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China 2024

Enforceable Supply Chain Security Policy with OPA Gatekeeper and Ratify

Faynman Zhou, Microsoft & Dahu Kuang, Alibaba Cloud

Who we are

- Feynman Zhou
- Product Manager for Microsoft Azure
- Ratify Maintainer, CNCF Ambassador

@FeynmanZhou

- Kuang Dahu
- Alibaba Cloud
- ACK Team, Senior Engineer
- github.com/DahuK

@DahuK

Agenda

- Why Software Supply Chain Security matters?
- Popular Open-Source Projects & Framework in the industry and CNCF
- How Ratify and OPA Gatekeeper help secure your supply chain
- End-to-end demo: Signing and verify images on Kubernetes

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Concepts and Challenges of Software Supply Chain Security

Traditional supply chain v.s. Software supply chain

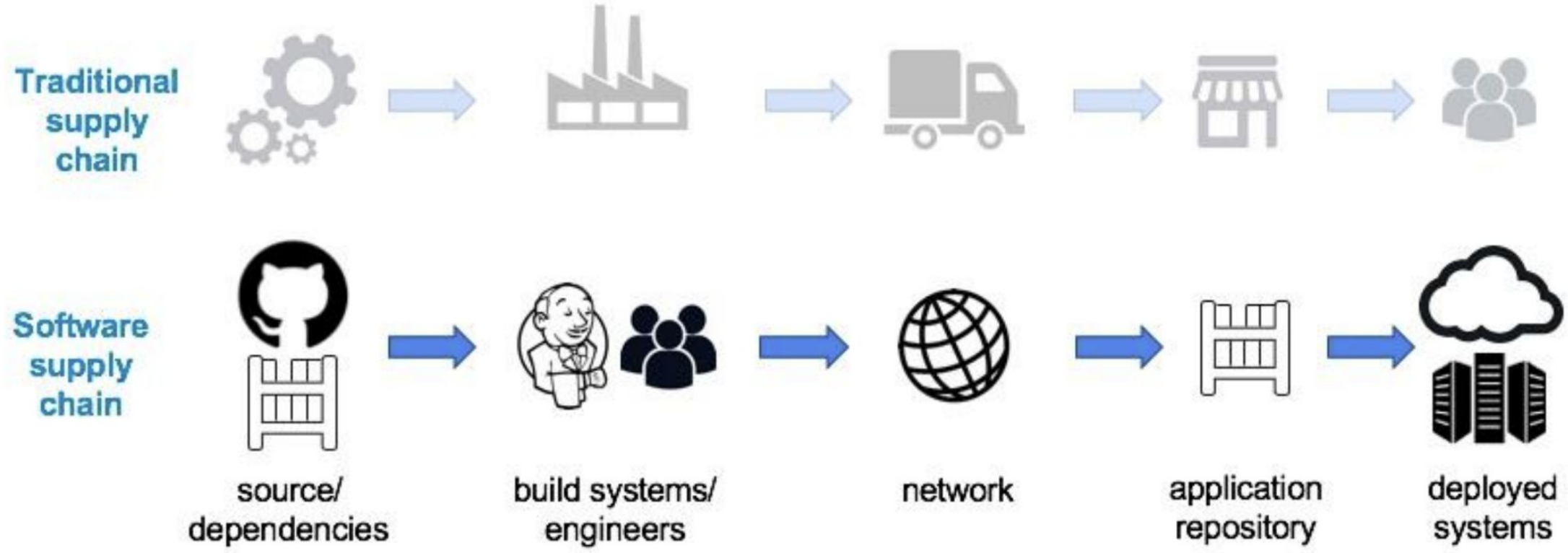


Image source: CNCF Software Supply Chain Security Paper

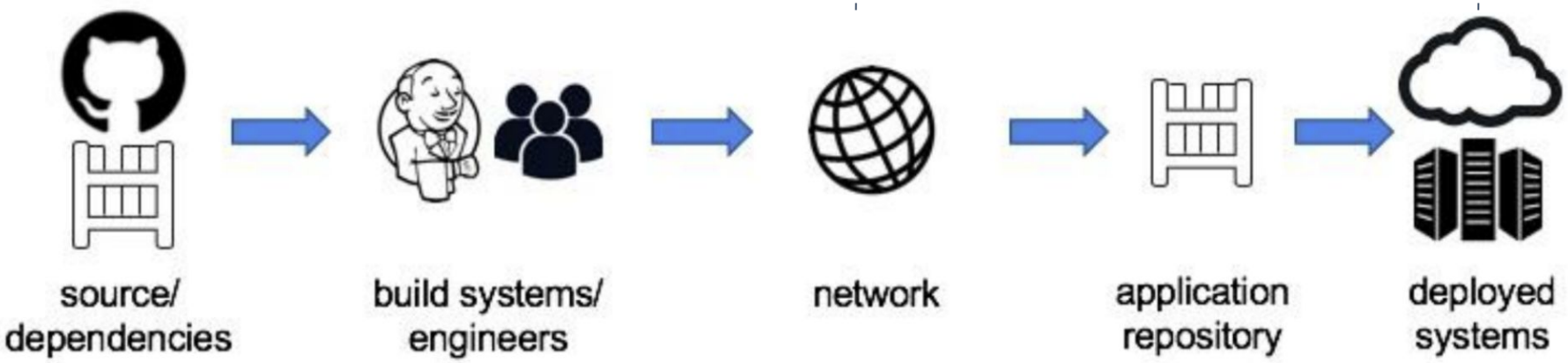
Potential security attacks and incidents

Code compromised
Non-compliant license

2021 hypocrite commits
2024 HashiCorp changed its OSS license

Network transformation attack

Deploy non-compliant code
System credential leak



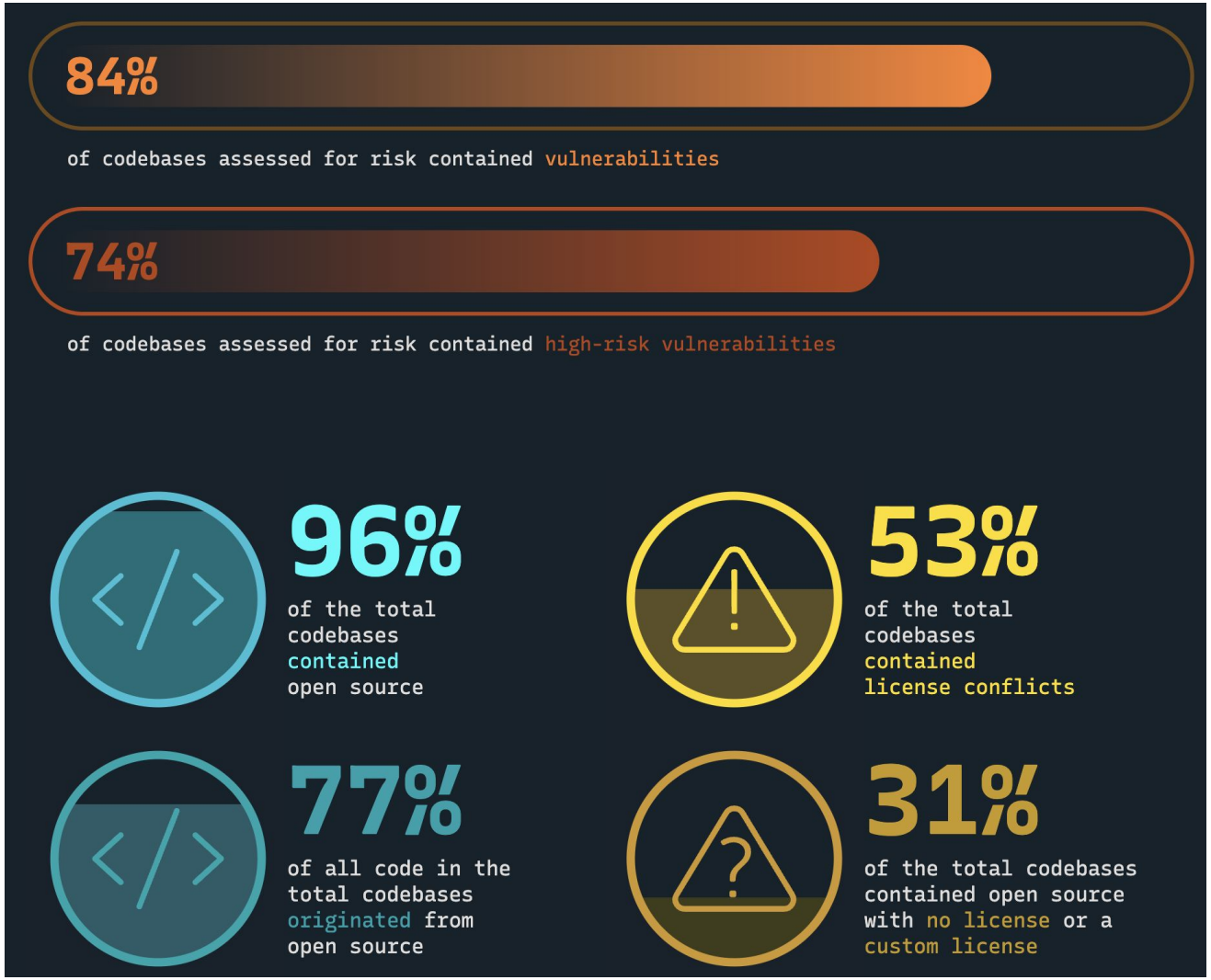
2024 XZ Utils (CVE-2024-3094)
2023 OpenAI
2021 CodeCov
2021 Log4j
2020 SolarWinds

Vulnerabilities in components or dependencies

Repository comprised

Security attack and risk assessments

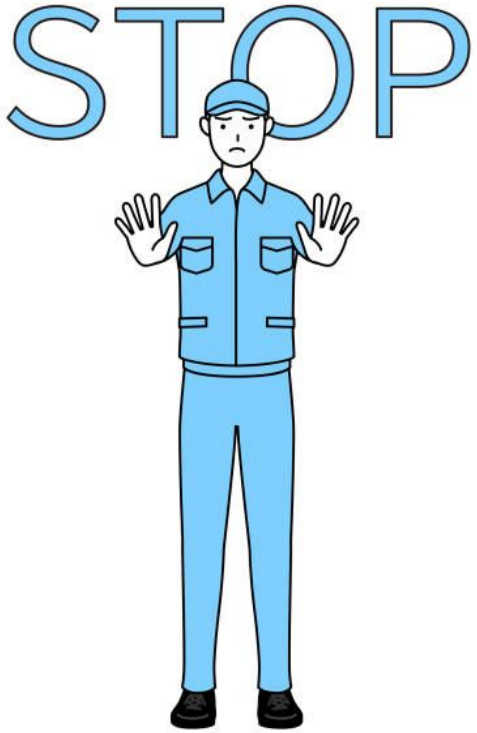
From《Synosys Open Source Security and Risk Analysis report - 2024》:



Security attack and risk assessments

Do not use any vulnerable dependencies!

Policy team



Do not use any outdated images from external registry!

Security manager

Do not use non-compliant open-source project

Compliance team

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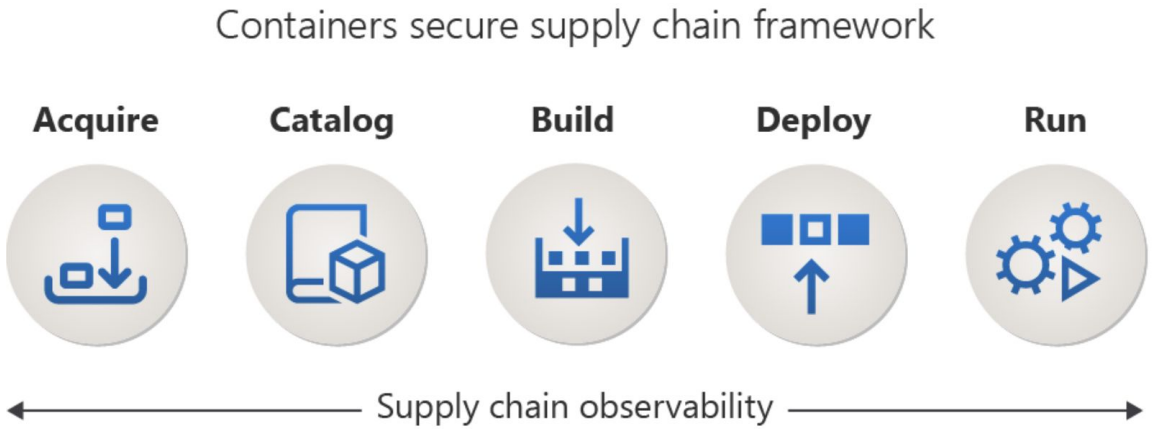
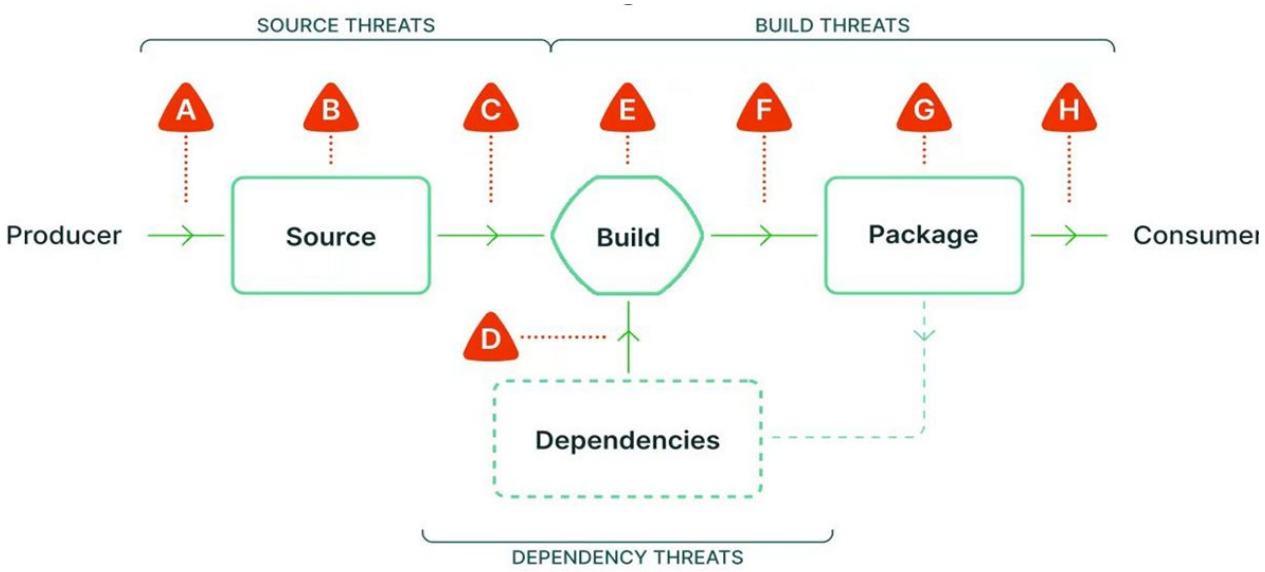
Popular OSS solutions and framework in the industry and CNCF

Popular Supply Chain Security frameworks

Containers Secure Supply Chain (CSSC) Framework



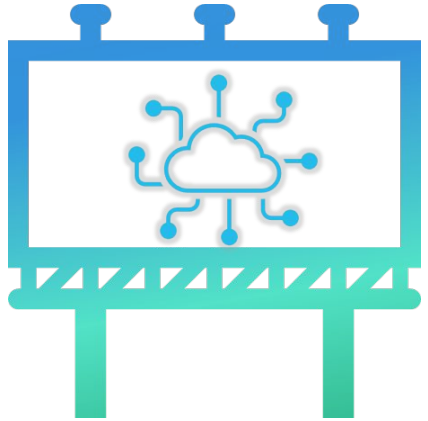
SLSA Framework



Popular OSS projects for securing supply chain

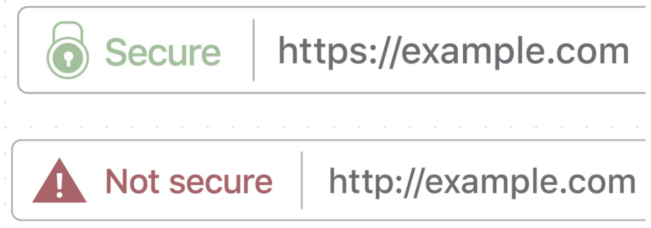
- **Sign and verify OCI Image**
  - Notation (Notary Project)
  - Cosign
- **OCI Artifact distribution**
  - ORAS
  - Regctl
  - Skopeo
  - Crane
- **Generate SBOM**
  - Microsoft sbom-tool
  - Syft / Docker SBOM
  - Xeol
- **Provenance attestation**
  - in-toto attestation

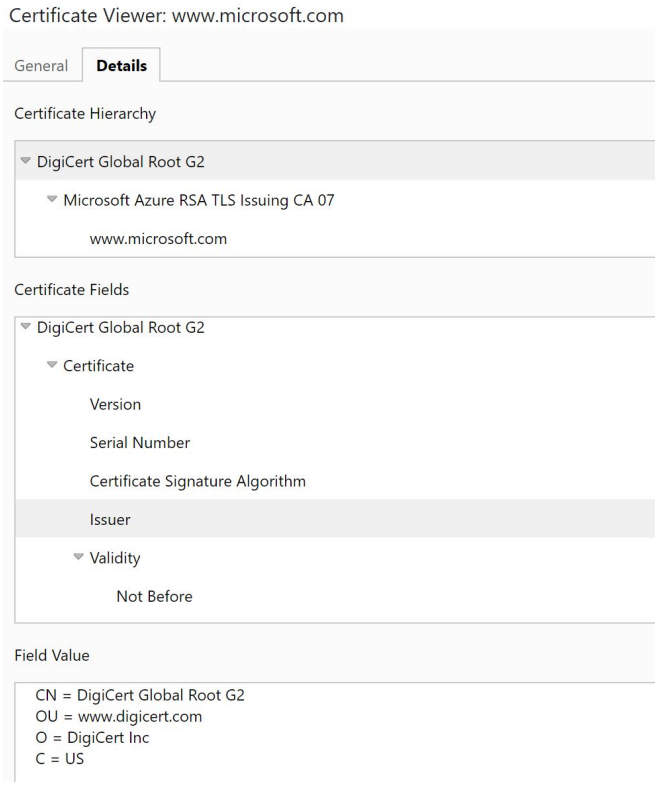
- **Policy Management**
  - Kyverno
  - Open Policy Agent (OPA) gatekeeper
- **Admission controller**
  - Ratify, Connaisseur
- **Runtime security**
  - Falco
- **Vulnerability scanning**
  - Trivy
  - Synk
  - Clair



Improve security posture in the digital world

How SSL Certificate secures the website?





Compare it with today's cloud-native application

- ✅ ghcr.io/kubecon/sample-image:signed
  - ✅ Signature
  - ✅ SBOM
  - ✅ Vulnerability scanning report
  - ✅ Provenance attestation
  - ✅ Image lifecycle metadata

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How Ratify and Gatekeeper help secure software supply chain

What is Notary Project

Ensure software authenticity and integrity

- Sign software artifacts, verify artifact with fine-grained policy
- Provide CLI, library, standard-based spec
- Built on standard PKI, support two signature envelope formats (JWS and COSE)
- Plugin extensibility for multi-cloud and on-prem: Alibaba Cloud, AWS, Microsoft Azure, Venafi, HashiCorp Vault

Adopters and Contributors

aws Microsoft Alibaba Cloud

VMware Tanzu containerd HARBOR

Venafi Kyverno

Notation CLI Command Sets

```
notation certificate: Manage certificates in trust store
notation key:         Manage keys used for signing
notation list:        List signatures of the signed artifact
notation login:       Log in to the registry
notation logout:      Log out from the registry
notation plugin:      Manage plugins
notation sign:        Sign artifacts
notation verify:      Verify OCI artifacts
notation version:     Show the notation version information
```

What is Ratify

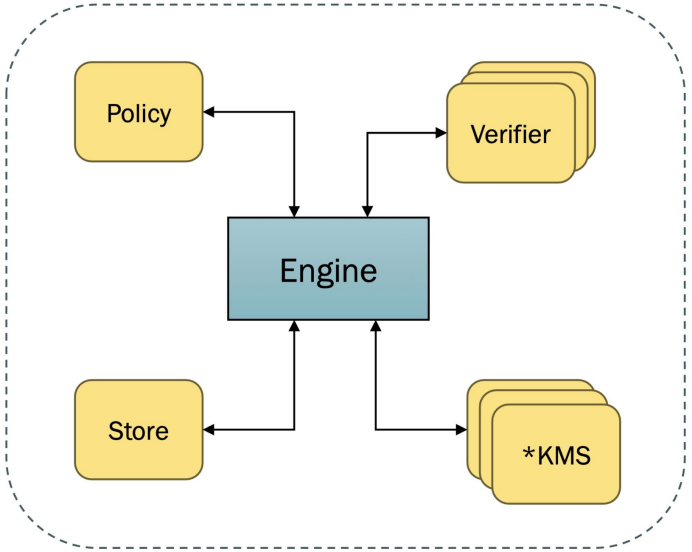
Verification framework for supply chain artifacts

Ratify

- Verify supply chain metadata including signatures (Notary Project, Cosign), vulnerability reports, and SBOMs
- Provide admission control on Kubernetes and a CLI tool for non-K8s scenarios
- Multiple artifact verifiers. Support Bring your own!
- Integration with AWS, Azure, Alibaba Cloud. Support any OCI compliant registries
- Multi-tenancy support

Community ecosystem and support

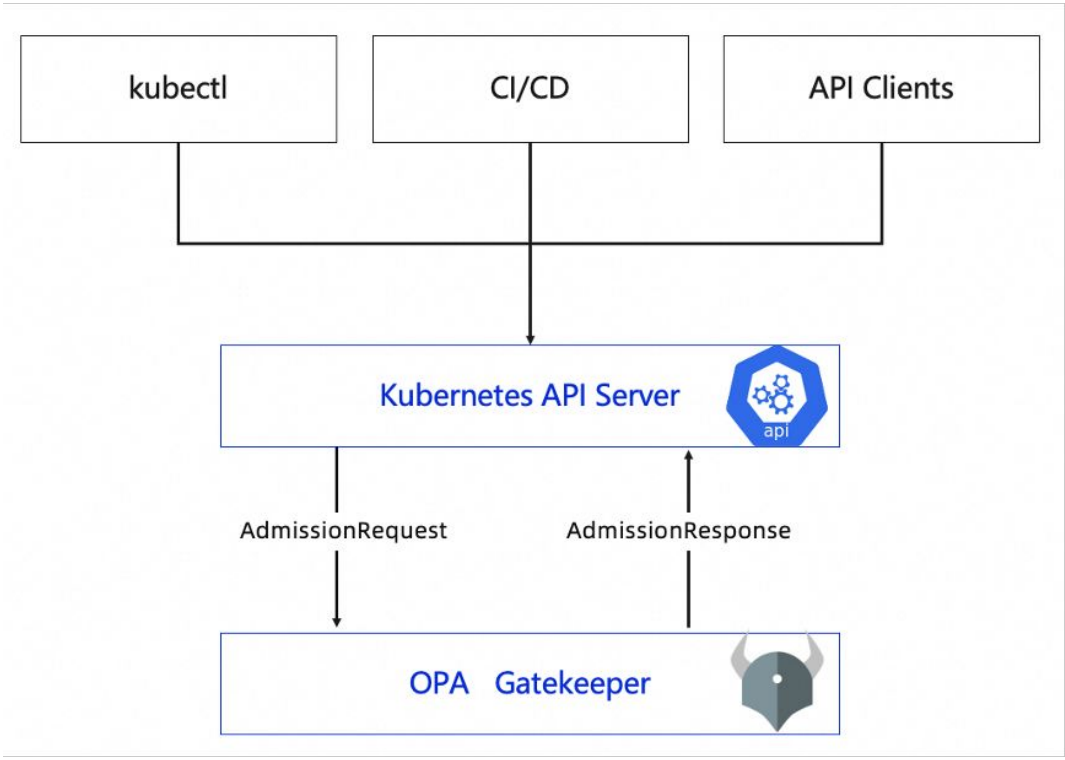
ORAS · Open Policy Agent · aqua trivy · notary project · sigstore cosign · Venafi · aws · Microsoft Azure · Alibaba Cloud



*KMS = Key Management System

What is OPA Gatekeeper

- Policy Enforcement & Real-time control
- CRD: first-class integration between OPA and Kubernetes
- ConstraintTemplate: Add a new policy via a new CR
- Constraints: Instantiations of policy template
- Multiple policy driver: Rego/CEL
- Stand library of policies
- External data and customized providers
- Enforcement and violations audits



From PSP to OPA Gatekeeper

2020

2021

Open Policy Agent

Pro:

- Secure by default

Con:

- too complex and inflexibility
- bug-prone
- hard to extend and maintain
- long-term beta or pending deprecation status

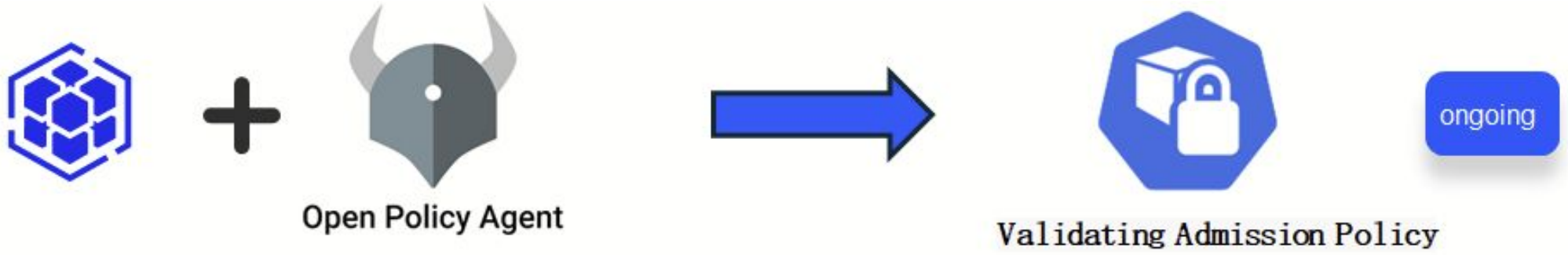
Pro:

- portability and extensibility
- active community and maintainability
- CRD based & mutating support

Con:

- learning cost on Rego
- hard integrate

Deep Integration with OPA Gatekeeper



- Pre-set policies
- Visualized policy governance
- Real-time viewing the enforcement and violation
- Integration with external cloud service

- Flexible
- Native support
- The best performance
- No additional webhook and controller

Performance Comparison

OPA & Gatekeeper

VS

Validating Admission Policy

- 3 master (4u8G) & 3 worker & 3 gatekeeper pods (1u512M limit)
- Max QPS of **880** and policy escape happen

- 3 master (4u8G)) & 3 worker
- Reach the maximum supported **1800**+ QPS of Apiserver without policy escape

Whitelist + static scan, is it enough?

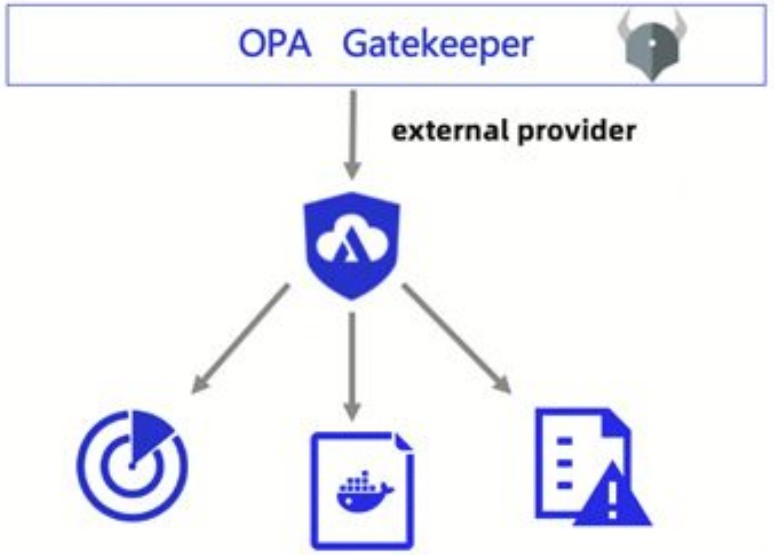
Whitelisted repos

```yaml
apiVersion: constraints.gatekeeper.sh/v1beta1
kind: ACKAllowedRepos
metadata:
  name: allowed-repos
spec:
  match:
    kinds:
      - apiGroups: [""]
        kinds: ["Pod"]
    namespaces:
      - "test-gatekeeper"
  parameters:
    repos:
      - "registry-vpc.cn-hangzhou.aliyuncs.com/acs/"
      - "registry.cn-hangzhou.aliyuncs.com/acs/"
```

Only allow images from whitelisted repositories

+

Detect malicious image + misconfiguration



[redacted] 100K+ violations per day in all ACK clusters

Proactive defense based on security scan results from external service

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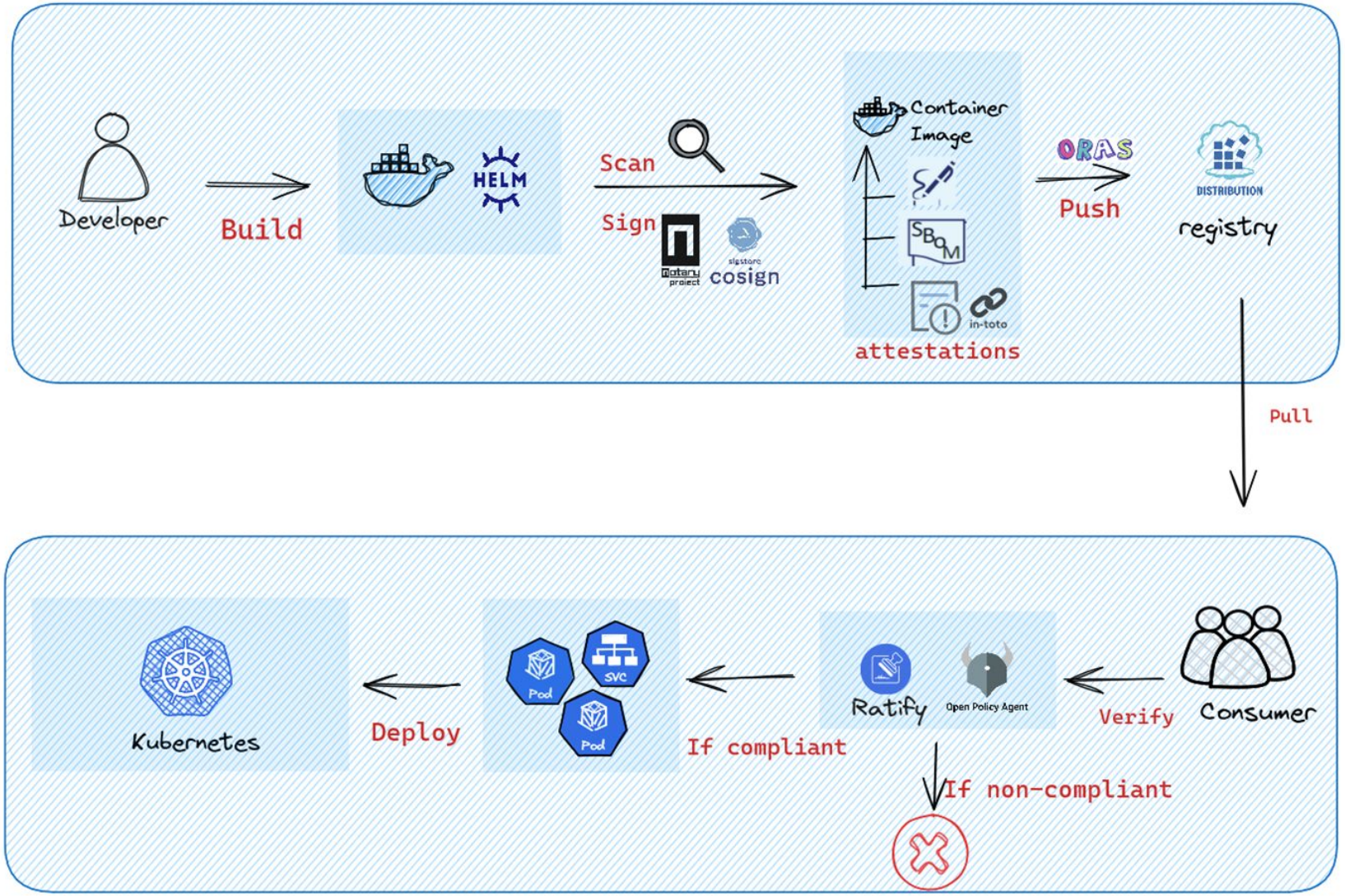
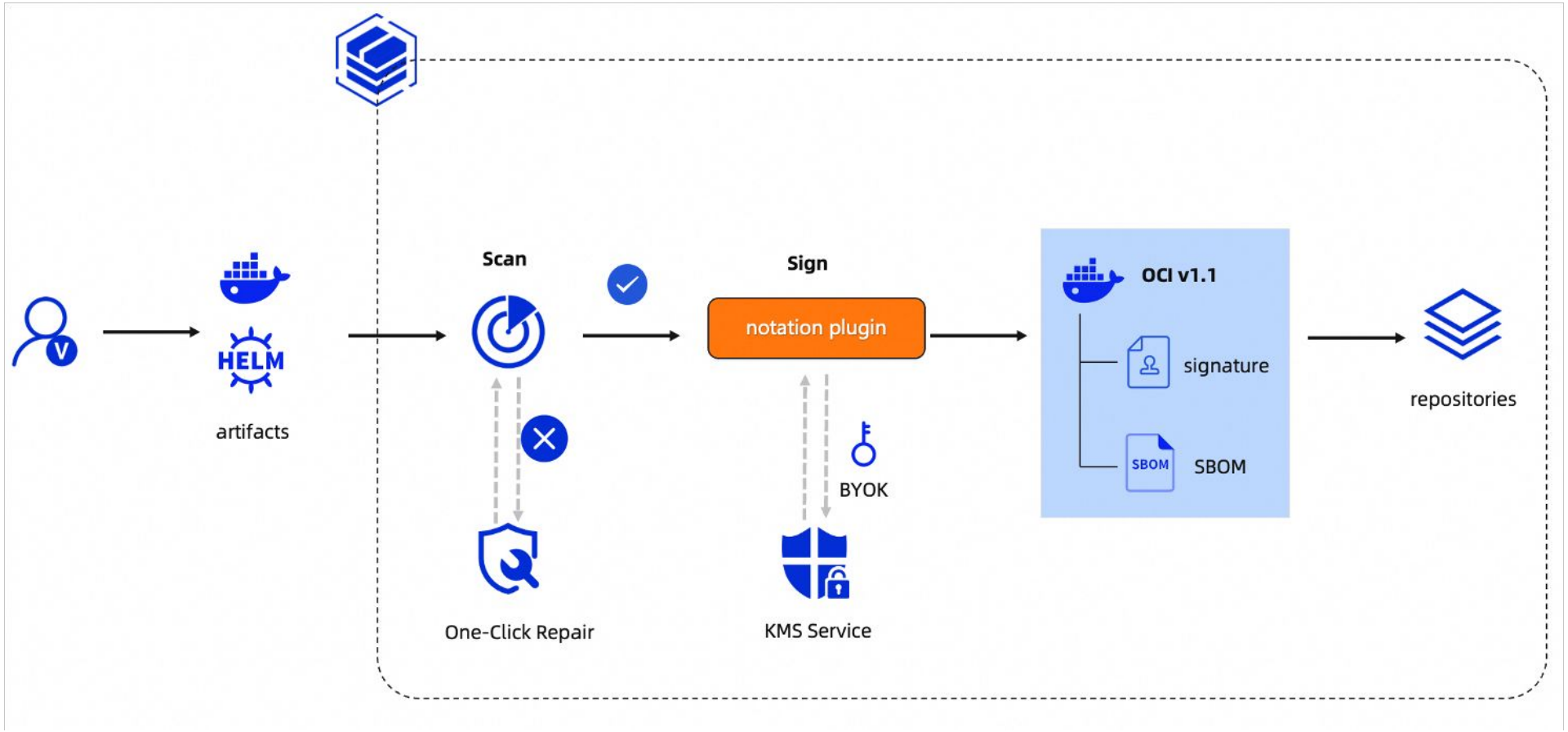
End-to-end demo: Signing and verify images on Kubernetes

Secure Supply Chain with Ratify and OPA Gatekeeper

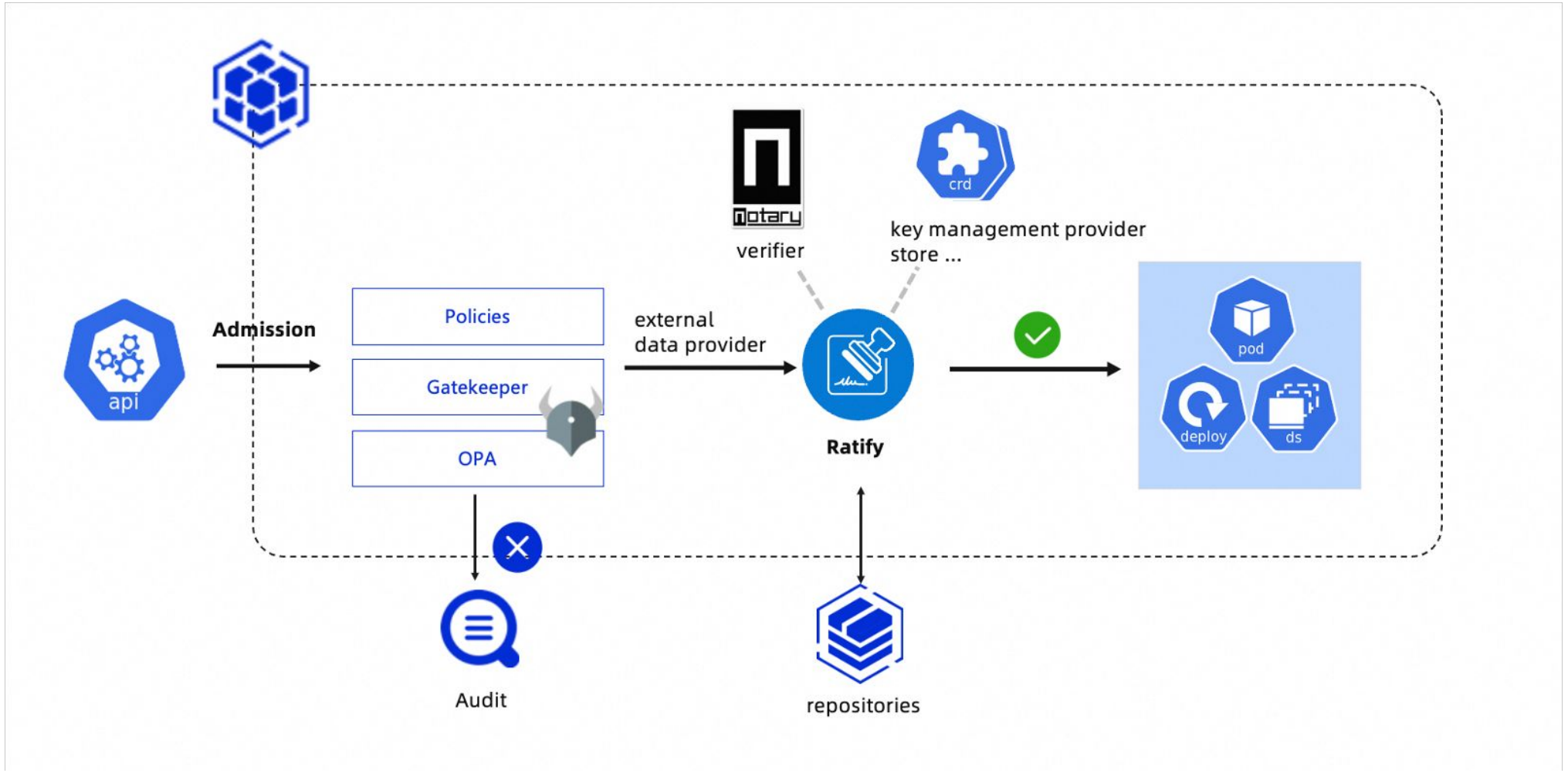


Secure Supply Chain with signing

Sign OCI image/artifact with Notation plugin



Verify signature in Kubernetes using Ratify



Verify signature in Kubernetes using Ratify

Demo

Verify SBOM and vulnerability report in Kubernetes using Ratify

Demo and doc:

- Vulnerability Report | Ratify
- SBOM Validation | Ratify

Check out: https://ratify.dev/

Wrap up & Questions

- Concepts and Challenges of Software Supply Chain Security
- Popular OSS solutions and framework in the industry and CNCF
- How Ratify and Gatekeeper help secure software supply chain
- End-to-end demo: Signing and verify images on Kubernetes

Useful links:

- Notary Project: https://notaryproject.dev
- Ratify: https://ratify.dev
- OPA Gatekeeper: https://open-policy-agent.github.io/gatekeeper/