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IPv4 Vs IPv6 QoS: A challenge in MANET

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Abstract*:* Mobile Ad Hoc Network (MANET) is collection of mobile nodes that communicate with each other without centralized control or established infrastructure. Due to rapidly deployable and Infrastructure less nature we can utilized MANET in various scenario like Earth quack, Military scenarios, Emergency/rescue operations, Students on campus, Free Internet connection sharing, Conferences etc. In current scenario various real-time applications like Audio/ Video or Internet protocol television (IPTV), Voice over IP (VoIP) , Videoconferencing ,Online transactions etc. are sensitive to network performance parameters like IPDV, throughput and drop , that's why we need to enable the network capability to provide better quality of service becomes very important. Current IP networks provide best effort traffic delivery to providing partial guarantees in terms of Quality of Service. However, there are services, including voice, with strong requirements for delay and delay jitter, which makes it necessary to add functionality to IPv4 networks in order to gain support for such services. IPv6 was developed due to the problems of IPv4 as above mentioned. In this paper we describe the various QoS models and mechanism that are used to provide QoS on a network. We also describe various QoS parameters. Then after we specify the features that use both IPv4 and IPv6 to implement QoS. Finally, we present the performance comparison of IPv4/IPv6 in MANET.

Key words: Delay, Jitter, MANET, QOS, VOIP,

INTRODUCTION

A mobile ad-hoc network is an independent system of mobile nodes connected by wireless links forming a short, live, on-the-fly network even when access to the Internet is unavailable. Nodes in MANETs generally operate on low power battery devices [1]. Host is also function as router. Routing in MANET is Multi hop. Nodes are mobile, topology can be very dynamic. Routes are frequently changing. Due to the dynamic topological changes, routing is the biggest challenging issue that is to be considered seriously when we talk about QoS.

Generally, QoS for a network is measured in terms of guaranteed amount of data which a network transfers from one place to another during a certain time [2]. There are several service models in wired networks. The two QoS Models are the Integrated Services (IntServ) [3] and the Differentiated Service (DiffServ) models [4]. Both of these models require accurate link state such as available bandwidth, packet loss rate, delay, and topology information. Due to dynamic topology and scarcity of resources in MANET maintaining the accurate routing information is very difficult. The Integrated Services (IntServ) is a flow-based QoS model designed for IP, where a flow is a kind of virtual circuit, from the source to the destination and inform all routers of the resource requirement by means of a signaling protocol. In MANET it is very tough ask to maintain a flow. The DiffServ model overcomes the difficulty in implementing and deploying IntServ model and Resource Reservation Protocol (RSVP) [5] in the Internet. **Resource reSerVation Protocol (RSVP)** is used to reserve the resources at intermediate routers between sender and receivers. While **DiffServ** is a simple, scalable mechanism for classifying and managing network traffic and providing quality of service (QoS) on modern IP networks, Motivated by scalability and better-than-best effort service without RSVP signaling. Flows are aggregated into a limited number of service classes.

Quality of Service (QoS) refers to the capability of a network to provide better service to selected network traffic while routing them through the network. In current scenario wide use of wireless technologies has increased the demand of QoS for multimedia and real-time applications in wireless networks and traditional internet QoS protocols like RSVP [3] cannot be used for wireless environment due to the error-prone nature of wireless links and the high mobility of mobile devices in MANETs. Therefore, providing QoS in MANETs is more challenging than in fixed and wireless networks.

MANET (Mobile Ad-Hoc Network)

In recent years with the decrease in the costs of mobile devices and the increase in their capacity, a new idea which is called ad-hoc network has been emerged. Mobile Ad Hoc Network (MANET) is collection of mobile nodes that communicate with each other without centralized control or established infrastructure. Rapidly deployable, self configurable and Infrastructure less Characteristics of MANET makes it easier network available any time

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anywhere. MANET is a collection of autonomous mobile hosts and these act as host and router, they can forward packets on behalf of the other nodes. Routing is multi hop. Nodes are mobile, topology can be very dynamic. Due to high mobility and scarcity of resources there are various challenges faced in MANET like Routing Quality of service(QoS) limited battery power, Security and scalability. Fig.1 shows a typical scenario of MANET where each node may be a laptop or PDA or Smartphone etc without having any infrastructure.

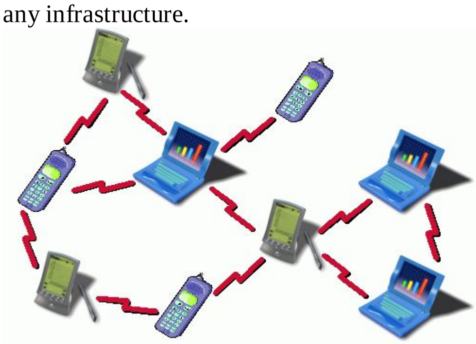

Fig 1: Mobile ad-hoc network

QUALITY OF SERVICE

Quality of Service (QoS) refers to the capability of a network to provide better service to selected network traffic. Where-Quality covers data loss, delay or latency, jitter, efficient use of network resources. And Service means end-to-end communication between applications (i.e. audio, video, E-mail).Goal of quality of service is to provide priority including dedicated bandwidth, reliability controlled jitter and latency. Implementing QoS in a network manages network performance in a more predictable way and uses bandwidth more efficiently [1].

QoS Metrics

Following are the various matrices to measure the quality of service to a network.

1) Bandwidth

Number of bits per second that a channel or a link can transmit. Maximum transmission power of a medium i.e. Wired or wireless. Band width is measured in terms of Htz or Bits per second. Increase the bandwidth in Htz will increase bits per second .for e.g. 1 Gbps to 100 Gbps for wired network and 54 Mbps for wireless 802.11standard.

2)End to End delay (Latency)

Time taken by entire message to completely arrive from source to destination. Latency can be defined as mentioned below.

Latency = Pt + Tt + Qd + Pd

Where- Pt is Propagation delay

Tt is Transmission delay

Qd is Queuing delay

Pd is Processing delay

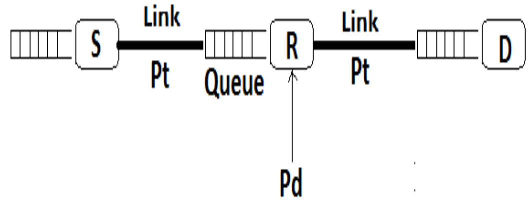

Fig. 2 End to End delay

3) Jitter

Differences between the latency of the consecutive packet arrived at receiver is simply Known as Packet Delay/latency variance. Jitter arises Due to congestion or different packets arrived from different routes. Jitter can be defined as given below

Avg. jitter= ∑i=1 to n (Latency i – Latency i-1)/n-1 per time unit

4) Packet Delivery Ratio (PDR)

Signifies the total number of packets successfully delivered to the destination. Also gives the packet loss ratio. For the real time applications avg. packet loss ratio must not accede 1%.

PDR= (No. of packets delivered / No. of Packets sent)*100

5) Round trip time (RTTP)

Time to send a packet and to get its acknowledgement. If the sent data packets as well as the response packet (ACK) have the same length, the round trip time can be expressed as: RTTP=2*Latency if forward delay = backward delay (typically assumed -- although not always accurate).

6) Link Utilization

Let us assume the following:

Transmission Delay (TD)

Time it takes a station to transmit a frame (normalized to a value 1)

Propagation Delay (PD)

The time it takes a bit to travel from sender to receiver

a= PD/TD

Where a ∝ PD

The link utilization Z= (1/1+2a)

If a =0 then Z =100 % but it is not feasible there must be some propagation delay.

If less the propagation time is more the number of frames on the link can be transmitted. If more number of frames can be sent on the link then the link utilization is efficient.

7) Throughput

The throughput is a measure of how fast we can actually send data through a network. The amount of data transferred from source to the destination in a specified amount of time. A link may have a bandwidth of B bps, but we can only send T bps through this link i.e. Always T<=B

The bandwidth is a potential measurement of a link; the throughput is an actual measurement of how fast we can send data.

Throughput = Amount of data transferred/ Transfer time

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Relation between QoS parameters

Less the propagation time is efficient the link utilization will be. If link utilization is high then the throughput will increase .It will also increase the PDR. More the bandwidth lesser the congestion and more throughputs. Throughput increases with data transfer size. If the PDR is high then the throughput is also high and PLR will be less.

QoS MODELS AND ARCHITECTURES

Two QoS architectures have been proposed and standardized by the IETF. The first is called Integrated Services (IntServ) and the second Differentiated Services (DiffServ). There are three levels of service: best effort, differentiated service and guaranteed services.Fig.3 tells that the overall network has divided into three kind of services.

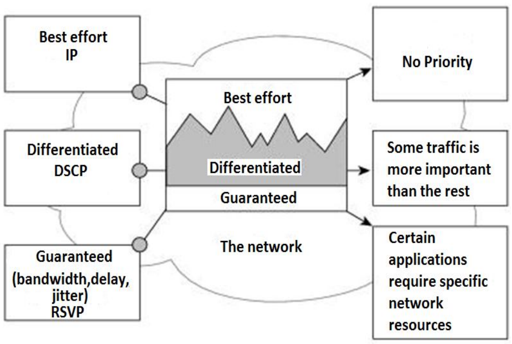

Fig.3 QoS Models

1) Best Effort Service

In this service model no special treatment is given to a specific flow means all the traffic have same priority. No guarantee of delivery is given .Unspecified variable rate and delivery time i.e. IP Datagram .Best-effort service can lead to packet loss, excessive end-to-end delay, and packet jitter.

2) Integrated Services (IntServ)

Integrated Services is a flow-based QoS model designed for IP. Where a flow is a kind of virtual circuit, from the source to the destination and informs all routers of the resource requirement. The idea of IntServ is that every router in the system implements IntServ, and every application that requires some kind of guarantees has to make an individual reservation. Every Intserv Routers maintain state info of allocated resources. Flow Specs describe what the reservation is for, while RSVP is the underlying mechanism to signal it across the network.It also allows both unicast and multicast transmissions.

Resource reSerVation Protocol (RSVP) is used to reserve the resources at intermediate routers between sender and receivers. Resource Reservation Protocol (RSVP) is a signaling protocol to help IP create a flow.

Following are the messages used in RSVP.

PATH message (Contains QoS requirements).

RESV message.

Error Message: Path error & Resv error

Flow Specification: To specify a flow we use following messages.

Rspec (resource specification) defines the resource that the flow needs to reserve (buffer, bandwidth, etc.).

Tspec (traffic specification) defines the traffic characterization of the flow.

2.1) Congestion Management Techniques

To avoid congestion various methods are implemented in routers to support the various signaling protocols. Creating different queues for different classes of traffic. An algorithm for classifying incoming packets and assigning them to different queues. Scheduling packets out of the various queues and preparing them for transmission.

Following are the queuing Techniques:

a) First in first out (FIFO) queues

It is the simplest type of queuing, is a simple buffer that holds outgoing packets until the transmission interface can send them. Packages are shipped out of the interface in the same order they arrive at the buffer.

b) Priority Queue (PQ)

In this method Packets are first assigned to a priority class where each priority class has its own queue. The packets in the highest-priority queue are processed first. Packets in the lowest-priority queue are processed last. Top priority is given for Mission critical data.

c) Weighted Fair Queuing (WFQ)

The queues are weighted based on the priority of the queues i.e. higher priority means a higher weight. The system processes packets in each queue in a round-robin fashion according to the weight assigned to a queue.

d) Modified Deficit Round Robin (MDRR)

MDDR tracks the number of bytes of data that was taking out above the set value. As a result, the average amount of data served, the tail will be very close to the value set. Additionally MDDR maintains a priority queue being served preferentially [6].

2.2) Congestion Avoidance Mechanisms

Following are various mechanisms to avoid congestion.

a)Tail drop

Trail drop treats all traffic equally and does not differentiate between classes of service. When the output queue is full packets are dropped until the congestion is eliminated.

b) Random Early Dropping

RED starts dropping packets randomly when the average queue size is more than a threshold value. RED also tells the packet source to decrease its transmission rate.

c) Weighted Random Early Dropping (WRED)

Is a modified RED strategy where in addition it drops low priority packets over high priority ones. For IntServ environments WRED drops non-RSVP-flow packets. For DiffServ environments WRED looks at IP precedence bits to decide priorities.

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3) Differentiated Services (DiffServ)

DiffServ is a simple, scalable mechanism for classifying and managing network traffic and providing quality of service (QoS) on modern IP networks. Motivated by scalability and better-than-best effort service without RSVP signaling. DiffServ uses the 6-bit Differentiated services Field (DS field) in the IP header for packet classification purpose. DiffServ relies on a mechanism to classify and mark packets as belonging to a specific class. DiffServ does not require an application to reserve resources for each flow but QoS requirements of users must be specified in a Service Level Agreement (SLA).

3.1) Traffic management mechanisms

DiffServ model has two following functional elements that is to be implemented by either edge or core routers.

- Edge functions: The following functions are performed at edge routers and nodes. Packet classification, Packet marking, Traffic conditioning
- Core functions: The core routers and nodes Forward packet based on per-hop behavior (PHB) associated with packet ' s class.

a)Classification and Marking

Packet classification identifies the traffic flow and marking identifies traffic flows that require congestion management or congestion avoidance on a data path. Packet is marked in the Type of Service (TOS) in IPv4. 6 bits used for Differentiated Service Code Point (DSCP) and determine PHB that the packet will receive.2 bits are currently unused.

b) Traffic Conditioning

Meters checks whether traffic falls within negotiated profile. While markers marks a packet by setting the DS value to a correct code point. And shaper buffers to achieve the flow rate, while Dropper drops the packet in case of congestion.

c) Forwarding (PHB)

The DSCP (Differentiated Services Code Point) is a 6-bit subfield that defines the per-hop behavior (PHB) .The core routers in the DiffServ model need to only forward packets according to the specified per-hop behaviors (PHB).

i. Default PHB

Any traffic that does not meet the requirements of any of the other defined classes is placed in the default PHB. The default PHB has best-effort forwarding characteristics. The recommended DSCP for the default PHB is 000000.

ii. Expedited Forwarding (EF) PHB

EF PHB has the characteristics of low delay, low loss and low jitter. These characteristics are suitable for voice, video and other real-time services. The recommended DSCP for expedited forwarding is 101110.

iii. Assured Forwarding (AF) PHB

This PHB Gives assurance of delivery under prescribed conditions. It sets out-of-profile traffic to high drop priority.

iv. Class Selector (CS) PHB

The Class Selector code points are of the form 'xxx000'. Maintain backward compatibility with the IP Precedence field. If a packet is received from a non-DiffServ aware router that used IP precedence markings, the DiffServ router can still understand the encoding as a Class Selector code point.

IPv4 AND IPv6 QOS SUPPORT

IPv6 was developed to solve some of the problems of IPv4, such as QoS, security and the IPv4 addresses reduction. Current IP networks provide better traffic delivery effort providing partial guarantees in terms of Quality of Service.IPv6 [7] is the new version of Internet Protocol (IP) and has been conceived as the successor to IPv4. IPv6 has been designed as an evolutionary step from IPv4 to allow a smooth transition from IPv4. The IPv6 protocol has two fields that can be used as tools for implementing QoS Flow Label and Traffic Class [8]. Support for resource allocation. In IPv6, the type-of-service field has been removed, but a mechanism (called flow label) has been added to enable the source to request special handling of the packet. This mechanism can be used to support traffic such as real-time audio and video. The priority field of the IPv6 packet defines the priority of each packet with respect to other packets from the same source. For example, if one of two consecutive datagrams must be discarded due to congestion, the datagram with the lower packet priority will be discarded. IPv6 divides traffic into two broad categories: congestion-controlled and non congestion-controlled[8].Flow Label to a router, a is a sequence of packets that share the same characteristics, such as traveling the same path, using the same resources, having the same kind of security, and so on. The field of 8 bits for Traffic Class in the IPv6 header is used by the source nodes and / or intermediate routers to identify and distinguish between different classes or priorities of IPv6 packets. Its function is similar to the IPv4 ToS field.

SIMULATION AND RESULTS

1. Simulation Test bed

Exata/Cyber 1.1 was used to simulate our scenario in which we have to evaluate the performance of both IPv4/IPv6 in MANET .In our scenario we have taken 100 nodes in 1500*1500m area and applied 5 CBR.

Whole simulation was performed to 300 seconds according to different mobility respectively 0, 5, 10, 15, 20m/s.24 packets were sent by each CBR of size 512 bytes. WRED was applied to avoid congestion. AODV routing protocol was applied which is one of the very popular protocol for MANET.

In our simulation we have compared performance of IPv4 and IPv6 protocol according to QoS parameters. We can guarantee the QoS of the network through classification, marking, queuing and traffic-policy methods like congestion avoidance and congestion management. In our simulation we have applied WRED for IPv6 based diffServ Model and IP precedence service in service type field of IP. Our objective of simulation was to evaluate the throughput and Packet delivery ratio in MANET. Highly dynamic topology of MANET leads into frequent Route breaks and new route

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discovery is done. When the mobility is high the probability of route breaks increases more. Due to frequent route breaks it takes more delay for packets to deliver, it will also increase the jitter value. In general we can say that these problems cost into low throughput or PDR. Also long Delay and high jitter is not suitable for real time applications. In fig. 4 the PDR value is high in IPv6 in comparison to IPv4, but as the mobility increases PDR value decreases, Also avg. PDR is less than 70% that is very less for real time applications. Fig.5 tells that as the mobility increases the jitter value also increase. The avg. jitter in fig. 5 is more than 300ms that is not suitable for real time applications. High mobility increases the delay. In our simulation the avg. Delay is more than 200ms (fig.6) not suitable for real time applications. As the mobility increases throughput decreases.

Though the PDR and Throughput value is high for the IPv6 in comparison to IPv4 but still these values are not suitable to real time applications like VOIP, IPTV etc.

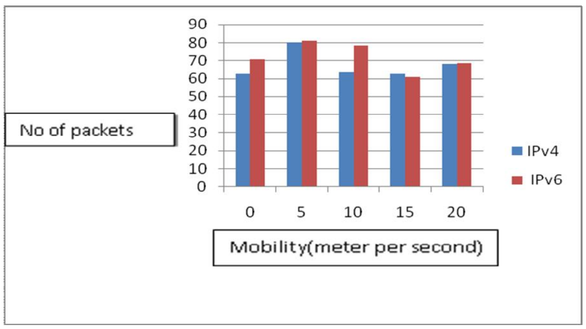

Fig. 4 Packet delivery ratio

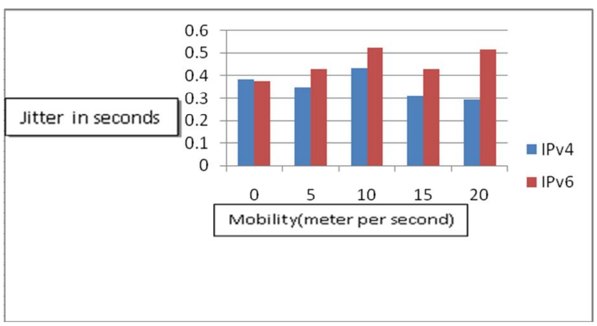

Fig. 5 Jitter in second

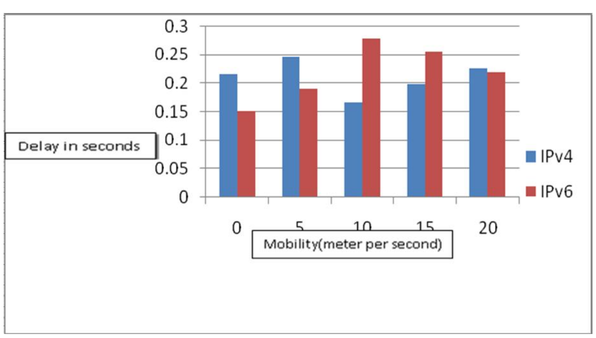

Fig. 6 end to end delay

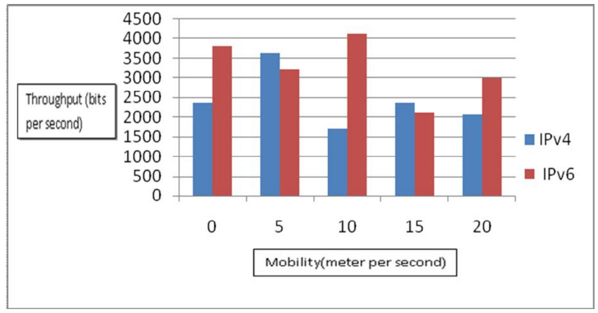

Fig. 7 Throughput

CONCLUSION

To provide QoS both IPv4 and IPv6 use same methods and architectures. The only difference is IPv6 provides classification of flows according to DSCP and Flow Level and IP precedence .As according to the simulation we have performed though the result for IPv6 are better than IPv6 but still not suitable for real time applications .Due to high mobility in Mobile Ad Hoc Networks both the IP version provides low QoS value . Because of dynamic topology and limited resources QoS support in MANETs is a very challenging task. Routing is a very important mechanism for QoS guaranteeing in network. QoS routing must find a path from a source to a destination which satisfies the QoS requirements. To support in applications in MANET we can utilize the routing as a method to provide QoS in MANET.

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