Canarying Well

Lessons Learned from Canarying Large Populations (and small ones, too)

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Canarying: What is that?

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  - Canary breathes faster and is smaller, getting affected faster than a human.

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- And apply to production systems…
  - We have a large service we want to sustain
  - We are okay losing a small chunk of it
  - We deploy production change with unknown impact to that small chunk, to detect danger

What we’re going to talk about

- Canarying as an A/B test of production systems
  - Specifically automated A/B test
  - No humans required to make decision
- Lots of illustrative examples
- Simple rules of thumb to get canarying quickly

What we’re not going to talk about

- Any particular technology to use for canarying (or monitoring, or deployment)
  - Your organization’s technology stack will likely dictate requirements anyway
- Statistics, accurate numbers, accurate math
  - There’s more knowledge on that in the audience :-)
  - Everything is illustration!
- Cover all important aspects of canarying
  - That’d take too long

To Canarying!

Conflicting Incentives

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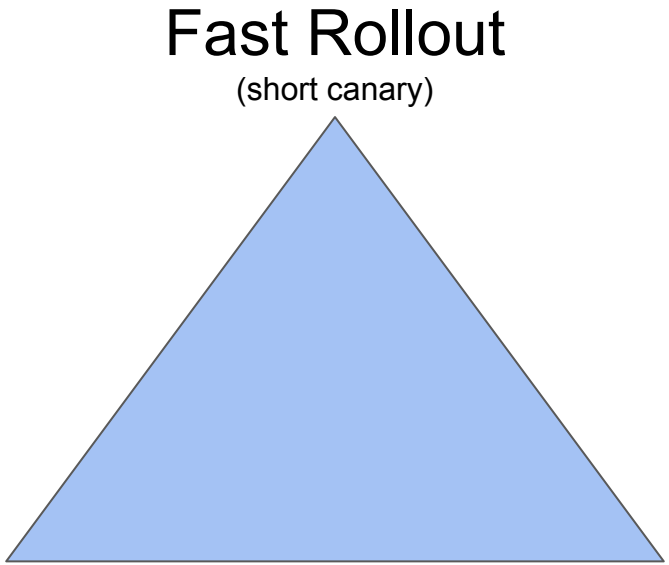
- Population size
  - You want small population, to minimize the impact on your service
  - You want large population, to maximize statistical significance of findings
- Metric selection
  - You want many metrics, to cover as many failure modes as you can think of
  - You want few metrics, to avoid increased risk of random benign failures
  - Extra: Some metrics *need* large population, or longer canarying time, or...

Triangle Of Canarying Priorities



Triangle Of Canarying Priorities

- Need to ensure balance between the three goals

- Want fast rollout?
  - Might need to compromise on large coverage, or small blast zone
- Want small impact of a bad canary?
  - Might need to compromise on large coverage or fast rollout
- Want large metric coverage?
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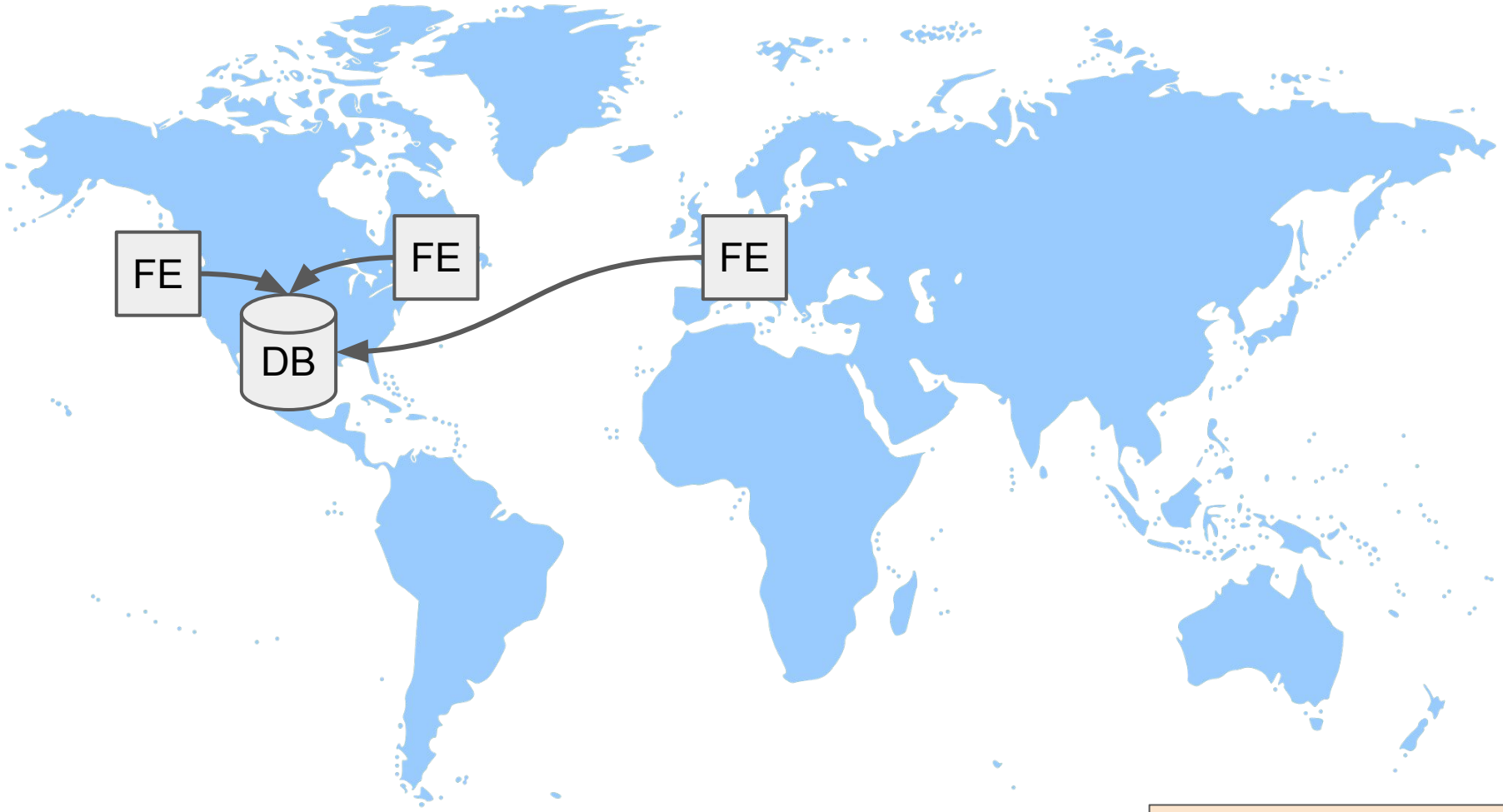
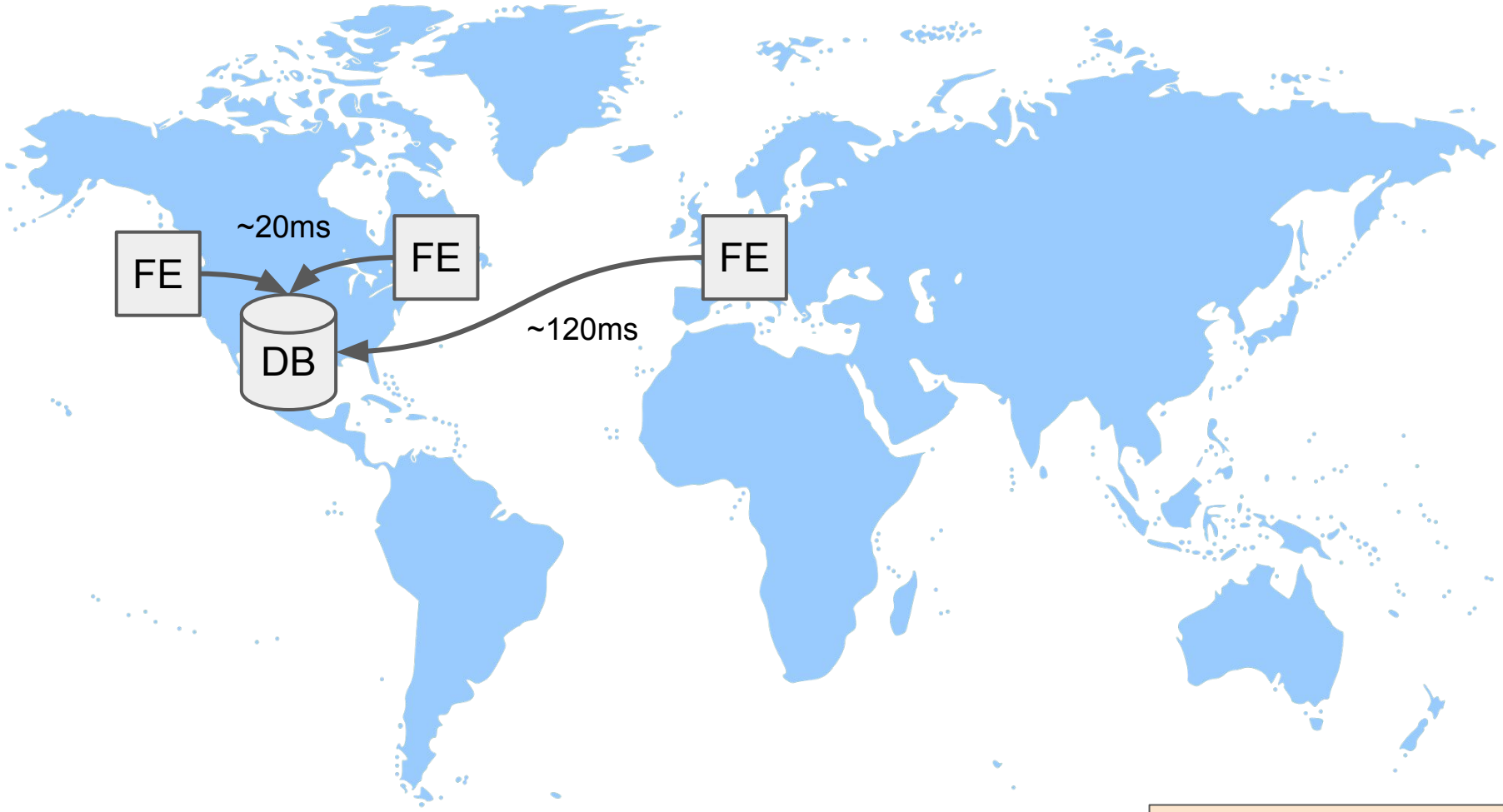
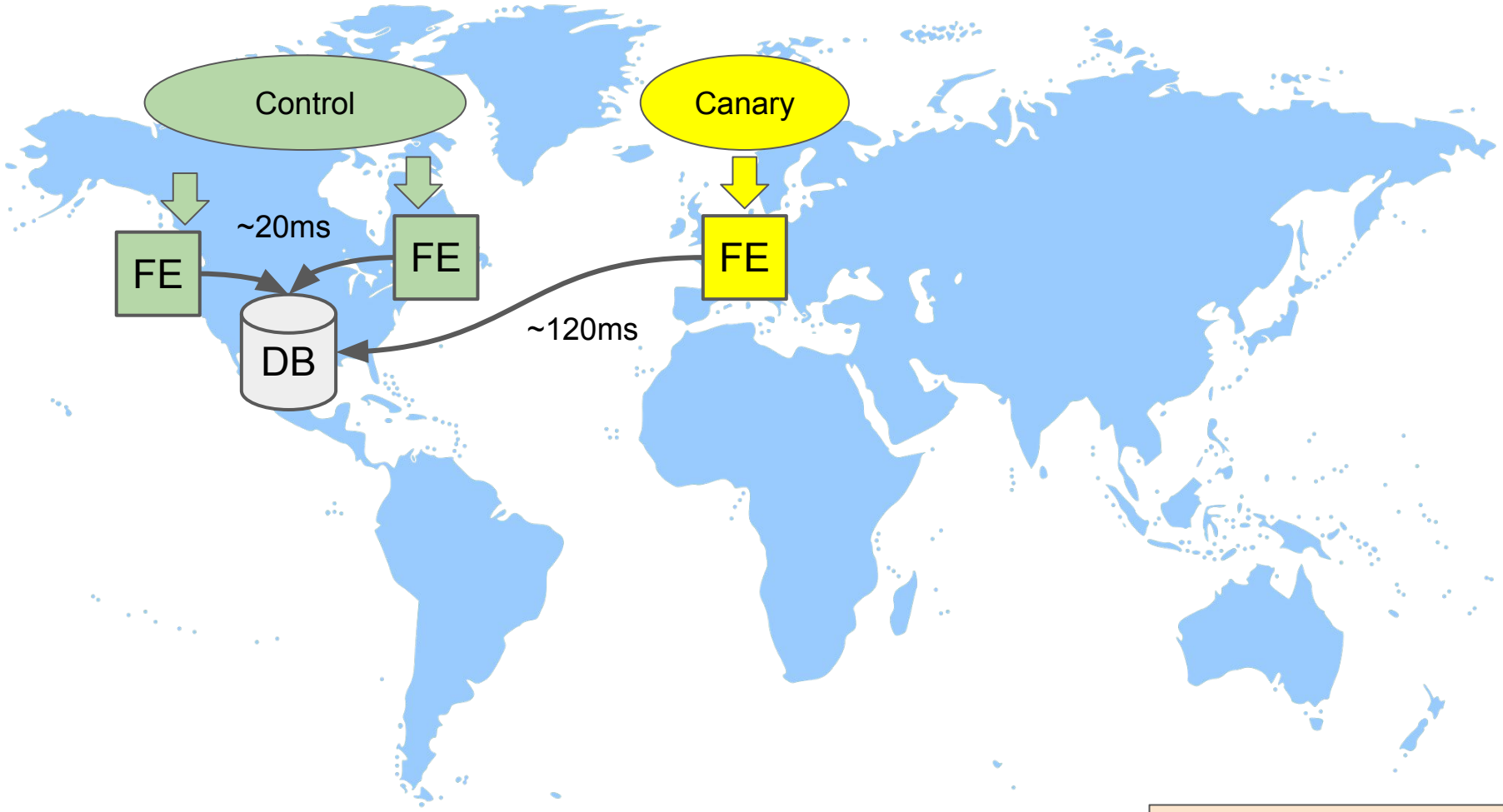
- Ignore these → increase risk of flakey canarying
  - As with all rules of thumb, this is not universal truth
  - Importantly, this is not binary! You don't really "*give up*" fast rollout, you compromise on it

Canary Population

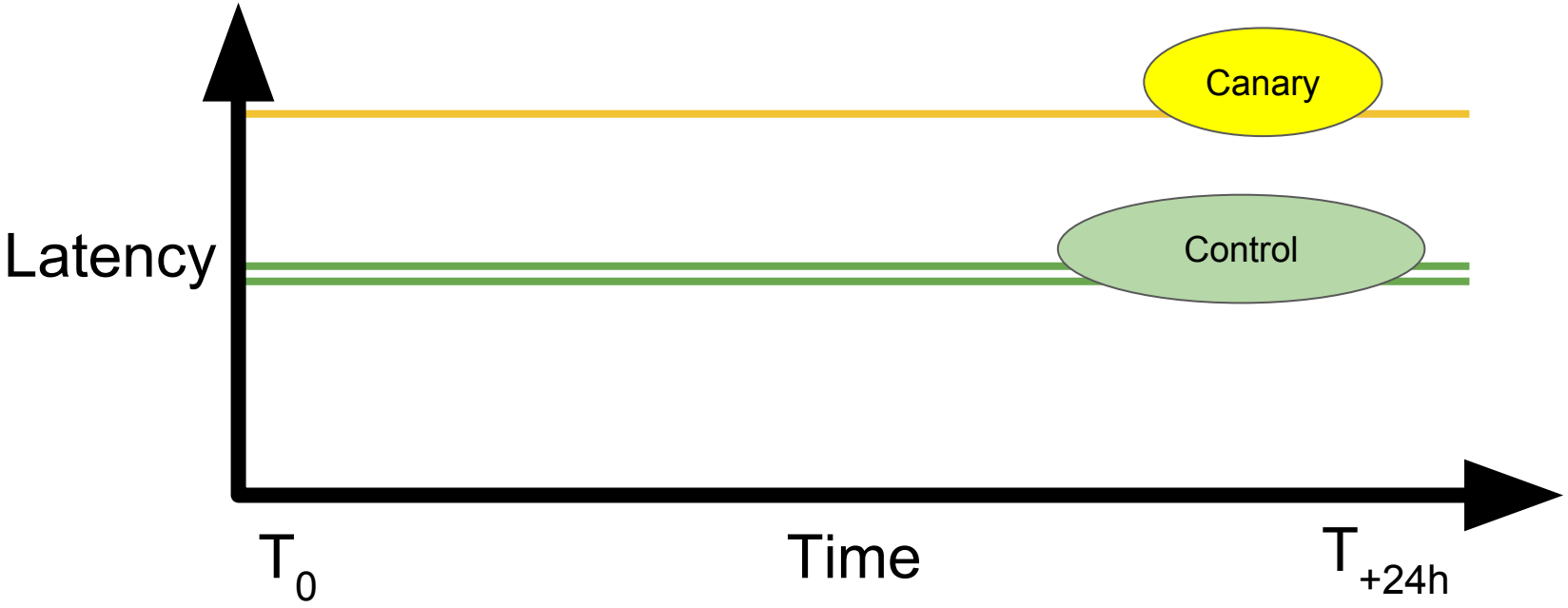
apples to apples







Example: Geographical distribution



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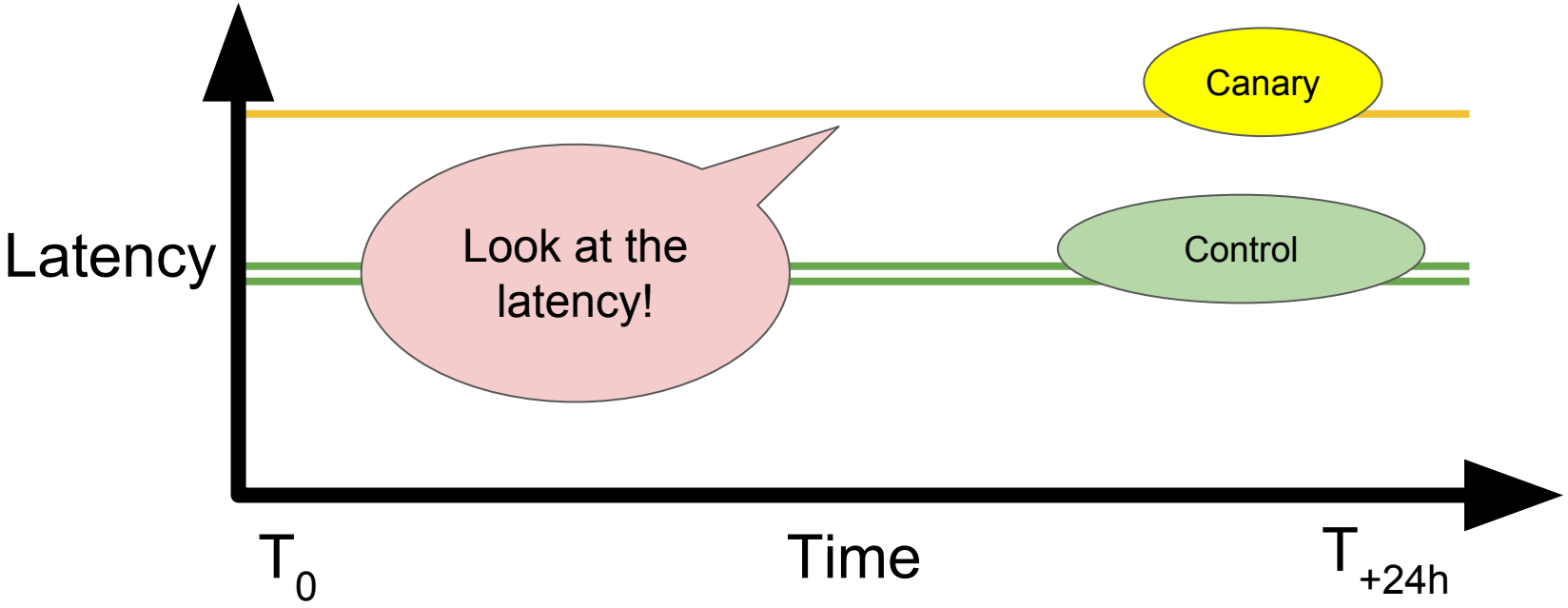

Example: Geographical distribution

- We’ve seen a 100ms increase in latency for our canary!

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- We’ve seen a 100ms increase in latency for our canary!
  Hang on a minute…

- We have observed that new release *and different continent* have a significant slowdown
  - Maybe not what we wanted to measure?

Takeaways

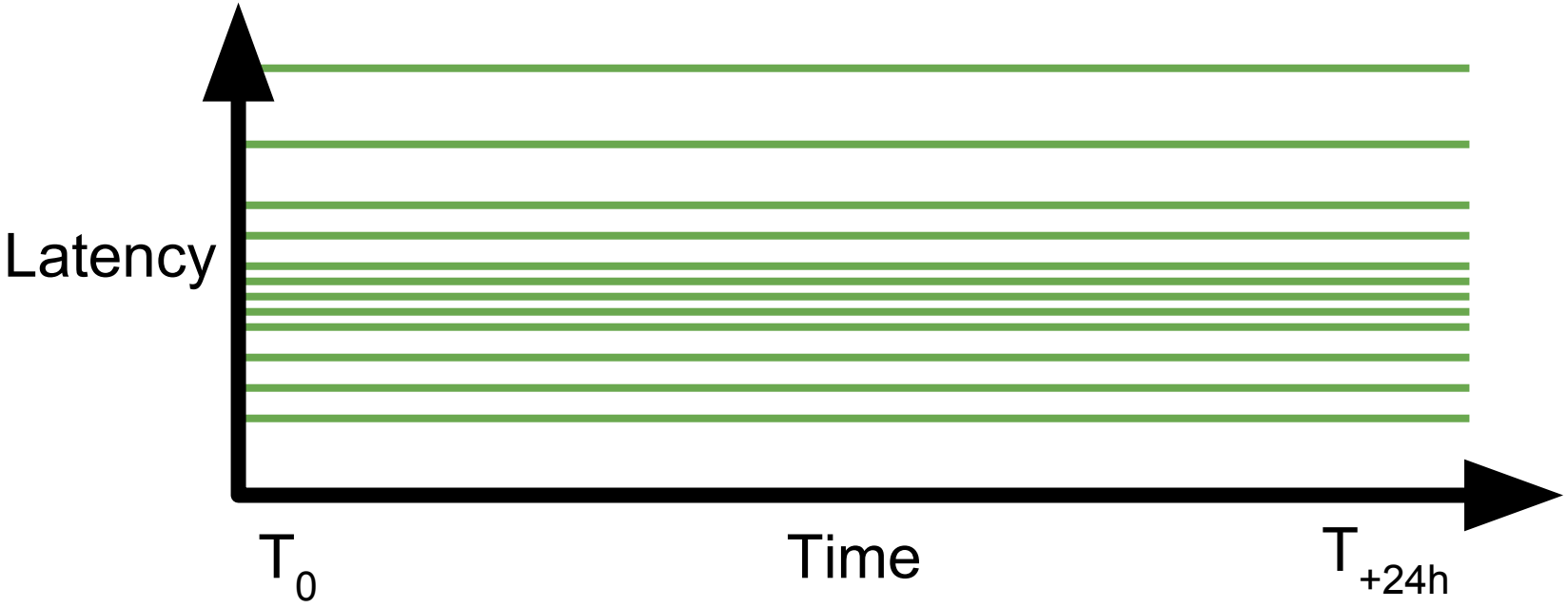
- It’s important to compare apples to apples
  - Better solution here would be to compare within a continent
  - Or to take slice of service in each continent, and compare it within the continent

- Your goal is to judge whether the production change is good
  - ...but what *other* things have you accidentally picked up in the process?

Canary Population

high variance behavior

Example: High variance among replicas



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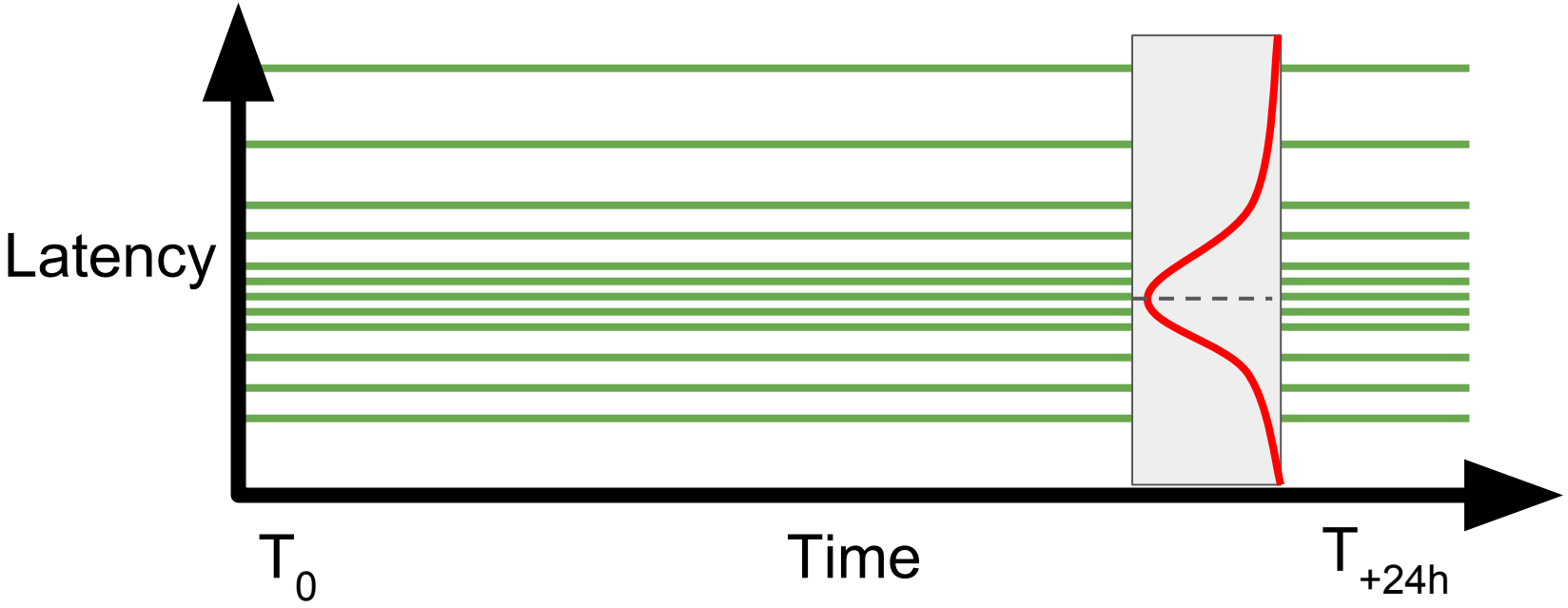

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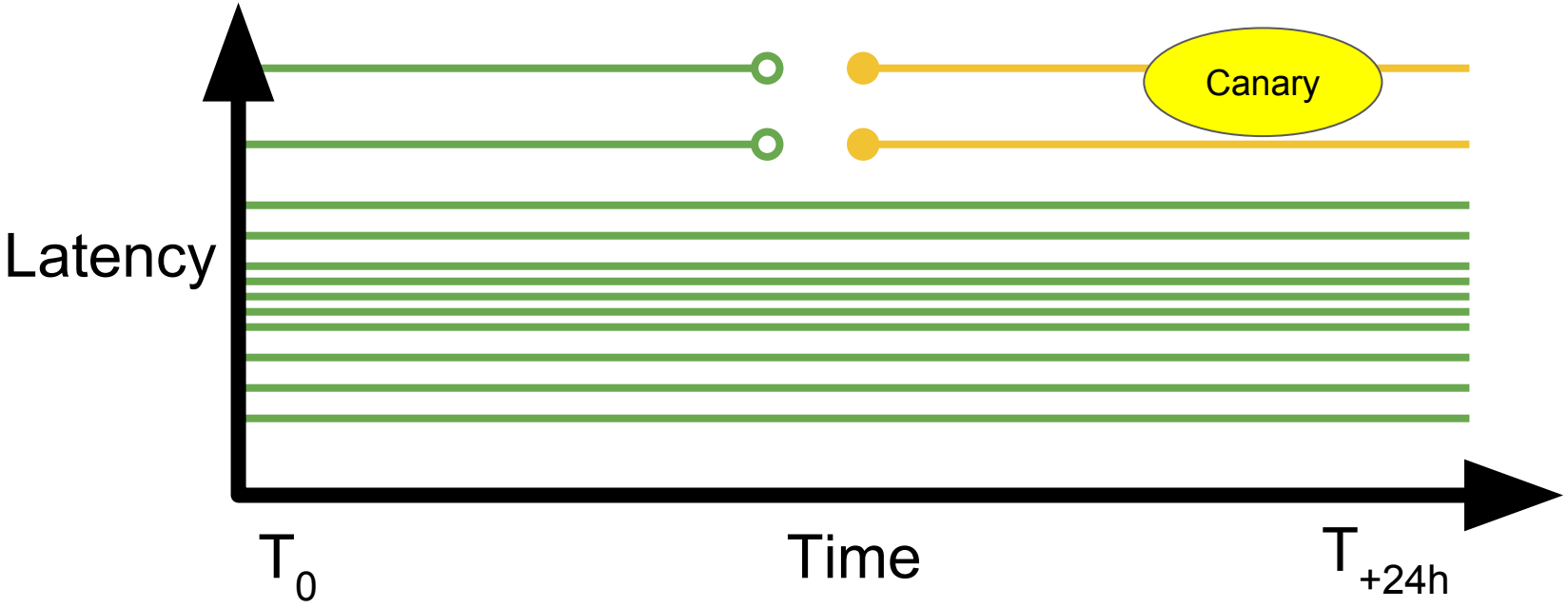

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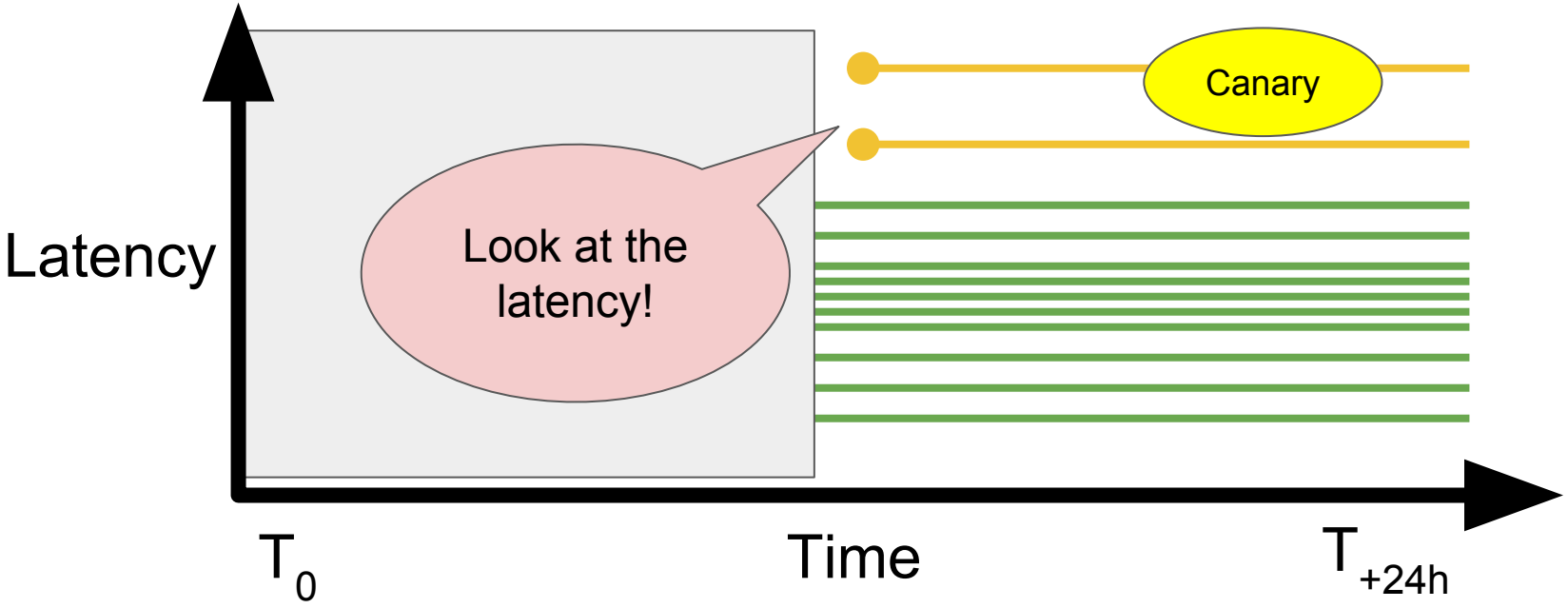

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- Selection process need not be random to cause problems
  - Consistently going from first replica to last replica is random in relation to the metrics!
  - Selection process is often oblivious to the metrics
  - Worse: There is often no single good solution to canary selection!

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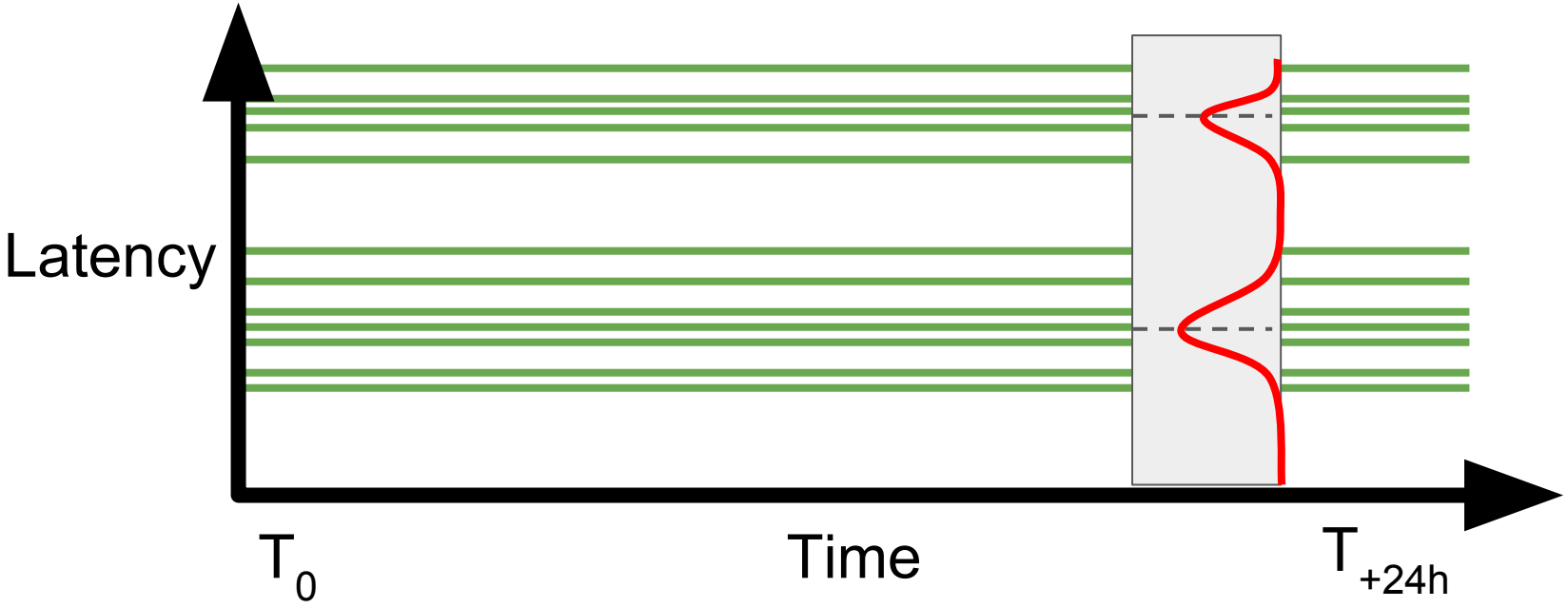
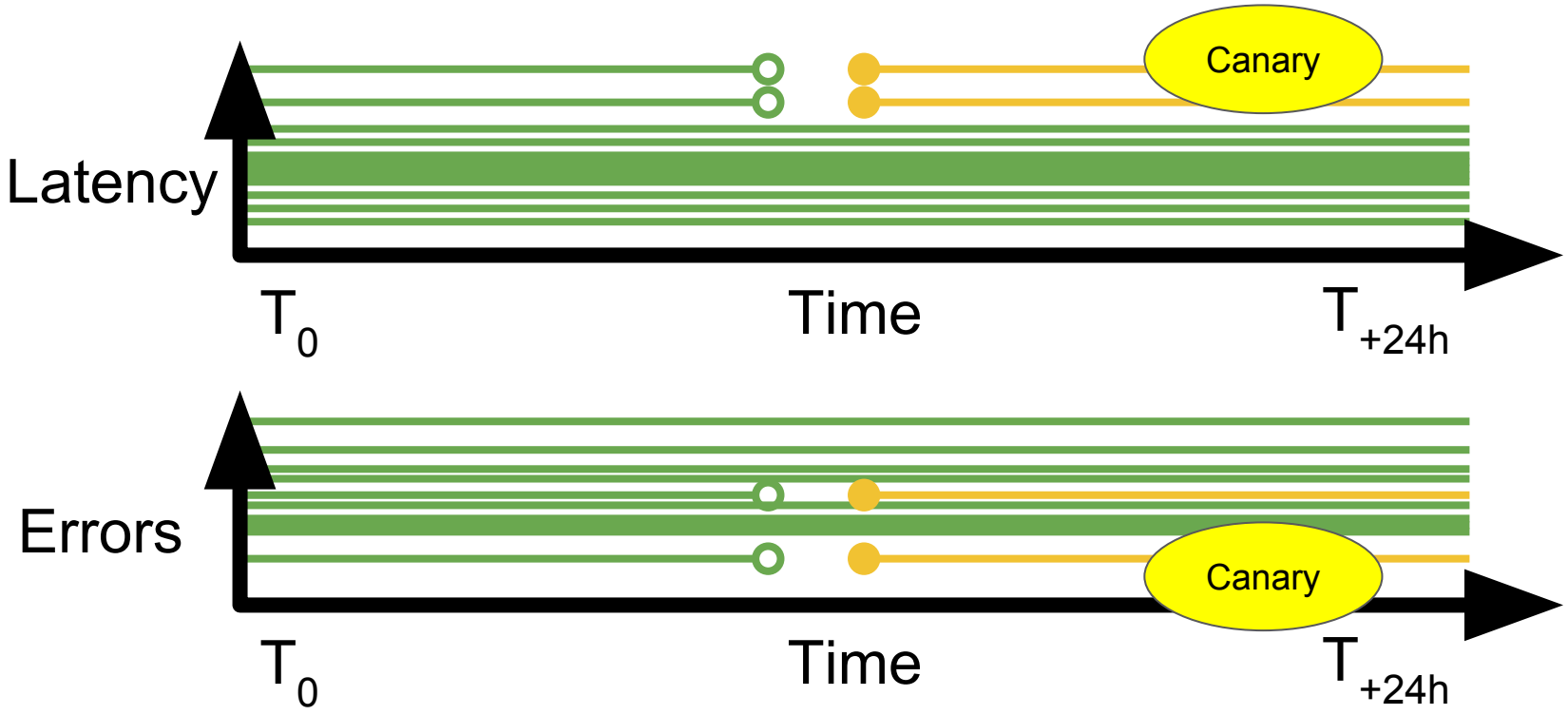
  - Worse: There is often no single good solution to canary selection!
- Before/after information can help, but it has its own pitfalls
  - More on that later

Example: Bimodal distribution

(Two server platforms?)



Example: Two metrics, different outliers



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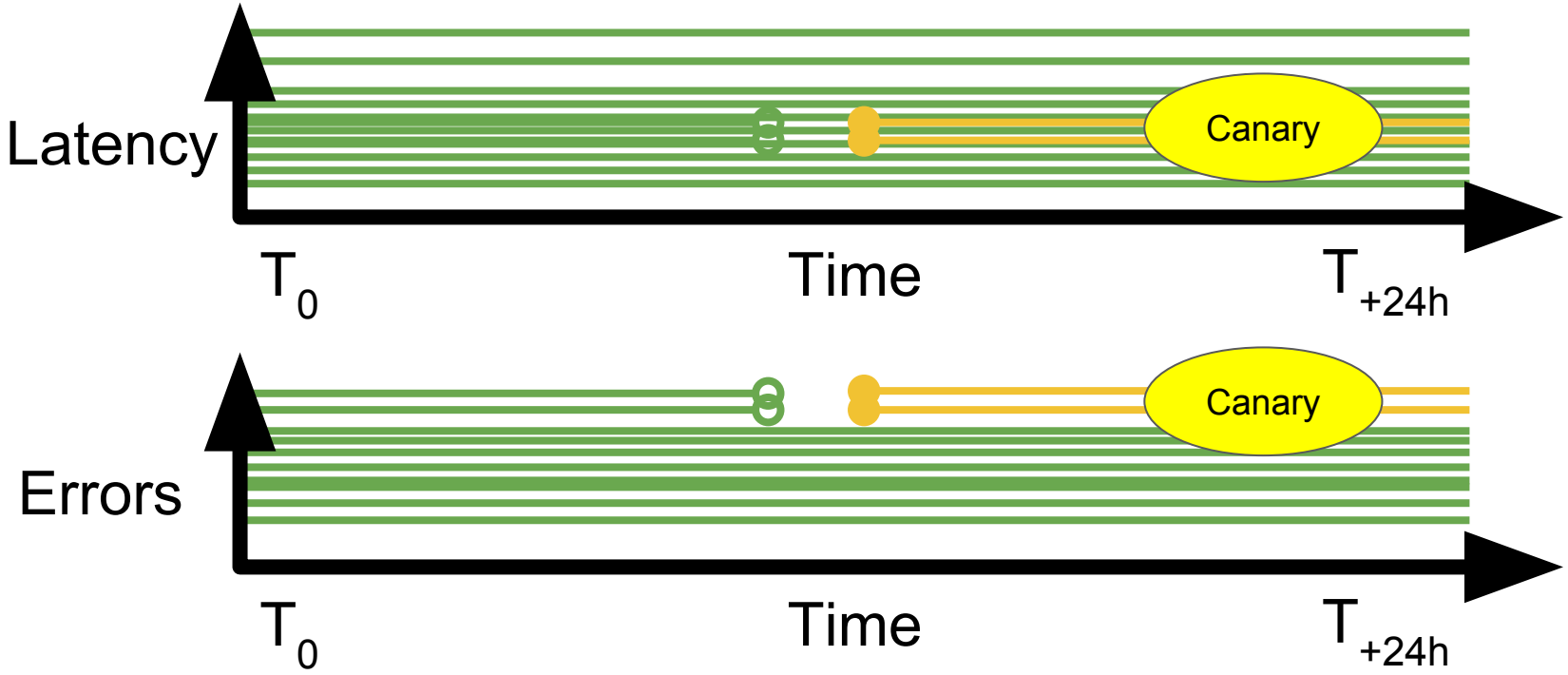


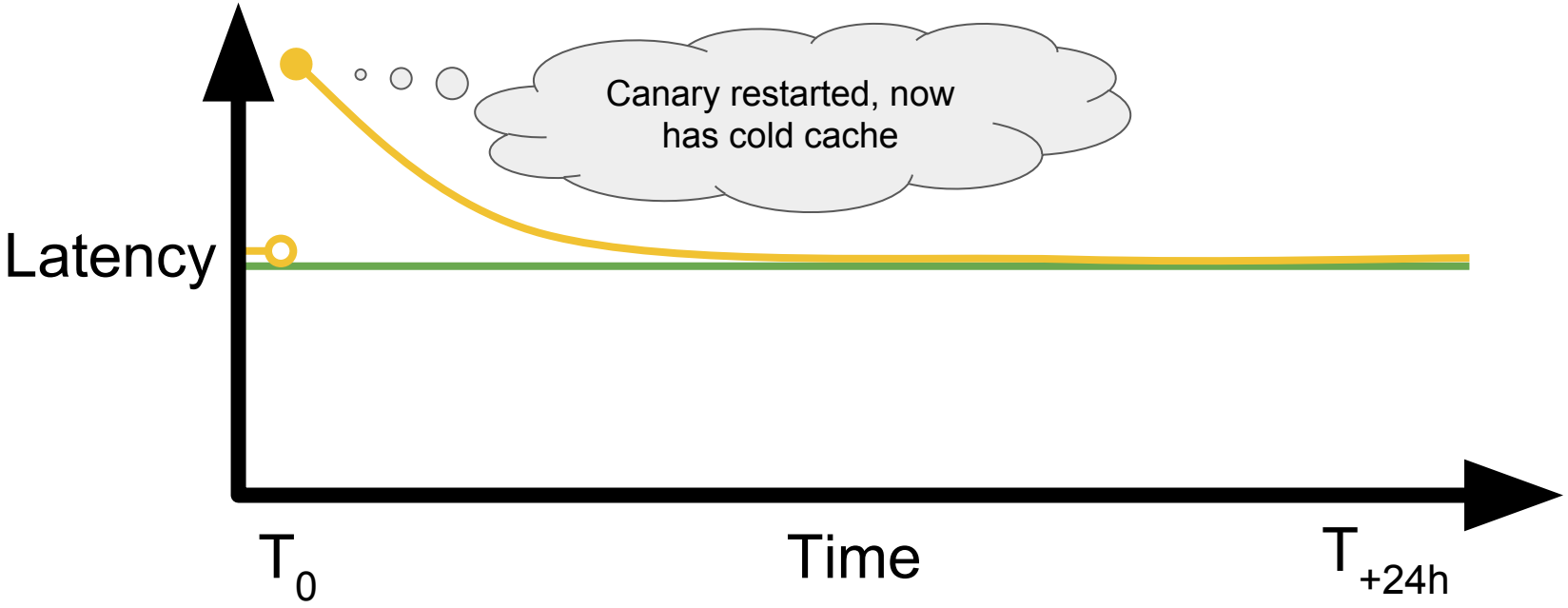
Takeaways #2

- The input data can be almost arbitrarily distributed
  - For multimodal data distributions, clustering methods may be very helpful
- Metric distribution depends both on population and metric
  - Example: crashes may be the same regardless of platform, latency might vary greatly
- Any two metrics can follow different distributions for the same population
  - Decisions on handling data are on *{population pair, metric distribution}* basis
  - No silver bullet for the entire population
    - Unless you have some domain specific prior knowledge…
- Your canary process might need to drop some metrics tests
  - There might not be a single canary selection that avoids outliers for all metrics!

Canary Duration

testing post-startup Behavior

Example: Service With Cache



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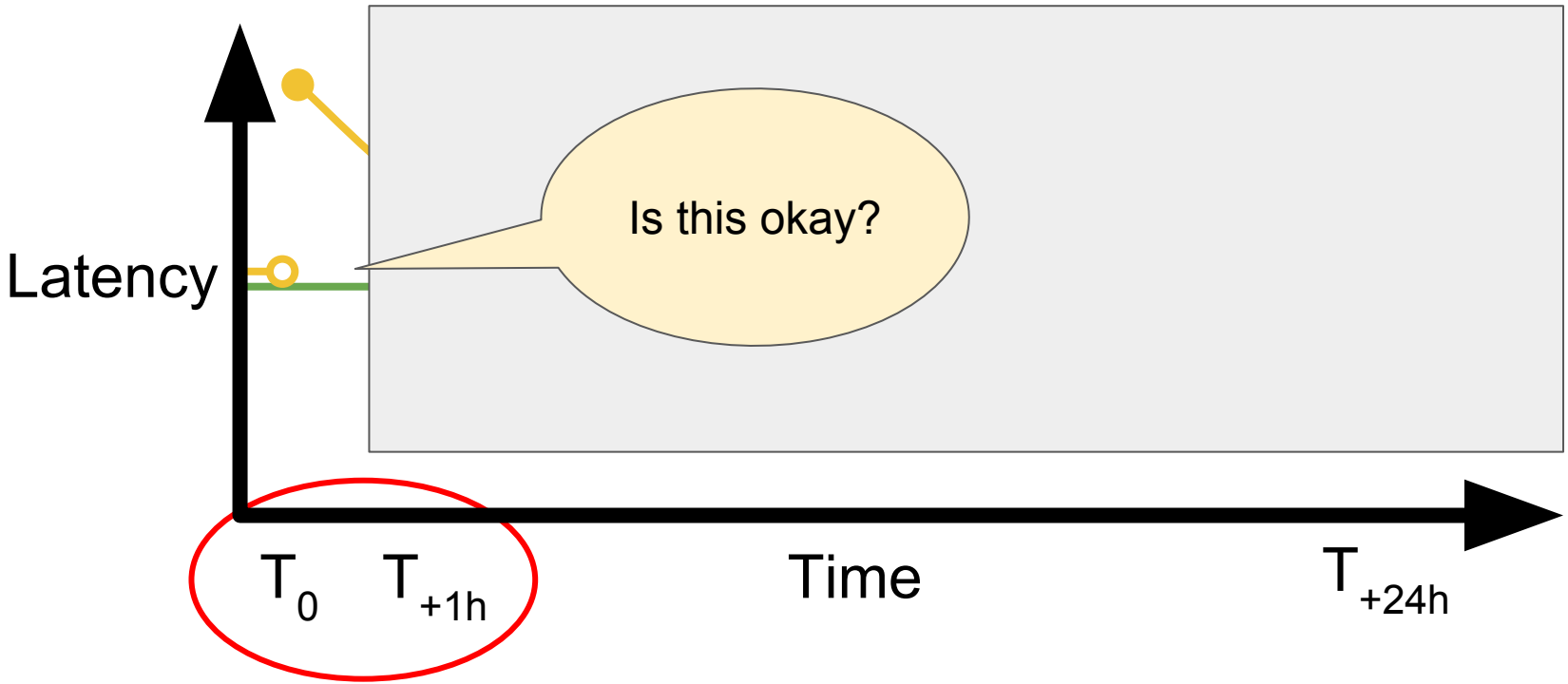

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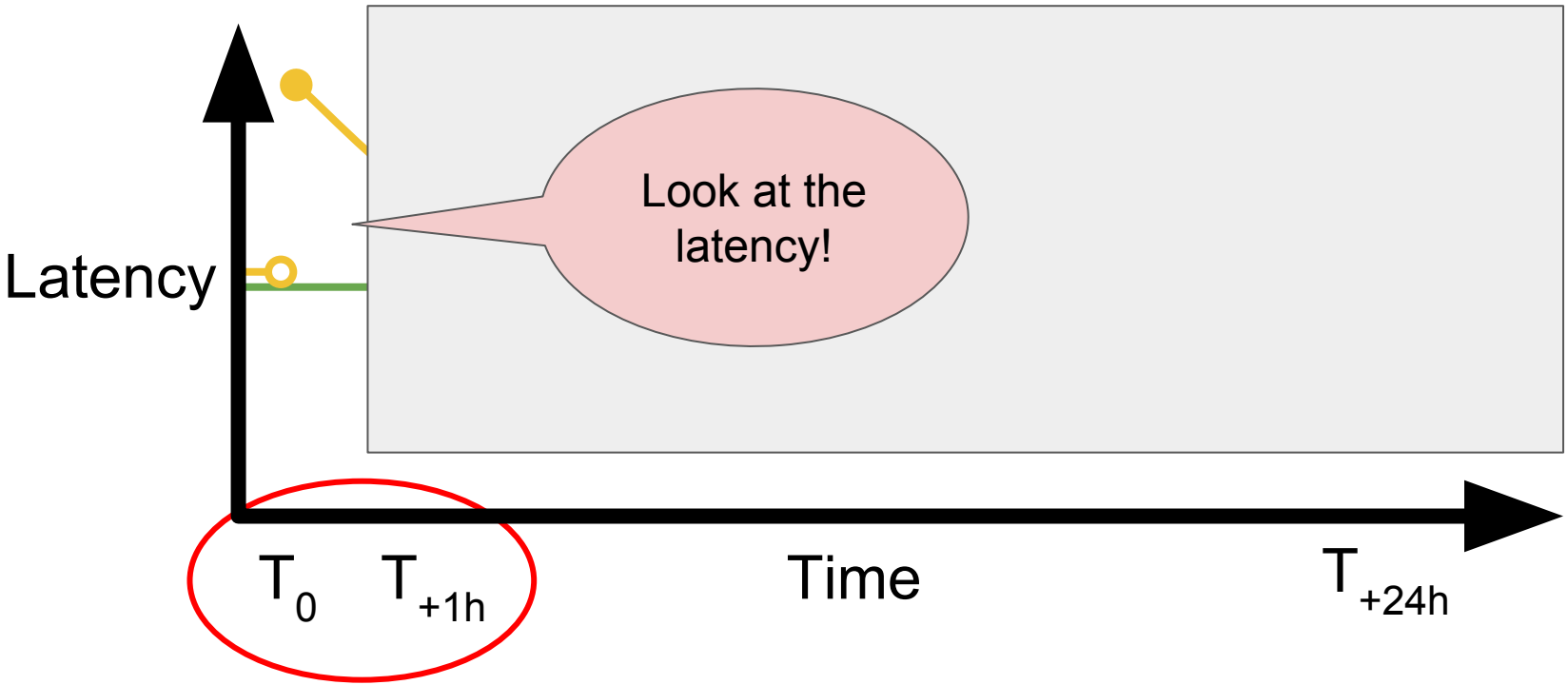
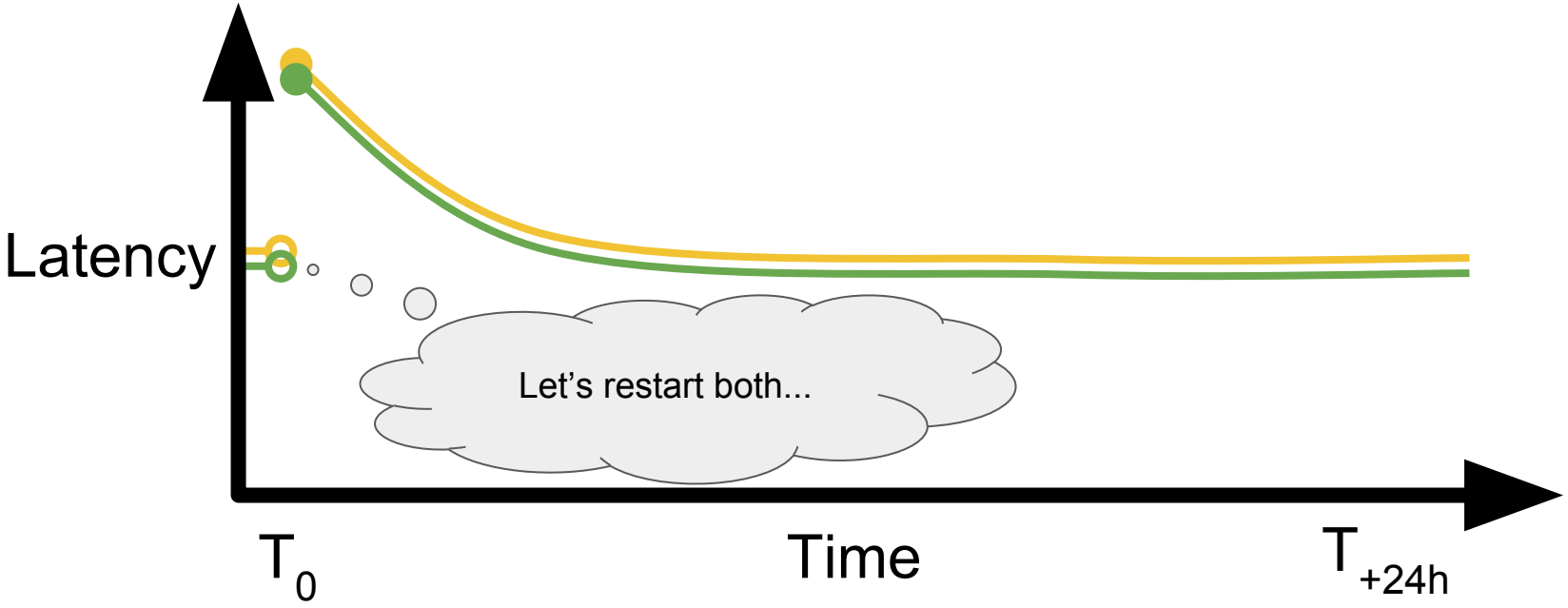


Example: Service With Cache

- But can’t I just restart some fraction of control too?
- Then I’m comparing apples to apples...

Example: Service With Cache, restarted



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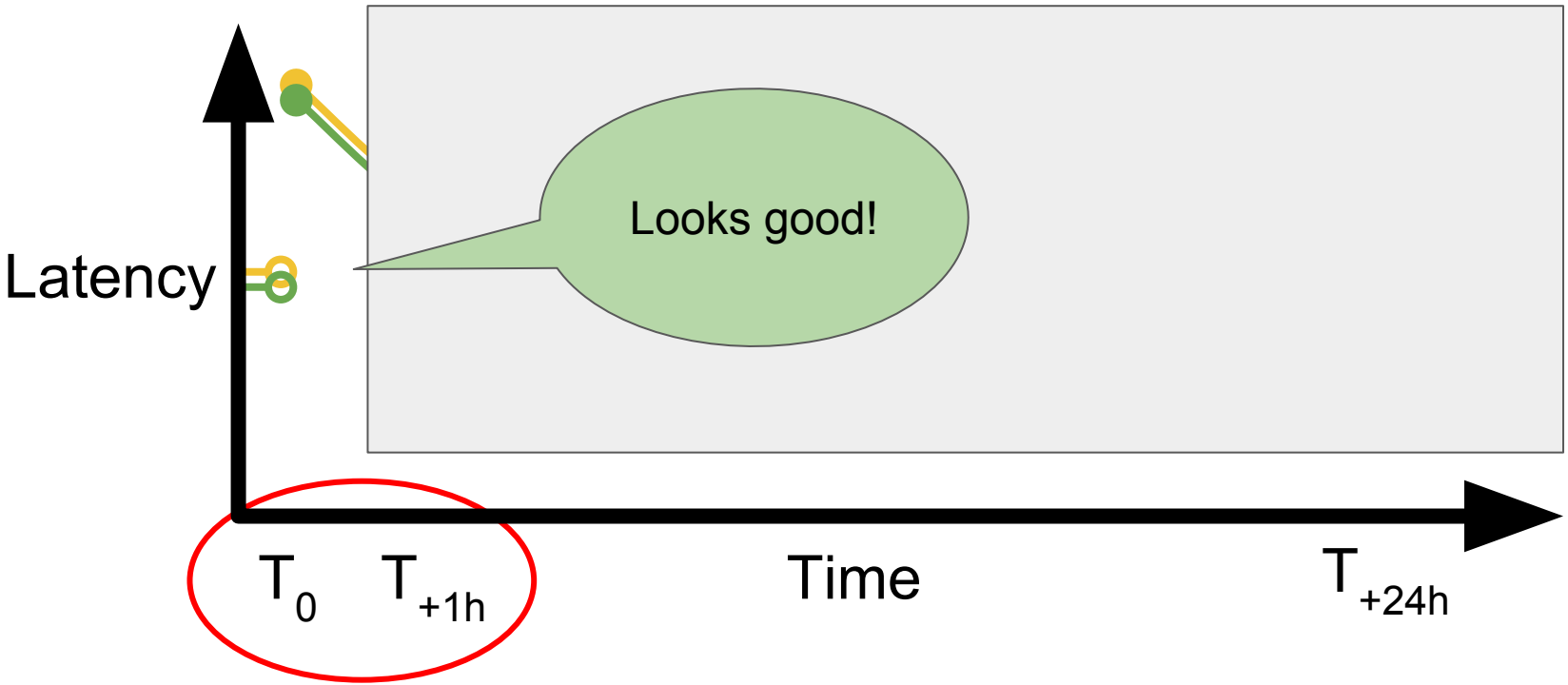

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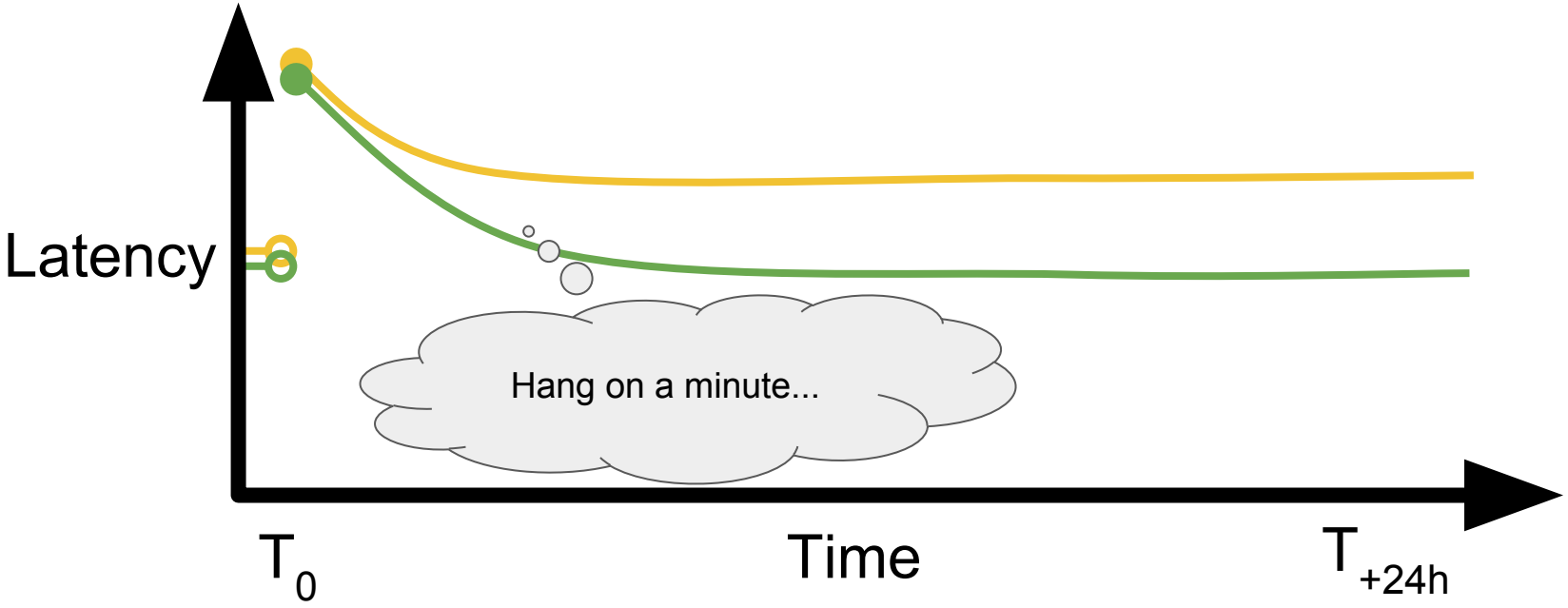

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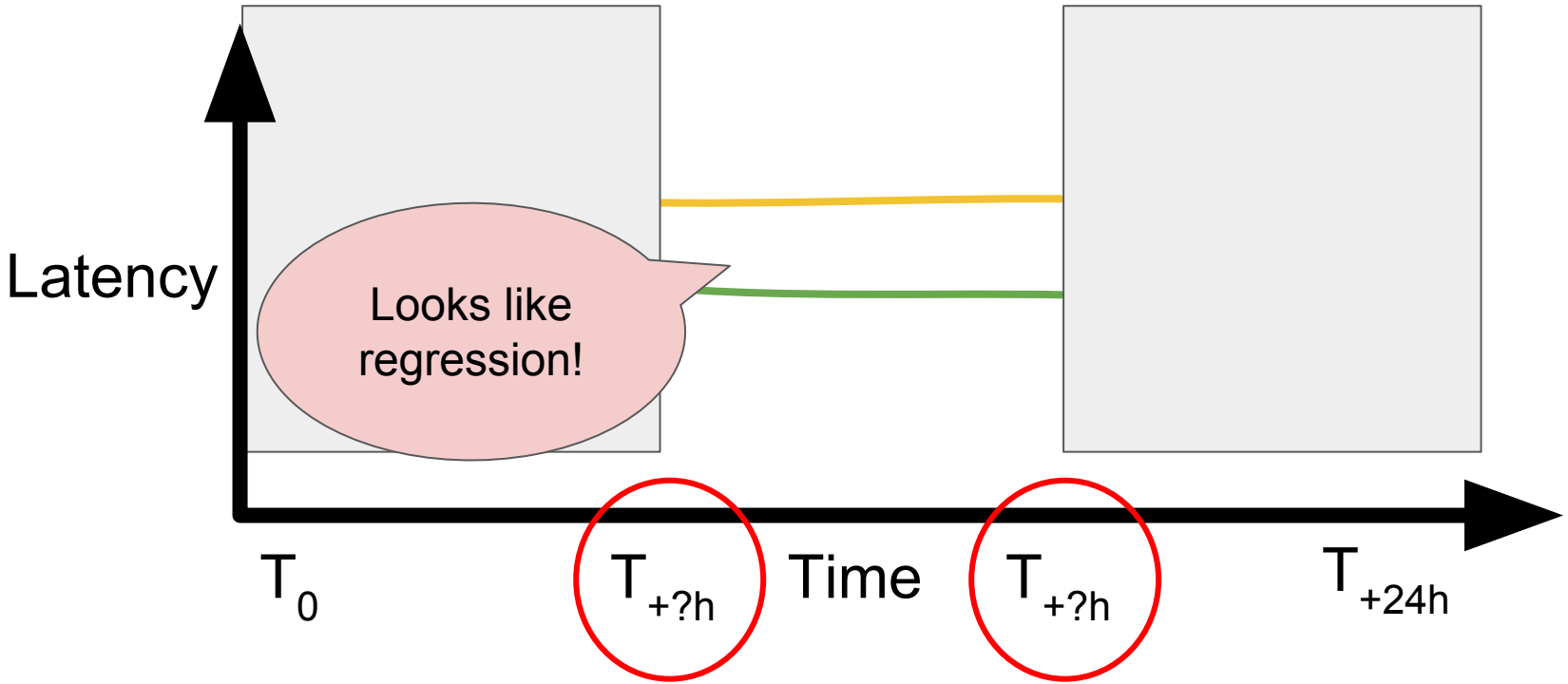


Takeaways

- Restarting fraction of control often doesn’t yield good results

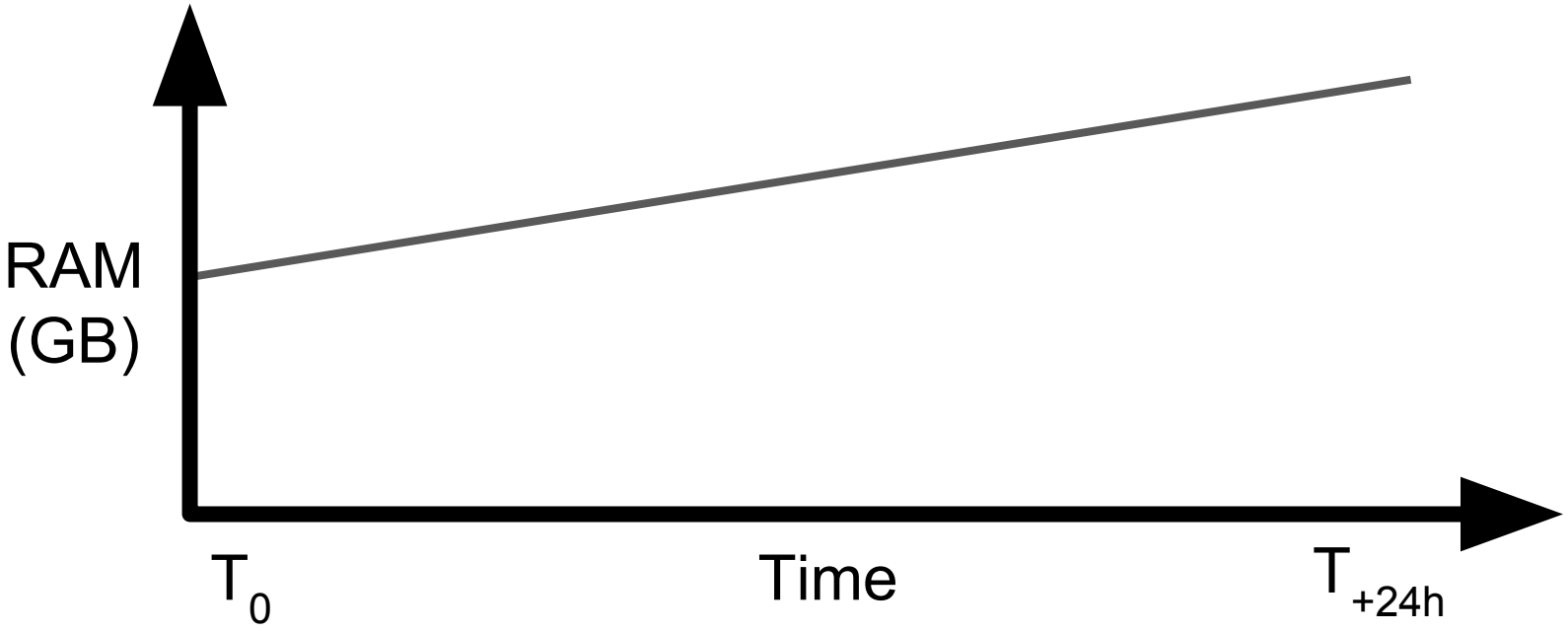
- You are deciding the fate of apples by comparing oranges to oranges
  - Apples are how the service operates, oranges how it starts up
  - It needs to be connected to the thing you actually meant to decide

- Instead: Identify “*point of stable operation*” and canary from there
  - This will take extra time in your release process, but it’s unavoidable if you want to measure the actual service behavior, rather than its post-startup behavior

Canary Duration

testing long-term trends

Example: Memory leak canary



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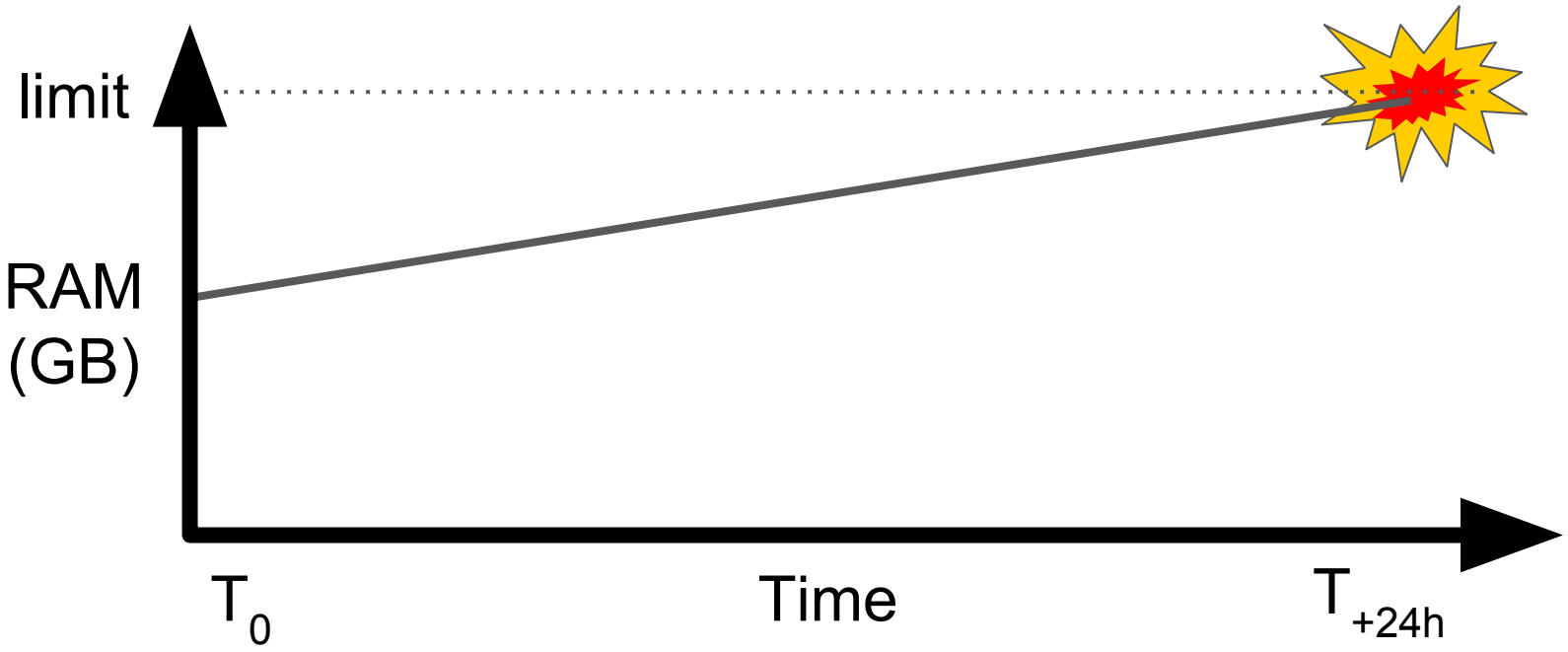

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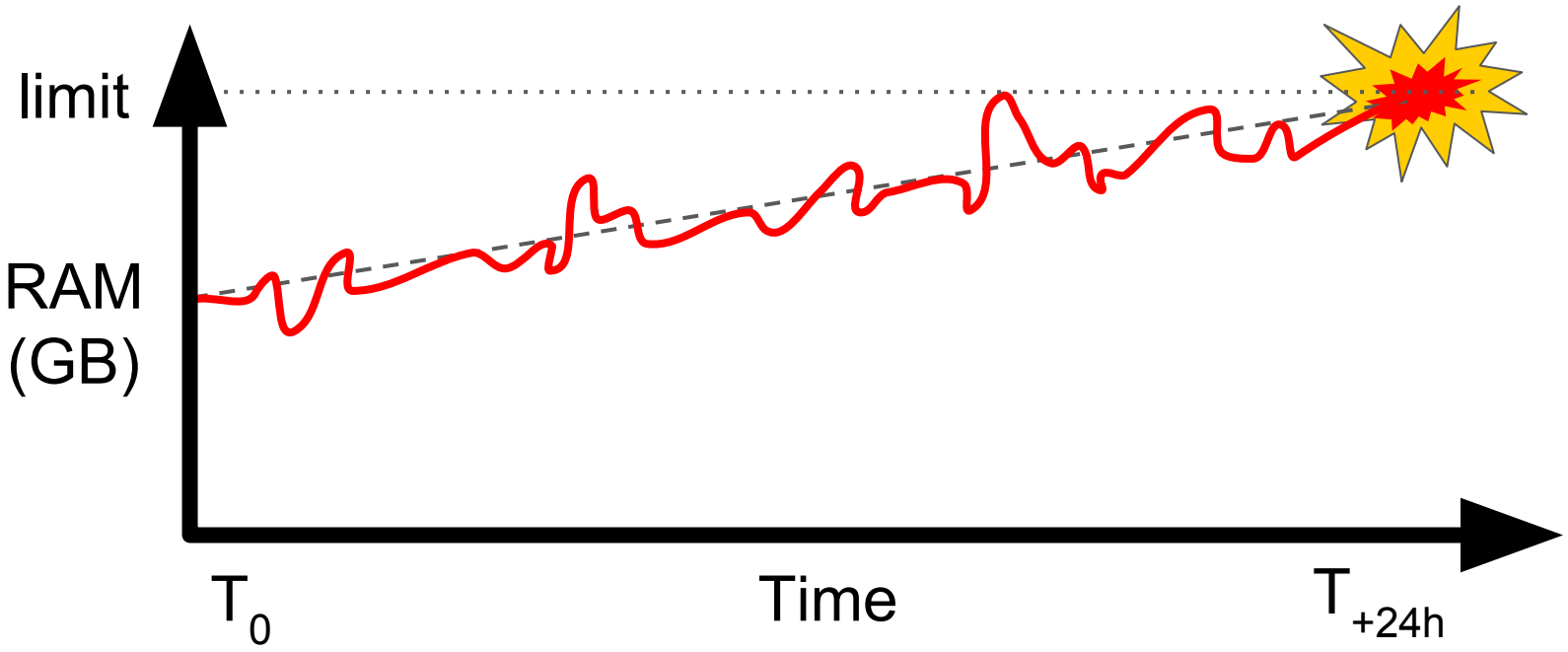

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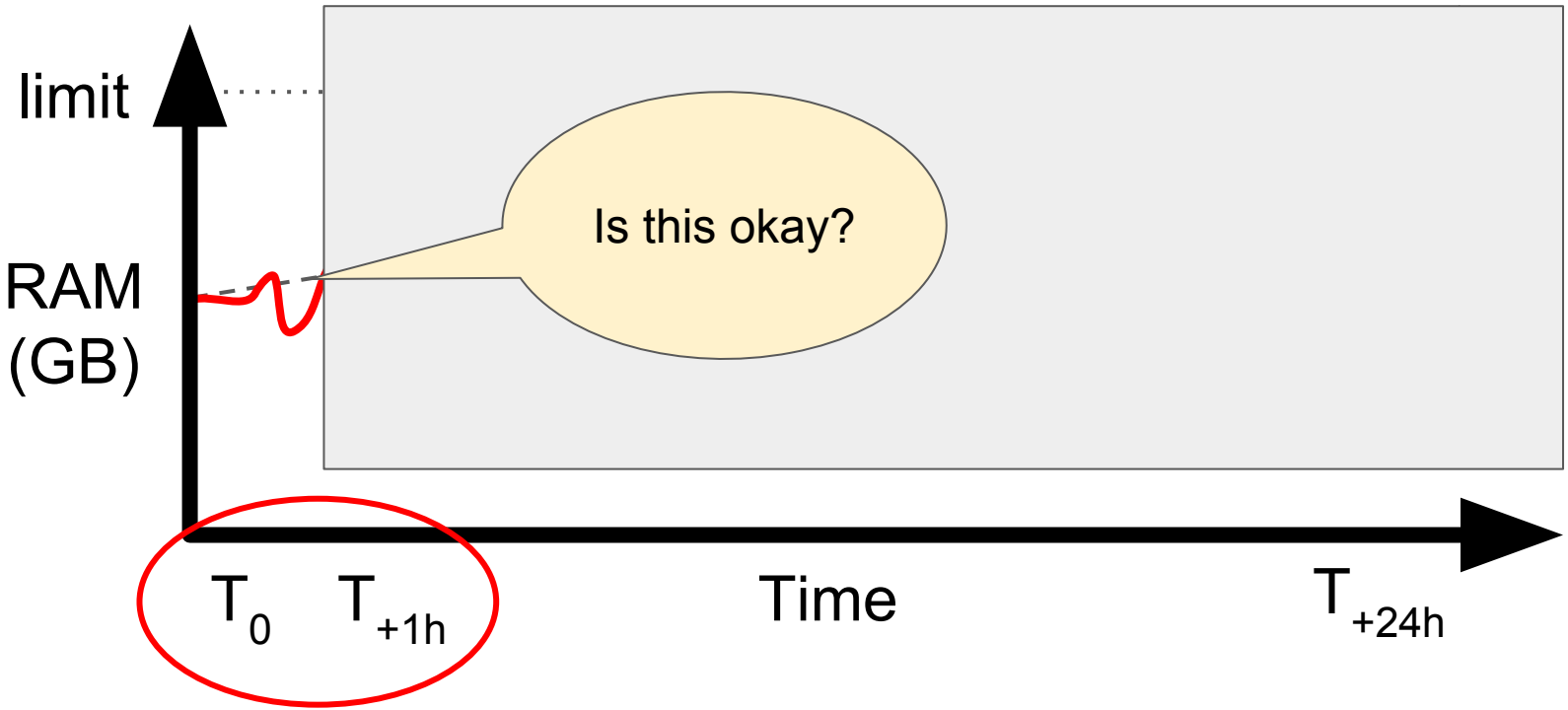

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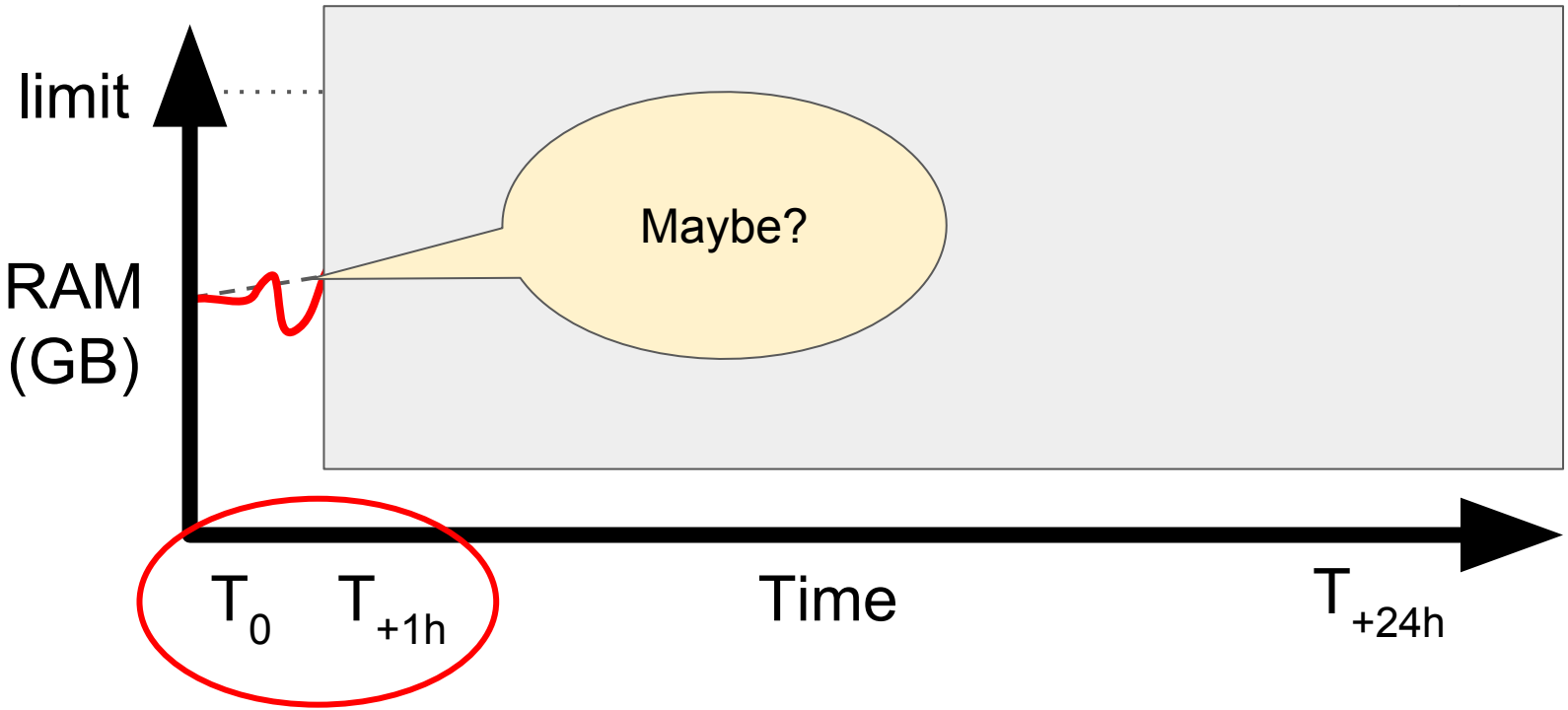


Takeaways

- Detecting memory leaks with canarying may require long canarying
  - Pushes us away from “fast rollout (short canary)”
- Not all memory-based tests require long canary
  - What if your canary unexpectedly has 2x memory usage than your control right after start?
  - Easy to detect quickly!
- Canarying doesn’t obviate the need to monitor
  - Recall canarying is time-limited!

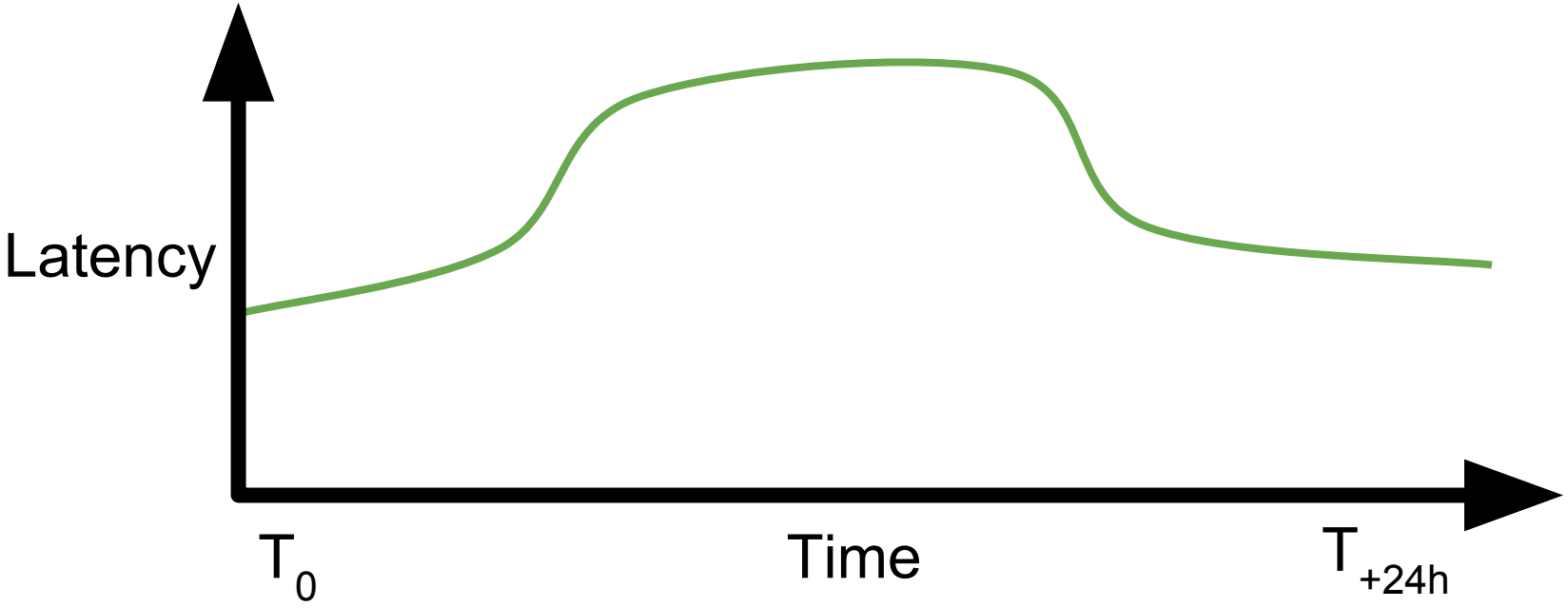
Canary Duration

before/after test

Before/after test

- With all these problems, maybe I can just quickly deploy?
  - We have fast rollback mechanism, we won’t hurt service terribly poorly...

Example: Before/after test



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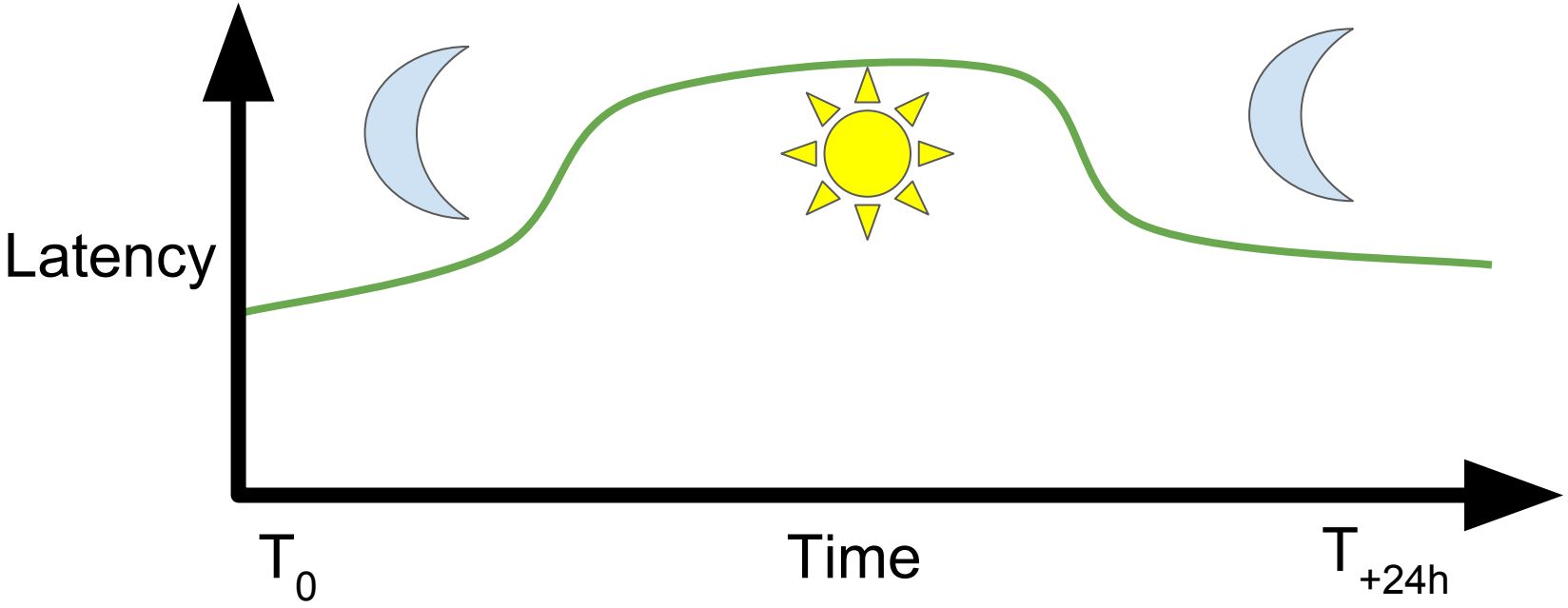

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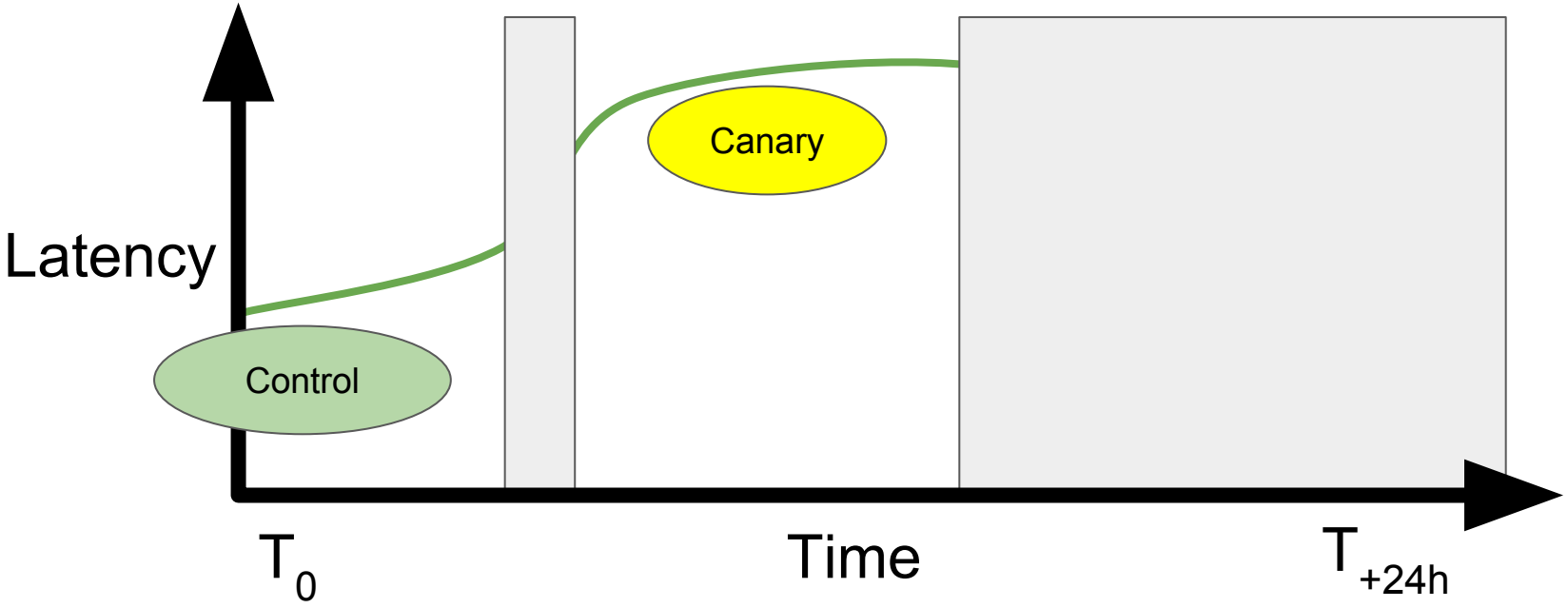

Example Takeaway

- Before/after tests often have us compare “*apples to stale apples*”
- Global comparison (e.g. 5% canary in each region) not always helpful
  - You may smooth out day cycle, but only partially
  - You may have different usage patterns in different regions
- Smaller-scale issues than day cycle include:
  - Brief traffic spikes
  - Machine deaths
- Not always the wrong choice! But be very cautious.
  - Catastrophic canary = loss of entire service until you can roll back!

Increasing Coverage

by adding more tests

Example: Compound probability

- Imagine you have 1% failure rate on each of your canary tests.
  - Might be false positive, might be true positive, doesn’t matter for this example.
  - Some might claim 1% false positive rate would be pretty nice score.
- If a metric fails the canary test, human needs to take a look.

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- You have 100 metrics to test.

P(single test failure) = 1%

P(at least one test failure out of 100) = 1 - P(no test failure) = 1 - $(1 - 1\%)^{100}$

= 1 - $(0.99)^{100}$ ~= 1 - 0.366 ~= 63.4%

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- You have 100 metrics to test.
- Two out of three releases will need human inspection!

Example: Compound probability

- This was all a lie!
  - Many assumptions made which are untrue.
  - Example: If your release is bad, failures are likely correlated, not independent.

- But it's a useful lie
  - "*All models are wrong, but some are useful*" (George Box, statistician)
  - Maybe you have 1% false positive ratio in your system? Or 0.1%?
  - It's a simplified analysis of achievability of your goals

Example: Compound probability

- You are likely able to increase accuracy of your test by giving it more data
  - Which means more time and/or larger population

Beware Meta Analysis

- It’s easy to bring meta analysis in:
  - “*But what if I require that any 10% checks need to fail before I bring a human?*”

- This has flaws, and might be a slippery slope:
  - Why 10%? Our canary checks are anchored in expected system behavior, 10% is not
  - Checks are not always of equal importance, so next on our slippery slope is adding weights
    - How do you decide those?
  - Slippery slope leads to tuning magic numbers not anchored in either goals or statistics

Prefer Few Metrics

- Key question:
  “What are the 3 metrics that most clearly indicate service health?”

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- Key question:
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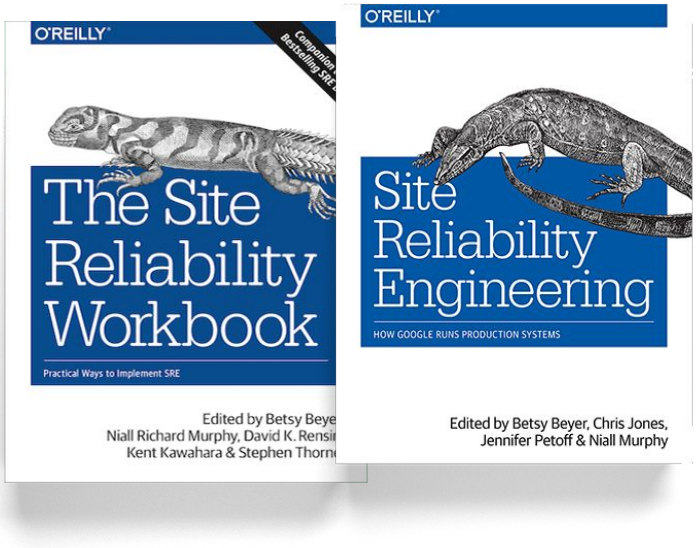
- Some of them should connect to your service’s SLI!

- Doesn’t mean you need 3 metrics, just that you can test for many issues with just a few



So in conclusion...

Canary In These 3 Simple Steps

1. Choose only few good metrics
    - They need to represent measure of problems in your service
    - They should be connected to your SLI
2. Ensure representative population
    - Random processes can be bad for you, increasing false positives
3. Compare apples to apples
    - If metric exhibits post-startup deviant behavior, maybe wait a bit
    - If you are deployed globally with mutually different behavior, maybe compare within regions

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3. Compare apples to apples
    - If metric exhibits post-startup deviant behavior, maybe wait a bit
    - If you are deployed globally with mutually different behavior, maybe compare within regions
4. Multi-stage canarying
    - Fist canary with very high confidence metrics, small population, fast canary -- fail fast
    - If that passes, do a larger population, longer duration, allowing you to use “*worse*” metrics

Takeaways

- Canarying can be easy and approachable.
  - Just follow three (or four) simple steps...
  - ...and then iterate on them to find what's best for you & your systems!
- Recall triangle of Canarying Priorities
- Statistics foundations are useful
- Some of the questions can be automated away with sufficiently advanced software