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Survey

A survey on parallel and distributed multi-agent systems for high performance computing simulations

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HIGHLIGHTS

- We survey Parallel and Distributed Multi-Agents Systems for HPC.
- We analyze the platform properties for distribution support.
- We have implemented a reference model to assess the impact of the properties on the simulation development.
- We assess the performance impact on the simulation scalability.

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ABSTRACT

Simulation has become an indispensable tool for researchers to explore systems without having recourse to real experiments. Depending on the characteristics of the modeled system, methods used to represent the system may vary. Multi-agent systems are often used to model and simulate complex systems. In any cases, increasing the size and the precision of the model increases the amount of computation, requiring the use of parallel systems when it becomes too large. In this paper, we focus on parallel platforms that support multi-agent simulations and their execution on high performance resources as parallel clusters. Our contribution is a survey on existing platforms and their evaluation in the context of high performance computing. We present a qualitative analysis of several multi-agent platforms, their tests in high performance computing execution environments, and the performance results for the only two platforms that fulfill the high performance computing constraints.

Contents

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1. Introduction

In the field of simulation, to improve the confidence in a result, we often need to overcome the limits of a model, for instance by increasing its size (simulate larger systems) or its accuracy (smaller discretization of the system). Increasing the size of a model or improving its accuracy has however a direct impact on the amount of computations necessary to animate the model. More computing resources are thus needed and centralized systems are often no longer sufficient to run these simulations. The use of parallel resources allows us to overcome the resource limits of centralized systems and thus to increase the size and the accuracy of the simulated models.

There are several ways to model a system [1]. For example, the time behavior of a large number of physical systems is based on differential equations. In this case the discretization of a model allows, most of the time, its representation as a linear system. It is then possible to use existing parallel libraries to take advantage of many computing nodes and run large simulations. On the other hand it is not possible to model every time-dependent system with differential equations. This is for instance the case of complex systems as defined in [2] where the complexity of the dependencies between the phenomena that drive the entity behaviors makes it difficult to define a global law modeling the entire system. For this reason multi-agent systems (MAS) are often used to model complex systems. MAS are based on an algorithmic description of individuals, agents, that simulate the expected behavior. Then the platform is in charge of animating the model, i.e. running the agent behaviors, either using a periodic time discretization, time steps, or a list of scheduled events. MAS thus propose a bottom-up modeling approach as opposed to the top-down approach of formal models. From the viewpoint of increasing the size or accuracy of simulations, multi-agent systems are constrained to the same rules as other modeling techniques.