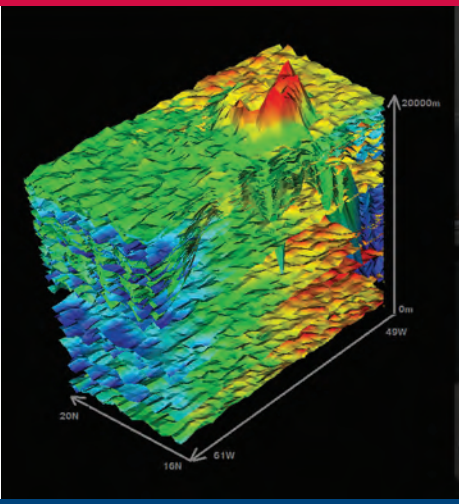
FAU
DEPARTMENT OF COMPUTER & ELECTRICAL ENGINEERING AND COMPUTER SCIENCE
College of Engineering & Computer Science
Florida Atlantic University

NSF



NATIONAL SCIENCE FOUNDATION
INDUSTRY/UNIVERSITY COOPERATIVE RESEARCH CENTER
FOR ADVANCED KNOWLEDGE ENABLEMENT

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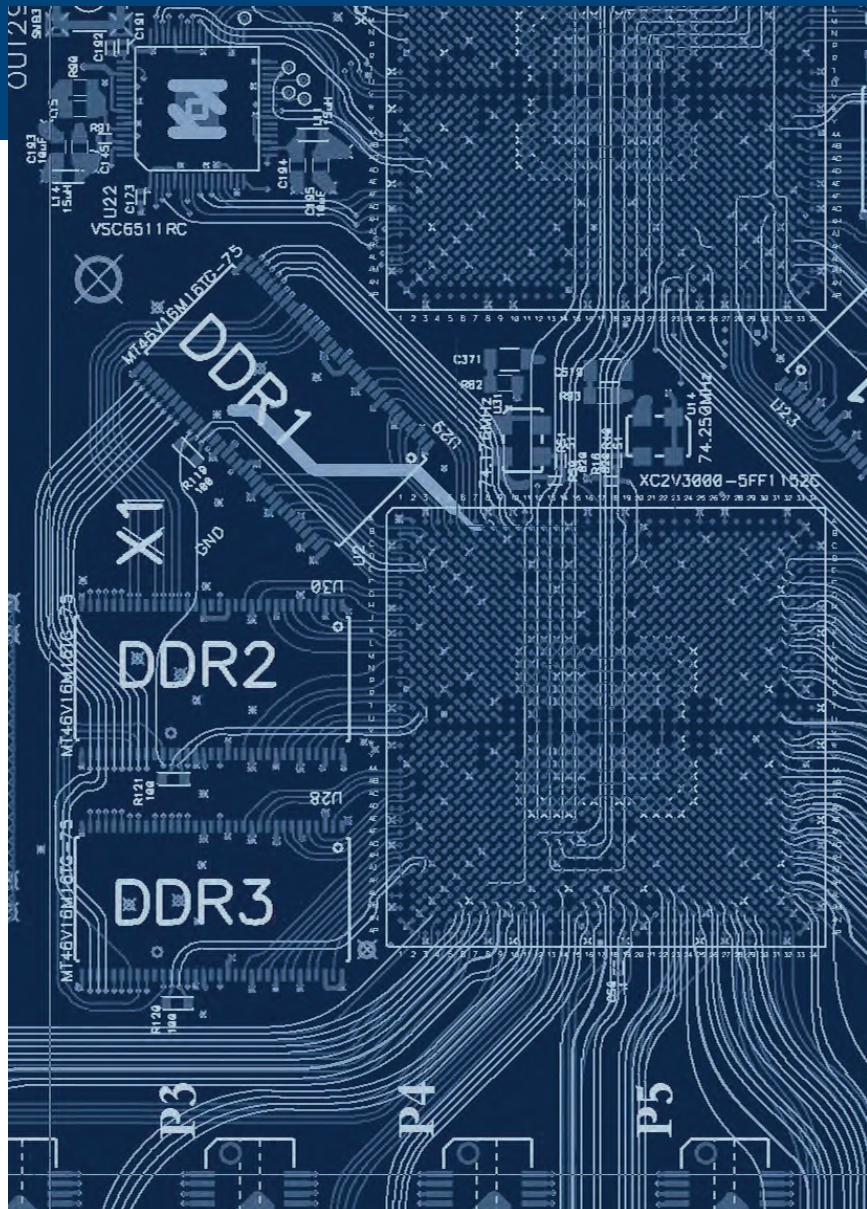
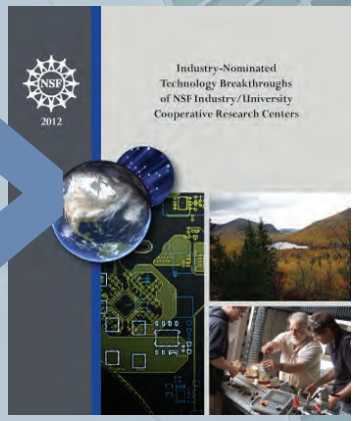


ABOUT THE CENTER



Our project on "Distributed Cloud Computing Study: 3-D Visualization Services for Climate Data on Demand," has been selected by NSF to be included in their recently published Compendium on "Industry-Nominated Technology Breakthroughs of NSF Industry/University Cooperative Research Centers", 2012.

In 2009, Florida Atlantic University received a five-year grant from the National Science Foundation (NSF) to create the site of the Center for Advanced Knowledge Enablement (CAKE) as an Industry/University Cooperative Research Center (I/UCRC) that will provide a framework for interaction between university faculty and industry in the critically important areas of information technology, communication, and computing. There are only 15 NSF-supported centers in these areas in the United States. Our Center operates as a site of the Florida International University center whose director is Dr. Naphtali Rishe.

The NSF I/UCRC has proven to be a win-win situation both for our university and our industry and government partners. We are thrilled with the opportunity to conduct industrially relevant research, receive additional funding for it, and moreover, benefit from the recognition and prestige of being an NSF research center.

Our Center is successfully building a bridge linking academia, industry, and government in a coordinated research initiative, which this region desperately needed. The Center, representing the combined efforts of FAU and FIU researchers, now has the critical mass to serve the information technology industry and to help South Florida IT mature into the top tier.

I am proud that our Center presently has 16 industry members with the total memberships of $1.3 million. We have 18 active

The I/UCRC CAKE is housed in the LEED Platinum certified Engineering East building.

industry projects with 13 faculty and more than 20 graduate and undergraduate students involved in these projects. One of our completed projects – a joint effort with FIU and the University of Maryland and sponsored by NSF, titled "Distributed Cloud Computing Study: 3-D Visualization Services for Climate Data on Demand," – has been selected by NSF to be included in their recently published Compendium on "Industry-Nominated Technology Breakthroughs of NSF Industry/University Cooperative Research Centers".

Several completed projects and relating results, products, and systems are now commercialized and being applied by local companies including Pronto Progress, Relli Technologies, Adventure Technologies, and Avocent.

This booklet presents the mission and research agenda of the Center, its organization, and memberships. It also introduces our industry partners, who are members of the Center, and the FAU faculty members involved in the research projects as well as a brief description of the applied research projects conducted by the Center.

Borko Furht, Ph.D.
Director, I/UCRC, FAU Site
Chair, Department of Computer & Electrical Engineering and Computer Science

MISSION AND RESEARCH AGENDA

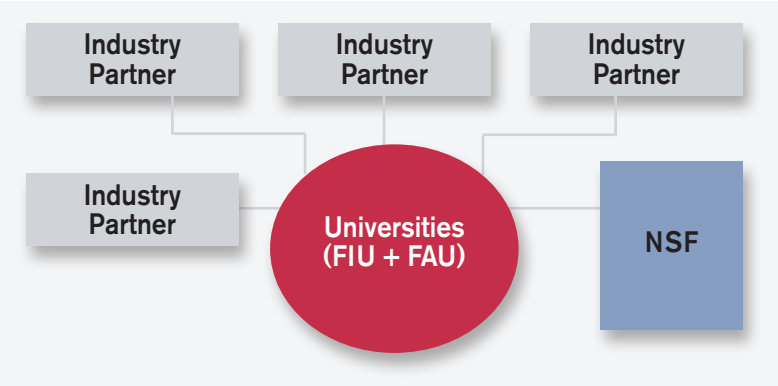
Our Center's mission is to accomplish the following goals:

- To continuously evolve an understanding of the technology needs of the industry sector through direct contact with industry professionals and related corporations.
- To identify applied research themes that meet the needs of private and public sectors.
- To conduct industry-relevant research.

Our Center research agenda includes the creation of new technologies for various Web-based applications, next generation hardware and software development techniques and tools, mobile and wireless systems and technologies, video compression and communication technologies and systems, networking and communication systems, data mining and machine learning technologies, and various interdisciplinary initiatives and applications including medical systems and healthcare informatics.

Our research is applicable to many fields, including national defense and homeland security, healthcare, biomedical science, environmental science, entertainment, finance, and technology services. Issues of interest to multiple industries are also explored through partnerships and collaborative research.

ORGANIZATION OF THE CENTER



Membership in our Center is open to private businesses, government agencies, and others with research needs in the areas of information technology, communications, and computing. The Center provides its partners with numerous benefits, including early access to research innovations and opportunities to interact and work with university faculty, students, and industry peers.

The Center's Industry Advisory Board (IAB), made up of representatives of all members, has the responsibility of determining the research areas and related projects in which membership fees will be invested. The IAB meets twice a year to discuss proposed projects and set research priorities for the Center. The IAB makes recommendations on research projects to be carried out by the Center and the allocation of resources to these projects.

MODEL OF THE I/UCRC

NSF seed funding ranges from $300,000 to $750,000 over five years, with sustaining support coming from CAKE members. Yearly membership fees range from $5,000 for small companies (affiliate members) to $50,000- $150,000 for medium and large companies (full members). Companies paying higher membership fees have priority in selecting the Center's research projects.

At this time the FAU Center has 16 companies with total memberships of about $1.3 million. We expect to continue to grow with the goal to have 25 members by 2014 with total memberships of $2.5 million.

The NSF program requires independent evaluators. Serving the Center in this capacity is Dr. Vida Scarpello, a recognized expert in the field of industrial relations who has been a consultant to major U.S. corporations as well as city and state governments.

Jay Salkini, CEO of Tecore Networks, addresses participants at the IAB meeting in October 2011.

The Interim Dean of the College of Engineering and Computer Science Dr. Mohammad Ilyas addresses participants at the Industry Advisory Board Meeting held at FAU in October 2011.

INDUSTRY MEMBERS

Since the FAU Center was established in August 2009, 16 companies joined the Center with total memberships of about $800,000 in cash and 1.45M in equipment and software.

COMPANY	TOTAL MEMBERSHIP	REPRESENTATIVE IN IAB
Adventure Technologies	$15,000	Mike Weir, CEO
Avocent	$58,000	Steve Geffin, Vice President www.avocent.com
Aware Technologies	$120,000 (in-kind)	Peter Millett, Chairman and CEO www.awaretechnology.com
CGC.com	$50,000	John Hruska, CEO www.wigime.com
Hillers Electrical Engineering	$18,600	Paul Hillers, CEO www.hillersee.com
ILS Technologies	$75,000 (in-kind)	Fred Yentz, CEO www.ilstechnology.com
Jansyl Technologies	$5,000	Sylvia Tantillo, CEO
Last Best Chance, LLC	$300,000	Mike Levine, Mgr

COMPANY	TOTAL MEMBERSHIP	REPRESENTATIVE IN IAB
LexisNexis	$82,000 $300,000 (in-kind)	Armando Escalante, CTO www.lexisnexis.com
MobileHelp	$48,000	Scott Adams, Chairman Robert Flippo, CEO www.mobilehelpnow.com
Pronto Progress	$35,000	Timothy Proksh, CEO www.prontoprogress.com
Relli Technologies	$50,000	Reuven Gilton, CEO www.relli.com
Smart VCR, LLC	$50,000	Mike Levine, CEO
Soren Technologies	$5,000	Faiz Fattech, CEO www.sorentech.com
Tecore Networks	$100,000	Jay Salkini, CEO www.tecore.com
Tecore Wireless Systems	$965,000 (in-kind)	Jay Salkini, CEO

INDUSTRY MEMBERS (continued)

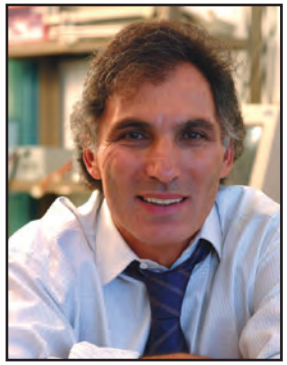
At one of the brainstorming meetings with industry members are: Zee Aganovic, CEO of Hiconversion; Armando Escalante, CTO of LexisNexis; Borko Furht, FAU; Tom Logar, CEO of BeSpotted; Juan Caraballo, IBM; and Mike Levine, Mgr of Last Best Chance.

FAU Research Park has 24 high-tech companies and an incubator with 17 start-ups. It provides 850 jobs. CAKE I/UCRC has relationships with the majority of companies.

At the IAB meeting at FAU (October 2011), Borko Furht, Director of the Center and Chair of the CEECS Department, presented a Certificate of Appreciation for the outstanding contributions to the FAU Center and the CEECS Department to the following industry members: Steve Geffin, VP of Avocent; Armando Escalante, CTO of LexisNexis; Jay Salkini, CEO of Tecore Networks; Mike Levine, Mgr of Last Best Chance; and Jaime Borras, CEO of Wireless Silicong Group and Chair of the IAB.

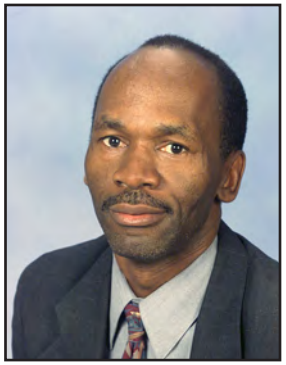
Signing the agreement with Pronto Progress: Dr. Shihong Huang, PI of the project; Dr. Borko Furht; and Tim Proksh, CEO of Pronto Progress.

RESEARCH FACULTY



Borko Furht, PhD
Director, Center for Advanced Knowledge Enablement
Chair & Professor,
Department of Computer and Electrical Engineering and Computer Science

Research Interests:
- Multimedia Systems
- Video Coding and Compression
- 3-D Video and Image Systems and Processing
- Internet Engineering
- Big Data Analytics



Valentine Aalo, PhD
Professor

Research Interests:
- Wireless Communications
- Statistical Decision Theory
- Satellite and Mobile Communication Systems
- Array Processing
- Radar Signal Processing

Ankur Agarwal, PhD
Associate Professor

Research Interests:
- Health & Medical Informatics System Design
- Embedded System Design
- Mobile Systems and Application Development
- MultiCore Architectures
- Real-Time System Design

Bassem Alhalabi, PhD
Associate Professor

Research Interests:
- Embedded Systems
- Web-Based Controls and Automation
- Remote Labs and Distance Learning Technologies

Jonathan Bagby, PhD
Associate Professor

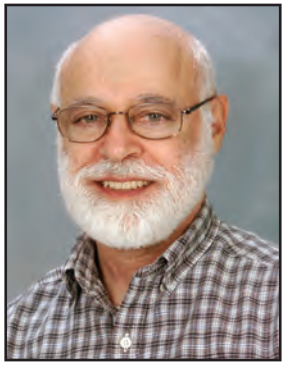
Research Interests:
- RF Circuits and Devices
- Numerical Electromagnetics
- Electromagnetic Scattering
- Guided Waves

Ionut Cardei, PhD
Associate Professor

Research Interests:
- Component-Based Software Design Automation
- Wireless Networking and Resource-Efficient Protocols for Constrained Networks
- Routing in Intermittent Wireless Ad-hoc Networks

Mihaela Cardei, PhD
Associate Professor

Research Interests:
- Wireless Networking
- Wireless Sensor Networks
- Network Protocols and Algorithm Design
- Combinatorial Optimization in Wireless Networks



Robert Cooper, PhD
Professor

Research Interests:
- Queueing Theory
- Performance Analysis of Computer and Telecommunication Systems

Nurgun Erdol, PhD
Professor

Research Interests:
- Digital Signal Processing
- Speech Processing
- Bio Signal Processing
- Statistical Signal Processing

RESEARCH FACULTY (continued)

Ed Fernandez, PhD
Professor

Research Interests:
- Data and Network Security
- Software Patterns
- Security Patterns
- Object-Oriented Design
- Fault-Tolerant Systems

Shihong Huang, PhD
Associate Professor

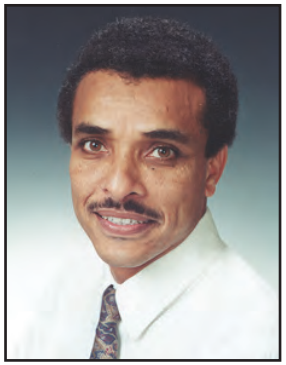
Research Interests:
- Reverse Engineering
- Program Comprehension
- Software Systems Redocumentation
- Software Visualization

Hari Kalva, PhD
Associate Professor

Research Interests:
- Video Compression and Communication
- Video Transcoding
- Universal Multimedia Access
- Mobile Multimedia
- Multimedia Programming

Taghi Khoshgoftaar, PhD
Professor

Research Interests:
- Data Mining and Machine Learning
- Software Engineering
- Bioinformatics and Biomedicine
- Biomedical Computing
- High Assurance Systems Engineering



Imad Mahgoub, PhD
Professor

Research Interests:
- Mobile Computing
- Wireless Sensor Networks
- Vehicular Networks
- Parallel and Distributed Systems

Oge Marques, PhD
Associate Professor and Associate Chair

Research Interests:
- Image and Video Processing
- Image Search and Retrieval
- Intelligent Vision Systems

Perambur Neelakanta, PhD,
Professor

Research Interests:
- Microwaves, Electromagnetics and Antennas
- Neural Complexity and Bioinformatics
- Radar and RF Communication Systems
- Electromagnetic Materials and Nanostructures
- Next-generation Telecommunications

Abhijit Pandya, PhD
Professor

Research Interests:
- Neural Network Algorithms
- VLSI Implementation of Neural Networks
- Low Power CMOS Circuit Design
- Digital Circuit Design
- Layout and Verification

Maria Petrie, PhD
Professor and Associate Dean for International Affairs

Research Interests:
- Modeling of Complex Systems
- Data and Network Security
- Information Assurance
- Engineering Pedagogy
- Global Engineering Education

RESEARCH FACULTY (continued)

Daniel Raviv, PhD
Professor

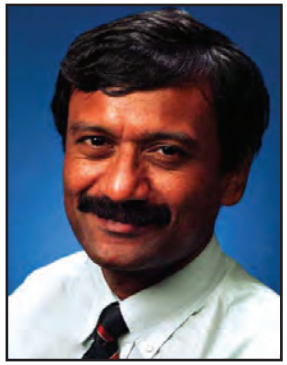
Research Interests:
- Real-Time Vision-Based Mobile Systems
- Intelligent Campus
- Driver-less Cars
- Creative, Innovative and Inventive Thinking
- Cyber-Physical Systems

William Rhodes, PhD
Professor

Research Interests:
- Imaging Systems
- Image Processing
- Information Optics
- Signal Processing

Zvi Roth, PhD
Professor and Associate Chair

Research Interests:
- Robotic and Machine Calibration
- Control Systems
- Analog Electronic Design
- Bioengineering
- Biotechnology Automation



Ravi Shankar, PhD
Professor

Research Interests:
- Systems Integration
- Concurrency
- Design Productivity
- Semantic Web

Martin Solomon, PhD
Professor

Research Interests:
- Complexity Theory
- Philosophical Aspects of Computability Theory
- Database

Vichate Ungvichian, PhD
Professor

Research Interests:
- Electromagnetic Compatibility
- Antennas
- Electromagnetic Systems Modeling
- Signal Integrity

Xin Wang, PhD
Associate Professor

Research Interests:
- Wireless Communications
- Networking
- Cross-layer Design and Optimization
- Medium Access Control
- Resource Allocation and Scheduling
- Signal Processing in Communications

Xingquan "Hill" Zhu, PhD
Associate Professor

Research Interests:
- Data Mining and Machine Learning
- Multimedia Computing and Multimedia Systems Information Retrieval

Hanqi Zhuang, PhD
Professor

Research Interests:
- Image Processing, Signal Processing and Applications
- Robotics, Computer Vision and Applications
- Assistive Technologies

LABORATORIES

Cloud Computing system with the innovative virtualization provides computing power for projects in the Center.

Tecore Wireless and Mobile Systems Laboratory

The NSF Center is located in the Engineering East building, which is LEED Platinum certified. There are a total of nine research and six instructional laboratories available for computer science, and computer and electrical engineering research and teaching. The building's powerful cloud computing system provides computer facilities for the majority of labs including two computer laboratories. There are also labs and facilities for mobile system development including for iOS development (iPhones/iPads) and Android development.

Four fully equipped research laboratories are presently assigned for research projects within the center – the Levine Innovation and Entrepreneurship Lab, the Tecore Mobile and Wireless Systems Lab, the Multimedia and Video lab, and the Software Engineering lab.

Apple Lab is used for developing iPhone/iPad mobile applications.

Multimedia lab is used for projects dealing with video and image processing.

DISTRIBUTED CLOUD COMPUTING: 3-D VISUALIZATION SERVICES FOR CLIMATE DATA ON DEMAND

Borko Furht and Hari Kalva, PIs ● Student: Reena Friedel

This study is a collaboration between CAKE (FIU and FAU Centers) and the Center for Hybrid Multicore Productivity Research at University of Maryland Baltimore County. The NSF Compendium is available at: www.nsf.gov/eng/iip/iucrc/compendium/index.jsp

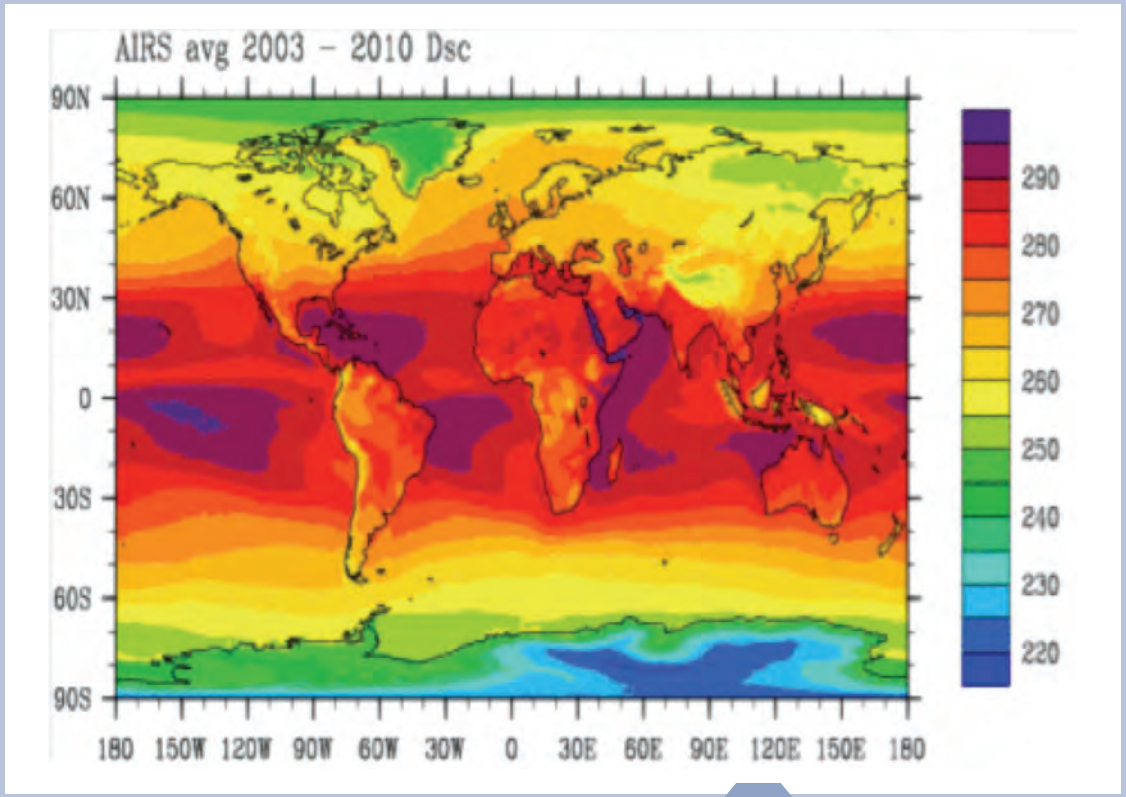
Measuring the surface temperature of the entire Earth on a daily basis is a difficult challenge because 75% of the planet is covered with oceans and ice. Continuously determining, for several days to weeks, the vertical thermal field around a hurricane surrounded by dynamically rotating clouds is needed for more accurate landfall predictions. Thus, for applications ranging from climate change to hurricanes, satellite measure the Earth's emitted infrared radiation twice daily with sufficiently high spatial and spectral resolution to provide an estimate of vertical profiles of regional or global surface brightness temperature (BT). However, in order to assess global warming, these temperatures need to be measured to within an accuracy of 0.10 °C per year since models indicate CO2 warming of ~20-30 over 100 years. Moreover, to resolve the structure around hurricanes, infrared data at resolutions of 1-5 km are needed. Not until 2002, when the Aqua satellite was launched, has there been a single satellite with instruments that can meet both the accuracy and the spatial resolution required.

In this multi-center collaborative project, researchers from the Center for Hybrid Multicore Productivity Research (CHMPR) at UMBC and the Center for Advanced Knowledge Enablement (CAKE) at FIU and FAU have developed the capability to deliver a decade of 3-D gridded arrays of animated visualizations of spectral IR satellite radiance data from instruments on AQUA. These animations render in 3-D the vertical structure of a decade of global and regional temperature trends occurring at the surface and lower troposphere. In addition, the gridding algorithm developed by CHMPR has been applied to providing CAKE with 3-D temperature profiles that specify the thermal structure around hurricanes in

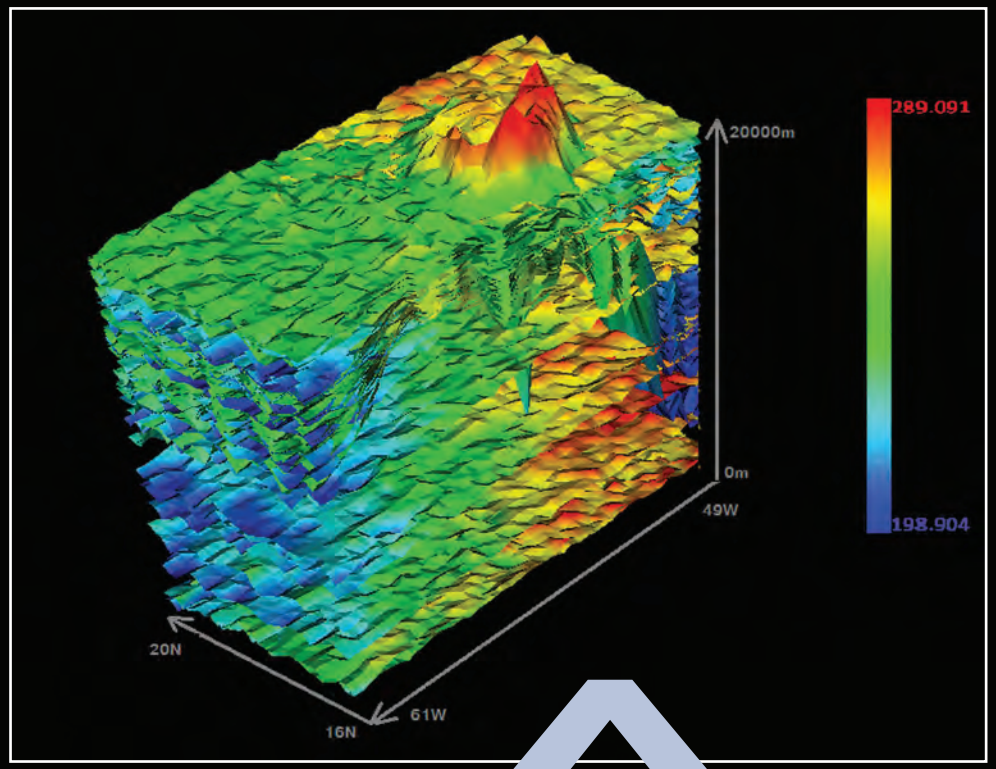
This article has been published in the NSF Compendium of Industry-Nominated Technology Breakthroughs of NSF Industry/University Cooperative Research Centers, 2012

order to improve their landfall prediction.

CHMPR and CAKE have implemented a distributed cloud computing web-based service, called SOAR that incorporates this visualization capability as a public service available on an advanced IBM-based server cluster. This system provides researchers and students with the ability to select regional and temporal periods and automatically transform IR orbital satellite data into spherical grid arrays of 3-D temperature profiles for viewing the continuous changing thermal structure of the atmosphere. The FIU site at CAKE augmented the satellite data visualization by providing spatiotemporal visualization and animation of the data. The FAU site at CAKE has developed tools for 3-D visualization of the vertical temperature profiles. When coupled with gridding CHMPR software, render for the past decade the first integrated



Atmospheric temperature layers up to 20,000 meters (65,619 feet).



Atmospheric temperature layers up to 20,000 meters (65,619 feet).

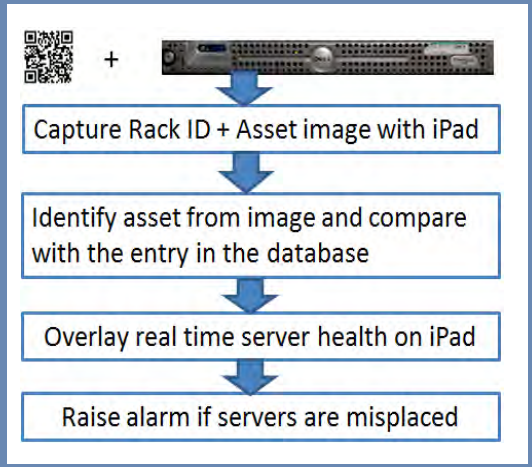
scientifically validated multi-year infrared brightness temperature record.

Economic Impact: Fundamental Decadal Data Records are highly desired products recommended by the National Academy of Science/National Research Council. The SOAR distributed cloud computing web-based service enhances NASA's ACCESS program by providing fundamental brightness temperature records. This can go a long way towards improving scientific and public understanding of the nature of global and regional climate change. As a result, everyone can be better positioned to design any necessary policies and actions for mitigating negative impacts on the economy.

ASSET IDENTIFICATION USING IMAGE DESCRIPTORS

Hari Kalva, PI ● Students: Reena Fridel and Oscar Figeruoa

Asset management is a time consuming and error prone process. Information Technology (IT) personnel typically perform this task manually by visually inspecting the assets to identify any misplaced assets. If this process is automated and provided to IT personnel it would prove very useful in maintaining and keeping track of assets in a server rack. A mobile/tablet based solution is developed to automate the process of asset identification. The asset management application on the tablet captures the images of assets and searches an annotated database to identify the asset. We evaluate the matching performance and time complexity of asset matching using three different image feature descriptors. Methods to reduce feature extraction and matching complexity were developed. Performance and accuracy tradeoffs were studied, domain specific problems were identified, and optimizations for mobile platforms were made. The results show that the proposed methods reduce the complexity of asset matching by 67% when compared to the matching process using unmodified image feature descriptors. The next phase of the project will focus on developing augmented reality extensions to overlay server health data on the asset being monitored.



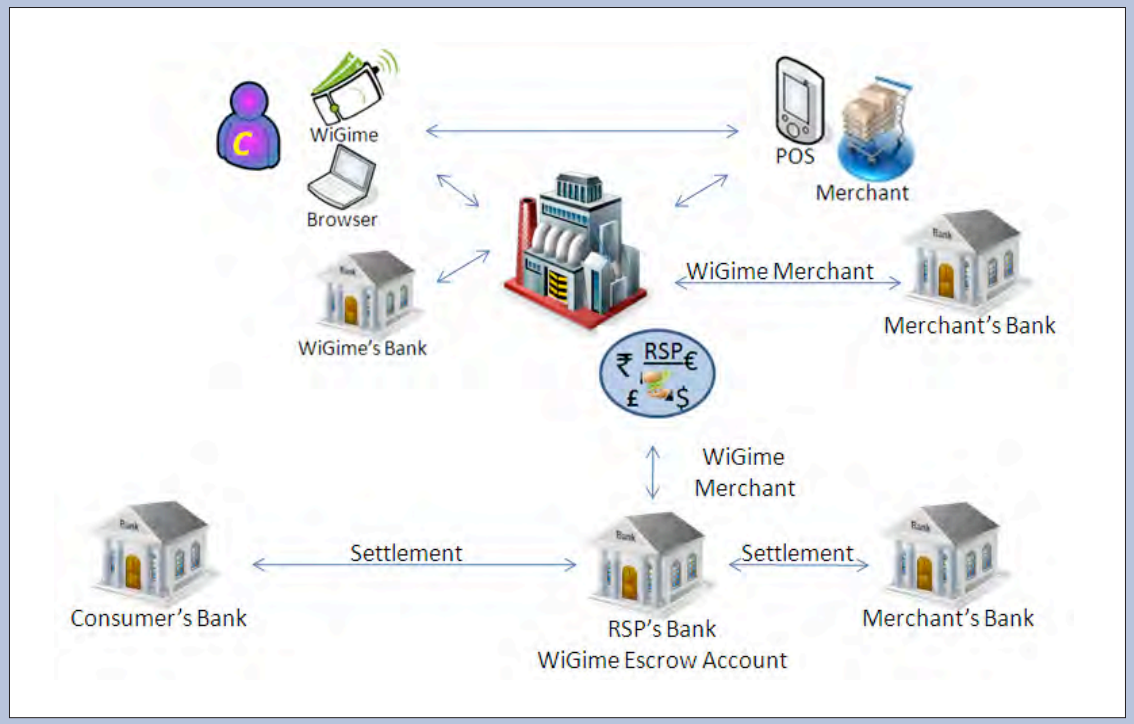
MOBILE COMMERCE TECHNOLOGY

Ankur Agarwal, PI

The use of a smartphone and the number of smartphone applications both are growing exponentially. The natural extension of this expansion is the growth of mobile commerce. This project explored various algorithms and methods for developing mobile commerce products. This extension of mobile commerce has potential to not only provide convenience of executing commerce through a mobile device but can also provide a higher level of security than existing methods. Among various security issues, mobile wallet can help track monies flowing through various countries and allow secured monitoring and tracking of money thereby reducing the possibilities of various types of transactional frauds associated with either lost or a stolen credit/ debit card or its information, identity theft and or money laundering schemes among others. The mobile and Web-based system algorithms were designed in compliance with the rules and regulations of the current banking industry standards such as (Know your Customers (KYC) and Anti Money Laundering (AML)). Various mobile applications related to mobile commerce was developed for an iPhone and Android platform. CAKE at FAU played a major role in conceptualizing the Mobile Point of Sale and the mobile based e-commerce products and developed the testing procedures for testing and debugging their backend code.

We developed the embedded device (hardware point-of-sale) which processed the WiGi proprietary barcode (an equivalent of a mobile

High Level WiGi Transaction Flow Industry partner interested in this project: Wigi,Inc.



currency). The embedded platform was connected with a physical printer for printing the receipt and was processing the transaction by connecting to the Web server through the Ethernet port. Later the entire platform was ported to an Android based Mobile phone. The center further worked with the company in conceptualizing the ecommerce application and algorithm for consumer shopping/ purchase through the mobile application from a print media by just scanning a 2-D barcode application.

The company today has more than 5 consumer centered products launched in the market. The project demonstrates the successful collaboration between academia and industry.

SERVICE ORIENTED ARCHITECTURE FOR AGILE AUTOMATED TESTING ENVIRONMENT

Ankur Agarwal, PI

System test development, automation and execution process are key stages of the overall product development in both New Product Introduction (NPI) as well as the manufacturing process for companies. For NPI, companies must create test beds and test stations to support product validation and verification efforts. For manufacturing companies, it is an ongoing process to ensure the product meets quality specifications and can be sold to customers. This testing process is not only time consuming but also resource intensive and thereby negatively impacting the overall system design productively impacting the overall system design productivity. Large and successful companies invest hundreds of thousands of dollars in enterprise test and automation execution systems to support their product development processes. Such infrastructure provides these companies with competitive advantage in systematically defining test plans and then quickly achieving automation and generating large amounts of product critical data.

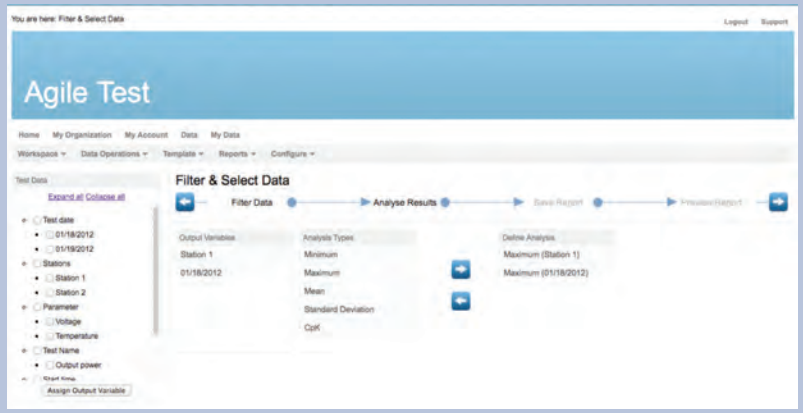
Generating, collecting, analyzing and consuming test data are keys to business intelligence for companies. Managing the creation of test plans, test automation, test data and then utilization of very expensive assets becomes a discipline and process of its own. Automation of the tests is a key component of today's modern day test process. The tests are often too complex to do manually and far too time consuming to be executed in a manufacturing environment. A test automation framework is the key to enhancing the productivity of overall team. The overall testing process is a long, resource consuming process which starts with the test plan development leading to development of testing software libraries, data sheet assembly, reservation of testing station, development of testing data, test station calibration, test execution, data collection and data analysis and reporting. It is absolutely evident that there is wide scope of process automation in system testing.

In this project we developed such automation framework by deploying a service oriented architecture for providing innovative processes,

which would allow the test data to be easily managed, visualized, and shared among various platforms in a interoperable manner. The test uses the concept of developing a test case library which can be shared across several platforms based on the test equipment specification and the Design Under Test (DUT). Users can then use these existing test cases and avoid developing the specific test cases for their design thereby, adding efficiency to this overall process. The system uses the ATML standard for providing an XML based standard for ATE and test information exchange. This standard was already been widely adopted by government agencies and industry. Naval Air Systems Command division in collaboration with industry leaders have collaborated in defining the XML schemas which would correctly represent test information and allow its interoperability.

INDUSTRY PARTNER INTERESTED IN THIS PROJECT:
Adventure Technologies

Screen Capture Data Selection and Report Creation Process



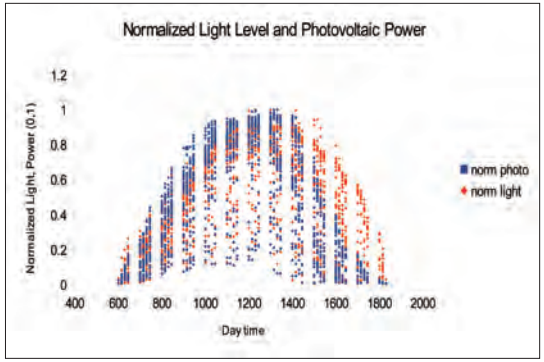
Various Types of Test Stations and Test Equipment

PROJECT 5

SMART BUILDING OPTIMIZATION SYSTEMS AND ALGORITHMS

Ionut Cardei and Borko Furht, PIs ● Student: Luis Bradley

The Engineering East building, which houses the FAU College of Engineering and Computer Science and the NSF I/UCRC, is LEED Platinum certified and relies on the newest green technologies to reduce its energy usage and environmental footprint. The building power, HVAC systems, and the server room are heavily instrumented with hundreds of sensors. For this project, we developed predictive models for energy systems and room comfort. These models are used in simulations to optimize building operations. An earlier study looked at the efficiency of the solar power system, currently generating 7-13% of the total consumed power. We investigate the relationships between the outside environmental parameters and the power generated. A model for power generation is designed to be used in the later phases of the project involving simulations. Early results indicate a strong correlation (84%) between the sky light level and generated power. We measured a loss in efficiency in the early afternoon explained by the panels being in the building's shadow in the late afternoon, shown in the chart.



In this project, we also use data mining techniques to identify the relationships between room comfort level (defined by temperature, CO_2, and humidity), HVAC parameters (air inflow temperature, room volume, occupancy), and external parameters (sun exposure, outside temperature, light, barometric pressure, precipitation). We derive the most relevant parameters for predicting room comfort, and associations between a desired comfort level and controllable or environmental metrics.

Using machine learning techniques, we compute models for the power consumed in the Engineering building by HVAC systems depending on a range of parameters, such as room parameters, outside environment (light level, precipitation, temperature, humidity), time, date, and estimated building occupancy. The predictive models for energy usage are used for optimizing the building's energy and occupant comfort level using simulations.

INDUSTRY PARTNER INTERESTED IN THIS PROJECT:
ILST
Technology and Aware Technology

PROJECT 6

CAMPUS 2020

Daniel Raviv, PI

This project deals with new ways for enhancing people's quality of life, by improving their interaction with the environment, and by boosting resource optimization. This person-centered venture aims at developing an environmentally-friendly interactive cyber-physical campus, for both knowledge and action. Its goal is to provide multi-source information and interface between humans and natural/man-made environments, using mobile tech devices as well as allowing for real-time sensor-based decisions and actions.

THE FOLLOWING PROJECTS ARE PART OF THE CAMPUS 2020 PROJECT.

- Smart Parking
- Smart Campus Tour
- Activity-Based Intelligent Campus
- Intelligent Sprinkler System
- Smart Speed Bump
- "Speed Reducer"
- Smart Campus Information Integration and Visualization
- Cell-Density-Based Information
- Driver Monitoring System
- Auto Door Opener
- Forensic-Related Projects

INDUSTRY PARTNER INTERESTED IN THIS PROJECT:
Last Best Chance, LLC

CAMPUS 2020: CAMPUS DRIVING AND DIRECTIONS ASSISTANT

Mihaela Cardei, PI
Students: Lori Watson and Iana Zankina

INDUSTRY PARTNER INTERESTED IN THIS PROJECT: Last Best Chance, LLC

The Campus 2020 project envisions a university campus where technology assists faculty, staff, students, and visitors to better and more efficiently accomplish their daily activities. Mobile devices have become ubiquitous and smart phones are quickly becoming the primary connectivity in today's society. The objective of this project is to develop a smartphone application that assists campus drivers and users to find driving and walking directions to a certain location on campus specified by building name/ID and room name/number. As the user changes his location, directions are updated accordingly. In-campus building information and directions are not available using commercial on-line map tools such as Google Maps. Two types of users will be considered: drivers and pedestrians. For drivers, the application will inform them of upcoming road signs (e.g. stop sign) and will alert them to slow-down if their speed exceeds the legal limit by a threshold (e.g. 3 mph). For pedestrians, both streets and walking paths/alleys are considered for finding the shortest path to the destination.

The Assistant will be able to provide directions to the destination depending on the user's current location, inside or outside. GPS will be used to identify the current location outside buildings. User location inside buildings will be derived from user context. The system computes the shortest path to the destination building first and refines the path when getting closer to the destination building. Then, directions to the final room destination are provided.

CAMPUS 2020: SMART SPRINKLER SYSTEM

Valentine Aalo and Daniel Raviv, PIs ● Students: Henley Wright, Richard Bagley, Patrick Green and Tsahi Strulovitch

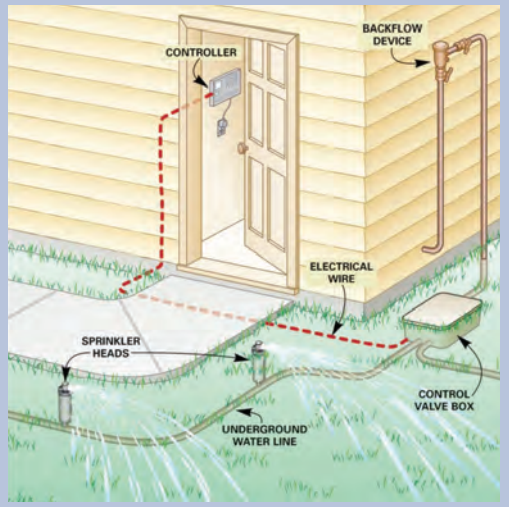
Water conservation is a crucial part of green technology. It is well known that landscape watering consumes more than half of urban water usage, and that landscapes are considerably overwatered. In addition, there is a steady rise in water rates across the country. However, more than just the cost of water usage, an additional cost of overwatering results from property destruction, water runoff, and liabilities. Ordinary irrigation systems typically cannot adjust to changing weather conditions and generally overwaters the landscape, leaving the property owner with high water bills and expensive property damage from foundation damage, soil erosion, mold and premature death of mature trees. The aim of this project is to save money and time by avoiding overwatering.

Three research issues which are envisioned in this project include system (i) data mining – design an algorithm that accurately maps the color-coded radar map to expected amount of rainfall expected at a specified location in a given time interval, (ii) data aggregation – design an algorithm to integrate the information gathered from multiple sources (rain forecast, weather and soil-related sensor measurements, local water-restriction information, and past rain history to decide when and how much to water, and (iii) data communication - communicate the control information via Wi-Fi to the sprinkler system at the location., which is specified by the zip code + 4 digits.

The main objective of this project is to design a commercially viable, smart sprinkler system that can be controlled and monitored via the internet. The final product is expected to save water, time, and energy:

- Cut watering costs by eliminating overwatering
- Increase watering effectiveness using weather data and user feedback
- Easy installation for all systems with minimal to no updates
- Smart device monitoring and adjusting capability via phone and internet
- Increase student knowledge in project design and implementation
- Generate residual income to fund other student projects.

INDUSTRY PARTNER INTERESTED IN THIS PROJECT:
Last Best Chance, LLC



PROJECT 6C

CAMPUS 2020: AUTOMATING SPACE IDENTIFICATION AND RESERVATION

Hari Kalva, PI ● Student: Fracisco Justo

Finding space to park a vehicle can be a time consuming and stressful process on large university campuses and venues such as malls and shopping centers. An ideal solution will provide users with directions to a specific open parking space. Installing networked sensors in each parking space is an expensive process that is difficult to install and maintain. We are developing a multi-sensor based, low cost solution to monitor parking lots and reserve parking spaces. Cameras will be used to monitor large parking lots and image and video processing based solutions are being developed to detect empty parking spaces as well as monitor occupancy and occupancy rates of parking lots. Sensors such as RFIDs, GPS, and the mobile phones of users will be explored to achieve the ideal of reserving a specific spot. The end goal of this project is a mobile app that communicates with a parking location service to identify and reserve parking spaces that are closest to a user's final destination.

INDUSTRY PARTNER INTERESTED IN THIS PROJECT:
ILST Technology and Aware Technology

(a) Original image (b) Processed image with occupied and empty space detection

CAMPUS 2020: SMART SPEED REDUCTION SYSTEM

Daniel Raviv and Valentine Aalo, PIs ● Students: Roger Hoskin, Bert Adams, Richard Mejia, Anthony Radzins, and Csaba Pek

Speed bumps and speed humps are commonly used "traffic calming" measures, which are usually made from asphalt that is up to six inches high and three feet wide. Such rigid speed bumps are "dumb" and do not respond to the traffic density, vehicular speed, and emergency scenarios. Many traffic fatalities have been attributed to rigid speed bumps. They can cause vehicle damage and contribute to pollution. As part of the Campus 2020 project, the smart speed reducer project is aimed to encourage drivers to drive at or below speed-limit on the university campus. We propose to design a speed bump that adjusts its "bump" according to the measured speed of the driver; it should flatten if the measure speed is at or below speed limit and rises if the vehicle speed exceeds the limit. Thus, the device rewards drivers who drive the speed limit and discourages those who do not. The technical issues involved in designing the intelligent speed reduction device include speed detection, speed bump mechanism, and assurance of system reliability.

INDUSTRY PARTNER INTERESTED IN THIS PROJECT:
Last Best Chance, LLC

NEW TECHNIQUES FOR WEB-BASED APPLICATIONS

Shihong Huang PI ● Students: Rowan Hughes and Eric Cho

The project investigates the existing and new technologies of various Web-based applications, and implements and deploys projects to customers. Over the past four years, in this project we implemented and deployed more than 15 Web applications to customer sites. These projects include: Legacy Web applications maintenance and evolution, Internet Transaction Processing, report generations from different databases (e.g., Crystal Report), migrating existing applications to Service Oriented Architecture (SOA), developing and enhancing web-based application services, application analysis and manipulation, reporting of business data, applications using OpenEdge, Progress, VB.Net, and Silverlight platforms, and evolving a client-server Epicor desktop application.

SALES HISTORY PROGRAM

Analyzing the profitability of a company is a very important task for company managers and financial analyzers. However, sometimes is difficult to find out where the profit is coming from and how each product is performing. In this project, we developed a system to monitor and analyze customer's revenue and generate quarterly financial reports.

The Sales History program has been developed in Silverlight and provides detailed data on the sales history over fiscal periods or over a specified period of time. The application allows the ability to "drill-in" and get specific information about where revenue is coming from and sale reports on products and sales representatives.

EPICOR MENU CUSTOMIZATIONS

Epicor is an extensive Enterprise Resource Planning (ERP) system software for businesses in the manufacturing, distribution, and retail and services industries. Epicor, being a 20+ years old program, is extremely large and encompasses the majority of the business process for its users. In this project, we created software modification and customization, so that the Epicor ERP can more closely suit the

specific needs for Pronto Progress clients.

Customizations include:

- Custom Entry form for Company specific Method of Manufacturing procedure, and
- User Interface to utilize customized functionality.

INDUSTRY PARTNER INTERESTED IN THIS PROJECT:
Pronto Progress

Report from Sales History Program

PROJECT 8

DEVELOPING MACHINE LEARNING ALGORITHMS ON HPCC/ECL PLATFORM

Taghi M. Khoshgoftaar, PI ● Student: Victor Herrera

From bioinformatics to social computing to document mining, whole new research areas exist today which were not possible even 20 years ago. This research demands large-scale systems to both manage and process huge quantities of data. Many traditional approaches fail when dealing with multi-gigabyte datasets, preventing researchers and practitioners from fully benefiting from the data.

The High Performance Cluster Computing (HPCC) architecture, which was developed in conjunction with the ECL programming language, is LexisNexis's answer to this challenge. This system has two essential functions for working with Big Data: HPCC is a cluster backend which stores and manages large quantities of data, making it accessible to the user in a timely manner, and ECL is the language which allows the user to perform queries on the data in question. One area where the HPCC platform is not yet fully mature, however, is the domain of machine learning (ML). Although HPCC includes some basic ML modules, many of the most commonly-used approaches in the field have yet to be implemented. The project objective is to extend ECL/HPCC to perform classification and regression using a wider range of ML algorithms. Further, we will implement our own algorithms in ECL, to make them widely available for a larger user base. With these additions, the HPCC/ECL platform will be fully prepared to take on the challenges posed by Big Data and permit a new scale of research.

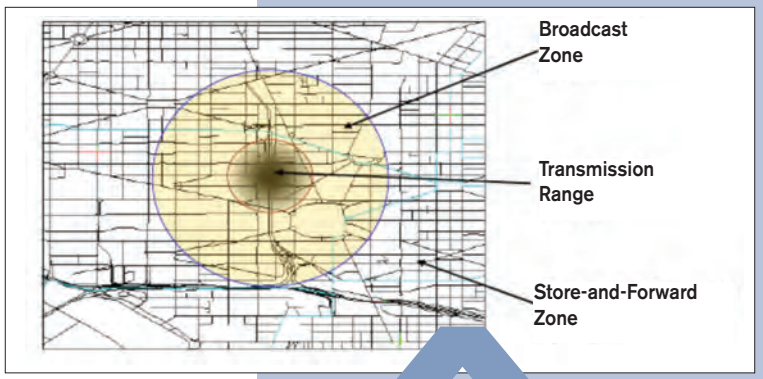
INDUSTRY PARTNER INTERESTED IN THIS PROJECT:
LexisNexis

PROJECT 9

HYBRID DATA DISSEMINATION IN VANET

Imad Mahgoub, PI
Student: Monika Rathod

Data dissemination in Vehicular Ad hoc NETworks (VANETs) is a key research area with applications that range from safety to traffic flow information to weather reports and related information. Delivering data with maximum efficiency and accuracy to a wide area is the focus of research in data dissemination protocols. Data propagation methods preferred for these specialized ad hoc networks fall under two mutually exclusive categories namely store-and-forward and multi-hop broadcasts. Store-and-forward generally consumes less bandwidth than multi-hop broadcast but propagates information more slowly. The goal of this project is to develop efficient solutions to the data dissemination problem that are broader in scope than previous works and are able to handle all types of data, both critical and non-critical. The research includes hybridization of ad-hoc communications by intelligently defining geographic zones in which multi-hop broadcast and store-and-forward dissemination are preferable, thus combining strengths of the two schemes and eliminating their weaknesses.



Hybrid data dissemination. The inner circle is the one-hop communication range and the outer circle designates the broadcast region. Outside the circles data is propagated via store-and-forward"

INDUSTRY PARTNER INTERESTED IN THIS PROJECT:
Tecore Networks

PROJECT 10

SELECTIVE BLOCKING OF CELLULAR COMMUNICATION

Imad Mahgoub, PI ● Student: Hamid Akbarian

Unauthorized use of cellular communication can put people's safety at risk as in illegal use of cell phones in prisons.

Illegal use of cellular communication in prisons

TEXTING WHILE DRIVING

It can also cause distractions, which maybe fatal as in the case of texting while driving. The goal is to research cost-effective solutions for selective blocking of cellular communication (voice and data) in a specific area where only authorized users can send or receive voice and data. The solutions have to cater to the different exisiting voice and data protocols and needs to address relevant legal and privacy issues.

INDUSTRY PARTNER INTERESTED IN THIS PROJECT:
Tecore Networks

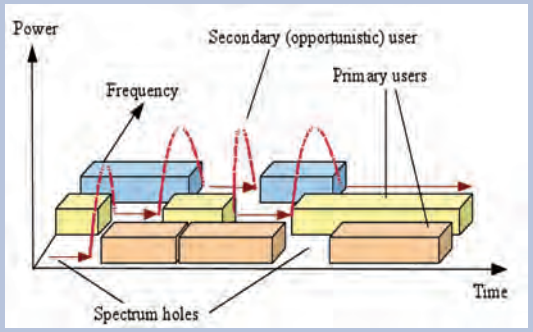
PROJECT 11

COMMUNICATION FRAMEWORK IN COGNITIVE RADIO NETWORKS

Mihaela Cardei, PI

The radio spectrum is a finite resource, which is now in great demand with the proliferation of new applications and services such as cellular phones, radio and television broadcast, Wi-Fi, sensor networks, broadband wireless Internet access, and so on. Large portions of the U.S. licensed spectrum are underutilized. To address the issue of spectrum scarcity, new communication paradigms have been proposed.

Cognitive radio has emerged as a promising technology to improve the overall spectrum usage by opportunistically allowing secondary users to utilize unused licensed bands, referred to as spectrum holes, while protecting the primary users' communication. Cognitive radio networks have cognitive and reconfigurable properties and the capability to detect unoccupied spectrum holes and change frequency for end-to-end communication. This project is aiming to design a communication framework that allows secondary users to communicate using the licensed spectrum, without disturbing the primary users' communication. To accomplish this, a learning-based network management approach will be investigated for network resource management. The proposed framework will improve spectrum utilization and prevent against intentional jamming.



INDUSTRY PARTNER INTERESTED IN THIS PROJECT:
Tecore Networks

DESIGN-SPACE ORIENTED CROSS-LAYER OPTIMIZATION FOR MOBILE INTERNET APPLICATIONS

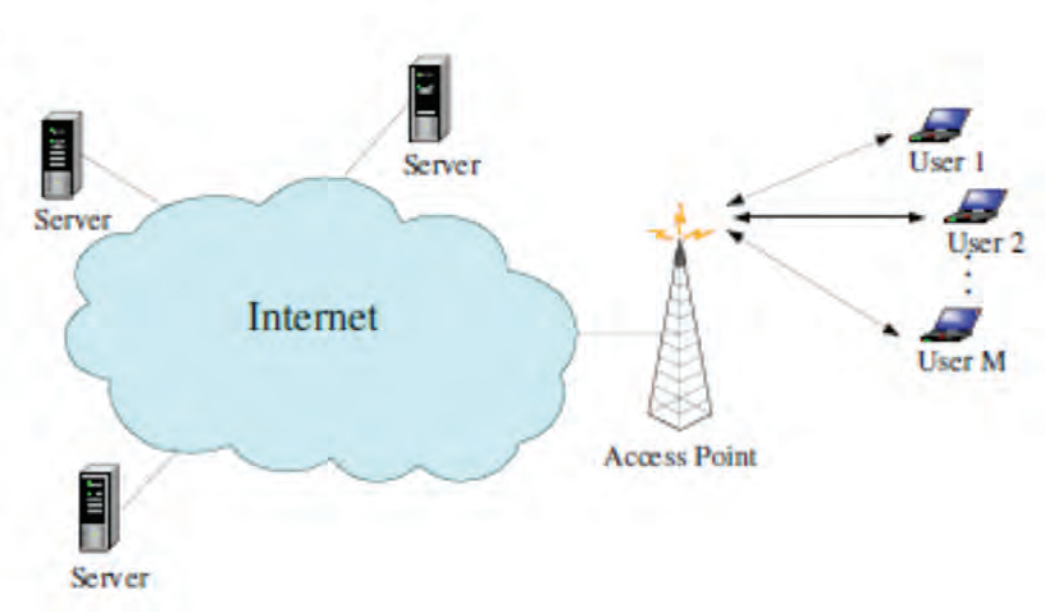
Xin Wang, PI

Most of the practical network protocols were designed based on sound yet ad-hoc heuristics. They have performed reasonably well as the Internet scaled up by six orders of magnitude. With the Internet continuing to grow, current protocols need to be re-engineered and optimized for emerging mobile applications.

Both engineering heuristics and optimization-theoretic approaches were recently employed to enhance/re-engineer the existing network protocols. The resultant schemes, however, either cannot provide analytical performance guarantees, or are difficult to be deployed with the current Internet infrastructure. To fill the gap, this project aims to developing a systematic approach to design and analysis of readily deployable, scalable, yet optimal network schemes for mobile Internet applications. As core of the Internet protocols, the TCP performs window-based congestion control for competing data flows. Adopting queueing delay as the congestion measure, we reveal that TCP window-control mechanism amounts to implicit updates of source rates as “primal variables” and queueing delays as “Lagrange dual variables” from optimization-theoretic perspective. Confining to the design space of Internet, we then envision that the keys to cross-layer Internet optimization are development of non-standard window-control oriented implicit primal-dual solvers for underlying utility maximization problems, and design of jointly optimal network protocols as decomposition of such solvers.

Capitalizing on this original idea, we consider an Internet with wired backbone and a single access point that provides one-hop communications for mobile devices to access Internet. The proposed research will bridge the gap between the current network optimization theory and practical Internet designs, and is expected to benefit directly applications to next-generation Internet protocols and designs.

In an even broader sense, the proposed high-performance network schemes for mobile Internet applications will have an impact on society, if one takes into account how the Internet and wireless devices are expected to transcend various aspects of our everyday life.



INDUSTRY PARTNER INTERESTED IN THIS PROJECT:
Tecore Networks

SMARTPHONE COGNITIVE NETWORKING FOR RAPID RESPONSE

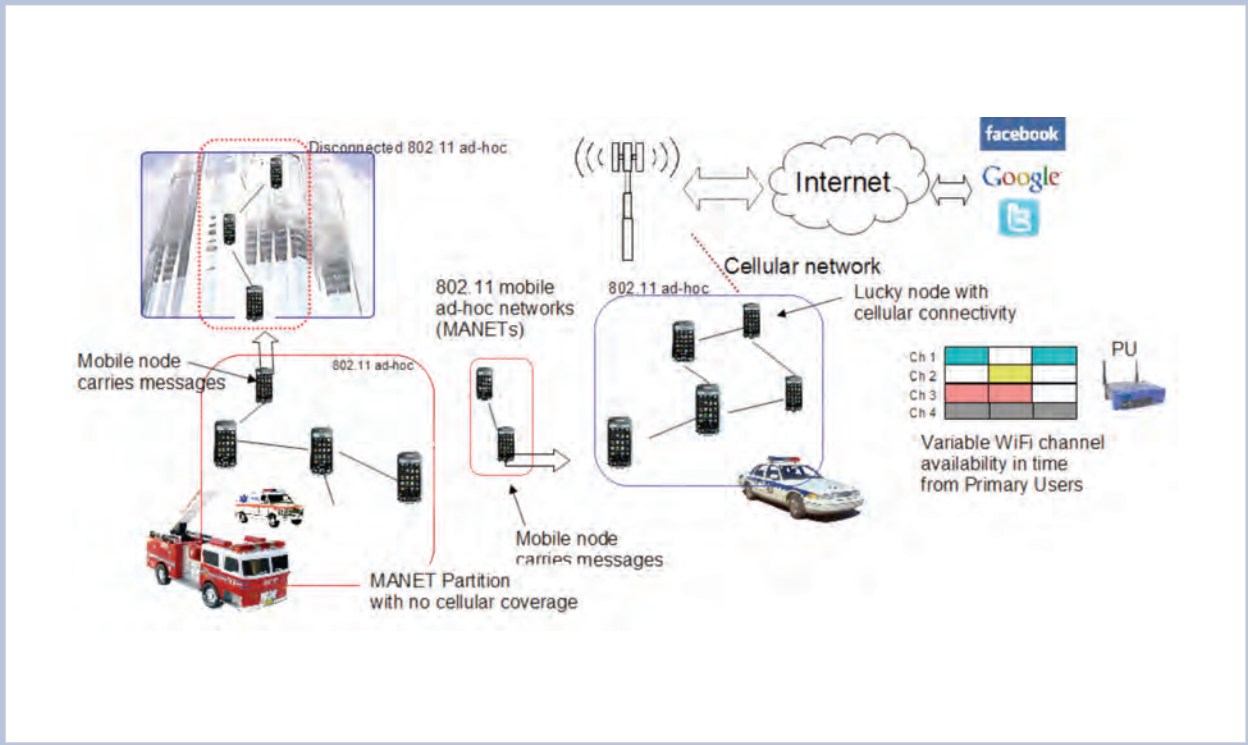
Ionut Cardei, PI

Rapid response teams have to deal with unpredictable RF conditions, sketchy spectrum availability, and system incompatibility. Collapsed buildings and damaged subway tunnels degrade signal quality inside.

Power outages affecting cellular base stations are common after earthquakes and weather disasters.

Ubiquitous smartphones with IEEE 802.11 adapters and GPS localization provide a powerful platform for opportunistic communication in difficult environments. Smartphones with IEEE 802.11 adapters configured in ad-hoc mode can form a wireless network that does not need any infrastructure to communicate end-to-end using multi-hop routes. Still, TCP/IP protocols only work if there is a continuously available path between endpoints. With intermittent connectivity, traditional IP MANET routing and transport protocols inevitably fail. The solution is to use Delay Tolerant Networking (DTN) techniques that can tolerate intermittent lack of end-to-end connectivity by storing and carrying messages. This project develops DTN protocols for rapid response applications that has 802.11 ad-hoc networks self-organize and deliver packets end-to-end when the network topology is dynamic from node mobility and sporadic link availability. The protocols rely on cognitive networking techniques. Channel allocation is aware of availability from primary users (access points), and usage policies in order to prevent interference and to satisfy message quality of service. Message forwarding is scheduled based on contextual information derived from the user's mission plan and resource availability. Conversely, the mission plan and node trajectory of some nodes is adjusted to serve communication demands using message ferrying.

These technologies will improve the effectiveness of communications for emergency response and for other ad-hoc scenarios using readily available smartphones when circumstances prohibit use of cellular or specialized government radio systems.



INDUSTRY PARTNER INTERESTED IN THIS PROJECT:
Tecore Networks

EFFECT OF INTERFERENCE IN RELAY-ASSISTED CELLULAR NETWORKS

Valentine A. Aalo, PI ● Student: Constatntine Mukasa

Motivated by the increasing demand for higher data rate, broader coverage, and lower infrastructure cost in wireless systems, a major effort is being made to study the use of relay stations in wireless networks. Base stations require considerable infrastructure cost whereas relays require very low-cost, operate at low power, and have no connection to wired infrastructure. Thus, the use of multi-hop relaying can provide considerable performance improvement to a wireless network through coverage enhancement, range extension and capacity enhancement, at relatively low cost to the service provider. Studies have shown that that use of relaying technology is a reliable way to improve the performance through cooperative diversity and extend the coverage of many wireless communication systems. The performance of a multi-hop relaying system with amplify-and-forward (AF) transmission in which the transmitted signal propagates through cascaded nodes, with each node amplifying and forwarding the received signal from the previous node to the next node, is sometimes of interest. Figure 1 shows a relay-assisted cellular network. However, in practice impairments such as co-channel interference (see figure 2) is inevitable due to aggressive frequency reuse employed in cellular networks to obtain high spectral utilization.

The effect of interference on the performance of multi-hop relay networks has not been studied extensively in the literature. In this work, we develop an analytical tool to study the performance of a multi-hop transmission

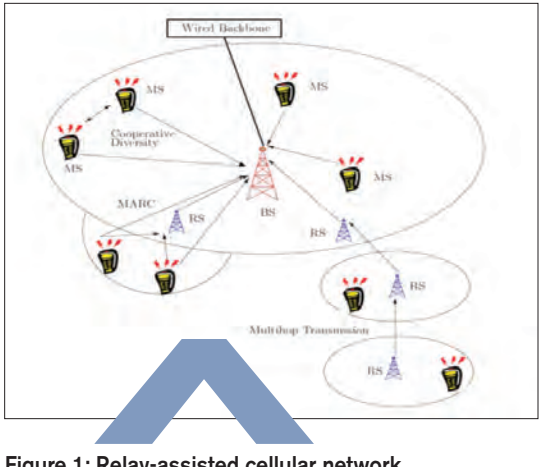


Figure 1: Relay-assisted cellular network

INDUSTRY PARTNER INTERESTED IN THIS PROJECT:
Tecore Networks

system with AF relays operating in a generalized fading environment in the presence of co-channel interference and thermal noise. We assume that the transmitting terminals in a wireless network are distributed in a plane according to a homogeneous Poisson Point Process (PPP). The statistical characteristics of the aggregate interference power at each relay node depends on the statistics of the individual signals, the randomness of which depends on such system characteristics as propagation effects, location of interferer, mobility patterns, and user activity. When the interfering signals sum incoherently, then the aggregate interference can be modeled as a shot noise process whose distribution follows an *a*-stable distribution under certain conditions. Based on this interference model, we derive the performance of a multi-hop relay network in the presence of thermal noise and interference in a generalized fading environment. The main objective of this work is to quantify the effect of interference on the performance of multi-hop relay networks. To this end, we derive the statistics of the end-to-end signal-to-interference-and-noise ratio (SINR) and several performance metrics in the presence of cochannel interference. Specifically, our goal is to achieve the following: (i) develop a statistical framework to characterize the statistics of a multi-hop relay transmission system in

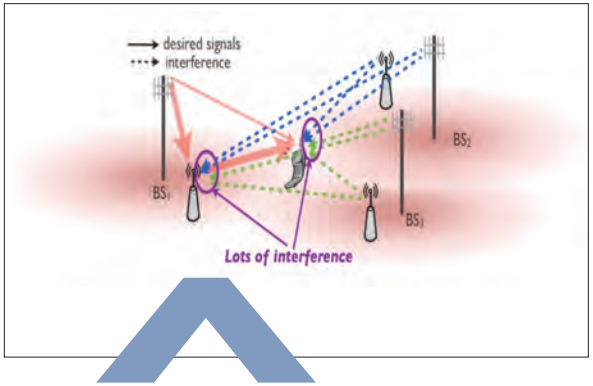


Figure 2: Interference in a relay network

which the relays employ the amplify-and-forward protocol and are located in a series network, (ii) derive closed-form expressions for relevant performance metrics in the presence of interference and noise in a fading environment, (iii) explore ways to cancel or mitigate the detrimental effect interference on system performance and (iv) validate the analytical results with extensive computer

PROJECT 15

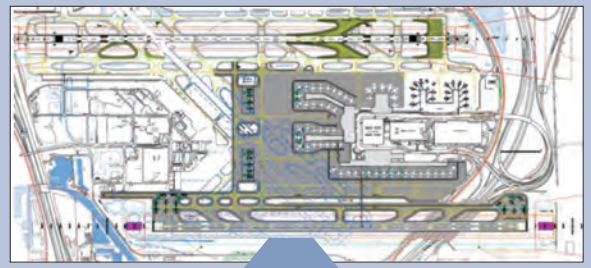
Fort Lauderdale-Hollywood International Airport, current aerial view

DESIGN OF AIRPORT ELECTRICAL SYSTEMS

Maria M. Larrondo Petrie, PI ● Student: Rosana Melendez

Renovation and expansion of transportation systems require minimization of disruption of service while incorporating best practices and cutting-edge technology to minimize energy consumption. The objective of this project is to analyze, model and document alternative designs and technologies that impact the efficiency of electrical systems used in airports with the goal of attaining maximum LEED certification for new airport constructions and expansions. A case study will focus on the proposed new International Concourse for the Fort Lauderdale-Hollywood International Airport expansion, projected to have 6 new gates for international flights. The research of design alternatives and efficiency maximization of the electrical systems will include alternative technologies such as LED for lighting and photovoltaic systems for fire alarms, to enable increased availability of normal, emergency and life safety power while maintaining service to the existing terminals.

The design analysis will include eleven major systems that require power, including control of lighting, conveyance, temperature, baggage handling, telecommunications, fire alarms and other security systems for emergency and life safety loads. The first phase of the research will focus on alternative designs for a photovoltaic system and analysis and verification that the design meets the systems requirements specified by the Transportation Security Administration and the Broward County Aviation Department.



Proposed Fort Lauderdale-Hollywood International Airport expansion

INDUSTRY PARTNER INTERESTED IN THIS PROJECT:
Hillers Electrical Engineering

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FAU Receives NSF Grant to Create Industry/University Cooperative Research Center for Advanced Knowledge Enablement

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Affiliation with and membership to FAU's CAKE is open to industry, government agencies and others with research needs. The center will provide its partners with numerous benefits including early access to research innovations, and opportunities to interact and work with faculty, students and industry peers. It addition, the center provides a platform to leverage research and development investments with multi-university centers renowned for their innovative research capabilities. There are currently 50 NSF-sponsored industry/university cooperative research centers in the U.S.

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REUTERS

FAU Receives NSF Grant to Create Industry/University Cooperative Research Center for Advanced Knowledge Enablement

BOCA RATON, Fla., Sept. 18 /PRNewswire-USNewswire/ -- Florida Atlantic University's department of computer and electrical engineering and computer science in the College of Engineering and Computer Science joins
International University (FIU) as one of only nine National Scie
(NSF) supported centers in the U.S. and one of two in the state
the area of information technology, communication and computing.
received a five-year grant from the NSF to create a site for the
Advanced Knowledge Enablement (CAKE) to provide a framework for
between university faculty and industry to pursue advanced resea
fields. Research that will be carried out by CAKE will fortify
science and technology and provide new capacity for economic pro
main objective of CAKE is to develop long-term partnerships amo
academia and government, and will feature high-quality industry
strong industrial support and collaboration in research and educ
direct transfer of university developed ideas, research, and te
U.S. industry. FAU's center will operate jointly with the FIU ce
last year.

"This is a win-win situation for both our university, and our in
government partners," said Dr. Borko Furht, chair, department o
electrical engineering and director of CAKE at FAU. "This grant
with the opportunity to conduct industrially relevant research,
additional seed funding, and moreover, benefit from the recognition and
prestige of being an NSF research center."

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PR NEWSWIRE 2 WEEKS AGO

FAU Receives NSF Grant to Create Industry/University Cooperative Research Center for Advanced Knowledge Enablement

BOCA RATON, Fla. , Sept. 18 /PRNewswire-USNewswire/ -- **Florida Atlantic University**'s department of computer and electrical engineering and computer science in the College of Engineering and Computer Science joins Florida International University (FIU)...

FULL ARTICLE AT PR NEWSWIRE

FAU

DEPARTMENT OF COMPUTER & ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

College of Engineering & Computer Science
Florida Atlantic University

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