Differentiated Quality of Service Scheme Based on the Use of Multi-classes of Ant-like Mobile Agents

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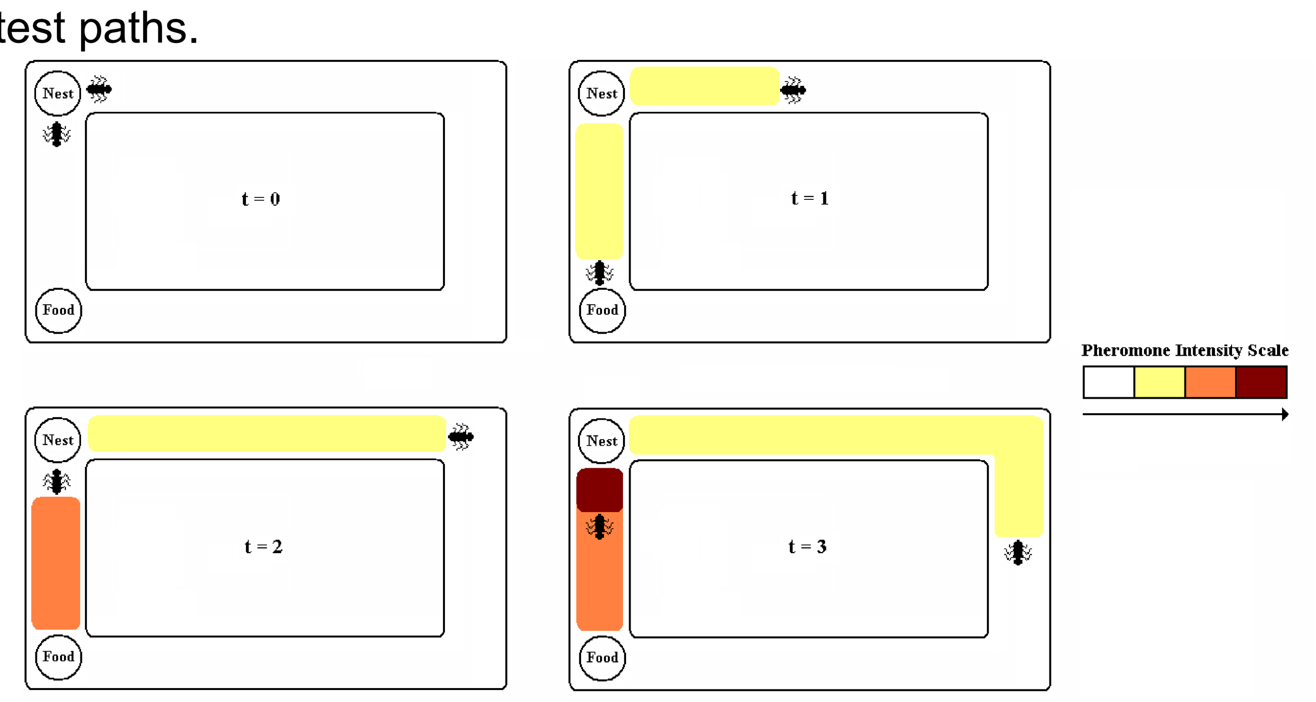
Abstract

We present AntNet-QoS, a novel approach for Quality of Service routing which allows dynamic scheduling and forwarding among multiple packet classes in a differentiated service (DiffServ) network. The algorithm takes inspiration from the Ant Colony Optimization framework, and in particular from AntNet, which is an adaptive routing algorithm for best effort traffic. We show through simulations that the proposed scheme, which is purely proactive and does not use any form of bandwidth reservation, can provide very good performance in terms of end-to-end delay, throughput and jitter, and can obtain a good differentiation between classes.

AntNet-QoS Inspiration

Using a simple pheromone laying-following mechanism, ant colonies in nature adaptively discover shortest paths.

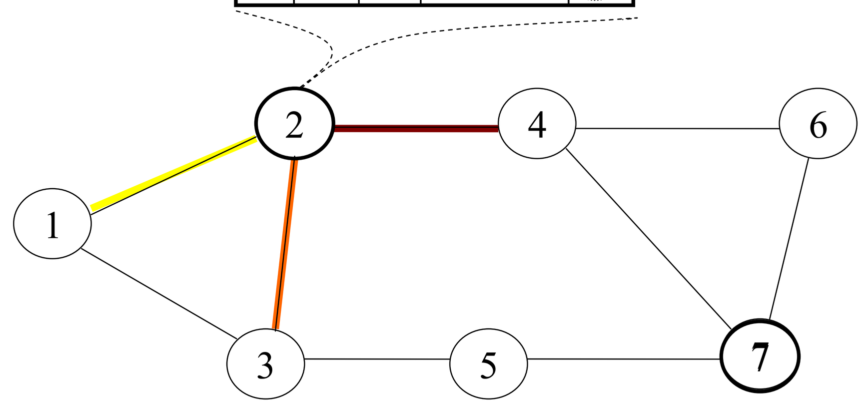


This was reverse-engineered as an adaptive routing algorithm for best-effort traffic: AntNet

Pheromone table (stochastic routing table)

neighbors \ destinations	1	3	...	7
1	.9	.08		.1
3	.09	.9		.3
4	.01	.02		.6

Estimated goodness of going to node 7 from node 2 through node 4.

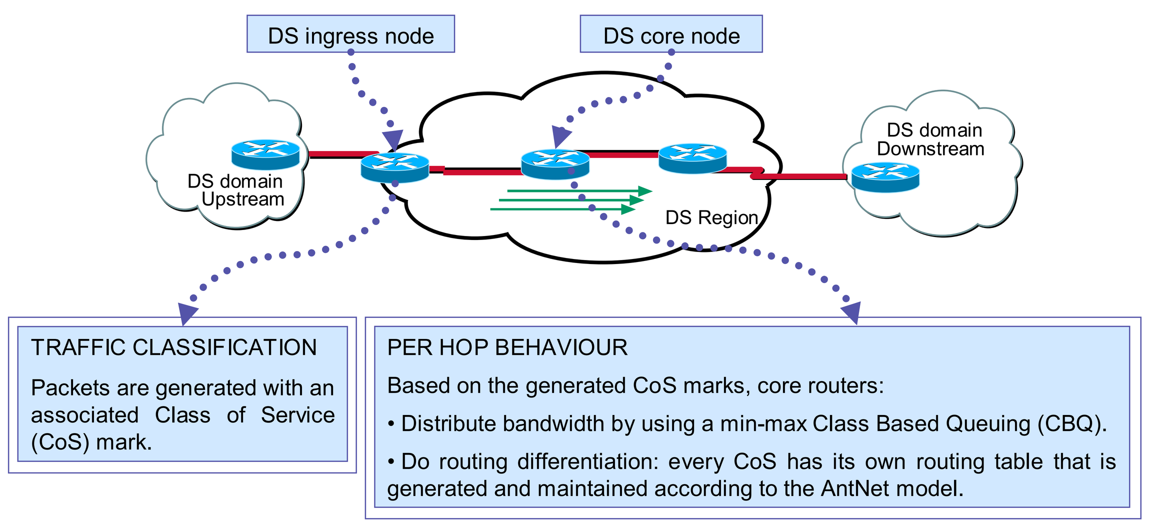


Data packets and ants are routed stochastically according to the value of pheromone values

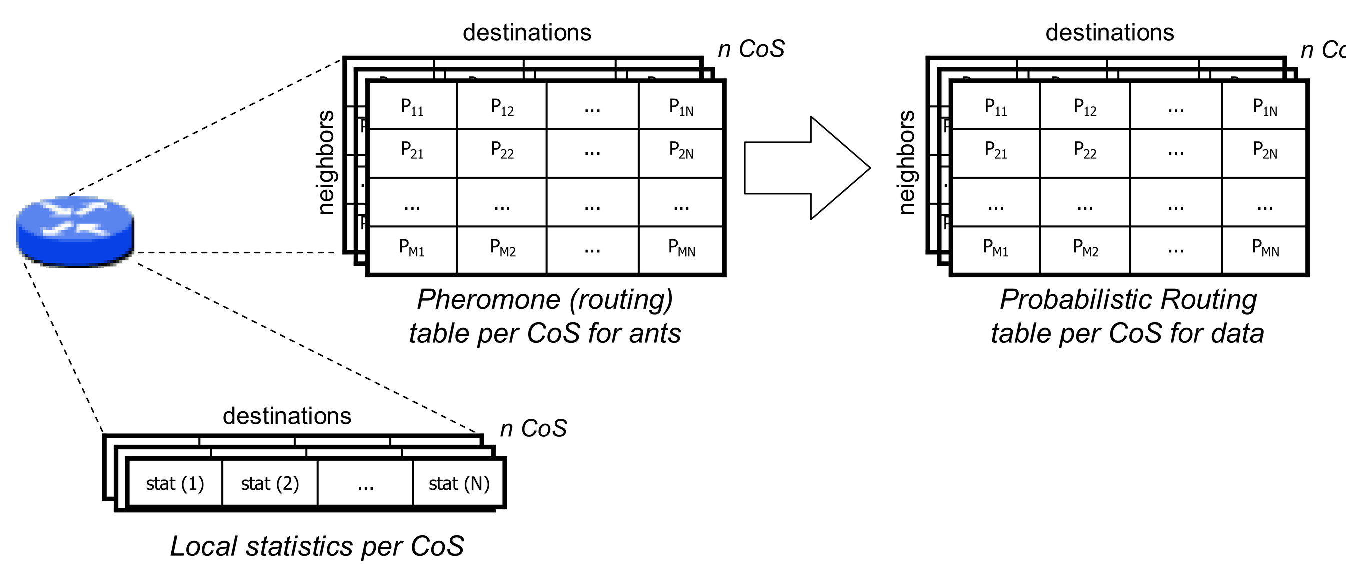
Artificial ant agents sample full paths and report quality to update pheromone tables.

AntNet-QoS

Our algorithm works inside a DiffServ architecture:



For each Class of Service (CoS), every node holds an ant routing table (called pheromone table), a data routing table, and a vector of statistics (average path delay, best path delay, delay variability)

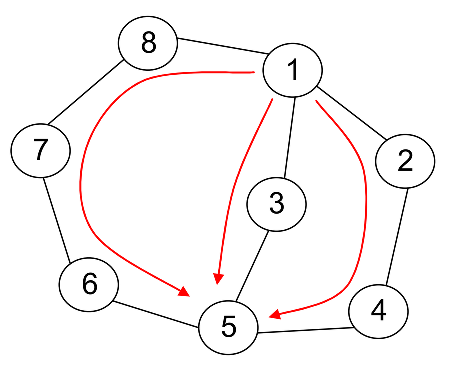


Ants are routed with higher priority than data, but respecting the class-based queuing, such that their pheromone reflects the conditions for the specific class.

Evaluation of AntNet-QoS

A. Traffic Distribution over Multiple Paths

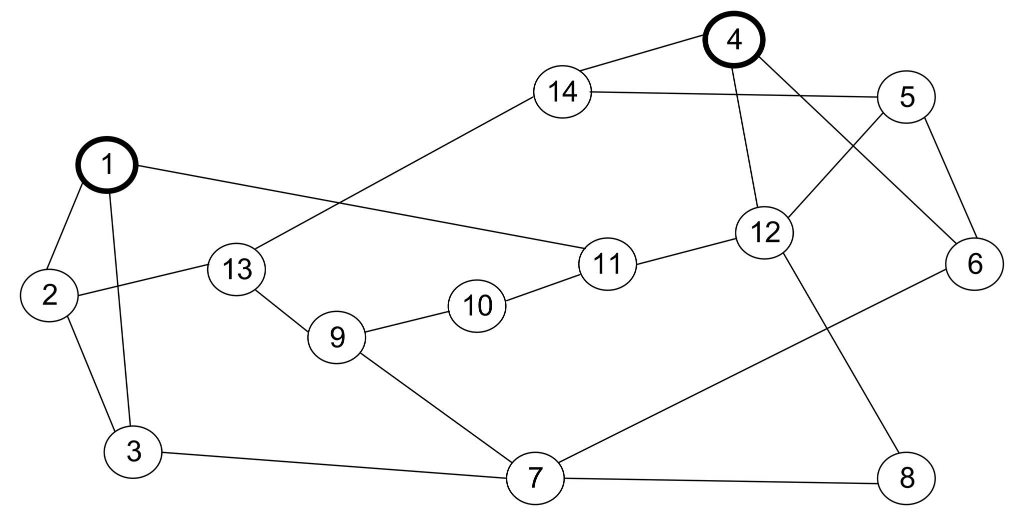
AntNet-QoS rapidly learns about the three possible paths and distributes the traffic in accordance with their respective capacity. After 35 seconds, 83% of the CoS_0 traffic follows the best path 1-3-5. The rest of the CoS_0 traffic follows the path 1-2-4-5. 59% of CoS_1 traffic follows the path 1-2-4-5, 35% follows the path 1-8-7-6-5, and the remaining 6% follows the path 1-3-5 (mainly used for CoS_0 traffic).



This simple example shows how the interaction between the class-based scheduling and the adaptive ant-based routing manages to respect the class priorities in the allocation of the best paths, while still giving acceptable performance to lower priority traffic by using alternative paths.

B. Analysis of the adaptive routing scheme

We investigate the effect of using different ant-sending rates and the performance of the algorithm in terms of throughput, delay and jitter. Low ant-sending rates correspond to low adaptivity, so that we are closer to traditional schemes where queuing preferences are the defining factor to provide QoS, while increasing the sending rate means giving more importance to our adaptive routing scheme.

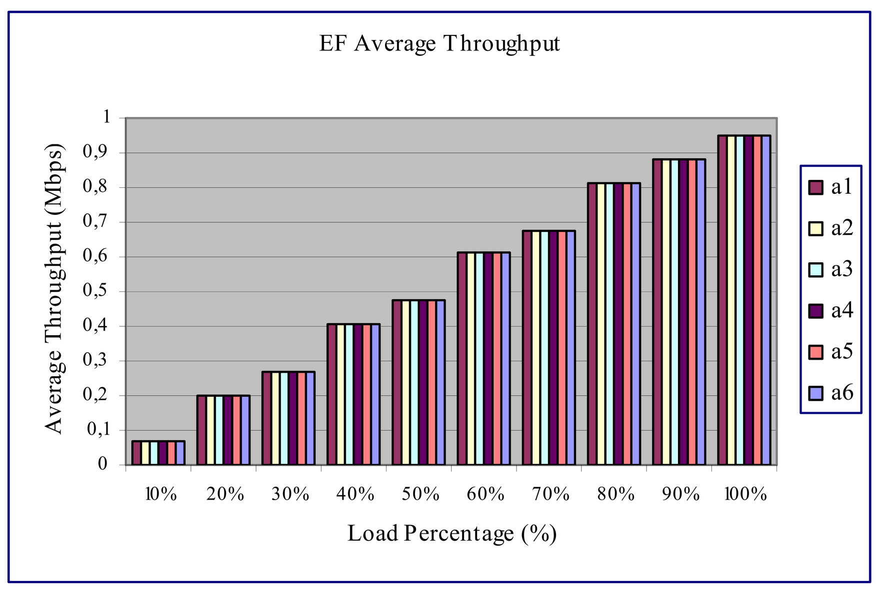


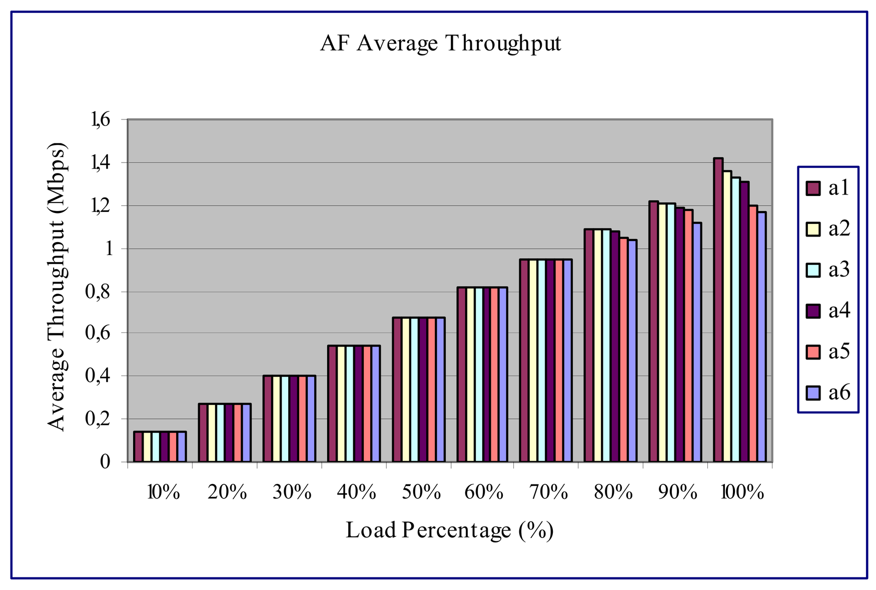
We send traffic from node 1 to node 4 considering the NSFNET-T1 network (14 nodes and 21 links of 1.5 Mbps).

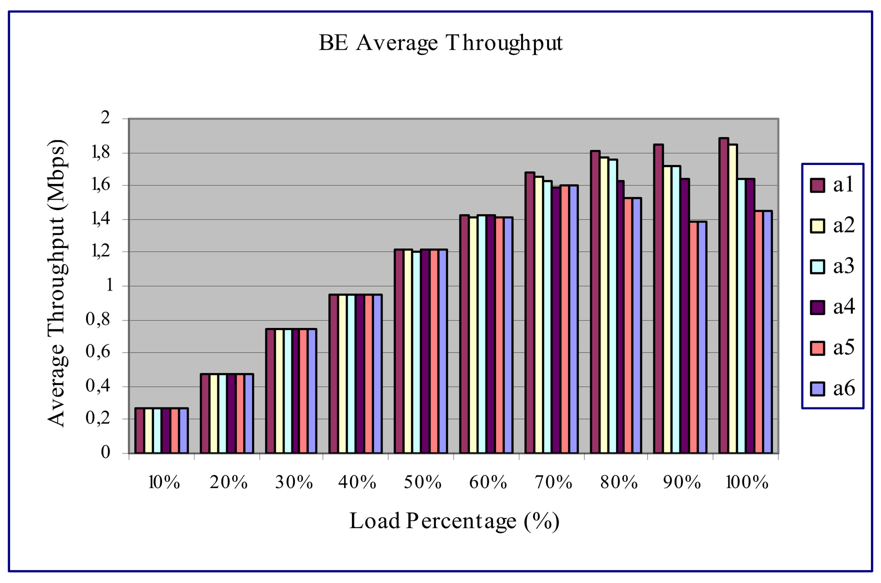
The offered throughput for EF class is 1 Mbps, for AF is 1.5 Mbps, and for BE is 2 Mbps.

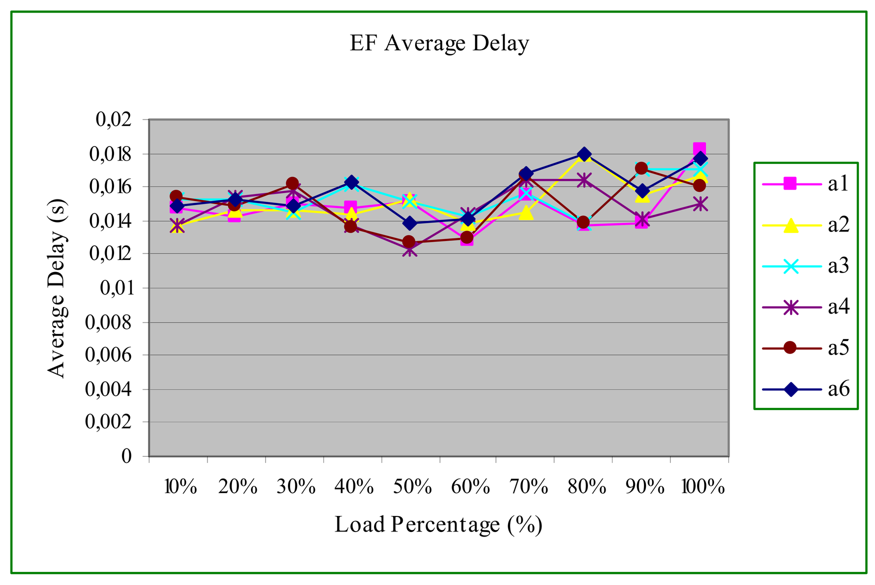
The simulation results show how the interaction between class-based queuing and adaptive ant-based routing can provide a good differentiation between the classes. For 100% network load, the obtained network efficiency is 89,1% when an ant is generated every 0,1 seconds.

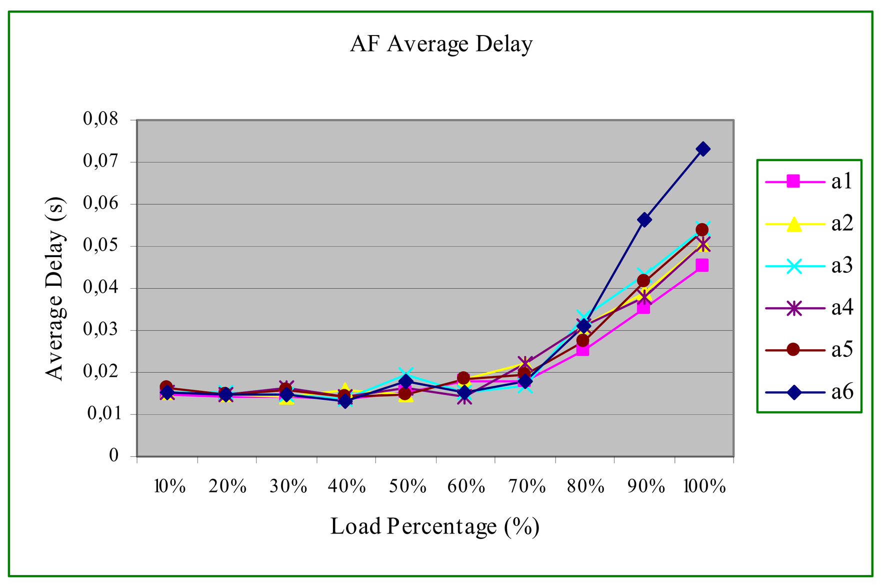
In the figures below, a_j means that one ant is generated every j/10 seconds.

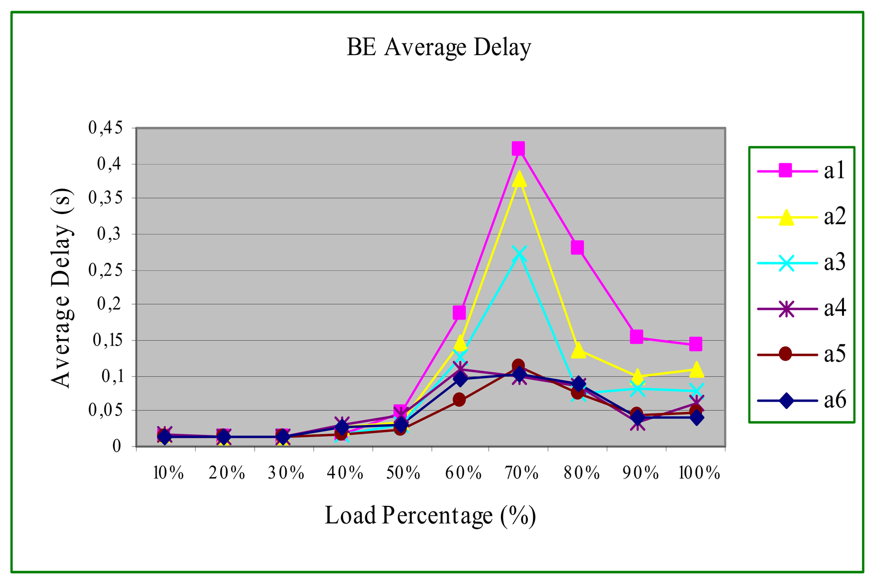


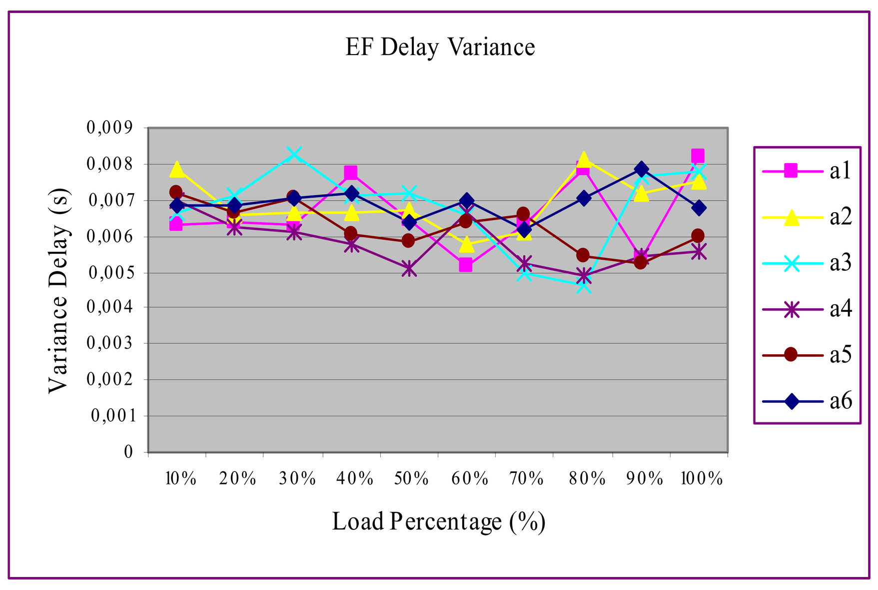


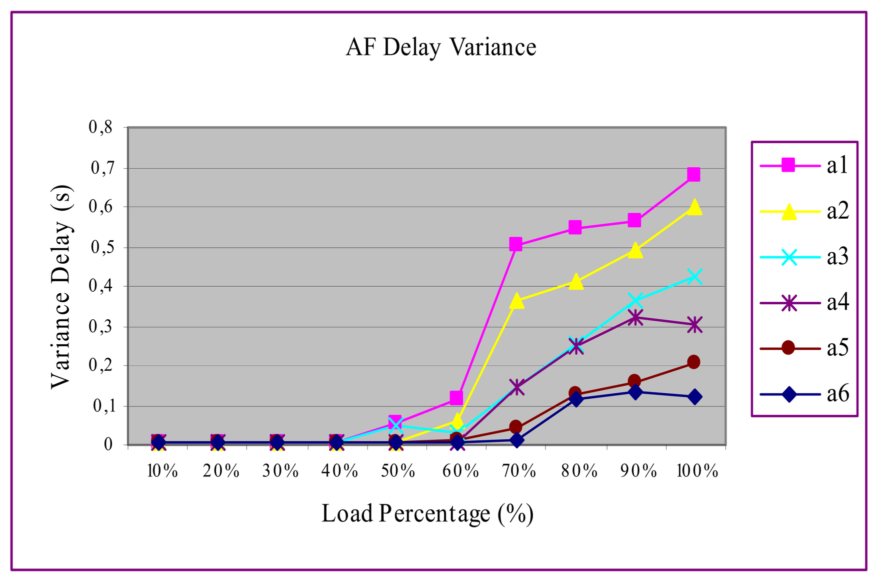


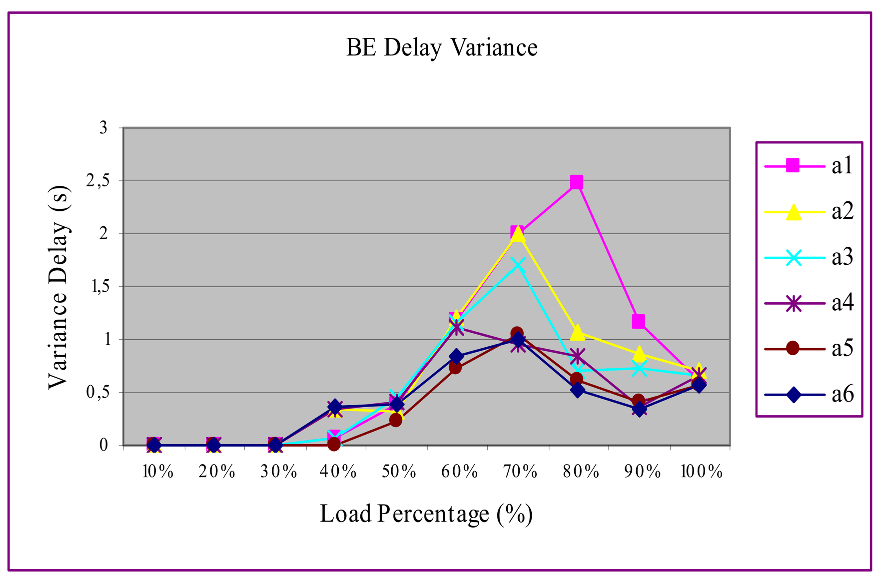


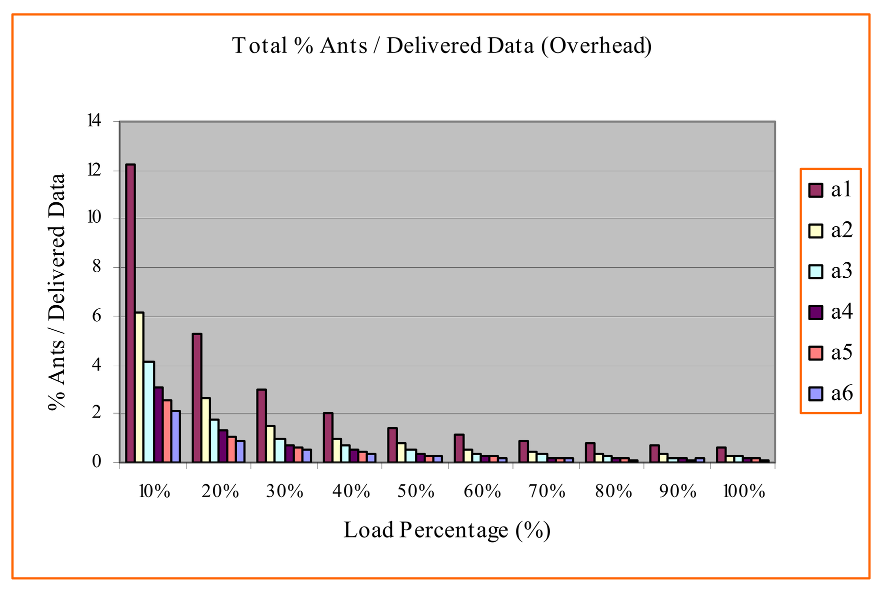












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