AWS re:Invent

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

NFX302

Keeping Netflix reliable using prioritized load shedding

Manuel Correa (he/him)
Senior Software Engineer
Netflix

Rob Hilton (he/him)
Principal Solutions Architect
Amazon Web Services

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

As a Netflix member . . .

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.



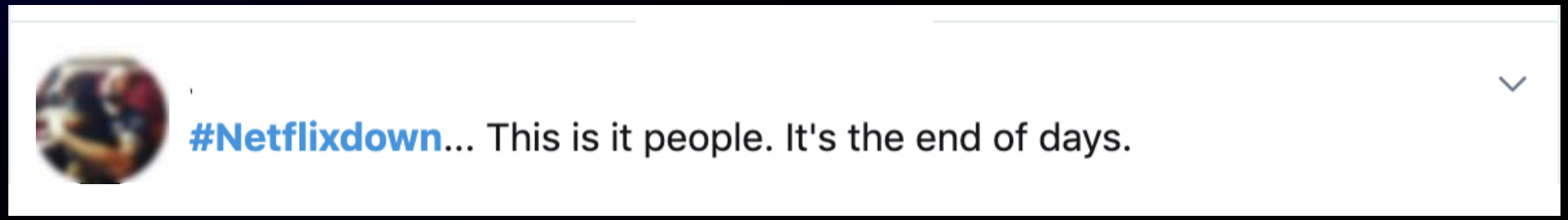
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.



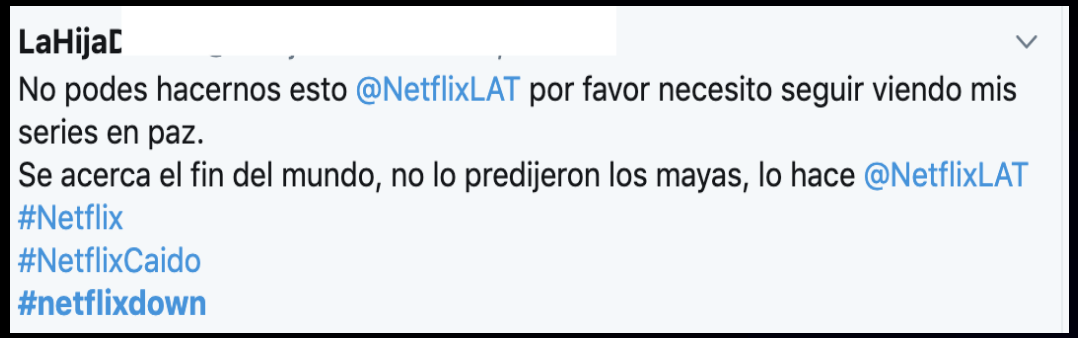
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.





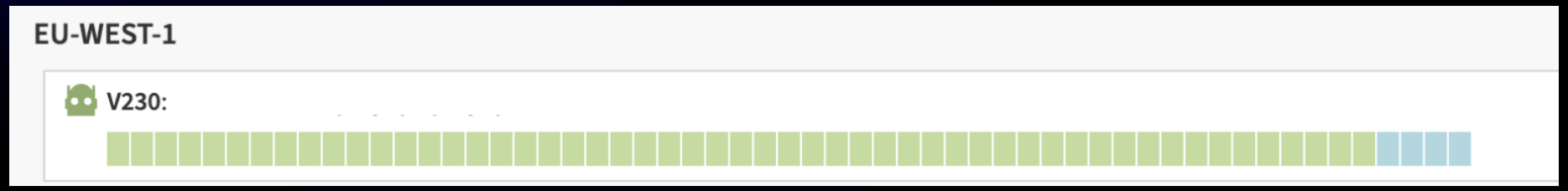


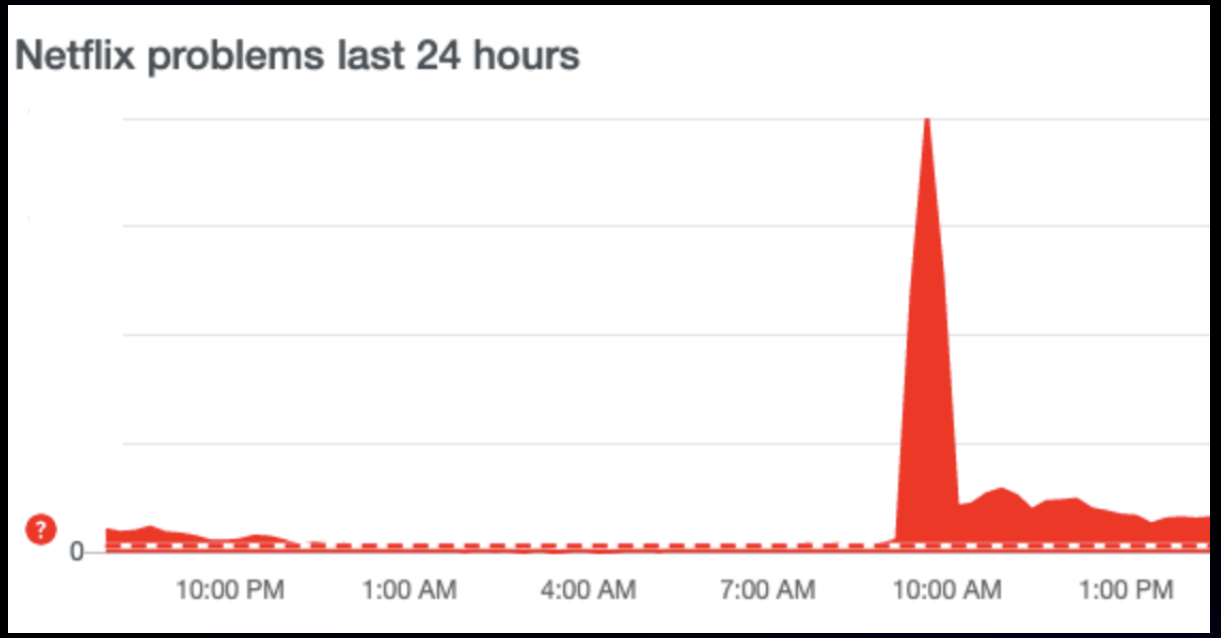
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

As a Netflix engineer . . .

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Underscaled service

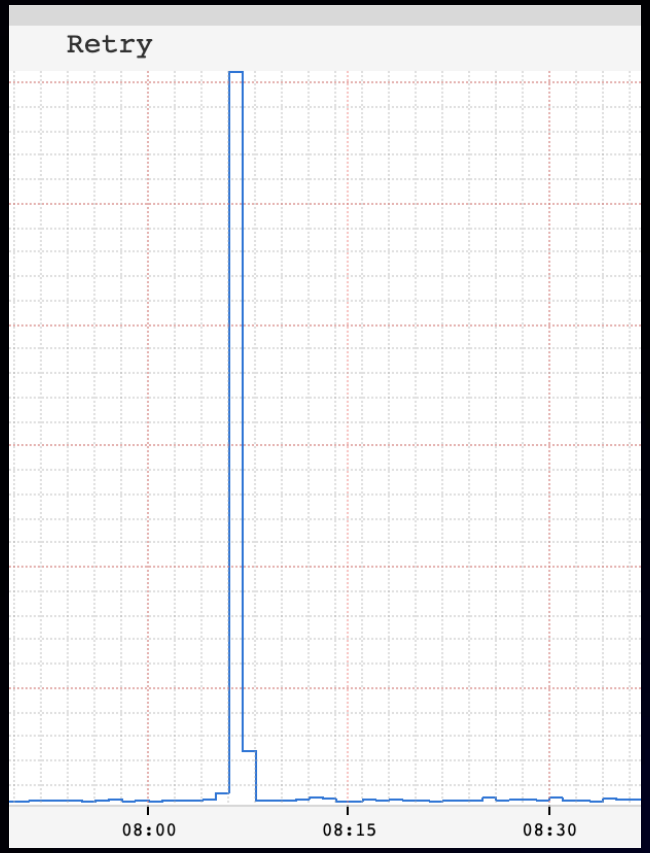




© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

ISP network blips





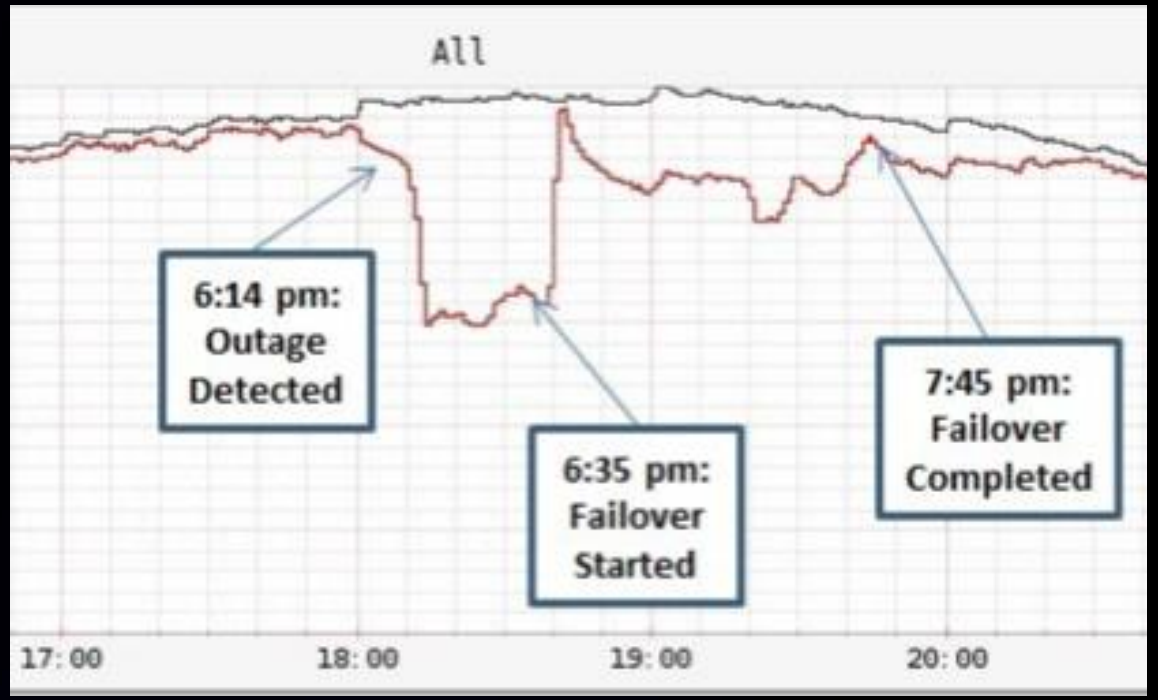
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Cloud infrastructure incidents

North America | South America | Europe | Asia Pacific

Recent Events	Details	
Amazon Simple Storage Service (N. Virginia)	Increased Error Rates	more
AWS CodeCommit (N. Virginia)	Increased Error Rates	more
AWS Elastic Beanstalk (N. Virginia)	Increased Error Rates	more
AWS Storage Gateway (N. Virginia)	Increased Error Rates	more

Remaining Services	Details
Amazon API Gateway (Montreal)	Service is operating normally
Amazon API Gateway (N. California)	Service is operating normally
Amazon API Gateway (N. Virginia)	Service is operating normally
Amazon API Gateway (Ohio)	Service is operating normally
Amazon API Gateway (Oregon)	Service is operating normally



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

A deployment of a non-playback service affecting ability to play



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Keeping Netflix reliable using prioritized load shedding

Manuel Correa (he/his/him)

Senior Software Engineer
Netflix

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Sustain Netflix service availability in moments of system failures by load shedding lower-priority requests



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

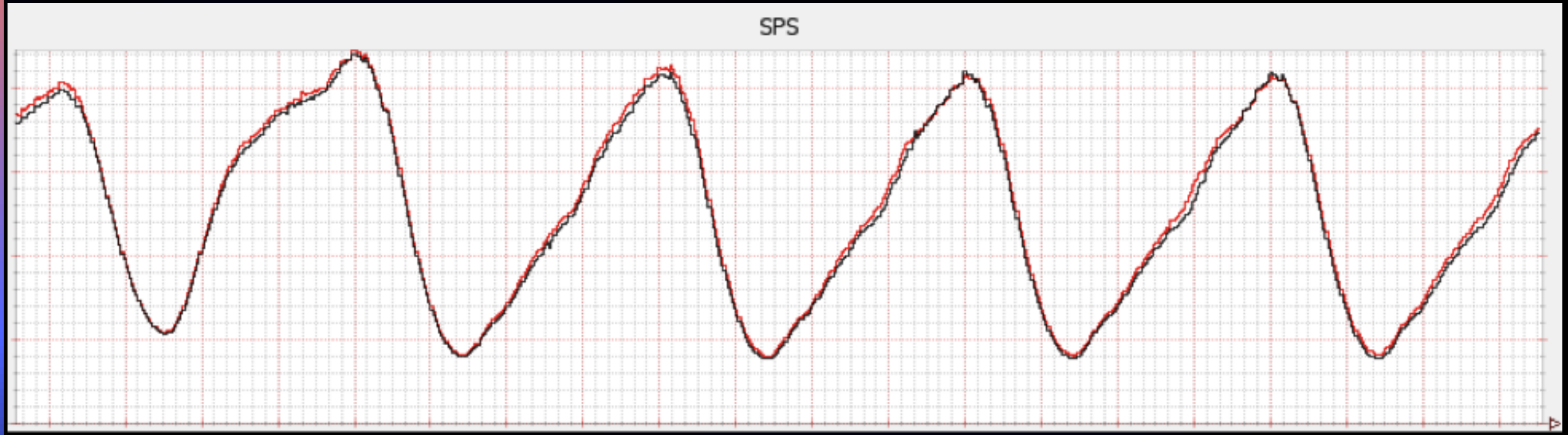
Sustain Netflix service availability in moments of system failures by load shedding lower-priority requests



aws

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Focus on one metric to measure success: Starts per second (SPS)



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.



Request taxonomy

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.



Request taxonomy



Progressively throttle requests

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.



Request taxonomy



Progressively throttle requests



Validate assumptions using fault injection (chaos testing)

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.



Request taxonomy

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Can your service tolerate disruption?
Can we assign low priority to your service?

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Can your service tolerate disruption?
Can we assign low priority to your service?

No! Please don’t **disrupt my service**.
It is critical for Netflix!

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Can your service tolerate disruption if that allows Netflix members to continue streaming?

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Can your service tolerate disruption if that allows Netflix members to continue streaming?

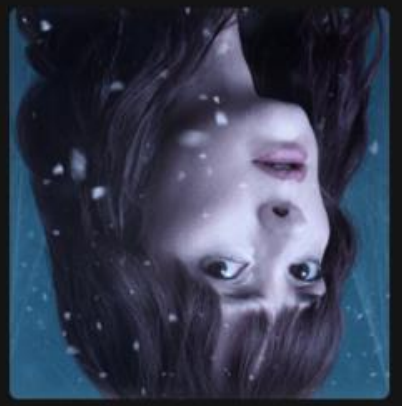
Yes! No need to ask!

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Who's watching?



Manuel



Cathy



Laura



Macondo



Isabella

MANAGE PROFILES

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Play

More Info

TV-14

I trust you will make her feel welcome.

Top 10 in the U.S. Today

1



2



3



4



5



6



Continue Watching for Cathy







S2:E3 "Dogfight"





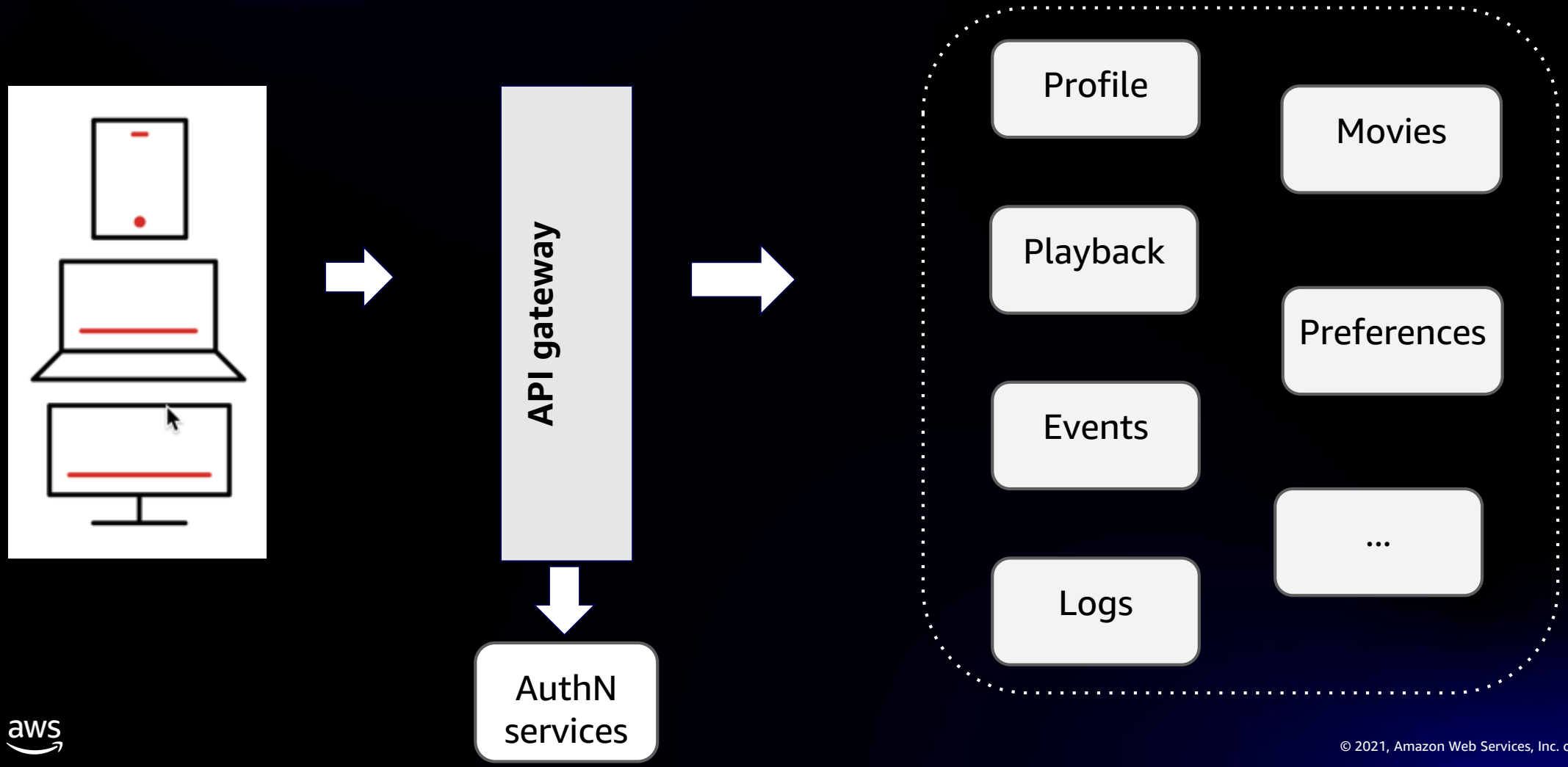


© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.



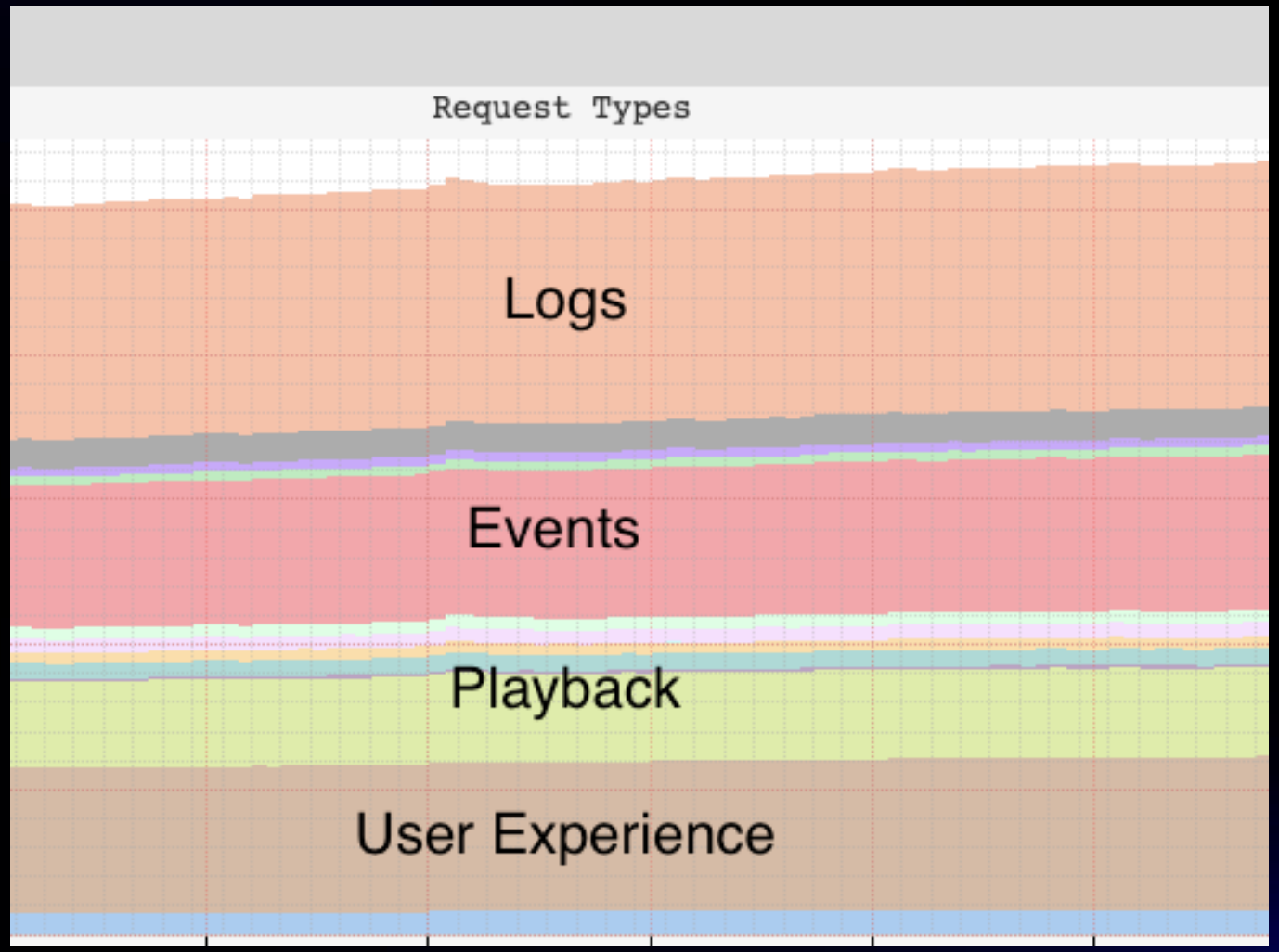
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Well-defined bounded context allows easier categorization of requests based on functions or features



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Throughput characteristics of request types influence the traffic that can be dropped to relieve resources



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

High impact

- APIs essential to the play experience
- If the API is down, customers won’t be able to play
- Very high SLA

Low impact

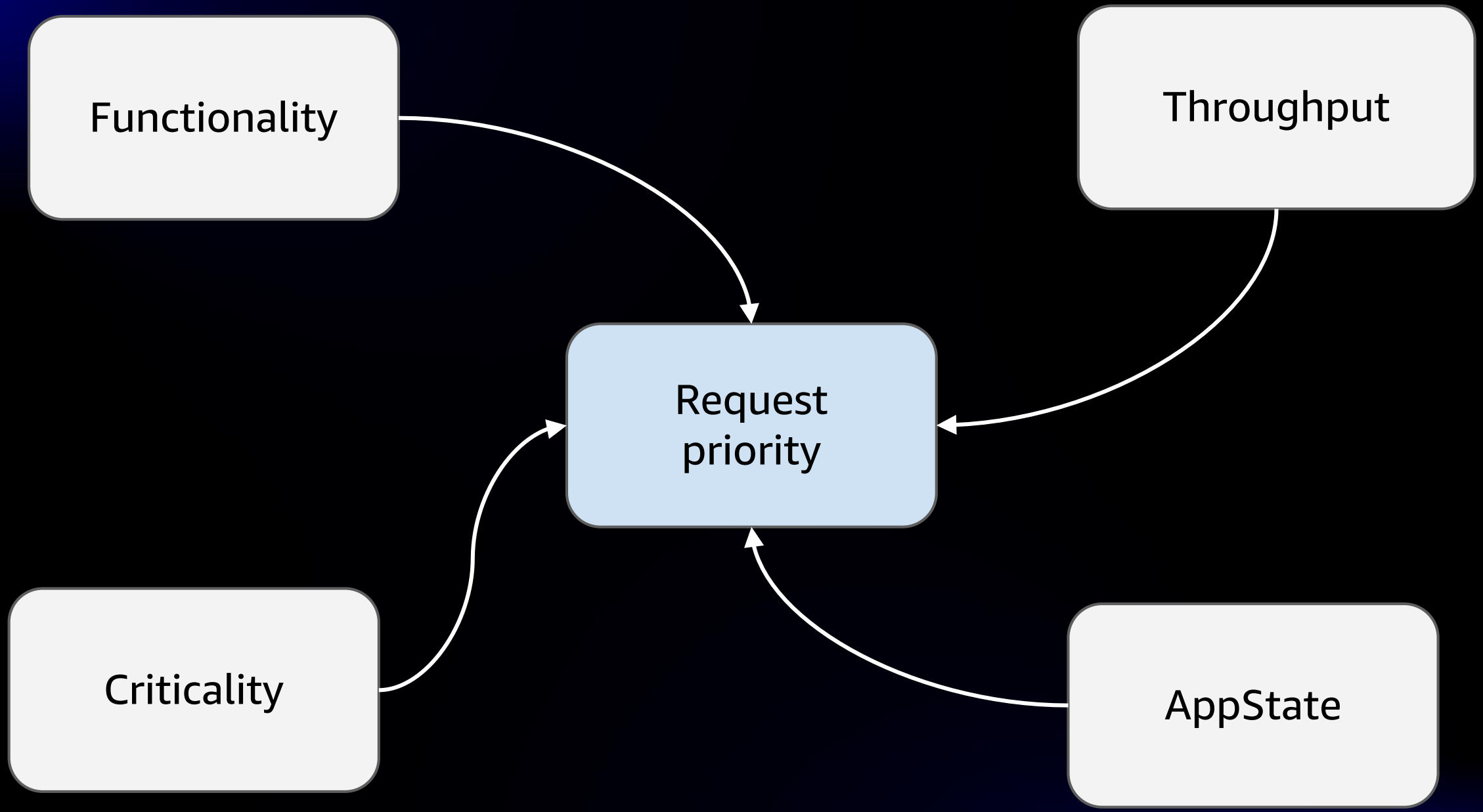
- API with well-defined fallback or not essential to the play experience
- Service degradation rather than a loss of service
- Flexible SLA

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.



Favor requests in the foreground (user initiated) vs. requests made in the background (app initiated)

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Assigning priority to the request uses all four dimensions



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Dimensions	Potential traffic drop	Priority
Low impact, high throughput	~40%	>= 90
Low impact, background	~60%	>= 80
Higher impact, lower throughput	~70%	>= 60
Higher impact, experience degradation	~80%	>= 40
High impact	~95%	>= 10
Full outage	100%	>= 1

aws

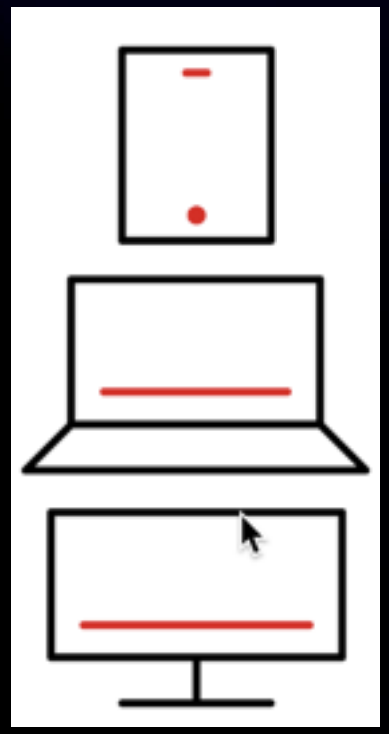
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.



Progressively throttle requests based on priority

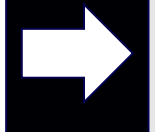
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

API gateway layer 7





N
L
B



API gateway (Zuul)

- Routing
- AuthN
- Insights
- ...

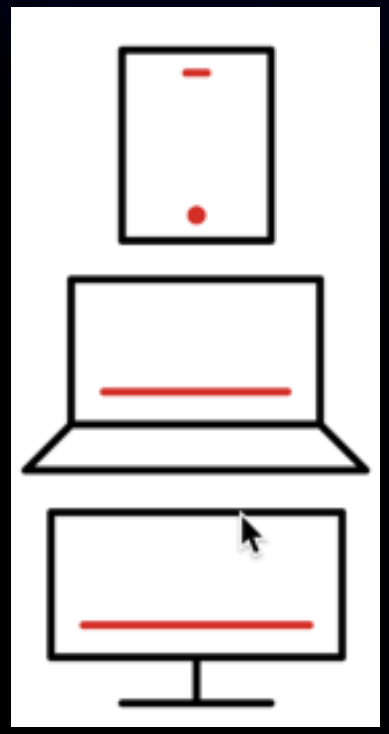


- Login
- Movies
- Playback
- Logs

aws

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

API gateway layer 7



NLB

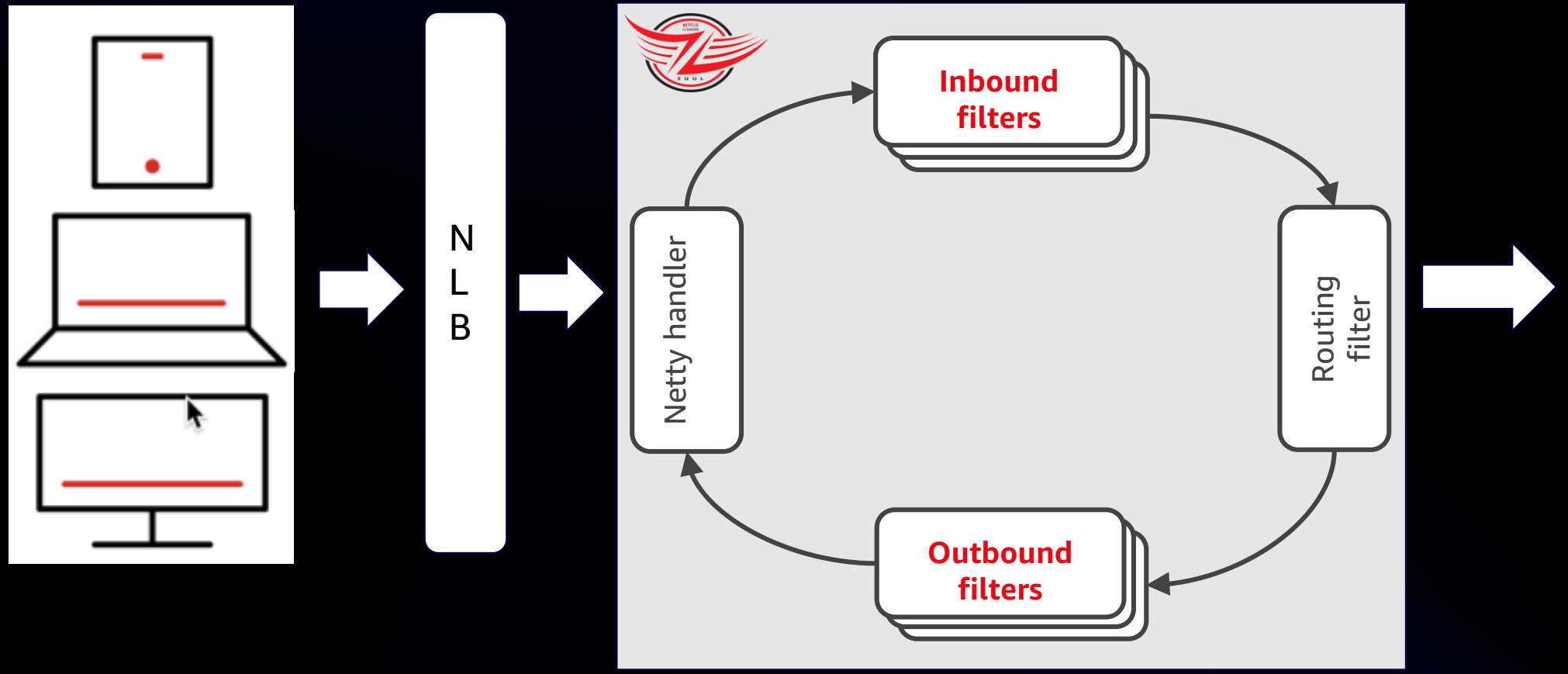
API gateway (Zuul)

- Routing
- AuthN
- Insights
- **Priority label**
- **Load shedding**

- Login
- Movies
- Playback
- Logs

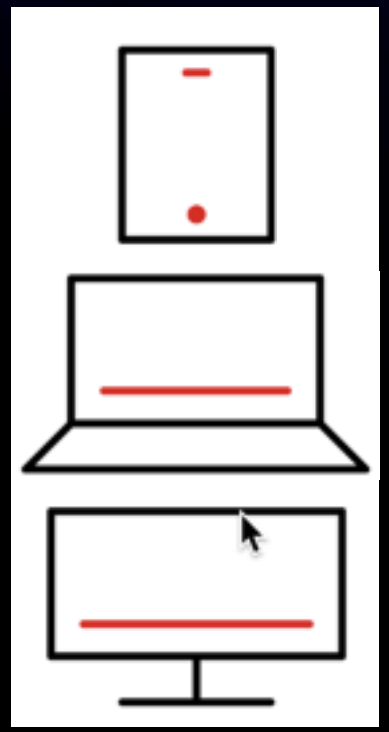
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

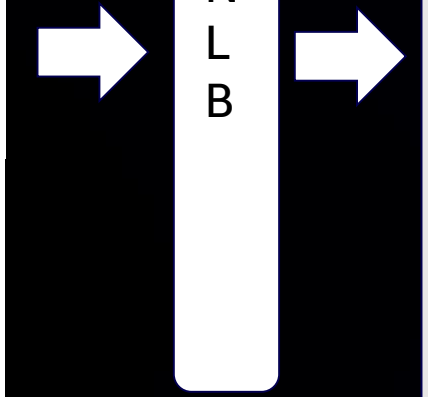
API gateway layer 7

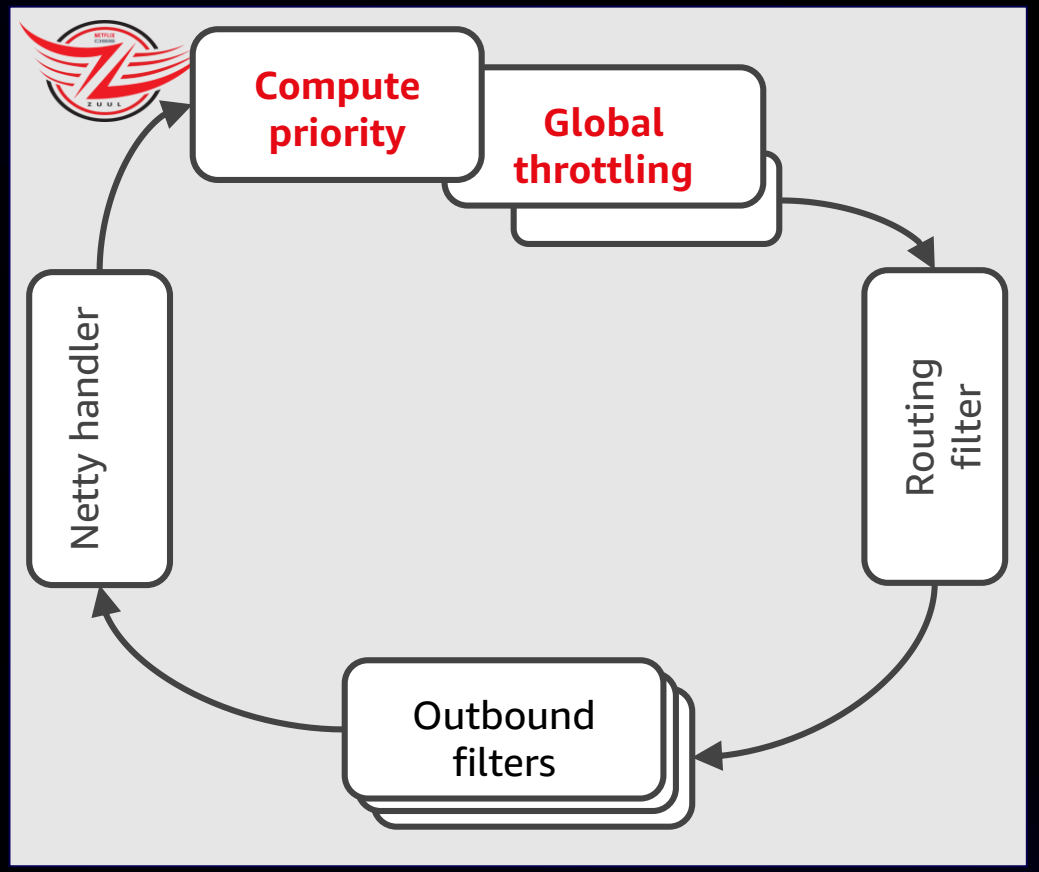


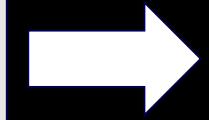
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

API gateway layer 7









Login

Movies

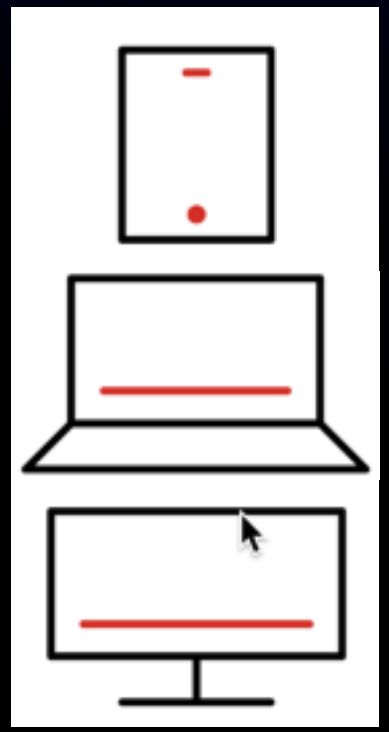
Playback

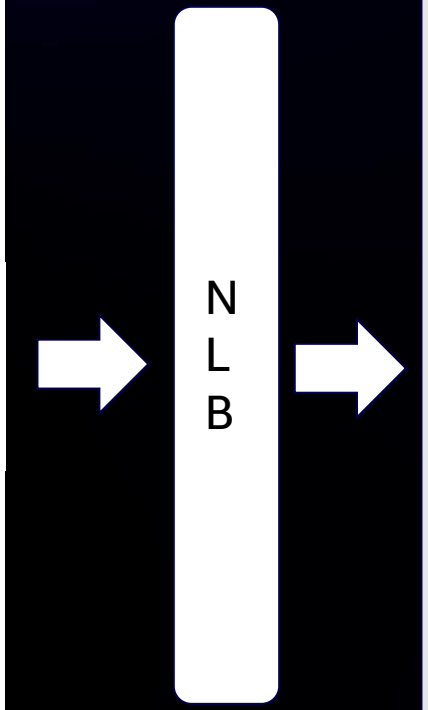
Logs

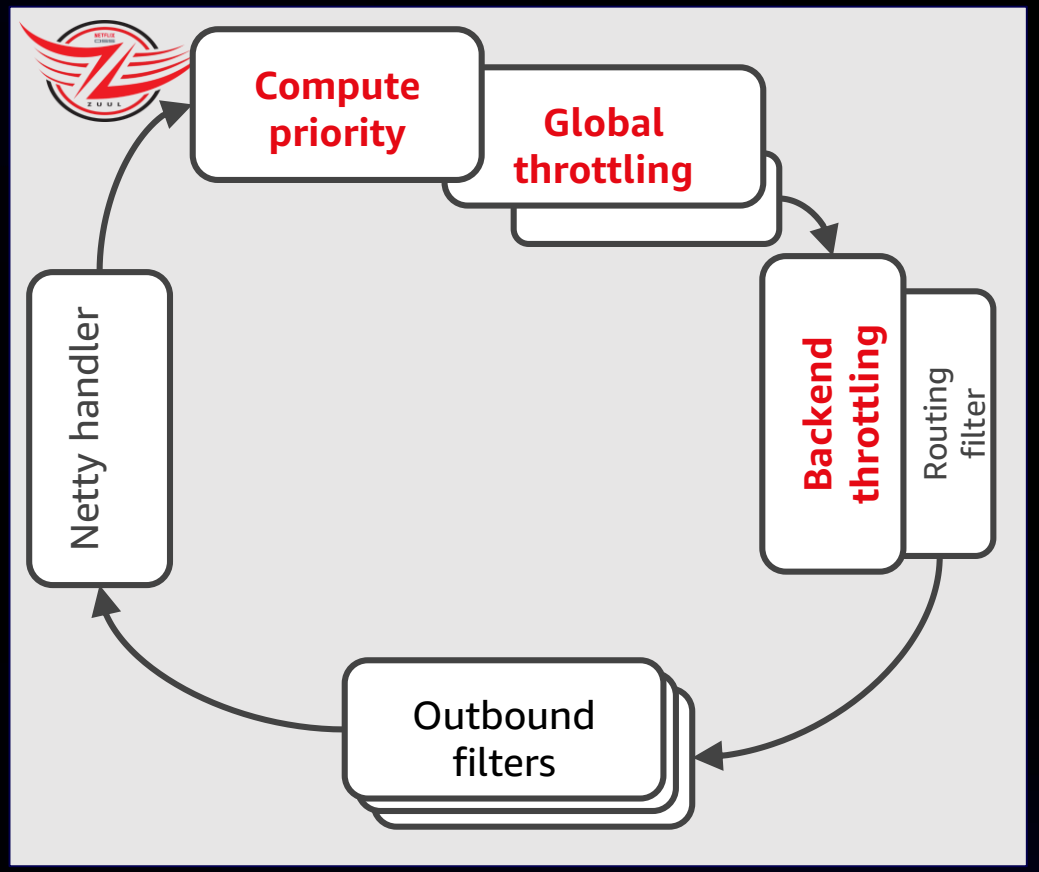
aws

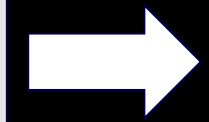
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

API gateway layer 7









- Login
- Movies
- Playback
- Logs

aws

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Progressive load shedding

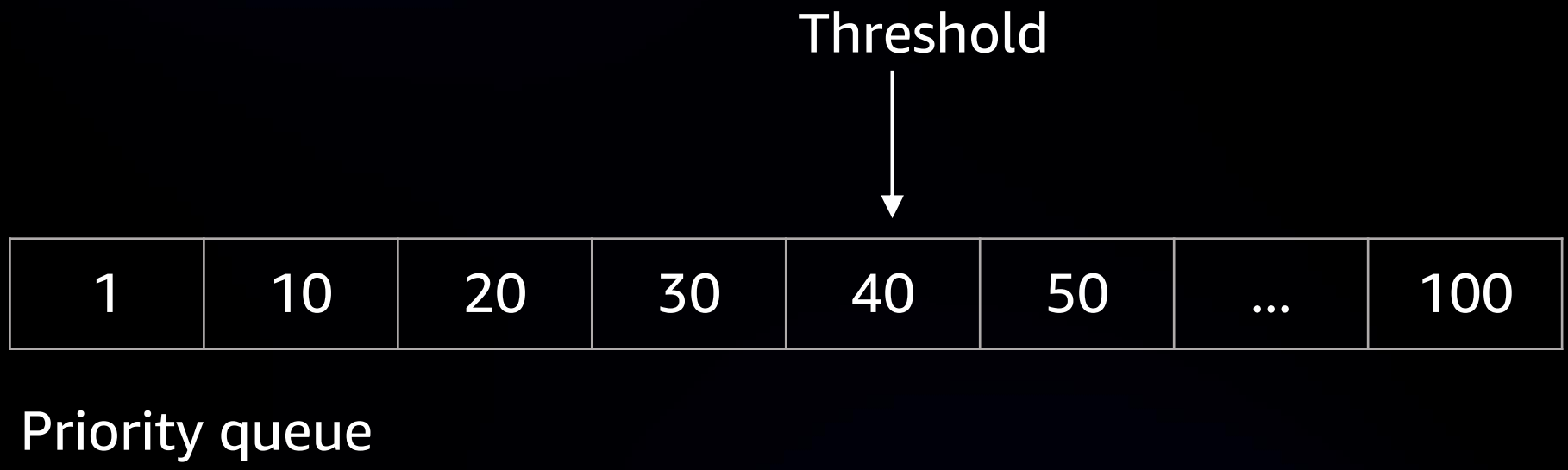


Priority queue

aws

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

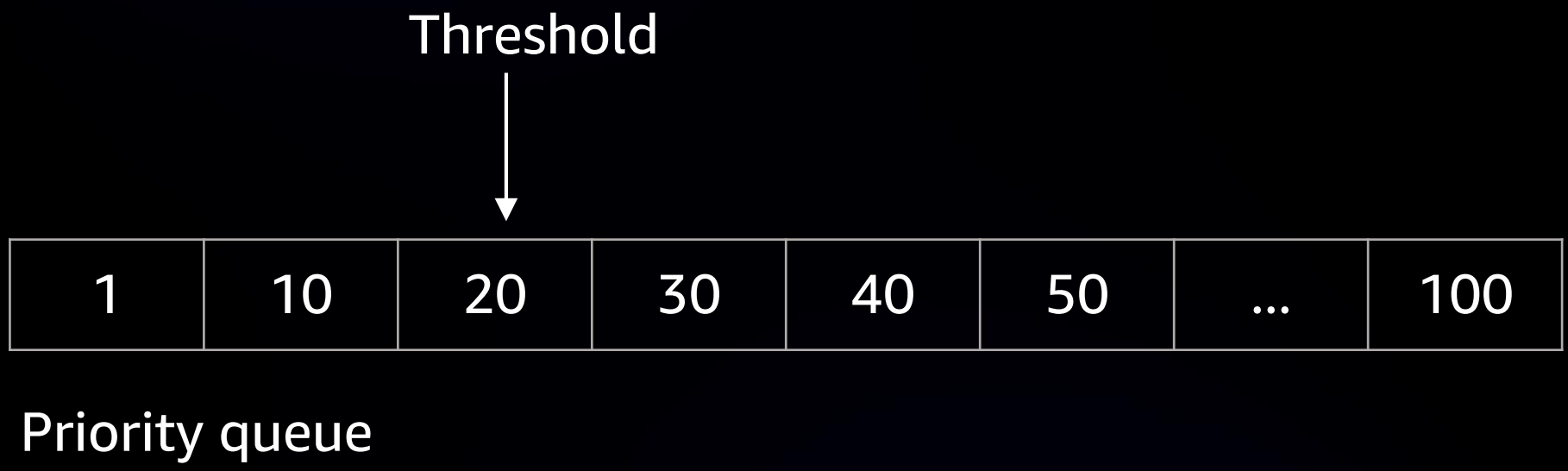
Progressive load shedding



aws

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Progressive load shedding



aws

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Progressive load shedding



aws

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Zuul determines the priority threshold based on resource constraints like CPU and backend error rates



CPU for global throttling



Error rate for backend throttling

aws

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

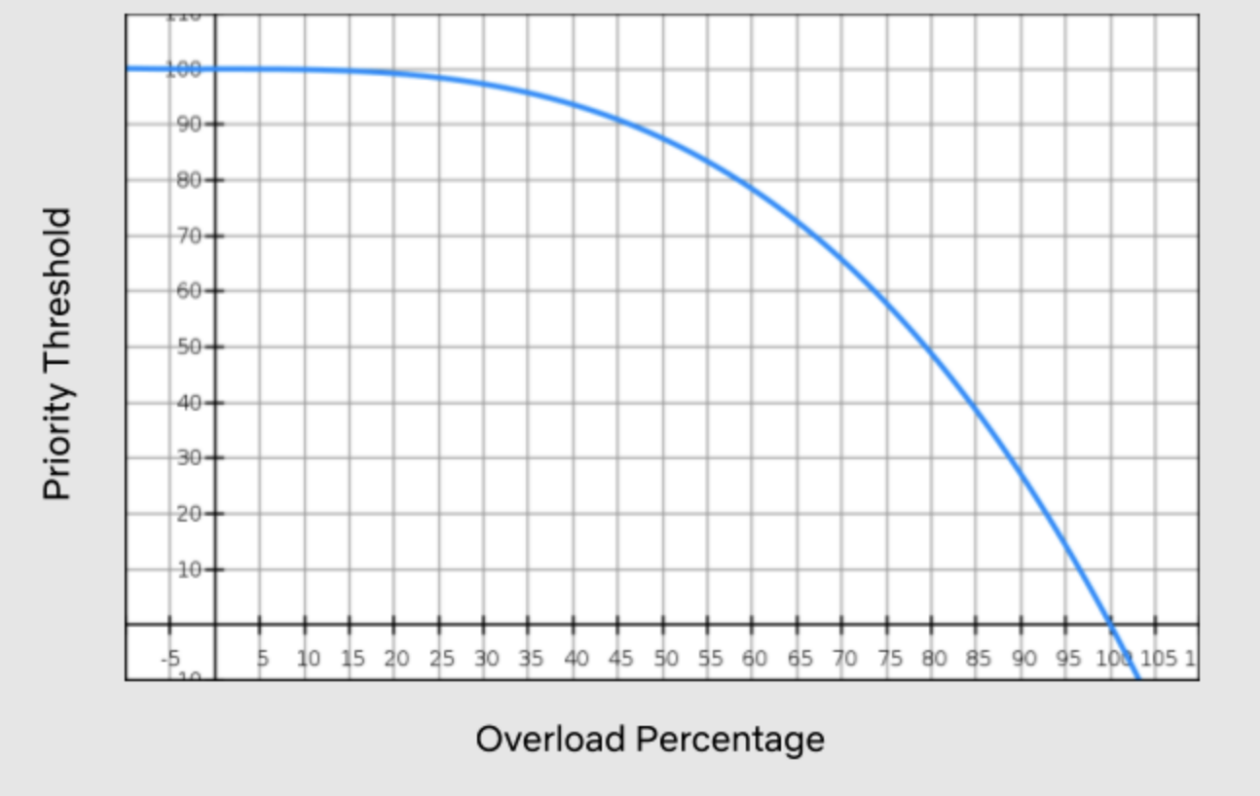
Progressive load shedding

```
if (priority >= priorityThreshold) {
    rejectRequest(request, context);
}
```

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Progressive load shedding

```
if (priority >= priorityThreshold) {
    rejectRequest(request, context);
}
```

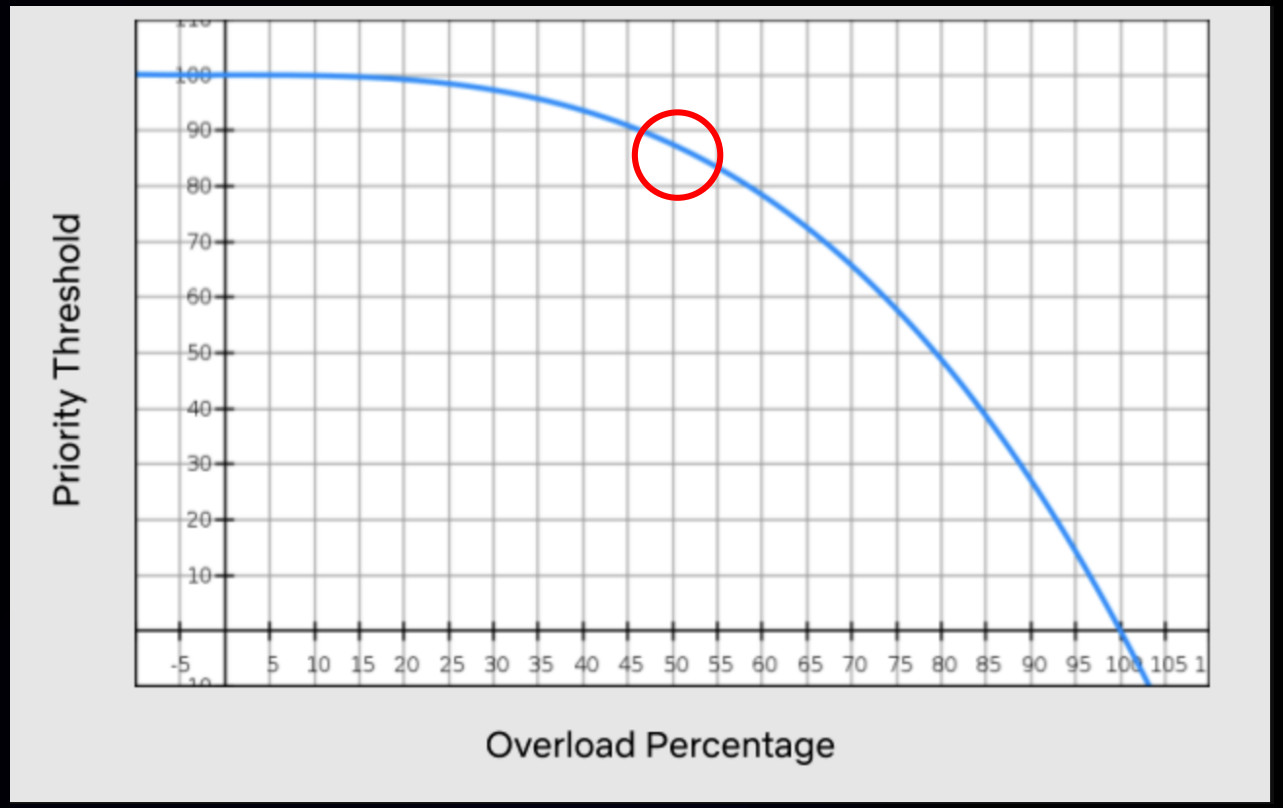


© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Progressive load shedding

```
if (priority >= priorityThreshold) {
    rejectRequest(request, context);
}
```

Constraint resource (CPU/ErrorRate)	Priority threshold
98	0.88
95	9.26
93	14.56
90	22.10
85	33.59
80	43.80
75	52.81
70	60.70
60	73.40
50	82.50
30	92.30
20	94.20
10	94.90



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Dimensions	Potential traffic drop	Priority
Low impact, high throughput	~40%	>= 90
Low impact, background	~60%	>= 80
Higher impact, lower throughput	~70%	>= 60
Higher impact, experience degradation	~80%	>= 40
High impact	~95%	>= 10
Full outage	100%	>= 1

aws

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Dimensions	Potential traffic drop	Priority
Low impact, high throughput	~40%	>= 90
Low impact, background	~60%	>= 80
Higher impact, lower throughput	~70%	>= 60
Higher impact, experience degradation	~80%	>= 40
High impact	~95%	>= 10
Full outage	100%	>= 1

aws

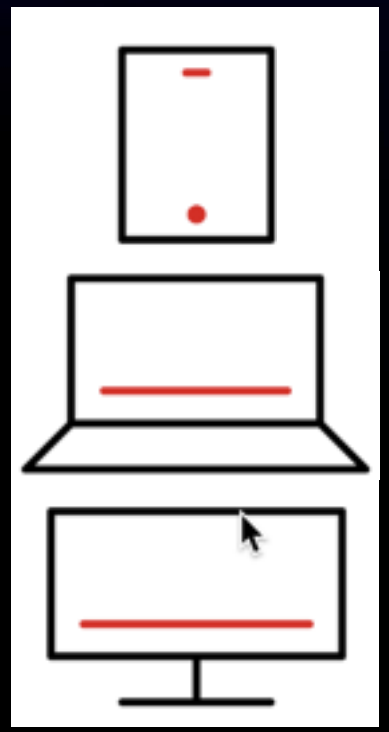
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

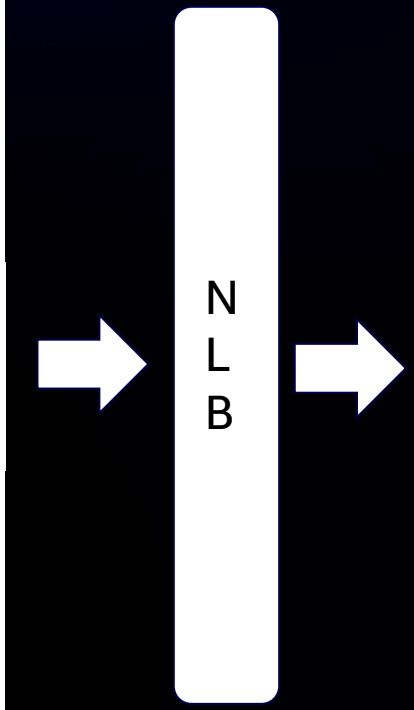
What about retry storms?

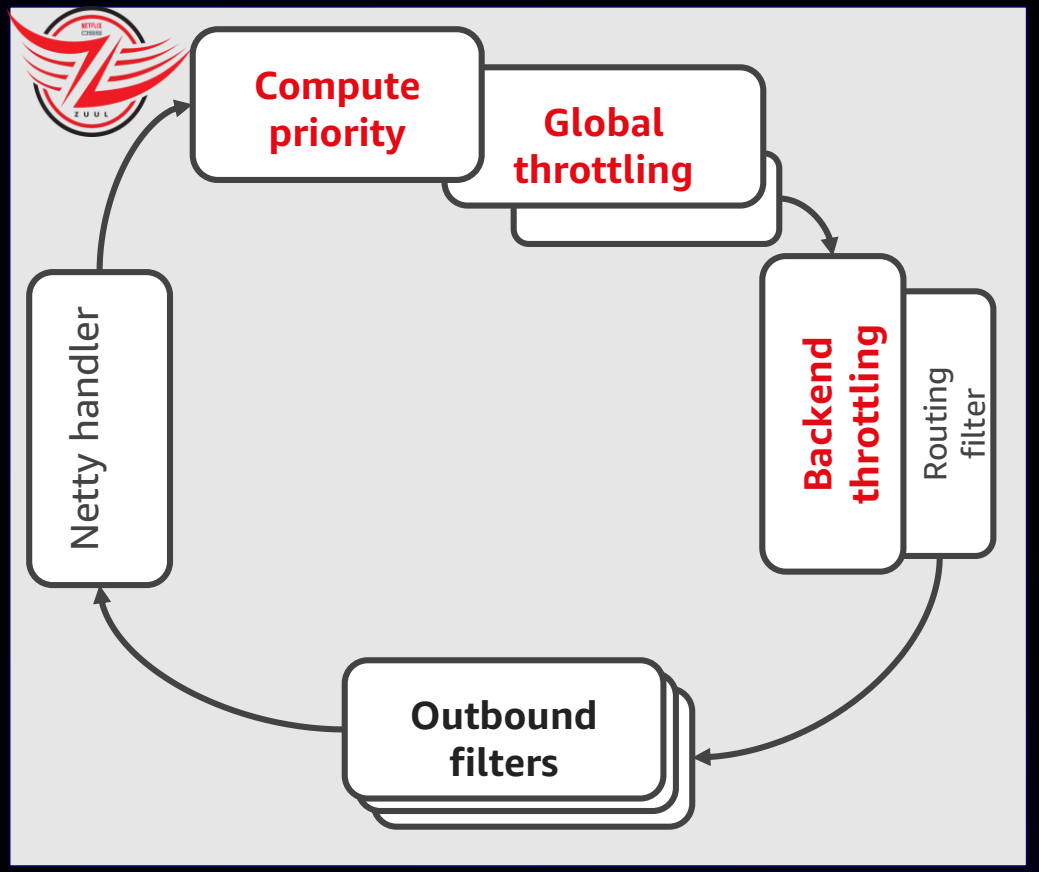


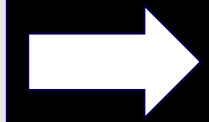
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

API gateway layer 7







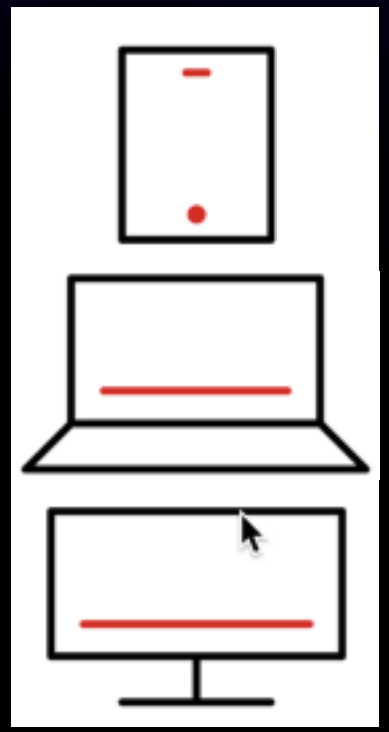


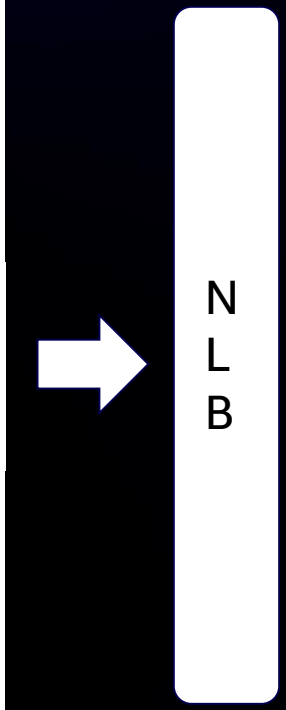
- Login
- Movies
- Playback
- Logs

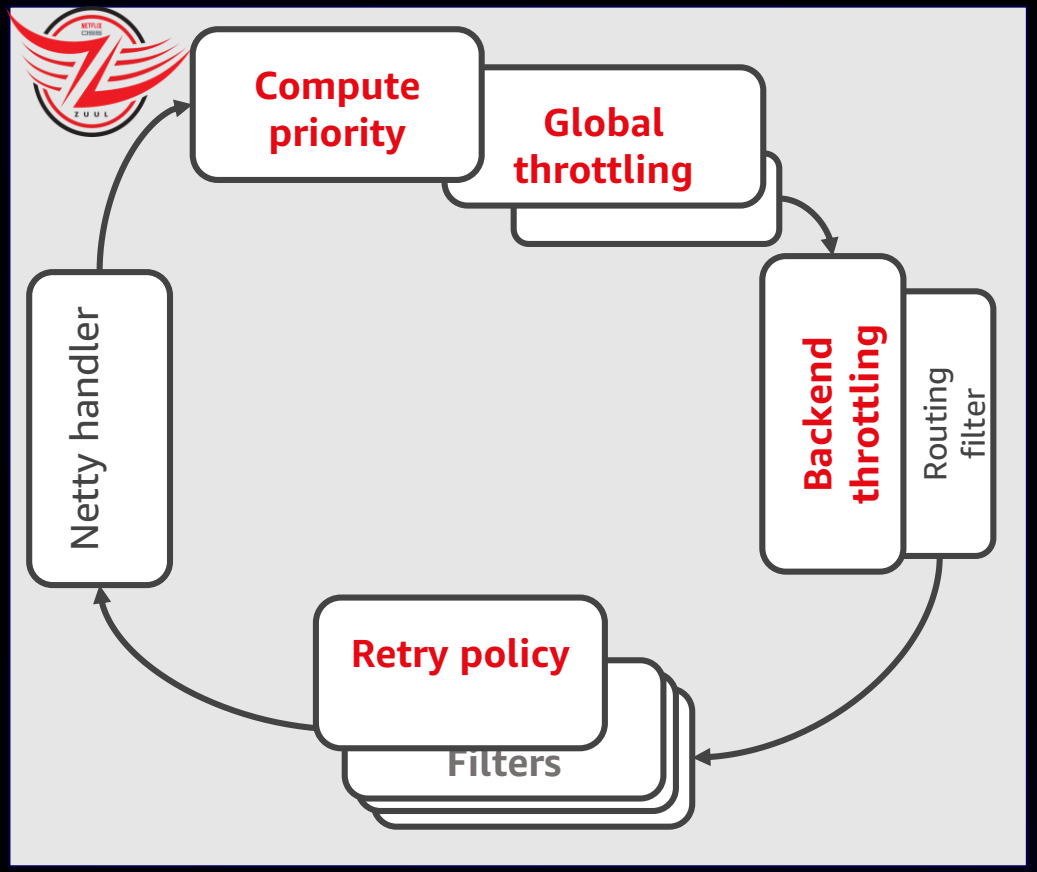
aws

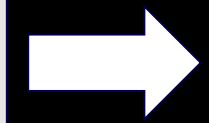
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

API gateway layer 7









- Login
- Movies
- Playback
- Logs

aws

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

```
{
"maxRetries" : <max-retries>,
“retryAfterSeconds”: <seconds>
}
```

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

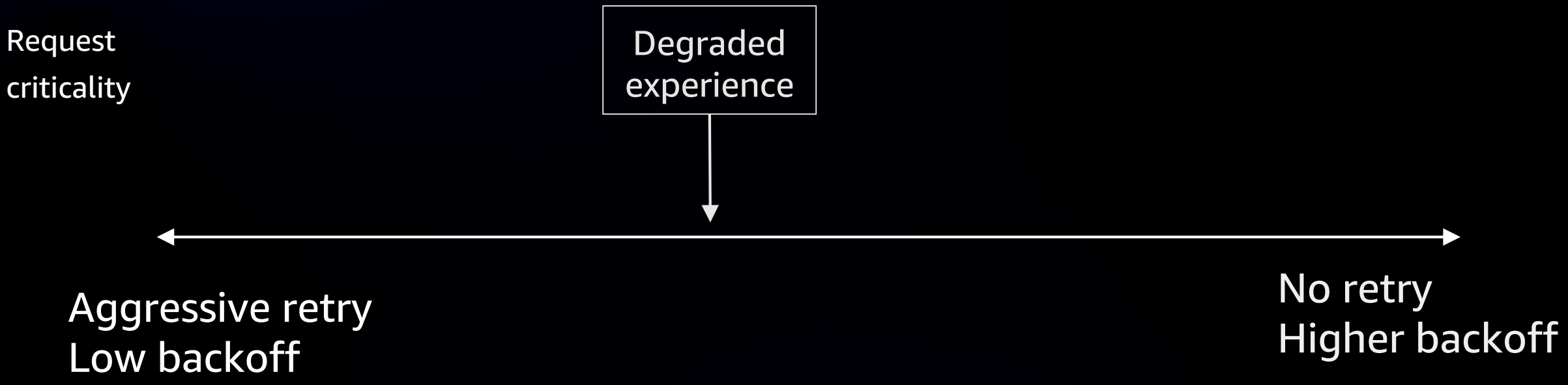
Progressive retry policy




```
{
"maxRetries" : 3,
“retryAfterSeconds”
: 1
}
```

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Progressive retry policy




```
{
"maxRetries" : 2,
“retryAfterSeconds”: 5
}
```

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Progressive retry policy

Request criticality




```
{
"maxRetries" : 1,
“retryAfterSeconds”: 30
}
```

aws

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.



Validate assumptions using fault injection (chaos testing)

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Fault injection experiments are used in chaos engineering, which is the practice of stressing an application in testing or production environments by creating disruptive events, such as sudden increase in CPU or memory consumption, observing how the system responds, and implementing improvements



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.



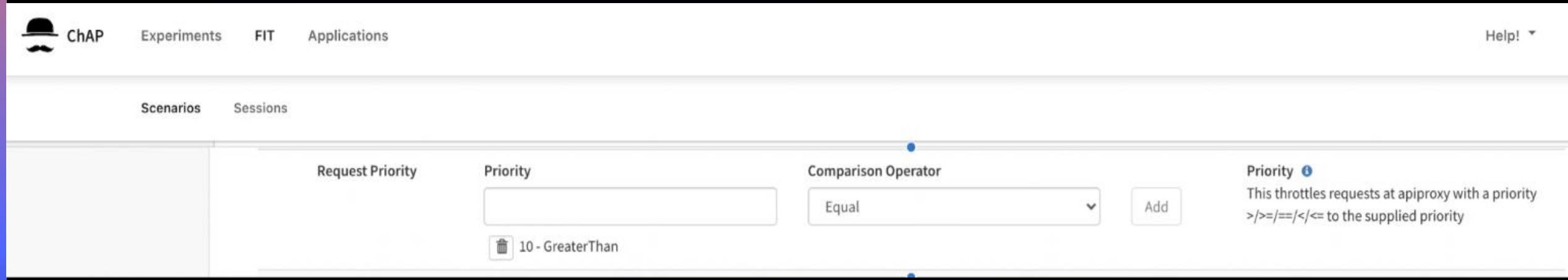


aws

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Experiment hypothesis:

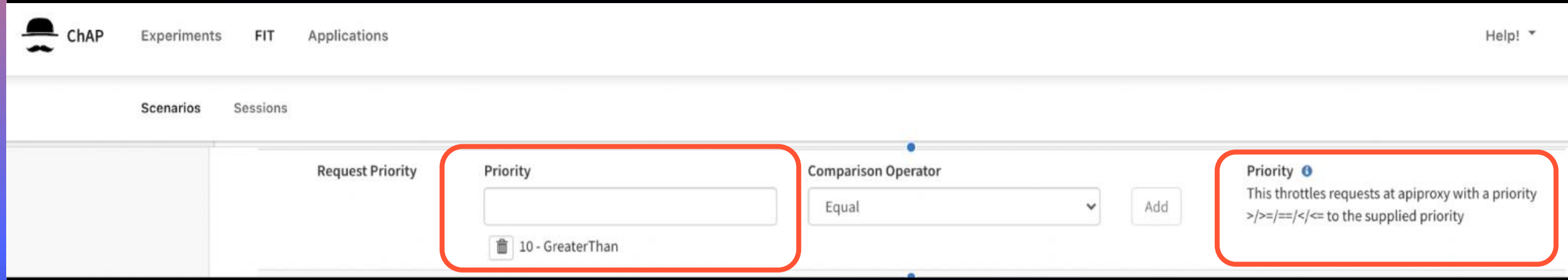
Throttling lower priority requests does not disrupt the ability to Play on a specific device



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

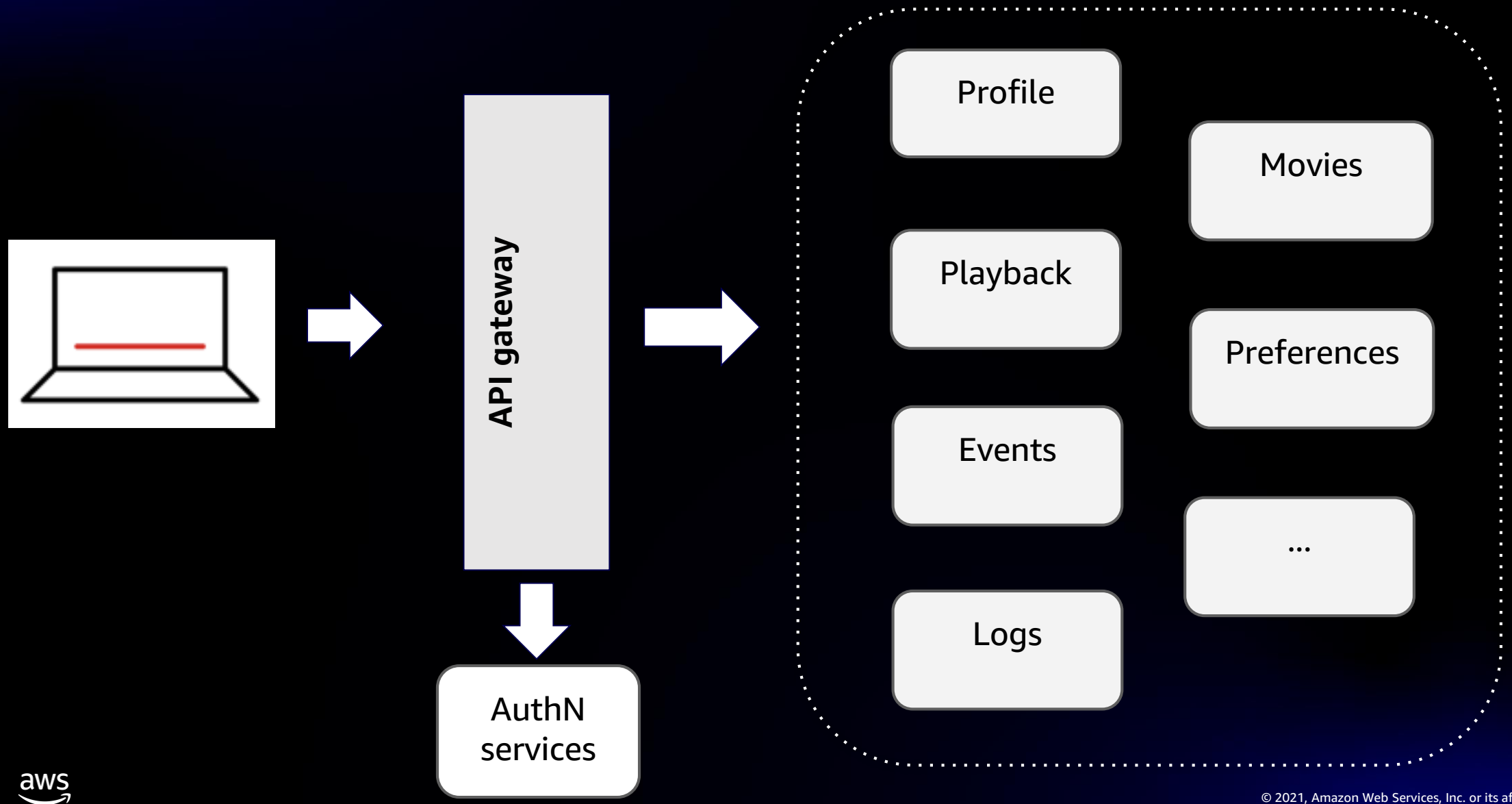
Experiment hypothesis:

Throttling lower priority requests does not disrupt the ability to Play on a specific device



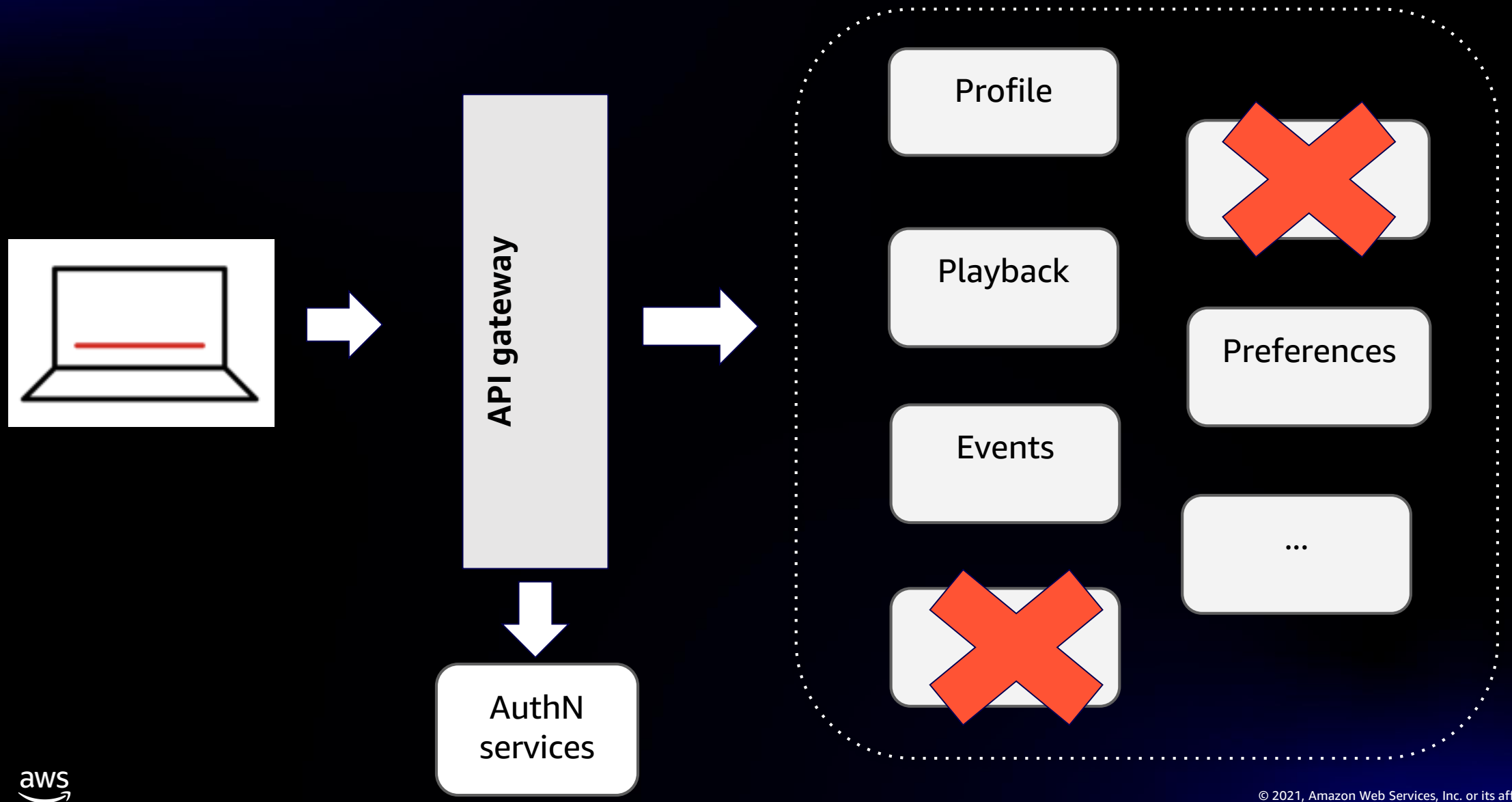
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Target a specific device and throttle low-priority services



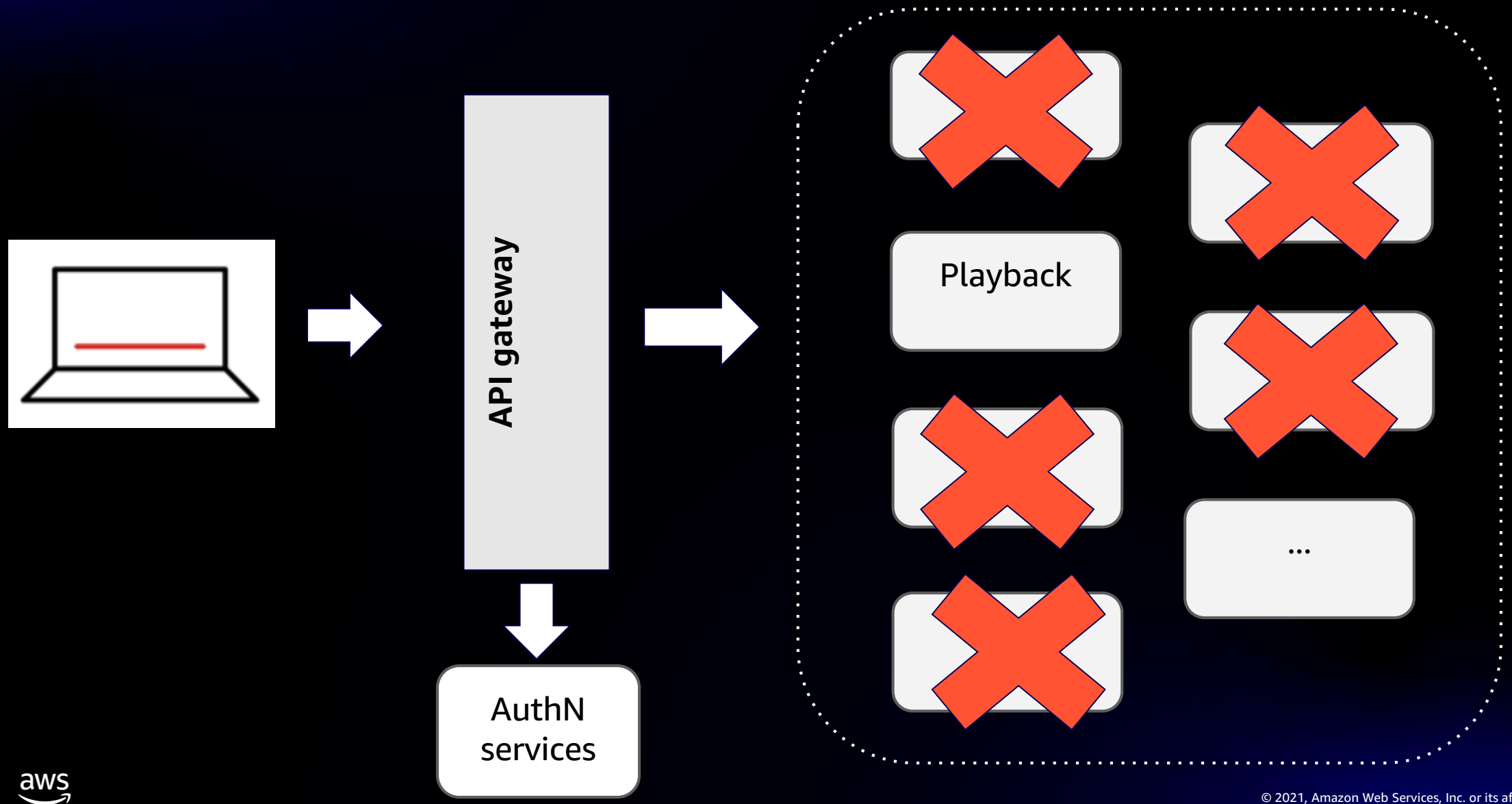
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Target a specific device and throttle low-priority services



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Target a specific device and throttle low-priority services

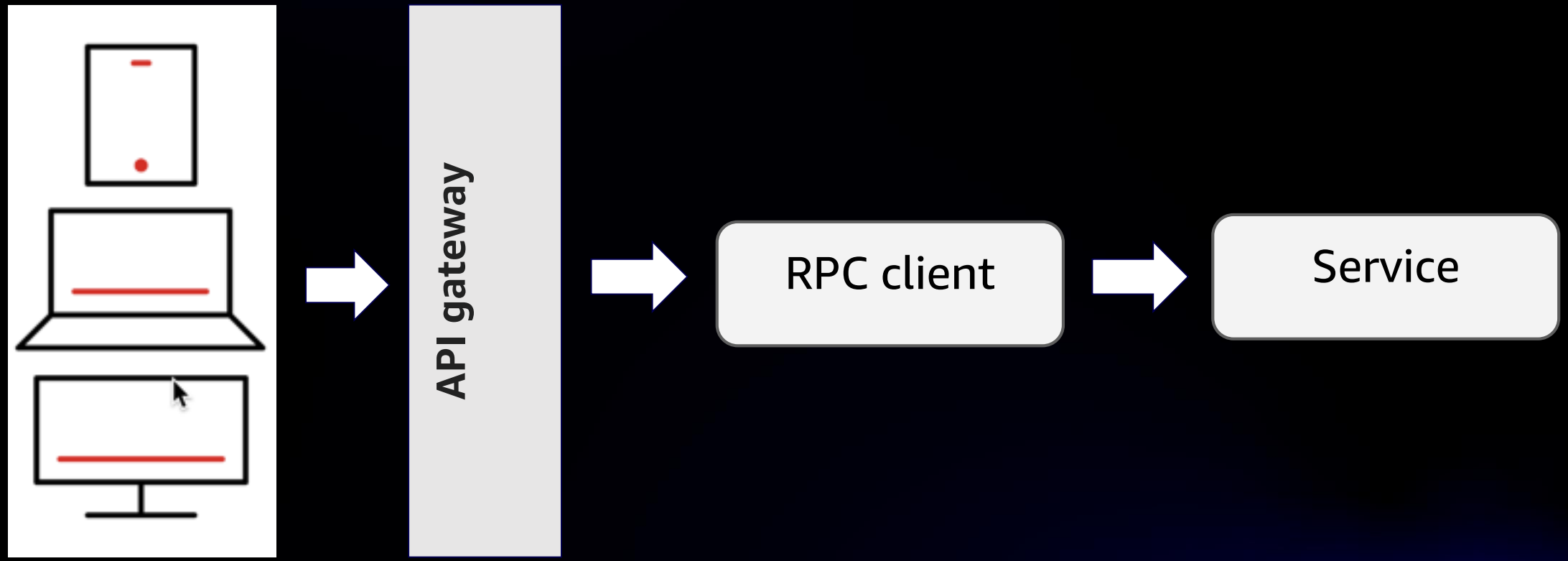


aws

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Experiment hypothesis:

Progressively throttling requests yields the same experience on all device types – TV, browser, and mobile

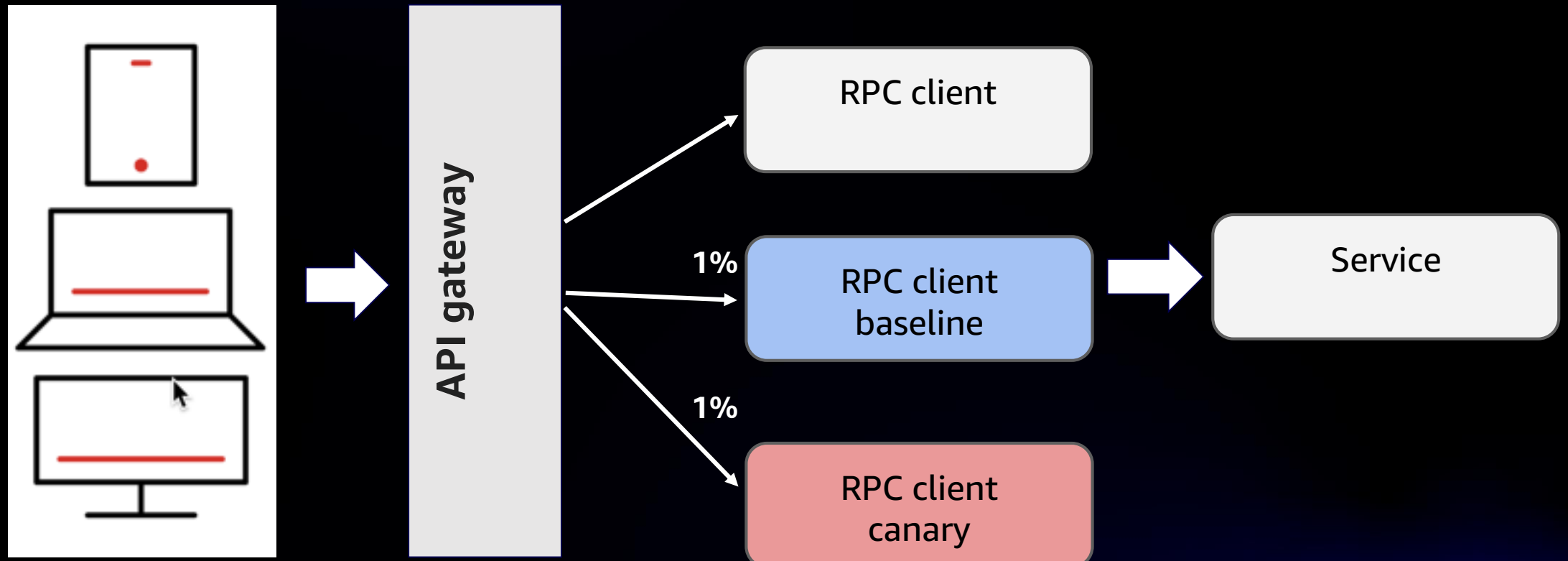


aws

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Experiment hypothesis:

Progressively throttling requests yields the same experience on all device types – TV, browser, and mobile

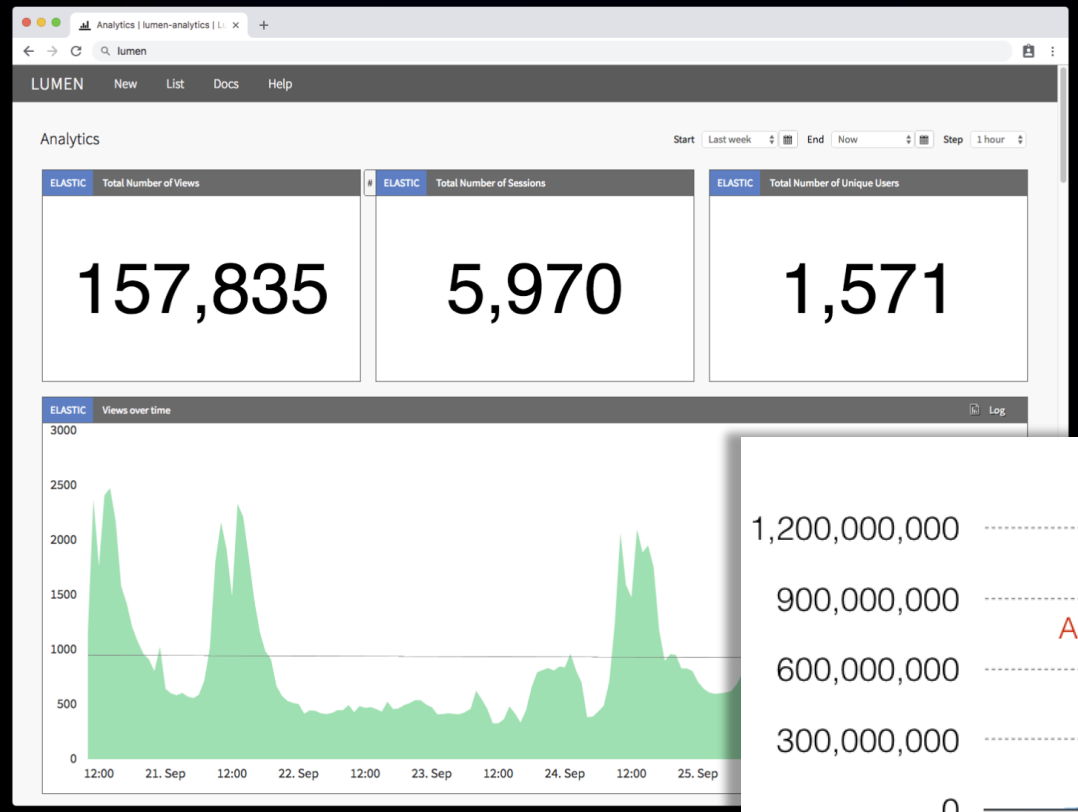


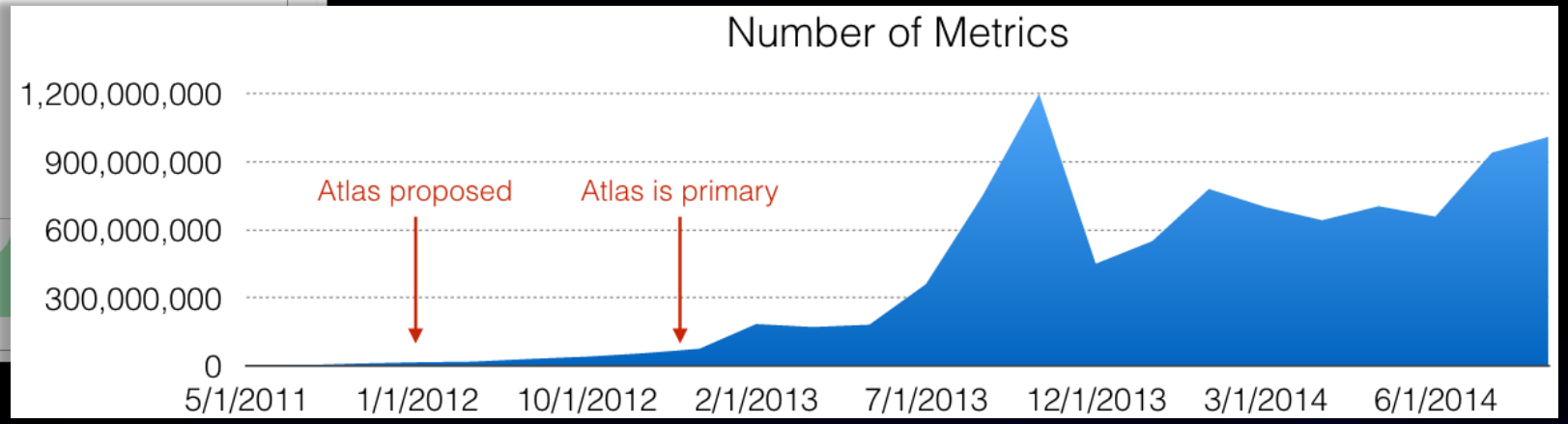
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

After all the pieces are in place, we turn our focus to observability and developer awareness





© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Takeaways

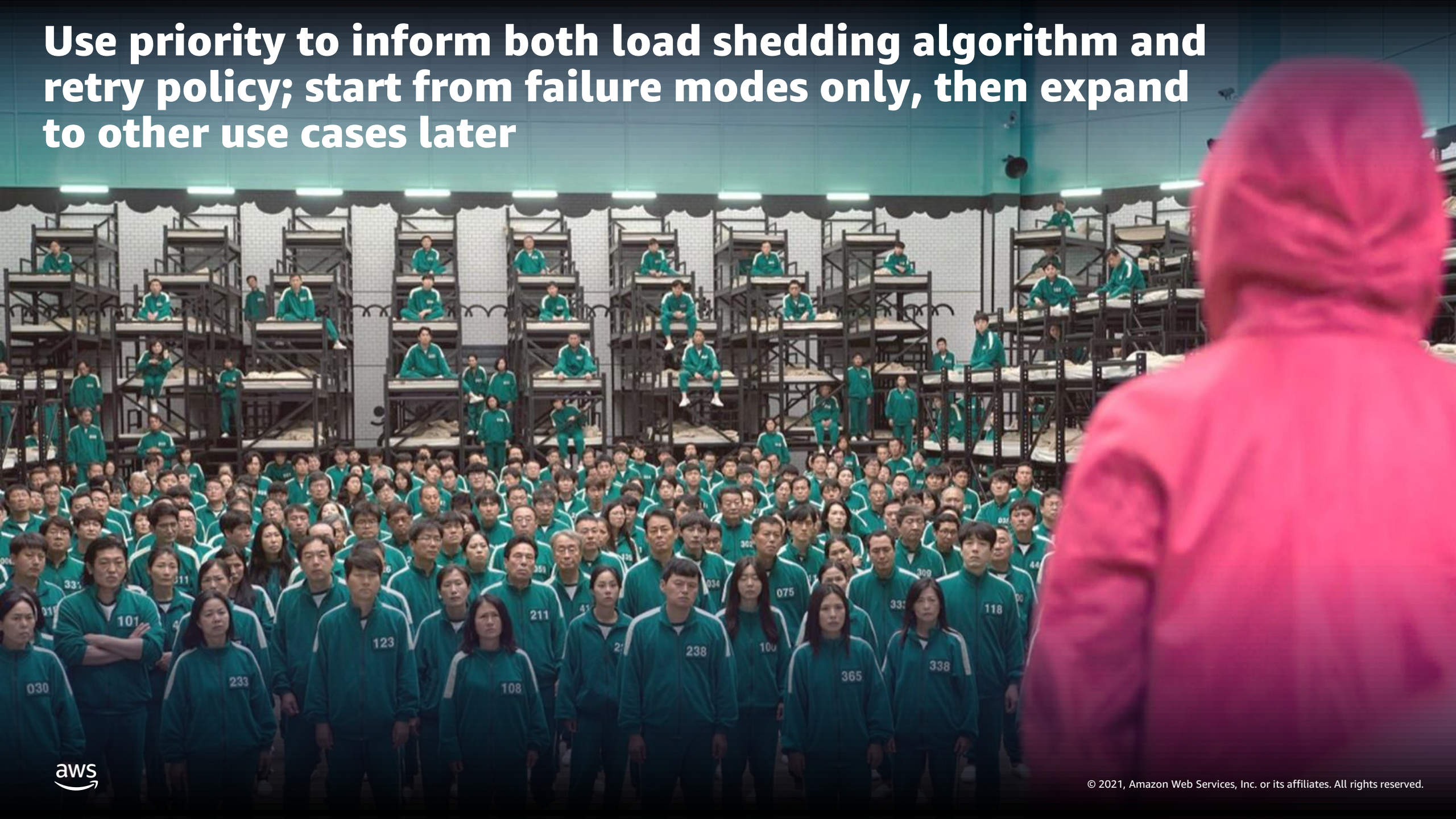
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Invest time on a well-defined but pragmatic request taxonomy



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Use priority to inform both load shedding algorithm and retry policy; start from failure modes only, then expand to other use cases later



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

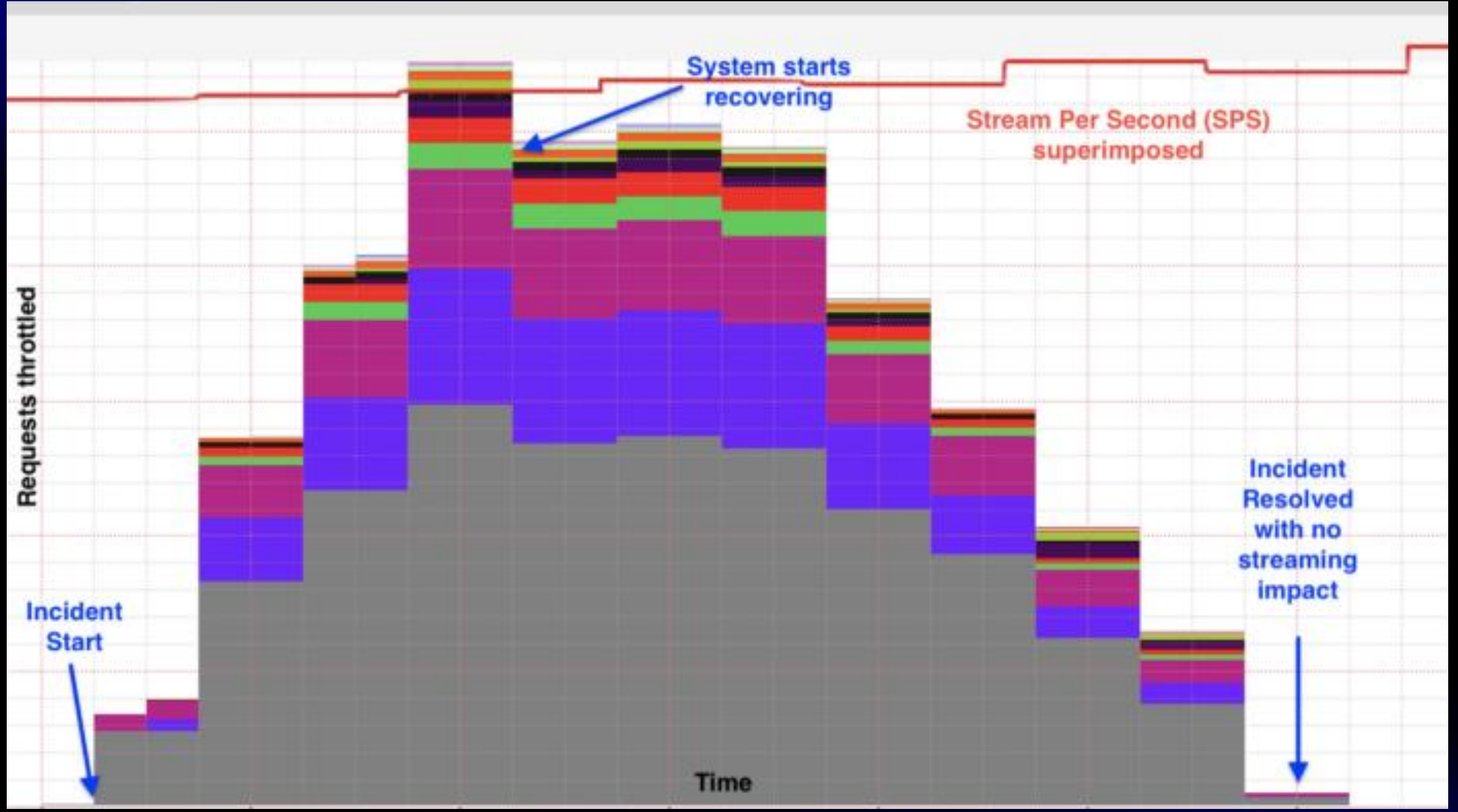
Failure injection allows testing initial request taxonomy assumptions and member impact when in load shedding mode



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

As a Netflix engineer . . .

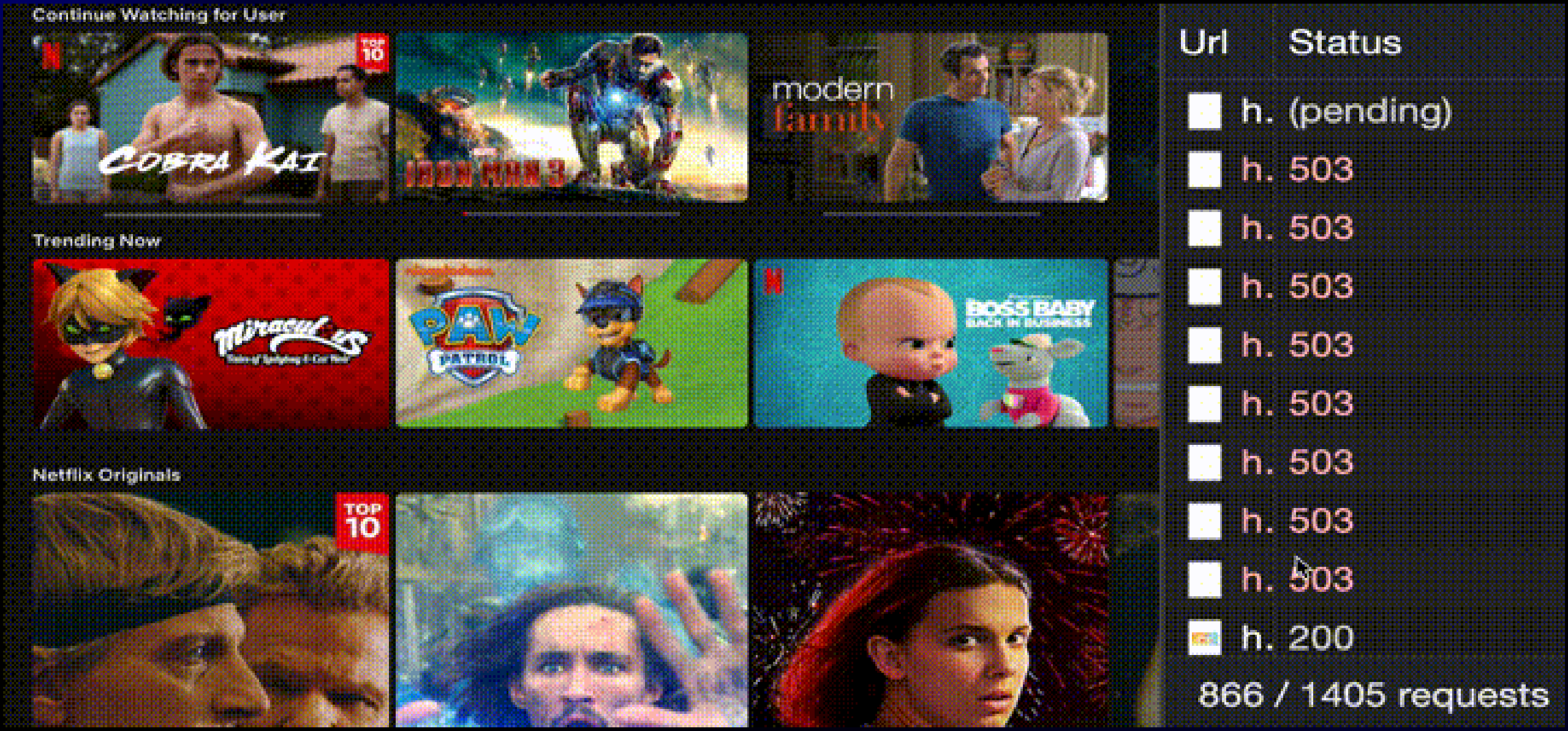
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

As a Netflix member . . .

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

We are not done yet

Tune request priority and algorithm

Using priority for quality of service (QoS)

More chaos testing

Other ideas?

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Thank you!

Manuel Correa



Prioritized load shedding blog post



linkedin.com/in/correamanuel



@mcorreadev

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.