JESSICA TAI / 11.06.18 / QCON SF

Airbnb's Great Migration:
From Monolith to Service-Oriented

Life with monolith

Growing pains

Migration to services

Service design principles

Best practices

Results

Life with monolith

Growing pains

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Service design principles

Best practices

Results

Life with monolith → Growing pains

Migration to services → Service design principles

Best practices → Results

Life with monolith

Growing pains

Migration to services

Service design principles

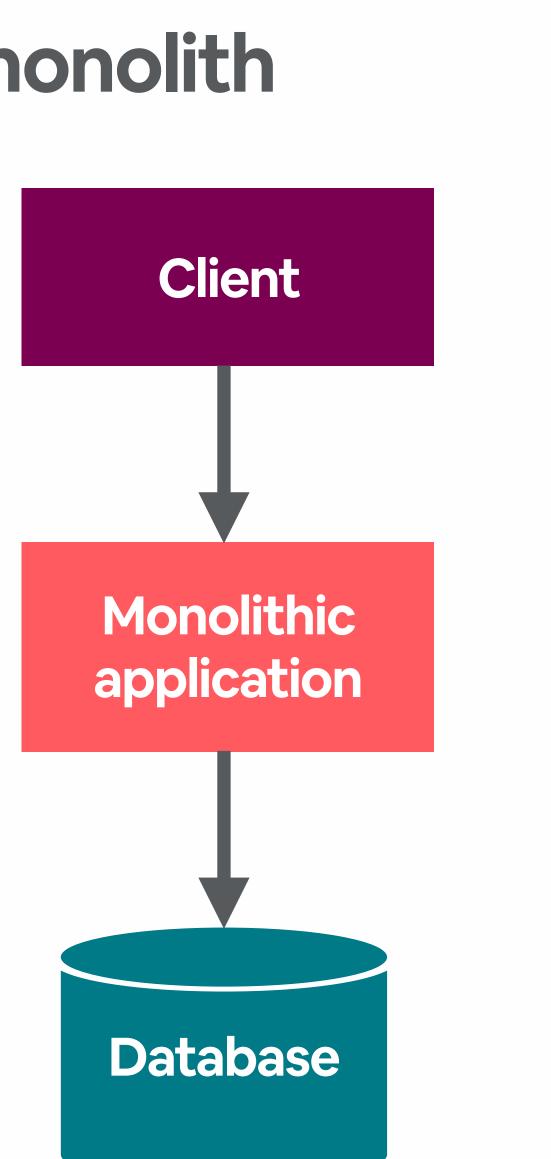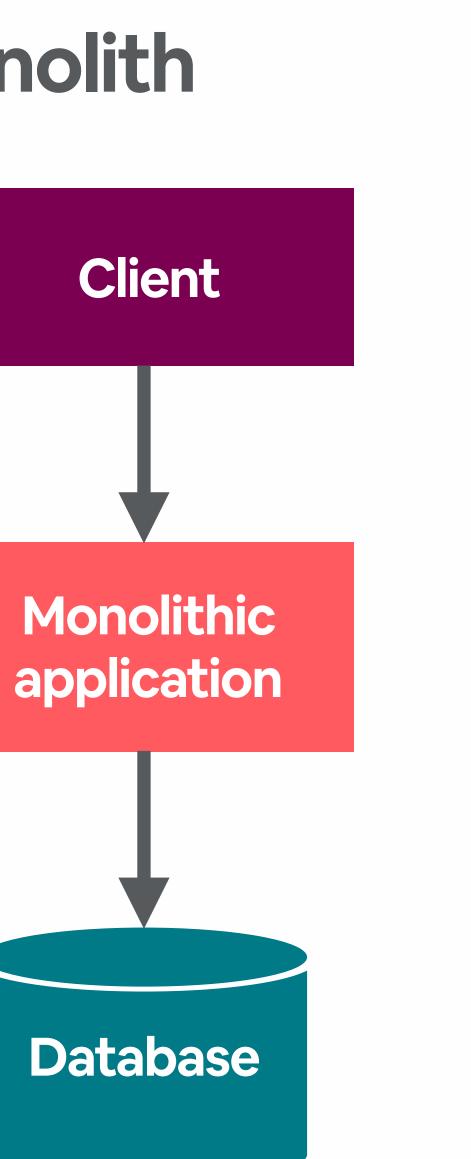Best practices

Results

Monorail, our Ruby on Rails monolith

Easy to get started with a monolith

EARLY AIRBNB

2014 new hire task

REQUIRED MESSAGE TO HOST

Database **model**

`host.first_name, message.save!`

2014 new hire task

REQUIRED MESSAGE TO HOST

View template

```
<h1>Tell your host %{host.name},
  "Hello"</h1>
```

Please correct the following
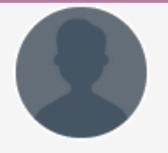
- Message to your host (required)

Payment

Country

United States ▼

Payment type

VISA xxxxxxxxxxx1111 ▼

VISA Name: **Test Guest**
Expires: **10/14**

Tell your host Bernat, "Hello"

Let Bernat know the purpose of your trip and about the other travelers in your party.

Message your host...

✓ By booking this listing, you agree to pay the total amount shown, which includes Service Fees, on the right and to the Terms of Service, House Rules, Cancellation Policy and Guest Refund Policy.

Book now

You will only be charged if the host accepts your request. They'll have 24 hours to reply. If the host declines or does not respond, no charge is made.

2014 new hire task

REQUIRED MESSAGE TO HOST
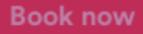
Controller endpoint logic

/submit_booking

Model **V**iew **C**ontroller in Monorail

Volunteer dev infra & sysops
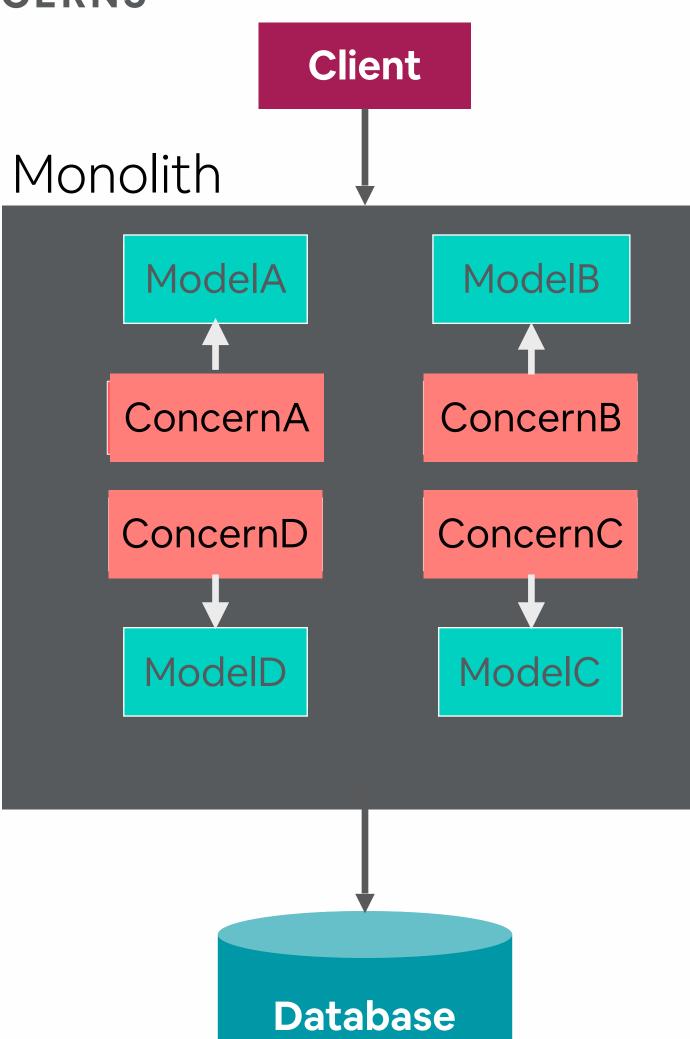
WHY DECIDE TO MIGRATE?

Difficult to scale monoliths
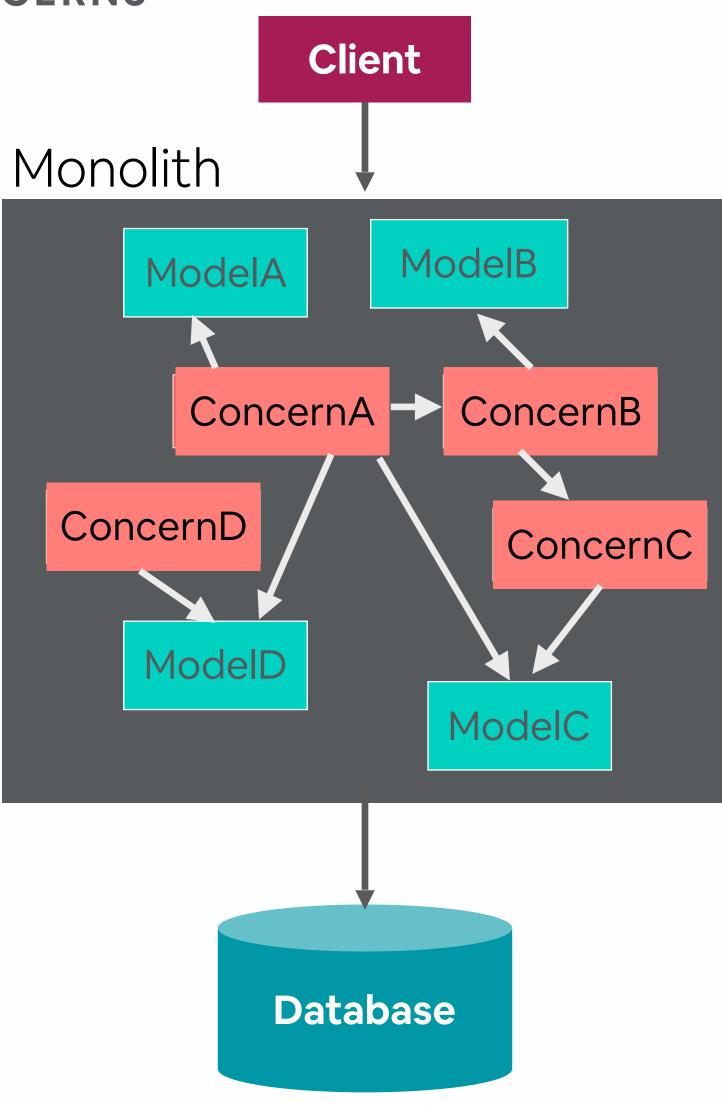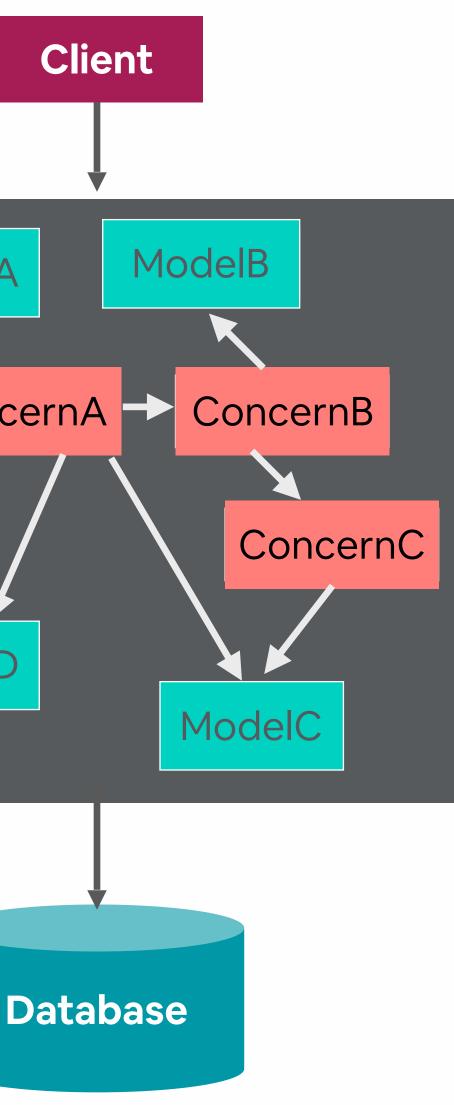
SINGLE MEGA-SERVICE FOR ALL CONCERNS

Difficult to scale monoliths

SINGLE MEGA-SERVICE FOR ALL CONCERNS

Difficult to scale monoliths

SINGLE MEGA-SERVICE FOR ALL CONCERNS

Client

Monolith

ModelA

ModelB

ConcernA

ConcernB

ConcernD

ConcernC

ModelD

ModelE

ModelC

Database
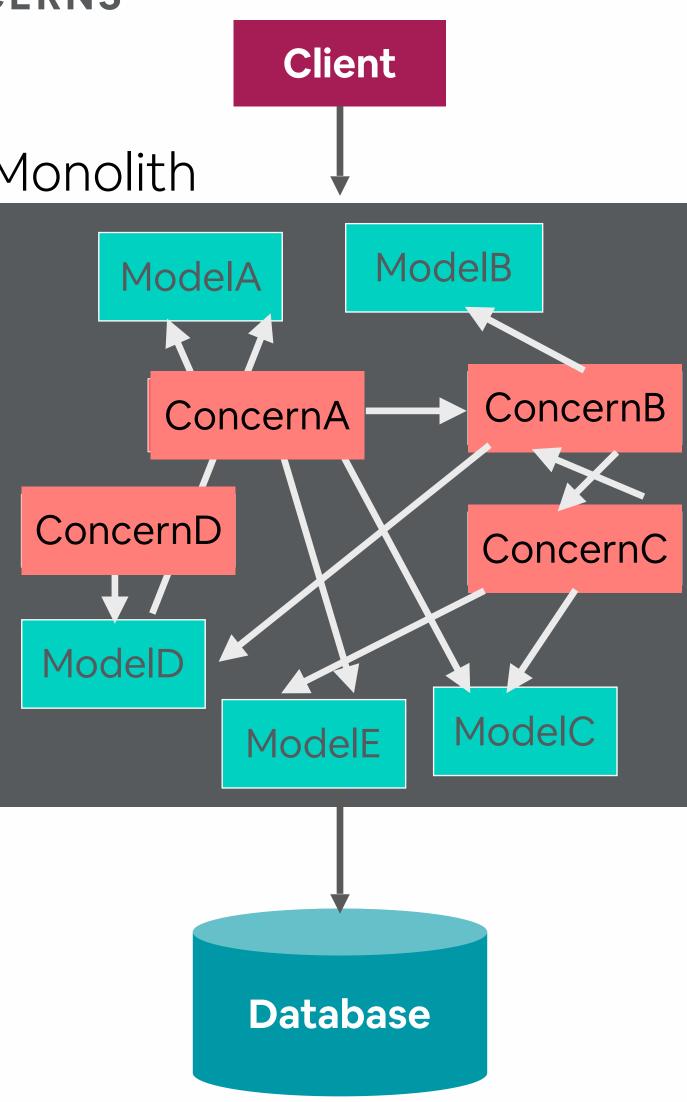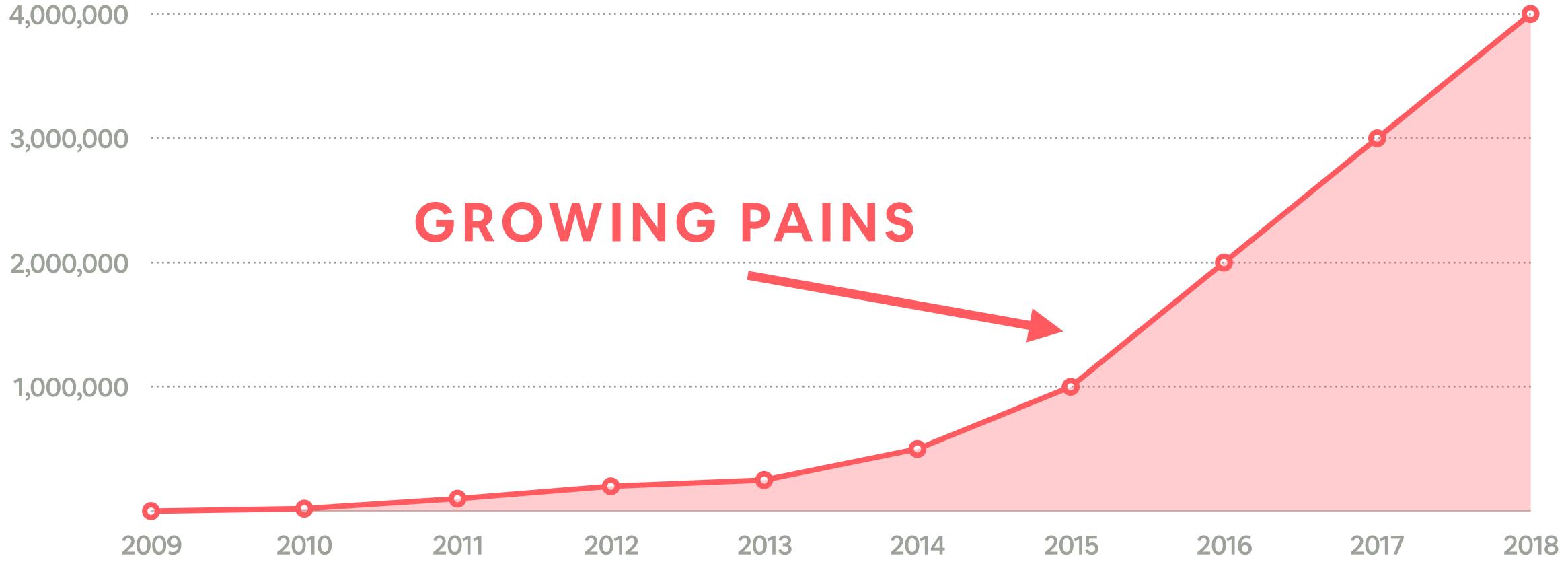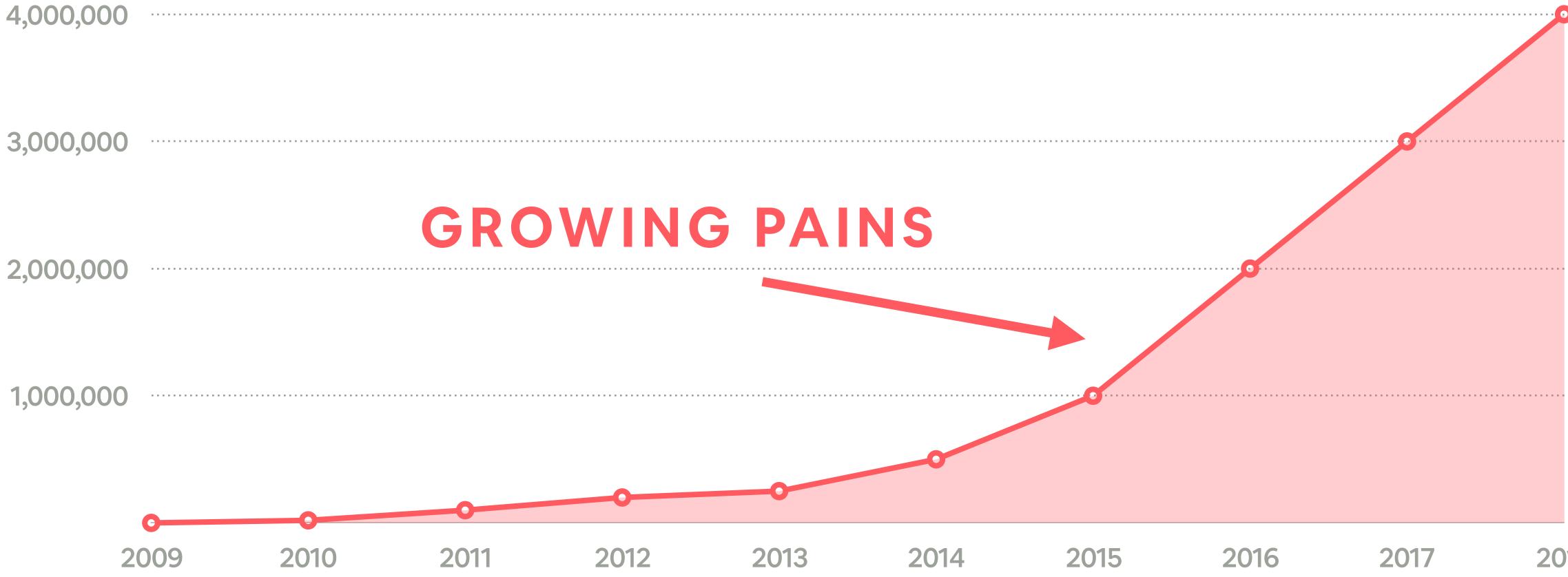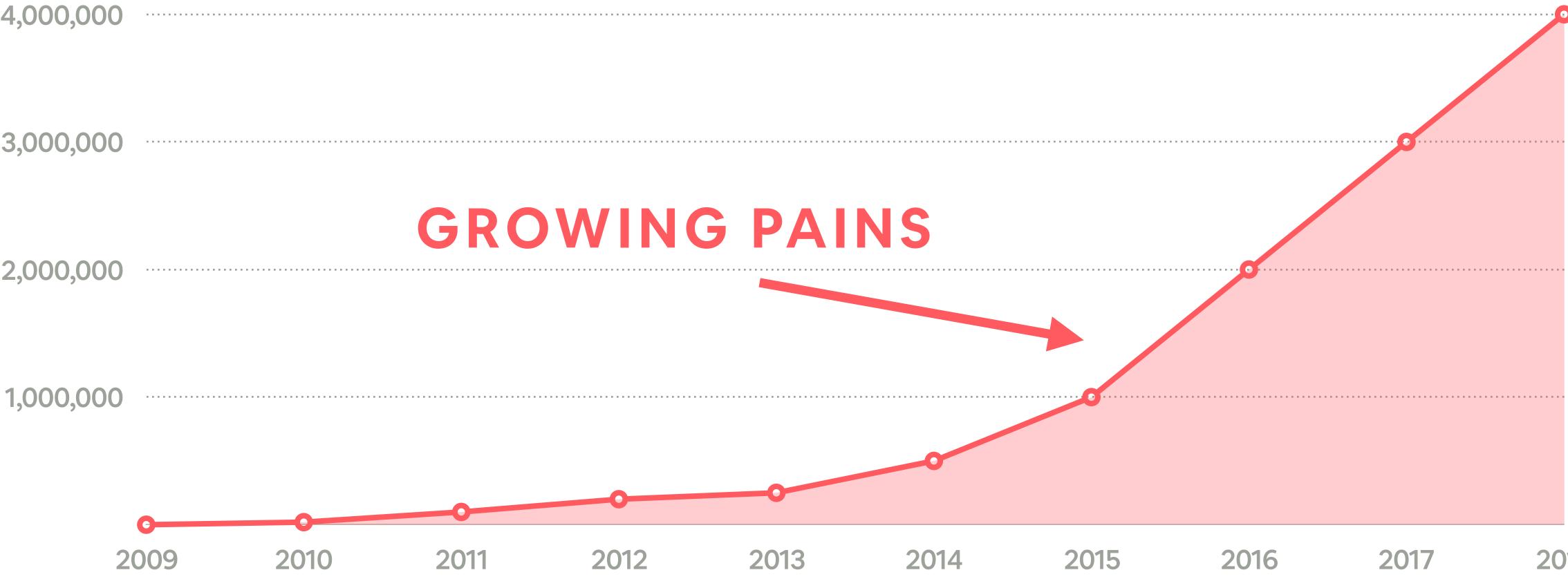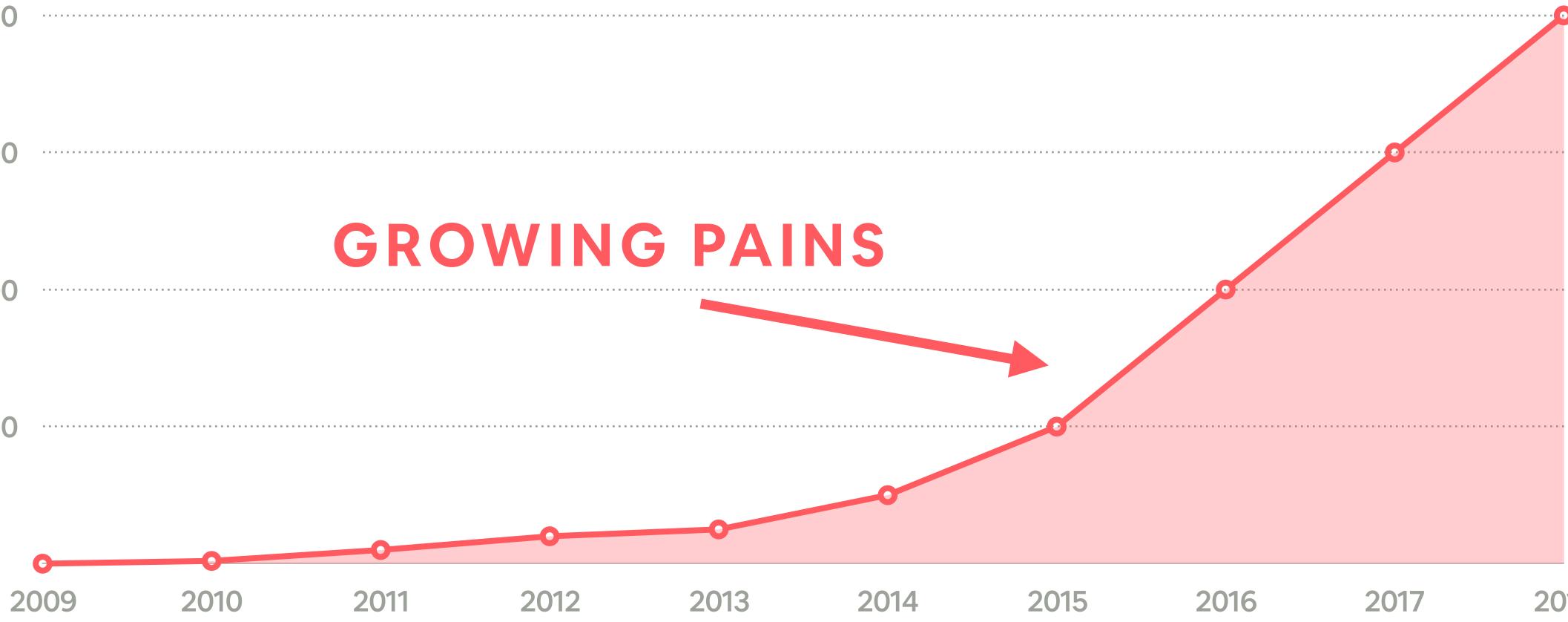
Increasingly large Monorail

LINES OF CODE GROWTH

GROWING PAINS

4,000,000

3,000,000

2,000,000

1,000,000

2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

Growing pains

200+
Engineers at Airbnb

200
Commits deployed to Monorail per day
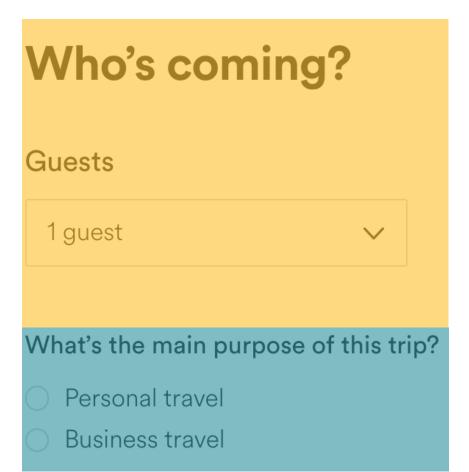
15h
Time Monorail deployed blocked per week

Message to host

This is a rare find. Kitty's place is usually booked.

Who's coming?

Guests

1 guest ⌄

What's the main purpose of this trip?

○ Personal travel
○ Business travel

Say hello to your host

Let Kitty know a little about yourself and why you're coming.

Hello Kitty! Can't wait to spend 1 night in your home.

Continue

Mushroom Dome Cabin: #1 on airbnb in the world

Entire home/apt in Aptos
★★★★★ 1165 reviews

👥 1 guest

📅 Jun 21, 2018 → Jun 22, 2018

$130.00 x 1 night	$130.00
Cleaning fee ?	$35.00
Service fee ?	$21.55
Occupancy Taxes ?	$18.15
Gift Credit	-$204.70
Total (USD)	**$0.00**

The quoted fees include any applicable exchange rate.

Moderate — free cancellation

Cancel within 48 hours of booking to get a full refund. More details

Tay
Stayed on April 2018

Featured review

"Staying at the Mushroom Dome was

Message to host

THOUSANDS OF LINES, HUNDREDS OF CONTRIBUTORS

More incidents

Slower deploy trains

More incidents
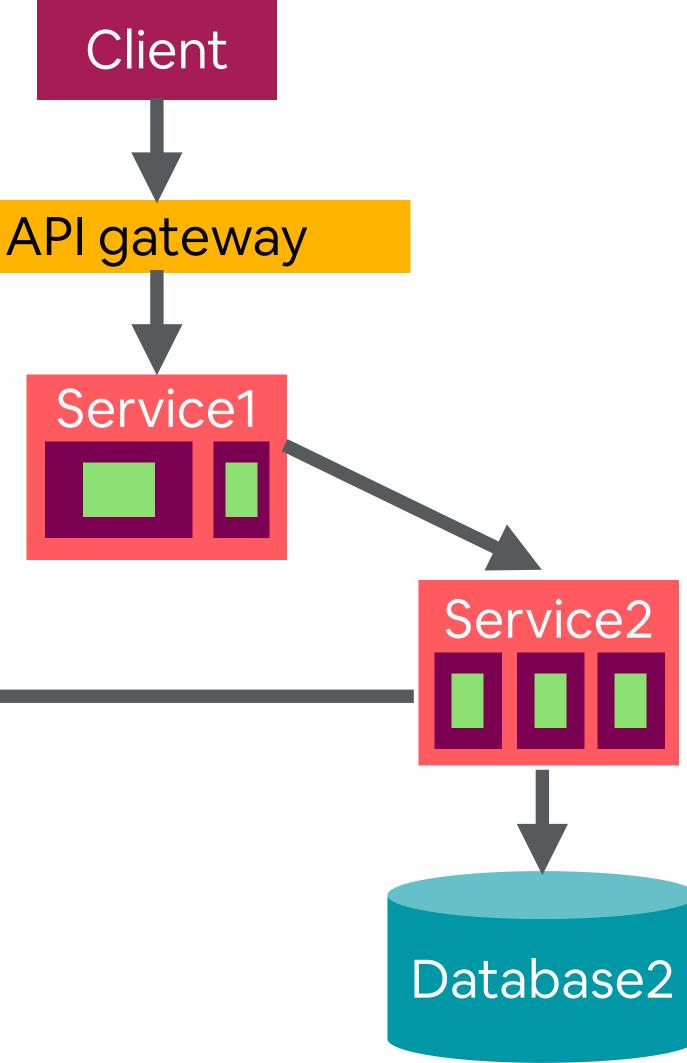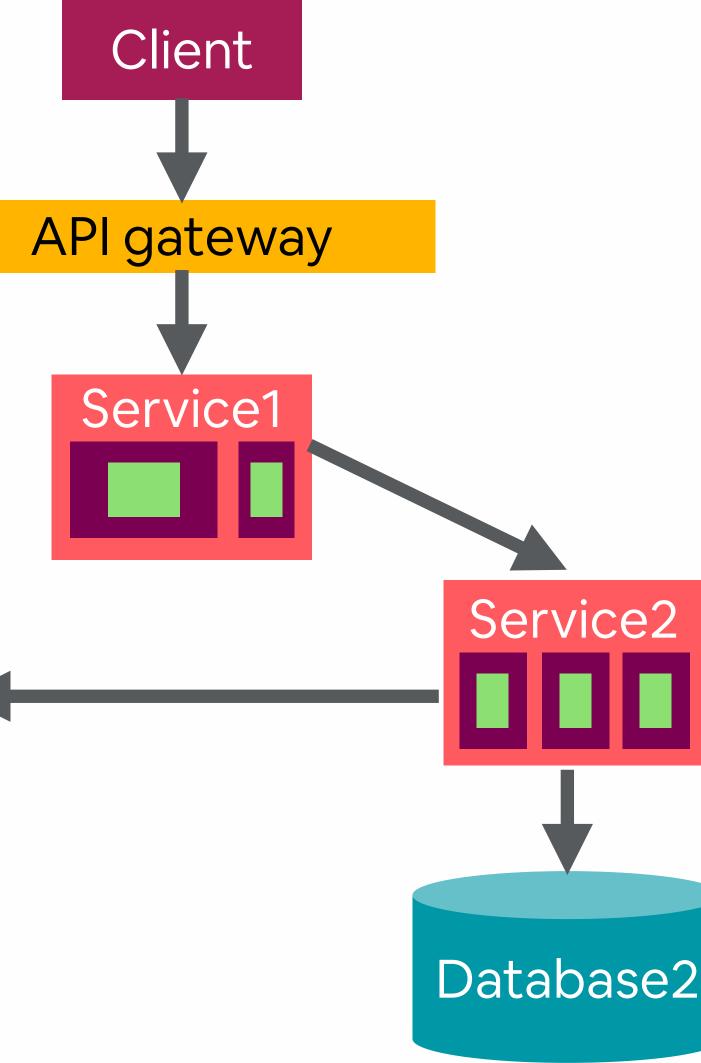
Slower deploy trains
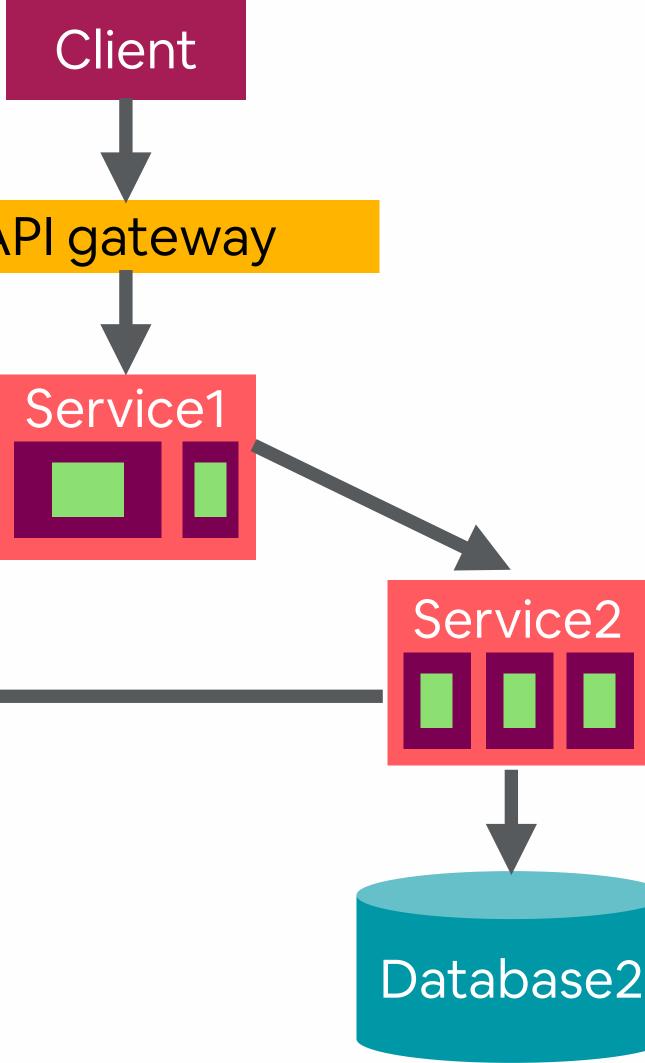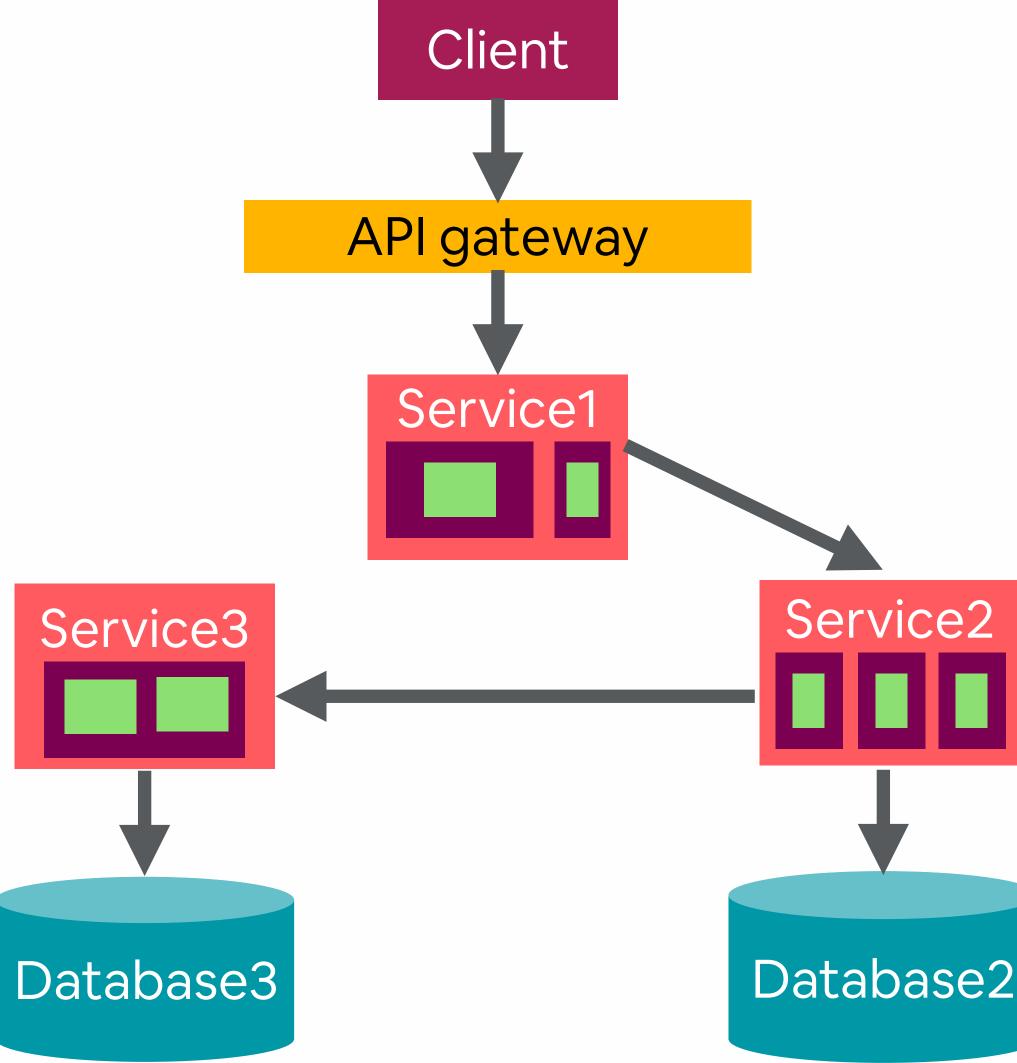
Our solution: Service-oriented architecture (SOA)

NETWORK OF LOOSELY-COUPLED SERVICES
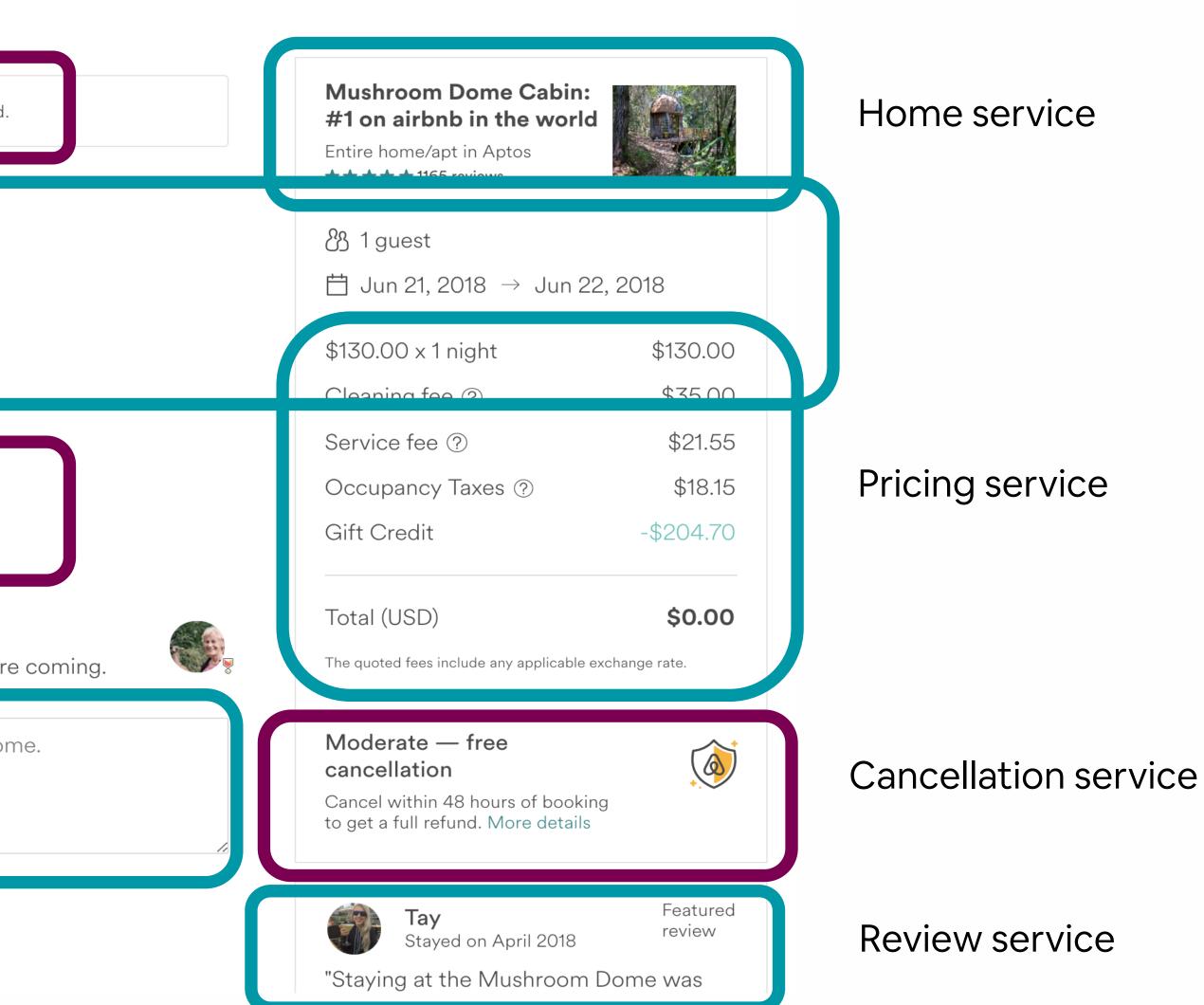
Checkout page in SOA

Home demand service

Home service

1. Review trip details → 2. Who's coming? → 3. Confirm and Pay

This is a rare find. Kitty's place is usually booked.

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Who's coming?

Reservation service

👥 1 guest

📅 Jun 21, 2018 → Jun 22, 2018

Guests

1 guest ⌄

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Occupancy Taxes ?	$18.15
Gift Credit	-$204.70
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The quoted fees include any applicable exchange rate.

Pricing service

Business travel service

What's the main purpose of this trip?

○ Personal travel
○ Business travel

Say hello to your host

Let Kitty know a little about yourself and why you're coming.

Messaging service

Hello Kitty! Can't wait to spend 1 night in your home.

Moderate — free cancellation

Cancel within 48 hours of booking to get a full refund. More details

Cancellation service

Continue

Tay
Stayed on April 2018

Featured review

"Staying at the Mushroom Dome was

Review service
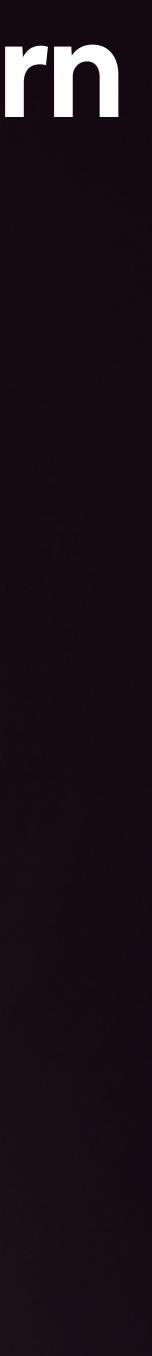
SOA DESIGN TENETS

Services own reads & writes
to their data

Services address a specific concern

Avoid duplicate functionality

**Mutations propagate
via standard events**
(open sourced Spinaltap)

GETTING STARTED WITH THE MIGRATION
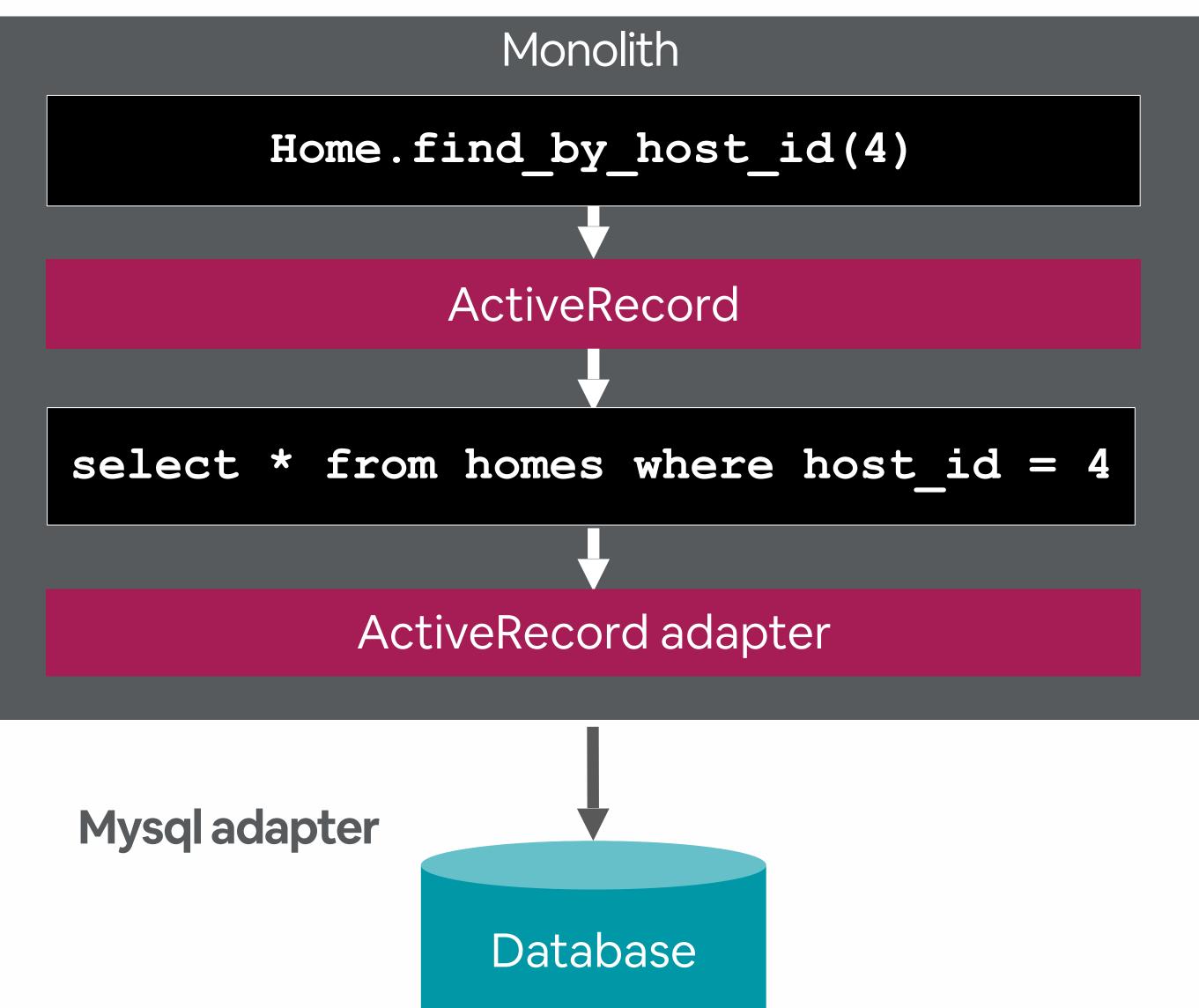
Idyllic home in the trees
HOSTED BY BAILEY

$99 PER NIGHT
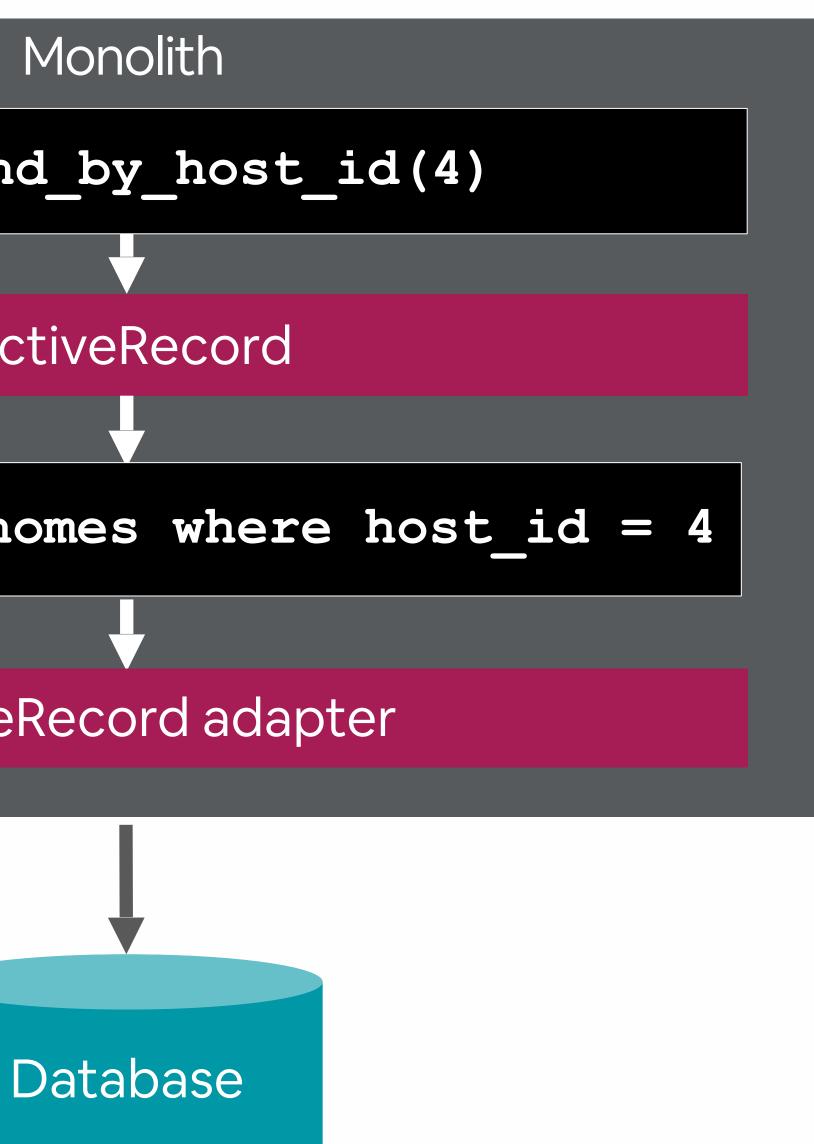
First attempts to break apart Monorail

- Replace data access methods with service call
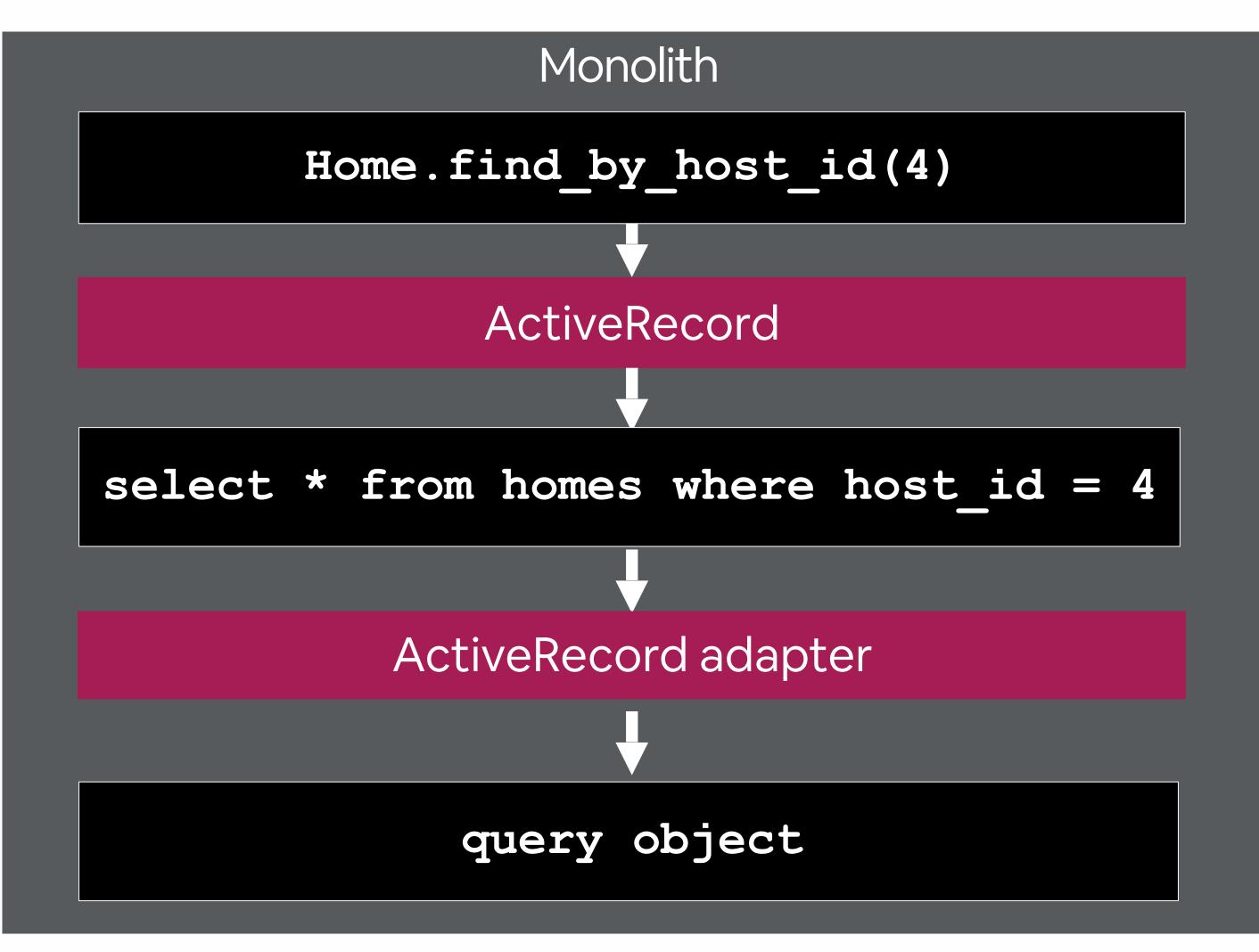
- Ruby metaprogramming to override methods

Migrating Rails's ActiveRecord

Monolith

```
Home.find_by_host_id(4)
```

ActiveRecord

```
select * from homes where host_id = 4
```

ActiveRecord adapter

Mysql adapter

Database

Custom ActiveRecord adapter

Monolith

```
Home.find_by_host_id(4)
```

ActiveRecord

```
select * from homes where host_id = 4
```

ActiveRecord adapter

```
query object
```

Parse to request object

Monolith

ActiveRecord adapter

query object

```
:type => :select,
:table => "homes",
:filters => [{
    :name => "host_id",
    :type => "integer",
    :nullable => false,
    :comparator => :eq,
    :value => 4,
  }],
:select => ["id", "host_id", "title"],
```

/loadHomes
{
  host_id: 4,
  fields: ["id", "host_id","title"]
}

Re-route queries to services

SERVICE INTERACTION DESIGN

Service request

Interim

Future

Monorail

API gateway

API traffic

Service

Service

Service types

STRICT FLOW OF DEPENDENCIES

API traffic

Presentation service

Synthesize data from services for end users

Middle tier

Shared validation logic

Derived data service

Data service

Shared business logic to disparate data sources

Derived data store

Own reads & writes to data entities

Database

Checkout page

API traffic

Checkout page presentation service

Write

Read

Reservation validation middle-tier service

Home demand derived data service

Home data service

Reservation data service

Offline booking trend stats

Home database

Reservation database

COMPARE FOR DIFFERENCES

Dual read comparison

Monolith

Read path B

Read path A

Service

Database

Gate	Compare	Ramp & wait	Wait	Switch
Admin UI configuration	1% traffic	Gradual increments	Gather traffic patterns	All traffic through service only

Dual read comparison

Monolith

Read path B

Read path A

Service

Database

Gate	Compare	Ramp & wait	Wait	Switch
Admin UI configuration	1% traffic	Gradual increments	Gather traffic patterns	All traffic through service only

Dual read comparison

Monolith

Read path B

Read path A

Service

Database

Gate	Compare	Ramp & wait	Wait	Switch
Admin UI configuration	1% traffic	Gradual increments	Gather traffic patterns	All traffic through service only

Dual read comparison

Monolith

Read path B

Read path A

Service

Database

Production traffic

5%

Gate

Admin UI configuration

Compare

1% traffic

Ramp & wait

Gradual increments

Wait

Gather traffic patterns

Switch

All traffic through service only

Dual read comparison

Monolith

Read path B

Service

Read path A

Database

Production traffic

10%

Gate	**Compare**	**Ramp & wait**	**Wait**	**Switch**
Admin UI configuration	1% traffic	Gradual increments	Gather traffic patterns	All traffic through service only

Dual read comparison

Monolith

Read path B

Read path A

Service

Database

25%

Production
traffic

Gate	Compare	Ramp & wait	Wait	Switch
Admin UI configuration	1% traffic	Gradual increments	Gather traffic patterns	All traffic through service only

Dual read comparison

Monolith

Read path B

Read path A

Service

Database

50%

Production traffic

Gate	Compare	**Ramp & wait**	Wait	Switch
Admin UI configuration	1% traffic	Gradual increments	Gather traffic patterns	All traffic through service only

Dual read comparison

Monolith

Read path B

Read path A

Service

Database

100%

Production traffic

Gate

Compare

Ramp & wait

Wait

Switch

Admin UI configuration

1% traffic

Gradual increments

Gather traffic patterns

All traffic through service only

Dual read comparison

Monolith

Read path B

Read path A

Service

Database

100%

Gate	Compare	Ramp & wait	**Wait**	Switch
Admin UI configuration	1% traffic	Gradual increments	Gather traffic patterns	All traffic through service only

Dual read comparison

Monolith

Read path B

Read path A

Service

Database

Gate	Compare	Ramp & wait	Wait	Switch
Admin UI configuration	1% traffic	Gradual increments	Gather traffic patterns	All traffic through service only

Dual read comparison

Monolith

Service   The read path

Database

Gate	Compare	Ramp & wait	Wait	**Switch**
Admin UI configuration	1% traffic	Gradual increments	Gather traffic patterns	All traffic through service only

Write comparison
DUAL WRITE TO SEPARATE DATABASES

Monolith

Presentation service

Write path A

Write path B

Write validation middle tier service

Reads

Production database

Shadow database

Write comparison: services

Monolith

Presentation service

The write path

Write validation
middle tier service

Production
database

Incremental migration

Migrate by endpoint

- Compare one endpoint at a time

- Unblock clients with incomplete service
  - e.g. `/loadUsers`
  - fetch users only by id

Migrate by attribute

Production traffic

Presentation service

Read migrated attributes

Read not-yet-migrated attributes

Service

Monolith

Database

Database

SOA BEST PRACTICES

Standardize service building

Frameworks
Auto-generate code

Testing & deploying
Replay production traffic

Observability
Standard templates

Service & client setup

Service

Business logic

Service & client setup

Service

Endpoint logic

Server transport

Business logic

Service & client setup

Java client

Client transport

Ruby client

Client transport

Service

Endpoint logic

Server transport

Business logic

Service & client setup

Java client

Metrics	Client transport
Data validation	Resilience
Error handling	

Ruby client

Metrics	Client transport
Data validation	Resilience
Error handling	Type checking

Service

Endpoint logic

Metrics	Data validation	Server transport	Server resilience

Business logic

Server metrics

Startup / teardown

Server diagnostics

Service & client setup

Java client

Metrics	Client transport
Data validation	Resilience
Error handling	

Ruby client

Metrics	Client transport
Data validation	Resilience
Error handling	Type checking

Service

Endpoint logic

Metrics	Data validation	Server transport	Server resilience

Business logic

Server metrics	Startup / teardown
Server diagnostics	

Dashboard

Alert

Runbook documentation

Service & client setup

Java client

Metrics	Client transport
Data validation	Resilience
Error handling	

Ruby client

Metrics	Client transport
Data validation	Resilience
Error handling	Type checking

Service

Endpoint logic

Metrics	Data validation	Server transport	Server resilience

Business logic

Server metrics

Server diagnostics

Startup / teardown

Dashboard

Alert

Runbook documentation

IDL using Thrift

IDL

Java client

Metrics	Client transport
Data validation	Resilience
Error handling	

Ruby client

Metrics	Client transport
Data validation	Resilience
Error handling	Type checking

Service

Endpoint logic

Metrics	Data validation	Server transport	Server resilience

Business logic

Server metrics	Startup / teardown
Server diagnostics	

Dashboard
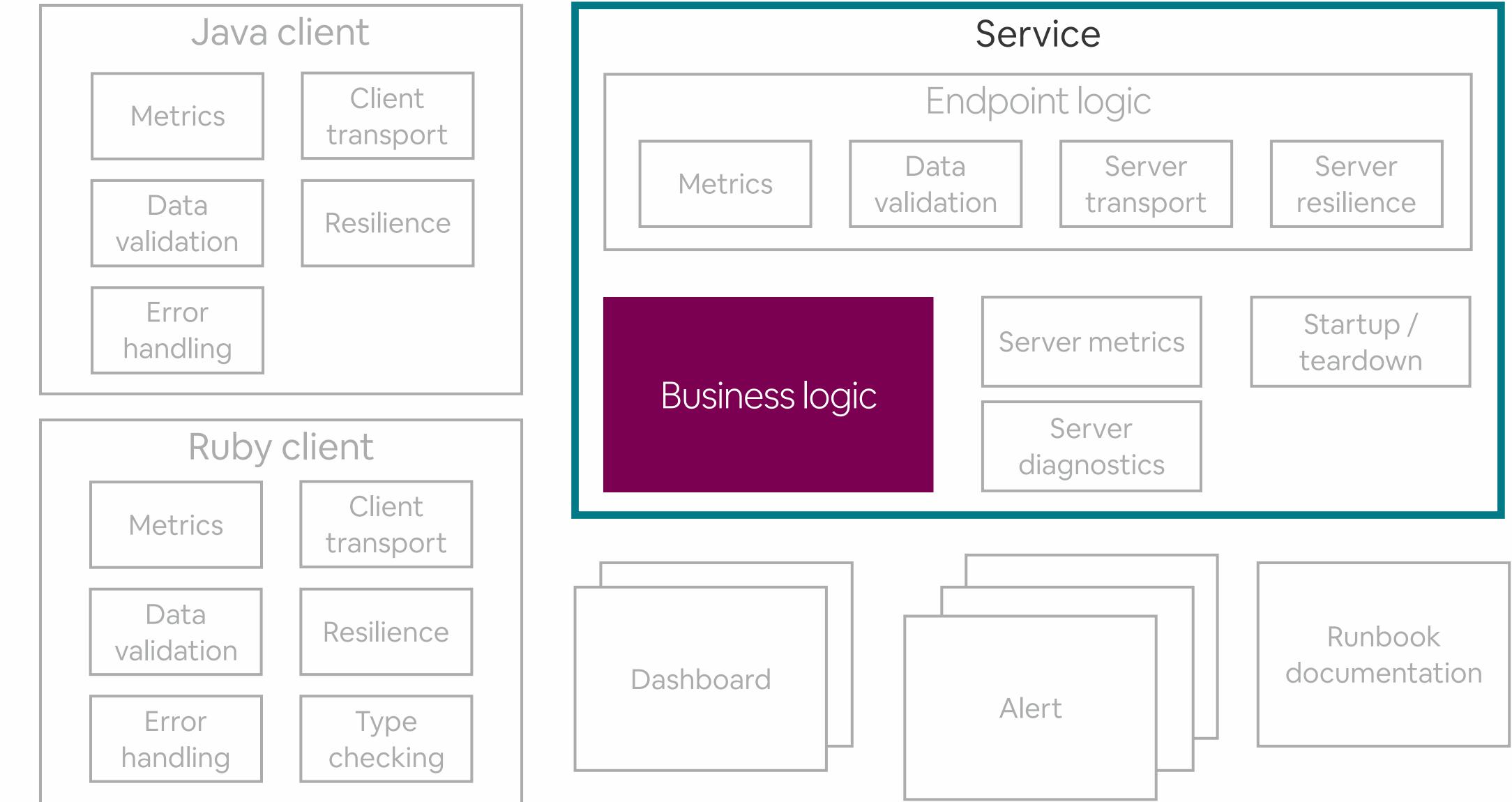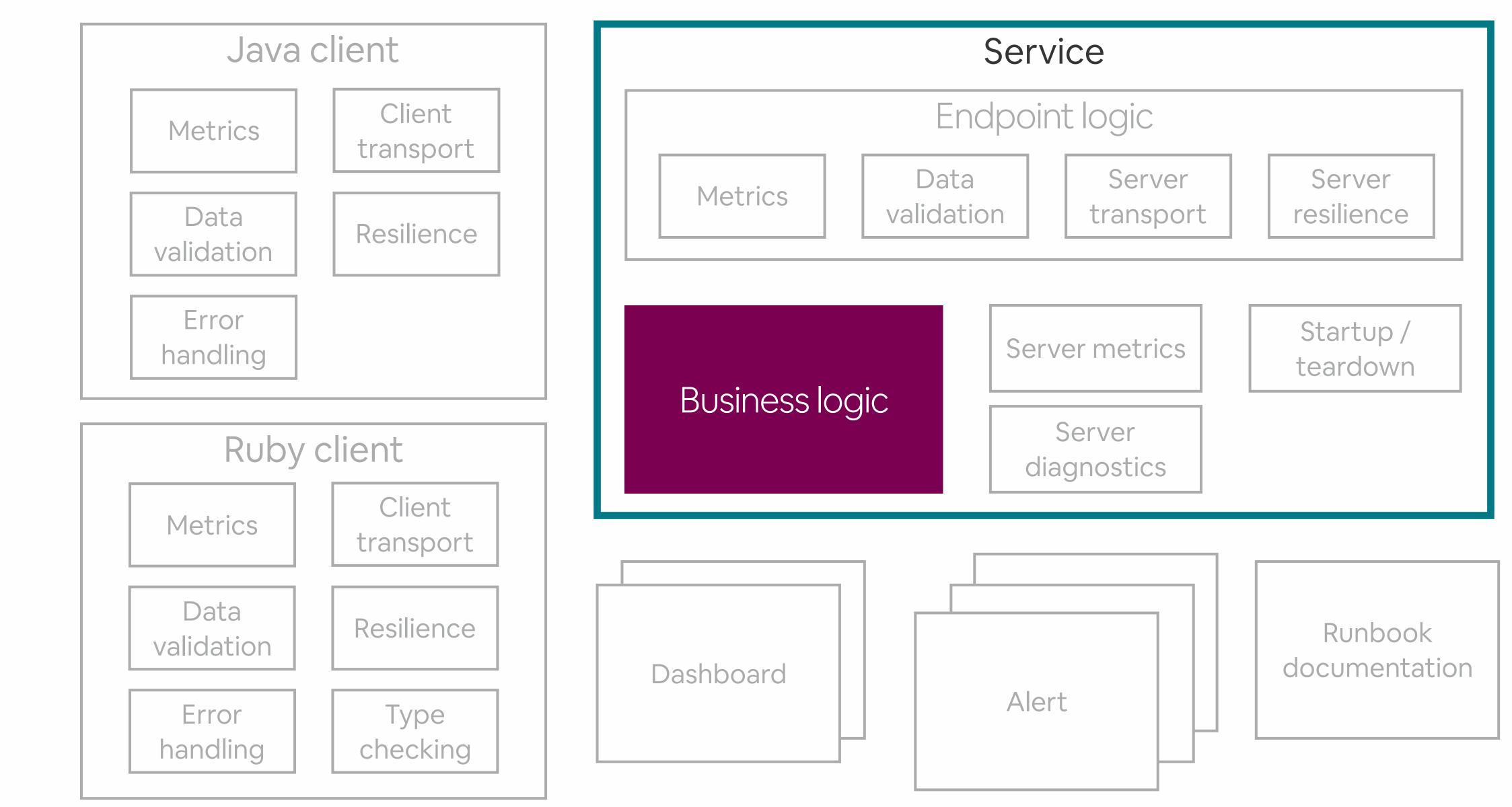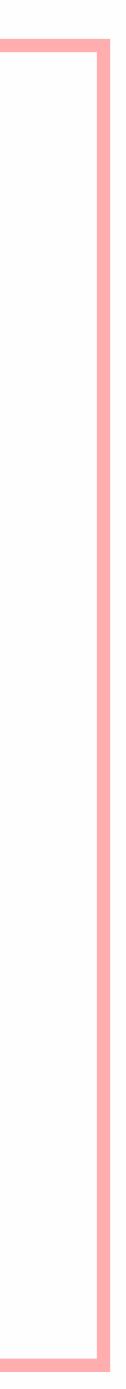
Alert

Runbook documentation

Coding services

BEFORE

AFTER

- Difficult to create and maintain services

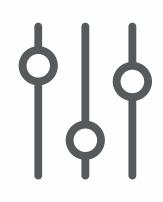- Custom Java vs. Ruby clients

- Autogenerated code framework & API

- Automated ruby gem client

Thrift IDL
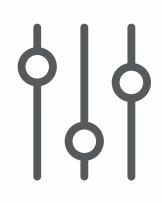
API FRAMEWORK

```thrift
/* Batch request */
struct LoadSomeDataRequest {
  1: optional set<i64> ids (non_null)
  2: optional bool fooBar
}

/* id to data response */
struct LoadSomeDataResponse {
  1: optional map<i64, SomeData> data
}
```

Thrift IDL

API FRAMEWORK

```
/* /loadSomeData endpoint */

LoadSomeDataResponse loadSomeData

(1: LoadSomeDataRequest request)

throws (1: SomeException exception1)

(accept_replay = "true", rate_limit = "true")
```

Testing & deploying

- Uncertainty in pre-production environments

- Trigger manual requests
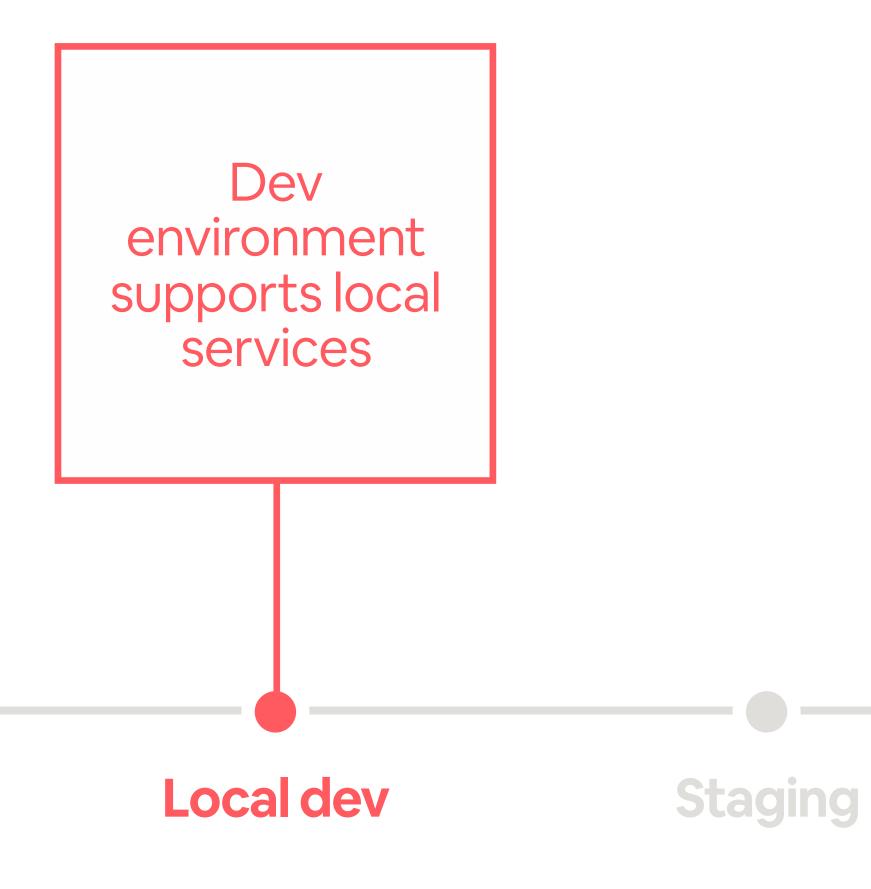
- Structured pre-production process

- Automated replayed traffic

Testing & deploying

TIMELINE

Dev environment supports local services

Local dev   Staging   Diffy   Canary   Production

Testing & deploying

TIMELINE

Replayed production traffic with other staging services

Local dev   Staging   Diffy   Canary   Production

Testing & deploying

TIMELINE

Compare responses from staging against production

Local dev   Staging   **Diffy**   Canary   Production
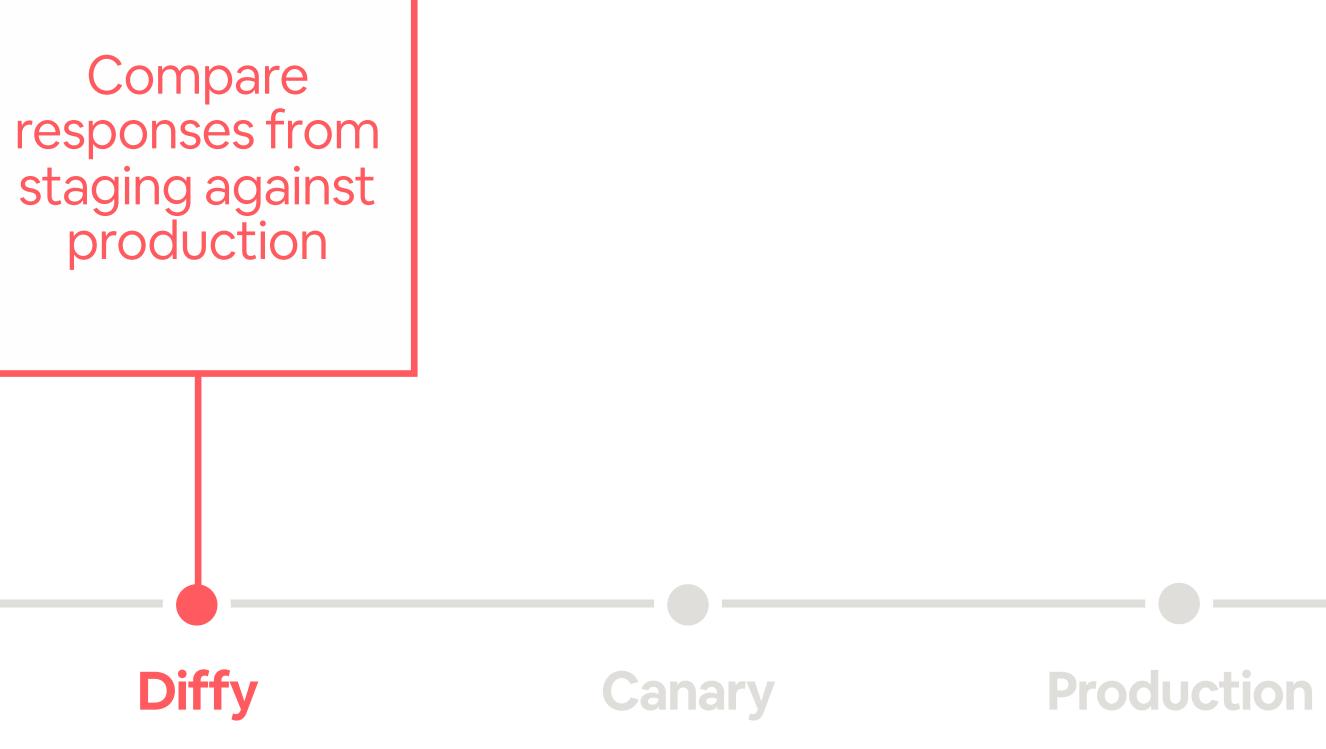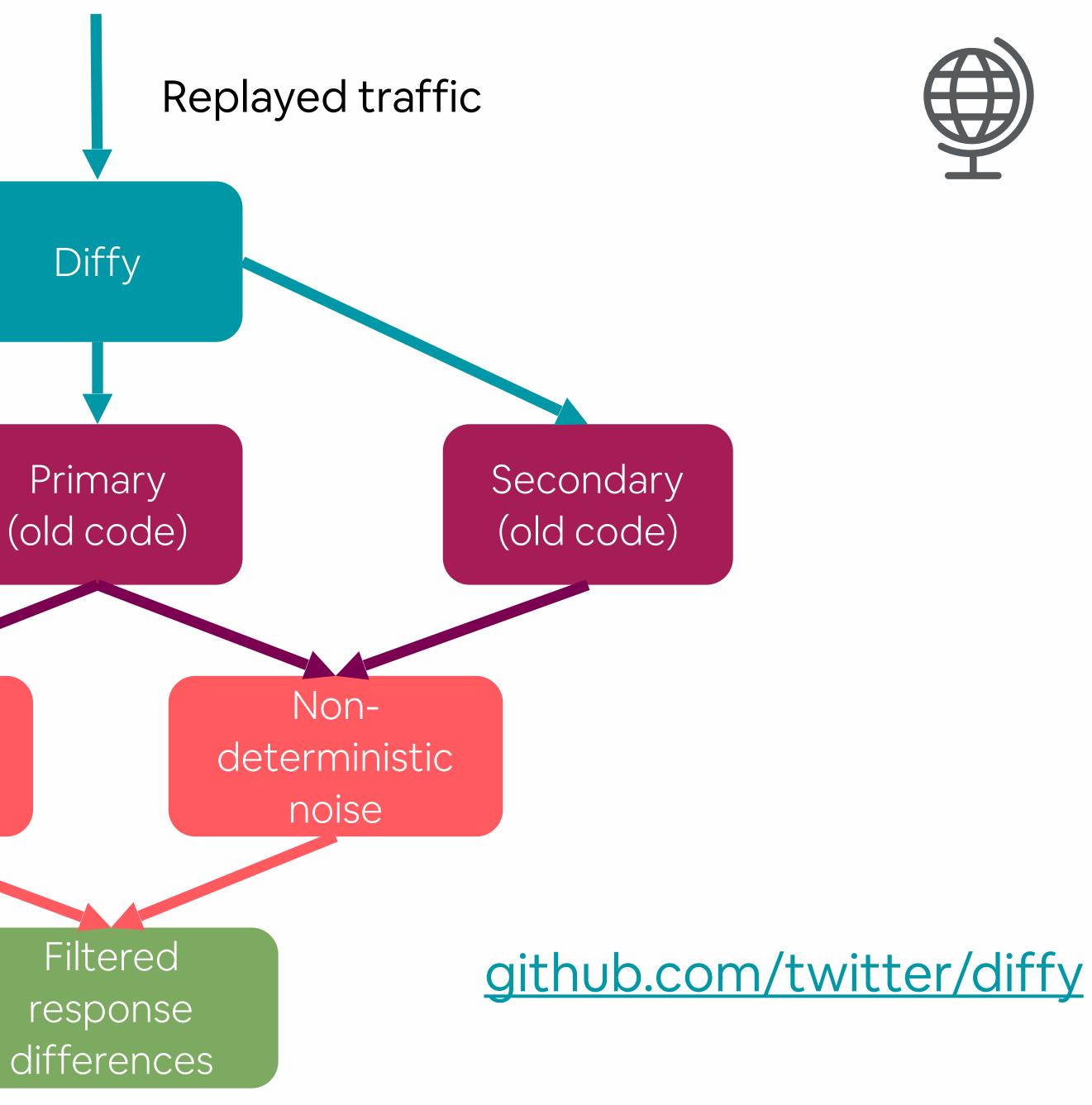
Regression Testing

DIFFY

Replayed traffic

Diffy

Staging
(new code)

Primary
(old code)

Secondary
(old code)

Raw response
differences
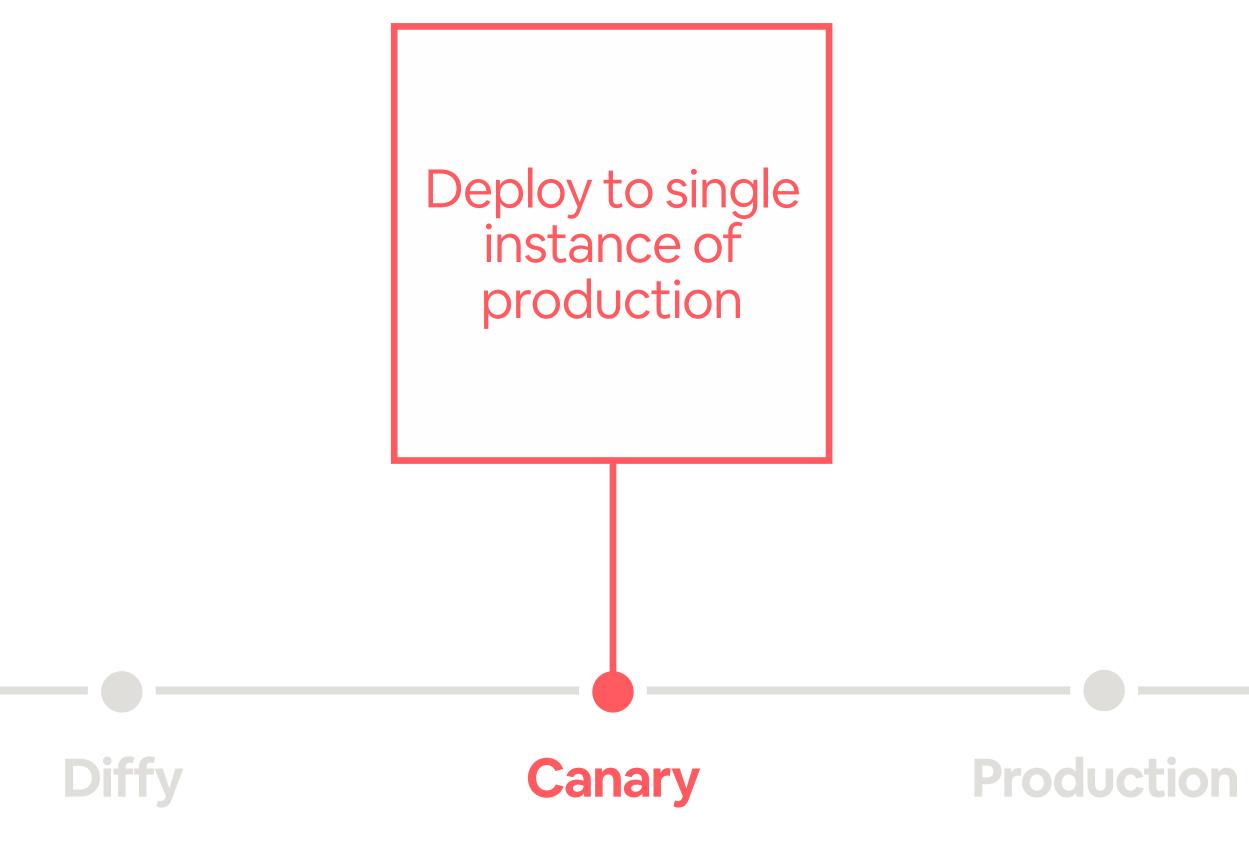
Non-
deterministic
noise

Filtered
response
differences

github.com/twitter/diffy

Testing & deploying

Deploy to single instance of production

Local dev

Staging

Diffy

Canary

Production

Testing & deploying

TIMELINE

Confidently deploy to prod

Local dev   Staging   Diffy   Canary   **Production**

Observability
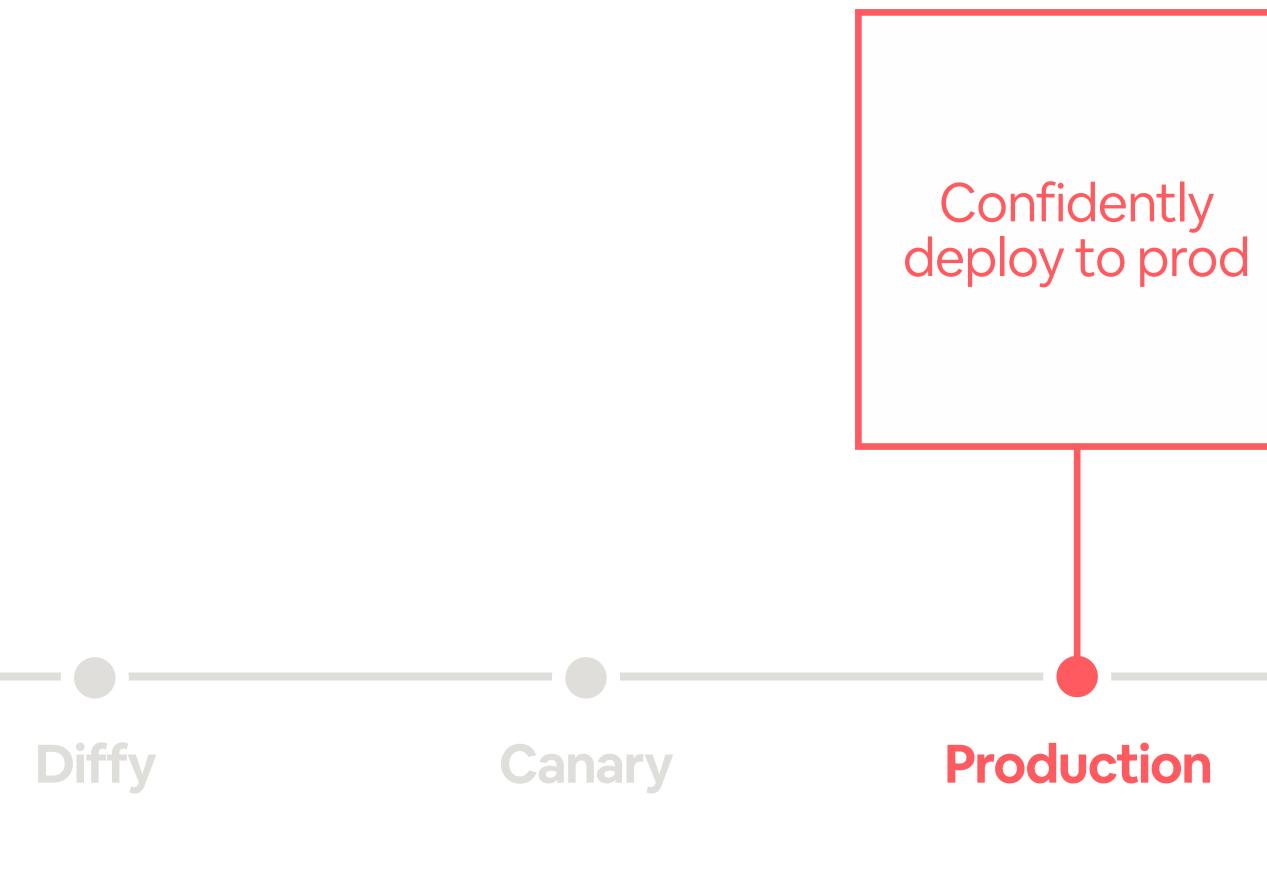
- Nonstandard metrics, dashboards
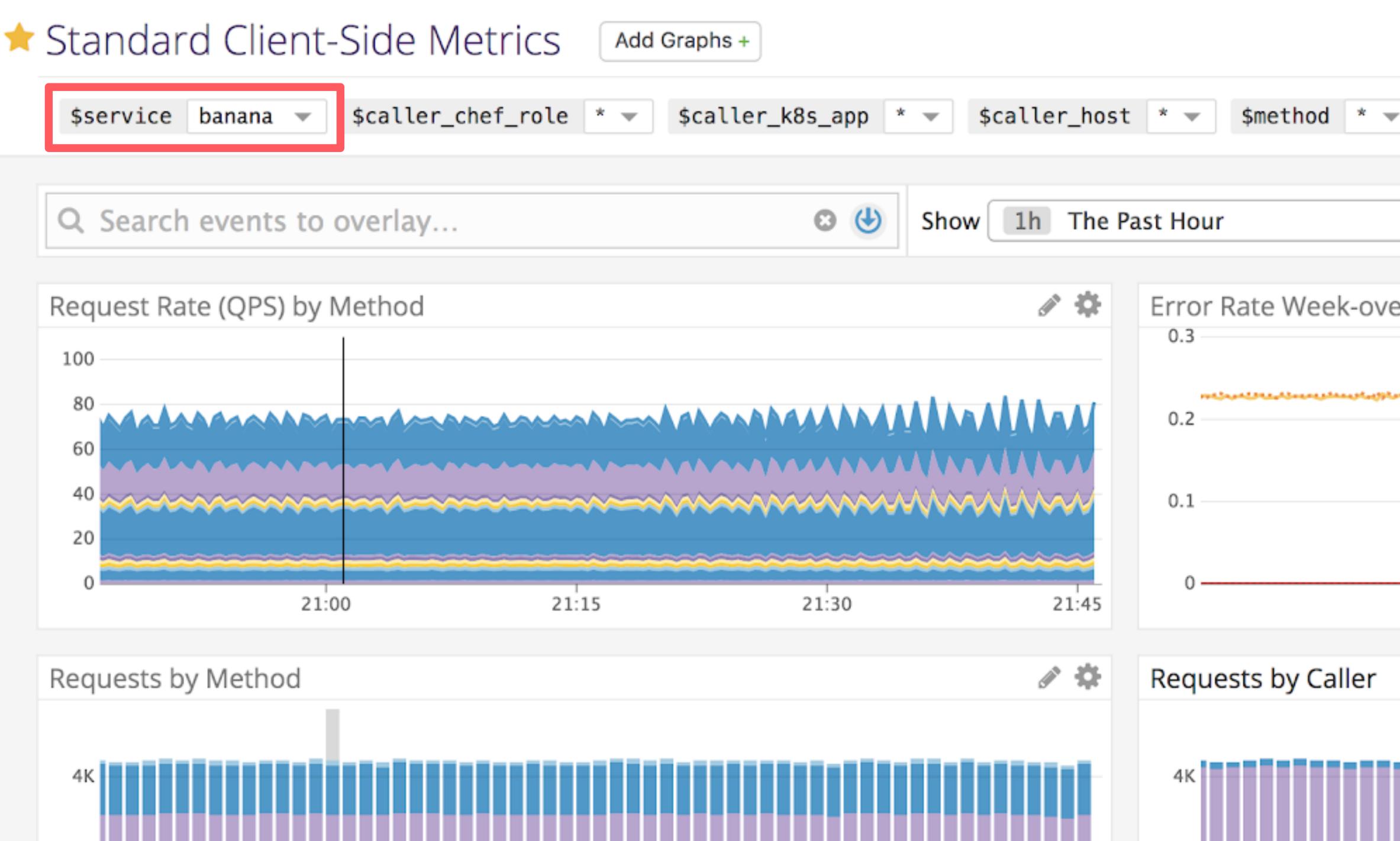
- Inconsistent alerts
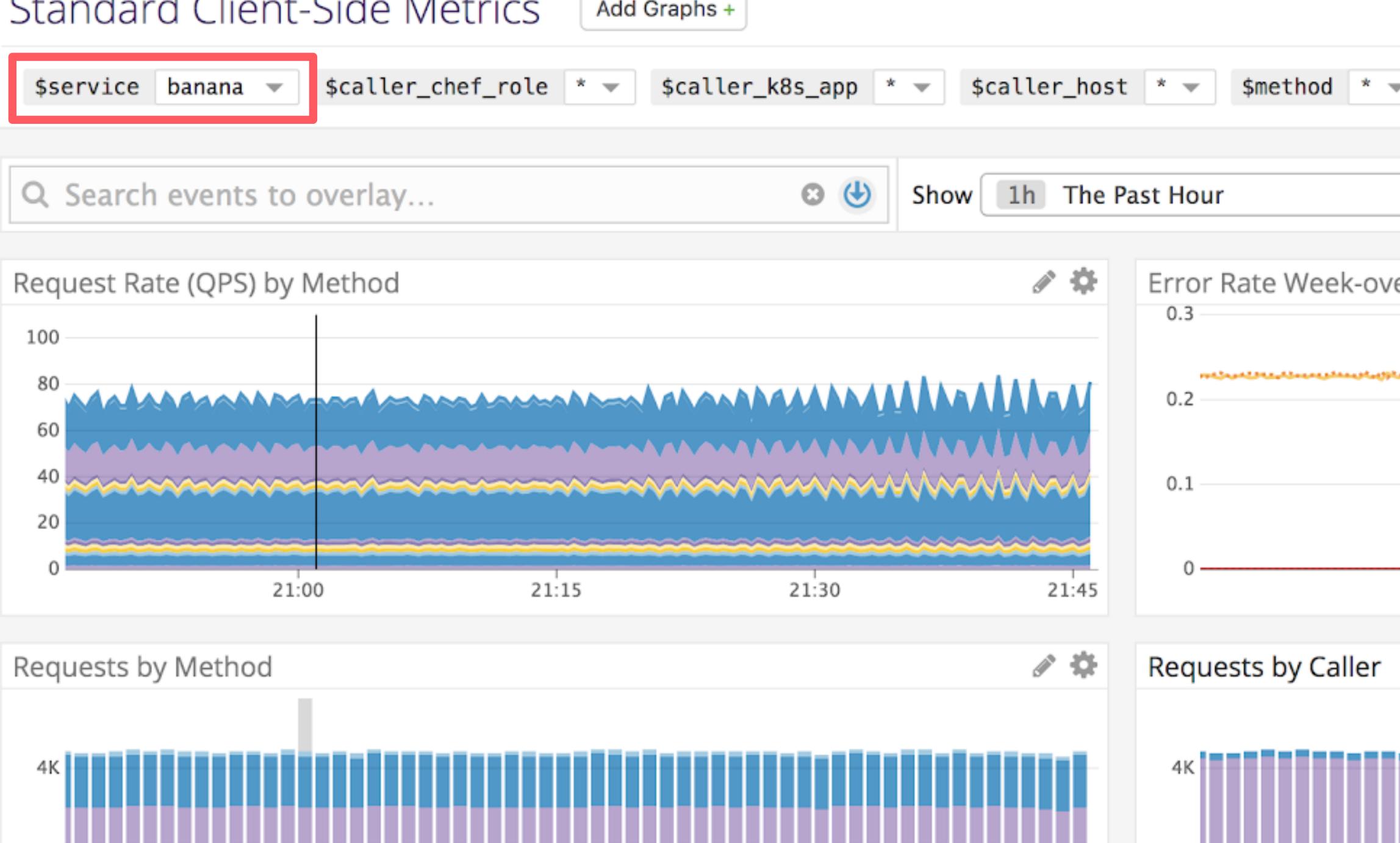
- IDL templated metrics, dashboards

- IDL annotation alerts

⭐ Standard Client-Side Metrics   Add Graphs +

🔍 Search events to overlay...   ⊗ ⏻   Show 1h The Past Hour

Request Rate (QPS) by Method   ✏️ ⚙️

100
80
60
40
20
0

21:00   21:15   21:30   21:45

Error Rate Week-over-week

0.3

0.2

0.1

0

21:00

Requests by Method   ✏️ ⚙️

4K

Requests by Caller

4K
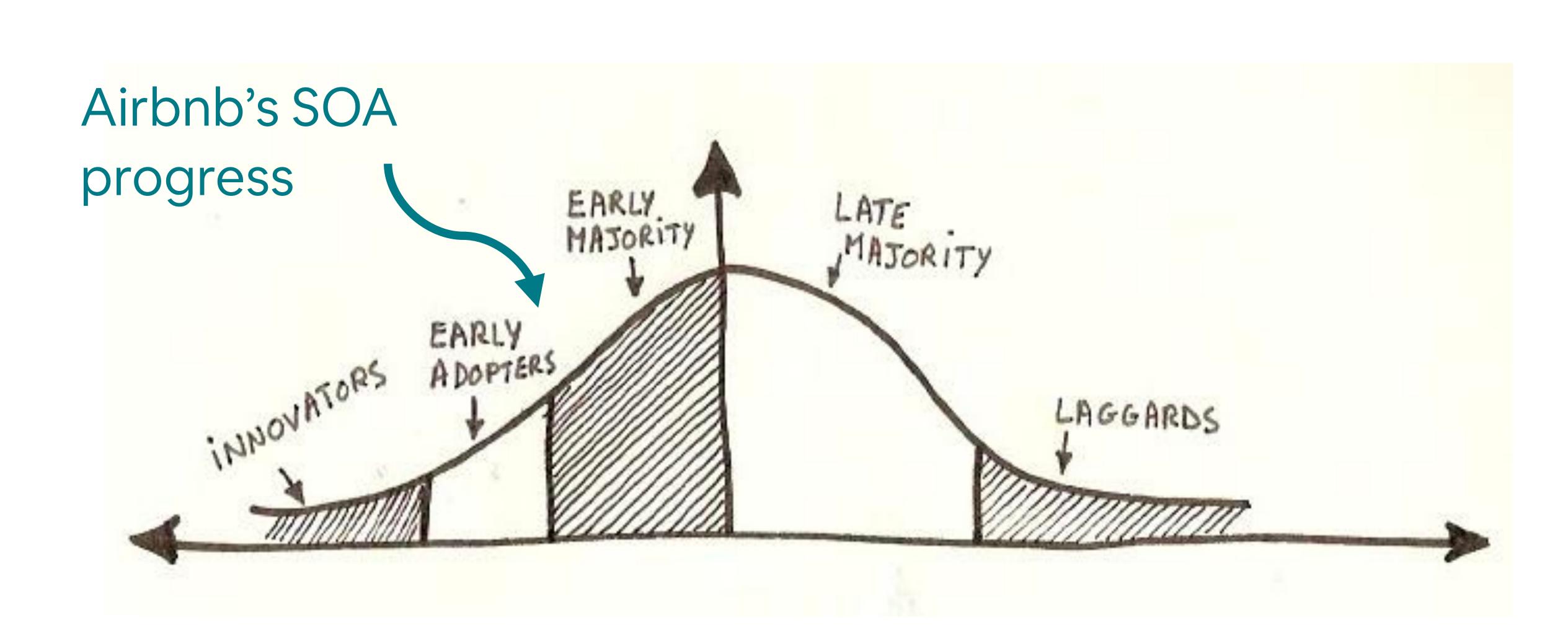
HOW IS THE MIGRATION GOING SO FAR?

Airbnb's SOA progress

INNOVATORS

EARLY ADOPTERS

EARLY MAJORITY

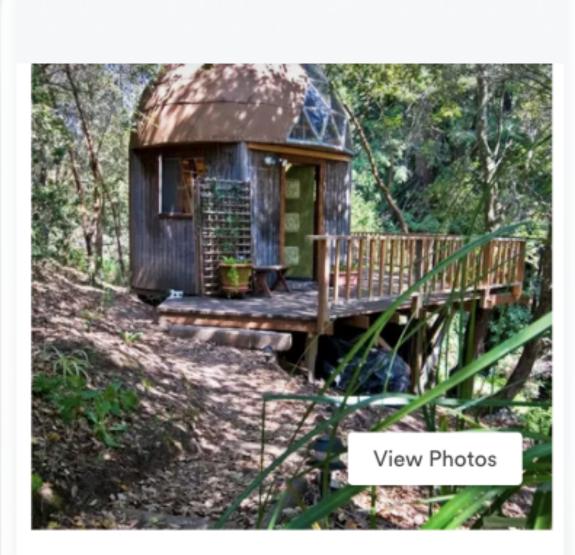LATE MAJORITY

LAGGARDS

250+ | Services using IDL framework

1000+ | IDL service endpoints supported

Promising initial results

- Faster build & deploy times
  - Hours (Monorail) to minutes (service)
  - Fewer reverts
- Clear service ownership
- Quicker bug fixes
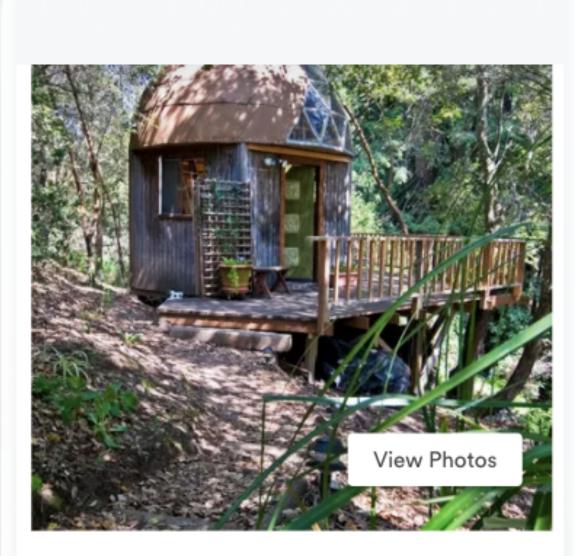
Latency results

- Ruby Monorail single-threaded

- Java services multi-threaded

- Lower latency from parallelization

  - Search results page **3x faster**

  - Home description page **10x faster!**

2017

800+

Engineers

3k

Deploys per week

2017	800+	3k
2018	1000+	10k
	Engineers	Deploys per week
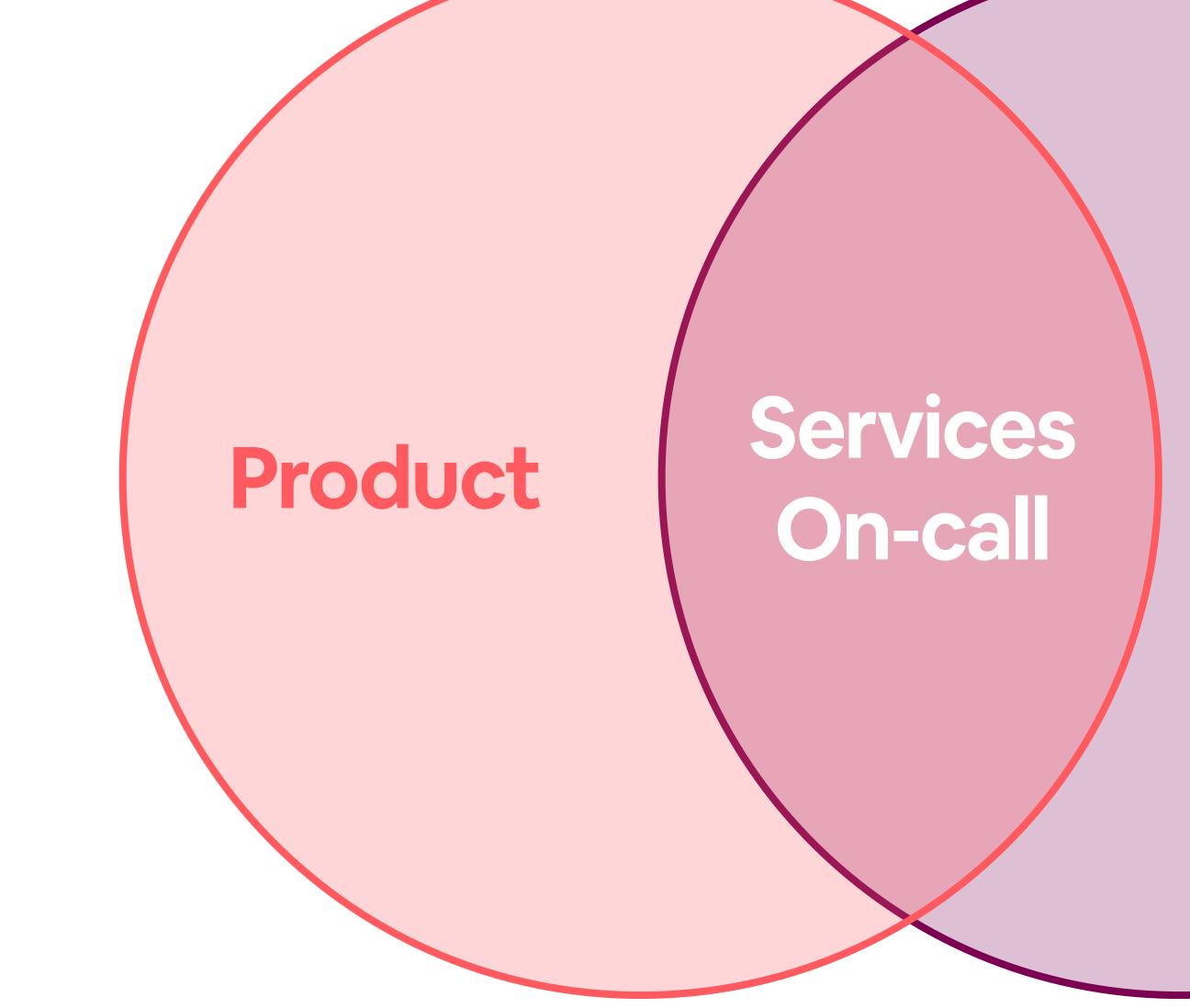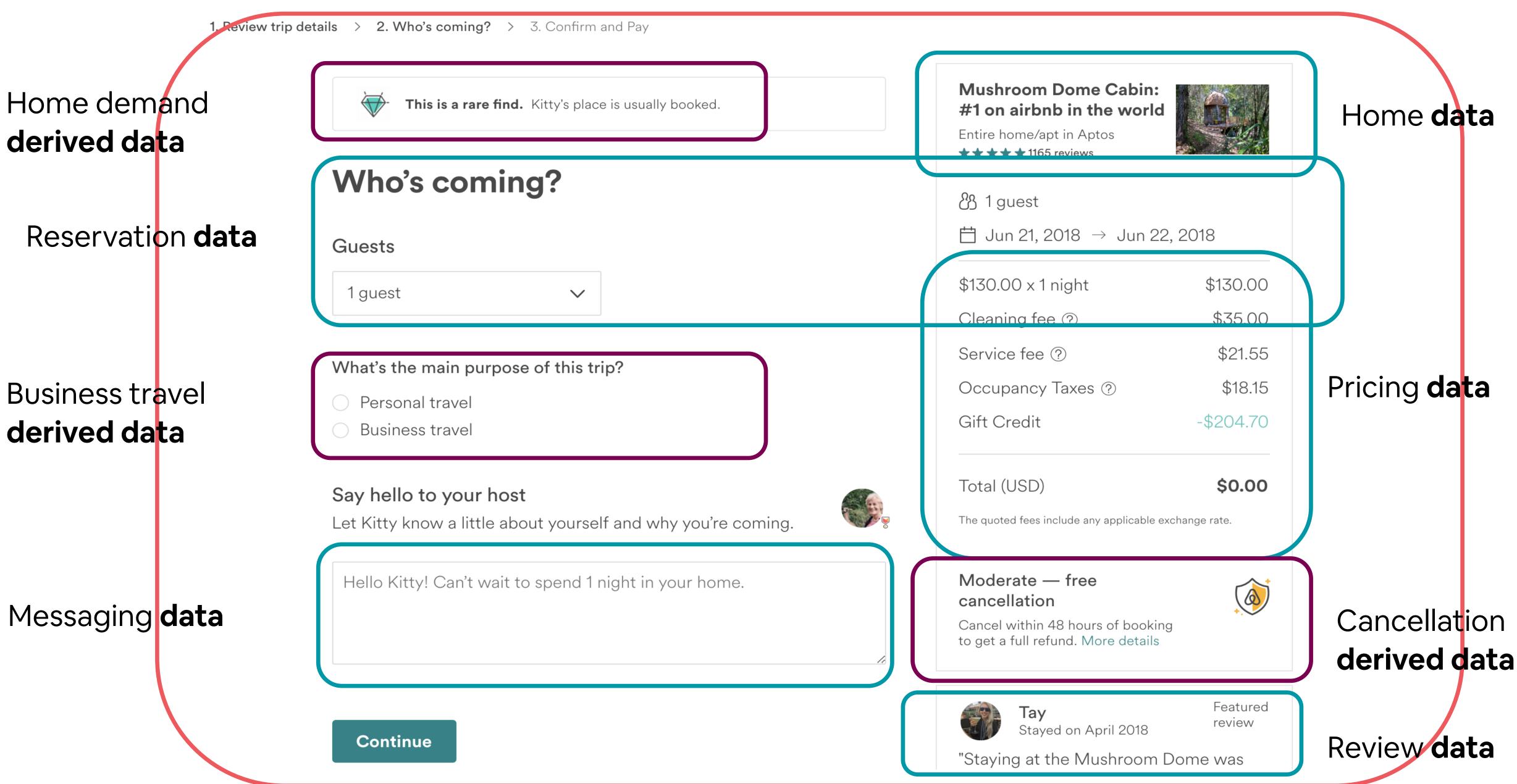
Checkout page required message in SOA

Checkout **presentation**

1. Review trip details → 2. Who's coming? → 3. Confirm and Pay

Home demand **derived data**

This is a rare find. Kitty's place is usually booked.

Mushroom Dome Cabin: #1 on airbnb in the world
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★★★★★ 1165 reviews

Home **data**

Who's coming?

Reservation **data**

Guests

1 guest ⌄

👥 1 guest

📅 Jun 21, 2018 → Jun 22, 2018

Business travel **derived data**

What's the main purpose of this trip?
○ Personal travel
○ Business travel

$130.00 x 1 night	$130.00
Cleaning fee ?	$35.00
Service fee ?	$21.55
Occupancy Taxes ?	$18.15
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Pricing **data**

Say hello to your host
Let Kitty know a little about yourself and why you're coming.

Messaging **data**

Hello Kitty! Can't wait to spend 1 night in your home.

Moderate — free cancellation
Cancel within 48 hours of booking to get a full refund. More details

Cancellation **derived data**

Continue

Tay
Stayed on April 2018

Featured review
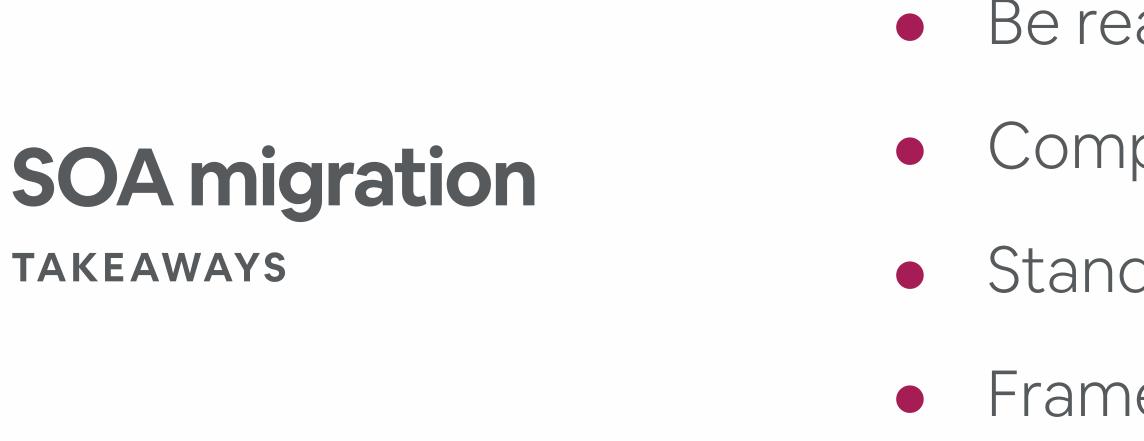
"Staying at the Mushroom Dome was

Review **data**

CAUTION

SOA is not for everyone

CAUTION
Distributed services

CAUTION

Complex service orchestration

CAUTION

High investment cost

SOA migration

TAKEAWAYS

- Be ready for a long commitment
- Compare slowly & carefully
- Standardize services
- Frameworks, tools, documentation

Look both ways
before your Great Migration

linkedin.com/in/jessicatai
@jessicamtai