

Περιεχόμενα

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Ζητούμενο 1

Εργαστήριο 5

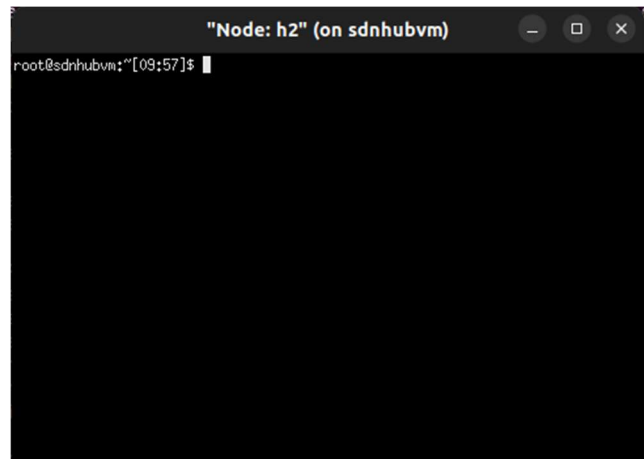
Β. Σενάριο 1

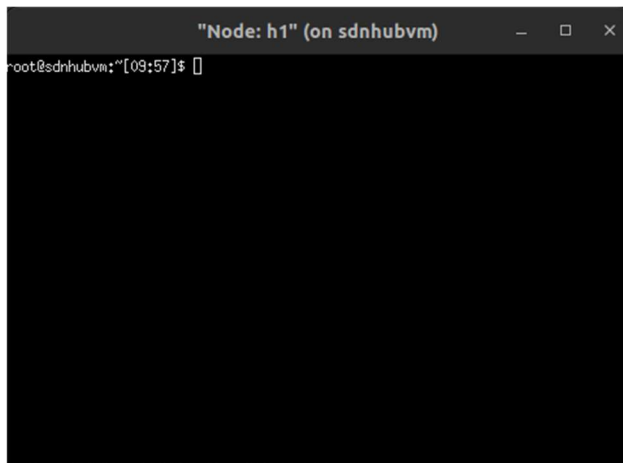
1. Δημιουργία δικτυώματος

```
ubuntu@sdnhubvm:~[09:35]$ sudo -E mn --  
controller=remote,ip=83.212.79.210,port=6633 --topo single,6 --mac --switch ovsk  
*** Creating network  
*** Adding controller  
*** Adding hosts:  
h1 h2 h3 h4 h5 h6  
*** Adding switches:  
s1  
*** Adding links:  
(h1, s1) (h2, s1) (h3, s1) (h4, s1) (h5, s1) (h6, s1)  
*** Configuring hosts  
h1 h2 h3 h4 h5 h6  
*** Starting controller  
c0  
*** Starting 1 switches  
s1 ...  
*** Starting CLI:
```

2. Ενεργοποιήστε xterm για τους host 1 και 2

```
sudo -X user@83.212.79.210  
sudo -X -p 3022 ubuntu@127.0.0.1  
mininet> xterm h1 h2
```





3. Ορισμός h1 ως server

```
root@sdnhubvm:~#[09:36]$ sudo iperf -s -u -i 1
-----
Server listening on UDP port 5001
Receiving 1470 byte datagrams
UDP buffer size: 208 KByte (default)
-----
[ 3] local 10.0.0.1 port 5001 connected with 10.0.0.2 port 59452
[ ID] Interval      Transfer    Bandwidth   Jitter     Lost/Total Datagrams
[ 3] 0.0- 1.0 sec   594 KBytes  4.87 Mbits/sec  1.106 ms    0/ 414 (0%)
[ 3] 1.0- 2.0 sec  1011 KBytes 8.28 Mbits/sec  1.357 ms    0/ 704 (0%)
[ 3] 2.0- 3.0 sec   775 KBytes 6.35 Mbits/sec  8.571 ms   540/ 1080 (50%)
[ 3] 3.0- 4.0 sec   389 KBytes 3.19 Mbits/sec  4.085 ms    0/ 271 (0%)
[ 3] 4.0- 5.0 sec   718 KBytes 5.88 Mbits/sec  1.518 ms  1069/ 1569 (68%)
[ 3] 5.0- 6.0 sec   973 KBytes 7.97 Mbits/sec  3.498 ms    0/ 678 (0%)
[ 3] 6.0- 7.0 sec   970 KBytes 7.95 Mbits/sec  1.561 ms    0/ 676 (0%)
[ 3] 7.0- 8.0 sec  1.01 MBytes 8.49 Mbits/sec  1.179 ms    0/ 722 (0%)
[ 3] 8.0- 9.0 sec  1.22 MBytes 10.3 Mbits/sec  1.684 ms    0/ 873 (0%)
[ 3] 9.0-10.0 sec   966 KBytes 7.91 Mbits/sec  1.835 ms    0/ 673 (0%)
[ 3] 0.0-10.4 sec  9.13 MBytes 7.37 Mbits/sec  1.876 ms  1608/ 8119 (20%)
[ 3] 0.0-10.4 sec 1 datagrams received out-of-order
read failed: Connection refused
[]
```

4. Ορισμός h2 ως client

```

root@sdnhubvm:~[09:36]$ sudo iperf -c 10.0.0.1 -i 1 -u -b 10m -S 0xB8
-----
Client connecting to 10.0.0.1, UDP port 5001
Sending 1470 byte datagrams
UDP buffer size: 208 KByte (default)
-----
[ 3] local 10.0.0.2 port 59452 connected with 10.0.0.1 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 3] 0.0- 1.0 sec  1.17 MBytes  9.80 Mbits/sec
[ 3] 1.0- 2.0 sec  1.18 MBytes  9.91 Mbits/sec
[ 3] 2.0- 3.0 sec  1.17 MBytes  9.82 Mbits/sec
[ 3] 3.0- 4.0 sec  1.18 MBytes  9.94 Mbits/sec
[ 3] 4.0- 5.0 sec  1.02 MBytes  8.60 Mbits/sec
[ 3] 5.0- 6.0 sec  1.09 MBytes  9.10 Mbits/sec
[ 3] 6.0- 7.0 sec  1.11 MBytes  9.30 Mbits/sec
[ 3] 7.0- 8.0 sec  1.12 MBytes  9.36 Mbits/sec
[ 3] 8.0- 9.0 sec  1.17 MBytes  9.82 Mbits/sec
[ 3] 9.0-10.0 sec  1.17 MBytes  9.83 Mbits/sec
[ 3] 0.0-10.0 sec 11.4 MBytes  9.54 Mbits/sec
[ 3] Sent 8120 datagrams
[ 3] Server Report:
[ 3] 0.0-10.4 sec  9.13 MBytes  7.37 Mbits/sec  1.876 ms 1608/ 8119 (20%)
[ 3] 0.0-10.4 sec  1 datagrams received out-of-order
root@sdnhubvm:~[09:36]$

```

Γ. Σενάριο 2

1. Δημιουργία ουρών και κανόνα QoS

```

mininet> sudo ovs-vsctl set port s1-eth1 qos=@newqos -- --id=@newqos create qos
type=linux-htb other-config:max-rate=6000000 queues=0=@q0,1=@q1 -- --id=@q0
create queue other-config:min-rate=3000000 other-config:max-rate=6000000 -- --
id=@q1 create queue other-config:min-rate=1000000 other-config:max-rate=3000000

```

2. Δημιουργία ροών και αντιστοίχιση με ουρές

```

mininet> sh ovs-ofctl add-flow s1
priority=1500,dl_type=0x800,nw_proto=17,nw_src=10.0.0.2,nw_dst=10.0.0.1,nw_tos=1
84,actions=set_queue:0,normal
mininet> sh ovs-ofctl add-flow s1
priority=1400,dl_type=0x800,nw_proto=17,nw_src=10.0.0.2,nw_dst=10.0.0.1,nw_tos=1
84,actions=set_queue:1,normal

```

3. Κίνηση μεταξύ h1 και h2

Παρατηρούμε ότι φτάνει μέχρι 6Mbits/sec.

```
"Node: h1" (on sdnhubvm)
root@sdnhubvm:~[09:48]$ sudo iperf -s -u -i 1
-----
Server listening on UDP port 5001
Receiving 1470 byte datagrams
UDP buffer size: 208 KByte (default)
-----
[ 3] local 10.0.0.1 port 5001 connected with 10.0.0.2 port 40070
[ ID] Interval      Transfer    Bandwidth    Jitter    Lost/Total Datagrams
[ 3] 0.0- 1.0 sec   709 KBytes  5.81 Mbits/sec  1.207 ms   0/ 494 (0%)
[ 3] 1.0- 2.0 sec   711 KBytes  5.82 Mbits/sec  1.223 ms   0/ 495 (0%)
[ 3] 2.0- 3.0 sec   712 KBytes  5.83 Mbits/sec  1.270 ms   0/ 496 (0%)
[ 3] 3.0- 4.0 sec   711 KBytes  5.82 Mbits/sec  1.173 ms   0/ 495 (0%)
[ 3] 4.0- 5.0 sec   708 KBytes  5.80 Mbits/sec  0.966 ms   0/ 493 (0%)
[ 3] 5.0- 6.0 sec   709 KBytes  5.81 Mbits/sec  1.409 ms   0/ 494 (0%)
[ 3] 6.0- 7.0 sec   712 KBytes  5.83 Mbits/sec  1.326 ms   0/ 496 (0%)
[ 3] 7.0- 8.0 sec   709 KBytes  5.81 Mbits/sec  1.456 ms   0/ 494 (0%)
[ 3] 8.0- 9.0 sec   709 KBytes  5.81 Mbits/sec  0.885 ms   0/ 494 (0%)
[ 3] 9.0-10.0 sec   711 KBytes  5.82 Mbits/sec  1.281 ms 199/ 694 (29%)
[ 3] 10.0-11.0 sec   690 KBytes  5.66 Mbits/sec  1.497 ms 250/ 731 (34%)
[ 3] 11.0-12.0 sec   698 KBytes  5.72 Mbits/sec  1.020 ms 218/ 704 (31%)
[ 3] 0.0-12.1 sec   8.33 MBytes  5.80 Mbits/sec  1.096 ms 685/ 6628 (10%)
[ 3] 0.0-12.1 sec   1 datagrams received out-of-order
read failed: Connection refused
█
```

```
"Node: h2" (on sdnhubvm)
root@sdnhubvm:~[09:48]$ sudo iperf -c 10.0.0.1 -i 1 -u -b 10m -S 0xB8
-----
Client connecting to 10.0.0.1, UDP port 5001
Sending 1470 byte datagrams
UDP buffer size: 208 KByte (default)
-----
[ 3] local 10.0.0.2 port 40070 connected with 10.0.0.1 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 3] 0.0- 1.0 sec   936 KBytes  7.67 Mbits/sec
[ 3] 1.0- 2.0 sec   896 KBytes  7.34 Mbits/sec
[ 3] 2.0- 3.0 sec   932 KBytes  7.63 Mbits/sec
[ 3] 3.0- 4.0 sec   958 KBytes  7.84 Mbits/sec
[ 3] 4.0- 5.0 sec   926 KBytes  7.59 Mbits/sec
[ 3] 5.0- 6.0 sec   857 KBytes  7.02 Mbits/sec
[ 3] 6.0- 7.0 sec   880 KBytes  7.21 Mbits/sec
[ 3] 7.0- 8.0 sec  1018 KBytes  8.34 Mbits/sec
[ 3] 8.0- 9.0 sec   1.05 MBytes  8.78 Mbits/sec
[ 3] 9.0-10.0 sec   1.02 MBytes  8.53 Mbits/sec
[ 3] 0.0-10.0 sec   9.29 MBytes  7.79 Mbits/sec
[ 3] Sent 6629 datagrams
[ 3] Server Report:
[ 3] 0.0-12.1 sec   8.33 MBytes  5.80 Mbits/sec  1.095 ms 685/ 6628 (10%)
[ 3] 0.0-12.1 sec   1 datagrams received out-of-order
root@sdnhubvm:~[09:51]$ █
```

4. Εποπτεία και τροποποίηση ουρών

```
mininet> sh ovs-vsctl list port s1-eth1
_uuid          : a279af44-7152-4eea-b4b9-2af5014dd242
bond_active_slave : []
bond_downdelay   : 0
bond_fake_iface  : false
bond_mode        : []
bond_updelay     : 0
external_ids     : {}
fake_bridge      : false
interfaces       : [1e58cded-3605-4c43-a619-5229a64bf718]
lacp             : []
mac             : []
name            : "s1-eth1"
other_config     : {}
qos             : a87f49c2-d676-4444-8221-ec5ee76f9585
rstp_statistics  : {}
rstp_status      : {}
statistics       : {}
status          : {}
tag             : []
trunks          : []
vlan_mode       : []
mininet> sh ovs-vsctl list qos
_uuid          : 508ab7c1-261e-4deb-a4cf-0d7f6ae804e8
external_ids   : {}
other_config   : {max-rate="6000000"}
queues        : {0=1907d432-e427-4827-8c39-ae30bb1109ba, 1=9db4c04b-de65-4b7f-9fe1-4dabcc24abf3}
type          : linux-htb

_uuid          : a202d7e1-63cb-42a2-95ef-3f003cc84213
external_ids   : {}
other_config   : {max-rate="6000000"}
queues        : {0=a6e54629-b667-4851-8eed-557b474e73cf, 1=c747e108-b333-4e2f-a245-8b1bf550d744}
type          : linux-htb

_uuid          : 015fef99-252b-4689-a4ba-801b05e362f8
external_ids   : {}
other_config   : {max-rate="6000000"}
queues        : {0=ba0696d1-cb8a-4627-9902-676bbe1f3093, 1=ed47e4ae-1a62-4e28-a872-afc70d48c86c}
```

type : linux-htb

_uuid : d9642691-2d2d-48bb-a39b-5d3accc13502

external_ids : {}

other_config : {max-rate="6000000"}

queues : {0=224c1231-094e-4c5e-900e-90c77cc2db3f, 1=0128e44e-dfc1-4a6f-a93d-bef3c59ca11e}

type : linux-htb

_uuid : e43b1a51-180f-46fc-9ebb-36cd88d8ba5e

external_ids : {}

other_config : {max-rate="6000000"}

queues : {0=6c47edb0-46b8-413c-b0ce-357aa8616189, 1=6903ec90-d8a0-4b1c-b860-56f978a84b31}

type : linux-htb

_uuid : a87f49c2-d676-4444-8221-ec5ee76f9585

external_ids : {}

other_config : {max-rate="6000000"}

queues : {0=0eca28a7-0384-458f-8e61-5e7a0ed45963, 1=a93c4e0f-f08e-4340-ad53-7f21b4c0c5fd}

type : linux-htb

_uuid : 26f88642-50d1-4d22-a558-5426585efc00

external_ids : {}

other_config : {max-rate="3000000"}

queues : {0=88e22e7f-4977-4ee8-aa7e-8240e6488158}

type : linux-htb

_uuid : 4592d16a-280a-4e54-923d-c5717e4323f7

external_ids : {}

other_config : {max-rate="6000000"}

queues : {0=fc342c5e-d753-41fd-a68a-ed010acd4b3b, 1=bd2e8d6e-65fd-40da-827d-9ad054dfcdcf}

type : linux-htb

_uuid : ae765b5b-bcc4-4e21-a7ac-4c807b419fcf

external_ids : {}

other_config : {max-rate="6000000"}

queues : {0=6b6ca30d-2755-49bc-a96e-831008203b67, 1=a3707a40-a613-436a-b9cb-086b9dc4a5bd}

type : linux-htb

_uuid : 0a1e8324-27b5-4b66-b23f-73f300d6f946

external_ids : {}

other_config : {max-rate="6000000"}

```

queues      : {0=2c9554ac-8a0d-4b3a-8190-09a0cc0376b3, 1=2cce43c3-5d94-4a05-ad56-8b644f0a4331}
type        : linux-htb

_uuid       : d3142654-f459-457b-9a16-699919038240
external_ids : {}
other_config : {max-rate="3000000"}
queues      : {0=a0b7b2dd-e402-4e14-a886-2b0ca27e9303}
type        : linux-htb

_uuid       : 2f7a637c-d79f-4815-a485-93c0457a2f94
external_ids : {}
other_config : {max-rate="6000000"}
queues      : {0=f286b86e-aa5d-4996-a3d0-4c882ef03f8d, 1=658755b9-cf3b-4fa4-85ce-4d01f99c7880}
type        : linux-htb

_uuid       : 19157f4d-131a-4591-ba31-a05eaf0f8e59
external_ids : {}
other_config : {max-rate="6000000"}
queues      : {0=0f8168f6-27fc-4e71-aec6-ea19084a2e1a, 1=baf6d95f-725a-4ed3-b0d2-3602dafa9ed0}
type        : linux-htb

_uuid       : 84296cb7-b761-4a9d-919c-d566ad9d9ad2
external_ids : {}
other_config : {max-rate="6000000"}
queues      : {0=5e9bedba-4cfb-4207-b06b-26be53112046}
type        : linux-htb

mininet> sh ovs-vsctl list queue

_uuid       : a3707a40-a613-436a-b9cb-086b9dc4a5bd
dscp        : []
external_ids : {}
other_config : {max-rate="3000000", min-rate="1000000"}

_uuid       : 6c47edb0-46b8-413c-b0ce-357aa8616189
dscp        : []
external_ids : {}
other_config : {max-rate="6000000", min-rate="3000000"}

_uuid       : 6903ec90-d8a0-4b1c-b860-56f978a84b31
dscp        : []
external_ids : {}
other_config : {max-rate="3000000", min-rate="1000000"}

```



```

_uuid      : ba0696d1-cb8a-4627-9902-676bbe1f3093
dscp       : []
external_ids : {}
other_config : {max-rate="6000000", min-rate="3000000"}

_uuid      : 224c1231-094e-4c5e-900e-90c77cc2db3f
dscp       : []
external_ids : {}
other_config : {max-rate="6000000", min-rate="3000000"}

_uuid      : 1907d432-e427-4827-8c39-ae30bb1109ba
dscp       : []
external_ids : {}
other_config : {max-rate="6000000", min-rate="3000000"}

_uuid      : 2cce43c3-5d94-4a05-ad56-8b644f0a4331
dscp       : []
external_ids : {}
other_config : {max-rate="3000000", min-rate="1000000"}

_uuid      : 0f8168f6-27fc-4e71-aec6-ea19084a2e1a
dscp       : []
external_ids : {}
other_config : {max-rate="6000000", min-rate="3000000"}
_uuid      : 0eca28a7-0384-458f-8e61-5e7a0ed45963
dscp       : []
external_ids : {}
other_config : {max-rate="6000000", min-rate="3000000"}

_uuid      : c747e108-b333-4e2f-a245-8b1bf550d744
dscp       : []
external_ids : {}
other_config : {max-rate="3000000", min-rate="1000000"}

_uuid      : 658755b9-cf3b-4fa4-85ce-4d01f99c7880
dscp       : []
external_ids : {}
other_config : {max-rate="3000000", min-rate="1000000"}

_uuid      : a6e54629-b667-4851-8eed-557b474e73cf
dscp       : []
external_ids : {}
other_config : {max-rate="6000000", min-rate="3000000"}

_uuid      : 5e9bedba-4cfb-4207-b06b-26be53112046

```

```

dscp      : []
external_ids : {}
other_config : {max-rate="3000000", min-rate="1000000"}

_uuid     : 9db4c04b-de65-4b7f-9fe1-4dabcc24abf3
dscp      : []
external_ids : {}
other_config : {max-rate="3000000", min-rate="1000000"}

_uuid     : 2c9554ac-8a0d-4b3a-8190-09a0cc0376b3
dscp      : []
external_ids : {}
other_config : {max-rate="6000000", min-rate="3000000"}

_uuid     : 6b6ca30d-2755-49bc-a96e-831008203b67
dscp      : []
external_ids : {}
other_config : {max-rate="6000000", min-rate="3000000"}

_uuid     : a0b7b2dd-e402-4e14-a886-2b0ca27e9303
dscp      : []
external_ids : {}
other_config : {max-rate="3000000", min-rate="1000000"}

_uuid     : fc342c5e-d753-41fd-a68a-ed010acd4b3b
dscp      : []
external_ids : {}
other_config : {max-rate="6000000", min-rate="3000000"}

_uuid     : f286b86e-aa5d-4996-a3d0-4c882ef03f8d
dscp      : []
external_ids : {}
other_config : {max-rate="6000000", min-rate="3000000"}

_uuid     : bd2e8d6e-65fd-40da-827d-9ad054dfcdfc
dscp      : []
external_ids : {}
other_config : {max-rate="3000000", min-rate="1000000"}

_uuid     : ed47e4ae-1a62-4e28-a872-afc70d48c86c
dscp      : []
external_ids : {}
other_config : {max-rate="3000000", min-rate="1000000"}

_uuid     : 0128e44e-dfc1-4a6f-a93d-bef3c59ca11e
dscp      : []

```

```

external_ids      : {}
other_config      : {max-rate="3000000", min-rate="1000000"}

_uuid            : 88e22e7f-4977-4ee8-aa7e-8240e6488158
dscp              : []
external_ids      : {}
other_config      : {max-rate="3000000", min-rate="1000000"}

_uuid            : baf6d95f-725a-4ed3-b0d2-3602dafa9ed0
dscp              : []
external_ids      : {}
other_config      : {max-rate="3000000", min-rate="1000000"}

_uuid            : a93c4e0f-f08e-4340-ad53-7f21b4c0c5fd
dscp              : []
external_ids      : {}
other_config      : {max-rate="3000000", min-rate="1000000"}

```

```

mininet> sh ovs-ofctl queue-stats s1
OFPST_QUEUE reply (xid=0x2): 2 queues
port 1 queue 0: bytes=9008941, pkts=6058, errors=687, duration=?
port 1 queue 1: bytes=0, pkts=0, errors=0, duration=?

```

Αφαιρούμε την ουρά q0.

```

Server listening on UDP port 5001
Receiving 1470 byte datagrams
UDP buffer size: 208 KByte (default)
-----
[ 3] local 10.0.0.1 port 5001 connected with 10.0.0.2 port 56864
[ ID] Interval      Transfer      Bandwidth      Jitter      Lost/Total Datagrams
[ 3] 0.0- 1.0 sec   356 KBytes    2.92 Mbits/sec  2.668 ms    0/ 248 (0%)
[ 3] 1.0- 2.0 sec   356 KBytes    2.92 Mbits/sec  2.920 ms    0/ 248 (0%)
[ 3] 2.0- 3.0 sec   356 KBytes    2.92 Mbits/sec  2.972 ms    0/ 248 (0%)
[ 3] 3.0- 4.0 sec   356 KBytes    2.92 Mbits/sec  2.817 ms    0/ 248 (0%)
[ 3] 4.0- 5.0 sec   356 KBytes    2.92 Mbits/sec  2.825 ms    0/ 248 (0%)
[ 3] 5.0- 6.0 sec   356 KBytes    2.92 Mbits/sec  1.744 ms    91/ 339 (27%)
[ 3] 6.0- 7.0 sec   356 KBytes    2.92 Mbits/sec  1.525 ms   549/ 797 (69%)
[ 3] 7.0- 8.0 sec   356 KBytes    2.92 Mbits/sec  1.260 ms   544/ 792 (69%)
[ 3] 8.0- 9.0 sec   356 KBytes    2.92 Mbits/sec  1.405 ms   557/ 805 (69%)
[ 3] 9.0-10.0 sec   356 KBytes    2.92 Mbits/sec  1.171 ms   529/ 777 (68%)
[ 3] 10.0-11.0 sec   356 KBytes    2.92 Mbits/sec  1.847 ms   540/ 788 (69%)
[ 3] 11.0-12.0 sec   356 KBytes    2.92 Mbits/sec  1.337 ms   557/ 805 (69%)
[ 3] 12.0-13.0 sec   356 KBytes    2.92 Mbits/sec  0.944 ms   540/ 788 (69%)
[ 3] 13.0-14.0 sec   356 KBytes    2.92 Mbits/sec  1.305 ms   544/ 792 (69%)
[ 3] 0.0-14.0 sec   4.88 MBytes    2.92 Mbits/sec  1.113 ms  4463/ 7942 (56%)
[ 3] 0.0-14.0 sec  1 datagrams received out-of-order
read failed: Connection refused

```

Αυτό έγινε γιατί αφού διαγράψαμε την ουρά q0 που είχε μεγαλύτερη προτεραιότητα, θα

τρέξει την ουρά q1 που έχει μικρότερη προτεραιότητα. Παρατηρούμε ότι φτάνει μέχρι 3Mbits/sec.

```
"Node: h2" (on sdnhubvm)
root@sdnhubvm:~[10:04]$ sudo iperf -c 10.0.0.1 -i 1 -u -b 10m -S 0xB8
-----
Client connecting to 10.0.0.1, UDP port 5001
Sending 1470 byte datagrams
UDP buffer size: 208 KByte (default)
-----
[ 3] local 10.0.0.2 port 56864 connected with 10.0.0.1 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 3] 0.0- 1.0 sec  1.12 MBytes 9.36 Mbits/sec
[ 3] 1.0- 2.0 sec  1.13 MBytes 9.47 Mbits/sec
[ 3] 2.0- 3.0 sec  1.12 MBytes 9.37 Mbits/sec
[ 3] 3.0- 4.0 sec  1.11 MBytes 9.33 Mbits/sec
[ 3] 4.0- 5.0 sec  1.13 MBytes 9.46 Mbits/sec
[ 3] 5.0- 6.0 sec  1.08 MBytes 9.09 Mbits/sec
[ 3] 6.0- 7.0 sec  1.11 MBytes 9.28 Mbits/sec
[ 3] 7.0- 8.0 sec  1.13 MBytes 9.47 Mbits/sec
[ 3] 8.0- 9.0 sec  1.11 MBytes 9.30 Mbits/sec
[ 3] 9.0-10.0 sec  1.11 MBytes 9.30 Mbits/sec
[ 3] 0.0-10.0 sec 11.1 MBytes 9.34 Mbits/sec
[ 3] Sent 7945 datagrams
[ 3] WARNING: did not receive ack of last datagram after 10 tries.
root@sdnhubvm:~[10:06]$
```

Γ. Σενάριο 3

1. Ενεργοποίηση xterm για τον host h3

```
mininet> xterm h3
```

2. Ενεργοποίηση αναλυτή πακέτων Wireshark

```
sudo wireshark
```

3. Ορισμός h3 ως client

Ξεκινάμε το capture και τρέχουμε τα παρακάτω.

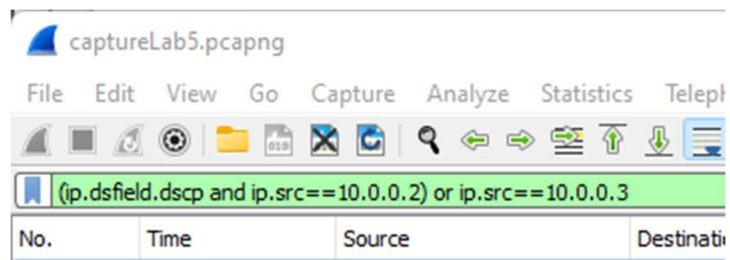
```
H1: sudo -s -u -i 1
```

```
H2: sudo iperf -c 10.0.0.1 -i 1 -u -b 10m -S 0xB8 -t 60
```

```
H3: sudo iperf -c 10.0.0.1 -i 1 -u -b 10m -t 60
```

και παράγεται το αρχείο captureLab5.pcapng.

4. Εφαρμογή φίλτρου στον αναλυτή πακέτων



5. Πεδίο DiffServ στην επικεφαλίδα IP

captureLab5.pcapng

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

(ip.dsfield.dscp and ip.src==10.0.0.2) or ip.src==10.0.0.3

| No. | Time | Source | Destination | Protocol | Length | Info |
|-----|----------|----------|-------------|----------|--------|-----------------------|
| 579 | 7.456453 | 10.0.0.2 | 10.0.0.1 | UDP | 1512 | 52709 → 5001 Len=1470 |
| 580 | 7.467988 | 10.0.0.2 | 10.0.0.1 | UDP | 1512 | 52709 → 5001 Len=1470 |
| 581 | 7.468976 | 10.0.0.2 | 10.0.0.1 | UDP | 1512 | 52709 → 5001 Len=1470 |
| 582 | 7.473042 | 10.0.0.2 | 10.0.0.1 | UDP | 1512 | 52709 → 5001 Len=1470 |
| 583 | 7.474775 | 10.0.0.2 | 10.0.0.1 | UDP | 1512 | 52709 → 5001 Len=1470 |
| 584 | 7.475813 | 10.0.0.2 | 10.0.0.1 | UDP | 1512 | 52709 → 5001 Len=1470 |
| 585 | 7.476717 | 10.0.0.2 | 10.0.0.1 | UDP | 1512 | 52709 → 5001 Len=1470 |
| 646 | 7.456760 | 10.0.0.2 | 10.0.0.1 | UDP | 1512 | 52709 → 5001 Len=1470 |
| 647 | 7.468394 | 10.0.0.2 | 10.0.0.1 | UDP | 1512 | 52709 → 5001 Len=1470 |
| 648 | 7.469285 | 10.0.0.2 | 10.0.0.1 | UDP | 1512 | 52709 → 5001 Len=1470 |
| 649 | 7.473351 | 10.0.0.2 | 10.0.0.1 | UDP | 1512 | 52709 → 5001 Len=1470 |

> Frame 579: 1512 bytes on wire (12096 bits), 1512 bytes captured (12096 bits) on interface s1-eth6, id 9
 > Ethernet II, Src: 00:00:00_00:00:02 (00:00:00:00:00:02), Dst: 00:00:00_00:00:01 (00:00:00:00:00:01)
 > Internet Protocol Version 4, Src: 10.0.0.2, Dst: 10.0.0.1
 > 0100 = Version: 4
 > 0101 = Header Length: 20 bytes (5)
 > > Differentiated Services Field: 0xb8 (DSCP: EF PHB, ECN: Not-ECT)
 > 1011 10.. = Differentiated Services Codepoint: Expedited Forwarding (46)

0000 00 00 00 00 01 00 00 00 00 02 08 00 45 b8E.
 0010 05 da 0c a7 40 00 40 11 13 b2 0a 00 00 02 0a 00@. @
 0020 00 01 cd e5 13 89 05 c6 fe 30 00 00 00 00 62 c30.....b.
 0030 24 ce 00 02 a6 ef 00 00 00 00 00 00 01 00 00 \$.
 0040 13 89 00 00 00 00 00 98 96 80 ff ff e8 90 36 3767
 0050 38 39 30 31 32 33 34 35 36 37 38 39 30 31 32 33 89012345 67890123

Differentiated Services Field (ip.dsfield), 1 byte

Packets: 73956 · Displayed: 70458 (95.3%) Profile: Default

6. Στατιστικά και αποτίμηση απόδοσης h2 και h3

Wireshark · Conversations · captureLab5.pcapng

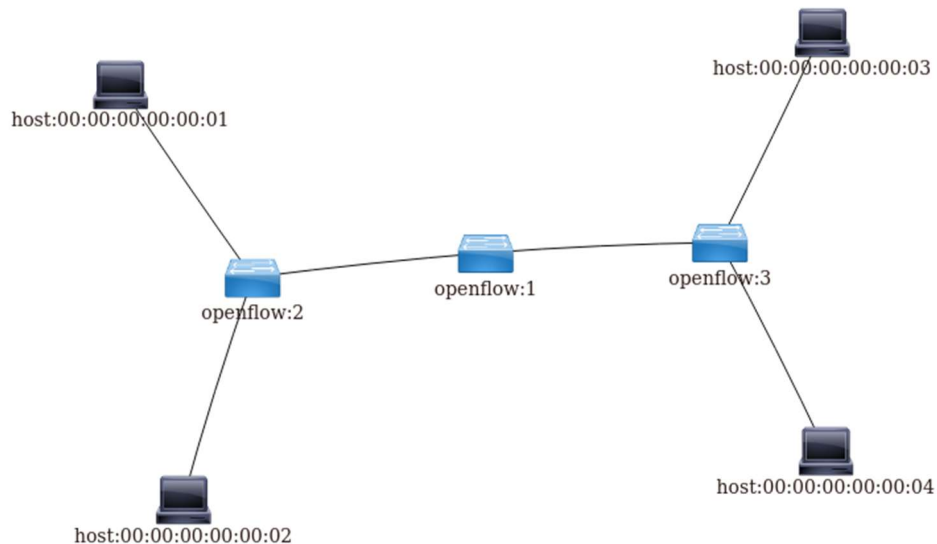
| Ethernet · 12 | | IPv4 · 6 | | IPv6 · 1 | | TCP · 9 | | UDP · 2 | | | | | |
|---------------|--------|-----------|--------|----------|-------|---------------|-------------|---------------|-------------|-----------|----------|--------------|--------------|
| Address A | Port A | Address B | Port B | Packets | Bytes | Packets A → B | Bytes A → B | Packets B → A | Bytes B → A | Rel Start | Duration | Bits/s A → B | Bits/s B → A |
| 10.0.0.2 | 52709 | 10.0.0.1 | 5001 | 41,179 | 62 M | 41,161 | 62 M | 18 | 27 k | 7.455332 | 62.6820 | 7943 k | |
| 10.0.0.3 | 40675 | 10.0.0.1 | 5001 | 29,291 | 44 M | 29,273 | 44 M | 18 | 27 k | 8.080409 | 62.0631 | 5705 k | |

| Host | Packet to h1 | Arrival rate (packets/sec) | Interarrival time (msec) | Tx (MB) |
|----------|--------------|----------------------------|--------------------------|---------|
| 10.0.0.2 | 41179 | 686,32 | 1,45705 | 62 |
| 10.0.0.3 | 29273 | 487,88 | 2,04967 | 44 |

Ζητούμενο 2

Δημιουργία δικτύωματος

```
ubuntu@sdnhubvm:~[07:01]$ sudo -E mn --  
controller=remote,ip=83.212.79.210,port=6633 --topo tree,depth=2,fanout=2 --mac --  
switch ovsk  
*** Creating network  
*** Adding controller  
*** Adding hosts:  
h1 h2 h3 h4  
*** Adding switches:  
s1 s2 s3  
*** Adding links:  
(s1, s2) (s1, s3) (s2, h1) (s2, h2) (s3, h3) (s3, h4)  
*** Configuring hosts  
h1 h2 h3 h4  
*** Starting controller  
c0  
*** Starting 3 switches  
s1 s2 s3 ...  
*** Starting CLI:
```



Ζητούμενο 3

Εισάγουμε τις κατάλληλες ροές, ουρές και κανόνες QoS.

```
mininet> sh ovs-vsctl set port s2-eth1 qos=@qos0 -- --id=@qos0 create qos type=linux-htb other-config:max-rate=8000000 queues=0=@q0 -- --id=@q0 create queue other-config:min-rate=1000000 other-config:max-rate=8000000
```

```
mininet> sh ovs-vsctl set port s2-eth2 qos=@qos1 -- --id=@qos1 create qos type=linux-htb other-config:max-rate=8000000 queues=1=@q1 -- --id=@q1 create queue other-config:min-rate=1000000 other-config:max-rate=8000000
```

```
mininet> sh ovs-ofctl add-flow s2
priority=1500,dl_type=0x800,nw_src=10.0.0.1,nw_tos=184,actions=set_queue:0,normal
```

```
mininet> sh ovs-ofctl add-flow s2
priority=1500,dl_type=0x800,nw_src=10.0.0.2,nw_tos=184,actions=set_queue:1,normal
```

```
mininet> sh ovs-ofctl add-flow s3
priority=1500,dl_type=0x800,nw_src=10.0.0.3,actions=drop
```

```
mininet> sh ovs-vsctl set port s3-eth2 qos=@qos2 -- --id=@qos2 create qos type=linux-htb other-config:max-rate=4000000 queues=2=@q2 -- --id=@q2 create queue other-config:min-rate=1000000 other-config:max-rate=4000000
```

```
mininet> sh ovs-ofctl add-flow s3
priority=1500,dl_type=0x800,nw_src=10.0.0.1,nw_dst=10.0.0.4,nw_tos=184,actions=set_queue:2,normal
```

```
mininet> sh ovs-ofctl add-flow s3
priority=1500,dl_type=0x800,nw_src=10.0.0.2,nw_dst=10.0.0.4,nw_tos=184,actions=set_queue:2,normal
```

Ζητούμενο 4

Πραγματοποιούμε δοκιμές.

Επικοινωνία h3 με h4.

```
"Node: h4" (on sdnhubvm)
root@sdnhubvm:~[08:04]$ sudo iperf -s -u -i 1
-----
Server listening on UDP port 5001
Receiving 1470 byte datagrams
UDP buffer size: 208 KByte (default)
-----
[]
```

```
"Node: h3" (on sdnhubvm)
root@sdnhubvm:~[08:05]$ sudo iperf -c 10.0.0.4 -i 1 -u -b 10m -S 0xB8
-----
Client connecting to 10.0.0.4, UDP port 5001
Sending 1470 byte datagrams
UDP buffer size: 208 KByte (default)
-----
[ 3] local 10.0.0.3 port 34242 connected with 10.0.0.4 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 3] 0.0- 1.0 sec  1.18 MBytes  9.91 Mbits/sec
[ 3] 1.0- 2.0 sec  1.19 MBytes  9.97 Mbits/sec
[ 3] 2.0- 3.0 sec  1.17 MBytes  9.80 Mbits/sec
[ 3] 3.0- 4.0 sec  1.18 MBytes  9.88 Mbits/sec
[ 3] 4.0- 5.0 sec  1.19 MBytes  9.97 Mbits/sec
[ 3] 5.0- 6.0 sec  1.16 MBytes  9.71 Mbits/sec
[ 3] 6.0- 7.0 sec  1.19 MBytes  9.96 Mbits/sec
[ 3] 7.0- 8.0 sec  1.18 MBytes  9.90 Mbits/sec
[ 3] 8.0- 9.0 sec  1.19 MBytes  9.95 Mbits/sec
[ 3] 9.0-10.0 sec  1.19 MBytes  9.98 Mbits/sec
[ 3] 0.0-10.0 sec  11.8 MBytes  9.90 Mbits/sec
[ 3] Sent 8423 datagrams
[ 3] WARNING: did not receive ack of last datagram after 10 tries.
root@sdnhubvm:~[08:07]$
```

Επικοινωνία h1 με h4.

```
"Node: h1" (on sdnhubvm)
root@sdnhubvm:~[08:02]$ sudo iperf -c 10.0.0.4 -i 1 -u -b 10m -S 0xB8
-----
Client connecting to 10.0.0.4, UDP port 5001
Sending 1470 byte datagrams
UDP buffer size: 208 KByte (default)
-----
[ 3] local 10.0.0.1 port 39682 connected with 10.0.0.4 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 3] 0.0- 1.0 sec   668 KBytes  5.47 Mbits/sec
[ 3] 1.0- 2.0 sec   690 KBytes  5.66 Mbits/sec
[ 3] 2.0- 3.0 sec   692 KBytes  5.67 Mbits/sec
[ 3] 3.0- 4.0 sec   607 KBytes  4.97 Mbits/sec
[ 3] 4.0- 5.0 sec   652 KBytes  5.34 Mbits/sec
[ 3] 5.0- 6.0 sec   749 KBytes  6.14 Mbits/sec
[ 3] 6.0- 7.0 sec   599 KBytes  4.90 Mbits/sec
[ 3] 7.0- 8.0 sec   699 KBytes  5.73 Mbits/sec
[ 3] 8.0- 9.0 sec   724 KBytes  5.93 Mbits/sec
[ 3] 9.0-10.0 sec   718 KBytes  5.88 Mbits/sec
[ 3] 0.0-10.0 sec   6.64 MBytes 5.57 Mbits/sec
[ 3] Sent 4736 datagrams
[ 3] WARNING: did not receive ack of last datagram after 10 tries.
root@sdnhubvm:~[08:09]$
```

```
"Node: h4" (on sdnhubvm)
-----
Server listening on UDP port 5001
Receiving 1470 byte datagrams
UDP buffer size: 208 KByte (default)
-----
[ 3] local 10.0.0.4 port 5001 connected with 10.0.0.1 port 39682
[ ID] Interval      Transfer    Bandwidth    Jitter    Lost/Total Datagrams
[ 3] 0.0- 1.0 sec   474 KBytes  3.88 Mbits/sec  1.630 ms  125/ 330 (38%)
[ 3] 0.0- 1.0 sec   125 datagrams received out-of-order
[ 3] 1.0- 2.0 sec   471 KBytes  3.86 Mbits/sec  1.625 ms    0/ 328 (0%)
[ 3] 2.0- 3.0 sec   474 KBytes  3.88 Mbits/sec  1.878 ms    0/ 330 (0%)
[ 3] 3.0- 4.0 sec   474 KBytes  3.88 Mbits/sec  1.990 ms    0/ 330 (0%)
[ 3] 4.0- 5.0 sec   471 KBytes  3.86 Mbits/sec  1.389 ms    0/ 328 (0%)
[ 3] 5.0- 6.0 sec   472 KBytes  3.87 Mbits/sec  2.274 ms    0/ 329 (0%)
[ 3] 6.0- 7.0 sec   472 KBytes  3.87 Mbits/sec  1.512 ms    0/ 329 (0%)
[ 3] 7.0- 8.0 sec   475 KBytes  3.89 Mbits/sec  1.900 ms    0/ 331 (0%)
[ 3] 8.0- 9.0 sec   471 KBytes  3.86 Mbits/sec  2.170 ms    0/ 328 (0%)
[ 3] 9.0-10.0 sec   472 KBytes  3.87 Mbits/sec  1.165 ms   46/ 375 (12%)
[ 3] 10.0-11.0 sec   474 KBytes  3.88 Mbits/sec  1.862 ms  154/ 484 (32%)
[ 3] 11.0-12.0 sec   475 KBytes  3.89 Mbits/sec  2.048 ms  153/ 484 (32%)
[ 3] 0.0-12.8 sec   5.91 MBytes  3.87 Mbits/sec  2.551 ms  516/ 4735 (11%)
[ 3] 0.0-12.8 sec   126 datagrams received out-of-order
read failed: Connection refused
```

Επικοινωνία h2 με h4.

```

"Node: h2" (on sdnhubvm)
root@sdnhubvm:~[08:11]$ sudo iperf -c 10.0.0.4 -i 1 -u -b 10m -S 0xB8
-----
Client connecting to 10.0.0.4, UDP port 5001
Sending 1470 byte datagrams
UDP buffer size: 208 KByte (default)
-----
[ 3] local 10.0.0.2 port 60083 connected with 10.0.0.4 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 3] 0.0- 1.0 sec   690 KBytes  5.66 Mbits/sec
[ 3] 1.0- 2.0 sec   729 KBytes  5.97 Mbits/sec
[ 3] 2.0- 3.0 sec   645 KBytes  5.28 Mbits/sec
[ 3] 3.0- 4.0 sec   752 KBytes  6.16 Mbits/sec
[ 3] 4.0- 5.0 sec   741 KBytes  6.07 Mbits/sec
[ 3] 5.0- 6.0 sec   620 KBytes  5.08 Mbits/sec
[ 3] 6.0- 7.0 sec   699 KBytes  5.73 Mbits/sec
[ 3] 7.0- 8.0 sec   680 KBytes  5.57 Mbits/sec
[ 3] 8.0- 9.0 sec   705 KBytes  5.77 Mbits/sec
[ 3] 9.0-10.0 sec   724 KBytes  5.93 Mbits/sec
[ 3] 0.0-10.0 sec   6.82 MBytes 5.72 Mbits/sec
[ 3] Sent 4867 datagrams
[ 3] WARNING: did not receive ack of last datagram after 10 tries.
root@sdnhubvm:~[08:11]$ █

```

```

"Node: h4" (on sdnhubvm)
-----
Server listening on UDP port 5001
Receiving 1470 byte datagrams
UDP buffer size: 208 KByte (default)
-----
[ 3] local 10.0.0.4 port 5001 connected with 10.0.0.2 port 60083
[ ID] Interval      Transfer    Bandwidth    Jitter    Lost/Total Datagrams
[ 3] 0.0- 1.0 sec   472 KBytes  3.87 Mbits/sec  1.899 ms  133/ 329 (40%)
[ 3] 0.0- 1.0 sec   133 datagrams received out-of-order
[ 3] 1.0- 2.0 sec   472 KBytes  3.87 Mbits/sec  1.703 ms   0/ 329 (0%)
[ 3] 2.0- 3.0 sec   474 KBytes  3.88 Mbits/sec  1.914 ms   0/ 330 (0%)
[ 3] 3.0- 4.0 sec   472 KBytes  3.87 Mbits/sec  1.882 ms   0/ 329 (0%)
[ 3] 4.0- 5.0 sec   471 KBytes  3.86 Mbits/sec  1.615 ms   0/ 328 (0%)
[ 3] 5.0- 6.0 sec   468 KBytes  3.83 Mbits/sec  1.874 ms   0/ 326 (0%)
[ 3] 6.0- 7.0 sec   469 KBytes  3.85 Mbits/sec  2.321 ms   0/ 327 (0%)
[ 3] 7.0- 8.0 sec   469 KBytes  3.85 Mbits/sec  1.488 ms   0/ 327 (0%)
[ 3] 8.0- 9.0 sec   474 KBytes  3.88 Mbits/sec  1.057 ms  39/ 369 (11%)
[ 3] 9.0-10.0 sec   471 KBytes  3.86 Mbits/sec  1.116 ms 164/ 492 (33%)
[ 3] 10.0-11.0 sec   475 KBytes  3.89 Mbits/sec  1.137 ms 152/ 483 (31%)
[ 3] 11.0-12.0 sec   472 KBytes  3.87 Mbits/sec  0.915 ms 163/ 492 (33%)
[ 3] 0.0-12.8 sec   5.91 MBytes 3.87 Mbits/sec  1.210 ms 652/ 4866 (13%)
[ 3] 0.0-12.8 sec   134 datagrams received out-of-order
read failed: Connection refused
█

```

Επικοινωνία h1 με h2.

```
"Node: h1" (on sdnhubvm)

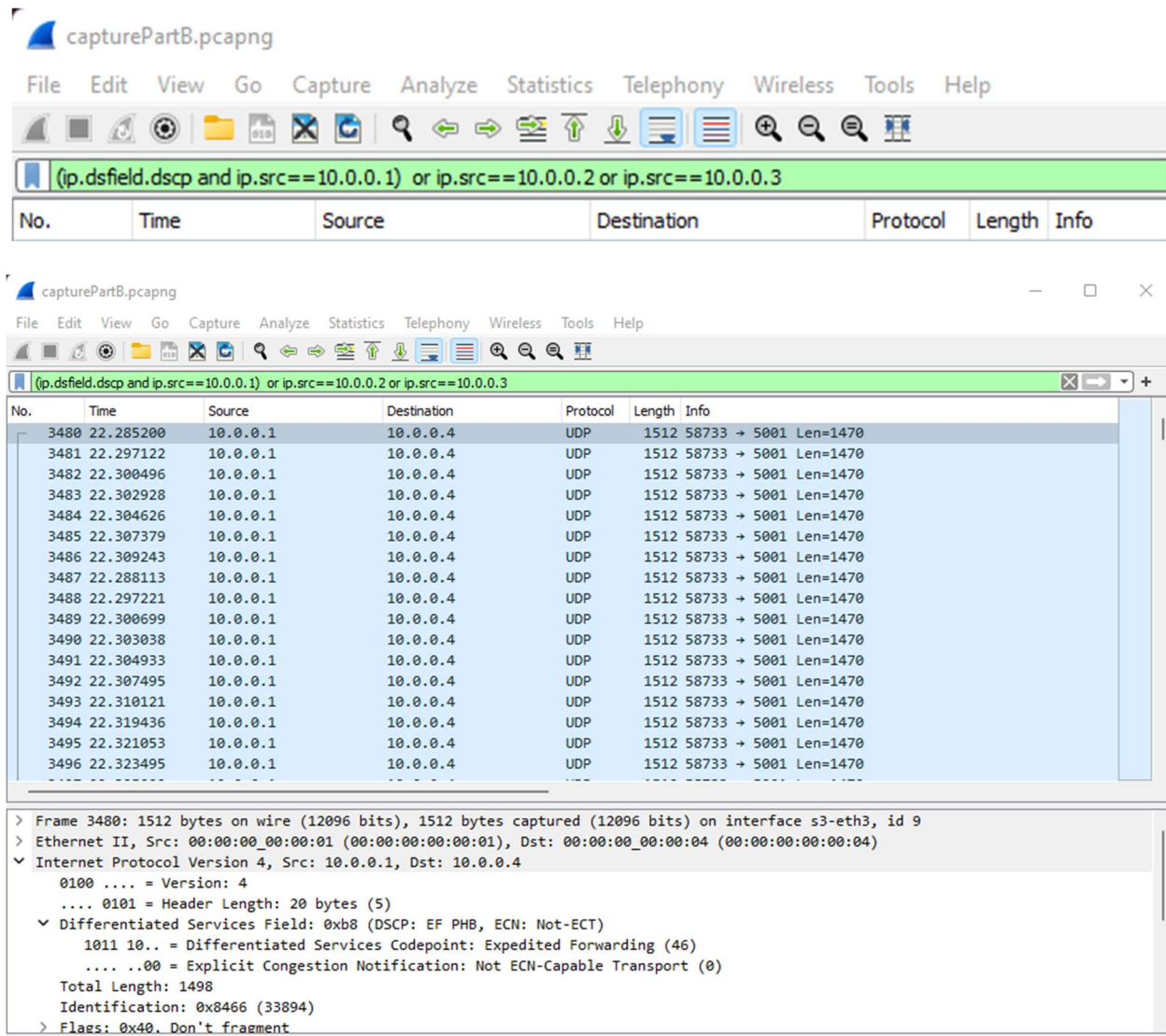
-----
Server listening on UDP port 5001
Receiving 1470 byte datagrams
UDP buffer size: 208 KByte (default)
-----
[ 3] local 10.0.0.1 port 5001 connected with 10.0.0.2 port 41614
[ ID] Interval      Transfer      Bandwidth      Jitter      Lost/Total Datagrams
[ 3] 0.0- 1.0 sec    890 KBytes    7.29 Mbits/sec  1.405 ms    0/ 620 (0%)
[ 3] 1.0- 2.0 sec    912 KBytes    7.47 Mbits/sec  1.260 ms    0/ 635 (0%)
[ 3] 2.0- 3.0 sec    856 KBytes    7.01 Mbits/sec  2.122 ms    0/ 596 (0%)
[ 3] 3.0- 4.0 sec    900 KBytes    7.37 Mbits/sec  1.241 ms    1/ 627 (0.16%)
[ 3] 3.0- 4.0 sec    1 datagrams received out-of-order
[ 3] 4.0- 5.0 sec    926 KBytes    7.59 Mbits/sec  1.559 ms    1/ 645 (0.16%)
[ 3] 4.0- 5.0 sec    1 datagrams received out-of-order
[ 3] 5.0- 6.0 sec    866 KBytes    7.09 Mbits/sec  2.309 ms    1/ 603 (0.17%)
[ 3] 5.0- 6.0 sec    1 datagrams received out-of-order
[ 3] 6.0- 7.0 sec    904 KBytes    7.41 Mbits/sec  1.831 ms    0/ 630 (0%)
[ 3] 7.0- 8.0 sec    856 KBytes    7.01 Mbits/sec  1.505 ms    0/ 596 (0%)
[ 3] 8.0- 9.0 sec    843 KBytes    6.90 Mbits/sec  1.674 ms    1/ 587 (0.17%)
[ 3] 8.0- 9.0 sec    1 datagrams received out-of-order
[ 3] 9.0-10.0 sec    881 KBytes    7.22 Mbits/sec  1.244 ms    0/ 614 (0%)
[ 3] 0.0-10.0 sec    8.63 MBytes    7.24 Mbits/sec  1.458 ms    4/ 6156 (0.065%)
[ 3] 0.0-10.0 sec    5 datagrams received out-of-order
```

```
"Node: h2" (on sdnhubvm)

root@sdnhubvm:~[08:13]$ sudo iperf -c 10.0.0.1 -i 1 -u -b 10m -S 0xB8
-----
Client connecting to 10.0.0.1, UDP port 5001
Sending 1470 byte datagrams
UDP buffer size: 208 KByte (default)
-----
[ 3] local 10.0.0.2 port 41614 connected with 10.0.0.1 port 5001
[ ID] Interval      Transfer      Bandwidth
[ 3] 0.0- 1.0 sec    891 KBytes    7.30 Mbits/sec
[ 3] 1.0- 2.0 sec    910 KBytes    7.46 Mbits/sec
[ 3] 2.0- 3.0 sec    854 KBytes    7.00 Mbits/sec
[ 3] 3.0- 4.0 sec    904 KBytes    7.41 Mbits/sec
[ 3] 4.0- 5.0 sec    926 KBytes    7.59 Mbits/sec
[ 3] 5.0- 6.0 sec    860 KBytes    7.04 Mbits/sec
[ 3] 6.0- 7.0 sec    906 KBytes    7.42 Mbits/sec
[ 3] 7.0- 8.0 sec    854 KBytes    7.00 Mbits/sec
[ 3] 8.0- 9.0 sec    844 KBytes    6.91 Mbits/sec
[ 3] 0.0-10.0 sec    8.63 MBytes    7.24 Mbits/sec
[ 3] Sent 6157 datagrams
[ 3] Server Report:
[ 3] 0.0-10.0 sec    8.63 MBytes    7.24 Mbits/sec  1.458 ms    4/ 6156 (0.065%)
[ 3] 0.0-10.0 sec    5 datagrams received out-of-order
root@sdnhubvm:~[08:13]$
```

Ζητούμενο 5

Κάνουμε capture με το wireshark και παράγεται το αρχείο capturePartB.pcapng.



Ζητούμενο 6

ΣΤΑΤΙΣΤΙΚΑ.

Wireshark · Conversations · capturePartB.pcapng

| Ethernet · 13 IPv4 · 21 IPv6 · 1 TCP · 28 UDP · 3 | | | | | | | | | | | | | |
|---|--------|-----------|--------|---------|--------|---------------|-------------|---------------|-------------|-----------|----------|--------------|--------------|
| Address A | Port A | Address B | Port B | Packets | Bytes | Packets A → B | Bytes A → B | Packets B → A | Bytes B → A | Rel Start | Duration | Bits/s A → B | Bits/s B → A |
| 10.0.0.1 | 58733 | 10.0.0.4 | 5001 | 8,662 | 13 M | 8,660 | 13 M | 2 | 3024 | 22.280743 | 60.0341 | 1744 k | |
| 10.0.0.2 | 38136 | 10.0.0.4 | 5001 | 8,961 | 13 M | 8,957 | 13 M | 4 | 4684 | 22.871834 | 60.0472 | 1804 k | |
| 10.0.0.3 | 39558 | 10.0.0.4 | 5001 | 1,869 | 2825 k | 1,869 | 2825 k | 0 | 0 | 23.586078 | 62.1648 | 363 k | |

| Host | Packet to h4 | Arrival rate (packets/sec) | Interarrival time (msec) | Tx (MB) |
|----------|--------------|-------------------------------|-----------------------------|---------|
| 10.0.0.1 | 8662 | 144,37 | 6,92681 | 13 |
| 10.0.0.2 | 8961 | 149,35 | 6,69568 | 13 |
| 10.0.0.3 | 1869 | 31,15 | 32,10273 | 2,825 |

Παρατηρήσεις

Όπου χρησιμοποιήθηκε screenshot αντί για κείμενο σε περιπτώσεις τερματικού, έγινε γιατί δεν υπήρχε η δυνατότητα αντιγραφής από το συγκεκριμένο τερματικό. Τα τερματικά του xterm έτρεξαν με την εντολή `ssh -X -p 3022 ubuntu@83.212.79.210` για την ενεργοποίηση του X11Forwarding και στην συνέχεια μέσα στο mininet xterm h*. Όλα σε περιβάλλον Ubuntu. Αυτή η μέθοδος δεν έδινε την δυνατότητα αντιγραφής από τα συγκεκριμένα τερματικά.