IaaS

Antonio Brogi

Department of Computer Science

University of Pisa

Server virtualization & hypervisors

Server Virtualization & Hypervisors

Definition of virtualization
- Virtualization is an "abstraction layer"
- OS no longer has to be bound to the server/pc it runs on
- OS abstracted from the HW, OS isn't installed directly on the HW
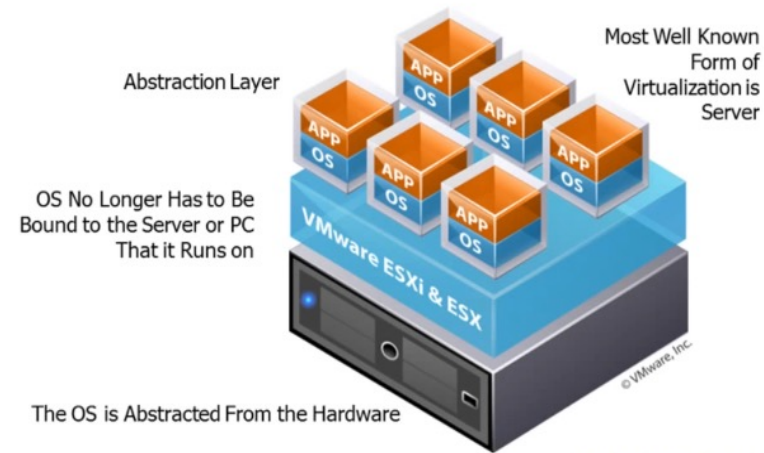
Server virtualization
- Virtualization layer between physical server and the OS you would normally install
- Virtual machines: where you actually install the OSs you are used to install, and the Apps

Definition of Hypervisor
- Creates the virtualization layer
- Contains the Virtual Machine Manager (VMM)

Type 1 vs. Type 2 Hypervisors
- Type 1 loaded directly on the HW, Type 2 loaded in an OS running on the HW
- Type 2 have greater overhead / lower consolidation ratio than Type 1
- Type 1 for data center, Type 2 for desktop/laptop

Server virtualization & hypervisors

How do you administer enterprise virtualization
- Examples of client apps used by administrator: VMware vSphere, MS Hyper-V
  - to create/run/turn off/reboot/take snapshots of/clone VMs
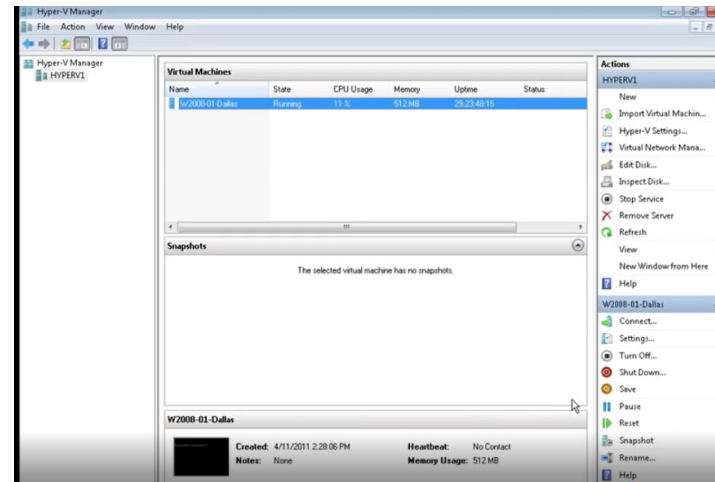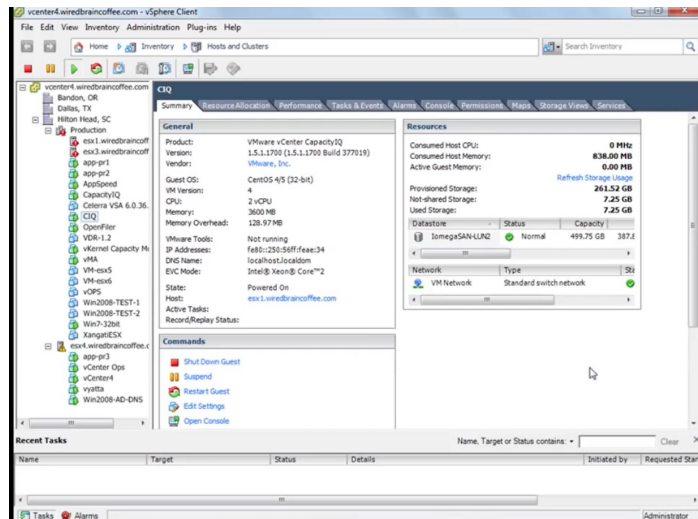
Ok but … where is the cloud?

Server virtualization & hypervisors

IaaS/Compute: Amazon EC2

Amazon Elastic Compute Cloud (EC2)

Amazon Elastic Compute Cloud (EC2)

- Mette a disposizione server virtuali (istanze) in modo semplice, veloce ed economico
- Scelta tipo istanza e template da utilizzare (Windows/Linux) e numero istanze con AWS management console (o librerie SDK)
- Ampia gamma di istanze (CPU, memoria, storage, GPU)
- Opzioni di pagamento: on demand, istanze riservate, istanze spot
- Sicurezza (Virtual Private Cloud - VPC)
- Storage persistente: Amazon Elastic Block Store (EBS)
- Autoscaling

EC2: Pricing

On demand

On-Demand Plans for Amazon EC2

Select a region, operating system, instance type, and vCPU to view rates

Region	Operating system
Europe (Milan)	Linux

Instance type	vCPU
All	All

Viewing 174 of 174 available instances

< 1 2 3 4 5 6 7 8 9 >

Instance name ▲	On-Demand hourly rate ▽	vCPU ▽	Memory ▽	Storage ▽	Network performance ▽
t4g.nano	$0.0048	2	0.5 GiB	EBS Only	Up to 5 Gigabit
t4g.micro	$0.0096	2	1 GiB	EBS Only	Up to 5 Gigabit
t4g.small	$0.0192	2	2 GiB	EBS Only	Up to 5 Gigabit
t4g.medium	$0.0384	2	4 GiB	EBS Only	Up to 5 Gigabit
t4g.large	$0.0768	2	8 GiB	EBS Only	Up to 5 Gigabit
t4g.xlarge	$0.1536	4	16 GiB	EBS Only	Up to 5 Gigabit
t4g.2xlarge	$0.3072	8	32 GiB	EBS Only	Up to 5 Gigabit
t3.nano	$0.006	2	0.5 GiB	EBS Only	Up to 5 Gigabit

Reserved instances

Standard Reserved Instances for Amazon EC2 | Convertible Reserved Instances for Amazon EC2

Reserved Instance Plans for Amazon EC2

Select terms for your Reserved Instances

Term length	Payment options
1 year	No Upfront

Select a region, operating system, and tenancy to view rates

Region	Operating system	Tenancy
US East (Ohio)	Linux	Shared

Viewing 397 of 113,011 available instances

< 1 2 3 4 5 6 7 ... 20 >

Instance name ▲	RI upfront fee ▽	RI monthly fees* ▽	RI effective hourly rate** ▽	Savings over On-Demand ▽	On-Demand rate ▽
a1.medium	$0	$11.75	$0.016	37%	$0.0255
a1.large	$0	$23.43	$0.032	37%	$0.0510
a1.xlarge	$0	$46.94	$0.064	37%	$0.1020
a1.2xlarge	$0	$93.81	$0.129	37%	$0.2040
a1.4xlarge	$0	$187.61	$0.257	37%	$0.4080
a1.metal	$0	$187.61	$0.257	37%	$0.4080
t4g.nano	$0	$1.90	$0.003	38%	$0.0042

Spot instances

Amazon EC2 Spot instances allow you to request spare Amazon EC2 computing capacity for up to 90% off the On-Demand price.

Dedicated hosts

Physical server with EC2 instance capacity fully dedicated to your use

750 hours per month
for 12 months with the AWS Free Tier

How To Launch A Linux Server on AWS EC2

https://www.youtube.com/watch?v=XvESEdap-4E&enablejsapi=1

Server virtualization & hypervisors

IaaS/Compute: Amazon EC2

IaaS market share

IaaS market share

Table 1. Worldwide IaaS Public Cloud Services Market Share, 2020-2021 (Millions of U.S. Dollars)

Company	2021 Revenue	2021 Market Share (%)	2020 Revenue	2020 Market Share (%)	2020-2021 Growth (%)
Amazon	35,380	38.9	26,201	40.8	35.0
Microsoft	19,153	21.1	12,659	19.7	51.3
Alibaba	8,679	9.5	6,117	9.5	41.9
Google	6,436	7.1	3,932	6.1	63.7
Huawei	4,190	4.6	2,681	4.2	56.3
Others	17,056	18.8	12,697	19.8	34.3
Total	**90,894**	**100.0**	**64,286**	**100.0**	**41.4**

Source: Gartner (June 2022)

Server virtualization & hypervisors

IaaS/Compute: Amazon EC2

IaaS market share

IaaS/Storage: Amazon S3

Amazon Simple Storage Service (S3)

"Everything must be made as simple as possible. But not simpler."

Amazon Simple Sorage Server (S3)

Amazon Simple Sorage Server (S3)

- Fornisce uno storage sicuro e facile da usare
- "Bucket"
- Diverse classi di memorizzazione (standard / standard infrequent access / glacier)
- Controllo configurabile accesso ai dati

S3: Pricing

	Storage pricing
S3 Standard - General purpose storage for any type of data, typically used for frequently accessed data	
First 50 TB / Month	$0.023 per GB
Next 450 TB / Month	$0.022 per GB
Over 500 TB / Month	$0.021 per GB
S3 Intelligent - Tiering* - Automatic cost savings for data with unknown or changing access patterns	
Monitoring and Automation, All Storage / Month (Objects > 128 KB)	$0.0025 per 1,000 objects
Frequent Access Tier, First 50 TB / Month	$0.023 per GB
Frequent Access Tier, Next 450 TB / Month	$0.022 per GB
Frequent Access Tier, Over 500 TB / Month	$0.021 per GB
Infrequent Access Tier, All Storage / Month	$0.0125 per GB
Archive Instant Access Tier, All Storage / Month	$0.004 per GB
S3 Intelligent - Tiering* - Optional asynchronous Archive Access tiers	
Archive Access Tier, All Storage / Month	$0.0036 per GB
Deep Archive Access Tier, All Storage / Month	$0.00099 per GB
S3 Standard - Infrequent Access** - For long lived but infrequently accessed data that needs millisecond access	
All Storage / Month	$0.0125 per GB
S3 One Zone - Infrequent Access** - For re-createable infrequently accessed data that needs millisecond access	
All Storage / Month	$0.01 per GB
S3 Glacier Instant Retrieval*** - For long-lived archive data accessed once a quarter with instant retrieval in milliseconds	
All Storage / Month	$0.004 per GB
S3 Glacier Flexible Retrieval (Formerly S3 Glacier)***- For long-term backups and archives with retrieval option from 1 minute to 12 hours	
All Storage / Month	$0.0036 per GB
S3 Glacier Deep Archive*** - For long-term data archiving that is accessed once or twice in a year and can be restored within 12 hours	
All Storage / Month	$0.00099 per GB

AWS Free Tier

As part of the AWS Free Tier, you can get started with Amazon S3 for free. Upon sign-up, new AWS customers receive 5GB of Amazon S3 storage in the S3 Standard storage class; 20,000 GET Requests; 2,000 PUT, COPY, POST, or LIST Requests; and 100 GB of Data Transfer Out each month.

Your usage for the free tier is calculated each month across all AWS Regions except the AWS GovCloud Region and automatically applied to your bill; unused monthly usage will not roll over. Restrictions apply; see offer terms for more details.

Amazon Elastic Block Store (EBS)

- Persistent block storage volumes for use with Amazon EC2 instances in the AWS Cloud

- Each Amazon EBS volume is automatically replicated within its Availability Zone to protect you from component failure, offering high availability and durability

- Designed for application workloads that benefit from fine tuning for performance, cost and capacity (e.g., big data analytics, stream processing, data warehousing)

Server virtualization & hypervisors

IaaS/Compute: Amazon EC2

IaaS market share

IaaS/Storage: Amazon S3

Dropbox

What if ...

we provide free storage to everybody?
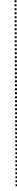
For the first eight years of its life, Dropbox stored billions and billions of files on Amazons S3

(files on S3, metadata on its own machines)

?
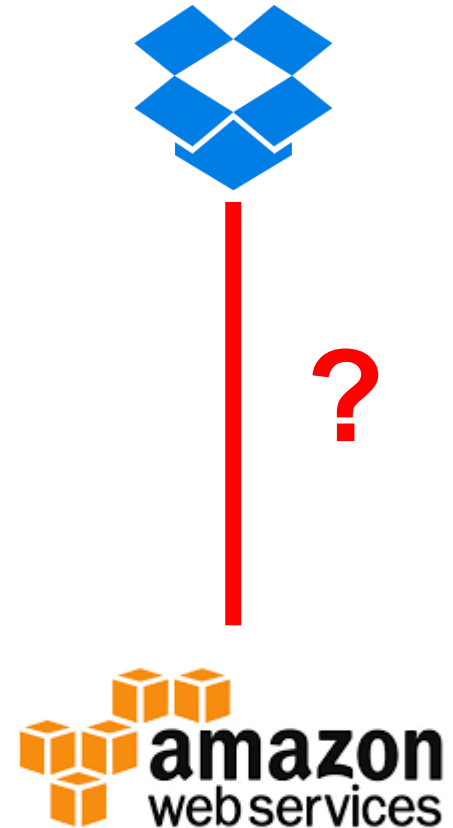
Dropbox's exodus

- Between 2014 and 2016, Dropbox built its own vast computer network and shifted its service onto a new breed of machines designed by its own engineers

- Big technical and logistical challenge
  - Custom-built hardware ("Diskotech") holding a petabyte of data
  - New code ("Magic Pocket")
  - Moving that many data
    - Petabytes of data across the Internet ($\approx$ 1day to transfer 4 petabytes of data)
  - Moving that many machines into data centers
    - Installing 40-50 racks of hardware a day
    - Ill-timed crashes: In one twenty-four hour period, trucks carrying machines to Dropbox data centers in different parts of the country had accidents
  - Need of completing exodus before expiration of main contracts with Amazon (to avoid renewal)
  - Do something like changing a tire while still driving
  - Magic Pocket didn't quite fit new hardware, Magic Pocket rebuilt
  - Dropbox made it!

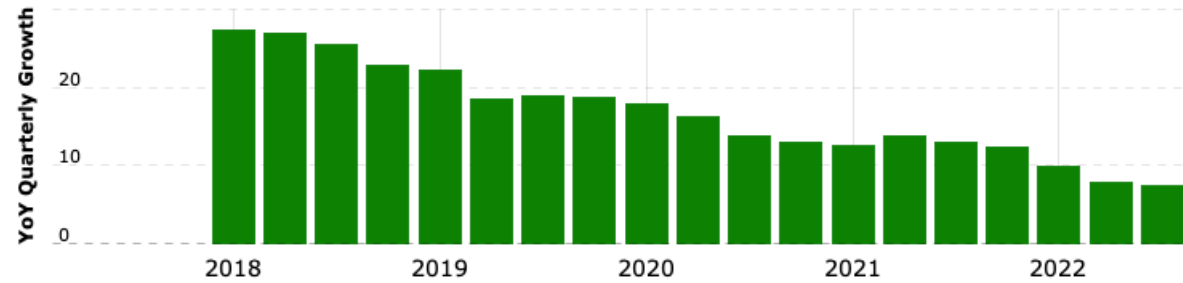# Dropbox's Exodus: Was it a good idea?

Pros
…
…

Cons
…
…

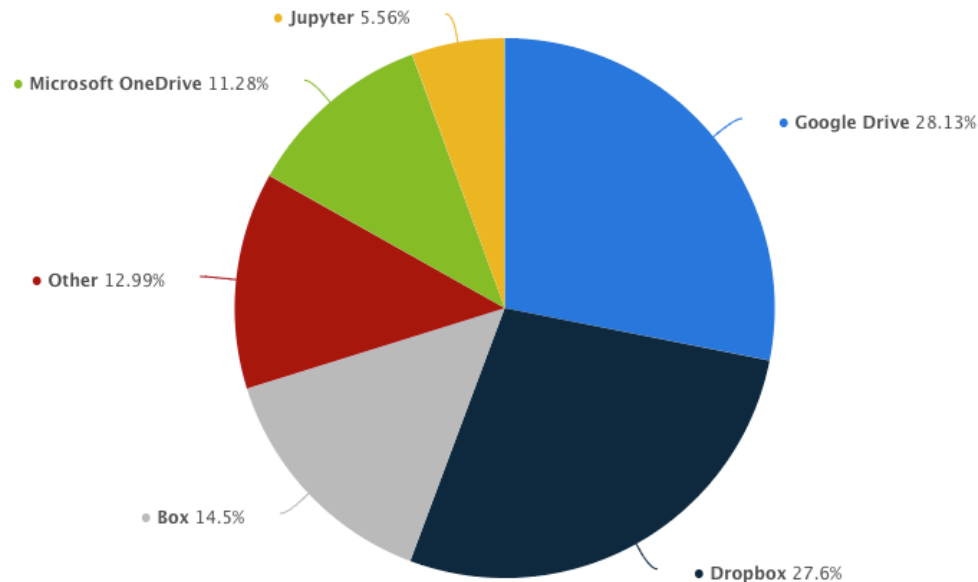*Poll: Would you have decided to migrate out of AWS?*
- *Yes*
- *Don't know*
- *No*

**Dropbox Annual Revenue
(Millions of US $)**

Year	Revenue
2021	$2,158
2020	$1,914
2019	$1,661
2018	$1,392
2017	$1,107
2016	$845
2015	$604

www.macrotrends.net

Leading vendors' share in the file sharing software market worldwide in 2022

- Jupyter 5.56%
- Microsoft OneDrive 11.28%
- Google Drive 28.13%
- Other 12.99%
- Box 14.5%
- Dropbox 27.6%

www.statista.com

Server virtualization & hypervisors

IaaS/Compute: Amazon EC2
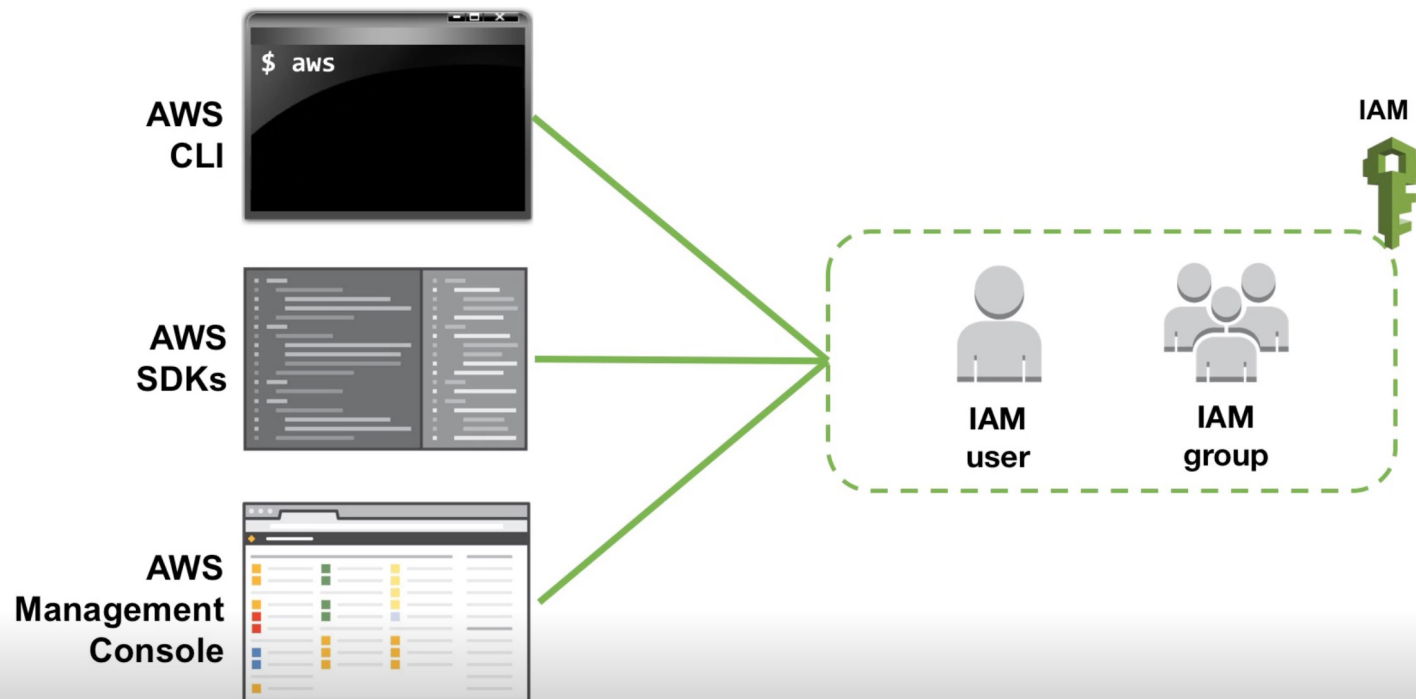
IaaS market share

IaaS/Storage: Amazon S3

Dropbox

AWS IAM (Identity and Access Management)

Introducing AWS IAM

User

IAM

AWS

Storage
Development and
Management Tools

Analytics   **Content Delivery**

Messaging   **Compute**

App Services

Database   Payments

Mobile   ***Networking***

On-Demand Workforce

VPC
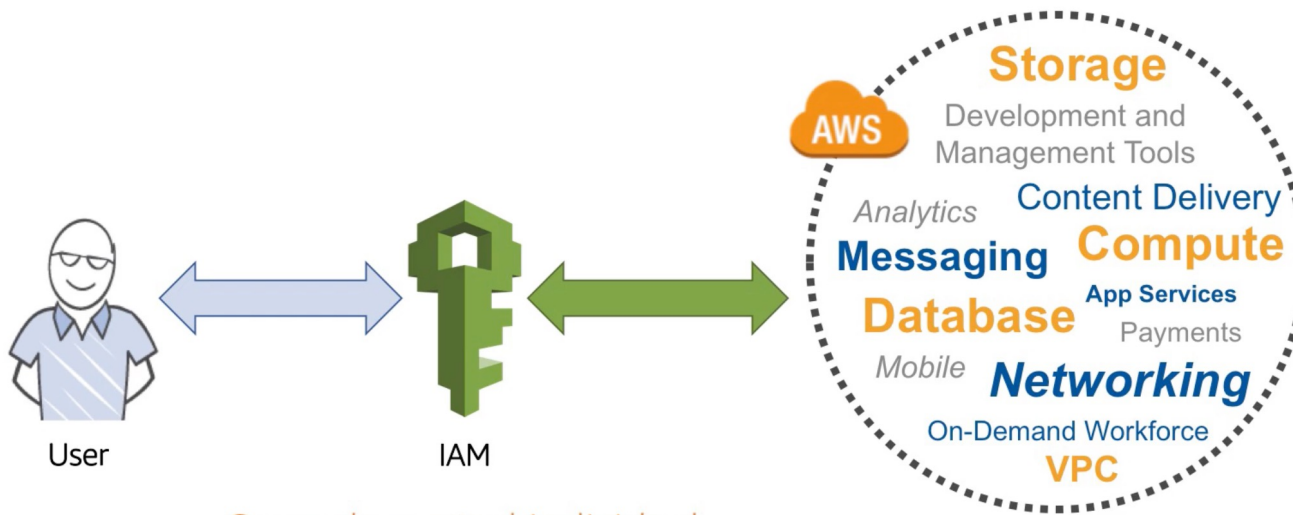
Securely control individual
and group access
to your AWS resources.

IAM Authorization

IAM Policies are JSON documents used to describe permissions within AWS.
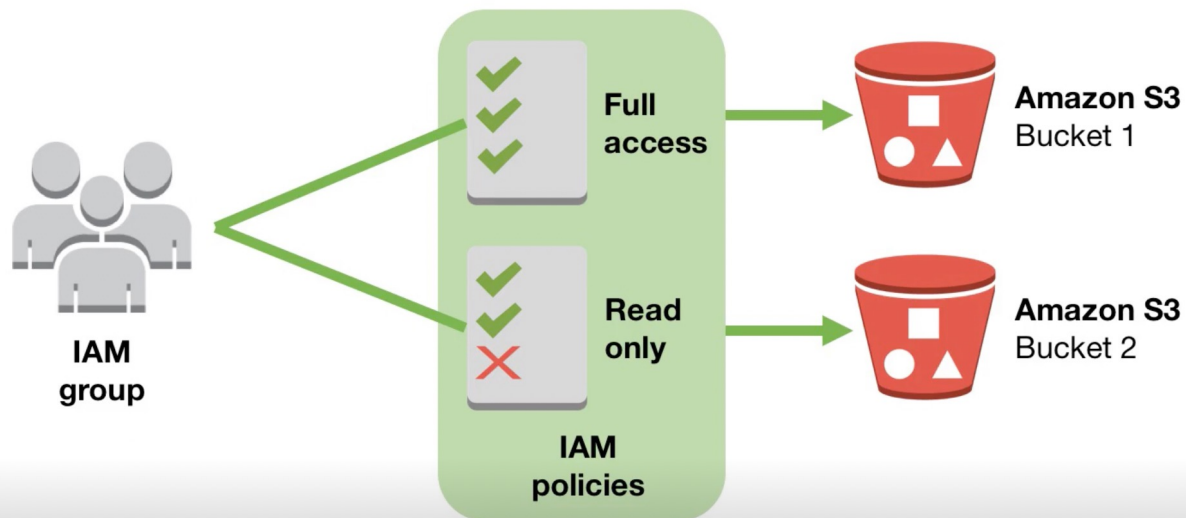
Sample Policy

IAM Policies are JSON documents used to describe permissions within AWS.

```
"Sid":    "Stmt1505076701000",
"Effect":    "Allow",
"Action":    [
    "s3:DeleteObject",
    "s3:GetObject"
],
"Condition":    {
    "IpAddress":    {
        "aws:SourceIP":    "10.14.8.0/24"
    }
},
"Resource":    [
    "arn:aws:s3:::billing-marketing",
    "arn:aws:s3:::billing-sales"
]
```

Who/what is authorized

Which task(s) are allowed

Which condition(s) need to be met for authorization

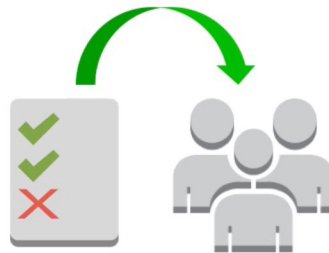Resources to which authorized tasks are performed
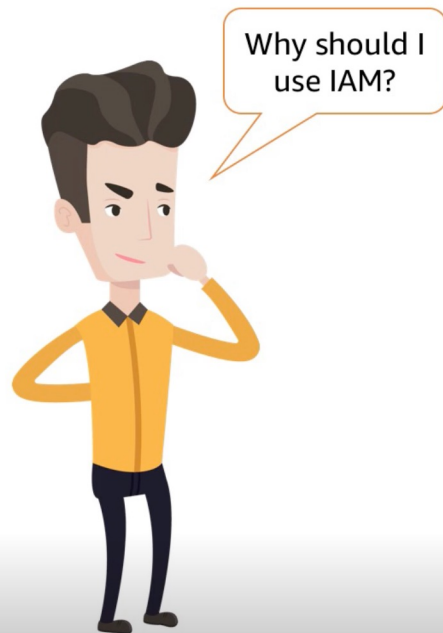
aws training and certification

Bringing it all Together

IAM Roles

IAM Role

- IAM users, applications, and services may assume IAM roles

- Uses an IAM policy for permissions