Comparison of Measurement-based Admission Control Algorithms for Controlled-load Service

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Joint work with

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Goal of study

To compare how high a utilization level various measurement-based admission control algorithms (MBAC's) can load a network while meeting a given target loss rate.

Outline

- Motivation and limitations of MBAC's
- Definition of controlled-load service
- The algorithms studied
- The measurement mechanisms
- Simulated topology
- Simulated sources
- Results and Summary

Motivation for MBAC's

To reserve or not to reserve?

Admission control:
Network resources not over-committed

Measurement-based admission control:

- Higher network utilization
- Increased revenue

Limitations of MBAC's

- High degree of statistical multiplexing
- Small-grain connections
- Uncorrelated sources
- No long vacation
- No quantitative guarantees

What is Controlled-load Service?

- Very relaxed service that gives only qualitative guarantee [Wro95]:

  > [Controlled-load service] tightly approximates the behavior visible to applications receiving best-effort service under unloaded conditions.

  Quantitatively:

  $$\bar{D} \leq b/r$$

  and

  $$\frac{loss}{b/r} \rightarrow 0$$

- Suitable for the heterogenous and decentralized Internet.
- Sources characterized only by peak rate and token-bucket filter.

The Algorithms

1. Simple sum (**SS**): $\nu + r < \mu$, where
   ν: sum of reserved rates,
   r: a flow's token rate, and
   μ: link bandwidth.

2. Measured sum (**MS**): $\hat{\nu} + r < \upsilon\mu$, where
   $\hat{\nu}$: measured load and
   υ: utilization target.

3. Decision-theoretic (**DT**): off-line computation of acceptance region [GKK95]

4. Hoeffding-bound based equivalent bandwidth (**HB**) [Floyd96]:

$$\begin{aligned}\widehat{C}_H(\hat{\nu}, \{p_i\}_{1\leq i\leq n}, \epsilon) &= \hat{\nu} + \sqrt{\frac{ln(1/\epsilon)\sum_{i=1}^{n}(p_i)^2}{2}}, \\ \widehat{C}_H + p &\leq \mu,\end{aligned}$$

   where p: a flow's peak rate, ϵ: loss rate, and n: number of admitted flows.

Peak rate

Both the DT and HB MBAC's require source's peak rate.

Peak rate derivation from token bucket filter parameters:

$$\widehat{p} \;=\; r + b/U,$$

where

- r: token bucket rate
- b: token bucket depth
- U: a user-defined averaging period.

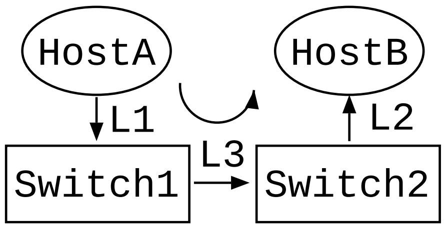
Three measurement mechanisms:

1. Time window:
   S: sampling period, T: time-window.

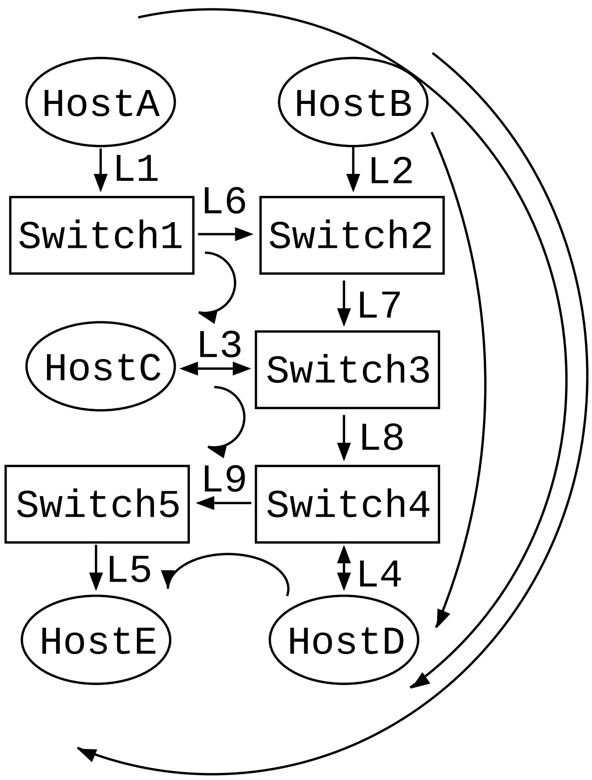
2. Point samples: $T/S = 1$

3. Exponential averaging:
   $\widehat{\nu}' = (1 - w) * \widehat{\nu} + w * \widehat{\nu}^S$,
   where
   - $w \in (0, 1)$
   - $\widehat{\nu}^S$: a load sample over S sampling period.

Simulated Topologies



(a) One-Link



(b) Four-Link

Source Models

Two-state Markov-ON/OFF:
Exponentially distributed ON, OFF times.
Exponentially distributed duration.

Long-range dependent source,
Two-state Pareto-ON/OFF:
Pareto distributed ON, OFF times
Lognormal distributed duration.

Fixed rate packet transmission.
Poisson flow arrivals.

Six Instantiations of the Two Source Models

EXP1: $p/a = 2$, $r = p = 64$Kbps.

POO1: $p/a = 2$, $r = p = 64$Kbps.

POO2: $p/a = 10$, $r = p = 64$Kbps.

EXP2: $p/a = 10$, $p = 1$Mbps, $\widehat{p} < p$.

POO3: $p/a = 10$, $p = 256$Kbps, $\widehat{p} > p$.

EXP3: $p = \infty$, $r = 512$Kbps.

Simulation Results: Single Hop

Model Name	SS		MS		DT($\widehat{p}$)		HB($\widehat{p}$)	
	%Util	#Actv	%Util	#Actv	%Util	#Actv	%Util	#Actv
EXP1	46	144	79	250	*97*	*308*	71	223
EXP2	28	28	75	74	38	37	12	12
EXP3	2	18	54	406	–	–	0.3	2
POO1	39	144	*86*	*330*	*99*	*381*	70	270
POO2	7	144	78	1539	*97*	*1912*	45	885
POO3	3	38	72	965	43	582	2	31

But for EXP3 source:

	MS υ =1.3	HB(r) ϵ =1e-6	HB(r) ϵ =1e-1
%Util	89	5	23

And %Util for EXP2 and POO3 in the HB(r) case:

Model	ϵ =1e-6	ϵ =1e-1
EXP2	41	68
POO3	12	37

Summary

Measurement-based admission control algorithms *can* achieve higher utilization than parameter based algorithms.

But the performance of each MBAC depends on the tuning of its parameters.