Precedence Based Preemption and Bandwidth Reservation Scheme in MANET

Sourabh Singh Verma[1], Saroj Kr. Lanka[2], R.B.Patel[3]

1. CSE Dept.,FET,Mody Institute of Technology and Science, Lachmangarh, Rajasthan.

2. IT Dept.,FET, Mody Institute of Technology and Science, Lachmangarh, Rajasthan.

3.CSE Dept., G. B. Pant Engineering College, Paudi Garhwal,Uttarakhand.

Abstract

Infrastructures less mobile networks are commonly known as Mobile Ad Hoc Networks (MANET). Quality of Service (QOS) constraints is highly required for multimedia communications with MANET. Providing QOS in MANET is not easy task due to its broadcast and dynamic nature. There are some number of protocols exist which takes care for the QOS. Some of them are Diffserv, Intserv, AQR etc. All have some limitations. This paper propose a protocol Preemption And Bandwidth Reservation Scheme (PBRS) which adds more functionalities with AQR[1] and added with AODV[2]. In addition to reserving bandwidth it will also provide preemption scheme. It will minimize number of preemption and will assure that preemption is being done fairly. Case studies between AODV[2] and PBRS shows the added advantage of PBRS over AODV[2] in terms of priority and preemption.

Keywords- MANET, QOS, PBRS, Preemption

I Introduction

Quality of Service in MANETs became an area of great interest. Besides the problems that exist for QoS in wire-based networks, MANETS impose new constraints. This is due the dynamic behavior and the limited resources of such networks.

The provision for QOS highly relies on resource/ bandwidth reservation. But just by reserving resources QOS parameters may not be fully achieved. It is also required to differentiate the priorities among the different flows that are ratting for the resources.

AODV [2] is taken as over basis for proposing PBRS (Preemption And Bandwidth Reservation Scheme). AQR concept is added with AODV because it has the bandwidth reservation process fasten with delay and cost constrained.

The objective of PBRS are:

(a) To provide preemption with fairness.
(b) A process based on backlog and priorities of flows.
(c) Minimizing the preemption disruption to existing connections.
(d) Providing best QOS to the high priority flows.

In the remaining sections different concepts and algorithms for PBRS are proposed. A sample decision table showing when to preempt a flow is calculated.A new *timebound(tb)* and flow table are introduced with PBRS which are explained in coming section

II Related Works and literature survey

The existing QoS models[3] can be classified into two different types-the Integrated Services (IntServ)[4]which and the Differentiated Services (DiffServ) IntServ[4] use Resource Reservation Protocol (RSVP)[5] which was designed as the primary signaling protocol to setup and maintain the virtual connection. But IntServ cannot be implemented in MANET environments as IntServ is not scalable .While IntServ provides per-flow guarantees, Differentiated Services (DiffServ) follows the philosophy of mapping multiple flows into a few service levels. DiffServ[6] overcome the difficulty of implementing and deploying IntServ and RSVP. In Diffserv At the boundary of the network, traffic entering a network is classified, conditioned and assigned to different behavior aggregates by marking a special DS (Differentiated Services) field in the IP packet header (TOS field in IPv4 or CLASS field in IPv6). The drawback of DiffServ is that traffic classification and conditioning only has to be done at the boundary nodes.. But in MANETs though there is no clear definition of boundary nodes. In CEDAR [7] QOS is maintained by extracting core graph, which is an overhead to estimate and it will be more complicated if number of nodes got increased. In CASMA [8] estimates the end-to-end path life time and does not provide any procedure for preemption. EERV[9] proposed reservation on end to end basis but does not provide precedence among flow.M-AODV[10] works as a variant of AODV with added QOS feature but priorty among flows with preemption is not considerd.AQR [1] proposed bandwidth reservation and also use delay and cost as its parameter to provide routing. It does only consider two kinds of flow best-effort and real-time flow, but obviously real-time applications can be classified into many priorities basis. The proposed PBRS (Preemption And Bandwidth Reservation Scheme) is a major advancement on AODV by considering priorities and backlog among flows.

III PBRS

It will consider priorities among the different real time application are also considered for reserving bandwidth. But in AQR traffic are just divided into two kind's real-time and best effort.In addition to priority it also takes account on the priority difference and the flow oldness (backlog). Procedure (PBRS) is used in PBRS for decide a flow request should be granted or not.

PBRS will take the decision for preempting a flow $flow_i$ on the basis of its priority p_i and oldness of $flow_i$. It is being assumed here that an older flow have high amount of backlog in queues, so if any older flow is preempted then there will be more data loss. Hence the flow having fewer backlogs is a better candidate to preempt as discussed in [8]. The preemption process is delayed till RREP message is received at a link. Bandwidth estimation in PBRS is same as estimated in [1][11]

a) Terms Used

Max ΔT_{P_i} =Threshold (max) time after which the link for flow having P_i priority cannot be preempted.

ΔT_{P_i} =is the current existing time of flow 'i' in link.

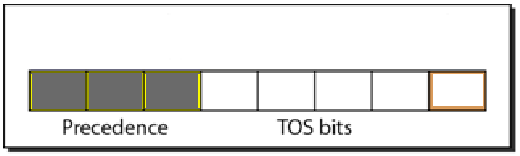
Fp(ΔP_{fi} , ΔT_{p_j}) is the probability function on priority difference and the oldness of a flow 'i' in link.

ΔP_{fi} =difference between priority of requested 'f' flow with the flow 'i'.

If difference in priorities ΔP_{ij} are less than probability for preemption will be less and vice versa. So that preemption among the flows where their priority is likely same are not preempted by newly arrived flow.

(b) Assumption and Motivations:

i. As it will use the three precedence bits of IP datagram, the total number of priorities are eight.



Service type

ii. The threshold difference is considered to be 3.that is, chances of preemption of a flow with priority difference less than 3 are less and if difference is more than 3 then probability is considered to be '1'.

iii. The older links are considered having more backlogs in queues, so preempting them will definitely cost more. As, it will have more packet loss and more delay. Therefore flows with low backlogs are candidate for the preemption.

iv. The oldness of a link is divided into four categories.

1. Just started(y value assigned 4)
2. Growing stage1(y value assigned 3)
3. Growing stage 2(y value assigned 2)
4.Grown stage(at this level probability of preemption will be '0' & y value assigned 1)

The probability to preempt the flow will decrease with the oldness of the flow (1 to 4) . 'y' value used and explained at section VI.

v. The difference in the priority is also taken into account because if we preempt flow 'i' with 'j' having marginal difference. Than we have to reroute the flow 'i' by another route and it will be a overhead and packet of flow 'i' will be lost in backlogs. So, it will be better to route 'j' from another path, may be another path have longer delays due to more number of hops

IV. PBRS Algorithm

Consider currently request flow 'f' is competing for the link 'k'

The procedure can be divided into three parts

a) Admission controller

Case1 (Breqj<=Bavailk)

Then 'k' can be assign to flow 'f' and metric is updated.

Case2 (Breqf>Bavilk) then do the following

Integer ,i=0,

size=size of flow table having priority <Pj

Array Pd[size],Bd[size]

Where Pd represent difference between priority of flows with flow 'f'. Bd is array that represents the bandwidth difference between the flows and require flow 'f'

b) Dropping RREQ

RREQ can be droped in any one case

i)We can drop RREQ if there is no such flow whose priority is less then requesting flow 'f' i.e size=0

ii) Can be dropped when the Breqj is more than the bandwidth occupied by each flow 'i' for(each i)

Breqf>Bocci

c).Calling Preemption

If RREQ is not dropped due to above reason, then preemption process can be called. Preemption process will be called for such a flow 'i' whose priority difference is highest with the flow 'f' and bandwidth required by flow f is lesser than by flow 'i'.

Preemption Process(Pd[i],flow i ,k)

End procedure PBRS

If success is returned then update the tables else drop RREQ packet.

Preemption Process(diffPif, flow to be preempted ,link)

If (Pf-Pi>=Max and ==0) then

Probability to preempt flow 'i' from link k will be 1. Hence success is returned to process procedure.

Else probability function is evaluated which can be given as follows:

If (ΔP_{fi} =Pf-Pi>=Max ΔP and ΔT_{p_j} ==0) then

Probability to preempt flow 'i' from link k will be 1. Hence success is returned to process procedure.

Else probability function is evaluated which can be given as follows:

Fp(ΔP_{fi} , ΔT_{p_j})={fd(ΔP_{fi}) x ft(ΔT_{p_j})}=p

$$\text{fd(X)}=\begin{cases} x/8 = 1 \text{ for } x = 4,5,6,7 \\ x/8 \quad \text{for else} \end{cases}$$

$$\text{ft(Y)}=\begin{cases} y/4 \text{ for } y=4,3,2 \\ (y-1)/4 \text{ for } y=1 \end{cases}$$

Note: Y=oldness of flow 'i' in link 'k'

Decision for the preemption of a flow from a link 'k'is given as follows:

Fp(ΔP_{fi} , ΔT_{p_j})=

$$\begin{cases} p \geq 0.25 \text{ then preempt the flow 'i'} \\ P < 0.25 \text{ then not to preempt the flow i} \end{cases}$$

V.Decision table

Total cases will be 8x8x4.Only sample of few cases are shown in the table:

Priority f	Priority i	Oldness(i)	ΔP_{fi}	Fp(ΔP_{fi} , ΔT_{p_j})	Decision to preempt flow i
0	7	3	-7	-0.65	no
5	3	1	2	0	no
7	2	1	5	0	no
4	0	2	4	0.5	yes
6	7	2	-1	-0.0625	no
6	6	2	0	0	no
6	5	2	1	0.0625	no
6	4	2	2	0.125	no
6	3	2	3	0.1875	no
6	2	2	4	0.5	yes
6	1	2	5	0.5	yes
6	0	2	6	0.5	yes
4	0	2	4	0.5	yes
4	7	2	-3	-0.1875	no
4	6	2	-2	-0.125	no
4	5	2	-1	-0.0625	no
4	4	2	0	0	no
4	3	2	1	0.0625	no
4	2	2	2	0.125	no
4	1	2	3	0.1875	no

VIa)Flow Table

Every node consists of flow table which stores the information of all the flows passing through a node. This is used in finding the flow that can be preempted. A snapshot of flow table is as follows:

Flow ID	Source ID	DestID	Priority	Bandwidth Reservation	Time in link

Flow Table

b) ***Time_bound(tb)Table***

It is being added here because we have preemption policy in PBRS. It is being written in RREQ phase and used by the RREP message to preempt/reserve the bandwidth at the intermediate nodes. A snapshot of time_bound table is given as follows:

FlowID (requested flow)	SourceID	DestID	Bandwidth_to_Reserve	FlowID of proposed preempted flow	Timer

Time_bound*(tb)* Table

An entry of this table will get purged if the timer's time out. Or it will be deleted when the node receive RREP.

VII Using Delayed RREP

In this section, some of the comparisons are done by reserving/preempting bandwidth effectively at the time of RREP not at the time at RREQ. During RREQ phase no reservation/preemption is done, just entry in the *timebound* table is performed. The different cases in which these approaches are beneficial are as follows.

a) Case 1: let us take a scenario (fig. 1) in which a flow 'j' having priority P_j is competing for transferring packets between 'S' to 'D'. So to perform this $RREQ_j$ packet is required to discover the path from 'S' to 'D'. Let us say that link 'AB' and 'EF' does not have available bandwidth which can accommodate the flow 'j'. If FRM returns success for the node 'A' and node 'E', then reservation is delayed until RREP received on these nodes. Let us say the RREQ from path S-A-B-C-D is

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received at node 'D'. Then RREP is send back to 'S' by path D-C-B-A-S not by D-H-G-F-E-S.

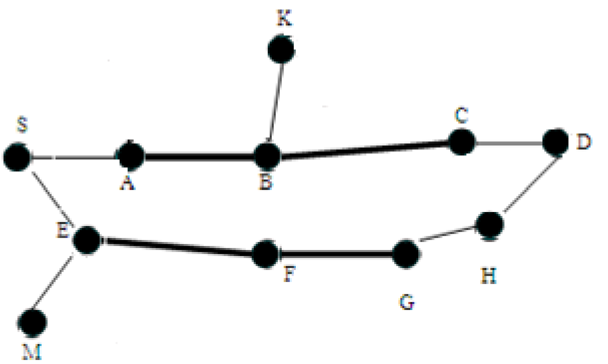


Figure 1: Showing two path form 'S' to 'D' S-S-B-C-D and S-E-F-G-H-D

So any suitable flow at link 'AB' is removed not the flow at link 'EF'. So we had minimized the number of preemption by 1. So none of the flow at 'EF' link is preempted.

Number of preemption by delaying is 1

Number of preemption without delaying is 2

b) Case 2 In this case we took a scenario (fig. 1) in which links 'AB', 'BC','EF' and 'FG' all four of them does not have available bandwidth. Now let us say that data are required to transfer from the source 'S' to destination 'D'. $RREQ_j$ is broadcasted from 'S' to 'A' and 'E'. Suppose that FRM process return success for the link 'AB' and 'EF' but returns failure for the link 'BC' and 'FG'. Then no preemption is performed in delayed process, while if we are not considering delayed preemption then two flows would have preempted in vain from link 'AB' and 'EF'.

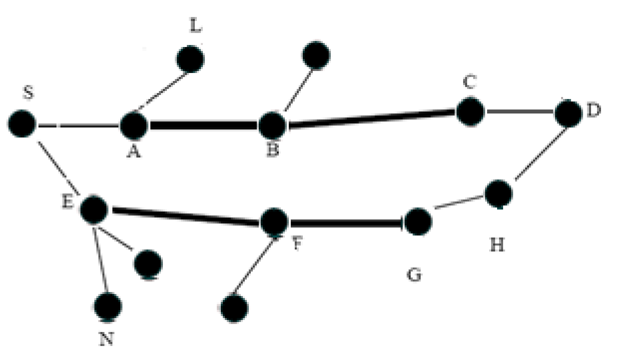


Fig 2 Showing 4 links fully reserved

So by not using delayed preemption/reservation 2 flows are preempted in vain

And by using delayed preemption/reservation 0 flows are preempted. So rerouting overhead of the preempted flows is omitted.

VII.Simulation Result And Comparision

We will campare AODV(with added admission control) and PBRS The scenario in figure3 shows flow 1 is flow from node 1 to 13 using link 4-5.

flow 2 is sending data from node 2 to 7 using link 4-5.

Flow3 is a request to send data from node 3 to node 7.

But bandwidth is not available at link 3-4.In case of AODV with added admission control, RREQ is broadcasted but RREQ will not move through path 3-4-5-6-7(as admission control return failure at link 4-5) but it will move from longer path 3-4-8-9-10-11-7.

Now let us consider what happen if we use PBRS procedure.

Flow 2 priority is 3 and oldness is level is 2.

Flow 3 priority is 7 so by applying the probability we get Fp(ΔP_{fi} , ΔT_{p_j})=0.5 >0.25 return success. So flow 2 can be preempted. Also, Bflow3<=Bflow2.

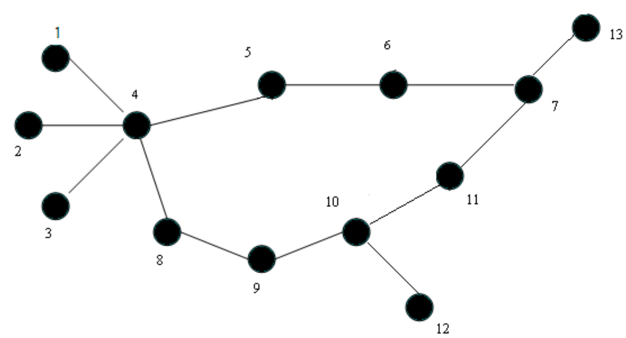
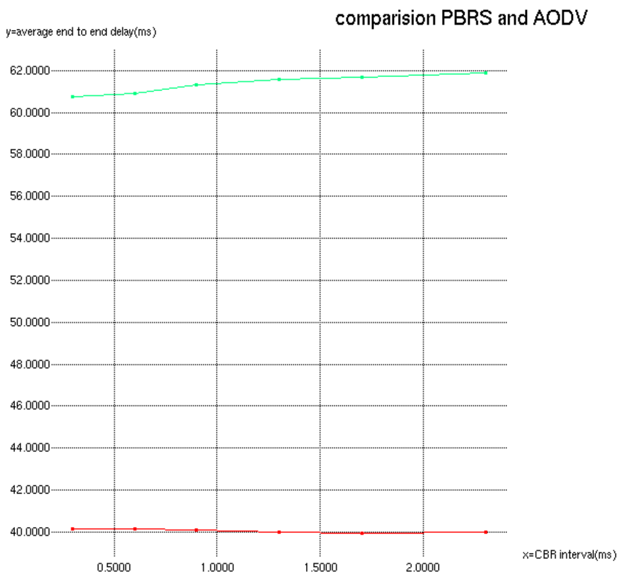


Fig. 3 Scenario for Analysis

Flow1 priority is 5 and flow oldness level is 1,then PBRS procedure will return 0.071 i.e failure so flow1 cannot be preempted.The performance between proposed PBRS and AODV is done in NS2 simulator[12]. CBR(Constant Bit

Rate) traffic generator with packet size 512bytes is being used over TCP.



End to End Delay and CBR interval is chosen as performance matrices. The result shows that PBRS is better than AODV.As in AODV the range of end to end delay is between 60 to 62 ms while in PBRS range is near to 40 ms. As in PBRS high priority data goes from shorter path by preempting low priority flow. While low priority flow can be moved to longer path, so a balanced is obviously made with both kinds of flows.

VIII.Conclusion

PBRS includes bandwidth preemption and bandwidth reservation scheme. Preemption is added with AODV in PBRS. We have shown that PBRS is fair to select the candidate flow for preemption. In case studies it is being shown with a scenario an advantage of PBRS over AODV. As it considers the priority difference and flow oldness (backlog). It is having delayed reservation policy which will decrease number of preempted flow in the network.

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