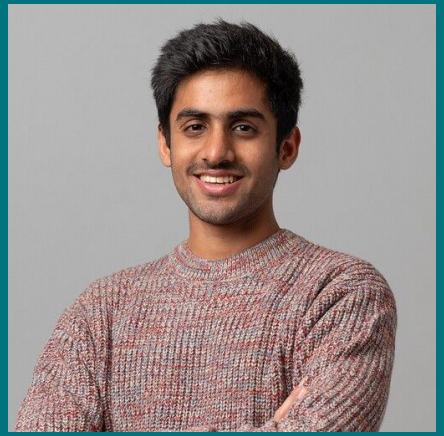
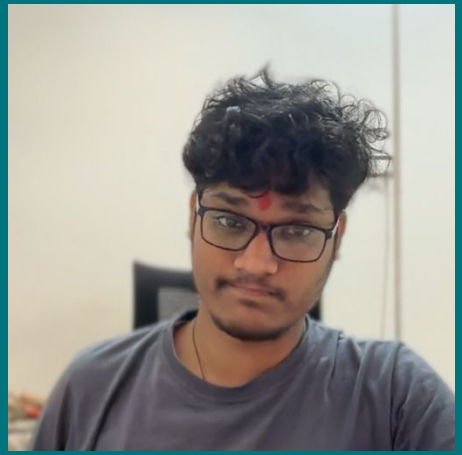
in-toto Attestations for What Really Happens in Your Build Pipeline, with Witness

Vyom Yadav (Canonical)
Rahul Vishwakarma (HighLevel)



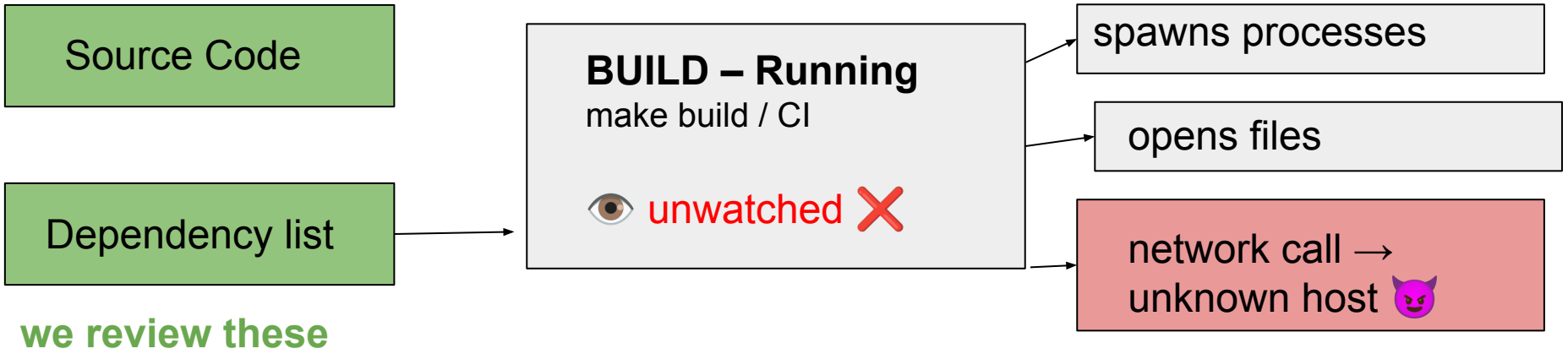
Security Engineer
@Canonical



Engineering Intern
@Highlevel

Do you know what your build actually did?

We inspect the inputs – not the build itself



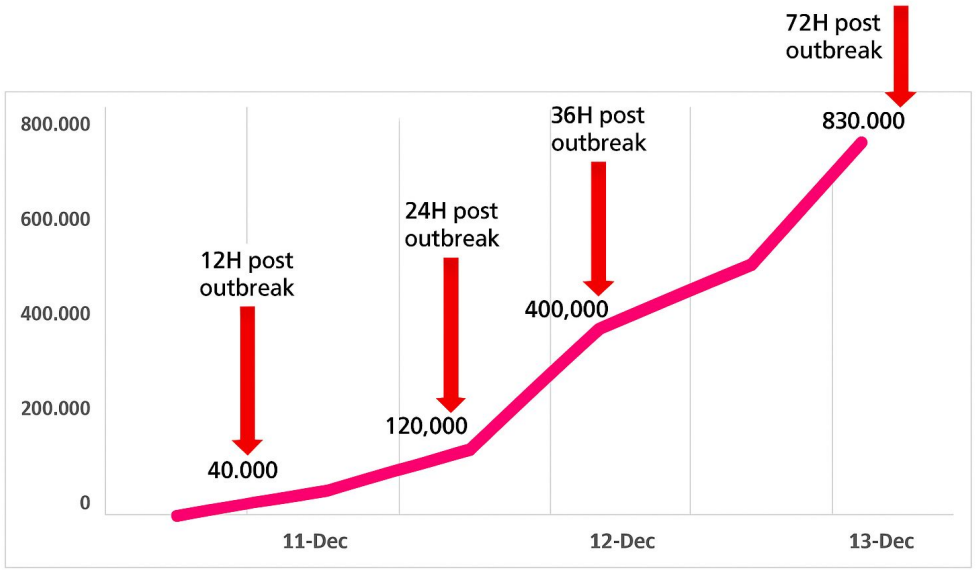
We review the inputs. The build's behaviour, processes, files, network, goes unwatched

When we don't know, we get burned

- Log4Shell (CVE-2021-44228), Dec 2021 : remote code execution
- The real damage: most orgs couldn't tell if they even used log4j
- It hid as a transitive dependency, buried deep
- Teams spent days just finding out if they were exposed

CVE-2021-44228

Why SBOMs matter



🚨 *"Do we use log4j?" nobody knows*
✅ Query → found, version 2.14.1, vulnerable

🚨 *Hard to assess radius across orgs? What services were affected?*
✅ Affected: 3 services, 2 teams

🚨 *Days to assess impact?*
✅ *Minutes, not days*

But can you trust your SBOM?

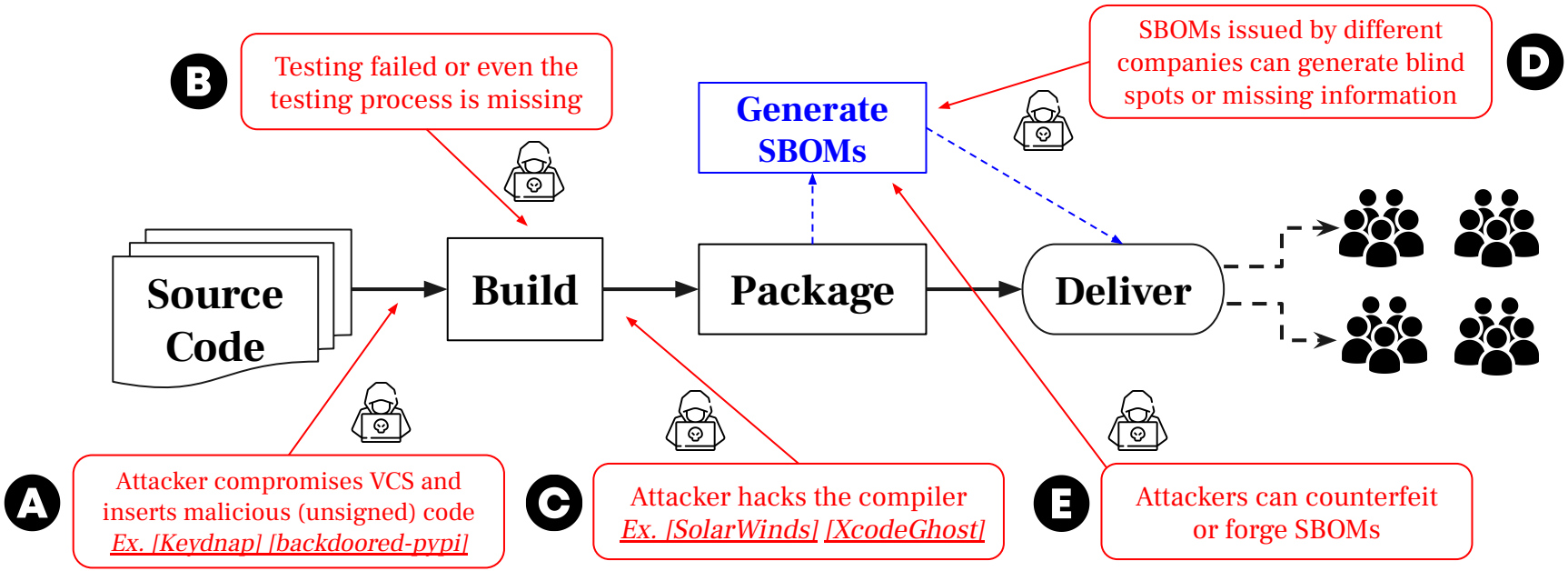
🚨**How was this SBOM generated?**
✅ With Witness : from the real build, not a manifest

🚨 **What information did it capture?**
✅ Processes, files, and the network : not just declared dependencies

🚨 **Is this information accurate?**
✅ Recorded from reality, not the plan (an attestation : records what really happened)

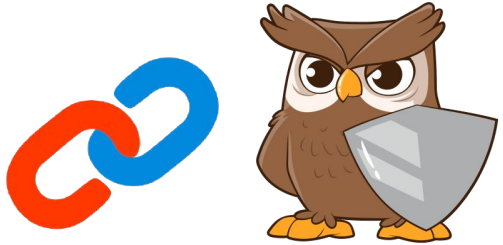
🚨 **Can you verify its authenticity?**
✅ Yes, it's cryptographically signed (DSSE : makes it verifiable)

Recap: Where Traditional SBOMs Break



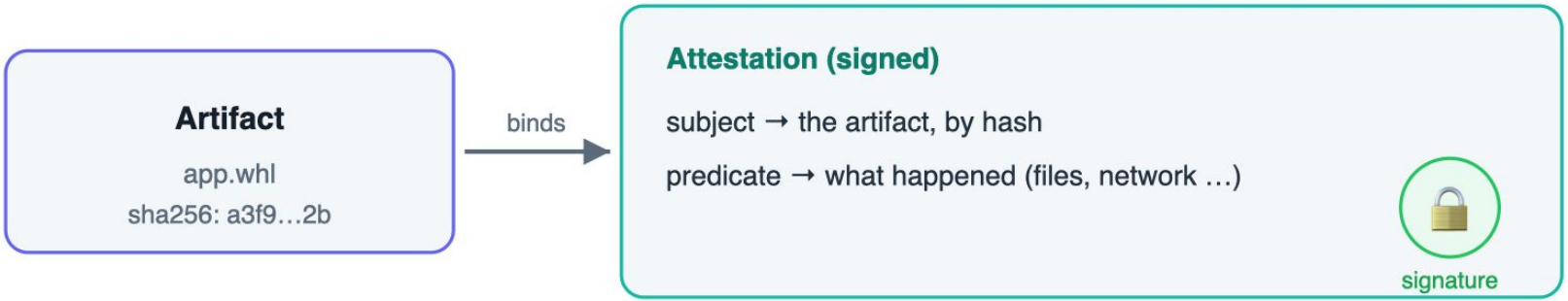
What we actually need is to verify the full story: who did what, when, and with what input. And that's exactly where in-toto comes in."

What is an attestation?



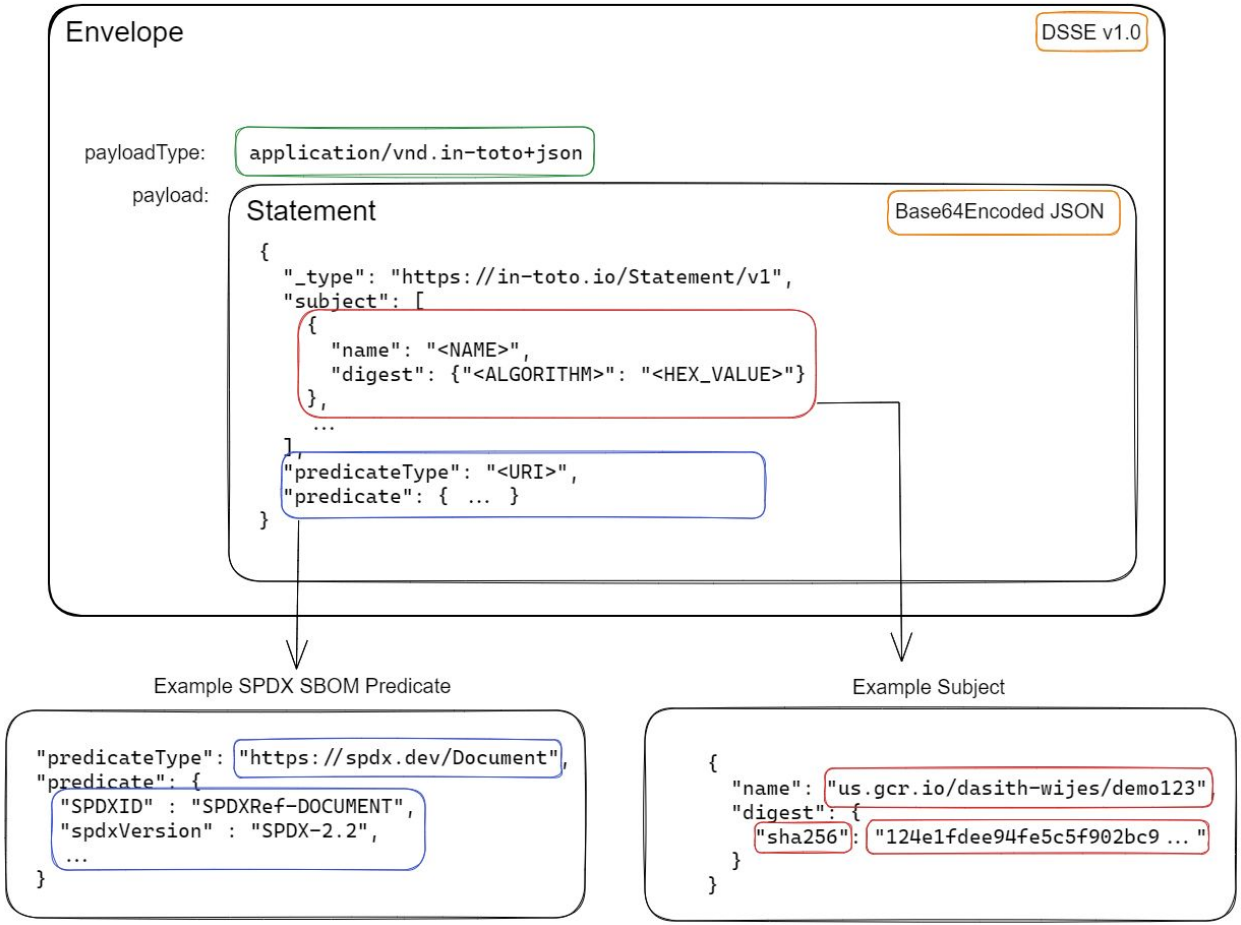
- A signed statement about a specific software artifact
- Structure: subject (which artifact, by hash) + predicate (the data/claim)
- Data inside an attestation is bound to that exact build, typed, and verifiable
- Not a log file you have to trust, evidence anyone can check

An attestation = a signed statement bound to one artifact



Data inside an attestation = evidence you can verify, not a log.

in-toto Attestation Framework



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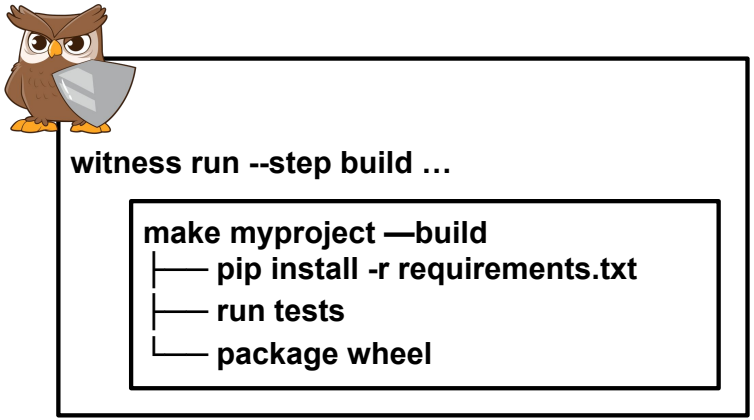
Wait…

Accurate SBOMs ?

Witness (in-toto): Monitor the actual build



Processes Spawned

Files Accessed

Git Commits

Environment

Network Calls

…

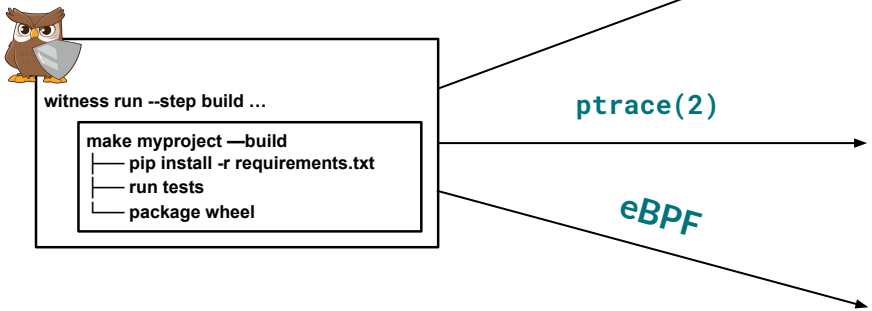
https://slsa.dev/spec/v1.0/about

https://in-toto.io/docs/what-is-in-toto/

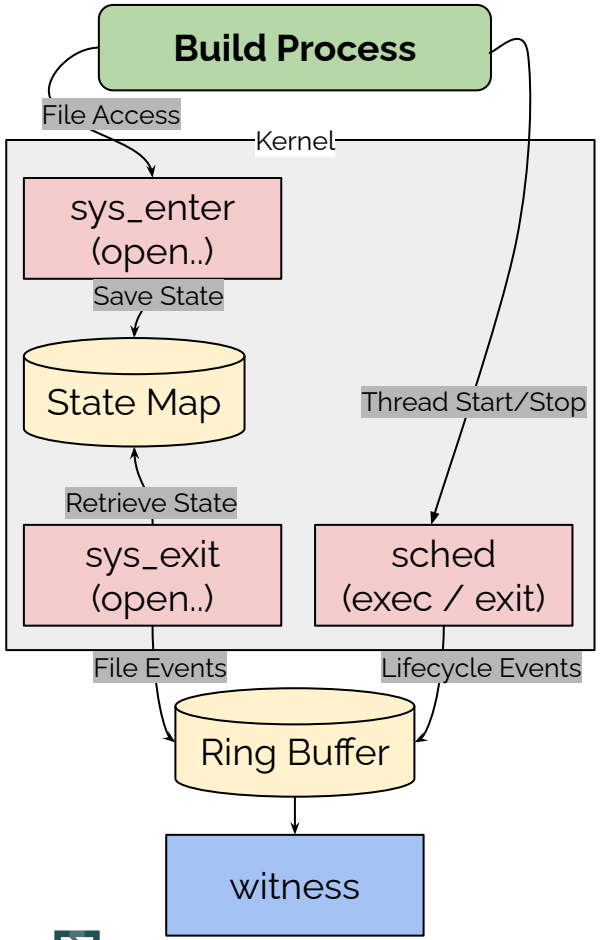
```
$ ./witness attestors list --experimental -c .witness.yaml
INFO    Using config file: .witness.yaml
```

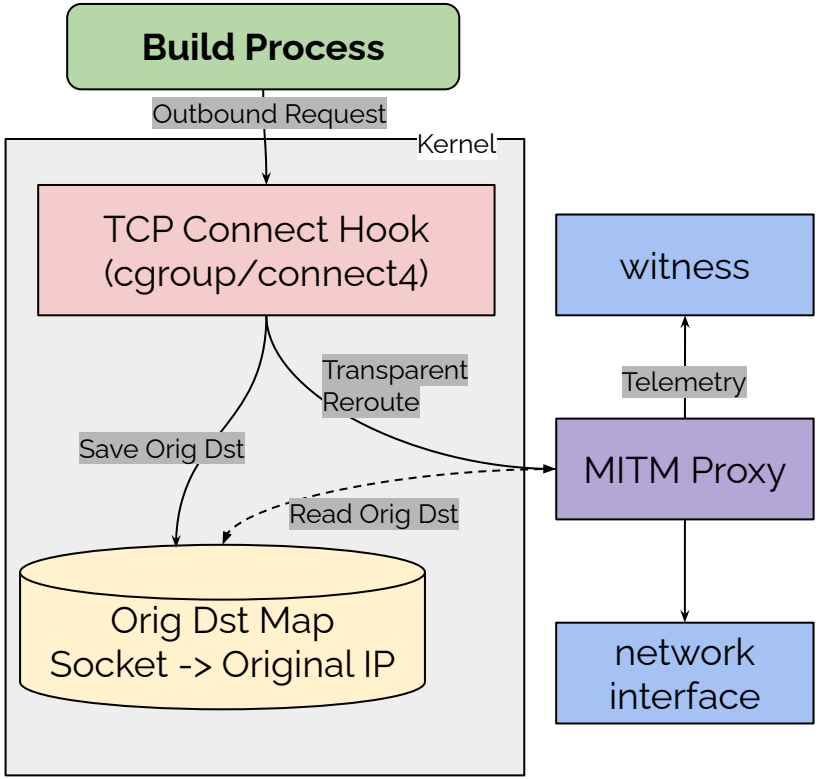
NAME	TYPE	RUN TYPE
maven	https://witness.dev/attestations/maven/v0.1	prematerial
sarif	https://witness.dev/attestations/sarif/v0.1	postproduct
policyverify	https://slsa.dev/verification_summary/v1	verify
aws	https://witness.dev/attestations/aws/v0.1	prematerial
slsa	https://slsa.dev/provenance/v1.0	postproduct
environment (default)	https://witness.dev/attestations/environment/v0.1	prematerial
jenkins	https://witness.dev/attestations/jenkins/v0.1	prematerial
omnitrail	https://witness.dev/attestations/omnitrail/v0.1	prematerial
product (always run)	https://witness.dev/attestations/product/v0.1	product
system-packages	https://witness.dev/attestations/system-packages/v0.1	prematerial
vex	https://openvex.dev/ns	postproduct
oci	https://witness.dev/attestations/oci/v0.1	postproduct
secretscan	https://witness.dev/attestations/secretscan/v0.1	postproduct
material (always run)	https://witness.dev/attestations/material/v0.1	material
link	https://in-toto.io/attestation/link/v0.3	postproduct
sbom	https://witness.dev/attestations/sbom/v0.1	postproduct
git (default)	https://witness.dev/attestations/git/v0.1	prematerial
gcp-iit	https://witness.dev/attestations/gcp-iit/v0.1	prematerial
gitlab	https://witness.dev/attestations/gitlab/v0.1	prematerial
network-trace (experimental)	https://witness.dev/attestations/network-trace/v0.1	execute
aws-codebuild	https://witness.dev/attestations/aws-codebuild/v0.1	prematerial
command-run (always run)	https://witness.dev/attestations/command-run/v0.1	execute
docker	https://witness.dev/attestations/docker/v0.1	postproduct
jwt	https://witness.dev/attestations/jwt/v0.1	prematerial
github	https://witness.dev/attestations/github/v0.1	prematerial
k8smanifest	https://witness.dev/attestations/k8smanifest/v0.2	postproduct
lockfiles	https://witness.dev/attestations/lockfiles/v0.1	prematerial

Witness Attestation Payload




```
"cmd":  ["pip", "install", "-r", "requirements.txt"],

"stdout": "Downloading urllib3-0.61.0-py3-none-any.whl",

"processes": [
   "program": "/usr/bin/pip",
   "processid": 47855,


   "openedfiles": {
        "...urllib3-1.26.5.egg-info/requires.txt":
             {"sha256": "7da776bbb1...."},
        "/lib/x86_64-linux-gnu/libssl.so.3":
             { "sha256": "660a6abea..."}


   "networkcalls": [
       "protocol": "tcp",
       "src_addr": "127.0.0.1:47644",
       "dst_addr": "https://pypi.org:443/simple/urllib3/",
       "data": {
           "request":
           "response":
```


Build Process
File Access
Kernel
sys_enter
(open..)
Save State
State Map
Thread Start/Stop
Retrieve State
sys_exit
(open..)
sched
(exec / exit)
File Events
Lifecycle Events
Ring Buffer
witness


Build Process
Outbound Request
Kernel
TCP Connect Hook
(cgroup/connect4)
witness
Telemetry
Transparent
Reroute
Save Orig Dst
MITM Proxy
Read Orig Dst
Orig Dst Map
Socket -> Original IP
network
interface

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Making SBOMs honest with SBOMit

SBOMit = SBOM + in-toto

SBOM + witness/in-toto = SBOMit

SBOM + 

= Enriched SBOM

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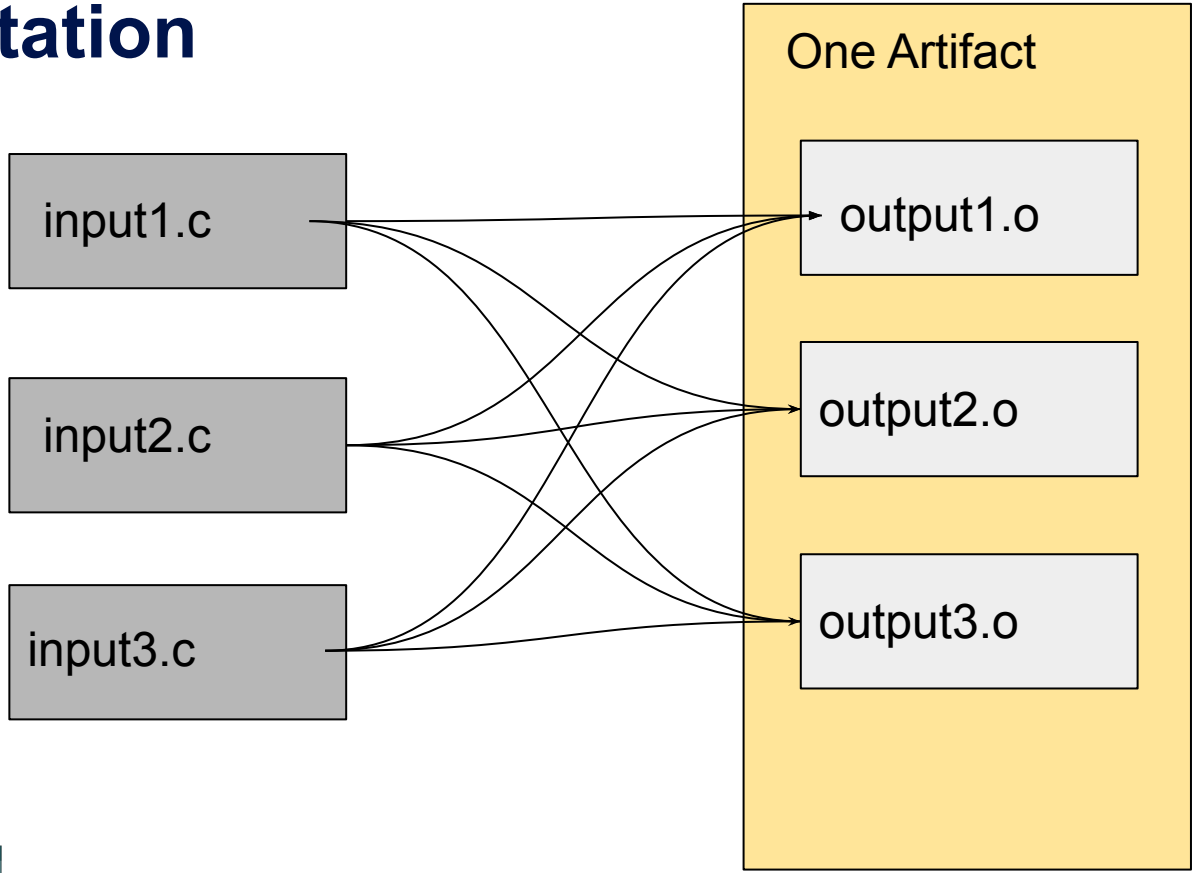
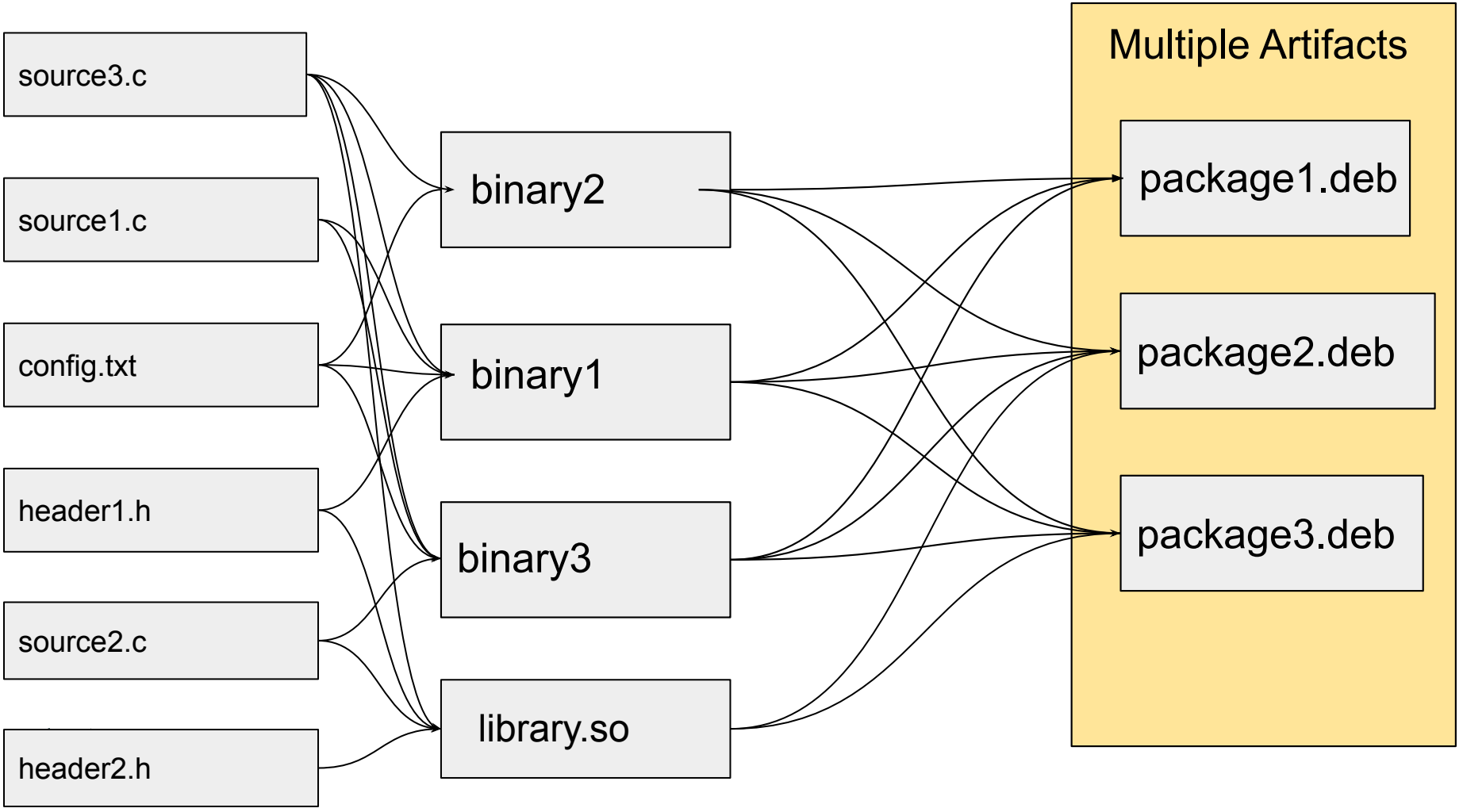
Demo

!Limitation


One Artifact
input1.c
input2.c
input3.c
output1.o
output2.o
output3.o


source3.c
source1.c
config.txt
header1.h
source2.c
header2.h
binary2
binary1
binary3
library.so
Multiple Artifacts
package1.deb
package2.deb
package3.deb

Join Us!

- First Friday of every month
- #in-toto & #in-toto-witness @ CNCF Slack Workspace
- #sbomit @ OpensSSF Slack Workspace
- https://github.com/in-toto
- https://github.com/in-toto/witness

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Thank you