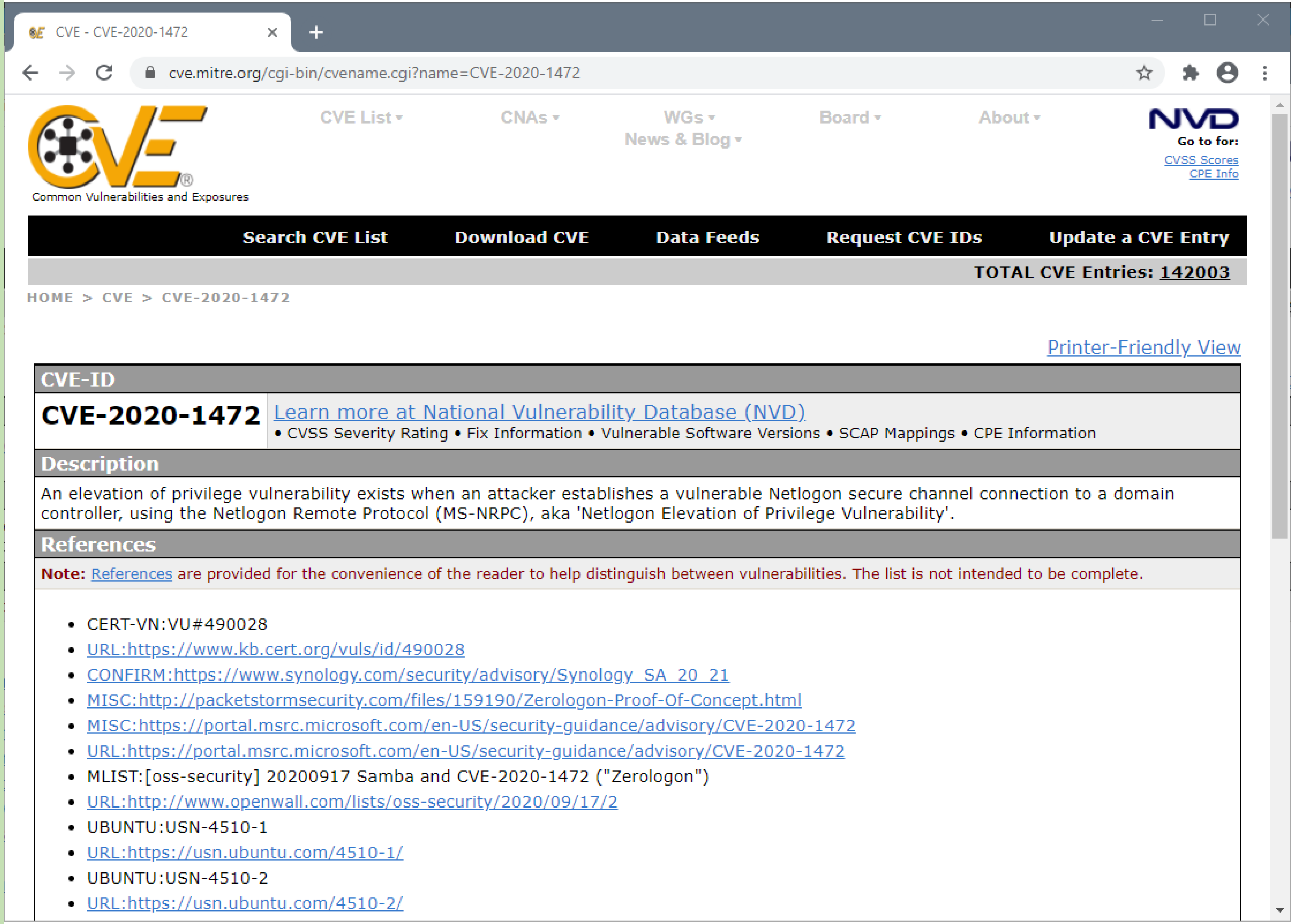
- Part of responsible disclosure: Until owner provides a fix

CVE-2020-1472

@MITRE

Basic information about the CVE

References to other trackers (provided for convenience)



TOTAL CVE Entries: 142003

HOME > CVE > CVE-2020-1472

Printer-Friendly View

CVE-ID

CVE-2020-1472 Learn more at National Vulnerability Database (NVD)
• CVSS Severity Rating • Fix Information • Vulnerable Software Versions • SCAP Mappings • CPE Information

Description

An elevation of privilege vulnerability exists when an attacker establishes a vulnerable Netlogon secure channel connection to a domain controller, using the Netlogon Remote Protocol (MS-NRPC), aka 'Netlogon Elevation of Privilege Vulnerability'.

References

Note: References are provided for the convenience of the reader to help distinguish between vulnerabilities. The list is not intended to be complete.

- CERT-VN:VU#490028
- URL:https://www.kb.cert.org/vuls/id/490028
- CONFIRM:https://www.synology.com/security/advisory/Synology_SA_20_21
- MISC:http://packetstormsecurity.com/files/159190/Zerologon-Proof-Of-Concept.html
- MISC:https://portal.msrc.microsoft.com/en-US/security-guidance/advisory/CVE-2020-1472
- URL:https://portal.msrc.microsoft.com/en-US/security-guidance/advisory/CVE-2020-1472
- MLIST:[oss-security] 20200917 Samba and CVE-2020-1472 ("Zerologon")
- URL:http://www.openwall.com/lists/oss-security/2020/09/17/2
- UBUNTU:USN-4510-1
- URL:https://usn.ubuntu.com/4510-1/
- UBUNTU:USN-4510-2
- URL:https://usn.ubuntu.com/4510-2/

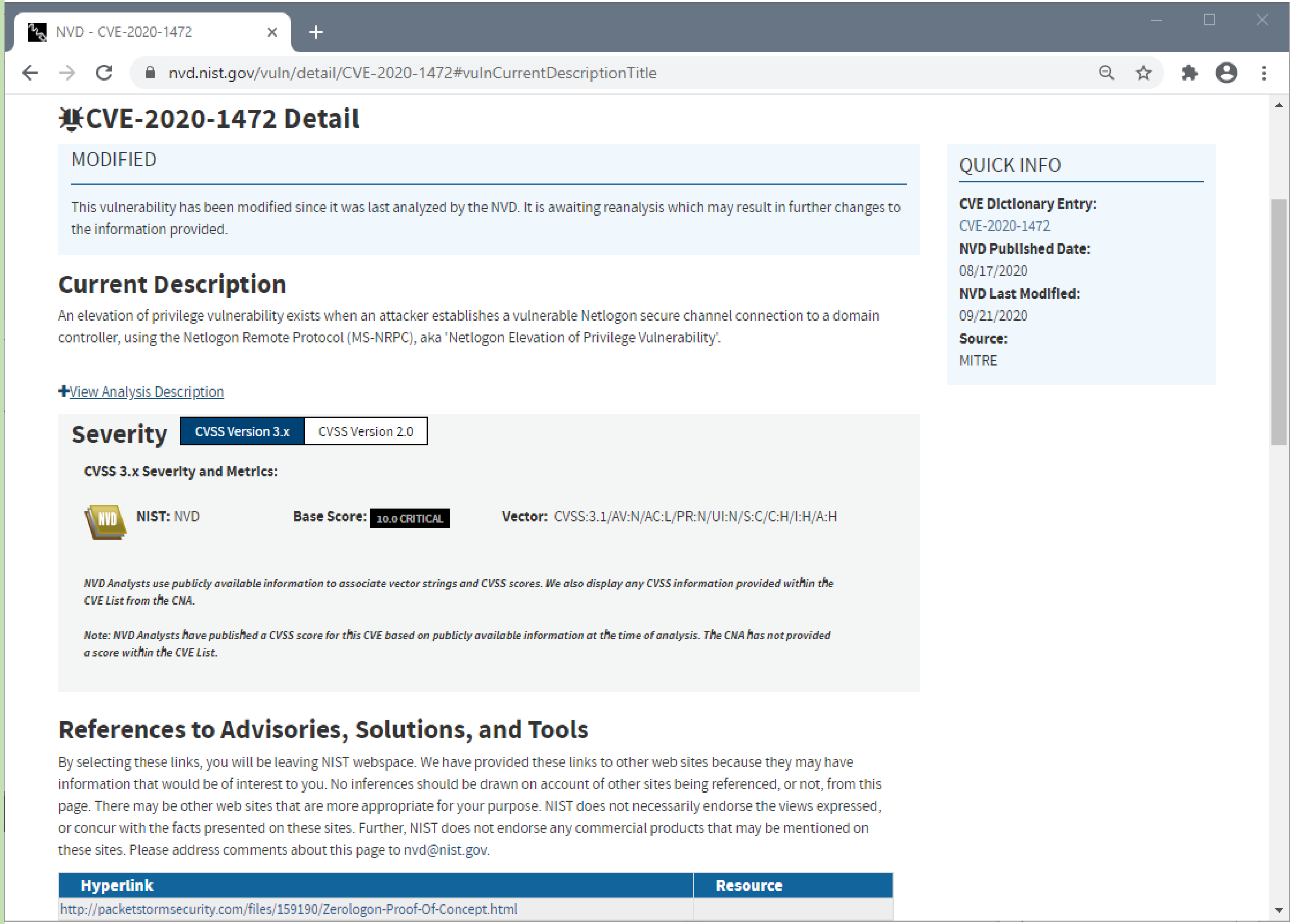
CVE-2020-1472

@NVD

Basic information about the CVE and a small analysis of it

The CVE Severity Score

Links to advisories, solutions



NVD - CVE-2020-1472
nvd.nist.gov/vuln/detail/CVE-2020-1472#vulnCurrentDescriptionTitle

CVE-2020-1472 Detail

MODIFIED

This vulnerability has been modified since it was last analyzed by the NVD. It is awaiting reanalysis which may result in further changes to the information provided.

Current Description

An elevation of privilege vulnerability exists when an attacker establishes a vulnerable Netlogon secure channel connection to a domain controller, using the Netlogon Remote Protocol (MS-NRPC), aka 'Netlogon Elevation of Privilege Vulnerability'.

+View Analysis Description

Severity

CVSS Version 3.x | CVSS Version 2.0

CVSS 3.x Severity and Metrics:

NIST: NVD **Base Score:** 10.0 CRITICAL **Vector:** CVSS:3.1/AV:N/AC:L/PR:N/UI:N/S:C/C:H/I:H/A:H

NVD Analysts use publicly available information to associate vector strings and CVSS scores. We also display any CVSS information provided within the CVE List from the CNA.

Note: NVD Analysts have published a CVSS score for this CVE based on publicly available information at the time of analysis. The CNA has not provided a score within the CVE List.

References to Advisories, Solutions, and Tools

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

Hyperlink	Resource
http://packetstormsecurity.com/files/159190/Zerologon-Proof-Of-Concept.html	

QUICK INFO

CVE Dictionary Entry:
CVE-2020-1472
NVD Published Date:
08/17/2020
NVD Last Modified:
09/21/2020
Source:
MITRE

CVE-2020-1472

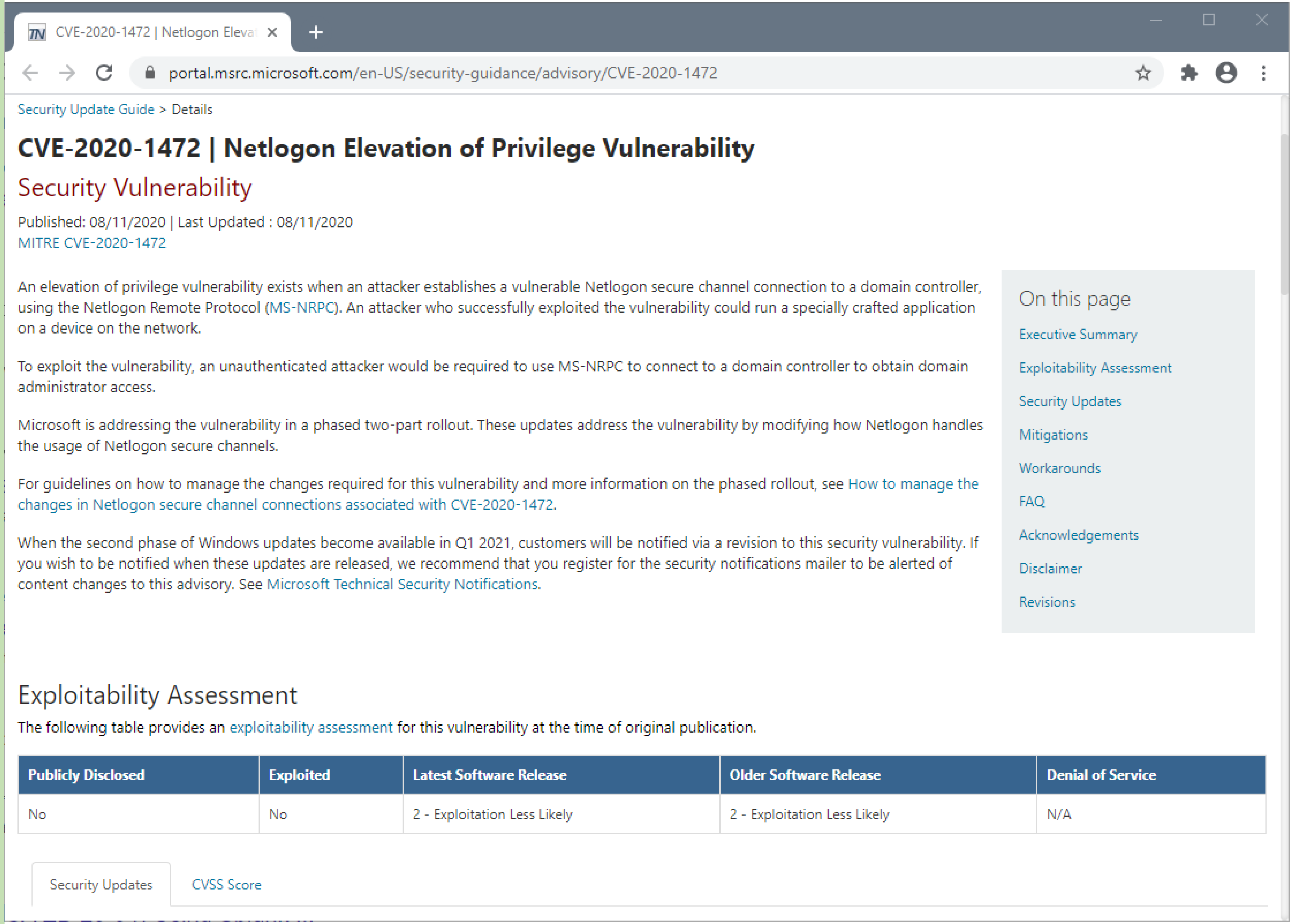
@Product Owner

More detail, why it happens, and how it can be mitigated

Information about patches/updates available to help IT staff and users

Information about it's exploitability.

Format is vendor dependent. Each vendor defines what/how to show information


CVE-2020-1472 | Netlogon Eleva
portal.msrc.microsoft.com/en-US/security-guidance/advisory/CVE-2020-1472

Security Update Guide > Details

CVE-2020-1472 | Netlogon Elevation of Privilege Vulnerability

Security Vulnerability

Published: 08/11/2020 | Last Updated : 08/11/2020
MITRE CVE-2020-1472

An elevation of privilege vulnerability exists when an attacker establishes a vulnerable Netlogon secure channel connection to a domain controller, using the Netlogon Remote Protocol (MS-NRPC). An attacker who successfully exploited the vulnerability could run a specially crafted application on a device on the network.

To exploit the vulnerability, an unauthenticated attacker would be required to use MS-NRPC to connect to a domain controller to obtain domain administrator access.

Microsoft is addressing the vulnerability in a phased two-part rollout. These updates address the vulnerability by modifying how Netlogon handles the usage of Netlogon secure channels.

For guidelines on how to manage the changes required for this vulnerability and more information on the phased rollout, see How to manage the changes in Netlogon secure channel connections associated with CVE-2020-1472.

When the second phase of Windows updates become available in Q1 2021, customers will be notified via a revision to this security vulnerability. If you wish to be notified when these updates are released, we recommend that you register for the security notifications mailer to be alerted of content changes to this advisory. See Microsoft Technical Security Notifications.

On this page

- Executive Summary
- Exploitability Assessment
- Security Updates
- Mitigations
- Workarounds
- FAQ
- Acknowledgements
- Disclaimer
- Revisions

Exploitability Assessment

The following table provides an exploitability assessment for this vulnerability at the time of original publication.

Publicly Disclosed	Exploited	Latest Software Release	Older Software Release	Denial of Service
No	No	2 - Exploitation Less Likely	2 - Exploitation Less Likely	N/A

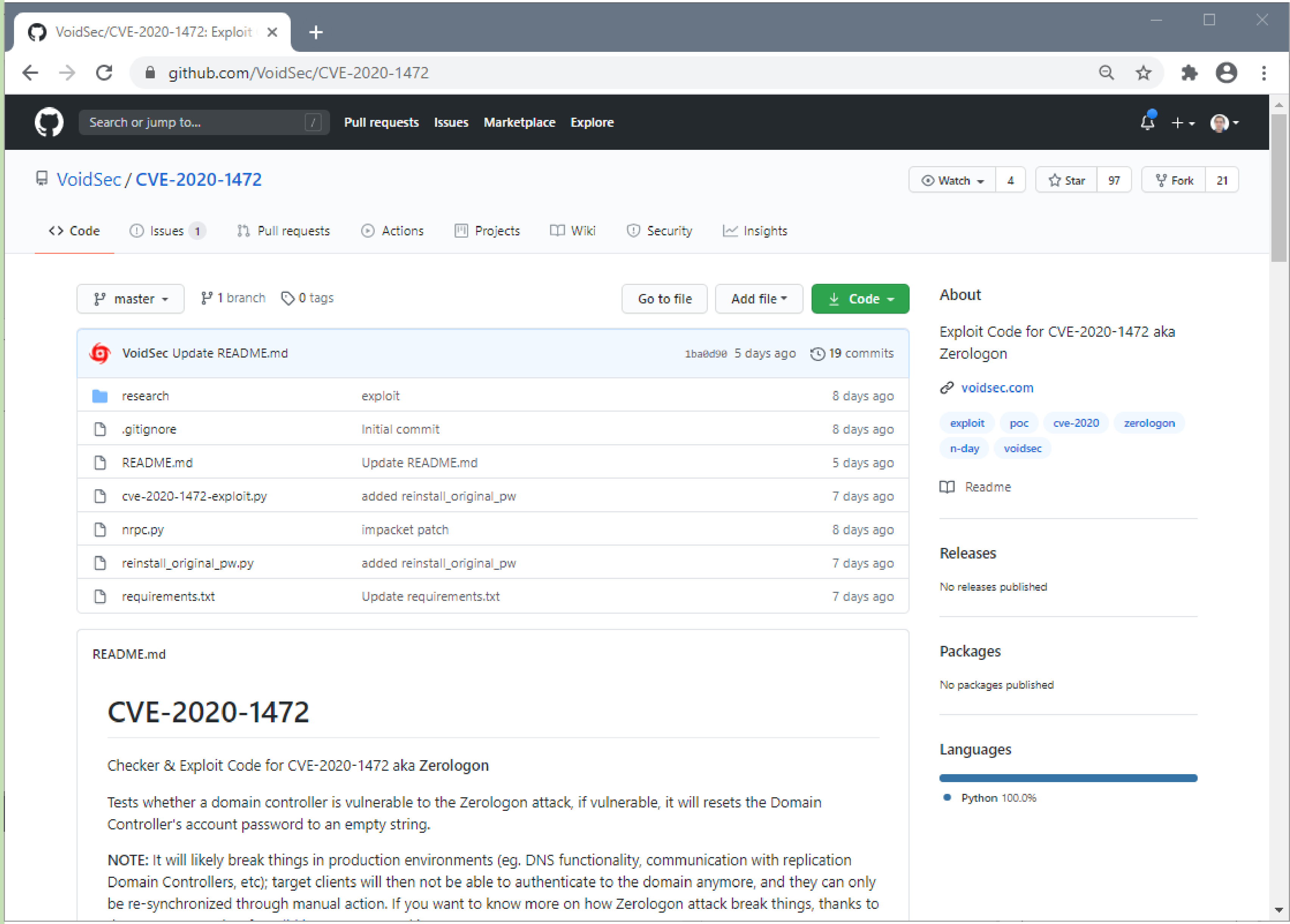
Security Updates | CVSS Score

CVE-2020-1472

@Other places

Independent researchers may publish validation tools or exploits

Very dynamic community with public and private facets



VoidSec Update README.md 1ba0d90 5 days ago 19 commits

research	exploit	8 days ago
.gitignore	Initial commit	8 days ago
README.md	Update README.md	5 days ago
cve-2020-1472-exploit.py	added reinstall_original_pw	7 days ago
nrpc.py	impacket patch	8 days ago
reinstall_original_pw.py	added reinstall_original_pw	7 days ago
requirements.txt	Update requirements.txt	7 days ago

README.md

CVE-2020-1472

Checker & Exploit Code for CVE-2020-1472 aka **Zerologon**

Tests whether a domain controller is vulnerable to the Zerologon attack, if vulnerable, it will resets the Domain Controller's account password to an empty string.

NOTE: It will likely break things in production environments (eg. DNS functionality, communication with replication Domain Controllers, etc); target clients will then not be able to authenticate to the domain anymore, and they can only be re-synchronized through manual action. If you want to know more on how Zerologon attack break things, thanks to

About

Exploit Code for CVE-2020-1472 aka Zerologon

voidsec.com

exploit poc cve-2020 zerologon n-day voidsec

Readme

Releases

No releases published

Packages

No packages published

Languages

Python 100.0%

Vulnerability tracking

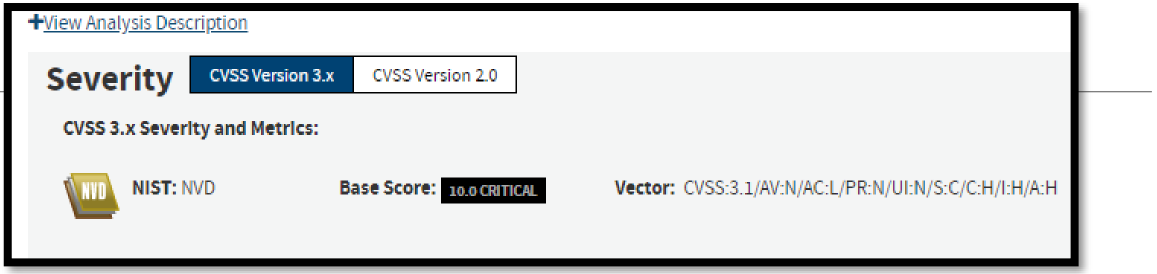
Not an easy task

- Exploits are not always known
- Impact and Value may be underestimated

Old feeds may create a false sense of security

A highly dynamic community is great…

- To defenders as they can test and implement defenses
- To attackers as they can incorporate exploits

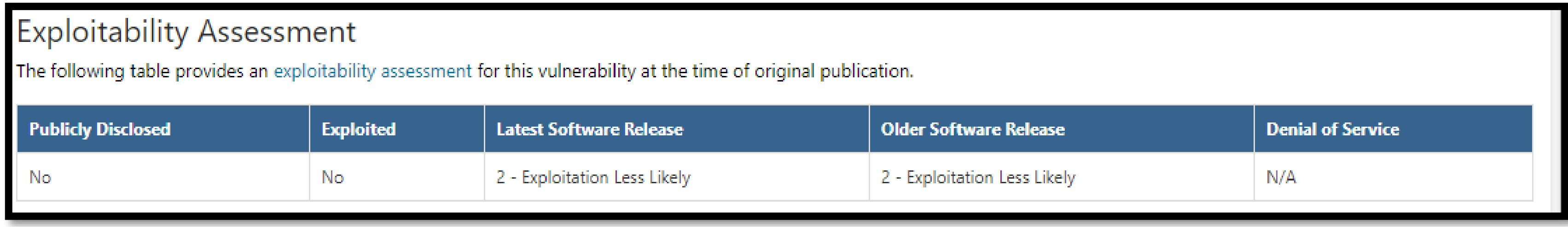


+View Analysis Description

Severity | CVSS Version 3.x | CVSS Version 2.0

CVSS 3.x Severity and Metrics:

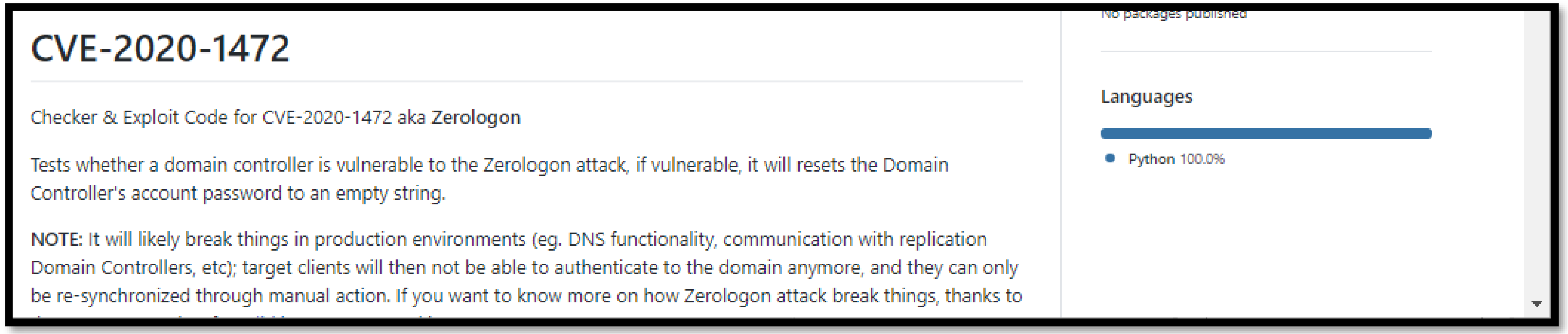
NIST: NVD   Base Score: 10.0 CRITICAL   Vector: CVSS:3.1/AV:N/AC:L/PR:N/UI:N/S:C/C:H/I:H/A:H



Exploitability Assessment

The following table provides an exploitability assessment for this vulnerability at the time of original publication.

Publicly Disclosed	Exploited	Latest Software Release	Older Software Release	Denial of Service
No	No	2 - Exploitation Less Likely	2 - Exploitation Less Likely	N/A



CVE-2020-1472

Checker & Exploit Code for CVE-2020-1472 aka **Zerologon**

Tests whether a domain controller is vulnerable to the Zerologon attack, if vulnerable, it will resets the Domain Controller's account password to an empty string.

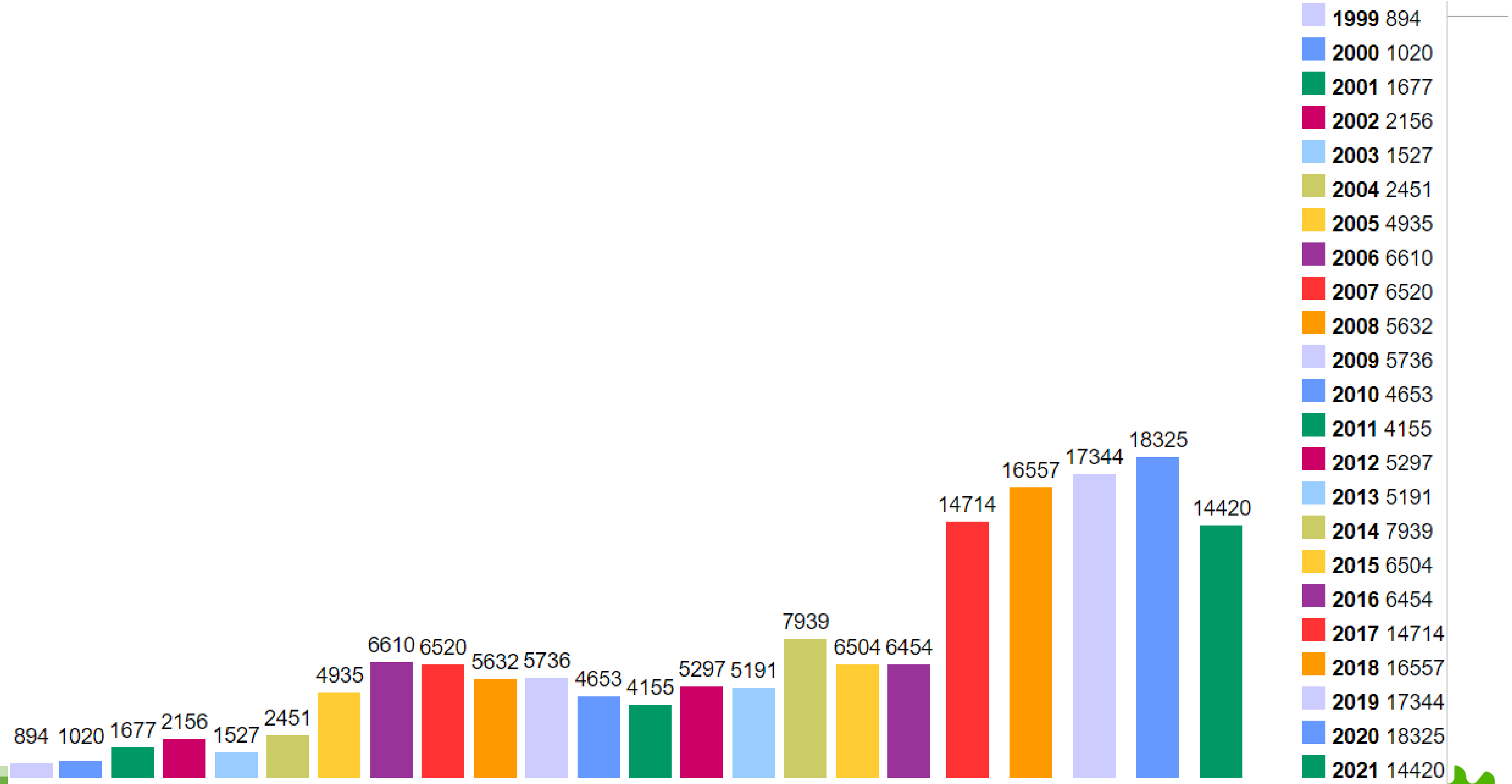
NOTE: It will likely break things in production environments (eg. DNS functionality, communication with replication Domain Controllers, etc); target clients will then not be able to authenticate to the domain anymore, and they can only be re-synchronized through manual action. If you want to know more on how Zerologon attack break things, thanks to

No packages published

Languages

● Python 100.0%

CVE per year – cvedetails.com (as of Sep 2021)



CVSS – Common Vulnerability Scoring System

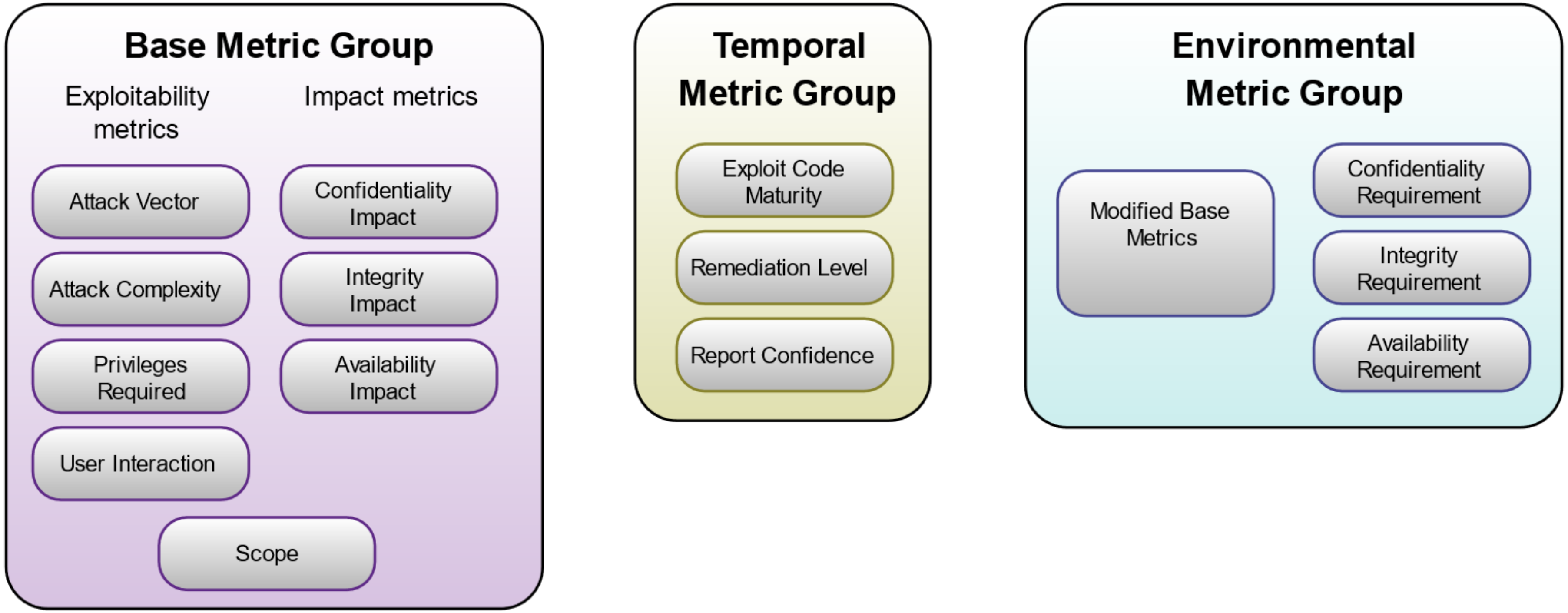
Provides a quick way to determine the severity of a vulnerability (0-10 score)

- Helps defenders prioritizing the deployment of mitigations
- Helps attackers selecting the most convenient vulnerability to explore
- Tends to be pessimistic (higher values)

Example: CVSS 3.1/AV:N/AC:L/PR:H/UI:N/S:U/C:L/I:L/A:N

- Final Score: 3.1 (LOW)
- Attack Vector: Network
- Attack Complexity: Low
- Privileges Required: High
- User Interaction: None
- Scope: Unchanged
- Confidentiality: Low
- Integrity: Low
- Exploit Availability: None

CVSS – Common Vulnerability Scoring System



Base Metric Group

Exploitability metrics

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

Impact metrics

- Confidentiality Impact
- Integrity Impact
- Availability Impact

Scope

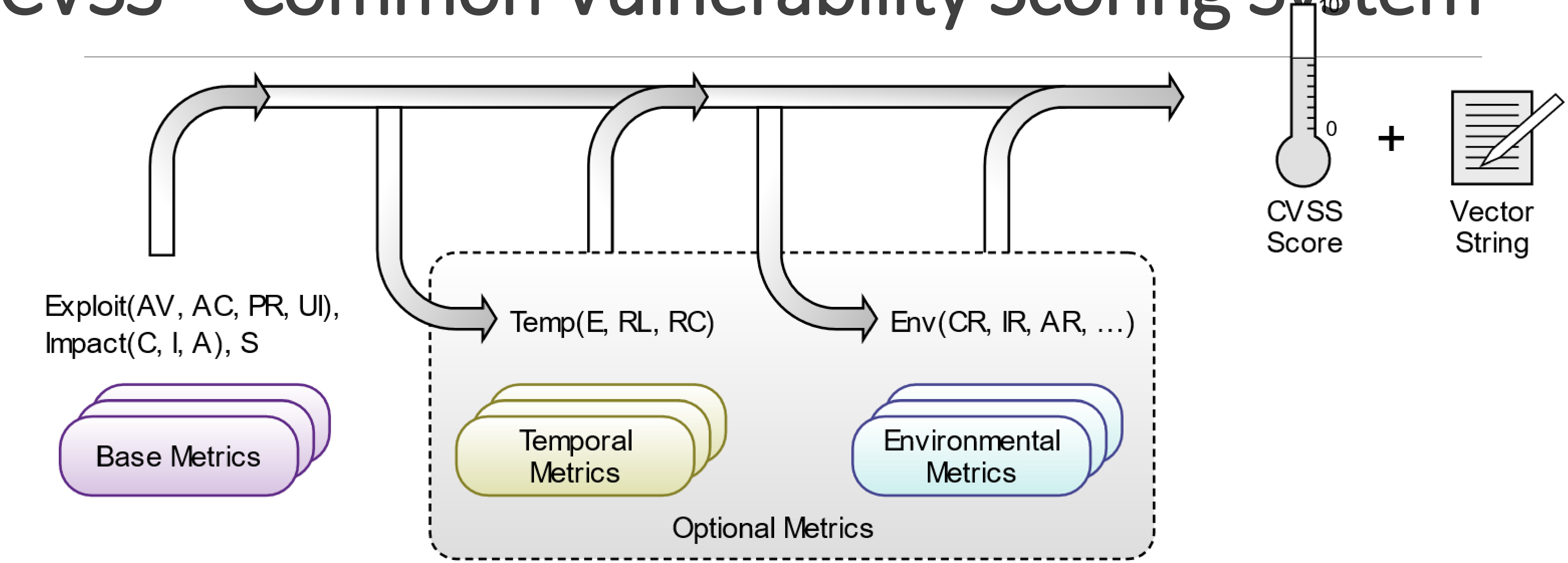
Temporal Metric Group

- Exploit Code Maturity
- Remediation Level
- Report Confidence

Environmental Metric Group

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

CVSS – Common Vulnerability Scoring System



Equations available at: https://www.first.org/cvss/specification-document

Calculator available at: https://www.first.org/cvss/calculator/3.1

Example: Base Metrics

The Base Score formula depends on sub-formulas for **Impact Sub-Score** (ISS), **Impact**, and **Exploitability**

ISS =	**1 - [(1 - Confidentiality) × (1 - Integrity) × (1 - Availability)]**
Impact =	
If Scope is Unchanged	6.42 × ISS
If Scope is Changed	7.52 × (ISS - 0.029) - 3.25 × (ISS - 0.02)^{15}
Exploitability =	8.22 × AttackVector × AttackComplexity × PrivilegesRequired × UserInteraction
BaseScore =	
If Impact \<= 0	0, *else*
If Scope is Unchanged	Roundup (Minimum [(Impact + Exploitability), 10])
If Scope is Changed	Roundup (Minimum [1.08 × (Impact + Exploitability), 10])

Vulnerability Disclosure

How should a research proceed when a vulnerability is found?

If the engagement is private: deliver to contracting entity

- May negotiate the public release the information…

What about other cases?

Vulnerability Disclosure: None

Researcher doesn’t notify vendor about vulnerability

- Doesn’t care
- Uses it as part of an arsenal or trades the information

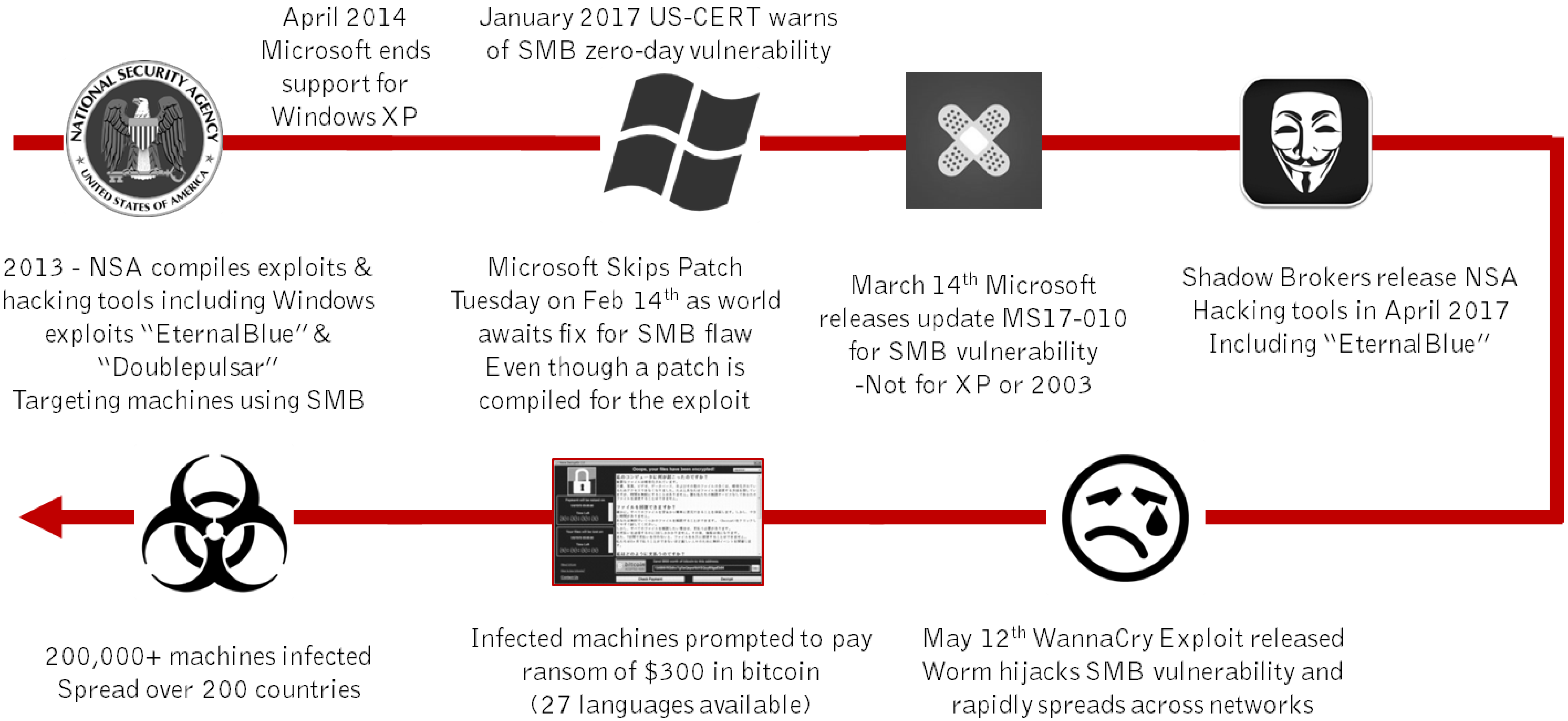
Leads to 0-day vulnerabilities

- Vulnerability is not known to the public and there is no direct remediation
- Some other third parties may also know about the vulnerability and exploit it

If impact is high, it creates major disruption when publicly known

- Quick adoption in malware and dissemination
  - Remember: Systems take at least one month to be patched

CVE-2017-0144 EternalBlue



2013 - NSA compiles exploits & hacking tools including Windows exploits "EternalBlue" & "Doublepulsar" Targeting machines using SMB

April 2014 Microsoft ends support for Windows XP

January 2017 US-CERT warns of SMB zero-day vulnerability

Microsoft Skips Patch Tuesday on Feb 14th as world awaits fix for SMB flaw Even though a patch is compiled for the exploit

March 14th Microsoft releases update MS17-010 for SMB vulnerability -Not for XP or 2003

Shadow Brokers release NSA Hacking tools in April 2017 Including "EternalBlue"

May 12th WannaCry Exploit released Worm hijacks SMB vulnerability and rapidly spreads across networks

Infected machines prompted to pay ransom of $300 in bitcoin (27 languages available)

200,000+ machines infected Spread over 200 countries

Source undetermined

Vulnerability Disclosure: Coordinated

1. Researcher informs vendor about vulnerability and impact

- Usually through a form of report with estimation of impact and/or demonstration

2. Vendor implements and distributes a correction

- But not always!

3. Vulnerability is mostly fixed in supported systems

Optional: CVE entry is requested: https://cveform.mitre.org/

Optional: A website with a fancy name is created for public awareness

CVE-2020-15802 – Sep 9 2020

https://hexhive.epfl.ch/BLURtooth/

Researcher:

- “We discovered the vulnerability in March 2020 and responsibly disclosed our findings along with suggested countermeasures to the Bluetooth SIG in May 2020. We kept our findings private and the Bluetooth SIG publicly disclosed them, without informing us, on the 10th of September of 2020. Our work is assigned CVE-2020-15802.”

Bluetooth SIG:

- At the time of writing, there are no deployed patches to address the BLUR attacks on actual devices. The Bluetooth SIG suggested that version 5.1 of the standard will contain guidelines to mitigate the BLUR attacks (e.g., disable key overwrites in certain circumstances as proposed in our countermeasures), but such guidelines are not (yet) public and we cannot comment on them. The Bluetooth SIG provides a public statement about BLURtooth and the BLUR attacks.

Vulnerability Disclosure: Full

Researcher discloses the vulnerability without warning

- As a CVE
- In a public mailing list
- As a blog entry, webpage or news item
- As an exploit

Vendor is pressured to issue a fix as soon as possible

- But not always
  - It doesn't!
  - It considers the product not supported
  - It under reports the issue

Some mayhem may occur until a fix is applied

- Remember all those phones/TVs/etc… without frequent updates