

# OCI Runtime Tools for Container Standardization

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- Background
- OCI Introduction
- Runtime Tools
- Our Contribution
- Future Plans
- Q&A

- Container-based solutions grow rapidly
  - Almost all major IT vendors and cloud providers supply
  - More and more people try to use
- There is a large ecosystem for container
  - Infrastructure vendor
  - Container runtime & orchestration
- Many container runtime technologies
  - Docker
  - Rocket/rkt
  - LXD
  - Hyper
  - ...

# Ecosystem and Containers

## Orchestration & Management

### Scheduling & Orchestration



### Coordination & Service Discovery



### Service Management



## Runtime

### OS



### Cloud-Native Storage



### Container Runtime



### Cloud-Native Network



## Provisioning

### Infrastructure Automation



### Host Management / Tooling



### Secure Images



## Infrastructure



Image From CNCF

# Before A Standard

- No open industry standards exist
  - Almost everyone has their own specs
- So, container technology seems to be fragmented
- Users hard to choose the best tools to build the best applications
  - No standards to evaluate
  - Not sure how to evaluate
- Users locked into a technology vendor in the long run
  - Hard to fit difference
  - High cost to transfer applications
- ...

- Make open industry standards for container
  - Unambiguous development direction
  - Portability issue
  - Promote development of container technology
- Help users to choose container-based solutions
  - Users can be guided by choosing the best tools to build the best applications they can
  - Users will not be locked into any technology vendor for the long run
  - Get high quality services

## ■ What is OCI

- Open Container Initiative, launched on June 22nd 2015
- a lightweight, open governance structure (project), formed under the auspices of the Linux Foundation
- 47 members, almost all major of IT vendors and cloud providers

## ■ Mission of the OCI

- promote and promulgate a set of common, minimal, open standards and specifications around container technology

## ■ Duties of OCI

- Creating a formal specification for container image formats and runtime
- Accepting, maintaining and advancing the projects associated with these standards
- Harmonizing the above-referenced standard with other proposed standards

## ■ runtime-spec

- specifications for standards on Operating System process and application containers
- <http://github.com/opencontainers/runtime-spec>

## ■ runtime-tools

- a collection of tools for working with the OCI runtime specification.
- <http://github.com/opencontainers/runtime-tools>

## ■ image-spec

- creates and maintains the software shipping container image format spec
- <http://github.com/opencontainers/image-spec>

## ■ image-tools

- a collection of tools for working with the OCI image specification.
- <http://github.com/opencontainers/image-tools>



## ■ runc

- a CLI tool for spawning and running containers according to the OCI specification
- <http://github.com/opencontainers/runc>

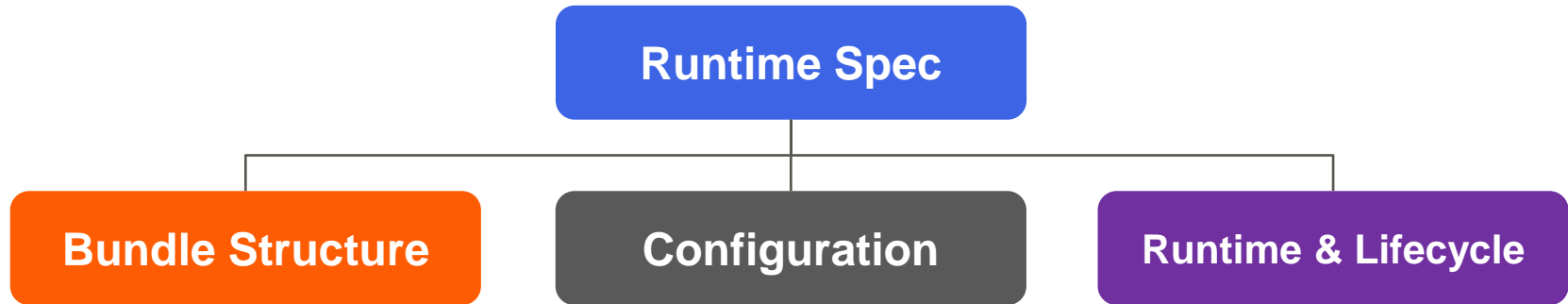
## ■ go-digest

- common digest package used across container ecosystem
- <http://github.com/opencontainers/go-digest>

## ■ go-selinux

- common SELinux package used across container ecosystem
- <http://github.com/opencontainers/go-selinux>

## ■ Main Content



## ■ Bundle Structure

- A format for encoding a container

## ■ Configuration

- Including supported platforms and details the fields that enable the creation of a container

## ■ Runtime & Lifecycle

- Execution environment and actions of container lifecycle

## Filesystem Bundle

### Container Format

This section defines a format for encoding a container as a *filesystem bundle* - a set of files organized in a certain way, and containing all the necessary data and metadata for any compliant runtime to perform all standard operations against it. See also [MacOS application bundles](#) for a similar use of the term *bundle*.

The definition of a bundle is only concerned with how a container, and its configuration data, are stored on a local filesystem so that it can be consumed by a compliant runtime.

A Standard Container bundle contains all the information needed to load and run a container. This MUST include the following artifacts:

1. `config.json` : contains configuration data. This REQUIRED file MUST reside in the root of the bundle directory and MUST be named `config.json` . See [config.json](#) for more details.
2. A directory representing the root filesystem of the container. While the name of this REQUIRED directory may be arbitrary, users should consider using a conventional name, such as `rootfs` . This directory MUST be referenced by `root` within the `config.json` file.

While these artifacts MUST all be present in a single directory on the local filesystem, that directory itself is not part of the bundle. In other words, a tar archive of a *bundle* will have these artifacts at the root of the archive, not nested within a top-level directory.

# Runtime Spec Screenshot

## Specification version

- **ociVersion** (string, REQUIRED) MUST be in [SemVer v2.0.0](#) for Runtime Specification with which the bundle complies. The Ope versioning and retains forward and backward compatibility with compliant with version 1.1 of this specification, it is compatible with specification, but is not compatible with a runtime that supports 1

## Example

```
"ociVersion": "0.1.0"
```

## Root

**root** (object, REQUIRED) specifies the container's root filesystem.

- **path** (string, REQUIRED) Specifies the path to the root filesystem or a relative path to the bundle. On Linux, for example, with a bundle `/rootfs`, the `path` value can be either `/to/bundle/rootfs` or `rootfs` field.
- **readOnly** (bool, OPTIONAL) If true then the root filesystem MUST be read-only. On Windows, this field must be omitted or false.

## Example

```
"root": {  
  "path": "rootfs",
```

## Mounts

**mounts** (array of objects, OPTIONAL) specifies additional mounts listed in order. For Linux, the parameters are as documented in [mount\(8\)](#) corresponds to the 'fs' resource in the [zonecfg\(1M\)](#) man page.

- **destination** (string, REQUIRED) Destination of mount point: path.
  - Windows: one mount destination MUST NOT be nested within another.
  - Solaris: corresponds to "dir" of the fs resource in [zonecfg\(1M\)](#).
- **type** (string, OPTIONAL) The filesystem type of the filesystem.
  - Linux: valid *filesystemtype* supported by the kernel as listed in [mount\(8\)](#), "xfs", "reiserfs", "msdos", "proc", "nfs", "iso9660").
  - Windows: this field MUST NOT be supplied.
  - Solaris: corresponds to "type" of the fs resource in [zonecfg\(1M\)](#).
- **source** (string, OPTIONAL) A device name, but can also be a directory.
  - Windows: a local directory on the filesystem of the container.
  - Solaris: corresponds to "special" of the fs resource in [zonecfg\(1M\)](#).
- **options** (list of strings, OPTIONAL) Mount options of the filesystem.
  - Linux: supported options are listed in the [mount\(8\)](#) man page. [Specific options](#) are listed.
  - Solaris: corresponds to "options" of the fs resource in [zonecfg\(1M\)](#).

## Example (Linux)

```
"mounts": [  
  {  
    "destination": "/tmp",  
    "type": "tmpfs",  
    "source": "tmpfs",  
    "options": ["noexec", "nosuid", "nodev"]
```

# Runtime Spec Screenshot

## State

The state of a container includes the following properties:

- **ociVersion** (string, REQUIRED) is the OCI specification version used by the runtime.
- **id** (string, REQUIRED) is the container's ID. This MUST be unique and there is a requirement that it be unique across hosts.
- **status** (string, REQUIRED) is the runtime state of the container. The possible values are:
  - **creating**: the container is being created (step 2 in the [lifecycle](#))
  - **created**: the runtime has finished the [create operation](#) (after step 3 in the [lifecycle](#)), but the container is neither exited nor executed the user-specified program
  - **running**: the container process has executed the user-specified program (step 5 in the [lifecycle](#))
  - **stopped**: the container process has exited (step 7 in the [lifecycle](#))

Additional values MAY be defined by the runtime, however, they MUST be defined above.

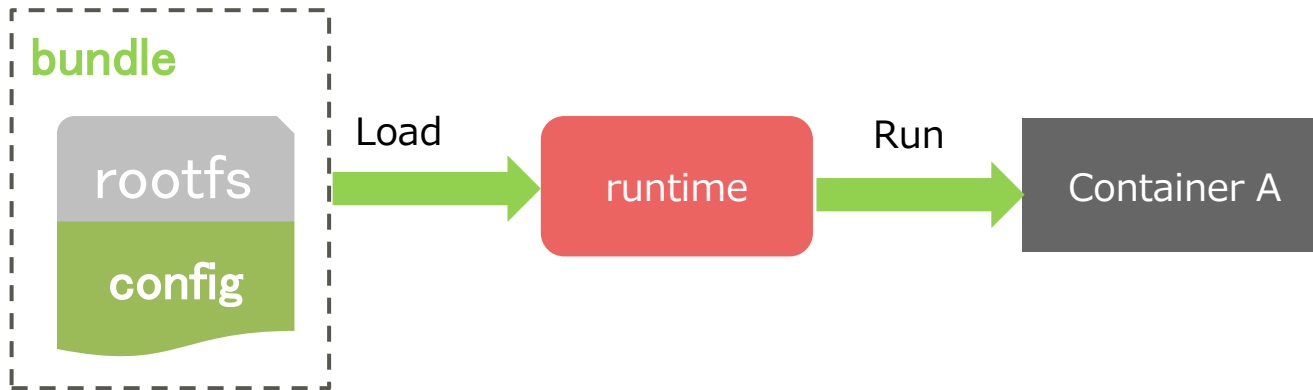
- **pid** (int, REQUIRED when **status** is **created** or **running**) is the process ID of the container's process.
- **bundle** (string, REQUIRED) is the absolute path to the container's bundle. The runtime can find the container's configuration and root filesystem on the host.

## Lifecycle

The lifecycle describes the timeline of events that happen from the creation of the container to its destruction.

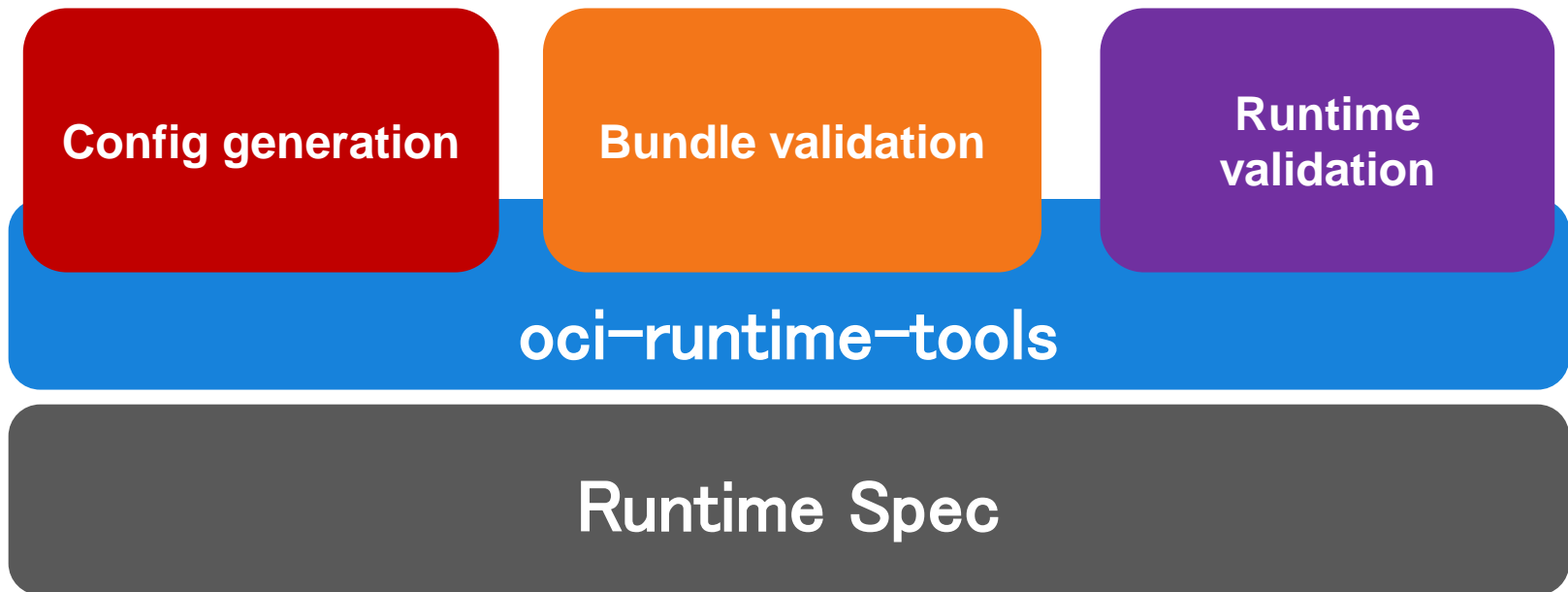
1. OCI compliant runtime's **create** command is invoked with the container's unique identifier.
2. The container's runtime environment MUST be created. If the runtime is unable to create the environment specified in the **config.json**, the user MUST be notified. The **config.json** requested in the **create** command MUST be created, the user MUST be notified. Any updates to **config.json** after this step MUST be rejected.
3. Runtime's **start** command is invoked with the unique identifier of the container.
4. The **prestart hooks** MUST be invoked by the runtime. If a hook fails, the container is destroyed, and continue the lifecycle at step 9.
5. The runtime MUST run the user-specified program, as specified in the **config.json**.
6. The **poststart hooks** MUST be invoked by the runtime. If a hook fails, the remaining hooks and lifecycle continue as if the hook had succeeded.
7. The container process exits. This MAY happen due to the user-specified program being invoked.
8. Runtime's **delete** command is invoked with the unique identifier of the container.
9. The container MUST be destroyed by undoing the steps 2 through 7.
10. The **poststop hooks** MUST be invoked by the runtime. If a hook fails, the remaining hooks and lifecycle continue as if the hook had succeeded.

# Bundle & Container



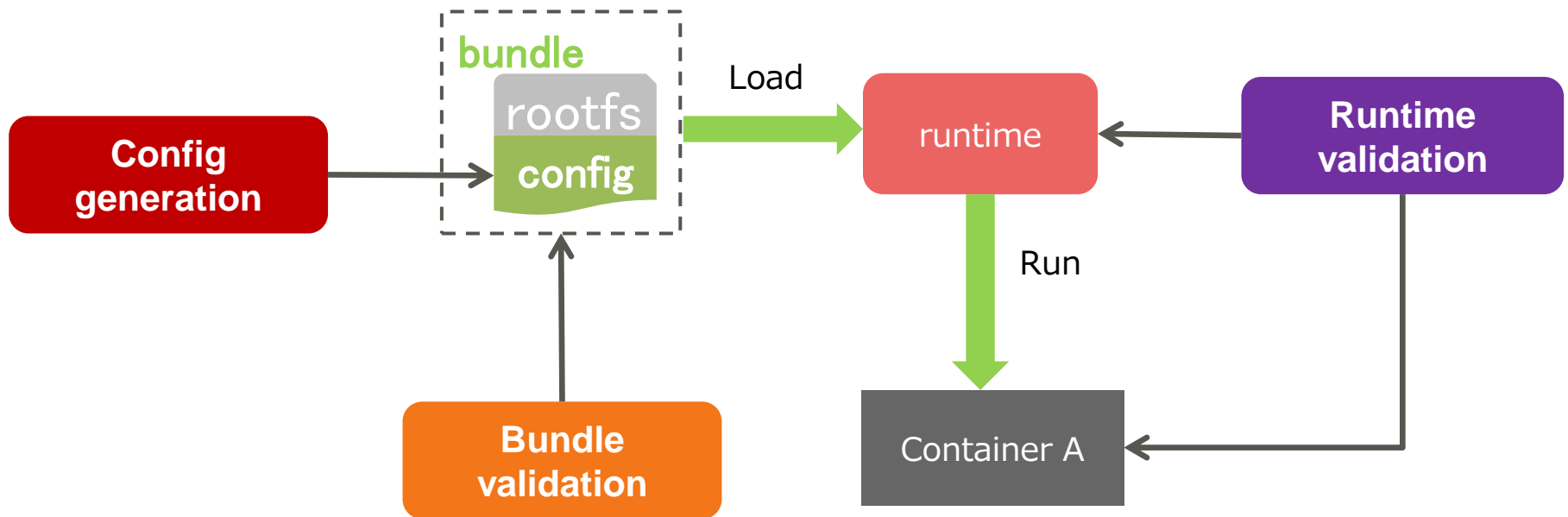
- How to judge if a bundle is usable and what's the problem
- How to judge a container is portable
- How to judge if a runtime meets requirements of runtime spec

## ■ Main Structure

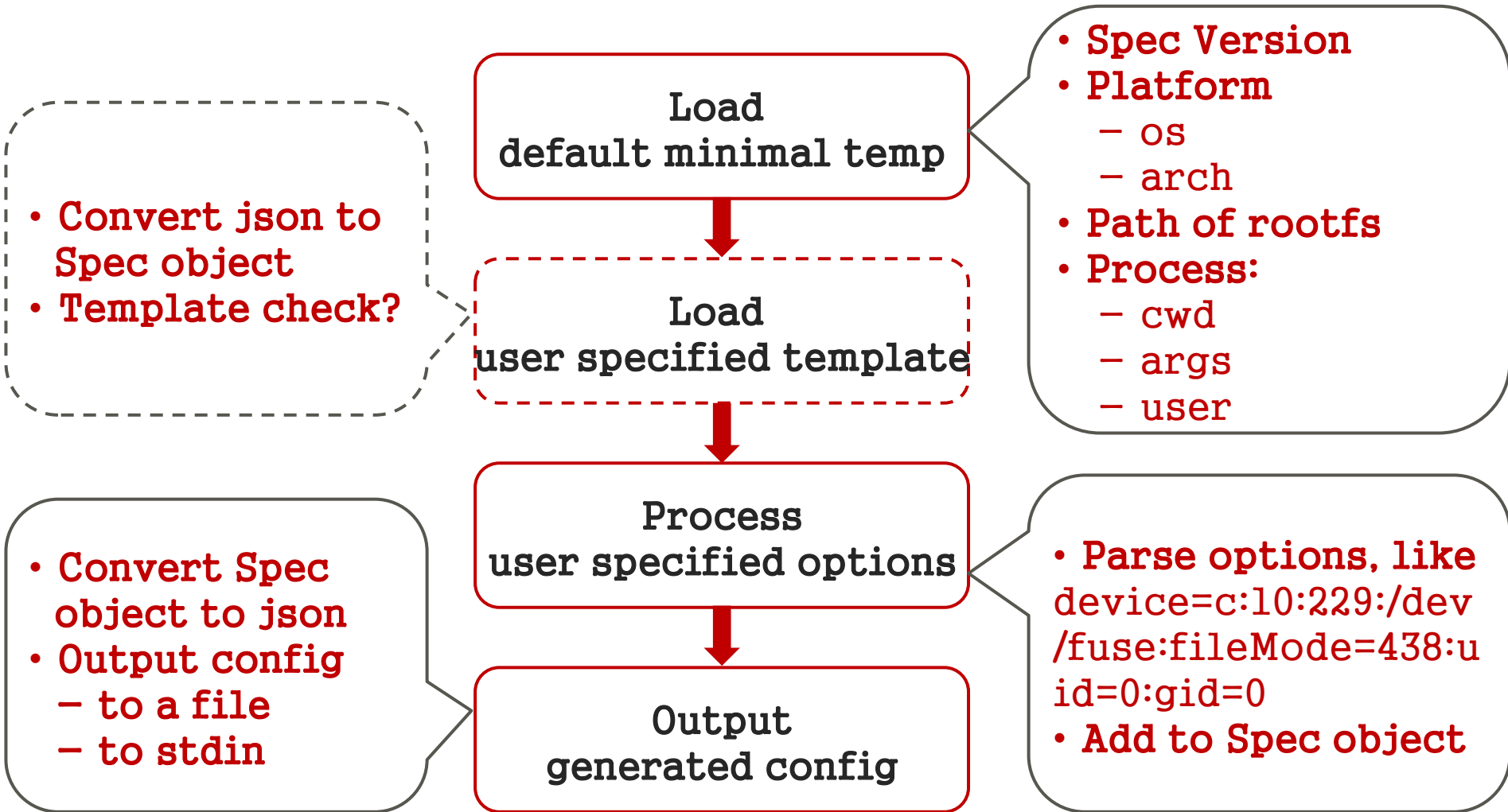




## ■ Usage & Relation



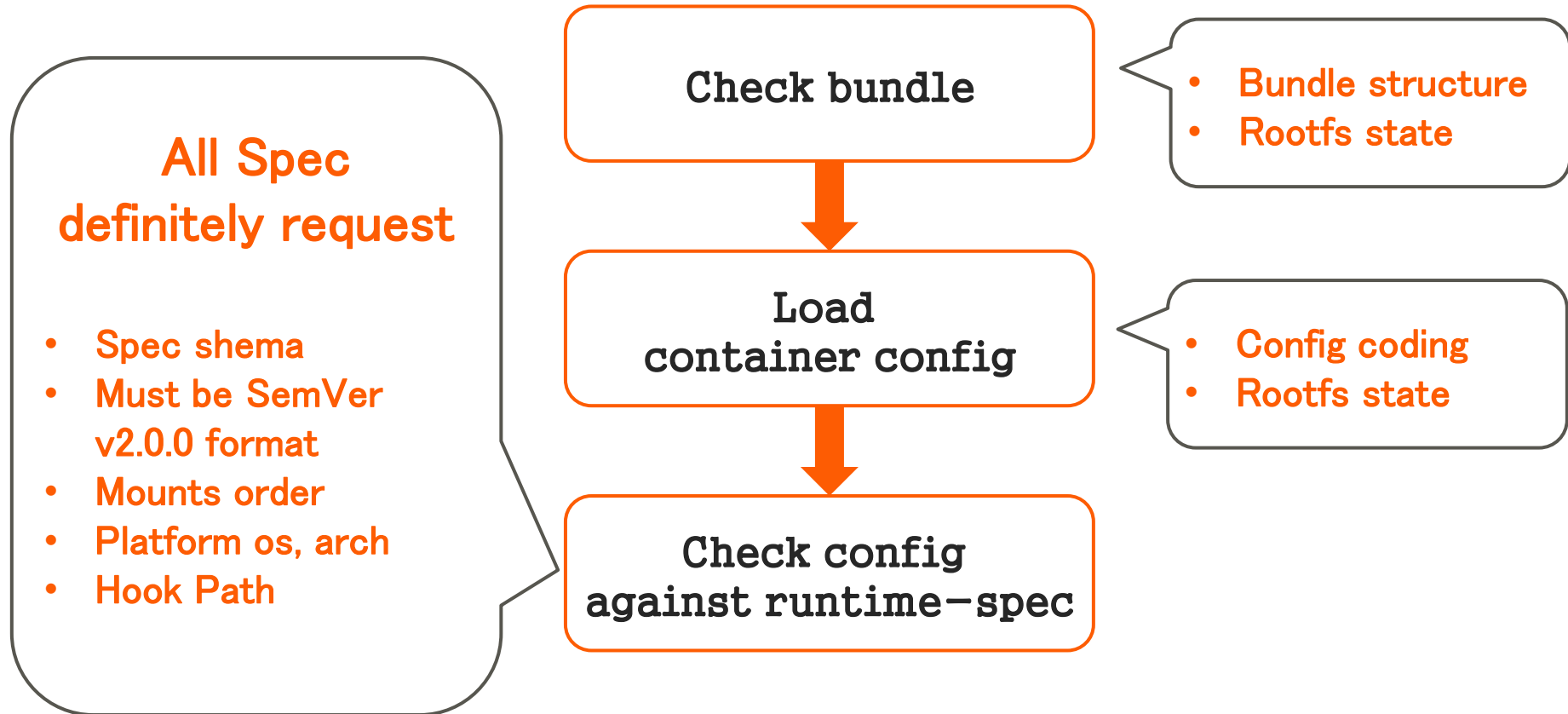
## ■ Work Flow



## ■ Example

```
$ oci-runtime-tool generate
{
  "ociVersion": "1.0.0-rc1-dev",
  "platform": {
    "os": "linux",
    "arch": "amd64"
  },
  "process": {
    "user": {
      "uid": 0,
      "gid": 0
    },
    "args": [
      "sh"
    ],
    "env": [
      "PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin
```

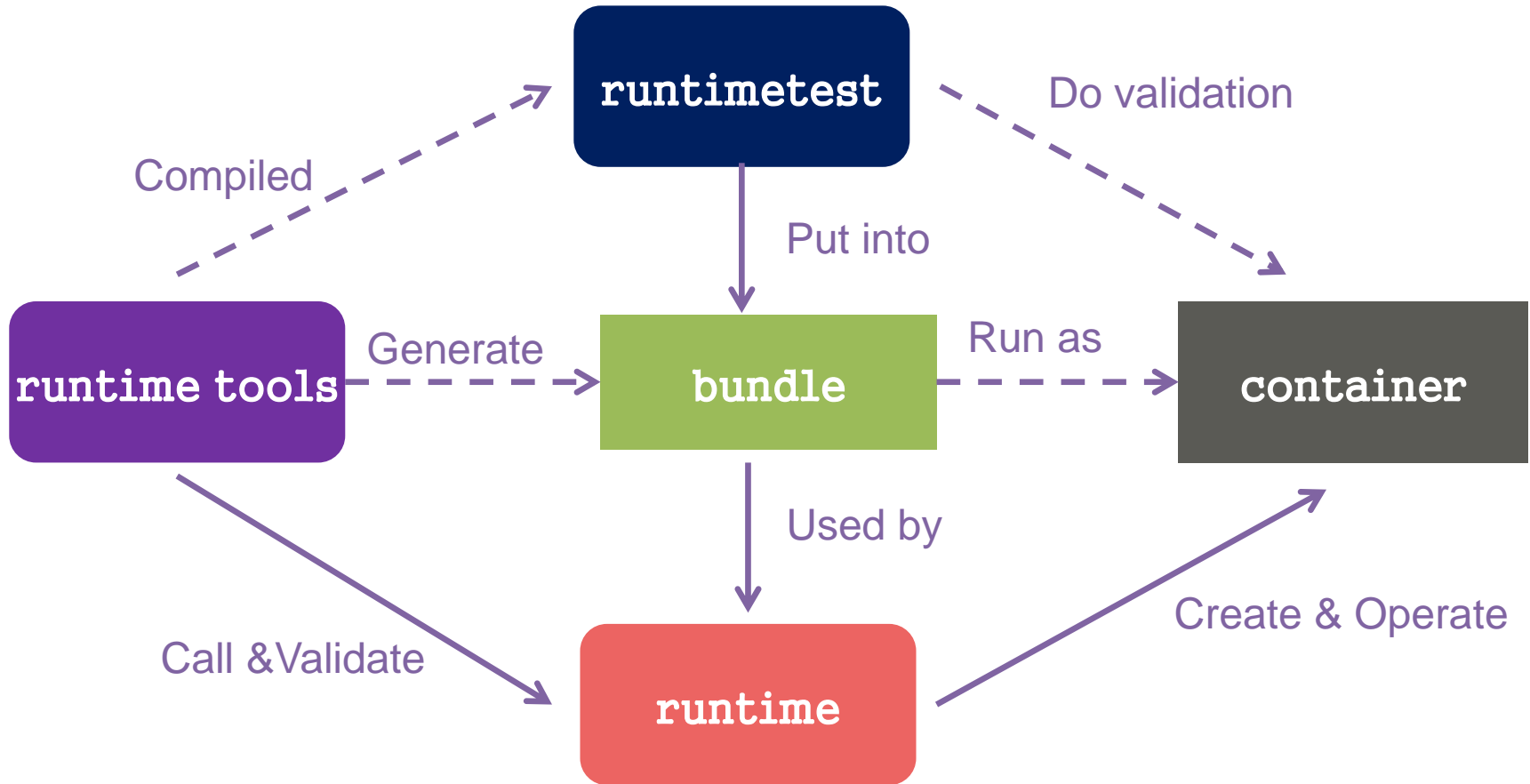
## ■ Work Flow



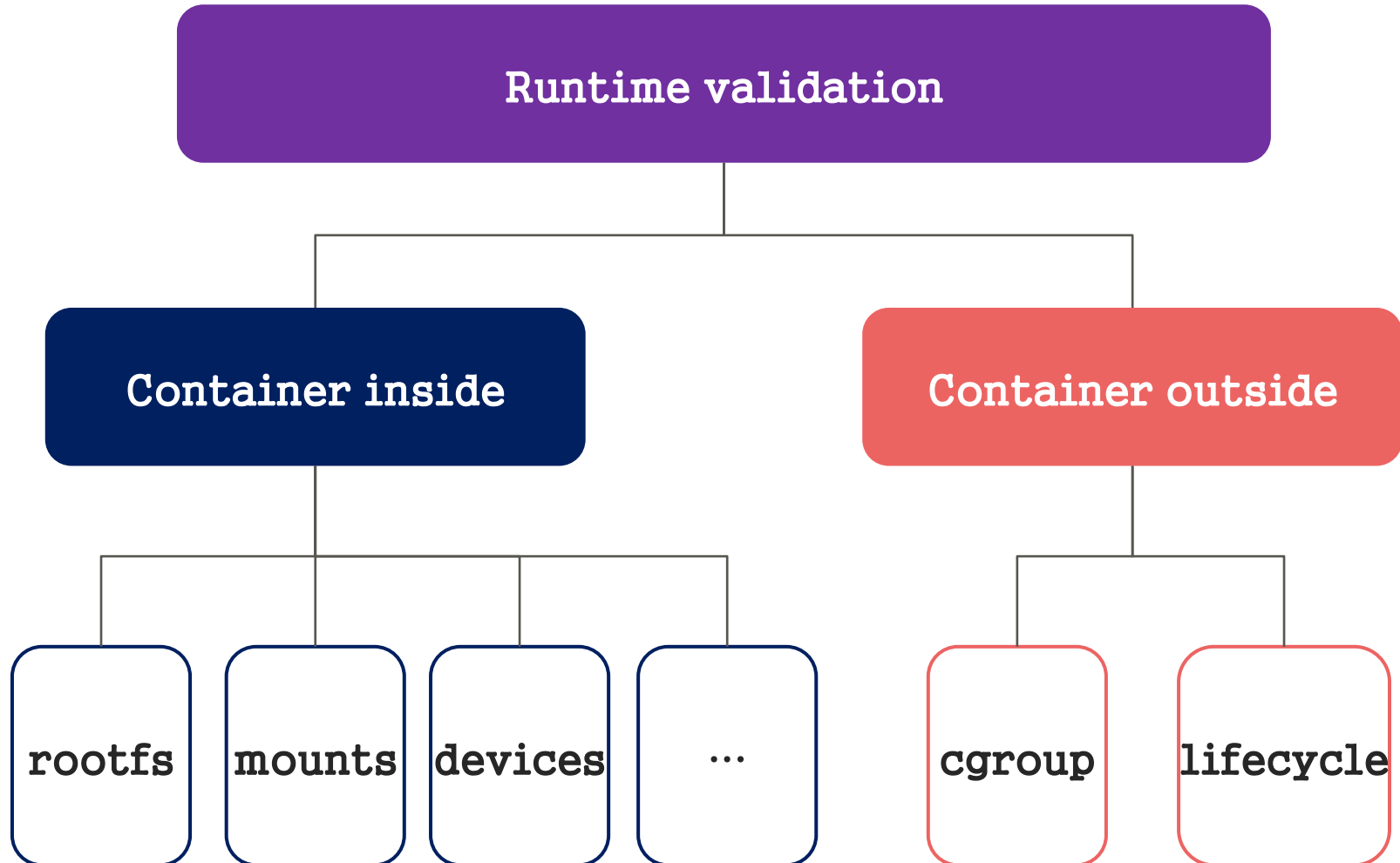
## ■ Example

```
$ oci-runtime-tool --host-specific --log-level=debug validate --path ~/testdir/  
DEBU[0000] check rootfs path  
DEBU[0000] check mandatory fields  
DEBU[0000] check semver  
DEBU[0000] check mounts  
DEBU[0000] check platform  
DEBU[0000] check process  
DEBU[0000] check os  
DEBU[0000] check linux  
DEBU[0000] check linux resources  
DEBU[0000] check linux seccomp  
DEBU[0000] check hooks  
Bundle validation succeeded.
```

## ■ Work Flow



## ■ Detailed Validation



## ■ Example

```
$ make localvalidation
RUNTIME=runc go test -tags "" -v github.com/opencontainers/runtime-tools/validation
=== RUN TestValidateBasicTAP version 13
ok 1 - root filesystem
ok 2 - hostname
ok 3 - mounts
ok 4 - capabilities
ok 5 - default symlinks
ok 6 - default devices
ok 7 - linux devices
ok 8 - linux process
ok 9 - masked paths
ok 10 - oom score adj
ok 11 - read only paths
ok 12 - rlimits
ok 13 - sysctls
ok 14 - uid mappings
```



## ■ Config Generation

- already finished 80%
- except blkio, hugepage, devices (but submitted patch)

## ■ Bundle Validation

- already finished 70%
- except groups related, schema


## ■ Runtime Validation

- reforming (container inside almost finished)
- cgroups, lifecycle

- **Runtime-tools: 117 commits**
  - Improve coverage of bundle & runtime tests
  - Enhance functionality of runtime-spec generation
  - Bug fix for code and document
- **Runtime-spec: 54 commits**
  - Help specify spec entries
- **Image-tools: 27 commits**
  - Enhance functionality
  - Bug fix
- **Image-spec: 24 commits**
  - Help specify spec entries

- Order of options problem
  - oci-runtime-tools generate `--rlimits-remove-all --rlimits-add RLIMIT_NOFILE:10:10`
- Runtime validation improvement
  - cgroup related validation
  - container lifecycle validation
- Platform portability
  - currently can only work on Linux
  - cross validation, windows bundle on Linux?
- More tests and trials by runtime creators

Thank you!  
Q&A



FUJITSU

shaping tomorrow with you