Demystifying Container Security

A whirlwind tour of container security features

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What is a Linux Container?

Introduction to Linux Containers

- **At the core, containers are just processes running on the host**
  - Effective mechanisms to secure, isolate, control and multiplex resources
- **Various use cases ranging from CI to micro-services**
  - Increasing popularity
- **Security skepticism is common and necessary**
  - Our talk demystifies containers security

Namespaces and Control Groups

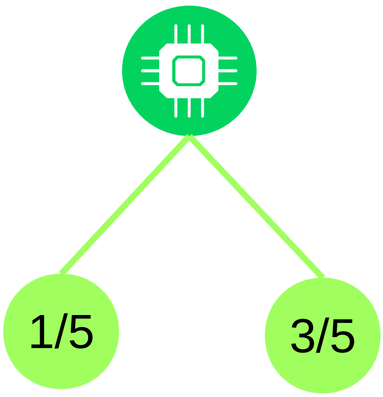
The core of what makes a container a container

Linux Namespaces

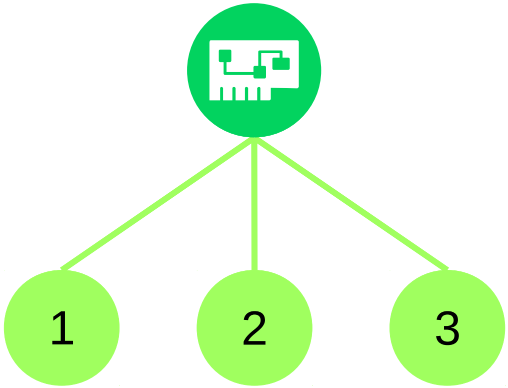
- **Kernel mechanism to isolate a process's view of the system**
  - **Network** devices, stacks, ports, etc.
  - **Mount** points
  - **Process** IDs
  - **User** and **group** IDs
  - **Host-** and **NIS domain** name
  - **Inter-process communication**
  - **Control groups**

Linux Control Groups

- **Control resources for groups of processes**
  - CPU
  - Memory
  - Devices
  - Block I/O
  - Freezer
  - Network priority
  - Processes



CPU Time



Network Priority

Namespaces vs Control Groups

- **The core of what makes a container a container**

- **Very different purposes**
  - Namespaces are for ***isolation*** and ***multiplexing***
  - Control Groups are for ***resource control***

- **More sophisticated versions of older Unix facilities**
  - Namespaces are (sort of) an extension of `chroot`
  - Control Groups are an extension of `ulimit`

Demo

Namespaces and Control Groups

Capabilities

- **A more granular way of providing privileges than just “root”**
  - Examples include mounting, loading kernel modules, network configuration

- **What's the goal of capabilities?**
  - If compromised, the process has limited rights
  - It's safer than running with full-root privileges

- **Open source Docker container engine provides support for giving containers limited capabilities**
  - By default, “root” in a container doesn’t have a full set of capabilities

Demo

Capabilities

SECCOMP

- **Linux technology that allows fine-grained syscall blocking**
  - Block by syscall number, arguments, architecture, eBPF filter, etc.
  - Used in many projects such as Chromium, Firefox, OpenSSH

- **Open source Docker container engine has a default whitelist profile**
  - Support for custom profiles
  - *Note:* Writing your own profile can be quite tedious
  - Default profile has protected against kernel 0-days

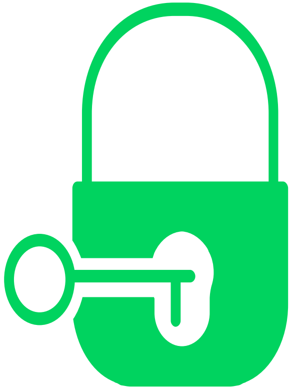
- **Works on any Linux system regardless of Linux Security Module**

Demo

SECCOMP

AppArmor

- **Linux technology that provides path-based access control**
  - Block certain types of access to paths, network resources, capabilities, etc.
  - Provides auditing capabilities
- **Open source Docker container engine has a default profile and supports custom profiles**
  - *Note:* Writing AppArmor profiles can also be tedious
    - See https://github.com/jessfraz/bane and https://github.com/docker-slim/docker-slim
  - AppArmor makes creating profiles based on "normal usage" simple
- **Default Linux Security Module on SUSE Linux Enterprise**
  - Seen as an easier to administer alternative to SELinux



Demo

AppArmor

Runtime Security

- **dockerd still runs as root**
  - Users with access to dockerd have effective root access
  - `rkt` still has a similar problem, despite having better least-privilege principles

- **Open source Docker container engine has support for access control plugins**
  - Very few available – they're hard to implement
  - Custom authentication is not implemented (only client certificates supported)

- **Only give access to dockerd to trusted users!**

Runtime Security

- **Vulnerabilities in a container engine can cause *host* exploits**
  - Docker's default security profiles have protected against Linux kernel 0-days
  - Security is all about layers
    - Requiring a container-engine exploit is another layer
  - User namespaces can help resolve some of the risks

- **Future directions and research:**
  - Rootless containers, a project within the Open Container Initiative
  - Lots of ongoing work to secure kernel primitives used by containers

Best Practices

- **Putting software in a container is safer than on your host**
  - But that doesn’t mean you should abandon common sense

- **Some best practices to get you started:**
  - Don't run as root, and if you do, use capabilities
  - Don’t use your entire host filesystem as a volume, only use what you need
  - Don't make your container a VM, put different services in different containers
  - Don’t run “unconfined”, tailor your security profiles to fit your needs

Image Security

- **Study from 2017 (Shu et al., CODASPY ‘17)**
  - 50% of images have not been updated in 200 days
  - 85% of **latest** official images have been updated in less than 14 days
  - Counter measures are easy!
  - Don’t run untrusted images, audit them like any other software

- **Portus** has integrated image scanning
  - Seamless administration of an on-premise image registry
  - Integrated access control (e.g., LDAP, OAuth2)
  - **zypper-docker** brings our package management to the world of containers
  - CoreOS Clair for additional image scanning

Image Security

- **Open Build Service**
  - Supports building various kinds of images using KIWI
  - Tracks package dependencies of built images
    - Unique feature in the container ecosystem
  - Updating images is easy, secure and automated

Take-Home Message

Running a service inside container is safer than running it outside a container.

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