Linux for beginners

Academic Enhancement Team

Linux for beginners

Outline

- What is the Linux operating system (OS)?
- Develop an understanding of how Linux treats files and their file systems.
- Create a toolbox of the most essential commands/utilities in Bash.
- Understanding remote access with SSH and file transfer with FTP.

Linux for beginners

What is Linux?

What is Linux?

Brief History of Linux

Origin:

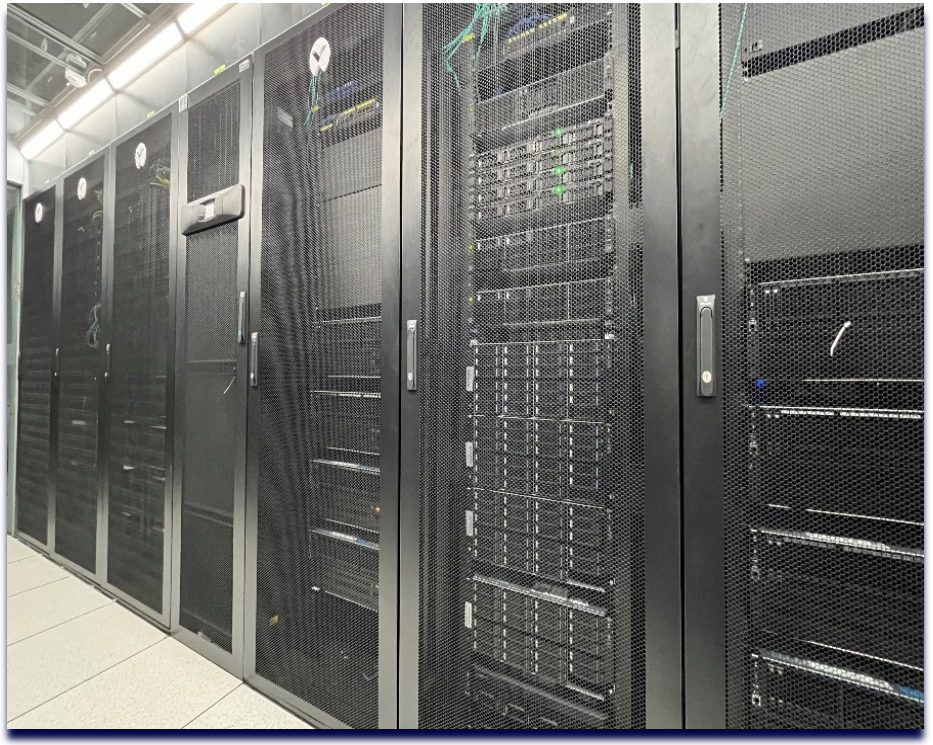
- Published by Linus Torvalds in 1991, related to Unix, MINIX, GNU Project, and POSIX standards.

Development Impact:

- Inspired by Unix, open source promotes rapid global adoption.

Key Features:

- Open Source: Source code can be obtained, modified, and distributed.
- Stability: Efficient and stable, requiring fewer restarts.
- Free: No licensing fees, free to download and use.



XJTLU launch a school-level HPC cluster in 2023. It is composed of multiple Linux systems using Rock Linux. https://hpc.xjtlu.edu.cn

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Files in Linux

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Files in Linux

What is a File in Linux?

- **File:** A file is a storage unit that can hold different kinds of content, such as text, images, and audio.

"Everything is a File" design:

- This concept means that in Linux, all entities, including folders and commands, are treated as files.

```
[root@lnxbio dev]# ls
autofs           hugepages
block            hwrng
bsg              infiniband
btrfs-control    initctl
bus              input
centos           ipmi0
char             kmsg
console          kvm
core             log
cpu              loop0
cpu_dma_latency  loop-control
crash            lp0
disk             lp1
dm-0             lp2
dm-1             lp3
dm-2             mapper
dm-3             mcelog
```

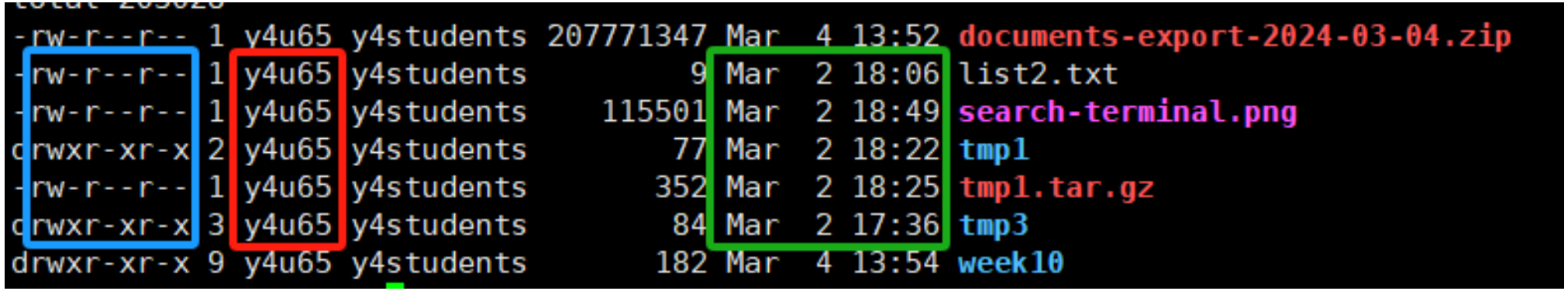
```
1.sh                  Mathematica_12.0.0_LINUX.sh  slurm-1124.out
2.sh                  matlab                       slurm-1226.out
AdapterRemoval        mobileOG-db                  slurm-2394.out
condarc               prometheus-slurm-exporter    slurm-3183.out
ctmp                  sethomequota.sh              slurm-3614.out
git1                  setup_ldap_user              slurmdbd.log
gittest               setup_quota                  SLURM_JOB_NODELIST.txt
g_mmpbsa-5.1.2        sif                          snode.slurm
g_mmpbsa-5.1.2.tar.gz slurm-1071.out               tmp
```

Files in Linux

File Meta-data:

•Files have additional information associated with them, which includes:

- **Owner(user)**: The person who controls the file.
- **Permissions**: Rules that determine who can access the file and what actions they can perform.
- **Timestamps**: Information about when the file was created, last modified, or last accessed.



Files in Linux

File Permissions in Linux

Types of Permissions

- **Read (r) (4)**
- **Write (w) (2)**
- **Execute (x) (1)**

How are permissions applied?

- **Owner(u)**
- **Group(g)**
- **Other(o)**

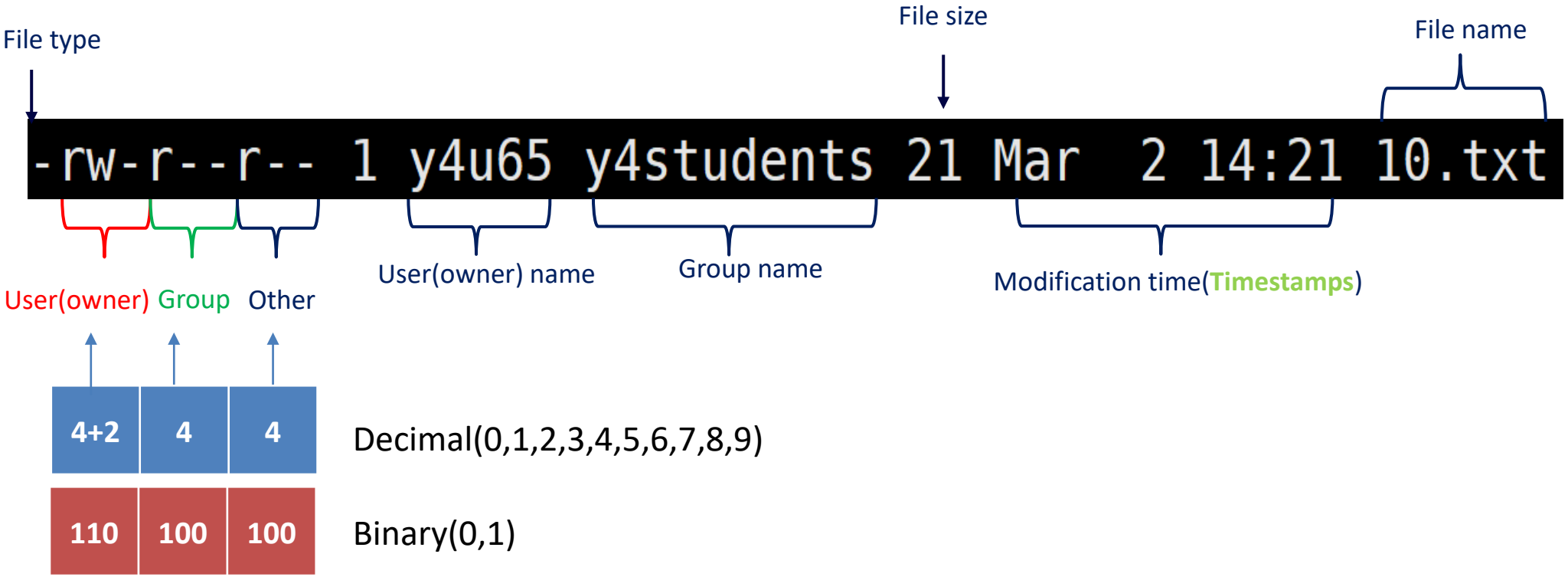
```
[y4u65@lnxbio ~]$
[y4u65@lnxbio ~]$ ls -al
total 24
drwx------  6 y4u65 y4students  148 Mar  1 12:35 .
drwxr-xr-x 46 root  root       4096 Mar  1 12:29 ..
-rw-------  1 y4u65 y4students   18 Mar  1 12:29 .bash_logout
-rw-------  1 y4u65 y4students  193 Mar  1 12:29 .bash_profile
-rw-------  1 y4u65 y4students  231 Mar  1 12:29 .bashrc
drwxr-xr-x  3 y4u65 y4students   18 Mar  1 12:29 .cache
drwxr-xr-x  3 y4u65 y4students   18 Mar  1 12:29 .config
drwxr-xr-x  2 y4u65 y4students    6 Mar  1 12:34 tmp1
drwxr-xr-x  2 y4u65 y4students   18 Mar  1 12:35 tmp2
-rw-------  1 y4u65 y4students   52 Mar  1 12:29 .Xauthority
-rw-------  1 y4u65 y4students  658 Mar  1 12:29 .zshrc
[y4u65@lnxbio ~]$
```

- *"d": directory (or if file);*
- *"r": read permission;*
- *"w": write permission;*
- *"x": execute permission (or permission to "cd" if it is a directory);*
- *"---": no permission.*
- *Each MODE is a string that sets file permissions using either symbols (like u, g, o, r, w, x) with operators (like +, -, =) or numeric values (0-7) representing different permission combinations.*

```
[y4u65@lnxbio tmp1]$
[y4u65@lnxbio tmp1]$ ls -l ys.txt
-rw-r--r-- 1 y4u65 y4students 23 Mar  2 14:17 ys.txt
[y4u65@lnxbio tmp1]$
[y4u65@lnxbio tmp1]$ chmod 600 ys.txt
[y4u65@lnxbio tmp1]$ ls -l ys.txt
-rw------- 1 y4u65 y4students 23 Mar  2 14:17 ys.txt
[y4u65@lnxbio tmp1]$
```

- *With chmod 600 ys.txt, the owner gets read-write (4+2), and the group and others get no permissions (0).*

Files in Linux

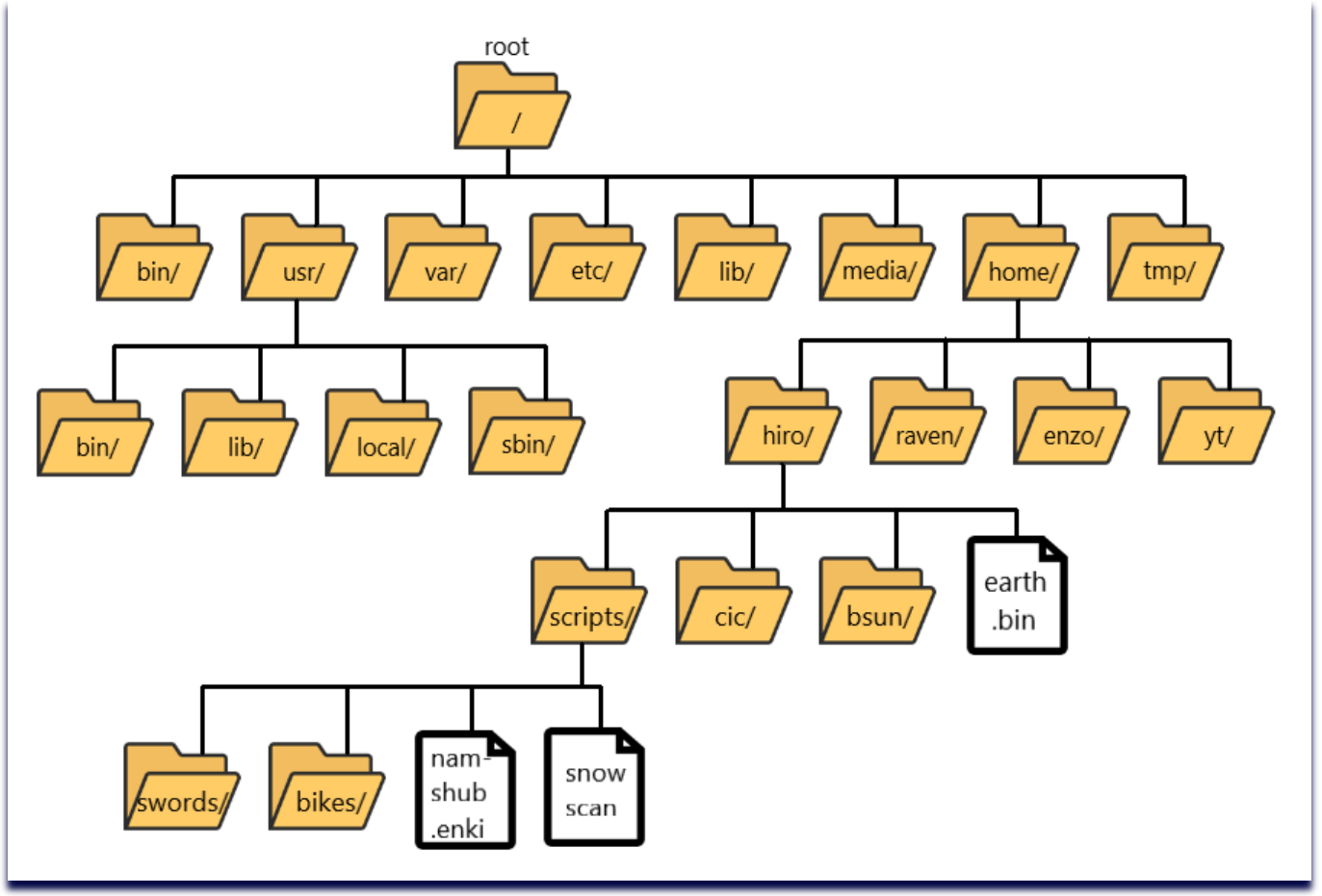


- *"10.txt" file permissions "-rw-r--r--" are expressed numerically as "0644". Only the file owner (User) can read and write, and others can only read the file.*

Files in Linux

File Organization in Linux

- **Directories:** Files are organized into directories, which serve a similar function to folders in other operating systems.
- **Root Directory:** Everything is mounted to the root directory, acting as the starting point for file organization.
- **Paths:** Files in Linux are identified by their location, known as the path.
  - **Absolute Path:** Refers to a file's location from the root (e.g., /home/y4u65/file1).
  - **Relative Path:** Refers to a file's location relative to the current position (e.g., if you're at /home/, the file would be accessed as y4u65/file1).
- **File Extensions:** While file extensions are not inherently meaningful to Linux, they can still be useful for personal organization and identification.



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Interacting with Linux: Shells

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Interacting with Linux: Shells

What is a shell?

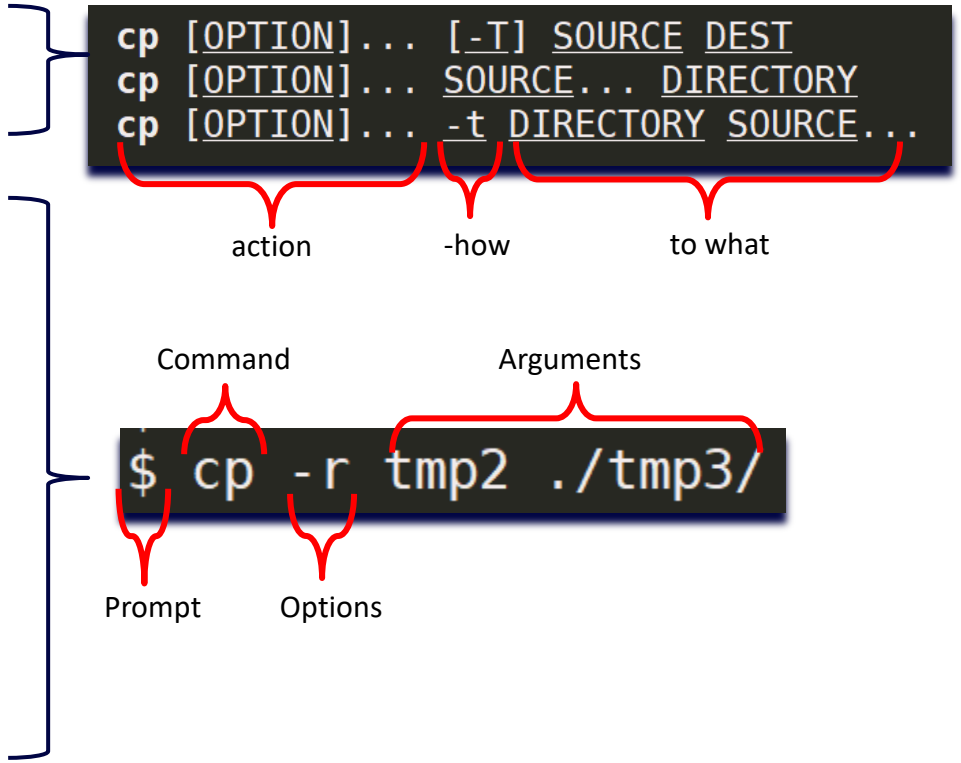
- A shell is a program providing a command-line interface for interacting with a computer's operating system.
- Many variants of Linux Shells
  - *sh*
  - *bash*
  - *tcsh/csh*
  - *zsh*

- We are going to focus on ***bash***

Interacting with Linux: Shells

Introduction to Built-Ins and Utilities

- **Built-In Commands vs. Utilities**
- **Command Structure**
  - COMMAND [-OPTIONS] [ARGUMENTS]
    - action [-how] [to what]
    - [OPTIONS] are inherently optional and often take the form of a switch or they set a value (--expression="xhpc")
    - [ARGUMENTS] can be mandatory or optional and usually denote the "things" you want the command to operate on



Interacting with Linux: Command Line Editors

Editing Files in Linux

Lightweight programs for editing text files in a terminal include:

The most common editors:

- Vim (vi)

Example usage: vim example.txt

If example.txt does not exist, it will be created.

Interacting with Linux: Command Line Editors

VIM novice level Summary

- **Moving cursor around**: **h** = left, **l** = right, **k** = up, **j** = down
- **Exit without saving**: Press **ESC** for command mode, then enter **:q!** to exit
- **Deleting characters**: Highlight a character and press **x** in command mode
- **Insert or append text**: Press **i** or **a** in command mode and start typing
- **Exit and save changes**: **:wq**

```
# This is a text file.
# I'm inserting text, and at the bottom
of the picture, there's a line that disp
lays "-- INSERT -- ".
~
~
~
-- INSERT --                2,100         All
```

https://linuxconfig.org/vim-tutorial

Linux for beginners

Essential Commands

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Essential Commands

Command	Useful option	Purpose
ls	List all the files in a directory	
	-la	It lists all the files in a directory and their details(including hidden files).
cd	Change directory to some other location.	
	..	Move up one directory.
	-	Return to previous directory.
pwd	Show the present working directory.	
	-P	Displays the physical path ignoring symbolic links.

```
[y4u65@lnxbio ~]$
[y4u65@lnxbio ~]$ ls
tmp1  tmp2
[y4u65@lnxbio ~]$ cd tmp2
[y4u65@lnxbio tmp2]$ pwd
/home/y4u65/tmp2
[y4u65@lnxbio tmp2]$
[y4u65@lnxbio tmp2]$ ls
tmp1
[y4u65@lnxbio tmp2]$ cd tmp1
[y4u65@lnxbio tmp1]$ pwd
/home/y4u65/tmp2/tmp1
[y4u65@lnxbio tmp1]$
[y4u65@lnxbio tmp1]$ pwd -P
/home/y4u65/tmp1
[y4u65@lnxbio tmp1]$
[y4u65@lnxbio tmp1]$ cd ..
[y4u65@lnxbio tmp2]$ pwd
/home/y4u65/tmp2
[y4u65@lnxbio tmp2]$ cd -
/home/y4u65/tmp2/tmp1
[y4u65@lnxbio tmp1]$
[y4u65@lnxbio tmp1]$ pwd
/home/y4u65/tmp2/tmp1
[y4u65@lnxbio tmp1]$
[y4u65@lnxbio tmp1]$ cd
[y4u65@lnxbio ~]$ pwd
/home/y4u65
[y4u65@lnxbio ~]$
```

Essential Commands

Command	Purpose
more	Displays file content in pages.
cat	Displays the entire file content.
sort	Sort a file or program output.
grep	Search for a pattern in a file or program output.

```
[y4u65@lnxbio tmp2]$ more ys.txt
# This is a text file.
[y4u65@lnxbio tmp2]$
[y4u65@lnxbio tmp2]$ cat ys.txt
# This is a text file.
```

```
[y4u65@lnxbio tmp1]$ sort number.txt
1
2
3
4
5
[y4u65@lnxbio tmp1]$
```

```
[y4u65@lnxbio tmp1]$
[y4u65@lnxbio tmp1]$ cat ys.txt
# This is a text file.
[y4u65@lnxbio tmp1]$
[y4u65@lnxbio tmp1]$ grep "text" ys.txt
# This is a text file.
[y4u65@lnxbio tmp1]$
```

- *"ys.txt" contains the # sign and a descriptive text.*

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Essential Commands

Command	Useful option	Purpose
cp	Copies a file from one location to another.	
	-r	Copy directories and their subdirectories.
mv	Moves a file to a new location, or renames it.	
mkdir	Make Directory.	
rm	Delete a file.	
	-rf	The -rf in rm -rf ensures forceful, recursive deletion without confirmation.

```
[y4u65@lnxbio ~]$ cp tmp1 tmp3
cp: omitting directory 'tmp1'
[y4u65@lnxbio ~]$
[y4u65@lnxbio ~]$ cp -r tmp1 tmp3
[y4u65@lnxbio ~]$
[y4u65@lnxbio ~]$ mv tmp2 tmp3/
[y4u65@lnxbio ~]$ ls
tmp1  tmp3
[y4u65@lnxbio ~]$ ls tmp3/
10.txt  number.txt  tmp2  ys.txt
[y4u65@lnxbio ~]$
```

```
[y4u65@lnxbio ~]$ mkdir ys
[y4u65@lnxbio ~]$ rm ys
rm: cannot remove 'ys': Is a directory
[y4u65@lnxbio ~]$ rm -rf ys
[y4u65@lnxbio ~]$ ls
tmp1  tmp3
```

Essential Commands

Before we learn about Linux shell commands, it is crucial to understand that the shell interprets various symbols and characters uniquely. This implies that certain characters typed can a) not be utilized in specific contexts, b) serve to execute special functions, or c) require "escaping" if intended for standard usage.

Symbol	Purpose
|	“Pipe”. Redirect the output of one command into another command.
>	Redirect output of a command into a new file. If the file already exists, over-write it.
>>	Redirect the output of a command onto the end of an existing file.
<	Redirect a file as input to a program.

```
[y4u65@lnxbio ~]$ ls | sort
tmp1
tmp3
[y4u65@lnxbio ~]$ ls > list.txt
[y4u65@lnxbio ~]$ ls
list.txt  tmp1  tmp3
[y4u65@lnxbio ~]$ cat list.txt >> list2.txt
[y4u65@lnxbio ~]$ ls
list2.txt  list.txt  tmp1  tmp3
[y4u65@lnxbio ~]$ cat < list2.txt
list.txt
tmp1
tmp3
```

Essential Commands

Command	Useful Option	Purpose
find	Copies a file from one location to another.	
	-r	Copy directories and their subdirectories.
awk	AWK is a tool for filtering and formatting text data.	
sed	sed is a text processing tool used for manipulating and transforming text files.	
wc	Prints the number of bytes, words and lines in a file.	
	-l	print the newline counts.

```
[y4u65@lnxbio ~]$ find . -name "ys.txt"
./tmp1/ys.txt
./tmp3/ys.txt
[y4u65@lnxbio ~]$ cat list2.txt
list txt
[y4u65@lnxbio ~]$ cat list2.txt | awk '{print $1}'
list
[y4u65@lnxbio ~]$ sed -i "s@list@LIST@g" list2.txt
[y4u65@lnxbio ~]$ cat list2.txt
LIST txt
[y4u65@lnxbio ~]$ wc -l list2.txt
1 list2.txt
[y4u65@lnxbio ~]$
```

Essential Commands

Command	Useful Option	Purpose
tar	-zcvf	Creates gzipped tar archive file from source folder.
	-xf	Extract archive file.
gzip	Compression a file with .gz extension.	
du	-sh	Summarizes sizes in human-readable format.

```
[y4u65@lnxbio ~]$ tar -zcvf tmp1.tar.gz tmp1
tmp1/
tmp1/ys.txt.gz
tmp1/10.txt.gz
tmp1/number.txt.gz
[y4u65@lnxbio ~]$ ls
list2.txt  tmp1  tmp1.tar.gz  tmp3
[y4u65@lnxbio ~]$ rm -rf tmp1
[y4u65@lnxbio ~]$
[y4u65@lnxbio ~]$ tar -xf tmp1.tar.gz
[y4u65@lnxbio ~]$ ls
list2.txt  tmp1  tmp1.tar.gz  tmp3
[y4u65@lnxbio ~]$
[y4u65@lnxbio ~]$ gzip list2.txt
[y4u65@lnxbio ~]$ ls
list2.txt.gz  tmp1  tmp1.tar.gz  tmp3
[y4u65@lnxbio ~]$ gzip -d list2.txt.gz
[y4u65@lnxbio ~]$ ls
list2.txt  tmp1  tmp1.tar.gz  tmp3
[y4u65@lnxbio ~]$
```

```
[y4u65@lnxbio ~]$ du -sh tmp1.tar.gz
4.0K    tmp1.tar.gz
```

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Remote Access and File Transfer

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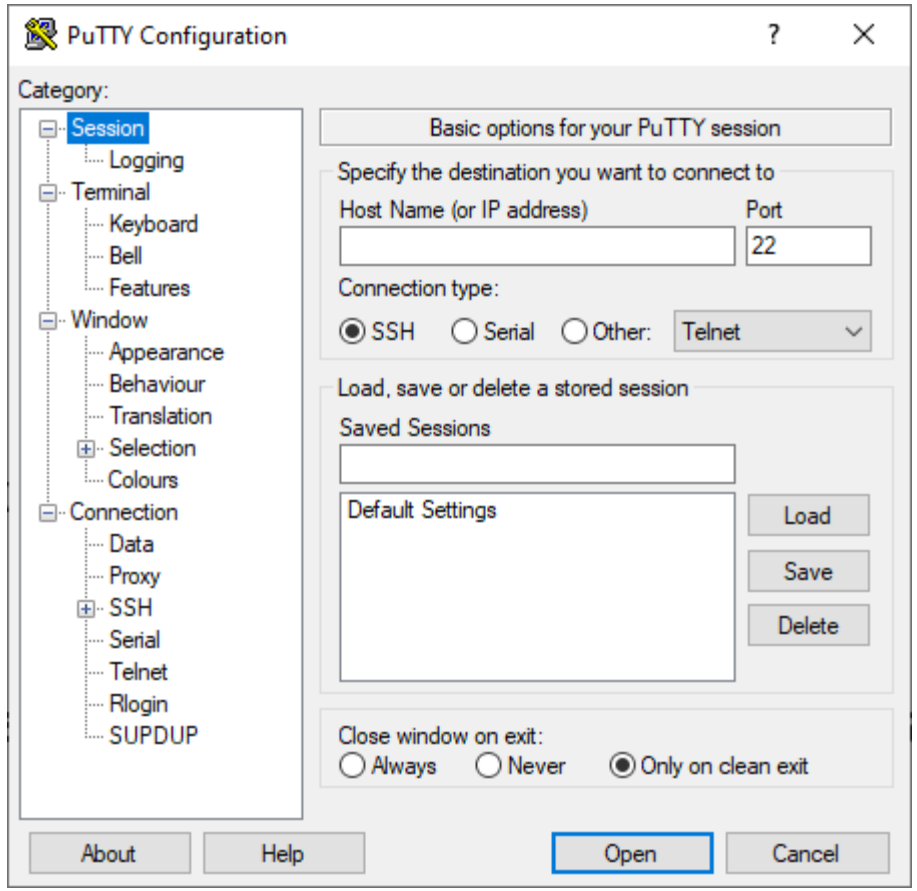
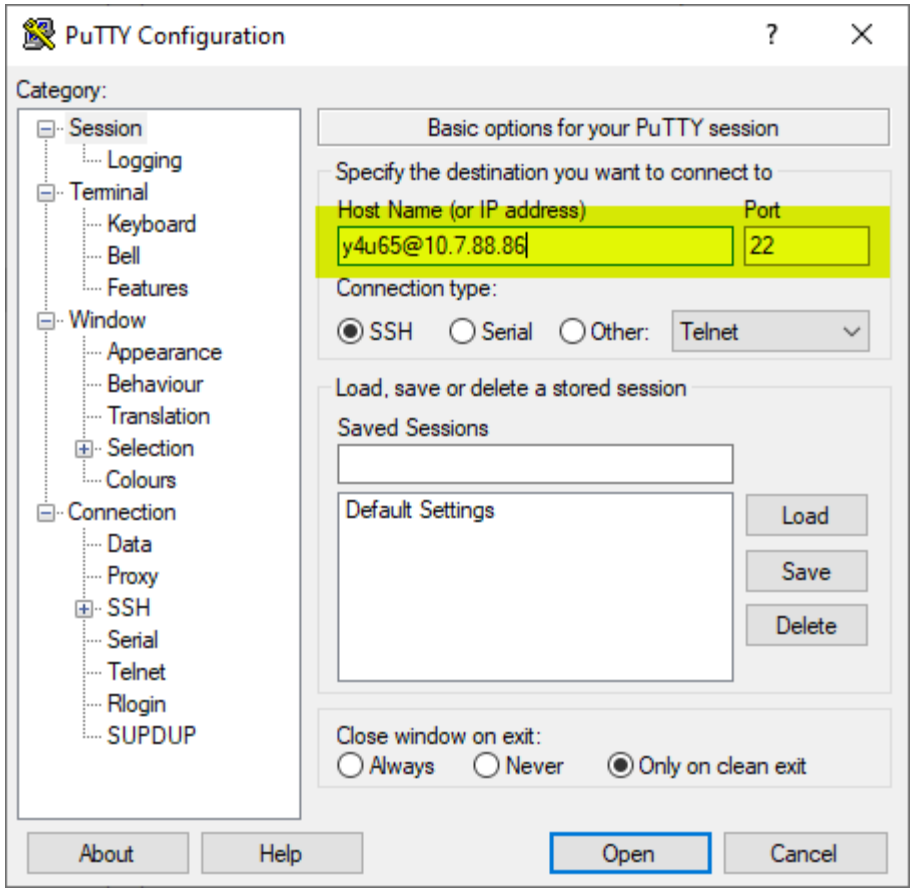
Remote Access and File Transfer: Windows





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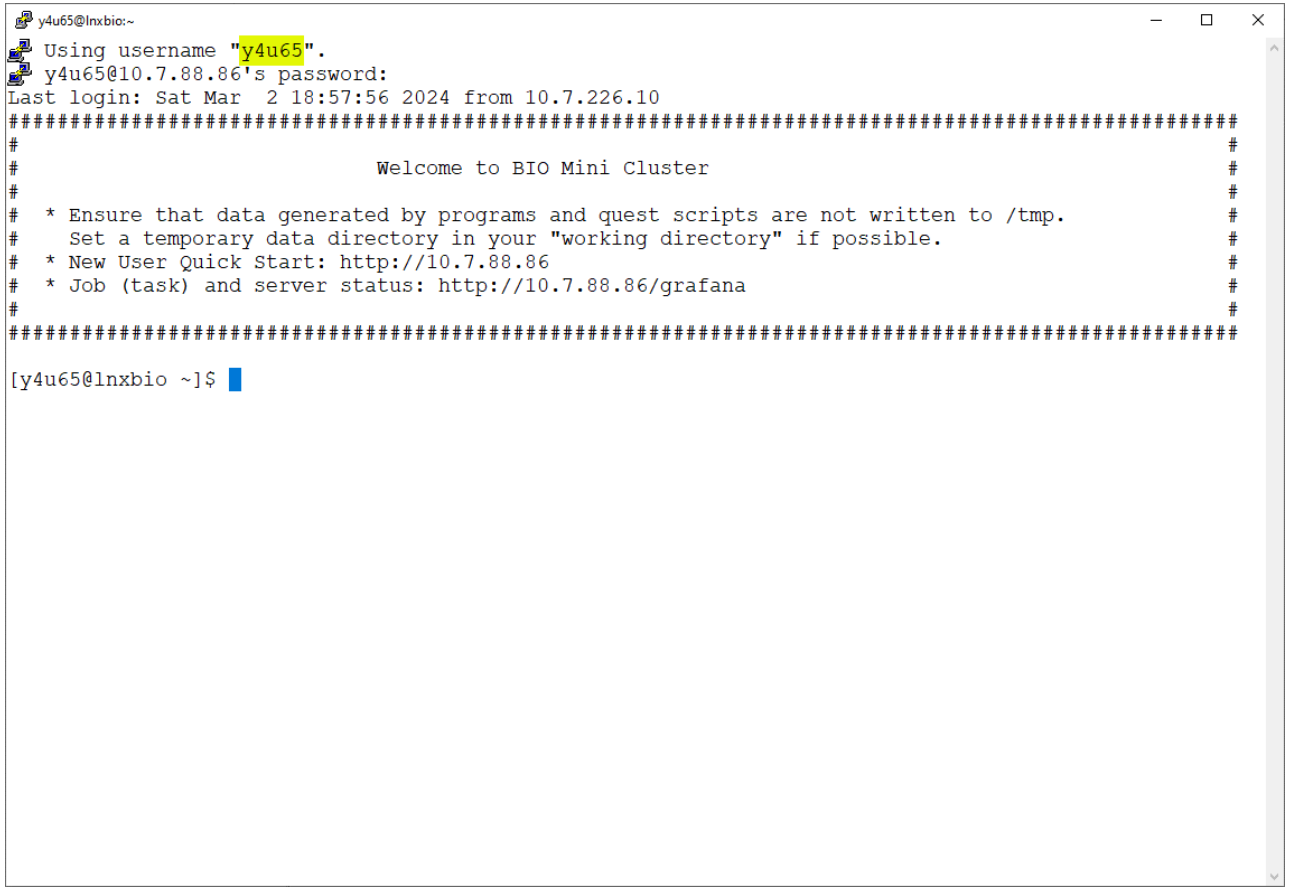
Remote Access and File Transfer: Windows



- *After entering your username and pressing Enter, a prompt will appear on the screen, and you can directly enter your password and press Enter to log in.*
- ***Note that there will be no pop-up window when entering your password.***

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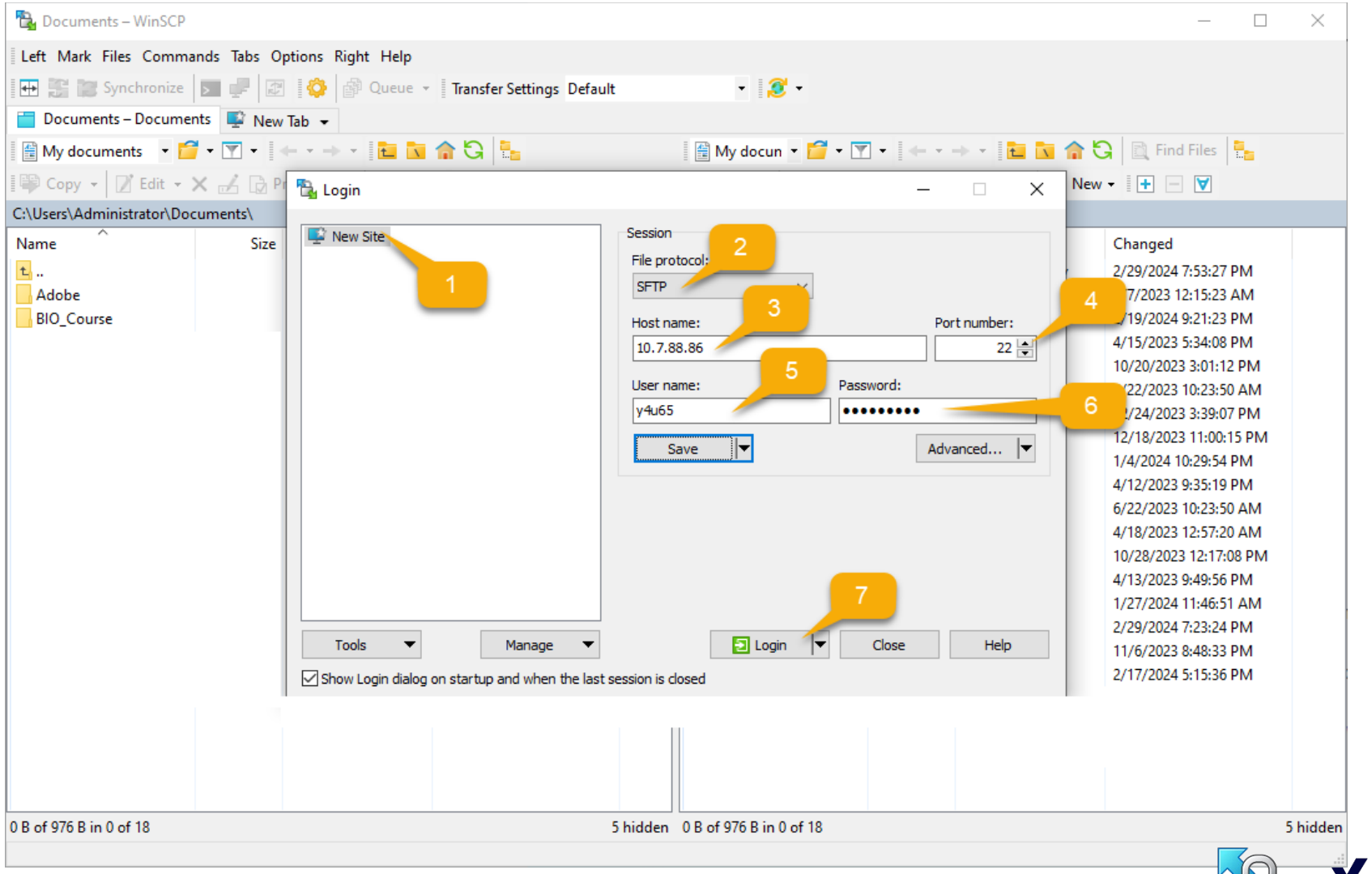
Remote Access and File Transfer: Windows



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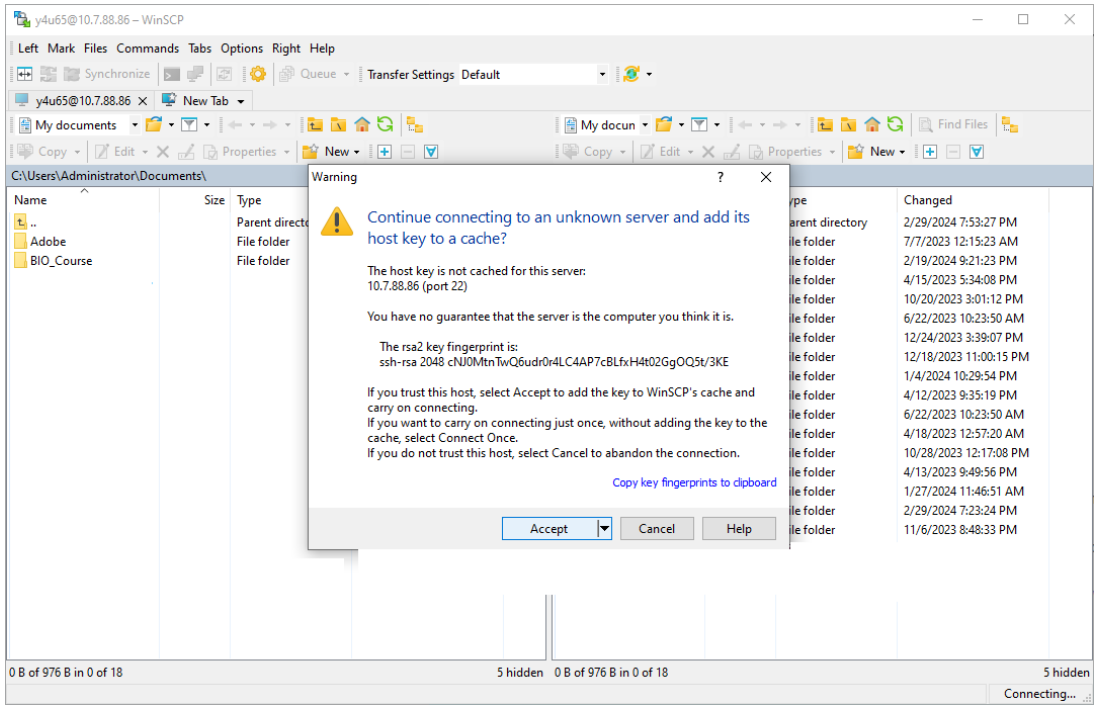
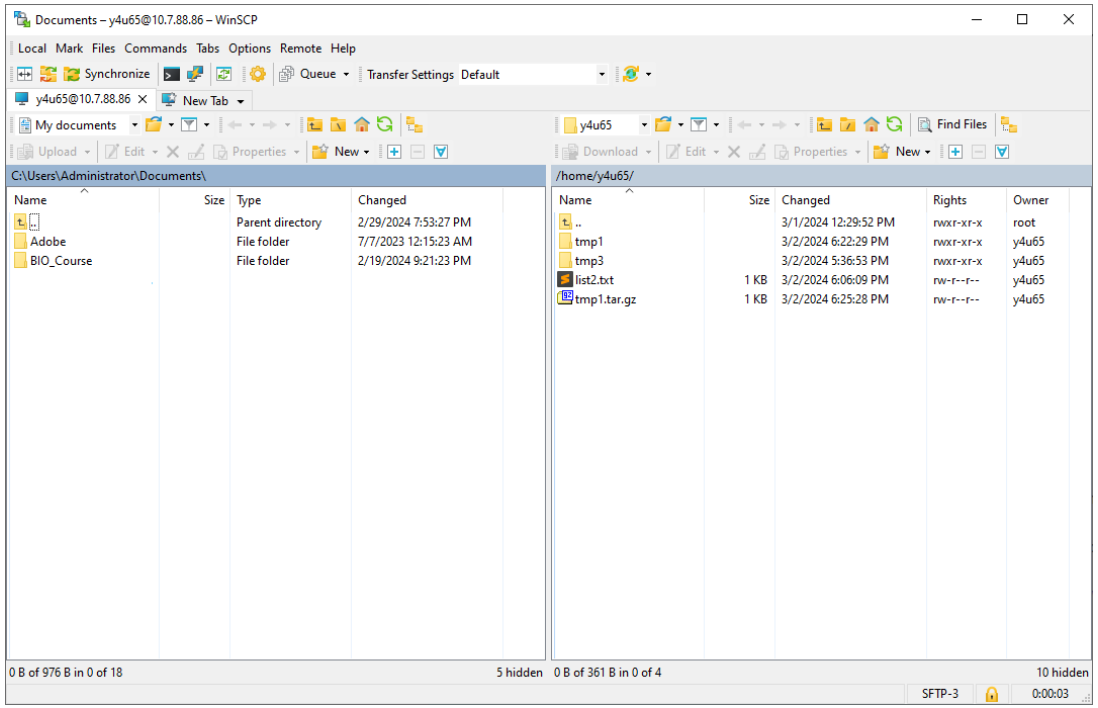
Remote Access and File Transfer: Windows





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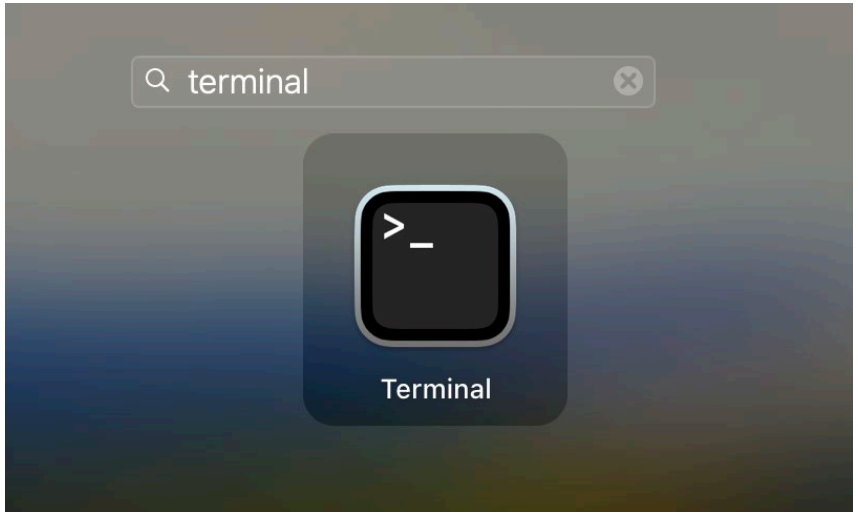
Remote Access and File Transfer: Apple macOS

```
$ssh y4u65@10.7.88.86
y4u65@10.7.88.86's password:
Last login: Sat Mar  2 18:59:36 2024 from 10.7.226.10
##############################################################################################################
#                                                                                                            #
#                              Welcome to BIO Mini Cluster                                                   #
#                                                                                                            #
#  * Ensure that data generated by programs and quest scripts are not written to /tmp.                       #
#    Set a temporary data directory in your "working directory" if possible.                                 #
#  * New User Quick Start: http://10.7.88.86                                                                 #
#  * Job (task) and server status: http://10.7.88.86/grafana                                                 #
#                                                                                                            #
##############################################################################################################

[y4u65@lnxbio ~]$
```

```
$cd Desktop
$ls
search-terminal.png
$
$rsync -avP search-terminal.png y4u65@10.7.88.86:~/
y4u65@10.7.88.86's password:
building file list ...
1 file to consider
search-terminal.png
      115501 100%   78.90MB/s    0:00:00 (xfer#1, to-check=0/1)

sent 115647 bytes  received 42 bytes  13610.47 bytes/sec
total size is 115501  speedup is 1.00
$
```



- If you are an Apple user, you can use the search function to look for "terminal" tools.
- Logging in and file transfer can be completed using ssh and rsync on this terminal.

THANK YOU

Further reading

- 2018: Bash Quick Start Guide: Getup and Running with Bash by Tom Ryder, Packt Publishing, ISBN 9781789538830