6.4 Networks overview: Homework

Requirements for **students of courses**:

- The tasks below are considered to be done on your own computer. If you wish, it's also possible to do almost anything except tasks 7 and 8 on the Sandbox servers. So tasks 1-6 are accepted regardless where they are performed, either on your own machine or an educational server.
- Wherever appropriate, please provide the exact commands and their output. Better to do this as text, not as screenshots.
- If you prefer screenshots, don't use external links to image sharing services, just put all pictures to the homework results, and ensure they are readable (e.g. not too small).

Tasks:

1. (1 point for every completed subtask) Using command-line tools, get the following information regarding network settings of your computer:
    1. IP address(es) and network interfaces.
    2. Netmask for every network interface. Also calculate the maximum number of hosts within this network.
    3. IP address of your default gateway.
    4. IP addresses of DNS servers.
2. Make a network trace between your computer and yandex.ru, using tracert (on Windows) or traceroute -nI (on macOS and Linux). Highlight or explicitly specify your default gateway in this trace. Remember this IP address of yandex.ru.
3. Repeat the task above for google.com. Find out and highlight the same hops seen in p.2 above.
4. Determine all IP addresses of yahoo.com.
5. Take any 3 of them and make a trace to each IP address. Which hops are the same for all chosen remote IP addresses?
6. Find all your network "neighbors" by using the "arp" tool.
7. (counted as 4 points is done correctly). Connect to Internet in a different way compared to p.1, e.g.: another WiFi access point, via smartphone acting like a router, etc. Repeat p.1 above. Highlight or explicitly specify all changes compared to p.1 above.
8. Having the same internet connection as in p.7, repeat p.2 above with the same IP address of yandex.ru. Highlight or explicitly specify common hops in these two traces.

1. Using command-line tools, get the following information regarding network settings of your computer:

1.1. IP address(es) and network interfaces.

ifconfig

IP address: 192.168.0.20

IP address: 127.0.0.1

Private IP addresses from OpenVPN Connect: inet 10.9.0.162 --> 10.9.0.161

```
lo0: flags=8049<UP,LOOPBACK,RUNNING,MULTICAST> mtu 16384
        options=1203<RXCSUM,TXCSUM,TXSTATUS,SW_TIMESTAMP>
        inet 127.0.0.1 netmask 0xff000000
        inet6 ::1 prefixlen 128
        inet6 fe80::1%lo0 prefixlen 64 scopeid 0x1
        nd6 options=201<PERFORMNUD,DAD>
gif0: flags=8010<POINTOPOINT,MULTICAST> mtu 1280
stf0: flags=0<> mtu 1280
anpi1: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
        options=400<CHANNEL_IO>
        ether 4e:08:a5:37:62:20
        inet6 fe80::4c08:a5ff:fe37:6220%anpi1 prefixlen 64 scopeid 0x4
        nd6 options=201<PERFORMNUD,DAD>
        media: none
        status: inactive
anpi0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
        options=400<CHANNEL_IO>
        ether 4e:08:a5:37:62:1f
        inet6 fe80::4c08:a5ff:fe37:621f%anpi0 prefixlen 64 scopeid 0x5
        nd6 options=201<PERFORMNUD,DAD>
        media: none
        status: inactive
en3: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
        options=400<CHANNEL_IO>
        ether 4e:08:a5:37:62:ff
        nd6 options=201<PERFORMNUD,DAD>
```

```
        media: none
        status: inactive
en4: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
        options=400<CHANNEL_IO>
        ether 4e:08:a5:37:62:00
        nd6 options=201<PERFORMNUD,DAD>
        media: none
        status: inactive
en1: flags=8963<UP,BROADCAST,SMART,RUNNING,PROMISC,SIMPLEX,MULTICAST> mtu
1500
        options=460<TSO4,TSO6,CHANNEL_IO>
        ether 36:5e:1c:8a:8b:00
        media: autoselect <full-duplex>
        status: inactive
en2: flags=8963<UP,BROADCAST,SMART,RUNNING,PROMISC,SIMPLEX,MULTICAST> mtu
1500
        options=460<TSO4,TSO6,CHANNEL_IO>
        ether 36:5e:1c:8a:8b:04
        media: autoselect <full-duplex>
        status: inactive
bridge0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
        options=63<RXCSUM,TXCSUM,TSO4,TSO6>
        ether 36:5e:1c:8a:8b:00
        Configuration:
                id 0:0:0:0:0:0 priority 0 hellotime 0 fwddelay 0
                maxage 0 holdcnt 0 proto stp maxaddr 100 timeout 1200
                root id 0:0:0:0:0:0 priority 0 ifcost 0 port 0
                ipfilter disabled flags 0x0
        member: en1 flags=3<LEARNING,DISCOVER>
                ifmaxaddr 0 port 8 priority 0 path cost 0
        member: en2 flags=3<LEARNING,DISCOVER>
                ifmaxaddr 0 port 9 priority 0 path cost 0
```

```
	nd6 options=201<PERFORMNUD,DAD>
	media: <unknown type>
	status: inactive
ap1: flags=8843<UP,BROADCAST,RUNNING,SIMPLEX,MULTICAST> mtu 1500
	options=6463<RXCSUM,TXCSUM,TSO4,TSO6,CHANNEL_IO,PARTIAL_CSUM,ZEROINV
ERT_CSUM>
	ether a6:cf:99:6b:c4:7c
	inet6 fe80::a4cf:99ff:fe6b:c47c%ap1 prefixlen 64 scopeid 0xb
	nd6 options=201<PERFORMNUD,DAD>
	media: autoselect (<unknown type>)
	status: inactive
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
	options=400<CHANNEL_IO>
	ether a4:cf:99:6b:c4:7c
	inet6 fe80::10d9:bacc:2144:a191%en0 prefixlen 64 secured scopeid 0xc
	inet 192.168.0.20 netmask 0xffffff00 broadcast 192.168.0.255
	nd6 options=201<PERFORMNUD,DAD>
	media: autoselect
	status: active
awdl0: flags=8843<UP,BROADCAST,RUNNING,SIMPLEX,MULTICAST> mtu 1500
	options=6463<RXCSUM,TXCSUM,TSO4,TSO6,CHANNEL_IO,PARTIAL_CSUM,ZEROINV
ERT_CSUM>
	ether 62:a3:98:cd:09:a6
	inet6 fe80::60a3:98ff:fecd:9a6%awdl0 prefixlen 64 scopeid 0xd
	nd6 options=201<PERFORMNUD,DAD>
	media: autoselect
	status: active
llw0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
	options=400<CHANNEL_IO>
	ether 62:a3:98:cd:09:a6
	inet6 fe80::60a3:98ff:fecd:9a6%llw0 prefixlen 64 scopeid 0xe
	nd6 options=201<PERFORMNUD,DAD>
```

```
	media: autoselect
	status: active
utun0: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1380
	inet6 fe80::8737:69d5:fbf:f738%utun0 prefixlen 64 scopeid 0xf
	nd6 options=201<PERFORMNUD,DAD>
utun1: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 2000
	inet6 fe80::82e5:d17c:31ac:2c5d%utun1 prefixlen 64 scopeid 0x10
	nd6 options=201<PERFORMNUD,DAD>
utun2: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1000
	inet6 fe80::ce81:b1c:bd2c:69e%utun2 prefixlen 64 scopeid 0x11
	nd6 options=201<PERFORMNUD,DAD>
utun3: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1380
	inet6 fe80::bba:b559:e01:8eaa%utun3 prefixlen 64 scopeid 0x12
	nd6 options=201<PERFORMNUD,DAD>
utun4: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1380
	inet6 fe80::60b5:16ea:ed45:9c5%utun4 prefixlen 64 scopeid 0x13
	nd6 options=201<PERFORMNUD,DAD>
utun5: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1380
	inet6 fe80::9e4a:7290:5142:e284%utun5 prefixlen 64 scopeid 0x14
	nd6 options=201<PERFORMNUD,DAD>
utun6: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1380
	inet6 fe80::3edd:64dc:bc75:c2bb%utun6 prefixlen 64 scopeid 0x15
	nd6 options=201<PERFORMNUD,DAD>
utun7: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1380
	inet6 fe80::930e:8461:e7a7:d330%utun7 prefixlen 64 scopeid 0x16
	nd6 options=201<PERFORMNUD,DAD>
utun8: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1380
	inet6 fe80::345d:a110:4c17:2021%utun8 prefixlen 64 scopeid 0x17
	nd6 options=201<PERFORMNUD,DAD>
utun9: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1500
	inet 10.9.0.162 --> 10.9.0.161 netmask 0xfffffffc
```

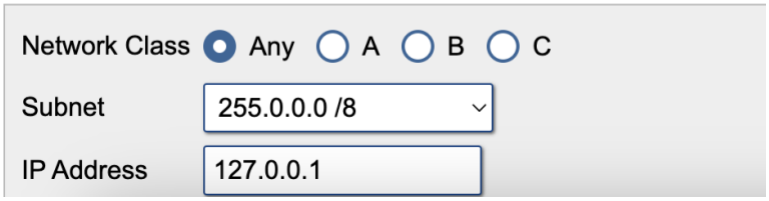
1.2. Netmask for every network interface. Also calculate the maximum number of hosts within this network.

127.0.0.1 netmask 0xff000000

Netmask: 255.0.0.0,
bitmask /8,
maximum number of usable hosts - 16,777,214:

Result

IP Address:	127.0.0.1
Network Address:	127.0.0.0
Usable Host IP Range:	127.0.0.1 - 127.255.255.254
Broadcast Address:	127.255.255.255
Total Number of Hosts:	16,777,216
Number of Usable Hosts:	16,777,214
Subnet Mask:	255.0.0.0
Wildcard Mask:	0.255.255.255
Binary Subnet Mask:	11111111.00000000.00000000.000000(
IP Class:	A
CIDR Notation:	/8
IP Type:	Public
Short:	127.0.0.1 /8
Binary ID:	01111111000000000000000000000001
Integer ID:	2130706433
Hex ID:	0x7f000001
in-addr.arpa:	1.0.0.127.in-addr.arpa
IPv4 Mapped Address:	::ffff:7f00.01
6to4 Prefix:	2002:7f00.01::/48

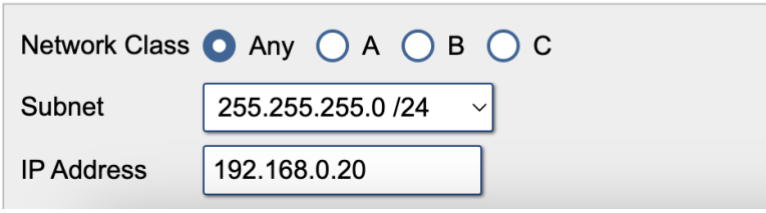


192.168.0.20 netmask 0xffffff00

Netmask: 255.255.255.0,
bitmask /24,
maximum number of usable hosts – 254:

Result

IP Address:	192.168.0.20
Network Address:	192.168.0.0
Usable Host IP Range:	192.168.0.1 - 192.168.0.254
Broadcast Address:	192.168.0.255
Total Number of Hosts:	256
Number of Usable Hosts:	254
Subnet Mask:	255.255.255.0
Wildcard Mask:	0.0.0.255
Binary Subnet Mask:	11111111.11111111.11111111.00000000
IP Class:	C
CIDR Notation:	/24
IP Type:	Private
Short:	192.168.0.20 /24
Binary ID:	11000000101010000000000000001010
Integer ID:	3232235540
Hex ID:	0xc0a80014
in-addr.arpa:	20.0.168.192.in-addr.arpa
IPv4 Mapped Address:	::ffff:c0a8.014
6to4 Prefix:	2002:c0a8.014::/48



10.9.0.162 --> 10.9.0.161 netmask 0xfffffffc

Netmask: 255.255.255.252,
bitmask /30,
maximum number of usable hosts – 2:

Result	
IP Address:	10.9.0.162
Network Address:	10.9.0.160
Usable Host IP Range:	10.9.0.161 - 10.9.0.162
Broadcast Address:	10.9.0.163
Total Number of Hosts:	4
Number of Usable Hosts:	2
Subnet Mask:	255.255.255.252
Wildcard Mask:	0.0.0.3
Binary Subnet Mask:	11111111.11111111.11111111.11111100
IP Class:	C
CIDR Notation:	/30
IP Type:	Private
Short:	10.9.0.162 /30
Binary ID:	00001010000010010000000010100010
Integer ID:	168362146
Hex ID:	0xa0900a2
in-addr.arpa:	162.0.9.10.in-addr.arpa
IPv4 Mapped Address:	::ffff:0a09.0a2
6to4 Prefix:	2002:0a09.0a2::/48

Result	
IP Address:	10.9.0.161
Network Address:	10.9.0.160
Usable Host IP Range:	10.9.0.161 - 10.9.0.162
Broadcast Address:	10.9.0.163
Total Number of Hosts:	4
Number of Usable Hosts:	2
Subnet Mask:	255.255.255.252
Wildcard Mask:	0.0.0.3
Binary Subnet Mask:	11111111.11111111.11111111.11111100
IP Class:	C
CIDR Notation:	/30
IP Type:	Private
Short:	10.9.0.161 /30
Binary ID:	00001010000010010000000010100001
Integer ID:	168362145
Hex ID:	0xa0900a1
in-addr.arpa:	161.0.9.10.in-addr.arpa
IPv4 Mapped Address:	::ffff:0a09.0a1
6to4 Prefix:	2002:0a09.0a1::/48

1.3. IP address of your default gateway.

```
netstat -rnf inet
default          192.168.0.1
```

1.4. IP addresses of DNS servers.

```
cat /etc/resolv.conf
8.8.8.8
```

2. Make a network trace between your computer and yandex.ru, using tracert (on Windows) or traceroute -nI (on macOS and Linux). Highlight or explicitly specify your default gateway in this trace. Remember this IP address of yandex.ru.

```
traceroute -nI yandex.ru
traceroute: Warning: yandex.ru has multiple addresses; using 5.255.255.77
traceroute to yandex.ru (5.255.255.77), 64 hops max, 72 byte packets
 1  192.168.0.1  4.366 ms  3.454 ms  3.429 ms
 2  100.104.128.1  53.630 ms  6.397 ms  6.542 ms
 3  217.107.123.78  6.616 ms  6.288 ms  6.527 ms
 4  87.226.139.20  6.717 ms  6.571 ms  6.823 ms
 5  185.140.148.157  25.621 ms  25.572 ms  25.840 ms
 6  188.254.94.106  41.223 ms  35.568 ms  36.059 ms
 7  93.158.172.23  29.514 ms  31.296 ms  28.552 ms
```

8 * * *

9 **5.255.255.77** 40.842 ms 32.529 ms 32.981 ms

My default gateway is 192.168.0.1 (first hop)
One of IP address of yandex.ru 5.255.255.77 (the last hop and comment in the first line)

(Following attempt were described in Submission comments from Wed, 6 Dec 2023, 9:34):

traceroute -I yandex.ru

traceroute: Warning: yandex.ru has multiple addresses; using **77.88.55.60**
traceroute to yandex.ru (77.88.55.60), 64 hops max, 72 byte packets
1 **192.168.0.1** (192.168.0.1) 3.967 ms 3.808 ms 3.032 ms
2 100.104.128.1 (100.104.128.1) 6.717 ms 21.048 ms 6.657 ms
3 217.107.123.78 (217.107.123.78) 6.605 ms 6.234 ms 16.624 ms
4 87.226.139.20 (87.226.139.20) 6.714 ms 7.489 ms 6.847 ms
5 185.140.151.249 (185.140.151.249) 25.825 ms 26.127 ms 25.668 ms
6 * * *
7 188.254.94.106 (188.254.94.106) 40.901 ms 34.393 ms 34.692 ms
8 * sas-32z2-lag-1.yndx.net (87.250.239.163) 41.424 ms 42.720 ms
9 * * *
10 yandex.ru (**77.88.55.60**) 32.856 ms 32.227 ms 32.668 ms

This time I get another IP address of yandex.ru 77.88.55.60 (the last hop).

Thus,
My default gateway is 192.168.0.1 (first hop)
One of IP address of yandex.ru **77.88.55.60** (the last hop)

3. **Repeat the task above for google.com. Find out and highlight the same hops seen in p.2 above.**

Highlighted the same hops seen in p.2 (green):

traceroute google.com

traceroute to google.com (142.250.74.174), 64 hops max, 52 byte packets
1 192.168.0.1 (192.168.0.1) 5.169 ms 3.739 ms 3.648 ms

2 100.104.16.1 (100.104.16.1) 6.794 ms 7.539 ms 6.800 ms

3 217.107.123.80 (217.107.123.80) 6.789 ms

217.107.123.78 (217.107.123.78) 6.138 ms

217.107.123.80 (217.107.123.80) 7.816 ms

4 87.226.139.20 (87.226.139.20) 6.306 ms

87.226.139.22 (87.226.139.22) 6.944 ms

87.226.139.20 (87.226.139.20) 7.475 ms

5 185.140.151.249 (185.140.151.249) 26.050 ms

188.254.25.77 (188.254.25.77) 33.741 ms

185.140.151.249 (185.140.151.249) 25.619 ms

6 * * *

7 72.14.209.89 (72.14.209.89) 34.775 ms 30.632 ms 31.316 ms

8 * * *

9 209.85.245.2 (209.85.245.2) 30.978 ms

108.170.250.129 (108.170.250.129) 35.898 ms

108.170.226.172 (108.170.226.172) 31.026 ms

10 108.170.250.113 (108.170.250.113) 32.189 ms

108.170.250.146 (108.170.250.146) 33.811 ms 43.415 ms

11 142.250.238.14 (142.250.238.14) 53.643 ms 57.483 ms

142.251.79.148 (142.251.79.148) 49.149 ms

12 209.85.241.33 (209.85.241.33) 52.341 ms

72.14.234.106 (72.14.234.106) 44.206 ms

108.170.227.248 (108.170.227.248) 57.307 ms

13 108.170.254.49 (108.170.254.49) 48.680 ms 44.326 ms 47.537 ms

14 142.251.236.71 (142.251.236.71) 52.998 ms 56.313 ms 52.408 ms

15 arn11s12-in-f14.1e100.net (142.250.74.174) 71.996 ms 51.109 ms 52.764 ms

4. Determine all IP addresses of yahoo.com

nslookup yahoo.com:

Non-authoritative answer:

Name: yahoo.com

Address: **98.137.11.163**

Name: yahoo.com

Address: **74.6.143.26**

Name: yahoo.com

Address: 74.6.143.25

Name: yahoo.com

Address: 74.6.231.20

Name: yahoo.com

Address: 74.6.231.21

Name: yahoo.com

Address: 98.137.11.164

or:

host -t A yahoo.com:

yahoo.com has address 74.6.231.20

yahoo.com has address 74.6.143.26

yahoo.com has address 98.137.11.163

yahoo.com has address 98.137.11.164

yahoo.com has address 74.6.143.25

yahoo.com has address 74.6.231.21

Get the same result.

5. **Take any 3 of them and make a trace to each IP address. Which hops are the same for all chosen remote IP addresses?**

98.137.11.163,

74.6.231.21,

74.6.143.26.

First 5 hops are the same for all chosen IP addresses.

Not sure about 6th hop. The second part of it is identical, but the beginning of hop or "ge-1-3-0.pat2.dee.yahoo.com" or "ge-1-3-0.pat1.dee.yahoo.com". Starting from 6th hop there are different routers to pass my traffic through, but IP are the same, so the 6th hop is the same too.

Staring from the 7th till the 10th hops used 2 or 3 routers from the same subnet or from different subnets, so I think, we can't say, that the hops are the same.

Hops from 11th till the end are different.

traceroute to 98.137.11.163 (98.137.11.163), 64 hops max, 52 byte packets

```
 1  192.168.0.1 (192.168.0.1)  11.031 ms  3.780 ms  3.246 ms
 2  100.104.16.1 (100.104.16.1)  7.340 ms  6.189 ms  5.971 ms
 3  217.107.123.78 (217.107.123.78)  6.222 ms  6.345 ms  6.716 ms
 4  87.226.139.20 (87.226.139.20)  7.003 ms  7.095 ms  6.577 ms
 5  188.128.126.71 (188.128.126.71)  64.667 ms *  591.799 ms
 6  ge-1-3-0.pat2.dee.yahoo.com (80.81.193.115)  74.239 ms
    ge-1-3-0.pat1.dee.yahoo.com (80.81.192.115)  73.366 ms
    ge-1-3-0.pat2.dee.yahoo.com (80.81.193.115)  66.703 ms
 7  ae-3.pat1.frz.yahoo.com (209.191.112.17)  76.059 ms
    ae-0.pat2.dez.yahoo.com (209.191.112.7)  123.271 ms
    ae-3.pat2.frz.yahoo.com (209.191.112.25)  174.090 ms
 8  ae-3.pat2.frz.yahoo.com (209.191.112.25)  176.824 ms
    ae-11.pat1.dce.yahoo.com (209.191.64.24)  174.303 ms
    ae-3.pat2.frz.yahoo.com (209.191.112.25)  175.364 ms
 9  ae-14.pat2.che.yahoo.com (209.191.64.39)  175.446 ms
    ae-11.pat1.dce.yahoo.com (209.191.64.24)  152.236 ms
    ae-14.pat2.che.yahoo.com (209.191.64.39)  205.430 ms
10  ae-12.pat1.dnx.yahoo.com (209.191.68.1)  212.684 ms
    ae-14.pat2.che.yahoo.com (209.191.64.39)  179.875 ms
    ae-12.pat1.dnx.yahoo.com (209.191.68.1)  192.341 ms
11  ae-12.pat1.dnx.yahoo.com (209.191.68.1)  189.998 ms
    ae-4.pat2.dnx.yahoo.com (209.191.64.81)  199.422 ms
    ae-19.pat1.gqb.yahoo.com (209.191.65.101)  220.345 ms
12  ae-21.pat2.gqb.yahoo.com (209.191.65.107)  248.483 ms
    et-18-0-0.msr2.gq2.yahoo.com (66.196.67.127)  210.118 ms
    et-0-0-0.msr2.gq2.yahoo.com (66.196.67.117)  215.808 ms
13  et-18-1-0.msr1.gq1.yahoo.com (66.196.67.103)  219.347 ms
    et-19-1-0.clr1-a-gdc.gq2.yahoo.com (98.136.158.201)  215.870 ms
    et-19-1-0.msr2.gq1.yahoo.com (66.196.67.111)  213.562 ms
14  lo0.fab4-1-gdc.gq2.yahoo.com (98.136.159.244)  211.884 ms
    et-1-0-0.clr1-a-gdc.gq2.yahoo.com (67.195.37.119)  214.994 ms
    lo0.fab3-1-gdc.gq2.yahoo.com (98.136.159.245)  275.771 ms
15  lo0.fab7-1-gdc.gq2.yahoo.com (98.136.159.241)  213.287 ms
    lo0.fab5-1-gdc.gq2.yahoo.com (98.136.159.243)  211.512 ms
```

usw2-1-lbc.gq2.yahoo.com (98.136.158.193) 211.437 ms
16 usw2-1-lbc.gq2.yahoo.com (98.136.158.193) 207.331 ms
media-router-fp74.prod.media.vip.gq1.yahoo.com (98.137.11.163) 296.133 ms
usw2-1-lbc.gq2.yahoo.com (98.136.158.193) 209.276 ms

traceroute to 74.6.231.21 (74.6.231.21), 64 hops max, 52 byte packets
1 192.168.0.1 (192.168.0.1) 4.260 ms 3.674 ms 3.505 ms
2 100.104.16.1 (100.104.16.1) 6.780 ms 6.444 ms 6.439 ms
3 217.107.123.78 (217.107.123.78) 6.828 ms 9.984 ms 6.759 ms
4 87.226.139.20 (87.226.139.20) 6.903 ms 6.787 ms 6.729 ms
5 * 188.128.126.71 (188.128.126.71) 64.587 ms
188.128.126.105 (188.128.126.105) 73.277 ms
6 ge-1-3-0.pat1.dee.yahoo.com (80.81.192.115) 67.253 ms
ge-1-3-0.pat2.dee.yahoo.com (80.81.193.115) 74.601 ms
ge-1-3-0.pat1.dee.yahoo.com (80.81.192.115) 65.088 ms
7 ae-3.pat2.frz.yahoo.com (209.191.112.25) 87.787 ms 79.443 ms
ae-3.pat1.frz.yahoo.com (209.191.112.17) 80.459 ms
8 ae-11.pat1.dce.yahoo.com (209.191.64.24) 151.802 ms
ae-0.pat2.frz.yahoo.com (209.191.112.49) 77.173 ms
ae-11.pat1.dce.yahoo.com (209.191.64.24) 154.515 ms
9 ae-11.pat1.dce.yahoo.com (209.191.64.24) 150.195 ms
ae-6.pat1.che.yahoo.com (209.191.64.43) 170.450 ms
ae-11.pat1.dce.yahoo.com (209.191.64.24) 149.684 ms
10 ae-14.pat2.che.yahoo.com (209.191.64.39) 180.537 ms
ae-7.pat2.nez.yahoo.com (209.191.64.214) 184.035 ms
ae-14.pat2.che.yahoo.com (209.191.64.39) 180.376 ms
11 et-0-1-1.msr2.ne1.yahoo.com (209.191.65.121) 174.302 ms
et-19-1-7.msr1.ne1.yahoo.com (216.115.105.29) 184.387 ms
ae-7.pat1.nez.yahoo.com (209.191.64.218) 186.093 ms
12 et-18-0-0.clr1-a-gdc.ne1.yahoo.com (98.138.97.23) 176.803 ms
et-19-1-7.msr2.ne1.yahoo.com (209.191.65.117) 176.047 ms
et-17-0-1.msr1.ne1.yahoo.com (216.115.105.179) 171.652 ms
13 lo0.fab4-2-gdc.ne1.yahoo.com (98.138.51.3) 179.001 ms

et-18-0-0.clr2-a-gdc.ne1.yahoo.com (98.138.97.27) 187.120 ms
lo0.fab8-2-gdc.ne1.yahoo.com (98.138.51.7) 174.825 ms
14 lo0.fab6-2-gdc.ne1.yahoo.com (98.138.51.5) 174.178 ms
usw1-1-lbd.ne1.yahoo.com (98.138.97.156) 183.349 ms
lo0.fab5-2-gdc.ne1.yahoo.com (98.138.51.4) 176.705 ms
15 media-router-fp74.prod.media.vip.ne1.yahoo.com (74.6.231.21) 178.898 ms 181.029 ms
usw2-1-lbd.ne1.yahoo.com (98.138.97.157) 196.859 ms

traceroute to 74.6.143.26 (74.6.143.26), 64 hops max, 52 byte packets
1 192.168.0.1 (192.168.0.1) 4.184 ms 3.681 ms 3.645 ms
2 100.104.16.1 (100.104.16.1) 6.866 ms 6.087 ms 6.698 ms
3 217.107.123.78 (217.107.123.78) 6.743 ms 6.570 ms 6.700 ms
4 87.226.139.20 (87.226.139.20) 6.702 ms 6.996 ms 6.800 ms
5 188.128.126.71 (188.128.126.71) 64.681 ms * *
6 ge-1-3-0.pat1.dee.yahoo.com (80.81.192.115) 74.654 ms
ge-1-3-0.pat2.dee.yahoo.com (80.81.193.115) 70.212 ms
ge-1-3-0.pat1.dee.yahoo.com (80.81.192.115) 68.594 ms
7 ae-3.pat2.frz.yahoo.com (209.191.112.25) 81.272 ms 89.248 ms
ae-1.pat2.dez.yahoo.com (209.191.112.9) 74.620 ms
8 ae-11.pat1.dce.yahoo.com (209.191.64.24) 155.091 ms
ae-3.pat2.frz.yahoo.com (209.191.112.25) 81.446 ms
ae-11.pat1.dce.yahoo.com (209.191.64.24) 158.235 ms
9 ae-11.pat1.dce.yahoo.com (209.191.64.24) 150.068 ms
ae-4.pat1.nyc.yahoo.com (209.191.64.1) 153.813 ms
ae-11.pat1.dce.yahoo.com (209.191.64.24) 151.045 ms
10 ae-4.pat1.nyc.yahoo.com (209.191.64.1) 153.940 ms
ae-0.pat1.bfw.yahoo.com (209.191.64.153) 177.636 ms
ae-14.pat2.nyc.yahoo.com (209.191.64.23) 162.471 ms
11 unknown.yahoo.com (74.6.227.47) 168.437 ms
et-0-1-1.msr2.bf2.yahoo.com (74.6.227.61) 166.373 ms
ae-0.pat1.bfw.yahoo.com (209.191.64.153) 178.563 ms
12 et-1-1-0.clr2-a-gdc.bf2.yahoo.com (74.6.122.57) 168.374 ms
et-19-0-1.msr2.bf1.yahoo.com (74.6.227.53) 169.665 ms

et-0-1-1.msr1.bf2.yahoo.com (74.6.227.67) 173.329 ms

13 lo0.fab8-1-gdc.bf2.yahoo.com (74.6.123.237) 177.564 ms

et-1-1-0.clr2-a-gdc.bf2.yahoo.com (74.6.122.57) 170.091 ms

lo0.fab5-1-gdc.bf2.yahoo.com (74.6.123.240) 171.910 ms

14 lo0.fab1-1-gdc.bf2.yahoo.com (74.6.123.244) 173.745 ms

usw2-1-lbb.bf2.yahoo.com (74.6.98.139) 168.171 ms

lo0.fab5-1-gdc.bf2.yahoo.com (74.6.123.240) 172.083 ms

15 media-router-fp74.prod.media.vip.bf1.yahoo.com (74.6.143.26) 167.752 ms 166.704 ms

usw1-1-lbb.bf2.yahoo.com (74.6.98.138) 167.702 ms

6. Find all your network "neighbors" by using the "arp" tool.

arp -a -n

? (192.168.0.1) at f4:e5:78:f1:ab:dd on en0 ifscope [ethernet]

? (192.168.0.10) at 36:8b:2d:32:87:da on en0 ifscope [ethernet]

? (192.168.0.12) at 86:bd:40:23:92:39 on en0 ifscope [ethernet]

? (192.168.0.255) at ff:ff:ff:ff:ff:ff on en0 ifscope [ethernet]

? (224.0.0.251) at 1:0:5e:0:0:fb on en0 ifscope permanent [ethernet]

? (239.255.255.250) at 1:0:5e:7f:ff:fa on en0 ifscope permanent [ethernet]

7. (counted as 4 points is done correctly). Connect to Internet in a different way compared to p.1, e.g.: another WiFi access point, via smartphone acting like a router, etc. Repeat p.1 above. Highlight or explicitly specify all changes compared to p.1 above.

Connected to the internet via smartphone acting like a router**:

7.1. IP address(es) and network interfaces.

ifconfig

IP address: 172.20.10.7 (new)

IP address: 127.0.0.1 (the same as in p.1.1)

Private IP addresses from OpenVPN Connect: inet 10.9.0.162 --> 10.9.0.161 (the same as in p.1.1.)

```
lo0: flags=8049<UP,LOOPBACK,RUNNING,MULTICAST> mtu 16384
	options=1203<RXCSUM,TXCSUM,TXSTATUS,SW_TIMESTAMP>
	inet 127.0.0.1 netmask 0xff000000
	inet6 ::1 prefixlen 128
	inet6 fe80::1%lo0 prefixlen 64 scopeid 0x1
	nd6 options=201<PERFORMNUD,DAD>
gif0: flags=8010<POINTOPOINT,MULTICAST> mtu 1280
stf0: flags=0<> mtu 1280
anpi1: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
	options=400<CHANNEL_IO>
	ether 4e:08:a5:37:62:20
	inet6 fe80::4c08:a5ff:fe37:6220%anpi1 prefixlen 64 scopeid 0x4
	nd6 options=201<PERFORMNUD,DAD>
	media: none
	status: inactive
anpi0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
	options=400<CHANNEL_IO>
	ether 4e:08:a5:37:62:1f
	inet6 fe80::4c08:a5ff:fe37:621f%anpi0 prefixlen 64 scopeid 0x5
	nd6 options=201<PERFORMNUD,DAD>
	media: none
	status: inactive
en3: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
	options=400<CHANNEL_IO>
	ether 4e:08:a5:37:62:ff
	nd6 options=201<PERFORMNUD,DAD>
	media: none
	status: inactive
en4: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
	options=400<CHANNEL_IO>
	ether 4e:08:a5:37:62:00
	nd6 options=201<PERFORMNUD,DAD>
```

```
	media: none
	status: inactive
en1: flags=8963<UP,BROADCAST,SMART,RUNNING,PROMISC,SIMPLEX,MULTICAST>
mtu 1500
	options=460<TSO4,TSO6,CHANNEL_IO>
	ether 36:5e:1c:8a:8b:00
	media: autoselect <full-duplex>
	status: inactive
en2: flags=8963<UP,BROADCAST,SMART,RUNNING,PROMISC,SIMPLEX,MULTICAST>
mtu 1500
	options=460<TSO4,TSO6,CHANNEL_IO>
	ether 36:5e:1c:8a:8b:04
	media: autoselect <full-duplex>
	status: inactive
bridge0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu
1500
	options=63<RXCSUM,TXCSUM,TSO4,TSO6>
	ether 36:5e:1c:8a:8b:00
	Configuration:
		id 0:0:0:0:0:0 priority 0 hellotime 0 fwddelay 0
		maxage 0 holdcnt 0 proto stp maxaddr 100 timeout 1200
		root id 0:0:0:0:0:0 priority 0 ifcost 0 port 0
		ipfilter disabled flags 0x0
	member: en1 flags=3<LEARNING,DISCOVER>
		ifmaxaddr 0 port 8 priority 0 path cost 0
	member: en2 flags=3<LEARNING,DISCOVER>
		ifmaxaddr 0 port 9 priority 0 path cost 0
	nd6 options=201<PERFORMNUD,DAD>
	media: <unknown type>
	status: inactive
ap1: flags=8843<UP,BROADCAST,RUNNING,SIMPLEX,MULTICAST> mtu 1500
```

```
	options=6463<RXCSUM,TXCSUM,TSO4,TSO6,CHANNEL_IO,PARTIAL_CSUM,ZEROIN
VERT_CSUM>
	ether a6:cf:99:6b:c4:7c
	inet6 fe80::a4cf:99ff:fe6b:c47c%ap1 prefixlen 64 scopeid 0xb
	nd6 options=201<PERFORMNUD,DAD>
	media: autoselect (<unknown type>)
	status: inactive
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
	options=400<CHANNEL_IO>
	ether a4:cf:99:6b:c4:7c
	inet6 fe80::10d9:bacc:2144:a191%en0 prefixlen 64 secured scopeid 0xc
	inet 172.20.10.7 netmask 0xfffffff0 broadcast 172.20.10.15
	nd6 options=201<PERFORMNUD,DAD>
	media: autoselect
	status: active
awdl0: flags=8843<UP,BROADCAST,RUNNING,SIMPLEX,MULTICAST> mtu 1500
	options=6463<RXCSUM,TXCSUM,TSO4,TSO6,CHANNEL_IO,PARTIAL_CSUM,ZEROIN
VERT_CSUM>
	ether ee:be:ef:28:25:b2
	inet6 fe80::ecbe:efff:fe28:25b2%awdl0 prefixlen 64 scopeid 0xd
	nd6 options=201<PERFORMNUD,DAD>
	media: autoselect
	status: active
llw0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
	options=400<CHANNEL_IO>
	ether ee:be:ef:28:25:b2
	inet6 fe80::ecbe:efff:fe28:25b2%llw0 prefixlen 64 scopeid 0xe
	nd6 options=201<PERFORMNUD,DAD>
	media: autoselect
	status: active
utun0: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1380
	inet6 fe80::8737:69d5:fbf:f738%utun0 prefixlen 64 scopeid 0xf
```

```
	nd6 options=201<PERFORMNUD,DAD>
utun1: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 2000
	inet6 fe80::82e5:d17c:31ac:2c5d%utun1 prefixlen 64 scopeid 0x10
	nd6 options=201<PERFORMNUD,DAD>
utun2: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1000
	inet6 fe80::ce81:b1c:bd2c:69e%utun2 prefixlen 64 scopeid 0x11
	nd6 options=201<PERFORMNUD,DAD>
utun3: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1380
	inet6 fe80::bba:b559:e01:8eaa%utun3 prefixlen 64 scopeid 0x12
	nd6 options=201<PERFORMNUD,DAD>
utun4: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1380
	inet6 fe80::60b5:16ea:ed45:9c5%utun4 prefixlen 64 scopeid 0x13
	nd6 options=201<PERFORMNUD,DAD>
utun5: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1380
	inet6 fe80::9e4a:7290:5142:e284%utun5 prefixlen 64 scopeid 0x14
	nd6 options=201<PERFORMNUD,DAD>
utun6: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1380
	inet6 fe80::3edd:64dc:bc75:c2bb%utun6 prefixlen 64 scopeid 0x15
	nd6 options=201<PERFORMNUD,DAD>
utun7: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1380
	inet6 fe80::930e:8461:e7a7:d330%utun7 prefixlen 64 scopeid 0x16
	nd6 options=201<PERFORMNUD,DAD>
utun8: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1380
	inet6 fe80::345d:a110:4c17:2021%utun8 prefixlen 64 scopeid 0x17
	nd6 options=201<PERFORMNUD,DAD>
utun9: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1500
	inet 10.9.0.162 --> 10.9.0.161 netmask 0xfffffffc
```

7.2. Netmask for every network interface. Also calculate the maximum number of hosts within this network.

127.0.0.1 netmask 0xff000000 (the same as in p.1.2)
Netmask: 255.0.0.0,
bitmask /8,

maximum number of usable hosts - 16,777,214

10.9.0.162 --> 10.9.0.161 netmask 0xfffffffc (the same as in p.1.2)
Netmask: 255.255.255.252,
bitmask /30,
maximum number of usable hosts – 2

172.20.10.7 netmask 0xfffffff0 (new)
Netmask: 255.255.255.240,
bitmask /28,
maximum number of usable hosts - 14

Result

IP Address:	172.20.10.7
Network Address:	172.20.10.0
Usable Host IP Range:	172.20.10.1 - 172.20.10.14
Broadcast Address:	172.20.10.15
Total Number of Hosts:	16
Number of Usable Hosts:	14
Subnet Mask:	255.255.255.240
Wildcard Mask:	0.0.0.15
Binary Subnet Mask:	11111111.11111111.11111111.11110000
IP Class:	C
CIDR Notation:	/28
IP Type:	Private
Short:	172.20.10.7 /28
Binary ID:	10101100000101000000101000000111
Integer ID:	2886994439
Hex ID:	0xac140a07
in-addr.arpa:	7.10.20.172.in-addr.arpa
IPv4 Mapped Address:	::ffff:ac14.0a07
6to4 Prefix:	2002:ac14.0a07::/48

7.3. IP address of your default gateway.

netstat -rnf inet

default 172.20.10.1 (new)

7.4. IP addresses of DNS servers.

cat /etc/resolv.conf

8.8.8.8 (the same as in p.1.2)

***Also activated VPN on iPhone, and connected to the internet via smartphone acting like a router (got the same results as described above).*

8. **Having the same internet connection as in p.7, repeat p.2 above with the same IP address of yandex.ru. Highlight or explicitly specify common hops in these two traces.**
Make a network trace between your computer and yandex.ru, using tracert (on Windows) or traceroute -nI (on macOS and Linux). Highlight or explicitly specify your default gateway in this trace. Remember this IP address of yandex.ru.

traceroute -nI 5.255.255.77

traceroute to 5.255.255.77 (5.255.255.77), 64 hops max, 72 byte packets

1 172.20.10.1 17.368 ms 28.079 ms 7.943 ms

2 * * *

3 * * *

4 * * *

5 * * *

6 * * *

7 * * *

8 188.170.161.57 84.429 ms 39.363 ms 54.947 ms

9 188.170.161.56 48.992 ms 40.017 ms 48.641 ms

10 **5.255.255.77** 62.310 ms 64.073 ms 95.937 ms

My default gateway in this trace is 172.20.10.1 (first hop),
IP of yandex.ru **5.255.255.77** (the last hop).

There is **1** common hop (the last one) in case where we traceroute to 5.255.255.77.

*(Following attempt were described in **Submission comments** from Wed, 6 Dec 2023, 9:34):*

There is **1** common hop (the last one) in case where we traceroute to 77.88.55.60

My default gateway in this trace is 172.20.10.1 (first hop)
*IP of yandex.ru **77.88.55.60***

traceroute -I 77.88.55.60
traceroute: Warning: yandex.ru has multiple addresses; using 77.88.55.88
traceroute to yandex.ru (77.88.55.88), 64 hops max, 72 byte packets
traceroute to 77.88.55.60 (77.88.55.60), 64 hops max, 72 byte packets
1 172.20.10.1 (172.20.10.1) 11.589 ms 3.659 ms 3.708 ms
*2 * * **
*3 * * **
*4 * * **

*5 * * **
*6 * * **
*7 * * **
8 188.170.161.57 (188.170.161.57) 85.377 ms 43.629 ms 56.806 ms
9 188.170.161.56 (188.170.161.56) 47.947 ms 52.783 ms 49.886 ms
*10 yandex.ru (**77.88.55.60**) 66.957 ms 69.600 ms 60.219 ms*