# **Exercise Introduction**

This sheet describes the format of the course and instructions on how to connect to the GWDG compute cluster via SSH as well as how to prepare the cloud environment for the hands-on exercises.

# **Course Format: Practicals**

The course *High-Performance Computing System Administration* 2023/24 takes place in an online format as a block course from the 16.10.23 to 20.10.23 and utilizes Big Blue Button rooms.

The first day will cover the basics of practical usage of Linux and HPC. The later days of the block course will go more in depth on topics regarding the system administration aspects of high-performance computing.

The main room is called **HPCSA**. In this room the lecturer will present the slides and guide you through the course.

As this course is intended to provide hands-on experience, the lecturers will ask you to complete exercises during the course. These exercises should be completed individually, however, you will form groups to support each other in case you get stuck. To allow for communication within said groups, each group will receive its own breakout room in BBB. The second BBB room called **HPCSA - Support** will be used for this. We will use two BBB rooms as Big Blue Button is limited, and it is currently not possible to be connected to a breakout room while also being able to listen the main room. If you need help from outside your group, feel free to ask for help in the broadcast room where the lecturer and a few helpers will be available. The format will be explained in more detail during the first session.

As you will be working with other participants of the course, you should be able to communicate with them via microphone if possible.

**Examination** The university students in this course will be able to choose topics related to High-Performance Computing System Administration at the end of the block course and work on a project based on said topic. For this, each student will be assigned a supervisor who is an expert on the given topic and who will guide the student. The student is expected to hand in a report by the end of the semester, which will be graded. For further details on the examination see https://hps.vi4io.org/teaching/autumn\_term\_2023/hpcsa# examination

For the beginning of the course it is enough to join the Course room.

Course Room: https://meet.gwdg.de/b/jul-pfo-7mr-txo

Support Room: https://meet.gwdg.de/b/jul-mii-pfh-shu

Please confirm before the course that you can connect to a BBB room and your microphone is working. You may use the Support room BBB instance to test your setup.<sup>1</sup>

<sup>&</sup>lt;sup>1</sup>If it doesn't work, please try first https://test.bigbluebutton.org/, then try with a different browser.

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# Task 1: SSH setup and Connecting to the GWDG HPC Cluster (15 min)

In order to follow along with the hands on exercises of this course and to complete the student projects, you need to log in to the GWDG Scientific Compute Cluster (SCC). If you have signed up for the course<sup>2</sup>, you should have received an SSH key per e-mail, which can be used to log in into the SCC.

The following instructions will help you connect to the SCC using your SSH key:

# Windows 10/11:

- Search for **Powershell**, right click, run as administrator
- Get-WindowsCapability -Online|Where-Object Name -like '\*SSH\*' If SSH client is not installed run the following command: Add-WindowsCapability -Online -Name OpenSSH.Client~~~0.0.1.0
- Confirm that it works by running ssh -V

# MacOS/Linux:

- Search for **Terminal** and open it
- Check ssh is provided by running the command  $\verb+ssh-V$

# Using SSH:

- Place the SSH key you received per mail in your user folder
- In PowerShell or Terminal type the following command ssh -i hpctrainingNN hpctrainingNN@login-mdc.hpc.gwdg.de
   -o ProxyCommand='ssh -W %h:%p hpctrainingNN@login.gwdg.de
   -i hpctrainingNN'
- Confirm the connection and enter the SSH keys passphrase  ${\bf twice}$
- The passphrase is described in the email you received
- Confirm that running hostname returns gwdu101 or gwdu102

This SSH command connects you as user *hpctrainingNN* to the SCC using the SSH key file with the same name. The proxy command is used to connect to the SCC over login.gwdg.de. This is necessary as the SCC is only reachable from inside the GÖNET. If you are already connected via the GWDG VPN or from a device inside the GÖNET, you do not need the proxy command.

# Hints

• If you get an error stating that the permissions of your ssh key are too open, you have to limit the files permission. Type chmod 400 hpctrainingNN to fix the permission.

 $<sup>^{2}</sup>$ If you signed up late, you might not have received a key. If that is the case please check your emails again and if there is no email with a key, contact jonathan.decker@uni-goettingen.de

• If you get an error stating that the format of your key is invalid, try opening the key file with a text editor and make sure it starts with -----BEGIN OPENSSH PRIVATE KEY----- and ends with -----END OPENSSH PRIVATE KEY-----. You can also try copying the content into a new file. Make sure that there is an empty line at the end of the file.

# Task 2: Prepare Cloud Environment (15 min)

During the HPCSA block course you will be completing exercises that involve the installation and configuration of software under a Linux system. As this typically requires root permission on a given system, which cannot be granted on the SCC system, you will instead use Virtual Machines (VMs) handled by the GWDG OpenStack instance. The following steps will show you how to set up VMs using the OpenStack web interface and how to connect to them. During the course you will be responsible for managing your VMs.

## Login

This section shows how to login into the OpenStack Dashboard.



Figure 1: GWDG OpenStack Horizon Dashboard

- 1. Find your username and password in the course email.
- 2. Open https://cloud.gwdg.de in your browser and select Login via AcademicID.
- 3. Use your username and password to login on the AcademicID web page.
- 4. You should be directed back to https://cloud.gwdg.de and see the OpenStack Horizon Dashboard similar to Figure 1

## Create SSH Key

This section shows how to create an SSH key pair, which can later be used to connect to your VMs.

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Network 3	Laptop	19:2b:af:bc:b5:61:b8:a5:2f:29:81:61:7f:37:09:8e	📋 Delete Key Pair
Identity 3	m26-l0d4a147834c551ac9229d399cc2cc988796dd2al9801372775a5a987110050	2b:97:63:d3:39:32:54:ed:e5:7e:15:16:90:18:92:d2	🛍 Delete Key Pair
	test-master1-dad3aed7abb58b026ed0168a3ic7951b1b5d509ea98c88l313c3d5296b4b9719	e3:73:88:0f:ae:fb:6a:37:24:9f:a5:69:19:32:1e:a4	📋 Delete Key Pair
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Figure 2: OpenStack key pairs

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		Displaying 5 items					

Figure 3: Create a new key pair

- 1. On the left side under **Compute** tab, select **Key Pairs**. You should see an empty key list similar to Figure 2
- 2. Click on **Create Key Pair** and name it **hpcsa-course-vm-key**. See Figure 3 for reference. Then create the key pair. This will automatically download the private key to your computer, which will be required later to connect to the VMs. You should see the created key pair in the overview.

## **Configure Security Groups**

This section shows how to configure the security groups on OpenStack to open ports for external and internal communication.

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Figure 4: OpenStack Security Groups Overview

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Volumes > Network ~		Description	created, you can add rules to the security group.	Filter Q + Create Security Group	Delete Security Groups
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Figure 5: Security Group Creation Dialog for SSH

1. One the left side, under **Network** tab, select **Security Groups**. The overview should show the default security group as shown in Figure 4.

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Figure 6: Manage Security Group Rules Overview

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O	Load Balancers Floating IPs rothestration > >	Displaying 2 items			and code in the spaces provided. Remote: "count specify the source of the traffic to be allowed via this rule. You may do so either in the form of an P address bock (CDR) or via a source group (Becurity Group). Selecting a security group as the source will allow any their instance in that sourity group access to any other instance that source you and the source Cancel Address and the source of the source of the source Address and the source of the source of the source of the source and the source of the source of the source of the source of the source of the source of the s			

Figure 7: Add Security Group Rule Dialog for SSH

- 2. Press Create Security Group and name it SSH as shown in Figure 5.
- 3. To edit the new group press Manage Rules and you should an overview similar to Figure 6.
- 4. Press **Add Rule** and in the new dialog under **Rule** select **SSH** from the drop-down menu as shown in Figure 7.



Figure 8: Security Group Creation Dialog for Internal

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Identity	>		10.254.1.0/24	to any outer mataneo via una fute.			
				Cancel Add			

Figure 9: Add Security Group Rule Dialog for internal TCP

- 5. Save this rule, go back to the security groups overview and create another security group called **Internal** as shown in Figure 8.
- 6. Manage the group **Internal** and add two new rules. For the first rule set **Rule** to **Custom TCP Rule** under **Open Port** set **All ports** and most importantly under **CIDR** set it to **10.254.1.0/24** as can be seen in Figure 9.

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	Load Balancers		IPv4	Remote * O	Remote: You must specify the source of the traffic to be			Delete Rule
	Floating IPs			CIDR •	allowed via this rule, you may do so either in the form of an IP address block (CIDR) or via a source group			Delete Rule
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Identity	>			10.254.1.0/24	to any other instance via this rule.			
					Cancel			

Figure 10: Add Security Group Rule Dialog for internal UDP

The **CIDR** setting configures the IP mask for which this rule is valid. This rule allows incoming TCP traffic on all ports for this VM as long as it comes from an IP within the mask **10.254.1.0/24**. This mask represents the internal IP addresses used by OpenStack so only your other VMs can use this rule.

7. Create a second rule in the **Internal** group using the same settings as for the other rule but setting **Rule** to **Custom UDP Rule** as shown in Figure 10.

## Launch Main Instance

This section shows how to launch your main instance, which will use CentOS 8 and be reachable from your machine via SSH.

- 1. On the left side, under **Compute** tab, select **Instances**. This opens the instance overview, which should show no instances as in Figure 11.
- 2. Click on Launch Instance and name your instance cluster-manager as shown in Figure 12.
- 3. Press Next to configure the Source. In the list of at the bottom find CentOS Stream 8 and press the up arrow on the right to select it. Then ensure that Create New Volume and Delete Volume on Instance Delete are both set to Yes. The dialog should look the same as shown in Figure 13.
- 4. Press **Next** to configure **Flavor**, which refers to the preset of compute resources your new instance will have. From the list find **m1.large** and press the arrow up on the right to select it such that it looks as shown in Figure 14.
- 5. Skip **Networks** and **Network Ports** and select **Security Groups**. Move both of your groups, **SSH** and **Internal** up via the arrow on the right such that it looks the same as in Figure 15.
- 6. Move on to **Key Pair** and select the key pair called **hpcsa-course-vm-key**, which you had created earlier via the arrow on the right such that it looks similar to Figure 16.
- 7. Press Launch Instance and see that the system is now working on provisioning your VM as can be

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Figure 11: OpenStack Instance Overview Empty

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seen in Figure 17.

8. After a short time, the instance should be ready and visible in the overview, similar to Figure 18.

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Figure 13: Launch Instance Source for Cluster-Manager

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Project		Project / Compute / Instances	Launch Instance								×				
	API Acces	, Instances	Details Source	Flavors manage Allocated	the sizing for	RAM	e, memory and	storage capacity	r of the instance.	Public	0				
	Overview Instance	v 5	Flavor	> m1.large	4	8 GB	80 GB	80 GB	0 GB	Yes	•	)=•		Filter	Launch Instance
	Image Key Pain	s Instance Name Image	Network Ports	Available	21 e for filters.						Select one	State	Time since created		Actions
	Server Group	S	Security Groups	Name	VCPUS	RAM	Total Disk	Root Disk	Ephemeral Disk	Public					
	Volumes		Key Pair	> c1.small	2	2 GB	20 GB	20 GB	0 GB	Yes	•				
	Network		Configuration	> m1.small	1	2 GB	20 GB	20 GB	0 GB	Yes	•				
	Orchestration 3		Server Groups	> c1.medium	4	4 GB	40 GB	40 GB	0 GB	Yes	•				
Identity	;		Metadata	> m2.small	1	4 GB	20 GB	20 GB	0 GB	Yes	•				
				> m1.medium	2	4 GB	40 GB	40 GB	0 GB	Yes	•				
				> c1.large	8	8 GB	80 GB	80 GB	0 GB	Yes	•				
				> m2.medium	2	8 GB	40 GB	40 GB	0 GB	Yes	•				
				> c1.xlarge	A 16	16 GB	160 GB	160 GB	0 GB	Yes	•				
				> m2.large	4	16 GB	80 GB	80 GB	0 GB	Yes	•				
				> m1.xlarge	8	16 GB	160 GB	160 GB	0 GB	Yes	•				
				> c1.xxlarge	<u>A</u> 16	🔺 32 GE	3 160 GB	160 GB	0 GB	Yes	•				
				> c1.2xlarge	A 32	🔺 32 GE	3 160 GB	160 GB	0 GB	Yes	•				
				> m2 vlarne	4	A 32 GF	B 160 GB	160 GB	0 GB	Yes					

Figure 14: Launch Instance Flavor for Cluster-Manager

#### Add a Floating IP Address

This section shows how to associate a floating IP address to your VM, which makes it possible to connect to the VM.

1. Under the **Compute** tab, on **Instances**, open the drop-down menu for your **cluster-manager** instance

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Project		Project / Compute / Instances	Launch Instance			20			
	API Acces	s	Details	Select the security groups to laun	ch the instance in.	6			
	Compute	, instances	Source	Name	Description				
	Overview	N 3	Flavor	> default	Default security group	•	) = •		Filter & Launch Instance
	Image	s Instance Name Ima	Networks age I	> SSH		•	State	Time since created	Actions
	Key Pair	s	Network Ports	> Internal		*			
	Server Group	S	Key Pair	✓ Available ①		Select one or more			
	Volumes :	> 	Configuration	Q Click here for filters.		×			
	Orchestration	, ,	Server Groups	Name	Description				
Identity	:	<b>,</b>	Scheduler Hints		No available item:	S			
			Metadata						
			× Cancel			KBack Next >      Launch Instance			
				_	_				

Figure 15: Launch Instance Security Groups for Cluster-Manager

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<b>-€</b> _ ■⊂	GWDG•GWE	DG_AGC_HPCSA_CONTR	IB jonathan.decker <del>-</del>		🛎 jonathan.dee	
Project	~	Project / Compute / Instances	Launch Instance	×		
	API Access	Instances	Details	A key pair allows you to SSH into your newly created instance. You may select an existing key pair, import a key pair, or generate a new key pair.		
Comp	oute 🗸 🗸	mstances	Source	+ Create Key Pair		
	Overview		Flavor	Allocated		Filter
	Images	Instance Name Image	Networks	Name Fingerprint	State Time since created	Actions
	Key Pairs		Network Ports	> hpcsa-course-vm-key 6f.df.06:80:09:b4:64:cc:cf:00:27:aa:ab:td:11		
	Server Groups		Security Groups	Displaying 1 item		
Volum	nes 🗲		Configuration	✓ Available Select one		
Netwo	rork >		Server Groups	Q Click here for filters.		
Orchestr	tration >		Scheduler Hinte	Displaying 5 items		
Identity	>		Materiale	Name Fingerprint		
			metadata	> delete-me 39:d8:79:ff:78:12:e2:21:84:39:dc:86	i:7d:08:df:ae	
				> Home PC 55:dd:tc:8d:83:e1:0d:cb:25:9a:6b:3	af2:41:ec:b7	
				> Laptop 19:2b:af:bc:b5:61:b8:a5:2f:29:81:61	:7f:37:09:8e	
				m26- f0d4a147834c551ac9229d399cc2cc988796dd2af9801372775a5a987f1f0050 2b:97.63:d3:39:32:54:ed:e5:7e:15:	6:90:18:92:d2 <b>•</b>	
				test-master1- dad3aed7abb58b026ed0168a3fc7951b1b5d509ea98c88l313c3d5296b4b9719 e3:73:88.0f:ae:fb:6a:37:24:9f:a5:69	:19:32:1e:a4	
				Displaying 5 items		
			X Cancel	(Back Next) & Launch Instance		

Figure 16: Launch Instance Key Pair for Cluster-Manager

and select Associate Floating IP from it as shown in Figure 19.

- 2. In the new dialog, click on the plus sign next to the **IP Address** drop-down menu, as shown in Figure 20, to allocate a new IP address.
- 3. In the following dialog, press Allocate IP without changing anything as shown in Figure 21.

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Project		~	Proj	ject / Compute / Instar	nces												
	Compute	API Access	Ins	stances													
		Overview															
		Instances									Instance ID = 🕶		Filter	Launch Instance 🛛 🛍 Dele	e Instances	More Actio	ons 🕶
		Images	Displ	aying 1 item													
		Key Pairs		Instance Name	Image Name	IP Address	Flavor	Key Pair	Status		Availability Zone	Task	Power State	Time since created	Actions		
	Ser	ver Groups	D	cluster-manager	-	10.254.1.26	m1.large	hpcsa-course-vm-key	Build	•	nova	Block Device Mapping	No State	0 minutes	Associate	Floating IP	•
	Volumes	>	Displ	aying 1 item													
	Network	>															
	Orchestration	>															
Identity		>															

Figure 17: Cluster-Manager Instance is Launching

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Project  API Access Compute	Project / Compute / Instance	35										
Overview							Instance ID =	•		Filter	Launch Instance	Delete Instances More Actions -
Images	Displaying 1 item											
Key Pairs	Instance Name	Image Name	IP Address	Flavor	Key Pair	Status	Avai	lability Zone	Task	Power State	Time since create	d Actions
Server Groups	Cluster-manager	-	10.254.1.26	m1.large	hpcsa-course-vm-key	Active	= nova		None	Running	1 minute	Create Snapshot -
Volumes >	Displaying 1 item											
Network >												
Orchestration >												
Identity >												



- 4. You are returned to the previous dialog, where an IPv4 address is now shown under the **IP Address** drop-down menu as shown in Figure 22. Confirm the association by pressing **Associate**.
- 5. In the instances overview you should now see two IP addresses for your **cluster-manager** instance in the respective column as shown in Figure 23. Make a note of the IP noted after **Floating IPs** as you will need it in the next step.

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Project  API Access Compute Overview	Project / Compute / Instances								
Instances Images Key Paire	Displaying 1 item	IP Address Flavor	Key Pair	In	stance ID = ▼ Availability Zone	Task	Filter Power State	Launch Instance	Actions
Server Groups Volumes > Network > Orchestration >	cluster-manager - Displaying 1 item	10.254.1.26 m1.large	hpcsa-course-vm-key	Active =	ି nova	None	Running	4 minutes	Create Snapshot   Associate Floating IP Attach Interface Edit Instance Attach Volume Update Metadata
									Edit Bocurity Groups Edit Port Geourity Groups Console View Log Pause Instance Suppend Instance Shelve Instance Lock Instance Lock Instance Hard Reboot Instance Hard Reboot Instance Paebull Instance Delete Instance

Figure 19: Cluster-Manager Actions Drop-Down Menu

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Project	~	Project / Compute / Instances		Manage Floating IP Associations		×					
	API Access Compute 🗸	Instances		IP Address * No floating IP addresses allocated • +	Select the IP address you wis selected instance or port.	sh to associate with the					
	Overview			Port to be associated * Cluster-manager: 10.254.1.26				Filter	Launch Instance		More Actions -
	Images Kor Pairs	Displaying 1 item	Image Name			Cancel Associate	Task	Power State	Time since cre	ated A	ctions
	Server Groups	Cluster-manager	-	10.254.1.26 m1.large hpcsa-course-vm-key	Active 🔊	nova	None	Running	4 minutes		Create Snapshot 👻
	Volumes > Network >	Displaying 1 item									
C	Orchestration >										
Identity	,										



## Connect to Instance with SSH

This section shows how to use SSH and your SSH key to connect to your VM.

1. Find the **hpcsa-course-vm-key.pem** you downloaded in your **Downloads** folder or where you have saved it and move it into your user folder.

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Project 🗸	Project / Compute / Instances	Allocate Floating IP	×			_	
API Access Compute 🗸	Instances	Pool * public	Description:				
Overview Instances		Description	Project Quotas Floating IP 0 of 3 Used		Filter	▲ Launch Instance a Delete	Instances More Actions +
Images Key Pairs	Displaying 1 item Instance Name Image Name			Task	Power State	Time since created	Actions
Server Groups	cluster-manager - Displaying 1 item		Cancel Allocate IP	None	Running	4 minutes	Create Snapshot -
Orchestration >							
Identity >							



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Project			_	Manage Floating IP	Associations		×	_			
i Tojoot	API Accoss	Project / Compute / Instance	S	ID Address 1							
	Compute	Instances		141.5.102.26	<b>•</b> +	Select the IP address you wish to as selected instance or port.	sociate with the				
	Overview			Port to be associated *							
	Instances			cluster-manager: 10.254.1.26	•				Filter	Launch Instance	
_	Images	Displaying 1 item									
	Key Pairs	Instance Name	Image Name			Car	cel Associate	Task	Power State	Time since cre	ated
	Server Groups	Cluster-manager		10.254.1.26 m1.large	hpcsa-course-vm-key	Active 🖆 no	/a	None	Running	4 minutes	
	Volumes >	Displaying 1 item									
	Network >										
	Orchestration >										
Identity	>										

Figure 22: Manage Floating IP Dialog with Allocated Floating IP

2. Open a terminal and confirm that you have **SSH** installed by following the platform specific instructions:

#### Windows 10/11

1. Search for **Powershell**, right click, run as administrator

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Project	API	► Access	Project / Compute / Instances	3										
	Compute O In	Verview Istances	Instances						Instance ID = •		Filter	Launch Instance	Delete Instances More Actions -	
	K	Images	Displaying 1 item	Image Name	IP Address	Flavor	Key Pair	Status	Availability Zone	Task	Power State	Time since created	Actions	
	Server	Groups	Cluster-manager		10.254.1.26 Floating IPs: 141.5.102.26	m1.large	hpcsa-course-vm-key	Active	⊫î nova	None	Running	18 minutes	Create Snapshot 💌	
c	Network Irchestration	> >	Displaying 1 item											

Figure 23: Instance Overview with Cluster-Manager with Floating IP



Figure 24: Connection to Cluster-Manager with SSH

- 2. Get-WindowsCapability -Online|Where-Object Name -like '\*SSH\*' If SSH client is not installed run the following command: Add-WindowsCapability -Online -Name OpenSSH.Client~~~0.0.1.0
- 3. Confirm that it works by running ssh -V

# MacOS/Linux

- 1. Search for **Terminal** and open it.
- 2. Check ssh is provided by running the command ssh -V

On MacOS/Linux you need to set the correct permission for the **hpcsa-course-vm-key.pem** key before it can be used with SSH.

Run chmod 600 hpcsa-course-vm-key.pem in the same folder as the key.

On Windows 11 you might get an error about the permission being to open when running SSH with the key. If that happens you can try the following workaround: Windows 11 SSH Permission Workaround

- 1. Select hpcsa-course-vm-key.pem and open properties. (Shortcut: Alt + Shift)
- 2. Go to Security  $\rightarrow$  Edit.
- 3. Remove all users except Administrators.
- 4. Click on Apply and OK.
- 5. Now open PowerShell as administrator
- 6. Run the code below

```
# Set Key File Variable:
New-Variable -Name Key -Value "$env:UserProfile\.ssh\known_hosts"
# Remove Inheritance:
Icacls $Key /c /t /Inheritance:d
# Set Ownership to Owner:
# Key's within $env:UserProfile:
Icacls $Key /c /t /Grant ${env:UserName}:F
# Key's outside of $env:UserProfile:
TakeOwn /F $Key
Icacls $Key /c /t /Grant:r ${env:UserName}:F
# Remove All Users, except for Owner:
Icacls $Key /c /t /Remove:g Administrator "Authenticated Users"
BUILTIN\Administrators BUILTIN Everyone System Users
# Verify:
Icacls $Key
# Remove Variable:
Remove-Variable -Name Key
```

Note: If the code above does not work, try again with the full path to the ssh known\_hosts file instead of using a variable.

#### Using SSH

- 1. In PowerShell or Terminal type the following command ssh -i hpcsa-course-vm-key.pem -o ServerAliveInterval=60 cloud@YOUR\_IP where YOUR\_IP is the IP address you got earlier.
- 2. When asked whether you want to continue, type in **yes** . See Figure 24 for comparison.
- 3. Confirm that running hostname returns cluster-manager.novalocal.

#### Launch Worker Instances

This section shows how to launch two worker instances at once.

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Compute     C		Please provide the initial hostname for the instance, the availability zone where it will b count. Increase the Count to create multiple instances with the same settings. Instance Name * worker Description Count * 2	be deployed, and the instance (3 Max) (100%) 11 Current Usage 2 Added 0 Remaining	Launch Instance     Celete (not)      Time since created      18 minutes	nogs More Actions + Actions Create Snapshot +
Orchestration	Server Groups Scheduler Hints Metadata ¥ Cancel	(Back N	Next ) 🕰 Launch Instance		

Figure 25: Launch Instance Details for Workers

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Compute     C	A https://cloud gwdg.de/hori/      DG_AGC_HPCSA_CONTP      Project / Compute / Instances      Instances      Displaying 1 item      cluster manager      Displaying 1 item      D	tort/project/instances/	Instance source is the template used to create snapshof), a volume or a volume snapshot (if e new volume. Select Boot Source [mage Volume Size (OB) * 5 Device Name vda Allocated Name > CentOS Stream & Senser vRi. 64 (cent)	an instance. You can u nabled). You can also	use an image, choose to use New Volume No Volume on In No Size	a snapshot of o persistent sto matance Delet Type B row	an instance (image rage by creating a e Visibility	Filter 🕰 Launch		Image: second secon
Circhestration		Scheduler Hints Metadata	Centod dateant of derive Add_der (add) Available  Q Click here for filters. Name AlmaLinux 8.8 Server x86_64 (add) AlmaLinux 9.2 Server x86_64 (add) Alpine CD CentOS 7.2009 Server x86_64 (add) CentOS Stream 9 Server x86_64 (add) Debian 10.13 Server x86_64 (add) Debian 11.7 Server x86_64 (add)	Updated 6/1/23 3:36 PM 6/1/23 5:18 PM 6/1/23 5:26 PM 6/1/23 5:26 PM 6/15/23 7:27 AM 6/15/23 7:27 AM	Size 4.00 GB 4.00 GB 4.00 GB 4.00 GB 4.00 GB 4.00 GB	Type \ raw F raw F raw F raw F raw F raw F raw F raw F	Select one X Yisibility Public			

Figure 26: Launch Instance Source for Workers

- 1. Under the **Compute** tab, select **Instances** and press **Launch Instance**.
- 2. Set the name to **worker** and the **Count** to **2** as shown in Figure 25.

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Project			Launch Instance								×	_		
Project	API Access	Project / Compute / Instances	Details	Flavors manage the	he sizing for t	the compute, i	memory and sto	orage capacity o	of the instance.		Ø			
	Compute 🗸	Instances	Source	Name \	CPUS	RAM To	tal Disk F	Root Disk	Ephemeral Disk	Public				
	Overview		Flavor	> c1.small 2		2 GB 20	GB 2	20 GB	0 GB	Yes	•	Filter	Launch Instance	Delete Instances More Actions -
	Images	Displaying 1 item	Networks	✓ Available (	21					5	Select one			
	Key Pairs	Instance Name Imag	Network Ports	Q Click here	for filters.						×	wer State	Time since created	Actions
	Server Groups	Cluster manager	Security Groups	Name	VCPUS	RAM	Total Disk	Root Disk	Ephemeral Disk	Public		oping	18 minutos	Create Snanshot *
	Volumes >		Key Pair	> m1.small	1	2 GB	20 GB	20 GB	0 GB	Yes	•	in ing	io minutes	
	Network >	Displaying 1 item	Configuration	> c1.medium	4	4 GB	40 GB	40 GB	0 GB	Yes	•			
	Orchestration >		Server Groups	> m2.small	1	4 GB	20 GB	20 GB	0 GB	Yes	•			
Identity	>		Scheduler Hints Metadata	> m1.medium	2	4 GB	40 GB	40 GB	0 GB	Yes	•			
				> c1.large	<mark>▲</mark> 8	8 GB	80 GB	80 GB	0 GB	Yes	•			
				> m2.medium	2	8 GB	40 GB	40 GB	0 GB	Yes	•			
				> m1.large	4	8 GB	80 GB	80 GB	0 GB	Yes	•			
				> c1.xlarge	<b>A</b> 16	🔺 16 GB	160 GB	160 GB	0 GB	Yes	*			
				> m2.large	4	🛕 16 GB	80 GB	80 GB	0 GB	Yes	•			
				> m1.xlarge	▲ 8	🔺 16 GB	160 GB	160 GB	0 GB	Yes	•			
				> c1.xxlarge	A 16	🛕 32 GB	160 GB	160 GB	0 GB	Yes	•			
				> c1.2xlarge	A 32	🔺 32 GB	160 GB	160 GB	0 GB	Yes	•			
				> m2.xlarge	4	A 32 GB	160 GB	160 GB	0 GB	Yes				

Figure 27: Launch Instance Flavor for Workers

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Project	~	Project / Compute / Instances	Launch Instance			×		
	API Access Compute	Instances	Details Source	Select the security groups to launce <ul> <li>Allocated </li> <li>Name</li> </ul>	n the instance in. Description	Ø		
	Overview Instances	Diselation 1 inte	Flavor Networks	<ul> <li>&gt; default</li> <li>&gt; Internal</li> </ul>	Default security group	¥	Filter A Launch Instance	Delete Instances     More Actions
	Images Key Pairs Server Groups	Instance Name Imag	Network Ports Security Groups	✓ Available ①		Select one or more	wer State Time since o	reated Actions
	Volumes >	Cluster-manager -	Key Pair Configuration	Q Click here for filters.	Description	×	nning 18 minutes	Create Snapshot 👻
	Orchestration >	cooperating them	Server Groups	> SSH		•		
Identity	>		Scheduler Hints Metadata					
			X Cancel			KBack     Next>     Launch Instance		

Figure 28: Launch Instance Security Groups for Workers

- 3. Under source set again CentOS Stream 8 as the OS from the menu at the bottom and both Create New Volume and Delete Volume on Instance Delete to Yes as shown in Figure 26.
- 4. Move on to **Flavor** and set it to **c1.small** from the list as shown in Figure 27.
- 5. Proceed with **Security Groups** and add only the **Internal** group as shown in Figure 28.

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Project <ul> <li>API Access</li> <li>Compute</li> <li>Instances</li> <li>Instances</li> <li>Instance Name</li> <li>Images</li> <li>Server Groups</li> <li>Network</li> <li>Deplaying 1 item</li> <li>Chastance Name</li> <li>Images</li> <li>Instance Name</li> <li>Images</li> <li>Instance Name</li> <li>Images</li> <li>Chastance Name</li> <li>Images</li> <li>Chastance Name</li> <li>Images</li> <li>Chastance Name</li> <li>Images</li> <li>Images</li></ul>	Launch Instance : : : : : : : : : : : : : : : : : : :	
	Metadata         39:d8:79:47:812:#221.84:39:d           > delete-me         39:d8:79:47:812:#221.84:39:d           > Home PC         55:dd:6.8d.83:e1:0.dd:b.25:9:a6           > Laptop         19:2b:afac:b5:61:b8:a5:21:29.8           > m26: 1054:a1:47:834:c5:1a:63229:d599cc2cc98876dd2a/9801372775a5a897110050         2b:97:63:d3:39:32:54:ed:e5:7e: bad3deed7:ab558b026ed0168a3(c795:1b:1b:5d509ea98c88d313:c3d528b4b9719           e3:73:88:0fa:erb:6a:37:24:9fa:t         Displaying 5 Items	:88-7d 08 dTae → 38 d7 41 sec b7 → 161 77 137 09 80 → 151 1 60 18 32 sd2 → 151 1 60 18 18 18 18 18 18 18 18 18 18 18 18 18

Figure 29: Launch Instance Key Pair for Workers

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Project	<b>v</b>	Project / Compute / Insta	inces										
Ce	ompute 🗸	Instances											
	Overview Instances						Instance ID = •		F	ilter 🔷 Lau	inch Instance (Quota	exceeded) 🗊 Delete Insta	Inces More Actions -
	Images	Displaying 3 items											
	Key Pairs	Instance Name	Image Name	IP Address	Flavor	Key Pair	Status		Availability Zone	Task	Power State	Time since created	Actions
Ve	Server Groups	wor ker 2	10.254.1.21	c1.small	hpcsa-course-vm-key	Build	∎°	nova	Block Device Mapping	No State	0 minutes	Associate Floating IP -	
N	letwork	wor ker 1	10.254.1.11	c1.small	hpcsa-course-vm-key	Build		nova	Block Device Mapping	No State	0 minutes	Associate Floating IP	
Identity	>	Cluster-manager	-	10.254.1.26 Floating IPs: 141.5.102.26	m1.large	hpcsa-course-vm-key	Active	=^	nova	None	Running	53 minutes	Create Snapshot 💌
		Displaying 3 items											

Figure 30: Instance Overview with Workers Launching

- 6. In the next step for Key Pair set the hpcsa-course-vm-key as shown in Figure 29.
- 7. Press Launch Instance and wait for the system to provision the two worker instances as shown in Figure 30.
- 8. After a short while the two instances become available and reach the state Active as shown in Figure 31.

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	Serv	ver Groups	•	worker-2	-	10.254.1.21	c1.small	hpcsa-course-vm-key	Active	=	nova	None	Running	1 minute	C	eate Snar	pshot 👻
	Volumes	>	0	worker-1	-	10.254.1.11	c1.small	hpcsa-course-vm-key	Active	<u>ا</u>	nova	None	Running	1 minute	C	eate Snar	pshot 👻
	Network	>				10.254.1.26											
	Orchestration	>	0	cluster-manager	-	Floating IPs: 141.5.102.26	m1.large	hpcsa-course-vm-key	Active	<b>e</b> î	nova	None	Running	53 minutes	C	eate Snap	pshot 👻
Identity		>															

Figure 31: Instance Overview with Workers Running

## Connect to Worker Instance via the Main Instance

This section shows how to connect to your **worker** instances by jumping through your **cluster-manager**.



Figure 32: Connected to Worker through Cluster-Manager via SSH

- 1. Note down the IP addresses of the worker nodes from the instances overview as visible in Figure 31.
- 2. In PowerShell or Terminal type the following command:

ssh -i hpcsa-course-vm-key.pem cloud@YOUR\_WORKER\_IP

-o ProxyCommand='ssh -W %h:%p cloud@YOUR\_FLOATING\_IP

-i hpcsa-course-vm-key.pem'

where YOUR\_WORKER\_IP is the IP address of one of your **workers** and YOUR\_FLOATING\_IP is the floating IP address of the **cluster-manager**. See for comparison Figure 32.

By switching the IP of the workers in the command, you can connect to the other worker.

# 3 Useful Commands

## **Rebooting Instances**

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Server Groups		) worker-2	-	10.254.1.21	c1.small	hpcsa-course-vm-key	Active	L.	nova	None	Running	1 minute	Create Snapshot 👻
Volumes >	C	) worker-1		10.254.1.11	c1.small	hpcsa-course-vm-key	Active	÷	nova	None	Running	1 minute	Associate Floating IP Attach Interface
Network > Orchestration >		) cluster-manager		10.254.1.26 Floating IPs: 141.5.102.26	m1.large	hpcsa-course-vm-key	Active	<b>P</b>	nova	None	Running	53 minutes	Detach Interface Edit Instance Attach Volume Detach Volume
ioentry >	Di	splaying 3 items											Update Metadata Edit Security Groups Edit Port Security Groups Console View Log Pause Instance Suspend Instance Sheve Instance Restor Instance Lock Instance Lock Instance Hard Reboot Instance Hard Reboot Instance Restor Instance Betar Instance Deleste Instance



When working with VMs, it might be necessary to reboot them via an external command. Under **Compute** tab, select **Instances** and find the **Actions** drop-down menu for each of your instances. This menu contains the options **Soft Reboot Instance** and **Hard Reboot Instance**, which cause an instance to restart. See for reference Figure 33.

# **SSH** Port Forwarding

When deploying applications on one of your VMs that expose a web interface, e.g., a web page, you might need to open said interface in a web browser on your workstation. For this you have two options, you either open the port as shown in the instructions above for the SSH port, or you use SSH port forwarding. Opening the port, especially, globally, poses certain security risks and should not be done casually. This option also only works when the application is running on a port on your **cluster-manager** and not on one of your **workers**.

The alternative is to use SSH port forwarding. You can forward a port from your cluster-manager to your workstation as follows:

ssh -L REMOTE\_PORT:FLOATING\_IP:LOCAL\_PORT -o ServerAliveInterval=60

-i hpcsa-course-vm-key.pem cloud@FLOATING\_IP

Use the floating IP of the **cluster-manager** as FLOATING IP and the port the application is using on the **cluster-manger** as REMOTE\_PORT. As LOCAL\_PORT you can use any port that is open on your workstation, even the same number as remote port. Please note that on Linux machines, the port numbers up to 1024 are typically handled as privileged ports so assigned any of them will require root privileges. Alternatively, you can use a higher port locally such as having the remote port 80 forwarded to your local port 8080.

While the port forward is running, you should be able to access the forwarded application under localhost: LOCAL\_PORT.

It is also possible to forward the port of a worker to your workstation as follows: ssh -L REMOTE\_PORT:YOUR\_WORKER\_IP:LOCAL\_PORT -i hpcsa-course-vm-key.pem cloud@YOUR\_WORKER\_IP

```
-o ProxyCommand='ssh -W %h:%p cloud@YOUR_FLOATING_IP
```

```
-i hpcsa-course-vm-key.pem'
```

## **File Transfer**

You can use the scp command to transfer files from your system to one of your VMs and from one of your VMs to your local system as follows:

To upload to **cluster-manager**:

scp -i hpcsa-course-vm-key.pem LOCAL\_FILE cloud@FLOATING\_IP:/home/cloud

Instead of /home/cloud you can specify another location for your file on the VM.

To download from **cluster-manager**:

scp -i hpcsa-course-vm-key.pem cloud@FLOATING\_IP:PATH\_TO\_THE\_FILE .

The specifies the location where to place the downloaded file and means in the current folder. To download from a **worker**:

scp -i hpcsa-course-vm-key.pem LOCAL\_FILE cloud@WORKER\_IP:/home/cloud

-o ProxyCommand='ssh -W %h:%p cloud@YOUR\_FLOATING\_IP

-i hpcsa-course-vm-key.pem'

To upload to a **worker**:

scp -i hpcsa-course-vm-key.pem cloud@WORKER\_IP:PATH\_TO\_THE\_FILE .

-o ProxyCommand='ssh -W %h:%p cloud@YOUR\_FLOATING\_IP

-i hpcsa-course-vm-key.pem'