Google

A Retrospective on Google's SBOM Implementation

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Part 1 recording:
https://drive.google.com/file/d/1wjuNEo7GwwZTehpcgVJaMI-8TdXkG2KF/view?usp=drivesdk

Feb 2025

1. How do we SBOM?
2. Lessons learnt from SBOM'ing

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2. Lessons learnt from SBOM'ing

Generate

Store

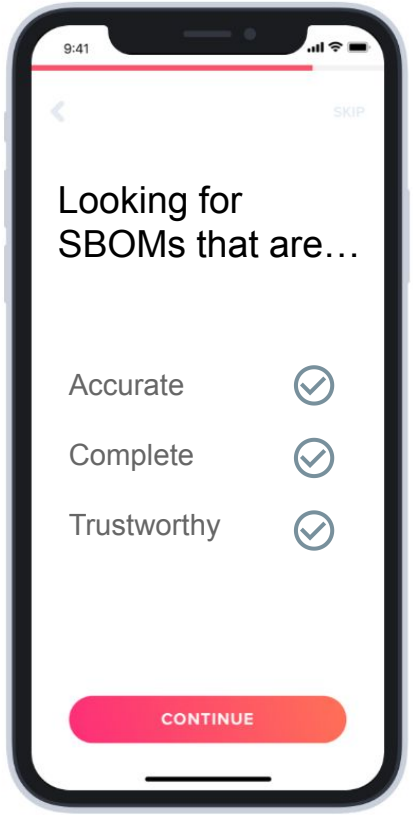
Retrieve

Applications

01

SBOM Design Principles

Where do we start? SBOMs?



What are properties of the SBOMs we want to strive for?

- Design doc with properties of SBOMs and best practices to achieve them
  - Properties
    - Accurate and complete
    - Trustworthy (Integrity & Provenance)

- Best practices: more throughout the talk!

Link to SBOM generation principles doc

Where do we start? YES

Opinionated or not? YES

- Problem scope is HUGE, many moving parts.

- Less is MORE
  - 1 standard: SPDX SBOMs
  - 1 storage and retrieval process
  - n builders << m products
  - etc.

SPDX

02

SBOM Generation

Generate

Source SBOMs??

Build SBOMs??

Analysis SBOMs?

Generate

Source SBOMs??

Build SBOMs??

Analysis SBOMs?

Source

Build

Artifact

- Includes tests and plugins
- Ambiguous dependency resolution

- Builds are lossy
- Loses context

Generate

Attaining good quality (accuracy and completeness):

- **BUILD-time whenever possible!! (extra credit for build tools)**

Source

Build

Artifact

Too much information (Inaccurate)

Too little information (Incomplete)

Generate: What we did

1. **Only build processes/builders can generate SBOMs**

2. **SBOM Generation tooling**
   a. Where possible, use build-tooling to generate SBOMs
      i. Android: dev/donation of SPDX Gradle plugin
      ii. Google3 (monorepo): Tooling leverages google3 metadata, annotations, and blaze
   b. Otherwise, use generic composition tooling (Syft, and internal version of osv-scalibr)

02

Store SBOM

Store

DATABASE !!
BLOB STORE!! WEB SCALE

Store

How do we create a SBOM database that we trust?

⇔

If we are using SBOMs to make security decisions, we need to trust them.

Store

Supply Chain Integrity Log
(SCILo)

For those familiar with
GUAC, it is similar
(& under the same team)

Store

I built an artifact, here's the build provenance to show it was securely built + build info

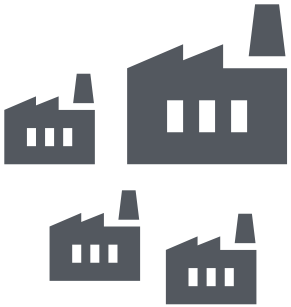
Signed by builder key

Great! This is a securely built artifact ("abcd..") by a trusted builder.

Builders

SCILo

Store



Builders

fe34..

in-toto

predicateType:
“ReferenceAttestation”

subject: {
...// software artifact hash
“sha256”:”abcd..”
}

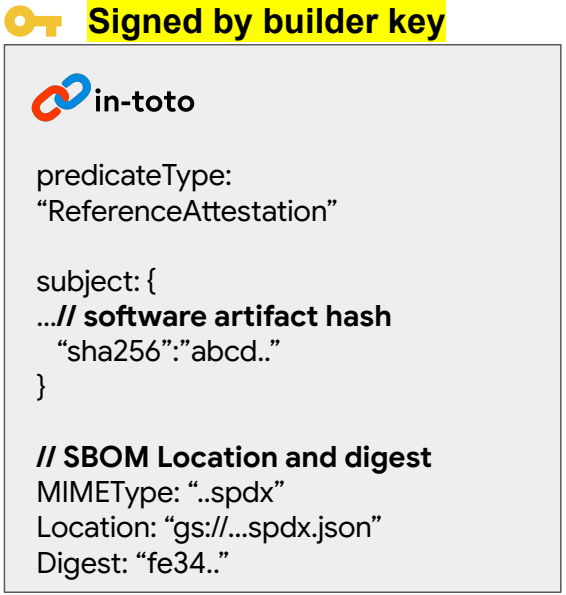
// SBOM Location and digest
MIMEType: “..spdx”
Location: “gs://...spdx.json”
Digest: “fe34..”

Great SBOM “fe34…” is for software “abcd..”.

SCILo

Link: [Intoto Reference Attestation]

Store



Great! I trust this builder’s SBOM generation process! Your SBOM is good!

Builders

SCILo

- SBOMs should be signed to ensure integrity
- The provenance of the SBOM should be accounted for

Store

SCILo

Artifact URI	Artifact Hash	SBOM
container_image://gcr.io/k8s	sha256:fefe..	/path/to/sbom-blob.spdx1.json
file://networkstore/somedir/binary	sha256:1234..	/path/to/sbom-blob.spdx2.json
container_image://staging.gcr.io/gke/abc	sha256:abcd..	/path/to/sbom-blob.spdx3.json
…	…	…

Great... This should be easy...

03

Retrieve SBOM

Retrieve: Ideal

<u>Want:</u>

Lookup
(“container_image://gcr.io/gke/abc”) =

Retrieve: Ideal

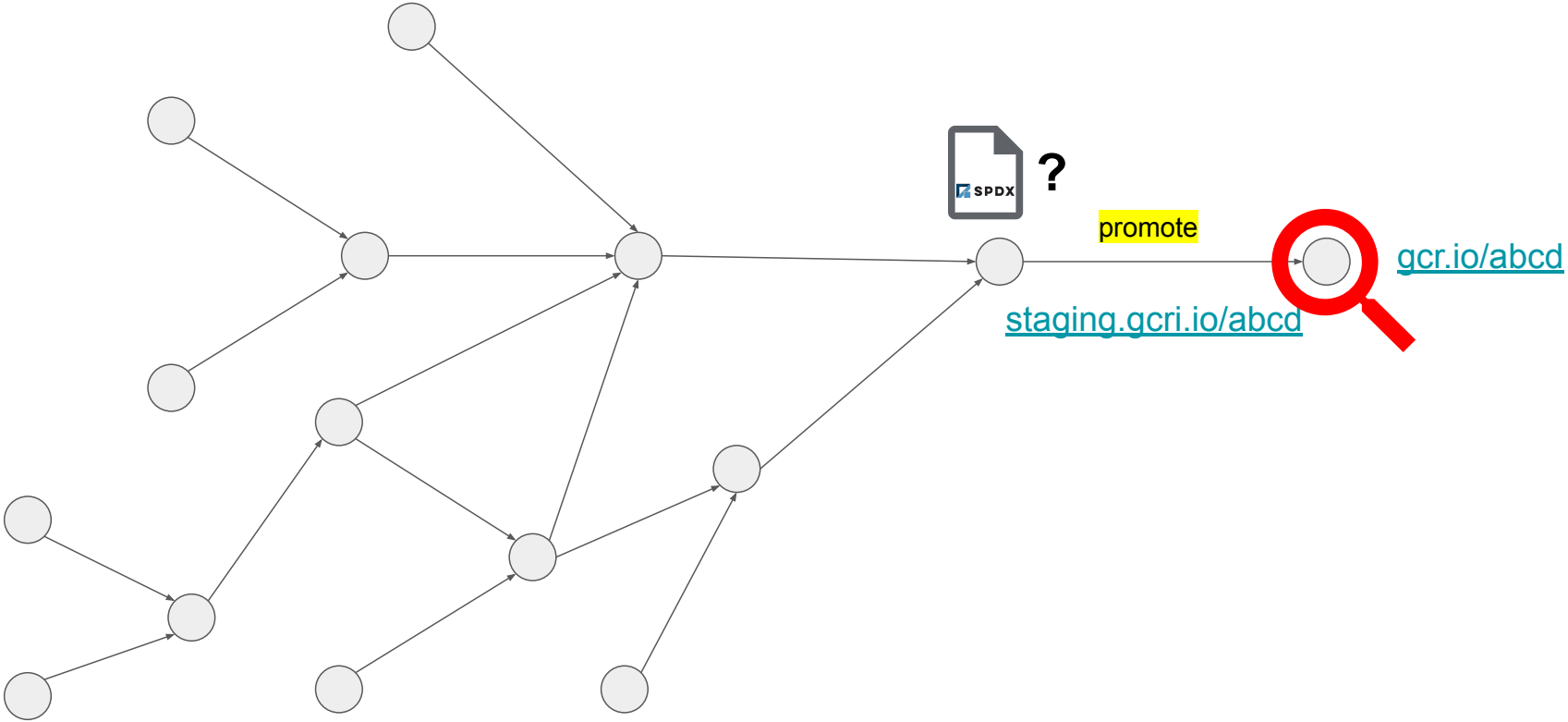
<u>Want:</u>

Lookup
(“container_image://gcr.io/gke/abc”) =

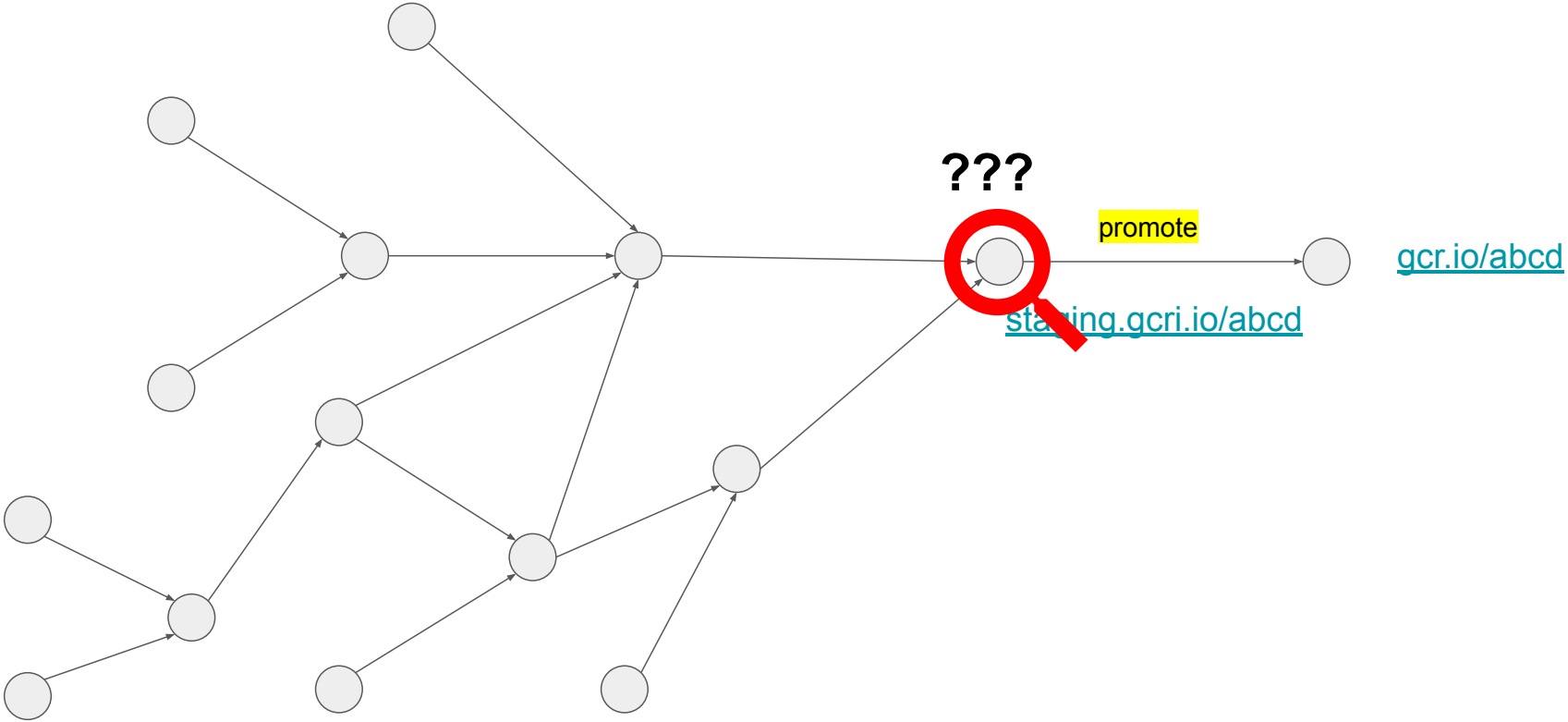
<u>Got:</u>

Lookup
(“container_image://gcr.io/gke/abc”) = NULL??

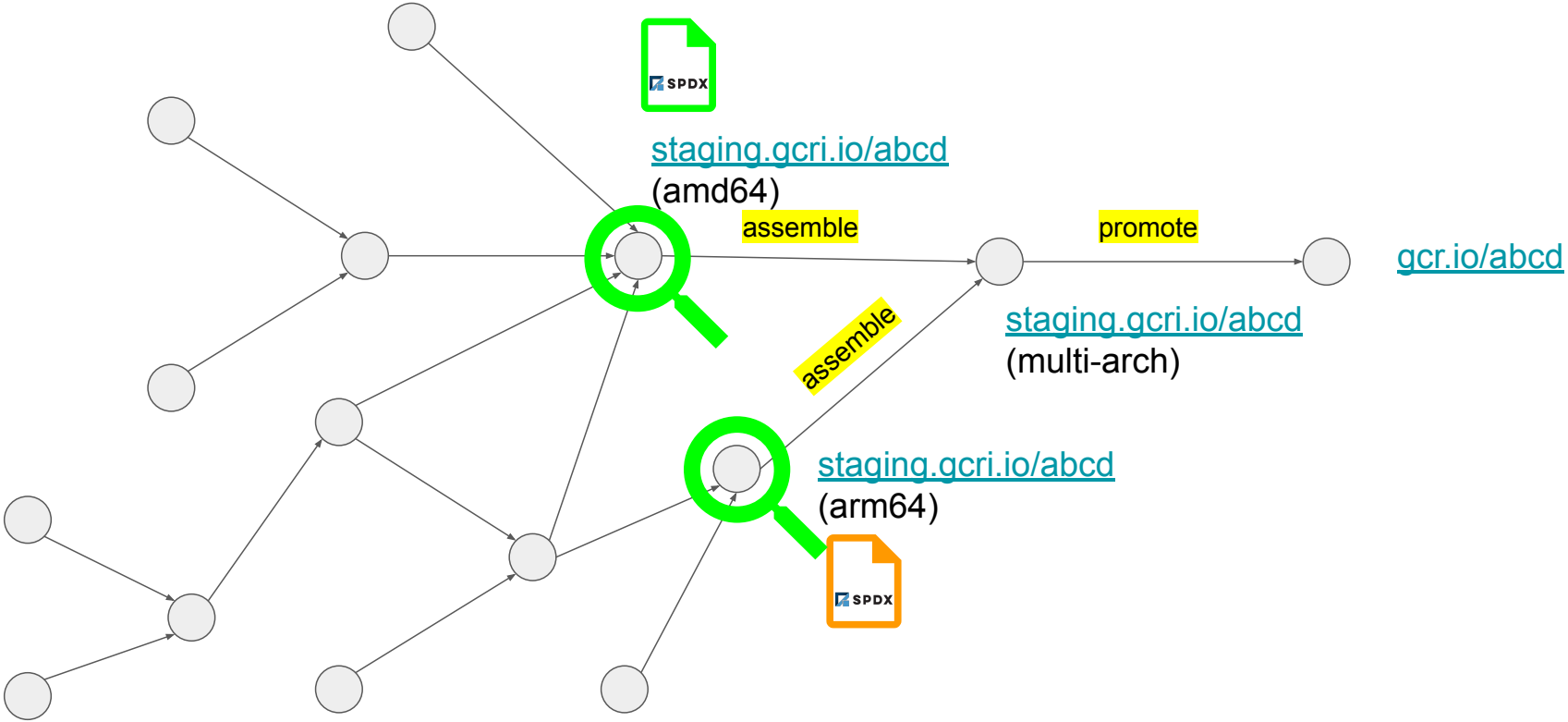
It’s a supply CHAIN....



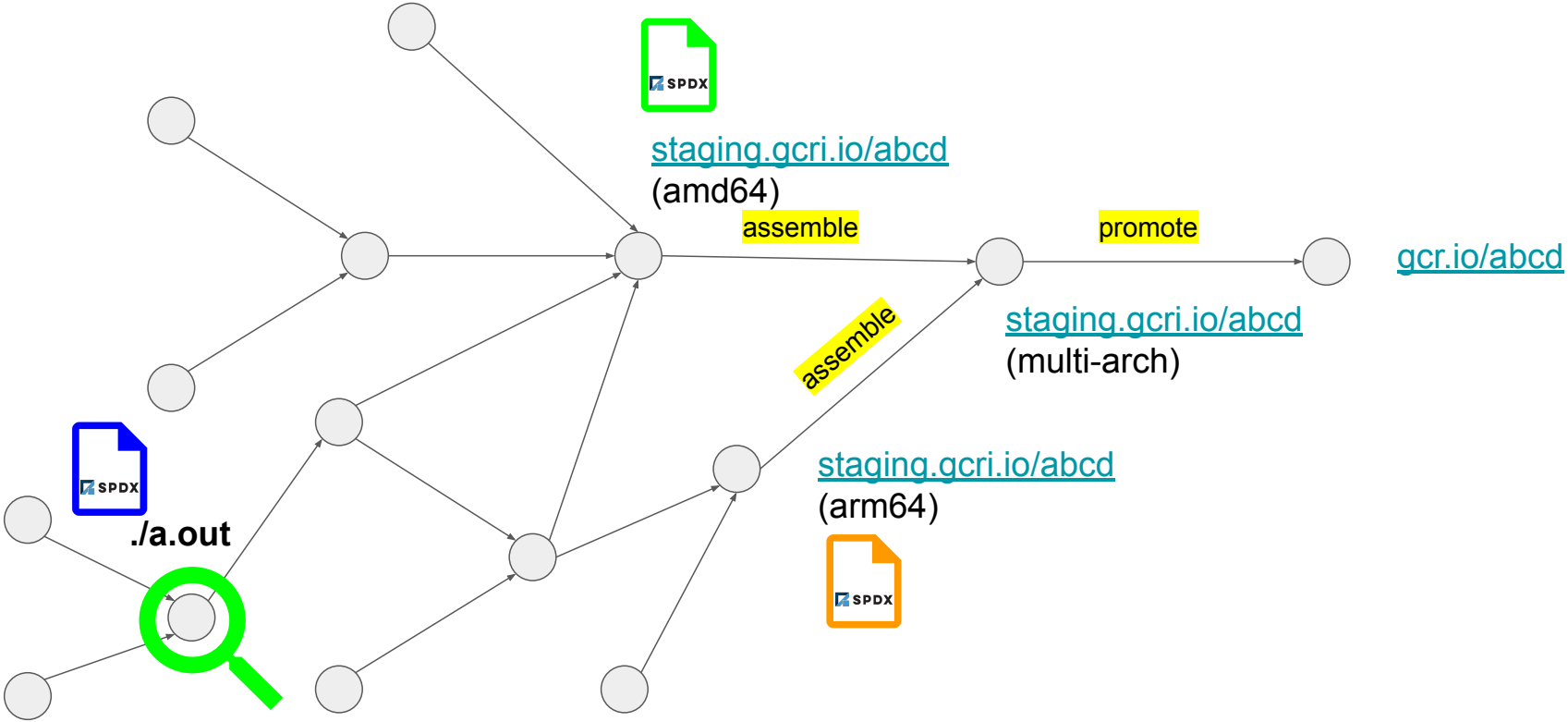
It’s a supply CHAIN....



It’s a supply CHAIN....



It’s a supply CHAIN....



Retrieve: Ideal

<u>Want:</u>

Lookup
(“container_image://gcr.io/gke/abc”) =

<u>Got:</u>

Lookup
(“container_image://gcr.io/gke/abc”) =

Retrieve: Edge cases

<u>“Edge” Cases</u>

- Container images manifest or config change (drift in hashes)
- Promoting images from staging to prod (change in reference)
- CI stages which result in change of hash (e.g. signing APKs)
- Inclusion of binaries which do not provide additional info
- Inclusion of binaries in packages that SCA tools can’t scan (e.g. installables)

Attaining good quality (accuracy and completeness):

- **Compose SBOMs to obtain a more complete SBOM**

WAIT!! What graph?

?????

gcr.io/abcd

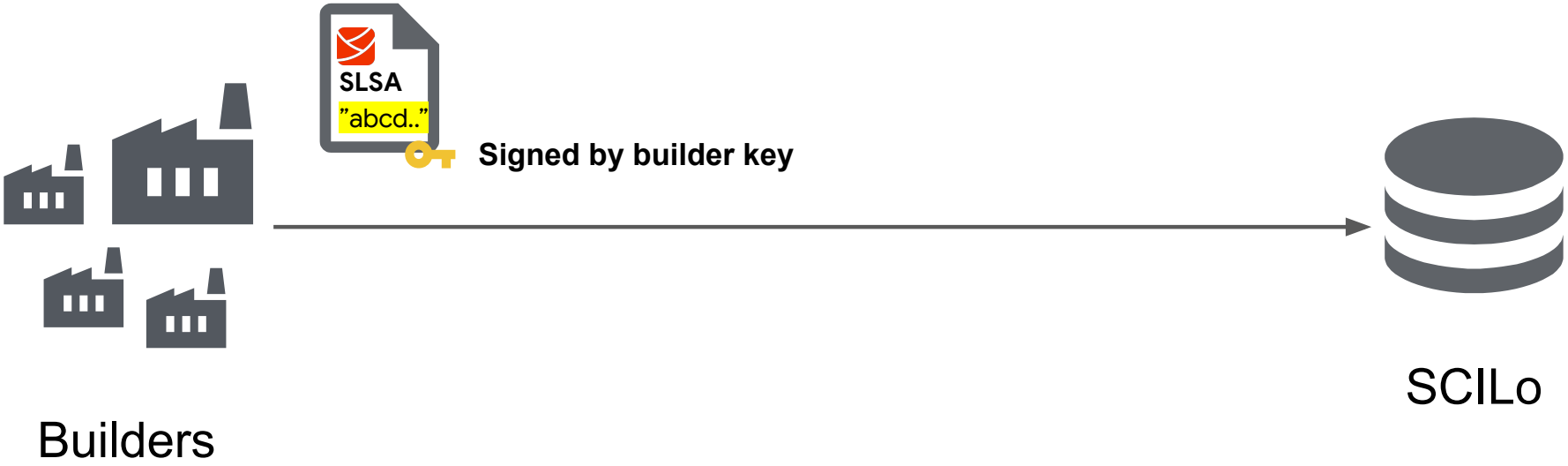
WAIT!! What graph?

BUILD! BUILD! BUILD!

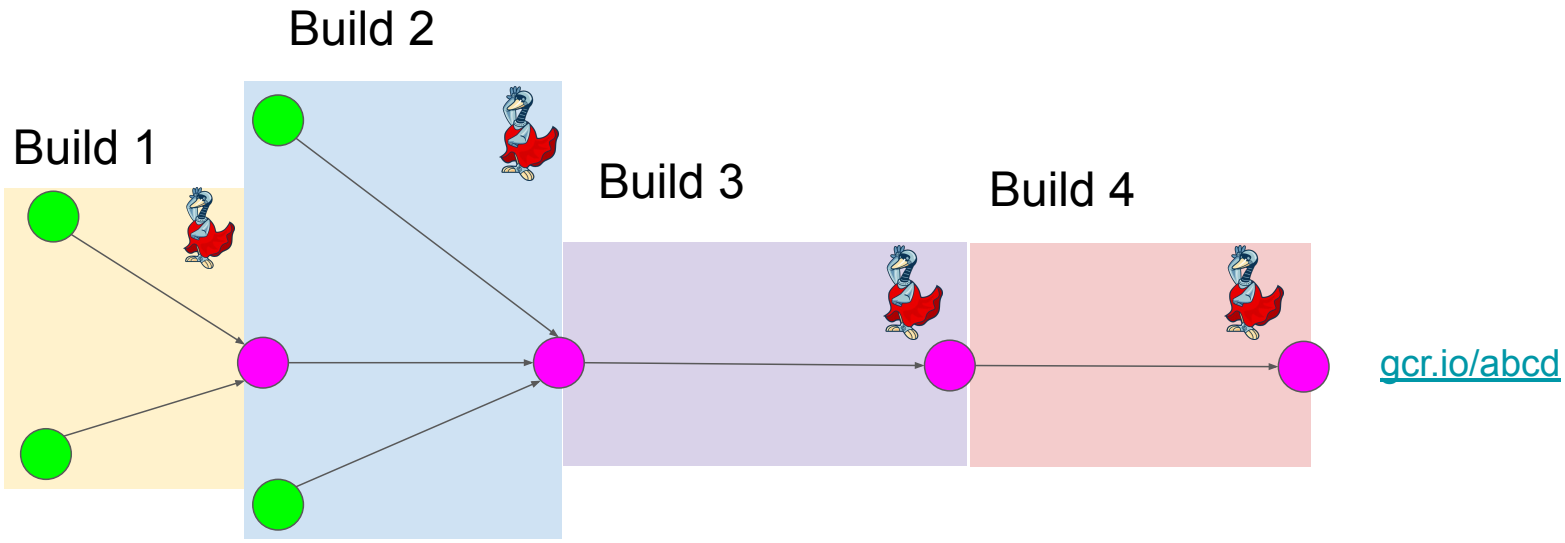
gcr.io/abcd

RECAP!

I built an artifact, here's the build provenance to show it was securely built **and what it was built from**



Using SLSA



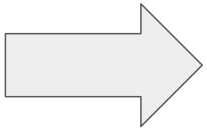
SLSA build metadata can be used to glue together lost pieces of SBOMs, creating more accurate SBOMs by composing them together!

https://slsa.dev/blog/2022/05/slsa-sbom

Retrieve Flow

Compliance Officer

Give me SBOMs for product **PixelOS**.



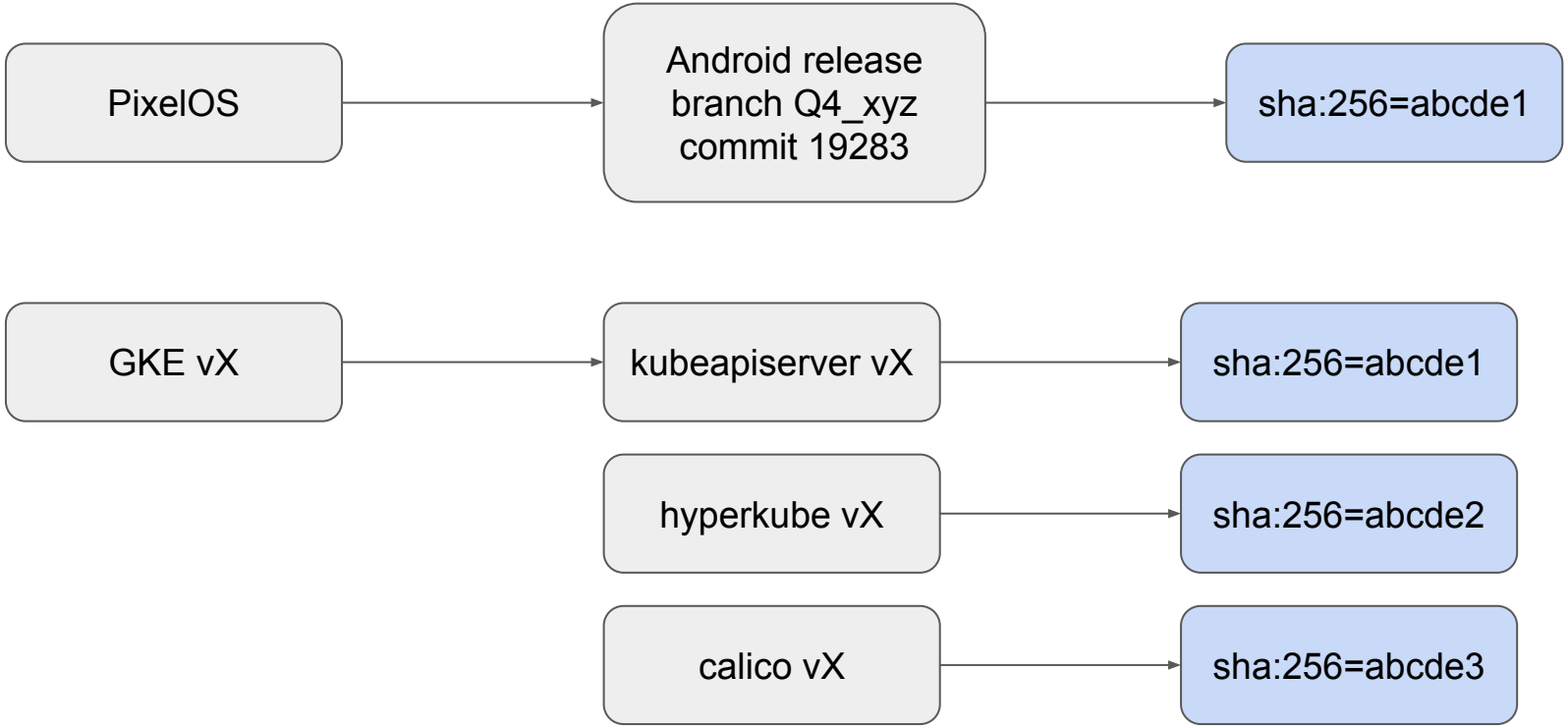
Product Owner

I am looking for ***URI: XYZ*** or *Hash:* ***sha256:abcd****…*

Translating request requirements is not easy

- Product mapping to software is HARD
- Effort needs to put into **maintaining software inventory**

Product mapping




Doing cool things with SBOMs
EO 14028 Compliance

04

Using SBOM

Using SBOMs

- Operationalizing an SBOM-based dependency inventory

SCILo

GUAC

+ Threat Intelligence
+ Organization Metadata

Incident Response (e.g. xz)

Quote from team: “We were able to figure out that we weren’t affected within 10 minutes”

Next, find where the package is used.

Purl

~ pkg:deb/debian/liblzma5@5.2.4-1

Dependent count

[redacted]

This search is limited to the latest builds of each ResourceUri.

ResourceUri

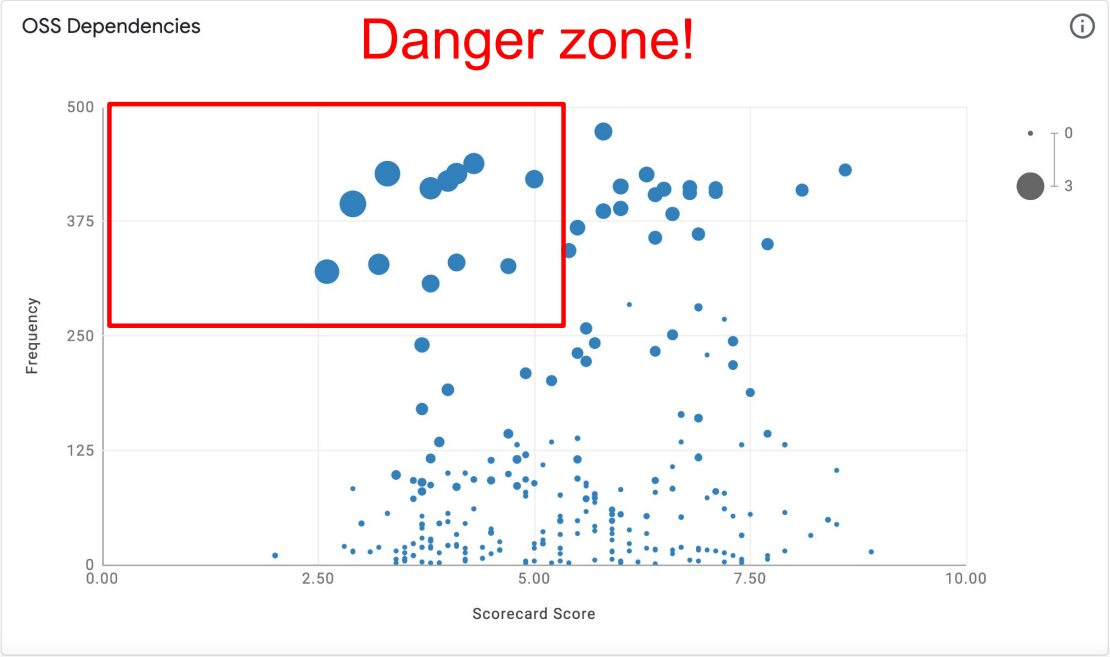
Point of contact not provided by SBOMs but VERY important!

ResourceUri	PointOfContact	
container_image://us-c[redacted]		
container_image://us-c[redacted]		{}
container_image://us-c[redacted]		{}
container_image://us-c[redacted]	{ "moma_team_id": [redacted] "buganizer_component": [redacted], [redacted] "team_email_addresses": ["overground-dev-null@google.com", "cloud-memcache-team@google.com"] }	{ "buganizer_component": "[redacted] }
container_image://us-c[redacted]		{}
container_image://us-c[redacted]		{}
container_image://us-c[redacted]		{}
container_image://us-c[redacted]		{}
container_image://gcr.[redacted]	{ "moma_team_id": [redacted] "buganizer_component": "[redacted] [redacted] "team_email_addresses": [[redacted]] }	{ "buganizer_component": [redacted]

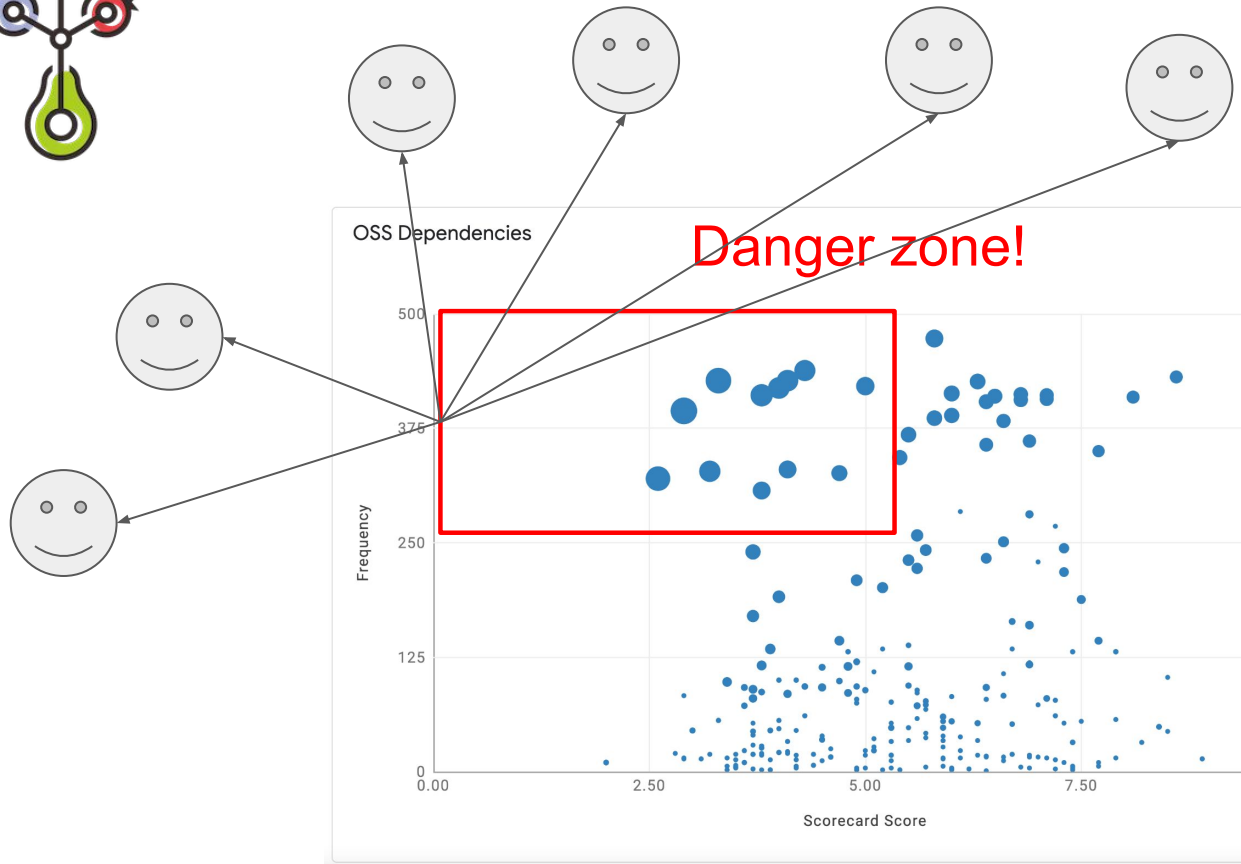
Because SBOMs are common formats across ecosystems, this queries across otherwise silo’ed systems

Fleet-wide Insights

Using GUAC + deps.dev, we mapped out fleet-wide dependency OpenSSF scorecard risks.



Fleet-wide Insights



Fleet-wide insights are only actionable if its scoped to someone that can take action

Here fleet = all container images across multiple orgs and ecosystems = little accountability

05

SBOMs Lessons Learned++

Using SBOMs: Lessons Learned

- Missing Software Identifiers

```
| | | "externalRefs": []
```

Using SBOMs: Lessons Learned

- Missing Software Identifiers
- SCA Shortcomings

```
1  {
2    "name": "extraneous-dev-dep",
3    "version": "0.0.0",
4    "dependencies": {
5      "d": "1.0.0"
6    }
7  }
```

pkg:npm/extraneous-dev-dep

Using SBOMs: Lessons Learned

- Missing Software Identifiers
- SCA Shortcomings

ljharb on Sep 19, 2023 Member ···

> Because it's a private package that just coincidentally has the same name as the malicious one, it is a false positive - so whatever tool is flagging this repo is broken, and you should strongly reconsider using a tool that is this naive about npm package names.

Duplicate of #303. Duplicate of #291. Duplicate of #288. Duplicate of #304. Duplicate of #305. Duplicate of #306. Duplicate of #309. Duplicate of #310. Duplicate of #311. Duplicate of #312. Duplicate of #314. Duplicate of #317. Duplicate of #318.

👎 9

Using SBOMs: Lessons Learned

- Missing Software Identifiers
- SCA Shortcomings
- Identifier Shortcomings

Using SBOMs: Lessons Learned

- Missing Software Identifiers
- SCA Shortcomings
- Purl Shortcomings
- Focus on SBOM Quality

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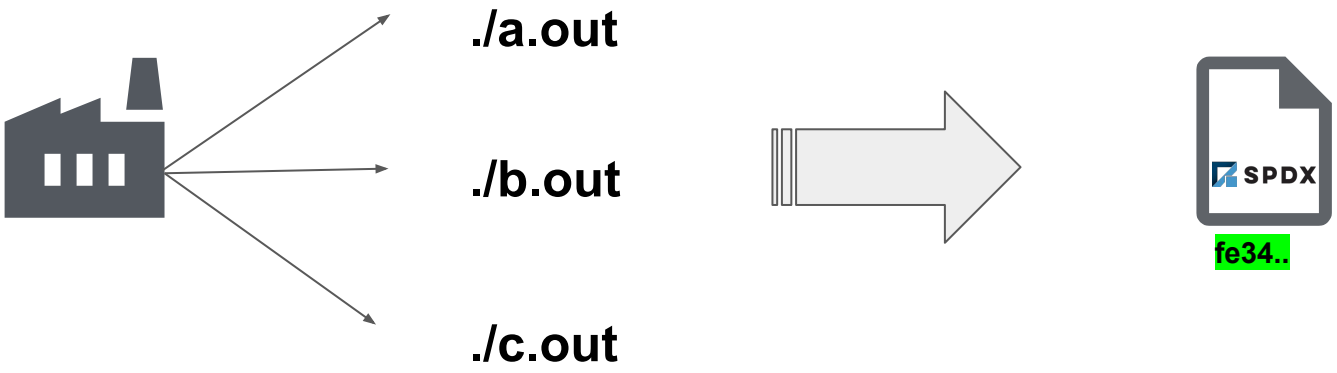

What now?

2021 - 2024 SBOMs @ Google

From 0* to...

4M
SBOMs a week

200M+
SBOMs

- Security and compliance teams now using SBOMs to help triage security/compliance issues
- SBOMs being part of several organizations' governance posture
- 2 Build SBOM tools, 1 Analysis SBOM tool, and more coming!

*We had some SBOMs generated from compliance purposes

What’s next

- SBOM Quality Library?
- Collaborating with OSV-SCALIBR
- Guac Software Identifiers Project
- Better organization metadata (via attestations)