Selective Aggregated Session Control with QoS Provisioning for GMPLS Networks

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Introduction

Carrier networks are gradually adopting a network model that consists of MPLS (Multiprotocol Label Switching) capable routers (GMPLS (Generalized Multiprotocol Label Switching) in the nearest future) and OXCs (Optical Crossconect) interconnected by high bandwidth WDM (Wavelength-division Multiplexing) links for transporting IP and Ethernet traffic. Globalization drives the quest for end-to-end QoS (Quality of Service) guarantees over different carrier networks. [1].

GMPLS is the proposed control plane solution for the next generation optical networking. GMPLS differs from the traditional MPLS with the added switching capabilities for lambdas and fibers, as well for time slots and packets. GMPLS makes the first step towards the integration of data and optical network architectures and significantly reduces the operational costs with easier network management and operation [2].

While GMPLS serves as the brilliant solution for NGN (Next Generation Networks) development strategy, which is mentioned to be QoS aware and concerning end-to-end provisioning, the effectiveness of the overloaded GMPLS routing device is directly dependent on effective QoS aware initialization session handling strategy.

One of the crucial indicators of the performance of routing device is the maximum capability of allowable volume of the newly initialized sessions per second. Even today, some bigger access network routing devices have to cope with many hundreds and even thousands of new connections per second. The edge routers are capable of processing more then 100000 connections/sec. Taking into consideration the volumes of new connection sessions mentioned above, the crucial issues is a proper mechanism for the effective session initialization handling in a peak hours, when the link utilization is very close to the maximum allowed.

As NGN network architecture aware applications, while setting up the new session, have the capability to provide information about the requested bandwidth and a level of the required QoS, the effective session handling mechanism should be able to cope with the subsequent tasks: provide the maximum link utilization, minimize the risk of link overutilization, provide the selective flow control, enforce the SLA fulfilling.

Looking from the perspective of ISP (Internet Service Provider) the very significant issue of the effective traffic management is the ability to maximize the number of most prior traffic class sessions to be connected in the overutilized conditions guaranteeing SLA provisioning for most prior type of services, as total revenue of ISP can be affected in case the SLA conditions are not enforced.

The actual CAC (Connection Admission Control) solutions are operating in a serial manner, processing one new session per time. Such an approach leads to the situation when the decision whether to accepts or deny the new session is based purely on the some defined metrics of the current link state. On the other hand, session metrics, such as QoS requirements and requested bandwidth, are not compared in between consecutive sessions. This leads to the situation, when the time scale in between close new session request instances is ignored.

The only applied solutions which take the time scale into consideration are various traffic forecasting techniques [3, 4]. The selfsimilar nature of the present-day aggregated multimedia traffic is highly restricting traffic forecasting effectiveness, especially in the short time forecasting periods [5].

All the difficulties mentioned above led to the concept of the incoming new sessions parallel processing. Such an approach at the very root overcomes the time scale ignorance restriction. It allows making the selective session CAC switching while making the session comparison in between the sessions themselves. The fixed bundle of the newly arrived sessions is buffered which gives the option for the maximum revenue comparison to

be performed.

In some previous publications, the authors have proposed fuzzy-logic based RSVP-TE protocol modifications, which have showed very promising results regarding proactive traffic engineering [6, 7]. While examining the papers mentioned above, one can find the extensively described results of simulation studies as well as practical fuzzy-CAC based RSVP-TE protocol realization on MPLS-TE testbed.

In the current paper, the authors propose the alternative approach for new session initialization handling in the overloaded GMPLS routers. The proposed selective AggSess AC (Aggregated Session Admission Control) approach in some respect can serve as a supplement to the fuzzy-CAC approach, which was proposed previously, or can act as a self-sufficient operational substitute for efficient QoS provisioning in GMPLS networks.

The concept of session aggregated selective control

The main idea of the AggSess AC is based on a concept of a bundle of a new session initialization connections that are analyzed intermediary. Looking from the perspective of ISP (Internet Service Provider) one of the most significant issues is the ability to maximize the number of higher traffic class sessions to be connected in the over-utilized conditions, thus maximizing pre-defined SLA enforcement. SLA contract between a customer and a service provider specifies the forwarding service that customer should receive and defines the set of parameters and their values which composes the service offered to specific class of traffic. Where the highest priority traffic is related to more stringent conditions of SLA and non-fulfilment of which could negatively affect the total revenue of ISP. Concept of SLA policy in one network domain is depicted on Fig. 1. The same SLA policy *m* is defined by all the edge routers in the same network domain.
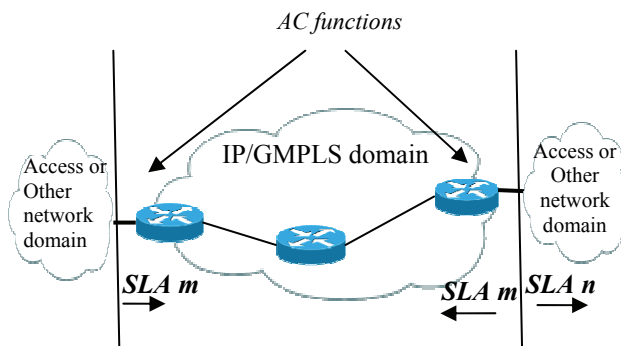

Fig. 1. Organized concept of SLA in IP/GMPLS networks

The aggregated session analysis is suitable only in the situation of a high link utilization rates, as otherwise the link traffic engineering is greatly straightforward and does not need any sophisticated techniques to maintain SLA defined QoS parameter values.
When a specific link utilization level A_{max} is achieved, the proposed session control solution start to aggregate all the new arrived sessions (Fig. 2). The aggregation is maintained in the time period which is not greater then y_{max}

or the aggregation stops if the predefined number of the new session n_{max} is collected. Hereby the objective of the routing device is to extract all the session initialization packets from the packet flow and then provide the adequate initialization packet classification to the appropriate QoS subclasses. For more diverse traffic classification the flows was divided into specific subclasses in the form of colours, which was chosen in respect to the bandwidth required and corresponding QoS class (Table 1).

The proposed AggSess AC solution provides the possibility of selective traffic session control at the cost of acceptable delay, which is injected while aggregating the new sessions to be parsed through the AC mechanism.
The modern core and edge routers are capable of processing thousands and even 100000 connections/sec. It means that minimal processing time of new connection for router that can perform 1000 connections/sec is 1ms, but if router performance is 10000 connections/sec minimal processing time is 0.1ms. Taking into account all the considerations mentioned above, the authors assume that maximal time of aggregation period y_{max} should not be more then 10ms which leads to the conclusion that the AggSess AC delay for session initialization will also be less then 10 ms.
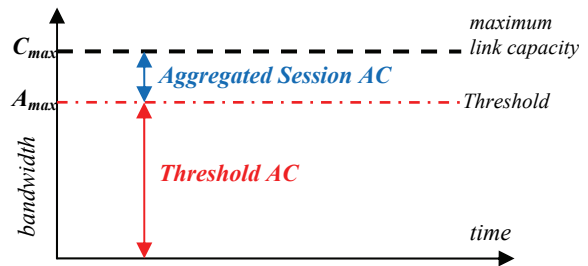

Fig.2. Session aggregation starting point - specific link utilization level A_{max}.

The AggSess AC decision making trigger can be defined in the way of *IF-THEN* rule:

IF *(time of aggregation period y == y_{max}) || (number of new sessions n == n_{max})*
MAKE DECISION
END.

Description of the simulation model

The current AggSess AC simulation model was developed using Matlab programming environment. The approximate scheme of the simulation model is depicted on Fig. 3.
Simulation model includes new session generator which is made of traffic trace file reader. For simulation purposes it was decided to use the synthetic workload generator rather than the real network traces because of the repeatability that allow us to perform the analysis in a flexible persistent way. Generated traffic trace includes information about the new flow requested bandwidth as well as QoS class. The other traffic generated trace file determines the relative time of arrival of a new session initialization packet. Traffic sources (*source 1,source2 ..source n*) were handled by session generator in a

sequential manner – the new source for the each new flow. The input buffer size was equal to $n_{max} =10$ and relative period of aggregation time was equal to $y_{max} =10$.
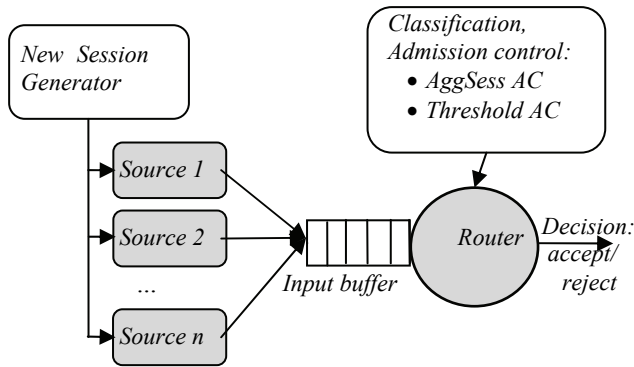

Fig. 3. Schema of the simulated AggSess AC and Threshold AC

For the current simulation model the maximal output link capacity (C_{max}) of the router was equal to 20000 bps ≈ 20 Mbps, and the threshold level A_{max} to start AggSess AC control algorithm was chosen to be equal to 18000 bps ≈18 Mbps.

The authors suggest classifying traffic by subclasses regarding two parameters such as required bandwidth and class of service (Table 1). Assuming that the proposed AggSess AC algorithm is intended to be used in situations of a high link utilization rate, when the remaining bandwidth is small, the very important issue is to make selective flow processing, which takes into account the ISP pre-defined traffic priorities.

A large number of the important sessions like VoIP, network management protocols (telnet, SSH, SNMP) requires bandwidth in the boundaries of tens to hundred of kbps. It means that one can maximize the overall revenue by accepting the highest priority flows with the lower required bandwidth. It is difficult to define the objective argument of the 400 kbps flow to be more acceptable than 500 kbps, therefore, the threshold for traffic classification was chosen at 150 Kbps, which is dominant in many of important sessions, such as VoIP.

On Fig. 4 the generated traffic trace is depicted after classification to the an appropriate subclasses (colours). In our simulation case, the "best effort" produces the basic type of traffic and all other types have an about similar distribution.
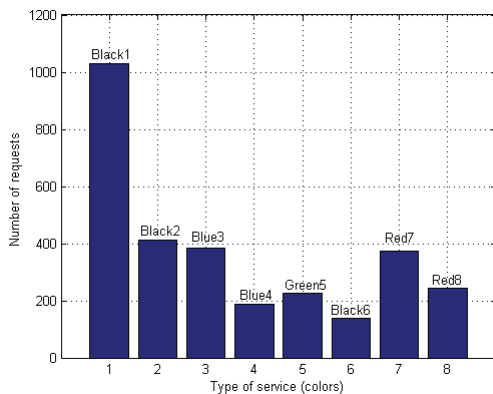

Fig. 4. Input traffic pattern classified by Type of Services (colours)

Table 1. Traffic classification

	Best Effort	Business (enterprice)	Control/ MGMT	Realtime
QoS Request bandwidth	Class1	Class2	Class3	Class4
≤150	Black2	Blue4	Green6	Red8
≥150	Black1	Blue3	Green5	Red7

*Note: *Control/MGMT – Control/management traffic.*

General results

Below one can find general practical results achieved by using both, AggSess AC and Threshold AC algorithms with the same input traffic pattern for decision making and in the same network conditions as described above. All the values are depicted for 3000 newly processed sessions.

For the revenue calculation and estimation the authors assumed a specific ratio for an each of traffic subclasses (colors) in the following way (Table 1):
- Ratio for black1 = 1;
- Ratio for black2 = 2;
- Ratio for blue3 =3;
- Etc.

In case with AggSess AC algorithm and based on an idea that peak hours scenario was simulated then average bundle size (number of the new session n_{max}) for each decision step were ~7,3 and 413 decisions were made while the Threshold AC made 3000 decisions.

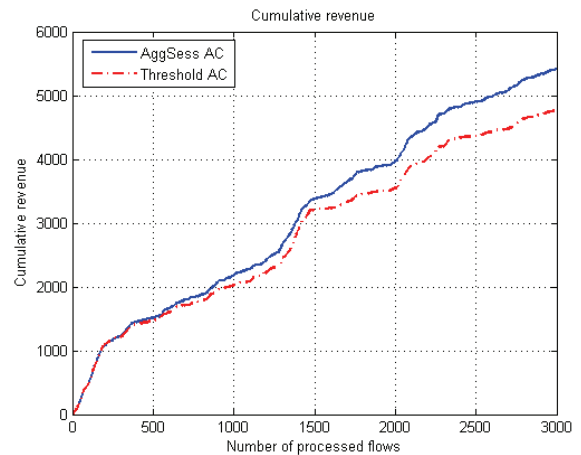Cumulative revenues of AggSess AC and Threshold AC are depicted on Fig. 5.

Fig. 5. AggSess AC and Threshold AC cumulative revenue

Table 2. Total revenue by different number of processed flows

Number of processed flows	500	1500	2500	3000
Total revenue (AggSess AC)	1511	3381	4895	5405
Total revenue (Threshold AC)	1469	3207	4367	4783

Cumulative revenues of AggSess AC and Threshold AC are depicted on Fig. 5. Results show that AggSess AC gives higher total revenue then Threshold AC algorithm while processing the same number new sessions. Such a

performance can be explained with the AggSess AC decision making manner, where the bundle of requests is analyzed intermediary at a high utilization rates. Such an operational manner provides more selective admission control. For better clearness total revenue by different number of processed flows is showed in Table 2.
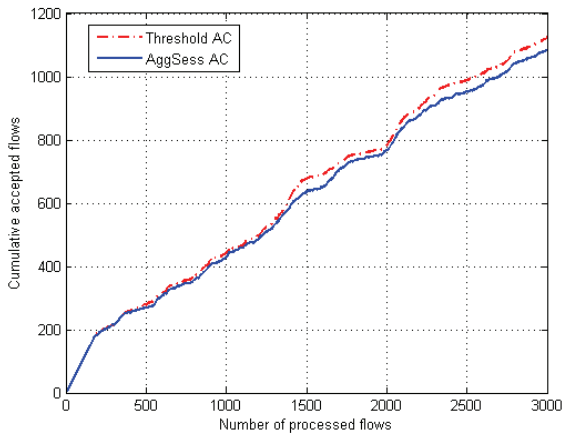

Fig. 6. Cumulative accepted flows

The Threshold AC accepts bigger number of flows if compared with the proposed AggSess AC. (Fig. 6.). The results show, that AggSess AC provides more efficient flow control, with the lower amount of the accepted flows. Such a result strongly depends on used traffic pattern as well as flow classification method.

Conclusions

The proposed fuzzy AggSess AC shows promising results and can be used as the GMPLS network control mechanism to deal with multiple class traffic of next generation fast optical networks which are anticipated to operate under GMPLS control plane. Simulation test results show that the performance of proposed algorithm is preferable to that of existing threshold AC. In the high utilization conditions AggSess AC guarantees increasing of total revenue if compared to classical Threshold AC. In simulation experiment with the defined traffic pattern the total revenue increased by the 12%. Such an increase is gained at the cost of insignificant delay increase while starting a new session.

Regarding the practical application of such an algorithm, the one of the most important task is to adjust the proper threshold level A_{max} as well as the maximum size of a session bundle. The future research anticipates the estimation of the parameters mentioned above, while performing the dynamic parameter modifications as well as looking for most appropriate and effective bundle processing algorithm.

References

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A. Skrastins, J. Jelinskis, G. Lauks. Selective Aggregated Session Control with QoS Provisioning for GMPLS Networks // Electronics and Electrical Engineering. – Kaunas: Technologija, 2012. – No. 6(122). – P. 75–78.

In this investigation the new AggSess admission control (AC) algorithm is presented for use in GMPLS networks. AggSess AC algorithm is tested on simulated network model, on which classical threshold AC algorithm is compared to the AggSess AC implementation. Main QoS characteristics are analyzed, experimental data are depicted and future research subjects are described. Ill. 6, bibl. 7, tabl. 2 (in English; abstracts in English and Lithuanian).

A. Skrastins, J. Jelinskis, G. Lauks. Atrankinė agreguota seanso kontrolė GMPLS tinkluose su rezervuojama QoS // Elektronika ir elektrotechnika. – Kaunas: Technologija, 2012. – Nr. 6(122). – P. 75–78.

Pateikiamas AggSess prieigos kontrolės (PK) algoritmas, skirtas naudoti GMPLS tinkluose. AggSess PK algoritmas testuotas naudojant tinkle modelį, kuriame klasikinis slenksčio PK algoritmas palygintas su AggSess PK implementacija. Nagrinėtos pagrindinės QoS charakteristikos, atvaizduoti eksperimentiniai duomenys ir apibrėžta tolesnių tyrimų tematika. Il. 6, bibl. 7, lent. 2 (anglų kalba; santraukos anglų ir lietuvių k.).