

Connecting with SSH

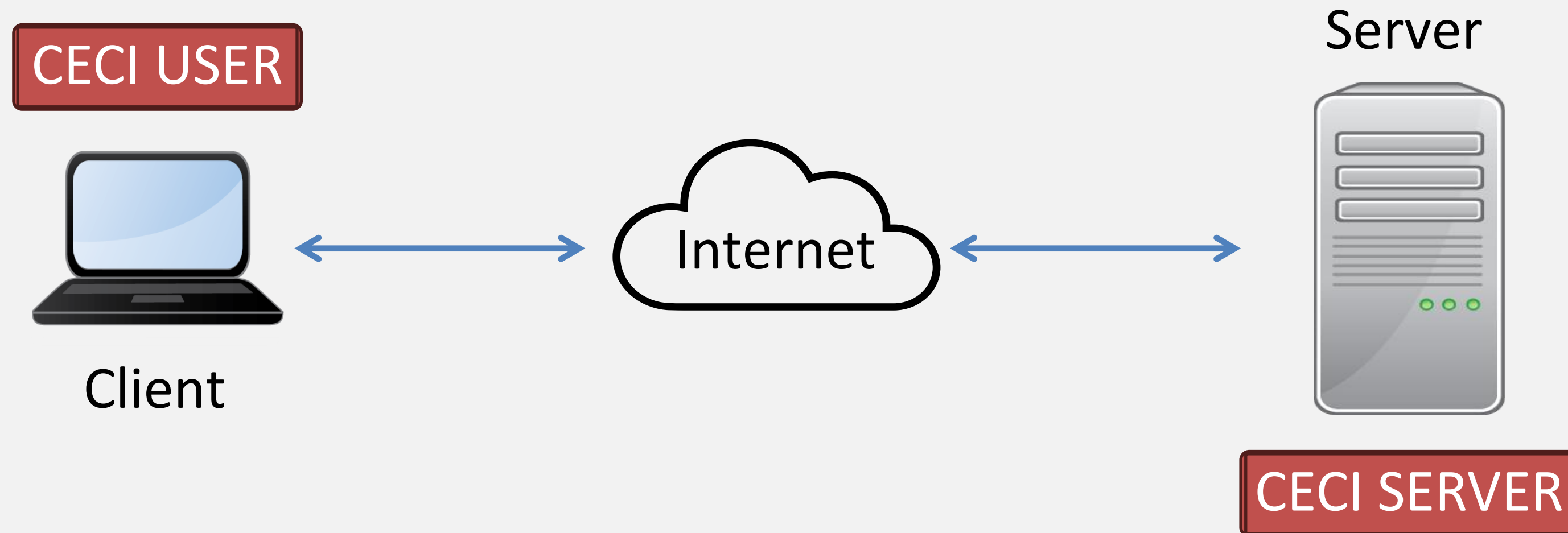
<https://indico.cism.ucl.ac.be/event/163/timetable>



SSH

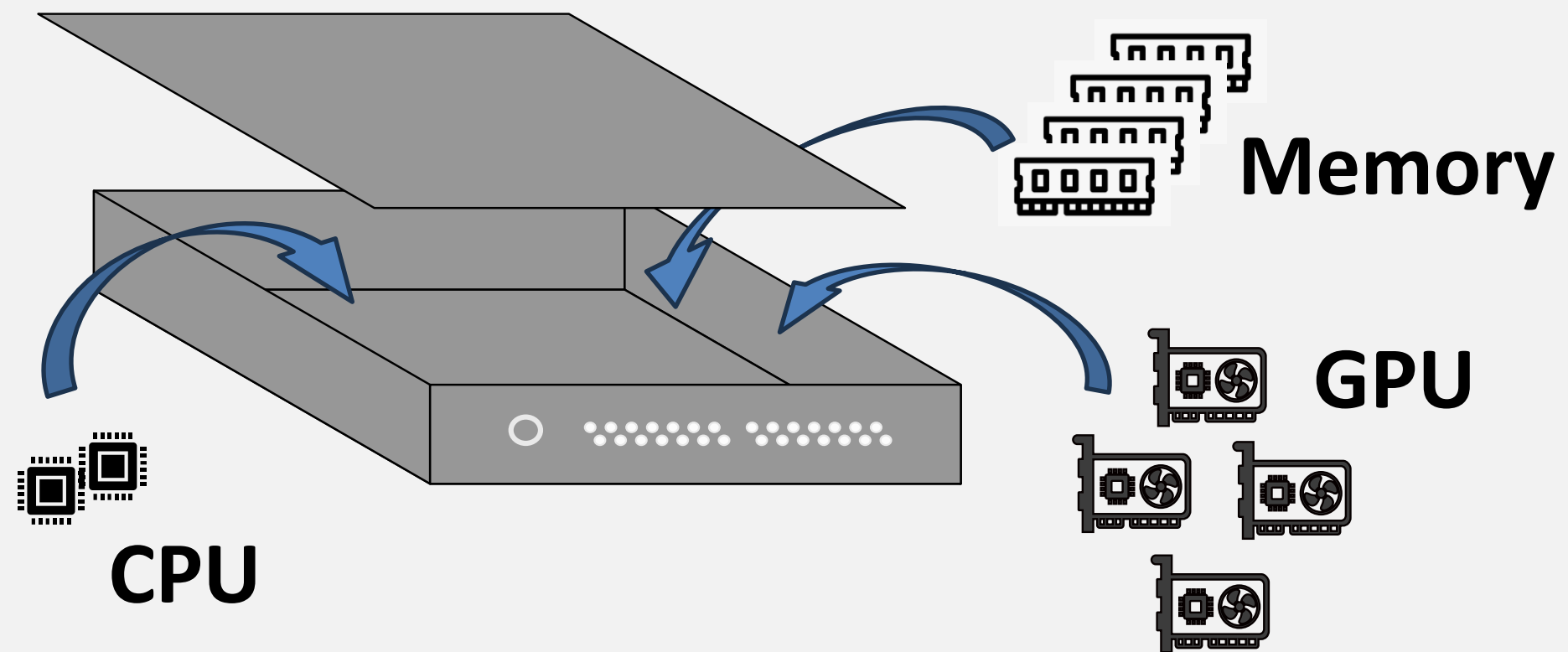
Secure Shell protocol

Client server model

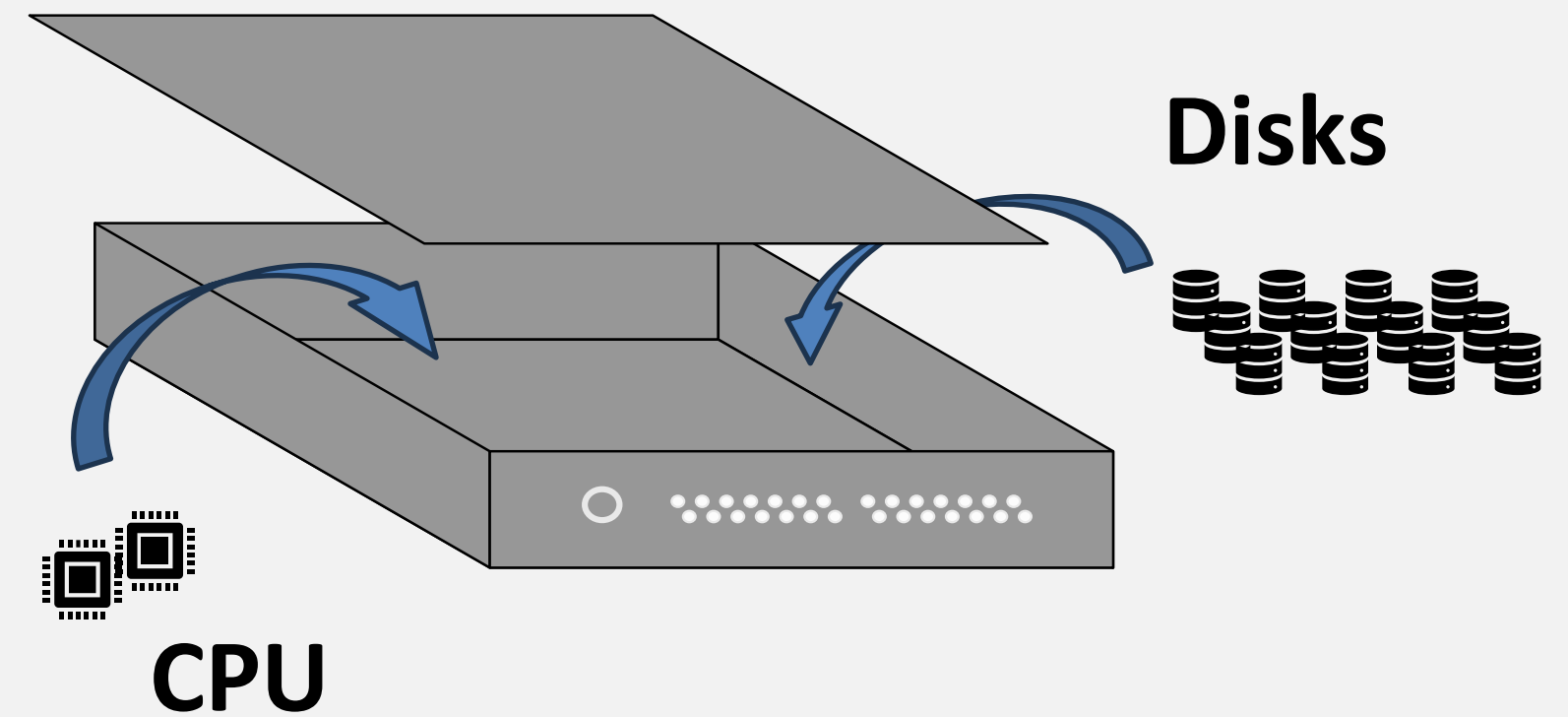


Context

Compute nodes for calculation



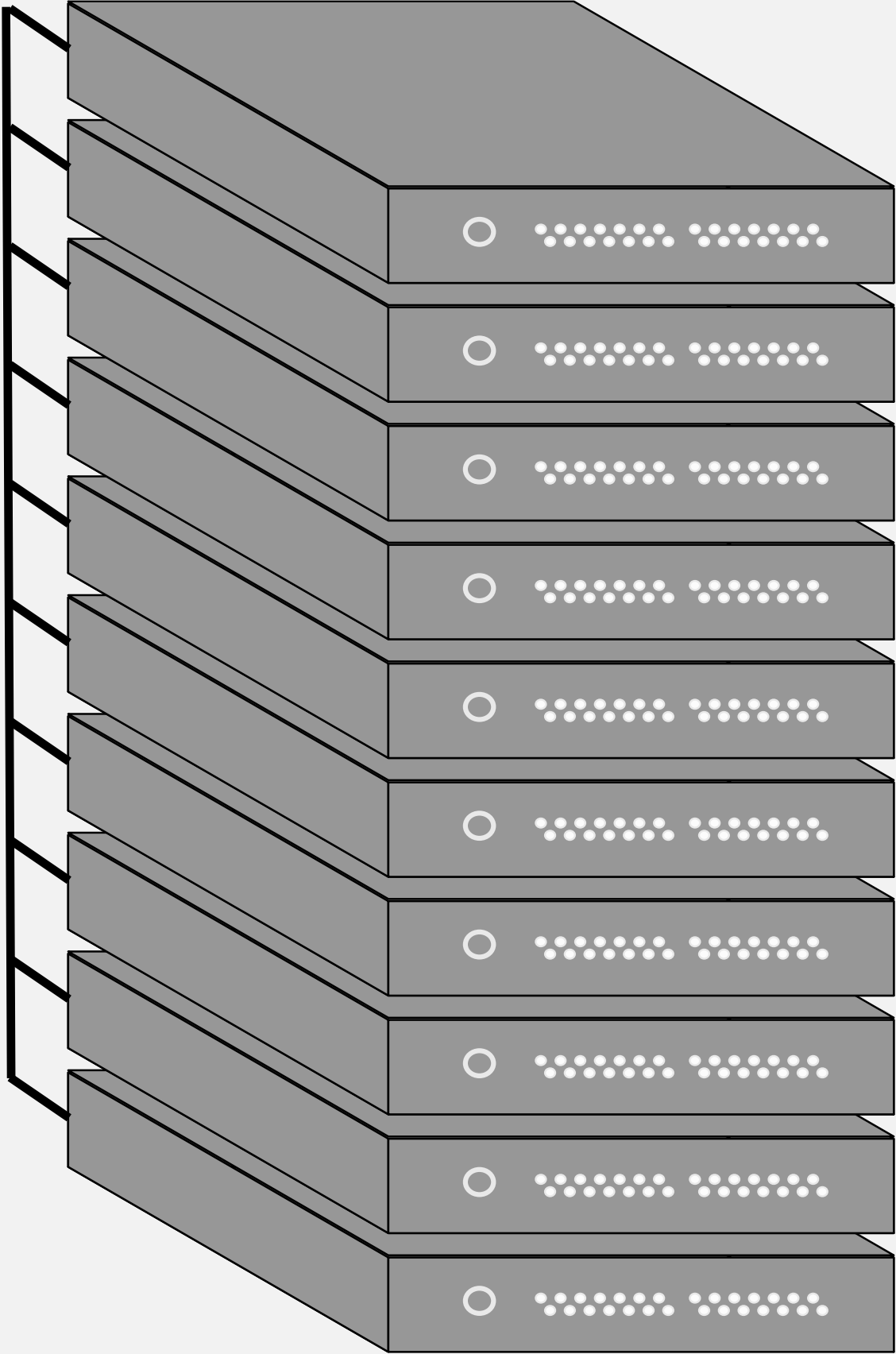
Storage nodes to save data files



Context

Cluster: stack of nodes

Fast Private network



Context

Cluster: stack of nodes



Fast Private network



Context

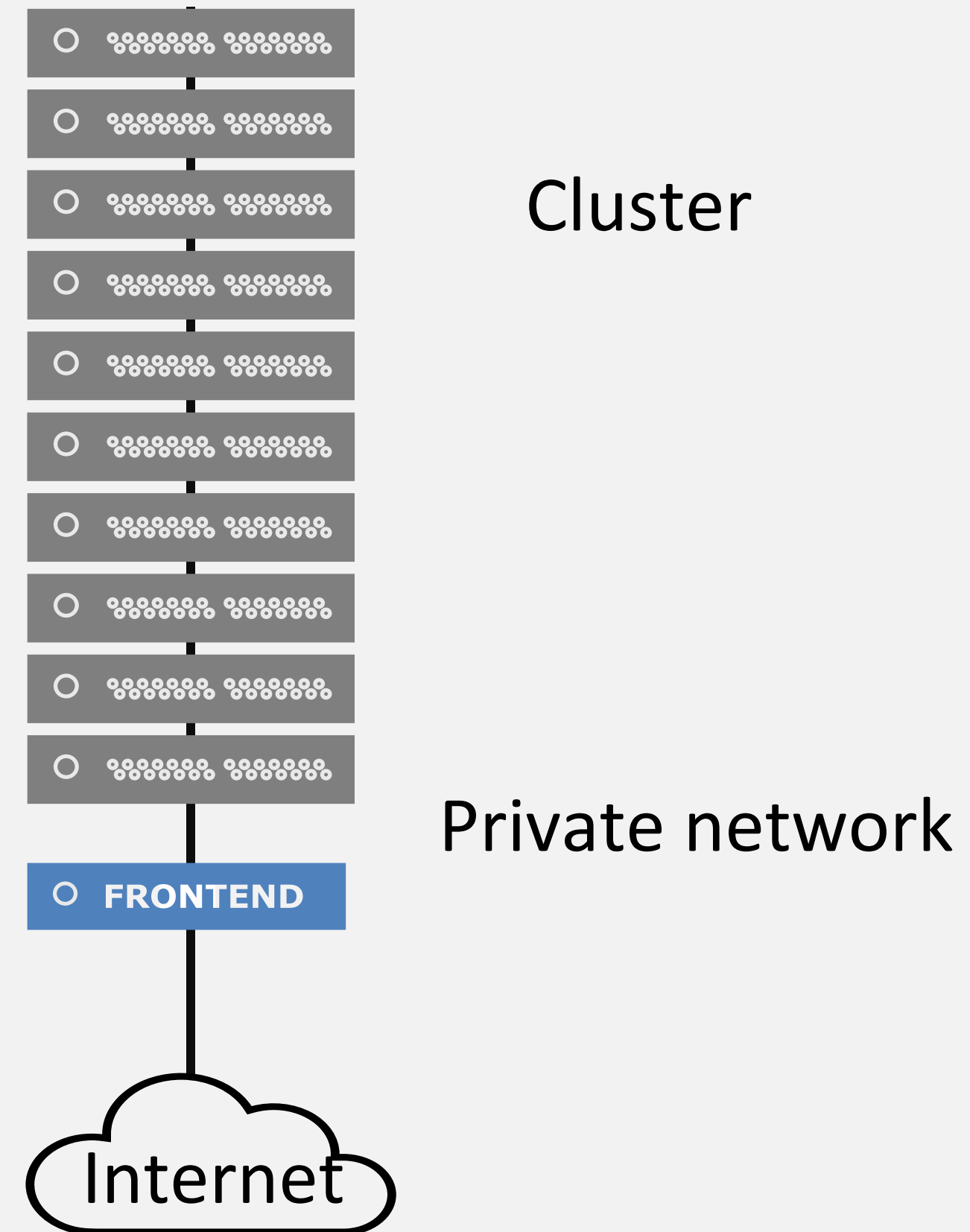
Frontend

You need to connect with SSH to the **frontend** to :

- **submit jobs** to the compute nodes (**SLURM**)
- **access** your results
- **edit** your files
- **compile (use debug partition)**
- **transfer** your data



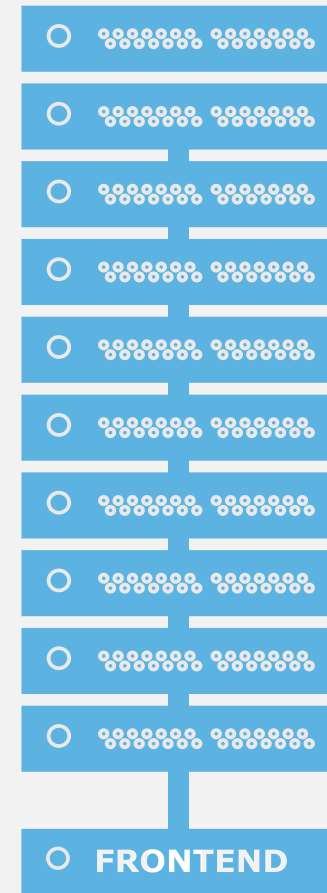
Do not run heavy jobs on the frontend



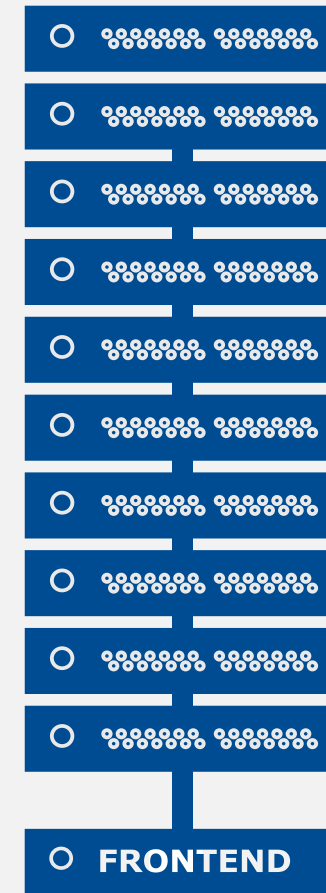
CÉCI Clusters

Context

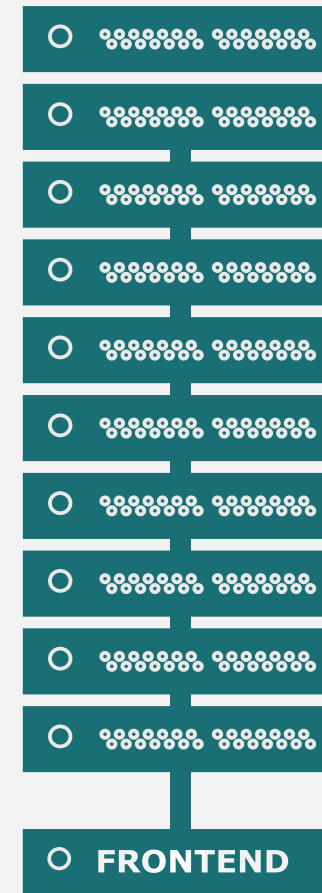
Lemaitre 4



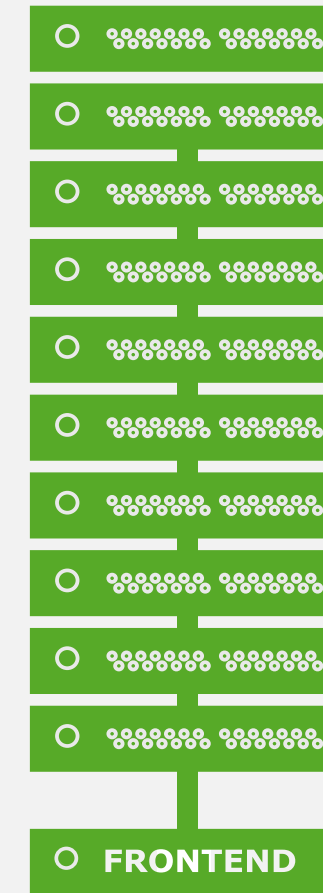
Lyra



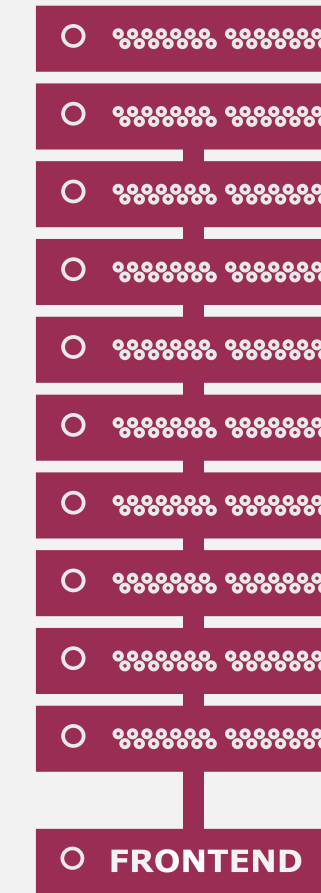
Nic5



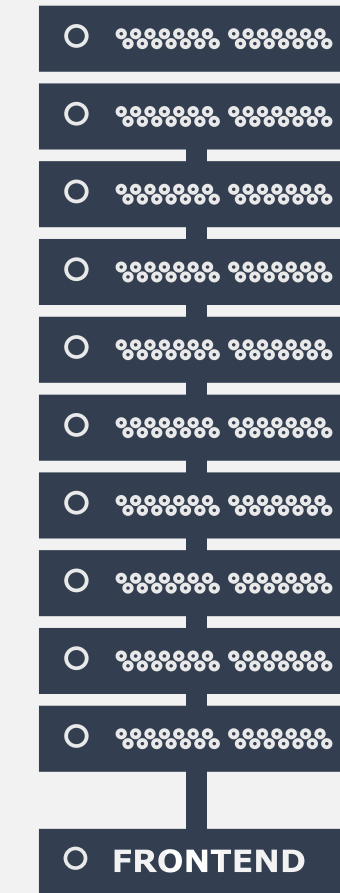
Hercules 2



Dragon 2



Lucia



5 CÉCI
Tier 2 clusters

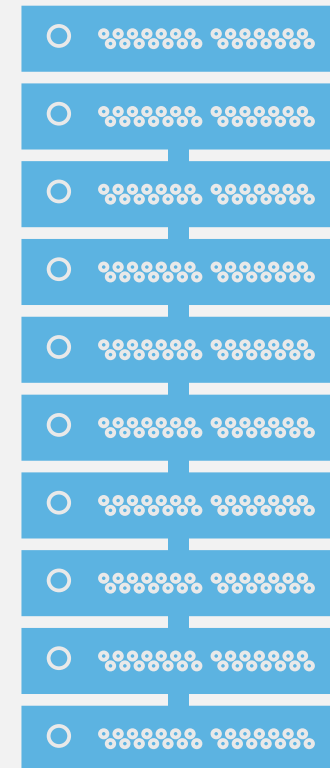
1 Cenaero
Tier 1 cluster



CÉCI Clusters

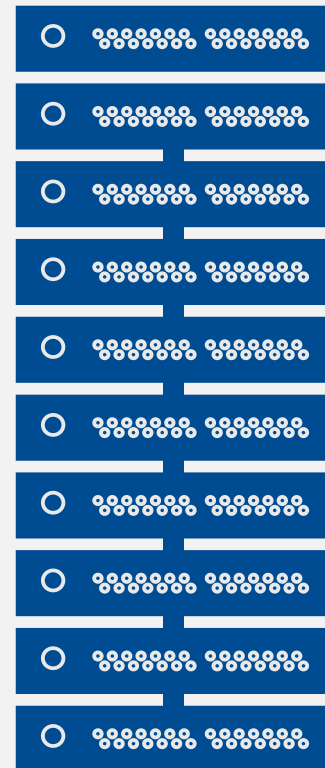
Context

Lemaitre 4



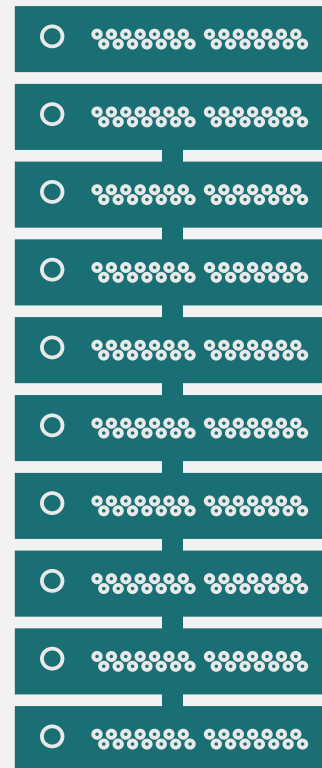
○ GATEWAY

Lyra



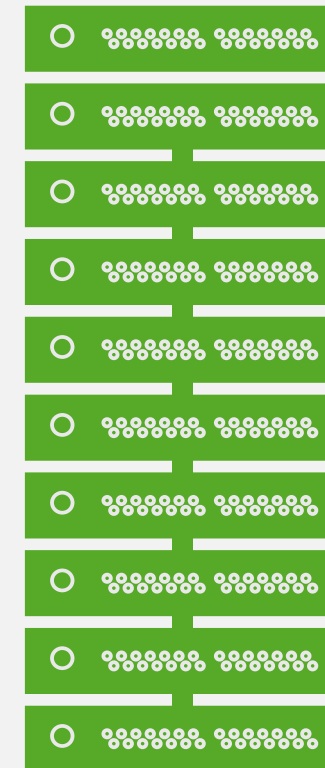
○ GATEWAY

Nic5



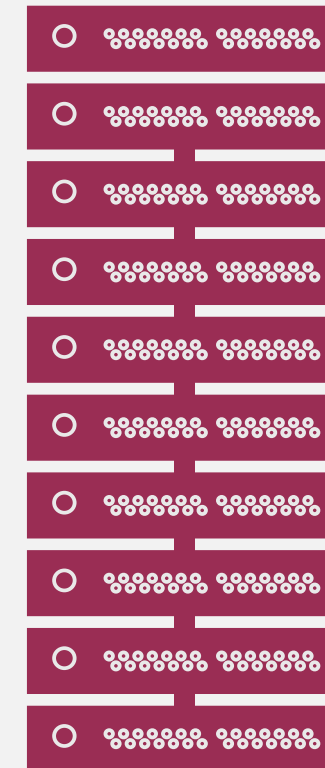
○ GATEWAY

Hercules 2



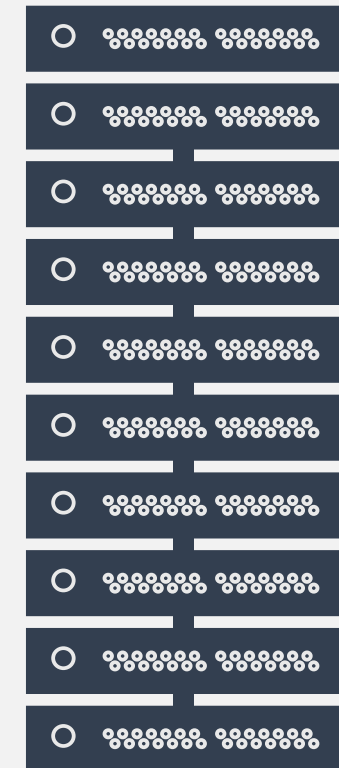
○ GATEWAY

Dragon 2



○ GATEWAY

Lucia

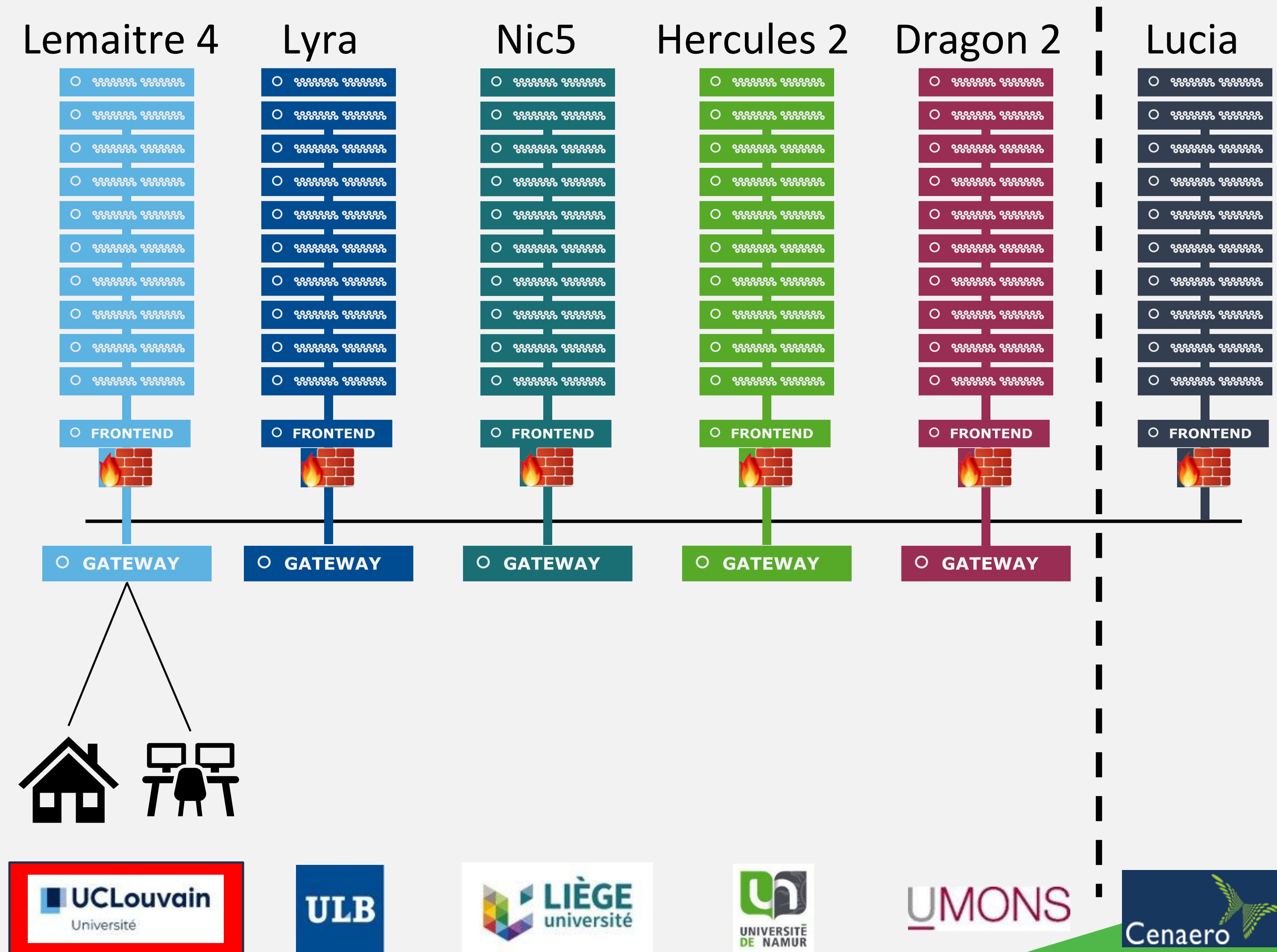


○ FRONTEND

Frontend Firewall rules
Access only through a Gateway

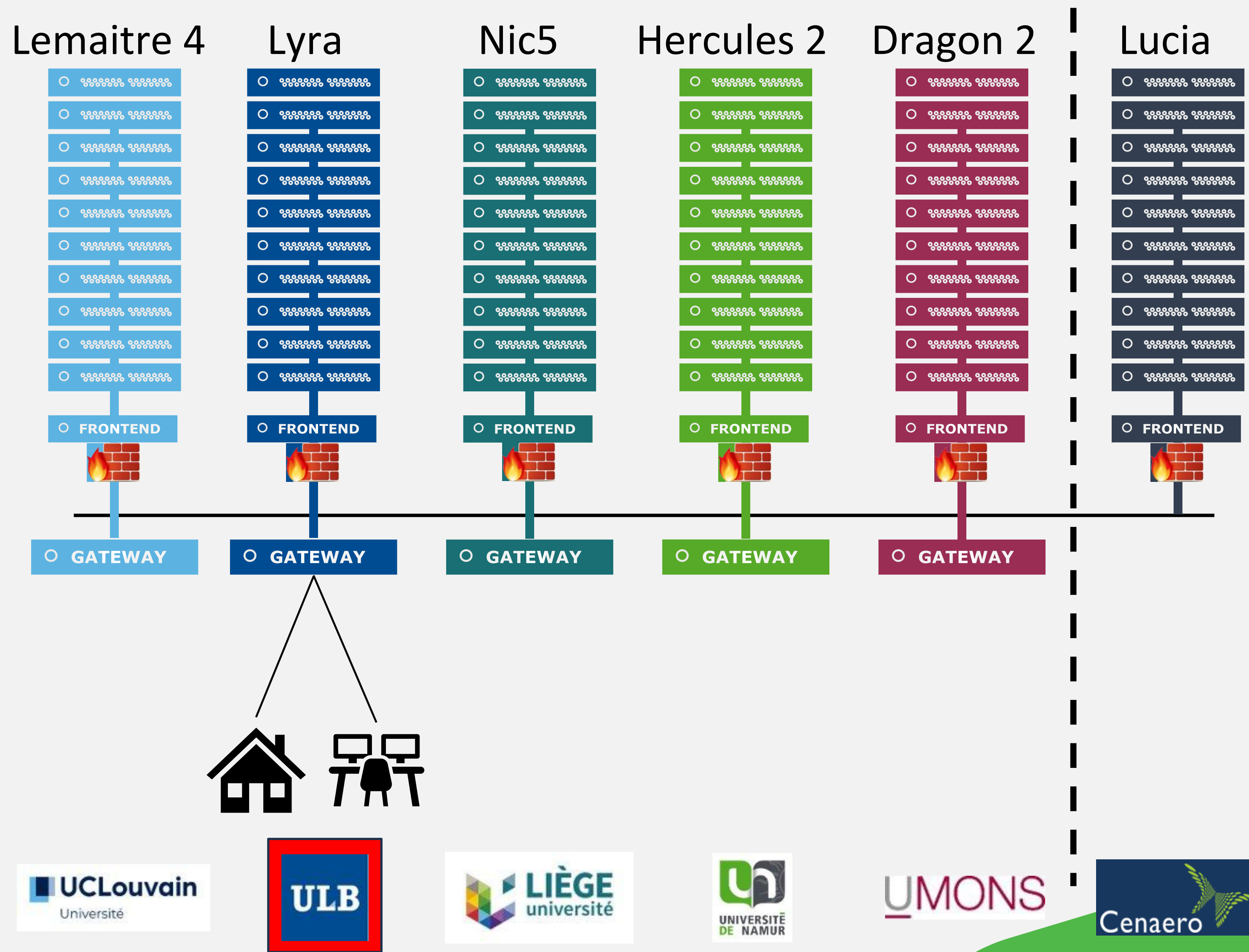
CÉCI Clusters

Context



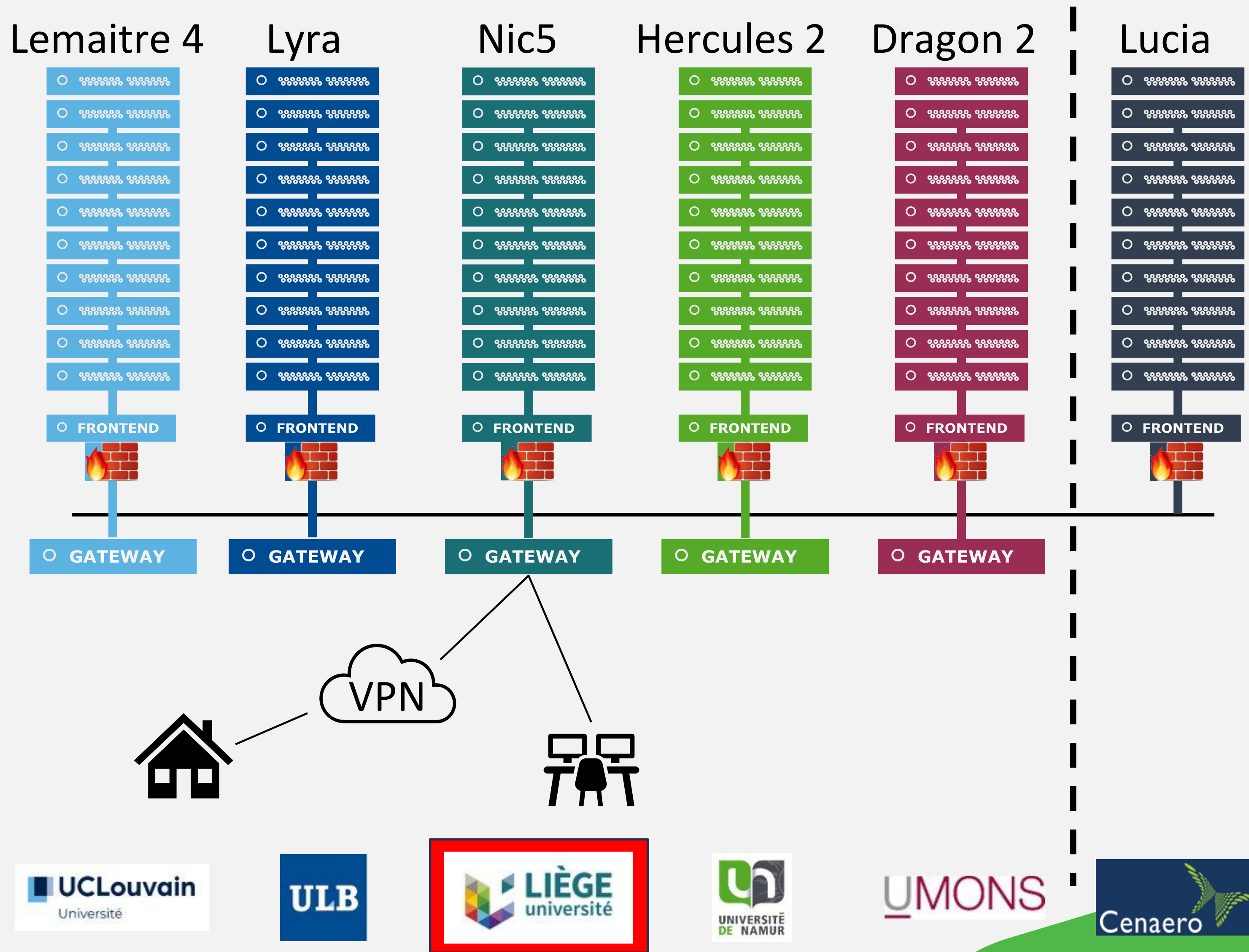
CÉCI Clusters

Context



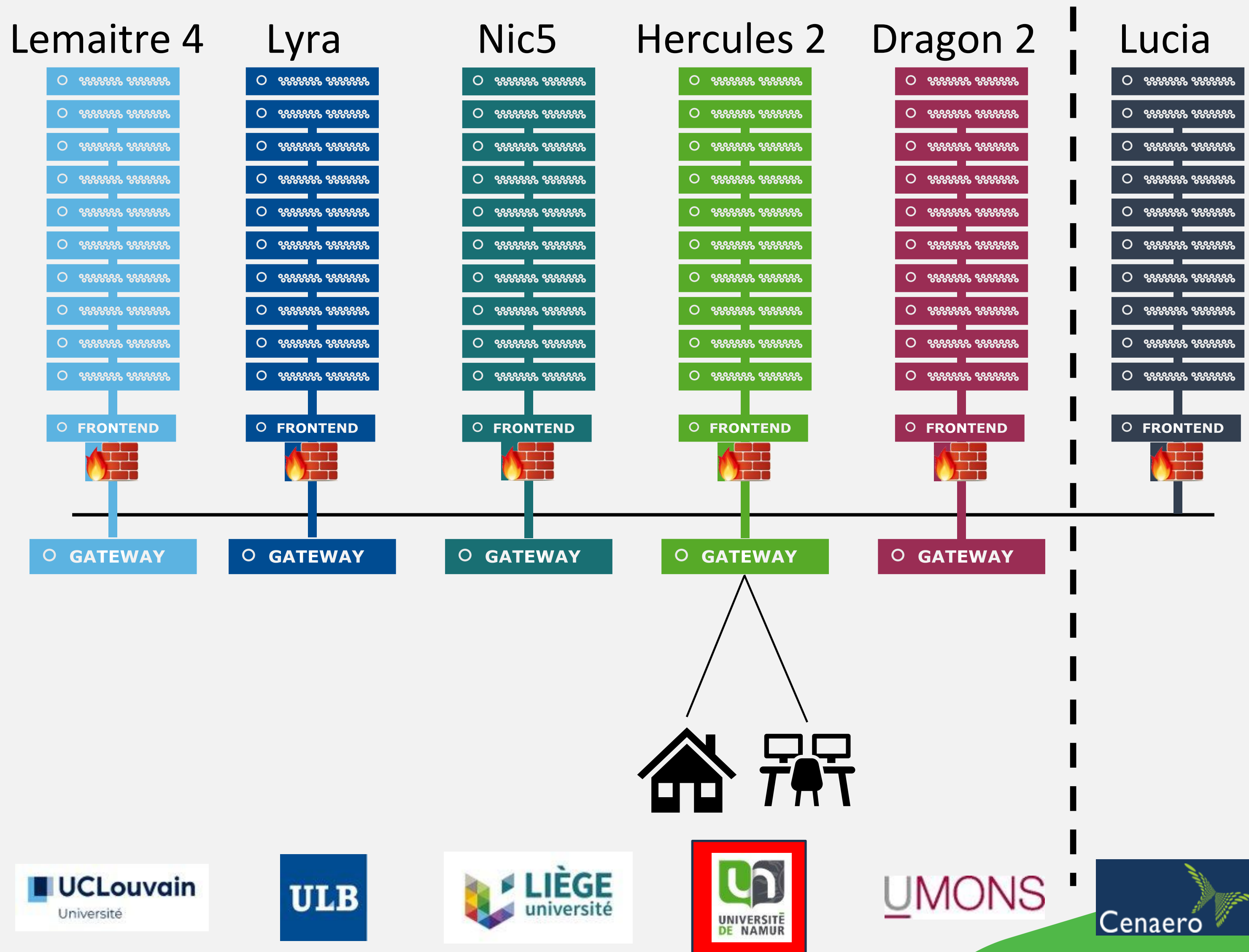
CÉCI Clusters

Context



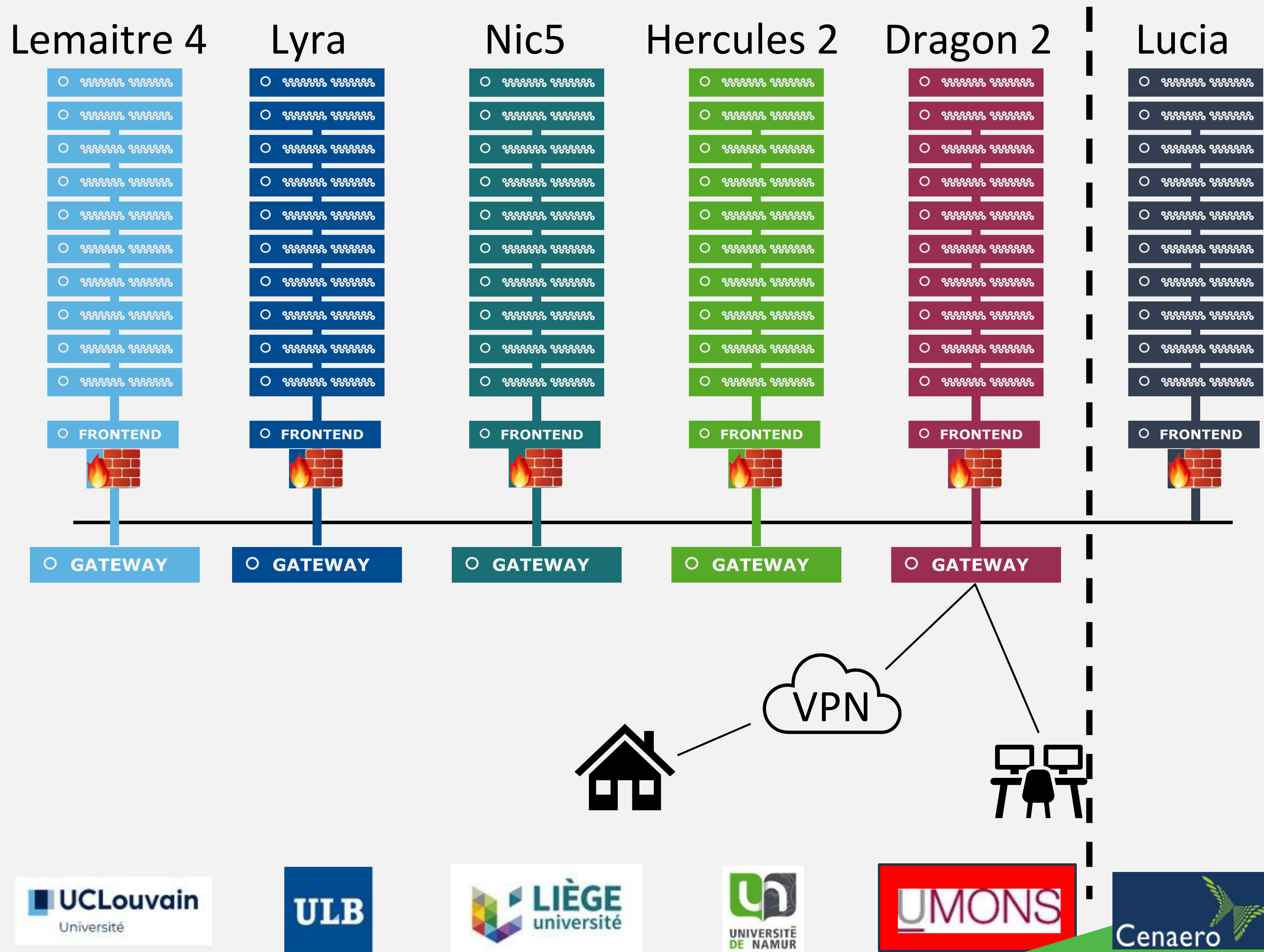
CÉCI Clusters

Context



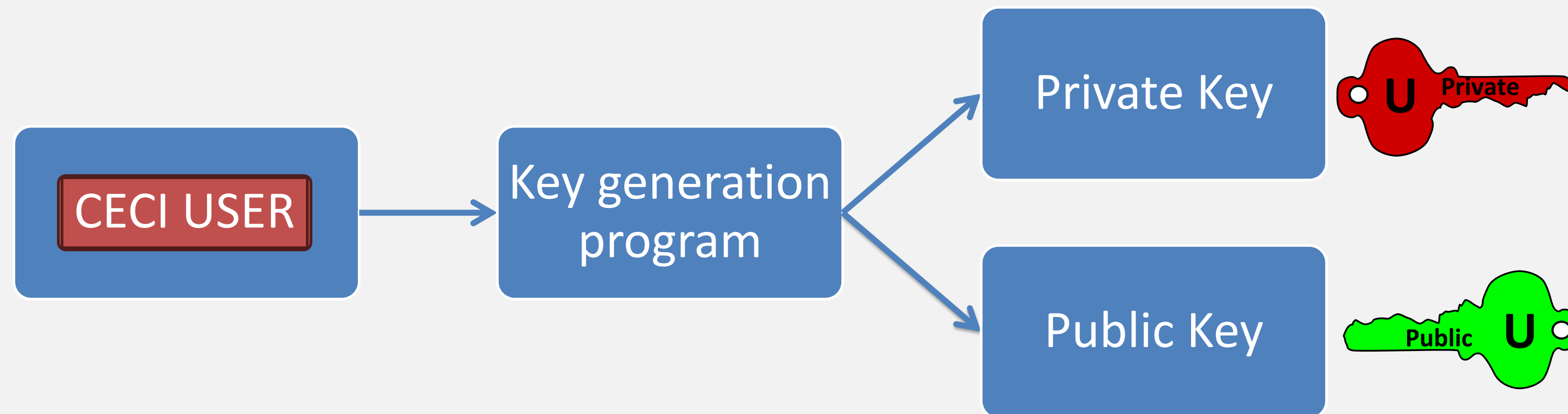
CÉCI Clusters

Context



Secure Shell protocol

Public-key cryptography for **authentication**

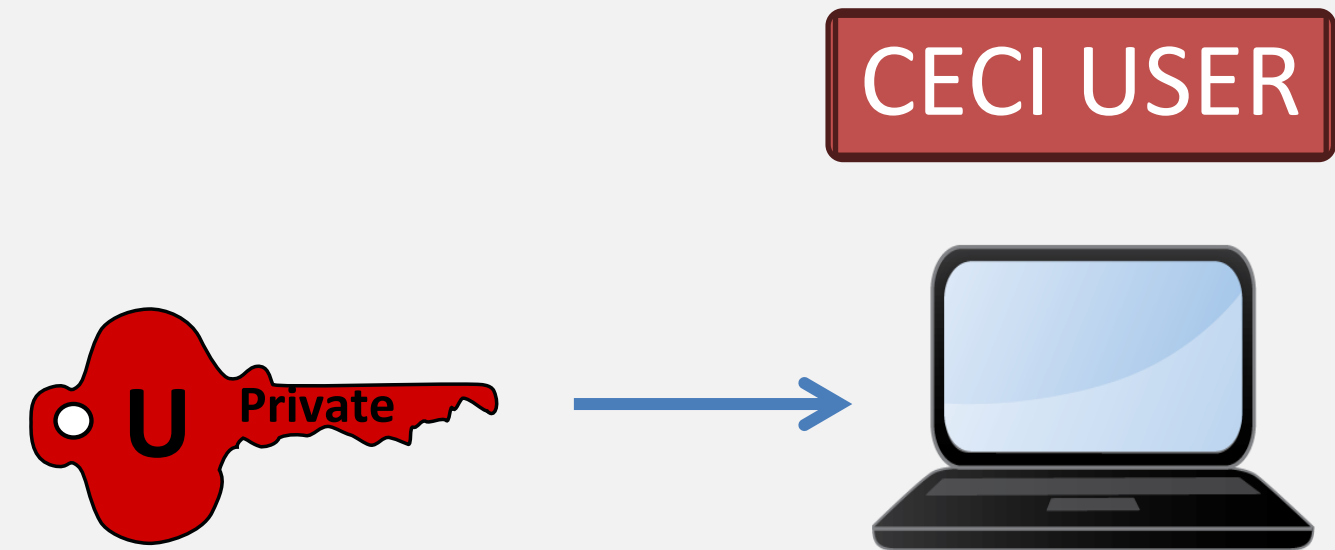


Secure Shell protocol

Public-key cryptography for **authentication**

Private key

- Proves your identity
- Encrypted with a passphrase for protection
- File named **id_<algorithm>** (e.g., id_rsa.cec)
- Used to sign messages or documents



Keep it secure:

- Store in a safe location
- Set correct file permissions

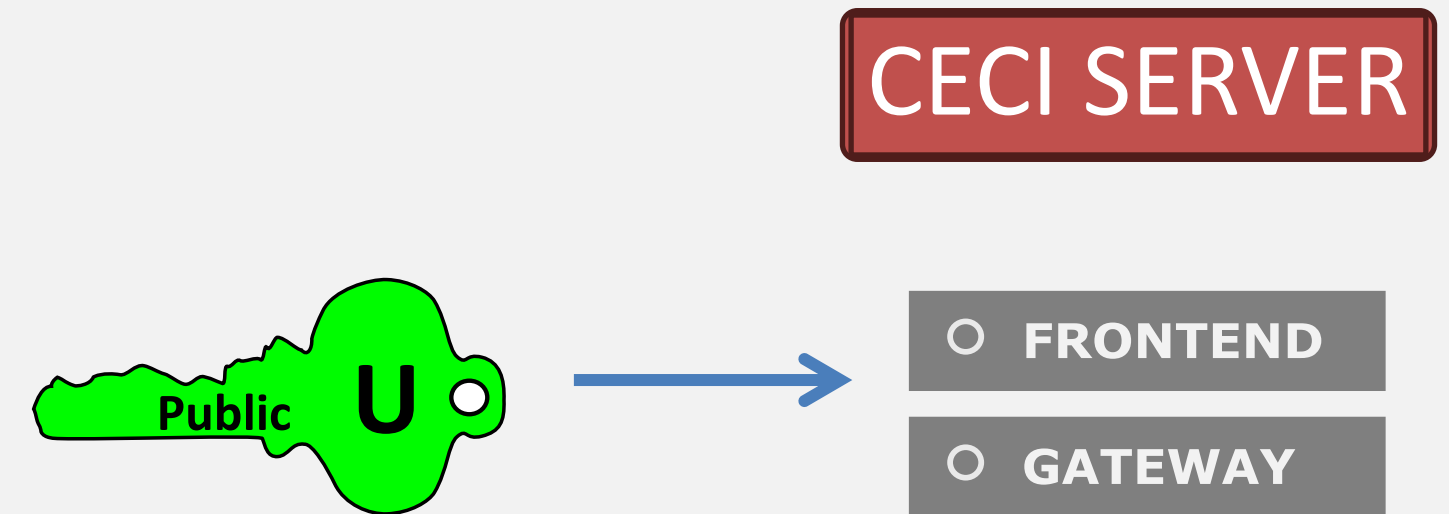
```
-----BEGIN OPENSSH PRIVATE KEY-----
b3BlbnNzaC1rZXktdjEAAAACmFlczI1Ni1jdHIAAAAGYmNyeXB0AAAAGAAAABAw9XHEY5
n25/tBVF33WGAgAAAAEAAAAAAEAAAIXAAAAB3NzaC1yc2EAAAADAQABAAQCAQK3dJeBAXne
X2wbh3hr51jRpEVbNJAuoav+DApUN4pvc2LVX+bSdorkO5Q8WOsmmfdD5KRWTaOzHnoMLQ
oodyVPXbQ0U3n7PKbWo4e6E6KDqr6hiADz/7k6CxuFENKaqJPEHQ+r8L2uI8hbi39jDW1g
...
...
qZArZOS6OMmQ7whVMdGLufJ0E3EWr1ooU4RgdbJLnaSAVjDZXsImWjHHjJsWHKqKM1ScXU
NkdGOO5LpOK3uFBvU+H4F+DYnZTBloa8VL3JNZy+MbDRUKwpreyy8gXqo9UvfV20HwjOr
NkE7jigKF+UJ9cceZs8XqNdmE=
-----END OPENSSH PRIVATE KEY-----
```

Secure Shell protocol

Public-key cryptography for **authentication**

Public key

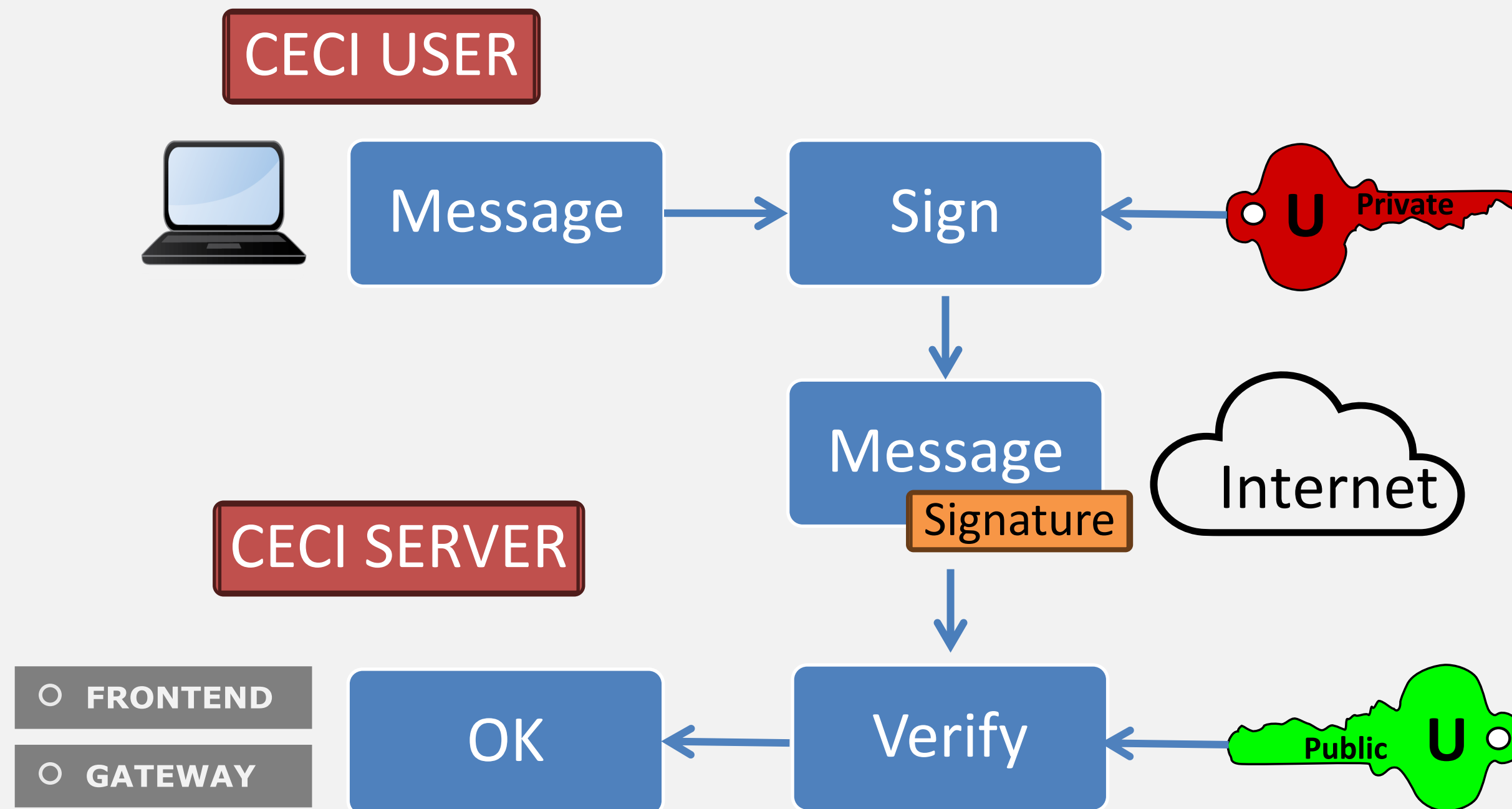
- Mathematically linked to the private key
- Installed on servers you want to access
- Used to verify your identity
- File named **id_<algorithm>.pub** (e.g., id_rsa.ceci.pub)
- Can also encrypt data (decryptable only with the private key)



```
ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAQK3dJeBAxneX2wbh3hr51jRpEVbNJAuoav+
DAPUN4pvc2LVX+bSdorkO5Q8WOsmmfdD5KRWTaOzHnoMLQoodyVPXbQ0U3n7PKbWo4e
...
ZGCTS/jY2i9QFUIp7+l1p9vqtNSVOulytwFfL7tU= relog@ceci-relog.segi.ulg.ac.be
```

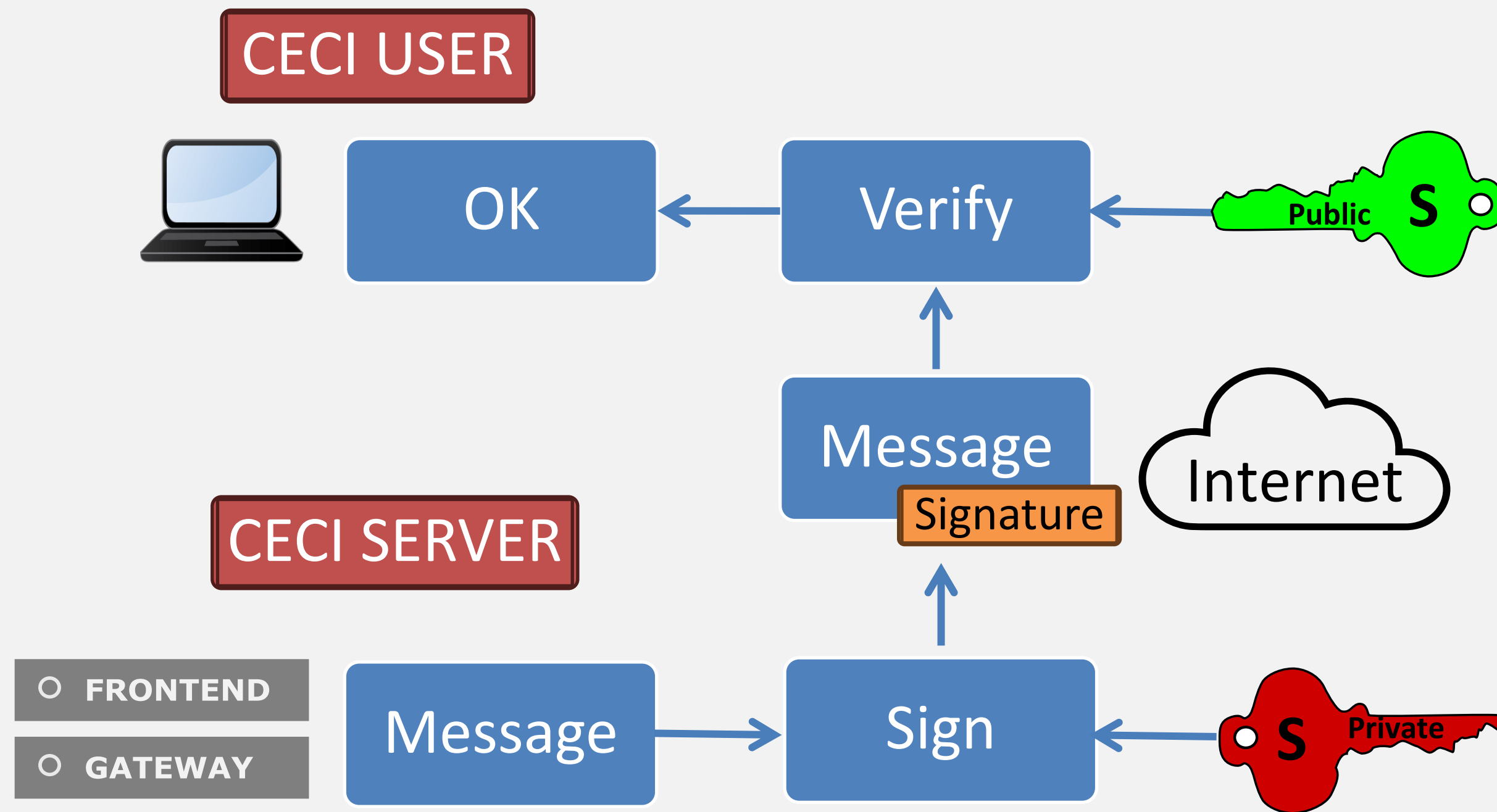
Secure Shell protocol

Public-key cryptography for **authentication**



Secure Shell protocol

Public-key cryptography for **authentication**



SSH

Secure Shell protocol

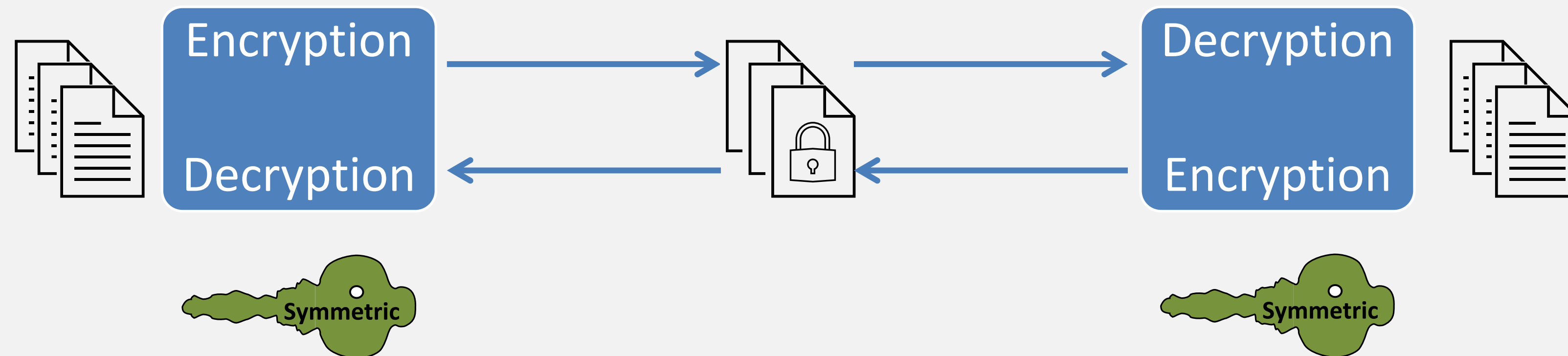
Encrypted communication and data transfer

CECI USER



CECI SERVER

- FRONTEND
- GATEWAY



Create an account and get your private key

CÉCI Account

Create an account and get your private key

CÉCI Clusters News Training FAQ Documentation Status Support Contact

Create/Manage Account

Access to the login management page will work only in Belgium

✓ Ok

CÉCI Consortium des Équipements de Calcul Intensif
6 clusters, 10k cores, 1 login, 1 home directory

CÉCI Login Management **FAQ**

I want to...

[create an account](#)

You are about to request an account on the CÉCI clusters.

The first step is to enter your email address. You will receive an email with a link to an online form which you will have to fill and submit.

Once your request has been approved, you will receive proper information on how to access the CÉCI clusters.

[renew my account](#)

[join an existing project](#)

create an account

My email address:

@uclouvain.be

Send

Create an account and get your private key

Click on the link sent to you by email and fill-in the form.

**Supervisor must have
a permanent academic
or scientific position**



1. Enter your information

First Name

Last Name

Email of Supervising Professor

 @unamur.be ▼

You are not allowed to give your own email address. We need a secondary contact. If you are the supervisor, please provide the email address of a trusted colleague.

2. Choose a credential

Login

The login must be between 4 and 8 characters long, can only contain lowercase letters, and must reflect your last name.

Passphrase

The passphrase must be at least 8 characters long and contain at least one figure, one uppercase letter and one special character

Please repeat Passphrase

3. Pick your affiliation

You need to choose your primary affiliation as recorded in the official directory of your university, down to the third level. Should an option be missing, please [contact us](#).

University

Université catholique de Louvain ➤

Département

Département des Sciences ➤

Unité / Laboratoire

Groupe de recherche sur les

Create an account and get your private key

Click on the link sent to you by email and fill-in the form.

UNamur users
Use your UNamur eid

1. Enter your information

First Name

Last Name

Email of Supervising Professor

 @unamur.be ▼

You are not allowed to give your own email address. We need a secondary contact. If you are the supervisor, please provide the email address of a trusted colleague.

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University	Département	Unité / Laboratoire
Université catholique de Louvain ➤	Département des Sciences ➤	Groupe de recherche sur les

Create an account and get your private key

Agree to the terms and conditions and submit

Only if you are
Member of a
Tier1 project

Universite de Mons

Université de Namur

Université libre de Bruxelles

Faculte de Medecine

Patrimoines, transmissions, heritages

appliquees et complexe

Unité d'analyse numérique

Unité de statistiques

4. Projects

Projects allow access to supplementary resources, a. o. the Tier-1 cluster. Please make sure you have the authorization from the project owner before choosing one. You will need to know the acronym of the project.

cecisys

Add project

☐ I have read and agree to the [terms and conditions](#).

5. Submit!

Once the form is completely filled-in, click the 'Send' button. A system administrator will review your request.

Send

If you want to save the current data and submit it later, click the 'Save' button.

Save

Create an account and get your private key

Wait ...

A sysadmin is reviewing your information



Create an account and get your private key

1. Sysadmin confirms the account.
2. Private and public key are generated
3. The private key is encrypted using the passphrase and **sent to you by email**



WARNING For security reasons

CÉCI does not keep a copy of your private key.

If you lose your key or passphrase or think it is compromised, you must **renew your CÉCI account** at

<https://login.cec-hpc.be>

Create an account and get your private key

Exercise :

Create your CÉCI account and get your public key

Create an account and get your private key

Save your identity file from the email and open a terminal

```
# Create .ssh directory and set your private key in your home folder.  
> mkdir -p ~/.ssh  
> mv ~/Downloads/id_rsa.ceci ~/.ssh  
# Set correct permission  
> chmod 600 ~/.ssh/id_rsa.ceci  
# Generate your public key file  
> ssh-keygen -yf ~/.ssh/id_rsa.ceci > ~/.ssh/id_rsa.ceci.pub
```

Create an account and get your private key

If you get “invalid format” or “error in libcrypto” error while generating the public key

```
# if you have dos2unix command  
> dos2unix ~/.ssh/id_rsa.cec
```

```
# if you do not have dos2unix  
> cp ~/.ssh/id_rsa.cec ~/.ssh/id_rsa.cec.bak  
> tr -d '\r' < ~/.ssh/id_rsa.cec.bak > ~/.ssh/id_rsa.cec
```

Creating your configuration file

- Go to the CÉCI wizard <http://www.cec-hpc.be/sshconfig.html>
- Fill the form
- Depending on your university, the number of inputs fields will change.
- Tick the field "Tier 1" if you have access to Lucia.

This page will help you create a valid and complete configuration file for your SSH client on Linux or MacOS. Just fill in the form below and copy paste the result in your ~/.ssh/config file.

Dropdown to choose University: UNamur

Your CÉCI login: ceciuser

Your UNamur eID login: gatewayuser

Do you have access to : Tier1 ☐

For UNamur members
your ceciuser = gatewayuser = your
UNamur Eid

Creating your configuration file

```
# University Gateway -----
Host gwceci
  Hostname gwceci.unamur.be
  User gatewayuser
  IdentityFile ~/.ssh/id_rsa.ceci

# CÉCI clusters -----
Host lyra lemaitre4 hercules nic5 dragon2
  User cecius
  ForwardX11 yes
  IdentityFile ~/.ssh/id_rsa.ceci
  ProxyJump gwceci
  ServerAliveInterval 120
  ServerAliveCountMax 100

Host lyra
  Hostname lyra.ulb.be
Host lemaitre4
  Hostname lemaitre4.cism.ucl.ac.be
Host hercules
  Hostname hercules.ptci.unamur.be
Host dragon2
  Hostname dragon2.umons.ac.be
Host nic5
  Hostname nic5.uliege.be
```

Your gateway server

Common properties to all frontends

Your private Key

Available frontend servers

GATEWAY

FRONTEND

FRONTEND

Creating your configuration file

Copy the result

Edit (nano, vi, emacs ...) a **.ssh/config** file and **paste** the result

```
# Create and edit the config file
> nano ~/.ssh/config
# Set correct permissions
> chmod 600 ~/.ssh/config
```

Creating your configuration file

Exercise:

Create your configuration file

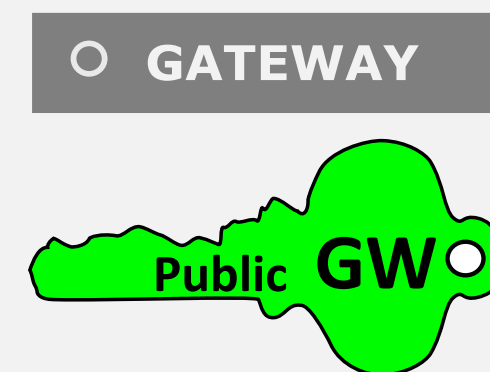
Connecting to a Frontend

Accept the public key of the CECI gateway
Stored in `~/.ssh/known_hosts` file

Connect to lemaitre4 frontend

```
> ssh lemaitre4
The authenticity of host 'gwceci.unamur.be (138.48.4.48)' can't be established.
RSA key fingerprint is SHA256:GfUSNZEfZg28WRCaxJvDNSCClhrX1IujNIky29ui7IY.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])?
```

Verify fingerprint and accept

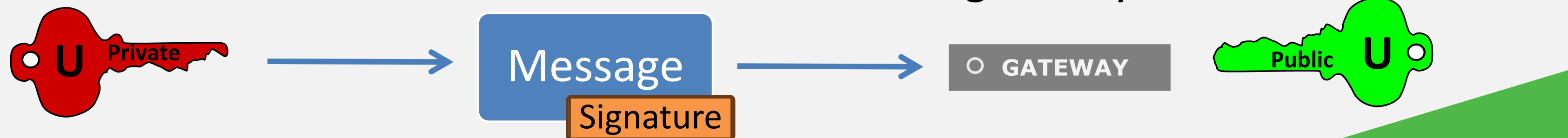


<https://support.ceci-hpc.be/doc/QuickStart/ConnectingToTheClusters/FromAUnixComputer/#gateways>

Connecting to a Frontend

Connect to lemaitre4 frontend

```
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RSA key fingerprint is SHA256:GfUSNZEfZg28WRCaxJvDNSCClhrX1IujNIky29ui7IY.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added 'gwceci.unamur.be' (RSA) to the list of known hosts.
Enter passphrase for key '/home/user/.ssh/id_rsa.ceci':
```



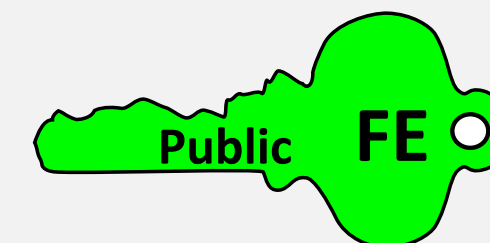
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Connect to lemaitre4 frontend

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This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added 'gwceci.unamur.be' (RSA) to the list of known hosts.
Enter passphrase for key '/home/user/.ssh/id_rsa.ceci':
The authenticity of host 'lemaitre4.cism.ucl.ac.be (<no hostip for proxy command>)' can't be established.
ED25519 key fingerprint is SHA256:mWlgUkE+tBNbklXLgvrt7pL/3Ohn7uidqFfBUU0fSkQ.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])?
```

○ FRONTEND

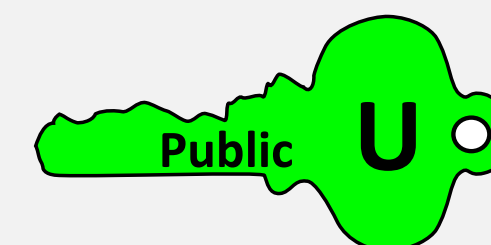
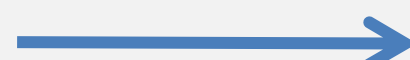
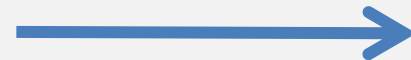
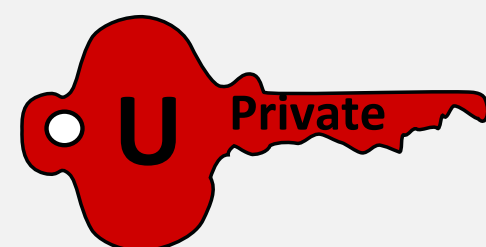


Connecting to a Frontend

Connect to lemaitre4 frontend

Decrypt your private key to sign a challenge message to authenticate to the Frontend

```
> ssh lemaitre4
The authenticity of host 'gwceci.unamur.be (138.48.4.48)' can't be established.
RSA key fingerprint is SHA256:GfUSNZEfZg28WRCaxJvDNSCClhrX1IujNlky29ui7lY.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added 'gwceci.unamur.be' (RSA) to the list of known hosts.
Enter passphrase for key '/home/user/.ssh/id_rsa.ceci':
The authenticity of host 'lemaitre4.cism.ucl.ac.be (<no hostip for proxy command>)' can't be established.
ED25519 key fingerprint is SHA256:mWlgUkE+tBNbklXLgvrt7pL/3Ohn7uidqFfBUU0fSkQ.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added 'lemaitre4.cism.ucl.ac.be' (ED25519) to the list of known hosts.
Enter passphrase for key '/home/user/.ssh/id_rsa.ceci':
```



SSH connection

Connecting to a Frontend

Connect to lemaitre4 frontend

Welcome to

```
/ _ _ _ ' _ / _ _ ( _ /
( _ ( / / ( / / / ( - /
```

...

...

~~~~~

196/10240 CPUs available (load 98%) - 154 jobs running, 3963 pending.

\* Job info for user ceciuser: 0 job running, 0 pending.

\*\* Account expiration: 2025-11-29

Don't know where to start?

--> [http://www.ceci-hpc.be/install\\_software.html](http://www.ceci-hpc.be/install_software.html)

--> [http://www.ceci-hpc.be/slurm\\_tutorial.html](http://www.ceci-hpc.be/slurm_tutorial.html)

[ceciuser@lm4-f001 ~]\$

## Connecting to a Frontend (X11 forwarding)

The **ForwardX11 yes** option in config file, allows you to run graphical programs on the frontend and display them on your local computer.

**Try it:** Connect to **lemaitre4** and run **xeyes** to test this feature.

```
[ceciuser@lm4-f001 ~]$ xeyes
```

macOS users need to install XQuartz ([www.xquartz.org](http://www.xquartz.org))



## Connecting to a Frontend

### Exercise:

Connect to **lemaitre4** frontend and execute **xeyes**

Use **ctrl-c** to stop xeyes

Use **exit** or **ctrl-d** to logout

### Try connection to other clusters:

ssh lyra

ssh hercules

ssh nic5

ssh dragon2



## SSH Agents, Passphrase managers

Use an SSH agent which will remember the passphrase so you do not have to type it in each time you issue the SSH command

```
# Check agent status
> ssh-add -l
# if you get this, your agent is not running
Could not open a connection to your authentication agent.
# if you get something like this, your private key is in memory
2048 20:6c:8c:cd:e8:e6:9b:4f:8c:9c:d6:8a:eb:37:6d:17 /home/user/.ssh/id_rsa.ceci (RSA)
```

## SSH Agents, Passphrase managers

You can start the agent and add the public key

```
# Start the agent
> eval $(ssh-agent)
# Add the private key
> ssh-add ~/.ssh/id_rsa.ceci
Enter passphrase for /home/user/.ssh/id_rsa.ceci:
Identity added: /home/user/.ssh/id_rsa.ceci (/home/user/.ssh/id_rsa.ceci)
# Check agent status
> ssh-add -l
2048 20:6c:8c:cd:e8:e6:9b:4f:8c:9c:d6:8a:eb:37:6d:17 /home/user/.ssh/id_rsa.ceci (RSA)
# Try connection
> ssh lemaitre4
```

## SSH Agents, Passphrase managers

You can have an ssh-agent started automatically at login by using password managing software such as

[Mac OS Keychain](#), [KDE KWallet](#), [Gnome Keyring \(Seahorse\)](#), etc.

Gnome Keyring loads all private keys in ~/.ssh folder **which have the corresponding public key.**

**Mac OS users.** Add those lines in the **config** file

```
Host *  
  AddKeysToAgent yes  
  UseKeychain yes
```

# Troubleshooting

You can use `-v`, `-vv` or `-vvv` to troubleshooting a session

```
> ssh lemaitre4 -v
OpenSSH_8.9p1 Ubuntu-3ubuntu0.13, OpenSSL 3.0.2 15 Mar 2022
debug1: Reading configuration data /home/user/.ssh/config
debug1: /home/user/.ssh/config line 8: Applying options for lemaitre4
debug1: /home/user/.ssh/config line 18: Applying options for lemaitre4
...
debug1: Server host key: ssh-rsa SHA256:GfUSNZEfZg28WRCaxJvDNSCClhrX1IujNIky29ui7IY
debug1: Host 'gwceci.unamur.be' is known and matches the RSA host key.
...
debug1: Offering public key: /home/user/.ssh/id_rsa.ceci RSA SHA256:lrQnhTiZvW0FXKoZmdfoNmZt2dr3d86PDmxhd995nnA explicit agent
debug1: Server accepts key: /home/user/.ssh/id_rsa.ceci RSA SHA256:lrQnhTiZvW0FXKoZmdfoNmZt2dr3d86PDmxhd995nnA explicit agent
Authenticated to gwceci.unamur.be ([138.48.4.48]:22) using "publickey".
...
debug1: Server host key: ssh-ed25519 SHA256:mWlgUkE+tBNbklXLgvr7pL/3Ohn7uidqFfBUU0fSkQ
debug1: Host 'lemaitre4.cism.ucl.ac.be' is known and matches the ED25519 host key.
...
debug1: Offering public key: /home/user/.ssh/id_rsa.ceci RSA SHA256:lrQnhTiZvW0FXKoZmdfoNmZt2dr3d86PDmxhd995nnA explicit agent
debug1: Server accepts key: /home/user/.ssh/id_rsa.ceci RSA SHA256:lrQnhTiZvW0FXKoZmdfoNmZt2dr3d86PDmxhd995nnA explicit agent
Authenticated to lemaitre4.cism.ucl.ac.be (via proxy) using "publickey".
```

SSH connection

## Troubleshooting

Check for common errors in [CÉCI documentation](#)

Or copy-paste the output and create an issue

<https://support.cec-hpc.be/cecihelp/>

A solid green shape in the bottom right corner of the slide, resembling a stylized hill or a corner element.

## SCP

You can copy files/directories back and forth between computers

```
# Create a temporary directory with dummy files on your computer
> mkdir -p cours_ssh/scp_test && touch cours_ssh/scp_test/file{1..4}.txt
# Execute a command in frontend to create a folder in non interactive session
> ssh lemaitre4 'mkdir -p cours_ssh'
# Copy the directory in recursive mode to your home directory in the lemaitre4 frontend
> scp -r cours_ssh/scp_test lemaitre4:cours_ssh/.
# Check content on frontend
> ssh lemaitre4 'ls cours_ssh/scp_test/'
# Copy it back in scp_test2 folder
> scp -r lemaitre4:cours_ssh/scp_test cours_ssh/scp_test2
# Check local copy
> ls cours_ssh/scp_test2
```



For copy between clusters. Use common [\\$CECIHOME](#) partition

## rsync

rsync is widely used for backups and mirroring

```
# Create a folder and dummy files in the frontend
> ssh lemaitre4 'mkdir -p cours_ssh/rsync_test; touch cours_ssh/rsync_test/file{1..4}.txt'
# Check
> ssh lemaitre4 'ls cours_ssh/rsync_test/'
# Transfer it to your computer
> rsync -avz --progress lemaitre4:cours_ssh/rsync_test cours_ssh/.
# Modify a file in the frontend and synchronize to your local copy
> ssh lemaitre4 'echo "Adding hello1 word in $(hostname)" >> cours_ssh/rsync_test/file4.txt'
> rsync -avz --progress lemaitre4:cours_ssh/rsync_test cours_ssh/.
# Check local copy
> cat cours_ssh/rsync_test/file4.txt
```

## rsync

rsync is widely used for backups and mirroring

```
# Modify a file in your computer and prevent Overwrite when synchronize -u
> echo 'Adding hello in client' > cours_ssh/rsync_test/file3.txt
> rsync -avzu --progress lemaitre4:cours_ssh/rsync_test cours_ssh/.
# Check
cat cours_ssh/rsync_test/file3.txt

# Delete a file in frontend
> ssh lemaitre4 'rm cours_ssh/rsync_test/file1.txt'
# Check remote content
> ssh lemaitre4 'ls cours_ssh/rsync_test/file1.txt'
# Synchronise local content with force delete (--del)
> rsync -avz --del --progress lemaitre4:cours_ssh/rsync_test cours_ssh/.
# Check local content
> ls cours_ssh/rsync_test/file1.txt
```

SSH-based file transfer

## SSHFS

Use SSHFS to mount a remote file system - accessible via SSH

### Linux install

```
# Debian, Ubuntu, Mint  
> sudo apt-get install sshfs
```

```
# Fedora, CentOS, Rocky  
> yum install sshfs
```

### Mac Os install

Install FUSE and SSHFS from <https://osxfuse.github.io/>



## SSHFS

### Example: Mount your [CECIHOME](#)

```
# Create on your computer a folder to mount the CÉCI Home
> mkdir ceci_home
# Mount the remote CÉCI Home on your computer from Hercules
# (you can check with another frontend)
> cluster=hercules
> sshfs -o uid=$(id -u) -o gid=$(id -g) $cluster:$(ssh $cluster 'echo $CECIHOME')/ ceci_home
# Create a file in the mounted directory
> echo 'file content from my computer' > ceci_home/file_fuse.txt
# Check the file content in the frontend and in mounted folder
> ssh $cluster 'cat $CECIHOME/file_fuse.txt'
> ls ceci_home
# Disconnect
> fusermount -u ceci_home
```

<https://www.unamur.be>

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