Measurement-Based Admission Control: What is the Research Agenda?

Lee Breslau*
Xerox Palo Alto Research Center
3333 Coyote Hill Road
Palo Alto, CA 94304
breslau@parc.xerox.com

Sugih Jamin†
Department of EECS
University of Michigan
Ann Arbor, MI 48109-2122
jamin@eecs.umich.edu

Scott Shenker
International Computer Science Institute
1947 Center St.
Berkeley, CA 94704-1198
shenker@icsi.berkeley.edu

February 19, 1999

Providing per-flow QoS typically requires some form of admission control; that is, flows must explicitly request service from the network and the network has the option of denying the request. Traditional admission control algorithms for *hard* real-time services (*i.e.*, services that provide a firm delay bound) use worst case analyses based on the traffic parameters provided by arriving flows. Such *parameter-based* admission control algorithms necessarily result in low utilization when the traffic is quite bursty. *Soft* real-time services such as Controlled Load [8] can use more relaxed admission control algorithms. For instance, one can use measurements to characterize the current load, rather than relying on worst-case analysis. Measurement-based admission control algorithms (MBACs) have been shown to achieve much higher utilization than parameter-based admission control algorithms [5]. There has been much research interest in MBACs, and several new MBACs have been proposed; see [2, 3, 4, 6, 7] for some examples. This research has typically focused on the equations (and, to a lesser extent, the measurement algorithms) used to decide whether or not to accept an incoming flow. These proposals range from the simple and *ad hoc* to the complicated and principled, derived from detailed mathematical analysis.

*Lee Breslau was supported in part by the Advanced Research Projects Agency, monitored by Fort Huachuca under contract DABT63-96-C-0105. The views expressed here do not reflect the position or policy of the U.S. government.

†Sugih Jamin is supported in part by NSF CAREER Award ANI-9734145, Presidential Early Carreer Award for Scientists and Engineers (PECASE) 1998, and equipment support from Sun Microsystems Inc. and Compaq (Digital Equipment) Corp.

However, until recently, there have been few efforts to empirically compare these various algorithms.

Recently, in [1] we have undertaken a systematic empirical examination of the relative performance of these algorithms. Much to our surprise, it appears that they all achieve almost identical levels of performance. That is, for a given level of QoS (which we take to be the dropping rate) they all achieve very similar levels of utilization. See, for example, Figure 1, where we depict the performance frontiers of several MBACs. Thus, regardless of whether the MBAC equation is ad hoc or principled, it produces essentially the same performance. Given this result, we claim that further research on different MBAC equations is largely irrelevant.

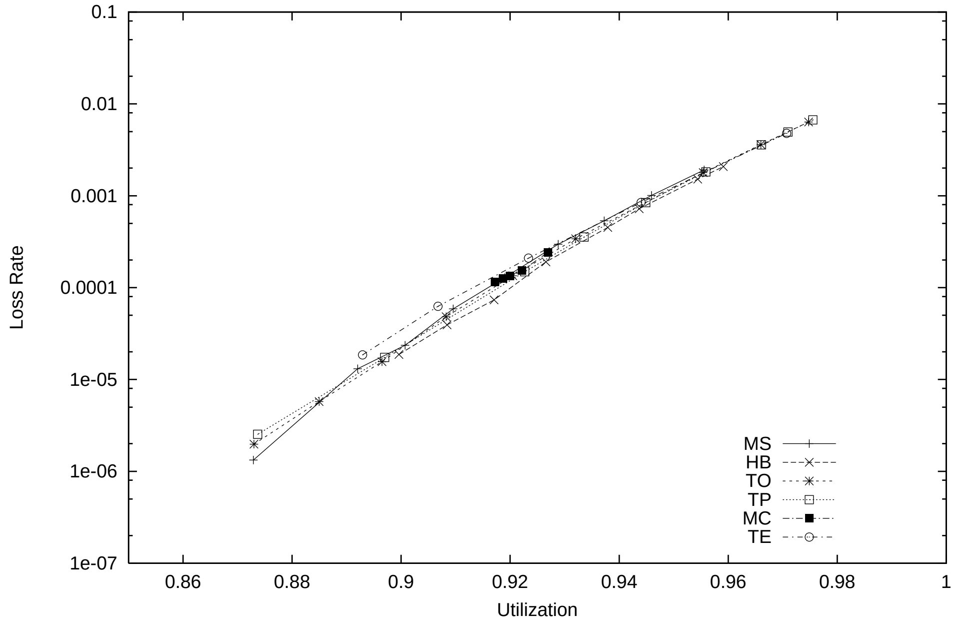

Figure 1: Loss rate and utilization achieved by 6 MBACs

Does this mean that all MBAC research is now moot? What, if any, research remains to be done on admission control? We now describe two characteristics of MBACs and discuss their implications on future research. First, existing algorithms are greedy, in the sense that they admit new flows as soon as resources become available. Second, the algorithms are local in the sense that an independent admission control decision is made at each hop along a path. Consider the effect of these two features. In the presence of heterogeneous flows (in terms of bandwidth requirements) the greedy nature of the algorithms leads them to discriminate against larger flows. In the limit of large demand, the MBACs will only admit small flows. Anytime there is room for a small flow, one will be admitted, so there will never be enough bandwidth available for a larger flow.

The local nature of MBAC decisions leads to a second kind of discrimination. If one applies traditional per-hop admission control, a flow is only admitted if the flow passes the local admission criterion at every hop. If it fails at a single hop, the flow is rejected. When flows traverse paths of different lengths, flows with longer paths will be less likely to be admitted. Again in the limit of large demand, the network will tend to admit only flows that traverse relatively short paths.

Taken together, the greedy and local nature of MBACs defines an implicit policy to admit small flows rather than large ones and flows traversing short paths (in terms of network hops) rather than long ones. This leads to the following question (about which we take no position at present): Is this the correct policy? If the answer is yes, then fortuitously for MBACs, no further work is required. If not, then (1) what is the correct policy, and (2) what mechanisms are required to achieve it?

Thus, we take the following position with regard to research on MBACs. Further research on better admission control equations will likely be a fruitless endeavor. Previous results suggest that there is little room to improve existing algorithms [1]. Rather, research should focus on the development of mechanisms that would enable MBACs to support a range of policy beyond the single policy implicit in current algorithms.

References

[1] Breslau, L., Jamin, S., and Shenker, S. Measurement-based admission control: An empirical performance comparison. Under submission, February 1999.

[2] Crosby, S., Leslie, I., McGurk, B., Lewis, J. T., Russell, R., and Toomey, F. Statistical properties of a near-optimal measurement-based cac algorithm. In *Proceedings IEEE ATM '97* (June 1997).

[3] Floyd, S. Comments on measurement-based admissions control for controlled-load services. Technical report, Lawrence Berkeley Laboratory, July 1996.

[4] Gibbens, R., and Kelly, F. "Measurement-Based Connection Admission Control". *15th International Teletraffic Congress* (Jun. 1997).

[5] Jamin, S., Danzig, P. B., Shenker, S. J., and Zhang, L. A measurement-based admission control algorithm for integrated services packet networks. *IEEE/ACM Transactions on Networking 5*, 1 (Feb. 1997), 56–70.

[6] Jamin, S., Shenker, S., and Danzig, P. "Comparison of Measurement-based Admission Control Algorithms for Controlled-Load Service". *Proceedings of the Conference on Computer Communications (IEEE Infocom)'97* (Apr. 1997). **URL** http://netweb.usc.edu/jamin/admctl/info97.ps.gz.

[7] Knightly, E. W., and Qiu, J. Measurement-based admission control with aggregate traffic envelopes. In *IEEE ITWDC '98* (Ischa, Italy, September 1998).

[8] Wroclawski, J. Specification of the controlled-load network element service. RFC 2211, Internet Engineering Task Force, Sept. 1997.