The Art of SLOs

*In the midst of **chaos**, there is also ~~opportunity~~ **reliability***

— *Sun Tzu*, The Art of War

Welcome!

Don't be shy … say ***hello*** to your neighbours

Group Agreements

- We're here to **learn**
- Please ask **questions** (raise your hand)
- **One** speaker at a time
- Assume **positive** intent
- "Why am I speaking?"

Agenda

- Terminology
- Why your services *need* SLOs
- Spending your error budget
- Choosing a good SLI
- Developing SLOs and SLIs

Service **L**evel **I**ndicator

A **quantifiable** measure of service **reliability**

Service **L**evel **O**bjectives

Set a **reliability target** for an SLI

Users? Customers?

Customers are users who **directly pay** for a service

Services *Need* SLOs

Don't believe us?

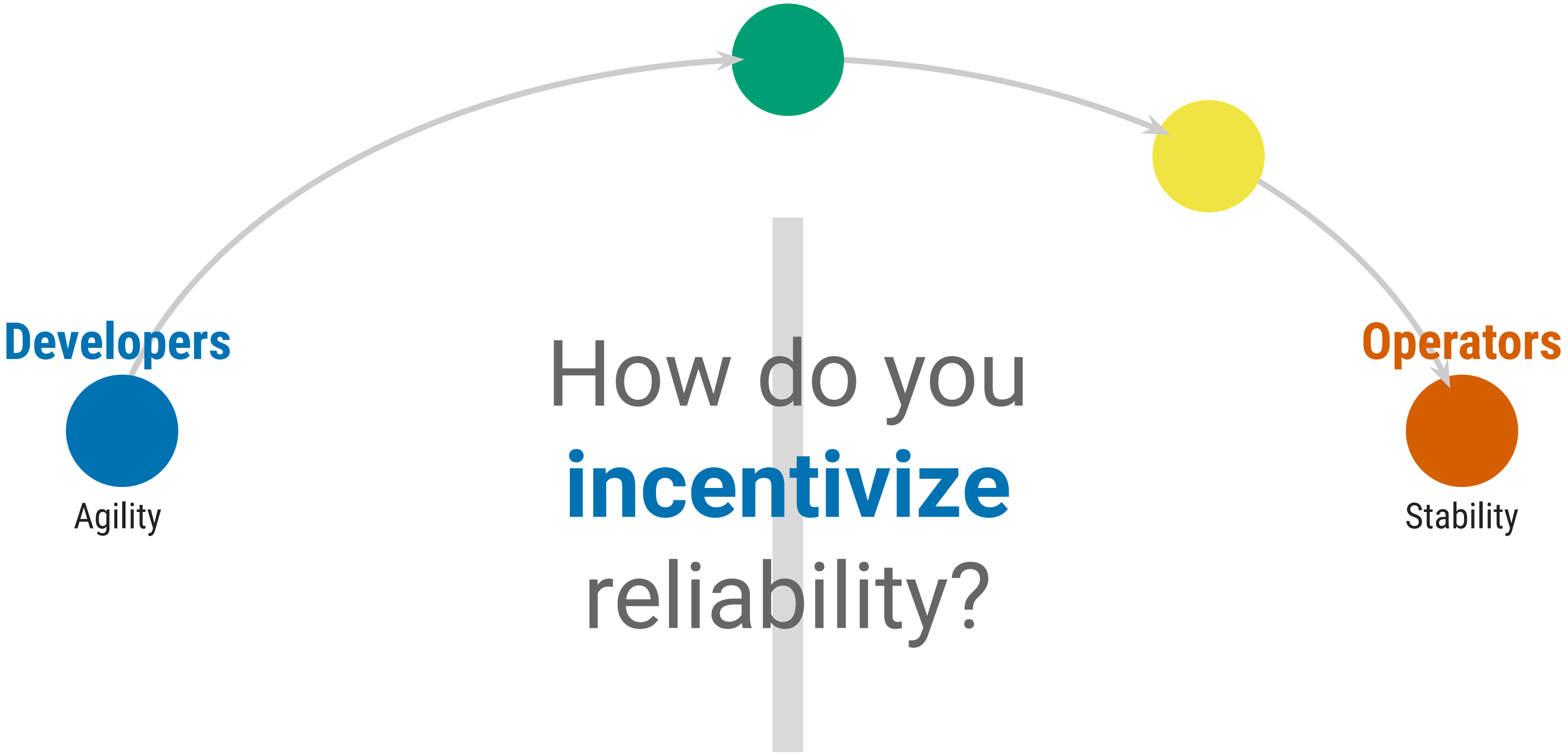
"Since introducing SLOs, the **relationship** between our operations and development teams has **subtly but markedly improved**."

– *Ben McCormack, Evernote;* The Site Reliability Workbook, Chapter 3

"... it is difficult to *do your job well* without clearly defining *well*. SLOs **provide the language** we need to **define *well***."

– *Theo Schlossnagle, Circonus;* Seeking SRE, Chapter 21

The **most important feature** of any system is its **reliability**

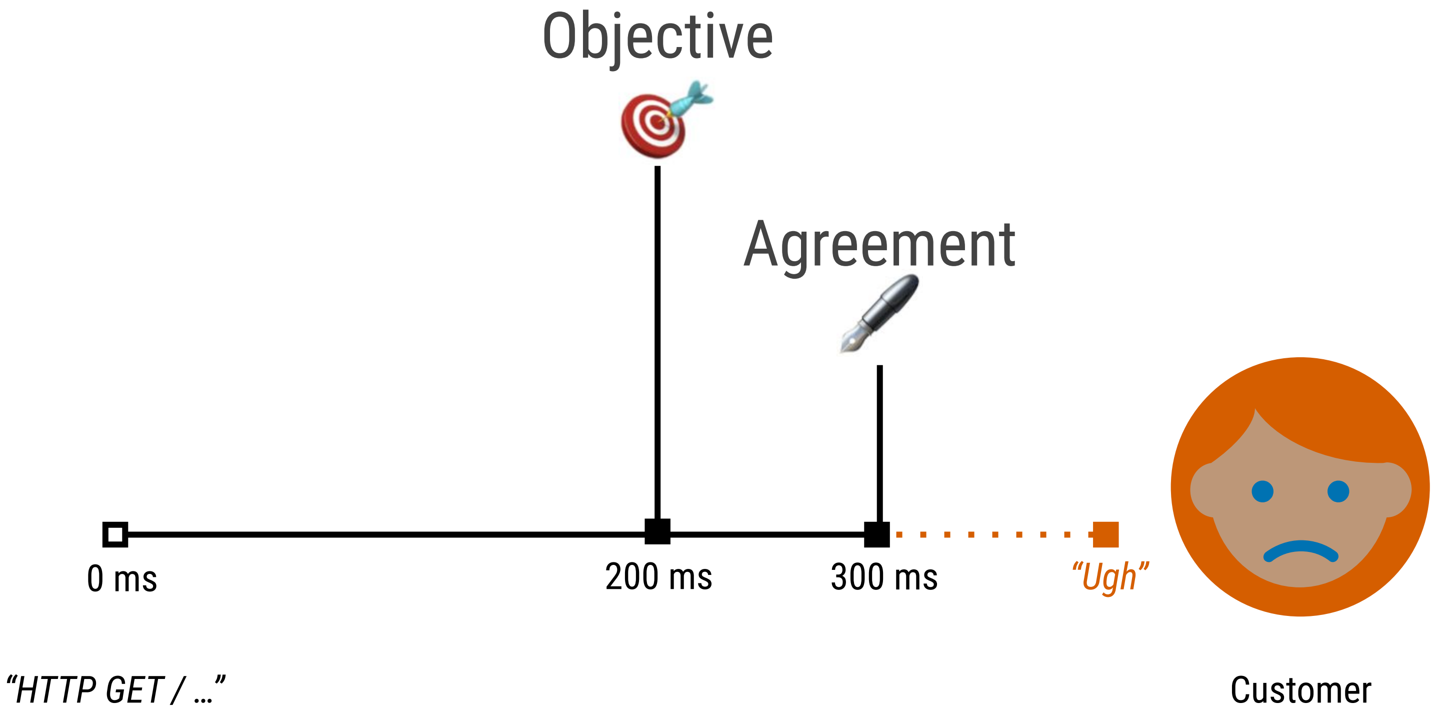


How do you **incentivize** reliability?

A **principled** way to agree on the **desired reliability** of a service

What does "**reliable**" mean?

Think about Netflix, Google Search, Gmail, Twitter…
how do you tell if they are ‘working’?



Objective

Agreement

0 ms

200 ms

300 ms

“Ugh”

“HTTP GET / …”

Customer

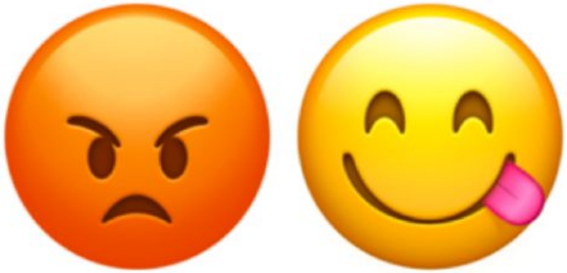
With me so far?

When do we need to make a service **more reliable**?

~~**100%**~~

100% is the **wrong** reliability target for basically **everything**

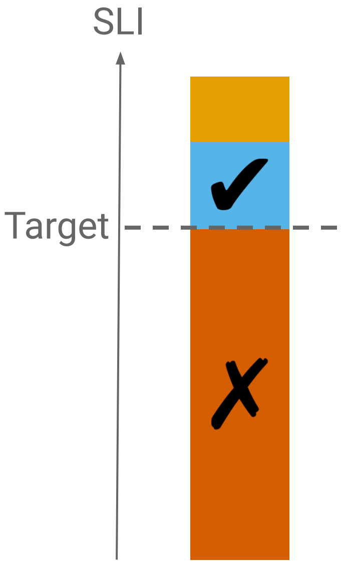
— ***Benjamin Treynor Sloss***, *VP 24x7, Google;* Site Reliability Engineering, Introduction



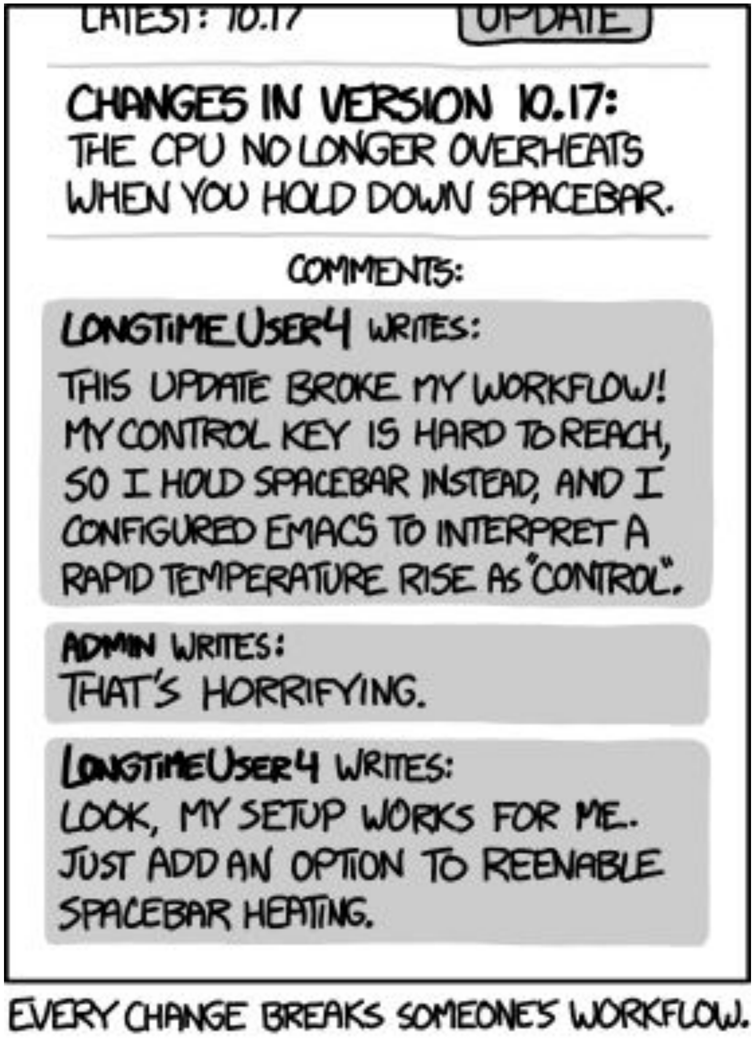
SLOs should capture the performance and availability levels that, if **barely met**, would keep the **typical customer** of a service happy

“meets SLO targets” ⇒ “happy customers”
“sad customers” ⇒ “misses SLO targets”

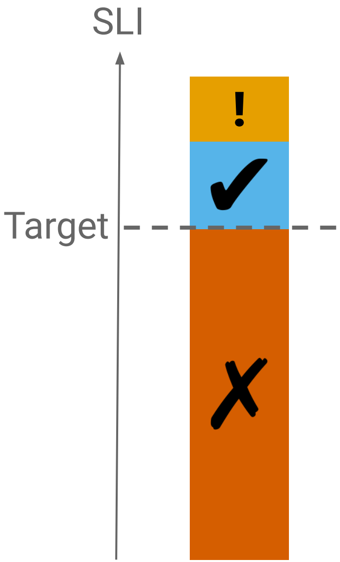
Measure SLO achieved & try to be ***slightly*** over target...



Google


LATEST: 10.17
UPDATE
CHANGES IN VERSION 10.17:
THE CPU NO LONGER OVERHEATS WHEN YOU HOLD DOWN SPACEBAR.
COMMENTS:
LONGTIME USER4 WRITES:
THIS UPDATE BROKE MY WORKFLOW! MY CONTROL KEY IS HARD TO REACH, SO I HOLD SPACEBAR INSTEAD, AND I CONFIGURED EMACS TO INTERPRET A RAPID TEMPERATURE RISE AS "CONTROL".
ADMIN WRITES:
THAT'S HORRIFYING.
LONGTIME USER4 WRITES:
LOOK, MY SETUP WORKS FOR ME. JUST ADD AN OPTION TO REENABLE SPACEBAR HEATING.
EVERY CHANGE BREAKS SOMEONE'S WORKFLOW.

"Workflow", *Randall Munroe, XKCD*
Source: https://xkcd.com/1172/



...but don't be too much better or users will **depend on it**

Error Budgets

An SLO implies an **acceptable level** of unreliability

*This is a **budget** that can be **allocated***

Implementation Mechanics

Evaluate SLO **performance** over a set **window**, e.g. 28 days

Remaining budget **drives prioritization** of engineering effort

ITIL Approximation

Service *in SLO* → most operational work is a **standard change**

Service **close** to being *out of SLO* → revert to **normal change**

(No, I don't understand the difference between "standard" and "normal" either…)

What should we **spend** our error budget on?

Error budgets can accommodate

- releasing new **features**
- expected system **changes**
- inevitable **failure** in hardware, networks, etc.
- planned **downtime**
- risky **experiments**

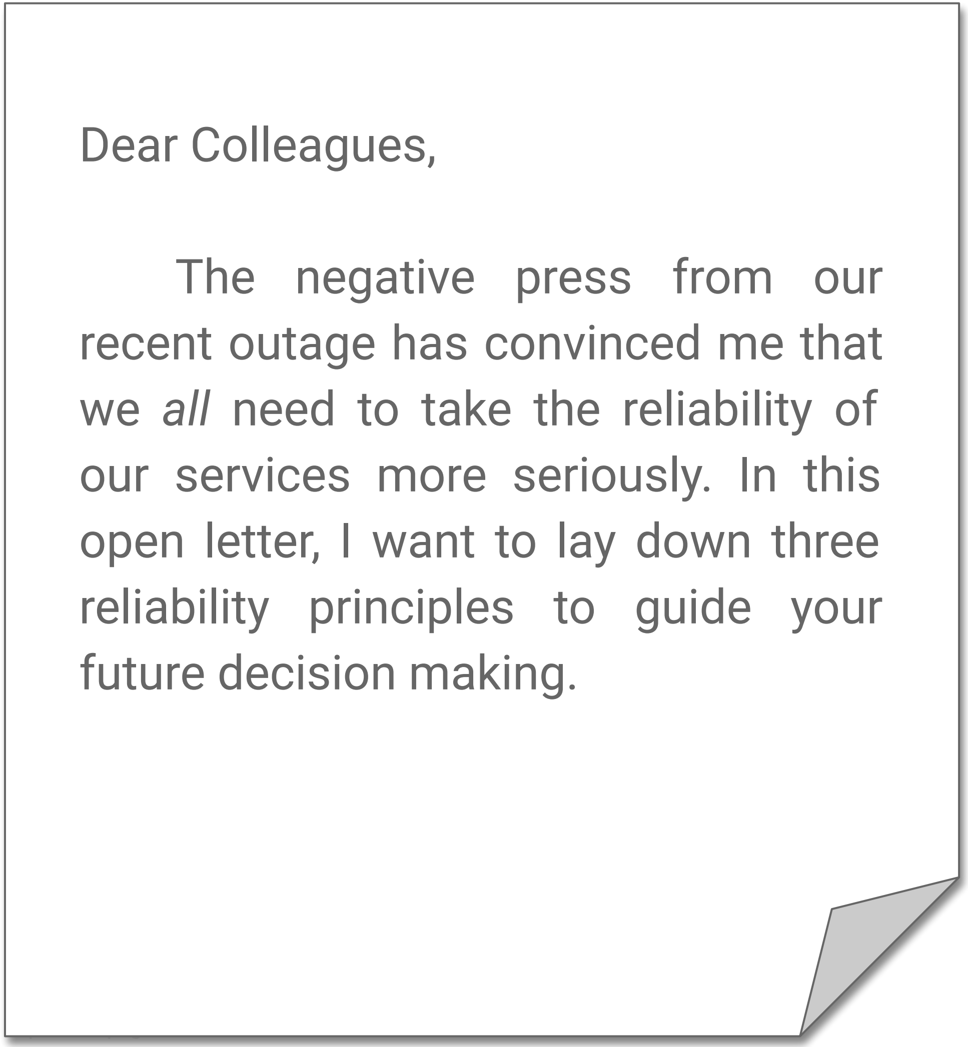
Benefits of error budgets

- **Common incentive for devs and SREs**
  Find the right balance between innovation and reliability
- **Dev team can manage the risk themselves**
  They decide how to spend their error budget
- **Unrealistic reliability goals become unattractive**
  These goals dampen the velocity of innovation
- **Dev team becomes self-policing**
  The error budget is a valuable resource for them
- **Shared responsibility for system uptime**
  Infrastructure failures eat into the error budget

Still with me?

Activity

Reliability Principles



Dear Colleagues,

The negative press from our recent outage has convinced me that we *all* need to take the reliability of our services more seriously. In this open letter, I want to lay down three reliability principles to guide your future decision making.

The first principle concerns our users. We let them down, but they deserve better. They deserve to be *happy* when using our services!

Our business must ...

1. ... rebuild user trust by making a financial commitment to reliability.
2. ... find ways to help our users tolerate or enjoy future outages.
3. ... meet our users expectations of reliability before building features.
4. ... build the features that make our users happy faster.
5. ... never suffer another outage, ever again!

The second principle concerns the way we build our services. We have to change our development process to incorporate reliability.

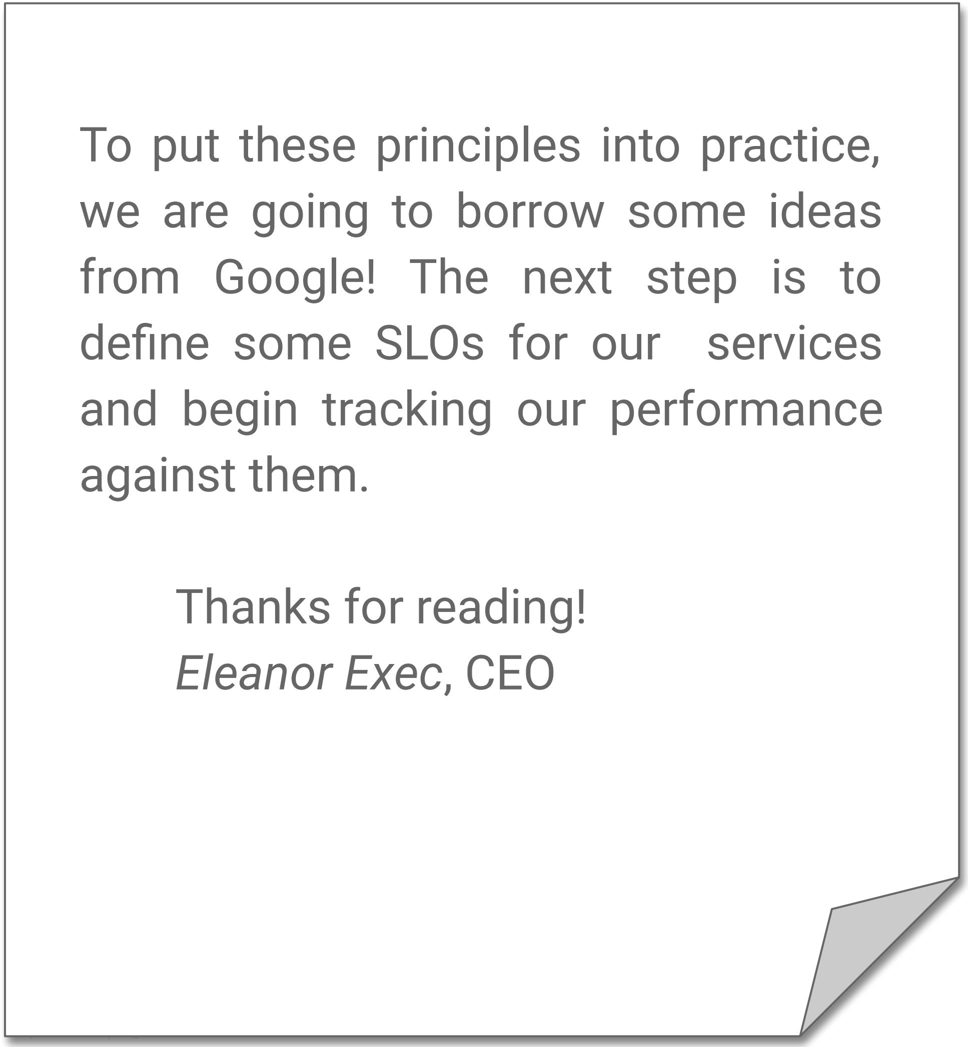
Our business must...

1. … choose to fail fast and catch errors early through rapid iteration.
2. … have Ops engage in the design of new features to reduce risk.
3. … only release new features publicly when they are shown to be reliable.
4. … build and release software in small, controlled steps.
5. … reduce feature iteration speed when our systems are unreliable.

The third principle concerns our operational practices. What we're doing today isn't working. Our Ops teams are burned out and our incident rate is too high. We have to do things differently to improve!

Our business must...

1. … share responsibility for reliability between Ops and Dev teams.
2. … tie operational response and team priorities to a reliability goal.
3. … make our systems more resilient to failure to cut operational load.
4. … give Ops a veto on all releases to prevent failures reaching our users.
5. … route negative complaints on Twitter directly to Ops pagers.

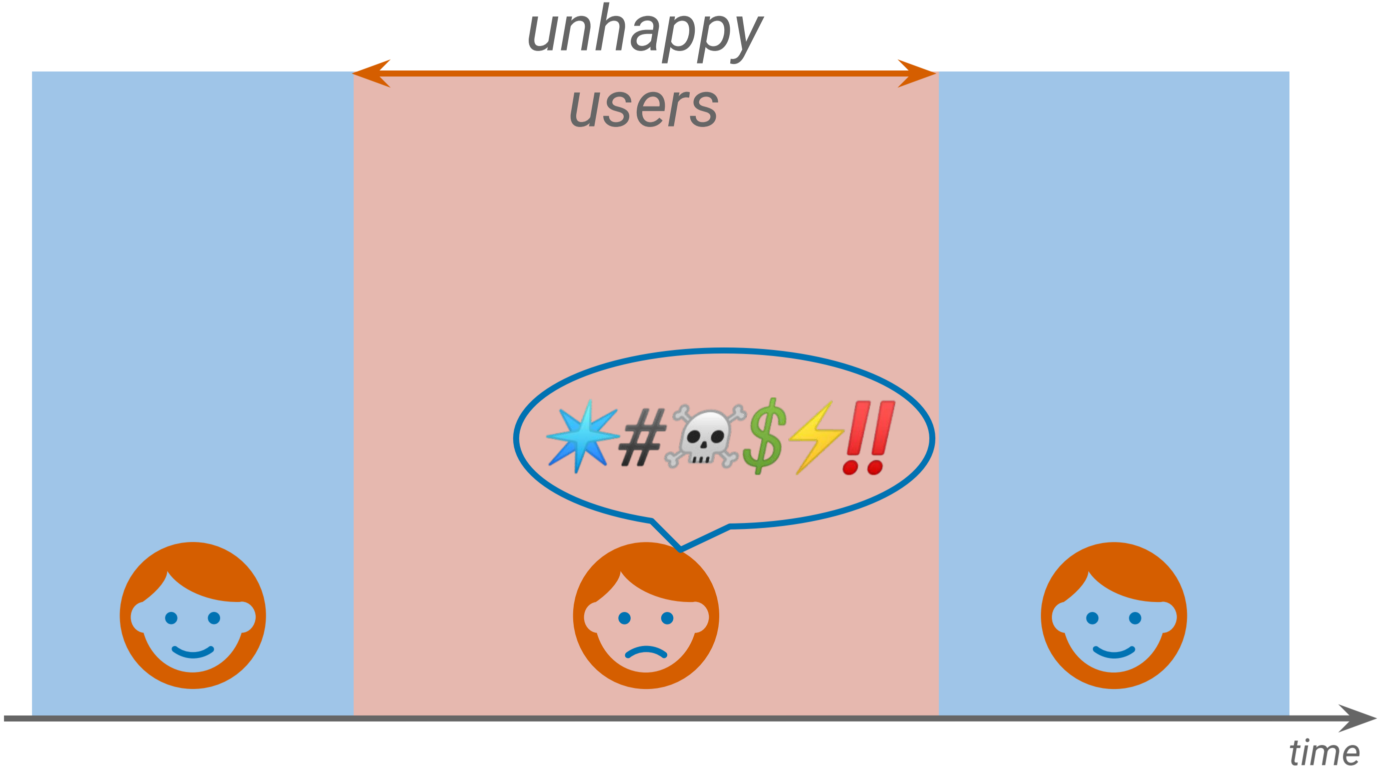


To put these principles into practice, we are going to borrow some ideas from Google! The next step is to define some SLOs for our services and begin tracking our performance against them.

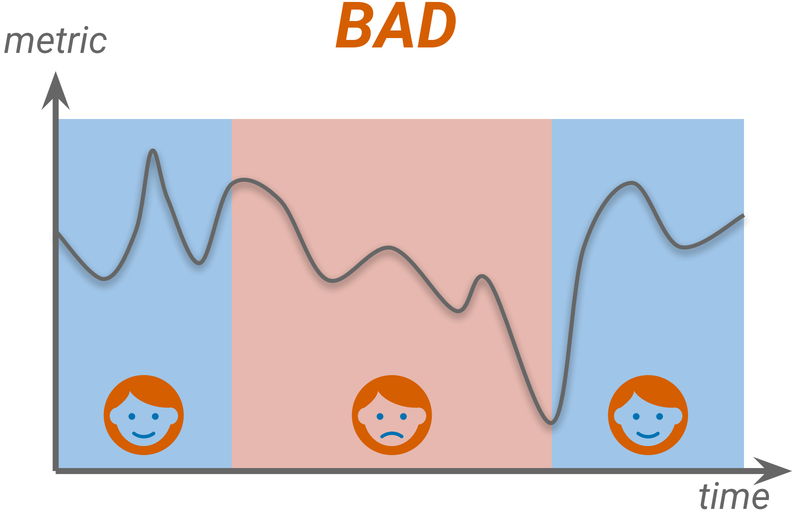
Thanks for reading!
Eleanor Exec, CEO

Break!

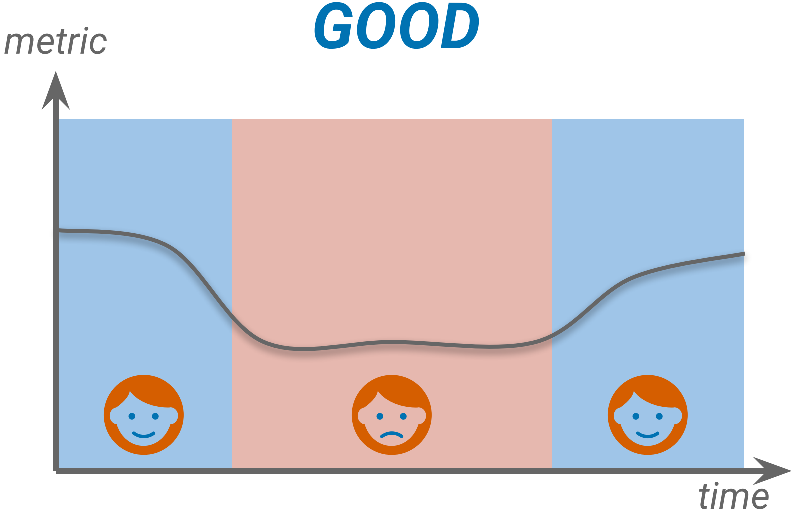
Choosing a Good SLI


unhappy
users
✴#☠$⚡‼
time

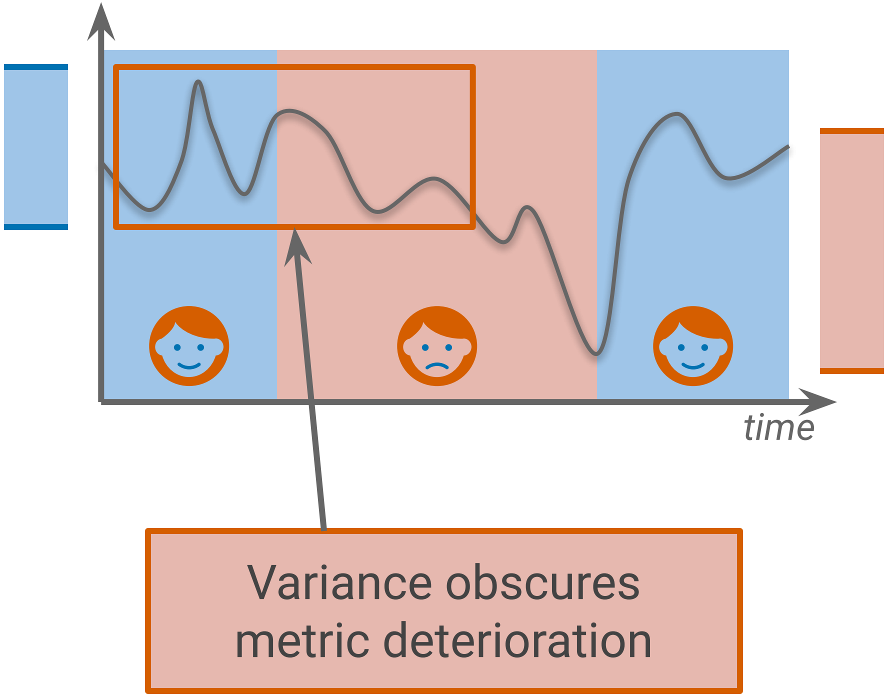
BAD



GOOD

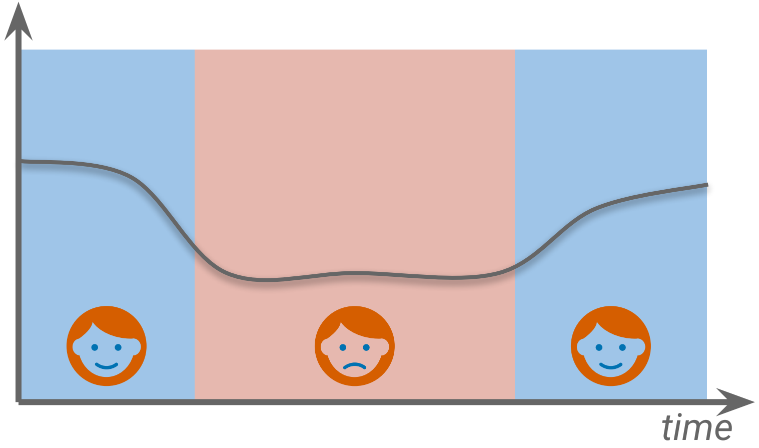


BAD

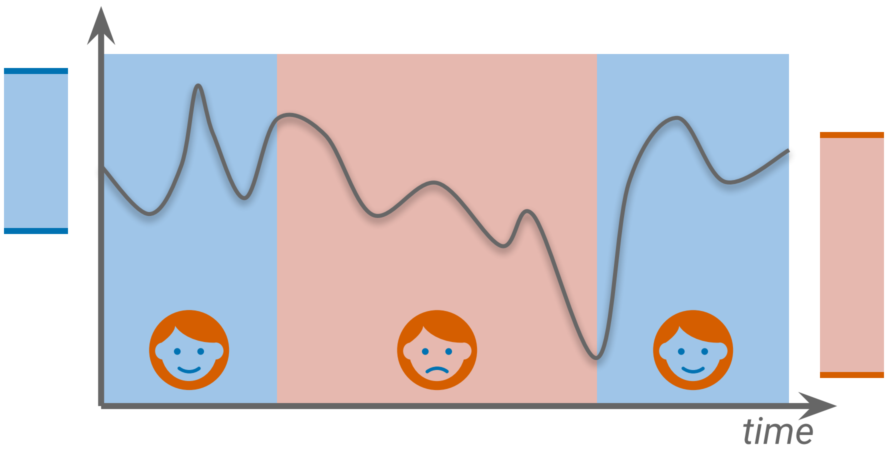


Variance obscures metric deterioration

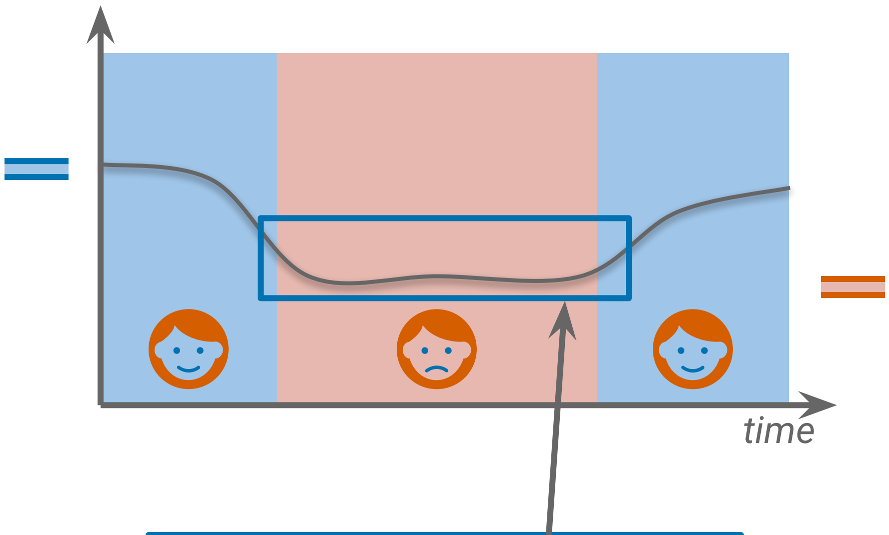
GOOD



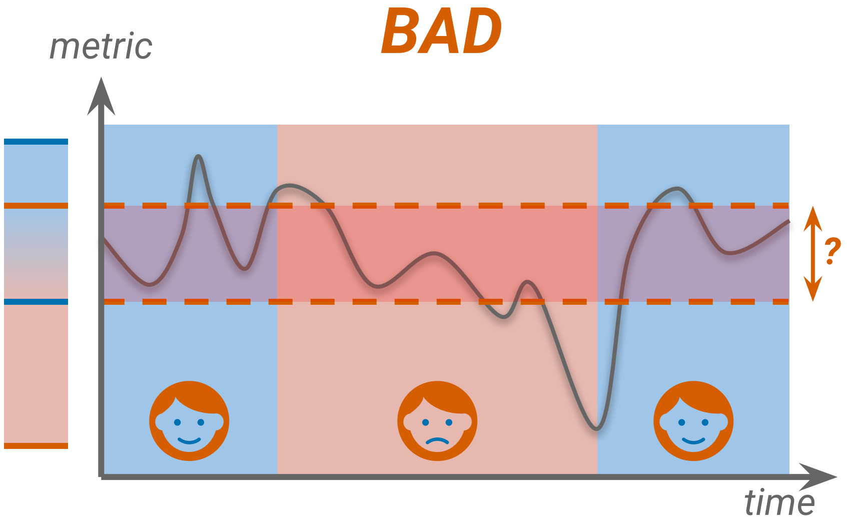
BAD



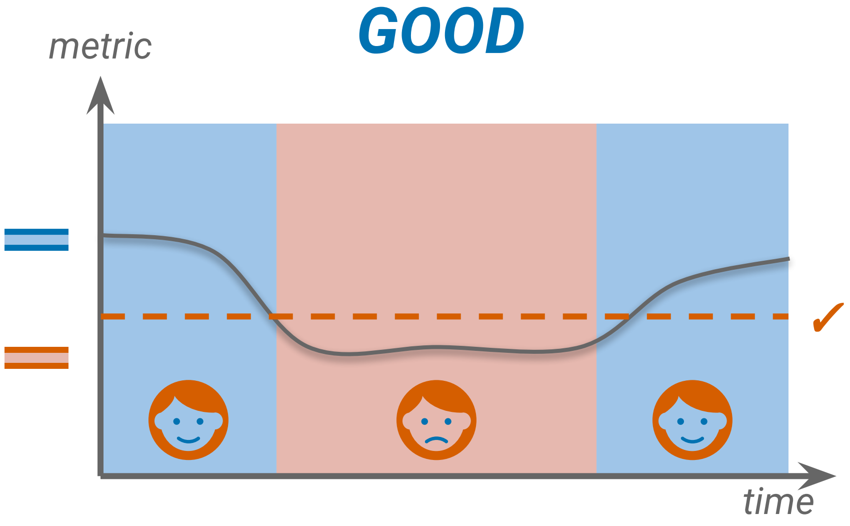
GOOD



Metric deterioration correlates with outage



Metric provides poor signal-to-noise ratio



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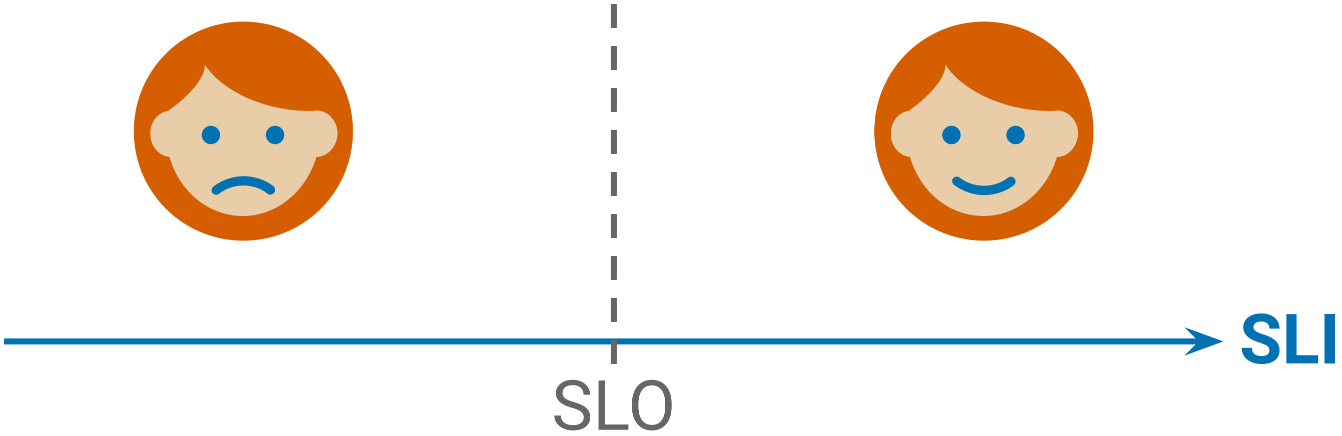
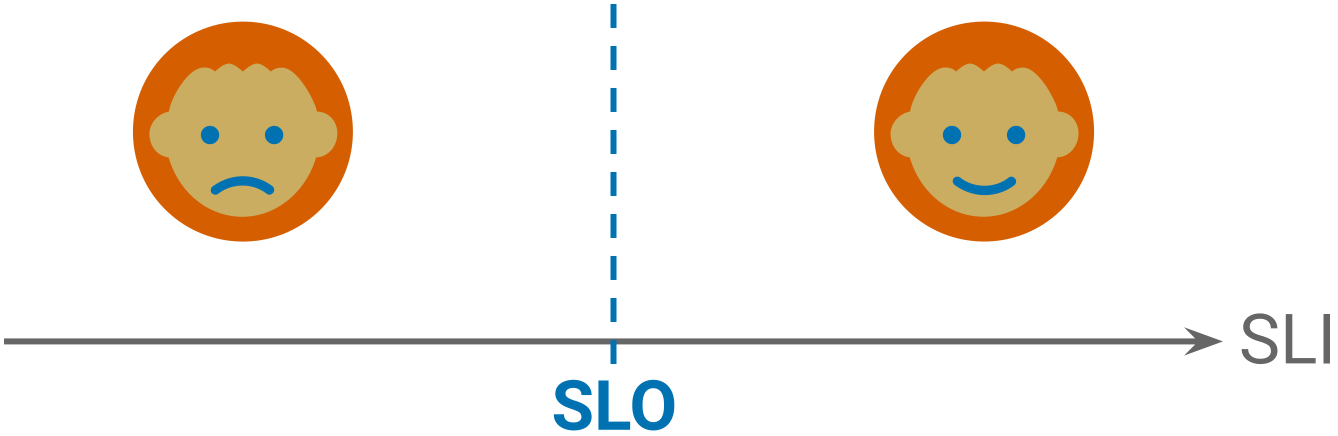

SLI
SLO

$$\text{SLI} : \left(\frac{\text{good events}}{\text{valid events}} \right) \times 100\%$$

3–5 SLIs*

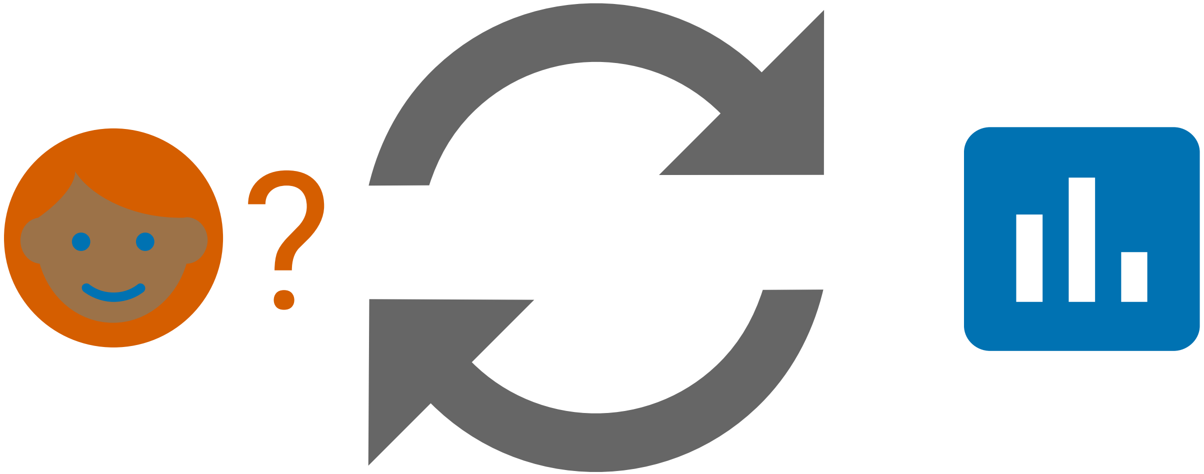
* per user journey


SLI
SLO

What **performance** does the **business** need?

User expectations
are *strongly* tied to
past performance

Continuous



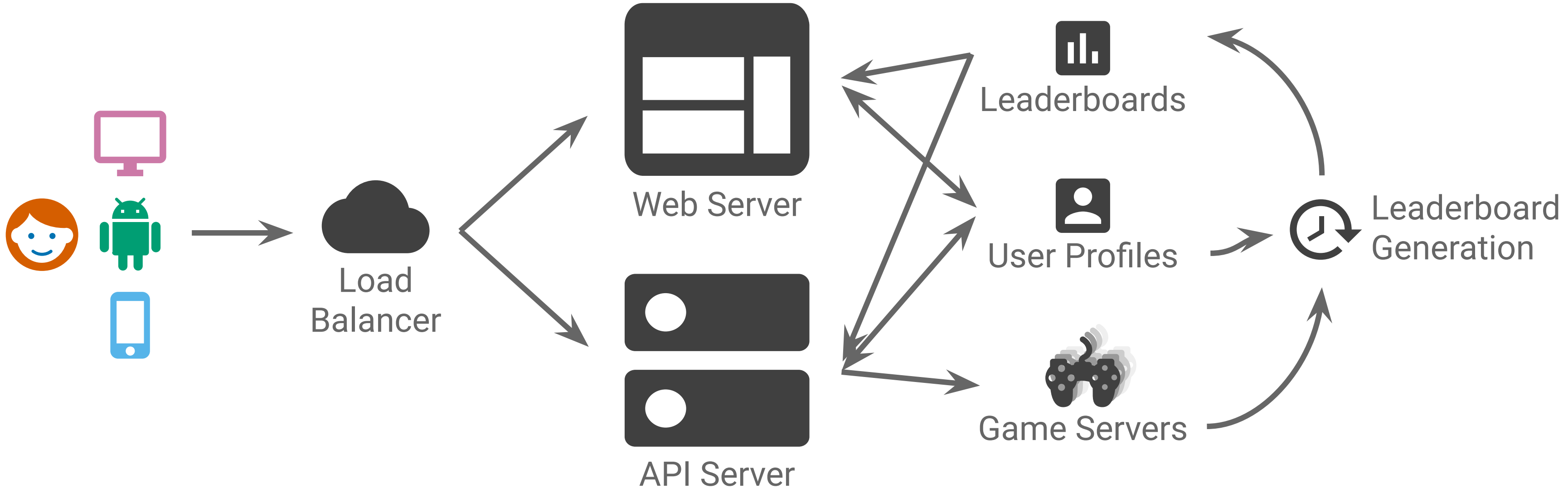
Improvement

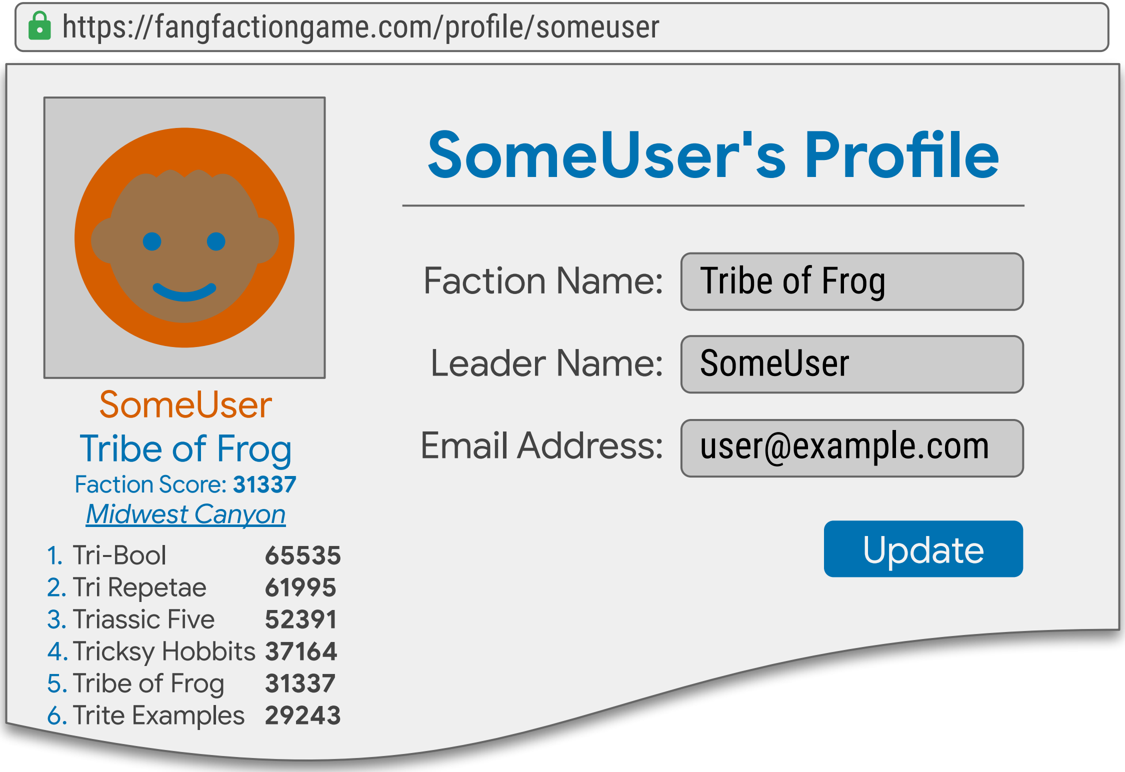
Information overload?

Developing SLOs and SLIs

?

Our Game: Fang Faction





https://fangfactiongame.com/profile/someuser

SomeUser

Tribe of Frog

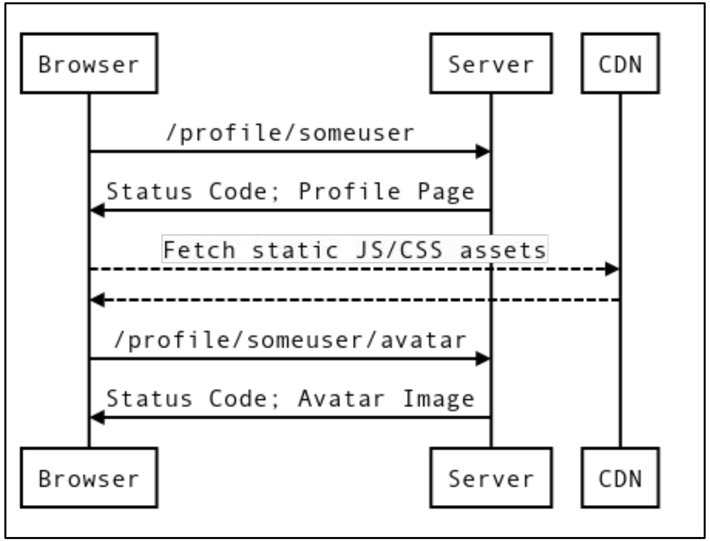
Faction Score: **31337**

Midwest Canyon

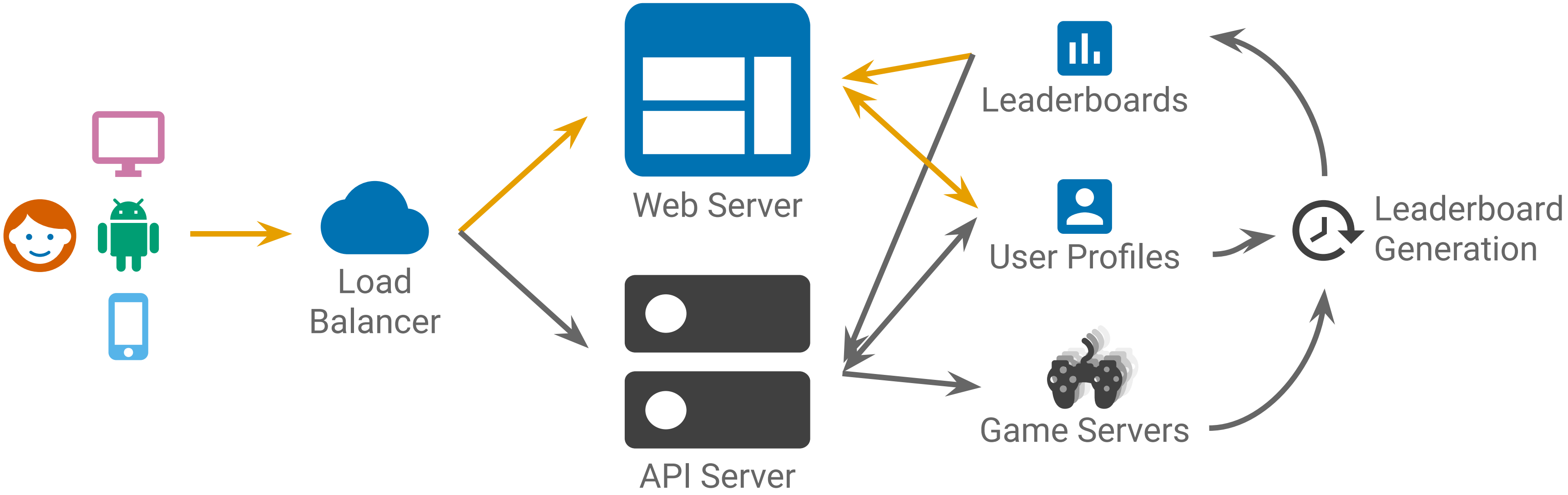
1. Tri-Bool	**65535**
2. Tri Repetae	**61995**
3. Triassic Five	**52391**
4. Tricksy Hobbits	**37164**
5. Tribe of Frog	**31337**
6. Trite Examples	**29243**

SomeUser's Profile

Faction Name:	Tribe of Frog
Leader Name:	SomeUser
Email Address:	user@example.com


Browser
Server
CDN
/profile/someuser
Status Code; Profile Page
Fetch static JS/CSS assets
/profile/someuser/avatar
Status Code; Avatar Image
Browser
Server
CDN

Loading a Profile Page



SLI Menu

Request / Response	Availability Latency Quality
Data Processing	Coverage Correctness Freshness Throughput
Storage	Throughput Latency

Availability

The **profile page** should load **successfully**

Latency

The **profile page** should load **quickly**

Availability

The **profile page** should load **successfully**

- How do we define **success**?
- Where is the success / failure **recorded**?

Latency

The **profile page** should load **quickly**

- How do we define **quickly**?
- When does the timer **start / stop**?

Availability

The **profile page** should load **successfully**

- How do we define **success**?
- Where is the success / failure **recorded**?

The proportion of **valid** requests served **successfully**.

Latency

The **profile page** should load **quickly**

- How do we define **quickly**?
- When does the timer **start / stop**?

The proportion of **valid** requests served **faster** than a threshold.

Availability

The **profile page** should load **successfully**

- How do we define **success**?
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The proportion of **valid** requests served **successfully**.

Latency

The **profile page** should load **quickly**

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Availability

The **profile page** should load **successfully**

- How do we define **success**?
- Where is the success / failure **recorded**?

The proportion of **HTTP GET** requests for **/profile/{user}** or **/profile/{user}/avatar** served **successfully**.

Latency

The **profile page** should load **quickly**

- How do we define **quickly**?
- When does the timer **start / stop**?

The proportion of **HTTP GET** requests for **/profile/{user}** served **faster** than a threshold.

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The proportion of **HTTP GET** requests
for **/profile/{user}** or **/profile/{user}/avatar**
that have ***2XX***, ***3XX*** or ***4XX*** **(excl. 429)** status.

Latency

The **profile page** should load **quickly**

- How do we define **quickly**?
- When does the timer **start / stop**?

The proportion of **HTTP GET** requests
for **/profile/{user}**
served **within *X* ms**.

SLI Menu

Measurement Strategies

- Application-level Metrics
- Logs Processing
- Front-end Infra Metrics
- Synthetic Clients/Data
- Client-side Instrumentation

Availability

The **profile page** should load **successfully**

- How do we define **success**?
- Where is the success / failure **recorded**?

The proportion of **HTTP GET** requests
for **/profile/{user}** or **/profile/{user}/avatar**
that have ***2XX***, ***3XX*** or ***4XX*** **(excl. 429)** status
measured at the **load balancer**.

Latency

The **profile page** should load **quickly**

- How do we define **quickly**?
- When does the timer **start / stop**?

The proportion of **HTTP GET** requests
for **/profile/{user}**
that send their **entire response within *X* ms**
measured at the **load balancer**.

Activity

Postmortem

Availability

Proportion of **HTTP GET** requests
for **/profile/{user}** or **/profile/{user}/avatar**
that have ***2XX***, ***3XX*** or ***4XX*** **(excl. 429)** status
measured at the **load balancer**

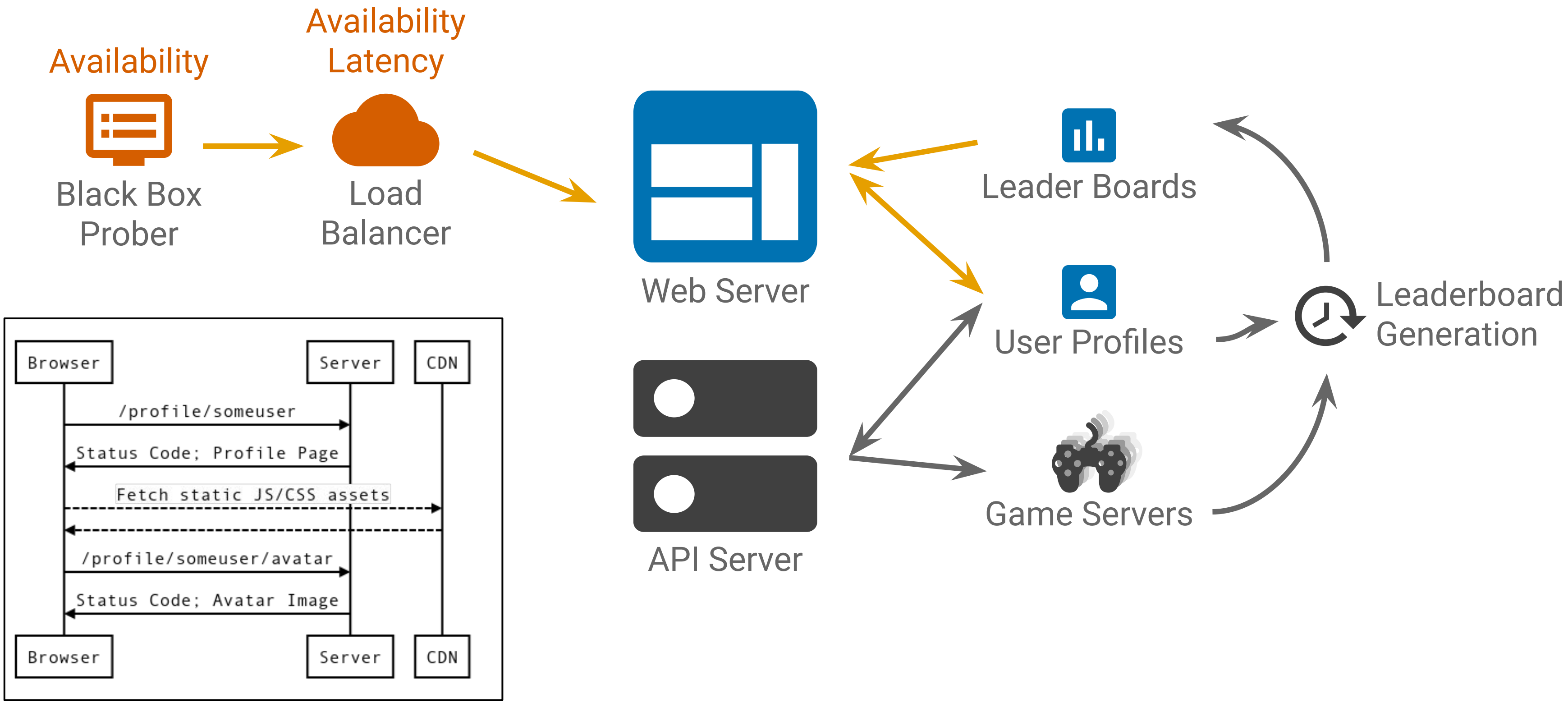
and

Proportion of **HTTP GET** requests
for **/profile/prober_user** and **all linked resources**
returning **valid HTML containing "ProberUser"**
measured by a **black-box prober** every 5s

Latency

Proportion of **HTTP GET** requests
for **/profile/{user}**
that send their **entire response within *X* ms**
measured at the **load balancer**

Do the SLIs cover the failure modes?



Activity

Define SLO Targets

What goals should we set for the reliability of our journey?

Your objectives should have both a **target** and a **measurement window**

Service	**SLO Type**	**Objective**
Web: User Profile	Availability	**99.95% successful** in **previous 28d**
Web: User Profile	Latency	**90%** of requests **< 500ms** in **previous 28d**
...	...	

Fallen asleep yet?

Break!

Workshop: Let's develop some more SLIs and SLOs!

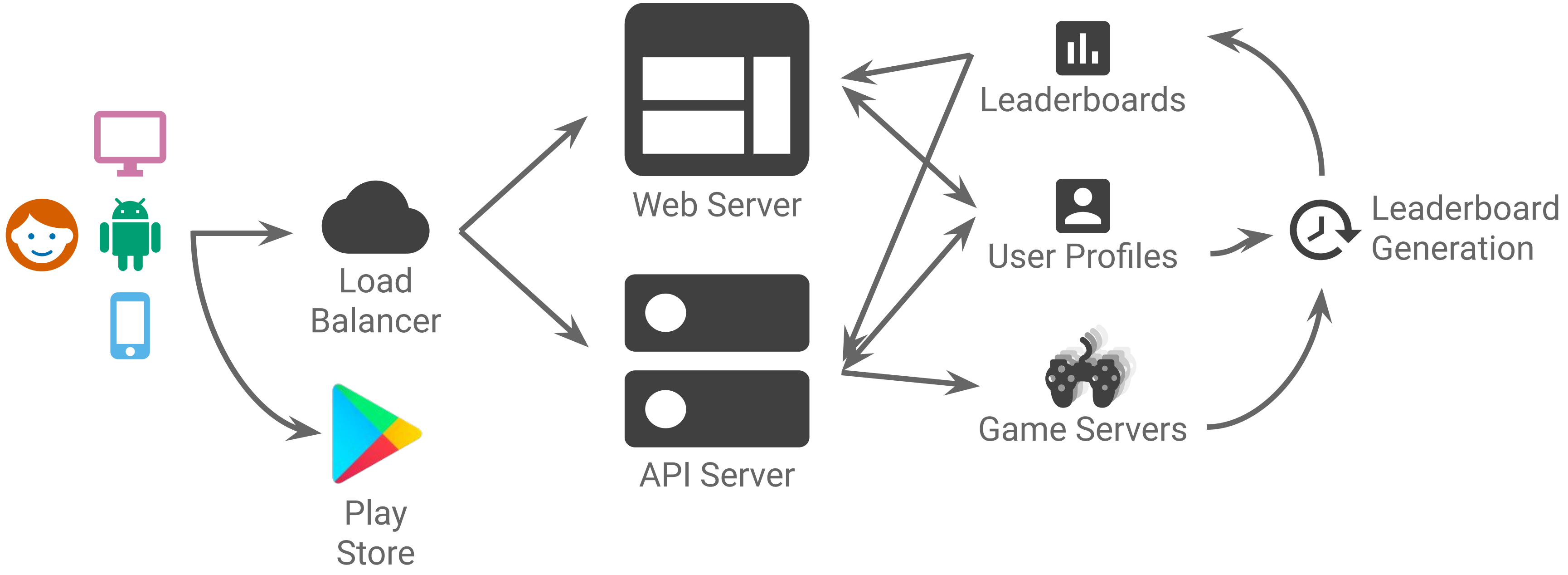
Follow the **process** we demonstrated for the *Buy In-Game Currency* journey:

1. Choose **SLI specifications** from the menu (see booklet, p6)
2. Substitute **definitions** in to create a detailed **SLI implementation**
3. Walk through user journey and look for **coverage gaps**
4. Set **aspirational SLOs** based on **business needs**

Once you're done, **choose another journey** as a group.

You have **roughly 45 minutes** for each journey.

Our Game: Fang Faction



Break!

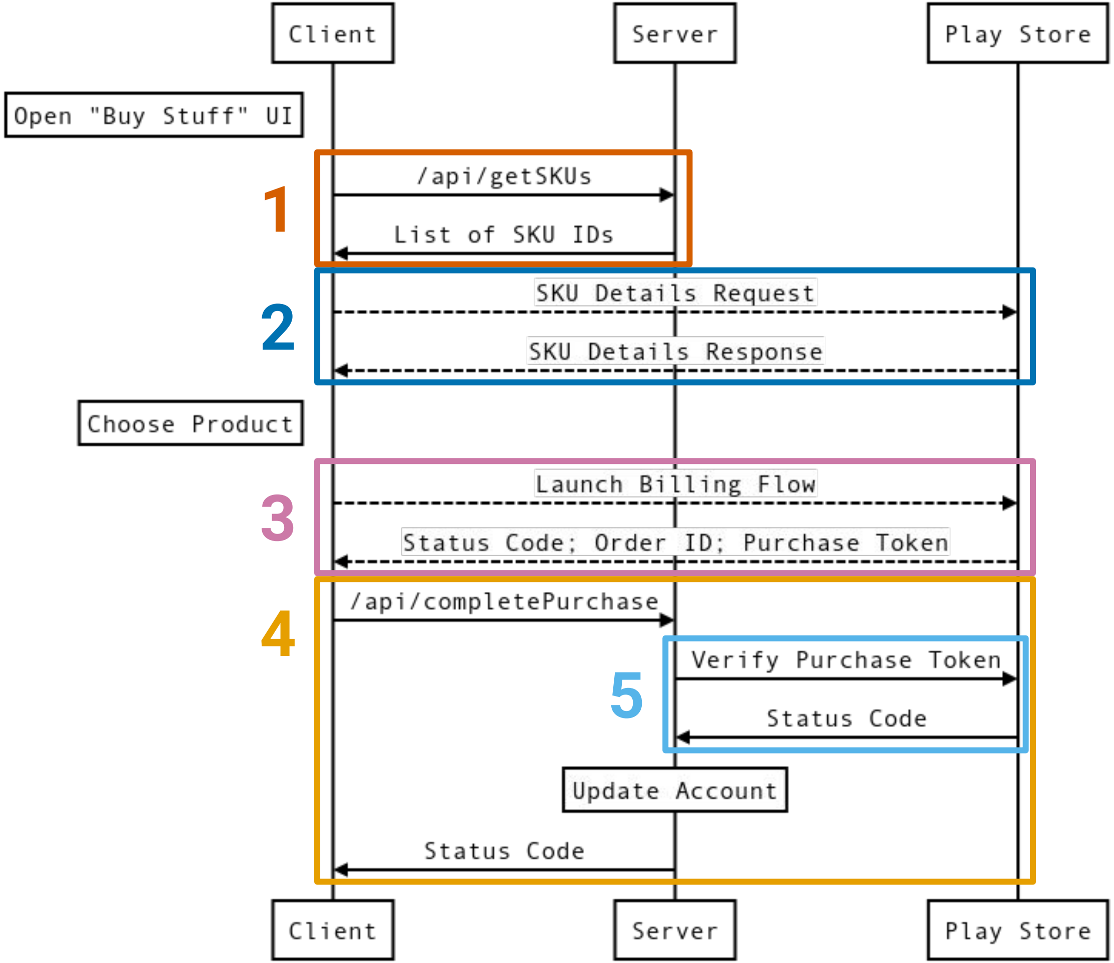
Buy In-Game Currency

Model Answer

Break Down The Journey

Five request/response pairs

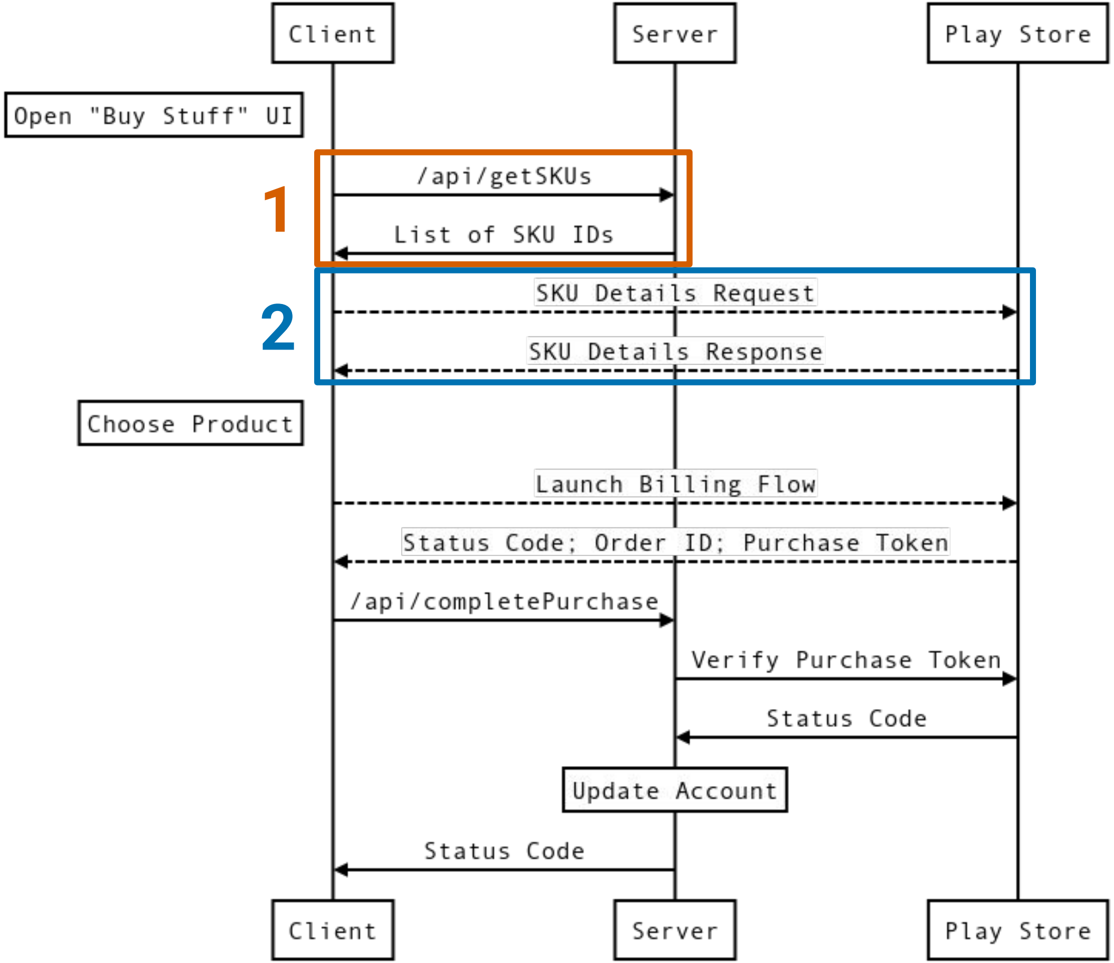
1. Fetch list of SKUs from API server
2. Fetch SKU details from Play Store
3. User launches Play billing flow
4. Send token to API server
5. Verify token with Play Store



Break Down The Journey

Journey has **two** parts. **A:** Fetch SKUs

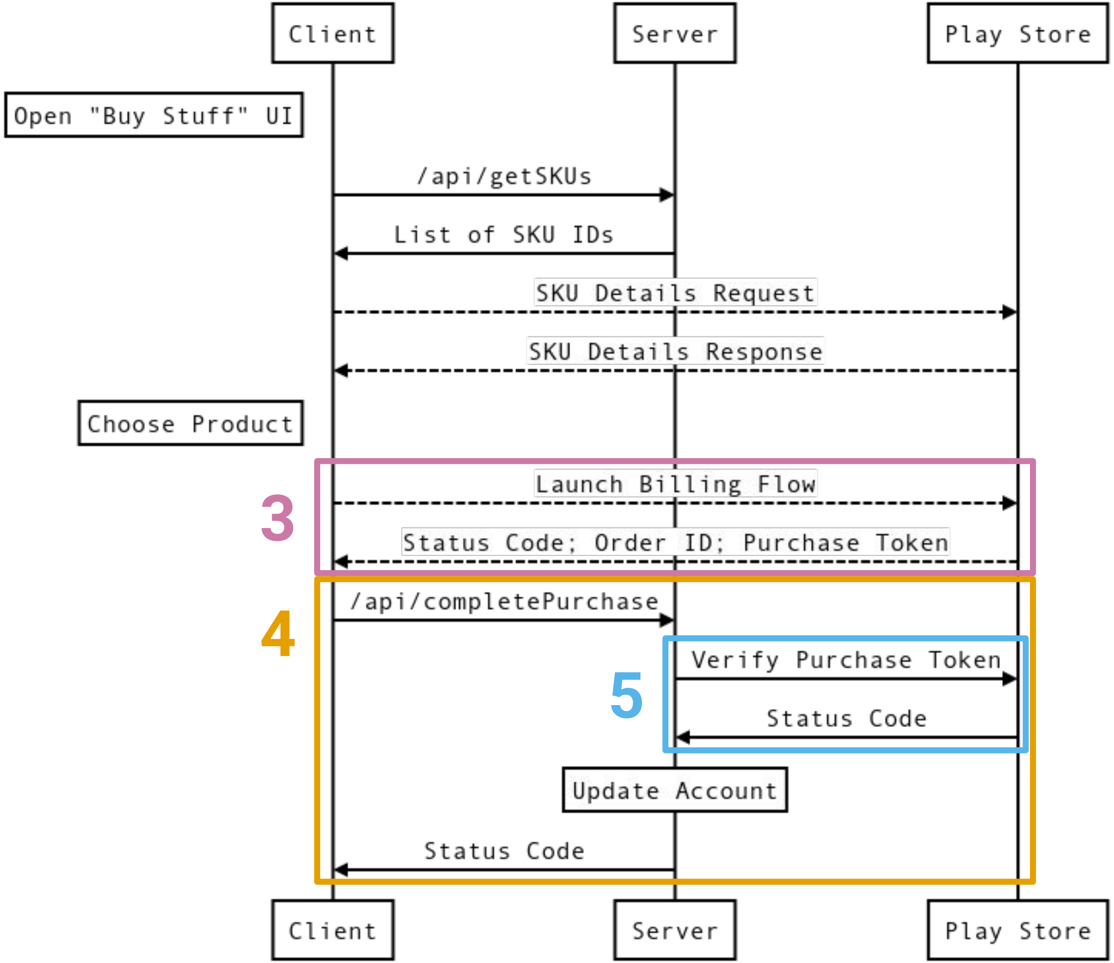
1. Fetch list of SKUs from API server
2. Fetch SKU details from Play Store
3. User launches Play billing flow
4. Send token to API server
5. Verify token with Play Store



Break Down The Journey

Journey has **two** parts. **B:** Buy Item

1. Fetch list of SKUs from API server
2. Fetch SKU details from Play Store
3. User launches Play billing flow
4. Send token to API server
5. Verify token with Play Store

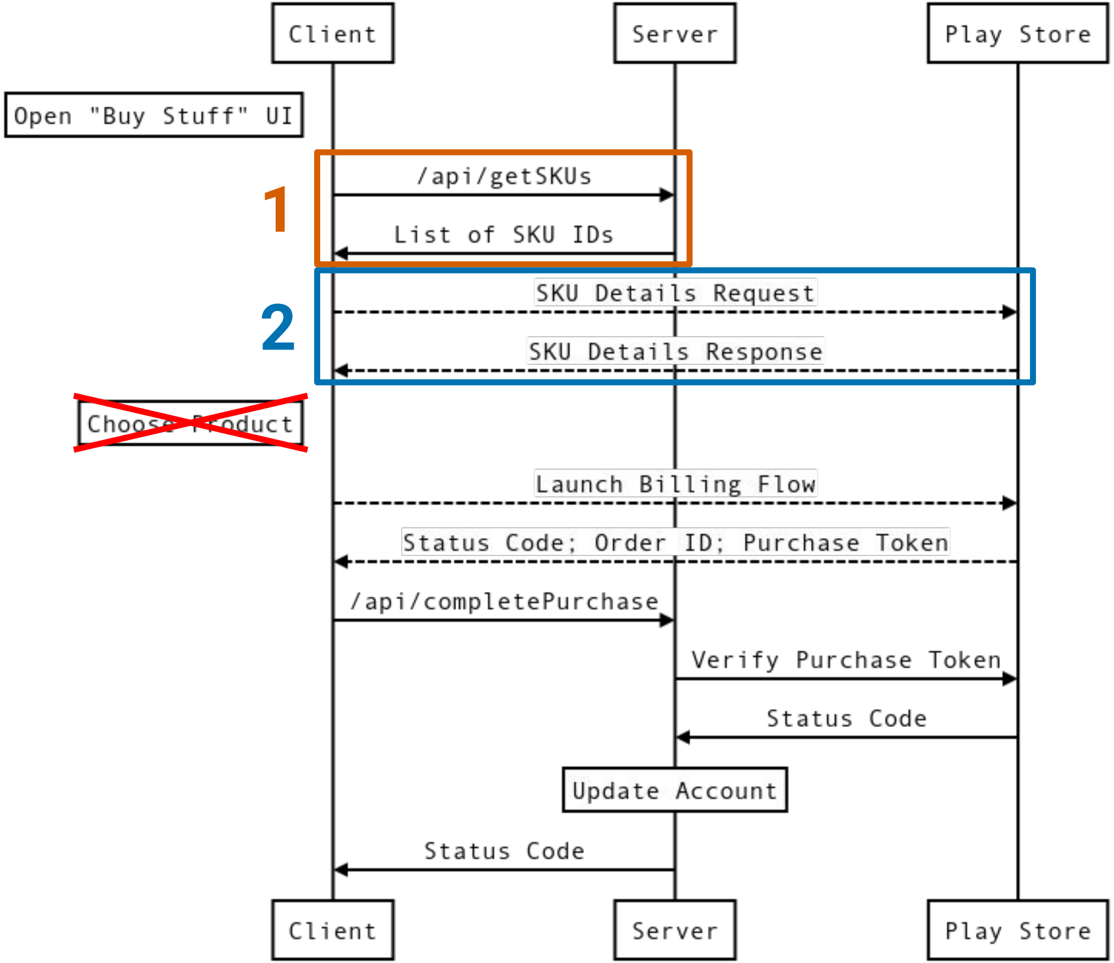


Break Down The Journey

User might choose **not** to buy an item :-(

1. Fetch list of SKUs from API server
2. Fetch SKU details from Play Store
3. User launches Play billing flow
4. Send token to API server
5. Verify token with Play Store

We have to treat these parts **separately**!



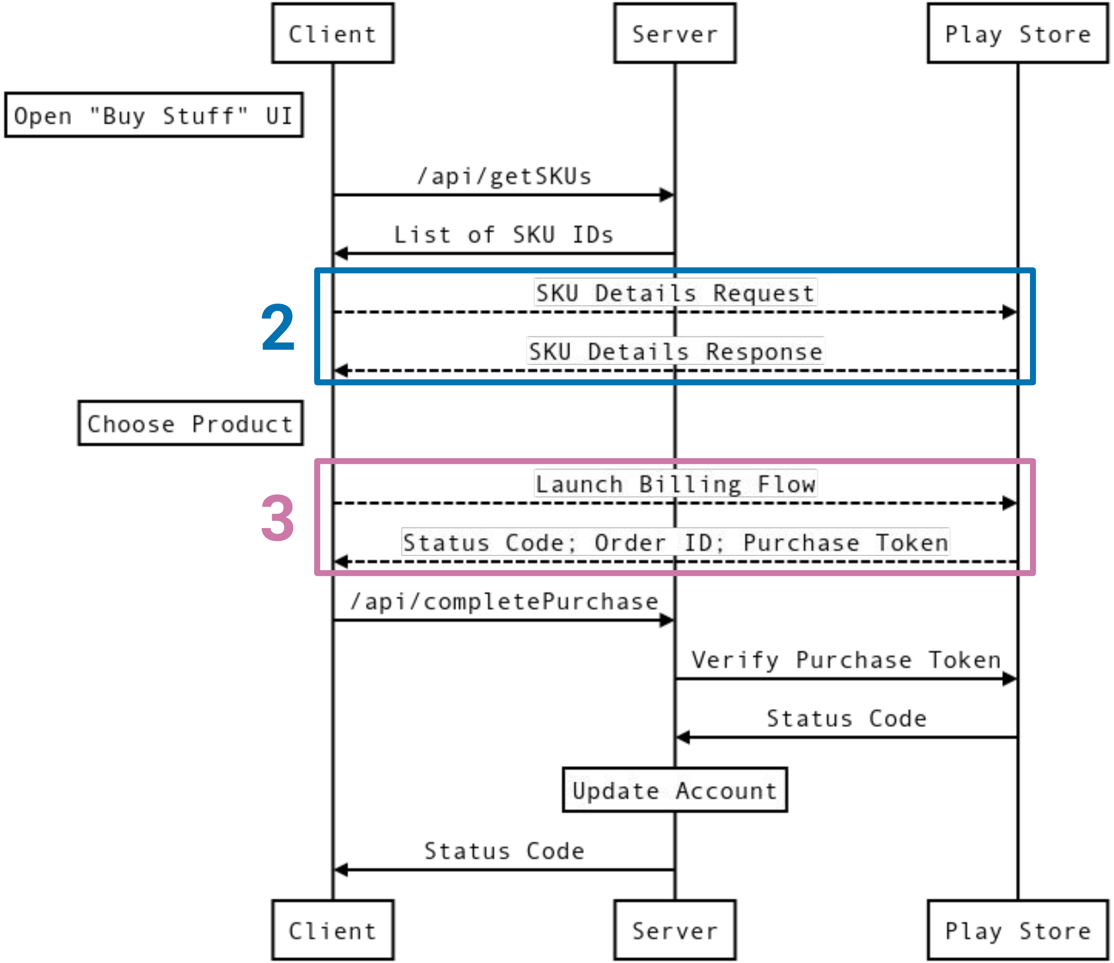
Google

Break Down The Journey

Two requests don't hit API server at all!

1. Fetch list of SKUs from API server
2. Fetch SKU details from Play Store
3. User launches Play billing flow
4. Send token to API server
5. Verify token with Play Store

Server or load balancer metrics **may not give enough coverage** of the journey :-(



Google

Break Down The Journey

Two requests don't hit API server at all!

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2. Fetch SKU details from Play Store
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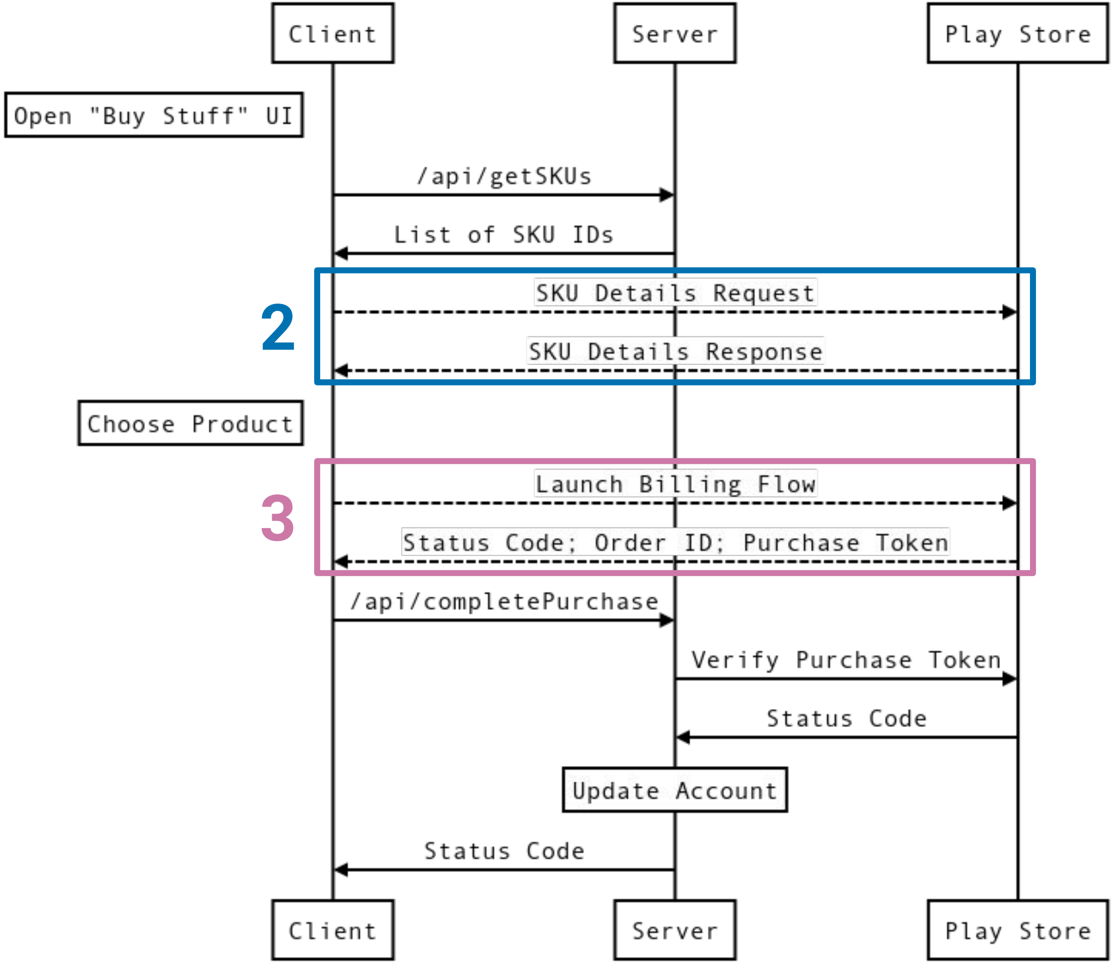
5. Verify token with Play Store

Server or load balancer metrics **may not give enough coverage** of the journey :-(

… we'll have to ask our users to **consent** to client-side telemetry.



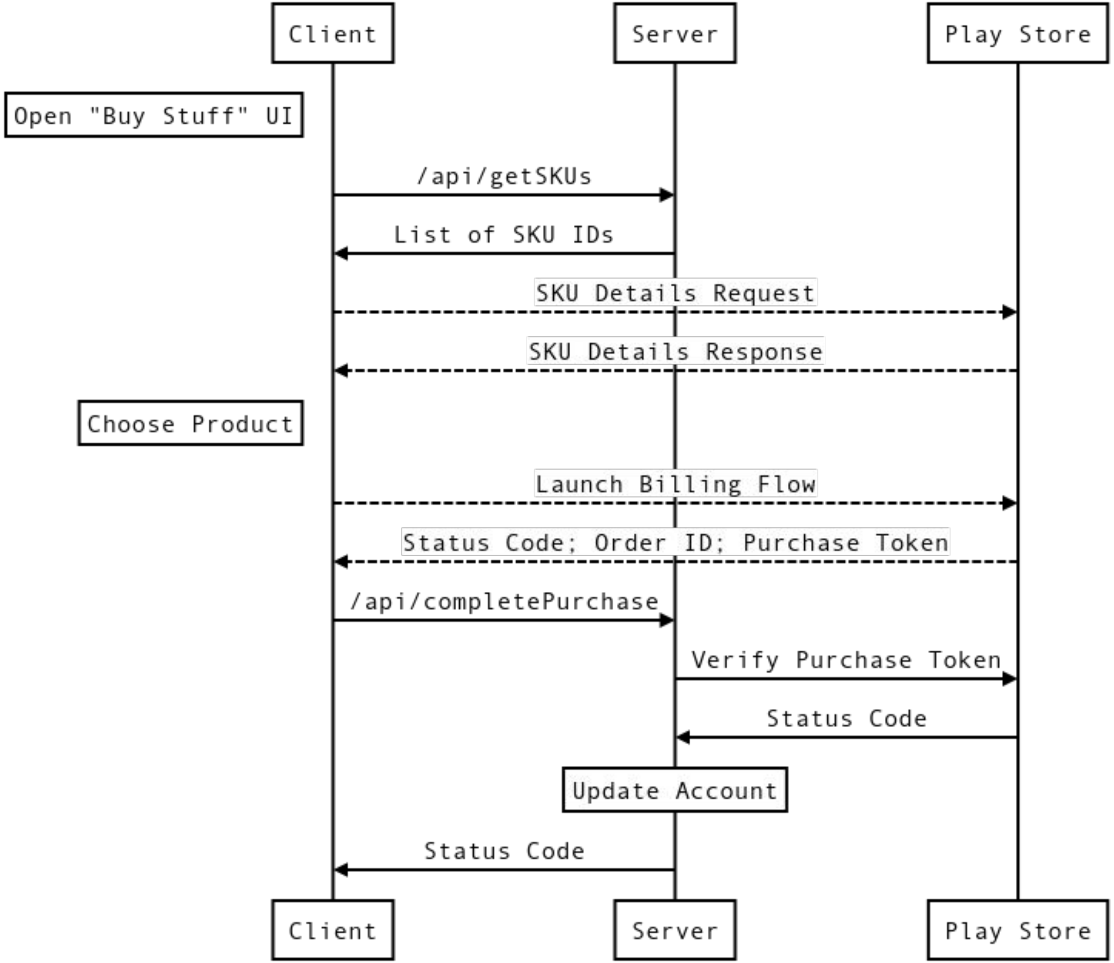
Buy Flow
What SLIs?

Buy Flow journey is

Request / Response

SLI menu suggests we use

Availability and **Latency** SLIs



Google

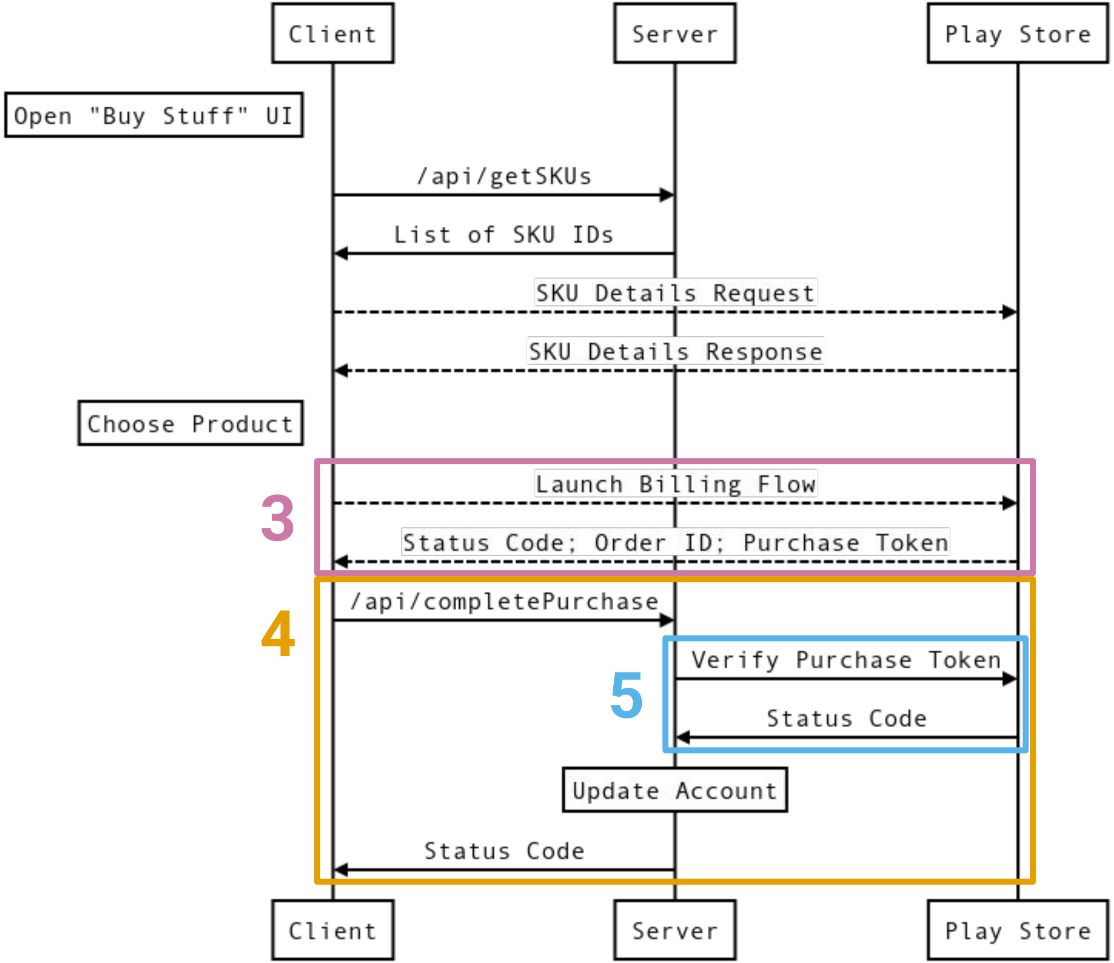
Buy Flow Availability: Specification

B makes money, so let's start with that

1. Fetch list of SKUs from API server
2. Fetch SKU details from Play Store
3. User launches Play billing flow
4. Send token to API server
5. Verify token with Play Store

<u>Availability SLI Specification</u>

The proportion of ***valid*** requests served ***successfully***.



Buy Flow Availability: Valid Requests

Availability SLI

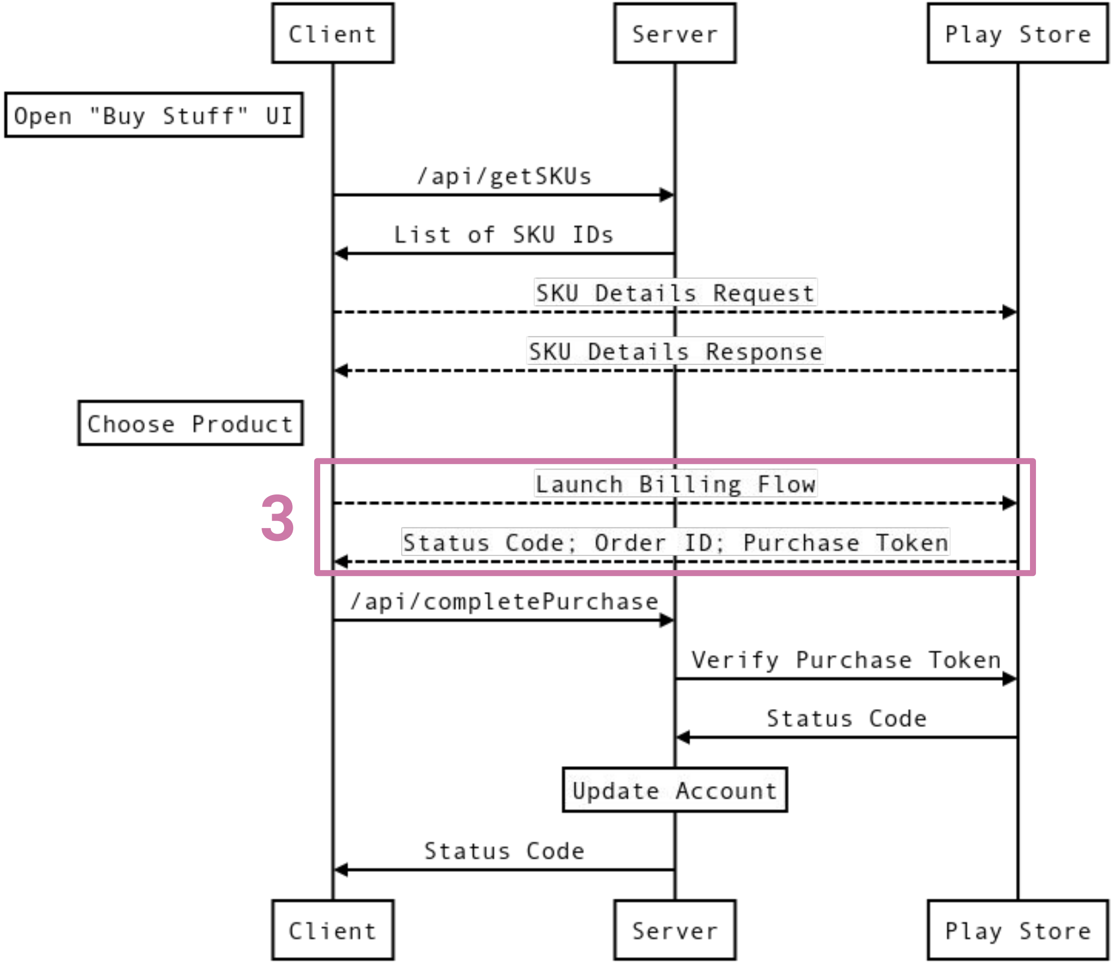
The proportion of ***valid*** requests served ***successfully***.

… but which requests are ***valid***?

3. User launches Play billing flow
4. Send token to API server?
5. Verify token with Play Store?

Launching the billing flow indicates a user's ***intent*** to buy a product

Users **consenting** to client-side telemetry collection allows us to **track** this intent



Buy Flow Availability: Success Criteria

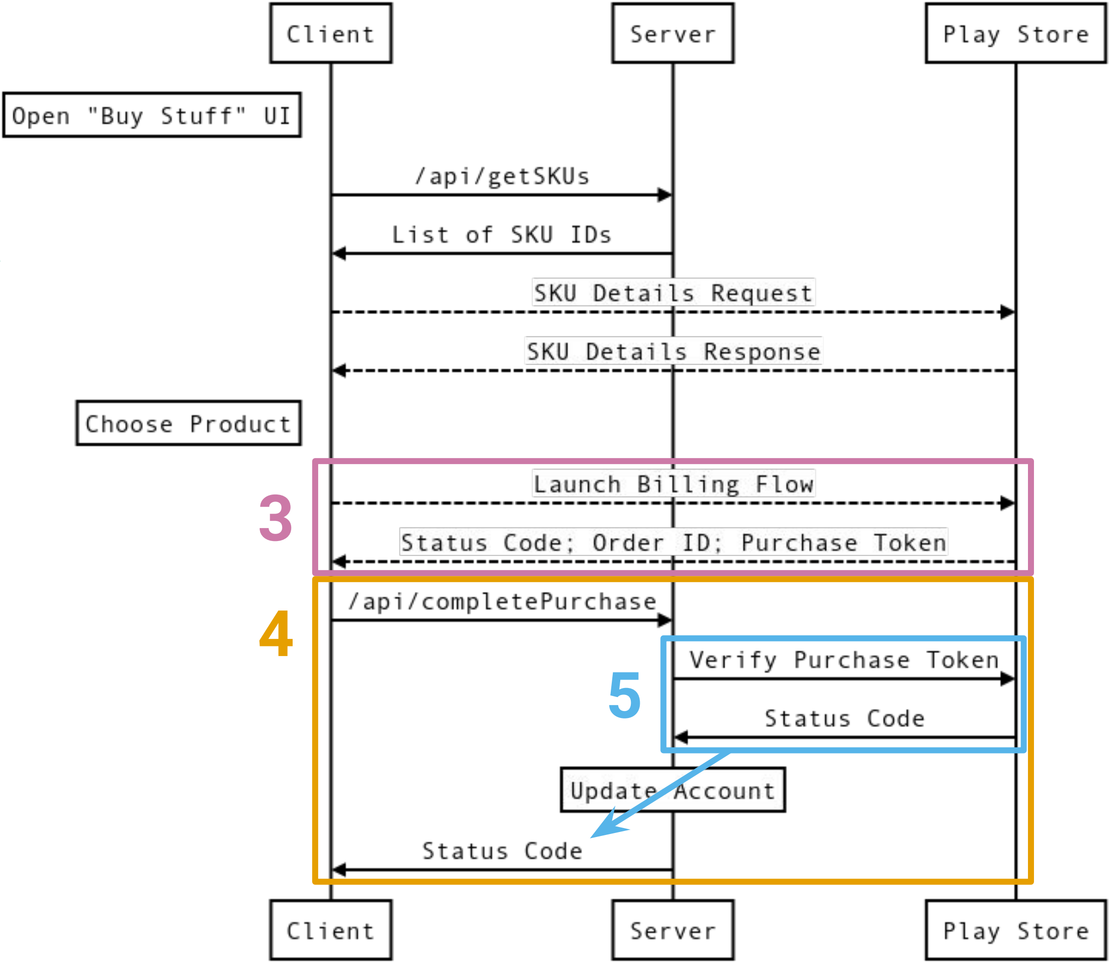
Availability SLI

The proportion of ***launched billing flows from users consenting to collection*** served ***successfully***.

… and how do we determine ***success***?

All interactions must be successful!

3. Good status code; purchase token
4. Good status code; account updated
5. Good status code; valid token
    - *Return **402** to API call when token is invalid*



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Buy Flow Availability: Measurement

Availability SLI

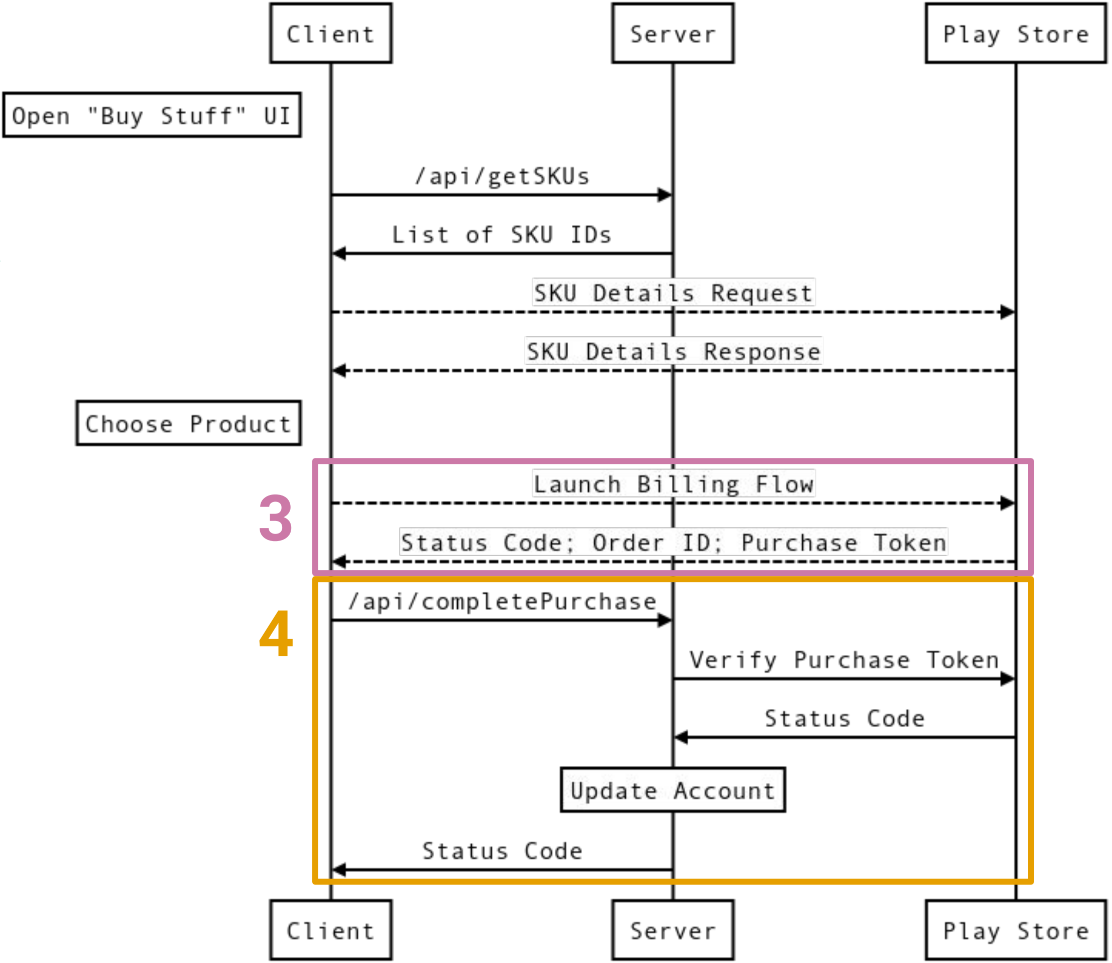
The proportion of ***launched billing flows from users consenting to collection*** where ***the billing flow returns***:

- OK *and a* purchase token
- *or* FEATURE_NOT_SUPPORTED
- *or* ITEM_UNAVAILABLE
- *or* USER_CANCELED

and ***/api/completePurchase returns***:

- 200 OK *and* Parseable JSON
- *or* 402 Payment Required

… but where are we ***measuring*** this?



Buy Flow Availability: Measurement

Availability SLI

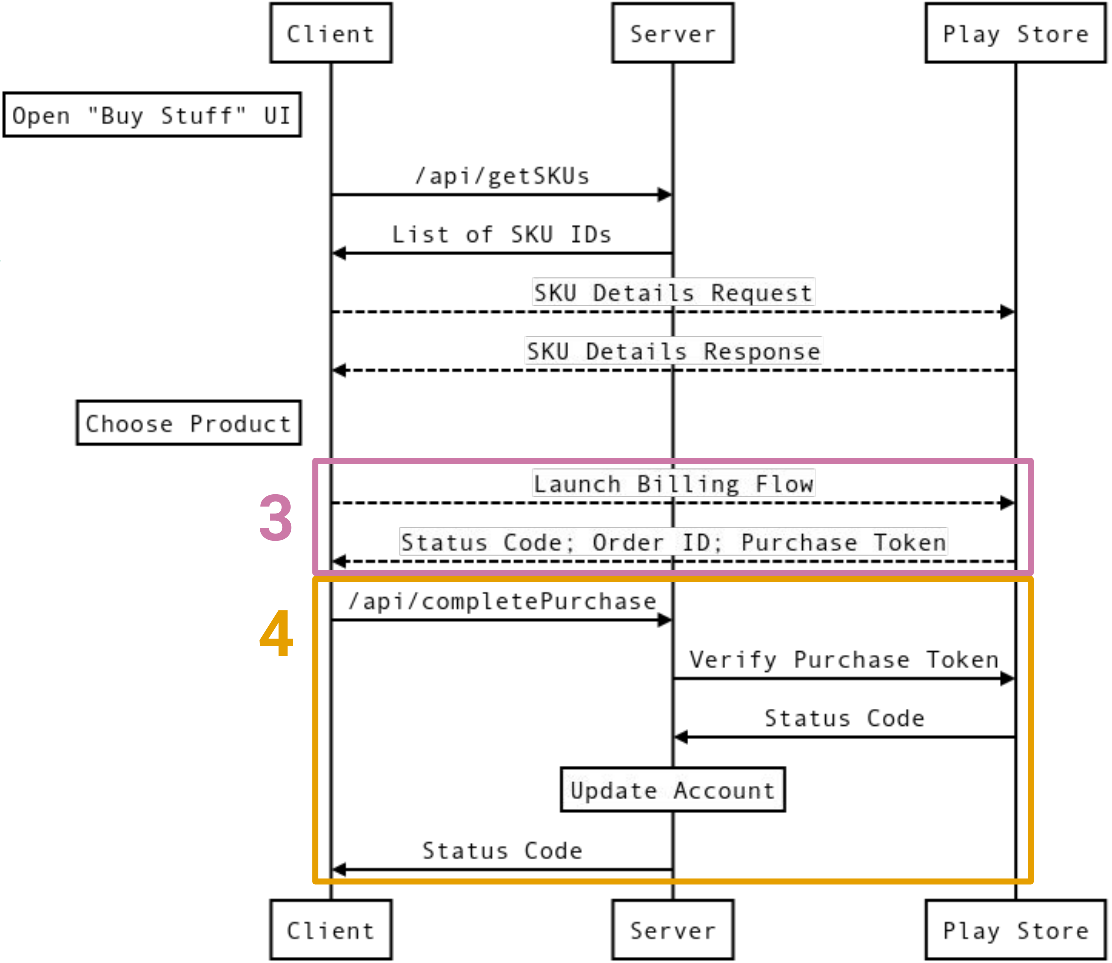
The proportion of ***launched billing flows from users consenting to collection*** where ***the billing flow returns***:

- OK
- *or* FEATURE_NOT_SUPPORTED
- *or* ITEM_UNAVAILABLE
- *or* USER_CANCELED

and ***/api/completePurchase returns***:

- 200 OK
- *or* 402 Payment Required
- *and* Parseable JSON

measured by the ***game client*** and reported back asynchronously.



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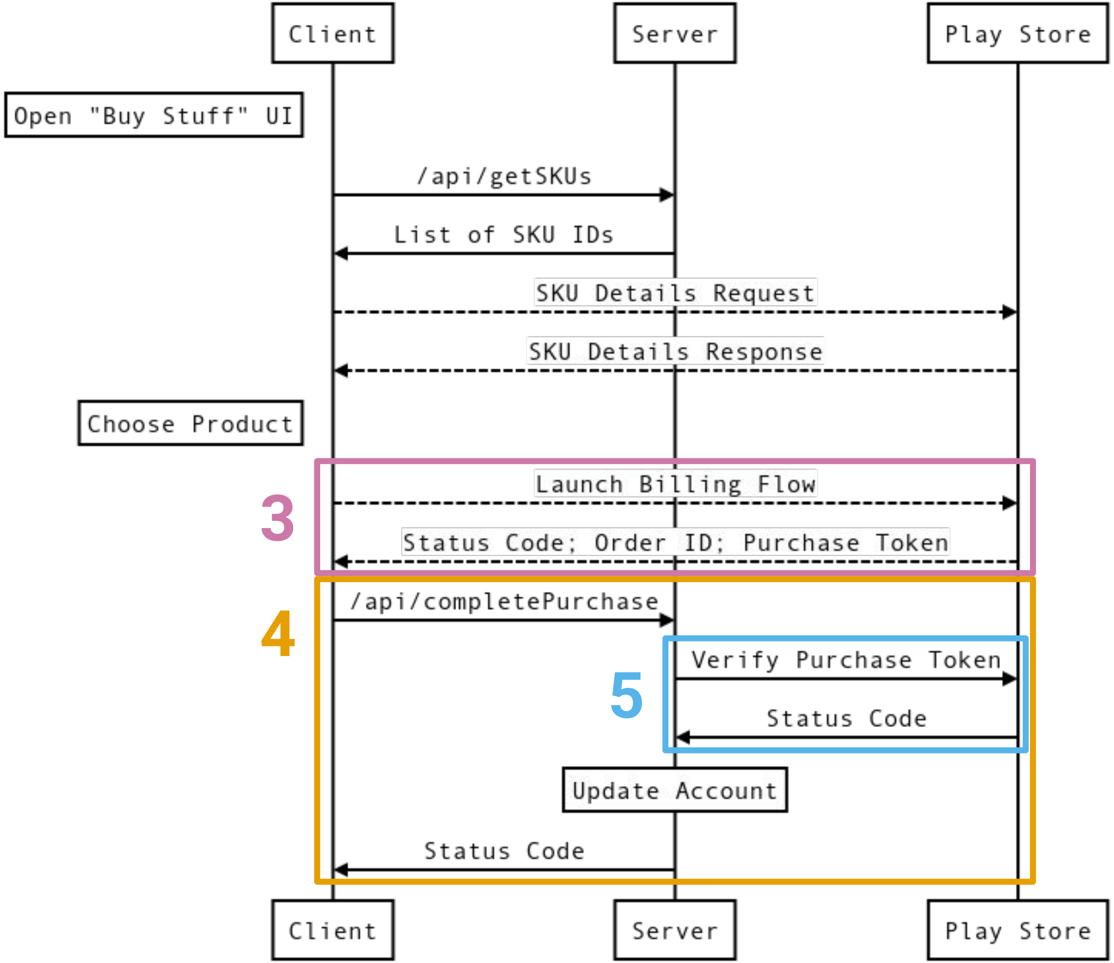
Buy Flow Latency: Specification

We want to measure latency for **B** too!

1. Fetch list of SKUs from API server
2. Fetch SKU details from Play Store
3. User launches Play billing flow
4. Send token to API server
5. Verify token with Play Store

Latency SLI Specification

The proportion of ***valid*** requests served ***faster*** than a threshold.



Buy Flow Latency: Valid Requests

Latency SLI

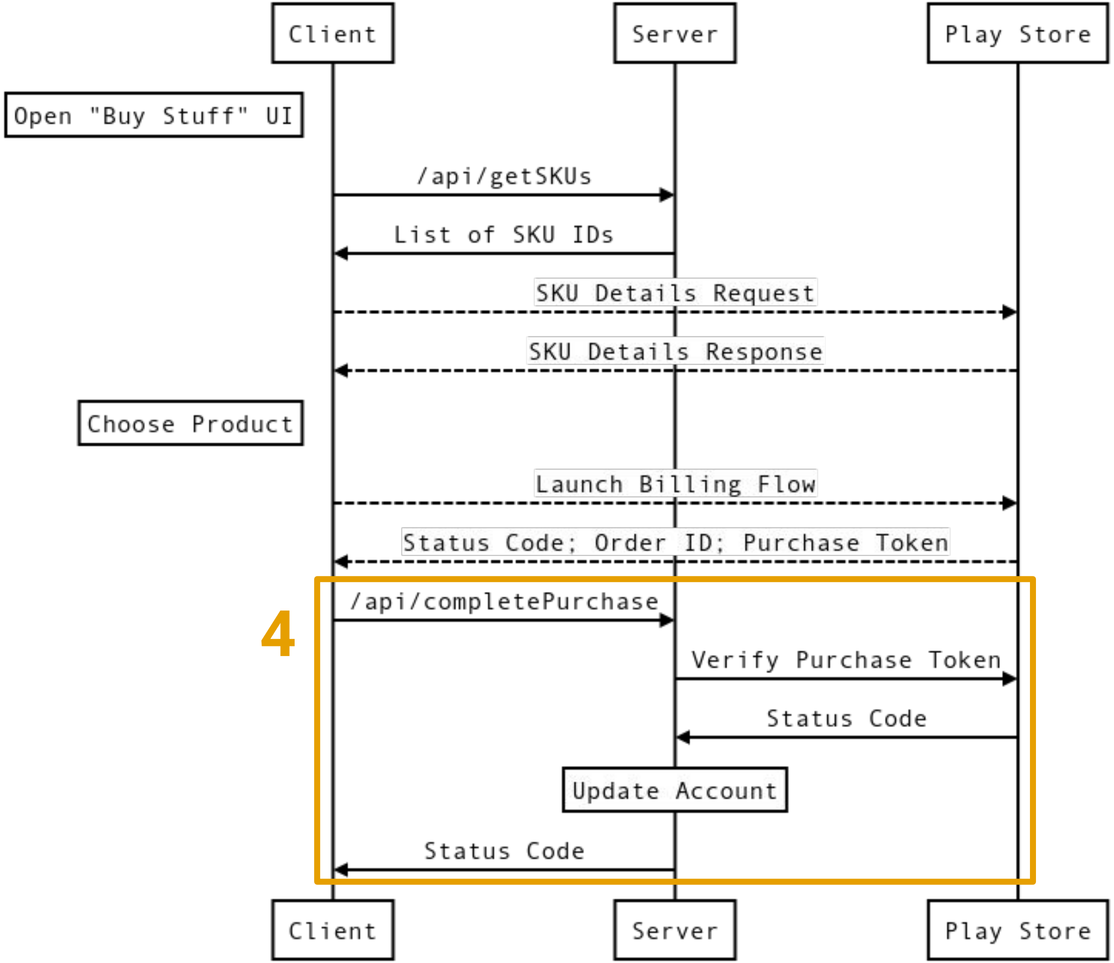
The proportion of ***valid*** requests served ***faster*** than a threshold.

… but which requests are ***valid***?

3. User launches Play billing flow?
4. Send token to API server
5. Verify token with Play Store?

Why not **3**?

- Too variable, SLI will have poor SnR
- Billing flow contains lots of "poking device with a finger" time



Buy Flow Latency: "Too Slow" Threshold

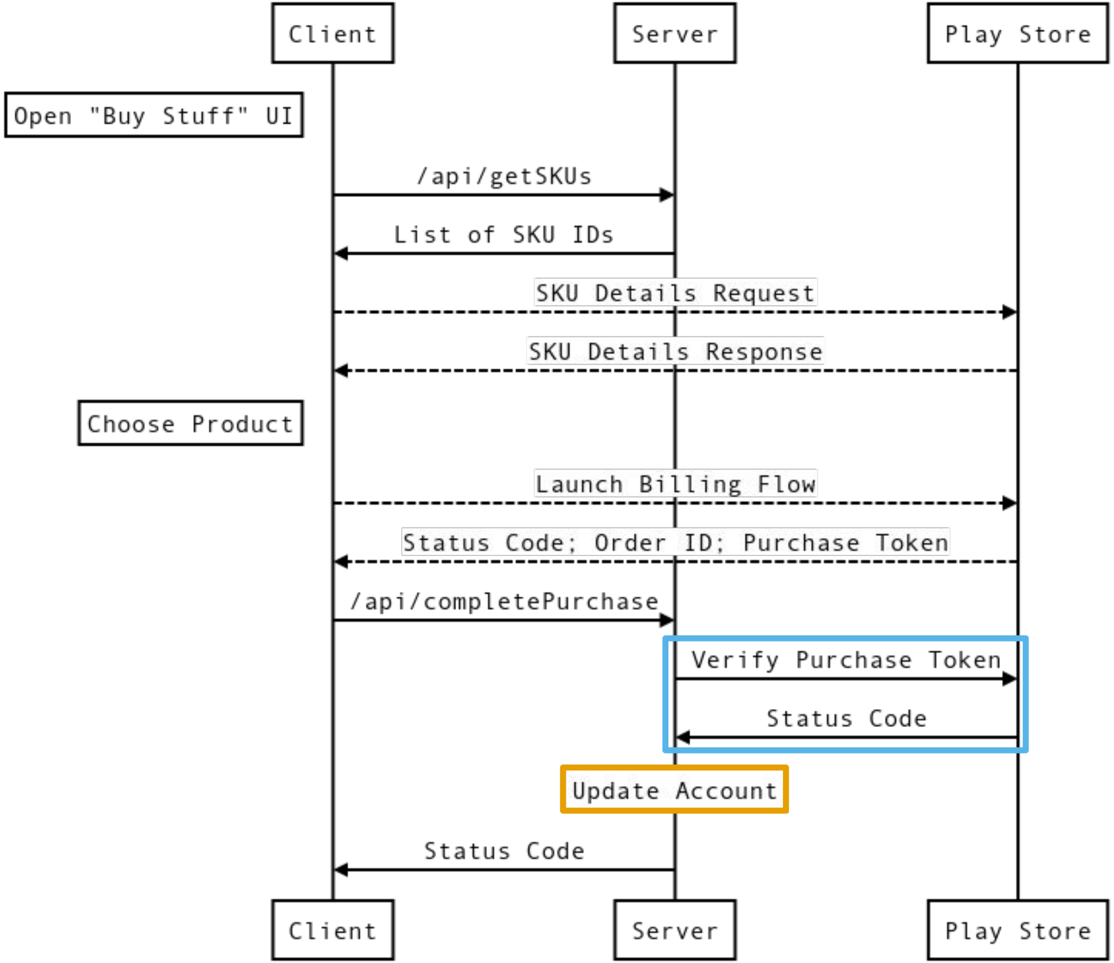
Latency SLI

The proportion of ***/api/completePurchase requests*** served ***faster*** than a threshold.

… and what is ***fast enough***?

Rough estimate time!

- Verify Token ***<= 500ms***
- Database Write ***<= 200ms***
- Round up a bit…



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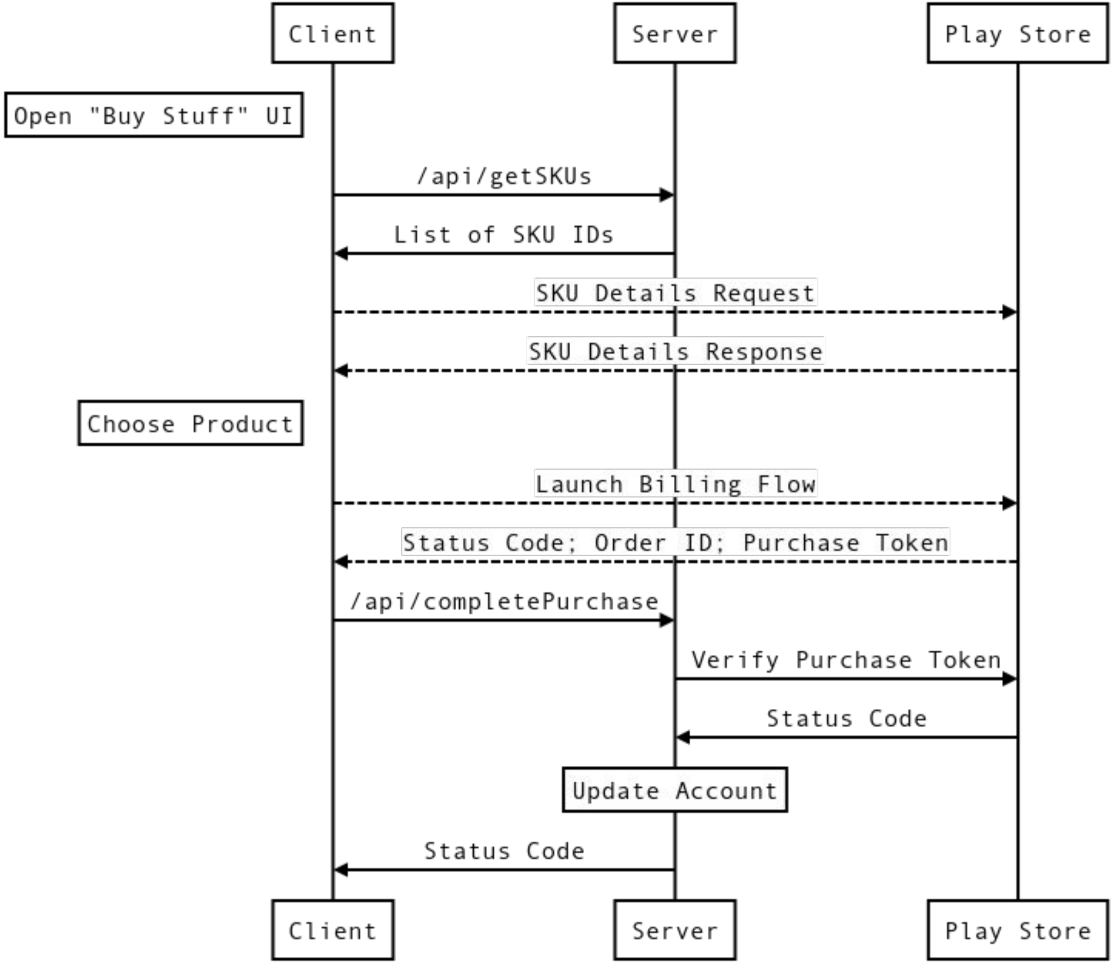
Buy Flow Latency: Measurement

Latency SLI

The proportion of ***/api/completePurchase requests*** served ***within 1000ms***.

… but where are we ***measuring*** this?

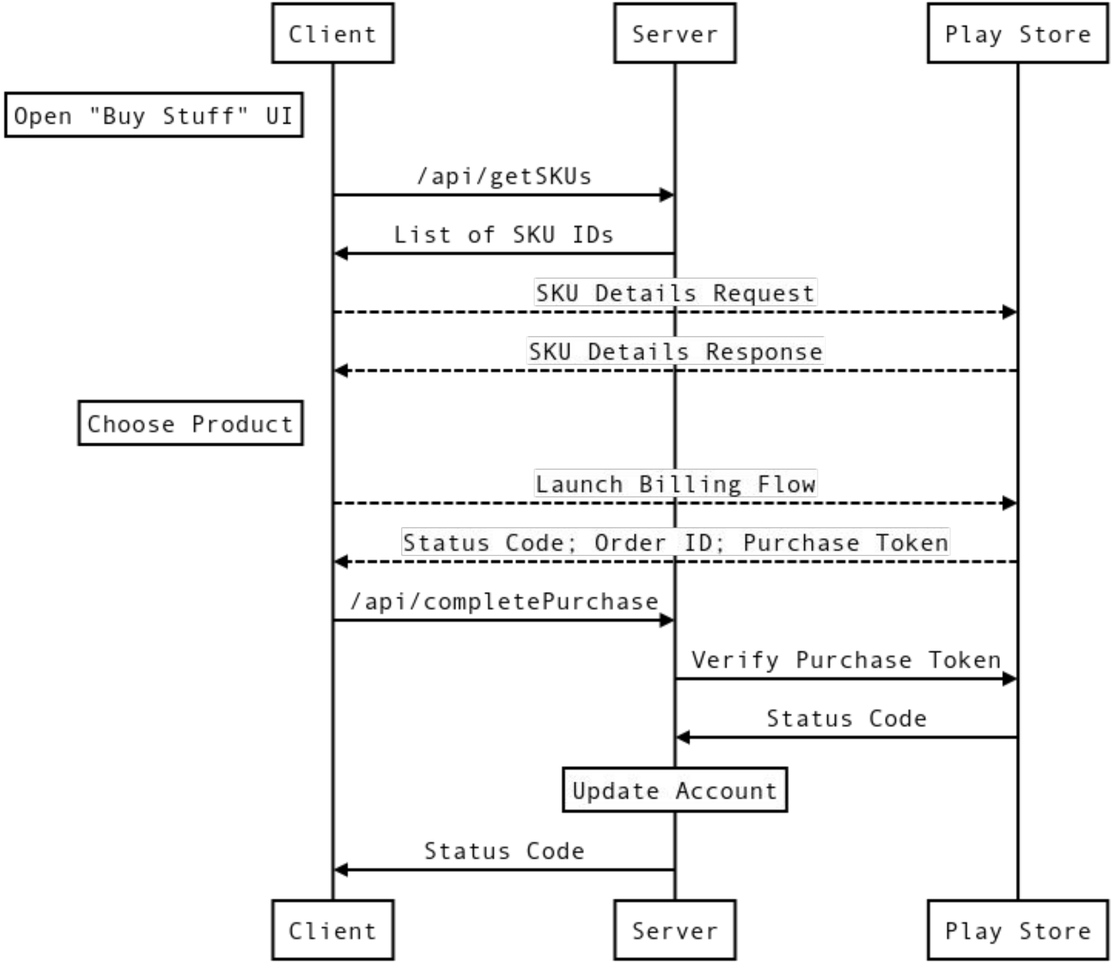
Where does the timer start/stop?



Buy Flow Latency: Measurement

Latency SLI

The proportion of ***/api/completePurchase requests*** where the ***complete response*** is returned to the client ***within 1000ms*** measured at the ***load balancer***.



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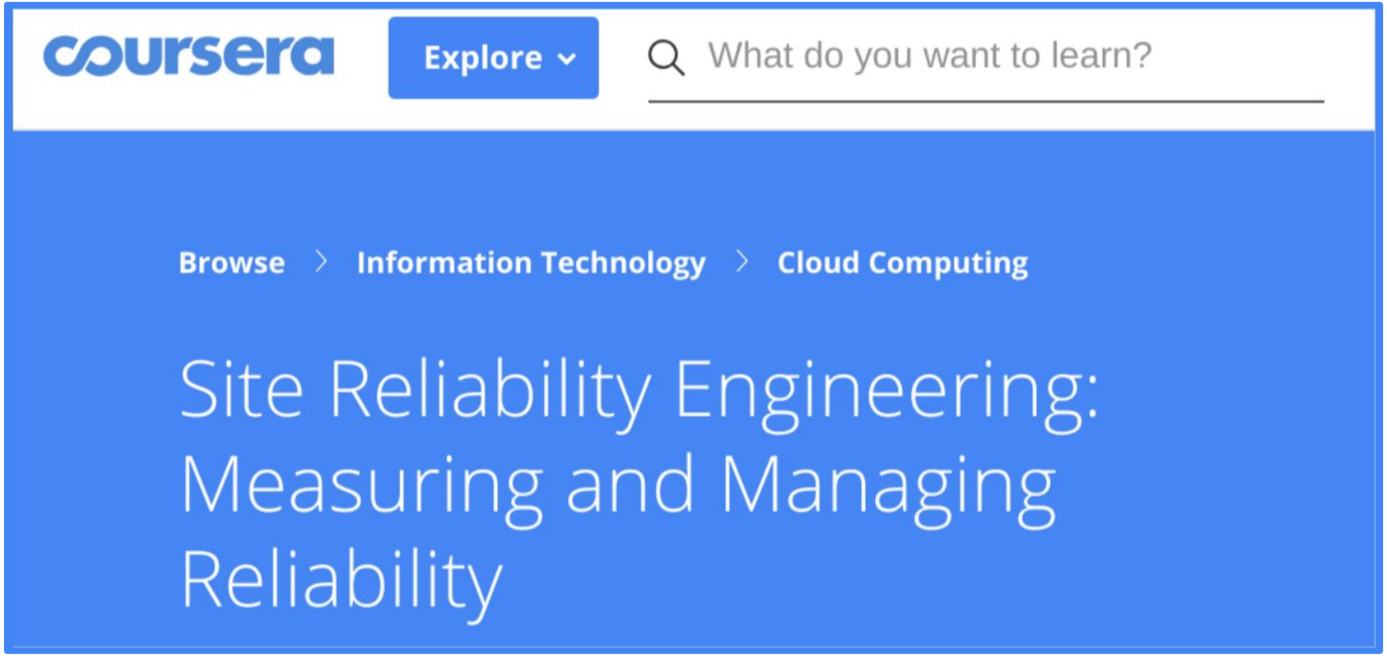

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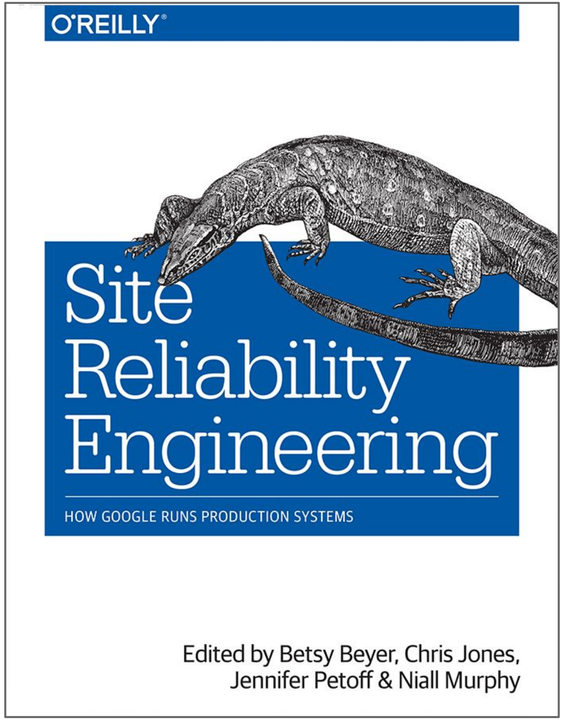

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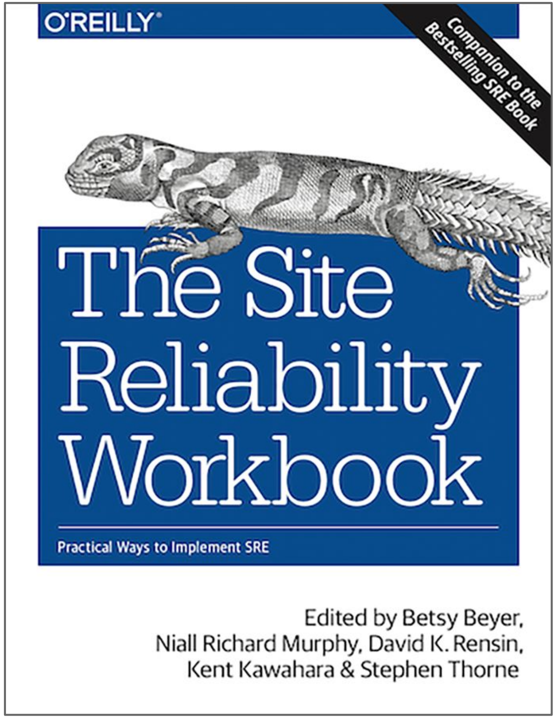

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