KubeRift

Fuzzy-First Kubernetes Operations Platform

A complete reference for installing, operating, and extending KubeRift — the terminal-native Kubernetes navigator written in Rust. Covers architecture, all keyboard actions, multi-cluster workflows, security model, and the open-source story of how a fuzzy-finder library became the foundation of a Kubernetes operations platform.

Version	0.1.2
Binary	`kf`
Source	github.com/syedazeez337/kuberift
Crate	crates.io/crates/kuberift
License	MIT
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1 The Skim Insight: Architecture Born from a Library

1.1 The Problem Space

Every Kubernetes practitioner eventually arrives at the same frustration: `kubectl get pods --all-namespaces` produces a wall of text, `kubectl describe` requires knowing the exact resource name, and switching between resource types means retyping commands. Existing tools like k9s take a "modal" approach—navigate menus, select a resource type, then a namespace, then an item—borrowed from graphical file managers.

KubeRift was conceived around a different premise: *what if the search box is the interface?* Type fragments of a pod name, a namespace, a status — the list filters instantly. No modes, no menus, no hierarchy to navigate. Just a fuzzy query and a live list.

That idea pointed immediately to a fuzzy-finder. But which one, and how?

1.2 Discovering Skim as a Library

The first prototype used **fzf** — the ubiquitous Go binary — through a subprocess pipe. It worked but felt architecturally wrong: items had to be serialized to plain text strings, sent through a pipe, and the selection had to be parsed back. Colors required ANSI escapes baked into strings. Preview required a shell command string. Multi-select results came back as newline-delimited text. Every richness in the Rust data model was lost at the pipe boundary and had to be laboriously reconstructed.

The pivotal discovery came from reading the README of **skim** (crates.io/crates/skim), a fuzzy finder written in Rust and MIT-licensed. Its README opens with a distinction invisible in most tools:

Note from the skim README

> *"Skim can be used as a library in your Rust project. The library allows you to embed the fuzzy-finder TUI directly in your binary and receive typed, structured results back — no subprocess, no pipe, no string serialization."*

This changed everything. Not a subprocess to spawn but a *trait to implement*.

1.3 The `SkimItem` Trait as Architectural Foundation

The `SkimItem` trait has four methods. Each one became a design decision that propagated through every layer of KubeRift:

```
pub trait SkimItem: Send + Sync + 'static {
    fn text(&self) -> Cow<str>;          // what skim fuzzy-matches against
    fn display(&self, ctx: DisplayContext) -> AnsiString; // colored list row
    fn preview(&self, ctx: PreviewContext) -> ItemPreview; // right-hand pane
    fn output(&self) -> Cow<str>;        // machine-parseable selection result
}
```

`text()` determined the search schema. To make a pod searchable by name, namespace, kind, status, and age simultaneously, all those fields had to be concatenated into a single string. This forced the design of `K8sItem` as a self-contained value type carrying all metadata.

`display()` established the visual contract. Because skim calls this on every render frame, the color-coding logic (red for critical, yellow for warning, green for healthy) had to be fast and allocation-minimal. The `StatusHealth` enum and its `classify()` function emerged directly from this requirement.

`preview()` revealed the threading model. Skim calls `preview()` from a *background thread* whenever the cursor moves. This is a blocking call — perfect for synchronous `kubectl` invocation. But supporting three preview modes (describe / yaml / logs) meant the preview function needed to read external state. The solution: a tiny file in `$XDG_RUNTIME_DIR/<pid>/preview-mode` containing a single digit. The `ctrl-p` binding writes a new digit to that file and signals skim to refresh. Clean, race-free, zero shared memory.

`output()` defined the action dispatch protocol. The string `"pod/production/api-server/my-context"`

became the canonical identifier threaded through every action function. The double-dash separator (`--`) before resource names in every kubectl invocation is a direct consequence of needing to reconstruct safe command lines from this identifier.

1.4 The Channel as the System's Spine

The second architectural insight was skim's `SkimItemSender`/`SkimItemReceiver` channel pair:

```
let (tx, rx): (SkimItemSender, SkimItemReceiver) = unbounded();

tokio::spawn(async move {
    // K8s watcher sends items as they arrive from the API
    while let Some(event) = watcher.next().await {
        tx.send(Arc::new(K8sItem::from(event))).ok();
    }
});

// Skim consumes from rx -- items appear as the cluster streams them
let output = Skim::run_with(&options, Some(rx));
```

This is a **multi-producer, single-consumer** pattern. For multi-cluster mode, it becomes *multi-producer*: one tokio task per kubeconfig context, all sending into the same channel, all items converging in a single skim session. The architecture handles one cluster and twenty clusters identically — the channel is the only integration point.

1.5 The Key Dispatch Pattern

Skim's `SkimOutput` returns a `final_key` field — whichever key ended the session. KubeRift registers every action key with the `accept` binding rather than `execute`. This means control always returns to Rust:

```
match output.final_key {
    Key::Enter     => action_describe(&items).await?,
    Key::Ctrl('l') => action_logs(&items).await?,
    Key::Ctrl('e') => action_exec(&items[0]).await?,
    Key::Ctrl('d') => action_delete(&items).await?,
    Key::Ctrl('f') => action_portforward(&items[0]).await?,
    Key::Ctrl('r') => action_rollout_restart(&items).await?,
    Key::Ctrl('y') => action_yaml(&items).await?,
    Key::Ctrl('x') => { /* context switch, relaunch */ }
    _ => {}
}
```

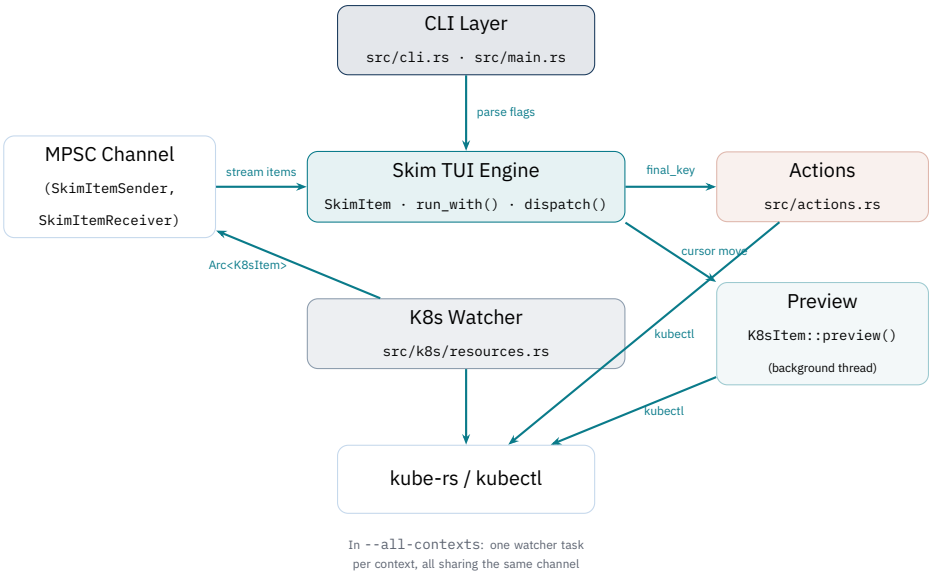
After every action, skim relaunches with a fresh channel but the same configuration. The user sees the live cluster list again, uninterrupted. This loop-after-action design means KubeRift feels more like a shell than an application — you run commands, you return to the prompt.

> **The founding insight in one sentence:** Skim's `SkimItem` trait, its MPSC item channel, and its `final_key` dispatch pattern collectively determined KubeRift's data model, threading architecture, preview mechanism, and action system — before a single line of Kubernetes code was written.

2 System Architecture

KubeRift is a single Rust binary structured in three layers that communicate through well-defined interfaces.

2.1 Layer Map



2.2 Component Responsibilities

CLI Layer (`src/cli.rs`, `src/main.rs`) Parses arguments via Clap, resolves the kubeconfig, determines single vs. multi-cluster mode, constructs the skim options (header text, keybinding strings, preview window placement), and drives the outer `loop { skim → dispatch → relaunch }`.

K8s Watcher (`src/k8s/resources.rs`, `src/k8s/client.rs`) Uses `kube::runtime::watcher` to stream `Applied`/`Deleted` events for all thirteen resource kinds concurrently. A coordinator task collects the initial batch, sorts by health priority (unhealthy first), and flushes to the channel. Subsequent live events are forwarded immediately.

Skim TUI Engine The embedded fuzzy-finder. Renders the list, handles keyboard input, calls `display()` on every frame and `preview()` on cursor movement. Returns a `SkimOutput` to Rust.

Actions (`src/actions.rs`) Pure functions that receive a slice of `Arc<K8sItem>` and shell out to `kubectl`. All commands use `--` before resource names (argument injection prevention). Dangerous operations include interactive confirmation.

Preview Thread Skim's internal background thread calls `K8sItem::preview()`, which reads the mode file and runs `kubectl describe`, `kubectl get -o yaml`, or `kubectl logs`.

2.3 Unhealthy-First Ordering

Health classification drives sort priority:

Status examples	Priority	Display color
CrashLoopBackOff, OOMKilled, Error, ImagePullBackOff	0 — Critical	**Red**
Pending, NotReady, Degraded (N/M), Terminating	1 — Warning	**Yellow**
Running, Ready, Bound, Active, Scheduled	2 — Healthy	**Green**
[DELETED]	1 — Unknown	**Dark gray**

Skim renders higher-indexed items at the *top* of the list. The watcher sends critical items *last* in the initial batch so they receive the highest indices and surface automatically without any filter.

3 Installation & First Run

3.1 Install Methods

Cargo (all platforms):

```
cargo install kuberift
```

Homebrew (macOS and Linux):

```
brew tap syedazeez337/kuberift
brew install kf
```

Arch Linux (AUR):

```
yay -S kuberift          # or paru -S kuberift
```

Pre-built binaries: Download from github.com/syedazeez337/kuberift/releases. Tarballs include the binary, shell completions, and a man page for Linux x86_64, Linux aarch64, macOS ARM, and macOS Intel.

3.2 Shell Completions

```
# Bash
kf --completions bash >> ~/.bash_completion

# Zsh
kf --completions zsh > "${fpath[1]}/_kf"

# Fish
kf --completions fish > ~/.config/fish/completions/kf.fish
```

3.3 First Run

```
kf              # Opens the TUI against your current kubeconfig context
kf pods         # Opens showing only pods
kf --read-only  # Opens in read-only mode (no delete/exec/port-forward)
```

If no cluster is reachable, KubeRift drops into **demo mode** automatically and displays eleven sample resources so you can explore the interface without a live cluster.

3.4 Command-Line Reference

Flag / argument	Behaviour
`[RESOURCE]`	Optional. Restrict to a single resource type. Accepts aliases: `po`/`pod`/`pods`, `svc`/`service`, `deploy`/`deployment`, `sts`/`statefulset`, `ds`/`daemonset`, `cm`/`configmap`, `secret`, `ing`/`ingress`, `no`/`node`, `ns`/`namespace`, `pv`, `pvc`, `job`, `cj`/`cronjob`. Unknown strings produce a warning and fall back to all resources.
`--context NAME`	Use a specific kubeconfig context instead of the current or last-saved one.
`--all-contexts`	Stream every kubeconfig context simultaneously in parallel. Each item is prefixed with its cluster name (color-coded). Actions pass `--context` to kubectl automatically.
`-n, --namespace NS`	Restrict to a specific namespace. Cluster-scoped kinds (Node, Namespace, PersistentVolume) are unaffected and always appear.
`-l, --label SEL`	Kubernetes label selector, e.g. `app=backend`, `env in (prod,staging)`, `!canary`.
`--kubeconfig PATH`	Alternate kubeconfig file path. Defaults to `$KUBECONFIG` or `~/.kube/config`.
`--read-only`	Disable exec, delete, port-forward, and rollout-restart. Describe, logs, and YAML remain available. Header shows `[READ-ONLY]`.
`--completions SHELL`	Print shell completions to stdout and exit. Values: `bash`, `zsh`, `fish`.

Flag / argument	Behaviour
`--mangen`	Print man page source to stdout and exit.
`--version`	Print version and exit.

3.5 Configuration Files

KubeRift stores minimal persistent state:

Path	Purpose
`~/.config/kuberift/last_context`	Last-used context name, restored on next launch. Written with `0o600` permissions.
`$XDG_RUNTIME_DIR/pid/preview-mode`	Preview mode digit (0/1/2). Per-PID subdirectory prevents symlink attacks. Deleted on exit.
`$XDG_RUNTIME_DIR/pid/preview-toggle`	Shell script cycled by `Ctrl-P`. Permissions: `0o700`.

Falls back to `/tmp/kuberift-<pid>/` when `$XDG_RUNTIME_DIR` is unavailable.

4 The TUI Interface

4.1 Layout

The TUI occupies 60% of the terminal height. The left pane shows the fuzzy-filtered resource list; the right pane (50% of width) shows the live preview for the highlighted item.

```
KubeRift  ctx:production  res:all              [ctrl-l logs  ctrl-e exec  ctrl-d delete
    ...]
> _                                          | Name:     api-server-abc
  pod  production/api-server-abc  Running 2d  | Namespace: production
  pod  production/worker-xyz      Running 2d  | Status:    Running
  pod  staging/frontend           Pending 5m  | Containers:
  svc  production/api-service     ClusterIP   |   api-server (running)
  deploy  production/backend      2/3     1h  | ...
```

The header line shows the active context, resource filter, and available key bindings. In `--all-contexts` mode it shows `ctx:all`.

4.2 Keyboard Reference

Key	Action	Notes
Type any text	Fuzzy filter	Matches name, namespace, kind, status, age simultaneously
↑ / ↓	Move cursor	
Tab	Toggle selection	Multi-select; selected items highlighted
Esc	Quit	
Enter	Describe	`kubectl describe`; multi-select supported
Ctrl-L	Logs	`kubectl logs --tail=200`; pods only; multi-select
Ctrl-E	Exec shell	Interactive `kubectl exec -it`; pods only; single item
Ctrl-D	Delete	Confirmation prompt; `>10` items requires typing `yes`; multi-select
Ctrl-F	Port-forward	Prompts for local/remote ports; pods and services; single item
Ctrl-R	Rollout restart	`kubectl rollout restart` + status; deploys/sts/ds; multi-select
Ctrl-Y	Print YAML	`kubectl get -o yaml`; multi-select
Ctrl-P	Cycle preview	Describe → YAML → Logs → (repeat)
Ctrl-X	Switch context	Opens secondary fuzzy picker listing all kubeconfig contexts

4.3 List Item Format

Each row in the list follows a fixed-width layout:

```
[kind:8]  [ctx/][ns/][name:31]  [status:17]  [age]
```

- **Kind** — 8 characters, left-aligned. Color per resource type (blue for services, yellow for deployments, magenta for configmaps/secrets, etc.)
- **Context prefix** — Shown only in `--all-contexts` mode, color-coded deterministically by cluster name hash.
- **Namespace** — Cyan; omitted for cluster-scoped resources (Node, Namespace, PV).
- **Name** — Truncated to 31 characters with an ellipsis (…) if longer.
- **Status** — Right-aligned to 17 characters. Color reflects health (red/yellow/green/gray).
- **Age** — Human-readable: `5m`, `2h`, `1d`. Dark gray.

4.4 Preview Modes

Mode	Key sequence	Command	Output
0 (default)	First `Ctrl-P`	`kubectl describe <kind> -n <ns> -- <name>`	Full description with events, conditions, labels
1	Second `Ctrl-P`	`kubectl get <kind> -o yaml ...`	Complete YAML manifest
2	Third `Ctrl-P`	`kubectl logs --tail=100 ...`	Last 100 log lines (pods only; error message otherwise)

The mode persists across cursor movements and resets to 0 when skim relaunches after an action.

5 Actions Reference

All actions live in `src/actions.rs` and are invoked after skim returns. They shell out to `kubectl` using `std::process::Command`.

5.1 Security Model

Every kubectl invocation uses `--` before the resource name to prevent argument injection (CWE-88):

```
Command::new("kubectl")
    .args(["describe", "pod", "-n", &ns, "--", &name])
    .status()?;
```

Namespace and context flags appear *before* `--` because kubectl requires it. This pattern is consistent across all seven action functions.

5.2 Action Details

Describe — `Enter`

Runs `kubectl describe <kind> <name>` for each selected item. Works on all resource types. Output printed to the terminal; skim relaunches afterward.

Logs — `Ctrl-L`

```
kubectl logs --tail=200 -n <namespace> -- <pod-name>
```

Non-pod items are silently skipped with a warning. Multi-select iterates all selected pods sequentially.

Exec — `Ctrl-E` (single item)

```
kubectl exec -it <pod> -n <namespace> -- /bin/sh
```

Opens an interactive shell with a TTY. Tries `/bin/sh` first; falls back to `/bin/bash` if the container doesn't have `sh`. Returns when the user types `exit` or presses `Ctrl-D`. Disabled in `--read-only` mode.

Delete — `Ctrl-D`

```
kubectl delete <kind> -n <namespace> -- <name>
```

> **Confirmation rules:** 1–10 items: prompt `Delete N resource(s)? [y/N]`. More than 10 items: full warning banner and requires typing `yes` (not just `y`). In both cases, empty input or any other string cancels without deleting.

Prints `✓ deleted pod/name` or `✗ delete failed ...` per item. Disabled in read-only mode.

Port-Forward — `Ctrl-F` (single item)

Applies to pods and services only. Prompts interactively:

```
Local port [default]:   (validates 1--65535; warns if < 1024)
Remote port [<local>]:  (defaults to local port)
```

Then runs:

```
kubectl port-forward pod/<name> <local>:<remote> -n <namespace>
```

Blocks until `Ctrl-C`. Prints `Forwarding localhost:N → pod/name port M (Ctrl-C to stop)` before blocking. Disabled in read-only mode.

Rollout Restart — `Ctrl-R`

Applies to Deployments, StatefulSets, and DaemonSets. Other kinds are warned and skipped.

```
kubectl rollout restart deploy/<name> -n <namespace>
kubectl rollout status  deploy/<name> -n <namespace>
```

Tracks rollout completion; output is live-streamed to the terminal. Disabled in read-only mode.

Print YAML — `Ctrl-Y`

```
kubectl get <kind> -o yaml -n <namespace> -- <name>
```

Works on all resource types. In multi-select, prints all YAMLs sequentially separated by `---`. Useful for piping into

`kubectl apply` or saving to files.

5.3 Multi-Select Behaviour Summary

Action	Multi-select	Notes
Describe		All items
Logs		Pod items only; others skipped
Exec	Single only	First selected item
Delete		Confirmation scales with count
Port-forward	Single only	First selected item
Rollout restart		Deploy/sts/ds only; others warned
Print YAML		All items

6 Advanced Usage

6.1 Resource Kinds Reference

KubeRift watches all thirteen standard Kubernetes resource types simultaneously:

#	Kind	Alias	Status field	Status values
1	Pod	`po`	Phase + waiting reason	Running, CrashLoopBackOff, Init:0/1, Pending, OOMKilled …
2	Service	`svc`	Type	ClusterIP, NodePort, LoadBalancer, ExternalName
3	Deployment	`deploy`	Ready/desired	2/3, 0/1, 1/1
4	StatefulSet	`sts`	Ready/total	2/2, 0/3
5	DaemonSet	`ds`	Ready/scheduled	3/3, 1/3
6	ConfigMap	`cm`	Literal	ConfigMap
7	Secret	—	Type	Opaque, kubernetes.io/tls, …
8	Ingress	`ing`	IP or hostname	1.2.3.4, example.com, <pending>
9	Node	`no`	Condition	Ready, NotReady
10	Namespace	`ns`	Phase	Active, Terminating
11	PersistentVolume	`pv`	Phase	Available, Bound, Released, Failed
12	PVC	`pvc`	Phase	Pending, Bound, Lost
13	Job	`job`	Status	Active(2), Complete, Failed(1)
14	CronJob	`cj`	Status	Scheduled, Active(N)

Nodes, Namespaces, and PersistentVolumes are *cluster-scoped* — they appear regardless of the `-n` namespace flag.

6.2 Multi-Cluster Workflows

Simultaneous watch across all contexts

```
kf --all-contexts
kf --all-contexts pods                  # pods only, all clusters
kf --all-contexts --read-only           # safe auditing
```

Each context runs as an independent tokio task. All items merge into one skim session. Context names are color-coded by a deterministic hash — the same cluster always appears in the same color across sessions. kubectl actions automatically add `--context <cluster>` for each item.

Interactive context switching

```
kf                # starts on last-used or current context
# press Ctrl-X
# -> fuzzy-picker lists all contexts alphabetically
# -> selecting one restarts the watcher; skim stays open
```

The selected context is saved to `~/.config/kuberift/last_context` and restored on the next launch.

Context-scoped launch

```
kf --context staging-eu-west
kf --context prod-us-east pods -n payments
kf --kubeconfig /etc/kubeconfigs/admin.yaml
```

6.3 Demo Mode

Demo mode activates automatically when kubectl cannot reach any cluster:

```
KUBECONFIG=/nonexistent kf      # -> [kuberift] No cluster. Showing demo data.
```

The demo set includes intentionally broken resources: a `CrashLoopBackOff` pod (surfaced at the top by the unhealthy-first sort), a `Pending` pod, several deployments with degraded replica counts, and healthy baseline resources. All UI features function normally in demo mode.

6.4 Read-Only Mode

```
kf --read-only
kf --read-only --context prod-cluster --all-contexts
```

Disabled in read-only mode

`ctrl-e` exec `ctrl-d` delete `ctrl-f` port-forward `ctrl-r` rollout-restart

Attempting a disabled action prints `[kuberift] read-only mode: <action> is disabled` and relaunches skim. The header shows `[READ-ONLY]` throughout the session.

6.5 Security Design

- **Argument injection (CWE-88):** All kubectl invocations use `--` before resource names. Namespace and context flags precede `--` as kubectl requires.
- **Symlink attacks (CWE-59/367):** Preview state is stored in `$XDG_RUNTIME_DIR/<pid>/` — a per-PID subdirectory. Directories: `0o700`. Files: `0o600`. Falls back to `/tmp/kuberift-<pid>/`.
- **Accidental bulk delete:** Deleting more than ten resources requires typing `yes` in full, not just pressing enter.
- **Privileged port warning:** Port-forward prompts warn when the chosen local port is below 1024.

6.6 Roadmap

Phase 0–6 are complete in v0.1.2. Planned future capabilities:

- **Resource usage metrics** — CPU and memory via `metrics-server`, shown in the status column.
- **Helm release browser** — list releases, diff, rollback.
- **RBAC-aware mode** — hide resources the current service account cannot access.
- **Saved views** — named filters persisted to the config directory.
- **CRD plugin system** — community-contributed watchers and status extractors for custom resources.
- **kubectl plugin compatibility** — installable as `kubectl kf` via `$PATH`.
- **Audit logging** — append-only log of all actions with timestamps and resource identifiers.

KubeRift — *kf*

Source: github.com/syedazeez337/kuberift

Crate: crates.io/crates/kuberift

Homebrew: `brew tap syedazeez337/kuberift && brew install kf`

License: MIT

Built with Rust · skim · kube-rs · ratatui

> The fastest path from a noisy cluster to a root-cause is a fuzzy query, an unhealthy-first sort, and a `ctrl-l`.