LOUISIANA TECH UNIVERSITY
AND
LOUISIANA STATE UNIVERSITY

2007-08 ANNUAL REPORT

LOUISIANA BOR PKSFI
CENTER FOR SMART CYBER CENTRIC SENSOR SURVEILLANCE SYSTEMS
GRANT# LEQSF (2007-12)-ENH-PKSFI-PRS-03

PI: Dr. Vir V. Phoha
Co-PIs: Dr. S. S. Iyengar, Dr. Kody Varahramyan, Dr. Peter Chen, and Dr. Gabrielle Allen

Chair of Research and Industrial Advisory Board: Dr. Les Guice

1. PERSONNEL: LIST ALL KEY PERSONNEL AND OTHER STAFF WHO PROVIDED *SIGNIFICANT* CONTRIBUTIONS TO THE PROJECT. PROVIDE INFORMATION ABOUT THE TYPES OF CONTRIBUTIONS MADE BY EACH LISTED PARTICIPANT AND CONTROLS IN PLACE TO ENSURE THAT THESE CONTRIBUTIONS ARE ADEQUATE TO THE PROJECT'S REQUIREMENTS.

1.1. Key Personnel and Their Contributions

1.1.1. Core Research Team

Dr. Vir V. Phoha (LA TECH), PI; Dr. S.S. Iyengar (LSU), Co-PI; Dr. Kody Varahramyan (LA TECH), Co-PI; Dr. Peter Chen (LSU), Co-PI; Dr. Gabrielle Allen (LSU), Co-PI; Dr. Asok Ray (Penn State University), Senior Consultant

Senior Researchers: Dr. Rastko Selmic (LA TECH), Dr. Christian Duncan (LA TECH), Dr. Tevfik Kosar (LSU)

Collectively the team and individually the investigators have produced significant research results supported by the PKSFI grant. Overall, the research team has to its credit more than *32* research papers (*21* published and *11* under review of publication), *4* patent applications, and *1* report of invention (see the attached document containing a list of publications). PI Phoha's new authentication technology has been licensed to ZEH Graphics software of Houston, Texas. Details follow.

Dr. Mangilal Agarwal, Dr. Vir Phoha, and Dr. Kody Varahramyan have been the key personnel associated with developing a chipless RFID sensor system platform consisting of passive chipless RFID sensor tags and specialized reader for cyber centric monitoring applications. Dr. Agarwal is a postdoctoral scholar who oversaw the daily implementation of the project. Dr. Phoha oversaw the computer system and internet communications parts of the project, and Dr. Varahramyan oversaw the overall aspects of the project, making sure that all the computer, sensor, wireless, and other components of the project progressed well and were successfully integrated and tested.

Dr. Phoha, Dr. Iyengar, Dr. Ray, and their students have collaboratively worked on anomaly detection in non-stationary environments, sensor fusion, and secure data aggregation problems. Together Dr. Iyengar and Dr. Phoha have successfully received $761,000 of DEPSCoR funding, have published two journal papers, and are working on many additional topics (see the attached list of publications). Dr. Peter Chen and his students have developed algorithms applicable to counterterrorism, learning, and conceptual modeling.

Dr. Phoha, Dr. Selmic, and Dr. Duncan have been addressing issues to solve sensor placement, finding holes in coverage, and other associated problems.

Dr. Kosar, Dr. Allen, and their students have been working on applying grid and distributed computing technologies to state-wide scientific applications, including sensor networking, coastal modeling, and reservoir simulations. They have developed novel distributed data management techniques and applied them in a new data-aware distributed batch scheduler that has been developed. These techniques include prediction models for tuning the optimal number of parallel streams in end-to-end data transfers across wide area data networks.

1.1.2. Research and Industrial Advisory Board

Dr. Les Guice (LA TECH), Chair of the Research and Industrial Advisory Board and VP for Research and Development.

Dr. Guice has been a major resource and motivator to make this project a success. He has established a Research and Industrial Advisory Board (RIAB) consisting of industry leaders, and has helped develop important contacts with AF Cyber Command, national laboratories such as Sandia National Labs, and industry partners such as NetQoS, Radiance Technologies, etc. The RIAB consists of the following members:

- Brooks Keel, Vice Chancellor, Research & Economic Development, Louisiana State University
- Doris Carver, Associate Vice Chancellor, Research & Economic Development, Louisiana State University
- Stan Napper, Dean, College of Engineering & Science, Louisiana Tech University
- Joel Trammell, CEO, NETQoS, Inc.
- Chris Mangum, Vice President, Strategic Planning, CenturyTel, Inc.
- Craig Spohn, Executive Director/President, Cyber Innovation Center
- Bob Fudickar, Director, Technology, Louisiana Office of Economic Development
- Bill Bailey, Vice President, Intelligence Systems, Radiance Technologies, Inc.
- Frank Auer, CEO, Praeses, LLC

1.1.3. New hires from support from PKSFI funding

Post-doctoral scientists (research assistant professor): Dr. Enam Karim (LA TECH), Dr. Kiran Balagani (LA TECH)

The new post-doctoral hires have submitted four research papers. In addition, Dr. Karim has submitted one Major Research Instrumentation Grant proposal to NSF and one research proposal to NSF.

Both the researchers have started collaboration with Co-PIs Iyengar (LSU) and Senior Consultant Ray in addition to collaborating with PI Phoha. As their research progresses, more team collaboration including other members of the PKSFI team will be added.

1.1.4. Technical and Administrative Support Team

Mr. Stan Finley (LA TECH), Technology Coordinator, Ms. Tina Allen (LA TECH), Administrative Assistant.

Stan Finley was hired on an interim basis to fill the position of Technology Coordinator. He has been representing Louisiana Tech in numerous meetings with the Air Force and industry partners. Stan has been meeting regularly with Air Force, industry, and Cyber Innovation Center personnel in the Bossier area. Stan has also researched and documented a number of potential contracting mechanisms that would be valuable to us in working with Air Force, government and industry partners. Finally, Stan has been working with Chris Womack, Coordinator of Technology at CEnIT and others to establish a Secure Information Sharing laboratory facility at the Cyber Innovation Center that will enable industry partners to demonstrate and test certain cyber security software resources. Stan has worked closely with Davy Norris, Director of Enterprise Center and Kathy Wyatt, Director Of Business Development in understanding the business development resources that the university has to support emerging businesses.

Tina Allen was hired in March 2008, replacing Kristin Martin, to provide administrative support for the Center. She is responsible for all administrative functions required in the day-to-day operation of the Center. This includes purchasing, travel, and assisting the faculty with submitting proposals and research publications. She played a major role in preparing the first edition of the CSC Newsletter released in April 2008. This newsletter will be released quarterly and is a means of providing research updates and information on the activities at the Center for Secure Cyberspace at Louisiana Tech. Tina also has responsibility for maintaining the Center's website. She also assisted in the organization and planning of the first Research and Industry Advisory Board held in April.

1.2. Controls in Place to Ensure Project Requirements

The PIs, Co-PIs, and senior researchers, as well as newly hired scientists, have met and discussed research progress and directions of research during the whole year. The control mechanisms include face-to-face meetings, Access Grid meetings, and phone and conference calls.

PI Phoha (LA TECH) LSU lead-Co-PI Iyengar, and Senior Consultant Ray (Penn State University) meet by telephone *at least once every week* to discuss progress of the project and overcome deficiencies in research. In addition, almost all the researchers have had frequent face-to face meetings; our goal is to have at least two face-to-face meetings per six months.

The following is a summary of the details of the meetings in which all (or most of the PKSFI team) were present.

PKSFI Project Kickoff Meeting (August 20, 2007): The kickoff meeting was held at Beau Rivage Hotel, Biloxi, MS, which was the same venue as the Post-Katrina Gulf Coast Network Science Forum. Those present were Les Guice, Vir Phoha, S. S. Iyengar, Peter

Chen, Kody Varahramyan, Gabrielle Allen, Tevfik Kosar, Christian Duncan, and Rastko Selmic (via phone), as well as observers Daryush Ila, Raymond Sterling, and Sumanth Yenduri. The minutes of the meeting are on record.

Access Grid Meetings (First on October 8, 2007 and second on November 12, 2007): Two Access Grid meetings of LA TECH and LSU researchers were held to discuss progress report. The minutes of the meeting are on record.

Cyberspace Research Workshop (November 27, 2007): This workshop, which was held in Shreveport, Louisiana, provided a venue to share fifteen peer reviewed research papers with peers across the country and coincided with the Air Force Cyberspace symposium. The conference was very well attended (136 participants) and received extensive media coverage.

Research and Industry Advisory Board Meeting (April 28, 2008): The first meeting of the RIAB was held at the LA TECH Technology Transfer Center in Shreveport, Louisiana. During the first half of the meeting PI Phoha updated the RIAB on the progress made so far; the feedback from the RIAB will help improve the teams' activities. During the second half of the meeting the researchers presented their work.

Meeting at LSU (May 27, 2008): The most recent meeting of the PKSFI research team was held in Coates Hall on the campus of LSU to discuss the progress of the PKSFI research. Those present were PI Phoha, Co-PIs Iyengar, Chen, Allen, and senior researcher Kosar. For logistics convenience, PI Phoha (LA TECH) met with the LA TECH team separately in Ruston.

The above meetings are in addition to the regular meetings that PI Phoha has with individual researchers.

2. ACTIVITIES AND FINDINGS:

2.1. Describe major research and educational activities undertaken in this reporting period;

The team, collectively and individually, has successfully addressed various research tasks outlined in the proposal. The research has resulted in *21* scholarly publications published or accepted for publication; *4* patents applications and *1* report of invention filed; and *11* research papers submitted and under review for publication.

Table 1 outlines the research activities outlined in the proposal and their status by the end of the first year of funding.

Table 1. A description of the four major research tasks and their status. Check mark indicates the task has started and the filled concentric circle indicates task has not yet started.

RESEARCH TASK #1

Investigate network formulation providing robust placement algorithms in uncertain environments and ill defined topologies.

TASK	*STATUS*
• Network Architectural Design Using Socio-Biological Principles	☑
• Adaptive Sensing in Non-stationary Environments	☑
• Embedding of Sensor Information at Grid Locations.	◉

RESEARCH TASK #2

Develop secure transmission to distributed cyber systems and build energy-efficient survivable communications routing and protocols for sensor data dissemination.

TASK	*STATUS*
• Develop Adaptive Attack Detection Mechanisms	☑
• Develop Resilience to Node Capture	◉
• Develop Robust Broadcast Routing Protocol for Sensor Networks	☑
• Develop Algorithms for Optimal Transmission Scheduling Under Power Constraints	☑

RESEARCH TASK #3

Develop automatic sensor data fusion, processing, and tools for integrated prediction, detection, and estimation for disaster precursors.

TASK	*STATUS*
• Rare Event Pattern Identification	☑
• Finding the Spatial-temporal Origins of Rare Events Based on Sensor Data	☑
• Secure Sensor Data Aggregation	◉
• Robust Sensor Data Fusion Using Dependence Tree Models	☑

RESEARCH TASK #4

Develop visualization software modules and perform experimental validation with simulated and actual sensors.

TASK	*STATUS*
• Develop Visualization Tools	☑
• Develop Smart Micro and Nano Scale Sensor Nodes	☑
• Validate Mathematical and Software Tools on Simulated and Actual Network of Sensors in the Center of Excellence	◉

2.2. Describe and provide data supporting the major findings resulting from these activities;

The research team has met or exceeded the goals promised in the project proposal. Table 2 outlines goals set for the first year of the project and the status at the end of the first year. Since the project built on the existing strength of the key researchers, the table also contains milestones achieved during the last three years.

Table 2. Milestones as promised in the proposal and the status. Checked indicates the milestone has been achieved and a checked and filled solid circle indicates the performance has exceeded the milestone.

Performance Measures and Expectations

	Since Funding	Year 1 Promised	Status	Last 3 years
Research Activity				
Research Milestones	Grid Formulation	Grid Formulation	☑	Various
Publications	21	6	☑ ●	over 32
Patents	4 filed; 1 ROI submitted	-	☑ ●	7 filed 1 issued
Grants	3 new funded	-	☑ ●	
Infrastructure				
Faculty Hiring	4 offered and 3 accepted	4	☑	4
Post-doc hiring	4 in place	4	☑	4
Labs	Sandia, Penn State, and LSU	Various	☑	Sandia, Penn State, LSU
Students	8 graduate and 4 undergraduates	6	☑ ●	
State-wide Impact				
Technology transfer	1 transferred ; 1 open	-	☑ ●	3 Technology transfer licenses; 1 open
Link with companies	2	No # specified	☑ ●	3
Support for AFCyber	Extensive		☑ ●	Initiated this year
Conferences	CSC, IRA-DSN	CSC	☑	

2.3. Describe the opportunities for faculty recruitment, retention and development, as well as post-doc, graduate and undergraduate student training provided by your project;

All the positions[1] are filled as requested except one faculty position at LA TECH where the candidate declined after a prolonged period of negotiations. We will re-advertize and hope to fill this position soon. The post-doctoral scientists are already in place at LA TECH and postdoctoral scientists at LSU have accepted the position with a start date of fall 2008. Details follow.

2.3.1. LA TECH

After a comprehensive national selection process, LA TECH has now in place the following:

1. Dr. Jean Gourd hired as a tenure-track assistant professor. He will start his duties effective July 1, 2008.
2. Dr. Enam Karim hired as research assistant professor (post-doctoral scientist), effective January 7, 2008.
3. Dr. Kiran Balagani hired as research assistant professor (post-doctoral scientist), effective March 1, 2008.

In addition, Dr. Mangilal Agarwal, a post-doctoral researcher (working with Co-PI Varahramyan) has been partially supported from PKSFI funds.

2.3.2. LSU

After a comprehensive national selection process the following faculty members and post-doctoral scientists have been hired and supported in part from the grant:

1. Dr. Jiang Zhang hired as tenure-track assistant professor (YALE, Assistant Professor who is currently at Stanford Research Institute).
2. Dr. Claire Montelini hired as tenure-track assistant professor (MIT, who is currently at University of California, San Diego, Machine Learning).
3. Dr. Gregory Vert (University of Nevada, Postdoctoral Scientist).
4. Dr. N. Parmeswaran (Visiting Faculty, Australia).

[1] *In the proposal, the PIs requested the faculty positions at both universities start in the fall of 2008. The post-doctoral positions at LA TECH were requested to start during the first year (2007-08) and at LSU to start during the second year (2008-09).*

Both LA TECH and LSU have supported graduate and undergraduate students. Most publications produced by the research team have students as co-authors. A list of students supported by PKSFI grant follows.

Graduate Students: Sudhir Shresha, Mercyma Balachandran, Shrijit Joshi, Kiran Balagani, Fayaz Baig, Jie Liu, Raja Mannam, Azaluddin Mohammad, Siuaroop Peesapati, and Ismail Akturk.

Undergraduate Students: Thomas Goodwin, Christina Foye, and Cyrus Robinson.

2.4. Describe the nature and scope of partnership activities; and

There have been considerable efforts to connect Center personnel with the Air Force Cyber Command (AFCYBER), the Cyber Innovation Center (CIC), and other industry and government partners (see details in Section 3.2, page 11). In addition to the existing collaborative activities, close research collaboration with Penn State University's Applied Research Laboratory is likely to result in new joint publications in sensor deployment in urban warfare environment. In addition, research collaboration of the PKSFI supported Center with Mississippi State University and the University of Tennessee, Chattanooga are being explored. Professor Bin Mai of Northwestern State University, Louisiana has visited LA TECH on numerous occasions for joint research activities resulting in a joint proposal to National Science Foundation (see *Proposals Under Consideration*, Section 10, page 10). PI Phoha and VP R & D Les Guice (LA TECH) have given presentations at Sandia National Labs, and C-PI Iyengar (LSU) collaborated with researchers from Oak Ridge National Labs.

2.5. Describe any problems encountered during the last year of project activities.

None

3. CONTRIBUTIONS: SUMMARIZE EFFORTS MADE TO BUILD RESEARCH AND EDUCATION CAPACITY, SECURE EXTERNAL FEDERAL AND PRIVATE-SECTOR FUNDING, BUILD INFRASTRUCTURE, CONTRIBUTE TO ECONOMIC DEVELOPMENT, AND ENSURE PROJECT SUSTAINABILITY OVER THE LONG TERM.

3.1. Efforts made to Build Research and Education Capacity, and Secure External Funding

The core research team has been complemented by seven new Ph.D. hires with one more faculty expected soon to make 18 doctoral-level research positions (eight core members of the team + seven new hires + 1 senior consultant who is deeply involved in the Center activities + 1 new post-doctoral position from newly received funding). Each of these seven hires will submit research proposals to build research and education capacity and secure external funding. Both LA TECH and LSU have made it a priority to hire the best talent. Three new faculty position offers have been accepted, and one more will be recruited through a national search. Two new faculty members will join LSU in the fall of 2008, and one new faculty member will start July 1, 2008 at Louisiana Tech. In addition, two new post-doctoral fellows have already joined Louisiana Tech and two new post-doctoral scientists will join LSU in the fall of 2008.

The Center is helping to co-sponsor a Cyber Discovery Camp for high school teachers and students June 9-14, 2008. There are approximately 35 students and 5 teachers participating in the event. The project is being organized and instructed by five Louisiana Tech faculty. The purpose is to support K-12 outreach and to enhance interactions in support of the Cyber Innovation Center and AFCYBER.

The team has already submitted six new proposals for funding, three of these proposals have been successful, one is in the final stages of negotiations, and two are pending. Details follow.

Funded proposals

1. "Secure and Survivable Cyber-Centric Sensor Networks: Algorithms and Architecture Research" PI S. S. **Iyengar**, Co-PI V. **Phoha**, Wu, and Park funded by DEPSCoR in the amount of $761,000 for the period July 1, 2008 – June 30, 2011.
2. "SURA Coastal Ocean Observing and Prediction Program (SCOOP)", PI G. **Allen**, Co-PI T. **Kosar** funded by NOAA/SURA in the amount of $50,000 (LSU share) for the period December 31, 2007 – April 30, 2008.
3. “Fault Detection and Isolation in Leader-Follower Networks,” PI R. **Selmic** funded by LaSPACE NASA in the amount of $38,211 for the period May 2008 – April 2009.
4. A proposal to build keystroke based authentication systems is in the final stages of being funded by AFRL, PI Vir **Phoha**.

Proposals Under Consideration

1. "MRI: Development of SensorPreter: an Instrument for Sensor-Sensor and Human-Sensor Dialogue," submitted to NSF on 01/24/2008 by Enam **Karim**, Vir **Phoha**, and Rastko **Selmic**; pending.
2. "CT-ER: Game Theoretic Strategies under Socio-economic Dynamics in Cyberspace," submitted to NSF on 03/24/2008 by Enam **Karim**, Vir **Phoha**, Jeffrey Walczyk, and Bin Mai; pending.

3.2. Build Infrastructure, contribute to economic development, and ensure project sustainability over the long term

The project team has demonstrated strong initiatives and success in pursuing additional grants to support the Center over the longer term. There have also been considerable efforts to connect Center personnel with the Air Force Cyber Command (AFCYBER), the Cyber Innovation Center (CIC), and other industry and government partners. As described earlier, two research workshops have been held this past year with representatives from the Center, the Air Force, the CIC, and industry partners present. Dr. Phoha, Dr. Chen, and Dr. Guice have also had numerous interactions with AFCYBER and AFRL to explore research needs and opportunities for collaboration. These interactions are leading to new contracts and grants. LA TECH has also been pursuing additional federal funding which could lead to new support for the Center's research program and infrastructure enhancements. Louisiana Tech has filed for three patents and has licensed one technology to ZEH Graphics software in Houston, Texas.

Louisiana Tech has also received money from the State of Louisiana to establish a multi-tenant building in its new research park (called the Louisiana Tech Enterprise Campus). The University has committed to provide 4,000 to 5,000 square feet of space in that building to house the Cyber Center. This will not only provide more effective space for the researchers, but it will provide ample room to develop a specialized laboratory that will advance the research activities and foster collaborations with some of the industry partners who are expected to occupy the building with the Center faculty.

4. PROJECT REVISION: PROVIDE A LISTING OF AND EXPLANATION FOR ANY SIGNIFICANT CHANGES IN THE WORK PLAN FOR UPCOMING YEAR, INCLUDING ANY CHANGES IN THE AMOUNT OF INVESTIGATORS' TIME DEVOTED TO THE PROJECT. IF YOU MADE SIGNIFICANT CHANGES TO THE PROJECT DESIGN AS OUTLINE IN THE PROPOSAL DURING THE PAST YEAR, PLEASE LIST AND EXPLAIN THE CHANGES, THE PURPOSES FOR THE CHANGES, AND THE RESULTS.

The project team has changed the name of the Center to the *Center for Secure Cyberspace*, which replaces the name *Center for Smart Cybercentric Sensor Surveillance Systems* as proposed in the project. The reason for this name change is to make it easier to communicate to the external public and potential industry partners. The structure of the Center as outlined in the PKSFI proposal will remain the same.

One of the Co-PIs, Kody Varahramyan, Director of the I*f*M, is leaving Louisiana Tech effective July 1, 2008. The new director of the I*f*M will replace Dr. Varahramyan in the PKSFI project. In the interim, Dr. Varahramyan will delegate his research responsibilities to his post-doctoral associate Dr. Mangilal Agarwal. Dr. Varahramyan will continue to be affiliated with Louisiana Tech and the *Center for Secure Cyberspace*, and involved in its' research activities.