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Implementation of OSPF protocol for directed & undirected graph problem in real life scenario

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ABSTRACT

OSPF protocol is used in large network. OSPF is shortened form of Open Shortest Path First. It is a dynamic routing protocol used in Internet Protocol networks. Specifically, it is a link-state routing protocol and falls into the group of interior gateway protocols, operating within a single Autonomous system. It gathers link state information from available routers and constructs a topology map of the network. The topology determines the routing table presented to the Internet Layer which makes routing decisions based solely on the destination IP address found in IP datagram. OSPF was designed to support Variable-length subnet masking (VLSM) or Classless Inter-Domain Routing (CIDR) addressing models. OSPF detects changes in the topology, such as link failures, very quickly and converges on a new loop-free routing structure within seconds. It computes the shortest path tree for each route using a method based on Dijkstra‘s Algorithm, a shortest path first algorithm. Dijkstra algorithm is a solution to the single-source shortest path problem in graph theory. Works on both directed and undirected graphs. However, all edges must have nonnegative weights. It follows Greedy Approach. There are two types of routing-Link State routing and Distance Vector routing. Dijkstra is based on Link State routing. In Link State routing each router keeps track of its incident links and cost on the link, whether the link is up or down. Each router broadcasts the link state to give every router a complete view of the graph. Each router runs Dijkstra ‘s algorithm to compute the shortest paths and construct the forwarding table. Thus, it chooses the path with min hops and topology changes can be detected with the help the help of beacons this algorithm is based on iterations. The topology of the network can be generated by collecting the OSPF messages.

Keywords: OSPF, RIP PROTOCOLS, IP (INTERNET PROTOCOL), VLSM.

1 INTRODUCTION

OSPF is an interior gateway protocol (IGP) for routing Internet Protocol (IP) packets solely within a single routing domain, such as an autonomous system. It gathers link state information from available routers and constructs a topology map of the network. The topology is presented as a routing table to the Internet Layer which routes datagrams based solely on the destination IP address found in IP packets. OSPF supports Internet Protocol Version 4 (IPv4) and Internet Protocol Version 6 (IPv6) networks and features variable-length subnet masking (VLSM) and Classless Inter-Domain Routing (CIDR) addressing models. OSPF detects changes in the topology, such as link failures, and converges on a new loop-free routing structure within seconds. It computes the shortest path tree for each route using a method based on Dijkstra's algorithm, a shortest path first algorithm. The OSPF routing policies for constructing a route table are governed by link cost factors (*external metrics*) associated with each routing interface. Cost factors may be the distance of a router (round-trip time), data throughput of a link, or link availability and reliability, expressed as simple unitless numbers. This provides a dynamic process of traffic load balancing between routes of equal cost.

An OSPF network may be structured, or subdivided, into routing areas to simplify administration and optimize traffic and resource utilization. Areas are identified by 32-bit numbers, expressed either simply in decimal, or often in octet-based dot-decimal notation, familiar from IPv4 address notation. By convention, area 0 (zero), or 0.0.0.0, represents the core or backbone area of an OSPF network. The identifications of other areas may be chosen at will; often, administrators select the IP address of a main router in an area as area identification. Each additional area must have a direct or virtual connection to the OSPF backbone area. Such connections are maintained by an interconnecting router, known as area border router

(ABR). An ABR maintains separate link state databases for each area it serves and maintains summarized routes for all areas in the network.

OSPF does not use a TCP/IP transport protocol, such as UDP or TCP, but encapsulates its data in IP datagrams with protocol number 89. This is in contrast to other routing protocols, such as the Routing Information Protocol (RIP) and the Border Gateway Protocol (BGP). OSPF implements its own error detection and correction functions.

OSPF uses multicast addressing for route flooding on a broadcast domain. For non-broadcast networks, special provisions for configuration facilitate neighbor discovery.[1] OSPF multicast IP packets never traverse IP routers (never traverse Broadcast Domains), they never travel more than one hop. OSPF is therefore a Link Layer protocol in the Internet Protocol Suite. OSPF reserves the multicast addresses 224.0.0.5 (IPv4) and FF02::5 (IPv6) for all SPF/link state routers (AllSPFRouters) and 224.0.0.6 (IPv4) and FF02::6 (IPv6) for all Designated Routers (AllDRouters), as specified in RFC 2328[3] and RFC 5340.[4]For routing multicast IP traffic, OSPF supports the Multicast Open Shortest Path First protocol (MOSPF) as defined in RFC 1584.[5] Cisco does not include MOSPF in their OSPF implementations. PIM (Protocol Independent Multicast) in conjunction with OSPF or other IGPs, is widely deployed.

2 OSPF CHALLENGES

The following are typical scenarios for using OSPF: When a single router or communications server must accommodate different sized TCP/IP Networks: Increasingly, ISPs need to divide or combine subnets to ensure the most efficient use of TCP/IP addresses. This capability, called variable length subnet masks (VLSM) or "classless" networking, is supported by OSPF. In contrast, RIP does not allow a network to be segmented or combined with others to create networks of different sizes.

When routing changes need to be propagated quickly: RIP can create too much network down time by taking too long to update routers with network changes; RIP needs a hold-down period to ensure that information it has generated has been properly propagated through the network. If a network has many routers, RIP updates can take several minutes to alert the entire network to the failure of a single router. OSPF updates are much faster than RIP updates. When more than 15 hops between routers are required: More than 15 hops might be a requirement in some larger networks. RIP will only support15 hops between routers, but OSPF can support up to 255 hops. When routing advertisements need to be password-protected to prevent network instability or sabotage: OSPF has packet authentication capability; RIP does not.

3 OSPF FEATURES

OSPF offers all the functionality of oldest routing protocol Routing Information Protocol (RIP), plus:

- Variable-length subnet mask (VLSM) support
- Routing updates without the 30-second "hold down" period required by RIP
- Up to 255 routed segments between routers
- Packet authentication of routing updates with both simple password and MD5 authentication
- Bandwidth optimization, including less frequent routing updates and a choice of metrics for defining the best links between routers.

4 DIJKSTRA'S ALGORITHM

Dijkstra's algorithm is an algorithm for finding the shortest paths between nodes in a graph, which may represent, for example, road networks. The algorithm exists in many variants; Dijkstra's original variant found the shortest path between two nodes, but a more common variant fixes a single node as the "source" node and finds shortest paths from the source to all other nodes in the graph, producing a shortest path tree. Dijkstra's original algorithm does not use a min-priority queue and runs in time O(|V|^2) (where |V| is the number of nodes. This is asymptotically the fastest known single-source shortest-path algorithm for arbitrary directed graphs with unbounded non-negative weights. In some fields, artificial intelligence in particular, Dijkstra's algorithm or a variant of it is known as uniform-cost search and formulated as an instance of the more general idea of best-first search.

4.1 PURPOSED ALGORITHM CODING:

In the following algorithm, the code u ← vertex in Q with min dist[u], searches for the vertex u in the vertex set Q that has the least dist[u] value. length(u, v) returns the length of the edge joining (i.e. the distance between) the two neighbor-nodes *u* and *v*. The variable *alt* on line 19 is the length of the path from the root node to the neighbor node *v* if it were to go through *u*. If this path is shorter than the current shortest path recorded for *v*, that current path is replaced with this *alt* path. The prev array is populated with a pointer to the "next-hop" node on the source graph to get the shortest route to the source.

```
1 functionDijkstra(Graph, source):
2
3 dist[source] ← 0          // Distance from source to source
4 prev[source] ← undefined // Previous node in optimal path initialization
5
6 for each vertex v in Graph:  // Initialization
7 ifv ≠ source// Where v has not yet been removed from Q (unvisited nodes)
8 dist[v] ← infinity            // Unknown distance function from source to v
9 prev[v] ← undefined           // Previous node in optimal path from source
10 end if
11 add v to Q// All nodes initially in Q (unvisited nodes)
12 end for
13
14 whileQ is not empty:
15 u ← vertex in Q with min dist[u]  // Source node in first case
16 remove u from Q
17
18 for each neighbor v of u:          // where v is still in Q.
19 alt ← dist[u] + length(u, v)
20 ifalt<dist[v]:              // A shorter path to v has been found
21 dist[v] ← alt
22 prev[v] ← u
23 end if
24 end for
25 end while
26
27 returndist[], prev[]
28
29 end function
```

4.2 PROOF OF CORRECTNESS

Proof is by induction on the number of visited nodes.Invariant hypothesis: For each visited node u, dist[u] is the shortest distance from source to u; and for each unvisited v, dist[v] is the shortest distance via visited nodes only from source to v (if such a path exists, otherwise infinity; note we do not assume dist[v] is the actual shortest distance for unvisited nodes).The base case is when there is just one visited node, namely the initial node source, and the hypothesis is trivial.

5 RESULTS USING MATLAB

5.1 MATLAB

MATLAB is a high performance language for technical computing. It integrates computation, visualization and programming in and easy to use environment where problems and solutions are expressed in familiar mathematical notation. MATLAB is an interactive system while basic data elementis an array that does not require dimensioning. This allows you to solve many technical computingproblems, especially those with matrix a vector formulations, in a fraction of the time it would take to write a program in a scalar non-interactive language such as C. the name MATLAB is an abbreviation of matrix laboratory

CONCLUSION

Results for directed and undirected graphs are successfully implemented in MATLAB 2013a with desired results. The OFDM implementation is to store vertices in an array or linked list will produce a running time of O(|V|^2 + |E|). For sparse graphs (with very few edges and many nodes), it can be implemented more efficiently storing the graph in an adjacency. This will produce a running time of $O((|E|+|V|) \log |V|)$. Finally, we made sure that it is a correct algorithm (e.g., it *always* returns the right solution if it is given correct input). With the help of two mathematical results: Lemma 1: Triangle inequality

If $\delta(u,v)$ is the shortest path length between u and v, $\delta(u,v) \le \delta(u,x) + \delta(x,v)$

Lemma 2:

The subpath of any shortest path is itself a shortest path.

We can claimthatanytimeweput a new vertex in network, we can saythatwealreadyknowtheshortestpathtoit.

7 Future Scope

1. Traffic Information Systems are most prominent use
2. Mapping (Map Quest, Google Maps), where multiple ways are available for same destination. (i.e. low nodes high edges)
3. Routing Systems
4. Wireless extensions of OSPF to support mobile ad hoc networking, with major focus on design and implementation of one of the most promising proposals
5. IPv6 Addresses with Embedded IPv4 Addresses using OSPF protocol.
6. Genetic interaction network

8 Snap shot & Simulation Results

Snap shot for various numbers of nodes have been taken, as shown by the figures.

- Fig.8.1 shows snap shot for 6 nodesand 11 edges for directed graph.
- Fig. 8.2 shows snap shot for result of shortest path6 nodesand 11 edges for directed graph.
- Fig.8.3 shows snap shot for 6 nodes and 11 edges for undirected graph.
- Fig. 8.4 shows snap shot for result of shortest path6 nodes and 11 edges for undirected graph.

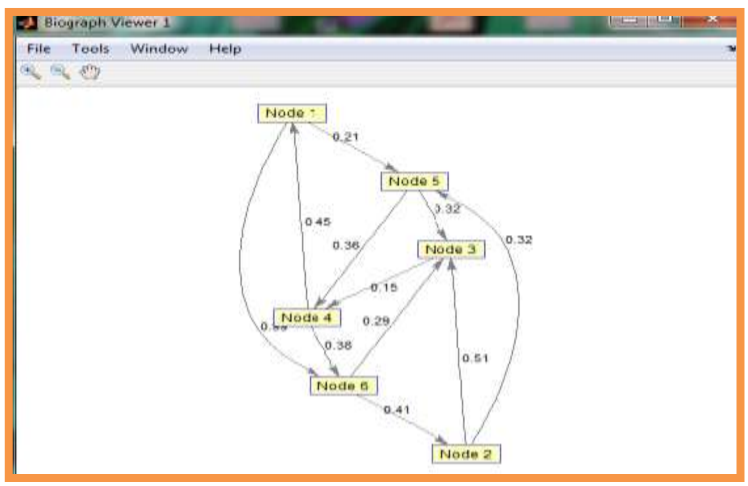

Fig.8.1 shows snap shot for 6 nodes and 11 edges for directed graph.

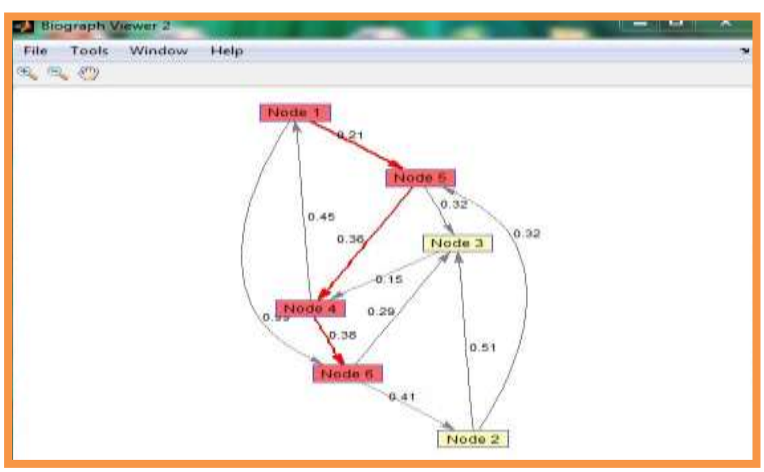

Fig. 8.2 shows snap shot for result of shortest path6 nodes and 11 edges for directed graph. path in the graph from node 1 to node 6: 1 5 4 6 (Distance: .9500)

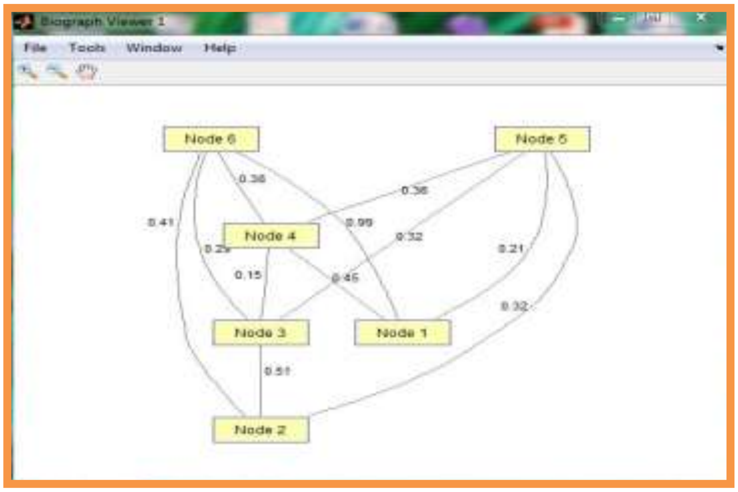

Fig. 8.3 shows snap shot for 6 nodes and 11 edges for undirected graph.

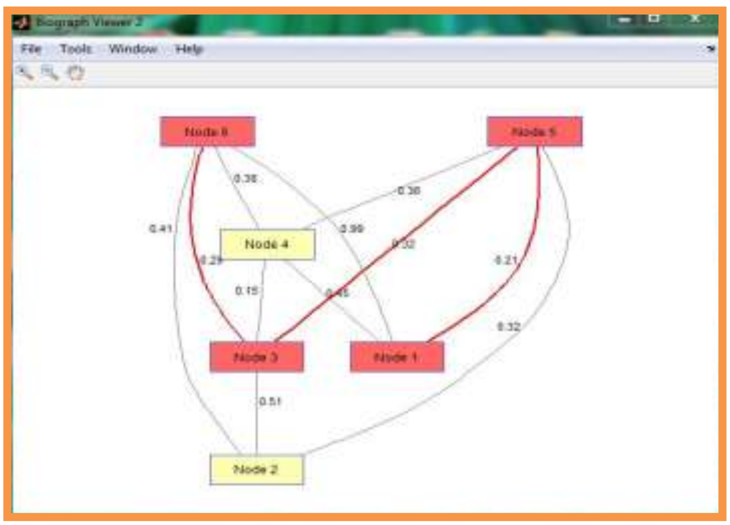

Fig. 8.4 shows snap shot for 6 nodes and 11 edges for undirected graph.

Fig. 8.4 shows snap shot for result of shortest path6 nodes and 11 edges for undirected graph.Shortest path in the graph from node 1 to node 6: 1 5 3 6 (Distance: .8200)

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Kirti is pursuing M.T ECH. from Rohtak Institute of Engg. & Mngt. Rohtak (2013-2015) and obtained B.TECH. degree in Computer Science & Engg. from co. affiliated by Maharshi Dayanand University 2013. Implementation of OSPF protocol for directed & undirected graph problem in real life scenario.