CENTRE FOR CYBER SECURITY BELGIUM

Log4J! What exactly is going on?

What is it? How to Identify, Patch or Mitigate?

How to Monitor for active exploitation attempts?

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TLP WHITE

16 December 2021

Agenda

- What is Log4j?
- What is the Log4Shell vulnerability?
- How to Identify vulnerable software?
- How to patch/mitigate?
- How to monitor/detect intrusion attempts?

What is Log4j?

- 20 years old, initial release on January 8, 2001
- Part of Apache Logging Services
  - Project Apache Software Foundation
- Java-based logging framework
- Abstraction layer for logging in Java programs
- Making it easy for developers to implement fast and reliable application logging.
- Features
  - Default and custom log levels
  - Simple configuration syntax
  - Fast & reliable with asynchronous loggers
  - API
  - Support for multiple formats, databases, log management systems

Log4j Example Code

```
import org.apache.log4j.Logger;

import java.io.*;
import java.sql.SQLException;
import java.util.*;

public class log4jExample{

   /* Get actual class name to be printed on */
   static Logger log = Logger.getLogger(log4jExample.class.getName());

   public static void main(String[] args)throws IOException,SQLException {
      log.debug("Hello this is a debug message");
      log.info("Hello this is an info message");
   }
}
```

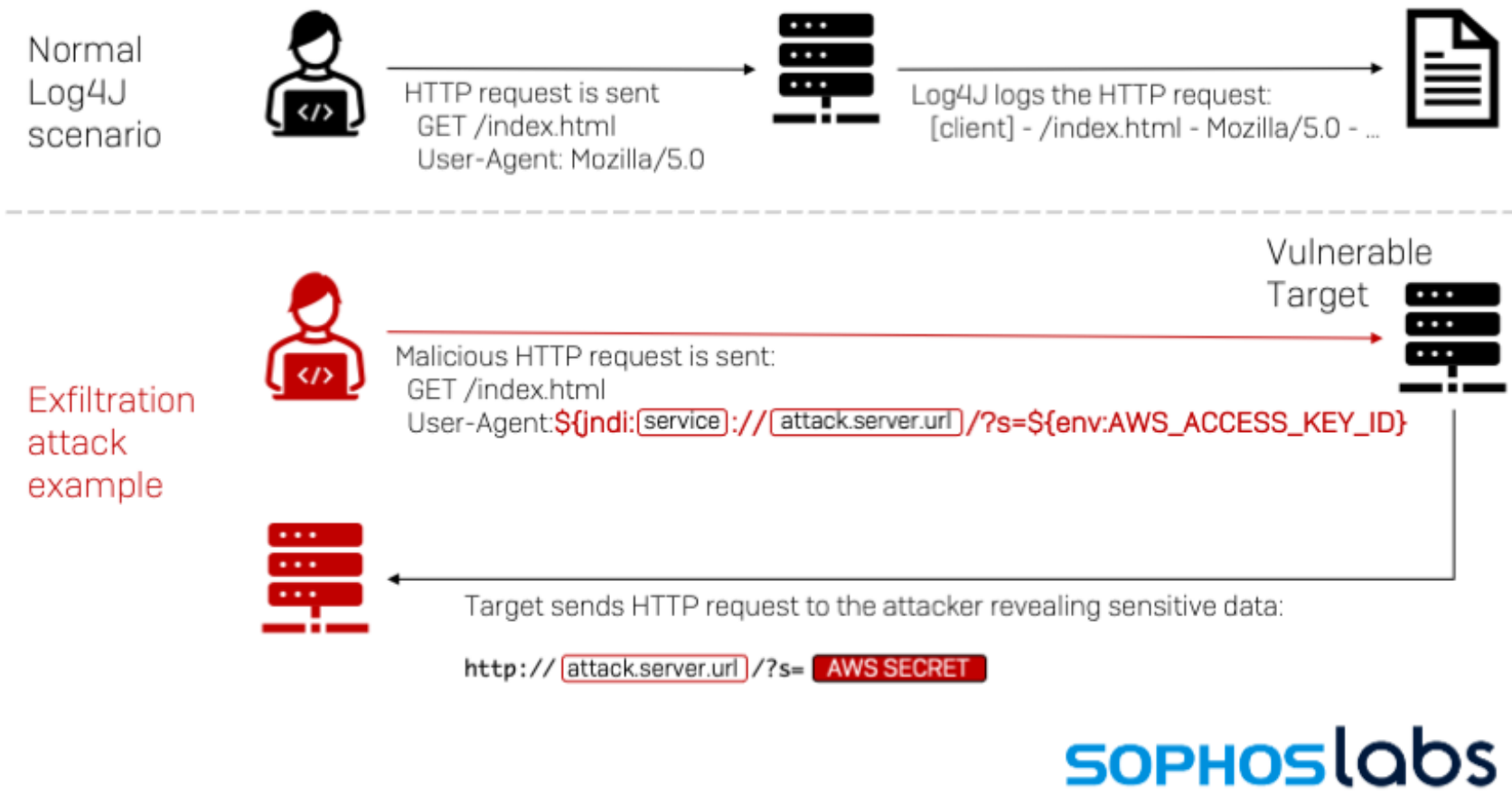
What is the Log4Shell vulnerability?

https://www.lunasec.io/docs/blog/log4j-zero-day/

- CVE-2021-44228
  - CVSSv3 score: 10/10
  - Remote Code Execution (RCE) vulnerability
  - Released with exploit code on Thursday 9 December 2021
- Affected software:
  - Apache Log4j
    - >= v2 2.0-beta9 AND <= v2.12.1
    - >= 2.13.0 AND < 2.15.0
    - Log4J 1.x with specific configs
  - Including ALL software using Log4J as a logging framework
- What is affected?
  - Message lookup substitution feature using JNDI
  - Enabled by default
  - No URL sanitization
  - Any kind of request is fully processed, even obfuscated or encoded (e.g., Base64)
  - Log4J reaches out to external server

- Risks
  - Successful exploitation attempt => unauthenticated attacker can remotely execute arbitrary code.
  - Actors actively scanning & exploiting in the wild
    - Installing coin miners or Cobalt Strike
    - Exfiltrating data from compromised systems
    - HAFNIUM (China state-sponsored)
      - Attack virtualization infrastructure
    - PHOSPHORUS (Iran)
      - Deploy ransomware
    - New Khonsari ransomware family + Orcus RAT
    - Other state actors experimenting: China, Iran, North Korea, Turkey
    - Initial Access Brokers (Windows / Linux)
    - Botnets: Mirai, Tsunami (Muhstik), Kinsing, Elknot (BillGates), m8220, SiteLoader, xmrig miner

What is the Log4Shell vulnerability?



What is the Log4Shell vulnerability?

https://www.lunasec.io/docs/blog/log4j-zero-day/

- CVE-2021-45046
  - CVSSv3 score: 3.7/10
  - Denial Of Service (DOS) attack in non-default configurations
  - Found and released on 13 December 2021
  - When logging configuration uses non-default Pattern layout:
    - With Context Lookup (e.g., $${ctx:loginId})
    - OR Threat Context Map (MDC) pattern (e.g., %X, %mdc, or %MDC)

- Affected software:
  - Java 7: < v2.12.2
  - Java 8+: < v2.16.0

Log4Shell - Timeline

24 November

- Vulnerability reported by Chen Zhaojun of Alibaba
- RCE using JNDI message lookups

26 November

- CVE-2021-44228 first reported

1st December 04:36 UTC

- First exploitations observed
- By Cloudflare & Cisco

9th December 14:25 UTC

- First tweets by @P0rZ9 including PoC exploit on Github
- LunaSec blog post

10th December

- Active scanning and exploitation observed in Belgium, incl. obfuscation
- Log4J 1.x vulnerable through JMSAppender
- CVE-2021-4104

11th December

- Apache releases first patch: v2.15.0
- Minecraft under active exploitation

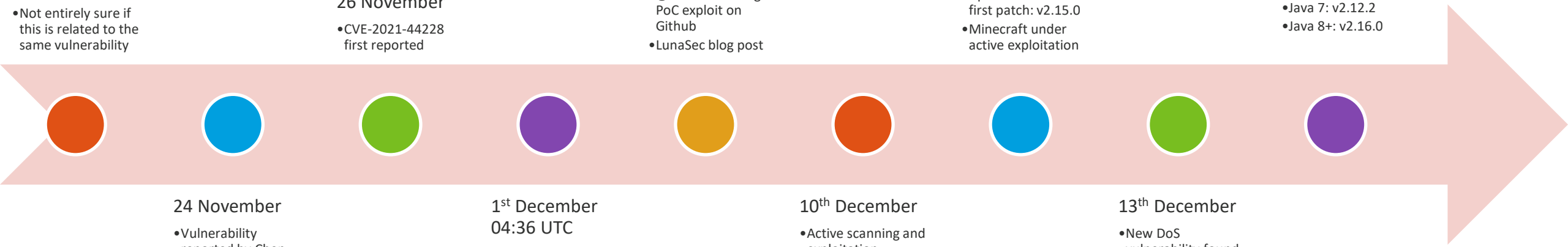
13th December

- New DoS vulnerability found with non-default configurations

14-15th December

- CVE-2021-45046 released
- New Log4J versions
  - Java 7: v2.12.2
  - Java 8+: v2.16.0

Log4Shell - Timeline



13 March

- Possible first POC on Github
- Not entirely sure if this is related to the same vulnerability

24 November

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How to Identify vulnerable software?

- Software lists
  - https://github.com/cisagov/log4j-affected-db
  - https://github.com/NCSC-NL/log4shell
  - https://www.techsolvency.com/story-so-far/cve-2021-44228-log4j-log4shell/
  - https://gist.github.com/SwitHak/b66db3a06c2955a9cb71a8718970c592
- Scan internally with scripts / commands
  - Use your own DNS server
  - Check which servers are doing a DNS lookup query after executing https://github.com/NorthwaveSecurity/log4jcheck
- Scan your own software project directories with Log4shell from LunaSec
  - https://github.com/lunasec-io/lunasec/releases/, https://www.lunasec.io/docs/blog/log4j-zero-day-mitigation-guide/
  - Scans for specific hashes and packages in your Java projects
  - Other languages like Scala, Groovy, or Clojure can also be impacted
  - Similar tool: https://github.com/logpresso/CVE-2021-44228-Scanner
- Scan your systems for these known vulnerable hashes: https://github.com/mubix/CVE-2021-44228-Log4Shell-Hashes/
- NCSC-UK: A file system search for log4j. Or checking dependency/package manager:

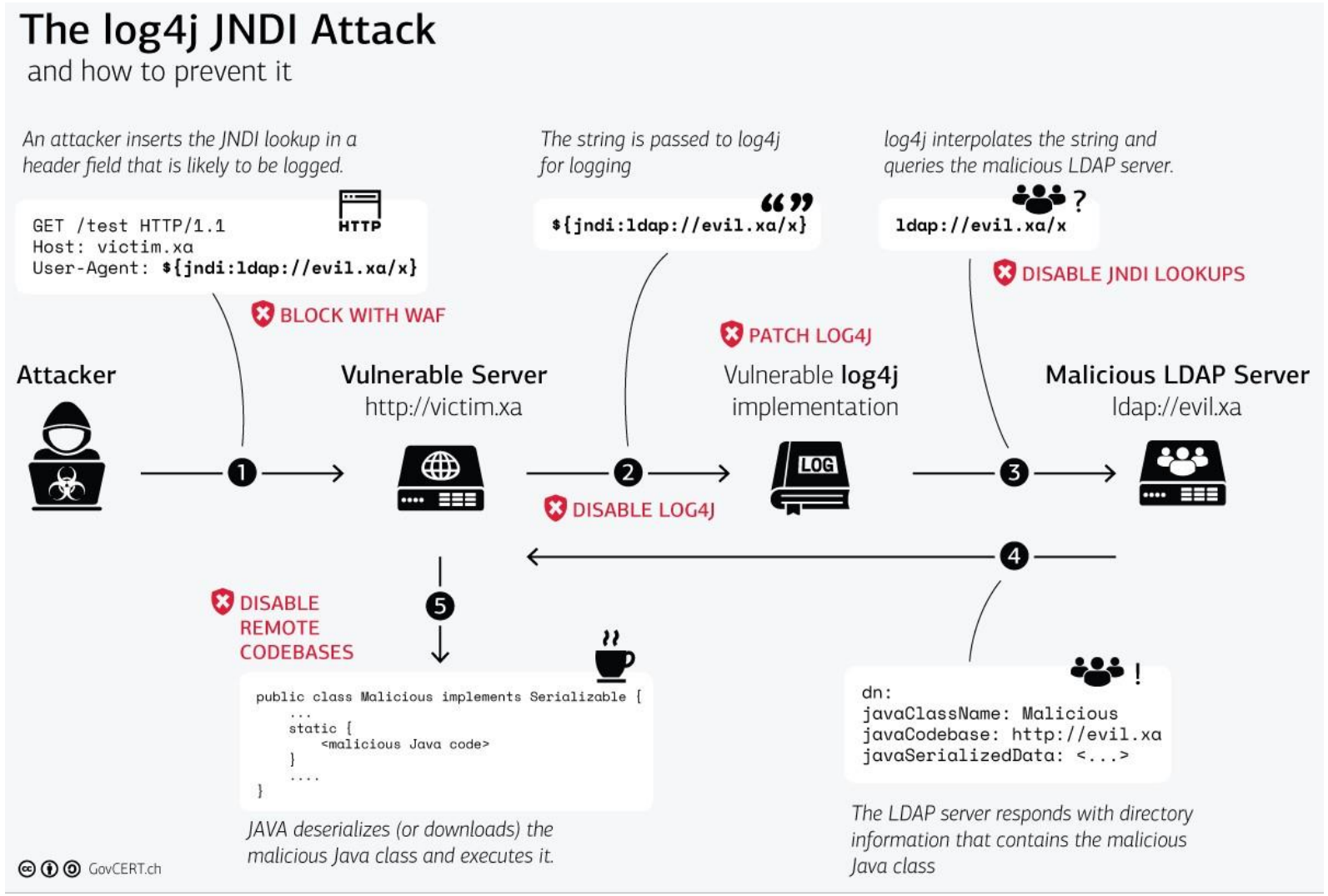
```
find / -type f -print0 |xargs -n1 -0 zipgrep -i log4j2 2>/dev/null
dpkg -l | grep log4j
```

How to patch/mitigate?

- Patch
  - all the software/appliances identified by your vendor with your vendor's recommendations/patches
    - See slide 10 on how to identify vulnerable software from the 4 lists.
  - Log4J libraries you use in your software to:
    - Java 7: v2.12.2
    - Java 8+: v2.16.0
- Mitigate
  - To mitigate vulnerabilities, users should switch **log4j2.formatMsgNoLookupsto to true** by:
    - Passing "-Dlog4j2.formatMsgNoLookups=true" as an argument when invoking Java.
    - Set environment variable
      - LOG4J_FORMAT_MSG_NO_LOOKUPS=true java ...
      - JAVA_OPTS=-Dlog4j2.formatMsgNoLookups=true
  - remove the JndiLookup class from the classpath:

```
zip -q -d log4j-core-*.jar org/apache/logging/log4j/core/lookup/JndiLookup.class
```

  - Check with your security vendors how they can mitigate this attack.
    - E.g.: F5, Microsoft, ESET, etc… have come out with mitigations using their security systems.
  - Nginx LUA script: https://github.com/infiniroot/nginx-mitigate-log4shell



Steps of a log4j JNDI attack and suggested mitigations (Source: Swiss CERT)

Known bad advice

- Updating Java is insufficient
- A Web Application Firewall (WAF) will help mitigate in combination with other mitigation and detection techniques
  - A WAF can not entirely mitigate Log4Shell
  - Cat and mouse game
- Updating the log statement format with %m{nolookupzz} is not advisable

How to monitor/detect intrusion attempts? (1/2)

- Scan local log files with Log4Shell Detector (Python): https://github.com/Neo23x0/log4shell-detector
- Manually search your log files with Grep / Zgrep commands:
  - https://gist.github.com/Neo23x0/e4c8b03ff8cdf1fa63b7d15db6e3860b
  - Has commands for obfuscated variants too
- Find vulnerable software on Windows

```
gci 'C:\' -rec -force -include *.jar -ea 0 | foreach {select-string "JndiLookup.class" $_} | select -exp Path
```

- Use YARA rules: https://github.com/Neo23x0/signature-base/blob/master/yara/expl_log4j_cve_2021_44228.yar
- Implement known IOCs in your detection/protection systems
- General detection regex

```
\${(\${(.*?:.*?:.*?:-)('"`)*(?1)}*[jndi:lapsrm]('"`)*}*){9,11}
```

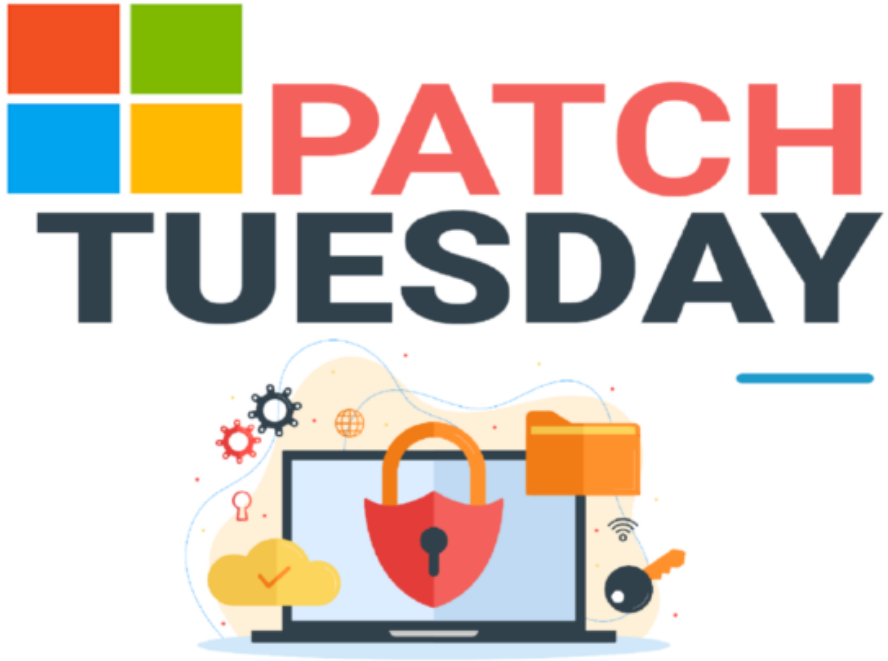
- Network-based detection
  - Diverto Nmap NSE scripts to check against log4shell: https://github.com/Diverto/nse-log4shell
  - NCC Group Log4Shell: Reconnaissance and post exploitation network detection: https://research.nccgroup.com/2021/12/12/log4shell-reconnaissance-and-post-exploitation-network-detection/

How to monitor/detect intrusion attempts? (2/2)

- Snort and Suricata rules
  - These are ET Open free community detections to alert on current exploit activity.
    - SID range 2034647-2034652: https://rules.emergingthreatspro.com/open/
- Host based detection
  - Florian Roth Sigma rule to detect an exploitation attempt against Log4j RCE vulnerability fields: https://github.com/SigmaHQ/sigma/blob/master/rules/web/web_cve_2021_44228_log4j_fields.yml
  - Florian Roth Sigma rule to Detect an exploitation attempt against Log4j RCE vulnerability: https://github.com/SigmaHQ/sigma/blob/master/rules/web/web_cve_2021_44228_log4j.yml
  - Powershell script to detect Log4Shell: https://github.com/sp4ir/incidentresponse/blob/35a2faae8512884bcd753f0de3fa1adc6ec326ed/Get-Log4shellVuln.ps1
  - Powershell script to perform a scan to see if it's vulnerable: https://github.com/crypt0jan/log4j-powershell-checker
  - NCCgroup Version hashes (MD5, SHA1 and SHA256) for Log4j2 versions: https://github.com/nccgroup/Cyber-Defence/tree/master/Intelligence/CVE-2021-44228
  - Huntress Online Log4Shell Vulnerability Tester: https://log4shell.huntress.com

Extras

- Don’t forget Microsoft Patch Tuesday
  - 1 zero-day: Windows AppX Installer Spoofing
  - 7 critical, 60 Important



- Next QCTR event on Thursday 13 January 2021
  - Invitation will be sent to anyone registered for any of the previous events
  - https://app.livestorm.co/ccb/
- Follow us on Twitter/LinkedIn
  - https://twitter.com/certbe
  - https://www.linkedin.com/company/centre-for-cybersecurity-belgium/mycompany/
- Extra source from our partner NCSC-NL:
  - https://github.com/NCSC-NL/log4shell
  - Includes Threat hunting info, identification and mitigation techniques, known software list
  - Includes a collection of IOC lists

Questions?

Updates?

Find extra updates on our advisory on https://cert.be/en/warning-active-exploitation-0-day-rce-log4j

Follow-up questions?

Send a mail to them to ews@cert.be

Intrusion identified?

Please report to us via:

cert@cert.be

https://cert.be/en/report-incident

NOTES

- Slide 5
  - https://www.lunasec.io/docs/blog/log4j-zero-day/
  - https://nvd.nist.gov/vuln/detail/CVE-2021-44228
  - https://www.microsoft.com/security/blog/2021/12/11/guidance-for-preventing-detecting-and-hunting-for-cve-2021-44228-log4j-2-exploitation/#nation-state
  - https://blog.netlab.360.com/ten-families-of-malicious-samples-are-spreading-using-the-log4j2-vulnerability-now/
  - https://businessinsights.bitdefender.com/technical-advisory-zero-day-critical-vulnerability-in-log4j2-exploited-in-the-wild
  - https://thehackernews.com/2021/12/hackers-exploit-log4j-vulnerability-to.html
- Slide 6: https://news.sophos.com/en-us/2021/12/12/log4shell-hell-anatomy-of-an-exploit-outbreak/
- Slide 7: https://nvd.nist.gov/vuln/detail/CVE-2021-45046
- Slide 8 & 9
  - 26/11: https://cve.mitre.org/cgi-bin/cvename.cgi?name=CVE-2021-44228, https://nvd.nist.gov/vuln/detail/CVE-2021-44228
  - 01/12: https://therecord.media/log4shell-attacks-began-two-weeks-ago-cisco-and-cloudflare-say/, https://twitter.com/eastdakota/status/1469800951351427073, https://blog.talosintelligence.com/2021/12/apache-log4j-rce-vulnerability.html
  - 09/12: https://www.lunasec.io/docs/blog/log4j-zero-day/, https://github.com/tangxiaofeng7/apache-log4j-poc
  - 10/12: https://cve.mitre.org/cgi-bin/cvename.cgi?name=CVE-2021-4104
  - 14-15/12: https://github.com/apache/logging-log4j2/tags
- Slide 10
  - https://www.bleepingcomputer.com/news/security/log4j-list-of-vulnerable-products-and-vendor-advisories/
  - https://github.com/cisagov/log4j-affected-db
  - https://github.com/NCSC-NL/log4shell
  - https://www.techsolvency.com/story-so-far/cve-2021-44228-log4j-log4shell/
- Slide 11: https://www.lunasec.io/docs/blog/log4j-zero-day-mitigation-guide/
- Slide 12
  - https://logging.apache.org/log4j/2.x/
  - https://www.govcert.ch/blog/zero-day-exploit-targeting-popular-java-library-log4j/