rulez: get a “Bill of Behavior” through the supply chain

for anomaly-based runtime security

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ASC Austrian Scientific Computing

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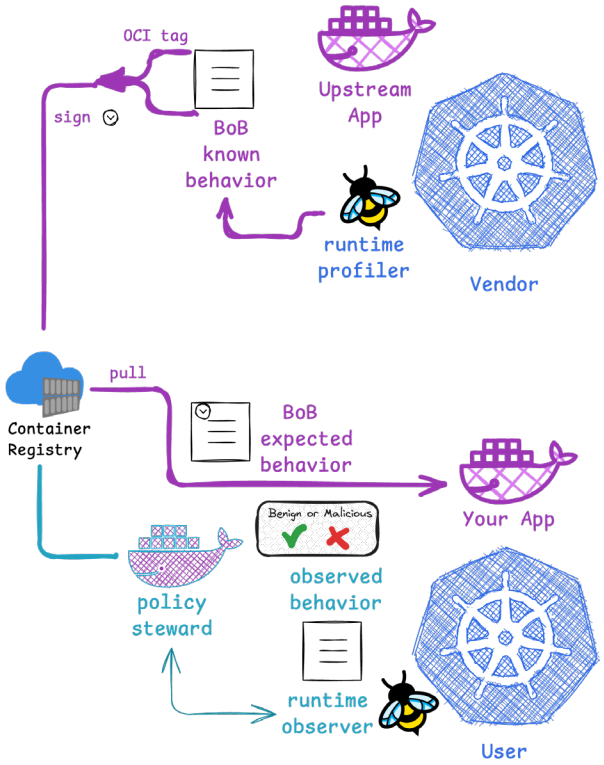
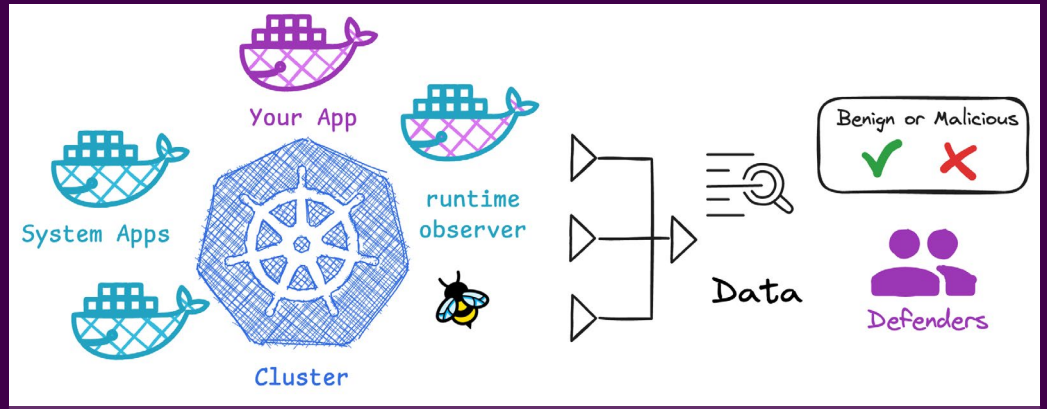
(S)BoB as a new standard - SBOM for runtime



- Software Bill of Behavior
  - How do you detect tampering?
  - Who writes runtime rules?
  - Who should write runtime rules?
  - Can we transfer runtimes rules from A -> B?
  - Alerting vs Enforcing
  - Attack Surface Shrinking
  - Integration into the ecosystem
  - What you can do today to benefit & help!



How do you detect tampering?

observe: get some data out

analyze: was this stuff bad?

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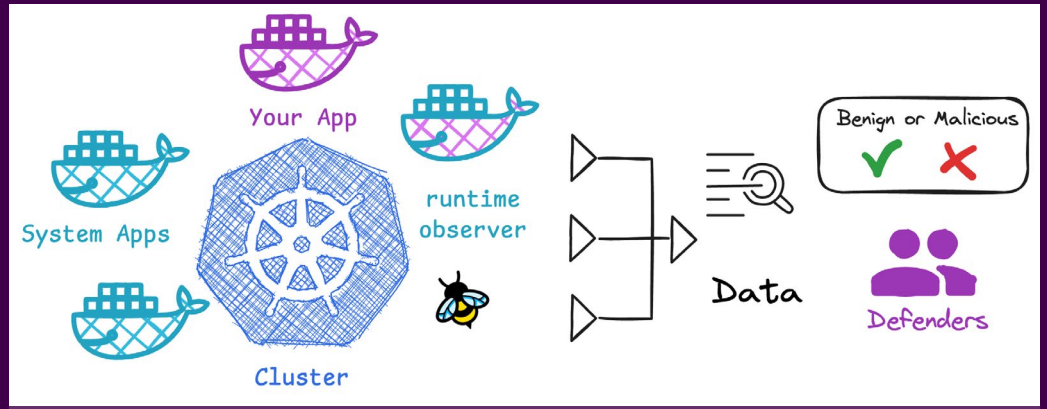

How do you detect tampering?

observe: get some data out

analyze: was this stuff bad?

You use RULES !

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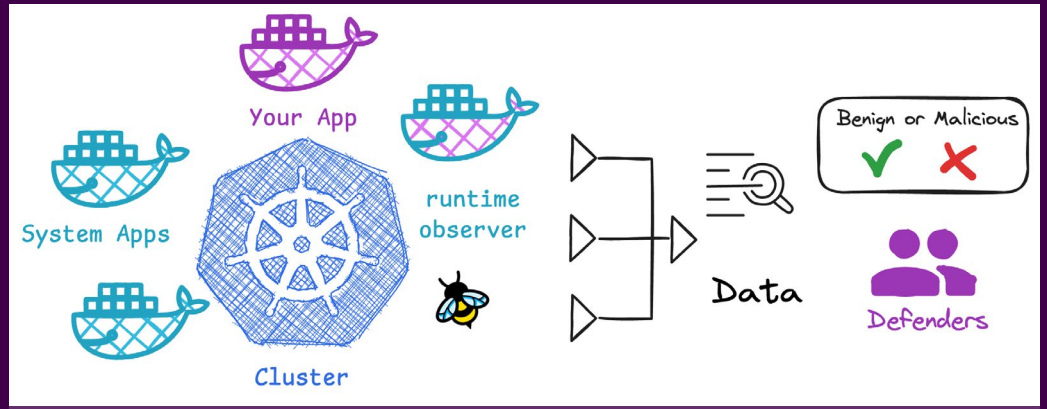

Who writes these rules?

Currently: you the user

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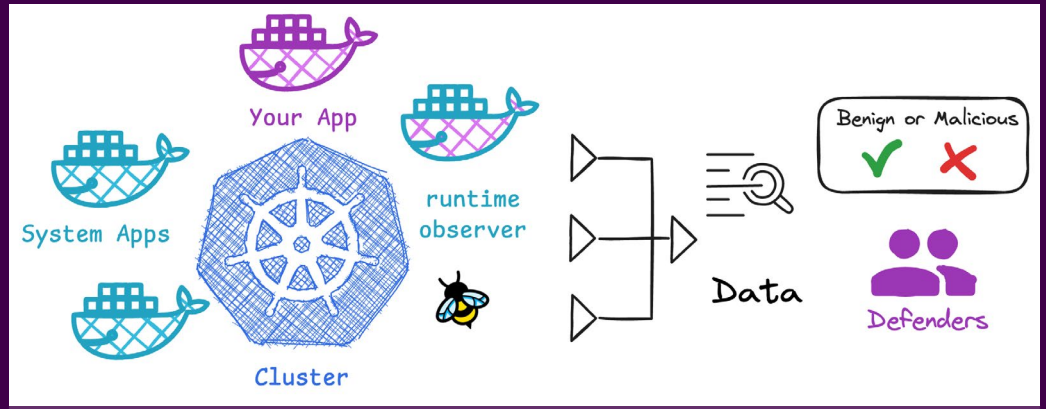

Who should write these rules?

Receive and modify the rules: you the user

Create and maintain the rules: the vendor or supplier

The people who made the SW

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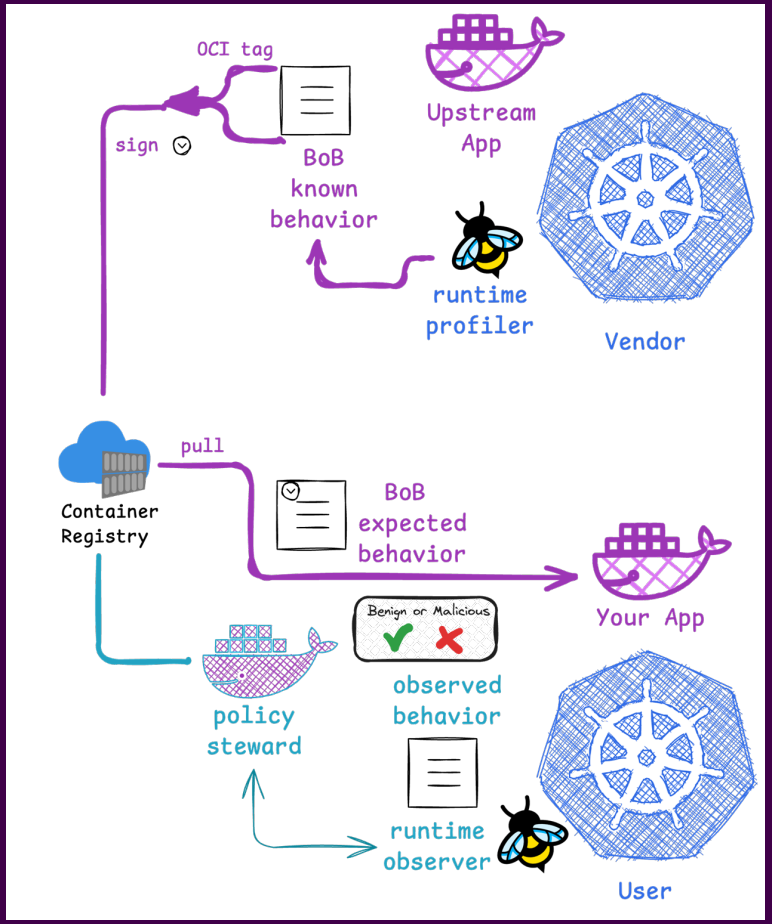
Transferability??!

it works on my cluster

BUT: will it work on your cluster



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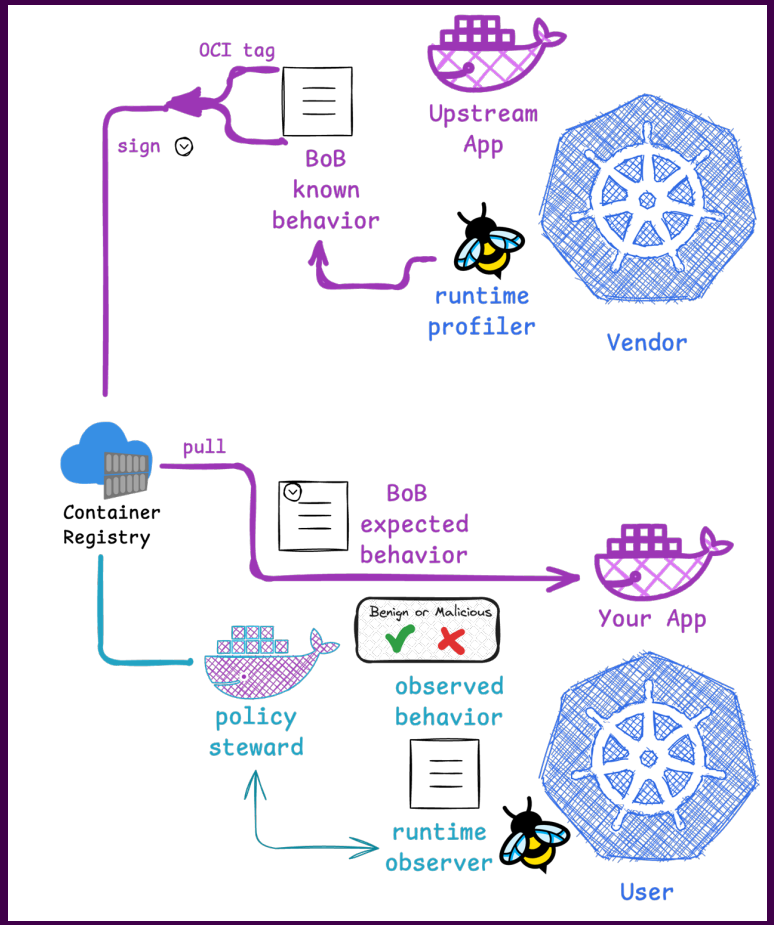
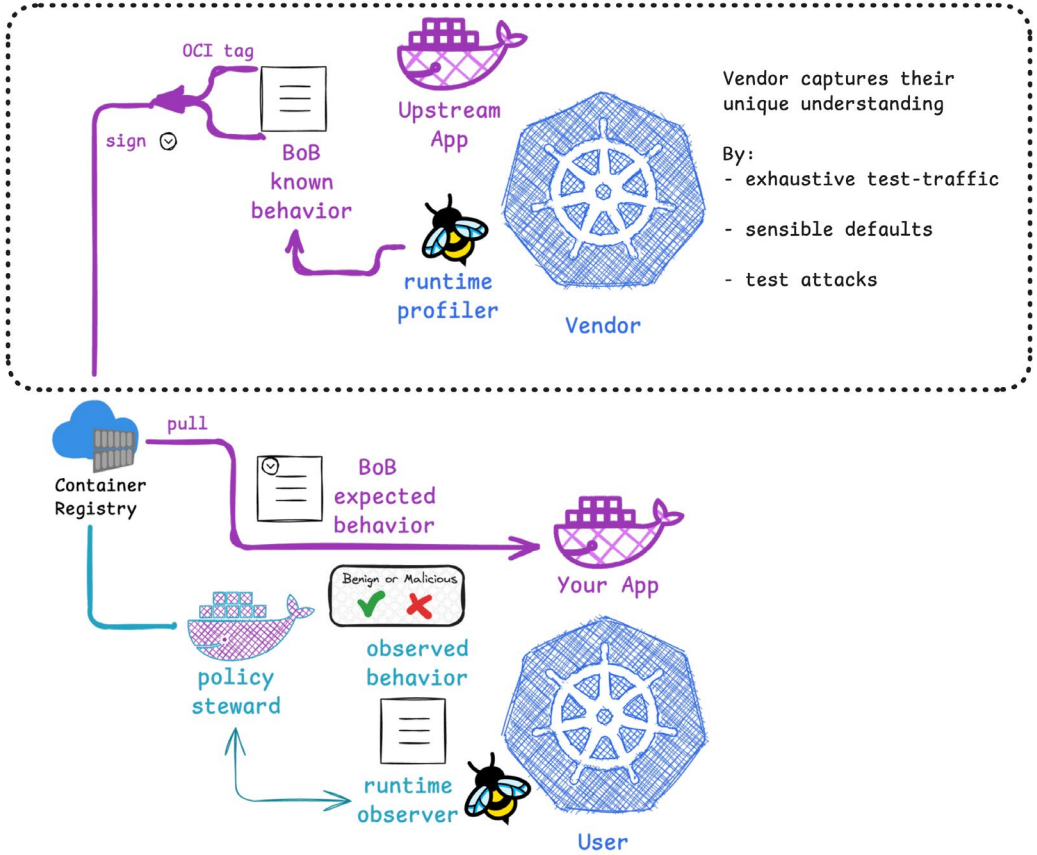
Idea of the year

attach a Bill of Behavior to software

to “supply” benign runtime rules



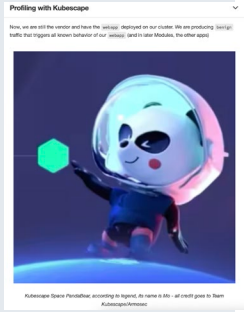
Vendor produces a BoB in spdx spec!



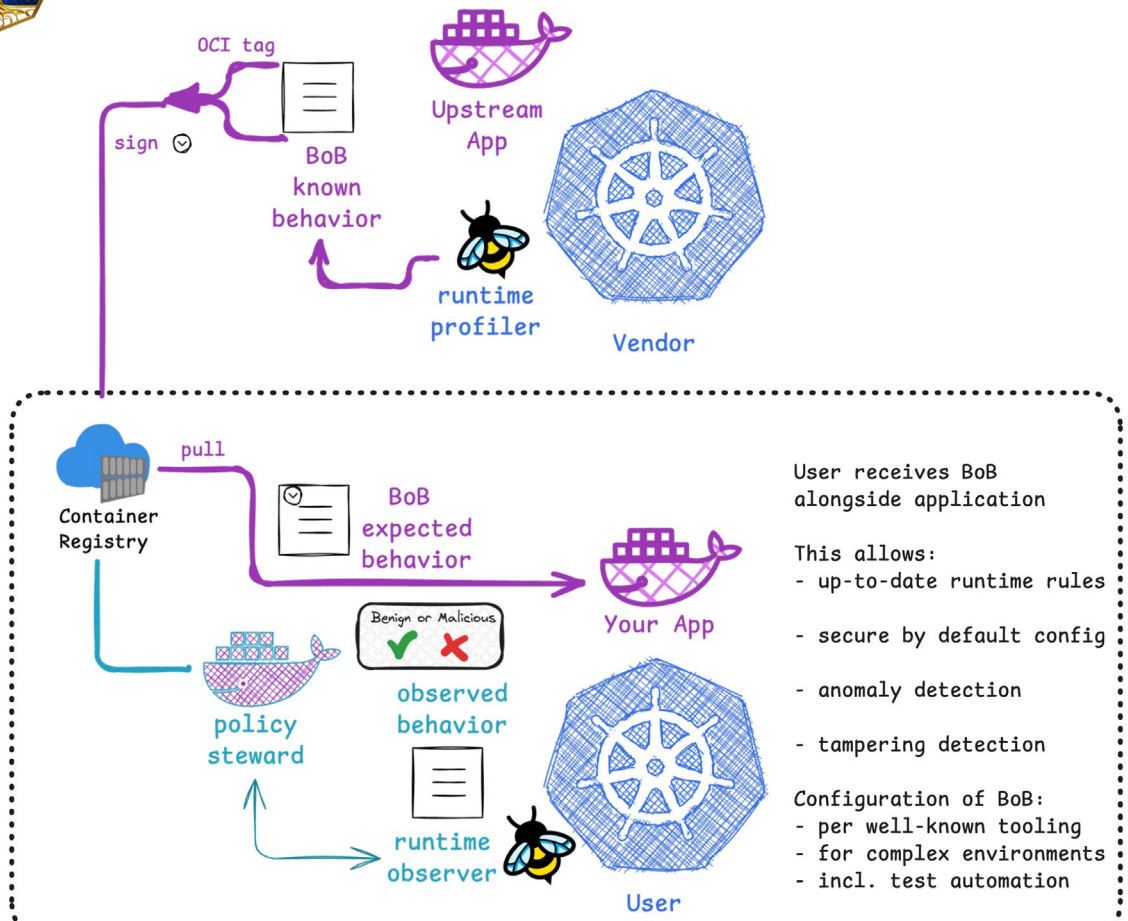
README Apache-2.0 license

```
apiVersion: spdx.softwarecomposition.kubescape.io/v1beta1
kind: ApplicationProfile
metadata:
  name: bob-application123
  namespace: {{ .Release.Namespace }}
spec:
  architectures:
  - amd64
  containers:
  - capabilities:  # KNOWN CAPABILITIES
    - DAC_OVERRIDE
    - SETGID
    - SETUID
    endpoints:     # KNOWN NETWORK
    - direction: inbound
      endpoint: :8080/ping.php
      headers:
        Host: # User accessible Overrides
        - {{ include "mywebapp.fullname" . }}.{{ .Release.Namespace }}.svc.cluster.local:{{ .V
      internal: false
      methods:
      - GET
    execs:       #KNOWN EXEC
    - args:
      - /usr/bin/dirname
      - /var/lock/apache2
      path: /usr/bin/dirname
    - args:
      - /bin/sh
      - -c
      - ping -c 4 172.16.0.2
      path: /bin/sh
    imageID: ghcr.io/k8sstormcenter/webapp@sha256:e323014ec9befb76bc551f8cc3bf158120150e2e277b
    opens:     #KNOWN FILE OPENS
    - flags:
      - O_CLOEXEC
      - O_DIRECTORY
      - O_NONBLOCK
      - O_RDONLY
      path: /etc/apache2/* #globs that generalize UUIDs or well-known FS structures
    - flags:
      - O_CLOEXEC
      - O_RDONLY
      path: /etc/group
    - flags:
      - O_CLOEXEC
      - O_RDONLY
      path: /etc/ld.so.cache
    rulePolicies:  # SPECIFIC EXCEPTION RULES
      R0001:
        processAllowed:
        - ping
        - sh
      R0002: {}
      ...
    syscalls:    # KNOWN SYSCALLS
    - accept4
    - access
    - arch_prctl
    - getegid
```

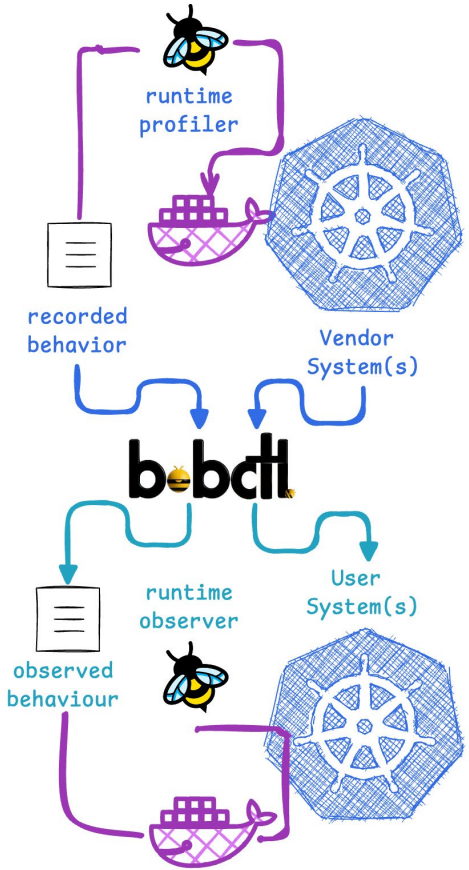
Thanks Matthias!



User receives the BoB with each update



BoBctl translates between systems



In order to allow for vendor neutrality:

Packaging systems:

- Helm

RunTime Engines:

- Kubescape 4.0 (Oct 2025)
- *NeuVector (possible)*
- *AppArmor (planned)*

Kubernetes:

- K8s: GKE, Vanilla, Talos, k3s, k0s
- Kind, Minikube
- *Openshift, SAP … (planned)*

https://github.com/k8sstormcenter/bobctl

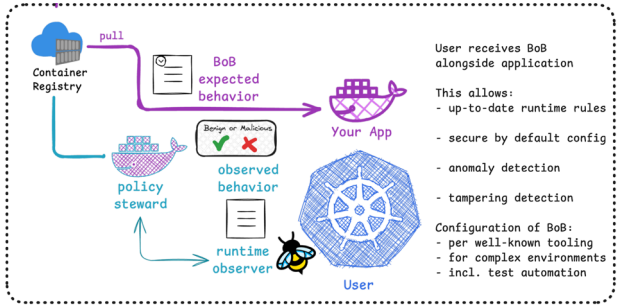
How much does it reduce the attack surface?

```
❯ ./attacksurface.sh
```

Profile	Capabilities	Network	Opens (#)	Execs (#)	Allowed Syscalls
Kubernetes Default (v1.33)	unconfined	CNI	unconfined	unconfined	363
catalogsource	CHOWN,DAC_OVERRIDE,DAC_READ_SEARCH,NET_ADMIN,SETGID,SETPCAP,SETUID,SYS_ADMIN	0	19	2	106
kelvin	DAC_OVERRIDE,DAC_READ_SEARCH,NET_ADMIN	0	97	1	76
pem	BPF,DAC_READ_SEARCH,IPC_LOCK,NET_ADMIN,PERFMON,SYS_ADMIN,SYS_PTRACE,SYSLOG	0	390	1	122
pletcd	NET_ADMIN,NET_RAW,SETGID,SETPCAP,SETUID,SYS_ADMIN	0	39	10	92
plnats	DAC_OVERRIDE,DAC_READ_SEARCH,NET_ADMIN	3	11	1	57
querybroker	DAC_OVERRIDE,DAC_READ_SEARCH,FOWNER,NET_ADMIN	0	20	1	107
viziercloudconnector	DAC_OVERRIDE,DAC_READ_SEARCH,NET_ADMIN	0	18	1	70
viziermeta	NET_ADMIN	0	16	1	65
vizieroperator	NET_ADMIN	1	13	1	104

CNCF Pixie provides real-time observability and debugging (based on eBPF)
pem = Pixie edge module (the agent that handles the tracing)

Enforcing vs Alerting




```
❯ ./attacksurface.sh
Profile                 Capabilities                                                                  Network  Opens (#)  Execs (#)  Allowed Syscalls
-------                 ------------                                                                  -------  ---------  ---------  ----------------
-----
pem                     BPF,DAC_READ_SEARCH,IPC_LOCK,NET_ADMIN,PERFMON,SYS_ADMIN,SYS_PTRACE,SYSLOG    0        390        1          122
-----
```

Anomaly Alerting for:

- Network Endpoints, RunTimeRules
- File Opens and SysCalls

RunTime Engines:

- Kubescape 4.0 (Q4 2025)

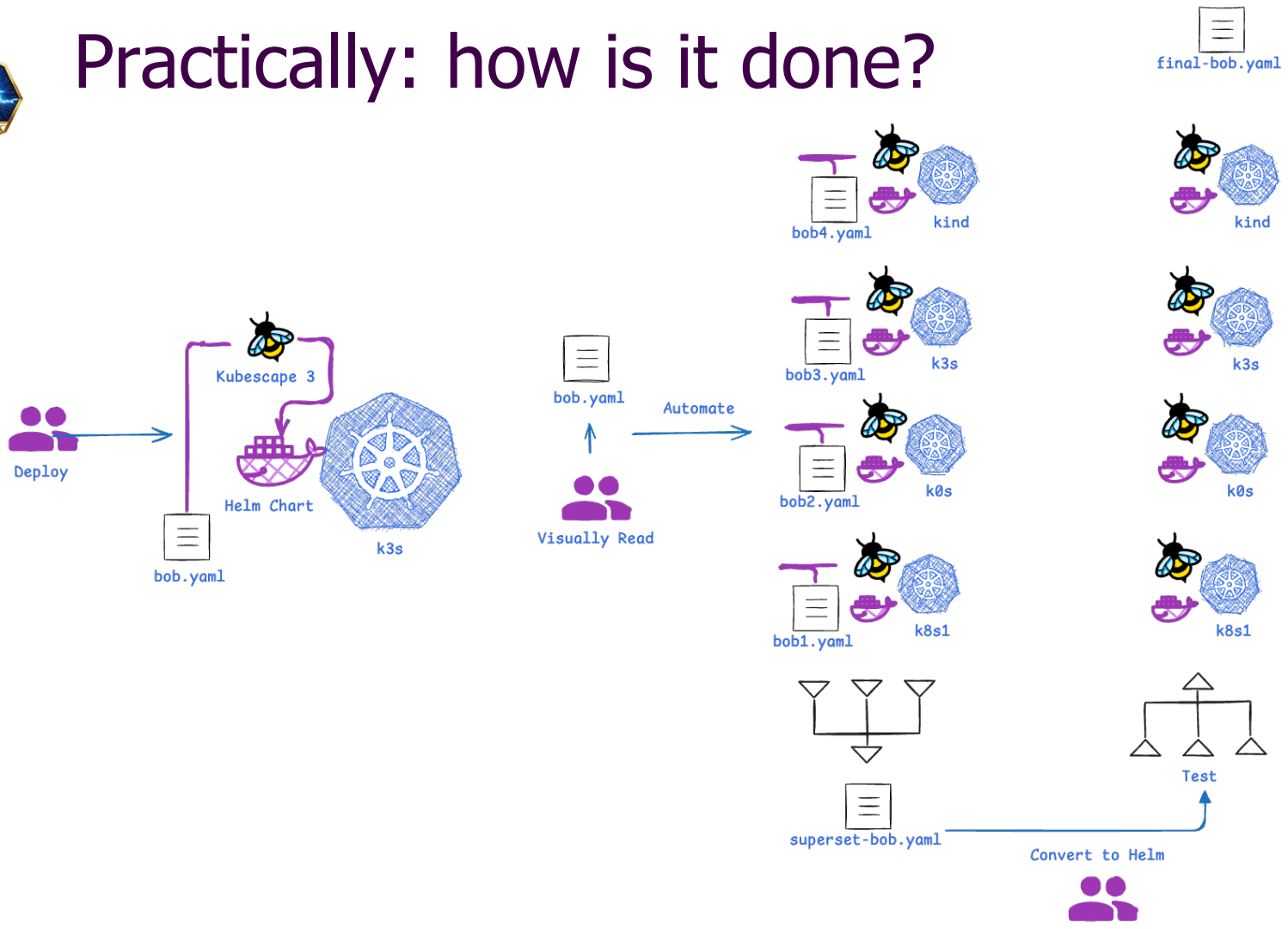
Enforcing for:

- {Capabilities, Executables} tuples

RunTime Engines:

- AppArmor (roadmap)

Practically: how is it done?



Practically: how is it done?

← Create Redis Bill of Behaviour on different Kernels, Kubernetes Versions, Kubernetes Distros and OSs

55 create systematic cicd pipeline with matrix output thats are easy ... #24

Summary

Jobs

- build (ubuntu-22.04, k3s, v1.30....
- build (ubuntu-22.04, k3s, v1.31.0)
- build (ubuntu-22.04, k3s, v1.32....
- build (ubuntu-22.04, k3s, v1.33....
- build (ubuntu-22.04, k3s, v1.33.2)
- build (ubuntu-22.04, kind, v1.30...
- build (ubuntu-22.04, kind, v1.31....
- build (ubuntu-22.04, kind, v1.32...
- build (ubuntu-22.04, kind, v1.33...
- build (ubuntu-22.04, kind, v1.33...
- build (ubuntu-22.04, minikube, ...
- build (ubuntu-22.04, minikube, ...
- build (ubuntu-22.04, minikube, ...
- build (ubuntu-22.04, minikube, ...
- build (ubuntu-22.04, minikube, ...
- build (ubuntu-24.04, k3s, v1.30....
- build (ubuntu-24.04, k3s, v1.31.0)
- build (ubuntu-24.04, k3s, v1.32....
- build (ubuntu-24.04, k3s, v1.33....
- build (ubuntu-24.04, k3s, v1.33....
- build (ubuntu-24.04, kind, v1.30...
- build (ubuntu-24.04, kind, v1.31....
- build (ubuntu-24.04, kind, v1.32...
- build (ubuntu-24.04, kind, v1.33...
- build (ubuntu-24.04, kind, v1.33...
- build (ubuntu-24.04, minikube, ...
- build (ubuntu-24.04, minikube, ...
- build (ubuntu-24.04, minikube, ...
- build (ubuntu-24.04, minikube, ...
- build (ubuntu-24.04, minikube, ...
- package-bobs

Annotations
1 error

package-bobs
succeeded 4 days ago in 3m 10s

- Set up job
- Checkout code
- Download all BoB artifacts
- Create a superset
- Package all BoBs into a tarball
- Upload BoB tarball
- setup kind
- Test superset Bob on kind
- Run helm test
- Upload superset BoB as the new final (and tested) Bill of Behavior
- Post setup kind
- Post Checkout code
- Complete job

summarize summary https://github.com/k8sstormcenter/bobctl/actions/runs/17190024510

Matrix Build Summary

OS	K8s Distro	K8s Version	Kernel Version	Status	Observed Syscalls	Observed Processes	Observed File Access
ubuntu-22.04	k3s	v1.30.0	6.8.0-1031-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-22.04	k3s	v1.31.0	6.8.0-1031-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-22.04	k3s	v1.32.0	6.8.0-1031-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-22.04	k3s	v1.33.0	6.8.0-1031-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-22.04	k3s	v1.33.2	6.8.0-1031-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-22.04	kind	v1.30.0	6.8.0-1031-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-22.04	kind	v1.31.0	6.8.0-1031-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-22.04	kind	v1.32.0	6.8.0-1031-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-22.04	kind	v1.33.0	6.8.0-1031-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-22.04	kind	v1.33.2	6.8.0-1031-azure	❌ failure	`getrusage, pidfd_open, pidfd_send_signal, writev`	N/A	N/A
ubuntu-22.04	minikube	v1.30.0	6.8.0-1031-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-22.04	minikube	v1.31.0	6.8.0-1031-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-22.04	minikube	v1.32.0	6.8.0-1031-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-22.04	minikube	v1.33.0	6.8.0-1031-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-22.04	minikube	v1.33.2	6.8.0-1031-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-24.04	k3s	v1.30.0	6.11.0-1018-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-24.04	k3s	v1.31.0	6.11.0-1018-azure	❌ failure	`alarm, getrusage, times, vfork, writev`	N/A	N/A
ubuntu-24.04	k3s	v1.32.0	6.11.0-1018-azure	❌ failure	`alarm, getrusage, times, vfork, writev`	N/A	N/A
ubuntu-24.04	k3s	v1.33.0	6.11.0-1018-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-24.04	k3s	v1.33.2	6.11.0-1018-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-24.04	kind	v1.30.0	6.11.0-1018-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-24.04	kind	v1.31.0	6.11.0-1018-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-24.04	kind	v1.32.0	6.11.0-1018-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-24.04	kind	v1.33.0	6.11.0-1018-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-24.04	kind	v1.33.2	6.11.0-1018-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-24.04	minikube	v1.30.0	6.11.0-1018-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-24.04	minikube	v1.31.0	6.11.0-1018-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-24.04	minikube	v1.32.0	6.11.0-1018-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-24.04	minikube	v1.33.0	6.11.0-1018-azure	✅ Success	`getrusage, writev`	N/A	N/A
ubuntu-24.04	minikube	v1.33.2	6.11.0-1018-azure	✅ Success	`getrusage, writev`	N/A	N/A

What is a (S)BoB?

We introduce the Software “Bill of Behavior” (BoB): a vendor-supplied profile detailing known benign runtime behaviors for software, designed to be distributed directly within OCI artifacts. Generated using eBPF, a BoB codifies expected syscalls, file access patterns, network communications, and capabilities. This empowers powerful, signature-less anomaly detection, allowing end-users to infer malicious activity or tampering in third-party software without the current burden of authoring and maintaining complex, custom security rules.

It solves the problem of distributing **secure-by-default** and **up-to-date** security rules for detection and defense.

Module 1: Record the runtime-profile of known behaviour
Taking the role of a software-vendor, we profile a sample-app and produce its BoB

Lesson: Vendor produces Bill of Behaviour for their application/product
Prerequisites and deployment of "sample app" for which we create a Bill of Behaviour

Module 2: Customer-Usage leverage the Bill of Behaviour for verification and detection

Step 2: Deploy the Application

Using a well-known `demo` ** app, we deploy a ping utility called `webapp` that has:

- **a) Desired functionality:** it pings things.
- **b) Undesired functionality:** it is vulnerable to injection (runtime is compromised)
  - *This is to mimic a CVE in your app.*
- **c) Tampering with the artefact:** In module 2, we will additionally tamper with the
  - *This is to mimic a SupplyChain corruption between vendor and you.*

```
> cd ~/bobctl
```

Step 3: Generate Traffic of Benign Behaviour

Benign (*adjective*) bi-ˈnīn

- **Benignity** (*noun*) bi-ˈnig-nə-tē
- **Benignly** (*adverb*) bi-ˈnīn-lē

Definitions/SYNONYMS:

1. Of a mild type or character that does not threaten health or life. *HARMLESS*.
2. Of a gentle disposition: *GRACIOUS*.
3. Showing kindness and gentleness. *FAVORABLE*, *WHOLESOME*.

User receives the BoB

Live demo

Course lesson by Constanze Roedig

Congrats! ✅

App 1: Deploy Webapp with its BoB

Here, most of the logic is hidden in a `Makefile`, this is the easiest method for the easiest application.

```
> make storage # auxiliary step
> make helm-install
```

```
runtimerulealertbinding.kubescape.io/all-rules-all-pods configured
sleep 5
kubectl rollout restart -n honey ds node-agent
daemonset.apps/node-agent restarted
kubectl wait --for=condition=ready pod -l app=kubevuln  -n honey --timeou
pod/kubevuln-77897b796c-qfdtf condition met
kubectl wait --for=condition=ready pod -l app=node-agent  -n honey --time
pod/node-agent-67b4g condition met
pod/node-agent-8g5nz condition met
pod/node-agent-vwpvx condition met
Installing webapp with BoB configuration ...
helm pull oci://ghcr.io/k8sstormcenter/mywebapp
Pulled: ghcr.io/k8sstormcenter/mywebapp:0.1.0
Digest: sha256:1f35668f2db47ec3e6c34ad597df3decfe3046d5e01963b46f2a73dcf0
Release "webapp" has been upgraded. Happy Helming!
NAME: webapp
LAST DEPLOYED: Fri Jul 18 15:29:37 2025
NAMESPACE: webapp
STATUS: deployed
REVISION: 2
NOTES:
Your webapp-mywebapp application is now deployed.
```

Congrats! ✅

IDE | Explorer | dev-machine | cplane-01 | node-01 | node-02 | dev-machine (2)

```
laborant@dev-machine:~$ cd ~
git clone https://github.com/k8sstormcenter/bobctl.git
cd bobctl
Cloning into 'bobctl'...
remote: Enumerating objects: 867, done.
remote: Counting objects: 100% (106/106), done.
remote: Compressing objects: 100% (55/55), done.
remote: Total 867 (delta 67), reused 61 (delta 47), pack-reused 761 (from 1)
Receiving objects: 100% (867/867), 343.51 KiB | 8.38 MiB/s, done.
Resolving deltas: 100% (450/450), done.
laborant@dev-machine:bobctl$ make storage # auxiliary step
make helm-install
kubectl apply -f https://openebs.github.io/charts/openebs-operator-lite.yaml
namespace/openebs created
serviceaccount/openebs-maya-operator created
clusterrole.rbac.authorization.k8s.io/openebs-maya-operator created
clusterrolebinding.rbac.authorization.k8s.io/openebs-maya-operator created
customresourcedefinition.apiextensions.k8s.io/blockdevices.openebs.io created
customresourcedefinition.apiextensions.k8s.io/blockdeviceclaims.openebs.io created
configmap/openebs-ndm-config created
daemonset.apps/openebs-ndm created
deployment.apps/openebs-ndm-operator created
deployment.apps/openebs-ndm-cluster-exporter created
service/openebs-ndm-cluster-exporter-service created
daemonset.apps/openebs-ndm-node-exporter created
service/openebs-ndm-node-exporter-service created
deployment.apps/openebs-localpv-provisioner created
kubectl apply -f https://openebs.github.io/charts/openebs-lite-sc.yaml
storageclass.storage.k8s.io/openebs-hostpath created
storageclass.storage.k8s.io/openebs-device created
kubectl apply -f storage/sc.yaml
storageclass.storage.k8s.io/local-hostpath created
kubectl patch storageclass local-hostpath -p '{"metadata": {"annotations":{"storage
class.kubernetes.io/is-default-class":"true"}}}'
storageclass.storage.k8s.io/local-hostpath patched
/usr/local/bin/helm repo add kubescape https://kubescape.github.io/helm-charts/
"kubescape" has been added to your repositories
/usr/local/bin/helm repo update
Hang tight while we grab the latest from your chart repositories...
...Successfully got an update from the "kubescape" chart repository
Update Complete. ⎈Happy Helming!⎈
/usr/local/bin/helm upgrade --install kubescape kubescape/kubescape-operator --vers
ion 1.28.0 -n honey --create-namespace --values kubescape/values.yaml
Release "kubescape" does not exist. Installing it now.
NAME: kubescape
LAST DEPLOYED: Sun Jul 20 05:40:50 2025
NAMESPACE: honey
STATUS: deployed
REVISION: 1
```

```
0:00Z",
          "upperLayer": false,
          "cwd": "/var/www/html",
          "path": "/bin/cat"
        }
      }
    },
    "containerID": "0b748fe5277a36f3
af625f35cd8f390f7dd900dfc853a72c861c
ae99dc"
  },
  "event": {
    "runtime": {
      "runtimeName": "containerd",
      "containerId": "0b748fe5277a36
b4af625f35cd8f390f7dd900dfc853a72c86
e4ae99dc",
      "containerName": "mywebapp-app
      "containerImageName": "ghcr.io
sstormcenter/webapp@sha256:e323014ec
fb76bc551f8cc3bf158120150e2e277bae1
c2da6c56c0a2b",
      "containerImageDigest": "sha25
622cf306b94e8a6e7cfd718f048015e0336
0f19228d8beee23a0ccc57bb"
    },
    "k8s": {
      "namespace": "webapp",
      "podName": "webapp-mywebapp-67
968bb-4t8cg",
      "podLabels": {
        "app.kubernetes.io/instance"
webapp",
        "app.kubernetes.io/name": "m
bapp",
        "pod-template-hash": "679659
b"
      },
      "containerName": "mywebapp-app
      "owner": {}
    },
    "timestamp": 1752990479151726967
    "type": "normal"
  },
  "level": "error",
  "message": "Unexpected process lau
ed: /bin/cat",
  "msg": "Unexpected process launche
  "time": "2025-07-20T05:47:59Z"
}
```

User receives the BoB
Live demo

Course lesson by Constanze Roedig

Congrats! ✅

2 Verify BoB (included in Webapp) via supplied test

Now, as user/customer, verify the app is working as intended by the vendor:

In a new tab `new terminal`, open the logs (for any anomalies)

```
> kubectl logs -n honey -l app=node-agent -f
```

Please, switch back to the original `dev-machine` tab, and proceed to test

```
> helm test webapp -n webapp
```

```
# make helm-test
NAME: webapp
LAST DEPLOYED: Fri Jul 18 15:29:37 2025
NAMESPACE: webapp
STATUS: deployed
REVISION: 2
TEST SUITE:     webapp-mywebapp-test-connection
Last Started:   Fri Jul 18 16:28:03 2025
Last Completed: Fri Jul 18 16:28:11 2025
Phase:          Succeeded
NOTES:
Your webapp-mywebapp application is now deployed.
```

The only logs, you should see are that the test-container was monitored

```
{"level":"info","ts":"2025-07-18T16:28:08Z","msg":"ApplicationProfileMana
{"level":"info","ts":"2025-07-18T16:28:37Z","msg":"ApplicationProfileMana
```

IDE | Explorer | dev-machine | cplane-01 | node- | dev-machine (2)

```
pp.kubernetes.io/name=mywebapp,app.kubernetes.io/instance=web
app" -o jsonpath="{.items[0].metadata.name}")
  kubectl --namespace webapp port-forward $POD_NAME 8080:80
rm -rf mywebapp-0.1.0.tgz
HASH=$(kubectl get rs -n webapp -o jsonpath='{.items[0].metad
ata.labels.pod-template-hash}')
The template has is
helm upgrade --install webapp oci://ghcr.io/k8sstormcenter/my
webapp --version 0.1.0  --namespace webapp --set bob.create=t
rue --set bob.ignore=false --set bob.templateHash=$(kubectl g
et rs -n webapp -o jsonpath='{.items[0].metadata.labels.pod-t
emplate-hash}')
Pulled: ghcr.io/k8sstormcenter/mywebapp:0.1.0
Digest: sha256:606bc61786ec40972cc7578a60d50b77ee895b661745a5
7ecfde4787b3964484
Release "webapp" has been upgraded. Happy Helming!
NAME: webapp
LAST DEPLOYED: Sun Jul 20 05:41:49 2025
NAMESPACE: webapp
STATUS: deployed
REVISION: 2
NOTES:
Your webapp-mywebapp application is now deployed.
To access your application, you can use port-forwarding:

  export POD_NAME=$(kubectl get pods --namespace webapp -l "a
pp.kubernetes.io/name=mywebapp,app.kubernetes.io/instance=web
app" -o jsonpath="{.items[0].metadata.name}")
  kubectl --namespace webapp port-forward $POD_NAME 8080:80
kubectl wait --for=condition=ready pod -l app.kubernetes.io/n
ame=mywebapp -n webapp
pod/webapp-mywebapp-67965968bb-4t8cg condition met
laborant@dev-machine:bobctl$ helm test webapp -n webapp
NAME: webapp
LAST DEPLOYED: Sun Jul 20 05:41:49 2025
NAMESPACE: webapp
STATUS: deployed
REVISION: 2
TEST SUITE:     webapp-mywebapp-test-connection
Last Started:   Sun Jul 20 05:45:40 2025
Last Completed: Sun Jul 20 05:45:48 2025
Phase:          Succeeded
NOTES:
Your webapp-mywebapp application is now deployed.
To access your application, you can use port-forwarding:

  export POD_NAME=$(kubectl get pods --namespace webapp -l "a
pp.kubernetes.io/name=mywebapp,app.kubernetes.io/instance=web
app" -o jsonpath="{.items[0].metadata.name}")
  kubectl --namespace webapp port-forward $POD_NAME 8080:80
```

```
  "ts": "2025-07-20T05:41:25Z",
  "msg": "started ptrace tracing"
}
{
  "level": "info",
  "ts": "2025-07-20T05:41:25Z",
  "msg": "started io_uring tracing"
}
{
  "level": "info",
  "ts": "2025-07-20T05:41:25Z",
  "msg": "started http tracing"
}
{
  "level": "info",
  "ts": "2025-07-20T05:41:25Z",
  "msg": "main container handler started"
}
{
  "level": "info",
  "ts": "2025-07-20T05:41:30Z",
  "msg": "RBCache - ruleBinding added/modified",
  "name": "/all-rules-all-pods"
}
{
  "level": "info",
  "ts": "2025-07-20T05:42:01Z",
  "msg": "ApplicationProfileManager - start monitor on co
ner",
  "preRunning": false,
  "container index": 0,
  "container ID": "0b748fe5277a36f38b4af625f35cd8f390f7dd
fc853a72c861dde4ae99dc",
  "k8s workload": "webapp/webapp-mywebapp-67965968bb-4t8c
748fe5277a36f38b4af625f35cd8f390f7dd900dfc853a72c861dde4a
c"
}
{
  "level": "error",
  "ts": "2025-07-20T05:42:53Z",
  "msg": "SbomManager - failed to save SBOM",
  "error": "Operation cannot be fulfilled on sbomsyfts.sp
oftwarecomposition.kubescape.io \"ghcr.io-k8sstormcenter-
pp-sha256-e323014ec9befb76bc551f8cc3bf158120150e2e277bae1
c2da6c56c0a2b-6c0a2b\": the object has been modified; ple
apply your changes to the latest version and try again",
  "namespace": "webapp",
  "pod": "webapp-mywebapp-67965968bb-4t8cg",
  "container": "mywebapp-app",
  "sbomName": "ghcr.io-k8sstormcenter-webapp-sha256-e3230
```

User receives the BoB
Live demo

3 Abuse the Webapp manually

We keep the terminal with the logs open, and proceed to manually exploit our app.

> This app is intentionally vulnerable. Do not use in production under any circumstances.

```
> make fwd
```

```
> curl localhost:8080/ping.php?ip=172.16.0.2\;ls
```

In the logs tab, you should see the `anomaly alerts`

```
{"BaseRuntimeMetadata":{"alertName":"Unexpected process launched","argume
{"BaseRuntimeMetadata":{"alertName":"Unexpected file access","arguments":
```

▶ Inspect the BoB profile (aka ApplicationProfile)

4 Abuse the Webapp via an automated negative test

We can also create known undesired behavior and test that it is detecteable in a predictable and consistent way:

In the next unit, we ll supply such an `attack-test` as part of the `BoB`, here we do it via `Makefile`. In the `original tab`, please run

```
> make attack
```

In the `logs tab`, you may observe a very predictable set of anomalies

IDE | Explorer | dev-machine | cplane-01 | node- | dev-machine (2)

```
namespace webapp -l "app.kubernetes.io/name=mywebapp,app.kube
rnetes.io/instance=webapp" -o jsonpath="{.items[0].metadata.n
ame}") 8080:80 &
laborant@dev-machine:bobctl$ Forwarding from 127.0.0.1:8080 -
> 80
Forwarding from [::1]:8080 -> 80
^C
laborant@dev-machine:bobctl$ curl localhost:8080/ping.php?ip=
172.16.0.2\;ls
Handling connection for 8080
<pre><strong>Ping results for 172.16.0.2;ls:</strong><br>PING
 172.16.0.2 (172.16.0.2) 56(84) bytes of data.<br><span style
='color: #4caf50;'>64 bytes from 172.16.0.2: icmp_seq=1 ttl=6
4 time=0.106 ms</span><br><span style='color: #4caf50;'>64 by
tes from 172.16.0.2: icmp_seq=2 ttl=64 time=0.127 ms</span><b
r><span style='color: #4caf50;'>64 bytes from 172.16.0.2: icm
p_seq=3 ttl=64 time=0.128 ms</span><br><span style='color: #4
caf50;'>64 bytes from 172.16.0.2: icmp_seq=4 ttl=64 time=0.10
4 ms</span><br><br>--- 172.16.0.2 ping statistics ---<br>4 pa
ckets transmitted, 4 received, 0% packet loss, time 3063ms<br
>rtt min/avg/max/mdev = 0.104/0.116/0.128/0.011 ms<br>index.h
tml<br>ping.php<br></pre><strong>Return status:</strong> 0lab
orant@dev-machine:bobctl$ makmake attack
curl 127.0.0.1:8080/ping.php?ip=1.1.1.1\;ls
Handling connection for 8080
<pre><strong>Ping results for 1.1.1.1;ls:</strong><br>PING 1.
1.1.1 (1.1.1.1) 56(84) bytes of data.<br><span style='color:
#4caf50;'>64 bytes from 1.1.1.1: icmp_seq=1 ttl=55 time=5.80
ms</span><br><span style='color: #4caf50;'>64 bytes from 1.1.
1.1: icmp_seq=2 ttl=55 time=5.83 ms</span><br><span style='co
lor: #4caf50;'>64 bytes from 1.1.1.1: icmp_seq=3 ttl=55 time=
5.79 ms</span><br><span style='color: #4caf50;'>64 bytes from
 1.1.1.1: icmp_seq=4 ttl=55 time=5.81 ms</span><br><br>--- 1.
1.1.1 ping statistics ---<br>4 packets transmitted, 4 receive
d, 0% packet loss, time 3005ms<br>rtt min/avg/max/mdev = 5.78
9/5.805/5.829/0.014 ms<br>index.html<br>ping.php<br></pre><st
rong>Return status:</strong> 0curl  127.0.0.1:8080/ping.php?i
p=1.1.1.1%3Bcat%20/proc/self/mounts
Handling connection for 8080
<pre><strong>Ping results for 1.1.1.1;cat /proc/self/mounts:<
/strong><br>PING 1.1.1.1 (1.1.1.1) 56(84) bytes of data.<br><
span style='color: #4caf50;'>64 bytes from 1.1.1.1: icmp_seq=
1 ttl=55 time=5.79 ms</span><br><span style='color: #4caf50;'
>64 bytes from 1.1.1.1: icmp_seq=2 ttl=55 time=5.83 ms</span>
<br><span style='color: #4caf50;'>64 bytes from 1.1.1.1: icmp
_seq=3 ttl=55 time=5.80 ms</span><br><span style='color: #4ca
f50;'>64 bytes from 1.1.1.1: icmp_seq=4 ttl=55 time=5.81 ms</
span><br><br>--- 1.1.1.1 ping statistics ---<br>4 packets tra
nsmitted, 4 received, 0% packet loss, time 3005ms<br>rtt min/
avg/max/mdev = 5.789/5.809/5.831/0.015 ms<br>overlay / overla
y rw,relatime,lowerdir=/var/lib/rancher/k3s/agent/containerd/
```


```
    "podName": "webapp-mywebapp-67965968bb-4t8cg",
    "podNamespace": "webapp",
    "podLabels": {
      "app.kubernetes.io/instance": "webapp",
      "app.kubernetes.io/name": "mywebapp",
      "pod-template-hash": "67965968bb"
    },
    "workloadName": "webapp-mywebapp",
    "workloadNamespace": "webapp",
    "workloadKind": "Deployment"
  },
  "RuntimeProcessDetails": {
    "processTree": {
      "pid": 7511,
      "cmdline": "/bin/sh -c ping -c 4 1.1.1.1;cat index.htm
",
      "comm": "sh",
      "ppid": 6630,
      "pcomm": "apache2",
      "hardlink": "/bin/dash",
      "uid": 33,
      "gid": 33,
      "startTime": "0001-01-01T00:00:00Z",
      "upperLayer": false,
      "cwd": "/var/www/html",
      "path": "/bin/dash",
      "childrenMap": {
        "cat 7516": {
          "pid": 7516,
          "cmdline": "/bin/cat index.html",
          "comm": "cat",
          "ppid": 7511,
          "pcomm": "sh",
          "hardlink": "/bin/cat",
          "uid": 33,
          "gid": 33,
          "startTime": "0001-01-01T00:00:00Z",
          "upperLayer": false,
          "cwd": "/var/www/html",
          "path": "/bin/cat"
        }
      }
    },
    "containerID": "0b748fe5277a36f38b4af625f35cd8f390f7dd90
dfc853a72c861dde4ae99dc"
  },
  "event": {
    "runtime": {
      "runtimeName": "containerd",
      "containerId": "0b748fe5277a36f38b4af625f35cd8f390f7dd
00dfc853a72c861dde4ae99dc",
```


User receives the BoB
Live demo

▶ Inspect the BoB profile (aka ApplicationProfile)

4 Abuse the Webapp via an automated negative test

We can also create known undesired behavior and test that it is detecteable in a predictable and consistent way:

In the next unit, we ll supply such an `attack-test` as part of the `BoB`, here we do it via `Makefile`. In the `original tab`, please run

```
> make attack
```

In the `logs tab`, you may observe a very predictable set of anomalies


```
{"BaseRuntimeMetadata":{"alertName":"Unexpected process launched","argume
{"BaseRuntimeMetadata":{"alertName":"Unexpected file access","arguments":
{"BaseRuntimeMetadata":{"alertName":"Unexpected process launched","argume
{"BaseRuntimeMetadata":{"alertName":"Unexpected process launched","argume
{"BaseRuntimeMetadata":{"alertName":"Unexpected file access","arguments":
{"BaseRuntimeMetadata":{"alertName":"Unexpected system call","arguments":
{"BaseRuntimeMetadata":{"alertName":"Unexpected process launched","argume
{"BaseRuntimeMetadata":{"alertName":"Unexpected domain request","argument
{"BaseRuntimeMetadata":{"alertName":"Unexpected system call","arguments":
{"BaseRuntimeMetadata":{"alertName":"Unexpected system call","arguments":
{"BaseRuntimeMetadata":{"alertName":"Unexpected system call","arguments":
{"BaseRuntimeMetadata":{"alertName":"Unexpected process launched","argume
{"BaseRuntimeMetadata":{"alertName":"Unexpected file access","arguments":
{"BaseRuntimeMetadata":{"alertName":"Unexpected Service Account Token Acc
```


5 Mimic a supply chain attack

WIP: make this automated and pretty

We also have a tampered version of `webapp` and there you'll notice

IDE | Explorer | dev-machine | cplane-01 | node- | dev-machine (2)

```
orant@dev-machine:bobctl$ make attack
curl 127.0.0.1:8080/ping.php?ip=1.1.1.1\;ls
Handling connection for 8080
<pre><strong>Ping results for 1.1.1.1;ls:</strong><br>PING 1.
1.1.1 (1.1.1.1) 56(84) bytes of data.<br><span style='color:
#4caf50;'>64 bytes from 1.1.1.1: icmp_seq=1 ttl=55 time=5.80
ms</span><br><span style='color: #4caf50;'>64 bytes from 1.1.
1.1: icmp_seq=2 ttl=55 time=5.83 ms</span><br><span style='co
lor: #4caf50;'>64 bytes from 1.1.1.1: icmp_seq=3 ttl=55 time=
5.79 ms</span><br><span style='color: #4caf50;'>64 bytes from
 1.1.1.1: icmp_seq=4 ttl=55 time=5.81 ms</span><br><br>--- 1.
1.1.1 ping statistics ---<br>4 packets transmitted, 4 receive
d, 0% packet loss, time 3005ms<br>rtt min/avg/max/mdev = 5.78
9/5.805/5.829/0.014 ms<br>index.html<br>ping.php<br></pre><st
rong>Return status:</strong> 0curl  127.0.0.1:8080/ping.php?i
p=1.1.1.1%3Bcat%20/proc/self/mounts
Handling connection for 8080
<pre><strong>Ping results for 1.1.1.1;cat /proc/self/mounts:<
/strong><br>PING 1.1.1.1 (1.1.1.1) 56(84) bytes of data.<br><
span style='color: #4caf50;'>64 bytes from 1.1.1.1: icmp_seq=
1 ttl=55 time=5.79 ms</span><br><span style='color: #4caf50;'
>64 bytes from 1.1.1.1: icmp_seq=2 ttl=55 time=5.83 ms</span>
<br><span style='color: #4caf50;'>64 bytes from 1.1.1.1: icmp
_seq=3 ttl=55 time=5.80 ms</span><br><span style='color: #4ca
f50;'>64 bytes from 1.1.1.1: icmp_seq=4 ttl=55 time=5.81 ms</
span><br><br>--- 1.1.1.1 ping statistics ---<br>4 packets tra
nsmitted, 4 received, 0% packet loss, time 3005ms<br>rtt min/
avg/max/mdev = 5.789/5.809/5.831/0.015 ms<br>overlay / overla
y rw,relatime,lowerdir=/var/lib/rancher/k3s/agent/containerd/
io.containerd.snapshotter.v1.overlayfs/snapshots/101/fs:/var/
lib/rancher/k3s/agent/containerd/io.containerd.snapshotter.v1
.overlayfs/snapshots/100/fs:/var/lib/rancher/k3s/agent/contai
nerd/io.containerd.snapshotter.v1.overlayfs/snapshots/99/fs:/
var/lib/rancher/k3s/agent/containerd/io.containerd.snapshotte
r.v1.overlayfs/snapshots/98/fs:/var/lib/rancher/k3s/agent/con
tainerd/io.containerd.snapshotter.v1.overlayfs/snapshots/97/f
s:/var/lib/rancher/k3s/agent/containerd/io.containerd.snapsho
tter.v1.overlayfs/snapshots/96/fs:/var/lib/rancher/k3s/agent/
containerd/io.containerd.snapshotter.v1.overlayfs/snapshots/9
5/fs:/var/lib/rancher/k3s/agent/containerd/io.containerd.snap
shotter.v1.overlayfs/snapshots/94/fs:/var/lib/rancher/k3s/age
nt/containerd/io.containerd.snapshotter.v1.overlayfs/snapshot
s/93/fs:/var/lib/rancher/k3s/agent/containerd/io.containerd.s
napshotter.v1.overlayfs/snapshots/92/fs:/var/lib/rancher/k3s/
agent/containerd/io.containerd.snapshotter.v1.overlayfs/snaps
hots/91/fs:/var/lib/rancher/k3s/agent/containerd/io.containe
r.snapshotter.v1.overlayfs/snapshots/90/fs:/var/lib/rancher/k
3s/agent/containerd/io.containerd.snapshotter.v1.overlayfs/sn
apshots/89/fs:/var/lib/rancher/k3s/agent/containerd/io.contai
nerd.snapshotter.v1.overlayfs/snapshots/88/fs:/var/lib/ranche
r/k3s/agent/containerd/io.containerd.snapshotter.v1.overlayfs
```


```
      "containerId": "0b748fe5277a36f38b4af625f35cd8f390f7dd5
00dfc853a72c861dde4ae99dc",
      "containerName": "mywebapp-app",
      "containerImageName": "ghcr.io/k8sstormcenter/webapp@sh
a256:e323014ec9befb76bc551f8cc3bf158120150e2e277bae11844c2da
c56c0a2b",
      "containerImageDigest": "sha256:c622cf306b94e8a6e7cfd71
8f048015e033614170f19228d8beee23a0ccc57bb"
    },
    "k8s": {
      "namespace": "webapp",
      "podName": "webapp-mywebapp-67965968bb-4t8cg",
      "podLabels": {
        "app.kubernetes.io/instance": "webapp",
        "app.kubernetes.io/name": "mywebapp",
        "pod-template-hash": "67965968bb"
      },
      "containerName": "mywebapp-app",
      "owner": {}
    },
    "timestamp": 1752990476105800465,
    "type": "normal"
  },
  "level": "error",
  "message": "Unexpected domain communication: github.com. fr
om: mywebapp-app",
  "msg": "Unexpected domain request",
  "time": "2025-07-20T05:47:56Z"
}
{
  "BaseRuntimeMetadata": {
    "alertName": "Unexpected system call",
    "arguments": {
      "syscall": "getpeername"
    },
    "infectedPID": 6602,
    "md5Hash": "4e79f11b07df8f72e945e0e3b3587177",
    "sha1Hash": "b361a04dcb3086d0ecf960d3acaa776c62f03a55",
    "severity": 1,
    "size": "730 kB",
    "timestamp": "2025-07-20T05:47:57.688648007Z",
    "trace": {},
    "uniqueID": "69bbdde26311ca1a112c3449cc03d209",
    "profileMetadata": {
      "status": "completed",
      "completion": "complete",
      "name": "replicaset-webapp-mywebapp-67965968bb",
      "failOnProfile": true,
      "type": 0
    }
  },
```


SBoB makes behavior prescriptive

No longer descriptive

Ask your primary care engineer
in case of unexpected side-channels

Tracing has been possible since the dawn of time: but

Instead of everyone recording profiles (potentially incl attacker behavior)

Explicit positives! Makes a DB look like a DB (and a debug pkg like a debug pkg)

Explicit negatives! If negative tests are supplied, users can verify their incident response

some room: to make it transfer well and allow good UX

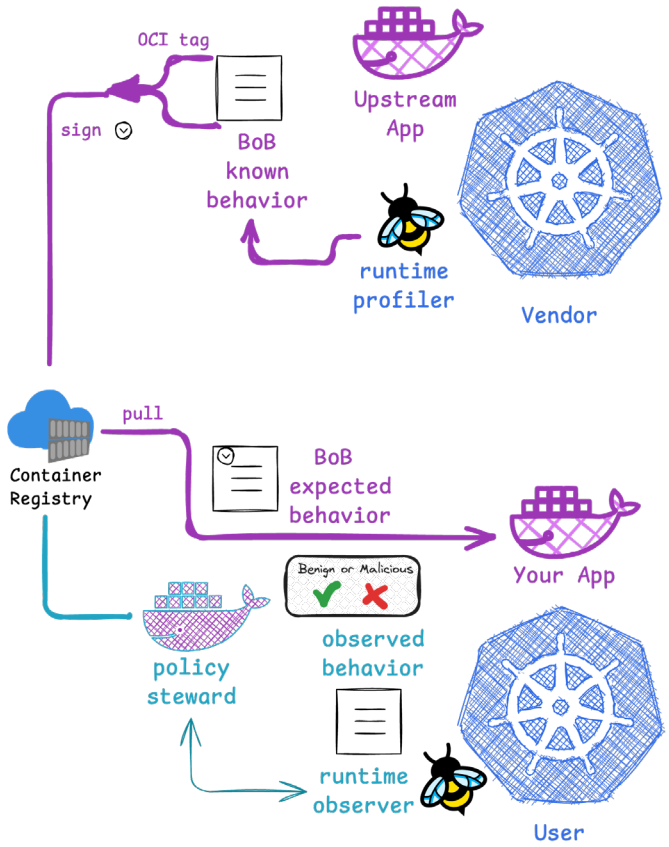
WANTED:
CNCF projects
with their test-suite

needs YOU !

k8sstormcenter

Roadmap

Edge cases, caveats



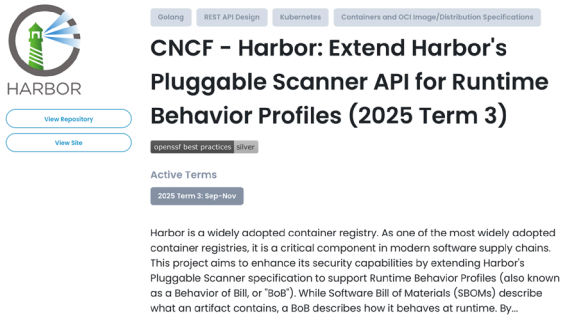
Research-Collaborations welcome!

Research funding requested for

- Additivity (e.g. various Sidecars like istio) ☑
- Large Parameter Studies ✅ TU WIEN TECHNISCHE UNIVERSITÄT WIEN
- UX Evaluation and Implementation
- Optimal Granularity 👨‍🎓

  (Performance vs Alert Fatigue)
- Integration into cloudnative ecosystem
- Maintenance

Ecosystem Integration Harbor



- SBOB integration into Harbor
- Attaching SBOB information alongside the OCI artefact
- Extending Harbor interface to 3rd party scanners
    - UI and reporting
    - Interfaces and API
- SBOM, SBOB, etc to represent different aspect of an application (see Open Component Model OCM)
- Implementation as part of the LFX mentorship program

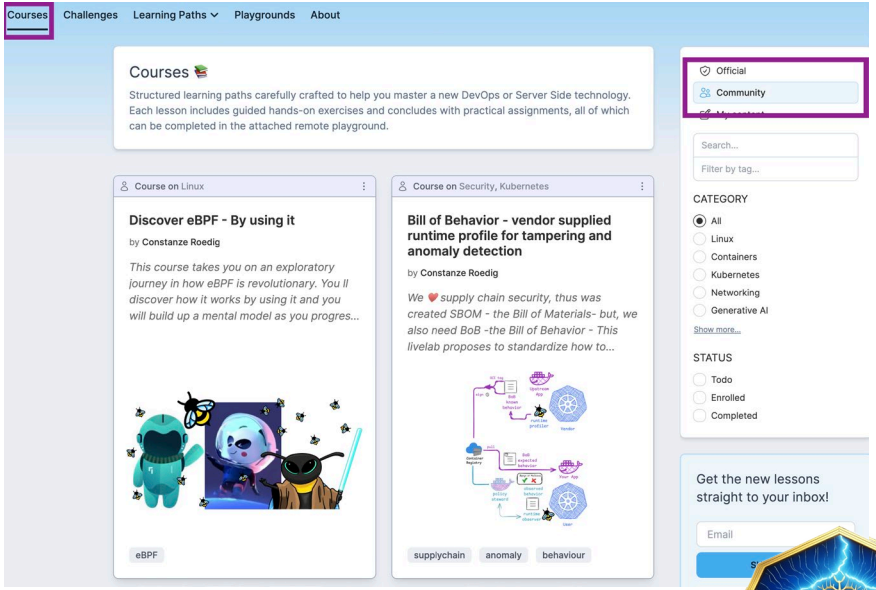
How you can benefit today
Don’t believe it … try out the lab

CNCF SW with test-suite WANTED

Bill of Behavior - vendor supplied runtime profile for tampering and anomaly detection

supplychain anomaly behaviour oci ebpf

We ❤️ supply chain security, thus was created SBOM - the Bill of Materials- but, we also need BoB -the Bill of Behavior - This livelab proposes to standardize how to record a benign behavior profile, extract, sign and publish it, for users to consume, ingest, verify it and detect attacks and tampering. For software-vendors, a BoB creates trust and transparency, For users, it makes anomaly detection realistically achievable.



https://labs.iximiuz.com/courses/bill-of-behaviour-c070da3a

Summary

Ask your primary care engineer
in case of unexpected effects

Container Beipackzettel

BoB: Software Bill of Behavior

What? generalized runtime profile encoding benign syscalls, paths, network, capas, execs

Who? Vendors attach to software at “the factory”

Why? Allows users to inherit maintained, up-to-date rules for anomaly detection

so that: Users stop play catch-up

CLOUD NATIVE DENMARK
October 7-8, 2025 • Aarhus

CNDA
Cloud Native Days Austria

ITSECURITY SUMMIT

Thank you !!

SOFIA | BULGARIA
KCD
GROWING CLOUD NATIVE TOGETHER

Redpill Linpro
Cloud

iximiuz Labs

SBoB would not have been possible without: Matthias, Ben, Thomas, Norman, Stefan, Peter, Markus, David, Pepijn, Mario, Ivan, Markus, Stephie, Andi, Ernst, Michi, Reini and Alois

https://cloudnativecompass.dev

https://www.letsboot.ch

https://kubescape.io

https://github.com/k8sstormcenter/bobctl

⭐ Star it if you want it ⭐