

Komunikacijske mreže

2. domaća zadaća

2009./2010.

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Sadržaj

Zadatak 1.	2
Zadatak 2.	3
Zadatak 3.	4
Zadatak 4.	5
Zadatak 5.	6
Zadatak 6.	6
Zadatak 7. – nije za DZ!!!	7

Zadatak 1.

```
IMUNES: pc1 (console)
[root@pc1 ~]# ping 10.0.8.10
PING 10.0.8.10 (10.0.8.10): 56 data bytes
64 bytes from 10.0.8.10: icmp_seq=0 ttl=59 time=33.874 ms
64 bytes from 10.0.8.10: icmp_seq=1 ttl=59 time=15.798 ms
64 bytes from 10.0.8.10: icmp_seq=2 ttl=59 time=15.895 ms
64 bytes from 10.0.8.10: icmp_seq=3 ttl=59 time=15.650 ms
64 bytes from 10.0.8.10: icmp_seq=4 ttl=59 time=16.820 ms
^C
--- 10.0.8.10 ping statistics ---
5 packets transmitted, 5 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 15.650/19.607/33.874/7.145 ms
[root@pc1 ~]#
```

No. ↓	Time	Source	Destination	Protocol	Info
1	0.000000	40:00:aa:aa:00:16	Broadcast	ARP	Who has 10.0.0.1? Tell 10.0.0.21
2	0.004632	40:00:aa:aa:00:00	40:00:aa:aa:00:16	ARP	10.0.0.1 is at 40:00:aa:aa:00:00
3	0.004741	10.0.0.21	10.0.8.10	ICMP	Echo (ping) request
4	0.033718	10.0.8.10	10.0.0.21	ICMP	Echo (ping) reply
5	1.001438	10.0.0.21	10.0.8.10	ICMP	Echo (ping) request
6	1.017156	10.0.8.10	10.0.0.21	ICMP	Echo (ping) reply
7	2.002985	10.0.0.21	10.0.8.10	ICMP	Echo (ping) request
8	2.018827	10.0.8.10	10.0.0.21	ICMP	Echo (ping) reply
9	3.005579	10.0.0.21	10.0.8.10	ICMP	Echo (ping) request
10	3.021176	10.0.8.10	10.0.0.21	ICMP	Echo (ping) reply
11	4.006494	10.0.0.21	10.0.8.10	ICMP	Echo (ping) request
12	4.023105	10.0.8.10	10.0.0.21	ICMP	Echo (ping) reply

Poslali smo 5 *ping* zahtjeva. Uхваćeno je 12 mrežnih paketa.

Prva dva paketa (ARP) pojavljuju se zato jer računalo prema cijeloj svojoj podmreži šalje upit kako bi se pronašla MAC adresa koja ima IP adresu željenog odredišta, te potom to odredište vraća pošiljaocu svoju MAC adresu.

Echo Request: računalo *pc1* šalje ICMP paket te očekuje od odredišta da ga vrati istog takvog.

Echo Reply: server vraća pošiljaocu (*pc1*) odaslani paket kako ga je primio.

Zadatak 2.

```
IMUNES: pc1 (console)
[root@pc1 ~]# ping -c 5 -m 3 10.0.8.10
PING 10.0.8.10 (10.0.8.10): 56 data bytes
36 bytes from 10.0.2.2: Time to live exceeded
Vr HL TOS Len ID Flg off TTL Pro cks Src Dst
4 5 00 5400 5924 0 0000 01 01 4467 10.0.0.21 10.0.8.10

36 bytes from 10.0.2.2: Time to live exceeded
Vr HL TOS Len ID Flg off TTL Pro cks Src Dst
4 5 00 5400 5e24 0 0000 01 01 3f67 10.0.0.21 10.0.8.10

36 bytes from 10.0.2.2: Time to live exceeded
Vr HL TOS Len ID Flg off TTL Pro cks Src Dst
4 5 00 5400 6324 0 0000 01 01 3a67 10.0.0.21 10.0.8.10

36 bytes from 10.0.2.2: Time to live exceeded
Vr HL TOS Len ID Flg off TTL Pro cks Src Dst
4 5 00 5400 6824 0 0000 01 01 3567 10.0.0.21 10.0.8.10

36 bytes from 10.0.2.2: Time to live exceeded
Vr HL TOS Len ID Flg off TTL Pro cks Src Dst
4 5 00 5400 6d24 0 0000 01 01 3067 10.0.0.21 10.0.8.10

--- 10.0.8.10 ping statistics ---
5 packets transmitted, 0 packets received, 100.0% packet loss
[root@pc1 ~]#
```

No. .	Time	Source	Destination	Protocol	Info
1	0.000000	40:00:aa:aa:00:16	Broadcast	ARP	Who has 10.0.0.1? Tell 10.0.0.21
2	0.006045	40:00:aa:aa:00:00	40:00:aa:aa:00:16	ARP	10.0.0.1 is at 40:00:aa:aa:00:00
3	0.006272	10.0.0.21	10.0.8.10	ICMP	Echo (ping) request
4	0.019171	10.0.2.2	10.0.0.21	ICMP	Time-to-live exceeded (Time to live exceeded in transit)
5	1.001238	10.0.0.21	10.0.8.10	ICMP	Echo (ping) request
6	1.009798	10.0.2.2	10.0.0.21	ICMP	Time-to-live exceeded (Time to live exceeded in transit)
7	2.002895	10.0.0.21	10.0.8.10	ICMP	Echo (ping) request
8	2.010434	10.0.2.2	10.0.0.21	ICMP	Time-to-live exceeded (Time to live exceeded in transit)
9	3.005521	10.0.0.21	10.0.8.10	ICMP	Echo (ping) request
10	3.013301	10.0.2.2	10.0.0.21	ICMP	Time-to-live exceeded (Time to live exceeded in transit)
11	4.007319	10.0.0.21	10.0.8.10	ICMP	Echo (ping) request
12	4.015939	10.0.2.2	10.0.0.21	ICMP	Time-to-live exceeded (Time to live exceeded in transit)

Odaslani paketi ne stižu na odredište budući da „umiru“ nakon trećeg skoka.

Zadatak 3.

```
IMUNES: pc1 (console)
[root@pc1 ~]# ping -c 1 -s 10000 10.0.8.10
PING 10.0.8.10 (10.0.8.10): 10000 data bytes
10008 bytes from 10.0.8.10: icmp_seq=0 ttl=59 time=15.946 ms

--- 10.0.8.10 ping statistics ---
1 packets transmitted, 1 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 15.946/15.946/15.946/0.000 ms
[root@pc1 ~]#
```

No. -	Time	Source	Destination	Protocol	Info
1	0.000000	10.0.0.21	10.0.8.10	IP	Fragmented IP protocol (proto=ICMP 0x01, off=0)
2	0.000004	10.0.0.21	10.0.8.10	IP	Fragmented IP protocol (proto=ICMP 0x01, off=1480)
3	0.000008	10.0.0.21	10.0.8.10	IP	Fragmented IP protocol (proto=ICMP 0x01, off=2960)
4	0.000012	10.0.0.21	10.0.8.10	IP	Fragmented IP protocol (proto=ICMP 0x01, off=4440)
5	0.000016	10.0.0.21	10.0.8.10	IP	Fragmented IP protocol (proto=ICMP 0x01, off=5920)
6	0.000020	10.0.0.21	10.0.8.10	IP	Fragmented IP protocol (proto=ICMP 0x01, off=7400)
7	0.000024	10.0.0.21	10.0.8.10	ICMP	Echo (ping) request
8	0.014722	10.0.8.10	10.0.0.21	IP	Fragmented IP protocol (proto=ICMP 0x01, off=0)
9	0.015679	10.0.8.10	10.0.0.21	IP	Fragmented IP protocol (proto=ICMP 0x01, off=1480)
10	0.015732	10.0.8.10	10.0.0.21	IP	Fragmented IP protocol (proto=ICMP 0x01, off=2960)
11	0.015734	10.0.8.10	10.0.0.21	IP	Fragmented IP protocol (proto=ICMP 0x01, off=4440)
12	0.015736	10.0.8.10	10.0.0.21	IP	Fragmented IP protocol (proto=ICMP 0x01, off=5920)
13	0.015738	10.0.8.10	10.0.0.21	IP	Fragmented IP protocol (proto=ICMP 0x01, off=7400)
14	0.015740	10.0.8.10	10.0.0.21	ICMP	Echo (ping) reply

Poslali smo *ping* paket veličine 10000 okteta. Paket je poslan fragmentiran (rastavljen) na šest dijelova. Svaki fragment, u sebi nosi dio cjelokupne poslane informacije.

Maksimalna veličina informacije u paketu iznosi 1500 okteta, a ovisi o tehnologiji izvedene mreže (za Ethernet/IEEE 802.3, MTU iznosi 1500 okteta).

Maksimalna veličina samog IP paketa iznosi 65,535 ($2^{16} - 1$) okteta.

Zadatak 4.

Čim je informacija veća, više se fragmenata šalje prema odredištu te se sukladno tome očekuje i više povratnih paketa. Budući da svakom fragmentu treba određeno vrijeme do pošiljatelja i natrag, za veću poslanu informaciju, tj. za više fragmenata iste, biti će potrebno dulje vrijeme slanja.

```
IMUNES: pc1 (console)
[root@pc1 ~]# ping -c 1 -s 256 10.0.8.10
PING 10.0.8.10 (10.0.8.10): 256 data bytes
264 bytes from 10.0.8.10: icmp_seq=0 ttl=59 time=15.660 ms

--- 10.0.8.10 ping statistics ---
1 packets transmitted, 1 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 15.660/15.660/15.660/0.000 ms
[root@pc1 ~]# ping -c 1 -s 4098 10.0.8.10
PING 10.0.8.10 (10.0.8.10): 4098 data bytes
4106 bytes from 10.0.8.10: icmp_seq=0 ttl=59 time=17.091 ms

--- 10.0.8.10 ping statistics ---
1 packets transmitted, 1 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 17.091/17.091/17.091/0.000 ms
[root@pc1 ~]# ping -c 1 -s 16000 10.0.8.10
PING 10.0.8.10 (10.0.8.10): 16000 data bytes
16008 bytes from 10.0.8.10: icmp_seq=0 ttl=59 time=21.496 ms

--- 10.0.8.10 ping statistics ---
1 packets transmitted, 1 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 21.496/21.496/21.496/0.000 ms
[root@pc1 ~]# ping -c 1 -s 25152 10.0.8.10
PING 10.0.8.10 (10.0.8.10): 25152 data bytes
25160 bytes from 10.0.8.10: icmp_seq=0 ttl=59 time=24.692 ms

--- 10.0.8.10 ping statistics ---
1 packets transmitted, 1 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 24.692/24.692/24.692/0.000 ms
[root@pc1 ~]#
```

```
IMUNES: pc1 (console)
[root@pc1 ~]# ping -c 1 -s 256 10.0.8.10
PING 10.0.8.10 (10.0.8.10): 256 data bytes
264 bytes from 10.0.8.10: icmp_seq=0 ttl=62 time=8.092 ms

--- 10.0.8.10 ping statistics ---
1 packets transmitted, 1 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 8.092/8.092/8.092/0.000 ms
[root@pc1 ~]# ping -c 1 -s 4098 10.0.8.10
PING 10.0.8.10 (10.0.8.10): 4098 data bytes
4106 bytes from 10.0.8.10: icmp_seq=0 ttl=62 time=9.171 ms

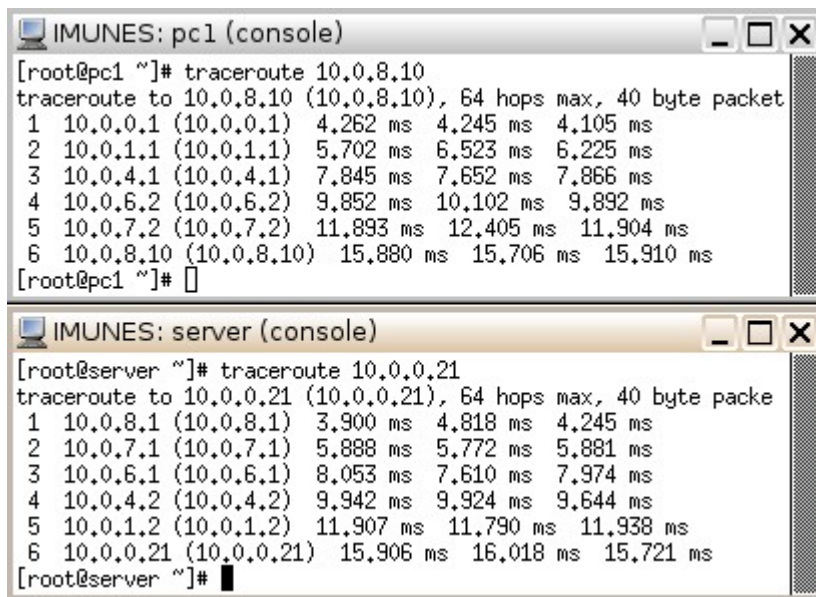
--- 10.0.8.10 ping statistics ---
1 packets transmitted, 1 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 9.171/9.171/9.171/0.000 ms
[root@pc1 ~]# ping -c 1 -s 16000 10.0.8.10
PING 10.0.8.10 (10.0.8.10): 16000 data bytes
16008 bytes from 10.0.8.10: icmp_seq=0 ttl=62 time=11.139 ms

--- 10.0.8.10 ping statistics ---
1 packets transmitted, 1 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 11.139/11.139/11.139/0.000 ms
[root@pc1 ~]# ping -c 1 -s 25152 10.0.8.10
PING 10.0.8.10 (10.0.8.10): 25152 data bytes
25160 bytes from 10.0.8.10: icmp_seq=0 ttl=62 time=15.019 ms

--- 10.0.8.10 ping statistics ---
1 packets transmitted, 1 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 15.019/15.019/15.019/0.000 ms
[root@pc1 ~]#
```

Možemo vidjeti da ukoliko direktno spojimo *router0* i *router7*, vrijeme za slanje jednako velikih paketa se smanji.

Zadatak 5.



```
IMUNES: pc1 (console)
[root@pc1 ~]# traceroute 10.0.8.10
traceroute to 10.0.8.10 (10.0.8.10), 64 hops max, 40 byte packet
 1  10.0.0.1 (10.0.0.1)  4.262 ms  4.245 ms  4.105 ms
 2  10.0.1.1 (10.0.1.1)  5.702 ms  6.523 ms  6.225 ms
 3  10.0.4.1 (10.0.4.1)  7.845 ms  7.652 ms  7.866 ms
 4  10.0.6.2 (10.0.6.2)  9.852 ms  10.102 ms  9.892 ms
 5  10.0.7.2 (10.0.7.2)  11.893 ms  12.405 ms  11.904 ms
 6  10.0.8.10 (10.0.8.10)  15.880 ms  15.706 ms  15.910 ms
[root@pc1 ~]#

IMUNES: server (console)
[root@server ~]# traceroute 10.0.0.21
traceroute to 10.0.0.21 (10.0.0.21), 64 hops max, 40 byte packe
 1  10.0.8.1 (10.0.8.1)  3.900 ms  4.818 ms  4.245 ms
 2  10.0.7.1 (10.0.7.1)  5.888 ms  5.772 ms  5.881 ms
 3  10.0.6.1 (10.0.6.1)  8.053 ms  7.610 ms  7.974 ms
 4  10.0.4.2 (10.0.4.2)  9.942 ms  9.924 ms  9.644 ms
 5  10.0.1.2 (10.0.1.2)  11.907 ms  11.790 ms  11.938 ms
 6  10.0.0.21 (10.0.0.21)  15.906 ms  16.018 ms  15.721 ms
[root@server ~]#
```

Vidimo da je paket od računala *pc1* do poslužitelja *server* prošao ukupno 5 čvorova (*router0*, *router1*, *router5*, *router6*, *router7*).

Vidimo da je paket od poslužitelja *server* do računala *pc1* prošao ukupno 5 čvorova (*router7*, *router6*, *router5*, *router1*, *router0*).

Primjećujemo da je paket proputovao jednaku stazu u oba smjera, te da mu je trebalo otprilike jednako vrijeme od početne do odredišne točke u oba smjera.

Zadatak 6.

Do greške može doći ako je primjerice TTL manji od potrebnih skokova kako bi se došlo do odredišta, ili ako koristimo sufiks *-r* (traženje u istoj podmreži), a odredište se nalazi u nekoj drugoj podmreži odnosno izvor i odredište nisu direktno spojeni...

Zadatak 7. – nije za DZ!!!

```
IMUNES: pc2 (console)
[root@pc2 ~]# ping -c 1 -s 1600 10.0.0.21
PING 10.0.0.21 (10.0.0.21): 1600 data bytes
1608 bytes from 10.0.0.21: icmp_seq=0 ttl=64 time=3.806 ms

--- 10.0.0.21 ping statistics ---
1 packets transmitted, 1 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 3.806/3.806/3.806/0.000 ms
[root@pc2 ~]# ping -c 1 10.0.8.10
PING 10.0.8.10 (10.0.8.10): 56 data bytes
64 bytes from 10.0.8.10: icmp_seq=0 ttl=59 time=26.401 ms

--- 10.0.8.10 ping statistics ---
1 packets transmitted, 1 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 26.401/26.401/26.401/0.000 ms
[root@pc2 ~]# ping -c 1 -s 1600 10.0.8.10
PING 10.0.8.10 (10.0.8.10): 1600 data bytes
1608 bytes from 10.0.8.10: icmp_seq=0 ttl=59 time=16.757 ms

--- 10.0.8.10 ping statistics ---
1 packets transmitted, 1 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 16.757/16.757/16.757/0.000 ms
[root@pc2 ~]#
```

No. .	Time	Source	Destination	Protocol	Info
1	0.000000	40:00:aa:aa:00:15	Broadcast	ARP	Who has 10.0.0.21? Tell 10.0.0.20
2	0.003288	40:00:aa:aa:00:16	40:00:aa:aa:00:15	ARP	10.0.0.21 is at 40:00:aa:aa:00:16
3	0.003381	10.0.0.20	10.0.0.21	IP	Fragmented IP protocol (proto=ICMP 0x01, off=1480)
4	4.723725	fe80::4200:aaff:feaa:ff02::9		RIPng ve	Response
5	13.904048	10.0.0.20	10.0.0.21	IP	Fragmented IP protocol (proto=ICMP 0x01, off=0)
6	13.904052	10.0.0.20	10.0.0.21	ICMP	Echo (ping) request
7	13.907642	10.0.0.21	10.0.0.20	IP	Fragmented IP protocol (proto=ICMP 0x01, off=0)
8	13.907775	10.0.0.21	10.0.0.20	ICMP	Echo (ping) reply
9	22.723254	10.0.0.1	224.0.0.9	RIPv2	Response
10	32.529404	40:00:aa:aa:00:15	Broadcast	ARP	Who has 10.0.0.1? Tell 10.0.0.20
11	32.533535	40:00:aa:aa:00:00	40:00:aa:aa:00:15	ARP	10.0.0.1 is at 40:00:aa:aa:00:00
12	32.533635	10.0.0.20	10.0.8.10	ICMP	Echo (ping) request
13	32.555669	10.0.8.10	10.0.0.20	ICMP	Echo (ping) reply
14	39.725197	fe80::4200:aaff:feaa:ff02::9		RIPng ve	Response
15	40.891155	10.0.0.20	10.0.8.10	IP	Fragmented IP protocol (proto=ICMP 0x01, off=0)
16	40.891159	10.0.0.20	10.0.8.10	ICMP	Echo (ping) request
17	40.906826	10.0.8.10	10.0.0.20	IP	Fragmented IP protocol (proto=ICMP 0x01, off=0)
18	40.907829	10.0.8.10	10.0.0.20	ICMP	Echo (ping) reply

Ako bi s računala *pc2* poslali naredbu *ping pc1*, došlo bi do greške, no ako pošaljemo naredbu „*ping 10.0.0.21*“ (IP adresa računala *pc1*), odaslat će se ARP paket kako bi se utvrdilo kome pripada ta IP adresa. ARP se odašilje prema svim MAC adresama te se javlja računalo koje ga ima ili usmjeritelj (prvi čvor) preko kojeg se ide do konačnog odredišta.

Nakon što se računalo *pc1* odazvalo sa svojom MAC adresom, poslat će se ICMP paket do računala *pc1* te će ono odgovoriti povratnom porukom (povratnim ICMP paketom). Računala *pc1* i *pc2* nalaze se u istoj podmreži te su spojene preko komutatora stoga nije bilo potrebno pronalaženje puta preko usmjeritelja.

Ako pak s računala *pc2* pošaljemo naredbu „*ping 10.0.8.10*“ (što je IP adresa *servera*), prvo se šalje ARP paket kako bi se utvrdilo kome pripada ta IP adresa. Nakon što se utvrdio put slanja, šalje se ICMP paket prema odredištu te odredište šalje povratni ICMP paket. Ukoliko su za *ping* zadani paketi veći od 1500 okteta, oni se fragmentiraju.