070

9th International Command and Control Research and Technology
Symposium
Coalition Transformation: An Evolution of People, Processes and
technology to Enhance Interoperability

Paper title:

Swarm intelligence for military logistics

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Extended Abstract

In this paper we describe a preliminary study exploring the possibilities of improving military logistics processes by applying so called *swarm intelligence* methods. The study is financed by the Swedish Defence Materiel Administration.

Swarm intelligence is a relatively new method of optimization. It takes its inspiration from the way social insects solve complicated planning and search problems. We believe that swarm intelligence methods will be a necessary part of a fully operating Network Centric or Network Based Defence.

Swarm intelligence was first used to explain how swarms and flocks of birds and fish form. It turns out that such aggregations can be formed by having a large number of simple agents following very simple rules (e.g., "don't collide", "try to move in the same directions as your neighbors", and "try to reach the center of your neighbors"). The aggregations are an emergent phenomenon, occurring when a large number of agents interact. Similar rules have been found to explain how ants and other social insects find food, how termites build nests, and many other phenomena. The method used by ants to find food has inspired an optimization method (ant colony optimization) that has been successfully used to approximately solve a wide variety of hard optimization problems. The method uses a large number of simple agents that communicate by depositing pheromones in the search landscape of the optimization problem.

The use of swarm intelligence for military purposes has so far been rather limited. It has been used by several authors[1][2] to control UAVs, and it has also been applied to a subproblem of threat assessment[3] and to construct communication networks resembling those of military forces[4].

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[1] Gaudiano, Shargel, Bonabeau, Clough, "Swarm intelligence: A new C2 paradigm with an application to control of swarms of UAVs", *ICCRTS 03,* Washington DC, paper 036 (2003)

[2] Schrage, Gonsalves, "Sensor scheduling using ant colony optimization", *6th International Conference on Information Fusion*, Cairns, Australia, pp 379-386 (2003)

[3] Svenson, Sidenbladh, "Determining possible avenues of approach using ANTS", *6th International Conference on Information Fusion*, Cairns, Australia, pp 1110-1117 (2003)

[4] Carling, Svenson, Mårtenson, Carlsen, "A flock-based model for ad hoc communication networks", *ICCRTS* 03, Washington DC, paper 63 (2003)

We see three major uses of swarm-inspired methods for logistics problem. The first two of these solve optimization problem using either ant colony optimization or particle swarm optimization based methods. The third uses swarming as a command and control concept, to optimize the handling of the supply chain. This paper will concentrate on the first two uses of swarm-inspired methods, but we believe that using swarming and simple rules for the individual entities will be essential for logistics and also general command and control in a future network based defence.