
KubeCon
CloudNativeCon
OPEN SOURCE SUMMIT
China 2023

Project Update and Deep Dive: containerd

Wei Fu, Microsoft
Iceber Gu(蔡威), DaoCloud

Community growth

CNCF PROJECTS

The adoption of CNCF incubated and graduated projects once again increased in 2022, with **OpenTelemetry** and **Argo** scoring the largest jumps in usage. The former rose from 4% in 2020 to 20% in 2022 and the later from 10% to 28%. Meanwhile **Containerd** (36% to 56%) and **CoreDNS** (48% to 56%) are the graduated projects with the greatest increase in use and evaluation.

https://www.cncf.io/reports/cncf-annual-survey-2022/

Community growth

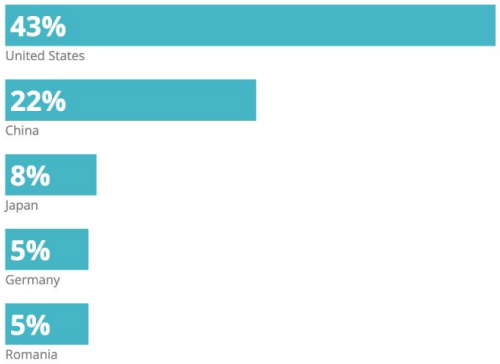
KubeCon CloudNativeCon OPEN SOURCE SUMMIT China 2023

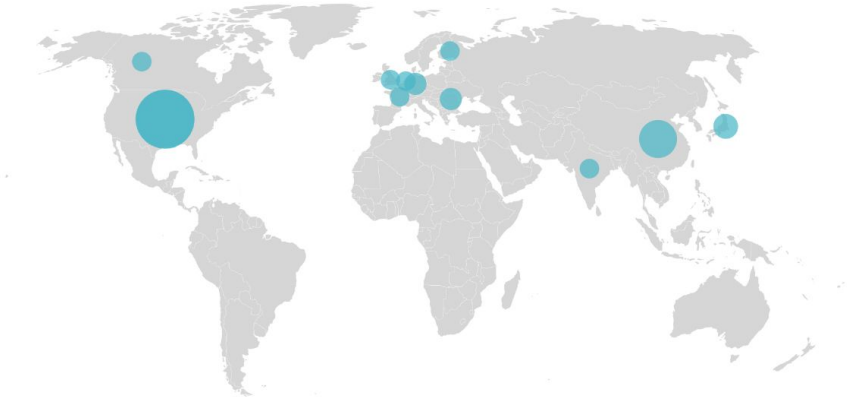
Contributors	Commits	Issues	Pull Requests
630 +4%	1,126 +2%	317 +27%	890 +10%

GEOGRAPHICAL DISTRIBUTION

Total contributors **increased by 5.71%** vs the previous time period.

TOP 5 REGIONS



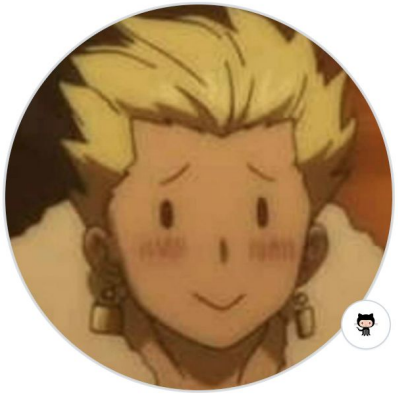


https://insights.v3.lfx.linuxfoundation.org/foundation/cncf/overview?project=containerd&bestPractice=false&repository=https:%2F%2Fgithub.com%2Fcontainerd%2Fcontainerd

New maintainers

Laura Brehm
laurazard · she/her

kiashok · she/her



Iceber Gu
Iceber

Krisztian Litkey
klihub

Supported Releases

Release	Status	Start	End of Life
1.5	End of Life	May 3, 2021	February 28, 2023
1.6	LTS	February 15, 2022	max(February 15, 2025 or next LTS + 6 months)
1.7	Active	March 10, 2023	max(March 10, 2024 or release of 2.0 + 6 months)
2.0	Next	TBD	TBD

containerd v1.6 - first LTS!

- Supported until **Feb 2025**
- Expand scope for backports
  - library dependency
  - toolchain (including Go)
  - compatibility with current Kubernetes versions
- Convert to a regular Active release with stricter backport criteria (Aug 2024)

containerd v1.7 - last 1.x release

- **Sandbox Service and API** (New! - Experimental)
  - Shim-level API to support groups of containers
  - Preview CRI Plugin v2 - *ENABLE_CRI_SANDBOXES=1*
- **Node Resource Interface** (Updated - Experimental)
  - Extensions for OCI-compatible container runtimes
  - TTRPC
- **Transfer Service** (New! - Experimental)
  - Support to transfer artifact objects between any source and destination
- **User-Namespace Support** (New! - Experimental)
- **gRPC Shim Support** (New! - Experimental)

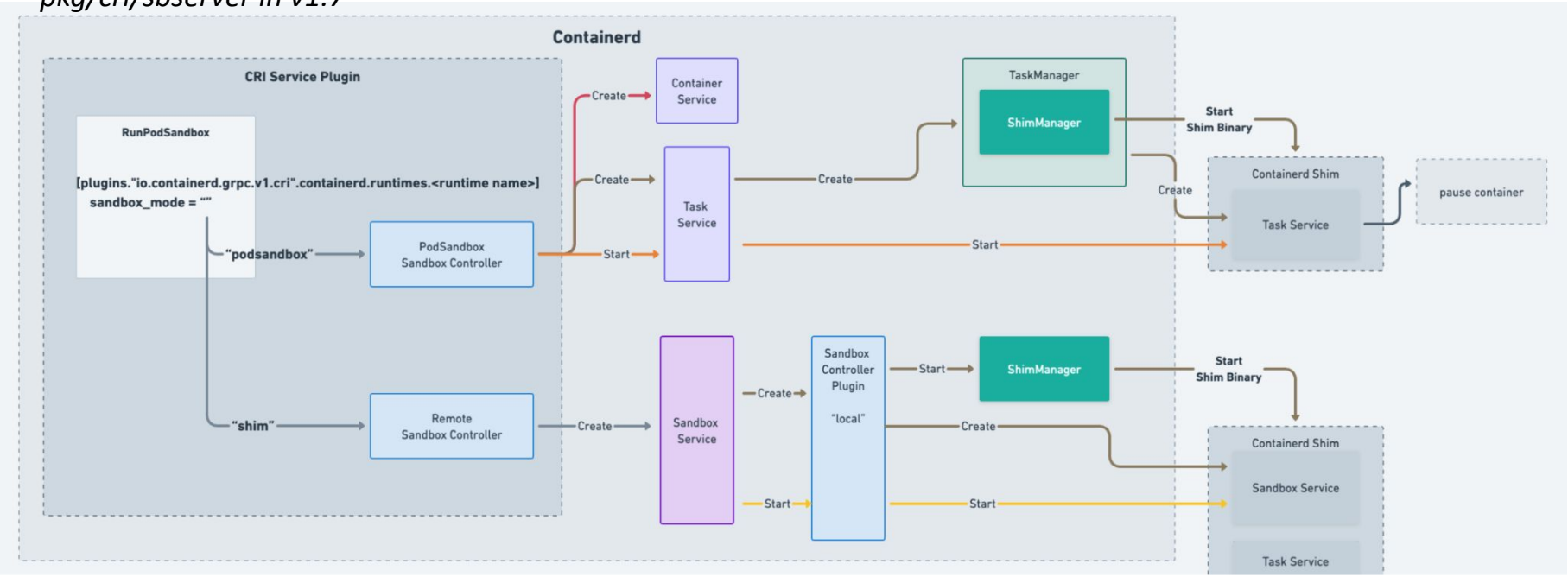
Sandbox Service and API

- New API to group container
  - runc.v2 uses i**o.kubernetes.cri.sandbox-id** to share one shim

- Sandbox Controller interface
  - Handle sandbox environment for grouped containers
  - Support to manage multiple runtime platforms - Linux/Unix/Windows

Sandbox Service and API

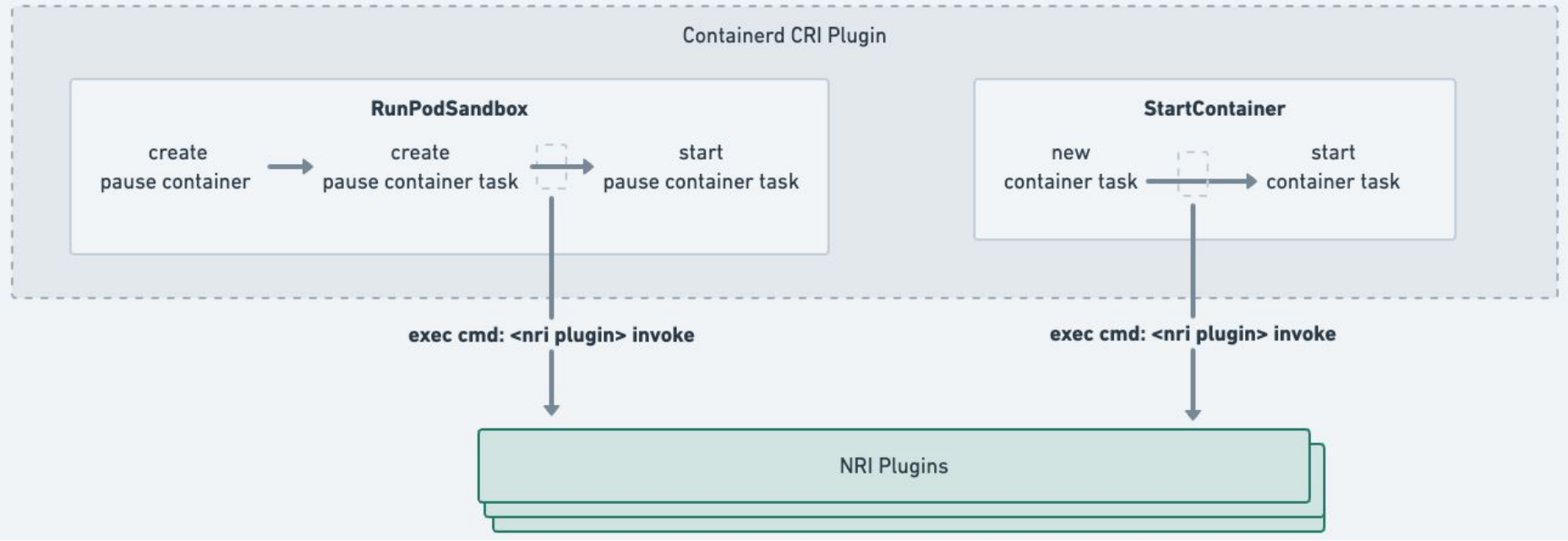
pkg/cri/sbserver in v1.7



- ENABLE_CRI_SANDBOXES=1 in v1.7
- Default in v2.0

Node Resource Interface

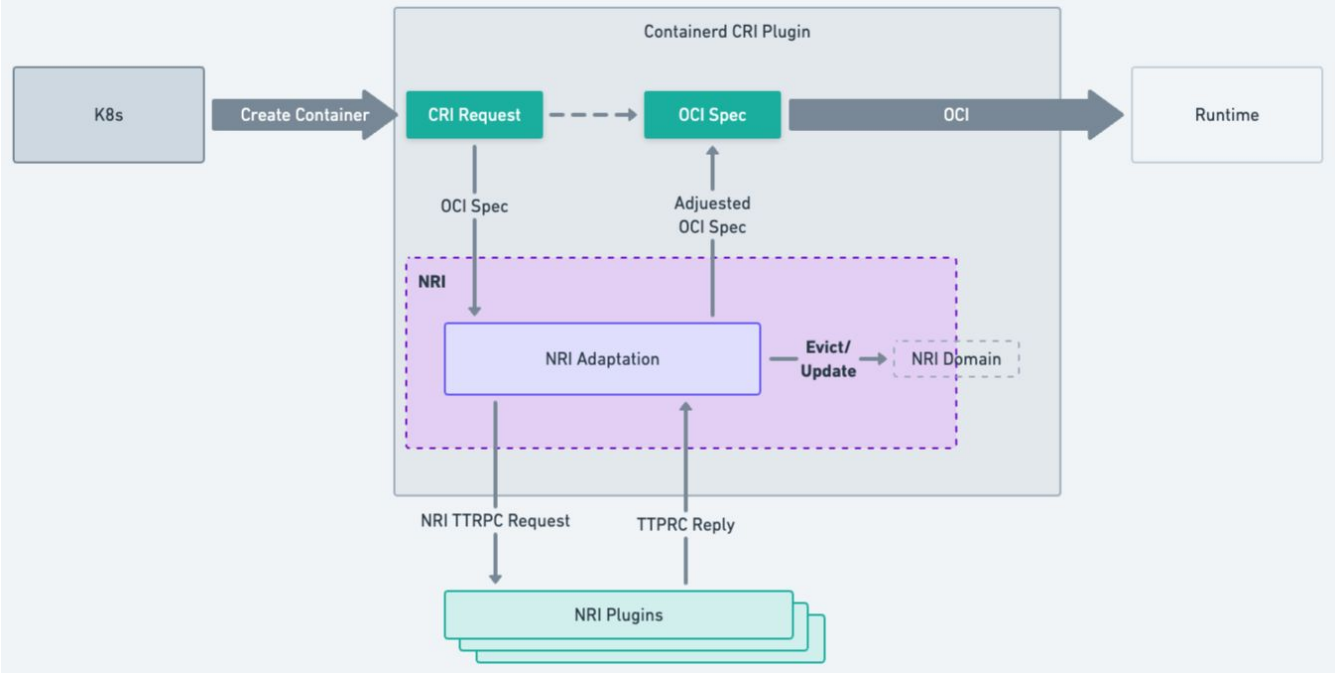
NRI v0.1: start the plugin binary



Node Resource Interface

- Middleware extension between CRI and OCI
- ttRPC bindings

Create a Container

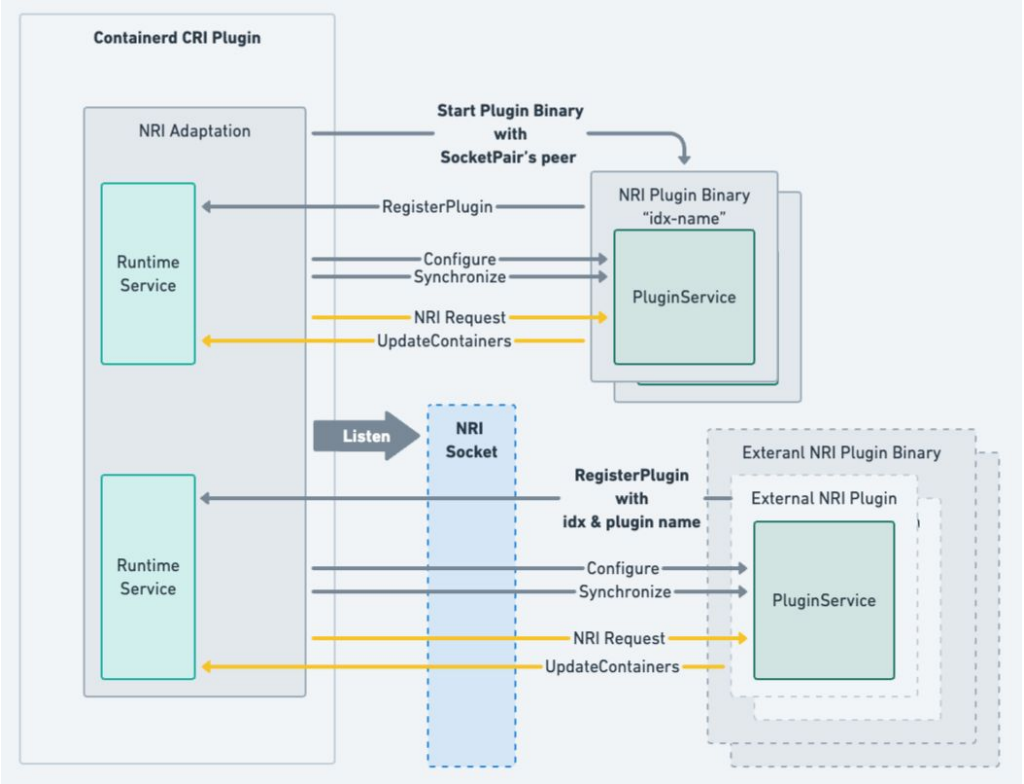


Node Resource Interface

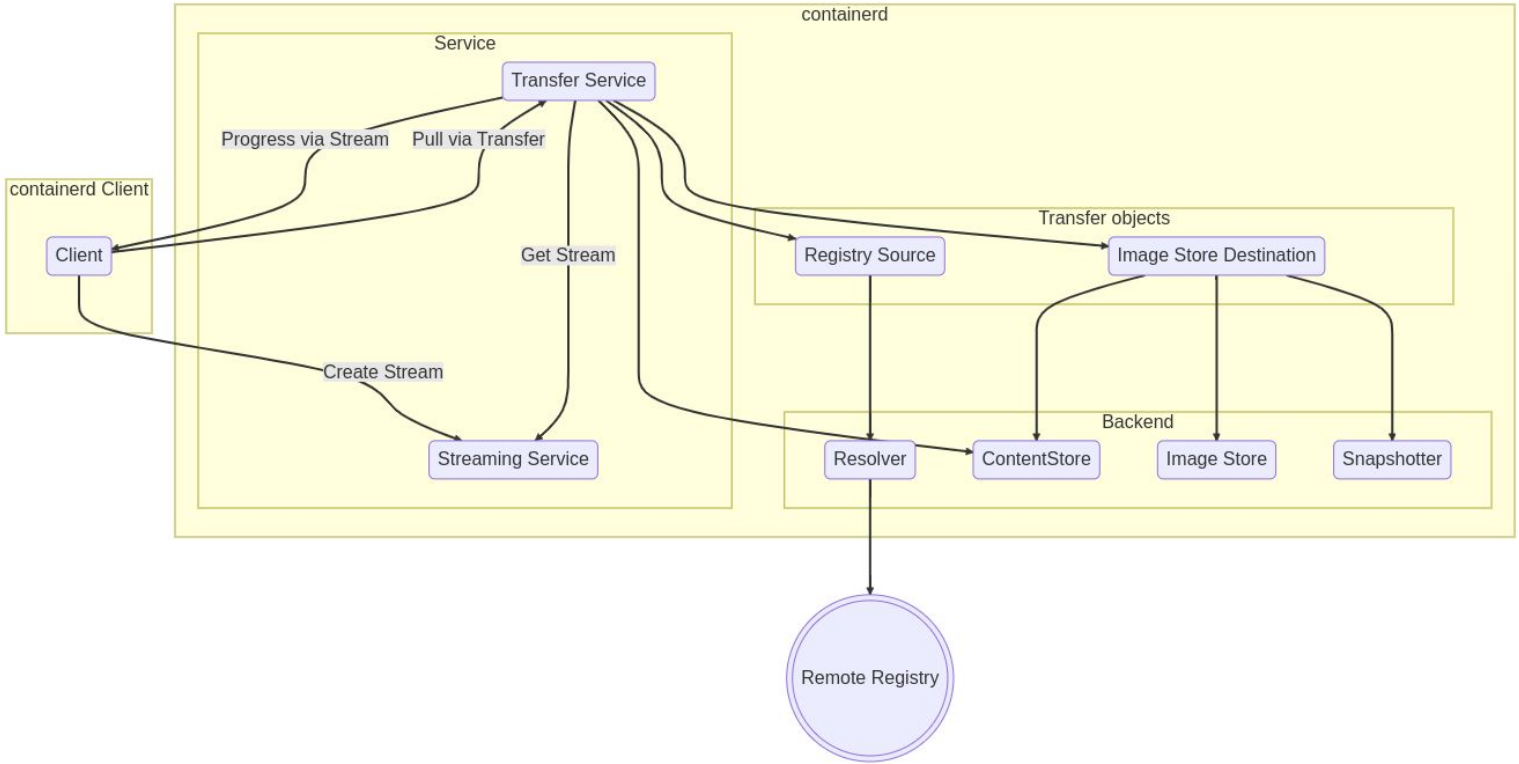
Plugin Registration

- NRI Plugin Binary
- External NRI Plugin

```
[plugins."io.containerd.nri.v1.nri"]
    # Enable NRI support in containerd.
    disable = false

    # Allow connections from externally launched NRI plugins.
    disable_connections = false

    # plugin_config_path is the directory to search for plugin-specific configuration.
    plugin_config_path = "/etc/nri/conf.d"

    # plugin_path is the directory to search for plugins to launch on startup.
    plugin_path = "/opt/nri/plugins"

    # plugin_registration_timeout is the timeout for a plugin to register after connection.
    plugin_registration_timeout = "5s"

    # plugin_requst_timeout is the timeout for a plugin to handle an event/request.
    plugin_request_timeout = "2s"

    # socket_path is the path of the NRI socket to create for plugins to connect to.
    socket_path = "/var/run/nri/nri.sock"
```



Transfer Service



Transfer Service

Source	Destination	Description
Registry	Image Store	"pull"
Image Store	Registry	"push"
Object stream (Archive)	Image Store	"import"
Image Store	Object stream (Archive)	"export"
Object stream (Layer)	Mount/Snapshot	"unpack"
Mount/Snapshot	Object stream (Layer)	"diff"
Image Store	Image Store	"tag"
Registry	Registry	mirror registry image

Transfer Service

- New use-cases and extensions
  - OCI Referrers API support (mountable images, lazy-loading images)
  - Signing and image validation
    - [transfer] plugin to transfer service for image verification
    - Support Ratify as a containerd plugin
  - Confidential computing (guest sandbox env is the destination)
  - Customize image pulling logic
- Enable Transfer Service in CRI plugin by default

User-Namespace Support

- **Support for user namespaces in stateless pods (v1.7)**
  - Only support emptyDir, configmap, secret, downwardsAPI
  - Use chown and cache the snapshots with same mapping
- **Supports Running Stateful Pods in (v2.0)**
  - Integrated with Idmapped mount (Merged in main branch!!!)
  - User Namespaces: Now Supports Running Stateful Pods in Alpha!

v2.0 - Release Plan

- **Alpha/Beta**: 2023.11 (KubeCon + CloudNativeCon North America)
- **Beta**: 2023.12
- **GA**: 2024.2.10

Component	Initial Release	Target Supported Release
Sandbox Service	containerd v1.7	containerd v2.0
Sandbox CRI Server	containerd v1.7	containerd v2.0
Transfer Service	containerd v1.7	containerd v2.0
NRI in CRI Support	containerd v1.7	containerd v2.0
gRPC Shim	containerd v1.7	containerd v2.0
CRI Runtime Specific Snapshotter	containerd v1.7	containerd v2.0
CRI Support for User Namespaces	containerd v1.7	containerd v2.0

v2.0 - Removed Features

Component	Deprecation release	Target release for removal	Recommendation
Runtime V1 API and implementation (`io.containerd.runtime.v1.linux`)	containerd v1.4	containerd v2.0 ✅	Use `io.containerd.runc.v2`
Runc V1 implementation of Runtime V2 (`io.containerd.runc.v1`)	containerd v1.4	containerd v2.0 ✅	Use `io.containerd.runc.v2`
config.toml `version = 1`	containerd v1.5	containerd v2.0 ✅	Use config.toml `version = 2`
Built-in `aufs` snapshotter	containerd v1.5	containerd v2.0 ✅	Use `overlayfs` snapshotter
Container label `containerd.io/restart.logpath`	containerd v1.5	containerd v2.0 ✅	Use `containerd.io/restart.loguri` label
`cri-containerd-*.tar.gz` release bundles	containerd v1.6	containerd v2.0 ✅	Use `containerd-*.tar.gz` bundles
Pulling Schema 1 images (`application/vnd.docker.distribution.manifest.v1+json`)	containerd v1.7	containerd v2.0	Use Schema 2 or OCI images
CRI `v1alpha2`	containerd v1.7	containerd v2.0 ✅	Use CRI `v1`
Legacy CRI implementation of podsandbox support	containerd v2.0	containerd v2.1	Disabled by default in 2.0 in favor of core sandboxed CRI plugin (use `DISABLE_CRI_SANDBOXES=1` to fallback to prior CRI podsandbox implementation)

v2.0 - Removed CRI Config Properties

Property Group	Property	Deprecation release	Target release for removal	Recommendation
`[plugins."io.containerd.grpc.v1.cri"]`	`systemd_cgroup`	containerd v1.3	containerd v2.0 ✅	Use `SystemdCgroup` in runc options (see below)
`[plugins."io.containerd.grpc.v1.cri".containerd]`	`untrusted_workload_runtime`	containerd v1.2	containerd v2.0 ✅	Create `untrusted` runtime in `runtimes`
`[plugins."io.containerd.grpc.v1.cri".containerd]`	`default_runtime`	containerd v1.3	containerd v2.0 ✅	Use `default_runtime_name`
`[plugins."io.containerd.grpc.v1.cri".containerd.runtimes.*]`	`runtime_engine`	containerd v1.3	containerd v2.0 ✅	Use runtime v2
`[plugins."io.containerd.grpc.v1.cri".containerd.runtimes.*]`	`runtime_root`	containerd v1.3	containerd v2.0 ✅	Use `options.Root`
`[plugins."io.containerd.grpc.v1.cri".containerd.runtimes.*.options]`	`CriuPath`	containerd v1.7	containerd v2.0 ✅	Set `$PATH` to the `criu` binary
`[plugins."io.containerd.grpc.v1.cri".registry]`	`auths`	containerd v1.3	containerd v2.0	Use `ImagePullSecrets`. See also #8228.
`[plugins."io.containerd.grpc.v1.cri".registry]`	`configs`	containerd v1.5	containerd v2.0	Use `config_path`
`[plugins."io.containerd.grpc.v1.cri".registry]`	`mirrors`	containerd v1.5	containerd v2.0	Use `config_path`

Expanded Ecosystem

- Built to be extensible
- Lots of places to plug in new functionality!
  - snapshotters
  - oci runtimes
  - runtime shims
  - clients
  - nri plugins
- New non-core projects are part of containerd
- A lot of adaptions from community project, vendor products.

Kubernetes distros adopting containerd

- Alibaba Cloud Container Service for Kubernetes
- Amazon Elastic Kubernetes Service
- Azure Kubernetes Service
- Google Kubernetes Engine
- Huawei Cloud Cloud Container Engine
- IBM Cloud Kubernetes Service
- Rancher K3s
- VMware Tanzu
- Volcengine Kubernetes Engine

Containerd Clients

- **ctr** - command-line development tool, core containerd project
- **nerdctl** - non-core containerd project - a Docker-like CLI
    - expanded functionality eg. Lazy-loading images, image encryption, image signing
- **crictl** - a CLI for CRI - Kubernetes project (part of cri-tools)

- **Colima** - container runtimes on macOS (and Linux) with minimal setup
- **Finch** - Docker-like CLI on MacOS
- **Rancher Desktop** - Docker-like experience on MacOS, Windows, and Linux

Snapshotters

- **Builtin**
  - overlayfs (Linux)
  - devmapper (Linux)
  - btrfs (Linux)
  - native (Linux/Unix/Windows)
  - blockfile (New! Linux/Unix)
  - zfs (Linux/Unix)
  - LCOW (Windows)
  - Windows (Windows)

- **Extension via proxy plugins**

- **Remote - Lazy Loading**
  - stargz (Filesystem, non-core project)
  - overlaybd (Block, non-core project)
  - nydus (Filesystem, non-core project)

  - SOCI (Filesystem, OSS vendor project)
  - GKE image streaming (Filesystem, vendor project)

Runtimes & Shims

- **runc** - standard OCI runtime for Linux containers
- **crun** - alternative OCI runtime for Linux containers, written in C
- **youki** - alternative OCI runtime for Linux containers, written in Rust
- **runj** - experimental OCI runtime for FreeBSD jails

- **runwasi** - (New! Non-core project) - OCI runtime for WASM
- **hcsshim/runhcs** - containerd shim and OCI runtime for Windows containers
- **Kata Containers** - hypervisor-based isolation for pods
- **gVisor/runsc** - independent kernel for isolation
- **firecracker-containerd** - hypervisor-based isolation for containers based on Firecracker
- **kuasar** - an efficient container runtime supporting multiple sandbox techniques.
- **inclavare-containers** - run containers in hardware-assisted Trusted Execution Environment (TEE)

- **embedshim** - An ebpf-based container task runtime manager

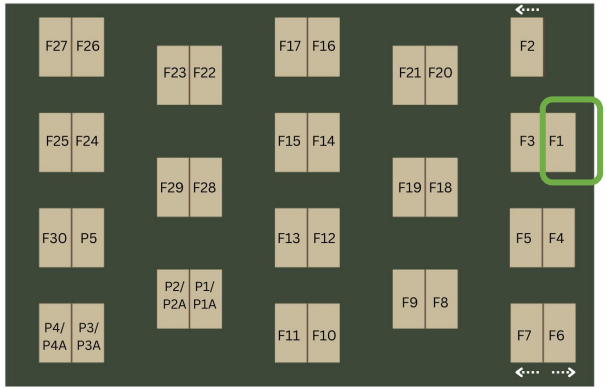
Getting involved

- #containerd and #containerd-dev channel on
  - CNCF Slack (https://slack.cncf.io)
- **Community Meeting on the second Thursday each month**
  - See CNCF Calendar for your timezone (https://cncf.io/calendar)
- Build something in the ecosystem!
- Discussion, issues and pull requests welcome!
  - https://github.com/containerd/containerd

Thank you

KubeCon CloudNativeCon OPEN SOURCE SUMMIT China 2023

PROJECT PAVILION FLOORPLAN

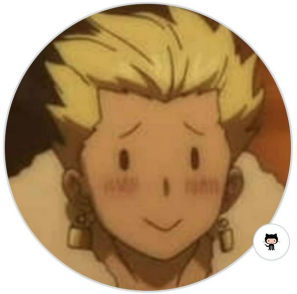


Full Time Kiosk
containerd F1
Prometheus F2
Kube-ovn F20
KubeArmor F21
Merbridge F22
open-cluster-management F23
ORAS F24
PipeCD F25
Pravega F26
SlimToolkit F27
Piraeus Datastore F28
Vineyard F29
Istio F3
WasmEdge F30
CubeFS F5

Full Time Kiosk
TiKV F4
KubeEdge F6
Kyverno F7
Longhorn F8
Notary F9
OpenKruise F10
Volcano F11
Aeraki Mesh F12
Antrea F13
Carina F14
Clusterpedia F15
FebEdge F16
hwameistor F17
K3s F18
Karmada F19

Part-Time Kiosk
Kubernetes P1
Harbor P1A
kubespray P2
SIG Node P2A
Cilium P3
Chaos Mesh P3A
Porter P4
Kepler P4A
Paralus P5

Fu Wei
fuweid · he/him



Iceber Gu
Iceber

Wednesday, 27 September: 10:30 - 14:15
Wednesday, 27 September: 15:45 - 18:45

Thursday, 28 September: 10:30 - 14:00