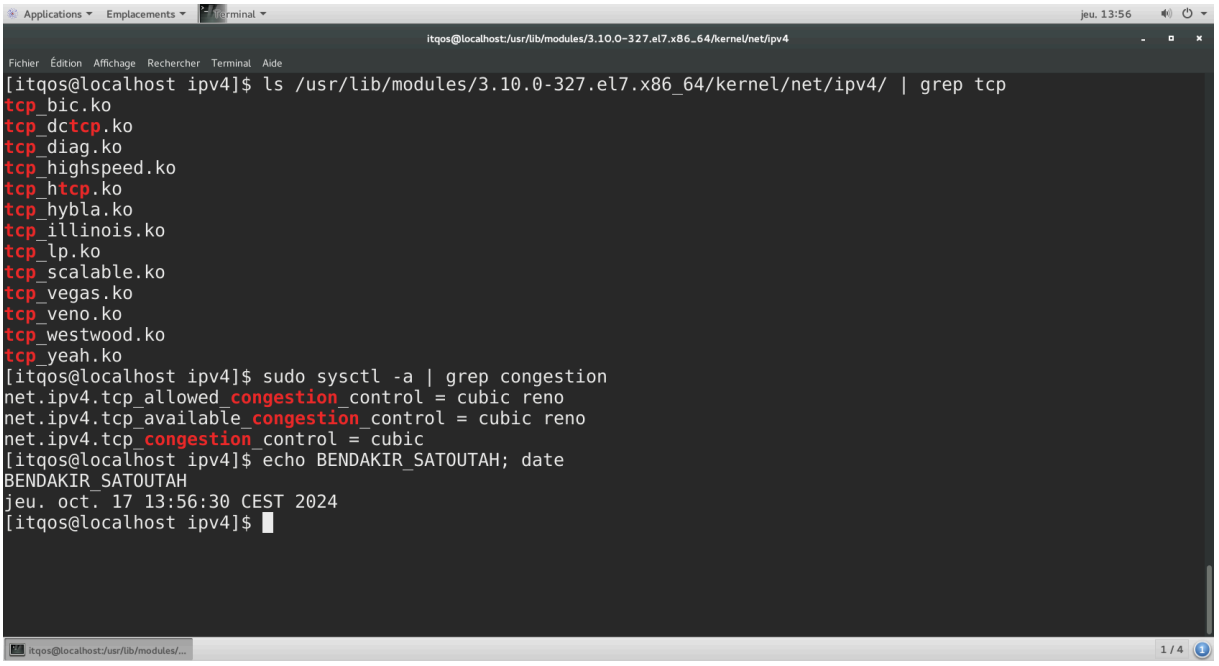
# Compte Rendu ITQoS TME2

## Response 1:



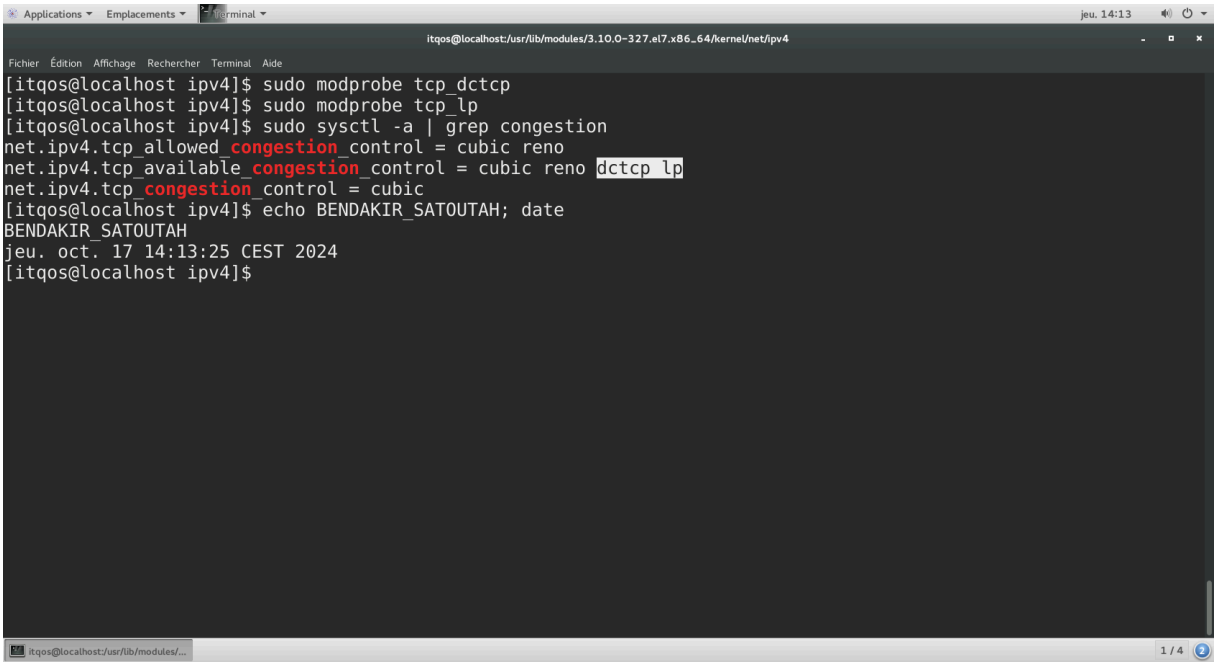

From the result of the first command, we can see that the machine uses a lot of congestion control protocols like **tcp_dctcp**, **tcp_lp**, **tcp_htcp**, **tcp_bic**, **tcp_hybla**, **tcp_scalable**, **tcp_vegas**…

From the result of the second command, we can see that the active protocols are **cubic** and **reno**.

## Response 2:

2.1. From the previous capture (last line of the second command), the current congestion control protocol is **tcp_cubic (**net.ipv4.tcp_congestion_control = cubic**)**.

2.2




After adding tcp_dctcp and tcp_lp as active congestion control protocols (the first two commands), we can see that they appear in the respective list (result of the third command).

# Response 3:

3.1

The name of the function that calculates the congestion window in TCP cubic is called **bictcp_update**.
The value of the constant c is **41**.

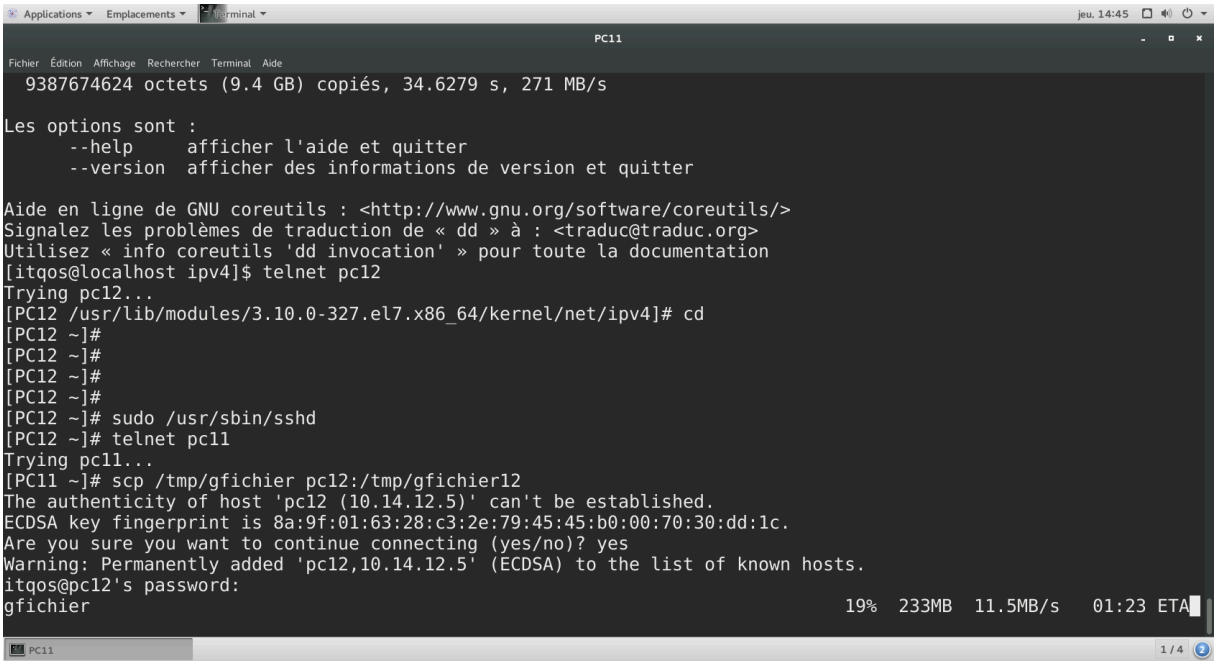
3.2

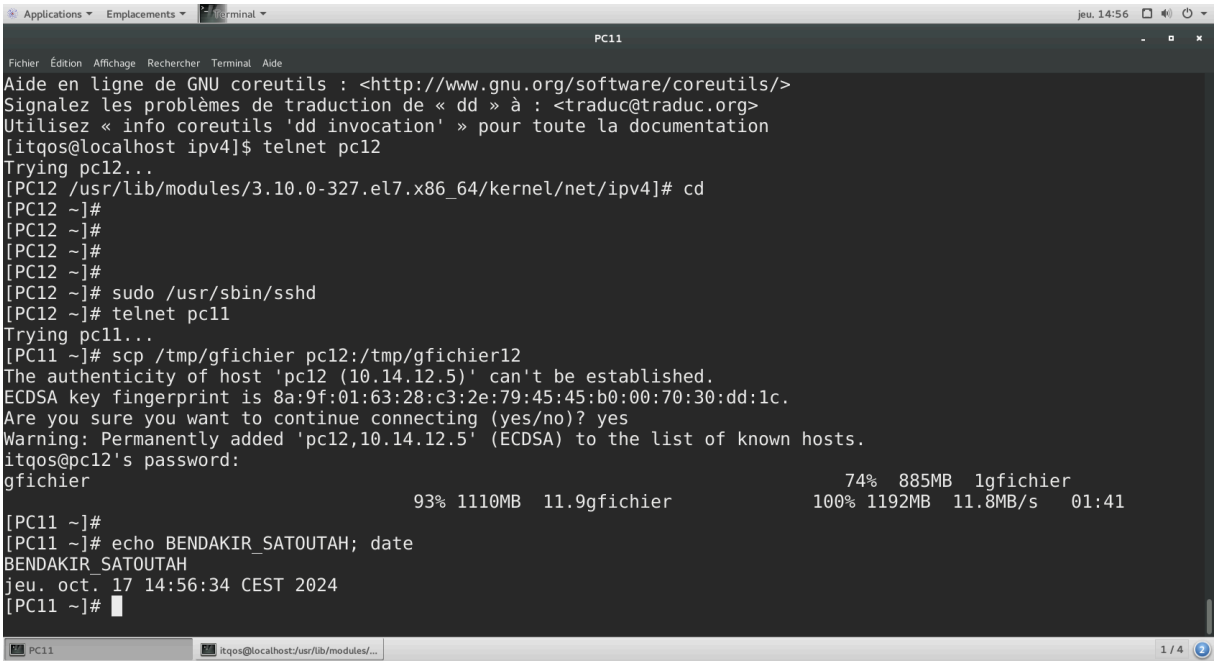
The value of the multiplicative factor β is calculated in the program thanks to the beta variable, which is set to **717**. This means that **β = 717 / 1024**, approximately **0.7**.

# Response 4:

4.1

During the transfer (first capture), we can see that the average output is **11.5MB/s = 96,46Mbit/s**. While at the end (second capture), it showed an average output of **11.8MB/s = 98.98Mbits/s**.

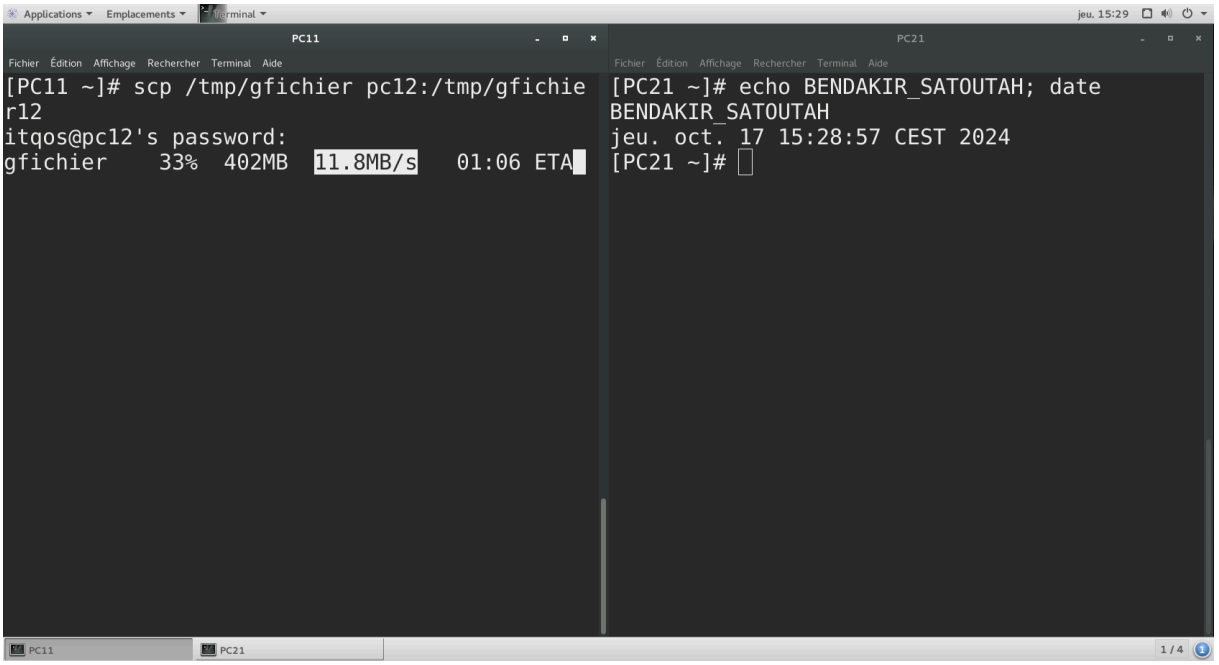


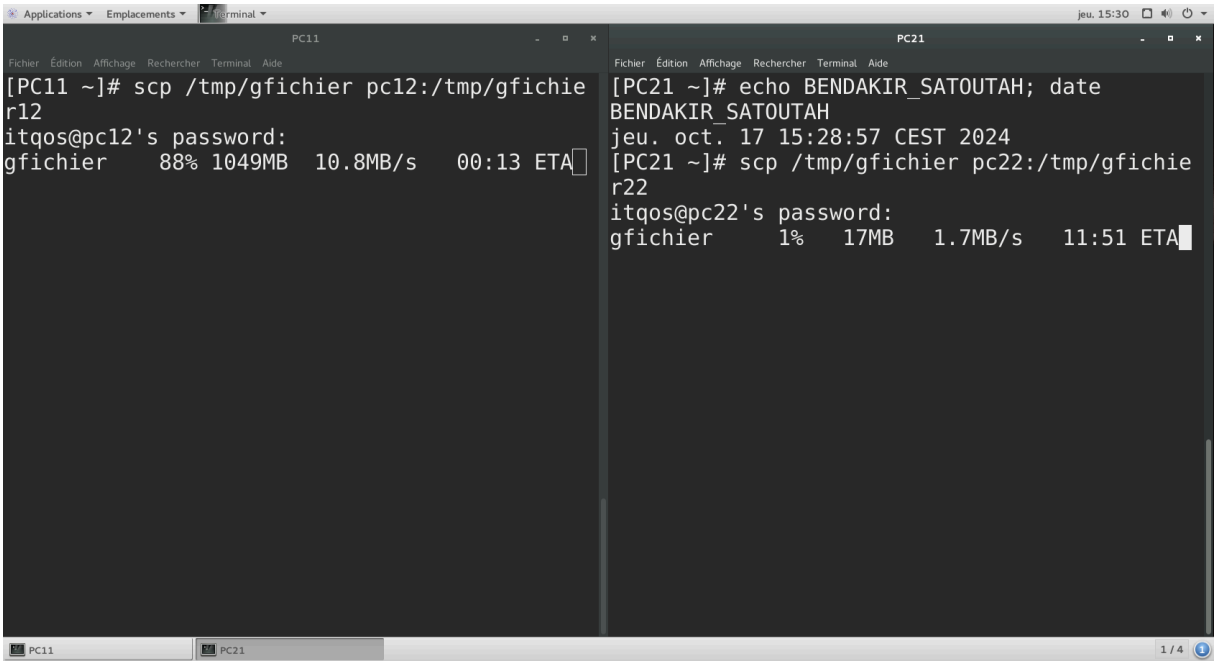



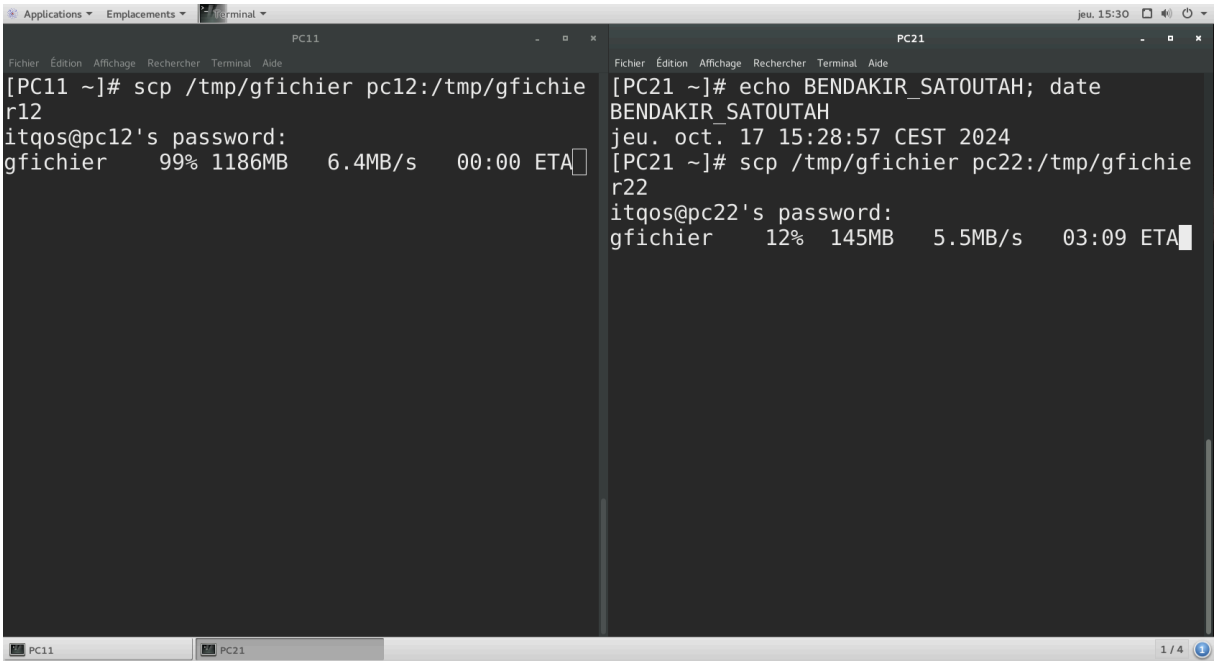

4.2

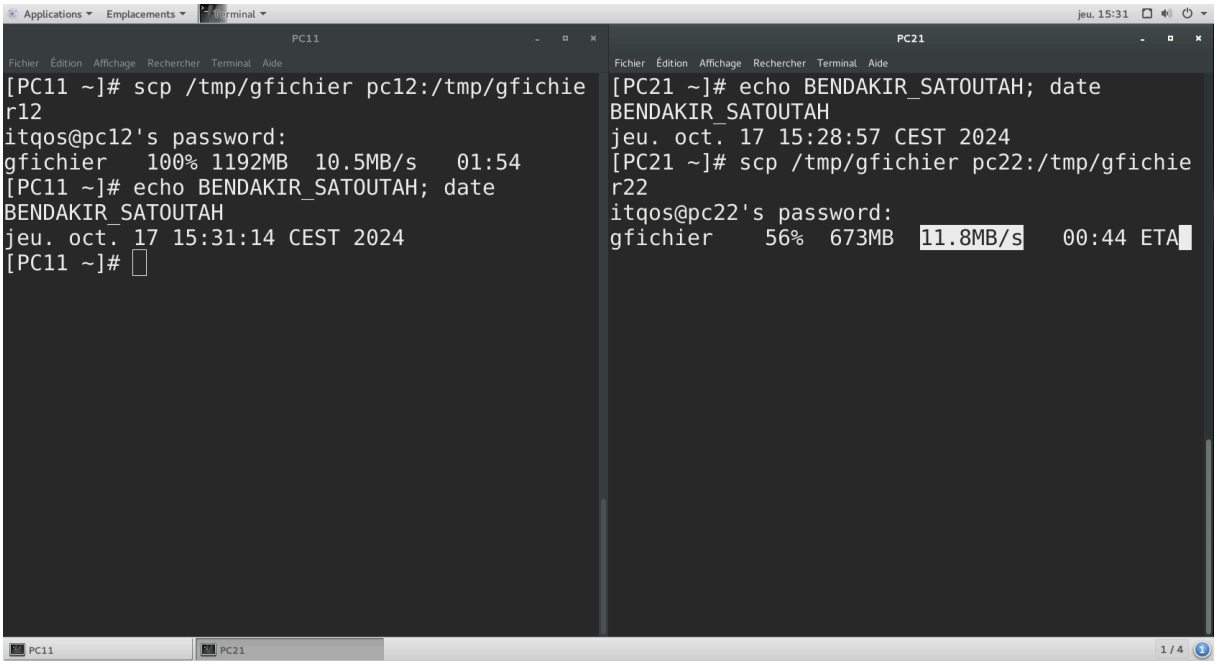
During the first transfer between PC11 -> PC12 (first capture), we can see that the average output is **11.8MB/s = 98.98Mbits/s**.
Then, when the transfer between PC21 -> PC22 begins (second capture), it has a weak output (**1.7MB/s = 14.26Mbits/s**) while the first transfer stills at a high output (**10.8MB/s = 90.59Mbits/s**).
However, after some time, the second transfer's output speed starts to increase while the first one's start to decrease in a linear way between them (third capture) i.e. the output of the first + the output of the second = the maximum output (approximately **11.8MB/s =**

**98.98Mbits/s**). We notice a convergence to the mean output (11.8 / 2 = **5.9MB/s = 49.49Mbit/s**).
Then when the first transfer's finish (fourth capture), the output of the second output starts increasing until it reaches the maximum output (**11.8MB/s = 98.98Mbits/s**).



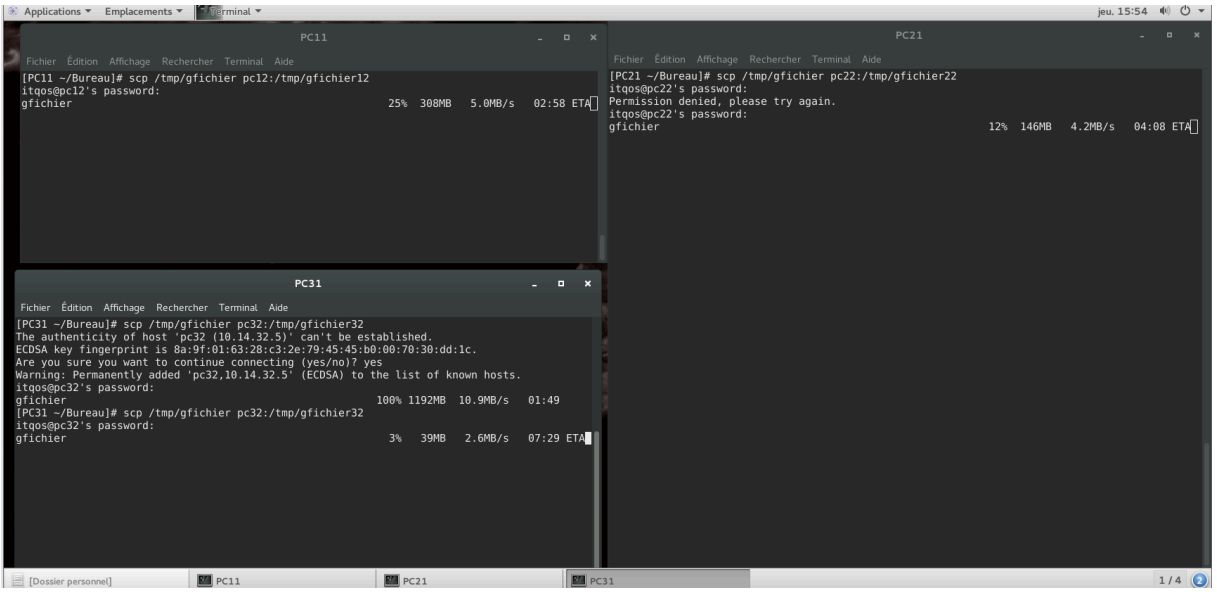





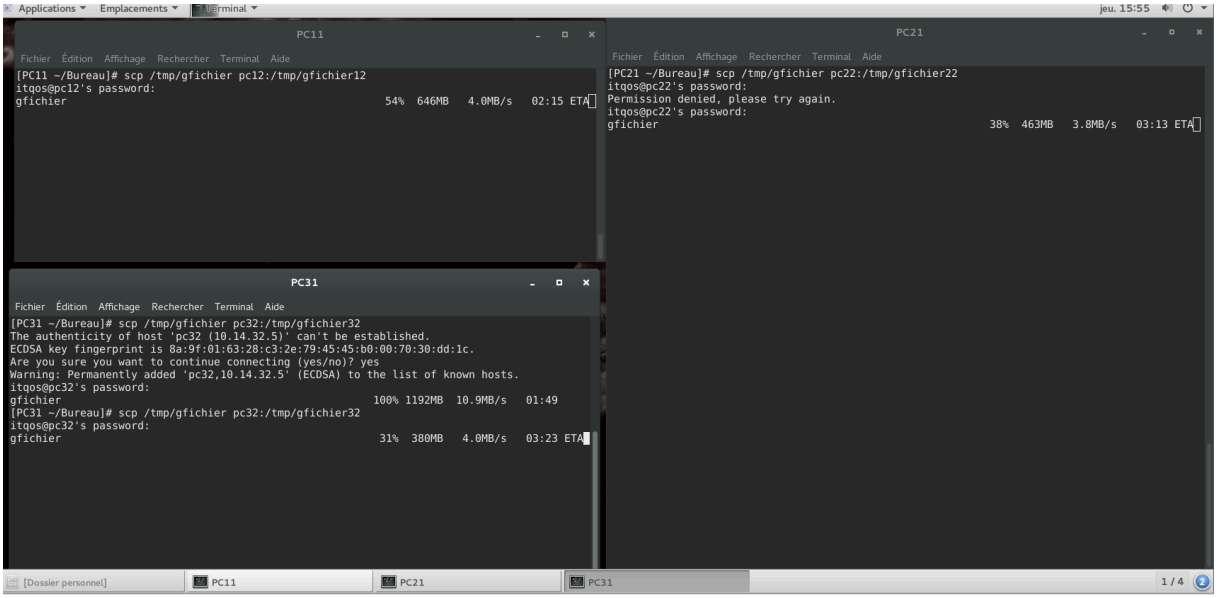




4.3

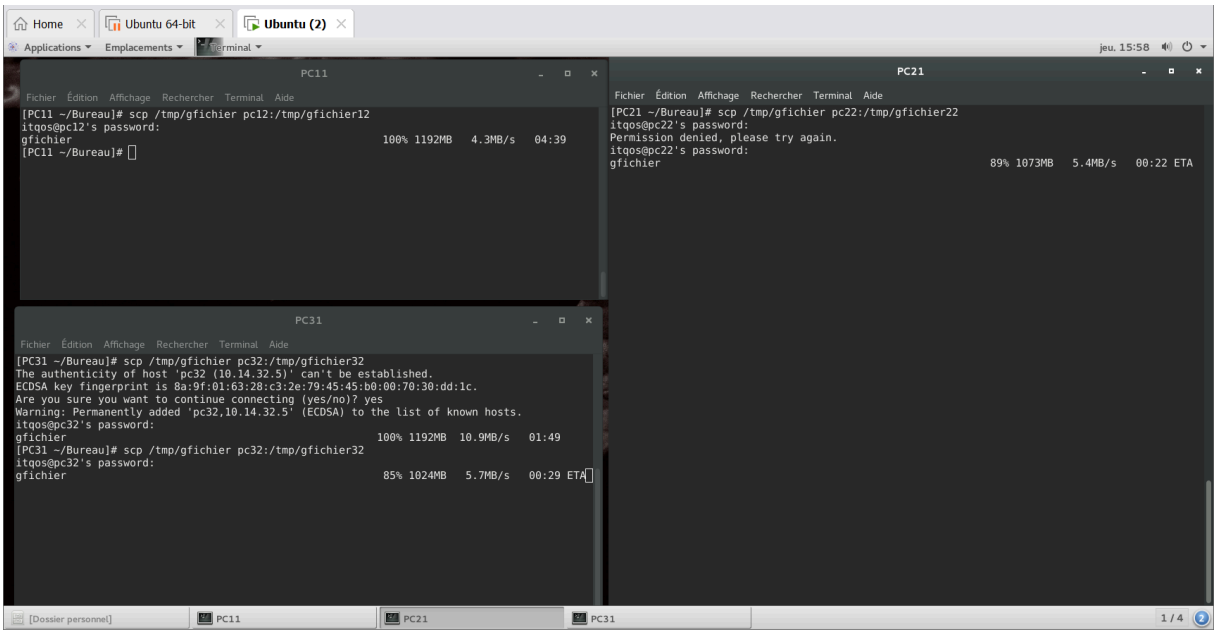
When we launch the three transfers (first capture, PC11 -> PC12 then PC21 -> PC22 then PC31 -> PC32), we notice how the first transfer had the highest output, while the second one had higher than the third.

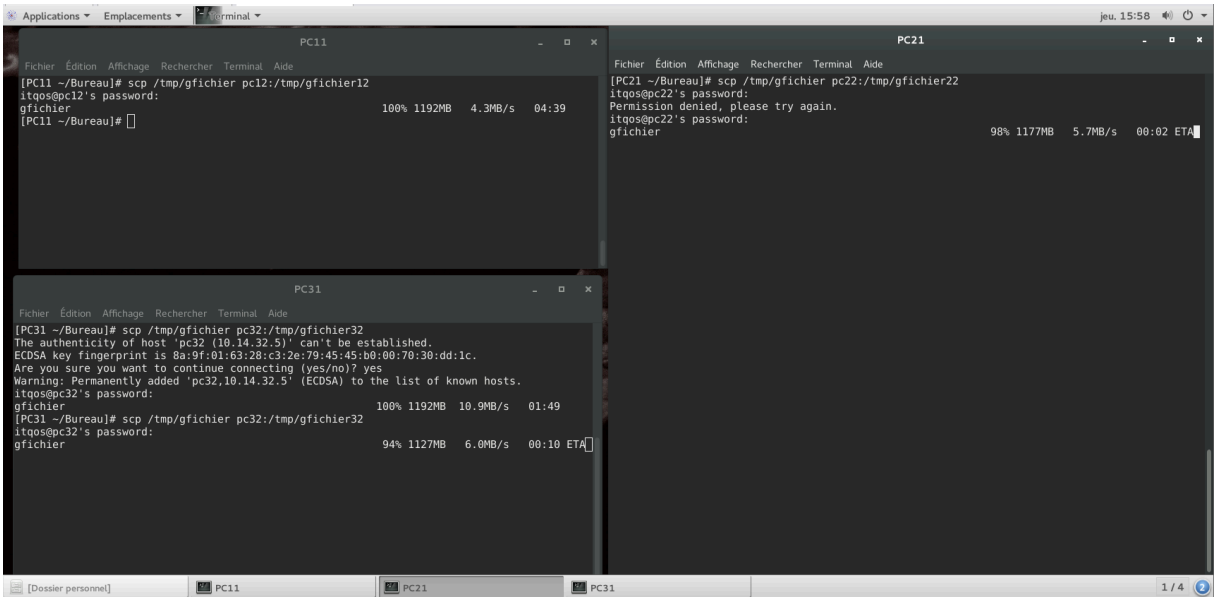


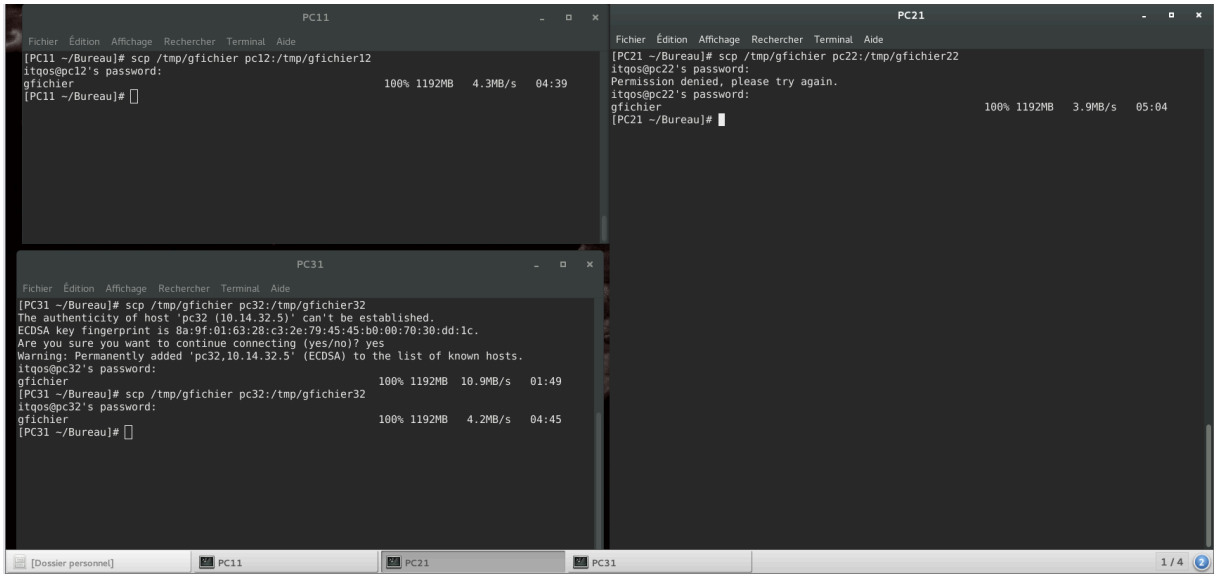

Then after a while, we notice how the three transfers slowly converge to the mean value (11.8 / 3 = **3.9MB/s = 32.71Mbit/s**) and stay there (second capture).




Then, when the first transfer finishes, the output of the other two transfers increases (third capture) until it reaches the new mean value (11.8 / 2 = **5.9MB/s = 49.49Mbit/s**) (fourth capture)

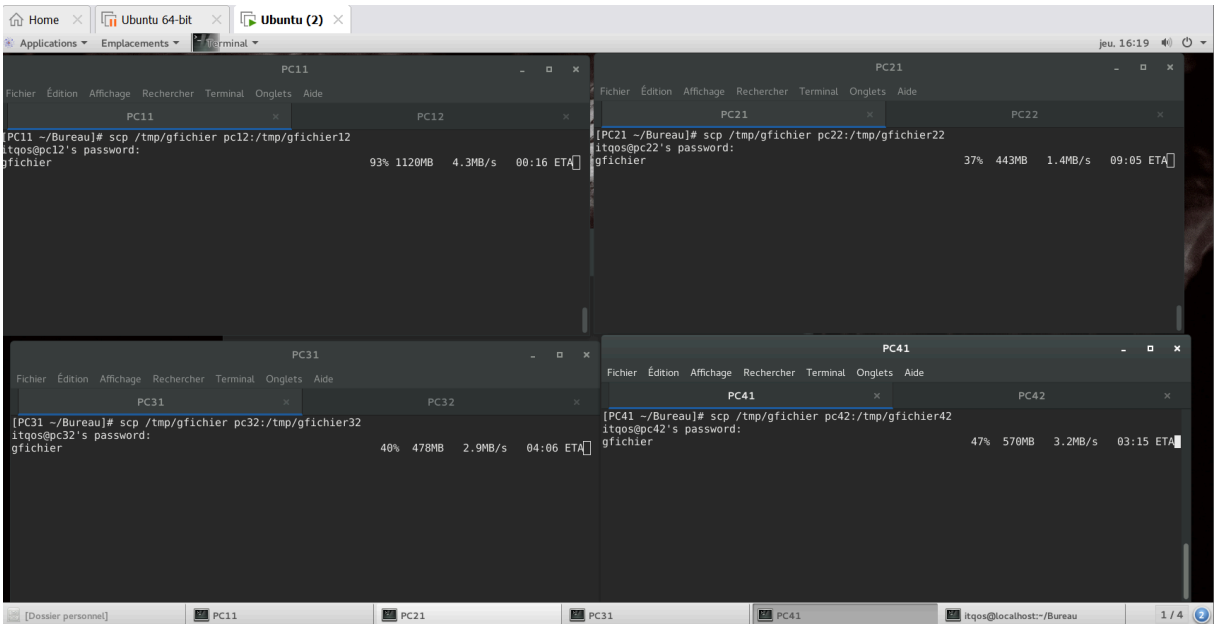

Home
Ubuntu 64-bit
Ubuntu (2)
Applications
Emplacements
Terminal
jeu. 15:58
PC11
Fichier Édition Affichage Rechercher Terminal Aide
[PC11 ~/Bureau]# scp /tmp/gfichier pc12:/tmp/gfichier12
itqos@pc12's password:
gfichier 100% 1192MB 4.3MB/s 04:39
[PC11 ~/Bureau]#
PC21
Fichier Édition Affichage Rechercher Terminal Aide
[PC21 ~/Bureau]# scp /tmp/gfichier pc22:/tmp/gfichier22
itqos@pc22's password:
Permission denied, please try again.
itqos@pc22's password:
gfichier 89% 1073MB 5.4MB/s 00:22 ETA
PC31
Fichier Édition Affichage Rechercher Terminal Aide
[PC31 ~/Bureau]# scp /tmp/gfichier pc32:/tmp/gfichier32
The authenticity of host 'pc32 (10.14.32.5)' can't be established.
ECDSA key fingerprint is 8a:9f:01:63:28:c3:2e:79:45:45:b0:00:70:30:dd:1c.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added 'pc32,10.14.32.5' (ECDSA) to the list of known hosts.
itqos@pc32's password:
gfichier 100% 1192MB 10.9MB/s 01:49
[PC31 ~/Bureau]# scp /tmp/gfichier pc32:/tmp/gfichier32
itqos@pc32's password:
gfichier 85% 1024MB 5.7MB/s 00:29 ETA
[Dossier personnel]
PC11
PC21
PC31
1 / 4

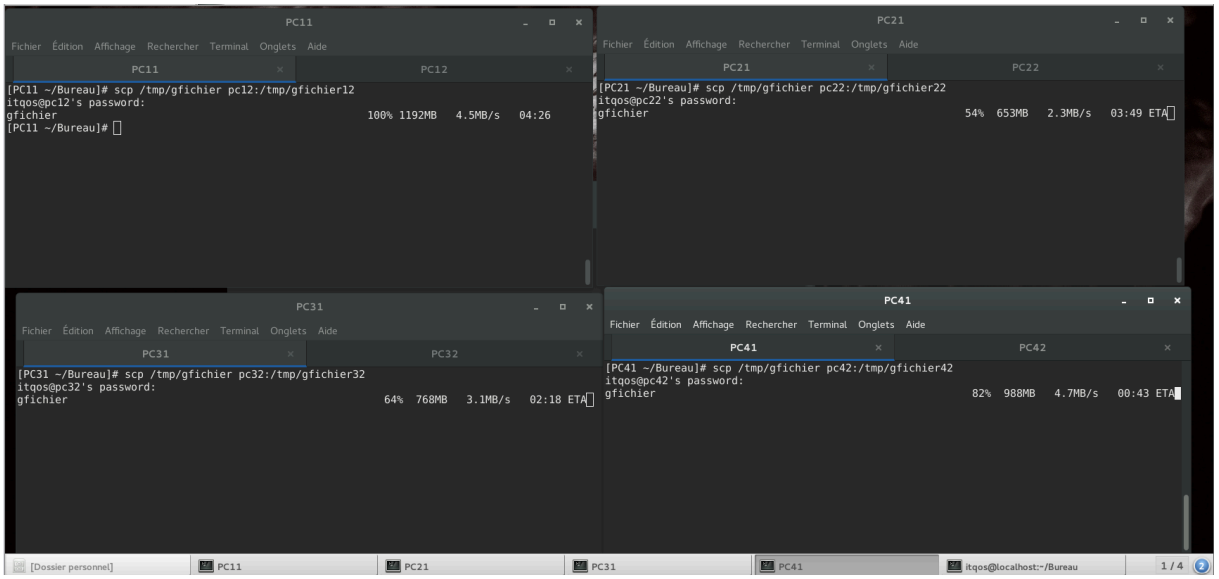

Applications
Emplacements
Terminal
jeu. 15:58
PC11
Fichier Édition Affichage Rechercher Terminal Aide
[PC11 ~/Bureau]# scp /tmp/gfichier pc12:/tmp/gfichier12
itqos@pc12's password:
gfichier 100% 1192MB 4.3MB/s 04:39
[PC11 ~/Bureau]#
PC21
Fichier Édition Affichage Rechercher Terminal Aide
[PC21 ~/Bureau]# scp /tmp/gfichier pc22:/tmp/gfichier22
itqos@pc22's password:
Permission denied, please try again.
itqos@pc22's password:
gfichier 98% 1177MB 5.7MB/s 00:02 ETA
PC31
Fichier Édition Affichage Rechercher Terminal Aide
[PC31 ~/Bureau]# scp /tmp/gfichier pc32:/tmp/gfichier32
The authenticity of host 'pc32 (10.14.32.5)' can't be established.
ECDSA key fingerprint is 8a:9f:01:63:28:c3:2e:79:45:45:b0:00:70:30:dd:1c.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added 'pc32,10.14.32.5' (ECDSA) to the list of known hosts.
itqos@pc32's password:
gfichier 100% 1192MB 10.9MB/s 01:49
[PC31 ~/Bureau]# scp /tmp/gfichier pc32:/tmp/gfichier32
itqos@pc32's password:
gfichier 94% 1127MB 6.0MB/s 00:10 ETA
[Dossier personnel]
PC11
PC21
PC31
1 / 4

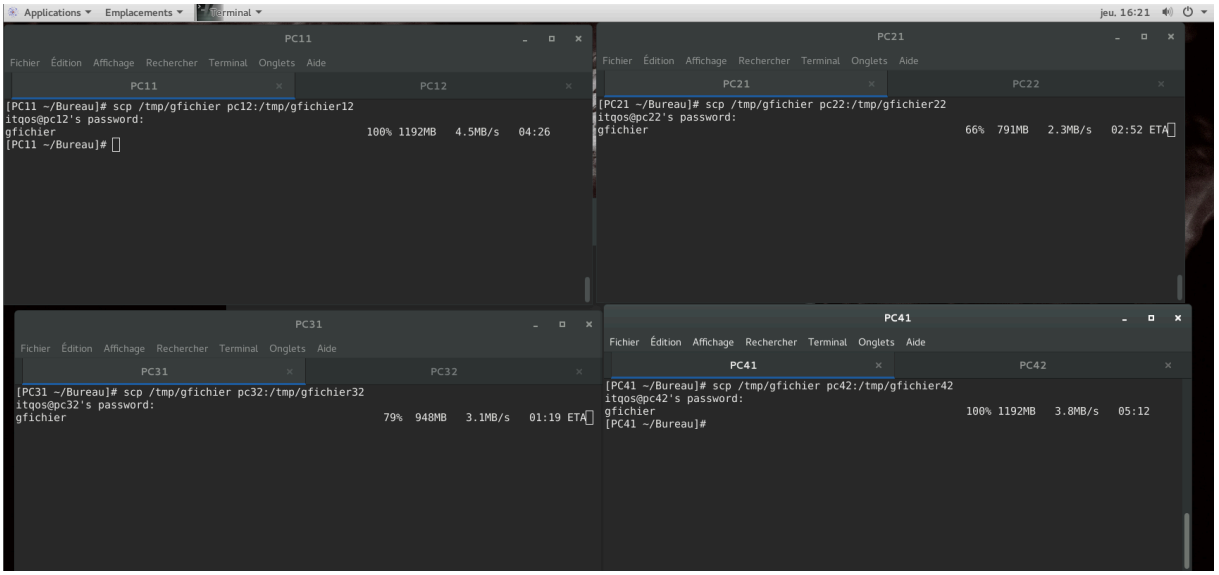

PC11
Fichier Édition Affichage Rechercher Terminal Aide
[PC11 ~/Bureau]# scp /tmp/gfichier pc12:/tmp/gfichier12
itqos@pc12's password:
gfichier 100% 1192MB 4.3MB/s 04:39
[PC11 ~/Bureau]#
PC21
Fichier Édition Affichage Rechercher Terminal Aide
[PC21 ~/Bureau]# scp /tmp/gfichier pc22:/tmp/gfichier22
itqos@pc22's password:
Permission denied, please try again.
itqos@pc22's password:
gfichier 100% 1192MB 3.9MB/s 05:04
[PC21 ~/Bureau]#
PC31
Fichier Édition Affichage Rechercher Terminal Aide
[PC31 ~/Bureau]# scp /tmp/gfichier pc32:/tmp/gfichier32
The authenticity of host 'pc32 (10.14.32.5)' can't be established.
ECDSA key fingerprint is 8a:9f:01:63:28:c3:2e:79:45:45:b0:00:70:30:dd:1c.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added 'pc32,10.14.32.5' (ECDSA) to the list of known hosts.
itqos@pc32's password:
gfichier 100% 1192MB 10.9MB/s 01:49
[PC31 ~/Bureau]# scp /tmp/gfichier pc32:/tmp/gfichier32
itqos@pc32's password:
gfichier 100% 1192MB 4.2MB/s 04:45
[PC31 ~/Bureau]#
[Dossier personnel]
PC11
PC21
PC31
1 / 4

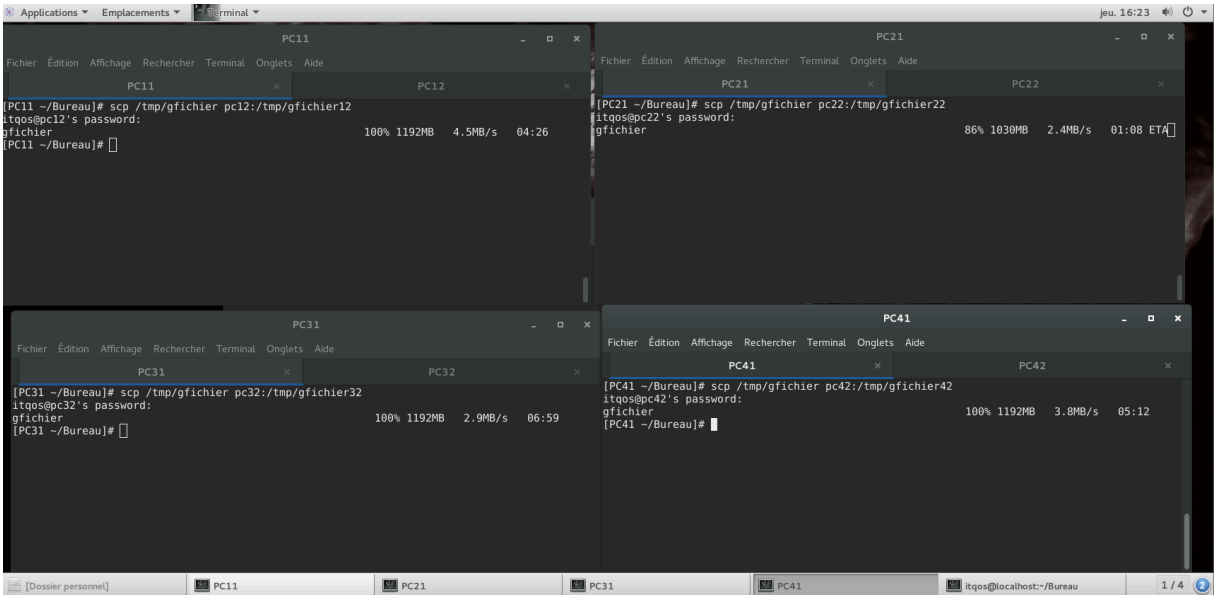
4.4.1

We launch four transfers (PC11 -> PC12, PC21 -> PC22, PC31 -> PC32, PC41, PC42). The following table summarizes the output of each transfer during the experiment:






| Step | Output PC11 -> PC12 | Output PC21 -> PC22 | Output PC31 -> PC32 | Output PC41 -> PC42 |
|---|---|---|---|---|
| All 4 transfers working (1st capture) | 4.3MB/s = 36.07Mbit/s | 1.4MB/s = 11.74Mbit/s | 2.9MB/s = 24.32Mbit/s | 3.2MB/s = 26.84Mbit/s |
| PC11 -> PC12 finished, 3 transfers working (2nd capture) | | 2.3MB/s = 19.29Mbit/s | 3.1MB/s = 26.00Mbit/s | 4.7MB/s = 39.42Mbit/s |
| PC41 -> PC42 finished, 2 transfers working (3rd capture) | | 2.3MB/s = 19.29Mbit/s | 3.1MB/s = 26.00Mbit/s | |

| | | | | |
|---|---|---|---|---|
| PC31 -> PC32 finished, 1 transfer working (4th capture) | | 2.3MB/s = 19.29Mbit/s | | |

4.4.2
To calculate Jain's fairness index, we use the transfers output of the first capture.

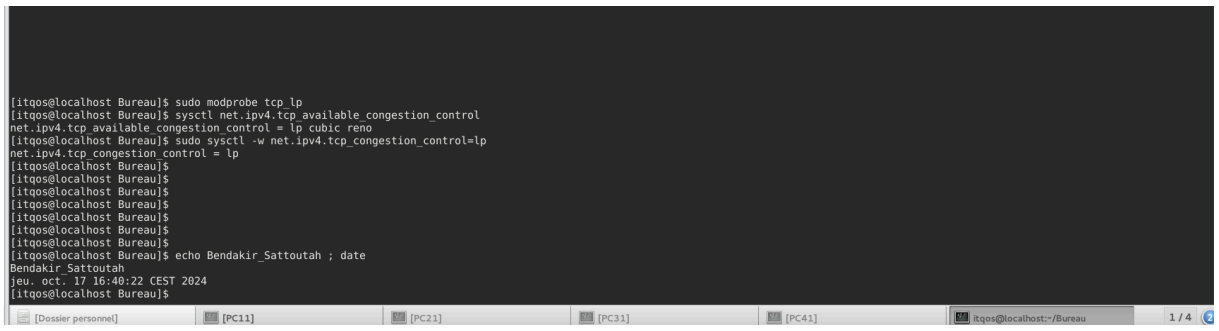
| Term | Output PC11 -> PC12 | Output PC21 -> PC22 | Output PC31 -> PC32 | Output PC41 -> PC42 |
|---|---|---|---|---|
| Xi | 4.3MB/s = 36.07Mbit/s | 1.4MB/s = 11.74Mbit/s | 2.9MB/s = 24.32Mbit/s | 3.2MB/s = 26.84Mbit/s |
| Yi | 50Mbit/s | 20Mbit/s | 26Mbit/s | 40Mbit/s |
| Zi | 0.7214 | 0.587 | 0.9354 | 0.671 |
| $Zi^2$ | 0.52 | 0.34 | 0.875 | 0.45 |

index = $2.9148^2$ / (4 * 2.19) = **0.969**

We notice that the index is close to 1, indicating that TCP was able to achieve fairness max-min in this case.

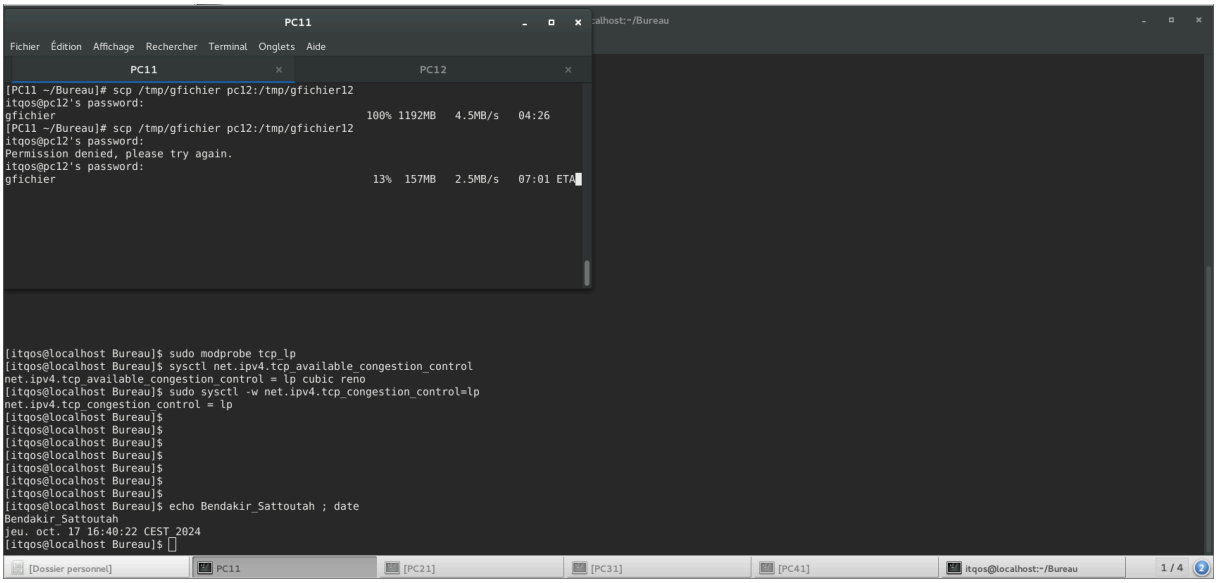
4.5

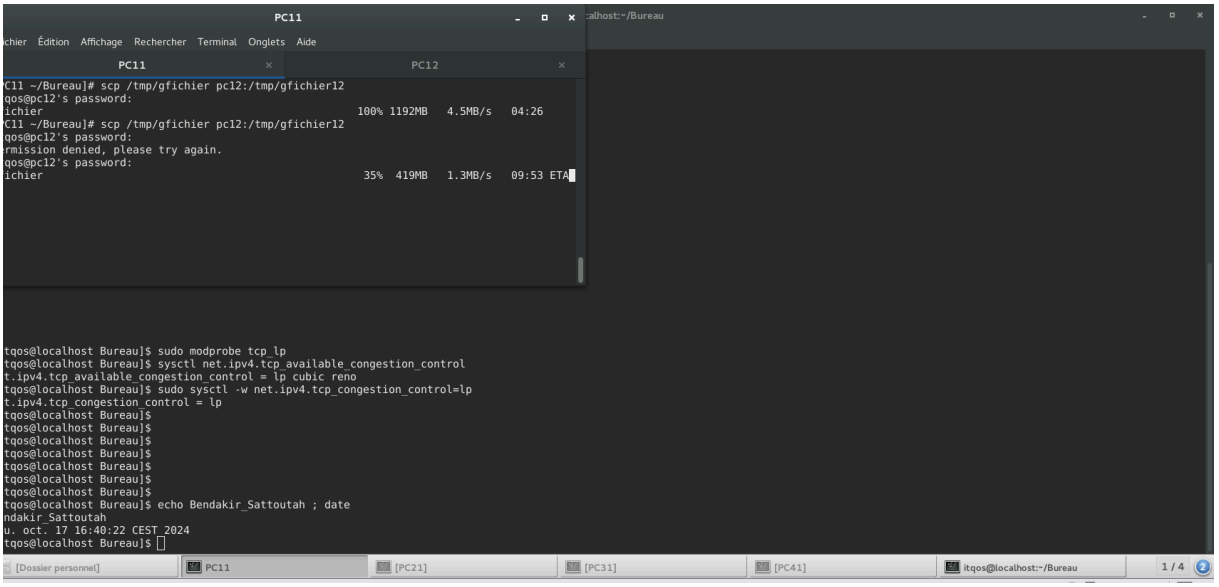
Activate Tcp_Lp

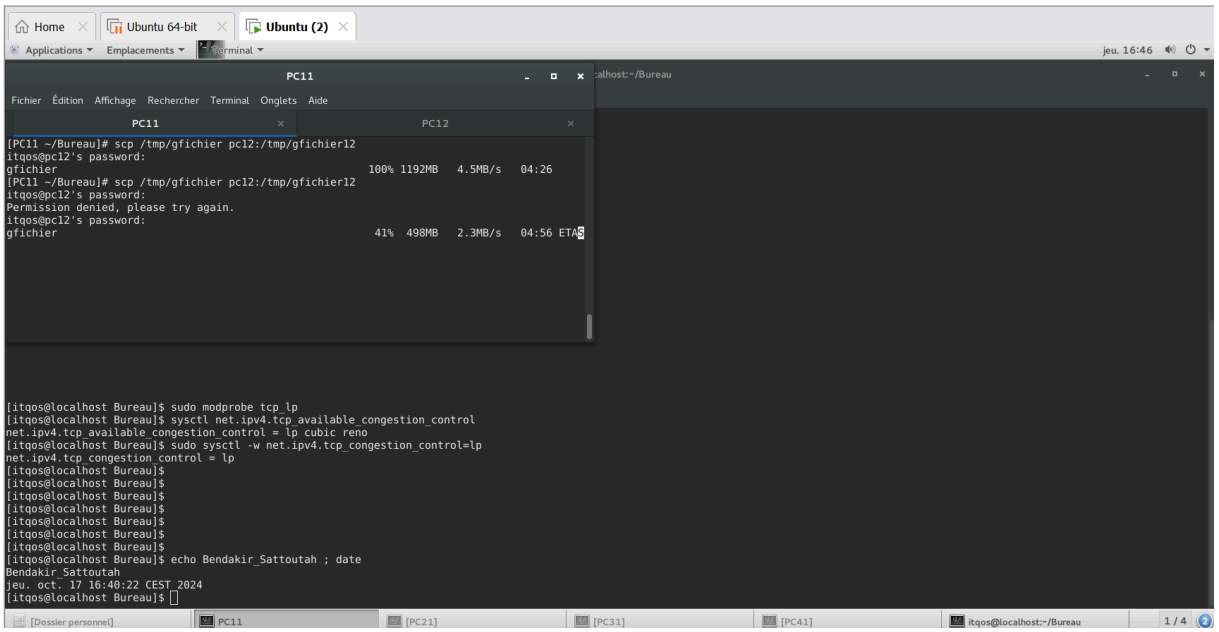



- When we initiated the transfer from PC11 to PC12 using TCP-LP as the congestion control mechanism, we observed that the throughput fluctuated, increasing and decreasing periodically. This behavior is characteristic of TCP-LP (Low Priority), which is designed to yield to regular TCP traffic and only use bandwidth when the

network is underutilized. The fluctuations in throughput are expected because TCP-LP actively adjusts its sending rate to avoid competing with higher-priority traffic, ensuring that it does not interfere with regular TCP flows. This behavior is normal for TCP-LP, as it aims to minimize its impact on the network's overall performance.






# Response 6:

6.1

The minimum threshold (min) should be set **lower than** the maximum threshold (max) to ensure sufficient space and time for managing packets, because we want to start marking packets once the queue exceeds the minimum threshold but before reaching the maximum threshold. If the minimum threshold is too close to the maximum threshold, packets may be marked too late, which could lead to congestion.

6.2

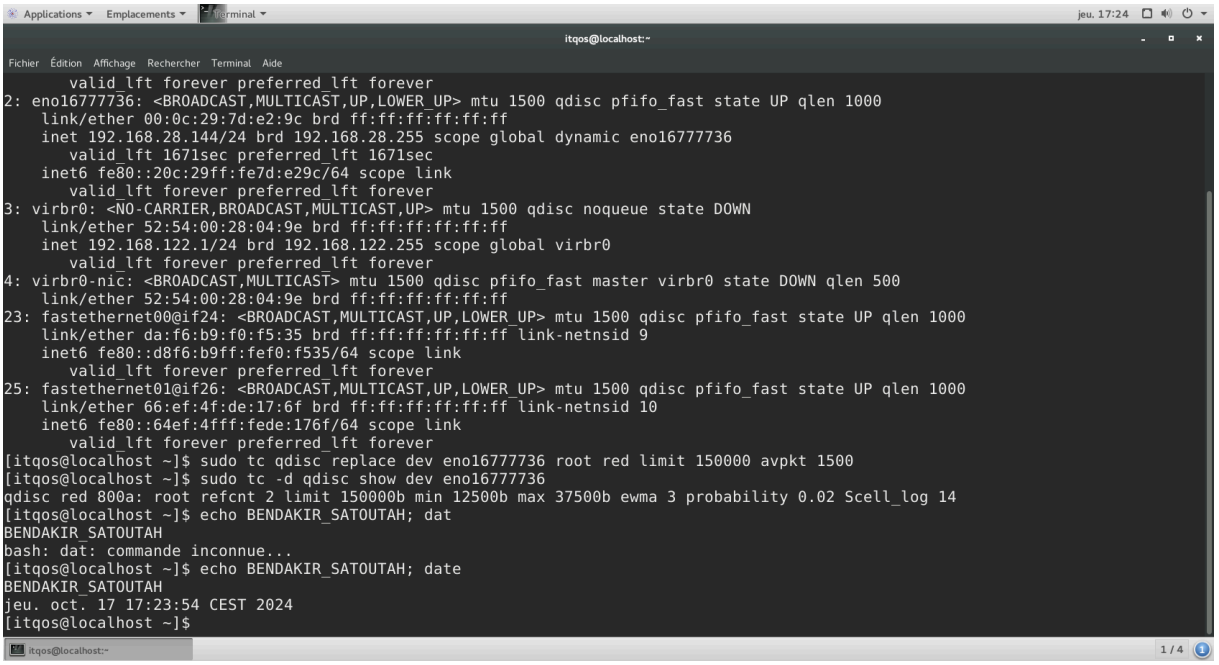
The maximum threshold (max) should be set **lower than** the physical buffer limit to prevent the queue from becoming completely full before congestion control mechanisms can be triggered. If the maximum threshold is equal to or too close to the physical limit, there won't be enough space and time to react to congestion, resulting in direct packet loss.

6.3

The maximum drop probability (max_p) should be set at a moderate level (e.g., 0.02 to 0.1). This is because a very low value would lead to ineffective congestion control (too few packets marked/dropped), while a very high value could lead to excessive packet loss and throughput degradation. The drop probability determines how aggressively RED responds to congestion.

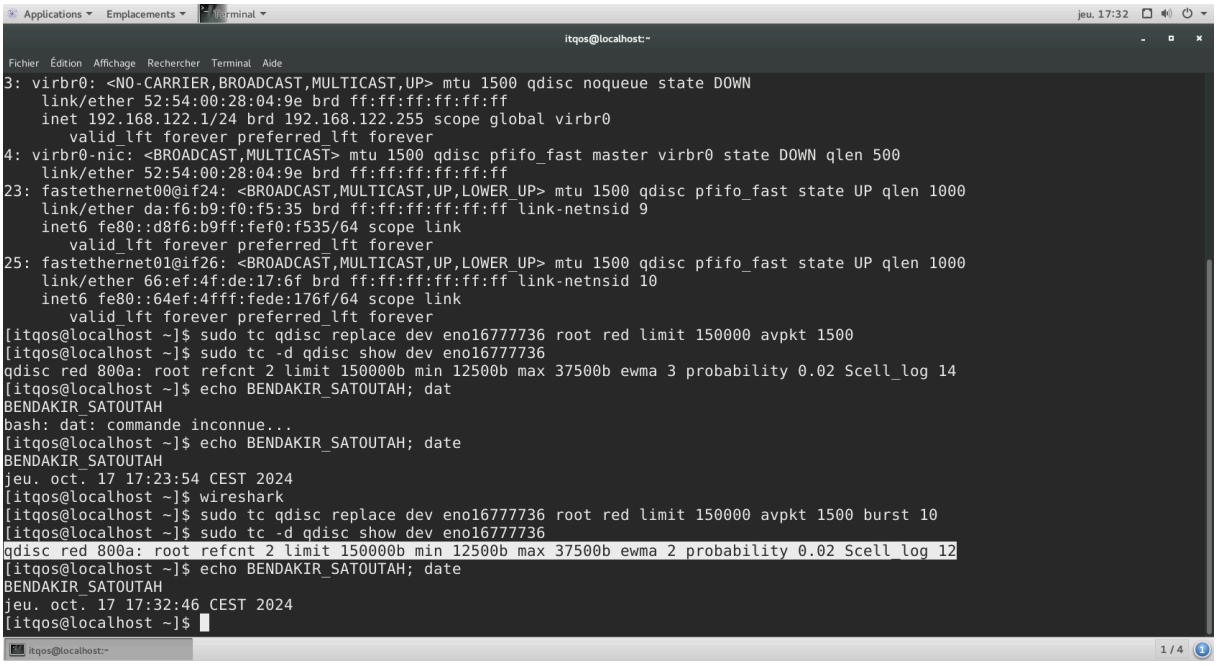
6.4

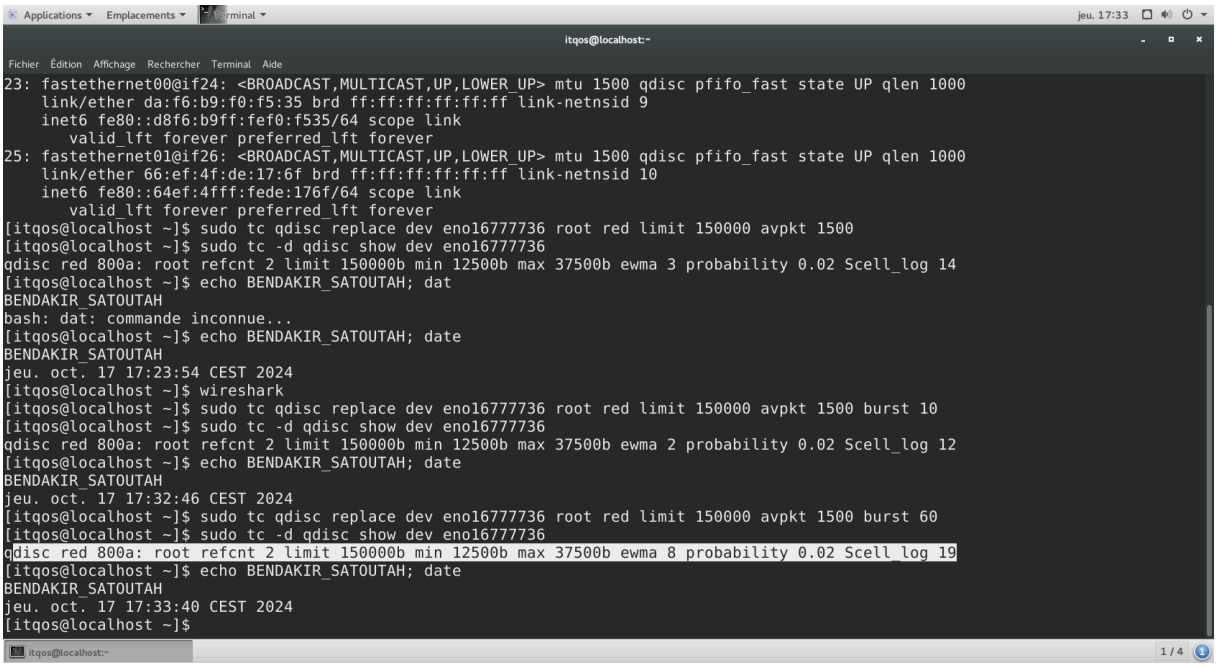
From the command’s result (in the capture), we can see that the minimum threshold (min) is set to **15000b** while the maximum threshold (max) is set to **37500b**. These thresholds respect the suggestions.



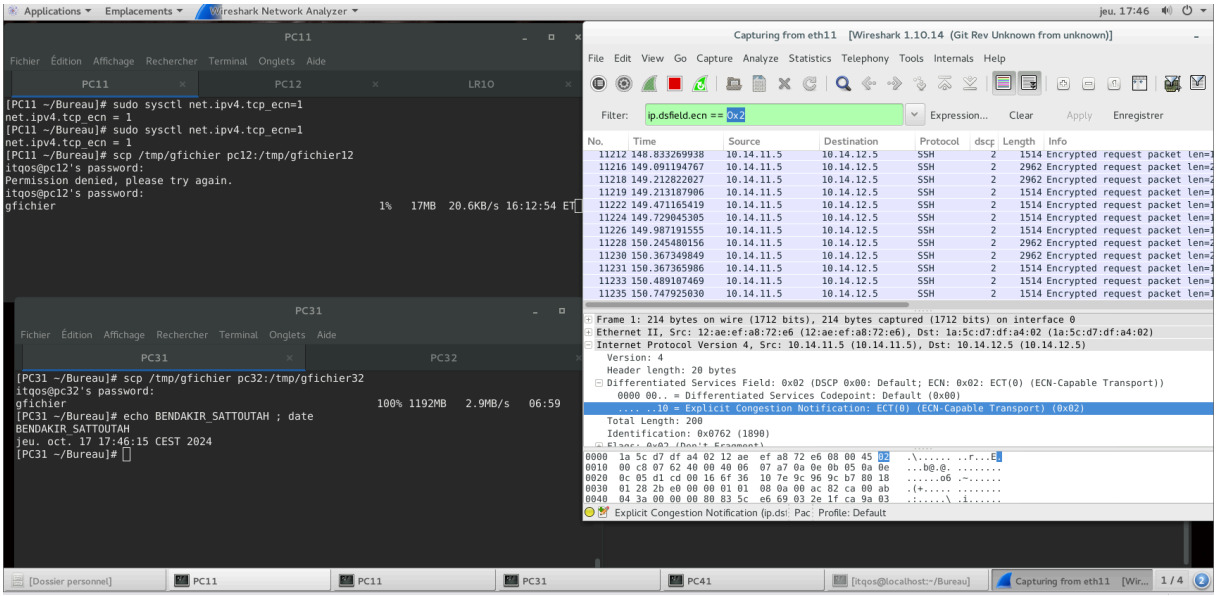

6.5

| Capture | ewma = wlog | les poids (w) |
|---|---|---|
| 1 | 2 | 0.25 |
| 2 | 8 | 1/256 = 0.0039 |




Applications Emplacements Terminal jeu. 17:33
itqos@localhost:~
Fichier Édition Affichage Rechercher Terminal Aide
23: fastethernet00@if24: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP qlen 1000
link/ether da:f6:b9:f0:f5:35 brd ff:ff:ff:ff:ff:ff link-netnsid 9
inet6 fe80::d8f6:b9ff:fef0:f535/64 scope link
valid_lft forever preferred_lft forever
25: fastethernet01@if26: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP qlen 1000
link/ether 66:ef:4f:de:17:6f brd ff:ff:ff:ff:ff:ff link-netnsid 10
inet6 fe80::64ef:4fff:fede:176f/64 scope link
valid_lft forever preferred_lft forever
[itqos@localhost ~]$ sudo tc qdisc replace dev eno16777736 root red limit 150000 avpkt 1500
[itqos@localhost ~]$ sudo tc -d qdisc show dev eno16777736
qdisc red 800a: root refcnt 2 limit 150000b min 12500b max 37500b ewma 3 probability 0.02 Scell_log 14
[itqos@localhost ~]$ echo BENDAKIR_SATOUTAH; dat
BENDAKIR_SATOUTAH
bash: dat: commande inconnue...
[itqos@localhost ~]$ echo BENDAKIR_SATOUTAH; date
BENDAKIR_SATOUTAH
jeu. oct. 17 17:23:54 CEST 2024
[itqos@localhost ~]$ wireshark
[itqos@localhost ~]$ sudo tc qdisc replace dev eno16777736 root red limit 150000 avpkt 1500 burst 10
[itqos@localhost ~]$ sudo tc -d qdisc show dev eno16777736
qdisc red 800a: root refcnt 2 limit 150000b min 12500b max 37500b ewma 2 probability 0.02 Scell_log 12
[itqos@localhost ~]$ echo BENDAKIR_SATOUTAH; date
BENDAKIR_SATOUTAH
jeu. oct. 17 17:32:46 CEST 2024
[itqos@localhost ~]$ sudo tc qdisc replace dev eno16777736 root red limit 150000 avpkt 1500 burst 60
[itqos@localhost ~]$ sudo tc -d qdisc show dev eno16777736
qdisc red 800a: root refcnt 2 limit 150000b min 12500b max 37500b ewma 8 probability 0.02 Scell_log 19
[itqos@localhost ~]$ echo BENDAKIR_SATOUTAH; date
BENDAKIR_SATOUTAH
jeu. oct. 17 17:33:40 CEST 2024
[itqos@localhost ~]$
itqos@localhost:~
1 / 4

6.6


Applications Emplacements Wireshark Network Analyzer jeu. 17:46
PC11
Fichier Édition Affichage Rechercher Terminal Onglets Aide
PC11 PC12 LR10
[PC11 ~/Bureau]# sudo sysctl net.ipv4.tcp_ecn=1
net.ipv4.tcp_ecn = 1
[PC11 ~/Bureau]# sudo sysctl net.ipv4.tcp_ecn=1
net.ipv4.tcp_ecn = 1
[PC11 ~/Bureau]# scp /tmp/gfichier pc12:/tmp/gfichier12
itqos@pc12's password:
Permission denied, please try again.
itqos@pc12's password:
gfichier 1% 17MB 20.6KB/s 16:12:54 ET
PC31
Fichier Édition Affichage Rechercher Terminal Onglets Aide
PC31 PC32
[PC31 ~/Bureau]# scp /tmp/gfichier pc32:/tmp/gfichier32
itqos@pc32's password:
gfichier 100% 1192MB 2.9MB/s 06:59
[PC31 ~/Bureau]# echo BENDAKIR_SATTOUTAH ; date
BENDAKIR_SATTOUTAH
jeu. oct. 17 17:46:15 CEST 2024
[PC31 ~/Bureau]#
Capturing from eth11 [Wireshark 1.10.14 (Git Rev Unknown from unknown)]
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Filter: ip.dsfield.ecn == 0x2 Expression... Clear Apply Enregistrer
No. Time Source Destination Protocol dscp Length Info
11212 148.833269938 10.14.11.5 10.14.12.5 SSH 2 1514 Encrypted request packet len=1
11216 149.091194767 10.14.11.5 10.14.12.5 SSH 2 2962 Encrypted request packet len=2
11218 149.212822027 10.14.11.5 10.14.12.5 SSH 2 2962 Encrypted request packet len=2
11219 149.213187906 10.14.11.5 10.14.12.5 SSH 2 1514 Encrypted request packet len=1
11222 149.471165419 10.14.11.5 10.14.12.5 SSH 2 1514 Encrypted request packet len=1
11224 149.729045305 10.14.11.5 10.14.12.5 SSH 2 1514 Encrypted request packet len=1
11226 149.987191555 10.14.11.5 10.14.12.5 SSH 2 1514 Encrypted request packet len=1
11228 150.245480156 10.14.11.5 10.14.12.5 SSH 2 2962 Encrypted request packet len=2
11230 150.367349849 10.14.11.5 10.14.12.5 SSH 2 2962 Encrypted request packet len=2
11231 150.367365986 10.14.11.5 10.14.12.5 SSH 2 1514 Encrypted request packet len=1
11233 150.489107469 10.14.11.5 10.14.12.5 SSH 2 1514 Encrypted request packet len=1
11235 150.747925030 10.14.11.5 10.14.12.5 SSH 2 1514 Encrypted request packet len=1
Frame 1: 214 bytes on wire (1712 bits), 214 bytes captured (1712 bits) on interface 0
Ethernet II, Src: 12:ae:ef:a8:72:e6 (12:ae:ef:a8:72:e6), Dst: 1a:5c:d7:df:a4:02 (1a:5c:d7:df:a4:02)
Internet Protocol Version 4, Src: 10.14.11.5 (10.14.11.5), Dst: 10.14.12.5 (10.14.12.5)
Version: 4
Header length: 20 bytes
Differentiated Services Field: 0x02 (DSCP 0x00: Default; ECN: 0x02: ECT(0) (ECN-Capable Transport))
0000 00.. = Differentiated Services Codepoint: Default (0x00)
.... ..10 = Explicit Congestion Notification: ECT(0) (ECN-Capable Transport) (0x02)
Total Length: 200
Identification: 0x0762 (1890)
0000 1a 5c d7 df a4 02 12 ae ef a8 72 e6 08 00 45 02 .\...... ..r...E.
0010 00 c8 07 62 40 00 40 06 07 a7 0a 0e 0b 05 0a 0e ...b@.@. ........
0020 0c 05 d1 cd 00 16 6f 36 10 7e 9c 96 9c b7 80 18 ......o6 .~......
0030 01 28 2b e0 00 00 01 01 08 0a 00 ac 82 ca 00 ab .(+..... ........
0040 04 3a 00 00 00 80 83 5c e6 69 03 2e 1f ca 9a 03 .:.....\ .i......
Explicit Congestion Notification (ip.ds! Pac Profile: Default
[Dossier personnel] PC11 PC11 PC31 PC41 [itqos@localhost:~/Bureau] Capturing from eth11 [Wir... 1 / 4