Software Engineering and Swarm-Based Systems

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ABSTRACT

We discuss two software engineering aspects in the development of complex swarm-based systems.

Categories and Subject Descriptors

D.2.2 [**Software Engineering**]: Requirements/Specifications – *languages, methodologies, tools*.

General Terms

Reliability, Languages, Verification.

Keywords

Autonomic Computing, Formal Methods, Multiagent Systems, Swarms.

1. INTRODUCTION

NASA researchers have been investigating various possible concept missions that would greatly advance future space exploration capabilities. The concept mission that we have focused on exploits the principles of autonomic computing as well as being based on the use of intelligent swarms, whereby a (potentially large) number of similar spacecraft collaborate to achieve mission goals. The intent is that such systems not only can be sent to explore remote and harsh environments but also are endowed with greater degrees of protection and longevity to achieve mission goals [1].

2. ANTS

ANTS (Autonomous Nano Technology Swarm) is a concept mission based on swarms. Its PAM (Prospecting Asteroid Mission) sub-mission involves the collection of scientific data from the asteroid belt. 1000 spacecraft each carrying a single instrument are launched from a Lagrangian point and form sub-swarms to identify asteroids of interest. Interested readers are directed to the ANTS website (http://ants.gsfc.nasa.gov/), or to [2], for further details.

3. SOFTWARE ENGINEERING

3.1 Formal Methods

The FAST (Formal Approaches to Swarm Technologies) project has been looking at the issues related to formally specifying and verifying swarm-based systems as exemplified by ANTS, and uses the PAM sub-mission for its investigation. The project surveyed a wide number of formal approaches, ranking them on their underlying formality, tool support, expressiveness, support for concurrency, support for expression of goals, prior use in agent-based and swarm-like applications, etc. The result is that the project came to the (not unexpected) conclusion that no single formal notation would be sufficient for such systems and a hybrid method would be required. The project has been working on developing such a hybrid method and support tools are planned. A detailed account of the FAST project is given in [3].

3.2 Model-Driven Architecture Approach for Policy Deployment

The development of any autonomic system will require that various policies are determined for the correct operation of the system. These policies are used for guiding the development of a self-managing system, and can be considered to be very high level requirements, and must be implemented by the autonomic managers, etc. at run time..

We are investigating an MDA approach, based on applying policies to swarms, avoiding platform-dependent details, and using MDA transformations of models through implementation. This is based on our previous work applying an Agent-Oriented methodology called MaCMAS (Methodology Fragment for Analyzing Complex Multi-Agent Systems) to modeling, specifying and deploying policies at runtime. We are working on automating the process of adding new policies, essentially using two UML-based Platform Independent Models (PIMS) for specifying autonomous and autonomic properties of the system and an operation to transform these models in order to implement the changes specified by the policy into the running system [4].

4. REFERENCES

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