Performance monitoring by swarm intelligence

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Abstract

Proper network management and provisioning of service guarantees and differentiation in the Internet requires high quality measurement data. It is a great challenge to obtain sufficient, necessary, correct, and fresh data for various network management and traffic engineering aspects, security and fraud detection, and accounting. Performance monitoring collects and aggregates quality attributes about a service, or a set of services. This is typically of interest to verify that a service is delivered according to the specifications, e.g. as given in Service Level Agreements.

As a supplement to best practise in performance monitoring this paper looks into the potential of collection and aggregation of performance data from indicies of a complex adaptive system based on swarm intelligence. The idea is to observe temporal variables of a swarm intelligence system designed e.g. for solving reliable path management problems [8, 7] or optimising routing [6, 1] in the Internet. These variables will change as the network changes and, hence, as the corresponding quality of the service delivered on this network changes. Previous studies [2] of the transient behaviour of, *CE ants* [3], a Cross Entropy based Ant system for path management, identified that several adaptive compontents of such a system can be used as indicators of the network condition status with respct to traffic load level and topology. The indicators include the stochatic routing matrix (the pheromones), routing path probability, cost values, and temperature (grade of convergence).

A CE ants system applied for monitoring of path quality is tested in a series of simulation experiments on Telenor's Internet backbone consisting of 216 nodes and 368 links. The CE ants system is designed to establish path between ingress and egress nodes, and the quality of the paths is monitored through the temperature and cost values. For comparison, link state (LS) and distance vector (DV) routing protocols are tested on the same network and the quality of the paths are monitored by active measurements, i.e. using ping packets that are sent between the ingress and egress nodes and are recording the round-trip-times. In all cases a few link failures are introduced and the reaction to these failures is of particular interest. The main observations are that link state and distance vector routing give the same results, while the CE ants system in some cases find better (i.e. lower delay) paths. Hence, using CE ants for monitoring the

LS or DV routing performance will potentially detect misconfigurations of e.g. link metics. The *overhead*, measured in the number of routing and measurement packets, is tuned to be small and identical for all 3 cases.

In parallel to large scale testing of the CE ants for monitoring, a prototype implementation of a CE ants IP router is prepared for demonstrating these principles in a small scale network. The implementation is based on *click* [4], a modular software router running on standard PCs. A working prototype implementation [5] based on a Mobile Agent System (Java based) demonstrated the feasibility. However, the solution suffered from severe performace limiations even in a small scale demo network. Providing new modules to the click router will provide useful insights in the complexity of implementing swarms in real operating routers, and detect potential performance bottleneck introduced by the CE ants system.

References

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