30 Eleanor Dr., # 908, Ottawa, ON, Canada, K2E 7E5   *+1 (613) 907-6109*
http://www.sce.carleton.ca/~ufarooq   ufarooq@sce.carleton.ca

UMAR FAROOQ

Research Interests

- Distributed Systems, Large-Scale Multi-Organizational Resource Sharing, High Performance Computing, Distributed Middleware, Grid Computing.
- Ubiquitous Computing, Pervasive Grids, Sensor Networks, Wireless Ad Hoc Networks.
- Performance Optimization, Scheduling Algorithms and Real-Time Systems.

Education

Ph.D. Candidate, Electrical Engineering (2003 – Present; Expected: May 2007)
Dept. of Systems and Computer Engineering (SCE), Carleton University, Ottawa, ON, Canada

Current GPA: 11.7/12. Advisers: S. Majumdar, E. W. Parsons

Dissertation Title: *A Framework to Achieve Guaranteed Quality of Service (QoS) for Applications and High System Performance in Multi-Institutional Grids*

M.A.Sc., Electrical Engineering (2001 – 2003)
Dept. of Systems and Computer Engineering (SCE), Carleton University, Ottawa, ON, Canada

GPA: 11.5/12. Advisers: S. Majumdar, E. W. Parsons

Dissertation Title: *High Performance Middleware for Mobile Wireless Publish/Subscribe Systems*

B. Sc. (Honors), Electrical Engineering (1997 – 2001)
Dept. of Electrical Engineering (EE), University of Engineering & Technology (UET), Lahore, Pakistan

Graduated with honors and distinction: ranked 2nd in the graduating class of 250. GPA: 91%

Awards and Honors

- Ontario Graduate Scholarship (OGS) for two consecutive years, Ontario, Canada. (2003-2005).
- Carleton Academic Excellence Scholarship for four straight years, Ottawa, Canada (2003-2007).
- Carleton University Graduate Scholarship for six straight years, Ottawa, Canada (2001 - 2007).
- Pakistan's National Award *Medal of Excellence for Academic Achievements* given by the President of Pakistan in 1999.
- Best Project Award for "Modeling Routing in Wireless Ad Hoc Networks using Cell-DEVS" in Modeling and Simulation Mini-Conference, Carleton University, Ottawa, Canada, 2003.
- Best Project Award for "Intelligent, Impromptu, Embedded Computing with JINI and JAVA Spaces" in All UET Final Year project Exhibition, Lahore, Pakistan, May 2001.
- UET merit certificates and scholarships for all four undergraduate years (1997 - 2001).
- *The Talented Student of the Year* Award by Punjab Group of Colleges, Pakistan, 1999.
- Selected student member of UET Proctor Board based on academic achievements (1999-2001).
- Pakistan's top scholarship *Nishan-e-Haider* for five successive years (1996 - 2001).
- Gold Medals for Overall First position in both *Higher Secondary and Secondary School Examinations* among over 60,000 students from all over Pakistan in 1996 and 1994 respectively.

Publications

Journal Papers in Review

- U. Farooq, S. Majumdar, E. W. Parsons, "Providing QoS Guarantees under Uncertain Runtimes of Jobs in Multi-Institutional Grid Computing," *Journal Paper in review*.

- U. Farooq, S. Majumdar, E. W. Parsons, "High Performance Middleware for Mobile Wireless Networks," *Journal Paper in review*.

Journal Publications

- U. Farooq, B. Balya, G. Wainer, "DEVS Modeling of Mobile Wireless Ad Hoc Networks", in *Elsevier Simulation Modelling Practice and Theory*, 2007 (to appear, accepted for publication).

- U. Farooq, Z. A. Chishti, F. Ahmed, S. Ahmed, "Experimenting with JINI on LINUX," in *Embedded Linux Journal*, January 2001, pp. 45-52.

Refereed Conference Publications

- U. Farooq, O. M. Kanwar, S. Majumdar, E.W. Parsons, "Building Advance Reservations Enabled Grid Computing Systems," *Conference Paper in review*.

- U. Farooq, S. Majumdar, E. W. Parsons, "Engineering Grids Applications and Middleware for High Performance", to appear in the *Proceedings of the 6th ACM International Workshop on Software and Performance(WOSP'07)*, Buenos Aires, Argentina, February 2007.

- U. Farooq, S. Majumdar, E. W. Parsons, "A Framework to Achieve Guaranteed QoS for Applications and High System Performance in Multi-Institutional Grid Computing," in the *Proceedings of the 35th International Conference on Parallel Processing (ICPP'06)*, pp. 373-380, Columbus, OH, August 2006.

- U. Farooq, S. Majumdar, E. W. Parsons, "Dynamic Scheduling of Lightpaths in Lambda Grids," in the *Proceedings of the 2nd IEEE International Workshop on Networks for Grid Applications (GRIDNETS'05)*, pp. 540-549, Boston, MA, October 2005.

- U. Farooq, S. Majumdar, E. W. Parsons, "Impact of Laxity on Scheduling with Advance Reservations in Grids," in the *Proceedings of the 13th IEEE International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems (MASCOTS'05)*, pp. 319-324, Atlanta, GA, September 2005.

- U. Farooq, K. I. Siddiqui, "Scalability Analysis of Multi-Tier Distributed Software Patterns using Layered Queuing Networks," in the *Proceedings of the 18th IEEE Annual Canadian Conference on Electrical and Computer Engineering (CCECE'06)*, pp. 1025-1028, Saskatoon, SK, Canada, May 2005.

- U. Farooq, S. Majumdar, E. W. Parsons, "Engineering Mobile Wireless Publish/Subscribe Systems for High Performance," in the *Proceedings of the 12th IEEE International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems (MASCOTS'04)*, pp. 295-305, Volendam, The Netherlands, October 2004.

- U. Farooq, T. Israr, K. I. Siddiqui, "Thin-Client Architecture for Location-Dependent Mobile Services over Short-Range Communications," in the *Proceedings of the 2nd International Conference on Computer, Communications and Control Technologies (CCCT'04)*, Austin, TX, August 2004.

- U. Farooq, B. Balya, G. Wainer, "Modeling Routing in Wireless Ad Hoc Networks Using Cell-DEVS," in the *Proceedings of the 2004 International Symposium on Performance Evaluation of Computer and Telecommunication Systems (SPECTS'04)*, pp. 285-292, San Jose, CA, July 2004.

- U. Farooq, E. W. Parsons, S. Majumdar, "Performance of Publish/Subscribe Middleware in Mobile Wireless Networks," in the *Proceedings of the 4th ACM International Workshop on Software and Performance (WOSP'04),* pp. 278-289, Redwood City, CA, January 2004.

Other Publications

- U. Farooq, S. Majumdar, E. W. Parsons, "QoSMOS: QoS aware resource Management in multi-Organizational gird Systems," *Poster, 2006 IBM Centers for Advance Studies Conference (CASCON'06)*, Markham, ON, Canada, October 2006.

- U. Farooq, S. Majumdar, E. W. Parsons, "Scheduling Advance Reservations on Shared Grid Resources." *Technical Report SCE-06-13*, Dept. of Systems and Computer Engineering, Carleton University, Ottawa, Canada, July 2006.

- U. Farooq, S. Majumdar, E. W. Parsons, "Efficiently Scheduling Advance Reservations in Grids." *Technical Report SCE-05-14*, Dept. of Systems and Computer Engineering, Carleton University, Ottawa, Canada, August 2005.

- U. Farooq, S. Majumdar, E. W. Parsons, "Semi-Durable Subscriptions: A Technique to Achieve High Performance in Mobile Wireless Publish/Subscribe Systems." *Technical Report SCE-03-17*, Dept. of Systems and Computer Engineering, Carleton University, Ottawa, Canada, July 2003.

Theses

- U. Farooq, "A Framework to Achieve Guaranteed Quality of Service (QoS) for Applications and High System Performance in Multi-Institutional Grids," *Ph.D. Thesis*, Dept. of Systems and Computer Engineering, Carleton University, Ottawa, Canada, May 2007 (expected).

- U. Farooq, "High Performance Middleware for Mobile Wireless Publish/Subscribe Systems," *M.A.Sc. Thesis*, Dept. of Systems and Computer Engineering, Carleton University, Ottawa, Canada, August 2003.

Projects and Experience

Research Experience

Real-Time and Distributed Systems Laboratory, Carleton University, Ottawa, ON, Canada.

- **Graduate Research Assistant** *(2001 – Present):* The research was funded by Nortel Networks and Natural Sciences and Engineering Research Council of Canada. Some of the significant research projects are listed.

    - A Framework for QoS Aware Resource Sharing in Multi-Organizational Grids *(in collaboration with Nortel Networks)***:** There are many examples of Grid applications that require QoS guarantees in terms of guaranteed response time and guaranteed allocation of heterogeneous resources in multiple domains. Specific examples include those in remote medicine, air traffic flow management, real-time control of sensitive sites and instruments and multimedia. Since there are multiple stakeholders in Grids – resource consumers and resource owners – each with different objectives and since Grid resources are shared by multiple applications which may belong to different administrative domains, it is difficult to meet QoS objectives of applications while maintaining high resource utilizations that is important to resource owners. My research presents a complete framework for resource sharing in multi-institutional Grids that can meet the objectives of the both stakeholders in Grids. The framework relies on the notion of under-constrained advance reservation requests which have laxity in their reservation windows. The framework provides components for each of the fabric, resource and collective layer of the Grid architecture and aligns well with other Grid technologies. Several components of the framework

are being integrated into the well-known Globus Toolkit with the aim of making them available as an add-on patch for users around the world.

- Application-Controlled Dynamic Scheduling of Optical Networks in Data/Lambda Grids (*in collaboration with Nortel Networks*): Dynamic optical networks hold the potential of satisfying very large bandwidth requirements of many of the Grid applications. However, encapsulation of optical network elements into manageable Grid resources and dynamic provisioning of lightpaths is necessary to meet the complex demand patterns of the Grid applications. In this project, I presented a scalable algorithm (Scaling through Subset Scheduling Algorithm) for an NP-Hard problem of scheduling on-demand and advance reservation requests for lightpaths. The algorithm meets the demands of applications while seeking to optimize usage of optical network. I also investigated the impact of data segmentation on performance and demonstrated how laxity in the reservation window can be exchanged for segmentation to achieve high utilization of lightpaths.

- Dynamic Matchmaking in Multi-Institutional Environments (*in collaboration with Nortel Networks)*: In any form of distributed computing, effective application-to-resource mapping and load balancing are important to meet performance objectives. This process is generally referred to as *matchmaking*. My research demonstrated that traditional matchmaking algorithms used in distributed computing result in poor performance when applied in multi-institutional settings particularly for workloads consisting of both advance reservations and best-effort jobs. I introduced a novel algorithm for matchmaking, Minimum Laxity Impact (MLI) that outperforms all other algorithms investigated in almost every respect for a wide range of workload parameters. In comparison to other algorithms, MLI results in the lowest response time for the users while providing the highest resource utilizations. Another application of MLI is as an effective meta-scheduler within Platform's Community Scheduler Framework (CSF) that is used to dispatch jobs to resource managers in multiple domains. MLI is currently being integrated into CSF.

- Configurable Grid Middleware: Modern resource sharing systems comprise thousands of resources and consumers. On such a scale, dynamic configuration of the system in accordance with workload conditions is necessary for high efficiency. My research introduces configurable Grid entities that adapt to meet the requirements of the system. I presented a novel heuristic-based scalable algorithm, Grid Scheduling with Deadlines (GSD), for an NP-Complete problem of scheduling advance reservation and on-demand requests on shared Grid resources on which a number of Grid jobs can run in parallel with each other. GSD supports non-preemptable and preemptable jobs and adapts itself to the workload conditions. I also introduced components that adapt the resource schedule to prevent performance degradation resulting from exceptions due to inaccurately estimated runtimes and abnormal terminations of jobs.

- Engineering Mobile Wireless Publish/Subscribe Systems for High Performance: The decoupled and asynchronous nature of the publish/subscribe paradigm makes it a good choice for mobile wireless networks. My experimental investigation however shows that the current implementations of publish/subscribe systems as well as the traditional solutions for extending publish/subscribe systems to the mobile domain do not perform well in highly mobile and unreliable wireless settings. I introduced a novel approach called semi-durable subscriptions for extending publish/subscribe systems to mobile wireless networks and proved its efficacy and superiority over traditional solutions.

- DEVS Modeling of Mobile Wireless Ad Hoc Networks: Analyzing wireless ad hoc networks is a complex task due to their dynamic and irregular nature. Cellular Automata (CA), a very popular technique to study self-organizing systems, can be used to model and simulate ad hoc networks, as the modeling technique resembles the system being modeled. Cell-DEVS was proposed as an extension to CA in which each cell in the system is considered as a DEVS model. In this project we show how these techniques can be used to model mobile wireless ad hoc

4

networks, making easy model definition, analysis and visualization of the results. With the help of Cell-DEVS we were able to extend ad hoc routing techniques for internetworking and multicast routing.

- High Performance Distributed Software Systems: Evaluating performance of software systems early in their life cycle helps in determining software bottlenecks and enables redesign (if necessary) without incurring substantial time and monetary costs. The process becomes even more important for multi-tier distributed applications where a bottleneck in one of the tiers can have devastating consequences for the whole system. My research analyses scalability of multi-tier distributed software patterns using layered queuing networks. The research provides an insight into the scalability behavior of different patterns. The results show that the choice of a scaling strategy should not only take into account the pattern being scaled up but should also take into consideration aspects such as the scale-factor to which scalability is desired and the size of the pattern.

Teaching Experience

Department of Systems and Computer Engineering, Carleton University, Ottawa, ON, Canada.

- **Graduate Teaching Assistant** *(Fall 2001 to Present):* I have been a teaching assistant for more than five years for several undergraduate courses including those on object oriented software development and computer systems. I administered projects, held lab sessions, created lab quizzes, and graded assignments and exams.

- **Guest Lecturer** *(Fall 2005, Fall 2006):* I delivered guest lectures to the graduate class of *SYSC 5207: Distributed Systems Engineering* taught by Professor S. Majumdar. I also helped in creating and grading assignments.

- **Co-Supervisor** *(Summer 2006 to Present):* I am co-supervising junior and senior-year undergraduate students working on research projects as interns in the department.

Department of Electrical Engineering, University of Engineering and Technology, Lahore, Pakistan.

- **Laboratory Coordinator** *(Fall 1999 to Winter 2001):* I was responsible for the administration, configuration and management of the Digital Laboratory for undergraduate java and operating system courses. I also helped in the preparation of a laboratory manual for a junior-year Digital Logic Programming course.

Industry Experience

Newcore Networks Inc., Mountain View, California, USA (Worked for them in Lahore).

- **Computer Consultant** *(July 2000 to March 2001):* My work involved RT-Linux kernel porting to a PowerPC-based embedded processor used in a network switch.

Recent Talks and Presentations

- *Resource Management in Lambda Grids,* Technical Presentation, Nortel Networks, Ottawa, Canada, May 2006.
- *Achieving QoS in Grids*, Real-Time & Distributed Systems Lab Seminar, Department of Systems and Computer Engineering, Carleton University, Ottawa, Canada, December 2005.
- *Scalability Analysis of Multi-Tier Distributed Software Patterns using Layered Queuing Networks* at CCECE 2005.

- *Grid Computing – Benefits and Challenges*, Invited Talk, University of Engineering and Technology, Lahore, Pakistan, April 2005.
- *Engineering Mobile Wireless Publish/Subscribe Systems for High Performance* at MASCOTS 2004.
- *Middleware for Mobile Computing,* Invited Talk, University of Engineering and Technology, Lahore, Pakistan, August 2004.

Professional Activities

- Technical Program Committee Member, *International Conference on Software Engineering Advances* (ICSEA 2006) October 29 - November 1, 2006.
- Technical Reviewer for several conferences and journals including IEEE MASCOTS 2004, Communications of the ACM and ICSEA 2006.
- Volunteered in Linux Standardization Process (Canadian Position).
- Student Member IEEE (2001 – Present) including IEEE Ottawa and IEEE Carleton branch.
- Vice President IEEE UET Student Branch (2000-2001).