A Graph Theory Algorithm To Find Shortest Path In Routing Protocol

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Abstract— In Computer Networks, routing protocol performs the task of communicating between the nodes and the way to establish path between the two nodes. It also has a responsibility of sharing information among the entire network from the source location to the destination location. For this to achieve, the route connected between source node to destination node is to be found. There are various algorithms to find the path between the two nodes. But we focus on finding the route between source to the destination node through shortest path. The main emphasis of this paper is to find the shortest path between the source node and destination node in Open Shortest Path First Protocol(OSPF) using Dijkstra's graph theory algorithm.

Index Terms— Dijkstra's Algorithm ,Graph Theory, Performance, OSPF, OSPF using Dijkstra's, Routing Protocol, Shortest Path.

1 Introduction

Routing protocol plays a vital role in establishing communication link between all its nodes. The nodes should have knowledge of the entire network structure. If an information has being passed from source node to destination node, then selecting the apt path to traversal is also assigned by routing protocols. To reach the destination node usage of shortest path will be benefited. Shortest path algorithm helps to find least expensive path on the network, based on the cost function.

The paper focuses on finding the shortest path between source and destination node in OSPF protocol using Dijkstra's algorithm. Section II describes the role of Routing Protocol. Section III explains about OSPF protocol. Section IV discuss the pseudo code about Dijkstra's algorithm. In Section V, we present about finding the shortest path in OSPF using Dijkstra's algorithm. Section VI explains the performance of OSPF and we conclude with future work.":

2 Routing Protocol

The work of node is to communicate information between nodes assigned by routing protocol. It also helps in passing information and data packets between the nodes. The nodes have information about the network directly attached and with the help of routing protocol, it is aware of the entire structure of the network.

There are different types of protocol, but we discuss about protocols used in IP network[1]. The IP network is classified into two categories:

- Interior Gateway Protocol
- Exterior Gateway Protocol

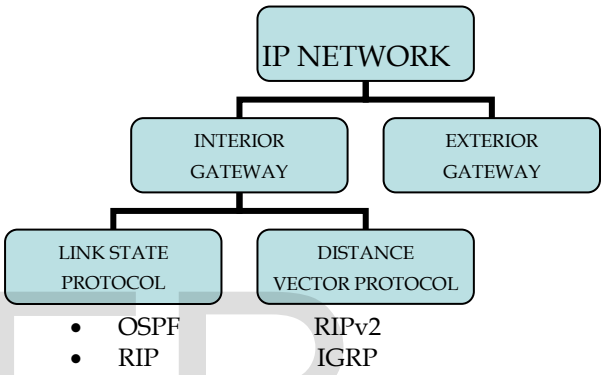

Fig 1 Types of IP Network

Interior Gateway protocol communicates routing data within a single routing domain. It is divided into Link State Routing protocol and Distance Vector Routing protocol. The link state routing protocol maintains the full structure of the network on each router connected to its network. For example, Routing Information Protocol (RIP) and Open Shortest Path First (OSPF). In the Distance Vector Routing protocol, the route information is periodically shared in the entire network. For example, Interior Gateway Routing Protocol (IGRP).

An exterior Gateway protocol communicates routing information with independent systems[2]. For example,

- Exterior Gateway Protocol (EGP)
- Border Gateway Protocol (BGP)

3 Open Shortest Path First (OSPF)

The most widely used routing protocols is OSPF and is suitable for large network. OSPF is a Link State protocol based on cost under a single routing solution that maintains information of all nodes on the network. Since each nodes holds the entire network structure information, each nodes can independently calculate the path to reach the destination by adopting shortest path algorithm namely Dijkstra's algorithm.

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4 Graph Theory Algorithm: Dijikstra's Algorithm

Graph theory is the study of graphs that concern with the relationship with edges and vertices. Graph theory is used to determine the relationship among in with the computer network. One of the graph theory algorithm is Dijkstra's algorithm, that is used to find the shortest path based on cost weightage. The advantage of using Dijkstra's algorithm is to find shortest path from the staring vertex to all other vertices in the graphs.

4.1 Dijikstra's Algorithm:

Step 1: Assign starting vertex to zero and assign all vertices distance to infinity.

Step 2: Starting vertex will be send to minimum priority queue based on distance & vertex.

Step 3: The vertex with minimum distance will be removed from the priority queue and update the queue.

Step 4: Check whether current vertex distance + edge weight is less than next vertex distance then send the next distance to the priority queue.

Step 5: Repeat step 2 to 4 until the priority queue is empty[3].

4.2 Pseudocode for Dijkstra's Algorithm

Consider source vertex is v and it should be a weighted graph g=(E,V). Source vertex S ∈ V to all vertex v ∈ V[10].

```
dist[s]←0
for all v ∈ V–{s}
do dist[v] ←∞
S ← ∅
Q←V
while Q≠∅
do u←mindistance(Q,dist)
        S←S U {u}
for all v ∈ neighbors[u]
        do if dist[v]>dist[u]+w(u,v)
                then d[v] ←d[u]+w(u,v)
return dist
```

Some of the principles used in Dijkstra's Algorithm are:

- It can be directed and undirected graphs
- All edges should have positive values.
- It should be a connected graph.

5 To Find The Shortest Path In OSPF Using Dijkstra's Algorithm

Dijkstra's algorithm is graph traversing algorithm. In computer network we have sender and receiver, sender will send some frame or message to receiver, but by the time receiver could receive the message, there are many parts which the message can take, that is the job of this algorithm. It will find the shortest path traversed to carry the message from sender to receiver.

Consider a network structure given below, the figure contains the nodes between A to H. We need to examine the shortest path, between A to D, where A being the sender and D being the Receiver.

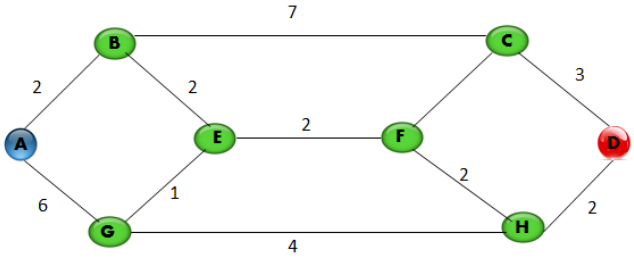

Fig 2 Nodes Representation

1. During the first stage, we need to find the shortest node from the neighbor nodes of source node.
2. During the second stage, we need to look for second shortest path node, which can be a neighbor node of source node or to the node found in the first stage.
3. During the third stage, the algorithm looks for third shortest path node form the source node. This node can be neighbor of source node or the nearest node found from first stage or second stage.
4. The process repeated, until all nodes are visited at-least once and if all nodes are visited once, then we can find the shortest path form the source node to destination node.

5.1 Formula used for comparing two nodes to find minimum value

Minimum(Destination value, Marked value + node value)

where, Destination values is the destination node value, Marked value is the source node value, Node value is the weightage of edge that connect source and destination[6].

For example:

If destination value =10, Marked value =5 and Edge weight=4. Substituting in the formula, we get

Min(10,5+4)
=Min(10,9)
=9 (Since 9 is smaller than 10)

To find the shortest path, we have marked the visited and unvisited nodes list in a table.

TABLE 1

TRAVERSAL OF NODES

VISITED	A	B	C	D	E	F	G	H
	0	∞	∞	∞	∞	∞	∞	∞
A	0	2 A	∞	∞	∞	∞	6 A	∞
A,B			9 B	∞	4 B	∞	6 A	∞
A,B,E			9 B	∞		6 E	5 E	∞
A,B,E,G			9 B	∞		6 E		9 G
A,B,E,G,F			9 B	∞				8 F
A,B,E,G,F,H			9 B	10 H				
A,B,E,G,F,H,C				10 H				

With the help of Dijkstra's algorithm, we were able to find the

shortest path between node A to node D. The final shortest path for the given node is A →B → E →F →H →D.

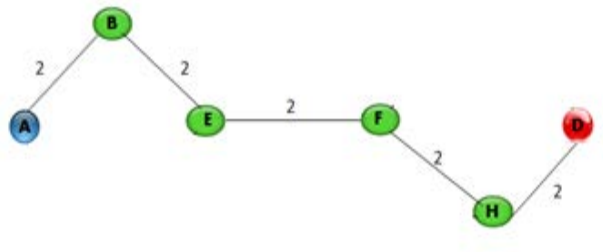

Fig 3 The shortest path between node A to node D

And the weight of the shortest path is 2+2+2+2+2 = 10 unit.

6. Performance of OSPF

We can measure the performance of OSPF under variety of strategy[7]. The performance measure of OSPF is specified in the table.

TABLE 2
PERFORMANCE OF OSPF

Performance	OSPF
Resources	Utilize more system resources
Packet Delay	High
Usage	In large network
Algorithm	Link State
Complexity	High

7 Conclusion

OSPF is a Link State Routing Protocol that is used for construction of larger network size. In this paper, we have concentrated about OSPF protocol. Dijkstra's algorithm is one of the best suited algorithms to find the shortest path for the given vertices. In future work we would implement OSPF protocol using NS2 simulator.

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