2013 Passive Wireless Sensor Workshop

Sponsored by ISA Communications Division Symposium

May 21-22, 2013

Melrose Hotel, Georgetown, Washington, DC

Chairman: Dr. Don Malocha/Univ of Central Florida donald.malocha@ucf.edu
Sponsor: ISA/Rodney Jones - Comm Division/Peter Fuhr, Ian Verhappen, Penny Chen

Purpose: To bring Passive Wireless Sensor(PWS) technology developers, manufacturers and potential industry end-users together to understand the larger market drivers that will drive costs down and applications up. We will also discuss logical next steps.

Objectives:

1. Understand various PWST technologies, actual & potential uses, and maturity.
2. Assess the future applications/advantages/limitations in various industries.
3. Assess what is needed for high volume production, standardization & communication.
4. Precipitate individual and group "next step" thinking to further develop/apply PWSTs.
5. Accumulate contacts for potential partnering activities(2012 PWST W-shop Summary)
6. Accumulate library of PWS Workshop Publicly Released Presentations - see ISA website

Who Should Attend:

- Industries and Government programs that could use a lot of cheap wireless sensors
- Sensor System, Surface Acoustic Wave(SAW) and Passive Wireless Sensor Developers
- Academic Institutions and Researchers
- Investors

Registration Website:
http://www.isa.org/MSTemplate.cfm?Section=Passive_Wireless_Sensor_Workshop&Site=Computer_Tech__Division&Template=/ContentManagement/MSContentDisplay.cfm&ContentID=92282

Registration: On-line or Printable Form:
http://www.isa.org/MSTemplate.cfm?Section=PWSW_2013&Site=Computer_Tech__Division&Template=/ContentManagement/MSContentDisplay.cfm&ContentID=92974

Summary of Previous (2011 & 2012) PWST Workshop Presentations:
http://www.isa.org/Content/Microsites530/Computer_Tech__Division/Home528/Passive_Wireless_Sensor_Workshop/PWSTPresentationSummaryGeorgeStudor.pdf

2013 PWS Workshop Description

The workshop will explore the current state of technology of passive wireless sensors tags (PWST) and their practical applications. As a quick background, a PWST has no battery, no expensive electronics at the sensor site and (of course) no need for a wired connection between the sensor and the data acquisition system. Passive Wireless Sensors could be useful at short or long range, mobile platforms or fixed, simply printed for shirt-sleeve environment or sophisticated for high performance and extreme environments. Surface Acoustic Wave(SAW)-based sensors, in a manner somewhat similar to a classic passive RFID tag, responds to a wireless interrogation signal from a reader, but unlike RFID it provides real-time sensor data along with its unique tag id, stored information and range. As time goes on, more interrogation methods are being discovered while the others are being matured. PWSTs should aspire to be manufactured in high volume – even incorporating direct write fabrication - resulting in an inexpensive devices. With its considerable potential read-range (separation distance between reader and device), compatibility with extreme environments, small size, autonomy of sensor installation, and "no onboard power" capabilities, PWSs have a wider application arena than traditional wireless sensors. Enabling technologies such as new manufacturing, materials, antennas and interrogators are encouraged to be brought forward. The workshop will explore these and other motivations for using PWSTs in a variety of fields, present and demonstrate current technologies, explore current and future applications of PWSTs in various industries (commercial buildings, industrial settings, transportation, aerospace, etc.). A key component of this two-day PWST Workshop is to facilitate discussions between end users and developers/suppliers on application areas of mutual interest.

Chairman, Don Malocha
Univ of Central Florida

Passive Wireless Sensor Workshop
Volunteers

Hossein Roufarshbaf
Research Assist Prof.
George Mason Univ

Maice Costa
E&CE Student
Univ of Maryland

Agenda - 2013 Passive Wireless Sensor Workshop - May 21 and 22

Session 1 - May 21 - Note: Remote Presentations highlighted in light blue					
1	8:00am - 8:15am	Univ of Central Florida	Workshop Introduction	Don	Malocha
2	8:15am - 9:00am	NASA/JSC-ES	Vision/PWS Workshop-SHM	George	Studor
3	9:00am - 9:30am	Canadian NRC - IVHM	Aerospace IVHM-DPHM	Prakash	Patnaik
4	9:30am - 10:00am	NAVAIR - TDA, Inc.	Rotorcraft Metal-rich Zones	Nagaraja	Iyyer
10:00am-10:15am Break					
Session 2 - May 21					
1	10:15am-10:45am	DOEOak Ridge Nat Lab	Low Cost Wireless Research	Wayne	Manges
2	10:45am- 11:15am	DOE/EERE Blg Tech Off	Low Cost Meter Challenge	Jason	Koman
3	11:15am -12:00pm	On-Ramp Wireless Inc.	Connecting Anything/ M2M	Ted	Myers
12:00pm - 1:00pm Lunch					
Session 3 - May 21					
1	1:00pm - 1:30pm	Rahrig Pacific Company	Environmental Service Tech	Joe	Delaney
2	1:30pm - 2:00pm	Rahrig Pacific Company	Supply Chain Solutions	Kaley	Parkinson
3	2:00pm - 2:30pm	TMI USA, Inc	Expanding Data Logger Use	Chris	Hough
4	2:30pm - 3:00pm	Tufts University	Micro UAV Platforms	Usman	Khan
3:00pm - 3:15am Break					
Session 4 - May 21					
1	3:15pm - 3:45pm	GE Global Research	Multi-Variable Sensors	Radislav	Potyrailo
2	3:45pm - 4:15pm	RF Micron Inc.	Self Tuning RFID	Shahriar	Rokhsaz
3	4:15pm - 4:45pm	Univ of Louisville	Physical Switch Sensors	Cindy	Hartnett
4	4:45pm - 5:00pm	Univ of Central Florida	Day 2 Planning/Wrap-up	Don	Malocha
Session 5 - May 22					
1	8:00am - 9:00am	Univ of Central Florida	PWS Technology	Don	Malocha
2	9:00am - 9:30am	ASR&D Corp	PWST SAW Sensor Systems	Jackie	Hines
3	9:30am - 10:00am	TriQuint Semi.	Bulk Acoustic Wave Sensors	Josh	Zepess
10:00am - 10:15am Break					
Session 6 - May 22					
1	10:15am - 10:45am	GVR Trade SA	UltraWBSAW Sensors&Tags	Victor	Plessky
2	10:45am - 11:15am	Univ of Maine	Smart Interrogators	Ali	Abedi
3	11:15am - 11:45am	Gentag, Inc.	Near Field Comm. Sensors	John	Peeters
4	11:45am - 12:00am	CPIAC-JohnsHopkins U	JANNAF Sensor Database	Nick	Keim
12:00am - 1:00pm Lunch					
Session 7 - May 22					
1	1:00pm - 1:45pm	Hydro-Technologies	Passive Sensing thru Metal	Corey	Jaskolski
2	1:45pm - 2:15pm	3Phoenix	Survivable Machinery Cntrl	Pat	Jordan
	2:15pm - 2:30pm	Wrap-up/1-on-1 Plan	Discuss 1-on-1, Feedback	Don	Malocha
2:30pm - 3:00pm Break - Room Arrange For One-on-One Sessions					
Session 8 - May 22					
	3:00pm - 5:00pm	One-on-One Sessions	1-on-1 Scheduled User-Developer discussions and demonstrations (Developers Signup for 15min blocks of time on User Schedules)		

2013 Passive Wireless Sensor Technology Workshop
Introduction

- **Passive Wireless Sensors are just one of the options in the "Tool Box" for reducing dependency on wired connectivity and adding functionality without wires or cables.**
- **PWS Technologies address common needs of NASA, other agencies and other industries.**
- **There are many types of Passive Wireless Sensors to investigate and compare with others.**
- **PWST Functionality, with no wire to the data acquisition system, or battery at the sensor:**
  - **IDs that are uniquely separable from many, perhaps hundreds of other tags.**
  - **Stored Info that can be retrieved and changed with remote/non-contact means.**
  - **Location/Range information**
  - **Real-time Sensor/State information**
- **Cost motivations:**
  - **Initial Purchases - Unique vs Standards**
  - **Integration, Modularity**
  - **Life-cycle Maintenance and End-of-Life**
  - **Sensor Data saves in other areas: operations, systems, anomalies, safety**
- **Added value when embedded during Manufacturing and Fabrication processes.**
- **Power-scavenging, if practical, can add benefits…avoid cost/restrictions of battery charging**
  - **Data Logging, Remote and Hazardous Operations, Event Monitoring/Reporting**
  - **Secure Communications, Longer Range Communications**
  - **Continuous Operations and Transmissions – if the scavenge source is consistent**
- **What will we be doing at this workshop?**
  - **Internalize the vision and the fundamentals of the technology**
  - **Learn about some of the specific technologies and the providers**
  - **Learn about some of the Industry needs**
  - **Learn about some next-step areas - new devices, manufacturing, communication…**
  - **Meet the Presenter opportunities during the breaks, lunch, dinner or ad-hoc.**
  - **Discuss Key Forward Planning topics/suggestions with the organizers**
  - **Plan to meet again and distribute workshop results on-line**
- **Workshop Premise:**
  - **Our organizations need to be able to take advantage of new technology…how?**
  - **Others are developing and using technology related to or the same as we want.**
  - **There is a lot of important development going on that we should know about.**
  - **We need more efficient ways to keep up with new technology.**
  - **Technology developers need to know what problems need solving.**
  - **"Out of the Box" thinking needs to move from gadget to System Engineering level.**
  - **Combined Business Cases in multiple industries may enable larger scale production.**
  - **Need to cross the walls between Industries, Government organizations and countries**
  - **Communication is the key - let's work at it!**

8:15AM, May 21 - Day 1 **Session 1 Presentation 2**

George Studor

"Passive Wireless Sensor Technology Summary"

george.f.studor@nasa.gov **NASA/Johnson Space Center, Houston, TX**

763-208-9283. 281-415-3987c **Structural Engineering Division**

Background: George Studor is a senior project engineer for technology applications the Structural Engineering Division at NASA's Johnson Space Center. His current focus is on Modular In-Space Wireless Structural Health Monitoring and Inspection Systems. He has lead NASA's Wireless Avionics Community of Practice since 2008. He was chair of the ISA Passive Wireless Sensor Technology Workshop in July 2011 and June 2012 and led a NASA In-Space Inspection Technology Workshop in Feb 2012. George initiated a large number of add-on stand-alone wireless instrumentation systems on Space Shuttle missions, and from those lessons learned, advocates change in aerospace vehicle architectures to enable reduced wires and connectors through "Fly-by-Wireless". George is chairman of the recently established International Council on System Engineering (INCOSE) Natural Systems Working Group, which seeks to include natural systems in standard system engineering practices. His BS/MS degrees are in Astronautical Engineering.

Abstract: Application of Wireless Technology to Aerospace Vehicles can have a number of advantages, but the perception the vulnerability of a single wireless link thwarts system engineering and accurate reliability analyses. Three elements to Fly-by-Wireless are essential: 1) A tool-box of alternatives to standard wiring and sensing, 2) Architectural provisions to all the alternatives to be applied, 3) Management direction and motivations to drive a change in the state-of-the-art. Although smart wireless sensor nodes and networks are coming into maturity, the cost per measurement point is still high and functionality somewhat limited - only applications that have extreme cost, schedule or physical difficulty can afford this solution. **Passive Wireless Sensors**, which do not need power source or wires at the sensor have the potential to provide extremely useful functional and performance benefits to aerospace vehicles, ground operations and test facilities at low cost. Typically, the test, flight test and operational health monitoring of structures, mechanical and thermal conditions of an aerospace vehicle make up a large percentage of the measurements desired, but the requested measurements are rarely fully implemented. By leveraging the similar benefits in other industries with much higher volume applications, aerospace structures can have a mutually beneficial relationship with them - bridging technical gaps and industry bridging cost needs. It is for this reason that George Studor began a series of Passive Wireless Sensor Workshops. **George will present a Vision overview and summaries of the 2011 and 2012 presentations.**

9:00am, May 21- Day 1 **Session 1 Presentation 3**

Dr. Prakash Patnaik

"Sensor Applications to IVHM in Aerospace Systems"

prakash.patnaik@nrc-cnrc.gc.ca **National Research Council(NRC) Aerospace**
613-991-6915 **Principal Research Scientist Lead-Air Defence System Program, Ottawa, CA**

Background: Dr Prakash Patnaik, Principal Research Scientist, Aerospace Defence Science & Technology, NRC Aerospace at the National Research Council Canada, a Canadian Government Agency. He is also serving as the NRC Chief Scientist Aerospace in the Defence R&D Canada. Prakash received his bachelor's degree in Metallurgical Engineering from NIT Rourkela, India, and Masters in Engineering from IIT Kharagpur and Ph.D. in Materials Science & Engineering from McMaster University in Canada in 1984. After spending 2 years at NRC's National Aeronautical Establishment as a Visiting Scientist, he moved to industry serving Orenda//Magellan Aerospace Corporation for 16 years. He then returned back to NRC in 2002 as Chief of Aerospace Materials and in 2006 became the Director of the Structures & Materials Performance laboratory. He is a fellow of the American Society for Materials International (1998), a distinguished Canada Council Lecturer in 2001 and a winner of the MacDonald Young Award in 2003 and Morris Cohen Award from CIM in 2005.

Prakash is a member of the Applied Vehicle Technology (AVT) Panel of NATO- Science & Technology Agency(STA) located in Paris. For his contribution to NATO Research & Development, Prakash received the NATO Panel Excellence award by Major General Albert Husniaux in 2012. He has received much other recognition in Canada and the United States for his contributions to Aerospace Research & Development, the most recent being the Fellow of the Canadian Academy of Engineering.

Abstract: NRC Aerospace has been developing different components of IVHM for last 5 years including SHM of Aerostructures and DPHM of Gas Turbines. These components of IVHM are fairly matured now and NRC is currently working towards integrating them into a bigger IVHM program. This paper will present the evolution of SHM and DPHM at NRC Aerospace and provided a number of key technology areas and will present a plan for integration. Application of various sensors and their limitation will be discussed. It was noted that a challenge for Wi-SHM is the current lack of wide-spread implementation of wired SHM systems. Defining benefits for Wi-SHM therefore requires that SHM benefits first be more broadly accepted by end-user communities. It has also been identified that creation of a protocol for wireless sensor specifications for consistent comparison of sensor performance, specifically dynamic response and range and under various environmental conditions. Separate protocols may be required for aircraft structural, spacecraft and engine environments. Separate protocols may also be required for different classes of sensors – Strain, Temperature, Pressure, Vibration, crack detection and growth monitoring, emissions etc.

9:30am, May 21 - Day 1 **Session 1 Presentation 4**

Nagaraja Iyyer
niyyer@tda-i.com
703 226 4070

" Exploring Passive RFID System in Metal Rich Environments Application to Rotorcraft Dynamic Component Tracking"

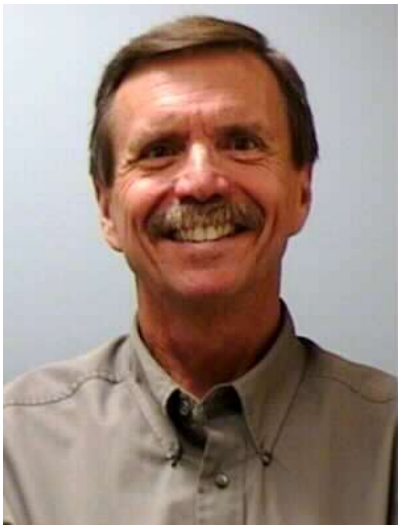
Technical Data Analysis, Inc, Director of Eng http://www.tda-i.com

Biography: Dr. Nagaraja Iyyer is Director of Engineering at Technical Data Analysis, Inc. (TDA) Falls Church, VA office. He has over 25 years of experience in aircraft structures engineering and application program development. The majority of his experience has been supporting the US Navy in its aircraft structural life surveillance and service life assessment and extension programs of various aircraft.. He is a principal investigator on many research projects with U.S. Navy. His interests in component fatigue life assessment led to parts and serial number tracking with RFID systems to build reliable component histories. Besides his current interests in RFID systems, he is developing reliable life prediction models for engineers and management, identifying and mitigating age-related problems, and developing new damage detection techniques. Dr. Iyyer has won numerous awards during his career, including the 2006 Naval Air Warfare Center Division's Area Commander's Award for his ground breaking development of a probabilistic risk assessment methodology and metrics to quantify the risk of continued US Navy P-3 flight operations.

Abstract: Over the last three years, TDA developed a framework for the rotorcraft dynamic component structural life tracking. The framework addressed three key important areas in dynamic component life tracking: accurate component tracking, reliable fatigue life assessment using HUMS and other sensor data, and dissemination of required information to stakeholders for decision making via an enterprise Web application. This discussion focuses on component tracking via RFID system to highlight challenges and lessons learned from our experience working with passive RFID system. TDA tested many metal mountable passive tags from different vendors both on and off rotorcraft. We found that the position and placement of the passive RFID tags has a significant impact on their performance, both in terms of energy harvesting from the RF signal and communication reliability. Our main objective was to increase the read range and efficiency in multi tag readability in metal rich environment near the rotor hub.

Research efforts with our University Partners at Missouri University of Science and Technology show that the introduction of special tags with modified impedance can mitigate the negative effects of mutual coupling in RFID systems. Rather than a focus on design improvements or redesign of a tag antenna, we explore techniques to dynamically adjust the scattering properties of the multiple tags to improve the received signal and improve effective communication range. We discuss our current research work on improving the passive tag readability in a complex metal-rich environment by (a) boosting the back-scatter signal from passive tags through beam forming and impedance matching techniques, (b) boosting the back scatter signal from an exciter powering method and (c) developing a smart placement algorithm involving tag and reader-antenna.

10:15AM, May 21 - Day 1	**Session 2 Presentation 1**
Wayne Manges	**"Low Cost Wireless Sensor Network Research at ORNL"**
865-574-8529	**Manager, Oak Ridge National Laboratory Industrial Wireless Program**
mangesww@ornl.gov	**Oak Ridge, TN**



Background: Wayne W. Manges currently directs the Oak Ridge National Laboratory's Industrial Wireless Program focusing on the application of wireless technology to the harsh environments common to industrial automation. Wayne's works extensively with stakeholders in the government and commercial sectors to provide cost-effective wireless technology that reduces energy intensity and improves energy and operational efficiencies. As an ISA Fellow, he focuses primarily in heavy industry, electrical transmission & distribution, and general industrial automation applications. With 34 years at ORNL, Wayne works with steel, paper, petro-chemical and other industries to bring robust, wireless technology to their markets and is committed to the deployment of integrated systems that solve real problems. He has worked on systems from one-of-a-kind uranium enrichment processes, intelligent robotics, manufacturing, and is currently working on the application of his expertise in systems to the development and deployment of intelligent wireless sensors. Wayne holds a B.S. in Education and Chemistry from California University of Pennsylvania, a B.S. in Electrical Engineering from the University of Pittsburgh, an M.S. in Natural Science from the Rensselaer Polytechnic Institute, and an M.S. in E.E. from the University of Tennessee.

Abstract: ORNL is heavily engaged in the development and deployment of wireless sensor networks. Two application areas that currently present opportunities for large-scale deployments are commercial building energy efficiency and environmental monitoring. Greater than 40% of all electricity consumed in the U.S. comes from buildings. Many buildings have very limited installed infrastructure to maintain energy efficient operation. ORNL has demonstrated that wireless sensor networks can enable >60% reduction in energy consumption in buildings. However, many building owners cannot afford to install and maintain sophisticated building automation systems, thus to continuously commission buildings low cost sensor network are needed. The value proposition has been shown with powered wireless networks. Low-cost passive wireless technology can significantly accelerate technology deployment. Global climate change is another area that has been at the forefront for more than a decade. Large-scale ecological observatory networks are being developed on a continental scale. There is keen interest in gathering geospatial time series data to provide ground truth to environmental forecasting models. Opportunities abound for passive sensor networks that can be deployed without the burden of replacing batteries. Finally, a brief summary of some new manufacturing tools and processes for printing sensors and electronics will be provided.

Co-authors are: Wayne Manges, Peter L. Fuhr, T. Kuruganti and T.J. McIntyre.

10:45AM, May 21 - Day 1		**Session 2 Presentation 2**
Jason Koman	**"Low-cost Wireless Meter Challenge"**	**DOE/EERE**
Jason.Koman@ee.doe.gov		**BTO Building Technology Office**
202-287-1578	**http://www1.eere.energy.gov/buildings/commercial/bba_wireless_metering.html**	

Background: Jason Koman began his professional career as an Analyst in former US President Bill Clinton's Climate Change Initiative (CCI). While serving as analyst Jason identified opportunities for emerging building energy efficiency technologies to gain market acceptance through new build and retrofit projects with CCI's partners. After two years, Jason became Director of CCI's Purchasing Alliance for Energy Efficient Building Technologies. In this role he managed all of CCI's relationships with technology manufacturers and interfaced with building owners in order to develop discrete project opportunities between the two. After leaving CCI, Jason studied at the University of California, Berkeley's Goldman School of Public Policy. During that time he consulted on energy-focused projects for the University of California, private consulting firms, the State of California and the Natural Resources Defense Council. He also taught classes in business ethics and green business strategies at the Haas School of Business at the University of California, Berkeley. Jason is currently serving as a Technology Program Specialist in the US Department of Energy's (DOE) Commercial Buildings Office. In this role he helps manage DOE's Commercial Building Energy Alliances, coordinates technology demonstration projects, manages DOE's Commercial Building Technology Challenges and works to integrate the vast array of building efficiency initiatives within the US Government with one another.

Abstract: Following the model of the U.S. Department of Energy's (DOE's) Better Buildings Alliance Rooftop Unit Challenge, DOE's Better Buildings Alliance Technology Solutions Team will soon be issuing the Low-cost Wireless Meter Challenge to industry to produce a cost-effective, wireless metering system capable of electrical energy measurement at various locations in a building and wireless communication to a remote data collection point within the building complex. The primary goal of the program is to catalyze the development of low cost panel-level metering solutions. In developing the specifications for this challenge, DOE considered input from federal agencies and members of the Better Buildings Alliance (BBA). Mr. Koman will discuss the DOE Industry Challenge model, the purpose and goals of the Metering Challenge, the Challenge Specification itself and the next steps and direction of the program.

11:15AM, May 21 - Day 1 **Session 2 Presentation 3**

Ted Myers **"Connecting Anything, a M2M Revolution"** **On-Ramp Wireless, Inc**
Ted.Myers@onrampwireless.com **www.onrampwireless.com**
858 592 6008

Background: Ted is a recognized expert in wireless communication systems and digital signal processing theory. He has a PhD and BS in Electrical Engineering from Virginia Tech and an MS in Electrical Engineering from the University of Maryland at College Park. Ted was a founder of CommASIC, where he developed the WBSP processor and its first application to the 802.11 a/b/g physical layer. Based on this architecture, the resulting chipset was a first-pass success and industry best in cost and power consumption, which led to the acquisition of CommASIC by Freescale Semiconductor. While at Freescale Semiconductor, Ted applied the WBSP processor architecture to various other wireless applications. Earlier in his career he led and/or contributed to numerous other physical layer designs for cellular applications and government satellite systems. Ted is a founder of On-Ramp Wireless and serves on the company's board.

Abstract: The presentation will discuss On-Ramp Wireless recent expansion of capabilities into global machine-to-machine connectivity based on Ultra-link Processing - a wireless sensor and control communications protocol with high capacity and long range capabilities suitable for smart grid and process automation industries. Ultra-Link Processing(tm) is the first wireless system purpose-built to solve the challenges of device monitoring in metro-scale deployments and other challenging radio environments. The technology addresses problems, such as coverage, capacity, robustness, and coexistence that can limit the large-scale deployment of wireless devices. The fundamental development of the ULP technology fills a massive gap in wireless performance; the void between existing communications platforms of higher data rate licensed spectrum cellular systems and free spectrum short-range wireless radio platforms (e.g., 900 MHz Frequency Hopping Spread Spectrum (FHSS), 802.11, 802.15.4) with mesh networking.

The On-Ramp Total Reach Network is the first wireless network designed from the ground up to power wide-area machine-to-machine communication. Other wireless networks including cellular and mesh lack the reach, capacity and scalability of the OTR Network. With -142 dBm receive sensitivity and 172 dB of link-budget, On-Ramp's Total Reach Network can connect anything, and anywhere - even underground. From industries as diverse as electric distribution and asset tracking, to water management and demand response the ecosystem of M2M applications and devices Power by On-Ramp is rapidly growing.

1:00PM, May 21 - Day 1 **Session 3 Presentation 1**

Joe Delaney **"Challenges in Solid Waste Collection Operations"** **Rehrig Pacific Co**
jdelaney@rehrigpacific.com **National Operations Technical Manager, Los Angeles, CA**
315-727-1608 **www.rehrigpacifc.com**

Joe Delaney is the Environmental Services Group National Operations Technology Manager. Joe who holds a bachelors degree in Economics and an associate's degree in Architecture, started his career in the public sector working for the New York City Department of Sanitation while attending NYU Wagner School of Public Administration. Joe moved west where he managed solid waste and recycling operations for three different Californian cities; Pasadena, Beverly Hills, and Santa Monica. Joe is recognized nationally for his expertise in developing volume based rate structures and improving operational efficiency through the implementation of fully automated collection operations in these cities. After almost 20 years working in local government, Joe came to the Rehrig Pacific Company nine years ago, when he started as a municipal manager in the Northeast and Region and began immediately to infuse technology into his municipal deals. First he used bar codes to track container deliveries in Providence, RI and then worked on RFID tags for the City of Toronto. Joe's innovative ideas put a RFID tags in the handle of our carts to protect them from the environment and improve read accuracy rate.

Abstract: Municipalities and waste management companies realize both the challenge and expense of providing waste and recycling planning, collections and processing. They also realize the opportunity to treat a significant portion of waste as a valuable resource and profit center by initiating creative recycling programs for their communities. Economic and environmental factors are pushing all parties involved in the waste management industry to use better technology and implement solutions that will improve customer service, reduce costs, increase revenues and improve sustainability. The waste container is a valuable asset and it can play an important part in an overall solution. The container is an asset that needs to be better managed in order to reduce operational costs, prevent capital loss and increase collection and material revenue streams.

The four key challenges facing the majority of solid waste collection operations today are: 1) the lack of **visibility** of the daily collection operations, 2) accurate service **verification**, 3) the ability to charge the **proper fees** for all services rendered and 4) proper container **maintenance and inventory** management.

The best solution to these challenges is to develop an asset management program which is based on the simple philosophy of value-added pro-active loss prevention on multiple levels. Implementing a solution which will provide accurate service verification data, insure the proper fees are charged for services rendered, and containers inventories are properly managed. Economic and environmental factors are driving innovation in the waste management industry. With mandates to reduce costs & increase revenue while meeting sustainability initiatives, it is clear that better technology such as passive wireless sensors, which can also improve customer service at low cost, is the best method to achieve these goals and is of interest to Rehrig.

1:30PM, May 21 - Day 1 **Session 3 Presentation 2**

Kaley Parkinson **"Intelligent RTI's for the Supply Chain"** **Rehrig Pacific, Los Angeles, CA**
kparkinson@rehrigpacific.com **Director, Supply Chain Technology Services**
925-360-1950 **www.rehrigpacifc.com**

Background: Kaley Parkinson is the Director of Supply Chain Technology Services at Rehrig. He has been focusing on new business development across multiple business units with Rehrig Pacific Company for the last seven years. Kaley specializes in enabling proven, commercialized technologies and applying them to specific uses in order to solve practical competitive issues and improve business practices. Combined with Rehrig's extensive experience in Reusable Transport Packaging (100 years, since 1913) he has been able to bring market changing technology solutions to the Supply Chain in multiple spaces including Cold Chain, Retail Distribution, Bulk Packaging, Beverage, Bakery, Food Service and many more. Kaley has had a widely varied career path which has seen involvement in multiple successful start-up ventures. Kaley is a graduate of the University of California, San Diego with a degree in Economics.

Abstract: The Global Business of the Supply Chain faces many obstacles; many are unique to the individual businesses they serve. Through the application of technology many of these challenges can be met and the benefits can be shared across a wide variety of channels. Some of these challenges are brought about through regulatory issues such as track and trace, chain of custody reporting; some are driven by safety concerns such as temperature and environmental factors; others still are driven by sustainability commitments; and finally there is the ever present driver of efficiency and cost reduction. The Supply Chain Business is particularly cost sensitive and emerging technology solutions that could potentially benefit the whole are often overlooked as they are deemed "too expensive" on a one way transport item such as a disposable case (corrugated cardboard) or a limited use wood pallet. These items make up a majority of secondary packaging in the worldwide supply chain and are a significant source of real dollar costs and costs in terms of carbon footprint as well. **One answer to this challenge is an RTI (Returnable Transport Item).** While the cost savings and environmental benefits resulting from the use of RTIs are significant, their adoption is often hampered by the misperception of the costs associated with loss, miss-management, and theft. With the emergence of sensor-enabled ***Intelligent RTIs*** – pallets, bins, totes and containers with integrated wireless condition and location monitoring devices the realities of these perceptions can be proven false. Additionally, their overall value to the supply chain increases dramatically with the ability to track and manage ***the condition*** **of the products** during transport – **as well as their location** – to enable a more intelligent, efficient and cost-effective supply chain. The goal is to look at better ways to adapt emerging wireless technologies to speed the adaption and effectiveness of these iRTI's. The solution will necessarily help improve freshness, sustainability, food quality and profitability by implementing proactive and exception-based decision making, prioritized routing, First Expired First Out (FEFO) inventory, and end-to-end traceability. Additionally, any solution must address asset management and utilization to reduce attrition and outage expenses. Lastly the solution should be capable of delivery management with better data access (GTIN, SSCC, tare weights, sanitation records, manifest data) and integration with existing WMS and ERP systems.

2:00PM, May 21 - Day 1		**Session 3 Presentation 3**
Chris Hough	**"Expanding Data Logger Applications "**	**TMI USA, Inc.**
chris.hough@tmigi.com		**Reston, VA**
703-668-0116		**www.tmi-orion.com**

Background: Chris Hough earned his Global MBA from Duke University. As the Director of Global sales for TMI USA, his current focus is to tie world class customer support to the long term innovation driven corporate strategy. Through Six Sigma process design, the goal is to leverage the innovation focus of an engineering led company to bend to a customer driven demand. Chris comes from a business consulting background and has been involved in a wide variety of projects including ties to the scientific community, such as designing software to isolate probability alleles in the human genome for the Human Genome Project at the National Institutes of Health, drug detection systems at Johns Hopkins University, to SAP global integration projects, as well as authoring white papers at the Central Intelligence Agency.

Abstract: Created in 1994 with the introduction of a small pressure and temperature data logger for sterilization control, TMI-Orion has since continued to innovate and to increase its offering to many industries world-wide. TMI develops and manufactures wireless high performance data loggers to measure and control a wide range of industrial applications such as food, pharmaceutical, hospitals, manufacturing, brick and tile, high heat metallurgy, automotive and aeronautical industries. We build wired and wireless, thermocouple and RTD platinum based solutions. In comparison tests we have the best known RF radio signal in many of these industries. We are interested in leveraging passive wireless technology to transmit through metal and water, as well as expand our current offerings and penetrate the automotive, aeronautical, and very high heat metallurgy and manufacturing markets.

2:30 PM, May 21 - Day 1 **Session 3 Presentation 4**

"Micro-UAV Platforms for Structural Health Monitoring and Inspection"

Usman Khan, Assistant Professor **E & CE, Tufts Univ., Medford, MA**
khan@ece.tufts.edu **http://www.ece.tufts.edu/~khan**
617-627-5299 **http://spartn.ece.tufts.edu**

Background: Usman Kahn is an assistant professor in Electrical and Computer Engineering at Tufts University. His research interests include robotics, signal processing, and sensing towards distributed estimation and control. Relevant applications are mobile/adaptive sensor networks, and autonomous UAV/ground robots. He received his B.S. from Univ of Engineering and Technology from Lahore-Pakistan in 2002, M.S. from Univ of Wisconsin-Madison in 2004, and Ph.D from Carnegie Mellon University in 2009. Most recently, Usman completed preliminary study on structural health monitoring (SHM) based on combined vibration and image data obtained from wireless accelerometers and aerial robots.

Abstract: In this talk, I will describe our recent work on autonomous aerial monitoring of critical infrastructures. The primary objective is to monitor and inspect an on-campus footbridge at Tufts, which is installed with several accelerometers and thermocouples. The current installation is based on a wired architecture and is challenged with high power consumption at the sensors (for long-distance data transfer), and frequent maintenance of the wires and other units.

Our vision is an autonomous UAV platform where a self-navigating UAV visits multiple collection-points (RFID tags) to gather data. For bridge inspection, we divide the bridge into several sub-structures and install multiple sensors at each sub-structure. Each sub-structure has one RFID tag mounted on a leader-node; the leader-node receives low-dimensional statistics computed at each sensor in its associated sub-structure, and periodically programs its RFID tag with this information. Subsequently, a UAV with an RFID read/write module visits each leader-node and reads the information from the tags.

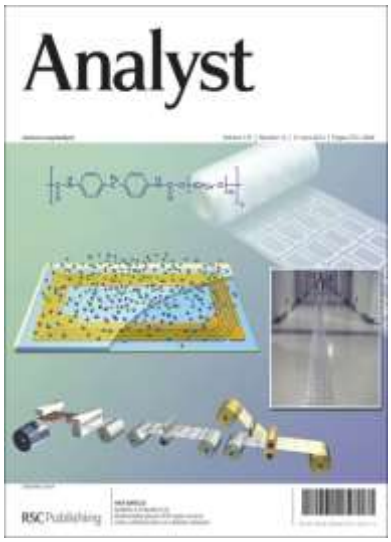
This platform has three major features: (i) The required communication, implemented between the sensors and a leader-node, is over short-distances resulting into a very low-power architecture; (ii) The UAV performs the entire operation autonomously—path planning and navigation is carried out on-board without any outside intervention; and, (iii) The automated diagnosis process at the UAV further enables the collection of additional damage-triggered information, e.g., high-sampled data, images, and videos.

Some demos are available on our lab's (Signal Processing and Robotic Networks) YouTube channel: http://www.youtube.com/user/SPARTNatTufts

3:15 PM, May 21 - Day 1 **Session 4 Presentation 1**

"Meeting Demanding Field-performance Requirements with Multivariable Flexible and Printed Gas Sensors"

Radislav Potyrailo **Principal Scientist, General Electric Global Research Center**
potyrailo@crd.ge.com **Niskayuna, NY**
(518) 387-7370 **http://ge.geglobalresearch.com/profiles/radislav-potyrailo/**



Background: Radislav A. Potyrailo is a Principal Scientist at GE Global Research Center in Niskayuna, NY. He holds an Optoelectronics degree from Kiev Polytechnic Institute, Ukraine, and a Ph.D. in Analytical Chemistry from Indiana University, Bloomington, IN. His research interests include functional nanomaterials, bioinspired photonics, and wireless sensors. Radislav has 150+ publications and 75+ granted US Patents. He gave 60+ invited and several keynote lectures on national and international technical meetings. He serves as an editor of the Springer book series *Integrated Analytical Systems*, Consulting Editor of *ACS Combinatorial Science,* and Editorial Board Member *of Sensors*. Most recent awards include 2010 Prism Award for photonics innovation by SPIE and 2012 Blodgett Award by GE Global Research for outstanding technical achievements. In 2011 Radislav was elected SPIE Fellow for achievements in fundamental breakthroughs in optical sensing and innovative analytical systems.

Abstract: Selective field detection of diverse gaseous analyte species remains an unmet goal with existing sensors and sensor arrays because of the need for detection of analytes in the presence of numerous interferences. Our R&D is focused on the development of multivariable sensors to boost selectivity of individual sensors against chemical interferences (e.g. background vapors) and physical interferences (e.g. temperature), to reduce or eliminate sensor aging effects, and to bring these sensors to demanding applications outside the pristine laboratory conditions. Our gas-detection strategy is based on multivariable sensors that utilize flexible and printed resonant devices as well as lithographically-fabricated resonant devices. We will discuss current performance characteristics of developed sensors that include ppm – ppb – sub-ppb detection sensitivity, rejection of high levels of interferences, and quantitation of individual vapors in their mixtures. We will further discuss results of our recent pilot-scale roll-to-roll manufacturing of flexible gas sensors, present examples of our sensor developments for food safety, bioanalytical, industrial, and homeland security applications, and provide critical analysis of the remaining challenges of gas sensing using passive sensors.

References: **1.**Potyrailo, R. A.; Surman, C.; Nagraj, N. N.; Burns, A., Materials and Transducers Toward Selective Wireless Gas Sensing, *Chem. Rev.* 2011, *111*, 7315–7354. **2.** Potyrailo, R. A.; Surman, C.; Monk, D.; Morris, W. G.; Wortley, T.; Vincent, M.; Diana, R.; Pizzi, V.; Carter, J.; Gach, G.; Klensmeden, S.; Ehring, H., RFID Sensors as The Common Sensing Platform for Single-Use Biopharmaceutical Manufacturing, *Meas. Sci. Tech.* 2011, *22*, art. no 082001**.** **3.**Potyrailo,R.A.; Nagraj,N; Surman,C.; Boudries,H.; Lai,H.; Slocik,J.M.; Kelley-Loughnane,N.; Naik,R.R., Wireless Sensors and Sensor Networks for Homeland Security Applications, *Trends Anal. Chem.* 2012, *40*, 133-145**.** **4.** Potyrailo, R. A.; Nagraj, N.; Tang, Z.; Mondello, F. J.; Surman, C.; Morris, W., Battery-free Radio Frequency Identification (RFID) Sensors for Food Quality and Safety, *J. Agric. Food Chem.* 2012, *60*, 8535-8543.

3:45PM, May 21 - Day 1 **Session 3 Presentation 2**

"Passive Wireless Sensing Powered by Chameleon™, a Self-Tuning Technology"

Shahriar Rokhsaz **Pres. and CEO, RF Micron**
(512) 535-4647 **Austin, TX**
shahriar.rokhsaz@rfmicron.com **www.RFMicron.com**

Background: Dr. Rokhsaz served as consultant to several companies, including Advanced Micro Devices, from 1995-1996. He joined Sigmatel Inc (public since 2003) as the 8th employee, where he successfully developed, designed and led the IRDA infrared transceiver product in to production. In 1999, he joined RocketChips Inc. which was later acquired by Xilinx for $300M. At Xilinx Dr. Rokhsaz led the 10Gb/s serializer and de-serializer (SERDES) program. The architecture developed under his technical leadership was later integrated in to Xilinx's FPGA with 10Gb/s serial ports. This product has since produced over $100M of revenue for Xilinx. During his tenure at Xilinx, in 2001, Dr. Rokhsaz joined University of Texas in Austin as an adjunct professor while active in the area of research with the University of Texas A&M.

Since 2007, he has consulted with several venture capital companies on technical viability of patents and technologies. Dr. Rokhsaz received his Ph.D. in the area of analog circuits and systems in Dec 1998 from Oklahoma State University. He holds over 30 granted and pending patents and has co-authored numerous journals and conference papers.

Abstract: Chameleon™ is a "self tuning" technology that allows the tag to automatically and precisely adapt to the correct geographical frequency and compensate for its surrounding interference (i.e. the item it is attached to). RFMicron has developed a new circuit embedded into a standards-compliant RFID chip that allows the chip to re-tune itself to adjust for environmental changes that would normally disrupt RF communications. That characteristic – adjusting to the environment – can be logically reversed and used for sensing. Devices using the chip can be designed so that a variety of different properties can be sensed. A first product, a simple moisture-humidity sensor, has been prototyped and will be shown along with initial characterization results. Read more at http://www.rfmicron.com/solutions/

5:15PM, May 21 - Day 1 **Session 4 Presentation 3**

Cindy Hartnett **"Physical Switch Sensors"** **University of Louisville, KY**

cindy.harnett@louisville.edu **Associate Professor, E and CE**

(502) 852-0689

Background: Cindy K. Harnett is an associate professor of Electrical and Computer Engineering at the University of Louisville. Her research interests focus on flexible micro-electromechanical systems (MEMS), micro-fluidics, and ultra-low-power sensor networks for environmental science, biomedicine, aerospace and other applications. She received her Ph.D. from Cornell University in Applied and Engineering Physics in 2000, her B.S. in physics from Harvey Mudd College, and worked at Sandia National Laboratories (California) in Microfluidics from 2001 to 2005.

Abstract: Power consumption has to be considered at the beginning of the sensor design process for passive wireless sensors. Pervasive, low-maintenance, battery-free wireless sensing will be realized with sensor elements that match the power resources of RF-powered and other energy-harvesting systems. This presentation will discuss the development of electro-mechanical switches on flexible substrates. The goal is a passive wireless sticker that can monitor the shape of deployable structures in aerospace applications. These bi-stable devices hold their state without power, so they can report on the shape of a structure even if polling rates are slow because of energy harvesting system constraints.

Topics to be covered are:

- Design rules for creating these bi-stable sensor elements for a given bend angle/size/weight range.
- A power-efficient method for scanning these flexible switch arrays with the microcontroller on WISP, a RFID-based sensor platform.
- MEMS and larger-scale fabrication methods for these devices.
- Algorithms for reconstructing a shape from an array of digital switch states.

8:00 AM, May 22 - Day 2 **Session 5 Presentation 1**

Don Malocha

"Passive Wireless Sensor Technology: Today & Tomorrow"

donald.malocha@ucf.edu **E & CE, University of Central Florida, Orlando**

407 823-2414 **http://caat.engr.ucf.edu**

Background: Donald C. Malocha is a Pegasus-Professor in the Electrical and Computer Engineering Dept., University of Central Florida (UCF), Orlando. Don received a joint BS in EE & CS, an MS in EE, and Ph.D. in EE from the University of Illinois, Urbana. He was member of the technical staff (MTS) at Texas Instruments Corporate Research Laboratory, Mgr. of Advanced Product Development, Sawtek, and an MTS at Motorola. He has been a Visiting Scholar at the Swiss Federal Institute of Technology, Zurich (ETH), Switzerland, and the University of Linz, Austria. He is a member emeritus of the Electronics Industries Association (EIA) and was a member of the Board of Directors of Piezo Technology, Inc. until merged as Mtron-PTI. He has and does have active leadership roles in IEEE-UFFC. He serves on the Technical Program Committees (TPC) of several major Technical forums. He has over 200 technical publications, 12 patents awarded, and several pending and has numerous awards to his credit. Don is a Fellow of the Institute of Electrical & Electronics Engineers (IEEE). His current research interests include solid–state devices, surface acoustic wave (SAW) and bulk acoustic wave (BAW) technology, sensors and wireless radio frequency identification systems. He is advisor for 37-MS and 19-PhD current or former students.

Abstract: This presentation will discuss SAW passive, wireless multi-sensor systems(PWS) under development for the past several years at the University of Central Florida. Several 915MHz orthogonal frequency coded(OFC) SAW multi-sensor systems are presented; including experimental data. The OFC SAW sensors, using both frequency diversity and pulse position reflectors to encode the device ID, and will be briefly contrasted to other embodiments. The transceiver hardware implements an asynchronous correlator approach, and post-processing and matched filter techniques of the received signal are used to extract the sensor information. Critical device and system parameters addressed include encoding, operational range, SAW device parameters, post-processing, and antenna-SAW device integration. The system is based on a software radio approach that provides great flexibility for many sensor types, future enhancements and diverse applications. Initial work on orthogonal frequency coded (OFC) SAW devices for RFID and communication began in 2000, and the first publication on SAW OFC was in 2004. The implementation of OFC in a SAW structure provides the greatest flexibility in time, frequency and code diversity. This adaptability has advantages in a multi-sensor system for identification and sensor accuracy, which will be presented. The device and systems to be discussed are based on an operational center frequency of 915MHz. The 5 chip OFC reflectors are used for encoding each device on YZ LiNbO3 and the devices are connected to a folded dipole antenna for reception and re-transmission of the interrogation signal. Several sensor types using the OFC SAW platform will be presented and videos will be shown demonstrating a variety of sensors, including temperature, closure, ranging, and room-temperature, rapid-reversible, hydrogen gas sensing; all using the same transceiver. Recent NASA-KSC test results of delivered sensors and systems will also be included. PWS SAW technology has verifiable operational prototypes, and integration into applications is beginning. Future work and projections for the PWS technology regarding frequency, bandwidth, range, applications, transceivers, and system hardware will be discussed.

11:00AM, May 22 - Day 2		**Session 5 Presentation 2**
Jackie Hines	**"PWST SAW-Sensor Systems"**	**President, ASR&D Corp**
jhines@asrdcorp.com		**Arnold, MD**
410-544-4664		**www.asrdcorp.com**

Background: Jackie Hines received her BS from Cornell and a M.S. & Ph.D in from the University of Central Florida. Jackie served on active duty in the U.S. Navy from 1984 though 1988 as an instructor at the U.S. Naval Nuclear Power School in Orlando FL and in the Reserves achieved the rank of Lt. Commander. At Sawtek, Jackie established and managed a SAW-based chemical sensor with ARPA and DOE support which was demonstrated at DOE's Savannah River Site in June 1998. It was capable of detecting, identifying, and quantifying volatile organic chemical vapors alone and in mixtures of up to two vapors plus water. Jackie served as Sawtek's Manager of Research and Development for over 10 years until she left to found her own consulting company in 2000. In August of 2005, having served as PI on two NASA contracts, Jackie founded Applied Sensor Research & Development Corporation to commercialize passive wireless acoustic wave sensor technologies. Located outside Annapolis, Maryland, ASR&D is an application engineering and contract research firm specializing in innovative chemical, biological, and physical acoustic wave sensor technologies for government and industrial clients. Jackie has been active in a wide range of professional activities, and currently serves as President of the IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society (UFFC-S).

Abstract: This presentation describes the development, operating principles, and experimental operation of a set of uniquely identifiable, wirelessly interrogable, passive surface acoustic wave (SAW) temperature sensors, and a prototype wireless interrogation system capable of reading the set of sensors and interpreting individual sensor responses. Using a combination of time diversity, frequency diversity, and chirp responses, a set of 32 individually identifiable temperature sensors were produced. When installed within specified configuration limits, the wireless interrogation system allows interrogation of the sensors in four groups of 8 sensors, or combinations thereof, simultaneously identifying and tracking the temperature of each sensor individually. The system also identifies sensors in the target group that are missing from the field of view. The transceiver utilizes a software-radio-based interrogation system architecture. The system operates in a semi-automatic mode, with sensor group selection and calibration requiring user interaction, and utilizes a PC-based LabView user interface for data acquisition and system control. This system was delivered to Marshall Space Flight Center and demonstrated last week, and a duplicate system will be demonstrated at the PWST workshop.

9:30 AM, May 22 - Day 2		**Session 5 Presentation 3**
Joshua Zepess	**"Bulk Acoustic Wave Sensors"**	**TriQuint Semiconductor, Inc.**
josh.zepess@tqs.com		**Bend, OR**
541-382-6706		**www.TriQuint.com**

Background: Joshua Zepess received his B.S.E.E. from the University of Central Florida in 1999 and M.B.A. from Concordia University in 2008. At the time, he worked as a thin film Process Technician for Sawtek, Inc. Upon graduation, he worked with Microsensor Systems Inc. on the streamline manufacture of a broad range of SAW-based hand-held sensor instrumentation used in Hospital and Military applications. Josh continued his acoustic training and developed his expertise as a SAW Design Engineer for TriQuint Semiconductor in 2001, creating next-generation filters for the mobile handset market. He seized upon an opportunity in 2005 when TriQuint acquired TFR Technologies Inc, a leading custom BAW filter manufacturer, to assist in the technology and knowledge transfer to TriQuint. He was able to briefly study under Ken Lakin and Kevin McCarron in BAW acoustics before becoming the Filter Design Manager for Defense Products within TriQuint in 2006. He has since expanded his design organization to include all filter designers for Infrastructure and Defense Products. He has two patents and has written several papers in the SAW and BAW acoustics field.

Abstract: Contributors: Joshua Zepess, Leonard Simpson, Kevin McCarron, John Belsick Bulk Acoustic Wave (BAW) devices are well-known for producing very small, high-performance filters. It is believed that the same characteristics of BAW devices that make them excellent filter choices also make them very applicable to the field of miniature high-sensitivity sensors. This discussion will describe those characteristics and how they may apply to high levels of sensitivity and extremely small size in both dry and aqueous-analyte sensor systems. While there remains much research to be done in the use of thin-film BAW resonators as sensors, we hope to set the stage for further exploration of its possibilities.

10:15AM, May 22 - Day 2 **Session 6 Presentation 2**

Victor Plessky

"Ultra-Wide Band SAW Sensors and Tags"

victor.plessky@gmail.com **Owner/Director, GVR Trade SA - Gorgier, Switzerland**

+41 32 8463039 **www.gvrtrade.com**

Co-Authors: M. Lamothe, V.Plessky, T. Ostertag, J.-M. Fried, and S. Ballandras

Background: **Prof. Victor Plessky** has worked in the field of SAW technology for more than 30 years. He is known as one of the authors of the STW (surface transverse waves), and as the author of the so called "Plessky equation" describing the dispersion of leaky SAWs in periodic gratings, presented by paragraphs in D. Morgan and K. Hashimoto books on SAW technology. Currently V. Plessky is developing high performance SAW-ID tags and sensors. In total he has published about 200 papers on SAW and authored more than 20 patents. Prof. Plessky has been Visiting Professor for many years in HUT, Helsinki, in Uppsala University, in EPFL, Lausanne, and in Freiburg University. During years 2010-2012 worked at FEMTO, Besançon, in the project "Chaires d'excellence" dedicated to the development of UWB SAW devices. He has supervised 15 Ph.D. theses. From 2003 he is an owner and director of the consulting company, GVR Trade SA(Gorgier, Switzerland) which is active in design of SAW devices, software development, consultations, etc.

Abstract: SAW tags and sensors often operate in 2.45 GHz ISM band using relatively narrow frequency Band = 82.5 MHz available there. The characteristics of SAW tags and sensors can be improved using the ultra wide band (UWB) technology. We have developed the prototype devices operating in 2000MHz - 2500MHz UWB frequency range. The UWB reader operating in continuous wave radar regime developed and manufactured. The first remote measurements has shown that we get compressed RF pulses of about 2 ns duration, which include unique RF filing of a few sinusoids with amplitude modulation. The precise measurement of the pulse position is possible by correlation methods, avoiding the phase ambiguity problem. The precision of the temperature definition of 0.1 °C can be obtained. Only 2 reflectors are necessary for such a sensor. The correlation method works even in multi-path environment with strong reflections form metal objects. The short compressed pulses allow measuring a number of sensors simultaneously just separating them in time. For the tag application at least 100 tags can be identify simultaneously in a limited temperature range $\Delta T < 100°C$. For such limited number of tags there is no "collision" problem.

The development by GVR of high-Q SAW resonators for sensors will be also briefly presented. The perspectives of SAW-tags operating in 5GHz- 6GHz frequency range will be discussed.

10:45AM, May 22 - Day 2		**Session 6 Presentation 2**
Ali Abedi	**"Smart Interrogators"**	**University of Maine, Orono, ME**
ali.abedi@maine.edu		**Wisenet Lab, Professor & Director**
207-581-2231		**http:// wisenet.eece.maine.edu**

Background: Ali Abedi received his PhD in Electrical & Computer Engineering (ECE) from University of Waterloo, Canada in 2004. He is currently Associate Professor of Electrical and Computer Engineering with joint appointments at School of Computing and Information Sciences at the University of Maine. He serves as Director of WiSe-Net Lab as well as Director of Center for Undergraduate Research at UMaine. He is also Guest Researcher at National Institute of Standards and Technology (NIST) and was visiting Professor at the University of Maryland, College Park, MD (2012), and Queen's University, Kingston, ON (2004). His research includes analytical performance evaluation of high performance codes for wireless networks and wireless sensing for aerospace and biomedical applications. Dr. Abedi is Co-founder of two startup companies: Activas-Diagnostics and Navindor, and author/Co-author of 4 books and over 70 journal and conference publications. He received a number of awards and recognitions from NSERC, JSPS, CSA, IEEE, IET, and NASA. Dr. Abedi is a member of Editorial board of Wireless Sensor Systems Journal, High Frequency Electronics, and Cyber journals. He is currently a senior member of IEEE and serves on IEEE Center for Leadership Excellence Committee, Chairs IEEE Int'l Conference on Wireless for Space and Extreme Environments (WiSEE 2013) and is one of the candidates for IEEE Board of Director in 2013.

Abstract: Wireless Sensor Networks can play a crucial role in transforming our society to be more energy efficient, provide us with new tools for scientific research, and enable an array of new safety and security applications for increased quality of life. One of the major hurdles in wide spread use of wireless sensing is limited available resources including power and spectrum. In this presentation, we review the paradigm changing cooperative cognition concept in the context of wireless sensing. The objective of this new approach is to efficiently use idle spectrum while allocating optimum power to interrogators. Smart interrogators can operate in licensed spectrum as long as they do not interfere with primary users. Statistics shows that license spectrum is idle over 70% of the time, which makes this approach even more attractive. Imperfections in sensing the spectrum whole and time synchronization issues have prevented usage of such cognitive schemes in the past. However, if we allow interference to happen and instead use secondary users as relays for primary owners of the spectrum, these technical issues can be addressed and overall system performance will be significantly improved. Methods of game theory can be used to model and analyze these systems and the associated networks. Efficient spectrum utilization enables a tradeoff between performance and latency in the network, which translates into higher data rates with less power consumption in wireless sensor systems.

11:15AM, May 22 - Day 2		**Session 6 Presentation 3**
John Peeters	**"NFC Sensors"**	**Gentag, Inc.**
john.peeters@gentag.com		**President and CEO**
240-994-2236		**www.Gentag.com**

Background: Dr. John P. Peeters currently is the President, CEO and Founder of Gentag, Inc. (www.gentag.com) a start-up company focusing on low cost, low power ubiquitous wireless sensor networks for cell phones based on Near Field Communication (NFC) technology. Prior to starting Gentag Dr. Peeters worked at the US Department of Energy. Dr. Peeters is an expert on biomarkers, sensors and nanotechnologies and has worked at or in collaboration with several of the US National Laboratories, the US Government, the US National Academy of Sciences and the United Nations. Dr. Peeters holds 20 issued sensor patents including the first nanotechnology patent describing organic-inorganic interfaces for single biomolecules (electronic antibodies). John obtained his Ph.D. from Cambridge University in England, a Masters in Genetics from the University of British Columbia and an Honors Bachelor of Science degree from the University of Massachusetts (USA), where he graduated Magna Cum Laude and with Honors.

Abstract: Near Field Communication (NFC) is a low power wireless technology that is being incorporated into all major brand cell phones. The technology is suitable for a variety of low cost passive (battery-less) sensors forming a completely new class of disposable wireless sensors for physical, chemical and biological applications. NFC presents significant advantages over Bluetooth and other sensors that require a battery. For example the technology is suitable for ultrathin diagnostic skin patches and a variety of printable sensors for food safety, smart labels and even advanced medical diagnostic sensors.

NFC sensors paired with smart diagnostic skin patches could transform the way healthcare is delivered globally. Hospital discharge patients could be closely monitored from the moment they leave the hospital, thus lowering readmissions and the costs associated thereof. Illness onset could be detected much more rapidly. Low-cost health monitoring solutions for those in developing countries could be deployed with relative ease. A robust ecosystem of this technology could provide large data sets that could help improve outcomes and lower medical costs worldwide.

This presentation will describe some of these applications and the likely impact of NFC on consumer and health markets, M2M, "Big Data" and the Internet of Everything (IoE).

11:45AM, May 22 - Day 2 **Session 6 Presentation 4**

Nick Keim **Chemical Propulsion Information**
443-718-5005 **Analysis Center, Johns Hopkins University**
nkeim@cpiac.jhu.edu

"JANNAF Joint Sensors Database"

Background: Nick Keim is the technical liaison for the Joint Army Navy NASA Air Force (JANNAF) Modeling & Simulation (MSS) and Exhaust Plume & Signatures (EPSS) Subcommittees. Nick received his B.S. in mechanical engineering from The Johns Hopkins University in 2005 and his MS in ME at Imperial College London in 2006. At the Johns Hopkins University Chemical Propulsion Information Analysis Center (CPIAC) he serves as an advisor to JANNAF Technical Steering Groups (TSGs) and panels, including the Joint Integrated Health Management (IHM) and Engine Health Management (EHM) Panels. Nick is currently working on the JANNAF-led Joint Sensors Database project.

Abstract: The Joint Sensors Database project grew out of a series of JANNAF workshops on sensors dating back to 2007. In 2013 the project was jointly funded by AFRL, NASA MSFC, GRC, and the DoE NETL. The goal of this database is to collaboratively collect and share detailed information on available and in-development sensors with applications to propulsion, energetics, and energy production systems. In addition to information on a given sensor, known applications of each sensor will be included with documentation of sensor performance and results. The database will be used to locate and compare available sensors but also to identify sensing technology gaps and share implementation knowledge. The database is currently under development. This presentation will give the background for the database, progress to date, and seek feedback on the types of data to be collected in order to ensure that the final product is a useful tool for the sensor community. With additional support, the potential exists to expand the database to the sensor community outside JANNAF to ISA and other sensor users and developers as well.

1:00PM, May 22 - Day 2 **Session 7 Presentation 1**

Corey Jaskolski **President**
cjaskolski@hydro-tech.com **Hydro Technologies, Inc, Windsor, CO**
970-686-6200, 970-672-6616 **www.hydro-tech.com**

"Passive Sensing through Metal Barriers"

Background: Corey Jaskolski is the founder and president of Hydro Technologies, a small engineering firm focused on developing enabling technologies for subsea and surface sensing as well as communications applications. Hydro Technologies has been active in: the development of a through metal barrier communications system, a multi-path immune acoustic modem, testing and evaluation of power systems for SOCOM special forces applications, a data acquisition system for the Advanced Arrestor Gear used for landing aircraft on carriers, and a series of sensor devices deployed in some of the worlds harshest environments including the face of Mount Everest. Mr. Jaskolski is the National Geographic Innovation Fellow and provides technical guidance and custom imaging hardware for ongoing National Geographic projects around the world.(see http://www.nationalgeographic.com/explorers/bios/corey-jaskolski/). Corey completed his B.S. in Mathematics and Physics at the University of Wisconsin and his M.S. in Electrical Engineering at the Massachusetts Institute of Technology. While enrolled in the M.S. program, Mr. Jaskolski also worked at Bluefin Robotics where he led development of the first pressure tolerant subsea battery packs and supported the development, global distribution, and deployment of these batteries including descending with these batteries to the wreck of Titanic on a 3-man submersible (12,500' deep). Mr. Jaskolski was also Director of Technology at the National Geographic Society where he led the team that developed imaging technologies including animal-borne systems that logged video, acoustic, accelerometer, and water parameter data and were deployed on over 30 marine species including Great White sharks and many species of whales.

Abstract: One of the primary challenges with wireless sensing in general, and passive sensing specifically is the difficulty presented by conductive barriers. RF based passive sensing can be entirely prohibited by even very thin metal barriers. In contrast, using magnetic based passive sensing coupled with techniques to cancel out undesired signals, due to locally induced eddy currents, allows for passive sensing through metal barriers of significant thickness. Through these techniques, it becomes possible to passively sense pressure, temperature, strain, and other parameters through metal barriers, which enable applications such as high pressure high temperature (HPHT) oil and gas sensing through pipe walls, sensing temperature through sealed containers, such as nuclear waste storage vessels for long term monitoring or cargo shipping containers for tamper detection in Homeland Security applications.

1:30PM, May 22 - Day 2 **Session 7 Presentation 2**

Patrick Jordan **"Wireless Sensing for Survivable Machinery Control"**

Patrick.Jordan@3Phoenix.net **Dir of Surface Sonar Systems, 3Phoenix, Inc**

(730) 956-6480 **http://3phoenix.com Chantilly, VA**

Background: Patrick Jordan is Director of Surface Sonar Systems at 3 Phoenix, Inc. in Chantilly, VA. He has over 20 years of engineering experience in aircraft simulation and sonar system development. He was the principal engineering at Lockheed Martin for sonar power system design and Senior Engineering Manager at Rockwell Collins for aircraft simulations. He currently works at 3 Phoenix, Inc. on sonar applications for both the military and commercial use. 3 Phoenix, Inc. is an engineering small business focused on providing innovative technology solutions to the Department of Defense and our industry partners. 3 Phoenix's core competencies include: Real Time System Architecture and Design; Passive and Active Sonar Signal Processing; Telecommunications and Embedded Design; Open Architecture Computing Environment Practices; Program Management and Financial Management. He has a B.S. in Mechanical Engineering from the University of Maryland.

Abstract: Among the Navy's goals for new ship construction are to achieve cost savings in ship installation, to increase survivability of the vital communications infrastructure, and to enable manning reductions through highly automated ship operations. The rapid advancements and proliferation of wireless technology makes it a primary candidate for adaptation to machinery health monitoring and total ship control systems in support of these objectives. A wireless sensing system designed for these purposes should consist of intra-compartment data communications (within a physical partition or logical node group), inter-compartment data communications (compartment to compartment), and aggregate data bandwidth for the entire control system. The particular challenges that must be addressed to enable wireless sensing and control in the shipboard environment are communications through and around steel ship compartments, secure software architectures for distributed control, and minimizing power requirements to enable the application of emerging parasitic or energy scavenging power technologies. Working on a research topic with the Office of Naval Research (ONR) on Wireless Sensing Technology, 3 Phoenix, Inc. (3Pi), with the support of North Carolina Agriculture and Technology (NCA&T) State University, has developed key technologies that address these challenges. The 3 Phoenix team has demonstrated the ability to communicate through steel at 5 Megabits per second (Mbps) using a prototype Ultrasonic Acoustic MODEM (UAM) along with demonstrating the ability to transfer Power-Through-Steel (PTS). The PTS demonstration produced 5 volts DC at 250 milliamps with an efficiency of over 60%.

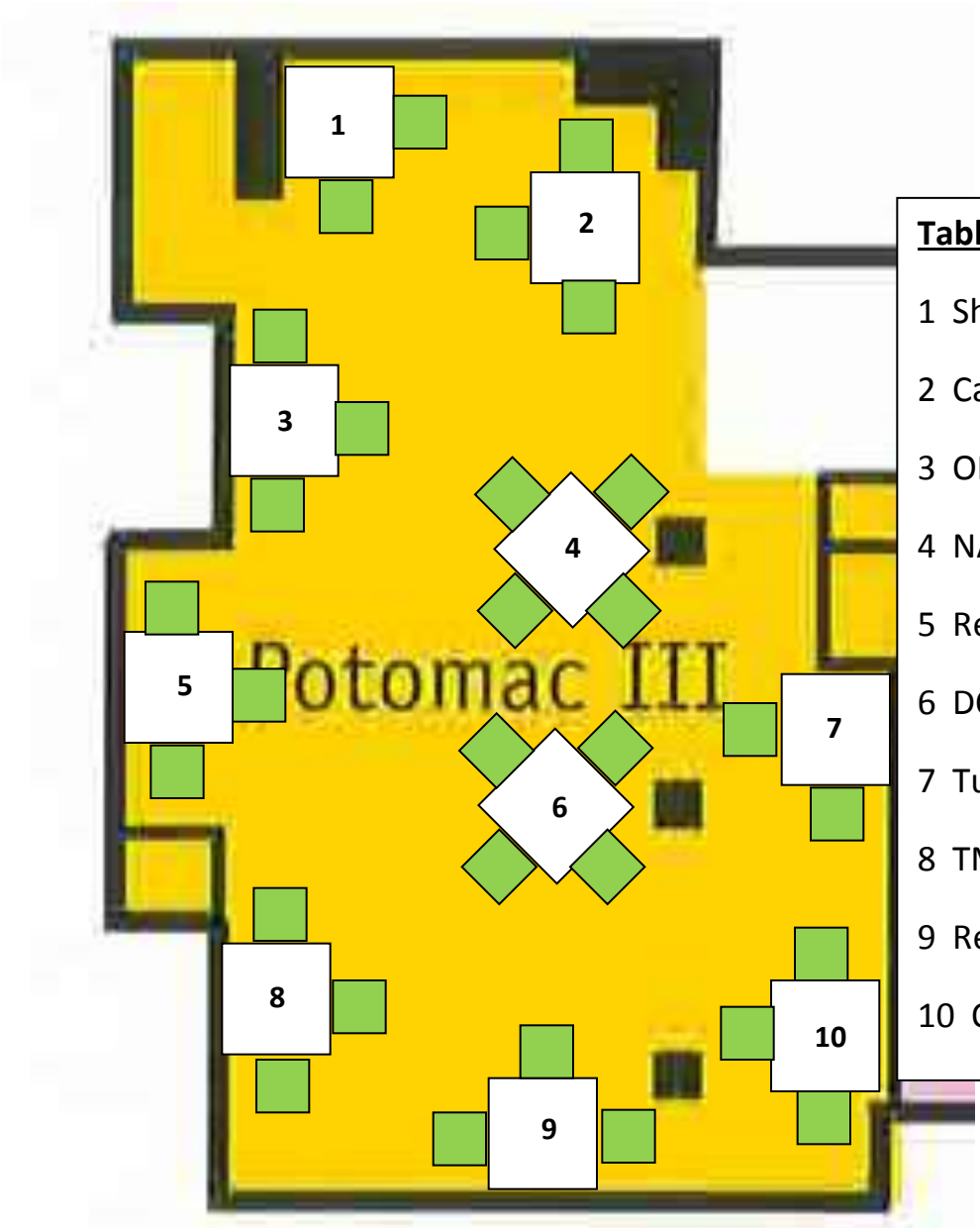


Table - End User

1 Shell

2 Canadian NRC - IVHM

3 ORNL Wireless Research

4 NAVAIR - TDA

5 Rehrig Supply Chain

6 DOE Low $ Meter Challenge

7 Tufts Univ: micro-UAVs

8 TMI Data Loggers

9 Rehrig Solid Waste Cont.

10 On-Ramp Wireless

Passive Wireless Sensor Workshop One-on-One Session

Patomic III

Configuration May 22 Session 8 (3pm-5pm)

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<tr><td colspan="2">Tuesday May 21</td><td colspan="2">Wednesday May 22</td></tr>
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