Special Issue: Advancing Simulation Theory and Practice with Distributed Computing
Editorial (Part B)

High Performance Simulation and Simulation Methodologies

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The realization of high performance simulation necessitates sophisticated simulation experimentation and optimization; this often requires non-trivial amounts of computing power. Distributed computing techniques and systems found in areas such as High Performance Computing (HPC), High Throughput Computing (HTC), e-infrastructures, grid and cloud computing can provide the required computing capacity for the execution of large and complex simulations. This extends the long tradition of adopting advances in distributed computing in simulation as evidenced by contributions from the parallel and distributed simulation community. There has arguably been a recent acceleration of innovation in distributed computing tools and techniques. This special issue presents the opportunity to showcase recent research that is assimilating these new advances in simulation. This special issue brings together a contemporary collection of work showcasing original research in the advancement of simulation theory and practice with distributed computing. This special issue has two parts. The first part (published in the preceding issue of the journal) included seven studies in high performance simulation that support applications including the study of epidemics, social networks, urban mobility and real-time embedded and cyber-physical systems. This second part focuses on original research in high performance simulation that supports a range of methods including DEVS, Petri nets and DES. Of the four papers for this issue, the manuscript by Bergero, et al. (2013), which was submitted, reviewed and accepted for the special issue, was published in an earlier issue of SIMULATION as the author requested early publication.

Contributed papers

Bergero, et al. (2013) introduces a novel parallelization technique for DEVS simulation of continuous and hybrid systems called Scaled Real-Time Synchronization (SRTS). In SRTS, models are split into several sub-models that are concurrently simulated on different processors; each sub-model locally synchronizes its simulation time with a scaled version of physical time in real-time fashion. SRTS uses the same physical time-scaling parameter throughout the entire simulation. The authors have also developed an adaptive version of this technique called Adaptive-SRTS; in this technique the time-scaling parameter evolves during the simulation according to the workload. Both SRTS and Adaptive-SRTS techniques are implemented in a DEVS simulation tool under a real-time operating system.

Adegoke, et al. also addresses parallel simulation of DEVS. The authors propose a theoretical guide in building a DEVS distributed simulation and present a formalization of underlying concepts to allow symbolic reasoning and automated code synthesis, for example, mapping DEVS Simulation Tree onto a DEVS Simulation Graph. They propose a taxonomy to identify the essential building blocks of performing Parallel Discrete-Event Simulation by utilizing DEVS (this is done through a review of existing DEVS implementation approaches). The taxonomy offers an abstract way for integrating heterogeneous DEVS implementation strategies and thus serves as a contribution to the on-going DEVS standardization efforts.

Latorre and Jimenez-Macias investigate decision making in discrete event systems with alternative structural configurations. They identify that a solution may be tackled by its transformation into an optimization problem. A variety of statements for this optimization problem can be presented by using different formalisms. These different statements allow developing diverse optimization algorithms for solving the problem, which may be very demanding for a computer. The authors pursue several approaches in order to reduce the computing requirements needed by these algorithms. The paper presents a new distributed methodology, which associates sets of alternative structural configurations of the system to different alternatives aggregating Petri nets, depending on the number of available processors. Under certain conditions, this methodology alleviates the computational requirements for every processor and speeds up the optimization process. A case-study is presented to illustrate their method.

The final paper of the special issue is by Tang and Yao. They present a GPU-based discrete event simulation kernel called gDES which implements three algorithms to maximize GPU efficiency - (a) an algorithm based on conservative time window that attempts to find a balance between maximizing the degree of parallelism and minimizing the cost of synchronization; (b) a memory management algorithm to store events such that memory consumption is at an acceptable rate; (c) an event redistribution algorithm that reassigns events of the same type to neighbouring threads to reduce the probability of branch divergence. A series of experiments with gDES and the algorithms are conducted and the results are comparing with a CPU-based simulator on a multi-core platform. The results show that, when compared with the latter, gDES can achieve a magnitude speedup when using the PHOLD and the QUEUEING NETWORK benchmark models for large scale simulation; the same is true for epidemic simulation.

Acknowledgements

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References

Bergero, F., Kofman, E. and Cellier, F. (2013). A novel parallelization technique for DEVS simulation of continuous and hybrid systems. *SIMULATION: Transactions of the SCS*, 89(6): 663-683.

Guest editor profile

Dr NAVONIL MUSTAFEE *(Nav) is a lecturer in the University of Exeter Business School. He is based at the Centre for Innovation and Service Research (ISR), which is a multi-disciplinary research centre that aims to bring academic rigour to the challenges of managing service organisations. Nav has research interests in distributed systems and M&S. He has applied distributed computing technologies like grid computing and Parallel and Distributed Simulation to execute large and complex simulations in application domains such as healthcare and banking. His current research explores the use of multiple Operations Research techniques and hybrid-simulation in the operations context. Nav publishes in both Computing and Operations Research/Simulation journals, including, Concurrency and Computation: Practice and Experience, Simulation: Transactions of the Society of Modelling and Simulation International, Journal of the Operational Research Society, International Transactions in Operational Research and ACM Transactions on Modelling and Computer Simulation. He is/has been the guest editor for special issues in journals such as Journal of Enterprise Information Management, Journal of Simulation and Concurrency and Computation: Practice and Experience. He has served as the co-program chair for the UK Operational Research Society's 55th Annual Conference (OR55) and is the program chair for the 2014 Spring Simulation Multi-Conference.*

Dr SIMON J E TAYLOR *has been an academic for over 20 years. He is the Founder and Chair of the international COTS Simulation Package Interoperability Standardisation Group at the Simulation Interoperability Standards Organization. He is the co-founding Editor-in-Chief of the Journal of Simulation. He was Chair of the Association for Computing Machinery's Special Interest Group for Simulation (2005-2008). He is a Reader in the School of Information Systems, Computing and Mathematics at Brunel University (UK) and leads the ICT Innovation Group. He has published over 150 research articles as well as attracting over £1M in research grants in computer simulation and distributed computing, some of which has led to major cost savings in industry. He has enthusiastically taught hundreds of computing students at Undergraduate and Postgraduate levels. His recent work has focused on the development of cloud-based high performance simulation for industry and the development of e-Infrastructures in Africa.*

END OF EDITORIAL B

Running order for the papers:

Advancing Sim Theory and Practice With Distributed Computing (Guest editor: Navonil Mustafee)			
Issue		Author	Title
	S-12-0026.R1	Zou et al.	#1 Epidemic simulation of large-scale social contact network on GPU clusters
Part 1 (Oct)	S-12-0022.R2	Hou	#2 Modeling and simulation of large-scale social networks using parallel discrete event simulation

	S-12-0039.R1	Zia	#3 An agent-based parallel geo-simulation of urban mobility during city-scale evacuation
	S-12-0044.R1	Collier and North	#4 Parallel agent-based simulation with repast for high performance computing
	S-12-0024.R2	Cordasco	#5 Bringing together efficiency and effectiveness in distributed simulations: The experience with D-Mason
	S-12-0025.R1	Pfeifer	#6 Simconnect and simtalk for distributed cyber-physical system simulation
	S-12-0037.R1	Li	#7 Compensatory dead reckoning-based update scheduling for distributed virtual environments
Part 2 (Nov)	S-12-0018.R1	Bergero	#1 A novel parallelization technique for DEVS simulation of continuous and hybrid systems
	S-11-0197.R3	Adegoke	#2 A unifying framework for specifying DEVS parallel and distributed simulation architectures
	S-11-0263.R1	Latorre, and Jimenez-Macias	#3 Simulation-based optimisation of discrete event systems with alternative structural configurations using distributed computation and the Petri net paradigm
	S-12-0023.R2	Tang and Yao	#4 A GPU-based discrete event simulation kernel

Note: **S-12-0018.R1** has already been published; We are including a reference to this paper (which was a special issue paper) in **part-B** of the editorial.