Knowledge-Based Admission Control: A Real-Time Performance Analysis

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***Abstract*—This demonstration consists of a web interface tool that illustrates the behavior of a prototype implementation of a new data-driven admission control solution. This solution that we refer to as Knowledge-Based Admission Control (KBAC) solution is described in [3]. Our KBAC solution builds an up-to-date *Knowledge Plane* of the link behavior by feeding a mono-server queue model. This demonstration offers visual display of instantaneous (i) *Knowledge Plane* building; (ii) performance of our KBAC solution. We also illustrate the behavior of our proposed solution that provides a good trade-off between flow performance and resource utilization.**

I. Introduction

Over the last few years, new usages such as streaming or live video watching are increasingly representing a significant part of Internet traffic. Network operators face the challenge of satisfying the quality of experience expected by end-users while, in the same time, avoiding the over-provisioning of transmission links. Bandwidth management offers a wide spectrum of policies to overcome this issue. Possible options include congestion control, scheduling algorithms, traffic shaping and admission control. In this paper, we focus on admission control.

Admission control has been an active field of research for many years. Despite the number and the variety of proposed solutions, virtually all of them, if not all, are hampered by the difficulty to calibrate correctly their tuning parameters so as to maximize the resource utilization and the QoS expected by the end-users. This issue has been discussed in several previous studies [2], [5], [6], [7], [8].

Unlike existing admission control solutions, we introduce a new Knowledge-Based Admission Control solution (KBAC) that avoids the critical step of precisely calibrating key parameters. Our KBAC solution builds its own *Knowledge Plane* by feeding a queuing theory model with recent measurements on the throughput of the on-going traffic and the associated QoS performance parameter.

II. Admission Control scheme

The following section includes a brief summary of the KBAC solution described in [3]. Our KBAC solution continuously monitors the activity of the communication link so as to collect measurement data. For each time window of length 200 ms, we measure the actual throughput of the on-going traffic, together with another QoS performance parameter (*i.e.*, packet delay or packet loss rate). These measured values are gathered together into one pair of measurements, denoted by *measurement point*.

A. Knowledge Plane

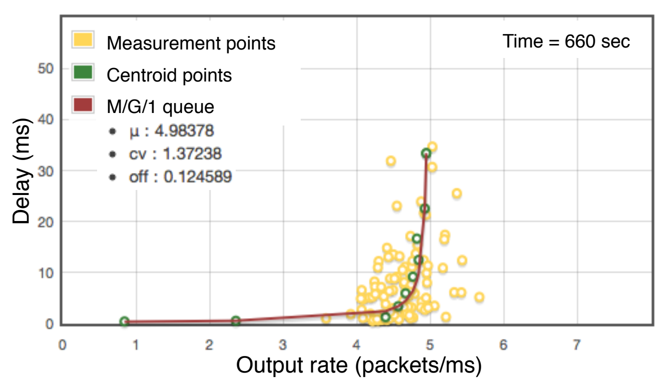

Fig. 1. *Knowledge Plane* building

Every period of length 20 s, we partition n *measurement points* into 10 points, denoted by *centroid points*, using *K-means* clustering method [10]. Note that, we limit n to 1000.

Once *centroid points* have been computed, using *Begin et al.* method [4], we attempt to automatically discover a queueing model (*i.e.*, *M/G/1* queue or *M/G/1/K* queue) that correctly reproduces the behavior exhibited by *centroid points*.

Figure 1 illustrates the measurement methodology described above. It shows an example of how we discover a queueing model whose performance matches closely to those known from the *centroid points*.

B. Decision algorithm

The decision algorithm, which determines whether to accept or reject a new flow, is based on a performance prediction. Thanks to the discovered queueing model, it attempts to adequately estimate the expected performance, $\widehat{P}$, of the link if the traffic workload was to be increased by this new flow.

It follows that our decision algorithm can be formalized as: a new flow is accepted if

$$\widehat{P} + \alpha\widehat{\sigma}_p < P^* \tag{1}$$

where P^* represents the target performance (it is typically a maximum tolerable delay or loss rate), $\widehat{\sigma}_p$ is the standard deviation of $\widehat{P}$, as delivered by the discovered queueing model, and α is a conservativeness tuning parameter.

III. Demonstration

A. Goals

This demonstration consists of a web interface tool that illustrates the behavior of a prototype implementation of our KBAC solution described in [3]. Our tool works in the following way. First, we carried out simulations using ns-3 and thus collect output traces with a special format. Second, the web interface replays the obtained traces and exhibits them in a graphical and interactive way. This interface is composed of two panels: Knowledge Plane building and performance results.

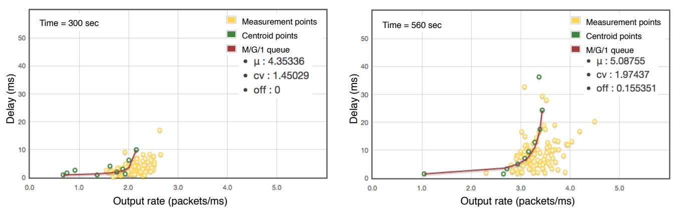

Fig. 2. Snapshots of the demonstration that shows the Knowledge Plane building at two different times

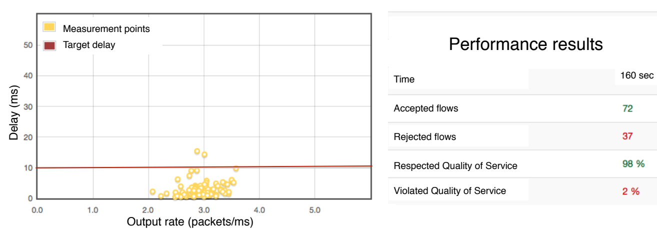

Fig. 3. Snapshot of the demonstration that shows the performance results of an AC solution

The Knowledge Plane building shows, at any time, the discovered queueing model whose parameters are set automatically (see Figure 2). Second, the performance results provide simulation results illustrating the performance of AC solutions (see Figure 3). Overall, the performance of AC solutions are evaluated through two performance indicators: (i) Number of accepted/rejected flows; (ii) Ratio of respected/violated QoS which represents the time periods with degraded quality of service. This demonstration is available at [1].

B. Used materials

For the sake of generality we chose to develop our tool based on a PHP web interface. The materials needed to run our demonstration consist of a web server and a simple machine.

C. Experimental setup

To test our solution, we carried out simulations using ns-3. Each simulation is run for a period of 30 minutes. We consider a communication link of capacity 10 Mb/s. The size of the buffer is set to 60 ms.

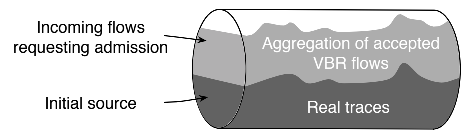

Fig. 4. On-going traffic conditions

In our experiments, we use real traces as an initial source with an average rate of transmitted packets equal to 2.5 Mb/s, to which is summed up the aggregation of VBR flows accepted by the admission control (see Figure 4). VBR flows arrive randomly to the communication link according to a Poisson process with a durations drawn from an exponential distribution with mean 120 s. Each VBR flow will generate packets of size equal to 190 bytes with an average sending rate of 64 kb/s. We compared our solution to two existing solutions (*Measured Sum* (MS) [6] and *Aggregate Traffic Envelopes* (Env) [9]), and to an *ideal admission control*. In this paper, we assess the behavior of our solution in the case of an admission threshold expressed as a maximum tolerable delay set to 10 ms, namely $P^* = 10$ ms.

D. Results display

Table I relates results on the performance of each admission control solution. It indicates that our KBAC solution leads to a ratio of accepted flows (*i.e.*, 28%) close to the one delivered by the ideal admission control (Ideal) (*i.e.*, 30%).

TABLE I
AC solutions performance indicators

	KBAC	MS	Env	Ideal
% accepted flows	28%	19%	32%	30%
% QoS violation	2%	0%	55%	0%

To conclude, our KBAC solution is able to provide a fair probabilistic guarantee and a good trade-off between flow performance and resource utilization. This ability stems from the quick and automatic adjustment of its admission policy according to the actual variations on the traffic conditions.

IV. Applicability in real-world networks

In real-world networks, operators aim to provide a good quality of service for each flow going through their autonomous system. Our KBAC solution could contribute to fulfill this demand since it maintains a probabilistic packet loss rate and a probabilistic packet delay under a given target.

As a matter of fact, KBAC solution can be implemented at each point of the network (*i.e.*, access and core). On one hand, at the access networks, implementing KBAC solution can be used to prevent some flows from accessing the network

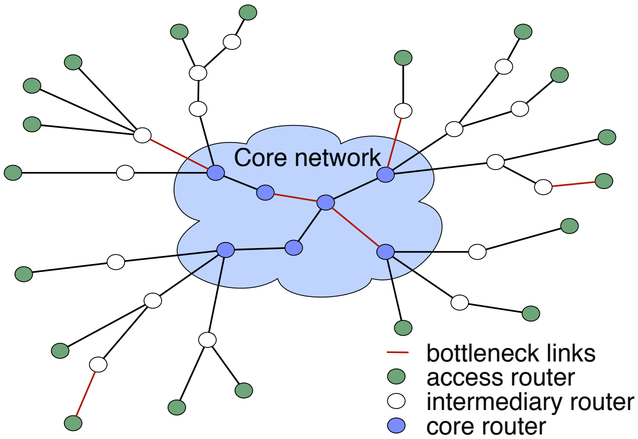

Fig. 5. Applicability of our KBAC solution in real-world networks

in order to avoid transmission links from getting congested. On the other hand, KBAC solution can also be implemented in core networks since congestion problems might occur. Overall, our solution could be implemented on a subset of links (*i.e.*, bottleneck links) in access and core networks, as shown in Figure 5 that represents an example of a real-world network.

Acknowledgment

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