

Admission control for Grid services in IP networks

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Abstract—Admission control is a key issue for Quality of Service (QoS) provisioning in IP networks. Two solutions have been proposed successively in this matter: service differentiation (DS) and flow aware networking (FAN). DS operates at the packet level whereas FAN operates at the scale of the IP flow. In this paper, we propose an original approach consisting in applying either DS or FAN admission control for Grid services. A Grid session may be seen as a succession of parallel TCP/IP flows characterized by data transfers with much larger volume than usual TCP/IP flows. We compare by means of computer simulations the efficiency of Grid over DS (GoDS) and Grid over FAN (GoFAN) architectures.

I. INTRODUCTION

Elastic traffic (web browsing, emails etc.) requires a minimum bandwidth. Stream traffic (interactive voice, video broadcasting etc.) needs low end-to-end delays as well as limited packet loss ratio. Admission control is mandatory at the ingress of IP networks to satisfy such QoS criteria. Two schemes have been proposed successively in this matter: DS [1] and FAN [2]. IP traffic characterization at the packet level is complex because of self-similarity. FAN considers QoS at the flow level and not at the packet level because IP traffic characterization at the flow level is much simpler than at the packet level. Grid services provisioning over IP networks is today a great challenge for the carriers. It consists in providing remote computing resources distributed over the network to run a job. A job is characterized by its size and its expected computation duration.

II. IP FLOWS AND GRID SESSIONS

An application session is made of a succession of flows, a flow being a succession of IP packets.

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IP flows can be modeled as a Kelly network with a processor sharing queue and an infinite server feedback [3]. It has been shown that the output process of a Kelly network is Poisson if its input is also a stationary Poisson process. This property is known as Poisson-In-Poisson-Out and justify that flows, as conceived by FAN architectures, arrive following a Poisson process in stationary regime [4]. To the best of our knowledge, the problem of Grid sessions admissibility in IP networks has not yet been investigated in the literature. Within the Grid community, a software platform known as Globus ToolKit considering Grid-FTP mechanisms has been developed [5]. This toolkit models a Grid session as parallel TCP/IP sessions. It has been shown that from 3 to 6 parallel TCP/Sack sessions are an acceptable Grid session model [6].

III. MAIN FAN AND DIFFSERV (DS) CHARACTERISTICS

DS admission control is based on packet marking, policing, active queue management and scheduling. FAN architecture provides two functionalities: admission control and scheduling that can be implemented gradually in the current Internet. Second generation FAN (2G-FAN) architecture implement implicit differentiation without any packet marking and policing. FAN scheduling consists in a priority queue and a secondary queue [7]. Admission control is based on two flow scheduling performance measures: Fair Rate (FR) and Priority Load (PL). FR is an estimator of the available bandwidth. PL is an estimator of the service rate in the priority queue. Implicit differentiation is based only on FR so flows with rate below an FR threshold are inserted in the priority queue.

IV. SIMULATION RESULTS

In order to make a fair comparison between 2G-FAN and DS, we configure the DS mechanism

as a physical queue with two virtual queues using the TSW2CM policer [8]. The DS Committed Information Rate (CIR) is chosen with the same value as the FR threshold. The common FR threshold and CIR value are set to 25 %. A GridFTP session is rejected if one or several of its TCP flows are rejected. The size of a job is equally distributed on the parallel TCP flows. Our simulation scenarios consists in multiplexing TCP sources connected to the same IP edge router [9]. The link between these sources and the edge router has a 100 Mbps capacity with a 1 ms propagation delay. The edge router is connected to a remote router on which is connected the receiver by means of a transmission link with 100 Mbps capacity and 5 ms propagation delay. A TCP/Reno window size of 5000 packets and an average packet size of 1000 bytes is adopted. Jobs' size follows a truncated exponential distribution with average value of 100 MBytes. Low and high truncation bounds are chosen from a long-run simulation with Pareto distribution. Individual TCP flows inter-arrival λ^* within a GridFTP session is distributed according to a uniform distribution over $[0, 10^{-2}]$ second. The GridFTP session's arrival rate λ varies from 1 to 20 per mn. Simulations with 30 replications using ns2^1 enable to compute 95 % confidence intervals.

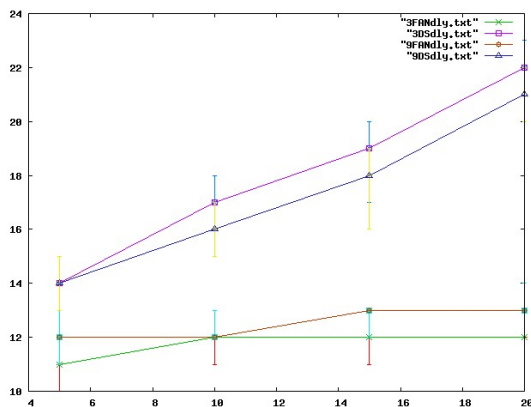


Fig. 1. GoFAN vs. GoDS: GridFTP delay.

Figure 1 shows the average GridFTP session delay W w.r.t. the arrival rate λ . For a given N , the benefit of 2G-FAN over DS does not depend on traffic load. The larger N , the lower this benefit. These results may be explained by the admission control policy inherent to both mechanisms. DS performs better when N increases, whereas it is the inverse for FAN. DS gives better results when

N increases, whereas fair scheduling and implicit differentiation in FAN gives better treatment when N decreases.

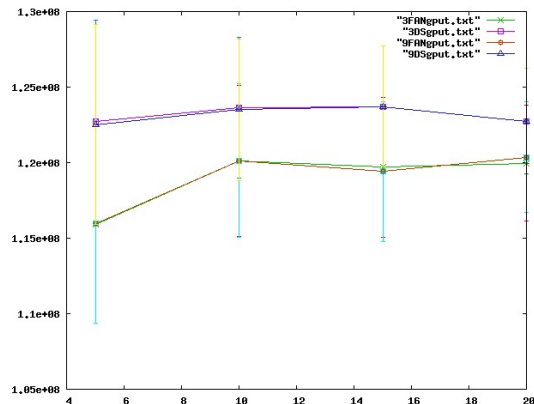


Fig. 2. GoFAN vs. GoDS: GridFTP goodput.

Figure 2 shows the average goodput per GridFTP session w.r.t. offered load λ . 2G-FAN provides better goodput than DS, the two mechanisms converging at high loads.

V. CONCLUSIONS AND FUTURE WORK

2G-FAN is better suited than DS for IP traffic admission control. We have shown that 2G-FAN remains superior to DS in Grid environment, even if flow parallelization of Grid sessions tends to reduce this advantage.

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