Optimizing Telecommunications in Vehicular Networks with a Parallel Multiobjective PSO

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This work presents pSMPSO, a master/slave version of the Speed-constrained Multi-objective Particle Swarm Optimization (SMPSO) algorithm that runs mutation and evaluation in parallel to accelerate the search. Our pSMPSO proposal has been validated on a real world problem in smart cities (not on an academic benchmark): the optimization of vehicular ad hoc network (VANETs) communications. We make our algorithm to find an efficient parameter setting of the Ad hoc On Demand Distance Vector (AODV) routing protocol. Our pSMPSO will optimize two conflicting quality-of-service goals: maximize the packet delivery ratio (PDR) and minimize the end-to-end delay (E2ED). The evaluation of every solution requires its simulation with real maps and traffic, what needs long running times (around 46 s.). The experimental validation of the proposed pSMPSO is performed by analyzing 15 independent runs of two multi-thread variants named pSMPSO-8 and pSMPSO-16. They are implementations with 8/16 particles in the swarm (8/16 threads). The average run time of executing pSMPSO-8 and pSMPSO-16 in a single processor is 7,773.62 and 11,603.73 m., respectively. Their multithreaded versions on a parallel computer reduce those times to 578.76 and 584.87 m., respectively. Thus, the average speedup is 6.88 for pSMPSO-8 and 13.43 for pSMPSO-16, showing a desirable almost-linear speedup. Also, the average computational efficiency is 85.96% (8 threads) and 83.95% (16 threads), really high values. In order to ease decision making we have selected representative solutions of the Pareto front and analyzed the induced behavior in communications of the real scenario. Compared to the standard RFC 3561 and to the optimized configuration got by a sequential and parallel PSO we can confirm that our pSMPSO outperforms the rest in terms of PDR and E2ED. Moreover, these improvements increase with the number of vehicles and the communications needs, i.e. they do scale to real cities.

Keywords: Data Routing, Parallel Multi-Objective Optimization, Software Protocol, Vehicular Ad Hoc Networks (VANET).