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THE PROPORTIONAL DIFFERENTIATED ADMISSION CONTROL - PDAC

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INTRODUCTION

The Differentiated Services (DiffServ) is regarded as one of the practical architectures to implement quality of service (QoS) on the Internet. The proportional differentiation services (PDS) proposed by Dovrolis et al. [1] provide an attempt to better express in terms of quantitative parameters the QoS perceived in a DiffServ environment. The model is based on the idea of relative differentiation where the QoS of a given class of traffic may change and fluctuates according to the current network congestion, however the quality spacing between different classes remains the same. The key features of a PDS architecture are: *predictability* (differentiation is independent of class load variations), *controllability* (network operator should be able to adjust the relative QoS between classes of traffic), and *scalability* (per-flow management should be avoided in the network core and resources should be allocated in a class basis). Within the PDS framework we propose the proportional differentiated admission control (PDAC) as a valuable service that controls the admission of traffic in the network and also provides QoS differentiation based on blocking probability.

THE PDAC PROBLEM:

$$\delta_1 B_1 = \delta_2 B_2 = \ldots = \delta_K B_K$$

find: $(C_1, C_2, \ldots, C_K)$ $\quad n_k = \lfloor C_k / b_k \rfloor$ find class partitions

$$\delta_1 \frac{\frac{\rho_1^{n_1}}{n_1!}}{\sum_{i=0}^{n_1} \frac{\rho_1^i}{i!}} = \delta_2 \frac{\frac{\rho_2^{n_2}}{n_2!}}{\sum_{i=0}^{n_2} \frac{\rho_2^i}{i!}} = \ldots = \delta_K \frac{\frac{\rho_K^{n_K}}{n_K!}}{\sum_{i=0}^{n_K} \frac{\rho_K^i}{i!}} \qquad \sum_{k=1}^{K} C_K = C$$

$b = (b_1, b_2, \ldots, b_K)$ — bandwidth requirements for each class connection (given)

$\delta = (\delta_1, \delta_2, \ldots, \delta_K)$ — class weights (set by operator)

$\rho = (\rho_1, \rho_2, \ldots, \rho_K)$ — class loads (have to be estimated)

ASYMPTOTIC APPROXIMATION:

$$\lim_{n\to\infty} B(n,\rho) = 1 - \frac{n}{\rho} \quad \text{for } \frac{n}{\rho} < 1$$

$$\delta_1\left(1 - \frac{C_1}{b_1\rho_1}\right) = \delta_2\left(1 - \frac{C_2}{b_2\rho_2}\right) = \cdots = \delta_K\left(1 - \frac{C_K}{b_K\rho_K}\right)$$

FEASIBILITY PROBLEM $C_j > 0 \Rightarrow C > \sum_{k=1}^{K} b_k \rho_k \left(1 - \frac{\delta_j}{\delta_k}\right)$

PDAC RELAXATION

$$\min_k \max\{\delta_k B_k\}$$

$$\xi^* = \min\{\xi \mid \delta_k B_k \le \xi, \quad k = 1,2,\ldots,K\}$$

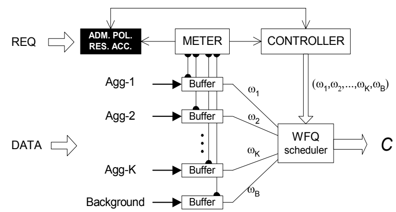
$$\min\left\{\xi \mid \delta_k C_k + \xi b_k \rho_k \ge \delta_k b_k \rho_k, \; C_k < b_k \rho_k, \; \sum_{k=1}^{K} C_k \le C\right\}$$

K+1 variables and 2K+1 constraints

NODE MODEL

class load estimation $\quad \theta = \dfrac{\sum_{i=0}^{N-1} x_k(i)}{N(1-\hat{B}_k)}$

admission control rule $\quad (x_k + 1) b_k \le \omega_k C$

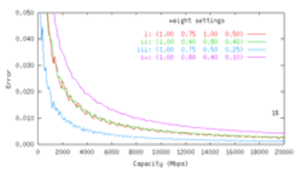


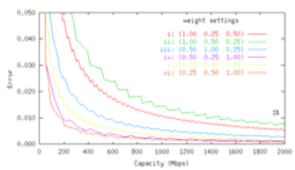
PDAC NUMERICAL RESULTS

	b(Kbps)	ρ	*C*(Mbps)
EXP1	(64,64,64)	(γ,2γ,3γ)	2γ
EXP2	(64,128,512,1000)	(8γ,4γ,γ, γ)	2γ

$$\text{error} = \sqrt{\frac{1}{K-1}\sum_{k=2}^{K}\left(\frac{\hat{\delta}_k - \delta_k}{\max\{\hat{\delta}_k, \delta_k\}}\right)^2}$$

scaling factor: γ





CONCLUSION

We proposed a service, the PDAC, which controls the admittance of traffic from different classes according to a predefined set of weights. Given that PDAC involves the use of complex blocking probability equations we applied asymptotic approximation to simplify the framework. Also we relaxed PDAC definition to overcome feasibility problems imposed by the equality constraints in general PDS goal. Numerical results showed that our approximated solution was adequate, specially for large scale problems when the limiting regime approximation is precise.

REFERENCES

[1] Salles R. M. and Barria J. A., “Proportional Differentiated Admission Control”, IEEE Communications Letters, Volume: 8 Issue: 5, (2004), pp. 320 -322.

[2] Salles R M, Barria J A, “Fair and efficient dynamic bandwidth allocation for multi-application networks” Computer Networks, 49, (2005) pp. 856-877.

[3] Salles R. M. and Barria J. A., “Utility-based Scheduling Disciplines for Adaptive Applications over the Internet”, IEEE Communications Letters, Volume: 6 Issue: 5, (2002), pp. 217 -219.