

Using Cloud Compute Services for Radiance Simulations

Andy McNeil

Disclaimers

- This presentation is offered with no warranty, use at your own risk.
- Andy is a hobbyist at best. Consult a network security expert for much better advice regarding security than what you're about to receive.
- There is likely a better way to do everything I'm going to show you.



shhhh...



There is no cloud.
It's just someone else's computer.

Why use someone else's computer?

- Computing resources scale with needs
 - Add and drop instances as your workload changes
 - No need to coordinate with coworkers for running jobs
- Zero up front cost | Hello Freelancers!
- Track costs by project and bill computing expense to client
- Use Linux-only Radiance features without having to get a linux / mac computer

Andy's experience in 2015-2016

☘ Lighting Team



Andrew McNeil – June 14, 2016 at 01:20 PM

As a contractor to Arup I (mostly) provide my own computing resources. For Radiance simulations I use the Amazon Elastic Compute Cloud (EC2). I've just been reviewing my usage statistics over the last 11 months, and thought I'd share with the lighting community.

With the EC2 you choose the specs of your instance when you request it. They have instances with specs ranging from 1 to 40 CPUs. I tended to use instances ranging from 32-40 cpus (depending on market pricing).

My usage statistics over the Past 11 months:

Total Cost: \$888

Total CPU hours: 69,028

Cost per CPU hour: \$0.013

On average over the 11 months I had 8.5 CPUs for \$900, which is competitive with purchasing a high end desktop computer (assuming a 3-4 year life). But the real benefit is scalability. You see I didn't have an 8 CPU computer, I had practically unlimited computing resources at my disposal when I needed them. For example, right now I have 4 x 40 CPU instances running (160 CPUs total!) and it is only costing me \$1.40 an hour at spot market pricing.

- 11 months
- \$900
- 69,028 CPU hours
(equivalent to 8.5 constantly running CPUs)
- 160+ CPUs running for short periods
- Zero CPUs most of the time

Who's Computer?

- AWS (Amazon)
- Azure (Microsoft)
- Google Cloud
- IBM Cloud
- **Cloud & Heat** - Distributed mini data centers that also provide heat to buildings
- And lots more...

Considerations - just a lazy list

- Access
- Storage
- Instance Configurations
- Computing Costs
- Spot / Low-Priority / Preemptible offering
- Your employer's preference (and your client's preference)

I chose **aws**

- It was 2015 - AWS was the leader in cloud services
- Now things are pretty even between biggest cloud providers
(but I still use AWS 'cause I'm an old dog) 🐕

Getting Started with AWS in Twenty-one Easy Steps!

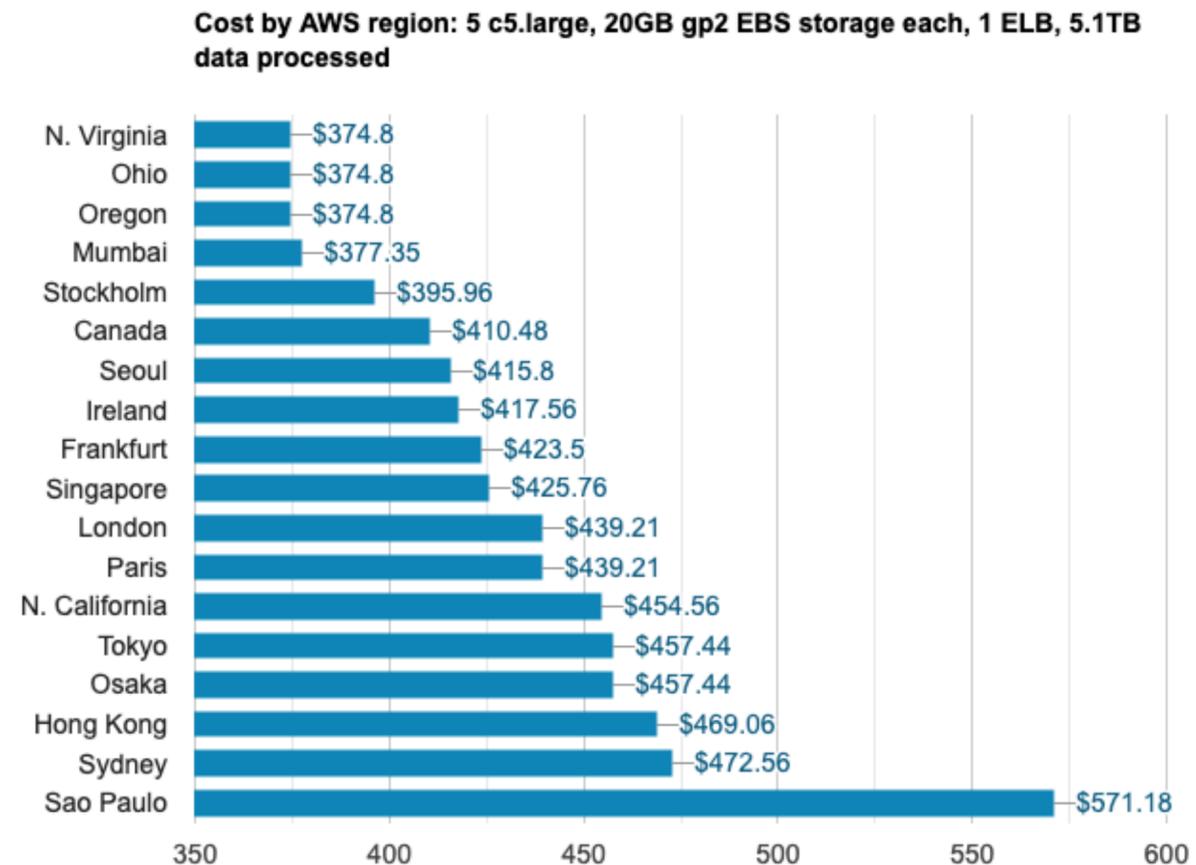
1. Create an AWS account
2. Choose a Region
3. Generate a key pair
4. Set up a security group
5. Choose spot or reserved instance
6. Select an instance type
7. Select a machine image
8. Launch instance
9. Connect to your instance
10. Install software
11. Save a machine image
12. Create persistent file storage
13. Mount persistent file storage
14. Upload Radiance model files
15. Start simulation
16. Set an alarm to terminate instance when simulation finishes
17. Launch an instance to retrieve results from file storage
18. Download results
19. Terminate instance
20. Get your cloud expenses and invoice your client
21. Bask in the glory of a job well done



AWS Regions

US East (Ohio)
US East (N. Virginia)
US West (N. California)
US West (Oregon)
Asia Pacific (Hong Kong)
Asia Pacific (Mumbai)
Asia Pacific (Osaka-Local)
Asia Pacific (Seoul)
Asia Pacific (Singapore)
Asia Pacific (Sydney)
Asia Pacific (Tokyo)
Canada (Central)
China (Beijing)
China (Ningxia)
EU (Frankfurt)
EU (Ireland)
EU (London)
EU (Paris)
EU (Stockholm)
Middle East (Bahrain)
South America (Sao Paulo)

- Choose a region based on proximity and cost.
 - N. California is the most expensive of the US regions, and typically the last to get new features.

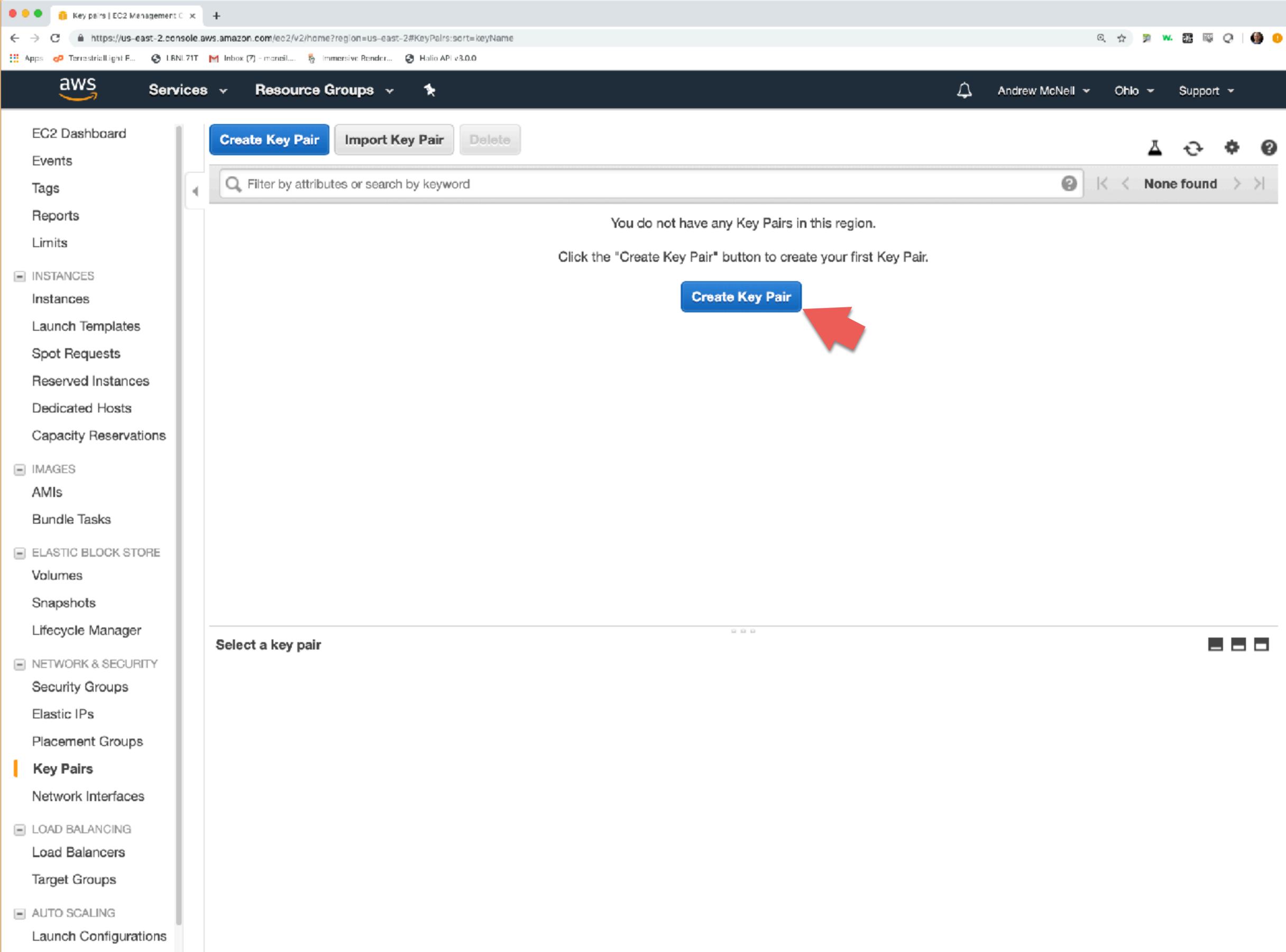


<https://www.concurrencylabs.com/blog/choose-your-aws-region-wisely/>

Key Pairs

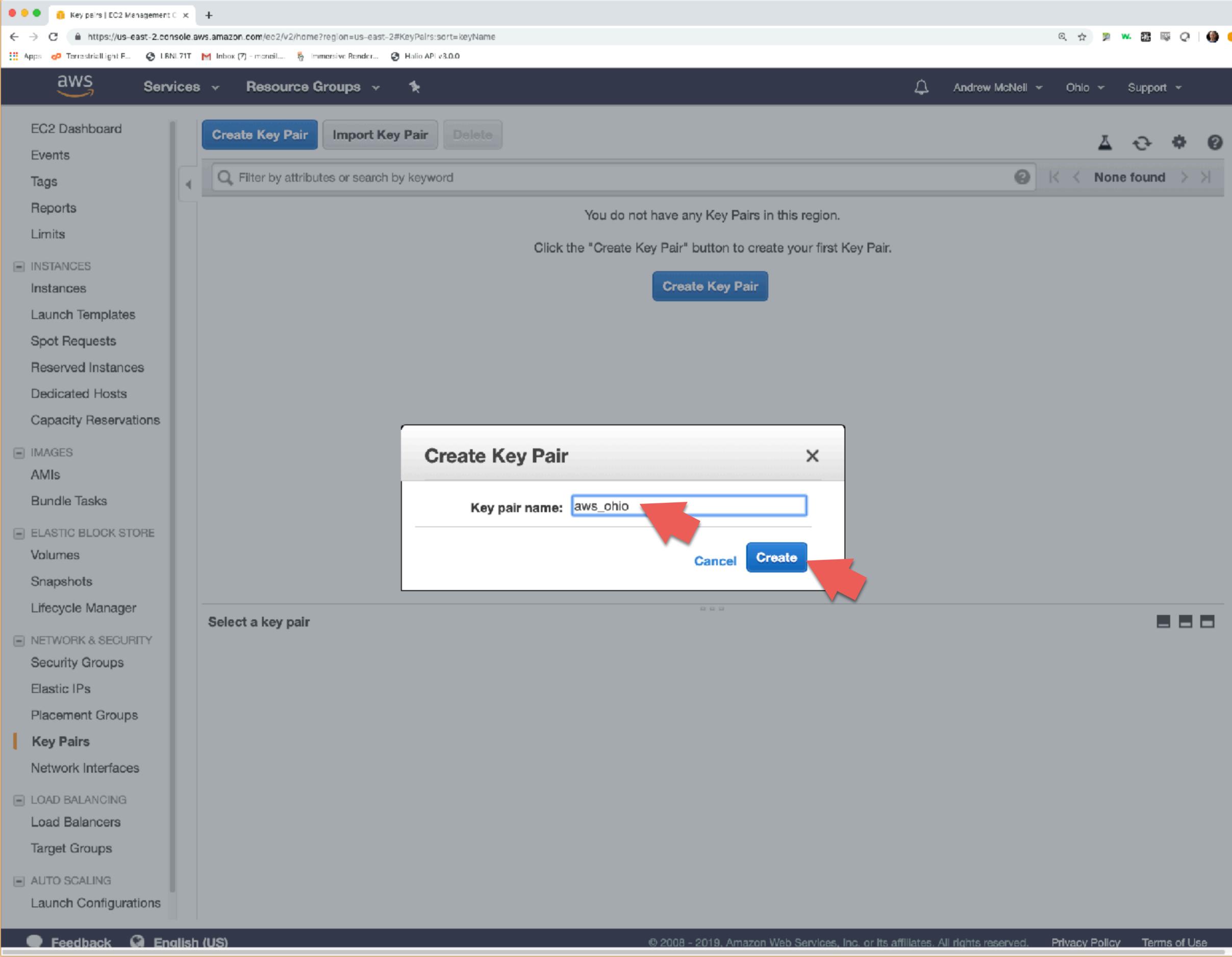


- Key pairs are used to securely access your AWS resources.
- Each key pair has a public and private component.
 - AWS keeps the public part
 - You get the private part.
- The private key is downloaded to your computer when it is created
 - There is no way to get the private key again
 - If you lose the private key file you'll have to generate a new key pair and delete the old one



To start, you have no key pairs in your account.

Click:
“Generate Key Pair”



Key pairs | EC2 Management Console

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#KeyPairs:sort=keyName

Services Resource Groups

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EC2 Dashboard

Events

Tags

Reports

Limits

INSTANCES

Instances

Launch Templates

Spot Requests

Reserved Instances

Dedicated Hosts

Capacity Reservations

IMAGES

AMIs

Bundle Tasks

ELASTIC BLOCK STORE

Volumes

Snapshots

Lifecycle Manager

NETWORK & SECURITY

Security Groups

Elastic IPs

Placement Groups

Key Pairs

Network Interfaces

LOAD BALANCING

Load Balancers

Target Groups

AUTO SCALING

Launch Configurations

Create Key Pair Import Key Pair Delete

Filter by attributes or search by keyword

None found

You do not have any Key Pairs in this region.

Click the "Create Key Pair" button to create your first Key Pair.

Create Key Pair

Create Key Pair

Key pair name: aws_ohio

Cancel Create

Select a key pair

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Enter a name for your key pair and click create.

Key pairs | EC2 Management Console

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#KeyPairs:sort=keyName

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EC2 Dashboard
Events
Tags
Reports
Limits

INSTANCES
Instances
Launch Templates
Spot Requests
Reserved Instances
Dedicated Hosts
Capacity Reservations

IMAGES
AMIs
Bundle Tasks

ELASTIC BLOCK STORE
Volumes
Snapshots
Lifecycle Manager

NETWORK & SECURITY
Security Groups
Elastic IPs
Placement Groups
Key Pairs
Network Interfaces

LOAD BALANCING
Load Balancers
Target Groups

AUTO SCALING

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aws_ohio.pem

Key pair name	Fingerprint
aws_ohio	da:bd:fa:2c:9f:ca:95:ae:09:60:29:46:1b:32:fe:88:3b:8b:e9:3e

Key Pair: aws_ohio

Key pair name	aws_ohio
Fingerprint	da:bd:fa:2c:9f:ca:95:ae:09:60:29:46:1b:32:fe:88:3b:8b:e9:3e



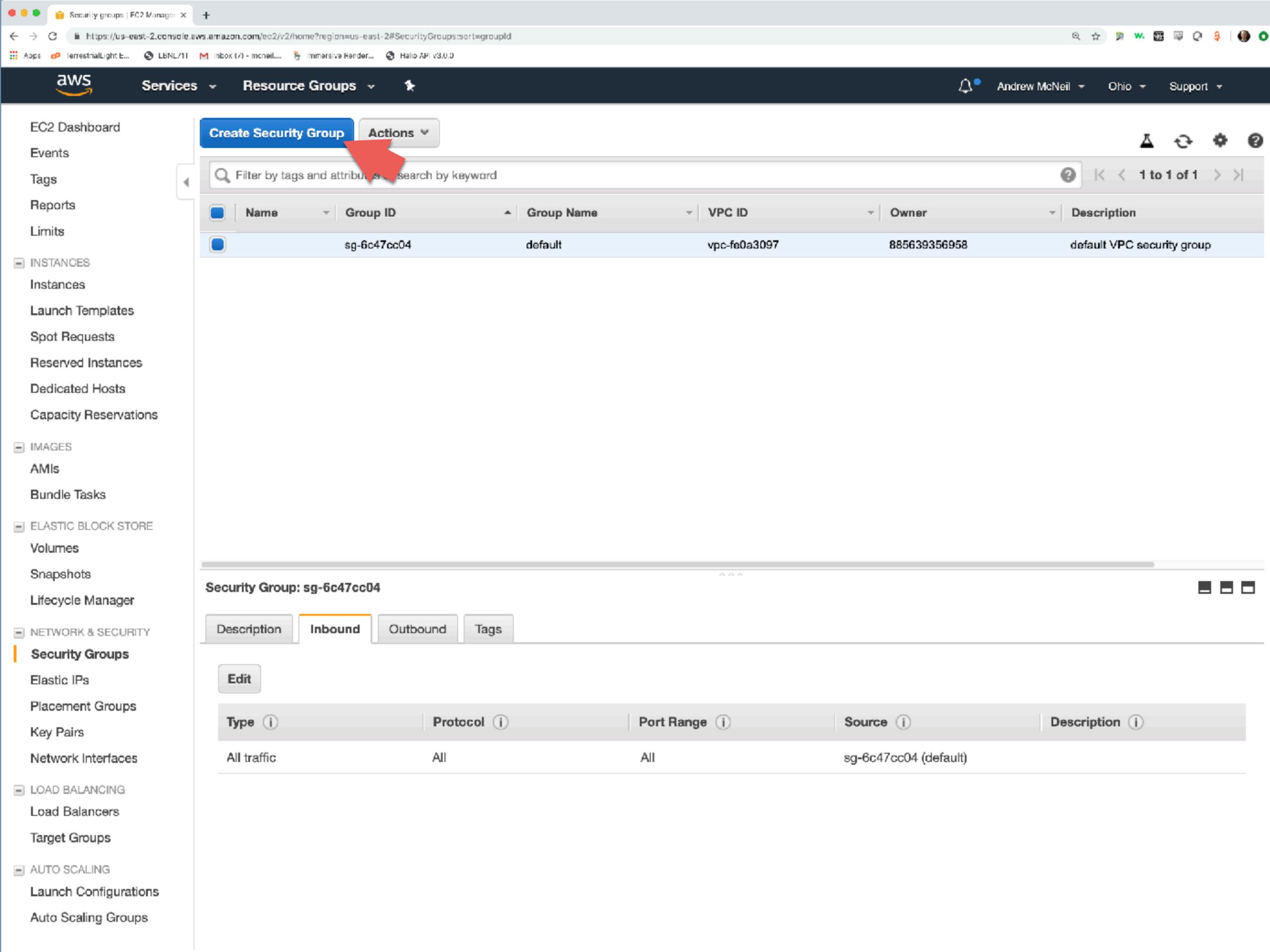
andy_ohio.pem is downloaded to my computer when I click “create”

Move your private key file somewhere secure and memorable. *I like to use a hidden folder for key files on my mac.*

Security Groups



- Sets access rules
 - restrict to IP address or only within security group
- Set accessible ports
 - SSH - port 22
 - NFS - port 2049
 - HTTP - port 80, HTTPS port 443
- When you launch an instance, a temporary security group is created, however it's simplest to use one that's already created.
- Useful for connecting EFS with ECS instances (we'll get to this later)



Security groups | EC2 Manager

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#SecurityGroups:sort=groupid

aws Services Resource Groups

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EC2 Dashboard
Events
Tags
Reports
Limits

INSTANCES
Instances
Launch Templates
Spot Requests
Reserved Instances
Dedicated Hosts
Capacity Reservations

IMAGES
AMIs
Bundle Tasks

ELASTIC BLOCK STORE
Volumes
Snapshots
Lifecycle Manager

NETWORK & SECURITY
Security Groups
Elastic IPs
Placement Groups
Key Pairs
Network Interfaces

LOAD BALANCING
Load Balancers
Target Groups

AUTO SCALING
Launch Configurations
Auto Scaling Groups

Create Security Group Actions

Filter by tags and attributes search by keyword

Name	Group ID	Group Name	VPC ID	Owner	Description
	sg-6c47cc04	default	vpc-fe0a3097	885639356958	default VPC security group

Security Group: sg-6c47cc04

Description Inbound Outbound Tags

Edit

Type	Protocol	Port Range	Source	Description
All traffic	All	All	sg-6c47cc04 (default)	



Your account contains a default security group that allows inbound connections from other instances in the security group and nowhere else.

Click 'Create Security Group' to make a new security group.



We'll create a security group with the following inbound access:

ssh from anywhere
(so you can connect to the instance from your computer)

nfs from anywhere
(we'll restrict nfs to this security group in the next step)

The screenshot shows the AWS Management Console interface. The main content area displays a table of security groups with columns for Name, Group ID, Group Name, VPC ID, Owner, and Description. A 'Create Security Group' dialog box is overlaid on top. The dialog has the following configuration:

- Security group name:** Basic
- Description:** SSH & NFS
- VPC:** vpc-fe0a3097 (default)

Under the 'Security group rules' section, the 'Inbound' tab is active. The rules table is as follows:

Type	Protocol	Port Range	Source	Description
SSH	TCP	22	Anywhere 0.0.0.0/0, :::/0	e.g. SSH for Admin I
NFS	TCP	2049	Anywhere 0.0.0.0/0, :::/0	e.g. SSH for Admin I

The 'Anywhere' dropdown for the NFS rule is highlighted with a blue box. At the bottom of the dialog are 'Cancel' and 'Create' buttons.

Security groups | EC2 Manager

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#SecurityGroups:sort=groupid

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EC2 Dashboard
Events
Tags
Reports
Limits
INSTANCES
Instances
Launch Templates
Spot Requests
Reserved Instances
Dedicated Hosts
Capacity Reservations
IMAGES
AMIs
Bundle Tasks
ELASTIC BLOCK STORE
Volumes
Snapshots
Lifecycle Manager
NETWORK & SECURITY
Security Groups
Elastic IPs
Placement Groups
Key Pairs
Network Interfaces
LOAD BALANCING
Load Balancers
Target Groups
AUTO SCALING
Launch Configurations
Auto Scaling Groups

Create Security Group Actions

Filter by tags and attributes or search by keyword 1 to 2 of 2

Name	Group ID	Group Name	VPC ID	Owner	Description
<input checked="" type="checkbox"/>	sg-07c3608c40753cd0d	Basic	vpc-fe0a3097	885639356958	SSH & NFS
<input type="checkbox"/>	sg-6c47cc04	default	vpc-fe0a3097	885639356958	default VPC security group

Security Group: sg-07c3608c40753cd0d

Description Inbound Outbound Tags

Edit

Type	Protocol	Port Range	Source	Description
SSH	TCP	22	0.0.0.0/0	
SSH	TCP	22	:::0	
NFS	TCP	2049	0.0.0.0/0	
NFS	TCP	2049	:::0	

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Now we have two security groups.



Edit the inbound rules for the new security group by adding the ID of the security group in the source field for NFS.

This will restrict inbound NFS to only services in this security group.

Edit inbound rules

Type	Protocol	Port Range	Source	Description
SSH	TCP	22	Custom 0.0.0.0/0	e.g. SSH for Admin Desktop
SSH	TCP	22	Custom ::/0	e.g. SSH for Admin Desktop
NFS	TCP	2049	Custom sg-07c3608c40753cd0d	e.g. SSH for Admin Desktop

Add Rule

NOTE: Any edits made on existing rules will result in the edited rule being deleted and a new rule created with the new details. This will cause traffic that depends on that rule to be dropped for a very brief period of time until the new rule can be created.

Cancel Save

Name	Group ID	Group Name	VPC ID	Owner	Description
	sg-07c3608c40753cd0d	Basic	vpc-fe0a3097	885639356958	SSH & NFS
	sg-6c47cc04	default	vpc-fe0a3097	885639356958	default VPC security group

Security groups | EC2 Manager

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#SecurityGroups:sort=groupid

Services Resource Groups

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EC2 Dashboard
Events
Tags
Reports
Limits
INSTANCES
Instances
Launch Templates
Spot Requests
Reserved Instances
Dedicated Hosts
Capacity Reservations
IMAGES
AMIs
Bundle Tasks
ELASTIC BLOCK STORE
Volumes
Snapshots
Lifecycle Manager
NETWORK & SECURITY
Security Groups
Elastic IPs
Placement Groups
Key Pairs
Network Interfaces
LOAD BALANCING
Load Balancers
Target Groups
AUTO SCALING
Launch Configurations
Auto Scaling Groups

Create Security Group Actions

Filter by tags and attributes or search by keyword 1 to 2 of 2

Name	Group ID	Group Name	VPC ID	Owner	Description
<input checked="" type="checkbox"/>	sg-07c3608c40753cd0d	Basic	vpc-fe0a3097	885639356958	SSH & NFS
<input type="checkbox"/>	sg-6c47cc04	default	vpc-fe0a3097	885639356958	default VPC security group

Security Group: sg-07c3608c40753cd0d

Description Inbound Outbound Tags

Edit

Type	Protocol	Port Range	Source	Description
SSH	TCP	22	0.0.0.0/0	
SSH	TCP	22	:::0	
NFS	TCP	2049	sg-07c3608c40753cd0d (Basic)	

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Now we have a custom security group.

Instance Types



- Dozens of machine instances available organized into categories:
 - General Purpose
 - M - balanced compute, memory, and storage
 - T - burstable
 - A - ARM
 - Compute Optimized
 - C: Lower cost per compute cycle
 - Storage Optimized
 - I: large SSD local storage
 - D: Very large HDD local storage (up to 48 TB)
 - H: Large HDD local storage (up to 16TB) and balanced compute and memory
 - Memory Optimized
 - R: more RAM per CPU
 - X: optimized for in memory database applications - lowest cost per GiB of RAM
 - Z: more RAM per CPU with highest CPU clock speed (4.0 GHz)
 - Accelerated Computing (GPU FGPA)
 - P: General Purpose GPU
 - G: Graphics intensive GPU
 - F: FGPA

Information about instance types



- Amazon's info:
<https://aws.amazon.com/ec2/instance-types/>
- This 3rd-party website is sortable, filterable and includes prices:
<https://www.ec2instances.info>

Three ways to purchase an instance



- On-demand - regular
- Reserved - pay by the year
- Spot - pseudo auction

On-Demand Instance



- You start and stop the instance.
- You are billed per hour at fixed rate, only for the time you use.
- Nothing can stop the instance except you.

Reserved Instance



- Discounts on long term reservations. The instance is yours for the duration of the term wether you use it or not.
- 38% discount for a 1-year reservation paid monthly
- 72% discount for a 3-year reservation paid in advance
- You probably don't want to use reserved instances

SPOT Instance



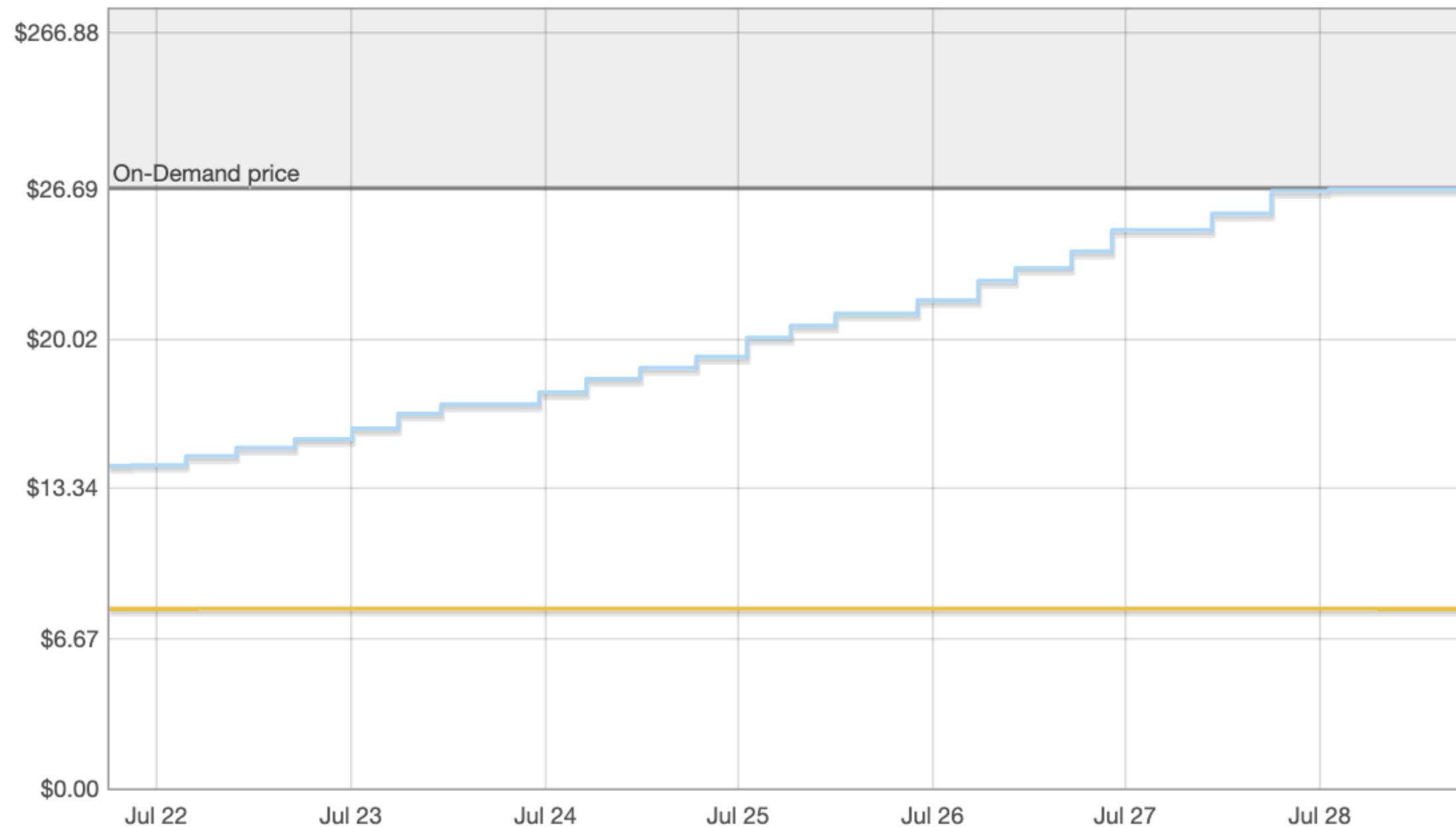
- You can get discounted rates on spare capacity (up to 90% discount).
- You bid the most you're willing to pay per hour.
- You pay the market clearing rate each hour (not your bid rate).
- If the market clearing rate exceeds your bid amount your instance is terminated without warning.

Spot Instance Pricing History

x



Product: Linux/UNIX Instance type: x1e.32xlarge Date range: 1 week



Date

7/28/2019
3:45:04 PM UTC-0700

On-Demand price

\$26.6880

Availability Zone Price

us-east-2a	\$8.0064
us-east-2b	\$26.6880

Close



shhhh...

My spot bidding strategy:

Bid a few cents more than the on-demand price.



The screenshot displays the AWS Management Console for the EC2 service in the US East (Ohio) region. The left-hand navigation pane lists various categories such as INSTANCES, IMAGES, ELASTIC BLOCK STORE, NETWORK & SECURITY, LOAD BALANCING, and AUTO SCALING. The main content area is divided into several sections: 'Resources' showing counts for Running Instances (0), Elastic IPs (0), Snapshots (0), Load Balancers (0), Security Groups (2), and others; 'Create Instance' with a prominent blue 'Launch Instance' button and a red arrow pointing to it; 'Service Health' indicating that the US East (Ohio) region is operating normally; and 'Scheduled Events' showing no events. The right-hand sidebar provides 'Account Attributes' like Supported Platforms (VPC) and Default VPC (vpc-fe0a3097), and 'AWS Marketplace' listings for software products like Barracuda CloudGen Firewall and Matillion ETL.



Let's launch an instance!

Launch Instance Wizard | EC2 | x

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#LaunchInstanceWizard:

Services Resource Groups

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1. Choose AMI 2. Choose Instance Type 3. Configure Instance 4. Add Storage 5. Add Tags 6. Configure Security Group 7. Review

Step 1: Choose an Amazon Machine Image (AMI) Cancel and Exit

An AMI is a template that contains the software configuration (operating system, application server, and applications) required to launch your instance. You can select an AMI provided by AWS, our user community, or the AWS Marketplace; or you can select one of your own AMIs.

Search for an AMI by entering a search term e.g. "Windows"

Quick Start 1 to 38 of 38 AMIs

My AMIs	 Amazon Linux 2 AMI (HVM), SSD Volume Type - ami-0d8f6eb4f641ef691 (64-bit x86) / ami-0f378490dca16e3f4 (64-bit Arm) Select
AWS Marketplace	Amazon Linux Free tier eligible Amazon Linux 2 comes with five years support. It provides Linux kernel 4.14 tuned for optimal performance on Amazon EC2, systemd 219, GCC 7.3, Glibc 2.26, Binutils 2.29.1, and the latest software packages through extras. Root device type: ebs Virtualization type: hvm ENA Enabled: Yes
Community AMIs	 Amazon Linux AMI 2018.03.0 (HVM), SSD Volume Type - ami-02f706d959cedf892 Select
<input type="checkbox"/> Free tier only ⓘ	Amazon Linux Free tier eligible The Amazon Linux AMI is an EBS-backed, AWS-supported image. The default image includes AWS command line tools, Python, Ruby, Perl, and Java. The repositories include Docker, PHP, MySQL, PostgreSQL, and other packages. Root device type: ebs Virtualization type: hvm ENA Enabled: Yes
	 Red Hat Enterprise Linux 8 (HVM), SSD Volume Type - ami-0520e698dd500b1d1 (64-bit x86) / ami-0099847d600887c9f (64-bit Arm) Select
	Red Hat Free tier eligible Red Hat Enterprise Linux version 8 (HVM), EBS General Purpose (SSD) Volume Type Root device type: ebs Virtualization type: hvm ENA Enabled: Yes
	 SUSE Linux Enterprise Server 15 SP1 (HVM), SSD Volume Type - ami-0e0bae59dc35fe89a (64-bit x86) / ami-0b49a8f443e46ff20 (64-bit Arm) Select
	SUSE Linux Free tier eligible SUSE Linux Enterprise Server 15 Service Pack 1 (HVM), EBS General Purpose (SSD) Volume Type. Public Cloud, Advanced Systems Management, Web and Scripting, and Legacy modules enabled. Root device type: ebs Virtualization type: hvm ENA Enabled: Yes
	 Ubuntu Server 18.04 LTS (HVM), SSD Volume Type - ami-05c1fa8df71875112 (64-bit x86) / ami-0606a0d9f566249d3 (64-bit Arm) Select



I've always used Amazon Linux. I don't have a good reason.





- 1. Choose AMI
- 2. Choose Instance Type
- 3. Configure Instance
- 4. Add Storage
- 5. Add Tags
- 6. Configure Security Group
- 7. Review

Step 2: Choose an Instance Type

Amazon EC2 provides a wide selection of instance types optimized to fit different use cases. Instances are virtual servers that can run applications. They have varying combinations of CPU, memory, storage, and networking capacity, and give you the flexibility to choose the appropriate mix of resources for your applications. [Learn more](#) about instance types and how they can meet your computing needs.

Filter by: All instance types Current generation Show/Hide Columns

Currently selected: t2.micro (Variable ECUs, 1 vCPUs, 2.5 GHz, Intel Xeon Family, 1 GiB memory, EBS only)

Family	Type	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance	IPv6 Support
<input type="checkbox"/> General purpose	t2.nano	1	0.5	EBS only	-	Low to Moderate	Yes
<input checked="" type="checkbox"/> General purpose	t2.micro <small>Free tier eligible</small>	1	1	EBS only	-	Low to Moderate	Yes
<input type="checkbox"/> General purpose	t2.small	1	2	EBS only	-	Low to Moderate	Yes
<input type="checkbox"/> General purpose	t2.medium	2	4	EBS only	-	Low to Moderate	Yes
<input type="checkbox"/> General purpose	t2.large	2	8	EBS only	-	Low to Moderate	Yes
<input type="checkbox"/> General purpose	t2.xlarge	4	16	EBS only	-	Moderate	Yes
<input type="checkbox"/> General purpose	t2.2xlarge	8	32	EBS only	-	Moderate	Yes
<input type="checkbox"/> General purpose	t3a.nano	2	0.5	EBS only	Yes	Up to 5 Gigabit	Yes
<input type="checkbox"/> General purpose	t3a.micro	2	1	EBS only	Yes	Up to 5 Gigabit	Yes
<input type="checkbox"/> General purpose	t3a.small	2	2	EBS only	Yes	Up to 5 Gigabit	Yes
<input type="checkbox"/> General purpose	t3a.medium	2	4	EBS only	Yes	Up to 5 Gigabit	Yes
<input type="checkbox"/> General purpose	t3a.large	2	8	EBS only	Yes	Up to 5 Gigabit	Yes
<input type="checkbox"/> General purpose	t3a.xlarge	4	16	EBS only	Yes	Up to 5 Gigabit	Yes

Cancel Previous **Review and Launch** Next: Configure Instance Details

Then you select the type of instance.

Make sure you only use the free tier eligible instance if you don't want to pay.



Launch Instance Wizard | EC2 | x

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#LaunchInstanceWizard:

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1. Choose AMI 2. Choose Instance Type 3. Configure Instance 4. Add Storage 5. Add Tags 6. Configure Security Group 7. Review

Step 3: Configure Instance Details

Configure the instance to suit your requirements. You can launch multiple instances from the same AMI, request Spot instances to take advantage of the lower pricing, assign an access management role to the instance, and more.

Number of instances [Launch into Auto Scaling Group](#)

Purchasing option Request Spot instances

Network [Create new VPC](#)

Subnet [Create new subnet](#)

Auto-assign Public IP

Placement group Add instance to placement group

Capacity Reservation [Create new Capacity Reservation](#)

IAM role [Create new IAM role](#)

Shutdown behavior

Enable termination protection Protect against accidental termination

Monitoring Enable CloudWatch detailed monitoring
[Additional charges apply.](#)

Tenancy [Additional charges will apply for dedicated tenancy.](#)

Elastic Inference Add an Elastic Inference accelerator
[Additional charges apply.](#)

T2/T3 Unlimited Enable
[Additional charges may apply](#)

▶ **Advanced Details**

[Cancel](#) [Previous](#) [Review and Launch](#) [Next: Add Storage](#)

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Nothing to do here yet.

But we'll do some things here later.



Launch Instance Wizard | EC2 | x

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#LaunchInstanceWizard:

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1. Choose AMI 2. Choose Instance Type 3. Configure Instance 4. Add Storage 5. Add Tags 6. Configure Security Group 7. Review

Step 4: Add Storage

Your instance will be launched with the following storage device settings. You can attach additional EBS volumes and instance store volumes to your instance, or edit the settings of the root volume. You can also attach additional EBS volumes after launching an instance, but not instance store volumes. [Learn more](#) about storage options in Amazon EC2.

Volume Type	Device	Snapshot	Size (GiB)	Volume Type	IOPS	Throughput (MB/s)	Delete on Termination	Encryption
Root	/dev/xvda	snap-077085afe6b3ee68d	8	General Purpose SSD (gp2)	100 / 3000	N/A	<input checked="" type="checkbox"/>	Not Encrypted

[Add New Volume](#)

Free tier eligible customers can get up to 30 GB of EBS General Purpose (SSD) or Magnetic storage. [Learn more](#) about free usage tier eligibility and usage restrictions.

[Cancel](#) [Previous](#) [Review and Launch](#) [Next: Add Tags](#)

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This is where you add EBS storage, if you decide to use that.



Launch Instance wizard | EC2 | x

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#LaunchInstanceWizard:

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Step 5: Add Tags

A tag consists of a case-sensitive key-value pair. For example, you could define a tag with key = Name and value = Webserver.
A copy of a tag can be applied to volumes, instances or both.
Tags will be applied to all instances and volumes. [Learn more](#) about tagging your Amazon EC2 resources.

Key (128 characters maximum)	Value (256 characters maximum)	Instances	Volumes	
project	radiance workshop	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

(Up to 50 tags maximum)

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If you want to track costs by project, add a tag here.

Also, you need to activate the tag in the cost management page (we'll do that towards the end)



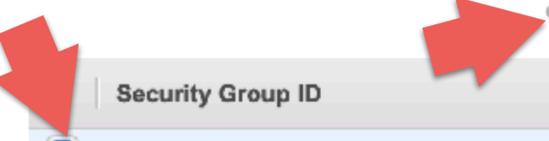


- 1. Choose AMI
- 2. Choose Instance Type
- 3. Configure Instance
- 4. Add Storage
- 5. Add Tags
- 6. Configure Security Group**
- 7. Review

Step 6: Configure Security Group

A security group is a set of firewall rules that control the traffic for your instance. On this page, you can add rules to allow specific traffic to reach your instance. For example, if you want to set up a web server and allow Internet traffic to reach your instance, add rules that allow unrestricted access to the HTTP and HTTPS ports. You can create a new security group or select from an existing one below. [Learn more](#) about Amazon EC2 security groups.

Assign a security group: Create a new security group
 Select an **existing** security group



Security Group ID	Name	Description	Actions
<input checked="" type="checkbox"/> sg-07c3608c40753cd0d	Basic	SSH & NFS	Copy to new
<input type="checkbox"/> sg-6c47cc04	default	default VPC security group	Copy to new

We'll use the security group we created.

Inbound rules for sg-07c3608c40753cd0d (Selected security groups: sg-07c3608c40753cd0d)

Type	Protocol	Port Range	Source	Description
SSH	TCP	22	0.0.0.0/0	
SSH	TCP	22	:::0	
NFS	TCP	2049	sg-07c3608c40753cd0d (Basic)	

[Cancel](#) [Previous](#) [Review and Launch](#)



Launch Instance Wizard | EC2

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#LaunchInstanceWizard:

Services Resource Groups

Andrew McNeil Ohio Support

1. Choose AMI 2. Choose Instance Type 3. Configure Instance 4. Add Storage 5. Add Tags 6. Configure Security Group 7. Review

Step 7: Review Instance Launch

Please review your instance launch details. You can go back to edit changes for each section. Click **Launch** to assign a key pair to your instance and complete the launch process.

⚠ Improve your instances' security. Your security group, Basic, is open to the world.

Your instances may be accessible from any IP address. We recommend that you update your security group rules to allow access from known IP addresses only. You can also open additional ports in your security group to facilitate access to the application or service you're running, e.g., HTTP (80) for web servers. [Edit security groups](#)

AMI Details [Edit AMI](#)

Amazon Linux 2 AMI (HVM), SSD Volume Type - ami-0d8f6eb4f641ef691

Free tier eligible Amazon Linux 2 comes with five years support. It provides Linux kernel 4.14 tuned for optimal performance on Amazon EC2, systemd 219, GCC 7.3, Glibc 2.26, Binutils 2.29.1, and the latest software packages through extras.

Root Device Type: ebs Virtualization type: hvm

Instance Type [Edit instance type](#)

Instance Type	ECUs	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance
t2.micro	Variable	1	1	EBS only	-	Low to Moderate

Security Groups [Edit security groups](#)

Security Group ID	Name	Description
sg-07c3608c40753cd0d	Basic	SSH & NFS

All selected security groups inbound rules

Type	Protocol	Port Range	Source	Description
SSH	TCP	22	0.0.0.0/0	
SSH	TCP	22	:::0	
NFS	TCP	2049	sg-07c3608c40753cd0d (Basic)	

[Cancel](#) [Previous](#) [Launch](#)



Yes, the security group is open to the world, but they can't get in without your private key.



Launch Instance Wizard | EC2

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#LaunchInstanceWizard:

Services Resource Groups

Andrew McNeil Ohio Support

1. Choose AMI 2. Choose Instance Type 3. Configure Instance 4. Add Storage 5. Add Tags 6. Configure Security Group 7. Review

Step 7: Review Instance Launch

Please review your instance launch details. You can go back to edit changes for each section. Click **Launch** to assign a key pair to your instance and complete the launch process.

⚠ Improve your instances' security. Your security group, Basic, is open to the world.

Your instances may be accessible from any IP address. We recommend that you update your security group rules to allow access from known IP addresses only. You can also open additional ports in your security group to facilitate access to the application or service you're running, e.g., HTTP (80) for web servers. [Edit security groups](#)

AMI Details

Amazon Linux 2 AMI (HVM), SSD Free tier eligible

Instance Type

Instance Type	ECUs	vCPUs
t2.micro	Variable	1

Security Groups

Security Group ID: sg-07c3608c40753cd0d

All selected security groups inbound rules

Type	Protocol	Port Range	Source	Description
SSH	TCP	22	0.0.0.0/0	
SSH	TCP	22	:::/0	
NFS	TCP	2049	sg-07c3608c40753cd0d (Basic)	

Select an existing key pair or create a new key pair

A key pair consists of a **public key** that AWS stores, and a **private key file** that you store. Together, they allow you to connect to your instance securely. For Windows AMIs, the private key file is required to obtain the password used to log into your instance. For Linux AMIs, the private key file allows you to securely SSH into your instance.

Note: The selected key pair will be added to the set of keys authorized for this instance. [Learn more about removing existing key pairs from a public AMI.](#)

Choose an existing key pair

Select a key pair

aws_ohio

I acknowledge that I have access to the selected private key file (aws_ohio.pem), and that without this file, I won't be able to log into my instance.

Cancel Launch Instances

Cancel Previous Launch

Feedback English (US)

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Pick the key you want to use, and then acknowledge that you have the key file.

The screenshot shows the AWS Management Console interface. At the top, the navigation bar includes the AWS logo, 'Services', 'Resource Groups', and user information for Andrew McNeil in the Ohio region. The left-hand navigation menu lists various services such as EC2 Dashboard, Events, Tags, Reports, Limits, INSTANCES, IMAGES, ELASTIC BLOCK STORE, NETWORK & SECURITY, LOAD BALANCING, and AUTO SCALING.

The main content area displays a table of EC2 instances. A single instance is listed with the following details:

Name	Instance ID	Instance Type	Availability Zone	Instance State	Status Checks	Alarm Status	Public DNS (IPv4)	IPv4 Public
	i-0558a0059aa9097...	t2.micro	us-east-2b	pending	Initializing	None	ec2-18-222-35-37.us-e...	18.222.35.3

Below the table, the details for the selected instance (i-0558a0059aa90975a) are shown. The public DNS is ec2-18-222-35-37.us-east-2.compute.amazonaws.com. The instance is in a 'pending' state and is of type 't2.micro' in the 'us-east-2b' availability zone. Other details include the AMI ID, platform, IAM role, key pair name (aws_ohio), owner, launch time, and termination protection.



There it is, you did it!

You are clouding!

Connecting to your instance



- Mac & Linux: use ssh
- Windows: use putty or your favorite ssh client

The screenshot displays the AWS Management Console interface for an EC2 instance. The instance list table shows the following details:

Name	Instance ID	Instance Type	Availability Zone	Instance State	Status Checks	Alarm Status	Public DNS (IPv4)	IPv4 Public
	i-0558a0059aa9097...	t2.micro	us-east-2b	running	2/2 checks ...	None	ec2-18-222-35-37.us-e...	18.222.35.3

The instance details page for **Instance: i-0558a0059aa90975a** shows the following network configuration:

Field	Value
Public DNS (IPv4)	ec2-18-222-35-37.us-east-2.compute.amazonaws.com
IPv4 Public IP	18.222.35.37
IPv6 IPs	-
Private DNS	ip-172-31-16-190.us-east-2.compute.internal
Private IPs	172.31.16.190
Secondary private IPs	-
VPC ID	vpc-fe0a3097
Subnet ID	subnet-955219ee
Network interfaces	eth0
Source/dest. check	True
T2/T3 Unlimited	Disabled
EBS-optimized	False
Root device type	ebs
Root device	/dev/xvda
Block devices	/dev/xvda

Connecting on Mac / Linux



```
andy — -bash — 80x24
Last login: Sun Aug 11 11:39:28 on ttys008
amcn:~ andy$ ssh -i aws_ohio.pem ec2-user@18.222.35.37
```

ssh command from mac

-i to use your private key file

ec2-user is the username for amazon linux

use the public IP for your instance

Connecting on Mac / Linux



```
andy — ssh -i aws_ohio.pem ec2-user@18.222.35.37 — 80x24
Last login: Sun Aug 11 11:39:28 on ttys008
[amcn:~ andy$ ssh -i aws_ohio.pem ec2-user@18.222.35.37
The authenticity of host '18.222.35.37 (18.222.35.37)' can't be established.
ECDSA key fingerprint is SHA256:pxosq3oYz00IHPIERekfuZUE0kLG/KnlG4AbWRXevuM.
Are you sure you want to continue connecting (yes/no)?
```

yes you want to continue connecting.

Connecting on Mac / Linux



```
andy — -bash — 80x24
Last login: Sun Aug 11 11:39:28 on ttys008
amcn:~ andy$ ssh -i aws_ohio.pem ec2-user@18.222.35.37
The authenticity of host '18.222.35.37 (18.222.35.37)' can't be established.
ECDSA key fingerprint is SHA256:pxosq3oYz00IHPIERekfuZUE0kLG/Kn1G4AbWRXevuM.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '18.222.35.37' (ECDSA) to the list of known hosts.
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
@                WARNING: UNPROTECTED PRIVATE KEY FILE!                @
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
Permissions 0644 for 'aws_ohio.pem' are too open.
It is required that your private key files are NOT accessible by others.
This private key will be ignored.
Load key "aws_ohio.pem": bad permissions
ec2-user@18.222.35.37: Permission denied (publickey,gssapi-keyex,gssapi-with-mic
).
amcn:~ andy$
```

whoops!

you need tighter permissions for
your private key.

Connecting on Mac / Linux



```
andy --bash-- 80x24
Last login: Sun Aug 11 11:39:28 on ttys008
[amcn:~ andy$ ssh -i aws_ohio.pem ec2-user@18.222.35.37
The authenticity of host '18.222.35.37 (18.222.35.37)' can't be established.
ECDSA key fingerprint is SHA256:pxosq3oYz00IHPIERekfuZUE0kLG/Kn1G4AbWRXevuM.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '18.222.35.37' (ECDSA) to the list of known hosts.
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
@                WARNING: UNPROTECTED PRIVATE KEY FILE!                @
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
Permissions 0644 for 'aws_ohio.pem' are too open.
It is required that your private key files are NOT accessible by others.
This private key will be ignored.
Load key "aws_ohio.pem": bad permissions
ec2-user@18.222.35.37: Permission denied (publickey,gssapi-keyex,gssapi-with-mic
).
[amcn:~ andy$ chmod 600 aws_ohio.pem
```

chmod 600 to prevent access from any other user.

Connecting on Mac / Linux



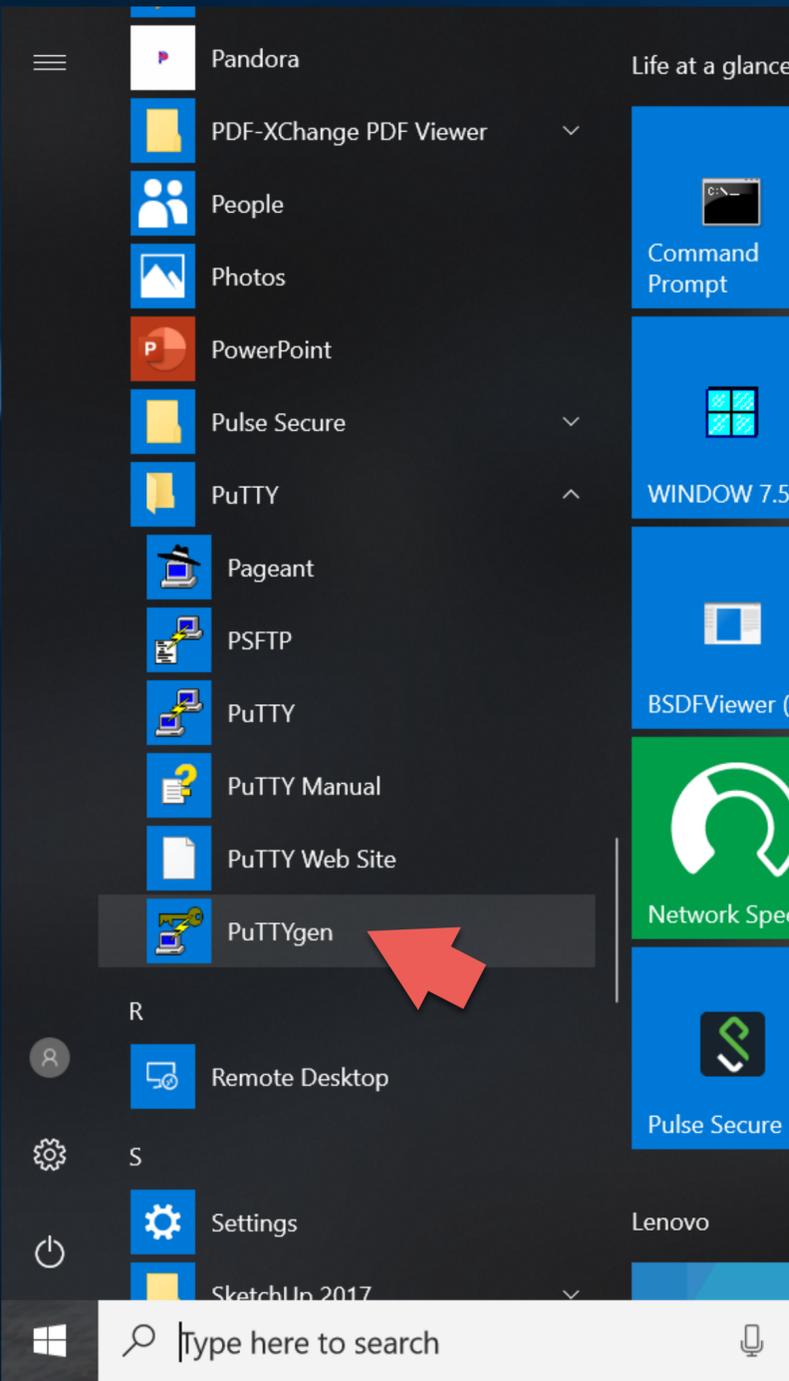
```
andy — ec2-user@ip-172-31-16-190:~ — ssh -i aws_ohio.pem ec2-user@18.222.35.37 — 80x24
ECDSA key fingerprint is SHA256:pxosq3oYz00IHPIERekfuZUE0kLG/Kn1G4AbWRXevuM.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '18.222.35.37' (ECDSA) to the list of known hosts.
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
@                WARNING: UNPROTECTED PRIVATE KEY FILE!                @
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
Permissions 0644 for 'aws_ohio.pem' are too open.
It is required that your private key files are NOT accessible by others.
This private key will be ignored.
Load key "aws_ohio.pem": bad permissions
ec2-user@18.222.35.37: Permission denied (publickey,gssapi-keyex,gssapi-with-mic
).
[amcn:~ andy$ chmod 600 aws_ohio.pem
[amcn:~ andy$ ssh -i aws_ohio.pem ec2-user@18.222.35.37
Last login: Sun Aug 11 18:37:28 2019 from c-67-169-62-4.hsd1.ca.comcast.net

  _ | _ | _ )
  _ | ( _ /   Amazon Linux 2 AMI
  _ |\_ | _ |

https://aws.amazon.com/amazon-linux-2/
4 package(s) needed for security, out of 12 available
Run "sudo yum update" to apply all updates.
[ec2-user@ip-172-31-16-190 ~]$
```

then ssh again and viola!

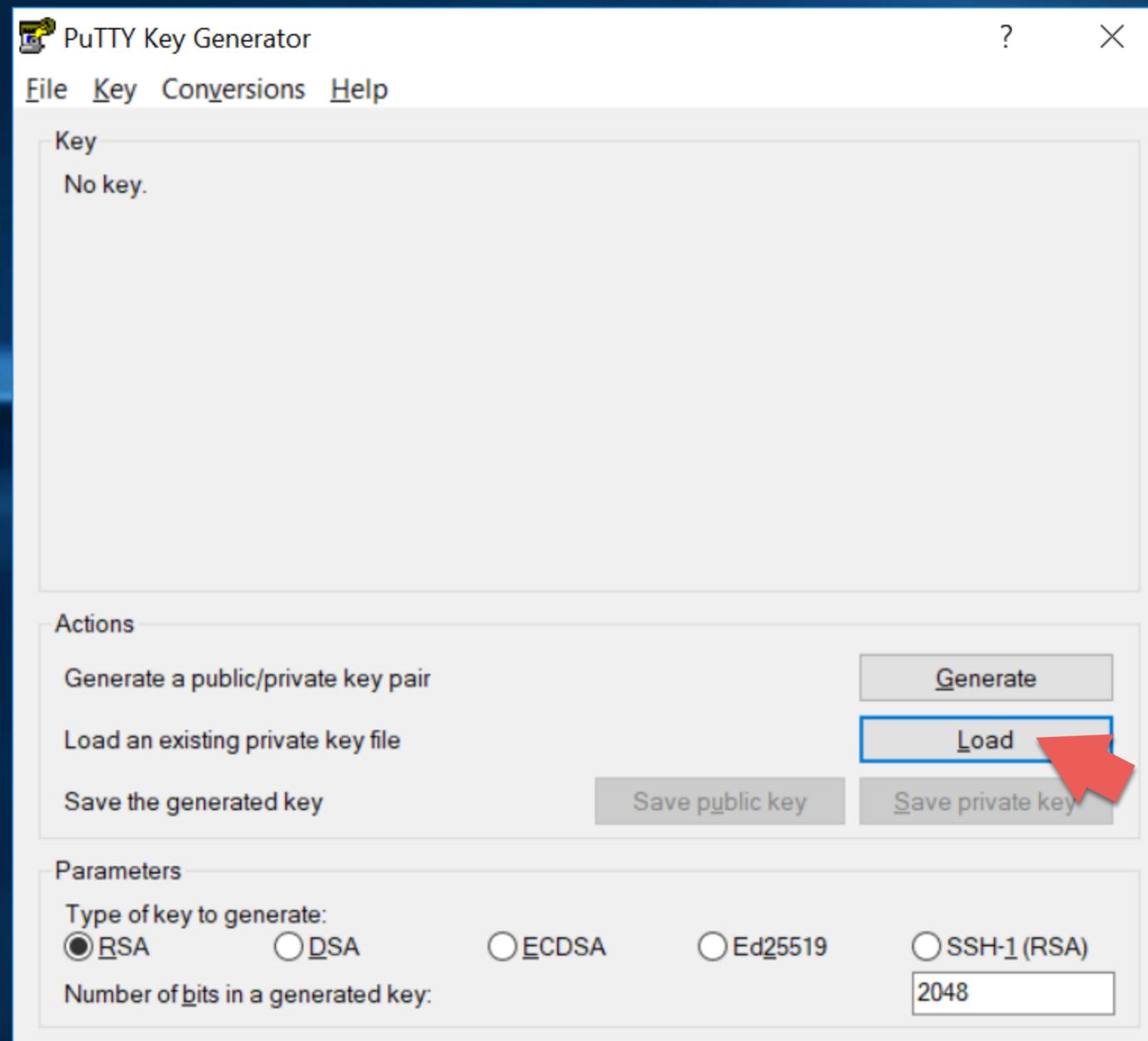
Connecting on Windows



First you need to convert your private key file to a PuTTY private key file.

Open PuTTYgen

Connecting on Windows



Click “Load”

Browse to and select your pem file from amazon.

Connecting on Windows



PuTTY Key Generator

File Key Conversions Help

Key

Public key for pasting into OpenSSH authorized_keys file:

```
ssh-rsa
AAAAB3NzaC1yc2EAAAADAQABAAQCKXBbxVuc9/UAHOjinUAVmsy2WTi2uOpOoqN
3We0fZ8XuM7ZM9eSalFp0M2ypawltLlvSCT
+my7qysnfKulkCtPKTggQwLjBRRq1lu05Wt71MHPTux0uOCjyQE1YyS
+E7h/2frNaichsWL4xQw7FWbkhJ6Mk1nTfRzq5nm3E4kT+F4FX788cD/
```

Key fingerprint: ssh-rsa 2048 76:19:5e:1c:83:ae:2d:19:cf:ea:ec:c2:56:86:52:01

Key comment: imported-openssh-key

Key passphrase:

Confirm passphrase:

Actions

Generate a public/private key pair

Load an existing private key file

Save the generated key

Parameters

Type of key to generate:

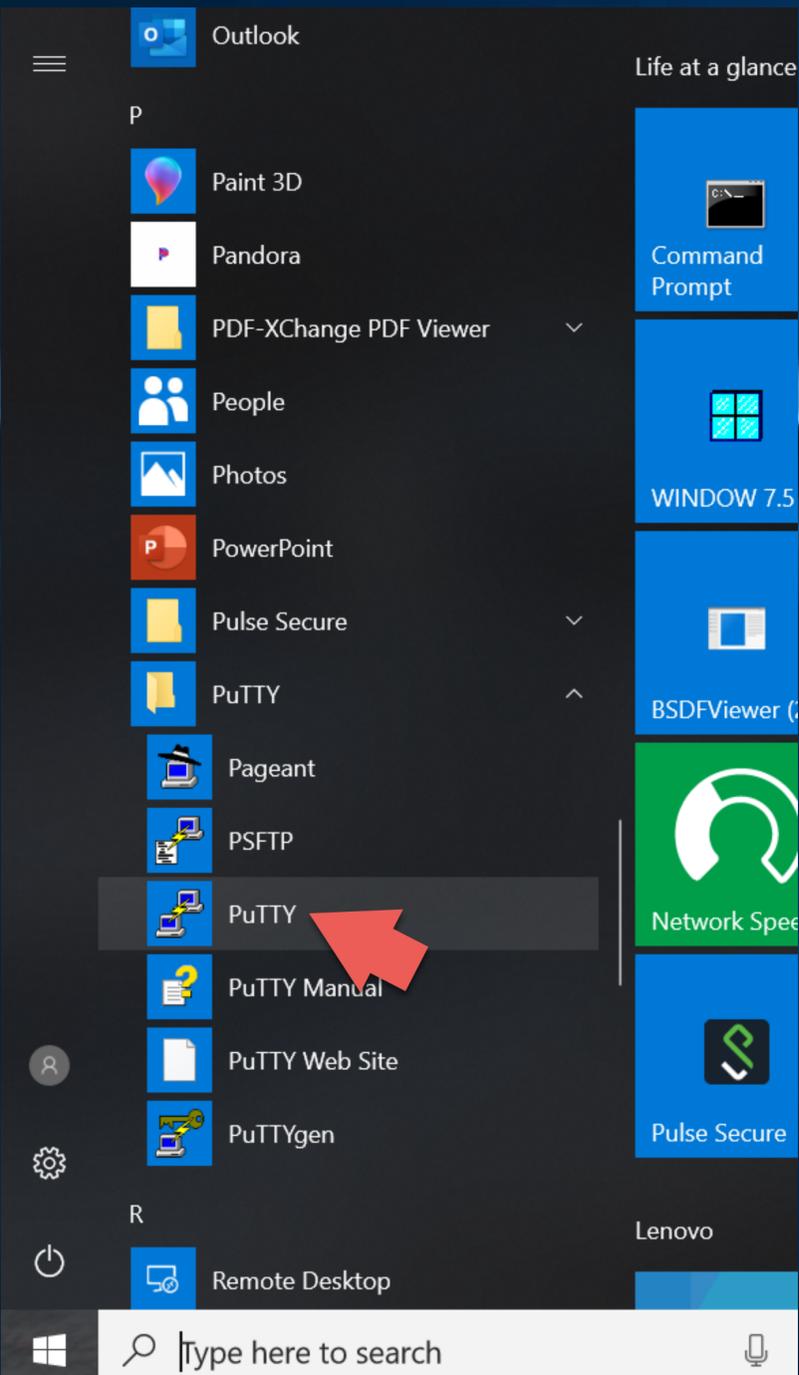
RSA DSA ECDSA Ed25519 SSH-1 (RSA)

Number of bits in a generated key: 2048

Click "Save private key"

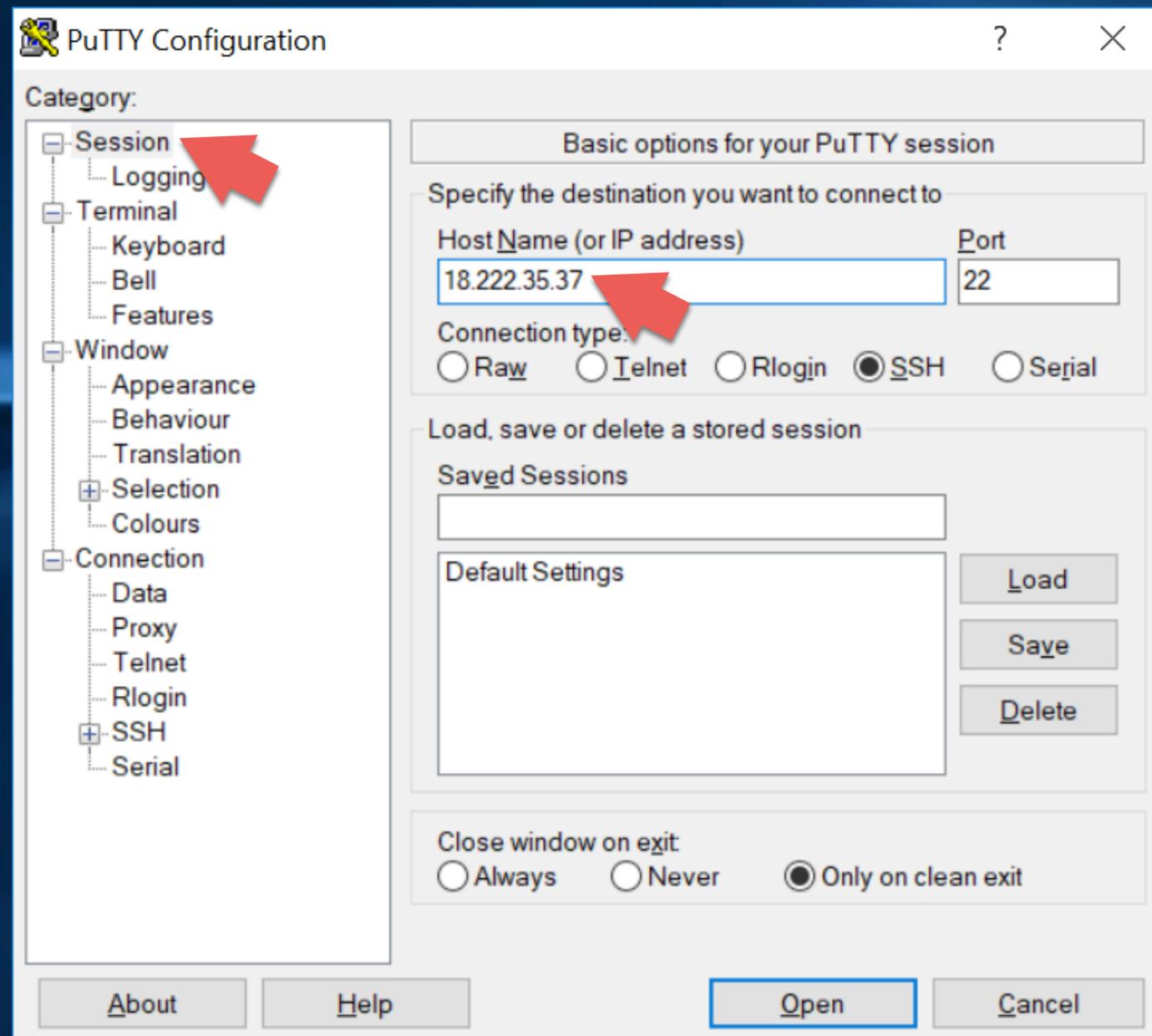


Connecting on Windows



Next Launch PuTTY

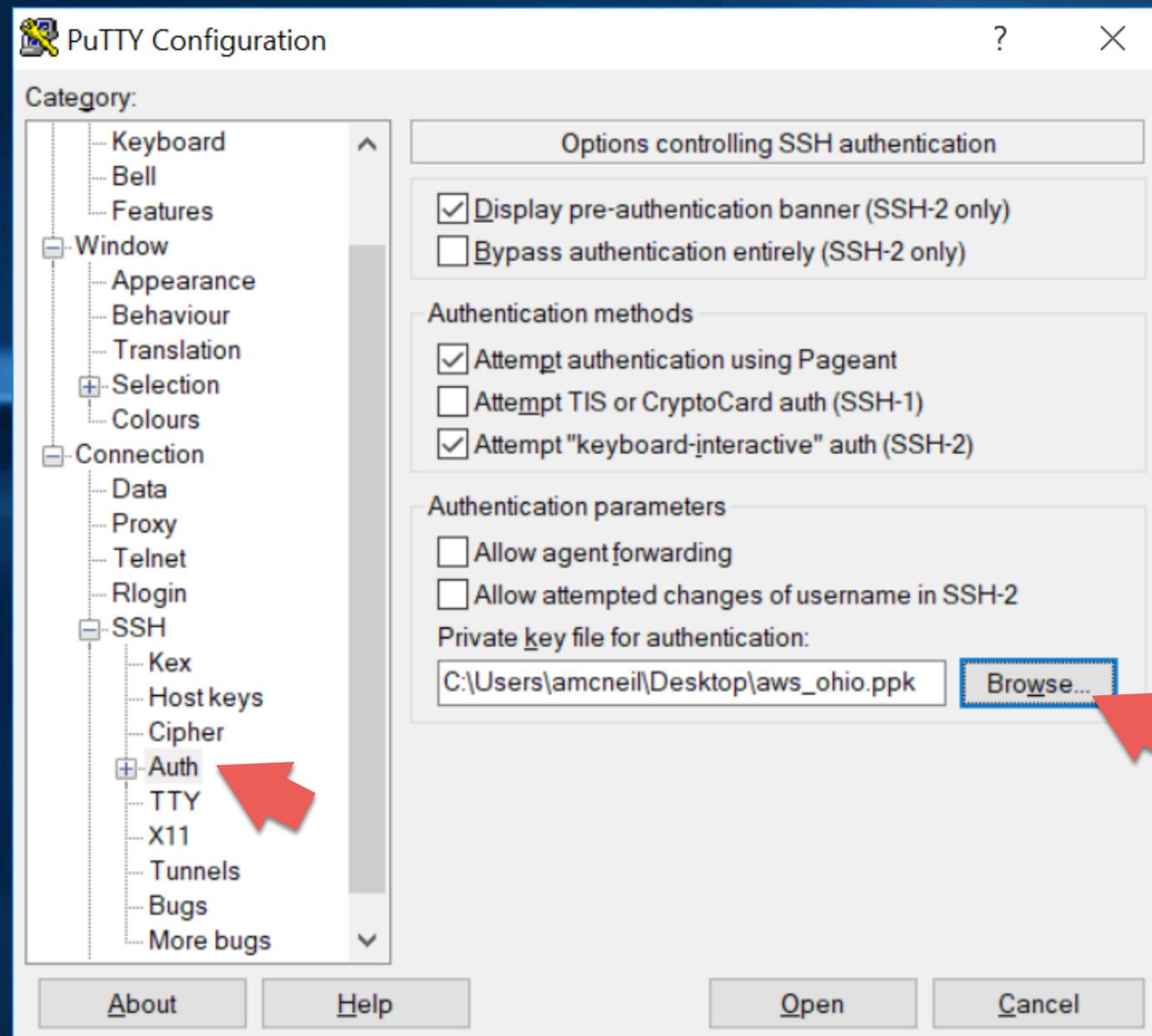
Connecting on Windows



Select Session, if not already selected

Enter the public IP address of your instance

Connecting on Windows

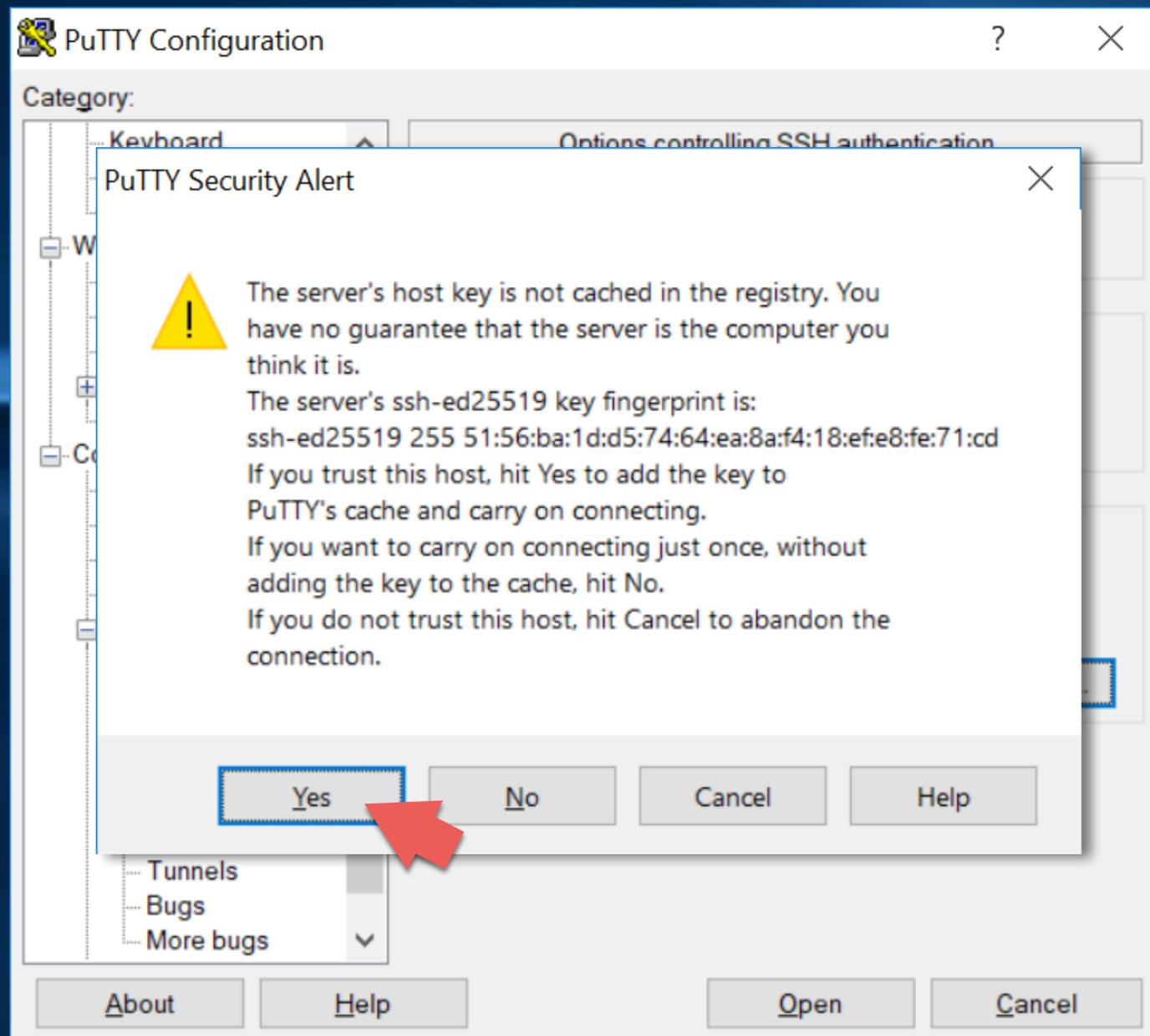


Select “Connection”
-> “SSH”
-> “Auth”

Click Browse, and select the
private key ppk file.

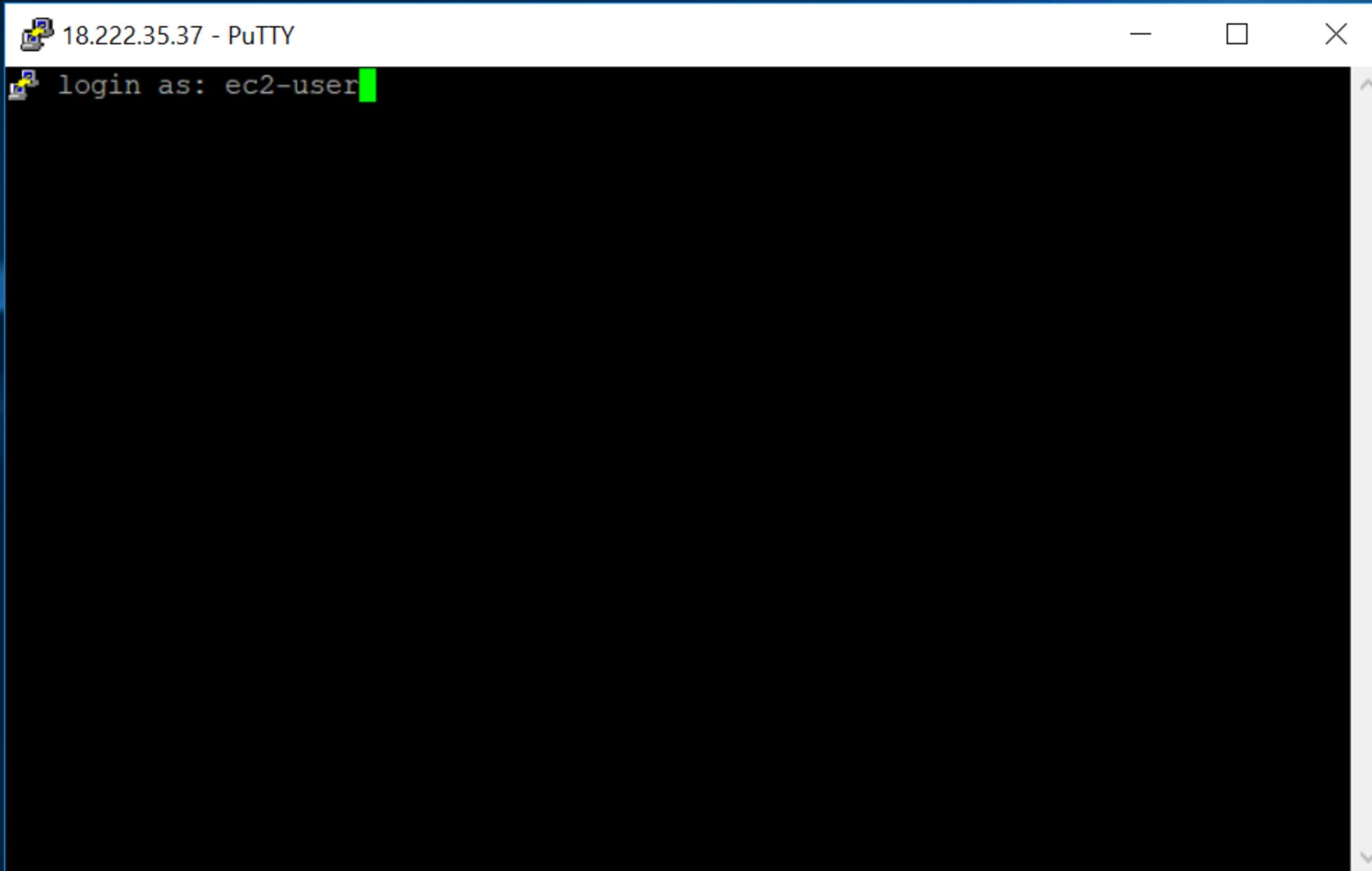
Then click “Open”

Connecting on Windows



Yes, you want to carry on connecting.

Connecting on Windows



The image shows a PuTTY terminal window with a white title bar containing the text "18.222.35.37 - PuTTY" and standard window control buttons. The terminal area has a black background with white text. The text "login as: ec2-user" is displayed, followed by a green cursor block. The terminal window is overlaid on a blue background with a faint Windows logo.

at the “login as:” prompt enter
ec2-user

Connecting on Windows



```
ec2-user@ip-172-31-16-190:~  
login as: ec2-user  
Authenticating with public key "imported-openssh-key"  
Last login: Sun Aug 11 19:36:48 2019 from c-67-169-62-4.hsd1.ca.comcast.net  
  
  _ |  _ |  )  
 _ | (  _ | /  Amazon Linux 2 AMI  
 _ | \  _ |  |  
  
https://aws.amazon.com/amazon-linux-2/  
[ec2-user@ip-172-31-16-190 ~]$ █
```

And you're in!

Look at that screen. Your family is going to think you're a nefarious hacker.

Regardless of OS, It's the same from here...



- Bourne-Again Shell (bash)
- package manager: yum

```
andy ec2-user@ip-172-31-16-190:~$ ssh -i ~/aws_ohio.pem ec2-user@18.222.35.37
Last login: Sun Aug 11 20:40:50 2019 from c-67-169-62-4.hsd1.ca.comcast.net

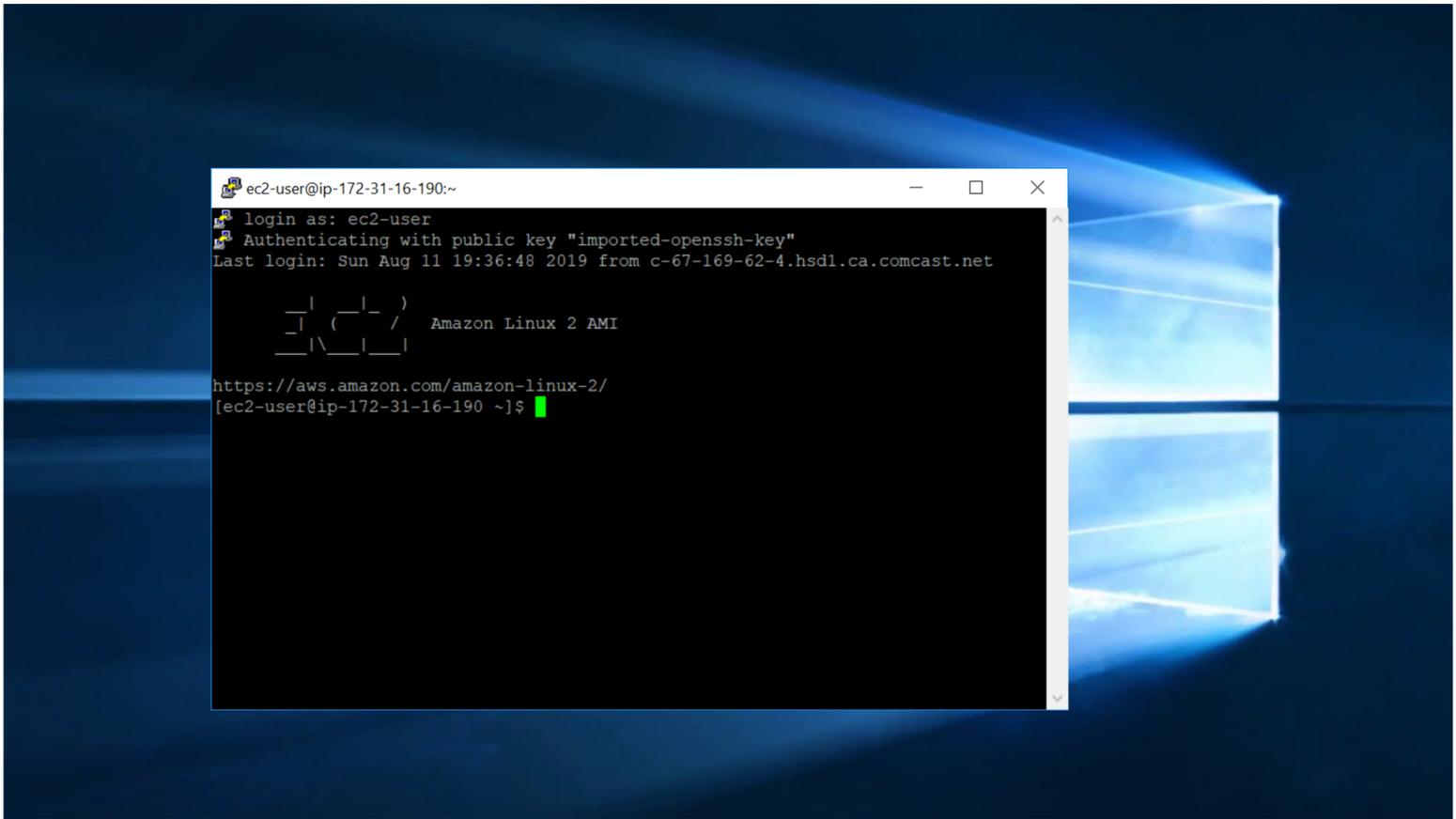
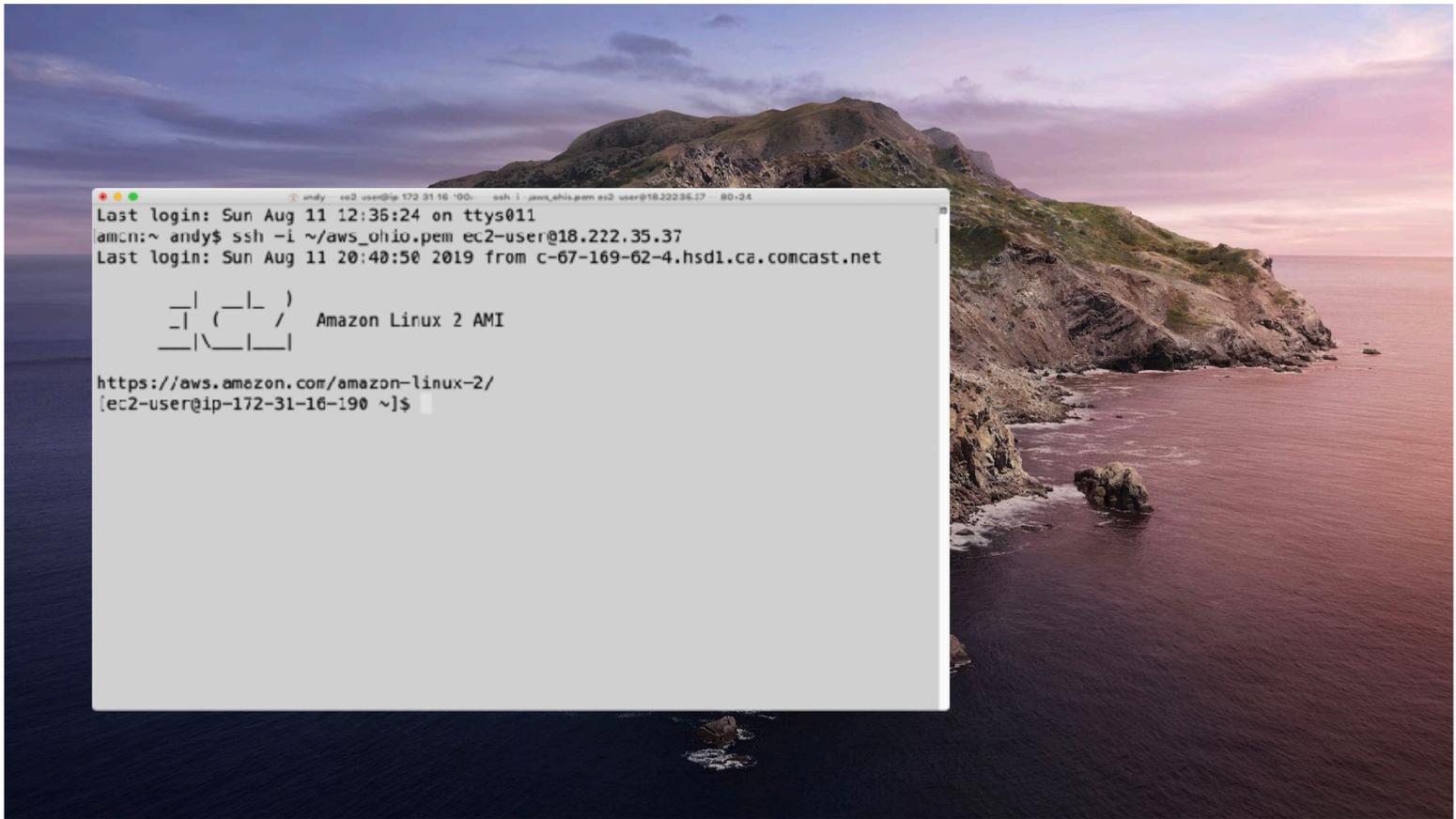
 _|_ ( _|_ /
_|_|_|_|_| Amazon Linux 2 AMI

https://aws.amazon.com/amazon-linux-2/
[ec2-user@ip-172-31-16-190 ~]$
```

```
ec2-user@ip-172-31-16-190:~$
login as: ec2-user
Authenticating with public key "imported-openssh-key"
Last login: Sun Aug 11 19:36:48 2019 from c-67-169-62-4.hsd1.ca.comcast.net

 _|_ ( _|_ /
_|_|_|_|_| Amazon Linux 2 AMI

https://aws.amazon.com/amazon-linux-2/
[ec2-user@ip-172-31-16-190 ~]$
```



Installing Software

- Amazon Linux uses yum package manager
 - First run yum update to get security and other updates
 - Then install packages needed to compile Radiance

```
sudo yum -y update
```

```
sudo yum -y install tcsh gcc gcc-c++ libX11-devel
```

Commands for installing RADIANCE

```
# create a directory for Radiance
mkdir Radiance
cd Radiance

# download Radiance HEAD from radiance-online.org
wget --no-check-certificate http://www.radiance-online.org/software/snapshots/radiance-HEAD.tgz
wget --no-check-certificate http://www.radiance-online.org/download-install/radiance-source-code/latest-release/radR52supp.tar.gz

# unpack tarballs
tar -xf radiance-HEAD.tgz
tar -xf radR52supp.tar.gz

# compile and install radiance
cd ray
sudo ./makeall install

# set raypath and copy cal files to raypath
echo RAYPATH=./usr/local/lib/ray/ > .bash_profile
echo export RAYPATH > .bash_profile
sudo cp src/cal/cal/* /usr/local/lib/ray/.

# check installation
rtrace -version
```

Run Mark Stock's Benchmark

```
# Install git
```

```
sudo yum -y install git
```

```
# clone benchmark repo
```

```
git clone https://github.com/markstock/Radiance-Benchmark4.git
```

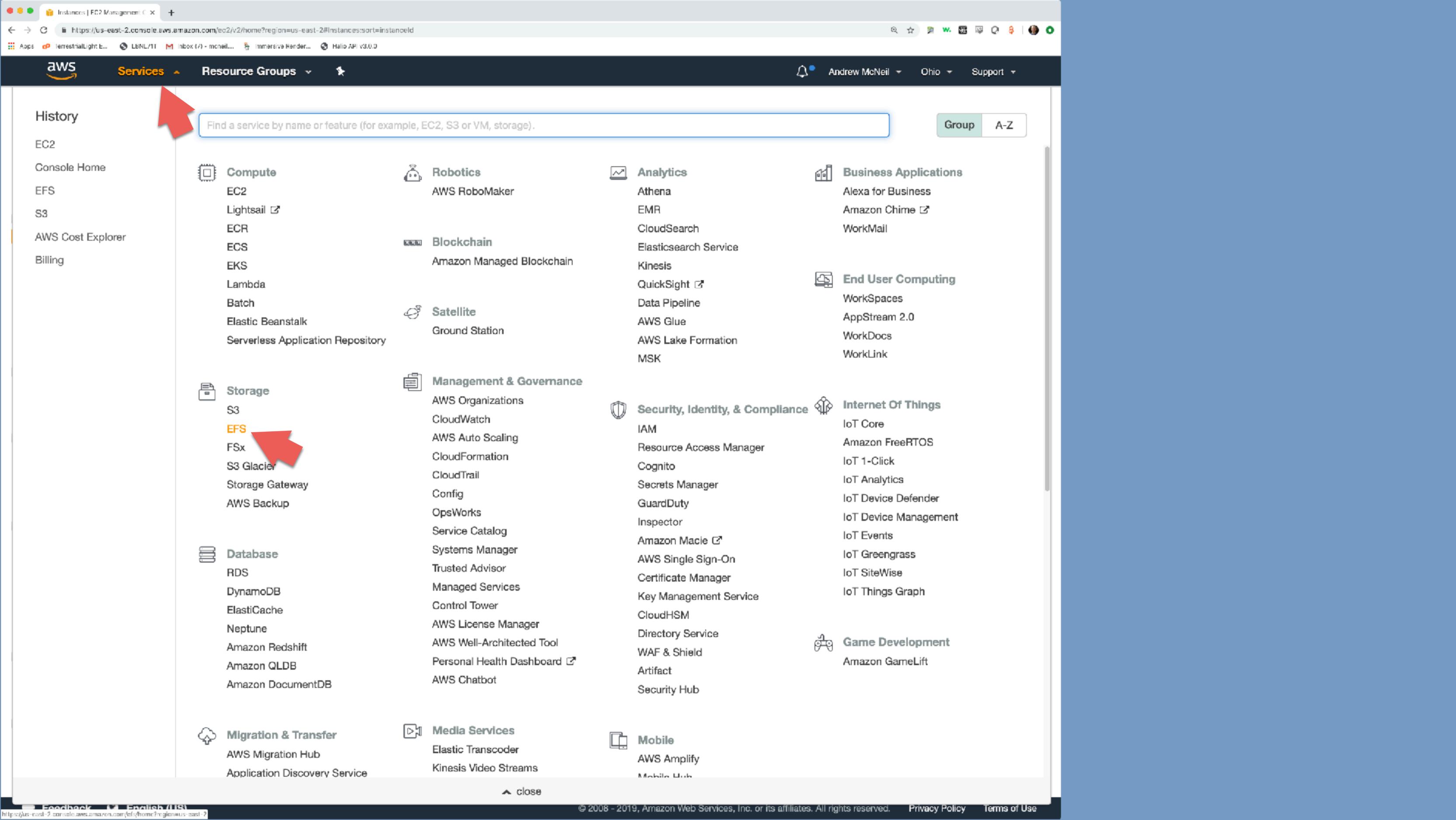
```
# run the benchmark
```

```
export NCPU=16; make smp
```

File Storage Options

	price per GB	
Simple Storage Service (S3)	\$0.02	<ul style="list-style-type: none">• object storage in flat environment• good for archiving tarballs of old projects, but not for active storage
Elastic Block Store (EBS)	\$0.10	<ul style="list-style-type: none">• Can be attached to a single EC2 instance• Easy to attach when launching instance• Limited to one availability zone (most regions have three zones)• Size is fixed and set when provisioned (you pay for empty GB)
Elastic File System (EFS)	\$0.30	<ul style="list-style-type: none">• Can be simultaneously attached to many EC2 instances• Must be mounted like a network drive (at the command line or with a startup script)• Spans availability zones (but limited to region)• Size is elastic, you only pay for GB used by your data

Andy recommends EFS



Services

Resource Groups



Andrew McNeil

Ohio

Support

History

- EC2
- Console Home
- EFS
- S3
- AWS Cost Explorer
- Billing

Find a service by name or feature (for example, EC2, S3 or VM, storage).

Group A-Z



Compute

- EC2
- Lightsail
- ECR
- ECS
- EKS
- Lambda
- Batch
- Elastic Beanstalk
- Serverless Application Repository



Robotics

- AWS RoboMaker



Analytics

- Athena
- EMR
- CloudSearch
- Elasticsearch Service
- Kinesis
- QuickSight
- Data Pipeline
- AWS Glue
- AWS Lake Formation
- MSK



Business Applications

- Alexa for Business
- Amazon Chime
- WorkMail



Blockchain

- Amazon Managed Blockchain



Satellite

- Ground Station



Management & Governance

- AWS Organizations
- CloudWatch
- AWS Auto Scaling
- CloudFormation
- CloudTrail
- Config
- OpsWorks
- Service Catalog
- Systems Manager
- Trusted Advisor
- Managed Services
- Control Tower
- AWS License Manager
- AWS Well-Architected Tool
- Personal Health Dashboard
- AWS Chatbot



Security, Identity, & Compliance

- IAM
- Resource Access Manager
- Cognito
- Secrets Manager
- GuardDuty
- Inspector
- Amazon Macie
- AWS Single Sign-On
- Certificate Manager
- Key Management Service
- CloudHSM
- Directory Service
- WAF & Shield
- Artifact
- Security Hub



Internet Of Things

- IoT Core
- Amazon FreeRTOS
- IoT 1-Click
- IoT Analytics
- IoT Device Defender
- IoT Device Management
- IoT Events
- IoT Greengrass
- IoT SiteWise
- IoT Things Graph



Storage

- S3
- EFS
- FSx
- S3 Glacier
- Storage Gateway
- AWS Backup



Database

- RDS
- DynamoDB
- ElastiCache
- Neptune
- Amazon Redshift
- Amazon QLDB
- Amazon DocumentDB



Migration & Transfer

- AWS Migration Hub
- Application Discovery Service



Media Services

- Elastic Transcoder
- Kinesis Video Streams



Mobile

- AWS Amplify
- Mobile Hub



Game Development

- Amazon GameLift

close

Flashio File System Manager

https://us-east-2.console.aws.amazon.com/efs/home?region=us-east-2#/first-run

Services Resource Groups

Andrew McNeil Ohio Support



Amazon Elastic File System (EFS)

Amazon EFS provides file storage for use with your EC2 instances.

[Create file system](#)

[Getting started guide](#)



Create

Create an Amazon EFS file system to store your files in the Amazon cloud. A file system grows and shrinks automatically with the files you put in, and you pay only for what you use.



Access

Write files to and read files from your Amazon EFS file system by using the NFSv4 protocol. Any number of EC2 instances can work with your file system at the same time, and your instances can be in multiple Availability Zones in a region.



Manage

You can easily administer your file system using the Amazon EFS console, CLI, and SDK.

[Elastic File System documentation & support](#)

[Getting started guide](#) | [Documentation](#) | [Support](#) | [Forums](#)

Feedback English (US)

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Create file system

Step 1: Configure file system access

Step 2: Configure optional settings

Step 3: Review and create

Configure file system access

An Amazon EFS file system is accessed by EC2 instances running inside one of your VPCs. Instances connect to a file system by using a network interface called a mount target. Each mount target has an IP address, which we assign automatically or you can specify.

VPC ⓘ

Create mount targets

Instances connect to a file system by using mount targets you create. We recommend creating a mount target in each of your VPC's Availability Zones so that EC2 instances across your VPC can access the file system.

	Availability Zone	Subnet ⓘ	IP address ⓘ	Security groups ⓘ
<input checked="" type="checkbox"/>	us-east-2a	<input type="text" value="subnet-4b494322 (default)"/>	Automatic ✎	<input type="text" value="sg-07c3608c40753cd0d - Basic ✕"/> <input type="text" value="sg-6c47cc04 - default ✕"/>
<input checked="" type="checkbox"/>	us-east-2b	<input type="text" value="subnet-955219ee (default)"/>	Automatic ✎	<input type="text" value="sg-07c3608c40753cd0d - Basic ✕"/> <input type="text" value="sg-6c47cc04 - default ✕"/>
<input checked="" type="checkbox"/>	us-east-2c	<input type="text" value="subnet-b99b0cf4 (default)"/>	Automatic ✎	<input type="text" value="sg-07c3608c40753cd0d - Basic ✕"/> <input type="text" value="sg-6c47cc04 - default ✕"/>

Cancel

Flash File System Manager

https://us-east-2.console.aws.amazon.com/efs/home?region=us-east-2#wizard/2

Services Resource Groups

Andrew McNeil Ohio Support

Create file system

Step 1: Configure file system access

Step 2: Configure optional settings

Step 3: Review and create

Configure optional settings

Add tags

You can add tags to describe your file system. A tag consists of a case-sensitive key-value pair. (For example, you can define a tag with key-value pair with key = Corporate Department and value = Sales and Marketing.) At a minimum, we recommend a tag with key = Name.

Key	Value	Remove
<input type="text" value="Name"/>	<input type="text" value="Add New Value"/>	<input type="button" value="✕"/>
<input type="text" value="Add New Key"/>	<input type="text"/>	

Enable lifecycle management NEW!

Automatically save up to 85% on your EFS bill as your access patterns change by enabling **Lifecycle Management** for your file system. Based on the policy you choose, any files in your file system that are not accessed for a period of time will automatically move to the EFS Infrequent Access (EFS IA) storage class. EFS IA provides price/performance that's cost-optimized for files not accessed every day. [Learn more](#)

Lifecycle policy

Choose throughput mode

We recommend **Bursting** throughput mode for most file systems. Use **Provisioned** throughput mode for applications that require more throughput than allowed by **Bursting** throughput. [Learn more](#)

Bursting

Provisioned

Choose performance mode

We recommend **General Purpose** performance mode for most file systems. **Max I/O** performance mode is optimized for applications where tens, hundreds, or thousands of EC2 instances are accessing the file system — it scales to higher levels of aggregate throughput and operations per second with a tradeoff of slightly

Lifecycle policy automatically moves files not recently accessed to lower cost storage

The next time its accessed there will be latency of up to 100ms. but then it's put back into the faster more expensive storage.

Flash File System Manager

https://us-east-2.console.aws.amazon.com/efs/home?region=us-east-2#/filesystems/fs-8e7921f7

Services Resource Groups Andrew McNeil Ohio Support

File systems

Success!

You have created a file system. You can mount your file system from an EC2 instance with an NFSv4.1 client installed. You can also mount your file system from an on-premises server over an AWS Direct Connect or AWS VPN connection. Click [here](#) for EC2 mount instructions, and [here](#) for on-premises mount instructions.

Create file system Actions

Name	File system ID	Metered size	Number of mount targets	Creation date
	fs-8e7921f7	6.0 KiB	3	08/11/2019, 18:51:37 UTC

Other details 

Tags [Manage tags](#)

No tags added

Owner ID 885639356958

File system state **Available**

Performance mode General Purpose

Throughput mode Bursting 

Encrypted No

Lifecycle policy 14 days since last access 

File system access [Manage file system access](#)

DNS name fs-8e7921f7.efs.us-east-2.amazonaws.com 

[Amazon EC2 mount instructions \(from local VPC\)](#)

[Amazon EC2 mount instructions \(across VPC peering connection\)](#)

[On-premises mount instructions](#) 

Mount targets

VPC	Availability Zone	Subnet	IP address	Mount target ID	Network interface ID	Security groups	Mount target state
	us-east-2c	subnet-b99b0cf4 (default)	172.31.46.223	fsmt-90a32ce9	eni-0c81bc56240e39e4a		Creating
vpc-fe0a3097	us-east-2h	subnet-955219ee	172.31.23.217	fsmt-	eni-		Creating

Your file system id is used for mounting to instances.

There are mount instructions on the EFS page if you ever forget. You don't need to download this pdf again just for mounting instructions.

Mounting Elastic File Storage

Install tools

```
sudo yum install -y amazon-efs-utils
```

create mount point

```
mkdir efs
```

mount

```
sudo mount -t efs fs-8e7921f7:/ efs
```

change owner and group if it's your first time mounting the file system

```
sudo chown ec2-user efs
```

```
sudo chgrp ec2-user efs
```

Saving a custom machine image

- It'd be nice to not have to do all this setup every time, right?
- Machine Images - You can save the state of the machine
- Configuration script - Allows you to run updates and mount EFS drives when the instance is started

Machine Images

- Remember this step when launching an instance? — — — — — >

The screenshot shows the AWS Management Console interface for the 'Launch Instance Wizard'. The current step is 'Step 1: Choose an Amazon Machine Image (AMI)'. The page includes a search bar, a 'Quick Start' sidebar, and a list of AMIs with their descriptions and 'Select' buttons. The AMIs listed are:

- Amazon Linux 2 AMI (HVM), SSD Volume Type** - ami-0d8f6eb4f641ef691 (64-bit x86) / ami-0f378490dca16e3f4 (64-bit Arm)
- Amazon Linux AMI 2018.03.0 (HVM), SSD Volume Type** - ami-02f706d959cedf892
- Red Hat Enterprise Linux 8 (HVM), SSD Volume Type** - ami-0520e698dd500b1d1 (64-bit x86) / ami-0099847d600887c9f (64-bit Arm)
- SUSE Linux Enterprise Server 15 SP1 (HVM), SSD Volume Type** - ami-0e0bae59dc35fe89a (64-bit x86) / ami-0b49a8f443e46ff20 (64-bit Arm)
- Ubuntu Server 18.04 LTS (HVM), SSD Volume Type** - ami-05c1fa8df71875112 (64-bit x86) / ami-0606a0d9f566249d3 (64-bit Arm)

The footer of the page contains 'Feedback', 'English (US)', and copyright information: '© 2008 - 2019, Amazon Web Services, Inc. or its affiliates. All rights reserved. Privacy Policy Terms of Use'.

Machine Images

- Let's create a machine image!

The screenshot displays the AWS Launch Instance Wizard, specifically Step 1: Choose an Amazon Machine Image (AMI). The page is titled "Step 1: Choose an Amazon Machine Image (AMI)" and includes a "Cancel and Exit" link. Below the title, there is a search bar with the placeholder text "Search for an AMI by entering a search term e.g. 'Windows'". The main content area is divided into a left sidebar and a main panel. The sidebar contains the following sections:

- Quick Start
- My AMIs** (highlighted with a red arrow)
- AWS Marketplace
- Community AMIs
- Ownership
 - Owned by me
 - Shared with me
- Architecture
 - 32-bit (x86)
 - 64-bit (x86)
 - 64-bit (Arm)
- Root device type
 - EBS
 - Instance store

The main panel displays the message: "You have not created any AMIs. You can launch instances using AMIs provided by AWS, our user community, or through the AWS Marketplace." The page footer includes a "Feedback" button, "English (US)" language selection, and copyright information: "© 2008 - 2019, Amazon Web Services, Inc. or its affiliates. All rights reserved. Privacy Policy Terms of Use".

The screenshot shows the AWS Management Console interface. On the left is a navigation sidebar with categories like EC2 Dashboard, INSTANCES, IMAGES, ELASTIC BLOCK STORE, NETWORK & SECURITY, LOAD BALANCING, and AUTO SCALING. The main area displays a table of EC2 instances. One instance is selected, and the 'Actions' dropdown menu is open, with 'Create Image' highlighted. A red arrow points to the 'Create Image' option. Another red arrow points to the 'Actions' button. A third red arrow points to the selection checkbox of the instance in the table. Below the table, the details for the selected instance (i-0558a0059aa90975a) are shown, including its state (running), type (t2.micro), and various network and storage configurations.

Name	Instance ID	Availability Zone	Instance State	Status Checks	Alarm Status	Public DNS (IPv4)	IPv4 Public
	i-0558a0059aa90975a	us-east-2b	running	2/2 checks ...	None	ec2-18-222-35-37.us-east-2.compute.amazonaws.com	18.222.35.37

Instance: i-0558a0059aa90975a		Public DNS: ec2-18-222-35-37.us-east-2.compute.amazonaws.com	
Description			
Instance ID	i-0558a0059aa90975a	Public DNS (IPv4)	ec2-18-222-35-37.us-east-2.compute.amazonaws.com
Instance state	running	IPv4 Public IP	18.222.35.37
Instance type	t2.micro	IPv6 IPs	-
Elastic IPs		Private DNS	ip-172-31-16-190.us-east-2.compute.internal
Availability zone	us-east-2b	Private IPs	172.31.16.190
Security groups	Basic. view inbound rules . view outbound rules	Secondary private IPs	
Scheduled events	No scheduled events	VPC ID	vpc-fe0a3097
AMI ID	amzn2-ami-hvm-2.0.20190618-x86_64-gp2 (ami-0d8f6eb4f641ef691)	Subnet ID	subnet-955219ee
Platform	-	Network interfaces	eth0
IAM role	-	Source/dest. check	True
Key pair name	aws_ohio	T2/T3 Unlimited	Disabled
Owner	885639356958	EBS-optimized	False
Launch time	August 11, 2019 at 11:13:03 AM UTC-7 (less than one hour)	Root device type	ebs
Termination protection	False	Root device	/dev/xvda
Lifecycle	normal	Block devices	/dev/xvda

Select the instance from which you want to generate a machine image.

Make sure it's not busy, it will be rebooted to make the image!

Instances | EC2 Management Console

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#Instances:sort=instanceId

Services Resource Groups

Andrew McNeil Ohio Support

EC2 Dashboard

Events

Tags

Reports

Limits

INSTANCES

Instances

Launch Templates

Spot Requests

Reserved Instances

Dedicated Hosts

Capacity Reservations

IMAGES

AMIs

Bundle Tasks

ELASTIC BLOCK STORAGE

Volumes

Snapshots

Lifecycle Management

NETWORK & SECURITY

Security Groups

Elastic IPs

Placement Groups

Key Pairs

Network Interfaces

LOAD BALANCING

Load Balancers

Target Groups

AUTO SCALING

Launch Configurations

Auto Scaling Groups

Launch Instance Connect Actions

Filter by tags and attributes or search by keyword

1 to 1 of 1

Name	Instance ID	Instance Type	Availability Zone	Instance State	Status Checks	Alarm Status	Public DNS (IPv4)	IPv4 Public
	i-0558a0059aa9097...	t2.micro	us-east-2b	running	2/2 checks ...	None	ec2-18-222-35-37.us-e...	18.222.35.3

Create Image

Instance ID *i* i-0558a0059aa90975a

Image name *i* Radiance

Image description *i* HEAD 2019-08-11

No reboot *i*

Instance Volumes

Volume Type <i>i</i>	Device <i>i</i>	Snapshot <i>i</i>	Size (GiB) <i>i</i>	Volume Type <i>i</i>	IOPS <i>i</i>	Throughput (MB/s) <i>i</i>	Delete on Termination <i>i</i>	Encrypted <i>i</i>
Root	/dev/xvda	snap-077085afe6b3ee68d	8	General Purpose SSD (gp2)	100 / 3000	N/A	<input checked="" type="checkbox"/>	Not Encrypted

[Add New Volume](#)

Total size of EBS Volumes: 8 GiB
When you create an EBS image, an EBS snapshot will also be created for each of the above volumes.

[Cancel](#) [Create Image](#)

Platform	-	Network interfaces	eth0
IAM role	-	Source/dest. check	True
Key pair name	aws_ohio	T2/T3 Unlimited	Disabled
Owner	885639356958	EBS-optimized	False
Launch time	August 11, 2019 at 11:13:03 AM UTC-7 (less than one hour)	Root device type	ebs
Termination protection	False	Root device	/dev/xvda
Lifecycle	normal	Block devices	/dev/xvda

Feedback English (US)

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The screenshot shows the AWS Management Console interface. At the top, there's a navigation bar with the AWS logo, 'Services', 'Resource Groups', and user information for Andrew McNeil in the Ohio region. The main content area displays a table of EC2 instances. One instance is selected, and a 'Create Image' dialog box is open in the foreground. The dialog box contains a green checkmark and the message 'Create Image request received.' with a link to view the pending image. Below this, there's a note about EBS snapshots and a 'Close' button. In the background, the instance details for 'i-0558a0059aa9097...' are visible, showing it's a t2.micro instance in the us-east-2b availability zone, currently in a 'running' state. A terminal window is also visible at the bottom right, showing the user's actions on the instance.

Name	Instance ID	Instance Type	Availability Zone	Instance State	Status Checks	Alarm Status	Public DNS (IPv4)	IPv4 Public
	i-0558a0059aa9097...	t2.micro	us-east-2b	running	2/2 checks ...	None	ec2-18-222-35-37.us-e...	18.222.35.3

Create Image

✔ Create Image request received.
[View pending image ami-01ad2f81030f30f31](#)

Any snapshots backing your new EBS image can be managed on the [snapshots screen](#) after successful image creation.

Close

```
[ec2-user@ip-172-31-16-190 ~]$ sudo cnown ec2-user ers
[ec2-user@ip-172-31-16-190 ~]$ sudo chgrp ec2-user efs
[ec2-user@ip-172-31-16-190 ~]$ Connection to 18.222.35.37 closed by remote host.
Connection to 18.222.35.37 closed.
amcn:~ andy$
```

Select the instance from which you want to generate a machine image.

Make sure it's not busy, it will be rebooted to make the image!

AMIs | EC2 Management Console

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#images:sort=name

Services Resource Groups

Andrew McNeil Ohio Support

EC2 Dashboard
Events
Tags
Reports
Limits

INSTANCES
Instances
Launch Templates
Spot Requests
Reserved Instances
Dedicated Hosts
Capacity Reservations

IMAGES
AMIs
Bundle Tasks

ELASTIC BLOCK STORE
Volumes
Snapshots
Lifecycle Manager

NETWORK & SECURITY
Security Groups
Elastic IPs
Placement Groups
Key Pairs
Network Interfaces

LOAD BALANCING
Load Balancers
Target Groups

AUTO SCALING
Launch Configurations
Auto Scaling Groups

Launch Actions

Owned by me Filter by tags and attributes or search by keyword 1 to 1 of 1

Name	AMI Name	AMI ID	Source	Owner	Visibility	Status	Creation Date	Platform
	Radiance	ami-01ad2f81030f30f31	885639356958/...	885639356958	Private	available	August 11, 2019 at 12:11:09 ...	Other Li

Image: ami-01ad2f81030f30f31

Details Permissions Tags

Edit

AMI ID	ami-01ad2f81030f30f31	AMI Name	Radiance
Owner	885639356958	Source	885639356958/Radiance
Status	available	State Reason	-
Creation date	August 11, 2019 at 12:11:09 PM UTC-7	Platform	Other Linux
Architecture	x86_64	Image Type	machine
Virtualization type	hvm	Description	HEAD 2019-08-11
Root Device Name	/dev/xvda	Root Device Type	ebs

Feedback English (US)

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There's our new image!

Configuration / Startup script

- There are some things you'll want to run every time you start an instance, for example:
 - `sudo yum -y update`
(for security)
 - `sudo mount -t efs myfilesystem:/ efs`
- Configuration scripts can be provided as a text file when launching an instance.
- Or you could put this in a `@reboot` cron job on the machine image.

Example Configuration Script

aws_startup.bsh:

```
#!/bin/bash  
  
yum -y update  
mount -t efs fs-8e7921f7:/ /home/ec2-user/efs
```

When provided as a configuration script, it is run with root privileges, so you don't need sudo.

Launch Instance Wizard | EC2

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#LaunchInstanceWizard:ami=ami-01ad2f81030f30f31

Services Resource Groups

Andrew McNeil Ohio Support

1. Choose AMI 2. Choose Instance Type 3. Configure Instance 4. Add Storage 5. Add Tags 6. Configure Security Group 7. Review

Step 1: Choose an Amazon Machine Image (AMI) Cancel and Exit

An AMI is a template that contains the software configuration (operating system, application server, and applications) required to launch your instance. You can select an AMI provided by AWS, our user community, or the AWS Marketplace; or you can select one of your own AMIs.

ami-01ad2f81030f30f31

Quick Start (0) 1 to 1 of 1 AMIs

My AMIs (1)

Radlance - ami-01ad2f81030f30f31 Select

HEAD 2019-08-11

64-bit (x86)

Root device type: ebs Virtualization type: hvm Owner: 885689358958 ENA Enabled: Yes

Community AMIs (0)

Ownership

Owned by me

Shared with me

Architecture

32-bit (x86)

64-bit (x86)

64-bit (Arm)

Root device type

EBS

Instance store

The following results for "ami-01ad2f81030f30f31" were found in other catalogs:

[3232 results](#) in AWS Marketplace

AWS Marketplace provides partnered Software that is pre-configured to run on AWS

Feedback English (US)

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When we go to launch an instance the new image is available.

Launch Instance Wizard | EC2

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#LaunchInstanceWizard:ami=ami-01ad2f81030f30f31

Services Resource Groups Andrew McNeil Ohio Support

1. Choose AMI 2. Choose Instance Type 3. Configure Instance 4. Add Storage 5. Add Tags 6. Configure Security Group 7. Review

Step 2: Choose an Instance Type

<input type="checkbox"/>	General purpose	t3.nano	2	0.5	EBS only	Yes	Up to 5 Gigabit	Yes
<input type="checkbox"/>	General purpose	t3.micro	2	1	EBS only	Yes	Up to 5 Gigabit	Yes
<input type="checkbox"/>	General purpose	t3.small	2	2	EBS only	Yes	Up to 5 Gigabit	Yes
<input type="checkbox"/>	General purpose	t3.medium	2	4	EBS only	Yes	Up to 5 Gigabit	Yes
<input type="checkbox"/>	General purpose	t3.large	2	8	EBS only	Yes	Up to 5 Gigabit	Yes
<input type="checkbox"/>	General purpose	t3.xlarge	4	16	EBS only	Yes	Up to 5 Gigabit	Yes
<input type="checkbox"/>	General purpose	t3.2xlarge	8	32	EBS only	Yes	Up to 5 Gigabit	Yes
<input type="checkbox"/>	General purpose	m5ad.large	2	8	1 x 75 (SSD)	Yes	Up to 10 Gigabit	Yes
<input type="checkbox"/>	General purpose	m5ad.xlarge	4	16	1 x 150 (SSD)	Yes	Up to 10 Gigabit	Yes
<input type="checkbox"/>	General purpose	m5ad.2xlarge	8	32	1 x 300 (SSD)	Yes	Up to 10 Gigabit	Yes
<input checked="" type="checkbox"/>	General purpose	m5ad.4xlarge	16	64	2 x 300 (SSD)	Yes	Up to 10 Gigabit	Yes
<input type="checkbox"/>	General purpose	m5ad.12xlarge	48	192	2 x 900 (SSD)	Yes	10 Gigabit	Yes
<input type="checkbox"/>	General purpose	m5ad.24xlarge	96	384	4 x 900 (SSD)	Yes	20 Gigabit	Yes
<input type="checkbox"/>	General purpose	m5a.large	2	8	EBS only	Yes	Up to 10 Gigabit	Yes
<input type="checkbox"/>	General purpose	m5a.xlarge	4	16	EBS only	Yes	Up to 10 Gigabit	Yes
<input type="checkbox"/>	General purpose	m5a.2xlarge	8	32	EBS only	Yes	Up to 10 Gigabit	Yes
<input type="checkbox"/>	General purpose	m5a.4xlarge	16	64	EBS only	Yes	Up to 10 Gigabit	Yes
<input type="checkbox"/>	General purpose	m5a.8xlarge	32	128	EBS only	Yes	Up to 10 Gigabit	Yes
<input type="checkbox"/>	General purpose	m5a.12xlarge	48	192	EBS only	Yes	10 Gigabit	Yes

Cancel Previous **Review and Launch** Next: Configure Instance Details

I'm going to launch a 16 CPU instance this time.

NOT FREE TIER!

Launch instance wizard | EC2 | x

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#LaunchInstanceWizard:ami=ami-01ad2f81030f30f31

aws Services Resource Groups Andrew McNeil Ohio Support

1. Choose AMI 2. Choose Instance Type 3. Configure Instance 4. Add Storage 5. Add Tags 6. Configure Security Group 7. Review

Step 3: Configure Instance Details

Configure the instance to suit your requirements. You can launch multiple instances from the same AMI, request Spot instances to take advantage of the lower pricing, assign an access management role to the instance, and more.

Number of instances [Launch into Auto Scaling Group](#)

Purchasing option Request Spot instances

Current price

Availability Zone	Current price
us-east-2a	\$0.1596
us-east-2b	\$0.1596
us-east-2c	\$0.6295

Maximum price

Persistent request Persistent request

Launch group (Optional)

Request valid from Any time [Edit](#)

Request valid to Any time [Edit](#)

Network [Create new VPC](#)

Subnet [Create new subnet](#)

Auto-assign Public IP

Placement group Add instance to placement group

Capacity Reservation [Create new Capacity Reservation](#)

IAM role [Create new IAM role](#)

CPU options Specify CPU options

Monitoring Enable CloudWatch detailed monitoring
[Additional charges apply.](#)

[Cancel](#) [Previous](#) [Review and Launch](#) [Next: Add Storage](#)

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And let's do a spot request too.

Launch Instance Wizard | EC2

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#LaunchInstanceWizard:ami=ami-01ad2f81030f30f31

Services Resource Groups

Andrew McNeil Ohio Support

1. Choose AMI 2. Choose Instance Type 3. Configure Instance 4. Add Storage 5. Add Tags 6. Configure Security Group 7. Review

Step 3: Configure Instance Details

	us-east-2b	\$0.1596
	us-east-2c	\$0.6295

Maximum price

Persistent request Persistent request

Launch group

Request valid from Any time [Edit](#)

Request valid to Any time [Edit](#)

Network [Create new VPC](#)

Subnet [Create new subnet](#)

Auto-assign Public IP

Placement group Add instance to placement group

Capacity Reservation [Create new Capacity Reservation](#)

IAM role [Create new IAM role](#)

CPU options Specify CPU options

Monitoring Enable CloudWatch detailed monitoring
[Additional charges apply.](#)

EBS-optimized instance Launch as EBS-optimized instance

Elastic Inference Add an Elastic Inference accelerator
[Additional charges apply.](#)

Advanced Details

User data As text As file Input is already base64 encoded

aws_startup.bsh

Scroll

We can add our configuration script as a file under advanced details.

Launch Instance Wizard | EC2

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#LaunchInstanceWizard:ami=ami-01ad2f81030f30f31

Services Resource Groups

Andrew McNeil Ohio Support

1. Choose AMI 2. Choose Instance Type 3. Configure Instance 4. Add Storage 5. Add Tags 6. Configure Security Group 7. Review

Step 5: Tag Spot Request

A tag consists of a case-sensitive key-value pair. For example, you could define a tag with key = Name and value = Webserver. [Learn more](#) about tagging your Amazon EC2 resources.

Note that these tags will be applied to this Spot instance request and not to any instances launched to fulfill this request.

Key (128 characters maximum)	Value (256 characters maximum)
project	radiance workshop

[Add another tag](#) (Up to 50 tags maximum)

[Cancel](#) [Previous](#) [Review and Launch](#) [Next: Configure Security Group](#)

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Tagging the spot request does not tag the instance. You need to tag the instance when it launches.

Launch Instance wizard | EC2 | x

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#LaunchInstanceWizard:ami=ami-01ad2f81030f30f31

Services Resource Groups

Andrew McNeil Ohio Support

1. Choose AMI 2. Choose Instance Type 3. Configure Instance 4. Add Storage 5. Add Tags 6. Configure Security Group 7. Review

Step 6: Configure Security Group

A security group is a set of firewall rules that control the traffic for your instance. On this page, you can add rules to allow specific traffic to reach your instance. For example, if you want to set up a web server and allow Internet traffic to reach your instance, add rules that allow unrestricted access to the HTTP and HTTPS ports. You can create a new security group or select from an existing one below. [Learn more](#) about Amazon EC2 security groups.

Assign a security group: Create a new security group Select an existing security group

Security Group ID	Name	Description	Actions
<input checked="" type="checkbox"/> sg-07c3608c40753cd0d	Basic	SSH & NFS	Copy to new
<input type="checkbox"/> sg-6c47cc04	default	default VPC security group	Copy to new

Warning

Rules with source of 0.0.0.0/0 allow all IP addresses to access your instance. We recommend setting security group rules to allow access from known IP addresses only.

Inbound rules for sg-07c3608c40753cd0d (Selected security groups: sg-07c3608c40753cd0d)

Type	Protocol	Port Range	Source	Description
SSH	TCP	22	0.0.0.0/0	
SSH	TCP	22	:::0	
NFS	TCP	2049	sg-07c3608c40753cd0d (Basic)	

[Cancel](#) [Previous](#) [Review and Launch](#)

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Instances | EC2 Management Console

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#Instances:sort=instanceId

Services Resource Groups

Andrew McNeil Ohio Support

EC2 Dashboard

Events

Tags

Reports

Limits

INSTANCES

Instances

Launch Templates

Spot Requests

Reserved Instances

Dedicated Hosts

Capacity Reservations

IMAGES

AMIs

Bundle Tasks

ELASTIC BLOCK STORE

Volumes

Snapshots

Lifecycle Manager

NETWORK & SECURITY

Security Groups

Elastic IPs

Placement Groups

Key Pairs

Network Interfaces

LOAD BALANCING

Load Balancers

Target Groups

AUTO SCALING

Launch Configurations

Auto Scaling Groups

Launch Instance Connect Actions

Filter by tags and attributes or search by keyword

Name	Instance ID	Instance Type	Availability Zone	Instance State	Status Checks	Alarm Status	Public DNS (IPv4)	IPv4 Public
	i-0558a0059aa9097...	t2.micro	us-east-2b	running	2/2 checks ...	None	ec2-18-222-35-37.us-e...	18.222.35.3
	i-09f1b883f8de003e6	m5ad.4xlarge	us-east-2a	running	Initializing	None	ec2-18-217-166-239.us...	18.217.166.

Instance: i-09f1b883f8de003e6 Public DNS: ec2-18-217-166-239.us-east-2.compute.amazonaws.com

Description Status Checks Monitoring Tags

Instance ID	i-09f1b883f8de003e6	Public DNS (IPv4)	ec2-18-217-166-239.us-east-2.compute.amazonaws.com
Instance state	running	IPv4 Public IP	18.217.166.239
Instance type	m5ad.4xlarge	IPv6 IPs	-
Elastic IPs		Private DNS	ip-172-31-8-156.us-east-2.compute.internal
Availability zone	us-east-2a	Private IPs	172.31.8.156
Security groups	Basic. view inbound rules . view outbound rules	Secondary private IPs	
Scheduled events	No scheduled events	VPC ID	vpc-fe0a3097
AMI ID	Radiance (ami-01ad2f81030f30f31)	Subnet ID	subnet-4b494322
Platform	-	Network interfaces	eth0
IAM role	-	Source/dest. check	True
Key pair name	aws_ohio	T2/T3 Unlimited	-
Owner	885639356958	EBS-optimized	True
Launch time	August 11, 2019 at 12:32:45 PM UTC-7 (less than one hour)	Root device type	ebs
Termination protection	False	Root device	/dev/xvda
Lifecycle	spot	Block devices	/dev/xvda
Monitoring	basic	Elastic Graphics ID	-

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Now that the spot request is fulfilled, you should remember to tag the resulting instance.

Instances | EC2 Management Console

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#Instances:sort=instanceId

aws Services Resource Groups Andrew McNeil Ohio Support

EC2 Dashboard
Events
Tags
Reports
Limits
INSTANCES
Instances
Launch Templates
Spot Requests
Reserved Instances
Dedicated Hosts
Capacity Reservations
IMAGES
AMIs
Bundle Tasks
ELASTIC BLOCK STORE
Volumes
Snapshots
Lifecycle Manager
NETWORK & SECURITY
Security Groups
Elastic IPs
Placement Groups
Key Pairs
Network Interfaces
LOAD BALANCING
Load Balancers
Target Groups
AUTO SCALING
Launch Configurations
Auto Scaling Groups

Launch Instance Connect Actions

Filter by tags and attributes or search by keyword 1 to 2 of 2

Name	Instance ID	Instance Type	Availability Zone	Instance State	Status Checks	Alarm Status	Public DNS (IPv4)	IPv4 Public
	i-0558a0059aa9097...	t2.micro	us-east-2b	running	2/2 checks ...	None	ec2-18-222-35-37.us-e...	18.222.35.3
	i-09f1b883f8de003e6	m5ad.4xlarge	us-east-2a	running	Initializing	None	ec2-18-217-166-239.us...	18.217.166.

Instance: i-09f1b883f8de003e6 Public DNS: ec2-18-217-166-239.us-east-2.compute.amazonaws.com

Description Status Checks Monitoring Tags

Add/Edit Tags

Key	Value
This resource currently has no tags	

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Now you should remember to tag your spot fulfilled instance.

Instances | EC2 Management Console

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#Instances:sort=instanceId

Services Resource Groups

Andrew McNeil Ohio Support

EC2 Dashboard
Events
Tags
Reports
Limits
INSTANCES
Instances
Launch Templates
Spot Requests
Reserved Instances
Dedicated Hosts
Capacity Reservations
IMAGES
AMIs
Bundle Tasks
ELASTIC BLOCK STORE
Volumes
Snapshots
Lifecycle Manager
NETWORK & SECURITY
Security Groups
Elastic IPs
Placement Groups
Key Pairs
Network Interfaces
LOAD BALANCING
Load Balancers
Target Groups
AUTO SCALING
Launch Configurations
Auto Scaling Groups

Launch Instance Connect Actions

Filter by tags and attributes or search by keyword 1 to 2 of 2

Name	Instance ID	Instance Type	Availability Zone	Instance State	Status Checks	Alarm Status	Public DNS (IPv4)	IPv4 Public
	i-0558a0059aa9097...	t2.micro	us-east-2b	running	2/2 checks ...	None	ec2-18-222-35-37.us-e...	18.222.35.3
	i-09f1b883f8de003e6	m5ad.4xlarge	us-east-2a	running	Initializing	None	ec2-18-217-166-239.us...	18.217.166.

Instance: i-09f1b883f8de003e6

Description Status Checks

Add/Edit Tags

Add/Edit Tags

Apply tags to your resources to help organize and identify them.

A tag consists of a case-sensitive key-value pair. For example, you could define a tag with key = Name and value = Webserver. [Learn more](#) about tagging your Amazon EC2 resources.

Key	Value
project	radiance workshop

Create Tag Cancel Save

This resource currently has no tags

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Now you should remember to tag your spot fulfilled instance.

Instances | EC2 Management Console

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#Instances:sort=instanceId

Services Resource Groups

Andrew McNeil Ohio Support

EC2 Dashboard
Events
Tags
Reports
Limits
INSTANCES
Instances
Launch Templates
Spot Requests
Reserved Instances
Dedicated Hosts
Capacity Reservations
IMAGES
AMIs
Bundle Tasks
ELASTIC BLOCK STORE
Volumes
Snapshots
Lifecycle Manager
NETWORK & SECURITY
Security Groups
Elastic IPs
Placement Groups
Key Pairs
Network Interfaces
LOAD BALANCING
Load Balancers
Target Groups
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Launch Configurations
Auto Scaling Groups

Launch Instance Connect Actions

Filter by tags and attributes or search by keyword 1 to 2 of 2

Name	Instance ID	Instance Type	Availability Zone	Instance State	Status Checks	Alarm Status	Public DNS (IPv4)	IPv4 Public
	i-0558a0059aa9097...	t2.micro	us-east-2b	running	2/2 checks ...	None	ec2-18-222-35-37.us-e...	18.222.35.3
	i-09f1b883f8de003e6	m5ad.4xlarge	us-east-2a	running	Initializing	None	ec2-18-217-166-239.us...	18.217.166.

Instance: i-09f1b883f8de003e6 Public DNS: ec2-18-217-166-239.us-east-2.compute.amazonaws.com

Description Status Checks Monitoring Tags

Add/Edit Tags

Key	Value
project	radiance workshop

Show Column

Feedback English (US)

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Now you should remember to tag your spot fulfilled instance.

Upload model files - Mac / Linux



- scp (secure copy)
- Copies files over ssh (similar syntax to ssh)

```
scp -i aws_ohio.pem -r my_model/ ec2-user@18.222.35.37:~/efs/
```

copy this to here

-i key.pem : private key

-r : recursive (copies directories and contents)

Upload model files - Windows

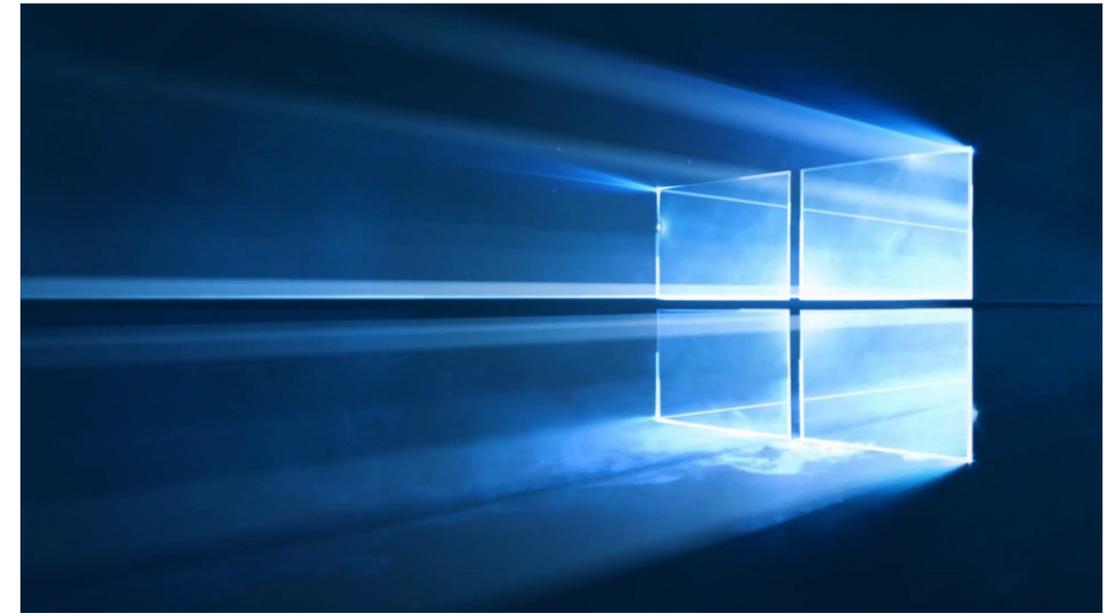
- pscp (PuTTY secure copy)
- Copies files over ssh

```
pscp -i aws_ohio.ppk -r my_model/ ec2-user@18.222.35.37:
```

copy this to here

-i key.ppk : private key

-r : recursive (copies directories and contents)



Uploading David's example files

#These commands are run locally.

upload zip files

```
scp -i ~/aws_ohio.pem 01_genBSDF.zip ec2-user@18.222.35.37:~/efs/.
```

```
scp -i ~/aws_ohio.pem example_noResults.zip ec2-user@18.222.35.37:~/efs/.
```

Start Simulation!!!!

- nohup (very important)
 - keeps a process running until it finishes, even if you log out
 - sends stdout to a file, nohup.out by default
 - to stop a process running with nohup, use ps to get the process id and kill to end it.

Running David's BSDF example

```
# unpack zip files
```

```
unzip 01_genBSDF.zip
```

```
unzip example_noResults.zip
```

```
# change permission to make scripts executable
```

```
# this can be avoided if script has 'bash myscript.sh' instead of './myscript.sh'
```

```
cd example_noResults
```

```
chmod +x *.sh scripts/*.sh
```

```
# copy cal file to current directory so script can find it
```

```
cp ../01_genBSDF/window7_2side.cal .
```

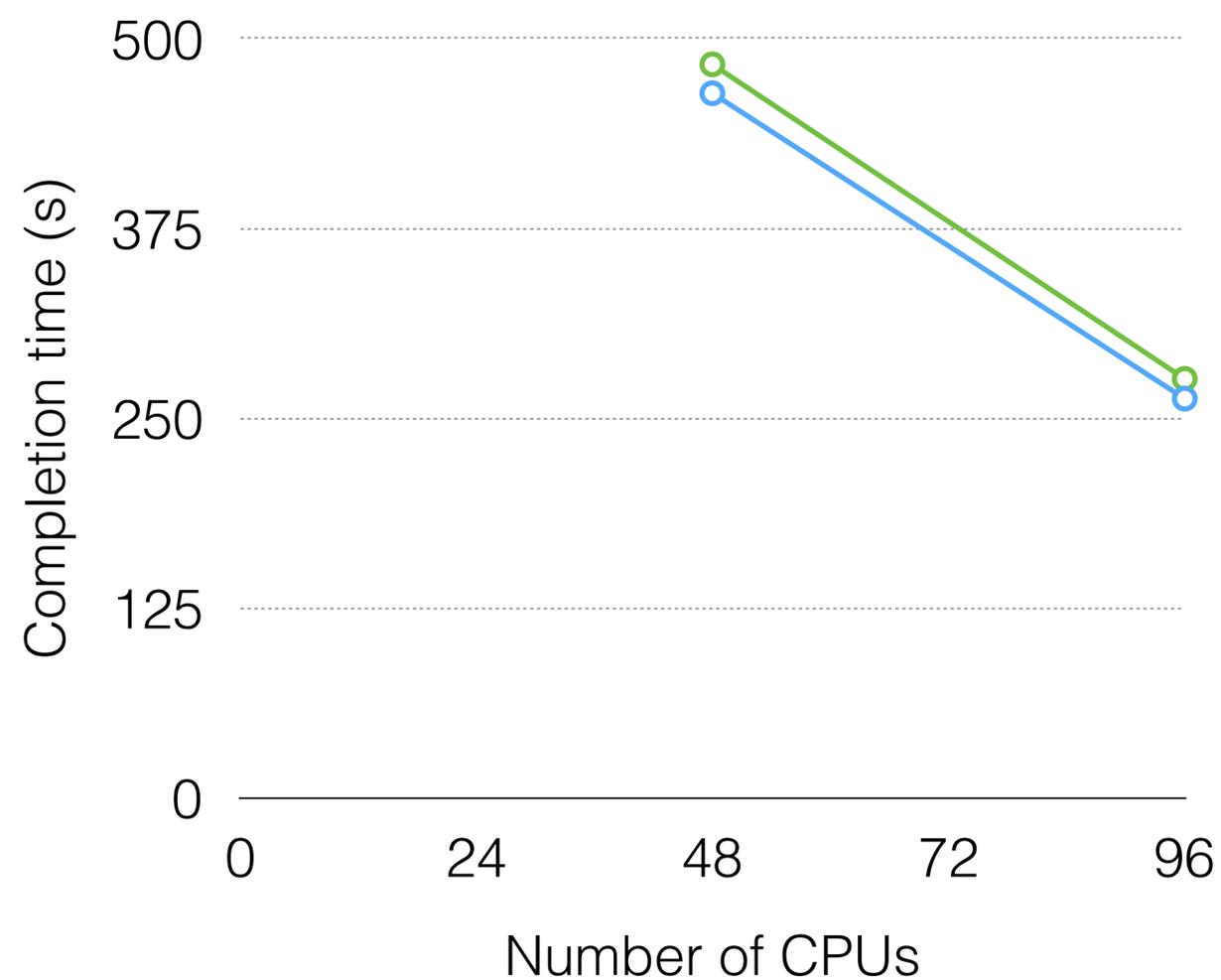
```
# run command
```

```
nohup time bash oo_all.sh &
```

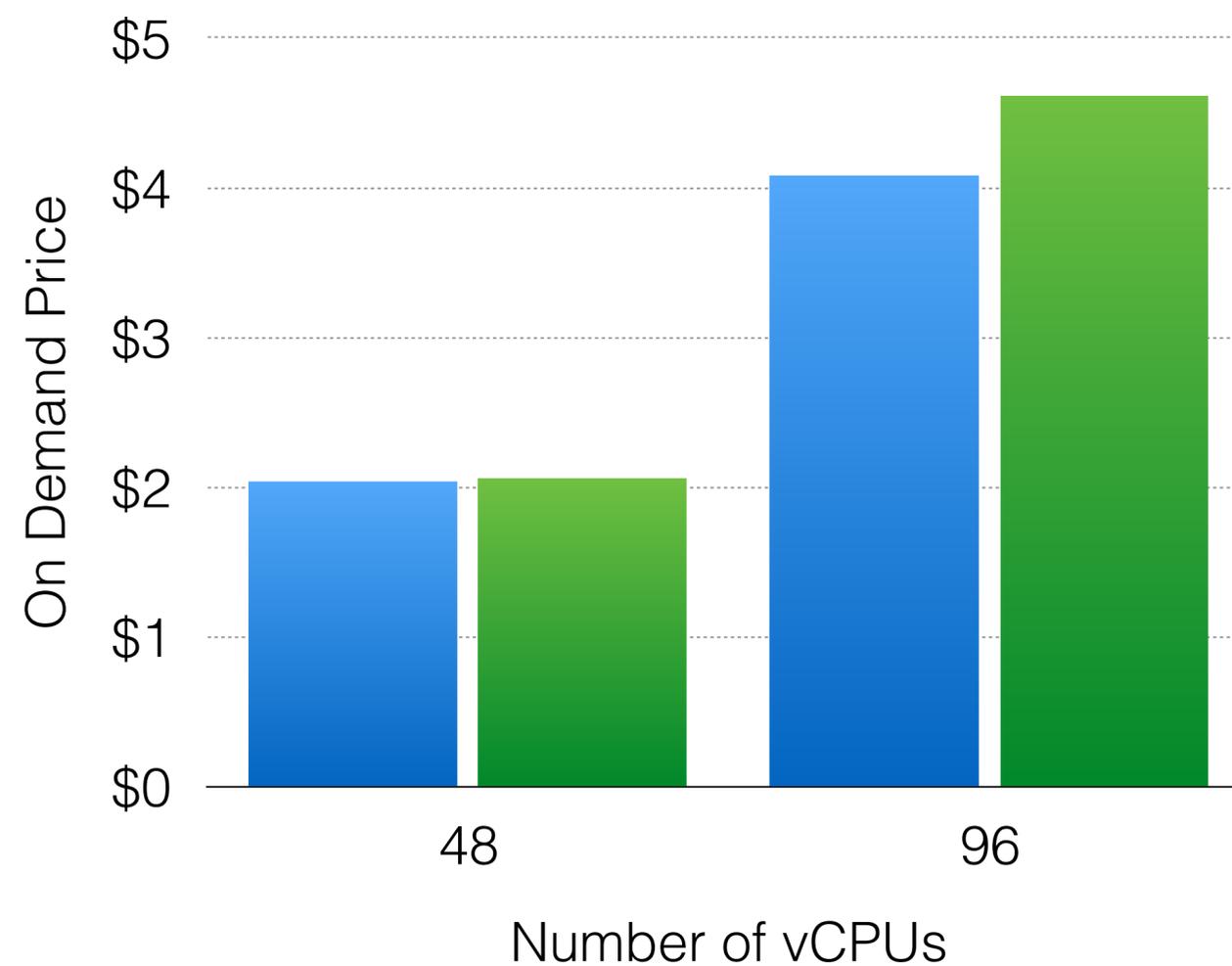
Benchmarks on David's example

Instance Type	vCPU	Physical Processor	Clock Speed	Memory (GiB)	File Storage	Time (s)	On Demand		Spot (18 Aug, 15:00)	
							Rate/hr	Cost	Rate/hr	Cost
c5.24xlarge	96	2nd Gen Xeon Platinum 8175CL	3.0 GHz	192	EBS	263	\$4.08	\$0.298	\$0.91	\$0.066
c5.24xlarge	96	2nd Gen Xeon Platinum 8175CL	3.0 GHz	192	EFS	441	\$4.08	\$0.500	\$0.91	\$0.111
m5.24xlarge	96	Intel Xeon Platinum 8175	3.1 GHz	384	EBS	276	\$4.61	\$0.354	\$0.96	\$0.074
m5d.24xlarge	96	Intel Xeon Platinum 8175	3.1 GHz	384	SSD	278	\$5.42	\$0.419	\$0.96	\$0.074
m5d.24xlarge	96	Intel Xeon Platinum 8175	3.1 GHz	384	EFS	463	\$5.42	\$0.697	\$0.96	\$0.123
c5.18xlarge	72	Intel Xeon Platinum 8124M	3 GHz	144	EBS	309	\$3.06	\$0.263	\$0.80	\$0.069
c5.18xlarge	72	Intel Xeon Platinum 8124M	3 GHz	144	EBS	501	\$3.06	\$0.426	\$0.80	\$0.111
c5.12xlarge	48	2nd Gen Xeon Platinum 8175CL	3.0 GHz	96	EBS	464	\$2.04	\$0.263	\$0.46	\$0.059
c5.12xlarge	48	2nd Gen Xeon Platinum 8175CL	3.0 GHz	96	EFS	638	\$2.04	\$0.362	\$0.46	\$0.082
m5.12xlarge	48	Intel Xeon Platinum 8175	3.1 GHz	192	EBS	483	\$2.06	\$0.276	\$0.54	\$0.072
m5.12xlarge	48	Intel Xeon Platinum 8175	3.1 GHz	192	EFS	665	\$2.06	\$0.380	\$0.54	\$0.100
c5.9xlarge	36	Intel Xeon Platinum 8124M	3 GHz	72	EBS	592	\$1.53	\$0.252	\$0.39	\$0.064
c5.9xlarge	36	Intel Xeon Platinum 8124M	3 GHz	72	EFS	774	\$1.53	\$0.329	\$0.39	\$0.084
c5.4xlarge	16	Intel Xeon Platinum 8124M	3 GHz	32	EBS	1220	\$0.68	\$0.230	\$0.15	\$0.051
c5.4xlarge	16	Intel Xeon Platinum 8124M	3 GHz	32	EFS	1415	\$0.68	\$0.267	\$0.15	\$0.059

Compute optimized instances completed the script in less time and cost less.

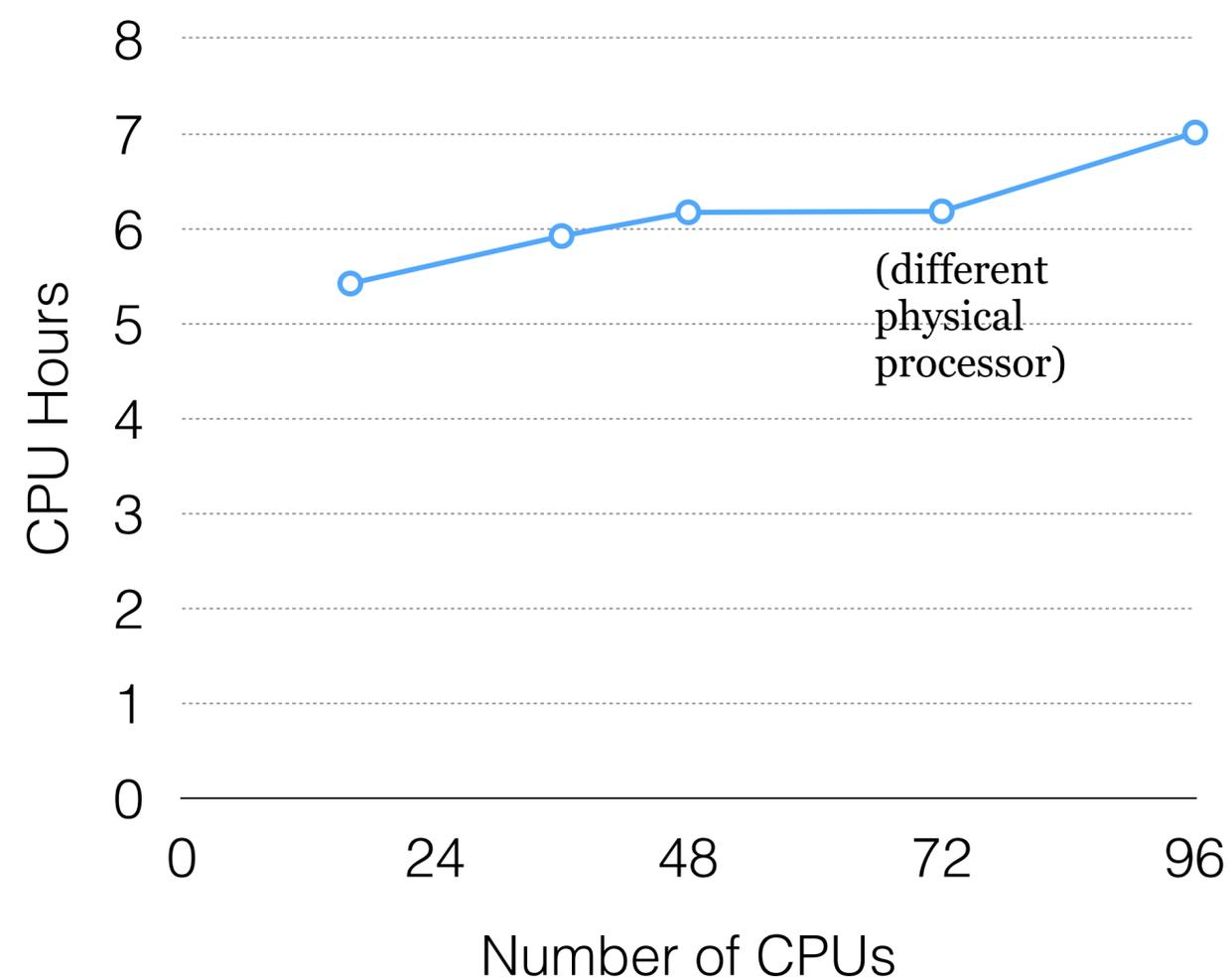
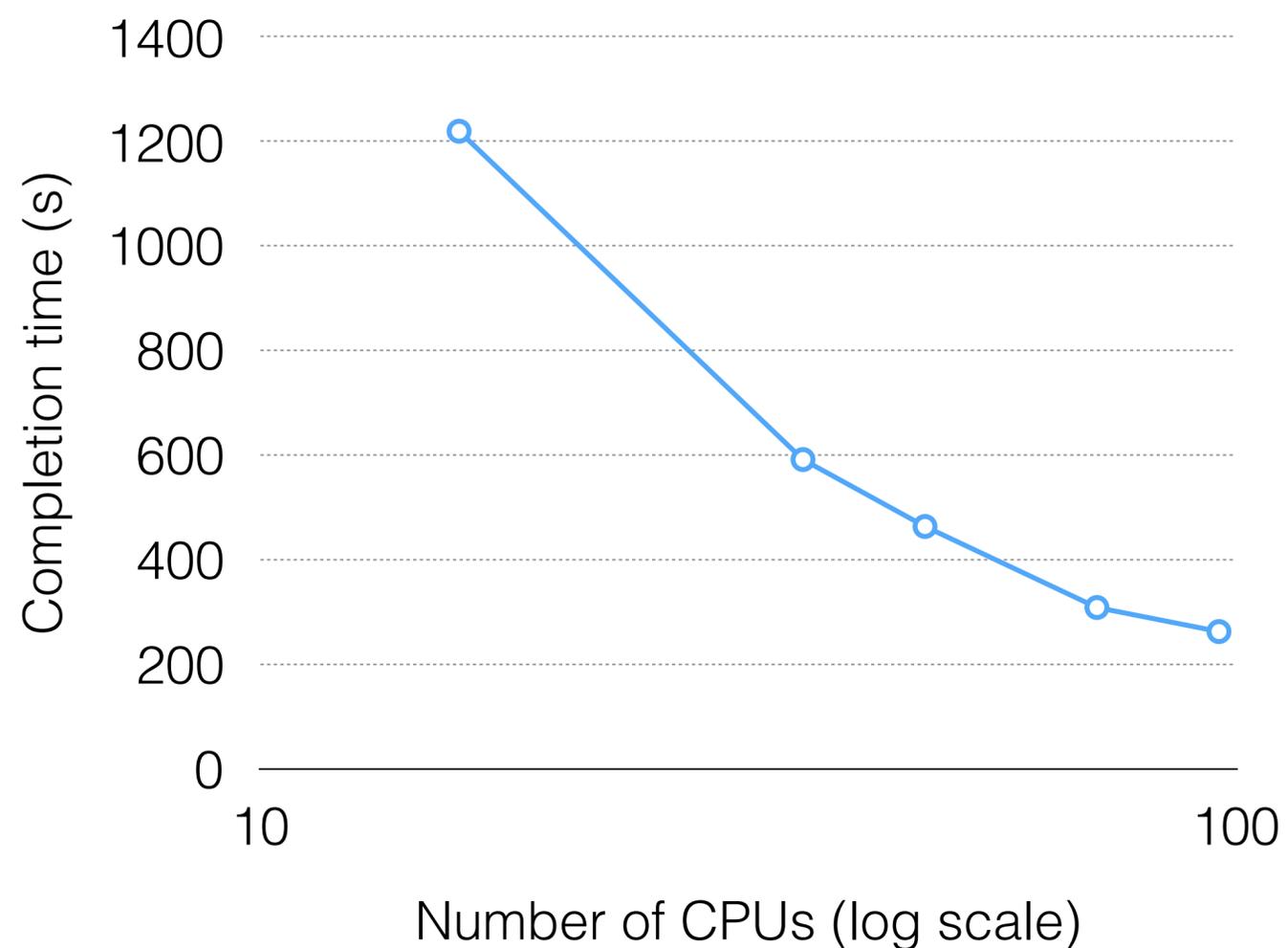


○ Compute Optimized
○ General Purpose



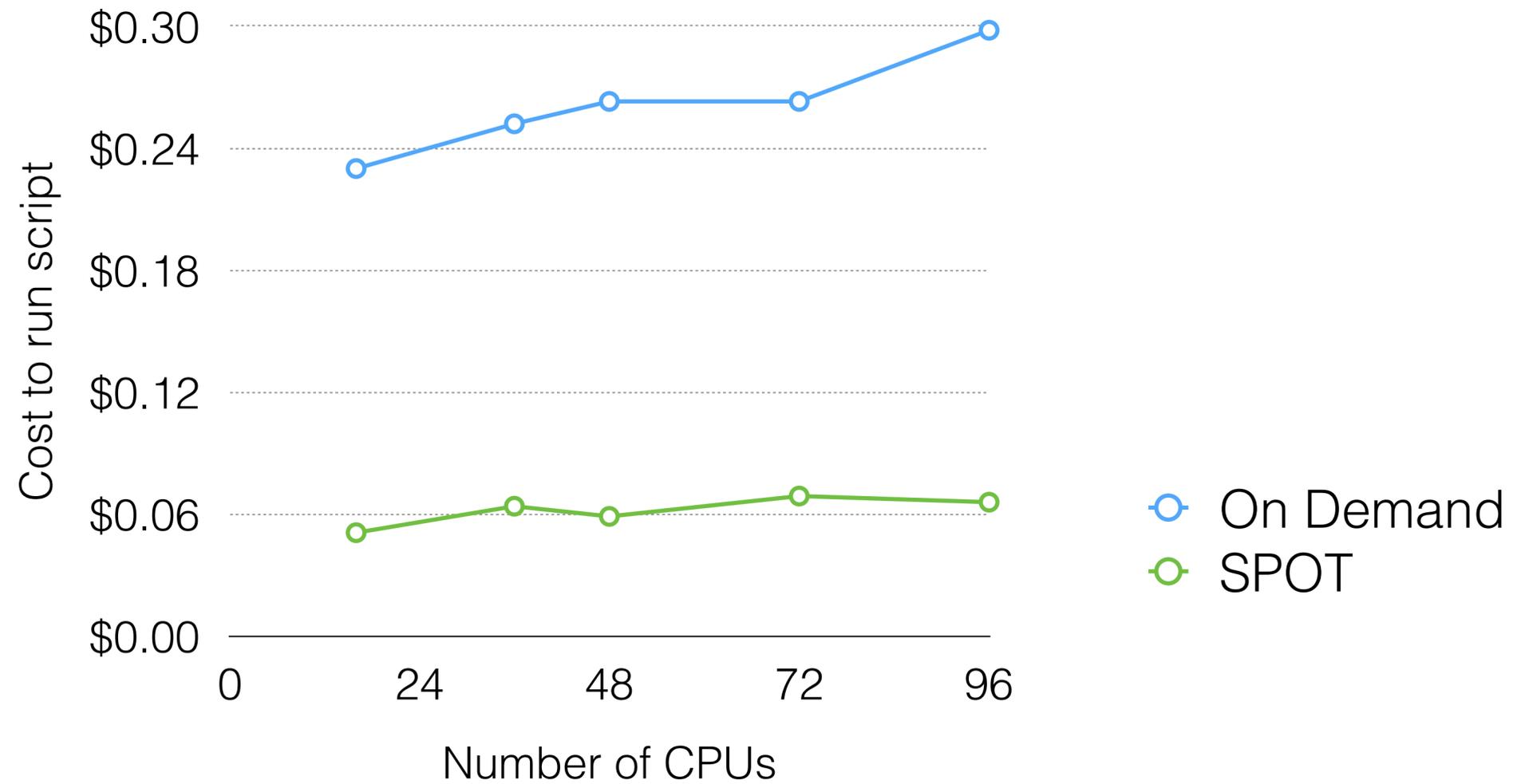
■ Compute Optimized
■ General Purpose

Increasing CPU count has diminishing returns, but for this simulation up to 96 CPUs are still effective.



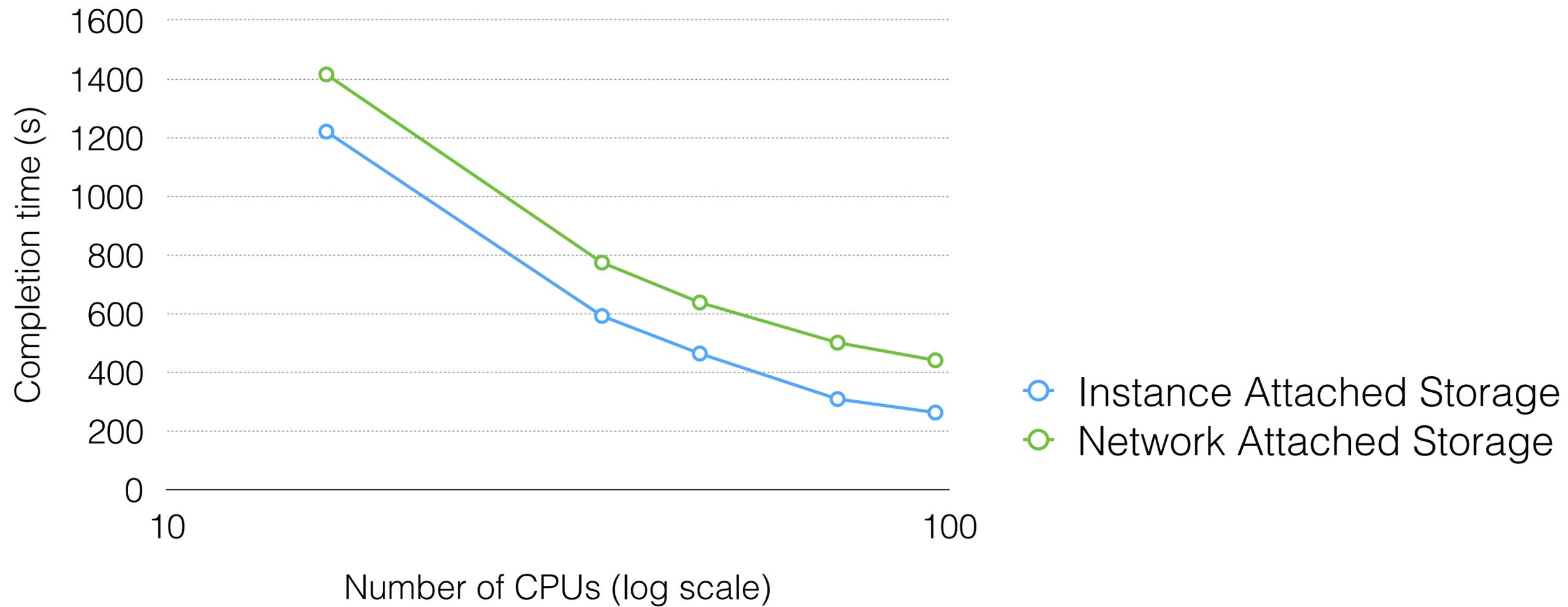
○ Compute Optimized Instances

The simulation cost increases with more vCPUs.



Cost is hourly price time simulation time. This assumes the instance is terminated immediately. Spot prices subject to variability.

Using instance attached storage (EBS) for simulation files was faster than using network attached storage (EFS)



Alarms

- Alarms take an action when the instance usage crosses a threshold.
- For example (and the only reason I use alarms):
 - Terminate the instance when the CPU is below 1% for 10 minutes
- Alarms cost \$0.10 each, though they save money by terminating idle instances (just make sure your results are on or moved to persistent storage).

Instances | EC2 Management Console

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#Instances:sort=instanceId

aws Services Resource Groups Andrew McNeil Ohio Support

EC2 Dashboard Events Tags Reports Limits INSTANCES Instances Launch Templates Spot Requests Reserved Instances Dedicated Hosts Capacity Reservations IMAGES AMIs Bundle Tasks ELASTIC BLOCK STORE Volumes Snapshots Lifecycle Manager NETWORK & SECURITY Security Groups Elastic IPs Placement Groups Key Pairs Network Interfaces LOAD BALANCING Load Balancers Target Groups AUTO SCALING Launch Configurations Auto Scaling Groups

Launch Instance Connect Actions

Filter by tags and attributes or search by keyword 1 to 3 of 3

Name	Instance ID	Instance Type	Availability Zone	Instance State	Status Checks	Alarm Status	Public DNS (IPv4)	IPv4 Public
	i-0558a0059aa9097...	t2.micro	us-east-2b	running	2/2 checks ...	None	ec2-18-222-35-37.us-e...	18.222.35.3...
	i-0884a292ab5e3d8...	t2.xlarge	us-east-2a	running	2/2 checks ...	None	ec2-13-59-13-222.us-e...	13.59.13.22...

Instance: i-0884a292ab5e3d881 Public DNS: ec2-13-59-13-222.us-east-2.compute.amazonaws.com

Description Status Checks **Monitoring** Tags

CloudWatch alarms: No alarms configured Create Alarm

CloudWatch metrics: Basic monitoring. Enable Detailed Monitoring Showing data for: Last Hour

Below are your CloudWatch metrics for the selected resources (a maximum of 10). Click on a graph to see an expanded view. All times shown are in UTC. View all CloudWatch metrics

CPU Utilization (Percent)

Disk Reads (Bytes)

Disk Read Operations (Operations)

Disk Writes (Bytes)

Disk Write Operations (Operations)

Network In (Bytes)

Network Out (Bytes)

Network Packets In (Count)

Network Packets Out (Count)

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Click on monitoring tab

Then on Create Alarm button

Instances | EC2 Management Console

https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#Instances:sort=instanceId

aws Services Resource Groups Andrew McNeil Ohio Support

EC2 Dashboard Events Tags Reports Limits INSTANCES Instances Launch Templates Spot Requests Reserved Instances Dedicated Hosts Capacity Reservations IMAGES AMIs Bundle Tasks ELASTIC BLOCK STORE Volumes Snapshots Lifecycle Manager NETWORK & SECURITY Security Groups Elastic IPs Placement Groups Key Pairs Network Interfaces LOAD BALANCING Load Balancers Target Groups AUTO SCALING Launch Configurations Auto Scaling Groups

Launch Instance Connect Actions

Filter by tags and attributes or search by keyword 1 to 3 of 3

Name	Instance ID	Instance Type	Availability Zone	Instance State	Status Checks	Alarm Status	Public DNS (IPv4)	IPv4 Public
	i-0558a0059aa9097...	t2.micro	us-east-2b	running	2/2 checks ...	None	ec2-18-222-35-37.us-e...	18.222.35.37
	i-0884a292ab5e3d8...	t2.xlarge	us-east-2a	running	2/2 checks ...	None	ec2-13-59-13-222.us-e...	13.59.13.222

Create Alarm

You can use CloudWatch alarms to be notified automatically whenever metric data reaches a level you define.

To edit an alarm, first choose whom to notify and then define when the notification should be sent.

Send a notification to: No SNS topics found...

Take the action:

- Recover this instance
- Stop this instance
- Terminate this instance
- Reboot this instance

AWS will use the existing Service Linked Role to perform this EC2 action. [Learn more.](#)

AWSServiceRoleForCloudWatchEvents (show IAM policy document)

Whenever: Average of CPU Utilization

Is: < 0.5 Percent

For at least: 3 consecutive period(s) of 5 Minutes

Name of alarm: awsec2-i-0884a292ab5e3d881-High-CPU-Utiliz

Cancel Create Alarm

Network Out (Bytes) 8,000 Network Packets In (Count) 80 Network Packets Out (Count) 80

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Alarms cost \$0.10 each.

They save money by terminating idle instances (just make sure your results are on or moved to persistent storage).

Download Results

- If you used an alarm to terminate your instance, you'll need to launch another instance to get your results.
- Use `scp` (Mac/Linux) or `pscp` (Windows) to download your result.

```
scp -i aws_ohio.pem -r ec2-user@18.222.35.37:~/efs/my_model/results/ .
```

```
pscp -i aws_ohio.ppk -r ec2-user@18.222.35.37:~/efs/my_model/results/ .
```

copy this

to here

Downloading Results

#These commands are run locally.

download results file

```
scp -i ~/aws_ohio.pem -r ec2-user@18.222.35.37:~/efs/example_noResults/result .
```

Terminate Instance

- When you're done, you terminate your instance
- *Not much else to say, this one is pretty self explanatory.*

The screenshot shows the AWS Management Console interface. At the top, the navigation bar includes the AWS logo, 'Services', 'Resource Groups', and user information for Andrew McNeil in the Ohio region. The left-hand navigation pane lists various AWS services, with 'INSTANCES' expanded to show 'Instances'. The main content area displays a table of EC2 instances. The instance with ID 'i-0fa6727b0599802de' is selected. An 'Actions' dropdown menu is open, showing options like 'Connect', 'Get Windows Password', 'Create Template From Instance', 'Launch More Like This', 'Instance State', 'Instance Settings', 'Image', 'Networking', and 'CloudWatch Monitoring'. The 'Instance State' sub-menu is also open, highlighting the 'Terminate' option. Below the instance list, the details for the selected instance are shown, including its ID, Public DNS, Instance state (running), Instance type (c5.4xlarge), Availability zone (us-east-2a), Security groups, and other configuration details.

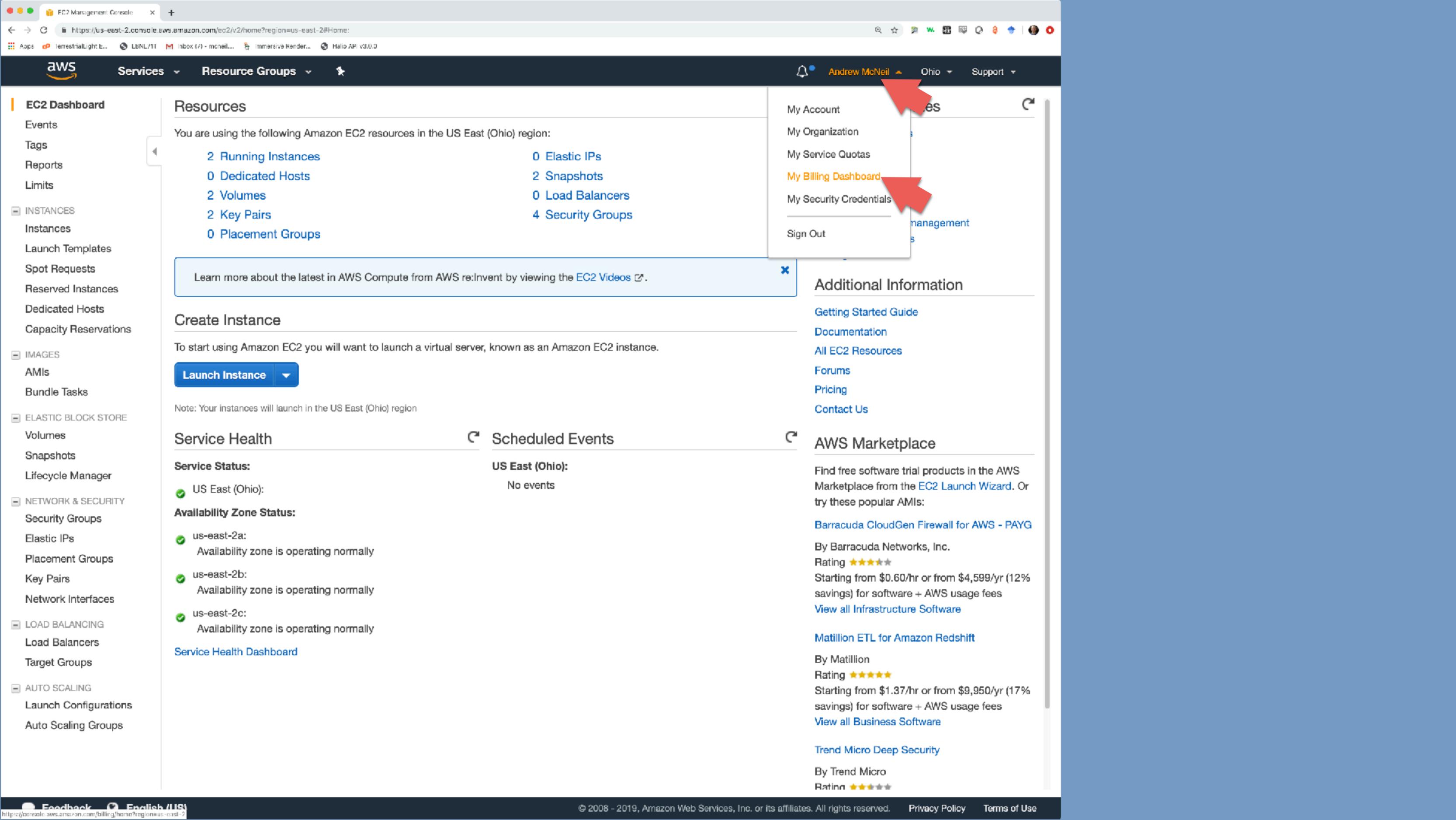
Name	Instance ID	Availability Zone	Instance State	Status Checks	Alarm Status	Public DNS (IPv4)	IPv4 Public
	i-06db84b469e3...		running	2/2 checks ...	None	ec2-18-218-51-41.us-e...	18.218.51.4
	i-0fa6727b0599802de		running	2/2 checks ...	None	ec2-3-17-176-79.us-ea...	3.17.176.79

Description	Status Checks	Monitoring	Tags
Instance ID	i-0fa6727b0599802de		
Instance state	running		
Instance type	c5.4xlarge		
Elastic IPs			
Availability zone	us-east-2a		
Security groups	Basic. view inbound rules . view outbound rules		
Scheduled events	No scheduled events		
AMI ID	RadianceWorkshop (ami-0a1c68afad094b151)		
Platform	-		
IAM role	-		
Key pair name	aws_ohio		
Owner	885639356958		
Launch time	August 18, 2019 at 6:02:55 PM UTC-7 (2 hours)		
Termination protection	False		
Lifecycle	spot		
Monitoring	basic		
Alarm status	None		
Kernel ID	-		
RAM disk ID	-		
Placement group	-		

Possibly the easiest step.

Invoice your client

- Activate tags for cost tracking
- Be diligent about tagging resources (this is the hard part)
 - Resources can NOT be tagged retroactively
- Use cost explorer to aggregate costs for each project



- EC2 Dashboard
- Events
- Tags
- Reports
- Limits
- INSTANCES
 - Instances
 - Launch Templates
 - Spot Requests
 - Reserved Instances
 - Dedicated Hosts
 - Capacity Reservations
- IMAGES
 - AMIs
 - Bundle Tasks
- ELASTIC BLOCK STORE
 - Volumes
 - Snapshots
 - Lifecycle Manager
- NETWORK & SECURITY
 - Security Groups
 - Elastic IPs
 - Placement Groups
 - Key Pairs
 - Network Interfaces
- LOAD BALANCING
 - Load Balancers
 - Target Groups
- AUTO SCALING
 - Launch Configurations
 - Auto Scaling Groups

Resources

You are using the following Amazon EC2 resources in the US East (Ohio) region:

2 Running Instances	0 Elastic IPs
0 Dedicated Hosts	2 Snapshots
2 Volumes	0 Load Balancers
2 Key Pairs	4 Security Groups
0 Placement Groups	

Learn more about the latest in AWS Compute from AWS re:Invent by viewing the [EC2 Videos](#).

Create Instance

To start using Amazon EC2 you will want to launch a virtual server, known as an Amazon EC2 instance.

[Launch Instance](#)

Note: Your instances will launch in the US East (Ohio) region

Service Health

- Service Status:**
- US East (Ohio): ✔
- Availability Zone Status:**
- us-east-2a: ✔ Availability zone is operating normally
 - us-east-2b: ✔ Availability zone is operating normally
 - us-east-2c: ✔ Availability zone is operating normally
- [Service Health Dashboard](#)

Scheduled Events

US East (Ohio):
No events

- My Account
- My Organization
- My Service Quotas
- My Billing Dashboard**
- My Security Credentials
- Sign Out

Additional Information

- [Getting Started Guide](#)
- [Documentation](#)
- [All EC2 Resources](#)
- [Forums](#)
- [Pricing](#)
- [Contact Us](#)

AWS Marketplace

- Find free software trial products in the AWS Marketplace from the [EC2 Launch Wizard](#). Or try these popular AMIs:
- [Barracuda CloudGen Firewall for AWS - PAYG](#)
By Barracuda Networks, Inc.
Rating ★★★★★
Starting from \$0.60/hr or from \$4,599/yr (12% savings) for software + AWS usage fees
[View all Infrastructure Software](#)
 - [Matillion ETL for Amazon Redshift](#)
By Matillion
Rating ★★★★★
Starting from \$1.37/hr or from \$9,950/yr (17% savings) for software + AWS usage fees
[View all Business Software](#)
 - [Trend Micro Deep Security](#)
By Trend Micro
Rating ★★★★★

aws Billing Management Console

https://console.aws.amazon.com/billing/home?region=us-east-2#

Services Resource Groups

Andrew McNeil Global Support

Home

- Cost Management
 - Cost Explorer
 - Budgets
 - Budgets Reports
 - Cost & Usage Reports
 - Cost allocation tags
- Billing
 - Bills
 - Payment history
 - Credits
 - Preferences
 - Billing preferences
 - Payment methods
 - Consolidated billing
 - Tax settings

Billing & Cost Management Dashboard

Getting Started with AWS Billing & Cost Management

- Manage your costs and usage using [AWS Budgets](#)
- Visualize your cost drivers and usage trends via [Cost Explorer](#)
- Dive deeper into your costs using the [Cost and Usage Reports](#) with [Athena integration](#)
- Learn more:** Check out the [AWS What's New webpage](#)

Do you have Reserved Instances (RIs)?

- Access the [RI Utilization & Coverage reports](#)—and RI purchase recommendations—via [Cost Explorer](#).

Month-to-Date Spend by Service

The chart below shows the proportion of costs spent for each service you use.

EC2	\$17.78
EFS	\$0.94
CloudWatch	\$0.29
DataTransfer	\$0.00
Other Services	\$0.00
Tax	\$0.00
Total	\$19.01

Spend Summary

Welcome to the AWS Billing & Cost Management console. Your last month, month-to-date, and month-end forecasted costs appear below.

Current month-to-date balance for August 2019

\$19.01

Period	Cost
Last Month (July 2019)	\$8.32
Month-to-Date (August 2019)	\$19.01
Forecast (August 2019)	\$26.41

Top Free Tier Services by Usage

View all

Click cost allocation tags

aws Billing Management Console

https://console.aws.amazon.com/billing/home?region=us-east-2#/preferences/tags

Services Resource Groups

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Home

- Cost Management
- Cost Explorer
- Budgets
- Budgets Reports
- Cost & Usage Reports
- Cost allocation tags**
- Billing
- Bills
- Payment history
- Credits
- Preferences
- Billing preferences
- Payment methods
- Consolidated billing
- Tax settings

Cost Allocation Tags

AWS-Generated Cost Allocation Tags

A *resource created by tag* is an AWS-generated cost allocation tag containing resource creator information that is automatically applied to the resources that you create. This feature is only available in the Billing & Cost Management console, and will not appear anywhere else in the AWS console, including the Tag Editor.

Activate

User-Defined Cost Allocation Tags

✔ Finished loading tags.

Activating tags for cost allocation tells AWS that the associated cost data for these tags should be made available throughout the billing pipeline. Once activated, cost allocation tags can be used as a dimension of grouping and filtering in Cost Explorer, as well as for refining AWS budget criteria.

Activate **Deactivate** **Undo**

Filter: All Search for a tag key... Tags per page: 100

<input type="checkbox"/>	Tag key*	Status
<input checked="" type="checkbox"/>	project	Active
<input type="checkbox"/>		Inactive
<input type="checkbox"/>	Project	Inactive
<input type="checkbox"/>	aws:ec2spot:fleet-request-id	Inactive

Select the tag(s) to track for cost allocations

Activate them

aws Billing Management Console

https://console.aws.amazon.com/billing/home?region=us-east-2#

Services Resource Groups

Andrew McNeil Global Support

Home

- Cost Management
 - Cost Explorer
 - Budgets
 - Budgets Reports
 - Cost & Usage Reports
 - Cost allocation tags
- Billing
 - Bills
 - Payment history
 - Credits
 - Preferences
 - Billing preferences
 - Payment methods
 - Consolidated billing
 - Tax settings

Billing & Cost Management Dashboard

Getting Started with AWS Billing & Cost Management

- Manage your costs and usage using [AWS Budgets](#)
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Do you have Reserved Instances (RIs)?

- Access the [RI Utilization & Coverage reports](#)—and RI purchase recommendations—via [Cost Explorer](#).

Month-to-Date Spend by Service [Bill Details](#)

The chart below shows the proportion of costs spent for each service you use.

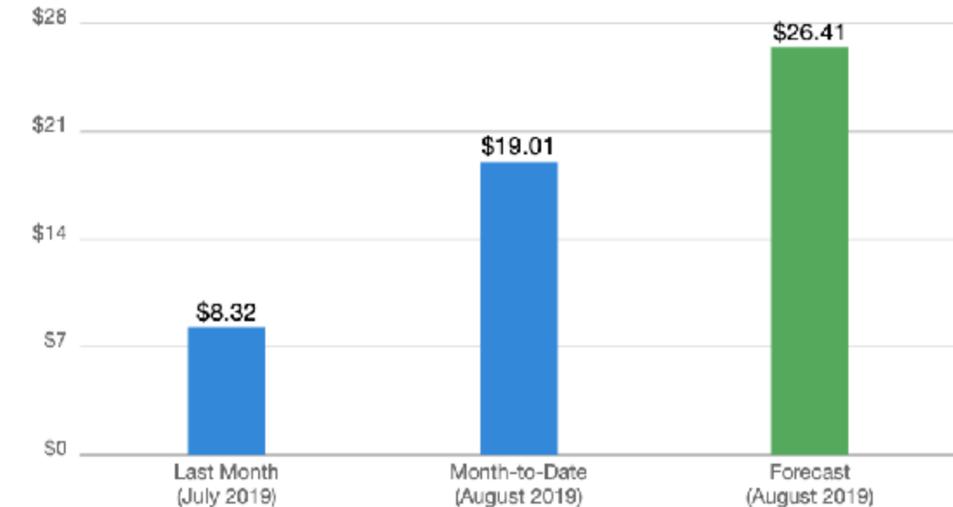


Spend Summary [Cost Explorer](#)

Welcome to the AWS Billing & Cost Management console. Your last month, month-to-date, and month-end forecasted costs appear below.

Current month-to-date balance for August 2019

\$19.01



Period	Cost
Last Month (July 2019)	\$8.32
Month-to-Date (August 2019)	\$19.01
Forecast (August 2019)	\$26.41

EC2	\$17.78
EFS	\$0.94
CloudWatch	\$0.29
DataTransfer	\$0.00
Other Services	\$0.00
Tax	\$0.00
Total	\$19.01

► Important Information about these Costs

Top Free Tier Services by Usage [View all](#)

Click cost explorer button

Cost Reports

https://console.aws.amazon.com/cost-reports/home#/dashboard

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AWS Cost Management

Month-to-date costs

\$18.99

↑ 330%
Over last month

Forecasted month end costs

\$42.26

↑ 408%
Over last month

Daily unblended costs (\$) [Explore costs](#)

August trends

Service usage

- [Amazon Elastic Compute Cloud - Compute costs are up \\$14.00 \(623%\)](#)
- [AmazonCloudWatch costs are up \\$0.01 \(5%\)](#)

Account usage

- [Andrew McNeil \(885639356958\) costs are up \\$14.58 \(330%\)](#)

Region usage

- [us-west-2 costs are up \\$3.95 \(89%\)](#)

Recently accessed reports [View all reports](#)

Report name	Report type	Time granularity	Last accessed
Daily costs	Cost & Usage	Daily	5 days ago

Viewing 1 of 7 total reports

Click explore costs

Cost Reports

https://console.aws.amazon.com/cost-reports/home#/custom?groupBy=None&hasBlended=false&hasAmortized=false&excludeDiscounts=true&excludeTaggedResources=false&timeRangeOption=Last14Days&granularity=Daily&reportNa...

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AWS Cost Management > Cost Explorer: Cost & Usage

What's New Advanced options, such as excluding refunds and credits, have been moved to the new 'Charge Type' filter. [Learn more.](#) **DISMISS**

Save as... Reports New report

Last 14 Days Daily Bar

Group by: None Service Linked Account Region Instance Type Usage Type Tag API Operation More

Costs (\$)

To see usage data, filter by "Usage Type" or "Usage Type Group" filters with matching units (e.g., hours).

Download CSV

	5*	Aug-16*	Aug-17*	Aug-18*	Total
Total cost (\$)	30	0.30	0.30	0.27	2.31

*Charges for your current billing period shown on these reports are estimated charges. Estimated charges shown on this page, or shown on any notifications that we send to you, may differ from your actual charges for this statement period. This is because estimated charges presented on this page do not include usage charges accrued during this statement period after the date you view this page. One-time fees and subscription charges are assessed separately from usage and recurring charges, on the date that they occur.

**Forecasted charges are estimated based on your historical charges and may differ from your actual charges for the forecast period. Forecasted charges are provided solely for your convenience and do not take into account changes to your use of services after the date on which you view this page.

All charges and prices are in US dollars.

FILTERS CLEAR ALL

- Service [Include all](#)
- Linked Account [Include all](#)
- Region [Include all](#)
- Instance Type [Include all](#)
- Usage Type [Include all](#)
- Usage Type Group [Include all](#)
- Tag
 - project** [Include only](#)
 - radlance workshop x 1
- API Operation [Include all](#)
- Charge Type [Exclude only](#)
 - Refund x
 - Credit x 2
- Availability Zone [Include all](#)
- Platform [Include all](#)
- Purchase Option [Include all](#)
- Tenancy [Include all](#)
- Database Engine [Include all](#)
- Legal Entity [Include all](#)
- Billing Entity [Include all](#)

You can filter by many attributes, including tags.

And you can download a CSV.

Bask in the glory!



Andy's Cloud College

THIS DIPLOMA IS PRESENTED TO

You

For Clouding Along During the Cloud Course

21 August 2019

