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Challenges of Quality of Services in Mobile Ad Hoc Networks

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Abstract: A Mobile Ad- Hoc Network (MANET) is composed of a group of mobile wireless nodes that form a network independently of any centralized administration, while forwarding packets to each other in a multi-hop manner. Such networks are characterized by dense node deployment, unreliable sensor node, frequent topology change, limited power and memory constraints. Due to the bandwidth constraint and dynamic topology of MANET, it is especially significant to be able to provide Quality of Service (QoS). However the characteristics of these networks makes QoS support a very challenging task. In this paper we present the various QoS models and also focusses on the various challenges involved in providing QoS in MANET.

Keywords: Mobile Ad Hoc Network, Quality of Service, Models, battery.

I. INTRODUCTION

Mobile Ad Hoc Network (MANET) represents autonomous distributed systems that are infrastructure less, fully distributed, and multi-hop in nature which are extension to the internet. As an autonomous system, MANET provides its own routing protocols and network management mechanisms. As a multi-hop wireless extension, it provides a flexible and flawless communication among its users or access to the Internet. Over the last several years, MANET has attracted considerable research attention in the general networking and performance community. Without any centralized access point, minimal configuration and quick deployment make mobile ad hoc networks suitable for emergency situations like monitoring disaster areas, military conflicts, emergency medical situations, etc, where the wired network is not available and mobile ad hoc networks can be the only means for communications and information access. However due to the evolution of the multimedia technology and the commercial interest of companies to reach widely civilian applications made QoS in MANETs an area of great interest. But providing QoS in MANET becomes very difficult and challenging tasks because network bandwidth is shared among neighboring nodes and the network topology continuously changes with node mobility. This condition requires extensive association between the nodes for establishing the routes and for securing the scarce resources necessary to provide the QOS.

Quality of Service (QoS) [1] is defined as a set of service requirements to be met by the network while transporting a packet stream from source to destination. In other terms QoS means that the network should provide some kind of guarantee or assurance about the level or grade of service provided to an application in terms of delay, jitter, available bandwidth, packet loss, and so on. The actual form of QoS and the QoS parameter to be considered depends upon specific requirements of an application. The goal of QoS provisioning is to achieve a more deterministic network behavior, so that information carried by the network can be better delivered and network resources can be better utilized. However, there still remains a significant challenge to provide QoS solutions and maintain end-to-end QoS with user mobility.

The remainder of this paper is organized as follows. In Section II, we discuss QoS parameters, Section III presents QoS models. The issues and challenges for provisioning QoS for MANETs are discussed in the section IV. Finally we draw the conclusions and discuss our findings in the field of QoS in MANET in Section V.

II. QOS PARAMETERS

QoS parameters differ from one application to another application. In case of Multimedia applications, the data rate and interruption are the key factors, whereas, in defense use, security and reliability become more important. If considering QoS required by emergency cases such as rescue, the important factor should be the availability of resources. In sensor networks, battery life and energy conservation would be the prime QoS parameters. In real time applications, QoS requests can be expressed in term of many metrics in routing protocols. The most popular metrics are data rate and delay. To satisfy QoS requirements, the corresponding available data rate and delay that could be provided by the network of each route should be calculated in order to see which route could be used with satisfying QoS.

III. QUALITY OF SERVICE MODELS

QoS model specifies an architecture in which some kind of services could be provided in MANETs. The model includes QoS resources reservation signaling, QoS routing and QoS Medium Access Control (MAC) as shown in Figure1.

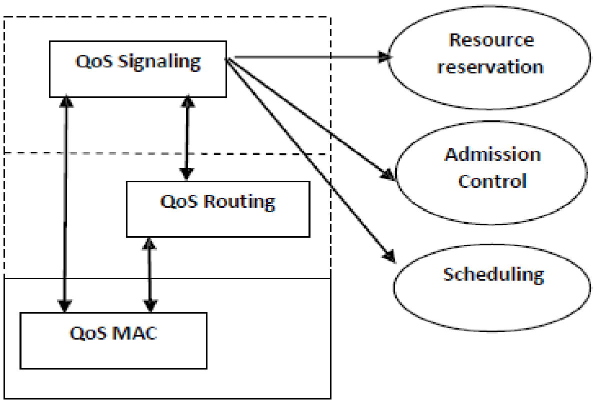


Fig. 1 QoS Model

The main requirements for a QoS Model for MANETs are as follows:-

a) Minimal overhead: In a wireless multi-hop network, the wireless link capacity, battery and computational resources are quite limited. Therefore a QoS model for MANET should minimize the signaling overhead as well as the computational overhead entailed in provisioning of QoS.

b) Robustness: QoS models should be capable of handling frequent route failures due to dynamic network topology. The QoS model should have mechanisms to adapt to the changing topology without creating bottlenecks, in a fast and efficient manner.

c) Fairness: The QoS resources should be shared in a fair manner among the wireless clients, and misbehaving nodes should not be allowed to make use of the network's resources without relaying packets for other nodes.

A QoS model for MANETs should consider the challenges of MANETs, e.g., dynamic topology and time-varying link. Some of QoS models are:

1. Integrated Service (IntServ) Model

The fundamental concept of the IntServe model is that the flow specific states are kept in every IntServ enables router[2]. A flow is an application session between a sender and a receiver. A flow specific state should include the information about bandwidth requirement, delay bound and cost etc. of the flow. Because every router keeps the flow state information, *IntServ* provides QoS to every individual flows. IntServ proposes two basic service classes concerning with integration along with Best-effort services .These are Guaranteed Service and the Controlled Load Service.

a) Best-effort services: The Best-effort services are those services that we currently experience on the internet. They are characterized by absence of any QoS specifications. The network provides the quality that it actually can contribute. Examples of best-effort traffic are FTP, mail and FAX.

b) Guaranteed Services [3]: The guaranteed service is provided for applications requiring fixed delay bound.

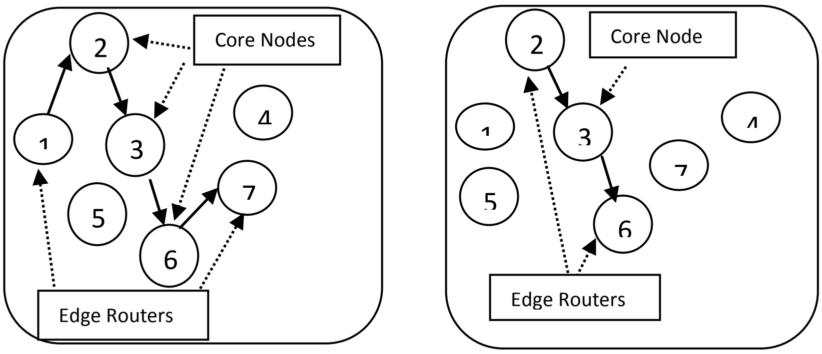
c) Controlled Load Services [7]: The controlled load service is used for the applications that require reliable and enhanced best effort service.

In an IntServ enabled router, IntServ is implemented with four main components [2]: the signaling protocol, the admission control routine, the classifier and the packet scheduler. Other components such as the routing agent and management agent are the original mechanisms of the routers and can be kept unchanged. It uses Resource Reservation Protocol (RSVP) to provide a circuit switched service in packet switched network. It aims to emulate a connection-oriented, virtual circuit connection for each flow admitted to the network. Admission control is used to make a decision whether to accept the resource requirement. It is invoked at each router to make a decision when a host requests a real time service along some paths through the internet. Admission control uses the RSVP to send the notification to the application whether its QoS requirement can be granted or not. The application can transfer its packets only after the QoS requirement is accepted. When a router receives a data packet, the classifier will perform Multi -Field (MF)[4] classification in which it classifies a packet based on multi fields such as the source and the destination addresses, the source and destination port number, Type Of Service(TOS) bits and protocol id in the packet header .Then the classified packet will be place into the corresponding queue according to the classification result. Finally the packet scheduler reorders the output queue to meet the different QoS requirements. IntServ is not feasible in MANETs due to the following reasons : (1) The drawback of IntServ is the scalability problem caused by the need of storing every flow state in the routes. (2) RSVP signaling packets use bandwidth needed to send data packets.(3) every mobile host must perform the processing of admission control, classification and scheduling which imposes a heavy burden for the resource-limited mobile hosts.

2. Differentiated Service (DiffServ) Model

DiffServ provides QoS to large class of data or aggregated traffic [8]. In DiffServ, routers are divided into two types: *edge routers* and *core routers*. Edge routers are at the boundary of the networks. Core routers forward packets based on the Type of Service bits in the IP header, called the DS field and they also need to follow the Per-Hop-Behavior (PHB) which takes charge of scheduling of packets [5]. When a data packet enters a DiffServ-enabled domain, an edge router marks the packet's DS field, and the interior routes along the forwarding path forward the packet based on its DS field. Since the DS field only codes very limited service classes, the processing of the core routers is very simple and fast. DiffServ does not maintain the state of each and every flow as IntServ does, but rather discriminates the packets according to their priority. DiffServ is easier to maintain, more scalable and has less signaling than IntServ. DiffServ is designed for static networks and thus cannot be applied directly to the mobile ad hoc environment. There are still some residual challenges in implementing DiffServ in MANETs:

(a)The identification of edge routers in MANETs is uncertain (see Figure 2). The source nodes play the role of edge routers. The intermediate nodes which are used for forwarding the data packets from sources to destinations are core nodes. But every node should have the functionality as both edge router and core router because the source nodes cannot be predefined.



(a) **(b)**

Fig.2 (a) node 2,3and 6 are the core nodes and node 1and 7 are the edge routers (b) Only node 3 is the core node and 2 and 6 nodes are the edge routers.

(b)The concept of Service SLA(Service Level Agreement) in the Internet does not exist in MANETs. The SLA, which is a form of contract between a customer and its ISP, which specifies the forwarding services the customer should receive, is hard to implement in MANETs because there is no available scheme for the mobile nodes to negotiate the traffic rates.

Below table1 shows the difference between IntServ and DiffServ QoS Models

TABLE1 : COMPARISON OF INTSERV AND DIFFSERV

Criteria	IntServ	DiffServ
Granularity	Individual flow	Aggregate of flows
State in routers	Per-flow	Per-aggregate
Classification	Header fields	DS field
Signaling	Required(RSVP)	Not required
Coordination	End-to-end	Per-hop
Scalability	< # of flows	< # of classes

3. Flexible QoS Model for MANET (FQMM)

Flexible QoS Model for MANETs (FQMM) was the first QoS model designed for MANETs. It combines the advantages of IntServ and DiffServ models and provides a hybrid scheme of per-flow provisioning as in IntServ and per-class provisioning as in DiffServ [12]. FQMM consist of three key features: dynamic roles of nodes, hybrid provisioning and adaptive conditioning.

a) Dynamic roles of nodes: As in DiffServ, three kinds of nodes (ingress, core and egress nodes) are defined in FQMM. An ingress node is a mobile node that sends data. Core nodes are the nodes that forward data for other nodes. An egress node is a destination node. The difference though is that in FQMM the type of a node has nothing to do with its physical location in the network, since this would not make any sense in a dynamic network topology.

Core nodes forward data packets by certain PHB (Per Hop Behavior) according to the DiffServ field in the packet header. FQMM can provide per flow QoS provisioning for high-priority flows. The question is how many high-priority flow sessions can coexist at the same time in the network. Another open issue is the scheduling performed by intermediate nodes.

b) Hybrid Provisioning: Provisioning is used to decide and allocate needed resources at various points in the networks —these points are mobile host in MANETs. The provisioning approach in FQMM consists of a hybrid per-flow (IntServ) and per-class (DiffServ) scheme in which traffic of the highest-priority is given per flow treatment, while other traffic is given per-class provisioning.

c) Adaptive conditioning: The adaptive traffic conditioner includes several components: a traffic profile, meter, marker and dropper. The traffic conditioner, which polices the traffic according to the traffic profile and is responsible for marking the traffic streams and discarding packets, is placed at the ingress node at which the traffic originates. For FQMM, the absolute traffic profile is not applicable since the effective bandwidth of a wireless link between nodes is time-varying. Thus, the traffic pro-file is defined as the relative percentage of the effective link capacity.

FQMM is the first attempt at proposing a QoS models for MANETs but with the following problems: 1) without an explicit control on the number of services with per-flow granularity, the scalability problem still exists 2) how to make a dynamically negotiated traffic profile is a very difficult problem 3) it is difficult to code the PHB in the DS field of IP, if the PHB includes per-flow granularity considering the DS field is at most 8 bits without extension.

IV. ISSUE AND CHALLENGES WHILE PROVIDING QOS IN AD-HOC NETWORKS

The major problems that are faced while providing the QoS in MANET are as follows:

1. Average end-to-end delay: End-to-end delay includes all possible delays in the network caused by route discovery latency, retransmission by the intermediate nodes, processing delay, queuing delay, and propagation delay. To average the end-to-end delay we add every delay for each successful data packet delivery and divide that sum by the number of successfully received data packets. This metric is important in delay sensitive applications such as video and voice transmission. All the factors which contribute in end- to end delay plays their role in making it difficult to provide QoS in MANET.

2. Security: The wireless environments, along with the nature of the routing protocols in MANETs, which require each node to participate actively in the routing process, introduce many security vulnerabilities. Therefore routing protocols should efficiently support security mechanisms to address these vulnerabilities. Authentication and encryption is the way to deal with it but unauthorized access of the keys within distributing it among the nodes in the ad-hoc network may violate QoS negotiations.

3. Route maintenance: Each mobile node in a MANET performs the routing functions for establishing the communication among different nodes. Nodes are free to move arbitrarily with different speeds; thus, the network topology may change randomly and at unpredictable time. The nodes in the MANET dynamically establish routing among themselves as they travel around, establishing their own network. The established routing path may be broken at any time even during the process of data transfer. Thus, the need arises of routing paths with minimal overhead and delay.

4. Lack of centralized control: The major advantage of wireless mobile nodes that they form a temporary network without the aid of a fixed networking infrastructure or centralized administration. Mobile nodes that are within each other's radio range communicate directly through wireless links. So there may not be any provision of centralized control on the nodes which leads to increased algorithm's overhead and complexity, as QoS state information must be disseminated efficiently.

5. Limited bandwidth: Wireless link continue to have significantly lower capacity than infrastructure networks. In addition, the realized throughput of wireless communication after accounting for the effect of multiple access, fading, noise, and interference conditions, etc., is often much less than a radio's maximum transmission rate.

6. Hidden terminal problem: The hidden terminal problem refers to the collision of packets at a receiving node due to the simultaneous transmission of those nodes that are not within the direct transmission range of the sender, but are within the transmission range of the receiver. It necessitates retransmission of packets, which may not be acceptable for flows that have strict QoS requirements. Some control packet exchange mechanisms [6, 9] reduce the hidden terminal problem only to a certain extent.

7. Energy Constrained Operation: The nodes in a MANET rely on battery power. These batteries are small and can store very limited amount of energy. On the other hand, transmission and processing required during routing involve expenditure of substantial amount of energy causing the batteries to get rapidly drained out, unless the routing protocol is carefully designed. Providing QoS consumes more energy due to overhead from the mobile nodes.

8. Node Mobility: Since the nodes in a MANET are allowed to move arbitrarily. So the network topology must be updated frequently to allow data packets to be routed to their destinations. Again, this invalidates any hard packet delivery ratio or link stability guarantees [10]. Furthermore, a QoS state which is link- or node position dependent must be updated with a frequency that increases with node mobility.

V. CONCLUSION

In this paper we have presented a comprehensive issues and challenges involved in providing QoS in MANETs. MANETs are likely to expand their applications in the future communication environments. Therefore the need for QoS will be an important and desirable component of MANETs. Several important research issues and open questions need to be addressed for providing the QoS in MANETs. The topology of an ad hoc network dynamically changes, it may affect QoS guarantees provided by the network because a change in the topology may require to rediscover the routes adding to the latencies and thus affecting the QoS. Therefore, major challenge involved in providing the QoS in mobile ad hoc networks is how to tackle changes in the topology of the network. Another challenge in case of MANETs is that the resources of participating nodes are limited. Therefore, a protocol that requires extensive computations and communications may not be a good option in such networks. Therefore, a protocol for providing QoS in ad hoc networks should be able to utilize the scarce resources in an efficient and effective manner. Capacity estimation, route discovery, route maintenance and feasible path selection are key issues that require further exploration.

References

1. Crawley E, Nair R, Rajagopalan B, Sandrick H. A Framework for QoS Based Routing in the Internet. RFC 2386, August 1998.
2. Yu C, Lee B, Youn H Y (2003) Energy-efficient routing protocols for mobile ad-hoc networks. Wiley J. Wireless Communications and Mobile Computing Journal 3(8): 959-973.
3. Shenker S, Partridge C, Guerin R (1997) Specification of guaranteed quality of service. RFC 2212.
4. Gupta P, McKeown N (1999) Packet classification on multiple fields. Proc. ACM SIGCOMM Conference on Applications, Technologies, Architectures, and Protocols for Computer Communications 147-160.
5. Shan Gong, ―Quality of Service Aware Routing Protocols for Mobile Ad Hoc Network‖. 2006.
6. IEEE Standards Board (1999) Part II: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications. The Institute of Electrical and Electronics Engineers Inc. www.csse.uwa.edu.au/adhocnets/802.1l-1999.pdf.
7. Wroclawski J (1997) Specification of the controlled-load network element service. RFC 2211. www.ietf.org/rfc/rfc2211.txt.
8. S. Blake, "An Architecture for Differentiated Services," Network Working Group Request for Comments, December 1998.
9. Karn P (1990) MACA - a new channel access method for packet radio. Proc. ARRLI CRRL Amateur Radio Ninth Computer Networking Conf. 134-140.
10. Y.Luo, J.Wang and J.Chen et al., "Algorithm based on mobility prediction and probability for energy efficient multicasting in ad-hoc networks" Computer research and development vol.43(2), pp.231-237,2006.

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