QOS & Route Reliability of Protocol in Mobile Adhoc Networks (MANET)

Gurjeet Singh 2. Prof(Dr.)Vijay Dhir
Ph.D Research Scholar, Deptt of CSE, Sant Baba Bhag Singh University, Jalandhar
Professor, Deptt of CSE, Sant Baba Bhag Singh University, Jalandhar

Abstract:
In this paper, we propose a novel routing protocol for the improvement of QOS & route reliability in mobile adhoc network on the bases of throughput and packet delivery ratio. The proposed routing protocol can quickly adapt to dynamic changes in network topology and link quality variations often encountered in tactical field operations. The performance of proposed protocol is shown to outperform other widely used reactive routing protocols assuming several performance metrics such as throughput and packet delivery ratio.

Keywords: Routing Protocols, MANET, NS-2

1. Introduction

Internet can be quite useful nowadays in supporting a lot of significant facilities. Internet is helpful for the financial organizations to do the online banking and trading. The health institutions arrange the mission and life-critical applications on the local networks and internet worldwide. The organizations make use of internet in the corporate network infrastructure (Jeremy et al, 2007). The society nowadays has faith in the networking infrastructures and in the development of popularity of internet which keeps on increasing and improving in computing and communication technologies. General convenience of wireless communication systems, mobile computing and handheld devices resulted in the development and importance of the wireless mobile ad hoc networks (MANETs). Wi-Fi, Home-RF, and Bluetooth are the examples of wireless technologies through which it is easy to access Web from mobile devices, printing the documents from PDAs and syncing the data in different office devices. These applications, though, depend on mobility support routers or base stations and usually it is important to form the communication once it is not possible to access wired infrastructure, or it is overloaded, demolished, or spoiled. Mobile ad hoc networks consider all the available mobile node as mediator switch by eliminating such reliance on fixed network infrastructure and due to that, they can extend the variety of mobile nodes beyond that of their base transceivers. Comfortable installation and upgrade, low cost and maintenance, increased flexibility, and being able to use new and effective routing protocols for the wireless communication are also some benefits of MANETs.

IEFT also known as MANET (Mobile Ad-hoc Networks) would be used in the ad-hock networks widely. The routing specifications are still in the development phase for all the ad-hoc IP networks that would support scaling to hundreds of nodes. The main objective is to complete this by 1999 and come up with new specifications to stay on par with the latest Internet standards.

Ad-hoc network consists of a network that is connected with many autonomous mobile nodes which are built with the help of multi-hop wireless communication without using any kind of fixed network infrastructure. Ad-hoc networks are used in a wide range of applications, including military services, war zones, disaster relief, emergency, etc. In this type of network, each and every mobile node would act as a router. A mobile ad-hoc network (MANET) is connected with mobile nodes with any kind of infrastructure. Mobile nodes are self-organized to serve as a network than as radio links. The main objective of MANET is to widen the mobility areas used in mobile, wireless and autonomous domains that would have a series of nodes which would form a routing infrastructure in ad-hoc manner.

The area that is developing would support various applications from highly dynamic Vehicular ad hoc networks (VANET) to the very less dynamic applications that are used not so often in mobile peer-to-peer mobile networks.

Generally, in ad-hoc networks, nodes would establish communication with each other with the help of radio signals that are broadcasted in nature. Basically, broadcast is a unique kind of multicast where all the nodes connected to the network would receive the message. Multicasting is a kind of communication process where the packet transmission is initiated by a user and this message would be sent to the one or multiple receivers connected to the network.

Multicasting has benefits in both wired and wireless networks and this is used as a critical technique in various applications, especially in audio and video conferencing, communication, groupware applications, e-learning, stock quotes, news, distribution of software, etc. In this type of communication, a small data would be shared with a myriad of recipients and the data would be replicated whenever required.

In the wired settings, there are two key multi-cast tree schemes are used. There include shortest-path tree and the other one is the core-based tree. The process to build a shortest path multi-cast tree would make sure to reach every destination from the source through a shortest path wherein the source node should build the tree roots by itself. There would be a myriad of shortest path trees available on the network. Basically, in the core-based multi-cast trees, the shortest path from source to destination cannot be assured, but there is one tree that is required to connect to source nodes to a group of receiver nodes.

It is hard to save energy in the multi-cast routing of the MANET. It is merely impossible to recharge a mobile node that is powdered with batteries. When the battery life is short, the performance of the network declines. To take complete advantage of nodes completely, traffic should be diverted in the route where the energy can be saved.

MANET is a daunting area as it has the ability to use in a wide range of applications. Rigorous research was done in different fields of multicast routing protocols, especially the taxonomy, performance, capacity over MANET that carried out the study. Tariq et al has explained about the traffic models for various multicast routing protocols that are used in MANETs. The multi-cast protocols would be divided into tree-based, stateless, hybrid mesh based and flooding protocols.

MANET would be used in different areas where there is quick deployment and reconfiguration of wired network is impossible including the battlefields, emergency search areas, classrooms, and conventions where the learners would share information through mobiles. These applications are used for multi-cast operations. In the wireless medium, it is even challenging to cut down the consumption of energy on the transmission overhead. Multicasting would be used to boost the effectiveness of wireless links to send messages and take complete advantage of the broadcast nature of the wireless transmission. The role played by multicast is critical in MANET.

In the wired arena, there are two key network approaches used. There are called as shortest path multicast tree and the other is the core-based tree. The shortest path would offer you the shortest path to reach the destination. However, it is important for every source to construct a tree. Basically, there would be many trees connected to the network and the overhead tree would be longer. On the flip side, core-based tree would build a single tree in every group to reduce the number of trees that are actually constructed. The multicast routing for MANET would solve various problems with the traits of MANET like low bandwidth issue, mobility and low power. In fact, MANET would have low bandwidth compared to the wired networks. The information collected from the routing table would cost you high. Mobility of nodes would cause many topological changes in the underlying networks to increase the viability of the information. Moreover, when there is a power shortage, then there would be a disconnect exists between the mobile units. Multicasting routing protocols would focus on different areas.

2. Features of Manet

- **Autonomous terminal** every mobile terminal in MANET is an independent node and it might operate as a host and a router. Mobile nodes can switch functions being a router too along with having basic processing capacity.
- **Distributed operation** Nodes in a MANET work together with each other so they can use security and routing functions in a separate way because there is not enough centralized force.
- **Multihop routing** Ad hoc routing algorithms is both single-hop and multi-hop, on the basis of various link layer features and the routing protocols. Single-hop MANET is more basic in

comparison to multi-hop as far as the structure and the use are concerned along with the cost of lesser applicability and functionality.

- **Dynamic network topology** Mobility of nodes results in the network topology which changes constantly along with the connectivity between networks. MANET must be adaptive towards traffic and broadcast situations and various mobility designs.
- **Fluctuating link capacity** Wireless link through which nodes can interact with each other depends on the noise, fading, and the interruptions. It does not have more bandwidth in comparison to a wired network and therefore bit error rates of the wireless channel are relatively high.
- **Light-weight terminals** Mobile MANET nodes which have low CPU processing ability, low memory size, and low power storage, require the enhanced systems and devices which can use processing and interacting functions.

3. Applications of Manets

There are a lot of possible applications in MANET in military and civilian areas. MANETs initially were useful in the rescue operations and as the contact device for the soldiers when they were at a war. Lately, propagation of mobile communication devices such as PDAs and laptop computers resulted in ad-hoc network being one of the must-have technologies, more particularly for the atmosphere which does not have much of the infrastructure. Set of applications for MANETs is assorted which varies from small and static networks which have limitations posited by power sources, to the large-scale, mobile, highly active networks. MANETs applications can arise in the conditions such as war or the regions which are affected by a huge disaster as the networks there require be installing instantly though there is unavailability of base stations or fixing network infrastructure.

Through the wireless networks, it is quite easy to have access of information and communication which can remove the distance, time, and location challenges for numerous applications that vary from cooperative, separate mobile computing to the disaster recovery like flood, fire, earthquake, and law enforcement activities like search and rescue operations in the isolated region, home networking application and battlefield communications (Samba Sesay et al, 2004). Majority of the applications in the ad hoc network are the group applications such as sharing the data in a conference room and multi-player game and therefore the effective multicast technology is required in ad hoc network.

4. Security challenges of Manets

Wireless communications provide a lot of advantages like movability, rigidness, increased efficiency and lesser installation costs. There is a risk in all the wireless technologies and few risks are quite same as the ones in wired networkers whereas others are worsened by wireless connectivity. The security problems are more essential in those networks in comparison with the wired networks. Some features of ad hoc network are there due to which it is quite hard to secure in comparison with infrastructure-based network.

- **Channel vulnerability** because the wireless channels are broadcasting in nature, network is easily accessible to malicious nodes and they can snoop and instill the messages with ease. Wireless links in MANETs are subject to link attacks which vary from passive eavesdropping to active impersonation, message replay and message misrepresentation (Zhou et al, 1999). Because of the active attacks, the rivals are able to alter information which breaches security services like accessibility, reliability, validation and non-refutation.
- **Node vulnerability** Mobile nodes are exposed to being compromised or physically captured because they have movements in the intimidating atmosphere where physical security standards are very low. These compromised nodes can lead to high risk along with the attacks by malicious nodes from exterior of network. Attackers might arrive via those nodes and sustain security attacks in system.
- **Power and computational limitations** Restrictions on the computational ability of mobile nodes and bandwidth restricted wireless channel avert the use of outdated security schemes that comprise of complicated computational systems.
- **Lack of central authority** there is not much central authority in MANET like the access points, base stations, etc. in which security devices are used in the wired networks.

- **Scalability** There should be scalability in security mechanisms for managing a lot of nodes in network.

5. Routing in Manets

As Routing is the basis for data exchange among wireless nodes, it becomes a significant function. Routing security in the wireless networks is a significant issue which is hard to solve (Deng et al, 2002). Major tasks of routing are routing information exchange, looking for a viable route between source and destination on the basis of different metrics and path maintenance. There are a lot of issues and obstacles in the routing in mobile ad hoc networks in comparison to the routing in outdated wired networks which have fixed infrastructure. Every wireless node is a router and is involved in routing protocol. Thus, routing depends on a vague trust relation between the involved devices. Issue of the routing increases later due to the restricting factors like quick change in the topology, high power consumption, low bandwidth and high error rates. Routing protocol structure must take the aforementioned obstacles into the account which are provoked due to the distinct features of ad hoc wireless networks.

5.1 Multicast Routing in Manets

Multicasting has turned out to be one of the most highlighted fields in the networking region. Multicast is when data is conveyed in a group of nodes which are recognized with the help of a distinctive address. Multicast service is very essential in the applications in which one-to-many dissemination is essential. In majority of the MANET frameworks, there are groups; and multicast usage decreases the cost of transmission, use of bandwidth, router processing and end-to-end delay because a single message is sent to numerous receivers at the same time. Broadcasting nature of the wireless links can enhance the use when it transmits numerous data packets copies which decrease transmission overhead. Multicasting in MANET is very complicated when compared to wired networks due to the node movement, interruptions by wireless signals and broadcasting nature of wireless communication.

5.2 Multicast Routing Protocols

Routing and multicasting in ad hoc network become quite hard due to the features of wireless channels such as low bandwidth, high error rate and restricted battery power. In comparison with the infrastructure-based networks in a MANET, every node is flexible and it is possible to connect it actively in an uninformed way. Nodes act as router and participate in the findings and maintenance so a precise route can be formed and due to this the routing protocols for the wired networks are not used in wireless networks directly. There are a few protocols formed for MANETs. Tree-based protocols and mesh-based protocols are two simple designs used in the multicast MANET protocols.

A communication network is able of receiving just one message out of an application as well as delivering replicates of that particular message to several receivers to various positions. The objective of multicasting is providing effective information to multiple recipients. In the process of multicast, the senders transfer every set of data or information for once and maximum one duplicated file of the bunch streams by means of the physical associations normally.

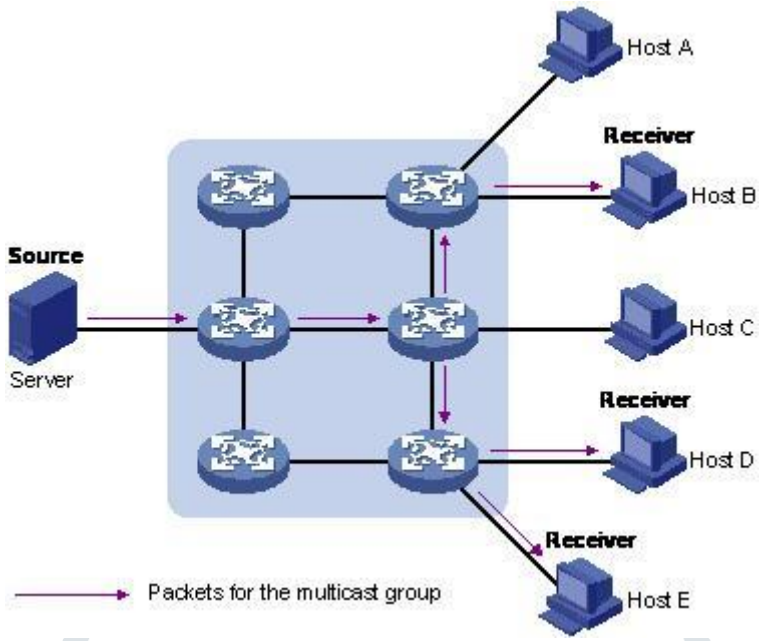


Figure 1.1: Multicasting Routing

As per this image, an origin or source sends a message to recipients (to Host B, D, and E). For single or unicast transportation, sender or source sends the identical data three times where the bandwidth utilization in between the source and the intermediary node will also be three times. For broadcast, other Hosts (Host A and C) will receive the bunches however it's not contextual with respect to the transmitted message, leading to unwanted bandwidth utilization. On the other hand, in case of multicast, just one copy of the message is sent from the source and at the intermediary nodes, this message is copied to be received by the multicasting group. This group can be of a handful of nodes to multiples as well as the thousands.

In fact, there might be routers which are not supportive of the multicasting on the network. A multicast router covers multicast bunches in unicast IP bunches within the tunnel mode after that transmits them to the surrounding multicast routers by means of the non-multicast routers. The surrounding multicasting routers eliminate the header of the unicast IP bunches. Afterward, these routers go on multicasting the bunches or packets, in this way, bypassing the change of the network structure hugely (Mohammad Banikazemi, 2000).

Transmitting several messages to multiple recipients at the same time with the help of a single broadcasting course is known as Multicasting. This is massively utilized in different internet applications, for example, this kind of data transfer is executed in various processes which are different in network capacities as well as in wishful outcomes.

For delivering the IP multicasting packets to the respective targets, minimum one routing protocol should be used in the network. These protocols are as follows:

a) Distance Vector Multicast Routing Protocol (DVMRP)
b) Multicast Extension to Open Shortest Path First (MOSPF)
c) Protocol Independent Multicast Sparse-Mode (PIM-SM)
d) Protocol Independent Multicast Dense-Mode (PIM-DM)
e) Core-Based Tree (CBT)

When it comes to a mobile ad hoc network, it doesn't have an established or rigid infrastructural aspect as well as carry dynamic and altering topology. The nodes are free to move on either side. These Ad hoc networks are commonly utilized in emergency criteria when there is no infrastructure. For example, during wars, disaster rescue operations and so on (Corson et al, 1999).

The designing of multicasting routing protocol is tough because of the natural or intrinsic and uncertain dynamic aspects. A lot of multicasting protocols are suggested with respect to mobile ad hoc networks. Depending upon the structural features of the network as well as multicasting packets are sent to several recipients, these multicasting protocols are then classified into two categories, which are: tree-based as well as mesh-based multicasting. The tree structure is popular due to its efficacy to use the network resource

maximally, on the other hand, the tree based multicasting protocols are usually further effective when it comes to transmission of data. Whereas the mesh protocols are extensive with respect to the topology alterations because of accessibility of several redundant ways between mobile nodes as well as outcomes in high packet delivery proportion. Alternatively, multicasting mesh does not do better when it comes to energy efficacy due to mesh-based protocols' dependence on broadcast streaming within the mesh. Hence, this engages several numbers of forwarding nodes as compared to multicast trees.

Briefly, the broadcast forwarding for mesh oriented protocols generates redundant connections to improve the packet transmitting ratio, although consumes more energy as compared to the tree based ones. The tree way acquires quite a few shortcomings. The courses or ways are non-optimized while the traffic is also focused on the tree instead of getting proportionately allocated throughout the network. From a mobility point of view, these are not strong or powerful due to the absence of backup way between an origin and a target. Apart from that, each tree based multicast protocols require a team leader or a central part/ rendezvous point for maintaining the data of the group or team as well as for creating multicasting trees.

In a multicasting packet system, all the recipients are from a team as well as a network structure like a tree or mesh. This is made when a multicasting group is built. Although, because of the node mobility issue, the network structural aspect is brittle, therefore, the multicasting bunch or packet might not be sent to a few members. As compensation of this issue, as well as to develop the packet delivery proportion, multicasting protocols for ad-hoc networks use to control or regulatory packets for refreshing the network structure in a periodic manner.

These underlying protocols are there for coping with multicasting in ad-hoc networks.

- Multicast Ad hoc On-demand Distance vector protocol (MAODV)
- Ad-hoc Multicast Routing (AMRoute)
- Ad hoc Multicast Routing protocol (AMRIS)
- Core Assisted Mesh Protocol (CAMP)
- On Demand multicast routing protocol (ODMRP)
- Protocol for Unified multicasting through Announcements (PUMA)

5.2.1 Tree based routing protocols

There is a single shared tree for each and every transmission in a tree-based protocol or various trees from the various sources to every destination of a multicast group. There is just a single route between source and destination. Tree-based protocol is very accessible and has decreased overhead which is a plus point. Though, the traffic focused on shared links leading to high tendency for blockage at shared links is a negative point. Multicast packets are usually forwarded in the less ideal routes because there is pressure upon them to be conveyed along the shared tree. Multicast Ad hoc On-Demand Distance Vector (MAODV) routing protocol (Royer et al 1999), Ad hoc Multicast Routing (AM Route) protocol (Mingyan Liu et al, 2002), Ad hoc Multicast Routing Protocol with the use of increasing id numbers (AMRIS) (Wu et al, 1999) are some examples of tree-based protocols.

5.2.2 Mesh based routing protocols

There is a mesh of connected nodes of network in mesh-based routing protocol due to which there are numerous paths from the sources to the multicast destinations. The use of the single mesh structure covering every multicast group member result in the numerous disused routes which neglect the constant mesh configurations and it decreases the interference by the existing multicast sessions along with decreasing protocol overhead. Mesh-based protocols result in blockage and later in low packet delivery ratio in the high traffic situations. On Demand Multicast Routing Protocol (ODMRP) (Lee et al, 1999) and Core Assisted Mesh Protocol (CAMP) (Garcia et al, 1999) are a couple examples of mesh-based protocol.

6. Problem Statement

Multicast routing problem (MRP) is one of the most difficult problems in communication networks in which the source node (or a set of source nodes) is connected to the set of destinations, while some cost function is simultaneously minimized. In a wireless network, due to the broadcast nature of the omni directional antennae, a single transmission can be received by all neighbors of the transmitting node. Therefore, the

multicast routing protocols designed for the traditional wired networks are not applicable to the wireless networks.

7. Need for the Study

Multicast data communication is an efficient communication scheme, especially in multi-hop ad hoc networks where the media access control (MAC) layer is based on one-hop broadcast from one source to multiple receivers. Compared to unicast, multicast over a wireless channel should be able to deal with varying channel conditions of multiple users and user mobility to provide good quality to all users. IEEE 802.11 does not support reliable multicast owing to its inability to exchange request-to-send/clear-to-send and acknowledgement packets with multiple recipients. Thus, several MAC layer protocols have been proposed to provide reliable multicast. However, additional overhead is introduced, as a result, which degrades the system performance. In this work, we address the challenge of high data rates and burst traffic where a large burst of packets needs to be transported to the final destination. We introduce multi-interface nodes in order to further enhance the network throughput when all the traffic is destined to the multiple receivers.

8. Research Methods

Multicast data communication is an efficient communication scheme, especially in multi-hop ad hoc networks where the media access control (MAC) layer is based on one-hop broadcast from one source to multiple receivers. Compared to unicast, multicast over a wireless channel should be able to deal with varying channel conditions of multiple users and user mobility to provide good quality to all users. IEEE 802.11 does not support reliable multicast owing to its inability to exchange request-to-send/clear-to-send and acknowledgement packets with multiple recipients. Thus, several MAC layer protocols have been proposed to provide reliable multicast. However, additional overhead is introduced, as a result, which degrades the system performance. In this work, we address the challenge of high data rates and burst traffic where a large burst of packets needs to be transported to the final destination.

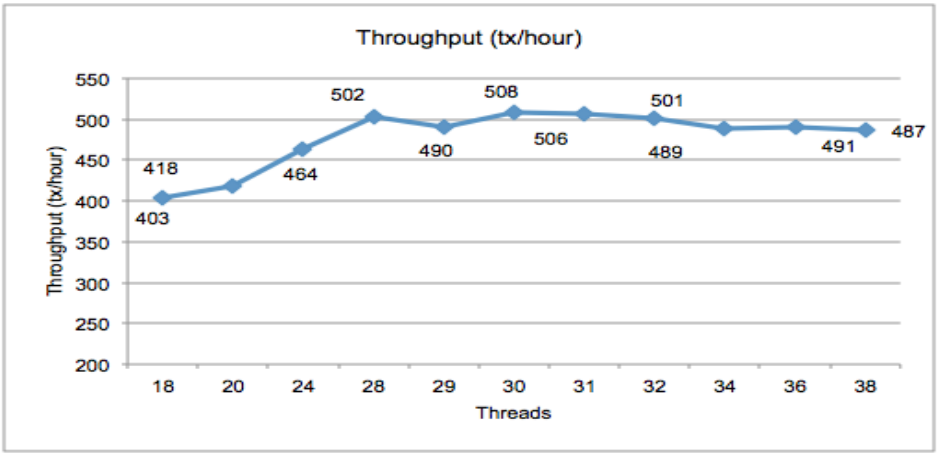
9. Results

Network simulator NS2 is used in this work for predicting the behavior of the network. Various attributes of the network has been modeled environment to access the network under different conditions.

Throughput

- Throughput is the number of packets successfully reached at destination per unit time.
- Throughput (kbps) = [(data received / (stop time – start time)) * (8/1000)]

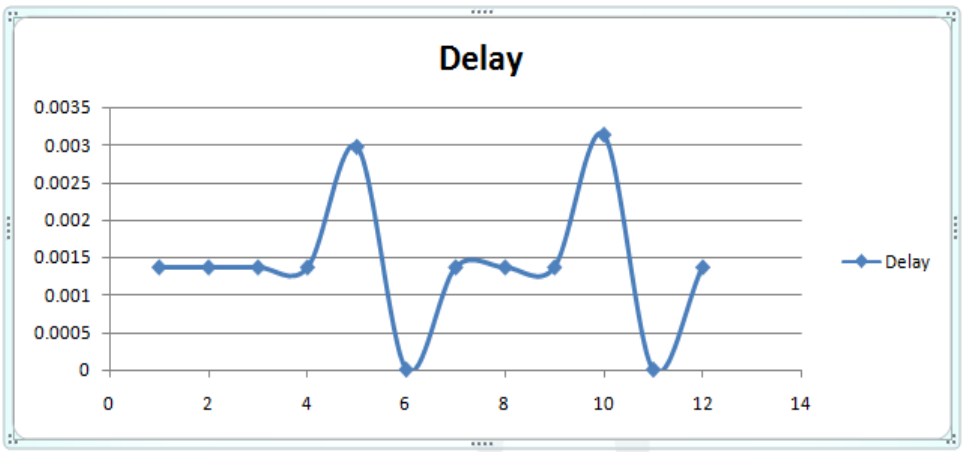
Simulation time(s)	Throughput
20	425.3
25	465.4
30	500.0
35	464.0



End to End Delay

- End to End Delay is the summation of Transmitting Delay (at MAC layer), Propagation Delay and queuing Time of a packet.
- End to End delay (ms) = (Communication end time – start time) / data received

Simulation time(s)	Normal delay(s)
5	0.003
7	0.005
10	0.0032
12	0.0013



Conclusion

In this research work, a quality of service and route reliability of routing protocol in mobile adhoc network is implemented in NS2 software tool. A study has been made in the field of multicast routing in a mobile ad hoc network environment. The proposed protocol has been evaluated on the basis on a number of parameters such as throughput and end to end delay. The throughput has been increased when transmitting

the packets by almost 50%. Similar improvements have also been registered in terms of packet delivery ratio which shows an increase of 6.25%.

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