Project Title: Wireless Ad Hoc and Sensor Network Security

Applicants:

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<td>Dept.</td>
<td>Networking, Security and Systems Administration</td>
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Wireless Ad hoc and Sensor Network Security

Wireless Ad hoc networks are gaining popularity due to their capability to establish communications among peer nodes in a self-organizing and adapting manner without any infrastructure. Nodes in wireless ad hoc networks act as hosts as well as routers. Mobile ad hoc networks (commonly known as MANETs) is a category under wireless ad hoc networks in which the nodes are mobile. MANETs are very useful for critical networking applications such as the military, law enforcement, disaster recovery and remote areas where communications infrastructure is not available.

Another category of wireless ad hoc networks are the wireless sensor networks (WSN) which are very popular for applications like environment monitoring, habitat monitoring, forest fire control, border surveillance and health monitoring among others. WSNs are different from MANETs as all nodes in the WSN are focused to achieve a common task. MANETS and WSNs are emerging network technologies and are expected to be widely deployed in the near future due to their wide ranging applications and ease and flexibility of deployment.

Currently these are communications network that are in urgent need for solutions to facilitate reliable and robust communications with a high demand for security due to the inherent nature of applications that use them. Being mobile and power constrained, the communicating nodes in such networks can not employ complex security algorithms or schemes. Hence one major design challenge in such wireless networks is “security”. However the security in the two types of networks has to be addressed differently due to the type of applications they target and the environment in which they operate.

Loss of confidentiality, integrity and availability along with various threats such as routing disruption attacks and resource consumption attacks are major risks associated with wireless communications, which will impact the network considerably due to their ad hoc nature and can render them useless or very dangerous under certain conditions. Besides the threats and vulnerabilities that exist in wired networks, such wireless ad hoc networks have additional security risks due to the unattended nature of the networks, openness of the wireless medium, lack of central infrastructure and dynamic topology changes. Hence the topic besides being very important for all students in networking is a major research area in the wireless networking community.

This proposal seeks support for developing an innovative course that will provide students with theoretical, practical and research experience and seed our undergraduate students’ research capability in an emerging networking area. The goal is to stimulate students’ creative thinking and develop their problem-solving strategies. The course is unique as the professors will closely involve and guide the students to work towards a research problem, implement and test the research ideas in a lab based environment and help them to publish the results. Funds permitting, one or two students will be encouraged to present the findings either in a technical conference or a workshop. This course addresses President Destler’s goal for innovation - “Looking at ways in which our curricula could be modified to encourage innovation and creativity and perhaps offer each student an opportunity to exercise his or her creative side before graduation”.

Targeted learners or population

- The primary audience for this course will be the 4th and 5th year undergraduates from the Kate Gleason College of Engineering and B. Thomas Golisano College of Computing and Information Sciences.
- Graduate students pursuing the Master’s degree in Information Assurance and Security at the B. Thomas Golisano College of Computing and Information Sciences may take this course as one of their electives
- It is also a good foundation course for students wishing to pursue a doctoral program in the area of networking due to the major research component and research training experience.
- In general, this course will be beneficial to anyone who would like to gain knowledge and experience in wireless ad hoc and sensor network security.

It is planned to offer this course twice per year with a section size of 24 students. The estimated number of learners impacted for the first year will be around 50 students.
Is this for a current course or new course? This is a new course.

Anticipated impact on teaching and/or learning.

The course will be handled in an innovative fashion. The projects for this course will target lab based test beds, which will be developed using the sensor kits and laptops available in the Networking Security and Systems Administration department. It is planned to extend the test bed to within the RIT campus, where permissible. This would serve as a showcase for our undergraduate students research skills. Following approach will be adopted.

(1) Build a WSN test bed for monitoring energy efficiency. This test bed will allow students to monitor energy efficiency in a building. The project will be handled as a continuing project with students in each following class contributing to the effort of their seniors to build a WSN solution that is robust. Students will be encouraged to analyze the data that they collect, discover trends and investigate reasons for the trends. They will also be encouraged to propose and test solutions to problems noticed. The results will be presented to the Campus Environment Committee to help in energy efficiency studies and green building. Embedded in this project will be a study of possible security threats due to wireless monitoring in the buildings. The test bed and the project will also provide students the opportunity to validate sensor networking theories and simulations in a practical manner. This will help them to identify limitations faced in real life by WSN users.

(2) Use the test bed built in the earlier activity to simulate MANETs/WSNs security threats and investigate new techniques to detect and prevent the threats and test them. A number of Intrusion Prevention and Intrusion Detection techniques and schemes for MANET and WSN security have been proposed in the research literature. A select set of such schemes as identified by the professors will be explored and evaluated by the students in a realistic environment afforded by the test bed. Impact of these mechanisms on the performance of MANETs and WSNs will be measured. Understanding, practicing, comparing and evaluating the effectiveness of these techniques will immensely help the students in gaining practical knowledge of security in MANETs and WSNs.

(3) Research publications in conferences and workshops is one component in the course. The course will be co-taught by three faculty members who have a rich research background covering several areas in MANETs and WSNs including security. The instructors will present real world problems to students and prepare them with the required knowledge via lectures in which the research aspects will be discussed. Students will form groups to work on a select set of problems. It is intended to foster students’ independent thinking and guide them to think out of the box, through this course. This is an important step into the research domain. Instructors will also provide guidance to solve the problems and write technical research papers.

(4) This course will help enrich security curriculum. GCCIS in RIT is a leader in the computer security and forensics field and the department of Networking Security and Systems Administration has been accredited as Center for Academic Excellence in Information Assurance. However, there are no courses in the current curriculum to cover the security aspects of MANETs and WSNs even though it is an important component of the security of cyber infrastructures. This new course will make our security curriculum stronger and more complete.

Project impact on student success

As stated earlier, both MANETs and WSNs are emerging network technologies that are expected to be widely deployed in the near future. RIT is one of the few universities that has a program in networking and security. This course will be a role model for introducing research into the networking curriculum in one of the foremost research areas in networking. This course will be adding a significant component to our existing programs. Students will not only gain hands on experience in a realistic MANET and WSN environment, but also develop their research and analytical skills on security in such networks. Under the supervision of three professors, students will experience new research skills such as conference paper writing and technical paper presentation in conferences. Students with such enhanced skill will certainly be more attractive to the wireless networking industry. Some of them may be the prospective students for our new PhD programs.
Impact measure, report findings, and sharing in a faculty forum.

We will measure the impact based on the following

1. The first one will be acceptance of the papers in technical conferences or workshops. The professors will provide information to students on technical conferences and workshops to target. They will assist the students to submit their papers to conferences. The projects conducted by the students will be used to apply for funding under the campus renewable energy and energy efficiency project. (Energy Bill Authorizes $750M in Assistance for Campus Energy Projects)

2. The second measure will be from student feedback through regular course evaluations. As this is the first course of its type, we intend to have regular student feedback and evaluations as the course progresses. We will also collect students’ ideas, concerns, and suggestions, and their feedback on the research component of the course. We will track students’ progress through classroom discussions on the research project as it evolves to help the faculty tailor the research requirements of the course and address concerns in time.

3. The third measure will be based on feedback from other RIT faculty and other universities. We will collect feedback from people involved in the test bed, for example, the Campus Environment Committee. If this project is funded, the lecture material and hands-on exercises along with teaching experiences will be disseminated through conferences workshops and Internet website. The feedback from other colleges and universities will be sought to help improve course content and research projects.

Report Findings

The presentation by the students in technical conferences and workshops will be one form of reporting the findings. The professors will share their experience on innovative teaching combined with research with colleagues in RIT and other universities.

Rationale for the project, as it ties to the intent of the grant

a. Why it is not part of regular college business?

GCCIS has just developed a new PhD program. Research was not a focus in this college till recently. With President Destler’s goal for innovation - “Looking at ways in which our curricula could be modified to encourage innovation and creativity and perhaps offer each student an opportunity to exercise his or her creative side before graduation”, we feel it is time to prove that both students and faculty are ready for the challenge.

b. Its relevance to required cluster, college, and/or department competencies

The department of Networking, Security and System Administration is well-known for its security and forensics curriculum, besides being accredited as a Center for Academic Excellence in Information Assurance. With emerging technologies such as MANETs and WSNs, this course introduced at an appropriate time will certainly enrich the security program. Not many universities offer this type of courses or programs and hence we feel, this course will attract prospective students to our programs.

c. Describe how your project is relevant to other faculty and what you think it would take to transfer your success to other faculty

This course will extend our current teaching horizon which is focused on networking and security, to security issues in the latest networking technologies such as MANETs and WSNs which are getting popular and attractive. Our experience of teaching combined with students’ research will be shared with other faculty. This will encourage other faculty to introduce similar research oriented courses and activities in their curriculum. This will provide visibility to our college and RIT as a leader not only in quality education but where education is combined with quality research at an early stage, to develop young researchers.
Relevant credentials, experience of involved faculty/staff

Dr. Yin Pan is an Assistant Professor in the Networking, Security and System Administration department. She received her Ph.D. in Systems Science and M.S. degree in Computer Science in 1997 from Binghamton University. Dr. Pan holds three US patents in areas of Network Quality of Services, Voice over IP and Artificial Intelligence. Recently, Dr. Pan has been actively involved in the network security area, especially in security audits and computer forensics. She holds the GIAC Systems and Network Auditor (GSNA) Certificate and has published many papers in security field.

Dr. Nirmala Shenoy is a Professor in the Networking, Security and System Administration department and also the Director, Lab for Wireless Networking and Security at RIT. She has a doctorate in the combined field of computer science and networking. Dr. Shenoy has been involved in wireless networking-related research projects for over 10 years and supervised several PhD students during this period. Her research focus is in the area of performance modeling and analysis, mobility management and modeling in wireless networks and sensor and ad hoc networks. Dr. Shenoy has over 10 years experience in managing, developing and field-testing industry-based research projects as a Research Scientist at Council of Scientific & Industrial Research (CSIR) Labs, Central Electronics Engineering Research (CEERI) Center, India. Dr. Shenoy served as an instructor and researcher at universities in Australia. She has led several wireless networking projects and served as consultant to several companies during this period. She has several publications in refereed journals and conferences, has served in technical committees in several conferences and organized and chaired workshops. She is reviewer for several refereed conferences and journals.

Dr. Sumita Mishra is a Visiting Assistant Professor in the Networking, Security and Systems Administration at RIT. She has a doctorate in Electrical Engineering with concentration in wireless communications. As the director of the Embedded Wireless Division of CompSys Technologies Inc., Amherst, NY, Dr. Mishra was actively involved for several years in technology development in the general areas of wireless networking and security. She has been working in the areas of security and mobility management for cellular and ad hoc networks. As a part of her Ph.D. thesis (funded in part by National Science Foundation), she developed an analytical framework for comparing different paging schemes in analog and PCS networks.

Innovation in the discipline or program

The MANET and WSN security course can be an elective course in our security and forensics program. It can be also a graduate elective in the Master’s degree in security at the B. Thomas Golisano College of Computing and Information Sciences. Students with wireless network as their concentration will certainly favor this course. The research component from this course will discover students’ research capabilities and encourage students to pursue MS or PhD programs.

Timetable for development of the project

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<th>Time</th>
<th>Activity</th>
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<tr>
<td>Summer 20074</td>
<td>Develop course content and generate research ideas</td>
</tr>
<tr>
<td>Fall 20081</td>
<td>Develop labs and test sensor test bed</td>
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<tr>
<td>Winter 20082</td>
<td>Offer the course for the first time</td>
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<tr>
<td>Spring 20083</td>
<td>Professors will help students to submit papers</td>
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<tr>
<td>Summer 20084</td>
<td>Arrangements will be made for conferences/workshops presentations</td>
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** No co funders are involved
** Letters of support from appropriate administrators included.