# AWS re:Invent

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

ARC309

# Build a high-throughput asset-tracking architecture

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# Agenda

Asset-tracking applications and challenges

The solution

Simulating

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# Asset-tracking applications and challenges

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# Location-based services market growth

## $39.2 billion

is what the LBS and RTLS market is expected to be worth by

## 2025



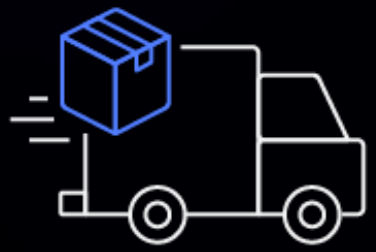
Source: Secondary literature, expert interviews, and MarketsandMarkets analysis

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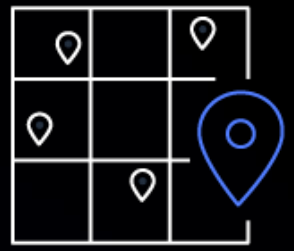
# Why do we track assets?



Are they performing well?



When are they arriving?



Where are they?



What is the status?

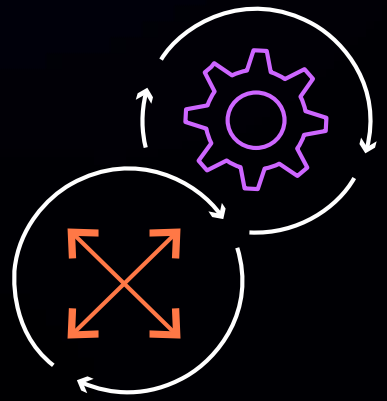
aws

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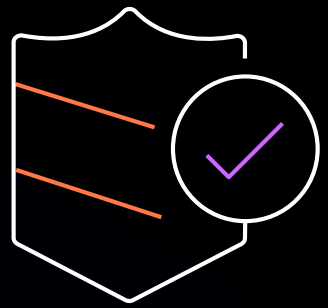
# Challenges to overcome



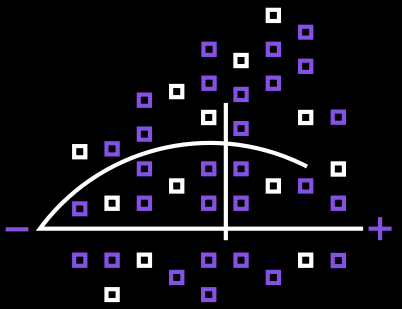
Infrastructure management



Performance and scalability



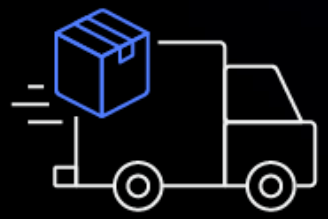
Security and isolation



Real-life volume simulation

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# Use case description



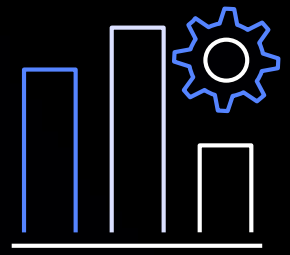
Asset



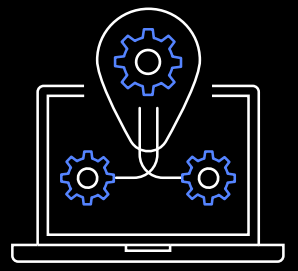
Tracking



Telemetry



Monitoring



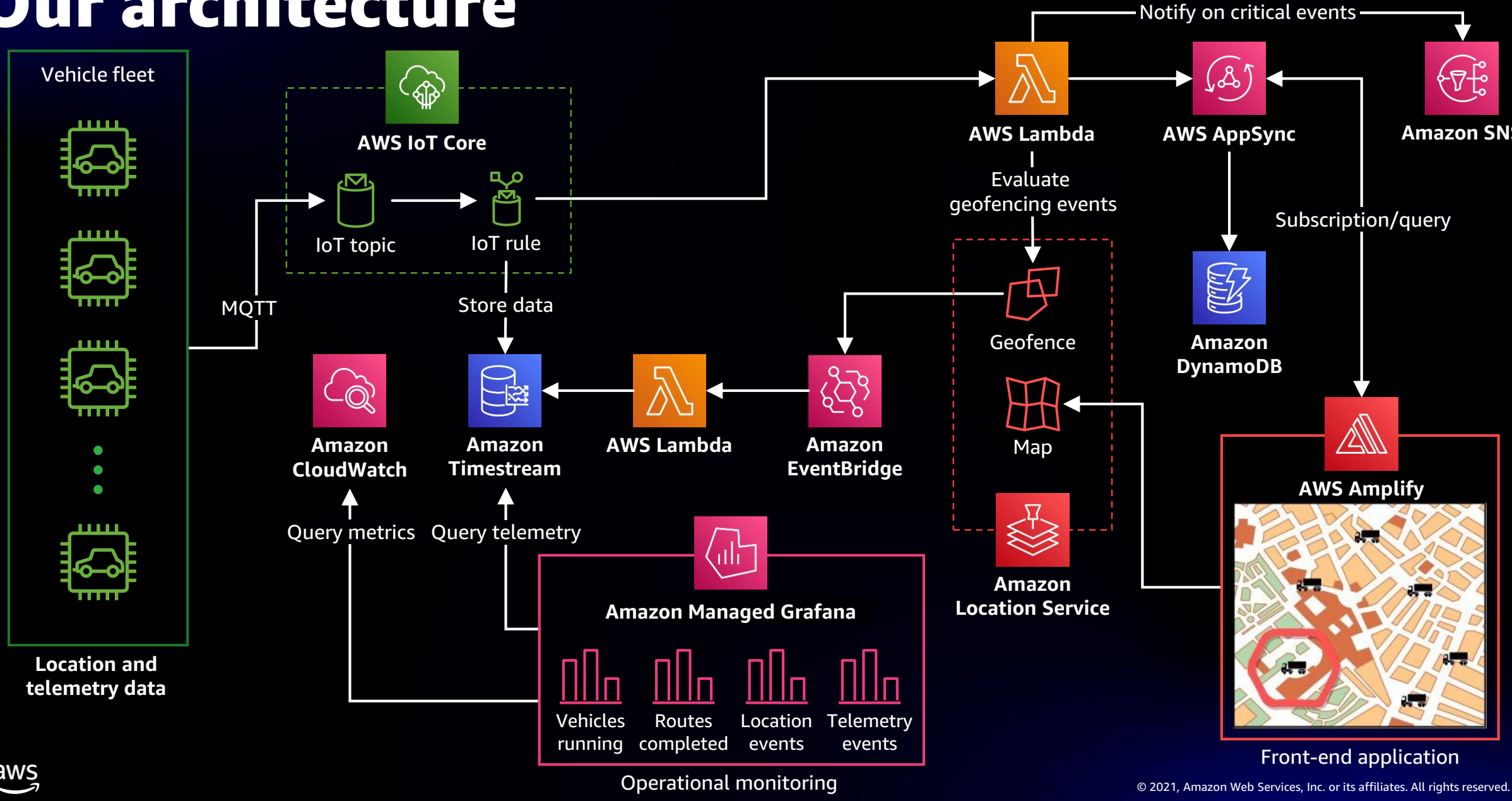
Simulation

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# The solution

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# Our architecture

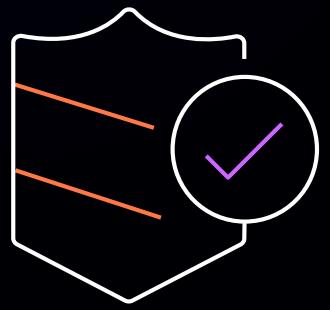



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# Security aspects



AWS shared responsibility model



Infrastructure security and isolation by design




Authentication and authorization

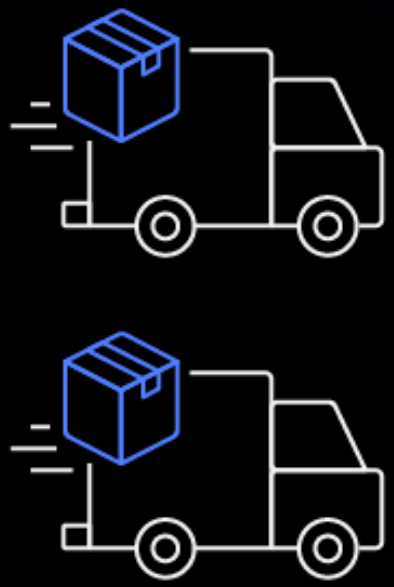


Data protection and privacy

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# Data ingestion – Logical flow

Connected IoT devices



IoT messages over MQTT

```
{
  "trip_id": "a18790c8-f46c-458f-ba80-605da891db42",
  "vin": "ABCDEFGH987654321",
  "timestamp": "2021-12-03 11:30:00.000000000",
  "name": "location",
  "latitude": "36.98502079071393",
  "longitude": "127.3974711572299"
}
```

AWS IoT Core





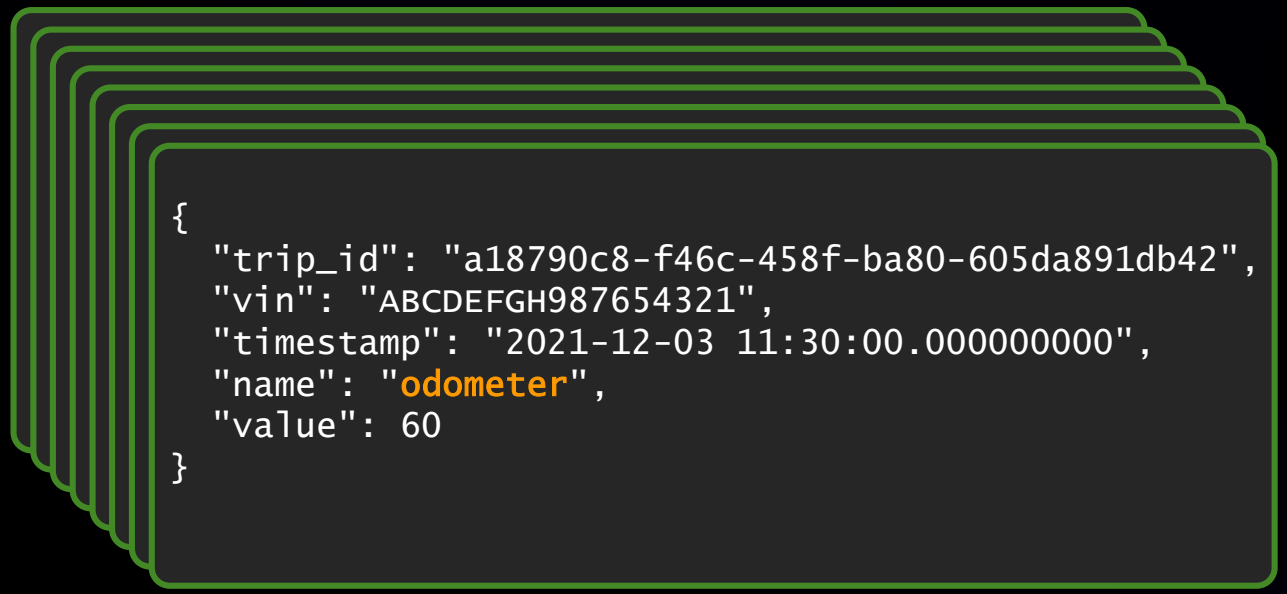
IoT topic

connectedcar/telemetry/<vin>

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# Data ingestion – Metrics

A set of individual messages with one metric each



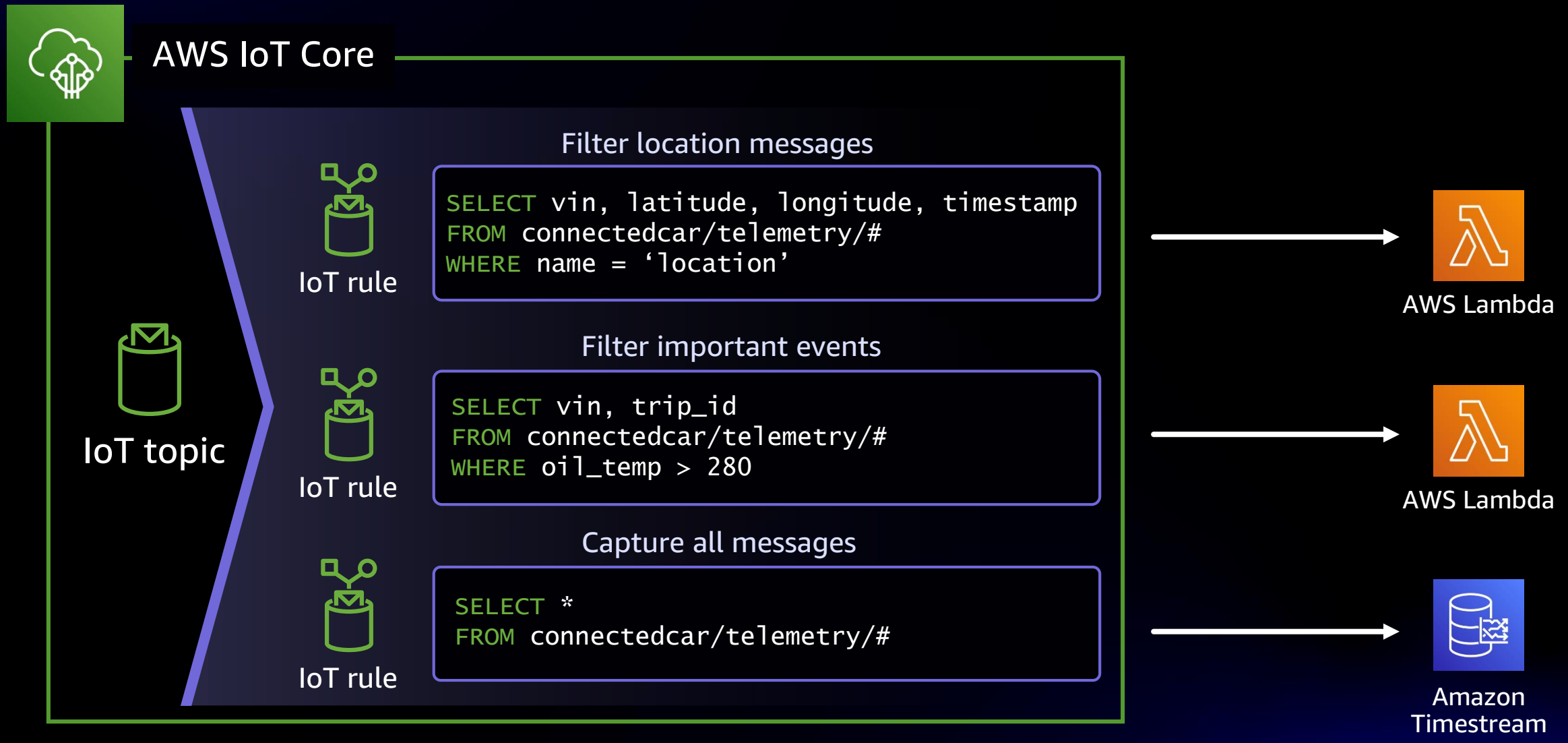
```
{
  "trip_id": "a18790c8-f46c-458f-ba80-605da891db42",
  "vin": "ABCDEFGH987654321",
  "timestamp": "2021-12-03 11:30:00.000000000",
  "name": "odometer",
  "value": 60
}
```

One individual message with a set of metrics

```
{
  "trip_id": "a18790c8-f46c-458f-ba80-605da891db42",
  "vin": "ABCDEFGH987654321",
  "timestamp": "2021-12-03 11:30:00.000000000",
  "location": "[36.985020,127.397471]",
  "acceleration": 52.75,
  "fuel_level": 85,
  "vehicle_speed": 78,
  "oil_temp": 225,
  "engine_speed": 5424,
  "torque_at_transmission": 321,
  "odomoter": 60
}
```

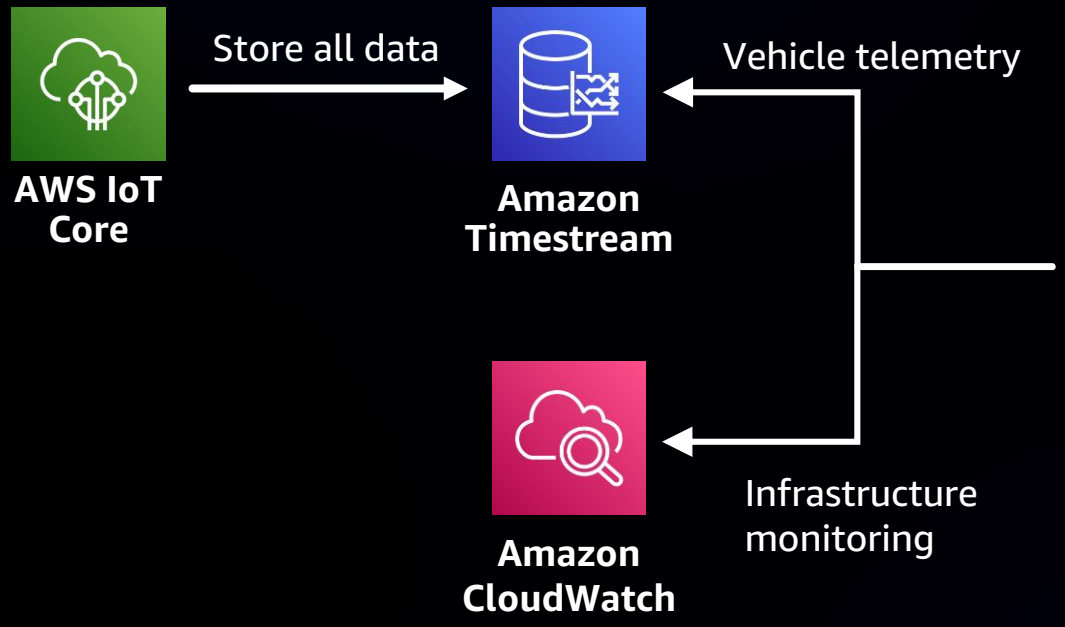
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# Data ingestion – Filters, rules, and actions

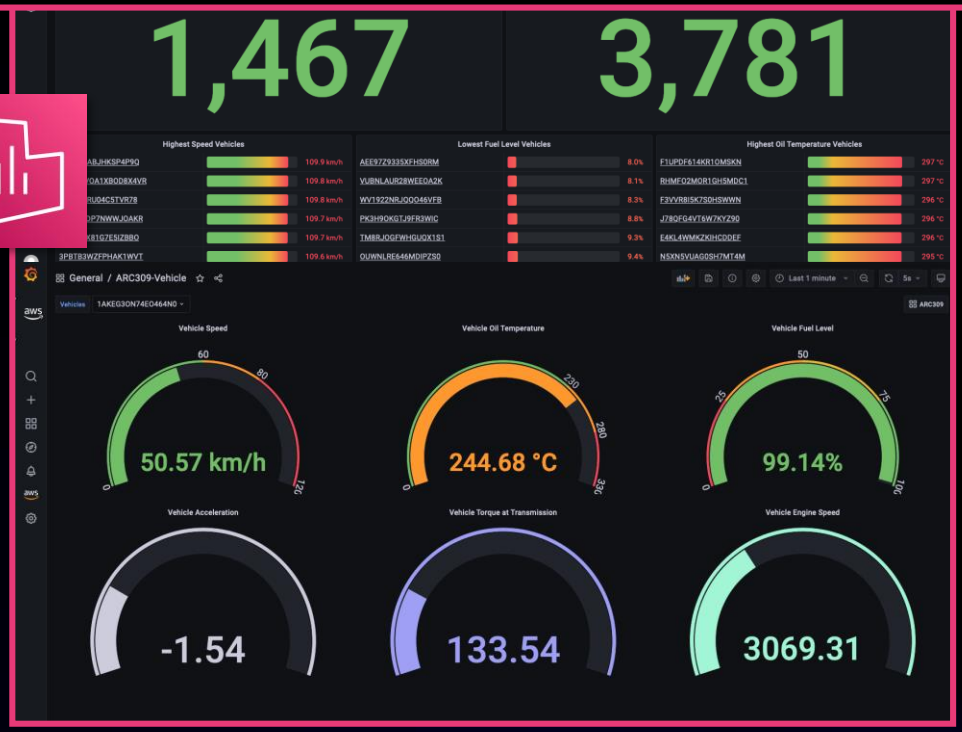



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# Monitoring – Logical flow




```
SELECT vin, avg(measure_value::double) AS speed
FROM $__database.$__table
WHERE $__timeFilter AND measure_name = 'vehicle_speed'
    GROUP BY vin
    ORDER BY speed DESC LIMIT 100
```




Amazon Managed Grafana

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# Alerting – Logical flow

**IoT rules**

Oil temperature > 280 degrees
Vehicle speed > 110 km/h
…

**App to person destinations**

Email notification
Mobile push notification
Mobile text messaging (SMS)
PagerDuty
AWS Chatbot



**AWS IoT Core**

Filter critical events



**AWS Lambda**

Process message and notify subscribers

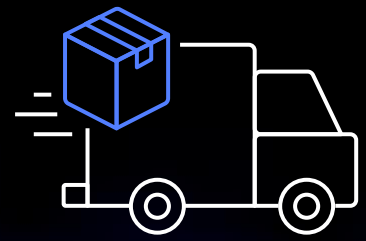


**Amazon SNS**

Notify operators

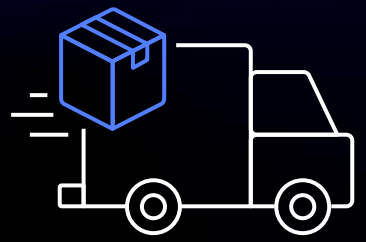


Notify driver



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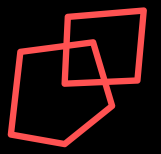
# Geofencing – Logical flow



```
request:{
   assetId: vehicleVin,
   location:[lat, lon]
}
```

Amazon Location Service





Geofence collection
(BatchEvaluateGeofences)



AWS IoT Core



AWS Lambda

Geofence evaluation request

Geofence event



AWS Lambda

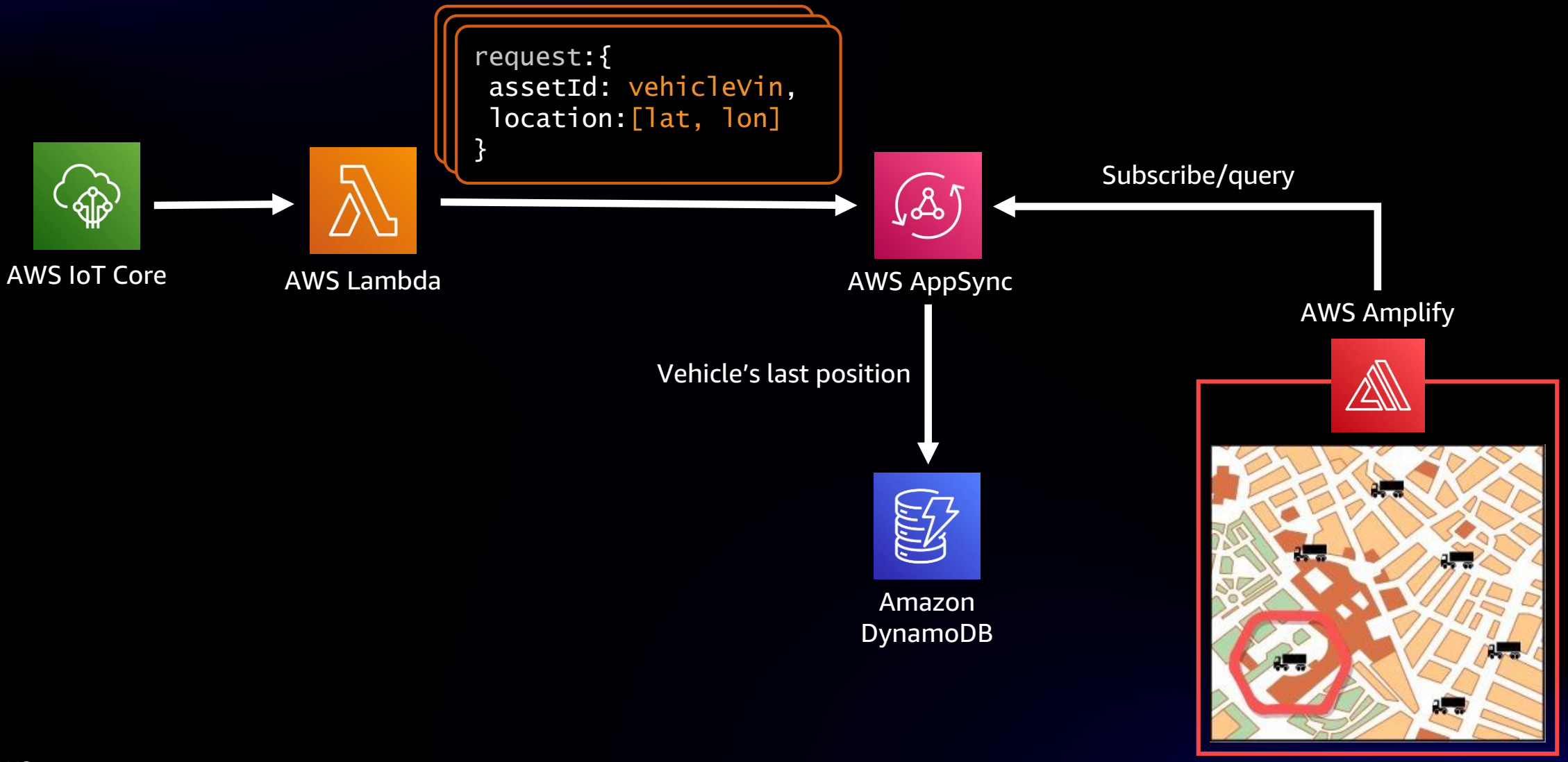


Amazon EventBridge

```
event:{
   assetId: vehicleVin,
   geofenceId: geofenceName,
   event: ENTER | EXIT,
   timestamp: timestamp
}
```

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# Front-end updates – Logical flow




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# Latitude and longitude decimal precision

30.33400990000026

-139.85147999999999




measurements at the equator

aws

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# Location caching with decimal precision

**Design with least-privileged precision to benefit**

- Consumer privacy
- Performance optimization
- Cost minimization

---

**Generate a cache-friendly identifier**

`[34.07,-118.24] == 9q5cv6k`

geohash.org

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# Location caching with decimal precision

## Vessels

20.073620
-156.240029

Position on the ocean 111 m

geohash: **9vk16w49hpd5**

## Vehicles

34.073620
-118.240029

Position on the road 11.1 m

geohash: **9q5cv6ujpxhh**

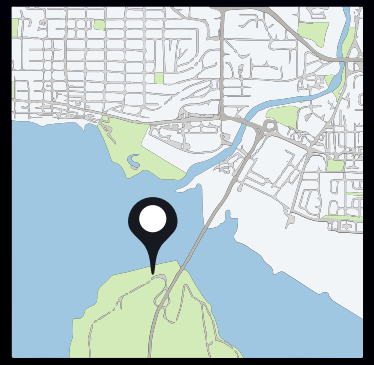
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# Amazon Location Service

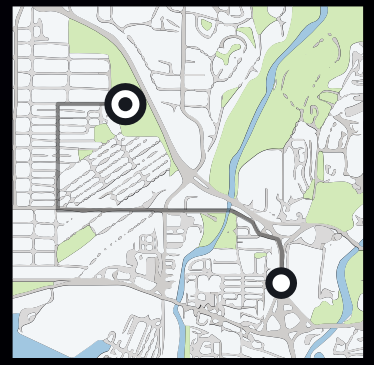
Maps



Places



Routes

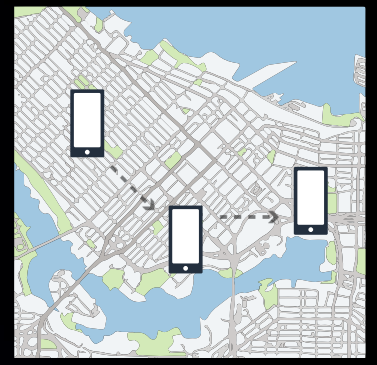


- External queries are anonymized
- Choice of data provider
- Data ownership – geocoding and reverse-geocoding

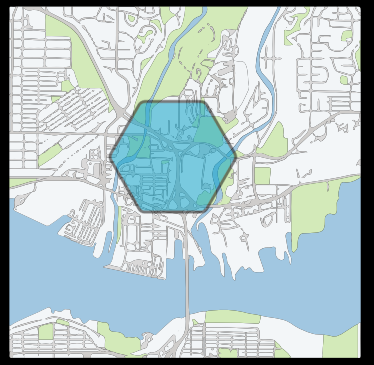
esri

here

Tracker



Geofences



- Data never leaves your AWS account
- Encrypted by design with service-managed keys
- Encryption with customer-managed keys

aws

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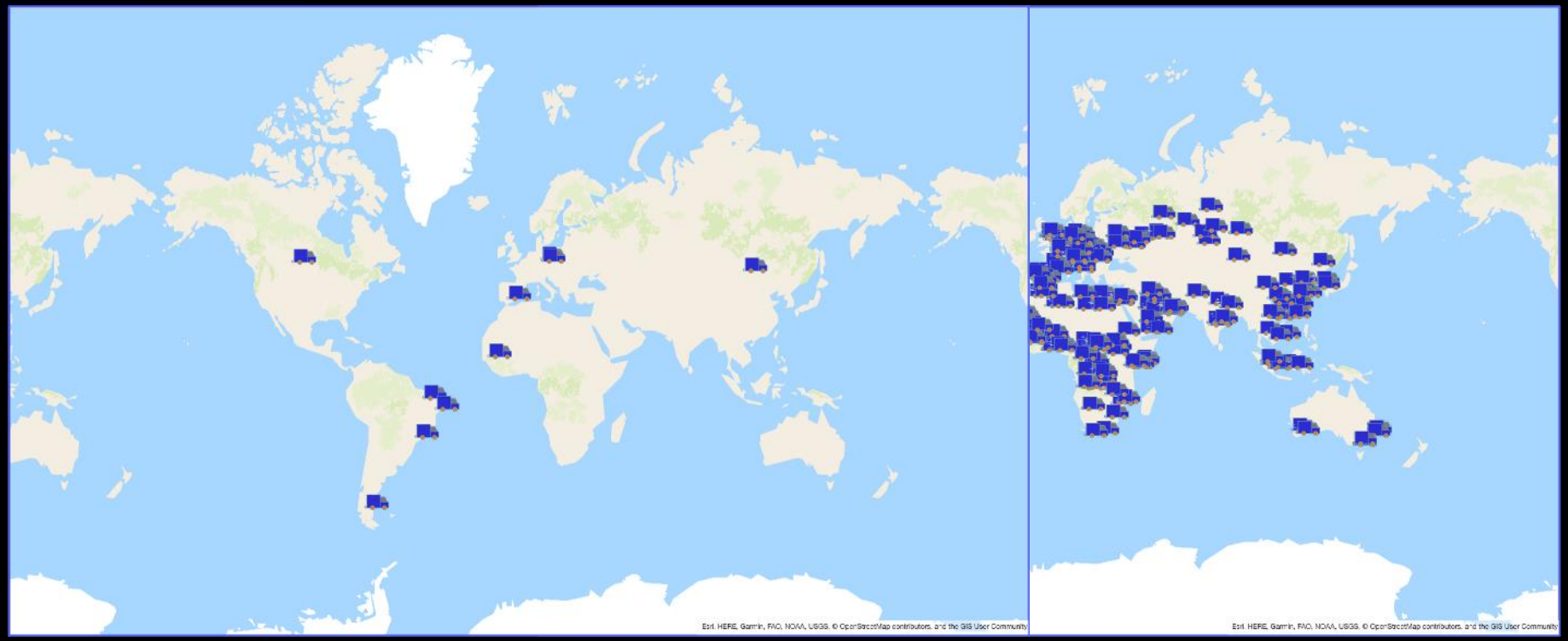
# Simulating

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# Testing the solution

This is easy

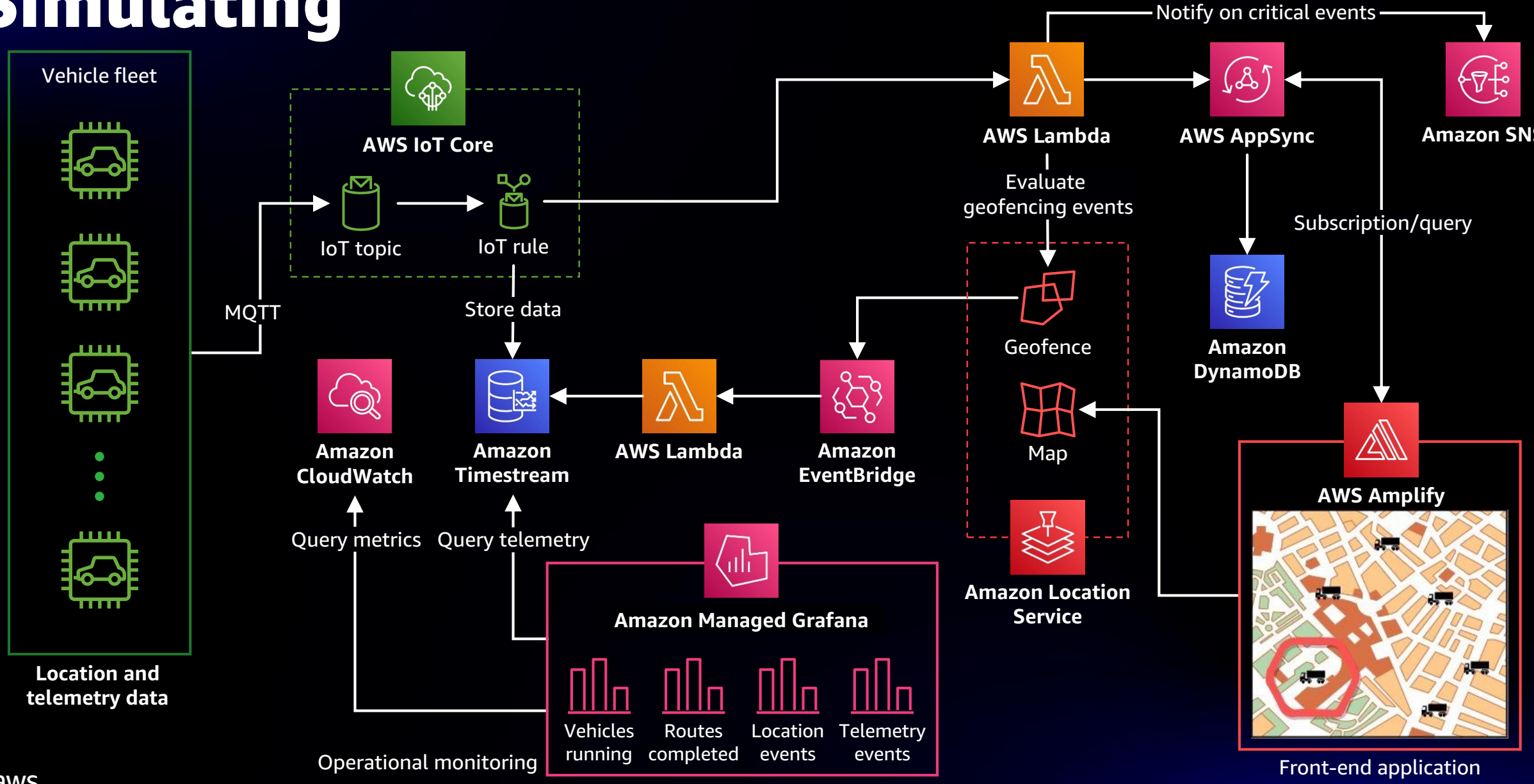
This … is not so easy



How can we test with 100,000 cars instead of 10?

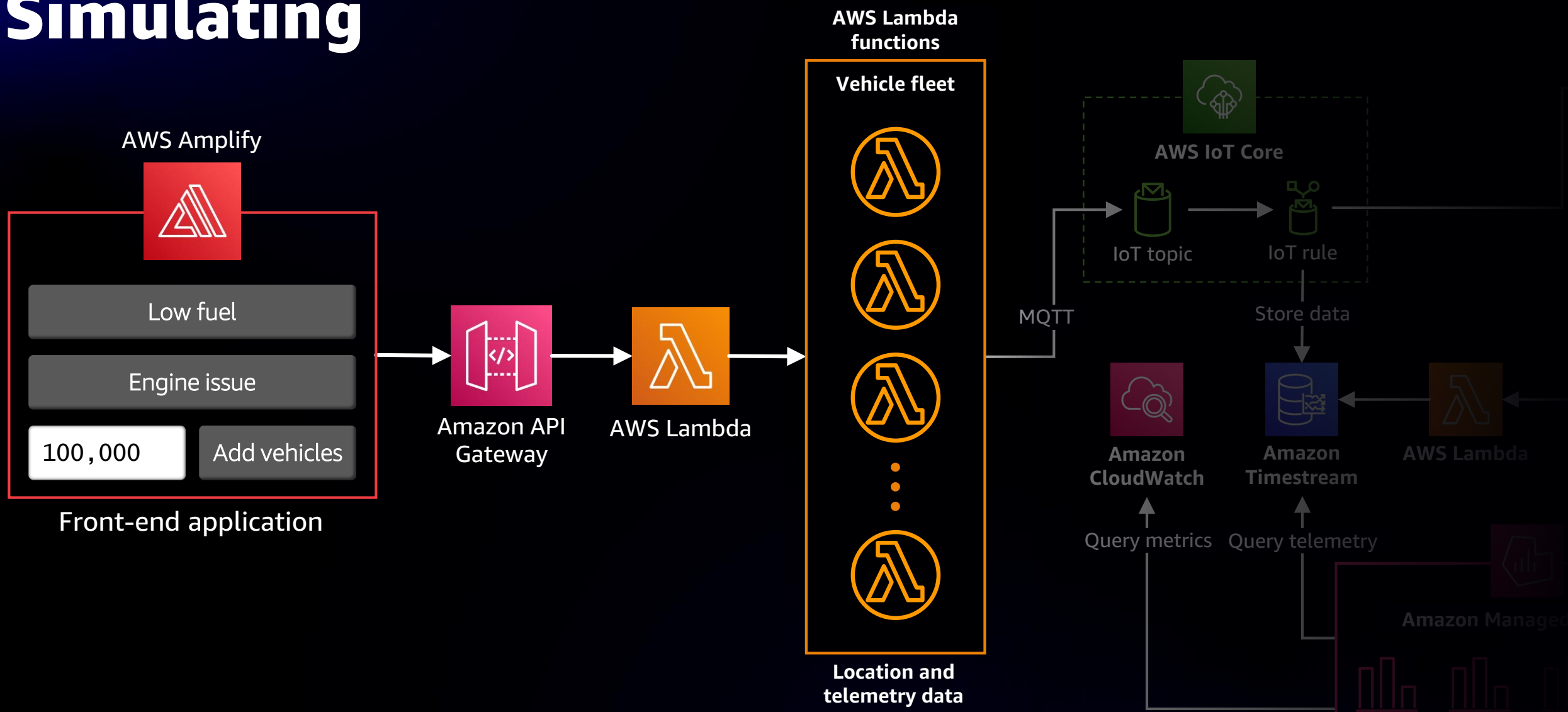
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# Simulating



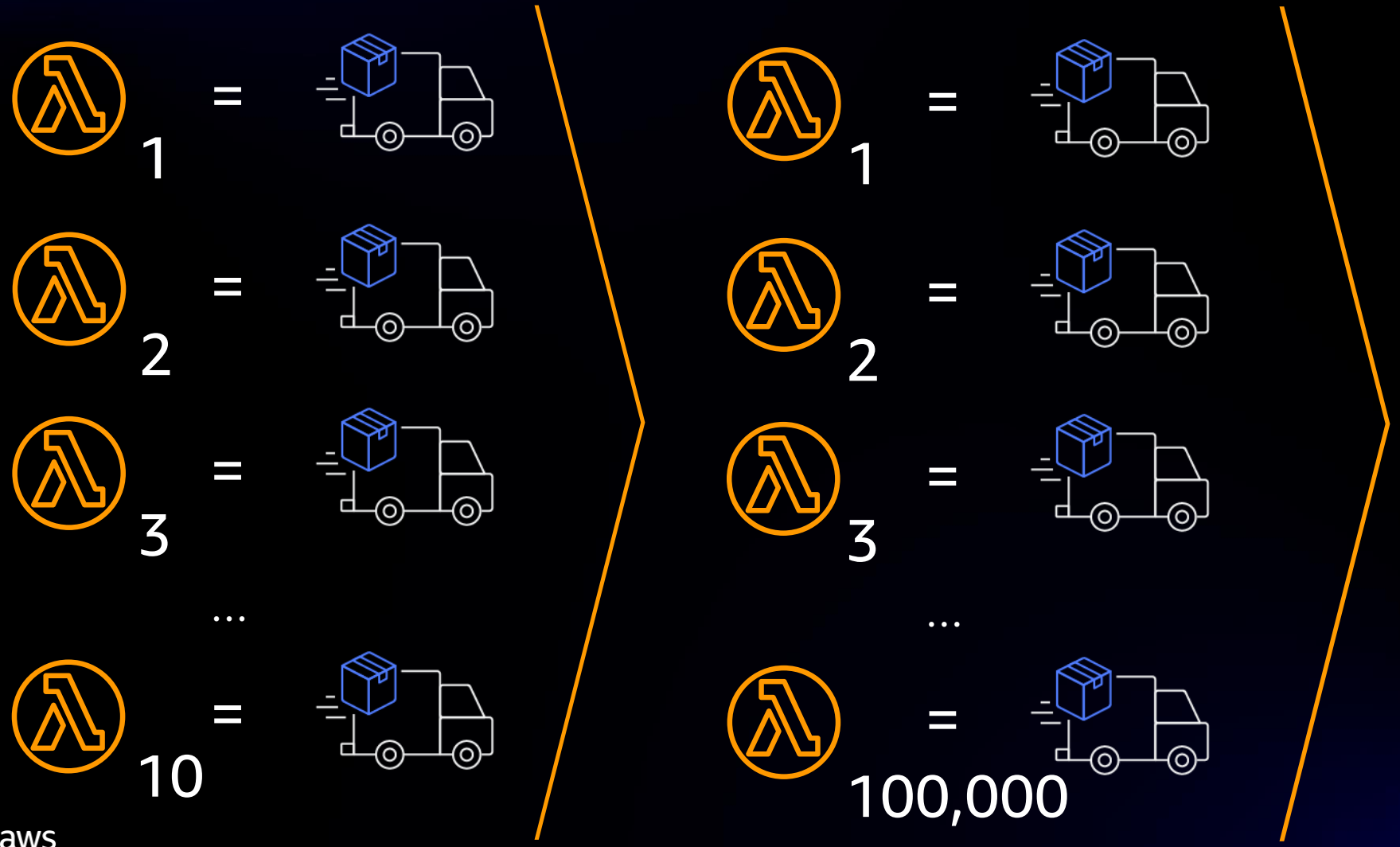

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# Simulating




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# Scaling challenges



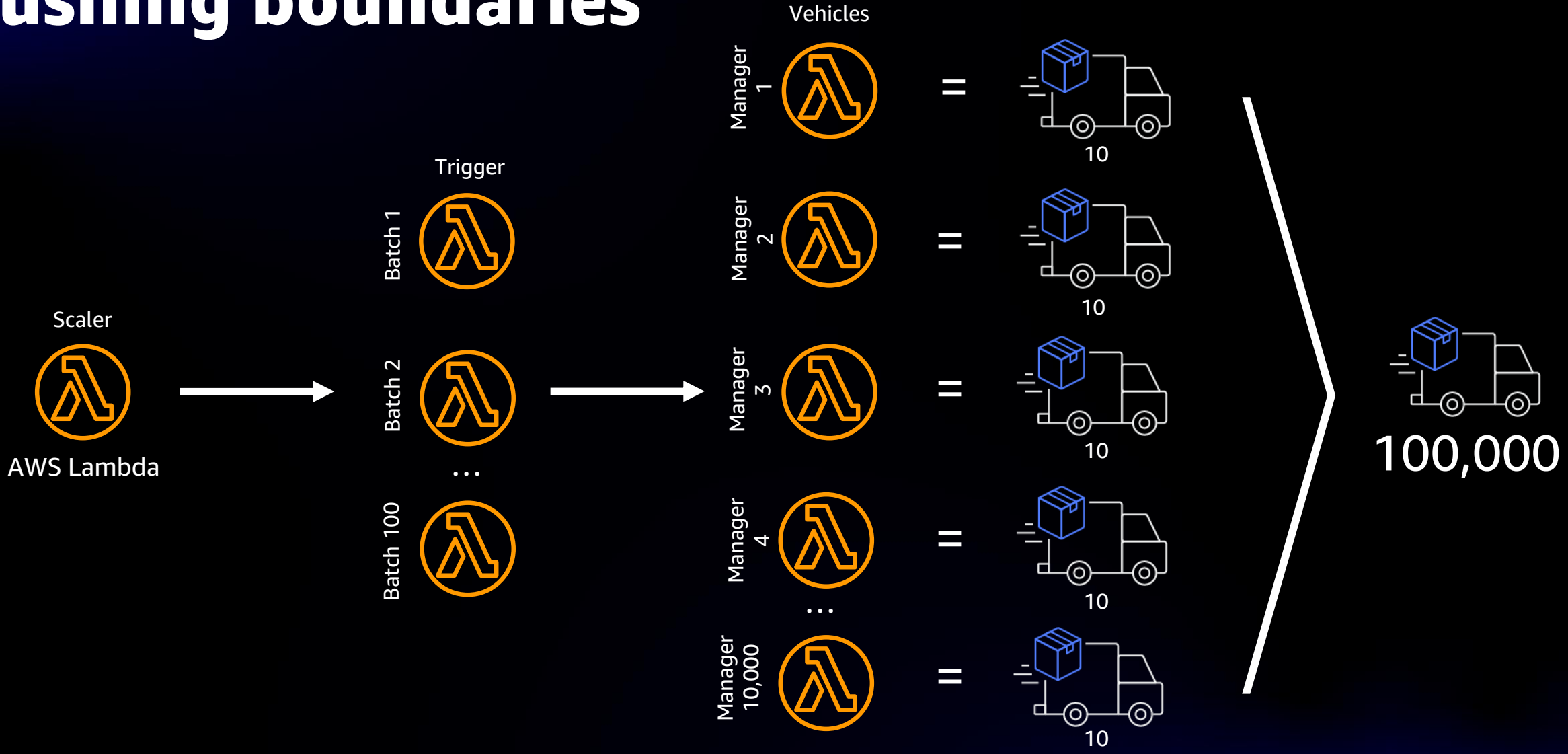

Timeout

Concurrency

Service limits

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# Pushing boundaries




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# Managing API throttling

Retry

Exponential backoff

Jitter

```
Do some asynchronous operation.
retries = 0

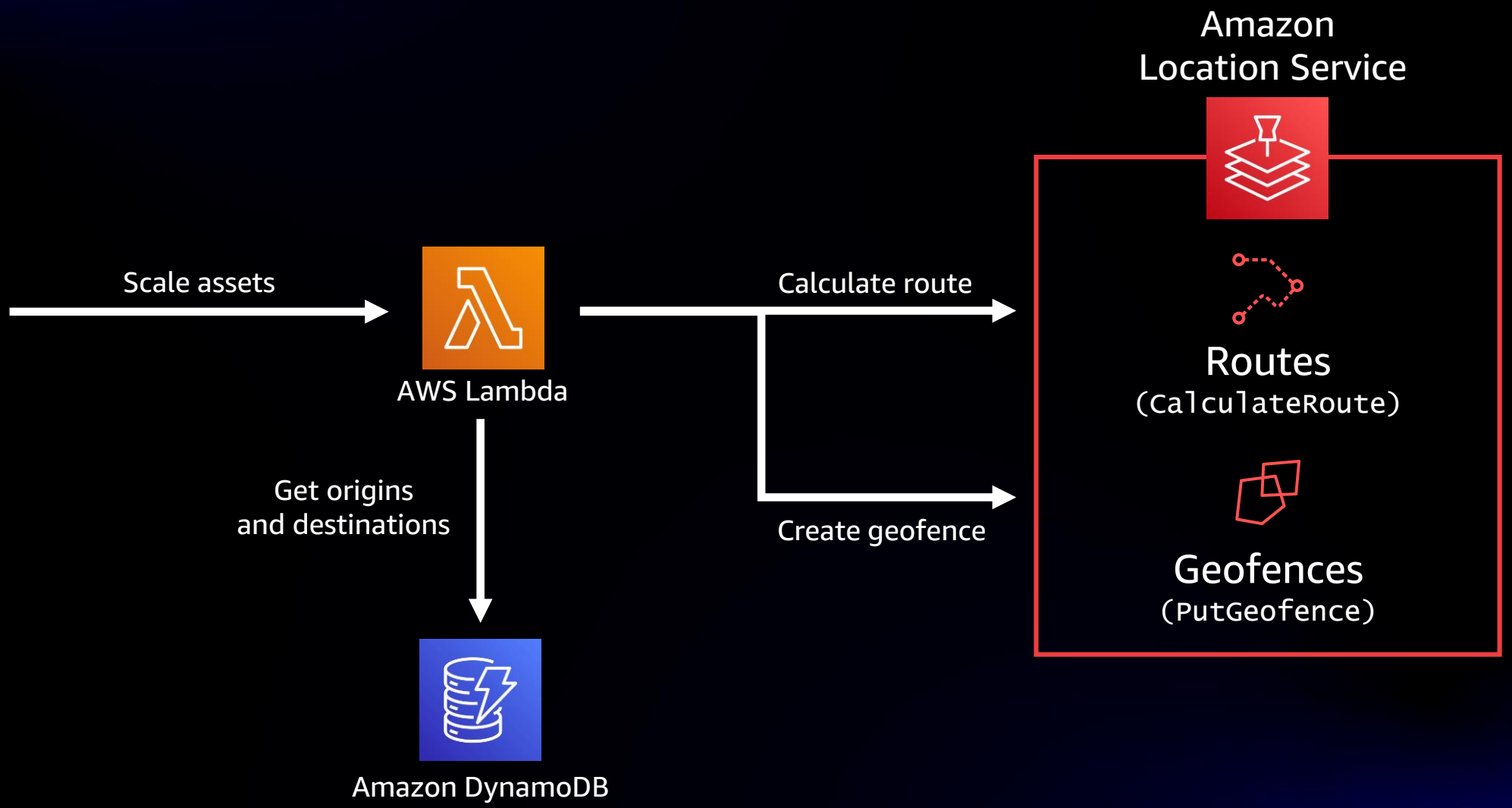
DO
    wait for (2^retries * 100) milliseconds
    status = Get the result of the asynchronous operation.

    IF status = SUCCESS
        retry = false
    ELSE IF status = NOT_READY
        retry = true
    ELSE IF status = THROTTLED
        retry = true
    ELSE
        Some other error occurred, so stop calling the API.
        retry = false
    END IF
    retries = retries + 1
WHILE (retry AND (retries < MAX_RETRIES))
```

**More details:** https://aws.amazon.com/blogs/mt/managing-monitoring-api-throttling-in-workloads/

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# Dynamic route – Logical flow




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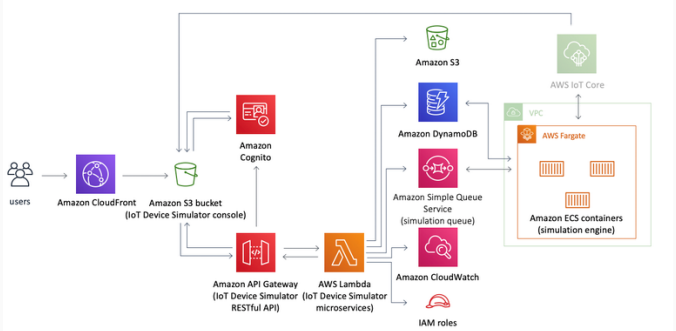
# Resources

## IoT Device Simulator

https://aws.amazon.com/solutions/implementations/iot-device-simulator/

### AWS Solutions Implementation overview

AWS offers a device simulation solution that enables customers to build a large fleet of virtual connected devices (widgets) from a user-defined template and simulate those widgets publishing data at regular intervals to AWS IoT. You can also monitor individual widgets from the simulator or observe how backend services are processing the data. The diagram below presents the architecture you can deploy in minutes using the solution's implementation guide and accompanying AWS CloudFormation template.




Click to enlarge

### IoT Device Simulator architecture

The IoT Device Simulator includes a device simulator API, which leverages Amazon API Gateway to invoke the solution's microservices (AWS Lambda functions). These microservices provide the business logic to perform operations on virtual devices and device types, record simulation metrics, and perform administration tasks. When the device simulator API receives an authorized request, Amazon API Gateway invokes the appropriate Lambda function. The Lambda function returns the execution results to the API, which returns the results to the simulator console.

When a device simulation request is received, the device microservice sends the request to a simulation queue in Amazon Simple Queue Service (Amazon SQS). Amazon Elastic Container Service (Amazon ECS) containers provisioned by AWS Fargate contain a simulation engine that periodically polls the simulation queue for simulation requests.

When a start simulation request is received, the simulation engine launches a virtual device that starts publishing simulated data to the AWS IoT endpoint. After the specified duration, the simulation engine stops the simulation, terminates the virtual device, and updates the device state and metrics in Amazon DynamoDB. A simulation console displays information about virtual devices and device types, simulation states, and user profiles. You use the console to create and terminate virtual devices, start and stop simulations, and view metrics.

Show less

### IoT Device Simulator

Version 2.1.1
Last updated: 07/2020
Author: AWS

**Estimated deployment time:** 10 min

Source code
CloudFormation template

View implementation guide
Launch in the AWS Console
Deploy with an AWS IQ expert

### Implementation resources

Download implementation guide
AWS Solution resources »
Contact us »

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# Thank you!

Fernando Rocha Silva

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Rafael Leandro Junior

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