**Estudo aumentando gradativamente a carga UDP. Qual o impacto no TCP? Ocorre starvation?**

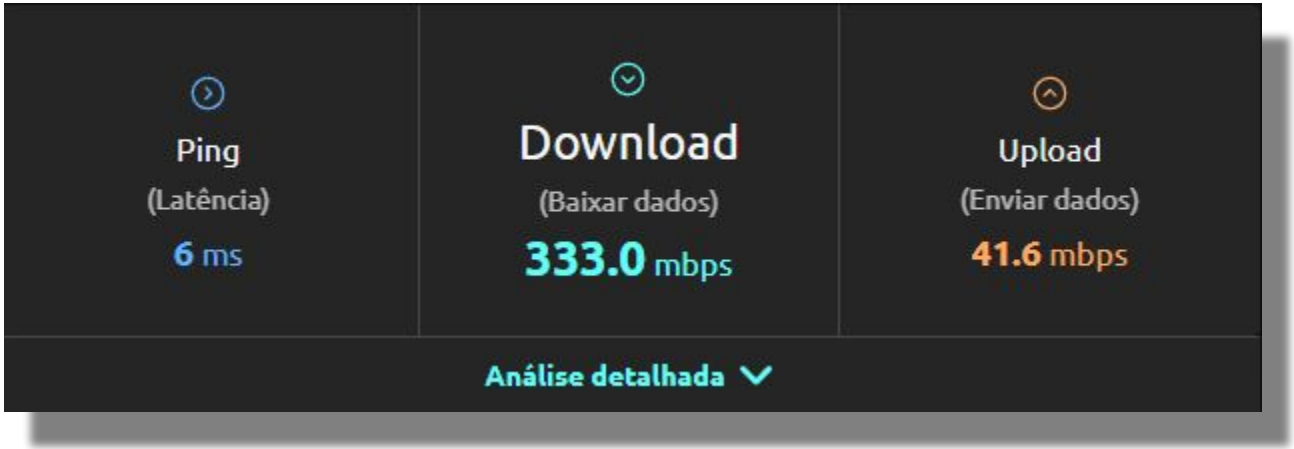
UDESC
UNIVERSIDADE
DO ESTADO DE
SANTA CATARINA

# Ferramentas utilizadas

- Iperf3 para monitoramento de rede
- Python para extrair os dados mais importantes

# Observações

- Para o cenário 1 e cenário 2 os computadores estão na mesma rede
- Foram fechado processos que consumiam banda
- Ambos continham o sistemas operacionais Windows 10



# Observações

TCP

- Executando servidor e cliente na mesma máquina

```
-----------------------------------------------------------
Server listening on 5201
-----------------------------------------------------------
Accepted connection from 192.168.0.136, port 36888
[  5] local 192.168.0.129 port 5201 connected to 192.168.0.136 port 36900
[ ID] Interval           Transfer     Bandwidth
[  5]   0.00-1.00   sec   265 MBytes  2.22 Gbits/sec
[  5]   1.00-2.00   sec   249 MBytes  2.09 Gbits/sec
[  5]   2.00-3.00   sec   282 MBytes  2.36 Gbits/sec
[  5]   3.00-4.00   sec   282 MBytes  2.37 Gbits/sec
[  5]   4.00-5.00   sec   290 MBytes  2.43 Gbits/sec
[  5]   5.00-6.00   sec   280 MBytes  2.35 Gbits/sec
[  5]   6.00-7.00   sec   285 MBytes  2.39 Gbits/sec
[  5]   7.00-8.00   sec   275 MBytes  2.31 Gbits/sec
[  5]   8.00-9.00   sec   258 MBytes  2.17 Gbits/sec
[  5]   9.00-10.00  sec   264 MBytes  2.21 Gbits/sec
[  5]  10.00-10.04  sec  11.0 MBytes  2.37 Gbits/sec
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bandwidth
[  5]   0.00-10.04  sec  0.00 Bytes  0.00 bits/sec                  sender
[  5]   0.00-10.04  sec  2.68 GBytes  2.29 Gbits/sec                  receiver
```

# Observações

UDP

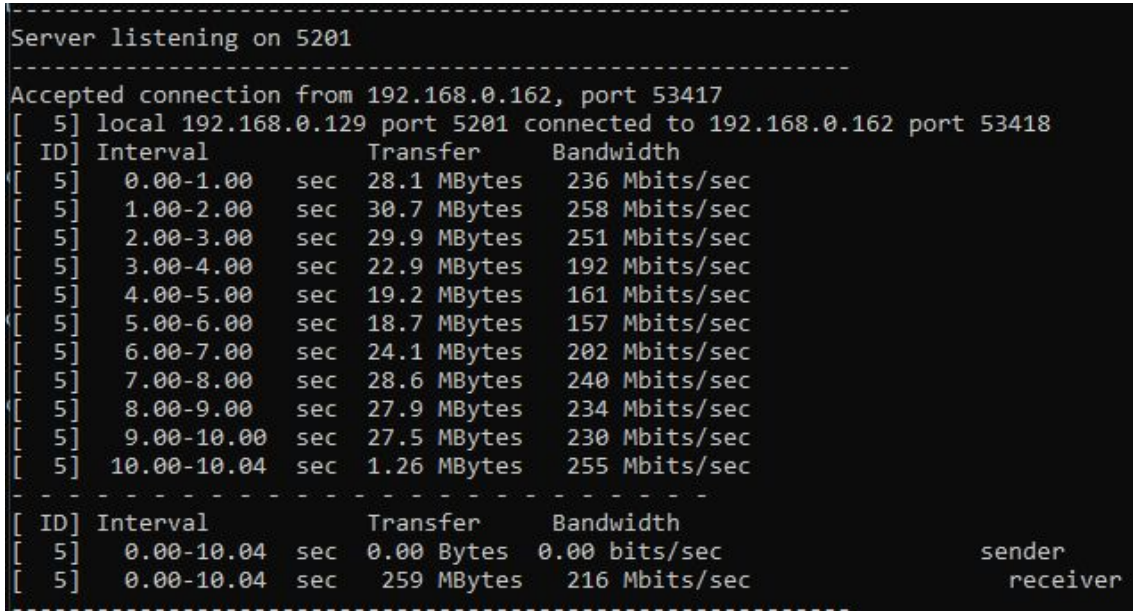
- Executando servidor e cliente na mesma máquina

```
-----------------------------------------------------------
Server listening on 5201
-----------------------------------------------------------
Accepted connection from 192.168.0.136, port 36134
[  5] local 192.168.0.129 port 5201 connected to 192.168.0.136 port 52902
[ ID] Interval           Transfer     Bandwidth       Jitter    Lost/Total Datagrams
[  5]   0.00-1.00   sec  40.1 MBytes   337 Mbits/sec  0.018 ms  22221/51040 (44%)
[  5]   1.00-2.00   sec  41.5 MBytes   348 Mbits/sec  0.024 ms  22775/52604 (43%)
[  5]   2.00-3.00   sec  42.0 MBytes   353 Mbits/sec  0.025 ms  26602/56795 (47%)
[  5]   3.00-4.00   sec  42.1 MBytes   353 Mbits/sec  0.026 ms  28487/58689 (49%)
[  5]   4.00-5.00   sec  42.2 MBytes   354 Mbits/sec  0.018 ms  27728/58036 (48%)
[  5]   5.00-6.00   sec  41.4 MBytes   347 Mbits/sec  0.018 ms  27703/57430 (48%)
[  5]   6.00-7.00   sec  42.3 MBytes   355 Mbits/sec  0.024 ms  27665/58077 (48%)
[  5]   7.00-8.00   sec  42.0 MBytes   352 Mbits/sec  0.020 ms  41587/71747 (58%)
[  5]   8.00-9.00   sec  40.7 MBytes   341 Mbits/sec  0.006 ms  87275/116500 (75%)
[  5]   9.00-10.00  sec  40.2 MBytes   337 Mbits/sec  0.011 ms  80285/109161 (74%)
[  5]  10.00-10.04  sec  1.41 MBytes   317 Mbits/sec  0.016 ms  2913/3924 (74%)
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bandwidth       Jitter    Lost/Total Datagrams
[  5]   0.00-10.04  sec  0.00 Bytes  0.00 bits/sec  0.016 ms  395241/694003 (57%)
-----------------------------------------------------------
```

# Observações

TCP

- Executando servidor (Ethernet) e cliente (Wireless) em máquinas separadas mas na mesma rede



```
-----------------------------------------------------------
Server listening on 5201
-----------------------------------------------------------
Accepted connection from 192.168.0.162, port 53417
[  5] local 192.168.0.129 port 5201 connected to 192.168.0.162 port 53418
[ ID] Interval           Transfer     Bandwidth
[  5]   0.00-1.00   sec  28.1 MBytes   236 Mbits/sec
[  5]   1.00-2.00   sec  30.7 MBytes   258 Mbits/sec
[  5]   2.00-3.00   sec  29.9 MBytes   251 Mbits/sec
[  5]   3.00-4.00   sec  22.9 MBytes   192 Mbits/sec
[  5]   4.00-5.00   sec  19.2 MBytes   161 Mbits/sec
[  5]   5.00-6.00   sec  18.7 MBytes   157 Mbits/sec
[  5]   6.00-7.00   sec  24.1 MBytes   202 Mbits/sec
[  5]   7.00-8.00   sec  28.6 MBytes   240 Mbits/sec
[  5]   8.00-9.00   sec  27.9 MBytes   234 Mbits/sec
[  5]   9.00-10.00  sec  27.5 MBytes   230 Mbits/sec
[  5]  10.00-10.04  sec  1.26 MBytes   255 Mbits/sec
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bandwidth
[  5]   0.00-10.04  sec  0.00 Bytes  0.00 bits/sec                  sender
[  5]   0.00-10.04  sec   259 MBytes   216 Mbits/sec                  receiver
-----------------------------------------------------------
```

# Observações

UDP

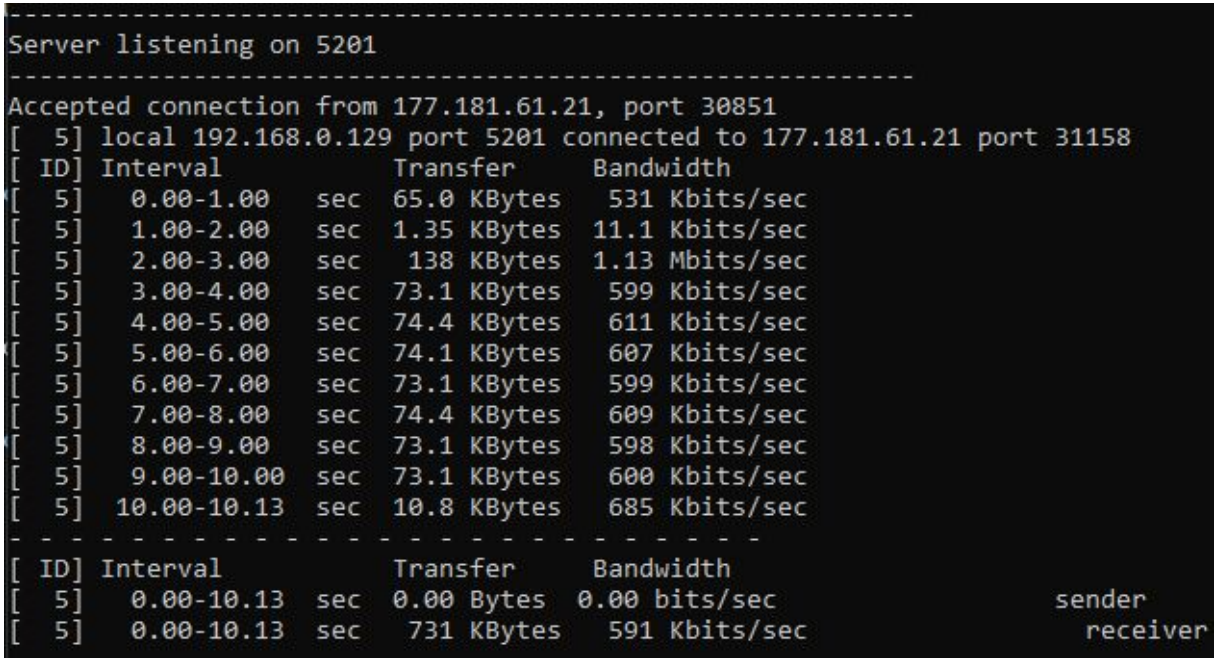
- Executando servidor (Ethernet) e cliente (Wireless) em máquinas separadas mas na mesma rede

```
-----------------------------------------------------------
Server listening on 5201
-----------------------------------------------------------
Accepted connection from 177.34.71.239, port 63815
[  5] local 192.168.0.129 port 5201 connected to 177.34.71.239 port 58868
[ ID] Interval           Transfer     Bandwidth       Jitter    Lost/Total Datagrams
[  5]   0.00-1.00   sec  38.4 MBytes   322 Mbits/sec  0.250 ms  0/4909 (0%)
[  5]   1.00-2.00   sec  41.1 MBytes   345 Mbits/sec  0.197 ms  0/5264 (0%)
[  5]   2.00-3.00   sec  40.6 MBytes   341 Mbits/sec  0.363 ms  0/5198 (0%)
[  5]   3.00-4.00   sec  40.5 MBytes   340 Mbits/sec  0.277 ms  0/5181 (0%)
[  5]   4.00-5.00   sec  40.8 MBytes   342 Mbits/sec  0.295 ms  22/5248 (0.42%)
[  5]   5.00-6.00   sec  40.6 MBytes   341 Mbits/sec  0.288 ms  8/5201 (0.15%)
[  5]   6.00-7.00   sec  40.7 MBytes   342 Mbits/sec  0.205 ms  0/5213 (0%)
[  5]   7.00-8.00   sec  41.0 MBytes   344 Mbits/sec  0.203 ms  0/5252 (0%)
[  5]   8.00-9.00   sec  40.3 MBytes   338 Mbits/sec  0.268 ms  0/5160 (0%)
[  5]   9.00-10.00  sec  40.8 MBytes   343 Mbits/sec  0.251 ms  35/5263 (0.67%)
[  5]  10.00-10.05  sec  2.18 MBytes   341 Mbits/sec  0.215 ms  0/279 (0%)
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bandwidth       Jitter    Lost/Total Datagrams
[  5]   0.00-10.05  sec  0.00 Bytes  0.00 bits/sec  0.215 ms  65/52168 (0.12%)
-----------------------------------------------------------
```

# Observações

TCP

- Executando servidor (Ethernet) e cliente (Wireless) em máquinas e redes separadas



```
-----------------------------------------------------------
Server listening on 5201
-----------------------------------------------------------
Accepted connection from 177.181.61.21, port 30851
[  5] local 192.168.0.129 port 5201 connected to 177.181.61.21 port 31158
[ ID] Interval           Transfer     Bandwidth
[  5]   0.00-1.00   sec  65.0 KBytes   531 Kbits/sec
[  5]   1.00-2.00   sec  1.35 KBytes  11.1 Kbits/sec
[  5]   2.00-3.00   sec   138 KBytes  1.13 Mbits/sec
[  5]   3.00-4.00   sec  73.1 KBytes   599 Kbits/sec
[  5]   4.00-5.00   sec  74.4 KBytes   611 Kbits/sec
[  5]   5.00-6.00   sec  74.1 KBytes   607 Kbits/sec
[  5]   6.00-7.00   sec  73.1 KBytes   599 Kbits/sec
[  5]   7.00-8.00   sec  74.4 KBytes   609 Kbits/sec
[  5]   8.00-9.00   sec  73.1 KBytes   598 Kbits/sec
[  5]   9.00-10.00  sec  73.1 KBytes   600 Kbits/sec
[  5]  10.00-10.13  sec  10.8 KBytes   685 Kbits/sec
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bandwidth
[  5]   0.00-10.13  sec  0.00 Bytes  0.00 bits/sec                  sender
[  5]   0.00-10.13  sec   731 KBytes   591 Kbits/sec                  receiver
```

# Observações

UDP

- Executando servidor (Ethernet) e cliente (Wireless) em máquinas e redes separadas

```
-----------------------------------------------------------
Server listening on 5201
-----------------------------------------------------------
Accepted connection from 177.181.59.60, port 20614
[  5] local 192.168.0.129 port 5201 connected to 177.181.59.60 port 20754
[ ID] Interval           Transfer     Bandwidth       Jitter    Lost/Total Datagrams
[  5]   0.00-1.00   sec  48.0 KBytes   393 Kbits/sec  2888.144 ms  0/6 (0%)
[  5]   1.00-2.00   sec  0.00 Bytes  0.00 bits/sec  2888.144 ms  0/0 (0%)
[  5]   2.00-3.00   sec  16.0 KBytes   131 Kbits/sec  2569.189 ms  537/539 (1e+02%)
[  5]   3.00-4.00   sec  40.0 KBytes   328 Kbits/sec  1907.839 ms  576/581 (99%)
[  5]   4.00-5.00   sec  24.0 KBytes   196 Kbits/sec  1607.851 ms  326/329 (99%)
[  5]   5.00-6.00   sec  0.00 Bytes  0.00 bits/sec  1607.851 ms  0/0 (0%)
[  5]   6.00-7.00   sec  32.0 KBytes   262 Kbits/sec  1259.409 ms  1217/1221 (1e+02%)
[  5]   7.00-8.00   sec  0.00 Bytes  0.00 bits/sec  1259.409 ms  0/0 (0%)
[  5]   8.00-9.00   sec  32.0 KBytes   262 Kbits/sec  1007.069 ms  1221/1225 (1e+02%)
[  5]   9.00-10.00  sec  8.00 KBytes  65.5 Kbits/sec  946.131 ms  181/182 (99%)
[  5]  10.00-10.62  sec  0.00 Bytes  0.00 bits/sec  946.131 ms  0/0 (0%)
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bandwidth       Jitter    Lost/Total Datagrams
[  5]   0.00-10.62  sec  0.00 Bytes  0.00 bits/sec  946.131 ms  4058/4083 (99%)
-----------------------------------------------------------
```

# Base do cenário de teste

- Cenário 1 (Cliente e Servidor em máquinas diferentes mas na mesma rede)
  - 1 processo TCP (máximo)
  - 2 processo TCP (máximo)
  - 1 processo TCP (máximo) + 1 processo UDP (20%)
  - 1 processo TCP (máximo) + 1 processo UDP  (40%)
  - 1 processo TCP (máximo) + 1 processo UDP  (80%)
  - 1 processo TCP (máximo) + 1 processo UDP  (100%)

- Cenário 2 (Cliente e Servidor em máquinas diferentes mas na mesma rede)
  - 1 processo TCP (máximo) + 2 processo UDP (0%)
  - 1 processo TCP (máximo) + 2 processo UDP (20%)
  - 1 processo TCP (máximo) + 2 processo UDP  (40%)
  - 1 processo TCP (máximo) + 2 processo UDP  (80%)
  - 1 processo TCP (máximo) + 2 processo UDP  (100%)

- Cenário extra:
  - 1 processo TCP (máximo) + 1 processo UDP  (100%)

# Comandos

***Servidor***:

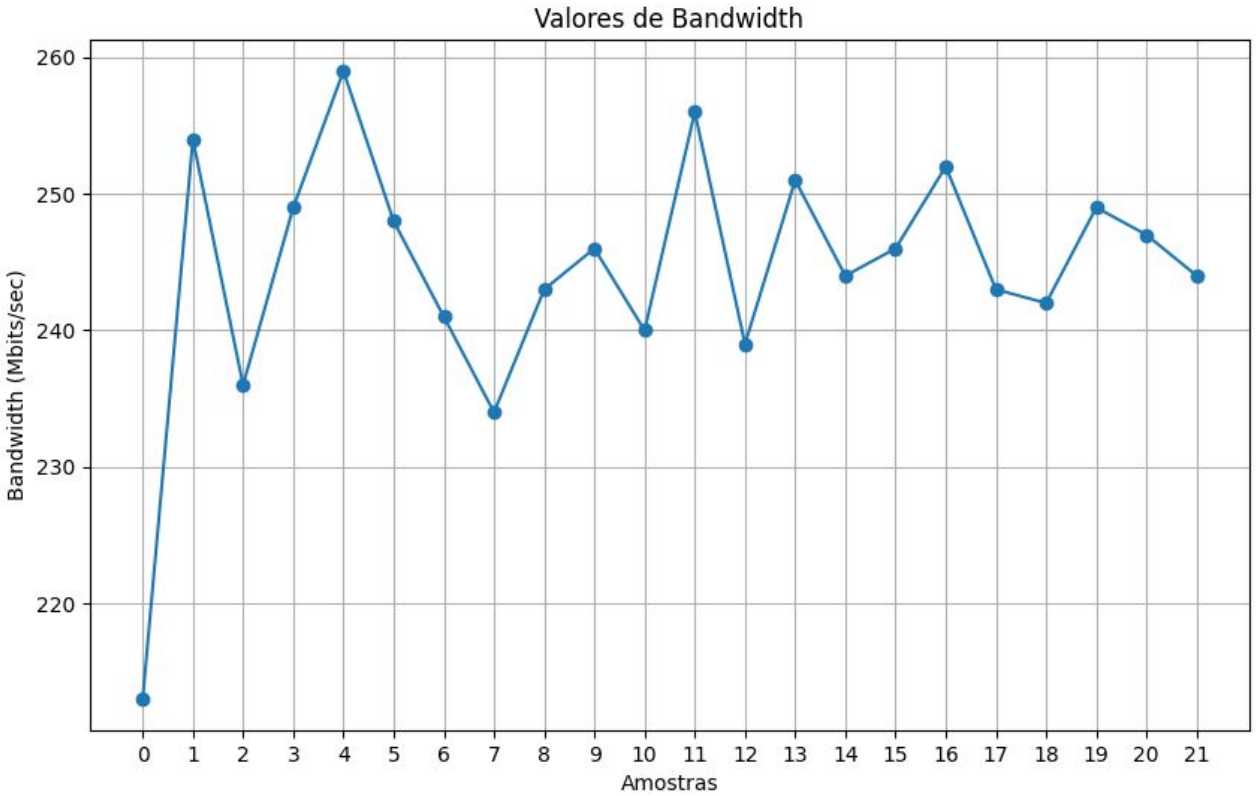
- Iniciar servidor TCP: iperf3 -s -p 5201  --logfile ./output.txt
- Iniciar servidor UDP: iperf3 -s -p 5202

***Cliente***:

- Iniciar cliente tcp: iperf3 -c ip_servidor -p porta_servidor_N -b 1G -t 0 -P 1 -R
- Iniciar cliente udp: iperf3 -c ip_servidor -p 5201 -u -t 10 -b 0 -R

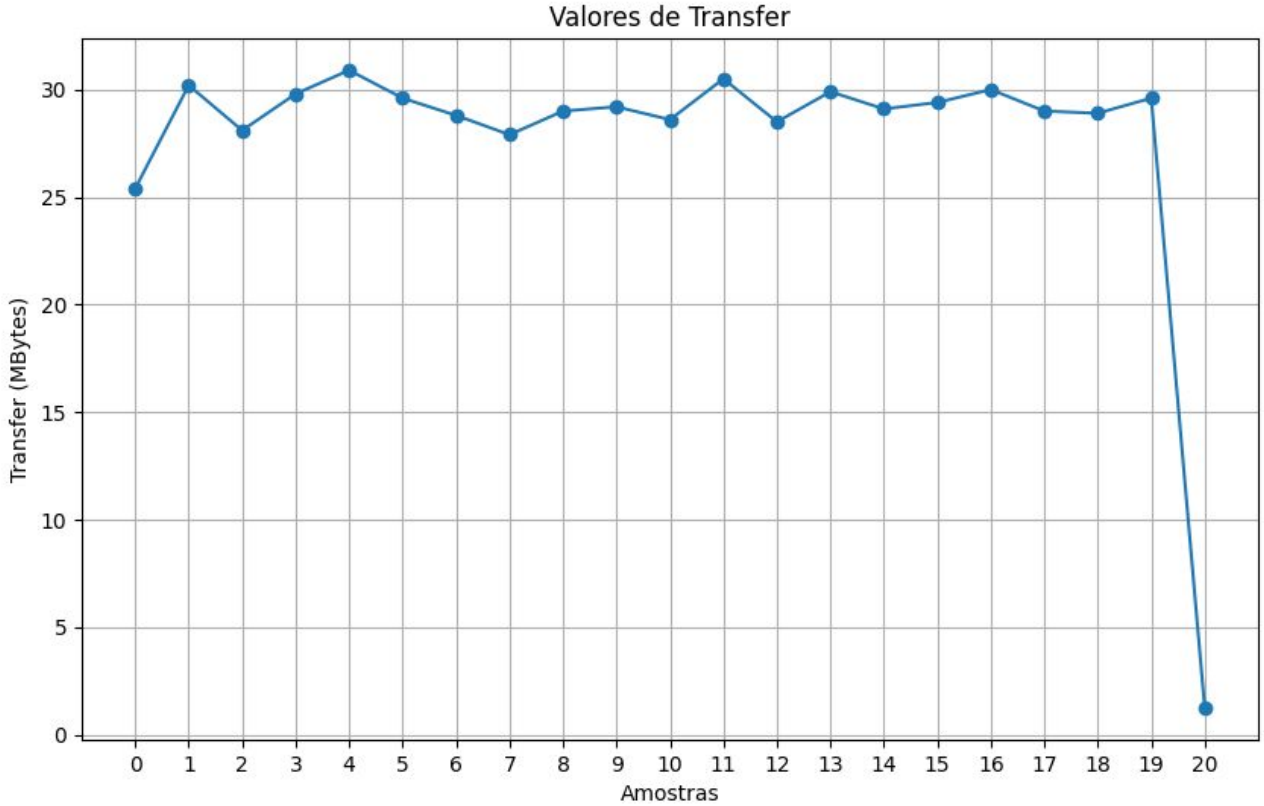
# Cenário de teste 1: Largura de Banda

- 1 processo TCP (banda máxima 250Mbits/sec)



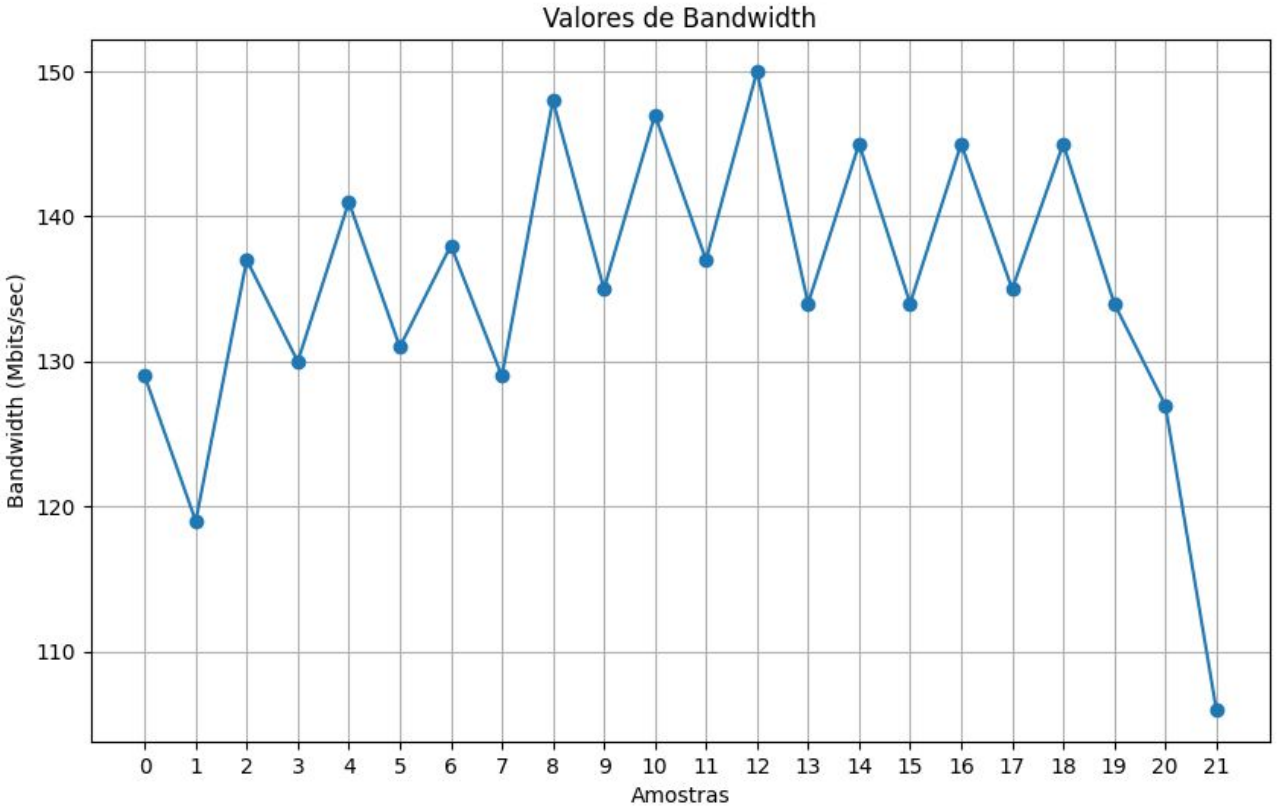
# Cenário de teste 1: Taxa de Tranferência

- 1 processo TCP (banda máxima 250Mbytes/sec)



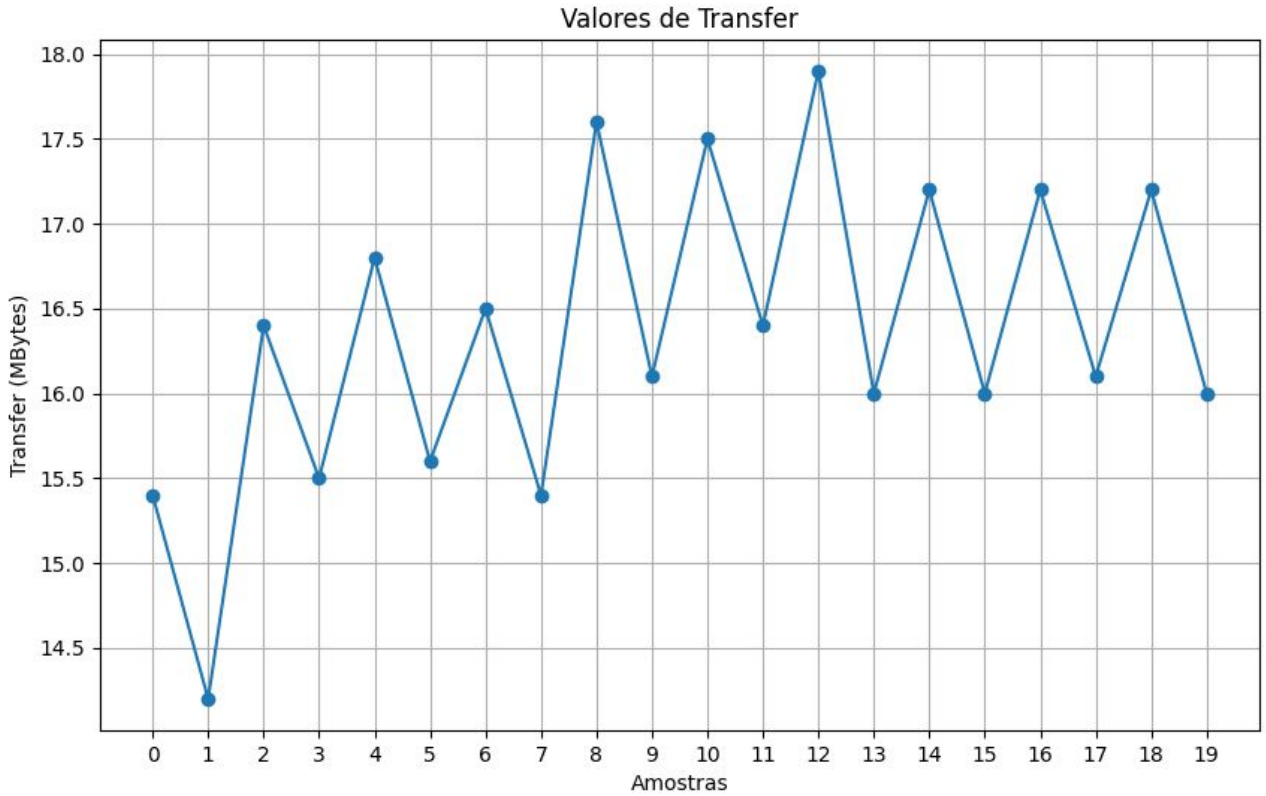
# Cenário de teste 1: Largura de Banda

- 2 processos TCP (banda máxima 250Mbits/sec)



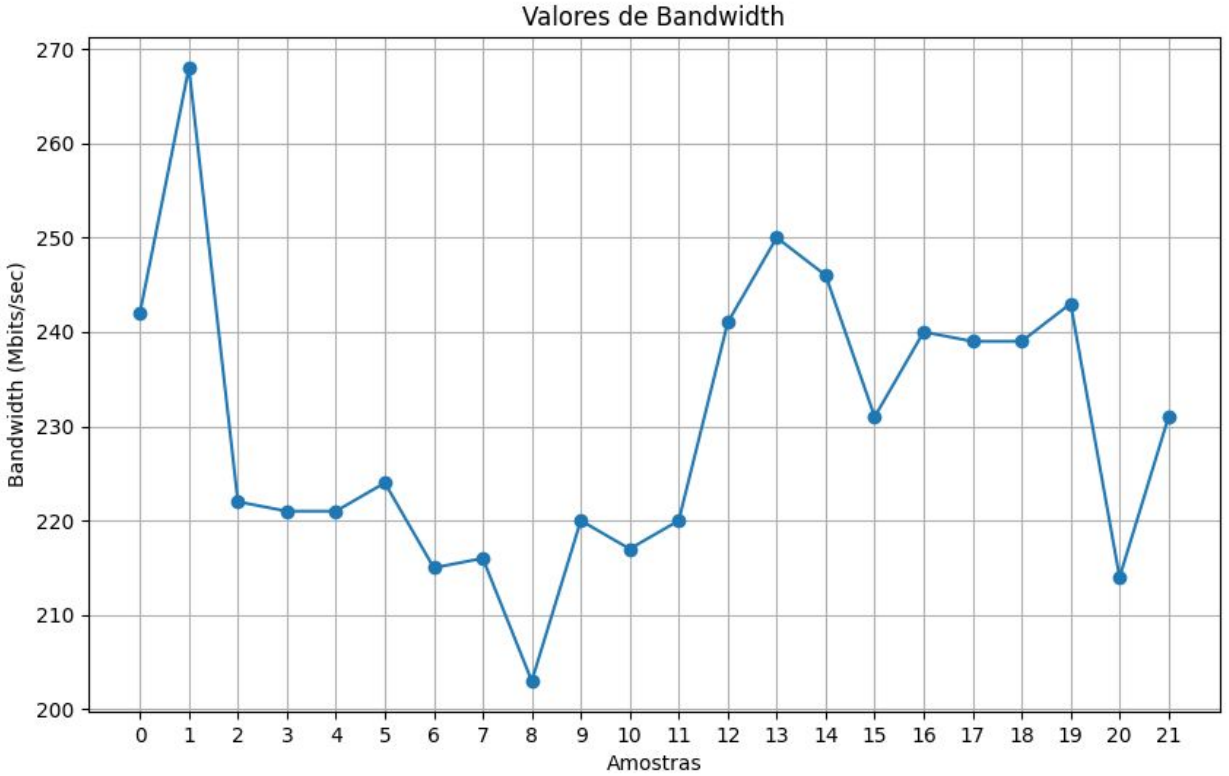
# Cenário de teste 1: Taxa de Tranferência

- 2 processos TCP (banda máxima 250Mbytes/sec)



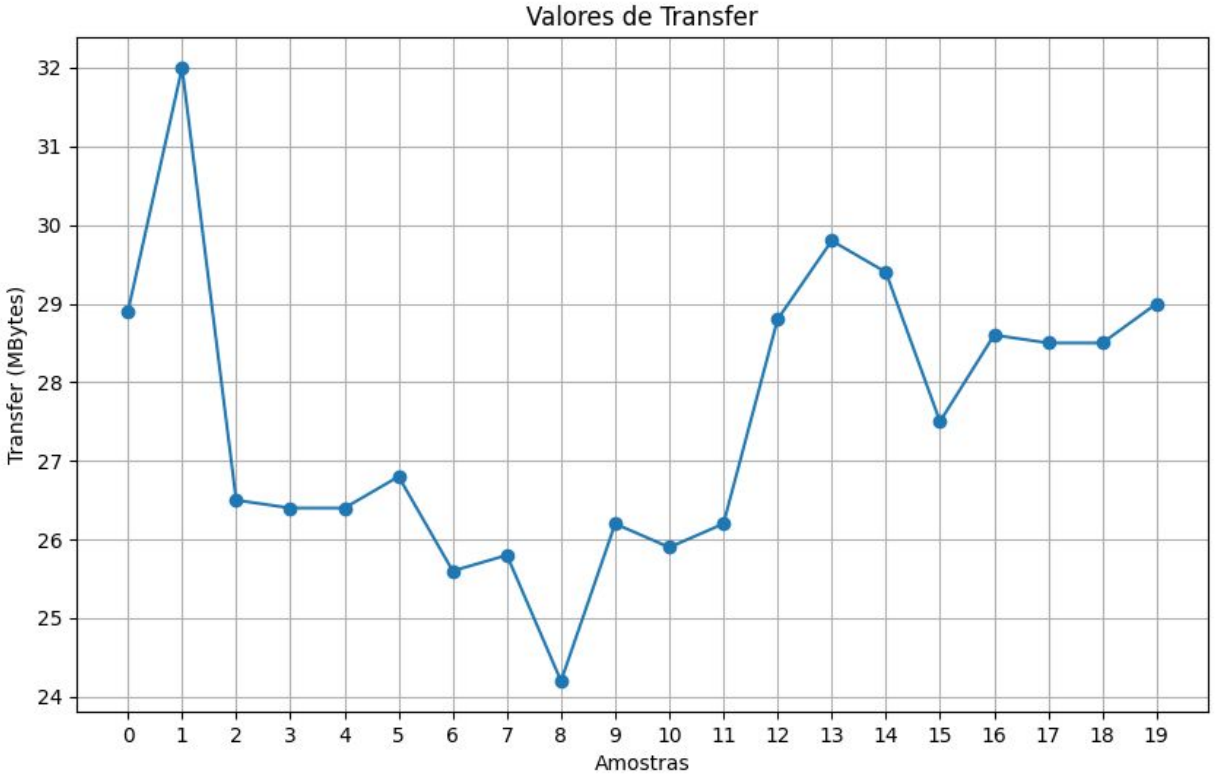
# Cenário de teste 1: Largura de Banda

- 1 processo TCP (banda máxima 250Mbits/sec)
- 1 Processo UDP 50M (20%)



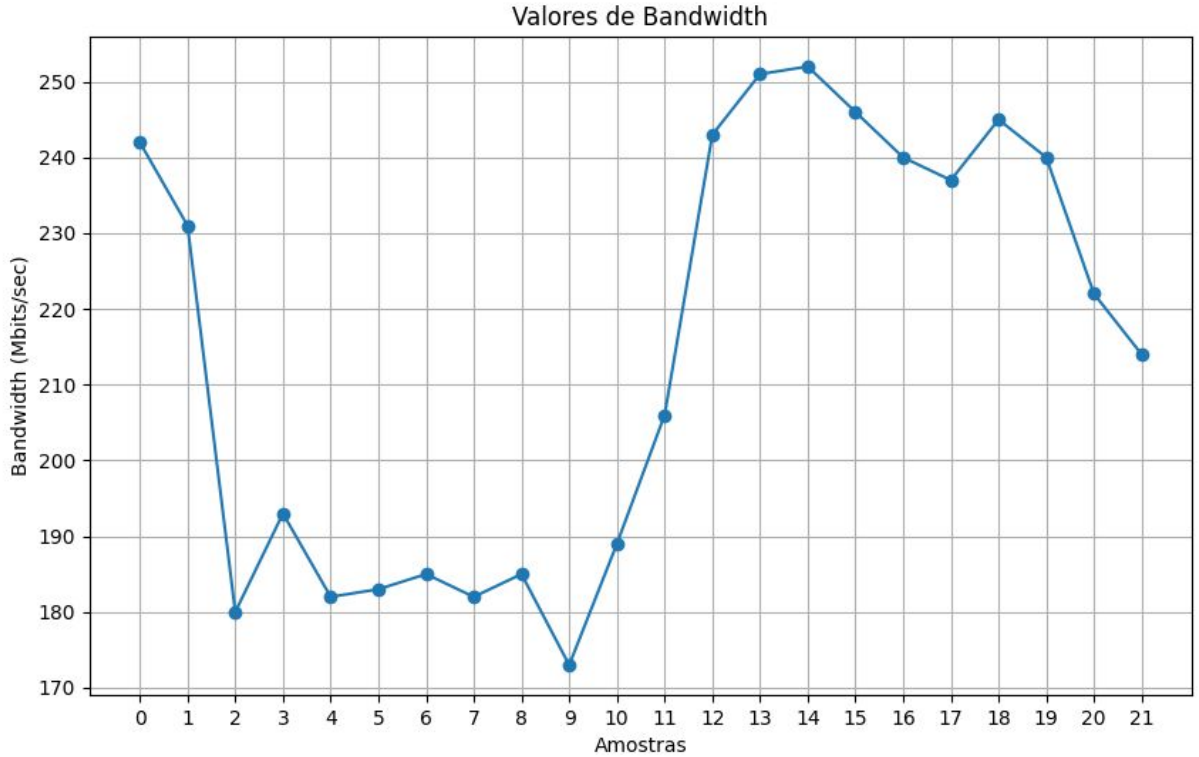
# Cenário de teste 1: Taxa de Tranferência

- 1 processo TCP (banda máxima 250Mbytes/sec)
- 1 Processo UDP 50M (20%)



# Cenário de teste 1: Largura de Banda

- 1 processo TCP (banda máxima 250Mbits/sec)
- 1 Processo UDP 100M (40%)



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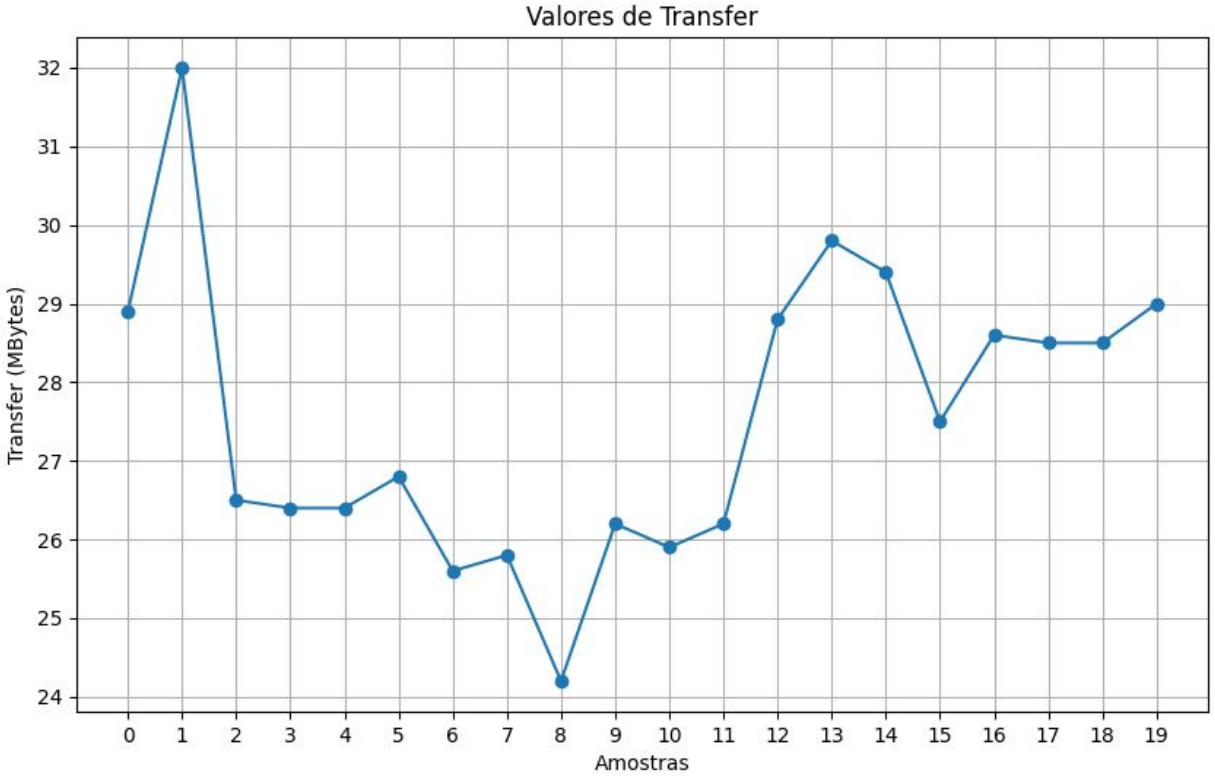
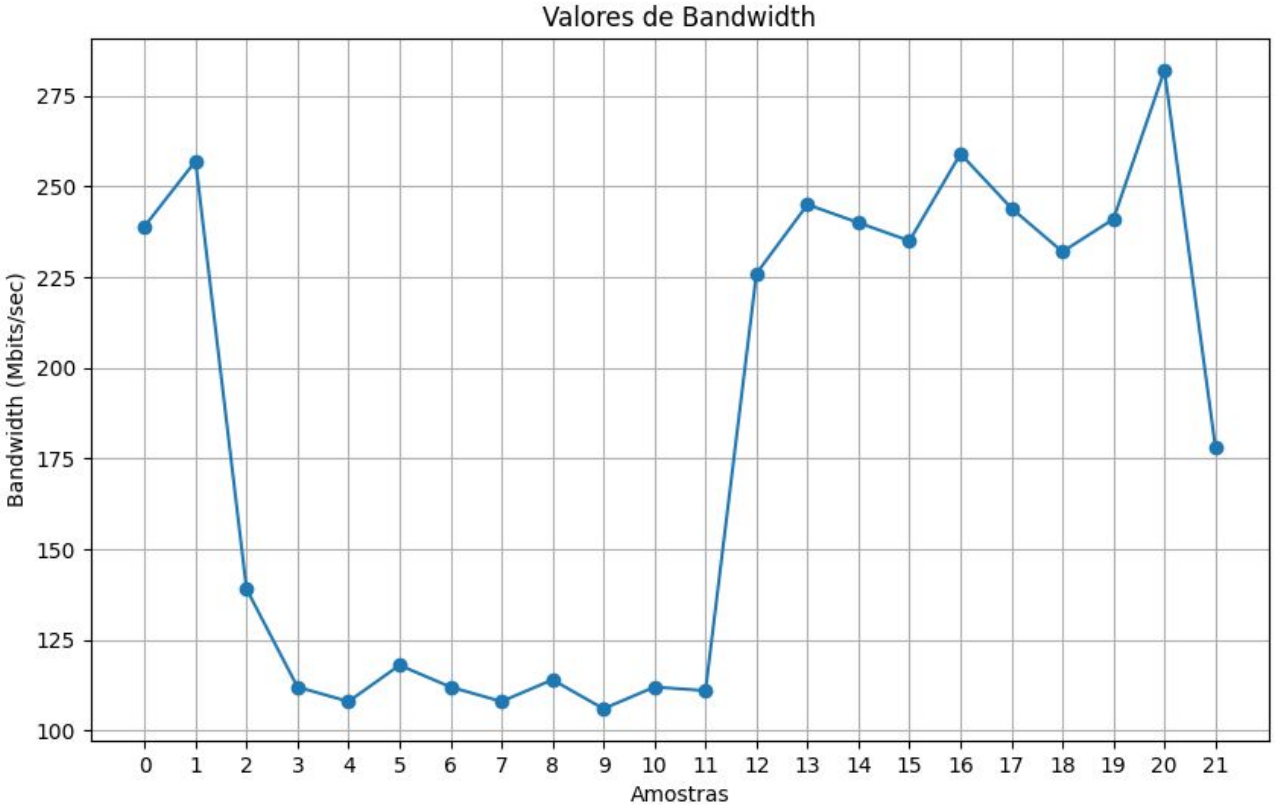
- 1 processo TCP (banda máxima 250Mbytes/sec)
- 1 Processo UDP 100M (40%)



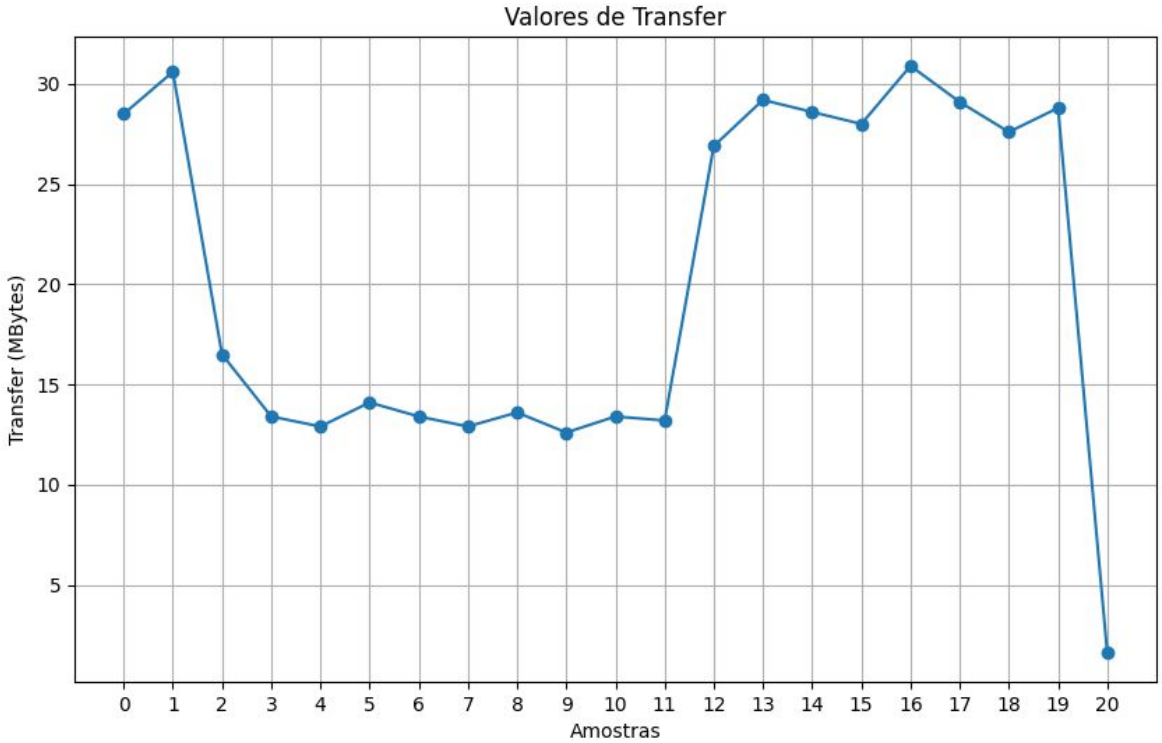
# Cenário de teste 1: Largura de Banda

- 1 processo TCP (banda máxima 250Mbits/sec)
- 1 Processo UDP 200M (80%)



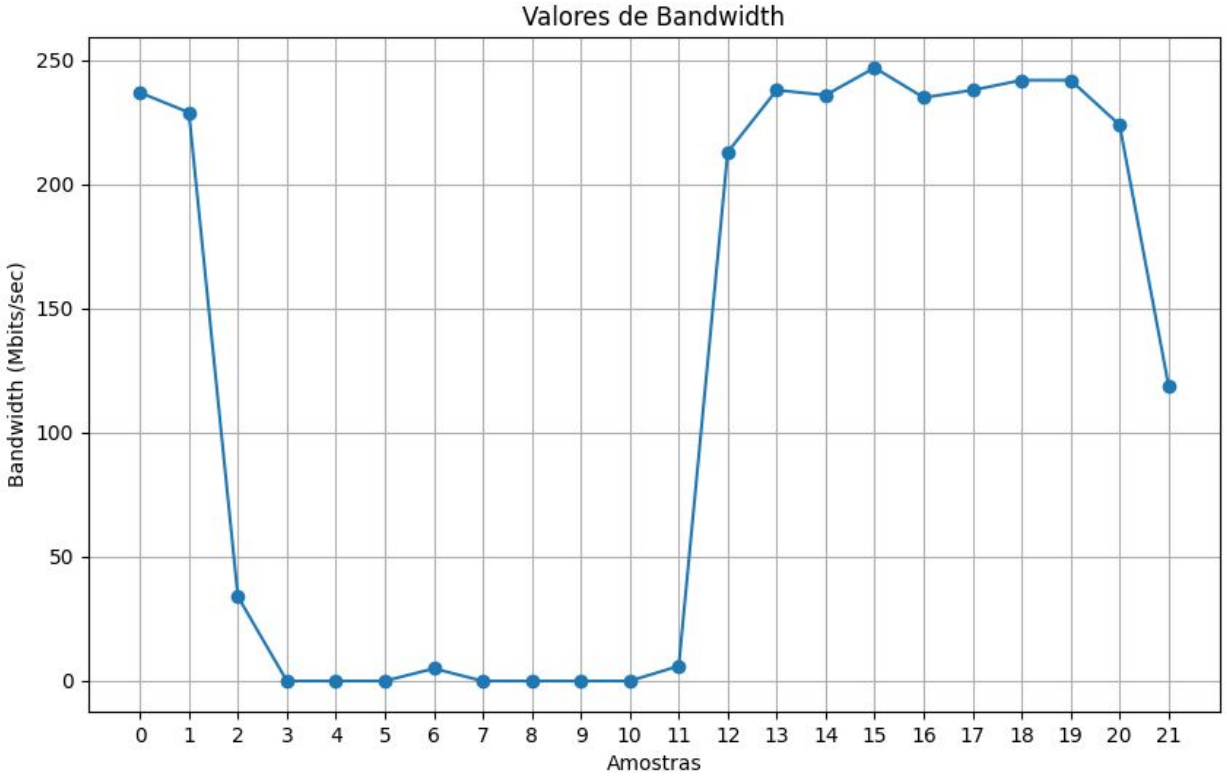
# Cenário de teste 1: Taxa de Tranferência

- 1 processo TCP (banda máxima 250Mbytes/sec)
- 1 Processo UDP 200M (80%)



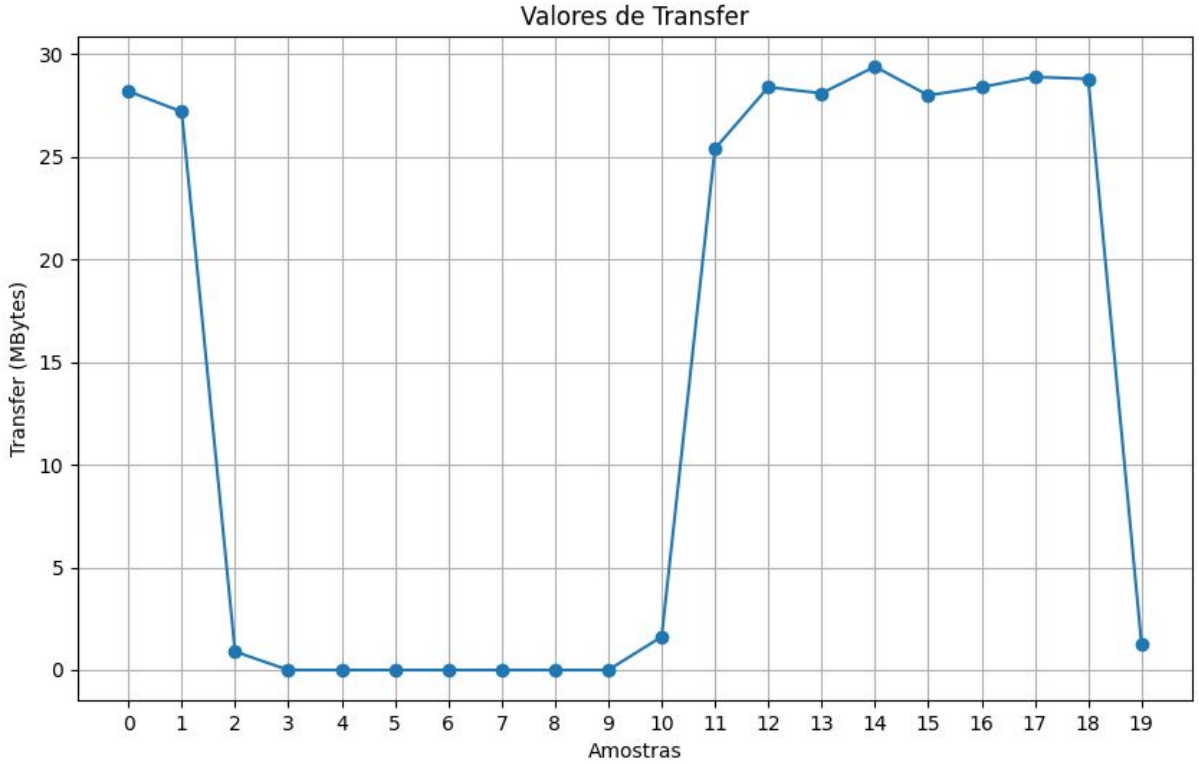
# Cenário de teste 1: Largura de Banda

- 1 processo TCP (banda máxima 250Mbits/sec)
- 1 Processo UDP 1G (+100%)



# Cenário de teste 1: Taxa de Tranferência

- 1 processo TCP (banda máxima 250Mbytes/sec)
- 1 Processo UDP 1G (+100%)

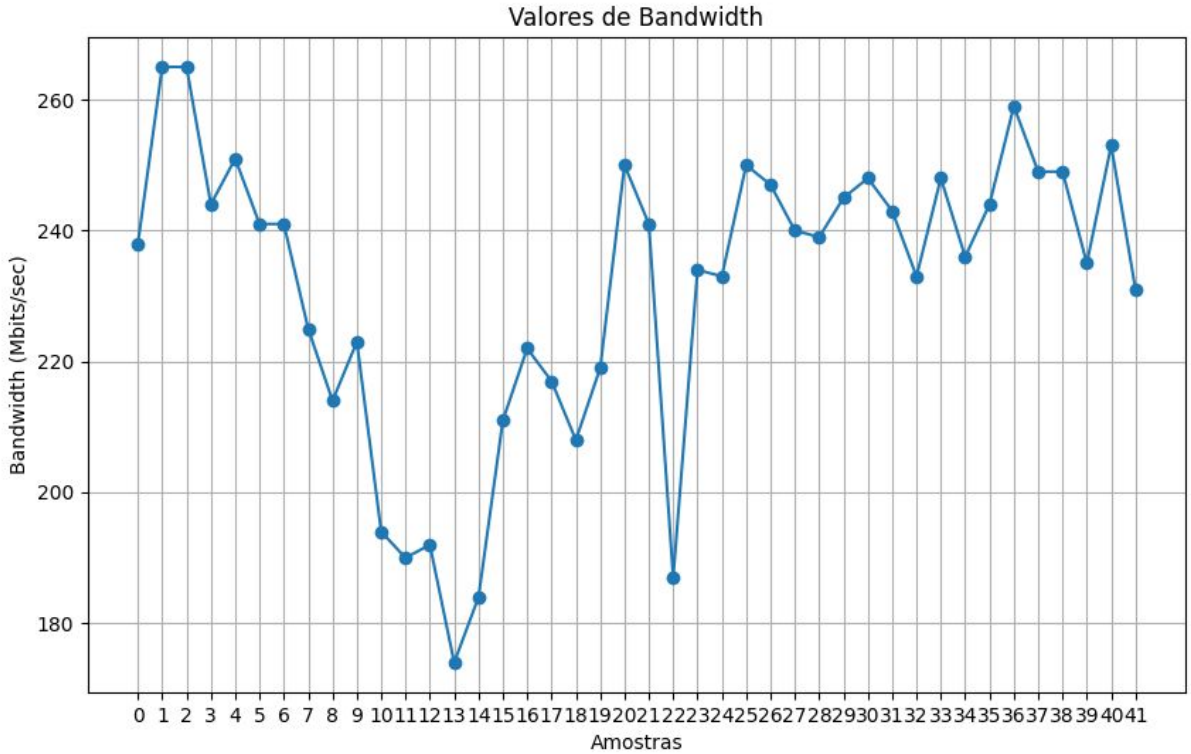


# Conclusão Cenário 1

- Com 100% da carga UDP, ocorre o starvation do TCP
- 80% de carga UDP não causa 80% de diminuição da largura de banda TCP
- A largura de banda e a taxa de tranferência diminuem de forma proporcional
- A situação crítica é quando ocorre a inanição em 100% do uso do UDP
- Com 2 processos TCP usando 100% da banda, há justiça
- Com 1 processo TCP usando 100% da banda e 1 processo UDP utilizando 100% da banda, ocorre inanição do TCP

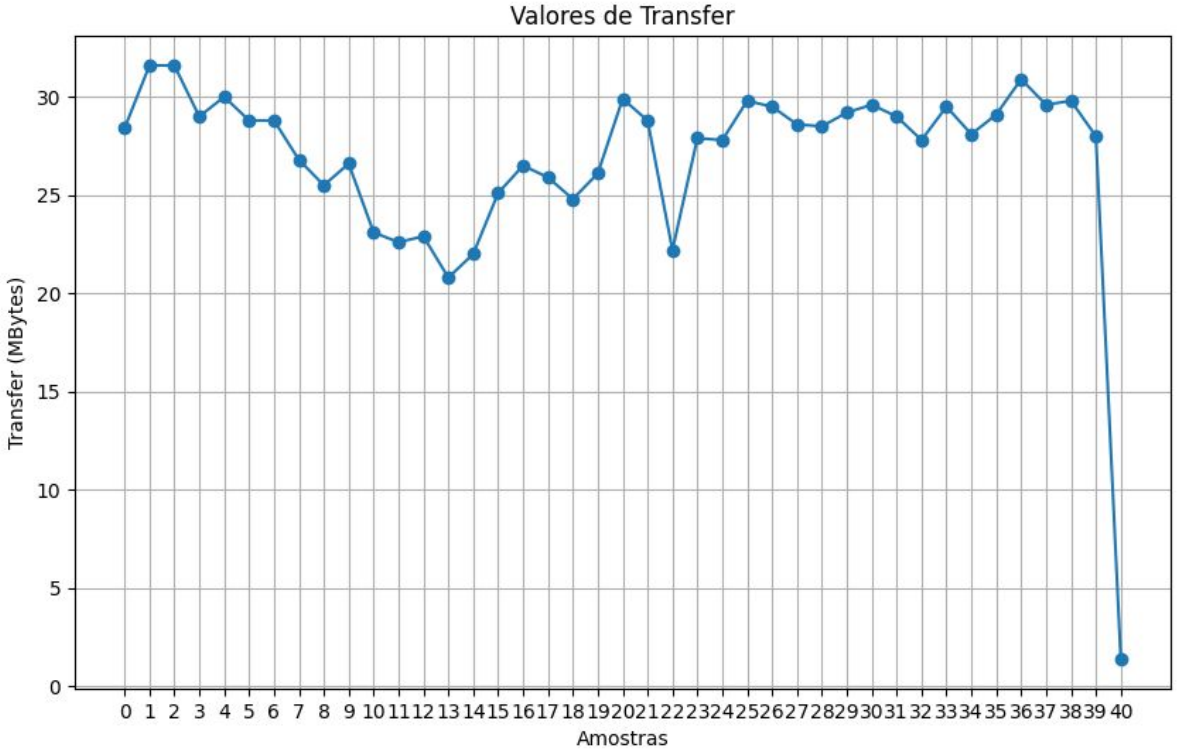
# Cenário de teste 2: Largura de Banda

- 1 processo TCP (banda máxima 250Mbits/sec)
- 2 Processo UDP 50M cada (20%)



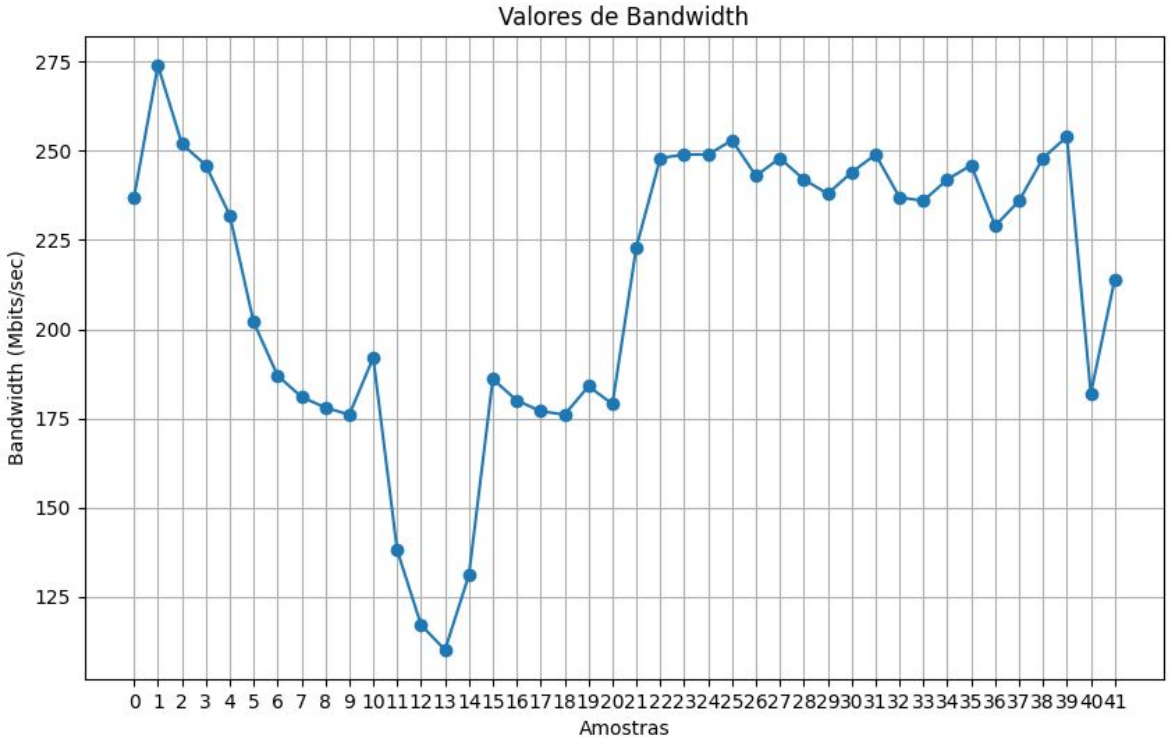
# Cenário de teste 2: Taxa de Tranferência

- 1 processo TCP (banda máxima 250Mbytes/sec)
- 1 Processo UDP 50M cada (20%)



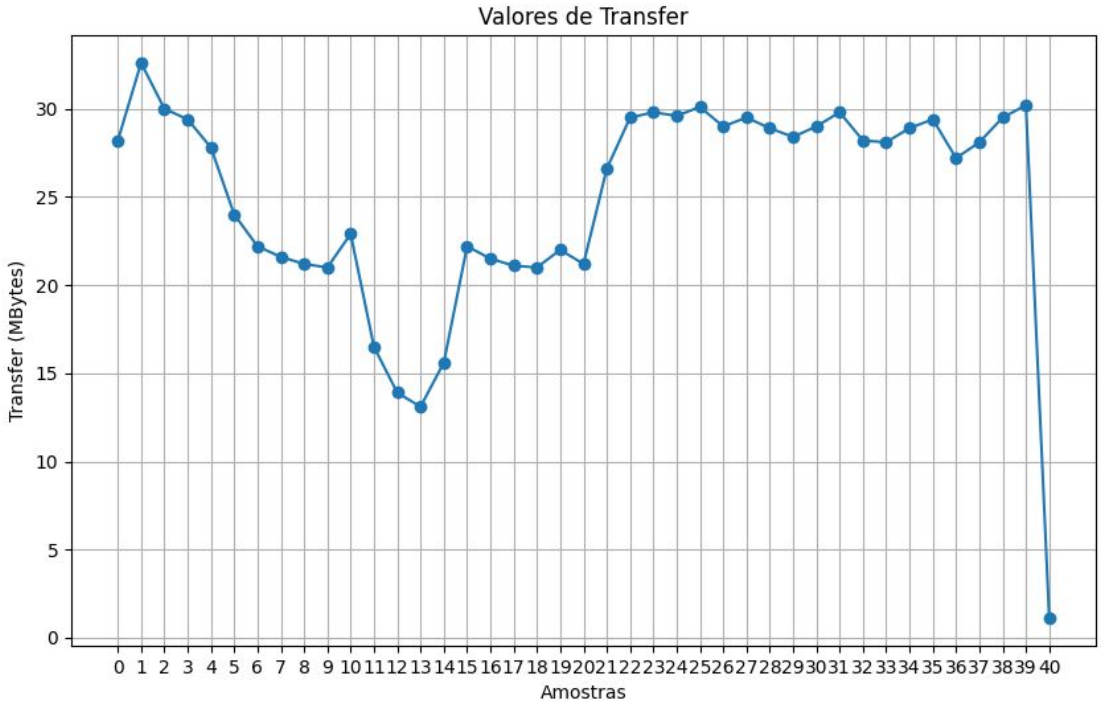
# Cenário de teste 2: Largura de Banda

- 1 processo TCP (banda máxima 250Mbits/sec)
- 2 Processo UDP 100M cada (40%)



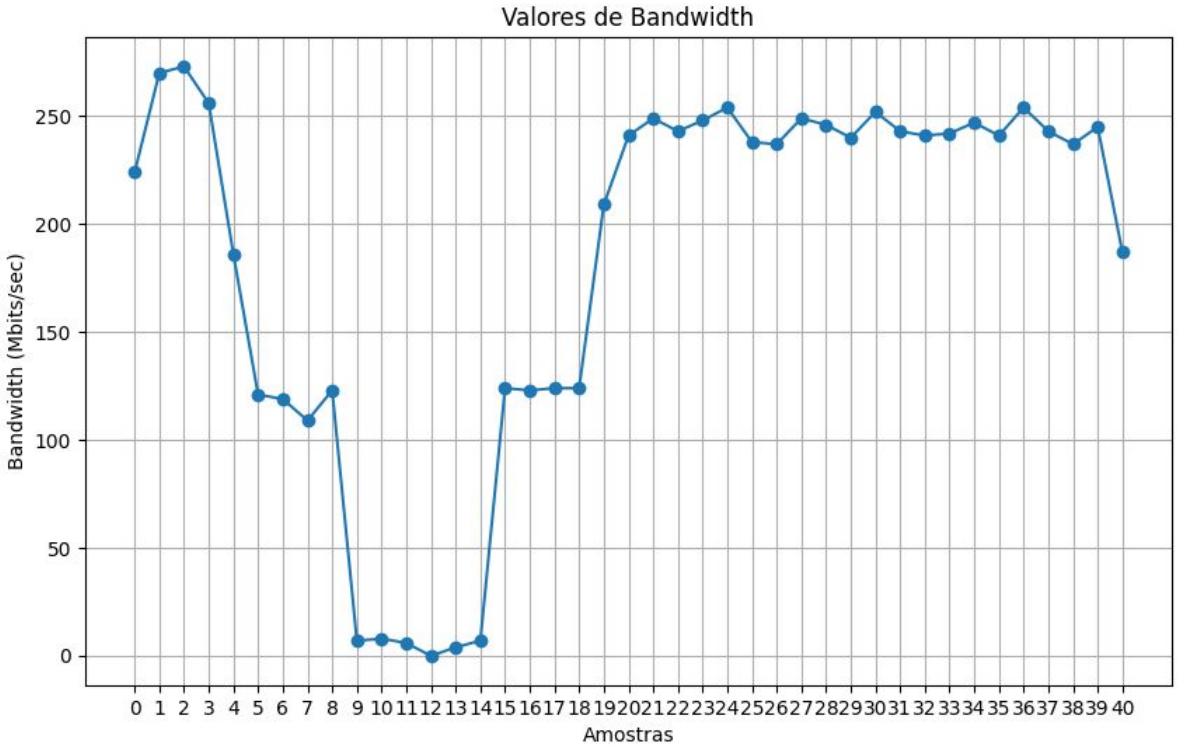
# Cenário de teste 2: Taxa de Tranferência

- 1 processo TCP (banda máxima 250Mbytes/sec)
- 1 Processo UDP 100M cada (40%)



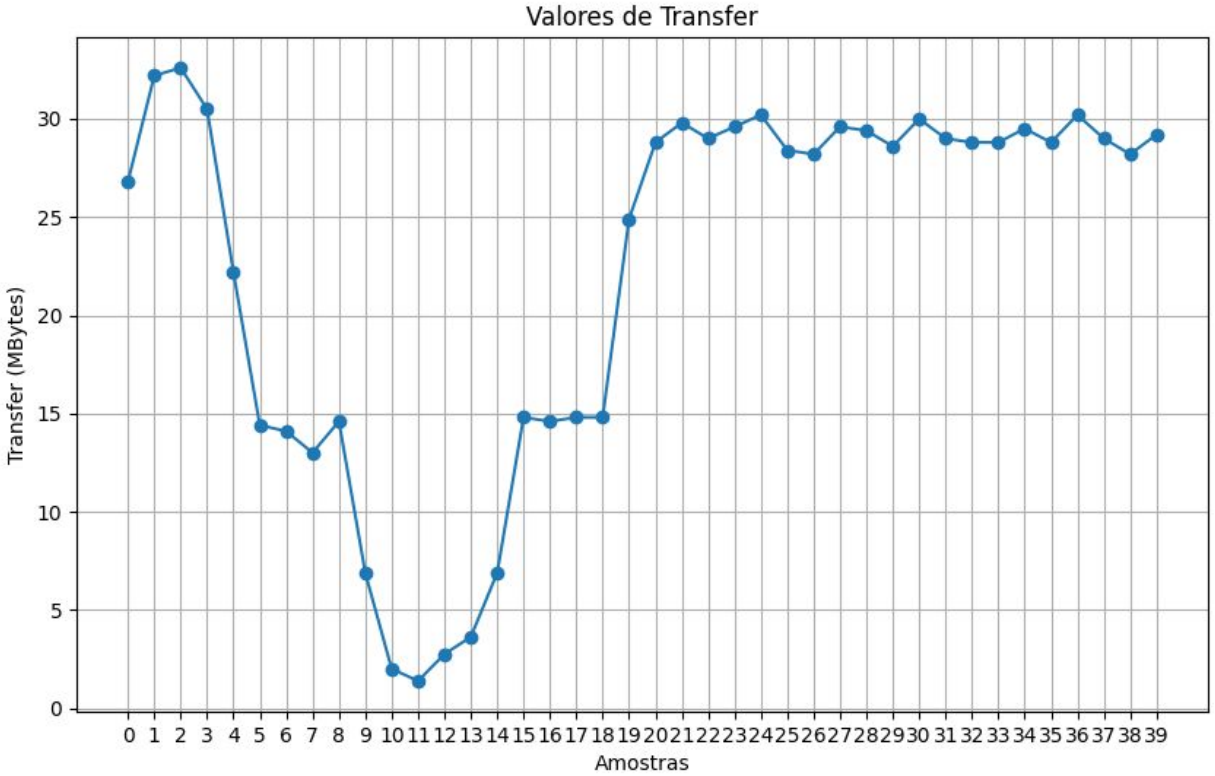
# Cenário de teste 2: Largura de Banda

- 1 processo TCP (banda máxima 250Mbits/sec)
- 2 Processo UDP 200M cada (80%)



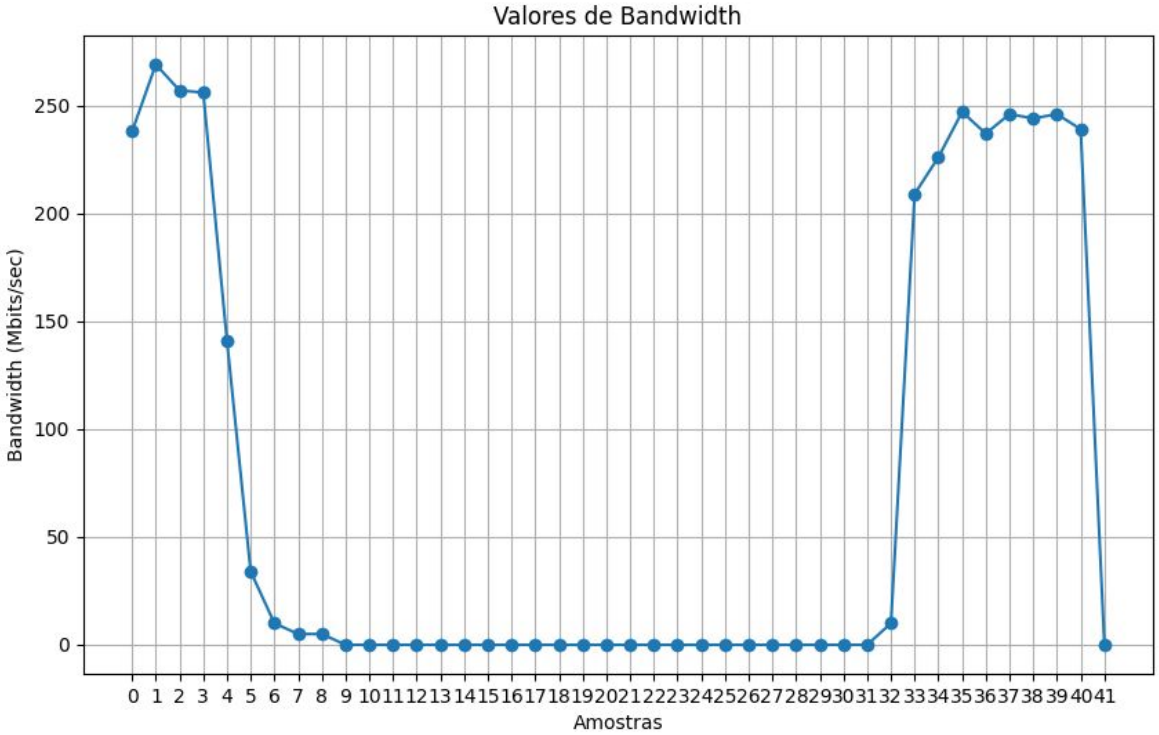
# Cenário de teste 2: Taxa de Tranferência

- 1 processo TCP (banda máxima 250Mbytes/sec)
- 1 Processo UDP 200M cada (80%)



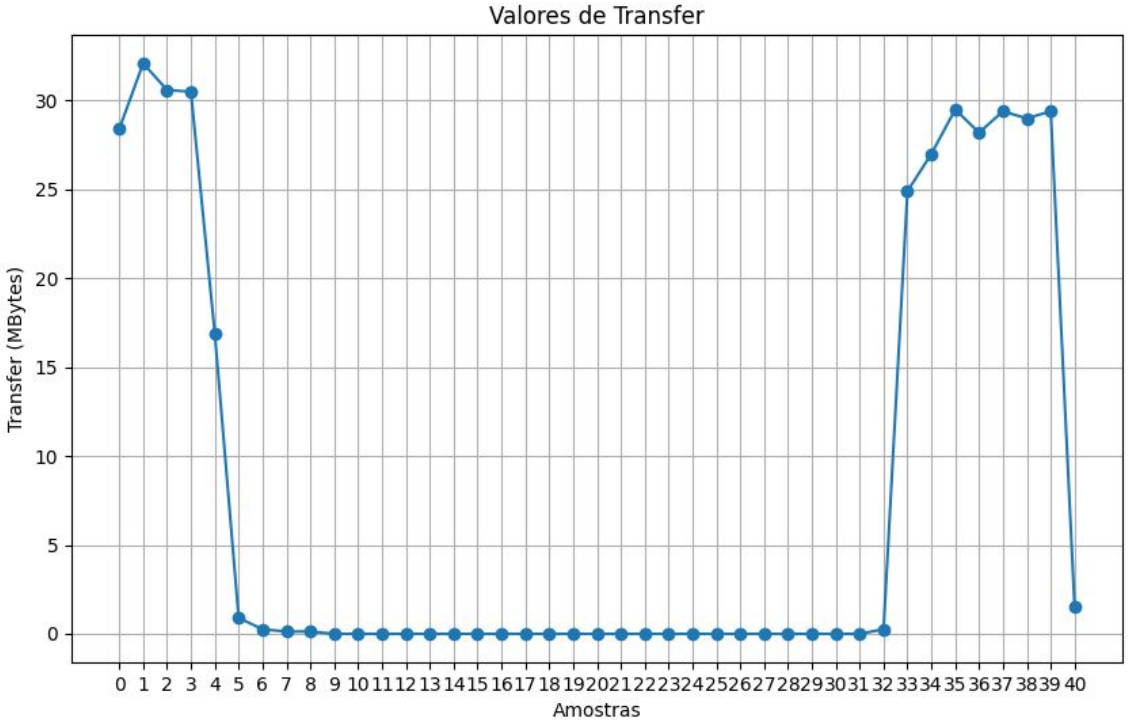
# Cenário de teste 2: Largura de Banda

- 1 processo TCP (banda máxima 250Mbits/sec)
- 2 Processo UDP 1G cada (+100%)



# Cenário de teste 2: Taxa de Tranferência

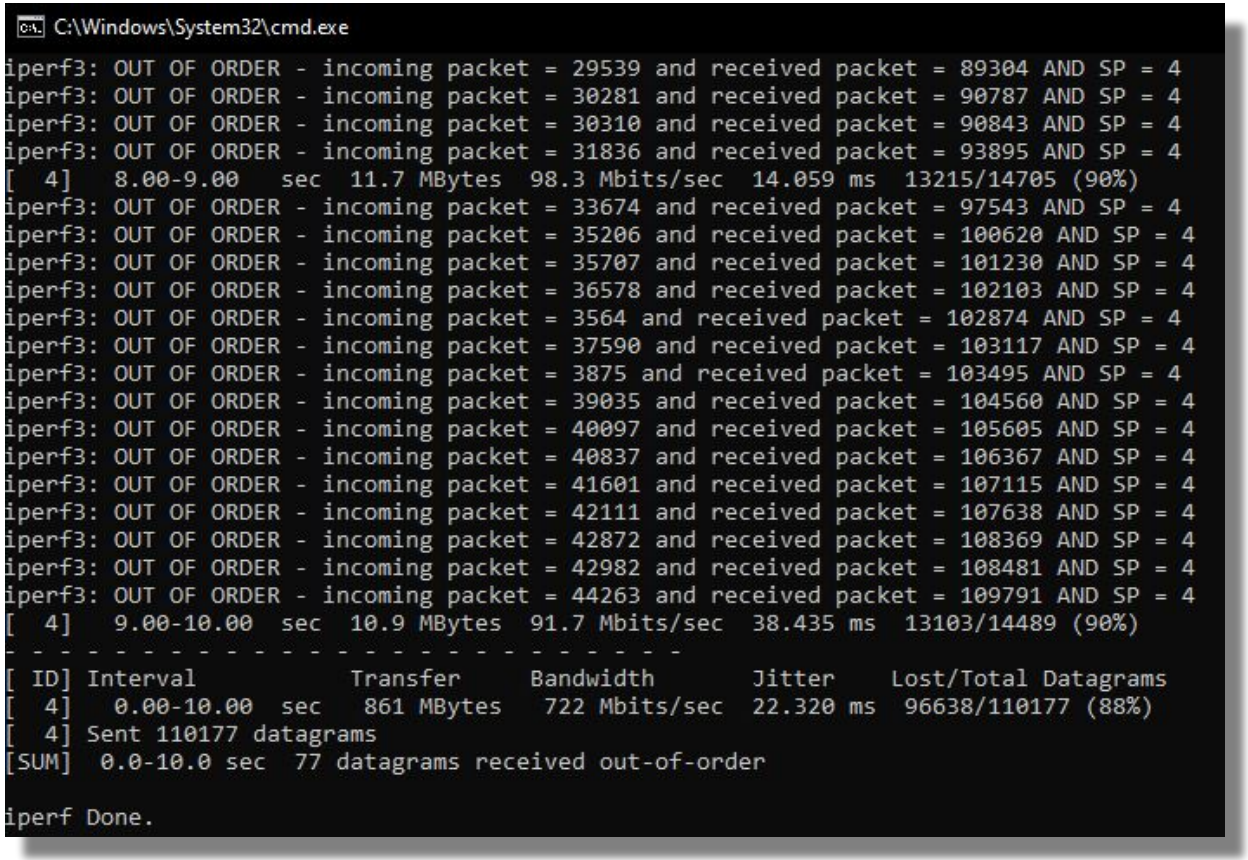
- 1 processo TCP (banda máxima 250Mbytes/sec)
- 1 Processo UDP 1G cada (+100%)



# Conclusão Cenário 2

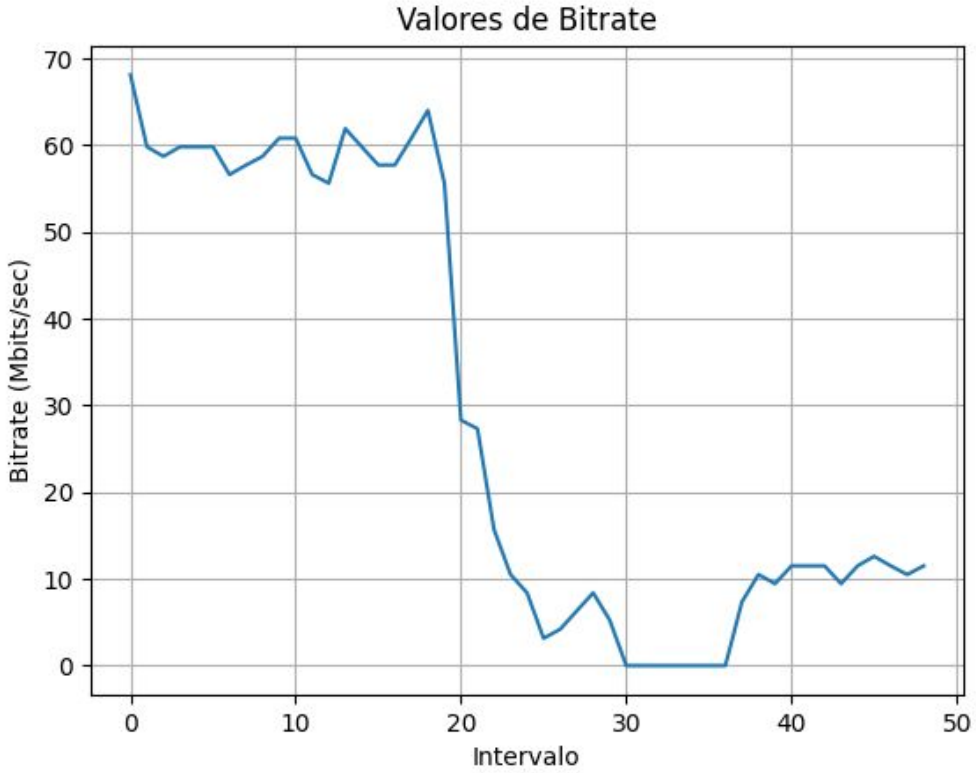
- Com mais processos TCP, a taxa de banda continua acompanhando proporcionalmente largura de banda
- Quanto mais processos, mais inanição e desigualdade vai existir para o TCP
- Quando 2 processos são colocados com alta carga UDP, os pacotes chegam fora de ordem e quase todos são perdidos

# Conclusão Cenário 2



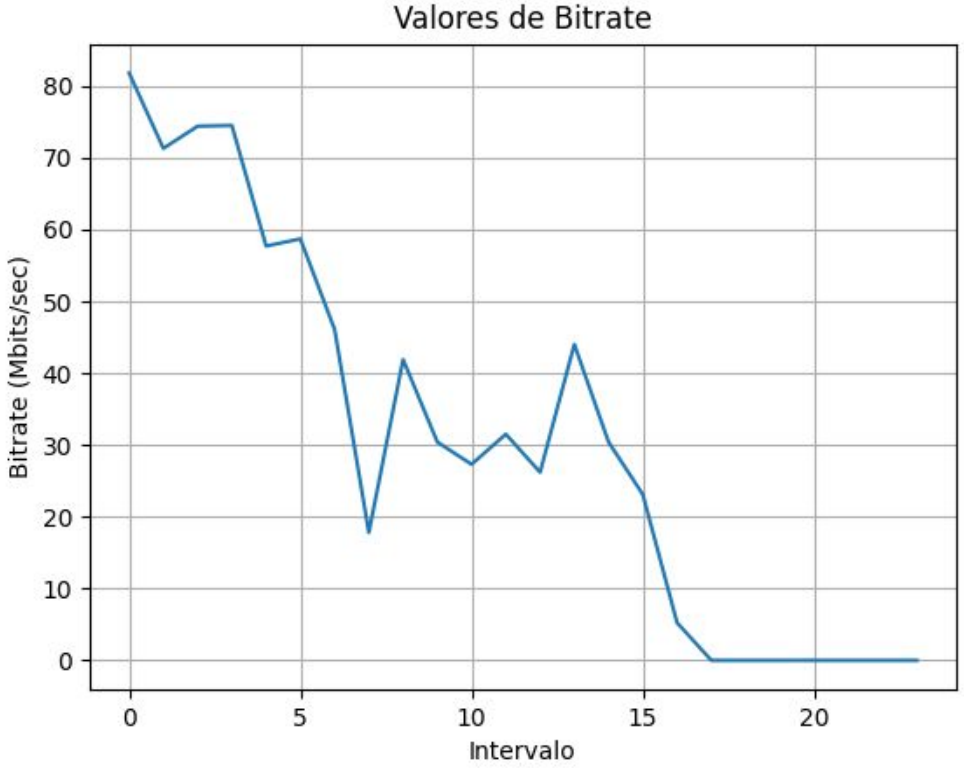
# Cenário extra: Inanição AWS EC2

- Teste1: 1 processo TCP 1G + 1 processo UDP 1G



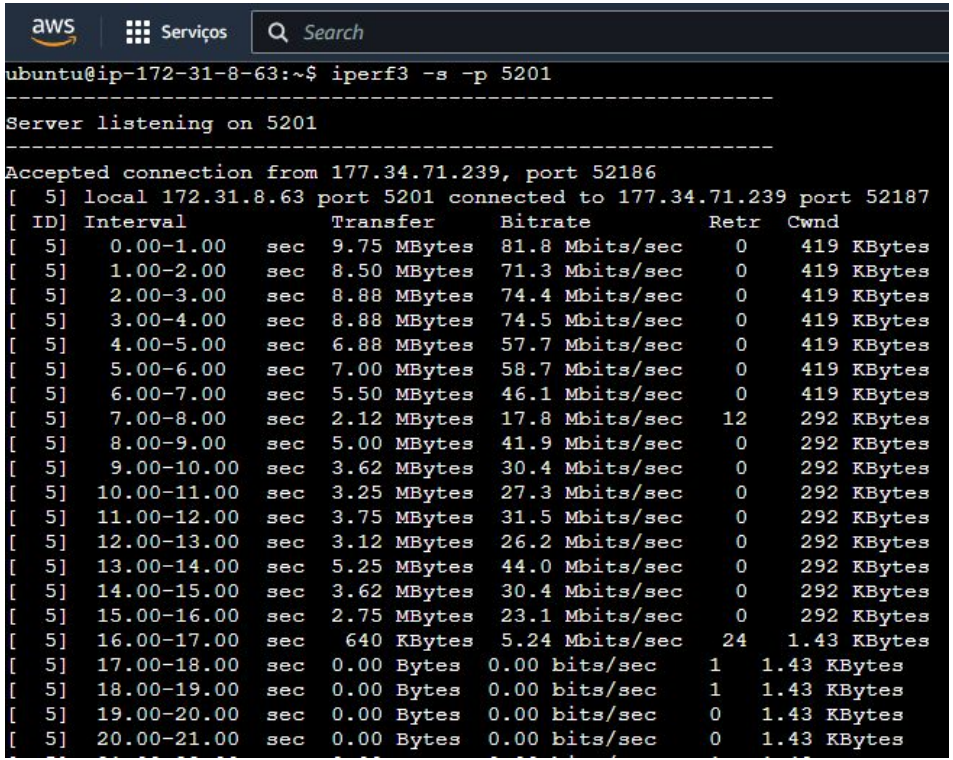
# Cenário extra: Inanição AWS EC2

- Teste2: 1 processo TCP 1G + 1 processo UDP 1G



# Cenário 3: Inanição AWS EC2

- 1 processo TCP 1G + 1 processo UDP 1G



# Conclusão Cenário Extra

- Servidores data centers também sofrem com inanição
- O tamanho da janela cwnd varia de acordo com a taxa de tranferência e largura de banda

# Créditos

Victor Eduardo Requia - victorrequia@gmail.com

Universidade do Estado de Santa Catarina - Joinville - SC
Professor: Guilherme Piegas
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