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A Review on Multicast Routing In Mobile Adhoc Network

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Abstract

Mobile Ad hoc NETwork (MANET) is a self-configuring infrastructure less network of mobile devices connected by wireless. Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. For the past few years, wireless technology is growing rapidly for the day to day activity of human lives in the form of cellular phones, wireless LAN, Bluetooth, location systems, smart homes and many more. There are enormous research issues in the MANET, which includes optimal routing, traffic engineering, transmission control protocol, security and virtualization. This paper focused on optimal multicast routing in MANET. This paper focused review on optimal multicast routing in MANET. Multicast is an efficient methodology to solve spatial and temporal complexity. In multicast, many research issues are considered, for example, Quality of service (QoS) multicast, minimum-cost multicast tree, end to end delay, interference, delay-and-bandwidth constraint problem, link stability estimation, utility based routing in QoS multicast routing are major focus of network researchers.

Keywords: Mobile Ad hoc Network, Multicast, Quality of service, Minimum-cost Tree, End to end delay, Interference

Introduction

Wireless technology has been growing rapidly in day to day usage. A wireless local area network that uses radio waves as its carrier. The last link with the users is wireless, to give a network connection to all users in a building or campus. Wireless

LANs operate in almost the same way as wired LANs, using the same networking protocols and supporting the most of the same applications.

Wireless communication has many segments such as Infra-structure based wireless communication, ad hoc wireless communication; satellite based wireless communication, and wireless local area network (Gazis et al 2005, Surachai et al 2010). Ad hoc network is applied widespread across the world in many different applications, which include all major engineering systems.

Cellular communication has introduced packet switching in addition to circuit switching in the Second Generation (2G) and it extends the features such as multimedia service in the 2.5G, video conferencing in Third Generation (3G) and internet protocol addressing based networking in the Fourth Generation (4G) (Bin Xie et al 2008). It is in progress to extend its capability through the Fifth Generation (5G) and it is also referred to as next generation network (Xiaohua et al 2010). Internet access through the cellular communication has increased rapidly over the last few years. It is due to the flexibility in the handling, mobility, reduced installation time, comparatively lower initial cost and nil maintenance cost on the user perception.

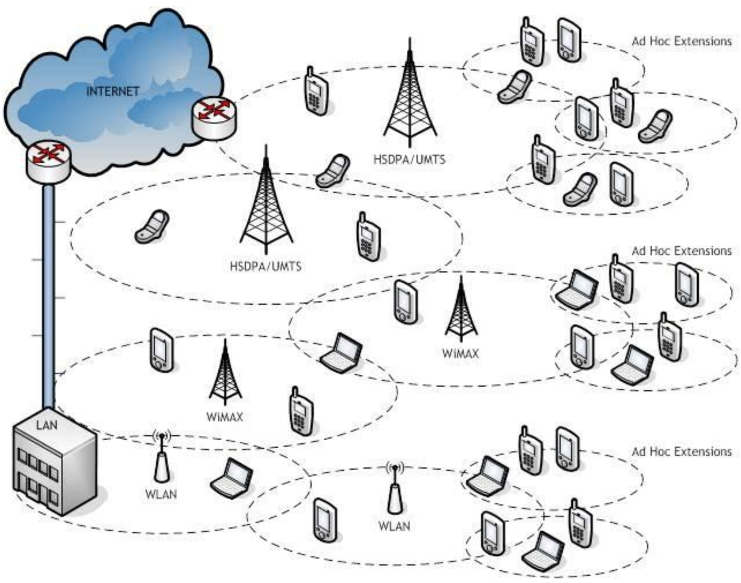

Figure 1: Ad Hoc Network Architecture

The other wireless segment is MANET, which is applied wide spread across the world in many different applications such as vehicular network, location based services, monitoring and controlling of disaster, border security, under sea gas pipelines. A typical wireless environment is shown in Figure 1. There are enormous research issues in the MANET, which includes optimal routing, traffic engineering, transmission control protocol, security and virtualization. This paper focused on optimal multicast routing in MANET.

MANET is distributed as self-organizing networks that can change locations and configure themselves on the fly. A MANET is a collection of autonomous nodes that communicate with one another by forming a multi-hop radio network and maintaining connections in a decentralized manner. MANET offer quick and easy deployment of network in situations where it is not possible otherwise. MANET offer unique benefits and versatility if the environment and application are appropriate, M-governance is one such application. MANET can be the best option for m-Governance services where there is no predefined infrastructure (Liang et al, 2011).

The deployment of a MANET within an enclosed area, such as a building in a disaster scenario, can provide a robust communication infrastructure for search and rescue operations. The dynamic composition of networked appliances, or virtual devices, enables users to generate complex, strong, and specific systems. Current MANET based composition schemes use service discovery mechanisms that depend on periodic service advertising by controlled broadcast, resulting in needless depletion of node resources.

Some of the research issues (Xin Li et al 2009) in the wireless network are listed below:

- Virtualization , Security ,traffic Management ,Optimal routing protocols
- Providing Quality of Service, Offering reliable services, Load balancing
- Transport Control Protocol (TCP), Effective Medium access scheme,
- Energy management, Scalability, Efficient node deployment,
- Self-organization and service discovery

This paper further reviewed research on multicast routing followed by a brief description on routing and multicast routing in the following section.

Overview of Network Routing

The routing protocol lies in the network layer, the task of wired routing protocol may be exchanging route information and finding feasible path, but in the wireless routing there are some more tasks added to meet the wireless environment which includes minimum power requirement, utilizing minimal network resources like bandwidth, gathering and updating link failures. Therefore, in order to provide optimal routing in the wired cum wireless environment, the routing protocols need to fulfill the following major challenges and requirements.

A routing protocol is a distributed process by which nodes within a network exchange reachability information and establish communication paths with other nodes in the network. In most routing protocols, a node is initially only aware of its neighbors and discovers routes to other nodes by exchanging routing messages with its neighbors. In the process, every node establishes a routing table that contains a next-hop entry corresponding to other nodes in the network.

The challenges of ad hoc routing are: suitability for wireless environment and challenges in the wireless networking environment such as mobility, bandwidth constraint, Error-prone and shared channel, Location dependent contention, and Resource Constraint like battery power, buffer size. The requirements are quick route configuration, loop free routing, minimum route acquisition delay, distributed routing approach, minimum control overhead, scalability, QoS, time sensitive traffic, and security.

Let V = {a, …, z} be a set of cities, A = {(r, s) : r, s € V} be the edge set, and δ(r, s) = δ(s, r) be a cost measure associated with edge (r, s) € A. The routing is the problem of finding a minimal cost closed tour that visits each city once, also called Travelling Salesman Problem (TSP).

In this case, the cities r € V are given by their co-ordinates (x_r, y_r) and δ(r, s) is the Euclidean distance between r and s, then it is Euclidean TSP. If δ(r, s) ≠ δ(s, r) for at least some (r, s) then the TSP becomes an Asymmetric TSP. Choosing a single feasible solution is called a single path while choosing all possible feasible solution is called a multi-path. In which, the multi path routing avoids traffic and helps to improves the network efficiency.

Dijkstra-old-touch-first with multipath routing extension is an extended version of conventional Dijikstra's shortest path algorithm that computing all lexicographic-lightest paths from a source to every other node in the network, but it requires additional computational efforts. Open Shortest Path First (OSPF) version 2 and OSPF – optimized multi-path are some of the extended version of traditional OSPF. S-OSPF is an improved version of OSPF for best effort networks.

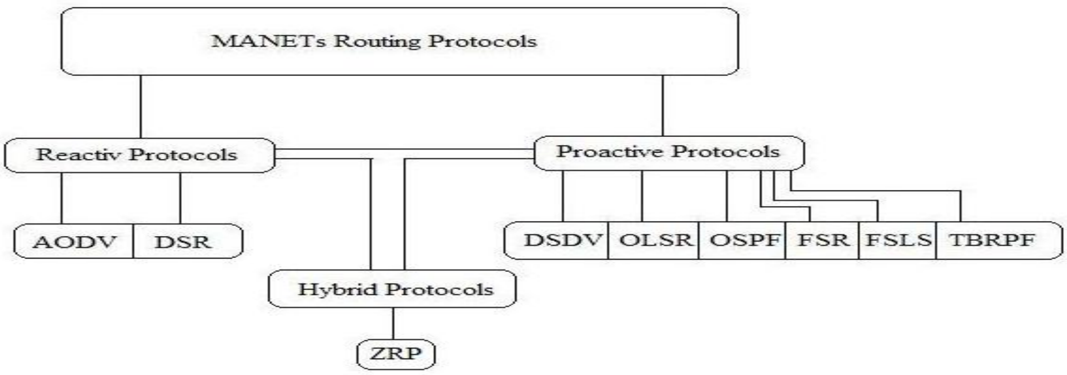

Figure 2: MANET's Routing Protocols

Previous routing protocols are identifying the optimum path based on a single network metric, which may be number of hops, shortest distance or shortest time. Also Zero-to-infinity in Distance Vector (DV) and transient loops in Link State (LS) are still an issue, which may lead heavy congestion and packet loss. Also previous routing protocols are identifying the optimum path based on mathematical parameters such as number of hops or shortest distance, and also it requires more computational efforts.

There are variety of wireless routing protocols such as Dynamic Source Routing (DSR), Destination Sequenced Distance Vector (DSDV), Ad-hoc On-demand Distance Vector (AODV), Wireless Routing Protocol (WRP), Cluster-head Gateway Source Routing (CGSR), Source Tree Adaptive Routing (STAR), Optimized Link State Routing (OLSR), Flow Oriented Routing (FSR), Hierarchical State Routing (HSR), Associativity Based Routing (ABR), and Signal Stability based Adaptive

Routing (SSA) are included in IEEE802 family standard. In addition to these routing protocols, stochastic routing also proposed for wireless networks.

The extended hybrid version of AODV and DSR, called DOA (DSR over AODV) is proposed as DSR for inter-segment and AODV for intra-segment routing for improving packet delivery ratio. However, it requires more control overhead and complexity when implementing in the real time. Energy efficiency is a major factor for wireless Ad hoc networks, which attracts many researches in the past few decades. The selection of the routing paths is a major design consideration that has a drastic effect on the resulting performance.

This paper further provides survey on research methodologies proposed in multicast routing in wireless communication.

Related Works In Multicast Routing

For the recent growth in the engineering domain, many emerging applications in the Internet require data delivery between a point to multipoint, or multipoint to multipoint. For example, audio or video conferencing, web cache updating, one-to-many file distribution, distance learning, and Internet games. Internet multicast is crucial to the development of the Internet due to its ability of data delivery between a point to multipoint, or multipoint to multipoint in an efficient and scalable way.

First multicast proposal in Internet is called host group model, which is proposed in 1980. In the host group model of multicast, the hosts are participating in the same multicast session and forming a host group identified by a single class D IP address. A host may join and leave the group at any time and may belong to more than one group at a time. To send datagram's to a group, a host need not know the membership of the group, or be a member of the group.

Data delivery in the "host group" model is best effort. Senders multicast to and receivers receive from their local links and it is the "multicast routers" that have the responsibility of delivering the multicast datagram's. This methodology further improved with the proposal of methodologies for multicast architecture, group management protocols, the IP multicast routing protocols, and multicast transport protocols. In these, the group management protocols are used for group member hosts to report their group information to the multicast routers on the subnet. Internet Group Message Protocol (IGMP) is the group management protocol currently used in Internet multicast.

There are few multicast protocol which incorporates the traditional routing protocols such as distance vector algorithm and Link state algorithm for providing routing information. Based on this information, each multicast router checks whether a packet is received from the interface used by the router to send packets to the sender. If so, the packet is forwarded according to the Output InterFace (OIF) list of the corresponding Source (S), Gateway(G) entry; otherwise, it is discarded. The (S, G) entry is set when the first packet sent from sender S to group G is received, with the oif list including all the interfaces except the incoming one. Some of the oifs will be pruned by prune messages sent from downstream multicast routers that do not use this router as an upstream router to the sender or do not wish to receive data of group

G. The pruned interfaces are marked as “pruned” and will be restored after a certain time-out period. Therefore, downstream routers need to send prune messages periodically to keep an interface “pruned.” This is called “flood and prune.” A downstream router can also send a “graft” message to cancel a “prune” state immediately.

Although multicast routing protocols provide best effort delivery of multicast datagrams on the Internet, many multicast applications have requirements beyond this. Therefore, various multicast transport protocols are proposed on top of the multicast routing protocols to meet the needs of different applications. Multicast transport protocols serve two major functions, namely, providing reliability and performing flow and congestion control. There are different definitions of reliability for different multicast applications. For example, total reliability is more suitable for reliable bulk-data transfer such as file distribution, while semi-reliability and time-bounded reliability are designed for loss-tolerant real-time applications such as video conferencing.

Multicast is an efficient methodology to solve spatial and temporal complexity. For example, in cognitive network, in order to improve the scalability, self-adaptation, self-organization, and self-protection in the network. In multicast, many research issues are considered, for example, Quality of service (QoS) multicast. Quality of service (QoS) multicast is an important network problem which focused by many researchers in the past few decades (Wang et al, 2014). Quality-of-service (QoS) multicast routing is an essential to many network applications such as IPTV, Internet radio, multimedia broadcasting, and real-time telecommunication. QoS multicast routing is a typical combinatorial optimization problem.

To develop an effective QoS multicast routing protocol in cognitive network, the cognitive behaviors to be summarized in the cognitive science for the network nodes. Based on the cognitive behaviors, a QoS multicast routing protocol oriented to cognitive network where each node only maintains local information to be designed. Routing in this design is formed based on a hop by hop way search. Few researchers proposed Ant Colony Optimization (ACO) for multicast routing (Yin et al, 2014). For detailed study on ACO for various engineering research is available in Chandramohan et al (2011(a),(b),(c)).

Nowadays, minimum-cost multicast tree, end to end delay, interference, delay-and-bandwidth constraint problem, link stability estimation (Xia et al, 2014), utility based routing (Kumar et al, 2013) in QoS multicast routing are major focus of network researchers. In which, the minimum cost is a most proposed methodology in multicast routing. Minimal cost multicast is finding a multicast structure that spans a source node and a set of destinations with respect to a set of constraints by minimizing the cost function.

Optimization of minimum cost for multicast network communications required Quality of Service (QoS) guarantees. Finding such a structure that satisfies the set of constraints is an NP-hard problem. To solve the addressed routing problem, most of the proposed algorithms focus on multicast trees. In some cases, the optimal spanning structure (i.e. the optimal multicast route) is neither a tree nor a set of trees nor a set of optimal QoS paths.

Moreover, predicting traffic demand is challenging due to the varying needs of the users which further limits the throughput. Hence, to overcome these difficulties, utility-based multicast routing and channel assignment scheme are proposed in Kumar et al (2013), which aim loop free routing and minimization of the total utility from a source to a destination at any time.

Table 1: Parametric Comparison

Parameters	***Reactive Protocol***	***Proactive Protocol***	***Hybrid Protocol***
Routing philosophy	Flat	Flat/Hierarchical	Hierarchical
Routing Scheme	On demand	Table driven	Combination of both
Control Traffic	Low	High	Medium
Latency	High due to flooding	Low due to routing tables	Inside zone low outside similar to reactive protocols
Scalability level	Not suitable for large networks	Low	Designed for large networks
Availability of routing information	Available when required	Always available stored in tables	Combination of both
Periodic Updates	Not needed as route available on demand	Yes, Whenever the topology of the network changes	Yes needed inside the zone
Storage Capacity	Low generally depends upon the number of routes	High due to the routing tables	Depends on the size of Zone, inside the zone sometimes high as proactive protocol
Mobility Support	Route Maintenance	Periodical updates	Combination of both

In any network, Quality of Service (QoS) is an important parameter for evaluating the performance of the particular network. The goal of QoS is to provide guarantees on the ability of a network to deliver predictable results. Elements of network performance within the scope of QoS often include availability, throughput, latency and error rate. QoS is especially more important for the new generation of Internet applications such as Voice over Internet Protocol, video-on-demand and other consumer services. An optimal routing will satisfy the above listed attributes of the QoS (Budyal et al, 2013).

Reliability is an important metric in the performance evaluation of all types of networks. Reliability of a particular network (Pin and Li, 2013) ensures user satisfaction through higher packet delivery ratio and avoiding the smaller number of packet loss. Reliability is more important for the emergency engineering services, as it involves real time data communication. Emergency engineering services are categorized as hard real time application, in which a small amount of data loss will lead to heavy loss. Reliability and congestion control are inter-dependent issues Chandramohan et al (2010). Further this paper provides simulation results of multicast and its comparison with traditional unicast routing methods such as LS and DV.

Results and Conclusion

The performances of proposed work are analyzed on two network parameters, 1) Latency and 2) Throughput. The latency gives maximum transmission time which includes, round trip time and waiting time in the network buffer. The throughput of the network provides average data transfer during one time unit.

The multicast routing is compared with traditional routing protocol Link State (LV) and Distance Vector (DS). Simulation carried out in Network Simulator 2, called NS2. The NS2 is a discrete event simulator which is preferred by most of the researchers and academician in worldwide. The simulation parameters are shown in Table 2. The number of node is varied and the performances are computed.

Table 2: Simulation Environment

Parameters	Values
Simulation Time	10 unit time
No of Nodes	100, 200, 300, 500 and 1000
Latency	Delay Time in Data Transmission
Throughput	Bits transmitted per unit time

The latency and throughput are observed from the simulation. The latency is shown in figure 2 and the throughput is shown in figure 3. From the result it is concluded that the multicast is more efficient than the traditional unicast routing protocol.

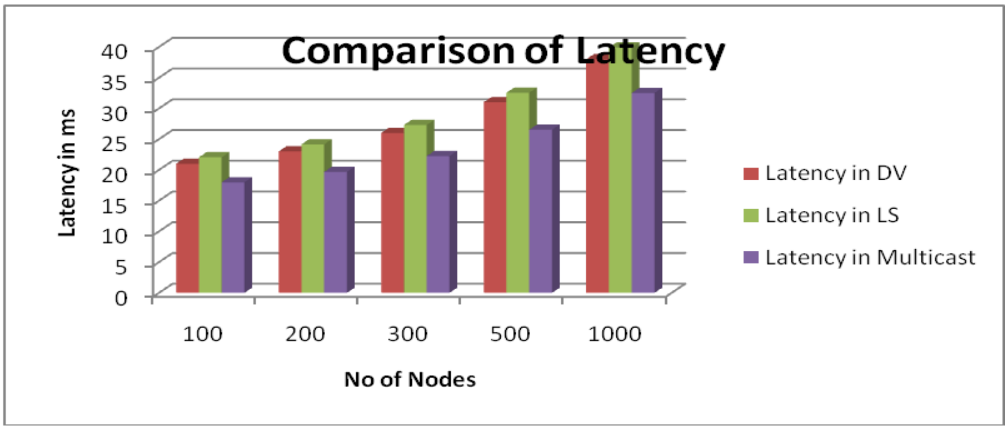

Figure 2: Comparison of Latency on Unicast and Multicast routing

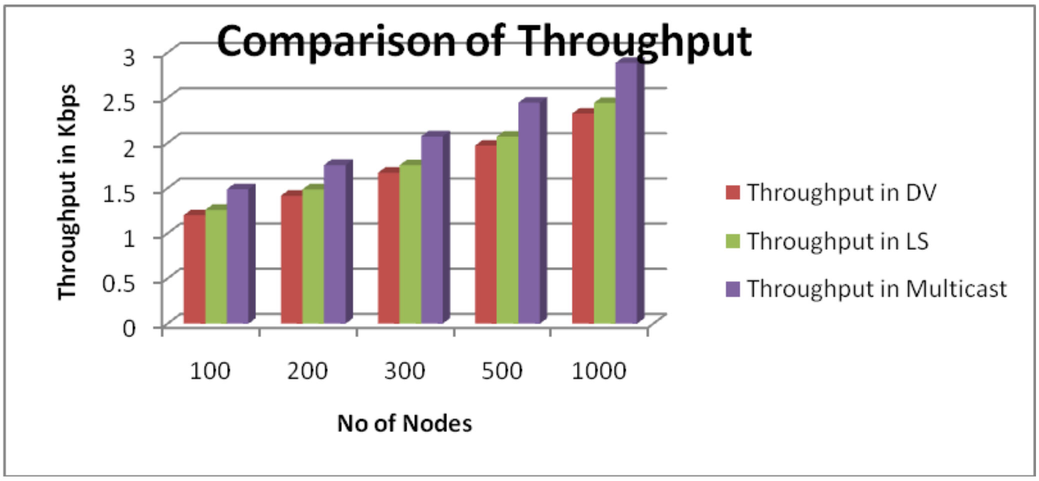

Figure 3: Comparison of Throughput on Unicast and Multicast routing

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