AWS re:Invent

NOV. 29 – DEC. 3, 2021 | LAS VEGAS, NV

API201

Application integration patterns for microservices

Dirk Fröhner (he/him)
Principal Solutions Architect
Amazon Web Services

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API201

Application integration patterns not only for microservices

Dirk Fröhner (he/him)
Principal Solutions Architect
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Agenda

Motivation

Patterns

Use cases

Resources

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Motivation

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“If your application is cloud-native, large-scale, or distributed, and doesn’t include a messaging component, that’s probably a bug.”

Tim Bray

General-purpose internet-software geek

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Potential drawbacks of synchronous systems

Synchronous systems are inherently tightly coupled

Problems in downstream systems can have immediate impact on upstream callers

Retries from upstream callers can easily fan out and amplify problems



Photo: Dirk Fröhner

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Potential drawbacks of synchronous systems

Synchronous systems are inherently tightly coupled

Problems in dow
can have immed
upstream caller

Retries from up
easily fan out a

. . . and some things simply take too much time to wait, or are asynchronous by nature



Photo: Dirk Fröhner

aws

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Patterns

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Patter

Gregor Hohpe and Bobby Woolf:

Enterprise Integration Patterns

Designing, Building, and Deploying Messaging Solutions



aws

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Message exchange

One-way

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Message exchange

One-way



Sender

Receiver

No response expected

Message intent

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Message exchange

One-way



Sender

Receiver

No response expected

Message intent

Asynchronous request-response

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Message exchange

One-way



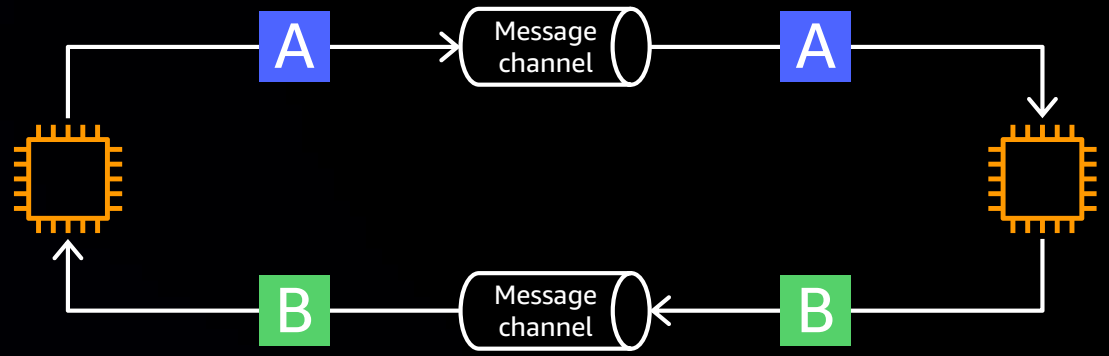
Sender

Receiver

No response expected

Message intent

Asynchronous request-response



Requester

Responder

Response expected

Return address

Correlation ID

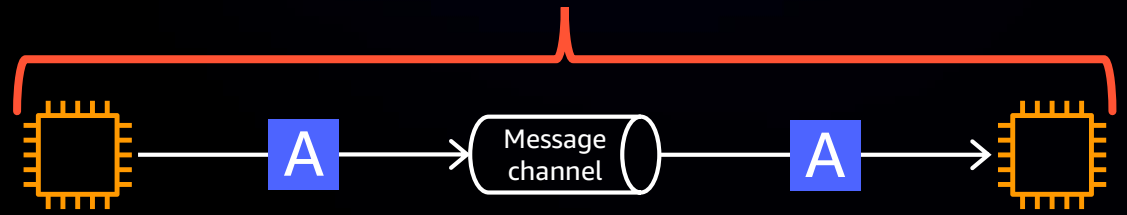
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Message exchange

One-way

Integration pattern



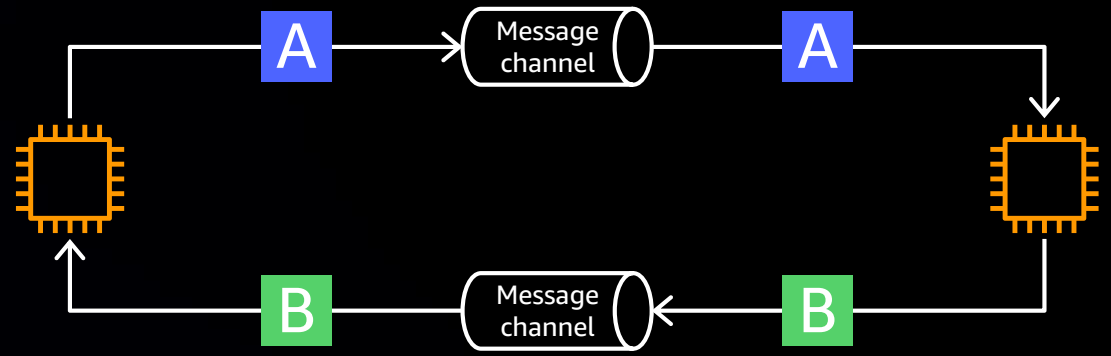
Sender

Receiver

No response expected

Message intent

Asynchronous request-response



Requester

Responder

Response expected

Return address

Correlation ID

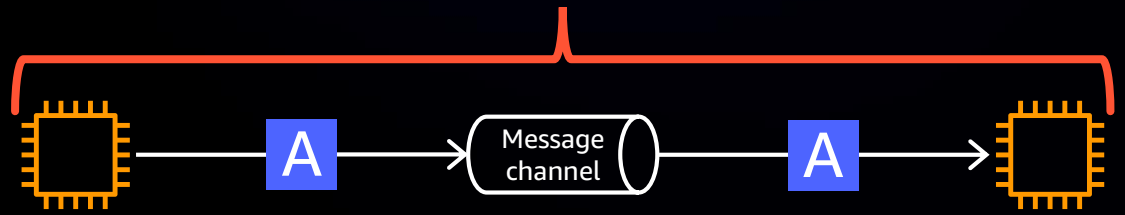
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Message exchange

Conversation pattern

One-way

Integration pattern



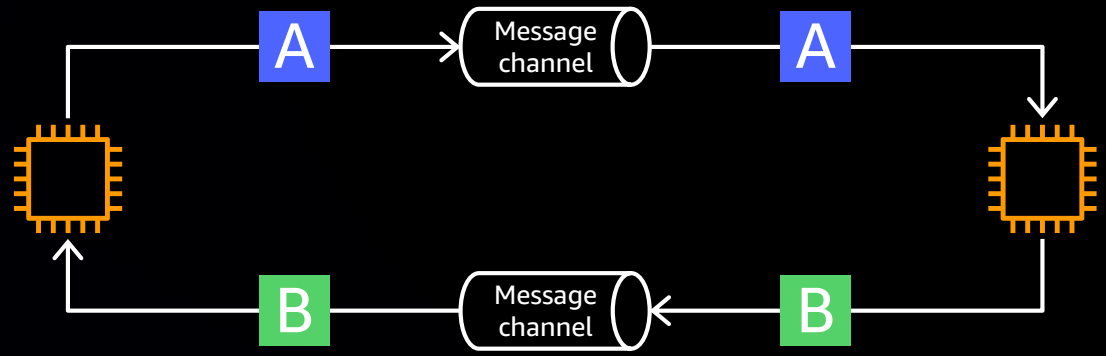
Sender

Receiver

No response expected

Message intent

Asynchronous request-response



Requester

Responder

Response expected

Return address

Correlation ID

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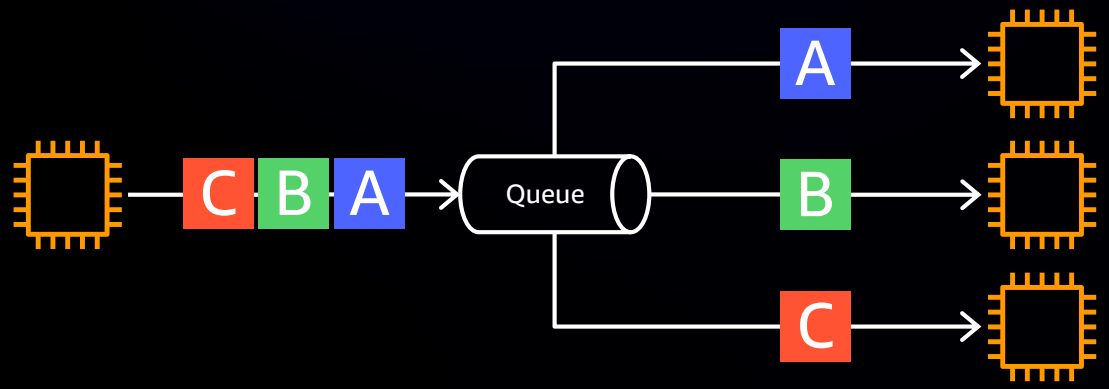
Message channels

Point-to-point (queue)

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Message channels

Point-to-point (queue)



Each message consumed by one receiver

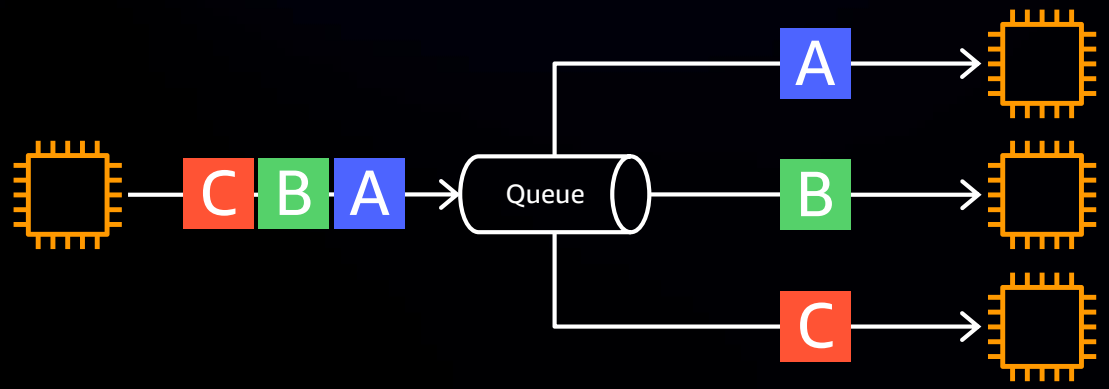
Consumers easy to scale

Buffering can flatten peak loads

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Message channels

Point-to-point (queue)



Each message consumed by one receiver

Consumers easy to scale

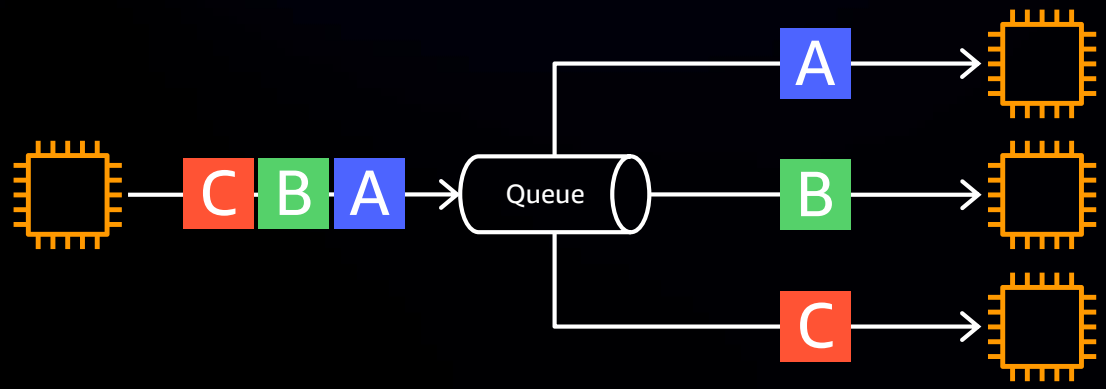
Buffering can flatten peak loads

Publish-subscribe (topic)

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Message channels

Point-to-point (queue)

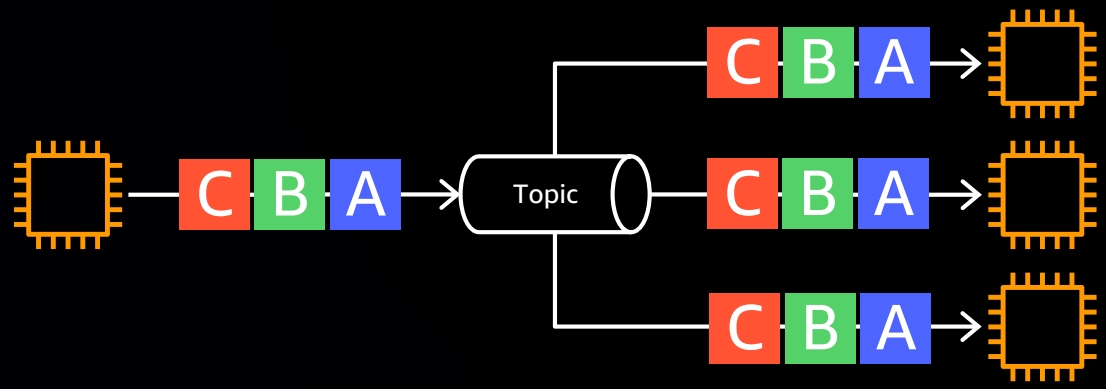


Each message consumed by one receiver

Consumers easy to scale

Buffering can flatten peak loads

Publish-subscribe (topic)



Each message consumed by each subscriber

How to scale consumers?

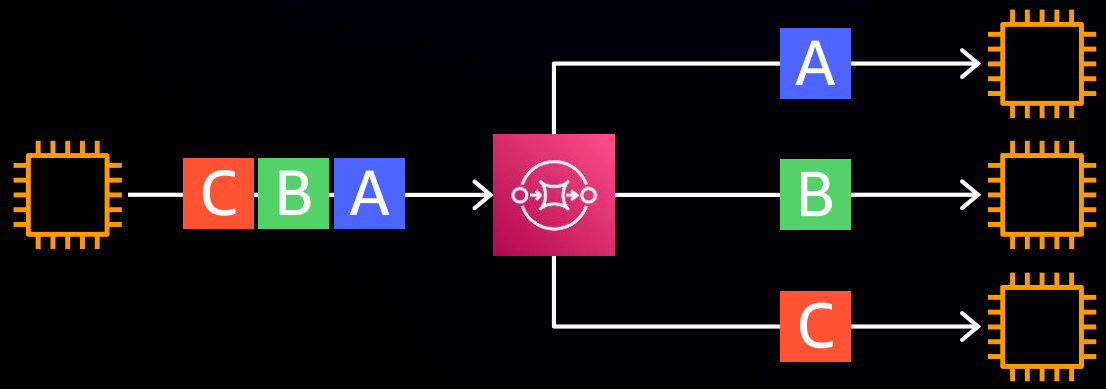
Conceptually no buffering

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Message channels

AWS services implementing
message queue and topic functionality

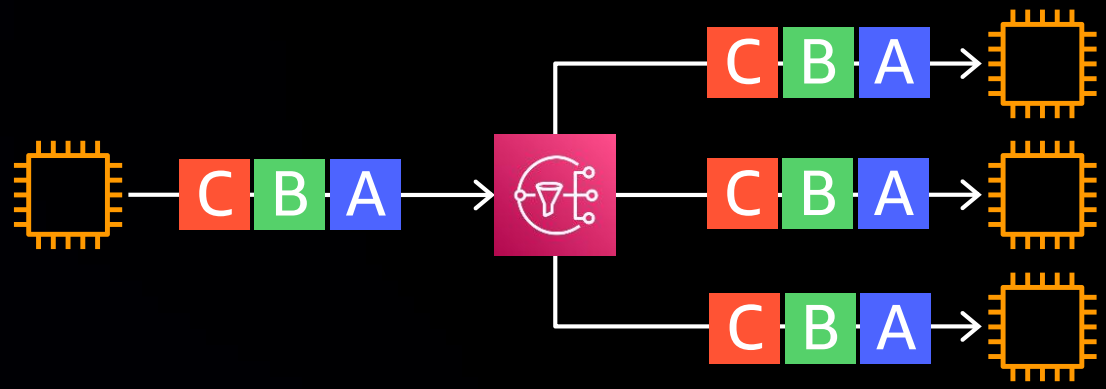
Point-to-point (queue)



Amazon Simple Queue Service (Amazon SQS)

Cloud-native & serverless

Publish-subscribe (topic)



Amazon Simple Notification Service (Amazon SNS)

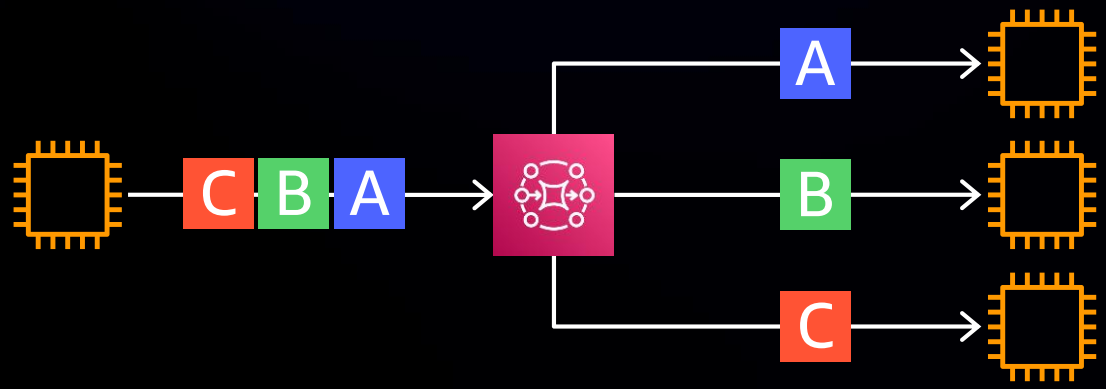
Cloud-native & serverless

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Message channels

AWS services implementing
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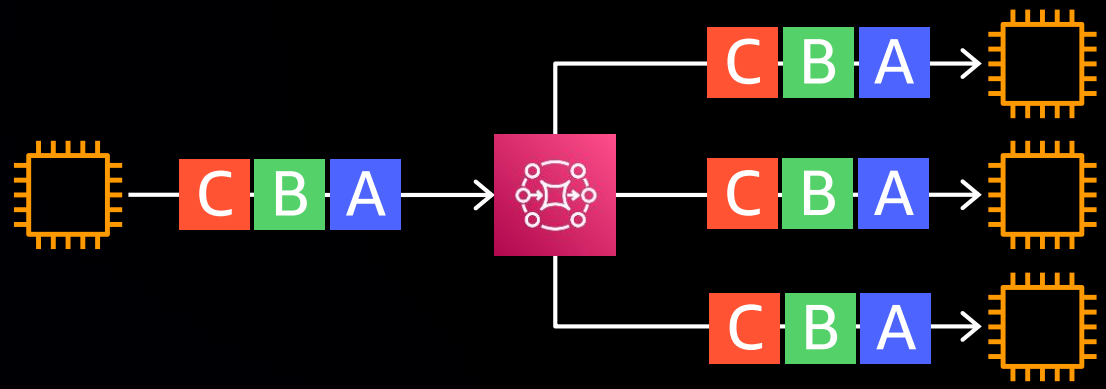
Point-to-point (queue)



Amazon MQ – managed RabbitMQ or Apache ActiveMQ

For applications constrained to industry-standard protocols like JMS or AMQP

Publish-subscribe (topic)



Amazon MQ – managed RabbitMQ or Apache ActiveMQ

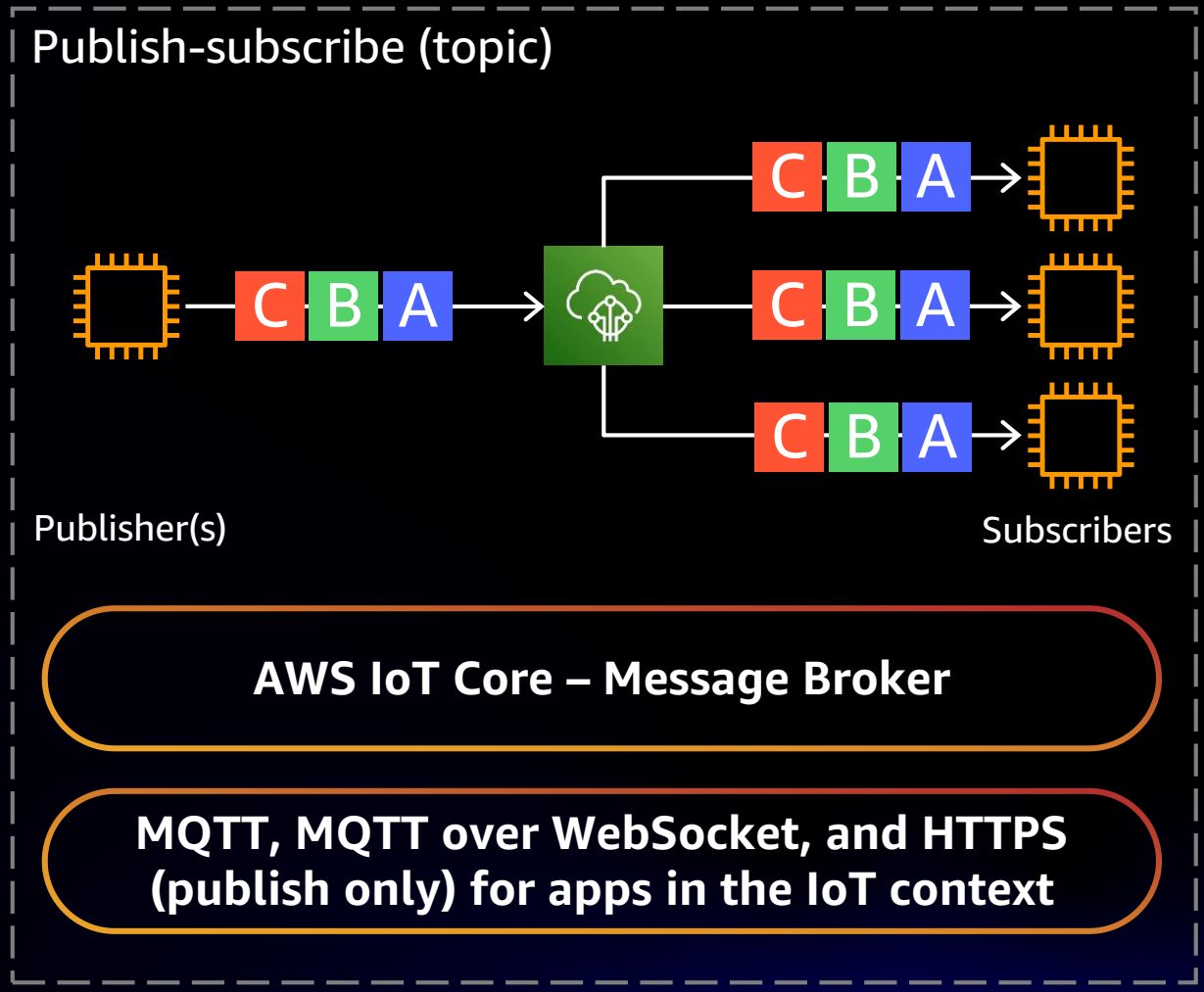
For applications constrained to industry-standard protocols like JMS or AMQP

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Message channels

AWS services implementing
message queue and topic functionality



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Message channels

What about . . .

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Message channels

What about . . .

Streams?

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Excursus: Message vs. stream processing

Both messaging topics and streams are fan-out patterns

Message processing

Stream processing

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Excursus: Message vs, stream processing

Both messaging topics and streams are fan-out patterns

Message processing



Each individual message is a unit of work

Messages deleted after consumption

Stream processing

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Excursus: Message vs. stream processing

Both messaging topics and streams are fan-out patterns

Message processing



Each individual message is a unit of work

Messages deleted after consumption

Stream processing



Batches of messages are units of work

Messages retained after consumption (until expiration)

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Message channels

What about . . .

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Message channels

What about . . .

Busses?

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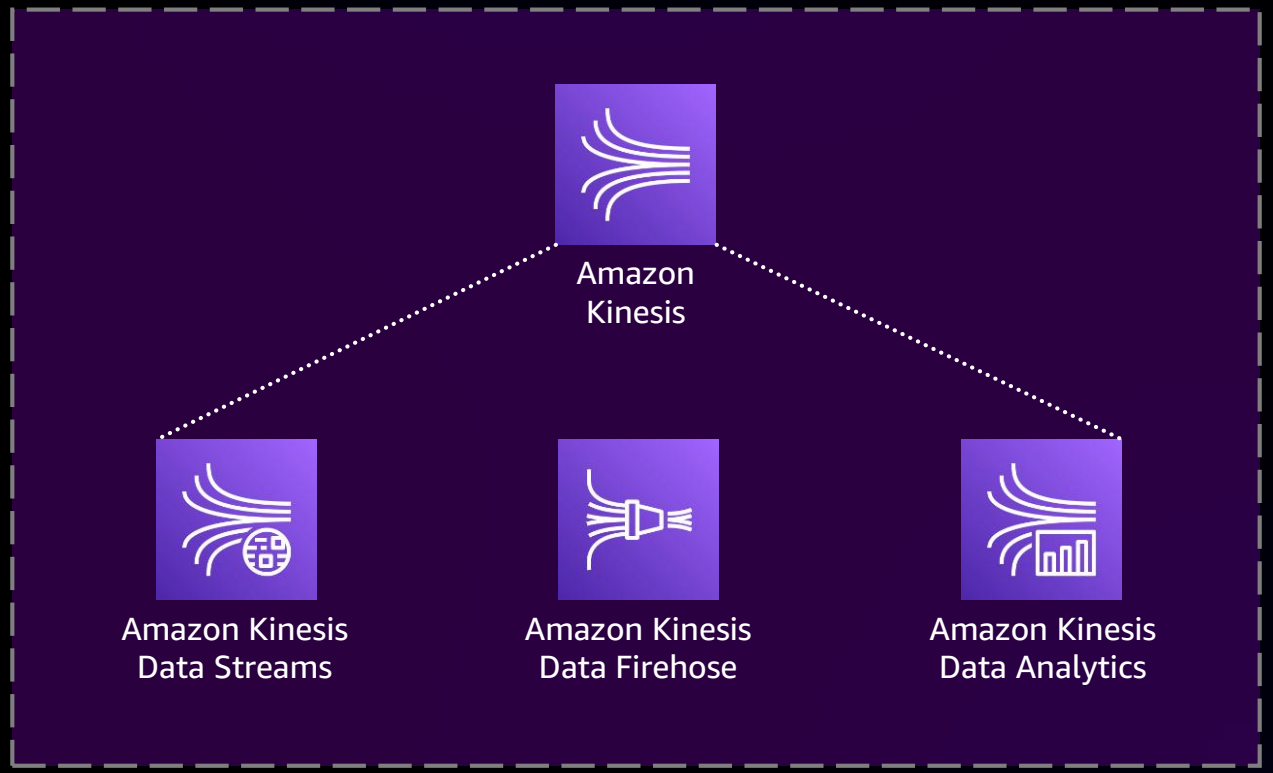
Excursus: Other fan-out patterns

AWS services for other fan-out patterns

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Excursus: Other fan-out patterns

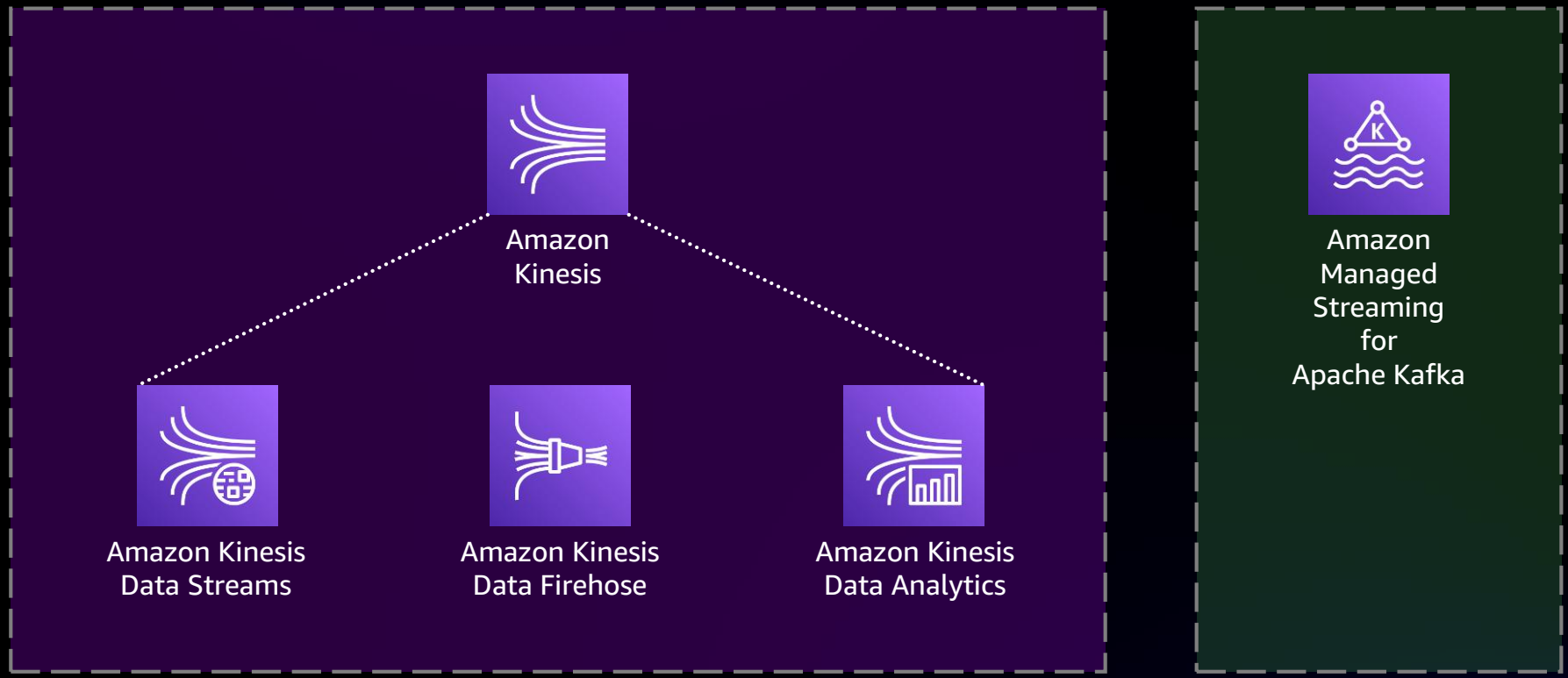
AWS services for other fan-out patterns



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Excursus: Other fan-out patterns

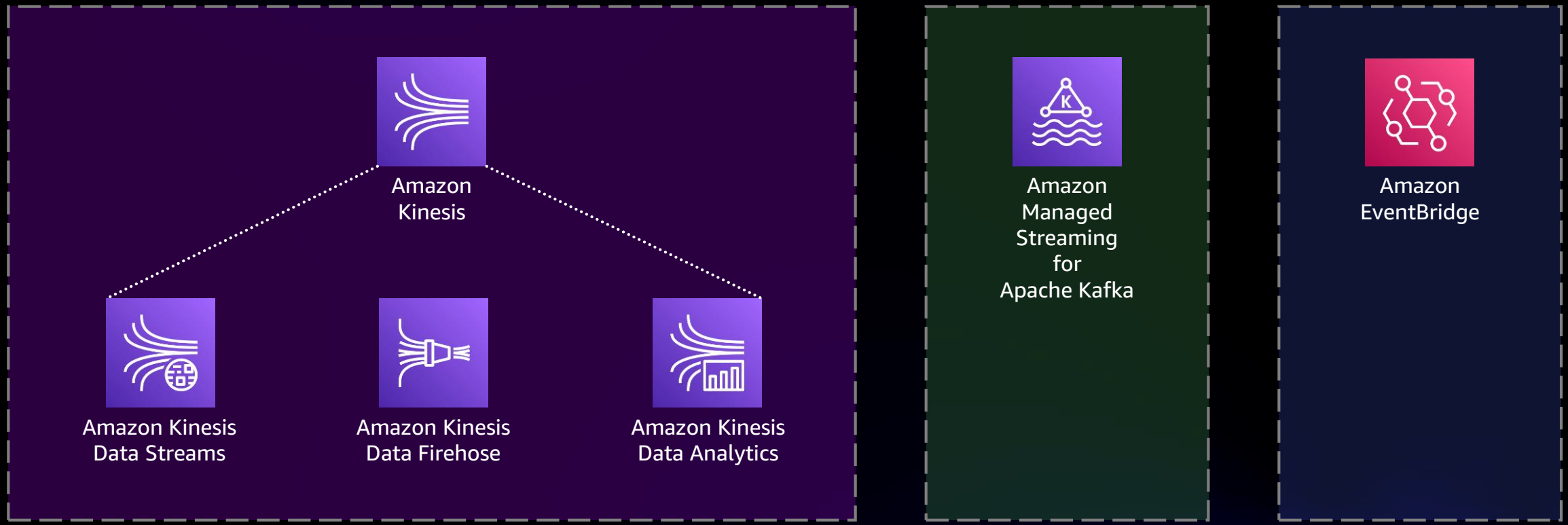
AWS services for other fan-out patterns



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Excursus: Other fan-out patterns

AWS services for other fan-out patterns



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Message channels

Topic-queue-chaining

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Message channels

Topic-queue-chaining

Reprise: How to scale consumers for publish-subscribe channels?

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Message channels

Topic-queue-chaining



Producer

Reprise: How to scale consumers for publish-subscribe channels?

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Message channels

Topic-queue-chaining



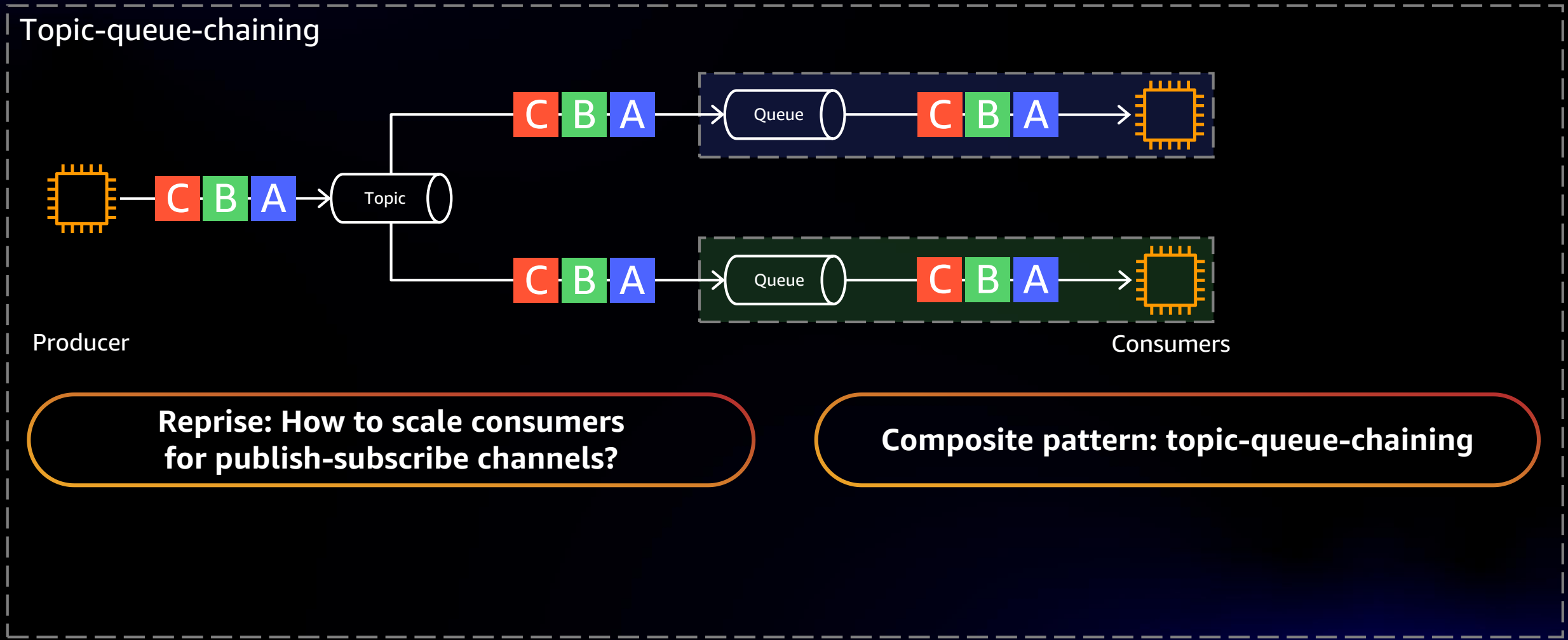
Producer

Reprise: How to scale consumers for publish-subscribe channels?

Composite pattern: topic-queue-chaining

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Message channels

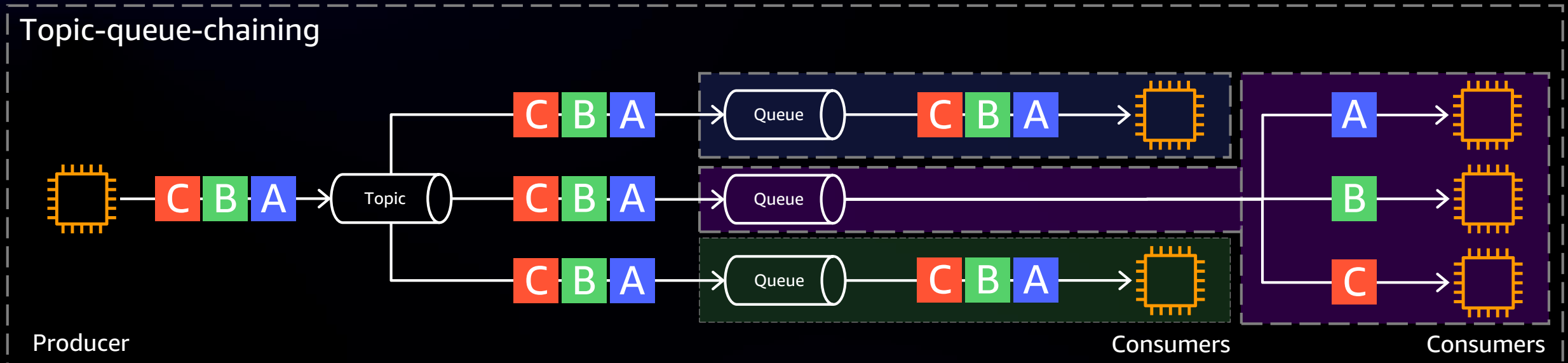


Reprise: How to scale consumers for publish-subscribe channels?

Composite pattern: topic-queue-chaining

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Message channels

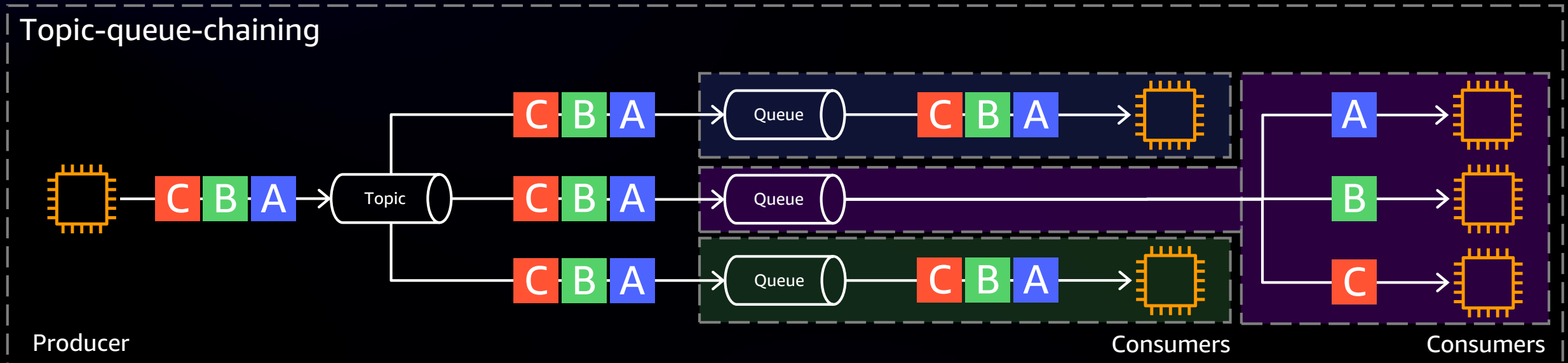


Reprise: How to scale consumers for publish-subscribe channels?

Composite pattern: topic-queue-chaining

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Message channels



Reprise: How to scale consumers for publish-subscribe channels?

Composite pattern: topic-queue-chaining

Best of both worlds: fan-out & consumer scale-out & buffering load balancing at the same time

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Message channels

Dead-letter queue (DLQ)

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Message channels

Dead-letter queue (DLQ)

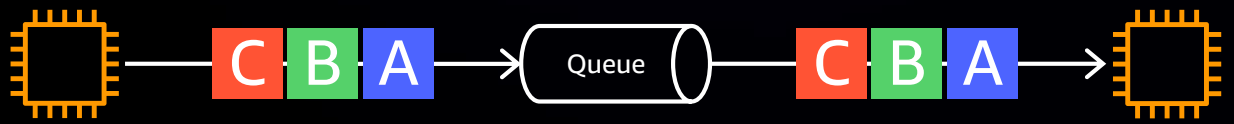


Producer

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Message channels

Dead-letter queue (DLQ)



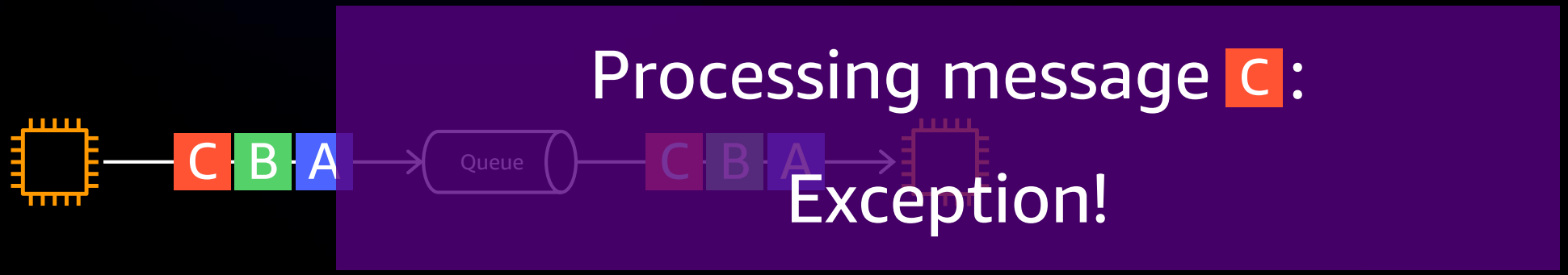
Producer

Consumers

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Message channels

Dead-letter queue (DLQ)



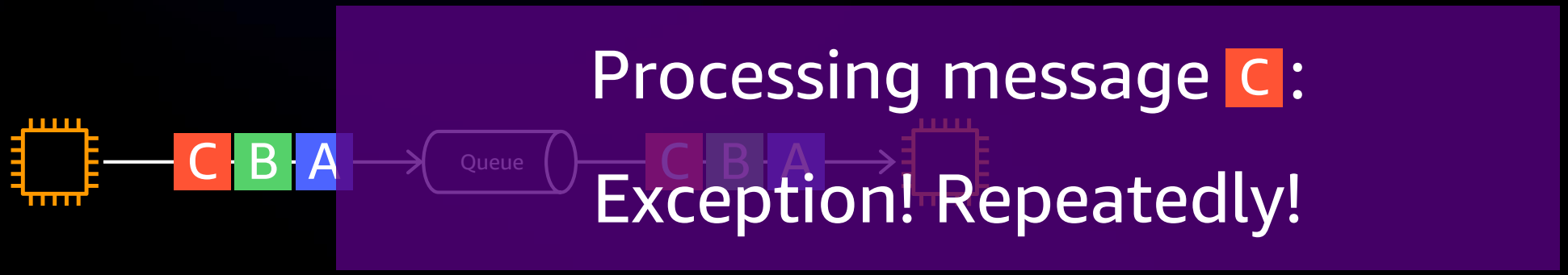
Producer

Consumers

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Message channels

Dead-letter queue (DLQ)



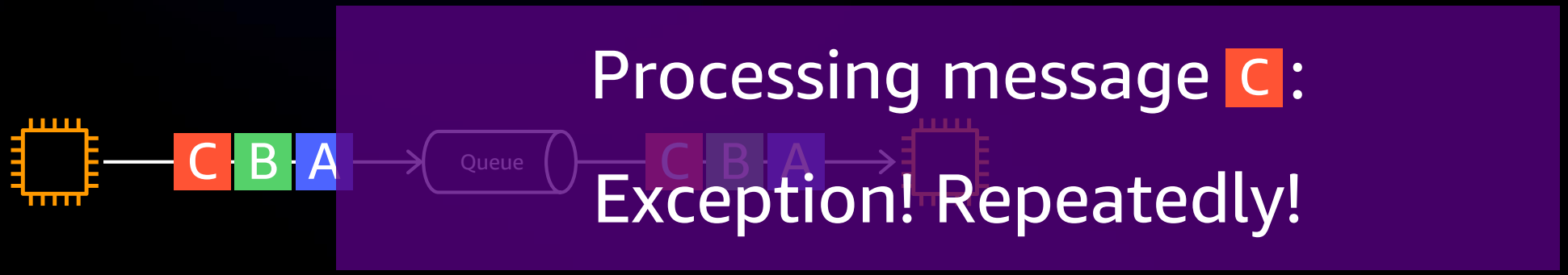
Producer

Consumers

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Message channels

Dead-letter queue (DLQ)



Producer

Consumers

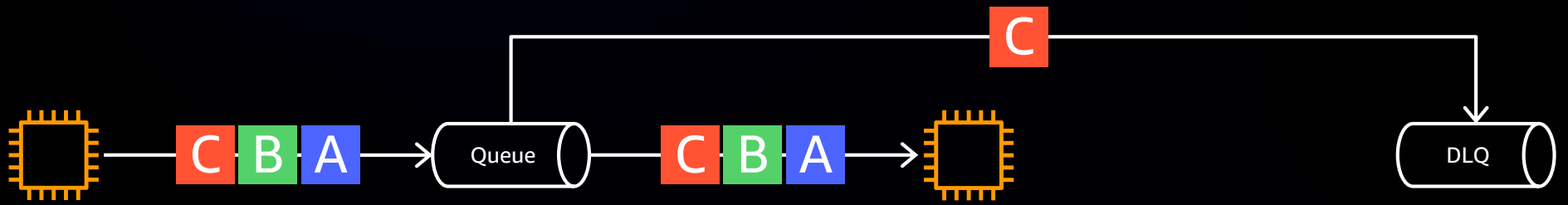
Transient failure mitigation

Poison pill handling

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Message channels

Dead-letter queue (DLQ)



Producer

Consumers

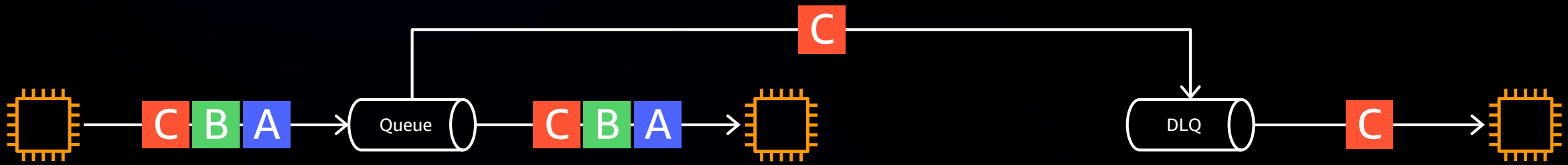
Transient failure mitigation

Poison pill handling

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Message channels

Dead-letter queue (DLQ)



Producer

Consumers

Application ops

Transient failure mitigation

Poison pill handling

No need for open-heart surgery – investigate without the hassle of production

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Message channels

Visibility timeout, inflight messages, and message acknowledgement

Case 1:

Fast enough consumer

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Message channels

Visibility timeout, inflight messages, and message acknowledgement



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Message channels

Visibility timeout, inflight messages, and message acknowledgement



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Message channels

Visibility timeout, inflight messages, and message acknowledgement



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Message channels

Visibility timeout, inflight messages, and message acknowledgement



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Message channels

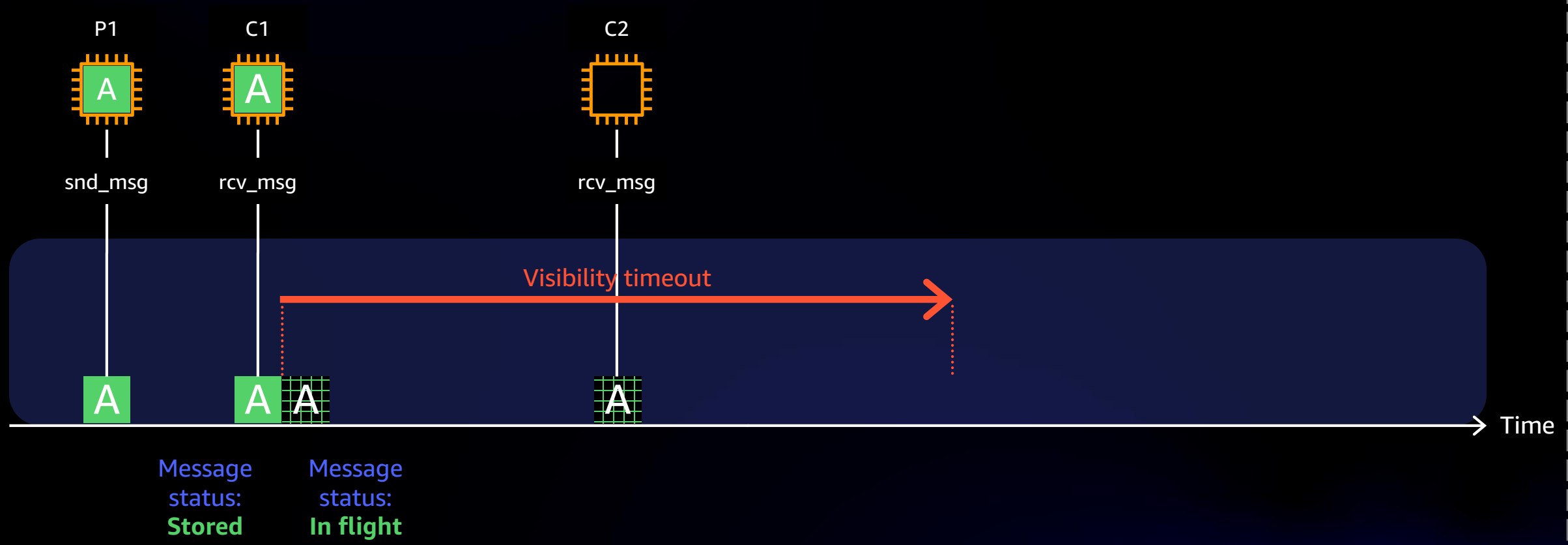
Visibility timeout, inflight messages, and message acknowledgement



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Message channels

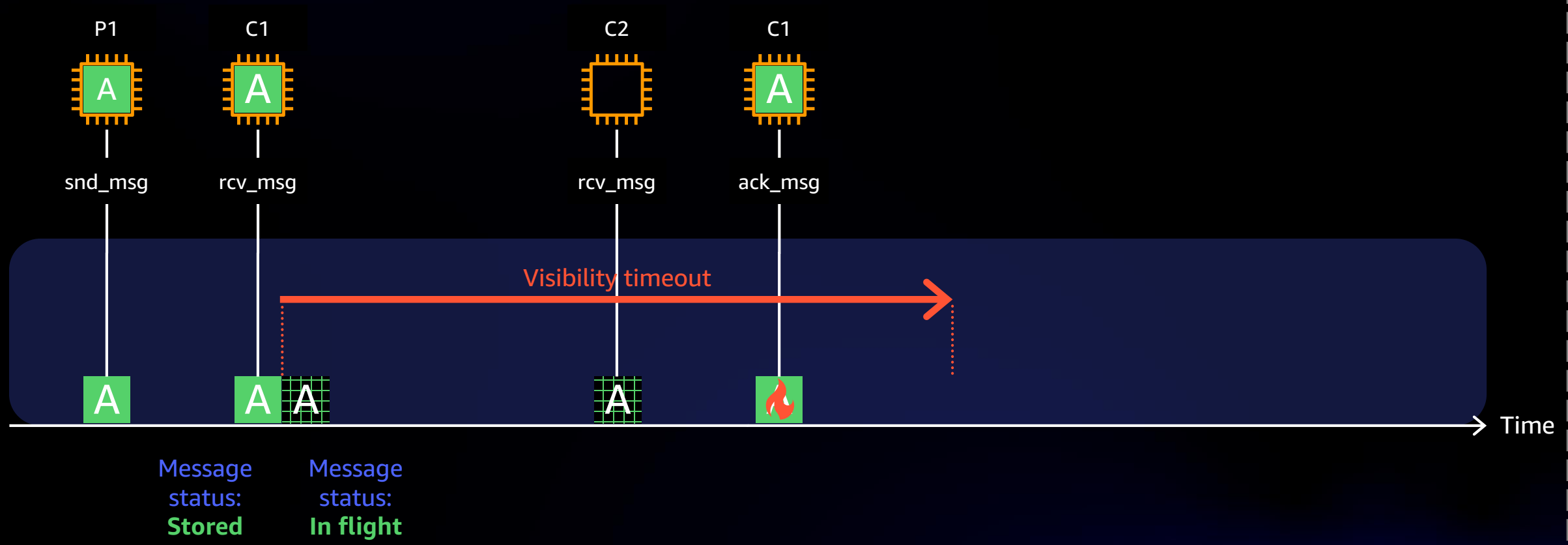
Visibility timeout, inflight messages, and message acknowledgement



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Message channels

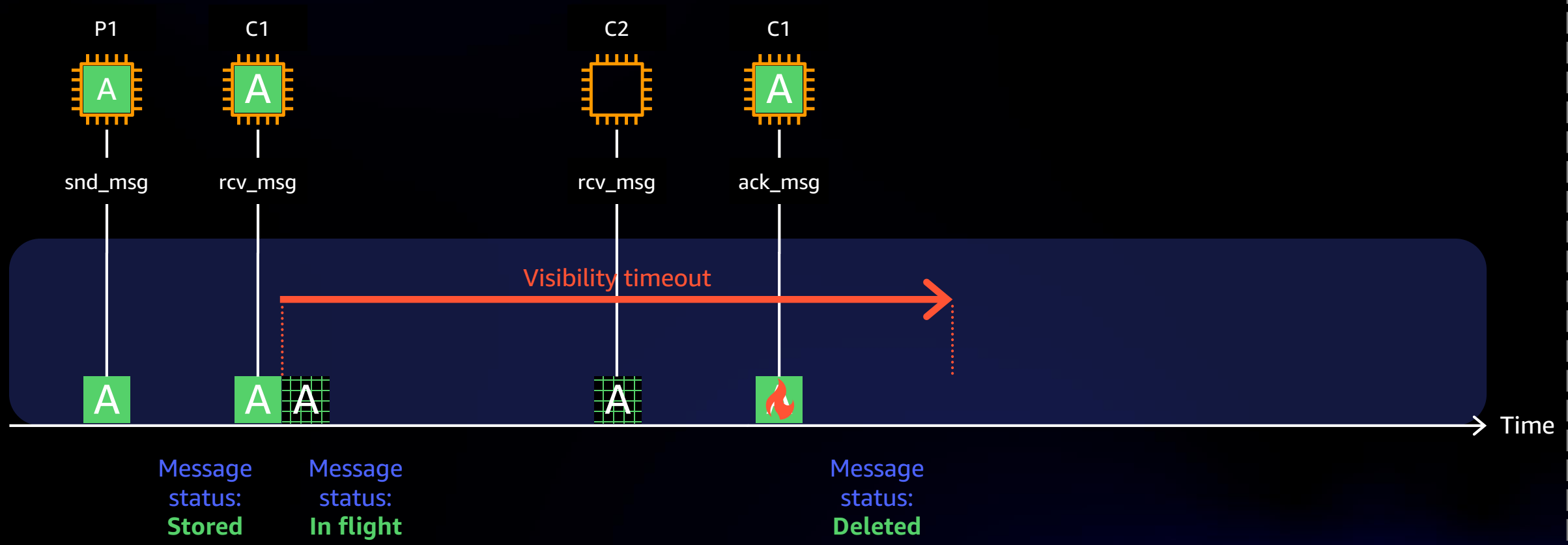
Visibility timeout, inflight messages, and message acknowledgement



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Message channels

Visibility timeout, inflight messages, and message acknowledgement



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Message channels

Visibility timeout, inflight messages, and message acknowledgement

Case 2:

Not fast enough consumer

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Message channels

Visibility timeout, inflight messages, and message acknowledgement



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Message channels

Visibility timeout, inflight messages, and message acknowledgement



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Message channels

Visibility timeout, inflight messages, and message acknowledgement



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Message channels

Visibility timeout, inflight messages, and message acknowledgement



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Message channels

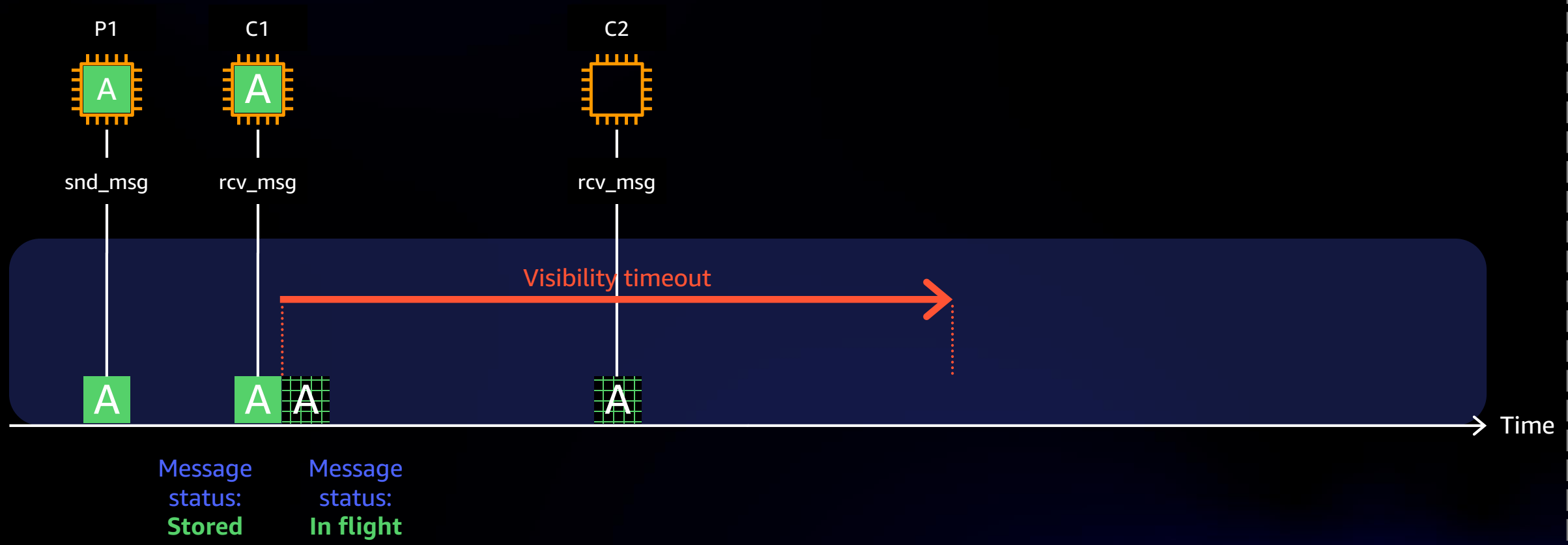
Visibility timeout, inflight messages, and message acknowledgement



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Message channels

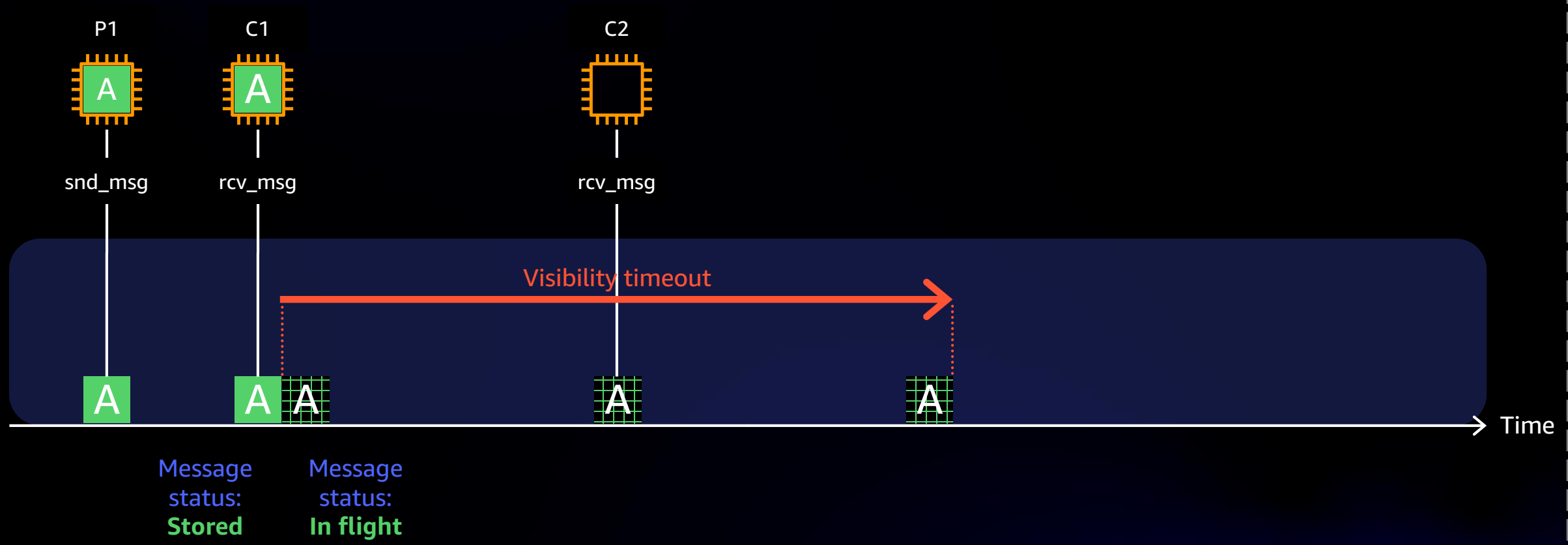
Visibility timeout, inflight messages, and message acknowledgement



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Message channels

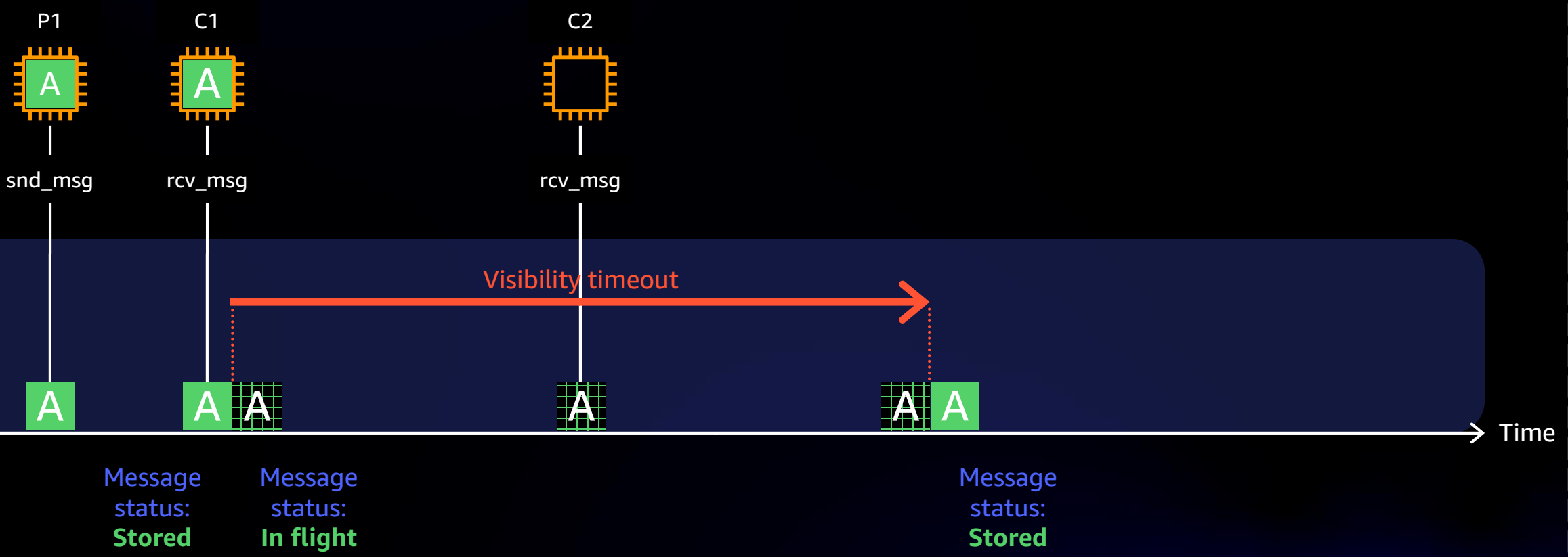
Visibility timeout, inflight messages, and message acknowledgement



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Message channels

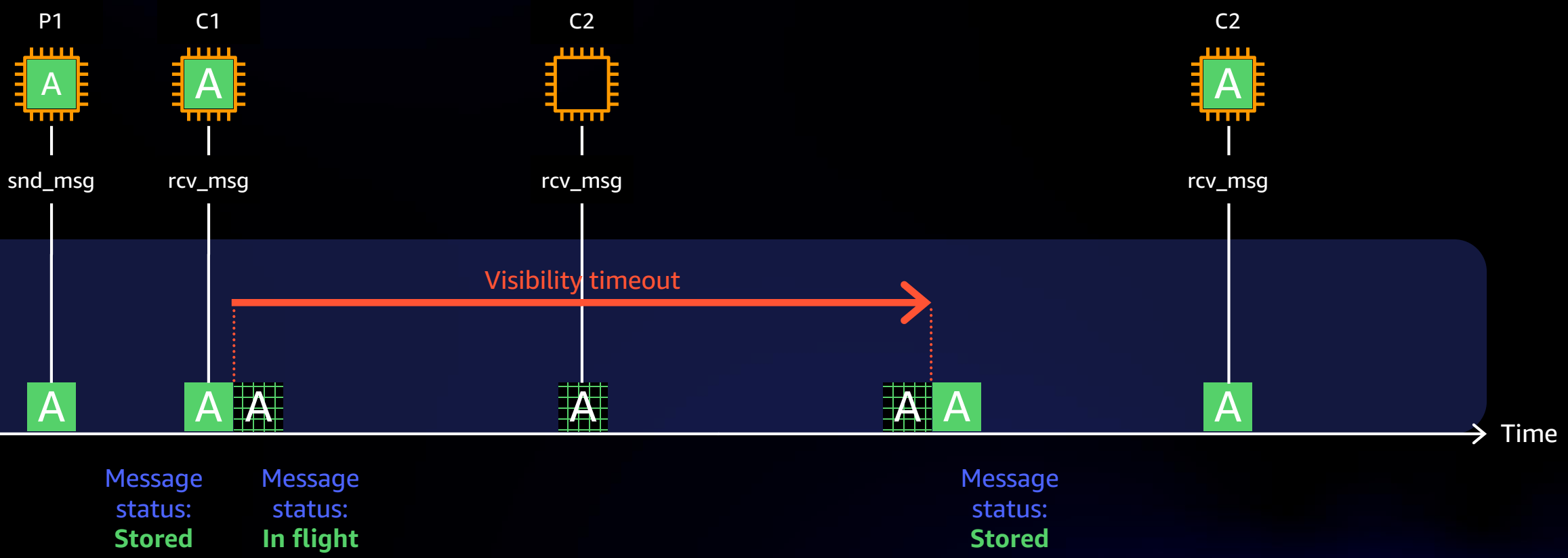
Visibility timeout, inflight messages, and message acknowledgement



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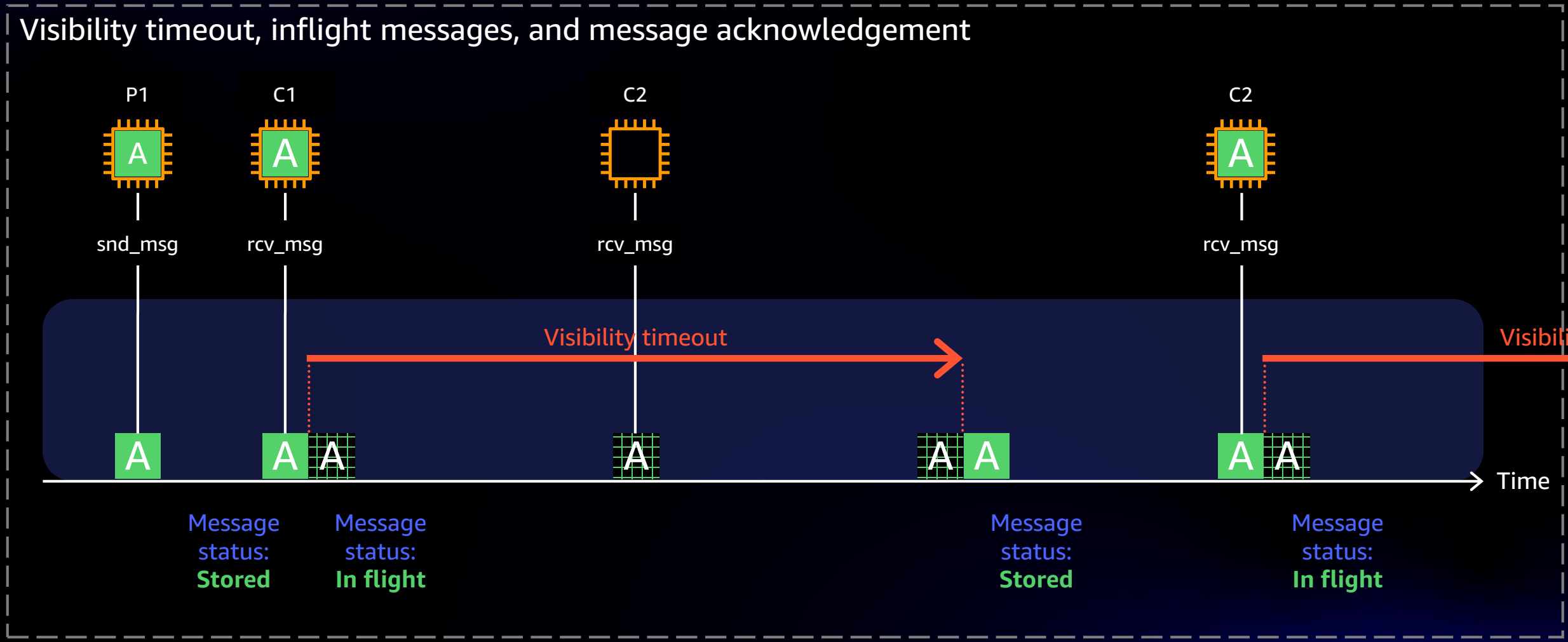
Message channels

Visibility timeout, inflight messages, and message acknowledgement



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Message channels



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Message channels

FIFO queues

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Message channels

FIFO queues

Strict order for message delivery

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Message channels

FIFO queues



Producer

Consumer

Strict order for message delivery

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Message channels

FIFO queues



Producer

Consumer

Strict order for message delivery

All magic comes with a price, deary

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Message channels

FIFO queues

What happens with multiple consumers?

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Message channels

FIFO queues

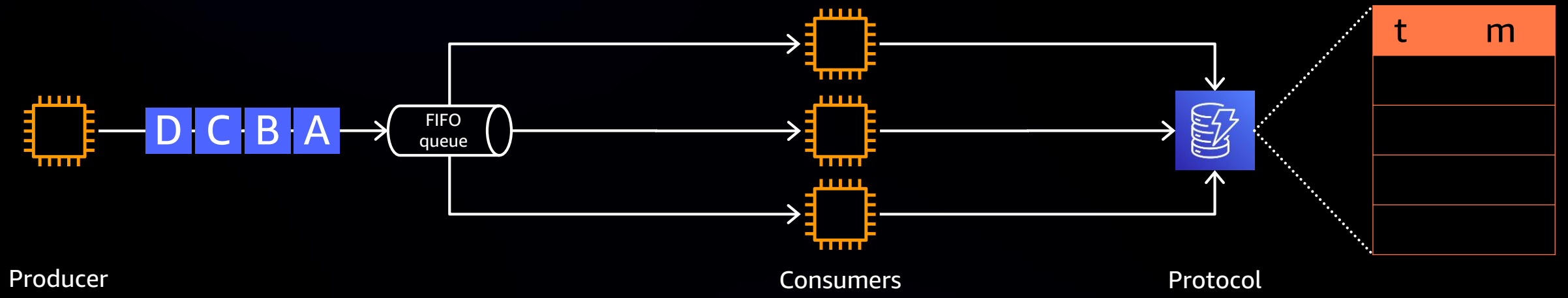
What happens with multiple consumers?

Concurrent message consumption!

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Message channels

FIFO queues



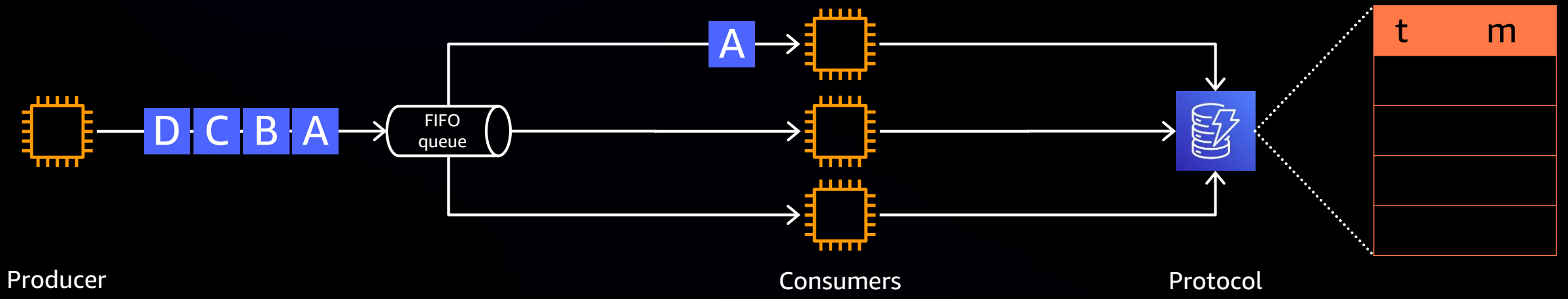
What happens with multiple consumers?

Concurrent message consumption!

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Message channels

FIFO queues



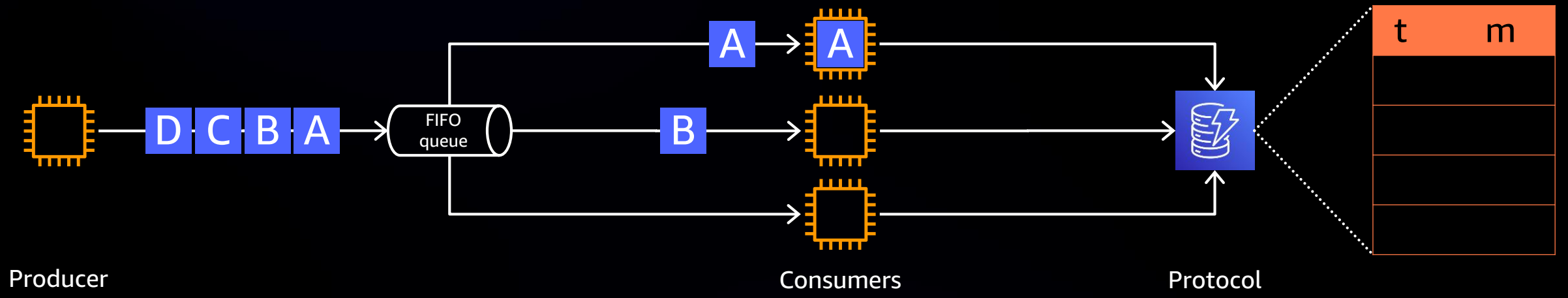
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Message channels

FIFO queues



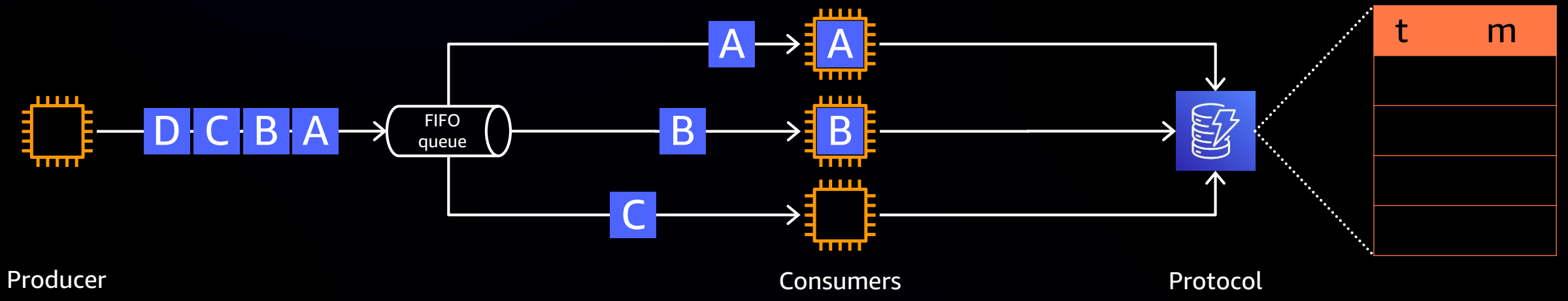
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Message channels

FIFO queues



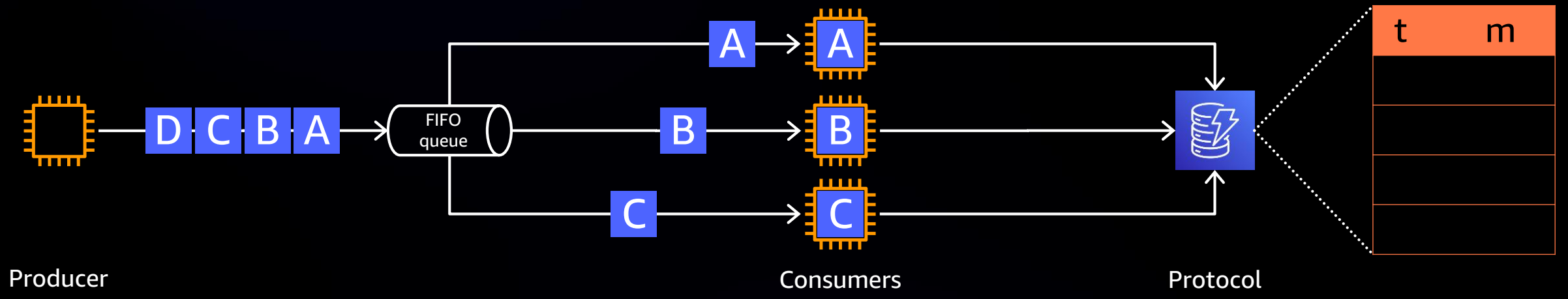
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Message channels

FIFO queues



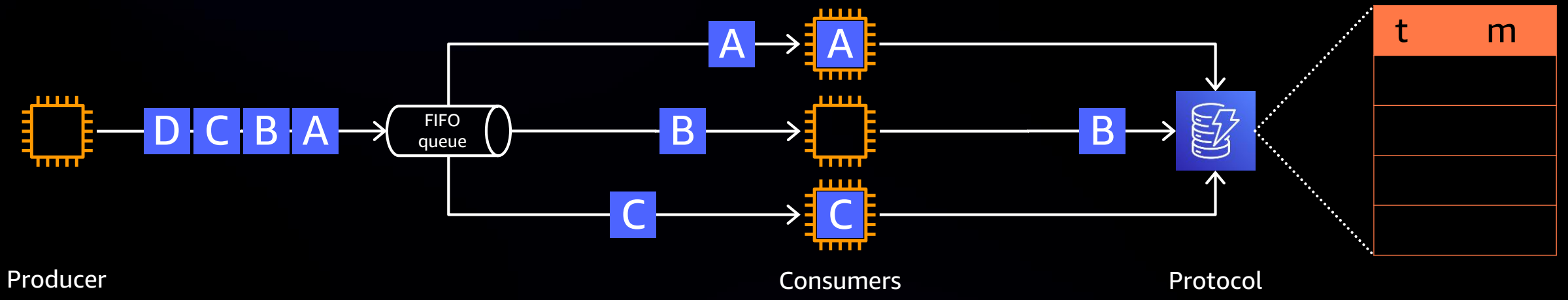
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Message channels

FIFO queues



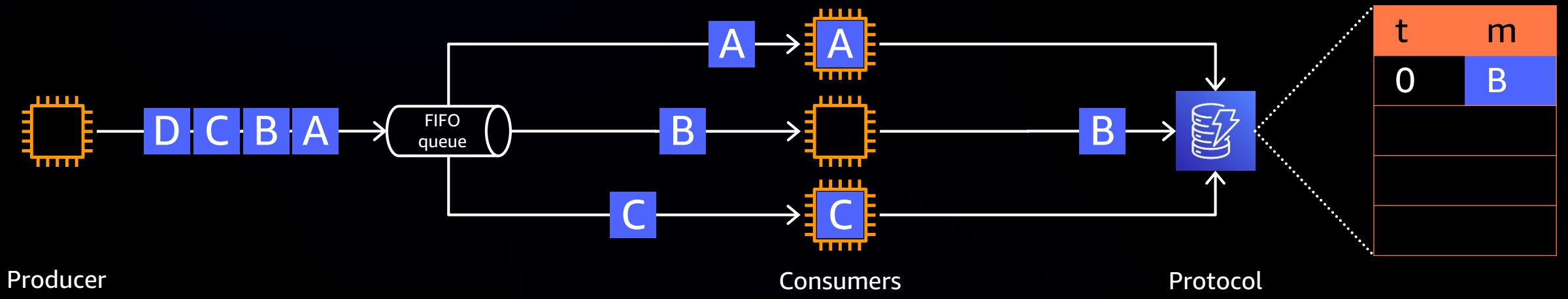
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Message channels

FIFO queues



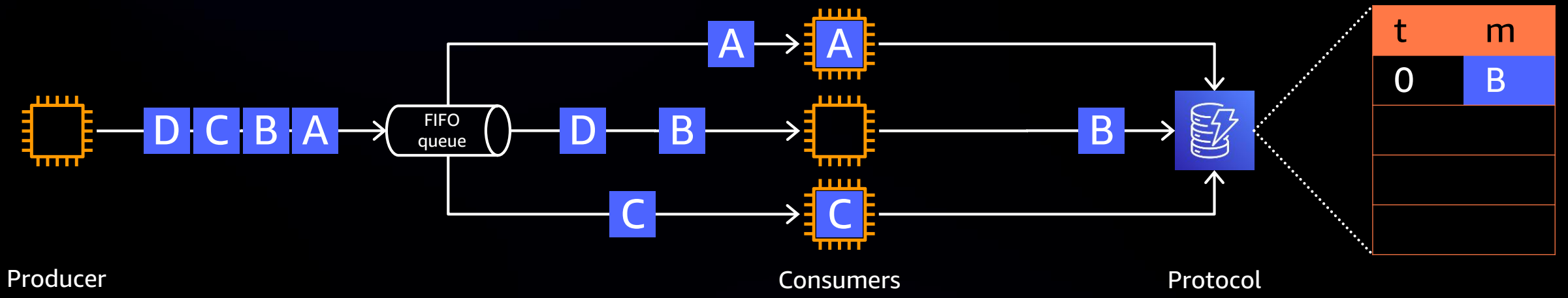
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Message channels

FIFO queues



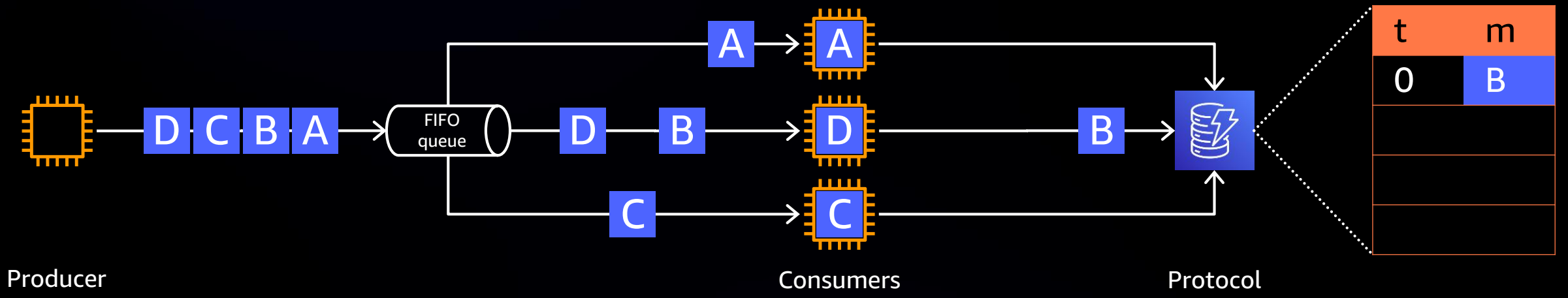
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Message channels

FIFO queues



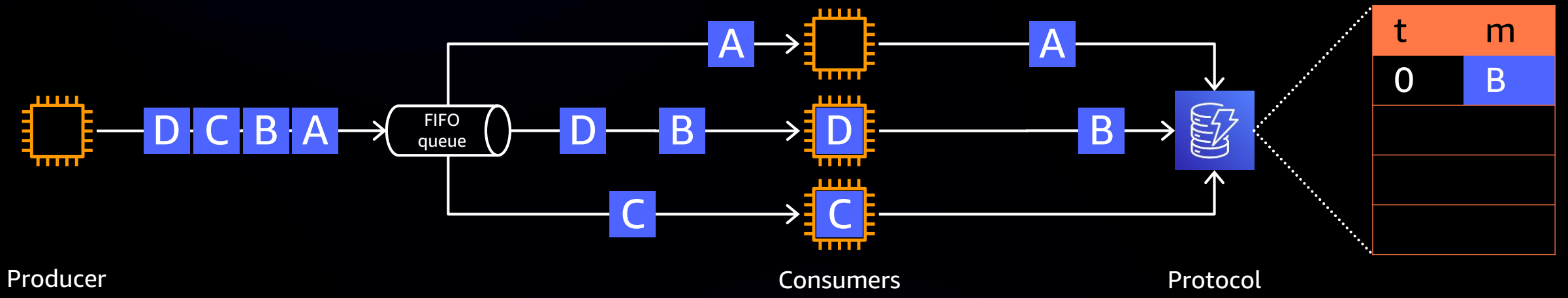
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Message channels

FIFO queues



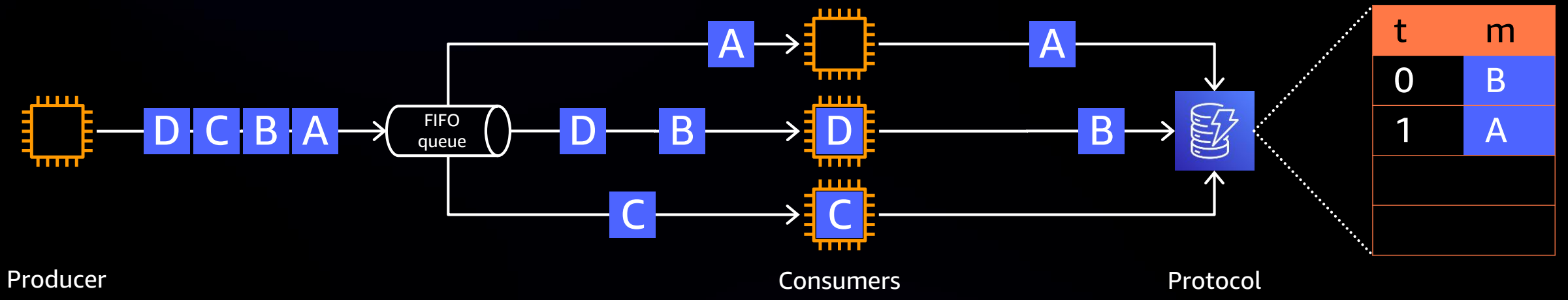
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Concurrent message consumption!

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Message channels

FIFO queues



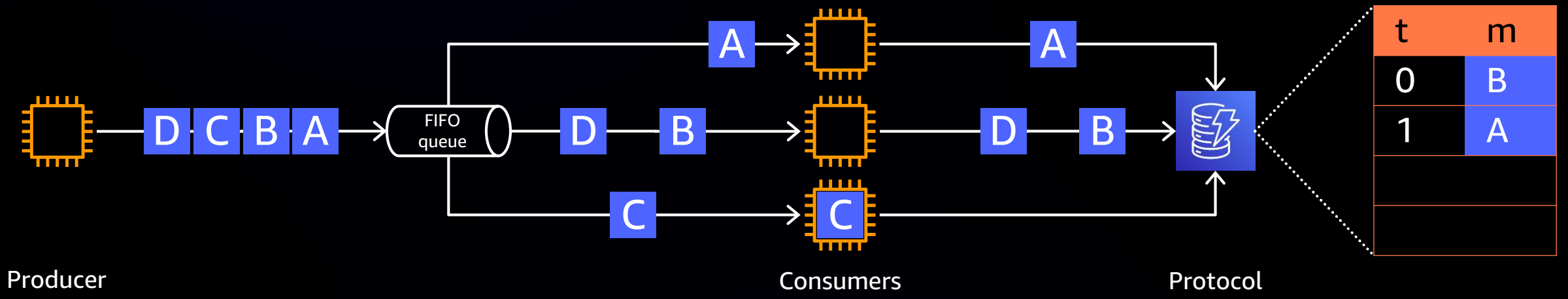
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Message channels

FIFO queues



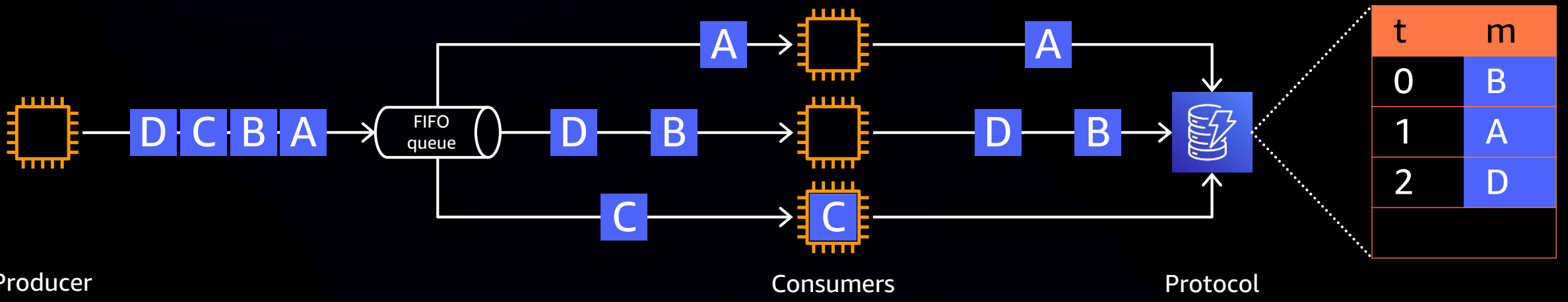
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Message channels

FIFO queues



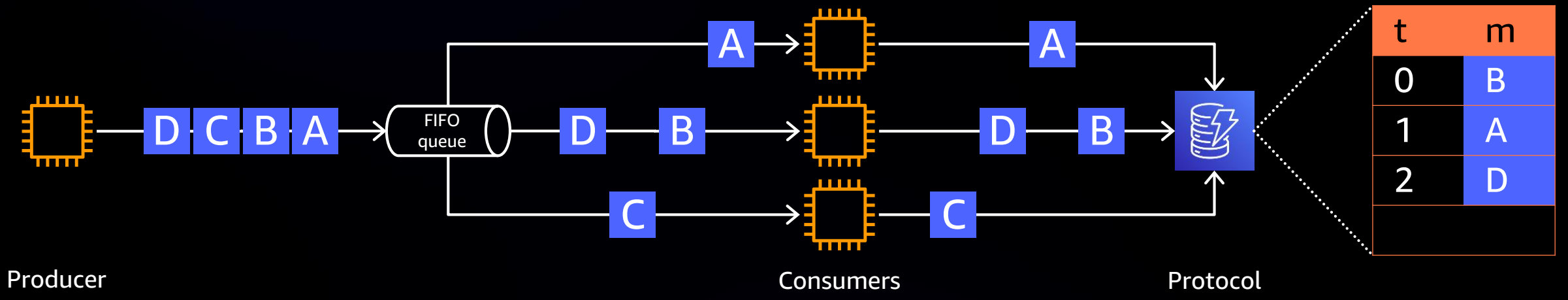
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Message channels

FIFO queues



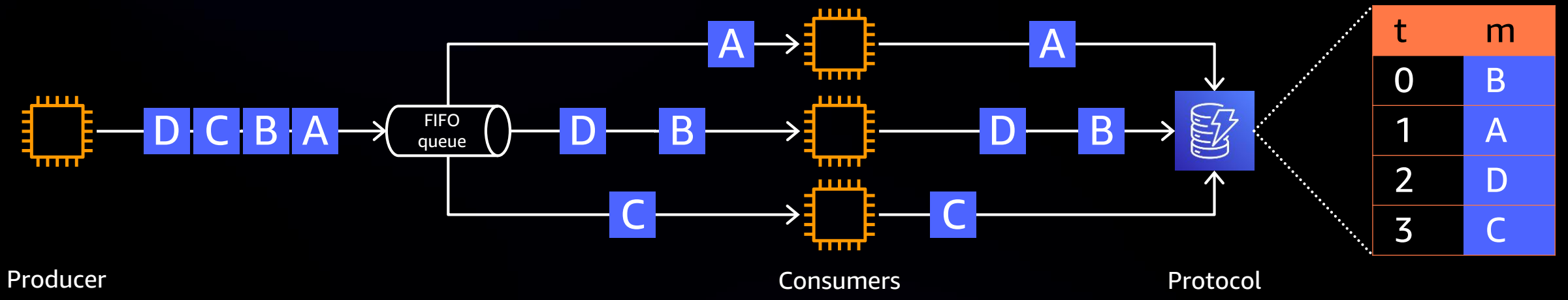
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Message channels

FIFO queues



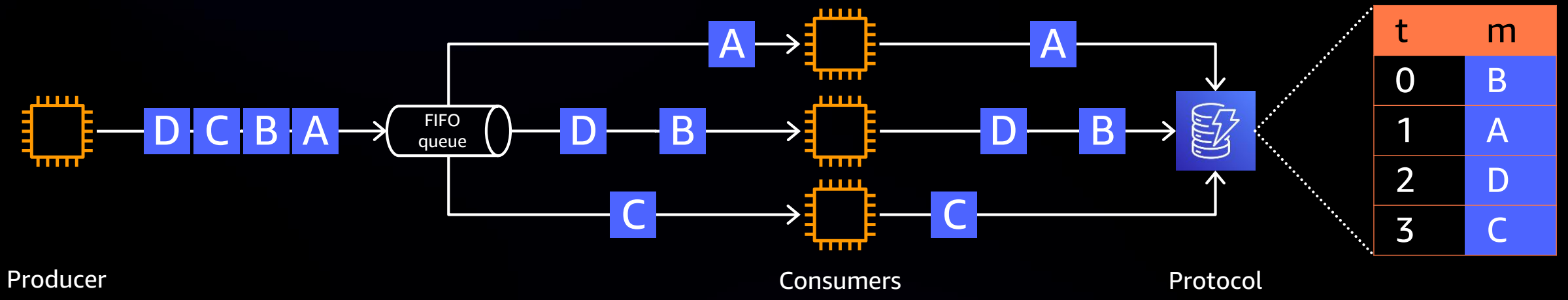
What happens with multiple consumers?

Concurrent message consumption!

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Message channels

FIFO queues



What happens with multiple consumers?

Concurrent message consumption!

Message processing time can vary and lead to order violation in consumer processes

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Message channels

Message groups

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Message channels

Message groups

Messages grouped by discriminator attribute

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Message channels

Message groups

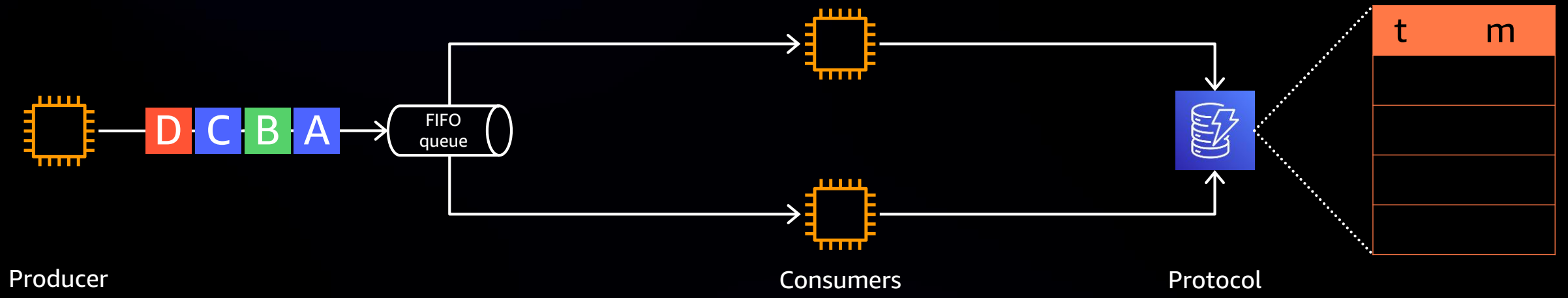
Messages grouped by discriminator attribute

Example: Amazon SQS message group IDs

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Message channels

Message groups



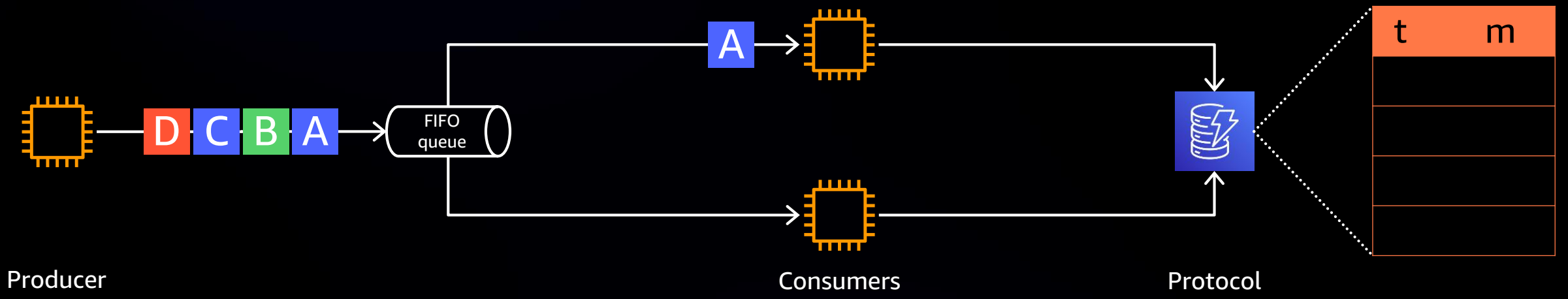
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Message channels

Message groups



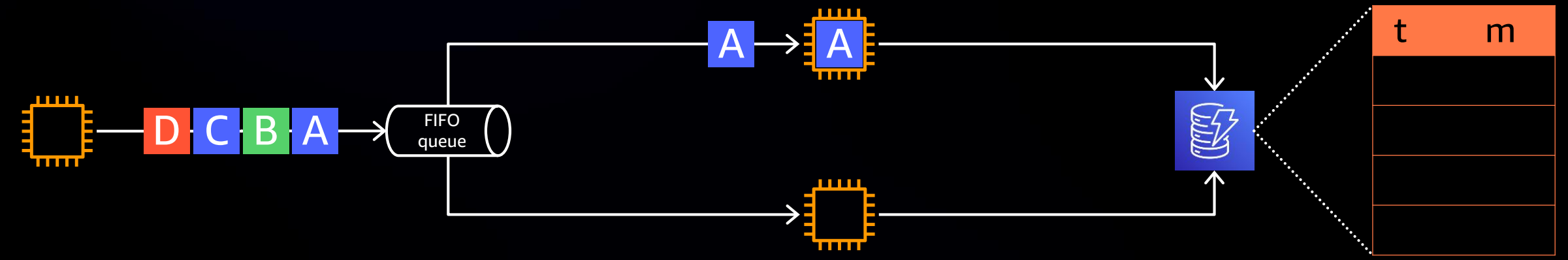
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Message channels

Message groups



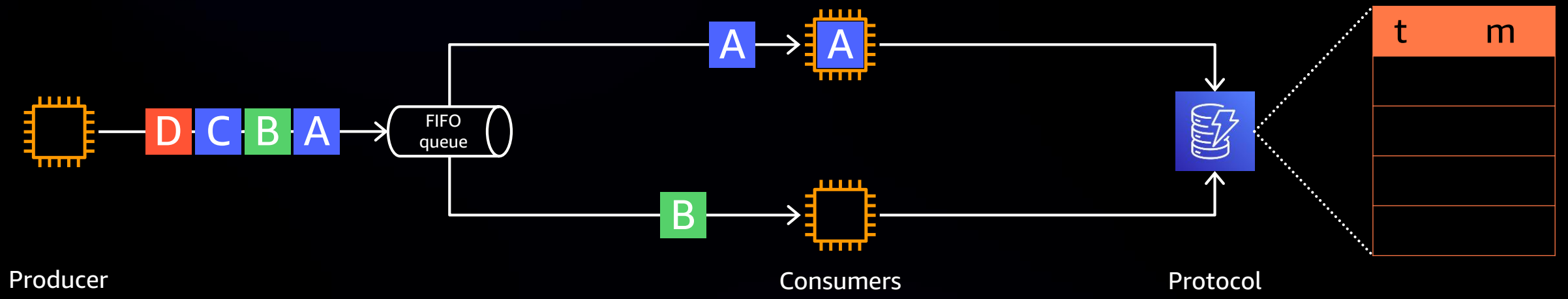
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Message channels

Message groups



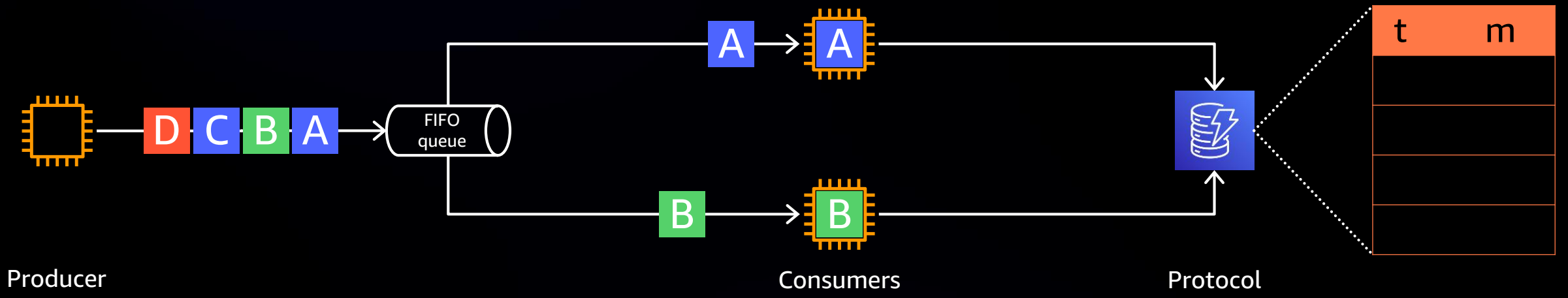
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Message channels

Message groups



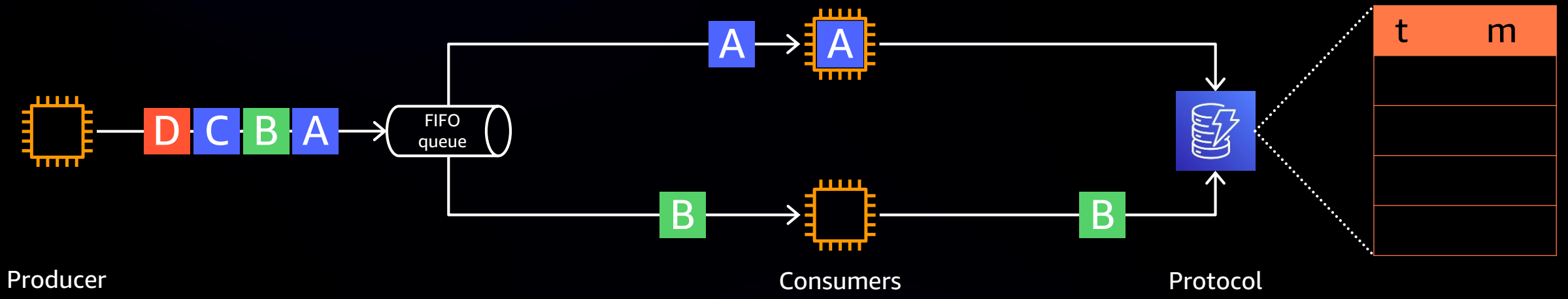
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Message channels

Message groups



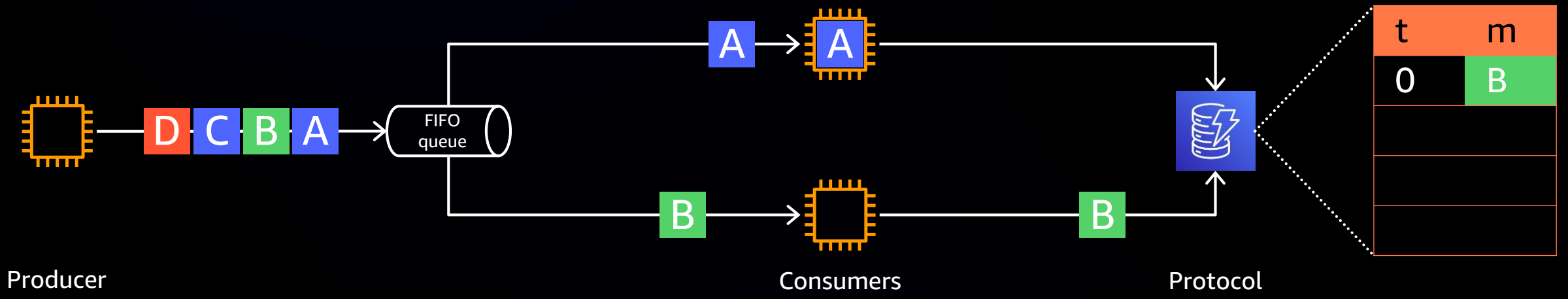
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Message channels

Message groups

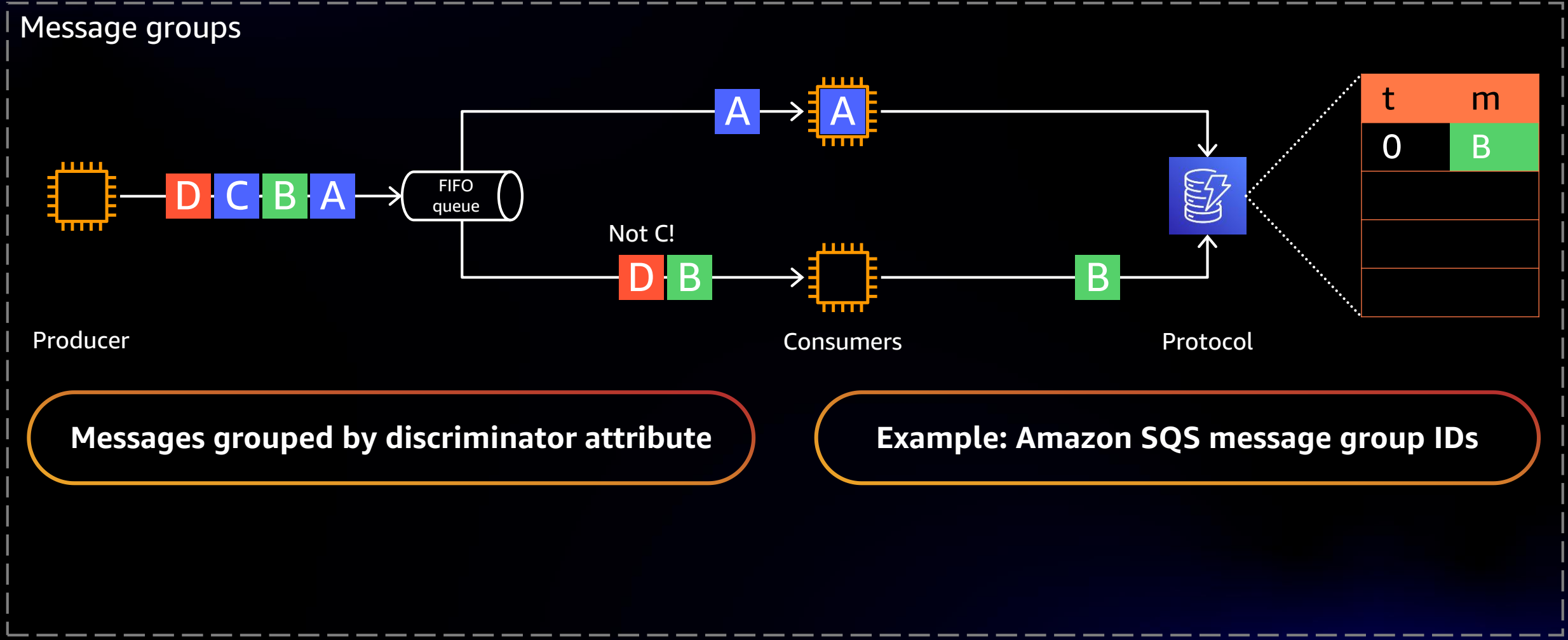


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Message channels

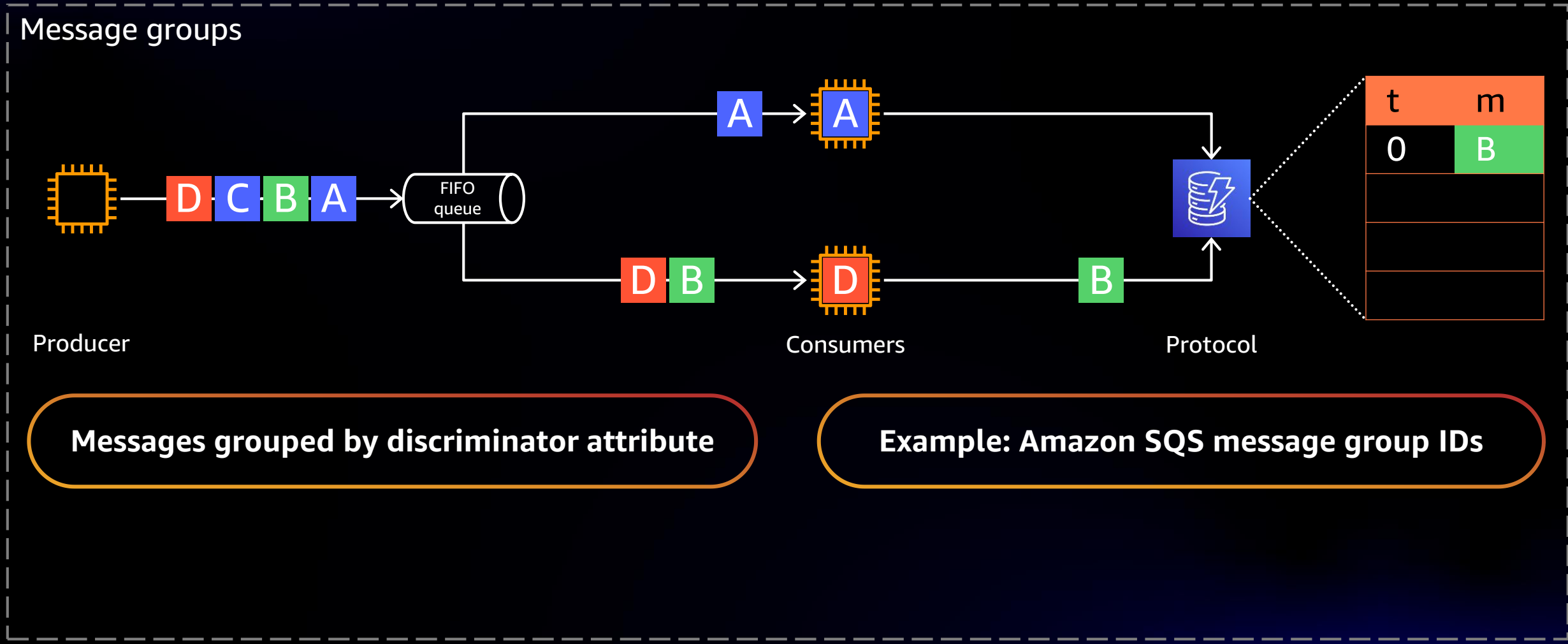


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Message channels



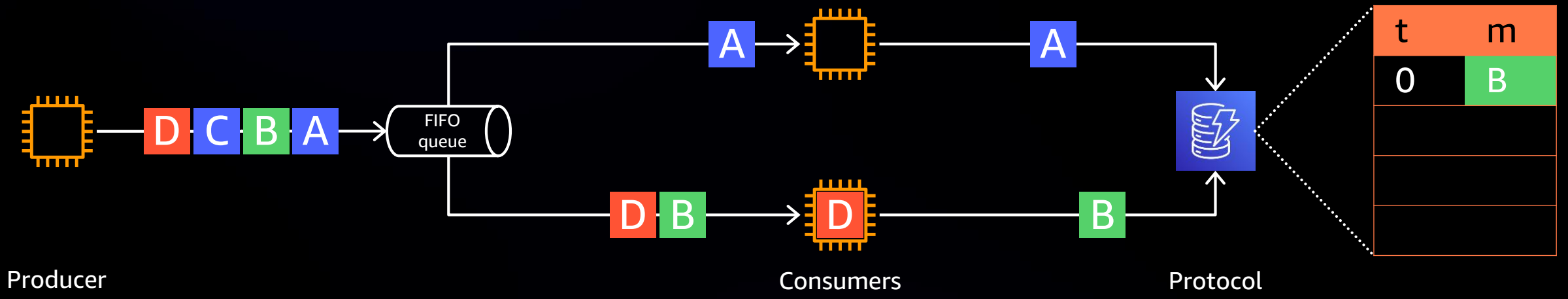
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Message channels

Message groups



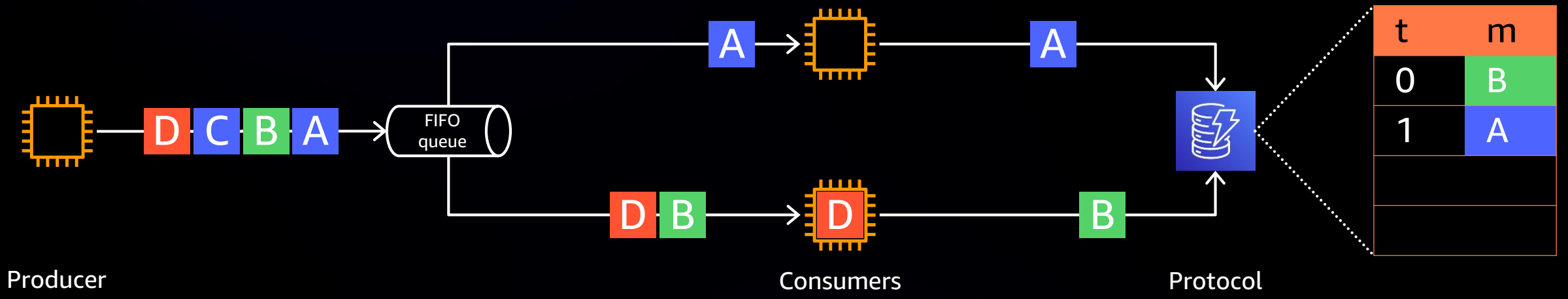
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Message channels

Message groups



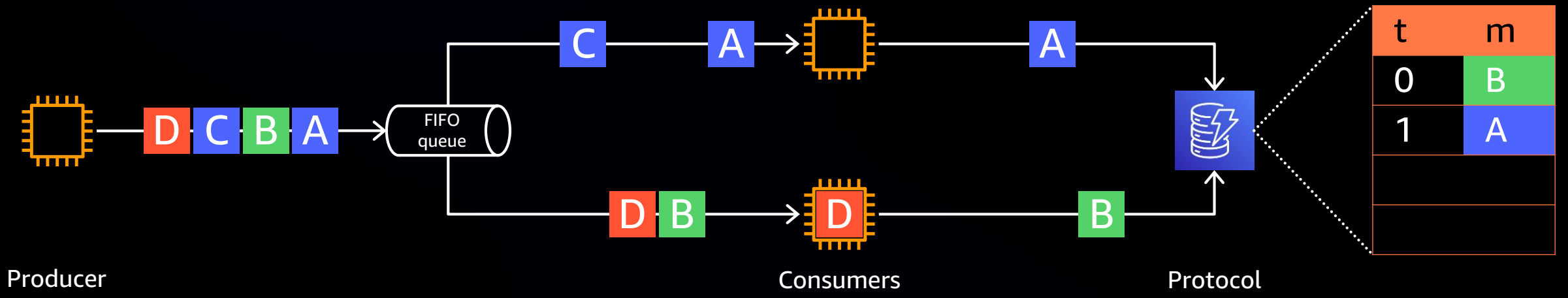
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Message channels

Message groups

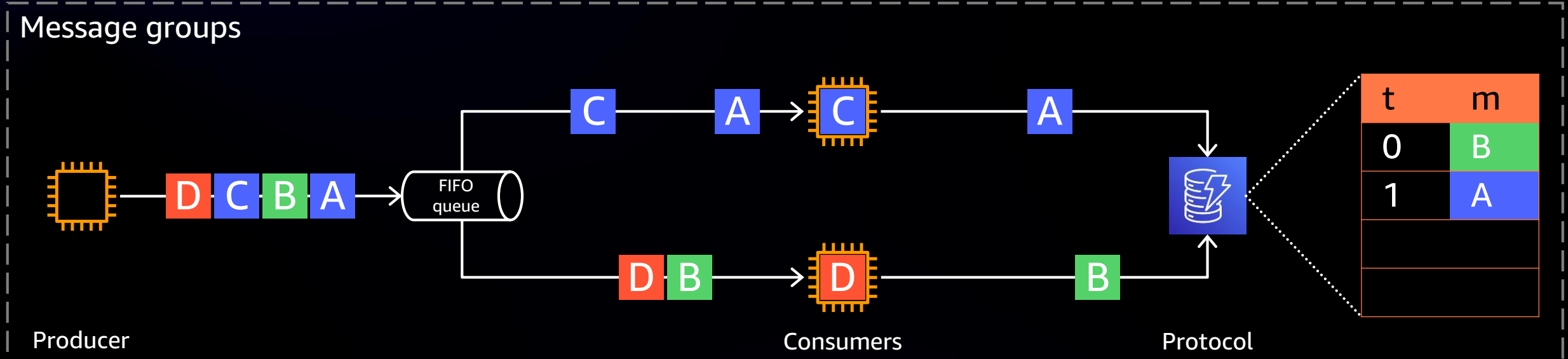


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Message channels

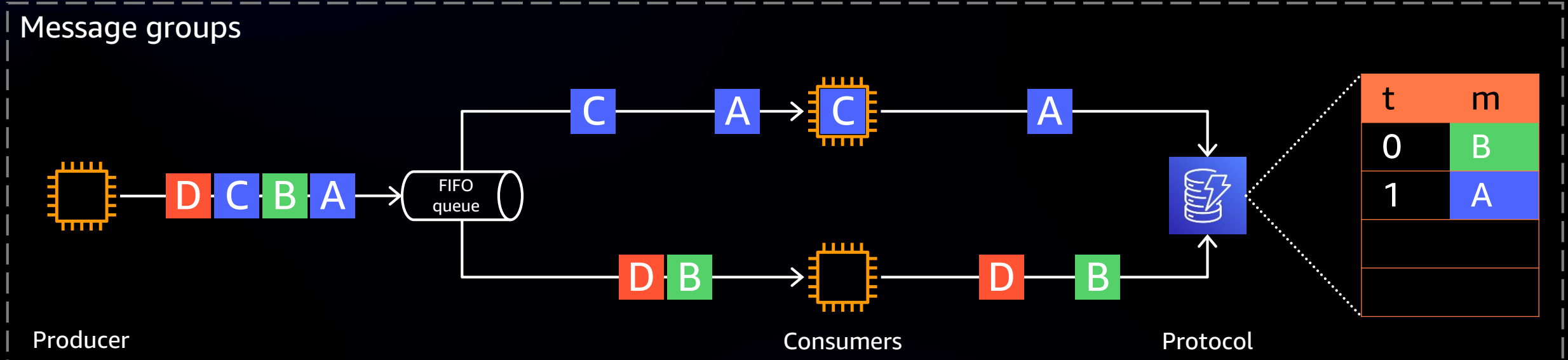


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Message channels



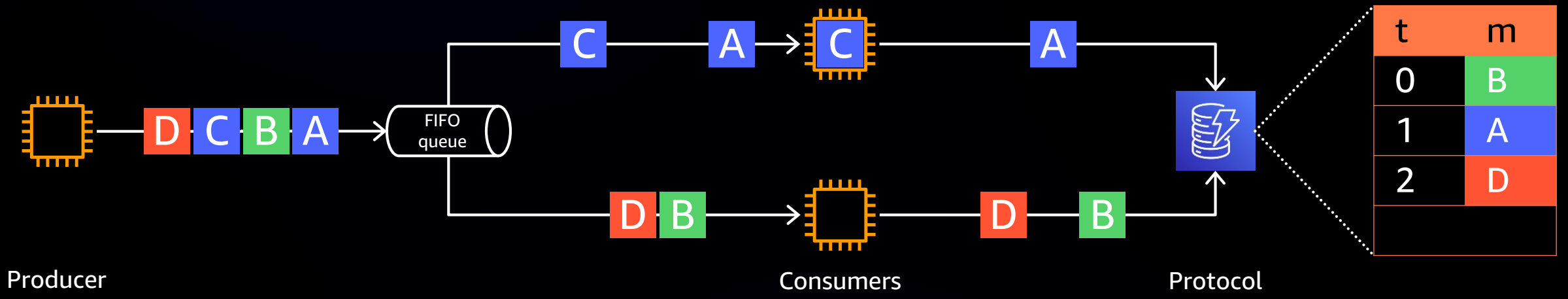
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Message channels

Message groups



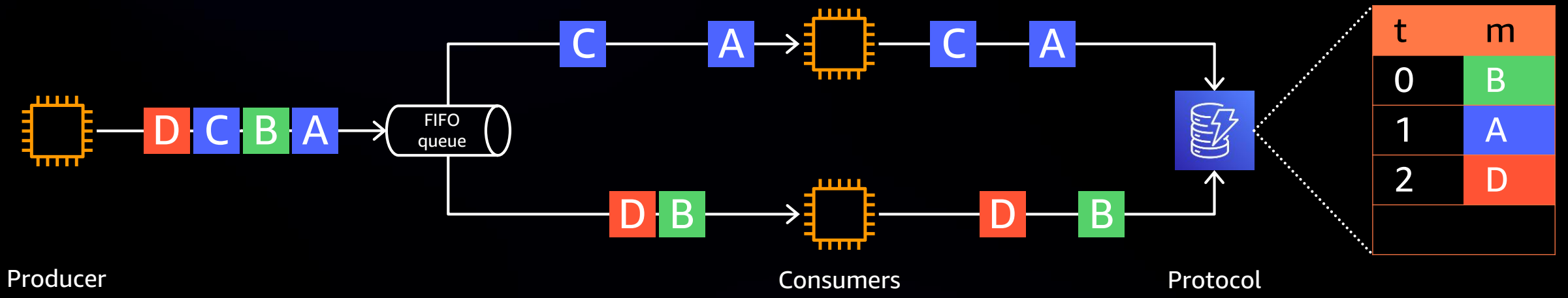
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Message channels

Message groups



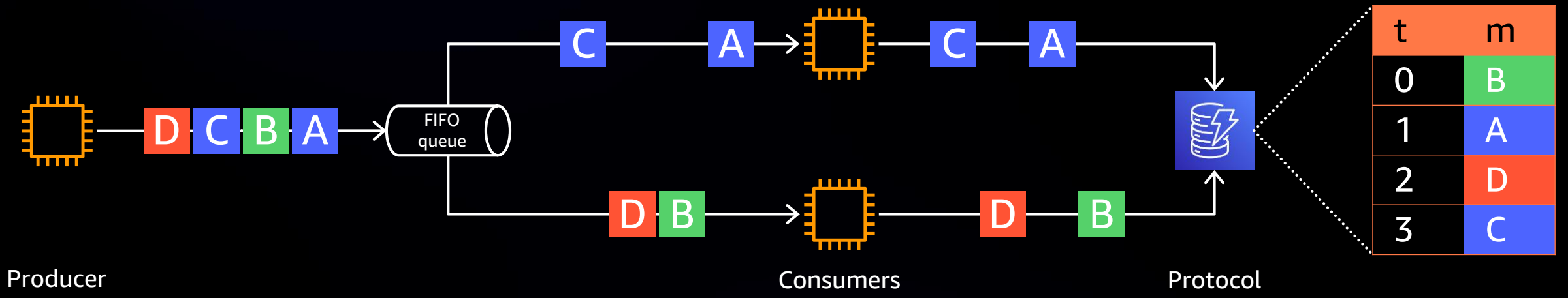
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Message channels

Message groups



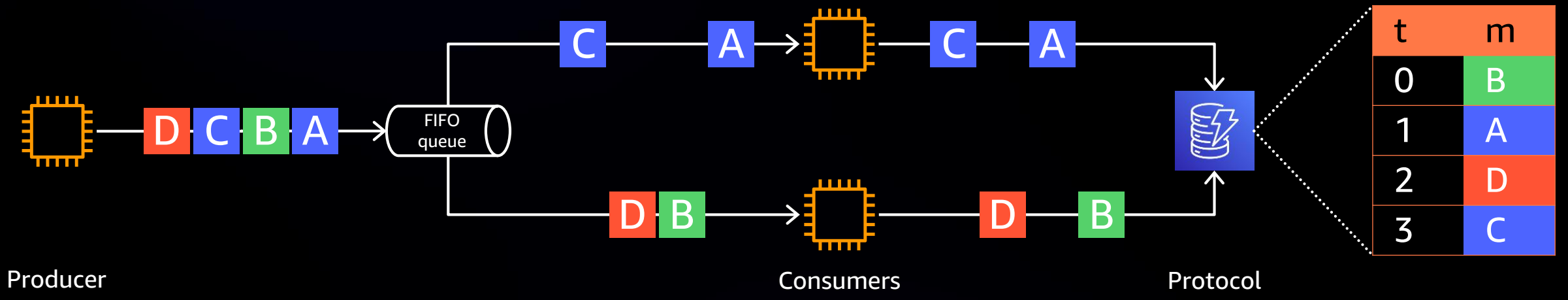
Messages grouped by discriminator attribute

Example: Amazon SQS message group IDs

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Message channels

Message groups



- Messages grouped by discriminator attribute
- Example: Amazon SQS message group IDs
- Order retained within each message group
- Consumer scale-out on # of message group IDs

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Message channels

Message groups



Producer

Local vs. global message order?

t	m
0	B
1	A
2	D
3	C

Messages groups

sage group IDs

Order retained within each message group

Consumer scale-out on # of message group IDs

aws

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Message channels

Message groups



Producer

What if a global order is needed?

t	m
0	B
1	A
2	D
3	C

Messages groups

sage group IDs

Order retained within each message group

Consumer scale-out on # of message group IDs

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Message channels

Message groups



t	m
0	B
1	A
2	D
3	C

What if a global order is needed?

One message group for all messages, with respective implications

Producer

Messages groups

sage group IDs

Order retained within each message group

Consumer scale-out on # of message group IDs

aws

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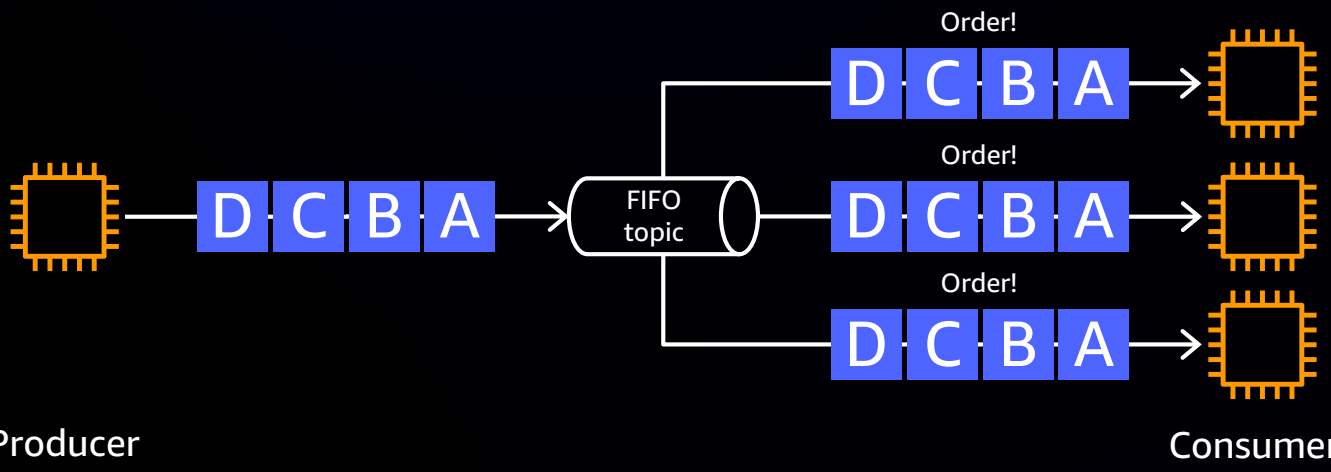
Message channels

FIFO topics

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Message channels

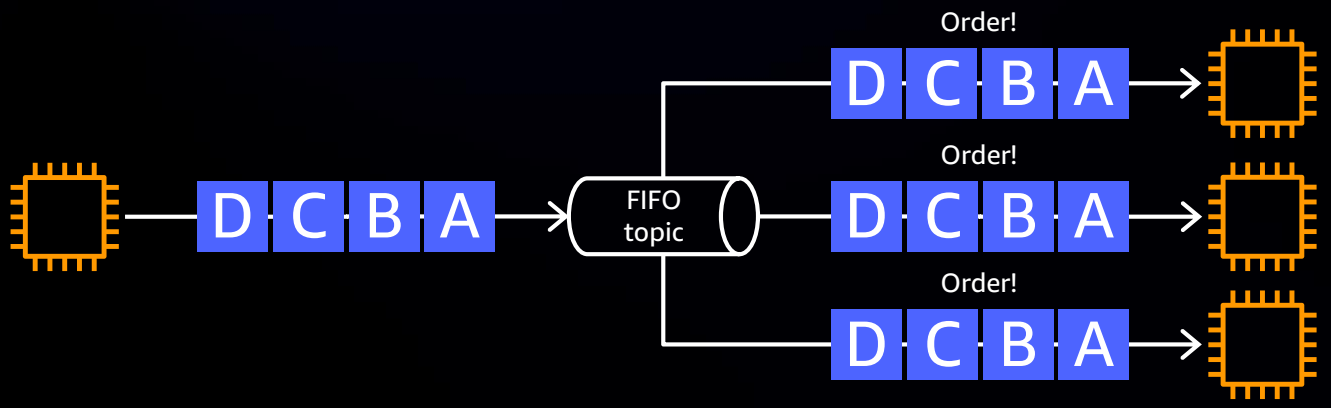
FIFO topics



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Message channels

FIFO topics

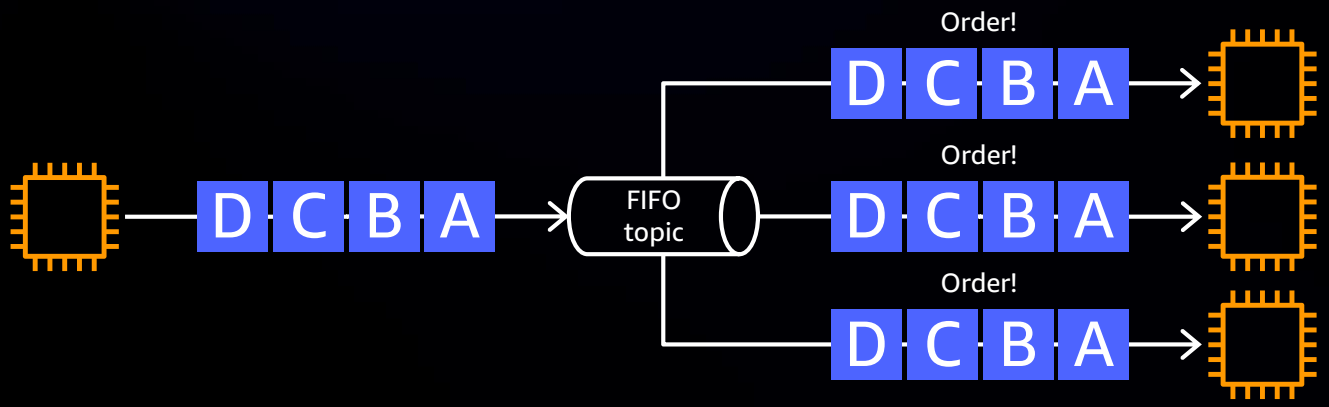


No concurrent consumers

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Message channels

FIFO topics



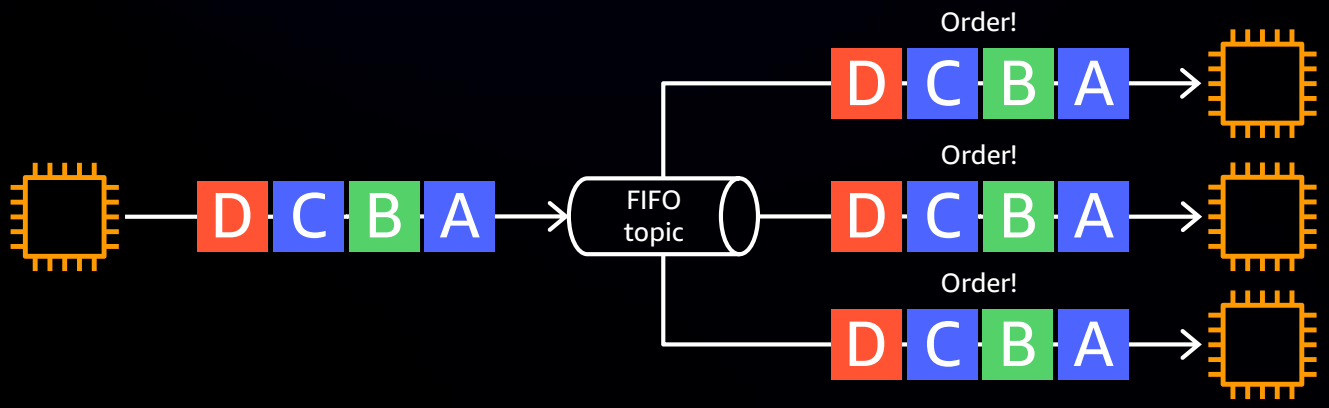
No concurrent consumers

What happens for topic-queue-chaining?

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Message channels

FIFO topics



No concurrent consumers

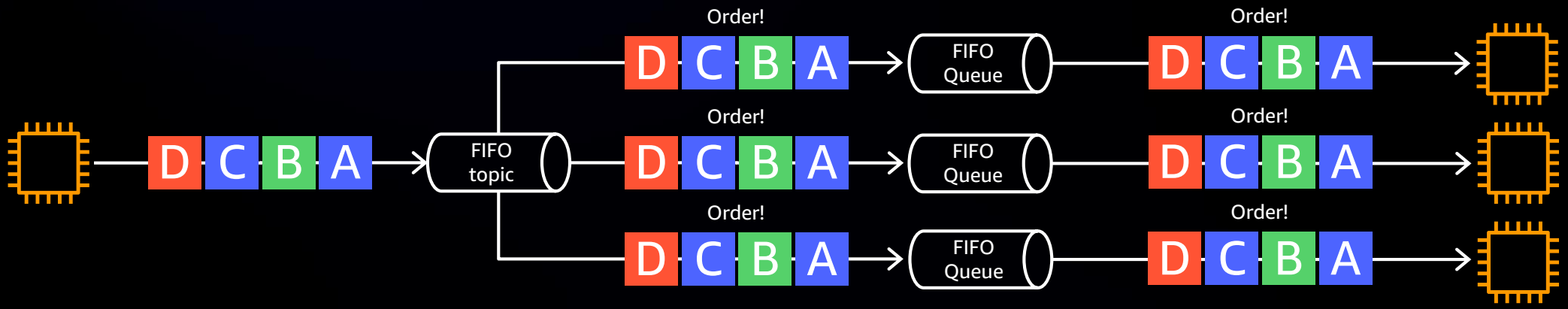
What happens for topic-queue-chaining?

SNS FIFO topics also use message groups (MG)

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Message channels

FIFO topics



No concurrent consumers

What happens for topic-queue-chaining?

SNS FIFO topics also use message groups (MG)

MG IDs to be forwarded into queue messages

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Message routing

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Message routing



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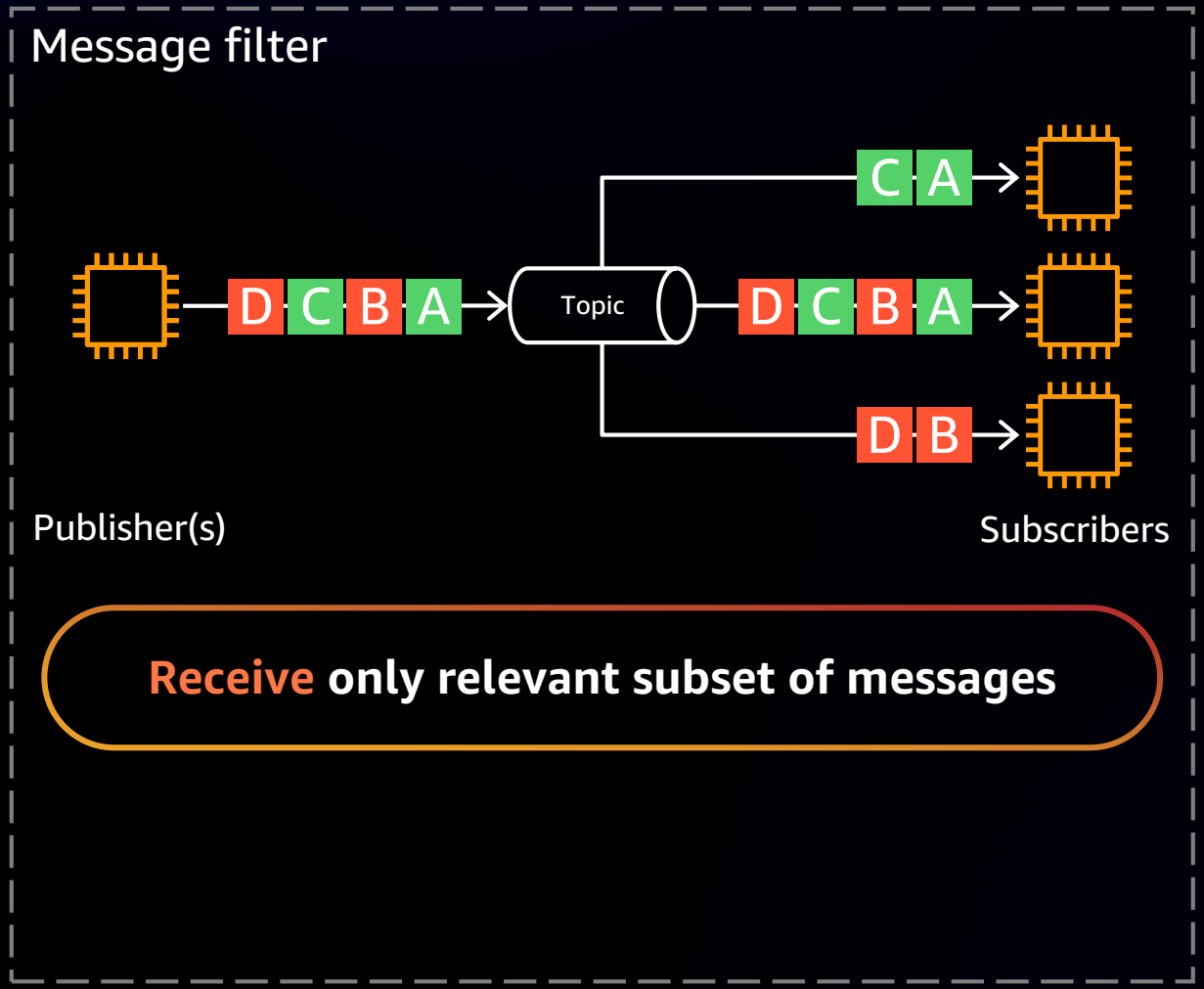
Message routing

Message filter

Receive only relevant subset of messages

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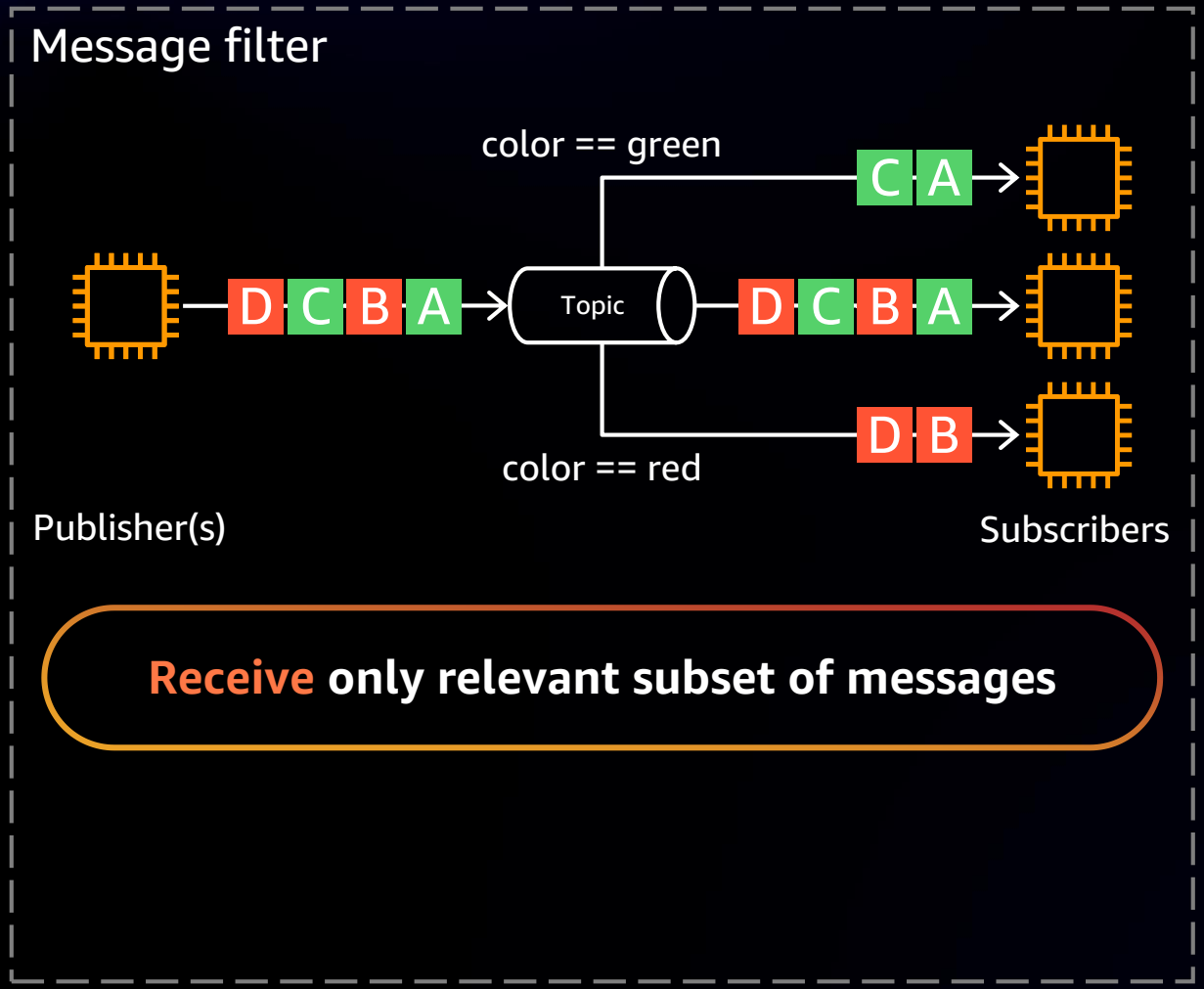
Message routing



Receive only relevant subset of messages

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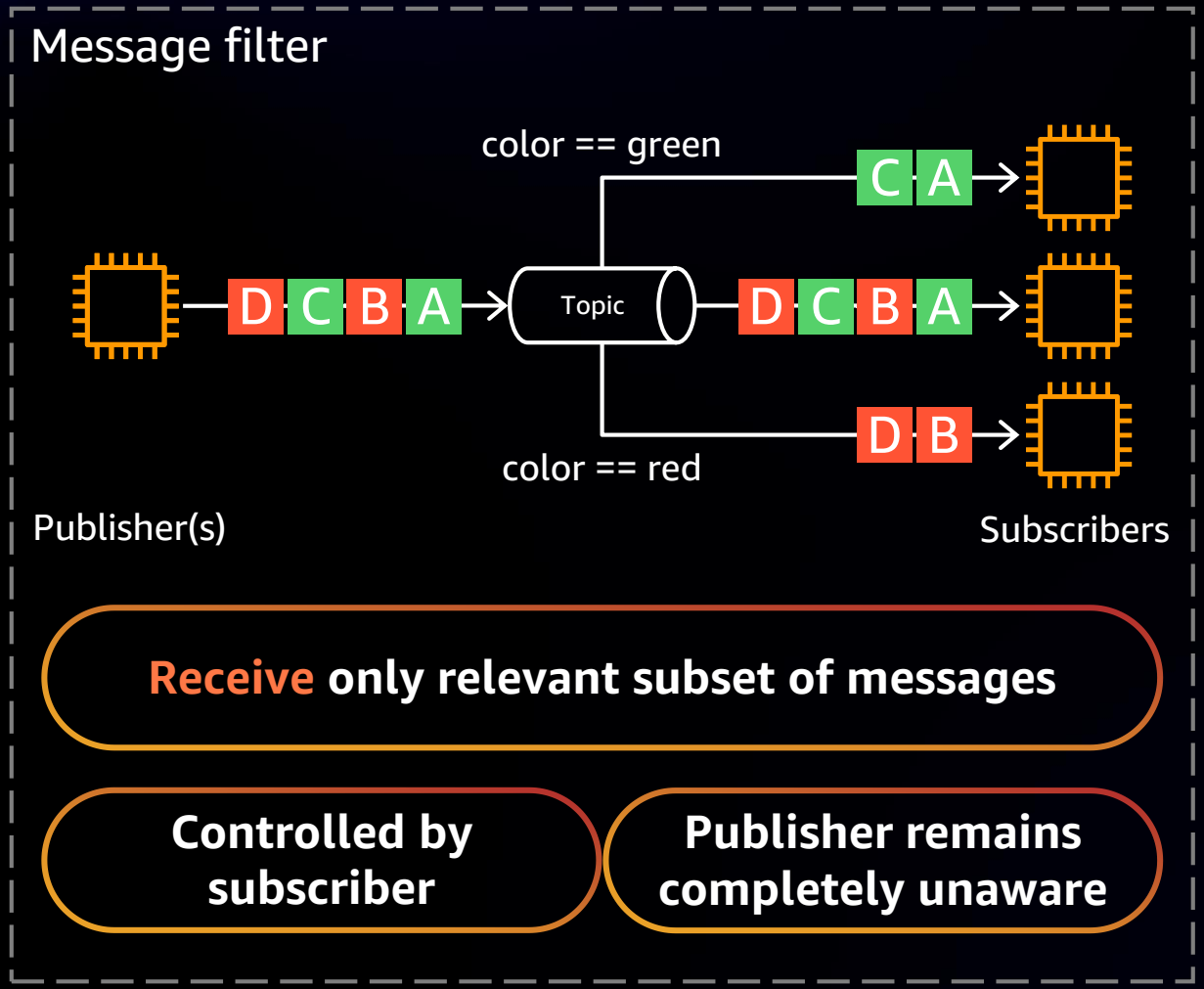
Message routing



Receive only relevant subset of messages

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Message routing



Receive only relevant subset of messages

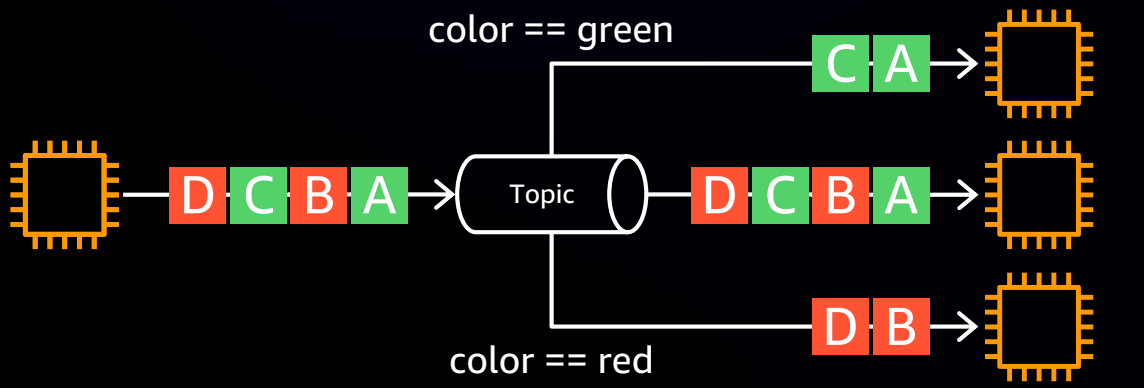
Controlled by subscriber

Publisher remains completely unaware

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Message routing

Message filter



Receive only relevant subset of messages

Controlled by subscriber

Publisher remains completely unaware

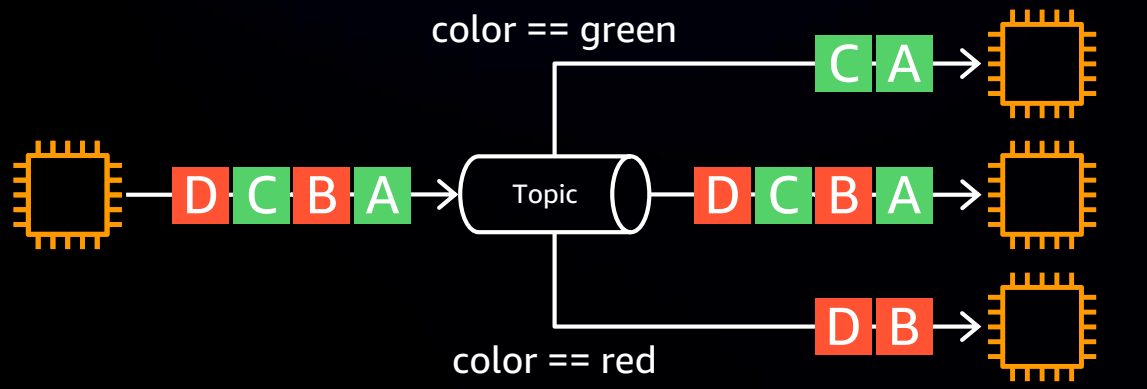
Recipient list

Send only relevant subset of messages to each subscriber

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Message routing

Message filter

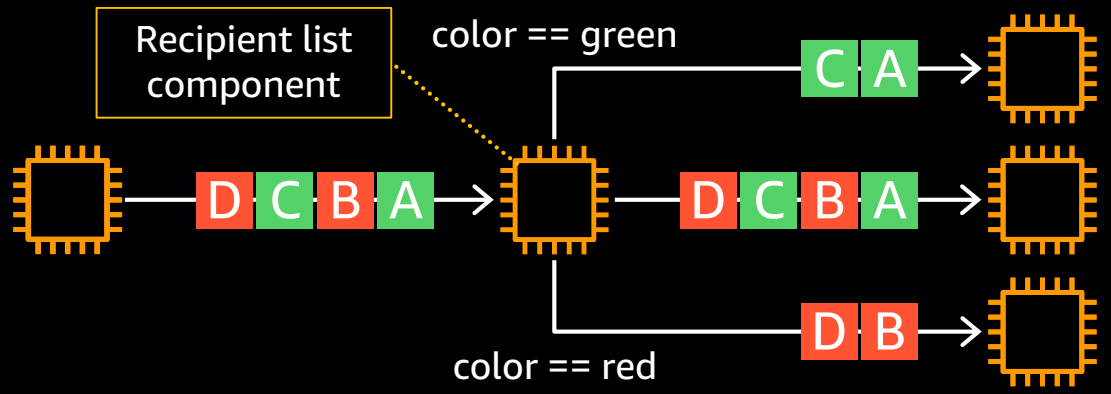


Receive only relevant subset of messages

Controlled by subscriber

Publisher remains completely unaware

Recipient list

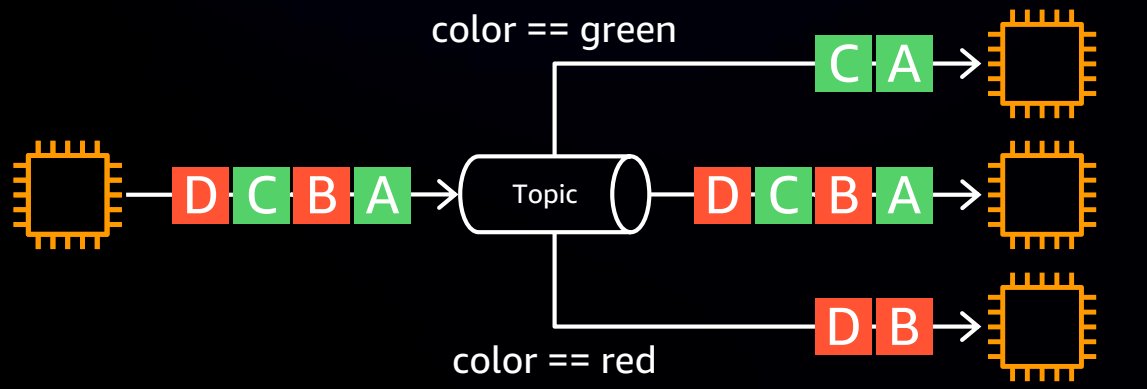


Send only relevant subset of messages to each subscriber

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Message routing

Message filter

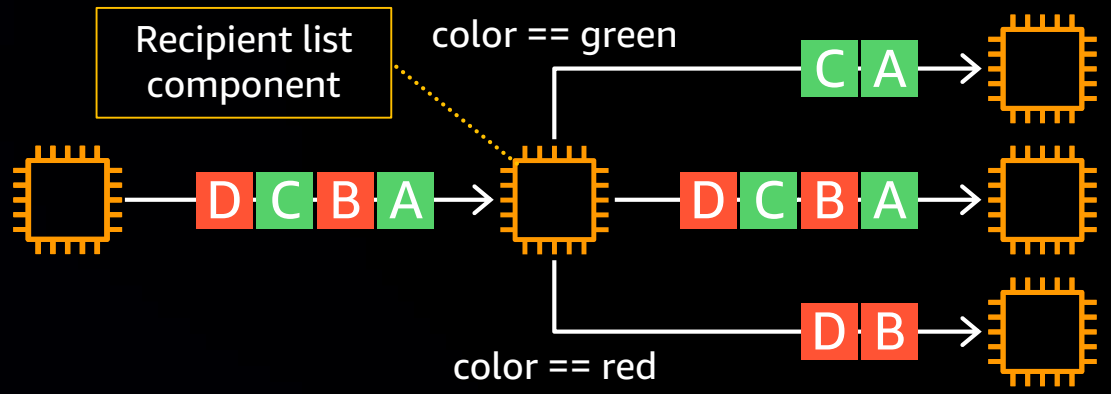


Receive only relevant subset of messages

Controlled by subscriber

Publisher remains completely unaware

Recipient list



Send only relevant subset of messages to each subscriber

Controlled directly by publisher or a separate component

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Message routing

Scatter-gather

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Message routing

Scatter-gather

How to distribute a request to relevant/interested parties and capture their individual responses?

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Message routing

Scatter-gather

How to distribute a request to relevant/interested parties and capture their individual responses?

For election or parallel processing scenarios, i.e., search for best response or accumulate responses

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Message routing

Scatter-gather



Requester

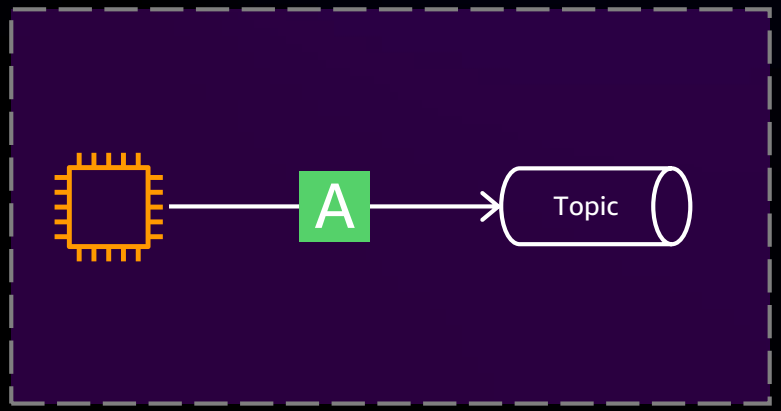
How to distribute a request to relevant/interested parties and capture their individual responses?

For election or parallel processing scenarios, i.e., search for best response or accumulate responses

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Message routing

Scatter-gather



Requester

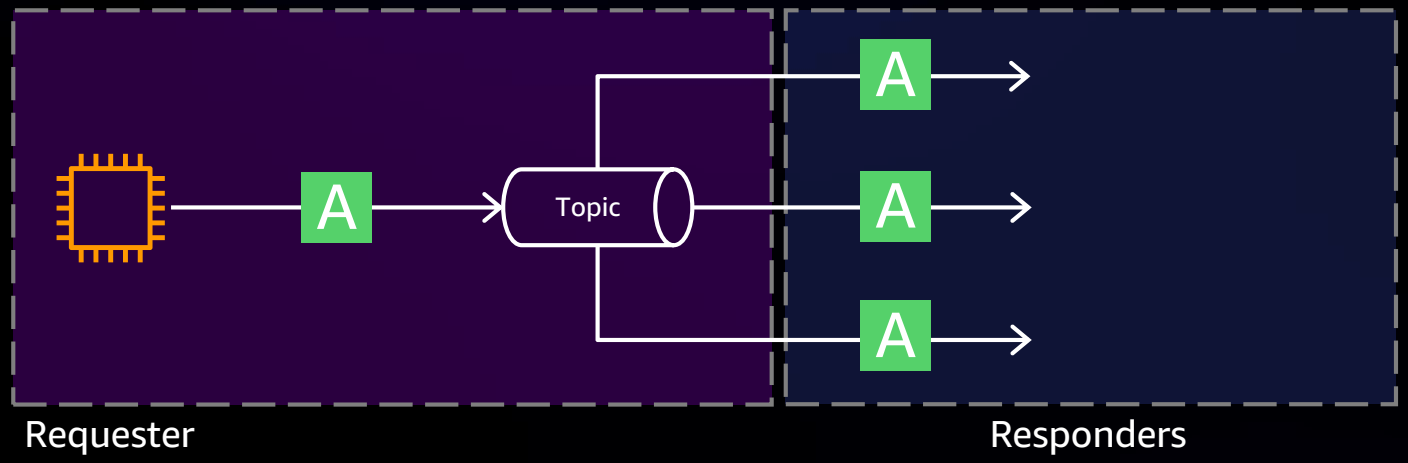
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Message routing

Scatter-gather



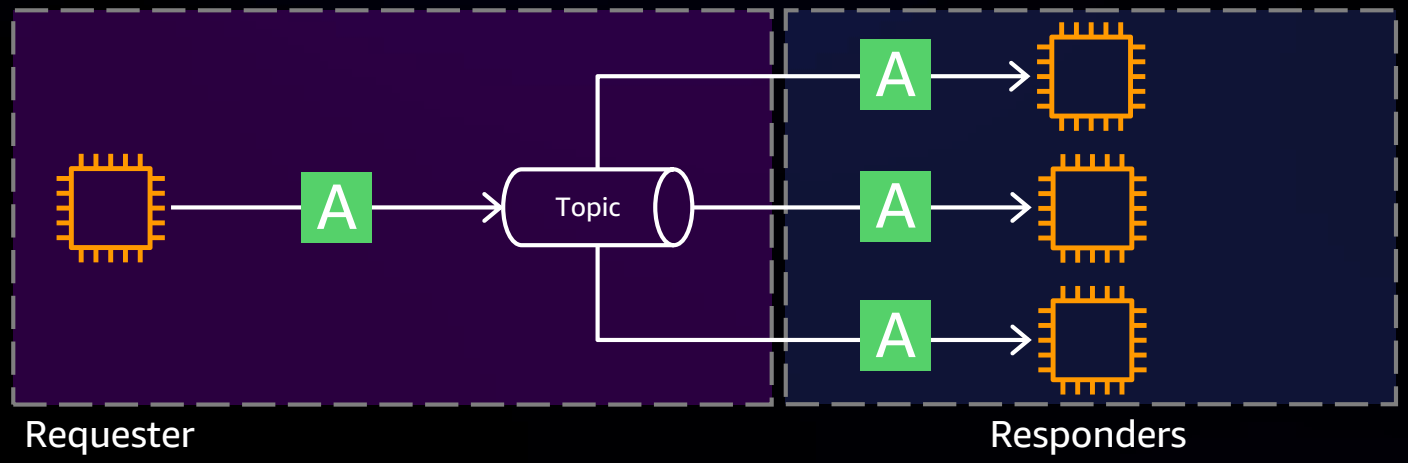
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Message routing

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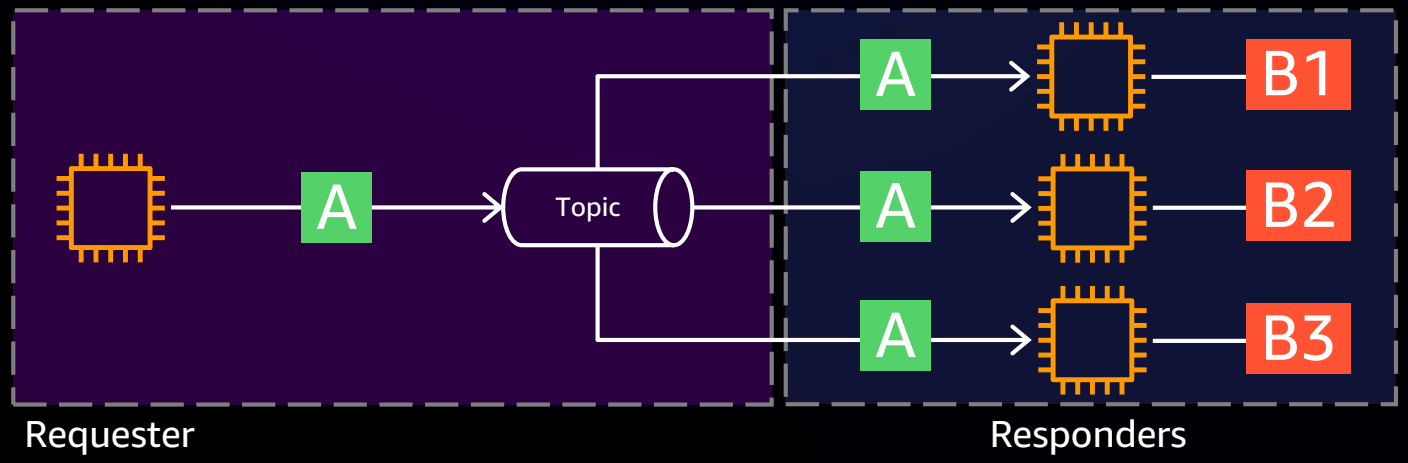
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Message routing

Scatter-gather



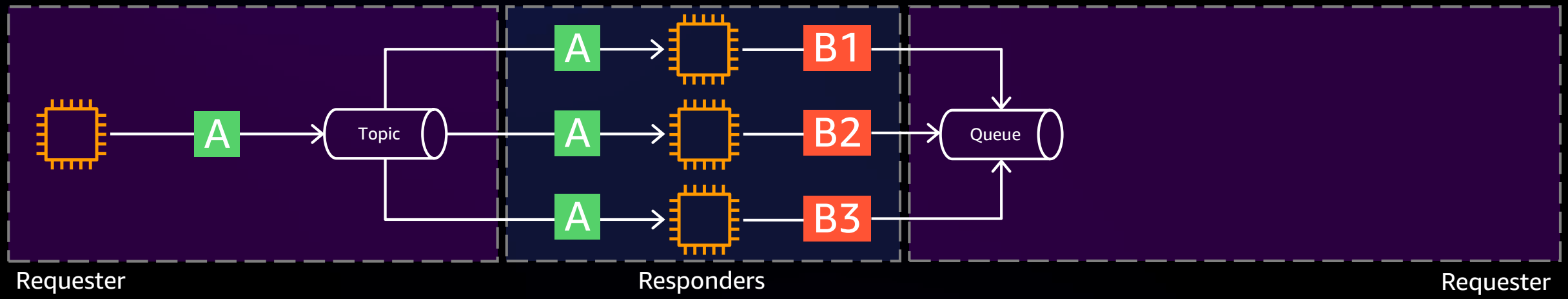
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For election or parallel processing scenarios, i.e., search for best response or accumulate responses

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Message routing

Scatter-gather



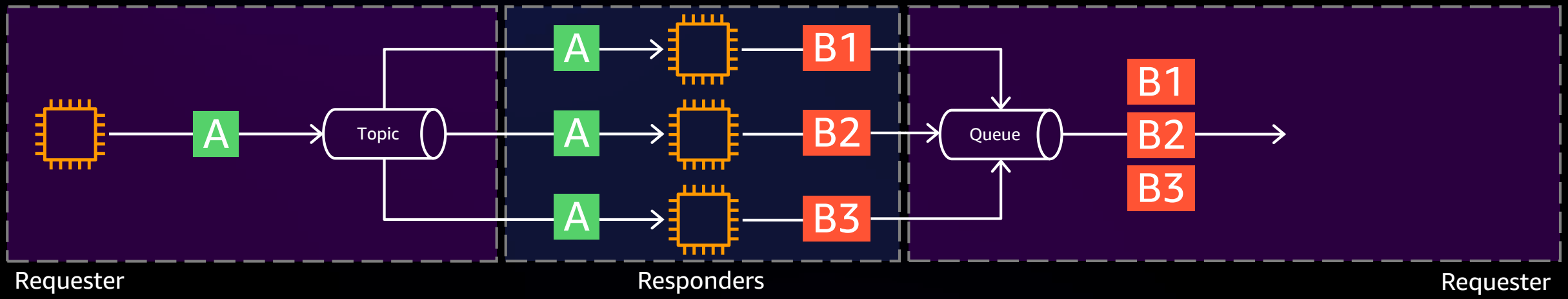
How to distribute a request to relevant/interested parties and capture their individual responses?

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Message routing

Scatter-gather



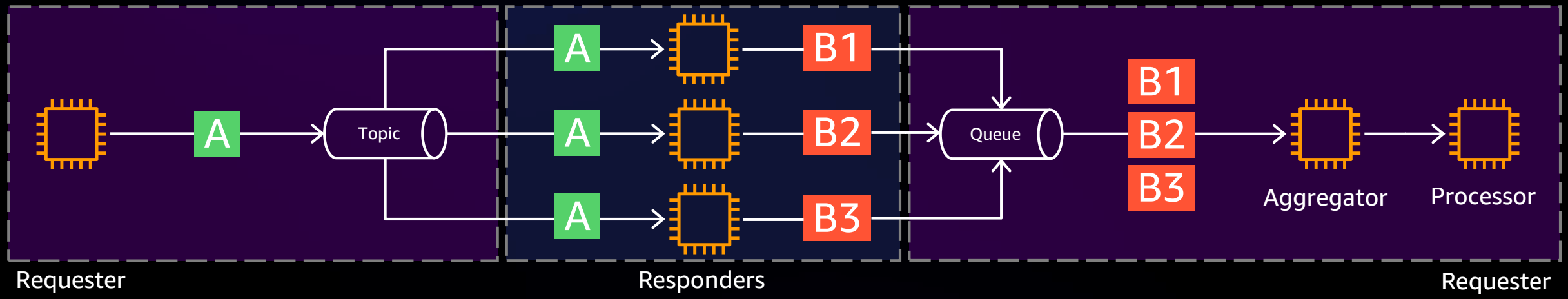
How to distribute a request to relevant/interested parties and capture their individual responses?

For election or parallel processing scenarios, i.e., search for best response or accumulate responses

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Message routing

Scatter-gather



How to distribute a request to relevant/interested parties and capture their individual responses?

For election or parallel processing scenarios, i.e., search for best response or accumulate responses

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Use cases

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Context: Wild Rydes, Inc.



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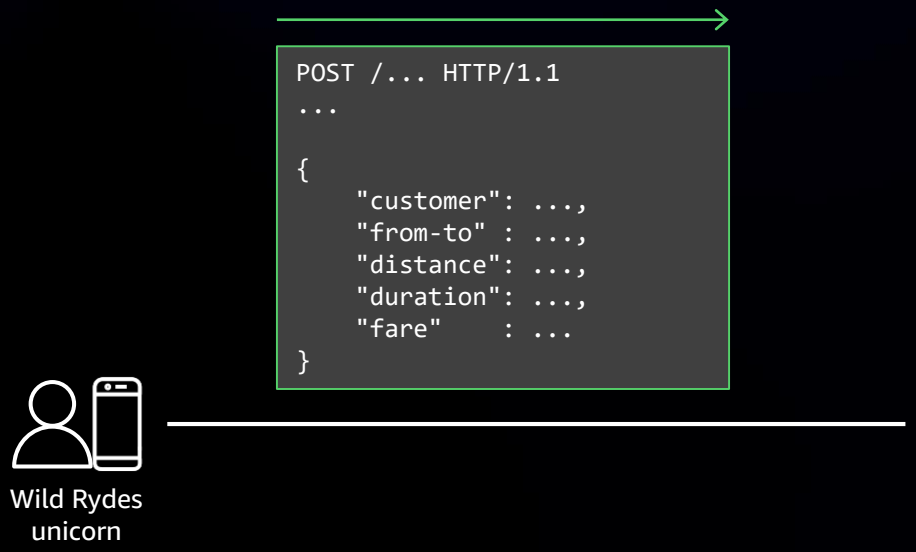


Wild Rydes unicorn

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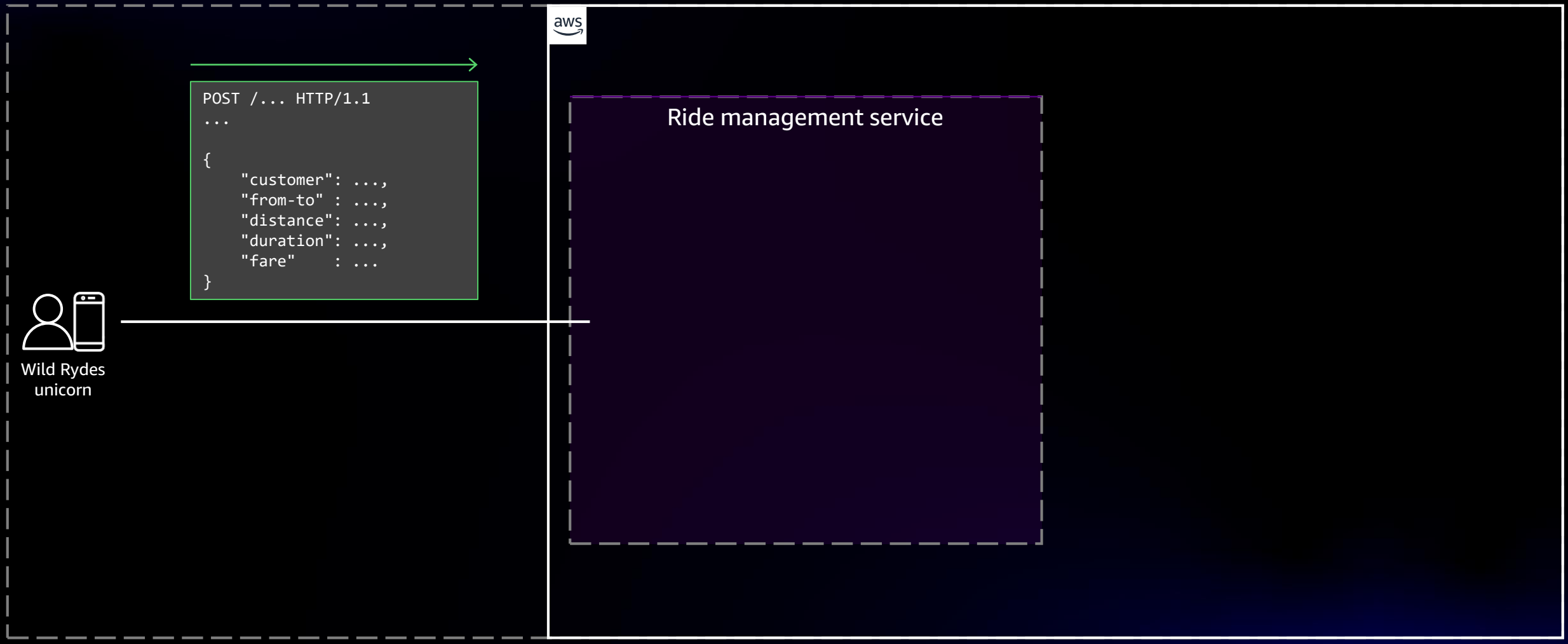
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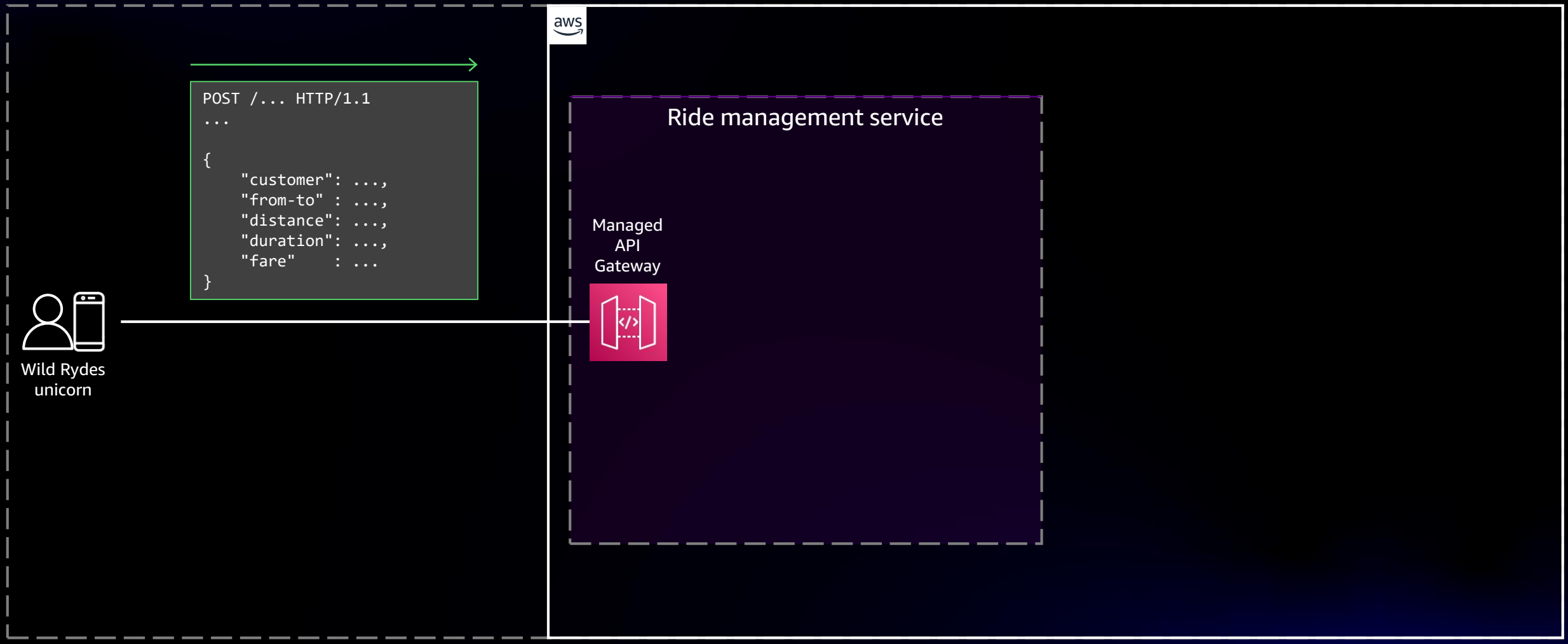
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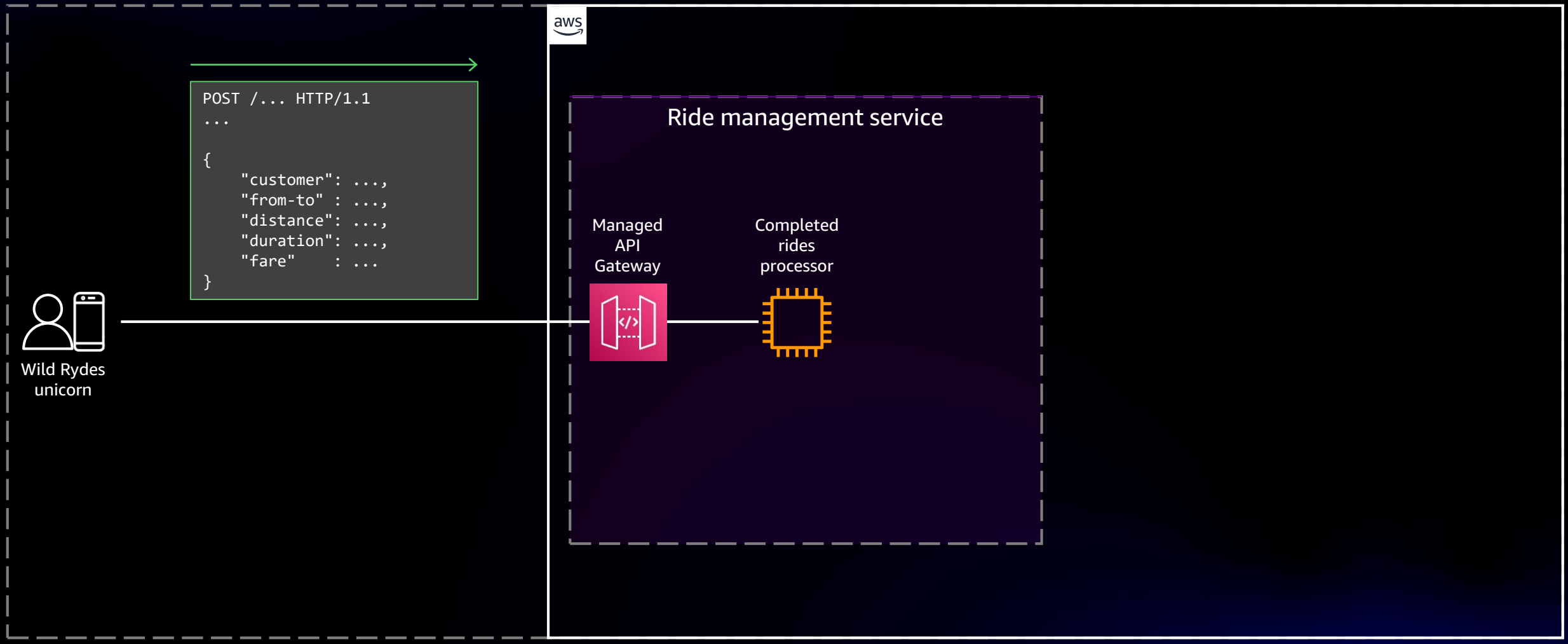


aws

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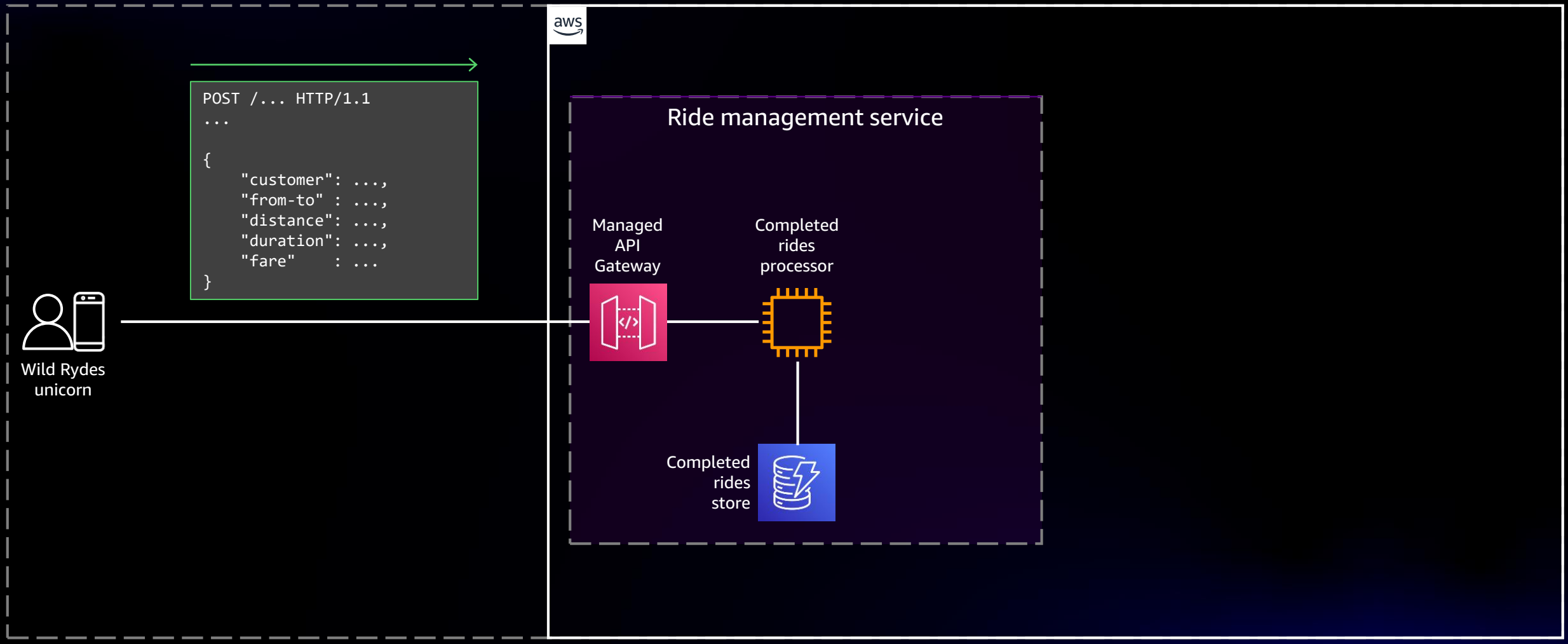
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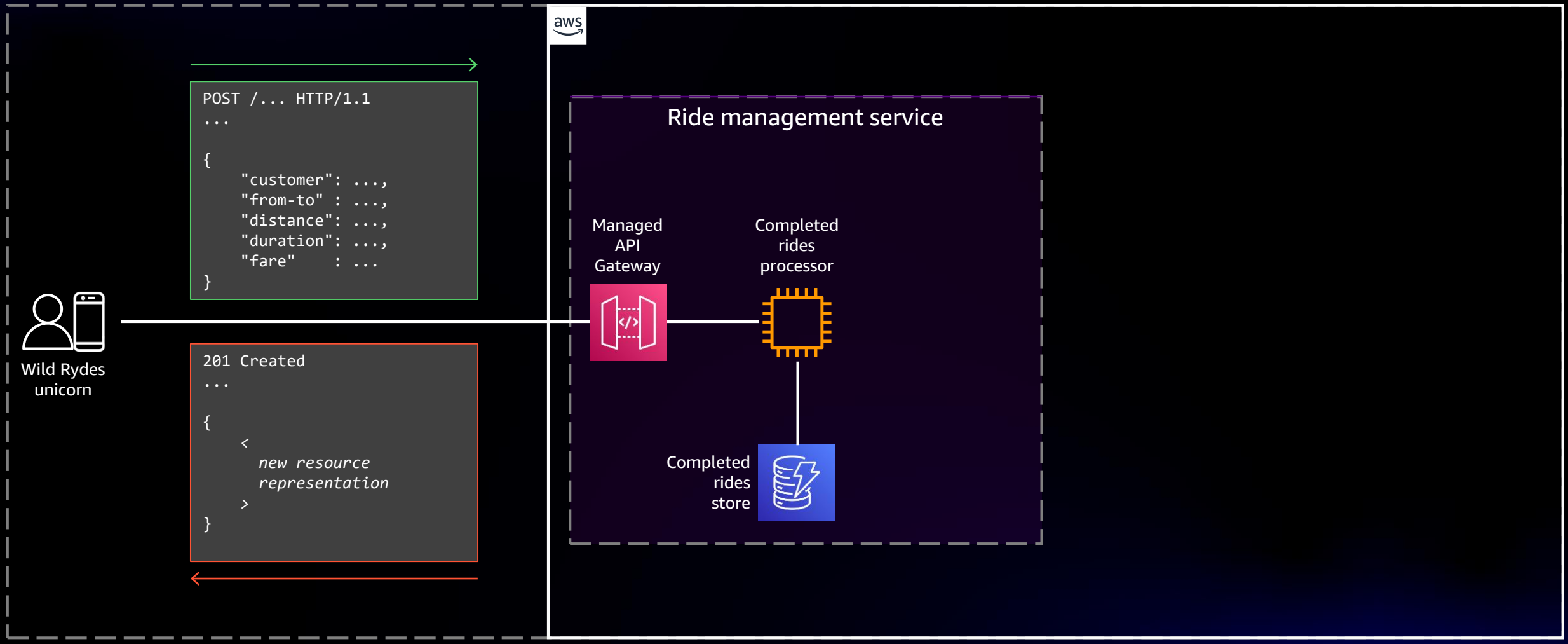
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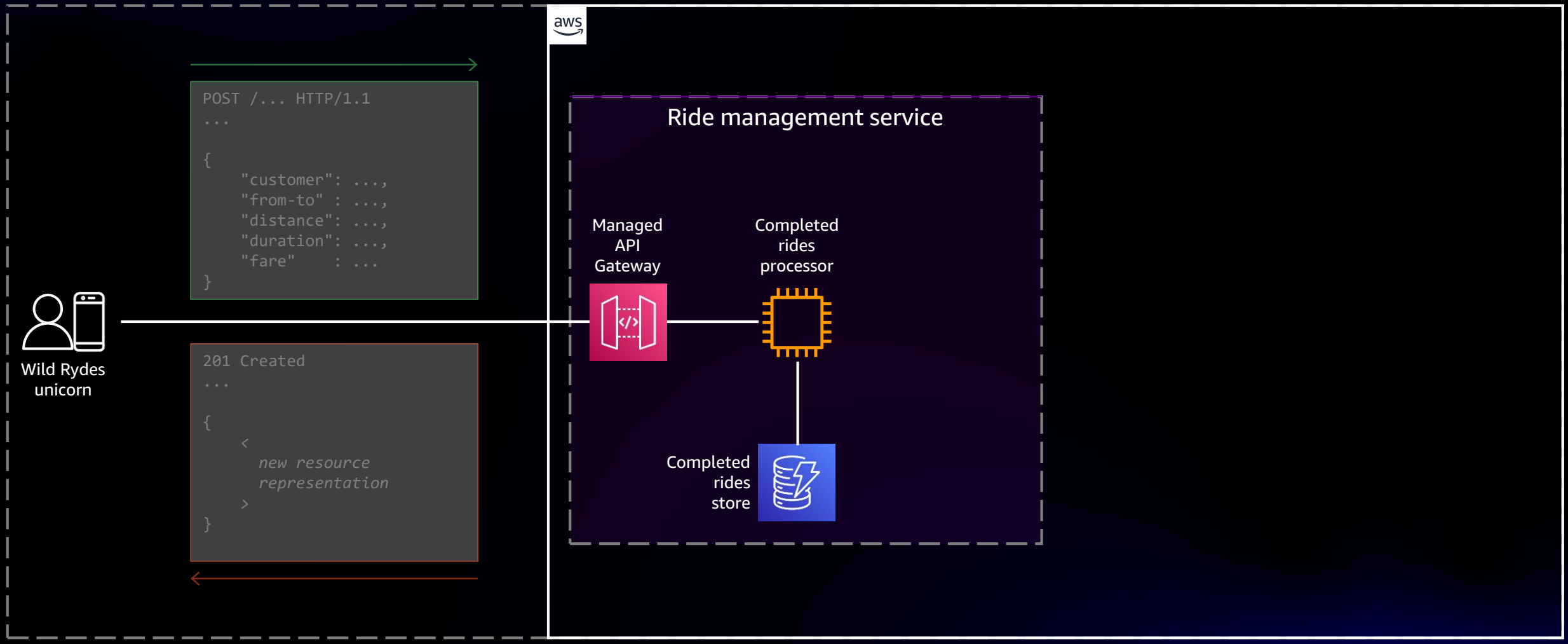
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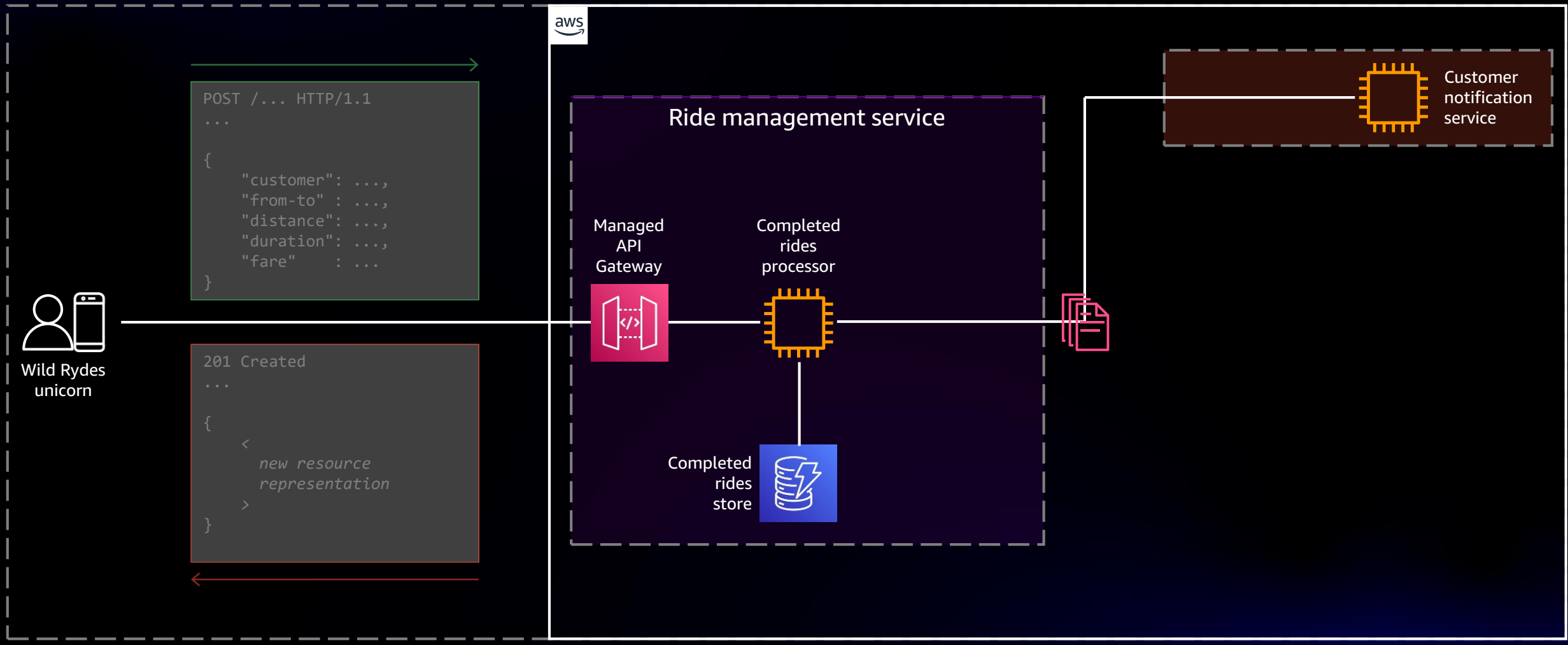
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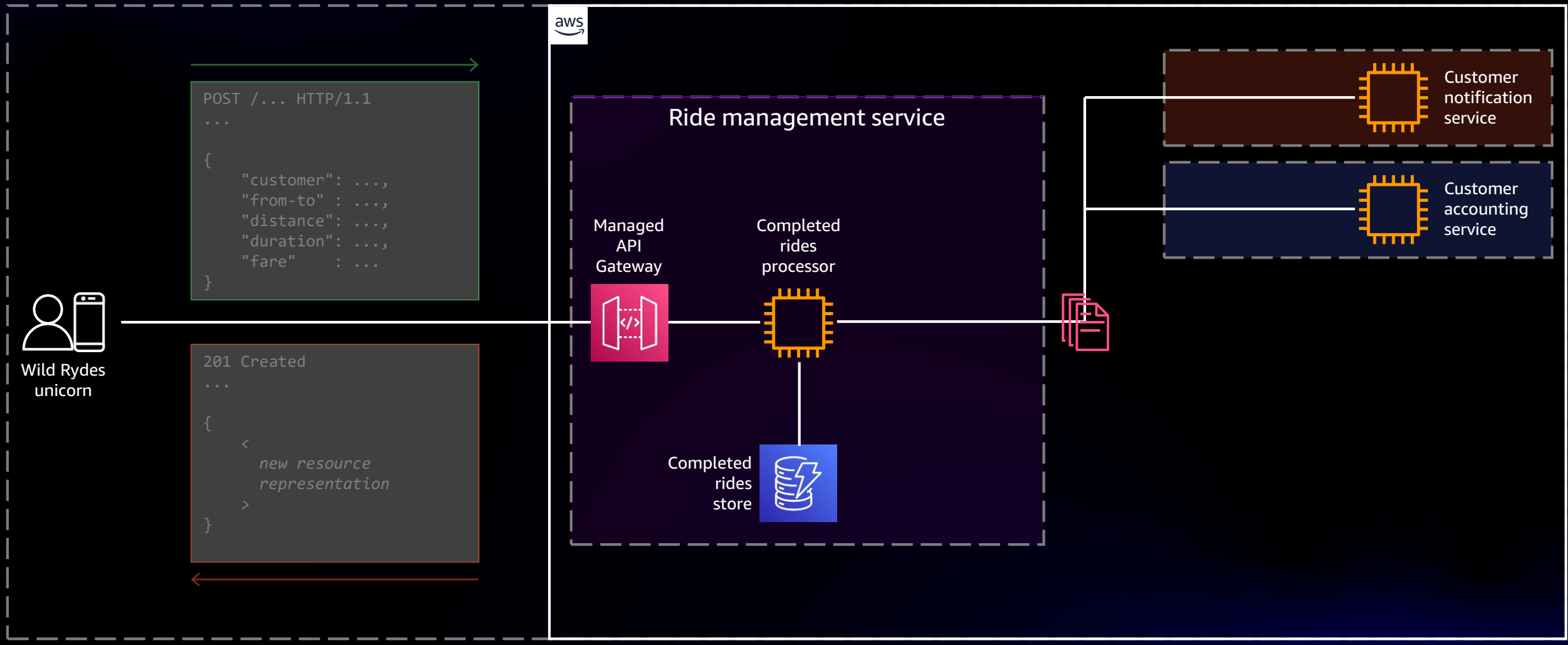


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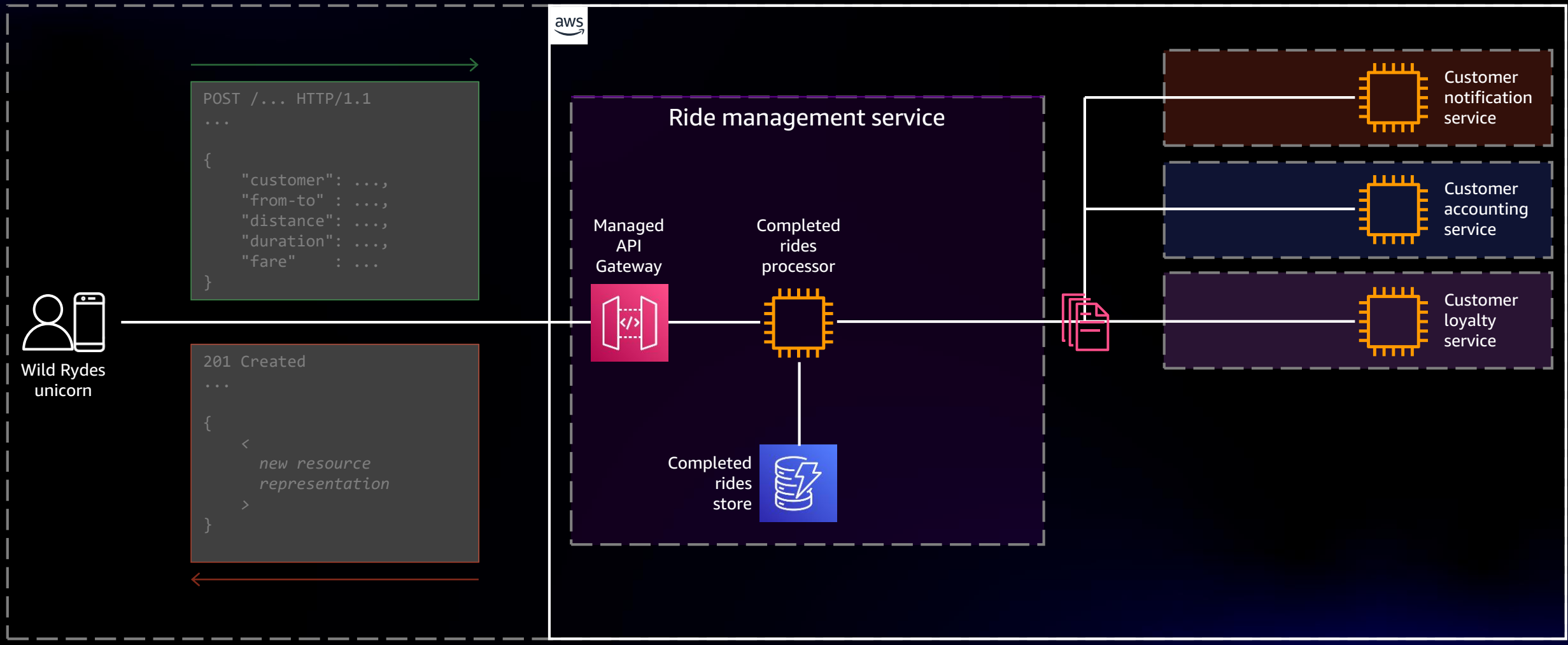
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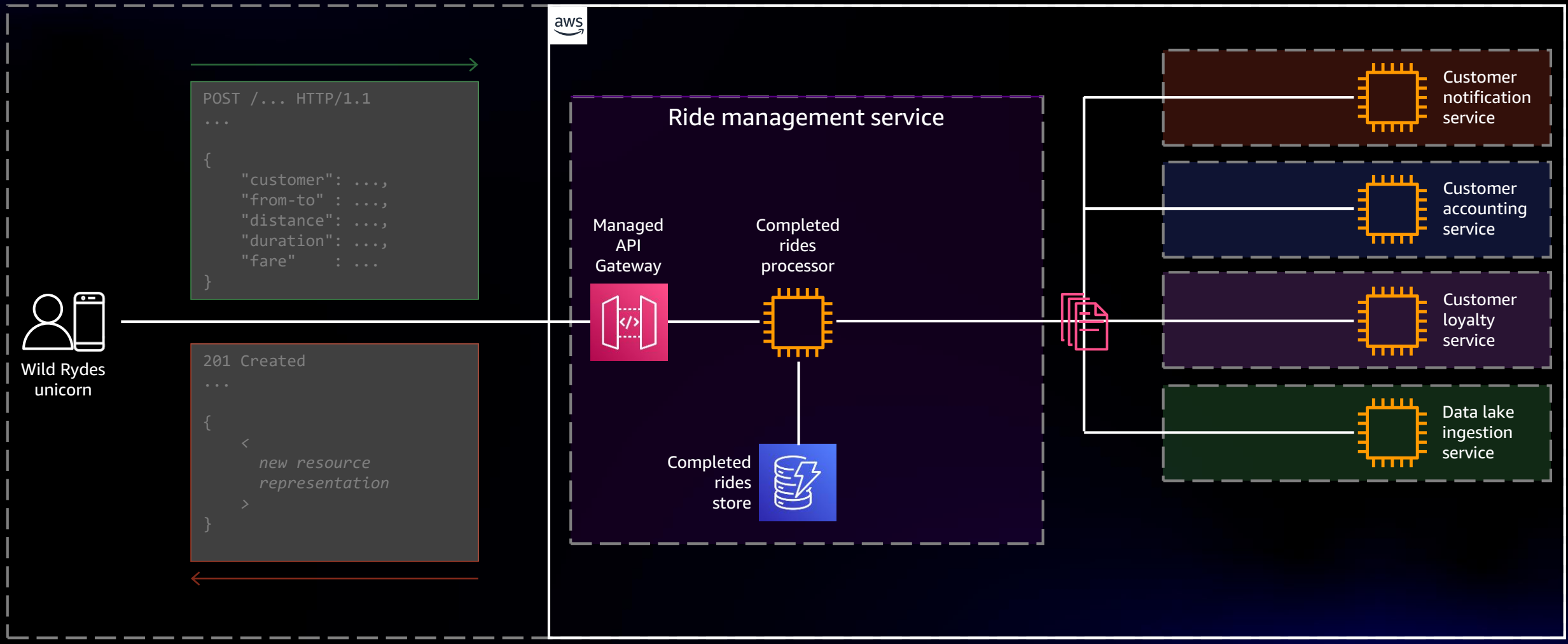
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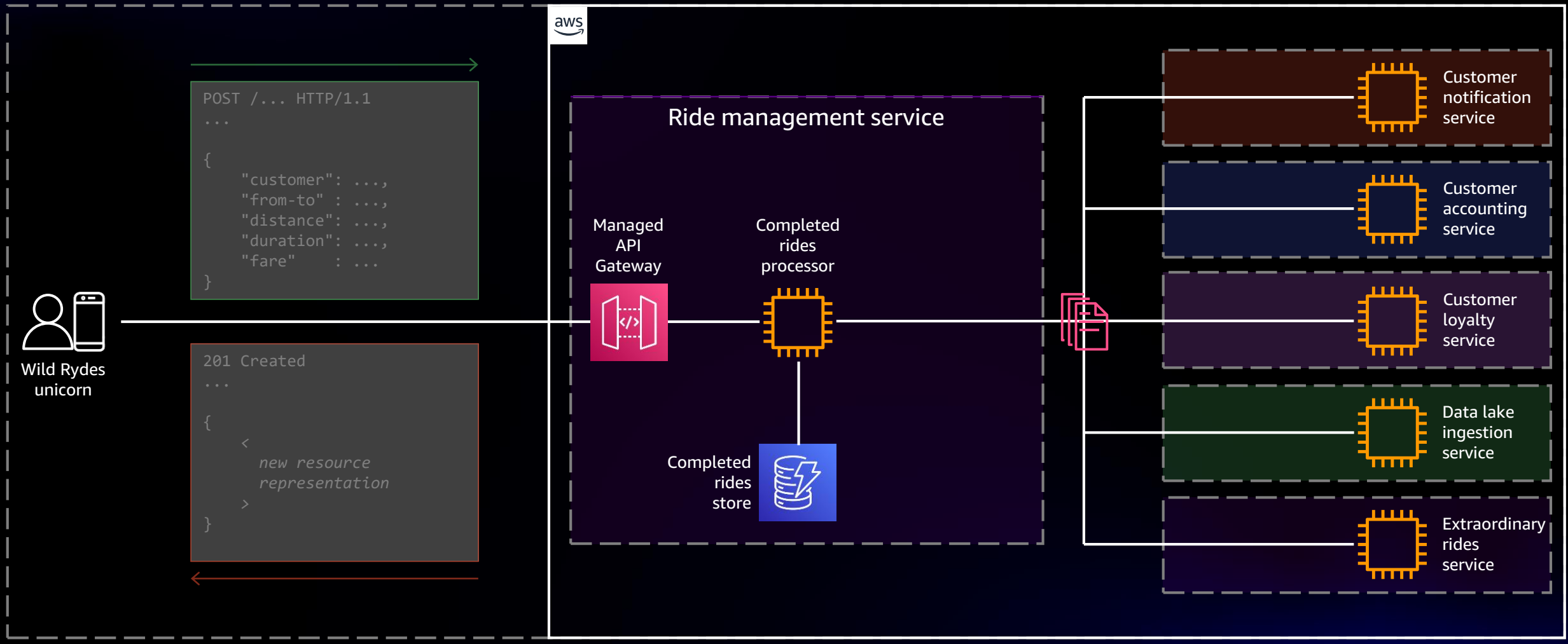
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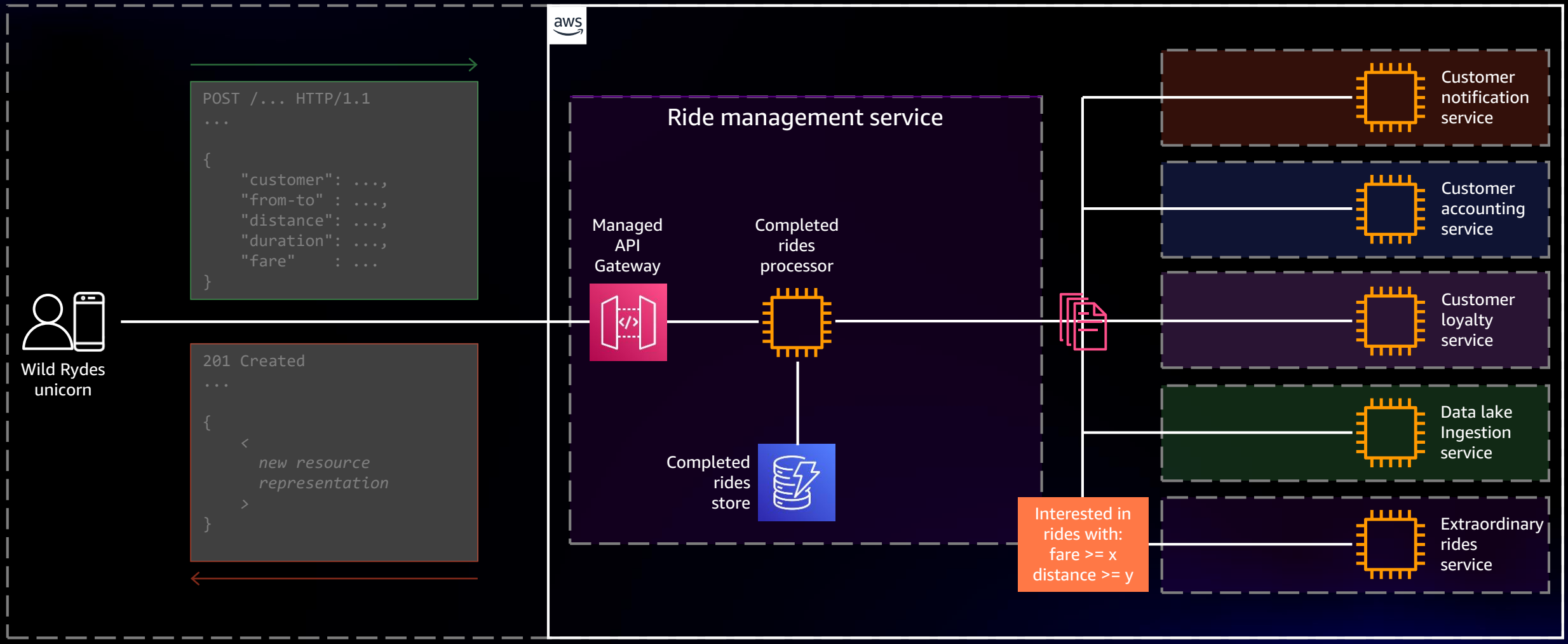
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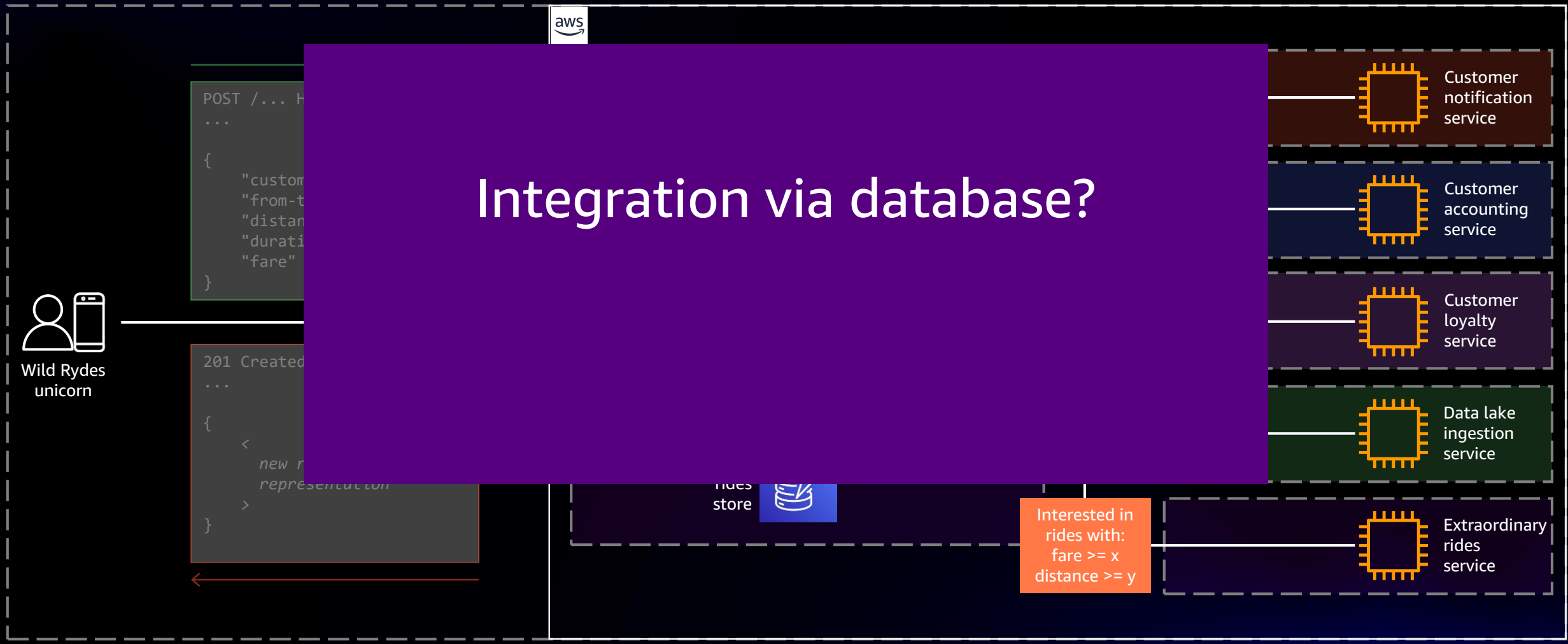
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Integration via database?

Oh my!

store

Interested in rides with:
fare >= x
distance >= y

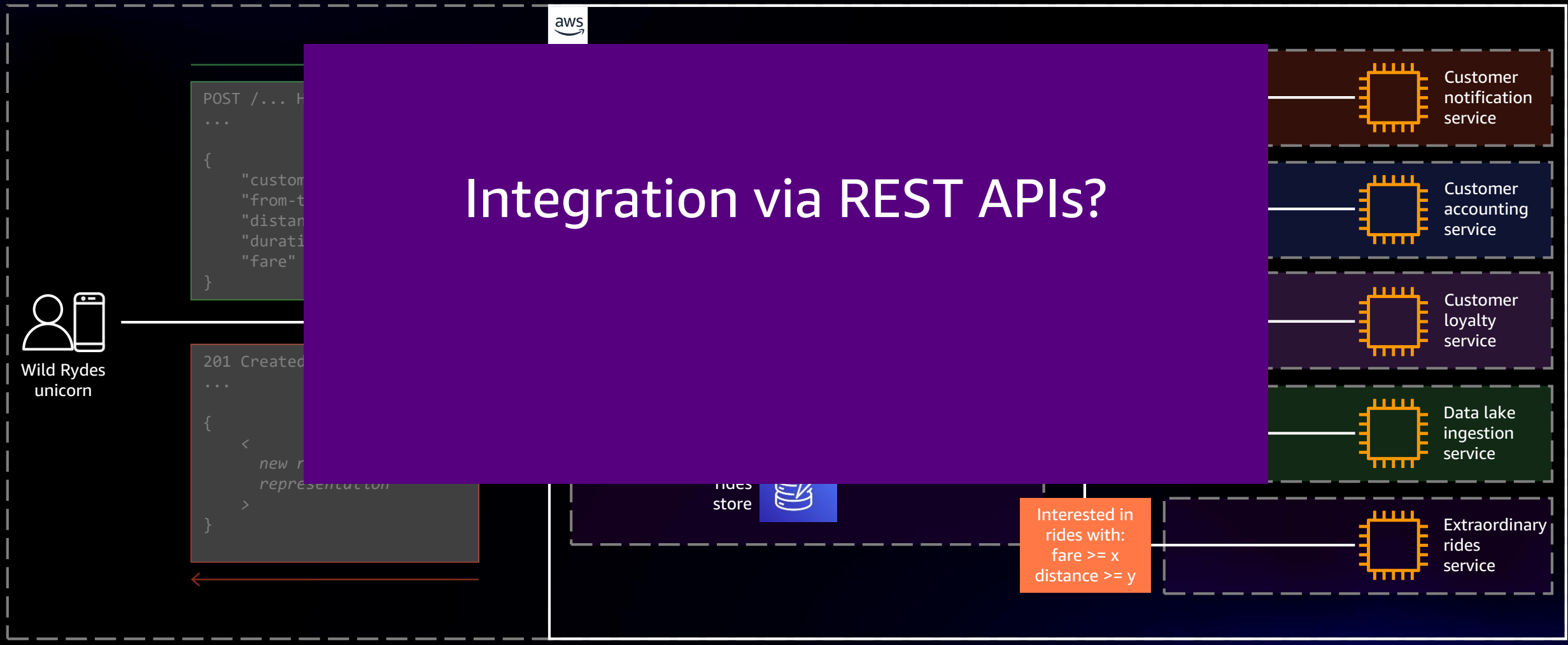


Photo: Dirk Fröhner

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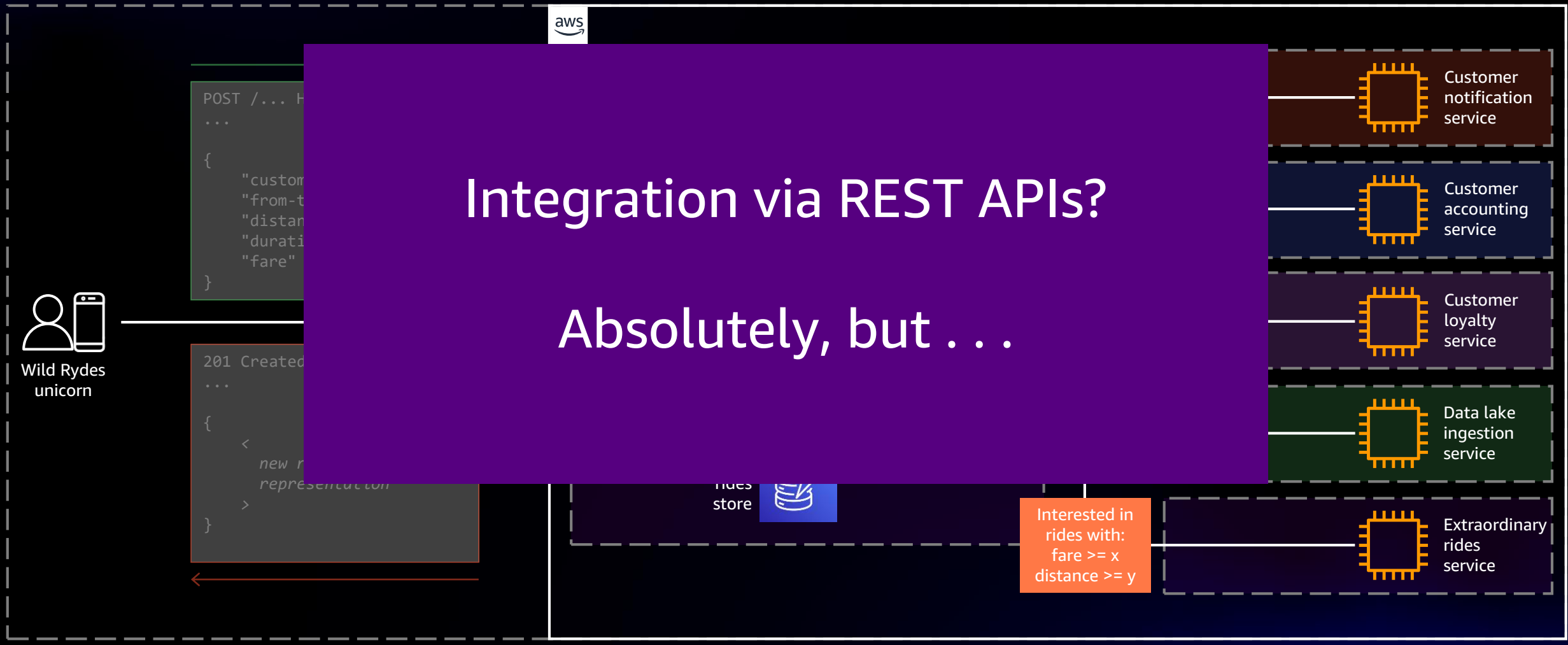
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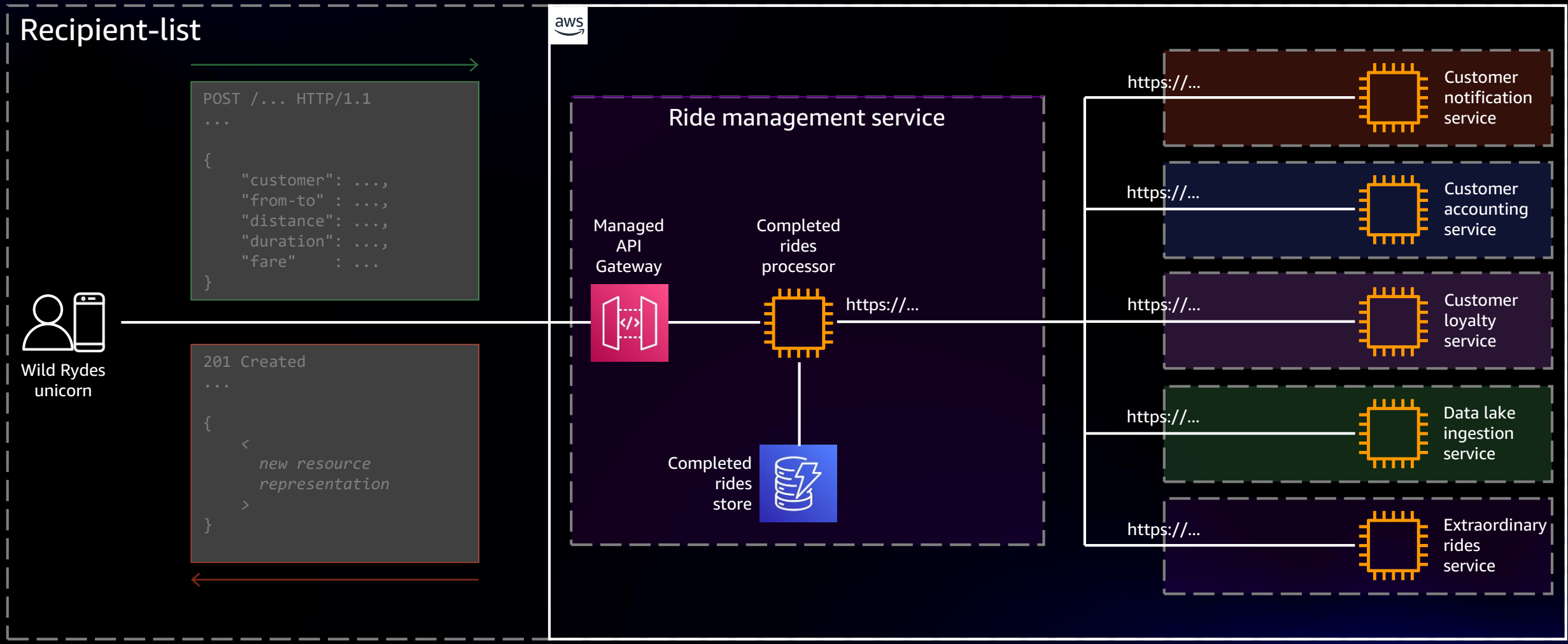
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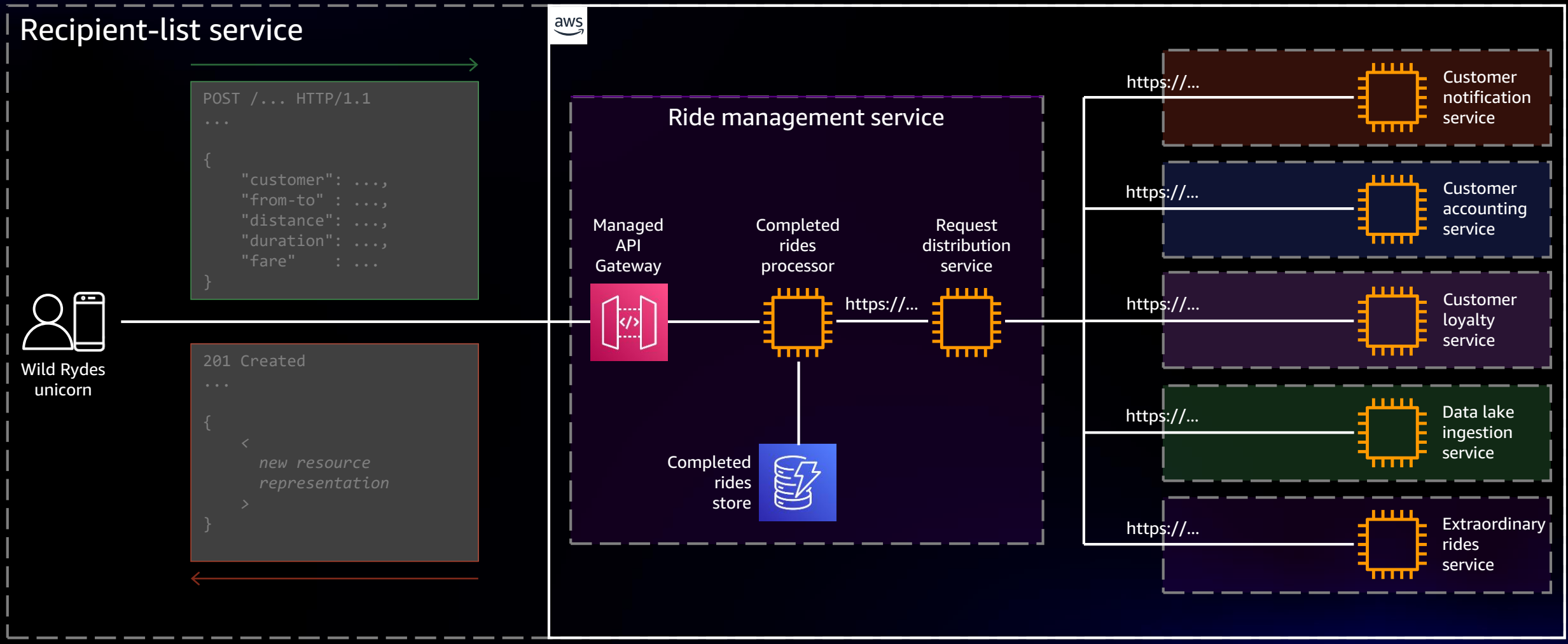
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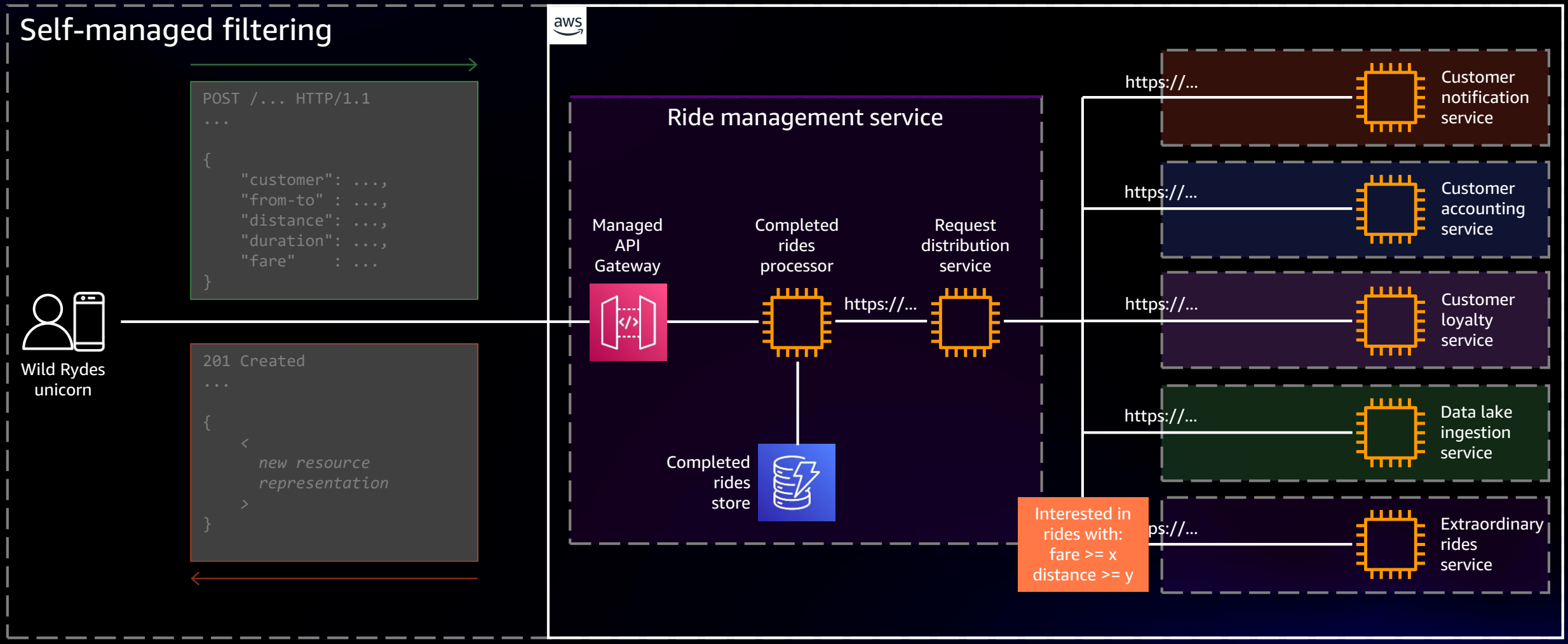
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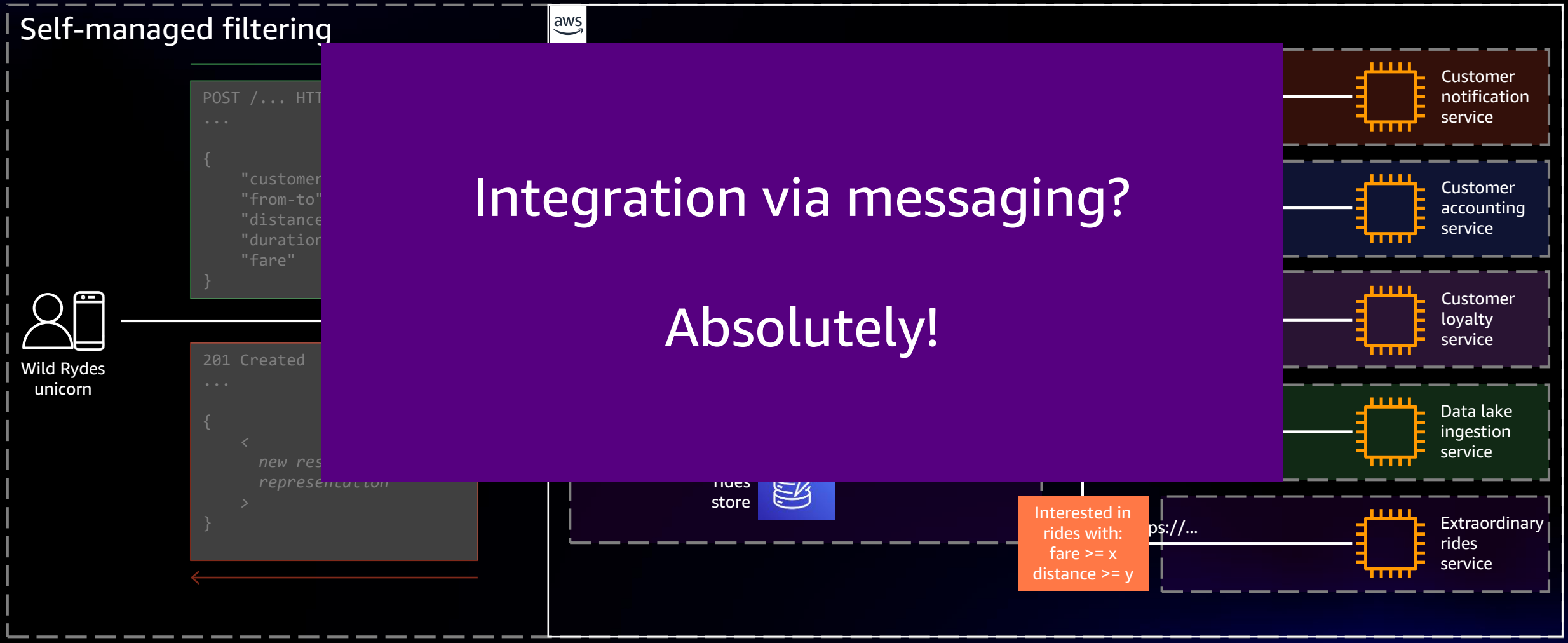
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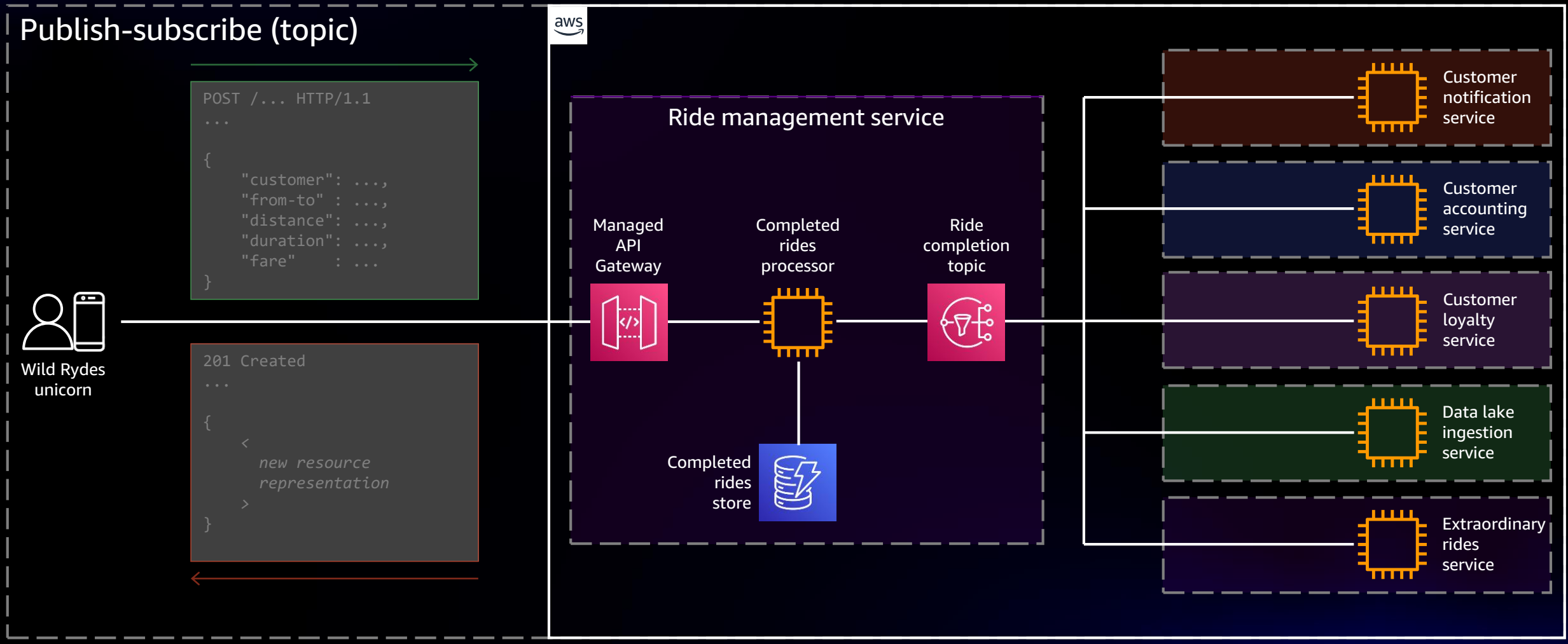
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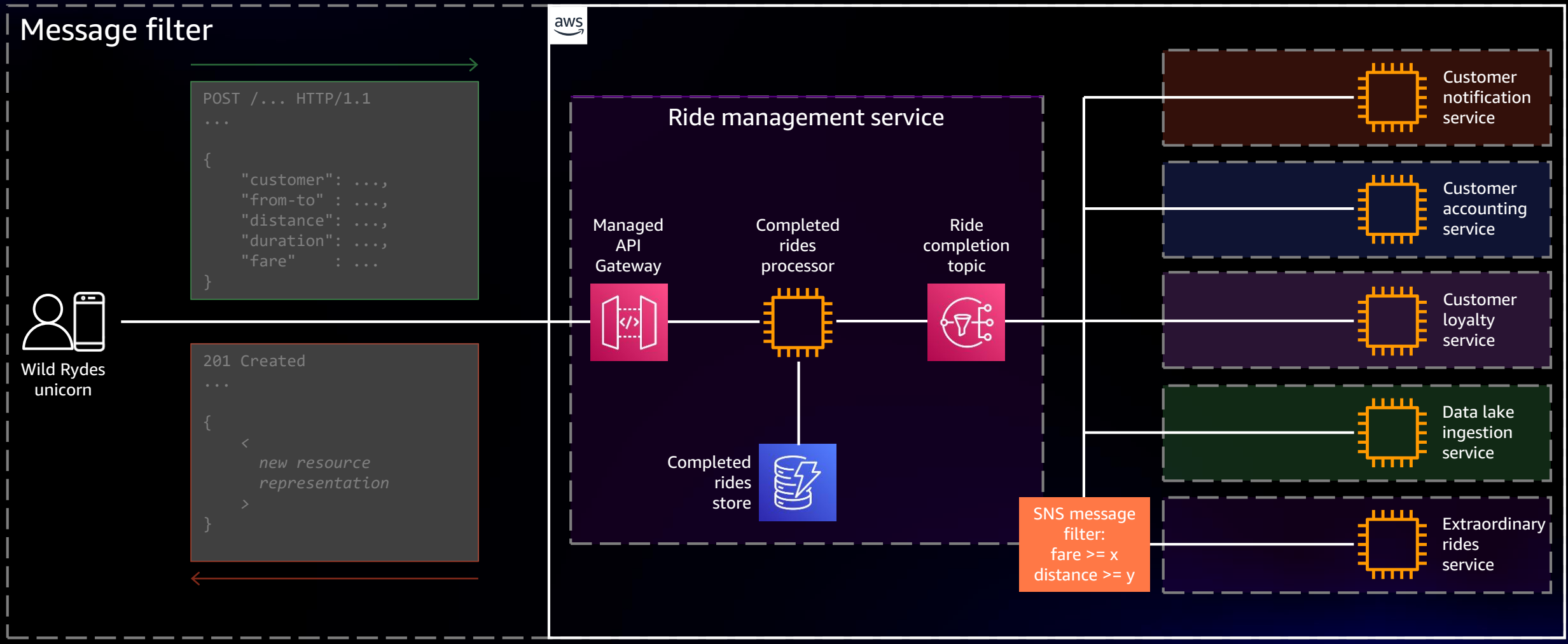
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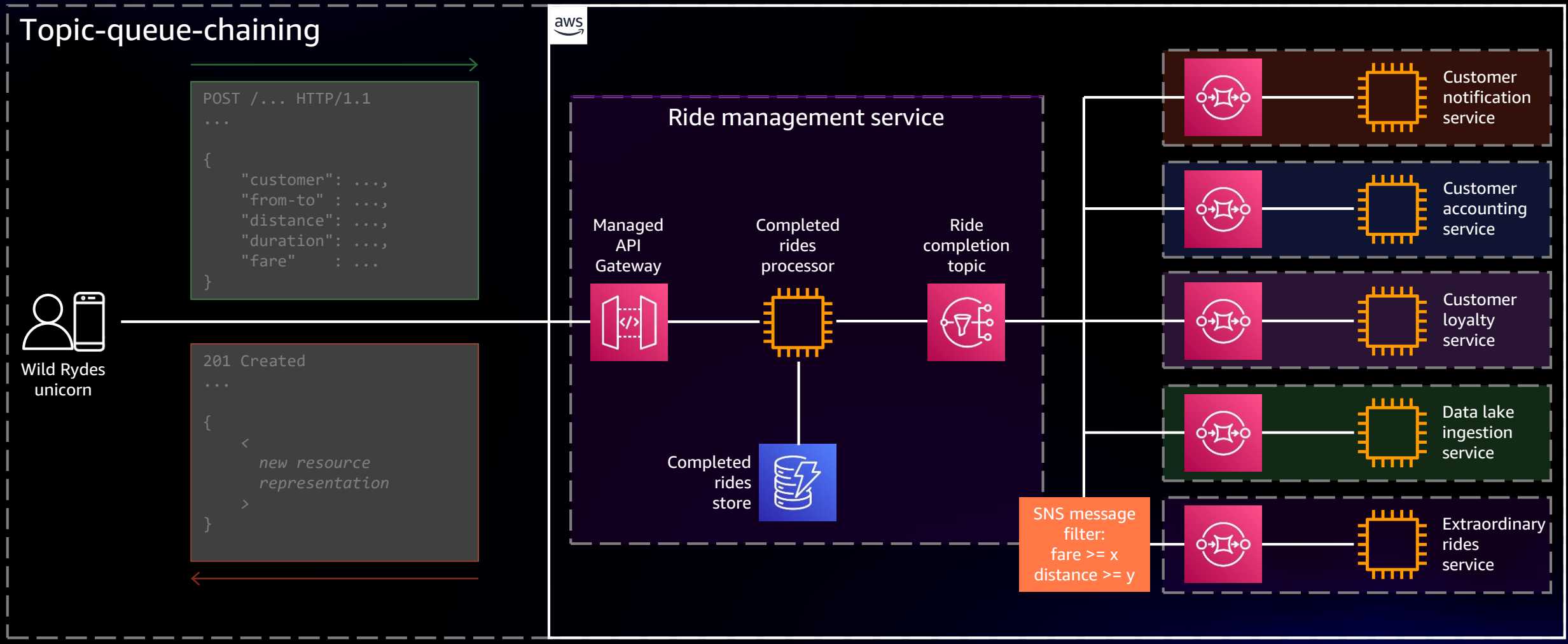
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All at once

Massive campaign with CTA:

Book this week!

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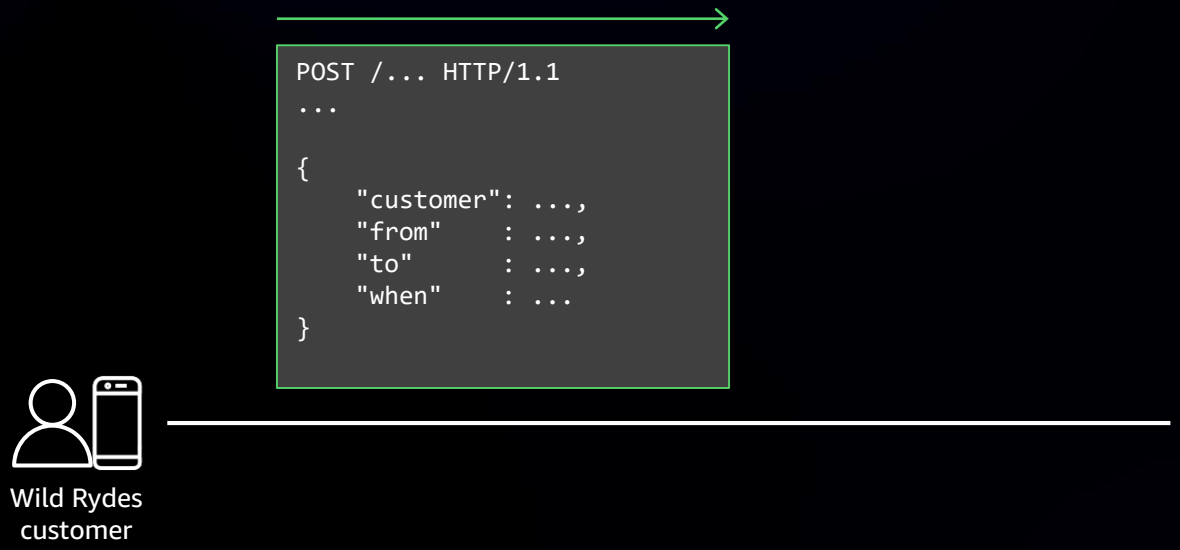
Wild Rydes customer

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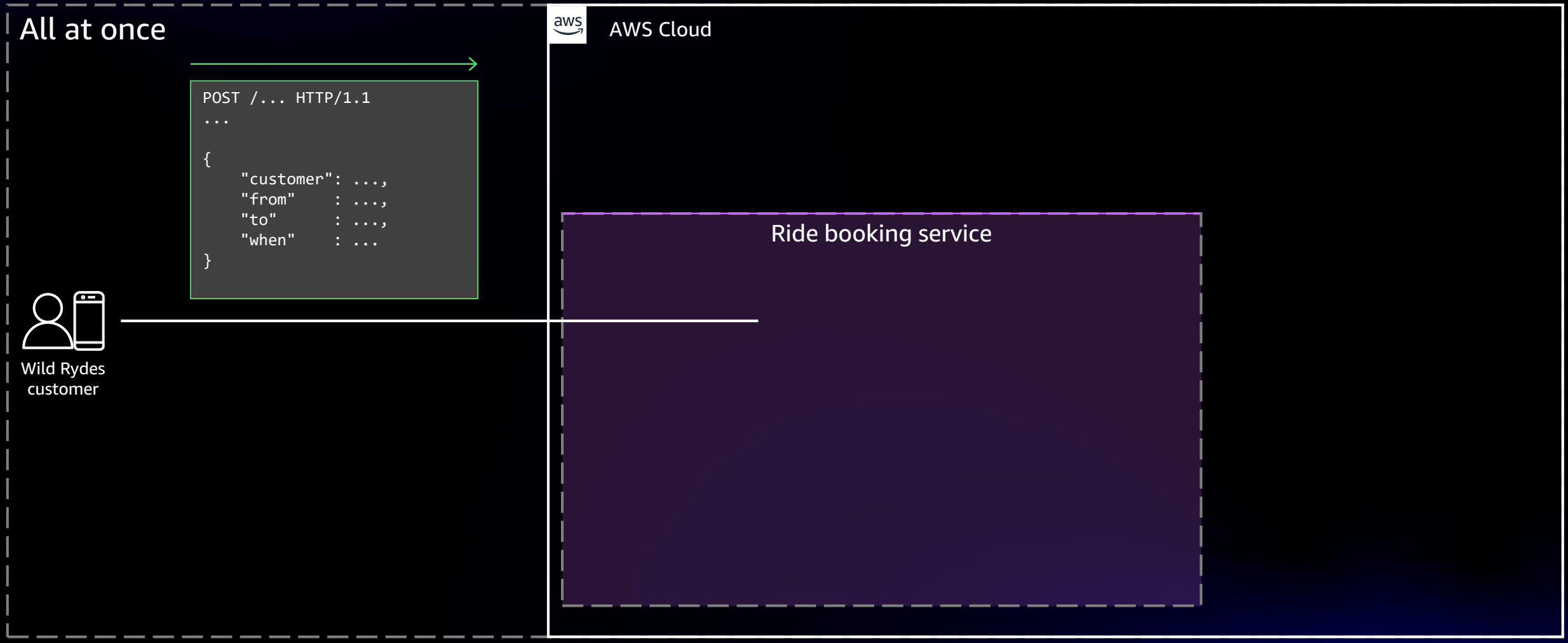
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Prebooking campaigns

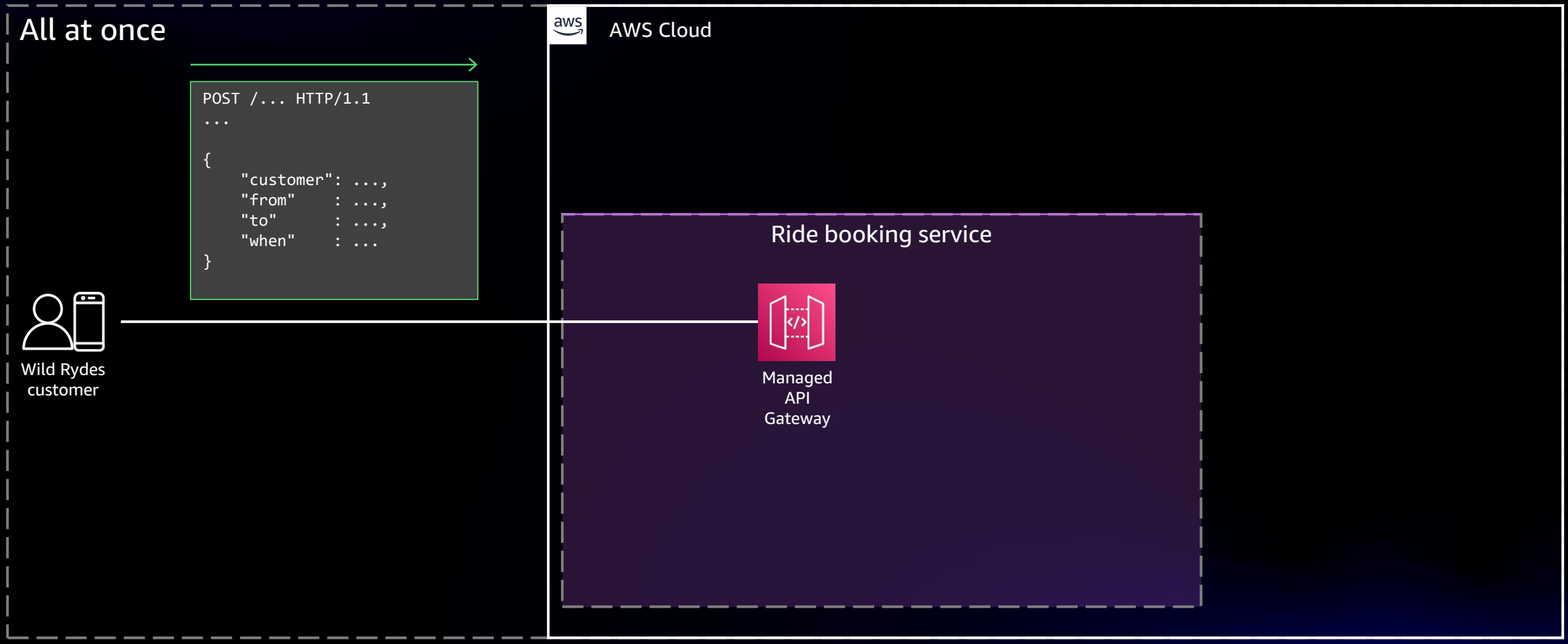
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Prebooking campaigns

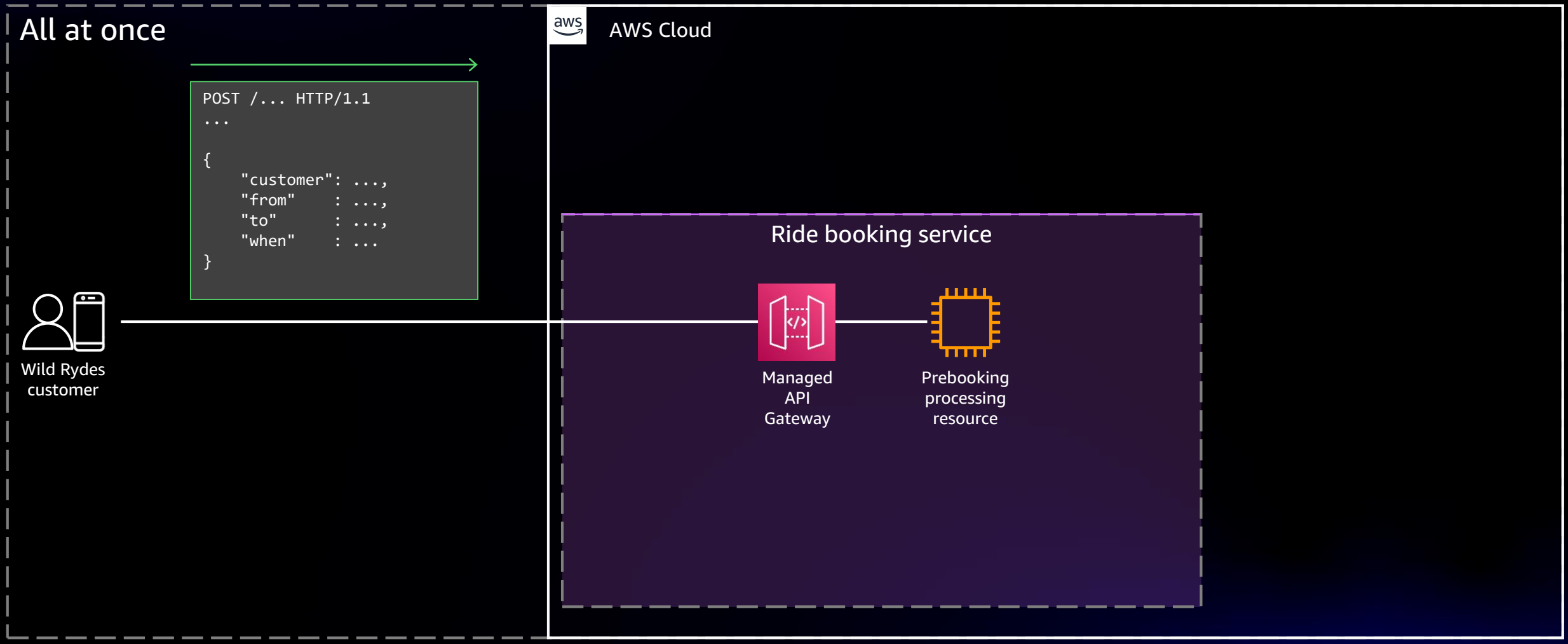
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Prebooking campaigns

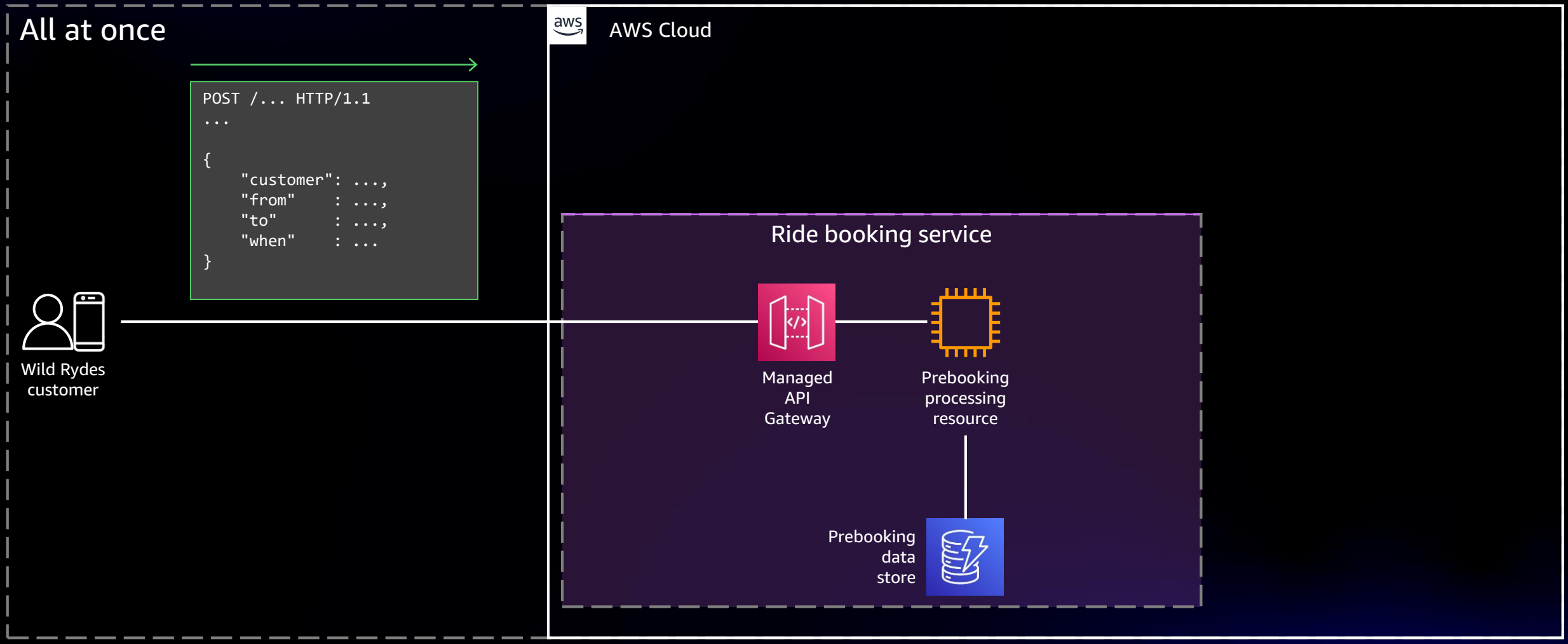
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Prebooking campaigns

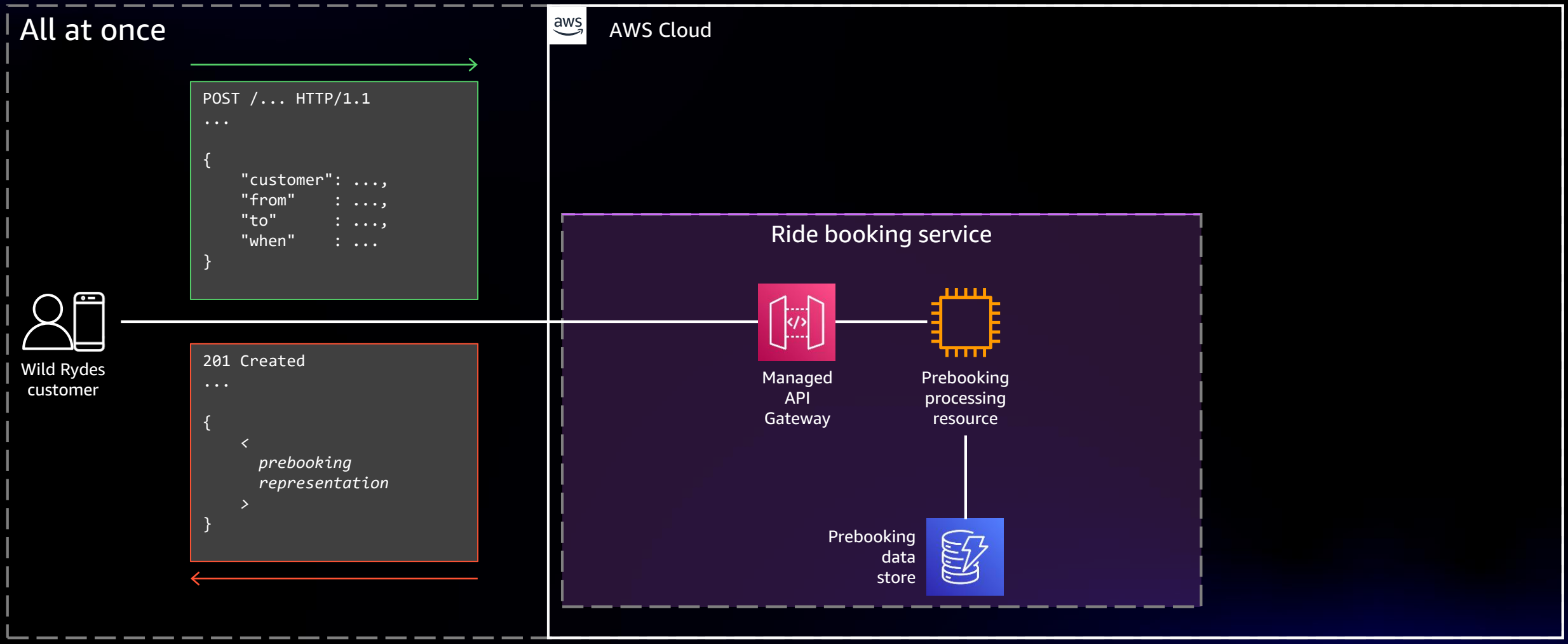
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Prebooking campaigns

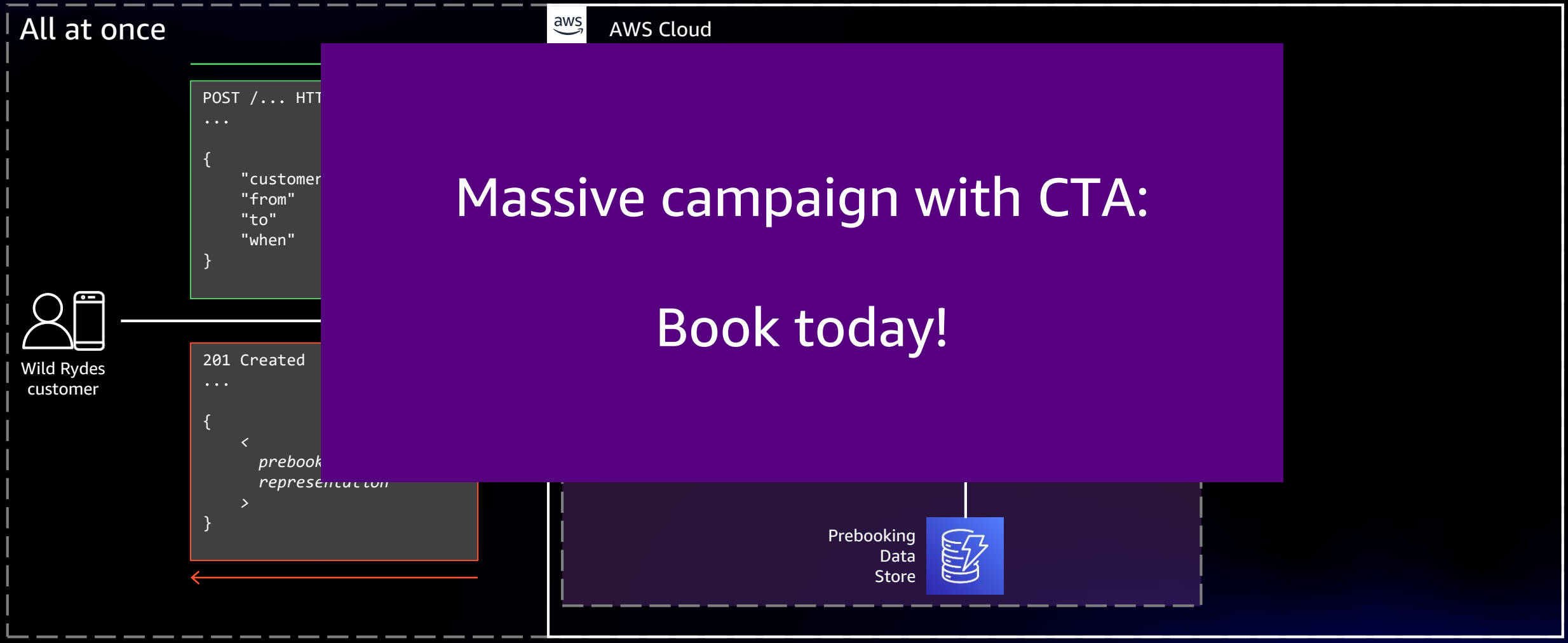
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Internal decoupling



Wild Rydes customer

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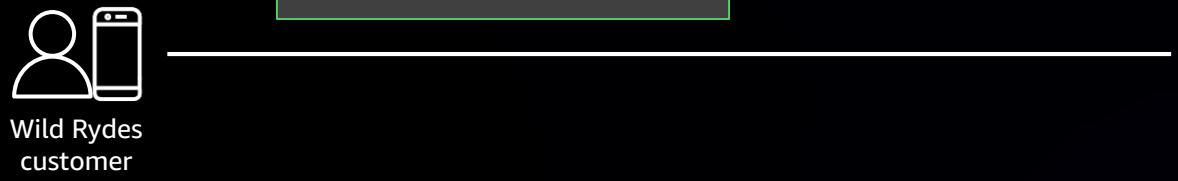
Prebooking campaigns

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Internal decoupling

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POST /... HTTP/1.1
...

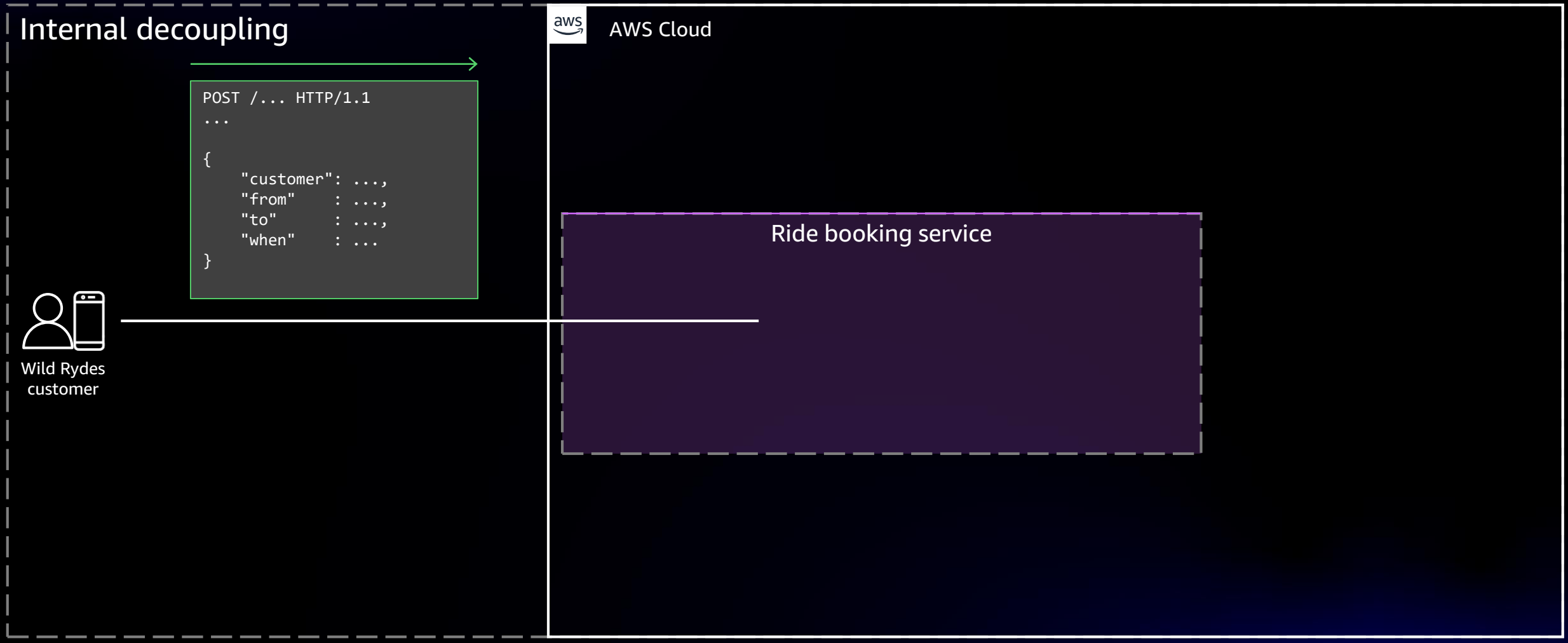
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    "customer": ...,
    "from"    : ...,
    "to"      : ...,
    "when"    : ...
}
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Prebooking campaigns

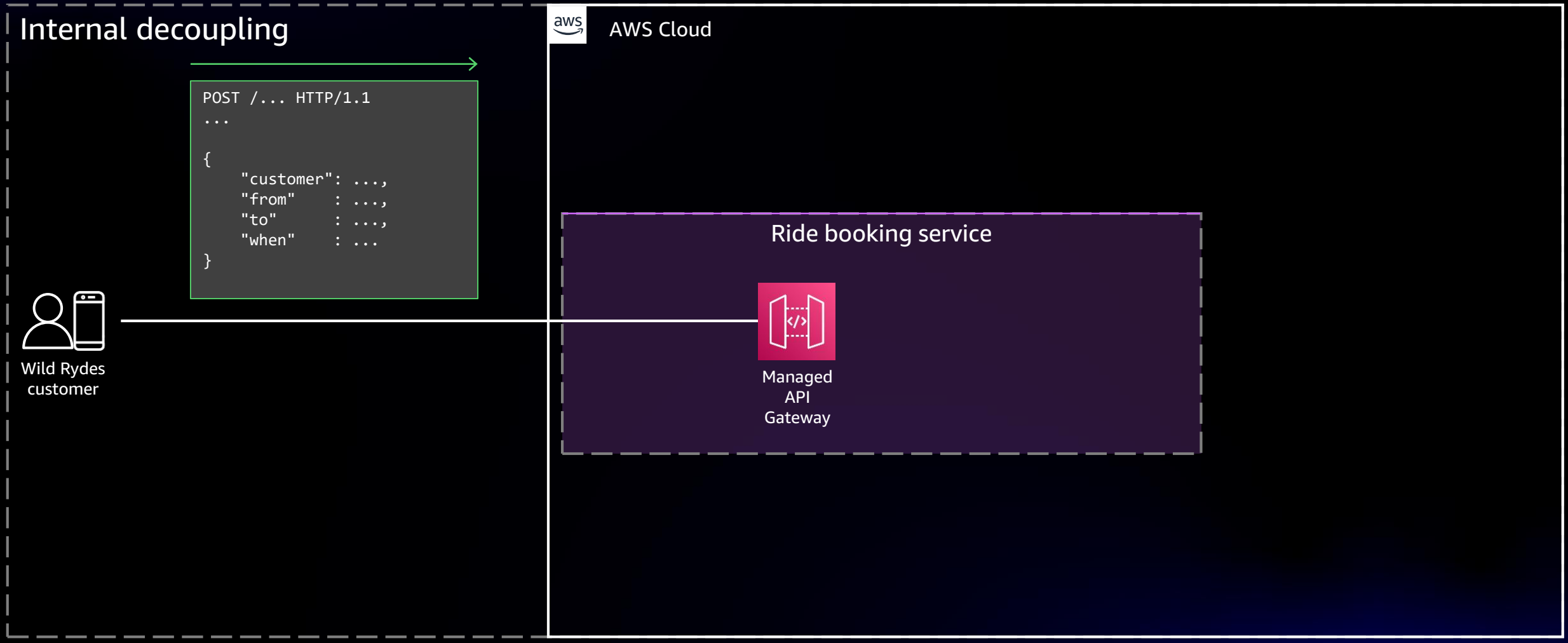
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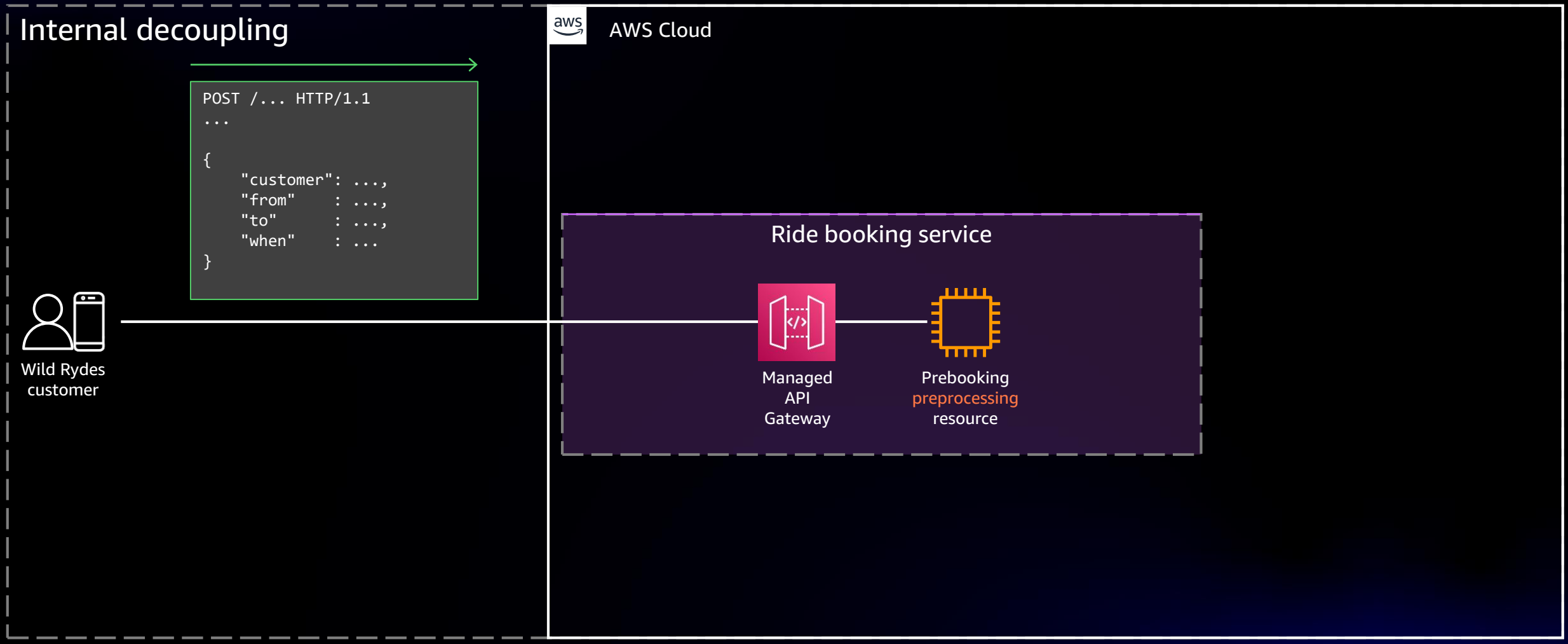
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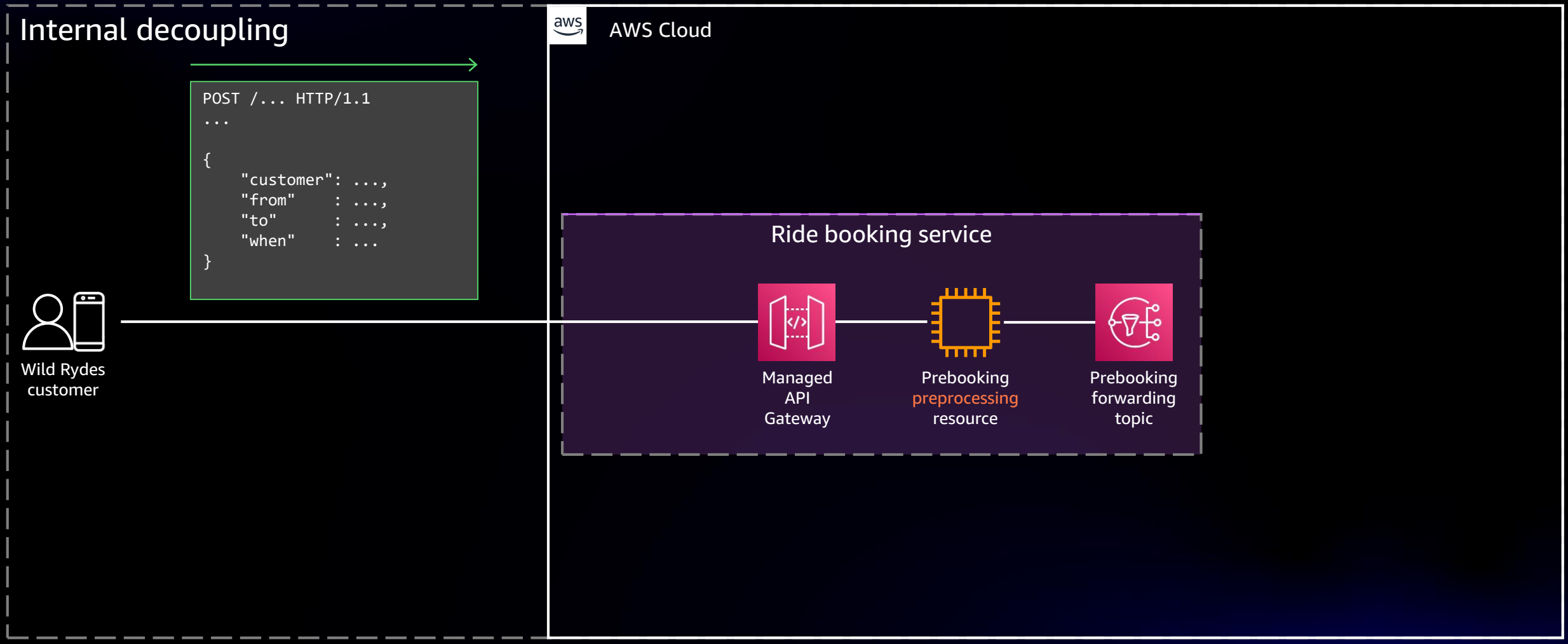
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Prebooking campaigns

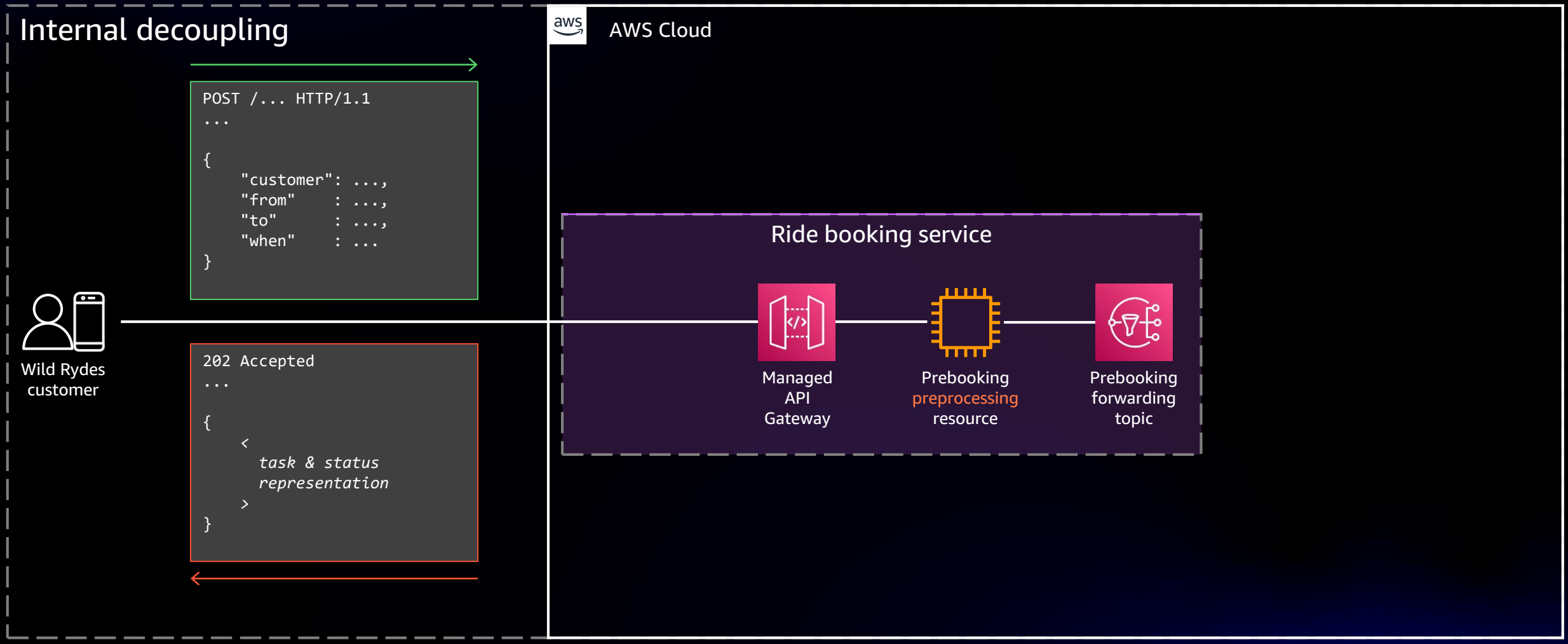
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Prebooking campaigns

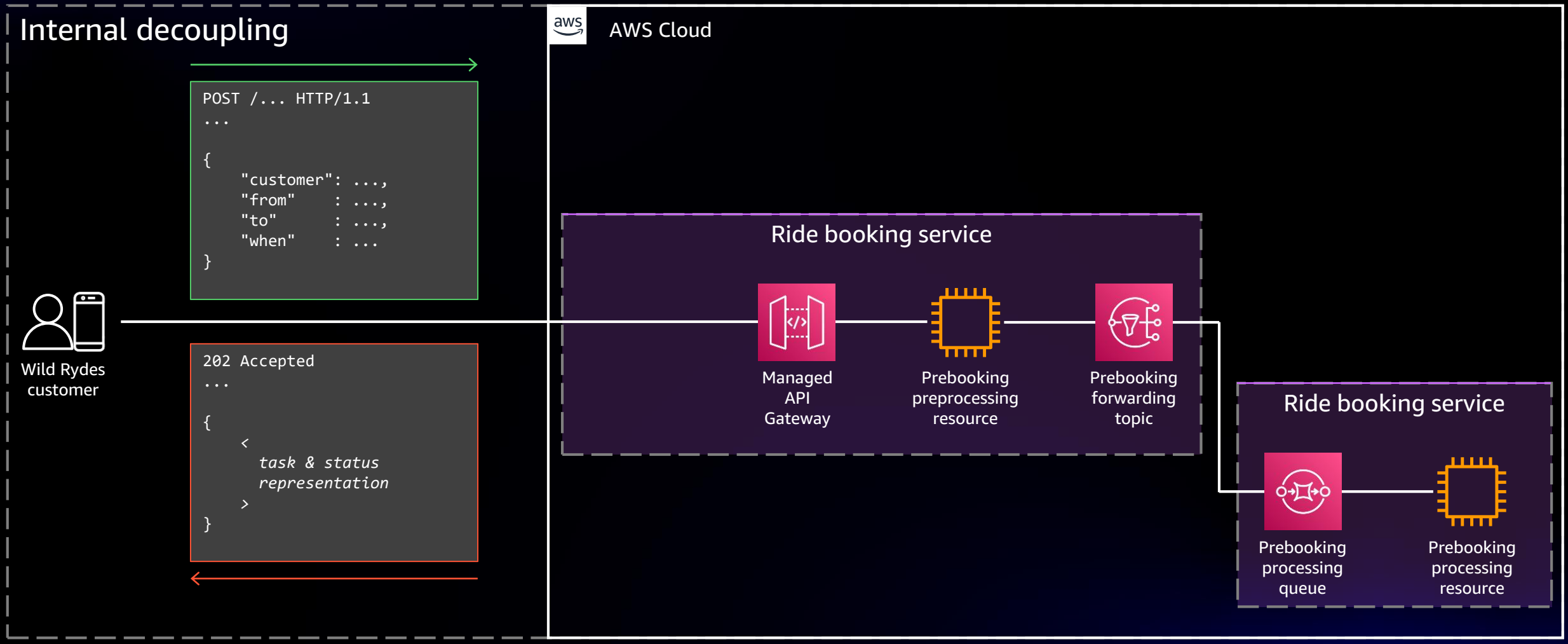
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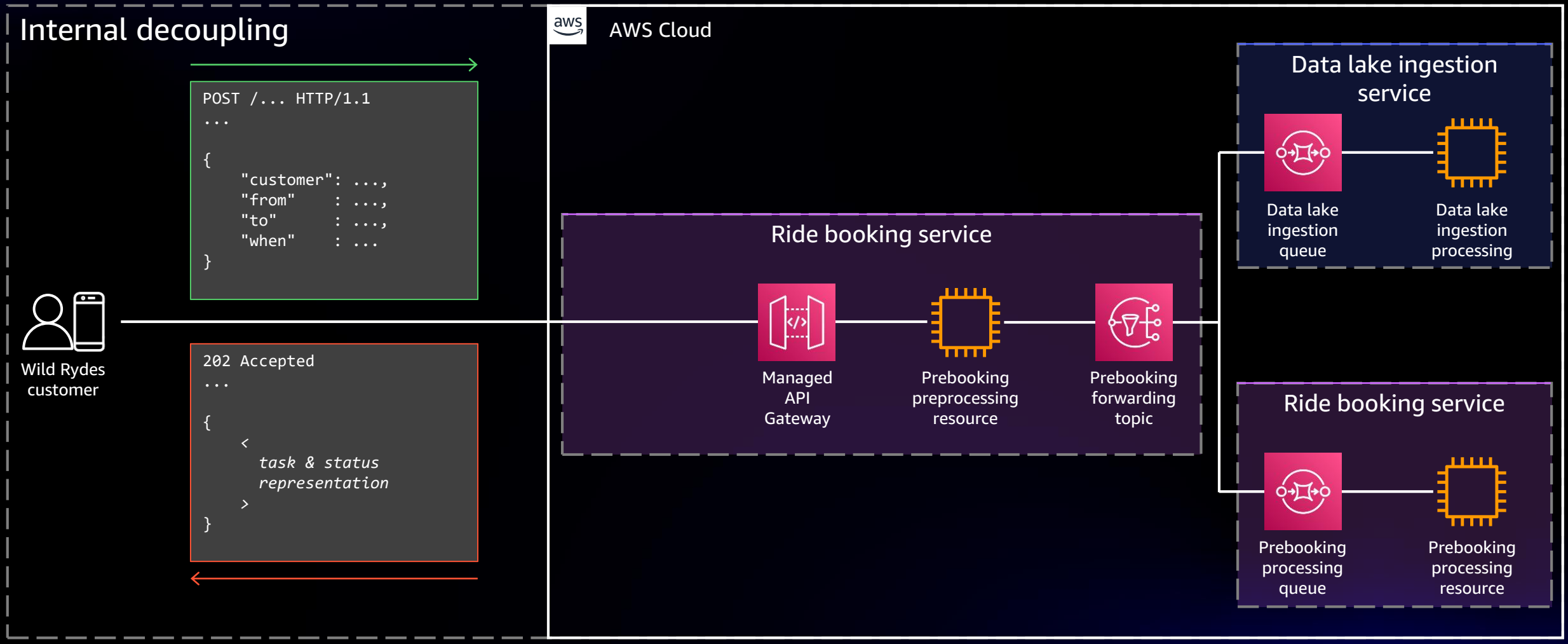
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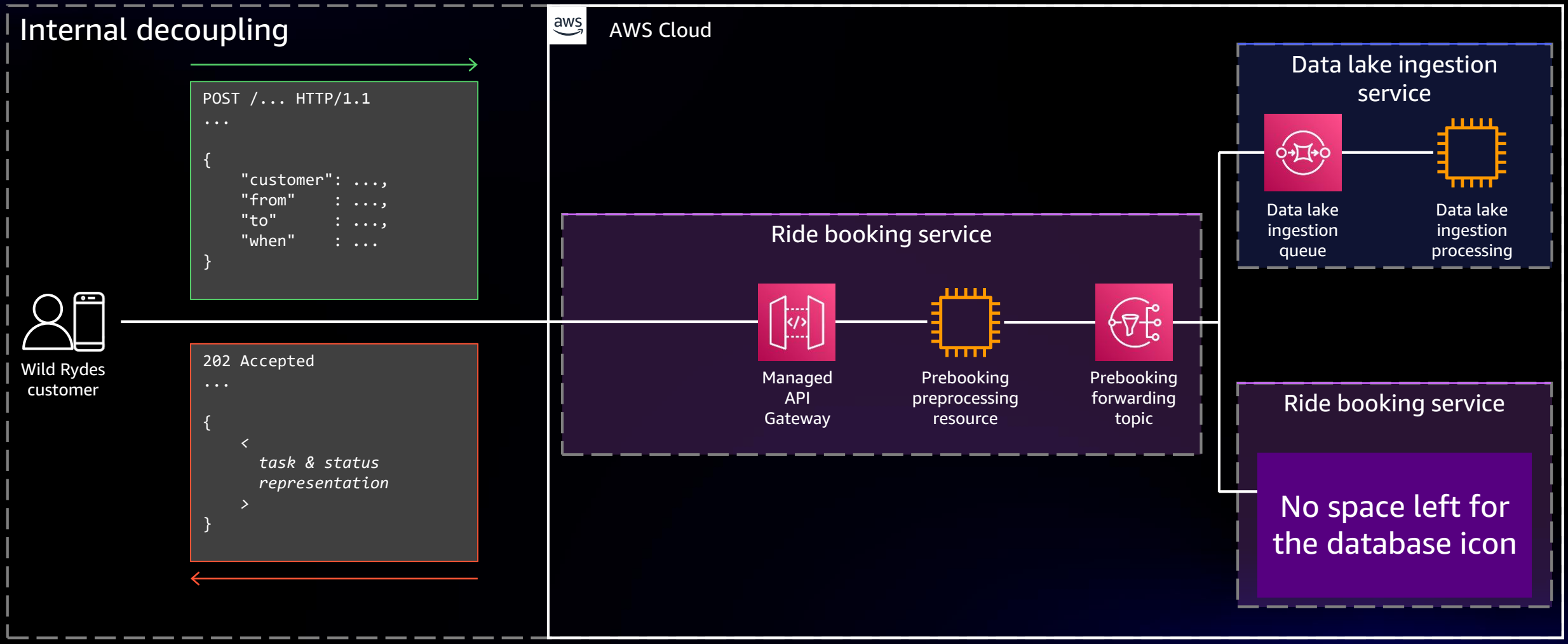
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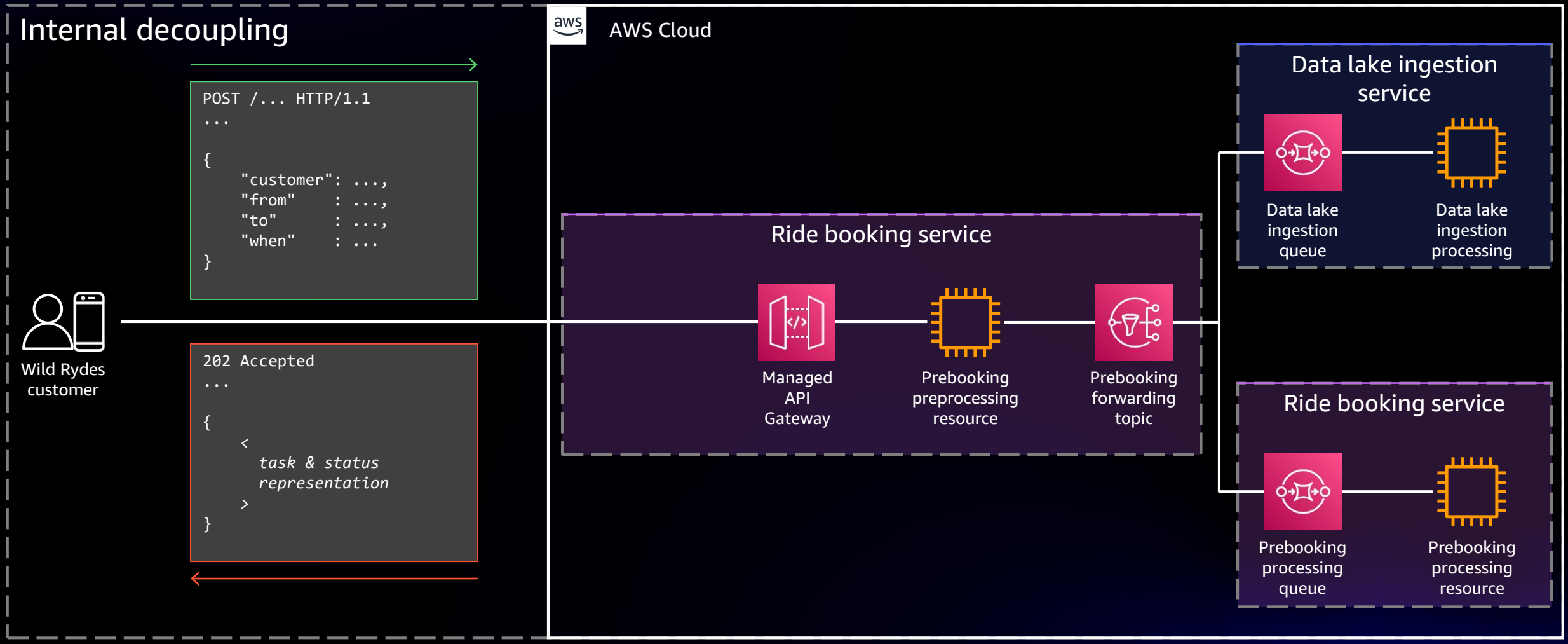
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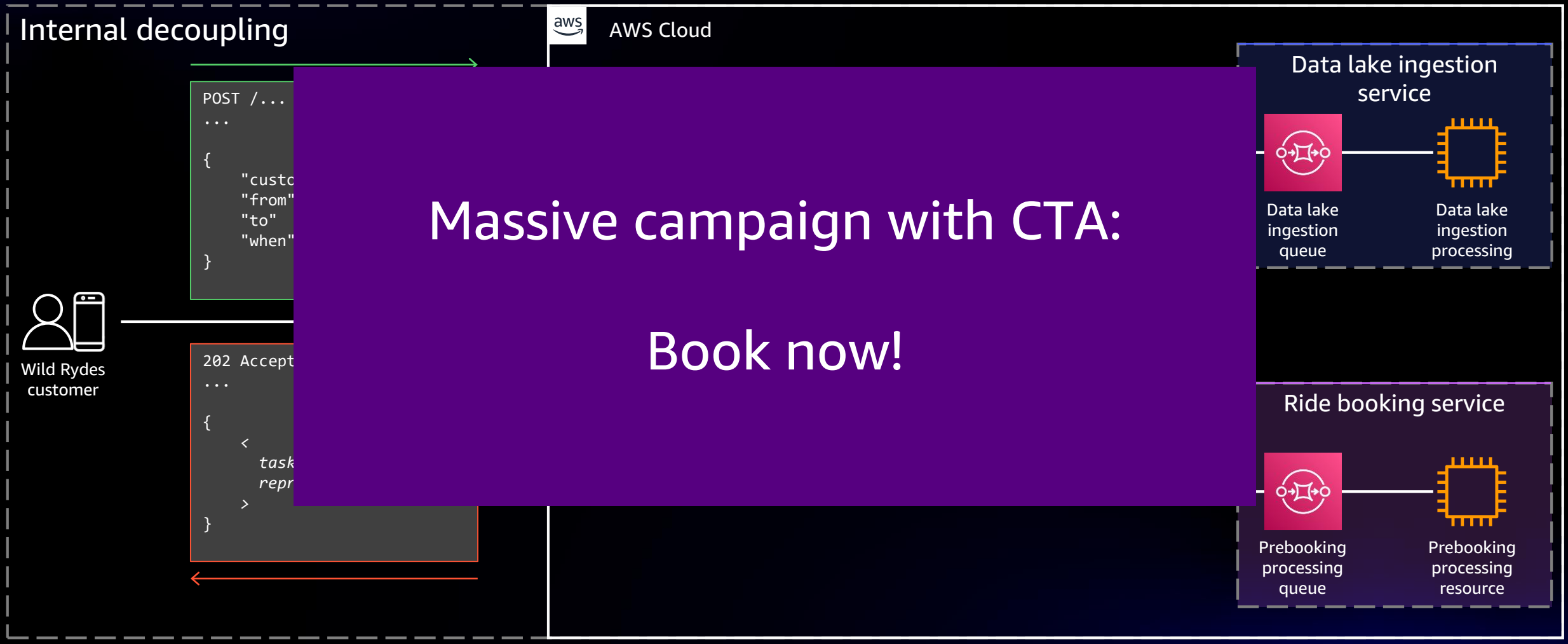
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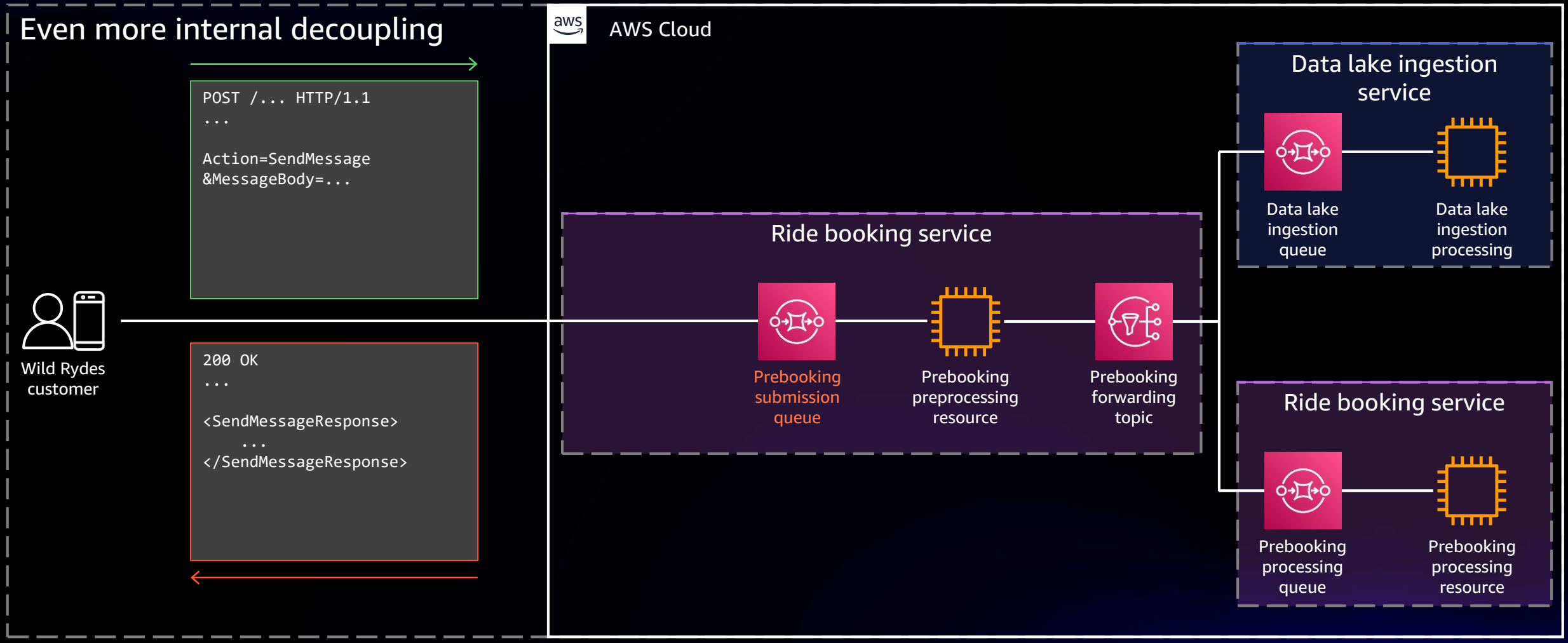
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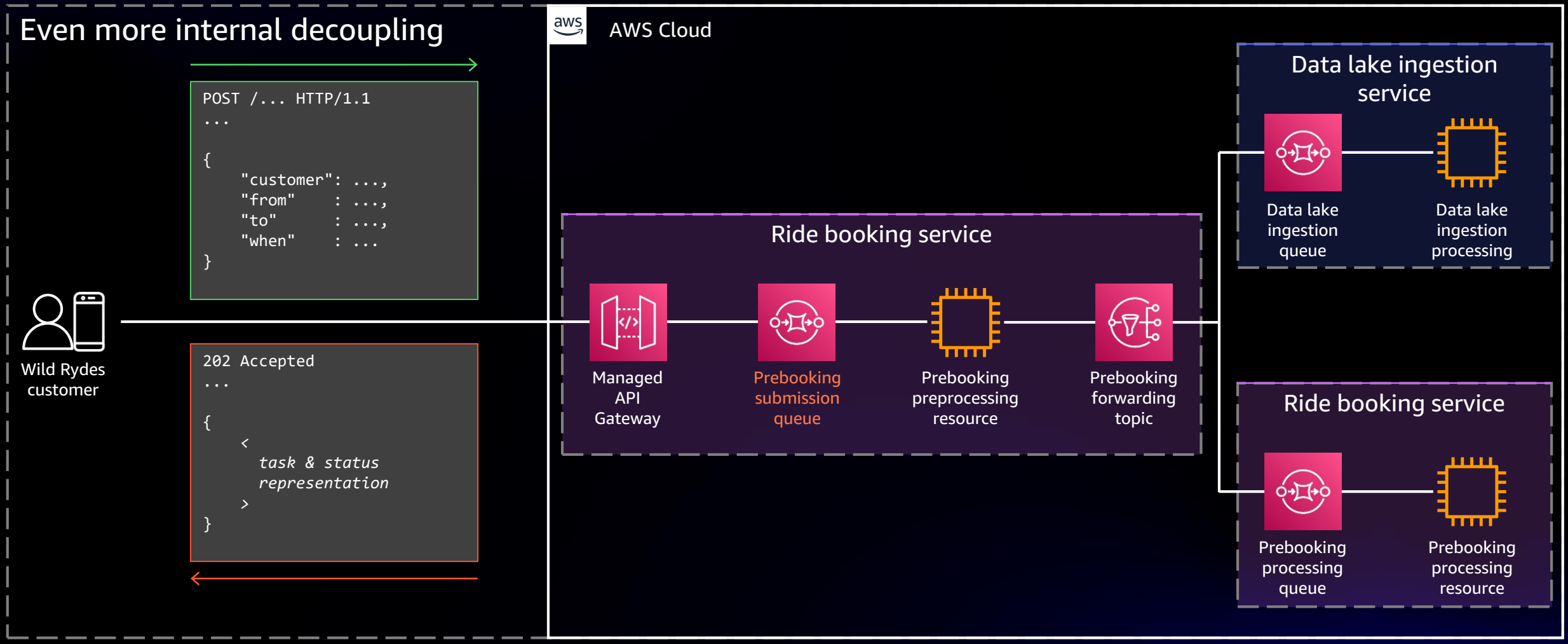
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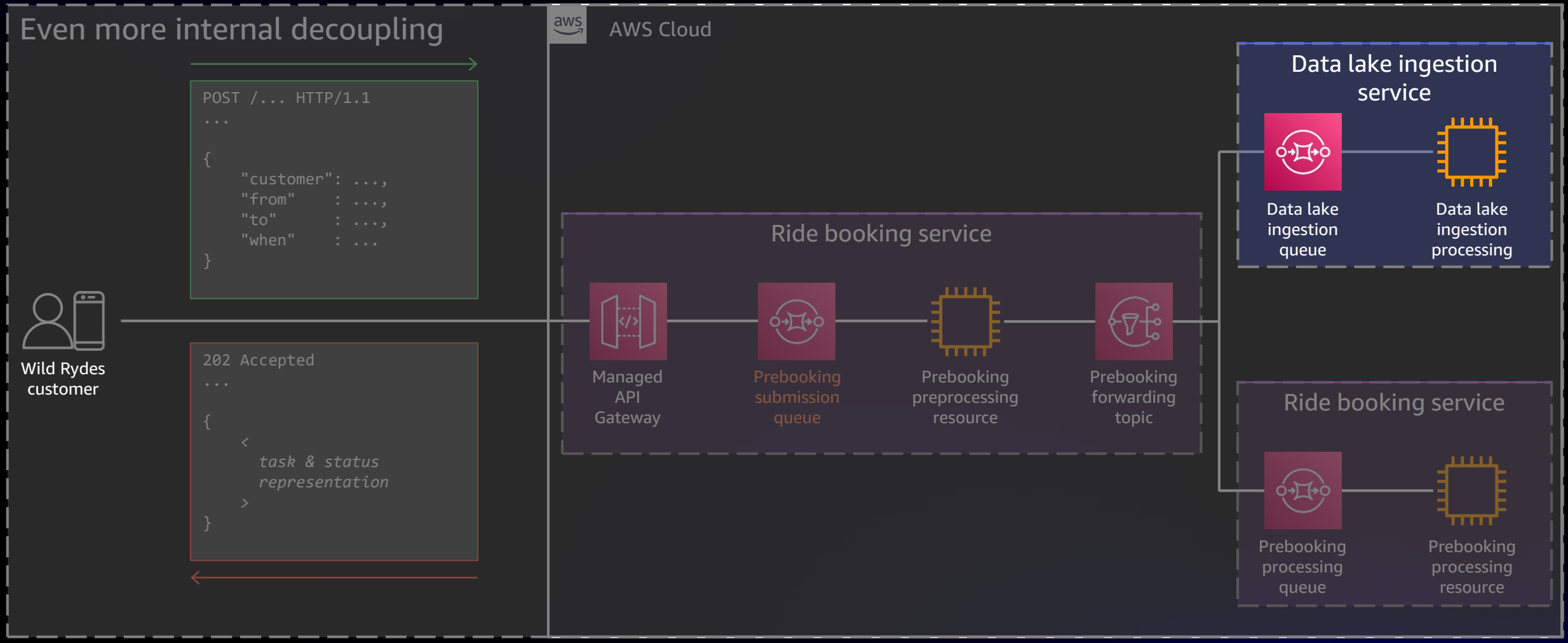
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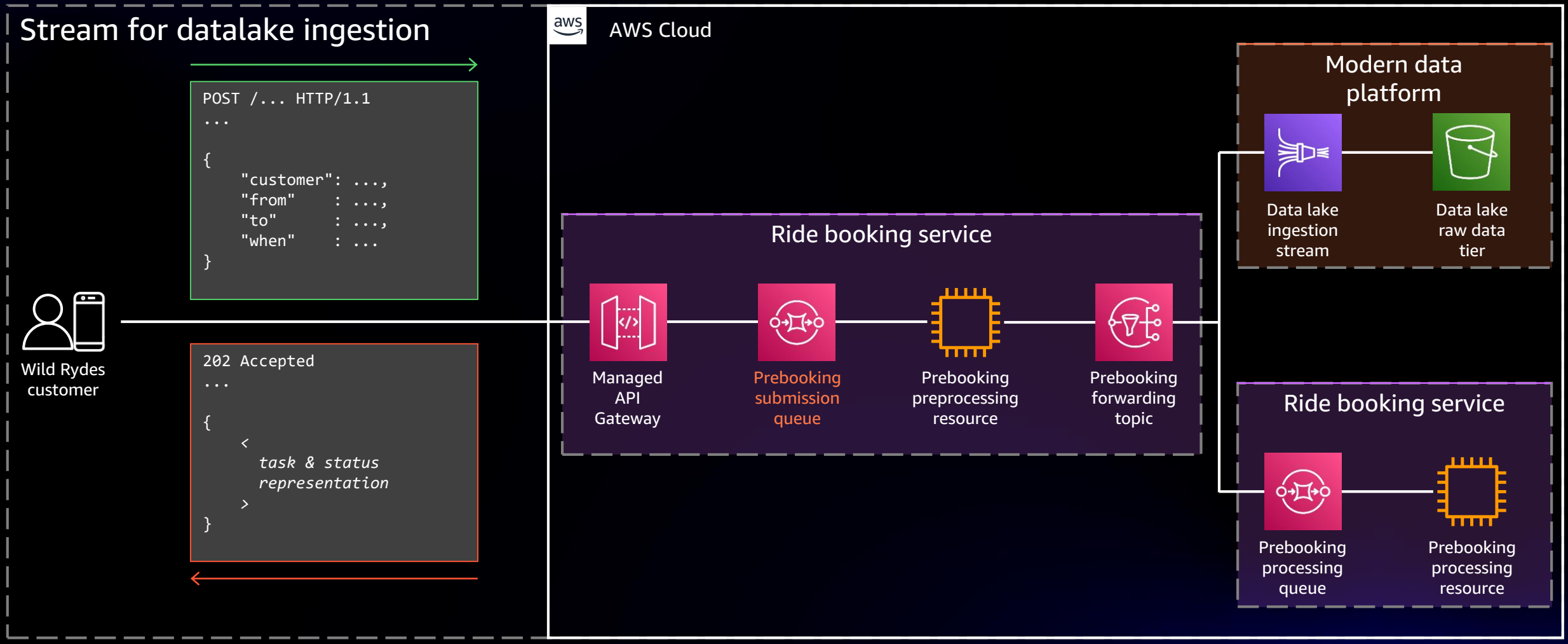
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Message routing

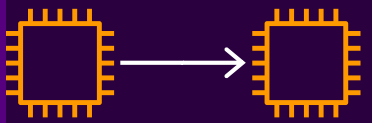
Scatter-gather



Requester

Remember the

scatter-gather pattern?



gregator Processor

Requester

How to distribut **ual responses?**

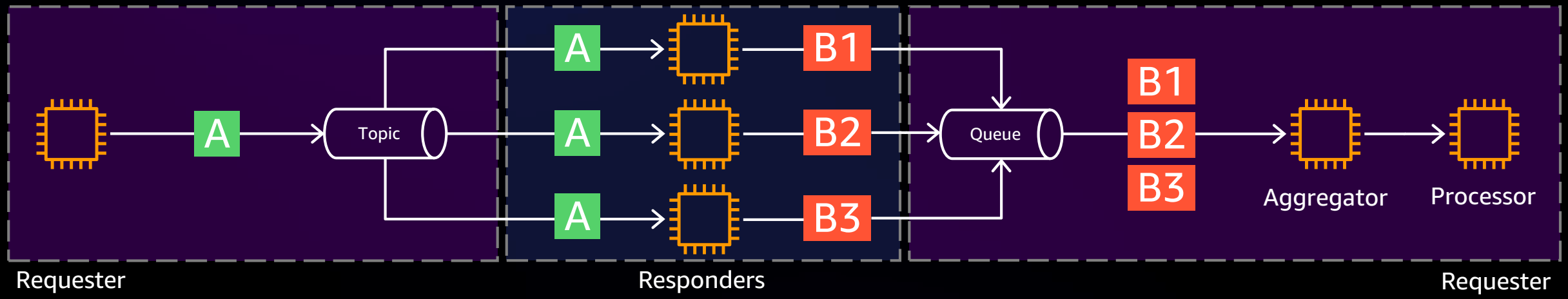
For election or parallel processing scenarios, i.e., search for best response or accumulate responses

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Message routing

Scatter-gather



How to distribute a request to relevant/interested parties and capture their individual responses?

For election or parallel processing scenarios, i.e., search for best response or accumulate responses

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Scatter-gather



Wild Rydes customer

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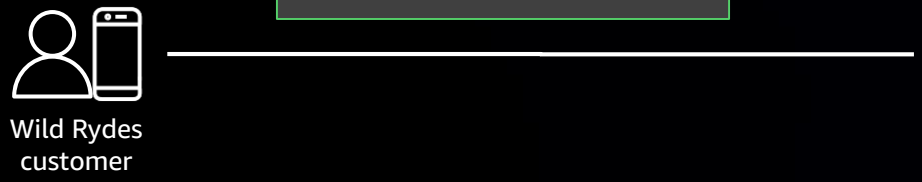
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Scatter-gather

```
POST /<submit> HTTP/1.1
...

{
    "customer": ...,
    "from"    : ...,
    "to"      : ...
}
```

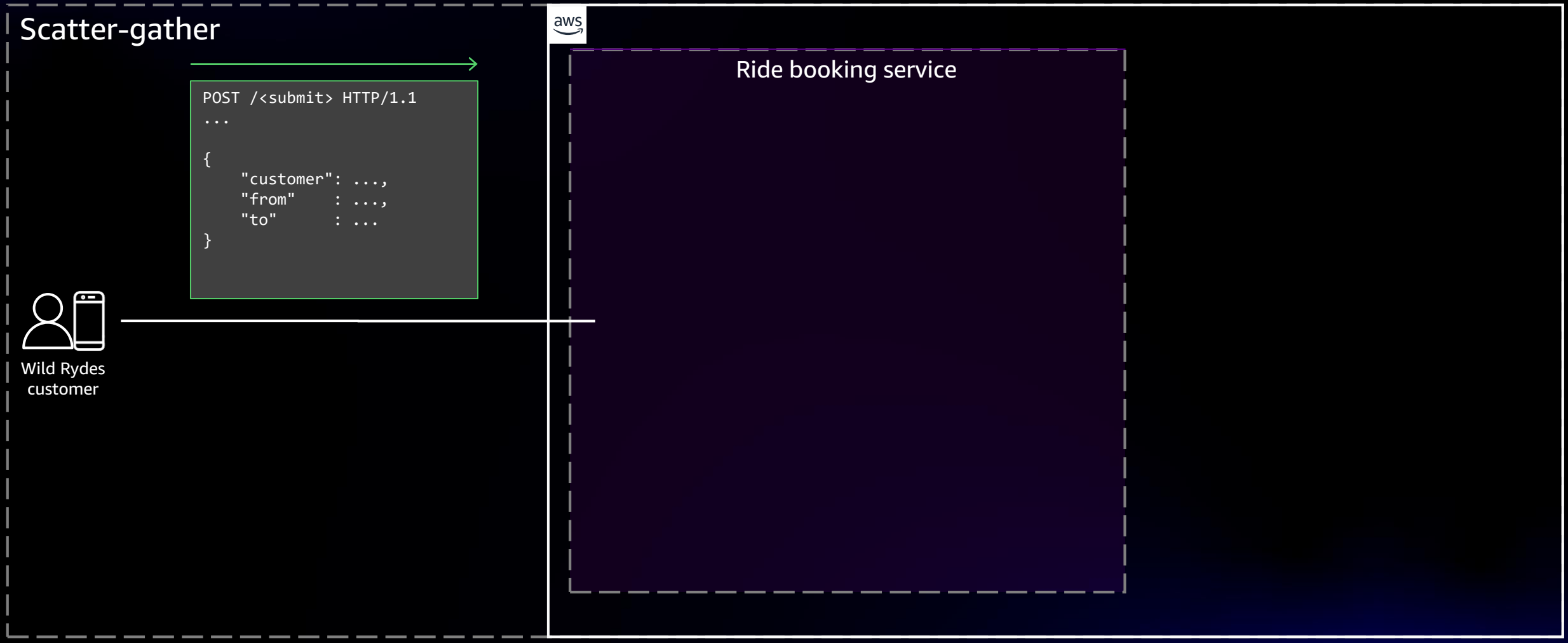


Wild Rydes customer

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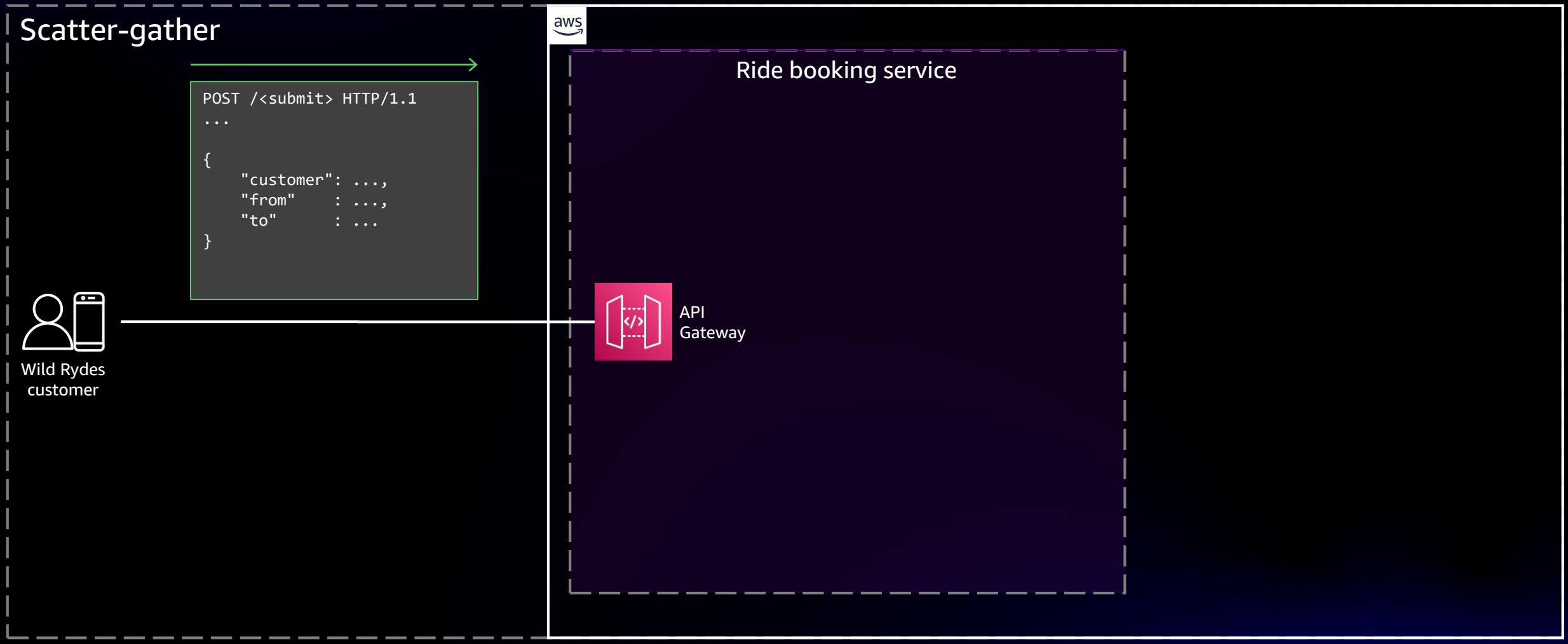
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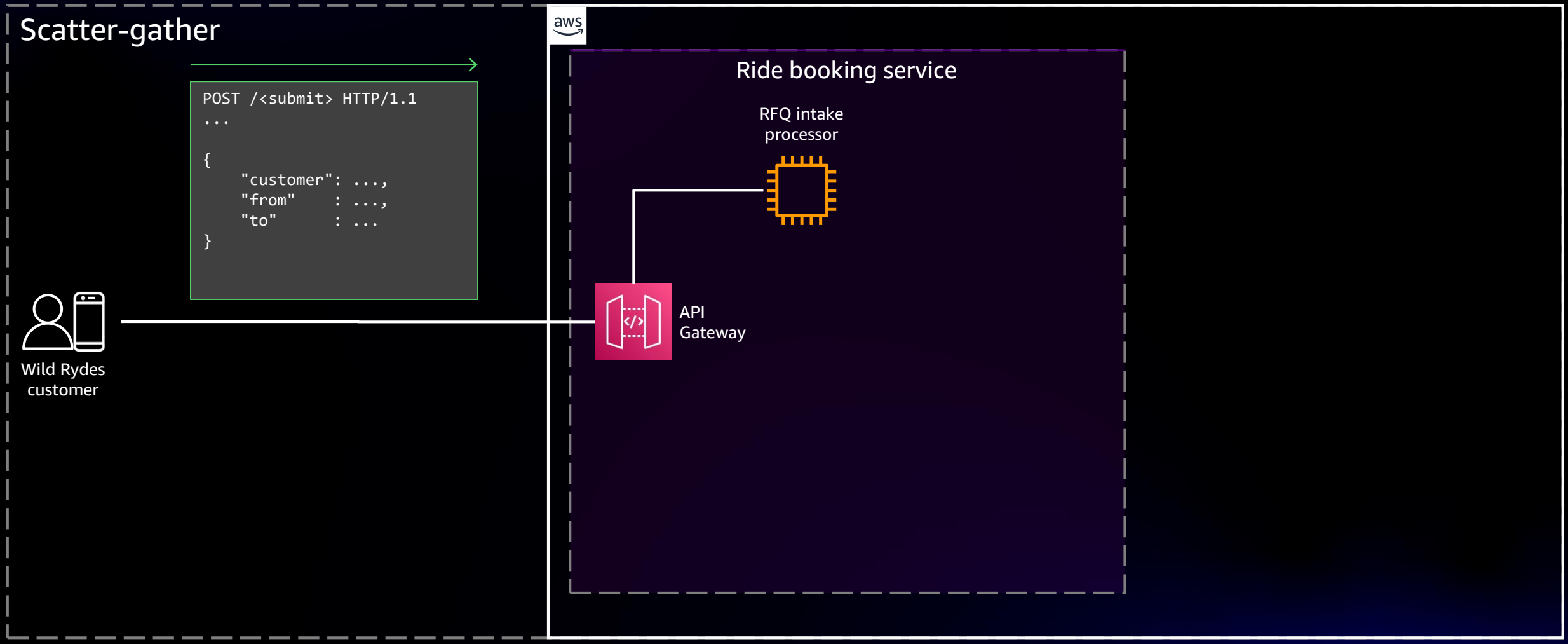
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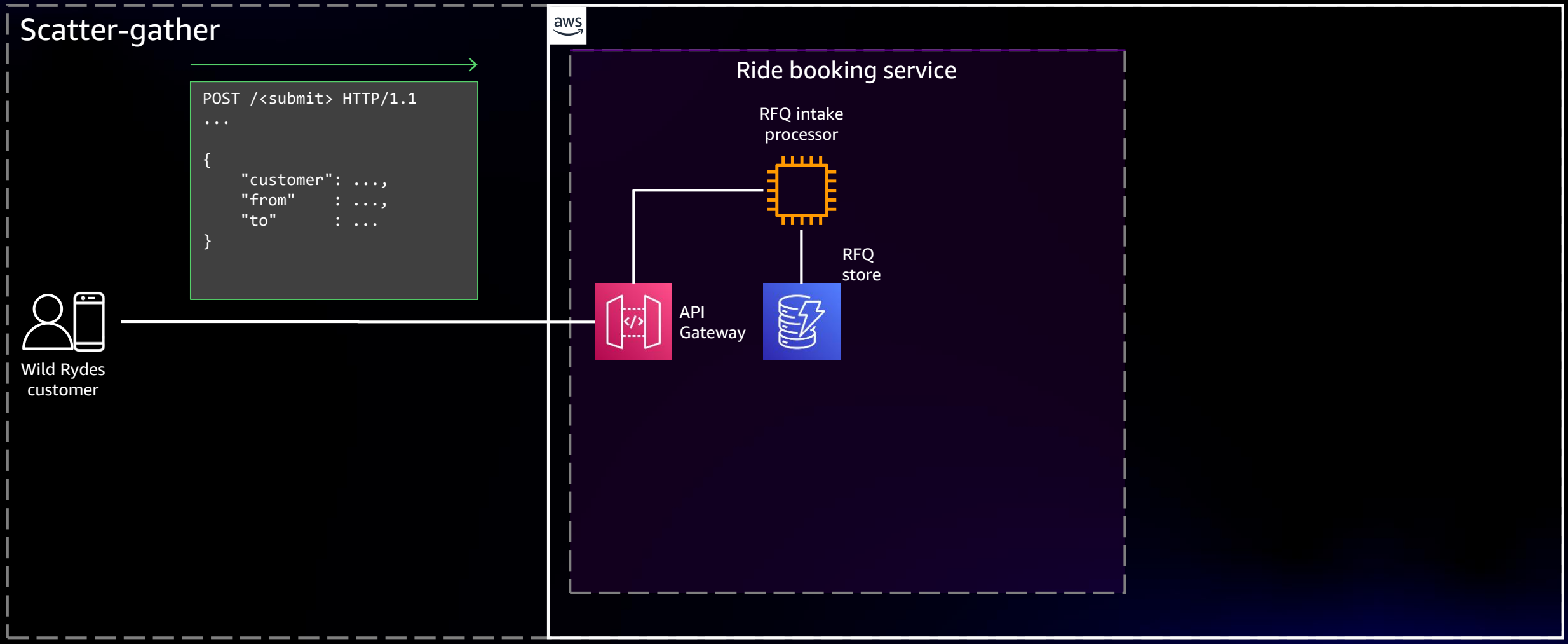
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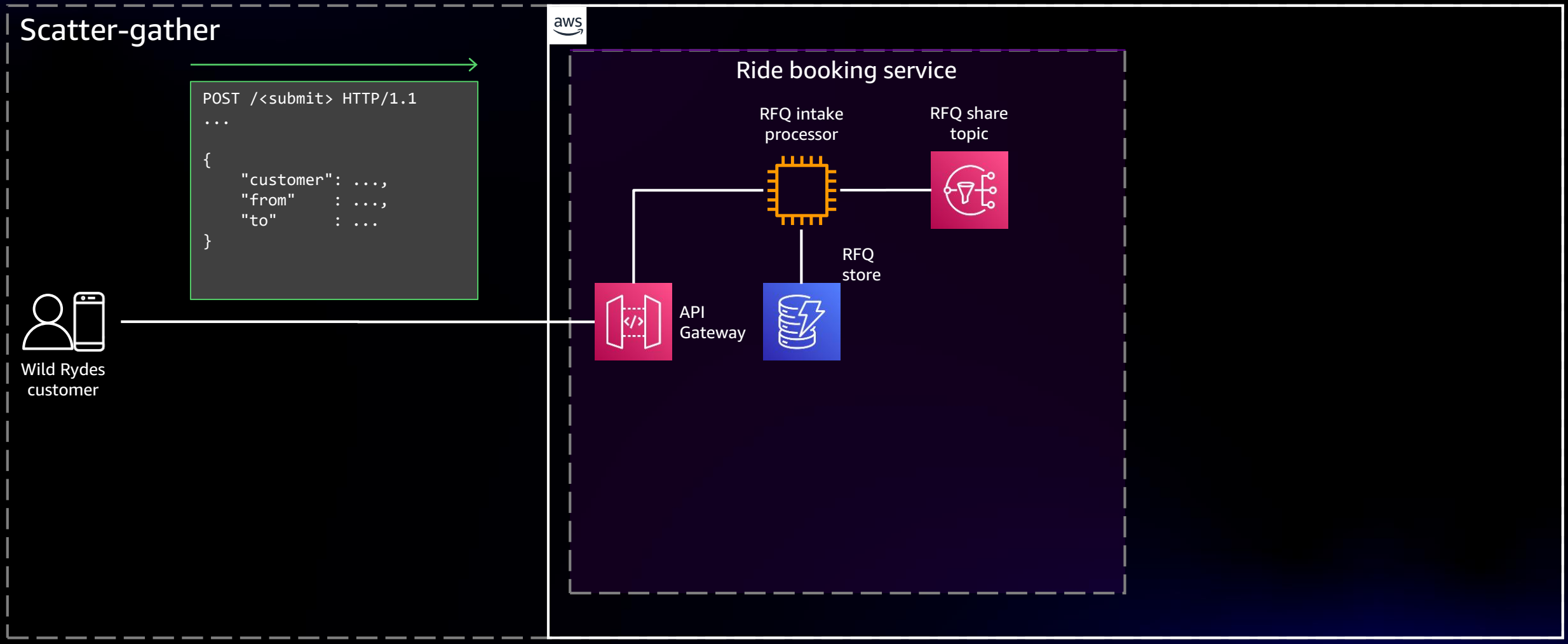
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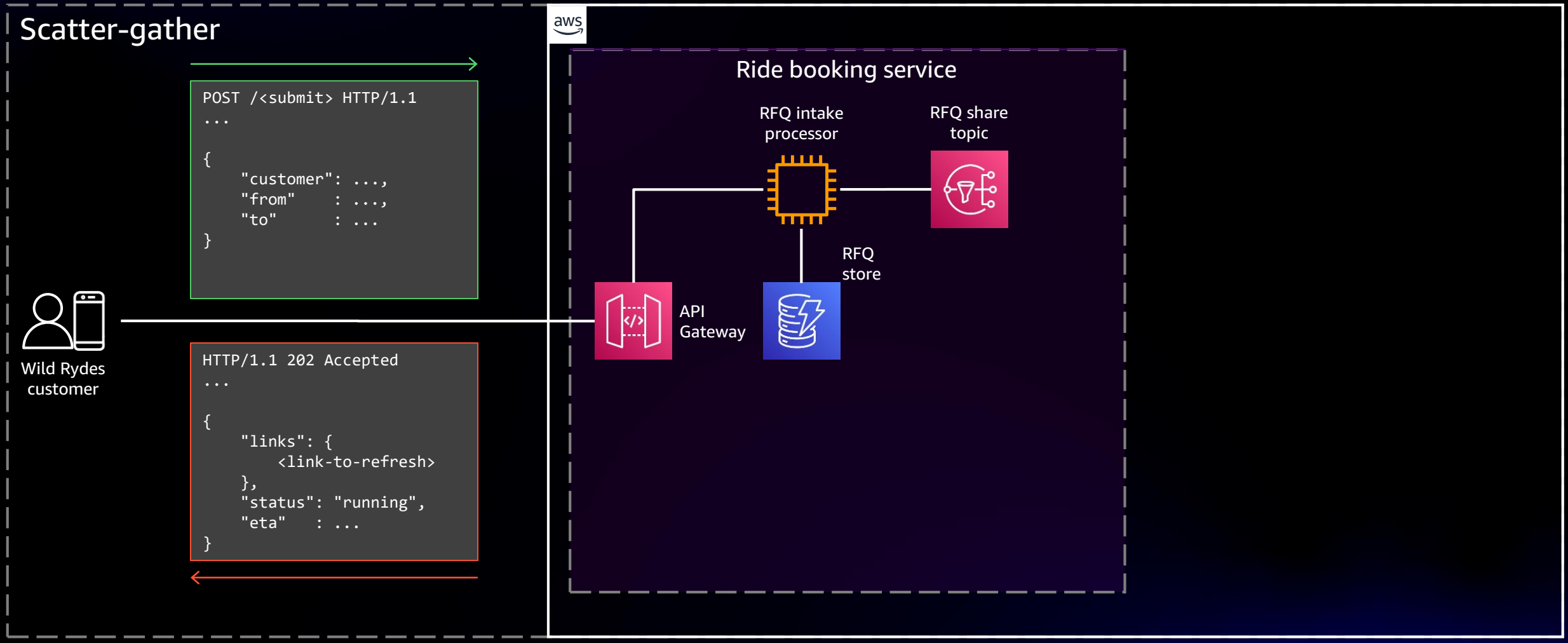
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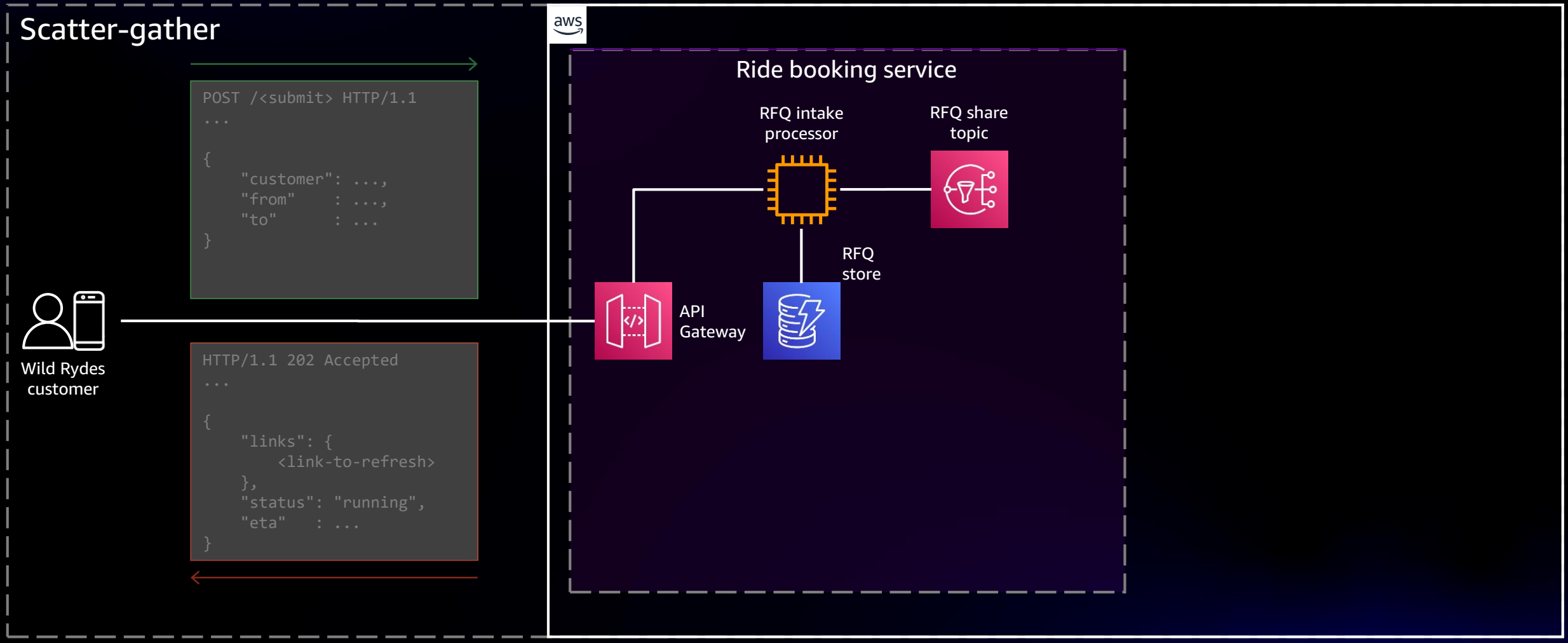
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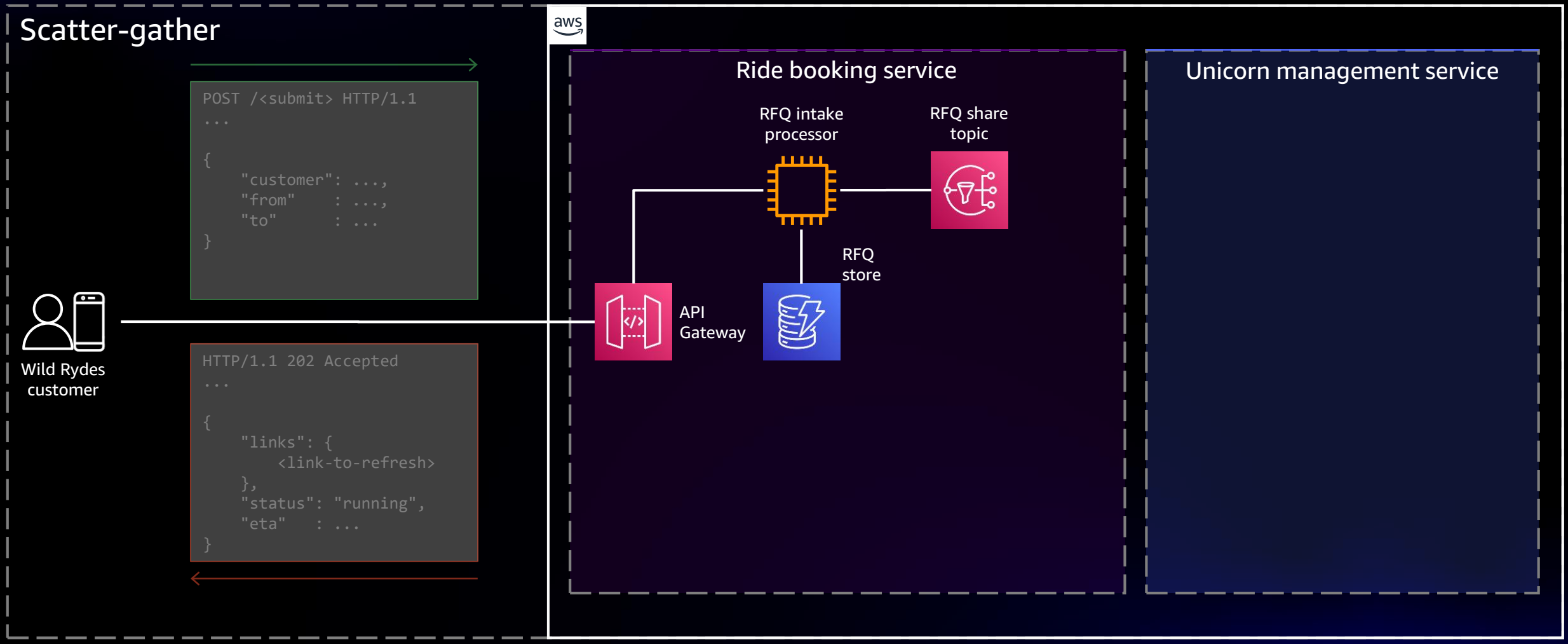
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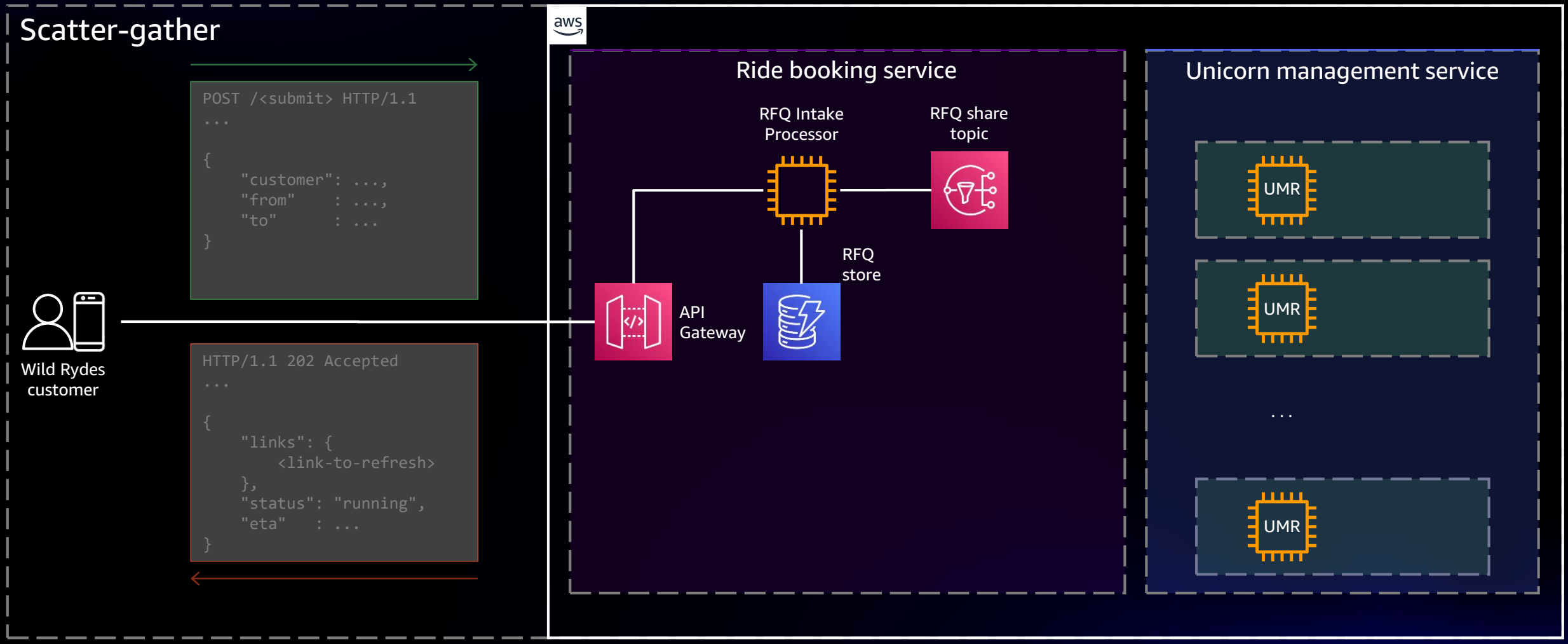


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UMR: Unicorn management resource

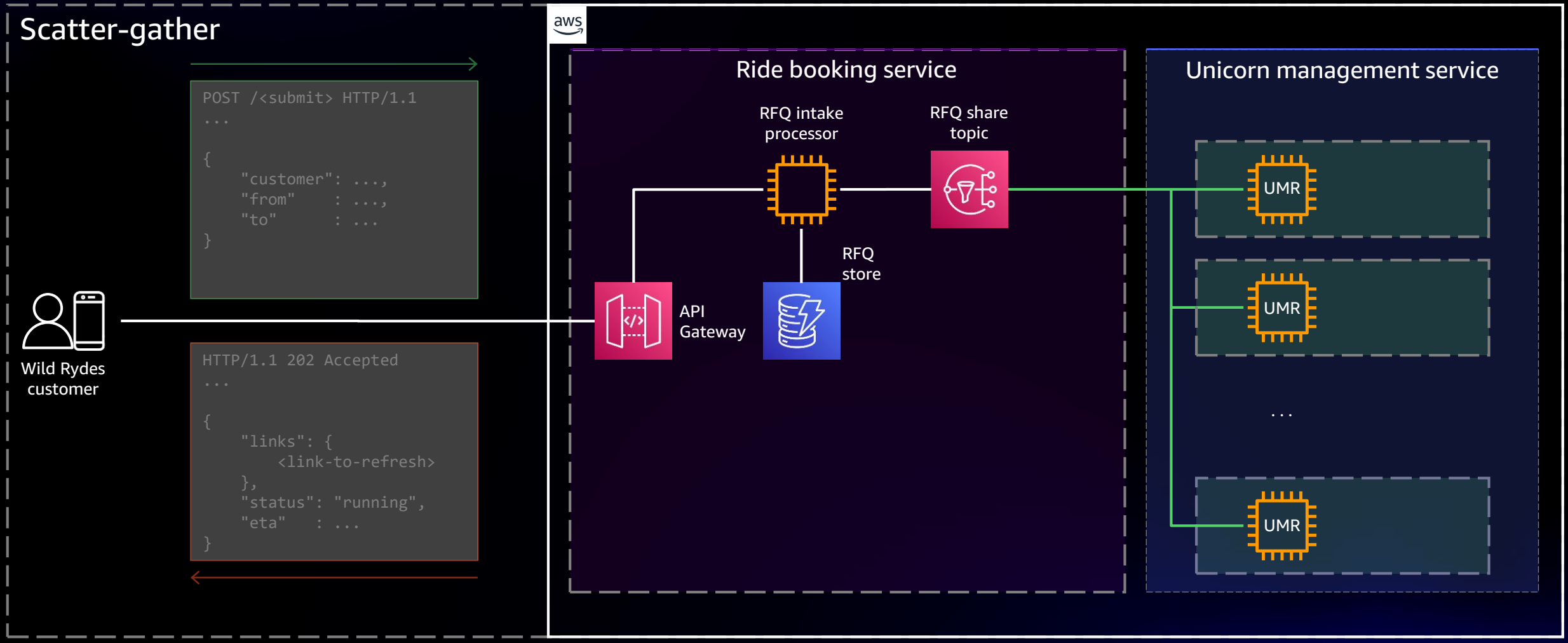


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UMR: Unicorn management resource



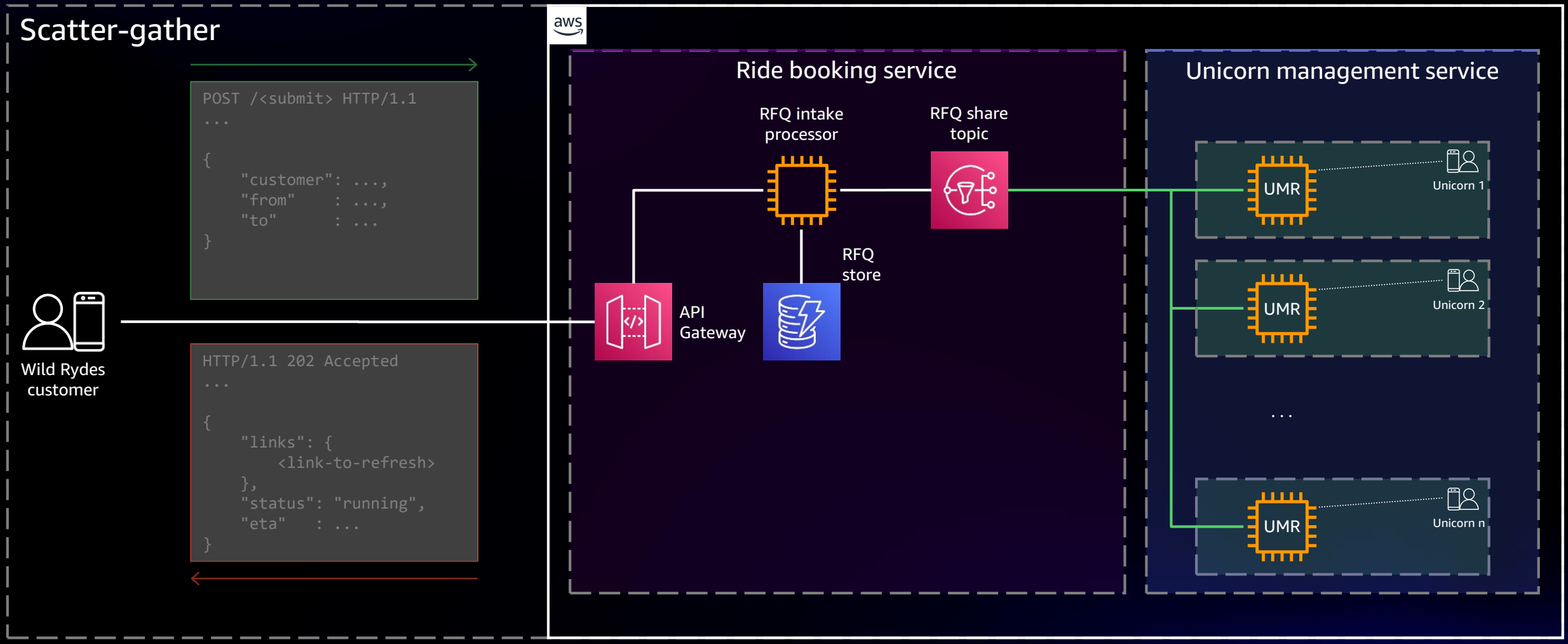
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UMR: Unicorn management resource

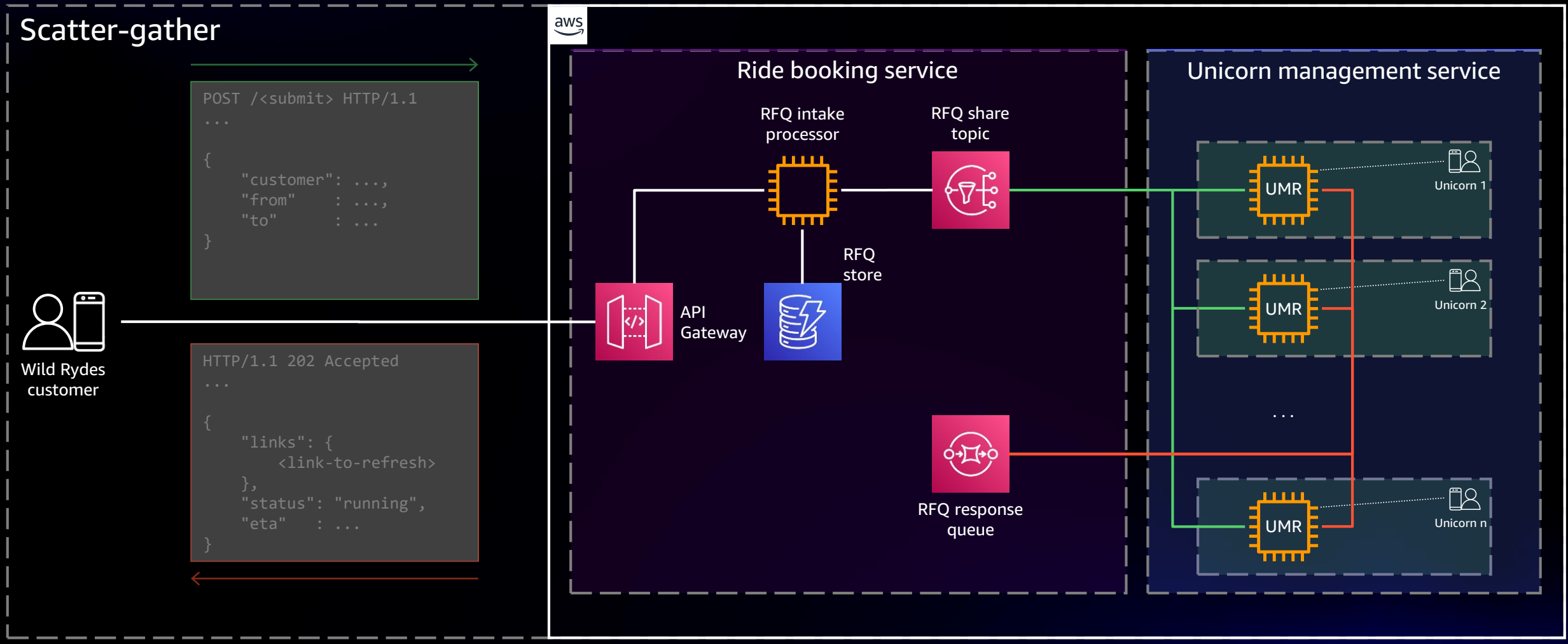


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UMR: Unicorn management resource

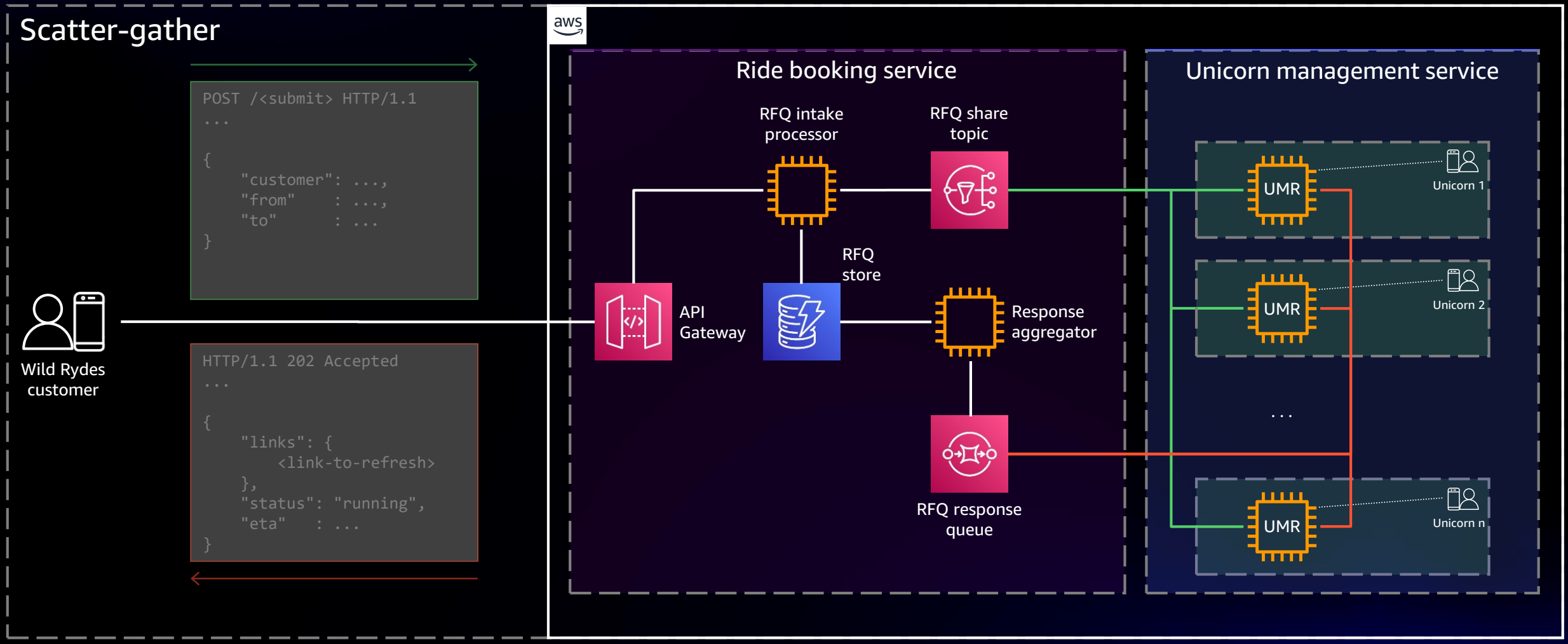


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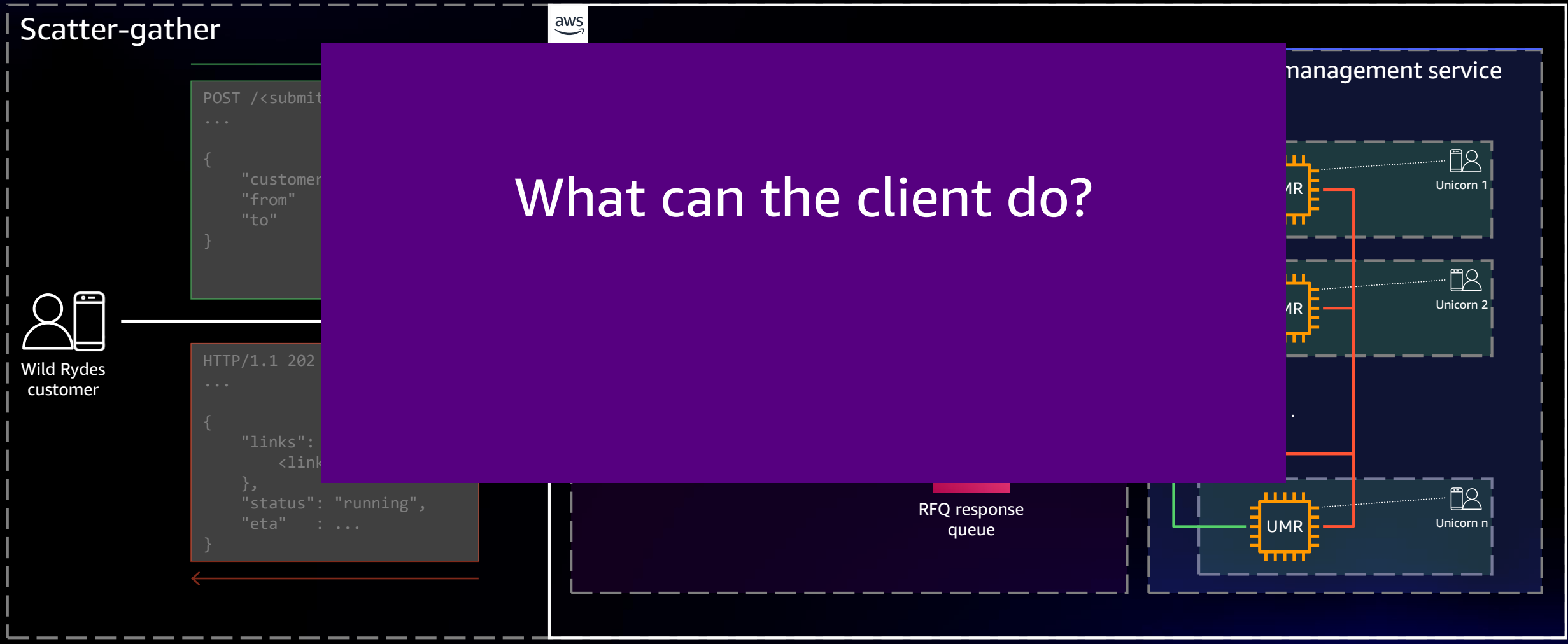
UMR: Unicorn management resource



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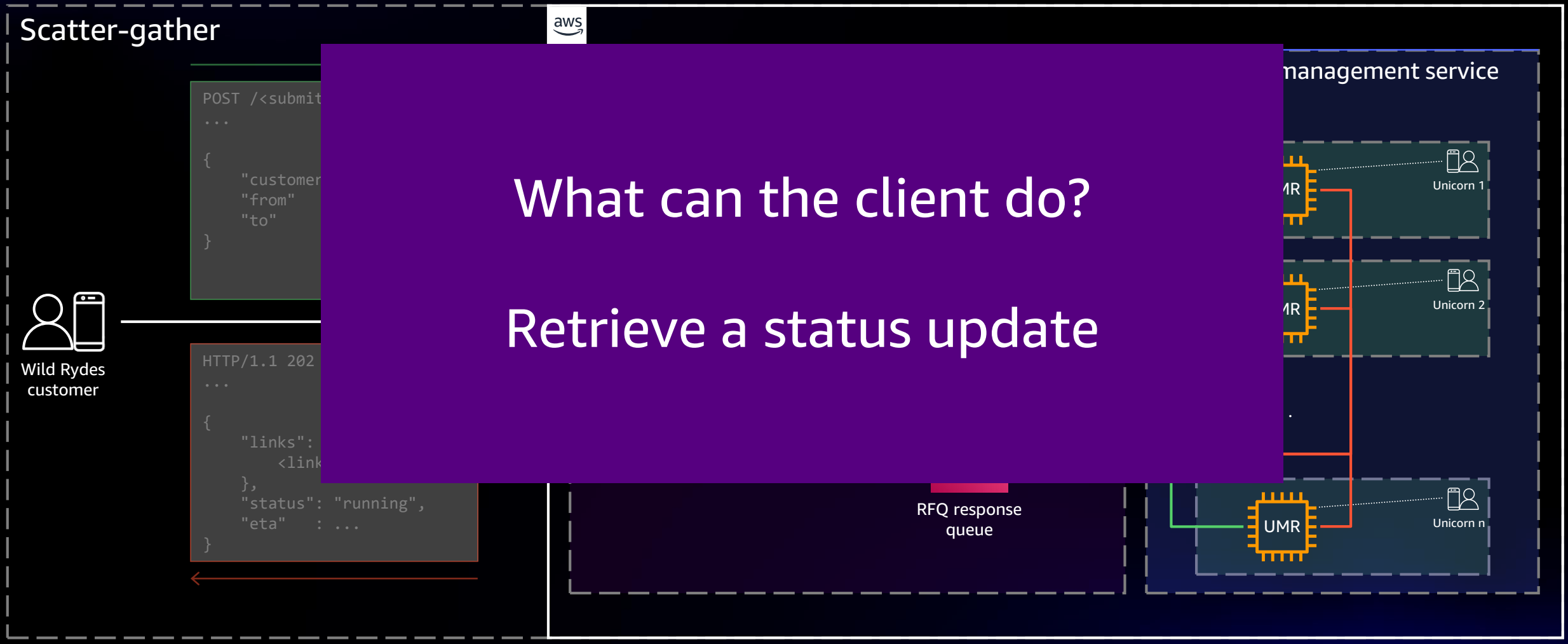
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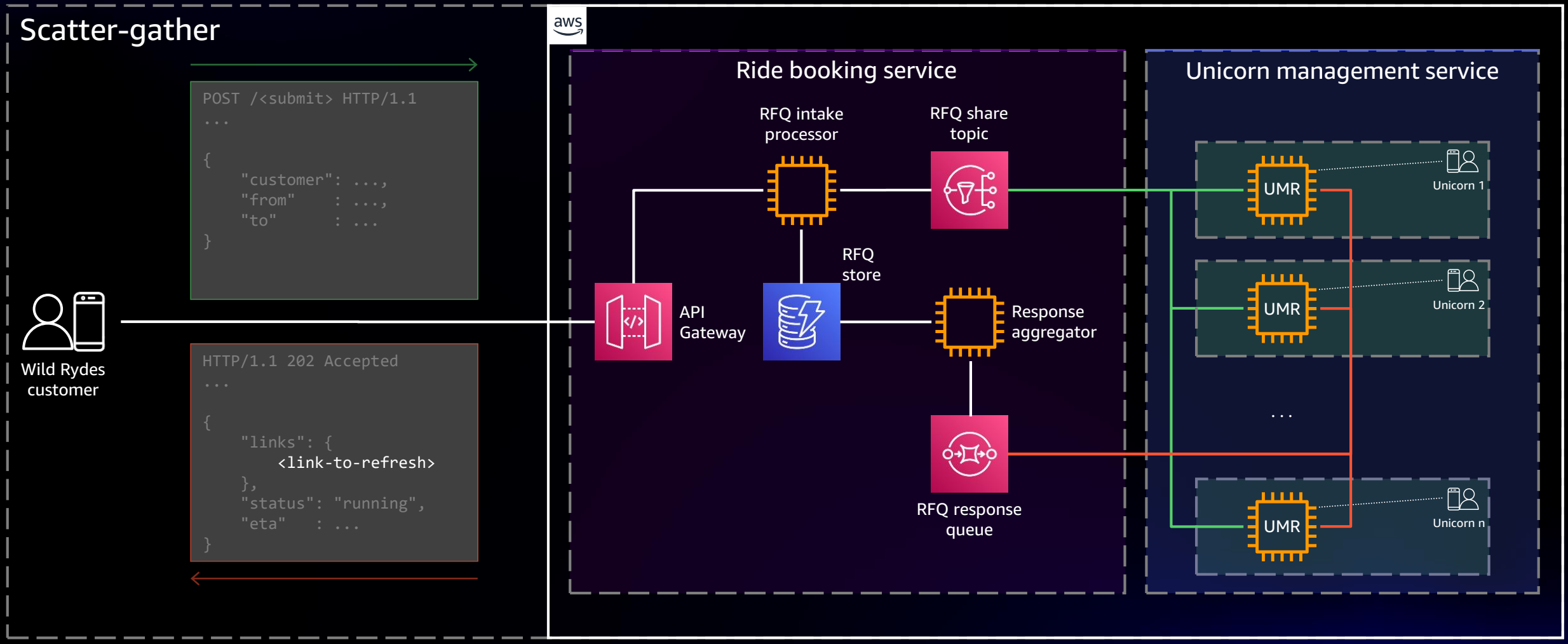


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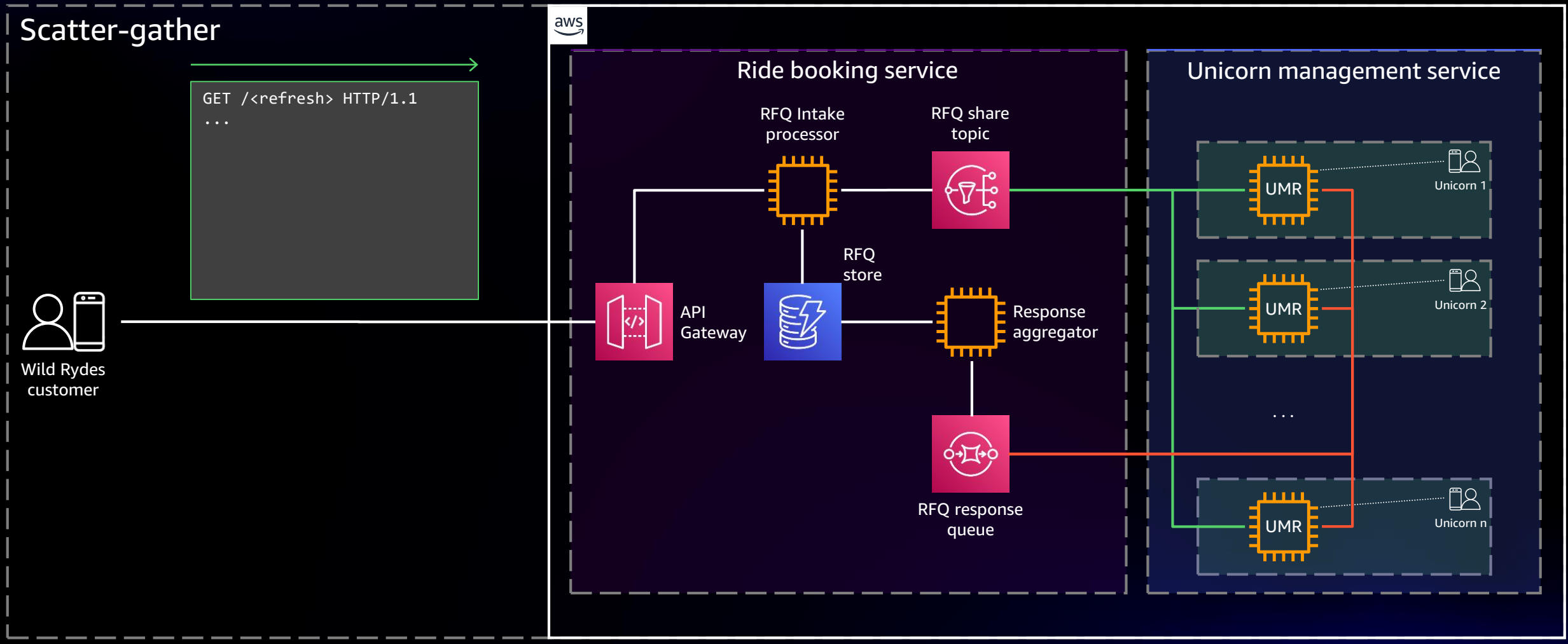
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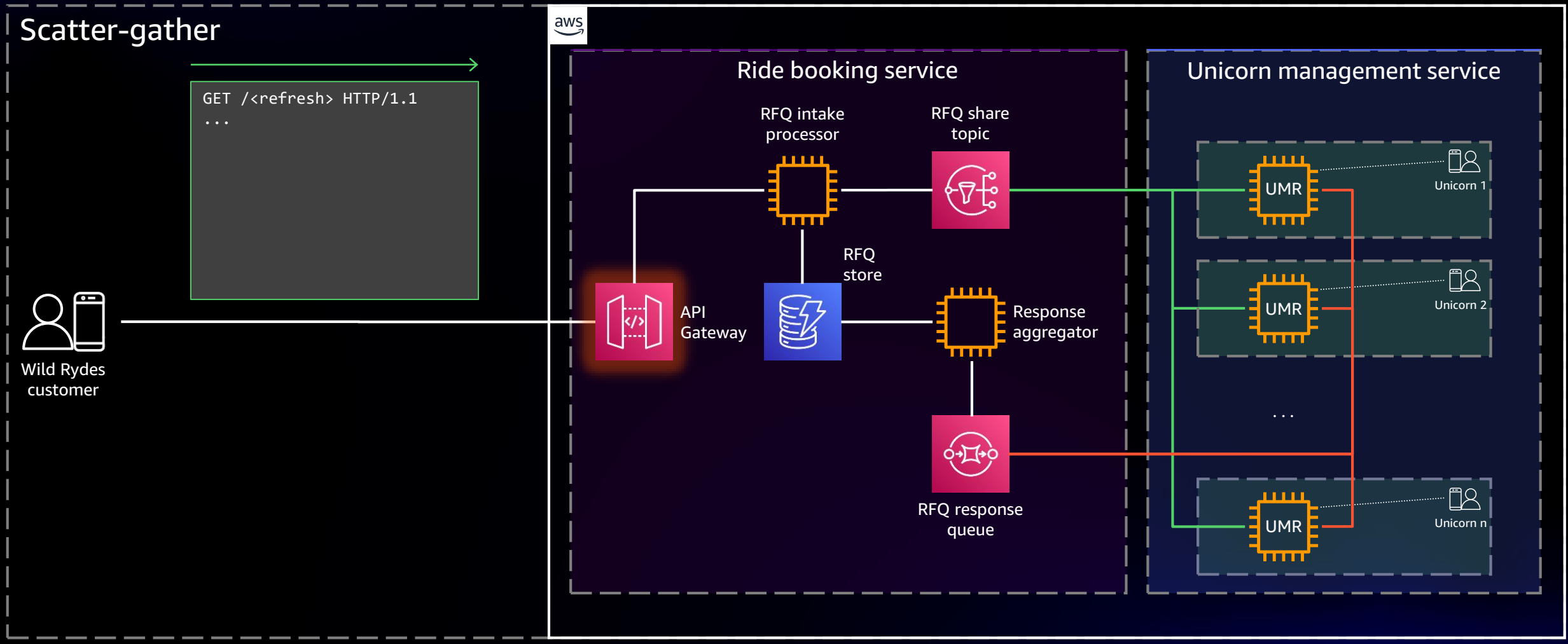
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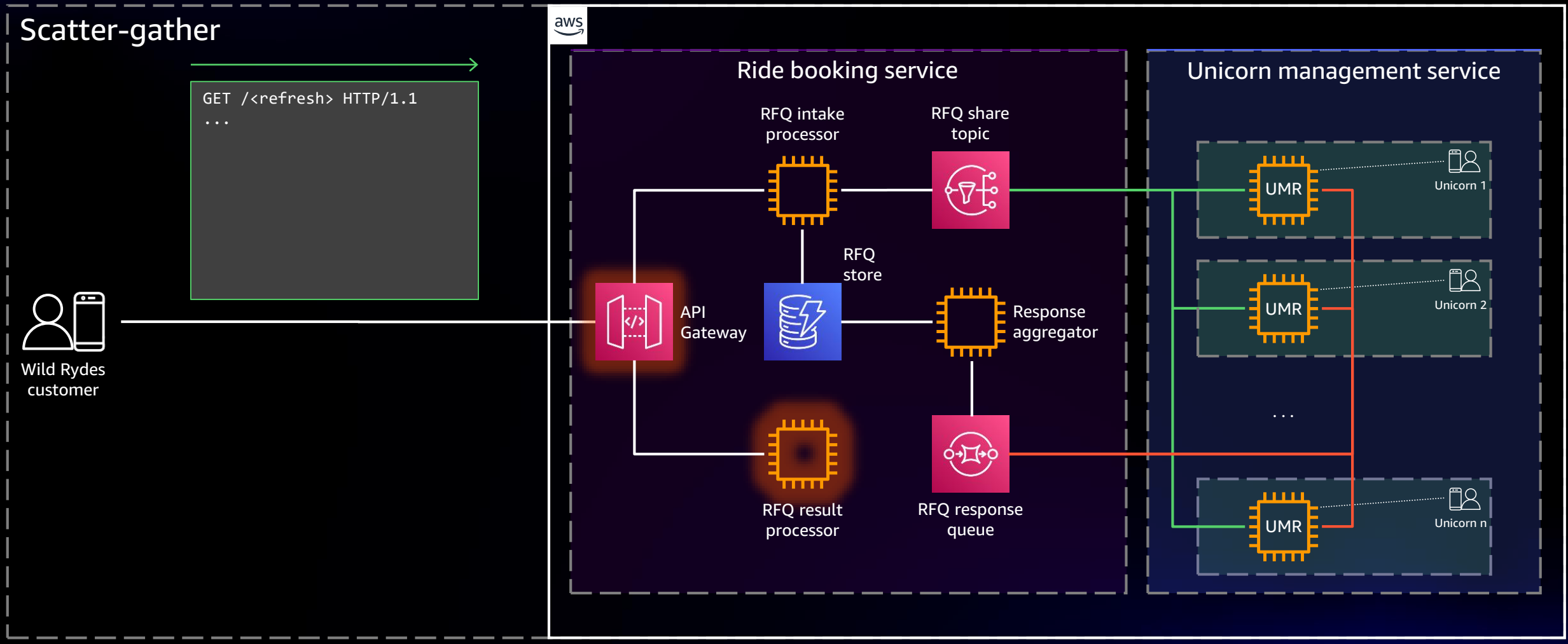
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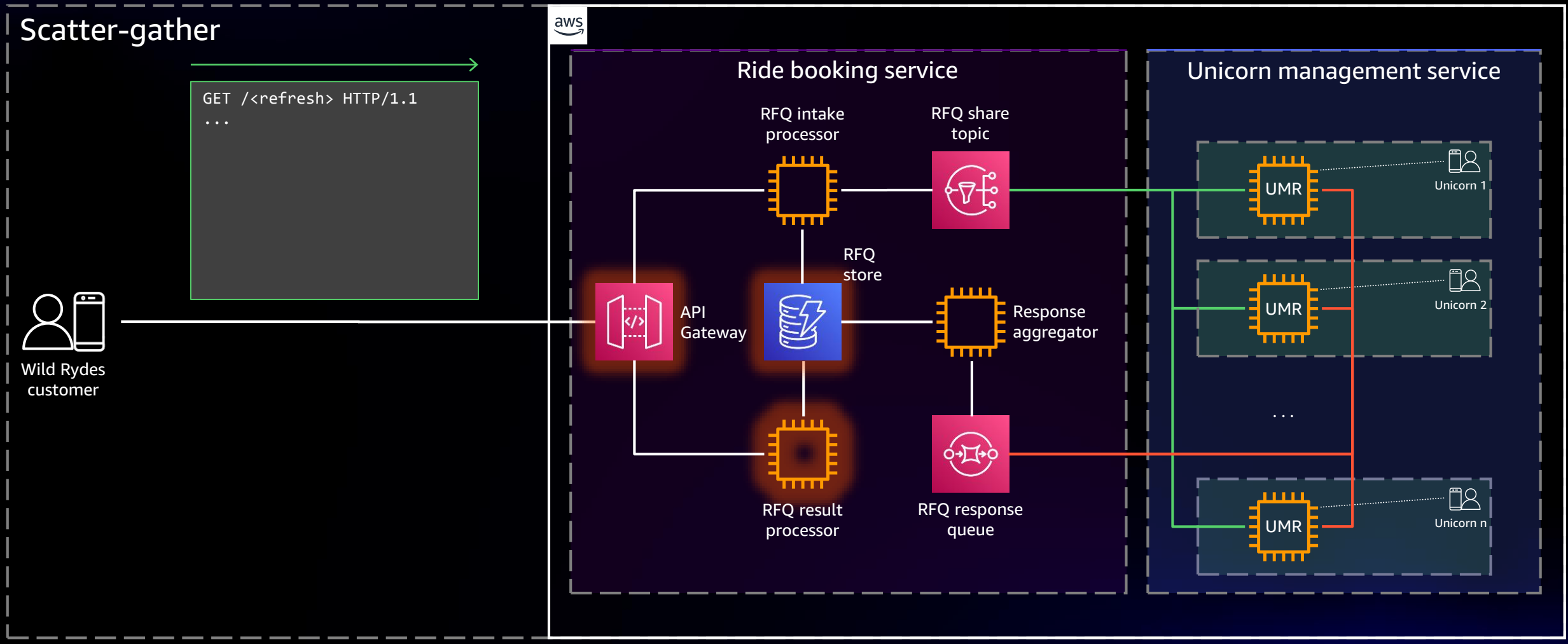
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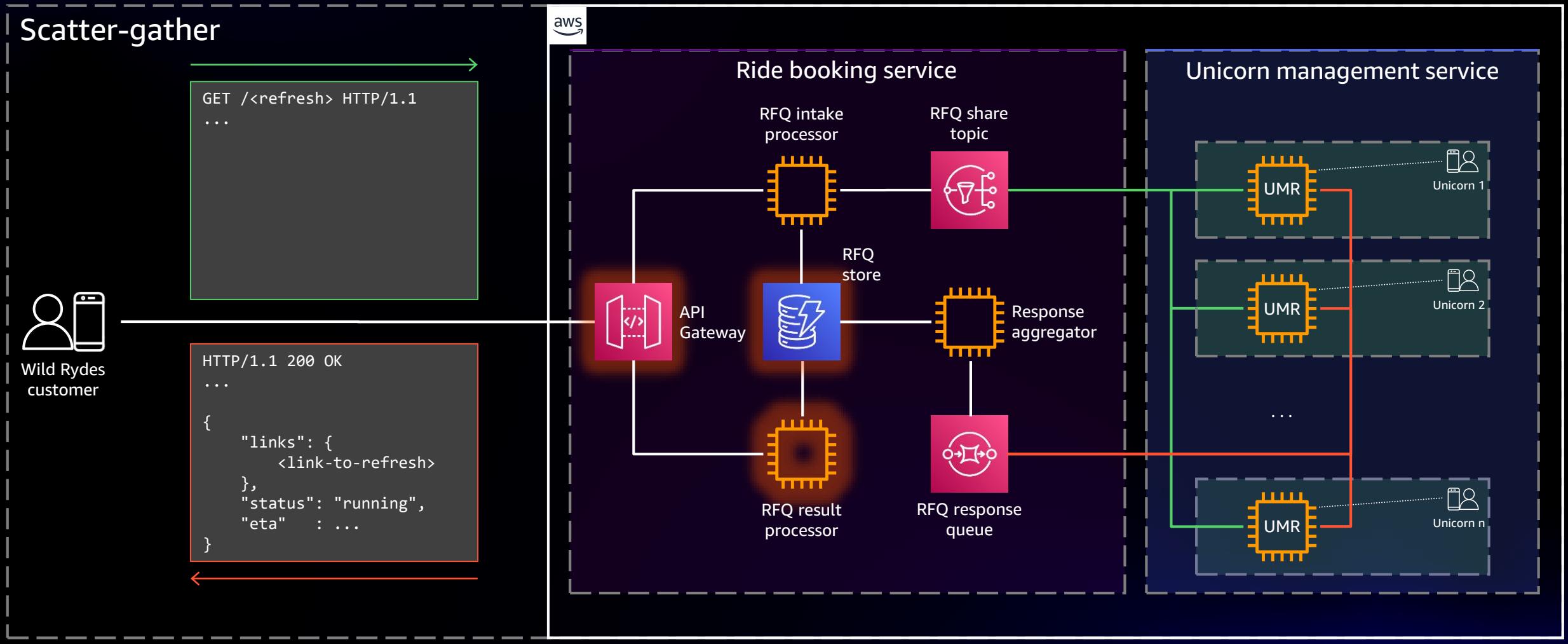
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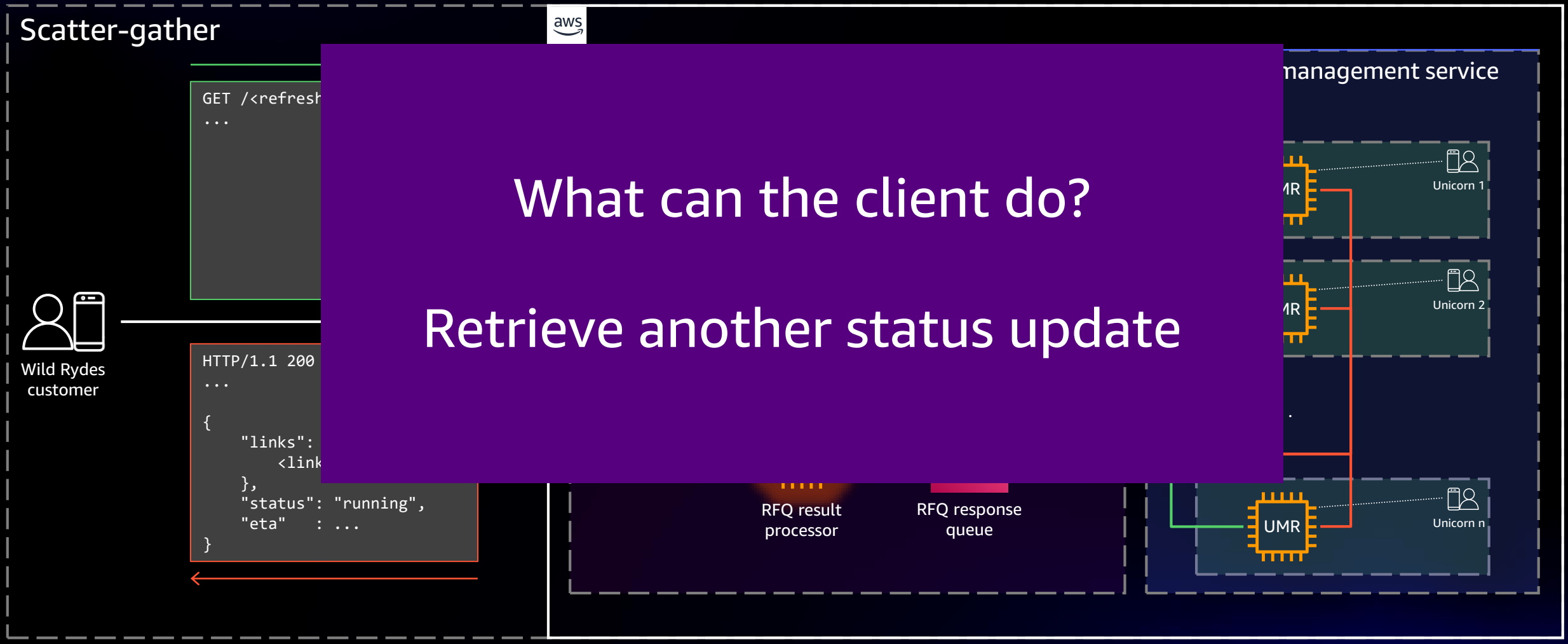


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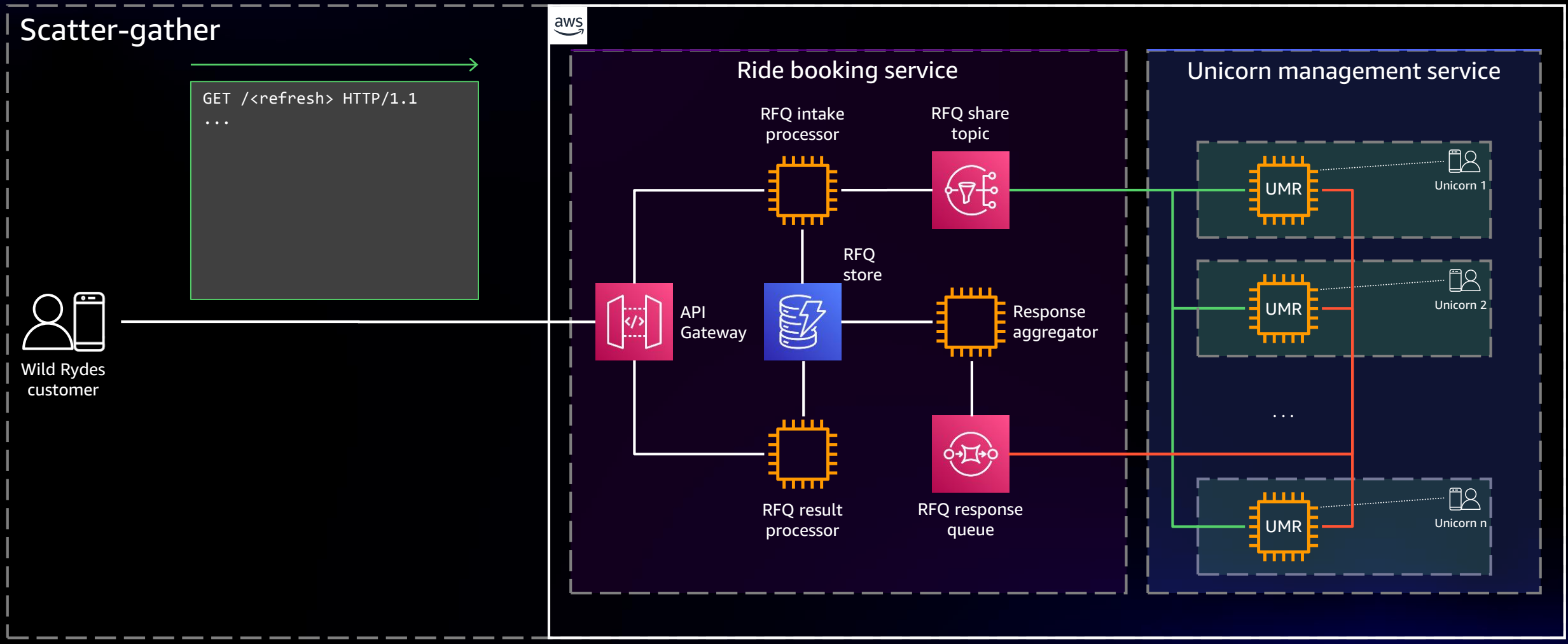
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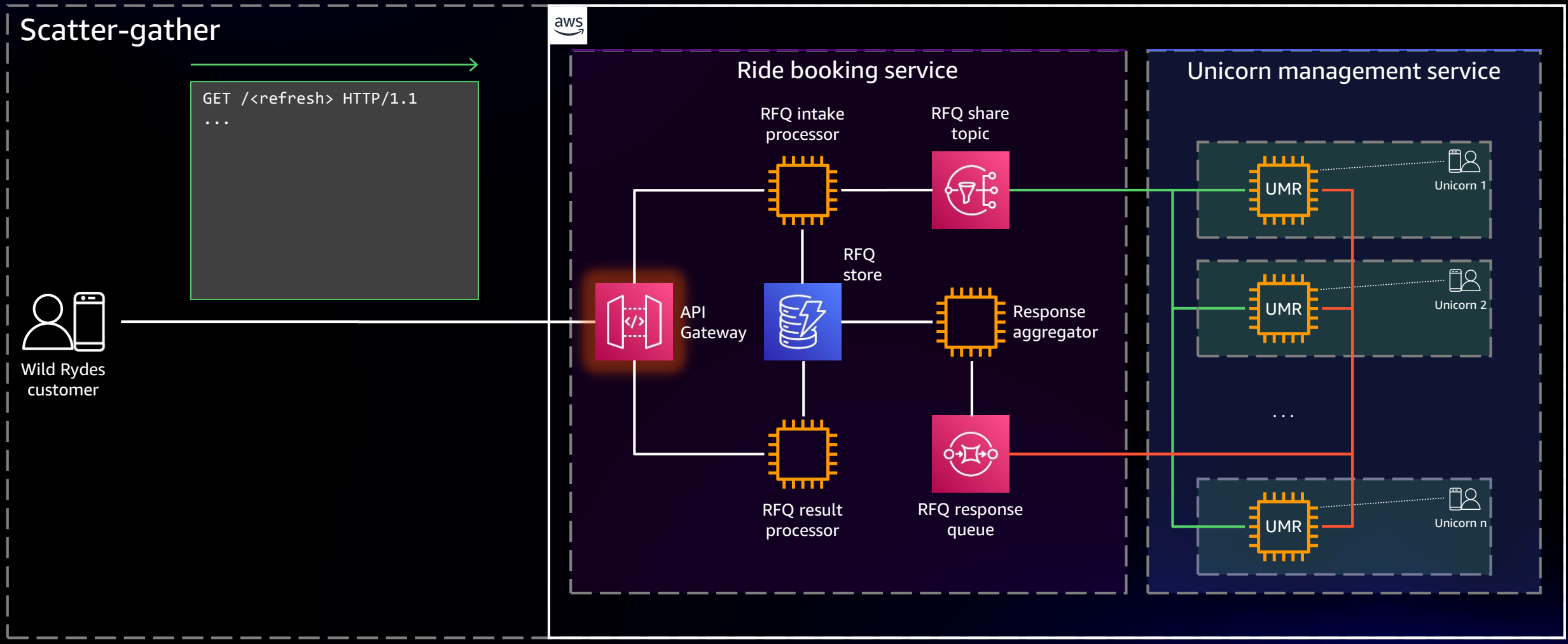
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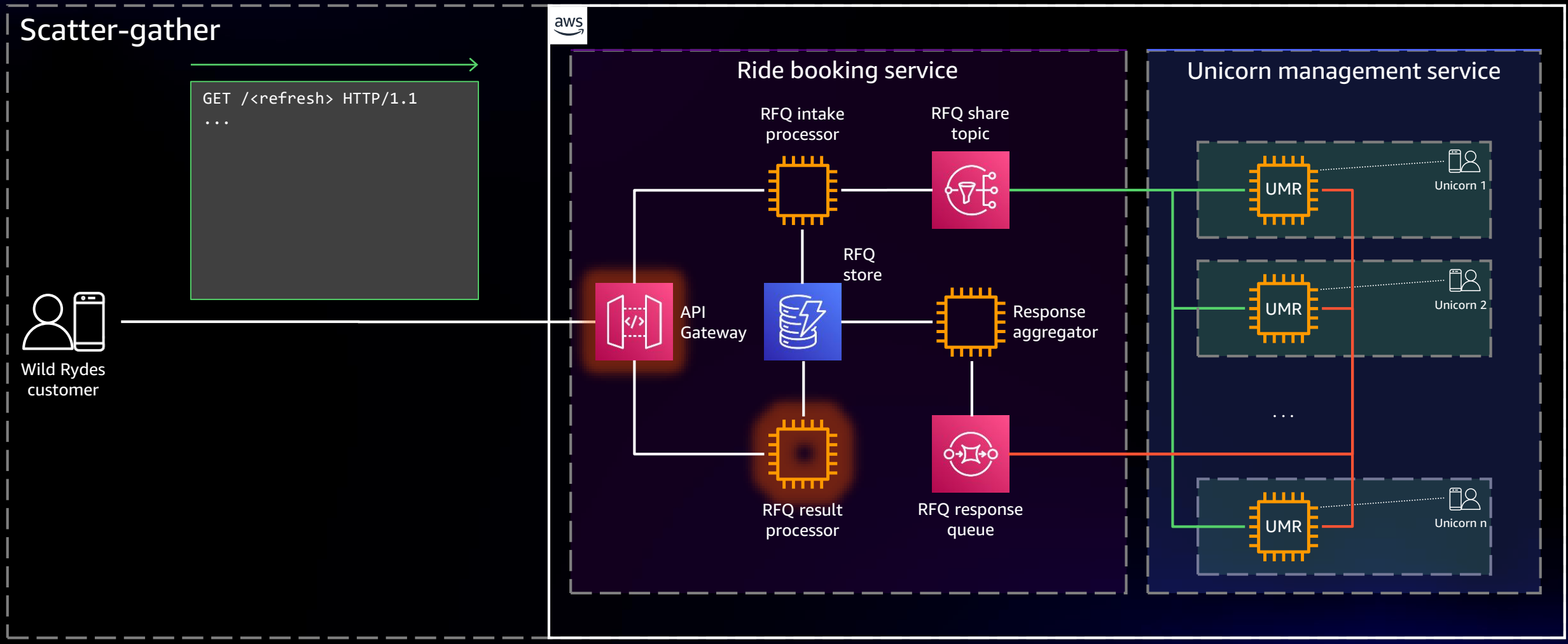
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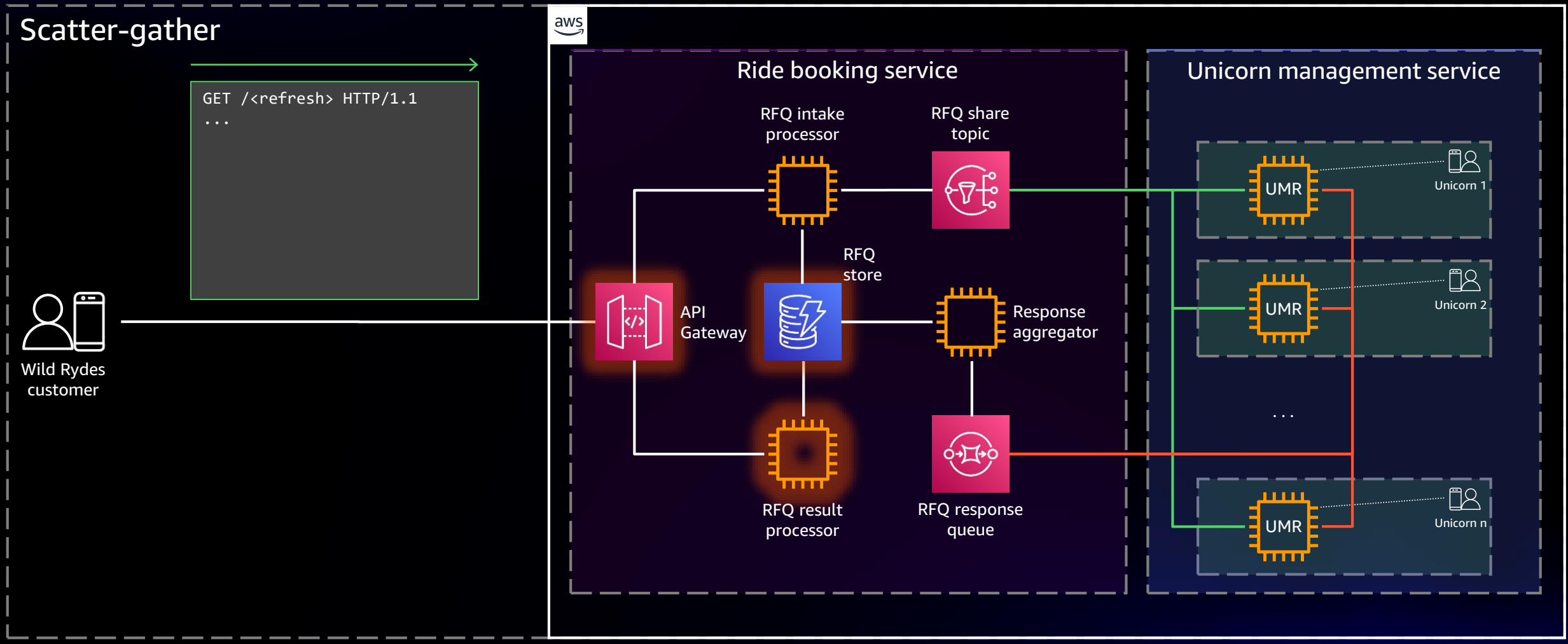
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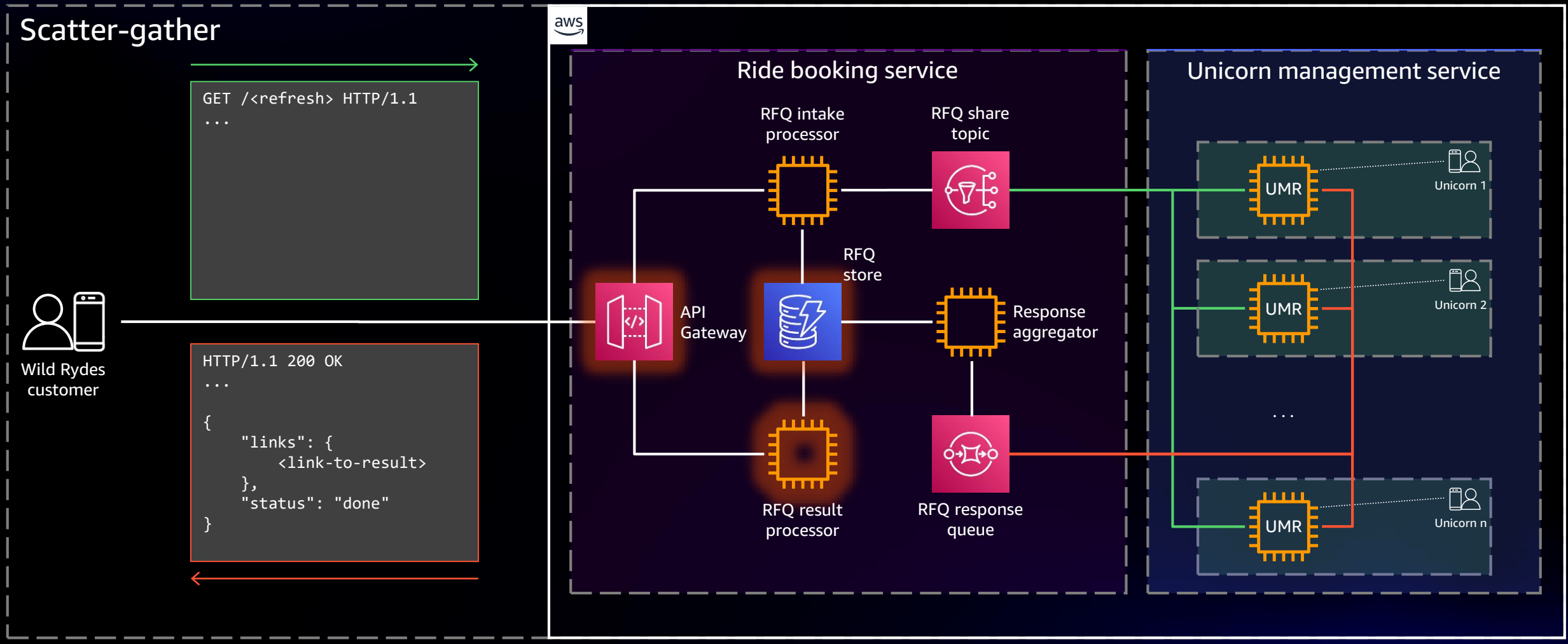
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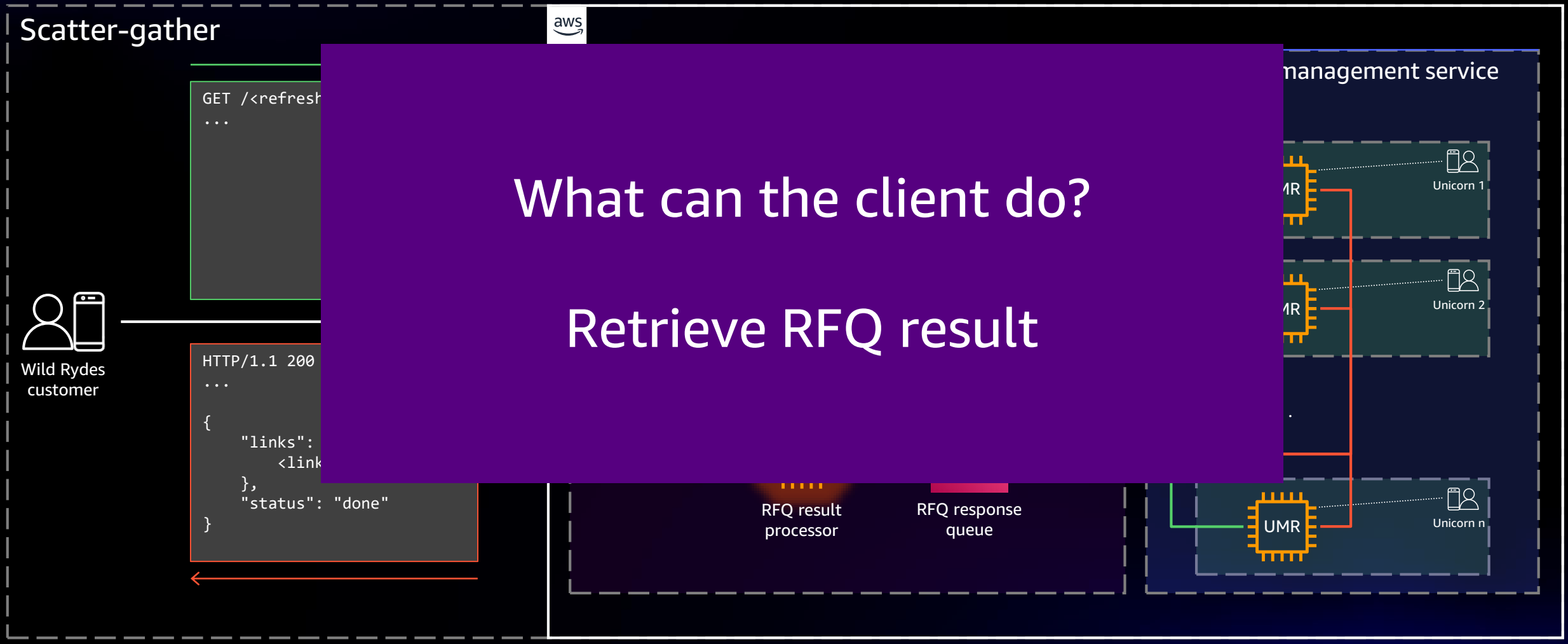
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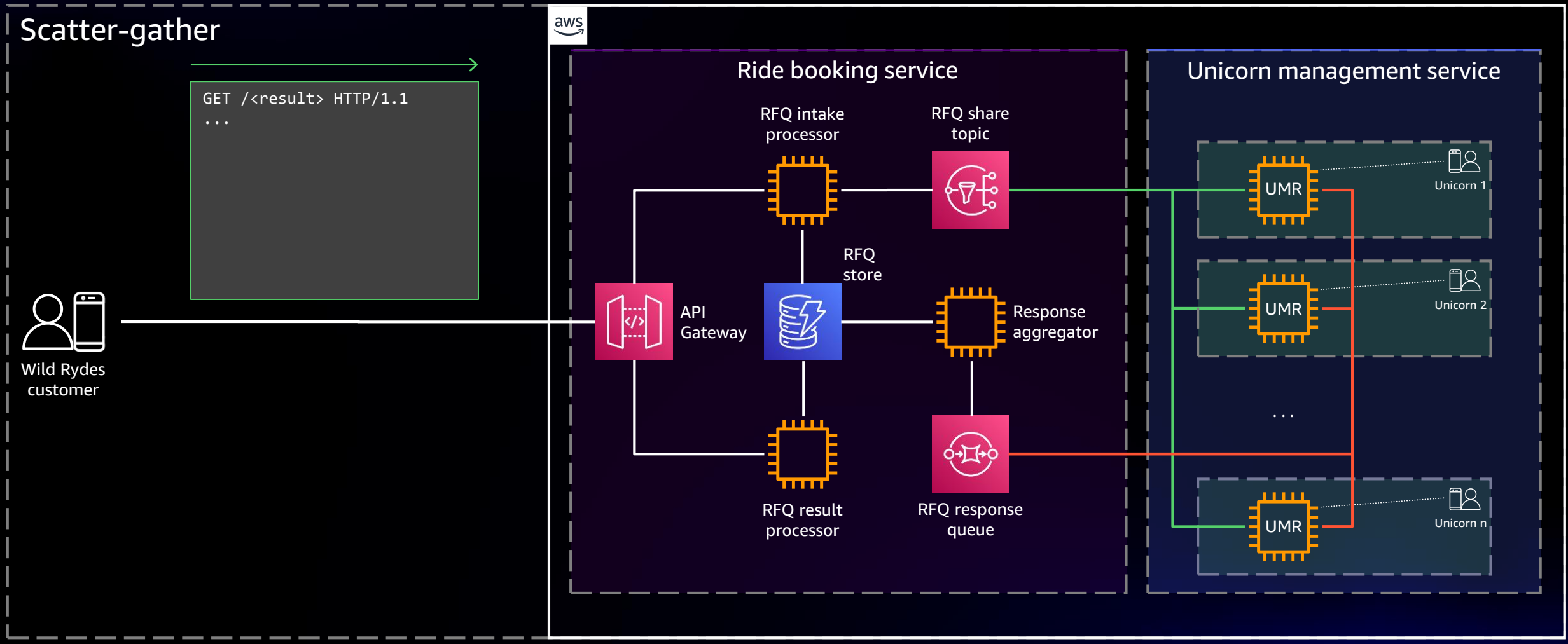


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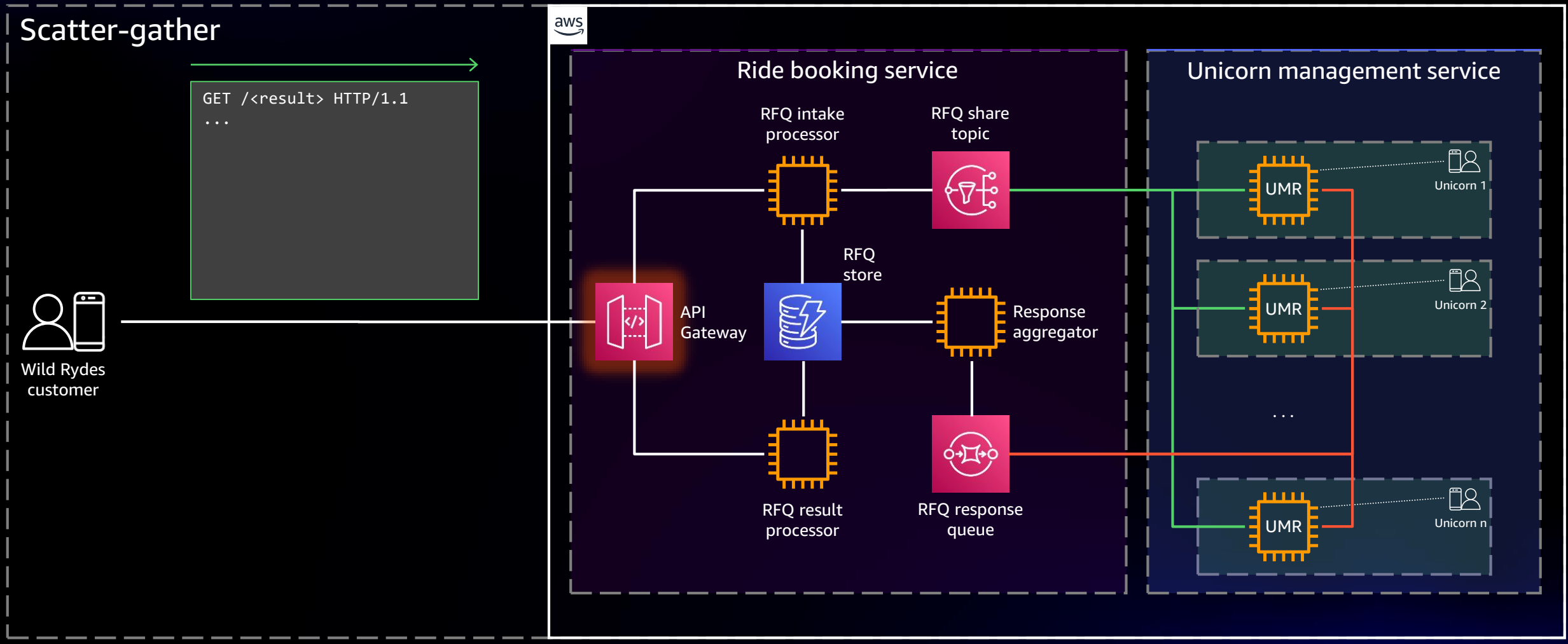
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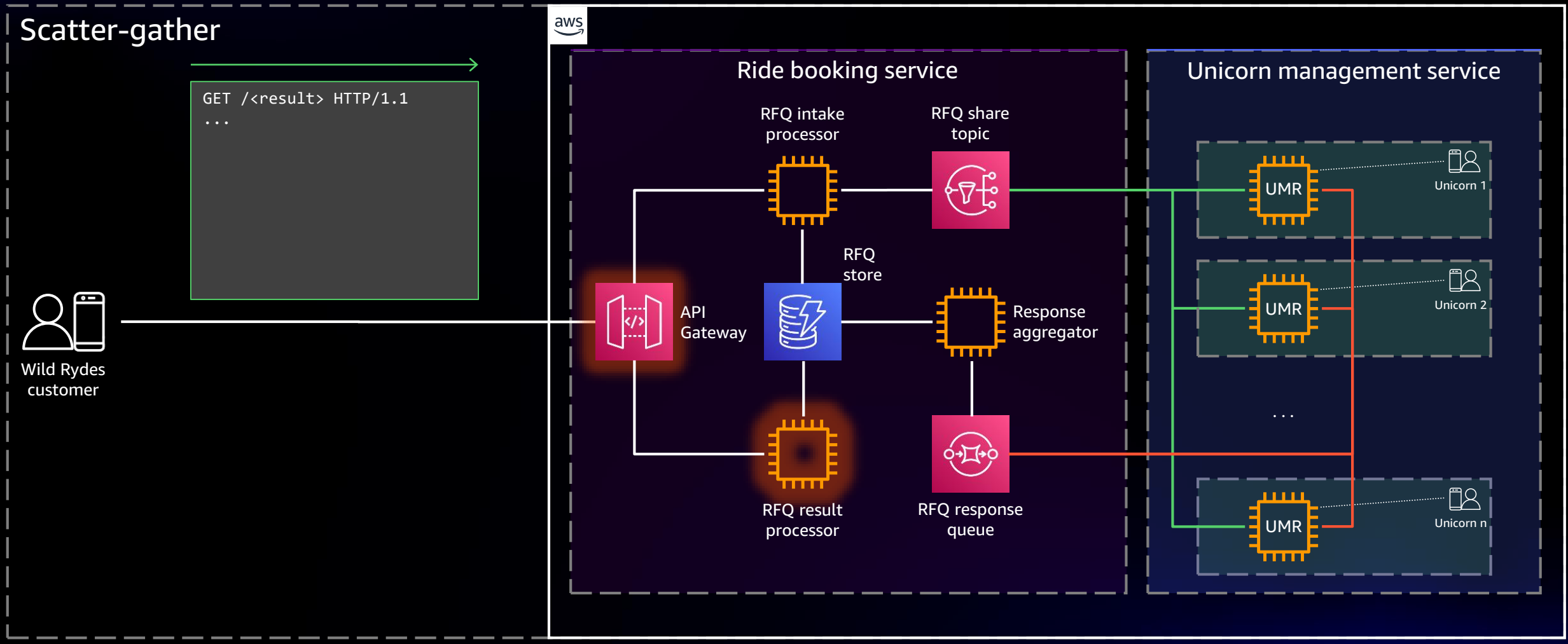
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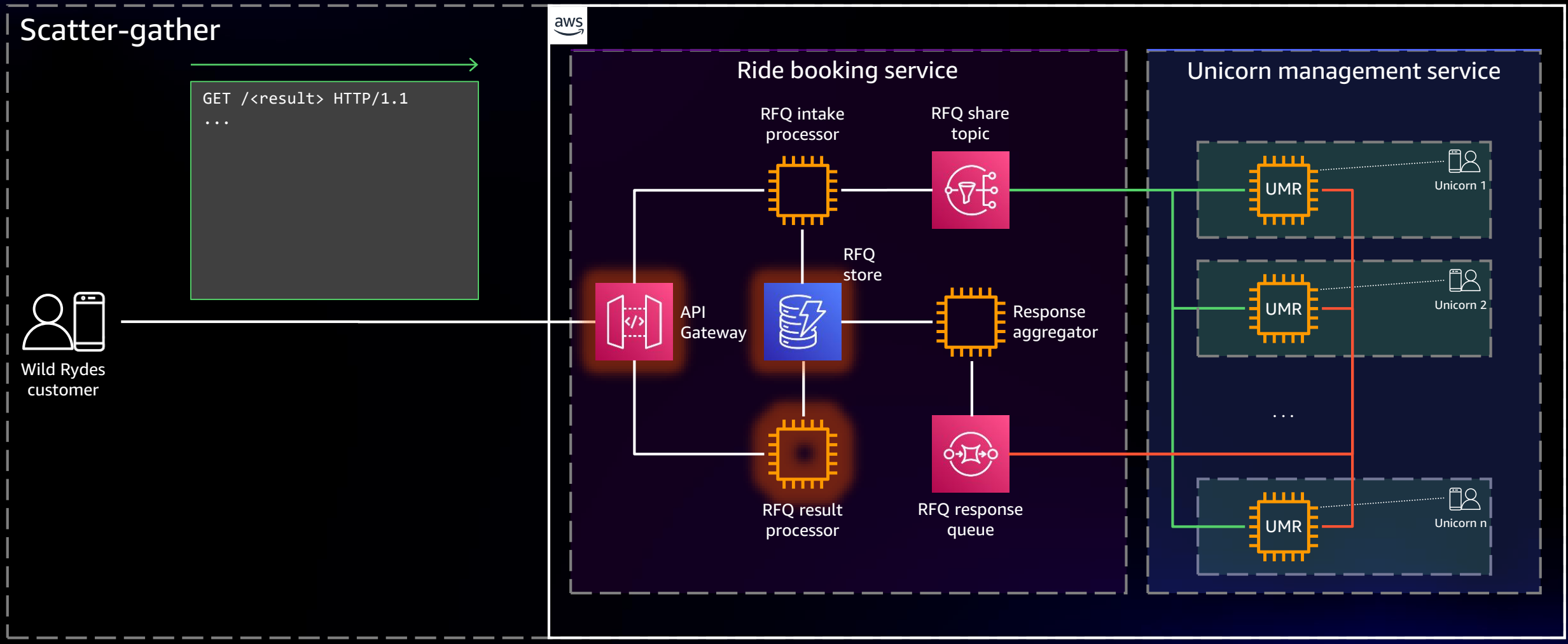
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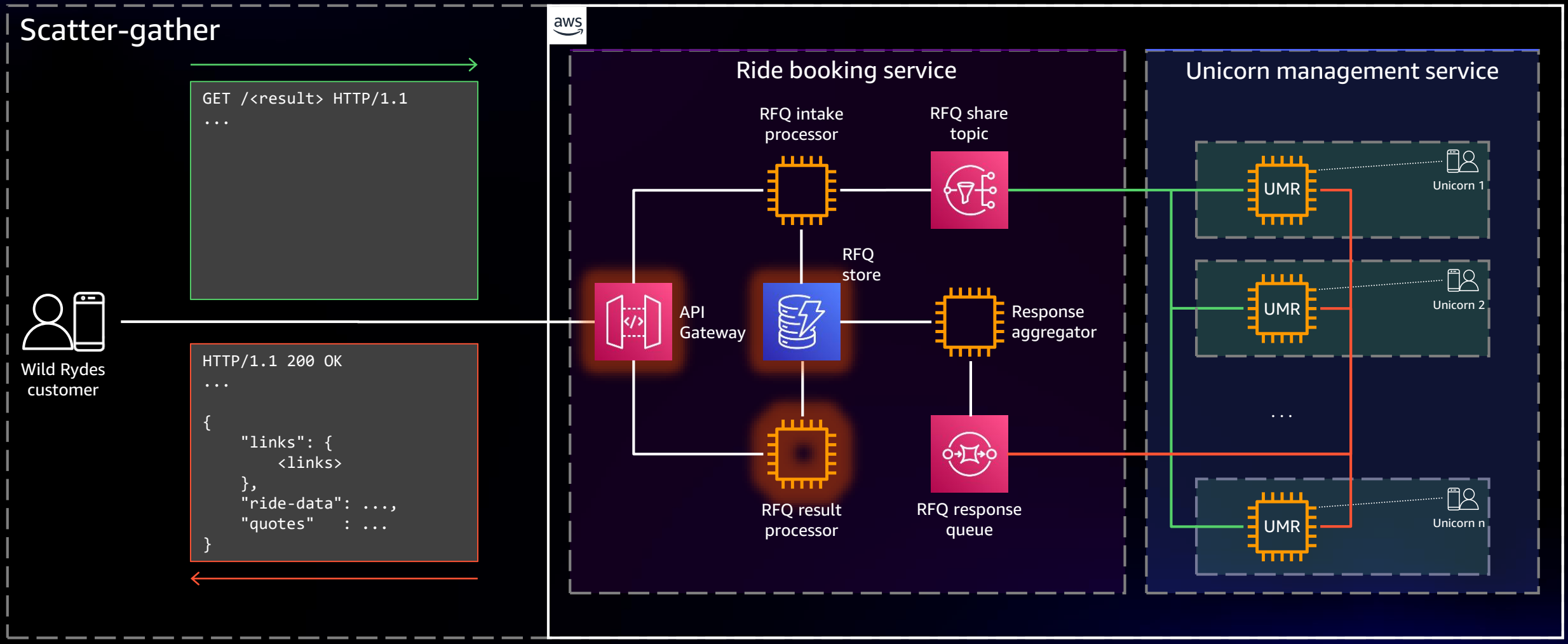
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Resources and call to action

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and keep in mind

Loose coupling is **always better** than **lousy** coupling

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Thank you!

Dirk Fröhner

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