
INGI 2142 - Group 8

Assignment 1 : Open Shortest Path First (OSPF)

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February 23, 2010

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The aim of this work was to configure a eight routers network and understand the way it works. This will be done via the OSPF protocol that presents interesting capabilities such as fast convergence, support of larger networks than other routing protocols (e.g RIP) and less susceptibility to bad routing information.

1 Question 1 : Paths from R1 to R3

| What is the path being taken by packets coming from R1 (i) to R3's loopback, (ii) to 10.10.1.9 ? Explain.

R1 - R3

We can see in listing 1, the path taken by packets from R1 to R3 goes through R2 (10.10.1.2) first, then goes to R3 (10.10.1.6). This is due to the fact that the cost between R1 and R2 is 400 and the cost between R2 and R3 is 100. Thus the sum of the cost of this path is 500, while the cost between R1 and R3 is 800. Since 500 is less than 800, the path through R2 is chosen.

The same path is taken by packets from R3 to R1 (listing 2).

R1 - 10.10.1.9

The packets sent from R1 to R3 (10.10.1.9) directly go to R3 (listing 3). This is due to the fact that R1 is directly connected to the 10.10.1.8/30 network. In fact, the router prefers the routes it knows over the routes it has learned via OSPF.

2 Question 2 : Link-State Database

| Take a look at the content of the Link State database on :
An internal router such as X

The content of the X's database is show on listing 4.

| An area border router such as R1

The content of the R1's database is show on listing 5.

| Explain the differences

The main difference that we can see is that router X belongs to only one area (area 2) so that the link-state database of router X contains only LSA from area 2. On the other hand, router R1 belongs to area 2 and the backbone area (area 0).

| What are the different types of LSAs that you see. What are they used for ?

- Type 1 - Router LSA
©Wikipedia : The router lists the links to other routers or networks in the same area, together with the metric. Type 1 LSAs are flooded across their own area only. The link-state ID of the type 1 LSA is the originating router ID.
- Type 2 - Network LSA
©Wikipedia : The designated router on a broadcast segment (e.g. Ethernet) lists which routers are joined together by the segment. Type 2 LSAs are flooded across their own area only. The link-state ID of the type 2 LSA is the IP interface address of the DR.
- Type 3 - Summary LSA
©Wikipedia : An Area Border Router (ABR) takes information it has learned on one of its attached areas and it can summarize it (but not by default) before sending it out on other areas it is connected to. This summarization helps provide scalability by removing detailed topology information for other areas, because their routing information is summarized into just an address prefix and metric. The summarization process can also be configured to remove a lot of detailed address prefixes and replace them with a single summary prefix, also helping scalability. The link-state ID is the destination network number for type 3 LSAs.

| What path would a packet take to go from router X to the loopback of router Y (i.e., 192.168.10.2)

The shortest path is X - R5 - R1 - R2 - R3 - R4 - Y.

| Validate this by looking at routing tables content ? What is the associated metric (verify it by issuing the right command on X), how is it computed ?

With the listing 6, we can see that X has computed a path to Y via 10.10.3.2 (FastEthernet1/0) with a cost of 1203. This cost is the sum of the link cost of the shortest path computed by OSPF : X - R5 - R1 - R2 - R3 - R4 - Y (link costs 1 + 500 + 400 + 100 + 200 + 1 + 1 = 1203).

| What is the difference with the path X computed ? Explain.

According to the listing 7, the difference is in R2. According to the cost, the packet would go to R3 (cost = 100) but this is not the case here. Actually, the packet goes directly to R4 because OSPF prefers an intra-area path to the destination Y. Y is in area 1 and R2 prefers to send the packet via its interface f0/0 already in area 1 (even if the cost is higher).

3 Question 3 : Designated Routers

| In your configuration, what are the DR and BDR routers elected on the Ethernet segment connecting R5, R6 and X? Explain. Then, ensure yourself that R5 will always be preferred as DR by using the ip ospf priority command under the right interface configuration.

According to the listing 8, the DR is X and the BDR is R6.

When the election is taking place, all the routers have a priority of 1 (default). Thus, the tie argument is the RID. Since 192.168.10.1 is higher than 192.168.1.6 and 192.168.1.5, X will win the process.

Let's change the priority of R5 (9).

In order to recompute the DR a request must be made, so we rebooted all the routers of the lan. R5 is now the DR (listing 10).

4 Question 4 : Summarization

Since the version is higher than 12.1 (12.4, listing 11), we don't need to add a null route in the routing table. This is done automatically while the summarization is done. http://ciscosystems.com/en/US/tech/tk365/technologies_white_paper09186a0080094e9e.shtml#t29

For instance, the summarization has been done on R2 with the command listed in listing 12.

The listings 13 and 14 show the database of R2 before and after the summarization. We can see that the Summary Net Link States are shorter and summarized for each area.

5 Question 5 : Inter vs Intra

We will use the route followed by packets between router Y and X to explain the way inter-area and intra-area routing is managed by the OSPF protocol. We can first remind us that OSPF prefers intra-area paths to inter-area paths (see RFC2328 p.109-Path-type). When using the traceroute command, we get the result shown in listing 15.

In summary, we have: X - R4 - R3 - R2 - R5 - Y.

The definitions given in RFC2328 for inter and intra area paths are :

- inter-area paths : Inter-area paths are paths to destinations in other OSPF areas
- intra-area paths : Intra-area paths indicate destinations belonging to one of the router's attached areas

So, according to these definitions, we can explain the result returned for the traceroute command.

- Between Y and R4 : we have no choice in the route, so the cost for this portion is 1.
- Between R4 and R3 : the route to the destination must go through the backbone area called "AREA0" so, the path with the lowest cost is chosen. That is, the route to R3 that costs 200 instead of 500 (to R2) is chosen.
- Between R3 and R2 : this path is chosen because the cost is less than the cost between R3 and R1, and both route are intra-area path so the minimal cost is preferred.

- Between R2 and R5 : the other interesting route that could be used is the one to R1. OSPF prefers the route to R5 because it's an intra-area path while the one to R1 is an inter-area path. So the protocol sends the packets to R5 without taking care of the cost of the link because as said earlier, this protocol prefers intra-area path to inter-area path.
- Between R5 and Y : the intra-area route with the lowest cost has been chosen.

6 Question 6 : Asymmetrical paths

We can see that the path from X to Y (listing 7) is not the same than the path from Y to X (listing 15), i.e. the path between those two routers is asymmetric. This is due to the inter vs intra politics of OSPF.

Nevertheless, one can want to have a perfectly symmetric and unique path between two hosts. A perfectly symmetric path can be wanted for several points. A point is that if the path is unique, traceroute will be more accurate since it will always indicate the path that is actually taken by packets. Another point is that if the path isn't symmetric, there may be congestion problem. Let's consider the network with 4 hosts: A, B, C and D. There is a path between A, C and B, and another one between A, D and B. Let's assume that A is sending a lot of packets to B through C and B is sending back ack to A through D. If D is congested, some ack could take more time to reach A. Thus, A will resend some packets, and C may become congested too.

We have two solutions to achieve a symmetrical path.

The first solution is to build a VLAN between X and Y. This VLAN will only contain the routers that belong to the path we want to use. This solution will lead to a new virtual link between X and Y. This link can have an OSPF metric, and can be advertised by OSPF. If this link goes down, OSPF will compute a new path that will be not longer symmetrical. Because of lack of time, we haven't implemented this solution.

Another solution is to use MPLS. This will be the subject of the next assignment.

A Question 1 : Paths from R1 to R3

Listing 1: Traceroute from R1 to R3

```
1 R1#traceroute 192.168.1.3 numeric
2
3 Type escape sequence to abort.
4 Tracing the route to 192.168.1.3
5
6   1 10.10.1.2 4 msec 8 msec 8 msec
7   2 10.10.1.6 8 msec * 16 msec
```

Listing 2: Traceroute from R3 to R1

```
1 R3#traceroute 192.168.1.1 numeric
2
3 Type escape sequence to abort.
4 Tracing the route to 192.168.1.1
5
6   1 10.10.1.5 4 msec 8 msec 4 msec
7   2 10.10.1.1 8 msec * 16 msec
```

Listing 3: Traceroute from R1 to 10.10.1.9

```
1 R1#traceroute 10.10.1.9 numeric
2
3 Type escape sequence to abort.
4 Tracing the route to 10.10.1.9
5
6   1 10.10.1.9 12 msec * 32 msec
7
8 R1#show ip route
9 Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
10        D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
11        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
12        E1 - OSPF external type 1, E2 - OSPF external type 2
13        i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
14        ia - IS-IS inter area, * - candidate default, U - per-user static
15        route
16        o - ODR, P - periodic downloaded static route
17 Gateway of last resort is not set
18
19     192.168.10.0/32 is subnetted, 2 subnets
20 O IA   192.168.10.2 [110/702] via 10.10.1.2, 00:01:10, FastEthernet1/0
21 O     192.168.10.1 [110/502] via 10.10.3.9, 00:01:10, FastEthernet0/0
22     10.0.0.0/8 is variably subnetted, 10 subnets, 2 masks
23 C     10.10.1.0/30 is directly connected, FastEthernet1/0
24 O IA   10.10.2.0/30 [110/900] via 10.10.1.2, 00:01:10, FastEthernet1/0
25 O     10.10.3.0/30 [110/501] via 10.10.3.9, 00:01:10, FastEthernet0/0
26 O     10.10.1.4/30 [110/500] via 10.10.1.2, 00:03:35, FastEthernet1/0
27 O IA   10.10.2.4/30 [110/701] via 10.10.1.2, 00:01:10, FastEthernet1/0
28 O     10.10.3.4/30 [110/1500] via 10.10.3.9, 00:01:10, FastEthernet0/0
29 C     10.10.1.8/30 is directly connected, FastEthernet1/1
30 O IA   10.10.2.8/30 [110/700] via 10.10.1.2, 00:01:10, FastEthernet1/0
31 C     10.10.3.8/30 is directly connected, FastEthernet0/0
32 O     10.10.3.16/28 [110/600] via 10.10.3.9, 00:01:15, FastEthernet0/0
33     192.168.1.0/32 is subnetted, 6 subnets
34 C     192.168.1.1 is directly connected, Loopback0
35 O     192.168.1.3 [110/501] via 10.10.1.2, 00:03:40, FastEthernet1/0
36 O     192.168.1.2 [110/401] via 10.10.1.2, 00:03:40, FastEthernet1/0
37 O     192.168.1.5 [110/501] via 10.10.3.9, 00:01:16, FastEthernet0/0
38 O IA   192.168.1.4 [110/701] via 10.10.1.2, 00:01:16, FastEthernet1/0
39 O     192.168.1.6 [110/601] via 10.10.3.9, 00:01:17, FastEthernet0/0
```

B Question 2 : Link-State Database

Listing 4: X's LSA

```
1 X#show ip ospf database
2
3         OSPF Router with ID (192.168.10.1) (Process ID 8)
4
5         Router Link States (Area 2)
6
7 Link ID      ADV Router    Age           Seq#          Checksum Link count
8 192.168.1.1  192.168.1.1   189          0x80000002   0x00EB38  1
9 192.168.1.2  192.168.1.2   189          0x80000002   0x00C46F  1
10 192.168.1.5  192.168.1.5   188          0x80000003   0x00F966  5
11 192.168.1.6  192.168.1.6   193          0x80000002   0x001405  2
12 192.168.10.1 192.168.10.1  190          0x80000002   0x00B914  3
13
14         Net Link States (Area 2)
15
16 Link ID      ADV Router    Age           Seq#          Checksum
17 10.10.3.1    192.168.10.1 190          0x80000001   0x00814B
18 10.10.3.5    192.168.1.5   189          0x80000001   0x002DA8
19 10.10.3.9    192.168.1.5   189          0x80000001   0x00F6DB
20 10.10.3.19   192.168.1.5   186          0x80000002   0x00292D
21
22         Summary Net Link States (Area 2)
23
24 Link ID      ADV Router    Age           Seq#          Checksum
25 10.10.1.0    192.168.1.1   229          0x80000001   0x000727
26 10.10.1.0    192.168.1.2   228          0x80000001   0x00012C
27 10.10.1.4    192.168.1.1   189          0x80000001   0x00CAFA
28 10.10.1.4    192.168.1.2   228          0x80000001   0x001640
29 10.10.1.8    192.168.1.1   230          0x80000001   0x006430
30 10.10.1.8    192.168.1.2   178          0x80000002   0x0048E5
31 10.10.2.0    192.168.1.1   189          0x80000001   0x0095A1
32 10.10.2.0    192.168.1.2   228          0x80000001   0x00E1E5
33 10.10.2.4    192.168.1.1   179          0x80000002   0x009E5B
34 10.10.2.4    192.168.1.2   189          0x80000001   0x00C3FE
35 10.10.2.8    192.168.1.1   179          0x80000002   0x006C8A
36 10.10.2.8    192.168.1.2   189          0x80000001   0x00688E
37 192.168.1.1  192.168.1.1   230          0x80000001   0x00B3B1
38 192.168.1.1  192.168.1.2   189          0x80000001   0x005C76
39 192.168.1.2  192.168.1.1   189          0x80000001   0x00587A
40 192.168.1.2  192.168.1.2   228          0x80000001   0x00A3BF
41 192.168.1.3  192.168.1.1   179          0x80000001   0x003A33
42 192.168.1.3  192.168.1.2   179          0x80000001   0x008578
43 192.168.1.4  192.168.1.1   179          0x80000002   0x00059D
44 192.168.1.4  192.168.1.2   189          0x80000001   0x002A41
45 192.168.10.2 192.168.1.1   179          0x80000002   0x00BFDA
46 192.168.10.2 192.168.1.2   189          0x80000001   0x00E47E
```

Listing 5: R1's LSA

```
1 R1#show ip ospf database
2
3         OSPF Router with ID (192.168.1.1) (Process ID 8)
4
5         Router Link States (Area 0)
6
7 Link ID      ADV Router    Age           Seq#          Checksum Link count
8 192.168.1.1  192.168.1.1   847          0x80000003   0x00BFEF  3
9 192.168.1.2  192.168.1.2   848          0x80000003   0x00F978  3
10 192.168.1.3  192.168.1.3   853          0x80000002   0x007A55  3
11
12         Net Link States (Area 0)
13
14 Link ID      ADV Router    Age           Seq#          Checksum
15 10.10.1.2    192.168.1.2   853          0x80000001   0x00479A
16 10.10.1.6    192.168.1.3   852          0x80000001   0x0031A9
```

17 10.10.1.9 192.168.1.3 852 0x80000001 0x0005D3

18

19 Summary Net Link States (Area 0)

20

21 Link ID	ADV Router	Age	Seq#	Checksum
22 10.10.2.0	192.168.1.2	889	0x80000001	0x00E1E5
23 10.10.2.0	192.168.1.3	851	0x80000001	0x00B24B
24 10.10.2.4	192.168.1.2	849	0x80000001	0x00C3FE
25 10.10.2.4	192.168.1.3	851	0x80000001	0x00FAF3
26 10.10.2.8	192.168.1.2	849	0x80000001	0x00688E
27 10.10.2.8	192.168.1.3	899	0x80000001	0x00C823
28 10.10.3.0	192.168.1.1	849	0x80000001	0x00E6DF
29 10.10.3.0	192.168.1.2	849	0x80000001	0x007A55
30 10.10.3.4	192.168.1.1	849	0x80000001	0x00E7EF
31 10.10.3.4	192.168.1.2	890	0x80000001	0x004884
32 10.10.3.8	192.168.1.1	890	0x80000001	0x008C33
33 10.10.3.8	192.168.1.2	849	0x80000001	0x00B919
34 10.10.3.16	192.168.1.1	849	0x80000001	0x00DE80
35 10.10.3.16	192.168.1.2	849	0x80000001	0x0072F5
36 192.168.1.4	192.168.1.2	849	0x80000001	0x002A41
37 192.168.1.4	192.168.1.3	852	0x80000001	0x006136
38 192.168.1.5	192.168.1.1	849	0x80000001	0x002645
39 192.168.1.5	192.168.1.2	849	0x80000001	0x00B9BA
40 192.168.1.6	192.168.1.1	849	0x80000001	0x0007FE
41 192.168.1.6	192.168.1.2	849	0x80000001	0x009A74
42 192.168.10.1	192.168.1.1	849	0x80000001	0x00F470
43 192.168.10.1	192.168.1.2	849	0x80000001	0x0088E5
44 192.168.10.2	192.168.1.2	849	0x80000001	0x00E47E
45 192.168.10.2	192.168.1.3	842	0x80000001	0x001C73

46

47 Router Link States (Area 2)

48

49 Link ID	ADV Router	Age	Seq#	Checksum	Link count
50 192.168.1.1	192.168.1.1	851	0x80000002	0x00EB38	1
51 192.168.1.2	192.168.1.2	852	0x80000002	0x00C46F	1
52 192.168.1.5	192.168.1.5	851	0x80000003	0x00F966	5
53 192.168.1.6	192.168.1.6	856	0x80000002	0x001405	2
54 192.168.10.1	192.168.10.1	854	0x80000002	0x00B914	3

55

56 Net Link States (Area 2)

57

58 Link ID	ADV Router	Age	Seq#	Checksum
59 10.10.3.1	192.168.10.1	854	0x80000001	0x00814B
60 10.10.3.5	192.168.1.5	852	0x80000001	0x002DA8
61 10.10.3.9	192.168.1.5	852	0x80000001	0x00F6DB
62 10.10.3.19	192.168.1.5	849	0x80000002	0x00292D

63

64 Summary Net Link States (Area 2)

65

66 Link ID	ADV Router	Age	Seq#	Checksum
67 10.10.1.0	192.168.1.1	890	0x80000001	0x000727
68 10.10.1.0	192.168.1.2	890	0x80000001	0x00012C
69 10.10.1.4	192.168.1.1	849	0x80000001	0x00CAFA
70 10.10.1.4	192.168.1.2	890	0x80000001	0x001640
71 10.10.1.8	192.168.1.1	890	0x80000001	0x006430
72 10.10.1.8	192.168.1.2	840	0x80000002	0x0048E5
73 10.10.2.0	192.168.1.1	849	0x80000001	0x0095A1
74 10.10.2.0	192.168.1.2	891	0x80000001	0x00E1E5
75 10.10.2.4	192.168.1.1	839	0x80000002	0x009E5B
76 10.10.2.4	192.168.1.2	851	0x80000001	0x00C3FE
77 10.10.2.8	192.168.1.1	839	0x80000002	0x006C8A
78 10.10.2.8	192.168.1.2	851	0x80000001	0x00688E
79 192.168.1.1	192.168.1.1	890	0x80000001	0x00B3B1
80 192.168.1.1	192.168.1.2	851	0x80000001	0x005C76
81 192.168.1.2	192.168.1.1	849	0x80000001	0x00587A
82 192.168.1.2	192.168.1.2	891	0x80000001	0x00A3BF
83 192.168.1.3	192.168.1.1	839	0x80000001	0x003A33
84 192.168.1.3	192.168.1.2	841	0x80000001	0x008578
85 192.168.1.4	192.168.1.1	839	0x80000002	0x00059D
86 192.168.1.4	192.168.1.2	851	0x80000001	0x002A41

87	192.168.10.2	192.168.1.1	839	0x80000002	0x00BFDA
88	192.168.10.2	192.168.1.2	851	0x80000001	0x00E47E

Listing 6: X's IP routes

```

1 X#show ip route
2 Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
3         D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
4         N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
5         E1 - OSPF external type 1, E2 - OSPF external type 2
6         i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
7         ia - IS-IS inter area, * - candidate default, U - per-user static
           route
8         o - ODR, P - periodic downloaded static route
9
10 Gateway of last resort is not set
11
12     192.168.10.0/32 is subnetted, 2 subnets
13 O IA   192.168.10.2 [110/1203] via 10.10.3.2, 00:08:14, FastEthernet1/0
14 C     192.168.10.1 is directly connected, Loopback0
15     10.0.0.0/8 is variably subnetted, 10 subnets, 2 masks
16 O IA   10.10.1.0/30 [110/901] via 10.10.3.2, 00:08:14, FastEthernet1/0
17 O IA   10.10.2.0/30 [110/1401] via 10.10.3.2, 00:08:14, FastEthernet1/0
18 C     10.10.3.0/30 is directly connected, FastEthernet1/0
19 O IA   10.10.1.4/30 [110/1001] via 10.10.3.2, 00:08:14, FastEthernet1/0
20 O IA   10.10.2.4/30 [110/1202] via 10.10.3.2, 00:08:14, FastEthernet1/0
21 O     10.10.3.4/30 [110/1001] via 10.10.3.2, 00:08:14, FastEthernet1/0
22 O IA   10.10.1.8/30 [110/1301] via 10.10.3.2, 00:08:14, FastEthernet1/0
23 O IA   10.10.2.8/30 [110/1201] via 10.10.3.2, 00:08:14, FastEthernet1/0
24 O     10.10.3.8/30 [110/501] via 10.10.3.2, 00:08:14, FastEthernet1/0
25 C     10.10.3.16/28 is directly connected, FastEthernet1/1
26     192.168.1.0/32 is subnetted, 6 subnets
27 O IA   192.168.1.1 [110/502] via 10.10.3.2, 00:08:17, FastEthernet1/0
28 O IA   192.168.1.3 [110/1002] via 10.10.3.2, 00:08:17, FastEthernet1/0
29 O IA   192.168.1.2 [110/902] via 10.10.3.2, 00:08:17, FastEthernet1/0
30 O     192.168.1.5 [110/2] via 10.10.3.2, 00:08:17, FastEthernet1/0
31 O IA   192.168.1.4 [110/1202] via 10.10.3.2, 00:08:17, FastEthernet1/0
32 O     192.168.1.6 [110/101] via 10.10.3.18, 00:08:17, FastEthernet1/1

```

Listing 7: Traceroute from X to Y

```

1 X#traceroute 192.168.10.2 numeric
2
3 Type escape sequence to abort.
4 Tracing the route to 192.168.10.2
5
6   1 10.10.3.2 44 msec 68 msec 12 msec
7   2 10.10.3.10 52 msec 88 msec 60 msec
8   3 10.10.1.2 92 msec 88 msec 96 msec
9   4 10.10.2.2 156 msec 92 msec 148 msec
10  5 10.10.2.6 128 msec * 172 msec

```

C Question 3 : Designated Routers

Listing 8: R5's DR (1)

```

1 R5#show ip ospf interface f1/1
2 FastEthernet1/1 is up, line protocol is up
3   Internet Address 10.10.3.19/28, Area 2
4   Process ID 8, Router ID 192.168.1.5, Network Type BROADCAST, Cost: 100
5   Transmit Delay is 1 sec, State DROTHER, Priority 1
6   Designated Router (ID) 192.168.10.1, Interface address 10.10.3.17
7   Backup Designated router (ID) 192.168.1.6, Interface address 10.10.3.18
8   Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
9   oob-resync timeout 40

```

```

10 Hello due in 00:00:06
11 Supports Link-local Signaling (LLS)
12 Index 4/4, flood queue length 0
13 Next 0x0(0)/0x0(0)
14 Last flood scan length is 5, maximum is 8
15 Last flood scan time is 0 msec, maximum is 4 msec
16 Neighbor Count is 2, Adjacent neighbor count is 2
17 Adjacent with neighbor 192.168.1.6 (Backup Designated Router)
18 Adjacent with neighbor 192.168.10.1 (Designated Router)
19 Suppress hello for 0 neighbor(s)

```

Listing 9: R5's DR config

```

1 R5(config)#interface f1/1
2 R5(config-if)#ip ospf priority 2

```

Listing 10: R5's DR (2)

```

1 R5#show ip ospf interface f1/1
2 FastEthernet1/1 is up, line protocol is up
3 Internet Address 10.10.3.19/28, Area 2
4 Process ID 8, Router ID 192.168.1.5, Network Type BROADCAST, Cost: 100
5 Transmit Delay is 1 sec, State DR, Priority 2
6 Designated Router (ID) 192.168.1.5, Interface address 10.10.3.19
7 Backup Designated router (ID) 192.168.10.1, Interface address 10.10.3.17
8 Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
9 oob-resync timeout 40
10 Hello due in 00:00:01
11 Supports Link-local Signaling (LLS)
12 Index 4/4, flood queue length 0
13 Next 0x0(0)/0x0(0)
14 Last flood scan length is 12, maximum is 12
15 Last flood scan time is 0 msec, maximum is 4 msec
16 Neighbor Count is 2, Adjacent neighbor count is 2
17 Adjacent with neighbor 192.168.1.6
18 Adjacent with neighbor 192.168.10.1 (Backup Designated Router)
19 Suppress hello for 0 neighbor(s)

```

D Question 4 : Summarization

Listing 11: R2's version

```

1 R2>show version
2 Cisco IOS Software, 7200 Software (C7200-P-M), Version 12.4(18), RELEASE
  SOFTWARE (fc1)
3 Technical Support: http://www.cisco.com/techsupport
4 Copyright (c) 1986-2007 by Cisco Systems, Inc.
5 Compiled Sat 01-Dec-07 03:07 by prod_rel_team
6
7 ROM: ROMMON Emulation Microcode
8 BOOTLDR: 7200 Software (C7200-P-M), Version 12.4(18), RELEASE SOFTWARE (fc1)
9
10 R2 uptime is 9 minutes
11 System returned to ROM by unknown reload cause - suspect boot_data[
  BOOT_COUNT] 0x0, BOOT_COUNT 0, BOOTDATA 19
12 System image file is "tftp://255.255.255.255/unknown"
13
14 Cisco 7206VXR (NPE200) processor (revision B) with 114688K/16384K bytes of
  memory.
15 Processor board ID 4294967295
16 R5000 CPU at 200MHz, Implementation 35, Rev 1.2
17 6 slot VXR midplane, Version 2.1
18
19 Last reset from power-on
20

```

```

21 -----
22 This Version of Cisco IOS Software is not supported on NPE200.
23 Please select a version of Cisco IOS software compatible with
24 this processor from http://www.cisco.com.
25 -----
26
27 Number of Fast PAs = 3
28 Number of Fast+Medium PAs = 3
29 Total number of PA bandwidth points consumed = 600
30 Please refer to the following document "Cisco 7200 Series Port Adaptor
31 Hardware Configuration Guidelines" on Cisco.com <http://www.cisco.com>
32 for c7200 bandwidth points oversubscription and usage guidelines.
33
34 5 FastEthernet interfaces
35 125K bytes of NVRAM.
36 4096K bytes of packet SRAM memory.
37
38 65536K bytes of ATA PCMCIA card at slot 0 (Sector size 512 bytes).
39 8192K bytes of Flash internal SIMM (Sector size 256K).
40 Configuration register is 0x2102

```

Listing 12: Summarization of R2

```

1 R2(config)#router ospf 8
2 R2(config-router)#area 0 range 10.10.1.0 255.255.255.0
3 R2(config-router)#area 1 range 10.10.2.0 255.255.255.0
4 R2(config-router)#area 2 range 10.10.3.0 255.255.255.0

```

Listing 13: R2's database before summarization

```

1 R2#show ip ospf database
2
3           OSPF Router with ID (192.168.1.2) (Process ID 8)
4
5   Router Link States (Area 0)
6
7   Link ID        ADV Router      Age           Seq#           Checksum Link count
8   192.168.1.1    192.168.1.1    846          0x80000003    0x00BFEF 3
9   192.168.1.2    192.168.1.2    845          0x80000003    0x00F978 3
10  192.168.1.3    192.168.1.3    850          0x80000002    0x007A55 3
11
12  Net Link States (Area 0)
13
14  Link ID        ADV Router      Age           Seq#           Checksum
15  10.10.1.2      192.168.1.2    850          0x80000001    0x00479A
16  10.10.1.6      192.168.1.3    850          0x80000001    0x0031A9
17  10.10.1.9      192.168.1.3    850          0x80000001    0x0005D3
18
19  Summary Net Link States (Area 0)
20
21  Link ID        ADV Router      Age           Seq#           Checksum
22  10.10.2.0      192.168.1.2    885          0x80000001    0x00E1E5
23  10.10.2.0      192.168.1.3    849          0x80000001    0x00B24B
24  10.10.2.4      192.168.1.2    845          0x80000001    0x00C3FE
25  10.10.2.4      192.168.1.3    849          0x80000001    0x00FAF3
26  10.10.2.8      192.168.1.2    847          0x80000001    0x00688E
27  10.10.2.8      192.168.1.3    897          0x80000001    0x00C823
28  10.10.3.0      192.168.1.1    848          0x80000001    0x00E6DF
29  10.10.3.0      192.168.1.2    848          0x80000001    0x007A55
30  10.10.3.4      192.168.1.1    849          0x80000001    0x00E7EF
31  10.10.3.4      192.168.1.2    888          0x80000001    0x004884
32  10.10.3.8      192.168.1.1    890          0x80000001    0x008C33
33  10.10.3.8      192.168.1.2    848          0x80000001    0x00B919
34  10.10.3.16     192.168.1.1    849          0x80000001    0x00DE80
35  10.10.3.16     192.168.1.2    848          0x80000001    0x0072F5
36  192.168.1.4    192.168.1.2    848          0x80000001    0x002A41
37  192.168.1.4    192.168.1.3    852          0x80000001    0x006136
38  192.168.1.5    192.168.1.1    849          0x80000001    0x002645
39  192.168.1.5    192.168.1.2    848          0x80000001    0x00B9BA

```

```

40 192.168.1.6      192.168.1.1      849      0x80000001 0x0007FE
41 192.168.1.6      192.168.1.2      848      0x80000001 0x009A74
42 192.168.10.1     192.168.1.1      849      0x80000001 0x00F470
43 192.168.10.1     192.168.1.2      848      0x80000001 0x0088E5
44 192.168.10.2     192.168.1.2      848      0x80000001 0x00E47E
45 192.168.10.2     192.168.1.3      842      0x80000001 0x001C73
46
47 Router Link States (Area 1)
48
49 Link ID          ADV Router        Age           Seq#           Checksum Link count
50 192.168.1.2      192.168.1.2      851          0x80000002 0x000133 1
51 192.168.1.3      192.168.1.3      858          0x80000002 0x0085C9 1
52 192.168.1.4      192.168.1.4      853          0x80000003 0x00123E 4
53 192.168.10.2     192.168.10.2     857          0x80000002 0x00AED9 2
54
55 Net Link States (Area 1)
56
57 Link ID          ADV Router        Age           Seq#           Checksum
58 10.10.2.2        192.168.1.4      853          0x80000001 0x005289
59 10.10.2.6        192.168.10.2     858          0x80000001 0x005077
60 10.10.2.10       192.168.1.4      859          0x80000001 0x0010C2
61
62 Summary Net Link States (Area 1)
63
64 Link ID          ADV Router        Age           Seq#           Checksum
65 10.10.1.0        192.168.1.2      892          0x80000001 0x00012C
66 10.10.1.0        192.168.1.3      846          0x80000001 0x00E6E0
67 10.10.1.4        192.168.1.2      893          0x80000001 0x001640
68 10.10.1.4        192.168.1.3      903          0x80000001 0x001045
69 10.10.1.8        192.168.1.2      843          0x80000002 0x0048E5
70 10.10.1.8        192.168.1.3      904          0x80000001 0x00583A
71 10.10.3.0        192.168.1.2      853          0x80000001 0x007A55
72 10.10.3.0        192.168.1.3      848          0x80000001 0x00745A
73 10.10.3.4        192.168.1.2      894          0x80000001 0x004884
74 10.10.3.4        192.168.1.3      848          0x80000001 0x002D3A
75 10.10.3.8        192.168.1.2      854          0x80000001 0x00B919
76 10.10.3.8        192.168.1.3      848          0x80000001 0x001AAD
77 10.10.3.16       192.168.1.2      854          0x80000001 0x0072F5
78 10.10.3.16       192.168.1.3      849          0x80000001 0x006CFA
79 192.168.1.1      192.168.1.2      855          0x80000001 0x005C76
80 192.168.1.1      192.168.1.3      849          0x80000001 0x00422B
81 192.168.1.2      192.168.1.2      895          0x80000001 0x00A3BF
82 192.168.1.2      192.168.1.3      850          0x80000001 0x008974
83 192.168.1.3      192.168.1.2      845          0x80000001 0x008578
84 192.168.1.3      192.168.1.3      906          0x80000001 0x0093CD
85 192.168.1.5      192.168.1.2      856          0x80000001 0x00B9BA
86 192.168.1.5      192.168.1.3      850          0x80000001 0x00B3BF
87 192.168.1.6      192.168.1.2      856          0x80000001 0x009A74
88 192.168.1.6      192.168.1.3      851          0x80000001 0x009479
89 192.168.10.1     192.168.1.2      857          0x80000001 0x0088E5
90 192.168.10.1     192.168.1.3      851          0x80000001 0x0082EA
91
92 Router Link States (Area 2)
93
94 Link ID          ADV Router        Age           Seq#           Checksum Link count
95 192.168.1.1      192.168.1.1      861          0x80000002 0x00EB38 1
96 192.168.1.2      192.168.1.2      860          0x80000002 0x00C46F 1
97 192.168.1.5      192.168.1.5      860          0x80000003 0x00F966 5
98 192.168.1.6      192.168.1.6      866          0x80000002 0x001405 2
99 192.168.10.1     192.168.10.1     864          0x80000002 0x00B914 3
100
101 Net Link States (Area 2)
102
103 Link ID          ADV Router        Age           Seq#           Checksum
104 10.10.3.1        192.168.10.1     865          0x80000001 0x00814B
105 10.10.3.5        192.168.1.5      864          0x80000001 0x002DA8
106 10.10.3.9        192.168.1.5      865          0x80000001 0x00F6DB
107 10.10.3.19       192.168.1.5      862          0x80000002 0x00292D
108
109 Summary Net Link States (Area 2)

```

110					
111	Link ID	ADV Router	Age	Seq#	Checksum
112	10.10.1.0	192.168.1.1	904	0x80000001	0x000727
113	10.10.1.0	192.168.1.2	902	0x80000001	0x00012C
114	10.10.1.4	192.168.1.1	864	0x80000001	0x00CAFA
115	10.10.1.4	192.168.1.2	902	0x80000001	0x001640
116	10.10.1.8	192.168.1.1	905	0x80000001	0x006430
117	10.10.1.8	192.168.1.2	852	0x80000002	0x0048E5
118	10.10.2.0	192.168.1.1	864	0x80000001	0x0095A1
119	10.10.2.0	192.168.1.2	903	0x80000001	0x00E1E5
120	10.10.2.4	192.168.1.1	854	0x80000002	0x009E5B
121	10.10.2.4	192.168.1.2	863	0x80000001	0x00C3FE
122	10.10.2.8	192.168.1.1	854	0x80000002	0x006C8A
123	10.10.2.8	192.168.1.2	863	0x80000001	0x00688E
124	192.168.1.1	192.168.1.1	905	0x80000001	0x00B3B1
125	192.168.1.1	192.168.1.2	863	0x80000001	0x005C76
126	192.168.1.2	192.168.1.1	865	0x80000001	0x00587A
127	192.168.1.2	192.168.1.2	903	0x80000001	0x00A3BF
128	192.168.1.3	192.168.1.1	855	0x80000001	0x003A33
129	192.168.1.3	192.168.1.2	853	0x80000001	0x008578
130	192.168.1.4	192.168.1.1	855	0x80000002	0x00059D
131	192.168.1.4	192.168.1.2	863	0x80000001	0x002A41
132	192.168.10.2	192.168.1.1	855	0x80000002	0x00BFDA
133	192.168.10.2	192.168.1.2	863	0x80000001	0x00E47E

Listing 14: R2's database after summarization

```

1 R2#show ip ospf database
2
3           OSPF Router with ID (192.168.1.2) (Process ID 8)
4
5   Router Link States (Area 0)
6
7   Link ID        ADV Router      Age           Seq#           Checksum Link count
8   192.168.1.1    192.168.1.1    10           0x80000004    0x00BDF0 3
9   192.168.1.2    192.168.1.2    14           0x80000005    0x00F57A 3
10  192.168.1.3    192.168.1.3    15           0x80000005    0x007458 3
11
12  Net Link States (Area 0)
13
14  Link ID        ADV Router      Age           Seq#           Checksum
15  10.10.1.2      192.168.1.2    14           0x80000003    0x00439C
16  10.10.1.6      192.168.1.3    436          0x80000001    0x0031A9
17  10.10.1.9      192.168.1.3    14           0x80000003    0x0001D5
18
19  Summary Net Link States (Area 0)
20
21  Link ID        ADV Router      Age           Seq#           Checksum
22  10.10.2.0      192.168.1.2    471          0x80000001    0x00F3D0
23  10.10.2.0      192.168.1.3    470          0x80000001    0x002BC5
24  10.10.3.0      192.168.1.1    469          0x80000001    0x00EED5
25  10.10.3.0      192.168.1.2    471          0x80000001    0x00824B
26  192.168.1.4    192.168.1.2    431          0x80000001    0x002A41
27  192.168.1.4    192.168.1.3    432          0x80000001    0x006136
28  192.168.1.5    192.168.1.1    6            0x80000003    0x002247
29  192.168.1.5    192.168.1.2    432          0x80000001    0x00B9BA
30  192.168.1.6    192.168.1.1    7            0x80000003    0x000301
31  192.168.1.6    192.168.1.2    432          0x80000001    0x009A74
32  192.168.10.1   192.168.1.1    8            0x80000003    0x00F072
33  192.168.10.1   192.168.1.2    422          0x80000001    0x0088E5
34  192.168.10.2   192.168.1.2    432          0x80000001    0x00E47E
35  192.168.10.2   192.168.1.3    433          0x80000001    0x001C73
36
37  Router Link States (Area 1)
38
39  Link ID        ADV Router      Age           Seq#           Checksum Link count
40  192.168.1.2    192.168.1.2    434          0x80000002    0x000133 1
41  192.168.1.3    192.168.1.3    436          0x80000002    0x0085C9 1
42  192.168.1.4    192.168.1.4    435          0x80000003    0x00123E 4
43  192.168.10.2   192.168.10.2   441          0x80000002    0x00AED9 2

```

```

44
45           Net Link States (Area 1)
46
47 Link ID      ADV Router    Age      Seq#      Checksum
48 10.10.2.2    192.168.1.4  436     0x80000001 0x005289
49 10.10.2.6    192.168.10.2 445     0x80000001 0x005077
50 10.10.2.10   192.168.1.4  439     0x80000001 0x0010C2
51
52           Summary Net Link States (Area 1)
53
54 Link ID      ADV Router    Age      Seq#      Checksum
55 10.10.1.0    192.168.1.2  477     0x80000001 0x005007
56 10.10.1.0    192.168.1.3  477     0x80000001 0x004A0C
57 10.10.3.0    192.168.1.2  477     0x80000001 0x00824B
58 10.10.3.0    192.168.1.3  12      0x80000004 0x007653
59 192.168.1.1  192.168.1.2  10      0x80000001 0x005C76
60 192.168.1.1  192.168.1.3  12      0x80000001 0x00422B
61 192.168.1.2  192.168.1.2  477     0x80000001 0x00A3BF
62 192.168.1.2  192.168.1.3  438     0x80000001 0x008974
63 192.168.1.3  192.168.1.2  436     0x80000001 0x008578
64 192.168.1.3  192.168.1.3  477     0x80000001 0x0093CD
65 192.168.1.5  192.168.1.2  436     0x80000001 0x00B9BA
66 192.168.1.5  192.168.1.3  12      0x80000003 0x00AFC1
67 192.168.1.6  192.168.1.2  436     0x80000001 0x009A74
68 192.168.1.6  192.168.1.3  12      0x80000003 0x00907B
69 192.168.10.1 192.168.1.2  427     0x80000001 0x0088E5
70 192.168.10.1 192.168.1.3  12      0x80000004 0x007CED
71
72           Router Link States (Area 2)
73
74 Link ID      ADV Router    Age      Seq#      Checksum Link count
75 192.168.1.1  192.168.1.1  18      0x80000003 0x00E939 1
76 192.168.1.2  192.168.1.2  440     0x80000002 0x00C46F 1
77 192.168.1.5  192.168.1.5  22      0x80000005 0x00F568 5
78 192.168.1.6  192.168.1.6  445     0x80000002 0x001405 2
79 192.168.10.1 192.168.10.1 442     0x80000002 0x00B914 3
80
81           Net Link States (Area 2)
82
83 Link ID      ADV Router    Age      Seq#      Checksum
84 10.10.3.1    192.168.10.1 442     0x80000001 0x00814B
85 10.10.3.5    192.168.1.5  441     0x80000001 0x002DA8
86 10.10.3.9    192.168.1.5  22      0x80000003 0x00F2DD
87 10.10.3.19   192.168.1.5  436     0x80000002 0x00292D
88
89           Summary Net Link States (Area 2)
90
91 Link ID      ADV Router    Age      Seq#      Checksum
92 10.10.1.0    192.168.1.1  478     0x80000001 0x001912
93 10.10.1.0    192.168.1.2  480     0x80000001 0x005007
94 10.10.2.0    192.168.1.1  15      0x80000003 0x00CC2E
95 10.10.2.0    192.168.1.2  480     0x80000001 0x00F3D0
96 192.168.1.1  192.168.1.1  479     0x80000001 0x00B3B1
97 192.168.1.1  192.168.1.2  13      0x80000001 0x005C76
98 192.168.1.2  192.168.1.1  15      0x80000003 0x00547C
99 192.168.1.2  192.168.1.2  480     0x80000001 0x00A3BF
100 192.168.1.3  192.168.1.1  15      0x80000003 0x003635
101 192.168.1.3  192.168.1.2  439     0x80000001 0x008578
102 192.168.1.4  192.168.1.1  15      0x80000003 0x00039E
103 192.168.1.4  192.168.1.2  439     0x80000001 0x002A41
104 192.168.10.2 192.168.1.1  15      0x80000003 0x00BDDB
105 192.168.10.2 192.168.1.2  440     0x80000001 0x00E47E

```

E Question 5 : Inter vs Intra

Listing 15: Traceroute from Y to X

```
1 Y#traceroute 192.168.10.1 numeric
2
3 Type escape sequence to abort.
4 Tracing the route to 192.168.10.1
5
6   1 10.10.2.5 36 msec 28 msec 40 msec
7   2 10.10.2.9 112 msec 24 msec 148 msec
8   3 10.10.1.5 28 msec 56 msec 52 msec
9   4 10.10.3.5 100 msec 96 msec 76 msec
10  5 10.10.3.1 88 msec * 60 msec
```