Real-ESSI Simulator

Cloud Computing Manual

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Chapter 1

Cloud Computing

(2017-2018-)

(In collaboration with Dr. Yuan Feng and Dr. Han Yang)

1.1 Chapter Summary and Highlights

Described in this chapter are details of accessing and using Real-ESSI Simulator using remote computers, the so called "cloud" computational resources. Current focus is on using Amazon Web Services (AWS) computers.

1.2 Real-ESSI Cloud Computing Overview

Cloud computing refers to the accessing and computing over the Internet rather than on local computers. Cloud computing is a model for enabling on-demand access to a shared pool of configurable computing resources, which can be setup and released rapidly.¹

Using Real-ESSI Cloud Service, users can get computing instances on demand without requiring a lot of maintenance and financial resources a common, local parallel computer, cluster would require. In addition, users do not need to go through the installation of the dependent libraries, source-code compilation and the installation of other related software, for example preprocessing and post-processing environment. The complete Real-ESSI Simulator system is pre-configured and built within the image such that Real-ESSI Simulator system is portable over the cloud. A stable, release version of Real-ESSI is built and can be used anywhere and anytime.

There are two ways to obtain a Real-ESSI image on Amazon Web Services (AWS):

- Obtain a Real-ESSI private image from Prof. Boris Jeremić, see Section 1.3.1 on page 7.
- Use a public image of Real-ESSI on AWS marketplace, as described in Section 1.3.2 on page 19.

After a Real-ESSI image is launched, a Real-ESSI EC2 instance is generated on AWS. The instance can be accessed through a X2GO client. The procedures are written in Section 1.4 on page 19.

When the simulation on the Real-ESSi instance is finished and all the output result files are fetched, remember to terminate the running instance so that AWS would not keep charging you. Section 1.5 on page 22 describes how to terminate a running Real-ESSI instance. See Section 1.8 on page 25 for more information about the cost of AWS cloud computing services.

1.2.1 Real-ESSI Cloud Service Content

One image is built for a single-machine setup, which contains

- Ubuntu 16.04 LTS Desktop and X2GO Server
- Real-ESSI sequential program

¹This is an excerpt from Jeremić et al. (1989-2025)

- Real-ESSI parallel program
- Real-ESSI 3C seismic motion developments (SW4)
- Real-ESSI pre-processing (gmESSI)
- Real-ESSI post-processing (PVESSIReader)
- Real-ESSI Editor, Sublime plug-ins
- Real-ESSI Documentation
- Real-ESSI Examples

1.3 Launch Real-ESSI Instance on AWS

A Real-ESSI instance can be launched either from the private image with authorization of Prof. Boris Jeremić or from the public image on AWS market place.

1.3.1 Launch Real-ESSI Instance from AWS Private Images

Follow the steps below to launch instances from Real-ESSI Private Image.

1. Create an AWS account.

AWS is the most widely used cloud service provider. If you do not have one, creating an AWS account is easy. You can create an AWS account through their website https://aws.amazon.com/. After you login, you can see the services on AWS Console Home as follows.



Figure 1.1: AWS Console Home.

2. Request the Real-ESSI image.

Real-ESSI image is currently a private Amazon Machine Images (AMI). After you get the 12-digit AWS account ID, email the AWS account ID to Prof. Boris Jeremić to obtain the Real-ESSI image. From AWS Console Home, go to Services \rightarrow EC2

Services A Resource Gr	oups 🗸 🏌		♪ oliver	▼ N. California ▼ Support ▼
History Console Home	ind a service by name or feature (for ex	ample, EC2, S3 or VM, storage).		Group A-Z
EC2 IAM Billing	Compute	Developer Tools	Analytics Athena EMR CloudSearch Elasticsearch Service Kinesis Data Pipeline QuickSight AWS Glue	Application Services Step Functions SWF API Gateway Elastic Transcoder Messaging Simple Queue Service Simple Notification Service Simple Email Service
	EFS Glacier Storage Gateway Database RDS	CloudFormation CloudTrail Config OpsWorks Service Catalog Trusted Advisor Managed Services	Artificial intelligence Lex Amazon Polly Rekognition Machine Learning	Business Productivity WorkDocs WorkMail Amazon Chime
	DynamoDB ElastiCache Amazon Redshift	Security, Identity & Compliance	AWS IoT AWS Greengrass	Desktop & App Streaming WorkSpaces AppStream 2.0
6 0 0	 Networking & Content Delivery VPC CloudFront 	IAM Inspector Certificate Manager Directory Service WAF & Shield	Contact Center Amazon Connect Game Development	
	Direct Connect Route 53	Artifact 🔤	Amazon GameLift	

Figure 1.2: AWS Services.

From EC2 Dashboard, go to AMIs to check the Real-ESSI image.



Figure 1.3: AWS EC2 Dashboard AMIs.

If users cannot find the Real-ESSI image, please make sure you are in the same AWS region with Prof. Boris Jeremić, the region is shown in the top-right corner on EC2 dashboard. The current Real-ESSI AMIs region are in both North California and Oregon. 3. Launch the Real-ESSI image.

	🎁 Services 🗸	Re	source	e Groups 👻 🔭 🛠				↓ oliver	✓ N. California	Support	¥
	EC2 Dashboard Events Tags	•	Laur	Actions 👻	Filter by tags and a	ttributes or search by	keyword			- ⊖ ∲ 3 of 3 >	? >I
	Reports Limits		d	Owned by me Public images	•	AMI Name 🔺	AMI ID 🔹	Source •	Owner -	Visibility	•
-	INSTANCES			Private images	m	compute-node essi-ecosystem	ami-7fe4cc1f ami-82e5cde2	855433193553/c 855433193553/	855433193553 855433193553	Private Private	
	Instances Spot Requests			empty desktop		Ubuntu-Desktop	ami-9ba38afb	855433193553/	855433193553	Private	
	Reserved Instances Dedicated Hosts										
= 	IMAGES AMIs Bundle Tasks										
	ELASTIC BLOCK STORE Volumes Snapshots										

Figure 1.4: AWS EC2 Private AMIs.

Follow the steps below to launch instances from the Real-ESSI image.

(a) Choose AMI.

	🎁 Services 🗸	Re	source	e Groups 👻 🛛 🛠				↓ oliver	r 👻 N. California 🕙	 Support 	•
	EC2 Dashboard	•	Laur	nch Actions 👻					Region	ତ 🕸	0
	Tags		Pri	vate images 👻 🔍 🛛	Filter by tags and a	ttributes or search b	y keyword		Ø K < 1 to	3 of 3 🔿	>
	Reports	L		Image Type	-	AMI Name 🔺	AMI ID 🔹	Source -	Owner -	Visibility	
	INSTANCES			essi-latest-parallel		compute-node	ami-7fe4cc1f	855433193553/c	855433193553	Private	
	Instances			essi-latest-ecosystem	ı	essi-ecosystem	ami-82e5cde2	855433193553/	855433193553	Private	
	Spot Requests	L		empty desktop		Ubuntu-Desktop	ami-9ba38afb	855433193553/	855433193553	Private	
	Reserved Instances										
	Dedicated Hosts										
-	IMAGES										
1	AMIs										
	Bundle Tasks	L									
-	ELASTIC BLOCK STORE	Ŀ									
	Snapshots										

Figure 1.5: EC2 Launch Steps: Choose AMI.

(b) Choose Instance Type

From AMIs, users can launch any number and type of instances and choose the desired EC2 configurations. In order to have the best experiences, the compute-optimized instances (C4, C5 as the latest one, as of early 2019) are recommended.

Û	Services 🗸 Reso	ource Groups 🗸	*			Ĺ oliv	rer 👻 N. California 👻	Support 👻
1. Ch	2. Choose Instan	ice Type 3. Con	figure Instance	4. Add Storage	5. Add Tags 6. Config	ure Security Group 7. R	leview	
Ste Amaz combi about	D 2: Choose an I on EC2 provides a wide sele nations of CPU, memory, st instance types and how the	nstance Ty ection of instance orage, and netwo ey can meet your o	ype types optimized rking capacity, an computing needs	to fit different use Id give you the flex	cases. Instances are vir kibility to choose the app	tual servers that can run ropriate mix of resource	applications. They have s for your applications.	e varying Learn more
Filter	All instance types	✓ Current	t generation 👻	Show/Hide Co	lumns			
Curr	ently selected: t2.micro (Va	ariable ECUs, 1 vC	PUs, 2.5 GHz, Inte	el Xeon Family, 1 G	GiB memory, EBS only)			
	Family -	Туре –	vCPUs (i) -	Memory (GiB)	Instance Storage (GB) (i) *	EBS-Optimized Available (i)	Network Performance (j)	IPv6 Support ▼ (j)
	General purpose	t2.nano	1	0.5	EBS only	-	Low to Moderate	Yes
	General purpose	t2.micro Free tier eligible	1	1	EBS only	-	Low to Moderate	Yes
	General purpose	t2.small	1	2	EBS only	-	Low to Moderate	Yes
	General purpose	t2.medium	2	4	EBS only	-	Low to Moderate	Yes
	General purpose	t2.large	2	8	EBS only	-	Low to Moderate	Yes
	General purpose	t2.xlarge	4	16	EBS only	-	Moderate	Yes
	General purpose	t2.2xlarge	8	32	EBS only	-	Moderate	Yes
	General purpose	m4.large	2	8	EBS only	Yes	Moderate	Yes
					Cancel Provious	Poview and Launch	Next: Configure Inc	tance Details

Figure 1.6: EC2 Launch Steps: Choose Instance Type.

(c) Configure Instance

tep 3: Configure Instar onfigure the instance to suit your requir access management role to the instar	ements nce, and	etails You can launch multiple instances from the same AMI, request Spot instances to take advantage of the lower pricing, assi more.
Number of instances	i	1 Launch into Auto Scaling Group 👔
Purchasing option		Request Spot instances
Network	i	vpc-535d3437 (default) C Create new VPC
Subnet	i	No preference (default subnet in any Availability Zone Create new subnet
Auto-assign Public IP	()	Use subnet setting (Enable)
IAM role	()	None C Create new IAM role
Shutdown behavior	i	Stop •
Enable termination protection	()	Protect against accidental termination
Monitoring	()	Enable CloudWatch detailed monitoring Additional charges apply.
Tenancy	()	Shared - Run a shared hardware instance Additional charges will apply for dedicated tenancy.
Advanced Details		

Figure 1.7: EC2 Launch Steps: Configure Instance.

(d) Add Storage

1. Choose Instance Type 3. Configure Instance 4. Add Storage 5. Add Tags 6. Configure Security Group 7. Review Step 4: Add Storage Step 4: Add Storage Gour instance Type Blaunched 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 (i) Size (GIB) (i) Volume Type (i) IOPS (i) Throughput (MB/s) (i) Delete on Termination (i) Encrypted Root /dev/sda1 Snap- 083ee962668b0be97 30 General Purpose St (i) 100 / 3000 N/A Not Encrypted Add New Volume Interview Interview Interview Interview Interview
Step 4: Add Storage Gover instance will be launched with the following storage device settings. You can attach additional EBS volumes and instance store volumes to your instance, or dit 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 torage options in Amazon EC2. Volume Type Device Snapshot ① Size (GiB) ① Volume Type ① IOPS ① Throughput (MB/s) ① Delete on Termination ② toot /dev/sda1 snap- 083ee962668b0be97 30 General Purpose S(*) 100 / 3000 N/A Not Encrypted
Volume Type Device Snapshot ① Size (GB) ① Volume Type ① IOPS ① Throughput (MB/s) ① Delete on Termination ② Encrypted ① toot /dev/sda1 snap- 083ee962668b0be97 30 General Purpose S(*) 100 / 3000 N/A Image: Comparison of the
toot /dev/sda1 snap- 083ee962668b0be97 30 General Purpose St ▼ 100 / 3000 N/A
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.

Figure 1.8: EC2 Launch Steps: Add Storage.

Review and Launch Next: Add Tags

Cancel Previous

(e) Add Tags

🧊 Services 🗸 Resource Groups 🖌 🔭		Ą	oliver 👻 N. California 👻 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: Add Tags A tag consists of a case-sensitive key-value pair. For example, you co 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	could define a tag with key = Nam t tagging your Amazon EC2 reso	e and value = Webserver. urces.	
Key (127 characters maximum)	Value (255 characters max	imum)	Instances () Volumes ()
	This resource currently has no	tags	
Choose t Make sure yo	the Add tag button or click to ad our IAM policy includes permissi	d a Name tag. ions to create tags.	
Add Tag (Up to 50 tags maximum)			
	Cancel	Previous Review and La	unch Next: Configure Security Group

Figure 1.9: EC2 Launch Steps: Add Tags.

(f) Configure Security Group.

Please keep the default Security Group setting.

(g) Review

You may be asked to create a key-pair for later access of the instance you created. The key-pair can be reused later if you created other instances. Besides, the key-pair is portable across other machines. Last but not least, the key-pair cannot be recreated after you launch the instance, so please make sure you save the key-pair in a safe place.

🧊 🛛 Services 🗸	Resource	Groups 👻	*					û ∣ oliver	• N	. California 👻	Support 👻
I. Choose AMI 2. Choo	se Instance Type	e 3. Confi	gure Instance 4.	. Add Storage	5. Add Tags	6. Config	gure Security Gro	up 7. Rev	view		
tep 7: Review	Instance	e Launc	h								
A Improve yo Your instances addresses onl You can also o Edit security g	ur instance s may be acces y. pen additional roups	s' security ssible from a l ports in you	y. Your securit any IP address. We ur security group to	e recommend	c-server, is c that you update cess to the appl	ppen to t your secu ication or	the world. urity group rule service you're	es to allow a	ccess fro	om known IP (80) for web s	servers.
AMI Details											Edit AMI
Root Device	Type: ebs Virtu	vCPUs	wm Memory (GiB)	Instance	: Storage (GB)	EB	S-Optimized A	vailable	Ne	Edit in:	stance type
t2.micro	Variable	1	1	EBS only	,	-			Lo	w to Modera	te
Security Groups										Edit secu	urity groups
Security Group ID			Name				Descriptio	on			
sg-adcf35cb			vnc-server				open ports f	or vnc-view	er		
All selected security	groups inbour	nd rules									
									Canc	Previou	us Launch

Figure 1.10: EC2 Launch Steps: Review.

4. Check the launched instances

After the launch, you can view the running instance through EC2 <code>Dashboard</code> \rightarrow <code>Instances</code>

	🧊 Services 🗸	Resource Groups 👻 🛛 🏠	🗘 oliver 🕶 N. California. 🕶 Support 👻
	EC2 Dashboard	Launch Instance Connect Actions ∨	÷ • 0
	Tags	Q. Filter by tags and attributes or search by keyword	
	Reports	Name - Instance ID - Instance Type - Availability Zone - Instance State - Status Check	s 👻 Public DNS (IPv4) 👻 IPv4 Public IP 👻
	Limits	i-051f8df1f5a8b8819 t2.micro us-west-1c Orunning 2/2 checks	s ec2-50-18-192-135.us 50.18.192.135
. 8	INSTANCES	compute and i.024a6e7aebae70e c3.2x1arrae useweet.1c estopped	
	Instances	L04952cc41d226750d c22darae Uswaet1c etopped	
	Spot Requests	i 0720064603069417b c2 9dargo us west to consider the stopped	
	Reserved Instances	i 099991ad8frd02040 t2 migro us wort 1a topped	-
	Dedicated Hosts		
	IMAGES	essinalesi roceousoricuoziui cicialita esperiente usivesita espere	· · · · · · · · · · · · · · · · · · ·
	AMIs	i-deocaid8/e/311102 c3.2xiarge ds-west-ic Stopped	•
	Bundle Tasks		
R	ELASTIC BLOCK STORE		
	Volumes		
	Snapshots		
	NETWORK & SECURITY		
6	Security Groups	• 	Þ
	Flastic IPs	Instance: i-051f8df1f5a8b8819 Elastic IP: 50.18.192.135	
	Placement Groups	Description Charles Manifestion Teac	
	Key Pairs	Description Status checks Monitoring Tags	
	Network Interfaces	Instance ID i-051f8df1f5a8b8819 Public DNS (IPv4) e	ec2-50-18-192-135.us-west- 1.compute.amazonaws.com
	LOAD BALANCING	Instance state running IPv4 Public IP	50.18.192.135
	Load Balancers	Instance type t2.micro IPv6 IPs -	
	Target Groups	Elastic IPs 50.18.192.135* Private DNS i	p-172-31-11-121.us-west- 1.compute.internal

Figure 1.11: EC2 Running Instances.

You can login to your instances either by ssh or by using X2GO client 1.4. Please note that every time when you restart the instances, the public IP address will change.

5. Fix Public IP Address (Optional)

The public IP address of Real-ESSI instances change for each reboot. If users want to have a fixed public IP address for every login, users can allocate one elastic IP address and associate the IP address to a Real-ESSI instance such that users can have a fixed public IP address for each login.

6. Attach more Storage (Optional)

The Real-ESSI Image holds 30GB Hard disk and already uses 15GB. In the case of a real large simulations, this size hard drive might not be enough for the full output. Users can attach more storage through elastic block store.

1.3.2 Launch Real-ESSI Instance from AWS Market Place

This section gives a quick start guide for using Real-ESSI on AWS market place.

Real-ESSI Simulator system (pre processing, main Real-ESSI program, post processing) is available on Amazon Web Services MarketPlace. Point your web browser to the Amazon Web Services Market Place, and search for "Real ESSI", "Real-ESSI" or "MS ESSI".

In summary, a quick guide to launching an instance from AWS Market Place is:

- Go to the ESSI Cloud Product Page.
- Click **Continue** to go to Launch ESSI from the Cloud.
- Click Manual Launch (use 1-Click Launch, if comfortable with settings).
- Click Launch from the EC2 Console for your preferred region.
- Select your **preferred instance** from the table, e.g. t2.micro.
- Click Review and Launch.

1.4 Connect to Real-ESSI Instance on AWS

1.4.1 Install X2GO Client

Before connecting to the Real-ESSI cloud, users should install the client-side of X2GO. X2Go is a remote desktop software that can visualize the launched Real-ESSI instance. Installation of X2GO for different operating systems is fairly straightforward, and users can find installation instructions on their own or follow installation instructions below.

Installing X2GO client on Ubuntu Linux

User can directly install X2GO client by using debian install utility, to install x2goclient.

Installing X2GO client on Apple Mac

Users can download the package through this link: http://code.x2go.org/releases/X2GoClient_latest_ macosx_10_9.dmg.

Installing X2GO client on Windows

Users can download the package through this link: http://code.x2go.org/releases/X2GoClient_latest_ mswin32-setup.exe.

Installing X2GO client on other operating systems

If you are using a different operating system, please refer to X2GO website for the installation. The X2GO website for client installation is https://wiki.x2go.org/doku.php/download:start

1.4.2 Configure the Client-Side of X2GO

For all operating systems, users will see the same session when they open the x2goclient new-session, as shown in Fig. 1.12.

Session	Connection	Input/Output	Media	Shared :	folders						
Session nam	e: your_ses	sion_name 🗲	- 10-	1. Se	essic	n I	Nar	me			
÷) « ch	ange icon									
Path: /											
Server			2	A \ A/C		۰.	مىرا				
Host:	34. 208. 157.	2	- 2.	AWS		100	re	SS			
Login:	ubuntu		- 3.	AWS	5 Use	er ľ	Var	ne			
SSH port:	22										
Use RSA/D	SA key for s	sh connection:	D:/cloud_	essi/aws_a	ccount. per	-		- 4.	AV	VS s	sh-k
📝 Try au	to login (vi	a SSH Agent or	default SS	H key)		5. (Che	eck	au	to-l	ogin
🔲 Kerber	os 5 (GSSAPI) authenticatio	n								-0
📃 Delega	tion of GSSA	PI credentials	to the ser	ver							
Use Pr	oxy server f	or SSH connecti	on								
Session t	ype										
XFCE		← 6). Gh	ange	e to	XF	CE				
				-							

Figure 1.12: Configuration of X2GO client.

- 1. Users can name their own session.
- 2. AWS IP address is to be copied from EC2 management console, from the description TAB of launched instance, at the bottom of the page. This is IPv4 Public IP... it goes into Host: ...
- 3. AWS User Name is "ubuntu".
- 4. AWS ssh-key is the one saved from before, in .ssh directory
- 5. Please check the auto-login.
- 6. Please change the session type to XFCE.
- 7. Click OK to finish the configuration.

In addition to the Desktop login, users can also use ssh to login the Real-ESSI Terminal.

```
1 chmod 400 your_ssh_key.pem
2 ssh -i your_ssh_key.pem ubuntu@your_AWS_public_IP_address
```

1.4.3 Connect to the Launched Instance

Click the configured session to connect to the ESSI instance. You should see a virtual desktop pop up on your local machine, as shown in Fig. 1.13. Now you have successfully connected to the Real-ESSI Simulator instance on AWS. You can now use Real-ESSI Simulator within the virtual desktop.



Figure 1.13: Connected to the already launched Real-ESSI instance.

1.5 Terminate Real-ESSI Instance on AWS

Once the Real-ESSI simulation on AWS is finished, the user can transfer output files to the local local computer, or leave them on AWS, preferably on cheap S3 storage Section 1.8 on page 25 provides detailed description of storage and transfer options and costs. **NOTE:** Users need to terminate the running Real -ESSI instance on AWS to avoid additional charges. The terminate operation is done on AWS console that is the same place where you launch the Real-ESSI instance. As shown Fig. 1.14, following steps are required:

- 1. Click 'Instances' from the sidebar to see all your running instances on AWS.
- 2. Choose the instance you want to terminate.
- 3. Click 'Actions'.
- 4. Click 'Instance State'

5. Click 'Terminate'

aws Services - Reso	ource Groups 👻 🔸			۵	hexiang_Wang @ 8189-6	978-1869 🔻 Oreg	on 🗸	Support	•	
EC2 Dashboard	stance - Connect	Actions A	_				Δ	Ð	\$?
Tags Q Filter t	y tags and attributes or sea	Connect				0 K	< 1 to 2	2 of 2	> >	
Reports Reports Imits INSTANCES Instances Launch Templates Spot Requests Reserved Instances Dedicated Hosts Scheduled Instances Capacity Reservations IMAGES	i-046422817 i-046422817 i-02227a53d	Get Windows Password Create Template From Instance Launch More Like This Instance State Instance Settings Image Networking CloudWatch Monitoring	ability Zone Instance Start Instance Stop Stop Boot Reboot Terminate	State - Stat	tus Checks ~	Alarm Status None is None is	Public ec2-34-	DNS (IP)	v4) -172.us	·
AMIs										
Bundle Tasks			0	0.0						•
ELASTIC BLOCK STORE Instance:	i-02227a53dad698417	Public DNS: ec2-34-218-224-1	72.us-west-2.compute.am	azonaws.com						Î
Snapshots Descripti	on Status Checks	Monitoring Tags								l
Lifecycle Manager	Instance ID	i-02227a53dad698417		Public DNS (IPv4)	ec2-34-218-224-172.us 2.compute.amazonaws	-west- s.com				
	Instance state	running		IPv4 Public IP	34.218.224.172					
Electic De	Instance type	t2.micro		IPv6 IPs	-					
Elastic IPS	Elastic IPs	ue weet 2e		Private DNS	ip-172-31-29-63.us-wes	st-2.compute.internal				
Placement Groups	Security groups	launch-wizard-22 view inbound rule	es view outbound	Secondary private IPs	172.31.29.03					
Key Pairs	Geounty groups	rules	to, new outbound	Secondary private ins						
Network Interfaces	Scheduled events	No scheduled events		VPC ID	vpc-c3030ca5					
	AMLID	Doal-ESSI ClobalDoloaco 18 12 (ami	-	Subpot ID	subpot-f6s7f200					-

Figure 1.14: Terminate a Real-ESSI Simulator instance.

1.6 Adding Permission for Private Real-ESSI Image to User AWS Accounts

login to AWS

sign in to console

go to image in a region, say N, California

then go to EC2

go to AMIs on left side

select image to be shared

go to Actions

go to Modify Image Permissons and put user account number then click Add Permission and then Save...

24 of <mark>63</mark>

1.7 Real-ESSI Instructional Videos Cloud Computing

This section presents few short instructional videos about how to use Real ESSI on Amazon Web Services (AWS) computers.

1.7.1 Installing X2GO for Windows

Youtube instructional video.

1.7.2 Installing X2GO for Macintosh

Youtube instructional video.

1.7.3 Installing X2GO for Linux

Youtube instructional video.

1.7.4 Launch AWS Marketplace

Youtube instructional video.

1.7.5 Access Running Instance on AWS

Youtube instructional video.

1.7.6 Start Real-ESSI Program on AWS

Youtube instructional video.

1.7.7 Run Real-ESSI Example Model on AWS

Youtube instructional video.

1.7.8 Visualize Real-ESSI Example Model on AWS

Youtube instructional video.

1.7.9 Post-Process, Visualize Real-ESSI Results on AWS

Youtube instructional video.

1.8 Cost of AWS EC2

The cost breakdown for using Real-ESSI on AWS (EC2) is:

• AWS computer cost

There are 3 ways to pay for AWS computer cost (EC2 instances)

- On-Demand instance, offers a real, instant pay-per-use model. On-Demand instance is sold at a fixed price, and AWS computer availability is guaranteed (within the limits of the service-level agreement). Running Real-ESSI On-Demand Instance: User prepares simulation runs, and then can simulate problems at hand immediately.
- Spot instance, uses spare AWS computers that users can bid for. Prices for those spot instances fluctuate based on the supply and demand of available AWS computers. When a user makes a bid for a Spot instance, a spot instance is launched when the bid exceeds the current Spot market price, and continues until terminated by the user. The user is charged the Spot market price, not the bid price while the instance runs. Spot instances can offer substantial savings over On-Demand instances, as shown in the AWS Spot Bid Advisor. Running Real-ESSI using Spot instance: User can prepare simulation runs, and then bid on computer hardware and run simulations at later time, when cost is acceptable.
- Reserved instance, uses spare AWS computers during scheduled, later time as determined by AWS and reserved by the user. Running Real-ESSI using Reserved Instance: User prepares simulation runs, and then reserves AWS computer to simulate problem at hand at predetermined/reserved time.

• AWS data storage cost

Input data/files and output data/files are stored using:

- Amazon Elastic Block Store (EBS), attached to a AWS computer (EC2 instance) during simulation run. Storage cost is charged by the size of storage in GB per month, pro-rated to the hour, until the storage is released. The cost of EBS is typically \$0.10 per GB per month. When running Real-ESSI program on AWS computer, the storage is used during simulation, while the data (input and output) is transferred out of the AWS computer, to other type of storage that is less expensive (the so called S3 storage, see below), or to user's desktop computer, before AWS computer/instance is terminated and storage released.
- Amazon Simple Storage Service (S3), offers better value for longer term data storage. S3 pricing varies by region and frequency of access. Cost of S3 storage is typically between \$0.0125 are \$0.03 per GB per month.

 Amazon Glacier, provides storage at an even lower cost of \$0.007 per GB per month for data archiving.

• AWS data transfer cost

Data transfer charges are listed as part of the On-Demand EC2 pricing. Transfer is typically charged at \$0.09 per GB beyond the first 1GB of data and up to the first 1TB of a given month. After the first TB, price drops down.

• Real-ESSI program cost

Use of Real-ESSI for educational purposes is free. For commercial use of Real-ESSI, please contact Prof. Jeremić or one of the commercial companies that offer access to Real-ESSI on AWS.

1.8.1 Cost of Running Real-ESSI on AWS

Small Size Real-ESSI Example

Imposed Motion Real-ESSI modeling and simulation on AWS summary:

- DOFs in the Model: 5,000
- Number of Time Step: 210
- Running Time: 30 Second
- Disk Space: 25 MB.
- Recommended Machine: Free Instance Amazon EC2 t2.micro

The Real-ESSI input files for this example are available HERE. The compressed package of input files is HERE.

The Modeling parameters are listed below

- Elastic Material Properties
 - Mass density, ρ , 2000 kg/m^3
 - Shear wave velocity, V_s , 500 m/s
 - Young's modulus, E, 1.1 GPa
 - Poisson's ratio, ν , 0.1

The thickness of the shell structure is 2 meters. The simulation model is shown below. The simulation results:

The time series of simulation results is shown in Fig. 1.17.

The response spectrum of motion is shown in Fig. 1.18.



Figure 1.15: Simulation Model.



Figure 1.16: Simulation Results.



Figure 1.17: Simulation Results: Acceleration Time Series with 1C imposed motion.



Figure 1.18: Simulation Results: Response Spectrum of Structure Top with 1C imposed motion.

Eigen Analysis Real-ESSI modeling and simulation on AWS summary:

- DOFs in the Model: 5,000
- Number of Eigenmodes: 10
- Running Time: 3 Second
- Disk Space: 25 MB.
- Recommended Machine: Free Instance Amazon EC2 t2.micro

The Real-ESSI input files for this example are available HERE. The compressed package of input files is HERE.

The thickness of the shell structure is 2 meters. The simulation model is shown below.



Figure 1.19: Simulation Model.

The eigen results:



Figure 1.20: Eigen Results (Eigen Mode 1 to 3 from left to right).



Figure 1.21: Eigen Results (Eigen Mode 4 to 6 from left to right).

Medium Size Real-ESSI Example

Elastic Material The compressed package of input files is available HERE. Real-ESSI modeling and simulation on AWS summary:

- DOFs in the Model: 132,000
- Number of Time Steps: 210
- Running Time: 10 minutes
- Disk Space: 3GB
- Recommended Machine: Amazon EC2 c4.2xlarge instance 8 cores.
- Estimated Bill in AWS Region Oregon/Ohio/Northern Virginia:
 - For simulation time: 0.398 * 10/60 = 0.07
 - For General Purpose (SSD) Storage: 0.1 * 3 = 0.3 (monthly)
 - For S3 Storage: 0.023 * 3 = 0.069 (monthly)

The Modeling parameters are listed below

- Elastic Material Properties
 - Mass density, ho, 2000 kg/m^3
 - Shear wave velocity, V_s , 500 m/s
 - Young's modulus, E, 1.1 GPa
 - Poisson's ratio, ν , 0.1

The illustration results of the simulation is shown in Fig. 1.23. It is noted that outside the DRM layer, there are no outgoing waves.

- **von-Mises Armstrong-Frederick Material** The compressed package of input files is available HERE. Real-ESSI modeling and simulation on AWS summary:
 - DOFs in the Model: 132,000
 - Number of Time Steps: 210
 - Running Time: 46 minutes



Figure 1.22: Simulation Model.





- Disk Space: 3GB
- Recommended Machine: Amazon EC2 c4.2xlarge instance 8 cores.
- Estimated Bill in AWS Region Oregon/Ohio/Northern Virginia:
 - For simulation time: 0.398 * 46/60 = 0.31
 - For General Purpose (SSD) Storage: 0.1 * 3 = 0.3 (monthly)
 - For S3 Storage: 0.023 * 3 = 0.069 (monthly)

The Modeling parameters are listed below

- von-Mises nonlinear hardening material model
 - Mass density, ρ , 2000 kg/m^3
 - Shear wave velocity, V_s , 500 m/s
 - Young's modulus, *E*, 1.1 GPa
 - Poisson's ratio, ν , 0.1
 - von Mises radius, k, 60 kPa
 - Nonlinear kinematic hardening, H_a , 30 MPa
 - Nonlinear kinematic hardening, C_r , 60
 - Shear strength ($\approx \sqrt{2/3} H_a/C_r$), S_u , 408 kPa
 - Isotropic hardening rate, K_{iso} , 0 Pa

SIMULATION TIME: With 8 cores on AWS EC2 c4.2xlarge instance, the running time for this example is 46 minutes.

Large Example

Elastic Simulation The Real-ESSI input files for this example are available HERE. The compressed package of Real-ESSI input files for this example is available HERE.

Real-ESSI modeling and simulation on AWS summary:

- DOFs in the Model: 210,000
- Number of Time Steps: 2065
- Running Time: 17 hours
- Disk Space: 45GB
- Recommended Machine: Amazon EC2 c4.8xlarge instance 36 cores.
- Estimated Bill in AWS Region Oregon/Ohio/Northern Virginia:
 - For simulation time: \$1.591 * 17 = \$27.05
 - For General Purpose (SSD) Storage: \$0.1 * 45 = \$4.5 (monthly)
 - For S3 Storage: 0.023 * 45 = 1.035 (monthly)
 - For Network Bandwidth if transfer: 0.09 * 45 = 4.05

SIMULATION TIME: With 32 cores on AWS EC2 c4.8xlarge instance, the running time for this example is 17 hours.



Figure 1.24: Simulation Model.

The Modeling parameters are listed below

• Soil

- Unit weight, γ , 21.4 kPa
- Shear velocity, Vs, 500 m/s
- Young's modulus, E, 1.3 GPa
- Poisson's ratio, ν , 0.25
- Shear strength, S_u , 650 kPa
- von Mises radius, k, 60 kPa
- kinematic hardening, H_a , 30 MPa
- kinematic hardening, C_r , 25
- Structure
 - Unit weight, γ , 24 kPa
 - Young's modulus, E, 20 GPa
 - Poisson's ratio, ν , 0.21

The input motion is a 3C wave from SW4.

Inelastic Simulation The Real-ESSI input files for this example are available HERE. The compressed package of Real-ESSI input files for this example is available HERE.

Real-ESSI modeling and simulation on AWS summary:

- DOFs in the Model: 210,000
- Number of Time Steps: 2065
- Running Time: 30 hours
- Disk Space: 45GB
- Recommended Machine: Amazon EC2 c4.8xlarge instance 36 cores.
- Estimated Bill in AWS Region Oregon/Ohio/Northern Virginia:
 - For simulation time: \$1.591 * 30 = \$47.73
 - For General Purpose (SSD) Storage: \$0.1 * 45 = \$4.5 (monthly)
 - For S3 Storage: 0.023 * 45 = 1.035 (monthly)
 - For Network Bandwidth if transfer: 0.09 * 45 = 4.05

SIMULATION TIME: With 32 cores on AWS EC2 c4.8xlarge instance, the running time for this example is 30 hours.

The Modeling parameters are listed below

- Soil
 - Unit weight, γ , 21.4 kPa
 - Shear velocity, Vs, 500 m/s
 - Young's modulus, *E*, 1.3 GPa
 - Poisson's ratio, ν , 0.25
 - Shear strength, S_u , 650 kPa
 - von Mises radius, k, 60 kPa
 - kinematic hardening, H_a , 30 MPa
 - kinematic hardening, C_r , 25
- Structure
 - Unit weight, γ , 24 kPa

- Young's modulus, *E*, 20 GPa
- Poisson's ratio, ν , 0.21
- Contact
 - Initial axial stiffness, k_n^{init} , 1e9 N/m
 - Stiffening rate, S_r , 1000 /m
 - Maximum axial stiffness, k_n^{max} , 1e12 N/m
 - Shear stiffness, k_t , 1e7 N/m
 - Axial viscous damping, C_n , 100 $N \cdot s/m$
 - Shear viscous damping, C_t , 100 $N\cdot s/m$
 - Friction ratio, μ , 0.25



Figure 1.25: Simulation Model.

1.8.2 Real-ESSI AWS Manual, April 2023

Real-ESSI AWS manual developed for the Real-ESSI Short Course, in March, April 2023, is provided below.

1. Summary and Highlights

This chapter describes details of accessing and using Real-ESSI Simulator using remote computers, the so-called "cloud" computational resources. The current focus is on using Amazon Web Services (AWS) computers.

Note: If you have a local Ubuntu desktop, you may download and install the Debian package for Real-ESSI. The procedures are documented in <u>Real-ESSI Simulator System Procurement</u> <u>Procedures</u>.

2. Real-ESSI Cloud Computing Overview

Cloud computing refers to the accessing and computing over the Internet rather than on local computers. Cloud computing is a model for enabling on-demand access to a shared pool of configurable computing resources, which can be setup and released rapidly.¹

Using Real-ESSI Cloud Service, users can get computing instances on demand without requiring a lot of maintenance and financial resources a common, local parallel computer cluster would require. In addition, users do not need to go through the installation of the dependent libraries, source-code compilation and the installation of other related software, for example preprocessing and post-processing environments. The complete Real-ESSI Simulator system is pre-configured and built within the image such that the Real-ESSI Simulator system is portable over the cloud. A stable, release version of Real-ESSI is built and can be used anywhere and anytime.



The suggested workflow for Real-ESSI cloud computing using AWS is shown above. The recommended workflow is a client-server style workflow, the most efficient and economical way to perform cloud computing. First, a local Ubuntu desktop (AWS Workspaces is a good

¹ This is an excerpt from <u>Jeremic et al. (1989-2023)</u>

substitute if you don't have a local Ubuntu desktop) is used to prepare input files, receive output files, and post-processing simulation results. Then, an AWS EC2 instance is used to conduct high-performance parallel computation from the Real-ESSI simulation. We will introduce detailed procedures in the following chapters.

3. Create AWS Account

3.1 AWS account types

There are two types of accounts on AWS, the Root user and the IAM user, each with unique credentials.

- The root user in Amazon Web Services (AWS) is the initial administrative user created when creating an AWS account. The root user has full access to all AWS services, financials, and resources in the account and can perform any action on them. It is highly recommended to avoid using the root user account for regular day-to-day operations in AWS due to security reasons.
- On the other hand, an IAM (Identity and Access Management) user is a user account that is
 created within your AWS account, separate from the root account. IAM users have a set of
 permissions that are defined by an AWS administrator (or yourself) to limit what actions they
 can perform in AWS. This allows you to grant specific permissions to users or groups of
 users without giving them full access to the AWS account.

IAM users can be created with unique usernames and credentials, and their permissions can be managed separately from the root user. This provides better security and allows you to grant different levels of access to different users or groups, based on their roles and responsibilities.

If you're a first-time user of AWS, your first step is to sign up for a Root user AWS account. When you sign up, AWS creates an AWS account with the details you provide and assigns the account to you. We also suggest activating multi-factor authentication (MFA) for the root user and assigning administrative access to a user. You can find complete documentation on AWS Account Management <u>here</u>.

3.2 Create a root user account

- To create your AWS account, open the <u>AWS home page</u> in your browser and choose **Create** an **AWS account**.
- Supply your email, then the code sent to your email address.

	Sign up for AWS
Explore Free Tier products with a new AWS account.	Root user email address Used for account recovery and some administrative functions
T	
	AWS account name Choose a name for your account. You can change this name in your account settings after you sign up.
	Verify email address
	OR
	Sign in to an existing AWS account

- Create a root user password. •
- Provide contact information. •
- Provide billing information. •
- Confirm your identity. ٠
- Select a support plan. The Basic support Free option is enough for using Real-ESSI. •
- Select Complete sign up •

Initial setups for your new AWS account 3.3

- Sign into your root account. •
- Switch your region to US West (Oregon). Your region is located near the top right corner of • your webpage.

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	U U		information to get the most out of A	Asia Pacific (Osaka)	ap-northeast-3	
	No recently vi	sited services	Training and certification	Asia Pacific (Seoul)	ap-northeast-2	
	Explore one of these comm	Learn from AWS experts and advance skills and knowledge.	Asia Pacific (Singapore)	ap-southeast-1		
	IAM EC2 S3 RDS Lambda			Asia Pacific (Sydney)	ap-southeast-2	
			What's new with AWS? 🖸	Asia Pacific (Tokyo)	ap-northeast-1	
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				Asia Pacific (Jakarta)	ap-southeast-3	
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 Search and select services for quick access later. In this manual, we will use several different AWS services. We can find them and add them to favorites. Go to the search bar near the top left of your webpage and search for the services we need. Click on the star symbol next to the service name to add it to your favorites. The service should appear near the top of your webpage for future quick access.

aws	Services	Q workspaces	×			ð þ	0	regon 🔻 🛛 Dr	HanYang 🔻
1 Works	paces								
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			Convert existing Amazon WorkSpaces to the WorkSpace Protocol without a rebuild [2] By: Andrew Morgan Date: January 18, 2023	es Streaming					
			Amazon WorkSpaces Introduces Ubuntu Desktops 🗗 By: Sébastien Stormacg 📋 Date: September 29, 2022	Cost	Management				
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The services we need are Workspaces and EC2.

4. Amazon Workspaces

If you already have and want to use your own local Ubuntu desktop, skip this chapter.

Summary: This chapter presents setting up, launching, and connecting to your Amazon Workspace. Note that Amazon Workspace is used as a substitute for local Ubuntu desktops.

Amazon WorkSpaces enables you to provision virtual, cloud-based Microsoft Windows, Amazon Linux, or Ubuntu Linux desktops, known as *WorkSpaces*. WorkSpaces eliminates the need to purchase and set up your own Ubuntu desktop. Instead, users can access their virtual desktops from multiple devices or web browsers. Complete documentation regarding Amazon Workspaces can be found <u>here</u>.

4.1 WorkSpaces quick setup

This tutorial uses the **Quick Setup** option to launch your WorkSpace. This option is available only if you have never launched a WorkSpace. Alternatively, for the full documentation see <u>here</u>.

Step 1: Launch the WorkSpace

- Open the WorkSpaces console at <u>https://console.aws.amazon.com/workspaces/</u>.
- Choose **Quick setup**. If you don't see this button, either you have already launched a WorkSpace in this Region, or you aren't using one of the <u>Regions that support Quick Setup</u>. In this case, see <u>Launch a virtual desktop using WorkSpaces</u>.

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Web Portals Documentation	How it works		Quick setup				
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			Pricing options				
	Benefits and features		Pay a fixed monthly fee per WorkSpace, or an hourly rate per WorkSpace.				
	Functionality Amazon WorkSpaces offers you an easy wat to provide a concurr machanel clearly	Streaming protocols Amazon WorkSpaces utilizes streaming controller to consider users a cocura and	Learn more about WorkSpaces Pricing 🖬				
	based virtual desktop experience to your end-users.	high quality experience.	Getting started				
	Amazon WorkSpaces Bundles	Bring Your Own Licenses	What is Amazon WorkSpaces?				
	To get started, select from a choice of Amazon WorkSpaces bundles that offer	You can bring your existing Windows 10 Desktop licenses to Amazon WorkSpaces	Getting started with WorkSpaces				
0	different hardware and software options,	and run them on hardware that is					

• For Create Users, enter the Username, First Name, Last Name, and Email. Then choose Next. Note that you can enter multiple users here, but this doesn't mean they can use the same Workspace. Instead, multiple Workspaces will be created, one for each user.

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WorkSpaces ×	WorkSpaces > WorkSpaces > Get Sta	arted							٩
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IP Access Controls	Select sundle	Users							
Account Settings WorkSpaces Web Web Portals Documentation	Step 3 Review	Username Music contain algherumeric and/or mummitic characteru. Create additional user Visu can add 4 more users.	First name Must contain dipharametic and/or nameric characters.	Last name Most contain alphanumeric and/or numeric characters.	Email Must be a valid email address.	Remove			
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• For **Bundles**, select a bundle (hardware and software) for the user with the appropriate protocol (PCoIP or WSP). For Real-ESSI cloud computing, choose PowerPro with Ubuntu 22.04 with the WSP protocol. You can find this bundle by its ID wsb-8w32qplfk.

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- Review your information. Then choose Create WorkSpace.
- It takes approximately 20 minutes, up to 40 minutes, for your WorkSpace to be created. When the launch is complete, the status is AVAILABLE and an invitation is sent to the email address that you specified for each user. If the users don't receive their invitation emails, see <u>Send an invitation email</u>.

Step 2: Connect to the WorkSpace

After you receive the invitation email, you can connect to the WorkSpace using the client of your choice. After you sign in, the client displays the WorkSpace desktop.

- If you haven't set up credentials for the user already, open the link in the invitation email and follow the directions. Remember the password that you specify as you will need it to connect to your WorkSpace.
- When prompted, download one of the client applications or launch **Web Access**. If you aren't prompted and you haven't installed a client application already, open https://clients.amazonworkspaces.com/ and download one of the client applications or launch **Web Access**.
- Start the client, enter the registration code from the invitation email, and choose **Register**.
- When prompted to sign in, enter the sign-in credentials, and then choose **Sign In**.
- (Optional) When prompted to save your credentials, choose Yes.

Step 3: Clean up (Optional)

If you are finished with the WorkSpace that you created for this tutorial, you can delete it. For more information, see <u>Delete a WorkSpace</u>.

4.2 Install Real-ESSI Debian package on your Workspace

Once you successfully connect to your Workspace, it will be the same as if you are working with a local Ubuntu desktop.



The next step is to install Real-ESSI on your Workspace. Full documentation can be found in Section 1.3 of the <u>Real-ESSI Simulator Procurement Manual</u>. Quick setup steps are summarized below.

Step 1: System libraries update/upgrade

Open a terminal and use the following commands.

sudo apt update sudo apt upgrade sudo apt autoremove

You will be asked to provide a password. The password is the same one you used to connect to your Workspace.

Step 2: Real-ESSI Debian package download

The Real-ESSI program Debian package can be downloaded <u>here</u>. Alternatively, contact Prof. Jeremic to arrange for a customized Real-ESSI Debian package.

Step 3: Real-ESSI Debian package install

Start the Real-ESSI Simulator Debian package install by removing the old installations of Real-ESSI. Then, go to the directory where you have downloaded the Real-ESSI Debian package. Install the Debian package, for example use the following command.

sudo apt install ./real-essi_23.01-1_amd64.deb

Note that some warning messages might appear but they don't affect the installation. After a successful installation, the sequential and parallel Real-ESSI executables, gmsh/gmESSI preprocessor, paraview/pvESSI post-processor/visualizer, Gmsh, and ParaView are all installed and ready to use.

Step 4: Load pvESSI plugin in ParaView

Start ParaView. Click **Tools**, then **Manage Plugins**. Click **Load New** and find the plugin **PVESSIReader.so** under directory /opt/paraview/lib/paraview-5.10/plugins/PVESSIReader/. Also, check the box **Auto Load** then close ParaView. Next time when ParaView is started, Real-ESSI output files can be visualized and post-processed.

Step 5: Install other useful programs

- **HDFView** can be used to open Real-ESSI output files, which are in HDF5 format.
- Sublime Text is the recommended editor for Real-ESSI input files and pre-processing files.

Documentation on how to install these programs can be found in Section 1.3.5 of the <u>Real-ESSI</u> <u>Simulator Procurement Manual</u>.

4.3 Build your model and prepare the input files

Once you have installed Real-ESSI on your Workspace, you are ready to start building your Real-ESSI model. You should finish preparing all the input files on your Workspace before moving on to the next Chapter. Full documentation on Real-ESSI pre-processing and input file formats is <u>available</u>.

Note that if the model is sufficiently small, you can simply run the simulation on your Workspace, without using the AWS Real-ESSI instance which is designed to be used in cases with large models.

5. Launch Real-ESSI Instance on AWS

A Real-ESSI instance can be launched either from the private image with authorization of <u>Prof.</u> <u>Boris Jeremic</u> or from the public image on AWS Marketplace (coming soon). Full documentation regarding launching an instance on AWS can be found <u>here</u>.

5.1 Launch Real-ESSI instance from AWS private images

Follow the steps below to launch instances from Real-ESSI Private Image.

Step 1: Request the Real-ESSI image

Real-ESSI image is currently a private Amazon Machine Images (AMI). After you get the 12-digit AWS account ID, email the AWS account ID to Prof. Boris Jeremic to obtain the Real-ESSI image.

To check if you have access to the Real-ESSI image, open the Amazon EC2 console at <u>https://console.aws.amazon.com/ec2/</u>. Go to **AMIs** and choose **Private images** to see the Real-ESSI image. Currently, the Real-ESSI AMIs are available in the **Oregon** region. The region is shown in the top-right corner on the EC2 dashboard.

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AMIs									
AMI Catalog									
Elastic Block Store									
Volumes									
Snapshots									
Lifecycle Manager									

Step 2: Launch the Real-ESSI instance

You can launch the Real-ESSI instance using the AWS Management Console as described in the following procedure. This tutorial is intended to help you quickly launch your first instance, so it doesn't cover all possible options. For information about advanced options, see <u>Launch an instance using the new launch instance wizard</u>. For information about other ways to launch your instance, see <u>Launch your instance</u>.

- Open the Amazon EC2 console at https://console.aws.amazon.com/ec2/.
- From the EC2 console dashboard, Go to AMIs and choose Private images to see the Real-ESSI image. Choose the image and choose Launch instance from AMI.

aws Services Q Sear	ch	[Alt+S]					⑦ Oregon ▼ Han_Yang ▼
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New EC2 Experience X Tell us what you think	Amazon Machine Images (AMIs) (1/1) Info Private images V Q. Find AMI by attribute or tag		(C 🛛 Recycle Bin	EC2 Image Builder	Actions 🔻	Launch instance from AMI
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▼ Images	Details Storage Tags						
AMI Catalog	AMI ID	Image type machine	Platform detai Linux/UNIX	lls	Root device typ EBS	0e	

• Under Name and tags, for Name, enter a descriptive name for your instance.

aws Services Q. Search (Alt+S)		A Ø Oregon ▼ Han_Yang ▼
EC2 > Instances > Launch an instance	▼ Summary	© [^]
Launch an instance two Amazon 622 allows you to oracte virtual machines, or instances, that run on the AWS Cloud. Quickly get started by following the simple steps below.	Number of Instances Into	
Name and tags Infe	Software Image (ANI) Real-ESSI25.01-1 ami-01dac5416771dd731	
Name e.g. Hy Web Server Add additional tags	Virtual server type (instance type) t2.micro Firewall (security group)	
Application and OS Images (Amazon Machine Image) inte Av84 is template that contains the offserer configuration (specified pattern, application server, and application) required to	New security group Storage (volumes) 1 volume(s) - 30 GiB	

 Under Instance type, you can select the hardware configuration for your instance. For Real-ESSI instances, the compute-optimized c6i series is recommended. Click the drop-down list under instance type and type c6i in the search bar. Depending on the size of your model, you can choose an instance type with appropriate computing power.

aws Services Q Search	[Alt+5]		E & Ø Oregon ▼ Han_Yang ▼
💆 WorkSpaces 🧧 Directory Service 🧑 EC2			
■ Instance type Info		Summary	© ^
Instance type		Number of Instances Info	
L2micro Free tier eligible Fore tier eligible Co-demand Disks printing 0.011 (sL05 per Hear On-demand SUBS printing 0.011 (sL05 per Hear On-demand SUBS printing 0.0116 (sL05 per Hear On-demand SHBs printing 0.0116 (sL	Compare Instance types	1 Software Image (AMI) Real-ESS123.01-1 wei 01d+2162714/d21	
Q c6i	×	am-010ac341677100751	
etil large Construction 1 4 GB Memory Con-Domand Linux pricing 0.05 USD per Hoar On-Demand SUB2 pricing 0.14 3 USD per Hoar On-Demand PHR pricing 0.14 3 USD per Hoar On-Demand PHR pricing 0.15 USD per Hoar	* ielected key pair before you launch	virtual server type (instance type) t2.micro Firewall (security group) New security group	
c6. Addates California III vCFU 33.080 Memory California Violaties (chicig) 7.476 USD per Hour On-Demand SUBS (chicig) 0.055 USD per Hour On-Demand PHRE (princ) 0.031 USD per Hour On-Demand PHRE (princ) 0.31 USD per Hour	C Create new key pair	Storage (volumes) 1 volume(s) - 30 GIB	
ed.3.2.2.eng Front, ed. 7.29 x-CPU, 356 dB Memory On-Demand DSE printing 5.555 UD per Hoar On-Demand Hums printing 11.328 UDD per Hoar On-Demand Hells printing 1.57 UDD per Hoar On-Demand Hells printing 5.7 UDD per Hoar	Edit	hours of 12.micro (or 13.micro in the Regions in which 12.micro is unavailable) instance usage on free ture AMb per month, 50 GHB of EBS storage, 2 million 104, 1 GB of magshabt, and 100 GB of bandwidth to the interment.	

• Under **Key pair (login)**, select the key pair for your instance.

aws	Services Q Search	[Alt+S]		E	
🧕 WorkSp	ices 🧧 Directory Service 🙋 EC2				
≡	Key pair (login) into You can use a key pair to securely connect to your instance. Ensure that you have access to the se the instance.	elected key pair before you launch	Summary		0
	Key nair name - required				
	Select	C Create new key pair			
	Q Proceed without a key pair (Not recommended) Default value account has uses	Edit	Real-ESSI 23.01-1 ami-01dac3416771dd731		
	account-han_yang Type: rsa		Virtual server type (instance type)		
	Network Info		(2.11610		
	vpc-0dcf9af30bacd2fc5		Firewall (security group)		
	Subnet Info		New security group		
	No preference (Default subnet in any availability zone)		Storage (volumes)		
	Auto-assign public IP Info		1 volume(s) - 30 GiB		
	Enable				
	Firewall (security groups) info A security group is a set of firewall rules that control the traffic for your instance. Add rules to allow i instance.	specific traffic to reach your	Free tier: In your first year includes 750 Hours of 12.micro (or 13.micro in the Regions in which 12.micro is unavailable) instance usage on free tier AMIs per		
	Create security group Select existing security group		month, 30 GIB of EBS storage, 2 million		
	We'll create a new security group called 'launch-wizard-2' with the following rules:		IOs, 1 GB of snapshots, and 100 GB of bandwidth to the internet.		
	Allow SSH traffic from Helps you connect to your instance 0.0.0.0/0				
	Allow HTTPS traffic from the Internet To set up an endpoint, for example when creating a web server		Cancel Launch instance Review commands		

If you have not created a key pair before, choose Create new key pair.

Create key pair	×
Key pairs allow you to connect to your instance securely.	
Enter the name of the key pair below. When prompted, store th and accessible location on your computer. You will need it later instance. Learn more [2]	e private key in a secure r to connect to your
Key pair name	
The name can include upto 255 ASCII characters. It can't include leading o	r trailing spaces.
Key pair type RSA 	
Key pair type RSA RSA RSA encrypted private and public key pair ED25519 ED25519 encrypted private and public key pair (Not supported for Will) ED25519	ndows instances)
Key pair type RSA RSA encrypted private and public key pair ED25519 ED25519 encrypted private and public key pair (Not supported for Will Private key file format	ndows instances)
Key pair type RSA RSA encrypted private and public key pair ED25519 ED25519 encrypted private and public key pair (Not supported for Wir Private key file format For us with OpenSSH	ndows instances)
Key pair type RSA RSA encrypted private and public key pair ED25519 ED25519 encrypted private and public key pair (Not supported for Will Private key file format • .pem For use with OpenSSH • .ppk For use with PuTTY	ndows instances)

Enter a descriptive name for your key pair. Leave everything else the same. Then click **Create key pair**. You will be prompted to save the key pair. Note that the key pair cannot be recreated after you launch the instance, so please make sure you save it in a safe place. The key pair can be reused later when you launch other instances.

• Under **Configure storage**, change the Root volume depending on the size of your model and simulation options.



• Click Launch instance. You should see the message below if the launch is successful.

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=	EC2 > Instances > Launch an instance					٢
	Success Successfully initiated launch of instance (i-0b530244ebf22deff0c) Launch log					
	Next Steps					
	Q. What would you like to do next with this instance, for exampler "treate alarm" or "create backup"	< 1	2 3	4 5	6 >	

• You can view your running instances by clicking **Instances** on the left side list of your screen.

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🦉 WorkSpaces 🛛 🗮 Directory Service	x 🖉 (G)	
New EC2 Experience X Tel us what you think X EC2 Dashboard EC2 Global View	C Connect Instance state V Actions V Learch Instance State V Learch Instance	> ©
Events	Name 🔻 Instance ID Instance state 🔻 Instance type 🔻 Status check Alarm status Availability Zone 🔻 Public IPv4 DNS 🔍 Public IPv4 DNS 🔍 Public IPv4 DNS	▼
Tags	□ Real-ESSI Test i-0b530244ebf2ddf6c	
Limits		
▼ Instances		
Instances		
Instance Types		
Launch Templates		
Spot Requests		
Savings Plans		
Reserved Instances		
Dedicated Hosts		
Scheduled Instances	Select an instance	⊚ ×
Capacity Reservations		

5.2 Launch Real-ESSI instance from AWS Marketplace

Coming soon...

6. Connect to Real-ESSI Instance

This chapter provides information about how to connect to a Real-ESSI instance after you have launched it, and how to transfer files between your local computer and your instance. For more information, please refer to the AWS documentation <u>here</u>. To troubleshoot connecting to your instance, see <u>Troubleshoot connecting to your instance</u>.

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After you launch your instance, you can connect to it and use it the way that you'd use a computer sitting in front of you. The following instructions explain how to connect to your instance using an SSH client. For more connection options, see <u>Connect to your Linux instance</u>.

6.1 **Prerequisites**

Before you connect to your Linux instance, complete the following prerequisites.

Check your instance status

After you launch an instance, it can take a few minutes for the instance to be ready so that you can connect to it. Check that your instance has passed its status checks. You can view this information in the **Status check** column on the **Instances** page.

Get the public IP address to connect to your instance

Click on your instance to show more information about it. You can find the public IPv4 address from either the summary or details. For example, the public IPv4 address is 35.92.170.125 for the instance shown below.

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👿 Workspores 👅 Directory Service 📝 10:2					
New EC2 Experience X Tel us what you think EC2 Dashboard EC2 Global View	Instances (1/1) two Q. Find instance by attribute or tog (case-sensitive) Instance state = numling X Clear filters	C co	meet Instance state V Actions V Launch instances V		
Events	✓ Name ▼ Instance ID Instance state ▼	7 Instance type 🔻 Status check Alarm status Availability Z	one マ Public IPv4 DNS マ Public IPv4 マ Elastic IP マ		
Tags	Real-ESSI Test I-0b530244ebf2ddf6c ORunning QC	c6I.4xlarge 🛛 2/2 checks passed No alarms 🕂 us-west-2c	ec2-35-92-170-125.us 35.92.170.125 -		
Limits	4		•		
▼ Instances					
Instances	Instance: i-0b530244ebf2ddf6c (Real-ESSI Test)	=	×		
Instance Types	Detaile Security Networking Storage Status checks	Monitoring			
Launch Templates	Urtans security interviencing storage status creacis information in age				
Spot Requests	▼ Instance summary Info				
Savings Plans	Instance ID	Public IPv4 address	Private IPv4 addresses		
Reserved Instances	□ I-0b530244ebt2ddt6c (Real-ESSI Test)	D 35.92.170.125 open address	D 172.31.4.255		
Dedicated Hosts	IPv6 address	Instance state	Public IPv4 DNS		
Scheduled Instances	-	⊘ Running	CI ec2-35-92-170-125.us-west-2.compute.amazonaws.com open address		
Capacity Reservations	Hostname type	Private IP DNS name (IPv4 only)			
▼ Images	IP name: ip-172-31-4-235.us-west-2.compute.internal	Ip-172-31-4-235.us-west-2.compute.Internal			
AMIs	Answer private resource DNS name IPv4 (A)	Instance type	Elastic IP addresses		
AMI Catalog					
▼ Elastic Block Store	assigned iP address S5.92.170.125 [Public IP]	vpc-0dcf9af30bacd2fc5	Opt-in to AWS Compute Optimizer for recommendations. Learn more		
Volumes	IAM Role	Subnet ID	Auto Scaling Group name		
Snapshots	-	subnet-0150a35f9420e6224 12	-		

Locate the private key and set the permissions

You must know the location of your private key file to connect to your instance. For SSH connections, you must set the permissions so that only you can read the file.

Get the fully-qualified path to the location on your computer of the .pem file for the key pair that you specified when you launched the instance.

Use the following command to set the permissions of your private key file so that only you can read it. Replace key-pair-name with the actual name of your key pair.

chmod 400 key-pair-name.pem

If you do not set these permissions, then you cannot connect to your instance using this key pair. For more information, see <u>Error: Unprotected private key file</u>.

6.2 Connect to your Real-ESSI instance using an SSH client

Use the following procedure to connect to your Linux instance using an SSH client. If you receive an error while attempting to connect to your instance, see <u>Troubleshoot connecting to</u> <u>your instance</u>.

• In a terminal window, use the **ssh** command to connect to the instance. You specify the path and file name of the private key (.pem) and the IPv4 address for your instance. To connect to your instance, use the following command.

ssh -i /path/key-name.pem ubuntu@IPv4-address

Replace /path/ with the full absolute path to your key pair. Replace key-name with the actual name of your key pair. Replace IPv4-address with the public IPv4 address of your instance.

You will see a response like the following:

```
The authenticity of host 'ec2-198-51-100-1.compute-1.amazonaws.com
(198-51-100-1)' can't be established.
ECDSA key fingerprint is 14UB/neBad9tvkgJf1QZWxheQmR59WgrgzEimCG6kZY.
Are you sure you want to continue connecting (yes/no)?
```

- (Optional) Verify that the fingerprint in the security alert matches the fingerprint that you
 previously obtained in <u>(Optional) Get the instance fingerprint</u>. If these fingerprints don't
 match, someone might be attempting a man-in-the-middle attack. If they match, continue to
 the next step.
- Enter yes.

You will see a response like the following:

Warning: Permanently added 'ec2-198-51-100-1.compute-1.amazonaws.com' (ECDSA) to the list of known hosts.

 (Optional) Create a directory to organize your Real-ESSI simulation files. Replace test_folder with your folder name.

mkdir test_folder

6.3 Transfer Input Files to Real-ESSI Instance

This section describes how to transfer files with the secure copy protocol (SCP). The procedure is similar to the procedure for connecting to an instance with SSH.

- Open a terminal on your local Ubuntu desktop (or Amazon Workspace).
- Determine the file location on your local Ubuntu desktop (or Amazon Workspace) and the destination path on the instance. In the following example, the name of the private key file is key-name.pem, the file to transfer is main.fei, and the IPv4 address of the instance is IPv4-address. Enter the following command in your terminal.

scp -i /path1/key-name.pem /path2/main.fei ubuntu@IPv4-address:/path3/

There are three paths in this command.

- > Replace /path1/ with the full absolute path to your key pair on your local desktop.
- > Replace /path2/ with the full absolute path to the file to transfer on your local desktop.
- > Replace /path3/ with the full absolute path to the destination on the Real-ESSI instance.

For example, your **scp** command may be:

```
scp -i /home/han/Documents/han-key.pem /home/han/My_Model/main.fei
ubuntu@52.26.2.245:/home/ubuntu/Test/
```

 If you haven't already connected to the instance using SSH, you will see a response like the following:

```
The authenticity of host 'ec2-198-51-100-1.compute-1.amazonaws.com (10.254.142.33)' can't be established.
RSA key fingerprint is
1f:51:ae:28:bf:89:e9:d8:1f:25:5d:37:2d:7d:b8:ca:9f:f5:f1:6f.
Are you sure you want to continue connecting (yes/no)?
```

(Optional) You can optionally verify that the fingerprint in the security alert matches the instance fingerprint. For more information, see (Optional) Get the instance fingerprint.

Enter yes.

If the transfer is successful, the response is similar to the following:

```
Warning: Permanently added 'ec2-198-51-100-1.compute-1.amazonaws.com' (RSA) to the list of known hosts.
main.fei 100% 164KB 1.3MB/s 00:00
```

 It's also possible to transfer entire folders using the scp command. In the following example, the name of the private key file is key-name.pem, the folder to transfer is folder, and the IPv4 address of the instance is IPv4-address. Enter the following command in your terminal.

scp -i /path1/key-name.pem -r /path2/folder ubuntu@IPv4-address:/path3/

There are three paths in this command.

- > Replace /path1/ with the full absolute path to your key pair on your local desktop.
- > Replace /path2/ with the full absolute path to the folder to transfer on your local desktop.
- > Replace /path3/ with the full absolute path to the destination on the Real-ESSI instance.

For example, your **scp** command may be:

scp -i /home/han/Documents/han-key.pem -r /home/han/My_Model_Folder ubuntu@52.26.2.245:/home/ubuntu/Test/

8. Run Simulations on Real-ESSI Instance

This chapter provides information about running your simulations on a launched Real-ESSI instance. Note that you should only attempt to do this after you have done the following:

- Create an AWS account
- Have access to a local Ubuntu desktop (or <u>Amazon Workspace</u>)
- Launch a Real-ESSI instance on AWS
- <u>Connect to the Real-ESSI instance you have launched</u>

Once you have successfully transferred your input files, open a new terminal and <u>connect to</u> <u>the Real-ESSI instance</u>. Your terminal should look like the following:

	□ ubuntu@ip-172-31-12-223: ~ Q = □ ×						
	han@cml02:-\$ ssh -i /home/han/Documents/account-han_yang.pem ubuntu@52.26.2.245 Welcome to Ubuntu 22.04.2 LTS (GNU/Linux 5.19.0-1022-aws x86_64)						
	* Documentation: https://help.ubuntu.com * Management: https://landscape.canonical.com * Support: https://ubuntu.com/advantage						
	System information as of Fri Mar 31 18:33:57 UTC 2023						
	System load: 0.0 Processes: 215 Usage of /: 18.9% of 28.89GB Users logged in: 1 Memory usage: 1% IPv4 address for ens5: 172.31.12.223 Swap usage: 0%						
	* Introducing Expanded Security Maintenance for Applications. Receive updates to over 25,000 software packages with your Ubuntu Pro subscription. Free for personal use.						
1	https://ubuntu.com/aws/pro						
	Expanded Security Maintenance for Applications is not enabled.						
	0 updates can be applied immediately.						
	1 additional security update can be applied with ESM Apps. Learn more about enabling ESM Apps service at https://ubuntu.com/esm						
	Last login: Fri Mar 31 17:41:01 2023 from 169.237.114.209 ubuntu@ip-172-31-12-223:-\$ []						

• Go to the directory where you transferred your input files. Use the following command:

cd /path/

Replace /path/ with the full absolute path to your input files on the Real-ESSI instance.

• Change the permission of your file so that it can be read and executed. Use the following command:

chmod a+rx main.fei

• Enter the following command to start your simulation:

```
mpirun -np num_pro essi-parallel -f main.fei
```

Replace num_pro with the number of processes you want to use to run the simulation. Note that this number must be smaller than the number of available processes on your Real-ESSI instance. Consider using a different instance type with more available processes if your current set up is not enough for your model.

• Once the simulation has successfully started, you should see something like the following:



Now you just need to wait for the simulation to finish.

 Once the simulation is finished, you can use the following command to list all the files in your current directory:

ls -1

You should see something like the following:

ubuntu@ip-172-31-12-223: -/Test/Input_FilesQ=-×ubuntu@ip-172-31-12-223: -/Test/Input_Files\$ ls -ltotal 348808×rw-rw-r1ubuntu45030Mar 3118:59Additional_Mass.fei×rw-rw-r1ubuntuubuntu237341Mar 3118:59Boundary_Conditions.fei
<pre>ubuntu@ip-172-31-12-223:-/Test/Input_Files\$ ls -l total 348808 -rw-rw-r- 1 ubuntu ubuntu 45030 Mar 31 18:59 Additional_Mass.fei -rw-rw-r- 1 ubuntu ubuntu 237341 Mar 31 18:59 Boundary_Conditions.fei -rw-rw-r 1 ubuntu ubuntu 70913 Mar 31 18:59 Contact_Elements_Bonded.fei -rw-rw-r 1 ubuntu ubuntu 0385627 Mar 31 18:59 Nodes.fei -rw-rw-r 1 ubuntu ubuntu 2956488 Mar 31 18:59 Rayleigh_Damping.fei -rw-rw-r 1 ubuntu ubuntu 49596219 Mar 31 19:09 Ventura_Hotel_SelTweight.h5.1.feioutput -rw-rw-r 1 ubuntu ubuntu 49566249 Mar 31 19:09 Ventura_Hotel_SelTweight.h5.3.feioutput -rw-rw-r 1 ubuntu ubuntu 49566480 Mar 31 19:09 Ventura_Hotel_SelTweight.h5.3.feioutput -rw-rw-r 1 ubuntu ubuntu 49566406 Mar 31 19:09 Ventura_Hotel_SelTweight.h5.3.feioutput -rw-rw-r 1 ubuntu ubuntu 495641600 Mar 31 19:09 Ventura_Hotel_SelTweight.h5.3.feioutput -rw-rw-r 1 ubuntu ubuntu 49066794 Mar 31 19:09 Ventura_Hotel_SelTweight.h5.3.feioutput -rw-rw-r 1 ubuntu ubuntu 49064794 Mar 31 19:09 Ventura_Hotel_SelTweight.h5.3.feioutput -rw-rw-r 1 ubuntu ubuntu 49064794 Mar 31 19:09 Ventura_Hotel_SelTweight.h5.3.feioutput -rw-rw-r 1 ubuntu ubuntu 49064794 Mar 31 19:09 Ventura_Hotel_SelTweight.h5.3.feioutput -rw-rw-r 1 ubuntu ubuntu 49064794 Mar 31 19:09 Ventura_Hotel_SelTweight.h5.3.feioutput -rw-rw-r 1 ubuntu ubuntu 49064794 Mar 31 19:09 Ventura_Hotel_SelTweight.h5.3.feioutput -rw-rw-r 1 ubuntu ubuntu 49064794 Mar 31 19:09 Ventura_Hotel_SelTweight.h5.3.feioutput -rw-rw-r 1 ubuntu ubuntu 49064794 Mar 31 19:09 Ventura_Hotel_SelTweight.h5.3.feioutput -rw-rw-r 1 ubuntu ubuntu 49064794 Mar 31 19:09 Ventura_Hotel_SelTweight.h5.3.feioutput -rw-rw-r 1 ubuntu ubuntu 49064794 Mar 31 19:09 Ventura_Hotel_SelTweight.h5.3.feioutput -rw-rw-r 1 ubuntu ubuntu 49064794 Mar 31 19:09 Ventura_Hotel_SelTweight.h5.3.feioutput -rw-rw-r 1 ubuntu ubuntu 49064794 Mar 31 19:09 Ventura_Hotel_SelTweight.h5.3.feioutput -rw-rw-r 1 ubuntu ubuntu 49064794 Mar 31 19:09 Ventura_Hotel_SelTweight.h5.3.feioutput -rw-rw-r 1 ubuntu ubuntu 49064794 Mar</pre>
<pre>ubuntu@tp=172-31-12-223:-/Test/Input_Files\$ ls -l total 348808 -rw-rw-r1 ubuntu ubuntu 45030 Mar 31 18:59 Additional_Mass.fei -rw-rw-r1 ubuntu ubuntu 237341 Mar 31 18:59 Boundary_Conditions.fei -rw-rw-r1 ubuntu ubuntu 70913 Mar 31 18:59 Elements.Fei -rw-rw-r1 ubuntu ubuntu 0303377 Mar 31 18:59 Elements.fei -rw-rw-r1 ubuntu ubuntu 6385627 Mar 31 18:59 Rayleigh_Damping.fei -rw-rw-r1 ubuntu ubuntu 2956488 Mar 31 18:59 Rayleigh_Damping.fei -rw-rw-r1 ubuntu ubuntu 49506219 Mar 31 19:09 Ventura_Hotel_Selfweight.h5.1.feioutput -rw-rw-r1 ubuntu ubuntu 49219167 Mar 31 19:09 Ventura_Hotel_Selfweight.h5.3.feioutput -rw-rw-r1 ubuntu ubuntu 49266794 Mar 31 19:09 Ventura_Hotel_Selfweight.h5.4.feioutput -rw-rw-r1 ubuntu ubuntu 47722288 Mar 31 19:09 Ventura_Hotel_Selfweight.h5.5.feioutput</pre>
total 348808 -rw-rw-r 1 ubuntu ubuntu 45030 Mar 31 18:59 Additional_Mass.fei -rw-rw-r 1 ubuntu ubuntu 237341 Mar 31 18:59 Boundary_Conditions.fei -rw-rw-r 1 ubuntu ubuntu 70913 Mar 31 18:59 Boundary_Conditions.fei -rw-rw-r 1 ubuntu ubuntu 10035377 Mar 31 18:59 Elements_Bonded.fei -rw-rw-r 1 ubuntu ubuntu 0385627 Mar 31 18:59 Rodes.fei -rw-rw-r 1 ubuntu ubuntu 2956488 Mar 31 18:59 Rodes.fei -rw-rw-r 1 ubuntu ubuntu 2956488 Mar 31 18:59 Rodes.fei -rw-rw-r 1 ubuntu ubuntu 2956488 Mar 31 19:09 Ventura_Hotel_Selfweight.h5.1.feioutput -rw-rw-r 1 ubuntu ubuntu 49596219 Mar 31 19:09 Ventura_Hotel_Selfweight.h5.2.feioutput -rw-rw-r 1 ubuntu ubuntu 4966794 Mar 31 19:09 Ventura_Hotel_Selfweight.h5.3.feioutput -rw-rw-r 1 ubuntu ubuntu 47722288 Mar 31 19:09 Ventura_Hotel_Selfweight.h5.4.feioutput
<pre>-rw-rw-r-1 ubuntu ubuntu 45030 Mar 31 18:59 Additional_Mass.fei -rw-rw-rr-1 ubuntu ubuntu 237341 Mar 31 18:59 Boundary_Conditions.fei -rw-rw-rr-1 ubuntu ubuntu 70913 Mar 31 18:59 Boundary_Conditions.fei -rw-rw-rr-1 ubuntu ubuntu 0033577 Mar 31 18:59 Elements.fei -rw-rw-r-1 ubuntu ubuntu 6385627 Mar 31 18:59 Nodes.fei -rw-rw-r-1 ubuntu ubuntu 2956488 Mar 31 18:59 Rayleigh_Damping.fei -rw-rw-r-1 ubuntu ubuntu 49596219 Mar 31 19:09 Ventura_Hotel_Selfweight.h5.1.feioutput -rw-rw-r-1 ubuntu ubuntu 49596794 Mar 31 19:09 Ventura_Hotel_Selfweight.h5.3.feioutput -rw-rw-r-1 ubuntu ubuntu 4956488 Mar 31 19:09 Ventura_Hotel_Selfweight.h5.3.feioutput -rw-rw-r-1 ubuntu ubuntu 49566494 Mar 31 19:09 Ventura_Hotel_Selfweight.h5.4.feioutput</pre>
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-rw-rw-r 1 ubuntu ubuntu 49960/94 Mar 31 19:09 Ventura_Motel_selTweight.hs.3.retoutput -rw-rw-r 1 ubuntu ubuntu 50541600 Mar 31 19:09 Ventura_Hotel_SelTweight.h5.4.feioutput -rw-rw-r 1 ubuntu ubuntu 47722288 Mar 31 19:09 Ventura_Hotel_SelTweight.h5.5.feioutput
-rw-rw-r 1 ubuntu ubuntu sos41600 mar 31 19:09 ventura_Hotel_Seltweight.hs.4.reloutput -rw-rw-r 1 ubuntu ubuntu 47722288 Mar 31 19:09 Ventura_Hotel_Selfweight.h5.5.feioutput
-rw-rw-r 1 ubuntu ubuntu 47722288 Mar 31 19:09 Ventura_Hotel_Selfweight.h5.5.reloutput
-rw-rW-F 1 ubuntu ubuntu 508905/3 Mar 31 19:09 Ventura Hotel Selfweight.ns.6.reloutput
-rw-rw-r 1 ubuntu ubuntu 3948/854 Mar 31 19:09 Ventura Hotel Seltweight.ns./.reloutput
-rw-rw-r 1 ubuntu ubuntu //514/ Mar 31 19:09 Ventura_HoteL_Settweight.ns.retoutput
-rw-rw-r 1 ubuntu ubuntu 12140 Mar 31 19:09 esst_31_03_2022_18_59.log
-rw-rw-r 1 ubuntu ubuntu 108104 Mar 31 18:59 generate_model_etastic.py
-rw-rw-r 1 ubuntu ubuntu osyy mar 31 18:59 matri. ret
-rw-rw-r 1 ubuntu ubuntu 48 Mar 31 18:39 perse_options.txt
ubuntu@tp-1/2-31-12-223:~/Test/Input_Files\$

Notice that all the output files and a log file are now present in your working directory. Note that all Real-ESSI output files have the suffix <u>feioutput</u>. For more information, refer to the <u>Real-ESSI Simulator Output Format Manual</u>.

9. Transfer Output Files to Local Desktop (or Amazon Workspace)

This chapter provides information about how to transfer the output files of your Real-ESSI simulation back to your local desktop (or Amazon Workspace). Note that you should only attempt to do this after your simulation has finished.

The **scp** command is used to transfer the output files from the launched Real-ESSI instance to your local Ubuntu desktop (or Amazon Workspace).

- Open a terminal on your local Ubuntu desktop (or Amazon Workspace).
- In the following example, the name of the private key file is key-name.pem and the IPv4 address of the instance is IPv4-address. Enter the following command in your terminal.

scp -i /path1/key-name.pem ubuntu@IPv4-address:/path2/*.feioutput /path3/

There are three paths in this command.

- > Replace /path1/ with the full absolute path to your key pair on your local desktop.
- > Replace /path2/ with the full absolute path to the location on the Real-ESSI instance.
- > Replace /path3/ with the full absolute path to the location on your local desktop.

Note that the format *.feioutput means that the scp command will be executed for all the files with the suffix .feioutput. This is useful since you will have multiple output files that need to be transferred.

For example, your **scp** command may be:

scp -i /home/han/Documents/han-key.pem

ubuntu@52.26.2.245:/home/ubuntu/Test/*.feioutput /home/han/output/

han@cml02: ~/Ventura_Hote	el/test_c	output	Q =		
<pre>han@cml02:~/Ventura_Hotel/test_output\$ scp -i ng.pem ubuntu@52.26.2.245:/home/ubuntu/Test/I ntura_Hotel/test_output/</pre>	. /home [nput_F	/han/Do iles/*.	cuments/ac feioutput	count-han /home/han	_ya /Ve
Ventura_Hotel_Selfweight.h5.1.feioutput	100%	47MB	10.9MB/s	00:04	
Ventura_Hotel_Selfweight.h5.2.feloutput	100%	47MB	11.1MB/S	00:04	
Ventura Hotel Selfweight.h5.4.feioutput	100%	48MB	11.1MB/S	00:04	
Ventura_Hotel_Selfweight.h5.5.feioutput	100%	46MB	11.1MB/s	00:04	
Ventura_Hotel_Selfweight.h5.6.feioutput	100%	49MB	11.1MB/s	00:04	
Ventura_Hotel_Selfweight.h5.7.feioutput	100%	38MB	11.1MB/s	00:03	
Ventura_Hotel_Selfweight.h5.feioutput	100%	757KB	8.3MB/s	00:00	

• If the transfer is successful, you should see something like the following:

• Now that you have all the output files on your local Ubuntu desktop (or Amazon Workspace), you can proceed to work with them as you wish, e.g. post-processing. For more information on what you can do with your output files, refer to the <u>Real-ESSI Simulator Post-Processing</u> <u>Manual</u>.

1.8.3 AWS for Education

Amazon Web Services provides grants for educators and students from member institution² through AWS Educate program. AWS Educate offers cloud content, training, collaboration tools and AWS technology **at no cost**. Some of the AWS Educate program benefits:

- For Educators
 - \$200 in AWS credits per educator at member institutions.
 - \$75 in AWS credits per educator at non-member institutions.
 - Free AWS Technical Essentials eLearning course.
 - Free access to AWS content for classes.
- For Students
 - \$100 in AWS credits per student at member institutions.
 - \$40 in AWS credits per student at non-member institutions.
 - Access to AWS Technical Essentials Training Course (a \$600 value).

If you have an email address from an educational institutions, you can use Real-ESSI on AWS for free through AWS Educate.

 $^{^{2}\}mbox{List}$ of member institution is available at this LINK.

1.8.4 AWS for Government

AWS GovCloud

AWS Secret Region

Bibliography

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