Technical Report
Assignment-3
CS3205,Introduction to Computer Networking
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Aim:

The aim of the assignment is to understand the OSPF algorithm used in routers.

Introduction:

OSPF is an intra autonomous system routing protocol.OSPF is conceived as the successor to RIP and as such has advanced features.OSPF is a link-state protocol that uses flooding of link state information and a dijkstra's least cost algorithm.With OSPF,a router constructs a complete topological map of the entire network.The router then locally runs dijkstra's shortest path algorithm to determine a shortest path tree to all subnets, with itself as the root node.The costs of the links are decided by network administrator.OSPF does not mandate a policy for how link weights are set.

With OSPF,a router broadcasts routing information to all other routers in the network.A router broadcasts link state information periodically.The OSPF protocol must itself implement functionality such as reliable message transfer and link state broadcast.The OSPF protocol also checks that links are operational and allows an OSPF router to obtain a neighbouring router's database of network wide link state.

Key features of OSPF model

- The intra-router messages can be authenticated using hash algorithms like MD5 to enhance security.
- When multiple same cost paths exist, the OSPF allows routers to use any of them so that none of them gets flooded.
- Integrated support for unicast and multicast routing using simple extensions to OSPF to get MOSPF.
- Support for hierarchy within a single routing domain.

An OSPF autonomous system can be configured hierarchically into areas.Each area runs its own OSPF link-state routing algorithm with each router in an area broadcasting its link state to all other routers in that area.Within each area, one or more area border routers are responsible for routing packets outside the area.Exactly one OSPF area in the AS is configured to be the backbone area.The backbone always contains all area border routers in the AS and may contain non-border routers as well.

Example 1

Network topology
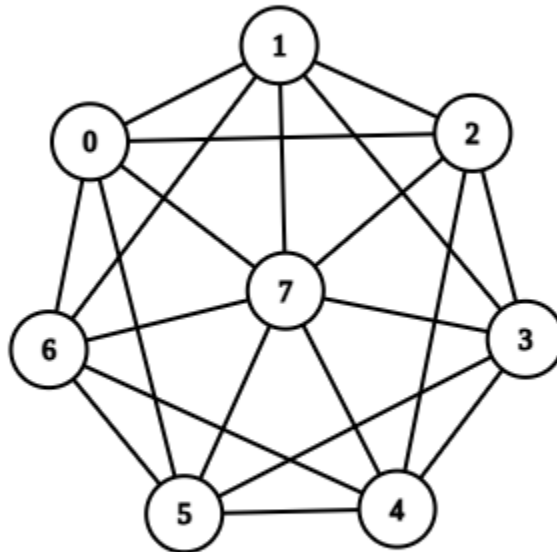
The input for the above topology is
The input for this example is

8 20
0 7 1 10
1 7 1 10
2 7 1 10
3 7 1 10
4 7 1 10
5 7 1 10
6 7 1 10
0 1 1 10
1 2 1 10
2 3 1 10
3 4 1 10
4 5 1 10
5 6 1 10
6 0 1 10
0 2 1 10
1 3 1 10
2 4 1 10

3 5 1 10
4 6 1 10
5 0 1 10

The example contains 8 routers and 10 links.
All the weights are a random value between 1 and 10.
The simulation has hello interval of 2 seconds,lsa interval of 2 seconds and shortest path finding interval of 5 seconds.

After running the simulation for 45 seconds,the routing tables look like this.

Node-0

1	0,2,1,	4
2	0,2,	1
3	0,2,1,3,	7
4	0,2,4,	5
5	0,5,	2
6	0,6,	3
7	0,5,7,	3

Node-1

0	1,7,0,	4
2	1,2,	7
3	1,3,	4
4	1,7,5,4,	10
5	1,7,5,	2
6	1,7,6,	4
7	1,7,	1

Node-2

0	2,0,	8
1	2,1,	3
3	2,1,3,	6
4	2,4,	4
5	2,7,5,	7
6	2,7,6,	9
7	2,7,	6

Node-3

0	3,7,0,	6
1	3,1,	3
2	3,1,2,	6
4	3,4,	10
5	3,7,5,	4

6	3,7,6,	6
7	3,7,	3

Node-4

0	4,6,0,	10
1	4,2,1,	7
2	4,2,	4
3	4,3,	10
5	4,5,	8
6	4,6,	7
7	4,5,7,	9

Node-5

0	5,0,	2
1	5,0,1,	11
2	5,0,2,	10
3	5,3,	10
4	5,4,	8
6	5,6,	5
7	5,7,	5

Node-6

0	6,0,	3
1	6,7,1,	11
2	6,7,2,	9
3	6,7,3,	9
4	6,4,	7
5	6,7,5,	4
7	6,7,	3

Node-7

0	7,0,	3
1	7,1,	1
2	7,1,2,	4
3	7,3,	3
4	7,1,2,4,	8
5	7,5,	5
6	7,6,	3

The routing table along for each node at different intervals of time can be seen here

Example 2

Network topology
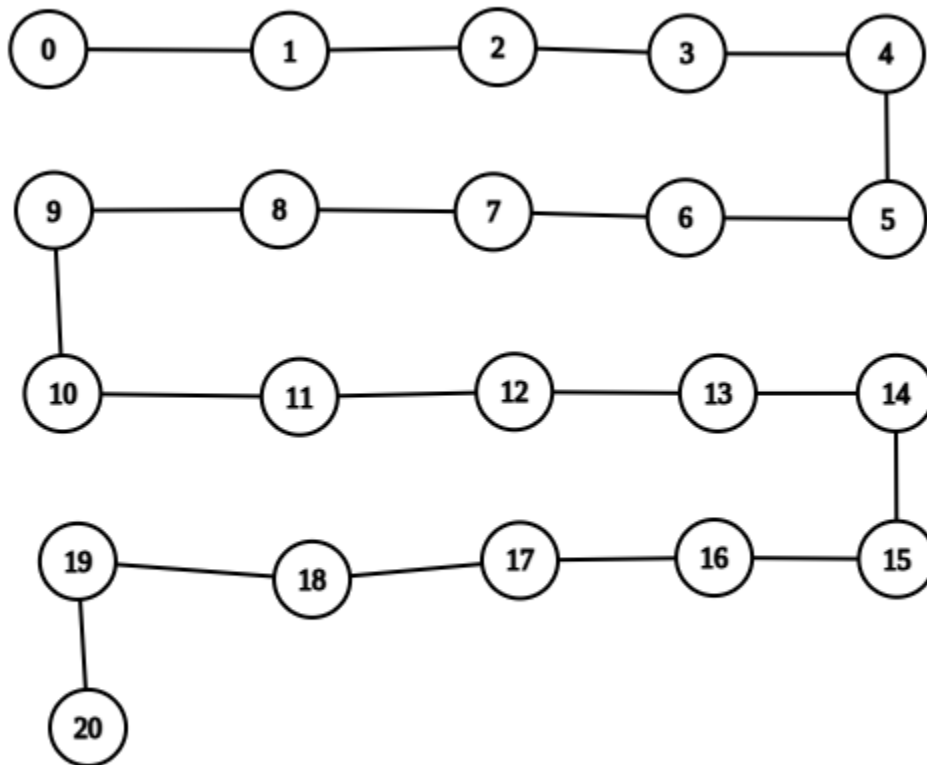
The input for the above topology is
21 20
0 1 1 10
1 2 1 10
2 3 1 10
3 4 1 10
4 5 1 10
5 6 1 10
6 7 1 10
7 8 1 10
8 9 1 10
9 10 1 10
10 11 1 10

11 12 1 10
12 13 1 10
13 14 1 10
14 15 1 10
15 16 1 10
16 17 1 10
17 18 1 10
18 19 1 10
19 20 1 10

The example contains 21 routers and 20 links.
All the weights are a random value between 1 and 10.
The simulation has hello interval of 2 seconds,lsa interval of 2 seconds and shortest path finding interval of 5 seconds.

After running the simulation for 45 seconds,the routing tables look like this.

Node-0
1 0,1, 6
2 0,1,2, 13
3 0,1,2,3, 17
4 0,1,2,3,4, 21
5 0,1,2,3,4,5, 29
6 0,1,2,3,4,5,6, 38
7 0,1,2,3,4,5,6,7, 39
8 0,1,2,3,4,5,6,7,8, 48
9 0,1,2,3,4,5,6,7,8,9, 50
10 0,1,2,3,4,5,6,7,8,9,10, 53
11 0,1,2,3,4,5,6,7,8,9,10,11, 55
12 0,1,2,3,4,5,6,7,8,9,10,11,12, 64
13 0,1,2,3,4,5,6,7,8,9,10,11,12,13, 66
14 0,1,2,3,4,5,6,7,8,9,10,11,12,13,14, 74
15 0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15, 78
16 0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16, 80
17 0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17, 87
18 0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18, 93
19 0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19, 97
20 0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20, 100

Node-1
0 1,0, 6
2 1,2, 9
3 1,2,3, 13
4 1,2,3,4, 17

5 1,2,3,4,5, 25
6 1,2,3,4,5,6, 34
7 1,2,3,4,5,6,7, 35
8 1,2,3,4,5,6,7,8, 44
9 1,2,3,4,5,6,7,8,9, 46
10 1,2,3,4,5,6,7,8,9,10, 49
11 1,2,3,4,5,6,7,8,9,10,11, 51
12 1,2,3,4,5,6,7,8,9,10,11,12, 60
13 1,2,3,4,5,6,7,8,9,10,11,12,13, 62
14 1,2,3,4,5,6,7,8,9,10,11,12,13,14, 70
15 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15, 74
16 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16, 76
17 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17, 83
18 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18, 89
19 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19, 93
20 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20, 96

Node-2
0 2,1,0, 17
1 2,1, 7
3 2,3, 5
4 2,3,4, 9
5 2,3,4,5, 17
6 2,3,4,5,6, 26
7 2,3,4,5,6,7, 27
8 2,3,4,5,6,7,8, 36
9 2,3,4,5,6,7,8,9, 38
10 2,3,4,5,6,7,8,9,10, 41
11 2,3,4,5,6,7,8,9,10,11, 43
12 2,3,4,5,6,7,8,9,10,11,12, 52
13 2,3,4,5,6,7,8,9,10,11,12,13, 54
14 2,3,4,5,6,7,8,9,10,11,12,13,14, 62
15 2,3,4,5,6,7,8,9,10,11,12,13,14,15, 69
16 2,3,4,5,6,7,8,9,10,11,12,13,14,15,16, 71
17 2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17, 74
18 2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18, 80
19 2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19, 83
20 2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20, 86

Node-3
0 3,2,1,0, 22
1 3,2,1, 12
2 3,2, 5
4 3,4, 4

5 3,4,5, 12
6 3,4,5,6, 21
7 3,4,5,6,7, 22
8 3,4,5,6,7,8, 31
9 3,4,5,6,7,8,9, 33
10 3,4,5,6,7,8,9,10, 36
11 3,4,5,6,7,8,9,10,11, 38
12 3,4,5,6,7,8,9,10,11,12, 47
13 3,4,5,6,7,8,9,10,11,12,13, 49
14 3,4,5,6,7,8,9,10,11,12,13,14, 57
15 3,4,5,6,7,8,9,10,11,12,13,14,15, 64
16 3,4,5,6,7,8,9,10,11,12,13,14,15,16, 66
17 3,4,5,6,7,8,9,10,11,12,13,14,15,16,17, 69
18 3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18, 75
19 3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19, 78
20 3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20, 81

Node-4
0 4,3,2,1,0, 25
1 4,3,2,1, 15
2 4,3,2, 8
3 4,3, 4
5 4,5, 2
6 4,5,6, 11
7 4,5,6,7, 12
8 4,5,6,7,8, 21
9 4,5,6,7,8,9, 23
10 4,5,6,7,8,9,10, 26
11 4,5,6,7,8,9,10,11, 28
12 4,5,6,7,8,9,10,11,12, 37
13 4,5,6,7,8,9,10,11,12,13, 39
14 4,5,6,7,8,9,10,11,12,13,14, 45
15 4,5,6,7,8,9,10,11,12,13,14,15, 52
16 4,5,6,7,8,9,10,11,12,13,14,15,16, 54
17 4,5,6,7,8,9,10,11,12,13,14,15,16,17, 57
18 4,5,6,7,8,9,10,11,12,13,14,15,16,17,18, 63
19 4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19, 66
20 4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20, 69

Node-5
0 5,4,3,2,1,0, 33
1 5,4,3,2,1, 23
2 5,4,3,2, 16
3 5,4,3, 12

4 5,4, 8
6 5,6, 2
7 5,6,7, 3
8 5,6,7,8, 12
9 5,6,7,8,9, 14
10 5,6,7,8,9,10, 17
11 5,6,7,8,9,10,11, 19
12 5,6,7,8,9,10,11,12, 28
13 5,6,7,8,9,10,11,12,13, 30
14 5,6,7,8,9,10,11,12,13,14, 36
15 5,6,7,8,9,10,11,12,13,14,15, 43
16 5,6,7,8,9,10,11,12,13,14,15,16, 45
17 5,6,7,8,9,10,11,12,13,14,15,16,17, 48
18 5,6,7,8,9,10,11,12,13,14,15,16,17,18, 54
19 5,6,7,8,9,10,11,12,13,14,15,16,17,18,19, 57
20 5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20, 60

Node-6
0 6,5,4,3,2,1,0, 35
1 6,5,4,3,2,1, 25
2 6,5,4,3,2, 18
3 6,5,4,3, 14
4 6,5,4, 10
5 6,5, 2
7 6,7, 2
8 6,7,8, 11
9 6,7,8,9, 13
10 6,7,8,9,10, 16
11 6,7,8,9,10,11, 18
12 6,7,8,9,10,11,12, 27
13 6,7,8,9,10,11,12,13, 29
14 6,7,8,9,10,11,12,13,14, 35
15 6,7,8,9,10,11,12,13,14,15, 42
16 6,7,8,9,10,11,12,13,14,15,16, 44
17 6,7,8,9,10,11,12,13,14,15,16,17, 47
18 6,7,8,9,10,11,12,13,14,15,16,17,18, 53
19 6,7,8,9,10,11,12,13,14,15,16,17,18,19, 56
20 6,7,8,9,10,11,12,13,14,15,16,17,18,19,20, 59

Node-7
0 7,6,5,4,3,2,1,0, 43
1 7,6,5,4,3,2,1, 33
2 7,6,5,4,3,2, 26
3 7,6,5,4,3, 22

4 7,6,5,4, 18
5 7,6,5, 10
6 7,6, 1
8 7,8, 9
9 7,8,9, 11
10 7,8,9,10, 14
11 7,8,9,10,11, 16
12 7,8,9,10,11,12, 25
13 7,8,9,10,11,12,13, 27
14 7,8,9,10,11,12,13,14, 33
15 7,8,9,10,11,12,13,14,15, 40
16 7,8,9,10,11,12,13,14,15,16, 42
17 7,8,9,10,11,12,13,14,15,16,17, 45
18 7,8,9,10,11,12,13,14,15,16,17,18, 51
19 7,8,9,10,11,12,13,14,15,16,17,18,19, 54
20 7,8,9,10,11,12,13,14,15,16,17,18,19,20, 57

Node-8
0 8,7,6,5,4,3,2,1,0, 52
1 8,7,6,5,4,3,2,1, 42
2 8,7,6,5,4,3,2, 35
3 8,7,6,5,4,3, 31
4 8,7,6,5,4, 27
5 8,7,6,5, 19
6 8,7,6, 10
7 8,7, 9
9 8,9, 4
10 8,9,10, 7
11 8,9,10,11, 9
12 8,9,10,11,12, 18
13 8,9,10,11,12,13, 20
14 8,9,10,11,12,13,14, 26
15 8,9,10,11,12,13,14,15, 33
16 8,9,10,11,12,13,14,15,16, 35
17 8,9,10,11,12,13,14,15,16,17, 38
18 8,9,10,11,12,13,14,15,16,17,18, 44
19 8,9,10,11,12,13,14,15,16,17,18,19, 47
20 8,9,10,11,12,13,14,15,16,17,18,19,20, 48

Node-9
0 9,8,7,6,5,4,3,2,1,0, 56
1 9,8,7,6,5,4,3,2,1, 46
2 9,8,7,6,5,4,3,2, 39
3 9,8,7,6,5,4,3, 35

4 9,8,7,6,5,4, 31
5 9,8,7,6,5, 23
6 9,8,7,6, 14
7 9,8,7, 13
8 9,8, 4
10 9,10, 3
11 9,10,11, 5
12 9,10,11,12, 14
13 9,10,11,12,13, 16
14 9,10,11,12,13,14, 22
15 9,10,11,12,13,14,15, 29
16 9,10,11,12,13,14,15,16, 31
17 9,10,11,12,13,14,15,16,17, 34
18 9,10,11,12,13,14,15,16,17,18, 40
19 9,10,11,12,13,14,15,16,17,18,19, 43
20 9,10,11,12,13,14,15,16,17,18,19,20, 44

Node-10
0 10,9,8,7,6,5,4,3,2,1,0, 57
1 10,9,8,7,6,5,4,3,2,1, 47
2 10,9,8,7,6,5,4,3,2, 40
3 10,9,8,7,6,5,4,3, 36
4 10,9,8,7,6,5,4, 32
5 10,9,8,7,6,5, 24
6 10,9,8,7,6, 15
7 10,9,8,7, 14
8 10,9,8, 5
9 10,9, 3
11 10,11, 3
12 10,11,12, 12
13 10,11,12,13, 14
14 10,11,12,13,14, 20
15 10,11,12,13,14,15, 27
16 10,11,12,13,14,15,16, 29
17 10,11,12,13,14,15,16,17, 32
18 10,11,12,13,14,15,16,17,18, 38
19 10,11,12,13,14,15,16,17,18,19, 41
20 10,11,12,13,14,15,16,17,18,19,20, 44

Node-11
0 11,10,9,8,7,6,5,4,3,2,1,0, 60
1 11,10,9,8,7,6,5,4,3,2,1, 50
2 11,10,9,8,7,6,5,4,3,2, 43
3 11,10,9,8,7,6,5,4,3, 39

4 11,10,9,8,7,6,5,4, 35
5 11,10,9,8,7,6,5, 27
6 11,10,9,8,7,6, 18
7 11,10,9,8,7, 17
8 11,10,9,8, 8
9 11,10,9, 6
10 11,10, 3
12 11,12, 3
13 11,12,13, 5
14 11,12,13,14, 11
15 11,12,13,14,15, 18
16 11,12,13,14,15,16, 20
17 11,12,13,14,15,16,17, 23
18 11,12,13,14,15,16,17,18, 29
19 11,12,13,14,15,16,17,18,19, 32
20 11,12,13,14,15,16,17,18,19,20, 33

Node-12
0 12,11,10,9,8,7,6,5,4,3,2,1,0, 68
1 12,11,10,9,8,7,6,5,4,3,2,1, 58
2 12,11,10,9,8,7,6,5,4,3,2, 51
3 12,11,10,9,8,7,6,5,4,3, 47
4 12,11,10,9,8,7,6,5,4, 43
5 12,11,10,9,8,7,6,5, 35
6 12,11,10,9,8,7,6, 26
7 12,11,10,9,8,7, 25
8 12,11,10,9,8, 16
9 12,11,10,9, 14
10 12,11,10, 11
11 12,11, 9
13 12,13, 2
14 12,13,14, 8
15 12,13,14,15, 15
16 12,13,14,15,16, 17
17 12,13,14,15,16,17, 20
18 12,13,14,15,16,17,18, 26
19 12,13,14,15,16,17,18,19, 29
20 12,13,14,15,16,17,18,19,20, 30

Node-13
0 13,12,11,10,9,8,7,6,5,4,3,2,1,0, 70
1 13,12,11,10,9,8,7,6,5,4,3,2,1, 60
2 13,12,11,10,9,8,7,6,5,4,3,2, 53
3 13,12,11,10,9,8,7,6,5,4,3, 49

4 13,12,11,10,9,8,7,6,5,4, 45
5 13,12,11,10,9,8,7,6,5, 37
6 13,12,11,10,9,8,7,6, 28
7 13,12,11,10,9,8,7, 27
8 13,12,11,10,9,8, 18
9 13,12,11,10,9, 16
10 13,12,11,10, 13
11 13,12,11, 11
12 13,12, 2
14 13,14, 6
15 13,14,15, 13
16 13,14,15,16, 15
17 13,14,15,16,17, 18
18 13,14,15,16,17,18, 24
19 13,14,15,16,17,18,19, 27
20 13,14,15,16,17,18,19,20, 28

Node-14
0 14,13,12,11,10,9,8,7,6,5,4,3,2,1,0, 76
1 14,13,12,11,10,9,8,7,6,5,4,3,2,1, 66
2 14,13,12,11,10,9,8,7,6,5,4,3,2, 59
3 14,13,12,11,10,9,8,7,6,5,4,3, 55
4 14,13,12,11,10,9,8,7,6,5,4, 51
5 14,13,12,11,10,9,8,7,6,5, 43
6 14,13,12,11,10,9,8,7,6, 34
7 14,13,12,11,10,9,8,7, 33
8 14,13,12,11,10,9,8, 24
9 14,13,12,11,10,9, 22
10 14,13,12,11,10, 19
11 14,13,12,11, 17
12 14,13,12, 8
13 14,13, 6
15 14,15, 7
16 14,15,16, 9
17 14,15,16,17, 12
18 14,15,16,17,18, 18
19 14,15,16,17,18,19, 21
20 14,15,16,17,18,19,20, 22

Node-15
0 15,14,13,12,11,10,9,8,7,6,5,4,3,2,1,0, 83
1 15,14,13,12,11,10,9,8,7,6,5,4,3,2,1, 73
2 15,14,13,12,11,10,9,8,7,6,5,4,3,2, 66
3 15,14,13,12,11,10,9,8,7,6,5,4,3, 62

4 15,14,13,12,11,10,9,8,7,6,5,4, 58
5 15,14,13,12,11,10,9,8,7,6,5, 50
6 15,14,13,12,11,10,9,8,7,6, 41
7 15,14,13,12,11,10,9,8,7, 40
8 15,14,13,12,11,10,9,8, 31
9 15,14,13,12,11,10,9, 29
10 15,14,13,12,11,10, 26
11 15,14,13,12,11, 24
12 15,14,13,12, 15
13 15,14,13, 13
14 15,14, 7
16 15,16, 2
17 15,16,17, 5
18 15,16,17,18, 11
19 15,16,17,18,19, 14
20 15,16,17,18,19,20, 15

Node-16
0 16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1,0, 85
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2 16,15,14,13,12,11,10,9,8,7,6,5,4,3,2, 68
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4 16,15,14,13,12,11,10,9,8,7,6,5,4, 60
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7 16,15,14,13,12,11,10,9,8,7, 42
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13 16,15,14,13, 15
14 16,15,14, 9
15 16,15, 2
17 16,17, 3
18 16,17,18, 9
19 16,17,18,19, 12
20 16,17,18,19,20, 13

Node-17
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1 17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1, 78
2 17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2, 71
3 17,16,15,14,13,12,11,10,9,8,7,6,5,4,3, 67

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14 17,16,15,14, 12
15 17,16,15, 5
16 17,16, 3
18 17,18, 8
19 17,18,19, 11
20 17,18,19,20, 12

Node-18
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1 18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1, 84
2 18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2, 77
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7 18,17,16,15,14,13,12,11,10,9,8,7, 51
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12 18,17,16,15,14,13,12, 26
13 18,17,16,15,14,13, 24
14 18,17,16,15,14, 18
15 18,17,16,15, 11
16 18,17,16, 9
17 18,17, 6
19 18,19, 3
20 18,19,20, 4

Node-19
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2 19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2, 80
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6 19,18,17,16,15,14,13,12,11,10,9,8,7,6, 55
7 19,18,17,16,15,14,13,12,11,10,9,8,7, 54
8 19,18,17,16,15,14,13,12,11,10,9,8, 45
9 19,18,17,16,15,14,13,12,11,10,9, 43
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15 19,18,17,16,15, 14
16 19,18,17,16, 12
17 19,18,17, 9
18 19,18, 3
20 19,20, 1

Node-20
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1 20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1, 88
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4 20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4, 73
5 20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5, 65
6 20,19,18,17,16,15,14,13,12,11,10,9,8,7,6, 56
7 20,19,18,17,16,15,14,13,12,11,10,9,8,7, 55
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13 20,19,18,17,16,15,14,13, 28
14 20,19,18,17,16,15,14, 22
15 20,19,18,17,16,15, 15
16 20,19,18,17,16, 13
17 20,19,18,17, 10
18 20,19,18, 4
19 20,19, 1

The routing table along for each node at different intervals of time can be seen here

Learnings:

With the help of this assignment, we understood how the OSPF algorithm works practically.We understood how OSPF manages to keep each router in touch to one another with the help of udp connections.With the help of dijkstra's algorithm,we found the shortest path to each node.

References:

Read more about OSPF [here](#)

Read about dijkstra's algorithm [here](#)