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An Infrastructure for Wide Area Large Scale Automated Information Processing

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Contents

1 Introduction

1.1 CONCEPTUAL FRAMEWORK

This project is developing a new conceptual framework for the automated processing of information arriving from physical sensors in a generalized wide-area, large-scale distributed network infrastructure. The project is focusing on water-related ecological and generalized environmental applications, and it is addressing issues such as scalability, modularity, signal representation, data coherence, data integration, distributed query processing, scheduling, computer performance, network performance, and usability. This new framework treats signals as elements in prescribed sets and their associated structures. The project is constructing a computational and information processing (CIP) environment to deal with the algorithmic treatment of signal-based large scale content in order to extract information relevant and important to a user. It is also developing new theories and algorithms for computational signal processing to gather, process, and efficiently represent data (compressed sensing) obtained from physical sensors. Furthermore, it is also developing concepts in middleware (web/grid) service integration, distributed query processing, scheduling, and virtualization and pervasive storage techniques to adapt to an ever changing network infrastructure as well as to provide a pathway between a physical world sensory reality, with its associated physical sensors, and a user with network infrastructure service-oriented needs.

1.2 INTELLECTUAL MERIT

The intellectual merits of this project can be described along three fundamental lines. The first line deals with the formulation of a conceptual framework for the automated processing of signal-based information in a generalized, large scale, distributed network infrastructure. The second line deals with the development of new theory and algorithms for *Computational Signal Processing* to gather, process, and efficiently represent data (compressed sensing) obtained from physical sensors, at one end of our proposed automated information system, as well as the development of new, non-traditional concepts in software applications for reconfigurable, multimode human-computer interfaces to render information important to a user, at the other end. Finally, the third line deals with the development of concepts in middleware (web/grid) service integration and as well as virtualization and pervasive storage techniques for an ever changing network service infrastructure and provide a pathway between a physical world sensory reality, with its associated physical sensors, and a particular user, with his/her network infrastructure service-oriented needs.

1.3 BROADER IMPACT

The WALSAIP project is collaborating with the scientific community in Puerto Rico in activities dealing with the automated information processing of sensor-based signals to assist in environmental monitoring endeavors at local natural research reserve facilities. It is also organizing educational activities with university students engaged in research work in diverse areas of science and engineering through field trips to designated environmental testbed sites. In addition, it is developing a series of brochures for dissemination to the general audience. The WALSAIP project is concentrating on the development of a framework for the treatment of signal-based information arriving from physical sensors in a wide-area, large scale setting, as it pertains to *environmental surveillance and monitoring* (ESM) applications. ESM deals with the gathering and processing of appropriate environmental information to aid in the process of effective decision making. The significant importance of this framework infrastructure relies upon its unified and integrated capability to treat the distributed acquisition, storing, processing, and rendering of information in a timely and mostly automated manner.

2 WALSAIP Goals and Objectives

This section describes the goals and objectives of the WALSAIP project which is entering into its fourth year of proposed integrated research and academic activities. The description of goals and objectives is preceded by a definition of a vision and a mission for the WALSAIP project.

A ***vision*** of the WALSAIP project is to effect *automation instantiations* throughout a *computational and information processing (CIP)* framework where information is **captured** from *observable entities* of a physical world through *distributed sensor networks* and **delivered** to human users by means of network services provided through a *cyberspace infrastructure*.

A ***mission*** of the WALSAIP project is the development of tools, applications, and services, in a multidisciplinary setting, that will facilitate prototyping a CIP framework.

A ***first goal*** is to develop modular, reconfigurable, and scalable working prototypes in the form of systems, tools, and applications to aid and support a network infrastructure for the automated processing of signal-based information acquired from arrays of sensors in heterogeneous, wide-area, large scale, distributed systems.

A ***second goal*** is to utilize developed working prototypes in specific scientific and engineering applications dealing with identification, monitoring, assessment, and management of regional natural resources in tropical areas, with particular emphasis given to the Caribbean region.

A ***third goal*** is to use acquired experience, expertise, and prototype works developed through this project as a vehicle to promote human networking with other institutions and sustain a very discernable presence in research and academic activities pertaining to an evolving cyberspace infrastructure and its necessary link to the physical environment.

The *main objectives* of the WALSAIP project are formulated as follows:

1. Continue the infrastructure development of laboratories associated to the project such as the Advanced Data Management Lab., Automated Information Processing Lab., Computing Research Lab., and Parallel and Distributed Computing Lab.

2. Foster, encourage, and promote the integration of the existing research and development areas to address complex, large scale, multidisciplinary problems in *information processing* and *network service infrastructure* associated with distributed sensor networks of environmental surveillance monitoring (ESM).

3. Provide a formal characterization of a computational and information processing (CIP) environment framework over a network service infrastructure (NSI).

4. Strengthen existing research and development groups with the recruitment of outstanding graduate students at the doctoral and master degree levels, continuing this way to increase the number of well qualified Hispanic women and underrepresented groups pursuing graduate education.

A set of integrated research and academic activities have been planned for this fourth year of the WALSAIP project in order to bring to fruition these goals and objectives. A dissemination and outreach plan is also being developed to inform the scientific community and the public in general, about the work of our students and professors.

3 WALSAIP Conceptual Design

3.1 WALSAIP CONCEPTUAL FRAMEWORK

Great advances in *sensors/actuators* technology, *digital communications* and *wireless networking* technology, and *computational and information processing* technology are demanding new theories, methods, and techniques aimed at improving our seamless understanding and interaction with our *physical world* or *sensory reality*. For instance, better conceptual tools and techniques are needed for performing tasks such as storage, manipulation, representation, visualization, and rendering when dealing with very large amounts of *signal-based content* in a network service infrastructure (see ***Figure 3.1.1*** and ***Figure 3.1.2*** below).

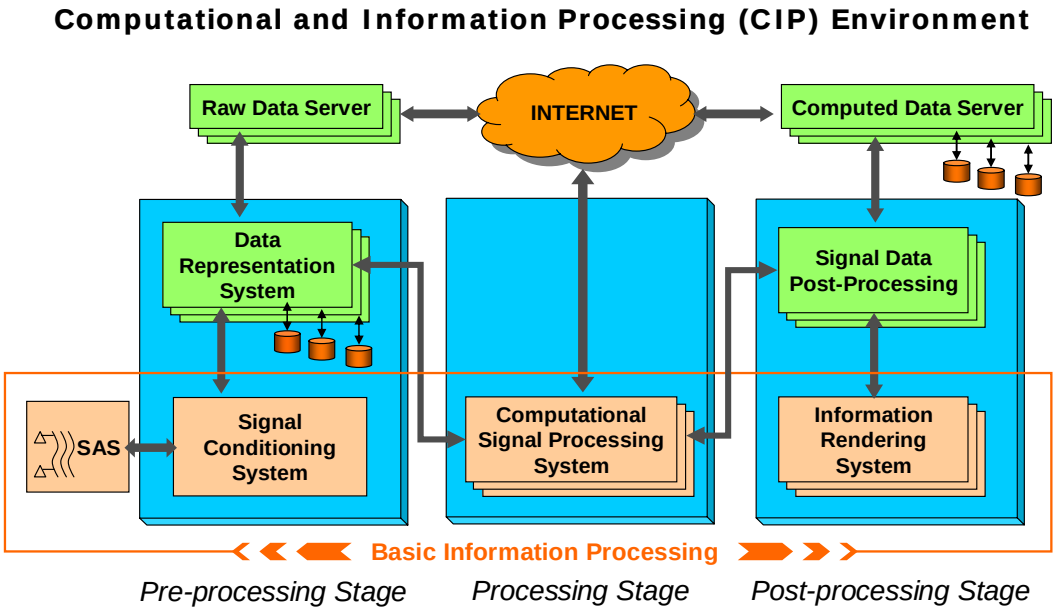

Figure 3.1.1: Basic vs. Net-Centric Information Processing

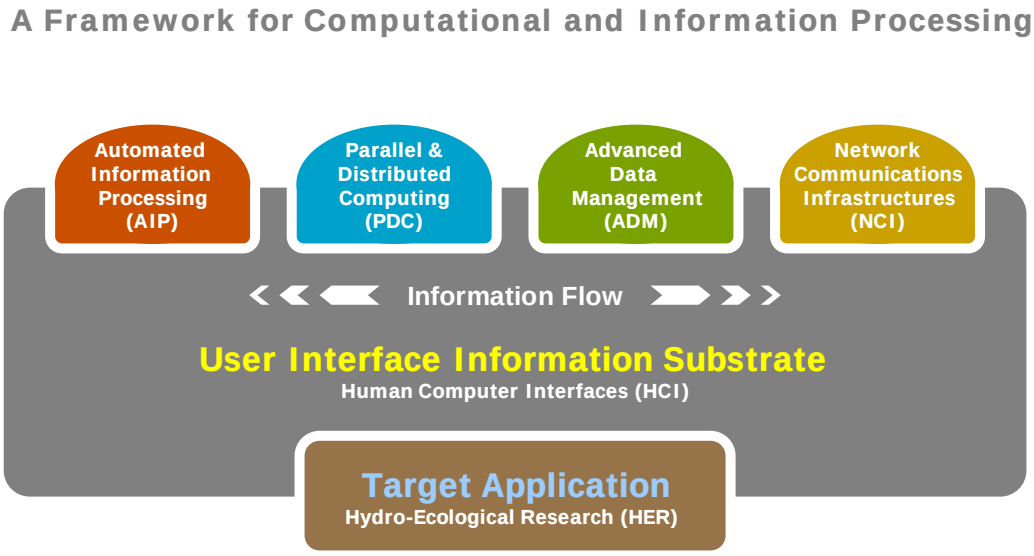

Figure 3.1.2: WALSAIP's Concept Framework in Terms of its R&D Areas

4 WALSAIP Accomplishments

In this section we describe accomplishments of the WALSAIP project for our third year of a five year program. We start by discussing our students who performed very well during the 2006/2007 academic year. A female student working under the WALSAIP project obtained her MS degree in Computer Engineering in spring 2007 and another male student is obtaining his doctoral degree from our program in Computing and Information Sciences and Engineering (CISE) during the summer of 2007. Currently, a total of five doctoral students and eight MS students are enrolled in the WALSAIP project, with one third of the students (5 out of 13) being female (see ***Figure 4.1*** below). A total of twelve (12) journal publications and thirty (30) refereed conference publications were produced by the WALSAIP project during its third year, ten (10) of them produced by students.

Professors collaborating in the WALSAIP project were active in research and development efforts and engaging in academic and research activities with students participating in the project. For instance, the International Symposium on Wireless and Pervasive Computing (http://www.iswpc.org/2007/) was organized during the winter of 2007 by members of the WASAIP project. In addition, a first Workshop on Wireless Networking, Automated Information Processing, and Web & Grid Services was also organized and sponsored by the WALSAIP Project during this symposium. Invited keynote speakers at the workshop were Dr. Sandra Thuel (http://www.bell-labs.com/user/thuel/), Dr. Sajal Das (*http://ranger.uta.edu/~das/*) and Ian Foster (*http://www-fp.mcs.anl.gov/~foster/*) who interacted with the audience in a very lively panel after their presentations. WASAIP professors have also being active collaborating with the scientific community as well as local representatives of federal agencies (NOAA, EPA, USGS, and NWS) in Puerto Rico in order to share data and knowledge about environmental surveillance monitoring activities. Two locations in the southern part of Puerto Rico have been chosen as developing testbeds for the WALSAIP project to place the necessary sensor network infrastructure to assist in monitoring efforts on local endangered species.

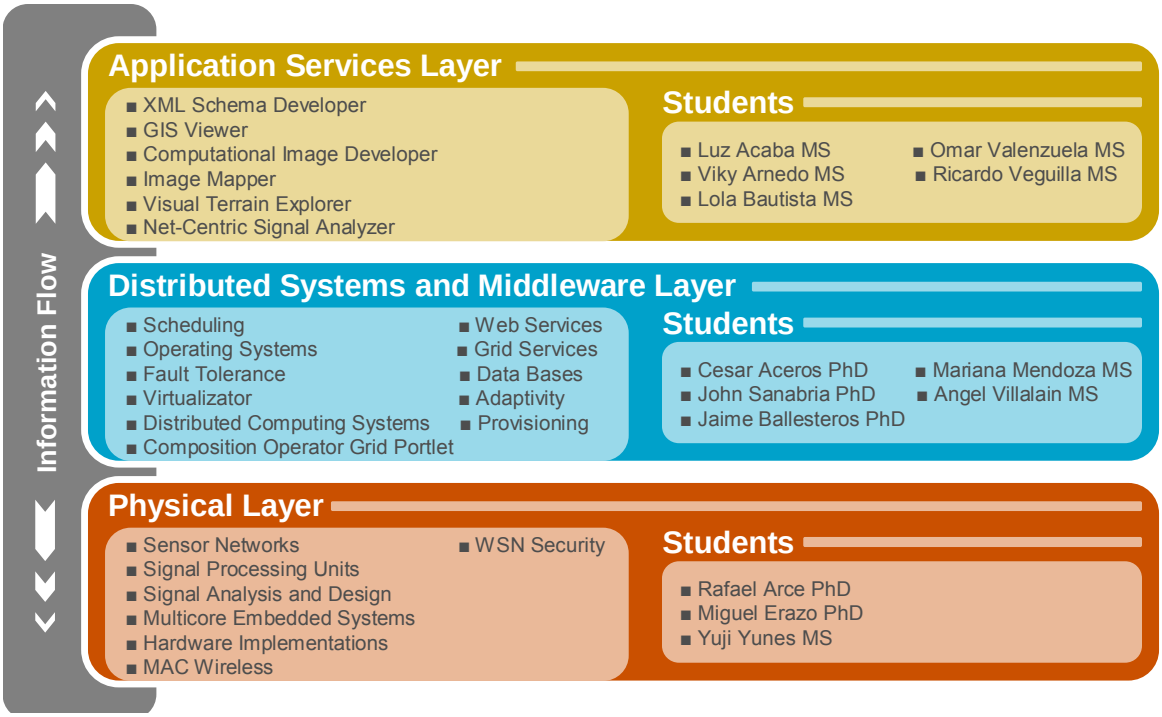

Figure 4.1: Student Research Areas Structured in Layers

4.1 *TESTBED DEVELOPMENT AT JOBOS BAY*

A distributed sensor network testbed is being developed at the Puerto Rico's Jobos Bay Natural Estuarine Research Reserve (JBNERR). A main objective of the testbed is to evaluate application prototypes instantiating aspects of the WALSAIP framework. The reserve has more than 2800 acres and it is located on the southern coast of Puerto Rico, between the municipalities of Guayama and Salinas. It is administered by the National Oceanic and Atmospheric Administration (NOAA) and it is managed locally by the Department of Natural and Environmental Resources (http://nerrs.noaa.gov/JobosBay/).

The Jobos Bay Reserve is the second largest estuarine area in Puerto Rico. It encompasses a chain of 15 tear shape mangrove islets known as Cayos Caribe and the Mar Negro area in western Jobos Bay. The reserve is home to the endangered brown pelican, peregrine falcon, hawksbill sea turtle, and West Indian manatee. The area is commercially important for marine recreation, commercial and recreational fishing, and ecotourism.

Figure 4.2: Jobos Bay Estuarine Research Reserve

5 WALSAIP Research Groups

The WALSAIP research groups are the Automated Information Processing, the Parallel and Distributed Computing, the Advanced Data Management, and the Network Communications Infrastructure. The development groups under the WALSAIP project are the Human-Computer Interfaces and the Hydro-ecological Research. Each one of these groups is conformed by one or more professors, associated research students, and external colleagues. We proceed to describe the activity of each group in more detail in the following subsections below.

5.1 *ADVANCED DATA MANAGEMENT (ADMG)*

5.1.1 Research Group Description

The Advanced Data Management group (ADMG) is directed by Prof. Manuel Rodriguez and it conducts research on issues pertaining to distributed databases, heterogeneous databases, Web services, e-Government, and Paper-equivalent electronic forms. Specific research issues associated with the WALSAIP project include:

1. Design, implement, and test a Database Middleware System for Wide-Area Networks in which mobile devices are treated as bona-fide data sources.

2. Develop and study algorithms for efficient query processing, including novel schemes with Quality-of-Services (QoS) guarantees.

3. Develop and study algorithms and protocol for efficient peer database selection in distributed networks.

4. Develop and study algorithms for client-side and server-side query execution recovery and result re-delivery in Wide-Area Networks.

5.2 AUTOMATED INFORMATION PROCESSING (AIPG)

5.2.1 Research Group Description

The Automated Information Processing Group (AIPG) is directed by Prof. Domingo Rodriguez and has the following main objectives:

1. The study of principles, concepts, methods, and rules for the measurement of *observable physical quantities* – where the main quest is to study techniques for *signal-based information processing* from physical sensor signal sources through a cyberspace infrastructure when the information is noisy and/or partial.

2. The analysis, synthesis, as well as *representation imaging* and rendering of distributed sensors array-based signals – where the main effort concentrates on the analysis, design, and implementation of time-*frequency tools* to study array-based non-stationary signals using *non-abelian signal processing, compressed sensing,* and *geometric group* theories.

3. The development of computational operator methods for the treatment of sensor-based large signal data sets – where the effort lies in the development of *operator signal algebra* computational methods, incorporating *engineering modeling and simulation techniques* and *methods of information geometry*, to treat multidimensional signal design, detection, and estimation problems.

5.3 HUMAN COMPUTER INTERFACES (HCIG)

5.3.1 Development Group Description

The Human-Computer Interfaces group (HCIG) is directed by Prof. Nestor Rodriguez and it is developing Web-based human interface applications that can facilitate the access and manipulation of data represented in image formats as well as the efficient and usable representation of environmental data in general.

5.4 HYDRO-ECOLOGICAL RESEARCH (HERG)

5.4.1 Development Group Description

The Hydro-ecological Research group (HERG) is directed by Prof. Ismael Pagán-Trinidad, of the UPRM Civil Engineering and Surveying Department, and has as external collaborators, Dr. Carlos Ruiz and Dr. John Nestler, both researchers from the Engineer Research and Development Center (ERDC) of the US Army Corps of Engineers at Vicksburg, Mississippi. HERG members are active in building sustainable collaborative relationships with local representatives of federal agencies (NOAA, EPA, USGS, and NWS) in Puerto Rico.

5.5 *NETWORK COMMUNICATIONS INFRASTRUCTURE*

5.5.1 Research Group Description

The network communications infrastructure group (NCIG) is directed by Prof. Yi Qian and is currently working in the areas of network sensor architecture and communications protocols and algorithms for environmental surveillance monitoring applications. The group is concentrating also on investigating the characterization and reliable and secure communication of a physical cyberinfrastructure to enhance environment monitoring, modeling and management. Specific objectives associated with NCIG include:

1. To design and implement a new energy aware medium access control (MAC) protocol for wireless sensor networks with wide-area large scale environmental monitoring applications

2. To study and analysis the performance of retransmission schemes for high-data-rate MAC protocol in wireless local area networks

3. To propose and study a framework for key management schemes in distributed wireless sensor networks with heterogeneous sensor nodes

5.6 PARALLEL AND DISTRIBUTED COMPUTING

5.6.1 Research Group Description

This research group is directed by Prof. Wilson Rivera. The research goal of PDCG is to study issues for distributed processing in wide area networks. The specific objectives include:

1. To design and implement adaptive quality of services (QoS)-based scheduling strategies for distributed processing

2. To study replication schemes for distributed sensor data

3. To study adaptive service provision and orchestration in wide area networks

4. To apply these research ideas to the framework being designed in the WALS-AIP project

6 WALSAIP Students

This section presents activities conducted by WALSAIP students during this past second year. It also presents a table with all students who have participated in the WALSAIP project since its beginning in September 2004. Most students have been fully supported with research assistantships provided by the WALSAIP the project.

Table 6.1: List of students under WALSAIP

Name	Program	Female	Male	Graduation Date
Yarilis Méndez	BS	1		Jun. 07
Jessica Jiménez	BS	1		Jun. 07
Angel Villalaín	MS		1	Jun. 07
Luz Acabá	MS	1		Dec. 07
Jorge Villamizar *	MS		1	Jun. 06
William de la Paz	MS		1	Dec. 07
Ana B. Ramírez	MS	1		Dec.06
Lola X. Bautista	MS	1		Jun. 07
Omar Valenzuela	MS		1	Dec. 07
Yuji Yunes	MS		1	Dec. 07
Ricardo Veguilla	MS		1	Jun. 08
Mariana Mendoza	MS	1		Dec. 07
Viky Arnedo Martínez	MS	1		Jun. 08
William Sánchez *	MS		1	Jun. 05
Yuki Yunes Saito *	MS		1	Jun. 05
Juan M. Solá *	Ph.D.		1	Dec. 07
John Sanabria	Ph.D.		1	Jun. 09
Miguel Erazo	Ph.D.		1	Jun. 09
Cesar A. Aceros	Ph.D.		1	Jun. 09
Rafael Arce*	Ph.D.		1	Jul. 07
Jaime Ballesteros	Ph.D.		1	Jun. 09

6.1 WALSAIP STUDENT ACTIVITIES

The WALSAIP project is promoting activities to continue enhancing the academic quality of its students. Among these activities are:

1. Assistance provided to WALSAIP students to publish their research work in refereed international conferences and journals

2. Mentoring provided by WALSAIP students to undergraduate students interested in conducting research in areas related to the WALSAIP project

3. Participation of WALSAIP students in poster sessions in local scientific and engineering activities to present their research work

4. General project meetings conducted with WALSAIP students so they can share their opinions on availability of academic resources and research infrastructure.

7 WALSAIP Strategic Directions

Some strategic directions are presented below for the WALSAIP project's fourth year.

1. Work on the ***Summer 2007 Workshop for WALSAIP Students***, were students will receive instructions on how to improve poster as well as lecture presentations.

2. Organize a couple of ***WALSAIP Project Open House*** activities (Fall 2007 and Spring 2008) where our students will present their *demonstration works* (**WALSAIP Demos**) in the area of signal-based automated information processing and their uses in environmental surveillance monitoring applications.

3. Develop a series of selected seminars directed at improving our multidisciplinary collaborative efforts on environmental surveillance monitoring (ESM).

4. Organize a series of selected activities directed at sustaining our journal publication outcome.

5. Establish a ***WALSAIP Lecture Series*** to disseminate research and development works being conducted by professors, students, and collaborators associated to the WALSAIP project.

6. Prepare a series of brochures to disseminate activities of the WALSAIP project to the general community.

7. Engage in WALSAIP outreach activities with local high school students.

8. Organize a series of field trips by WALSAIP professors and students to the developing testbeds at Jobos Bay National Estuarine Research Reserve and the Guanica Dry Forest Reserve in the southern part of Puerto Rico.

9. Strengthen collaborative ties with local representatives of federal agencies (NOAA, EPA, USGS, and NWS).

10. Improve human networking activities and collaborative efforts with academic and research institutions throughout United States and Latin America.

8 WALSAIP Publications

Below are the publications of the WALSAIP Project from May 2006 to May 2007.

8.1 JOURNAL PUBLICATIONS

1. Kejie Lu, Yi Qian, Mohsen Guizani, and Hsiao-Hwa Chen, "A Distributed Key Management Scheme in Heterogeneous Wireless Sensor Networks," accepted for publications, to appear in *IEEE Transactions on Wireless Communications*.
2. Yi Qian, Kejie Lu, and David Tipper, "A Design for Secure and Survivable Wireless Sensor Networks," *IEEE Wireless Communications*, Vol.14, Issue 4, August 2007.
3. Bo Rong, Yi Qian, and Kejie Lu, "Integrated Downlink Resource Management for Multiservice WiMAX Networks," accepted for publications, to appear in *IEEE Transactions on Mobile Computing*, Vol.6, No.6, June 2007.
4. Kejie Lu, Yi Qian, and Hsiao-Hwa Chen, "A Secure and Service-Oriented Network Control Framework for WiMAX Networks," *IEEE Communications*, Vol.45, No.5, May 2007.
5. Bo Rong, Yi Qian, and Hsiao-Hwa Chen, "Adaptive Power Allocation and Call Admission Control in Multiservice WiMAX Access Network," *IEEE Wireless Communications*, Vol.14, Issue 1, pp.14-19, February 2007.
6. Kejie Lu, Dapeng Wu, Yi Qian, Yuguang Fang, Robert Caiming Qiu, "Performance of An Aggregation-Based MAC Protocol for High-Data-Rate Ultra-Wideband Ad Hoc Networks," *IEEE Transactions on Vehicular Technology*, Vol.56, No.1, pp.312-321, January 2007.
7. Rose Q. Hu, Yi Qian, Yu Cheng, Sastri Kota, "Cross-Layer Design for Call Admission Control of a High Capacity GEO Satellite Network with On-Board Cross-Connect," *International Journal of Satellite Communications and Networking*, Vol.24, No.6, pp.455-470, November-December 2006.
8. Nayda G. Santiago, D. T. Rover, Domingo Rodriguez, "A Statistical Approach for the Analysis of the Relation between Low-Level Performance Information, the Code, and the Environment," Journal of Information, vol. 9, no. 3, pp. 503-518, May 2006.
9. Abraham Diaz, Domingo Rodriguez, "Cyclic Convolution Algorithm Formulations Using Polynomial Transform Theory," Accepted for Publication, Journal of Computers, Academic Publisher, Finland, 2007.
10. Rafael Arce Nazario, Manuel Jiménez, Domingo Rodriguez, "Algorithmic-level Exploration of Discrete Signal Transforms for Partitioning to Distributed Hardware Architectures," Accepted for publication on Journal of IET Computers & Digital Techniques, April, 2007.
11. Kejie Lu, Jianfeng Wang, Dapeng Wu, Yuguang Fang, "Performance of A Burst-Frame-Based CSMA/CA Protocol: Analysis and Enhancement," Accepted for Publication by the *ACM Wireless Networks*.
12. Yu Zheng, Kejie Lu, Dapeng Wu, Yuguang Fang, "Performance Analysis of IEEE 802.11 DCF in Imperfect Channels," *IEEE Transactions on Vehicular Technology*, Vol. 55, No. 5, pp. 1648-1656, Sept. 2006.

8.2 REFEREED CONFERENCE PUBLICATONS

1. Bo Rong, Yi Qian, Kejie Lu, "Revenue and Fairness Guaranteed Downlink Adaptive Power Allocation in WiMAX Access Networks", *Proceedings of 16th IST Mobile and Wireless Communications Summit*, Budapest, Hungary, July 1-5, 2007.
2. Bo Rong, Yi Qian, Kejie Lu, "Downlink Call Admission Control in Multiservice WiMAX Networks", *Proceedings of IEEE ICC'2007*, Glasgow, UK, June 24-28, 2007.
3. Kejie Lu, Tao Zhang, Shengli Fu, Yi Qian, Ashwin Gumaste, and S.-Q. Zheng, "A Design Principle for Future High-Speed Networks", *Proceedings of High-Speed Networks Workshop 2007*, In Conjunction With IEEE INFOCOM'2007, May 6-12, 2007, Anchorage, Alaska.
4. Yi Qian, Kejie Lu, David Tipper, "Towards Survivable and Secure Wireless Sensor Networks", *WIA'2007*, *Proceedings of IEEE IPCCC'2007*, New Orleans, LA, April 11-13, 2007.
5. Miguel A. Erazo Villegas, Yi Qian, "SEA-MAC: Simple Energy Aware MAC Protocol for Wireless Sensor Networks for Environmental Monitoring", *Proceedings of ISWPC'2007*, San Juan, PR, February 5-7, 2007.
6. Mohamad Y. Alsaadi, Yi Qian, "Performance Study of a Secure Routing Protocol in Wireless Mobile Ad Hoc Networks," *IEEE Proceedings of ISWPC'2007*, San Juan, PR, February 5-7, 2007.
7. Jing Deng, Yi Qian, "The Head-of-Line Blocking Problem on Exposed Terminals in MANETs," *Proceedings of IEEE GLOBECOM'2006*, San Francisco, CA, November 27 – December 1, 2006.
8. Bo Rong, Yi Qian, Rose Q. Hu, Sghaier Guizani, Michel Kadoch, "Key Management for Pyramidal Security Model of Multicast Communication in Mobile Ad Hoc Networks," *Proceedings of IEEE GLOBECOM'2006*, San Francisco, CA, November 27 – December 1, 2006.
9. Kejie Lu, Yi Qian, Shengli Fu, "Enhancing The Performance of Wireless LANs in Error-Prone Environment," *Proceedings of IEEE GLOBECOM'2006*, San Francisco, CA, November 27 – December 1, 2006.
10. Kejie Lu, Yi Qian, "On the Performance of A Distributed Key Management Scheme in Heterogeneous Wireless Sensor Networks," Proceedings of IEEE MILCOM'2006, Washington, DC, October 23-25, 2006.
11. Wei Zha, Rose Q. Hu, Yi Qian, Yu Cheng, "An Adaptive MAC Scheme to Achieve High Channel Throughput and QoS Differentiation in a Heterogeneous WLAN," *Proceedings of QShine'2006*, Waterloo, Canada, August 7-9, 2006.
12. Kejie Lu, Yi Qian, "Performance Analysis of a Retransmission Scheme for High-Data-Rate MAC Protocol in Wireless LANs," *Proceedings of IEEE ICC'2006*, Istanbul, Turkey, June 11-15, 2006.
13. Rafael Arce Nazario, Manuel Jiménez, D. Rodriguez. "Partitioning Exploration for Automated Mapping of Discrete Cosine Transforms onto Distributed Hardware Architectures". Accepted to the 50th IEEE Midwest Symposium on Circuits and Systems. August 2007. Montreal, Canada.
14. Rafael Arce Nazario, Manuel Jiménez, Domingo Rodriguez. "High-level Partitioning of Discrete Signal Transforms for Multi-FPGA Architectures". 16th IEEE International Conference on Field Programmable Logic and Applications. August 2006. Madrid, Spain.

15. Ana Ramirez, Domingo Rodriguez, “Automated Hardware-in-the-Loop Modelling and Simulation in Active Sensor Imaging Using TI6713 DSP Units,” 2006 IEEE Midwest Symposium on Circuits and Systems, San Juan, Puerto Rico, August 2006.

16. Rafael Arce Nazario, Manuel Jiménez, Domingo Rodriguez. “Functionally-aware Partitioning of Discrete Signal Transforms for Distributed Hardware Architectures”. 49th IEEE Midwest Symposium on Circuits and Systems. August 2006. San Juan, PR.

17. Abraham H. Diaz-Perez, Domingo Rodriguez, “One Dimensional Cyclic Convolution Algorithms with Minimal Computational Complexity,” IEEE ICASSP 2006, Toulouse, France, May 2006.

18. Becerra-Fernandez, I. Prietula, M., Madey, G., Rodriguez, D., “Project Ensayo: a Virtual Emergency Operations Center for Disaster Management Research, Training, and Discovery,” IEEE First International Conference on Global Defense and Business Continuity (ICGDBC 2007), July 2007, San Jose, CA.

19. Hua Zhu, Kejie Lu, "On The Interference Modeling Issues for Coordinated Distributed Scheduling in IEEE 802.16 Mesh Network," in the Third International Conference on Broadband Communications, Networks and Systems (BROADNETS 2006), October 1-5, 2006, San José, California, USA.

20. Xiaodong Huang, Qinya She, Tao Zhang, Kejie Lu, Jason P. Jue, "Small Group Multicast with Deflection Routing in Optical Burst Switched Networks," in Proc. of International Workshop on Optical Burst/Packet Switching (WOBS 2006), in conjunction with BroadNets 2006 in San José, Ca. on Oct. 2nd, 2006.

21. Kejie Lu, Jiangfeng Wang, Dapeng Wu, Yuguang Fang, "Performance of A Burst-Frame-Based CSMA/CA Protocol for High Data Rate Ultra-Wideband Networks: Analysis and Enhancement,"' in Proc. of The Third International Conference on Quality of Service in Heterogeneous Wired/Wireless Networks (QShine 2006), August 7-9, 2006, Waterloo, Ontario, Canada.

22. Marc De Leenheer, Farid Farahmand, Kejie Lu, Tao Zhang, Pieter Thysebaert, Bruno Volckaert, Filip De Turck, Bart Dhoedt, Piet Demeester, Jason P. Jue, "Anycast Algorithms Supporting Optical Burst Switched Grid Networks," in Proc. of International Conference on Networking and Services (ICNS'06), July 16-18, 2006, Silicon Valley, USA.

23. Hua Zhu, Kejie Lu, "Performance of IEEE 802.16 Mesh Coordinated Distributed Scheduling Under Realistic Non-Quasi-Interference Channel," in Proc. of the International Conference on Wireless Networks (ICWN'06), June 26-29, 2006, Las Vegas, USA.

24. Kejie Lu, Tao Zhang, and Ayat Jafari, “Performance of An Anycast Routing Scheme in All-Optical Networks”, Proceedings of IEEE ICC’2007, Glasgow, UK, June 24-28, 2007.

25. D. Arias, J. Sanabria, W. Rivera, “Grid based Pervasive Distributed Storage,” IEEE International Symposium on Wireless Pervasive Computing (ISWPC), San Juan, Puerto Rico, 2007

26. D. Arias, M. Mendoza, F. Cintron, K. Cruz, W. Rivera, “Grid portal development for sensing data retrieval and processing,” IEEE/ACM Second International Workshop on Grid Computing Environments (GCE06), Supercomputing 2006, Tampa, Florida, Nov. 2006.

27. D. Arias, W. Rivera, “Using Grid Computing to Enable Distributed Radar Data Retrieval and Processing,” IEEE International Conference on Parallel and Distributed Computing, Applications and Technologies (PDCAT), 2006.

28. C. Gerardino, Y. Rivera, J. Goodman, W. Rivera, “Parallel Implementation of an Inversion Model for Hyperspectral Remote Sensing,” 49th IEEE Midwest Symposium on Circuits and Systems (MWSCAS'06).

29. W. Lozano, Wilson Rivera, “An Adaptive Quality of Service based Scheduling Algorithm for Wide Area Large Scale Problems,” IEEE International Conference on Network Computing and Applications, 2006.

30. G. Chaparro, N.G. Santiago, W. Rivera, J.F. Vega, “Petri Net Workflow Modelling for Digital Publishing Measuring Quantitative Attributes,” IEEE International Symposium on Dependable, Autonomic and Secure Computing (DASC'06), 2006.

8.3 OTHER PUBLICATIONS

1. T. Kielmann and Wilson Rivera, “Editorial: Special issue on adaptive Grid Middleware,” Concurrency & Computation: Practice & Experience, Vol. 18, No. 13, 2006.

2. Yi Qian, Prashant Krishnamurthy, and David Tipper, “Wireless Systems Security and Survivability,” in Information Security and Survivability: Principles and Interactions, Edited by Yi Qian, James Joshi, David Tipper, and Prashant Krishnamurthy, to be published by Morgan Kaufmann in 2007.

3. Yi Qian, Shafaq Chaudhry, and Ratan Guha, “Resource Management in WiMAX Networks,” in WiMax/MobileFi: Advanced Research and Technology, Edited by Yang Xiao, to be published by Auerbach Publications, CRC Press in 2007.