@MELANIECEBULA / JUNE 2019 / KUBECON CHINA

Performing Infrastructure Migrations

at Airbnb Scale


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Who am I?

AIRBNB CASE STUDY

Migrations: Airbnb Case Study

Kubernetes (k8s) is an open-source system for automating deployment, scaling, and management of containerized applications.

Migrations: Airbnb Case Study

70% of services

in kubernetes

Migrations: Airbnb Case Study

300+ critical services

in kubernetes

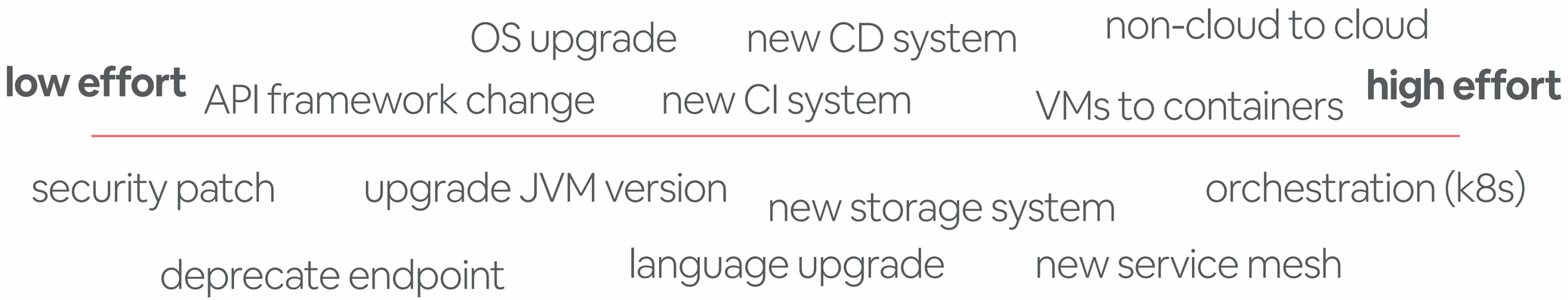
WHAT ARE MIGRATIONS

Example Migrations

- non-cloud to cloud
- VMs to containers
- configuration management to orchestration
- API framework changes (ex: circuit breaking, request throttling)
- new CI, build, or deploy system
- new service proxy or service mesh
- new language/framework version
- security patches
- ... and more!

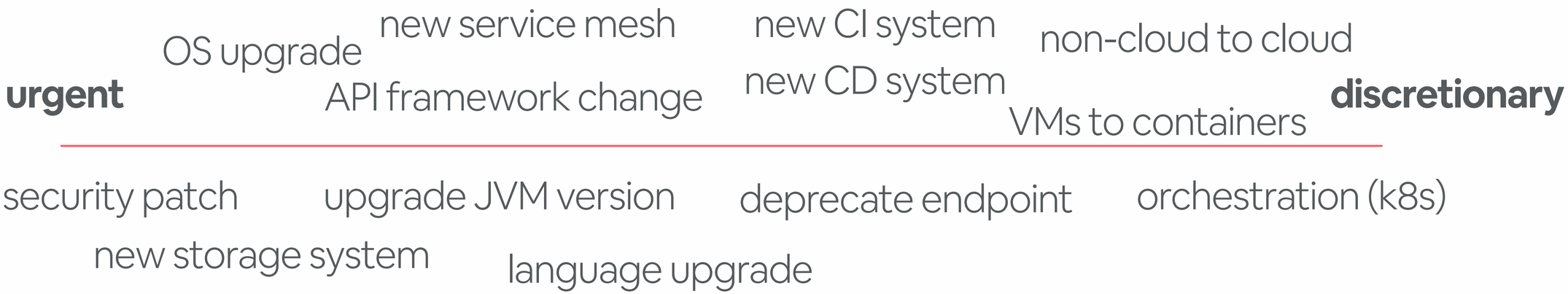
Migrations

“LOW” TO “HIGH” EFFORT



Migrations

"URGENT" AND "DISCRETIONARY"



Migrations

NEED AT “LOW” VS “HIGH” SCALE

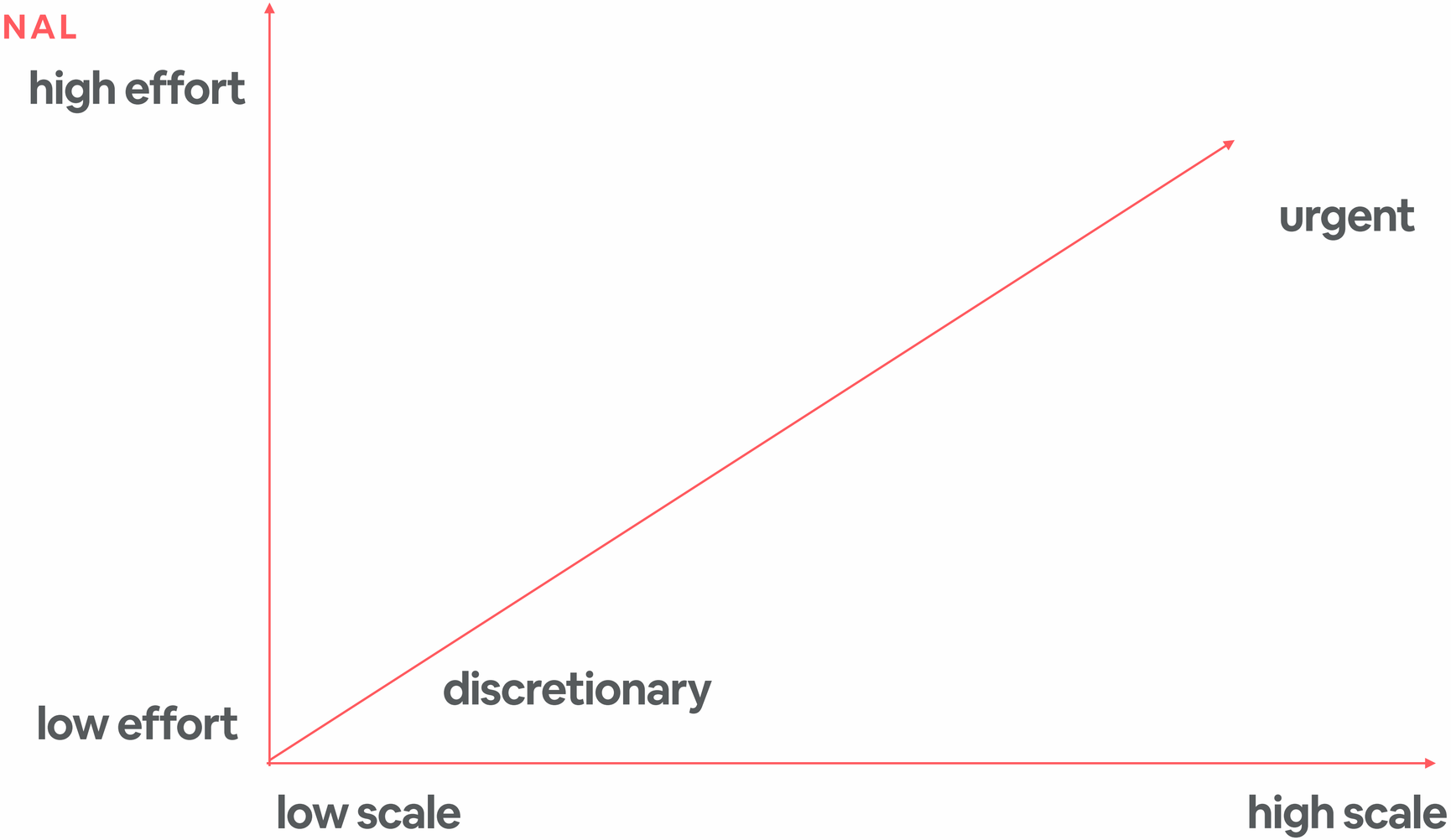
language upgrade
deprecate endpoint
VMs to containers

low scale
upgrade JVM version
non-cloud to cloud
orchestration (k8s)
high scale

security patch
OS upgrade
new CI system
new CD system
API framework change
new service mesh
new storage system

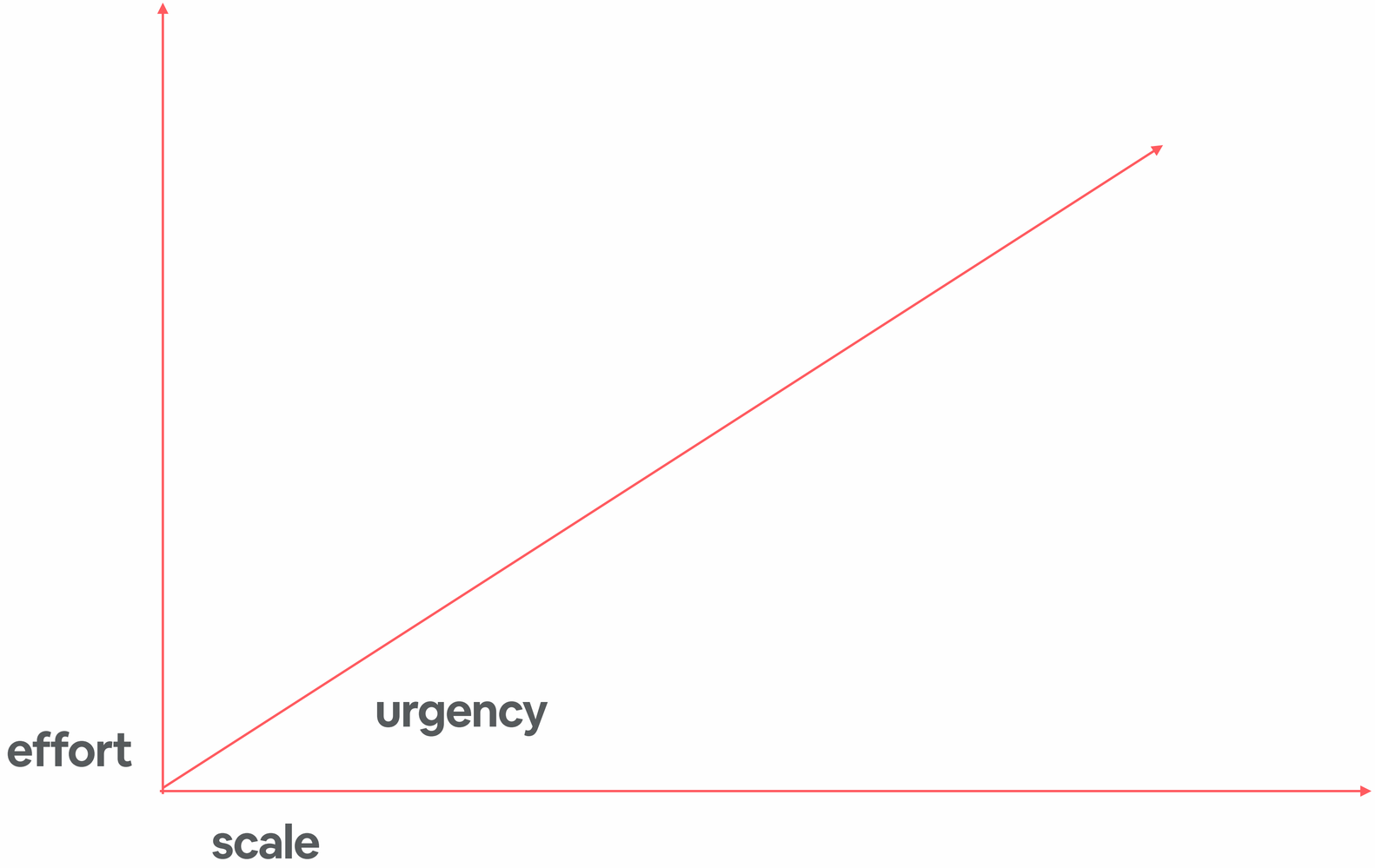
Migrations

ARE MULTIDIMENSIONAL



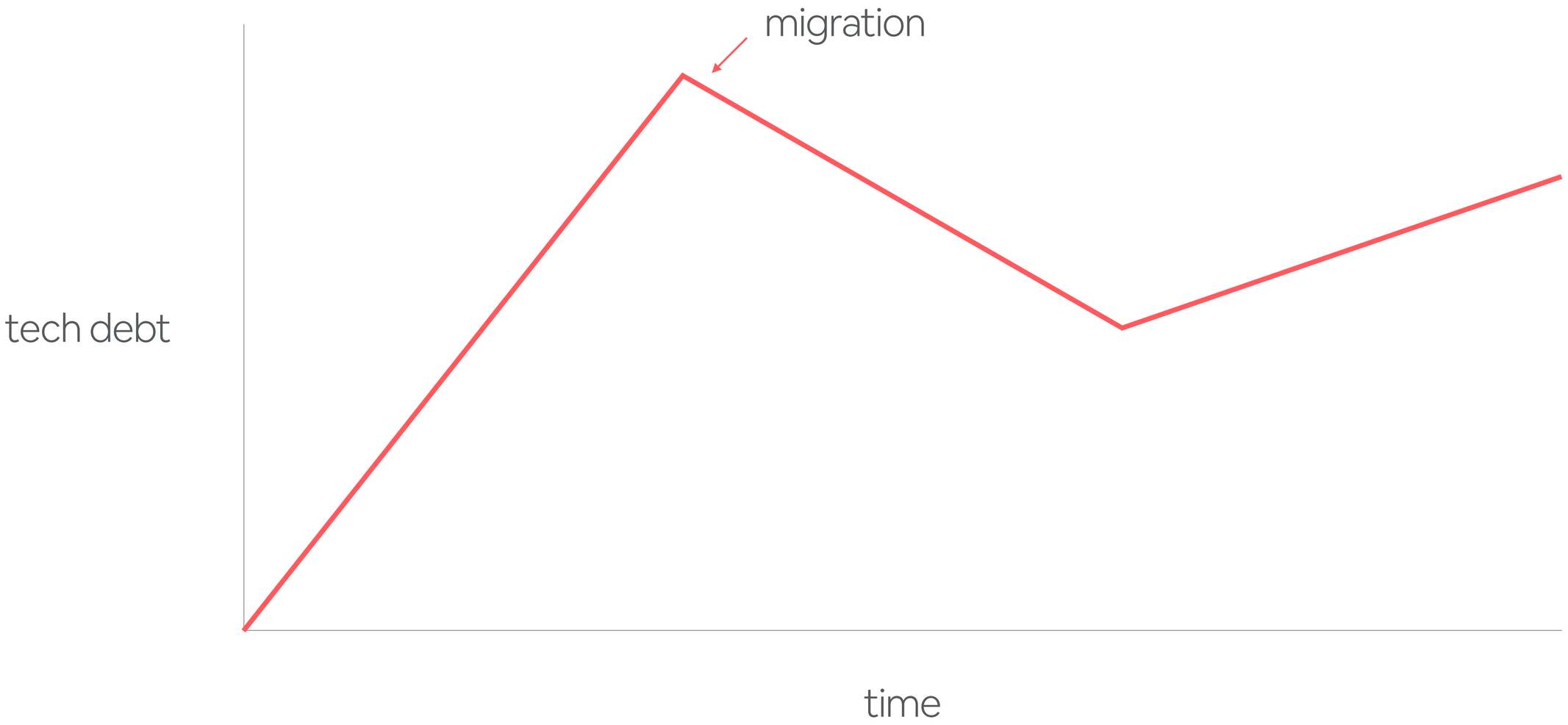
Migrations

ARE MULTIDIMENSIONAL



WHY ARE MIGRATIONS IMPORTANT

Migrations reduce tech debt



Examples of tech debt

- low developer velocity
- slower CI, builds, deploys
- non-reproducibility
- reduced resiliency
- hitting scaling limits
- networking issues
- security holes
- outdated language/framework version
- end-of-life systems
- ... and more!

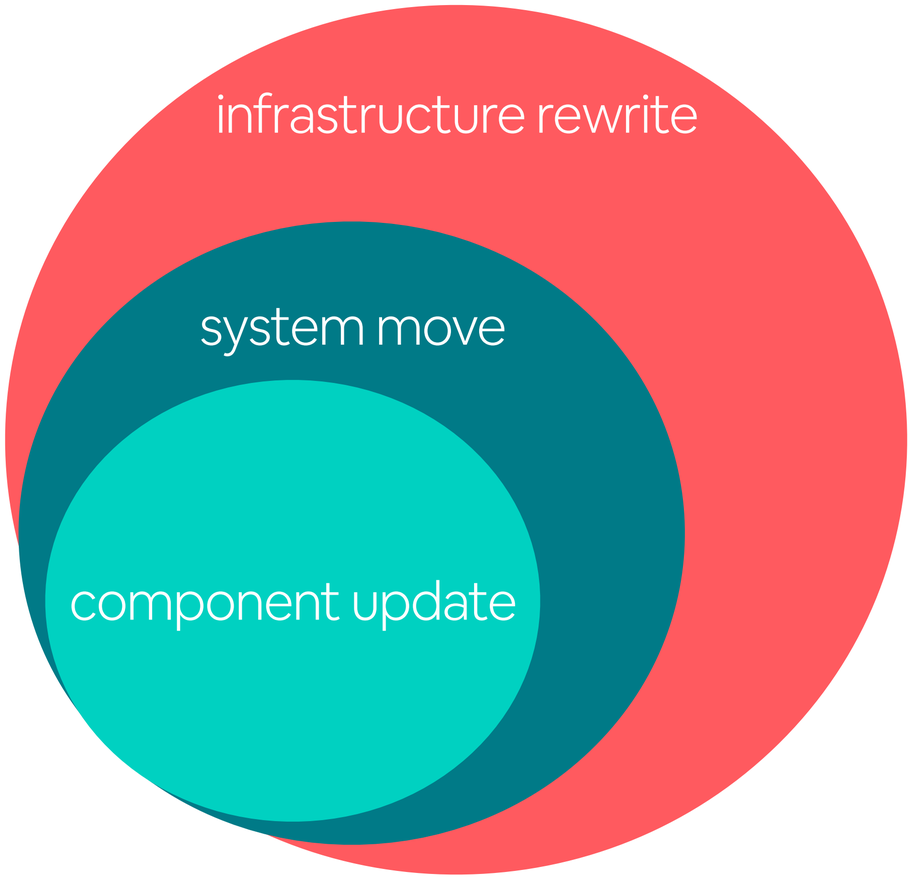
Migrations are the sole lever to systematically create technical leverage at scale

MIGRATION STRATEGIES

MIGRATION TYPES

Migration types

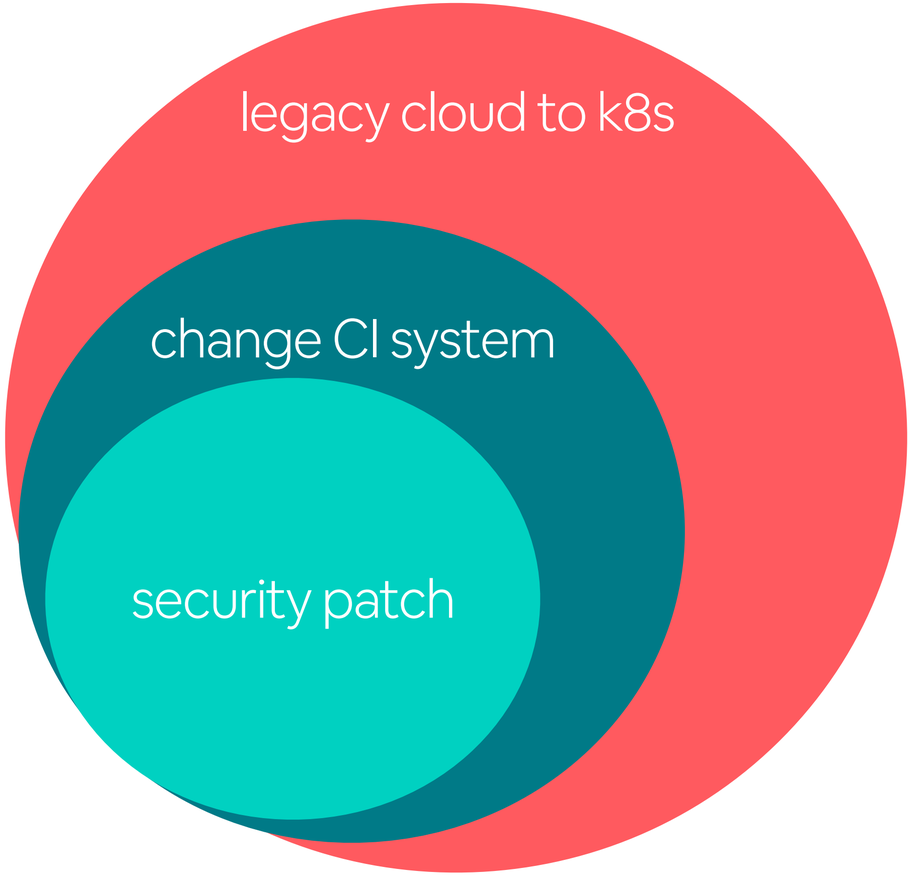
- **component:** upgrades, patches, refactors
- **system:** move from one system to another
- **infrastructure:** rewrite underlying infra



Migration types

AIRBNB EXAMPLE

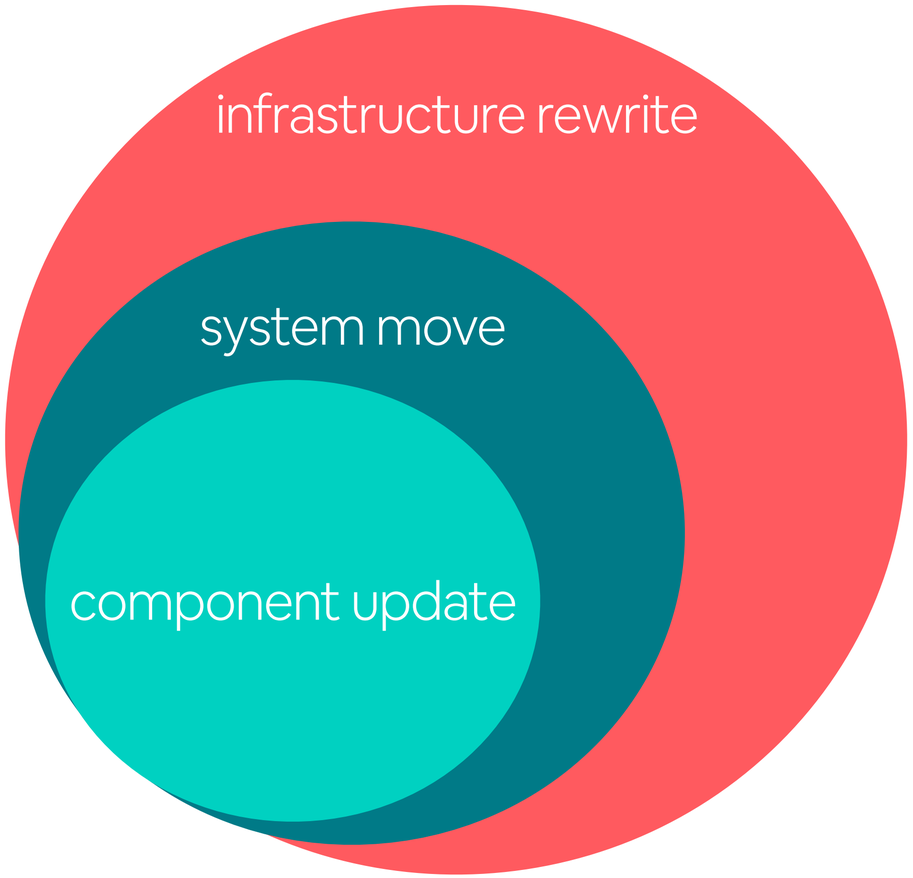
- **component:** security patch, upgrade ruby, upgrade ubuntu, deprecate endpoint
- **system:** new CI/CD system, new build system, deployment pipelines, new proxy, new load balancer, new service mesh, new storage
- **infrastructure:** move to cloud, containerization, k8s, change cloud provider



Migration types

STRATEGIES

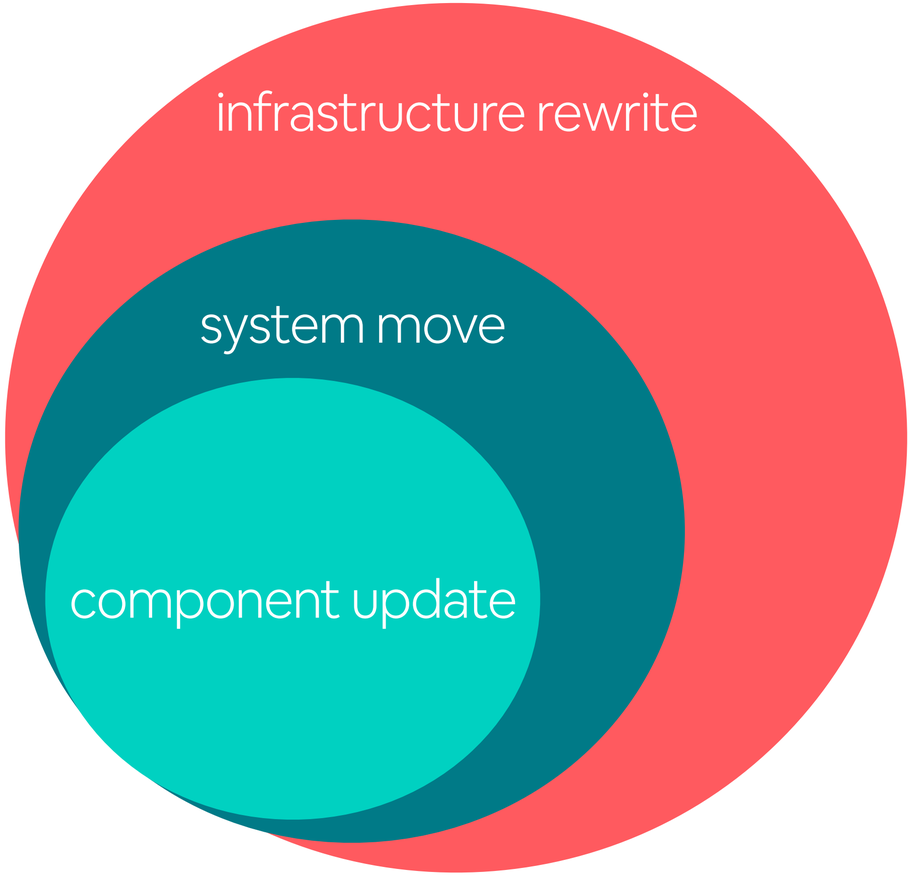
- **know which type** you're dealing with
- exponentially **increasing complexity** for each type
- more complex means **more resourcing required** and **more risk**



MIGRATION SEQUENCING

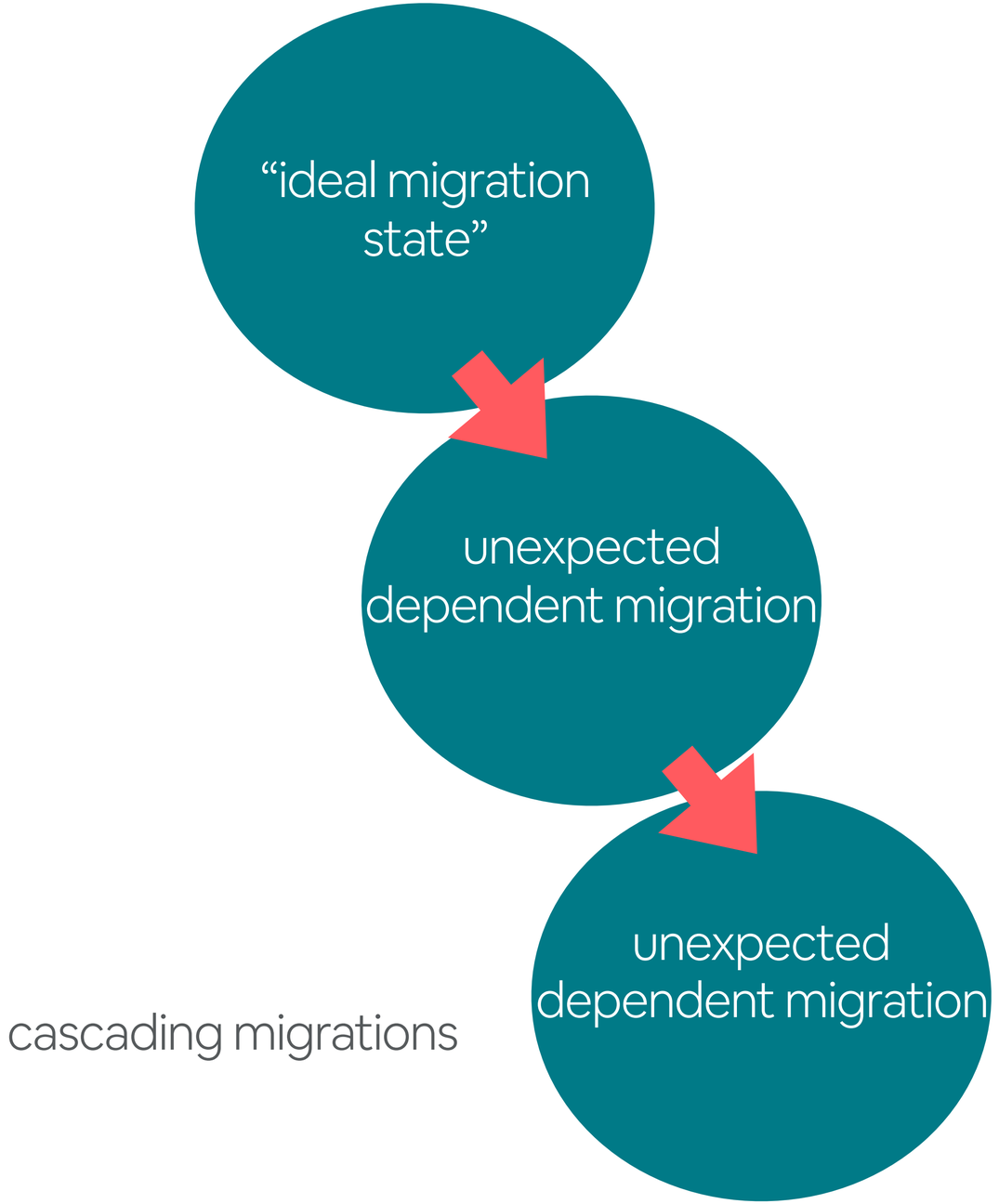
Sequenced Migrations

- complex migrations likely have **dependent migrations**
- requires planning: **migration sequencing**
- or infrequent **cascading migrations** and inefficient **simultaneous migrations**



Cascading Migrations

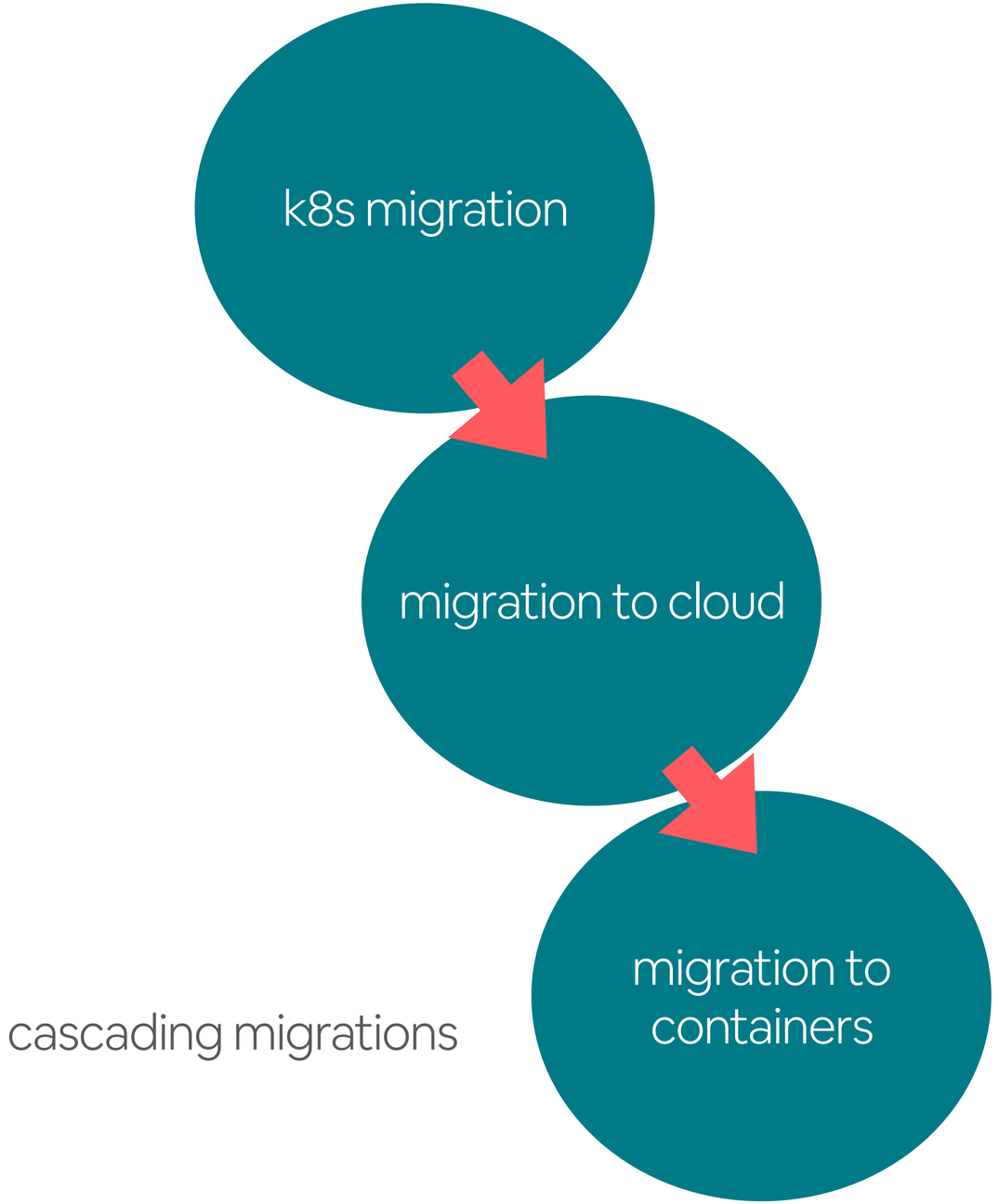
- **infrequent migrations can cause** a rewrite or **cascading migrations**
- because small incremental changes are not made, **a rewrite is required** to get to the ideal end state
- cascading complexity means **higher risk** overall



Cascading Migrations

EXAMPLE

- going from non-cloud to k8s
- for high availabilty, consider completing incremental migrations sequentially



cascading migrations

Simultaneous Migrations

- **inefficient migrations can cause** overall migration velocity to slow down and leads to **simultaneous migrations**
- simultaneous migrations don't necessarily depend on each other
- but they do **affect the overall complexity** of the system and introduce additional risk

simultaneous migrations

Simultaneous Migrations

EXAMPLE

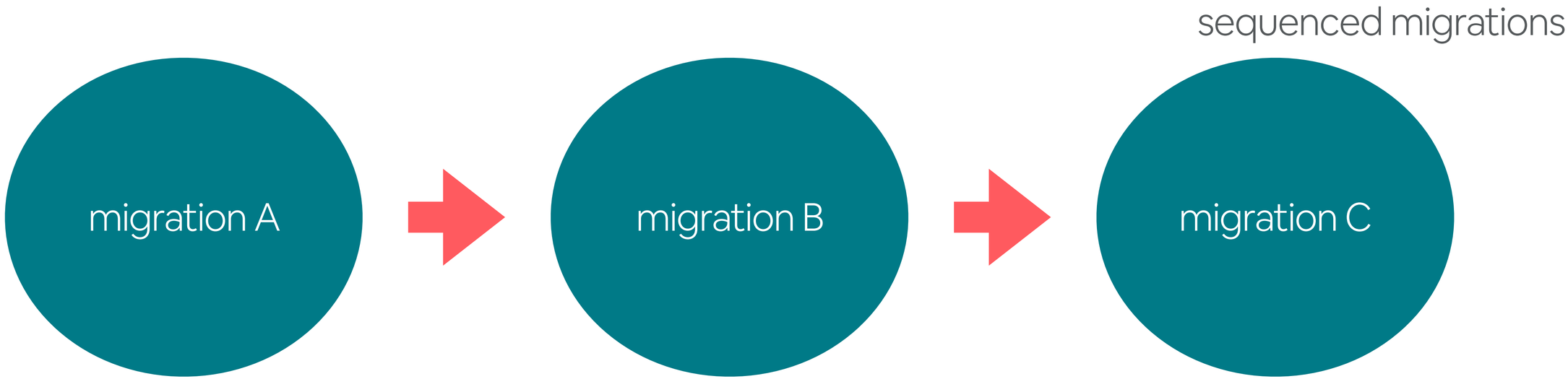
- are these migrations really independent?
- could each migration be making assumptions about your system?
- does your migration need to support a mixed state from another migration?

simultaneous migrations

Sequenced Migrations

STRATEGIES

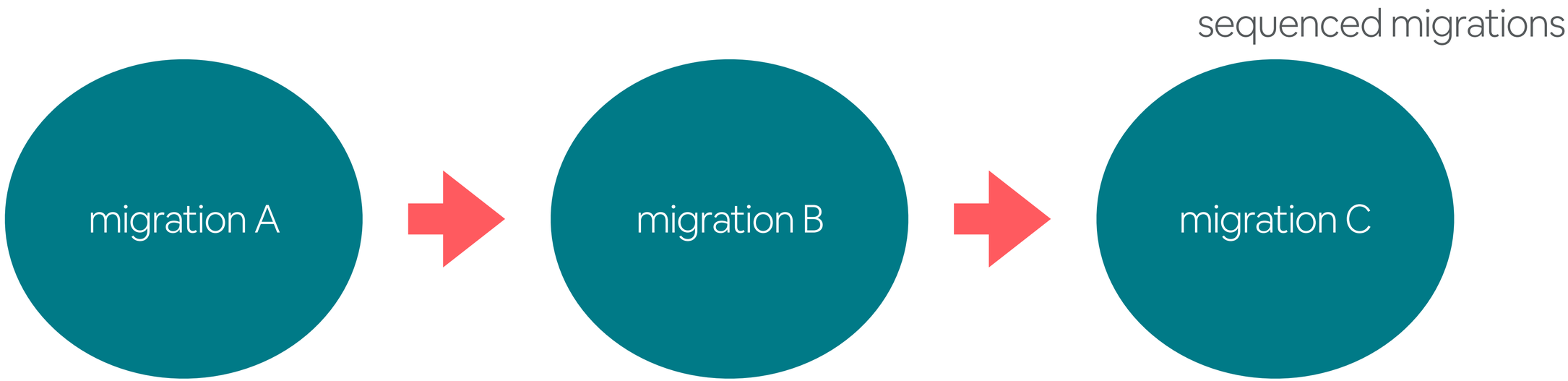
- a minor migration now can become an infrastructure rewrite later
- make migration **frequent and efficient**
- **tightly scoped migrations** are easier
- **sequenced migrations** are safer



Sequenced Migrations

STRATEGIES

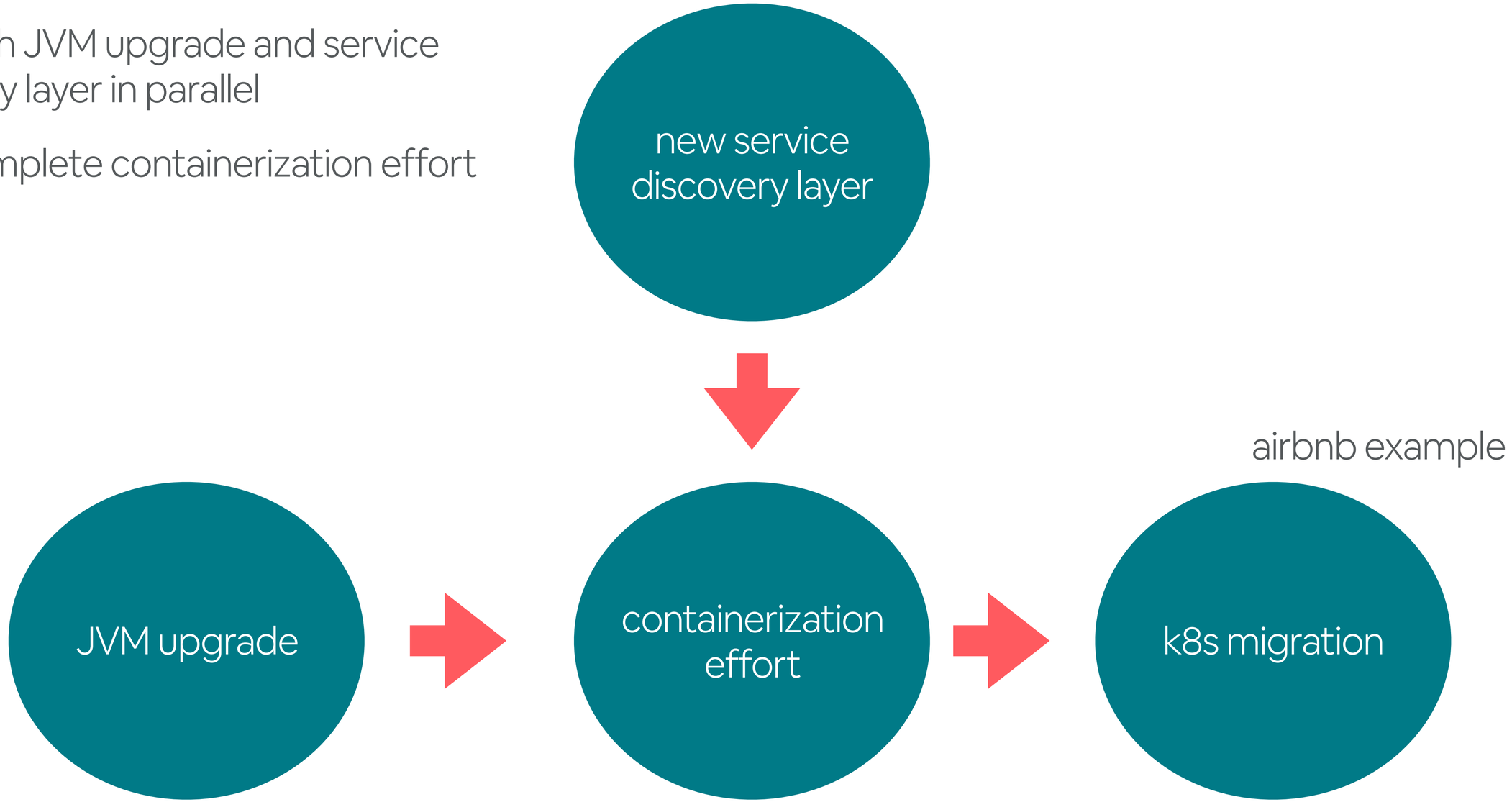
- **lower risk** migrations
- requires **more planning** and time
- can **parallelize migrations** without dependencies



Sequenced Migrations

EXAMPLE

- start with JVM upgrade and service discovery layer in parallel
- then complete containerization effort



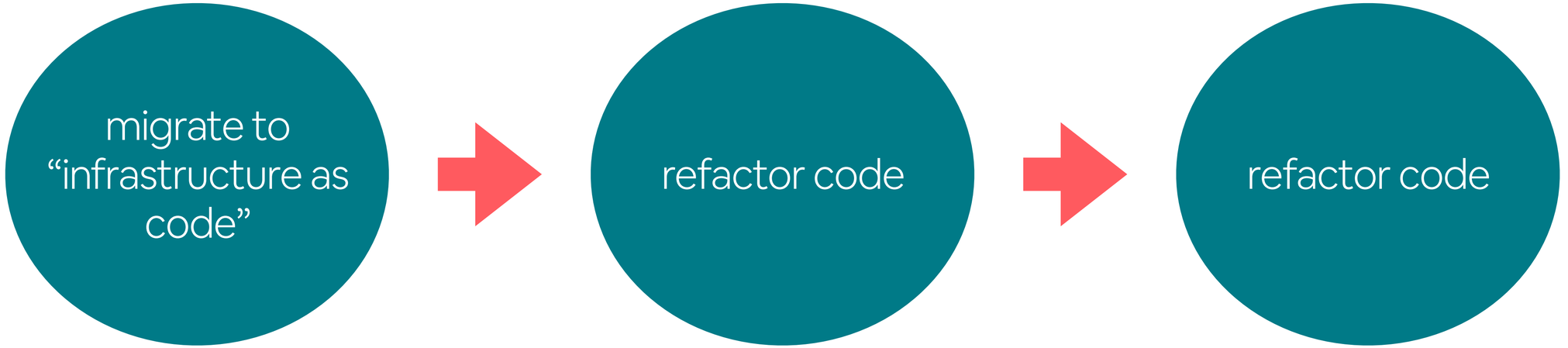
airbnb example

Prioritized Migrations

STRATEGIES

- **prioritize** migrations that reduce or simplify further migrations
- example: migrate to “infrastructure as code” first
- following migrations are now code refactors

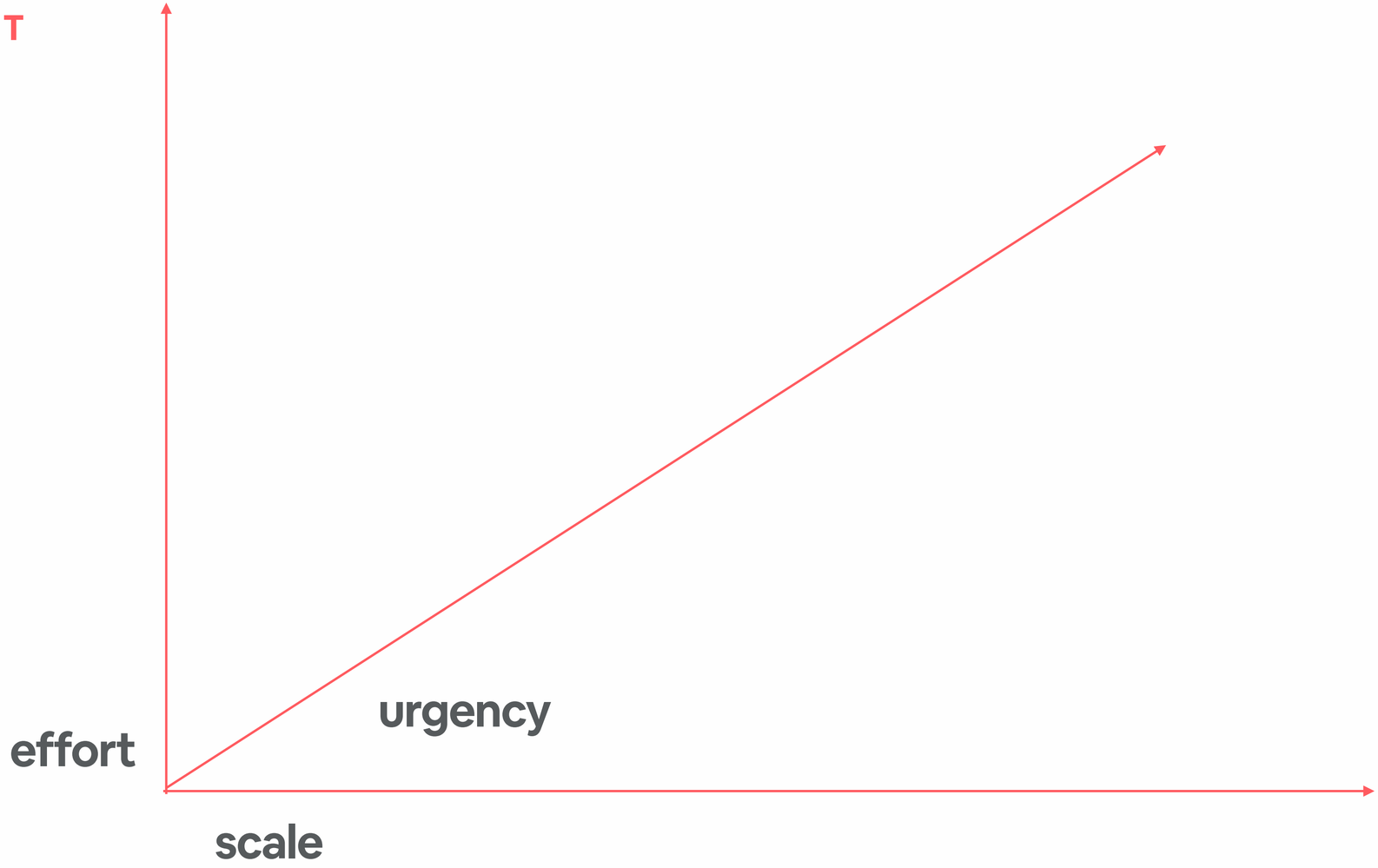
example prioritization



MIGRATION AT SCALE

that new service mesh you were thinking about

IS SUDDENLY VERY URGENT



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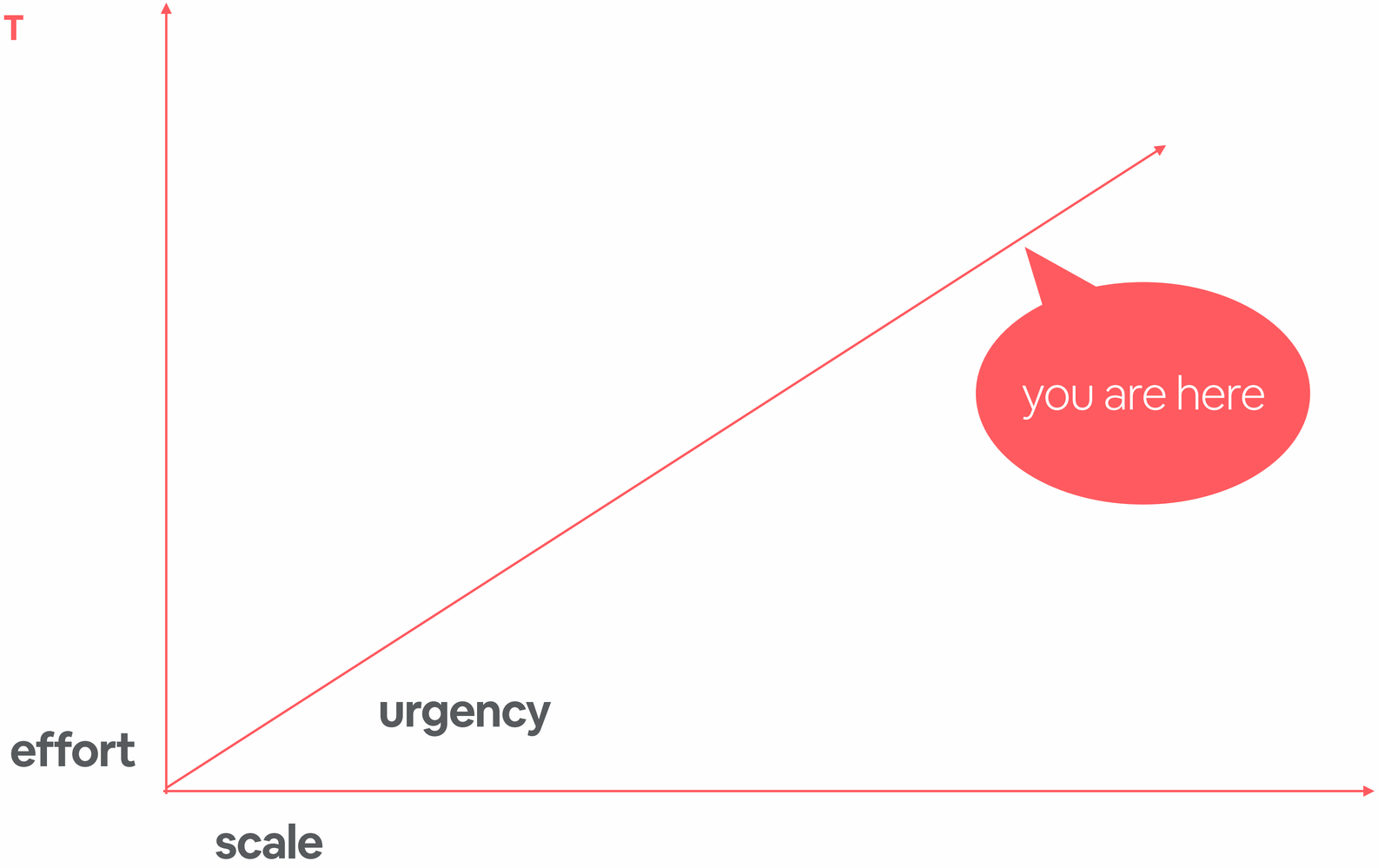
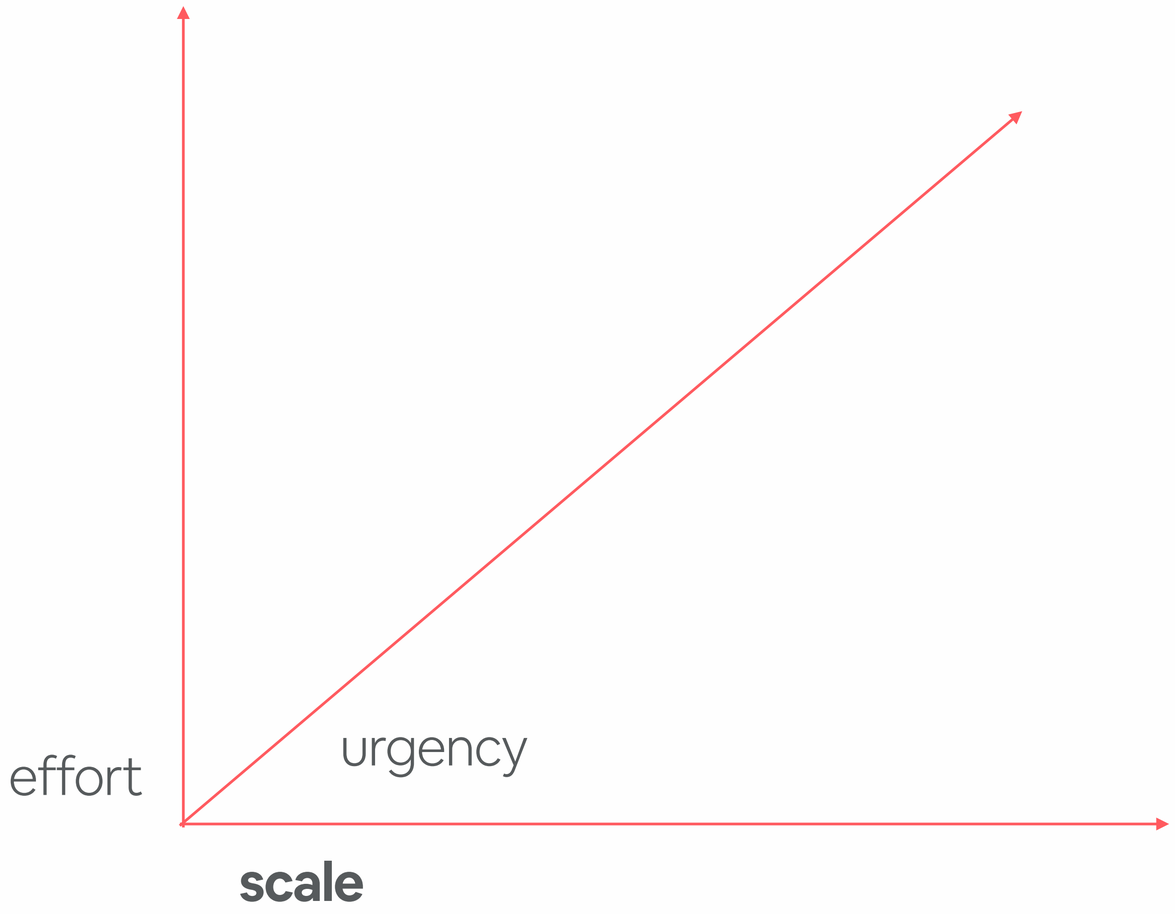


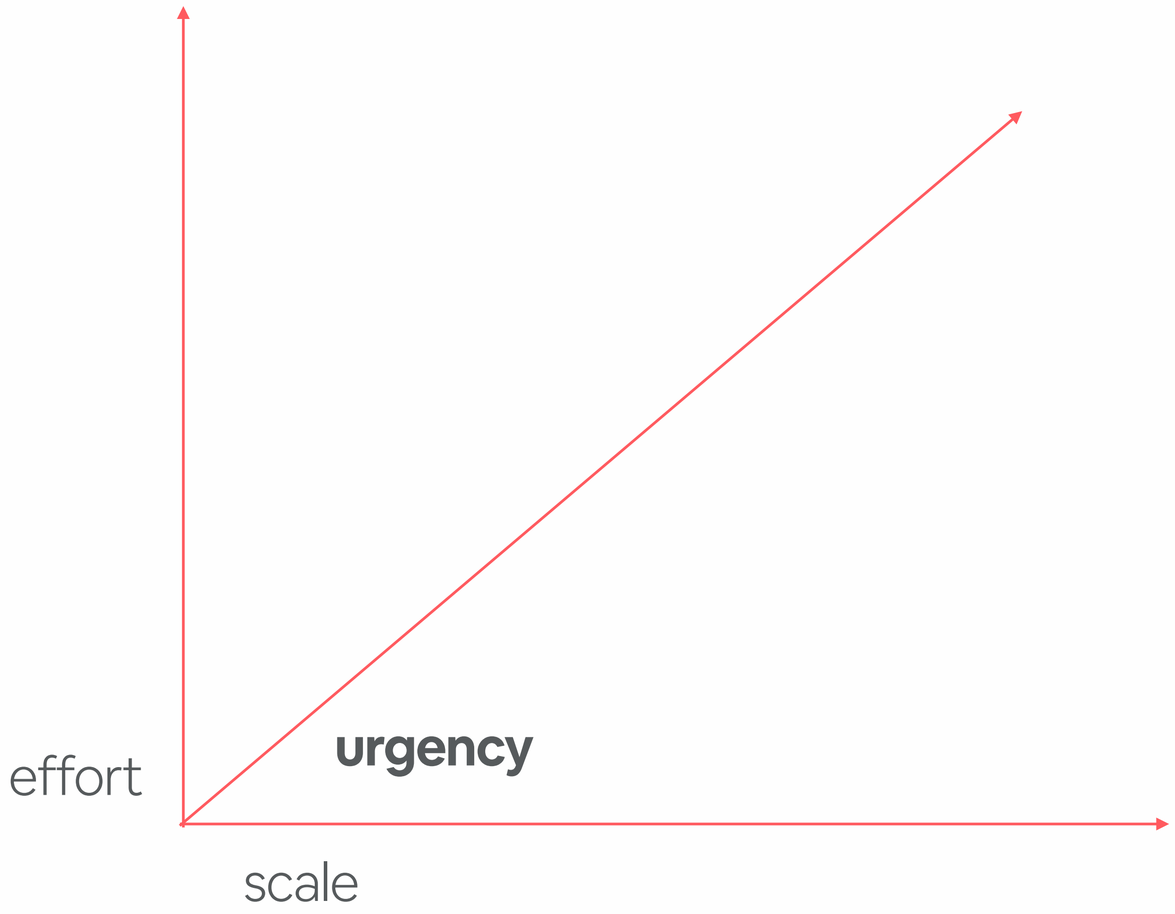
Migration at scale

- scale can introduce **increased load or traffic**



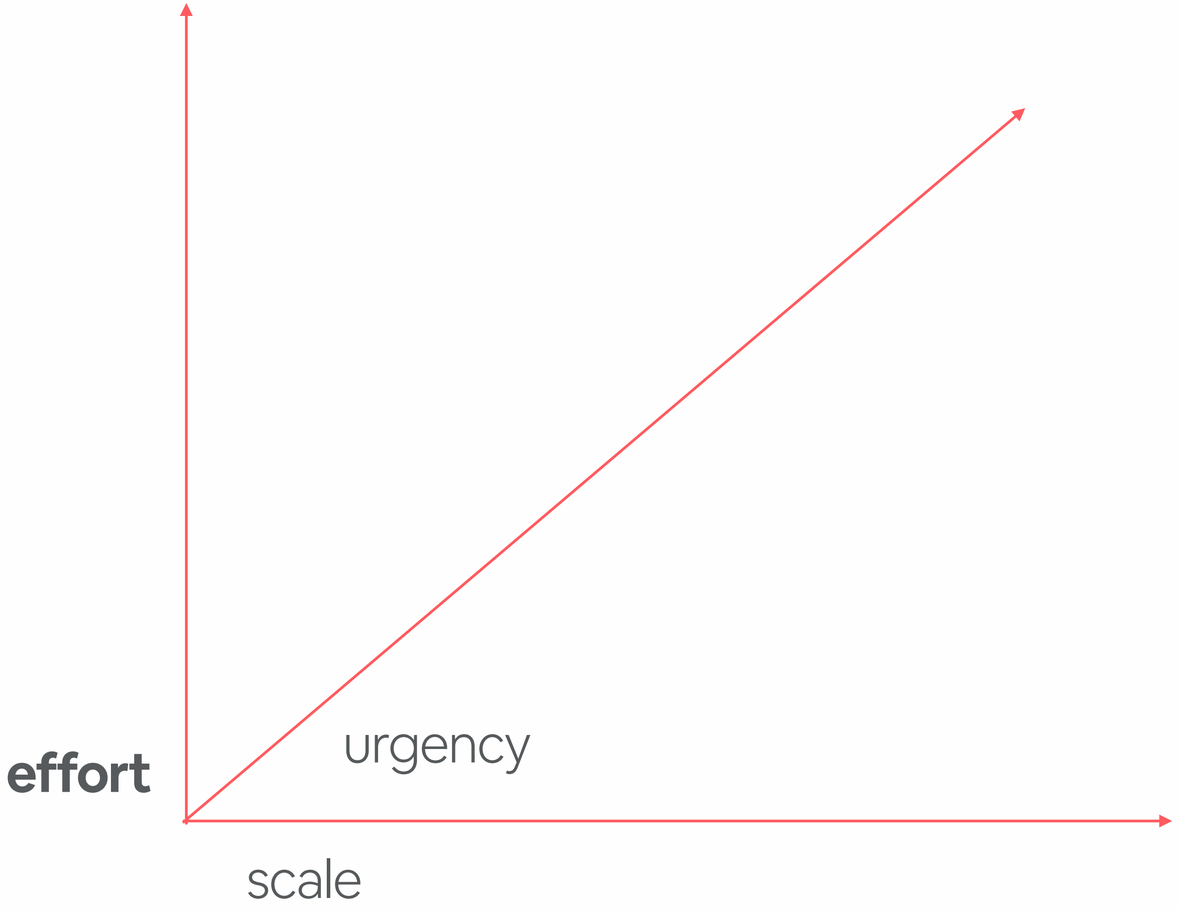
Migration at scale

- when not planned for, this can introduce **forced urgency**



Migration at scale

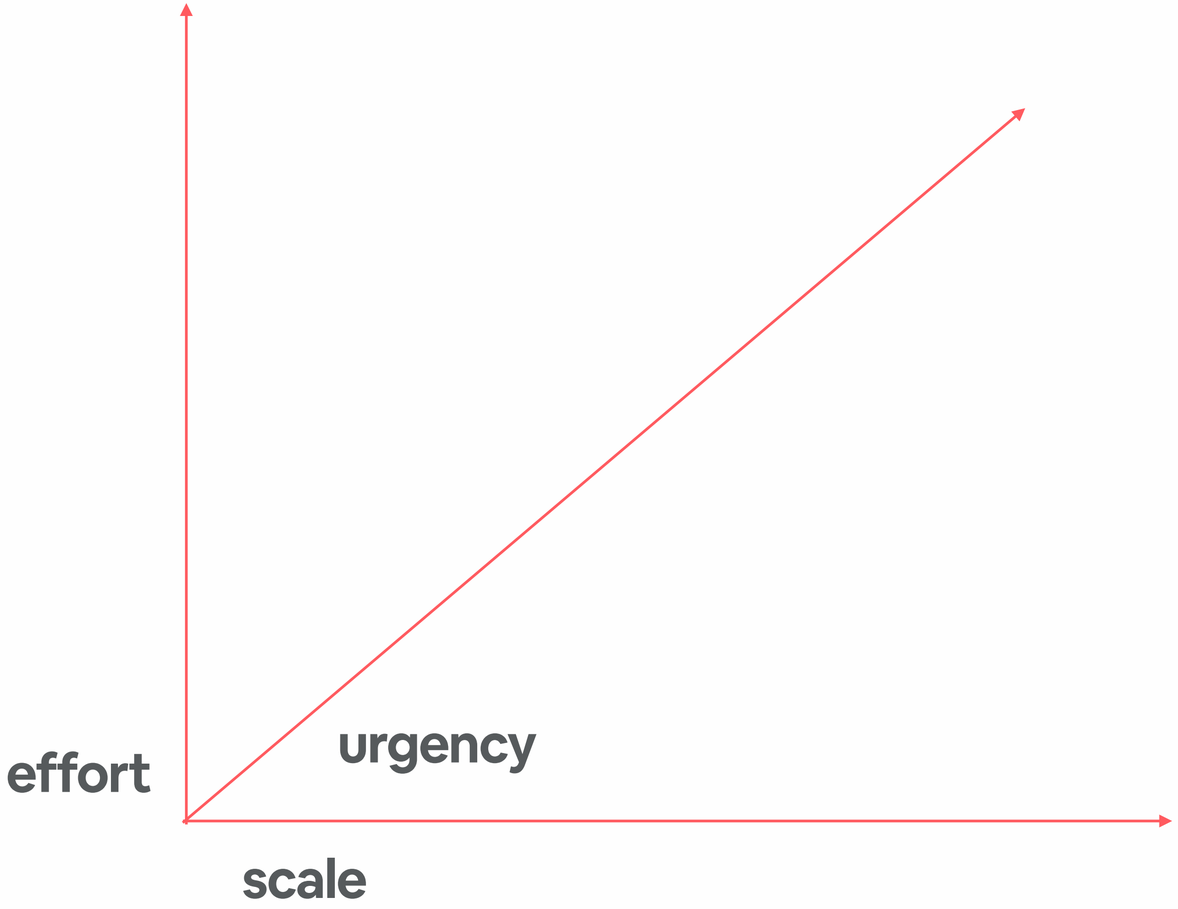
- operating at scale can means you need to **migrate more** services, databases, etc
- **increased effort** comes from number of surface to migrate and complexity



Migration at scale

EXAMPLE

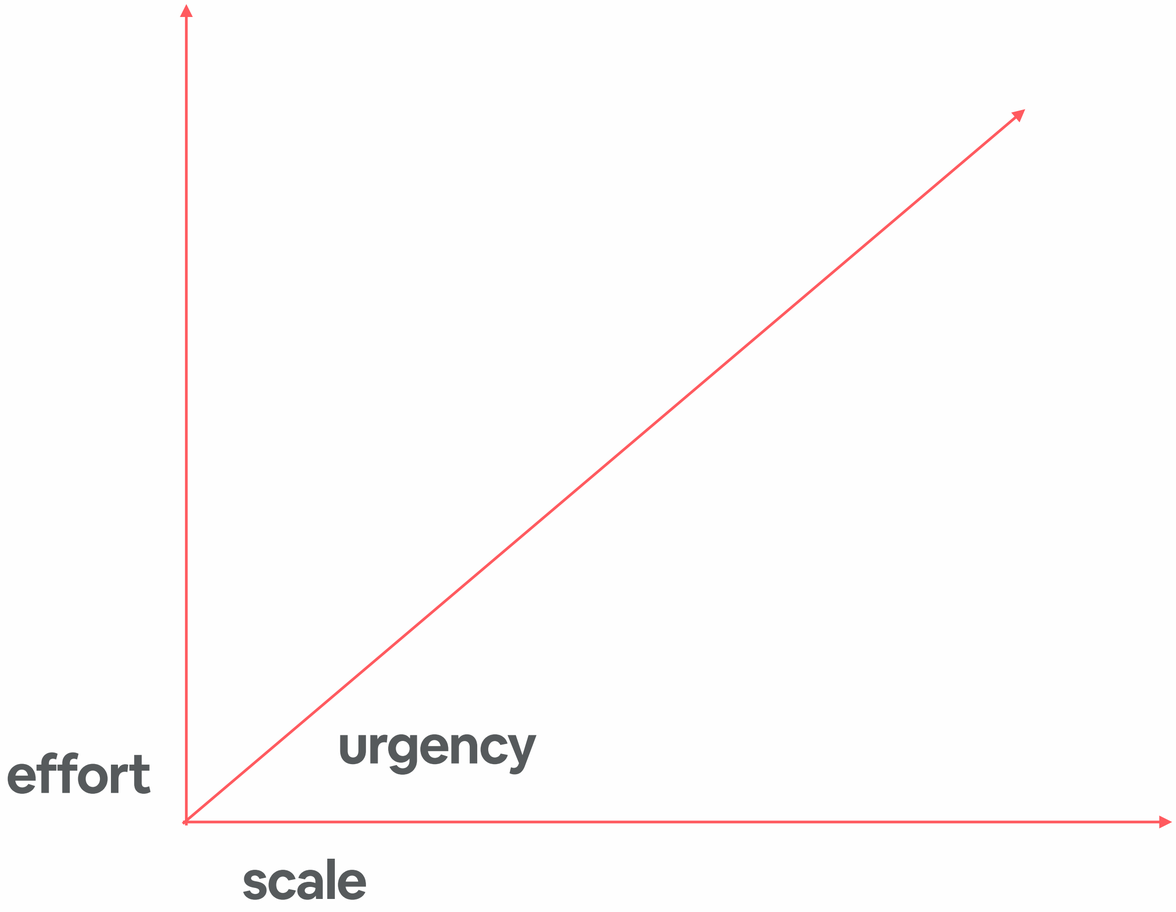
- you want to switch from using HAProxy to Envoy Proxy
- you have **exponentially more services** and edges
- issues with HAProxy **compound with more edges**



Migration at scale

STRATEGIES

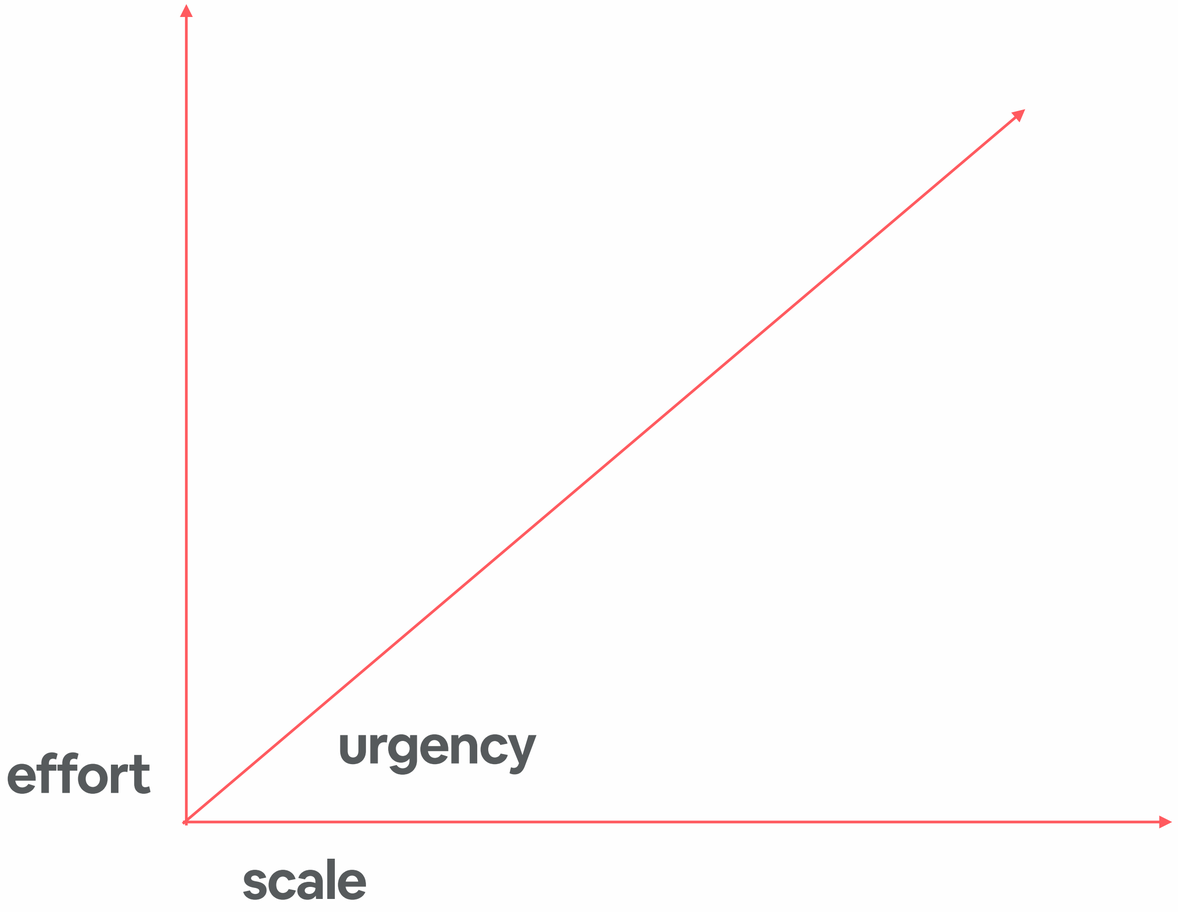
- **forecast** expected load
- **stress test** systems for actual load
- get ahead of the problem with **long-term planning** before it becomes firefighting



Migration at scale

STRATEGIES

- make time work for you
- deprecate the old thing first
- **make the new approach the default**



make the new approach

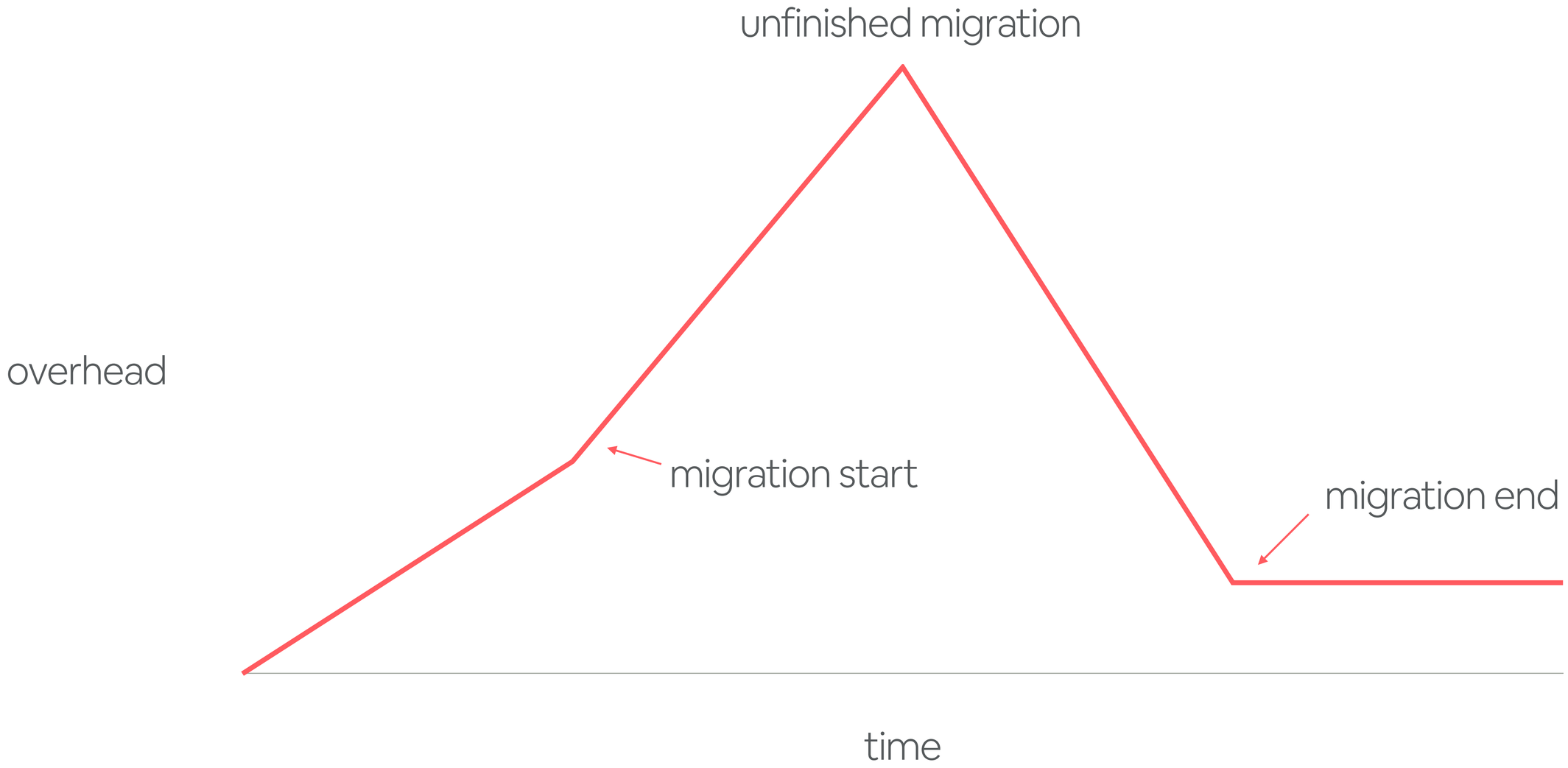
THE DEFAULT

Airbnb example:

- moving monolithic service configuration to their service codebases
- **exponentially more services** are being created
- create a service generator that **generates services using new approach**

MIGRATION OVERHEAD

Migration overhead



migrating is an explicit tradeoff of taking on overhead now to reduce worse overhead later.

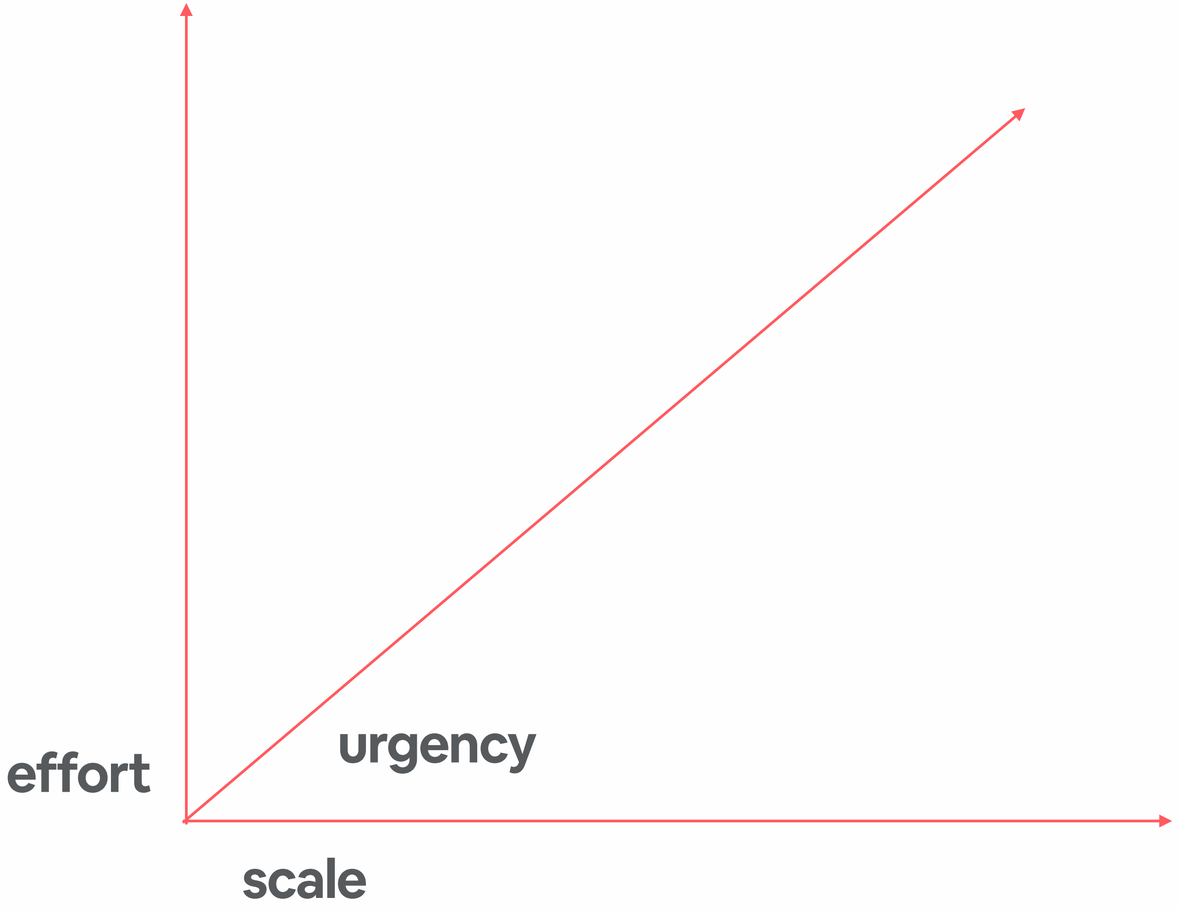
Migration overhead

- for those **running** the migration effort
- for those **migrating** to the “new” thing
- for those **maintaining** both the “new” and “old” thing

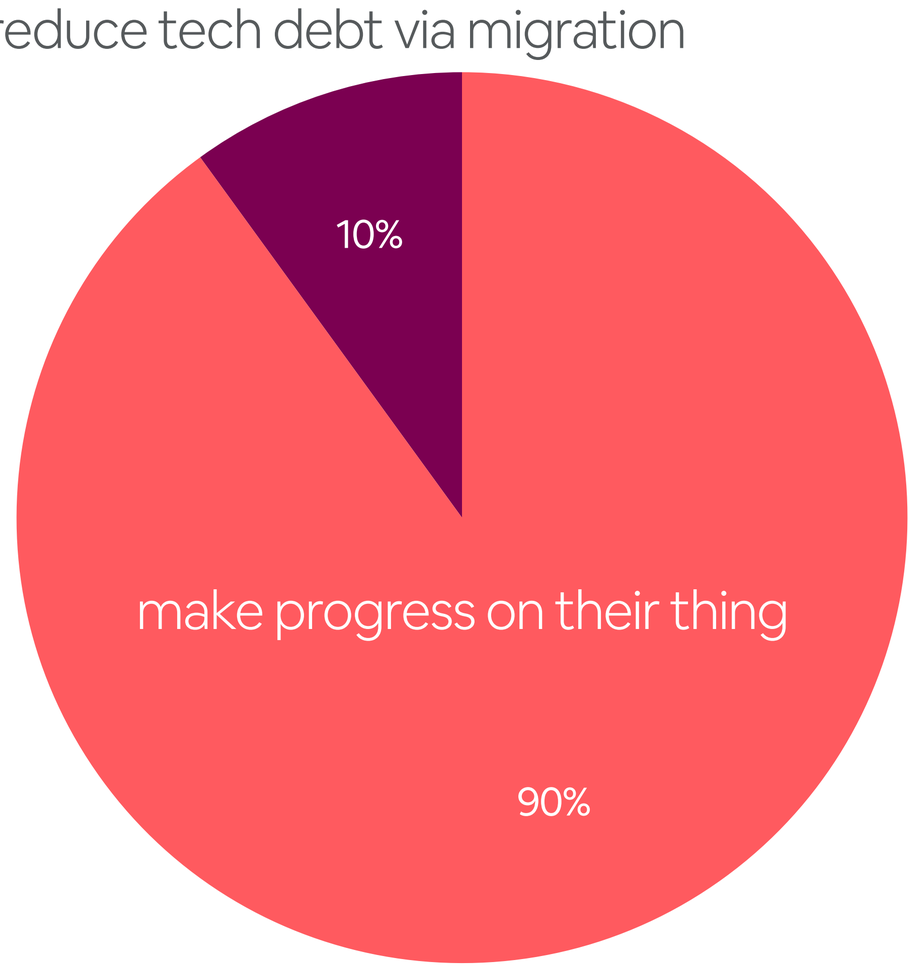
Migration overhead

EXAMPLE

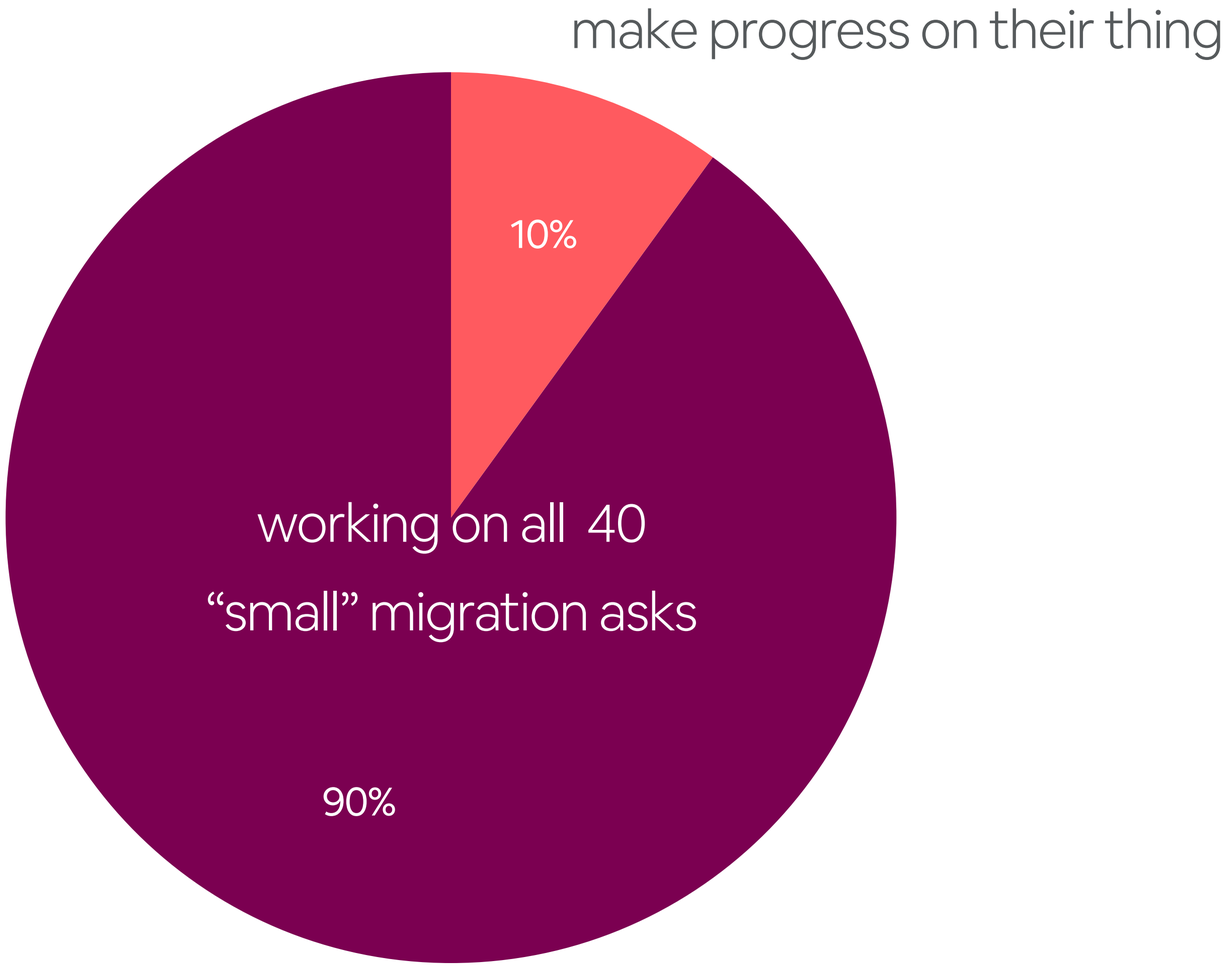
- you want to switch from using HAProxy to Envoy Proxy
- you have **exponentially more services** and edges
- you have more complexity with **different use cases** (ex: HTTP, TCP)
- you're patching HAProxy while building out Envoy Proxy (**maintaining mixed state**)



Migration overhead: what developers want



Migration overhead: what developers get



Unfinished migrations

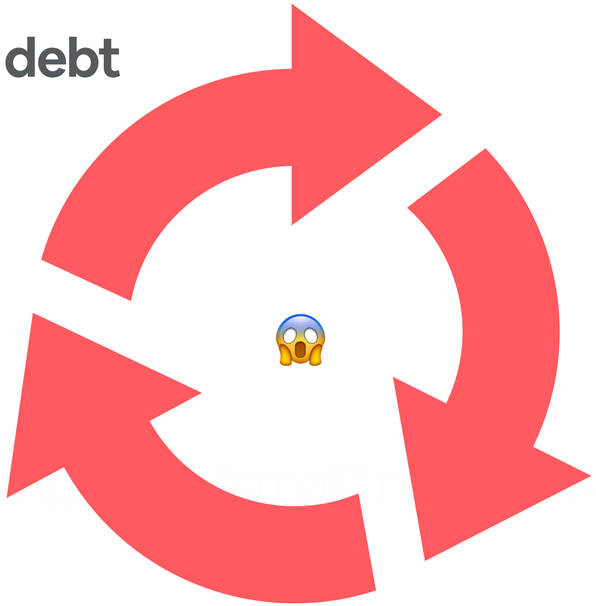
worsening tech debt

start a new migration

migration is not 100% finished

Unfinished migrations

worsening tech debt



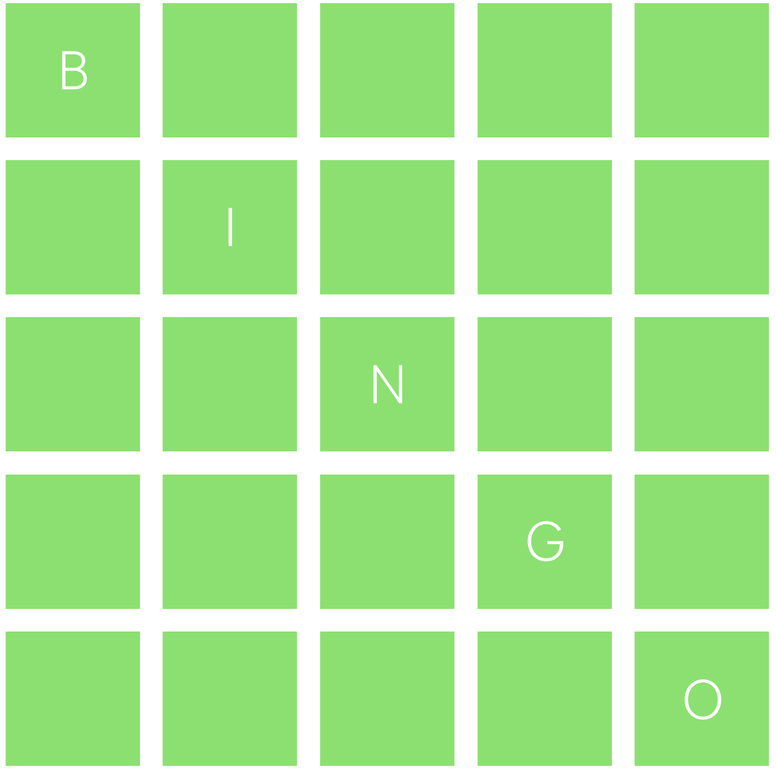
start a new migration

migration is not 100% finished

Unfinished migrations

WORST BINGO EVER

- future **migrations are now harde**r
- **tech debt is now worse** instead of better
- bugs, regressions, **edge cases** (BINGO)



your infrastructure state diagram

unfinished migrations make tech debt worse.

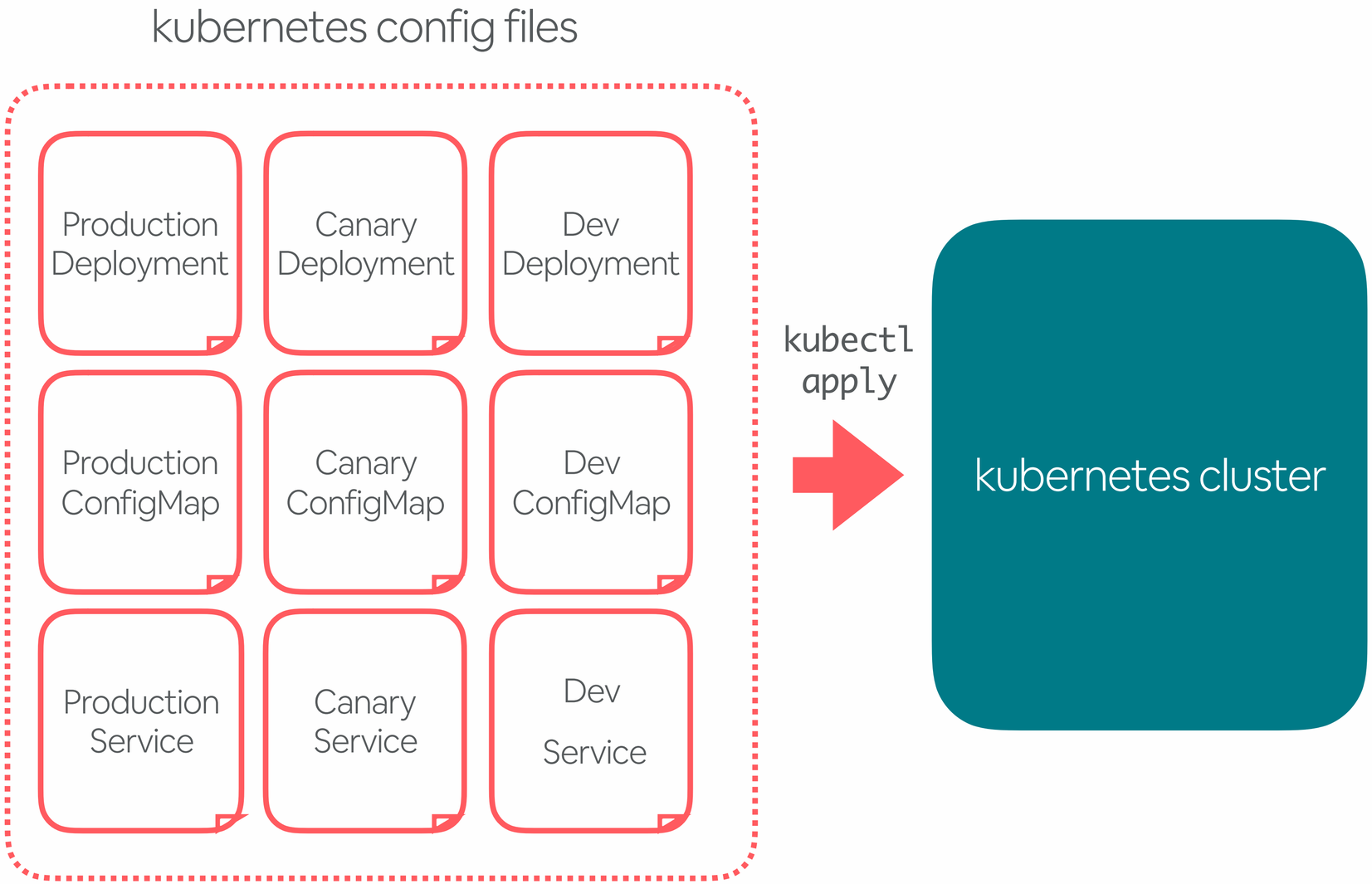
Migration overhead

STRATEGIES

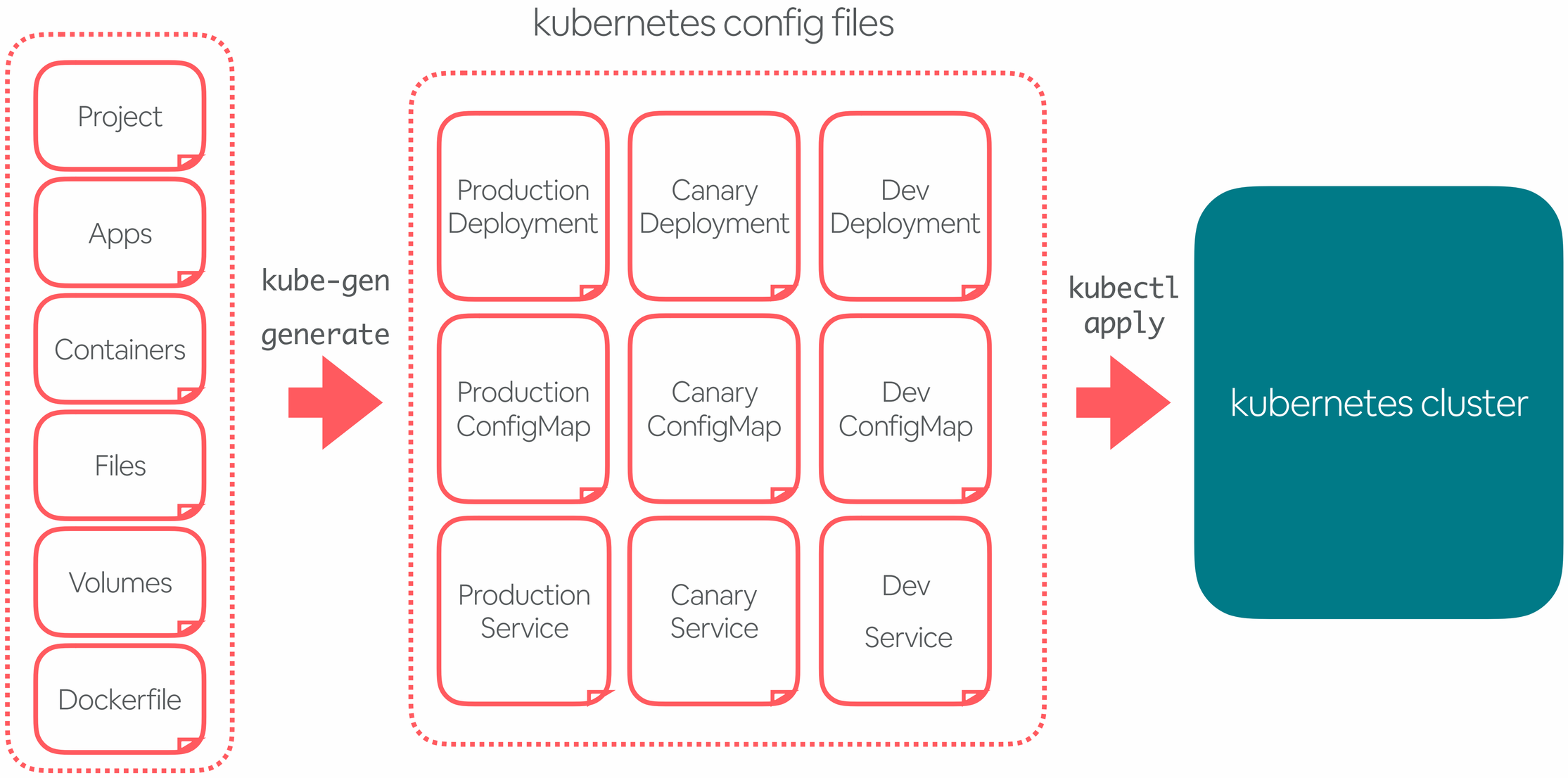
- develop **abstractions** over the infrastructure you migrate
- make the current migration easier
- avoid leaky abstractions
- **makes future migrations easier**

abstraction

AIRBNB EXAMPLE

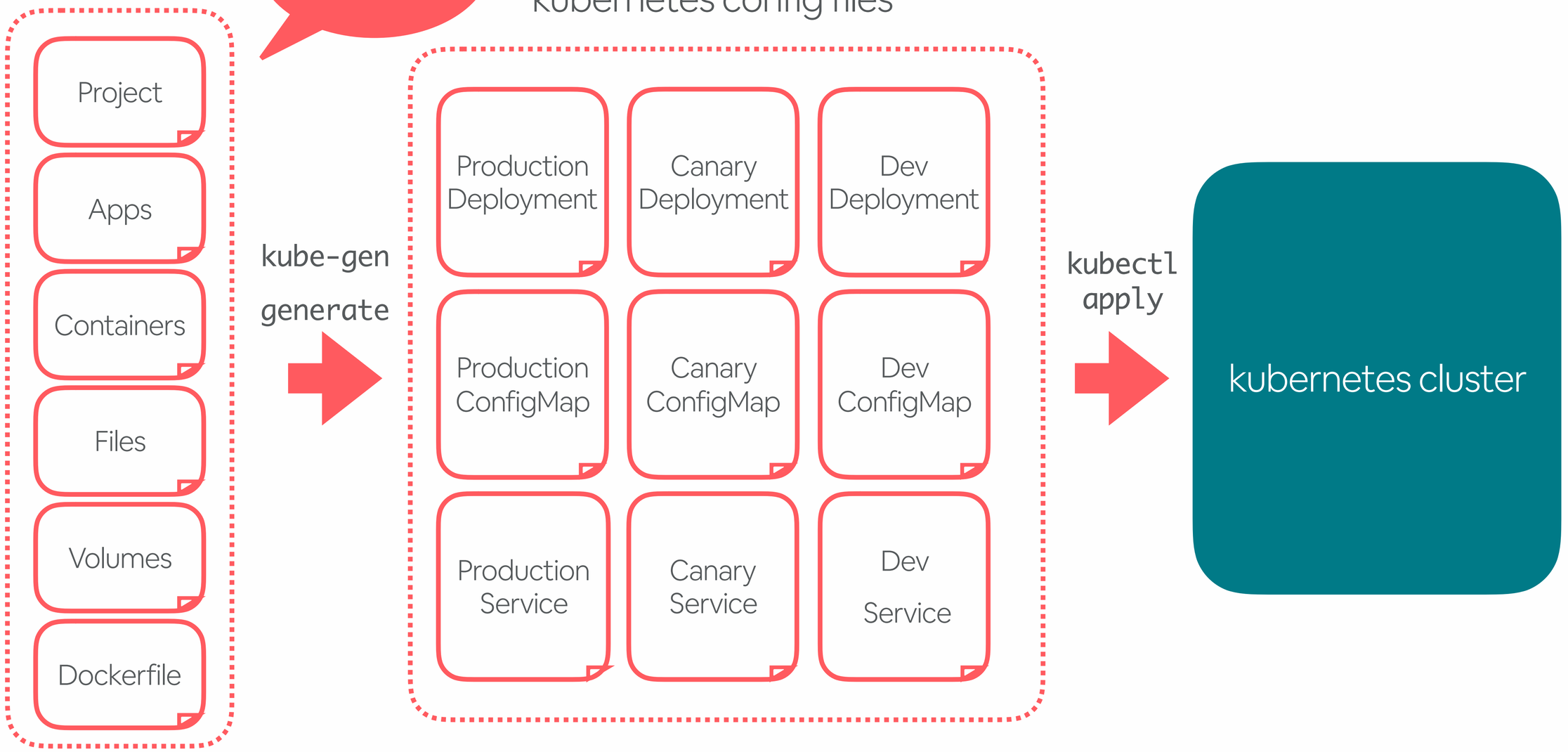


generating k8s configs

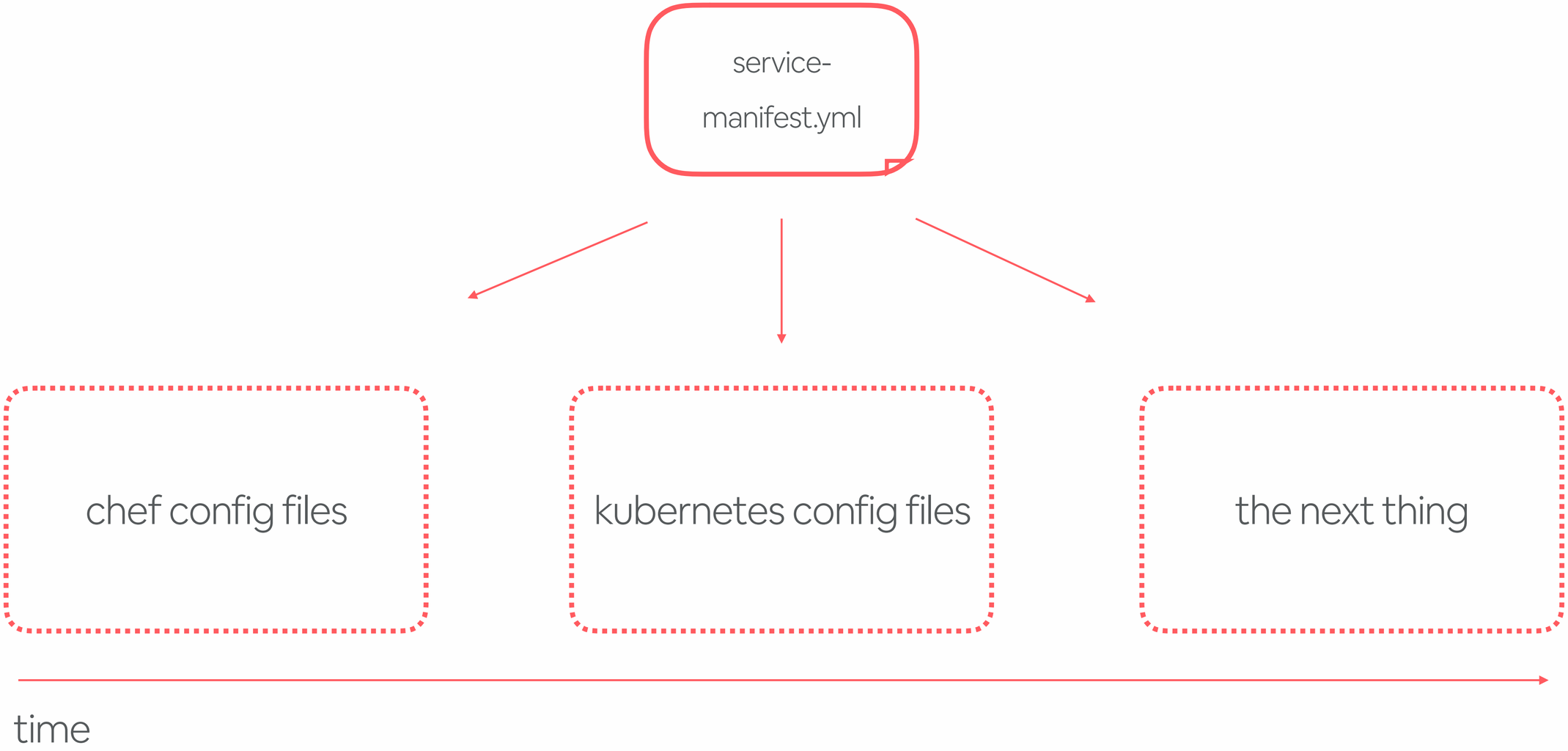


generating k8s

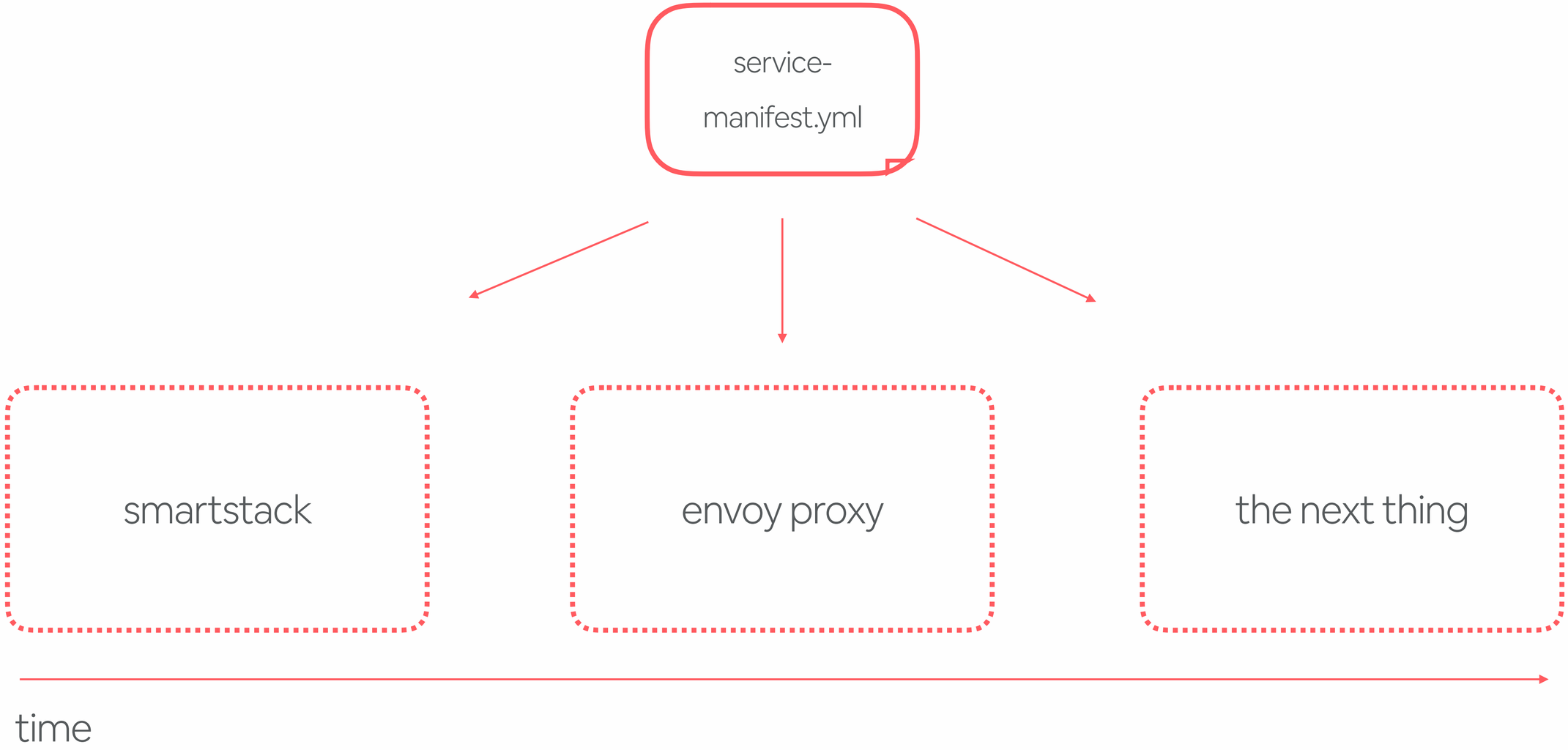
abstraction



better abstraction?



better abstraction?

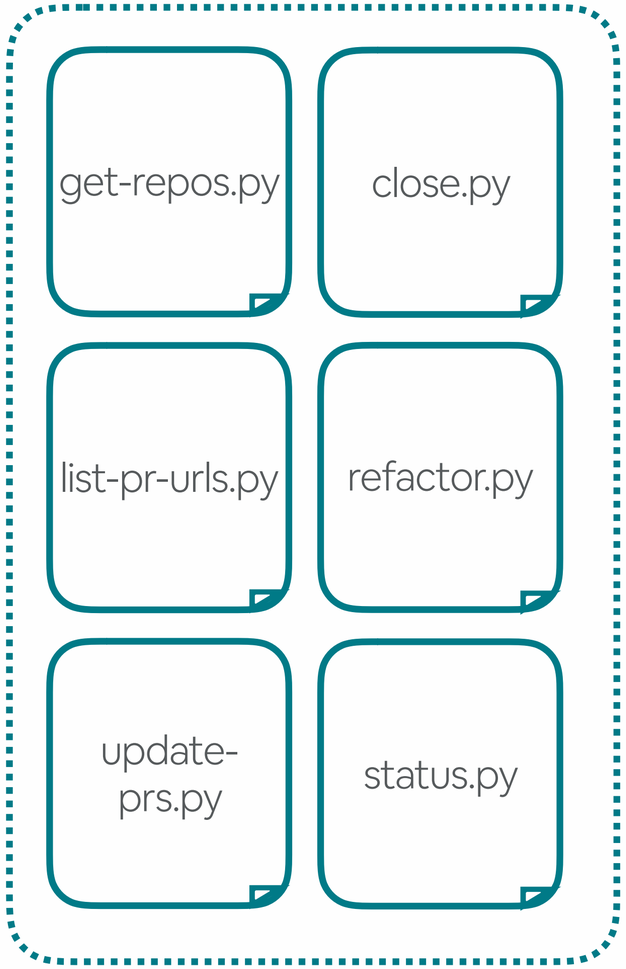


Migration overhead

STRATEGIES

- **standardize on the 90%** use case
- **automatically migrate** for the standard use case
- migrate under an **abstraction layer**
- **migrate programmatically** as a code refactor

How do we migrate programmatically?



refactorator

- service configuration lives alongside application code
- many simple migrations are **automated refactors**
- refactor process is a collection of modular scripts that cover refactor lifecycle

The lifecycle of a refactor

Run Refactor

Checks out repo, finds project, runs refactor job, tags owners, creates PR

Update

Comments on the PR, reminding owners to verify, edit, and merge the PR

Merge

Merges the PR with different levels of force

What do we migrate programmatically?

EXAMPLES

- configuration upgrades (ex: k8s version)
- base image upgrades
- security patches
- changing CI/CD system
- deprecating configuration feature
- migrating monolithic configuration to service code

MIGRATION PROGRAM

Migration strategy: make one person do it

Make one person
do all of it

one engineer enables
and completes entire
migration

Migration strategy: make one person do it

pros:

- very **tight feedback loop** for gaps in the migration process
- **easy to track and finish**

cons:

- scale makes this an impossible long-term strategy

Migration strategy: make devs do all of it

Make devs do all of it

devs are given timelines and asked to self-serve migration before deadline

Migration strategy: make devs do all of it

pros:

- very **low overhead** for overwhelmed infra team
- distributed effort

cons:

- **no feedback loop** for unexpected migration blockers / risks
- **migrations left unfinished**

Migration strategy: an actual migration program

Create a migration program

migration team owns migration end-to-end and partners with leadership and devs to finish

Migration strategy: an actual migration program

pros:

- migration can be systematically **enabled and vetted**
- migration can be **sequenced** with others
- **tight feedback loop** for gaps in the migration process
- distributed effort
- easy to track and **finish**

MIGRATION LIFECYCLE: VALIDATE PHASE

Validate Phase

DOES IT WORK?

- a design document
- a prototype
- tie in with overall roadmap
- stress test with early users
- ***iterate until...*** you're convinced you've fully validated the technology

Validate Phase

AIRBNB EXAMPLE

- k8s design document
- a prototype (cluster, simple k8s service)
- tie in with service discovery migration plan
- stress test with high-latency low-thoroughput services

MIGRATION LIFECYCLE: ENABLE PHASE

Enable Phase

MAKE THE MIGRATION WORK

- build tooling
- build abstraction layer
- make the new thing the default
- write documentation & code labs
- programmatically migrate the 90%
- ***iterate until...*** you're convinced you've fully enabled the migration

Enable Phase

AIRBNB EXAMPLE

- new project tool, CLI tool, integration with CI/CD tooling
- k8s abstraction layer
- new services are created with new project tool
- docs, code labs, and training classes
- migration tooling

MIGRATION LIFECYCLE: FINISH PHASE

Finish Phase

IS EVERYTHING CUT OVER?

- migration plan and sequencing
- programmatically migrate services
- engage with leadership
- set and track across migration goals
- work with devs to identify ongoing risks & blockers
- be prepared for migrations to get harder to finish towards the end
- ***iterate until...*** you've fully migrated to the new system

Finish Phase

AIRBNB EXAMPLE

- phased migrations to k8s
- engage with leadership across business units (dev teams)
- set and track across migration company goals
- TPM & PM work with devs to identify ongoing risks & blockers
- migration-specific documentation & tooling (80% of dev services)
- eng runs office hours to help with tricky migrations
- still working on this phase!

10 Takeaways

1. identify migration type to determine overall complexity and risk
2. run frequent, efficient, and tightly-scoped migrations
3. sequence, prioritize, and parallelize migrations
4. long-term planning, forecasting, and stress-testing to avoid surprise migrations
5. make the new approach the default
6. fully finish migrations to reduce tech debt
7. develop abstractions over infrastructure
8. run migrations as code refactors
9. run a migration program with a migration lifecycle
10. iterate on your migration to ensure its fully validated, enabled, and finished