Balancing the Workload of Compute Clusters in Distributed Multi-Agent System Simulations

Multi-agent systems, with their autonomous and decentralized properties, are a well suited basis for the development of decentralized control mechanisms for innovative advancements of future power distribution grids. To enable the development and analysis for scenarios close to reality, a huge amount of several thousand components has to be considered. This leads to additional challenges when designing performant ways to execute such high-scaled multi-agent systems on distributed high-performance computing systems. One way to achieve sufficient performance is to make sure that the corresponding high-performance computing system is properly utilized by means of assigning the emerging workload onto the distributed hardware in a balanced way. Therefore, in this thesis several approaches of agent distributions, with their common goal of balancing the workload of compute clusters in distributed multi-agent system simulations, are analyzed, developed, and compared with respect to their performance. For all work done, the SwarmGrid project, which was developed to simulate the earlier mentioned decentralized control mechanisms for power distribution grids, served as a use case. For this use case, two new methods called Workitembased Extension and Balanced Workitembased Extension were developed. Both methods are based on Hu's Level Algorithm. As the name indicates, in contrast to the Level Algorithm, those algorithms work on the basis of topology based workitems, i.e. sets of agents. Both new approaches distribute the agents with respect to linear inter-agent dependencies occurring in the corresponding simulations. The balanced version of this extension takes additional care of the total number of agents created in the different processes. For the new methods, as well as Hu's Level Algorithm, benchmark tests were done and compared to the currently existing way of evenly distributing all agents into a given number of processes. During all tests, the total amount of simulation time needed was measured for different numbers of processes. The presented results show that simple, static and non-preemptive approaches of agent distribution can have a major impact on the total execution time of multi-agent system based simulations.