Google Cloud

Running Reliable systems

Part 2: Service Level Objective (SLO) Math

HPE Meetups 2022

Meet our speaker

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Let's begin with...

What I hope you already know: What an SLO **is**.

What I hope you'll learn: How to **use** SLOs. How **not** to use SLOs.

Heads up: Math Ahead. It is just probability.

A challenge of defining SLO

The Front Door SLO

User happiness

- ★ **Available** enough
- ★ **Fast** enough
- ★ **Complete** enough

Meet Expectations –
Don't Expect Perfection

Photo by Evelyn Paris on Unsplash

"Nested" SLOs

"But it's more complicated than that"
"My service depends on other teams"

~~Bad~~ Naive Math

IF user expects	99.0%
THEN webserver should be	99.**9**%
THEN hypervisor should be	99.**99**%
THEN infrastructure should be	99.**999**%

… but what there are *more* layers? 🤯

Photo by Nathan Dumlao on Unsplash

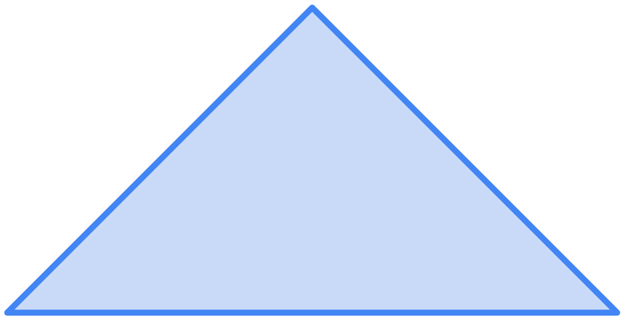
DevOps/IT Strategies: The Pyramids

Component-level reliability

Scalable reliability

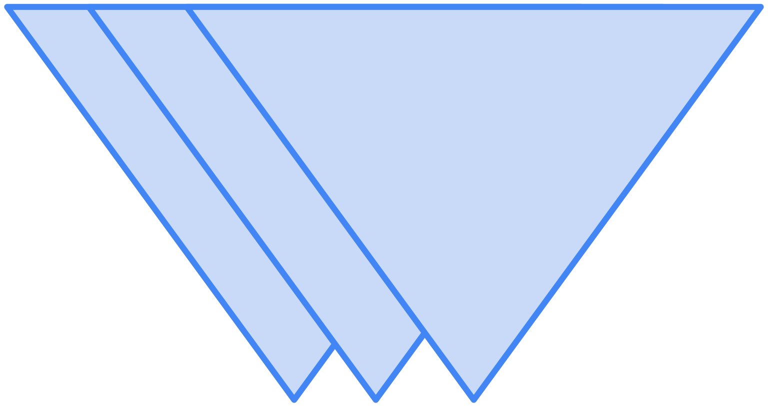
Component-Level Reliability

- Solid base (big cold building, heavy iron, redundant disks/net/power)
- **Each** component up as much as possible
- **Total availability** as goal
- Scales up

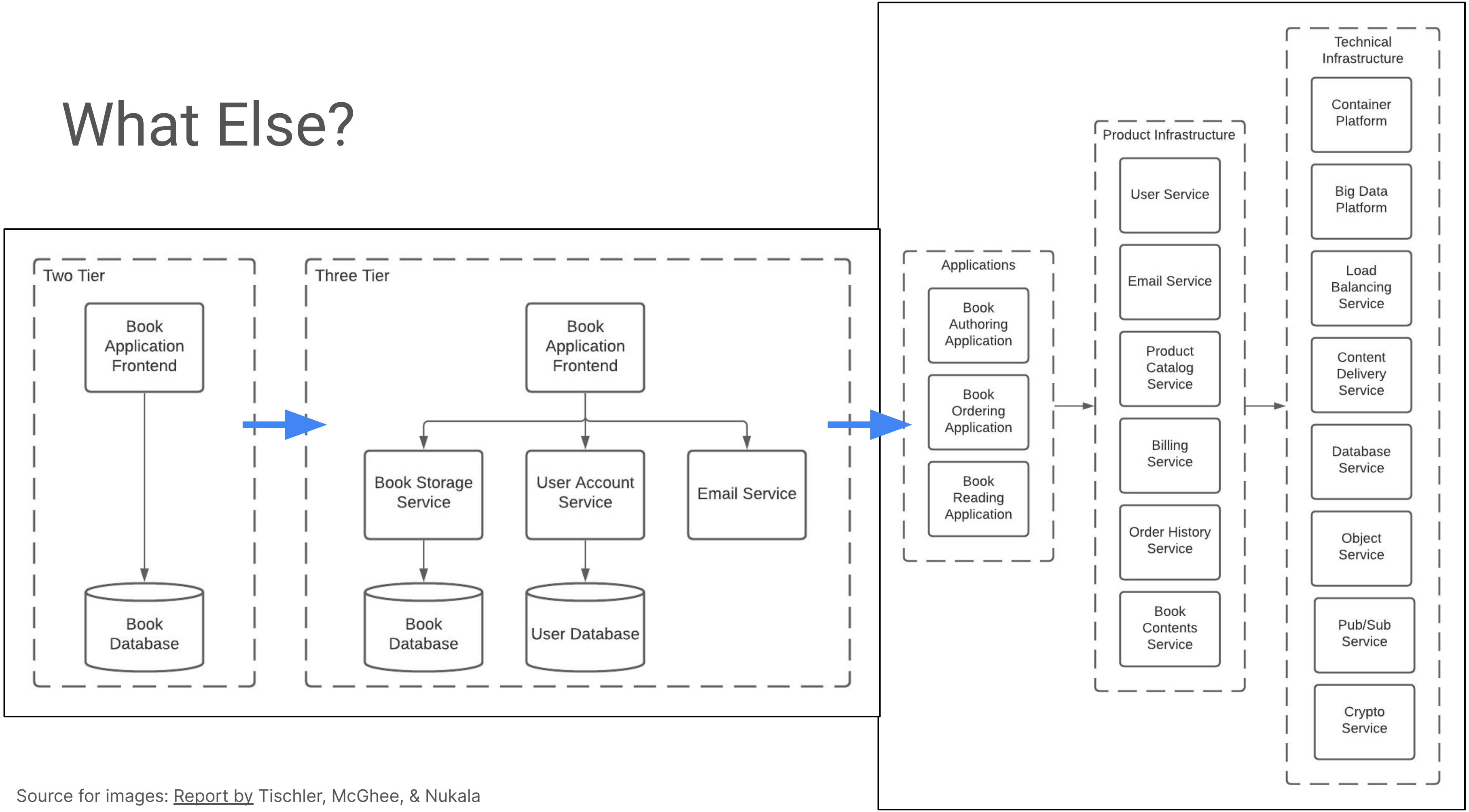


Scalable Reliability

- Less-reliable, but Cost-effective base
- Warehouse scale (many machines)
- Software improves availability
- Aggregate availability as goal
- Scales out



What Else?



Source for images: Report by Tischler, McGhee, & Nukala

Good math to calculate SLO

Probability, Really Quick

One 6-sided dice:

"bad" roll $\frac{1}{6}$ = 0.167...

vs.

"good" roll $\frac{5}{6}$ = 0.833...

For **Four** 6-sided dice:

$\frac{5}{6} \cdot \frac{5}{6} \cdot \frac{5}{6} \cdot \frac{5}{6}$ = 0.482

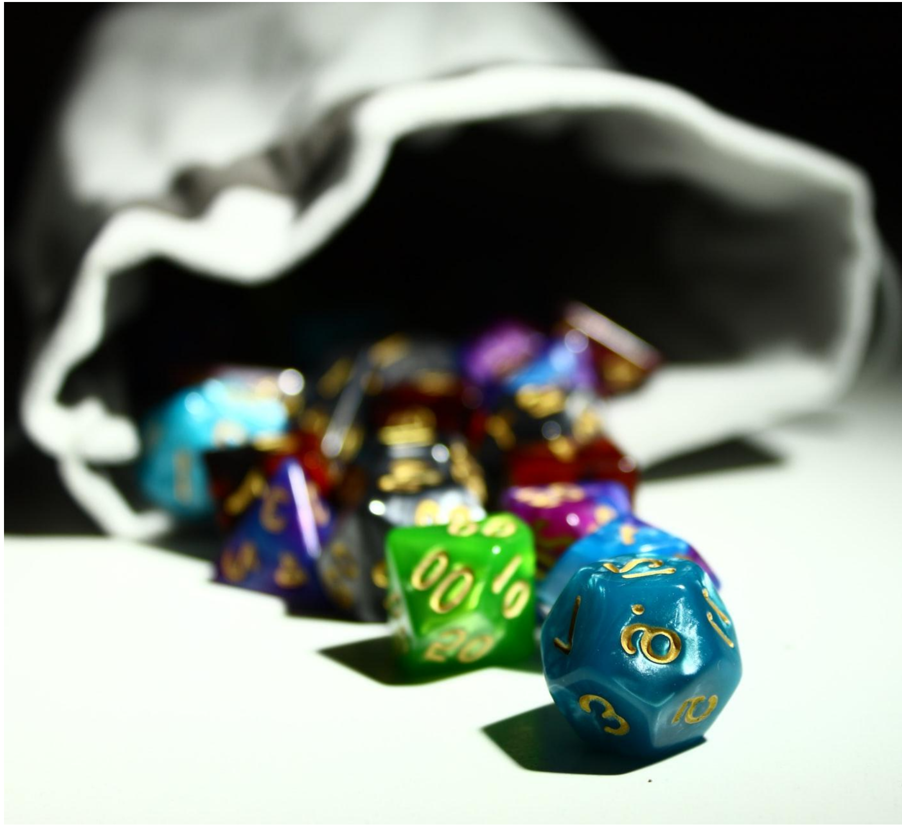


Photo by Alperen Yazgı on Unsplash

"you'll never do as well as the **worst case single throw**"

Probability, Really Quick

Four N-sided dices:

$((N-1)/N)^4$

eg: 10-sided: $(0.9)^4 = 0.6561$

M arbitrary-sided dices:

$(N_1 - 1/N_1) * (N_2 - 1/N_2) * (N_M - 1/N_M)$

eg: two 6-sided, one 10 sided, one 20 sided dice:
5/6•5/6•9/10•19/20 = 0.83•0.83•0.90•0.95 = **0.59**

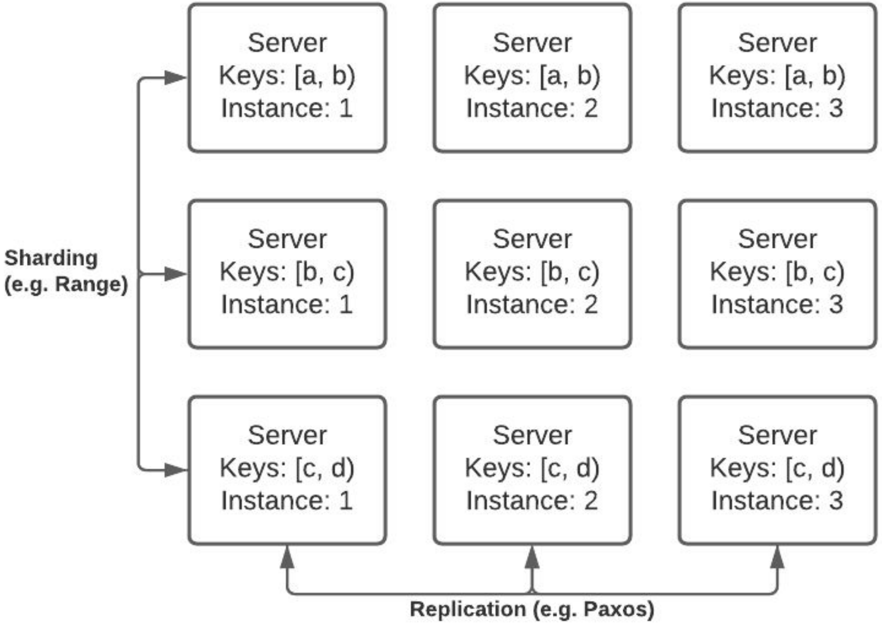
"you'll never do as well as the **worst case single throw**"

Photo by Alperen Yazgı on Unsplash

Good Math Needs a Model

Distributed system model to allow

- Scalability (Horizontal, Vertical)
- Sharding, Partitioning
- Replication, Load Balancing



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Serial Services

Sequential dependencies:

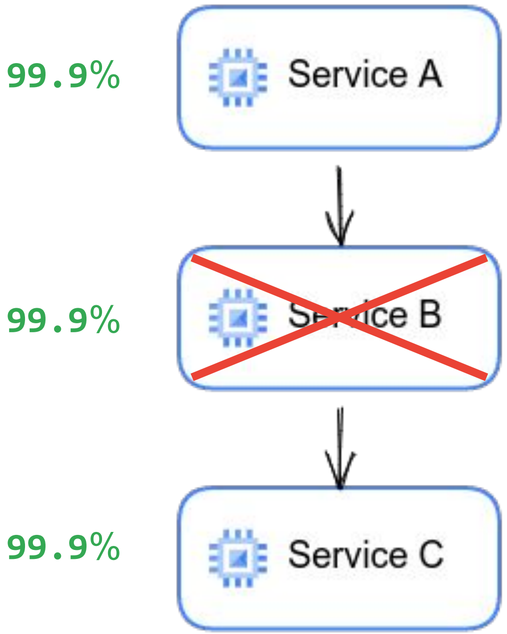
3 nines @ depth 3 gets us "2.7" nines

$$0.999 \cdot 0.999 \cdot 0.999 = \mathbf{0.997}$$

Or **99.7%** a.k.a **SLO^depth**

By the way...

$$0.999 \cdot 0.9999 \cdot 0.99999 = \mathbf{0.9988901}$$



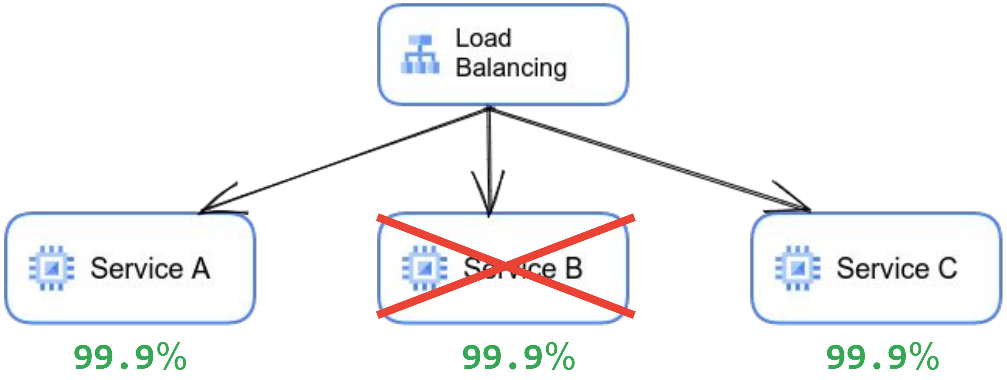
"your **architecture choices** can have more of an impact than SLOs of your dependencies"

Parallel Services

Parallel service composition when they all are needed:

0.999•0.999•0.999 = 0.997

Or **99.7%** a.k.a **SLO^depth**

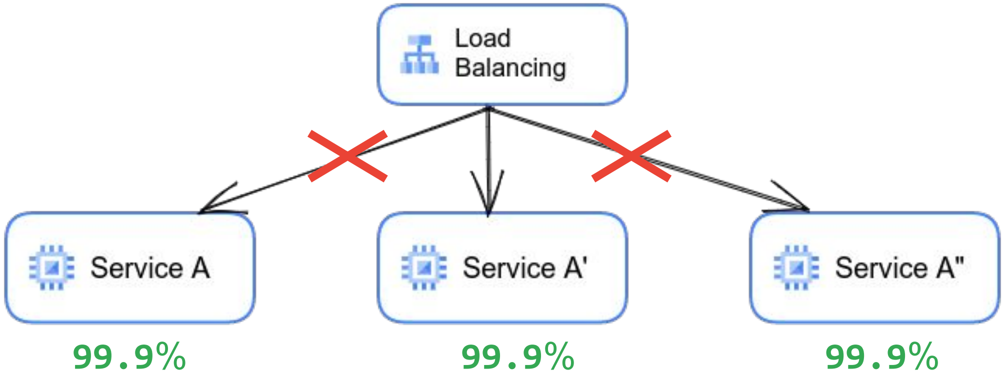


Parallel Services With Redundancy

Computed SLO:

1 - failure_ratio^redundancy

where **failure_ratio** = 1 - service SLO



For 3 copies of the *same* service

$1-(0.001)^3 = .999999999$

Or **99.99...**% (9 nines!!)

Set Theory of SLO

	Intersection availability / **all** dependencies must be available /			**Union availability** / at **least one** dependency is available /	
Component Availability	Number of Components			Number of Components	
	3	10	100	2	3
99%	97%	90%	37%	**4** Nines	**6** Nines
99.9%	99.7%	99%	90%	**6** Nines	**9** Nines
99.99%	99.97%	99.9%	99%	**8** Nines	**11** Nines
99.999%	99.997%	99.99%	99.9%	**10** Nines	**15** Nines

$$SLO_1 \bullet SLO_2 \bullet \ldots \bullet SLO_N$$

$$1-(FR_1 \bullet FR_2 \bullet \ldots \bullet FR_N)$$

Is it for real?
Why aren't we swimming in nines?

Reality Behind the Theory

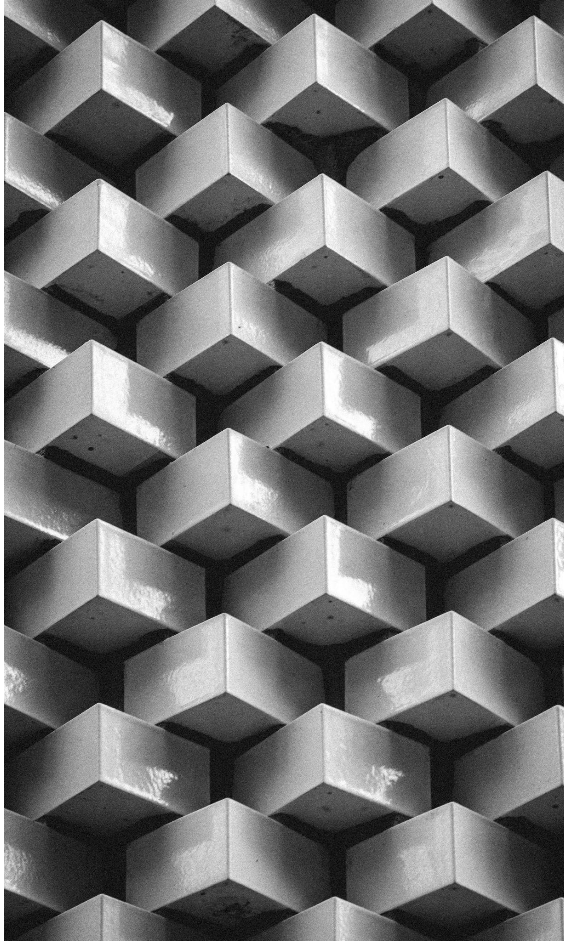
- Technical bottlenecks
  - Networking and Load Balancing are nines-lynchpin
  - End-to-end SDLC ownership
- Human bottlenecks
  - Mistakes, Churn, Toil
  - Shallow Understanding / Striving for Over-Simplified Learnings

What to do?

- ✓ DO NOT worry about downward implications of your SLOs
- ✓ CONSIDER your customer's happiness first and foremost
- ✓ HELP infrastructure teams understand the new world

Two Models

- ★ Stacks:
  - ○ Multiple copies of real stack
  - ○ No problem to lose one
  - ○ Advantage Load Balancing among copies
- ★ Service Mesh:
  - ○ Hard to accomplish
  - ○ Cognitive & operational cost
  - ○ Better resilience and flexibility



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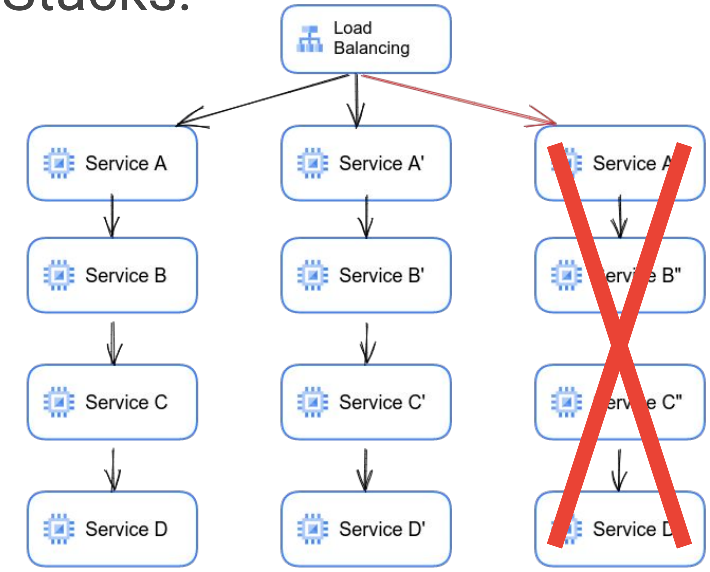
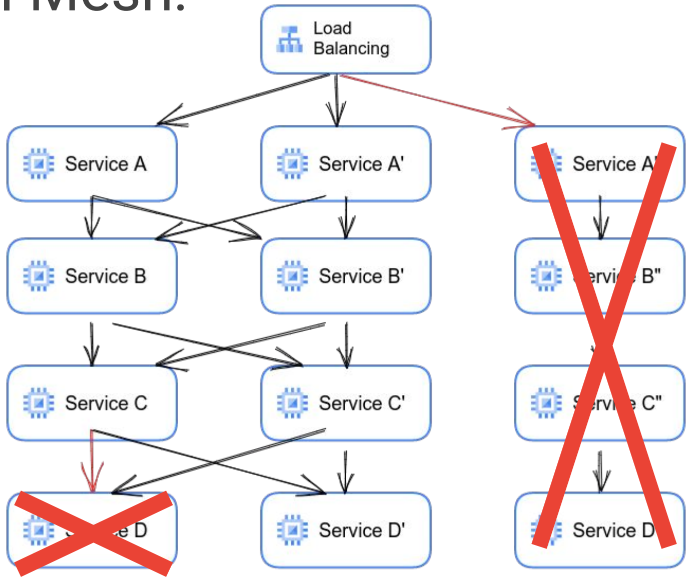
Two Models

Stacks:



Full Mesh:



99.9%

99.9%

99.9%

99.9%

Gnarly Details

- ✓ Other models
  - ➔ **Y**ou **O**nly **L**ook **O**nce (YOLO)
  - ➔ Megalith
- ✓ Costs
  - ➔ Compute and storage
  - ➔ Operational complexity
  - ➔ Consistency, sharding, replication
- ✓ Further reading
  - ➔ Failure domains and modes
  - ➔ Graceful degradation

Photo by Natalya Letunova on Unsplash

This seems too easy! You're totally right...

Fallacies (so far):

(1) SLOs must get tighter with depth

(2) I need to control the entire stack

Solutions:

(1) Resilience via Engineering!

(2) Do I own load balancer, mobile tower, power grid?

You can build
more reliable things
on top of
less reliable things

Watch "SRE I aspire to be" by @aknin

Closing...

You should design a **system** at "the front door". It's a common mistake to follow Conway's Law and define it at team boundaries, then get frustrated by the "bad math" that ensues.

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Thank you

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