QUALITY OF SERVICE ISSUES FOR MULTISERVICE IP NETWORKS

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Abstract: Our paper deals with utilization of Quality of Service (QoS) mechanisms for backbone IP network capable of transport of voice, data and video services. The first part presents selected QoS mechanisms for multiservice IP networks. The next part discusses impact of selected QoS mechanisms on multimedia traffic through simulations. In the final part we have proposed combination of QoS methods for selected network configuration.

1 INTRODUCTION

The convergence of networks and services brings new opportunities for delivering of services. One of these opportunities is the delivery of Triple Play packages. The network operators provide voice, television and data services through single access to provider and single transport network. Until recently each of these services was delivered through its own network which met the requirements on quality of transmission for particular service (telephone network, television, internet). Single universal network has to be capable of transmitting of these services with the respect of their quality of service requirements. In our work we have focused on preventive traffic control through admission control (AC) methods for IP networks (Más, 2008) and Bandwidth Constraints (BC) models (Faucheur, 2005), (Ash, 2005) of QoS Differentiated Services (DiffServ) architecture.

2 ADMISSION CONTROL

The main task of admission control methods is to accept new traffic flow only if the network can guarantee the QoS parameters of the new flow and the admission of this flow will not degrade QoS of existing flows. Also the efficient utilization of the network resources is the goal of admission control methods. Various AC methods for IP networks were proposed in the literature, i.e. Bandwidth Broker based AC, Measurement based AC, Probe based AC (Bohnert, 2007). We have aimed to Measurement based AC (MBAC) due to their simple implementation and acceptable computational requirements. We will focus on Measured Sum and Effective Bandwidth based admission algorithms.

3 SIMULATION MODEL

The QoS mechanisms have been simulated for one 100 Mbit/s link of backbone IP/MPLS network. Simulations were performed in open source Network Simulator 2.29. It is object oriented simulator of discrete events with focus on telecommunication networks. We have divided our simulations into three parts:

- simulations without QoS mechanisms,
- simulations with bandwidth constraint models (MAM, RDM),
- application of MBAC Measured Sum method on video traffic.

Simulation time was set to 8 seconds. We have to note that this time does not correspond to real situation, but it is sufficient for demonstration of behavior of network and QoS mechanisms. Parameters of Voice over IP (VoIP), Video on Demand (VoD) and data traffic are set in Table 1. Traffic flows were set for simulation needs so that link overload and high packet losses will occur. Input traffic is shown in Table 2.

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Table 1: Traffic parameters.

Traffic type	Codec	Required bandwidth per flow	Packet length
VoIP	G.729	8 kbit/s	10 B
VoD	MPEG-4	6 Mbit/s	100 B
Data	n/a	Unrestricted	100 B

Table 2: Input traffic flows.

Traffic flows	Total capacity [Mbit/s]	Start time [s]	Flow duration [s]
1 x Data	70	0	5
3 x VoD	18	1	3
6 x VoD	36	1.5	3
1000 x VoIP	8	2	2
2 x VoD	12	2.5	2
1 x Data	70	3	5
10 x VoD	60	5.5	2

4 SIMULATION RESULTS

4.1 Simulation without QoS

In this simulation scenario the traffic flows are not prioritized, all flows are treated as equivalent. In the case of link overload every flow is degraded without respect of its QoS requirements. The results of simulation are shown in the table 3, where *R* represents total transmitted packets, *D* is number of dropped packets and *L* is percentual loss for whole link and particular traffic types. We can see that total packet loss without utilization of QoS mechanisms is 28.45%. Packet losses for each type of traffic are comparable, the slightly higher loss of video traffic is due to its start when the network is overloaded. In the Figure 1 we can see link throughput during our simulation. After link overload each flow compete for required link capacity. Total link utilization reached 90.83%.

Table 3: Transmitted and dropped packets without QoS mechanisms. *R* - transmitted packets, *D* - dropped packets, *L* - loss.

Packets	D	R	L [%]
VoIP	57473	142526	28.74
VoD	117204	265293	30.64
Data	237451	628797	27.41
Total	412128	1036616	28.45

4.2 Simulations with BC Models

This scenario illustrates the use of Bandwidth Constraint models as QoS mechanism in IP/MPLS network. We have studied the network behavior when MAM or RDM model (Faucheur, 2005) is implemented and their efficiency during link overload and congestion. We have divided traffic into three classes according priorities. For each class we have assign bandwidth determined during system design. We have used following traffic classes and their parameters:

- VoIP traffic – priority 1 (the highest), reserved bandwidth 9 Mbit/s,
- VoD traffic – priority 2, reserved bandwidth 36 Mbit/s,
- Data traffic – priority 3 (the lowest), reserved bandwidth 55 Mbit/s.

4.2.1 Simulation with MAM Model

Maximum Allocation Bandwidth Constraints Model (MAM) is based on strict maximum bandwidth allocation. The main principle of MAM model is to strict allocation of maximal bandwidth for defined traffic class. The simulation results for this model are presented in the Table 4 and Figure 2. From the table IV we can see that loss of VoIP packets dropped to 0%, but the packet losses of other traffic classes have been increased. It is due to each flow has allocated certain capacity that can be used, but nor exceeded even if there is spare bandwidth on the link. The behavior of MAM model is obvious in the figure 2 from 4.5 to 5.0 seconds when only 70 Mbit/s flows are active, but they share only 55 Mbit/s of bandwidth, while the total bandwidth is 100 Mbit/s. The similar example is in time interval 0 – 1 s when only one 70 Mbit/s flow is accommodated on the link and which uses only allocated bandwidth of 55 Mbit/s. This approach leads to inefficient utilization of network resources. The link utilization is decreased to 79.83%.

Table 4: Transmitted and dropped packets for MAM model. *R* - transmitted packets, *D* - dropped packets, *L* - loss.

Packets	D	R	L [%]
VoIP	0	199999	0
VoD	142978	239449	37.39
Data	327342	538897	37.79
Total	470320	978345	32.47

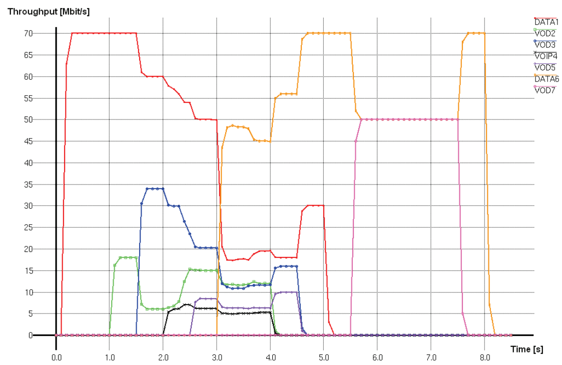

Figure 1: Throughput of particular flows without utilization of QoS mechanisms.

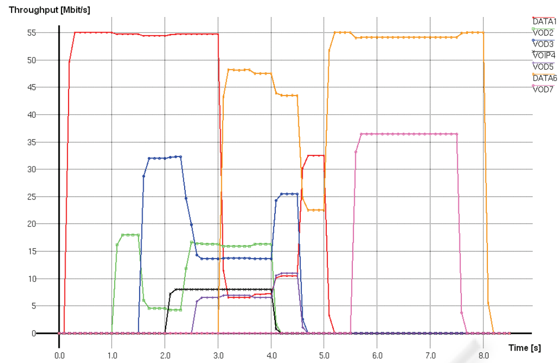

Figure 2: Throughput of particular flows with implementation of MAM model.

4.2.2 Simulation with RDM Model

Russian Dolls Bandwidth Constraints Model (RDM) model offers cumulative sharing of bandwidth among various traffic classes. Simulation results for RDM model are presented in the Table 5 and Figure 3. We can see that the VoIP were transmitted again without losses, but contrary to MAM model, the loss of data flows and total link loss are better than in the case of MAM model. RDM model allows sharing of unused bandwidth, so traffic flows can exceed their allocated bandwidth. But only flows with the lower priority are allowed to exceed allocated bandwidth. This behavior is obvious in the figure 3 from 4.5 to 5.0 seconds when two traffic flows use the whole link bandwidth even though they have allocated only 55 Mbit/s. Another example can be seen in time interval 0 – 1 s when one 70 Mbit/s flow with assigned 55 Mbit/s bandwidth uses full 70 Mbit/s. The use of RDM model leads to more efficient utilization of network resources. The link utilization is now increased to 90.88%. Based on the previous simulation results we have decided to use RDM model in our system proposal due to better link bandwidth utilization and bandwidth guarantee for each of services.

Table 5: Transmitted and dropped packets for RDM model.

Packets	D	R	L [%]
VoIP	0	199999	0
VoD	142810	239687	37.34
Data	217162	649086	25.07
Total	359972	1088772	24.85

4.3 Simulation with MBAC for Video Traffic

With the regard of simulation results of RDM model simulation we have to improve loss of VoD packets, which reached almost 40%. For VoD traffic we have allocated bandwidth of 36 Mbit/s, but during almost the whole simulation the bandwidth required by active VoD connections exceeded this limit. Hence we have decided to use MBAC method for video traffic. We have compared three MBAC methods (Measured Sum, Effective Bandwidth based on Hoeffding Bounds and Tangent at Peak) by simulations. Based on these simulations we have decided to use Measured Sum method (Nevin, 2008) because it has reached several times zero packet loss. The number of sampling periods per time window n we have set to 10 and allowable link utilization is 100%. The simulation results we can see in the Table 6 and in the Figure 4.

We can observe that packet loss of VoIP traffic is unchanged by Measured Sum method compared to previous simulation. Application of Measured Sum admission control method has impact on the packet loss of VoD traffic, which has now zero value.

It is due to rejection of connections exceeding the allocated bandwidth by their requirements. The packet loss of data traffic is also decreased, because MS method accepts less of VoD connections, so the data flows can use bandwidth dedicated to VoD traffic. Total link utilization reached 90.88% and

Table 6: Transmitted and dropped packets for RDM model with Measured Sum MBAC for VoD traffic.

Packets	D	R	L [%]
VoIP	0	199999	0
VoD	0	224999	0
Data	202482	663766	23.37
Total	202482	1088764	15.86

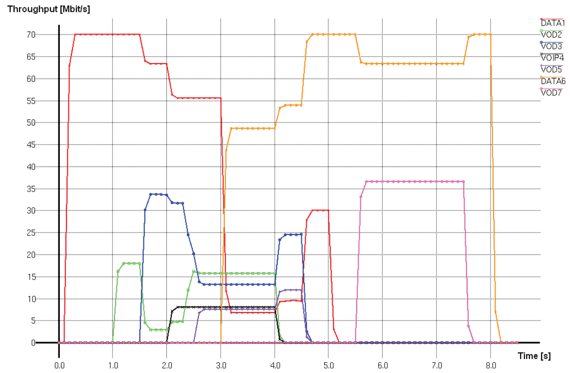

Figure 3: Throughput of particular flows with implementation of RDM model.

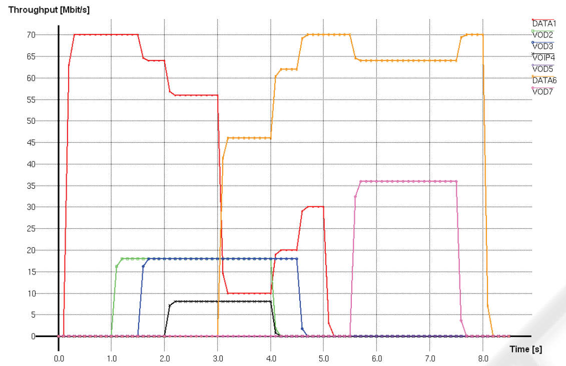

Figure 4: Throughput of particular flows with implementation of RDM model and Measured Sum method for VoD traffic.

total packet loss dropped to 15.68%. It is not necessary to add additional QoS mechanisms, because we have reached zero losses for the services with the higher QoS requirements. Admission control Measured Sum method can be applied also on VoIP traffic. We have met the QoS requirements of VoIP by RDM model by dividing of bandwidth among particular traffic classes.

5 CONCLUSIONS

Internet Protocol networks naturally offer only best-effort service. Hence, many different QoS mechanisms for IP networks have been proposed. We have verified two of these mechanisms for the multiservice IP network by simulations.

Based on our simulations we have proposed efficient combination of measurement based admission control and bandwidth constraint model for QoS provision for voice, video and data services transmitted over single IP network.

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