Realistic Comparison of Performance Parameters of Static and Dynamic Unicast Routing over Mesh Topology

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Abstract- In this paper a realistic comparison analysis of the static and dynamic routing protocols has been made. Parameters of performance selected for this analysis are average delay, average throughput and average packet loss in different mesh network. Both the routing protocols are used by the network architectures and designers in practice. A static routing protocol does not check the connection once it has been established i.e. during transmission of data transfer whereas dynamic routing protocol periodically checks the connection and also update the path accordingly. Analysis conducted in this paper presents that the dynamic routing is better than static routing in term of average delay and average packet delivery ratio while static routing is better than dynamic routing with respect to average throughput. All the simulations have been done with the help of Network Simulator Tool NS2.

Keywords-Dynamic Protocol, Static Protocol, Packet delivery ratio, Throughput; Delay.

1 INTRODUCTION

In the present scenario, computer communication network is a necessary entity that is widely touched all over the world [1]. A network may be wired or wireless according to the network planners. Both have certain advantages and limitations [2]. Communication networks primarily have components such as switches, hubs, routers and bridges as its nodes. Routers used to communicate with different network nodes within the network with the help of routing protocols. Two such specified nodes are 's' source and 't' destination nodes. There may exist various end-to-end connections between 's' and 't' nodes corresponding to the path. Here we are considering static and dynamic routing protocols for making end-to-end connections. In the static routing the strategy of routing is the default route computation with the help of some parameters like cost, bandwidth and delay [3]. The routing protocol is computed once in the simulation. In dynamic routing the protocol is runs over the algorithm distributed bellman ford or (distance vector) routing.

In text various techniques for routing have been mentioned such as Optimized Link State Routing Protocol (OLSR) [4], Destination-Sequenced Distance Vector routing (DSDV), Open Shortest Path First (OSPF) [5-6] etc.
In this paper a Brief Overview of Unicast Routing Protocols [7] and its types has been given with their advantages and limitations.

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Unicast routing: In computer networking, unicast routing is used to send a message from source to destination [8] in the single network which is identified by the unique address. Unicast routing is used where traffic is forwarded from source to destination with in the network with unique address.

Types of unicast routing protocols

Static: in this type Dijkstra All-pairs Shortest Path First (SPF) [9] is used and this is calculated once before start of simulation.

Advantages and limitation of static routing protocol:

Static routing protocol takes very less memory or CPU overhead so due to this, it is very efficient in bandwidth allocation. In static routing congestion is not a problem because routes are not updated periodically and calculates the path only once in the starting. In static routing administrator has full control over network
However, as a limitation network topology is adjusted manually if any change or fault occurs in the network

Dynamic: in this type of routing an agent is created per node and based on distance vector (Distributed Bellman-Ford) algorithm. This type is based on costs of link and supports for multiple paths to the same destination in the network.

Advantages and limitation of dynamic routing protocol:

Dynamic routing protocol is simpler to configure on larger networks. If any link goes down it has been chosen a different (or better) route between source to destination. It is very adaptive in load balancing between multiple links of a network.
However, as a limitation the choice of best path is not in the hands of network administrator. Also in dynamic routing protocol no. of updates are shared between routers, due to this it is bandwidth consuming and additional load on

Center Processing Unit/Read Only Memory (CPU/RAM).

This paper has been consists of VI sections as follows. In the II section background details of comparison has been described. In section III network performance evaluation is explained and in section IV simulation has been shown. Performance analysis has been given in the section V. In the last section VI conclusion has been presented.

2 Background Details of Comparison

2.1 Dijkstra all pair shortest path first

In Static routing protocol, Dijkstra's algorithm has been used for choosing the shortest path. Dijkstra's algorithm [10] solves the single-source shortest path first problem when all edges have non-negative weights. In this algorithm starts at the source vertex, S, and it expand a tree, T, that covers all vertices reachable from S. Vertices are added to T in Order of distance which means that first S, then the closest vertex to S, then next closest, and so on. Implementation given bellows shows that graph G is represented by adjacency lists.
Initialization of all nodes set with distance infinite except source node. Source node has to be set with 0 and setting it as active. Mark the distance of source node as permanent and all other distances are temporarily. Calculate temporary distance of all neighbor nodes of the active node by summing up its distance with the weights of the edges. If calculated distance of a node is smaller than current distance, update the distance and set the current node as antecessor. This step is the central idea of algorithm. After updating distances, set node with minimal temporary distance as active and mark it as permanent. These steps has been repeated until no any single node left with permanent distance, which neighbors still have temporary distances.

Pseudo code

DIJKSTRA (G, w, S)

- Initialize single-source (G, S)
- S-{} // this will contains vertices of final shortest-path weights from S
- Priority queue Q is initialized i.e. Q-V [G]
- If priority queue Q is not empty do
- u- extract min (Q) //gives new vertex
- S- S E{u} //Put each vertex v as selected adjacent to u
- For each vertex v in Adj[u] do
- Select the (u, v, w)

Advantages and limitations:

Once this algorithm is carried out it will give least cost path for all static nodes but the limitation for this algorithm is that it will not calculate negative weight arcs. If any negative weight arc occurs then it has given acyclic graph and most often cannot give shortest path.

Distributed Bellman-Ford

In dynamic routing protocol, the Bellman-Ford algorithm [11] finds the shortest paths, from a given source node to all other nodes in network. The general idea of using this algorithm is that it finds the shortest single arc path and then shortest path of at most two arcs. This algorithm calculated the shortest path as given in the steps:

Pseudo Code

- Graph and source vertex.
- Find shortest to all vertices from source. If there is a negative weight cycle, then shortest distances are not calculated, negative weight cycle is reported.
- First step is initialized distances from source to all vertices as infinite and source at zero.
- Create an array of distance dist[] of size |v| with values as infinite except dist[source vertex]
- This step calculates shortest distances and does following |V|-1 times where |V| is the number of vertices in given graph
- Repeat this for each edge u-v.
- If dist[v]> dist[u] +weight of edge uv, then update dist[v] else no update.

Advantages and limitations:

Bellman-ford algorithm maximizes the performance of system and also it updates the paths after periodic time intervals. So if any changes are there in network it will compute path again. The limitation of this algorithm in RIP is that it does not take weights into consideration.

3 Network Performance Evaluations

Performance is the major part of network management and network administrator [12] always set it as good as possible for a given cost. Three parameters evaluate the performance depending on analytical designing, simulation and analysis. Simulation is being most important due to its accuracy, time, cost and less assumption.

Performance Metrics

There are no of qualitative and quantitative performance parameters [13] that can be used to compare routing protocols. This paper has been considered the following parameters to evaluate performance of routing protocols.

Average Throughput: This is the rate (bits/time unit) at which bits transferred between sources to sink for a longer time period [14]. Instantaneous throughput is the rate at a given point in time

$$A.T. = \frac{\text{Total no of bytes received}}{\text{Total time of transmission}}$$

Average Delay: This parameter represents average delay and indicates how much time it has been taken by the packet to travel from source to destination and measured in seconds [15].

$$\text{A.D.} = \frac{\sum(\text{Arrive time - send time})}{\text{Number of connection}}$$

Average Packet Delivery Ratio: Average packet delivery ratio is calculated by dividing the number of packets received by sink through the number of packet originated by the source [16]. This average specifies that rate of packet loss in network which leads to limit the throughput of network.

$$\text{A.P.D.R.} = \frac{\text{Number of packet received}}{\text{Number of packet send}}$$

4 Simulation

In this section, simulation has been done using network simulator tool. NS-2 is an open source simulation tool [17,18] and written in C++ and OTcl. In beginning it is difficult for first time user, because very few user-supportive manual. One can found it easy when he gets into it. NS-2 is chosen as a simulator tool among other simulation tools because it is used for designing new protocols, comparison of different routing protocols and various performance parameters. It is also freely available for all platforms like Mac OS, Linux, Windows and large number of people use for development and research.
Here simulation has been done using 7 nodes and 15nodes mesh topology for performance comparison of both static and dynamic routing protocols. The simulation setup has been given in the table.

TABLE 1
SIMULATION SETUP

Parameter	Value
Protocol	Rtproto DV, Rtproto Static
Traffic source	Constant bit rate (CBR)
Packet size	500 bytes
No. of nodes	7,15
Application	UDP
Simulation time (sec)	5

The duplex link has been used for connecting the nodes with droptail queue. For static routing rtproto static agent and for dynamic routing rtproto DV agent has been used. UDP protocol is used for transmission of data between nodes. CBR application generate the traffic of 80 Kbps attached at node 0 with source and sink is attached at node 6 in 7 node mesh topology and at node 14 in 15 node mesh topology. Traffic using CBR has been started at .5 second and stopped 4.5 second. Using trace file generated by the simulation, the performance analysis has been observed.

5 Performance analysis

In this section, the simulation of the mesh networks with different nodes, the observation of performance Parameters are shown below like average throughput, average packet loss and average delay. These parameters are explained one by one using help of charts.

5.1 Instantaneous throughput: In fig. 1instantaneous throughput for static routing protocol and fig. 2 for dynamic routing protocol has been shown that dynamic routing is good because packets sent through constant bit rate (CBR) using UDP agent are started at 0.5 sec, so in dynamic routing is done fast and at .5 it gives the instantaneous throughput of 14.6 for seven nodes and 82.86 for 15 nodes.

TABLE 2

INSTANTANEOUS THROUGHPUT OF STATIC AND

DYNAMIC ROUTING PROTOCOL WITH DIFFERENT NO OF NODES

Time (sec)	Mesh topology with 7 nodes		Mesh topology with 15 nodes	
	Static	Dynamic	Static	Dynamic
0.5104	--------	14.8639	---------	82.8646
1.0104	2310.15	2352	5155.88	5264
1.5104	2400	2400	5600	5600
2.0104	2400	2400.45	5600	5602.4
2.5104	2400	2402.46	5600	5606.72
3.0104	2400	2400	5600	5601.44
3.5104	2400	2400	5600	5600
4.0108	2400	2406.86	5600	5605.44
4.5108	2400	2402.13	5600	5608.64

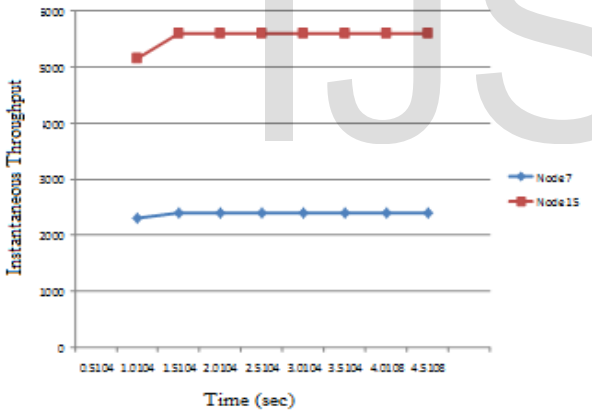

FIG. 1 INSTANTANEOUS THROUGHPUT FOR STATIC ROUTING PROTOCOL

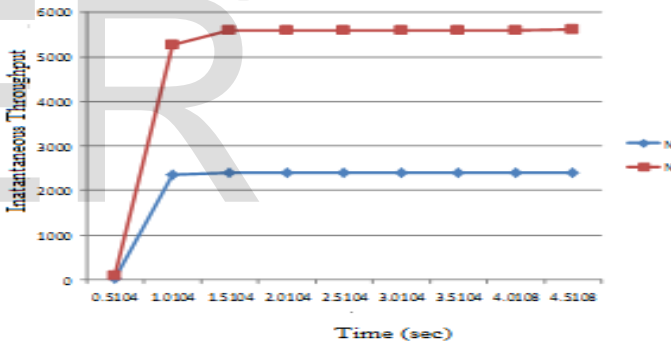

FIG. 2 INSTANTANEOUS THROUGHPUT FOR DYNAMIC ROUTING PROTOCOL

5.2 Average throughput: In our observation from fig. 3 we see that best average throughput is shown by static routing protocol. It can easily observe that dynamic routing protocol has low throughput. This lacking in the performance indicated that dynamic routing is not good with network

5.3 Average delay: Average delay in fig. 4 shows that delay is worst in static routing protocol in comparison with dynamic routing. Due to fast conversion of routing path in dynamic routing lower the delay in network. With increasing the number of nodes it can easily examine that average delay has avalanche of delay in static routing protocol with comparison of dynamic routing protocol.

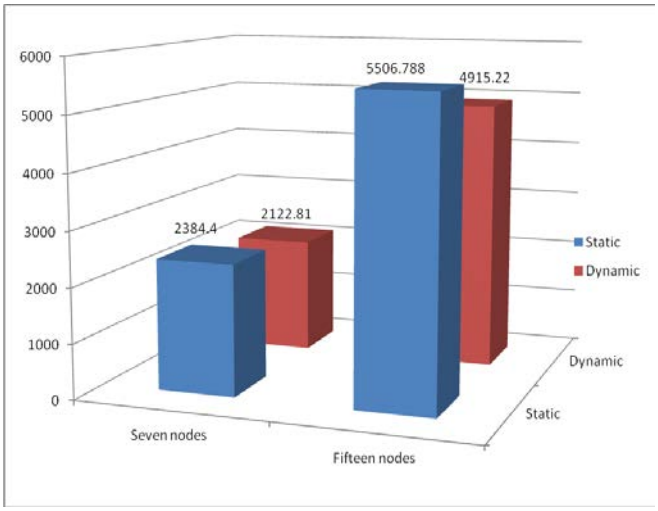

FIG. 3 RESULTS OF AVERAGE THROUGHPUT

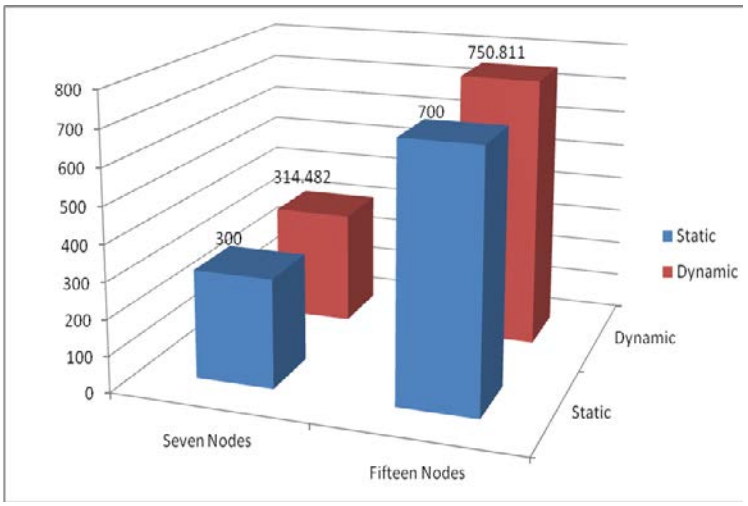

FIG. 5 RESULTS OF AVERAGE PACKET DELIVERY RATIO

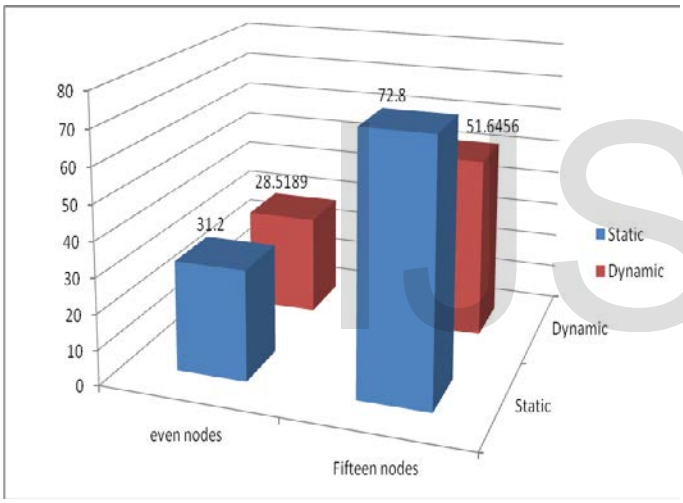

FIG. 4 RESULTS OF AVERAGE DELAY (SEC)

5.4 Average packet delivery ratio: Fig. 5 depicts the average packet delivery ratio, the average packet delivery ratio of dynamic routing protocol is better than static routing protocol. We can explain the good performance of dynamic routing protocol with remark that when it finds the best path in between routing, it takes that route which utilizes the bandwidth in best way.

6 CONCLUSION

This paper makes the realistic comparison of static and dynamic routing protocols using NS2 simulator. By observing the results we examine that the dynamic routing is better than static routing in terms of average delay and average packet delivery ratio. Static routing also has certain merits over dynamic routing particularly in terms of average throughput. This work can be further extended including other routing protocols like OSPF, EIGRP, and BGP etc. with performance parameters.

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