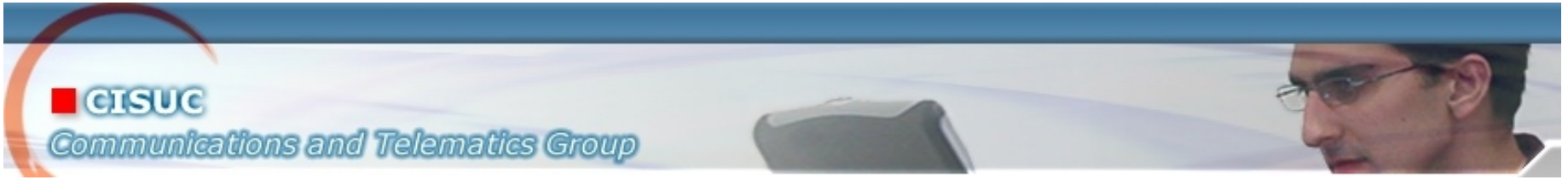
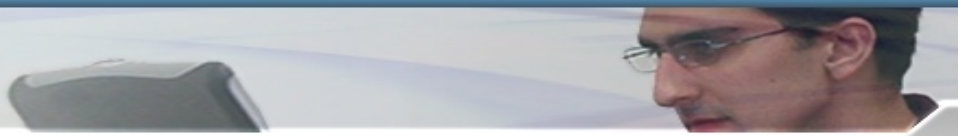


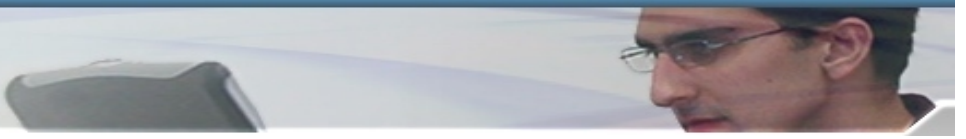
Measurement-Based Admisson Control

Thomas Bohnert
Laboratory of Communication and Telematics
University of Coimbra – Portugal



Admission Control – Basic concepts

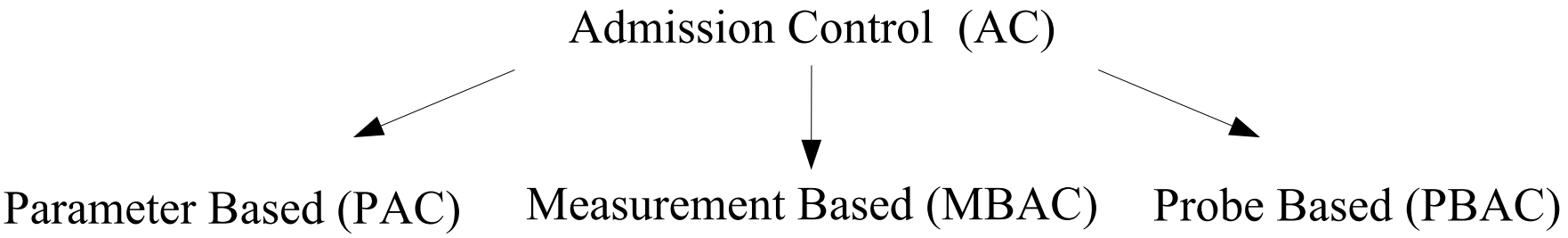
- Statistical resource sharing and QoS provisioning is contradictory
- If traffic volume is overwhelming, buffer-management applies “Implicit Packet-level Admission Control”
  - Uncontrolled QoS degradation
- Admission Control to manage resources competition in advance
  - Admit only a limited number of resource consumers
  - Preventive Congestion Control



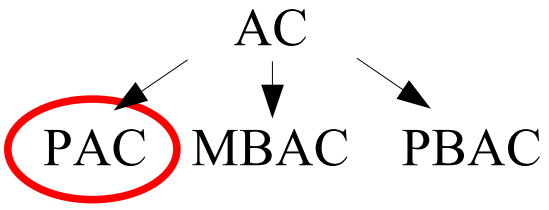
Admission Control – Basic concepts

- AC-Definition:
  - A flow is only admitted if characteristics of the aggregate, i.e. already admitted flows, superimposed with that of the prospect are bounded, i.e. QoS is guaranteed (deterministically or statistically)
- AC-Design goals:
  - Client: Guarantee QoS
  - ISP: Optimize resource utilization (number of flows)

Admission Control – Taxonomy

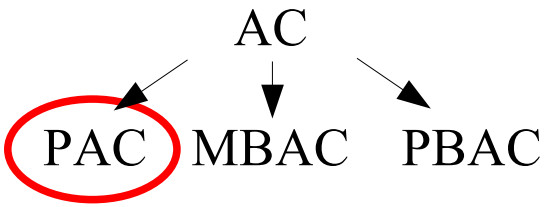


Parameter Based AC



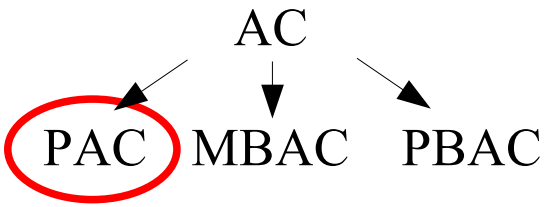
- Based on *a priori* knowledge and (source) models
  - Example: SimpeSum
    - Required bandwidth is sum of Peak Rates (PR)
- Advantage: Simple, deterministic QoS
- Issues:
  - No accounting for SMUX
  - Sources seldom send with their Peak Rate (PR)
    - Unused resources in busy hours; in anyway a short fraction of total time.

Parameter Based AC

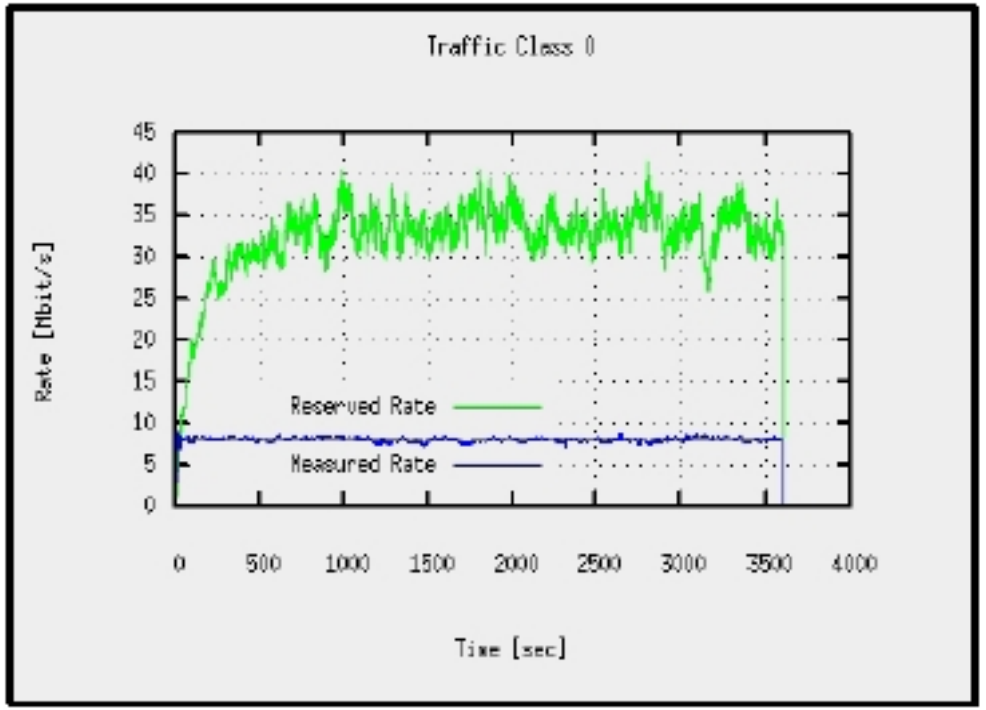


- Issues (cont):
  - Replacing Peak Rate with Sustained Rate is no solution
    - How to determine Sustained Rate in advance?
    - Not mean, variance is critical, partly network induced
  - Network and no source models are needed
    - A priori modelling network dynamics is difficult

Parameter Based AC (cont)

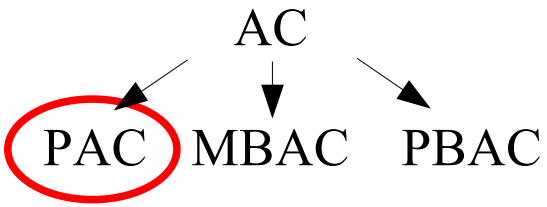


- Assumed versus Consumed resources

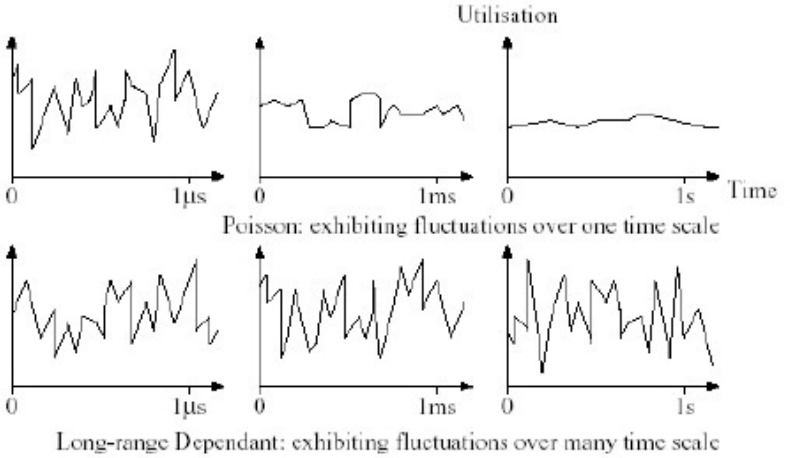


- Poisson flow arrivals, lambda =35
- Two state Markov ON/OFF sources, PR =1 mbps

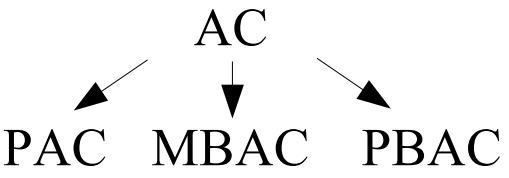
Parameter Based AC (cont)



- Issues (cont)
  - Complexity of modelling (asymptotic second-order) Self-Similar and Long-Range-Dependent network traffic
  - Accounting for weekly/daily/hourly varying traffic patters
  - Exceptional traffic patterns

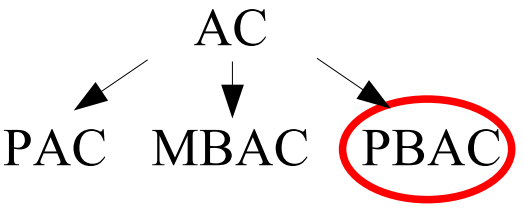


From PAC to MBAC/PBAC

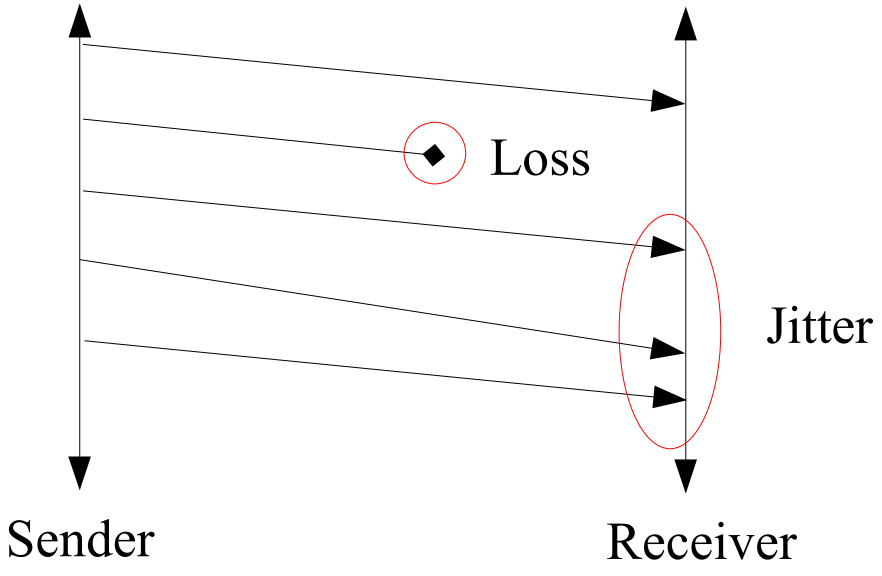


- How to overcome these adverse features?
  - Rather to search for a suitable model, measure *actual* traffic characteristics and compute statistics in *real-time*
    - Probe Based AC
    - Measurement Based AC

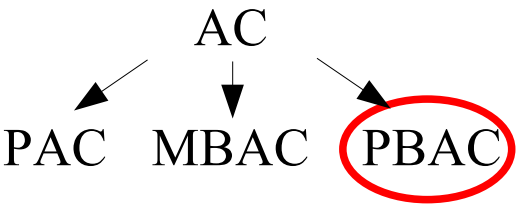
Probe Based AC



- Rationale
  - Send probe packets and measure Loss and/or Delay and/or Jitter
  - If measurement parameters are to a certain extent, admit, else reject

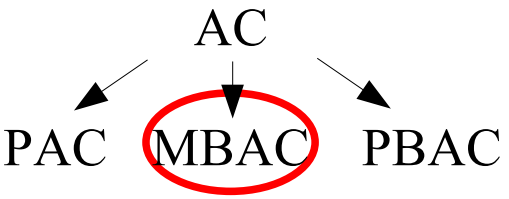


Probe Based AC



- Advantage:
  - Transparent to routers, complies DiffServ concept
  - No central point of failure, no state management
- Issues:
  - Imprecise, only appropriate for *relaxed* streaming traffic
  - Long probing time delays application start-up
  - Bandwidth stealing and trashing
  - Dependent on end-point cooperation

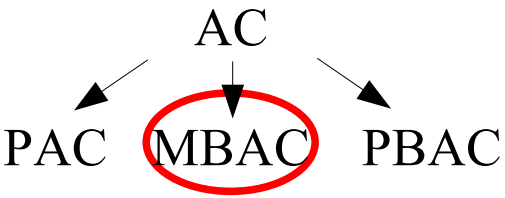
Measurement Based AC

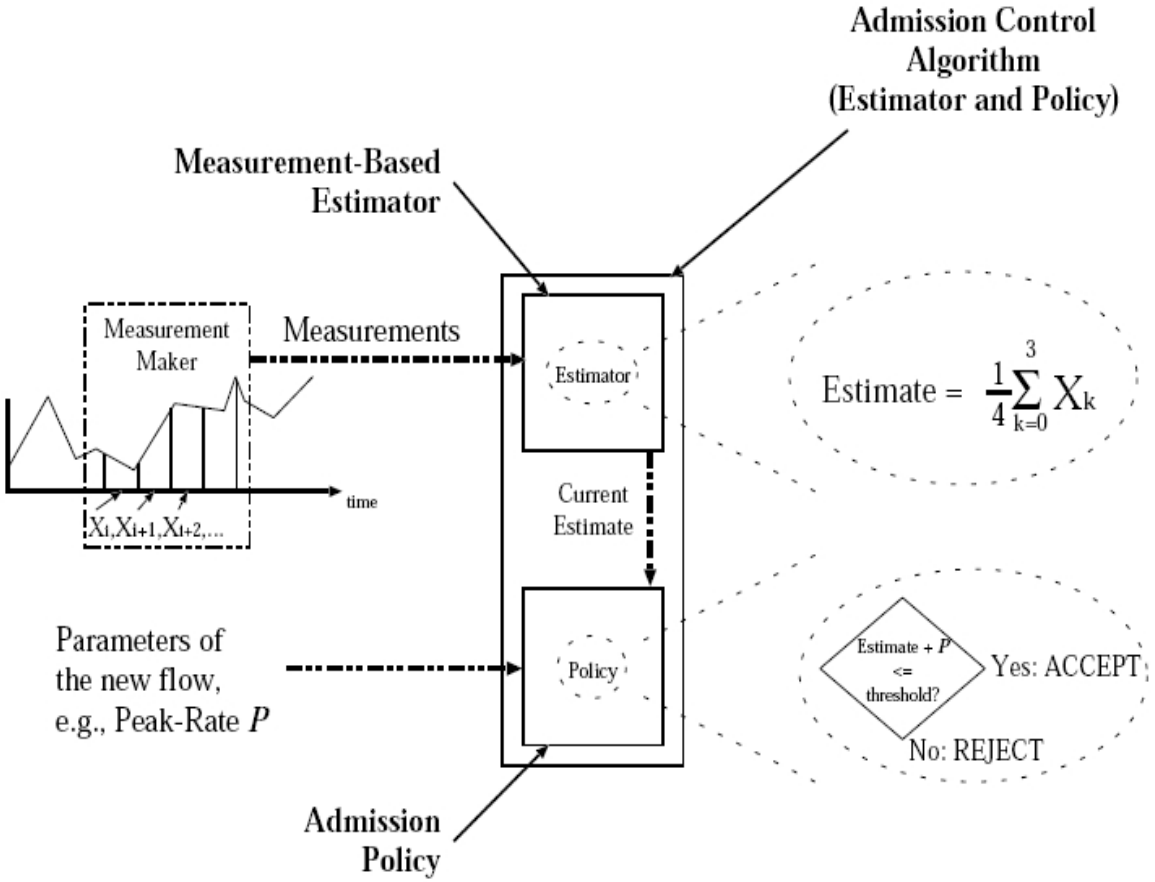


- Effective Bandwidth/Capacity Approach (EB/EC)
- ***Measure*** Loss, Delay, Arrival Rate, Buffer Occupancy, etc.
- Insert measured values and prospects *descriptor* into probability model, ***estimate*** EB required for the aggregate
  - EB=f(QoS-Target, Measurements, Queueing Discipline)
- Apply admission ***policy***

```
if {EB < C}
   admit
else
   reject
```

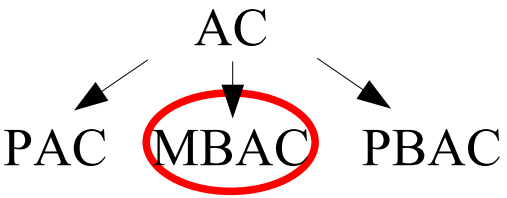
Measurement Based AC





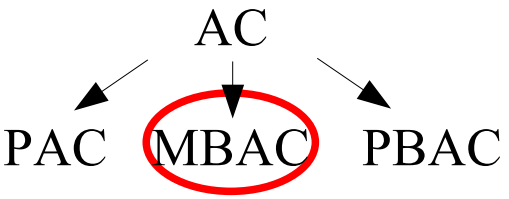
Source: Andrew William Moore: Measurement Based Management of Network Resources

Measurement Based AC



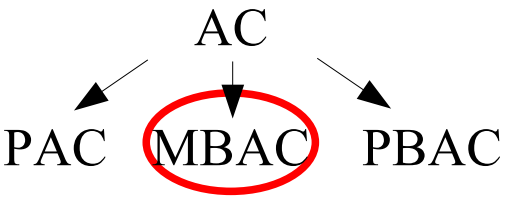
- Advantages
  - Deals best with changing traffic/network conditions
- Issues
  - Algorithms are hard to tune
    - Parameters without intuitive meaning
  - Measurement / Estimation is sensitive to time scales
  - Performance is subject to a trade-off between reduced state compatibility and accuracy

Measurement Based AC - Insight



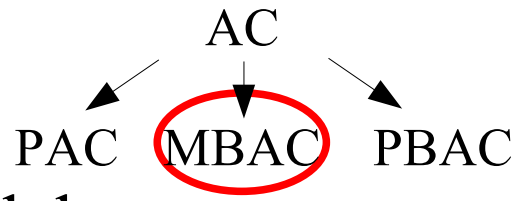
- Performance Measures
  - Utilization versus Loss
    - Only representative for heterogeneous source case!
  - QoS accuracy versus parameter setting
- General results
  - Algorithms perform almost equally well/bad independent of analytical complexity
  - High utilization for loss loss rates, but imprecise
- Why?

Measurement Based AC - Insight



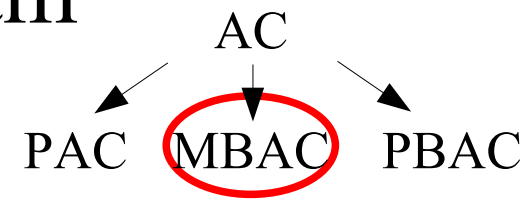
- Estimator Rationale
  - Buffer overflow and/or packet delay approximation
  - Based on statistical assumptions, notably
    - Distribution of arrival process
  - Distribution of arrival process is a function of
    - Number of sources, holding time,
    - Traffic composition (hetero-/homogeneous sources)
  - Limits applicability of algorithms in multi-service environments

Measurement Based AC - Insight



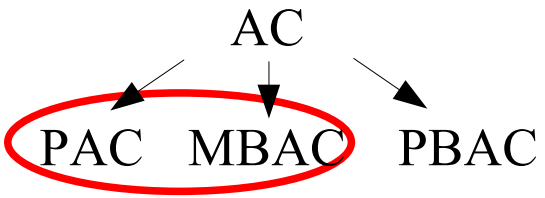
- Many estimators build upon Gaussian models
  - Future aware, CLT-motivated
  - Closed under superposition
  - Allows for arbitrary autocorrelation structure, including LRD
- Gaussian assumption may not be valid (CLT)
  - > Histogram-Based Algorithms

Measurement Based AC - Histogram



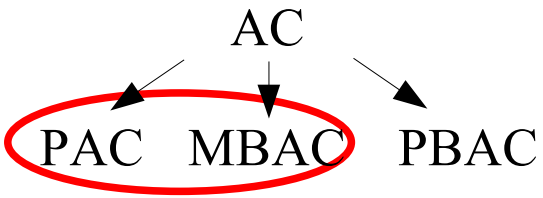
- Record arrival process over different time scales t
- Estimate mean(t) and variance(t)
- max(t){mean(t) + variance(t) * alpha(t)} = EB(dts)
- EB(dts) + PR < C(dts)
- Compute alpha(t)
  - Estimate PDF using Non-parametric Density Estimation
  - CDF(alpha) = overflow probability (QoS Target)

An Alternative Approach



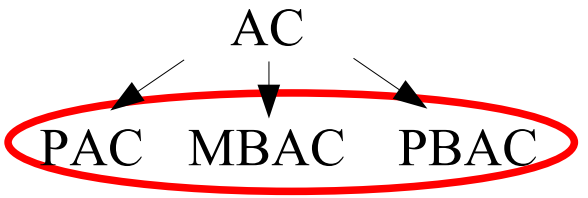
- PAC (EB=sum(pr)) is simple, precise but ineffective
  - Actually, EB=sum(pr)*alpha
  - alpha=f(SMUX)
    - Can we “measure/estimate” SMUX gain?
- Histogram-Based approach
  - Maintain MaxDelay/MeasuredDelay ratio historgram
  - Simple measure for SMUX, i.e. alpha

An Alternative Approach



- Advantage
  - Simple and efficient
  - Reduced statistical dependence
- Issue
  - Histogram accuracy
  - Histogram update
    - Delay until new flows impact is recorded in measurements
    - Solution: Update histogram artificially

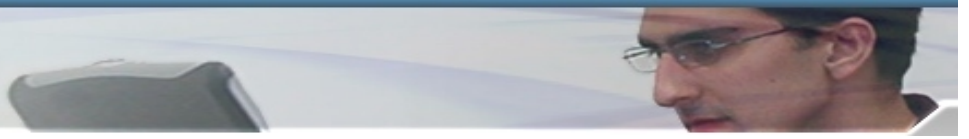
Some Closing Remarks



- How important is precision?
  - P{Block}~3% only
  - Applicability and simplicity more important
- Co-existence of BE and ST
  - An AC should never reject a paying (ST) customer
  - Dynamic Resource Distribution (DRD)

Summary

- Why AC
  - Preventive Congestion Control
- Overview about AC approaches
  - PAC, PBAC and MBAC
    - Features, advantages and issues
- MBAC
  - Measure, Estimate apply Policy – how universal?
  - Histogram-Based methods for flexibility
- PBAC-MBAC
  - Make the best of both



Questions

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