# Blow up the monolith?

## Serverless computing, nanofunctions, & Amazon Lambda

# Disclaimer

This is a concept and code that I'm still experimenting with. It is not live in production.

# "Serverless Computing"

- How can you have your code executed without a computer?
- There is some hype here...

# "Serverless Computing"

Not "there is no server"

But "I don't know anything about the server"

You pay someone else to set it up, configure it, patch it, etc.

Can't even tell what OS is running

# Monolith

All-in-one program

- that's hard to scale,
- hard to add functionality to due its complexity,
- or both

Recurring pattern that tends to arise naturally

# Scaling a monolith

In 2017, well-established approach is to break the monolith into microservices which can be scaled and enhanced independently, by different teams

- have had very good experience with this
- still my first recommendation

# However...

- Finding the places to separate the existing code into microservices can be difficult
- Refactoring can help a lot by letting you identify the candidates for microservices and refine them into independent entities (http://stevecorwin.com/blog/2016/09/05/steps-towards-breaking-up-a-monolith/)

# Separating can still be difficult

Sometimes no matter what you do you find yourself looking at something like this:

**ShiftServices**

fetchShiftById
fetchShiftResults
fetchOpenShifts
fetchPendingRequestedShifts
fetchUrgentShifts
fetchAwardedShiftsByUser
fetchAwardedShiftsByDate
fetchNotAwardedToBidderShifts
fetchAllAwardedShiftsByUser
fetchAllAwardedShiftsByAdmin
fetchExportableScheduledShifts
fetchScheduledShiftsByUser
fetchOnCallShifts
fetchScheduledShifts
fetchNonDutyShifts

# Amazon Lambda examples

- GetOrders function is separate from the CreateOrder function, which is separate from the DeleteOrder function
- One customer gets a high % of traffic on GetOrders, a different customer gets high % of traffic on CreateOrder
- Can scale functions independently

# The Vision

**ShiftServices**

fetchShiftResults

fetchShiftById

fetchOpenShifts


hPendingRequestedShifts

fetchUrgentShifts

fetchAwardedShiftsByUser

fetchAwardedShiftsByDate

fetchNotAwardedToBidderShifts

# Nanofunction (TM)

What do you call something that's broken into even smaller pieces than a microservice?

Independent of vendor

Microservice: Order service has GetOrders endpoint, CreateOrder endpoint, DeleteOrder endpoint

Separate, smaller functions → “nanofunction”

# Why Amazon Lambda for this?

- It was available
- Amazon AWS is widely used and has a solid track record
- Amazon Lambda was launched November 2014
- You can start for free

# Amazon Lambda

Supports Java, Python, Node.js (JavaScript), C#

Suggested for lots of different use cases

- Data Processing
- Real-time File Processing
- Real-time Stream Processing
- Extract, Transform, Load
- IoT Backends
- Mobile Backends
- Web Applications

# "Hello world" Lamda

```
public class Hello {
    public String myHandler(int myCount, Context
    context) {
        LambdaLogger logger = context.getLogger();
        logger.log("received : " + myCount);
        return String.valueOf(myCount);
    }
}
```

http://docs.aws.amazon.com/lambda/latest/dg/get-started-step4-optional.html

# Realistic PoC

- Java
- Takes a couple of inputs
- Returns results based on a database query
- Then add a second nanofunction that stores data into the database

# Shared Database - project structure

(project directory)
- ├── model (maps directly to tables)
- ├── core (ex: DAOs)
- ├── nanofunction (orchestrates core)
- └── lambda (Amazon-specific)

Dependencies go up not down

Lambda as thin as possible

Multiple nanofunctions share core

# Amazon technologies needed

- IAM (creating users and roles to use for accessing the AWS web UI and using the CLI)
- S3 (for storing Java code for Lambda)
- AWS CLI (for deploying and testing my nanofunction)
- RDS (for MySQL database)
- VPC (so Lambda can connect to database)
- Subnets & Security Groups
- EC2 (to have a server where I can run a MySQL client)
- Lambda
- Amazon API Gateway (for the RESTful endpoint)

# Sign up for AWS

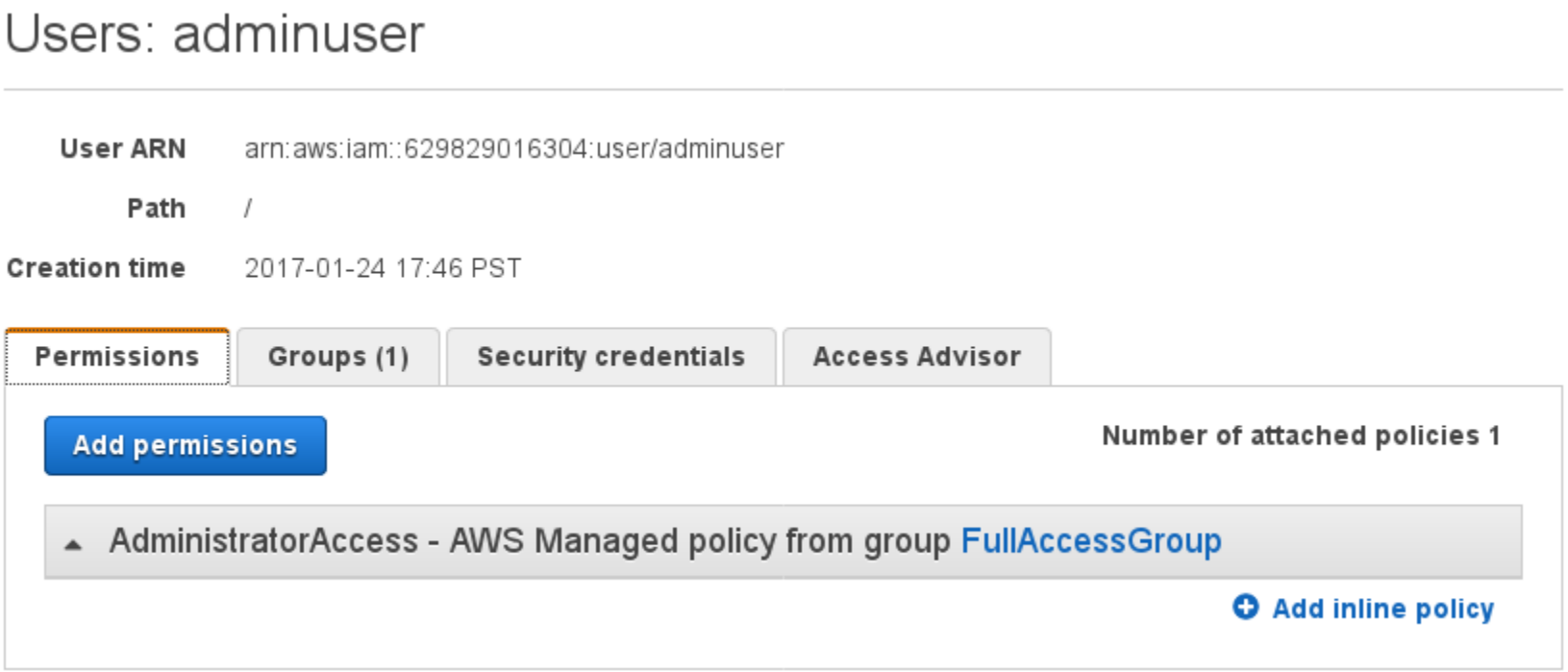
https://aws.amazon.com/

PoC all done using free resources

Set up billing alert just in case

# IAM admin user

http://docs.aws.amazon.com/lambda/latest/dg/setting-up.html



# IAM role for S3 storage

Because "AWS Lambda requires an Amazon S3 bucket to store your Java project when you upload it."

IAM -> Role -> Create Role

1. In Role Name, use a name that is unique within your AWS account (for example, steve-s3-full-access-role).
2. In Select Role Type, choose AWS Service Roles, and then choose AWS Lambda. This grants the AWS Lambda service permissions to assume the role.
3. In Attach Policy, choose AmazonS3FullAccess.

# IAM role for VPC access

VPC = virtual private cloud, a virtual network dedicated to your AWS account. Contains AWS resources such as RDS instances.

IAM -> Role -> Create New Role

1. In Role Name, use a name that is unique within your AWS account (for example, steve-lambda-vpc-access-role).
2. In Select Role Type, choose AWS Service Roles, and then choose AWS Lambda. This grants the AWS Lambda service permissions to assume the role.
3. In Attach Policy, choose AWSLambdaVPCAccessExecutionRole.

# Create an S3 bucket

AWS regions:
http://docs.aws.amazon.com/general/latest/gr/rande.html#lambda_region

Put everything in the same region for performance and simplicity
In this presentation everything is in us-west-2 (Oregon)

# Install AWS CLI

Much more concise than the web UI
Easier to document
Easier to repeat

http://docs.aws.amazon.com/cli/latest/userguide/installing.html

```
$ pip install --upgrade --user awscli
```

```
$ aws help
$ aws lambda help
```

# Configure AWS CLI

http://docs.aws.amazon.com/lambda/latest/dg/setup-awscli.html

```
$ aws configure --profile adminuser
  AWS Access Key ID [None]: AKIAJG2JLCGQCLLW1234
  AWS Secret Access Key [None]:
3B/61xAOpjTvIjCgKuqu78NWfbKJJI/6Y123456
  Default region name [None]: us-west-2
  Default output format [None]: json
```

# AWS Security Group

“A security group acts as a virtual firewall that controls the traffic for one or more instances. When you launch an instance, you associate one or more security groups with the instance. You add rules to each security group that allow traffic to or from its associated instances.”

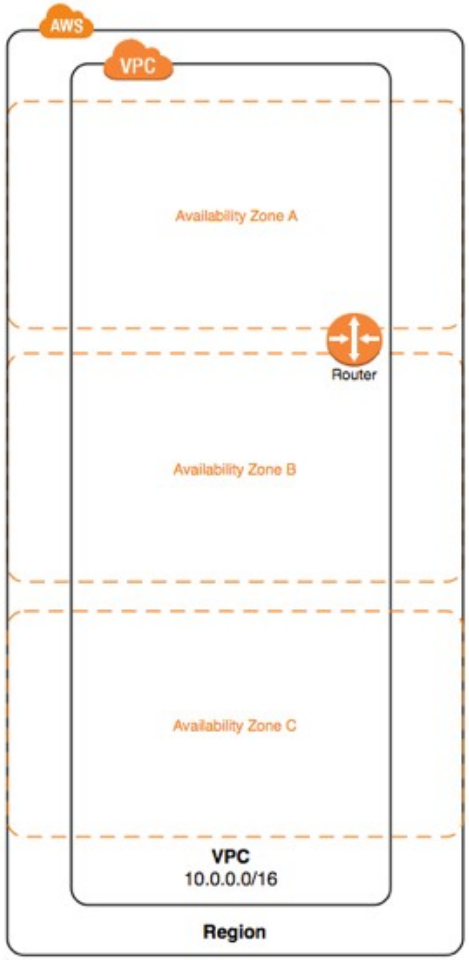
Much easier if everything is in the same security group

# AWS Subnet

Subnet = subset of the IP address range to a VPC. Some instances get more than one subnet, some only one.

Development is easier if everything is in the same subnet.

Different subnets are possible, outside scope of this presentation.




**Main route table**

| Destination | Target |
|---|---|
| 10.0.0.0/16 | local |

# RDS (for MySQL)

```
$ aws rds create-db-instance --db-instance-
    identifier SteveMySQLForLambdaTest --db-
    instance-class db.t2.micro --engine MySQL
    --allocated-storage 5 --no-publicly-accessible
    --db-name SteveTestDB --master-username
    steve --master-user-password supersecret
    --backup-retention-period 3 --profile adminuser
```

# RDS (for MySQL) - result


```
{ "DBInstance": {   ...
      "VpcSecurityGroups": [
         {  "Status": "active", "VpcSecurityGroupId": "sg-8cc7c812" }  ],
      ...
      "DBSubnetGroup": { "Subnets": [
            { "SubnetStatus": "Active",
"SubnetIdentifier": "subnet-19617512",
               "SubnetAvailabilityZone": { "Name": "us-west-2a" }
      "VpcId": "vpc-b9ef3c12",
            }, … }  }
```

# EC2 (for MySQL client)

- Need to choose suitable image; I used "Ubuntu Server 16.04 LTS (HVM), SSD Volume Type"
- For size I chose t2.micro "Free tier eligible"
- Use VPC, subnet, and security group to match RDS for MySQL

# EC2 – allow ssh

Security group sg-8cc7c812

Inbound rule: allow ssh (port 22) from 0.0.0.0/0

| Type | Protocol | Port Range | Source |
|---|---|---|---|
| All traffic | All | All | sg-8cc7c8f5 (default) |
| All traffic | All | All | sg-a39383da (launch-wizard-1) |
| SSH | TCP | 22 | 0.0.0.0/0 |
| SSH | TCP | 22 | ::/0 |

# EC2 – install MySQL client

```
$ sudo apt-get update
$ sudo apt-get install mysql-client-core-5.7

$ mysql -v
    --host=stevemysqlforlambdatest.clmy82gfefkm.us-
    west-2.rds.amazonaws.com --user=steve
    --password=supersecret SteveTestDB
```

Create tables as needed

# Lambda!

Goal: nanofunctions that connect to a database

Code we need:

- request handler (called for every request)
- Amazon-specific code
- code to connect to the database

# Lambda request handler

```
@Override
public String handleRequest(HelloInput helloInput, Context
    context) {

       return "Hello " + helloInput.getFirstName()
          + ", shift data is " +
          fetchShiftsNanofunction.fetchAllShiftsAsString();
}
```

# Lambda-specific code

```
package com.apihealthcare.lamba;

import com.amazonaws.services.lambda.runtime.Context;
import com.amazonaws.services.lambda.runtime.RequestHandler;
import com.apihealthcare.dao.ShiftDAO;
import com.apihealthcare.lambda.HelloInput;

public class FetchShiftsLambda implements
    RequestHandler<HelloInput, String> {

   @Override
   public String handleRequest(HelloInput helloInput, Context
    context) {
```

# Lambda constructor

```
private static FetchShiftsNanofunction fetchShiftsNanofunction;

public FetchShiftsLambda() throws SQLException
{
    fetchShiftsNanofunction = new FetchShiftsNanofunction();
    LOGGER.debug( "FetchShiftsLambda constructor done" );
}
```

# Database connections

```
// JDBC_URL =
    "jdbc:mysql://stevemysqlforlambdatest.clmy82gfefkm.us-west-
    2.rds.amazonaws.com:3306/SteveTestDB";
public FetchShiftsNanofunction() throws SQLException {
   shiftDao = new ShiftDAO( JDBC_URL, USERNAME,
    PASSWORD );
   LOGGER.debug( "FetchShiftsNanofunction constructor done" );
}
```

- As of 3/20/17, Amazon Lambda does not support connection pooling
- Other languages: creating the equivalent of a static member variable

# Database connections - continued

Write code that checks for a valid DB connection and creates one if needed

One connection per Lamba instance

In my testing, only lost connection after rebooting RDS MySQL

One request every 5 minutes sufficient

Constructor log output not written anywhere I can find

# Build with Maven

Starter pom:
http://docs.aws.amazon.com/lambda/latest/dg/java-create-jar-pkg-maven-no-ide.html

- aws-lambda-java-core (required)
- aws-lambda-java-log4j (optional)

$ mvn clean package → target/lamba-java-example-1.0-SNAPSHOT.jar

# Uploading the jar – first time

```
$ aws lambda create-function --function-name
    FetchShiftsLambda --zip-file
    fileb:///home/steve/swdev/aws/HelloWorldJava/targ
    et/lambda-java-example-1.0-SNAPSHOT.jar --role
    arn:aws:iam::629829011234:role/steve-lambda-vpc-
    access-role --handler
    com.apihealthcare.lambda.FetchShiftsLambda::han
    dleRequest --runtime java8 --vpc-config
    'SubnetIds=subnet-19617512,SecurityGroupIds=sg-
    8cc7c812' --timeout 60 --region us-west-2 --profile
    adminuser
```

# Uploading the jar – first time - continued

--function-name: used to identify Lambda

--zip-file: “fileb://” + path to your jar

--role: full arn of role that allows the Lambda VPC access

--handler: full package and class name + “::” + name of function that Lambda framework should call

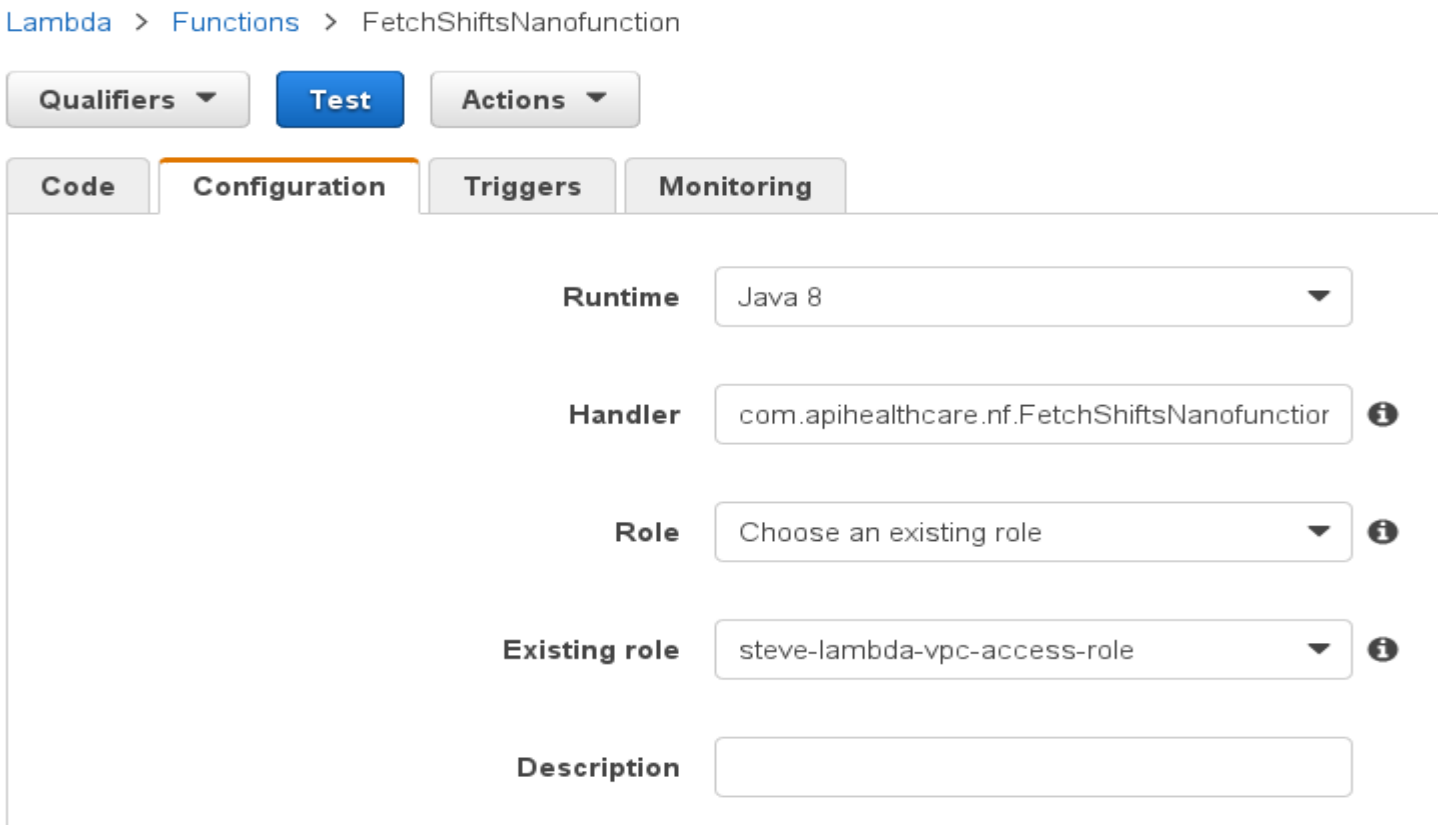
--vpc-config 'SubnetIds=subnet-19617512,SecurityGroupIds=sg-8cc7c812' → use the subnet Id and security group from RDS instance

--timeout: needs to allow time for DB connection

# Uploading the jar – second time

```
$ aws lambda update-function-code --function-name
    FetchShiftsLambda --zip-file
    fileb:///home/steve/swdev/aws/HelloWorldJava/targ
    et/lambda-java-example-1.0-SNAPSHOT.jar
    --region us-west-2 --profile adminuser
```

# Testing the jar – Web UI




"Test" button → supply JSON for input

Output: response, log output, time/resources consumed

# Testing the jar – AWS CLI

```
$ aws lambda invoke --function-name
    FetchShiftsLambda --log-type Tail --payload
    '{"firstName": "lambda-invoke", "lastName":
    "Command Line"}' --region us-west-2 --profile
    adminuser lambdaOutput.txt
```

lambdaOutput.txt has response

LogResult is the base64-encoded logs for the Lambda function invocation.

```
$ base64 --decode <<<  {contents of double quotes}
```

# Demo

https://us-west-2.console.aws.amazon.com/lambda/home?region=us-west-2#/functions/FetchShiftsLambda?tab=configuration

Sample test event:

{ "firstName":"Gipsy", "lastName":"Kings" }

# RESTful API

GET

POST

etc.

curl https://9k196bl123.execute-api.us-west-2.amazonaws.com/prod/ShiftMgr2?firstName=GetViaCurl&lastName=Calling

# Amazon API Gateway

Capable of creating RESTful endpoints for many things, including Lambda functions

Lots of flexibility

Not so simple...

Use the same region as everything else, at least in development

# Create REST API

Create the API

Get the rest-api-id

```
$ aws apigateway create-rest-api --name ShiftOps2
    --region us-west-2 --profile adminuser
{
    "name": "ShiftOps2",
    "id": "9k196bl123",
    "createdDate": 1488577949
}
```

9k196bl123  is your rest-api-id

# Get the Root Resource ID

Creation doesn't return the new root resource ID

```
$ aws apigateway get-resources --rest-api-id
    9k196bl1k1 --region us-west-2 --profile adminuser
{
    "items": [
        {
            "path": "/",
            "id": "j9vz8sl123"          } ] }
```

j9vz8sl123 = root-id = parent-id

# Create a Resource in the API

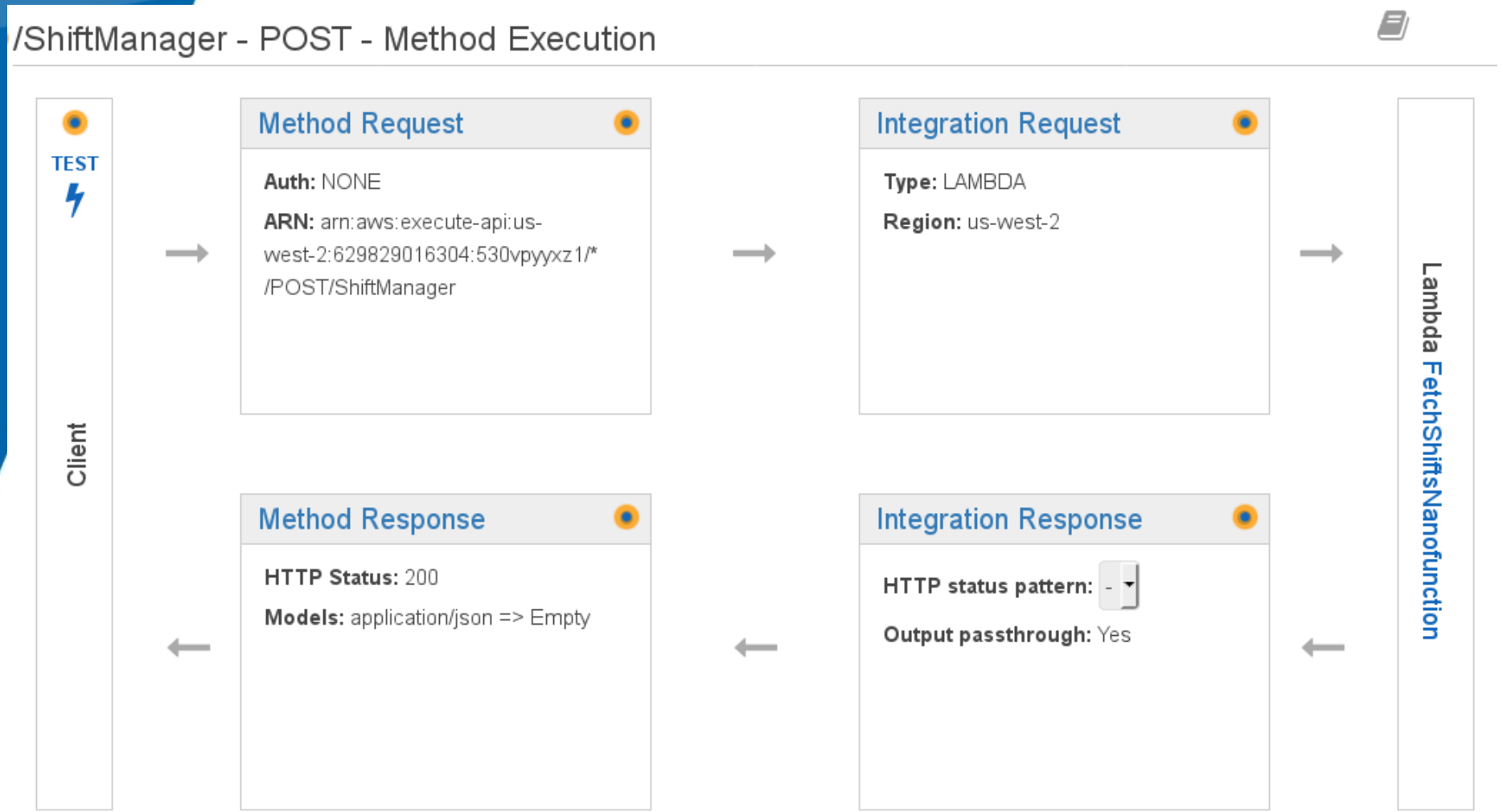
Resources can have GET, POST, etc. methods

path-part becomes part of the URL

```
$ aws apigateway create-resource --rest-api-id
    9k196bl123 --parent-id j9vz8sl123 --path-part
    ShiftMgr2  --region us-west-2 --profile adminuser
{
    "path": "/ShiftMgr2", "pathPart": "ShiftMgr2",
    "id": "56a212", "parentId": "j9vz8sl123"
}
```

56a212 = resource-id

# API Resource flow



# Implement POST first

- For each HTTP method there is a Method Request and an Integration Request
- Method Request may be HTTP GET or HTTP POST
- Integration Request for a Lambda is always a POST, even when Method Request is a GET
- Tutorials don't always make it clear which one they're referring to

# Create a POST method on the resource

```
$ aws apigateway put-method --rest-api-id 9k196bl123
    --resource-id 56a212 --http-method POST
    --authorization-type NONE --region us-west-2
    --profile adminuser
```

# Create the POST destination

Set the FetchShiftsLambda as the destination for the POST

```
$ aws apigateway put-integration --rest-api-id
    9k196bl123 --resource-id 56a212 --http-method
    POST --type AWS --integration-http-method POST
    --uri arn:aws:apigateway:us-west-
    2:lambda:path/2015-03-
    31/functions/arn:aws:lambda:us-west-
    2:629829011234:function:FetchShiftsLambda/invoc
    ations  --region us-west-2 --profile adminuser
```

# Request and Response Mappings

For each HTTP method

- Method Request
- Integration Request
- Integration Reponse
- Method Response

Mappings can do a variety of transformations

JSON in, JSON out → leave at default (passthrough, empty)

# Stages

- API Resources can be deployed to stages, which you name
- Typical stage names are “test” and “prod”

# Deploy API to “prod” Stage

$ aws apigateway create-deployment --rest-api-id 9k196bl123 --stage-name prod --region us-west-2 --profile adminuser

The “prod” stage was automatically created since it didn't exist

# Grant permission to invoke

Grant the Amazon API Gateway service principal (apigateway.amazonaws.com) permissions to invoke FetchShiftsNanofunction

```
$ aws lambda add-permission --function-name
    FetchShiftsLambda --statement-id apigateway-prod
    --action lambda:InvokeFunction --principal
    apigateway.amazonaws.com --source-arn
    "arn:aws:execute-api:us-west-
    2:629829011234:9k196bl123/*/POST/ShiftMgr2"
    --region us-west-2 --profile adminuser
```

statement-id value must be unique

# Grant permission to invoke – part 2

Grant to your deployed API (ShiftMgr2) permissions to invoke FetchShiftsLambda

$ aws lambda add-permission --function-name FetchShiftsLambda --statement-id apigateway-prod --action lambda:InvokeFunction --principal apigateway.amazonaws.com --source-arn "arn:aws:execute-api:us-west-2:629829011234:9k196bl123/prod/POST/ShiftMgr2" --region us-west-2 --profile adminuser

statement-id value must be unique

This is for the “prod” stage

# Test with Web UI

← Method Execution /ShiftManager - POST - Method Test

Make a test call to your method with the provided input

## Path

No path parameters exist for this resource. You can define path parameters by using the syntax **{myPathParam}** in a resource path.

## Query Strings

No query string parameters exist for this method. You can add them via Method Request.

## Headers

No header parameters exist for this method. You can add them via Method Request.

## Stage Variables

No stage variables exist for this method.

## Request Body

```
1  { "firstName":"AWS Web UI", "lastName"
       :"Calling"}
```

# Test with AWS CLI

```
$ aws apigateway test-invoke-method --rest-api-id
    9k196bl123 --resource-id 56a212 --http-method
    POST --path-with-query-string "" --body
    "{ \"firstName\":\"AWS
    CLI\",\"lastName\": \"Calling\"}"  --region us-west-2
    --profile adminuser
```

Response is large

- "status": 200
- body
- Endpoint request body after transformations
- Endpoint response body before transformations

# Test with curl

```
$ curl -X POST -d "{ \"firstName\":\"Curl\",\"lastName\":
    \"Calling\"}" https://9k196bl123.execute-api.us-west-
    2.amazonaws.com/prod/ShiftMgr2
```

Web browser should work now too

# Implement GET

- Can be same Lamba as the POST
- Query parameters will require input mapping template

# Create a GET method on the resource

```
$ aws apigateway put-method --rest-api-id 9k196bl123
    --resource-id 56a212 --http-method GET
    --authorization-type NONE --region us-west-2
    --profile adminuser
```

# Create the GET destination

Set the FetchShiftsLambda as the destination for the POST

$ aws apigateway put-integration --rest-api-id 9k196bl123 --resource-id 56a212 --http-method **GET** --type AWS --integration-http-method **POST** --uri arn:aws:apigateway:us-west-2:lambda:path/2015-03-31/functions/arn:aws:lambda:us-west-2:629829011234:function:FetchShiftsLambda/invocations --region us-west-2 --profile adminuser

# Deploy API to “prod” Stage

```
$ aws apigateway create-deployment --rest-api-id
    9k196bl123 --stage-name prod --region us-west-2
    --profile adminuser
```

Uses the “prod” stage that already exists

# Grant permission to invoke

Grant the Amazon API Gateway service principal (apigateway.amazonaws.com) permissions to invoke FetchShiftsLambda

```
$ aws lambda add-permission --function-name
    FetchShiftsLambda --statement-id apigateway-prod
    --action lambda:InvokeFunction --principal
    apigateway.amazonaws.com --source-arn
    "arn:aws:execute-api:us-west-
    2:629829011234:9k196bl123/prod/GET/ShiftMgr2"
    --region us-west-2 --profile adminuser
```

statement-id value must be unique

This is for the “prod” stage

# Request and Response Mappings

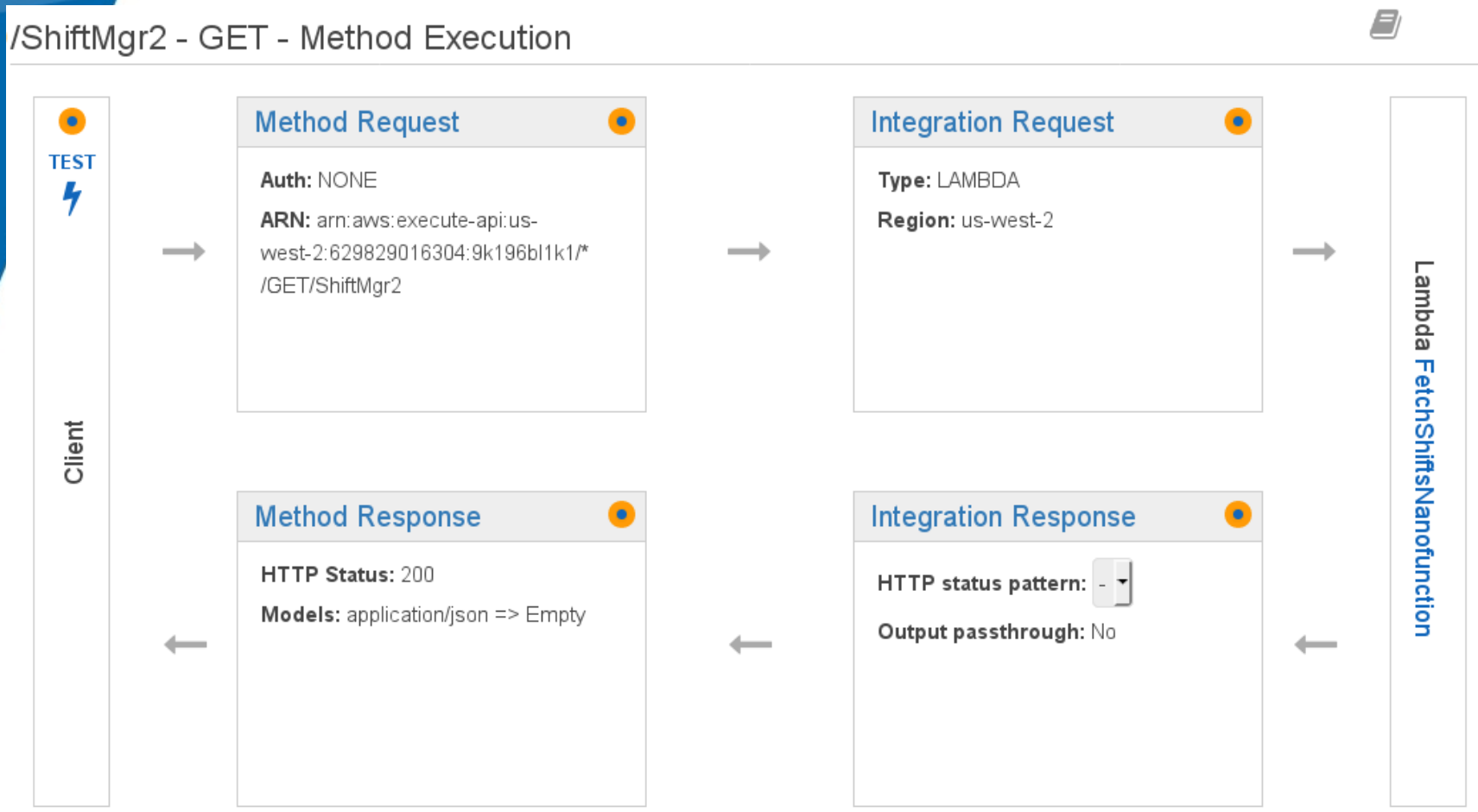
For each HTTP method

- Method Request
- Integration Request
- Integration Reponse
- Method Response

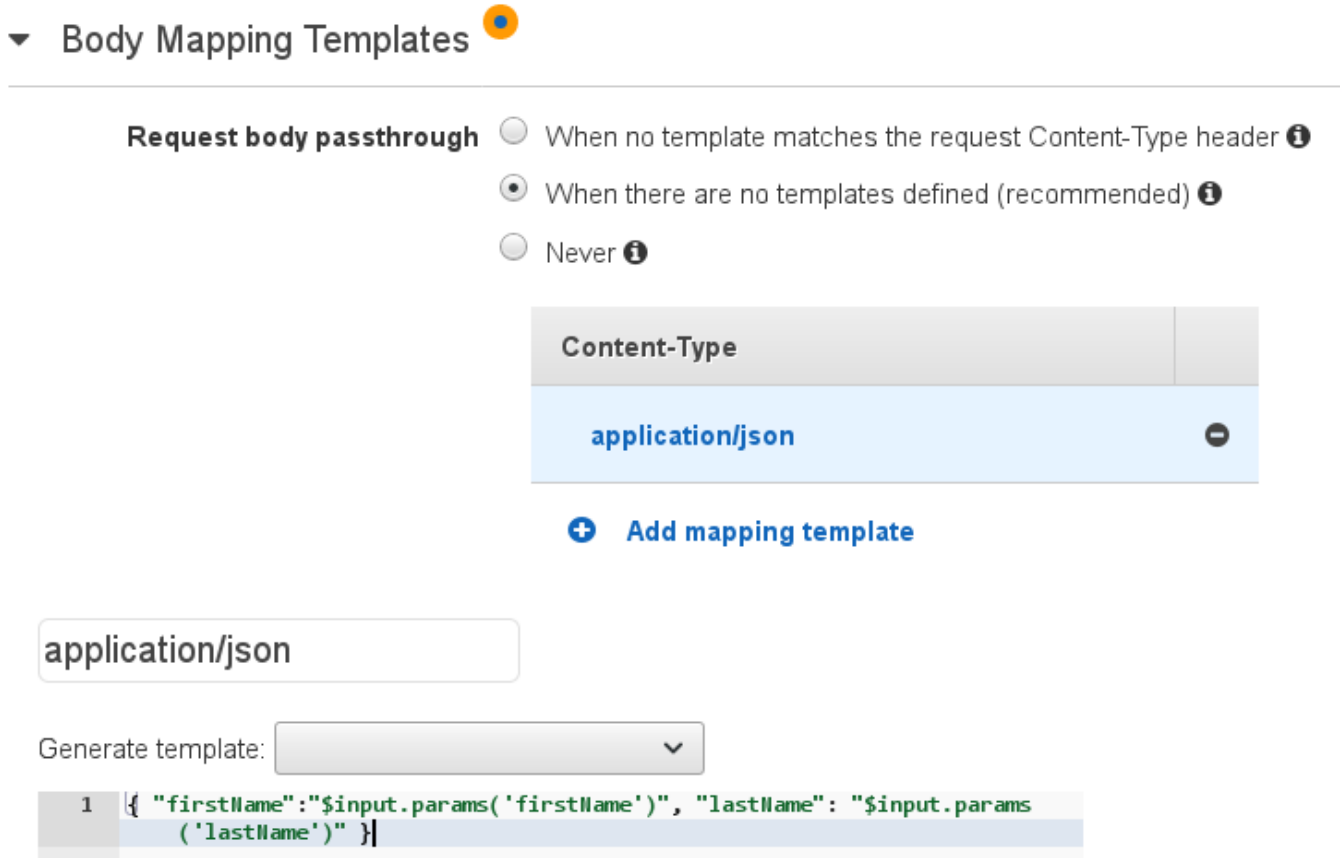
For GET, Integration Request can map query parameters to Lambda inputs

JSON out → leave at default (passthrough, empty)

# GET Resource Flow

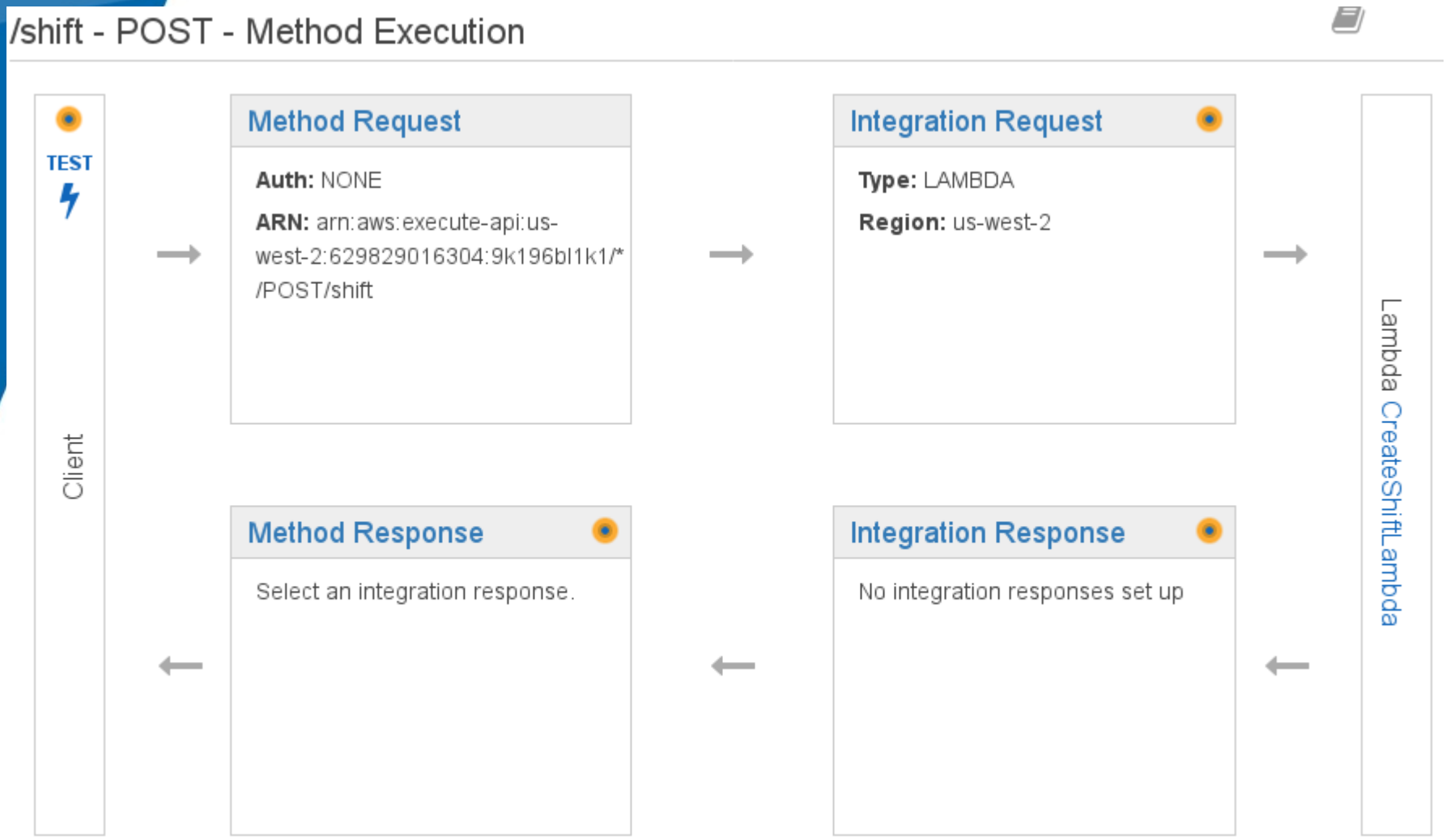


# Integration Request Body Mapping




{ "firstName":"$input.params('firstName')",
"lastName": "$input.params('lastName')" }

# API Resource flow (needs responses)



# Test with AWS CLI

```
$ aws apigateway test-invoke-method --rest-api-id
    9k196bl123 --resource-id 56a212 --http-method
    GET -path-with-query-string "?
    firstName=GetViaCurl&lastName=Calling"  --region
    us-west-2 --profile adminuser
```

Response is large

- "status": 200
- body
- Endpoint request body after transformations
- Endpoint response body before transformations

# Test with curl

$ curl --insecure https://9k196bl123.execute-api.us-west-2.amazonaws.com/prod/ShiftMgr2?firstName=GetViaCurl&lastName=Calling

GET output always shows up on a separate line

Web browser should work now too

# Demo RESTful store and retrieve

```
$ curl --insecure https://9k196bl123.execute-api.us-
    west-2.amazonaws.com/prod/ShiftMgr2?
    firstName=GetViaCurl&lastName=Calling
```

```
curl --insecure -X POST -d
    "{\"startDateMillis\": \"1486047600000\", \"endDateM
    illis\": \"1486090800000\"}"
    https://9k196bl123.execute-api.us-west-
    2.amazonaws.com/prod/shift
```

GET output always shows up on a separate line

# What has this shown?

It does work – RESTful endpoints are possible

Allows outsourcing much of hosting and operations

# Caveats

Learning curve

Every so often a response will be very slow

- JVM start up
- connecting to database

Nanofunctions will be integrating at the database, with all the known downsides

If Amazon Lambda closed down most of your code would still work but you'd have to find a new way of hosting it

# Alternatives to AWS operations

- serverless.com
- Ansible

# serverless.com/framework/

"The Serverless Platform is coming"

"Serverless is an MIT open-source project, actively maintained by a vibrant and engaged community of developers."

Node.js version 4 or greater

Can also deploy Python and Java

Supports AWS, Azure, Google Cloud Platform, and IBM OpenWhisk

"Forum Posts – 100+"

google '"serverless framework" java' → lots of hits

# Ansible

Lambda support new in version 2.2

API Gateway separate github project

- "v0.0.0a Build Status  Unstable work in Progress"
- https://github.com/pjodouin/ansible-api-gateway

# Potential open source project

Nanofunction hosting inside Java container

# Q & A