Analysis for Internet Protocol (IP) and Ad hoc Network Routing

Dr. P. R. Gundalwar[1], Dr. Bhakar Y. Kathane[2]

Associate Professor, Pad. Dr. D. Y. Patil Institute of MCA, Akurdi, Pune, Maharastra, India[1]

Assistant Professor, Bhawabhuti Mahavidyalaya Amgaon, Distt. Gondia, Maharastra, India[2]

ABSTRACT: Routing plays a vital role in data communication network. Different protocol performs differently in different scenario according to their specialty and need. This paper is focused on routings, protocols, their challenges and issues. There is no single protocol that performs well in accepting different challenges and issues in routing. The purpose of this study is to explore different challenges and issues of routing algorithms in a classified way for IP networks and ad hoc networks.

KEYWORDS: Routing, MANET, AODV, DSDV, RIP, OSPF

I. INTRODUCTION

Networking and internet has become one of the most influential forces for making communication easy and inexpensive around the globe. The Internet is comprised of millions of millions routers interconnected each other by means of communication links that route the packets towards their defined destinations. Routers join two or more networks for packet transport between nodes using shortest path using routing algorithms. Every router is responsible to take appropriate decision on each incoming packet.

The job of routing protocol is to provide the information about networks and routers from the surrounding environment and stores the computed information into routing table in the router's memory. Routing algorithms use this information to compute its routing decisions to calculate the best path from one network to another. The outcome of this computation is then used to determine where to send information. This computation is performed in different ways from protocols to protocols.

Routing protocols specify how routers communicate with each other by disseminating information and designed to update the routing rules according to dynamic network environment. In routing each node makes its own routing decision in finding next node along the path toward the destination. This process is repeated until the packet is finally delivered to destination or in few cases may be resulted in lost. Information of the next node is stored in routing table. The packets are forwarded through the optimum path according to the routing algorithm which utilizes a routing table to store the results of metrics used to evaluate network performance. Routing table is synchronized by two methods of routing: Static routing and dynamic routing. In static routing each router is manually configured with a list of destinations and the next hop to reach that destination. This process is very cumbersome to handle when there is large number of destinations and routers. Similarly, updating routing table become very difficult and time consuming when network topology changes frequently. Dynamic routing uses a routing protocol that updates routing table continuously to determine the optimized path to the destination nodes in dynamic network.

II. LITERATURE REVIEW

An extensive literature survey has been referenced to analyze IP network and ad hoc network routing.

Routing is performed for many kinds of networks such as telephone networks, internet and transportation networks. Routing in internet is based on packet switching using the hardware devices such as routers, bridges, gateways, switches etc. Routing involves two activities: determining optimal routing paths and transferring packets through internetwork. The process of path determination is accomplished with the help routing algorithms. There are several methods are available for finding the best path from source to destination node including routing algorithm. Routing algorithms initiate and maintains routing table which contains the complete route information for the packet from

source node to destination node through intermediate nodes, if any. The route information varies form one algorithm to another. There are two basic types of routing algorithms: distance-vector routing and link-state routing algorithm [1].

Many routing protocols have been proposed with the IETF working documents published in Internet Drafts (ID) and Request for Comments (RFC). Numerous projects related to different aspects of MANET are employed by academics and researches in various institutes all over the world [2],[3].

Ad hoc networks are easily deployed allowing a plug-play communication method of networking. Many authors have focused the classification of the ad hoc routing protocols are of two types: proactive which are table based protocol and reactive are on-demand protocol. In proactive protocols, each node is capable of maintaining a routing table that contains routes to all nodes in the network. Nodes must be able to exchange messages periodically with routing information to keep the routing table up-to-date. In reactive protocols, nodes compute the routes and maintain routing information only when it is needed by establishing routes as and when required by the source. Most of the work done related to the performance comparison of ad hoc network routing protocols includes either proactive or reactive or both. NS-2, OPNET, GLOMOSIM, QualNet, OMNET++, etc, are network simulators used by authors. The efficiency and performance metrics used in experiments are traffic sent and traffic received, response time, delay variation, network throughput, end-to-end delay, energy, routing load, etc [4],[5],[6].

III. INTERNET PROTOCOL (IP) NETWORK ROUTING

Routing protocols are based on routing algorithm and rely on various metrics to find the best path to transmit data across IP (Internet Protocol) networks. Autonomous System (AS) is owned and administered by a single commercial entity, and implements some set of routing policies in deciding how to route its packets to the rest of the Internet, and how to export its routes to other AS. Routing protocols are classified as Inter Gateway Protocols (IGP) and Exterior Gateway Protocols (EGP) according to the information used within AS or between two or more AS respectively. Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Interior Gateway Routing Protocol (IGRP), Extended Interior Gateway Routing Protocol (EIGRP) and Intermediate System to Intermediate System (IS-IS) are examples of IGP while Border Gateway Protocol (BGP) is example of EGP. There are various metric such as end-to-end delay, delay variation, traffic sent and received, throughput, etc are used to analyze the efficiency and performance of the network in real-life applications such as database entry, database query, web browsing, Electronic mail (Email), File Transfer Protocol (FTP), HTTP (Hyper Text Transport Protocol) video conferencing, audio, etc which is dependent on applied routing algorithm in that network topology and other factors [1],[8].

IV. AD HOC NETWORK ROUTING

Ad hoc Network is a dynamic distributed self organize network system of wireless nodes where in the nodes move independent of each other without a central control infrastructure. Ad hoc networks may operate autonomously or may be connected to the Internet. Each node acts as a router to find out the optimal path to forward a packet over bandwidth-constrained wireless links. Mobile Ad hoc Network (MANET) is emerging technology for civilian and military applications. Internet Engineering Task Force (IETF) has been proposed various protocols in two broad categories of routing used in ad hoc networks are proactive routing and reactive routing. Some of the proactive routing algorithms are Destination Sequenced Distance Vector (DSDV), Optimized Link State Routing (OLSR) etc and reactive routing algorithms are Ad hoc On Demand distance Vector (AODV), Dynamic Source Routing (DSR), Ad hoc on demand Multipath Distance Vector (AOMDV) etc [9].

V. NETWORK ROUTING ALGORITHM

The selection of routing algorithm is based on the network characteristics with the impact and purpose of routing. The network characteristics in IP networks such as ASs connectivity, network topology area, devices used in the network etc and in ad hoc network such as network density, node mobility, traffics patterns are considered for improving the efficiency and performance analysis of routing algorithms.

The performance of routing algorithm checks the ability to select the best route depends on the metric and metric weights used to make calculation with minimum software and limited physical resources. Routing algorithms perform correctly and timely in the face of unusual and unforeseen circumstances as routers are located at network junction points. Using routing algorithms routers must convergent quickly when network event occurs updating routing information to recalculate optional routes and causes all routers to agree on the best route avoiding routing loops [1],[3],[8].

VI. CHALLENGES

A node sends a packet to a destination through intermediate nodes while acting as a router. IP networks and ad hoc networks have to use dynamic network topology and limited resources to establish communication with each node in multi-hop fashion. Due to this routing functionality is very complex job that can be operated either manually or automatically to face following challenges [7].

The challenges in implementing routing algorithms in IP network are:

- **Routing Administration:** Routers forms hierarchical relationships with similar policy driven routers by grouping into areas for easy of administration.

- **Routing Table Maintenance:** Routing algorithms updates routing information in the routing table of routers for every change in the network topology for path determination.

- **Network Convergence time:** Routers take some time to gain its steady sate after there is a change in the network due to link-failure or node failure.

- **Route flaps**
  Network failure or recovery causes number of routes flaps during the time to gain steady state.

- **Routing load on processor**
  Routing load on processor causes by frequent changes in the network state that generates a heavy volume of control traffic or due to slow processing of control packets.

  The challenges in implementing routing algorithms in ad hoc network are:

- **Distributed Operation:** Each individual node acts as a router and responsible for packet routing activities using routing protocols.

- **Dynamic Topology:** Ad hoc network always experiences sudden and unpredictable change in network topology since the nodes moves randomly.

- **Energy Consumption:** The nodes are dependent on limited battery life. Battery power of a node is important issue in order to avoid termination of node or failure of network.

- **Wireless Transmission:** The mobility of nodes is affected due to limited range of wireless transmission forcing network topology to change suddenly as nodes frequently out of transmission range.

- **Traffic Overhead:** Node recalculates their routing information for broken links resulting into additional traffic overhead.

- **Limited Resources:** Node device features with small physical size and weights for increasing mobility across network topology. This limits the required resources such as memory, computation power and battery power.

  The challenges in implementing routing algorithms in both IP network and ad hoc network are:

- **Route discovery:** Routing algorithm, determine the best route using suitable metric from source node to destination node exploring all possible routes. Neighbor routers helps for determining alternative routes, if available any.

- **Router discovery:** Every router discovers their neighbors in anticipating that the neighbor is working in cooperative environment for exchange routing information.

- **Multicasting:** Routing protocols causes the nodes used in the topological area to transfer packets to multiple nodes at once in less time.

- **Loops:** Routing protocols guarantees that packets transit to the destination follows the loop free path for avoiding wastage of bandwidths or CPU utilization.

- **Multiple routes:** Routing protocol allows discovering multiple routes against any one route get broken before reaching to destination.

- **Security:** Malicious nodes enter into networks at any time due to mobility and wireless nature.

VII.   ISSUES

In the last decade the Internet has expanded and continued in several ways such as number of ASs connected to the Internet have increased enormously, diversity of the real-time applications supported in the Internet have increased, and ad hoc network applications have been successfully implemented in military and commercial applications. This tendency has increased the demand of efficiency and performance of IP networks as well as ad hoc networks. Thus, the issues in routing algorithms used in IP network and ad hoc network are [7]:

- **Quality of Service (QoS):** Routing algorithm works with minimum software and hardware resources in sustaining a certain quality of service while the network condition constantly changes.

- **Path Optimality:** Routing algorithms are used to select the optimum route with applied metric from source to destination in network topology.

- **Network Convergence:** Routing algorithm causes the routers to change as per the demand raised in the network topology to avoid routing loops giving effective results.

- **Robustness:** Routing algorithm performs in the approved manner in the unforeseen circumstances, such as hardware failures, high load conditions, and incorrect implementations.

- **Scalability:** Routing algorithm should maintain its persistent performance level in increased number of resources used in network.

- **Flexibility:** Routing algorithm quickly and accurately adapts to a variety of network circumstances such as changes in router availability, network bandwidth, queue size, network delay, etc.

- **Security:** A link between pairs of nodes is highly vulnerable. Insertion of spurious information into routing packets causes various problems to efficient routing.

- **Capability:** Routing algorithm responds efficiently in handling real-time applications such as audio and video.

VIII.   CONCLUSION

Routing decision is important for improving network performance. Measuring efficiency and performance of routing algorithm in any network is a complicated problem. For challenges and issues, the routing algorithm should be precisely selected to overcome lack of cooperation among nodes, resulted failures of nodes and communication links, unstable network state etc. In real life applications, it is really impractical and time-consuming process to enhance the bandwidth utilization, higher throughput, lesser overheads, minimum consumption of energy, etc. This requires studying and planning for implementing routing algorithms suitable for different network and its types for verifying certain performance metrics based on network characteristics and supporting application. The overall performance of the network depends mainly on the routing algorithm, so research on the routing algorithms must be done before deciding which routing algorithm to implement on the network pertaining to emerging challenges and issues.

Thus, there is a need to design, deploy, test, and analyze routing protocols which perform efficiently and effectively in real life network scenarios.

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BIOGRAPHY

Dr. P. R. GUNDALWAR, is Associate Professor at Pad. Dr. D. Y. Patil Institute of MCA, Akurdi, Pune (MS), India. He received PhD (Computer Science) from Ph.D. R.T.M. Nagpur University, Nagpur and MCA from Amravati University, Amravati. His interests are in Computer Networks, Network Security and Optimization Techniques.

Dr. Bhaskar Y. Kathane is Assistant Professor in the Computer Science Department at Bhawabhuti Mahavidyalaya Amgaon,Distt. Gondia (MS), India. He received Ph.D. (Computer Science) from R.T.M. Nagpur University, Nagpur and M.Sc. (Computer Science) from SRTM University, Nanded. His research interests include Virtual Intelligent SoftLab (VIS); A Software Solution for Laboratories and computer networks.