Assignment 4 Report 1dv701 GNS3

Author Yi Shu Yang, yy222cm@student.lnu.se

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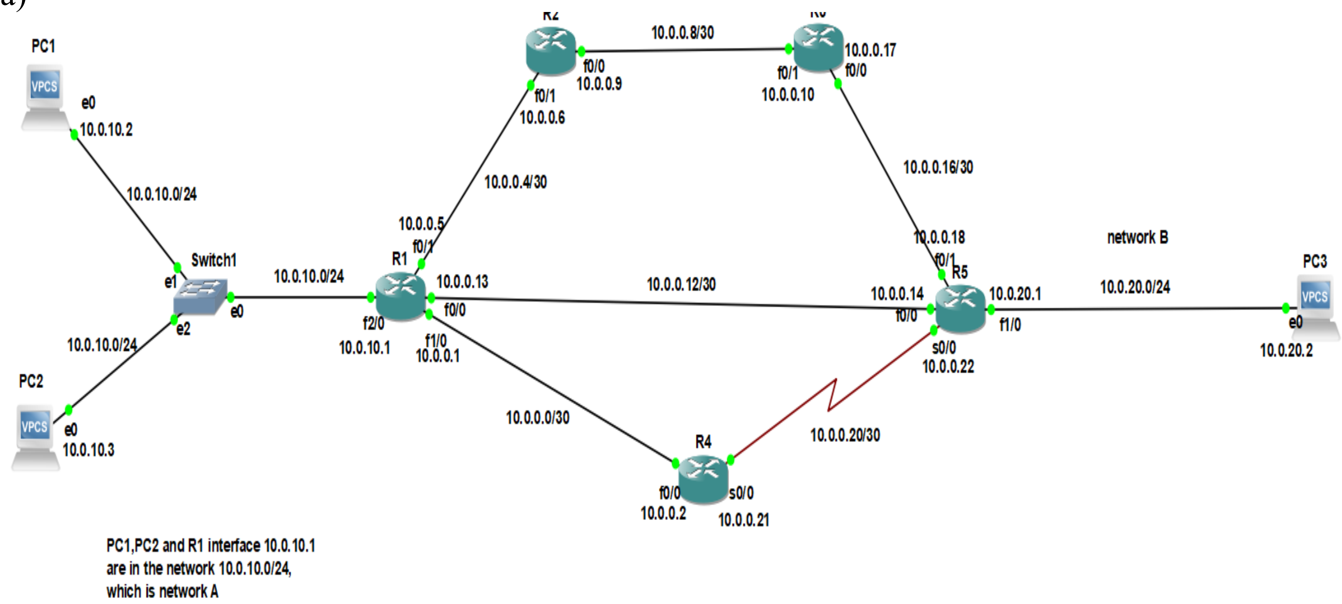
Problem 1

a)



b)

1. ping from **PC-1 to PC-2**

```
PC1
ping 10.0.10.3
84 bytes from 10.0.10.3 icmp_seq=1 ttl=64 time=0.575 ms
84 bytes from 10.0.10.3 icmp_seq=2 ttl=64 time=0.550 ms
84 bytes from 10.0.10.3 icmp_seq=3 ttl=64 time=0.620 ms
84 bytes from 10.0.10.3 icmp_seq=4 ttl=64 time=0.675 ms
84 bytes from 10.0.10.3 icmp_seq=5 ttl=64 time=0.589 ms

PC1>
```

It is successful. Since PC-1 and PC-2 are both in network A.

2. ping from **PC-1 to PC-3**

```
PC1
ping 10.0.20.2
*10.0.10.1 icmp_seq=1 ttl=255 time=45.219 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=2 ttl=255 time=15.409 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=3 ttl=255 time=15.628 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=4 ttl=255 time=15.843 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=5 ttl=255 time=15.361 ms (ICMP type:3, code:1, Destination host unreachable)

PC1>
```

It is unsuccessful since PC-1 is in the subnet 10.0.10.0/24 (network A) and PC-3 is in the subnet 10.0.20.0/24 (network B), which means direct ping will fail.

3. ping from **R1 to PC-1**

```
R1#ping 10.0.10.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.10.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/24/64 ms
R1#
```

It is successful. Since R1 interface 10.0.10.1 and PC-1 are both in network A.

4. ping from **R1 to R3**

```
R1#ping 10.0.0.10

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.10, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
R1#
```

It is unsuccessful since R1 and R2 are in the subnet 10.0.0.4/30 and R2 and R3 are in the subnet 10.0.0.10/30, which means R1 and R3 are not in the same subnet, so ping will not success.

c)
First of all, NM-1FE-TX and NM-16ESW have NM (Network Module) slots larger than WIC slots, which also have a higher throughput. The NM cards generally have more processing power than WICs, and can offer more LAN-type interfaces. Whereas WIC (WAN Interface Card) slots are small slots and the actual throughput is limited in the WIC slots compared to the NM slots. Hence here is trivial since WIC-1T only used for the subnet 10.0.0.20/30 which has a relatively low throughput, 1544 kbps. While NM-1FE-TX and NM-16ESW can be used for much higher throughput like 10Mbps and 100Mbps.

Secondly, NM-1FE-TX has 1 fast ethernet port and NM-16ESW is a switching module with 16 fast ethernet ports and provides some basic switching functionality. Which means that NM-16ESW has more ethernet ports than NM-1FE-TX although they are both Network Modules.

d)
/24 subnet can have as many as 254 host IP address but /30 subnet can only have 2 host IP address. Which means that more IP addresses can be allocated to the hosts in the 24/ subnet whereas only two host IP addresses can be allocated to /30 subnet.

Problem 2

a)

[ip] is the ip address of the intended visiting network the current router wants to arrive, which could be either /30 subnet in the backbone network or /24 subnet form network A or B.

[mask] is the subnet mask of the visiting network above.

[router_interface] is just specifying which interface you are going through to arrive that network, e.g. f0/0 or we call it “the next hoop” to go through.

[metric]: A metric is a weighted cost assigned to static and dynamic routes. Metrics have a value between 1 and 254. Lower metrics are considered better and take precedence over higher costs. Here path with higher throughput has lower metric number.

b)

1. PC-1 to PC-3

```
ping 10.0.20.2
10.0.20.2 icmp_seq=1 timeout
10.0.20.2 icmp_seq=2 timeout
84 bytes from 10.0.20.2 icmp_seq=3 ttl=62 time=61.530 ms
84 bytes from 10.0.20.2 icmp_seq=4 ttl=62 time=62.013 ms
84 bytes from 10.0.20.2 icmp_seq=5 ttl=62 time=61.448 ms

PC1> trace 10.0.20.2
trace to 10.0.20.2, 8 hops max, press Ctrl+C to stop
 1   10.0.10.1   16.163 ms  14.143 ms  14.827 ms
 2   10.0.0.14   46.386 ms  38.070 ms  46.411 ms
 3   *10.0.20.2   62.609 ms (ICMP type:3, code:3, Destination port unreachable)

PC1>
```

I choose the path: PC-1 to R1 to R5 to PC-3 since there is a direct path from R1 to R5 which only go through one subnet 10.0.0.12/30. So only two interface 10.0.10.1 and 10.0.0.14 to go through from PC-1 to PC-3 to arrive at 10.0.20.2 which is the ip address of PC-3.

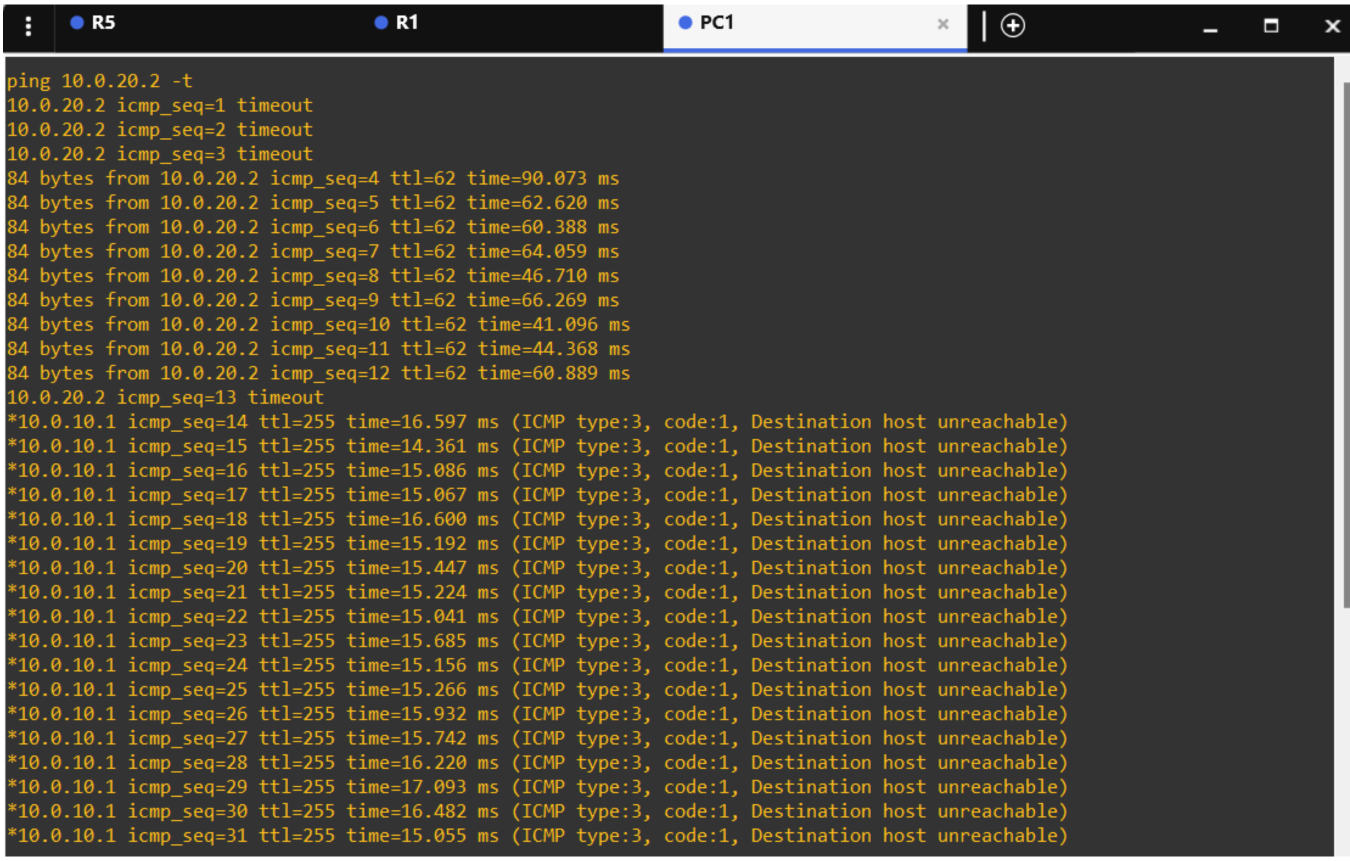
2.PC-3 to PC-2

```
ping 10.0.10.3
10.0.10.3 icmp_seq=1 timeout
10.0.10.3 icmp_seq=2 timeout
84 bytes from 10.0.10.3 icmp_seq=3 ttl=62 time=62.178 ms
84 bytes from 10.0.10.3 icmp_seq=4 ttl=62 time=61.832 ms
84 bytes from 10.0.10.3 icmp_seq=5 ttl=62 time=60.955 ms

PC3> trace 10.0.10.3
trace to 10.0.10.3, 8 hops max, press Ctrl+C to stop
 1   10.0.20.1   15.896 ms  15.127 ms  15.200 ms
 2   10.0.0.13   44.785 ms  44.992 ms  46.011 ms
 3   *10.0.10.3   59.902 ms (ICMP type:3, code:3, Destination port unreachable)

PC3>
```

I choose the path: PC-3 to R5 to R1 to PC-2 since there is a direct path from R5 to R2 which only go through one subnet 10.0.0.12/30. So only two interface 10.0.20.1 and 10.0.0.13 to go through from PC-3 to PC-2 to arrive at 10.0.10.3 which is the ip address of PC-2.

c)

1. continuous ping from PC-1 to PC-3 with f0/0 (f2/0 in the graph) in R1 and f0/0 (f2/0 in the graph) in R5 shutdown screenshot:




```
ping 10.0.20.2 -t
10.0.20.2 icmp_seq=1 timeout
10.0.20.2 icmp_seq=2 timeout
10.0.20.2 icmp_seq=3 timeout
84 bytes from 10.0.20.2 icmp_seq=4 ttl=62 time=90.073 ms
84 bytes from 10.0.20.2 icmp_seq=5 ttl=62 time=62.620 ms
84 bytes from 10.0.20.2 icmp_seq=6 ttl=62 time=60.388 ms
84 bytes from 10.0.20.2 icmp_seq=7 ttl=62 time=64.059 ms
84 bytes from 10.0.20.2 icmp_seq=8 ttl=62 time=46.710 ms
84 bytes from 10.0.20.2 icmp_seq=9 ttl=62 time=66.269 ms
84 bytes from 10.0.20.2 icmp_seq=10 ttl=62 time=41.096 ms
84 bytes from 10.0.20.2 icmp_seq=11 ttl=62 time=44.368 ms
84 bytes from 10.0.20.2 icmp_seq=12 ttl=62 time=60.889 ms
10.0.20.2 icmp_seq=13 timeout
*10.0.10.1 icmp_seq=14 ttl=255 time=16.597 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=15 ttl=255 time=14.361 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=16 ttl=255 time=15.086 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=17 ttl=255 time=15.067 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=18 ttl=255 time=16.600 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=19 ttl=255 time=15.192 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=20 ttl=255 time=15.447 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=21 ttl=255 time=15.224 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=22 ttl=255 time=15.041 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=23 ttl=255 time=15.685 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=24 ttl=255 time=15.156 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=25 ttl=255 time=15.266 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=26 ttl=255 time=15.932 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=27 ttl=255 time=15.742 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=28 ttl=255 time=16.220 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=29 ttl=255 time=17.093 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=30 ttl=255 time=16.482 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=31 ttl=255 time=15.055 ms (ICMP type:3, code:1, Destination host unreachable)
```

We can see that after both shutdown ip address 10.0.10.1 from R1 can’t be reached anymore.

2. continuous ping from PC-3 to PC-2 with f0/0 (f2/0 in the graph) in R5 and f0/0 (f2/0 in the graph) in R1 shutdown screenshot:

```
ping 10.0.10.3 -t
10.0.10.3 icmp_seq=1 timeout
10.0.10.3 icmp_seq=2 timeout
10.0.10.3 icmp_seq=3 timeout
84 bytes from 10.0.10.3 icmp_seq=4 ttl=62 time=63.927 ms
84 bytes from 10.0.10.3 icmp_seq=5 ttl=62 time=62.024 ms
84 bytes from 10.0.10.3 icmp_seq=6 ttl=62 time=60.258 ms
84 bytes from 10.0.10.3 icmp_seq=7 ttl=62 time=61.805 ms
84 bytes from 10.0.10.3 icmp_seq=8 ttl=62 time=50.887 ms
84 bytes from 10.0.10.3 icmp_seq=9 ttl=62 time=62.530 ms
84 bytes from 10.0.10.3 icmp_seq=10 ttl=62 time=45.678 ms
84 bytes from 10.0.10.3 icmp_seq=11 ttl=62 time=61.633 ms
84 bytes from 10.0.10.3 icmp_seq=12 ttl=62 time=60.363 ms
84 bytes from 10.0.10.3 icmp_seq=13 ttl=62 time=60.864 ms
84 bytes from 10.0.10.3 icmp_seq=14 ttl=62 time=60.384 ms
84 bytes from 10.0.10.3 icmp_seq=15 ttl=62 time=61.434 ms
84 bytes from 10.0.10.3 icmp_seq=16 ttl=62 time=61.727 ms
84 bytes from 10.0.10.3 icmp_seq=17 ttl=62 time=61.023 ms
84 bytes from 10.0.10.3 icmp_seq=18 ttl=62 time=46.852 ms
84 bytes from 10.0.10.3 icmp_seq=19 ttl=62 time=45.154 ms
84 bytes from 10.0.10.3 icmp_seq=20 ttl=62 time=62.179 ms
84 bytes from 10.0.10.3 icmp_seq=21 ttl=62 time=59.894 ms
84 bytes from 10.0.10.3 icmp_seq=22 ttl=62 time=61.296 ms
*10.0.20.1 icmp_seq=23 ttl=255 time=44.620 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.20.1 icmp_seq=24 ttl=255 time=14.768 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.20.1 icmp_seq=25 ttl=255 time=16.786 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.20.1 icmp_seq=26 ttl=255 time=15.735 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.20.1 icmp_seq=27 ttl=255 time=15.137 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.20.1 icmp_seq=28 ttl=255 time=15.066 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.20.1 icmp_seq=29 ttl=255 time=13.187 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.20.1 icmp_seq=30 ttl=255 time=14.200 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.20.1 icmp_seq=31 ttl=255 time=14.523 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.20.1 icmp_seq=32 ttl=255 time=15.251 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.20.1 icmp_seq=33 ttl=255 time=15.610 ms (ICMP type:3, code:1, Destination host unreachable)
```

We can see that after both shutdown ip address 10.0.20.1 from R5 can’t be reached anymore.

d)
1. from PC-1 to PC-3

Now I have configured all ip routers in all 3 paths.

```
PC1

trace 10.0.20.2
trace to 10.0.20.2, 8 hops max, press Ctrl+C to stop
 1   10.0.10.1   15.093 ms  15.398 ms  15.274 ms
 2   10.0.0.6   45.196 ms  45.439 ms  45.760 ms
 3   10.0.0.10   72.583 ms  76.058 ms  74.924 ms
 4   10.0.0.18   106.669 ms  106.929 ms  107.172 ms
 5     *  *  *
 6   *10.0.20.2   121.342 ms (ICMP type:3, code:3, Destination port unreachable)

PC1> trace 10.0.0.14
trace to 10.0.0.14, 8 hops max, press Ctrl+C to stop
 1   10.0.10.1   15.413 ms  14.700 ms  15.171 ms
 2   *10.0.0.14   75.397 ms (ICMP type:3, code:3, Destination port unreachable)

PC1> trace 10.0.0.22
trace to 10.0.0.22, 8 hops max, press Ctrl+C to stop
 1   10.0.10.1   16.091 ms  14.885 ms  14.642 ms
 2   10.0.0.2   45.689 ms  45.407 ms  46.272 ms
 3   *10.0.0.22   77.369 ms (ICMP type:3, code:3, Destination port unreachable)

PC1>
```

We first just trace from PC-1 to PC-3 and see what the original path is, just the preferred path in this topology.

As it is seen on the following graph:

It is easy to see that the middle path is the favourite one by the topology.

Now we do the continuous ping from PC1 to PC3, and shut down this path.

```
trace 10.0.20.2
trace to 10.0.20.2, 8 hops max, press Ctrl+C to stop
 1   10.0.10.1   15.331 ms  16.376 ms  15.648 ms
 2   10.0.0.14   45.805 ms  44.843 ms  30.387 ms
 3     *  *  *
 4   *10.0.20.2   91.802 ms (ICMP type:3, code:3, Destination port unreachable)

PC1> trace 10.0.20.2
trace to 10.0.20.2, 8 hops max, press Ctrl+C to stop
 1   10.0.10.1   15.184 ms  15.081 ms  15.996 ms
 2   10.0.0.14   46.431 ms  44.857 ms  44.564 ms
 3   *10.0.20.2   92.326 ms (ICMP type:3, code:3, Destination port unreachable)
```

Now we are ready to shut down the current path just shutting down f0/0 of R1 and f0/0 of R5 and see new data packages effect with new path. Below is the change of continuous ping.

```
PC1> ping 10.0.20.2 -t
10.0.20.2 icmp_seq=1 timeout
10.0.20.2 icmp_seq=2 timeout
84 bytes from 10.0.20.2 icmp_seq=3 ttl=60 time=76.133 ms
84 bytes from 10.0.20.2 icmp_seq=4 ttl=60 time=91.300 ms
84 bytes from 10.0.20.2 icmp_seq=5 ttl=60 time=91.658 ms
84 bytes from 10.0.20.2 icmp_seq=6 ttl=60 time=90.971 ms
84 bytes from 10.0.20.2 icmp_seq=7 ttl=60 time=90.974 ms
84 bytes from 10.0.20.2 icmp_seq=8 ttl=60 time=91.829 ms
84 bytes from 10.0.20.2 icmp_seq=9 ttl=60 time=91.253 ms
84 bytes from 10.0.20.2 icmp_seq=10 ttl=60 time=94.549 ms
84 bytes from 10.0.20.2 icmp_seq=11 ttl=60 time=92.732 ms
84 bytes from 10.0.20.2 icmp_seq=12 ttl=60 time=91.620 ms
84 bytes from 10.0.20.2 icmp_seq=13 ttl=60 time=76.384 ms
84 bytes from 10.0.20.2 icmp_seq=14 ttl=60 time=92.475 ms
84 bytes from 10.0.20.2 icmp_seq=15 ttl=60 time=92.058 ms
84 bytes from 10.0.20.2 icmp_seq=16 ttl=60 time=91.985 ms
84 bytes from 10.0.20.2 icmp_seq=17 ttl=60 time=89.313 ms
84 bytes from 10.0.20.2 icmp_seq=18 ttl=60 time=77.251 ms
84 bytes from 10.0.20.2 icmp_seq=19 ttl=60 time=92.218 ms
84 bytes from 10.0.20.2 icmp_seq=20 ttl=60 time=76.073 ms
84 bytes from 10.0.20.2 icmp_seq=21 ttl=60 time=92.113 ms
84 bytes from 10.0.20.2 icmp_seq=22 ttl=60 time=77.450 ms
84 bytes from 10.0.20.2 icmp_seq=23 ttl=60 time=90.589 ms
84 bytes from 10.0.20.2 icmp_seq=24 ttl=60 time=92.610 ms
10.0.20.2 icmp_seq=25 timeout
84 bytes from 10.0.20.2 icmp_seq=26 ttl=60 time=123.791 ms
84 bytes from 10.0.20.2 icmp_seq=27 ttl=60 time=122.653 ms
84 bytes from 10.0.20.2 icmp_seq=28 ttl=60 time=123.948 ms
84 bytes from 10.0.20.2 icmp_seq=29 ttl=60 time=122.964 ms
84 bytes from 10.0.20.2 icmp_seq=30 ttl=60 time=122.526 ms
84 bytes from 10.0.20.2 icmp_seq=31 ttl=60 time=138.570 ms
84 bytes from 10.0.20.2 icmp_seq=32 ttl=60 time=121.789 ms
84 bytes from 10.0.20.2 icmp_seq=33 ttl=60 time=121.474 ms
84 bytes from 10.0.20.2 icmp_seq=34 ttl=60 time=125.430 ms

PC1>
```

Clearly only one packet here is lost with icmp_seq = 25 here. Clearly the connection before and after is the same which means new connection is successful.

```
PC1> trace 10.0.20.2
trace to 10.0.20.2, 8 hops max, press Ctrl+C to stop
 1   10.0.10.1   16.001 ms  14.482 ms  14.968 ms
 2   10.0.0.6   45.518 ms  45.292 ms  45.363 ms
 3   10.0.0.10   72.374 ms  61.516 ms  76.660 ms
 4   10.0.0.18   105.329 ms  106.172 ms  105.852 ms
 5     *  *  *
 6   *10.0.20.2   121.790 ms (ICMP type:3, code:3, Destination port unreachable)

PC1>
```

Clearly after the middle one is shut down, the system chooses the upper one, that is because the metric of upper three networks are all 1 (lowest) because they all have 100Mbps which is the highest throughput, while the down one has a serial connection of only metric 3 (1544kbps) which is very small.

When the static routing is made, it is stable, then it will choose the path that transmit fastest.

1. from PC-3 to PC-2

We first just trace from PC-3 to PC-2 and see what the original path is, just the preferred path in this topology.

As it is seen on the following graph:

It is easy to see that the middle path is the favourite one by the topology.

Now we do the continuous ping from PC3 to PC2, and shut down this path.

```
PC3> trace 10.0.10.3
trace to 10.0.10.3, 8 hops max, press Ctrl+C to stop
 1   10.0.20.1   15.149 ms  14.505 ms  14.668 ms
 2     *10.0.0.13   76.130 ms  75.425 ms
 3     *  *  *
 4   *10.0.10.3   61.350 ms (ICMP type:3, code:3, Destination port unreachable)

PC3>
```

Now we are ready to shut down the current path just shutting down f0/0 of R5 and f0/0 of R1 and see new data packages effect with new path. Below is the change of continuous ping.

```
PC3> ping 10.0.10.3 -t
84 bytes from 10.0.10.3 icmp_seq=1 ttl=62 time=62.325 ms
84 bytes from 10.0.10.3 icmp_seq=2 ttl=62 time=62.425 ms
84 bytes from 10.0.10.3 icmp_seq=3 ttl=62 time=60.141 ms
84 bytes from 10.0.10.3 icmp_seq=4 ttl=62 time=61.779 ms
84 bytes from 10.0.10.3 icmp_seq=5 ttl=60 time=106.930 ms
10.0.10.3 icmp_seq=6 timeout
*10.0.20.1 icmp_seq=7 ttl=255 time=29.864 ms (ICMP type:3, code:1, Destination host unreachable)
84 bytes from 10.0.10.3 icmp_seq=8 ttl=60 time=109.743 ms
84 bytes from 10.0.10.3 icmp_seq=9 ttl=60 time=105.424 ms
84 bytes from 10.0.10.3 icmp_seq=10 ttl=60 time=105.714 ms
84 bytes from 10.0.10.3 icmp_seq=11 ttl=60 time=106.365 ms
84 bytes from 10.0.10.3 icmp_seq=12 ttl=60 time=123.567 ms
84 bytes from 10.0.10.3 icmp_seq=13 ttl=60 time=93.286 ms
84 bytes from 10.0.10.3 icmp_seq=14 ttl=60 time=121.541 ms
84 bytes from 10.0.10.3 icmp_seq=15 ttl=60 time=107.193 ms
84 bytes from 10.0.10.3 icmp_seq=16 ttl=60 time=121.356 ms
84 bytes from 10.0.10.3 icmp_seq=17 ttl=60 time=122.109 ms
84 bytes from 10.0.10.3 icmp_seq=18 ttl=60 time=123.488 ms
84 bytes from 10.0.10.3 icmp_seq=19 ttl=60 time=121.944 ms
84 bytes from 10.0.10.3 icmp_seq=20 ttl=60 time=108.174 ms
84 bytes from 10.0.10.3 icmp_seq=21 ttl=60 time=122.329 ms
```

Clearly only two packets here are lost with icmp_seq = 6 and 7 here. Clearly the connection before and after is the same which means new connection is successful.

```
PC3> trace 10.0.10.3
trace to 10.0.10.3, 8 hops max, press Ctrl+C to stop
 1   10.0.20.1   15.048 ms  15.165 ms  14.667 ms
 2   10.0.0.17   45.564 ms  46.023 ms  47.344 ms
 3   10.0.0.9   76.697 ms  75.535 ms  77.926 ms
 4   10.0.0.5   107.567 ms  106.009 ms  105.749 ms
 5   *10.0.10.3   126.452 ms (ICMP type:3, code:3, Destination port unreachable)
```

Clearly after the middle one is shut down, the system chooses the upper one, that is because the metric of upper three networks are all 1 (lower) because they all have 100Mbps which is the highest throughput, while the down one has a serial connection of only metric 3 (1544kbps) which is very small.

When the static routing is made, it is stable, then it will choose the path that transmit fastest.

Problem 3

a)
1. R1

```
R1#enable
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#router rip
R1(config-router)#version 2
R1(config-router)#no auto-summary
R1(config-router)#network 10.0.10.0
R1(config-router)#network 10.0.0.5
R1(config-router)#network 10.0.0.13
R1(config-router)#network 10.0.0.1
R1(config-router)#end
R1#
*Mar  1 01:02:35.375: %SYS-5-CONFIG_I: Configured from console by console
R1#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
C       10.0.10.0/24 is directly connected, FastEthernet2/0
R       10.0.0.8/30 [120/1] via 10.0.0.6, 00:00:08, FastEthernet0/1
C       10.0.0.12/30 is directly connected, FastEthernet0/0
C       10.0.0.0/30 is directly connected, FastEthernet1/0
C       10.0.0.4/30 is directly connected, FastEthernet0/1
R       10.0.0.16/30 [120/1] via 10.0.0.14, 00:00:11, FastEthernet0/0
R       10.0.20.0/24 [120/1] via 10.0.0.14, 00:00:11, FastEthernet0/0
R       10.0.0.20/30 [120/1] via 10.0.0.14, 00:00:13, FastEthernet0/0
                     [120/1] via 10.0.0.2, 00:00:26, FastEthernet1/0
R1#
```

Four networks that are adjacent to R1 should be configured through RIP version 2. They are 10.0.10.0, 10.0.0.5, 10.0.0.13, 10.0.0.1.

2. R2

Two networks that are adjacent to R2 should be configured through RIP version 2. They are 10.0.0.4 and 10.0.0.8.

```
R2#enable
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#router rip
R2(config-router)#version 2
R2(config-router)#no auto-summary
R2(config-router)#network 10.0.0.4
R2(config-router)#network 10.0.0.8
R2(config-router)#end
R2#
*Mar  1 01:03:41.335: %SYS-5-CONFIG_I: Configured from console by console
R2#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
R       10.0.10.0/24 [120/1] via 10.0.0.5, 00:00:05, FastEthernet0/1
C       10.0.0.8/30 is directly connected, FastEthernet0/0
R       10.0.0.12/30 [120/1] via 10.0.0.5, 00:00:05, FastEthernet0/1
R       10.0.0.0/30 [120/1] via 10.0.0.5, 00:00:05, FastEthernet0/1
C       10.0.0.4/30 is directly connected, FastEthernet0/1
R       10.0.0.16/30 [120/1] via 10.0.0.10, 00:00:18, FastEthernet0/0
R       10.0.20.0/24 [120/2] via 10.0.0.10, 00:00:20, FastEthernet0/0
                     [120/2] via 10.0.0.5, 00:00:07, FastEthernet0/1
R       10.0.0.20/30 [120/2] via 10.0.0.10, 00:00:20, FastEthernet0/0
                     [120/2] via 10.0.0.5, 00:00:07, FastEthernet0/1
R2#
```

3. R3

```
R3#enable
R3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#router rip
R3(config-router)#version 2
R3(config-router)#no auto-summary
R3(config-router)#network 10.0.0.8
R3(config-router)#network 10.0.0.16
R3(config-router)#end
R3#
*Mar  1 01:05:07.075: %SYS-5-CONFIG_I: Configured from console by console
R3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
R       10.0.10.0/24 [120/2] via 10.0.0.18, 00:00:27, FastEthernet0/0
                     [120/2] via 10.0.0.9, 00:00:20, FastEthernet0/1
C       10.0.0.8/30 is directly connected, FastEthernet0/1
R       10.0.0.12/30 [120/1] via 10.0.0.18, 00:00:27, FastEthernet0/0
R       10.0.0.0/30 [120/2] via 10.0.0.18, 00:00:27, FastEthernet0/0
                    [120/2] via 10.0.0.9, 00:00:20, FastEthernet0/1
R       10.0.0.4/30 [120/1] via 10.0.0.9, 00:00:21, FastEthernet0/1
C       10.0.0.16/30 is directly connected, FastEthernet0/0
R       10.0.20.0/24 [120/1] via 10.0.0.18, 00:00:00, FastEthernet0/0
R       10.0.0.20/30 [120/1] via 10.0.0.18, 00:00:00, FastEthernet0/0
R3#
```

Two networks that are adjacent to R3 should be configured through RIP version 2. They are 10.0.0.8 and 10.0.0.16.

4. R4

Two networks that are adjacent to R4 should be configured through RIP version 2. They are 10.0.0.0 and 10.0.0.20.

```
R4#enable
R4#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R4(config)#router rip
R4(config-router)#version 2
R4(config-router)#no auto-summary
R4(config-router)#network 10.0.0.0
R4(config-router)#network 10.0.0.20
R4(config-router)#end
R4#
*Mar  1 01:07:03.323: %SYS-5-CONFIG_I: Configured from console by console
R4#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
R       10.0.10.0/24 [120/1] via 10.0.0.1, 00:00:21, FastEthernet0/0
R       10.0.0.8/30 [120/2] via 10.0.0.22, 00:00:17, Serial0/0
                    [120/2] via 10.0.0.1, 00:00:21, FastEthernet0/0
R       10.0.0.12/30 [120/1] via 10.0.0.22, 00:00:17, Serial0/0
                     [120/1] via 10.0.0.1, 00:00:21, FastEthernet0/0
C       10.0.0.0/30 is directly connected, FastEthernet0/0
R       10.0.0.4/30 [120/1] via 10.0.0.1, 00:00:21, FastEthernet0/0
R       10.0.0.16/30 [120/1] via 10.0.0.22, 00:00:19, Serial0/0
R       10.0.20.0/24 [120/1] via 10.0.0.22, 00:00:19, Serial0/0
C       10.0.0.20/30 is directly connected, Serial0/0
R4#
```

5. R5

```
R5#enable
R5#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R5(config)#router rip
R5(config-router)#version2
                         ^
% Invalid input detected at '^' marker.

R5(config-router)#version 2
R5(config-router)#no auto-summary
R5(config-router)#network 10.0.0.20
R5(config-router)#network 10.0.0.16
R5(config-router)#network 10.0.0.12
R5(config-router)#network 10.0.20.0
R5(config-router)#end
R5#
*Mar  1 01:08:17.571: %SYS-5-CONFIG_I: Configured from console by console
R5#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
R       10.0.10.0/24 [120/1] via 10.0.0.13, 00:00:08, FastEthernet0/0
R       10.0.0.8/30 [120/1] via 10.0.0.17, 00:00:07, FastEthernet0/1
C       10.0.0.12/30 is directly connected, FastEthernet0/0
R       10.0.0.0/30 [120/1] via 10.0.0.21, 00:00:11, Serial0/0
                    [120/1] via 10.0.0.13, 00:00:08, FastEthernet0/0
R       10.0.0.4/30 [120/1] via 10.0.0.13, 00:00:08, FastEthernet0/0
C       10.0.0.16/30 is directly connected, FastEthernet0/1
C       10.0.20.0/24 is directly connected, FastEthernet1/0
C       10.0.0.20/30 is directly connected, Serial0/0
R5#
```

Four networks that are adjacent to R5 should be configured through RIP version 2. They are 10.0.20.0, 10.0.0.16, 10.0.0.12, 10.0.0.20.

6. traceroute from PC-1 to PC-3 screenshot

```
PC1
trace 10.0.20.2
trace to 10.0.20.2, 8 hops max, press Ctrl+C to stop
 1   10.0.10.1   13.920 ms  14.365 ms  16.089 ms
 2   10.0.0.14   45.274 ms  45.328 ms  46.962 ms
 3     **10.0.20.2   60.199 ms (ICMP type:3, code:3, Destination port unreachable)

PC1>
```

7. traceroute from PC-3 to PC-2 screenshot

```
PC3
trace 10.0.10.3
trace to 10.0.10.3, 8 hops max, press Ctrl+C to stop
 1   10.0.20.1   15.325 ms  16.296 ms  16.751 ms
 2   10.0.0.13   45.856 ms  46.224 ms  47.203 ms
 3     **10.0.10.3   61.853 ms (ICMP type:3, code:3, Destination port unreachable)

PC3>
```

8. Explain the most efficient chosen path

Clearly from the two above screenshot the middle path for both PC1 to PC3 and PC3 to PC2 have been chosen, which is the path that just connecting R1 and R5. It is easy to understand although the upper one has highest throughput of 100Mbps, but it goes though totally 5 interfaces among 4 different routers and PC3, which means the middle path is more direct. Similarly, the down path has 4 interfaces to go through, and the connection throughput between the serial 0/0 is extremely low (1544kbps), so it is also not chosen.

b)

1. PC1 to PC3

We show the traceroute in the beginning again:

```
PC1

trace 10.0.20.2
trace to 10.0.20.2, 8 hops max, press Ctrl+C to stop
 1   10.0.10.1   13.920 ms  14.365 ms  16.089 ms
 2   10.0.0.14   45.274 ms  45.328 ms  46.962 ms
 3     **10.0.20.2   60.199 ms (ICMP type:3, code:3, Destination port unreachable)

PC1>
```

Now we show the continuous ping with middle path being shut down by f0/0 of R1 and f0/0 of R5:

```
PC1    R1    R5

ping 10.0.20.2 -t
10.0.20.2 icmp_seq=1 timeout
10.0.20.2 icmp_seq=2 timeout
84 bytes from 10.0.20.2 icmp_seq=3 ttl=62 time=60.335 ms
84 bytes from 10.0.20.2 icmp_seq=4 ttl=62 time=60.945 ms
84 bytes from 10.0.20.2 icmp_seq=5 ttl=62 time=62.788 ms
84 bytes from 10.0.20.2 icmp_seq=6 ttl=62 time=61.360 ms
84 bytes from 10.0.20.2 icmp_seq=7 ttl=62 time=46.441 ms
84 bytes from 10.0.20.2 icmp_seq=8 ttl=62 time=60.794 ms
*10.0.10.1 icmp_seq=9 ttl=255 time=16.174 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.10.1 icmp_seq=10 ttl=255 time=16.770 ms (ICMP type:3, code:1, Destination host unreachable)
10.0.20.2 icmp_seq=11 timeout
10.0.20.2 icmp_seq=12 timeout
10.0.20.2 icmp_seq=13 timeout
10.0.20.2 icmp_seq=14 timeout
10.0.20.2 icmp_seq=15 timeout
10.0.20.2 icmp_seq=16 timeout
10.0.20.2 icmp_seq=17 timeout
10.0.20.2 icmp_seq=18 timeout
84 bytes from 10.0.20.2 icmp_seq=19 ttl=60 time=76.296 ms
84 bytes from 10.0.20.2 icmp_seq=20 ttl=61 time=61.749 ms
84 bytes from 10.0.20.2 icmp_seq=21 ttl=61 time=61.252 ms
84 bytes from 10.0.20.2 icmp_seq=22 ttl=61 time=61.387 ms
84 bytes from 10.0.20.2 icmp_seq=23 ttl=61 time=47.111 ms
84 bytes from 10.0.20.2 icmp_seq=24 ttl=61 time=46.282 ms
84 bytes from 10.0.20.2 icmp_seq=25 ttl=61 time=60.943 ms
84 bytes from 10.0.20.2 icmp_seq=26 ttl=61 time=61.745 ms
84 bytes from 10.0.20.2 icmp_seq=27 ttl=61 time=61.821 ms
84 bytes from 10.0.20.2 icmp_seq=28 ttl=61 time=61.816 ms
84 bytes from 10.0.20.2 icmp_seq=29 ttl=61 time=61.361 ms
84 bytes from 10.0.20.2 icmp_seq=30 ttl=61 time=46.237 ms
84 bytes from 10.0.20.2 icmp_seq=31 ttl=61 time=47.918 ms

PC1>
```

Here 10 packages are lost before new path is implemented by RIPv2 configuration.

```
PC1> trace 10.0.20.2
trace to 10.0.20.2, 8 hops max, press Ctrl+C to stop
 1   10.0.10.1   14.835 ms  14.512 ms  14.997 ms
 2   10.0.0.2   45.732 ms  44.952 ms  45.070 ms
 3   10.0.0.22   45.832 ms  44.907 ms  45.309 ms
 4     *  *  *
 5   *10.0.20.2   60.273 ms (ICMP type:3, code:3, Destination port unreachable)

PC1>
```

We can see that after middle path is shut down, the RIPv2 chooses the down one, that is because RIPv2 have to re-configurate and allocate ip routes after the middle path is shut down, where the down path has fewer routers to deal with, so it chooses the down path instead of the upper one with more routers to go through.

This means RIPv2 is not a very stable configuration like static routing since it is dynamic. It will choose the path with less rebuilding workload.

1. PC3 to PC2

We show the traceroute in the beginning again:

Still the middle path is chosen.

```
PC3
trace 10.0.10.3
trace to 10.0.10.3, 8 hops max, press Ctrl+C to stop
 1   10.0.20.1   15.325 ms  16.296 ms  16.751 ms
 2   10.0.0.13   45.856 ms  46.224 ms  47.203 ms
 3     **10.0.10.3   61.853 ms (ICMP type:3, code:3, Destination port unreachable)

PC3>
```

Now we show the continuous ping with middle path being shut down by f0/0 of R1 and f0/0 of R5:

```
ping 10.0.10.3 -t
10.0.10.3 icmp_seq=1 timeout
10.0.10.3 icmp_seq=2 timeout
84 bytes from 10.0.10.3 icmp_seq=3 ttl=62 time=62.418 ms
84 bytes from 10.0.10.3 icmp_seq=4 ttl=62 time=62.312 ms
84 bytes from 10.0.10.3 icmp_seq=5 ttl=62 time=61.560 ms
84 bytes from 10.0.10.3 icmp_seq=6 ttl=62 time=61.887 ms
*10.0.20.1 icmp_seq=7 ttl=255 time=15.766 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.20.1 icmp_seq=8 ttl=255 time=15.567 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.20.1 icmp_seq=9 ttl=255 time=16.540 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.20.1 icmp_seq=10 ttl=255 time=16.212 ms (ICMP type:3, code:1, Destination host unreachable)
10.0.10.3 icmp_seq=11 timeout
10.0.10.3 icmp_seq=12 timeout
10.0.10.3 icmp_seq=13 timeout
10.0.10.3 icmp_seq=14 timeout
10.0.10.3 icmp_seq=15 timeout
10.0.10.3 icmp_seq=16 timeout
10.0.10.3 icmp_seq=17 timeout
10.0.10.3 icmp_seq=18 timeout
10.0.10.3 icmp_seq=19 timeout
84 bytes from 10.0.10.3 icmp_seq=20 ttl=60 time=91.743 ms
84 bytes from 10.0.10.3 icmp_seq=21 ttl=60 time=90.300 ms
84 bytes from 10.0.10.3 icmp_seq=22 ttl=60 time=91.637 ms
84 bytes from 10.0.10.3 icmp_seq=23 ttl=60 time=93.894 ms
84 bytes from 10.0.10.3 icmp_seq=24 ttl=60 time=91.584 ms
84 bytes from 10.0.10.3 icmp_seq=25 ttl=60 time=91.782 ms
84 bytes from 10.0.10.3 icmp_seq=26 ttl=60 time=90.890 ms
84 bytes from 10.0.10.3 icmp_seq=27 ttl=60 time=76.455 ms
84 bytes from 10.0.10.3 icmp_seq=28 ttl=61 time=61.184 ms
84 bytes from 10.0.10.3 icmp_seq=29 ttl=61 time=61.957 ms
84 bytes from 10.0.10.3 icmp_seq=30 ttl=61 time=60.543 ms
```

Here 13 packages are lost before new path is implemented by RIPv2 configuration.

```
PC3> trace 10.0.10.3
trace to 10.0.10.3, 8 hops max, press Ctrl+C to stop
 1   10.0.20.1   14.952 ms  14.682 ms  15.991 ms
 2   10.0.0.21   15.886 ms  15.327 ms  14.395 ms
 3   10.0.0.1   44.783 ms  45.043 ms  44.648 ms
 4     *  *  *
 5   *10.0.10.3   61.703 ms (ICMP type:3, code:3, Destination port unreachable)

PC3>
```

We can see that after middle path is shut down, the RIPv2 chooses the down one, that is because RIPv2 have to re-configurate and allocate ip routes after the middle path is shut down, where the down path has fewer routers to deal with, so it chooses the down path instead of the upper one with more routers to go through.

This means RIPv2 is not a very stable configuration like static routing since it is dynamic. It will choose the path with less rebuilding workload.

Problem 4

a)

- Actually it is easy to understand here since We already have decided subnet division, where R1 and PC1, PC2 are in network A, R5 and PC3 are in network B, R1 to R5 are in backbone network. So I set Network A to be area 1, Network B to be area 2, backbone to be area 0.

Here is the demonstration of networks with appropriate ip addresses, wildcard mask and area id for each router.

1. R1

```
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#router ospf 1
R1(config-router)#network 10.0.10.0 0.0.0.255 area 1
R1(config-router)#network 10.0.0.4 0.0.0.3 area 0
R1(config-router)#network 10.0.0.0 0.0.0.3 area 0
R1(config-router)#network 10.0.0.12 0.0.0.3 area 0
R1(config-router)#end
R1#
```

2. R2

```
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#router ospf 1
R2(config-router)#network 10.0.0.4 0.0.0.3 area 0
R2(config-router)#network 10.0.0.
*Mar  1 01:10:29.883: %OSPF-5-ADJCHG: Process 1, Nbr 10.0.10.1 on FastEthernet0/1 from LOADING to FULL, Loading Don
R2(config-router)#network 10.0.0.8 0.0.0.3 area 0
R2(config-router)#end
R2#
```

3. R3

```
R3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#router ospf 1
R3(config-router)#network 10.0.0.8 0.0.0.3 area 0
R3(config-router)#network
*Mar  1 01:12:37.027: %OSPF-5-ADJCHG: Process 1, Nbr 10.0.0.9 on FastEthernet0/1
 from LOADING to FULL, Loading Done
R3(config-router)#network 10.0.0.16 0.0.0.3 area 0
R3(config-router)#end
R3#
```

4. R4

```
R4#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R4(config)#router ospf 1
R4(config-router)#network 10.0.0.0 0.0.0.3 area 0
R4(config-router)#network 10.0.0.
*Mar  1 01:15:45.179: %OSPF-5-ADJCHG: Process 1, Nbr 10.0.10.1 on FastEthernet0/
0 from LOADING to FULL, Loading Done
R4(config-router)#network 10.0.0.20 0.0.0.3 area 0
R4(config-router)#
*Mar  1 01:15:53.931: %OSPF-5-ADJCHG: Process 1, Nbr 10.0.20.1 on Serial0/0 from
 LOADING to FULL, Loading Done
R4(config-router)#end
R4#
```

5. R5

```
R5#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R5(config)#router ospf 1
R5(config-router)#network 10.0.0.16 0.0.0.3 area 0
R5(config-router)#network 10.0.0.20 0.0.0
*Mar  1 01:13:41.779: %OSPF-5-ADJCHG: Process 1, Nbr 10.0.0.17 on FastEthernet0/
1 from LOADING to FULL, Loading Done
R5(config-router)#network 10.0.0.20 0.0.0.3 area 0
R5(config-router)#network 10.0.0.12 0.0.0.3 area 0
R5(config-router)#network 10
*Mar  1 01:14:05.951: %OSPF-5-ADJCHG: Process 1, Nbr 10.0.10.1 on FastEthernet0/
0 from LOADING to FULL, Loading Done
R5(config-router)#network 10.0.20.0 0.0.0.255 area 2
R5(config-router)#
```

- OSPF uses a cost metric that represents the status of the link and the bandwidth of the interface in an algorithm to determine the best route to a destination. The algorithm used is called the SPF (shortest path first) or Dijkstra algorithm.
  So the upper link has metric value: 1,
  The middle link has metric value: 2,
  The down link has metric value: 3.

b)
1. PC1 to PC3

```
trace 10.0.20.2
trace to 10.0.20.2, 8 hops max, press Ctrl+C to stop
 1   10.0.10.1   14.998 ms  15.382 ms  15.290 ms
 2   10.0.0.6   45.181 ms  45.242 ms  45.992 ms
 3   10.0.0.10   75.200 ms  75.329 ms  75.318 ms
 4   10.0.0.18   105.064 ms  105.309 ms  105.130 ms
 5     *  *  *
 6   *10.0.20.2   120.547 ms (ICMP type:3, code:3, Destination port unreachable)

PC1>
```

Clearly the upper traceroute is selected by ospf routing since lowest metric (highest throughput).

```
PC1> ping 10.0.20.2 -t
10.0.20.2 icmp_seq=1 timeout
10.0.20.2 icmp_seq=2 timeout
84 bytes from 10.0.20.2 icmp_seq=3 ttl=60 time=120.332 ms
84 bytes from 10.0.20.2 icmp_seq=4 ttl=60 time=120.181 ms
84 bytes from 10.0.20.2 icmp_seq=5 ttl=60 time=120.263 ms
84 bytes from 10.0.20.2 icmp_seq=6 ttl=60 time=120.337 ms
10.0.20.2 icmp_seq=7 timeout
*10.0.0.6 icmp_seq=8 ttl=254 time=45.282 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.0.6 icmp_seq=9 ttl=254 time=45.519 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.0.6 icmp_seq=10 ttl=254 time=45.290 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.0.6 icmp_seq=11 ttl=254 time=45.446 ms (ICMP type:3, code:1, Destination host unreachable)
84 bytes from 10.0.20.2 icmp_seq=12 ttl=62 time=60.404 ms
84 bytes from 10.0.20.2 icmp_seq=13 ttl=62 time=60.337 ms
84 bytes from 10.0.20.2 icmp_seq=14 ttl=62 time=60.273 ms
84 bytes from 10.0.20.2 icmp_seq=15 ttl=62 time=60.332 ms
84 bytes from 10.0.20.2 icmp_seq=16 ttl=62 time=60.336 ms
84 bytes from 10.0.20.2 icmp_seq=17 ttl=62 time=60.244 ms
84 bytes from 10.0.20.2 icmp_seq=18 ttl=62 time=60.319 ms
84 bytes from 10.0.20.2 icmp_seq=19 ttl=62 time=60.333 ms
84 bytes from 10.0.20.2 icmp_seq=20 ttl=62 time=60.362 ms
84 bytes from 10.0.20.2 icmp_seq=21 ttl=62 time=60.538 ms
```

Here 5 packages are lost where icmp_seq ranges from 7 to 11.

```
PC1> trace 10.0.20.2
trace to 10.0.20.2, 8 hops max, press Ctrl+C to stop
 1   10.0.10.1   15.348 ms  15.490 ms  15.164 ms
 2   10.0.0.14   60.262 ms  45.118 ms  45.134 ms
 3     *  *  *
 4   *10.0.20.2   60.080 ms (ICMP type:3, code:3, Destination port unreachable)
```

After the upper path is shut down, clearly the middle one is selected as we discussed above that middle path now have lowest metric (2, smaller than 3 of the down one).

2.PC3 to PC2

```
trace 10.0.10.3
trace to 10.0.10.3, 8 hops max, press Ctrl+C to stop
 1   10.0.20.1   14.951 ms  15.099 ms  15.085 ms
 2   10.0.0.17   45.158 ms  45.076 ms  45.118 ms
 3   10.0.0.9   75.213 ms  75.175 ms  75.278 ms
 4   10.0.0.5   105.122 ms  105.031 ms  105.159 ms
 5     **10.0.10.3   120.002 ms (ICMP type:3, code:3, Destination port unreachable)
```

Clearly the upper traceroute is selected by ospf routing since lowest metric (highest throughput).

```
PC3> ping 10.0.10.3 -t
84 bytes from 10.0.10.3 icmp_seq=1 ttl=60 time=277.518 ms
84 bytes from 10.0.10.3 icmp_seq=2 ttl=60 time=287.710 ms
84 bytes from 10.0.10.3 icmp_seq=3 ttl=60 time=256.313 ms
84 bytes from 10.0.10.3 icmp_seq=4 ttl=60 time=438.326 ms
10.0.10.3 icmp_seq=5 timeout
*10.0.0.17 icmp_seq=6 ttl=254 time=68.167 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.0.17 icmp_seq=7 ttl=254 time=114.761 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.0.17 icmp_seq=8 ttl=254 time=108.032 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.0.17 icmp_seq=9 ttl=254 time=76.298 ms (ICMP type:3, code:1, Destination host unreachable)
84 bytes from 10.0.10.3 icmp_seq=10 ttl=62 time=172.076 ms
84 bytes from 10.0.10.3 icmp_seq=11 ttl=62 time=111.259 ms
84 bytes from 10.0.10.3 icmp_seq=12 ttl=62 time=115.447 ms

PC3>
```

Here 5 packages are lost where icmp_seq ranges from 5 to 9.

```
PC3> trace 10.0.10.3
trace to 10.0.10.3, 8 hops max, press Ctrl+C to stop
 1   10.0.20.1   46.287 ms  47.813 ms  43.484 ms
 2   10.0.0.13   91.836 ms  153.831 ms  122.783 ms
 3   *10.0.10.3   143.535 ms (ICMP type:3, code:3, Destination port unreachable)
```

After the upper path is shut down, clearly the middle one is selected as we discussed above that middle path now have lowest metric (2, smaller than 3 of the down one).

Problem 5

1. Static routing

Static routing is a very stable routing connection with high working effectiveness and efficiency when it is applied, this can be evidence by the very few packages lost in problem 2 screenshot.

```
PC3> ping 10.0.10.3 -t
84 bytes from 10.0.10.3 icmp_seq=1 ttl=62 time=62.325 ms
84 bytes from 10.0.10.3 icmp_seq=2 ttl=62 time=62.425 ms
84 bytes from 10.0.10.3 icmp_seq=3 ttl=62 time=60.141 ms
84 bytes from 10.0.10.3 icmp_seq=4 ttl=62 time=61.779 ms
84 bytes from 10.0.10.3 icmp_seq=5 ttl=60 time=106.930 ms
10.0.10.3 icmp_seq=6 timeout
*10.0.20.1 icmp_seq=7 ttl=255 time=29.864 ms (ICMP type:3, code:1, Destination host unreachable)
84 bytes from 10.0.10.3 icmp_seq=8 ttl=60 time=109.743 ms
84 bytes from 10.0.10.3 icmp_seq=9 ttl=60 time=105.424 ms
84 bytes from 10.0.10.3 icmp_seq=10 ttl=60 time=105.714 ms
84 bytes from 10.0.10.3 icmp_seq=11 ttl=60 time=106.365 ms
84 bytes from 10.0.10.3 icmp_seq=12 ttl=60 time=123.567 ms
84 bytes from 10.0.10.3 icmp_seq=13 ttl=60 time=93.286 ms
84 bytes from 10.0.10.3 icmp_seq=14 ttl=60 time=121.541 ms
84 bytes from 10.0.10.3 icmp_seq=15 ttl=60 time=107.193 ms
84 bytes from 10.0.10.3 icmp_seq=16 ttl=60 time=121.356 ms
84 bytes from 10.0.10.3 icmp_seq=17 ttl=60 time=122.109 ms
84 bytes from 10.0.10.3 icmp_seq=18 ttl=60 time=123.488 ms
84 bytes from 10.0.10.3 icmp_seq=19 ttl=60 time=121.944 ms
84 bytes from 10.0.10.3 icmp_seq=20 ttl=60 time=108.174 ms
84 bytes from 10.0.10.3 icmp_seq=21 ttl=60 time=122.329 ms
```

However, it requires much time for the programmer to manually set up the static routing, for example, here for R1 there should be configured 5 ip static routing with much information inserted, not to mention that there are more complicated topology.

So it is good to be used in simple topology requiring stable routing connection.

2. Dynamic routing RIPv2

Dynamic routing RIPv2 is the most easy one to understand and apply among all the three routings because it only require you to insert the information of the networks that are adjacent to the router without inserting subnet mask or gateway. So it is the easiest one regarding to routing complication and routing time.

```
R3#enable
R3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#router rip
R3(config-router)#version 2
R3(config-router)#no auto-summary
R3(config-router)#network 10.0.0.8
R3(config-router)#network 10.0.0.16
R3(config-router)#end
R3#
*Mar  1 01:05:07.075: %SYS-5-CONFIG_I: Configured from console by console
R3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
R       10.0.10.0/24 [120/2] via 10.0.0.18, 00:00:27, FastEthernet0/0
                     [120/2] via 10.0.0.9, 00:00:20, FastEthernet0/1
C       10.0.0.8/30 is directly connected, FastEthernet0/1
R       10.0.0.12/30 [120/1] via 10.0.0.18, 00:00:27, FastEthernet0/0
R       10.0.0.0/30 [120/2] via 10.0.0.18, 00:00:27, FastEthernet0/0
                    [120/2] via 10.0.0.9, 00:00:20, FastEthernet0/1
R       10.0.0.4/30 [120/1] via 10.0.0.9, 00:00:21, FastEthernet0/1
C       10.0.0.16/30 is directly connected, FastEthernet0/0
R       10.0.20.0/24 [120/1] via 10.0.0.18, 00:00:00, FastEthernet0/0
R       10.0.0.20/30 [120/1] via 10.0.0.18, 00:00:00, FastEthernet0/0
R3#
```

However, it is the most unstable among the three once there is shutdown in preferred path, noticed that 13 packages are lost in problem 3.

```
ping 10.0.10.3 -t
10.0.10.3 icmp_seq=1 timeout
10.0.10.3 icmp_seq=2 timeout
84 bytes from 10.0.10.3 icmp_seq=3 ttl=62 time=62.418 ms
84 bytes from 10.0.10.3 icmp_seq=4 ttl=62 time=62.312 ms
84 bytes from 10.0.10.3 icmp_seq=5 ttl=62 time=61.560 ms
84 bytes from 10.0.10.3 icmp_seq=6 ttl=62 time=61.887 ms
*10.0.20.1 icmp_seq=7 ttl=255 time=15.766 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.20.1 icmp_seq=8 ttl=255 time=15.567 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.20.1 icmp_seq=9 ttl=255 time=16.540 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.20.1 icmp_seq=10 ttl=255 time=16.212 ms (ICMP type:3, code:1, Destination host unreachable)
10.0.10.3 icmp_seq=11 timeout
10.0.10.3 icmp_seq=12 timeout
10.0.10.3 icmp_seq=13 timeout
10.0.10.3 icmp_seq=14 timeout
10.0.10.3 icmp_seq=15 timeout
10.0.10.3 icmp_seq=16 timeout
10.0.10.3 icmp_seq=17 timeout
10.0.10.3 icmp_seq=18 timeout
10.0.10.3 icmp_seq=19 timeout
84 bytes from 10.0.10.3 icmp_seq=20 ttl=60 time=91.743 ms
84 bytes from 10.0.10.3 icmp_seq=21 ttl=60 time=90.300 ms
84 bytes from 10.0.10.3 icmp_seq=22 ttl=60 time=91.637 ms
84 bytes from 10.0.10.3 icmp_seq=23 ttl=60 time=93.894 ms
84 bytes from 10.0.10.3 icmp_seq=24 ttl=60 time=91.584 ms
84 bytes from 10.0.10.3 icmp_seq=25 ttl=60 time=91.782 ms
84 bytes from 10.0.10.3 icmp_seq=26 ttl=60 time=90.890 ms
84 bytes from 10.0.10.3 icmp_seq=27 ttl=60 time=76.455 ms
84 bytes from 10.0.10.3 icmp_seq=28 ttl=61 time=61.184 ms
84 bytes from 10.0.10.3 icmp_seq=29 ttl=61 time=61.957 ms
84 bytes from 10.0.10.3 icmp_seq=30 ttl=61 time=60.543 ms
```

So it is good for those complicated topology that with many routers and don't require stable connection as priority, where configuration in short time is priority.

3. OSPF routing

Similarly, OSPF only need you to insert the information of network adjacent to you, however, it requires information of wildcard mask and area number as division of subnet group. So, it is a little more complicated than ripv2 but easier than static routing considering configuration complexity and time-consumption.

```
R4#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R4(config)#router ospf 1
R4(config-router)#network 10.0.0.0 0.0.0.3 area 0
R4(config-router)#network 10.0.0.
*Mar  1 01:15:45.179: %OSPF-5-ADJCHG: Process 1, Nbr 10.0.10.1 on FastEthernet0/
0 from LOADING to FULL, Loading Done
R4(config-router)#network 10.0.0.20 0.0.0.3 area 0
R4(config-router)#
*Mar  1 01:15:53.931: %OSPF-5-ADJCHG: Process 1, Nbr 10.0.20.1 on Serial0/0 from
 LOADING to FULL, Loading Done
R4(config-router)#end
R4#
```

And it has lost 5 packages during shutdown the preferred path, stabler than ripv2 but not as stable as static routing in terms of stability.

```
PC3> ping 10.0.10.3 -t
84 bytes from 10.0.10.3 icmp_seq=1 ttl=60 time=277.518 ms
84 bytes from 10.0.10.3 icmp_seq=2 ttl=60 time=287.710 ms
84 bytes from 10.0.10.3 icmp_seq=3 ttl=60 time=256.313 ms
84 bytes from 10.0.10.3 icmp_seq=4 ttl=60 time=438.326 ms
10.0.10.3 icmp_seq=5 timeout
*10.0.0.17 icmp_seq=6 ttl=254 time=68.167 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.0.17 icmp_seq=7 ttl=254 time=114.761 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.0.17 icmp_seq=8 ttl=254 time=108.032 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.0.17 icmp_seq=9 ttl=254 time=76.298 ms (ICMP type:3, code:1, Destination host unreachable)
84 bytes from 10.0.10.3 icmp_seq=10 ttl=62 time=172.076 ms
84 bytes from 10.0.10.3 icmp_seq=11 ttl=62 time=111.259 ms
84 bytes from 10.0.10.3 icmp_seq=12 ttl=62 time=115.447 ms

PC3>
```

But the most profit point for OSPF is that it always chooses the fastest path with highest throughput, so it is good for topology which requires highest speed utility and high load in the path.