

# Congestion Control

# Transport layer protocols

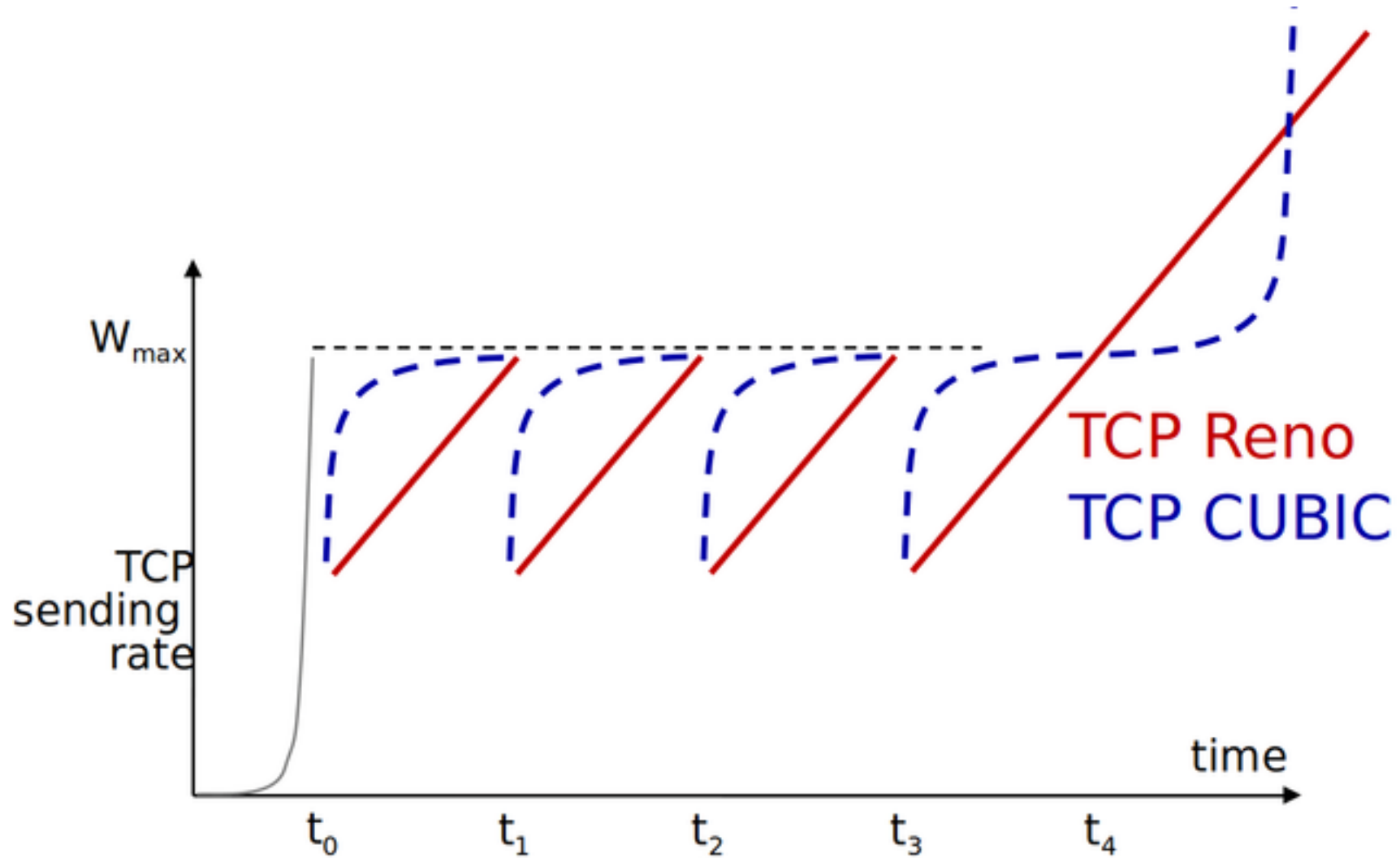
- Transmission Control Protocol (TCP)

- Connection-oriented
- Three-way handshake
- Congestion control
- Flow control
- Acknowledgement mechanism
- Slow

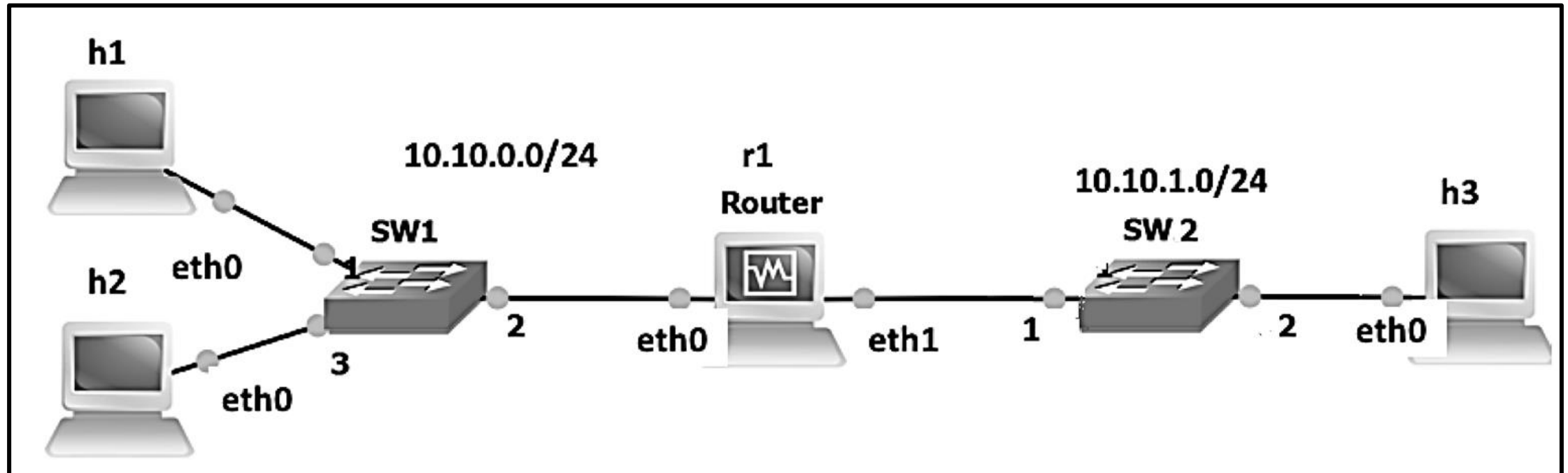
- User Datagram Protocol (UDP)

- Connection-less
- No handshake mechanism
- No congestion control
- No flow control
- No acknowledgement
- Fast

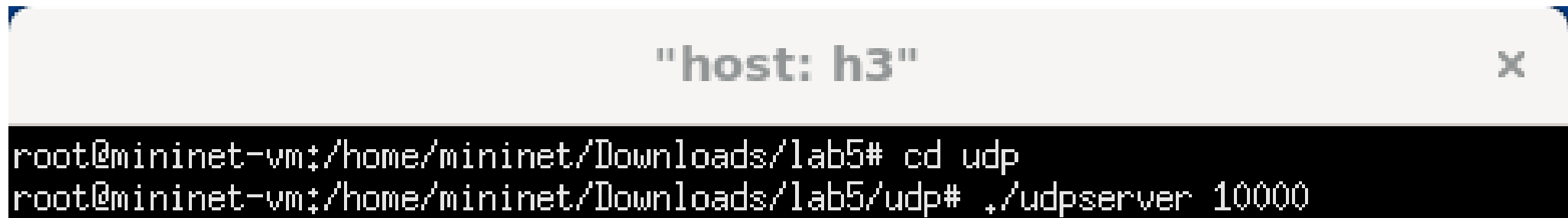
# TCP congestion control



# lab6.py



# UDP connection



```
root@mininet-vm:/home/mininet/Downloads/lab5# cd udp
root@mininet-vm:/home/mininet/Downloads/lab5/udp# ./udpserver 10000
```

A terminal window titled "host: h3" with a close button (x) in the top right corner. The terminal shows two lines of text: the first line is the command `cd udp` and the second line is the command `./udpserver 10000`. The prompt for the first line is `root@mininet-vm:/home/mininet/Downloads/lab5#` and for the second line is `root@mininet-vm:/home/mininet/Downloads/lab5/udp#`.

"host: h1"

x

```
root@mininet-vm:/home/mininet/Downloads/lab5# cd udp
```

```
root@mininet-vm:/home/mininet/Downloads/lab5/udp# ./udpclient 10.10.1.3 10000 100
```

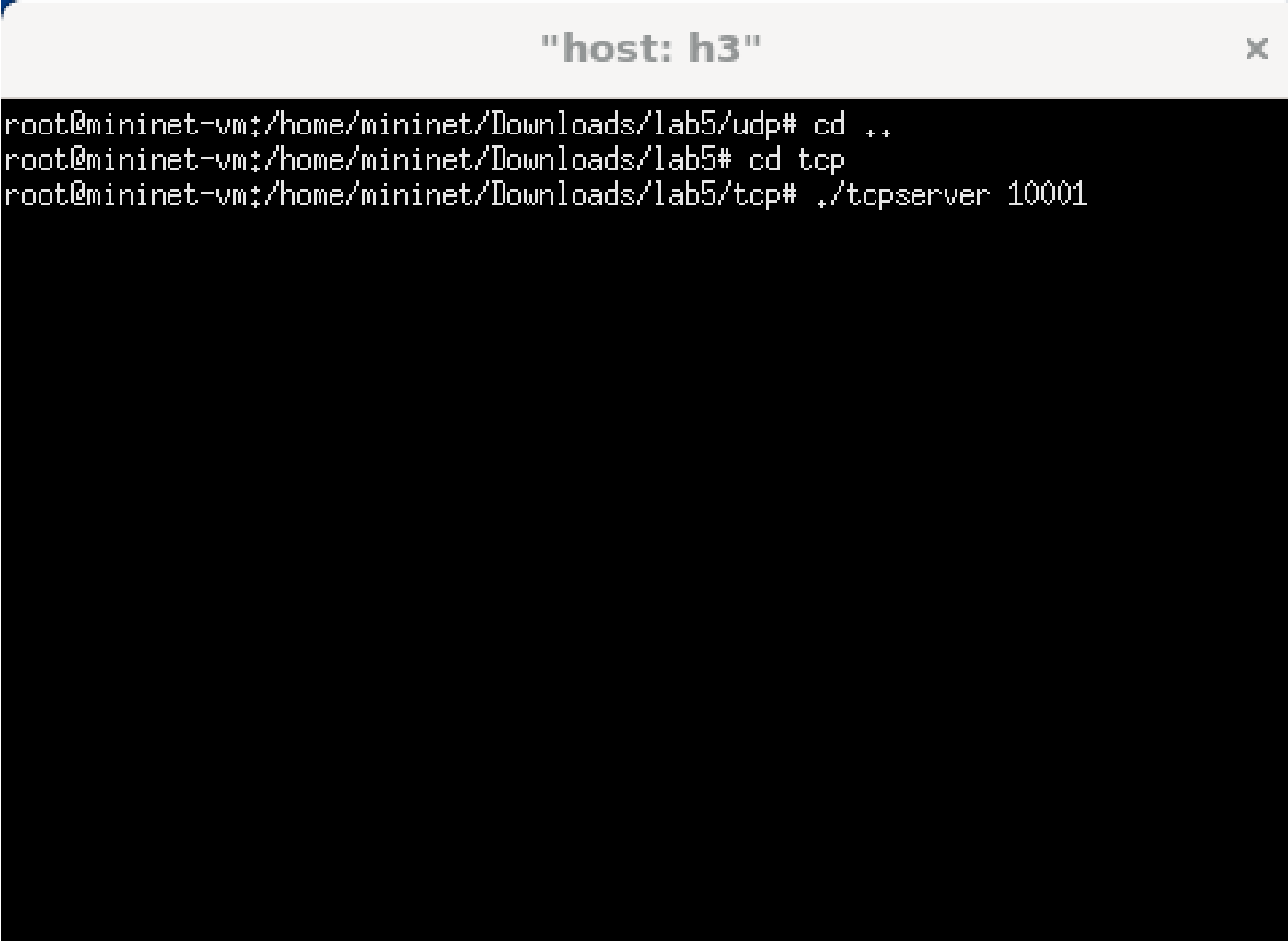
```
1.0s - sent: 14 pkts, 107.6 kbits/s
2.1s - sent: 27 pkts, 100.0 kbits/s
3.1s - sent: 40 pkts, 99.8 kbits/s
4.2s - sent: 53 pkts, 102.6 kbits/s
5.2s - sent: 66 pkts, 100.0 kbits/s
6.2s - sent: 79 pkts, 100.1 kbits/s
7.3s - sent: 92 pkts, 100.3 kbits/s
8.3s - sent: 105 pkts, 100.1 kbits/s
9.4s - sent: 118 pkts, 100.2 kbits/s
10.4s - sent: 131 pkts, 100.1 kbits/s
11.4s - sent: 144 pkts, 100.1 kbits/s
12.5s - sent: 157 pkts, 100.2 kbits/s
13.5s - sent: 170 pkts, 100.2 kbits/s
14.6s - sent: 183 pkts, 100.1 kbits/s
15.6s - sent: 196 pkts, 100.1 kbits/s
16.6s - sent: 209 pkts, 100.2 kbits/s
17.7s - sent: 222 pkts, 100.3 kbits/s
18.7s - sent: 235 pkts, 99.9 kbits/s
19.8s - sent: 248 pkts, 100.1 kbits/s
20.8s - sent: 261 pkts, 100.1 kbits/s
21.8s - sent: 274 pkts, 100.3 kbits/s
```

"host: h3"

x

```
root@mininet-vm:/home/mininet/Downloads/lab5# cd udp
root@mininet-vm:/home/mininet/Downloads/lab5/udp# ./udpserver 10000
0.0s - received: 1/ sent: 1 pkts (loss 0.000%), 0.2 kbit/s
47.0s - received: 14/ sent: 14 pkts (loss 0.000%), 100.3 kbit/s
48.0s - received: 27/ sent: 27 pkts (loss 0.000%), 100.0 kbit/s
49.0s - received: 40/ sent: 40 pkts (loss 0.000%), 100.0 kbit/s
50.1s - received: 53/ sent: 53 pkts (loss 0.000%), 100.0 kbit/s
51.1s - received: 66/ sent: 66 pkts (loss 0.000%), 100.0 kbit/s
52.2s - received: 79/ sent: 79 pkts (loss 0.000%), 100.0 kbit/s
53.2s - received: 92/ sent: 92 pkts (loss 0.000%), 99.9 kbit/s
54.2s - received: 105/ sent: 105 pkts (loss 0.000%), 100.1 kbit/s
55.3s - received: 118/ sent: 118 pkts (loss 0.000%), 100.0 kbit/s
56.3s - received: 131/ sent: 131 pkts (loss 0.000%), 100.0 kbit/s
57.4s - received: 144/ sent: 144 pkts (loss 0.000%), 100.0 kbit/s
58.4s - received: 157/ sent: 157 pkts (loss 0.000%), 100.0 kbit/s
59.4s - received: 170/ sent: 170 pkts (loss 0.000%), 100.0 kbit/s
60.5s - received: 183/ sent: 183 pkts (loss 0.000%), 100.0 kbit/s
61.5s - received: 196/ sent: 196 pkts (loss 0.000%), 100.0 kbit/s
62.6s - received: 209/ sent: 209 pkts (loss 0.000%), 100.0 kbit/s
63.6s - received: 222/ sent: 222 pkts (loss 0.000%), 99.8 kbit/s
64.6s - received: 235/ sent: 235 pkts (loss 0.000%), 100.2 kbit/s
65.7s - received: 248/ sent: 248 pkts (loss 0.000%), 100.0 kbit/s
66.7s - received: 261/ sent: 261 pkts (loss 0.000%), 100.0 kbit/s
67.8s - received: 274/ sent: 274 pkts (loss 0.000%), 100.0 kbit/s
```

# TCP connection



```
root@mininet-vmt:/home/mininet/Downloads/lab5/udp# cd ..  
root@mininet-vmt:/home/mininet/Downloads/lab5# cd tcp  
root@mininet-vmt:/home/mininet/Downloads/lab5/tcp# ./tcpserver 10001
```



"host: h1"



```
root@mininet-vm:/home/mininet/Downloads/lab5/udp# cd ..
root@mininet-vm:/home/mininet/Downloads/lab5# cd tcp
root@mininet-vm:/home/mininet/Downloads/lab5/tcp# ./tcpclient 10.10.1.3 10001
0.0:      0.0kbps avg (    0.0[inst],    0.0[mov,avg]) cwnd 10 rtt  1.9ms
0.0:      0.0kbps avg (    0.0[inst],    0.0[mov,avg]) cwnd 18 rtt  8.8ms
0.0:      0.0kbps avg (    0.0[inst],    0.0[mov,avg]) cwnd 30 rtt 11.5ms
0.0:      0.0kbps avg (    0.0[inst],    0.0[mov,avg]) cwnd 44 rtt 17.0ms
0.2:      0.0kbps avg (    0.0[inst],    0.0[mov,avg]) cwnd 13 rtt 22.1ms
0.3:      0.0kbps avg (    0.0[inst],    0.0[mov,avg]) cwnd 19 rtt 20.1ms
0.4:      0.0kbps avg (    0.0[inst],    0.0[mov,avg]) cwnd 23 rtt 25.1ms
0.5:      0.0kbps avg (    0.0[inst],    0.0[mov,avg]) cwnd 15 rtt 16.1ms
0.6:      0.0kbps avg (    0.0[inst],    0.0[mov,avg]) cwnd 20 rtt 21.5ms
0.7:      0.0kbps avg (    0.0[inst],    0.0[mov,avg]) cwnd 24 rtt 26.3ms
0.8:      0.0kbps avg (    0.0[inst],    0.0[mov,avg]) cwnd 16 rtt 16.7ms
1.0:      0.0kbps avg (    0.0[inst],    0.0[mov,avg]) cwnd 21 rtt 22.6ms
1.1: 9195.5kbps avg ( 9195.5[inst], 9195.5[mov,avg]) cwnd 12 rtt 26.6ms
1.2: 9195.5kbps avg ( 9195.5[inst], 9195.5[mov,avg]) cwnd 20 rtt 21.7ms
1.3: 9195.5kbps avg ( 9195.5[inst], 9195.5[mov,avg]) cwnd 12 rtt 25.8ms
1.5: 9195.5kbps avg ( 9195.5[inst], 9195.5[mov,avg]) cwnd 19 rtt 20.2ms
1.6: 9195.5kbps avg ( 9195.5[inst], 9195.5[mov,avg]) cwnd 24 rtt 25.9ms
1.7: 9195.5kbps avg ( 9195.5[inst], 9195.5[mov,avg]) cwnd 16 rtt 16.7ms
1.8: 9195.5kbps avg ( 9195.5[inst], 9195.5[mov,avg]) cwnd 21 rtt 22.6ms
1.9: 9195.5kbps avg ( 9195.5[inst], 9195.5[mov,avg]) cwnd 12 rtt 25.3ms
2.0: 9195.5kbps avg ( 9195.5[inst], 9195.5[mov,avg]) cwnd 18 rtt 18.9ms
```

Capturing from r1-eth0 [Wireshark 1.10.6 (v1.10.6 from master-1.10)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
2	0.007003000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
3	0.016072000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
4	0.023665000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
5	0.031216000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
6	0.040005000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
7	0.048301000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
8	0.055022000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
9	0.063939000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
10	0.071510000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp

▶ Frame 1: 1042 bytes on wire (8336 bits), 1042 bytes captured (8336 bits) on interface 0

- ▶ Ethernet II, Src: 92:ce:13:1f:54:f1 (92:ce:13:1f:54:f1), Dst: c6:4e:62:e9:95:e1 (c6:4e:62:e9:95:e1)
- ▶ Internet Protocol Version 4, Src: 10.10.0.1 (10.10.0.1), Dst: 10.10.1.3 (10.10.1.3)
- ▶ User Datagram Protocol, Src Port: 58293 (58293), Dst Port: ndmp (10000)
- ▶ Data (1000 bytes)

Offset	Hex	ASCII
0000	c6 4e 62 e9 95 e1 92 ce 13 1f 54 f1 08 00 45 00	.Nb.....T...E.
0010	04 04 21 1a 40 00 40 11 00 b8 0a 0a 00 01 0a 0a	...!.@. ....
0020	01 03 e3 b5 27 10 03 f0 19 19 32 33 38 33 37 0a	....'... ..23837.
0030	00 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01	.....
0040	01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01	.....
0050	01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01	.....

Frame (frame), 1042 bytes Packets: 6212 - Di... Profile: Default

Capturing from r1-eth0 [Wireshark 1.10.6 (v1.10.6 from master-1.10)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
2	0.007003000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
3	0.016072000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
4	0.023665000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
5	0.031216000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
6	0.040005000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
7	0.048301000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
8	0.055022000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
9	0.063939000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
10	0.071510000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp

▶ Frame 1: 1042 bytes on wire (8336 bits), 1042 bytes captured (8336 bits) on interface 0

▶ Ethernet II, Src: 92:ce:13:1f:54:f1 (92:ce:13:1f:54:f1), Dst: c6:4e:62:e9:95:e1 (c6:4e:62:e9:95:e1)

▶ Internet Protocol Version 4, Src: 10.10.0.1 (10.10.0.1), Dst: 10.10.1.3 (10.10.1.3)

▶ User Datagram Protocol, Src Port: 58293 (58293), Dst Port: ndmp (10000)

▶ Data (1000 bytes)

0000	c6 4e 62 e9 95 e1 92 ce 13 1f 54 f1 08 00 45 00	.Nb.....T...E.
0010	04 04 21 1a 40 00 40 11 00 b8 0a 0a 00 01 0a 0a	...!.@. ....
0020	01 03 e3 b5 27 10 03 f0 19 19 32 33 38 33 37 0a	....'... ..23837.
0030	00 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01	.....
0040	01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01	.....
0050	01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01	.....

Ethernet (eth), 14 bytes

Packets: 6212 · Di... Profile: Default

Capturing from r1-eth0 [Wireshark 1.10.6 (v1.10.6 from master-1.10)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
2	0.007003000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
3	0.016072000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
4	0.023665000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
5	0.031216000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
6	0.040005000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
7	0.048301000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
8	0.055022000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
9	0.063939000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
10	0.071510000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp

▶ Frame 1: 1042 bytes on wire (8336 bits), 1042 bytes captured (8336 bits) on interface 0

▶ Ethernet II, Src: 92:ce:13:1f:54:f1 (92:ce:13:1f:54:f1), Dst: c6:4e:62:e9:95:e1 (c6:4e:62:e9:95:e1)

▶ Internet Protocol Version 4, Src: 10.10.0.1 (10.10.0.1), Dst: 10.10.1.3 (10.10.1.3)

▶ User Datagram Protocol, Src Port: 58293 (58293), Dst Port: ndmp (10000)

▶ Data (1000 bytes)

Offset	Hex	ASCII
0000	c6 4e 62 e9 95 e1 92 ce 13 1f 54 f1 08 00 45 00	.Nb..... ..T...E.
0010	04 04 21 1a 40 00 40 11 00 b8 0a 0a 00 01 0a 0a	...!.@. ....
0020	01 03 e3 b5 27 10 03 f0 19 19 32 33 38 33 37 0a	...'... ..23837.
0030	00 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01	.....
0040	01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01	.....
0050	01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01	.....

Internet Protocol Version 4 (ip), 20 bytes Packets: 6212 · Di... Profile: Default

Capturing from r1-eth0 [Wireshark 1.10.6 (v1.10.6 from master-1.10)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
2	0.007003000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
3	0.016072000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
4	0.023665000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
5	0.031216000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
6	0.040005000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
7	0.048301000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
8	0.055022000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
9	0.063939000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
10	0.071510000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp

▶ Frame 1: 1042 bytes on wire (8336 bits), 1042 bytes captured (8336 bits) on interface 0

▶ Ethernet II, Src: 92:ce:13:1f:54:f1 (92:ce:13:1f:54:f1), Dst: c6:4e:62:e9:95:e1 (c6:4e:62:e9:95:e1)

▶ Internet Protocol Version 4, Src: 10.10.0.1 (10.10.0.1), Dst: 10.10.1.3 (10.10.1.3)


▶ User Datagram Protocol, Src Port: 58293 (58293), Dst Port: ndmp (10000)

▶ Data (1000 bytes)


0020	01 03 e3 b5 27 10 03 f0 19 19 32 33 38 33 37 0a	...'...23837.
0030	00 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01	.....
0040	01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01	.....
0050	01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01	.....
0060	01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01	.....
0070	01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01	.....

User Datagram Protocol (udp), 8 bytes      Packets: 6212 - Di...      Profile: Default



 **Capturing from r1-eth0 [Wireshark 1.10.6 (v1.10.6 from master-1.10)]** - + x

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help



Filter:  Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
2	0.007003000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
3	0.016072000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
4	0.023665000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
5	0.031216000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
6	0.040005000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
7	0.048301000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
8	0.055022000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
9	0.063939000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp
10	0.071510000	10.10.0.1	10.10.1.3	UDP	1042	Source port: 58293 Destination port: ndmp

▶ Frame 1: 1042 bytes on wire (8336 bits), 1042 bytes captured (8336 bits) on interface 0

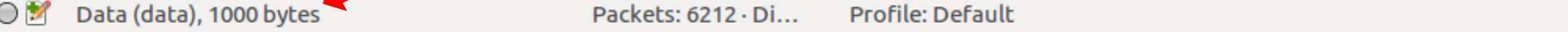
▶ Ethernet II, Src: 92:ce:13:1f:54:f1 (92:ce:13:1f:54:f1), Dst: c6:4e:62:e9:95:e1 (c6:4e:62:e9:95:e1)

▶ Internet Protocol Version 4, Src: 10.10.0.1 (10.10.0.1), Dst: 10.10.1.3 (10.10.1.3)

▶ User Datagram Protocol, Src Port: 58293 (58293), Dst Port: ndmp (10000)

▶ Data (1000 bytes)

0020	01 03 e3 b5 27 10 03 f0 19 19 32 33 38 33 37 0a	.....'... ..23837.
0030	00 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01	.....
0040	01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01	.....
0050	01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01	.....
0060	01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01	.....
0070	01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01	.....

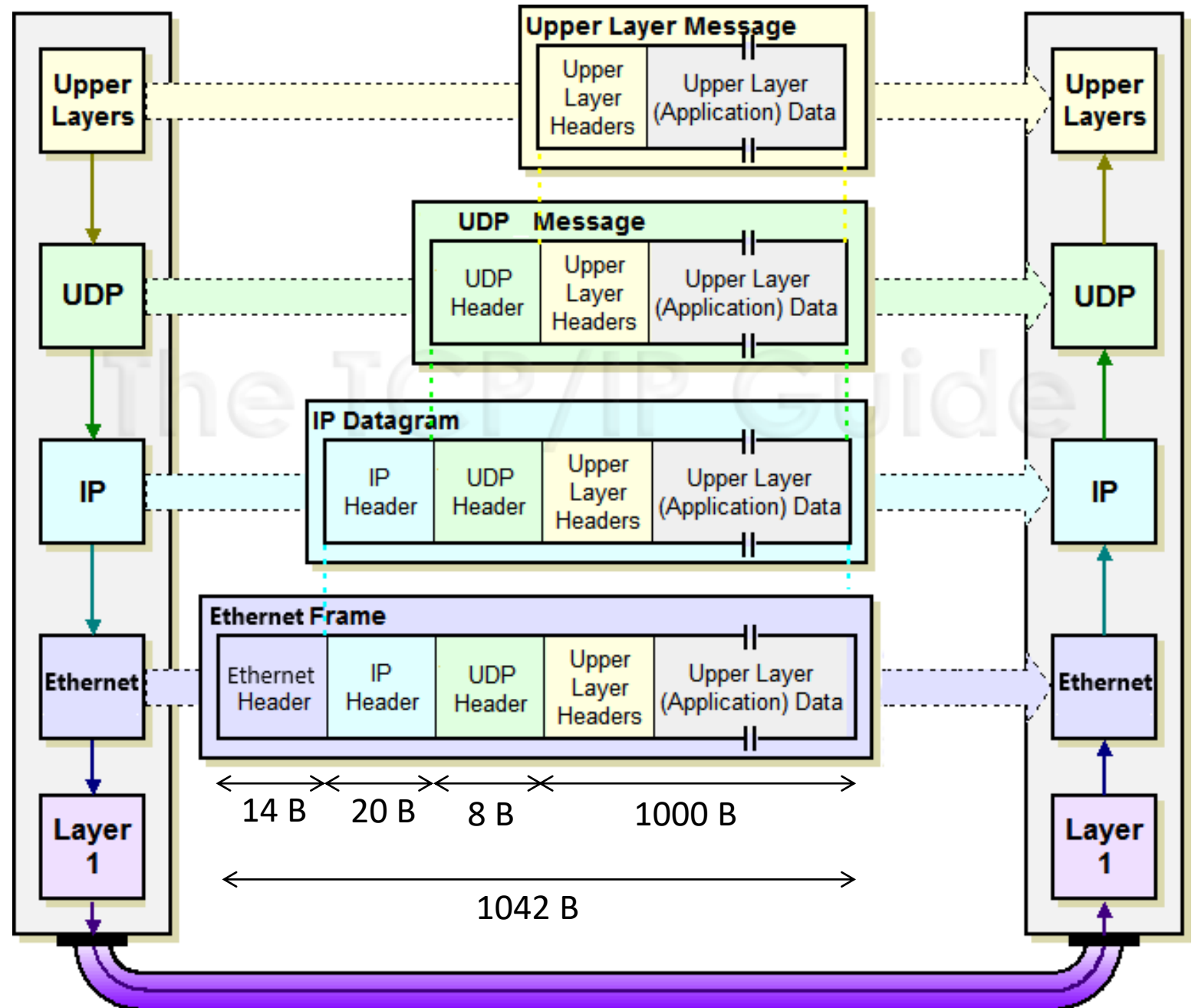
 Data (data), 1000 bytes Packets: 6212 · Di... Profile: Default

# UDP connection

Max total rate = 3 Mbps

Goodput:

$$3 * \frac{1000}{1042} = 2879 \text{ kbps}$$



Capturing from r1-eth0 [Wireshark 1.10.6 (v1.10.6 from master-1.10)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter:  Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
2	0.000025000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1489993 Ack=1 Win=58 Len=1448 T
3	0.000084000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=1449 Win=16320 Len=0 TSva
4	0.000098000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1491441 Ack=1 Win=58 Len=1448 T
5	0.000120000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=2897 Win=16318 Len=0 TSva
6	0.000133000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1492889 Ack=1 Win=58 Len=1448 T
7	0.001375000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=4345 Win=16322 Len=0 TSva
8	0.001398000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1494337 Ack=1 Win=58 Len=1448 T
9	0.002566000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=5793 Win=16322 Len=0 TSva
10	0.002584000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1495785 Ack=1 Win=58 Len=1448 T
11	0.002750000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=7241 Win=16322 Len=0 TSva

▶ Frame 2: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 bits) on interface 0

▶ Ethernet II, Src: 92:ce:13:1f:54:f1 (92:ce:13:1f:54:f1), Dst: c6:4e:62:e9:95:e1 (c6:4e:62:e9:95:e1)

▶ Internet Protocol Version 4, Src: 10.10.0.1 (10.10.0.1), Dst: 10.10.1.3 (10.10.1.3)

▶ Transmission Control Protocol, Src Port: 37126 (37126), Dst Port: scp-config (10001), Seq: 1489993, Ack: 1, Len: 1448

▶ Data (1448 bytes)

0000	c6 4e 62 e9 95 e1 92 ce 13 1f 54 f1 08 00 45 00	.Nb..... ..T...E.
0010	05 dc 16 b6 40 00 40 06 09 4f 0a 0a 00 01 0a 0a	....@.@. .0.....
0020	01 03 91 06 27 11 3e fc ab a3 5d 79 fa 70 80 10	....'.>. ..]y.p..
0030	00 3a 1a e6 00 00 01 01 08 0a 00 58 57 2d 00 58	.:..... ...XW-.X
0040	57 2d 00 00 00 00 00 00 00 00 00 00 00 00 00	W-.....
0050	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	.....

Frame (frame), 1514 bytes      Packets: 13250 · Displayed: 13250 (100....      Profile: Default



Capturing from r1-eth0 [Wireshark 1.10.6 (v1.10.6 from master-1.10)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
2	0.000025000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1489993 Ack=1 Win=58 Len=1448 T
3	0.000084000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=1449 Win=16320 Len=0 TSva
4	0.000098000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1491441 Ack=1 Win=58 Len=1448 T
5	0.000120000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=2897 Win=16318 Len=0 TSva
6	0.000133000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1492889 Ack=1 Win=58 Len=1448 T
7	0.001375000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=4345 Win=16322 Len=0 TSva
8	0.001398000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1494337 Ack=1 Win=58 Len=1448 T
9	0.002566000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=5793 Win=16322 Len=0 TSva
10	0.002584000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1495785 Ack=1 Win=58 Len=1448 T
11	0.002750000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=7241 Win=16322 Len=0 TSva

▶ Frame 2: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 bits) on interface 0

▶ Ethernet II, Src: 92:ce:13:1f:54:f1 (92:ce:13:1f:54:f1), Dst: c6:4e:62:e9:95:e1 (c6:4e:62:e9:95:e1)

▶ Internet Protocol Version 4, Src: 10.10.0.1 (10.10.0.1), Dst: 10.10.1.3 (10.10.1.3)

▶ Transmission Control Protocol, Src Port: 37126 (37126), Dst Port: scp-config (10001), Seq: 1489993, Ack: 1, Len: 1448

▶ Data (1448 bytes)

Offset	Hex	ASCII
0000	c6 4e 62 e9 95 e1 92 ce 13 1f 54 f1 08 00 45 00	.Nb..... ..T...E.
0010	05 dc 16 b6 40 00 40 06 09 4f 0a 0a 00 01 0a 0a	....@.@. .0.....
0020	01 03 91 06 27 11 3e fc ab a3 5d 79 fa 70 80 10	....'.>. ..]y.p..
0030	00 3a 1a e6 00 00 01 01 08 0a 00 58 57 2d 00 58	.:..... ...XW-.X
0040	57 2d 00 00 00 00 00 00 00 00 00 00 00 00 00 00	W-.....
0050	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	.....

Ethernet (eth), 14 bytes      Packets: 13250 · Displayed: 13250 (100....      Profile: Default

Capturing from r1-eth0 [Wireshark 1.10.6 (v1.10.6 from master-1.10)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter:  Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
2	0.000025000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1489993 Ack=1 Win=58 Len=1448 T
3	0.000084000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=1449 Win=16320 Len=0 TSva
4	0.000098000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1491441 Ack=1 Win=58 Len=1448 T
5	0.000120000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=2897 Win=16318 Len=0 TSva
6	0.000133000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1492889 Ack=1 Win=58 Len=1448 T
7	0.001375000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=4345 Win=16322 Len=0 TSva
8	0.001398000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1494337 Ack=1 Win=58 Len=1448 T
9	0.002566000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=5793 Win=16322 Len=0 TSva
10	0.002584000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1495785 Ack=1 Win=58 Len=1448 T
11	0.002750000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=7241 Win=16322 Len=0 TSva

▶ Frame 2: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 bits) on interface 0

▶ Ethernet II, Src: 92:ce:13:1f:54:f1 (92:ce:13:1f:54:f1), Dst: c6:4e:62:e9:95:e1 (c6:4e:62:e9:95:e1)

▶ Internet Protocol Version 4, Src: 10.10.0.1 (10.10.0.1), Dst: 10.10.1.3 (10.10.1.3)

▶ Transmission Control Protocol, Src Port: 37126 (37126), Dst Port: scp-config (10001), Seq: 1489993, Ack: 1, Len: 1448

▶ Data (1448 bytes)

Offset	Hex	ASCII
0000	c6 4e 62 e9 95 e1 92 ce 13 1f 54 f1 08 00 45 00	.Nb..... ..T...E.
0010	05 dc 16 b6 40 00 40 06 09 4f 0a 0a 00 01 0a 0a	....@.@. .0.....
0020	01 03 91 06 27 11 3e fc ab a3 5d 79 fa 70 80 10	...'>. ..]y.p..
0030	00 3a 1a e6 00 00 01 01 08 0a 00 58 57 2d 00 58	..... ..XW-.X
0040	57 2d 00 00 00 00 00 00 00 00 00 00 00 00 00 00	W-.....
0050	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	.....

Internet Protocol Version 4 (ip), 20 bytes      Packets: 13250 · Displayed: 13250 (100....      Profile: Default

Capturing from r1-eth0 [Wireshark 1.10.6 (v1.10.6 from master-1.10)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
2	0.000025000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1489993 Ack=1 Win=58 Len=1448 T
3	0.000084000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=1449 Win=16320 Len=0 TSva
4	0.000098000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1491441 Ack=1 Win=58 Len=1448 T
5	0.000120000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=2897 Win=16318 Len=0 TSva
6	0.000133000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1492889 Ack=1 Win=58 Len=1448 T
7	0.001375000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=4345 Win=16322 Len=0 TSva
8	0.001398000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1494337 Ack=1 Win=58 Len=1448 T
9	0.002566000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=5793 Win=16322 Len=0 TSva
10	0.002584000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1495785 Ack=1 Win=58 Len=1448 T
11	0.002750000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=7241 Win=16322 Len=0 TSva

▶ Frame 2: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 bits) on interface 0

▶ Ethernet II, Src: 92:ce:13:1f:54:f1 (92:ce:13:1f:54:f1), Dst: c6:4e:62:e9:95:e1 (c6:4e:62:e9:95:e1)

▶ Internet Protocol Version 4, Src: 10.10.0.1 (10.10.0.1), Dst: 10.10.1.3 (10.10.1.3)

▶ Transmission Control Protocol, Src Port: 37126 (37126), Dst Port: scp-config (10001), Seq: 1489993, Ack: 1, Len: 1448

▶ Data (1448 bytes)

0020	01 03 91 06 27 11 3e fc ab a3 5d 79 fa 70 80 10	...'.>. ..]y.p..
0030	00 3a 1a e6 00 00 01 01 08 0a 00 58 57 2d 00 58	.:..... ..XW-.X
0040	57 2d 00 00 00 00 00 00 00 00 00 00 00 00 00	W-.....
0050	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	.....
0060	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	.....
0070	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	.....

Transmission Control Protocol (tcp), 32 bytes Packets: 13250 · Displayed: 13250 (… Profile: Default

Capturing from r1-eth0 [Wireshark 1.10.6 (v1.10.6 from master-1.10)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
2	0.000025000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1489993 Ack=1 Win=58 Len=1448 T
3	0.000084000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=1449 Win=16320 Len=0 TSva
4	0.000098000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1491441 Ack=1 Win=58 Len=1448 T
5	0.000120000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=2897 Win=16318 Len=0 TSva
6	0.000133000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1492889 Ack=1 Win=58 Len=1448 T
7	0.001375000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=4345 Win=16322 Len=0 TSva
8	0.001398000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1494337 Ack=1 Win=58 Len=1448 T
9	0.002566000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=5793 Win=16322 Len=0 TSva
10	0.002584000	10.10.0.1	10.10.1.3	TCP	1514	37126 > scp-config [ACK] Seq=1495785 Ack=1 Win=58 Len=1448 T
11	0.002750000	10.10.1.3	10.10.0.1	TCP	78	scp-config > 37126 [ACK] Seq=1 Ack=7241 Win=16322 Len=0 TSva

▶ Frame 2: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 bits) on interface 0

▶ Ethernet II, Src: 92:ce:13:1f:54:f1 (92:ce:13:1f:54:f1), Dst: c6:4e:62:e9:95:e1 (c6:4e:62:e9:95:e1)

▶ Internet Protocol Version 4, Src: 10.10.0.1 (10.10.0.1), Dst: 10.10.1.3 (10.10.1.3)

▶ Transmission Control Protocol, Src Port: 37126 (37126), Dst Port: scp-config (10001), Seq: 1489993, Ack: 1, Len: 1448

▶ Data (1448 bytes)

Offset	Length	Time	Source	Destination	Protocol	Length	Info
0040	57 2d	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	W-	.....			
0050		00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00		.....			
0060		00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00		.....			
0070		00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00		.....			
0080		00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00		.....			
0090		00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00		.....			

Data (data), 1448 bytes

Packets: 13250 · Displayed: 13250 (... Profile: Default



# TCP connection

Max total rate = 3 Mbps

Goodput:

$$3 * \frac{1448}{1514} = 2869 \text{ kbps}$$

