CROSS DOMAIN QoS MAPPING BETWEEN WMN AND FIXED TOPOLOGY FOR END-TO-END QoS GUARANTEE

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بسم الله الرحمن الرحيم

Dedication

I dedicate this thesis
to Islam
which has taught me the meaning of life

&

to my Dear Parents Javed Akhtar and Azra Begum
who are the epitome of my existence and
supported me in making this Dream come true

&

To my dear brothers Imran, Kamran and Mehmood
and my sweet sister Farkhanda

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Declaration

I hereby declare that this Thesis "***Cross Doamin QoS Mapping between WMN and Fixed Topology for end-to-end QoS guarantee***" neither as a whole nor as a part has been copied out from any source. It is further declared that i have done this research with the accompanied report entirely on the basis of my personal efforts, under the proficient guidance of my teachers especially my supervisor **Mr. Mata-ur-Rehman**, Assistant Professor, DSE, IIUI and my Co-supervisor **Ms. Muneera Bano**, Assistant Professor, DSE, IIUI. If any part of the system is proved to be copied out from any source or found to be reproduction of any project from any of the training institute or educational institutions, I shall stand by the consequences.

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Project In Brief

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Abstract

Wireless Mesh Network is a communication network made up of radio nodes organized in a mesh topology. WMN can self organize, self configure and self heal themselves. WMN is a type of ad hoc network. As deployment of WMN continues to rise, it is predictable that these networks to have the capability to support the new generation of streaming-media application, such as Voice over IP (VoIP) and video on demand. We propose a mechanism to provide end-to-end QoS guarantee to real time flows having source in WMN and destination in fixed topology. Our proposed mechanism modify existing scheduling mechanism and reserves a time slot for forwarding of real time flows pass through WMN and also extend same mechanism at gateway. Gateway then forwards packets according to specification of real time flows in fixed topology network. This is an effective technique that increases throughput of real time flows continue for longer period of time.

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Chapter 1

Introduction

1 Introduction

Wireless Mesh Network (WMN) is a communication network made up of radio nodes organized in mesh topology. In WMN, nodes can communicate with one another via multi-hop routing and forwarding.WMN can self organize, self configure and self heal themselves. These characteristics enable its flexible integration, quick deployment, easy maintenance and its ability of capacity enhancement, connectivity and throughput. Nodes in WMN can automatically establish an ad hoc network and maintain mesh connectivity.

WMN consists of three types of nodes. Mesh router, Mesh client and Gateway. In addition to mesh networking among mesh router and mesh client, the gateway functionalities in mesh router enable the integration of WMN with various types of other networks. Generally mesh routers are static and mesh clients are mobile. Power constraints are only for mesh clients. Mesh router can achieve same coverage using lower transmission power through multi-hop communication. WMN is a type of Ad Hoc Network but, because of its easy network maintenance, robustness, reliable service coverage, WMN expands the capabilities of Ad hoc network.

As deployment of WMN continues to rise, it is predictable that these networks to have the capability to support the new generation of streaming-media application, such as Voice over IP (VoIP) and video on demand. To support next generation application with real time requirements WMN must provide advanced, highly developed and strong QoS guarantees. [3] Compared to MANET, WMN seems to be a better candidate for provision QoS, as they have advantage of the presence of relatively static mesh routers, no power constraint and low node mobility, providing a comparatively more established wireless mesh back bone. [8]

1.1 QoS Guarantees

As described in rfc 2386, QoS can be considered as set of service requirement to be met by network while transporting a packet from source to destination. It can be considered as a guarantee by a network to provide a pre-defined set of services to a user in terms of bandwidth, delay, packet loss and jitter. Services can be provided to users at different levels with different capabilities. [6]

- **Assured Guarantee:**

  Network provides guarantee of delivery of services equal to or better than the requested services by users.

- **Limited Guarantee:**

  Network offer guarantee of delivery of requested services for certain percentage of traffic over some particular duration of time.

- **Flexible Guarantee:**

  Here network tries to give services requested by users but with no assurance. This case is more appropriate for Mobile networks.

- **Best Effort:**

  No service guarantee for any flow of packets. All flows treated equally. No special treatment for any flow.

1.2 Challenges for provisioning QoS in WMN

WMN are widely used in a variety of application such as disaster relief, emergency response, intelligent transportation system, metropolitan area networks and building automation etc.[7] To support real time application such as video on demand and Voice over IP (VoIP) WMN must provide strong and consistent QoS guarantee. QoS provisioning in wireless mobile networks is quite a challenging task as compared to wired network because architecture of wireless mobile networks having many difficulties associated with it. Some of major challenges in provisioning QoS over WMN are

1. Limited capacity:

Bandwidth is very expensive resource in wireless network so it must be utilized very carefully and nodes of wireless mobile network bound the communication capacity because of single radio interface.

2. Interference and Fading effects:

Due to poor communication system in multi-hop wireless networks, interference and multi-path fading effects increases. So QoS provisioning becomes very difficult.

3. No centralized control:

As there is no centralized control in WMN so calculation of accurate delay bounds, keep track of node's position and information related to resource, required for real time applications, becomes very difficult.

4. Network heterogeneity:

As routers and clients in WMN having different characteristics in terms of mobility and consumption of resources so Because of this heterogeneity present in WMN, makes provisioning of QoS becomes very tricky.

5. Diverse QoS constraint:

As different real time application may have different QoS requirement, so one single standard for provisioning QoS is not enough. Diverse nature of application makes provision of QoS very complicated. [2]

1.3 Research Motivation

Deployment of WMN is increasing quickly from home-based application to industrial and economical fields because of its unique characteristics. In WMN it is default requirement to support network access for both conventional and mesh clients. So mesh routers need to be capable of integrating heterogeneous wireless network. Therefore design of special type of

QoS aware gateways that connects wired and wireless network is vital issue in wireless network development.

WMN can be used as a back bone for connecting various different networks, so special type of gateways are required for this purpose, which connects wire-line and wireless network in an efficient manner. Due to changeable load from other users sharing the same network resources, the bit-rate (the maximum throughput) that can be provided to a certain data stream may be too low for real time multimedia applications if all data streams get the same scheduling priority for forwarding in WMN. Differences of QoS solutions present on both side of gateway impose various challenges on its design. Different QoS solution may have different QoS parameters, different QoS measuring criteria and may be not compatible with each other. To provide homogenous solution for effective end-to-end communication it is vital that the QoS solution should handle real time traffic in WMN as well as at gateway. So in order to improve end-to-end communication in WMN problems related to cross domain QoS connectivity issue should be considered.

1.4 Problem Domain

Major QoS solutions developed for WMN provide QoS guarantee in WMN only. To provide QoS guarantee to real time applications, a mechanism is required that operate throughout the heterogeneous network. For solving cross domain connectivity problems, cross domain QoS mapping is one of the key challenges. To provide end-to-end QoS guarantee for real time and multimedia applications, when different QoS models are integrated, a mapping procedure is performed at the edge of each network. QoS mapping can be considered as main component in QoS-aware routing in WMN. Mapping procedure should be compatible with the QoS solution present in WMN so that gateway effectively perform mapping.

When any packet travels from one network to another through gateway, a model is required at gateway to properly map the flows so that other network accept the flow and treated it as real time flow to provide end-to-end QoS guarantee. Mapping can be flow-to-flow, flow-to-class, class-to-flow and class-to-class.

This research is going to develop a mechanism for providing QoS guarantee to real time application over WMN and extend this solution for QoS mapping that operates at gateways of WMN so gateway also treat real time flows separately to increase the throughput of real time flows, where one communication end point is in WMN and other communication end point is in some fixed topology network. Mapping procedure at gateway is compatible with QoS solution present in WMN, so that gateway treated packets coming from WMN in the same way and forwarded to fixed topology network. As no such relevant approach for WMN have been found in literature so this approach for end-to-end QoS provisioning in WMN is quite unique.

1.5 Research Overview

The main focus of this research work is to propose a mechanism to provide end-to-end QoS guarantee to real time application when source of flow is in WMN and destination is in fixed topology network. First a mechanism is proposed to provide QoS guarantee to real time application, to increase the throughput of real time flows, when packets are forwarded from source to gateway, so modify existing scheduling mechanism. As all the communication takes place between source to destination through gateway so a mapping mechanism is proposed for gateways to treat real time application in the same way. Further through this mapping mechanism, gateway sends packets towards destination in fixed network according to specification of fixed network for providing QoS guarantee to real time application. The following is the brief overview of whole research work.

- As simple AODV works well for only wireless network and is not suitable for our problem scenario, so we use AODV+ for routing packets when source is in WMN and destination is in fixed topology network.
- Develop a mechanism for specially handling real time flows, to increase throughput, from source to gateway.
- Enhance the mechanism so that at gateway also treat real time flows separately and send real time packets towards the destination in fixed topology network in proper time.

- Gateway forwards packets towards destination according to specifications present in fixed topology network to provide QoS guarantee to real time applications.
- Implement the above mentioned approaches on given network scenario specially designed to check the performance of these approaches.
- Use Network Simulator-2.34 for whole implementation process and run simulations for through performance evaluation.
- Simulation results and performance analysis is provided.
- At the end a conclusion of whole research work is performed.

1.6 Organization of the Thesis

The rest of the thesis is organized as follows.

Chapter 2: Literature survey is give in order to review the existing related work in detail. Important findings are extracted and shaped at the end in form of finding table.

Chapter 3: Requirement analysis gives an analysis of existing QoS approaches for fixed topology network and WMN to define our problem domain. Formulate the problem in detail and at the end gives problem statement.

Chapter 4: Proposed solution and methodology explains our proposed solution in detail.

Chapter 5: This chapter gives a brief introduction of network simulator-2 and our topological scenario. Implementation detail of our proposed solution is also describes. Also gives details of the performance metrics chosen, simulation results and at the end performance analysis is given.

Chapter 6: Discusses conclusions drawn from simulation experiments and scope for future work.

Chapter 2

Literature Survey

2 Literature Survey

2.1 Introduction

The main focus of this chapter is to provide detail of our literature survey that explains what we are actually trying to investigate. We will investigate different QoS aware routing approaches for WMN and then point out architecture specification of QoS aware routing over heterogeneous networks and then highlight Why QoS parameter mapping is necessary for end-to-end QoS provisioning over WMN?

In Section 2.2 Related Research to existing mechanisms for QoS provisioning over heterogeneous networks and existing cross domain QoS models is given. Main emphasis is given towards generating valuable findings from related research. Section 2.3 organizes research findings of section 2.2 in tabular form. Section 2.4 gives limitations of different approaches investigate in previous section.

2.2 Related Research

2.2.1 QoS-aware Routing in WMN

A lot of research has been done to solve QoS provision problems related to routing in WMN.

The early proposals for QoS provisioning in WMN are Quality of Service Routing in WMN (QUORUM), Wireless Mesh Routing (WMR) protocol and Distributed end-to-end Allocation of Time Slot for Real Time Traffic (DARE) protocol. All above mentioned QoS aware routing protocols use reactive route discovery mechanism to discover route and for QoS routing, perform resource reservation along the path from source to destination, for a specific period of time, before transmitting real-time transmission.[3,11,15]

After investigating various characteristics of these protocols and features they provide for QoS-aware routing in WMN, QUORUM can be considered as better approach for provisioning of QOS in WMN as QUORUM has more features like stable link selection, limiting route discovery and detection of QoS misbehaving nodes [2].

QUORUM provides strong QoS guarantee to real time applications such as Voice over IP (VoIP) and Video on Demand (VOD). A dummy-RREP phase, during route discovery, accurately estimates end-to-end delay for a route. To find out most robust link robustness metric is used. This robustness metric also deals with nodes which exist in gray-zone and nodes that are not behaving properly. [3]

In WMR [15], information about bandwidth and delay is also embedded in route request packet during route discovery phase in order to perform admission control process. Source makes reservation on all the intermediate nodes through route request packets. A time out mechanism is used for the expiration of particular reservation.

DARE [11], uses AODV for routing and proposes a time slot reservation mechanism from source to destination for forwarding of real time packets. This reservation is periodic and in order to avoid interference during this reserved time slot, all the neighboring nodes along the reserved path are not allowed to transmit or receive any kind of data.

As both Reactive and Proactive routing have their own characteristics and can be used for QoS provisioning in WMN.

In order to check which type of routing is more suitable in WMN, after performing a comparison of three prominent multicast routing protocols over WMN, it is concluded that proactive routing is not suitable for WMN because proactive routing has huge routing overhead, so mesh based reactive routing is more suitable for WMN.As there is no multicast routing protocol for WMN so three prominent multicast routing protocols are selected for this purpose. Multicast Open Shortest Path First (MOSPF) is a proactive routing protocol, while On-demand Multicast Routing Protocol (ODMRP) and On-demand Distance Vector (MAODV) Protocol are reactive routing protocols. [1].

Finding No. 1:

Most of QoS routing protocols in WMN uses reactive route discovery mechanism and perform resource reservation for QoS provisioning.

Finding No. 2:

QoS solutions in WMN provide QoS guarantee in WMN and mesh based reactive routing is more suitable for WMN.

2.2.2 Cross Domain QoS routing in WMN

WMN can self organize, self configure and self heal themselves. These characteristics enable its flexible integration, quick deployment, easy maintenance and offer more robustness. It is default requirement in WMN to access different network technologies. When WMN act as a backbone, different wired and wireless technologies uses this backbone to forward their packets. [8]

When WMN is interconnected with some other networks e.g. fixed topology network, the cross domain connectivity problem arises. After reviewing literature it is found that no research efforts have been made in this context. Although in [3], an effective routing protocol is proposed to provide strong QoS guarantee over WMN, but this protocol is effective in WMN and not provide QoS for heterogeneous environment.

Finding No. 3:

No research effort have been made to sole cross domain connectivity problems, for end-to-end QoS guarantee when WMN is a part of heterogeneous network.

2.2.3 QoS solutions in Heterogeneous Wireless Network (HWN)

Some research efforts have been made to provide end-to-end QoS guarantee in HWN. Policy based QoS supporting system infrastructure is proposed to provide QoS in HWN. Decision making process is used for QoS aware routing. The policies whose conditions satisfy the particular condition will be activated automatically by the policy descision engine. [4]

Introducing fuzzy control into policy based management reduces the average delay up to 30 percent. Fuzzy control enable policies like, "IF average delay is moderate AND average mobility is low, THEN bandwidth must be increased."[5]

Parameter mapping and monitoring have been considered As Main component for QoS-aware routing in above mentioned approaches for QoS aware routing in HWN.

Users specify their QoS requirement at application level. In order to provide end-to-end QoS guarantee to end-users various component like hosts, protocols, intermediate routers and operating systems cooperate with each other. Each intermediate network in a HWN may have separate QoS solution, so in order to provide end-to-end QoS guarantee a mapping procedure must be performed. [10]

Finding No. 4:

QoS parameter mapping can be considered as main component in QoS-aware routing in HWN.

2.2.4 QoS Mapping

When two prominent QoS models, Integrated Services (IntServ) and Differentiated Services (DiffServ), working together to provide end-to-end Qos guarantee, QoS parameter mapping have been performed at the border between IntServ and DiffServ domains and between DiffServ domains. For this purpose different QoS management function can be implemented in multiple forms according to particular policy for end-to-end QoS guarantee. [10]. A mapping function is defined to properly map the flows of IntServ to DiffServ classes, when IntServ have been implemented at the edge and DiffServ at the core of network. Effectiveness of this network is quantativly evaluated by measuring queue size of DiffServ router, drop ratio of packets and non-conformant packets. Results show that this approach is effective in queuing delay and jitter. [13]

A mapping procedure is also performed at the edge of each network architecture, having DiffServ QoS model, to provide QoS for real time and multimedia applications over heterogeneous network. [14]

Finding No. 5:

To provide QoS for real time and multimedia application, when different QoS models are integrated, a mapping procedure is performed at the edge of each network.

2.2.5 Cross Domain QoS Models for Ad-hoc network

When one communication end point is in ad-hoc network and other communication end point is in some fixed topology network, to provide end-to-end QoS guarantee, cross domain connectivity problem arises. Cross domain QoS model operated at gateway of ad-hoc network solve problems related to QoS provisioning. Cross domain QoS model decreases the variation in provided bandwidth at gateways and decrease end-t-end delay. [9]

PYLON-Lite, cross domain model for ad-hoc network operated at gateways, assumed that SWAN model has been implemented on ad-hoc network and DiffServ model on fixed topology network. Compatibility module is used for protocol conversion. Results show smoother transitions for both upstream and downstream flows and decrease in end-to-end delay. Mapping of QoS parameter of different QoS models is one of the key challenges to design cross domain QoS model. [6]

Finding No. 6

To design cross domain QoS model, for solving cross domain connectivity problem in ad-hoc , QoS mapping is one of the key challenges.

2.3 Table of Findings Extracted from Literature Survey

Table 2.1" Findings from Literature"

Finding No.	Findings	Reference No.
1	Most of QoS routing protocols in WMN use reactive route discovery mechanism and perform resource reservation for QoS provisioning.	[3],[11],[15]
2	QoS solutions in WMN provide QoS guarantee in WMN and mesh based reactive routing is more suitable for WMN.	[1],[2],[3]
3	No research effort have been made to solve cross domain connectivity problems, for end- to-end QoS guarantee when WMN is a part of heterogeneous network.	[8]
4	QoS parameter mapping can be considered as main component in QoS-aware routing in HWN.	[4],[5],[10]
5	To provide QoS for real time and multimedia application, when different QoS models are integrated, a mapping procedure is performed at the edge of each network.	[10],[13],[14]
6	To design cross domain QoS model, for solving cross domain connectivity problem in ad-hoc, QoS mapping is one of the key challenges.	[9],[6]

2.4 Limitations

From above Literature Survey it becomes clear that existing QoS routing protocol provide QoS solution for only WMN. All the above mentioned approaches for provisioning QoS in WMN works well when WMN is not connected to any other network. When WMN uses as back bone or used by a heterogeneous network and packet needs to cross domain, end-to-end QoS provisioning is not possible due to different QoS models implemented on each network.

As different cross domain QoS solution exists for heterogeneous network and Ad hoc network, but they can't be used as it is in WMN because of different architecture and characteristics of WMN. These approaches require huge modification if we use them in WMN.Therefore these approaches must be modified if we want to use them in WMN.

Chapter 3

Requirement Analysis

3 Requirement Analysis

3.1 Introduction

Different real time applications may have different QoS requirements and a specific mechanism is required to fulfill those requirements. We call this specific mechanism as QoS model. In order to perform requirement analysis, first of all deep understanding of underlying QoS approaches, implemented on each side of gateway, are required. There are many approaches existing for fixed topology network and WMN but here we specify few models for fixed topology network and few for WMN in order to define our problems. Section 3.1 defines models for fixed topology and Section 3.2 defines models for WMN. Section3.3 formulate problem in detail. Section3.4 defines our problem scenario. Section 3.5 defines focus of our research.

3.2 QoS models for fixed topology network

IETF has proposed few QoS models for fixed topology network because of increase demand for real time applications, which require more throughput and other certain resources like bandwidth, delay, jitter etc along the path from source to destination. Major QoS models proposed by IETF for fixed topology network are Differentiated Services (DiffServ) and Integrated Services (IntServ). Another important QoS model proposed by IETF by combining the features of both QoS models is called Intserv operations over DiffServ domains,

3.2.1 Integrated Services

In IntServ resources are reserved on per flow basis. Before the starting of transmission first a path is set up and specific resources, requested by application, must be reserved along the path from source to destination. This reservation is made for each flow so all the intermediate routers from source to destination must have information of this reservation for each flow.

IntServ use RSVP for resource reservation. So all the routers in IntServ domain must understand RSVP. Before starting transmission, sender first sends a PATH message to receiever to reserve resources. All the intermediate routers forward this message until it reaches the destination. The intermediate routers may accept this message or reject according to availability of resources. When receiver receives this message it sends RESV message back to source. When sender receives RESV message from receiver, it starts sending data along the reserved path. IntServ provides assured guarantee to requested applications.

This model works effectively and shows good performance when size of network is small and less number of flows pass through it. But as the network size increases and number of flows increases, a scalability issue arises in this model which degrades the performance of model. IntServ works more effectively at edge of network. [6]

3.2.2 Differentiated Services

DiffServ model provide services to real-time applications without the need of keeping information of each flow at each core router and no signaling information is required.

DiffServ architecture is composed of number of functional elements including small set of per hop behaviors (PHB).The major functional elements consists of packet classification and conditioning functions.

Packet classification is performed after checking various fields (source address, destination address, DSCP value etc) of IP packet header. Two type of classifier used for this purpose.BA classifier and MF classifier. Traffic conditioning includes marking, metering, shaping and dropping of packets. The edge router or source of traffic check IP packet header and based on service agreement and policy assign a specific code point (DSCP value) to a group of flows. These group of flows having same code point forms a behavior aggregate (BA). This BA receives same treatment (per hop behavior) along the path from source to destination. Two PHB proposed by IETF .Assured Forwarding (AF) and Expedited Forwarding (EF) or premium services.

Edge routers in DiffServ perform traffic classification and conditioning and core routers simply forward packets according to specified PHB. So no extra information of flows needs to be stored at core routers. Thus DiffServ model provides scalable solution to many QoS problems. DiffServ provides statistical guarantee of forwarding of real-time applications. DiffServ works more efficiently and is more suitable at core of network. [6, 17]

3.2.3 IntServ operation over DiffServ Domains

As it is explained above Intserv are more suitable for edge network and DiffServ at core of network. IETF proposed combine working of both these models and implement specific model in a part of network where it shows good performance. ARSVP is used in this model.

Admission control to allocate available resources to different application is performed only at edge routers and thus resources are allocated more efficiently. When source of traffic performs packet classification and marking, it scales best, and when edge routers performs marking, multi flow classification mechanism is configured in edge routers for this purpose.

To properly map IntServ flows to appropriate PFB, special and well organized mapping policies are implemented. This mechanism provides a cross domain QoS solution over wired network, having IntServ on one side and DiffServ on other side and thus solves scalability problems. Results shows less delay, smaller jitter, small queue size, and flows having different QoS requirement are not affected by other traffic flows. [6, 16]

3.3 QoS models for WMN

The field of QoS routing and provision in WMNs is comparatively new if it is compared with work in QoS provisioning in IP networks and MANETS. Due to presence of static mesh routers, less mobility and less power constraint provisioning of QoS is relatively easy in WMN as compared to MANETS. Many major extensions have been done in field of QoS provisioning in WMN. Major approaches for provisioning QoS in WMN are Quality of service routing in Wireless Mesh Network (QUORUM) [3], Wireless Mesh Routing (WMR) Protocol [15] and Distributed End-to-End Allocation of Time Slots for Real-Time Traffic (DARE) Protocol. [11]

3.3.1 Quality of service routing in Wireless Mesh Network (QUORUM)

In QUORUM reactive route discovery mechanism is followed for routing. All the routers have a Flow Table and updated this table when any flow comes and reserve resources.

For admission control when any new flow comes and needs to reserve resources, first availability of resources is checked. If resources are available, flow is accepted then all the intermediate nodes between source and destination check the resources and maintain a flow table entry for particular flow. If there is no flow table entry for a particular flow, node sends error RREP message back to source to rediscover path.

QUORUM select more robust link for routing packets. Frequent "Hello" messages from neighbor in a specific time are counted for this purpose. If this number is greater than specific threshold it is considered as more robust link.

During the phase of route discovery, if source and destination are in connected through same mesh router then only those nodes receive topology control information served by that mesh router. If source and destination are connected through different mesh routers, then nodes served by these two mesh routers and all mesh routers in a network receive control information. Nodes receive control information from only robust neighbor.

For estimating end-to-end delay, during route discovery phase, when node receives RREP from receiver, it first sends stream of DUMMY packets along the path specified by RREP message. DUMMY packets have same size, data rate and priority as the actual packet has. Through this nodes estimate end-to-end delay. If the delay is under certain bounds, then source stars sending real-time actual stream of packets.

In QUORUM a node may not treat properly. It may utilize its neighbor's routes for routing its packets but not allow its neighbors to utilize its route and its neighbors route their packets by using other routes. This problem is solved in QUORUM, node only route packets of that neighbor having link quality higher then certain threshold calculated through "Hello" messages.

3.3.2 Wireless Mesh Routing (WMR) Protocol

For performing admission control process when any node wants to start transmission it first sends a route request packet to destination. Required information for bandwidth and delay constraint is embedded in this message. When any intermediate node receives route request packet, it checks availability of resources, if enough resources are available, a node adds a routing table entry and marked it as "explored". Destination after receiving Route request packet sends a reply to source. In this way source makes reservation.

For Route Discovery and Route Registration WMR makes use of frequent 'Hello" messages, contains information about number of hops that node is away from router, in order to discover a route. When source receive route reply message from destination, it starts sending data and the intermediate nodes check availability of resources again and then modify routing table entry from "explored" to "registered" and accepts flow.

If the destination node finds time-out for a particular reservation, it considered as route failure and initiates new route discovery towards a source of traffic.

3.3.3 Distributed End-to-End Allocation of Time Slots for Real-Time Traffic (DARE) Protocol

DARE proposed no particular routing strategy. It assumes that paths are already set up by following any routing mechanism (reactive or proactive) and DARE only concerned with provisioning of QoS along that path.
Source of traffic reserve a time slot along the path towards destination. This reservation is periodic and repeated after specific period of time. e.g. particular flow reserve link for 10 ms repeated after every 50 ms for 5 min.

When any node wants to sent data it first sent a Request to Reserve (RTR) message to receiver. This message contains the detail information of required resources. When any intermediate node receives RTR, it first checks availability of resources. If enough resources are available it makes an entry for that flow in its reservation table and mark it as "preliminary" and then forward RTR to other intermediate nodes. If not enough resources are available node does not forward RTR message. When receiver receives a RTR message it sends Clear To Reserve (CTR) message back to source and edit entry as "fixed" in reservation table. All the intermediate nodes starts RTR timer after forwarding RTR message and if no CTR message is received in that time period it considered as reservation time out and clear entry in reservation table. If no time slot is available for particular time at any intermediate node, information of next available time slot is sends back to source. When source node receives CTR message from destination it starts sending data along the reserved path.

In order to avoid interference of neighboring nodes along the reserved path, all the nodes adjacent to intermediate nodes involve in reservation also receive RTR and CTR messages and other reservation information about time slots. These adjacent nodes then do not transmit any flow during that reserved time-slot. For further minimizing the effect of interference intermediate nodes along the reserved path also avoid using time-slot made by nodes 2 hops away from reserved path.

3.4 Problem Formulation in detail

After understanding the above mentioned approaches, it becomes clear that these approaches have different mechanism for providing QoS to end users. All of above mentioned approaches use different parameters of QoS and all of above mentioned approaches give valuable performance when they used in a separate network and provide QoS solution in WMN.

From literature survey it becomes clear that different solution for provisioning QoS to real time applications in HWN and ad hoc network can't be used in WMN as it is and these approaches need huge modifications if we want to use it in WMN, when WMN is a part of heterogeneous network.

Both network (fixed topology and WMN) can connect with each other through gateway to form a heterogeneous network. When end-user in WMN wants to send data to a destination in fixed topology network, flows of traffic needs to cross domain. As both models have different specification in terms of service provisioning mechanism, availability of resources, mobility, power consumption, link capacity, bandwidth, average delay and routing mechanism. When any flow of packets cross the domain and reaches at gateway it is required that gateway also handle the packet in the same sense as it is handled in WMN and when packet enters in other network through gateway, it is impossible that packet automatically adopt the specification of other network. So that a particular mechanism is required at gateway that is compatible with QoS present at WMN and to properly map the flow coming from one network according to the specification of other network. Thus other network also treated separately the real time application and provide end-to-end QoS guarantee.

Real time applications require more throughputs then best effort applications, but when all the flows whether it is real time or best effort flows have same scheduling priority, throughput and quality of real time flows can be greatly affected.

3.5 Problem Scenario

When a source in WMN wants to start transmission, it sends its packet to its neighbor according to the specification of routing protocol. Source may have different type of applications. It can be real time application that require special treatment in terms of throughput, bandwidth, delay etc. from source to destination and needs that its packets should be reached at destination in proper time with less packet loss. Application can also generate best effort traffic that requires no special treatment and no guarantee for forwarding of its packets.

If there is no mechanism present for handling real time and best effort packets separately, routing protocol handles both type of traffic equally. So a special mechanism is necessary for handling packets separately. If there exists a mechanism in WMN for providing QoS to real time application, it is also necessary that gateway also have knowledge of it so that it also handle packets in the same sense and the solution for QoS provisioning at gateway should be compatible with WMN. When these packets reaches at gateway, gateway also handle both type of traffic in the same way and thus forward packets towards destination in fixed topology network in the same way.

The QoS solution in WMN is limited to nodes part of WMN and when these packets reaches at gateway enters in fixed topology network it also require quality of service. If there exists any solution for providing QoS to real time application gateway is unaware of it and it simply forward all packets as best effort packets, So all the real time packets also treated as best effort traffic while travelling through fixed topology network. So from gateway to its destination it may face many problems including packet loss due to congestion, may suffer from interference effect and thus quality of service required by end users is not fully accomplished. So a mapping mechanism required at gateway so that gateway map the flows coming from WMN according to the specification of fixed topology network to provide end-to-end QoS guarantee.

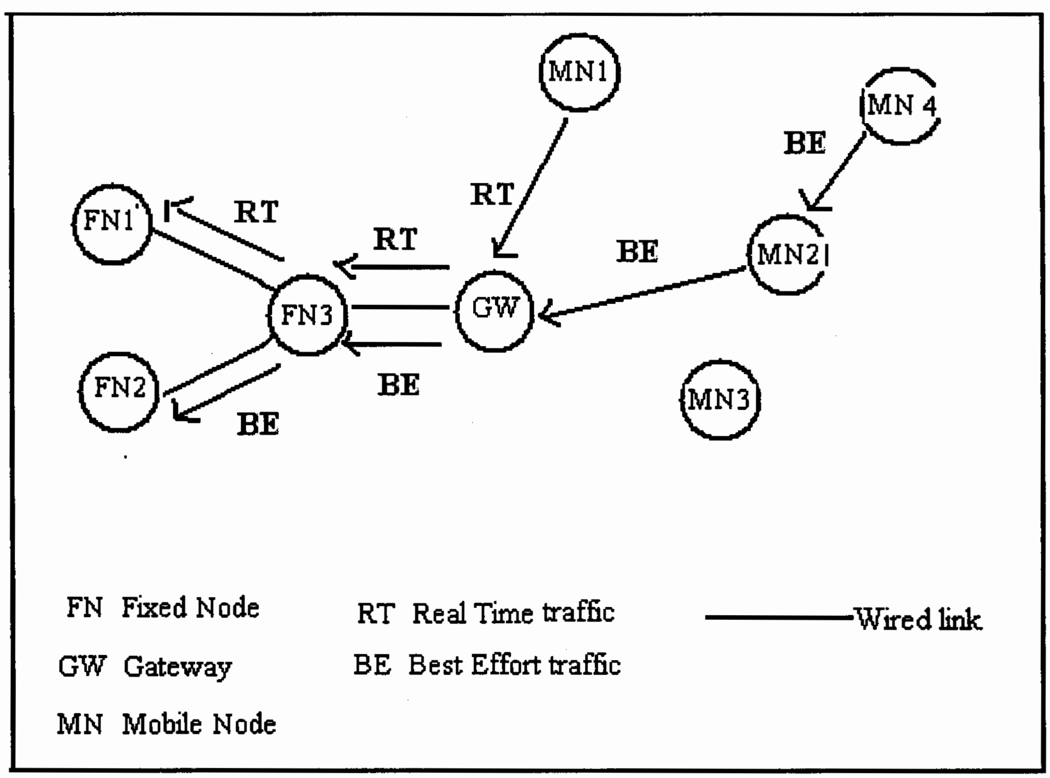

Figure 3.1 Problem scenario

Figure 3.1 shows our problem scenario. Nodes FN1, FN2, FN3 forms a fixed topology network and having direct links and FN3 is connected with gateway (GW) through a direct link. Nodes MN1, MN2, MN3, and MN4 form WMN. MN1 and MN4 are mobile nodes. MN1 is a real time source and sends real time packets towards a destination (FN1) in a fixed topology network through gateway while MN4 is a best effort source and sends best effort packets towards a destination (FN2) in fixed topology network through gateway.

When both the sources MN1 and MN4 start sending packets simultaneously, there is a load of both type of traffic on gateway. Gateway treated both type of traffic equally and if there are more best effort reached at gateway, it forward most of the time only best effort packets which causes more delay in forwarding of real time packets from gateway so throughput of real time flows decreases and destination receives less number of packets in more time.

A mechanism is required at gateway so in spite of more load of best effort packets on gateway, it sent real time packets properly so that destination of real time application receives packets in time and according to specification of fixed topology network.

3.6 Problem Statement

A special mechanism is required at gateways for mapping. This QoS solution at Gateway should be compatible with both the QoS solution present in WMN and fixed topology network. When a real time flow coming from WMN, it should be treated seperatly and when it reaches at gateways its QoS parameter properly mapped according to its requirement at gateway. Bandwidth assigns to it according to its type, and time slots reserved for scheduling it to meet its requirement at gateway. Also from gateway to destination in fixed topology network bandwidth is assigned to it according to real time application requirement. In this way quality of service required by end user is completely fulfill. This mechanism increase throughput of flows at gateway and also increases throughput at final destination in fixed topology network.

Chapter 4

Proposed Solution

4 Proposed Solution

4.1 Introduction

Our proposed solution to the problem defined in chapter 3 is to develop a mechanism to properly map QoS parameter between fixed topology network on one side of gateway and WMN QoS model on other side of gateway. Our solution is light weight solution that requires implementing only necessary functionalities over WMN and for QoS mapping at gateways and so not imposing extra load on gateways. Our solution provide end-to-end QoS guarantee and increases throughput at gateway and also at final destination. Section 4.2 gives proposed solution in detail.

4.2 Proposed Mechanism

Our proposed solution implemented on following type of topology.

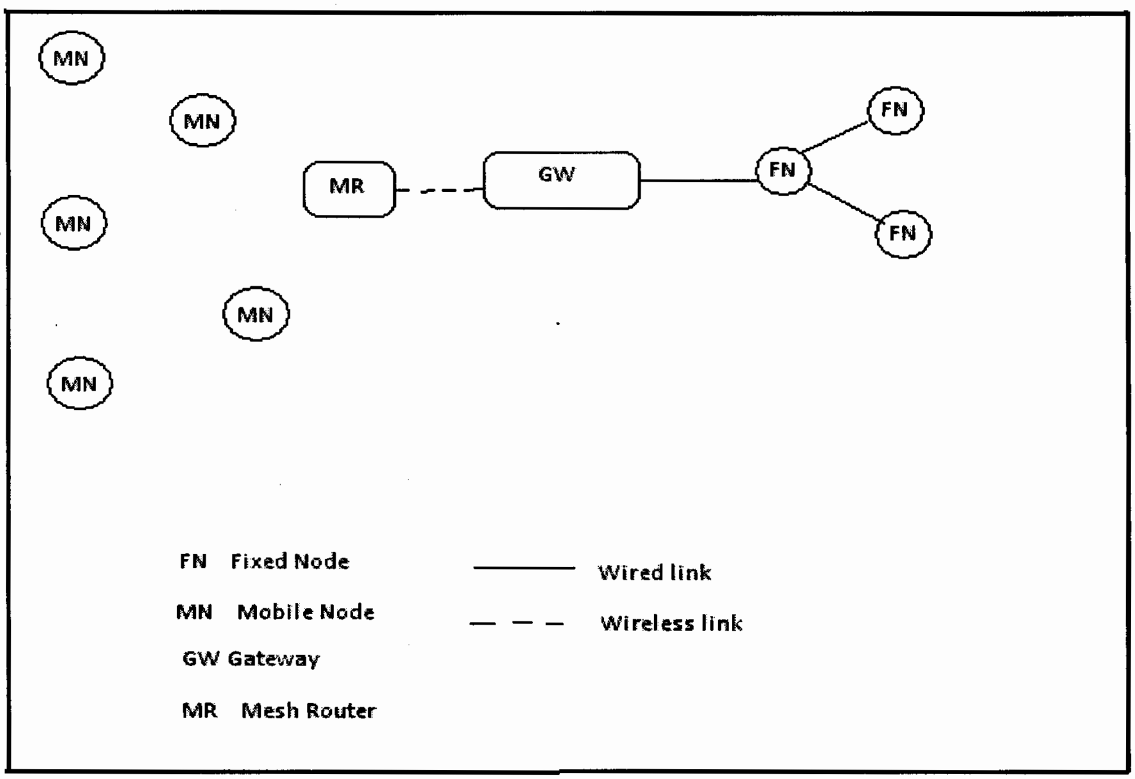

Figure 4.1 Topology for Proposed mechanism

Our proposed solution can be divided into two parts.

- Implementing Time slot scheduling mechanism for real time traffic on WMN
- Mapping procedure for time slot at gateways and forwarding traffic towards wired network

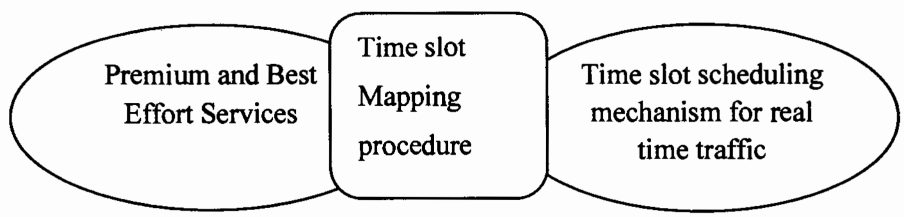

Figure 4.2 Proposed mechanism scenario

4.2.1 Implementing Time slot scheduling mechanism for real time traffic on WMN

Our proposed solution has no concern with routing over WMN i.e how packets are routed along paths and how different routes are selected for flows. As it is described in our literature survey that Reactive routing is more suitable for WMN, so we select AODV+ as our routing protocol. Our proposed solution presents a time slot scheduling mechanism for provisioning QoS provision for real time traffic. In normal procedure packets, both best effort and real time, buffered in a queue on source node as well as intermediate node and waiting for forwarding towards destination. Packets sent from queue one by one as they come to the head of the queue without considering that whether it is real time or best effort packet.

In our proposed solution we present a time slot scheduling mechanism for handling real time traffic separately and thus give more priority to real time flows for providing QoS to real time packets.

When source node wants to communicate with node resides in fixed topology network and receives RREP from gate way, source first checks its sending buffer, As source can also act as intermediate node for flows coming from other nodes so its sending buffer consist of different type of packets. It can be best effort packets, Real time packets and Control packets. The main aim behind our proposed mechanism for QoS providing over WMN is that Real time packets resides for minimum time in Queue. When source node checks its sending buffer and according to requirement of application make search for packets for a particular destination. In normal procedure source node checks packets in sending buffer and as it found packet, simply forward it one by one without considering its type. Our proposed solution treated best effort packets and real time packets separately. We chose one best effort source and one real time source. Source first check sending buffer for a packet of particular destination and at the same time it checks type of packet.

In order to give more priority to real time packets a large time slot is reserved for forwarding packets from queue. During this time slot source checks packet type and only forwards real time packets, and time other then this time slot source sends other best effort packets. All the intermediate nodes till the gateway follow same procedure until the packet reaches gateway. In this way destination receives more real time packets in less time than normal dequeue procedure and so increase end-to-end throughput for real time packets.

Figure 3.3 shows an example queue having Real time (RT) and Best Effort packets (BE) and their respective position in Queue. Packet position at number 1 represents Head of the queue and Packet position at number fourteen shows tail of the queue and it is assumed that queue can hold maximum fourteen packets at any given time. If ten packets leave queue and forwarded to their destination in 10ms then by following normal dequeue procedure five real time and five best effort packets forwarded to destination and so particular destination for real time traffic receives five packets in 10ms. So the number of packets forwarded to real time and best effort traffic destination are equal.

In our proposed solution when first search for a packet of particular destination requested by application is performed and at the same time search for real time packets for a particular destination is performed. In this way in first 10 ms eight real packets forwarded to destination so eighty percent time of first ten milliseconds is reserved for real time traffic and for the rest of twenty percent time best effort traffic will be forwarded to its respective destination. In this way destination receives more real time packets in less time and throughput is increased.

Head ↓ **Tail** ↓

Packet Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Packet Type	RT	BE	BE	RT	RT	BE	BE	BE	RT	RT	RT	RT	BE	RT

Figure 4.3 Example queue with respective position of packets

4.2.2 Mapping procedure for scheduling time slot at gateway and forwarding traffic towards wired network

We are using AODV, a reactive routing protocol for routing in our implementation. As in AODV a path is established from source to destination when it is required by application. Source receives a RREP from destination which indicates that a route is available and then source starts sending data towards destination by following the path reserved through RREQ-RREP process.

As wired and wireless network differs in their topological structure, availability of bandwidth, method of handling traffic etc. If the source of wireless network wants to communicate with node exists in wired or fixed topology network, it is not possible for destination to receive RREQ from source and thus source does not receive RREP. In this case the entire communication take place between wireless and wired network through gateway, so instead of communicating directly with wired node, source all its data towards gateway and then gateway forwards this traffic towards wired node.

As on one side, gateway is communicating with a node part of WMN so because of our proposed mechanism, from WMN gateway receives more real time data packets then best effort data packets. In our proposed solution, we implement same procedure for exiting of data packets placed in the sending buffer of gateway. Gateway is connected to fixed node on the other side of network. When gateway receives any packet from WMN, it checks type of packet that is either it is real time data packet or best effort packet.

Real time data packets required more bandwidth and assured forwarding where as best effort packets requires low bandwidth and no tight bound for its forwarding so for effectively routing over wired network, in our proposed solution we use premium forwarding for real time data packets and best effort forwarding for best effort traffic.

In our proposed solution for premium forwarding we assign more bandwidth to real time data packets and in case of congestion on the node in wired network less possibility of dropping of real time data packets. For best effort traffic we assigns less bandwidth to best effort packets and as best effort packets requires no specific guarantee for their forwarding so in case of congestion on node placed in wired network instead of dropping of real time packets, best effort packets will be dropped.

When gateway checks the type of packet it recently receive and found that it is real time data packet then assigns it premium forwarding and so real time data packets can utilize more bandwidth having more guarantee for delivery of packets at the destination and at the same time by our modified procedure of exiting of packets from sending buffer at gateway, gateway sends more real time packets toward node of wired network. Hence destination receives more real time packets in minimum time. In this way real time data packet receives more quality of service while travelling through source to destination.

Figure 3.4(a) shows initial positions of nodes at t=5 sec when mobile node1 MN1 is moving and sending data packets to fixed node FN1 through gateway (GW) . MN1 is a real time source and generates real time traffic. At this stage as no other communication take place between any other two nodes and so less load on gateway and gateway effectively forwards packets to destination. Queue consists of only real time data packets as shown in figure 3.4(b). Queue size is 20 and figure shows 14 packets in queue.

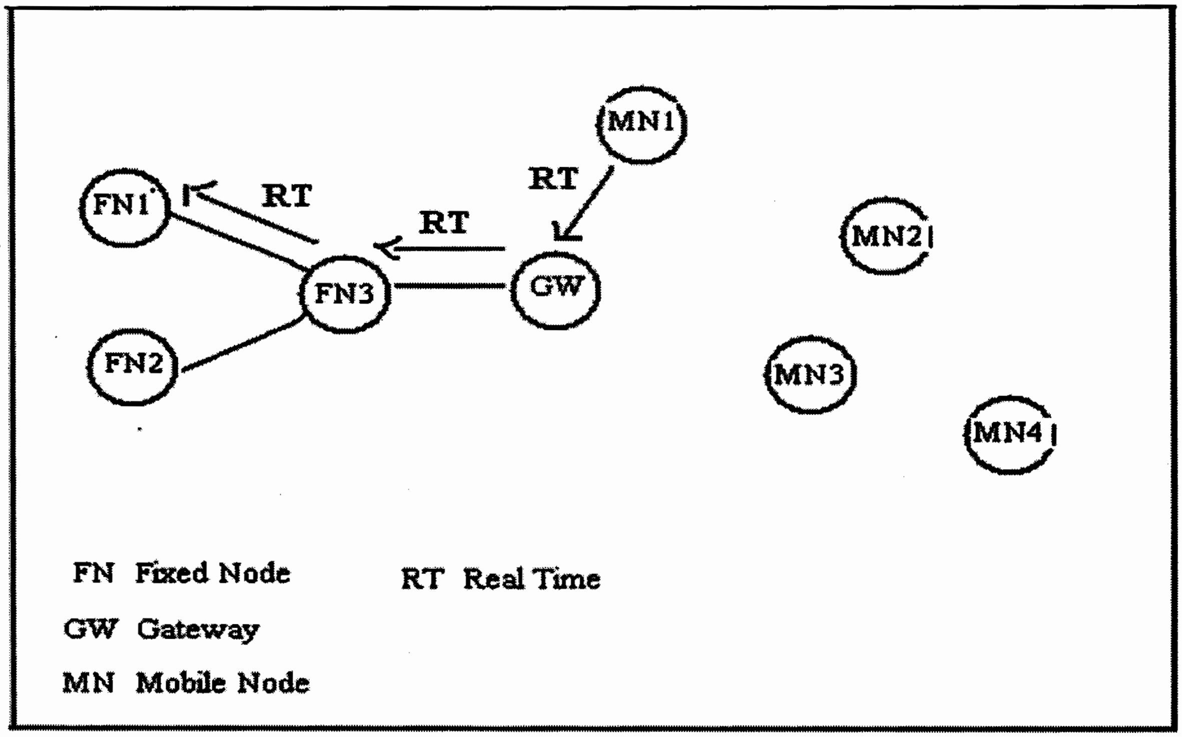

Figure 4.4(a) Node position at t=5 seconds

Head ↓ **Tail** ↓

Packet Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Packet Type	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT

Figure 4.4(b) Queue position at t=5 seconds

Figure 3.5(a) shows position of nodes at t=20 sec when mobile node MN4 is also moving and sending packets towards fixed node FN2 through gateway (GW). MN4 generates best effort traffic. At this stage both type (real time and best effort) of traffic pass through gateway towards fixed destinations, So gateway apply mapping procedure and sends more packets towards real time destination than best effort packets.

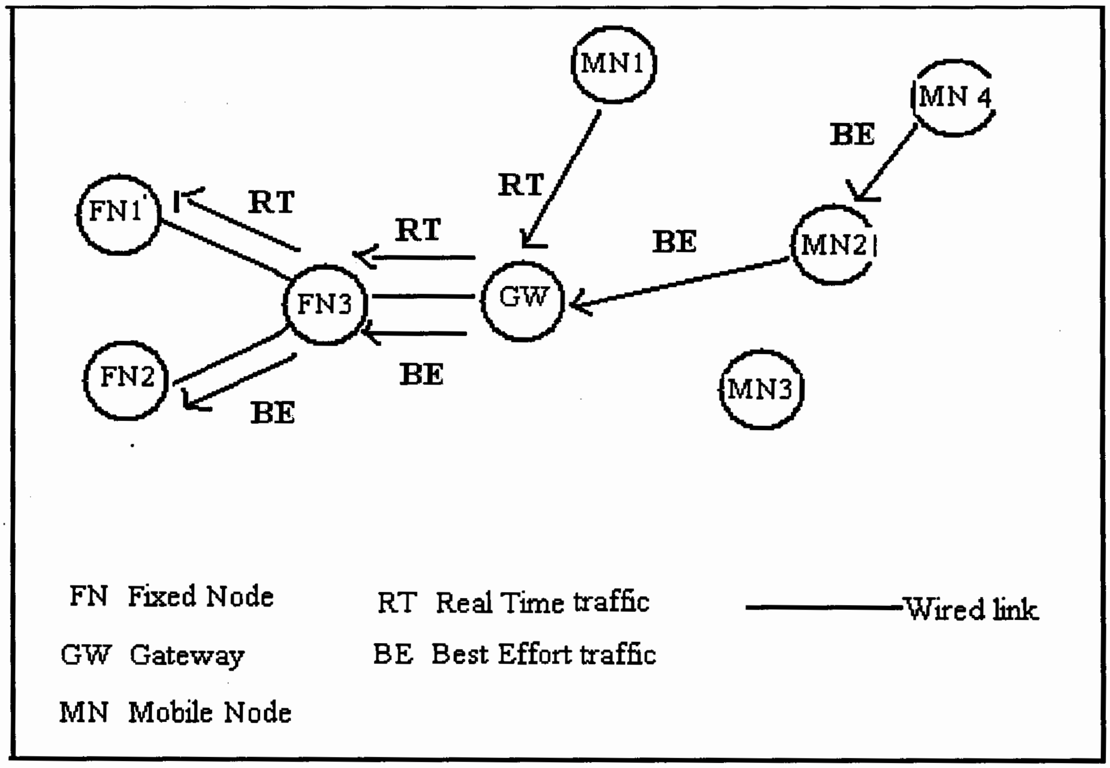

Figure 4.5(a) Node position at t=20 seconds

Figure 3.5 (b) shows queue position at t=20 seconds when queue consists of both the real time and best effort packets. Without performing mapping at gateway, in first 10 ms four real time and six best effort packets will be forwarded and low bandwidth will be assigned to it. After applying mapping for each 10 ms, for 8 ms real time packets will be forwarded and in this way eight real time packets will be forwarded in the same time and more bandwidth will be assigned to it.

Head ↓ **Tail** ↓

Packet Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Packet Type	BE	RT	BE	BE	RT	BE	BE	RT	RT	BE	RT	RT	RT	RT

Figure 4.5(b) Queue position at t=20 seconds

Chapter 5

Implementation

5 Implementation

5.1 Introduction

This section describes implementation detail of our proposed solution. Section 5.2 describe the simulation tool we used in our simulation and then why we select this tool. Section 5.3 describes our topological scenario, addressing scheme for assigning IP addresses to both wired and wireless nodes and traffic generating application used in our simulation process. Section 5.4 describes NS-2 setting and configuration parameters used in our simulation. Section 5.5 describes our performance metrics. Section 5.6 provides detail of Simulation results. Section 5.7 analyses the whole performance.

5.2 Use of Network Simulator (NS-2.34)

We are using Network Simulator (NS-2.34) [18] for our simulation process. We mainly selected NS-2 because

- NS-2 is the most commonly used simulator for wireless simulations. NS-2 is Linux based and it can be downloaded very easily from internet and as it is an open source software so modification can be made in it for improvements of different simularions

- Extensions in different wireless routing protocols for their performance improvements can be made easily in NS-2 after thorough understanding of NS-2 environment.

- As most of the QoS aware routing mechanisms were simulate by using NS-2 so we also use it for better performance comparison. As AODV+ is also implemented using NS-2.

The Network Simulator (NS-2) is a discrete event simulator developed by the University of California at Berkeley. It provides substantial support for simulation of unicast routing, and multicast routing and QoS routing protocols over wired and wireless (local and satellite) and Wired-cum-wireless networks. The Monarch research group at Carnegie-Mellon University developed support for simulation of multi-hop wireless networks complete with physical, data link, and medium access control (MAC) layer models on NS-2. It provides tools for generating data traffic and node mobility scenario patterns for the simulation.

NS-2 provides a split-programming model. The simulation kernel is implemented using C++, while the Tcl scripting language is used to express the definition, configuration and the control of the simulation. This split-programming approach has proven benefits over conventional programming methods. Also, NS-2 can produce a detailed trace file and an animation file called nam file for each network simulation that is very convenient for analyzing the protocol behavior.

5.3 Wired-cum-Wireless topology

Our topological scenario consists of both wired and wireless nodes and all the communications between wireless and wired nodes take place through gateway. So we used wired-cum-wireless topological configuration for our simulation process. Our topology consists of three wired nodes, one gateway and five wireless nodes.
Wired nodes exchange information among themselves based on their topological structure i.e. how nodes are connected to one another through links. However there is no concept of links in wireless network. Packets are routed in wireless topology using their routing protocols which build forwarding tables by exchanging routing information among neighbors. In order to route packets between wired and wireless nodes, in ns-2 the whole topology is divided into different domains. Hierarchical addressing scheme is used here to assign IP address to nodes.

We used two traffic generation applications in our simulation process. One of the traffic generating application uses constant bit rate (CBR) to simulate Real time flows, whereas other application uses TCP connection that simulate FTP to simulate best effort traffic. As TCP generate Best Effort traffic that does not require any service quality.

5.4 NS-2 setting and parameters

Table 4.1 shows complete detail of NS-2 node parameter setting which is used to configure our topological scenario.

X dimension of topology	500
Y dimension of topology	500
Routing protocol	AODV
Link layer type	LL
MAC type	Mac/802_11
Interface Queue	Queue/Drop Tail/PriQueue
Maximum packets in Ifq	50
Antenna model	Antenna/Omni Antenna
Radio propagation model	Propagation/Two Ray Ground
Network Interface	Phy/WirelessPhy
Channel type	Channel/Wireless Channel
Gateway discovery method	Reactive
Number of fixed nodes	3
Number of mobile nodes	5
Number of Gateway	1
Simulation time	40 seconds

Table (5.1) Configuration of node parameters

As Gateway acts between wired and wireless domains so gateway also require wired routing mechanism. This is done by setting node-config option –wiredRouting ON. After creating the gateway node, reconfigure this option as –wired Routing OFF for wireless nodes. All other node-config options used for gateway remains same as of wireless nodes.

5.5 Performance metrics

In order to check the performance of our proposed mechanism we have used following metrics.

Average Throughput

Throughput is the total number of packets received successfully in the given time. Due to varying load from other users sharing the same network resources, the bit-rate (the maximum throughput) that can be provided to a certain data stream may be too low for real time multimedia applications if all data streams get the same scheduling priority for forwarding in WMN. We will check the throughput at gateway and also at final destination.

5.6 Simulation Results

We will compare the performance of our proposed mechanism with basic AODV+. First of all basic AODV+ is run on given WMN scenario in NS-2 and different performance parameters are calculated and results are generated in graphical form produced by using trace files. After this our proposed mechanism of time slot and mapping is implemented on AODV+ and results are produced in graphical form and then a comparison is performed between the two graphs.

We simulated the results in NS2 by taking parameters (pause time) on X-axis and performance metric (throughput) on Y-axis.

The pause time is the time interval during which different parameters are calculated .In the figure below at equal intervals the throughput is calculated as shown in figures.

Performance Comparison:

Throughput at Gateway:

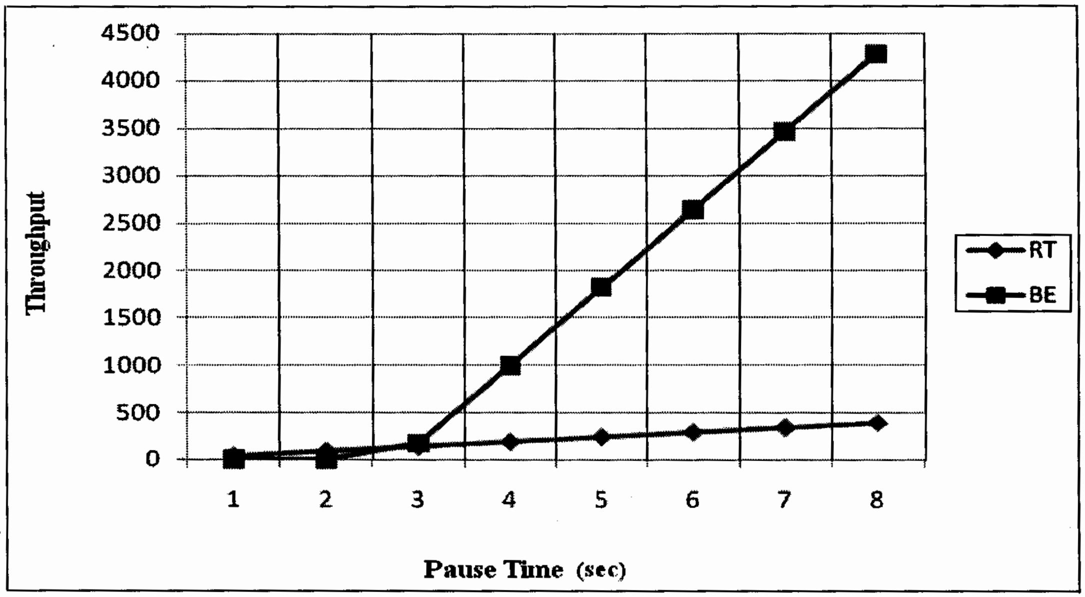

Figure 5.1 Throughput VS pause time of basic AODV+

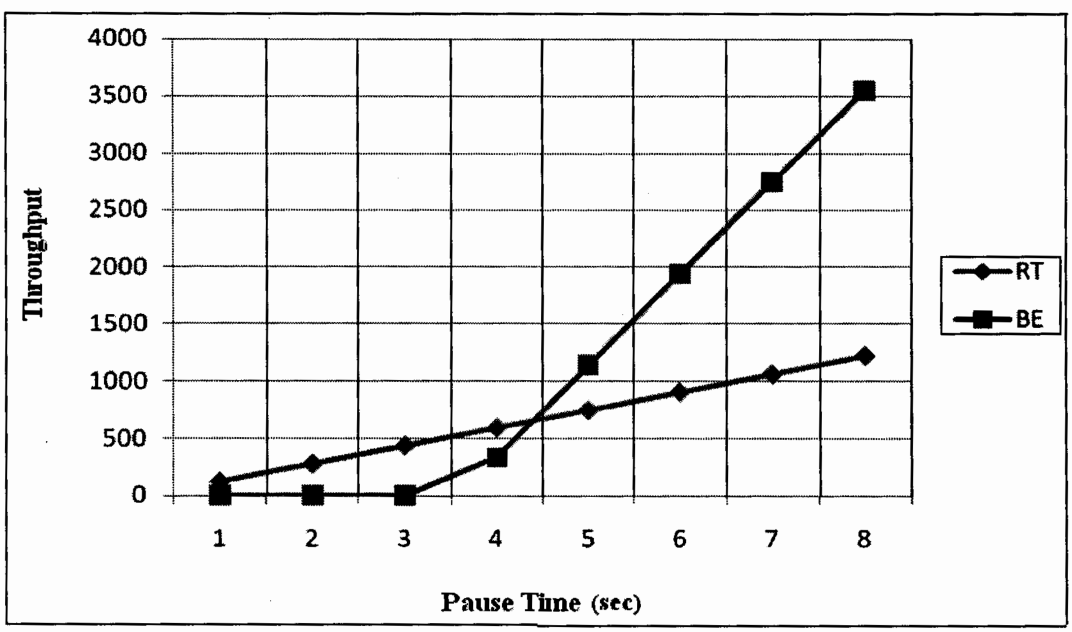

Figure 5.2 Throughput Vs Pause time of modified AODV+

Figure 5.1 shows throughput at gateway of basic AODV+. Throughput of Real time packets is much less then throughput of Best effort packets. In the start of simulation at pause time 15 seconds throughput of both real time and best effort packets are equal but after this throughput of best effort packets increased significantly.

Figure 5.2 clearly shows the difference of performance between basic AODV+ and my modified AODV+ with time slot mechanism. Throughput of real time packets increased significantly as the pause time increases. Throughput of our proposed time slot mechanism for real time packets is higher than the throughput of basic AODV+. Due to time slot mechanism real time packets also uses bandwidth effietently. It clearly shows that our proposed mechanism shows good performance for real time packets.

Throughput at destination before and after mapping:

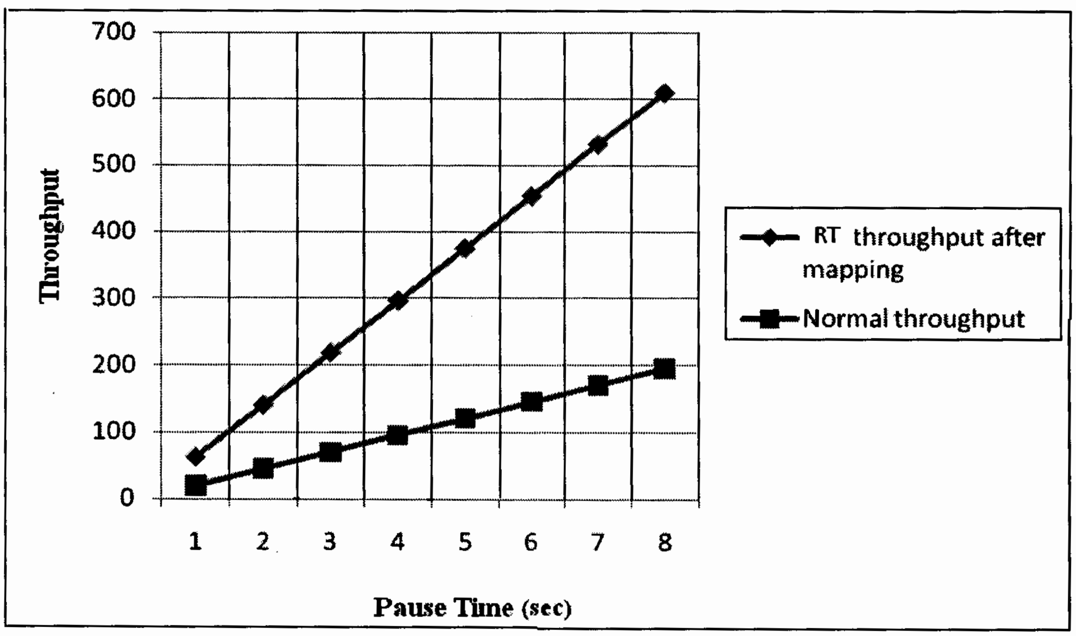

Figure 5.3 Throughput Vs pause time at destination before and after mapping

Figure shows a comparison between Throughput of real time packets at destination in wired network of basic AODV+ and after mapping and time slot mechanism at gateway. It is clear from figure that throughput of real time packets increases significantly as the pause time increases when mapping and time slot mechanism is applied at gateways and reaches at its highest level at pause time=40 seconds. It becomes clear that our proposed mechanism shows good performance in case of longer real time transmission from start to end.

5.7 Analysis of Performance

After analyzing the performance of basic AODV + and modified AODV+, it becomes clear that our modified AODV+ shows greater performance for real time transmission. Throughput is very important performance metric for real time transmission. In our proposed mechanism when we reserve a slot of time for real time transmission, real time data packets use shared bandwidth effectively and so more packets reached at gateway.

In basic AODV as the pause time increases the throughput of real time transmission decreased. In our modified AODV+ throughput for real time transmission is significantly increased so our modified AODV+ shows good performance when real time transmission continues over longer period of time. Because of this throughput of best effort transmission is slightly decreased but this decrement in throughput for best effort does not affect it.

After performing all this analysis it is proven that our modified AODV+ uses bandwidth more efficiently and is more suitable for real time transmission continues over longer period of time and duration of real time transmission does not affect the quality of transmission.

Chapter 6

Conclusion and Future Work

. Conclusion

In this chapter achievements in form of what we really succeed in doing and then some concluding marks are given and then and the highlight some future work.

6.1 Conclusion

We propose a mechanism to provide QoS guarantee to real time application when source of traffic is in WMN and destination is in fixed topology network. We develop a mechanism to handle real time flows in WMN by reserving a time slot for forwarding. During this time slot only real time packets are forwarded towards a gateway. Reservation is based on the number of real time packets placed in a sending buffer at any given time. Along with searching for packets for particular destination in sending buffer, packet type is also considered and tries to send more real time packets towards gateway. The same mechanism is also extended for mapping at gateway and gateway also handle real time flows separately and at the same time forward real time packets towards the destination according to the specification for handling real time flows in fixed network. This is an efficient technique for providing end-to-end QoS guarantee to real time application when packets are forwarded through networks having different architecture and specifications. Our proposed mechanism shows good performance for flows continues for longer period of time and increases throughput at gateways and also increases throughput at the final destination Simulation results validate the performance of our proposed mechanism.

6.2 Achievements

- In thesis first we did a deep analysis about existing QoS solution for WMN to know about what are the limitations of these solutions when WMN is used in HWN and what type of routing is more suitable for WMN and as we are considering heterogeneous network so analyze some models for HWN. After studying about this we highlight that QoS mapping is very essential in QoS aware routing in HWN.
- After studying literature we find out that a mechanism is required that handle real time flows throughout the heterogeneous network when source of traffic is in WMN and its destination is in fixed topology network.

- We propose a mechanism to provide QoS guarantee to real time application when source of traffic is in WMN and destination is in fixed topology network. We develop a mechanism to handle real time flows in WMN by reserving a time slot for forwarding of real time flows.

- The same mechanism is also extended for mapping at gateway and gateway also handle real time flows separately and at the same time forward real time packets towards the destination according to the specification for handling real time flows in fixed network.

- This is an efficient technique for providing end-to-end QoS guarantee to real time application when packets are forwarded through networks having different architecture and specifications.

- Our proposed mechanism shows good performance for flows continues for longer period of time and increases throughput at gateways and also increases throughput at the final destination.

6.3 Future work

Here throughput of real time traffic is increased after modifying existing forwarding mechanism. Throughput can also be further increased by considering the delay parameter.

Our proposed solution handles flows when source is in WMN and destination is in fixed topology. It can be enhance for flows having source in fixed topology and destination is in WMN.

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Appendix

Appendix

Simulation code used in simulation process using NS-2 is given below with files names.

Queue.h

```
#ifndef __aodv_rqueue_h__
#define __aodv_rqueue_h_

//#include <packet.h>
#include <ip.h>
#include <agent.h>

/*
 * The maximum number of packets that we allow a routing protocol to buffer.
 */
#define AODV_RTQ_MAX_LEN     64      // packets

/*
 *  The maximum period of time that a routing protocol is allowed to buffer
 *  a packet for.
 */
#define AODV_RTQ_TIMEOUT     30       // seconds

class aodv_rqueue : public Connector {
 public:
      aodv_rqueue();

      void          recv(Packet *, Handler*) { abort(); }

      void          enque(Packet *p);

         inline int     command(int argc, const char * const* argv)
           { return Connector::command(argc, argv); }

      /*
       *  Returns a packet from the head of the queue.
       */
      Packet*        deque(void);

      /*
       * Returns a packet for destination "D".
       */
      Packet*        deque(nsaddr_t dst);
  /*
```

```
 * Finds whether a packet with destination dst exists in the queue
 */
    char        find(nsaddr_t dst);

private:
    Packet*      remove_head();
    void        purge(void);
      void           findPacketWithDst(nsaddr_t dst, Packet*& p, Packet*& prev);
      bool           findAgedPacket(Packet*& p, Packet*& prev);
      void           verifyQueue(void);

    Packet       *head_;
    Packet       *tail_;

    int         len_;

    int         limit_;
    double       timeout_;

};

#endif /* __aodv_rqueue_h__ */
```

Queue.cc

```
#include <assert.h>

#include <cmu-trace.h>
#include <aodv/aodv_rqueue.h>

#define CURRENT_TIME    Scheduler::instance().clock()
#define QDEBUG

/*
  Packet Queue used by AODV.
*/
int i=1;

aodv_rqueue::aodv_rqueue() {
  head_ = tail_ = 0;
  len_ = 0;
  limit_ = AODV_RTQ_MAX_LEN;
  timeout_ = AODV_RTQ_TIMEOUT;
```

```
}

void
aodv_rqueue::enque(Packet *p) {
struct hdr_cmn *ch = HDR_CMN(p);


 /*
  * Purge any packets that have timed out.
  */
 purge();

 p->next_ = 0;
 ch->ts_ = CURRENT_TIME + timeout_;

 /*
  * The maximum number of packets that we allow a routing protocol to buffer:
  * limit_ = AODV_RTQ_MAX_LEN = 64 packets
  */
 if (len_ == limit_) {
 Packet *p0 = remove_head();          // decrements len_

   assert(p0);
   if(HDR_CMN(p0)->ts_ > CURRENT_TIME) {
     fprintf(stderr, "%d - DROP_RTR_QFULL uid=%d\n",HDR_IP(p0)->saddr(),
             HDR_CMN(p0)->uid());
     drop(p0, DROP_RTR_QFULL);
   }
   else {
     fprintf(stderr, "%d - DROP_RTR_QTIMEOUT uid=%d\n",HDR_IP(p0)->saddr(),
             HDR_CMN(p0)->uid());
     drop(p0, DROP_RTR_QTIMEOUT);
   }
 }

 if(head_ == 0) {
   head_ = tail_ = p;
 }
 else {
   tail_->next_ = p;
   tail_ = p;
 }
 len_++;
#ifdef QDEBUG
   verifyQueue();
```

Appendix

```
#endif // QDEBUG
}


Packet*
aodv_rqueue::deque() {
Packet *p;

 /*
  * Purge any packets that have timed out.
  */
 purge();

 p = remove_head();
#ifdef QDEBUG
 verifyQueue();
#endif // QDEBUG
 return p;

}


Packet*
aodv_rqueue::deque(nsaddr_t dst) {
Packet *p, *prev;

 /*
  * Purge any packets that have timed out.
  */
 purge();

// if(i%10 == 0){
 findPacketWithDst(dst, p, prev);
// i=i+1;

 assert(p == 0 || (p == head_ && prev == 0) || (prev->next_ == p));

 if(p == 0) return 0;

 if (p == head_) {
   p = remove_head();
 }
 else if (p == tail_) {
   prev->next_ = 0;
   tail_ = prev;
```

```
  len_--;
 }
 else {
  prev->next_ = p->next_;
  len_--;
 }

#ifdef QDEBUG
 verifyQueue();
#endif // QDEBUG
 return p;
//}
//else
//{
 //return 0;
//}

}

char
aodv_rqueue::find(nsaddr_t dst) {
Packet *p, *prev;

 findPacketWithDst(dst, p, prev);
 if (0 == p)
  return 0;
 else
  return 1;

}




/*
  Private Routines
*/

Packet*
aodv_rqueue::remove_head() {
Packet *p = head_;

 if(head_ == tail_) {
  head_ = tail_ = 0;
 }
```

Appendix

```
else {
  head_ = head_->next_;
}

if(p) len_--;

return p;

}

void
aodv_rqueue::findPacketWithDst(nsaddr_t dst, Packet*& p, Packet*& prev) {


  p = prev = 0;
  for(p = head_; p; p = p->next_) {
        //              if(HDR_IP(p)->dst() == dst) {
        if(i%5 == 0){
            if(HDR_IP(p)->daddr() == dst) {

         return;
   }
  }
   else
  {

   if(HDR_IP(p)->daddr() == dst && HDR_CMN(p)->ptype()== PT_UDP) {
   return;
  }
   }
   i=i+1;
   prev = p;
  }
}


void
aodv_rqueue::verifyQueue() {
Packet *p, *prev = 0;
int cnt = 0;

 for(p = head_; p; p = p->next_) {
  cnt++;
  prev = p;
 }
```

Appendix

```
assert(cnt == len_);
assert(prev == tail_);

}


/*
void
aodv_rqueue::purge() {
Packet *p;

 while((p = head_) && HDR_CMN(p)->ts_ < CURRENT_TIME) {
   //. assert(p == remove_head());
   p = remove_head();
   drop(p, DROP_RTR_QTIMEOUT);
 }

}
*/

bool
aodv_rqueue::findAgedPacket(Packet*& p, Packet*& prev) {

  p = prev = 0;
  for(p = head_; p; p = p->next_) {
    if(HDR_CMN(p)->ts_ < CURRENT_TIME) {
      return true;
    }
    prev = p;
  }
  return false;
}

void
aodv_rqueue::purge() {
Packet *p, *prev;

 while ( findAgedPacket(p, prev) ) {
        assert(p == 0 || (p == head_ && prev == 0) || (prev->next_ == p));

        if(p == 0) return;

        if (p == head_) {
                p = remove_head();
        }
```

```
        else if (p == tail_) {
                prev->next_ = 0;
                tail_ = prev;
                len_--;
        }
        else {
                prev->next_ = p->next_;
                len_--;
        }
#ifdef QDEBUG
        verifyQueue();
#endif // QDEBUG

        p = prev = 0;
 }

}
```

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Dear Ms. Jabeen,

Re: 724-021 CROSS DOMAIN QoS MAPPING BETWEEN WMN AND FIXED TOPOLOGY FOR END-TO-END QoS GUARANTEE.

Congratulations, your paper has been accepted for oral presentation and publication at the IASTED International Conference on Parallel and Distributed Computing and Systems (PDCS 2010), to be held from November 08, 2010 to November 10, 2010, in Marina Del Rey, USA. We cordially invite you to attend and present your paper at the conference. We also encourage you to register and book your flight as soon as possible, if you have not already done so.

Please complete the following by the registration deadline of September 27, 2010.

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Once again, congratulations on your PDCS 2010 acceptance. We are very excited to be able to include your research and ideas in the conference, and we look forward to seeing you in Marina Del Rey, USA.

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CROSS DOMAIN QoS MAPPING BETWEEN WMN AND FIXED TOPOLOGY FOR END-TO-END QoS GUARANTEE

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ABSTRACT
Wireless Mesh Network is a communication network made up of radio nodes organized in a mesh topology. It is expected that WMN to have the ability to support the new generation of streaming-media applications. We propose a time slot scheduling mechanism to provide end-to-end QoS guarantee to real time flows having destination in fixed topology. Our proposed mechanism reserves a time slot for forwarding of real time flows through WMN and also at gateway. Gateway then forwards packets according to specification of real time flows in fixed topology network. This is an efficient technique that increases throughput of real time flows continue for longer period of time. Gateway and final destination receive more real time packets in the same time. When pause time increases and load of best effort traffic increases, throughput of real time packets does not affected so much by more load best effort traffic and thus quality of real time transmission is improved.

KEY WORDS
Wireless mesh networks, Quality of Service, fixed topology, algorithms for heterogeneous system.

1. Introduction

Wireless Mesh Network (WMN) is a communication network made up of radio nodes organized in mesh topology. In WMN, nodes can communicate with one another via multi-hop routing and forwarding.WMN can self organize, self configure and self heal themselves. WMN is a type of Ad Hoc Network but, because of its easy network maintenance, robustness, reliable service coverage, WMN expands the capabilities of Ad hoc networks. These characteristics enable its flexible integration, quick deployment, easy maintenance and its ability of capacity enhancement, connectivity and throughput. In addition to mesh networking among mesh router and mesh client, the gateway functionalities in mesh router enable the integration of WMN with various types of other networks. [1], [2]

As deployment of WMN continues to grow, it is expected that these networks to have the ability to support the new generation of streaming-media application, such as Voice over IP (VoIP) and video on demand. To support next generation application with real time requirements WMN must provide improved and strong Quality of Service (QoS) guarantees. [3]

Services can be provided to users at different levels with different capabilities. [4] Network provides guarantee of delivery of services equal to or better than the requested services by user, guarantee of delivery of requested services for certain percentage of traffic over some specific period of time, provide services requested by users but with no guarantee or all flows treated equally.

QoS provisioning in wireless mobile networks is quite a challenging task as compared to wired network because architecture of wireless mobile networks having many difficulties associated with it. [5] Difficulties including poor communication system in multi-hop wireless networks, interference and multi-path fading effects, absence of centralized control in WMN, network heterogeneity present in WMN and diverse nature of application make provision of QoS very complicated.

In WMN it is default requirement to support network access for both conventional and mesh clients, so special type of gateways are required for this purpose that connects wire-line and wireless network in an efficient manner. Some of the major QoS solutions for fixed topology are Integrated services [4] Differentiated services [6] and Integrated service operation over differentiated services network [7]. While for WMN some major solutions are Quality of Service in Wireless Mesh Networks (QUORUM) [3], QoS Routing for Mesh-Based Wireless LANs (WMR) [7] and Distributed Allocation of time slots for real-time traffic in a wireless multi-hop network (DARE) [8].

Due to varying load from other users sharing the same network resources, the bit-rate (the maximum throughput) that can be provided to a certain data stream may be too low for real time multimedia applications if all data streams get the same scheduling priority for forwarding in WMN.

Differences of QoS solutions present on both side of gateway impose various challenges on its design. Different QoS solution may have different QoS parameters. These parameters needs mapping at gateways to provide homogenous solution for effective end-to-end communication.

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The main focus of this research work is to propose a mechanism to provide end-to-end QoS guarantee to real time application when source of flow is in WMN and destination is in fixed topology network. First a mechanism is proposed to give more scheduling priority to real time application when packets are forwarded from source to gateway then enhance it for mapping at gateways to treat real time application in the same way. Further through this mapping mechanism, gateway sends packets towards destination in fixed network according to specification of fixed network to increase throughput of real time applications.

The rest of the paper is organized as follows: Literature survey and problem formulation is presented next section. Then the solution and design methodology is presented and after that simulation results and performance analysis is presented and at the end conclusions drawn from simulation experiments is given.

2. Related Work

A lot of research has been done to solve QoS provision problems related to routing in WMN when both source and destination are in WMN. Some research efforts are made to handle only QoS provisioning problems over WMN and some handle both routing and QoS provisioning together.

2.1 QoS provisioning and routing over WMN

Quality of Service Routing in WMN (QUORUM) [3] uses reactive route discovery mechanism for routing. All the routers have a Flow Table and updated this table when any flow comes and reserve resources. A dummy-RREP phase, during route discovery, accurately estimates end-to-end delay for a route. Robustness metric is used for selecting more robust link.

Wireless Mesh Routing (WMR) Protocol [9] makes a reservation from source to destination by first sending a RREQ message containing information about bandwidth and delay also. A time-out mechanism is used for expiration of a particular reservation.

Distributed end-to-end Allocation of Time Slot for Real Time Traffic (DARE) protocol [8] proposed no particular routing strategy and only concerned with provisioning of QoS along the path. For provisioning QoS, periodic time slot reservation is made from source to destination and in order to avoid interference all the neighboring nodes do not transmit or receive during this reserved time-slot.

In [10] after performing a comparison among three prominent multicast routing protocols over WMN, it is concluded that reactive routing is more suitable for routing in WMN.

In [5] after investigating different characteristics of three early proposals for QoS provisioning in WMN, it is concluded that reactive routing and reservation mechanism is more suitable for QoS provisioning over WMN.

In [2], it is stated that, it is default requirement in WMN to access different network technologies so form a heterogeneous environment. Although in [3], an effective routing protocol is proposed to provide strong QoS guarantee over WMN, but all the protocols, we mentioned in our literature survey is effective over WMN only and not provide QoS guarantee for heterogeneous environment.

2.2 QoS solutions in Heterogeneous Network (HN)

To provide end-to-end QoS guarantee in Heterogeneous Wireless Network (HWN) [11] proposed a Policy based QoS supporting system infrastructure to make decision about QoS routing. A policy decision engine automatically activated a particular policy if it satisfies the particular condition.

The proposed mechanism in [12] introduced fuzzy control into policy based management which reduces the average delay up to 30 percent. QoS mapping and monitoring have been considered as main component for QoS-aware routing in HWN.

When two prominent QoS models, Integrated Services (IntServ) and Differentiated Services (DiffServ), working together to provide end-to-end Qos guarantee, [10] proposed different QoS management function that can be implemented in multiple forms according to particular policy.

In [13] a mapping function is proposed to properly map the flows of IntServ to DiffServ classes, when IntServ have been implemented at the edge and DiffServ at the core of network. Effectiveness of this network is quantitatively evaluated by measuring queue size of DiffServ router, drop ratio of packets and non-conformant packets. Results show that this approach is effective in queuing delay.

2.3 Cross Domain QoS Model for Ad-hoc networks

In [14] a QoS model is proposed that is operated at gateway of ad-hoc network to solve problems related to QoS provisioning when one communication end point is in ad-hoc network and other communication end point is in some fixed topology network, to provide end-to-end QoS guarantee. Model decreases the variation in provided bandwidth at gateways and decrease end-to-end delay.

Another model named PYLON-Lite [4], cross domain model for ad-hoc network operated at gateways, assumed that SWAN model has been implemented on ad-hoc network and DiffServ model on fixed topology network. Compatibility module is used for protocol conversion. Results show smoother transitions for both upstream and downstream flows and decrease in end-to-end delay.

The study of literature gives an insight of different QoS routing mechanism over WMN and QoS solutions for heterogeneous network to achieve optimal performance in the given network scenarios. Due to varying specifications of WMN and heterogeneous network different mechanism are proposed by considering load, throughput (bandwidth), delay to provide end-to-end QoS guarantee.

3. PROPOSED TIME SLOT SCHEDULING MECHANISM

Our proposed solution has no concern with routing over WMN and use reactive routing protocol Ad-Hoc On Demand Distant Vector Routing, AODV+ [15] for routing.

We modify existing scheduling mechanism for forwarding of real time packets. In normal procedure packets, both best effort and real time, buffered in a queue on source node as well as intermediate node and waiting for forwarding towards destination. Packets sent from queue one by one as they come to the head of the queue without considering that whether it is real time or best effort packet.

When source node wants to communicate with node resides in fixed topology network and receives RREP from gate way, source first checks its sending buffer for packet of particular destination, as source can also act as intermediate node for flows coming from other nodes so its sending buffer consist of different type of packets. It can be best effort packets, real time packets and control packets. The main aim behind our proposed mechanism for QoS provisioning over WMN is that, Real time packets resides for minimum time in Queue. In normal procedure source node checks packets in sending buffer for a particular destination and as it found packet, simply forwards it one by one without considering its type. Our proposed solution treated best effort packets and real time packets separately. We chose one best effort source and one real time source. Node first check sending buffer for a packet of particular destination and at the same time it also checks type of packet.

In order to give more priority to real time packets a large time slot is reserved for forwarding of packets from queue. During this time slot, node checks packet type and only forwards real time packets, and time other then this time slot, node sends best effort packets. All the intermediate nodes till the gateway follow same procedure until the packet reaches at gateway. In this way gateway receives more real time packets in less time than normal scheduling procedure and so increase end-to-end throughput for real time packets.

Figure 1 shows an example queue having Real time (RT) and Best Effort packets (BE) and their respective position in Queue. Packet position at number 1 represents Head of the queue and Packet position at number eleven shows tail of the queue and it is assumed that queue can hold maximum eleven packets at any given time. If eight packets leave queue and forwarded to their destination in 8ms then by following normal scheduling

Packet Position	1	2	3	4	5	6	7	8	9	10	11
Packet Type	RT	BE	BE	RT	RT	BE	BE	BE	RT	RT	RT

Figure1.Example Queue with Respective Packet Position

procedure three real time and five best effort packets forwarded to destination and so particular destination for real time traffic receives three packets in 8ms. As more load of best effort traffic so less number of real time packets are forwarded towards the gateway.

In our proposed solution when first search for a packet of particular destination requested by application is performed and at the same time search for real time packets for a particular destination is performed. In this way in first 8 ms six real packets forwarded to destination. So eighty percent time of first eight milliseconds is reserved for real time traffic and for the rest of twenty percent time best effort traffic will be forwarded to its respective destination. In this way destination receives more real time packets in less time and throughput of real time traffic is increased.

4. Mapping Mechanism at Gateway

As we are using AODV+ for routing in which a source receives RREP from destination which indicates that a route is available from source to destination but in this heterogeneous environment destination is outside WMN so source receives no RREP from destination and thus all the communication between source and destination take place through gateway.

Real time data packets required more bandwidth and assured forwarding so we assign more bandwidth to real time data packets and in case of congestion on the node in wired network less possibility of dropping of real time data packets. As best effort packets requires no tight bound for its forwarding, we assigns less bandwidth to best effort packets for routing through fixed network.

We extend same procedure for forwarding of data packets placed in the sending buffer of gateway. When gateway checks the type of packet it recently receive and found that it is real time data packet then assigns it premium forwarding and so real time data packets can utilize more bandwidth having more guarantee for delivery of packets at the destination and at the same time by our modified procedure of scheduling of packets from sending buffer at gateway, gateway sends more real time packets toward node of wired network. Hence destination receives more real time packets in minimum time. In this way real time data packet receives more quality of service while travelling through source to destination.

Figure 2 shows initial positions of nodes at t=5 sec when mobile node 5 is moving and sending data packets to fixed node 0 through gateway (node 3) . Node 5 is a real time source and generates real time traffic. At this stage as no other communication take place between any other two nodes and so less load on gateway and gateway effectively forwards packets to destination. Queue consists of only real time data packets as shown in Figure 3. Queue size is 20 and figure shows 10 packets in queue.

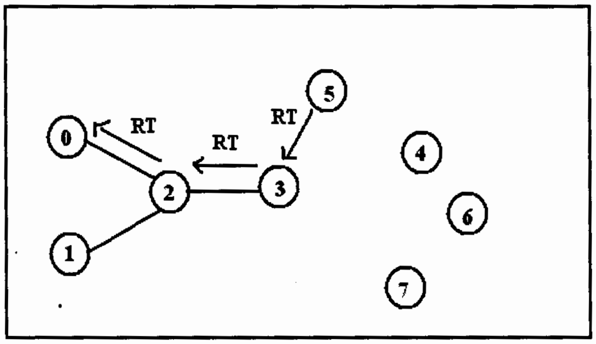

Figure2. Node position at t=5 seconds

Packet Position	1	2	3	4	5	6	7	8	9	10
Packet Type	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT

Figure3. Queue position at t=5 seconds

Figure 4 shows position of nodes at t=20 sec when mobile node 7 is also moving and sending packets towards fixed node 1 through gateway (node 3). Node 7 generates best effort traffic. At this stage both type (real time and best effort) of traffic pass through gateway towards fixed destinations, So gateway apply mapping procedure and sends more packets towards real time destination than best effort packets.

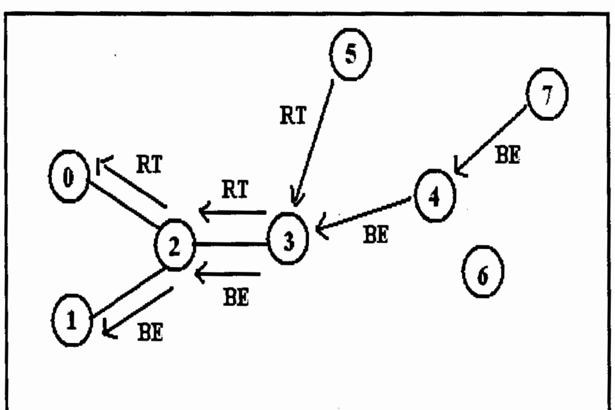

Figure4. Node position at t=20 seconds

Figure 5 shows queue position at t=20 seconds when queue consists of both the real time and best effort packets.

Packet Position	1	2	3	4	5	6	7	8	9	10
Packet Type	RT	BE	BE	RT	RT	BE	BE	BE	RT	RT

Figure5. Queue position at t=20 seconds

Without performing mapping at gateway, in first 8ms three real time and five best effort packets will be forwarded and low bandwidth will be assigned to it. After applying mapping for each 10 ms, 8 ms real time packets will be forwarded and in this way eight real time packets will be forwarded in the same time and more bandwidth will be assigned to it. So increase the end-to-end throughput for real time flows.

5. Implementation and Performance Results

5.1 Wired-cum-Wireless Topology

Our topological scenario consists of both wired and wireless nodes and all the communications between wireless and wired nodes take place through gateway. So we used wired-cum-wireless topological configuration for our simulation process.

5.2 Hierarchical Addressing Scheme

Wired nodes exchange information among themselves based on their topological structure i.e. how nodes are connected to one another through links. However there is no concept of links in wireless network. Packets are routed in wireless topology using their routing protocols which build forwarding tables by exchanging routing information among neighbours. In order to route packets between wired and wireless nodes, in ns-2 the whole topology is divided into different domains. Hierarchical addressing scheme is used here to assign IP address to nodes.

5.3 Traffic Generation

We used two traffic generation applications in our simulation process. One of the traffic generating application uses constant bit rate (CBR) to simulate Real time flows, whereas other application uses TCP connection that simulate FTP to simulate best effort traffic. As TCP generate Best Effort traffic that does not require any service quality.

5.4 NS-2 Parameter Setting

Table I shows complete detail of NS-2 node parameter setting which is used to configure our topological scenario As Gateway acts between wired and wireless domains so gateway also require wired routing mechanism. This is done by setting node-config option –wiredRouting ON. After creating the gateway node, reconfigure this option as –wired Routing OFF for wireless nodes. All other node-config options used for gateway remains same as of wireless nodes.

Table I NS-2 Parameter Setting

X dimension of topology	500
Y dimension of topology	500
Routing protocol	AODV
Link layer type	LL
MAC type	Mac/802_11
Interface Queue	Queue/Drop Tail/PriQueue
Maximum packets in Ifq	50
Antenna model	Antenna/Omni Antenna
Radio propagation model	Propagation/TwoRay Ground
Network Interface	Phy/WirelessPhy
Channel type	Channel/Wireless Channel
Gatewaydiscovery method	Reactive
Number of fixed nodes	3
Number of mobile nodes	5
Number of Gateway	1
Simulation time	40 seconds

5.5 Performance Metrics

We compared our proposed time slot scheduling and mapping mechanism with basic AODV+ without scheduling mechanism and evaluate the performance according to following metric.

5.5.1 Average throughput

Throughput is the total number of packets received successfully in the given time.

We will check the throughput at gateway and also at final destination.

5.6 Simulation Results

First of all basic AODV+ is run on given WMN scenario in NS-2 and different performance parameters are calculated and results are generated in graphical form produced by using trace files.

After this our proposed mechanism of time slot and mapping is implemented on AODV+ and results are produced in graphical form and then a comparison is performed between the two graphs.

We simulated the results in NS2 by taking parameters (pause time) on X-axis and performance metric (throughput) on Y-axis. The pause time is the time interval during which different parameters are calculated .In the figure below at equal intervals the throughput is calculated as shown in figures.

5.7 Comparison of Performance

Figure 6 shows throughput at gateway of basic AODV+. Throughput of Real time packets is much less then throughput of Best effort packets. In the start of simulation at pause time 15 seconds throughput of both real time and best effort packets are equal but after this throughput of best effort packets increased significantly.

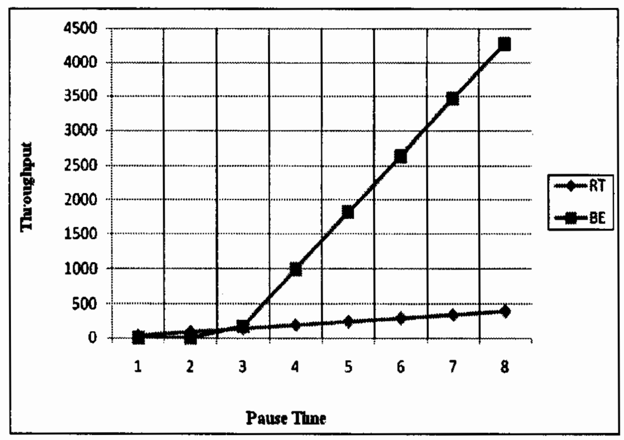

Figure6. Throughput Vs Pause time without modification

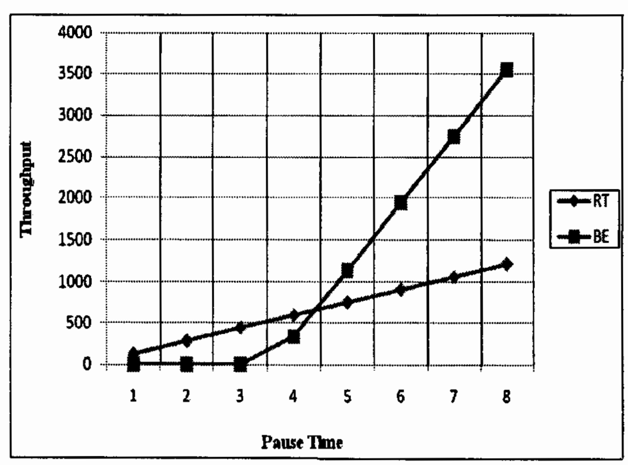

Figure7. Throughput Vs Pause time of modified AODV+

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Figure 7 clearly shows the difference of performance between basic AODV+ and my modified AODV+ with time slot scheduling mechanism. Throughput of real time packets increased significantly as the pause time increases. Throughput of our proposed time slot mechanism for real time packets is higher than the throughput of basic AODV+ without modification.

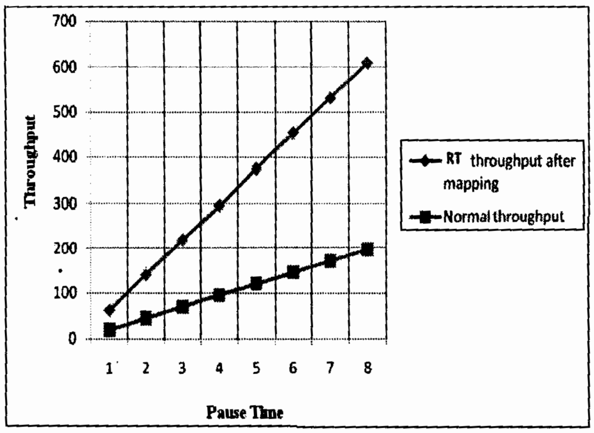

Figure8. Throughput Vs pause time before and after mapping

Figure 8 shows a comparison of throughput of real time packets at final destination in wired network. This comparison is performed only for real time packets to check and validate the performance of our proposed mechanism for real time packets having source in WMN and destination in wired network. The comparison is performed between throughputs of real time packets reaches at destination before and after mapping and time slot scheduling mechanism at gateway. In figure "Normal throughput (red line)" shows throughput of real time packets before mapping and time slot scheduling mechanism at gateway and "RT throughput after mapping (blue line)" shows the throughput of real time packets after mapping and time slot scheduling mechanism. It is clear from figure that in the start of transmission at t=5 sec there is no major difference between the two throughputs but as the pause time increases, difference between two throughputs significantly increased. Before mapping and time slot scheduling mechanism as most of the real time packets dropped in the way because of more load of best effort packets so only 200 real time packets reaches at destination when the transmission completed at t=40 sec, whereas after our proposed mapping and time slot scheduling mechanism almost 600 real time packets reached at final destination at t=40 sec so throughput of real time packets increased significantly. It becomes clear that our proposed mechanism shows good performance in case of longer real time transmission from start to end.

5.8 Analysis of Performance

After analyzing the performance of basic AODV + and our modified AODV+, it becomes clear that our modified AODV+ shows greater performance for real time transmission. In our proposed mechanism when we reserve a slot of time for real time transmission, real time data packets use shared bandwidth effectively and so more packets reached at gateway.

In basic AODV+ as the pause time increases the throughput of real time transmission is greatly affected because of more load of best effort packets on different nodes and gateway. Basic AODV+ is suitable for real time transmission having short duration less than 15 sec but shows poor performance when real time transmission continues for longer period of time as less number of real time packets reaches at destination because after t=15 sec, when load of best effort increases, most of the time is consumed by simply forwarding of best effort packets. In our modified AODV+ as time slot is reserved for forwarding of real time packets, from start to end of transmission, so throughput for real time transmission is significantly increased and more real time packets reaches at gateway and at final destination thus our modified AODV+ shows good performance when real time transmission continues over longer period of time. Because of this throughput of best effort transmission is slightly decreased but this decrement in throughput for best effort does not affect it. It is proven that our modified AODV+ uses bandwidth more efficiently and is more suitable for real time transmission continues over longer period of time and duration of real time transmission does not affect the quality of transmission.

6. Conclusion

We developed a time slot scheduling mechanism and enhance it for mapping at gateway to handle real time flows that needs to cross the domain, by modifying the scheduling mechanism. In our proposed mechanism, a time slot is reserved for forwarding of real time packets and along with searching for packets for particular destination in sending buffer, packet type is also considered and in the same time more real time packets forwarded to destination. This is an efficient technique for providing end-to-end QoS guarantee and shows good performance for flows continues for longer period of time and increases throughput at gateways and also increases throughput at the final destination. In this way gateway and final destination receives more real time packets in less time than normal scheduling procedure and so increase end-to-end throughput for real time packets.Throughput of real time packets does not affected so much by more load of best effort traffic as the pause time increases and thus quality of transmission is improved. Simulation results validate the performance of our proposed mechanism.