Admission Control Method with the Proposed Weighting Parameter

ERIK CHROMY, MATUS SINDLER, IVAN BARONAK
Faculty of Electrical Engineering and Information Technology
Slovak University of Technology in Bratislava
Ilkovicova 3, 812 19 Bratislava
SLOVAKIA
erik.chromy@gmail.com, msindler94@gmail.com, baronak@ut.fei.stuba.sk

Abstract: Admission control is an important tool for ensuring the quality of service in IP networks. This type of control mechanism should be implemented mostly in access networks in the nodes where the traffic is aggregated. Admission control can be defined as a set of principles used to protect the network from overloading and it is also responsible for efficient utilization of network resources. The goal of admission control method is to guarantee the quality of the service for the newly accepted connection without limitation of the other existing connections, to decide quickly with minimal delay and efficient use of the bandwidth capacity. In our paper, we introduce a new admission control method that is based on the Simple Sum method. The proposed method does not reserve a peak rate for each data stream but it uses the value of the traffic rate, that is dependent on the number of already received data streams.

Key-Words: Admission Control, Quality of Service, Bandwidth.

1 Introduction

Admission Control [1-7] is an important process in terms of the quality of service ensuring. The main task is to identify and to ensure the transmission resources for the incoming traffic. However, this can not affect or limit the quality of service (QoS) [8-13] of an existing service in the network [14-15]. The decision about access is implemented through the decision methods that works based on a variety of criteria. Based on these criteria it is determined, whether or not the incoming connection will be accepted.

All the admission control (AC) methods have one basic condition, which is expressed as follows:

$$P\left[\sum_{i=1}^{N} r_i(t) \geq C_m\right] \leq \varepsilon \; . \tag{1}$$

The equation (1) represents the probability, where the sum of the current bit rates ri of the all N connections, that shares the total capacity Cm, must be less than ε. The parameter ε determines the upper limit of the overload [15].

The required properties of the admission control methods are:

- to ensure the quality of service for the new incoming connection without limiting the other existing connections,
- to decide quickly with minimal delay and
- efficient bandwidth use.

1.1 Analyzed Admission Control Methods

In our paper, we have analyzed the following AC methods: Simple Sum and Acceptance Region.

Simple Sum Method is a very simple admission control method, where the sum of the transfer rates of the existing data streams and the new incoming data stream does not exceed the bandwidth of the output medium. Then the following equation applies:

$$V + v_n \leq C_m \; , \tag{2}$$

where V [kbit/s] is the sum of the transmission rates of the existing connections, v_n [kbit/s] is the required transfer rate of the new incoming connection and C_m [kbit/s] represents the total bandwidth that is at the output of the node (e.g. router) [14].

Acceptance Region Methods decides about accepting of a new data stream based on the current status of the system and also based on the area in which the system is located - in the area of acceptance or rejection. The acceptance area is calculated to provide the maximum utilization of the system at an acceptable loss value. This method assumes that the new requirements arrive according to the Poisson distribution and the following equation is applied:

$$np(1 - e^{-sp}) + e^{-sp}v \leq \theta C \ , \qquad (3)$$

where n represents the number of accepted data streams, p [kbit/s] represents the peak rate of a new connection, s is the parameter from the interval <0,1>, v [kbit/s] represents the current transmission rate of the existing data connections, C_m [kbit/s] indicates the maximum capacity of the transfer medium and θ is the parameter of a link utilization, that takes values from the interval (0,1> [16].

2 Simulation of the Selected Admission Control Methods

For the simulation needs of individual admission control methods, we have used data flow generators that are gradually connecting to the network. After applying the selected AC method, it is decided about the accepting or rejecting the given data connection.

2.1 Data Stream Generator

The network topology that we have used in our simulations is depicted in the Fig. 1.

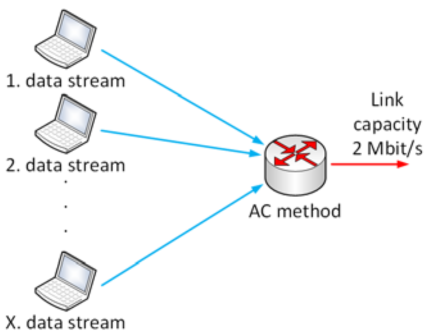

Fig. 1. Network topology scheme.

The admission control method is applied on the node (i.e. the router) to which the data streams are gradually connected. The node then decides about accepting or rejecting the data stream, it depends on the actual usage of the transfer medium. For the simulation needs, we have created a simple data stream generator that generates a general data traffic (data streams). The data streams are connected gradually and have an optional mean rate value. We have created a generator with 50 data streams whose requirements are gradually incoming to the node (at random time intervals). The individual data streams are represented by transfer rate value, that are generated with a Poisson distribution with mean value 64 kbit/s. In our simulations, it is very important, that the data streams have a variable bit rate character. The link capacity C_m is limited on the value 2 Mbit/s.

For better visualisation, on the following figure (Fig. 2) is depicted the time flow of one generated data stream.

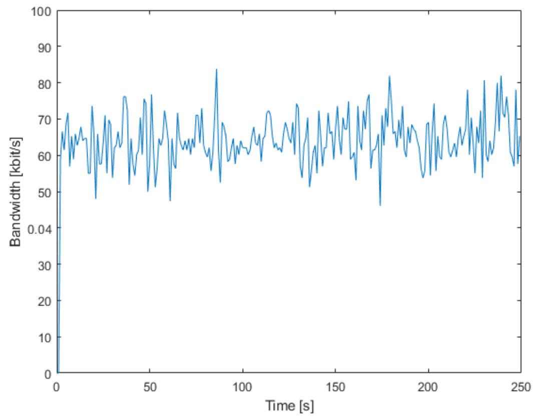

Fig. 2. Time flow of one generated data stream.

2.2 Simple Sum Method

Simple Sum method is based on the simple condition of the sum of the requested transmission rates for individual connection. The efficiency of this method depends on the bandwidth that is determined for each data stream. In this simulation, the peak rate of the data streams was used.

In Fig 3. we can see, that the usage of the link capacity is less than 70 %. It was accepted only 24 data streams, but for these data streams is guaranteed quality of service. Using this method, there is no situation that the total link capacity will be exceeded. Thus, there is no loss. This method is not effective in terms of the use of the media transfer capacity. Therefore, this method can be used to transfer data streams that are loss and delay sensitive. The Simple Sum method decides quickly because of only the basic mathematical operations are used.

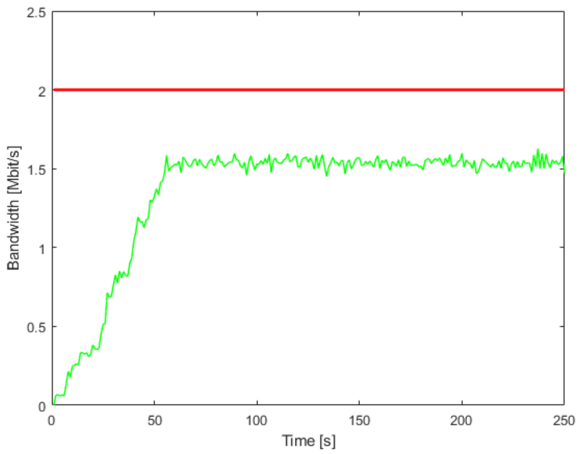

Fig. 3. Accepted data traffic with the Simple Sum method.

Table 1. Simulation results of the Simple Sum method.

Parameters	Values
Number of accepted data streams	24
Number of mathematical operations	2
Link utilization C_m [%]	67.38
Number of overloads	0
Loss [%]	0

2.3 Acceptance Region Method

Acceptance Region method is a little bit more complex than the previous method (Simple Sum). For decision, it uses a more complex condition with multiple parameters and also more mathematical operations (which adversely affects on the decision efficiency). This method no longer allocates a peak rate for each data stream. It allocates such bandwidth that the acceptable loss value is not exceeded. This will allow us more efficient use of the transmission capacity.

The link utilization has increased significantly compared to the simple sum method (82 %). Up to 30 data connections have been accepted. However, by applying this method also some losses occurred - at some time intervals the maximum link capacity was exceeded (marked with a red ring in the Fig. 4). The total loss is 0.0069 %. In our simulation, the parameter of the utilization θ was set to 0.95 and the parameter s to 0.7.

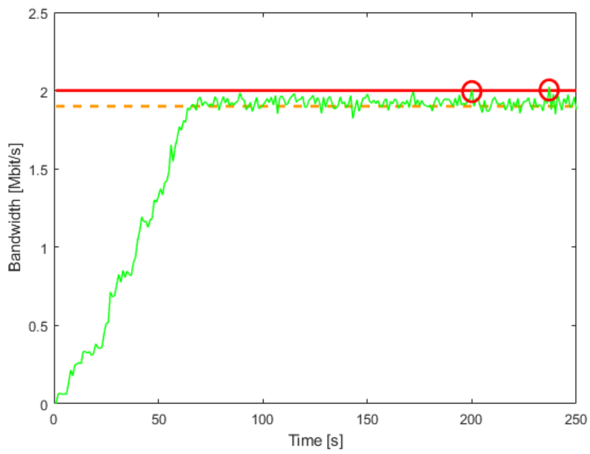

Fig. 4. Accepted data traffic with the Acceptance Region method.

The Acceptance Region method is more effective than the Simple Sum method in terms of the usage of the media capacity. It uses the link capacity up to the limit of the utilization θ. However, this results in a possibility of loss. Also, this method uses a more complex decision condition, which results in an extension of the decision time. Therefore, this method is more suitable for data transmission which has not exact requirements on loss and delay.

Table 2. Simulation results of the Acceptance Region method.

Parameters	Values
Number of accepted data streams	30
Number of mathematical operations	13
Link utilization C_m [%]	82.07
Number of overloads	2
Loss [%]	0.0069

3 Admission Control Method Proposal

As the basis, for the design purpose of our admission control method we have used the Simple Sum method. The principle of the proposed method is, that it does not reserve a peak rate for each data stream but it reserves a lower value of transmission rate that is dependent on the number of already received data streams and on their transmission rate calculated at the previous decision.

That's why we've proposed a new parameter in our method *m*. The proposed method accepts additional data streams based on the following equation:

$$V + pm^{\frac{1}{n}} \leq \theta C_m \,, \tag{4}$$

where V [kbit/s] represents the bandwidth of existing connections calculated at the previous decision, p [kbit/s] represents the peak rate of the new connection. m is a parameter selected from the interval (0,1> and represents the basic value needed for the calculation of the weight, which will be allocated to the data stream. n represents the number of the data streams, C_m [kbit/s] is the maximum link capacity. θ is the link utilization parameter, which takes values from the interval (0,1>.

As already mentioned, our method does not reserves a peak rate for each data stream, but only o part of it. It could also be said, that the proposed method allocates a certain weight to each new data stream. The weight that multiplies the peak rate, depends on the number of accepted data streams n. If the number of received data streams is low, also the assigned weight and the calculated transmission rate will be low. As the number of received data streams will be higher, then the calculated transmission rate will approach the peak rate of the given data stream. How the calculated transfer rate will approach the peak rate depends on the value of the set parameter m, that takes values from the interval (0,1>. In the Fig. 5 we can see how the weight of the transfer rate will vary depending on the value of the parameter m.

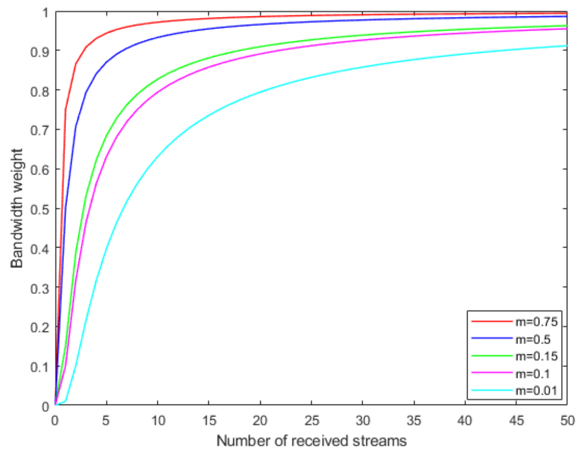

Fig. 5. The dependence of the transfer rate weight based on the number of received data streams and the parameter *m*.

3.1 Simulation of the Proposed Admission Control Method

The simulation principle is the same as in previous methods. The proposed admission control method uses an method, that is derived from the Simple Sum method. Our method does not allocate a peak rate for each data stream, but we have used the parameter *m* for weighting the transfer rates depending on the number of accepted data streams. The method is simpler than the Acceptance Region method with respect to the computational performance.

When comparing the time flows of the data traffic accepted with our proposed method (the Fig. 6) and the accepted data traffic with the Simple Sum method (the Fig. 3) we can see that the proposed method has received significantly more data streams. Our proposed AC method has accepted 29 data streams, the link utilization has increased to the limit of the usability and there was no overload. In our simulations, the value of the parameter m was set to value 0.15 (here, the most data streams were received and the loss was 0).

Table 3. Simulation results of the proposed admission control methods.

Parameters	Values
Number of accepted data streams	29
Number of mathematical operations	6
Link utilization C_m [%]	79.70
Number of overloads	0
Loss [%]	0

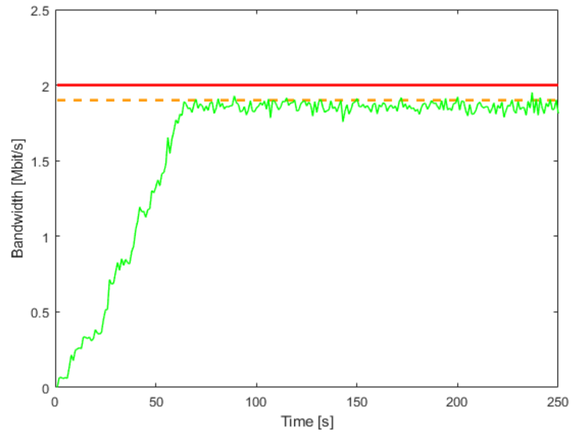

Fig. 6. Accepted data traffic controlled by the proposed admission control method.

3.2 Comparison of the Simulated AC methods

All simulated admission control methods can be compared in several ways: number of accepted data streams, link utilization, number of mathematical operations that are needed for the accepting of one data stream (i.e. decision complexity), number of overloads and also loss. The Fig. 7 shows the data traffic received by the individual admission control methods.

From the view of the number of accepted data streams, the Acceptance Region method has accepted the most data streams (30). Then our proposed AC method (29 data streams) and then Simple Sum method (24 data streams).

The same order is in terms of the link utilization. Acceptance Region method has reached the highest link utilization (82 %), our proposed method 79 % and the Simple Sum method 67 %. These values were calculated from the total link capacity during the entire simulation.

From the view of the decision complexity of the method, we have used the number of mathematical operations (per one decision). Based on the number of mathematical operations, simulated methods can be compared in terms of their decision e□ciency. The minimum number of operations per decision (two) requires the Simple Sum method. So we can assume, that this method is the fastest method from all the simulated methods. The second method is our proposed method (6 mathematical operations). From the view of the number of mathematical operations, the most complex method is the Acceptance Region method (13 mathematical operations). However, this comparison may not be unambiguous because the methods were compared only in terms of the number of mathematical operations and not in terms of the time complexity of the individual mathematical operations.

From the view of the number of overloads and loss the simulation results are as follows. The Simple Sum method and our proposed method were without overloads and thus also without loss. When simulating the Acceptance Region method, the link capacity exceeded 2 times, with overall loss 0.0069 %.

Table 4. Overall simulation results of the AC method.

Parameters	Simple Sum	Acceptance region	Proposed Method
Number of accepted data streams	24	30	29
Number of mathematical operations	2	13	6
Link utilization C_m [%]	67.38	82.07	79.70
Number of overloads	0	2	0
Loss [%]	0	0.0069	0

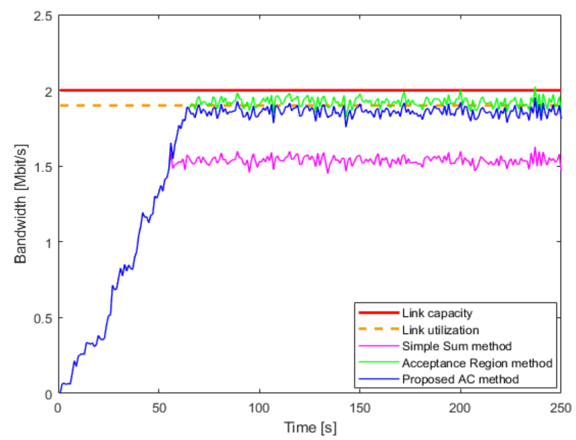

Fig. 7. Comparison of the accepted data tra□c by the individual AC methods.

4 Conclusion

Our proposed admission control method is based on the Simple Sum method. The proposed method does not reserve a peak rate for each data stream but it uses the value of the traffic rate that is dependent on the number of already received data streams. It means that we have added some weighting of the transmission rate to the equation. Our proposed method was simulated and compared with other simulated admission control methods.

For the simulation purposes, we have used a simple data stream generator that generates general data stream with Poisson distribution and with the same average transmission rate value. Therefore, in the next work we will focus on the simulation, comparison and design of the admission control method for a specific traffic (e.g. VoIP and IPTV). The results of the presented simulations and the design of our method allow us to continue working on this very interesting topic.

Acknowledgement This article was created with the support of the Ministry of Education, Science, Research and Sport of the Slovak Republic within the KEGA agency project – 007STU–4/2016 Progressive educational methods in the field of telecommunications multiservice networks and VEGA agency project – 1/0462/17 Modeling of qualitative parameters in IMS networks.

References:

[1] Alipour, E., Mohammadi, K.: Adaptive Admission Control for Quality of Service Guarantee in Differentiated Services Networks. International Journal of Computer Science and Network Security 8, 93–98 (2008)

[2] Jiang, Y., Emstad, P., Nevin, A., Nicola, V., Fidler, M.: Measurement-Based Admission Control for a Flow-Aware Network. In: Next Generation Internet Networks (2005), pp. 1–8. https://doi.org/10.1109/NGI.2005.1431683

[3] Jamin, S., Danzig, P., Shenker, S., Zhang, L,: A Measurement-based Admission Control Algorithm for Integrated Services Packet Networks (Extended Version). IEEE/ACM Transactions on Networking, 20 pages (1997)

[4] Yi-ran, G., Suo-ping, W., Hai-ya, W.: A structural comparison of measurement based admission control algorithms. The Journal of China Universities of Post and Telecommunications 13, 81–86 (2006)

[5] ETSI ES 282 003 v3.5.1: Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Resource and Admission Control Sub-System (RACS): Functional Architecture (2011)

[6] De Rango, F., Tropea, M., Fazio, P., Marano, S.: Call admission control with statistical multiplexing for aggregate MPEG traffic in a DVBRCS satellite network. In: GLOBECOM 05, IEEE Global Telecommunications Conference, St. Louis, USA, (2005)

[7] Gibbens, R., Kelly, F., Key, P.: A Decision-Theoretic Approach to Call Admission Control in ATM Networks. IEEE Journal on Selected Areas in Communications 13, 1101–1114 (1995)

[8] Halas, M., Klucik, S.: Modelling the Probability Density Function of IPTV Traffic Packet Delay Variation. Advances in Electrical and Electronic Engineering 10, 259–263 (2012)

[9] Klucik, S., Lackovic, M.: Modelling of H.264 MPEG2 TS Traffic Source. Advances in Electrical and Electronic Engineering 11, 404–409 (2013)

[10] Frnda, J., Voznak, M., Sevcik, L.: Impact of packet loss and delay variation on the quality of real-time video streaming. Telecommunication Systems 62, 265–275 (2016)

[11] Orcik, L., Voznak, M., Rozhon, J., Rezac, F., Slachta, J., Toral-Cruz, H., Lin, J.C.W.: Prediction of Speech Quality Based on Resilient Back propagation Artificial Neural Network. Wireless Personal Communications 96, 5375–5389 (2017)

[12] Bosternak, Z., Roka, R.: Approach of the T-CONT allocation to increase the bandwidth in passive optical networks. Radioengineering 26, 954–960 (2017)

[13] Bosternak, Z., Roka, R.: Bandwidth Scheduling Methods for the Upstream Traffic in Passive Optical Networks. Przeglad Elektrotechniczny, 9–12 (2018)

[14] Chromy, E., Kavacky, M., Dresto, L.: Admission Control Methods in IMS Networks. International Journal of Advances in Telecommunications, Electrotechnics, Signals and systems 5(3), 142–145 (2016)

[15] Cuba, M., Baronak, I.: Admission Control Methods in IMS Networks. Advances in Electrical and Electronic Engineering 14, 358–363 (2016)

[16] Chromy, E., Wu, T.-Y., Cipov, R., Kavacky, M., Klucik, S., Baronak, I., Orcik, L.: Study of Admission Control Methods for IPTV Services. Proceedings of the 3rd Czech-China Scientific Conference (2017)