Specification of Reconfigurable MAS: A Hybrid Formal Approach

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Abstract. In this paper we suggest that Population P Systems and Communication X-machines may be combined into one hybrid formal method which facilitates the correct specification of reconfigurable multi-agent systems.

1 Introduction: Formal Methods for MAS

Recently there has been an increasing interest towards biological and biologically-inspired systems such as insect colonies (ants, bees), flocks of birds, tumours growth etc. The motivation behind their development varies: (a) need of biologists to simulate and observe their behaviour, (b) understanding of how nature deals with various problematic situations has inspired problem solving techniques (Swarm Intelligence, Ant Colony Optimisation, robotics and DNA computing), (c) development of unconventional computational models [1].

These systems can be mapped to multi-agent systems (MAS). Each biological entity is an agent and the overall system's behaviour is the result of the agents' actions, the interactions among them and between them and the environment.

There is a number of agent engineering paradigms used in industry and academia but the more complex a MAS is, the less easy it is to ensure correctness at the modelling level. Correctness implies that all desired properties are verified for the model and that a testing technique is applied to prove that the implementation has been built in accordance to the verified model.

Another key aspect that has to be dealt with at the modelling level is the dynamic nature of the configuration of such MAS. Communication between two agents may need to be established or ceased at any point and also new agents may appear in the system while existing ones may be removed.

In order to formally model each agent as well as the dynamic behaviour of MAS, a formal method should be capable of rigorously describing knowledge, behaviour, communication and dynamics. A plethora of formal methods is available; some focus on the data structures of a system and the operations employed to modify their values, others on describing the control over a system's states and