Comments on the Performance of Measurement Based Admission Control Algorithms

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Infocom 2000

Survey of Measmt Based AC Schemes

Many different varieties of MBACs:

- Some based on “solid” math models (eg, theory of large deviations)
- Others “ad hoc” (no theory underpinning)
- Different load estimations: from simple point estimate, to exp averaging , combined mean and variance measmts, etc

How to compare them?

- Use *packet loss* as measure of service failure
- *Loss-load curve*: loss rate occurring at given level of service utilization

The Ingredients of MBAC

Two key components:

- Network load measurements (on aggregate rather than per flow)
- Adm control decision based on load measmt

Service Characterization

Service requested by appl:

- defined by token bucket params – token rate ***r***, bucket depth ***b***

Service delivered:

- Measured in terms of packet drop rate

MBACs surveyed

Measured Sum:

- Token rate of new flow + aggregate measured rate of existing flows must be less than utilization threshold

“Hoeffding” bounds:

- Peak rate of new flow + aggregate equiv bdw of existing flows must be less than link bdw

Tangent of equiv bdw curve:

- A given “function” of equiv bdw less than link bdw

Measure CAC:

- Peak rate of new flow + “large deviation” equiv bdw estimate less than link bdw

Aggregate Traffic Envelopes, etc

Meas.mts vs Parameter Adm Control

Parameter based Adm Control:

- *Hard* real time services
- decision based on worst case bounds
- typically, low network utilization

Measurement based Adm Control:

- *Soft* real time services (occasional pkt loss or delay violation)
- Decision based on existing traffic measurements
- Higher utilization than parameter – based
- The Adm Control scheme of choice in DiffServ

MBACs surveyed (cont)

Each one of the surveyed CAC schemes has two components:

(a) Load estimate (including new flow)

(b) Admission control decision

Can pair up Load estimate and Adm decision across schemes (mix and match)!

MBACs surveyed (cont)

- Each scheme has a parameter that can be tuned to make it more or less “aggressive”, eg. Target loss rate or Target link utilization
- Performance can be measured by loss-vs-load curve

Simulation Methodology

Two types of sources:

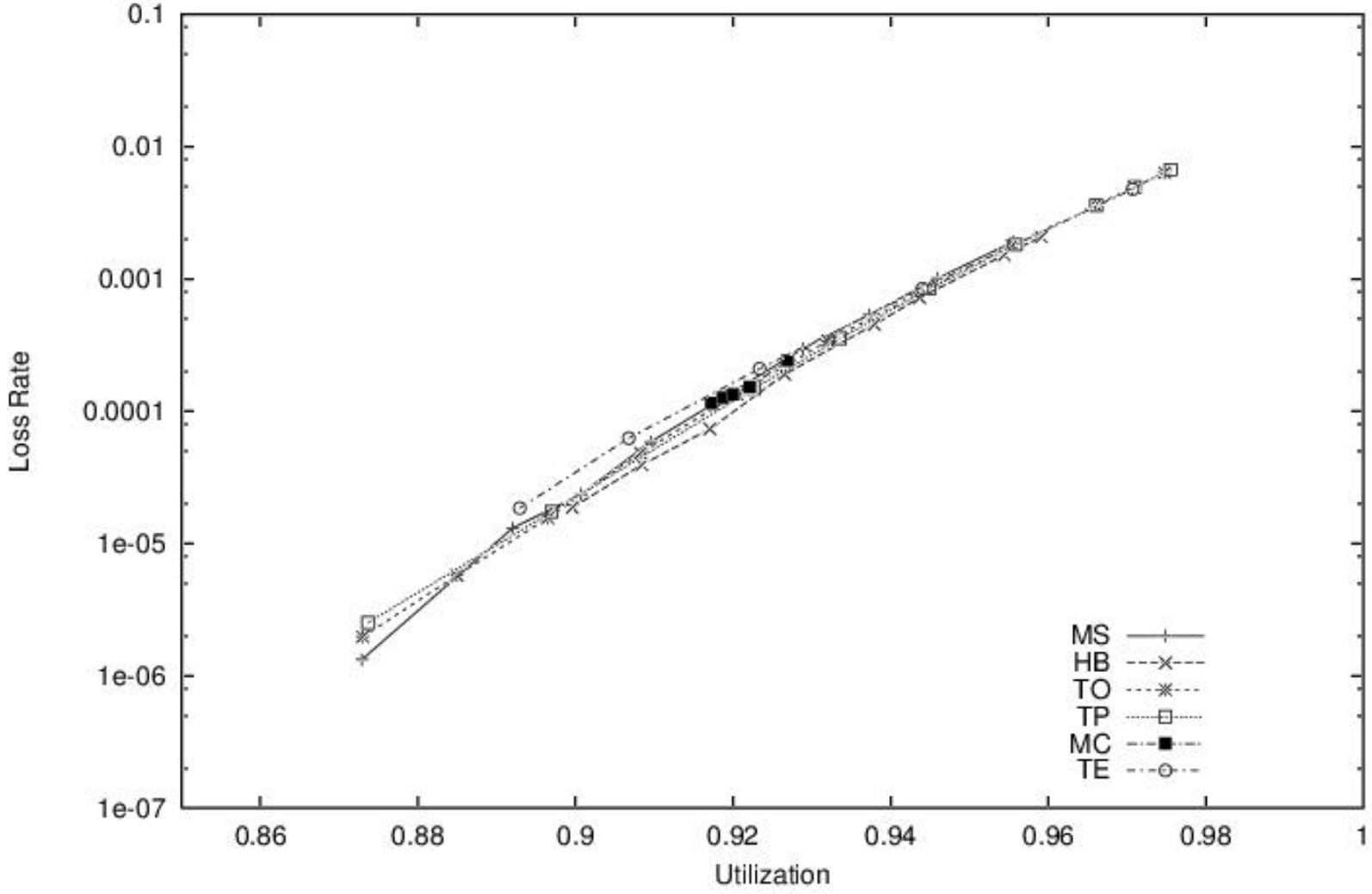
- ON/OFF sources: random ON and OFF intervals
- Video traces

Sources policed by token bucket

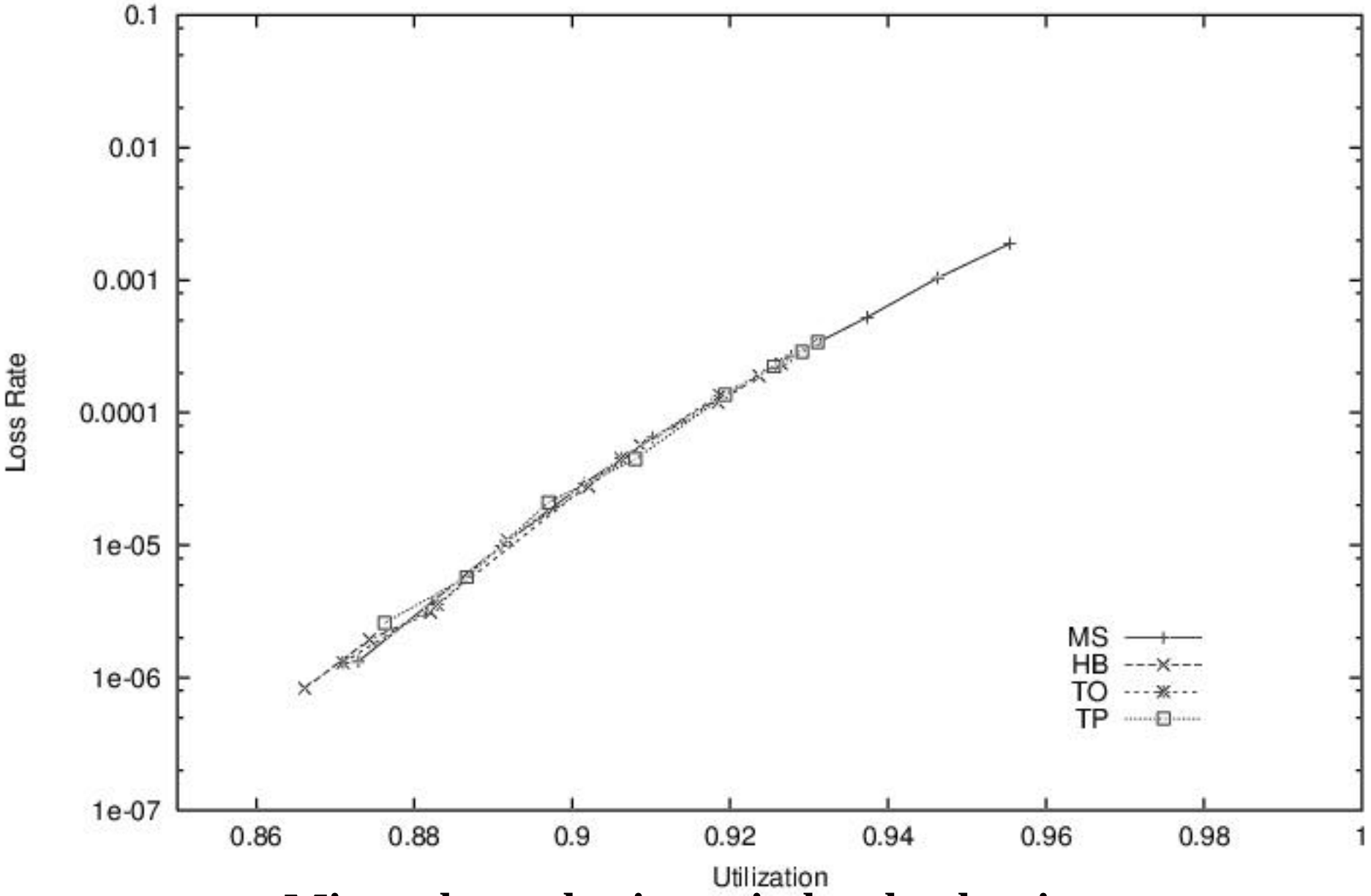
- Token bucket parameters used in “parameter based” Call Admission control
- For ON/OFF token rate = 64kbps; bucket depth=1

Configuration Parameters

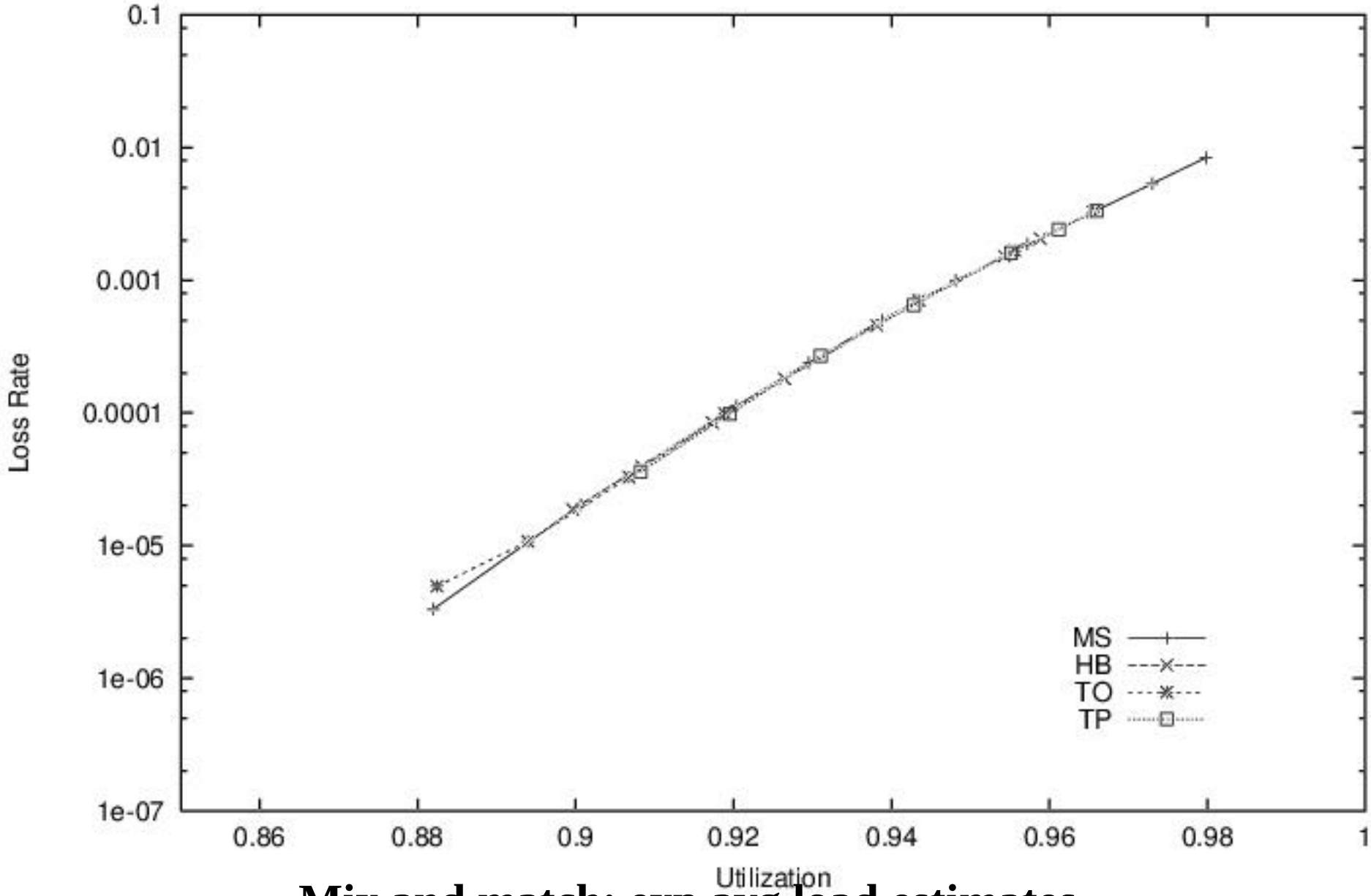
- **Single bottleneck link:** 10 Mbps
- Bottleneck buffer: 160 pkts
- Packet length: 128 bytes
- Heavy offered load (to force CAC and rejections)



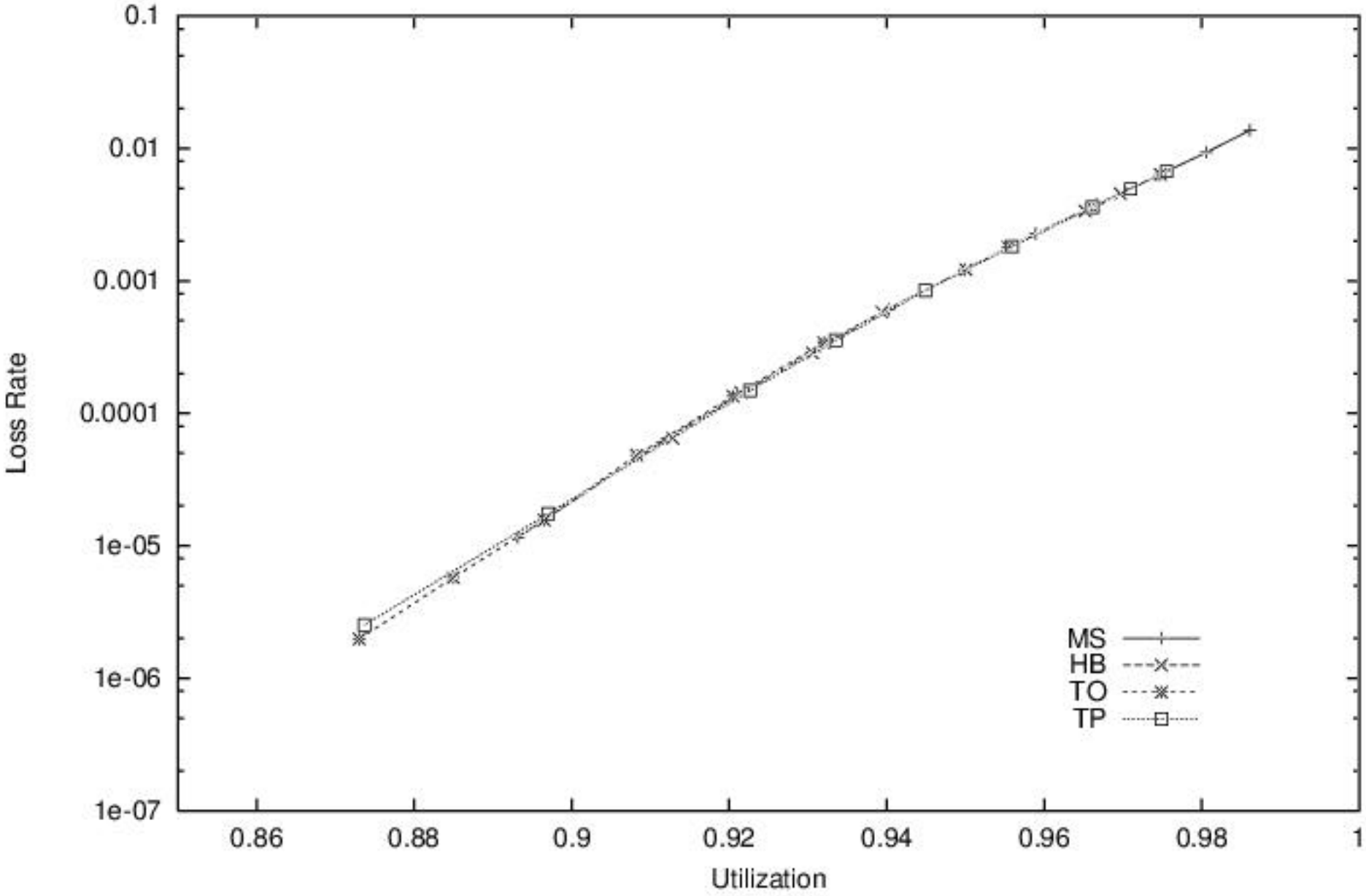
ON/OFF traffic experiments



Mix and match: time window load estimates



Mix and match: exp avg load estimates



Mix and match: point sample load estimates

Model Robustness

- The experiments show **extraordinary robustness** of performance to different MBCA schemes
- Additional experiments (not shown here) show similar robustness to : very bursty ON/OFF sources; long range dependant processes; video sources etc

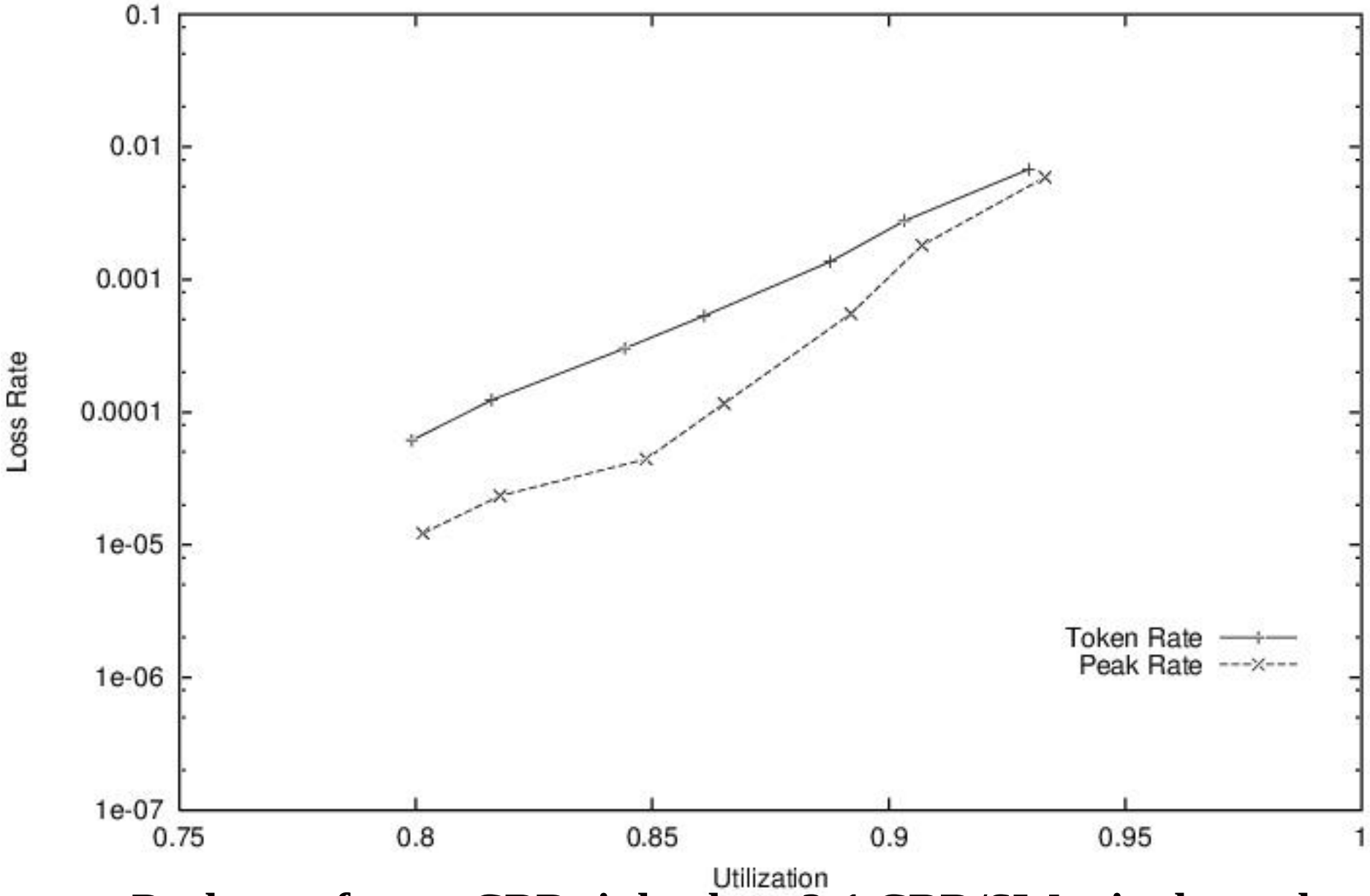
Heterogenous traffic

Two simultaneous sources:

- Star Wars: 350Kbps avg, 1200 Kbps peak; r=800Kbps, b=200 Kb
- CRB: 800Kbps; r=800Kbps, b=1.6Kb (single pkt)

Measured Sum scheme- two versions:

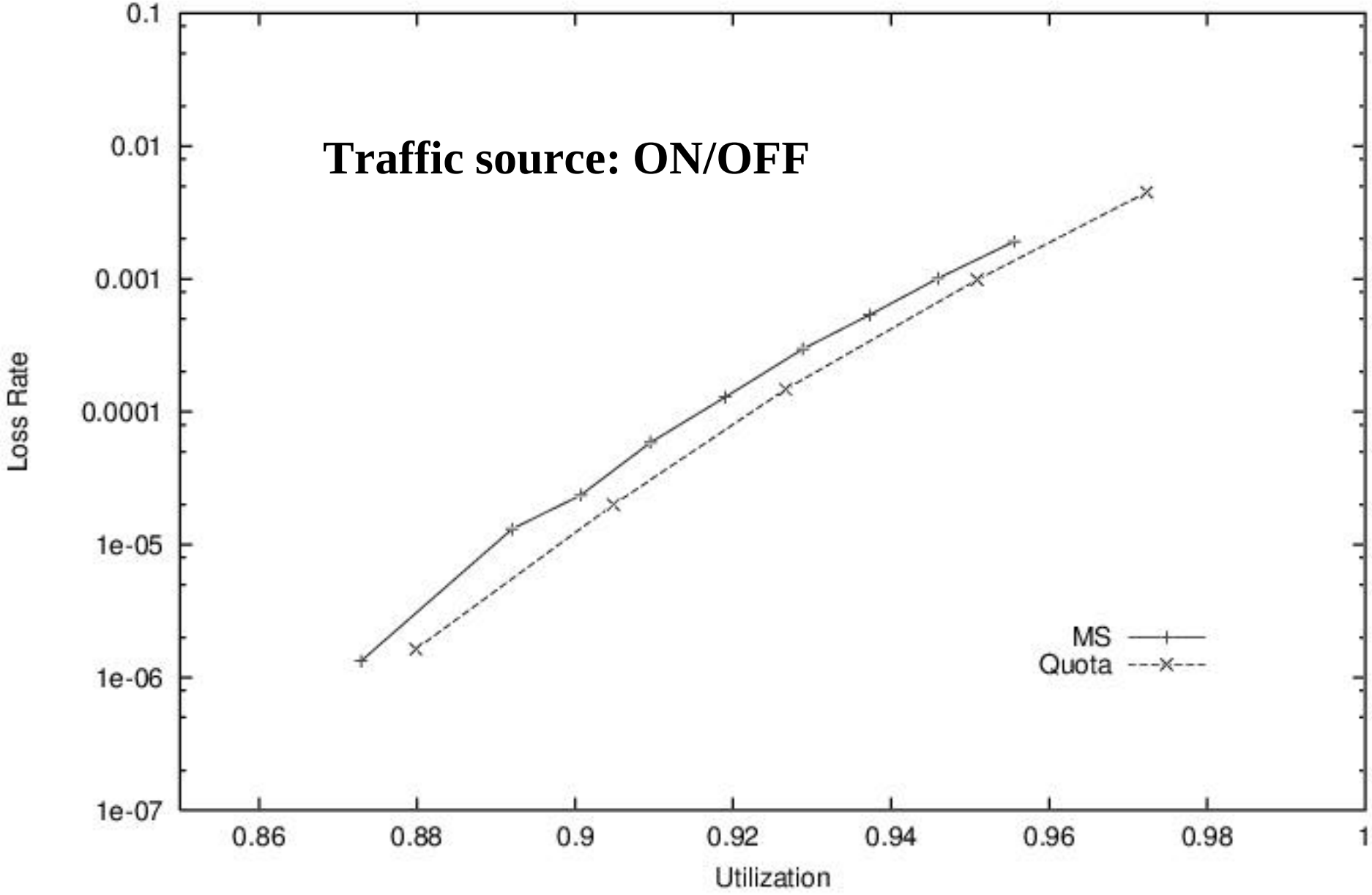
- **Token rate** used for new flow: SW=CBR=800;
- **Peak rate** used for new flow: SW=1200; CBR=800



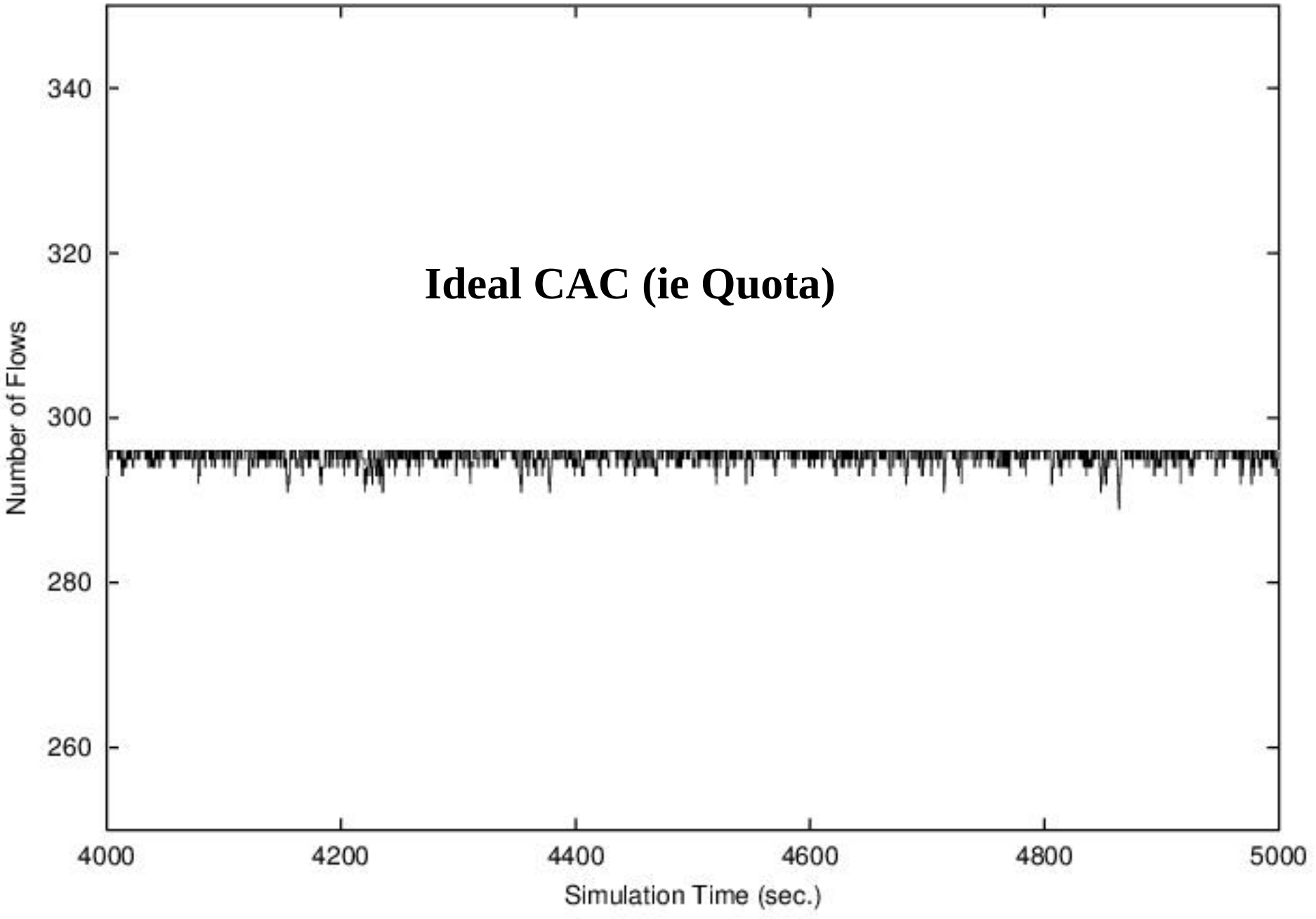
Peak rate favors CBR; it leads to 3:1 CBR/SW mix; lower loss

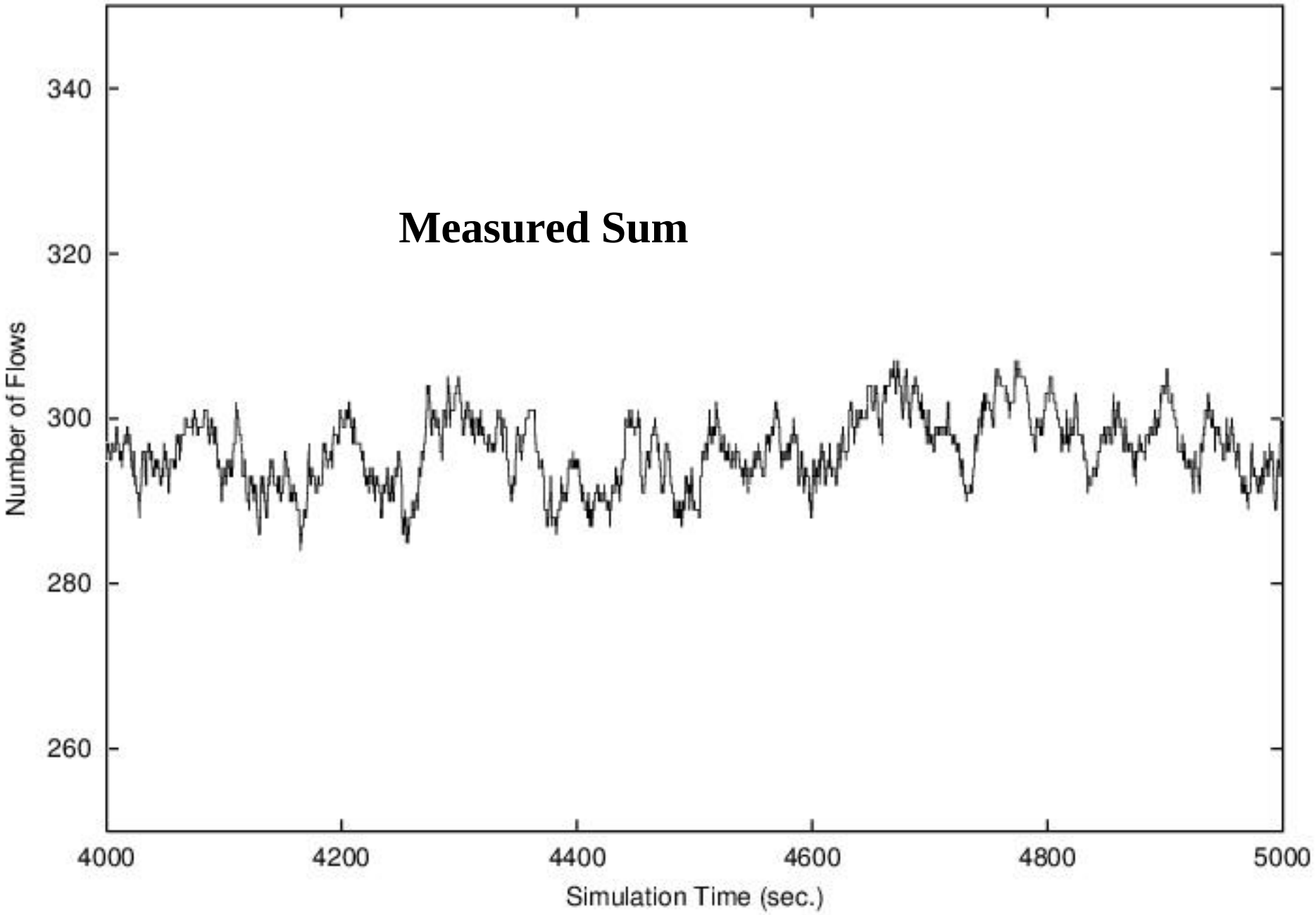
Comparing with Ideal CAC

- **Ideal CAC** algorithm: maintain the "**quota**" of flows constant = N, where N is determined by target loss rate
- Ideal CAC has prior knowledge of current # of flows
- **Measured Sum** alg must "guess" N from load measurements;
- Ideal CAC is open loop; it wins as it leads to **lower load fluctuations**
- Measured Sum uses closed loop feedback control; it tend to overreact leading to **higher oscillations** and possible instability



Ideal CAC (ie Quota) vs Measured Sum


Ideal CAC (ie Quota)
Number of Flows
340
320
300
280
260
4000
4200
4400
4600
4800
5000
Simulation Time (sec.)


Measured Sum
340
320
300
280
260
Number of Flows
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4200
4400
4600
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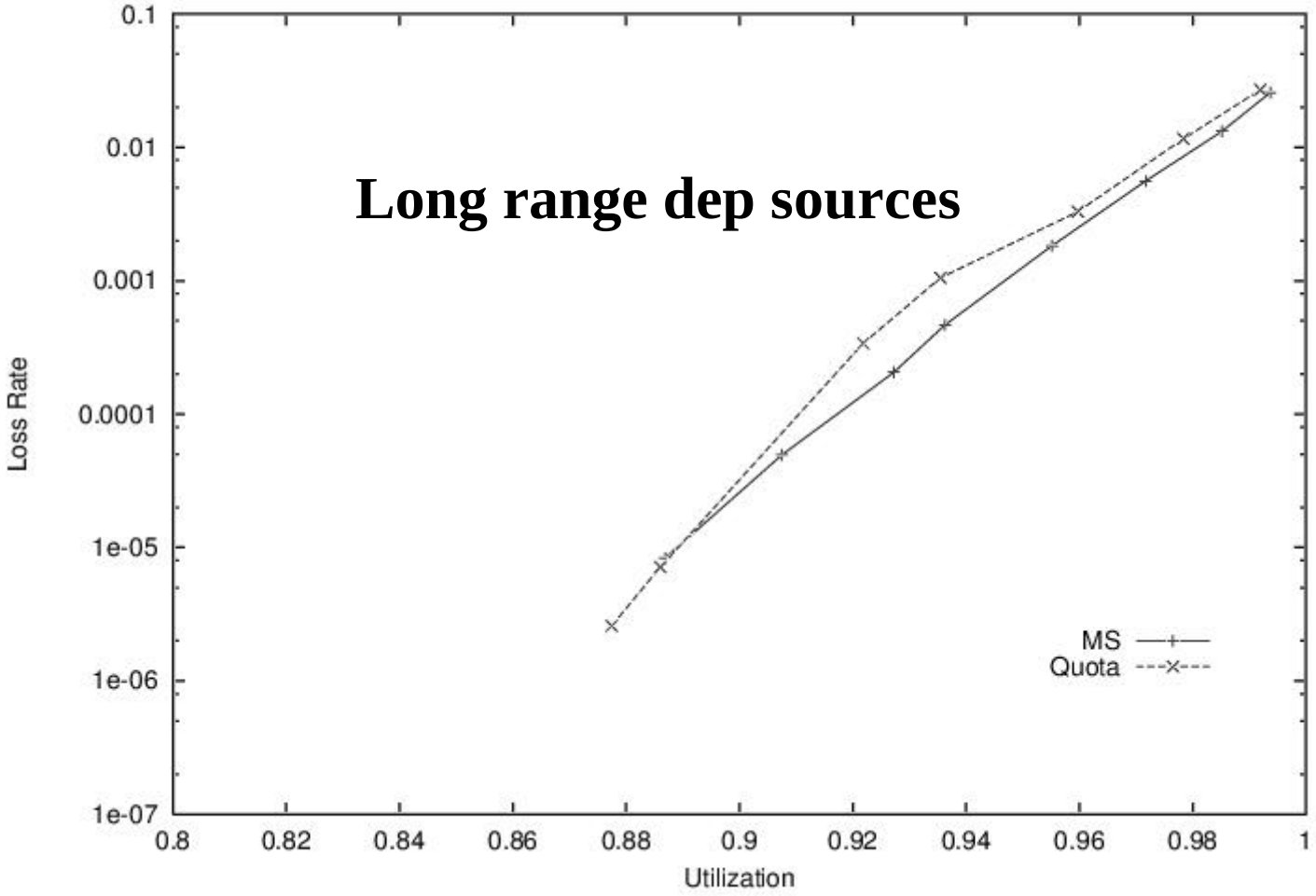
5000
Simulation Time (sec.)

Ideal vs MS in Long Range Dependance

- Long Range Dep source: ON/OFF interval Pareto distributed; flow lifetime lognormal
- “Quota” does not work very well here: no notion of *ideal* quota valid all the time
- Measured Sum, on the other hand, can track the flow fluctuations => lower loss rate!



Quota vs Measured Sum

Can we predict MBAC loss?

- Network operators would like to predict loss to set operating point (eg, target utilization in the Measured Sum scheme)
- **Question**: can we **preselect** the “control knobs” and expect results consistent with prediction?
- **Answer**: not quite! Better to measure resulting loss rate and adjust knobs accordingly
- Results in next slide are based on:
  - **MC** scheme: measure CAC – large dev estimate of existing flows + peak of new flow
  - **TE** (Traffic Envelope): measured max aggregate envelope of existing + peak of new flow

Algorithm	Source Model	Target Loss Rate	Actual Loss Rate
TE	EXP1	10^{-6}	1.9×10^{-5}
TE	EXP1	10^{-2}	4.8×10^{-2}
TE	Star Wars	10^{-6}	5.5×10^{-4}
TE	Star Wars	10^{-2}	4.4×10^{-3}
TE	EXP2	10^{-6}	3.1×10^{-5}
TE	EXP2	10^{-2}	1.8×10^{-3}
TE	POO1	10^{-6}	1.3×10^{-2}
TE	POO1	10^{-2}	4.1×10^{-2}
MC	EXP1	10^{-6}	1.1×10^{-4}
MC	EXP1	10^{-2}	2.4×10^{-4}
MC	Star Wars	10^{-6}	3.0×10^{-3}
MC	Star Wars	10^{-2}	4.5×10^{-3}
MC	EXP2	10^{-6}	1.7×10^{-4}
MC	EXP2	10^{-2}	2.0×10^{-4}
MC	POO1	10^{-6}	1.2×10^{-2}
MC	POO1	10^{-2}	1.6×10^{-2}

Conclusions

- All MBAC schemes achieve identical loss-load performance (no matter the effort spent in developing sophisticated measurements)
- Flow heterogeneity must be addressed by policy – aggregated measured based control is unfair
- MBAC does better than Ideal “Quota” scheme in Long Range Dependency
- Predictive “knobs” do not work well; need to monitor loss directly and use feedback