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NORTH AMERICA

Embedded Linux Conference

Is Maven safe for production?

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About the speakers

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- CNCF contributor and maintainer
- Container build and secure supply chain
- Helped ship freight containers
- Swam with Olympians

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Sr. Principal DevRel Engineer
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- Chainguard Libraries for Java champion
- Maven trainer and commiter
- Repository manager expert
- Book author and writer
- Open source hacker

Agenda

- What is “safe” and “for production?”
- What is Maven?
- “Battle stories”
    - Generating SBOMs
    - Harden builds
    - SLSA
- How can we improve security?
- Q&A

What does “safe” and “for production” even mean?

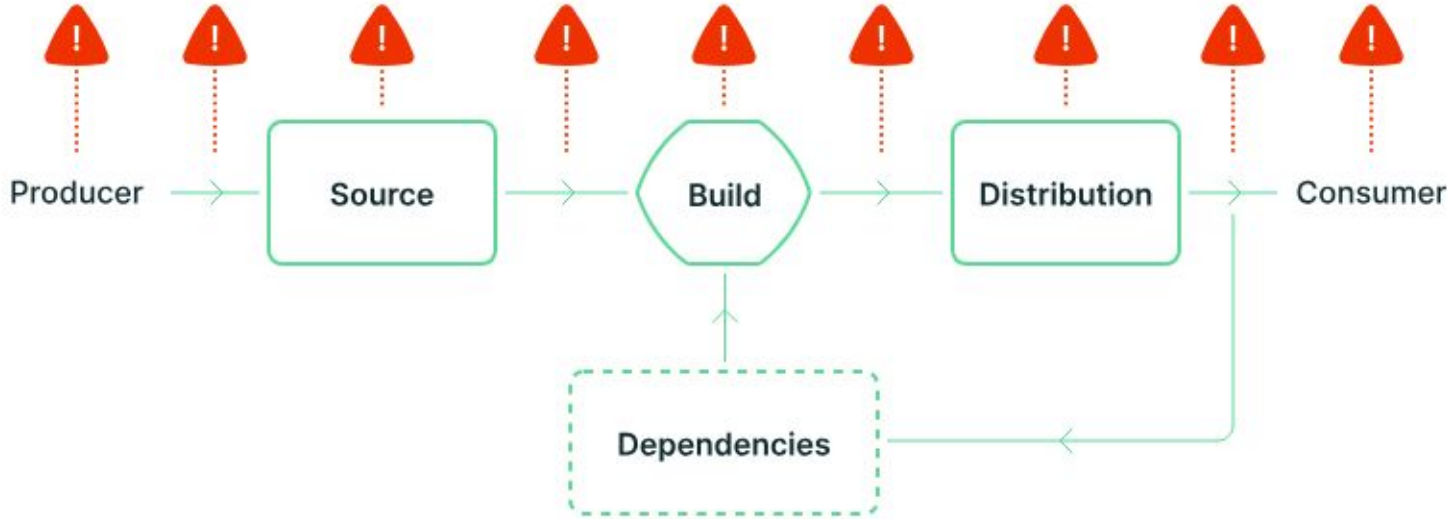
Quality and security of your software supply chain

*It should be **secure** to run a **reproducible** build and **reliably build** your application:*

- Maven, plugins, extensions, repository managers
- External sources - Maven Central and other repositories
- Build runtime environment
- Output artifacts and complementary info

Classification as **S**upply-chain **L**evels for **S**oftware **A**rtifacts - https://slsa.dev

SLSA threat model - attack vectors everywhere



What is Maven?

Maven build ingredients

- Mostly widely used Java/JVM build system
- A flexible plugin execution framework
- Supports whatever you can implement in a plugin
- Nearly all functionality comes from plugins
- Strict around convention over configuration

It just works

mvn clean install

Plugins and extensions

- Core building blocks for functionality
- Plugin version are set in Maven binary
- Often changed in organization or project (pom.xml)
- Loaded from repositories like other dependencies
    - quickstart example - two project dependencies, >400 dependencies overall
- Extensions: customize Maven, some very useful features possible
    - Polyglot Maven
    - Mimir

Dependencies

- Everything your **app** and **build** need
  - Scopes - compile, test, runtime
  - Including plugins
- Plugins and extensions have dependencies
- Dependencies have dependencies
- Automatically resolved to one version
- All are sourced from repositories
- Maven Central by default

```
<dependency>
  <groupId><groupId>
  <artifactId></artifactId>
  <version></version>
  <classifier></classifier>
  <scope></scope>
  <type></type>
<dependency>
```

Security of maven central repository

- **Strict user validation**
- **Required** package namespacing (group ID)
- **Verified** namespace access from DNS and other sources
- Artifact checksums and PGP signatures
- Verification during staging, before publication
- Malware prevention, using signals from Sonatype Nexus Firewall

Operated by Sonatype - https://central.sonatype.com/

Battle stories: Software bill of materials

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What is an SBOM?

- Software Bill of Materials
- Made for machines
- Standardized formats
- Vendors may need to produce this (ex: CRA)

How can I make an SBOM with Maven?

- Maven dependency plugin:

  ```
  mvn dependency:tree -DoutputType=json
  ```

- CycloneDX Maven Plugin:

  ```
  mvn org.cyclonedx:cyclonedx-maven-plugin:makeAggregateBom
  ```

- SPDX Maven Plugin:

  ```
  mvn org.spdx:spdx-maven-plugin:createSPDX
  ```

SBOM for plugins?

Plugins

- Gap in existing tools
- Dynamic dependency loading
- Non-Java dependencies

Extensions - more challenging!

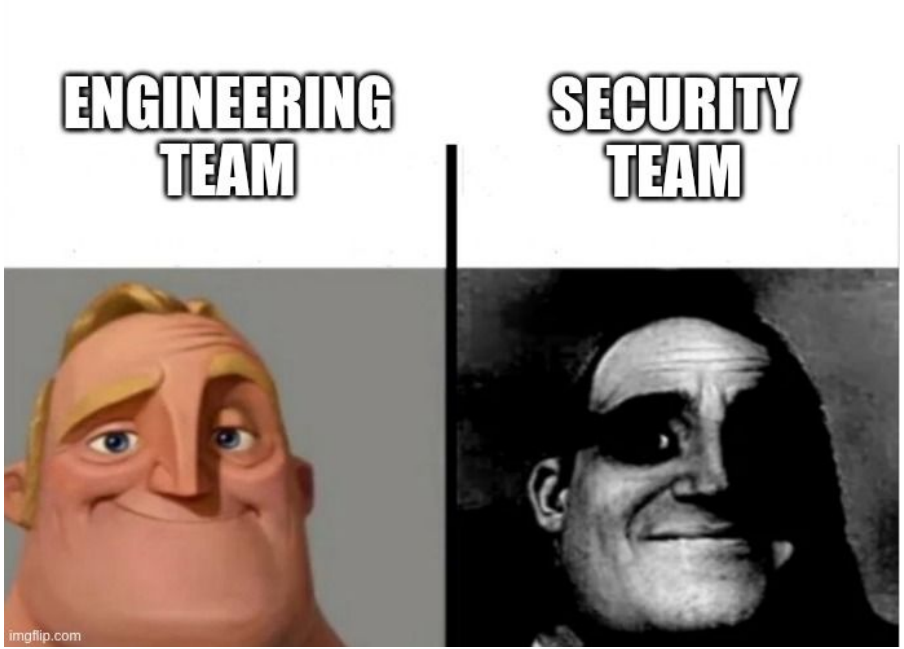
- Core extensions “outside project” - early loading
- Build extensions “inside project” - lazy loading

```
build.plugins[*].plugin.extensions=true
```

```
build.extensions[*].extension
```

Shading

- Use case: “über JARs”
- Dependencies can be included as ***relocated compiled code***
- “Reduced POM” output hides dependency tree!



Battle stories: Hardened builds

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Dependency rebuilds

Why do this?

- Prevent malware
- Add additional metadata
    - SBOMs (CycloneDX, SPDX, etc.)
    - Provenance
- Security patching*
- Control of supply chain

Code archeology

Rebuilding old releases is hard:

- Where is the source code? Is the release commit/tag correct?
- Not in a mono repo for mixed use ideally
- Does mvn clean install work?
- Before JDK 8 is harder since no open source distro available

Hope is doesn't use Ant or Gradle…

Obstacles and challenges

- Different Java language level for different modules
  - Potentially difficult to choose JDK
  - Trino JDBC driver vs Trino itself
- Release frequency can be too high and too low
  - aws-sdk or wso2 - every commit?! - too much churn
  - Apache hive - about once a year or less - too many security issues
- Native code is tricky and platform dependent, luckily rare
  - Tomcat JNI
  - RPM builds from Maven projects
  - Airlift compression library
  - Go-based launcher in Trino

Battle stories:
Secure builds and making SLSA

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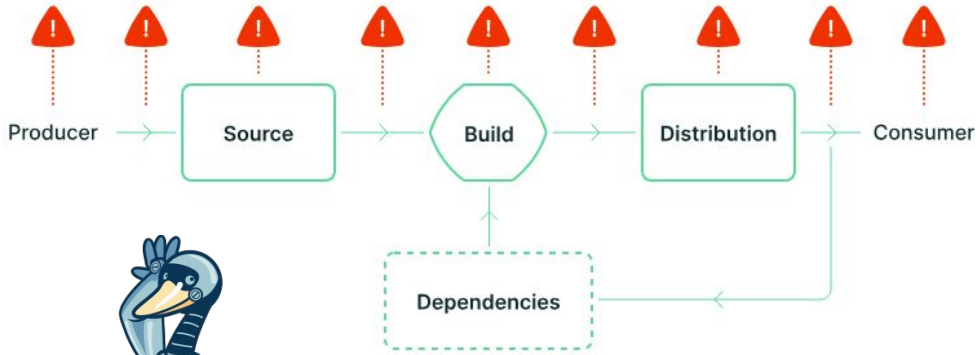
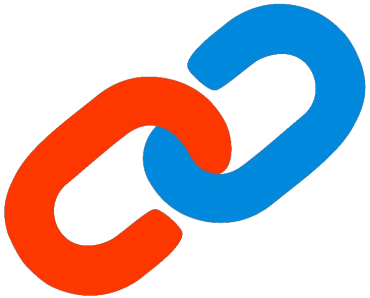
Making SLSA

- **S**ecurity **L**evels for **S**oftware **A**rtifacts
- Key feature: *signed system attestations*
- Published “tracks”
  - **Build** - harden the build infrastructure
  - **Source** - harden the source code
- Not a silver bullet - see “mini Shai-Hulud”



Attestations and signatures

- Attestation: machine readable statement (in-toto)
- Summary attestation (VSA)
- Signing
  - Traditional PGP
  - Cosign “keyless”



in-toto

sigstore

cosign

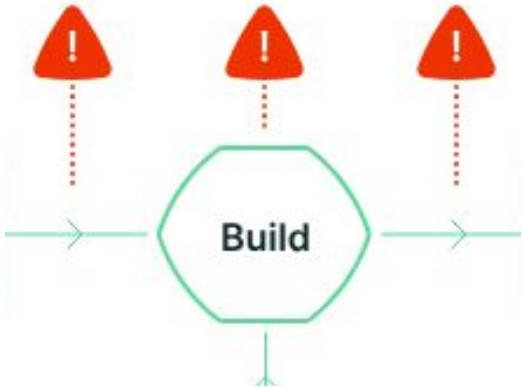
Build threats

Threat: build from bad code, process, system

Mitigation: system-generated attestation

Threat: tampered artifact or attestation

Mitigation: signed artifacts and attestations; digest references



How to generate?

- Build task/step
- “Observer” pattern - Tekton Chains
- GitHub Action Workflow

Source track

Threat: code without context

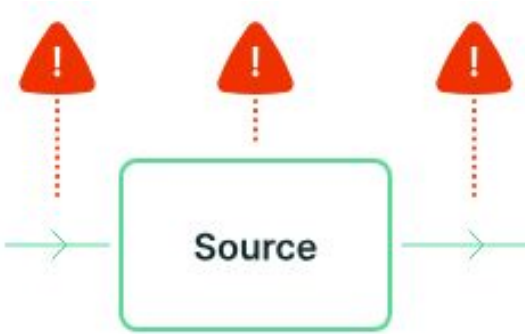
Mitigation: modern version control system

Threat: insider overwrites

Mitigation: branch protection

Threat: unauthorized code change

Mitigation: coherent history, identity management



Threat: privilege abuse

Mitigation: two-party review

Draft tracks

Build environment

- Harden the build machinery
- Attest the execution environment
- Validate expected environment state prior to build execution
- Hardware-level attestations

Dependencies

- Inventory build dependencies
- Vulnerability triage and remediation
- Trusted sourcing of third party artifacts
- Policy-driven dependency consumption

Dependency level 4 and Maven

- Dependency inventory ✅
- Vulnerability triage tools ✅
  - Renovate
  - GitHub Dependabot
- Producer-controlled dependency sources ✅
  - Mirroring encouraged
  - Strong vendor ecosystem
- Proactive defense from upstream attacks ✅
  - Verified artifact domains (Maven Central)
  - Required signatures and sources (Maven Central)
  - Immutable versions (Maven Central)

How can we improve safety?

Lock down your Maven use

- Control Maven version with wrapper, standard build env, and enforcer
- Pin your Maven plugin and extension versions
- Ensure correct Java version and config - enforcer plugin, .mvn/jvm.config
- Maven configuration in ./mvn/maven.config
- Potentially standardized settings.xml in .mvn

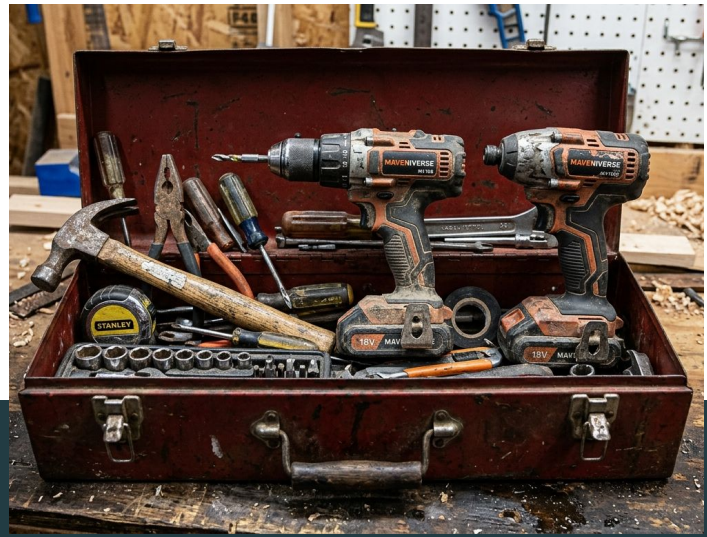
Dependency safety

- Understand your dependencies
  - dependency:tree|analyze|list
- Automate dependency updates
  - Renovate, Dependabot, versions plugin
- Update often
- All are sourced from repositories
- Understand those source repositories
- Use a repository manager as cache and control layer

```
<dependency>
  <groupId><groupId>
  <artifactId></artifactId>
  <version></version>
  <classifier></classifier>
  <scope></scope>
  <type></type>
<dependency>
```

Useful plugins, tools, and tips

- Help, versions, enforcer, and various other plugins
- Maveniverse tools and libraries
  - Njord - deployment to Maven Central
  - Mima and Toolbox
  - Mimir - better local cache
  - Pilot - terminal UI
- Reproducible builds guide

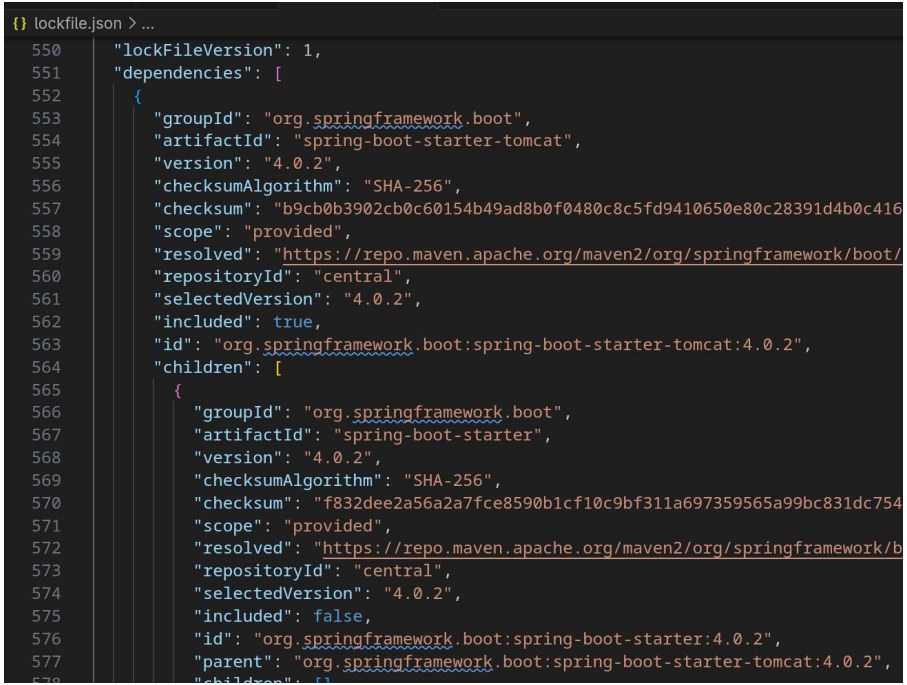


Checksums and lockfiles for Maven

- Trusted checksums

```
-Daether.artifactResolver.postProcessor.trustedChecksums=true
-Daether.artifactResolver.postProcessor.trustedChecksums.checksumAlgorithms=SHA-256
-Daether.artifactResolver.postProcessor.trustedChecksums.record=true
```

- Maven lockfile plugin



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Making a Lockfile for Maven

What else can we do?

- README file with build and release profile instruction
- Make sure mvn clean install works
- Don’t use version ranges …
- Make your build independent of a version control system
- Do the same for the release build configuration

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Is Maven safe for production?

Yes!

Ways to contribute

- Improve your own project
- Follow our advice
- Update dependencies
- Use the tools and thank the maintainers
- Help upstream

References

- Maven: https://maven.apache.org/
- Maven Central: https://central.sonatype.com/
- SLSA: https://slsa.dev
- Maveniverse tools: https://maveniverse.eu/
- Maven build requirements
  https://github.com/simpligility/maven-build-requirements
- Maven Lockfile Plugin: https://github.com/chains-project/maven-lockfile

Questions?

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Thank you!