

Advanced Parallel/Distributed Simulation Benchmark for Cellular Models

Shafagh Jafer, Ph.D. Candidate
Systems & Computer Engineering Department
Carleton University, Ottawa, ON, K1S 5B6

Modeling and simulation (M&S) methodologies have become crucial for implementing, designing, and analyzing a broad variety of systems. Among the existing modeling and simulation techniques, DEVS (Discrete Event System Specification) formalism provides a discrete-event approach which allows construction of hierarchical models in a modular manner. DEVS formalism has been extended to handle simultaneous event execution. Parallel DEVS or P-DEVS, allows more efficient execution of models in parallel and distributed environments by keeping the major properties of the original DEVS formalism and just extending it to overcome the serialization constraints. DEVS and Cell-DEVS formalisms have been successfully used to develop complex models in different fields of science including: physics, biology, chemistry, ecology, as well as computer networks, traffic modeling, and many other systems. Example of such models would be: fire spread in forests, land battlefield of two armies, computer networks, and ATLAS.

The focus of our research is on improving the capability of CD++ in supporting P-DEVS and Parallel Cell-DEVS modeling and simulation. Our work is based on previous research: PCD++ which is an optimistic DEVS and Cell-DEVS parallel simulator, and the conservative PCD++ simulator for DEVS and Cell-DEVS. We aim at: 1) modifying the existing optimistic simulator to enhance the performance of large scale models executions, 2) analyzing the performance of these two simulators using precise testing scenarios. We present new implementations in the Time Warp protocol to improve the CD++-based parallel and distributed simulations by controlling the optimism of our optimistic PCD++ simulator. We have implemented two new protocols, namely *Local Rollback Frequency Model* (LRFM) and *Global Rollback Frequency Model* (GRFM) to limit the optimism. This was done by modifying the WARPED kernel to implement a Near Perfect State Information (NPSI) mechanism based on the number of rollbacks. The idea is to reduce the number of rollbacks by suspending the simulation object within logical process that has large number of rollbacks, hence blocking it from flooding the net with anti-messages. However, this new design allows the logical process to stay receiving input events and inserting them into the corresponding message queues. After a predefined duration, the suspended simulation object is released and will resume its simulation duties. The LRFM protocol is only based on local information of the logical processes. Thus, the simulation object will be suspended or allowed to continue simulation only based on its number of rollbacks. In contrast, in the GRFM protocol, each simulation object uses global information in such a way that among all the simulation objects residing on all logical processes, the one with greatest number of rollbacks must be suspended for a predefined duration.

The main goal of our current research work is to enhance the maximum capability of the two mentioned PCD++ simulators in terms of handling the number of nodes driving the simulation, complexity of the model, and the size of the model.