International Journal of Distributed and Parallel Systems (IJDPS) Vol.3, No.2, March 2012

# PERFORMANCE ANALYSIS OF OSPF IN MULTICAST ROUTING USING RPF TECHNIQUE

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## ABSTRACT

*Open Shortest Path first is most widely used interior gateway routing protocol, biggest it can update the routing in Autonomous system. Link-state routing protocols generate routing updates only when a change occurs in the network topology. When a link changes state, the device that detected the change creates a link-state advertisement (LSA) concerning that link and sends to all neighboring devices using a special multicast address. Each routing device takes a copy of the LSA, updates its link-state database (LSDB), and forwards the LSA to all neighboring devices. OSPF provides a technique RPF, the traffic may not occur and the packets can be freely to reach the destination router (DR).*

## KEYWORDS :

*LSA , DVMRP, IGP, OSPF, ABR, PIM-SM,MRP,RPF PIM-SM, PIM-DM*

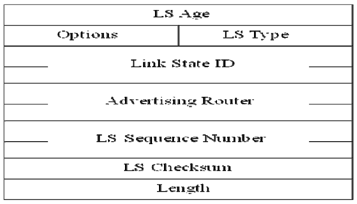
## 1 .INTRODUCTION

Open Shortest Path First is developed began in 1987OSPF Working Group (part of IETF)OSPFv2 first established in 1991Many new features added since then updated OSPFv2 specification in RFC 2178. Original IGP used was RIP Based on Bellman-Ford Algorithm Worked well in small systems Suffered from problems of Distance Vector Protocol Count to Infinity Problem Slow Convergence. This protocol can be used to forward information through Interior Gateway Routing Protocol. Faster Convergence and less consumption of network resources more descriptive routing metric configurable and its value ranges between 1 and 65,535 no restriction on network diameters it has equal-cost multipath and transmitting packets a way of load balancing. It is a distributed replicated database model & its describes complete routing topology

DOI : 10.5121/ijdps.2012.3213

## OSPF is a link-state protocol

The LSAs are then reliably distributed to all other routers in a process called flooding, which allows OSPF routers synchronize their topology databases. This carries a local piece of routing topology distribution of LSA's using reliable flooding is used to identify all routers. As long as every OSPF router has an identical link-state database, every router can calculate the shortest paths to the advertised destination, using the Dijkstra algorithm.OSPF operation OSPF routers typically go through the following stages to maintain the operation of an entire network. It's identical for all routers.



LSA Header

Neighbor discovery

Database synchronization

Route calculations

### 1.1 Neighbor discovery.

OSPF forms adjacencies between neighboring routers operating in the same area. OSPF Neighboring routes can be updated every 30 secs, and the Hello message can be forwarded in their Autonomous Area of Network. Hello protocol packets are sent periodically to establish and maintain neighbor relationships between OSPF neighbors. OSPF goes through several stages when discovering a neighbor: Down, Init, and 2-way (see Figure 1). The DR is the elected router with the highest priority on a broadcast network. The Designated Router concept minimizes the number of adjacencies that must be formed in a broadcast network and the amount of routing information that must be disseminated to adjacencies. The BDR is elected to minimize down time if the DR fails. In that event, the BDR assumes DR responsibility, and a second BDR is elected. The router which connected in the BDR is elected for the broadcast.

### 1.2 Database synchronization.

With IP there are two Link-State protocols in use OSPF (Open Shortest Path First) and IS-IS (Intermediate System to Intermediate System). Both work in much the same way, but OSPF is more commonly used. This white paper examines OSPF synchronization.OSPF database exchanges are intended to synchronize the link-state database between routers in the network.Collection of all OSPF LSAs in databases exchanged between neighbors & synchronization thru reliable flooding gives the complete routing topology each OSPF router has identical link-state database. OSPF Hello Protocol Hello packets sent out every 10 seconds helps to detect failed neighbors RouterDeadInterval (default 40 seconds) and it also ensures that link is bidirectional direction which neighboring routers agree on intervals hello interval set so that a link is not accidentally brought down. Crucial to ensure correct and loop free routing it must be done before 2 neighbors start communication and also whenever new LSAs are introduced which uses reliable flooding each router sends LSA headers to its neighbor when connection comes up requests only those LSAs which are recent Neighboring routers first exchange hellos a database description packet packet establishes the sequence number the other router sends LSA headers sequence number incremented for every pair do database description packets implicit acknowledgement for the previous pair after examining LSA headers explicit request sent for complete LSAs Starts when a router wants to update self-originated LSAs Every time Link State Update packets for Neighbor installs more recent LSAs into its database floods out on all interfaces except the one on which it arrived reliability-retransmissions until acks received.

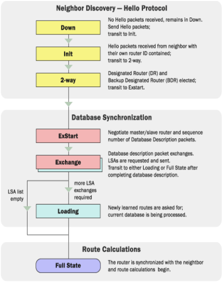


**Fig:1**

### 1.3. Route calculations.

Link costs configurable by administrator Smaller values for more preferred links must make sense to add link costs different costs for each link direction possible Dijkstra's shortest path algorithm implemented every 30 secs neighbors value updated and it incrementally calculates tree of shortest paths each link in the network examined once finally computes all multiple shortest paths (equal-cost multipath). Special routers called AS boundary routers at the edge of OSPF domain ASBRs originate AS-External LSAs use only routes for which the choice of an ASBR makes sense are imported otherwise default routes are used AS external LSAs similar to Summary LSAs with 2 additional fields. The metric is then appended to a route before it is advertised to its peers. The more links the route passes through in the higher Link-state protocols like OSPF base their metrics on links. AS-External LSAs flooded across borders ASBR summary LSAs used to know the location of the originator of AS-External LSA Link State ID of ASBR Summary LSA set to the OSPF router ID of the ASBR whose location is advertised similar to summary LSA in all other respects.

## 2. LINK STATE ADVERTISEMENTS:

It is important to know different Link State Advertisements (LSAs) offered by OSPF protocol. Type 1 LSAs are flooded to a single area only. Network link advertisements generated by designated routers (DRs) giving the set of routers attached to a particular network. Identifying LSAs LS type field & Link State ID field. Mostly LSA mostly carries addressing information IP address of externally reachable network Every time it update the Advertising Router field which originating router's OSPF router ID.

Verifying LSA contents which LS Checksum field and it computed by the originating router and left unchanged thereafter LS age field not included in checksum Removing LSAs from databases LS Age field start with a ranges from 0 to 30 min.Max Age LSAs used to delete outdated LSAs.LSAs are flooded to the area that contains the network.. Describes routes to the ASBR.Generated by the ASBR and provides links external to the Autonomous System (AS). LSAs are loaded to all areas except stub areas and totally stubby areas. Group membership link entry generated by multicast OSPF routers.NSSA external routes generated by ASBR. Only flooded to the NSSA. The ABR converts LSA into LSA before flooding them into the backbone (area 0).Its shown in fig 2.

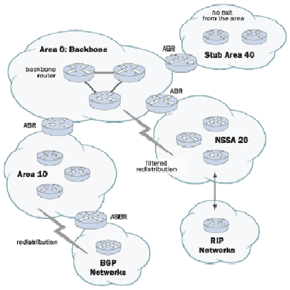


**Figure 2.** OSPF with multiple areas.

### 2.1 Methodology:

**Objective.**

. OSPF Routing Protocol Emulation can be used to run this test.

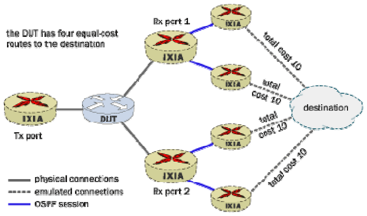


**Figure3. OSPF Equal Cost Path Verification Test topology.**

| parameter | Description |
|---|---|
| Traffic Rate | Rate at which traffic is sent to the destination network |
| Number of Ports | The number of Tx (traffic) and Rx (OSPF) ports |
| Number of Routes | The number of routes can be increased and load balancing take place over several destinations |
| Number of Routers per Port | The number of emulated routers per physical port can be varied |

## 2.2. Link State(Ls) Routing Algorithm

Dijkstra's algorithm
_ topology and link costs known to all nodes
_ accomplished via "link state broadcast"
_ all nodes have same info
_ computes least cost paths from one node (source) to all other nodes
_ gives forwarding table forthat node
_ iterative: after k iterations,know least cost path to k destination nodes
Notation:
_ c(x,y): link cost from node x to y;
set to _ if a and y
are not direct neighbors
_ D(v): current value of cost of path
from source to dest. v
_ p(v): v's predecessor node along path from source to v _
N': set of nodes whose least cost path is definitively known

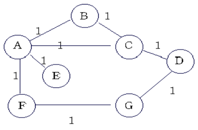
### 2.2.1 Dijsktra's Algorithm

```
Initialization (u = source node):
  N' = {u} /* path to self is all we know */
  for all nodes v
    if v adjacent to u
      then D(v) = c(u,v) /* assign link cost to neighbours */
      else D(v) = 0
Loop
  find w not in N' such that D(w) is a minimum
  add w to N'
  update D(v) for all v adjacent to w and not in N' :
    D(v) = min( D(v), D(w) + c(w,v) )
    /* new cost to v is either old cost to v or known
    shortest path cost to w plus cost from w to v */
until all nodes in N'
```

### 2.2.2 Distance-Vector Routing

A router using a distance vector routing protocol does not have the knowledge of the entire path to a destination network. The router only knows the direction or interface in which packets should be forwarded and the distance or how far it is to the destination network some distance vector routing protocols call for the router to periodically broadcast the entire routing table to each of its neighbors. This method is inefficient because the updates not only consume bandwidth but also consume router CPU resources to process the updates. Periodic Updates are sent at regular intervals (30 seconds for RIP and 90 seconds for IGRP).Even if the topology has not changed in several days, periodic updates continue to be sent to all neighbors. Neighbors are routers that share a link and are configured to use the same routing protocol. The router is only aware of the network addresses of its own interfaces and the remote network addresses it can reach through its neighbors Broadcast Updates are sent to 255.255.255.255. Neighboring routers that are configured with the same routing protocol will process the updates. All other devices will also process the update up to Layer 3 before discarding it. Some distance vector routing protocols use multicast addresses instead of broadcast addresses. shown in table1.

### Example 1



| Information Stored at Node | Distance to Reach Node | | | | | | |
|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G |
| A | 0 | 1 | 1 | □ | 1 | 1 | □ |
| B | 1 | 0 | 1 | □ | □ | □ | □ |
| C | 1 | 1 | 0 | 1 | □ | □ | □ |
| D | □ | □ | 1 | 0 | □ | □ | 1 |
| E | 1 | □ | □ | □ | 0 | □ | □ |
| F | 1 | □ | □ | □ | □ | 0 | 1 |
| G | □ | □ | □ | 1 | □ | 1 | 0 |

Table 1. Initial distances stored at each node(global view).

We can represent each node's knowledge about the distances to all other nodes as a table like the one given in Table 1.

Note that each node only knows the information in one row of the table.

Every node sends a message to its directly connected neighbors containing its personal list of distance. ( for example, A sends its information to its neighbors B,C,E, and F. )

1. If any of the recipients of the information from A find that A is advertising a path shorter than the one they currently know about, they update their list to give the new path length and note that they should send packets for that destination through A. ( node B learns from A that node E can be reached at a cost of 1; B also knows it can reach A at a cost of 1, so it adds these to get the cost of reaching E by means of A. B records that it can reach E at a cost of 2 by going through A.)
2. After every node has exchanged a few updates with its directly connected neighbors, all nodes will know the least-cost path to all the other nodes.
3. In addition to updating their list of distances when they receive updates, the nodes need to keep track of which node told them about the path that they used to calculate the cost, so that they can create their forwarding table. ( for example, B knows that it was A who said " I can reach E in one hop" and so B puts an entry in its table that says " To reach E, use the link to A.)

| Information Stored at Node | Distance to Reach Node | | | | | | |
|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G |
| A | 0 | 1 | 1 | 2 | 1 | 1 | 2 |
| B | 1 | 0 | 1 | 2 | 2 | 2 | 3 |
| C | 1 | 1 | 0 | 1 | 2 | 2 | 2 |
| D | □ | 2 | 1 | 0 | 3 | 2 | 1 |
| E | 1 | 2 | 2 | 3 | 0 | 2 | 3 |
| F | 1 | 2 | 2 | 2 | 2 | 0 | 1 |
| G | □ | 3 | 2 | 1 | 3 | 1 | 0 |

Table 2. final distances stored at each node ( global view).

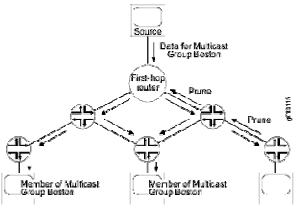
In practice, each node's forwarding table consists of a set of triples of the form:( Destination, Cost, NextHop).For example, Table 3 shows the complete routing table maintained at node B for the network in figure1.

| Destination | Cost | NextHop |
|---|---|---|
| A | 1 | A |
| C | 1 | C |
| D | 2 | C |
| E | 2 | A |
| F | 2 | A |
| G | 3 | A |

**Table 3. Routing table maintained at node B.**

## 3. Reverse Path Forwarding

IP multicasting uses reverse path forwarding (RPF) to verify that a router receives a multicast packet on the correct incoming interface. The RPF algorithm allows a router to accept a multicast datagram only on the interface from which the router would send a unicast datagram to the source of the multicast datagram.fig1 illustrates reverse path forwarding in a network where all routers run *dense-mode* multicasting protocols. Routers that receive a multicast datagram associated with a group for which they have no hosts return *prune* messages upstream toward the source of the datagram. Upstream routers do not forward subsequent multicast datagram's to routers from which they receive prune messages. This technique creates a *source-rooted tree* (SRT), also known as a *shortest-path tree* (SPT), — a structure that connects the source of a datagram to sub networks of a multicast group through the shortest path. For more information on dense-mode protocols, see PIM DM



When all routers in a network are running *sparse-mode* multicast protocols, the routers forward a multicast datagram only to other routers with downstream members of the groups associated with the datagram. Routers running sparse-mode protocols forward multicast traffic only when explicitly requested to do so, whereas routers running dense-mode protocols forward multicast traffic except when explicitly requested not to do so. For more information on sparse-mode protocols, see PIM SM, later in this RPF may take place through static routes, dynamic routes, or local subnets. You can define static routes for this purpose and view information associated with RPF routes.

## 4. PIM – SM

PIM _SM is a protocol for efficiently routing Internet Protocol (IP) packets to multicast groups that may span wide-area and inter-domain internets. The protocol is named protocol-independent because it is not dependent on any particular unicast routing protocol for topology discovery, and sparse-mode because it is suitable for groups where a very low percentage of the nodes (and their routers) will subscribe to the multicast session. Unlike earlier dense-mode multicast routing protocols such as DVMRP and dense multicast routing which flooded packets across the network and then pruned off branches where there were no receivers, PIM-SM explicitly constructs a tree from each sender to the receivers in the multicast group.

### 4.1. Flooding and Reverse Path Forwarding

Flooding is a technique which traffic may occur or the Destinated Router can' receives a packet or overhead associated with standard flooding. Because a router accepts a packet from only one neighbor, it floods the packet only once, which means (assuming point-to-point links) each packet is transmitted over each link once in each direction. An example of RPF is shown in fig:1

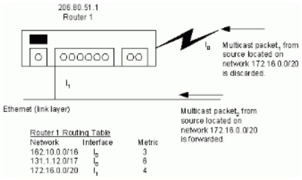


**Figure 1: Example of RPF**

In this example, the router discards the packet that came from a source on network 172.16.0.0/20 through interface I0. This is because its routing table does not list this interface as the shortest path to network 172.16.0.0/20. If the router had a packet to forward to that network, it would use I1. The packet that arrives through interface I1 is forwarded because the routing table lists this interface as the shortest path to the network. Notice that the router's unicast routing table determines the shortest path for the multicast packets.

### 4.2 Shortest-Path Trees

Shortest path trees is finding the shortest path in a network using a technique Leave and join the spanning trees. The minimum cost of the tree is calculated by the edges of the graph. shortest path problem is the problem of finding a path between two vertices (or nodes) in a graph such that the sum of the weights of its constituent edges is minimized. An example is finding the quickest way to get from one location to another on a road map; in this case, the vertices represent locations and the edges represent segments of road and are weighted by the time needed to travel that segment.

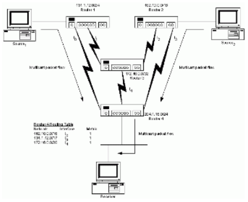


**Figure 2: Example of an SPT**

In this example, the SPT for Source1 is through interface I0 on Router 1, even though there is an alternative path through the combination of Routers 1 and 3. The SPT for Source2 is through interface I3, even though, once again, there is an alternative but longer path. (In this example, the metric is hop counts).

## 5.Conclusion

OSPF is a scalable routing solution for the ever growing IP networks of today. Its complex and descriptive topology advertisement and the concept of hierarchical routing areas satisfy the demands of the most diversified network designs. Quick convergence and the robustness of link-state database exchanges are the key features of OSPF networks. Also important is OSPF's improved design for network security. With all the enhanced features and capabilities of OSPF networks, a proper test methodology is essential to help network equipment manufacturers and network planners in several critical areas Conformance to standards, to ensure interoperability in a complex, multi-vendor environment. Network scalability, to understand network limitations Performance characterization, to avoid bottlenecks.

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## Acknowledgments

I would like to thank Dr.A.Marimthu Asst.Professor, Govt. Arts College, Autonomous College, Coimbatore.

I sincere thanks to my co-author who has me lot of moral supports for this effective topic.

Last but not least my sincere thanks to Secretary IJCNC who gave a lot ideas review help me to success of my publications.

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