Running Kubevirt Workloads with No Additional Privileges

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What is coming?

- Kubernetes & Kubevirt crash course
- How is security enforced ?
- What is enforced ?
- Where did we start, where are we now and Where are we heading?

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What is Kubernetes?

“Open-source system for automating deployment, scaling, and management of Containerized applications.”

Source: *https://kubernetes.io/*

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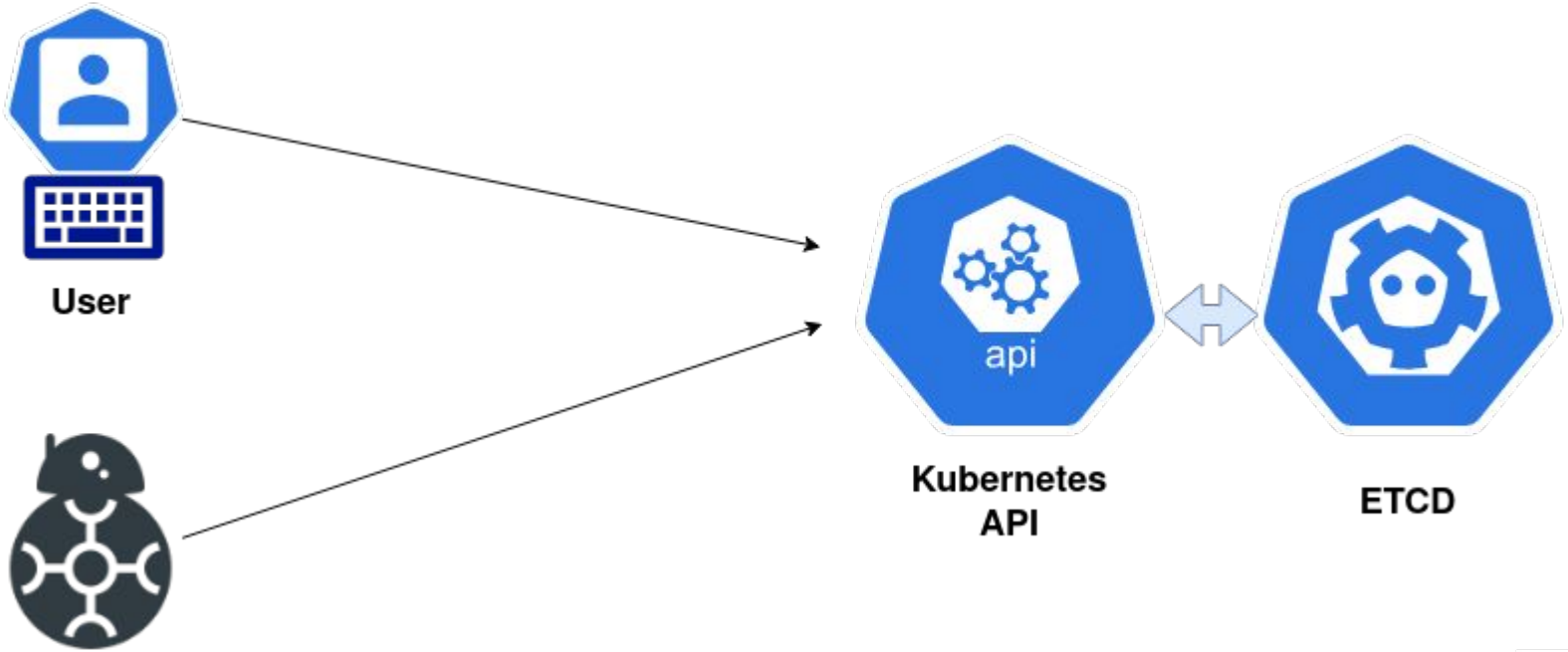
How does the Kubernetes look like?



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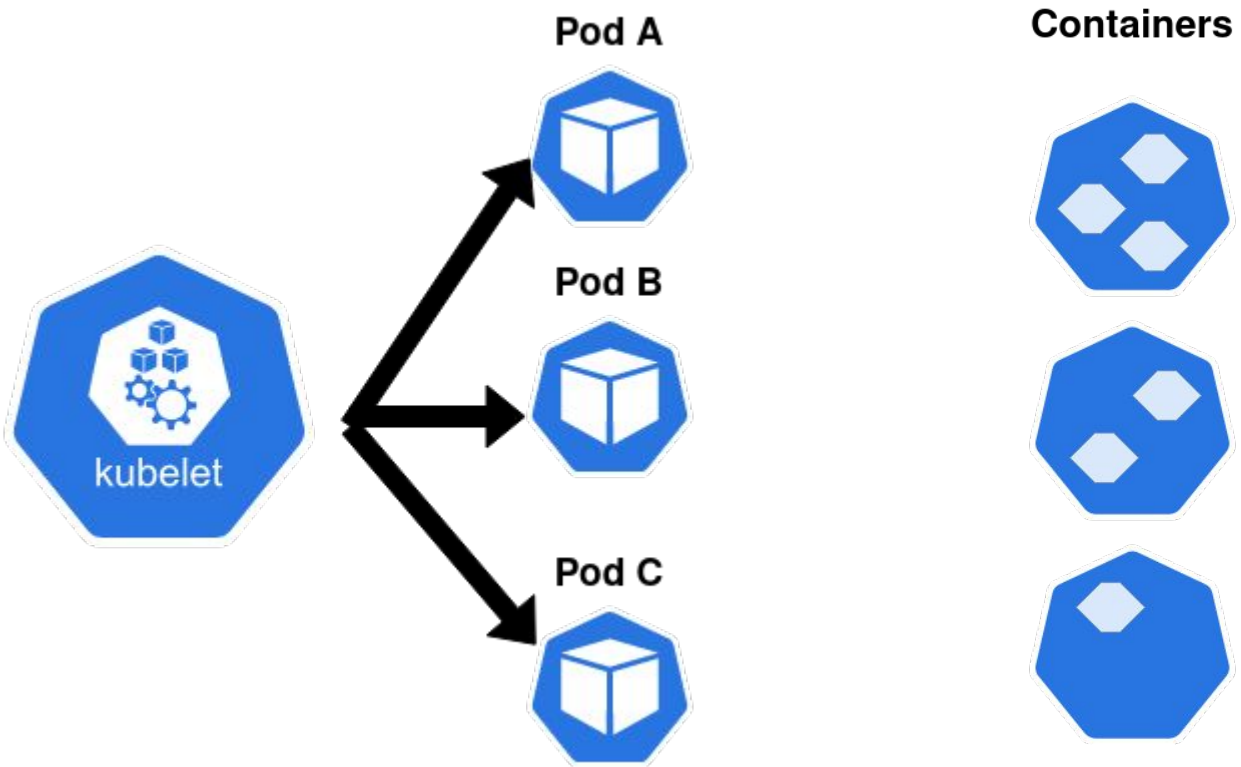
Node perspective



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What is Kubevirt?

“KubeVirt is a Kubernetes extension that allows running traditional VM workloads natively side by side with Container workloads.”

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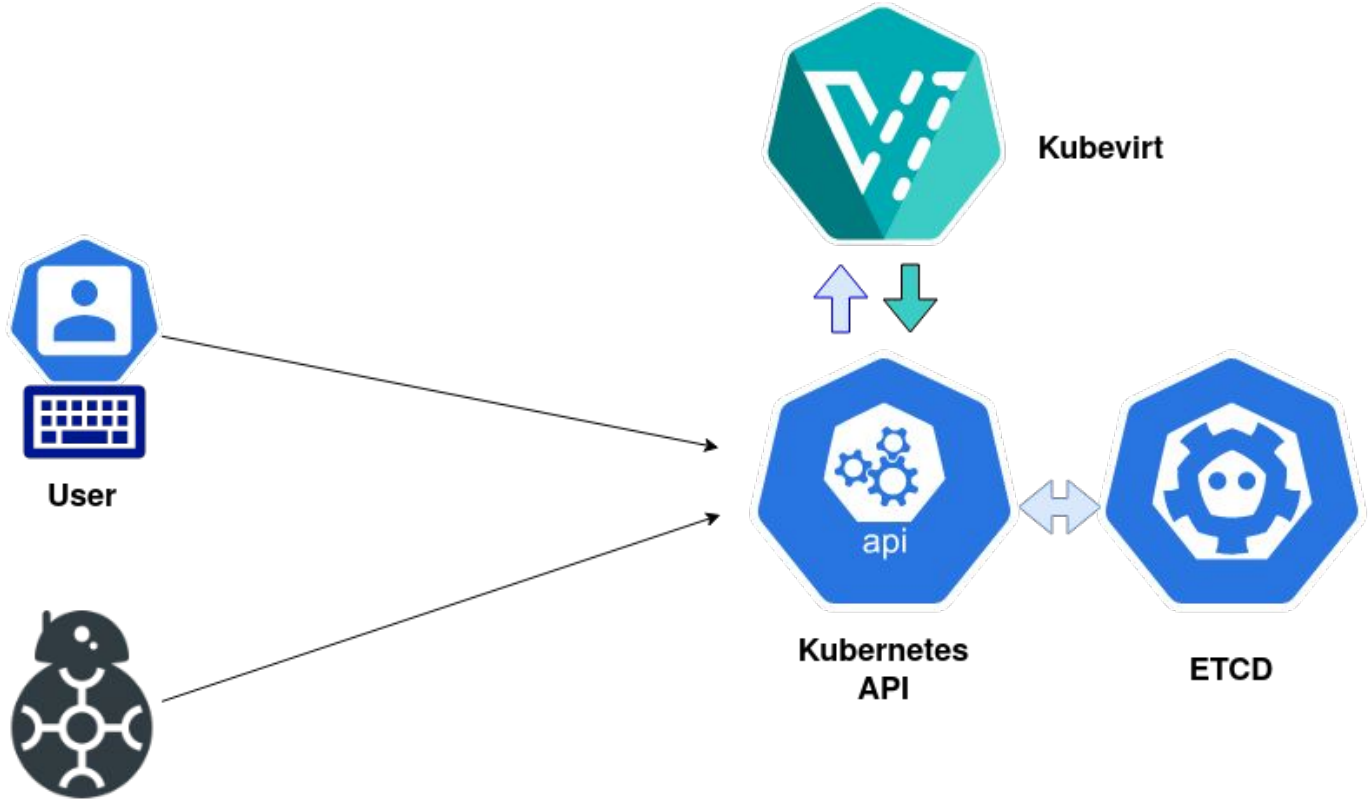
Kubevirt Integration



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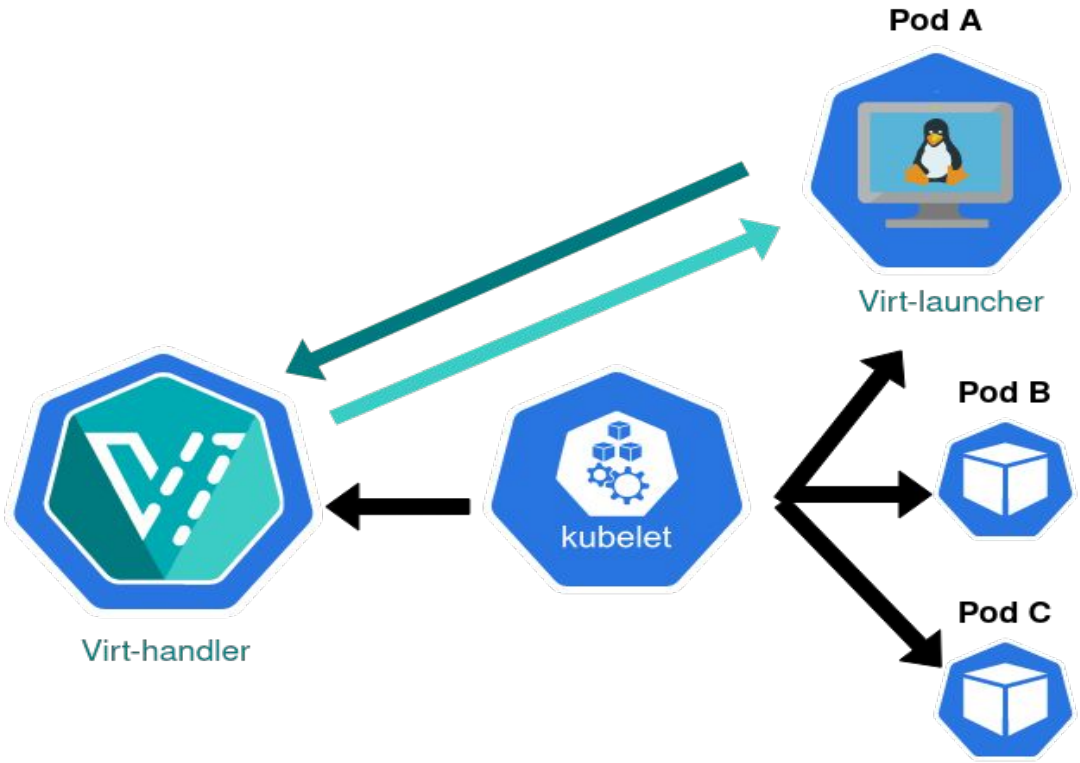
Node perspective



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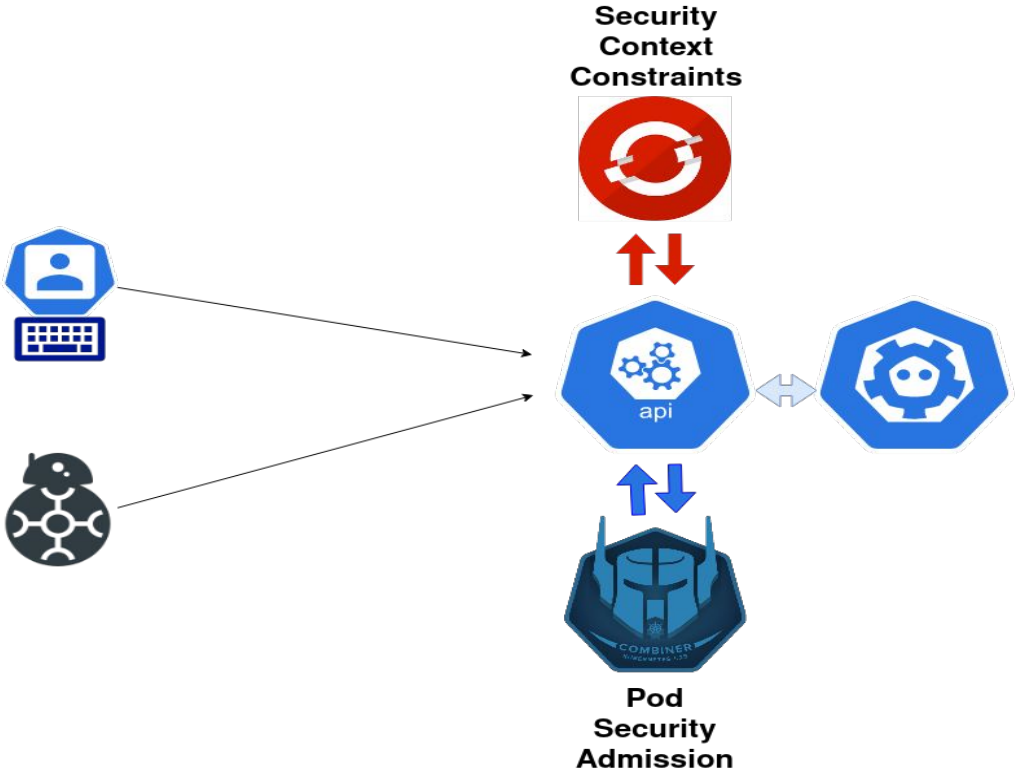
How is security enforced?



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Security policies

- Restricted - hardening best practices
- Privileged - allows for known privilege escalations

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What is restricted?

- Capabilities
- Selinux/AppArmor
- Running as Root
- Privileged containers
- Seccomp
- Privilege Escalation (no_new_privs bit)
- HostPath volumes
- Host Ports

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Kubevirt

- Capabilities
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“That's one small step for security”

- First step was to have unprivileged networking
- We used NET_ADMIN, NET_RAW, NET_BIND_SERVICE because:
  - Pod gets IP address
  - Containers gets Interface that requires configuration
  - Configuration of network requires privileges
  - Interface IP needs to be exposed to Guest (DHCP)

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Solution

- Offload network setup to privileged component (Virt-handler - privileged container)
- Requires Libvirt “Unmanaged” option
- Existing management tool is losing privileges
- NET_BIND_SERVICE stays around

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Running as Non-root

"As easy as setting user for workload & using Libvirtd in session mode"

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Running as any non-root user

- Security policies requires anyuid
- Pre-allocated ranges of uids
- Qemu processes can’t read each others disk
- Filesystem permissions are set at build time of container images
- Modifying container FS at runtime can trigger copy

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Solution

- Use “EmptyDir” feature that is just tmpfs with relaxed permissions
- Manage the permissions by Kubevirt

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Storage for non-root user

- Filesystem/Block Volumes don’t have standardized permissions
- Kubernetes provides feature “fsgroup”
  - Does not always work
  - Restricted by some policies

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Solution

- Manage permissions with privileged component (Virt-handler - privileged container)

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Devices for non-root user

- Kubernetes expose devices through device plugins
- Devices are exposed with same permissions as on the host
  - This lead to inconsistencies depending on the setup
  - Not usable out-of-box for non-root users most of the time

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Solution

- Manage permissions with privileged component (Virt-handler - privileged container)
- Drawback is that we can only manage devices that we know

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Capabilities for non-root containers

Transformation of capabilities during execve()

During an execve(2), the kernel calculates the new capabilities of the process using the following algorithm:

```
P'(ambient)     = (file is privileged) ? 0 : P(ambient)

P'(permitted)   = (P(inheritable) & F(inheritable)) |
                  (F(permitted) & P(bounding)) | P'(ambient)

P'(effective)   = F(effective) ? P'(permitted) : P'(ambient)

P'(inheritable) = P(inheritable)    [i.e., unchanged]

P'(bounding)    = P(bounding)       [i.e., unchanged]
```

where:

```
P()   denotes the value of a thread capability set before the
      execve(2)

P'()  denotes the value of a thread capability set after the
      execve(2)

F()   denotes a file capability set
```

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Solution

- Non-root containers requires file capabilities on the executed binary
- Ambient capabilities are the future
  - They don’t require changes to image
  - Keeps working with no_new_privs bit
  - Missing support in Kubernetes

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Drawback

“File capabilities require always requesting the capabilities for workload, disallowing opt-in approach”

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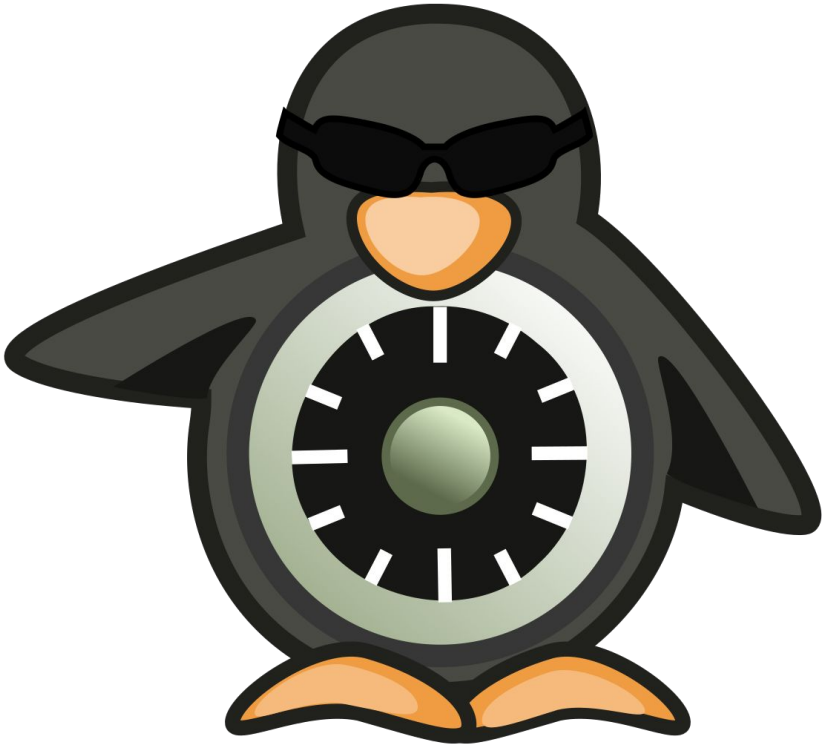
SELinux



Keep me enabled!

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What's left to do?

- Arbitrary user running workloads
  - How does user namespaces affect this?
- Remove custom SELinux policy
  - Upstream rules that makes sense for general container use cases
  - Use alternative API that are not requiring privileges
- Upstream support for Ambient capabilities
- Switch to “Restricted first” approach?

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Thank you

You can get in touch with Kubevirt

- Twitter @kubevirt
- Slack kubevirt-dev

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KVM FORUM