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Binary Version Is Not Behavior: Skip-Level Kubernetes Control Plane Upgrades With KEP-4330

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Behavior Ships With the Binary

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Immediate GA Surface

New binary serves promoted GA APIs immediately.



Asymmetric State Writes

Persisted state lacks downgrade guarantees.



Feature Gate Shifts

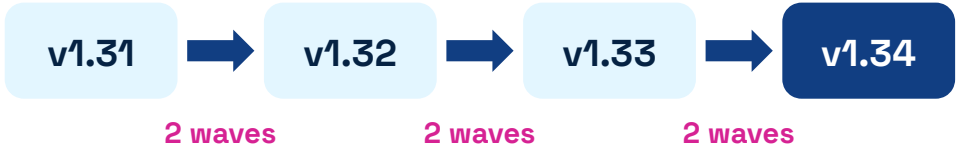
Default gate flips coincide with binary restart.

All three are bound to one event: the binary restart.

The Cost of One Minor at a Time

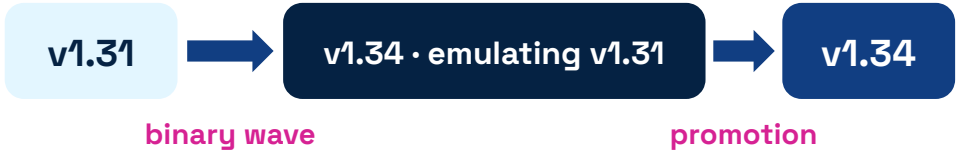
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One minor at a time



6 fleet waves

With emulated version



1 binary wave + promotion

```
upgrade time ≈ rollouts × ramps × (deploy + soak) ÷ daily window
```

Emulation changes one term: rollouts.

Two waves per minor is our rollout unit: apiserver first, then controller-manager and scheduler.

Deploy Is Not Release

Applications

DEPLOY
Ship the new build dark

RELEASE
Turn behavior on with a flag

Control plane, before

DEPLOY
Restart on the new binary

RELEASE
Same restart, all at once.

Control plane, with emulation

DEPLOY
New binary, emulated version pinned

RELEASE
Raise the emulated version

Multi-Release Control Plane Emulation via KEP-4330

Binary Leap: Jump v1.31 to v1.34 in one step.

Deferred Promotion: Decouple binary swap from gate flips.

Reversible Soak: Downgrade binaries cleanly before promoting state.

```
kube-apiserver \
  --emulated-version=1.31

# Binary Version: v1.34.0
# Emulated API & Gates: v1.31
# Storage Versions: readable by v1.31
```

How Would We Know If It Didn't Work?

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Is the jump in range?

The emulated version is validated as a window: up to three minors behind the binary.

Do gates and APIs act like v1.31?

Versioned gates and API lifecycles resolve against the emulated version.

Can storage roll back?

Storage versions stay readable back to the minimum compatibility version.

What isn't emulated?

Bug fixes and new fields. It's not bug-for-bug, so canary still matters.

Operational Boundary Traps & Live Verification

Skip-Level Operator Traps

Early Flag Evaluation: Gates removed by v1.34 fail at flag parsing, even when emulating v1.31.

Pre-Upgrade Pruning: Strip those gates from config before the binary swap.

Kubelet Version Ceiling: Node versions must not exceed the active emulated version.

Newer Gates Unavailable: Gates added after v1.31, like ComponentStatusz, can't be enabled.

Telemetry & Version Signals

Build Metric Blindspot: `kubernetes_build_info` exposes binary version only.

Emulation Truth: `/version` and `version_info` report binary, emulation and min compatibility.

Gate Auditing: Verify active feature gates via `kubernetes_feature_enabled`.

How the Rollout Ran

00	01	02	03	04	05
Gate sanitization	**Canary**	**Staging**	**Production fabrics**	**Corp & grid**	**Promotion**
Removed gates out of config	Emulation and gates verified	Soak before production	Region by region, with soak	Rest of the fleet	Its own change

AT EVERY STAGE

Emulation confirmed | Control plane healthy under load | Binary rollback available

v1.31 to v1.34 Skip-Level Rollout & Rollback Matrix

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Upgrade Phase	Binary Version	Emulated Version	Storage Versions	Rollback Mechanism
0. Gate Sanitization	v1.31	v1.31 (Default)	v1.31	Manifest Revert
1. Binary Leap & Soak	**v1.34**	v1.31 (Pinned)	Readable by v1.31	**Direct Binary Downgrade**
2. State Promotion	**v1.34**	**v1.34 (Promoted)**	Readable by v1.33	**Flag Step-Back to v1.33 + Restart**

What to Take Home



Separate code from behavior

Roll out the binary with behavior pinned, then promote as its own change.



Prune gates first

Remove gates the new binary won't accept before the swap.



Verify, don't assume

/version, version_info and the gate metric show what's live.

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Thank You & Questions

Scan the session QR code to share feedback on Sched

linkedin.com/in/marulkar

github.com/marulkar



BACKUP

Common Questions

`--min-compatibility-version`

Ships in v1.35. On v1.34 it defaults from the emulated version.

APIs removed after v1.31

Available as in v1.31 while emulating. Migrate clients before promotion.

Alpha features

Not supported with emulation. Check what you enable first.

Why two waves per minor?

Our rollout unit is per component. Shipping the control plane together makes it one.