

Carl Tropper

Professor Emeritus

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1 Education

Bachelor of Science in 1968, McGill University, Montreal, Canada

PhD in Mathematics in 1973, Polytechnic Institute of New York, Brooklyn, New York

2 Academic and Industrial Experience

McGill University, School of Computer Science, Montreal, Canada 1984-present. Professor Emeritus of Computer Science. I have worked in the area of parallel simulation since its inception and have developed synchronization and load balancing algorithms belonging to both of the churches of parallel simulation-conservative and optimistic. Two areas for which we developed synchronization and load balancing algorithms were gate level chip simulations and gravitational n-body simulations. We developed a parallel environment for gate level simulation which incorporated the algorithms which we developed. Gravitational N-Body simulation is used to study a wide range of astrophysical models ranging from the dynamics of galaxies and globular clusters containing 10^{16} stars to planetary systems with dozens of bodies. We introduced a discrete event approach to solve the equations of motions for the bodies as a replacement for the more expensive (and traditional) time stepping approach for their solution.

Recently I have been working on the use of parallel simulation in computational neuroscience. We collaborated with the NEURON group at Yale. During this time we developed a parallel discrete-event stochastic simulator for reaction-diffusion models of neurons. Stochastic models provide a fine grain view of the chemical reactions at the basis of a neuron's functioning, while traditional continuous models are simulated by differential equations.

California Institute of Technology, Pasadena, California Sabbatical year 1991-92. A sabbatical was spent at the Jet Propulsion Laboratories of the California Institute of Technology, working on a project whose goal it was to verify the sequence of commands sent to a spacecraft. I developed a synchronization mechanism to execute the verification model on a distributed memory machine.

Bolt, Beranek and Newman , 1982-84, Cambridge, Mass, *Senior Scientist*. As part of a network design and performance group, I worked on a number of projects whose principle orientation was to develop new routing algorithms and flow control strategies for the ARPANET. The ARPANET was the research predecessor of the INTERNET which was designed and implemented by BBN. I participated in the Packet Radio project. My orientation was towards the development of routing and flow control algorithms.

MITRE Corporation, Bedford, Mass ,1978-82, *Member, Technical Staff* As a member of the local area networking group at MITRE, I participated in design studies for the Air Force and other DOD clients. The local area networking group at MITRE was one the first developers of Ethernet technology, pioneering a broadband approach. While at MITRE, I wrote a book on the performance of local area networks, /bfLocal Computer Network Technologies. It contained a description of LAN access protocols, and compared their performance via both queuing and simulation models.

Boeing Computer Services , McLean, Virginia, 1976-78 *Senior Analyst*. I participated in the development of a combined arms simulation model for the Air Force.

Rutgers University, Department of Mathematics 1973-76. *Assistant Professor of Computer Science* I taught undergraduate mathematics courses. During my tenure at Rutgers, I also worked for **Data Systems Analysts**, a company which developed real-time software for airplane flight controllers.

3 Publications

3.1 Journal Papers

1. Load balancing for multi-threaded PDES of stochastic reaction-diffusion in neurons, with Zhongwei Lin, Yiping Yao, Robert Mcdougal, Mohammad Patoary, William Lytton, M.L. Hines ,*Jour. Simul.* 2017 Aug;11(3):267-284.
2. Parallel stochastic discrete event simulation of calcium dynamics in neurons, with Mohammad Patoary, Zhongwei Lin, Robert McDougal , William Lytton, itIEEE Trans Comp Biology and Bioinformatics 2017
3. Multi-Threaded Stochastic PDES for Reactions and Diffusions in Neurons. *ACM Trans. on Modelling and Computer Simulation*, with Zhongwei Lin, Mohammad Pataory, YipingYao, November 2016; 27(2):1.
4. Optimization Techniques for Parallel Digital Logic Simulation, with Sina Meraji, *IEEE Trans. on Parallel and Distributed Systems*, Sept. 2011, pp.545-554

5. On the Scalability and Dynamic Load Balancing of Optimistic Agent-based Gate Level Simulation, with Sina Meraji and Wei Zhang, *IEEE Trans. Computer Aided Design of Integrated Circuits and Systems (TCAD)*, 29(9),pp.1368-1380
6. A Design Driven Partitioning Algorithm, with Lijun Li ,*Trans. of the Society of Computer Simulation (SCS)*, volume 84, issue 4, April 2009, pp. 257-270
7. Towards Large Scale Optimistic VLSI Simulation, with Qing Xu, *Simulation Modeling Practice and Theory (SIMPRA,journal of Eurosim)*
8. Towards Distributed Verilog Simulation, with Lijun Li and Hai Huang,*International Journal of Simulation:Systems, Science and Technology (IJS3T)*, vol 4, nos 3-4, September 2003, pp. 44-55.
9. Parallel and Discrete Event Simulation-Applications, *Journal of Parallel and Distributed Computing, Special issue on parallel and distributed discrete-event simulation*, March2002, p.327-335.
10. Parallel and Distributed Simulation, *Parallel and Distributed Computing Practices-Special issue on distributed simulation*, July 2002
11. Flow Control and Dynamic Load Balancing in Time Warp, with Myongsu Choe, *Transactions of the Society for Computer Simulation*, vol.18, no. 1, March 2001, pp. 9-24.
12. Local versus Global Lookahead in Conservative Parallel Simulation, with Azzedine Boukerche, *Parallel Computing*,North-Holland, Elsevier, vol.27,no.8, pp.1033-1055
13. On the Parallel Simulation of Fixed Channel Allocation Algorithms, with Peter Alleyne, *Wireless Networks*,vol.5,pp.209-218,Baltzer Science Science Publishers, the Netherlands
14. Scalable Clustered Time Warp and Logic Simulation,with Herve Avril, *VLSI Design,Special Issue on Current Advances in Parallel Logic Simulation*, Gordon-Breach, vol9,no3,pp291-313, 1999.
15. A Distributed Graph Algorithm for the Detection of Local Cycles and Knots, with Azzedine Boukerche, *IEEE Transactions on Parallel and Distributed Systems*, August, 1998, pp. 748-758
16. Parallel Simulation on the Hypercube Multiprocessor, with Azzedine Boukerche, *Distributed Computing*, Springer Verlag, vol.8, no.4, pp.181-191, 1995
17. On Load Balancing and Process Migration in Time Warp, with David Glazer, *IEEE Transactions on Parallel and Distributed Computing*, March 1993,pp 318-328

18. Optimal Packet Size in packet-Switching Networks, with Claude Evequoz, *Computer Networks and ISDN Systems*, vol. 25, 1992, pp.387-404
19. Approximate Analysis of Bulk Closed Queuing Networks, with Claude Evequoz, *INFOR, Canadian Operational Research Society*, Feb.1992
20. The Distributed Simulation of Clustered Processes, with Bojan Groselj, *Distributed Computing* Springer-Verlag, 1991, pp. 111-121
21. A New Metric for Dynamic Routing, with David Glazer, *IEEE Transactions on Communications*, vol. 38, issue 3, March 1990. pp.360-367.
22. On Buffer Allocation in Transport Protocols, with A.Zissopoulos, *Computer Networks and ISDN Systems*, vol. 16, no.5, May 1989, pp. 383-393
23. On Reassembly Delay in Packet-Switching Networks, Claude Evequoz, *Computer Networks and ISDN Systems*, vol.15, no.1 1988, pp.1-25
24. On Priorities and Performance in Packet-Switching Networks, *Computer Networks and ISDN Systems*, vol 12, no.2, 1987, pp.89-99
25. Pseudosimulation: An Algorithm for Distributed Simulation with Limited Memory, with Bojan Groselj, *International Journal of Parallel Programming*, vol15, no5, October 1987, pp.42-82

3.2 Conference Papers

1. Optimizations for Neuron Time Warp (NTW) for stochastic reaction-diffusion models of neurons, with Mohammad Patoary, Robert McDougal, William W. Lytton, *Winter Simulation Conference. 2017*,
2. A Multi-threaded simulator for reaction diffusion simulations in NEURON, with Zhongwei Lin, Mohammad Patoary, Robert McDougal, William W. Lytton, Michael L. Hines, *SigSim-Pads 2015 - Proceedings of the 3rd Acm SigSim Conference On Principles of Advanced Discrete Simulation*, pp.157-167
3. NTW-MT: a multi-threaded simulator for reaction diffusion simulators in NEURON, with Zhongwei Lin, Mohammad Patoary, Michael Hines *PADS 2015*
4. Neuron Time Warp, with Zhongwei Lin, Mohammad Patoary, Robert McDougal, *Proceedings of the 2014 Winter Simulation Conference*, pp.3447-3458
5. Modeling large scale circuits using massively parallel discrete-event simulation, with E. Gonsiorowski, C. Carrothers, *Proceedings of the 2012 Ieee 20th International Symposium On Modeling, Analysis and Simulation of Computer and Telecommunication Systems, Mascots 2012*, pp. 127-133.

6. Parallel Discrete Event N-body Techniques, with Matthew Holly, *2011 Principles of Advanced and Distributed Simulation*, Nice, France, 14-17 June, 2011, pp. 1-10 **Best Paper Award**
7. A Simulated Annealing Technique for Optimizing Time Warp Simulations, Wei Zheng, Sina Meraji, Carl Tropper, *Second International Conference on Computer Modeling and Simulation (ICCMS2010)*, pp.197-201, Sanya, China, January 2010
8. A Machine Learning Approach for Optimizing Parallel Logic Simulation, Sina Meraji, Carl Tropper, *International Conference on Parallel Processing (ICPP2010)*, July, 2010
9. A Multi-State Q-Learning Approach for the Dynamic Load Balancing of Time Warp, Sina Meraji, Carl Tropper, *24th ACM/SCS/IEEE Workshop on the Principles of Advanced and Distributed Simulation (PADS2010)*, Atlanta, Georgia, May 2010
10. A Reinforcement Learning Approach for Dynamic Load Balancing of Parallel Digital Logic Simulation, Sina Meraji, Carl Tropper, *22nd ACM Symposium on Parallelism in Algorithms and Architectures (SPAA 2010)*, Santorini, Greece, June 2010
11. On the Scalability of Parallel Verilog Simulation, Sina Meraji, Wei Zheng, Carl Tropper, *International Conference on Parallel Processing (ICPP)*, September 22-September 29, 2009, Vienna, Austria
12. On Determining how many Computers to Use in a Parallel VLSI Simulation, Qing Xu, Carl Tropper, *Workshop on Advanced and Distributed Simulation (PADS 2009)*, June 22-June 25, 2009, Lake Placid, NYS, USA
13. On the Scalability and Dynamic Load Balancing of Parallel Verilog Simulation, Sina Meraji, Carl Tropper, *2009 Winter Simulation Conference (WSC)*, Austin, Texas, December 13-December 16, 2009
14. Using Genetic Algorithms to Limit the Optimism in Time Warp, Jun Wang, Carl Tropper, *2009 Winter Simulation Conference (WSC)*, Austin, Texas, December 13-December 16, 2009
15. A Simulated Annealing Technique for Optimizing Time Warp Simulations, Wei Zheng, Sina Meraji, Carl Tropper, *International Conference on Parallel and Distributed Systems (ICPADS09)*, December 8-December 11, 2009, Shenzhen, China
16. Selecting the GVT interval in Time Warp distributed simulation using reinforcement learning, Jun Wang and Carl Tropper, *Annual Simulation Symposium 2009*, March 2009
17. A multi-way design driven algorithm for distributed VLSI design, Lijun Li and Carl Tropper, *ICPP*, Portland, Oregon, September 2008

18. Optimizing the Time Warp Protocol with Learning Automata, with Jun Wang, *2007 European Simulation and Modeling Conference, ESM 2007*
19. A Design Driven Partitioning Algorithm for Distributed Verilog Simulation”, with Lijun Li, *PADS 2007*, San Diego, California, pp. 211-219, **Nominated for Best Paper**
20. Optimizing Time Warp Simulation with Reinforcement Learning, with Jun Wang, *2007 Winter Simulation Conference*, Washington, DC
21. Compiled Code in Distributed Logic Simulation, with Jun Wang, *2006 Winter Simulation Conference*, Monterey, California
22. XTW, a Parallel and Distributed Logic Simulator, with Qing Xu, *PADS 2005*, pp 181-188, June 2005
23. Parallel Logic Simulation of Million Gate VLSI Circuits, with L.Zhu,G.Chen, B.Szymanski, T. Zhang, *MASCOTS 05*, Atlanta, Ga., September, 2005.
24. XTW: A Parallel and Distributed Logic Simulator, with Qing Xu, *ASP-DAC2005 (Asian South- Pacific Design Automation Conference)*, January, 2005.
25. ”Nicarus:A Distributed Verilog Compiler, with Jun Wang, *2004 International Conference on Parallel Processing, 3rd workshop for compile and run-time techniques*, Montreal, Canada
26. Event Reconstruction vs Dynamic Checkpointing, with Lijun Li, *PADS04*, May 2004, pp. 37-44.
27. Accelerate Simulation on Myrinet Cluster, with Lijun Li, *ASTC*, Arlington, Va. 2004
28. Flow Control in Optimistic Simulation, with L. Solomen, *17th European Simulation Multiconference, HP5*, Nottingham, England, June, 2003
29. DVS-An Object Oriented Framework for Distributed Simulation, with Lijun Li, *PADS2003*, June 10-13,2003, San Diego, California, pp. 173-180
30. Distributed Simulation of Channel Allocation Algorithms, with O. Cismasu, *MASCOTS02*, October 12-16, 2002, Ft. Worth, Texas,pp.329-338.
31. The Dependence List in Time Warp, with Jing lei Zheng, *PADS2001*, pp. 35-46, Lake Arrowhead, California, **Nominated for the Best Paper Award**
32. Flow Control and Dynamic Load Balancing in Time Warp, with M. Choe, *Proc. 33rd Annual Simulation Symposium*, April, 2000, pp. 219-226.
33. On Learning Algorithms and Balancing Loads in Time Warp, with M. Choe, *PADS99*, May2-5, Atlanta, Georgia,pp.101-108.

34. The Parallel Simulation of Distributed Channel Allocation Algorithms, with Peter Alleyne, *Wireless Communications Workshop, MASCOTS98*, Montreal, Canada, June 19-27,1998
35. On Metrics for the Dynamic Load Balancing of Optimistic Simulations, with K.el Khatib, HICSS 32, *Proceedings of the 32nd Annual Hawaii International Conference on System Sciences,Hawaii,Track 8* January, 1999
36. An Efficient GVT Algorithm using Snapshots, with M. Choe, *CSMA98*, Orlando, Florida, November, 1998
37. Parallel Simulation of Billiard Balls using Shared Variables, with P MacKenzie,*PADS96(Proc. 10th Workshop on Parallel and Distributed Simulation)*, Philadelphia, Penn., May 22-24, 1996, pp. 190-195.
38. The Dynamic Load Balancing of Clustered Time Warp for Logic Simulation,with H. Avril, *PADS96*, Philadelphia, Penn., May 22-24, 1996, pp.20-27.
39. SGTNE: Semi-Global Time of the Next Event Algorithm, with A. Boukerche, *PADS95*,Lake Placid, New York State, June, 1995, pp.68-77
40. Clustered Time Warp and Logic Simulation, with H Avril, *PADS95*, Lake Placid, New York State, June, 1995, pp.112-119
41. A Distributed Algorithm for the Detection of Local Knots and Cycles, with A. Boukerche, *Proc. Ninth International Parallel Processing Symposium*,25-28, April 1995,Santa Barbara, California, pp.118-127.
42. Hierarchical Scheduling of the Time of Next Event Heuristic on Distributed Memory Machines, with A. Boukerche, *Proc. 28th Annual Simulation Symposium*, Phoenix, Arizona, 9-13 April 1995, pp. 155-165.
43. An Efficient Distributed Cycle/Knot Detection Algorithm, *Proc 1993 Canadian Conference on Electrical and Computer Engineering*, 14-17 September 1993, pp. 619-622, vol.2
44. A Static Partitioning and Mapping Algorithm for Conservative Parallel Simulations, with A. Boukerche, *PADS94*, Edinburgh, Scotland, pp.164-173
45. Parallel Simulation of Communicating Finite State Machines, with A. Boukerche, *PADS93*, San Diego, California, May 1993, vol. 23, no.1, pp. 143-151
46. On the Performance of Time Warp, with N. Krivossidis, *International Conference on Parallel Processing*, Chicago, Illinois, August, 1992
47. On Distributed and Pseudosimulation,with C. Cote, *PADS92*, SCS Simulation Series, vol.24, no.3, pp. 97-107

48. A Performance Analysis of Distributed Simulation with Clustered Processes, with A. Boukerche, *1991 IEEE Workshop on Parallel and Distributed Computing, SCS* vol.23, no.1, pp.112-125
49. End-to-End Delay of Multiple Packet Messages in Window Flow Controlled Packet-Switched Networks, with C. Evequoz, *IEEE INFOCOM*, 3-7 June, 1990, pp. 47-54, vol.1.
50. Local Deadlock Detection for Distributed Simulation, with L. Liu, *1990 PADS*, SCS vol. 22, no. 1, pp. 64-70
51. A Deadlock Resolution Scheme for Distributed Simulation, with B. Groselj, *1989 PADS*, Tampa, Florida, SCS vol. 21, no. 2, pp.108-113
52. The Time-of-Next-Event Algorithm, with B. Groselj, *PADS88*, San Diego, SCS vol. 19,no.3, pp. 25-30
53. On Re-Assembly Delay in Packet Switching Networks, with C. Evequoz, *INFOCOM87*
54. A Congestion Based Dynamic Routing Algorithm, with D. W. Glazer, *ICC87*
55. On Congestion Based Dynamic Routing ,with D. Glazer, *Telecom 87*, Geneva, Switzerland, vol. III.3, pp.377-381
56. On Priorities in a Packet-Switching Network, *19th Annual Hawaiian Conference on System Science*, Honolulu, Hawaii, 1986.
57. Distributed Simulation Using a Look-Ahead Algorithm, with B. Groselj, *ACM Workshop on Distributed Computing*, Amsterdam, Holland, 1986
58. Priorities and Performance in Packet-Switching Networks, *IEEE INFOCOM86*, Miami, Fla.
59. Re-Transmission Protocols for Ethernet, *IEEE ICC83*, Boston, Mass.

3.3 Book

Local Computer Network Technologies, *Academic Press*,1981, provides a comprehensive overview of the channel access techniques for local area networks which were in existence at the time of its publication. It discusses their performance as portrayed by both queuing and simulation models.

3.4 Technical Reports

1. Window - A Queuing Model of the ARPANET, BBN Internal Report, July 1984.
2. On Multipath Routing, BBN Internal Report. 3.

3. Packet size in the ARPANET, BBN Internal Report.
4. Computerized Models for the Design and Analysis of Computer-Communications Networks, ESDTR-79-128, MITRE Corp., Bedford, Mass., May, 1979.
5. Models of Local Networks, ESD-TR-80-111, MITRE Corp., April 1980.
6. Software Timing Studies for the Hughes Class 1 JTIDS Terminals, Working Papers 23253, MITRE Corp., March 1981.
7. Applications of Distributed Database Technology to Tactical C3. Working Paper 23323 (joint with D. Lambert and W. Tracton, MITRE Corp. March 1983

4 Invited Talks

1. Polytechnic Institute of NYU, *Computational science*, November, 2008
2. Monmouth University, *Distributed VLSI Simulation*, March 2005.
3. Polytechnic University of New York, *Distributed Verilog Simulation*, December, 2003.
4. Nortel Corporation, Ottawa, Ontario, *Optimistic VLSI discrete event simulation*, March, 1999.
5. Panasonic Laboratories, Princeton, New Jersey, *Optimistic VLSI Simulation*, June, 1996.
6. Lucent Laboratories, New Jersey, *Load balancing in distributed simulation*, May 1995.
7. SRI, San Francisco, California. *Distributed simulation*, May, 1995.
8. Zycad, San Francisco, California, *Distributed simulation of digital circuits*, June, 1993. Zycad is a computer aided design company
9. ISI, Los Angeles, California, *Time of Next Event Algorithm*, June 1992. ISI is a distinguished research affiliate of the University of Southern California. The foundation Internet protocol, TCP/IP, was created at ISI.
10. Jet Propulsion Laboratories, Pasadena, California. October, 1991, *Scalable conservative distributed simulation*. JPL is a laboratory of both NASA and Caltech, and is responsible for unmanned space probes.

5 Professional activities in the research community

5.1 External evaluator for theses and promotions

1. External evaluator for promotion for Chris Carrothers, to full professor, in the Department of Computer Science, Rennsalaer Polytechnic Institute, Troy, New York State, USA, 2009
2. External evaluator for promotion for Wentong Cai, to full professor, Division of Computer Science, School of Computer Engineering, Nanyang Technological University, Singapore, 2007
3. External evaluator for promotion for Georgios Theorodopoulos, to senior lecturer, at the School of Computer Science, University of Birmingham, UK. because of my work in load balancing, 2005
4. External doctoral thesis reviewer Doctoral dissertation of Zeng Yi, Nanyang Technological University, Singapore, 2004
5. Doctoral thesis opponent University of Lapeenranta, Finland. This was a formal (oral) exam in which I served as the sole examiner for the doctoral candidate in front of a general audience at the university.

5.2 Reviewer for research grants

1. research grant reviewer Israel Science Foundation, 2005.
2. research grant reviewer US National Science Foundation, 2002-3.
3. research grant reviewer NSERC, 2009,2010

5.3 Program committees

1. I have done extensive work with PADS, the premier conference in the field of parallel and distributed simulation, having served on the program committee since 1992, and having served as a technical and general chair for the conference.
2. Program Committee, DS-RT 2010
3. Program Committee, 3rd International Conference on Simulation Tools and Techniques (Simutools), Torremolinos, Malaga, Spain, March, 2010
4. General Chair, 23rd Workshop on the Principles of Advanced and Distributed Simulation (PADS 2010)
5. Program Chair, 11th Workshop on Parallel and Distributed Simulation (PADS97), held in Lockenhaus, Austria

6. General Chair, 9th Workshop on Parallel and Distributed Simulation (PADS95), Lake Placid, New York State, June, 1995
7. Program Co-Chair, ACM MSWIM, Conference on the Modelling and Simulation of Mobile Networks, Boston, August, 2000.
8. Program Committee for PADS (Parallel and Distributed Simulation Workshop), 1992-present. PADS is the premier conference in the area of distributed simulation.
9. Program Committee for MASCOTS97 (Sixth International Symposium on Modeling, Analysis, and Telecommunications)

5.4 Editorial work

1. Editorial board Transactions of the Society for Computer Simulation, SCS
2. Editorial board, Parallel and Distributed Computing Practices, Nova Science Publishers, New York
3. Guest Editor, Journal of Parallel and Distributed Computing (Academic Press), Special Issue on Distributed and Parallel Simulation, March 2002.
4. Guest Editor, Parallel and Distributed Computing Practices, Nova Science Publishers, Special Issue on Distributed and Parallel Simulation, July 2002
5. Journal and conference reviews -I have reviewed numerous articles for journals, including IEEE Computer, IEEE Transactions on Communications, ACM Transactions on Modelling and Simulation, Transactions of the Society for Computer Simulation, and the IEEE Transactions on Parallel and Distributed Computing, as well as for simulation, computer network and VLSI conferences