Networks Assignment 3: OSPF Routing

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1 Aim

To implement OSPF routing in UDP for the application of finding shortest paths through the nodes using Djikstra's algorithm. This experiment is parallel to the routing algorithm used during transmission in routers.

2 Introduction

Open Shortest Path First (OSPF) is a routing protocol for Internet Protocol (IP) networks.OSPF is a widely used in large enterprise networks.OSPF was designed as an interior gateway protocol (IGP), for use in an autonomous system such as a local area network (LAN).Routing protocols like OSPF calculate the shortest route to a destination through the network based on an algorithm. OSPF was developed so that the shortest path through a network was calculated based on the cost of the route, taking into account bandwidth, delay and load. Therefore, OSPF undertakes route cost calculation on the basis of link-cost parameters, which can be weighted by the administrator. OSPF was quickly adopted because it became known for reliably calculating routes through large and complex local area networks.

3 Experiment Details

3.1 Simulation Setup

The code is written in $C++$, and so is compiled using $G++$. The algorithm involves using pthreads and mutexes. Input files are also present which are used to test the authenticity of the experiment. The first test file contains 8 nodes and 21 links whereas the second test file contains 8 nodes and 20 links.

3.2 Entities involved and functions in each entity

The only code involved is ospf.cpp. This consists of 5 functions apart from main. Main is only involved in taking input and appropriately making threads for 4 of the functions.

The first function thread is hif. This function sends a message "HELLO $< src\_id >$" periodically to all its neighbours.

The next function thread is lsaf. This function periodically sends an lsa message which consists of the costs of links to all its neighbours. This message is also sent to all its neighbours.

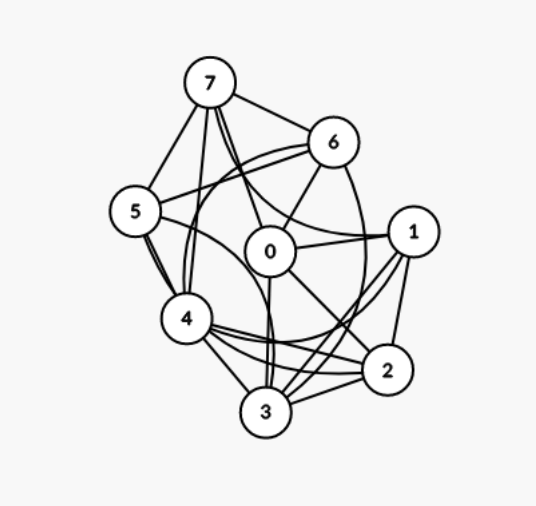
The third function thread is spff. This function periodically calculates the shortest path and its cost from the source node to all the other nodes and prints in the output file.

The fourth function thread is hirf. This is involved in receiving all types of messages. If it recieves a hello message, it replies with a "HELLOREPLY j i < *link_cost*" message. If it receives a hello reply message, it takes the link cost and stores it appropriately. Similarly, if it gets an lsa message, it stores the data and then forwards it to all its neighbours.

4 Results

The first graph input is as follows:

8 21
0 1 1 10
1 2 10 30
2 3 50 65
3 4 110 150
4 5 5 60
5 6 56 75
6 7 80 120
7 0 45 72
0 2 56 63
1 3 39 43
2 4 90 200
3 5 76 378
4 6 12 35
5 7 13 69
6 0 50 100
7 1 200 210
0 3 20 40
1 4 70 90
2 5 131 145
3 6 160 190
4 7 200 250



Result of each node over 200 secs: Node 0:

Routing Table for Node no.0 at time 20s :

Destination	Path	Cost
1	0–1	2
2	0–2	58
3	0–3	29
4	No Path	
5	No Path	
6	0–6	87
7	0–7	46

Routing Table for Node no.0 at time 40s :

Destination	Path	Cost
1	0–1	6
2	0–2	59
3	0–3	25
4	0–6–4	
120		
5	0–7–5	
103		
6	0–6	89
7	0–7	61

Routing Table for Node no.0 at time 60s :

Destination	Path	Cost
1	0–1	1
2	0–1–2	

13
3 0–3 34
4 0–6–4
72
5 0–7–5
92
6 0–6 53
7 0–7 55

Routing Table for Node no.0 at time 80s :

Destination Path Cost
1 0–1 8
2 0–1–2
20
3 0–3 26
4 0–1–4
79
5 0–7–5
79
6 0–6 100
7 0–7 51

Routing Table for Node no.0 at time 100s :

Destination Path Cost
1 0–1 10
2 0–1–2
36
3 0–3 34
4 0–6–4
99
5 0–7–5
118
6 0–6 70
7 0–7 54

Routing Table for Node no.0 at time 120s :

Destination Path Cost
1 0–1 3
2 0–1–2
20

3	0–3	26
4	0–1–4	
90		
5	0–1–4–5	
107		
6	0–6	83
7	0–7	55

Routing Table for Node no.0 at time 140s :

Destination	Path	Cost
1	0–1	8
2	0–1–2	
37		
3	0–3	33
4	0–1–4	
90		
5	0–7–5	
90		
6	0–6	95
7	0–7	67

Routing Table for Node no.0 at time 160s :

Destination	Path	Cost
1	0–1	6
2	0–1–2	
23		
3	0–3	32
4	0–6–4	
93		
5	0–7–5	
91		
6	0–6	70
7	0–7	55

Routing Table for Node no.0 at time 180s :

Destination	Path	Cost
1	0–1	5
2	0–1–2	
22		
3	0–3	29

4 0–6–4
78
5 0–6–4–5
87
6 0–6 55
7 0–7 66

Routing Table for Node no.0 at time 200s :

Destination	Path	Cost
1	0–1	6
2	0–1–2	
19		
3	0–3	36
4	0–1–4	
77		
5	0–1–4–5	
85		
6	0–6	76
7	0–7	56

Node 1:

Routing Table for Node no.1 at time 20s :

Destination	Path	Cost
0	No Path	
2	No Path	
3	No Path	
4	No Path	
5	No Path	
6	No Path	
7	No Path	

Routing Table for Node no.1 at time 40s :

Destination	Path	Cost
0	1–0	3
2	1–2	12
3	1–0–3	
28		
4	1–4	72
5	1–0–7–5	
106		
6	1–0–6	

92
7 1–0–7
64

Routing Table for Node no.1 at time 60s :

Destination	Path	Cost
0	1–0	4
2	1–2	12
3	1–0–3	38
4	1–4	71
5	1–0–7–5	96
6	1–0–6	57
7	1–0–7	59

Routing Table for Node no.1 at time 80s :

Destination	Path	Cost
0	1–0	5
2	1–2	26
3	1–0–3	31
4	1–4	90
5	1–0–7–5	84
6	1–0–6	105
7	1–0–7	56

Routing Table for Node no.1 at time 100s :

Destination	Path	Cost
0	1–0	6
2	1–2	17
3	1–3	40
4	1–4	87
5	1–4–5	122

6 1–0–6
76
7 1–0–7
60

Routing Table for Node no.1 at time 120s :

Destination	Path	Cost
0	1–0	4
2	1–2	29
3	1–0–3	
30		
4	1–4	82
5	1–4–5	
99		
6	1–0–6	
87		
7	1–0–7	
59		

Routing Table for Node no.1 at time 140s :

Destination	Path	Cost
0	1–0	3
2	1–2	17
3	1–0–3	
36		
4	1–4	88
5	1–0–7–5	
93		
6	1–0–6	
98		
7	1–0–7	
70		

Routing Table for Node no.1 at time 160s :

Destination	Path	Cost
0	1–0	2
2	1–2	17
3	1–0–3	
34		
4	1–4	83

5 1–0–7–5
93
6 1–0–6
72
7 1–0–7
57

Routing Table for Node no.1 at time 180s :

Destination	Path	Cost
0	1–0	8
2	1–2	13
3	1–0–3	
37		
4	1–4	71
5	1–4–5	
80		
6	1–0–6	
63		
7	1–0–7	
74		

Routing Table for Node no.1 at time 200s :

Destination	Path	Cost
0	1–0	1
2	1–2	13
3	1–0–3	
37		
4	1–4	81
5	1–4–5	
89		
6	1–0–6	
77		
7	1–0–7	
57		

Node 2:

Routing Table for Node no.2 at time 20s :

Destination	Path	Cost
0	2–0	60
1	2–1	12
3	2–3	63

4 2–4 105
5 2–5 132
6 2–0–6
147
7 2–0–7
106

Routing Table for Node no.2 at time 40s :

Destination Path Cost
0 2–1–0
18
1 2–1 15
3 2–1–0–3
43
4 2–1–4
87
5 2–1–0–7–5
121
6 2–1–0–6
107
7 2–1–0–7
79

Routing Table for Node no.2 at time 60s :

Destination Path Cost
0 2–1–0
31
1 2–1 27
3 2–3 59
4 2–1–4
98
5 2–1–0–7–5
123
6 2–1–0–6
84
7 2–1–0–7
86

Routing Table for Node no.2 at time 80s :

Destination Path Cost

0 2–1–0
27
1 2–1 22
3 2–1–0–3
53
4 2–1–4
112
5 2–1–0–7–5
106
6 2–1–0–6
127
7 2–1–0–7
78

Routing Table for Node no.2 at time 100s :

Destination Path Cost
0 2–1–0
28
1 2–1 22
3 2–3 58
4 2–1–4
109
5 2–5 135
6 2–1–0–6
98
7 2–1–0–7
82

Routing Table for Node no.2 at time 120s :

Destination Path Cost
0 2–1–0
27
1 2–1 23
3 2–3 53
4 2–1–4
105
5 2–1–4–5
122
6 2–1–0–6
110
7 2–1–0–7

82

Routing Table for Node no.2 at time 140s :

Destination	Path	Cost
0	2–1–0	31
1	2–1	28
3	2–3	59
4	2–4	112
5	2–1–0–7–5	121
6	2–1–0–6	126
7	2–1–0–7	98

Routing Table for Node no.2 at time 160s :

Destination	Path	Cost
0	2–1–0	22
1	2–1	20
3	2–1–0–3	54
4	2–1–4	103
5	2–1–0–7–5	113
6	2–1–0–6	92
7	2–1–0–7	77

Routing Table for Node no.2 at time 180s :

Destination	Path	Cost
0	2–1–0	36
1	2–1	28
3	2–3	53
4	2–1–4	99

5 2–1–4–5
108
6 2–1–0–6
91
7 2–1–0–7
102

Routing Table for Node no.2 at time 200s :

Destination	Path	Cost
0	2–1–0	25
1	2–1	24
3	2–3	52
4	2–1–4	105
5	2–1–4–5	113
6	2–1–0–6	101
7	2–1–0–7	81

Node 3:

Routing Table for Node no.3 at time 20s :

Destination	Path	Cost
0	3–0	30
1	3–0–1	32
2	3–2	62
4	3–4	127
5	3–2–5	194
6	3–0–6	117
7	3–0–7	76

Routing Table for Node no.3 at time 40s :

Destination	Path	Cost
0	3–0	25
1	3–0–1	

31
2 3–0–1–2
43
4 3–0–1–4
103
5 3–5 94
6 3–0–6
114
7 3–0–7
86

Routing Table for Node no.3 at time 60s :

Destination Path Cost
0 3–0 34
1 3–0–1
35
2 3–0–1–2
47
4 3–0–1–4
106
5 3–0–7–5
126
6 3–0–6
87
7 3–0–7
89

Routing Table for Node no.3 at time 80s :

Destination Path Cost
0 3–0 29
1 3–0–1
37
2 3–2 52
4 3–0–1–4
127
5 3–0–7–5
108
6 3–0–6
129
7 3–0–7
80

Routing Table for Node no.3 at time 100s :

Destination	Path	Cost
0	3–0	34
1	3–1	40
2	3–2	57
4	3–1–4	127
5	3–0–7–5	152
6	3–0–6	104
7	3–0–7	88

Routing Table for Node no.3 at time 120s :

Destination	Path	Cost
0	3–0	27
1	3–0–1	30
2	3–0–1–2	59
4	3–0–1–4	112
5	3–0–1–4–5	129
6	3–0–6	110
7	3–0–7	82

Routing Table for Node no.3 at time 140s :

Destination	Path	Cost
0	3–0	28
1	3–0–1	36
2	3–0–1–2	53
4	3–4	121
5	3–0–7–5	

118
6 3–0–6
123
7 3–0–7
95

Routing Table for Node no.3 at time 160s :

Destination	Path	Cost
0	3–0	35
1	3–1	40
2	3–1–2	
57		
4	3–1–4	
123		
5	3–0–7–5	
126		
6	3–0–6	
105		
7	3–0–7	
90		

Routing Table for Node no.3 at time 180s :

Destination	Path	Cost
0	3–0	31
1	3–0–1	
36		
2	3–0–1–2	
49		
4	3–0–1–4	
107		
5	3–0–1–4–5	
116		
6	3–0–6	
86		
7	3–0–7	
97		

Routing Table for Node no.3 at time 200s :

Destination	Path	Cost
0	3–0	22

1 3–0–1
28
2 3–0–1–2
41
4 3–0–1–4
109
5 3–5 101
6 3–0–6
98
7 3–0–7
78

Node 4:

Routing Table for Node no.4 at time 20s :

Destination Path Cost
0 4–3–0
167
1 4–1 74
2 4–2 186
3 4–3 137
5 4–5 39
6 4–6 25
7 4–3–0–7
213

Routing Table for Node no.4 at time 40s :

Destination Path Cost
0 4–1–0
85
1 4–1 82
2 4–1–2
94
3 4–1–0–3
110
5 4–5 43
6 4–6 26
7 4–6–7
123

Routing Table for Node no.4 at time 60s :

Destination Path Cost

0 4–1–0
82
1 4–1 78
2 4–1–2
90
3 4–3 116
5 4–5 40
6 4–6 35
7 4–5–7
97

Routing Table for Node no.4 at time 80s :

Destination Path Cost
0 4–1–0
78
1 4–1 73
2 4–1–2
99
3 4–1–0–3
104
5 4–5 35
6 4–6 21
7 4–5–7
48

Routing Table for Node no.4 at time 100s :

Destination Path Cost
0 4–1–0
76
1 4–1 70
2 4–1–2
87
3 4–1–3
110
5 4–5 17
6 4–6 32
7 4–5–7
50

Routing Table for Node no.4 at time 120s :

Destination	Path	Cost
0	4–1–0	76
1	4–1	72
2	4–1–2	101
3	4–1–0–3	102
5	4–5	58
6	4–6	31
7	4–5–7	105

Routing Table for Node no.4 at time 140s :

Destination	Path	Cost
0	4–1–0	85
1	4–1	82
2	4–1–2	99
3	4–1–0–3	118
5	4–5	38
6	4–6	32
7	4–5–7	85

Routing Table for Node no.4 at time 160s :

Destination	Path	Cost
0	4–1–0	83
1	4–1	81
2	4–1–2	98
3	4–1–0–3	115
5	4–5	9
6	4–6	33
7	4–5–7	70

Routing Table for Node no.4 at time 180s :

Destination	Path	Cost
0	4–6–0	76
1	4–1	78
2	4–1–2	91
3	4–6–0–3	105
5	4–5	8
6	4–6	23
7	4–5–7	37

Routing Table for Node no.4 at time 200s :

Destination	Path	Cost
0	4–1–0	87
1	4–1	86
2	4–1–2	99
3	4–3	122
5	4–5	48
6	4–6	32
7	4–5–7	77

Node 5:

Routing Table for Node no.5 at time 20s :

Destination	Path	Cost
0	No Path	
1	No Path	
2	No Path	
3	No Path	
4	No Path	
6	No Path	
7	No Path	

Routing Table for Node no.5 at time 40s :

Destination	Path	Cost

0 5–4–1–0
116
1 5–4–1
113
2 5–4–1–2
125
3 5–4–1–0–3
141
4 5–4 31
6 5–4–6
57
7 5–7 57

Routing Table for Node no.5 at time 60s :

Destination Path Cost
0 5–7–0
63
1 5–7–0–1
64
2 5–7–0–1–2
76
3 5–7–0–3
97
4 5–4 59
6 5–6 66
7 5–7 13

Routing Table for Node no.5 at time 80s :

Destination Path Cost
0 5–7–0
94
1 5–7–0–1
102
2 5–7–0–1–2
128
3 5–7–0–3
120
4 5–4 54
6 5–6 62
7 5–7 33

Routing Table for Node no.5 at time 100s :

Destination	Path	Cost
0	5–7–0	116
1	5–4–1	126
2	5–2	140
3	5–7–0–3	150
4	5–4	56
6	5–6	74
7	5–7	47

Routing Table for Node no.5 at time 120s :

Destination	Path	Cost
0	5–4–1–0	114
1	5–4–1	110
2	5–2	139
3	5–4–1–0–3	140
4	5–4	38
6	5–4–6	69
7	5–7	47

Routing Table for Node no.5 at time 140s :

Destination	Path	Cost
0	5–7–0	124
1	5–7–0–1	132
2	5–2	140
3	5–7–0–3	157
4	5–4	58
6	5–6	65
7	5–7	61

Routing Table for Node no.5 at time 160s :

Destination	Path	Cost
0	5–7–0	87
1	5–7–0–1	93
2	5–7–0–1–2	110
3	5–7–0–3	119
4	5–4	36
6	5–6	62
7	5–7	29

Routing Table for Node no.5 at time 180s :

Destination	Path	Cost
0	5–7–0	84
1	5–7–0–1	89
2	5–7–0–1–2	102
3	5–7–0–3	113
4	5–4	40
6	5–4–6	63
7	5–7	34

Routing Table for Node no.5 at time 200s :

Destination	Path	Cost
0	5–7–0	75
1	5–7–0–1	81
2	5–7–0–1–2	94
3	5–7–0–3	111
4	5–4	34

6 5–4–6
66
7 5–7 27

Node 6:

Routing Table for Node no.6 at time 20s :

Destination	Path	Cost
0	6–0	81
1	6–0–1	
83		
2	6–0–2	
139		
3	6–0–3	
110		
4	6–4	31
5	6–4–5	
70		
7	6–7	97

Routing Table for Node no.6 at time 40s :

Destination	Path	Cost
0	6–0	81
1	6–0–1	
87		
2	6–0–1–2	
99		
3	6–0–3	
106		
4	6–4	19
5	6–4–5	
62		
7	6–7	101

Routing Table for Node no.6 at time 60s :

Destination	Path	Cost
0	6–0	90
1	6–0–1	
91		
2	6–0–1–2	
103		
3	6–0–3	

124
4 6–4 32
5 6–5 56
7 6–5–7
69

Routing Table for Node no.6 at time 80s :

Destination Path Cost
0 6–0 88
1 6–0–1
96
2 6–0–1–2
122
3 6–0–3
114
4 6–4 29
5 6–5 61
7 6–7 83

Routing Table for Node no.6 at time 100s :

Destination Path Cost
0 6–0 88
1 6–4–1
84
2 6–4–1–2
101
3 6–0–3
122
4 6–4 14
5 6–4–5
31
7 6–4–5–7
78

Routing Table for Node no.6 at time 120s :

Destination Path Cost
0 6–0 96
1 6–4–1
94
2 6–4–1–2

123
3 6–0–3
122
4 6–4 22
5 6–5 56
7 6–5–7
103

Routing Table for Node no.6 at time 140s :

Destination Path Cost
0 6–0 91
1 6–0–1
99
2 6–0–1–2
116
3 6–0–3
124
4 6–4 23
5 6–4–5
61
7 6–7 80

Routing Table for Node no.6 at time 160s :

Destination Path Cost
0 6–0 53
1 6–0–1
59
2 6–0–1–2
76
3 6–0–3
85
4 6–4 23
5 6–4–5
32
7 6–4–5–7
61

Routing Table for Node no.6 at time 180s :

Destination Path Cost
0 6–0 56

1 6–0–1
61
2 6–0–1–2
74
3 6–0–3
85
4 6–4 25
5 6–4–5
33
7 6–4–5–7
62

Routing Table for Node no.6 at time 200s :

Destination Path Cost
0 6–0 90
1 6–0–1
96
2 6–0–1–2
109
3 6–0–3
126
4 6–4 20
5 6–4–5
68
7 6–4–5–7
102

Node 7:

Routing Table for Node no.7 at time 20s :

Destination Path Cost
0 7–0 67
1 7–0–1
69
2 7–0–2
125
3 7–0–3
96
4 7–6–4
125
5 7–5 42
6 7–6 94

Routing Table for Node no.7 at time 40s :

Destination	Path	Cost
0	7–0	62
1	7–0–1	68
2	7–0–1–2	80
3	7–0–3	87
4	7–5–4	44
5	7–5	13
6	7–5–4–6	70

Routing Table for Node no.7 at time 60s :

Destination	Path	Cost
0	7–0	61
1	7–0–1	62
2	7–0–1–2	74
3	7–0–3	95
4	7–5–4	87
5	7–5	28
6	7–5–6	94

Routing Table for Node no.7 at time 80s :

Destination	Path	Cost
0	7–0	69
1	7–0–1	77
2	7–0–1–2	103
3	7–0–3	95
4	7–5–4	

118
5 7–5 64
6 7–6 106

Routing Table for Node no.7 at time 100s :

Destination Path Cost
0 7–0 69
1 7–0–1
79
2 7–0–1–2
96
3 7–0–3
103
4 7–5–4
124
5 7–5 68
6 7–6 113

Routing Table for Node no.7 at time 120s :

Destination Path Cost
0 7–0 63
1 7–0–1
66
2 7–0–1–2
95
3 7–0–3
89
4 7–5–4
61
5 7–5 23
6 7–6 90

Routing Table for Node no.7 at time 140s :

Destination Path Cost
0 7–0 58
1 7–0–1
66
2 7–0–1–2
83
3 7–0–3

91
4 7–5–4
94
5 7–5 36
6 7–5–6
101

Routing Table for Node no.7 at time 160s :

Destination	Path	Cost
0	7–0	50
1	7–0–1	
56		
2	7–0–1–2	
73		
3	7–0–3	
82		
4	7–5–4	
95		
5	7–5	59
6	7–6	99

Routing Table for Node no.7 at time 180s :

Destination	Path	Cost
0	7–0	48
1	7–0–1	
53		
2	7–0–1–2	
66		
3	7–0–3	
77		
4	7–5–4	
80		
5	7–5	40
6	7–6	92

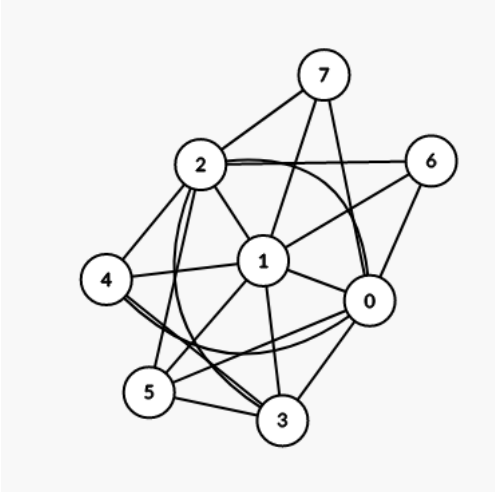
Routing Table for Node no.7 at time 200s :

Destination	Path	Cost
0	7–0	66
1	7–0–1	
72		

2	7–0–1–2	
85		
3	7–0–3	
102		
4	7–5–4	
73		
5	7–5	39
6	7–6	88

The second graph input is as follows:

```
8  20
0  1  1  10
0  2  56  63
0  3  20  40
0  4  210  260
0  5  49  59
0  6  50  100
0  7  45  72
1  2  10  30
1  3  39  43
1  4  70  90
1  5  74  300
1  6  110  170
1  7  30  60
2  3  50  65
2  4  90  200
2  5  131  145
2  6  81  102
2  7  95  195
3  4  110  150
3  5  76  378
```



Result of each node over 200 secs: Node 0:

Routing Table for Node no.0 at time 20s :

Destination	Path	Cost
1	0–1	8
2	0–2	59
3	0–3	29
4	0–4	219
5	0–5	55
6	0–6	99
7	0–7	60

Routing Table for Node no.0 at time 40s :

Destination	Path	Cost
1	0–1	7
2	0–1–2	
32		
3	0–3	40
4	0–1–4	
87		
5	0–5	52
6	0–6	95
7	0–1–7	
40		

Routing Table for Node no.0 at time 60s :

Destination	Path	Cost
1	0–1	4

2 0–1–2
15
3 0–3 25
4 0–1–4
77
5 0–5 53
6 0–6 72
7 0–1–7
56

Routing Table for Node no.0 at time 80s :

Destination Path Cost
1 0–1 1
2 0–1–2
13
3 0–3 36
4 0–1–4
84
5 0–5 58
6 0–6 86
7 0–7 45

Routing Table for Node no.0 at time 100s :

Destination Path Cost
1 0–1 5
2 0–1–2
25
3 0–3 37
4 0–1–4
91
5 0–5 53
6 0–6 78
7 0–7 60

Routing Table for Node no.0 at time 120s :

Destination Path Cost
1 0–1 2
2 0–1–2
20
3 0–3 31

4 0–1–4
87
5 0–5 54
6 0–6 87
7 0–1–7
44

Routing Table for Node no.0 at time 140s :

Destination Path Cost
1 0–1 8
2 0–1–2
21
3 0–3 37
4 0–1–4
87
5 0–5 53
6 0–6 73
7 0–1–7
42

Routing Table for Node no.0 at time 160s :

Destination Path Cost
1 0–1 10
2 0–1–2
35
3 0–3 20
4 0–1–4
83
5 0–5 58
6 0–6 52
7 0–1–7
43

Routing Table for Node no.0 at time 180s :

Destination Path Cost
1 0–1 10
2 0–1–2
30
3 0–3 38
4 0–1–4

92
5 0–5 55
6 0–6 100
7 0–1–7
42

Routing Table for Node no.0 at time 200s :

Destination	Path	Cost
1	0–1	6
2	0–1–2	
21		
3	0–3	33
4	0–1–4	
76		
5	0–5	52
6	0–6	52
7	0–1–7	
45		

Node 1:

Routing Table for Node no.1 at time 20s :

Destination	Path	Cost
0	1–0	3
2	1–2	25
3	1–0–3	
32		
4	1–4	80
5	1–0–5	
58		
6	1–0–6	
102		
7	1–7	33

Routing Table for Node no.1 at time 40s :

Destination	Path	Cost
0	1–0	3
2	1–2	11
3	1–3	40
4	1–4	73
5	1–0–5	
55		

6 1–0–6
98
7 1–7 52

Routing Table for Node no.1 at time 60s :

Destination	Path	Cost
0	1–0	8
2	1–2	12
3	1–0–3	
33		
4	1–4	83
5	1–0–5	
61		
6	1–0–6	
80		
7	1–7	59

Routing Table for Node no.1 at time 80s :

Destination	Path	Cost
0	1–0	7
2	1–2	20
3	1–3	42
4	1–4	86
5	1–0–5	
65		
6	1–0–6	
93		
7	1–0–7	
52		

Routing Table for Node no.1 at time 100s :

Destination	Path	Cost
0	1–0	9
2	1–2	18
3	1–3	39
4	1–4	85
5	1–0–5	
62		
6	1–0–6	
87		

7	1–7	42

Routing Table for Node no.1 at time 120s :

Destination	Path	Cost
0	1–0	5
2	1–2	13
3	1–0–3	36
4	1–4	79
5	1–0–5	59
6	1–0–6	92
7	1–7	34

Routing Table for Node no.1 at time 140s :

Destination	Path	Cost
0	1–0	10
2	1–2	25
3	1–3	43
4	1–4	73
5	1–0–5	63
6	1–0–6	83
7	1–7	33

Routing Table for Node no.1 at time 160s :

Destination	Path	Cost
0	1–0	9
2	1–2	20
3	1–0–3	29
4	1–4	82
5	1–0–5	67
6	1–0–6	61
7	1–7	32

Routing Table for Node no.1 at time 180s :

Destination	Path	Cost
0	1–0	6
2	1–2	15
3	1–3	39
4	1–4	70
5	1–0–5	61
6	1–2–6	103
7	1–7	39

Routing Table for Node no.1 at time 200s :

Destination	Path	Cost
0	1–0	10
2	1–2	24
3	1–3	39
4	1–4	78
5	1–0–5	62
6	1–0–6	62
7	1–7	48

Node 2:

Routing Table for Node no.2 at time 20s :

Destination	Path	Cost
0	No Path	
1	No Path	
3	No Path	
4	No Path	
5	No Path	
6	No Path	
7	No Path	

Routing Table for Node no.2 at time 40s :

Destination	Path	Cost
0	2–1–0	32
1	2–1	29

3 2–3 63
4 2–1–4
102
5 2–1–0–5
84
6 2–6 81
7 2–1–7
81

Routing Table for Node no.2 at time 60s :

Destination Path Cost
0 2–1–0
19
1 2–1 11
3 2–1–0–3
44
4 2–1–4
94
5 2–1–0–5
72
6 2–6 84
7 2–1–7
70

Routing Table for Node no.2 at time 80s :

Destination Path Cost
0 2–1–0
27
1 2–1 20
3 2–3 52
4 2–1–4
106
5 2–1–0–5
85
6 2–6 102
7 2–1–0–7
72

Routing Table for Node no.2 at time 100s :

Destination Path Cost

0 2–1–0
30
1 2–1 21
3 2–3 59
4 2–1–4
106
5 2–1–0–5
83
6 2–6 102
7 2–1–7
63

Routing Table for Node no.2 at time 120s :

Destination Path Cost
0 2–1–0
29
1 2–1 24
3 2–3 52
4 2–4 98
5 2–1–0–5
83
6 2–6 88
7 2–1–7
58

Routing Table for Node no.2 at time 140s :

Destination Path Cost
0 2–1–0
24
1 2–1 14
3 2–3 51
4 2–1–4
87
5 2–1–0–5
77
6 2–1–0–6
97
7 2–1–7
47

Routing Table for Node no.2 at time 160s :

Destination	Path	Cost
0	2–1–0	21
1	2–1	12
3	2–1–0–3	41
4	2–1–4	94
5	2–1–0–5	79
6	2–1–0–6	73
7	2–1–7	44

Routing Table for Node no.2 at time 180s :

Destination	Path	Cost
0	2–1–0	34
1	2–1	28
3	2–3	58
4	2–1–4	98
5	2–1–0–5	89
6	2–6	98
7	2–1–7	67

Routing Table for Node no.2 at time 200s :

Destination	Path	Cost
0	2–1–0	23
1	2–1	13
3	2–1–3	52
4	2–1–4	91
5	2–1–0–5	75

6 2–1–0–6
75
7 2–1–7
61

Node 3:

Routing Table for Node no.3 at time 20s :

Destination	Path	Cost
0	3–0	30
1	3–0–1	
38		
2	3–2	60
4	3–4	116
5	3–0–5	
85		
6	3–0–6	
129		
7	3–0–1–7	
71		

Routing Table for Node no.3 at time 40s :

Destination	Path	Cost
0	3–0	21
1	3–0–1	
28		
2	3–0–1–2	
39		
4	3–0–1–4	
101		
5	3–0–5	
73		
6	3–0–6	
116		
7	3–0–1–7	
80		

Routing Table for Node no.3 at time 60s :

Destination	Path	Cost
0	3–0	22
1	3–0–1	
26		

2 3–0–1–2
38
4 3–0–1–4
109
5 3–0–5
75
6 3–0–6
94
7 3–0–1–7
85

Routing Table for Node no.3 at time 80s :

Destination	Path	Cost
0	3–0	39
1	3–1	40
2	3–1–2	
60		
4	3–1–4	
126		
5	3–0–5	
97		
6	3–0–6	
125		
7	3–0–7	
84		

Routing Table for Node no.3 at time 100s :

Destination	Path	Cost
0	3–0	38
1	3–1	41
2	3–1–2	
59		
4	3–4	123
5	3–0–5	
91		
6	3–0–6	
116		
7	3–1–7	
83		

Routing Table for Node no.3 at time 120s :

Destination	Path	Cost
0	3–0	28
1	3–0–1	30
2	3–0–1–2	43
4	3–0–1–4	109
5	3–0–5	82
6	3–0–6	115
7	3–0–1–7	64

Routing Table for Node no.3 at time 140s :

Destination	Path	Cost
0	3–0	24
1	3–0–1	32
2	3–2	57
4	3–0–1–4	105
5	3–0–5	77
6	3–0–6	97
7	3–0–1–7	65

Routing Table for Node no.3 at time 160s :

Destination	Path	Cost
0	3–0	31
1	3–1	40
2	3–2	54
4	3–1–4	122
5	3–0–5	89
6	3–0–6	

83
7 3–1–7
72

Routing Table for Node no.3 at time 180s :

Destination	Path	Cost
0	3–0	21
1	3–0–1	31
2	3–0–1–2	46
4	3–0–1–4	101
5	3–0–5	76
6	3–0–6	121
7	3–0–1–7	70

Routing Table for Node no.3 at time 200s :

Destination	Path	Cost
0	3–0	36
1	3–0–1	42
2	3–2	63
4	3–0–1–4	120
5	3–0–5	88
6	3–0–6	88
7	3–0–1–7	90

Node 4:

Routing Table for Node no.4 at time 20s :

Destination	Path	Cost
0	4–1–0	88
1	4–1	85

2 4–1–2
110
3 4–3 116
5 4–1–0–5
143
6 4–1–0–6
187
7 4–1–7
118

Routing Table for Node no.4 at time 40s :

Destination Path Cost
0 4–1–0
78
1 4–1 75
2 4–1–2
86
3 4–3 113
5 4–1–0–5
130
6 4–1–2–6
167
7 4–1–7
127

Routing Table for Node no.4 at time 60s :

Destination Path Cost
0 4–1–0
90
1 4–1 82
2 4–1–2
94
3 4–1–0–3
115
5 4–1–0–5
143
6 4–1–0–6
162
7 4–1–7
141

Routing Table for Node no.4 at time 80s :

Destination	Path	Cost
0	4–1–0	87
1	4–1	80
2	4–2	90
3	4–1–3	122
5	4–1–0–5	145
6	4–1–0–6	173
7	4–1–0–7	132

Routing Table for Node no.4 at time 100s :

Destination	Path	Cost
0	4–1–0	90
1	4–1	81
2	4–1–2	99
3	4–1–3	120
5	4–1–0–5	143
6	4–1–0–6	168
7	4–1–7	123

Routing Table for Node no.4 at time 120s :

Destination	Path	Cost
0	4–1–0	75
1	4–1	70
2	4–1–2	83
3	4–1–0–3	106

5 4–1–0–5
129
6 4–1–0–6
162
7 4–1–7
104

Routing Table for Node no.4 at time 140s :

Destination Path Cost
0 4–1–0
93
1 4–1 83
2 4–1–2
108
3 4–1–3
126
5 4–1–0–5
146
6 4–1–0–6
166
7 4–1–7
116

Routing Table for Node no.4 at time 160s :

Destination Path Cost
0 4–1–0
84
1 4–1 75
2 4–1–2
95
3 4–1–0–3
104
5 4–1–0–5
142
6 4–1–0–6
136
7 4–1–7
107

Routing Table for Node no.4 at time 180s :

Destination	Path	Cost
0	4–1–0	
79		
1	4–1	73
2	4–1–2	
88		
3	4–1–3	
112		
5	4–1–0–5	
134		
6	4–1–0–6	
179		
7	4–1–7	
112		

Routing Table for Node no.4 at time 200s :

Destination	Path	Cost
0	4–1–0	
81		
1	4–1	71
2	4–1–2	
95		
3	4–1–3	
110		
5	4–1–0–5	
133		
6	4–1–0–6	
133		
7	4–1–7	
119		

Node 5:

Routing Table for Node no.5 at time 20s :

Destination	Path	Cost
0	No Path	
1	No Path	
2	No Path	
3	No Path	
4	No Path	
6	No Path	
7	No Path	

Routing Table for Node no.5 at time 40s :

Destination	Path	Cost
0	5–0	58
1	5–0–1	65
2	5–0–1–2	76
3	5–0–3	98
4	5–0–1–4	138
6	5–0–6	153
7	5–0–1–7	117

Routing Table for Node no.5 at time 60s :

Destination	Path	Cost
0	5–0	58
1	5–0–1	62
2	5–0–1–2	74
3	5–0–3	83
4	5–0–1–4	145
6	5–0–6	130
7	5–0–1–7	121

Routing Table for Node no.5 at time 80s :

Destination	Path	Cost
0	5–0	56
1	5–0–1	57
2	5–0–1–2	77
3	5–0–3	

92
4 5–0–1–4
143
6 5–0–6
142
7 5–0–7
101

Routing Table for Node no.5 at time 100s :

Destination	Path	Cost
0	5–0	53
1	5–0–1	
58		
2	5–0–1–2	
76		
3	5–0–3	
90		
4	5–0–1–4	
143		
6	5–0–6	
131		
7	5–0–1–7	
100		

Routing Table for Node no.5 at time 120s :

Destination	Path	Cost
0	5–0	58
1	5–0–1	
60		
2	5–0–1–2	
73		
3	5–0–3	
89		
4	5–0–1–4	
139		
6	5–0–6	
145		
7	5–0–1–7	
94		

Routing Table for Node no.5 at time 140s :

Destination	Path	Cost
0	5–0	50
1	5–0–1	58
2	5–0–1–2	83
3	5–0–3	87
4	5–0–1–4	131
6	5–0–6	123
7	5–0–1–7	91

Routing Table for Node no.5 at time 160s :

Destination	Path	Cost
0	5–0	56
1	5–0–1	66
2	5–0–1–2	86
3	5–0–3	76
4	5–0–1–4	148
6	5–0–6	108
7	5–0–1–7	98

Routing Table for Node no.5 at time 180s :

Destination	Path	Cost
0	5–0	49
1	5–0–1	59
2	5–0–1–2	74
3	5–0–3	87

4 5–0–1–4
129
6 5–0–6
149
7 5–0–1–7
98

Routing Table for Node no.5 at time 200s :

Destination	Path	Cost
0	5–0	57
1	5–0–1	
63		
2	5–0–1–2	
87		
3	5–0–3	
90		
4	5–0–1–4	
141		
6	5–0–6	
109		
7	5–0–1–7	
111		

Node 6:

Routing Table for Node no.6 at time 20s :

Destination	Path	Cost
0	No Path	
1	No Path	
2	No Path	
3	No Path	
4	No Path	
5	No Path	
7	No Path	

Routing Table for Node no.6 at time 40s :

Destination	Path	Cost
0	6–0	80
1	6–0–1	
87		
2	6–2	83
3	6–0–3	

120
4 6–0–1–4
160
5 6–0–5
132
7 6–0–1–7
139

Routing Table for Node no.6 at time 60s :

Destination	Path	Cost
0	6–0	56
1	6–0–1	
60		
2	6–0–1–2	
72		
3	6–0–3	
81		
4	6–0–1–4	
143		
5	6–0–5	
109		
7	6–0–1–7	
119		

Routing Table for Node no.6 at time 80s :

Destination	Path	Cost
0	6–0	70
1	6–0–1	
71		
2	6–0–1–2	
91		
3	6–0–3	
106		
4	6–0–1–4	
157		
5	6–0–5	
128		
7	6–0–7	
115		

Routing Table for Node no.6 at time 100s :

Destination	Path	Cost
0	6–0	86
1	6–0–1	91
2	6–2	97
3	6–0–3	123
4	6–0–1–4	176
5	6–0–5	139
7	6–0–1–7	133

Routing Table for Node no.6 at time 120s :

Destination	Path	Cost
0	6–0	75
1	6–0–1	77
2	6–2	89
3	6–0–3	106
4	6–0–1–4	156
5	6–0–5	129
7	6–0–1–7	111

Routing Table for Node no.6 at time 140s :

Destination	Path	Cost
0	6–0	99
1	6–2–1	106
2	6–2	92
3	6–0–3	136
4	6–2–1–4	179
5	6–0–5	

152
7 6–2–1–7
139

Routing Table for Node no.6 at time 160s :

Destination	Path	Cost
0	6–0	84
1	6–0–1	94
2	6–2	88
3	6–0–3	104
4	6–0–1–4	176
5	6–0–5	142
7	6–0–1–7	126

Routing Table for Node no.6 at time 180s :

Destination	Path	Cost
0	6–0	84
1	6–0–1	94
2	6–2	90
3	6–0–3	122
4	6–0–1–4	164
5	6–0–5	139
7	6–0–1–7	133

Routing Table for Node no.6 at time 200s :

Destination	Path	Cost
0	6–0	94
1	6–2–1	98
2	6–2	85

3 6–0–3
127
4 6–2–1–4
176
5 6–0–5
146
7 6–2–1–7
146

Node 7:

Routing Table for Node no.7 at time 20s :

Destination	Path	Cost
0	7–0	61
1	7–1	59
2	7–1–2	
84		
3	7–0–3	
90		
4	7–1–4	
139		
5	7–0–5	
116		
6	7–0–6	
160		

Routing Table for Node no.7 at time 40s :

Destination	Path	Cost
0	7–1–0	
46		
1	7–1	43
2	7–1–2	
54		
3	7–1–3	
83		
4	7–1–4	
116		
5	7–1–0–5	
98		
6	7–1–2–6	
135		

Routing Table for Node no.7 at time 60s :

Destination	Path	Cost
0	7–1–0	45
1	7–1	37
2	7–1–2	49
3	7–1–0–3	70
4	7–1–4	120
5	7–1–0–5	98
6	7–1–0–6	117

Routing Table for Node no.7 at time 80s :

Destination	Path	Cost
0	7–1–0	39
1	7–1	32
2	7–1–2	52
3	7–1–3	74
4	7–1–4	118
5	7–1–0–5	97
6	7–1–0–6	125

Routing Table for Node no.7 at time 100s :

Destination	Path	Cost
0	7–0	53
1	7–1	49
2	7–1–2	67
3	7–1–3	88
4	7–1–4	

134
5 7–0–5
106
6 7–0–6
131

Routing Table for Node no.7 at time 120s :

Destination	Path	Cost
0	7–1–0	39
1	7–1	34
2	7–1–2	47
3	7–1–0–3	70
4	7–1–4	113
5	7–1–0–5	93
6	7–1–0–6	126

Routing Table for Node no.7 at time 140s :

Destination	Path	Cost
0	7–0	50
1	7–1	50
2	7–1–2	75
3	7–0–3	87
4	7–1–4	123
5	7–0–5	103
6	7–0–6	123

Routing Table for Node no.7 at time 160s :

Destination	Path	Cost
0	7–0	49

1 7–1 54
2 7–1–2
74
3 7–0–3
69
4 7–1–4
136
5 7–0–5
107
6 7–0–6
101

Routing Table for Node no.7 at time 180s :

Destination Path Cost
0 7–1–0
47
1 7–1 41
2 7–1–2
56
3 7–1–3
80
4 7–1–4
111
5 7–1–0–5
102
6 7–1–0–6
147

Routing Table for Node no.7 at time 200s :

Destination Path Cost
0 7–1–0
58
1 7–1 48
2 7–1–2
72
3 7–1–3
87
4 7–1–4
126
5 7–1–0–5
110

6 7–1–0–6
110

5 Learning Outcomes

From this experiment, I was able to learn about OSPF routing algorithm and how it is implemented. I was also able to see one of the many aspects in which Djikstra's algorithm is used in practice. I also saw the ways in which threads and Mutexes are used and its implementation. I learnt about UDP as well especially in multi client setting.

6 Conclusion

Through this experiment we see the various aspects of OSPF routing and how the routers communicate with each other. Although it is not a full fledged model it captures the essence of the underlying algorithm by using UDP and similar communication messages. Through this simulation we could see how the shortest path is calculated and its variations.

7 References

https://en.wikipedia.org/wiki/Open_Shortest_Path_First
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