Hybrid Wireless Network Approach for QoS

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***Abstract*—** Fast improvement of wireless networks has stimulated variety of wireless applications that have been used in number of areas such as commerce, emergency services, military, education, and entertainment. As wireless communication capture popularity, specific research has been devoted to supporting real-time transmission with Quality of Service (QoS) requirements for wireless network applications. At the same time, a wireless hybrid network that combines a mobile wireless ad hoc network (MANET) and a wireless infrastructure network has been considered to be a better option for the next generation wireless networks. By directly implementing resource reservation-based QoS routing for MANETs, hybrids networks inherit invalid reservation and race condition problems in MANETs.

Keywords- *Hybrid wireless networks, MANET, Infrastructure Network, quality of service*

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I. Introduction

Nowadays, people desire to watch videos, play games, watch TV, and make long-distance conferencing via wireless mobile devices "on the go." The Vast use of wireless and mobile devices and the increasing demand for mobile multimedia streaming services are leading to a promising near future where wireless multimedia services are widely deployed. For example, the number of wireless Internet users has tripled world-wide in the last three years, and the number of Smartphone users in US has increased from 92.8 million in 2011 to 121.4 million in 2012, and will reach around 207 million by 2017 [1]. Similarly, hybrid wireless networks have been proven to be a improved network. Hybrid networks synergistically mixed infrastructure networks and MANETs to leverage each other.

Specifically, infrastructure networks improve the scalability of MANETs, while MANETs automatically establish self-organizing networks, extending the coverage of the infrastructure networks. The main goal is how to determine paths that fulfill QoS constraints. Routing is the process of finding the path, identifying the best with QoS, and maintaining paths from a source node to destination node to deliver data packets. The aim of every routing algorithm is to transmit data traffic from source to destination with maximizing network performance and minimizing costs.

The infrastructure mode has the base stations as central control. It acts as wireless interface between the mobile devices providing fixed network of limited range. On the basis of this infrastructure model for wireless communications, the data communication from base stations is routed across a fixed network to its destination. Mobility is managed by allocating a limited set of communications frequency channels to each BS. Here the quality of service is achieved by providing admission control, resource reservation, priority scheduling of packet etc.

In case of MANETS the infrastructure in not available .The mobile nodes itself from the network without taking help of Base stations. Hence the MANET has the features like unpredictable node mobility, wireless multi-hop communication, contention for wireless channel access, limited battery power and range of mobile devices as well as the absence of a central coordination authority.

The hybrid wireless networks are mixed both kinds of networks. So the routing algorithms for hybrid networks should consider all attributes of cellular and MANETs. However, small effort has been taken to support QoS routing in hybrid networks. Most of the current works in these networks focus on increasing network capacity or routing reliability but cannot provide QoS-guaranteed services. A routing protocol for hybrid wireless networks should have the following attributes [2]

- It must be completely distributed.
- It must be applicable to dynamic topology changes caused by the mobility of nodes.
- Route calculation and maintenance must involve a least number of nodes.
- It must overcome invalid path reservation problem.
- It must overcome race condition problems for resources reservation.
- The count of packet collision must be kept to a least.
- It must optimally use resources like bandwidth, computing power, memory and battery power.

- It should take benefits of available resources like base stations and multi interface feature of mobile nodes.
- It should be able to provide QoS demanded by the applications.

II. Literature Review

A. Infrastructure Networks

Existing approaches for providing guaranteed services in the infrastructure networks are based on two models [16]: integrated services (IntServ) and differentiated service (DiffServ) IntServ is a stateful model that uses resource reservation for individual flow, and uses admission control and a scheduler to maintain the QoS of traffic flows. In contrast, DiffServ is a stateless model which uses coarse-grained class based mechanism for traffic management.

B. MANET

The various routing algorithm proposed for comparative study can be categorized by following aspects: Resource reservation based & No of hops between source node and destination. [2]

The QoS provision for mobile adhoc networks is very challenging task. Due to dynamic nature of these networks the routes between the nodes are frequently breaking. Hence we cannot directly adapt the routing algorithms available for cellular networks.

The various resource reservation based algorithms for MANETs are as follows: [3]

- Extension of Dynamic Source Routing protocol (E-DSR),
- Ad Hoc on Demand Distance Vector protocol (E-AODV),
- Temporally Ordered Routing Protocol (E-TORA),
- Destination Sequenced Distance Vector protocol (E-DSDV),
- Zone Routing Protocol (E-ZRP).

Here the intermediate nodes along with the path, reserve the resources for the source node. But due to dynamic nature of MANET the nodes are moving. Hence the reserved paths are no longer remaining valid. Due to this, algorithms have to suffer from invalid reservation problem. When the workload of the system increases, the probability that two or more source nodes simultaneously reserve the same resources at a node increases due to the race condition problem arises. Also, the nodes close to the Access points (APs) are more likely to be congested. There is no resource scheduling mechanism in these algorithms. Hence, the QoS throughput of reservation based algorithms decreases in a highly loaded system.

Y. Wei and D. Gitlin in 2004 has proposed a two-hop packet forwarding mechanism, in which the source node adaptively chooses direct transmission and forward transmission to base stations. In two-hop, the packets are always forwarded to the nodes with higher transmission link rate. Without any buffer management strategy, the nodes with higher transmission links are very easily overloaded as the workload in the system increases. Hence, it may suffer severe buffer congestion in the selected node with high bandwidth. [4]

X.DU in 2004 has considered non-homogeneous properties of mobile nodes such as terms of transmission power, bandwidth, processing capability, etc. The QoS routing protocol takes advantage of the different transmission capability of multi-class nodes. They design more efficient QoS routing protocol that calculates bandwidth and reserves slots for MANET. Here the node location information is used to help the routing. [5]

V. Venkataramanan, X. Lin, L. Ying, and S. Shakkottai in 2010 proposed a scheduling algorithm to ensure the smallest buffer usage of the nodes in the forwarding path to base stations. S-Multihop only focuses on buffer usage of the next hop node, which increases the QoS of packet transmission to a certain extent but cannot ensure the QoS of the forwarding. However, these works focus on maximizing network capacity based on scheduling but fail to guarantee QoS delay performance. Two-hop has less QoS throughput increase rate than S-Multihop as the number of source nodes increases. [6]

Some works consider providing multipath routing to increase the robustness of QoS routing.

M. Conti, E. Gregori, and G. Maselli in 2004 has proposed Reliable and efficient forwarding mechanism (REEF) which takes advantage of multipath routing and transport layer information to estimate the best route through which packets have to be forwarded. Based on reliability Indexes every node has a dynamically updated reliability table containing a value for every outgoing link to a neighbor. Every time the node sends a packet on a path, it updates the reliability value associated to the neighbor through whom the packet has passed: the updating is positive whenever the packet delivery is successful, negative otherwise. The main goal of REEF was to improve network throughput and balance network utilization at the same time. [7]

C. Shen and S. Rajagopalan in 2005 has designed and implemented a packet delivery improvement service for multicast routing in mobile ad hoc networks called Protocol-Independent Packet Delivery Improvement Service (PIDIS).

PIDIS is an adaptive, persistent packet recovery mechanism which uses Swarm Intelligence to gossip for lost packets effectively. They proposed to let a source node fetch the lost packets from its neighbors to recover the multicast traffic. [8]

H. Wu and X. Jia in 2006 have proposed a new scheme that uses multiple paths/trees in parallel to meet the QoS requirements of a call. The trees are maintained by source node by collecting network information on demand. The major advantages are it greatly reduces the system blockings. Thus, system resources can be better utilized. Multicast routing is done in a distributed fashion. [9]

C. Hybrid Wireless Network

For hybrid wireless networks specially, very few algorithms are proposed by considering its complete properties. The existing algorithms concentrate on system capacity, cooperative resource sharing, path discovery to improve the only cellular network performance. But at the same time mobile ad hoc mode is ignored. Also the property of mobile nodes with multiple interfaces is also not fully utilized. Service oriented algorithm for hybrid wireless networks still has a lot of work to be done. The current work in hybrid networks focus on increasing network capacity or routing reliability but cannot provide QoS-guaranteed services. Here a utility maximization framework that is capable of selecting the best relay strategy, power, and rate allocation is proposed. Various relay selection protocols, which achieves higher bandwidth efficiency are given below.

A. Bletsas, A. Khisti, D.P. Reed, and A. Lippman in **2006** tried to select “best” relay that has the maximum instantaneous value of a metric which can achieve higher bandwidth efficiency for data transmission. [10]

Ng and Yu in 2007 considered cooperative networks that use physical layer relaying strategies, which take advantage of the broadcast nature of wireless channels and allow the destination to cooperatively “combine “signals sent by both the source and the relay to restore the original signal. This paper illustrates that by adopting a cross-layer approach that takes into account both the power and bandwidth availability and the traffic demand of each user, cooperative relaying in the physical layer has the potential to significantly improve the overall system performance. [11]

J. Cai, X. Shen, J.W. Mark, and A.S. Alfa in 2008 proposed a semi distributed relaying algorithm to jointly optimize relay selection and power allocation of the system. User relaying algorithms, in terms of relay node selection and power allocation, are proposed for wireless relay networks. [12]

P. Jiang, J. Bigham, and J. Wu in 2008 proposed a resource provision method in hybrid networks modeled by IEEE802.16e and mobile WiMax to provide service with high reliability. [13]

Y. Wei, M. Song, F.R. Yu, Y. Zhang, and J. Song in 2010 proposed to use the first-order finite state Markov channels to approximate the time variations of the average received signal-to-noise ratio (SNR) for the packet transmission and use the adaptive modulation and coding scheme to achieve high spectral efficiency. The obtained relay-selection policy has an indexability property, which dramatically reduces the online computation and implementation complexity. [14]

S. Lee and S. Lee in 2010 presented a framework of link capacity analysis for optimal transmission over uplink transmission in multi hop cellular networks. [15]

D. Proposed Method

Very few methods have been proposed to provide QoS guaranteed routing for hybrid networks in dynamic environment. Unlike the above works, QoS oriented distributed routing algorithm (QOD) aims to provide QoS guaranteed routing. QOD fully takes advantage of the widely deployed APs, and novelly treats the packet routing problem as a resource scheduling problem between nodes and APs. Here the focus is on the neighbor node selection for QoS-guaranteed transmission. QOD is the first work for QoS routing in hybrid networks. This paper makes five contributions. [16]

- ***QoS-guaranteed neighbor selection algorithm.*** The algorithm selects qualified neighbors and employs deadline-driven scheduling mechanism to guarantee QoS routing.
- ***Distributed packet scheduling algorithm***. After qualified neighbors are identified, this algorithm schedules packet routing. It assigns earlier generated packets to forwarders with higher queuing delays, while assigns more recently generated packets to forwarders with lower queuing delays to reduce total transmission delay.
- ***Mobility-based segment resizing algorithm.*** The source node adaptively resizes each packet in its packet stream for each neighbor node according to the neighbor’s mobility in order to increase the scheduling feasibility of the packets from the source node.
- ***Soft-deadline based forwarding scheduling algorithm***. In this algorithm, an intermediate node first forwards the packet with the least time allowed

to wait before being forwarded out to achieve fairness in packet forwarding.

- ***Data redundancy elimination based transmission.*** Due to the broadcasting feature of the wireless networks, the APs and mobile nodes can overhear and cache packets. This algorithm eliminates the redundant data to improve the QoS of the packet transmission.

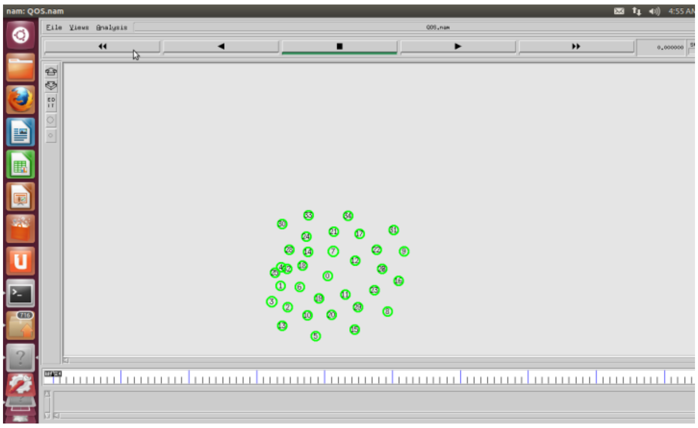
In order to enhance the QoS support capability of hybrid networks, in this paper, we propose a QoS-Oriented Distributed routing protocol (QOD). Usually, a hybrid network has widespread base stations. The data transmission in hybrid networks has two features. First, an AP can be a source or a destination to any mobile node. Second, the number of transmission hops between a mobile node and an AP is small. The first feature allows a stream to have any cast transmission along multiple transmission paths to its destination through base stations, and the second feature enables a source node to connect to an AP through an intermediate node.

A. *Advantages of Proposed System:*

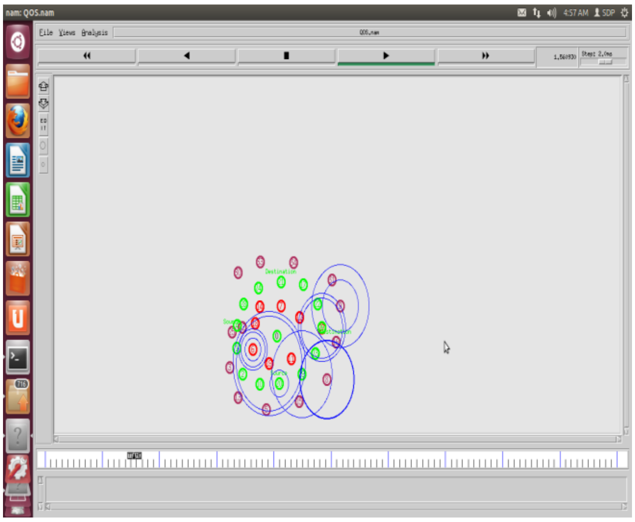
- The source node schedules the packet streams to neighbors based on their queuing condition, channel condition, and mobility, aiming to reduce transmission time and increase network capacity.

- Taking full advantage of the two features, QOD transforms the packet routing problem into a dynamic resource scheduling problem.

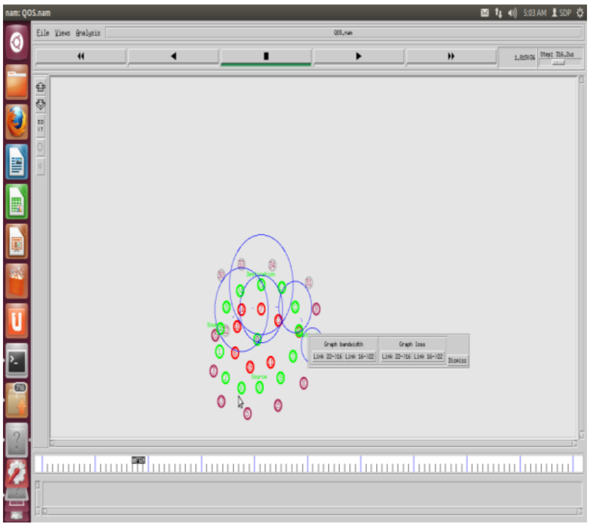
B. *System Screenshots*



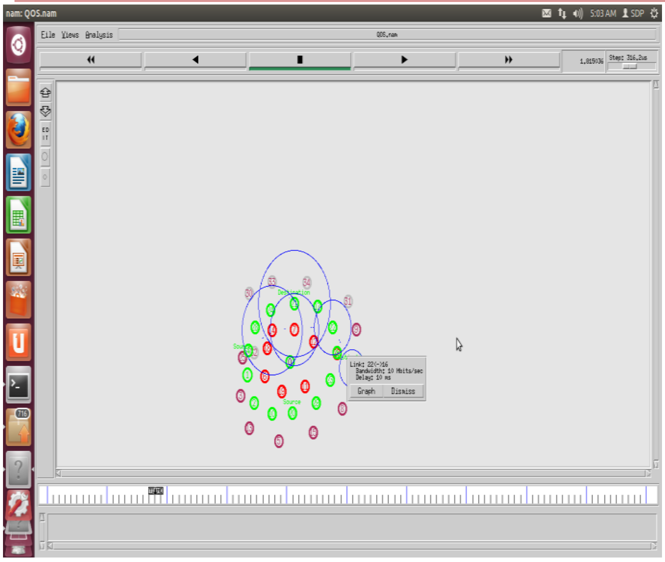
- In the above screenshot we can see that their 34 nodes available in the network. Among these nodes, node 20 &25 are configured as Source node whereas node 21 & 16 are configured as Destination node.



- In the above screenshot, we can see that the nodes are assign with their respective labels. Along with these the nodes perform the anycasting for the formation of links for forwarding the packets from Source to Destination.



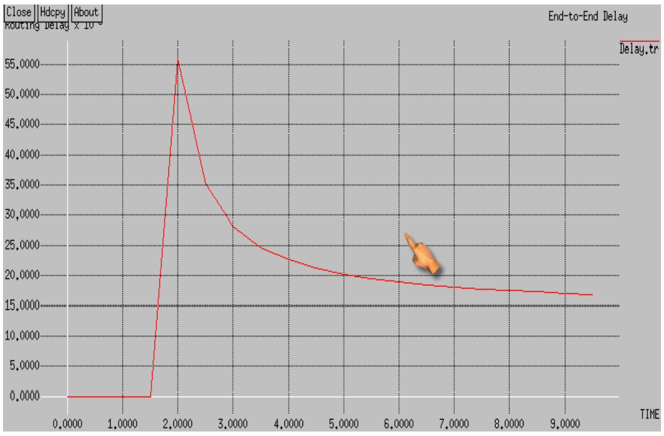
- Here the link is formed dynamically amongst the nodes based on the QOD parameters and packets are forwarded dynamically to their respective Destination.



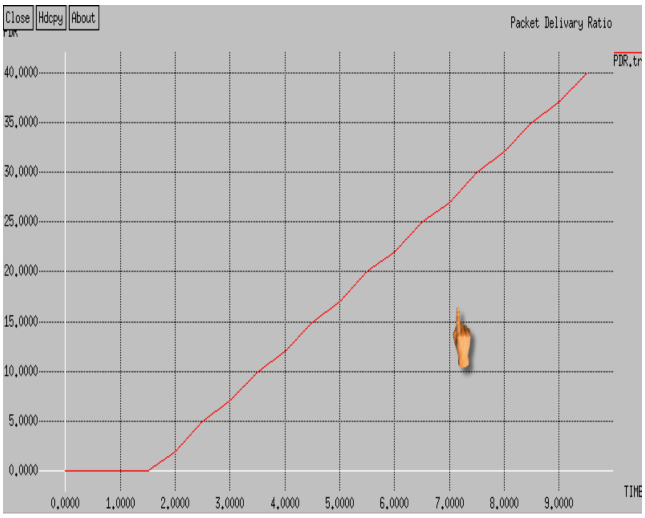
- While forwarding the packets,we can observe that the constant delay i.e.10ms is generated and finally the packet is reached at Destination.

C. Result Analysis

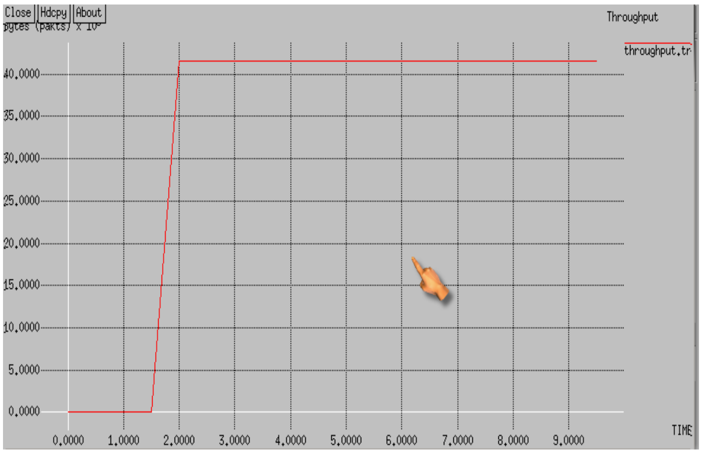
1. End to End Delay



2. Packet Delivery Ratio



3. Throughput



CONCLUSION

QoS is a set of service requirements that should be provided by the network while transporting a data flow. QoS is measured by parameters like available bandwidth, packet loss rate, estimated delay, packet jitter, hop count and path reliability. This survey gives study of QOS requirements of hybrid wireless networks. The existing approaches are not fully focusing on complete properties of hybrid wireless networks. Although the QOD approach seems to be more promising compare to other approaches as it solves the invalid reservation problem and race condition problem.

How to guarantee the QoS in hybrid wireless networks with high mobility and fluctuating bandwidth still remains an open question. Experimental results show that QOD can achieve high mobility-resilience, scalability, and contention reduction. In the future, we plan to evaluate the performance of QOD based on the real test bed.

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