

SBOM Analysis

Transitive Dependencies & Supply Chain Lineage

Cybersecurity Use Cases: Full Code-to-Cloud Traceability with Neo4j

Based on: [pedroleitao-neo4j/cyber-sbom](https://github.com/pedroleitao-neo4j/cyber-sbom)

What is an SBOM?

The "Pre-packaged Meal" Analogy

Think of an application as a pre-packaged meal:

- The **label** lists the ingredients (libraries/components).
- Developers don't write everything from scratch; they use libraries.
- Those libraries use *other* libraries, creating a **hidden chain**.

The Goal: Move from guessing risk to total traceability.

The Problem: Hidden Ingredients

Traditional tools focus on top-level dependencies, missing **Transitive Risks**.

- **Invisible Chains:** Risks buried 4-5 layers deep in the software lineage.
- **Zero-Day Lag:** Finding affected apps manually can take weeks.
- **The Gap:** Disconnect between Development (code) and Operations (cloud servers).

The Solution: Cyber-SBOM Graph

Building on the **VPEM** (Vulnerability Prioritization) model, this solution provides:

1. **Transitive Traversal:** Navigating recursive `DEPENDENCY_OF` relationships.
2. **Zero-Day Resilience:** Instant impact analysis for new CVEs.
3. **Code-to-Cloud Visibility:** Linking vulnerable code directly to the `ComputeInstances` where it is running.

Core Project Architecture

1. Data Ingestion (`loader.ipynb`)

- Loads transitive dependency data into the VPEM graph.
- Simulates multi-tier software lineage.

2. SBOM Analysis (`sbom.ipynb`)

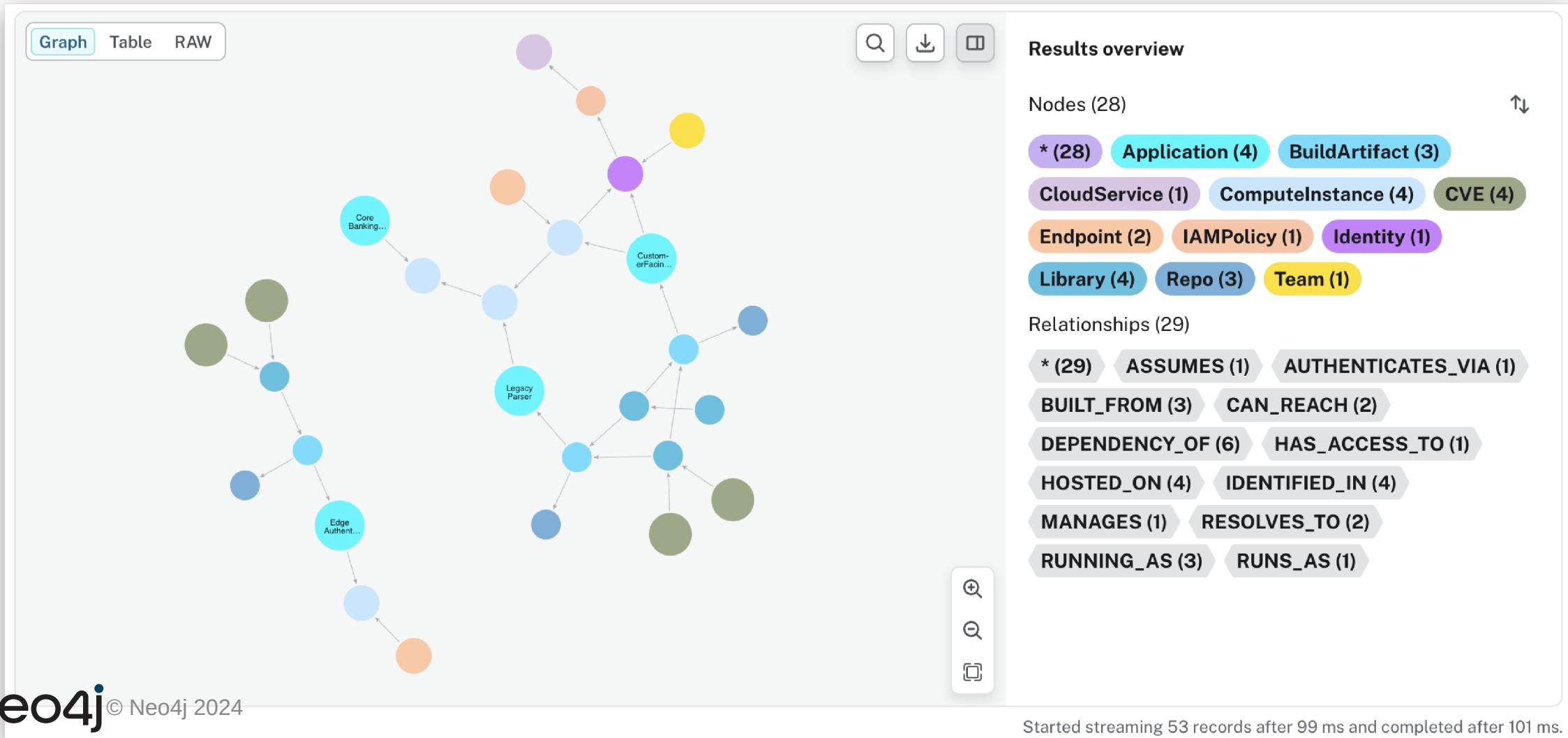
- Identifies vulnerabilities in deep dependencies.
- Maps risk to internet-facing production infrastructure.

Analysing the Blast Radius

The Application View Graph

- **Traceability:** Map the path from a poisoned 3rd-party library to a business app.
- **Exposure:** Correlate vulnerable code with infrastructure data.
- **Real-time:** See which internet-facing servers are running "at-risk" artifacts.

The Blast Radius Graph



The Resulting Graph Schema

The model uses a **Security Knowledge Graph** to map three distinct layers:

- Layer 1: Threat Intel (CVE, NVD, CISA KEV).
- Layer 2: Software Lineage (Recursive `DEPENDENCY_OF` relationships).
- Layer 3: Infrastructure (Build artifacts → Applications → ComputeInstances).

The Graph Advantage: Impact Analysis

Unlike flat lists, Neo4j allows for **Transitive Dependency Traversal**:

- **Impact Analysis:** Instantly find every server affected by a new vulnerability.
- **Chokepoint Discovery:** Find internal shared components that, if patched, resolve the highest number of reachable risks.
- **Remediation Efficiency:** Prioritize by "reachability" and "exposure."

Key SBOM Queries

Transitive Risk Discovery (CVE → App)

Identify affected apps and their dependency chains for any CVE.

```
MATCH (v:CVE)-[:IDENTIFIED_IN]->(lib:Library)
MATCH path = (lib)-[:DEPENDENCY_OF*1..3]->(art:BuildArtifact)-[:RUNNING_AS]->(app:Application)
RETURN v.id AS cve,
       lib.name AS vulnerable_lib,
       app.name AS affected_app,
       nodes(path) AS dependency_chain
```

Visualise Log4Shell Chain

Directed Graph of Dependency Paths

Example for CVE-2021-44228 (Log4Shell) from library to applications.

```
MATCH (v:CVE {id: 'CVE-2021-44228'})-[:IDENTIFIED_IN]->(lib:Library)
MATCH path = (lib)-[:DEPENDENCY_OF*1..3]->(art:BuildArtifact)-[:RUNNING_AS]->(app:Application)
RETURN path
```

Render paths with `networkx` + `matplotlib` to show lineage and relationship types.

Reachability to Internet-Facing Hosts

Full Code-to-Cloud Trace

Trace vulnerable libs to running servers with public IPs for patch urgency.

```
MATCH (v:CVE)-[:IDENTIFIED_IN]->(l:Library)
MATCH path = (l)-[:DEPENDENCY_OF*1..3]->(:BuildArtifact)-[:RUNNING_AS]->(app:Application)-[:HOSTED_ON]->(ins:ComputeInstance)
WHERE ins.public_ip IS NOT NULL
RETURN v.id AS cve,
       app.name AS app,
       ins.name AS server,
       ins.public_ip AS ip
```

Outward System Integration

The insights from this analysis **flow into**:

- **DevSecOps (CI/CD)**: Automatically fail builds that introduce critical transitive risks.
- **Security Operations (SOAR)**: Prioritize patching for internet-facing hosts.
- **Compliance**: Generate "Full Lineage" reports for regulatory requirements (e.g., Executive Order 14028).

Questions?

GitHub: [pedroleitao-neo4j/cyber-sbom](https://github.com/pedroleitao-neo4j/cyber-sbom)

Reference: VPEM (Vulnerability Prioritization and Exposure Management)