Accelerating Time to Science on AWS

IS&T Colloquium, NASA Goddard Space Flight Center, April 6th, 2016

Jamie Baker

Principal, Federal Scientific Accounts
bakjames@amazon.com

Amazon.com…
?
… AWS: the leader in utility
(aka cloud) computing

2004

amazon.com

$7B retail business
~10,000 employees
A whole lot of servers

2013

amazon web services

Every day, AWS adds enough
server capacity to power this
$7B enterprise

amazon web services

Said another way…

AWS is deploying the equivalent of a top-20 supercomputer every few days

amazon web services

AWS is Leader and Visionary

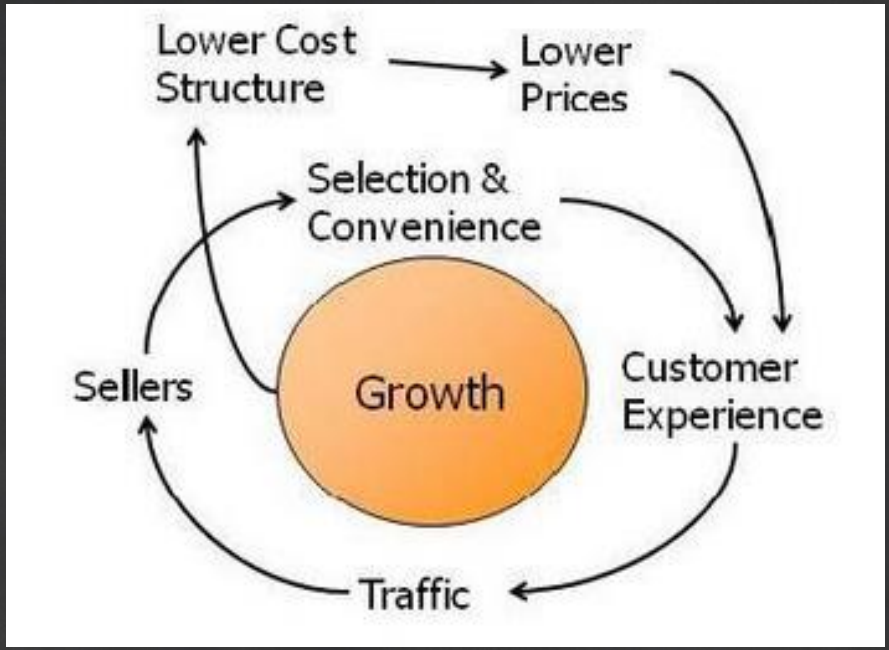
Gartner Magic Quadrant for Cloud Infrastructure as a Service, Worldwide

Source: Gartner (May 2015)

Gartner "Magic Quadrant for Cloud Infrastructure as a Service, Worldwide," Lydia Leong, Douglas Toombs, Bob Gill, May 18, 2015. This Magic Quadrant graphic was published by Gartner, Inc. as part of a larger research note and should be evaluated in the context of the entire report. The Gartner report is available at http://aws.amazon.com/resources/analyst-reports/. Gartner does not endorse any vendor, product or service depicted in its research publications, and does not advise technology users to select only those vendors with the highest ratings or other designation. Gartner research publications consist of the opinions of Gartner's research organization and should not be construed as statements of fact. Gartner disclaims all warranties, expressed or implied, with respect to this research, including any warranties of merchantability or fitness for a particular purpose.

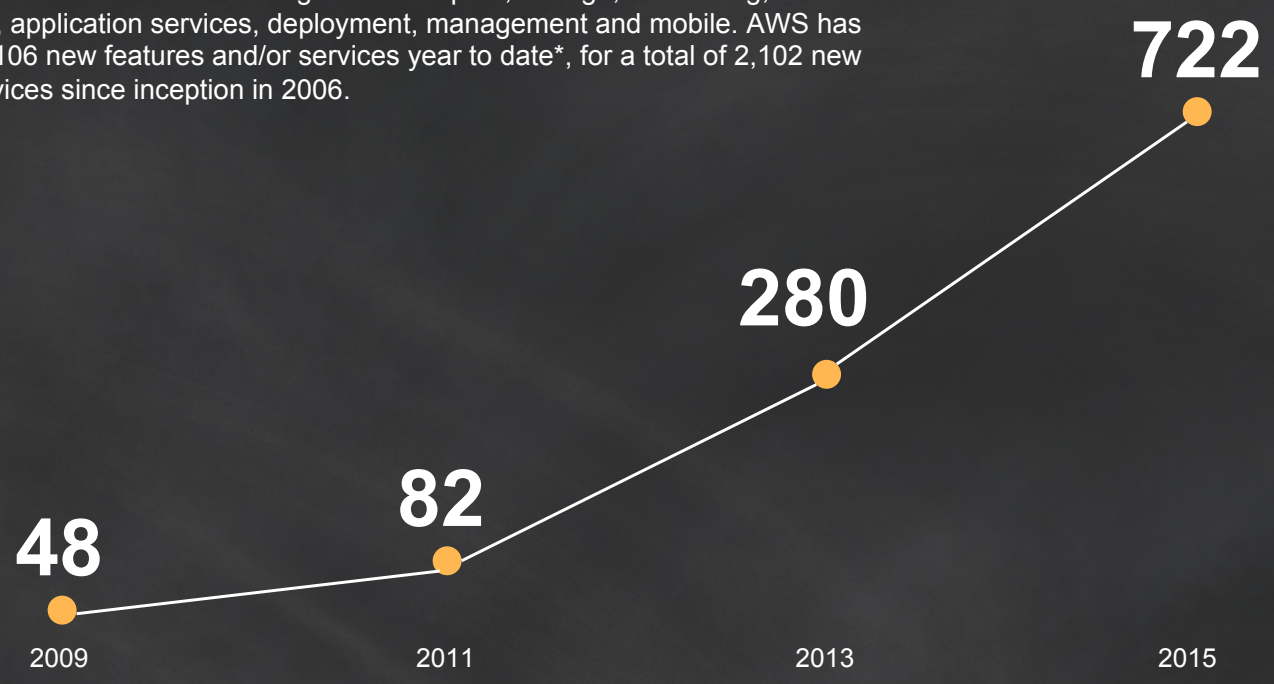
amazon web services

Amazon Virtuous Cycle



AWS Rapid Pace of Innovation

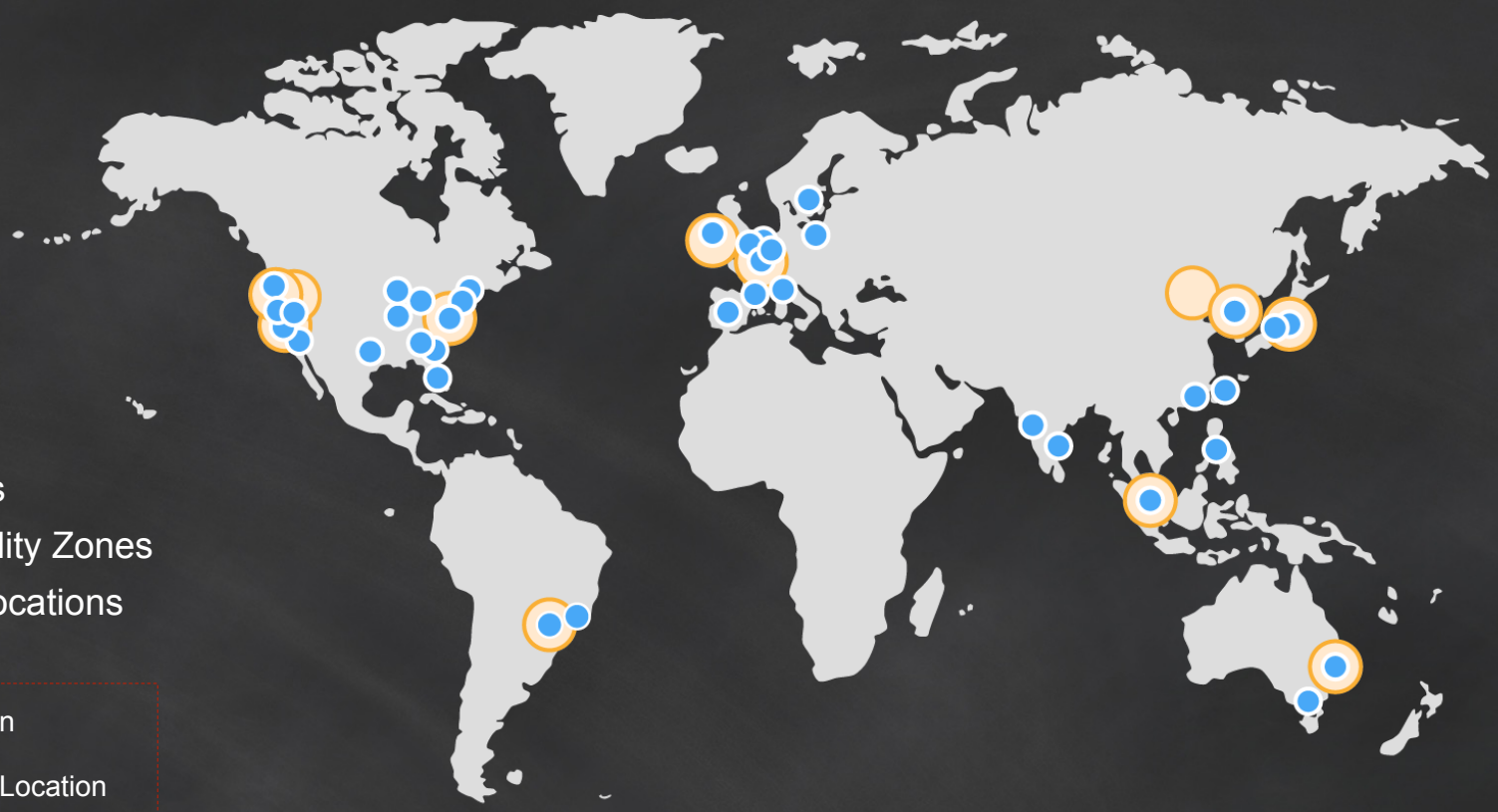
AWS has been continually expanding its' services to support virtually any cloud workload and now has more than 70 services that range from compute, storage, networking, database, analytics, application services, deployment, management and mobile. AWS has launched a total of 106 new features and/or services year to date*, for a total of 2,102 new features and/or services since inception in 2006.



*As of 1 April 2016

amazon web services

Globally Accessible: AWS Global Infrastructure



12 Regions

33 Availability Zones

54 Edge Locations

Region

Edge Location

You choose where your apps and data go!

amazon web services

North America

US East (N. Virginia) Region

EC2 Availability Zones: 5

Launched 2006

US West (Oregon) Region

EC2 Availability Zones: 3

Launched 2011

US West (N. California) Region

EC2 Availability Zones: 3

Launched 2009

AWS GovCloud (US) Region

EC2 Availability Zones: 2

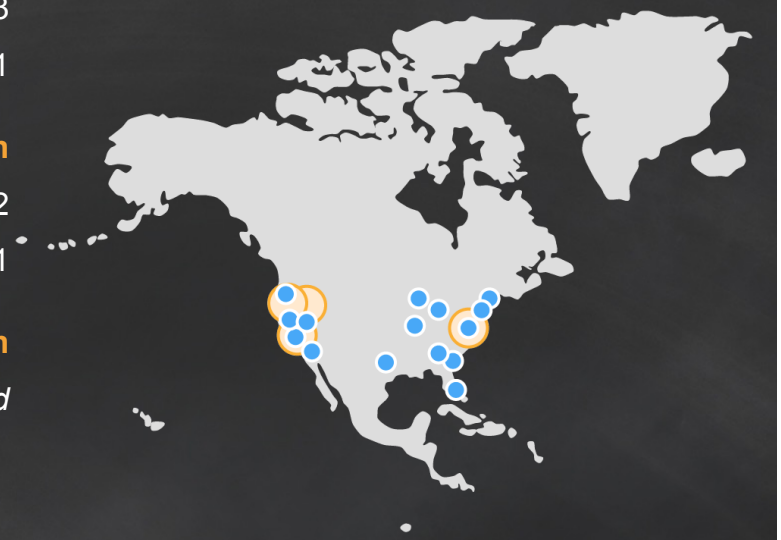
Launched 2011

Canada (Montreal) Region

Announced

US Central (Ohio) Region

Announced



AWS Edge Locations

Ashburn, VA (3); Atlanta, GA; Chicago, IL; Dallas/Fort Worth, TX (2); Hayward, CA; Jacksonville, FL; Los Angeles, CA (2); Miami, FL; New York, NY (3); Newark, NJ; Palo Alto, CA; San Jose, CA; Seattle, WA; South Bend, IN; St. Louis, MO

amazon web services

Enterprise Applications	**Virtual Desktops**		**Sharing and Collaboration**		
Platform Services	**Databases** Relational NoSQL Caching	**Analytics** Hadoop Real-Time Data Warehouses Data Workflows	**App Services** Queuing Orchestration App Streaming Transcoding Email Search	**Deployment and Management** Containers DevOps Tools Resource Templates Usage Tracking Monitoring and Logs	**Mobile Services** Identity Sync Mobile Analytics Notifications
Foundation Services	Compute (VMs, Auto Scaling and Load Balancing)	Storage (Object, Block and Archive)	Security and Access Control	Networking	
Infrastructure	Regions	Availability Zones	Content Delivery Networks and Points of Presence		

amazon web services

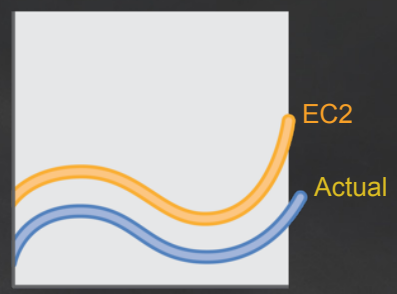
Compute Services

Amazon EC2

Elastic **virtual servers**
in the cloud

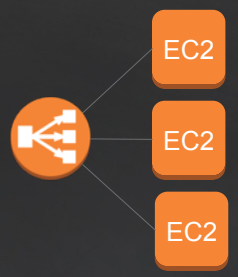
Auto Scaling

Automated scaling
of EC2 capacity



Elastic Load Balancing

Dynamic
traffic distribution



EC2

There are a couple dozen EC2 compute instance types alone, each of which is optimized for different things.

One size does not fit all.

Memory Optimized

R3

R3 instances are optimized for memory-intensive applications and have the lowest cost per GiB of RAM among Amazon EC2 instance types.

Features:

- High Frequency Intel Xeon E5-2670 v2 (Ivy Bridge) Processors
- Lowest price point per GiB of RAM
- SSD Storage
- Support for Enhanced Networking

Model	vCPU	Mem (GiB)	SSD Storage (GB)
r3.large	2	15.25	1 x 32
r3.xlarge	4	30.5	1 x 80
r3.2xlarge	8	61	1 x 160
r3.4xlarge	16	122	1 x 320
r3.8xlarge	32	244	2 x 320

Use Cases

We recommend memory-optimized instances for high performance databases, distributed memory caches, in-memory analytics, genome assembly and analysis, larger deployments of SAP, Microsoft SharePoint, and other enterprise applications.

GPU

G2

This family includes G2 instances intended for graphics and general purpose GPU compute applications.

Features:

- High Frequency Intel Xeon E5-2670 (Sandy Bridge) Processors
- High-performance NVIDIA GPU with 1,536 CUDA cores and 4GB of video memory
- On-board hardware video encoder designed to support up to eight real-time HD video streams (720p at 30fps) or up to four real-time FHD video streams (1080p at 30 fps).
- Support for low-latency frame capture and encoding for either the full operating system or select render targets, enabling high-quality interactive streaming experiences.

Model	vCPU	Mem (GiB)	SSD Storage (GB)
g2.2xlarge	8	15	1 x 60

Use Cases

Game streaming, video encoding, 3D application streaming, and other server-side graphics workloads.

http://aws.amazon.com/ec2/instance-types/

C4

C4 instances are the latest generation of Compute-optimized instances, featuring the highest performing processors and the lowest price/compute performance in EC2.

Features:

- High frequency Intel Xeon E5-2666 v3 (Haswell) processors optimized specifically for EC2
- EBS-optimized by default and at no additional cost
- Ability to control processor C-state and P-state configuration on the c4.8xlarge instance type
- Support for Enhanced Networking and Clustering

Model	vCPU	Mem (GiB)	Storage	Dedicated EBS Throughput (Mbps)
c4.large	2	3.75	EBS-Only	500
c4.xlarge	4	7.5	EBS-Only	750
c4.2xlarge	8	15	EBS-Only	1,000
c4.4xlarge	16	30	EBS-Only	2,000
c4.8xlarge	36	60	EBS-Only	4,000

C3

Features:

- High Frequency Intel Xeon E5-2680 v2 (Ivy Bridge) Processors
- Support for Enhanced Networking
- Support for clustering
- SSD-backed instance storage

Model	vCPU	Mem (GiB)	SSD Storage (GB)
c3.large	2	3.75	2 x 16
c3.xlarge	4	7.5	2 x 40
c3.2xlarge	8	15	2 x 80
c3.4xlarge	16	30	2 x 160
c3.8xlarge	32	60	2 x 320

M3

This family includes the M3 instance types and provides a balance of compute, memory, and network resources, and it is a good choice for many applications.

Features:

- High Frequency Intel Xeon E5-2670 v2 (Ivy Bridge) Processors*
- SSD-based instance storage for fast I/O performance
- Balance of compute, memory, and network resources

Model	vCPU	Mem (GiB)	SSD Storage (GB)
m3.medium	1	3.75	1 x 4
m3.large	2	7.5	1 x 32
m3.xlarge	4	15	2 x 40
m3.2xlarge	8	30	2 x 80

Use Cases

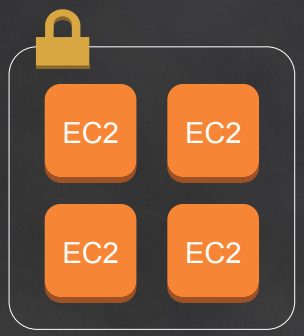
Small and mid-size databases, data processing tasks that require additional memory, caching fleets, and for running backend servers for SAP, Microsoft SharePoint, and other enterprise applications.

amazon web services

Networking Services

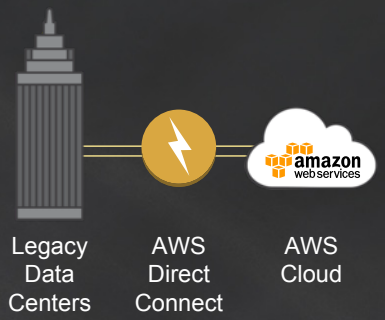
Amazon VPC

Private, isolated section of the AWS cloud



AWS Direct Connect

Private connectivity between AWS and your data center



Amazon Route 53

Domain Name System (DNS) web service

Storage Services

Amazon EBS

Block storage
for use with
Amazon EC2

Amazon S3

Internet
scale storage
via API

Images
Videos
Files
Binaries
Snapshots

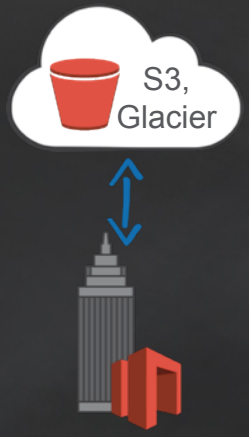
Amazon Glacier

Storage for
archiving
and **backup**

Images
Videos
Files
Binaries
Snapshots

AWS Storage Gateway

Integrates
on-premises IT
and AWS storage



Application Services

Amazon CloudFront

Distributing content globally

Amazon CloudSearch

Managed **search service**

Amazon Elastic Transcoder

Video transcoding

Database Services

Amazon RDS

Managed **relational database service**

Amazon DynamoDB

Managed **NoSQL database service**

Amazon ElastiCache

In-memory **caching** service

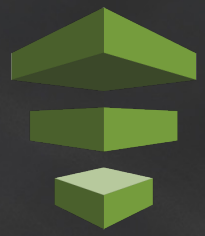
Big Data Services

Amazon Elastic MapReduce
(Amazon EMR)

Hosted **Hadoop framework**

AWS Data Pipeline

Move data among AWS services and on-premises data sources



Amazon Redshift

Petabyte-scale **data warehouse** service

Deployment and Administration

Amazon CloudWatch

Monitor resources

AWS Identity and Access Management (IAM)

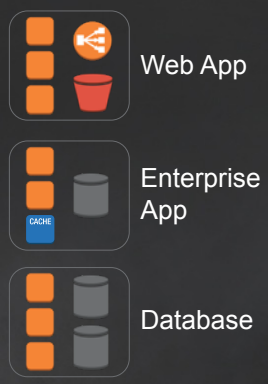
Manage **users, groups, and permissions**

Amazon OpsWorks

DevOps framework for application lifecycle management

AWS CloudFormation

Templates to deploy and manage

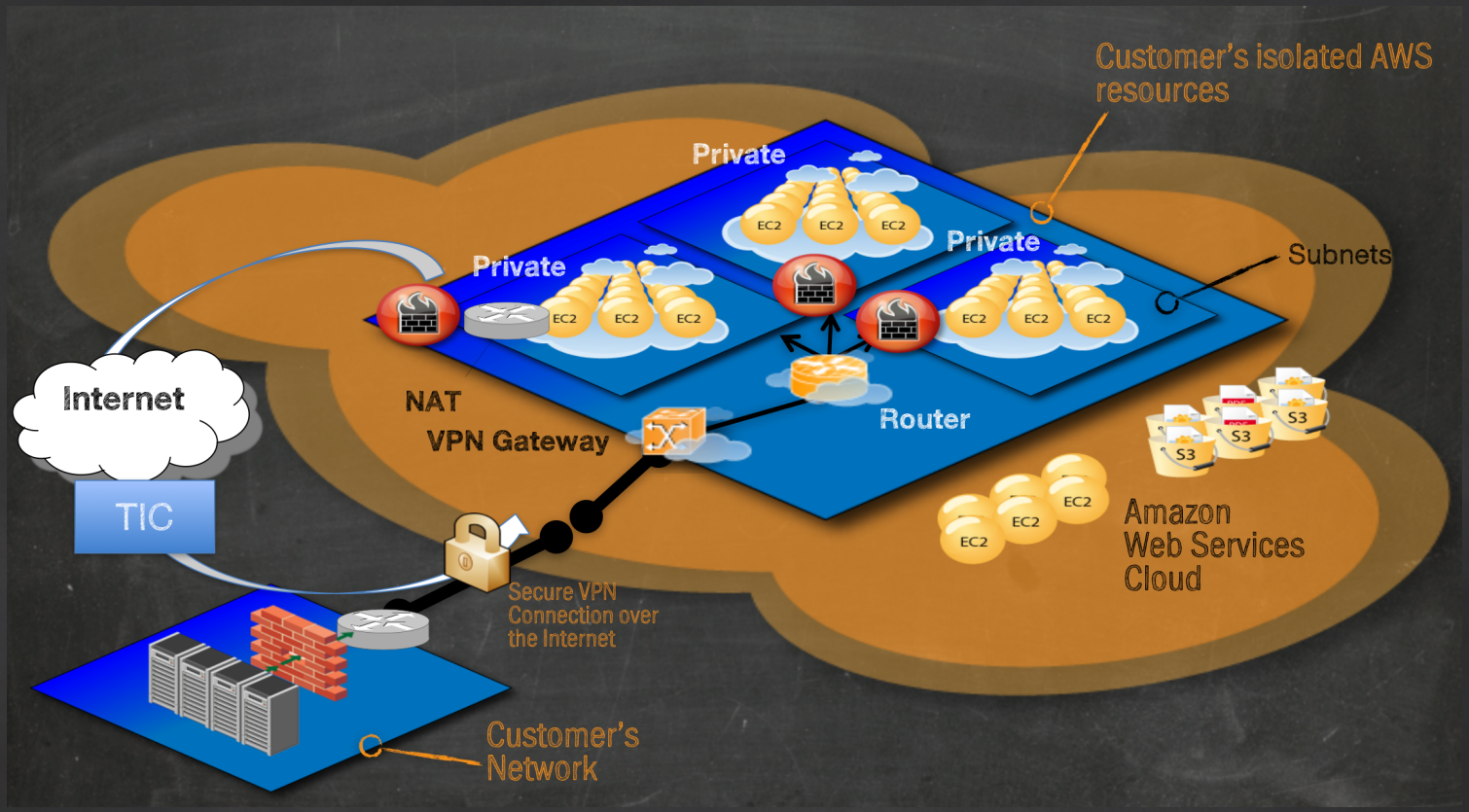


AWS Elastic Beanstalk

Automate resource management

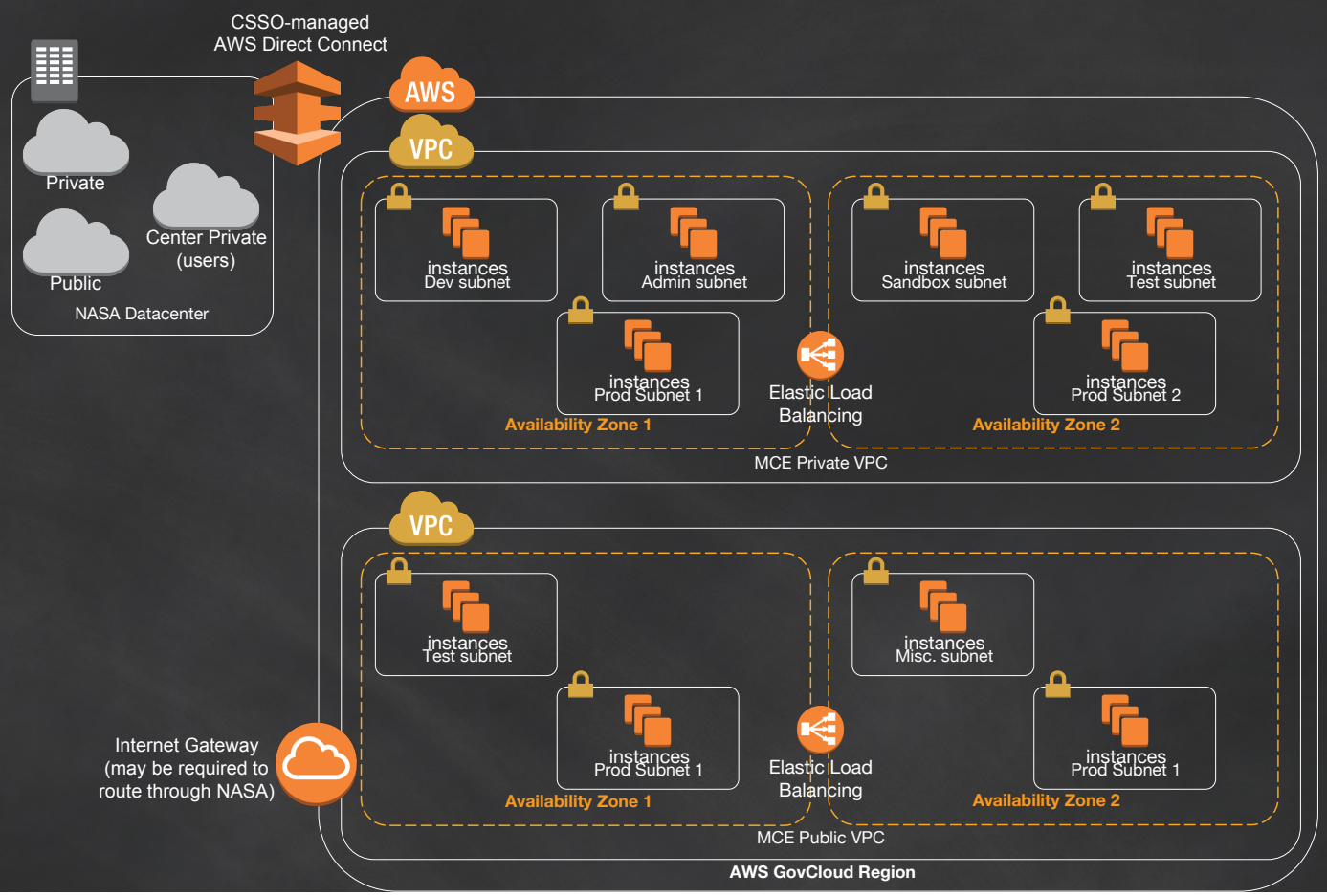
Secure: Virtual Private Cloud

Extremely secure by default.



amazon web services

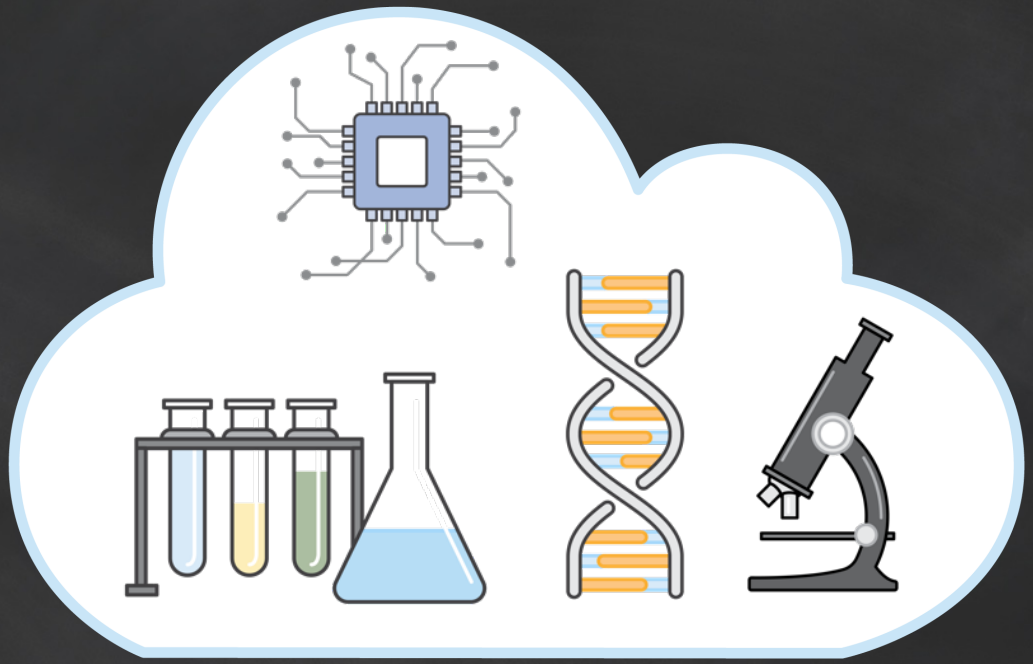
High-level Architecture



amazon web services

What do we mean by Scientific Computing?

Scientific Computing refers to the application of simulation, mathematical modeling and quantitative analysis to analyze and solve scientific problems.

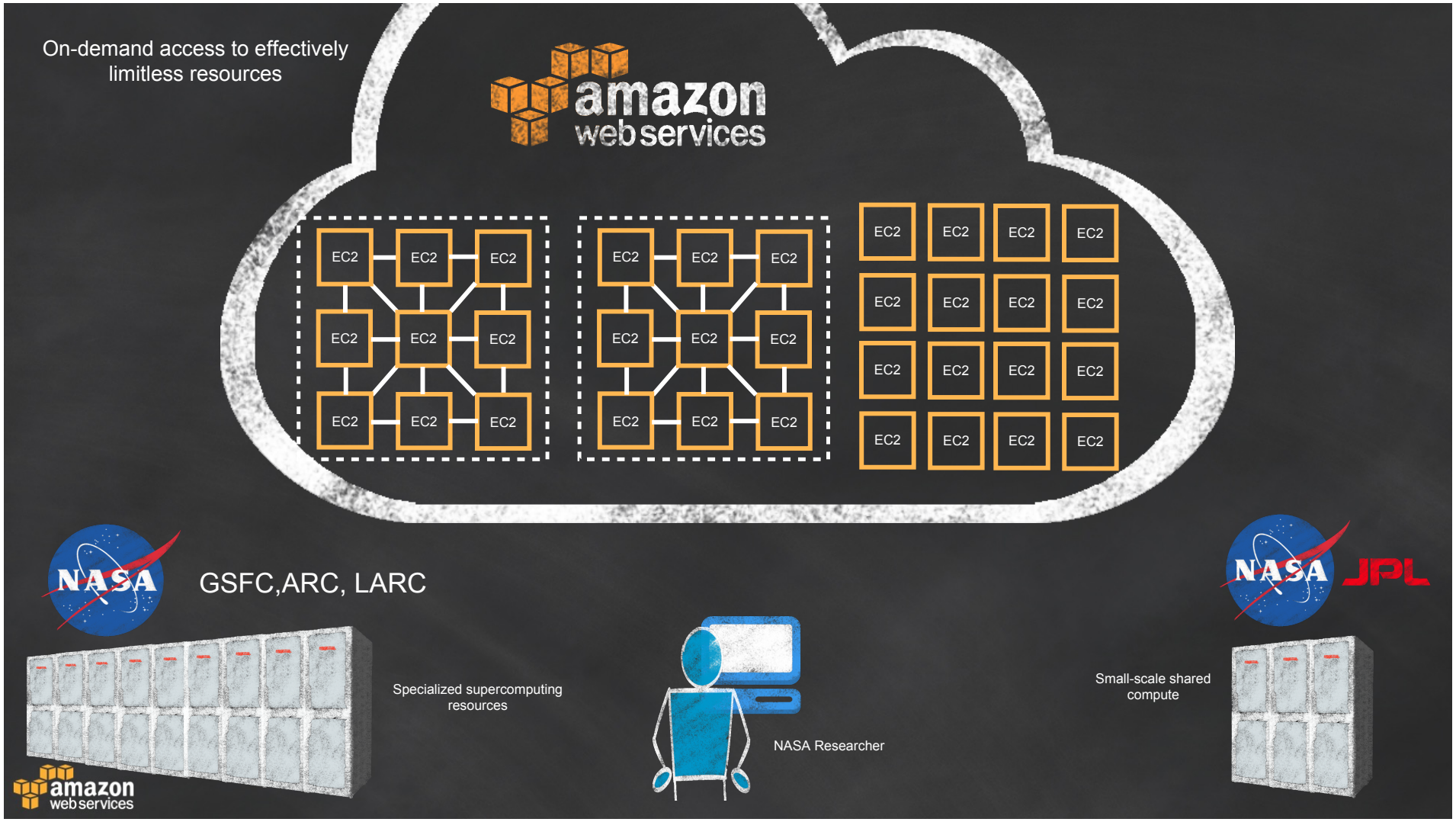


amazon web services

How is AWS used for Scientific Computing?

- High Performance Computing (HPC) for Engineering and Simulation
- High Throughput Computing (HTC) for Data-Intensive Analytics
- Hybrid Supercomputing centers
- Collaborative Research Environments
- Citizen Science
- Science-as-a-Service
- On-Demand Academic Training/Lab Environments

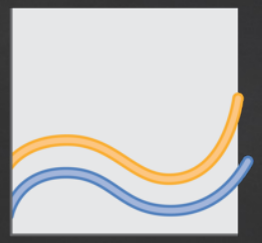
amazon web services


On-demand access to effectively limitless resources
amazon web services
EC2
GSFC,ARC, LARC
Specialized supercomputing resources
NASA Researcher
Small-scale shared compute
JPL

Why do researchers love using AWS?

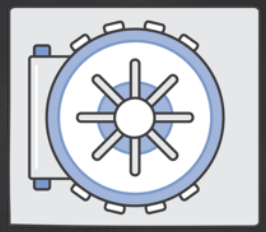
Time to Science
Access research infrastructure in minutes

Low Cost
Pay-as-you-go pricing



Elastic
Easily add or remove capacity

Globally Accessible
Easily Collaborate with researchers around the world



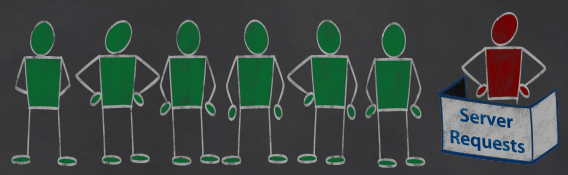
Secure
A collection of tools to protect data and privacy

Scalable
Access to effectively limitless capacity

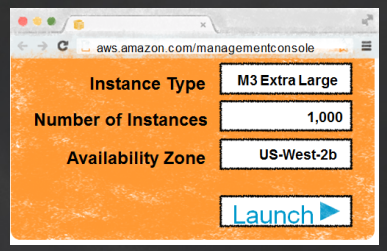
amazon web services

Elastic: Research can't afford to be slow

Old World:
Infrastructure in Weeks



AWS:
Infrastructure in Minutes



Add New Test Environment

Remove Test Environment

Add New DR Environment on East Coast

Add 100 Servers for Enrollment

Remove 100 Servers after Enrollment

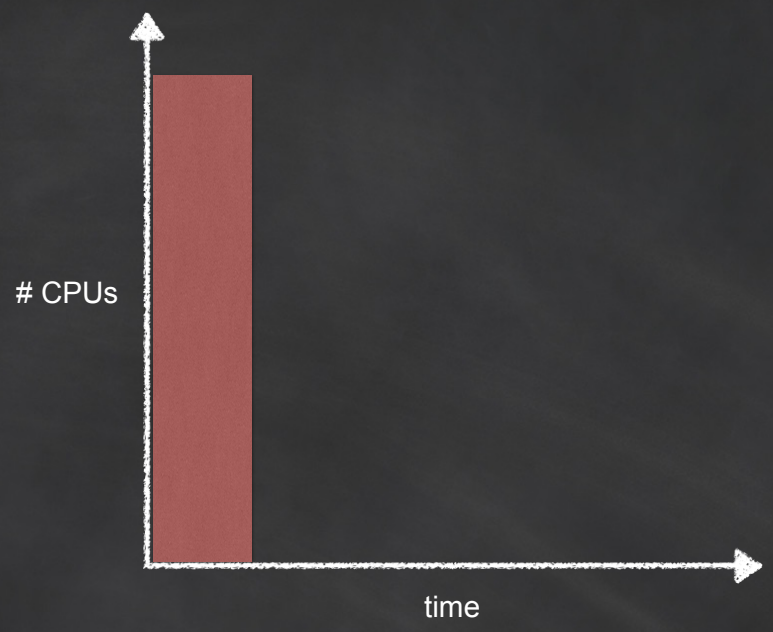
Deploy 10,000 Core HPC Cluster

Shut down 10,000 Core HPC Cluster

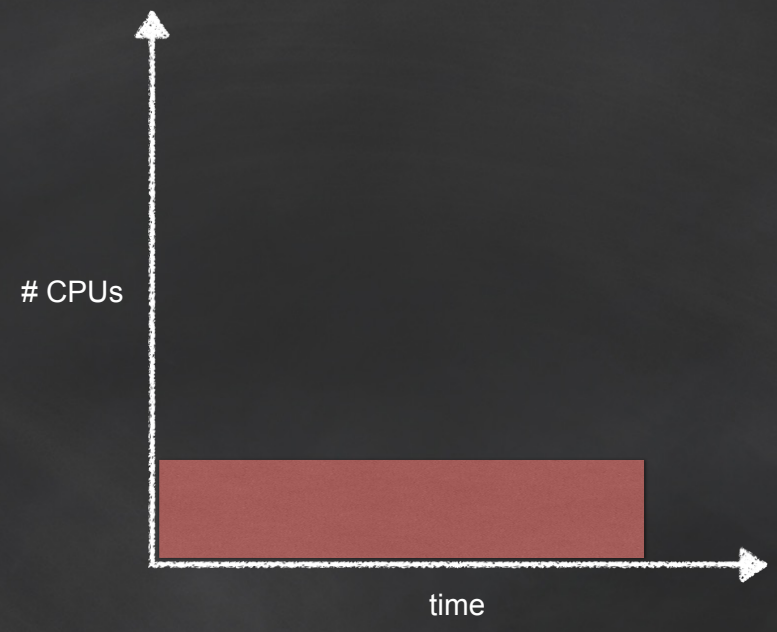
Everything changes with this kind of agility

amazon web services

Scalable: Scientific results faster with scale



Wall clock time: **~1 hour**

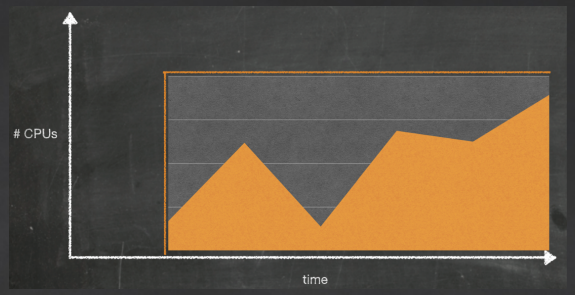


Wall clock time: **~1 week**

Cost: equal

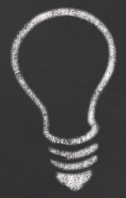
amazon web services

Low Cost: pay-as-you-go pricing



When you only pay for what you use …

- If you're only able to use your compute, say, 30% of the time, you only pay for that time.



… you have options.

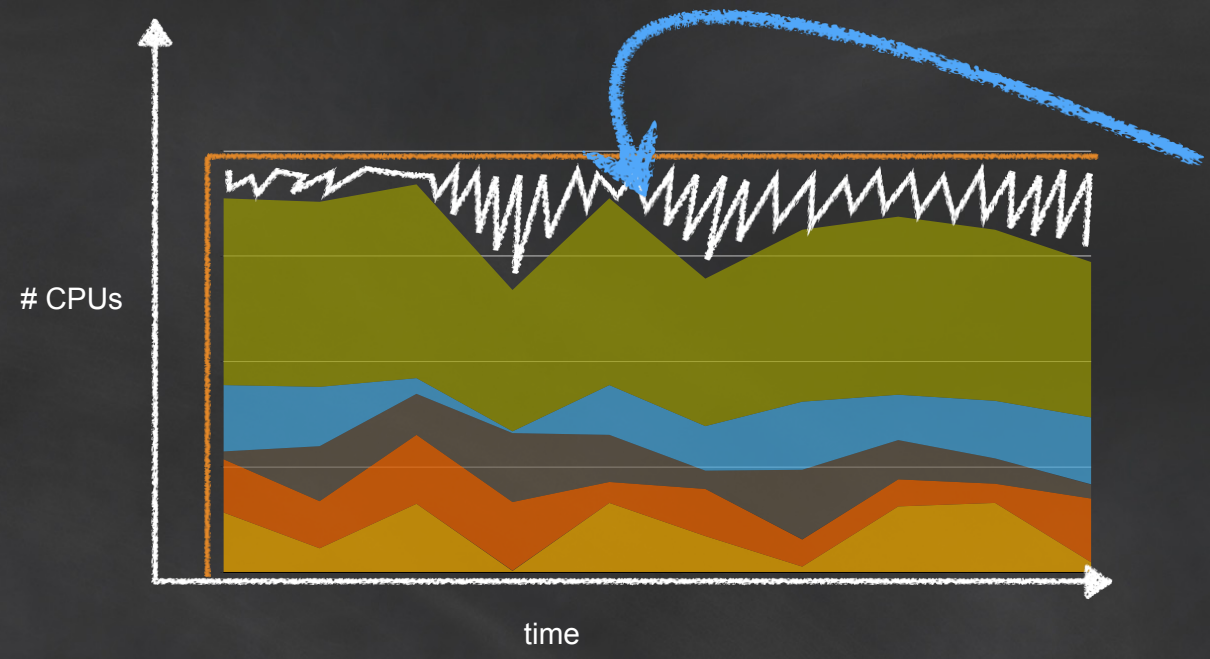
1 Pocket the savings
- Buy chocolate
- Buy a spectrometer
- Hire a scientist.

2 Go faster
- Use 3x the cores to run your jobs at 3x the speed.

3 Go Large
- Do 3x the science, or consume 3x the data.

amazon web services

Low Cost: Spot Market



Spot Market

Our ultimate space filler.

Spot Instances allow you to name your own price for spare AWS computing capacity.

Great for workloads that aren't time sensitive, and especially popular in research (hint: it's really cheap).

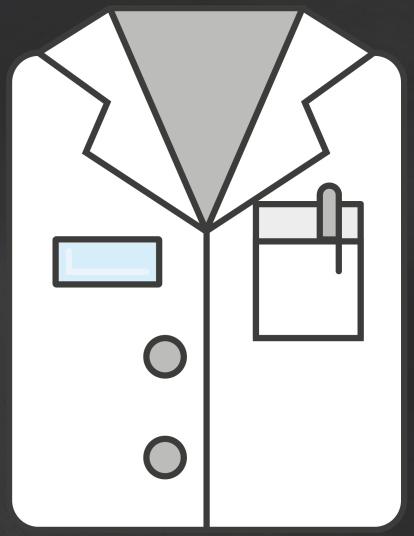
amazon web services

Low Cost: Research Grants

AWS provides free usage credits to help researchers:

- Teach advanced courses
- Explore new projects
- Create resources for the scientific community

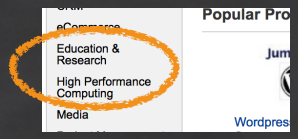
aws.amazon.com/grants



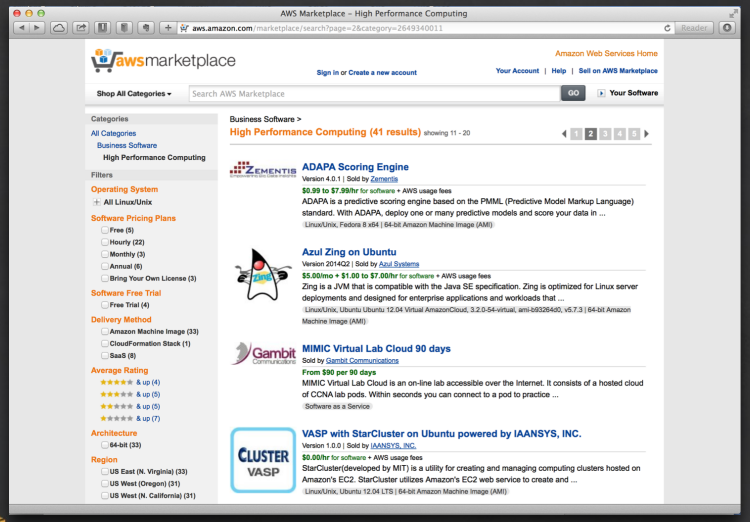
amazon web services

Time to Science: The AWS MarketPlace

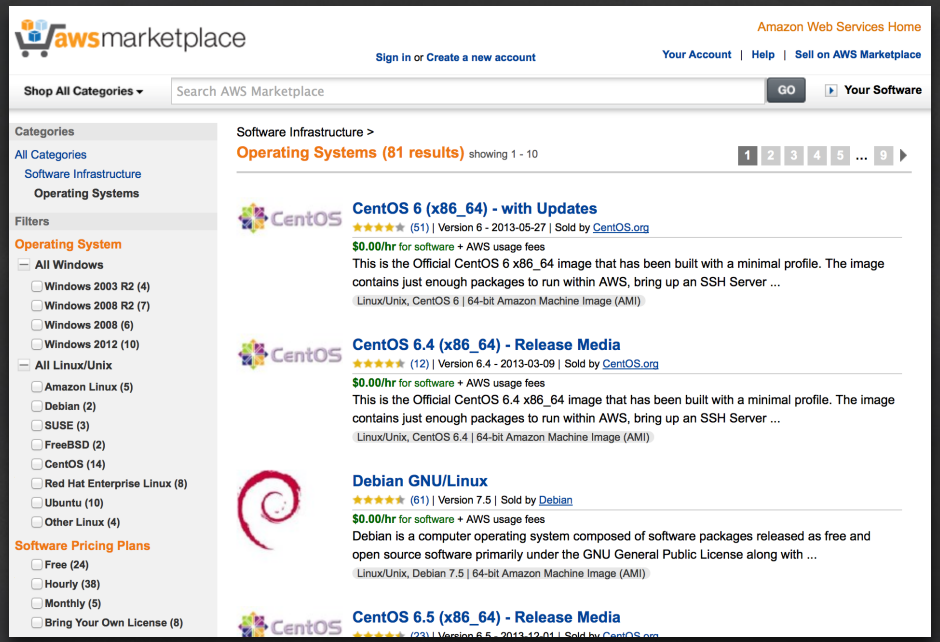
aws.amazon.com/marketplace



Dozens of scientific applications. Need more!

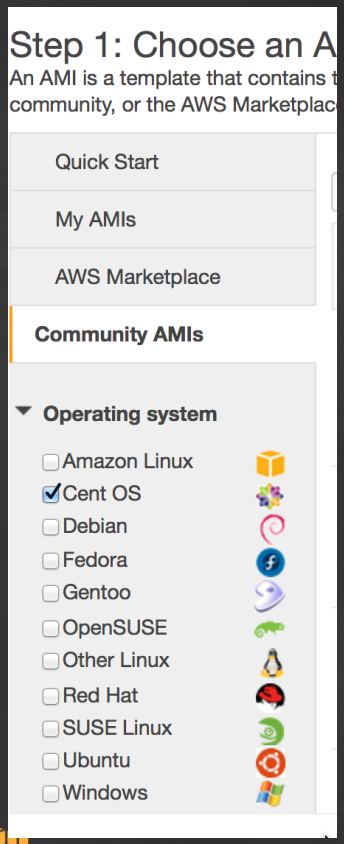


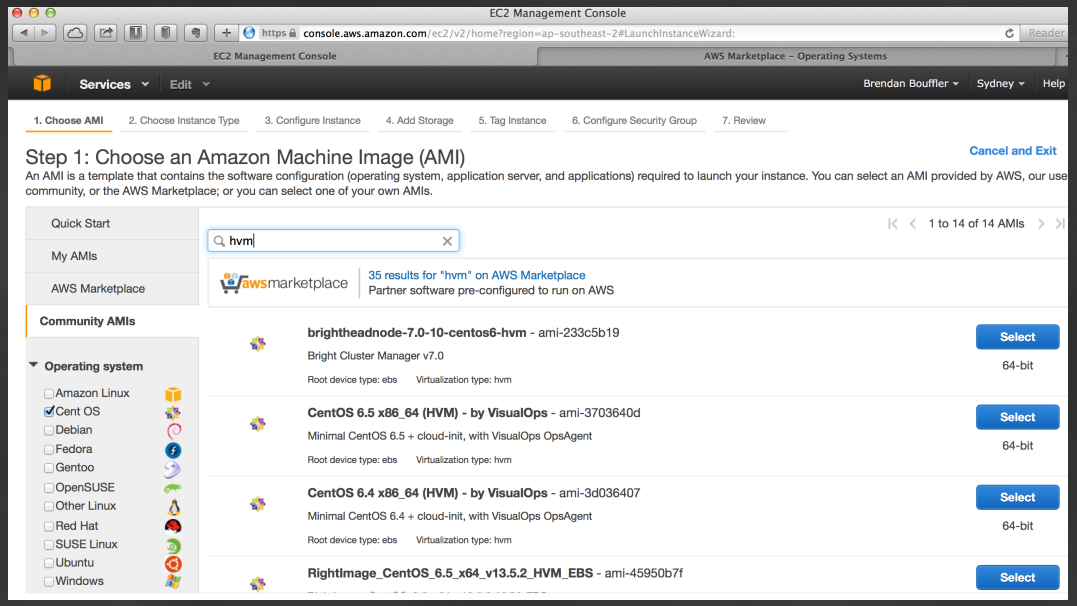
Almost all major research-focused operating systems.



amazon web services

Time to Science: Community AMIs

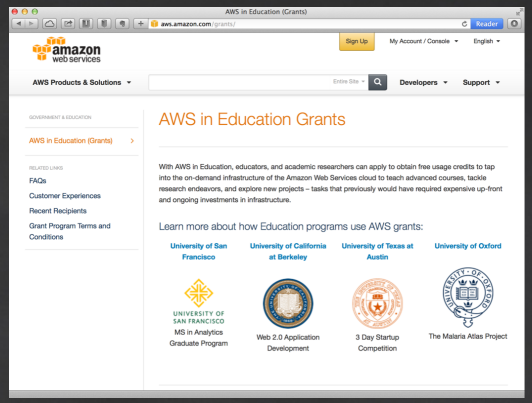




amazon web services

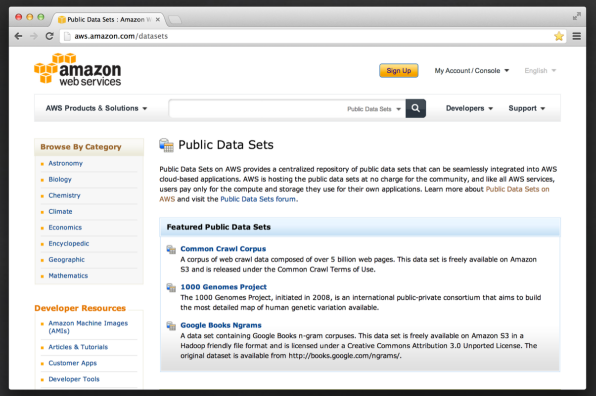
AWS Global Impact Initiatives for Science

AWS Research Grants



- Grants to initiate & support development of cloud-enabled technologies.
- Typically one-off grants of AWS resources like EC2 (compute) or S3 & EBS (storage) or more exotic like Kinesis & twitter feeds.
- Frequently results in reusable resources, like AMIs or open data, which we strongly encourage.
- Lowers the risk to try the cloud.

AWS Hosted Public Datasets



- Large and globally significant datasets hosted and paid for by AWS for community use.
- Data can be quickly and easily processed with elastic computing resources in the surrounding cloud.
- AWS hopes to enable more innovation, more quickly.
- Provided in partnership with content owners, who curate the data.

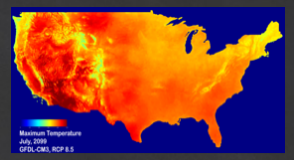
AWS SciCo Team

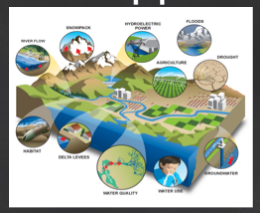
- Dedicated team focusing on Scientific Computing & Research workloads
- Globally focussed and engaged in Big Science projects like the SKA.
- Leveraging AWS resources all over the world.
- Ensuring the cloud is able to make a disruptive impact on science.

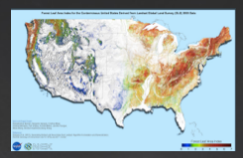
amazon web services

AWS and the NASA Earth eXchange (NEX)

- National Climate Assesment datasets hosted on AWS
- Machine images, tutorials and hosted workshops provided by NASA
- Data and Software now available to those without @nasa.gov email addresses
- Enables crowd-sourced citizen science applications like those found on the Zooniverse







Climate Researchers

Thank you

Visit the NASA EMCC online: https://intranet.share.nasa.gov/agency/cloudservices